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2019

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ARCHAEOLOGY OF THE INDUSTRIALISATION AND SOCIAL DEVELOPMENT AT A SILVER MINE IN THE GREATER PRETORIA REGION FROM 1889 TO 1927

Graham Walter Reeks

A thesis submitted to the Faculty of Science, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Doctor of Philosophy

Johannesburg 2019

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DECLARATION

I declare that this thesis is my own, unaided work. It is being submitted for the Degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination at any other University.



Graham Walter Reeks

_28th day of August, 2019

ABSTRACT

South Africa is a land in which mining has played a pivotal role over the last one hundred and fifty years. Silver was one of the metals prospected for and mined during the 1885-1895 period. There were a few silver mines that developed into very successful operations and produced large tonnages of argentiferous lead or copper and the largest of these, and the primary focus of this thesis, was the mine now referred to as the Argent silver mine.

This thesis is about the development of mineral beneficiation technology, coupled with excavations and the analysis of the lifeways of the black mine workers at the Argent mine. I intend to follow the trend taken by some archaeologists over the last ten years for such sites in both the UK and the USA and combine an industrial archaeological study with the social or historical archaeological study. This holistic multi-disciplinary approach to industrial or mining sites and their communities helps to provide a more integrated analysis of humans and technology at a particular site (Norris 2009; Ford 2011; Tumberg 2012; Cowie 2015).

The Argent Silver Mine appears to have been at the forefront of new and developing mining beneficiation technologies, both in the 1890s and the 1920s. This thesis will show how many of the new beneficiation technologies were apparently employed at the Argent mine before being brought into more general use in other mining industries, such as gold, in South Africa.

The social development of South Africa's black people, from the late nineteenth century, has been one of repression and enforced living conditions. From a formerly agrarian and rural lifestyle they became cogs in the wheels of industrialisation and foremost in this industrial jump, was the mining industry. Mining began in the 1870s with diamonds at Kimberley and gold at Pilgrim's Rest in eastern Mpumalanga. It was, however, the finding of gold on the Witwatersrand that opened up so many mining industries, of which silver mining was but one, coupled with ancillary engineering support industries. It was this industrialisation that was to change black lives forever and to create the urban black populations of South Africa today. The results of this thesis provide evidence of their lifeways and potential employment positions on a silver mine.

DEDICATION

This special dedication is to my wife Glynn, my partner of 39 years. We have been on many journeys together over the years. She has been my anchor when things went wrong in my career as an engineering project manager, but she was also so supportive when I had successes in that career. It was Glynn who drove me to study again in 2000 - “do it for fun” she said. It took a while, then gentle and not so gentle prodding for me to take the plunge, signing up to study archaeology and history at UNISA. The results after all of the eighteen years since then are a BA, BA (hons), and an MA cum laude and now this thesis.

Glynn is not normally a field person, but on one occasion when most of my team had to cancel for the day, she stepped in, and helped me finish excavating one of the foundations of a structure. Her encouragement and help has been amazing. Her most important role for me has been that of editor and proof reader. Her hours of conversations on ways to improve the text of this thesis have strengthened the final product, even though at times it has seemed ‘why’? It is to her that I owe such a big than you for helping me over the years with my studies and especially with the final product - this thesis. Glynn I owe you so much that the words “thank you”, do not seem to convey the depth of my gratitude and love.

ACKNOWLEDGEMENTS

I would like to express my deepest thanks to Professor Karim Sadr of the Archaeology Division of the School of Geography, Archaeology and Environmental Studies (GAES) at the University of the Witwatersrand. In 2015 he was head of the GAES department and when I approached him with the concept of the study towards a doctoral degree, he was extremely positive and supportive. I also wish to thank my supervisor Professor Amanda Esterhuysen of the Archaeology Division, for her positive support, discussions, guidance, patience and comments on the chapters, I would also like to thank her for the financial support through a bursary which has allowed me to complete this thesis.

I would also like to thank Mr Paul den Hoed, Senior Lecturer at the University of the Witwatersrand School of Chemistry and Metallurgical Engineering and visiting Professors Rodney Jones of Mintek, and visiting Adjunct Professor Marek Dworzanowski for their involvement over many meetings to discuss the beneficiation processes and machinery of the two time periods. I would also like to thank them for taking time to visit the remains of the Argent mine with me and for later supporting me at a meeting of the Mineralogical Association of South Africa (MINSA) in 2018, when I presented a talk on the history of the silver mines of greater Pretoria.

When I was investigating the use of reinforced concrete in the construction of the Beneficiation plant and associated structures during 1919-20, I approached the SA Reinforced Concrete Engineers Association. I would like to thank Mr Jeffery Thomas of the Association for the helpful discussion on reinforced concrete and he presented me with a book on Structural Concrete in South Africa by Fredman (1964). I also approached Senior Lecturer Dr Mike Otieno in the School of Civil and Environmental Engineering at the University of the Witwatersrand and received additional guidance as to the earliest known use of reinforced concrete in South Africa.

The research for this thesis was begun before I even began my MA degree in 2009. It consisted of collecting and collating documents from archives, mining companies and libraries. As is often the case, much of the company and archival documentation is of little or no use within the constraints of the approaches, both for my MA and for this thesis.

However, without certain people I would not have been able to locate and copy the documents that I have, and I thank all for their help.

During the three years of this project I have been asked to lead outings to the Argent mine and discuss the importance of the archaeological remains of the Argent silver mine. I have led an outing for the members of the SA Archaeological Society and was chosen to lead a field excursion for the South African conference of the International Mineral Association IMA in 2015. I wish to thank the respective committees for involving me in their activities and allowing me to showcase my work on the Argent mine.

Various staff members in the Audio Visual Library within the UNISA Library helped me with the microfilms of the 1890s newspaper the *Standard and Diggers' News.* Similarly various staff members at the National Archives of South Africa in Pretoria helped me locate documents and, most importantly the negatives of the four photographs of the damage done to the TSM buildings during the Anglo-Boer War 1899-1902. Of particular importance to this thesis was the photograph of the concentration plant.

The major source of documents covering the TSM mine reside in the Barlow Rand Archives in Sandton, Johannesburg. This valuable collection of original mining company documents and letter books has provided me with weeks of exciting searching, reading and transcribing. Without this as a source, I would not have been able to produce the history of the TSM for my MA and the technological details of the beneficiation plant and production figures and costs for this thesis. I must thank Julia Woolcott who at the time of my final research at the archive some three years ago was the Legal Librarian.

The Argent mine is located on the farm Dwarsfontein in the district of Delmas. A new owner took over the property in 2015, just as I was beginning my preliminary research for this project. Initially I was worried about access and restrictions on excavations. I met the current owner, Mr Bertie Truter, and after telling him about the history of the mine and its importance, he granted me permission to visit whenever I wanted to and I want to thank him for that. I also met his farm manager Mr Wessel Badenhorst, who lives in one of the original 1920s mine management houses. He has been most helpful over the years, granting me access to visit and excavate whenever I phoned him for permission.

Back copies of the *SA Mining Journal* from 1890 – 1919, and the *SA Mining and Engineering Journal* from 1894-1927 were read from cover to cover and apart from a great deal of historical data on the Argent mines, of importance to this project was the technological data on the 1920s beneficiation plant and photographs of the plant which have been used in this thesis.

Several years ago, a geologist friend at Gold Fields who sadly has now passed away, allowed me to borrow the *Transvaal Silver and Base Metals* Company files of Argent and these provided significant details on the beneficiation plant in the 1920s, as well as substantial details on the quantities of or raised bullion produced and associated costs and profits.

During the preliminary survey of the mine site, José Clara, a good friend through the SA Archaeological Society, helped me with the survey of the surface workings and the proposed excavation areas of the two 'compound' areas. Through José, and his contacts, we obtained three days free satellite connection time which allowed us to complete a satellite survey of virtually the entire Argent mine site. He also helped with mapping software, the production of the excavation site layout and geo-referenced mapping. Once I had received the permit from SAHRA, José also helped survey and position the nine permanent ground beacons, which we concreted into the ground at specific points with the farm manager's permission. I must also thank the satellite connection company, OmniSTAR (Cape Town) part of Trimble Navigation Technology SA (Pty) Ltd, and in particular Zuhayr Harricombe, who facilitated the connection. Aerial photographs - geo referenced orthophotos - were supplied by Julile Sihlangu of the Rural Development Department, Cape Town.

During the excavations, which took place over weekends, I had a number of people helping me at different times. Most were post graduates in archaeology. A very big "thank you" to the following people – past students with me at UNISA – Karin Scott, Heidi Fivas, Rina Faria, Benjamin Dacca, Johan Smit, Romy Parsons, Jaco van Dyk, Mariette Harcombe and her husband Etienne. Also to Law Pinto and Hilary Geber from Wits and the SA Archaeological Society, Michele Joubert from UP, and a family friend Sharlane Trollip.

During the post excavation analysis, the 1000 plus bones and bone fragments were given to professional archaeozoologist Karin Scott to analyse and describe for me. I would like to

thank her for her friendship over the years that we have known and worked together and for what was a time consuming task in identifying the Argent bone material. I must thank her most deeply for providing me with the detailed report which appears as (Appendix 4) and the results of which are discussed in (Chapter 12). I would also like to thank Karin's assistant and student in archaeozoology, Lechè Brits for her involvement in the analysis.

The plans of each site were drawn using a CAD program – QCAD. I wish to thank Andrew Mustan of Ribbonsoft in Switzerland, not only for an easy to use product, but also his help when it was needed.

Three other people deserve a very special mention, my son Ian, who has not only helped me with my MA survey and excavations, but assisted me on many days during which we carried out numerous pedestrian surveys of the Argent site prior to assisting with the satellite survey for this project. He has also been with me and helped on every day of the excavations. He got married in August of 2016 and introduced his new wife, Christine, to the world of archaeological excavation. She became a star excavator, and most definitely the 'bottle queen'. If a bottle was to be found Christine found and excavated it. She also has the recognition of finding the largest artefact – the wheelbarrow frame. During post excavation work they have both assisted me with the cleaning of the artefacts. The third person is my daughter Megan, she has been so supportive of my studies over the years and the current work on this PhD. The irony for us is that she was studying at Wits when I was doing my MA at UNISA, now we have swopped Universities and she is at UNISA and I am at Wits. To the three of you a very big thank you for all of your help and support.

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GLOSSARY OF ACRONYMS

Acronyms, which appear in the text and footnotes

AGM	Annual General Meeting
AIA	Archeolgical Institute of America
BRA	Barlow Rand Archives
ERPM	East Rand Propriety Mines
GFSA	Gold Fields of South Africa
GME	Government Mining Engineer
GPR	Ground Penetrating Radar
HE	H. Eckstein & Co Archives
JCI	Johannesburg Consolidated Investment
JPL	Johannesburg Public Library
MNV	Minimum Number of Vessels
NAD	Native Affairs Department
NASA	National Archives of South Africa
ngl	Normal Ground Level
SAHRA	South African Heritage Resources Agency
SAIMM	South African Institute of Mining and Metallurgy
SAMEJ	South African Mining and Engineering Journal
SAMJ	South African Mining Journal
SIA	Society for Industrial Archeology
STP	Shovel Test Pit
TSBM	Transvaal Silver and Base Metals
TSM	Transvaal Silver Mine
UK	United Kingdom
UNISA	University of South Africa
USA/US	United States of America/United States
ZAR	Zuid Afrikaansche Republiek

Shortened or abbreviated names

Anglo American Corporation Co Ltd	Anglo American
Australian Institute of Mining and Metallurgy	Australian IMM
General Mining and Finance Corporation Co Ltd	General Mining
Gold Fields of South Africa Co Ltd	Gold Fields
University of the Witwatersrand	Wits

Chapter 1

Introduction

1.1 Introduction

The focus of this study grew out of an interest in the silver mines of Gauteng, South Africa. Previous research, (Reeks 2012) focussed on the period 1885-1999, and the history of the silver mining industry in greater Pretoria. The finding of information on the mineral beneficiation processes and the machines at the Argent mine during the production operations in the 1890s and 1920s piqued my interest and provided the material framework for this research.

Although work has been done on the social and historical side of South African mining, little has been done to investigate the technology behind the mining operation and the interrelated social aspects of the black miners who were involved with the operations of the various machines. This thesis follows such trends in the field of industrial archaeology in the UK and USA.

To date, very few industrial archaeology studies dealing with mining operations have been carried out in South Africa. In searching for such a study - which covers both the technology and associated social aspects of the operation - no other theses have been found. Studies involving aspects of industrial structures have been carried out as part of Environmental Impact Assessments (EIAs) or Heritage Impact Assessments (HIAs) in terms of the National Heritage Resources Act [No 25 of 1999].[1] Some South African industries or structures that have been studied are Worth's (2004) PhD thesis on the grain silos and demolished gas works in Cape Town, Behrens (1999) MA on the Modderfontein dynamite factory in

[1] In 2008 a site survey and an archival search were conducted as part of a Phase 2 HIA on the remains of a 1930s-40s black miner compound at the disused Vlakfontein Gold Mine near the town of Springs on the Eastern Witwatersrand. Reeks, G. 2008 *Impact of the proposed Gauteng road between Sam Smith Road and Vlakfontein Road, Ekurhuleni Metropolitan Council;* Reeks, G. & Coetzee, F. 2010. *Cultural Heritage Investigation of Historical Lime Kilns on the property of PPC Slurry Operation, near Mafikeng, North West Province*; Reeks, G. & Coetzee, F. 2012. *Cultural Heritage Investigation of Historical Steel-Framed building on the property of PPC Slurry operation, near Mafikeng, North West Province*.

Johannesburg, and Dembelembe's (2013) MA thesis on the Cape Glass Co. The latter followed on from the book *Re-discovering the Cape Glass Co at Glencairn*, by Saitowitz and Lastovika (1998).

Masters and Doctorial studies on aspects of mining operations such as Nattress' (1987) MA study of a tin mining town in the Rooiberg region, reflects mining as potential subject matter for both historians and archaeologists. Weiss' (2009) PhD thesis on the Kimberley diamond mine compound, Stewart's (2012) PhD thesis on working hours in South African gold mines, and Nkosi's (2011) book *Mining Deep*, which was largely based on his PhD thesis on labour structures in South African gold mines, are three that formed part of the background to my research. A chapter written by Moroney (1982), in a book edited by Marks & Rathbone (1982), in which he dealt with compounds on the mines had a huge impact on my understanding of compounds. This has been followed by reading Lawrence's (1994) MA thesis on black miners at the Kimberley mine from 1867 to 1893. Many studies of the social lives of South Africa's black miner work force have been made, with those by van Onselen (2001), Callinicos (1981), and Allen (1992) being some of the most important. By conducting archaeological excavations at the site of the black miner 'native location'[2] at the Argent mine in parallel with the industrial archaeological study, it was hoped that each study would provide integrated support for the other and I feel that the results discussed in this thesis have shown this to be true.

Mineral beneficiation is the converting of a single metallic or a polymetallic ore into a product that can be sold. This could be a concentrate of the metallic minerals or a smelted metal product, such as gold bullion, or ingots of a base metal. Mines around the world sell such semi-processed ores as their 'finished products', but these are often sold to other companies for further processing or refining, into a final metallic product.

Mineral beneficiation is a field - as with so many technical industries - that has changed significantly over the past 150 years. Over the past hundred years there have been articles in journals on various aspects of beneficiation at South African mines and one such article by

[2] The term 'native location' was totally capitalised on the original 1920 TSBM mine plan. When referring directly to the Argent TSBM black miner residential area in the text, the term appears in single quotes and lower case to avoid too much capitalisation. The quotes are merely to emphasise reference to the TSBM site. Where the term is used in general discussion within the text, it is not in quotes.

Clayden (1922) is used in this thesis in conjunction with other sources where they detail parts of the 1920s process at the Argent silver mine. However, for the majority of such publications they would be specific to a mine or a metallic ore, or a specific problem in treating an ore and therefore not relevant to the Argent silver mine in the 1890s or 1920s. Much of the technology of beneficiation from the 1890s has been superseded by modern processes. In the 1920s some of the 1890s technology had been abandoned for improved technologies and these are investigated in this study.

Although there have been many books published on the history of mining in South Africa such as Rosenthal (1970) on gold; Worger (1987) on diamonds, Jones (1995) on a large mining company - General Mining and Finance Corporation - in Johannesburg, and Lang (1986) on the South African Chamber of Mines, very few books deal with the beneficiation technologies. A book by Cowey (1994) presented a pictorial history of mineral mining in South Africa and included pictorial details of some parts of the more modern beneficiation plants, but it was primarily intended as a coffee table book.

1.2 Research aims

There are two primary aims in the research. Firstly, to understand the beneficiation processes at the Argent mine in the 1890s and 1920s. Secondly, an attempt is made to re-construct some aspects of the lifeways of the black mine workers at the Argent mine in the same periods of operation.

1.3 Research objectives

The objectives will be to analyse and evaluate the foundation structures of the beneficiation plants at the Argent mine through pedestrian surveys and by comparing them with documents and photographs in an attempt to recreate the processes. Additionally, to investigate and describe the development of the technologies during the 1890s and 1920s periods of operation at the mine.

A further objective is to develop the operational costs for the Argent mine in the two time periods, to try and determine the profitability of the mining operation and its beneficiation processes.

By conducting archaeological excavations on an area of the mine where it has been determined that middens and some of the foundation structures of the black mine worker housing area exist, it is hoped to obtain enough data to provide an analysis of social conditions of the miners for the two time periods.

The records of how many black mine workers were employed at the Argent mine during the 1890s and 1920s exist, but there are no details of their specific job functions. By being able to re-create the beneficiation processes and the machinery involved, one of the objectives is to attempt to populate the mine and its plant with job positions for the black mine workers.

1.4 Location of the Argent silver mine

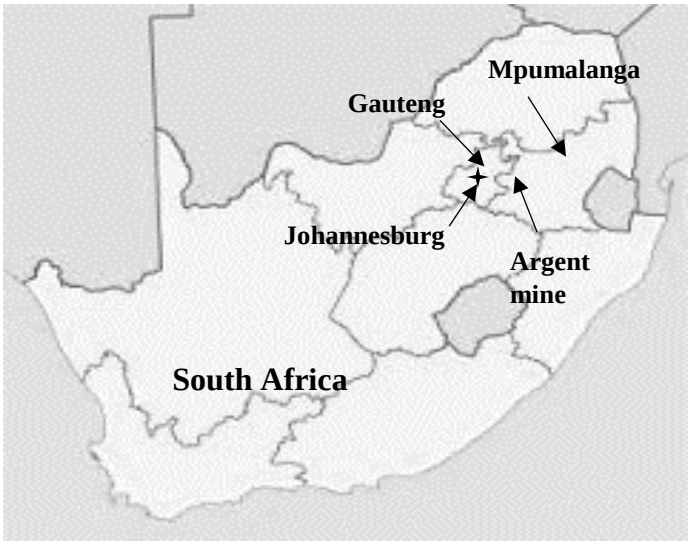


Figure 1. Map of South Africa showing the two provinces mentioned in the text and location of Johannesburg.
(Drawn G. Reeks)

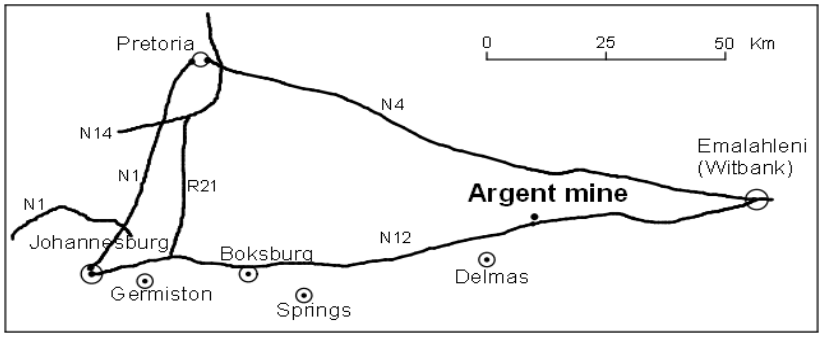


Figure 2. Map showing major highways of the eastern Witwatersrand and the location of the Argent Mine. (Drawn G. Reeks)

The Argent silver mine is located approximately 100 km east of Johannesburg, close to the main highway (N12), between Johannesburg and Witbank – renamed eMalahleni in 2006 - and a rail junction named Argent on the main railway line to the north eastern part of South Africa. The nearest small town is Delmas, to the south west of the mine (Figures 1, 2 & 3).

It is difficult to determine if it was on any historical route to the 1870s gold fields of Pilgrims Rest/Barberton or not. It is thought that early prospectors may have passed over the area in the late 1880s and prior to the mine being actively prospected. However, it has been impossible to determine who discovered the mineralised area at Argent.

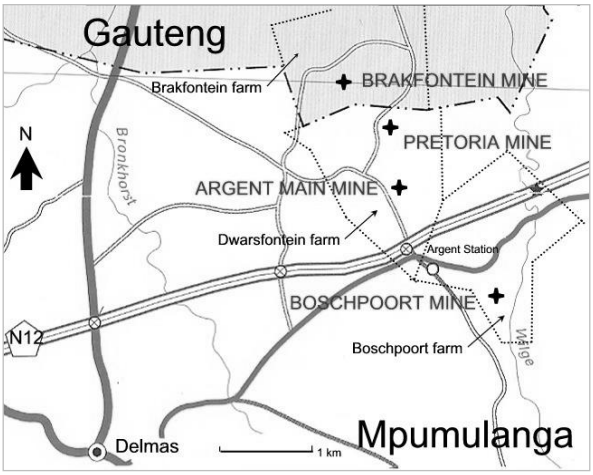


Figure 3. The four silver mines at the Argent silver mine location, dating from 1890s and 1920s (Reeks 2012).

1.5 Landscape at Argent

The geology of the area defines the landscape. It consists of Karroo sediments overlying rocks of the Bushveld Complex in which the ore body mineralisation took place. The topography is a gentle rolling to relatively flat Highveld[3] and is dominated by extensive crop and cattle farming. Tree growth is sparse, except along stream lines. Historically, the area has been farming land since the 1880s and the area has always been sparsely populated. The development of Johannesburg began in 1886, with eMalahleni (Witbank) being proclaimed

[3] Highveld is the name given the inland area of South Africa, largely the provinces of Gauteng and the Free State where the altitude is generally above 1500m but less than 2100m. https://en.oxforddictionaries.com/definition/highveld (Accessed on 3 January 2019).

in 1903 and Delmas a few years later in 1907.[4] During the research into the black mineworkers at the TSBM mine, a file was found in the National Archives of South Africa which presented details of various labour problems at the mine and mention was also made of there being a Police station in Delmas.[5] Food supplies, even in the 1890s and 1920s, would not have been easy to obtain and clearly this was one of the reasons for the mine to operate its own crop and livestock farm for its mining staff.

To the west of the mine and some 50 km from it, lies the town of Springs, and there was only a dirt road connecting the two in the 1920s. It would have many hours to transport any form of goods or produce from Springs to the mine. In the 1890s transport of goods would have been by oxen or mule wagon. Those who had horses as a mode of transport would have still had a journey that would have taken a considerable amount of time to travel the 100 km to or from Johannesburg, due to the need to rest the horses periodically.

The mine used to send weekly reports to head office in Johannesburg and a quote in the SAMJ gives some idea of the travelling time:

> The Company despatches a mail wagon from the mine every Wednesday, as far as the railway at Boksburg, returning after the weekly meeting of the Board on Thursday. The drive from the mine occupies about seven hours, including outspans.[6]

From the mine to Boksburg, the eastern most town on the Witwatersrand in the 1890s, is a distance of approximately 60km. The four photographs (Figures 4-7), that follow, illustrate the general flat topography of the area surrounding the mine. As can be seen, trees are sparse and the mature ones are generally of medium height, 8-10 m, consisting dominantly of the invasive species Black wattle, *Acacia mearnsi*, along with undefined species of pine and eucalyptus. The most common indigenous bush in the area is of the genus *Rhus*. Although surface water is mainly restricted to small slow moving streams, at the Argent mine

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4 https://archive.org/details/DictionaryOfSouthernAfricanPlaceNames (Accessed on 17 January 2018).

5 NASA, Pretoria. Depot TAB, Source GNLB. Type LEER. Volume no 226, System 01. Ref. 494/15 part 1 – Conditions of employment of natives on mines outside labour districts: Transvaal Silver and Base Metals Limited, Dwarsfontein, Pretoria District. 1920-1921.

6 'Transvaal Silver Mines', *The South African Mining Journal*, Vol. 1, (3 September 1892), pp. 863-866.

underground water became a huge problem at the first level (30-40 m). This was captured in many press reports of the 1890s with comments such as “great difficulty has had to be encountered owing to the presence of water”.[7]



General views of the farming landscape surrounding the ruins of the Argent mine.
(Photographs by G. Reeks)

Figure 4. Landscape to the east of the mine.



Figure 5. Landscape to the west of the mine



Figure 6. Landscape to the north of the mine



Figure 7. Landscape to the south of the mine

7 ‘Transvaal Silver Mines’ *The Diggers’ News,* 9 July 1889.

1.6 A brief background history of the Argent mine

The Argent mine, whether operating as the Transvaal Silver Mine (hereafter TSM) or Transvaal Silver & Base Metals (hereafter TSBM) mine is tied to the history of the three other mines located close by, as shown on Figure 3. It is therefore necessary to present a brief history of the mines so as to provide context for this thesis. Although TSM was the first mine to open in 1899, it was followed by the formation of another silver mining company, the Witpoortje Syndicate Ltd.[8] In 1891 the syndicate opened mines on the farms Boschpoort, Brakfontein and Witpoortjie, which was closer to Bronkhorstspruit, some 20 km north of Argent.[9] The Witpoortjie mine was more of a trial operation and was eventually abandoned by the syndicate.[10] Many of the letters in the archive files of the H. Eckstein & Company refer to these other operations. There was a very close relationship between the TSM and Witpoortje Syndicate companies, not least because of the fact that directors of the one company sat on the board of the other, including the Randlord[11] Lionel Phillips who was eventually to become chairman of both companies.

When General Mining started TSBM in 1919, they took out leases on the land of the Brakfontein and Boschpoort mines. As will be discussed in Chapter 5, TSBM eventually re-opened the Brakfontein as a production mine 1920.[12] The Pretoria mine was opened in 1920 under the management of the Pretoria Silver Lead Mines Ltd.[13] It has always seemed strange to me that TSBM did not take out options or leases on the land on which the Pretoria mine was developed. It is especially strange when the two companies were mining the same

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8 The spelling of the farm Witpoortjie is different from that of the company 'Witpoortje Syndicate', *The South African Mining Journal,* Vol. 1, (17 October 1891), p. 49.

9 BRA. Archives of H. Eckstein & Co. - HE 149 - L Phillips - Outgoing general and London letters, Dec 1889 - May 1892. Letters from February 14 1891 refer to 'Silver farms' or 'Witpoortjie' and detail the development of the mines on the farms Boschpoort and Brakfontein.

10 BRA. Archives of H. Eckstein & Co. - HE 149 - L Phillips - Outgoing general and London letters, Dec 1889 - May 1892. Letter dated October 24 1891.

11 The term "Randlords apparently originated in the British press (*The Daily Chronicle*) in the early 20th century (original date not cited) and was used to describe the mining magnates of the late 19th and early 20th centuries Witwatersrand gold fields. https://en.oxforddictionaries.com/definition/randlord (Accessed on 15 January 2019).

12 'Progress of Transvaal Silver', *The SA Mining & Engineering Journal,* (12 February 1921), p. 633.

13 'Pretoria Silver Lead', *The SA Mining & Engineering Journal,* (9 March 1921), p. 841.

mineralised vein, albeit about 3 km apart. The Pretoria mine always struggled for capital and although they sank a shaft to 30 m and developed drives from the shaft to intersect the mineralised vein, it was never a significant producer of lead (Reeks 2012).

The Argent mine was originally opened as the Transvaal Silver Mine Ltd in 1889 under the control of Barney Barnato and Woolf Joel, both of whom founded and operated the Johannesburg Consolidated Investment (JCI) group of gold mining companies.[14] The TSM was taken over by the H. Eckstein and Co. in 1890 and it was then that TSM was placed under the chairmanship of Lionel Phillips, who was also a senior partner in the Eckstein firm.[15]

In the 1890s the mine was a significant producer of lead and more especially silver, producing totals of some 6 000 tons of lead and 17 tons of silver (Reeks 2012). Although it was officially de-registered as a company in 1910, it ceased mining and concentrating operations in 1895, when four of its directors - including Lionel Phillips - were arrested as conspirators in the Jameson Raid and the Reform Committee (Reeks 2012).[16]

There was some minor tribute mining conducted by small operators between 1908 and 1913 and some 700 tons of lead concentrates were produced, yielding 1 850 kg of silver. Most of this is thought to have come from re-working of the surface dumps.[17]

General Mining and Investment Corporation Ltd, was founded in 1895 as a gold mining group by the brothers George and Leopold Albu. In 1918-19 it took out prospecting licences on a wide area of land surrounding the old silver mines of the 1890s, which included the TSM.[18] In 1920 the TSBM began installing a new headgear, modern boiler house and

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14 Registrar of Companies, Pretoria. File 01/00219/06, Transvaal Silver Mines, Registered 31 January 1889.

15 BRA. Archives of H. Eckstein & Co. - HE 149 - L Phillips - Outgoing general and London letters, Dec 1889 - May 1892. Letters dated April 18 and July 18 1890.

16 'Imprisoned Directors', *The South African Mining Journal,* Vol. 5, (9 May 1896), pp. 617-618.

17 'Transvaal Silver Mines: Let on Tribute', *The South African Mining Journal*, (14 March 1908), p. 16.

18 'Transvaal Silver successful flotation', *The SA Mining & Engineering Journal,* (20 December 1919), p. 321.

electrical generating plant, along with surface rail tracks, conveyors, water reservoirs and re-developing the mine underground.[19]

A mine village of housing for the white management of the mine was eventually constructed, together with the relatively new concept of a native location replacing the old compound system.[20] The location of all of the houses and an area defined as 'native location' are shown on the 1920s mine plan (Appendix 1.0). The change in definition of the 'compound' is discussed in more detail in Chapter 8. As will be discussed in Chapter 5 and 6, a completely new beneficiation plant was designed and installed at the TSBM.

The TSBM mine was very successful, in that it produced over 16 000 tons of lead, nearly 200 tons of copper, 45 tons of silver and 20 kg of gold. Final closure in 1925-26 was brought about by a world decline in the price of silver and more importantly a decline in the price of lead, making such mining at Argent uneconomic (Reeks 2012:20-23). At the same time development to the 7th level of the mine indicated declining values of the two metals and a pinching out of the vein at that level. This led to the eventual closure of the TSBM mine in 1925.[21] In seven years the mine had installed and operated some of the most modern beneficiation processes and machinery in the world for the 1920s and it is this evidence that is presented in this thesis.

Although the history of the Argent mine continued in the 1950s and 1970s, when a consortium consisting of Goldfields, Anglo American and General Mining dewatered the mine with the intention of sampling the remaining ore body, during both time periods the prices of the metals having risen, dropped again to uneconomic levels, before any underground development could begin (Reeks 2012).

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19 'Progress of the Transvaal Silver and Base Metals', *The SA Mining & Engineering Journal,* (30 October 1920), p. 187.

20 The black mineworker compounds on the diamond mines in Kimberley had been constructed as 'Closed Compounds'. In other words the black mineworkers had no access to the outside world during the extent of their contract with the mine. In effect they were prisoners of the mining company. The gold mines did not install such a system on the Witwatersrand and their compounds were classified as 'Open Compounds', however although in theory a mine worker could leave the compound to go into the nearest town it was only at the permission of the Compound manager and once he had issued a pass to the mine worker. The 'native location' at the TSBM in the 1920s is discussed in full in Chapter 8 (Moroney (1978).

21 'Transvaal Silver & Base Metals – quarterly report', *The SA Mining & Engineering Journal,* (14 November 1925), p. 309.

1.7 Bibliographic Notes and Primary Sources

Extensive use has been made of the records from the Barlow Rand Archive of the H. Eckstein and Co documents. This is a valuable source of data dealing with the day to day management of the various operations of the Eckstein group and is particularly useful in understanding the relationships between the Randlord partners of Eckstein, Phillips and Beit and their mine managers in the various volumes of letter books. The archive also contains the original annual reports of the chairman, mine manager and technical manager of the TSM and these were a major source for details on the buildings and the machinery/processes adopted in the 1890s.

A letter book was a means of hand writing a letter and at the same time retaining a carbon copy record of the correspondence. Each book contained 100 numbered pages, where the upper original was perforated along the binding side which was removed and sent to the recipient and the carbon copy was retained in the bound book. The name 'letter books' is derived from the full name of 'letter press copy books' Each partner kept a set of such books, with prior designations such as Personal, Company Correspondence or Letters to London.

Many of the documents covering the technological and architectural aspects of the Argent mine were found in the mine engineer's reports, which were included in the annual reports of the company. Thus the originals of the reports and proceedings of the 2nd to the 6th Annual General Meetings of the TSM in the Barlow Rand Archive (BRA) became vital documents in being able to re-create the beneficiation process of the 1890s mine.

Similarly, the Gold Fields files and the engineer's reports that they contained, helped with the 1920s beneficiation technology. As with most industrial archaeology studies, the analysis of a particular system relies on merging the field observations with documentary evidence such as reports, plans, photographs, and external sources such as patents and technological books on beneficiation or mineral dressing.

I started with modern textbooks on mineral dressing from the mining engineering library at the University of the Witwatersrand, but for the most part they did not help with technology from 130 years ago. It resulted in a search for and acquisition of Victorian mining technology textbooks, the oldest one dating from the 1880s. From these books came a full understanding

of the processes involved in the 1890s TSM beneficiation plant. Later publications were to help with the huge advances in mineral processing technology from 1910 to 1919, when the new TSBM mine installed many new machines and processes. I tried to understand when these machines entered the mining market. As they were either from the USA or UK manufacturers, the original patents were sourced and these provided an earliest available marketing date for such machines.

Searches of the Internet often helped locate other mines in Africa that may have employed such machines or processes, but it became apparent that few instances existed of other mines employing such technologies before Argent. Another source of information are back issues of the British Association of Industrial Archaeologies journal *Industrial Archaeology Review*. Also looked at were the back issues of *Industrial Archaeology*, which is the journal of the American Society for Industrial Archaeology.

Secondary sources such as newspapers, like the 1890s *Standard and Diggers' News* - held on microfilm in the Audio Library of UNISA - and mining journals, such as, the *SA Mining Journal* - which around 1919 changed its name to the *SA Mining and Engineering Journal* - helped with pictures of the plants and in some cases with descriptions of the plants or processes employed at Argent. The SAMJ and SAMEJ journals became major sources of data for both the 1890s and 1920s operations. An almost full set of the journals prior to the 1930s is kept in the library of the Council of Geoscience and it is a valuable resource for data on the early mining industry of South Africa as it began publication in 1890.

1.8 Organisation of the Chapters

Following this introductory chapter, Chapter 2 presents a brief analysis of the differences between the UK and the USA in the basic training as an archaeologist and the implications for further training as a historical or industrial archaeologist. This continues with a discussion on the emergence of industrial archaeology and how social theory has become relevant to industrial archaeology. The discussion leads into the developments of theory and methodology in modern industrial archaeology, followed by the focus on the Argent project and its specific theoretical approaches.

Chapter 3 discusses the beneficiation processes of the TSM in the period 1889-1896. It was a period of jostling between rival Randlords such as Barney Barnato, Hermann Eckstein, Lionel Phillips and Alfred Beit. It was also when new techniques of beneficiation would be tried alongside more traditional ones and these are discussed in more detail in Chapter 4, where the different beneficiation processes are analysed along with the capital costs and the resultant profit or losses for the company owners.

Chapter 5 deals with the new era of mining starting in the year 1919. Why, when there was a world economic depression, did the General Mining Corporation consider it the right time to launch a new lead and silver mine? On top of such a risk, why did they also take the decision to install so many new technologies in the construction of the plant and in beneficiation processes and machines? As with Chapters 3 and 4 dealing with the 1890s period Chapter 5 leads into Chapter 6 and looks into the new mineral processing technologies of the 1920s. This is followed by Chapter 7 which seeks to understand how effective these new technologies were and analyses the costs and profits to the Transvaal Silver & Base Metals company.

Chapter 8 moves into the social archaeology part of this thesis by firstly discussing the terms compound and native location. The focus of the entire chapter is on the black mineworkers at the Argent mine. How were they recruited? What jobs did they do? How much were they paid? What sorts of food could they have eaten? By understanding the beneficiation process an attempt is made to fit the known number of workers at the Argent mine into potential job categories in an attempt to give the hundreds of unnamed black mineworkers a third dimension.

Chapter 9 moves into the detail of the surveys conducted on both the industrial and social areas of the project. It also looks at the sub-sites and methodologies behind the choices of excavation areas. Chapter 10 continues with specific details and plans of each of the excavated sub-sites, including a general discussion on the significant finds at each sub-site. Chapter 11 provides a statistical analysis of the five major categories of artefacts found within the excavations. It also looks at the stratigraphic sections of the two major excavations and provides a horizontal analysis of the artefacts leading to some interesting conclusions. Chapter 12 reviews the previous chapters drawing on the findings of each chapter and taking the points into discussion in order to understand the relevance and

importance of the findings. This leads into the final chapter where the conclusions are drawn and stated.

One of the Appendices is the archaeozoological report covering the description and identification of the complete and fragmentary animal bones recovered from the excavations. There is also an analysis and photographs of the significant finds of artefacts from the various excavations. The last appendix lists the artefacts found and provides details.

Many of the quotes used in this thesis reflect an attitude of the pre-1994 period when derogatory names were applied or used when speaking or writing about the black people of South Africa. South Africa prior to 1994 was a country with a number of designations used to describe either a particular race or religious preference or possibly a region of origin, for example in Colonial and post-Colonial times Indians or Muslims or Cape Coloureds (Lawrence 1994). Derogatory terms were not only applied by the White race to others, but was also used by Afrikaners when describing people from the UK or vice versa. Thankfully in our modern South Africa such terms as existed and were used, have become illegal to use.

South African black people have for hundreds of years been defined by a tribal name, for example Xhosa or Venda, but while these terms are not necessarily derogatory other terms that have been used in the past are. One of these terms appears in some of the newspaper or early journal quotes used in this thesis and it is the term *Kaffir*. In Arabic the word simply means 'non believer' and would have meant a 'non-believer in God.' In the latter part of 19th century it developed as a hugely derogatory term when describing black people.[22] I have made a decision to remove this term from any direct quotes used in this thesis, but not to change the quote too dramatically, therefore such a term will appear as 'k…..' but without the quotation marks.

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[22] https://public.oed.com/blog/word-stories-kaffir/ (Accessed on 12 January 1019). Retention of the term, even indicated by the letter 'k' is merely retained for historical context and is in no manner intended to be derogatory.

Chapter 2

Reviewing Past Approaches to Industrial Sites and Developing a Theoretical Framework

2.1 Introduction

Industrial archaeology has its origins in the UK, from where it spread to the USA. Initially it developed into a specific area of research, distinct from the more mainstream historical archaeology. The different avenues of archaeological training between the UK and USA are briefly discussed in order to present the primary differences of archaeological focus between the two countries. I will investigate the evolution of industrial archaeology as a distinct systematic study in the academic world. This will be followed by an overview of the Argent project and the theoretical and methodological approaches that will be followed in both the industrial and social archaeology of this thesis.

2.2 A brief background to training as a Historical or Industrial Archaeologist

The American system of qualifying to become an archaeologist involves initial training as an anthropologist and then further training in the field of archaeology, which in the USA is considered a sub-field of anthropology. In comparison the European system is more closely aligned to the discipline of history (Johnson 2010:185). The implications of this are that for archaeologists in the USA, the primary focus of study is on the social aspects i.e. housing, food types and household utensils of a site, followed by the historical and more rarely, the industrial aspects. In the UK, it is the historical aspects that form the basis of study and the social implications follow. Therefore, in both countries, since the late 1990s, there has been a realisation that there has to be a balanced study of social and historical aspects and that with any site there is a context, an impact and an effect. In both countries this approach is changing and in the discussion below such changes will be outlined, as the research programmes should always have a direct relationship with the theoretical approaches to the study.

2.3 The emergence of Industrial Archaeology

As with the study of history, that of archaeology is also defined by time zones. Thus as with Neolithic, Roman or Medieval archaeology, industrial archaeology in the UK focuses on a cultural period – the industrial revolution. Societies all over the world have changed over time, but no change has had such a profound impact on populations, their movements and methods of production as the 18th and 19th century 'industrial revolutions' did. In the UK and the USA, both of which had industrial revolutions, albeit 150 years apart, it has been easier to create time frames that serve as 'windows' of the respective industrial archaeologies. As far back as 1948, historians were defining the industrial revolution in the UK as "…an affair of economics as well as of technology…the two movements…relied upon inventions, transport, finance and a division of labour" (Ashton 1977:76). Steam (1993:5); further stated "how it transformed the way men and women worked by increasing specialisation, coordination and the rate of production*"* (Labadi 2001:78).

In reviewing the origins and development of industrial archaeology over the last sixty years, the first appearance of the term industrial archaeology in print was in 1955 in an article in *The Amateur Historian* by industrial historian, Michael Rix (Cossons 1973:19; Palmer & Neaverson 1998:1). Over the years the concept of industrial archaeology has gone through many growing pains of definition, the most difficult of which has been defining the term "industrial". In the UK in the mid-1950s industrial archaeology began as the saving and restoration of eighteenth and nineteenth century machinery. The early approach to the study of industrial sites, both in the UK and USA, was by groups of enthusiastic amateurs with some involvement by professional archaeologists. The primary action of these keen amateurs was to study and preserve the sites especially in the UK. Offering explanations about the operations of these sites was considered sufficient. The concept of broad research questions and a debate on the significance of the site in relation to other factors, such as similar sites or machines, was not part of their rationale.

Martin outlines how, in both countries, national societies were eventually formed in the early 1970s - such as the Association for Industrial Archaeology (AIA) in the UK and in the USA the Society for Industrial Archeology (SIA)[1] (Martin 2009).

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[1] The SIA deliberately dropped the second "a" in the spelling of archaeology (Martin 2009).

By the mid-1960s, some professional archaeologists saw this as a possible area for investigation, noting however, that it lacked a theoretical base and had no particular methodology (Grant 1987:118; Palmer & Neaverson 1998:3). Johnson stated that:

> …most work in this area has concentrated on the archaeological elucidation of the development of the technologies involved rather than the social and cultural parameters (Johnson 1996:12; Palmer & Neaverson 1998:3).

In 1968 Vincent Foley published an article in which he outlined his concerns and reservations regarding the emerging field of industrial archaeology (Foley 1968). The following year Robert Vogel, in response to Foley's article, put forward his viewpoints in favour of developing the field of industrial archaeology, which primarily contradicted Foley's assertions (Vogel 1969). I will discuss the three main arguments that Vogel raised, as they form some of the main foundations of industrial archaeology. The two papers by Vogel and Foley demonstrated the level of antagonism between historical archaeologists and those who supported the emerging field of industrial archaeology in the 1960s.

Foley (1968) believed that excavating was of primary importance and it was that activity that defined you as an archaeologist. Vogel (1969), disagreed with this and felt even archaeologists who only excavated occasionally, are still archaeologists. Foley also did not believe that archaeology was about preservation of the site, implying that was not the responsibility of an archaeologist. For Vogel, preservation was an integral part of an industrial archaeological study. Thirdly, it appeared that Foley had reservations regarding the lack of professionalism among supporters of industrial archaeology. He felt threatened in his own status and that of the field of archaeology by "the incursion of bumbling amateurs" (Vogel 1969:88). This, to some extent, mirrors the concept of industrial archaeologists held by academic archaeologists in the UK in the 1960s. (Foley 1968; Vogel 1969).

One of the early concerns with the name of the sub-field was the word "industrial." By its very nature it seemed to imply machines, manufacture and processes. As a discipline, industrial archaeology draws its conclusions "…from a wide variety of disciplines, demanding an appreciation on the one hand of economic or social history or geography and on the other of a knowledge of mechanical or civil engineering, of metallurgy or

architecture" (Cossons 1973:19). Thus the industrial archaeologist uses a broad tablet of disciplines to gather data. However, it is now recognised that industrial growth through the ages to the present day is responsible for many sites of interest to industrial archaeologists.

The earliest Industrial Revolution began in England in the 1760s with the development of the steam engine and its use in the new industries of mining, iron making, pottery and weaving to name a few. Canals were the first major mode of transport followed by railways. By the 1840s many new developments and mechanised industries had been created (Hobsbawn 1962; 1999; Thompson 1966; Ashton 1977). In the USA, there were two primary periods of industrial revolution with the first one being 1820-1840 and as Brinkley (2004:259) terms it "the emergence of the factory". The second period of an Industrial Revolution in the USA, was in fact similar to the UK in that it started around the mid-1870s. It was the rapid development of many new technologies coupled with new methods of production, the growth of the railways, communications systems and electricity as well as the growth of a steel making industry that in fact became the catalyst for industrial development in the USA (Freidel & Drewry 1970; Hobsbawn 1999; Brogan 2001; Brinkley 2004). It was not until diamond mining became mechanised in the 1890s, coupled with the beginnings of a rail network, that South Africa can be said to have embraced mechanisation. However, it was the gold mining industry that was the true catalyst in engineering growth (Lacour-Gayet 1977; Muller 1993).

The industrial revolutions in the UK, USA and South Africa created social stress among the poorer echelons of the population. In the UK the transition from agrarian economies to industrialised societies created a rich factory, mill or mine owner strata (Thompson 1966). It also created large, poorly paid worker societies, who for decades were just a means to getting the products made or mined. Between these two classes you had a developing lower middle class – those who became the foremen and the shift bosses.

In the late 1980s-1990s academic historical and post-medieval archaeologists in the UK began taking an interest in the work that AIA were doing and many professional archaeologists realised that industrial archaeology was not "solely a movement to conserve the industrial past but a discipline trying to understand its meaning and its relevance to modern society" (Palmer 2005:11). It was becoming a part of mainstream archaeology, with the involvement of newly qualified second and third generation specialists in industrial

archaeology.

Early studies of industrial sites in UK and the USA have focused upon two divergent, though interrelated fields, either the industrial or the social facilities. Industrial archaeologists have sought to excavate and discuss the technology of a specific site. McCutcheon defines it as the "effects and remains of past industrial and commercial activity" (McCutcheon 1983:162). By comparison, Palmer & Neaverson (1998:1) define industrial archaeology as the "systematic study of structures and artefacts as a means to understanding our industrial past*".* Whereas, historical archaeologists have tended to focus on the "locations of social life within industrial landscapes" (Norris 2009:33). Palmer (2005:10) argued that "the full meaning of a site can only be extracted if the material evidence is considered within a framework of inference which seeks to establish social as well as economic and technological significance."

Thus industrial archaeology has evolved into a disciplined study of industry, one in which the broader research agendas often include both technical and social studies, resulting in a holistic approach. For several decades there was a rivalry between the less academic industrial archaeologists and the academic historical archaeologists. Both were carrying out parallel studies of industry and achieving great results in terms of public interest.

In the early 1980s and 1990s, both in the UK and the USA, there were a number of moves to raise the importance of industrial archaeology. The focus was to define industrial archaeology both at an academic and government level, which included the creation of legislation to protect such monuments with excavation protocols and post-excavation curation (Starbuck 1980; McCutcheon 1983; Palmer 1991, 1994; Crandall, Rowe & Parnell 2001; Martin 2009). In a similar manner the South African Heritage Resource Agency (SAHRA) is responsible for archaeological work conducted in South Africa.

Ironically, this very move led to the questions of who is qualified to excavate industrial sites and what specialised training is needed to become an industrial archaeologist? Little agreement could be reached at the time among academics as to an all-encompassing definition of industrial archaeology (Starbuck 1980; Palmer 1991). Was it systems of production, transportation, the machines, the technology, the people or the places?

Was industrial archaeology about the site remains, historical documents or the excavations and artefacts?

Many of the archaeological methodologies were typical of the processual approach to archaeological sites and it was only during the development of post-processualism in the late 1970s/early 1980s that a potential new method of examining industrial sites began to develop (Swanepoel 2007: 25-27). Suddenly, the artefact remains, other than the machines or buildings on industrial sites, had significance. Palmer and Neaverson summed it up succinctly:

> Preservation is only part of industrial archaeology, and its main thrust should be towards the recording of artefacts and structures and illuminating the context of people at work in the past (Palmer and Neaverson 1998:3).

The 1990s was a period of change in UK and USA industrial archaeology. In the UK and USA a number of professional archaeologists began writing books or chapters on the subject or on specific industrial sites (Alfrey & Clark 1993; Schackel 1996; Palmer and Neaverson 1998; Belford 2001; Cassella and Symonds 2005; McGuire & Reckner 2003; 2005). One of the most extensive studies was of an early industrial landscape in the UK, in which a variety of industries developed in a former agrarian setting and not only co-existed as industries, but also impacted upon the social structures and development in the Ironbridge Gorge in England. It was published as a book by Judith Alfrey and Catherine Clark in 1993 as the *Landscape of Industry* (Alfrey & Clark 1993).

In 1998, Palmer and Neaverson published *Industrial Archaeology: Principles and Practice* (Palmer & Neaverson 1998). This book was ground breaking in the world of industrial archaeology as it showed that the field needed to seriously change direction in its approach to understanding the meaning of the sites and machinery. In other words, it needed to broaden its outlook and take on-board a more holistic approach to what the industrialisation had created, changed or impacted upon, and this included such avenues as landscape, social impact or human agency and material culture.

In 2000, Dr Marilyn Palmer was awarded a chair in Industrial Archaeology at the University of Leicester (Gwyn 2009; Horning and Palmer 2009:9). This was possibly the pivotal

moment in bringing the formerly 'amateur' movement into the academic and professional fold of archaeology. Many papers and books on industrial archaeology have followed and yet there are still debates and conferences (in the UK) on the 'rivalry', between historical, post-medieval and industrial archaeology. One such conference in the UK in 2008, entitled, *Crossing Paths or Sharing Tracks,* focused on the complex problem of which branch of archaeology should be studying and conducting work on industrial projects. The papers presented were from a wide range of practitioners of all three branches of archaeology, as described above, coupled with engineers, historians and heritage specialists. The overriding conclusion to the conference was that the "…perceived animosity between the various practitioners is largely illusory" and that, effectively, it does not matter who does the research as long as it is "…well-grounded in thorough analysis yet contextualised on a broad enough level to ensure that the relevancy of the work is apparent" (Horning & Palmer 2009:406).

2.4 Industrial Archaeological approaches in South Africa

In South Africa, sadly, historical industry is rarely saved. An example is the tourist site with the industrial remains of the beneficiation plant, albeit in a dilapidated condition, of the gold mining village of Pilgrim's Rest in Mpumalanga, South Africa. Sadly, in my opinion this entire village has lost, not only its previous charm, but also much of its mining heritage in the over-exploitation by a tourist industry. There seems to be a tendency to legally or illegally destroy or bulldoze, historical sites, even if the site is not to be developed.[2] Many historical buildings have been destroyed in Johannesburg in the name of progress. We need industrial or historical archaeology to record such sites for posterity, even if they cannot be saved (Reeks 2012). South Africa's mining heritage dates back over 170 years, yet very little of these mines remain as tangible sites and in some cases not even structural ruins.

The history of some of the mines has been written. Many of the mining or beneficiation technologies were imported from Europe or the USA, modified to local conditions or even developed in South Africa and were possibly ground-breaking, but they have not been recorded or researched. These technological developments should be recognised and who better than industrial archaeologists, who are technically and historically trained.

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[2] "The battle to rebuild Jo'burg's historic laundry buildings has finally been won." *Mail & Guardian* 25 May 2016.

2.5 The introduction of Social theory into Industrial Archaeology

For many years domestic artefacts and signs of human existence have not been actively sought on industrial sites. The whole complexity of technical-social interactions has been separated by those wishing to study the industry and those looking at the social structures, when in fact the two were parts of a much wider interrelated system. A seemingly common feature of industrial period photographs is that they show a mine, a mill or a factory, but not the associated housing for the workforce. This apparent lack of interest by the owners of recording such housing for their workforce began to change in the 1980s in South Africa, when historians or anthropologists such as Callinicos (1981); Moroney (1982); Marks & Rathbone (1982); Earles (1988); Breckenridge (1990); Crush (1994); van Onselen (2001); Weiss (2011): Myers & Moshenska (2011) began publishing papers and books on the social conditions of the black mine workers of South Africa.

The transition or adoption of social anthropological techniques into historical archaeology has had a clear impact on the scope of industrial archaeology or the archaeology of capitalism. It has led to a better understanding of capitalist industrialisation and its broader impact on the underclasses. Johnson's book *An Archaeology of Capitalism* focuses more on how societies changed their lifeways and skills, than on how capital oppressed the working classes (Johnson 1996). The iconic work by E.P. Thompson - *The Making of the English Working Class* - covers a fifty-year period; 1780 – 1830 (Thompson 1966). This was a period that moved away from an agrarian economy, to one where men, women and children were forced off the land and had to seek employment from entrepreneurs, factory and mine owners, to work long hours, often in poor conditions. It was the start of the new class system in the UK and later in the USA, the birth of the so called "working class." In South Africa a similar rural migration among the black population was taking place in the 1890s. The rinderpest cattle disease epidemic crippled the black and white farmers, leading to many deaths due to starvation not only in South Africa but throughout southern Africa. The introduction of hut taxes on the black population, was primarily a means of coercing black males to seek employment, on the mines, as a source of cheap labour. Records show that between 1910 and 1940, over 50% of the mine-workers were recruited from outside of South Africa (Wolpe 1995; Beinart & Dubow 1995; Harrington et al 2004).

The whole concept of industrial archaeology is thus ultimately based upon an understanding

of the relationship between the power of the owner of an industry and its workforce. The power of the owner over the past three centuries has often been misguided by religion, social status and, from the mid-19th century, by a third force - money. The imbalance of economic power in Europe created the conditions for the development of early republicanism and later basic socialism, which was to develop into classical Marxism and eventual communism/Leninism in the 20th century (Droz 1967:62-68; Rude 1972:185; Stone 1983:118-121 & 386-388).

The 18th and 19th century housing within the Ironbridge Gorge area of Staffordshire, England - now defined as the birthplace of the Industrial Revolution - includes rows or groups of houses that often represent 'residential segregation' as well as the development of small and closely confined areas of poor housing (Alfrey & Clark 1993; Hyde 1995:70). In this example the lowest paid workers were housed close to the river and the different ranks of supervisory staff were housed progressively higher up the sides of the valley, often with each social level gaining slightly larger areas of land. Similar stratification of houses can be found in the Cornish and Welsh mining districts in the UK, dating from the same period. It is the social stratification in the Ironbridge Gorge area that became the point of interest to the social perspective of my thesis and this is discussed in Chapter 8.

Orange (2008) partially paraphrasing (Palmer 2005) stated that industrial archaeology:

> …is concerned with the interpretation of the surviving material evidence in order to understand past human activity and secondly with a preservation movement largely focused on the recording and description of individual buildings.

This is evidence of a clear shift in the concept of industrial archaeology to include a degree of interpretive archaeology. I do not believe this should be seen as a shift to, or an acceptance of post-processualism, but merely a realisation that some of the goals of interpretive archaeology are relevant to the overall goals of modern industrial archaeology. In other words it is one of the tools or theoretical approaches of modern industrial archaeology. Casella in her "Alderley, Sandhills project" discussed the impact of "industrialisation and de-industrialisation on working class rural England." "Her excavation of a domestic site related to the copper working industries of Alderley Edge in Cheshire, made use of extensive artefact analysis" (Palmer 2005:14; Casella & Croucher 2010).

The evolving approach, in the UK and USA, over the last five years or so in the development of industrial archaeology has been a holistic approach to the studies of industrial sites. In effect it has broadened the scope of historical archaeology from social anthropology or social history through archival documentary evidence, field work excavations and artefact analysis, to include the study of the industrial process, the machinery and the technology of a site and its landscape impact.

"Industrial," is the manufacturing or production process, the machinery, the products produced and the conditions of the workforce? It is all of these descriptions, but it is also the mines that produce the products from the ground. The transport systems required at all stages of the industrialisation process and the infrastructure such as bridges and harbours that supports such transport and manufacturing processes. The unique combination of the modern approach to industrial archaeology as discussed by (Hardesty 1988; Ford 2011; Tumberg 2012; Cowie 2015) in which their studies combined the interconnectedness of industry and daily social life, (Hardesty 1998; Knapp et al (1998); Cowie 2015:1) are what possibly led the way to this holistic approach of industrial sites. There is a general consensus that industrial archaeology is about an understanding of interrelated systems of economic forces coupled with the technologies of a process, transport networks, and most importantly the social context of those involved in the process.

A mine has a finite life depending upon the demand for or the availability of the commodity. Thus, the mining community as defined by Van Bueren (2002) is a "peripheral work settlement". A point made by Van Beuren is the relationship between those in the "peripheral settlement and those owning the means of production" Van Bueran (2002:4):

> …the increasing social and geographic distance… [of] the owners of many 19th and 20th century western work settlements [who] lived elsewhere and relied on managers and other middlemen to intercede for them. By distancing themselves from the inequities and poor living conditions of the work settlements they owned, elites could more easily ignore or deny responsibility for those conditions (Van Bueren 2002).

2.6 Developments in Industrial archaeological theory and methodology

Palmer set out a 'research framework' for industrial archaeology incorporating nine themes

which she outlines as focal points for an investigation; in effect, the primary questions or methodological approaches to a study (Palmer 2005:16-17). In doing this she has highlighted the principal concerns, and at the same time, a theoretical direction when seeking the answers in an industrial archaeological study.

Palmer draws attention to links between production and consumption when understanding the workplace and questions, were there patterns of surveillance in the workplace and did this amount to control of the workforce? She emphasises the importance of industrial settlement patterns, and their involvement in determining class, status and identity. She suggests that industrial archaeological studies should try to determine if a site is formed by social control[3], paternalism[4] or philanthropy[5]. This aspect will be developed in Chapter 8. Further she questions what impact did industrialisation have on the built landscape and when exposed, what is the significance of the artefacts and industrial remains? The extent of societal change also leaves patterns that can be recognised and thus be compared with similar sites on a world basis (Palmer 2005:16-17).

Historical and industrial archaeologists now accept that historical documents and records - by definition - include plans, photographs and maps, and provide a different perspective to a site than that provided by the artefacts or structural remains. All are sources that are able to confirm an analysis or provide a different insight which then needs to be discussed after contradictory arguments are created (Hodder 1994:111).

2.7 Development of an understanding of the Social Landscape at the Argent mine

In the social analysis of the Argent Silver Mine in the 1890s and 1920s, one is faced with the former period displaying characteristics of social stratification where a small group of

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3 "Social control is the enforcement of conformity by society upon its members, either by law or by social pressure". https://www.dictionary.com/browse/social-control (Accessed on 16 February 2019).

4 Paternalism is defined as "The attitude or policy of a government or other authority that manages the affairs of a country, company, community, etc., in the manner of a father, especially in usurping individual responsibility and the liberty of choice" (McLeod 1984).

5 "Philanthropy is the desire to promote the welfare of others, expressed especially by the generous donation of money to good causes". https://en.oxforddictionaries.com/definition/philanthropy (Accessed on 16 February 2019).

capitalists – the Randlords – owned and controlled the productive resources of the mining industry of South Africa. In doing so they employed workers who fell into a general category of "working class". The working class in the South African Republic (ZAR) of the 1890s, and in the Union of South Africa as it was in the 1920s, was further stratified along lines of racial separation, which prior to the period of Apartheid (post 1949) was defined as Segregation (Lacour-Gayet 1977:295; Muller 1993:429-435; 465-466).

When the Argent mine was re-opened in 1919 as the TSBM, black mine workers were recruited to work on the mine. This thesis will endeavour to investigate how they were recruited, what employment positions were open to them, and how much they were paid? It is hoped that the Company records will yield the relevant data or alternatively some of it will be available through the Chamber of Mines archives.

In trying to understand the lifeways of the black mine workers at Argent, analysis of their housing areas and associated middens, discovered during the initial land survey, will be made. The almost complete lack of documentary records concerning the black mineworkers at Argent underpins the importance of the archaeology of the foundations and middens of their residential areas to provide sufficient data to determine part of their lifeways and food ways. It is known that the gold mines operated 'open compounds' for their black mine workers (Callinicos 1981), as an alternative to the so called 'closed compound' of the diamond mines. Segregation of the black mineworkers at the Argent mine will be explored through the type and location of their accommodation for both the 1890s and 1920s periods. What is not known is what type of compound existed at the Argent mine and hopefully through documentary research and archaeological excavation, this question will be answered.

Terms such as 'social injustice', 'human rights' and 'social inequalities' most likely did not exist in 1920s South Africa. The social norm was to keep blacks and whites apart and although the site more than likely kept to these spatial relationship principles, it does appear that the black mineworkers lived in a more relaxed environment - even if it was a paternalistic one where it appears everything was provided to them. These avenues are explored in more detail in Chapters 8 and 12. What has been determined from the initial documentary research is that there was not a compound either 'open' or 'closed' at Argent and that Argent may well have been a social experiment by providing the black mineworkers

more agency in determining their social structures within the designated ‘native location’ accommodation area. This will be explored in detail in chapter 8.

In developing the understanding of the black mineworker native location and the 1890s black mine worker compound - if in fact the 1890s facility was a compound - one is faced with very few comparable South African works, either as dissertations or theses. Two such works by Behrens (1999) and Weiss (2009) were used and their approaches to black industrial worker or black mine worker were noted.

2.8 Conclusion

It is my intention to study the site using the techniques of both industrial and historical/social archaeology, but in a holistic framework as defined above. It will be a multidisciplinary study utilising mineral processing technology, mining engineering, studies of the landscape and built environment, historical and archival documentation, social history along with GPS satellite surveying techniques, excavations and artefact analysis. To give effect to this statement I will be following the approach outlined by Palmer (Palmer 2005:16), looking at both the technological development of the mine and the living and working conditions of the Argent black miner workforce within the time periods.

The industrial archaeological part of this thesis will look at the technologies of the beneficiation of ores in the 1890s and 1920s, how they differed and what advances in technologies can be seen.

The details of the social conditions of the black mine workers on the mine will be gathered and examined from the excavations of the foundations of housing structures, and the identification and classification of artefacts from the middens and possibly house foundations discovered during the initial surface survey. The spatial layout of the ‘native location’ at the Argent mine will also be studied and is reviewed in Chapter 8 section 8.3 and discussed in Chapter 12.

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Chapter Three

The beneficiation and mining processes of the Transvaal Silver Mine 1889-1896

3.1 Introduction

This chapter and chapter 4 will look at, and discuss, the mining technology at the Transvaal Silver Mine in the latter part of the 19th century. The processes and machines that were installed and used will be analysed. The mines and mining groups created in the late 1880s in South Africa were mostly controlled by the famous Randlords (Wheatcroft 1985). Consulting mining engineers and metallurgists trained in the USA or Germany were considered to be leaders in their field and were consequently hired for these positions (Rosenthal 1970:178). However, the underground managers and skilled deep level miners were generally British or German (Callinicos 1981; van Onselen 2001). These demographics were reflected in those employed at the Transvaal Silver Mines Company.

From an archaeological point of view, very little of the 1890s building structures remain in 2018. Surface surveys and some excavations were carried out in 2012 (Reeks 2012). The data from those surveys was compared with the original historical mine plans[1] dating from 1890 and 1892. They were found in the plans file of Barlow World Ltd Archives and referenced by the name Transvaal Silver Mine. When compared with the survey data there was a high degree of compatibility. Both mine plans were incomplete and despite efforts to find more plans, no additional surface plans of a date later than 1892 have been found. Research into the mechanised beneficiation technologies of the 1880s/1890s has led to a better understanding of what was a very young science and industry at that time in South Africa. The two mine plans of the TSM were helpful in understanding the initial mining operation and its basic methodology. A re-evaluation of the buildings has been made with specific focus on the location of the roasting and smelting plant, as well as the black miner compound. By following clues in documents and drawing together independent, but

[1] BRA. Archives of H. Eckstein & Co. Plans File:
Plan of the surface and underground of the Transvaal Silver Mine – 1890.
Plan of the underground of the Transvaal Silver Mine – 1892.

disparate links**,** it has been possible to identify and propose a location for the roasting and smelting plant.[2]

I made a significant find in the National Archives of South Africa, in Pretoria, some years ago when four photographic negatives were found showing four of the buildings of the TSM. These were taken in 1901/2 as part of a war damages claim.[3] The most significant of these photographs for this thesis was the one showing the concentration plant, which does not appear on either of the mine plans. However, the actual date of this plant has now been established from the newspaper reports and a close inspection of the TSM company records.

The 1892 General Manager's report proved particularly valuable as it presented details of the surface development of the buildings and the beneficiation equipment along with the hoisting and pumping equipment of the mine. This led to a discovery, previously unrealised, that the mine had a "Cornish pit work" or pumping arrangement, details of which are discussed along with drawings of the equipment. What has been significant in this project for the 1890s period was the availability of detailed records. Often a make of machine or a name of the sub-process was in the sources.

Many of the decisions regarding the treatment of the ore from 1889 onwards were caught up in the boardroom politics of the company and from 1890 the partners of the holding company – H. Eckstein & Co. Although the mine had great potential, it was hampered by the process of continually changing its ore treatment methodology. This resulted in substantial downtimes, re-establishment of a workforce, and the short periods of actual successful beneficiation of the ores.

3.2 The Transvaal Silver Mines (TSM) under the control of the Barnato's in 1889- to early 1890

The Transvaal Silver Mines company was formed on the 23rd January 1889. It is not clear if prospecting took place before or after the company was formed, the earliest mention of

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2 'Transvaal Silver Mines', *The South African Mining Journal,* Vol. 1, (3 September 1892), pp. 863-866.

3 NASA, Pretoria. Depot TAB, Source CJC. Volume no 43, Ref. CJC796 – Claims for Compensation British Subject Transvaal. Pretoria. Transvaal Silver Mines Limited. 1903-1904.

the deposit at what became the TSM operation is in a letter re the discovery in July 1885 of a new mineral.[4] This mineral was unique in South Africa at what became the TSM mine. In 1893 a book *The Minerals of Southern Africa* described the mineral crocoite, as occurring at the TSM (Wilson-Moore & Wilmer 1893:61).

Sources state that the "lode had been prospected at nine points by winzes and shafts"[5] and this most probably included the prospecting shaft. In February 1889 a brief report mentions lead ore being found with a high assay of silver.[6] It would appear investment in the property was carried out at the same time as prospecting, because the Transvaal Silver Mines Ltd was registered on 31 January 1889 with a capital of £270 000, a considerable sum of money in the 1880s; approximately £31 million in 2018 or R0.6 billion.

The first board of directors included the following notable South African mining people: Barney Barnato (chairman), the diamond magnate, as well as chairman of the Johannesburg Consolidated Investment Company (JCI) which he founded in 1889; George Farrar chairman of the Witpoortje Syndicate (another silver mining company) and founder and chairman of the ERPM Gold Mine, George Kynoch founder of an ammunition and fertiliser company in UK and South Africa, also a director of the Nevada Silver Mining and Smelting Co west of Pretoria and S.W. Jameson, the brother of Dr Jameson of the infamous Jameson Raid and a director of the Willows (Silver) Mine, Ltd located east of Pretoria (Reeks 2012:71).[7]

It would seem from the 1889 newspaper reports that progress was swift in the development of surface winzes to test the quality of the ore-body. In the quote there is, however, an error in the number of 'small incline' shafts mentioned when it states "Seven small incline shafts

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4 Dawson, E, Chemical & Metallurgical Laboratory, Pretoria, ZAR. Letter to the Mineralogical Society, London, 'Lead chromate from near Pretoria', 27 July 1885, *Mineralogical Magazine,* Vol. 6, 1886, p.p. 18-19. Samples of the mineral were sent to London for analysis and the results indicated the very rare mineral species crocoite ($PbCrO_4$**).**

5 BRA. Archives of H. Eckstein & Co HE 5 annexure 25: Report by TSM Wilkinson, A. 22 August 1901.

6 *The Diggers' News* 9 February 1889.

7 Registrar of Companies, Pretoria. File 01/00219/06, Transvaal Silver Mines Ltd, Registered 31 January 1889.

are down to various depths of 30 to 43 feet on the western side, two to the west and two to the east of the main vertical shaft",[8] which is explained when Furlonge's report is discussed below.

An incline shaft can still be seen in the large sinkhole east of the main shaft. According to the 1892 plan, it is probably winze number IE2.[9] This sink hole has been growing in diameter over the last twenty years and it is most likely the result of near surface stopes collapsing.

The earliest official report on the TSM was found in the Johannesburg Public Library (JPL) and was written by W.H. Furlonge, for the Directors of the Transvaal Silver Mine.[10] At the time he was a land surveyor based in Barberton and wrote the report after two visits to the TSM, in July and in November 1889. (Plug 1990).[11] His report details the extent of the mining development carried out on the prospecting shaft and the sinking of the new main shaft measuring 12 ft. (4 m) x 6 ft. (2 m) south of the prospecting shaft. He correctly mentions three winzes to the east and four to the west of the prospecting shaft, in contradiction to *The Diggers' News* incorrect report cited above. He discusses the high inflow of water at a depth of 60 ft. (18 m) and of it being "20-30 000 gallons per hour", further stating that the pumping equipment being delivered from the UK should easily overcome this inflow.[12] *The Diggers' News* reported a 'powerful hauling and pumping plant from the Sandycroft Foundry Company' being delivered and installed at the mine.[13] Clearly Furlonge considered the mine a viable proposition as he details the average values of the ore between 40 – 70 ozs silver/ton and running as high as 250 ozs/ton on the eastern winzes.

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8 *The Diggers' News* 11 June 1889.

9 BRA. Archives of H. Eckstein & Co. Plans File:
Plan of the underground of the Transvaal Silver Mine – 1892.

10 JPL Harold Strange Library - Transvaal Silver Mines - Report to Directors of Transvaal Silver Mines by W.H. Furlonge, (26 November 1889), Archive Ref 622 Silver Mining.

11 'William Holland Furlonge'. Retrieved from http://www.aols.org/sites/default/files/Furlonge-W.H.pdf (Accessed on 10 October 2018): http://www.s2a3.org.za/bio/Biograph_final.php?serial=1008 on W.H. Furlonge (Accessed on 10 October 2018).

12 Transvaal Silver Mines - Report to Directors (see footnote number 9).

13 *The Diggers' News* 6 June 1889.

Although he discusses reduction of the ore in reverberating or cupola furnaces, these were not initially installed.[14]

The initial opening up of the mining operation in 1889 was through a long set of surface trenches up to 3m deep in places. These are still visible today, and run roughly east and west of the prospect shaft and the later main shaft over a distance of about 300 m in each direction. The trenches proved the existence of ore and a set of surface winzes or inclined shafts as described in Furlonge's report, were developed. The prospect shaft appears to have been a single cage shaft, probably 3 x 3.5 ft. (0.9 x 1.1 m) and although now blocked 2 m below normal ground level, its position is visible on surface. Associated with the shaft are the remains of a concreted area with some brick walling, most likely the possible foundations for the shaft headgear. The bricks are low grade, hand-made sun-dried or low fired clay type. According to *The Diggers' News*, the sinking of the main shaft - 8 x 5 ft. (2.4 x 1.5 m) - was planned for September.[15]

The original plan in 1889, for the treatment of ore, when the mine was under the control of Barney Barnato and his nephew Woolf Joel, appears to have been sorting the ore by hand and probably reducing it in size by hand hammering/crushing (cobbing), to separate the ore from the waste rock. This was followed by bagging the ore for shipment by ox-wagon to Charlestown in Natal – the nearest railhead for Durban before 1895 and then exported by sea to Swansea in the UK for smelting.[16] When one considers that an ox wagon could only transport 3.5 tons per time, one can imagine that transportation by such means must have been a huge proposition.

The first mention of a shipment of ore is in an anonymous report published in *The Diggers' News* in December 1889.[17] The report states that the main shaft had reached a depth of 100ft. (30 m) and that the ore assayed at "…50% lead and 75 ozs of silver per ton. 25 tons of ore was shipped to Barnato Brothers in London."

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14 JPL Harold Strange Library - Transvaal Silver Mines - Report to Directors of Transvaal Silver Mines by W.H. Furlonge, (26 November 1889), Archive Ref 622 Silver Mining.

15 *The Diggers' News* 22 August 1889.

16 *The Diggers' News* 11 April 1991.

17 *The Diggers' News* 7 December 1889.

It is not clear from the documentary evidence who the first mine manager was and thus who decided on the original hoisting and pumping equipment or the method of ore recovery in the period 1889-1890. It may have been a member of Barnato's JCI staff at the time, but this cannot be confirmed.

At the first AGM of the shareholders, which was held on the 31 January 1890, it was reported that Mr Jas Gay had been appointed as the new manager as he had extensive experience in silver mining.[18] Biographical searches have been unsuccessful on Gay, but as the Nevada and Colorado silver mines were major silver mining fields at the time, it is possible that as he was an American mining manager/engineer.

The issue of Barnato purchasing shares in JCI using TSM funds was raised at the TSM Annual General Meeting. When the evidence of this misuse of funds by Barnato was raised by Eckstein, Beit and Phillips - directors of H. Eckstein & Co (later Rand Mines) – "it led to a hostile takeover by these shareholders of Transvaal Silver Mines Ltd. and the removal of Barney Barnato" and his control of TSM (Reeks 2012:73-74).

3.3 The Company falls under H. Eckstein & Co control in early 1890

Once the hostile takeover by the H. Eckstein & Co was completed in early 1890, Lionel Phillips, a senior partner of the Eckstein Company, became chairman of Transvaal Silver Mines Ltd. After the takeover of the company, the mine was inspected by American mining engineer Hennen Jennings. One year later at the AGM in 1891 he reported that after the takeover by H. Eckstein & Co: "The mine was closed down on the April 10th1890 and the Main Shaft allowed to fill up with water to the natural level".[19]

Hennen Jennings was one of a handful of experienced American mining engineers who came to South Africa in 1890. He was a graduate of Harvard University in 1877, before working on gold mines in California and Venezuela. In 1889 he was appointed as Group Consulting

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18 *The Diggers' News* 1 February 1890.

19 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by H. Jennings. February 1891:5.

Engineer of H. Eckstein & Co.[20] After the takeover of TSM from Barnato, he provided a detailed report to the directors of TSM of the development of the mining operation, initial equipment and mine buildings.[21] His description of both the equipment and the building structures appears to be what was on the site during the Barnato operation. Jennings mentions "one iron head-gear complete, 30 ft. (9 m) high, with two hoist cages and a 12 inch Cornish pump" which he cites as being on hand, but not in use. This would imply that the 10 ft. (3 m) high wooden head-gear described below was in use on the main shaft. Jennings' 1890 report continues with the list of the primary installed pumping and hoisting equipment as:

> One 8 hp. Sandycroft Steam Winch. Hoist – 2 drums.
>
> One 6 hp. pumping engine – cylinder 6 inch diameter, 12 inch stroke. Pinion 1ft., spur wheel 5 ft. This operates: two - 6 inch Cornish Pumps, one with 3 ft. stroke and one with 4 ft. stroke. One 16 hp. Sandycroft Boiler, supplied with heater.
>
> A wooden head-gear 10 ft. high – two sheaves 3 ft. in diameter.[22]

A drawing of an 1879 winch shown below was found in Williams' Perran Foundry catalogue.[23]

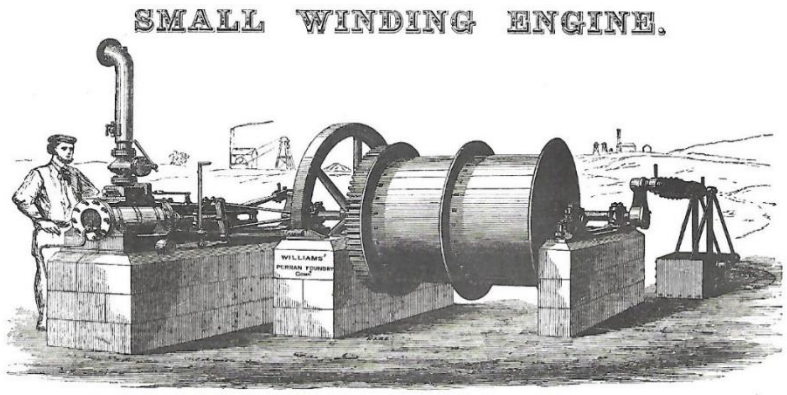


Figure 8. Williams' Perran Foundry Winding engine c1880. Actual details of this machine were not recorded in the source but it is believed to be similar to the Sandycroft Winding Engine installed at TSM. (Williams' Perran Foundry Co., Cornwall catalogue, Reprinted by The Trevithick Society, 1986).

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20 Biographical notes on Hennen Jennings on https://www.s2a3.org.za/bio/Biograph_final.php?serial=1439 (Accessed on 18 February 2019).

21 JPL Harold Strange Library - Transvaal Silver Mines - Report to Directors of Transvaal Silver Mines by H Jennings, (April 1890), Archive Ref 622 Silver Mining.

22 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by H. Jennings. April 1890:10.

23 Williams' Perran Foundry Co., Cornwall catalogue, Reprinted by The Trevithick Society, Cornwall, UK. 1986.

Jennings in his 1890 annual report, stated that in his opinion the pumping equipment was undersized for the future development of the mine and recommended it be replaced with a 9 inch Cornish pump. He also mentions that he considered the 12 inch pump as oversized for the pumping requirements. When describing the reduction of the ores, he recommended the installation and use of a 36 inch diameter round water jacket smelting furnace.[24] He further stated that use of a reverberatory furnace to roast the ores had been used in America, but that they were expensive to run, due to the need for good quality fire brick, also both types of furnace require good quality coke for their operation. These comments are interesting because Jennings contradicts them in his report in 1892, in which he recommends the use of a concentration plant.[25] [26] It is thus very difficult to decide which system of beneficiation he truly supported. His recommendation was to employ a skilled metallurgist with a proven track record of treating similar classes of ore to the TSM, coupled with a thorough analysis of the availability of good smelting coke.

In April 1892, Jennings stated that there was 11 000 tons of ore at 'grass' – ore that was on surface awaiting treatment - and approximately 39 000 tons more in undeveloped areas between the surface and the 130ft. (40 m) and 230 ft. (70 m) levels.[27] This would have been enough to keep the two smelting furnaces going for 5 years without any further development of the mine.[28]

3.3.1 The management of Otto H. Hahn as metallurgist and general manager 1890-1892

In early 1890 Lionel Phillips, chairman of TSM, announced the appointment of Otto H. Hahn both as general manager and metallurgist to the TSM. Hahn, a German, had been engaged in the smelting of lead and silver ores in the USA and Mexico for twenty years.[29]

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24 JPL Harold Strange Library -Transvaal Silver Mines - Report to Directors of Transvaal Silver Mines by H Jennings, (April 1890), Archive Ref 622 Silver Mining.

25 BRA. Archives H. Eckstein & Co HE 5 TSM – AGM Report by H. Jennings March 31 1892:6-7.

26 'Transvaal Silver Mines', *The South African Mining Journal,* Vol. 2, (21 January 1893), p. 257.

27 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by H. Jennings. March 31 1892:6-7.

28 'Transvaal Silver Mines', *The South African Mining Journal,* Vol. 1, (3 September 1892), pp. 863-866.

29 BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM Report. April 9 1891:2.

He had been general manager of the Union Minera at Zimapan, Mexico and the metallurgist for the Colorado Smelting Company in the USA (Fell 2009:99).[30] Before coming to South Africa he was involved in the smelting operation at the Kansas City Smelting and Refining Company also in the USA at which he is said to have improved their smelting process.[31] What became of Mr Jas Gay, the previous manager, is unknown. On Hahn's appointment Jennings, for some unknown reason, effectively resigned from active participation with the TSM operation, although he remained as group consulting engineer to the H. Eckstein & Co.[32] As Jennings advocated the employment of a metallurgist one presumes there was a personal conflict with Hahn. Hahn was to carry out chemical and metallurgical studies of the TSM ores to determine the best and most profitable methods of reducing and smelting the ores.[33] His proposals seem to revolve around both a direct shipment of the rich ores and the erection of a smelting plant consisting of two reverberatory furnaces for roasting and two blast furnaces for smelting the ore to base bullion.[34]

Hahn believed the ore needed to be roasted before smelting to reduce the lead - and zinc - sulphide level in the ore which hindered the smelting process. The fine dust created by the explosives in the mining operation, along with the fines created by the crushing operation also needed to be roasted to form a clinker prior to smelting. As will be seen in the text below, the start-up of the smelting operation was beset with the problems relating to the supply of quality local coke or at least that comparable in quality to imported Welsh coke. The imported coke cost more, which lowered the profit levels of the finish smelted bullion. This became a continual topic of dissension between Otto H. Hahn and Philips and was never resolved.[35]

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30 BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM Report. April 9 1891:2.

31 Ibid.

32 BRA. Archives of H. Eckstein & Co HE 5 TSM – 3rd AGM Report. April 21 1892.

33 BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM Report. April 9 1891:2.

34 Ibid.

35 BRA. Archives of H. Eckstein & Co HE 151 letters from August 4 1892 to October 7 1892.

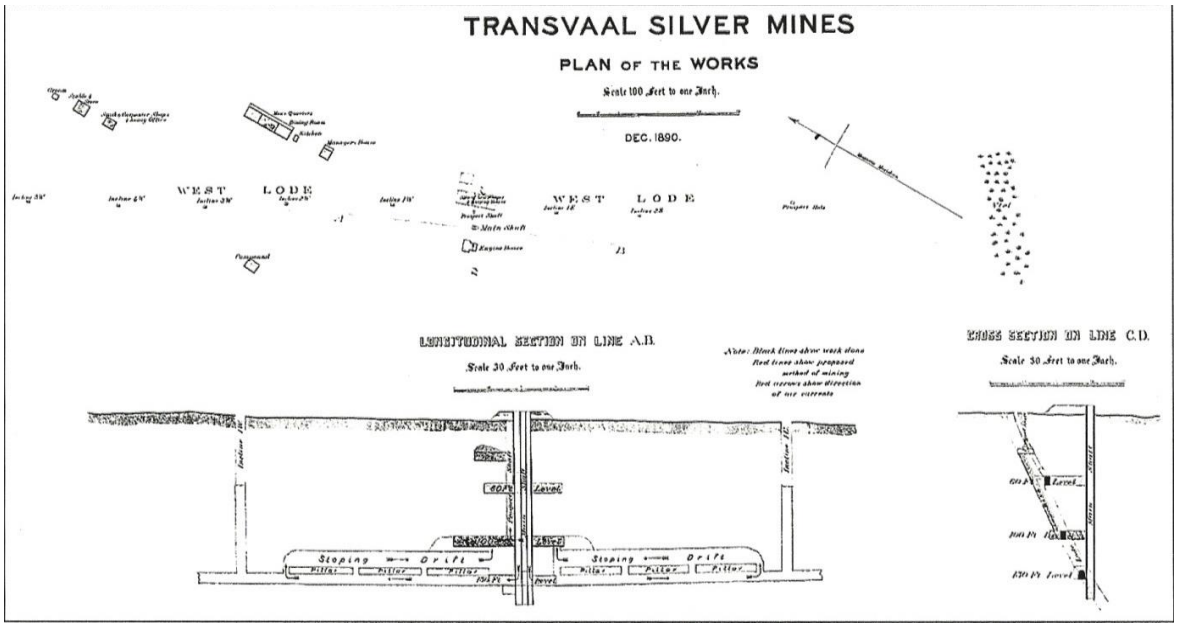


Figure 9. Transvaal Silver Mine Ltd. 1890 mine plan – underground and surface structures. Some of the details on the plan may be poor, due to the reduction from an A1 size original. The plan is reproduced as Appendix 2.0 as a full A4 page copy.

According to the documents/records the mine installed smelting 'blast furnaces' and roasters in 1891/2 and additional buildings of noted sizes.[36] It was not apparent from extensive pedestrian surveys of the site where the foundations for such buildings were located. Surveys carried out since 2012 revealed the site/foundation material of the original 1889 blacksmiths shop and stable, located in the maize field north west of the shaft, however only scatterings of broken brick remain (Figure 9). The 1889 general manager's house/office and the white miner single quarters were located and partially excavated in 2010 (Reeks 2012).

Dewatering began in July of 1890 coupled with the redesign of the main shaft, pumping facilities and development of the mining stopes and drifts on the 100 ft. (30 m) and 130 ft. (40 m) levels.[37] To overcome the high inflow of water a cistern chamber was cut at the 130 ft. (40 m) level. The report by Jennings mentions that the following equipment was purchased and installed:

> Pumping Engine (Ruston & Proctor), horizontal, high pressure, indicating 77 hp. at half cut off, single cylinder 13 inch diameter, 24 inch stroke, with extra heavy fly-

[36] BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM General Manager's Report. April 9 1891.

[37] BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by H. Jennings. April 1890:6-7.

> wheel. In order to increase its power, and guard against breakage, a new extra strong steel gearing has been ordered from England. This will allow sinking to a depth of 1000 feet, with present amount of water.
> Winding Engine (Tangye), 28 hp. two cylinder double drums (independent) 54 in and 14 in, mounted on an iron girder frame.
> Pit Work (Harvey & Co) 10 in. Cornish pit work consisting of 250 ft. 10 in. x 10 in. pitch pine spear rods, plunger complete, T bob, and 2 Pitman rods (Figure 10 & 11).
> Two (Frazer and Chalmers) stationary multi-tubular boilers, 48 in. x 14 ft. with a 65 ft. [20 m] smoke stack, and all fittings.[38]

At the second AGM of the TSM in April 1891 it was stated that redesign of the main shaft had been completed and that they had about 2 700 tons of ore 'at grass'[39] – at a gross value of £23 000.[40] Discussions centred on the shipping of the ore to London. The ore was worth £26/ton and the shipping costs to London were £5/ton.

It was further reported that the development of the mine continued well, with the main shaft reaching a depth of 166 ft. (51 m) and through the development of stopes on the 130 ft. (40 m) level and of the incline winzes, the ore-body had been proved rich over 1 000 ft. (304 m) laterally.[41] The only negative aspect of the report was that development of the East lode was halted due to a high inflow of water at 48 ft. (15 m) and thus the need for larger pumps.[42]

The second AGM report (1891) also presented the first details of the productive capacity of the mine under Hahn, and the expected annual returns once the beneficiation plant was in full operation. Apart from the furnaces and roasters, the report mentions that the cost of the rock breakers, additional buildings, blowers and all appliances including erection would be no more than £20 000.[43] Hahn stated in his report to the AGM that the plant was expected

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38 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by H. Jennings. April 1890:6-7.

39 Ore stockpiled on surface awaiting treatment or shipping.

40 BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM Report. April 9 1891:2.

41 BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM General Manager's Report. April 9 1892.

42 BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM Report. April 9 1891:2.

43 Ibid.

to have a capacity of 80 tons per day or 24 000 tons per annum, providing an annual gross product of £210 000 of bullion from the furnaces and £63 000 from shipments of high grade ore. The cost of each ton treated and shipment of the bullion to Europe was not expected to exceed £6. This would provide an expected profit of £60 000 for the bullion plus £40 000 for the high grade ore shipped.[44] A detailed analysis of the actual costs and productive capacity is given in Chapter 4 and as will be seen, differs significantly from Hahn's predictions. Hahn stated that he did not consider the transportation of the product was:

> …of a very serious nature", [and that]…the reduction of 2 000 tons ore per month would result in the production of about 400 tons of bullion, to which must be added the 200 tons of selected ore, making 600 tons per month to transport by ox wagon. Each wagon will take about 3.5 tons, and therefore 175 loads [of ore and bullion per month] would have to be removed.[45]

In reality Hahn only managed to produce around 700 tons of bullion and 700 tons of high grade ore in one year, therefore he was correct to state that transport would not be a serious problem. The real problem is that he never met his production target of 400 tons of bullion and 200 tons of high grade ore per month. These values are derived from the calculations carried out as part of Chapter 4. Of course TSM was only one mine, and when one considers the needs of the gold mines and the citizens of Johannesburg and surrounding towns, it gives some idea of the huge logistical ox-wagon transport industry prior to the rail line being extended from Charlestown to Johannesburg, The full rail link between Durban and Johannesburg, was only completed in 1895 (Cameron & Spies 1986:177).

The need for fresh farm produce at the TSM mine became clear when the AGM report mentions:

> …they had within the last six months made a garden, from which an ample supply of vegetables…had been drawn…and from which about 100 bags of mealies for their [employees] winter requirements had been furnished.[46]

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44 BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM Report. April 9 1891:2.

45 Ibid.

46 BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM Report. April 9 1891.

In the Consulting Engineer's, report he states that:

> A piece of land, about 25 acres, has been fenced off, and in part planted with vegetables of all kinds, which it is not possible to obtain otherwise, and a large crop of mealies [maize] is also looked for, as the ground is well irrigated. It is expected that this undertaking will be more than self-supporting…[47]

In Hahn's General Manager's report in April 1892 he writes, "The Company has about 65 acres under cultivation, mostly planted with mealies [maize]. The growing of vegetables is only a moderate success; the vermin getting the lion's share".[48]

Livestock was kept at the mine and it can be assumed that this was a primary source of meat. Each of the AGM financial reports from 1890 to 1895 shows 'livestock (written off)' as an item. The reports do not define the stock or how much was written off, but Hahn's report in 1892 mentions "a cattle kraal for cattle and sheep".[49] It is hoped such animals will be confirmed by the archaeological excavations of the middens of the compounds. It is already known from pedestrian surveys of the areas that bones do exist. This aspect will be covered in later chapters dealing with the social archaeology.

The underground development of the mine at the 130 ft. (40 m) level was based on a 'drift stope' system of mining.[50] His report continued by describing the method where a drift or tunnel was driven along the ore-body leaving a solid strip of lode about 2 m above the main drift.

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47 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by H. Jennings. March 31 1892:7.

48 BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM General Manager's Report. April 9 1892:12.

49 Ibid. p 11

50 Ibid. p 6.

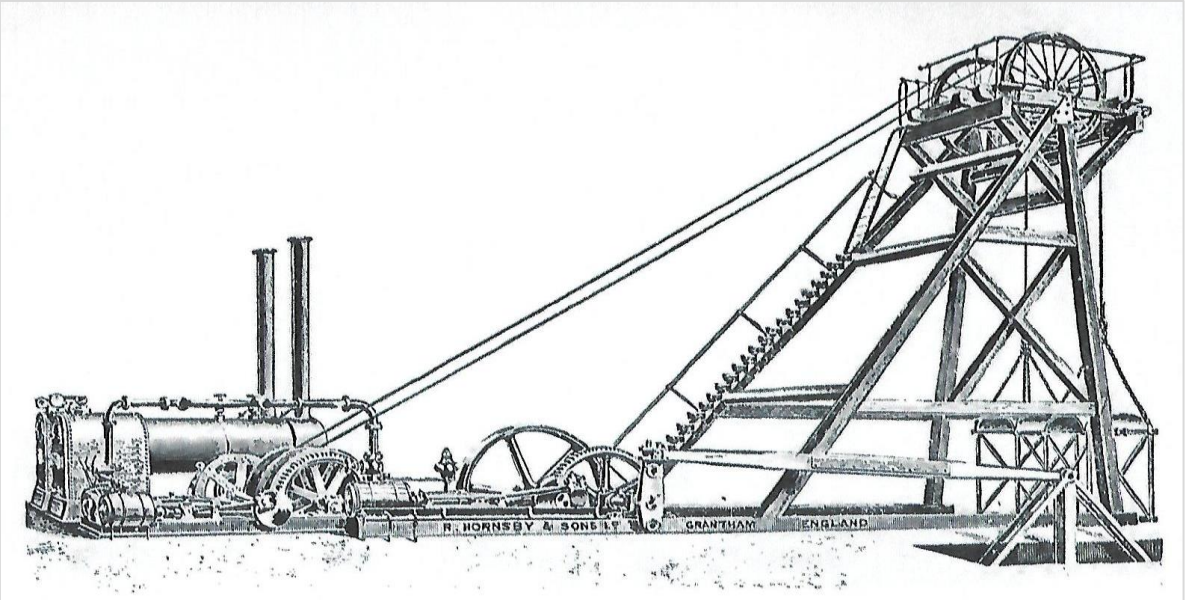


Figure 10. Arrangement of winding gear coupled with a pumping engine attached to a flat rod and the Tee bob. Note although this shows a different make of engine namely R Hornsby & Son Ltd the arrangement is the same as was installed at Argent (Davies 1902:91).

At intervals of about 15 m this strip was pierced and the lode mined out in a stope or gallery about 4-6 m high above the pillar or remaining lode material. The 1890 mine plan (Figure 9) showing a longitudinal section of the mine gives some idea of the mining method.[51] Once the lode material was mined out, a sub-level was put in above the mined out lode leaving a 2 m thick bed of lode to work on and the process of mining was repeated. Finally the lode material remaining between the original drift and the sub-levels was removed. The ore and waste was removed from the stoping[52] areas along the drifts to the main shaft and raised to the surface for treatment.[53]

An additional development on the mine in 1890 was the installation of a 12 hp. engine to supply power and lighting. This was necessary because of the isolated nature of TSM, about 100 km from Johannesburg. It was also necessary to equip the mine with a machine shop -

51 BRA. Archives of H. Plans file - Plan of the surface and underground of the Transvaal Silver Mine – 1890.

52 Stoping area – part of an ore body opened up through tunnels and raises ready for mining. (Thrush 1986).

53 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by H. Jennings. April 1891:6.

with a lathe and drill press; a carpenter's shop - with a circular saw bench all of which required power. A blacksmith's shop with two forges was also installed.[54]

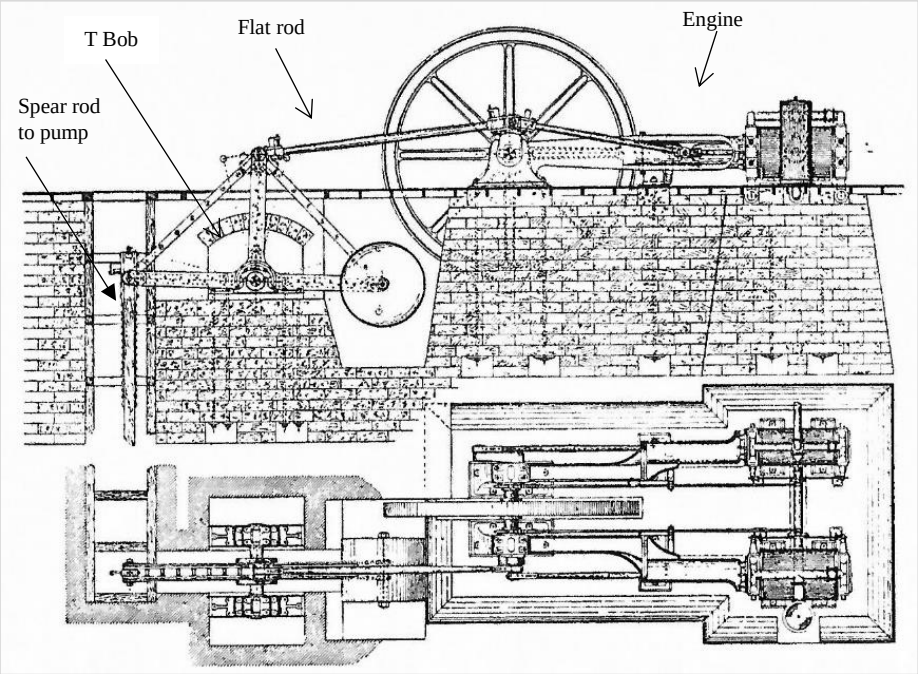


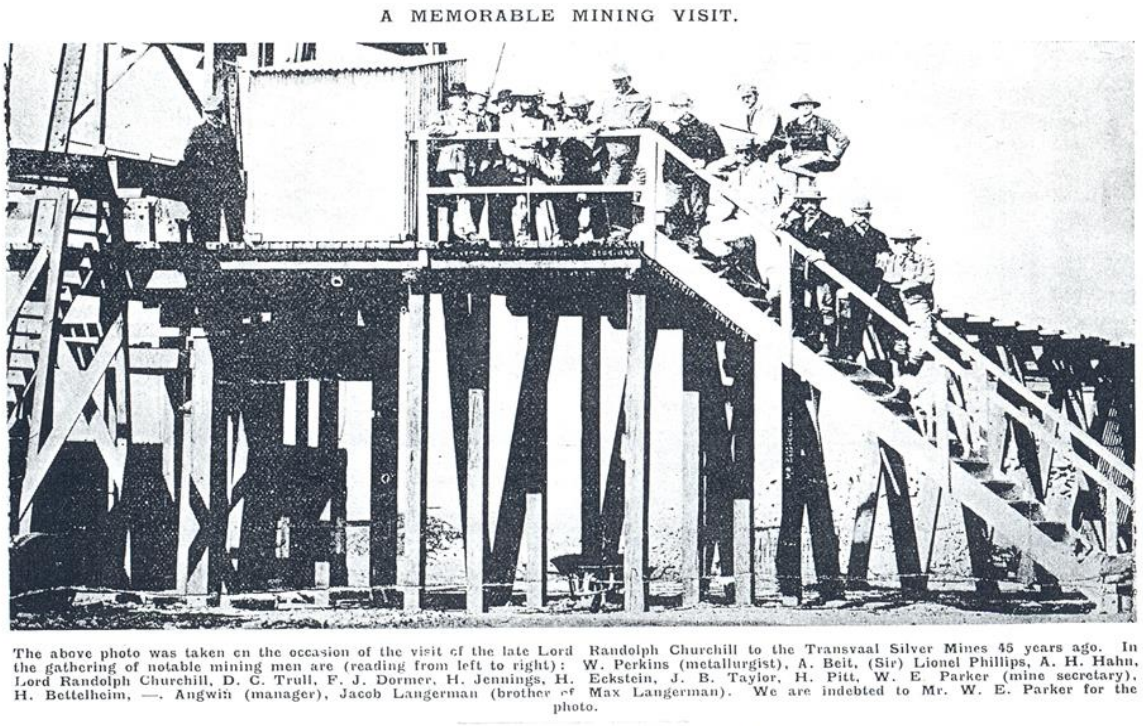
Figure 11. Showing a detail of a T bob, engine, and spear rod at the pumping shaft. (Davies 1902:115).

By December 1891 the smelting plant was in the process of being delivered to the mine. A report in the *SA Mining Journal* mentions two water jacket blast furnaces, two reverberatory roasting furnaces, two Baker blowers, Cornish rolls and a rock breaker.[55] Underground development of the mine was progressing well, with the main shaft reaching 300 ft. (91 m) in depth and a new level at 230 ft. (70 m) being developed.[56]

54 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by H. Jennings. April 1891:7.

55 'Transvaal Silver Mines', *The South African Mining Journal*, Vol. 1, (5 December 1891), p. 161.

56 Ibid.



A MEMORABLE MINING VISIT.

The above photo was taken on the occasion of the visit of the late Lord Randolph Churchill to the Transvaal Silver Mines 45 years ago. In the gathering of notable mining men are (reading from left to right): W. Perkins (metallurgist), A. Beit, (Sir) Lionel Phillips, A. H. Hahn, Lord Randolph Churchill, D. C. Trull, F. J. Dormer, H. Jennings, H. Eckstein, J. B. Taylor, H. Pitt, W. E Parker (mine secretary), H. Bettelheim, —. Angwin (manager), Jacob Langerman (brother of Max Langerman). We are indebted to Mr. W. E. Parker for the photo.

Figure 12. Historical photograph of the visit by Lord Randolph Churchill to the Transvaal Silver Mines Ltd sometime in 1891 (Reeks 2012).[57]

In 1891 a visit was paid to the mine by Lord Randolph Churchill - Winston's father - as part of his tour of "Rhodesia" and South Africa. His visit is described in his book *Men, Mines and Animals of South Africa* 1893, and it also provides a brief discussion on the silver mining industry of the 1890s (Reeks 2012).

When the picture (Figure 12) was used in previous research (Reeks 2012), the importance of the elevated landing station at the main shaft and the raised trestle in the background was not realised. In Jennings' 1890 report he describes the elevated landing station clearly shown in the photograph: "The landing station will be raised 14ft. above ground level, and trucks run over trestle work to ore dressing floors." [58]

Jennings' last report for TSM was in March 1892. He describes a new cistern having been cut at the 230 ft. level and repositioning of the 10 inch Plunger pump there from where it had been located on the 130 ft. (40 m) level. He also mentioned the drawing lift that was connected to the main pit work being extended down to the 330 ft. (100 m) level in the main

57 'A memorable mining visit', *The SA Mining and Engineering Journal*, (25 January 1936), p. 695.

58 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by H. Jennings. April 1890:7.

shaft.[59] Further in his report Jennings also mentions that work on the East or number 2 shaft had been suspended on 16 January. However he did not elaborate other than to say further prospecting was needed when the company was in a better financial position. When Hahn's report for the same AGM was read, he seemed to indicate a more likely reason, namely that:

> The ore struck in the East Lode proved so refractory that it could not have been made available for smelting without machine-dressing, and I therefore recommended to you the suspension of operations on that mine until…when the dressing works [is in operation].[60]

By July 1892 one of the blast furnaces had been 'blown in',[61] with the second one being commissioned in October. In the short time that the blast furnaces were in operation the report states that 360 tons of bullion was produced, yielding 1.2 tons of silver and 356 tons of lead and it was stated that the actual smelting process was a success.[62] The closure of the smelting operation therefore appears strange and no reason was given. Why go from the original crushing and bagging process to a smelting operation, albeit with the associated problems of the cost and supply of coke, only to suspend operation of the blast furnaces after a few months?

It was found that local coke was only marginally inferior in quality to imported coke and thus, to save costs, local contracts for supply were entered into. Ironically this supply became dubious and the furnaces were shut down pending better supplies of local coke. This was never achieved and the original local supplier was eventually taken to court by the company for failure to supply as per a contract (Reeks 2012). This supply problem was something which Hahn openly stated was not of his concern as he was the smelter.[63] Hahn's report appears to be making excuses as to why the operation was not a success.

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59 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by H. Jennings. March 31 1892.

60 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by General Manager. 8 April 1892:11.

61 To put a new or re-built blast furnace into production.

62 'Transvaal Silvers Co', *The South African Mining Journal,* Vol. 2, (1 October 1892), p. 14.

63 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by General Manager. 8 April 1892:9.

Hahn stated that Jennings had recommended that two water jacketed open top blast furnaces be ordered, but that he decided to add two roasting furnaces to de-sulphurise the lead and zinc in the ore prior to going to the blast furnaces. One furnace from the USA was the same as Hahn had used at the Consolidated Kansas City Smelting and Refining Company, and a second furnace was ordered from the Sandycroft Foundry Company in the UK.[64] No explanation was given as to why the order was split between two manufacturers, in two countries. Hahn also talks of the difficulty of procuring fire-brick for the furnaces. He mentioned the world renowned Stourbridge firebricks that had been ordered from England, but had arrived in a broken and unusable condition. It appears that he was eventually supplied by the Boksburg and Vaal River Brickworks of Lewis and Marks.[65] TSM did make low grade fired and unfired bricks and some of these have been found in various excavations. Generally they are unmarked and have a rounded appearance on all faces. They are also of low strength and possibly only suitable for walls.

I believe, reading the reports and subsequent correspondence, that there was considerable friction and disagreement between Hahn and Jennings. As stated earlier Jennings resigned as Consulting Engineer to the TSM in the beginning of 1892, but he was still the Consulting Engineer to the H. Eckstein & Co group, which in effect controlled the Transvaal Silver Mine Co.

No remains of the smelter or roaster house or examples of 1890s fired bricks have ever been found in the pedestrian surveys of the mine. However, in Hahn's report he states that:

> …the site of the Reduction Works was located by Mr Jennings and the writer on the 21st July at a distance of 700 yards [210 m] to the north-east of the Main Shaft.[66]

It also mentions the cleaning out of the company's quarry and the levelling of the site. Knowing the approximate position of both the reduction works and quarry has possibly answered the question as to where they were located. The distance and direction ties in with

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64 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by General Manager. 8 April 1892:9.

65 Ibid.

66 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by General Manager. 8 April 1892:10.

the location of the 1920s slime dam and so it is proposed that the remains of structures, if any existed in 1919, were buried under the 1920s slime dam.

The report by Hahn in 1892 gives dimensions for the roaster shed as 100 ft. x 84 ft. (30 x 26 m). It was designed to contain the two reverberatory roasting furnaces each 75 ft. long x 17 ft. (23 x 5 m) wide.[67] Although Hahn's report presents a very detailed listing of the structures constructed for the smelting and reduction works, apart from the mention of its approximate location, no surface plan dated 1892 or later has been found and therefore it is only speculation as to the location of the reduction works. Both the roaster house and blast furnace department had 60 ft. (18 m) and 100 ft. (30 m) high chimney stacks respectively. Apart from the roaster department described above there was a crushing department in a building measuring 40 ft. x 24 ft. (12 x 7 m), its location is also unknown.

Hahn's report provides details of the equipment as:

> … a 15 inch x 9 inch Blake Jaw crusher, a set of geared Cornish Rolls 26 inch diameter x 12 inch face and a sample grinder. The Boiler and Machinery department was housed in a building measuring 97 ft. x 37 ft. [29 x11 m] and housed the two tubular Fraser and Chalmers boilers. It also housed a Fraser and Chalmers 14 inch x 42 inch Corliss engine (Figure 13) which supplied the power to two Baker blowers, a no 4 Knowles feed pump and the crushing machinery.[68] [69]

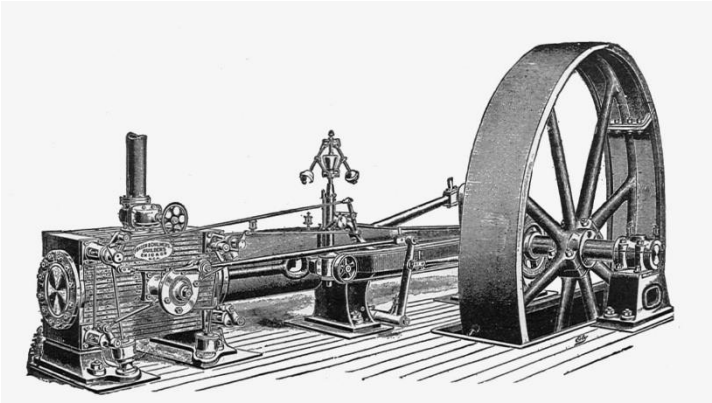


Figure 13. Fraser and Chalmers Horizontal Corliss Engine (Hawkins 1904:182).

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67 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by General Manager 8. April 1892:9.

68 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by General Manager. 8 April 1892:10.

69 A conversion table of Imperial to Metric measurements is provided as Appendix 7.0.

Along with the construction of the reduction works, a great many other structures were built over the same period and this may account for the shortage of funds for coke. Generally, the buildings seem to have been of wood frames and corrugate sheeting. In 1890 there was a black miner house/hostel measuring 13 ft. x 12 ft. (4 x 3.5 m) and one 25 ft. x 15 ft. (7.5 x 4.5 m), but the only reference to a 'compound' is on the 1890 surface plan which shows a single building. The 1892 report states the construction of three black miner compounds 29 ft. x 23 ft. x 5 ft. (9 x 7 x 2 m) and a fourth of the same size at the East Lode/Shaft. It is not clear if the three compound buildings mentioned on the next page replaced the first building or not. As will be discussed in Chapter 9 the description here of three compound buildings ties in with the field archaeology. It is assumed that they were constructed in the same location as those dating from the 1890s. A further discussion on this point is made in section 4.8 of Chapter 4. Unfortunately the 1892 mine plan (Figure 14) does not show surface details.

By April 1892 the following additional buildings to those above were also erected according to the 1892 AGM report by Hahn:

> One general office 48ft. x 52 ft. built of wood and galvanised iron, with lining of burnt brick. It contains two offices, four bedrooms, one dining room, kitchen and servants' rooms and is lighted in the evening with electric lights.
> One assay office and laboratory, 44 ft. x 32 ft., built of sandstone, and having brick partition walls.
> One dynamite magazine, 19 ft. x 16 ft., of sandstone.
> One granary or mealie [maize] meal store 40 ft. x 22 ft., of sandstone.
> One warehouse for supplies, 40 ft. by 22 ft. of sandstone.
> One scale house, attached to the weighbridge, 17 ft. x 13 ft. of wood and iron, with lining of sun-dried brick. Contains office of weigh clerk and bedroom for same.
> One black hospital, with physician's dispensary, 33 ft. x 19 ft. 9in, of wood and iron, lining of sun-dried brick. Contains ward for six beds, and two small rooms.
> One cottage for Chief Fitter and family, 25 ft. x 23 ft., of wood and iron with lining of sun-dried brick. Contains one sitting room, two bedrooms, and a kitchen.
> One brick kiln, 22 ft. x 16 ft. and 14 ft. high, of stone and brick. Has a capacity of 22 000 bricks, which are baked 50 hours.
> One brick shed, 18 ft. x 100 ft., of wood and galvanised iron.

> One cattle kraal, 102 ft. x 54 ft., of stone, for cattle and sheep.
> One tool shed at reduction works, 11 ft. x 8 ft. x 7 ft., of wood and iron.
> One oil house at mine 12 ft. x 10 ft. x 7 ft., of wood and iron.
> One blacksmiths shop at reduction works, 26 ft. x 20 ft., of wood and iron, with one stone forge and brick chimney. This was an additional forge to the original two which were described as: One blacksmith's shop, 30 ft. x 30 ft. x 15 ft., of wood and iron; contains two forges of stone with iron funnels.
> Three black mineworker compounds, each 29 ft. x 23 ft. x 5 ft., of wood and iron.
> One raster shed, 84 ft. x 100 ft., of wood and iron.
> One engine and boiler shed, 97 ft. x 37 ft., of wood and iron.
> One engine house at east lode, 59 ft. x 20 ft., of wood and iron.
> One black mineworker compound at east lode 29 ft. x 23 ft. x 5 ft., of wood and iron.
> One blacksmith shop at east lode, 19 ft. x 14 ft. x 9 ft., of wood and iron, with stone forge and brick chimney.
> The addition to the white men's quarters was also constructed since. The boarding house is of wood and iron, and occupies an area of 175 ft. x 26 ft. It contains a dining hall, two rooms for boarding house attached, and 24 rooms for 2 workmen each. The kitchen, which is separated from the dining- room by an open air space, is also built of wood and iron, and is 22 ft. x 12 ft. x 10 ft. high.[70]

Hahn's report also listed the existing buildings which would have been erected sometime from 1889 to 1891. By adding these to the list above it is possible to get a full understanding of how complex the buildings at the TSM mine were by 1892.

> One engine house, 100 ft. x 30 ft. x 15 ft., of wood and iron, contains boilers, engines, fitter's room, and carpenters shop, and a grist mill in an annex.
> One blacksmith shop, 30 ft. x 30 ft. x 15 ft., of wood and iron; contains two forges of stone with iron funnels.
> One shed, 46 ft. x 16 x 9 ft., of wood and iron; used for storage of lime, cement, and other rough goods.
> One meat-house 12 ft. x 8 ft. x 10 ft. of wood and iron, brick lined.

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[70] BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by General Manager. 8 April 1892:11.

> One house, 30 ft. x 26 ft. x 10 ft., of wood and iron, partially brick lined. Contained old assay office, shop, and mealie store, and will be turned into additional living quarters.
>
> One building, 31 ft. x 25 ft. x 10 ft. of wood and iron; contains one room occupied by groom, one stable and one store room. The latter will be turned into additional stabling room as soon as new warehouse is ready for occupancy.
>
> One stable, 19 ft. x 16 ft. x 9 ft. of wood and iron, formerly occupied by boarding house keeper's horses, now by Company's coach horses.
>
> One black mineworkers house, 45 ft. x 12 ft. x 9 ft., and one 25 ft. x 15 ft. x 11 ft., both of wood and iron.
>
> One warehouse near reduction works, 9 ft. x 15 ft. x 8 ft., of stone and brick. This use to be the dynamite magazine, but is now used for storing articles belonging to reduction works to prevent their misappropriation.[71]

Mention of the cattle and sheep kraal in Hahn's report is significant as it confirms the archaeological record of the bones of such animals. Hahn also mentions a 'meat house' – presumed to mean a butchery or meat store. Its construction details mention it being lined with brick. With the Highveld [72] summer heat it is unlikely that meat products would have been kept for too long after slaughtering. No mention is made of a cold store, but the mine had electricity so it is quite possible that they may have had such a facility to keep meat and vegetable products fresh. A grist mill also indicates that they most probably ground maize, or a portion of it to make a coarse meal flour and samp. More detail on potential foods for the black mine workers is given in Chapter 8.

The details of buildings presented in Hahn's report increases the understanding of the complexity of the 1890s TSM site. Clearly there were many more large structures than appear to have survived and the main reasons could be two fold. Firstly, and most importantly, the reconstruction during the 1919-1922 period destroyed any surviving 1890s structures that where considered of little use or possibly were in the way of the new plant. Secondly, it is known from historical records and the photographs of damaged buildings,

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71 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by General Manager. 8 April 1892.

72 Highveld summer heat averages around 24-28ºC but can reach as high as 35ºC https://www.worldweatheronline.com/johannesburg-weather-averages/gauteng/za.aspx (Accessed on 5 January 2019)

that many of the structures were destroyed during the Anglo-Boer War of 1899-1902. It is also possible that some of the structures/materials were removed by local farmers returning after the signing of the 1902 Peace Treaty for the re-building of their farm structures.

It is interesting to note how important the role of the Chief Fitter was considered in the early 1890s, in that he was provided with a 'cottage' for him and his family, which consisted of one sitting room, two bedrooms, and a kitchen.

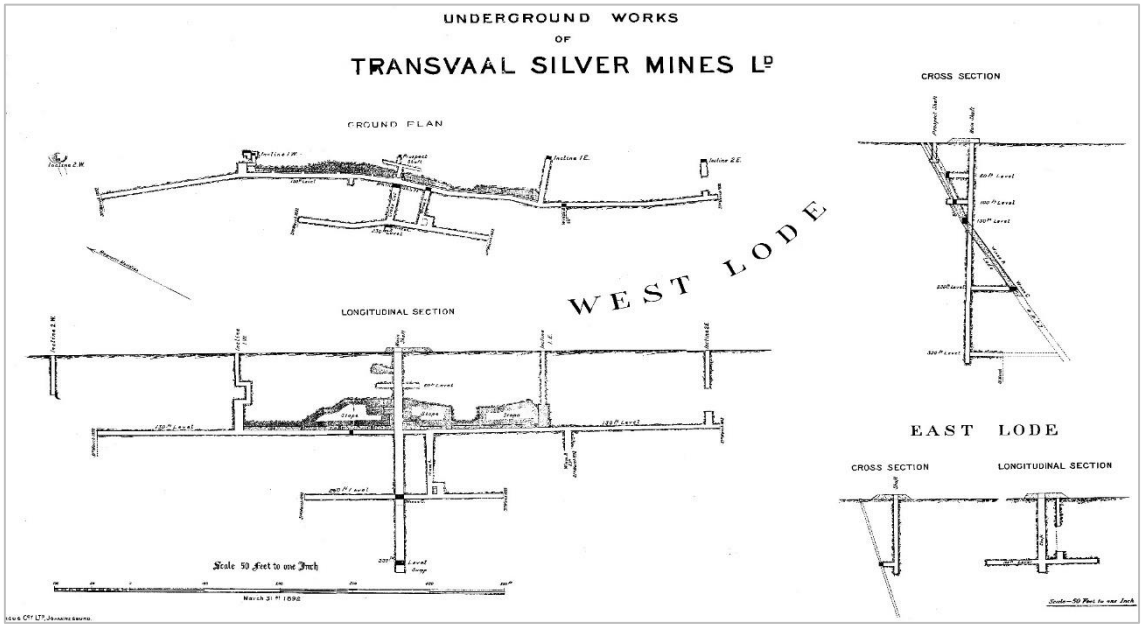


Figure 14. Transvaal Silver Mine Ltd. 1892 underground mine plan. Note some of the details on the plans may be poor, due to the reduction from an A1 size original. The plan is reproduced as Appendix 3.0 in a larger scale.

A report in *SA Mining Engineering Journal* in July 1892 describes the smelting operation as producing bullion bars weighing about one hundredweight (51 kg) and assaying about 150ozs of silver per ton.[73] In September 1892 an article was published in the same journal presenting a very detailed report on the mine. The section dealing with the description of the smelting plant, its operation and equipment and is copied in full below:

> The ore to be smelted is roughly dressed by sorting. This ore is then trammed down from the shaft to the smelting works, situated about 700 yards to the north east of it.

73 'Transvaal Silver Mines', *The South African Mining Journal,* Vol. 1, (30 July 1892), p 785.

> The two smelters or water-jacket blast furnaces, are contained in a large building 45 ft. by 52 ft., entirely closed in. The smelting area of the furnaces at the level of the tuyeres is 3 ft. 6 in. by 8 ft. 4 in. Each furnace has a daily smelting capacity of about 36 to 40 tons of ore, which yields from 7 to 9 tons of lead bullion daily. The fumes from the furnace are drawn off below the charge floor, through a wrought iron tube 3 feet in diameter, which connects with a brick flue 8 feet wide and 8 feet high and 50 feet long, terminating in a dust chamber 25 feet by 32 feet by 12 feet, and through this to a stack partly brick and partly iron, about 100 feet high. The air blast is supplied by two No 5½ Baker Blowers, which deliver into a large main pipe 79 feet long and 42 inches in diameter, which is connected with 12 inch supply pipes fitting into ten 4 inch openings for the tuyeres pipes. The molten lead is drawn off from the bottom of the furnaces through an automatic tap, into a kettle, from whence it is ladled into moulds. The charge floor is situated about 22 feet above the smelting floor, the furnaces being of the open top type, with no iron hood covering them in. The charge of the ore, fluxes and coke are raised from the level of the smelting floor at the back of the furnaces by one of Reedy's double platform elevators of 2000 lbs. capacity. The different materials making up the charge – such as ore, various fluxes, coke etc. are stored in bins, in a shed behind the smelter.[74]

It has been difficult to find a drawing of such a smelting blast furnace, however in the book by Eissler (1891), there is an advertisement for Commons & Co., London - an ore dressing machinery manufacturer – with a drawing that matches the description above. In a book by Peters (1899) there is an illustration of an American design water jacket furnace which may be similar in design to the ones installed at TSM. Both drawings are reproduced on the next page (Figures 15 and 16). Figure 17 is included to illustrate the principle of operation of the reverberatory furnace which was used to roast the ore to remove the sulphur content prior to the smelting operation. The Reedy's catalogue (Figure 18) illustrates various types of elevators but it is not known the exact type of unit installed at Argent.

No drawing of the UK Sandycroft Foundry Co furnace has been found.

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74 'Transvaal Silver Mines', *The South African Mining Journal*, Vol. 1, (3 September 1892), pp. 863-866. Quoted in full as many minor details on the plant are revealed in the description.

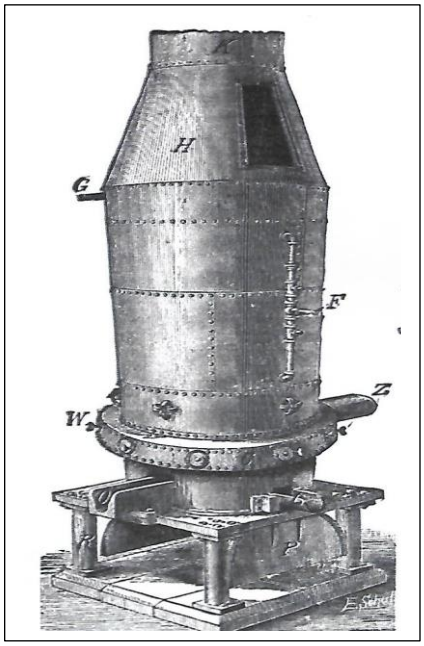


Figure 15. Example of an American design water jacket smelting furnace (Peters 1899:267).

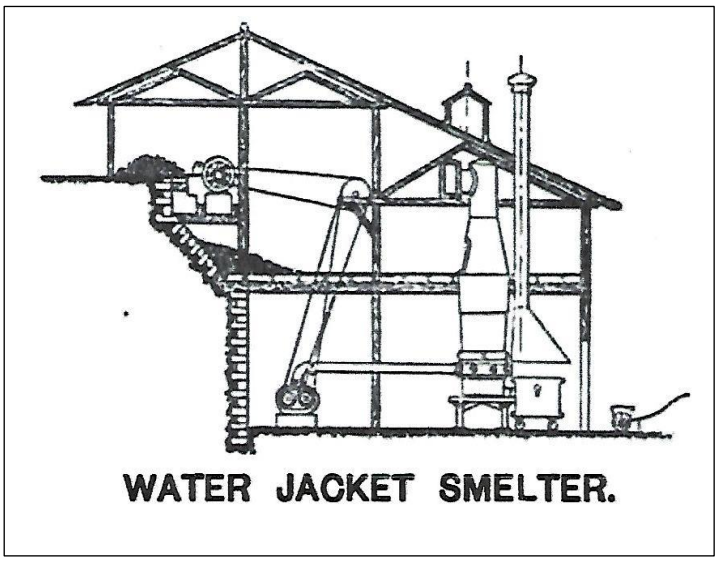


Figure 16. Idealised sketch of a smelting house with a Water Jacket smelter and charging floors (Eissler 1891:435).

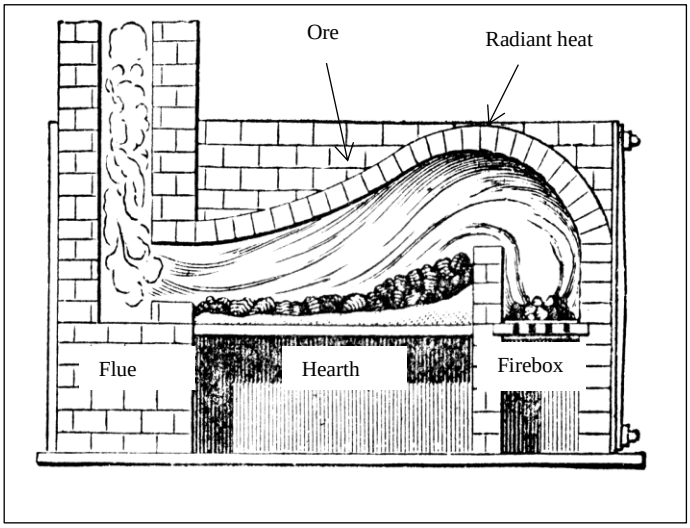


Figure 17. Principle of operation of a reverberatory furnace for roasting the ore. The reflected heat roasts the ore.[75]

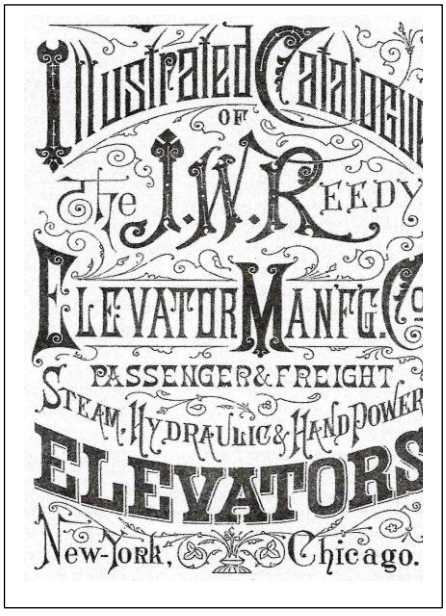


Figure 18. Front cover of Reedy's elevator catalogue c1880s (In G. Reeks collection).[76]

[75] https://www.911metallurgist.com/blog/reverberatory-furnace on Principle of operation of a reverberatory furnace for roasting the ore. (Accessed on 17 Jan 2018).

[76] Reedy, J.W. 1885. Elevators Illustrated Catalogue. Chicago, USA.

In September 1892 an article in the *SAMJ* detailed how they charged the smelting furnace, which is given as:

> Coke 200 lbs.; oxidised ore, 250 lbs.; lead smalls [small particles], 805 lbs.; iron ore, 75 lbs.; limestone (dolomite), 120 lbs.; and slag 200 lbs. Alternatively instead of the slag and smalls a total of 1250 lbs. of ore plus fluxes was used.[77]

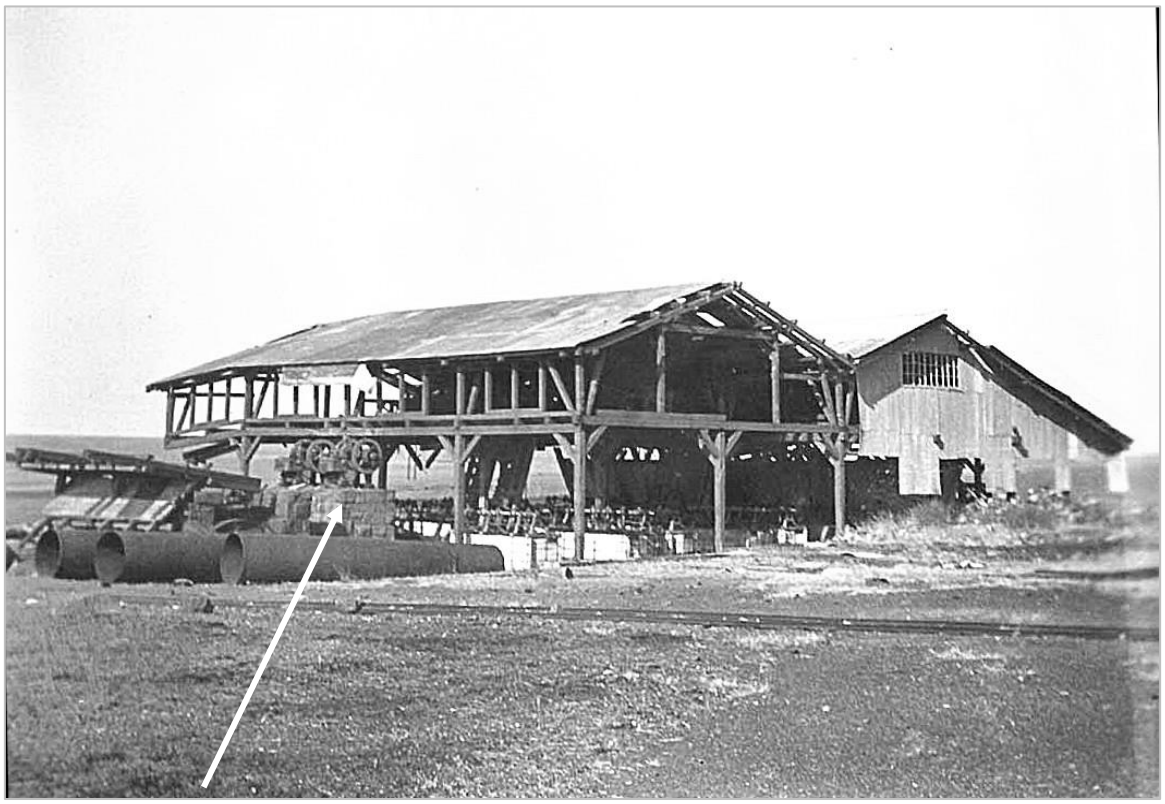


Figure 19. Blake jaw crushers & foundations in 1902 (they are behind the large pipes) with the 1893 concentration plant building behind.[78]

Apart from a hand picking operation at the shaft, once the ore had been trammed to the reduction plant, one of the first operations appears to have been a primary crushing operation using a Blake Jaw crusher with a 15 inch x 9 inch jaw opening. It is likely that when the concentration plant was commissioned in 1893, the Blake Jaw crushers were re-located and installed on the dressed stone foundations that still remain on surface today. This idea is developed in 4.1 of Chapter 4. In the 1902 photograph (Figure 19) of the concentration plant

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77 'Transvaal Silver Mines', *The South African Mining Journal*, Vol. 1, (3 September 1892), pp. 863-866.

78 NASA, Pretoria. Depot TAB, Source CJC, Volume No. 43, Ref. CJC796 – Claims for Compensation British Subject Transvaal. Pretoria. Transvaal Silver Mines Limited.

building that was found in NASA, two Blake Jaw crushers are shown on the dressed stone foundation.

Hahn's 1892 AGM report stated that the Jaw crushers were used to break the larger lumps of ore, limestone, slag, and iron ore to a convenient size for the blast furnaces. The crushing department was housed in a building measuring 24 ft. x 40 ft. (7 x 12 m) and apart from the Jaw crushers, also contained a set of Cornish Rolls which were used as a secondary crushing operation to reduce the ore to a size suitable for roasting. The crushing department must have been located close to both the blast furnace building and the roaster building.[79]

Mention has been made of the Roasting operation and a full description of the plant was given in Hahn's annual report (TSM General Managers report 8 April 1892:11). The roaster building was 100 ft. long x 84 ft. (30 x 25.5 m) wide and was located next to the smelter and crusher buildings. Two reverberating roasting furnaces were constructed and they measured 75 ft. long x 17 ft. (23 x 5 m) wide. They must therefore have been parallel to each other. They terminated in a flue 5 ft. wide x 6 ft. high and 70 ft. long (1.5 x 2 x 21 m). The flue was connected to a condensing chamber 20 ft. x 25 ft. by 12 ft. (6 x 8 x 4 m) high and through this to a chimney 3 ft. in diameter and 60 ft. (18 m) high.[80] From these descriptions, apart from a detailed analysis of the machinery and processes used at the mine in 1892, it has also been possible to illustrate most of the machines.

In September 1892 a lengthy three page article on the TSM appeared in the *SA Mining Journal*. Apart from presenting details on the history, mine development and operation, it also yielded details of the management at the mine and of staffing numbers. "The manager is Mr O.H. Hahn, a smelter of long and varied experience, formerly of the Pueblo Smelting Works, Colorado. Mr Angwin is the mine manager", [actually he was the underground manager at TSM and later became the general manager of the ERPM gold mine]. "Mr Ablett, [is] the assayer, and Mr Pitt looks after the cultivation of the estate".[81]

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79 BRA. Archives of H. Eckstein & Co HE 5 TSM – AGM Report by General Manager. 8 April 1892.

80 'Transvaal Silver Mines', *The South African Mining Journal,* Vol. 1, (3 September 1892), pp. 863-866.

81 Ibid.

It appeared that Hahn was not interested in his position as General Manager of the mine, seeming to focus more on his role as metallurgist. The basis for this statement is a number of letters in the private correspondence between Lionel Phillips and Alfred Beit - in the London office. A letter from Phillips to Beit reported that: "Hahn does not go down the mine".[82] Despite being General Manager and there being an Underground Manager it would be still be normal practice for a person in Hahn's position to still go underground from time to time.

The company's decision to shut the smelting furnaces down after running for only a few months operation, created a depressing effect on the share price.[83] Because of the excess of ore on the surface it was decided to temporarily suspend further mining development operations. They had enough coke to keep the roaster furnaces in operation to treat the ore stored on the surface. Having done that, they decided to start smelting again, but then found that they did not have enough coke to run both the roaster and smelters. The period around the end of 1892 is rather confusing in that the press releases go from indicating that a local coke supply has been found, to local coke was becoming more expensive and the smelting would be stopped.[84] [85] [86] No mention is made of a cut back in staff levels, but it has to be assumed that it occurred.

The eventual collapse of the smelting operation at the TSM was mainly due to the cost of imported coke or the lack of local coke. When coupled with a small fall in the international prices of lead and silver, a lower profit margin was realised and this was seemingly laid at the feet of Hahn.

It was also said that Hahn had resisted bringing qualified smelters and roasters to the mine, feeling instead that he could train local people – something he never managed to do.[87]

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82 BRA. Archives of H. Eckstein & Co HE 149 19 March 1892:919.

83 'Financial and General Notes', *The South African Mining Journal*, Vol. 2, (1 October 1892), p. 6.

84 Ibid.

85 'Transvaal Silver Mines', *The South African Mining Journal*, Vol. 1, (29 October 1891), p. 69.

86 'Transvaal Silver Mines', *The South African Mining Journal*, Vol. 2, (21 January 1893), p. 257.

87 'Transvaal Silver Mines', *The South African Mining Journal*, Vol. 1, (10 September 1892), p. 886.

However, while these reasons may have been valid, there was an even more serious reason which is described in the next paragraphs and which eventually cost Hahn his job at the TSM.

In the 4th AGM report of March 1893, it is stated that the production of local coke was inhibited by the lack of proper production facilities. It further stated that an investigation by the general manager – Hahn – found that the ore contained a higher percentage of sulphur - actually 8% - substantially different to the 3% he had first calculated. Hahn stated that to deal with the volumes of ore with the higher sulphur content would require ten more reverberatory roasters at a cost of £20 000, coupled with higher volumes of fluxes, which in turn required greater heat and thus higher volumes of coke per roaster, thus making the process far more expensive and therefore less profitable. It appears that despite the chairman's praise for the company having gained the services of Hahn two years earlier, he became the 'fall guy' when the system failed.[88] A letter from Phillips to Beit stated "…as we shall be bound to keep Hahn until the end of March 93 unless he resigns voluntarily".[89] Clearly there was a significant breakdown in relations between Phillips and Hahn, as on the back of the letter was a handwritten note 'Hahn is useless'.

The fact that Hahn had miscalculated the percentage of sulphur in the ore and his solution was more capital expense to the mine, this idea did not go down well with the Directors and is seen as the primary reason for his apparent dismissal or resignation in March 1894. It was stated in the AGM report for 1894: "prior to April 1st when the agreement between the Company and the late General Manager, Mr O.H. Hahn terminated".[90] It is interesting to note two of the comments in the personal mail between Lionel Phillips – chairman of TSM - and Alfred Beit in the London Office as they show a clear shift in management's support for Hahn. "Hahn's extravagance and incapability as a general manager is appalling".[91] "Our visit only confirms our suspicions as to Mr Hahn's incompetence as general manager, he has

88 BRA. Archives of H. Eckstein & Co HE 5 TSM – 4th AGM Report by General Manager. 9 March 1893.

89 BRA. Archives of H. Eckstein & Co files HE 149 p. 869 27 December 1891.

90 BRA. Archives of H. Eckstein & Co HE 5. TSM 5th AGM report. 29 March 1894.

91 BRA. Archives of H. Eckstein & Co HE 151:130 16 September 1892.

made an unpardonable blunder as a metallurgist".[92] A comment from Phillips on finding out about the incorrect analysis of the sulphur content in the ore.

3.4 Wertheman takes over from Hahn at TSM in 1893

In February 1893 an article in the SAMJ mentions the arrival and appointment on a one year contract of a new General Manager, Mr E. Wertheman.[93] It appears that Wertheman was on some sort of retainer from at least September 1892, because in a letter to Beit, Philips states:

> …directly Wertheman saw the mine he said "this is a concentrating prospect, whether you smelt here or not, you must concentrate" I employed him to draw plans and specs for a concentrating plant.[94]

After being employed by TSM, Wertheman was sent to England to oversee the manufacture and shipping of the new concentration plant. It must have been at some time between February 1893, when Wertheman arrived at the TSM, and June of the same year when installation of the new concentration machinery began, that the new building for the concentration plant was constructed. Installation of the equipment was completed, including commissioning, by mid-September 1893.[95] By October it was stated that the plant had exceeded expectations.[96] By November it was producing between 400 and 500 tons of concentrates monthly.[97]

There were two articles published, on different dates, in the *SAMJ* on the concentration process and equipment installed at the Argent mine in 1893. The relevant portions of the articles have been partially re-worked into one contiguous description of the process. Explanatory comments have been added where necessary.

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92 BRA. Archives of H. Eckstein & Co HE 151:184 7 October 1892.

93 'Financial & General Notes', *The South African Mining Journal,* Vol. 2, (4 February 1893), p. 290.

94 BRA. Archives of H. Eckstein & Co HE 151 p. 184 7 October 1892.

95 'Transvaal Silver Mines', *The South African Mining Journal,* Vol. 7, (23 September 1898), p. 906.

96 'Transvaal Silver', *The South African Mining Journal,* Vol. 3, (14 October 1893), p. 22.

97 'Transvaal Silvers', *The South African Mining Journal,* Vol. 3, (11 November 1892), p. 195.

The ore, as it arrived from the stopes, [was] dumped into a main receiving bin, from where it [passed] over perforated feeders into Lührig stone breakers".[98] [This machine has not been found in any textbook of the time and it should possibly read Blake Jaw Crushers]. From the jaw crushers the ore went to hand selection process to remove waste rock from the ore. "The crushed ore [was then] re-crushed by passing it through a pair of coarse Cornish rolls. The crushed product from the rolls was then elevated into a set of sizing trommels. The different sized ores [resulting] from each trommel",[99] "…served to separate [it] into five distinct sizes".[100] "The fine pulp from the classifying trommels was then conducted into hydraulic classifiers, which separated out two products" – [a coarse and fine grade].[101] The coarse product was returned via elevators to the Cornish rolls; and the finer product was passed onto Lührig vanners. The intermediate sizes from the trommels passed "on to the jigging machines which were arranged in series, each machine was specifically designed to treat a given class [or grade] of pulp. The [resulting] slimes were passed over Lührig vanners. The concentrates [were] collected, while the 'middlings' were elevated, and once more put through two fresh sets of rolls, and subjected to precisely the same process" [as described above].[102]

The 3 June reference states after the hydraulic classifying process that the finer product was passed to:

> Steiner's tables, which are practically the same as the Belharz and Lührig concentrators. These consist of endless travelling belt like a Frue Vanner, but with side percussion, the pulp, however, being delivered on one side of the belt, and the concentrates and waste taken off on the other, instead of the ends as on the Frue Vanner.[103]

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98 'Transvaal Silver Mines', *The South African Mining Journal,* Vol. 2, (3 June 1893), p. 564.

99 Ibid.

100 'Transvaal Silvers', *The South African Mining Journal,* Vol. 2, (10 February 1894), p. 286.

101 'Transvaal Silver Mines', *The South African Mining Journal,* Vol. 2, (3 June 1893), p. 564.

102 'Transvaal Silvers', *The South African Mining Journal,* Vol. 2, (10 February 1894), p. 286.

103 'Transvaal Silver Mines', *The South African Mining Journal,* Vol. 2, (3 June 1893), p. 564.

Despite rigorous attempts to find details on a "Steiner" table or "Belharz" table mentioned above, none has been found. However, by chance an old book on the dressing of minerals dating from 1909 by Henry Louis was found, and in it were details of a Bilharz-Stein bumping table. As the report above is by a journalist it has to be assumed that he got the names transposed and incorrectly spelt.

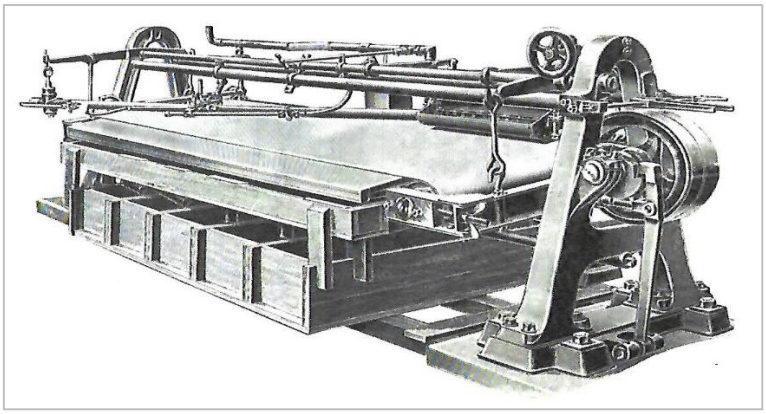


Figure 20. Bilharz-Stein bumping table (Louis 1909:362)

A picture of the Bilharz-Stein bumping table or concentrator is shown above (Figure 20.) Bumping table is assumed to be an early term for a shaking table or Vanner. In Louis' book he states rather interestingly that the "Lührig Vanner is practically identical with the Bilharz-Stein table", words that seem to repeat the press report of 3rd June 1893 and quoted on the previous page (Louis 1909:361). More details on the Lührig Vanner machine are given in Chapter 4. Another source describes part of the plant as consisting of:

> The concentrating machinery itself has been supplied by Carl Lührig, of Dresden, through the Lührig Company. In addition to two pairs of rolls, screens, elevators, and sorting appliances, it comprises 16 jigs and 16 Lührig tables…with the water supply…drawn solely from the mine and is available at a pressure for the working of the vanners and Spitzkasten.[104]

This is the only mention of a 'Spitzkasten', but it defines a type of hydraulic classifier machine and more details on this machine are given in Chapter 4. By November the press

[104] 'Transvaal Silvers', *The South African Mining Journal,* Vol. 2, (10 February 1894), p. 286.

were reporting that the management were very happy with the start-up of the concentrating plant and they also mentioned that the plant was producing 400 to 500 tons of concentrates per month.[105] By February some idea of daily average production was possible:

> The concentrates after collection are dried and sacked, each bag containing 1 cwt…the latest returns showing that 2500 tons have been treated in 26 days. The concentrates produced amount to about 25% of the total tonnage dealt with thus 2500 tons of ore producing about 600 tons of concentrates. The concentrates on arrival in Europe are sold to Germany to one of the large ore-treating establishments at Metternich or Aix-la Chapelle…Better prices can sometimes be obtained at Swansea, [smelter in Wales].[106]

The newspaper report also mentioned that the company had experimented with running the concentration plant at night. The results were not favourable, due to operating costs at night being doubled. Additional operating problems such as visibility to close monitoring of the machines in restricted electric lighting conditions, coupled with the need for downtime at night to maintain and overhaul settings on the machines reduced feasibility. It had been found that these additional problems were not countered by an increase in product output.[107]

It was also mentioned in the same article that Mr Wertheman had endeavoured, with some success, to train the black miners to operate the drills single handed - using one man not two - on each drill. This idea was aimed at reducing mining costs and the number of personnel needed. It was countered with an increase in the rate of pay for the miners involved. Other aspects of improving mining efficiency was the offer by Wertheman to pay the miners more per day if they drilled three holes 30 inches (760 mm) deep instead of the normal two holes in one shift. This action of trying to exploit the black miner to carry out more mining operations was perhaps way ahead of its time. It indicates a desire on the part of some managements to increase productivity as a way to reduce costs and improve profits, but at

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105 'Transvaal Silvers', *The South African Mining Journal,* Vol. 3, (11 November 1892), p. 195.

106 'Transvaal Silvers', *The South African Mining Journal,* Vol. 2, (10 February 1894), p. 286.

107 Ibid.

the same time Wertheman was willing to recognise the acceptance by the black miner for the changes, by paying more for the work.[108]

As stated above, Wertheman was employed on a one year contract, although Lionel Phillips, the chairman, of the TSM, tried to convince him to stay on. Phillips indicated that he hoped to make further arrangements with Wertheman about such a decision as he would be difficult to replace.[109] Phillips was not successful and announced that Wertheman was due to leave the company at the end of April 1894.[110] It is not clear who managed the mine and concentration plant between April 1894 (when Wertheman left) and March 1895 when all mining and beneficiation processes were closed down.

The 6th Annual General Meeting was not held as per normal in March/April of the year, but was "rolled over" to November 1895. The reason for the delay was to compile an account of sales for all of the ore and concentrates shipped from the mine up to when the mine's operation, both mining development and ore processing was stopped in March of 1895. The report was for a period of 15 months of operation as a producing mine. It was explained by Lionel Phillips, as chairman for the meeting that the world price of silver and lead had fallen to such an extent that it had made the operation of the TSM uneconomic.[111] It was decided to stop all dewatering of the mine from March 1895, because of the cost of running the pumps. The result was that mining operations were closed down and put onto a 'care and maintenance' form of operation, under the control of a caretaker at the mine.[112]

It should be realised that the world price of silver was significantly affected by the collapse of the world market for the metal due to the repeal of the Sherman Silver Purchase Act of 1893 in the USA (Brinkley 2004:526-529). This marked the beginning of an economic depression in the United States - the so called "Panic of 1893" - and this escalated to such

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108 'Transvaal Silvers', *The South African Mining Journal,* Vol. 2, (10 February 1894), p. 286.

109 BRA. Archives of H. Eckstein & Co HE 5. TSM 5th AGM report. 29 March 1894.

110 'Transvaal Silver Mines', *The South African Mining Journal,* Vol. 3, (7 April 1894), p. 412.

111 BRA. Archives of H. Eckstein & Co HE 5. TSM 6th AGM - Directors report. 29 October 1895.

112 Ibid.

an extent that it had a negative impact on world trade and mining from 1893-1895. (Brinkley 2004:526-529).

By the beginning of 1896 the Transvaal Republic (ZAR) was in turmoil due to the failed Jameson Raid. The result was a tremendous disruption in the mining industry of Johannesburg and in May 1896 a list of company directors, who were involved with the Reform Committee, was published.[113] The Reform Committee members were arrested, imprisoned and put on trial and this effectively crippled the mining industry of the Witwatersrand for months. Among the directors listed were Lionel Phillips, George Farrar, Samuel Jameson and H.A. Rogers. All four were directors of the Transvaal Silver Mine and although the mine, as an operation, had effectively closed down at this stage, the company was still listed. No records of an AGM were found for 1896 and it is presumed that one was not held due to the arrest of the Directors (Reeks 2012:2-3).

In August of 1897 the 8th AGM of the Transvaal Silver Mines Co. was held. It was stated in the AGM report that the balance sheet covered the year ended December 1896 and the first six months of 1897. It was reported that the economic conditions which had prevailed in 1895 were the same over the past two years and that the mine was still under the control of a caretaker. This situation continued for a further two years, up to the start of the Anglo Boer War in 1899. The only expenses of the mining company were the cost of the caretaker and the payment of rent on the portions of the farm Dwarsfontein worked by the company.[114] [115] The Transvaal Silver Mine Co Ltd., was in existence until 1909, when it was finally liquidated. It never produced any more ores, bullion or concentrates after its operations were suspended in March 1895, although some tribute mining was carried out by a small company in 1908-9, the details of this operation are outside of the scope of this thesis, but were discussed in (Reeks 2012).[116]

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113 'Imprisoned Directors', *The South African Mining Journal,* Vol. 5, (9 May 1896), pp. 617-618.

114 'Transvaal Silver Mines', *The South African Mining Journal,* Vol. 6, (28 August 1897), pp. 1044-1045.

115 'Transvaal Silver Mines', *The South African Mining Journal,* Vol. 7, (3 September 1898), p. 997.

116 'Transvaal Silver Mines: Let on Tribute', *The South African Mining Journal*, (14 March 1908), p. 16.

3.5 Conclusion

In the 1890s, the mine whilst very rich in lead and silver, appears to have been poorly managed, not only at local level, but also at head office directorial level. Tensions between American and German mining engineers, while not obvious, can be inferred in the references found in TSM company reports. Derogatory personal comments about Hahn were found in correspondence between the chairman of TSM, Lionel Phillips, and various parties. These tensions ultimately led to changes in both the mine manager and beneficiation methodologies at the TSM, resulting in the financial failure of the mine.

In the next chapter a more detailed study will be made of the machines used in the concentration process, coupled with the three types of beneficiation treatment of the ores and an analysis of the capital costs and the profit or losses incurred by the TSM. The chapter will also look in detail at the staffing levels reported in the various sources over the six years of it being an operating mine. This will be done with an analysis of the compound structures in an attempt to gain an idea of how big the 1890s compound structures were. It is these structures which will form part of the social archaeological field examinations in later chapters.

Chapter Four

Analysis of the beneficiation machinery of the concentration plant and the cost structures of the three beneficiation processes 1889-1896

4.1 Introduction

Apart from presenting a more detailed narrative on the individual concentrating machines and sub processes, this chapter will look at the costs of each of the processes in the life of the mine. The overall profit or loss of each process and thus the financial success of the TSM in the 1890s will be analysed.

Between 1889 and 1895 the ore was treated in three distinct beneficiation processes. High grade ore, with an assay value of lead at > 50% and silver at > 50 ozs/ton, was considered rich enough to ship directly to the smelting plants in Europe. Truscott (1923:4) presents some facts regarding the value of ores acceptable to smelting companies. He states a metal 'content as low as 30% may be accepted for oxidised ores…while that for sulphide ores is 50-60%.' This gives a clue as to why the high grade ores, assayed at 70-80% lead at the TSM, being galena or lead sulphide, were shipped without any on-site treatment other than crushing and bagging. In 1891, Lionel Phillips, the chairman of TSM, announced that 'the ore they were shipping was practically base bullion, as it contained about 70% lead and 90 ounces of silver per ton'.[1]

As was discussed in the previous chapter, Hahn put in a smelting and roasting process designed to de-sulphurise the ore (roasting), followed by smelting the ore to produce enriched bullion which was shipped as 51 kg ingots with an assay value of around 72% lead and 72 ounces silver/ton. Hahn's beneficiation plant did not include any form of concentration plant before the roasting operation. This weakness precluded the mining and conversion of the full range or ores from the lower to medium grades of ore as they would have been uneconomic to process due to their lower silver and lead values.

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1 BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM Report. 9 April 1891.

To overcome this and be able to sell the lower grade ores, thus realizing the mine's full economic potential, the lower and some of the middle grades of ore had to be concentrated before smelting. This technology was installed by the last manager - Wertheman - in 1893. His idea was to enrich the poor to middle level value ores to a higher assay value and thus create a more saleable product. The concentrates were dried, bagged and shipped to Europe.

The 1880 to 1890s period, in the world mining industry, was when there were a number of innovative ore dressing inventions, machines that improved crushing and separation of ore particles from waste or tailings. These early concentrating machines - as installed by Wertheman - by comparison to modern techniques were not necessarily efficient in producing a pure product, but for the 1890s the impact on the level of economic returns was enormous.

4.2 An explanation of some of the machines and processes used in the 1890s concentration process

To assist with an understanding of the process of concentration as installed by Wertheman a flow diagram of the process has been created (Figure 21), coupled with an explanation of what the machines did.

In many cases these machines have been superseded by better sub-processes and/or machines and in fact most of the 1890s manufacturers no longer exist, although the principle of the various sub-processes do. Where possible, illustrations of the machines or similar machines to those described, have been included in this chapter.

In both the smelting/roasting plant, and the later concentration plant, the first step was the same - primary crushing. Hahn mentions the use of a Blake jaw crusher.[2] When the ore reached the surface from underground, the large pieces were reduced to a more manageable size, essentially a machine replaced a sledge hammer.

[2] BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM General Manager's Report. 9 April 1891.

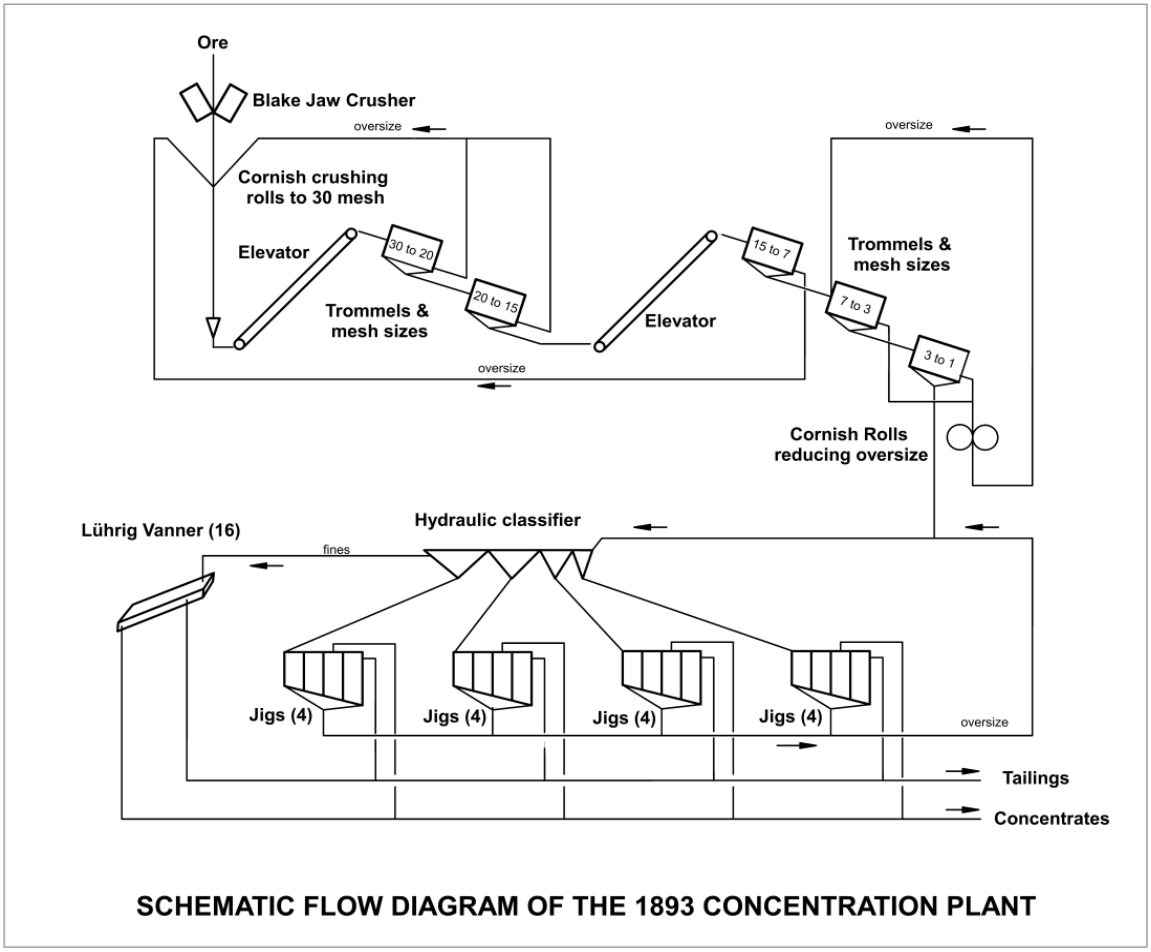


Figure 21. Schematic flow diagram of the concentration plant on the TSM 1893-1895. It is based on the known items of equipment purchased by Wertheman, along with various engineering journal articles (as quoted). The sizes shown on the trommels and Cornish Rolls are hypothetical but are based on flow diagrams in various textbooks. (Truscott, 1923; Richards & Locke 1940). The bold numbers in brackets refer to the number of machines in the references. It is unclear if there was more than one hydraulic classifier. It is however more likely that there were four classifiers feeding the 16 Jigs (P. den Hoed and M. Dworzanowski at School of Chemistry and Metallurgy, University of the Witwatersrand, 2017 – pers. comm. 15 May 2017) (Diagram drawn by G. Reeks).

An early description of his beneficiation plant mentions the ore being fed into "Lührig stone breakers".[3] Despite an extensive search of 1890s mining literature, no reference has been found to such a machine, although the name Lührig did exist. Similarly, no mention is made of the use of Hahn's Blake jaw crushers by Wertheman. However, the photograph of the concentration plant dating to 1901 shows a clear image of jaw crushers on the dressed stone foundations. The crushers have been identified as Blake jaw crushers (Figure 22). It is

3 'Transvaal Silver Mines', *The South African Mining Journal*, Vol. 2 (3 June 1893), p. 564.

therefore doubtful that the Lührig stone breaker existed at Argent. It is believed that the Blake Jaw crushers were re-used by Wertheman and that the reporter from the South African Mining Journal (SAMJ) used an incorrect name.

4.2.1 The Blake Jaw Crusher

Various sources dealing with mining beneficiation, mostly American, allude that the most common machine used in crushing in the 1890s was the reciprocating Blake Jaw crusher (Richards 1903:13; Davies 1902:222). This crusher was invented in 1852 by the American Eli Blake, who was looking for a quick way to crush rock during a road building project. The basic design of the Blake is still used to this day and is often found on small mining operations and quarries, although larger, modern mines make use of the more efficient machine called a gyratory crusher.

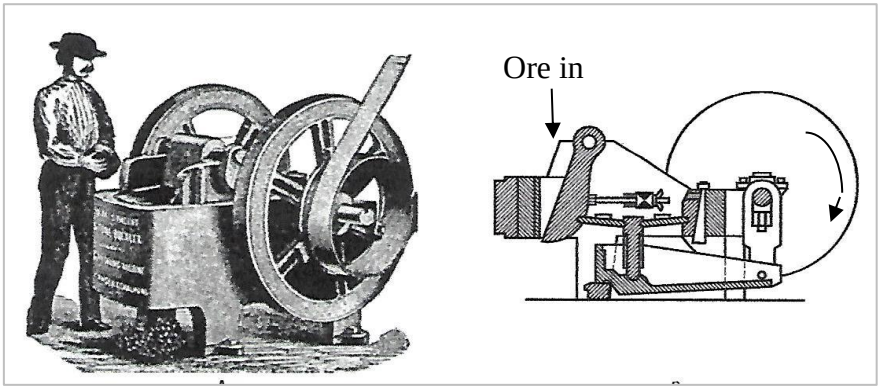


Figure 22. Blake Jaw crusher (Lynch & Rowland 2005:62).

The Blake crusher consisted of a fixed jaw and a moving jaw that was pivoted at the top and connected to rods which in turn were joined to an eccentric shaft (Figure 22). As the shaft rotated, the rods reciprocated back and forth, thus causing the moving jaw to open and close. As the rock was fed into the top of the jaws, the reciprocating motion of the moving jaw crushed the larger pieces. They fell under gravity and in doing so were crushed again until achieving a size that allowed the chunks to fall through the gap at the bottom of the jaws (Richards 1903:13; Truscott 1923:37). The illustration, (Figure 22) also reveals the substantial cast metal frame of the machine.

4.2.2 The Cornish Rolls

Once the ore had been reduced in the Blake crusher, it had to be further reduced to an intermediate size. Most countries in the 1880s/90s used the Gravity Stamp Mill as the standard secondary crushing machine, as was the case on the gold mines of South Africa and the metal mines of the USA (Lynch & Rowland 2005:56). The Stamp Mill reduces the size of the ore by pounding it with a heavy vertical falling hammer (Lynch & Rowland 2005:53). The Cornish Rolls - invented by John Taylor, a mining engineer in 1804 in Cornwall, England - work by feeding ore into a vee gap between two counter rotating rollers (see Figure 23) (Wills 1979:168). One roller is fixed in the frame of the machine and the other is allowed to effectively 'float' horizontally under heavy spring pressure. The speed of rotation and the gap between the rollers were set to produce a particular crushed size. As the rock falls into the gap it is crushed until it is reduced in size, so that it can fall through the gap between the rollers. Several Cornish Rolls can be set up, so that each machine reduces the ore to a smaller size until the desired fragment size is reached (Truscott 1923:72). The illustration below, (Figure 24) shows a typical Cornish roll machine, which, by the 1890s, had developed to machines capable of exerting a very high crushing power. Cornish Rolls are sometimes also described as 'roller crushers' (Davies 1902:256).

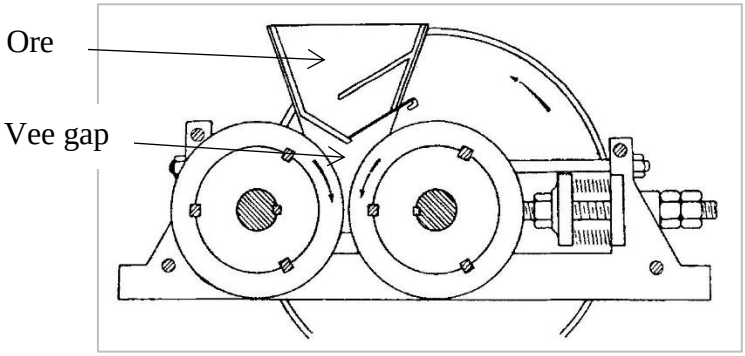


Figure 23. Cornish Roll showing directions of rotation and vee gap (Wills 1979:168).

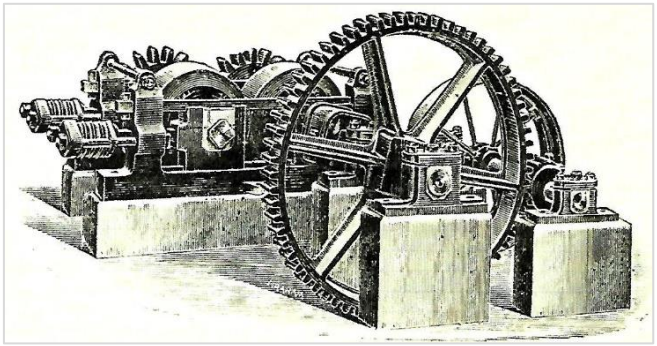


Figure 24. Cornish Rolls machine with the feed chute and machine covers removed.
(Davies 1902:238).

Wertheman chose to use the Cornish Roll, as the very nature of this crusher allowed for the machines to be set up in series at different crush sizes. This principle allowed for reduced amounts of fines or powder to be produced and certainly less than gravity stamps (Truscott 1923). This was particularly important to Wertheman, because he was to rely on a German design of jigging machines for the concentration of the intermediate sized ore and he wanted to avoid fines where possible.

4.2.3 The Trommels

From the Cornish Rolls the crushed rock was raised to an upper floor in the concentration building by a bucket elevator, mentioned in Chapter 3 page 58. In the photograph of the building, (Figure 19) there is an angled shadow which may well have been such an elevator as shown in (Figure 25). From the elevator the ore was fed into a set of revolving trommels or rotating screens of five different mesh sizes.[4] A picture of such a revolving trommel with three stages is shown (Figure 26).

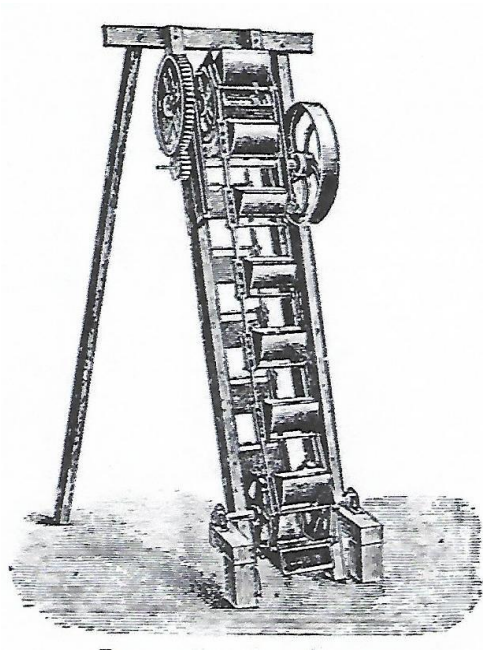


Figure 25. Bucket elevator
(Davies 1902:409)

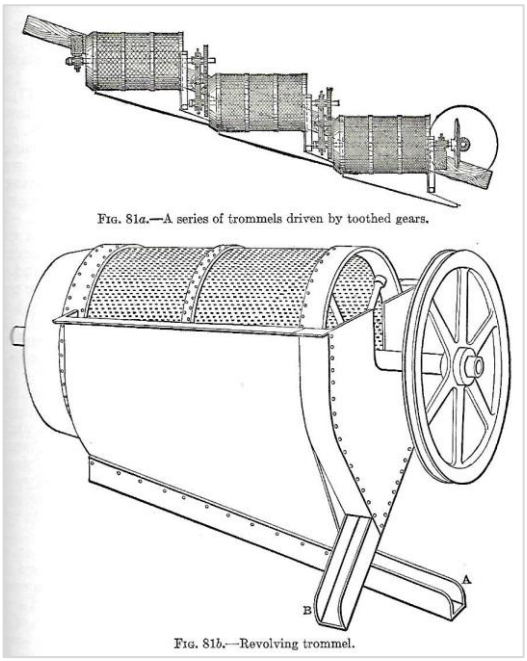


Figure 26. Revolving trommel and a Series Trommel.
(Richards & Locke 1940:121)

4 'Transvaal Silvers', *The South African Mining Journal,* Vol. 3, (10 February 1894), p. 286.

The ‘middlings’, or oversized crushed rock was fed back into the crushing rolls for re-crushing. In effect the trommel is a rotating sizing sieve and similar devices are still in use on mines to this day. From the flow diagram (Figure 21) one can see that the process of crushing was followed by a closed loop flow of the ore until it had reached the desired size for the jigging machines. After passing through the trommels, the correct size of ore was moved to the next stage for concentration.

Once the ore has been screened into it various sizes, two products generally emerged, the fines and the coarse material. The fines were treated by the next process, which was hydraulic classification and the coarser sized material was treated by jigging, which will be described first.

4.2.4 The Jigging process

The late 19th century was a period of intense competition in the ore dressing machine market and the jigging process was one area that saw many developments (Davies 1902: Truscott 1923). The following description of the process is loosely based on Truscott (1923:303). Ore/waste mixture was suspended in water and fed into the jig. As it passed over a sieve, a plunger exerted an upward motion to the water and ore mixture. The lighter waste material and the small particles of ore floated to the surface and were carried over the partitions between each chamber and were captured for the next stage of jigging. As the ore was heavier than the waste rock fragments, the ore fell under gravity at a faster rate and settled first, thus creating a separation of the two or more densities of material. An important dynamic in the success of this process was that the fragments of ore and waste were the same physical size, hence the need for a refined pre-treatment of screening.

In Chapter 3 it was stated that the plant consisted of 16 Jigs, but no mention has been found in the textbooks of Lührig jigs and so it is believed that if they existed, that they may have been similar to the Harz or plunger type jig.

This type of jig was the most common jigging method among American and German jig machine manufacturers in the 1880/90s (Richards 1909; Truscott 1923).

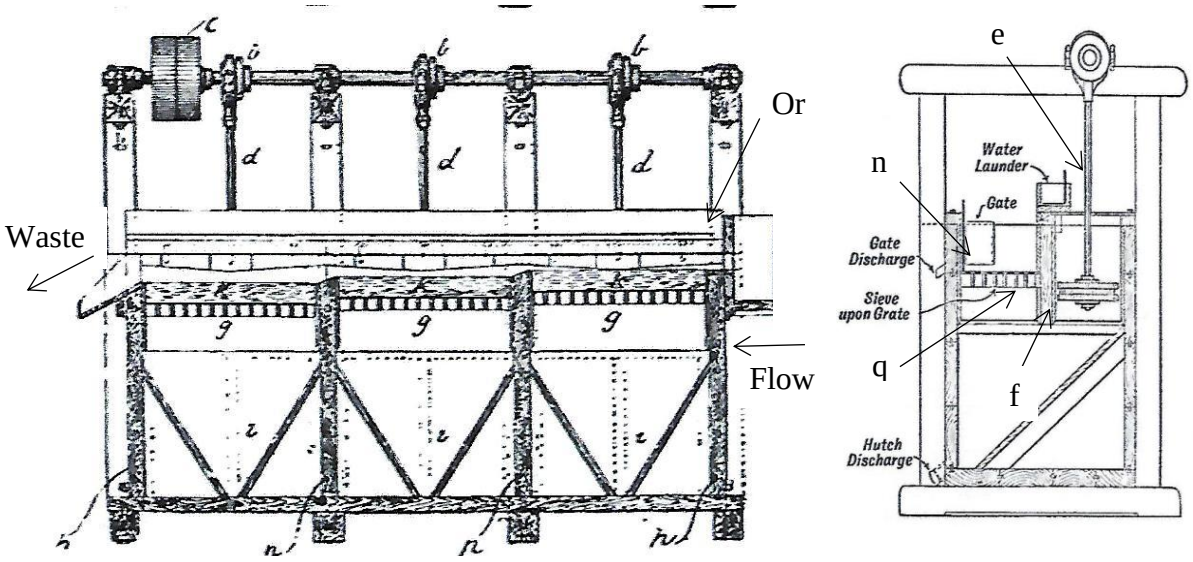


Figure 27. Longitudinal and cross section of a three stage Harz Jig - water flow, right to left. (Davies 1902:294 and Truscott 1923:303)

It could be used on both coarse and fine ores, and a range of specific gravities (Richards 1903:283). The machine consisted of a tank, referred to as a 'hutch' in many of the 1890s textbooks (Richards 1903:295; Pryor 1965:309). The illustration, (Figure 27) shows how it is divided along its length by a vertical partition (f), one side of which was a screen (q) and on the other the plunger area (e) for creating the currents in the water. The jig was commonly divided into 2, 3 or 4 compartments each with its own plunger and sieve thus creating a cascade system for concentration. Beneath the plunger and sieve was a hopper compartment (l) that sloped to a common point at the front of the machine for the discharge of the fine concentrate.

Between each jig compartment was a partition, the top of which was 10 cm above the sieve. The following sieve was 25 mm below the previous compartment sieve. As the water rose it flowed over the partition and it carried the lighter particles with it. The larger ore particles built up in the compartment until such a level that they could overflow into the catchment chamber (n) and in turn pass to the next stage - either further crushing for coarse ore or to the fine ore jigs. The fines collected in the hopper (l) are in turn passed through, either a fine jig or directly to the Vanners which will be described below. It can be seen that for each stage there was a repeat of the processing of jigging and trommels until the particles of concentrated ore were fine enough for the final separation process of the Vanners.

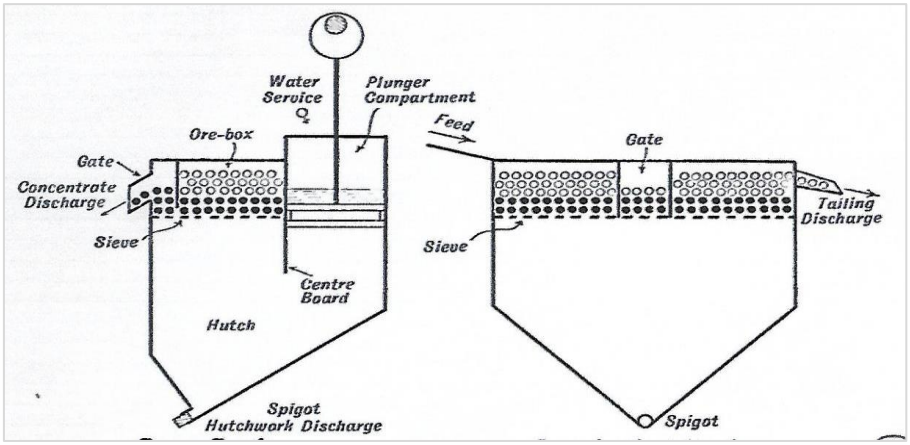


Figure 28. Diagrammatic sections of a single cell in a Harz Jig. The sections illustrate the gate discharge for concentrate, spigot discharge for fines and overflow discharge for tailings (Truscott 1923:303).

The simplified drawings show a typical 3 stage Harz jig (Figures 27 and 28). The plunger moved downwards, raising the water and particles in the sieve chamber thus separating the waste in light particles that then flowed into the next chamber. The heavy mineral particles shown in black passed into the coarse concentrate discharge.

Various jigging plants have been compared in textbooks (Richards 1909; Truscott 1923) and generally the size of the crushed ore to be jigged varies from 8 - 30mm in size. The historical documents of TSM indicate that they had a series of five mesh sizes of trommel and 16 jigs. It can be assumed that they had a process of treating a range of fragment sizes, which not only separated the ore, but in some cases returned it for further crushing and re-jigging. Thus there would be coarse, intermediate and fine jigging or as Truscott (1923:309), states "…jigging represents 'class concentration,'" with the middlings being returned to the Cornish Rolls for further crushing. In the photograph (Figure 19) of the concentration plant I suspect that the lines of low units with round discs at the top are in fact lines of Harz Jigs.

4.2.5 Hydraulic Classifying

The process of hydraulic classifying on TSM in the 1890s was one where the actual machine cannot be described or named.[5] As with jigging, there were a number of different machines and methodologies employed in hydraulic classification in the 1880s - 1890s. In principle

[5] 'Transvaal Silver Mines', *The South African Mining Journal,* Vol. 2, (3 June 1893), p. 564.

the process can be likened to the old gold miners of the 19th century who used a sluice box, where fine pulp or powdered rock carried in a flow of water deposited the heavy particles of mineral out in a set of containers or troughs. The heavy and largest particles would separate out in the first compartment, then as the velocity of the water decreased due to the shape and size of the next trough, the next size of heavy particle would settle out and so on until with the final stage of separation the flow was such that it only carried waste particles (Richards 1909:242; Wills 1979:267).

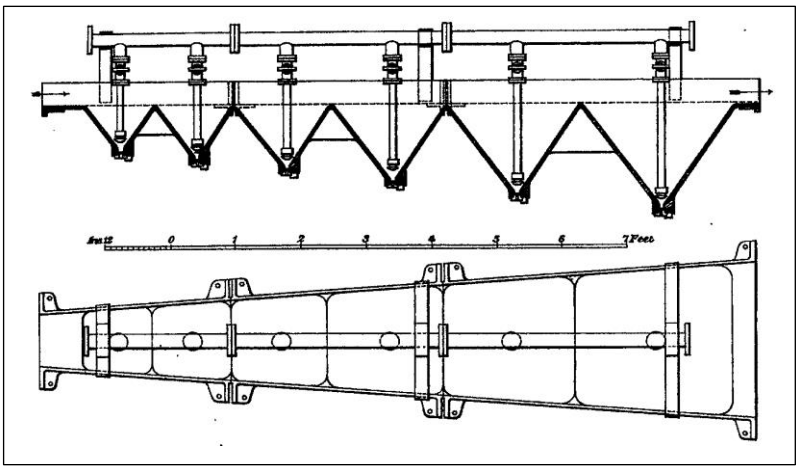


Figure 29. Lenique hydraulic classifier dating to c1888. Flow of water and concentrate from left to right (Louis 1909:237)

A Lenique classifier, which is a version of the Spitzkasten and dates from around 1888 is shown in (Figure 29). It is believed that a similar machine was installed at TSM. International technology of mineral dressing in the 1890s was changing at a frenetic pace. The first design of such a process was called a Spitzkasten. It had been invented by a German mining engineer Peter Ritter Von Rittinger in the mid nineteenth century. It is not clear if the use of the term *Spitzkasten*, was an error by the reporter at the time, or if he was told that TSM had such machines.[6]

I am inclined to believe that the reporter may have thought that there were *Spitzkasten*, but such technology was already some 30-40 years old in 1891. I do not believe Wertheman would have used such old technology, but would have chosen a more modern derivative of the *Spitzkasten* type of machine. Competing manufacturers, both in the USA and Europe, developed many new hydraulic classifier machines, some with just minor variations from their competitors (Richards 1909; Truscott 1923; Wills 1979).

6 'Transvaal Silvers', *The South African Mining Journal,* Vol. 2, (10 February 1894), p. 286.

4.2.6 The Vanner or fines jigging

The final machine to be described here is the Lührig Vanner. This was a very exciting find in the research, because of how new this type of technology was in 1893, and especially the Lührig Vanner. Despite the Lührig Vanner only being patented in May 1892,[7] Wertheman purchased them in the early part of 1893 – demonstrating the application of modern technology at the TSM.

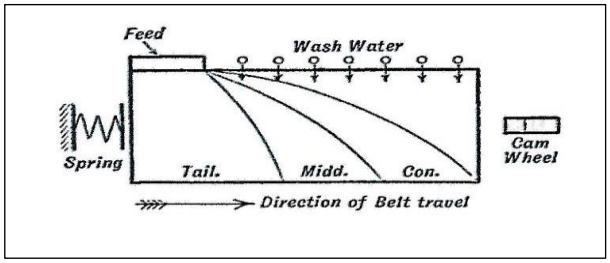


Figure 30. Diagram illustrating the direction of feed, water and eventual separation of tailings, middlings and concentrates on a Lührig Vanner (Truscott 1923:358).

A Vanner is a machine illustrated in (Figure 31) in which the fine particles of 'pulp' [very fine rock particles in a liquid] are fed along a moving belt that is slightly angled both from one end to the other and across the width:

> As the material is fed from the box at the top corner of the machine onto the belt it travels forward with each particle along a particular diagonal line, the resultant of the belt travel and of a film-sizing movement downstream under the action of wash-water delivered along the upper edge. (Truscott 1923:358).

Thus the lighter particles (tailings) will go off first and the heavier particles (ore concentrate) will travel with the belt and come off last. As the belt and flow of fine particles were transported along in a flow of water there was a distinct separation of heavy minerals from the lighter waste particles, (see Figure 30).

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[7] USA Patent no 474,023 A – Apparatus for washing, separating, and concentrating ores of different specific gravity. Patent granted 3 May 1892.

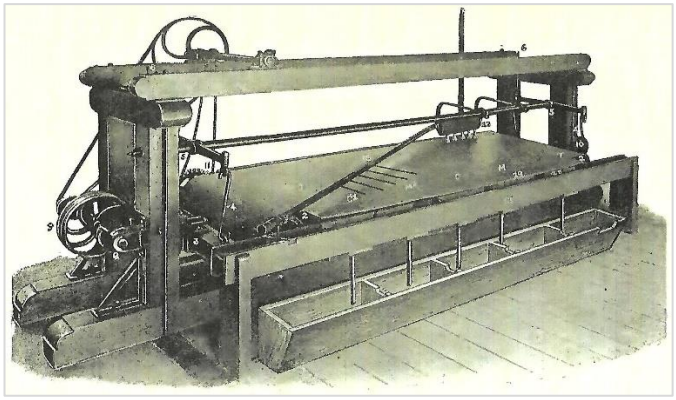


Figure 31. Lührig Vanner (Davies 1902:345)

Note the picture is the reverse of the diagram in Figure 30.

The action of the Vanner is the final sub-process of concentration of the ore prior to drying of the concentrates and bagging for shipment. In many of the textbooks of the 1880s, the process of fines concentration was through a machine called a Buddle (Milne 1893:267; Truscott 1923:341).

This machine pre-dated the Vanner and was common in the Cornish tin and copper mines of the 1800s, as well as the silver lead mines of the USA. It is very interesting that the TSM should have gone for such new technology as Vanners, especially as the chosen machine was only patented in 1892, but it does seem to indicate how forward thinking Wertheman was.

The earliest form of the moving belt Vanner was the Frue Vanner originally invented in 1874 and modified over the next ten years. This was followed by the Billharz-Stein Vanner or bumping table and shown in Chapter 3 – (Figure 20) It was improved upon by the better design of the Lührig Vanner, also a side bumping table, which in turn competed worldwide with the American Frue Vanner and later with the Wilfley table (Milne 1893; Truscott 1923). The modern concentration plant machines are more efficient, but the basic process with their closed loops of re-processing of oversized product is the same today.

4.3 How effective was the beneficiation process in the 1890s?

Before Hahn, a basic technique "mine the ore – high grade – crush and bag for export" was used. Whilst such a process is slow and labour intensive, it allowed the mine to develop and prove the existence of an economical ore-body.

The smelting plant designed by Hahn, was commissioned in July 1892 and achieved production by August, producing a good product in the form of bars of bullion. Mis-management by Hahn in not procuring a good quality coke for the furnaces, but also in not obtaining a lasting supply of local coke, crippled the success of the process. The roasting operation similarly appears to have been a moderate success. The high cost of the equipment and raw materials for the furnaces along with the associated machinery meant that the mine could not produce a smelted product at a profit. The capital outlay plus operating expenses for the reduction works are analysed below.

When Wertheman was appointed (late 1892 - early 1893), he proposed, a more advanced process than the mine had used in 1889. More money was spent on extensive alterations to the surface plant of the mine. No records have been found detailing what happened to the smelting and roasting furnaces that Hahn installed. Were they sold, scrapped or left to rot? There is a mention in the 1895 Annual Report of the selling of some machinery, but no details are provided.[8] Again at the 9th AGM in 1898 mention is made about the potential to liquidate the company and sell the assets.[9] Although all operations on the property had ceased in 1895, it was not liquidated until 1909. Some of the plant and machinery was reported being sold in 1905, but no details were given of what machinery was sold.[10]

Wertheman spent the first three months of his employment procuring machines in Europe.[11] From the time that he took overseas, one is inclined to speculate that he was also looking at possible places to apply to, when his TSM contract finished in 1894. In the new process, the ore was crushed and concentrated as a metallic powder, with the waste rock being separated

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8 BRA. Archives of H. Eckstein & Co. HE 5. TSM 6th AGM report. 14 November 1895.

9 BRA. Archives of H. Eckstein & Co. HE 5. TSM 9th AGM report. 3 September 1898.

10 'Transvaal Silver Mines', *The South African Mines, Commerce & Industries,* Vol 3, (5 August 1905).

11 BRA. Archives of H. Eckstein & Co. HE 5. TSM 5th AGM report. 29 March 1894.

and thrown away. The concentrate was bagged and shipped to Germany for smelting and refining.[12] Such development cost money in labour and materials, money which should have been better spent on the mineral dressing side of the business. Wertheman left the companies employment at the end of April 1894.[13] The political scene in the ZAR was worsening and by 1895 it had become impossible to invest in the country with any certainty of a financial return.

Was the mine a financial success, even if it was not a large scale mining success? The only way of assessing this is to determine if it made a loss or a profit, while it was in operation? In both the smelting and the concentration operating periods, huge amounts were spent on equipping the mine with machinery and buildings. Fortunately the total costs were found in the company records as were the amounts of ore raised, treated and sold on as ore, bullion or concentrates. In some cases they have had to be extrapolated from other figures or values. The results are reviewed in the next section and are also shown as a set of calculations in Table 1.

4.4 The Smelting and Roasting process – costs, expenditure and profit/loss

It is difficult to come to a conclusion regarding the predicted cost per ton of the smelting operation and/or the roasting operation. This is due primarily to the metallurgical and financial miscalculations by Hahn, his wishful thinking, and the Head Office calculations which differ with Hahn's. An external variation which also impacted on the profitability of the operations was the international price of lead and silver.

Hahn stated in early 1891 that he believed the envisaged reduction plant would be capable of processing 80 tons per day or 24 000 tons per year, based on operating for 300 days per annum. He expected the reduction process to yield an annual gross product of about £210 000. He also anticipated shipments of about 2 400 tons of selected high grade ore direct to the smelters in Wales and he calculated that this alone would yield a return of about £63 000. He expected the cost of coke, limestone (flux) and shipping to Europe would leave

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12 'Mining News', *The South African Mining Journal,* Vol. 3, (10 February 1894), p. 286.

13 BRA. Archives of H. Eckstein & Co. HE 5. TSM 5th AGM report. 29 March 1894.

a margin of £60 000 on treated ore, to which must be added at least £40 000 on the shipping of selected high grade ore, making a total profit of £100 000 per annum.[14]

At the end of July 1892, a report stated that both furnaces were in operation and producing about 8 tons of bullion per day per furnace.[15] By the middle of September 1892, Phillips was already worried about the effectiveness of the smelting process. In a letter to Beit in London he wrote "Last month's report shows that running one furnace with English coke leaves no profit and if anything a loss".[16] By the end of September, it was announced that all smelting operations had been suspended due to a shortage of coke. At the same time roasting operations would continue, so as to prepare the ore for when the smelting was re-started. It appears that the furnaces, both smelting and roasting, were only in operation for a period of about 2.5 to 3 months, and were then closed down permanently.[17]

From the accounts, the cost of the reduction works was stated to have been £25 024.[18] The machinery and process does appear to have worked, i.e. it produced bullion as per its specifications, albeit at a higher cost due to the price of the imported coke. It was announced at the 2nd Annual General meeting that Hahn had been appointed as metallurgist and general manager of the TSBM mine and these dual roles could have created conflict situations for him. In fact it would have been unusual for the general manager to also act as the beneficiation plant manager, due to the work load that both positions entailed.[19] The supply of good quality local coke was a serious problem and one for which Hahn seemingly took no responsibility. The quote as follows presents some idea of the problem:

One would normally expect problems in the procurement of essential products for the operation of the mine to be resolved as part of the management function of the general

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14 BRA. Archives of H. Eckstein & Co. HE 5 TSM – 2nd AGM General Manager's Report 9. April 1891:2.

15 'Financial & General Notes', *The South African Mining Journal,* Vol. 1, (30 July 1892) p. 785.

16 BRA. Archives of H. Eckstein & Co. HE 149 p130 16 September 1892).

17 BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM Report 9. April 1891.

18 BRA. Archives of H. Eckstein & Co HE 5 TSM – 4th AGM report financial statement. 1893.

19 Ibid. 2nd AGM Report 9 April 1891.

manager. Hahn's opinion was that the supply of coke was not the concern of the metallurgist or smelter, seemingly abrogating his additional role as general manager.

The assayed value of the smelted bullion was of silver averaging up to 150 ozs/ton and 72% lead. It is difficult to know the exact amount of bullion produced, as various sources give slightly different values. It is believed that a calculated value of approximately 1 433 tons is reasonable. This value agrees with Hahn's statement that the furnaces would jointly produce 500 tons bullion per month. It is known that the furnaces began operation in mid-July and seem to have been operational until the end of September, when the roasters were brought on line.

Profit and Loss Accounts for the years ending 1892 and 1893 and a report in the SA Mining Journal [20] shows the following tonnages and sales values recorded: Note the superscripts refer to the reference numbers in Table 1.

Year ending

December 1892	363 tons	£7 400[4c] = £20/ton
	346 tons	£7 909[4d] = £23/ton
December 1893	338 tons	£10 140[5a] = £30/ton [21]
	376 tons	£9 062[5b] = £24/ton
	10 tons	£ [240][5c] = see comment below
	1 433 tons	**£ [34 741]**

The amount of 10 tons reflected in the 1893 bullion account at £559[5e] is incompatible with the value of silver during the 1890s, as this would give a highly inflated value per ton of £55.9/ton. In order to develop a value of bullion shipments, the previous 1893 value of £24/ton giving a value for the 10 tons of £240 will be used. Because this is an extrapolated/calculated figure, it and the totals are shown in [ ] to reflect the fact that they are not the figures cited in the financial reports.

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[20] 'Financial & General Notes', *The South African Mining Journal*, Vol. 2, (15 April 1893), p. 451.

[21] Ibid.

Table 1. Analysis and calculations of the ore mined, ore shipped coupled with bullion and concentrates production and sales

In trying to calculate whether the mine and its production processes ran at a loss or made a profit, the original financial accounts as shown in the AGM reports have been used. Problems were found in places in that for example sometimes the amount sold did not marry the amount produced. Where amounts have been estimated or extrapolated from the disclosed amounts they are shown in brackets - [ ].

year of AGM	year of operation	ref no	Notes	product sold
1890	1889	1a	ore shipped **25 tons** 1a No details of operating or shipping costs, or selling price	ore
1891 2nd AGM	1890	2a	ore raised = ~ 2000 tons ore shipped = **176 tons** and sold for £3 523 = £20 per ton No operating costs are given in the accounts so it is impossible to calculate the cost /ton of ore raised or the cost/ ton of ore being processed and shipped	ore
1892 3rd AGM	1891	3a 3b	ore raised = 7234 tons @ £5 509 (mining acc#) = £1.30/ton ore shipped = **508 tons** sold for [£8128] = [£16/ton] ore shipped = **332 tons** sold for £6 253 = £17/ton = total of 840 tons sold for £ [14 381] NOTE an amount of 714 tons was sold for £11 232 ans is shown in the sales acc# = £16/ton. However the 714 is a mystery as the two figures shown above do not make 714. I have used the value attached to the 714 to get a £/ton value for the 508 tons. the estimated or extrapolated figures are shown in [ ]	ore
1893 4th AGM	1892	4a 4b 4c 4d	ore raised = 13690 tons @ £8168 (mining acc#) = £1.67/ton ore shipped = **706 tons** sold for £11 924 = £17/ton ore shipped = **53 tons** sold for £795 = £15/ton bullion shipped = 363 **tons** sold for £7 400 --- tons of ore smelted = 1997 tons = 5.5 tons of ore for 1 ton bullion bullion shipped 346 **tons** sold for £7 909 --- tons of ore smelted = [1903] tons = [5.5] tons of ore for 1 ton bullion total bullion shipped = [709] tons and sold for £ [15 309] from 3 900 tons of ore = £21.6/ton	ore and smelted bullion

Table continues on next page

1894 5th AGM	1893	0 0 5a 5b 5c 0 5d 5e 0 0 5f 5g 0 0 0 0	ore raised = 7738 tons @ £5 946 (mining acc#) = £1.3/ton ore shipped = **687 tons** sold for £8 763 = £ 13/ton ore shipped = **5 tons** sold for £64 = £13/ton total ore shipped = 693 tons sold for £8 827 An additional amount of **338** tons appears to have been shipped In April 1894 and was reported in the SAMEJ being valued at £10 140. However this was not reported in the AGM financiaL results for some reason. bullion shipped = **376 tons** sold for £9 062 bullion shipped =**10 tons** sold for £ [240] not the £550 shown in the bullion acc# total bullion sold = 386 tons sold for £ [9 302] = £ 24/ton **1 ton of concentrates needs 4.738 tons of ore** (statement on p.6 of AGM report. concentrates produced = **1263 tons** from 5972 tons of ore was sold at [£9 786] estimated in accounts concentrating cost and shipping = £2439 cost per ton = £1.93/ton therefore 1 ton of concentrates needs 4.738 tons of ore costing £1.3 or 4.738 x 1.3 = £6.16 per ton therefore the 1263 tons of concentrates cost: concentrating cost + cost of ore = production cost to sale = 1.93 + 6.16 = £8.09/ton x 1263 tons = £10 217 So 1263 tons cost £10 217 to point of sale but they sold it for £9786 = **loss of £431**	ore, bullion and concentrates
1895 6th AGM	1894 and 3 months of 1895	6a	Total value of ore and concentrates shipped in 1894/5 = 4617 tons. As the total concentrates shipped = 4364 tons the total for ore must be 4617-4364 = 253 tons. ore raised = 20 226 tons in the 15 month reported in the AGM report @ £10 337 (mining acc#) = £0.5/ton ore shipped = **253 tons** sold for £1 700 = £6.71/ton **1 ton of concentrates needs 6.763 tons of ore** (statement in AGM report.) the accounts show two amounts as sales of concentrates y/e 1894 = £29 680; y/e 1895 = £12 566 concentrates produced = 4364 tons from 28 904 tons of ore was sold at £42 246 this brings total sales of ore and concentrates to the figure in the accounts of £43 947 concentrating cost and shipping = £11 155 cost per ton = £2.56/ton therefore the **4364 tons** of concentrates cost: concentrating cost + cost of ore = production cost to sale = 2.56 + 0.5 = £3.06/ton x 4364 tons = £13 353 so 4364 tons cost £13 353 to point of sale but they sold it for £42 246 = **profit of £28 893**	concentrates and some ore

The total amount recovered in sales appears to have been £34 741. When the recovery of the roasting process is analysed it is not clear if all of the roasted ore was subsequently smelted or not. No mention is made of the roasted ore being treated for recovery of the metals or if it was shipped as roasted ore. Of course the prices realised at sales has to be offset by the capital cost of the reduction plant and the operating costs when it was in operation. Such figures given in the Profit and Loss Accounts for the years ending 1892 and 1893, but it does not appear that the capital cost of the reduction plant was taken into the calculations of profitability of the operation. The capital cost below is derived from the Statement of Liabilities and Assets from the 4th AGM Annual Report 1893.

4.4.1. Smelting and Roasting operation costs

Capital cost of the 'smelting works' including buildings and ancillary machinery (Dec 1892):	£25 024
Smelting and Roasting account for year ended 31 December 1892:	£10 809 [22]
Smelting and Roasting account for year ended 31 December 1893:	£ 7 485 [23]
	£18 294

The cost of smelting and shipping = £43 318 /÷1433 = £30 /ton
The cost of sales of bullion = £34 741÷1433 = £24 /ton

Thus the total capital expenditure and operating cost for the reduction process was £43 318, this meant that the total income of £34 741 against total costs as above of £43 318 leaves a:

Net loss from the smelting process of £8 577.

In a press report for March 1893 it was stated that "it now appears smelting will not pay".[24] Hahn's solution to the problem he had created, was to suggest the construction of 10 more roasting furnaces at an additional cost of £20 000.[25]

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22 BRA. Archives of H. Eckstein & Co HE 5 TSM – 4th AGM report, 9 March 1893.

23 BRA. Archives of H. Eckstein & Co HE 5 TSM – 5h AGM report, 29 March 1894.

24 'Financial & General Notes', *The South African Mining Journal*, Vol. 2, (11 March 1893), p. 372.

25 BRA. Archives of H. Eckstein & Co HE 5 TSM – 4th AGM report, 9 March 1893.

4.5 The concentration process – costs, expenditure and profit/loss

Was this a success? In terms of the technology involved – yes. Wertheman said he needed £10 000 to purchase the plant, but according to the financial report for 1893[26] he spent £17 638. In March 1893 Beit wrote to Phillips in Johannesburg:

> Wertheman has returned to London after exhaustive examination of all the best installations for concentration. He decided to have an installation from Lührig of Dresden, the cost free on board Hamburg will be about £4 500 and weight 150 tons.[27]

Clearly he badly underestimated the capital expenditure, as well as the total mass of equipment which would have had a significant impact – although it is not recorded – on the shipping cost to Durban and the wagon transport costs to the mine.

In a letter to Beit in London, Phillips wrote "Wertheman report shows that he expects to make by means of concentration a profit of £30 000 a year".[28] As the calculations below will show, this was also an amount that was never achieved, even in a full year of concentration.

The final set of financial accounts for the TSM company cover the period from January to December 1894, coupled with a separate set of accounts for the period January to September 1895. The financial analysis is complicated by the amounts shown of ore raised, ore treated and tons of concentrates produced reflects the totals for a 15 month period – January 1894 through to March 1895.[29] Further complications of the final analysis for 1895 are the accounts that reflect sales of ore and concentrates as one amount of £12 566. However, the operating expenses are shown as two individual amounts. It is stated that the total amount of ore and concentrates shipped in the 15 months was 4 617 tons. As the total of concentrates was 4 364 tons this means that there were 253 tons of high grade ore shipped with the concentrates, the figure used in the previous section.

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26 BRA. Archives of H. Eckstein & Co HE 5 TSM – 4th AGM report, 9 March 1893.

27 BRA. Archives of H. Eckstein & Co HE 58 p 498, 17 March 1893.

28 BRA. Archives of H. Eckstein & Co files HE 151 p. 424, 21 January 1893).

29 BRA. Archives of H. Eckstein & Co HE 5 TSM 6th AGM report, 14 November 1895.

In the 5th AGM report its states that in the year 1893 – 7 738 tons of ore were raised of which 693 tons of high grade ore was shipped, 1 418 tons were smelted, and 5 972 tons were treated by concentration. One has to assume that these values are correct (they do not add up to 7 738 tons), but it is impossible to determine where the error was.

A table in the 5th AGM report presents results for the period from October 1893 to February 1894. However, even the figures given in the table do not agree with those presented in the profit and loss account for the year. It is unclear why they produced a table showing 5 months which included January and February of 1894. The financial results ran from January to December thus the addition of the two months merely presents false financial results or, at best, a confusing analysis. Accordingly, the table has been modified below to show the results for the three months to the end of 1893.

Table 2. **Showing approximate results of concentration operations for the 3 months October 1893 to December 1893.**

Cost of mining at 13s/ton	Tons of ore treated	Tons of concentrates won	Cost of concentration at 8s 4.1d/ton	No of tons of ore per ton of concentrates	Average cost/ton concentrates	Cost of 1263 tons concentrates
£3 881	5 972	1 263	£4 488	4 732	38.6s	**£2 439**

The cost of mining the 5 972 tons of ore was given as 13s per ton of ore, and the average cost of concentration was given as 8s 4.1d per ton. The average production rate of 4,732 tons of ore produced 1 ton of concentrates is given in the 5th AGM report The General expenses, rent, interest etc., was given as **£2 387.** An error occurred in the TSM accounts in that no allowance was made for the cost of mining as shown in the table above (in bold).

Thus the total cost of production of concentrates was **£8 707. After payment of the shipping of the 1 263 tons of concentrates it was sold for £9 787, yielding a net profit was £1 080.**

In the period 1894/5 it is reported in the 6th AGM report that 4 617 tons of concentrates and ore were shipped, consisting of 4 364 tons of concentrates. This must mean that 253 tons was shipped as high grade ore, therefore the bulk of the mining account must have been for the ore raised for the concentration process.[6a] The cost per ton of ore raised (see Table 1),

was calculated at approximately £0.5/ton, and the mining costs directly related to the cost of concentrating for the 15 months of 1894/5 have been included below.

Table 3. Showing approximate results of concentration operations for the 15 months January 1894 to March 1895.

Cost of mining at 10s 2d/ton	Tons of ore treated	Tons of concentrates won	Cost of concentration at 7s 6.7d/ton	No of tons of ore per ton of concentrates	Average cost/ton concentrates	Cost of 4364 tons concentrates
£15 004	29 517	4 364	£11 155	6.763	50.72s	**£11 155**

The cost of mining the 29 517 tons of ore was given as 10s 2.65d per ton of ore, and the average cost of concentration was given as 7s 6.7d per ton. The average production rate of 6 763 tons of ore produced 1 ton of concentrates is given in the 6th AGM report. This represents a drop from the 4 732 tons per one ton of concentrates for the 3 months of 1893. The General expenses, rent, interest etc., was given as **£7 841.**

Thus the total cost of production of concentrates was **£34 000. After payment of the shipping of the 4 364 tons of concentrates and the 253 tons of ore was sold at £43 947 the net profit was £9 947.**

In analysing the production and shipment of concentrates detailed on the Profit and Loss Accounts for the years ending December 1893, 1894 and September 1895 the figures have been rounded to show only the pound sterling values except the prices per ton which show the lower values of shillings and pence.

From the 5th AGM report it is stated that the concentration plant was commissioned and in full operation by 17 October 1893.[30] This means that it was in operation for a period of 17.5 months before having to close down. Capital cost of the 'concentration works' including buildings and ancillary machinery was: **£17 638** (Dec 1893)

Thus the total net profit from the concentration process for the two years was approximately £11 027 however this did not take the capital cost into consideration and so therefore the concentration process made an overall loss of £6 611.

[30] BRA. Archives of H. Eckstein & Co HE 5 TSM – 5h AGM report, 29 March 1894.

4.6 Mining and Sales of high grade ore without processing

The profit or loss made on the mining and sale of high grade ore has been impossible to fully calculate for the years 1889-1895. The table below shows the values that were recorded for the various years. As can be seen no sales value or production costs have been found for the 25 tons shipped in 1889. A similar problem exists for the following year, when the cost of production was not disclosed.

If the grade value of the ore mined in 1894/5 had dropped below an acceptably 'high grade' value, then this could answer the lack of a tonnage figure, apart from the extrapolated figure of 253 tons in 1895, The rapid fall in value of the ore they were mining and/or shipping is reflected in the huge difference in the £/ton value in 1895.

Table 4. Cost of mining, value of sales of high grade ore and profit – 1889-1895

Year	Ore shipped (tons)[ref]	selling price (£)	selling price per ton(£)	mining production costs (£)	profit (£)
1889	25[1a]	not recoded	_	not recorded	not recorded
1890	176[2a]	3 523	20	not recorded	not recorded
1891	508[3a]	[8128]	16	5 509	[8 872]
	332[3b]	6 253	17		
1892	706[4a]	11 924	17	8 168	[3 755]
	53[4b]	795	15		
1893	687[5a]	8 763	13	5 946	[2 821]
	5[5b]	64	13		
1894	no ore shipped	_	_	8 612	_
1895	[253][6a]	1700	8	[850]	[1 575]
	2 745	**41 150**		**29 085**	**17 023**

For the four years where the cost of mining and value of sales was recorded – 1891 to 1893 and 1895 - the profit per annum on the mining and selling of high graded ore is reflected in the table below (Table 4). The figures for the four years illustrate that the operation did make a profit, but a very marginal one. It can be assumed that any profit made on the 1889 and

1890 shipment of ore would not have covered the cost of production. Even though the operating costs were much lower due to a smaller workforce, and lower capital expenditure costs, in the opening years it is doubtful they would have realised a profit.

The amount of tons shipped as shown in (Table 4) was only 2 745 tons. Although it was sold for £41 150, the recorded cost of production for the whole period is incomplete, specifically 1889/90. As it is believed that no profit was made on the shipments of 25 tons and 176 tons respectively, by eliminating these values from the overall mining to the sale/profit picture, the total mined was thus: 2 544 tons (1891-1895) selling for £29 499 and:

Yielding a net profit of £17 023

4.7 Value of silver and lead outputs for the period 1889-1895

The table on the next page (Table 5), shows the values of silver and lead assayed in the various batches of ore raised or treated i.e. as high graded ore, smelted to bullion or reduced to concentrates. For most of the 1890s and even as the mine went deeper, the assay values for lead and silver remained fairly constant at 72% lead and at 72 ozs silver per ton of ore – see (Table 5). The higher value of 90 ozs silver/ton realized in 1890 can be traced to the area of stopes on the eastern side of the main shaft close to winze IE2, where the vein on the 100 ft. level opened to a width of 2-4 m with high values of primary and secondary lead and silver minerals (Reeks 2012:173).[31]

The greatest threat to the viability of the Transvaal Silver Mine was the employment of four mine managers in a six year period. Each had different ideas of how the ore should be beneficiated, each installing different processes, and at least two - Hahn and Wertheman - made inflated forecasts of potential profits.

[31] BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM - Engineers report p. 6, April 1892.

Table 5. Analysis of the period 1889-1894 with the bullion metals produced and capital equipment expenditure values

year	period - months	ore raised (tons)	waste raised (tons)	Value of ore		ore and concentrates (con) shipped (tons)	Potential 0utput of lead (tons)	Potential output of silver (ozs)	Potential output of silver (kg)	Bullion values				Asset value				Primary references for data
				silver (ozs/ton)	lead (%/ton)					bullion shipped (tons)	Potential output of lead (tons)	Potential output of silver (ozs)	Potential output of silver (kg)	machinery account	Smelting plant	Concentrating plant	buildings account	
1889	Jan to Dec			75	50	25												*The Diggers' News* Dec 7 1889 and 2nd AGM report 1891
1890	Jan to Aug	2 000+		90	69	176	121	15 840	449					£7 386			£3 357	2nd AGM report 9 April 1891 Consulting engineers report
1891	Jan to Dec	7 234	3 431	93	72	508	366	47 244	1 339					£12 339 + £7 889 (in transit)			£9 386	3rd AGM report 21 April 1892 Consulting engineers report
				89	72	332	239	29 548	838									
1892	Jan to Dec	13 690	3 951	72	72	706	508	50 832	1 441	709 @ 150 ozs Ag/ton	510	105 350	3 015	£13 749	£25 024			4th AGM report 9 March 1893 SAMJ 11 March 1893
						53	38	3 816	108									
1893	Jan to Dec	7 738	201	72	72	687	495	49 464	1 402	386 @ 150 ozs Ag/ton	278	57 900	1 641	£13 875	£26 240	£17 638	£12 483	5th AGM report 9 March 1894
						5	4	360	10									
						253	182	18 216	516									
						1 263 (con)	909	93 462	2 650									
1894	Jan 1894 to Mar 1895	20 226		72	72	4 364 (con)	3 142	314 208	8 908					£13 181	£26 242	£16 498	£12 483	6th AGM Report 14 Nov 1895 SAMJ 10 Feb 1894
sub totals		**50 888**					**6 005**		**17 661**		**788**		**4 656**					

An external factor that greatly influenced the economic survival of the TSM was the international price of the two primary metals recovered. The values of these commodities were set by the London Metal Exchange, but in 1889 the values of both metals began a period of decline on world markets. A critical point was reached in 1893 with the repeal of the Sherman Silver Purchase Act in the USA (Brinkley 2004). A further historical low point in the international values of silver and lead in 1895 due to the first severe economic depression in the United States in 1893-1895 was instrumental in the TSM mine being forced to close down (Brinkley 2004; Reeks 2012).

Note – because certain figures of production differ slightly with those presented in (Reeks 2012) and so there are marginal differences in the total of silver and lead produced reflected in (Table 4).

Water always seemed to be a problem at the TSM. The pumped amount recorded in 1891 was 35 923 526 gallons. In 1892 it was 27 561 215 gallons and in 1893 - 27 399 526 gallons. This equates to a monthly average of 2 524 563 gallons. Values for 1890 and 1894 were most probably similar.

4.8 Analysis of the mine and workers, when was it working – how many workers

In early 1890, shortly after the H. Eckstein Company took over the TSM from the Barnato Group, the American mining engineer Hennen Jennings wrote a report for the new management in which he presented details of the mine, its buildings and potential employees. He stated that "the buildings will give accommodation for a working force of 14 white men and 50 'k…..'" [32]

With company reports for the years 1890 through to 1895, when the mine shut down, it was hoped that staff numbers for each year would be recorded. No records of staff levels have been found for 1890. Apart from a comment in the 2nd AGM report - 'when the staff was increased'[33] there was only one year when full details were presented in TSM Company AGM reports and that was 1892. The roasting and smelting operation of 1892 employed:

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[32] JPL Harold Strange Library - Transvaal Silver Mines - Report to Directors of Transvaal Silver Mines by H Jennings, (April 1890), Archive Ref 622 Silver Mining.

[33] BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM Report, 9 April 1891.

> 17 white men, comprising miners, engine-drivers, tool-sharpeners, carpenter and smith, and 200 or more natives. At the reduction works there are employed:-1 constructing engineer, 3 fitters, 8 carpenters, 1 blacksmith, 4 masons, 3 bricklayers. Additionally at the ore floors, brickyard, clay-pits and quarry:-13 additional white men a total of 33 white men and 120 natives – the additional staff consists of four clerks.[34] [35] [There were two managers; the underground and the general manager].

When this operation was replaced by the concentrating operation from the end of September 1893 there appears to have been a huge reduction in staff, as only 13 white employees and 100 black employees are mentioned in a press report.[36] As shown below there were staff related to the drying and bagging of the concentrates. What is unclear, but can be assumed, is that when the smelting and roasting operation was closed down in March 1893, staff connected with the operation, were dismissed. It was only from the end of July 1893 that the concentrating plant equipment arrived and the concentrating plant became operational from the end of September 1893.[37] In a press report it was stated:

> At present the staff employed consists of 13 white men and 100 'k……', but this will now have to be considerably increased… For the supervision of this plant two white men are employed, whilst in the drying, sacking, addressing, delivery, etc. of the concentrates, a staff of 16 'k……' and one "handy" white man is engaged; some 12 000 sacks being dealt with per month'.[38]

There has to be a correlation between the amount of ore raised and the number of both black and white underground mine workers. Unfortunately, the only year where the individual numbers of miners are recorded is 1892. By looking at the volumes of ore raised it can be assumed that in the peak years of 1892 (13 690 tons) and 1894 (20 226 tons) there was a corresponding higher number of underground miners, see Table 5.

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34 BRA. Archives of H. Eckstein & Co HE 5 TSM – 3rd AGM Report, 21 April 1892.

35 'Transvaal Silver Mines', *The South African Mining Journal,* Vol. 7, (3 September 1898), p. 997.

36 'Transvaal Silvers', *The South African Mining Journal,* Vol. 2, (10 February 1894), p. 286.

37 'Transvaal Silvers', *The South African Mining Journal,* Vol. 2, (16 September 1893), p. 895.

38 'Transvaal Silvers', *The South African Mining Journal,* Vol. 2, (10 February 1894), p. 286.

What is also important about Jennings' first report is that he states that the accommodation would provide for a working force of about 14 whites and 50 blacks on the property. The 1890 mine plan (Figure 9) provides details of where some of the original structures were located relative to the main shaft. It can be seen and will be discussed later that the 1890s black mine worker compound structure appears as a single building although it is drawn very much smaller than the white miner living quarters, which Jennings states the white miner living quarters consists of 6 sleeping rooms, a dining room and kitchen and measured 24 ft. (7 m) wide x 49 ft. (15 m) long.[39] The initial black mine worker compound needed to house 50 black mine workers. Only a single building is indicated on the 1890s surface plan of the mine. However, in Hahn's report at the 3rd AGM he disclosed that there were 'two old' compound buildings and it is presumed these dated from 1889. He also states the construction of three new compound buildings was in progress, additional to the two old buildings, plus one to be built on the East Lode.[40]

It is difficult to reconstruct the sleeping quarters of the 1890s black mine worker compound. In a Heritage Impact Assessment of an old mine compound at the Vlakfontein gold mine c1940s, conducted in 2008, it was found that a room measuring 5.5 m x 6.6 m accommodated 36 miners on 10 bunks, 3 tiers high (Reeks 2008; Callinicos 1981). In Hahn's 1892 report he describes two old compound structures, dating from 1889 that were built for the black mine workers. One measures 13.7 m x 3.8 m and the other 7.75 m x 4.6 m.[41] With such sizes it could be possible to fit 39 miners into the largest house and 27 into the smaller one, on the basis of three high bunks. It was therefore possible to accommodate the 50 black mine workers indicated in the early reports of 1889-1890 in the two buildings.

The four new additional compound buildings were constructed sometime during 1891-1892. The individual buildings measured 8.9 m x 7.14 m and therefore could probably accommodate 15 men by 3 high, totalling 45 men on bunks around the walls, with the possibility that more may have been positioned in the middle of the building. In fact the shape of the building does not lend itself to economical bed positioning. Thus the three

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39 JPL Harold Strange Library - Transvaal Silver Mines - Report to Directors of Transvaal Silver Mines by H Jennings, (April 1890), Archive Ref 622 Silver Mining.

40 BRA. Archives of H. Eckstein & Co HE 5 TSM – 3rd AGM General Manager's Report, 21 April 1892.

41 BRA. Archives of H. Eckstein & Co HE 5 TSM – 3rd AGM Engineer's Report, 21 April 1892.

structures as indicated in Hahn's report could accommodate at least 135 men. The new building on East Lode could have accommodated a further 45 men as described above. The 1889 structures providing for a further 66 mine workers, therefore the potential total was for about 246 people.

It is difficult to rationalise these numbers with Hahn's staffing level indicated above for 1891 of 320 men. If the buildings described above were the only ones erected then there must have been a higher occupancy level than that indicated in the various buildings. It is my belief that the black staff numbers were inflated, especially those working underground, which Hahn stated numbered 200. Unfortunately, none of the TSM accounts reflect labour costs at the mine, so it is impossible to know what the exact level of black miner employment was from 1889 to 1895. If numbers were inflated it may have been to give the impression of the mine being bigger than it actually was, in order to boost shareholder confidence.

I think the statistics stated above for 1889 and 1890 were reasonably accurate, as the mine was in initial development with very little in the way of beneficiation. It is known that after the takeover by the H. Eckstein & Co. in early 1890, that the underground sections were shut down for a period of three months, from 10 April, and allowed to flood. The mine was de-watered from the end of July 1890, but work could only resume from 17 August when it was free of water. Presumably during this period the number of underground mine workers were reduced. The following year Hahn was appointed in early April 1891 and he not only started building the new smelting plant and other buildings, but also began extensive development of the mine underground as can be seen from the feature under Assets in the December 1891 financial report. By the end of 1891 the mine had raised 7234 tons of ore, plus some 3500 tons of waste rock. If one assumes that this was produced over a 12 month period, which equates to approximately 35 tons/day, based on a 300 day/year working period, it is unlikely that this would require 200 men to produce.[42]

It is known that the Reduction plant was commissioned in July 1892. Even allowing for the fact that staff would be required to build and install the plant before July, it seems unlikely that they would have employed the full complement of 100 black workers before March 1892, when the largest items of plant started to arrive at TSM.

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42 BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM Report, 9 April 1891.

Once the reduction works was commissioned, it was only in operation until January-February 1893, before being shut down permanently. What happened to the approximate 100 black and 13 white staff, primarily employed in the reduction works? The most likely scenario is that they were dismissed or at least a large percentage of them were. It is also known from the records, that once the furnaces were commissioned, that all mine development work and mining had stopped. This was because they had so much ore 'at grass' and development of the ore bodies was completed for at least 5 years.[43] As erection of buildings for the new concentration plant was probably only begun in the middle of 1893, because the plant was only commissioned near the end of September 1893.[44] It would be more likely that the overall staff compliment was severely reduced both underground, and on surface from January 1893 for at least six months. The 8000 tons of ore raised in 1893 probably only began once the new concentrating plant was under construction.

4.9 Conclusions

This chapter has tried to cover each machine or process and describe the functions, processes and impact of the machines. Hahn clearly made many mistakes and they are discussed in detail in Chapter 12. What was surprising is that although Hahn came as a "well respected metallurgist" he made several fundamental metallurgical errors in his beneficiation process and these are also discussed in Chapter 12. Wertheman was similarly put on a pedestal of "great metallurgist" by Lionel Phillips, the Chairman of TSM. Although Wertheman did correctly concentrate the ore and ship without roasting or smelting, his process included the testing of very new machines such as the Lührig Vanner in the final stage of a multiple crushing process. It is my belief that he was using Argent as a test bed for a future employer's mining operation and the fact that he rejected the offer of an extension to his one year Argent contract would seem to add strength to this argument.

It became clear in this chapter that the management of the mine was not stable - over the six year life of the mine in the 1890s it had significant changes in the beneficiation technologies. Hahn and Wertheman - were clearly men of wide experience in the metallurgical processes of lead and silver mining. What went wrong?

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43 'Transvaal Silvers Co.' *The South African Mining Journal,* Vol. 1, (29 October 1891), p. 69.

44 'Transvaal Silver Mines, Ltd.', *The South African Mining Journal,* Vol. 2, (23 September 1893), p. 906.

In analysing the processes and machines used in the 1890s for the beneficiation of the lead and silver, it became clear that despite a number of new machines being invented in the 1880s, Hahn did not install any form of concentrating equipment in order to be able to convert the lower grades of ores to recover the two metals. It appeared that his philosophy was, crush and ship the rich 'bullion' grade ores and crush and smelt the medium to high grade ores. This would have worked on deposits that Hahn was familiar with - the rich silver mines of Nevada, USA - but his fatal error was he miscalculated the level of sulphur in the ores and his roasting process could not handle the higher levels.

It appears that Wertheman's analysis of the Argent ores provided an opinion that smelting would not be profitable with the low to medium grades of ore and convinced TSM management to abandoned Hahn's smelting process. Wertheman believed that the greater amount of ore at Argent was low to medium grade and in order to make this a saleable product it had to be concentrated.

The calculations on the capital expenditure and sales of ore, concentrate or bullion were carried out to try and establish if the TSM was profitable or not. Although the calculations are lengthy and, by their very nature, sometimes subjective due to the lack of detailed records, results were produced and they are discussed further in Chapter 12.

The closure of TSM in 1895 was mainly due to a severe fall in the international price of lead and silver, with silver reaching its lowest price in history at 2s 4d per ounce and lead as low as £9 8s per ton.[45] Coupled with the falling prices, was the excessive rising costs of transport to and from the mine, with the nearest railway connection in the early 1890s being as was stated in Chapter 3 at Charlestown in Natal. A further factor was the high inflow of water into the upper level of the mine.[46]

In the next Chapter the beneficiation operation under the ownership of The General Mining Company in the 1920s will be investigated, a period when the Transvaal Silver Mine was renamed to the Transvaal Silver & Base Metals Company.

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45 'Transvaal Silver Mines, Ltd.', *The South African Mining Journal,* Vol. 2, (23 September 1893), p. 906.

46 Ibid.

Chapter 5

Analysis of the beneficiation plant of Transvaal Silver and Base Metals Co Ltd. 1919-1926

5.1 Introduction

Following the closure and eventual liquidation of the Transvaal Silver Mines Ltd. in 1909, there were periods of tribute mining by small companies from 1907-1914, but no large mining company took an interest in the mine until just after the end of the First World War in 1919. With the war ending, the need for lead for munitions, declined significantly. However, there was still a demand for lead to reconstruct the economies and buildings destroyed in the war zones of the First World War. General Mining and Finance Corporation, hereafter referred to as General Mining, formed a company in 1919 called the Transvaal Silver and Base Metals Co Ltd, hereafter TSBM.[1] Very few primary historical documents of this company have survived. Contemporary sources from 1919-1926 enabled the re-creation of the beneficiation process, which forms the main focus of this chapter. An analysis of the machinery installed will form part of the narrative, coupled with flow diagrams of the respective processes described.

5.2 TSBM begins

The old TSM, became a part of TSBM from 1920, but was always designated 'main mine' in the 1920s. TSBM looked at the whole district for potential lead and silver mines. It took out leases on the old TSM mine, as well as the Brakfontein, Boschpoort and Oudezwaanskraal mines along with various additional extensions to adjoining farm land (Reeks 2012). Having said this, the main focus of development and reconstruction in 1919 was at the old 1890s TSM.

Although the TSBM Company was a separate listed company on the Johannesburg stock exchange, of its five directors four were from General Mining.[2] Many of the technical and

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1 Registrar of Companies, Pretoria: File 01/06172/06, Transvaal Silver & Base Metals Ltd, Registered 24 November 1919.

2 This statement is based on the details in the abridged prospectus for TSM where it named five directors. Sir George Albu (chairman of General Mining), Arthur French (Manager at General Mining), Erroll Hay

financial management functions were also controlled from the General Mining Company. The Company Secretary of TSBM - Mr JV. Blinkhorn - was also from General Mining. To a large extent control of General Mining, a company that had been formed in 1895 by the 'gold mining' Randlord brothers Sir George and Leopold Albu, was still largely owned and controlled by them in the 1920s (Reeks 2012). This company would re-prospect the region and dewater some of the 1890s silver mines for investigation, resulting in re-working the old TSM and Brakfontein silver mines.

Once the re-building began at the old TSM mine, it became the centre for all development within the TSBM operations. It was stated in the previous chapter that due to the low profitability of some parts of the ore-body - on all three levels - of the TSM that there were unworked areas When re-sampled these areas were found to be payable at the 1920s prices for the metals.[3]

5.3 The rise in international prices of silver and lead in 1919

Renewed interest in lead and silver in 1919 impacted on the world metal markets, causing the prices of lead and silver to rise. An article in November 1919 put lead being quoted at around £34 per ton with silver at 5 shillings and 8 pence per ounce.[4] The other significant factor in support of re-opening the mines around Argent were the greatly improved transport facilities of road and rail.[5] It was stated in an internal document of General Mining that:

> ...metal values of over 150% higher than the average values realised from 1891 to 1895, [coupled] …with greatly improved transport facilities and the possibility of much higher and cheaper concentration by more modern processes that the operation

(Technical Advisor to General Mining) and George Gooch Holms (Mining Engineer to General Mining). The fifth director was Compte Francois de Ferrieres a director of the Robinson Gold Mining Company. 'Abridged prospectus of the TSBM', *SA Mining & Engineering Journal.* (6 December 1919).

3 When the original Gold Fields files dealing with the 'Argent' mines were borrowed by me, they contained a separate 12 page document. The document was unlisted in the catalogue file. It was however considered genuine as it contained information that would have only been available to the General Mining author in 1919. It appears to have been the draft prospectus for the new TSBM Company.

4 'Important silver and base metal flotation', *The SA Mining & Engineering Journal,* (29 November 1919), p. 250.

5 Ibid.

> of these deposits is placed on a very different footing to that ruling 25 or more years ago.[6]

One of the key statements in the quote above is '*…the possibility of much higher and cheaper concentration by more modern processes'*. This statement is believed to have been the driving force behind the technologies put in place at the TSBM mine and which will be developed in the research forming the narrative of this chapter and Chapter 6.

An anonymously written article in the SAMEJ in December 1919 presented details of the successful launch of the TSBM Company on the Johannesburg Stock Exchange.[7] The article also highlighted several economic factors which played a role after the end of World War 1. "Heavy purchases of silver by India and other Eastern countries" (the other countries are not named in the article) was the primary cause in the rise and maintained high price of the metal.[8] The purchases were attributed to the high degree of prosperity in those countries. At the same time the Mexican revolution resulted in a huge drop in the production of silver from that country – dropping from 226 million ozs in 1911 to 167 million ozs in 1917.[9] It was expected that the recovery in production in that country would be slow. In the USA, many of the copper mines were also silver producers, but with the fall in demand for copper, [again probably due to the drop in demand for munitions] the production of silver as a by-product fell away. Finally, it was expected that as Germany - as part of her war reparations - was forced to hand over its gold reserves to the Allies at the end of the First World War, she would be forced to return to a silver standard.[10]

A later issue of the SAMEJ (10 January 1920) highlighted another factor also related to the World War. A significant impact on the post war demand for silver was that due to the enormous number of deaths during the war, many heroic and serving members of military

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6 See foot note number 3 on page 97.

7 Transvaal Silver successful flotation', *The SA Mining & Engineering Journal,* (20 December 1919), p. 321.

8 Ibid.

9 Ibid.

10 Ibid.

and non-military forces would be honoured with medals. As was stated what should not "…be forgotten [was] that many millions of silver medals [would] be struck".[11]

The outlook for lead was much the same. The scarcity of trained miners and smelters in the world labour market, coupled with the scarcity or poor supply of much needed supplies in these industries led to a world-wide shortage of lead and thus an increase in its price as a commodity.[12] There was a need to develop new industries or rebuild old ones in South Africa in 1919, to meet the financial needs of the country and the social needs of a population desperate for work and this is discussed in more detail in the next section.

5.4 The World economic position in 1919-1920

Launching of this post First World War mining company was of significance, because it showed a determination in South Africa to move forward with its recovery process. In many mining industries there was stagnation due to the economic fall-out from the war. De Beers, as a company, had achieved a consolidation of its major diamond mines in South Africa with the exception of the Premier mine near Pretoria. This mine was still controlled by Thomas Cullinan until 1917, when De Beers was able to gain a controlling interest in the mine. (Davenport 2013:256-258). The outbreak of the war in 1914 led to a severe drop in the sales of diamonds and De Beers was forced to close all of its mining operations, only restarting the washing of ore at three of its mines in 1916 (Davenport 2013:260). Its monopolistic control of the mining and selling of diamonds was particularly badly hit by the much lower consumer demand for diamonds during and post the First World War. The impact was extended in 1918 when an outbreak of Spanish influenza crippled the city of Kimberley. In fact the impact was so great that the company once again suspended all of its mining operations in South Africa until 1924 when world market conditions for diamonds began to improve (Davenport 2013:266-267).

The gold mines of South Africa were also in serious financial trouble in the immediate post 1918 years. At that time gold, as a commodity, was sold internationally at a fixed price, in fact South Africa was forced to sell its gold production to the Bank of England at a price

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11 'Transvaal Silver & Base Metal Flotation', *The SA Mining & Engineering Journal,* (10 January 1920), p. 391.

12 Ibid.

which was seven shillings lower than the 1914 price and yet mining and wage costs kept rising (Davenport 2013:303). Prior to the First World War the mines had been "forced to exploit the richer parts of the ore" (Davenport 2013:303), but such exploitation meant that by 1917 fourteen of the formerly profitable gold mines became 'low grade' ore producers. By 1919 three of those mines had been forced to close down and the number of marginal mines had risen to twenty-one, There was a very real danger of "21 mines of the 39 gold mines on the Witwatersrand falling into the unprofitable category" (Davenport 2013:303-306).

Unrest among the white miners had led to a number of disruptive strikes in 1905, 1907 and 1913. In the struggling post-war period, Britain, as the major economy of the world, was forced to abandon the gold standard in March 1919 (Davenport 2013:305). This forced a depreciation of sterling and boosted the gold price. It also meant that, rather than having to sell gold via the Bank of England, the mines could sell it on the open market and so for the first time in the 20th century the gold mines of the Witwatersrand were able to return reasonable profits (Davenport 2013:305). Carelessly – with hindsight – the mines relaxed their watch on operating costs and via the Chamber of Mines granted a 40 per cent increase in wages of the white workforce but at the same time kept black wages low (Davenport 2013:305).

In the years 1920-21 an extremely deep international deflationary recession hit the United States and many European countries. Economists cite the large influx of returning troops creating a surge in the labour force which the post war economies could not absorb as one of the causes for the recession. Vernon suggests that the large rise in unemployment in 1920 could be explained by the continued effects of the 1918-19 demobilisations and in effect the over- supply of labour, although as he discusses this was not the sole reason (Vernon 1991).

He argues that it was more likely to be "caused by a decline in aggregate demand coupled with an increase in aggregate supply", in other words the producers of goods were oversupplying and the demand for such goods was not there (Vernon 1991).[13] In the USA and Europe especially, there was also a huge shift in employment dynamics. During the war, because men had been forced to go into the armed forces, it had created a shortage of labour which in time was filled by women. After the war and demobilisation, the men were re-employed in many industries, leaving the women as unemployed workers, the number of which rose substantially both in the USA and Europe especially in 1920 (Vernon 1991).

The War in Europe created a situation where South Africa was in effect cut off from manufactured goods, especially replacements for existing equipment on the mines. The lack of merchant ships to bring the goods to South Africa created opportunities for local production, and a need to be able to locally repair or replace items of equipment. This led to the beginning of a South African manufacturing and engineering industry during the War years which also began manufacturing civilian consumer goods as well, and this continued until the downturn in the South African economy in 1920 (Jones & Muller 1992:69).

Estimates put the rise in industrial output in South Africa between 1916-17 and 1920-21 at 43%. (Jones & Muller 1992:68-69). Local production of materials such as bricks, cement, lime and timber, along with many civilian products such as clothing, footwear and processed food created new industries, which after the war took advantage of new markets overseas. (Jones & Muller 1992:69). In the post war years, many new engineering companies began operating due to a demand from the mining industry for locally repaired items, and some developed into primary manufacturers of components and machines in South Africa.

However, from the end of 1920 when the world recession also hit South Africa it caused a severe deflation in wages and the value of manufactured and grown products. South Africa was lucky though, as the actual decrease during this period was only about 4 per cent, before

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[13] *Aggregate supply* is defined as: "Total of all goods and services (including exports and imports) supplied at every price level, within a national economy during a given period. Also called total output." http://www.businessdictionary.com/definition/aggregate-supply.html. (Accessed on 30 Dec 2018).
Aggregate demand is defined as: "the total level of demand for desired goods and services (at any time by all groups within a national economy) that makes up the gross domestic product (GDP). Aggregate demand is the sum of consumption expenditure, investment expenditure, government expenditure, and net exports."
http://www.businessdictionary.com/definition/aggregate-demand.html. (Accessed on 30 Dec 2018).

rising again in 1923 (Jones & Muller 1992:69). By comparison the USA is estimated to have gone through an 18 per cent deflation (Vernon 1991). By 1921 the gold price began to fall again. Suddenly operating costs, not only on the mines, but also in the new industries, became an issue. Many gold mines became marginal or loss makers. The political climate in South Africa was also becoming more militant among the white workers, both mining and industrial, who saw all industries as symbols of the capitalists, keeping the workers as poor as possible. Labour, especially among the white miners, was led by a communist inspired leadership and this created a political 'powder keg with a burning fuse' in 1920 (Krikler 2005). The 'Rand Revolt' began on January 1st 1922 which led not only to huge loss of life and serious damage to many of the gold mines, but to the State making war against part of its civilian population in Johannesburg (Krikler 2005).

Within this poor economic climate, 1918-1922, General Mining chose to launch a new mining venture. Despite falling gold prices, a collapsed diamond market, the rise of a communist inspired strike-hungry workforce, in both the coal and gold mining industry, at the launch of the TSBM mine on the Johannesburg Stock Exchange, the shares were 'over-subscribed'[14] eleven times.[15] Clearly a small percentage of the population of South Africa were still financially comfortable. Behind the General Mining plan of the new mine was one of the last surviving 1890s Randlords – Sir George Albu – chairman and founder of General Mining in 1895. At the close of the 1st AGM of the TSBM Company Albu made a statement that:

> He had been induced by the desire, if possible, to create in South Africa a new industry. He was not disappointed in his vision. As to the value of the property, he did not know it. All he knew was that the new industry which he desired to create in the country had enormous chances.

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14 The term *oversubscribed* refers to launch of new shares placed on the market and where the number of shares applied for is greater than are available. For example there are 1000 shares for sale but the number of shares wanted for purchase is 10 000 shares. It is then said to be oversubscribed ten times. The usual result is that the share allocation is reduced proportionally per investor to the number of shares he/she wishes to purchase. https://financial-dictionary.thefreedictionary.com/oversubscription (Accessed on 30 Dec 2018).

15 'Transvaal Silver successful flotation', *The SA Mining & Engineering Journal,* (20 December 1919), p. 321.

> He did not like to tell them what he really believed - what the future of the property would be to them and to South Africa, because it would be too visionary, but he had the highest expectations.[16]

5.5 Initial re-development of the mine 1919-1922

In April 1920, at an interim meeting of shareholders, the acting chairman, Arthur French made a statement dealing with the large area of prospecting that TSBM had secured:

> …the enormous area [under investigation]…is quite impossible for us to tackle the proposition on a wholesale scale as such a policy would obviously absorb the whole of the working capital in a few weeks.[17]

With this statement he made it clear that the company was focussing on the old 'main mine' of the TSM, and mention is made of a plant for de-watering of the mine arriving on the site. It was also announced that one of the dumps of the TSM Company had been tested and found to contain high grade ore, some of which was shipped to the UK for testing in order to develop the ideal method for the new treatment plant for the ore.[18]

In July 1920 it was announced that TSBM had acquired the rights to the Ferguson lease, see (Figure 32) portion of Dwarsfontein for £15 000 and this gave the company access to the extensions of the lode of the 'main mine' of TSM.[19] They estimated that this acquisition would give them access to about 157 000 tons of ore.

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16 'Report of 1st AGM of TSBM Ltd', *The SA Mining & Engineering Journal,* (1 January 1921), pp. 463-465.

17 'The outlook for Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (24 April 1920), p. 190.

18 Ibid.

19 'Progress of Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (31 July 1920), p. 514.

It was also announced that the main mine had been dewatered to a depth of 13m and that new surface equipment, consisting of two 100hp boilers, steam winding engine and air compressor had arrived on site.[20]

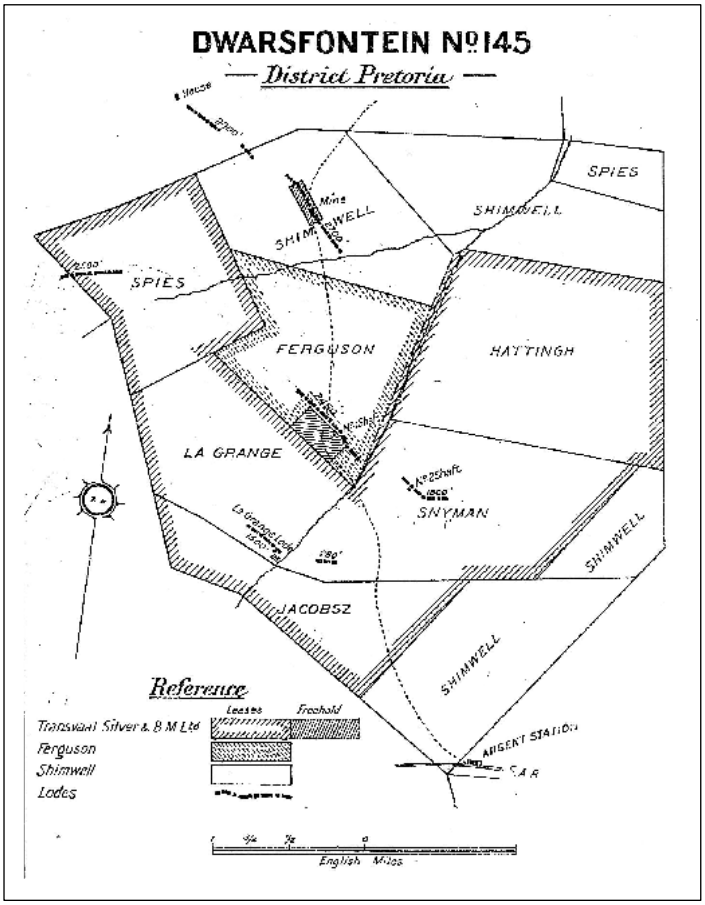


Figure 32. Dwarsfontein farm showing leased portions of the farm and the primary lodes.[21]

By the 1920s, prospecting had become a more serious undertaking with geologists carrying out field testing in the form of drilling on the ore bodies followed by extensive sampling of the cores recovered. This meant that many teams were working on different aspects of the development at the same time.[22]

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20 'General Mining Co AGM with ref to TSBM', *The SA Mining & Engineering Journal,* (18 September 1920), p. 27.

21 'Some of the Lodes of the Transvaal Silver & Lead mines', *The SA Mining & Engineering Journal,* (28 August 1920), p. 659.

22 'Progress of the Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (30 October 1920), p. 187.

Coupled with the surface drilling, the company also began investigations into the dewatering of the other old silver mines in the district.[23] By the end of the year, the company announced the finding of new lodes of argentiferous lead, as well as the results on existing lodes showing that they extended over greater distances than had been expected, and that the total length of proven mineralised vein on the farm Dwarsfontein alone was approximately 6.4 km.[24]

From articles published in the *SA Mining and Engineering Journal* (SAMEJ) it has been possible to follow the progress of dewatering of the 'main mine', as well as the installation of the beneficiation plant. Fortunately, there are detailed descriptions of the plant installed, coupled with photographs of the plant buildings and headgear. When these sources are used in conjunction with the physical analysis of foundations, made during the archaeological pedestrian surveys, and modern photographs of the foundations, it has been possible to fully re-create the 1920s beneficiation plant at the TSBM main mine. More detail on this development and of the technology will be given in Chapter 6 under the sub-heading of 'New Technologies'. In July 1920 it was announced that Dr Edward Heberlein, a well-respected European metallurgist, had been employed to consult on the design of the smelting and concentration plants to be installed at TSBM.[25] In September it was announced that samples of ore had been sent to him for experimental purposes and it was expected that within the next few months he will have completed his investigations.[26]

The main operation offices and beneficiation plant of the new company were located on the site of the old TSM on the farm Dwarsfontein. The general idea was that ores from the other mines, when and if they were re-opened, would be transported and fed into the new beneficiation operation (Figure 33).

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23 'Progress of Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (31 July 1920), p. 514; 'General Mining Co AGM with ref to TSBM', *The SA Mining & Engineering Journal,* (18 September 1920), p. 27.

24 Ibid; (SAMEJ 31 July 1920); 'Transvaal Silver & Base Metals Ltd', *The SA Mining & Engineering Journal,* (1 January 1921), p. 463.

25 'Progress of Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (31 July 1920), p. 514.

26 'General Mining Co AGM with ref to TSBM', *The SA Mining & Engineering Journal,* (18 September 1920), p. 27.

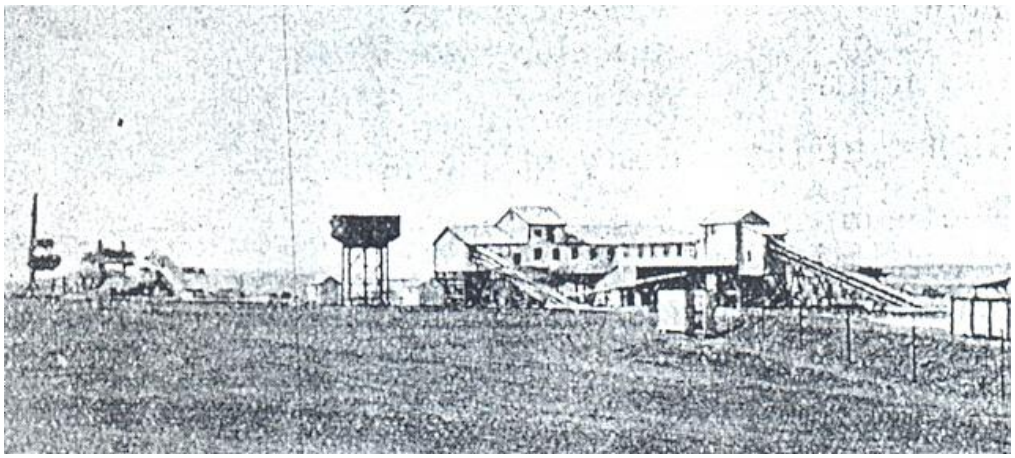


Figure 33. Historical photograph of the Argent mine - general view of the 1920s beneficiation plant.[27] The main part to the right of the picture is the incline conveyor leading to the primary crusher and then the secondary crusher plant (see Figs 36 and 37).

As the drilling and prospecting operations were completed at many of these satellite operations (mines), the results were not encouraging and so they were closed down, or were not developed as they were considered to be un-economic or too distant from the Argent mine.[28] This left the Brakfontein mine as the only additional feeder of ore to the new plant and it was further developed underground.

A new headgear was erected at the old TSM shaft (Main mine) (Figure 34). Dewatering was continued and completed to the 140 ft. (42 m) level or about 17 ft. (5 m) below the first level of the mine. It was expected that the dewatering of the remaining levels of the mine would be completed fairly quickly once the new Tangye air compressor and its associated air lift system had been installed.[29]

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27 'Transvaal Silver', *The SA Mining & Engineering Journal,* (19 August 1922), p.1676.

28 'Progress of the Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (30 October 1920), p. 187; 'Report of 1st AGM of TSBM Ltd', *The SA Mining & Engineering Journal,* (1 January 1921), p. 463-465.

29 'Progress of Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (31 July 1920), p. 514.

In December 1919, the SAMEJ produced a small article on 'Froth Flotation Concentration' stating that this important invention, by Minerals Separation Ltd of London, was possibly going to be used at the new TSBM mine.[30] The residues would be capable of treatment by the proposed oil flotation plant. It was proposed a de-sulphurising and smelting plant be erected to treat the high grade ore and the fines, and that such a plant had been ordered and should be in operation by the first half of 1921.[31]

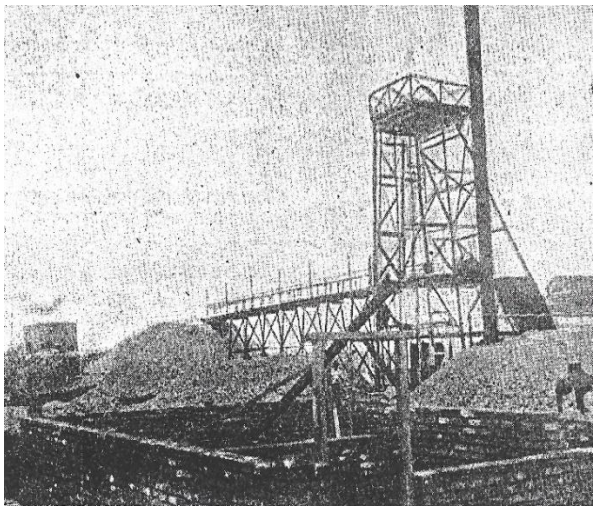


Figure 34. Historical photograph of the 1920 steel headgear installed at TSBM No 1 shaft.[32]

The first time that the proposed equipment for the new beneficiation plant was mentioned was in a report of the 1st AGM of the TSBM Company held in December 1921.[33]

> …a power plant, consisting of an additional Stirling boiler, a 400 KVA generator set, a smaller generator set…which will enable electric pumps to be installed in the shafts and also provide power for the concentrating and smelting plants.

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30 'Froth Flotation Concentration', *The SA Mining & Engineering Journal,* (13 December 1919), p. 290.

31 'Progress of the Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (30 October 1920), p. 187.

32 'Transvaal Silver & Base Metals – progress report', *The SA Mining & Engineering Journal,* (13 August 1921), p. 1646.

33 'Report of 1st AGM of TSBM Ltd', *The SA Mining & Engineering Journal* (1 January 1921), pp. 463-465.

> A Crushing and sorting plant consisting of a main crusher delivery belt, wash trommel, collecting boxes and pump, sorting belt, secondary crushers, etc., which will be capable of dealing with the tonnage delivered from the shafts in one eight hour shift.
>
> Concentration plant, consisting of a 300-ton bin, rolls, bucket elevators, sizing trommels, jigs, cones, Dorr thickener tank, 6 ft. by 22". Hardinge Ball mill, and Dorr classifier together with a mineral separation unit for dealing by the oil flotation process with 200 tons per day of slime, return water pumps, sumps, etc.
>
> The oil flotation plant…will be of sufficient capacity…to deal also with the dump of 30 000 tons of jig residues…with the installation of a second Hardinge Ball mill with Dorr classifier. Smelting plant, de-sulphurising plant and smelting furnace capable of producing 500 tons of silver-lead bullion per month.[34]

Many of the machines or processes installed at the TSBM mine were new to 20th century mining as can be determined from the dates of patents and mining machinery catalogues. This led to the detailed analysis of the machinery and processes that forms the basis of Chapter 6. The initial plan was to install and commission the plant by July 1921. It was expected that they would have to upgrade the plant within a short time period to be able to handle double the initial tonnage. Such an upgrade was not expected to cost more than an additional £16 000.[35]

The prospecting that had taken place in 1919-1920 at the old TSM and Brakfontein mines had, for the most part, been very successful for TSBM. They had proven reserves of mineralisation from the western end of the vein in number 1 shaft to the eastern extension of the vein in the number 2 shaft, a distance of over 60 00ft. (1 824 m).[36] Also, having re-opened all three TSM levels in the mine, coupled with the development of the second level

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34 'Report of 1st AGM of TSBM Ltd', *The SA Mining & Engineering Journal* (1 January 1921), pp. 463-465.

35 Ibid.

36 'Transvaal Silvers: Development and Treatment Schemes', *The SA Mining & Engineering Journal*, (8 January 1921), p. 483.

on No 2 shaft they had a total of 10 'development headings'[37] from which they could extract ore.[38]

The TSBM Company came under a brief threat in early February 1921, when it was reported that there was a big drop in the price of lead and silver, but the company assured investors that the lower prices were still higher than the lowest prices used to calculate the profitability of re-opening the silver mines. Later that month several announcements were made in connection with the beneficiation plant. These included plans for the concentration plant, "capable of dealing with 4 000 tons per month".[39] The blast furnace that had been ordered from Europe had arrived at the coast, and that the de-sulphurising pots were also on the way to Delagoa Bay (Maputo). In terms of building construction, the report stated that two new married quarters had been completed; a third one was nearing completion. "A third block of single quarters and a boarding house" were also under construction. The new explosives magazine had been constructed close to the No 1 shaft headgear.[40]

From an historian's point of view, although the original company reports of TSBM Company have not been traced, most were reproduced as Quarterly, AGM and Extra-Ordinary General meeting reports in the *SA Mining and Engineering Journal,* coupled with almost weekly progress reports in the same journal. In April it was announced that Dr Edward Heberlein had arrived at the mine to oversee the installation of the plant.[41] In a most unusual practice, because it divulged an operational methodology, the company published two partial flow sheets of the process provided by the group consulting engineer Mr Errol Hay.

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37 A term used to define a tunnel being driven forward to expose and develop new ore bodies.

38 'Transvaal Silvers: Development and Treatment Schemes', *The SA Mining & Engineering Journal,* (8 January 1921), p. 483.

39 'Transvaal Silver', *The SA Mining & Engineering Journal*, (5 February 1921), p. 604.

40 'Progress at Transvaal Silver', *The SA Mining & Engineering Journal,* (12 February 1921), p. 633.

41 'Progress at Transvaal Silver and Base Metals', *The SA Mining & Engineering Journal,* (23 April 1921), p. 1036.

Three flow diagrams have been drawn based on data from multiple sources where the specific processes are described and on a partial flow diagram in the SAMEJ.[42]

Harold W. Clayden delivered a paper on the beneficiation plant of TSBM mine to a meeting of the SA Institution of Engineers in 1922 (Clayden 1922). As Consulting Mechanical and Electrical Engineer to the TSBM he was in a very strong position to talk on this subject. He converted his paper into a lengthy two-part, five page article that appeared in the *SA Mining and Engineering Journal* in June 1921.[43] It provided comprehensive details on the layout of the property, the proposed beneficiation plant and the geology of the various TSBM mines/options.[44] These articles were the main sources of information on the beneficiation plant.

The average grade of lead in the two shafts of the mine was 11% and silver ran at 10.5oz per ton.[45] This meant that the grade of silver was approximately one ounce of silver per one per cent of lead.[46] As this was too low for profitable treatment in any blast furnace, it required preliminary concentration to raise the grade from 11% to at least 55%, resulting in an increased silver content.[47]

The overall process designed by Dr Edward Heberlein consisted of four dominant sub processes, namely; sorting and crushing, concentrating, roasting and sintering and smelting. Each will be dealt with separately. The bullion product was to be shipped overseas for

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42 'Flow Sheet - Transvaal Silver & Base Metals, Limited', *The SA Mining & Engineering Journal,* (7 May 1921), p. 1083; 'Transvaal Silver & Base Metals Limited - part 1', *The SA Mining & Engineering Journal,* (11 June 1921), p. 1271-1273. 'Transvaal Silver & Base Metals Limited – part 2', *The SA Mining & Engineering Journal,* (18 June 1921), p. 1337-1338.

43 'The Reduction & treatment plant of the Transvaal Silver and Base Metals'. *The SA Mining & Engineering Journal,* (21 October 1922), p. 123; 'The Reduction & treatment plant of the Transvaal Silver and Base Metals'. *The SA Mining & Engineering Journal,* (28 October 1922), p. 161-163.

44 'Transvaal Silver & Base Metals Limited - part 1', *The SA Mining & Engineering Journal,* (11 June 1921), p. 1271-1273. 'Transvaal Silver & Base Metals Limited – part 2', *The SA Mining & Engineering Journal,* (18 June 1921), p. 1337-1338.

45 'Transvaal Silver & Base Metals Limited – part 2', *The SA Mining & Engineering Journal,* (18 June 1921), p. 1337-1338.

46 Ibid.

47 Ibid.

refinement into the respective metals contained therein, the dominant metals being lead and silver, with additional metals such as zinc, copper and gold also being recovered.

Flow Charts are not the easiest of charts to follow, and so for the purposes of this thesis they have been broken down into smaller charts for each of the major processes in the text below and redrawn in a diagrammatic format. In trying to re-create the beneficiation process at the 'main mine' of TSBM, not all of the sources contained exact details of the machines used, or the make of such machines. It has therefore been necessary to rely on several sources, each of which described part of the process. The following sections, describing the sub processes or machines in more detail, are therefore largely cited from the following sources: *The Journal of SA Institution of Engineers* Vol 33(1) 16 September 1922: SAMEJ 7 May: 18 June and 28 October 1922.

5.6 Crushing and sorting process

Once the ore had been delivered to the surface, it was transferred to an ore bin and then passed to a Jaw Crusher[48] where, according to the flow diagram (Figure 35), it was reduced to 4" (100 mm) pieces. The make and model of this Jaw Crusher does not appear in the TSBM records, but it was probably a Blake Jaw Crusher, described in the previous chapter, as this was the most common make of crusher at the time other than stamp mills. The crushed ore was carried via a bucket conveyor to a washing trommel, with a ¾" (19 mm) mesh size. The oversize was passed to a hand sorting belt where any waste rock was removed and transferred to the dump. The hand- picked ore was conveyed to two Sturtevant roll-jaw crushers, (size 20" x 6") (Clayden 1922) where it was reduced to ¾" (19 mm) mesh size and merged with the trommel fines and then conveyed to the mill bin. The Sturtevant roll-jaw crushers are similar to the Cornish Roll Crusher described in the previous chapter.

During the research no details of a machine called a 'Roll Jaw Crusher' was found described in mineral dressing textbooks. Although the firm Sturtevant still exists in the USA, and were contacted for possible information, they informed me that they had no records of a roll-jaw

[48] 'Flow Sheet - Transvaal Silver & Base Metals, Limited', *The SA Mining & Engineering Journal,* (7 May 1921), p. 1083; 'The Reduction & Treatment Plant of the Transvaal Silver & Base Metals – part 2', *The SA Mining & Engineering Journal,* (28 October 1922), p.161.

crusher or of their roll crushers having been at TSBM and were unable to help with illustrations.[49]

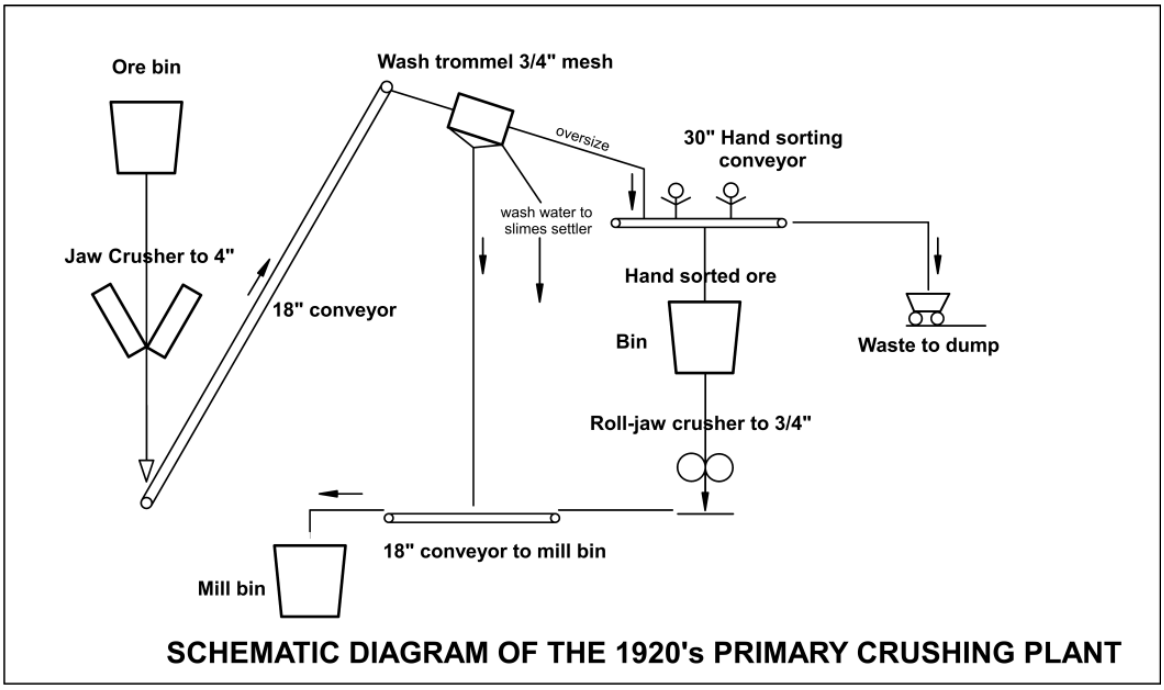


Figure 35. Flow diagram of the Crushing process at the TSBM mine c 1919-1926 based on part of the original Flow sheet,[50] and text descriptions (Clayden 1922).
(Drawn by G. Reeks).

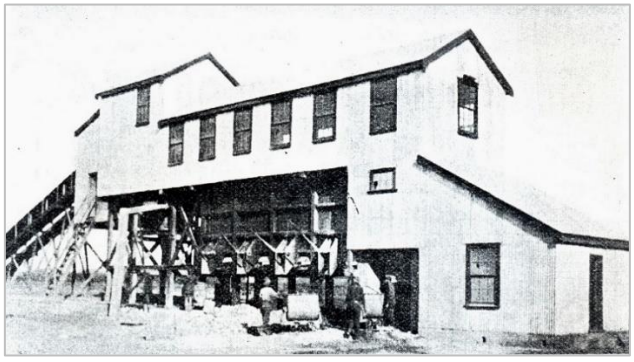


Figure 36. Historical photograph of the Primary crusher and sorting station showing incline conveyor that fed rock to the jaw crusher and secondary crusher machinery.[51]

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49 A modern catalogue of Sturtevant crushing and grinding machines was found at http://www.info@sturtevantinc.com. (Accessed on 12 Jan 2017) A machine is listed capable of producing a ¾" (19 mm) product.

50 'Flow Sheet - Transvaal Silver & Base Metals, Limited', *The SA Mining & Engineering Journal,* (7 May 1921), p. 1083.

51 'The Reduction & Treatment Plant of the Transvaal Silver & Base Metals – part 1', *The SA Mining & Engineering Journal,* (21 October 1922), p.123.

5.7 Concentration process

From the mill bin an elevator took the ore to a ¼" (6 mm) mesh trommel. The oversize was passed through a set of 16" x 36" (400 x 900 mm) Allis-Chalmers crushing rolls and then, by gravity it was returned back to the mill bin elevator - 'thus making a closed circuit'.[52] The undersize from the ¼" (6 mm) trommel was elevated to two ⅛" (3 mm) mesh trommels and from here the process became a little more complex (Clayden 1922).[53] The oversize i.e. <6 mm to >3 mm was sent to six '2 compartment Harz Jigs', see (Chapter 4) (Clayden 1922). Most of the galena (lead sulphide) was separated from the waste fragments (tailings). The galena went to a jig concentrate bin in the smelting plant, with the tailings going to two diaphragm cones for further processing.[54]

Returning to the 3 mm mesh trommel, the undersize or <3 mm fragments flowed into a two spigot hydraulic classifier which in turn produced three products. The Number 1 spigot produced <3 mm to >14 mesh material. The Number 2 spigot produced a <14 mesh to >60 mesh product.[55]

The overflow of the two spigot classifier was classified as a <60 mesh product and that went to a Spitzkasten hydraulic classifier for further treatment of the fines (Clayden 1922).[56] The products from the Number 1 and 2 spigots went into separate 2 compartment Harz jigs, each of which gave concentrates and tailings.

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52 'Flow Sheet - Transvaal Silver & Base Metals, Limited', *The SA Mining & Engineering Journal,* (7 May 1921), p. 1083.

53 'The Reduction & Treatment Plant of the Transvaal Silver & Base Metals – part 2', *The SA Mining & Engineering Journal,* (28 October 1922), p.161.

54 'Flow Sheet - Transvaal Silver & Base Metals, Limited', *The SA Mining & Engineering Journal* (7 May 1921) p. 1083; 'Transvaal Silver & Base Metals Limited – part 2', *The SA Mining & Engineering Journal,* (18 June 1921), pp. 1337-1338.

55 'The Reduction & Treatment Plant of the Transvaal Silver & Base Metals – part 2', *The SA Mining & Engineering Journal,* (28 October 1922), p.161.

56 'Transvaal Silver & Base Metals Limited – part 2', *The SA Mining & Engineering Journal,* (18 June 1921), pp. 1337-1338.

The tailings from both spigots went to the diaphragm cones and the concentrates went into the concentrate bin (Clayden 1922).[57]

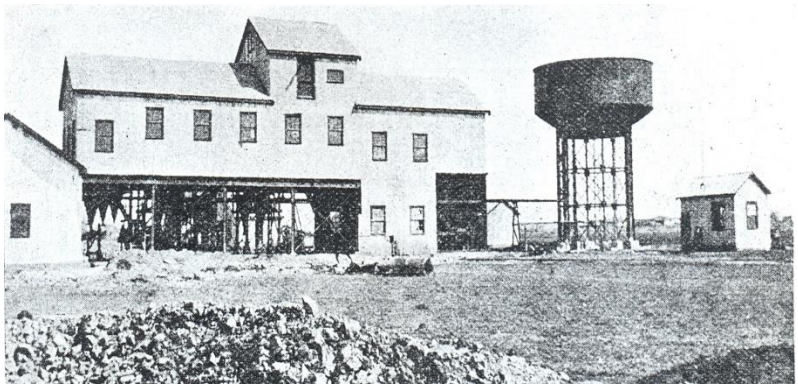


Figure 37. Historical photograph of the Secondary crushing plant which contained the wash trommels, crushing rolls and Harz jig machines (Clayden 1922).[58]

From the two diaphragm cones, the coarse material went into two Hardinge Conical Ball Mills - 6ft. x 22" (2 x 0.6 m) - for further refined grinding, each being capable of grinding 100 tons per day.[59] In 1920 this was a very new technology in the field of fine grinding. The finer overflow from the Diaphragm Cones joined with the overflow from the 2 Spigot Classifier and it went through a Spitzkasten machine, the overflow of which went to a Dorr thickener (Clayden 1922).[60] The underflow from the Spitzkasten was routed to the Dorr Classifiers. The output from the Dorr Classifiers went into Thickening Cones with the overflow material joining with the overflow from the Spitzkasten and both were de-watered in a Dorr Thickener (Clayden 1922).[61] The slimes from the Dorr Thickener was pumped to the slimes dam where it was contained untill it became solidified (see figure 39).

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57 'Transvaal Silver & Base Metals Limited – part 2', *The SA Mining & Engineering Journal,* (18 June 1921), pp. 1337-1338.

58 Ibid.

59 'The Reduction & Treatment Plant of the Transvaal Silver & Base Metals – part 2', *The SA Mining & Engineering Journal,* (28 October 1922), p.161.

60 'Transvaal Silver & Base Metals Limited – part 2', *The SA Mining & Engineering Journal,* (18 June 1921), p. 1337-1338; 'The Reduction & Treatment Plant of the Transvaal Silver & Base Metals – part 2', *The SA Mining & Engineering Journal,* (28 October 1922), p.161.

61 'The Reduction & Treatment Plant of the Transvaal Silver & Base Metals – part 2', *The SA Mining & Engineering Journal,* (28 October 1922), p.161.

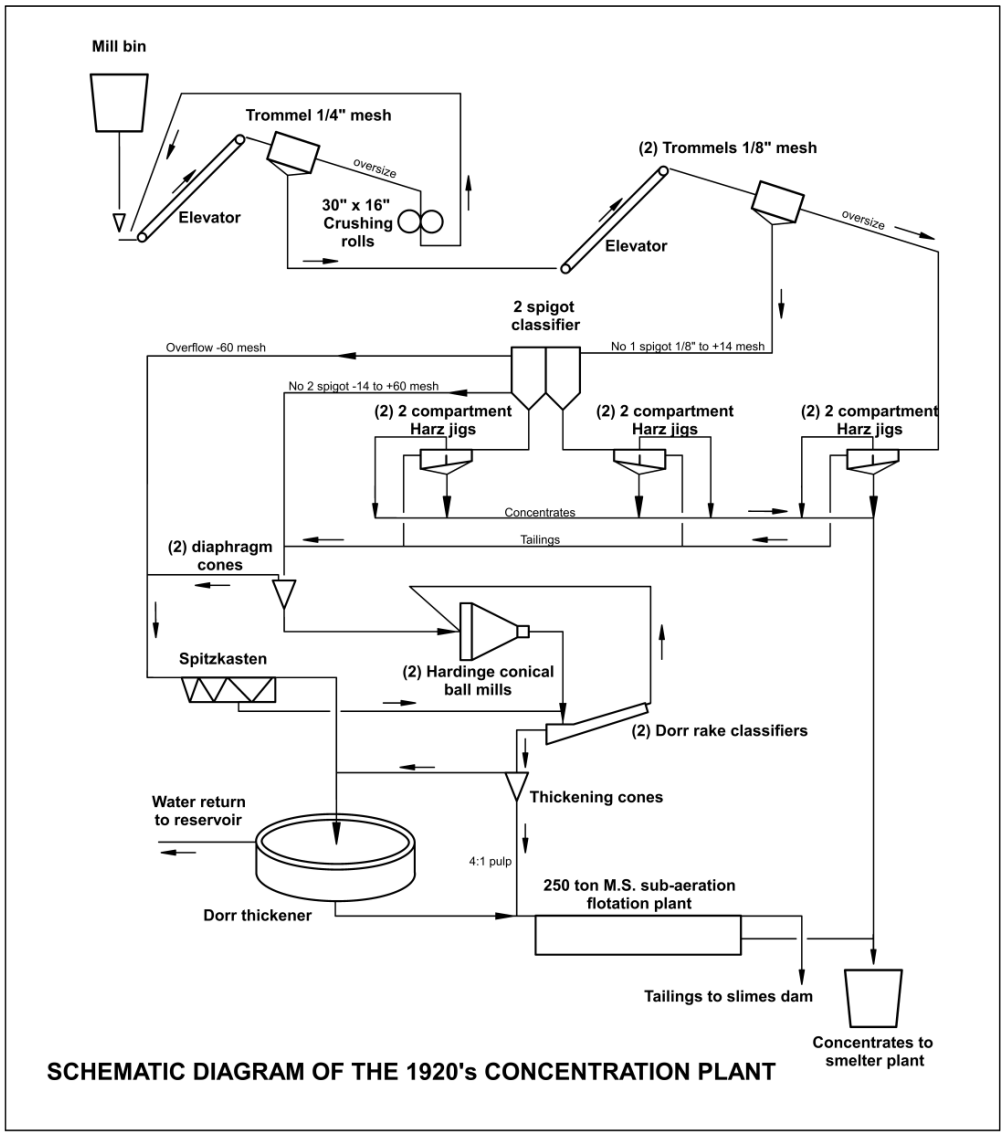


Figure 38. Schematic diagram of the Concentration process at the TSBM mine c 1919-1922 based on part of the original Flow sheet,[62] and text descriptions (Clayden 1922). (Drawn by G. Reeks).

The clear water from the Thickener was sent to the return water pumps for re-use.[63] Unfortunately no photographs have been found showing the Ball mill part of the plant, but substantial, well-constructed reinforced concrete foundations still exist where the ball mills were located.

62 'Flow Sheet - Transvaal Silver & Base Metals, Limited', *The SA Mining & Engineering Journal,* (7 May 1921), p. 1083.

63 Ibid.

The underflow from the Thickening Cones and the Dorr Thickener joined to make up a pulp of 4 to 1, water to ore.[64] This pulp was passed through to a 250 ton Minerals Separation Ltd sub-aeration flotation plant to separate the remaining galena from any remaining gangue (waste).[65] Together with the Hardinge Ball Mill technology, this was also a very new development in mineral dressing processes. Other new or relatively new technologies in 1920 were Dorr Thickeners and Classifiers and they will be discussed in the next chapter.



Figure 39. Photograph of part of the slimes dam in 2017. (G. Reeks photo).

The separation of the three sizes of ore/concentrate defined a route through the beneficiation process. Product No 1 consisted of coarse hand sorted ore >19mm and was thus suitable for direct supply to the roasting pots as it would allow for the air blast to travel between the fragments.[66] Product No 2, although finer at <6 mm to 60 mesh, could be classified as a granular product and provided the blast velocity was not excessive it would allow for the air flow without too much loss of the fine dust.[67] The very fine product, Product No 3, was the final output of the flotation plant (the concentrates) and this had to be roasted and sintered into an agglomerated mass which was ultimately fed into the blast furnace.[68]

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64 'Flow Sheet - Transvaal Silver & Base Metals, Limited', *The SA Mining & Engineering Journal,* (7 May 1921), p. 1083.

65 'Transvaal Silver & Base Metals Limited – part 2', *The SA Mining & Engineering Journal,* (18 June 1921), pp. 1337-1338.

66 Ibid.

67 Ibid.

68 'The Reduction & Treatment Plant of the Transvaal Silver & Base Metals – part 2', *The SA Mining & Engineering Journal,* (28 October 1922), p.161.

Another very new technology in South Africa at this time was the use of reinforced concrete in the construction of the substantial foundations for the buildings and machines of the mine. This will also be discussed in greater detail in the next chapter, but from a civil engineering point of view it is a very exciting development in the research for this project.

5.8 Roasting and Sintering Process

In 1890 the TSM employed Otto H. Hahn as metallurgist and general manager. His employment was detailed in Chapter 3, as was his eventual downfall, due to his miscalculation of the amount of sulphides in the ore, which jeopardised the effectiveness of the roasting process. Typical of many lead deposits around the world, the primary ore of lead and the richest source of the metal was a lead sulphide - galena (PbS), but as the mine went deeper so additional sulphides were contained as components of the ore. These were copper sulphide - chalcopyrite ($CuFeS_2$) and zinc sulphide - sphalerite (ZnS). The metallurgists of the 1920s calculated the degree of sulphides in the ore accurately and designed the process of removing the sulphur on sounder principles, unlike Hahn.

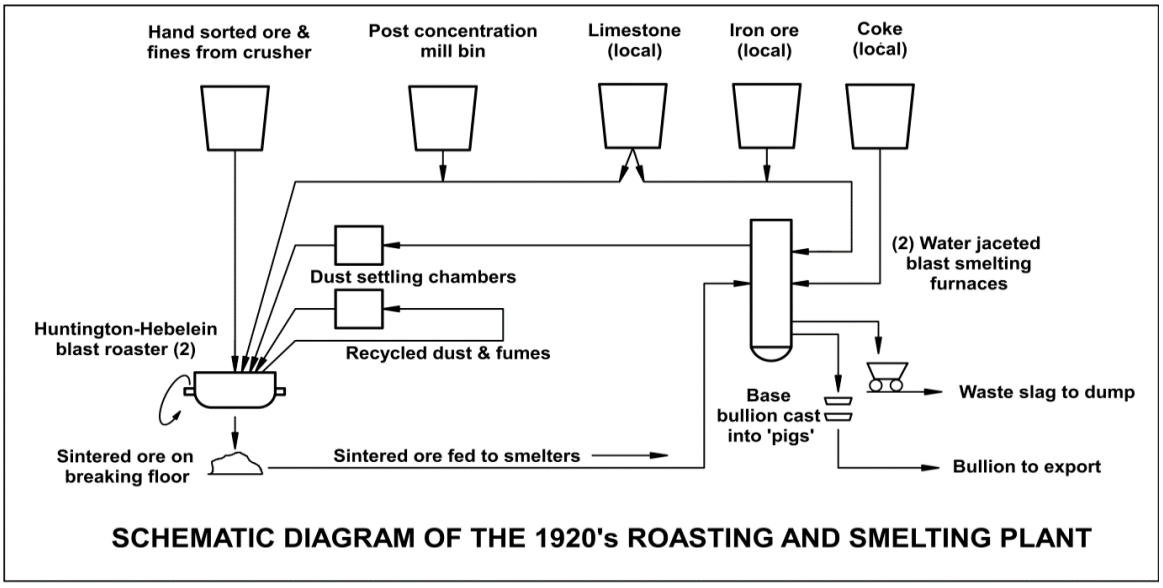


Figure 40. Schematic diagram of the 1920s roasting and smelting process. Based on part of the original Flow sheet,[69] and text descriptions (Clayden 1922). (Drawn by G. Reeks).

[69] 'Flow Sheet - Transvaal Silver & Base Metals, Limited', *The SA Mining & Engineering Journal*, (7 May 1921), p. 1083.

The removal of sulphides began by sintering the ore, followed by a blast roasting process.[70] The Huntington-Heberlein process was invented in the USA and patented in 1898.[71] The fines from the flotation process at the TSBM mine were initially sintered in two Huntington-Heberlein cast-iron blast roasting pots.

The pots were circular, about 2 m deep with a perforated false bottom, and were capable of holding a ten ton charge.[72] They were mounted on travelling trunnions to allow for tipping and movement over the blower box. Initially a layer of ash was placed on the false bottom of the pot. The primary reason for this was to stop the sintered material from sticking to the pot.[73] Approximately 1 ton of red hot roasted material was then added as the next layer, and finally a layer of moist galena concentrates along with a quantity of limestone completed the charge.[74] All that remains at the mine of the roasting and smelting pots and conveyors to the pots are the very substantial 10-15 m tall concrete foundations on which the smelting units were supported.

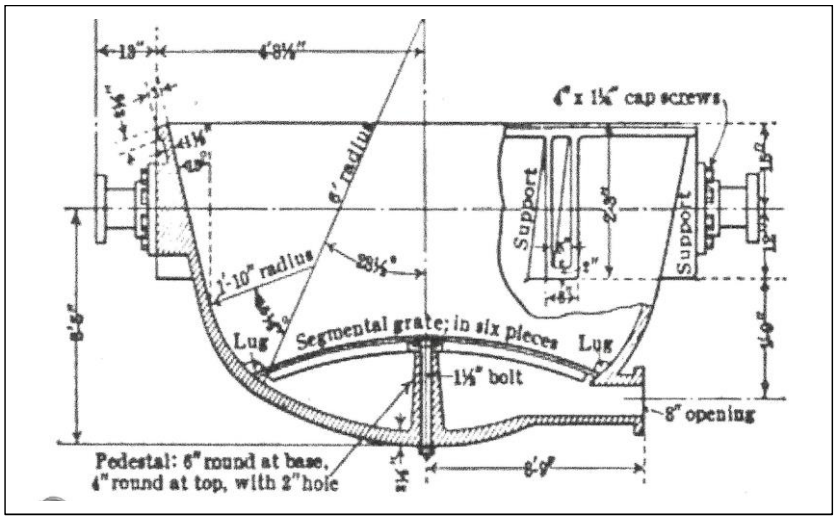


Figure 41. Huntington-Heberlein pot. (Austin 1921: p. 111)

70 'Transvaal Silver & Base Metals Limited – part 2', *The SA Mining & Engineering Journal,* (18 June 1921), pp. 1337-1338.

71 US Patent number 600347 A – Process of treating sulphide ores of lead, &c., preparatory to smelting. Patent granted 8 March 1898.

72 'Transvaal Silver & Base Metals Limited – part 2', *The SA Mining & Engineering Journal,* (18 June 1921), pp. 1337-1338.

73 Ibid.

74 Ibid.

The historical photograph of the beneficiation plant (Figure 42) shows an incline conveyor on the left side of the smelting plant. The remains of some foundation blocks of this conveyor have been located in what is now a mealie field and good sized samples of limestone that were used in the roasting and smelting, can still be found on the surface. A clear example of the impact of mining on farm production can be seen in the photograph below (Figure 43), in the area that was originally at the base of the 1920s incline. It was adjacent to the remains of the roaster and smelter plants. Close to the dump of white rock, in (Figure 42), it is possible to make out a wagon and a team of animals but it is unclear if they are oxen or horses.

The maize, currently nearing maturity (March 2017), in an area of about 20 m diameter, clearly exhibit stunted growth with the plants themselves only reaching a height of 0.5 m to 1 m and with cobs being only 10 cm long x 2 cm in diameter. It is believed that this is due to an excess of calcium carbonate in the localised soil thereby impacting significantly on the pH value of the local soil. This is a clear sign of the historical mining pollution impacting on the soil of a modern farm.

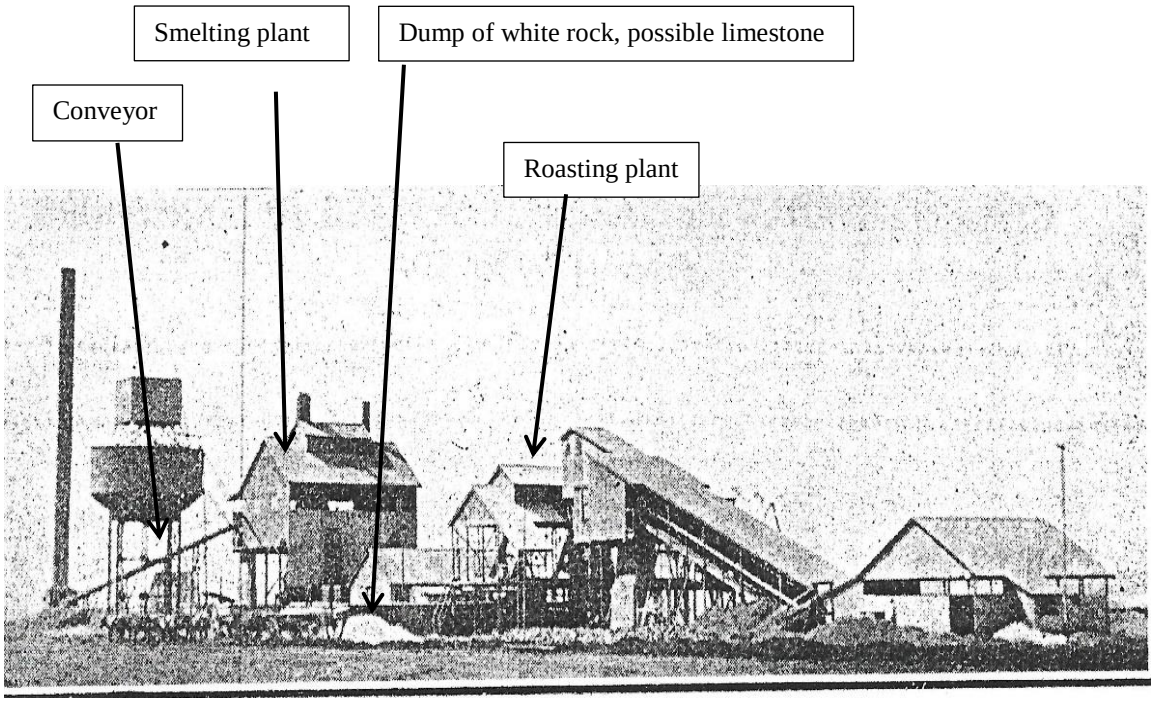


Figure 42. Historical photograph of the smelting and roasting sintering plant at TSBM c1922.[75]

[75] 'Progress of flotation process' *The SA Mining & Engineering Journal,* (2 December 1922), p.321.



Figure 43. Photograph of the stunted mealies, in a localised area but with normal healthy mealies in the background. Note the pieces of white limestone rock on the surface of the soil. (G. Reeks photo)

Once the charged pot was filled, it was moved over the blower box and the blast turned on. The heat from the roasted ore was sufficient to ignite the whole charge.[76] The dust, gases and fumes were collected in a hood and these were passed to a dust settling chamber where they were collected and returned for further sintering,[77] the degree of desulphurisation required governed the length of time of combustion. Generally it appears that the time taken per charge varied between 12 and 16 hours, at which point the pot was moved to above the discharge floor, where it was inverted and the red hot agglomerated mass fell out.[78] The final stage was to break the mass down to lumps suitable for feeding into the smelting furnace.[79]

5.9 Smelting process

The schematic diagram (Figure 40) also shows the final process of smelting in the blast furnaces and the production of base bullion. The smelting plant consisted of two water-jacket blast furnaces.[80] They had been designed to be capable of producing up to 500 tons

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76 'Transvaal Silver & Base Metals Limited – part 2', *The SA Mining & Engineering Journal,* (18 June 1921), pp. 1337-1338.

77 Ibid.

78 Ibid.

79 Ibid.

80 'The Reduction & Treatment Plant of the Transvaal Silver & Base Metals – part 2', *The SA Mining & Engineering Journal,* (28 October 1922), p.161.

of silver-lead bullion per month.[81] This was the same basic furnace that had been installed by Hahn in 1891, although the design presumably was more modern than Hahn's furnaces. Unfortunately the manufacturer for these furnaces is not recorded.

The 'charge' of the water-jacket blast furnaces consisted of the agglomerated roasted concentrates, as shown on the diagram (Figure 40), limestone, iron ore and coke. The coke was obtained from a colliery in Vryheid, while the limestone came from a local unnamed source.[82] The iron ore was apparently mined on the property of TSBM.[83] Both the iron ore and limestone were added as fluxes to the smelting process.

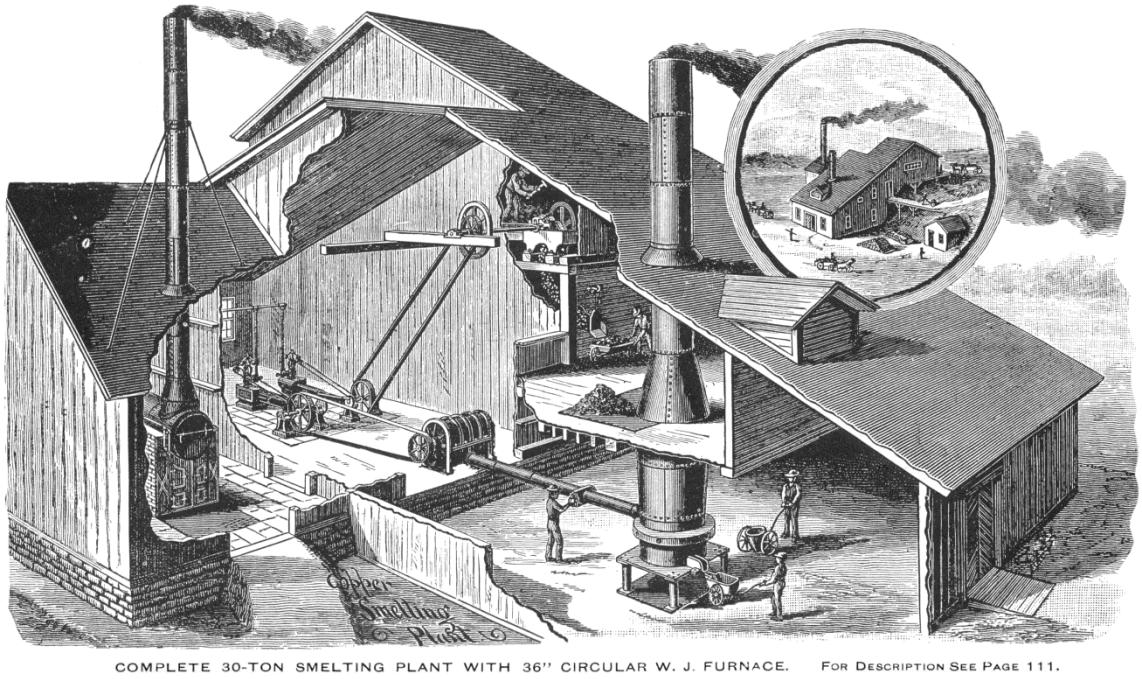


Figure 44. Artist's impression of a smelting plant for copper or lead ores using a water jacket blast furnace. c1890s through to 1920s. Such a plant is similar to what would have existed at the TSM and TSBM mine at Argent in the 1890s and 1920s.[84]

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81 'Report of 1st AGM of TSBM Ltd', *The SA Mining & Engineering Journal,* (1 January 1921), pp. 463-465.

82 'Transvaal Silver & Base Metals Limited – part 2', *The SA Mining & Engineering Journal,* (18 June 1921), pp. 1337-1338.

83 Ibid.

84 Anaconda Copper Mining Co., Foundry Department. Montana, USA. 1897. Catalogue no 1. Plate no 83. p. 110.

Blasts of air were fed through 6 tuyeres and were capable of supplying up to 3 000 cubic feet of air per minute.[85] The resulting dust and gasses were passed to a dust settling chamber from where they were returned to the roasting (sintering) pot charge.[86] The smelting furnaces produced two products - base bullion and slag. At the TSBM mine the bullion was cast into 50 kg 'pigs' that were shipped to Europe for refining and ultimate recovery of the various metals. The slag waste was poured into slag pots and transferred to the adjoining slag dump, where it was poured and allowed to cool. The slag dump can still be seen on the site to this day. The installation was commissioned in early January 1924 and was soon producing metallic copper bullion.



Figure 45. Foundations of the Roasting plant 2016.
(G. Reeks Photo)

5.10 Power Plant facility

To supply electrical power to the mine a new power plant was constructed. The equipment consisted of a Stirling Boiler, a 400 KVA generator set and an ancillary generator.[87] This plant was designed to be large enough to supply power requirements for underground, as well as the concentrating and smelting operations.[88] In August it was announced that a

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85 'The Reduction & Treatment Plant of the Transvaal Silver & Base Metals – part 2', *The SA Mining & Engineering Journal,* (28 October 1922), p. 161.

86 'Transvaal Silver & Base Metals Limited – part 2', *The SA Mining & Engineering Journal,* (18 June 1921), pp. 1337-1338.

87 'Report of 1st AGM of TSBM Ltd', *The SA Mining & Engineering Journal,* (1 January 1921), pp. 463-465.

88 Ibid.

second boiler had been installed in the generating plant.[89] Clayden (1922) stated that they had increased the number of boilers to three and each boiler was rated at 350 hp. An earlier mention in the sources of two 100 hp boilers is now believed to refer to the power units for the number 1 shaft winding engine installed in 1920 and which was later upgraded.[90] Clayden (1922) noted that most of the small equipment was purchased as 'out of use' machinery on the Rand, and that this equipment was acquired from General Mining's gold mines.

The remains of the boiler house have been looked at in detail and the foundations of the boilers and generator coupled with building foundations, are still in very good condition. The photographs (Figures 46-49) offer a number of views of the foundations.



Figure 46. Corner foundations of boiler house



Figure 47. Foundations for two boilers



Figure 48. Generator foundation



Figure 49. Ash chutes to lower railcar line used to carry ash to the dump.

Various views of the foundations of the boiler and generating house taken in 2016. (G. Reeks photos)

89 'General Mining Co AGM with ref to TSBM', *The SA Mining & Engineering Journal*, (27 August 1921), p. 1752.

90 'Progress of Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal*, (31 July 1920), p. 514.

5.11 Matte Treatment plant

By 1923, the mine had accumulated a large amount of copper rich matte from the smelting furnace as a secondary bi-product. This matte had been stored since the commissioning of the furnaces in 1921 and by early 1924 amounted to approximately 2 400 tons.[91] Apart from being a valuable source of income once processed, with the copper at 6.1%, it also contained residual amounts of lead at 11.4% and silver at 17.3 ozs per ton.[92]

It was decided to recover these amounts by installing a set of crushing rolls to reduce the matte and putting it through a mechanical roasting furnace of the Godfrey type, followed by a small reverberatory slag settling furnace (Reeks 2012).[93]

5.12 Installation of the Roasting and Smelting plants

In October 1920 it was announced that the TSBM company had ordered the roasting and smelting plant to treat high grade ore and fines and that it was expected to be in operation early in 1921.[94] In various issues of the *SA Mining Engineering Journal* from January 1921, mention is made of trial or small experimental beneficiation processes and a the possibility of a trial smelting plant, with a nominal capacity of about 30 tons daily.[95] It is as though they wished to test the process before finalising the design on a full plant. However, it appears this idea was superseded, as by August the company was reporting that it had been decided to install the full plant and that orders had been made during the year for such a plant.[96]

By February 1921 the final plans for the first unit of the concentration plant were being prepared and the smelting blast furnaces, which had been ordered from Europe, had arrived

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91 'Transvaal Silvers', *The SA Mining & Engineering Journal,* (16 February 1924), p. 585.

92 Ibid.

93 'Transvaal Silver & Base Metals, ', *The SA Mining & Engineering Journal,* (31 July 1920), p. 514.

94 'Progress of the Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (30 October 1920), p. 187.

95 'Transvaal Silvers: Development and Treatment Schemes', *The SA Mining & Engineering Journal,* (8 January 1921), p. 483.

96 'General Mining Co AGM with ref to TSBM', *The SA Mining & Engineering Journal,* (27 August 1921), p. 1752.

at the coast. The roasting pots had also been shipped from Europe.[97] In August work on the roasting and smelting plant foundations and building structures was completed and all the equipment ordered from Europe was either on site, or awaiting delivery from the coast.[98] In the 2nd AGM report it was made clear why there was a change of plan from the smaller trial plants to the revised orders for full size plants.

Simply put, they had found and developed more ore than had been expected and so the larger plants were justified.[99] Six months later it was found that the roasting plant required a third Huntington-Heberlein pot and this was manufactured locally for commissioning in August.[100]

It is known that the co-inventor of the roasting process, Dr Ferdinand Heberlein was a German, as it is stated as such on his patent.[101] He was resident in London in 1907 when another patent was awarded to him. Although the consulting metallurgist from London was Dr Edward Heberlein, research into biographical sources has been unable to find any relational links.

In the 'end of the year' progress report issued by the mine and published in the SAMEJ in January 1922, it was stated that the sorting and crushing plant was running smoothly, and that the concentration plant had been successfully commissioned in the last quarter of 1921 and installation of the second smelting furnace was well advanced.[102] Towards the end of January 1922 a report in the SAMEJ mentions that TSBM had removed the cages from the No1 shaft, transferring them to the re-furbished shaft at Brakfontein and that they had installed two 2-ton skips in the No 1 shaft along with a more powerful new 13"x 26" (330

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97 'Progress at Transvaal Silver', *The SA Mining & Engineering Journal,* (12 February 1921), p. 633.

98 'Transvaal Silver & Base Metals – progress report', *The SA Mining & Engineering Journal,* (13 August 1921), p. 1646.

99 'Report of 2nd AGM of TSBM Ltd', *The SA Mining & Engineering Journal,* (17 December 1921), pp. 571-573.

100 'Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (29 July 1922), p. 1595.

101 US Patent number 600347 A – Process of treating sulphide ores of lead, &c., preparatory to smelting. Patent granted 8 March 1898.

102 'Transvaal Silver – progress report', *The SA Mining & Engineering Journal,* (28 January 1922), p. 741.

mm x 660 mm) Robey hoist.[103] The moving of the cages to the Brakfontein mine, and the installation of the Robey hoist allowed for larger cages and ore hoists to be installed in the number 1 shaft of the Argent mine.

5.13 Construction of the buildings at TSBM

Apart from erecting some temporary buildings in 1919, primarily to serve as field offices while the company was surveying the mine and adjoining potential sites, very little construction was carried out until early 1920.[104] By July 1920 the mine announced that it had completed the construction of the head-quarter's house and office, along with the European single quarters in which there was a dining room and a kitchen. Accommodation for the black mine workers at this stage consisted of a seven room building with bunks. Unfortunately the report did not state how many bunks there were in a room. This point is raised again in Chapter 8, (8.3).

The statement regarding the bricks is puzzling, because the archaeological pedestrian surveys have not shown any evidence of brickmaking. Low to medium fired bricks were found in certain parts of the site, but they are of poor quality. The majority of the good quality bricks connected with the 1920s structures are clearly identified as being made by the contemporary 'Boksburg Brick Company'.

By October an additional three European married quarters and a compound office were nearly complete.[105] Later that year the air compressor house, the assay office, some married and additional single quarters, extensions to the black miner compound building and change rooms at the two shafts were completed. It was stated that the approximate cost of the construction had been £24 700.[106]

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103 'Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (29 July 1922), p. 1595.

104 'The outlook for Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (24 April 1920), p. 190.

105 'Progress of the Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (30 October 1920), p. 187.

106 'Report of 1st AGM of TSBM Ltd', *The SA Mining & Engineering Journal,* (1 January 1921), pp. 463-465.

In 2015 Jose Clara [a land surveyor] and I conducted a satellite survey of the land surface and remains of the TSM and TSBM mines. We discovered and mapped the foundation remains of four buildings south west of the No 1 shaft. It appeared as if three of the structures were more likely to be from the 1920s, however the fourth one had a dressed stone foundation and contained internal wall foundations indicating that it had two or possibly three rooms. It is clear that it had a veranda, because the 'front door' and steps down from the veranda to normal ground level were separated by about 1.5m. It is the second house from the right in the picture below.

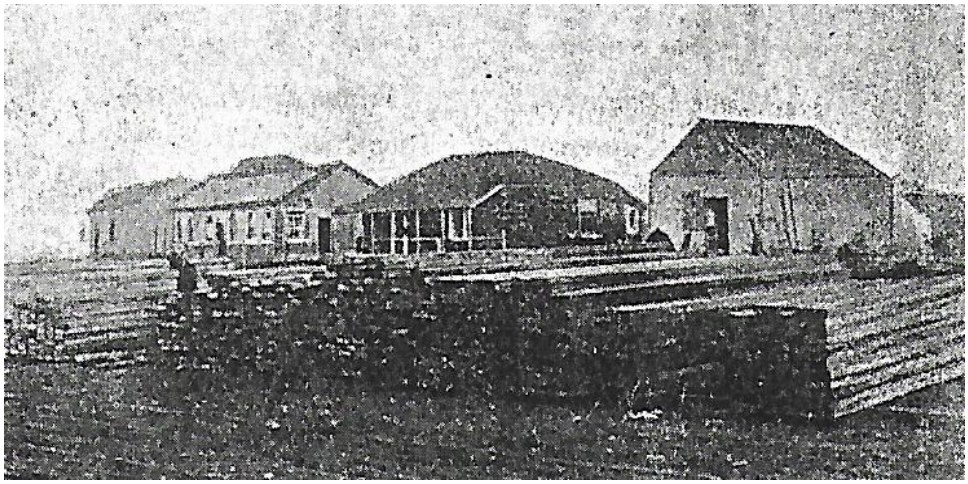


Figure 50. Picture showing four structures at the TSBM mine. The second one from the right has now been recognised as dating from the 1890s TSM.[107]

There were also the remains of steel pipes - cut off at ground level - typical of veranda roof support poles. In going through the records and photographs in my possession, I realised that here was a classic case of written and photographic records coming together. The photograph (Figure 50), clearly shows a structure with a veranda, and a pole supported roof. For many years since identifying this house's stone foundations I have suspected that it dated from the 1890s and it was possibly the house used by the directors of TSM when they stayed at the mine. The logic being it was far from the manager's house and other TSM structures, thus giving the directors some degree of separation for confidential discussions. The

[107] 'Transvaal Silver & Base Metals Limited - part 1', *The SA Mining & Engineering Journal*, (11 June 1921), p. 1271-1273.

extensive report in the SAMEJ on TSBM, which included the photograph shown on the previous page, describes it as:

> …a view of some of the buildings and offices in their present state. The low-roofed stone building is the only structure which remains at the present day to denote the activity of the company which originally worked the mine. The building on its right represents the assay office, which is in the course of construction.[108]

By October 1921 the crusher house and its equipment had been completed along with the conveyor to the wash trommel.[109] The concentration plant was under construction and was expected to be completed by the end of the year. It was announced that the roasting plant was in operation and that the first unit of the smelting plant was at the commissioning stage.[110]

5.14 Senior Technical Personnel connected with TSBM

At the first AGM of the TSBM in January 1921 it was reported that they were employing 40 white mine workers and 250 black mine workers.[111] The chairman, Sir George Albu, clarified the position of the company as one that operated under the General Mining umbrella. He made the announcement that although Mr Oliver King had been the driving force behind the acquisition of the various freeholds of land by General Mining, Mr King had been appointed as Consulting Geologist to the group. Albu also stated that technical development and control at TSBM would be put under the control of the Engineering Department of the General Mining group controlled by Mr Errol Hay. A Mr J. Ritchie was appointed as Mine Manager at TSBM.[112] Mr Harold Clayden (discussed on page 110) was

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108 'Transvaal Silver & Base Metals Limited - part 1', *The SA Mining & Engineering Journal,* (11 June 1921), p. 1271-1273.

109 'The Position at the Transvaal Silver Mines', *The SA Mining & Engineering Journal,* (13 October 1921), p.205.

110 Ibid.

111 'Report of 1st AGM of TSBM Ltd', *The SA Mining & Engineering Journal,* (1 January 1921), pp. 463-465.

112 Ibid.

appointed as Consulting Mechanical and Electrical Engineer to TSBM.[113] The resident mine metallurgist was a Mr Gentles.[114] In all of the sources, these are the only men involved with the technology of the mine who were named.

5.15 Conclusion

This chapter aimed to describe the beneficiation process at the TSBM mine in the 1920s. The use of historical and modern photographs, integrated with the available written records enabled a reconstruction of the 1920s beneficiation processes and plant. In analysing such records it has become clear that the TSBM mine installed a number of extremely modern technologies for the 1920s - 'state of the art processes and machines'. The TSBM property is most probably unique in South Africa in that the physical remains of the mine and its beneficiation plant in the form of foundations of structures lying above the soil surface are extensive and generally well preserved. One is able, with the benefit of the surface mine plan and historical photographs, to recognise the functions of the concrete foundations, whether they were the foundations for machines or the foundations of external walls of buildings.

The industrial archaeology of this project is not so much the physical excavation of the remains of an industrial beneficiation plant associated with a lead/silver mine dating from the 1890s and 1920s, as it is trying to understand the technology behind the mine in those two time periods. In most industrial archaeology projects that I have studied, the actual processes involved in old mines under investigation do not have the benefit of the detailed documentation and photographs that I have had on this project. Thus in describing the relevant processes involved in both time periods, I have been able to understand the development of the beneficiation technologies and at the same time show how, within a period of 25 years, there were huge technological leaps. A comparison and discussion on these technological developments will be carried out in Chapter 12.

Investigation of the surface soil during various pedestrian surveys of the areas in the beneficiation plant yielded a few industrial artefacts, such as a steel grinding ball in the

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113 'The Reduction & Treatment Plant of the Transvaal Silver & Base Metals – part 2', *The SA Mining & Engineering Journal*, (28 October 1922), p.163.

114 Ibid

foundation area of the conical ball mill. These have been recorded as surface finds and given a location based on the part of the plant where they were found. However, no sub-surface excavations of any part of the beneficiation plant were planned or conducted for this project.

The next chapter will look at the new construction and mineral processing technologies in more detail, including a basic description of the operation or introduction of such specific technologies.

Chapter 6

The most 'modern' base metal beneficiation plant in South Africa – the beneficiation and concentration plant of the period 1919-1927

6.1 Introduction

This chapter will take a detailed look at the major advances in the new technologies of beneficiation or mineral dressing installed at the 1920s TSBM mine. Although the title is my own, it could surely have been written by a journalist writing about the TSBM mine in 1922, when all aspects of it were commissioned. From the detailed description of the construction of the new, re-furbished silver mine and its beneficiation process or plant as described in Chapter 5, it is clear that Dr Edward Heberlein, the chief designer of the plant, was from a new generation of mining metallurgists and he was prepared to use new and, in some cases, barely tested processes or machinery.

My research into the machinery and processes has led to a number of surprises. It is my opinion, based on an analysis of the technologies and beneficiation machinery, that this mine was technologically way ahead of most of the gold mines of the Witwatersrand in the 1920s. Much of the technology used was so new that in many cases, it will be argued, that TSBM mine may have been the first to use such technologies in South Africa.

The initial idea of a trial beneficiation plant was abandoned by the TSBM management in 1920 in favour of a full sized plant. Dr Heberlein was engaged to design the plant in July 1920,[1] and the buildings and imported machinery were commissioned by the end of 1921.[2] This represents a period of some 18 months, which by modern standards, for completion of

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1 'Progress of Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal*, (31 July 1920), p. 514.

2 'Report of 2nd AGM of TSBM Ltd', *The SA Mining & Engineering Journal*, (17 December 1921), pp. 571-573.

a plant of such complexity, would be remarkable, but for the early 20th century was exceptional.[3] Even Sir George Albu's brother, Leopold, standing in for George at the 2nd AGM of TSBM remarked:

…the time taken to bring the company to a producing stage is remarkably short, particularly in comparison with the five to seven years to which we have grown accustomed in the case of our gold ventures.[4]

6.2 Developments with the various TSBM properties in 1920

When the TSBM Company was launched, it had taken out options on a wide geographical area surrounding the old TSM silver mine. As was mentioned in the previous chapter included in its lease options were the old mines of Brakfontein, Boschpoort, Witkop and Oudezwaanskraal.[5] During 1920 it was announced that the Witkop mine was too poor and too far from the TSBM reduction plant to transport the ore economically and they therefore had abandoned it as an option. It was also mentioned that the lode had been inspected at Oudezwaanskraal, but further inspection of the mine would be held over until a later date.[6]

Prospecting on surface and underground was carried out at the Boschpoort mine,[7] but it would appear TSBM eventually abandoned that mine as well, however, it was stated in the 2nd AGM in 1921, that it was not worked due to lack of funds,[8] ultimately the Boschpoort mine may have been considered too small to re-open.[9] The Oudezwaanskraal mines were

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3 This evaluation is based on my own experience as an engineering project manager working on similar modern high technology projects.

4 'Report of 2nd AGM of TSBM Ltd', *The SA Mining & Engineering Journal,* (17 December 1921), pp. 571-573.

5 'Progress of Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (31 July 1920), p. 514.

6 'Transvaal Silver', *The SA Mining & Engineering Journal,* (1 January 1921), pp. 464-465.

7 'Transvaal Silver Base Metals – Special meeting' *The SA Mining & Engineering Journal,* (30 April 1921), p. 1076.

8 'Report of 2nd AGM of TSBM Ltd', *The SA Mining & Engineering Journal,* (17 December 1921), pp. 571-573.

9 Goldfields of SA file ARG 820/1/1 GEOL (1) report no 1 - 20 February 1919.

never reopened before the TSBM Company was eventually liquidated in 1926. I suspect the problem with the Oudezwaanskraal mine was that the ore being more of an argentiferous antimony copper deposit, the antimony would have created metallurgical problems at the beneficiation stage.[10] The Brakfontein mine was dewatered and the shaft re-equipped with a head gear. After sampling and further development of the mine it was decided to re-open it and ship the ore by ox-wagon to the TSBM main mine for treatment.[11]

6.3 The older technologies of beneficiation machinery installed in 1919-20

The TSBM company records indicate the re-use of machinery most probably acquired from various gold mines within the General Mining group. For instance, the power plant which consisted of boilers, compressors and a generator was apparently "…purchased from out-of-use machinery on the Rand" (Clayden 1922:21). Similarly, the primary crushing equipment also appears to have been purchased on the Rand. Although not named, I presume the primary crusher was a Blake Jaw crusher similar to what was used by TSM as no mention is made by Clayden of the use of a stamp mill. Two Sturtevant Roll Jaw crushers were the secondary crushers at the TSBM mine,[12] and despite being described as "of an old type," it had never been used and most probably dated from the early 1900s (Clayden 1922:22). Sturtevant USA were contacted for possible information on this machine, but replied that they had no such name and that it may have been a journalistic error, because their machines have always been known as 'roll crushers.' They also had no records of one of their machines being at Argent, only on the gold mines, but they did not specify the mine or parent company. Also mentioned as a secondary crusher was an old Allis-Chalmers 16 in x 36 in crushing roll, most probably from the early 1900s and similar in design to a Cornish Roll, that would have been used in the 1890s. Various sizing rotating trommels, six two compartment Harz jigs and conveyors make up some of the smaller items of equipment also acquired from other mines. In the flow diagram (Figure 38), a 'Spitzkasten' hydraulic classifier is shown and although it is not mentioned as such in the description of the plant, it is indicated as such on the concentration plant flow diagram.

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10 Goldfields of SA file ARG 820/1/1 GEOL (1) report no 1 - 20 February 1919.

11 'Transvaal Silver & Base Metals Limited - part 1', *The SA Mining & Engineering Journal*, (11 June 1921), pp. 1271-1273.

12 'Transvaal Silver & Base Metals Ltd', *The SA Mining & Engineering Journal*, (7 October 1922), p. 69.

In Chapter 5.11, it is stated that the new roasting and smelting furnaces were imported, as were the MS Flotation plant and the Hardinge Conical Ball Mills, the Dorr Classifier and Dorr Thickener. In order to present some idea of how 'modern' this equipment and technology installed at the TSBM mine was in 1920, the major items are discussed below.

6.4 New Mineral Processing Technology in the 1920s

In re-creating the 1920s beneficiation process the huge leap in beneficiation and other technologies between the 1890s and the 1920s was revealed. So many of the processes, technologies and machines of the 1920s at Argent were found to be 'ground-breaking' and in some cases totally new beneficiation technologies to South Africa.

6.4.1 Reinforced Concrete Technology

When the initial mapping of the 1920s foundations began, two features stood out. The area covered by the 1920s mine plant and housing structures is extensive and very little of the 1890s foundations remain in situ. Many of the 1920s concrete foundations are substantial blocks of reinforced concrete. The reinforcing is recognisable in many places by the ends of steel rods either showing proud of the concrete or leaving a typical rust stain on the surface of the concrete.[13]

6.4.1.1 Brief history of the introduction of Reinforced Concrete technology to South Africa

The first industrial structures built using the new technique of reinforced concrete in South Africa appear to date from 1906-1907, which was a reservoir at St Georges Park in Port Elizabeth. The first bridge in reinforced concrete in South Africa was over the Kowie River in Port Alfred in 1907, and the first such bridge in the former Transvaal was commenced in 1909 in Barberton (Fredman 1964). The first reinforced concrete framed building appears to have been the Transvaal Hat & Cap Company factory in Troye St, Johannesburg, designed in 1921 and constructed sometime around 1921/22 (Fredman 1964:35). By this time the

[13] I contacted the SA Reinforced Concrete Engineers Association in Johannesburg and after discussions with their director Mr Jeffery Thomas I was given a book written in 1964 by R. Fredman on the history of Structural Concrete in South Africa. Part of another book written by that doyen of South African history - Eric Rosenthal – *The story of Portland Cement in South Africa* was provided to me by The Cement Institute in Midrand, Gauteng and it is listed in the bibliography.

TSBM mine had already completed its mine headgear foundations, boiler building, crushing, smelting and concentration plants building foundations and machine foundations all in reinforced concrete, with some of the foundations being many meters high and thick.

A brief review of literature for the earliest use of reinforced concrete and its introduction by the mines of the Witwatersrand was made. It appears that the first mines to introduce the technology were the Simmer East mill where they constructed a stamp mill foundation in 1909 and the City Deep Gold mine in Johannesburg, where in 1910 it was used in the construction of settling tanks and in the construction of some parts of the buildings of the Reduction plant (Fredman 1964:47).[14] Despite trying to locate other mines opened in the early 1910s-1920s period, I have not been able to locate any other mine using reinforced concrete on such a large scale as at the TSBM.

By the early 1930s the technology was more widely employed on new mines. Therefore, it seems reasonable to say that TSBM was one of the first South African, post First World War, mines of the 1920s to make use of this new technology on such a large scale, Further use of the technology, on such a scale, only began on the new mines of the 1930s.



Figure 51. Foundations of the smelter furnace (Photo by G. Reeks)



Figure 52. Foundations of the ball mills and the flotation plant.
(Photo by G. Reeks)

[14] 'The use of concrete in reduction Plants', *The SA Mining & Engineering Journal*, (19 February 1910), p. 630.



Figure 53. Foundations for the roaster pots. (Photo by G. Reeks)



Figure 54. Foundations of the primary crusher plant. (Photo by G. Reeks)



Figure 55. Foundations for roaster station. (Photo by G. Reeks)



Figure 56. Foundation of part of the Godfrey roaster. (Photo by G. Reeks)



Figure 57. One of the foundations in the Boiler house showing machine bolts. (Photo by G. Reeks)



Figure 58. External wall foundations showing bolts for structural steel (Photo by G. Reeks)

The photographs (Figures 51-58) capture some of the substantial reinforced concrete foundations of the 1920s TSBM beneficiation plant. For example the smelter foundations measure approximately 1.2 x 6 x 10-15 m high (Figure 51). The roaster foundation is a solid block of concrete measuring 3 x 4 x 8 m high (Figure 53).

The use of reinforced concrete was obviously a much faster construction option than dressed stone or brick. It was inherently stronger than the other materials and was relatively easy to mould or cast using pre-form shuttering as some of the Argent foundations show. Its continued presence at Argent with very little weather damage showing, attests to its longevity.

On many of the wall foundations, the foundation bolts cast into the concrete help reveal that the vertical structural part of the buildings were steel columns. Many of the pictures of the concrete foundations (Figure 56 and Appendix 8) show the marks of the shuttering in the form of parallel lines on the vertical faces. They also reveal the complexity of some of the foundations.

6.4.2 Hardinge Conical Ball Mill – USA Patent 1914

Mines around the world in the 19th and early 20th centuries reduced ores to a fine size using some of the varieties of Cornish Rolls or Roller Mills. Stamp Mills, a common machine on the gold mines of the Witwatersrand and many other mines around the world, had serious limitations as to how fine a particle size they could reduce the product to. Many were still in operation on South African gold mines until 1948.[15] As a technology, the Stamp Mill dates from as far back as AD 900, when pure muscle power was used as the process for crushing ore. By the 15th Century, development of crushing had advanced and water powered multiple stamp mills had become the norm (Lynch and Rowland 2005:54). By the early 1900s new processes of mineral separation dictated that ores needed to be ground to a fineness resembling flour in order to liberate the very fine mineral particles from the waste material (Richards & Locke 1940:67). This could not be achieved with Stamp Mills or Cornish Rolls, and so there was a need for a new process or machine.

This led to the invention and development of a tumbling grinding mill. The driving force behind this invention was that metalliferous mines around the world were rapidly running out of rich ore bodies, and ores were becoming finer, that is to say the ore particles were smaller and less common or technically the grade of the ore or its richness was dropping. Thus one ton of ore produced less of the metals after treatment. Gold ores on the

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15 University of the Witwatersrand, William Cullen Library - Historical Papers Archive, No A1132.

Witwatersrand experienced this when the ore bodies changed from the upper levels of more oxidised rock, to the gold impregnated sulphide rich reefs (Lynch and Rowland 2005:99). The cyanide process largely overcame this problem, but for lead, copper and zinc mines, such as the TSBM silver-lead mines, and others around the world, this was not an option.

In researching the history of the conical ball mill installed at Argent I came to realise that there was a predecessor – the tube mill. Invented in the USA it consisted of a long rotating tube filled with pebbles and was initially used for grinding limestone for cement. It has been very difficult to establish when the first tube mill, the forerunner of the conical ball mill, was installed on the South African Gold mines. JDF Jones in his history of Gencor states "The Albu's [George and Leopold Albu founders of General Mining] were alert to technical change, they pioneered the installation and use of the early tube mill for instance" (Jones 1995:57). The source does not give a date, but by association of the adjoining text it may have been as early as 1898, although I do not believe they implemented such advances until around 1904-6 when they upgraded their mines in the Krugersdorp area of the West Rand. Lynch and Rowland (2005:106) make mention of tube mills being used in South Africa in the early 1900s. Another source, discussing some technical advances introduced by the Central Mining Corporation [successor to the Corner House Group] around 1911, states that "On the technical side, Central Mining and Rand Mines introduced measures to improve production including tube mills…" (Konczacki et al 2013:71). It is worth noting that both of these companies; the Corner House Group and General Mining, displayed a desire for technological advancement in their mineral processing and both were involved with the Argent silver mines albeit at different times.

One of the greatest technological jumps in world beneficiation technology was the introduction of flotation (Jameson 1992). But, it could not have occurred without a parallel jump in the grinding of ores to a flour-like powder and the tube mill was the beginning in this process. This led to the eventual patenting in 1914 of the Hardinge Conical Ball Mill.[16] Thus the conical ball mill was a parallel development and an invention complimented flotation technology. In the USA experiments were being conducted on the effectiveness of the conical ball mill (Metz 1918).

[16] US Patent No US 1115531 A. – Apparatus for grinding ores and other materials. Patent granted 3 November 1914.

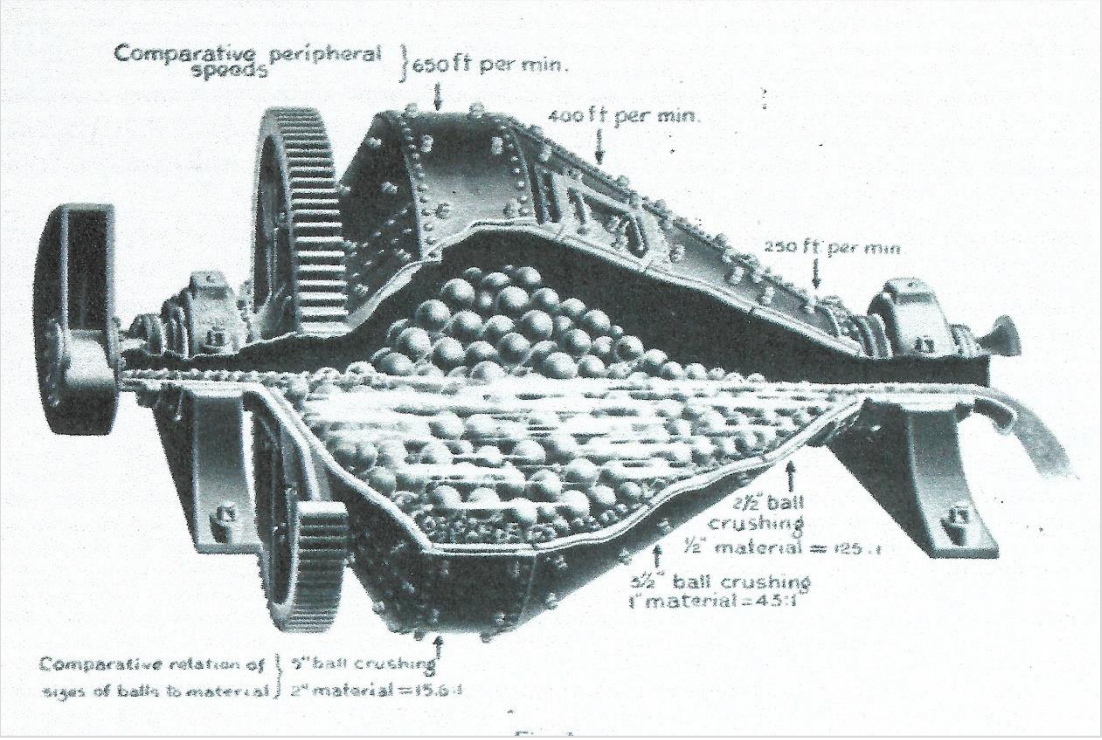


Figure 59. Hardinge Conical Ball Mill.[17]

In 1970 the Johannesburg Mayor's office asked the Chamber of Mines for an analysis of stamp mills on the gold mines. The reply presents some astonishing details of just how far behind other major mining nations the South African mining industry was in developing new technology, up to and including the 1970s:

By the end of 1948 there were still some 22 producing mines with a total of 4 577 stamps in operation.' The report also stated that the number of mills had been 'dwindling steadily since the last major installation on the Witwatersrand in 1918.[18]

This shows that at both periods of the Argent mine's operation - 1890s and 1920s - the South African operating companies were clearly ahead of other contemporary mines in the country in their crushing technology. By the second decade of the 20th century, tube mills which had originally started by using pebbles as the grinding media had developed into using cast iron and forged steel balls. Just before the First World War a new version of the tube mill was introduced to international and South African mining companies - the Rod Mill (Lynch &

17 Hardinge Company. 1920. The Hardinge Conical Mill catalogue no 7 May 1920, New York.

18 University of the Witwatersrand, William Cullen Library - Historical Papers Archive,. No A1132.

Rowland 2005:110). In effect it was the same as a ball mill, but steel rods were used as the grinding media instead of steel balls or stone pebbles. Tube mills lasted on the South African gold mines for many decades and many mines were still using them after the Second World War.

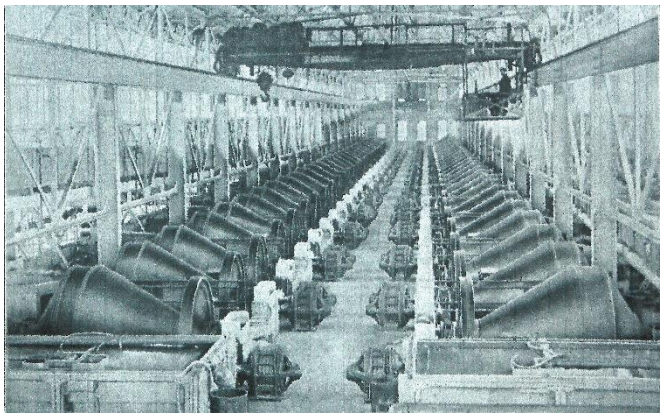


Figure 60. An early example of the significant use of Hardinge Conical Ball Mills at the Calumet and Hecla Mine, Michigan, USA in 1910.[19]

In 1910 Harlowe Hardinge, an American consulting mining engineer, noticed 'that large and small rocks moved at different rates when moving down an incline' and it was this Archimedean screw principle of physics that gave Hardinge the idea for his mill (Lynch and Rowland 2005:108). His breakthrough was recognising that as the cylindrical mill rotated, the cone shape induced the larger rocks and grinding media to stay at the largest diameter of the mill, but as the ground rock became finer is migrated down the length of the drum. From this he developed the Conical Ball Mill, with the early units using pebbles being installed on a trial basis in 1908 at a Michigan copper mine (Lynch and Rowland 2005:108). The immediate result was a clear increased recovery of copper to as high as 75%, compared to a tube mill and the cruder edge-roller or Chilean mill with apparently much lower recovery rates.

The first units of the Hardinge Conical Ball Mill were commissioned at the Calumnet and Hecla copper mine in 1910 (Lynch and Rowland 2005:108). By 1919 the pebbles in the Hardinge mill were replaced with the steel balls and it is believed that the recovery rate rose

[19] Hardinge Company. 1920. The Hardinge Conical Mill catalogue no 7 May 1920, New York.

to 90%. By then early flotation was being used at the mine so it is difficult to quantify which technology contributed to the improved recovery of the metal (Lynch and Rowland 2005:108). A number of further developments in 1914 led to Hardinge receiving another patent,[20] and a further one in 1920[21] which most likely covered the design of machine installed at TSBM in 1921.

It has not been possible to ascertain which mine in South Africa was the first to install Hardinge Ball Mill technology. It is known that the Hardinge mills were installed at TSBM in 1920-21 and so it is possible that these machines were the first of their type in South Africa. The mills installed at TSBM were Hardinge Conical Ball Mills type 6ft. 22", in other words the largest diameter was 6ft. (2 m) and then the cone part would have been about 4 ft. (1.5 m) diameter. The overall length of the mill was nearly 16 ft. (5 m).[22]



Figure 61. Foundations of the Hardinge Conical ball mill. (G Reeks photo)



Figure 62. The plinth supported the bearings of the Hardinge Conical ball mill. (G Reeks photo)

The significance of the Hardinge Conical Ball Mill was its increase in the efficiency of grinding, coupled with lower energy requirements needed to drive the mill (Lynch and Rowland 2005:108). On entering the mill, the material drops to the point of the largest diameter of the cone. At this point it comes into contact with the largest of the balls and because it is the largest diameter of the cone the periphery of the cone is travelling at the

[20] US Patent No US 1115531 A – Apparatus for grinding ores and other materials. Patent granted 3 November 1914.

[21] US Patent No 1355474 A – Conical Mill. Patent granted 12 October 1920.

[22] Hardinge Company. 1920. The Hardinge Conical Mill catalogue no 7 May 1920, New York.

highest surface speed. This allows the balls to travel to the highest point of the cone before dropping under gravity – thus producing the highest crushing/grinding force (Truscott 1923:125). The fine particles travel in water and migrate down the length of the cone where, although the peripheral speed is lower, the smaller balls can operate on the fines and ensure finer crushing/grinding. As the particles travel the length of the cone they are repeatedly crushed. The energy required for crushing is thus reduced as the particles travel until they exit in the water based slurry at the open end of the cone. It is a continuous classification process and produces a finer product that the earlier tube or rod mills (Truscott 1923:126).

6.4.3 Dorr classifier – patented in 1907 with modifications in 1912 and 1915

With the advancement of grinding technology, producing very fine powders using tube mill and later conical mill technologies in the early decades of the 20th century, a need arose to classify it into an acceptably fine product and the remaining coarse product was returned for further grinding. Classifying is a process that led to a number of inventions in the late 19th century, one of them the Rittinger Spitzkasten machine that was described in chapter 4 and which was used in both the 1890s TSM mine and in the 1920s as part of the TSBM beneficiation plant. The Spitzkasten was suitable for coarser grains – nominally to 1mm (Louis 1909:231), but not the classifying of the very fine material produced by the Hardinge Mill. There were a number of variations including the cone or 'Callow' classifier, which depended upon the separation of the fine material being transported in the water and over a lip of the cone and the heavier material sinking to the apex of the cone from where it was passed on to the next stage (Truscott 1923:273). This earlier design of classifier was used at TSBM.

In 1894, a young student, John Van Nostrand Dorr (Figure 63) obtained a BSc in chemistry from Rutgers University in the USA (Haynes 1983:109). He became an industrial chemist and in the early 1900s began working on a gold mine in south Dakota USA, specifically on the separation and treatment of fine solids (Haynes 1983:109). The introduction of the tube mill in 1904 and the later Hardinge Ball Mill in 1907 led to the development of a more efficient classifier - the Dorr Rake Classifier (Figure 64).

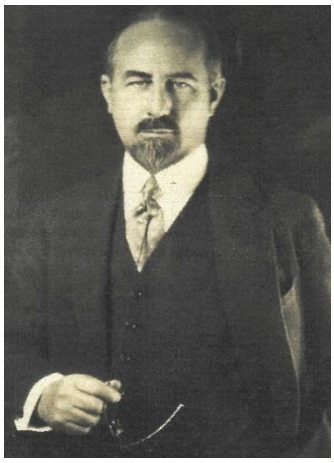


Figure 63. John Van Nostrand Dorr (1872-1962) National Mining Hall of Fame & Museum, Leadville, Colorado, USA.[23]

In 1904 Dorr saw the weakness of the cone or 'Callow' classifier, which was developed in the late 1890s. With the finer grinding of material, the apex of the cone often clogged with the fines, which would eventually break, taking with the sudden rush on exit some of the coarser material (Richards & Locke 1940:160). Dorr invented the mechanical rake classifier in 1904 and it was patented in 1907.[24] From the original 1907 patent for the machine many additional variations and patents were filed and awarded, the principal ones being in 1912 and 1915.[25]

It is more than likely that the First World War was the major cause of it not being adopted on the Witwatersrand gold mines in the second decade of the 1900s. I have not been able to find any references to its adoption in this period, as described in Chapter 5 (5.2), the period from 1918 through to 1930 was not a good period for the gold mines of the Rand. In fact with so many gold mines having to close in the period 1918-1929 it was unlikely that new technologies would be tried.

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23 'National Mining Hall of Fame & Museum – John Van Nostrand Dorr'. http://www.mininghallofflame.org/inductee/dorr, (Accessed on 18 January 2018); 'The Dorr Company', *Industrial & Engineering Chemistry*, 1925 17 (12), pp. 1293-1294.

24 US Patent number 849379 A – Ore-classifier. Patent granted 9 April 1907.

25 US Patent number 1024647 A – Ore conveyor and classifier. Patent granted 30 April 1912; US Patent number 1156543 A – Ore-classifier. Patent granted 12 October 1915.

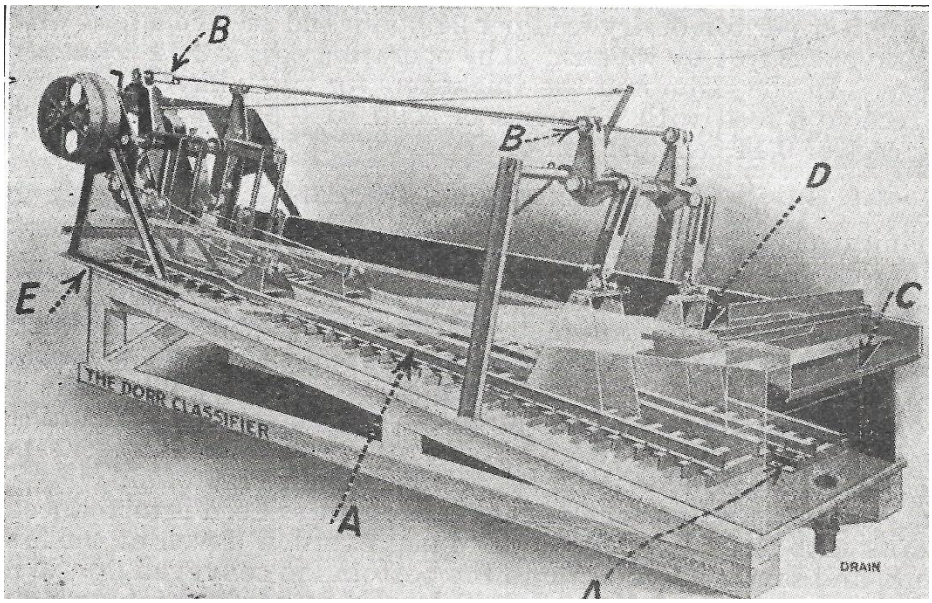


Figure 64. Dorr Rake Classifier (Richards & Locke 1940:164).

The result was the ground material was finer and generally did not need additional grinding as it did through close circuit regrinding with the cone classifiers.

In 1920, the new technologies seemed to be the desired approach for the TSBM Company. The TSBM may therefore have once again been one of the earliest to use this technology in South Africa, a process far better than any other form of classification in the post First World War South Africa.

Principle of operation

Truscott (1923:267) describes the machine as consisting of a ‘rectangular settling tank’ which measured approximately 5 m long x 1.6 m wide sloping at a shallow angle, with the one end under about 0.4 m of water. The pulp was fed into the machine, shown below (Figure 65), at ‘Feed’. The coarse material settled and the fine light material with the excess of water flowed over the weir as the slime.

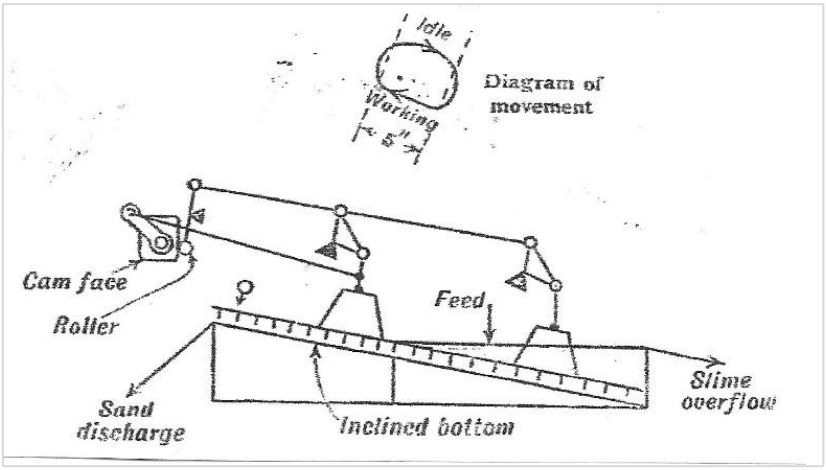


Figure 65. Principle of operation of the Dorr Rake Classifier (Truscott 1923:267)

When the heavier material sank to the bed it came into contact with a rake mechanism, consisting of a series of blades set across the narrow width of the bed and attached to a frame. The frame moved in an oscillating backwards and forwards, motion and at the same time through a lever arrangement the motion was one of raking on the upstroke followed by the rakes being lifted clear of the bed for the return downward stroke. With each up stroke the heavy particles were mechanically moved upwards in water which created a settling action. The particles moved out of the water, and were eventually raked over the top of the bed.

6.4.4 Dorr thickener - patented in 1915

Once the fines have gone through the various closed loops of return for re-sizing and grinding there comes a point where the pulp has reached the required level of concentration prior to moving to the roaster (sintering) process. The water from the previous processes acted as a transport medium. At this point the fines needed to be separated from the water. The principle of operation behind thickeners is explained on the next page. In virtually all cases, and especially in the 21st century, they are very large circular tanks (Figure 66). In most photographs of modern mineral dressing plants, such as on South Africa's gold mines, there are often large circular tanks visible with water in them - these are thickeners.

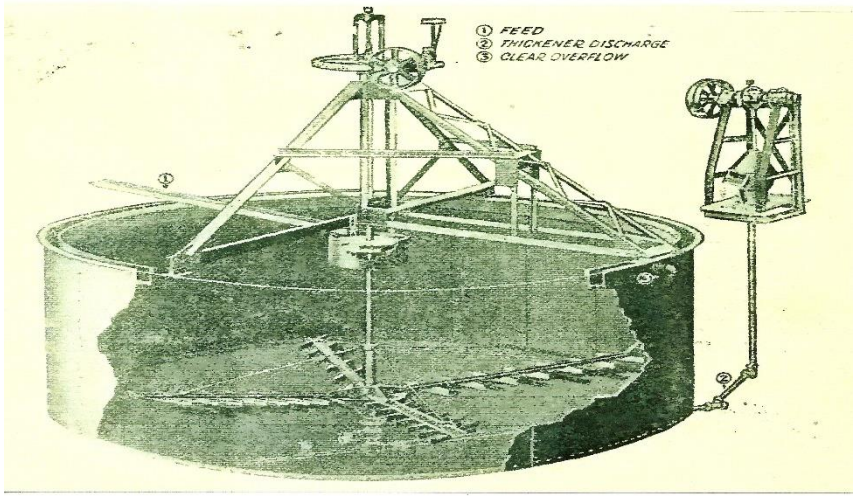


Figure 66. Dorr Thickener. (Truscott 1919:274)

In some cases modern ones can be as large as 40 m diameter.[26] Their primary purpose is to remove the excess water from a pulp of water and fine solids (Truscott 1923:274). In 1915, a patent was granted to Dorr for his invention of the circular thickener.[27] The diagram below shows the principal actions of the machine (Figure 67). The conical ball mill and flotation technology needed to use an excess of water in the mineral dressing technologies, but at one stage in the process, the excess water had to be eliminated.

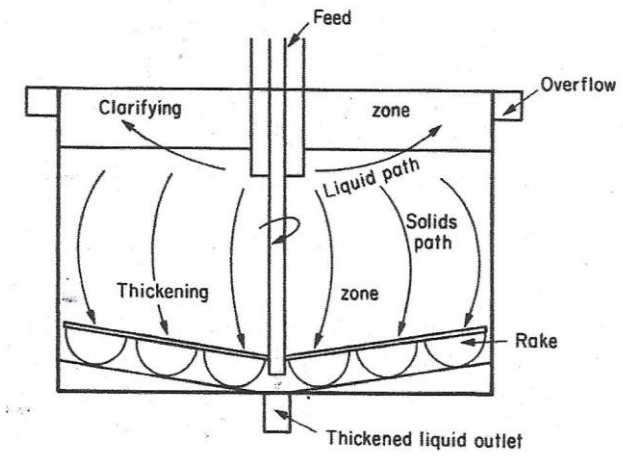


Figure 67. The principle of action within a Dorr Thickener (Wills 1979:376).

[26] Personal recollection from when I was involved in mechanised mining research on some of the gold mines of South Africa.

[27] US Patent number 1140131 A – Apparatus for continuously separating solids from liquids. Patent granted 18 May 1915.

Dorr's invention was incredibly simple. According to Richards & Locke (1940:160) the pulp is fed into the tank via a small feed well located in the centre of the tank and just below the surface of the water in the tank. The solid particles under the action of gravity drop to the bottom of the tank in what is effectively a tank of still water. A slowly rotating rake mechanism, carrying four radial arms on which the raking blades are mounted, forces the settled particles (thickened solids) to the centre of the shallow cone-shaped bottom of the tank where an outlet pipe feeds a solids pump, which in turn feeds the solids to the next stage in the process. The excess of clear water, which of course would include the water that carried the pulp to the thickener, gradually overflows over the top edge of the tank to a water recovery system for re-use

From the 1920s flow diagram of the concentration process (Figure 38) it is known that the TSBM process had a Dorr thickener to treat the overflows of both the Spitzkasten machine and the thickening cones. In effect, this was the final recovery of possible fines of ore and such material was added to the pulp that was fed to the Minerals Separation Sub-Aeration flotation plant. This was also a relatively new technology, having only been patented in 1915, possibly making this the first installation on any South African mine shortly after the end of the First World War.

6.4.5 Flotation technology - patented in 1912 and revised 1914

As with many inventions, there is a process where an unworkable idea is developed to a point where it does work. The idea of a froth of bubbles being used to separate and support fine grains of minerals started in the late 19th century, but the technology was not really perfected until 1902 when an Italian, Alcide Froment, patented his invention.[28] (Richards & Locke 1940:233). His process relied on a chemical reaction between sulphuric acid and the carbonates in the gangue to produce bubbles. These bubbles carried the particles of released sulphides to the surface from where they were recovered. His invention was purchased by the British company *Minerals Separation Ltd* in 1903.

[28] 'History of Flotation Patents', https://www.911metallurgist.com/blog/froth-flotation-patent-history, (Accessed 20 January 2018); 'Froth flotation machines', https://www.911metallurgist.com/blog/froth-flotation-machines, (Accessed 20 January 2018).

Froment's process used the addition of a small amount of mineral engine oil and the chemical reaction to create bubbles.[29] Ironically he never thought of using air to create the bubbles. Minerals Separation's metallurgists, Sulman and Picard developed the agitation-froth process and in 1905 took out revised patents based on the use of air to froth the mixture (Richards & Locke 1940:234).[30] A number of inventors worldwide took up the challenges of froth flotation, which ended a series of bitter court cases over patent infringements, especially in the USA. In 1912 Minerals Separation obtained a license from a Belgium chemist De Bavay and after trading patents they began working together, installing flotation plants around the world.[31] Obviously, the First World War halted development and installation of more plants.

In March 1922 it was announced by Minerals Separation Ltd that they would be opening an office and research laboratory in South Africa. The Sub-aeration Froth Flotation process, although new to South Africa, was not a new process having been patented in 1912, but the Minerals Separation Company claimed that it had "proved itself as the most efficient and economical method of concentrating every kind of ore known".[32] The Falcon mine in Zimbabwe was the first to install a flotation plant in Africa and a statement was made:

The Falcon mine, Rhodesia, has been using a Minerals Separation [name of the company] process for many years, and now Minerals Separation have plants running at the Cam and Motor and the Transvaal Silver base Metals Mine.[33]

It was subsequently denied that the Cam and Motor mine had a flotation plant running and in fact a later article described the Cam and Motor flotation plant as only "now running successfully".[34] The TSBM Company stated as early as December 1919 that they would

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29 'History of Flotation Patents', https://www.911metallurgist.com/blog/froth-flotation-patent-history, (Accessed 20 January 2018); 'Froth flotation machines', https://www.911metallurgist.com/blog/froth-flotation-machines, (Accessed 20 January 2018).

30 US Patent number 835120 A - Ore concentration. Patent granted 6 November 1906.

31 'Historical note: Minerals Separation Ltd'. http://www.austehc.unimelb.edu.au/guides/mine/historicalnote.htm, (Accessed 20 January 2018).

32 'Minerals Separation Progress', *The SA Mining & Engineering Journal,* (4 March 1922), p.920.

33 Ibid.

34 'Progress of flotation process', *The SA Mining & Engineering Journal,* (2 December 1922), p.321.

most probably use the Minerals Separation Ltd oil flotation technology in their beneficiation plant.[35] It now seems almost certain that the TSBM flotation plant was the first to be installed and commissioned in South Africa and only the second one to be installed in Africa. The flow sheet dated May 1921 was already naming a 250 ton Minerals Separation Sub-aeration plant within the flow diagram.[36]

In December 1921 it was reported that the concentration plant which had to have included the flotation plant was expected to be fully commissioned "within the next few weeks".[37] A year later in December 1922 a report appeared,[38] indicating that several gold and base metal mines had installed flotation plants manufactured by Minerals Separation Ltd, and that they were being commissioned and showing success. Among the mines were Sheba gold mine and Messina copper mine and a new plant at Namaqua copper was under installation.[39] It mentioned that the plant at TSBM had been working satisfactorily, as had a plant at the Falcon mines (Zimbabwe). A new proposal for a plant at the Modder Deep gold mine was under review and it was expected to be in operation in early 1923.[40]

Research into the new technologies at the TSBM revealed the Messina copper mine - another base metal operation - was a contemporary operation. Messina began its initial operations in 1908 and relied on technologies such as Blake Jaw crushers and crushing rolls to reduce its ores and Harz jigs. Messina relied on a technology developed in the mid-1890s - the Wilfley table - predecessor of flotation technology, and patented in 1896.[41] This was a development of the Lührig Vanner - used by TSM. In July 1922 it was announced that the Messina mine, after having been closed, was being re-developed with a more modern beneficiation technology which was to include a Mineral Separation Ltd (MS) Sub-Aeration Flotation

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35 'Froth Flotation Concentration', *The SA Mining & Engineering Journal,* (13 December 1919), p. 290.

36 'Flow Sheet - Transvaal Silver & Base Metals, Limited', *The SA Mining & Engineering Journal,* (7 May 1921), p. 1083.

37 'Report of 2nd AGM of TSBM Ltd', *The SA Mining & Engineering Journal,* (17 December 1921), pp. 571-573; 'Transvaal Silver – progress report', *The SA Mining & Engineering Journal,* (28 January 1922), p.741.

38 'Progress of flotation process' *The SA Mining & Engineering Journal,* (2 December 1922), p.321.

39 Ibid.

40 Ibid.

41 'The Messina Copper mine', *The SA Mining Journal,* (16 May 1908), pp.284-285.

plant.[42] In a report in December 1922 it was announced that the TSBM, Messina and Sheba plants were all working successfully.[43] TSBM's MS flotation plant preceded the installation and commissioning of the Messina plant by, almost a year.

This makes the analysis of the TSBM mine in the 1920s very exciting, because it shows that the plant was designed with 'state of the art' beneficiation technology. Now, of course in the 21st century, flotation is a standard method of concentration in base and precious metal mines all over the world. In trying to trace the Minerals Separation Company it has been discovered that despite them still being registered in the UK, the company itself no longer trades. What has been found is that there are many references on the internet to the company facing litigation in America for patent violations in the early part of the 20th century and so it is possible that they may well have gone insolvent or been taken over by a competitor.

Principle of operation

The principle of frothing is when air is dispersed in water and it forms bubbles which have a degree of stability as they rise to the surface. How such bubbles perform in the water is determined by the inclusion of a flotation reagent or surfactant which is added to the fine pulp - mixture of very fine particles and water - prior to introduction into the flotation cells. In the case of the TSBM unit, coal tar was used and was obtained from the Johannesburg Gas Works.[44]

In a Minerals Separation sub-aeration flotation machine (Figure 68), the pulp was introduced into the first cell and in the earliest machines the principle of a counter-flow from the aeration compartment of a cell to the previous cell was not incorporated in the design.

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42 'Messina Copper', *The SA Mining Journal* (20 July 1912), p. 783.

43 'Progress of flotation process' *The SA Mining & Engineering Journal,* (2 December 1922), p.321.

44 'The Reduction & Treatment Plant of the Transvaal Silver & Base Metals – part 2', *The SA Mining & Engineering Journal,* (28 October 1922), p.161.

An impeller, which provided the aeration and flow, was positioned close to the bottom of the individual cells. The TSBM machine had 10 cells.[45] There were two compartments in each cell. At the bottom, an agitation area and directly above it a baffle to break the pulp before entering the frothing compartment. The froth rose to the surface and was either removed mechanically or overflowed the lip of a weir. The tailings sank to the bottom of the cell and passed through an opening into the agitation compartment of the next cell where the process was repeated (Truscott 1923:399-415; Richards & Locke. 1940:251-260)

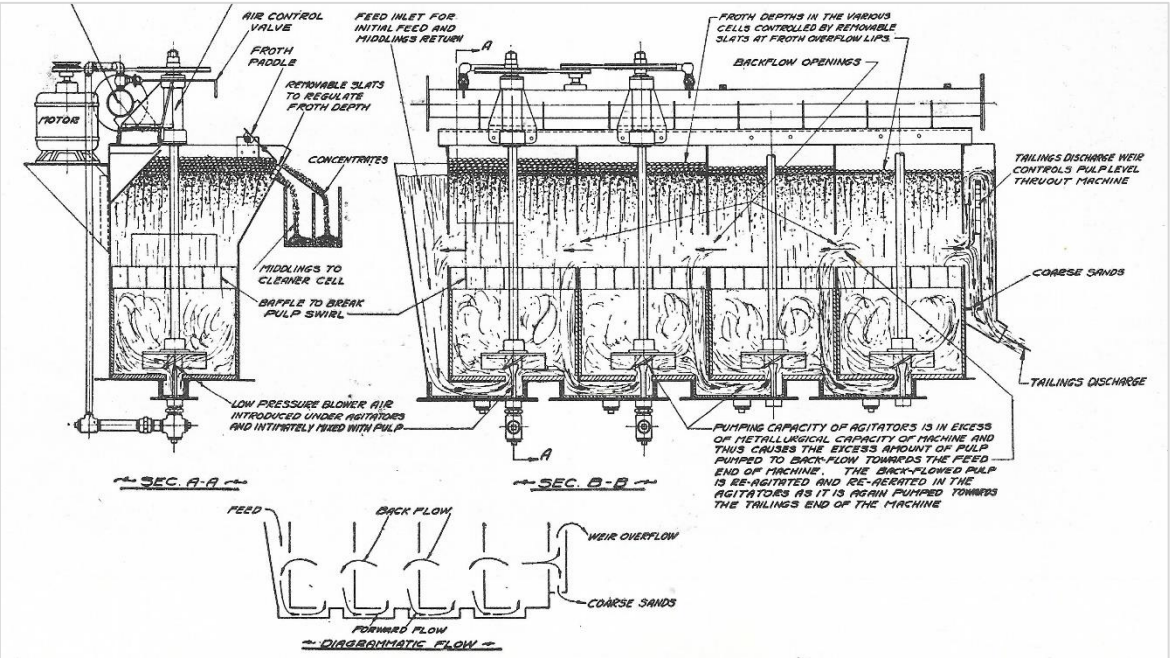


Figure 68. Drawing showing the flows and principle parts of a Minerals Separation Ltd Sub-Aeration Flotation Cell machine. (Richards & Locke. 1940:253).

The surfactant preferentially attached itself to the desired particles of ore such that when they came into contact with the bubbles they attached themselves to the bubbles and rose to the surface of the cell as froth covered in the mineral particles. The non-ore particles did not attach themselves to the bubbles and through a process of gravitation and migration travel down the series of cells that in effect remove the bulk of the ore particles in the first few cells, the middlings were removed in the next series of cells and finally any remaining particles in the last few cells.

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45 'The Reduction & Treatment Plant of the Transvaal Silver & Base Metals – part 2', *The SA Mining & Engineering Journal*, (28 October 1922), p.161.

The final resulting tailings or 'slime' is pumped to a waste slimes dam.[46]

This is a simplified explanation of the sub-aeration flotation process. The actual science and engineering behind the process called flotation has, since 1920, been the subject of dozens of textbooks and for many metallurgists and chemists a 'life's work'. The technology has developed to such an extent that a number of different metallic ore particles can now be separated and removed through the action of different surfactants.

Minerals Separation Ltd and their machines were like so many new technologies - overtaken by new developments, new ideas and new companies entering the market, but the basic concept was created by them has lasted to modern times (Wills 1979:310-319). As with a number of technologies, flotation technology has migrated to other industries such as waste water treatment and paper recycling. It has however gained a reputation and has been called "…the single most important operation used for the recovery and upgrading of sulphide ores" (Jameson 1992).

6.4.6 The Roasting process - Huntington-Heberlein furnaces & Godfrey Roaster

The technologies of the roasting and smelting operations were surprisingly not modern by 1920s standards. The main roasting furnaces were Huntington-Heberlein furnaces and date from an American patent originally awarded in 1898 [47] and in a later patent in 1907.[48] The Huntington-Heberlein process was a batch process, whereas the later invention in 1909 by Dwight-Lloyd was a continuous roasting process and therefore more efficient in terms of ore throughput as it allowed for a continuous feed of ore in and roasted ore out. This 'blast up' type of operation was eventually superseded by the 'blast down' process when the Dwight-Lloyd continuous roaster or moving grate furnace, was patented in 1900.[49] One wonders why in 1919-1920 when the TSBM plant was being designed, they went for the

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46 'Transvaal Silver & Base Metals Ltd', *The SA Mining & Engineering Journal*, (7 October 1922), p. 69.

47 US Patent number 600347 A – Process of treating sulphide ores of lead, &c., preparatory to smelting. Patent granted 8 March 1898.

48 US Patent number 844355 A – Treatment of ores preparatory to smelting same. Patent granted 19 February 1907.

49 US Patent No 642,602 A. Process of Calcining. Patent granted 6 February 1900.

older technology. For a detail drawing of the Huntington-Heberlein Roasting pot refer to the previous chapter (Figure 41).

The Godfrey rotary roaster, used for the recovery of the copper matte and possibly used to preheat/roast some of the ore before charging the Huntington-Heberlein furnaces, appears to have been installed or constructed around February 1924 when it was decided to treat the copper matte.[50]



Figure 69. Concrete foundations for the Godfrey type Roaster at the TSBM mine. (G. Reeks photo).

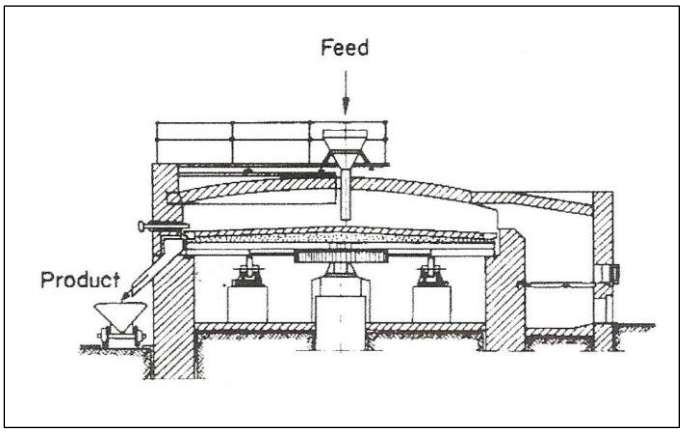


Figure 70. Godfrey type of rotary roasting or sintering furnace. (Habashi 2005)

Note. The heavy hatched 'wall' in the diagram is what can be seen in Figure 69 taken at Argent in 2017.

50 'Transvaal Silvers', *The SA Mining & Engineering Journal,* (16 February 1924), p. 585.

6.5 Conclusion

The main conclusion of this chapter is that in 1919-1920 Dr Edward Heberlein was certainly a forward thinking designer of base metal beneficiation plants. He was clearly not afraid to utilise extremely new technologies. Technologies, that even by American and European standards, were brand new and which had been developed within a few years of each other. The use of new technologies installed at TSBM, such as the Conical Ball Mill, the Dorr thickener, Dorr Classifier and MS Flotation were so new that I believe their installation at Argent was the first instance of their use in South Africa. The use of reinforced concrete at the TSBM mine is difficult to place in a ‘first use’ category, but it appears to have been the first substantial use of reinforced concrete on any mine on the Witwatersrand.

Chapter 7

Analysis of ore mined, bullion shipped, costs and profits

7.1 Introduction

The main focus of this chapter is an analysis, as far as possible, of records revealing the amounts of ore raised, the relative values of the metals as percentages of the ore and an analysis of how much silver lead and other metals that the TSBM operation produced. The monetary values of the metals is a significant factor in determining the financial strength of the TSBM operation and where possible these have also been analysed. In the final part of the analysis the question of the profitability of the TSBM venture will be explored, or as has been determined in Chapter 4 in the 1890s with the TSM, did the TSBM Company also make an overall loss on capital invested?

In trying to analyse the amount of ore mined, smelted or shipped a significant number of individual reports in the *SA Mining & Engineering Journal* have been used. They are detailed below in chronological order. Many of the figures reflected below do not appear in the mine manager's consolidated monthly reports, which forms part of the Gold Fields of SA (GFSA) files. It has therefore been decided to use the SAMEJ references first and then include the GFSA document at the end of this chapter for comparison. The first figures in the GFSA document are recording tons milled for April 1922. It is sometimes difficult to understand why the figures differ, because surely the reporters would have obtained their figures from the mine reports or the mine manager. The mine records the percentage of lead or silver per ton of ore, but strangely not what it was sold for. By comparing the two sources it has been found why the SAMEJ had no report of production for some months e.g. January to March 1922. The simple reason is - when viewing the mine manager's reports - there was no production.

On reviewing the Gold Fields files, a table was found that formed part of the extracts of TSBM mine manager's reports copied by Dr F.S. De Jager. He was a geologist for Gold Fields between the 1950s -1980s, and took it upon himself to copy details from the original

Mine Manager's reports, feeling that they were part of a history that should not be lost.[1] One report detailed monthly production figures from November 1921 through to October 1925, when the mine closed down. These figures have been reproduced in Table 6 and 7 in conjunction with data from other sources such as the SA Mining and Engineering Journal (SAMEJ). Together they present a very clear picture of tonnages mined, milled and bullion produced along with the profits made. From the chart it appears that no production or delivery of ore/bullion took place from November 1921 to March 1922. This is strange and in conflict with the press reports detailed below. Table 7 is a consolidated table with the original Mine Managers figures shown in black and the figures from the various SAMEJ extracts shown in red.

In some cases the values from the two sources do not agree, and in such situations the Mine Manager's figures are used, as they are more likely to be the most accurate figure. For the most part the variations are minor. One of the confusing aspects of the SAMEJ reports is that they mention the 'results for the first quarter' and it is not always clear which months they are talking about. In some cases they are clearly talking about the first calendar quarter i.e. January to March. However, in other cases they are referring to the financial quarters and the company accounts reflect the first quarter as November to January. Another aspect of the Gold Fields document not shown on the new version (Table 7) are the minor notes in the 'remarks' column.[2] This has been done for two reasons, one to save space on the chart and secondly because the notes are included in the text below, they are shown as – 'note.'

7.2 Ore shipments

Two small shipments consisting of 30 and 42 tons of hand-picked high grade ore were produced in November of 1920. The ore was recovered from surface winzes and prospecting activities.

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1 In a report on the structure and possible remaining economic potential of the main vein. 20 April 1989, de Jager states that the "reports are in narrative fashion, but nevertheless containing valuable mineral, geological and exploration details." Gold Fields of SA file ARG 820/1/2 LEA-ZIN de JAGER.

2 Chart title: Statistics compiled from Manager's monthly reports from April 1922 to July 1925 in Gold Fields of SA file ARG 820/1/2 LEA-ZIN de JAGER.

The assay value was stated to be 60% lead and 74 ozs silver per ton and was believed to have a value of about £1 800 (see Table 7).[3] In the 2nd AGM report of the company in December 1921, it was announced that the roasting and smelting plant had been commissioned and that the recovery results were excellent at 95.3% for lead and 96.6% for silver.[4] Mention is made of a shipment of bullion resulting from the trial run of the roasting and smelting plant being made in November 1921. No details of the tonnage shipped to Europe were disclosed, but the value was expected to raise £3 600.[5] In the progress report published in January 1922 it states that for the year ending December 1921, the mine had shipped 91 tons of lead bullion, produced from smelting hand-picked high grade ore. It does not say when during the year this bullion was produced or its financial value. It does say the assay value was 98.16% lead and 110.12 ozs silver per ton.[6] It is almost certain that this refers to the shipment that raised £3 600.

In April it was announced that the output for the first quarter of 1922 had been 365.9 long tons of lead bullion, containing 41 348.7 ozs silver and that this had been produced by the small furnace, as the large furnace was still being installed.[7] There was an earlier brief notice that the mine had produced 191 tons lead bullion in February and that it contained 19 673 ozs of silver.[8] No other monthly outputs were found for the months of January or March 1922. The second quarter report gave details of the tonnage of ore treated in the three months as 11 866 tons.[9] Unfortunately no details of bullion output and silver were found for the second quarter (April-June), although a gross bullion value was given as £46 264.

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3 Transvaal Silver', *The SA Mining & Engineering Journal,* (5 February 1921), p. 604.

4 'Report of 2nd AGM of TSBM Ltd', *The SA Mining & Engineering Journal,* (17 December 1921), p. 571-573.

5 Ibid.

6 'Transvaal Silver – progress report', *The SA Mining & Engineering Journal,* (28 January 1922), p. 741.

7 'Transvaal Silvers progress', *The SA Mining & Engineering Journal,* (29 April 1922), p. 1167.

8 'Transvaal Silver & Base Metals Ltd – Output for February', *The SA Mining & Engineering Journal,* (1 April 1922), p. 1019.

9 'Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal*, (29 July 1922), p.1595.

In the third quarter the values were reported on a monthly basis and they were as follows:

Table 6. Third quarter values of bullion production for 1922.[10]

Month	Bullion (tons)	Containing silver (ozs)	Value of silver
July	321.3	31 064	£12 840
August	402.32	39 972	£15 657
September	461.02	44 731	£18 120

The output for October was stated as 430 297 long tons of lead bullion containing 41 726 ozs silver valued at £16 760.[11] November's output was said to be 426.134 long tons of lead bullion containing 42 859 ozs silver valued at £16 500.[12] No production values were given for December although an amount of ore was milled. At the 3rd AGM it was declared that the total gross profit for the year was £17 295, which - after repaying loans and interest - yielded a net profit of £14 486.[13] The second half of 1922 was the most successful according to the monthly SAMEJ reports in terms of production at the mine. The years 1923-1925 present a very broken set of records in the SAMEJ and with such incomplete records it has been impossible to compare the monthly outputs and sales. The original chart shows the production values in terms of tons of ore raised, tons milled and the base values of the two primary metals in the ores. The problem of the tonnages of bullion produced over the same period is that the value of the metals contained therein varied from month to month and even where the ore value of silver increases or decreases there is no direct relationship with the final bullion content value of the silver. This aspect can be clearly seen with the figures of July to November 1922, which is the only part of the consolidated chart where the manager's figures and the SAMEJ sales can be compared.

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10 'Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (12 August 1922), p. 1658; 'Transvaal Silver & Base Metals Ltd', *The SA Mining & Engineering Journal,* (9 September 1922), p. 1779; (7 October 1922), p. 69.

11 'Transvaal Silver & Base Metals Ltd', *The SA Mining & Engineering Journal,* (18 November 1922), p. 264.

12 'Transvaal Silver & Base Metals Ltd', *The SA Mining & Engineering Journal,* (16 December 1922), p. 376.

13 'The Position and Prospects of Transvaal Silvers', *The SA Mining & Engineering Journal,* (30 December 1922), p. 441.

In February 1923, it was stated that the output for January was 475 961 long tons of lead bullion containing 45 764 ozs silver and valued at £19 143.[14] March yielded an output of 441.0 long tons of lead bullion containing 44 334 ozs silver valued at £17 984.[15] A note in the original chart for February 1923 states 'No 2 shaft closed down'.[16] No bullion output figures were found for the second quarter. However, in the December issue of SAMEJ the third quarter figures (Jul-Sep) were published as follows: Ore treated 15 937 short tons producing 1 192 long tons of lead bullion containing 132 734 ozs of silver estimated at £46 318.[17] At the 4th AGM held in December, it was announced that a gross profit of £55 090 had been made producing a net profit of £51 230 for the year and that the mine had raised 92 817 tons of ore of which 62 745 tons were milled and had produced 5 424 long tons of lead containing 542 510 ozs of silver.

It was also stated that the mine had accumulated a large tonnage of copper-rich matte. This matte, a by-product of the smelting, contained about 6% copper along with small amounts of residual lead, silver and gold. It was decided that the mine would install a new set of rolls for crushing the matte and construct a Godfrey type of rotary mechanical roaster to treat the matte and once the matte was enriched to 50-55%, it would be profitable to export it to Europe.[18] It is not explained in the AGM report why the recovery rate had dropped significantly to 83.82% for lead and 84.61% for silver. Whether the fall off in the grade of ore towards the end of 1924 had something to do with it is not known.

In December 1924 the 5th AGM was not a happy one. A series of statements by the Chairman presented the prospects that new finds of payable ore were running out. The only other mine in the company that was feeding ore into the beneficiation plant was the Brakfontein mine. At the No 1 (Main mine) shaft on Dwarsfontein, the lode was getting narrower and the ore

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14 'Transvaal Silver & Base Metals, Limited', *The SA Mining & Engineering Journal,* (10 February 1923), p. 620.

15 'Transvaal Silvers', *The SA Mining & Engineering Journal,* (14 April 1923), p. 106.

16 Gold Fields of SA file ARG 820/1/1 GEOL (1) report no 9.

17 'Transvaal Silver', *The SA Mining & Engineering Journal,* (15 December 1923), p. 821.

18 'Transvaal Silver & Base Metals, Limited', *The SA Mining & Engineering Journal,* (22 December 1923), p. 362; 'Transvaal Silvers', *The SA Mining & Engineering Journal,* (16 February 1924), p. 585.

less economic. A prospecting borehole was drilled to 1 050ft (319 m) and it was planned to drill to 1 500ft (456 m) by February 1925.[19] The amount of ore crushed in 1924 was 55 417 tons producing 4 859 long tons of lead bullion containing 503 943 ozs silver to a value of £204 969. This amounted to a treatment of 7 378 tons less ore than in 1923 and although the grade was much lower the sales value was up for both metals and yielded a profit of £92 555 for the year. When added to the previous year's appropriation account of £62 716 it gave a total of £158 271. An outstanding loan by General Mining of £73 797 was repaid, leaving a balance of £83 752. It was also stated that the treatment of copper matte was going well.[20] A point of interest in the report is the mention of TSBM paying Company Tax of £5.

At the 5th AGM it was also reported that despite development of the no 1 shaft to a 7th level, coupled with the drilling of a borehole to 1 050 ft. no appreciably economic deposits had been found. A similar gloomy picture existed at Brakfontein, where despite development on the 3rd level, no more economical ore had been found.[21] Brakfontein (No 3 mine) was finally closed as an operation in November 1924 and this was reflected in the Manager's monthly reports, (Table 7). At the beginning of 1925 mention is made of 'the old jig tailings' at the Main mine. It is not clear if it is referring to the 'old' TSM 1890s tailings, or the previous year's TSBM tailings and which amounted to some 30 000 tons. However, as is shown in section 7.2, the early press reports of 1920 make mention of the 'jig residues' from the old TSM mine and that they amounted to some 30 000 tons. These were to be put through the concentrating plant.[22] The quarterly report - November 1924 to January 1925 - gave a better idea of the production figures. The amount of ore treated was put at 13 112 tons, which yielded 847.07 tons of bullion, yielding 840.77 tons of lead, 102 821.74 ozs of silver and 44.9 tons of copper from the treatment of the 95.5 tons of accumulated copper matte. This gave a sales value of £51 322 yielding a net profit for the quarter of £26 527.[23] On February 14 it was announced that the borehole had intersected the lode at a depth of 1 476ft (449 m).

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19 'The outlook for Transvaal Silvers', *The SA Mining & Engineering Journal*, (20 December 1924), p. 415.

20 Ibid.

21 Ibid.

22 'Transvaal Silver & Base Metals Ltd', *The SA Mining & Engineering Journal*, (7 February 1925), p. 583.

23 Ibid.

Although the lode had a width of about 20 inches (0.5 m) it was massive siderite (iron carbonate) and contained virtually no lead ore.[24]

The amount of ore treated in the final quarter July – September 1925 had been nil. The output from the final amount of matte was 136 long tons of copper and 264 long tons of lead bullion containing 254 long tons of lead and 40 205 ozs of silver, plus 704 fine ozs of gold. This was the only time gold production was mentioned. It was estimated the gross value of the final output would be £25 056, which after finalising working costs was expected to yield a net profit of £12 081.[25] The treatment of the final stocks of by-products, concentrates and flue dust was completed by the end of September, following which the brickwork and crucible of the furnace was demolished. The metal bearing materials of the circular furnace where then smelted in the 3ft circular furnace which was then broken up and the lead-saturated brick was sent to the Witwatersrand Co-operative Smelting Works for treatment. The board recommended that the TSBM Company be voluntarily liquidated and by October of 1926 the whole of the mine's plant was offered for sale along with the substantial holdings of freehold land.[26] The 6th AGM was scheduled for December 1925, but no report of its proceedings has been found.

In July 1926 it was announced that all underground operations were shut down in May 1925 and after final concentration and smelting, the 'beneficiation plant was closed down on 4th August'.[27] After the clean-up operations, the property was put into the hands of a caretaker and the final closing of the entire TSBM mine was on 10th October 1925.[28] An Extraordinary General Meeting was held in November 1926, but the statements were ones of despair. The company announced that in trying to save the plant they had offered it as a custom smelter. However, nothing came of this idea and it was stated that the cash, less current liabilities of

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24 'Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (14 February 1925), p. 629.

25 'Transvaal Silver & Base Metals Ltd – quarterly report', *The SA Mining & Engineering Journal,* (14 November 1925), p. 309.

26 'Transvaal Silver', *The SA Mining & Engineering Journal,* (16 October 1926), p. cover.

27 Gold Fields of SA file ARG 820/1/2 LEA-ZIN de JAGER. 'A report on the structure and possible remaining economic potential of the main vein.' 20 April 1989.

28 'Transvaal Silver & Base Metals Ltd', *The SA Mining & Engineering Journal,* (14 July 1926), p. 475.

the company, was £144 000 and that despite some offers having been received for the plant - all of which had been rejected - a satisfactory offer had been made by the parent company General Mining to purchase the whole of the plant for £14 000. This was accepted, making the entire assets of the company - after any liabilities - worth £159 000. This resulted, after liquidation, in the company being in the position to pay a first and final dividend of 10s 6d per share.[29] It was announced that the final liquidation of the TSBM Company would take place on 20 December 1926.[30]

This brought the second and final stage of mining development and processing of silver rich lead ores at the mine to a close. There was further interest in the mine in the 1940s and again by a consortium of Gold Fields, General Mining and Anglo American in the 1950s and 1970s. No mining actually took place during these time periods and there were no beneficiation plants at the mine, therefore they do not form part of this thesis.

7.3 Production outputs in tons of ore milled and production of bullion

Table 7 is a compilation of figures taken from the Mine Manager's reports over a four year period. The numbers, shown in black, are from the original documents (Mine Manager's reports) in the Gold Fields files. There was also an insert on the original table which is reproduced below.[31] The other sources of data were the reports in the *SA Mining and Engineering Journal* and their figures have been extracted and are shown in red in Table 7.

STATISTICS COMPILED FROM ANNUAL REPORTS OF PRODUCTION

TONS MILLED:		PROFIT		
1922	34 366 TONS	1922	£17 920-15-10	
1923	62 795 "	1923	£55 090-18-9	
1924	55 417 "	1924	£93 263-11-2	estimated
1925	34 232 "	1925	£61 355-1-0	estimated
Total	**186 810 Tons**		**£227 630-5-11**	

29 'Transvaal Silver & Base Metals Ltd', *The SA Mining & Engineering Journal,* (27 November 1926), p. 341.

30 'Transvaal Silver & Base Metals Ltd', *The SA Mining & Engineering Journal,* (18 December 1926), p. cover.

31 Gold Fields of SA file ARG 820/1/2 LEA-ZIN de JAGER. 'A report on the structure and possible remaining economic potential of the main vein.' 20 April 1989.

Table 7. Statistics compiled from Mine Manager's monthly reports of production. SAMEJ reported figures shown in red.

Month	Year	Primary Source of ore (tons)					Waste rock %	Tons milled	Lead %	Silver ozs	Profit		Price		Amount of bullion produced tons	Calculated amount silver produced ozs	sales value	Stated gross annual profit	Stated net annual profit
		No 1 mine	No 2 min e	No 3 Mine	Surface dumps	Total tons					Total £	per ton milled (shillings)	lead/ton	Silver /fine oz. pence					
last 1/4	1920				xx	92			60	74							£1 800		
NOVEMBER	1921														no output given				
DECEMBER	"																		
JANUARY	1922														91		£3 600	£17 295	£14 486
FEBRUARY	"														191	19 673			
MARCH	"														no output given				
APRIL	"							3 403	11.6	10.3									
MAY	"							3 698	10.6	9.4									
JUNE	"							4 765	9.8	8.79									
JULY	"							5 100	8.3	7.3					321.3	31 064	£12 840		
AUGUST	"							5 833	9.2	8.6					402.32	39 972	£15 657		
SEPTEMBER	"							5 385	8.6	8					461.02	44 731	£18 120		
OCTOBER	"							6 182	8.8	8.1					430.297	41 726	£16 760		
NOVEMBER	"							5 093	8.4	7.9	4 365				426.134	42 859	£16 500		
DECEMBER	"							4 871	8.71	8.16	6 758				no output given				
JANUARY	1923	6 403			330	6 733	?	5 691	9	8.6	6 583		£27-10-0	34	475.961	45 764	£19 143		
FEBRUARY	"	5 499		401	320	6 170	?	5 182	9.3	8.7	5 689		£28-7-6	32	no output given				
MARCH	"	4 945		883	323	6 151	?	5 225	8.9	8.2	6 123	23.44	£27-10-0	34	441	44 334	£17 984		
APRIL	"	4 889		854	326	6 069	?	5 338	8.4	7.8	4 459	16.7	£25-10-0	33					
MAY	"	5 637		863	191	6 691	19	5 210	7.9	7.2	3 309	12.7	£25-0-0	34	no output given				
JUNE	"	5 551		660	27	6 628	15	5 067	8.2	7.3	1 227	4.84	£23-15-0	33				£55 090	£51 230
JULY	"	5 676		629		6 305	14	5 181	7.9	7.5	3 682	14.21	£23-15-0	33					
AUGUST	"	6 266		649		6 915	12	5 777	8	7.6	4 054	14.03	£24-0-0	33	1 192	132 732			
SEPTEMBER	"	5 023		908		5 931	15	4 932	7.9	7.2	4 755	19.28	£25-0-0	33					
OCTOBER	"	5 240		1 004		6 244	13	5 228	7.4	6.8	5 328	20.38	£26-10-0	33					
NOVEMBER	"	5 077		1 000		6 077	14	5 078	7.5	7	3 679	14.49	£27-10-0	33					
DECEMBER	"	4 863		955		5 818	16	4 666	7.4	7	4 381	18.78	£29-0-0	34					
JANUARY	1924	5 576		1 039		5 615	17	5 284	6.8	6.4	3 551	13.44	£30-0-0	34	4 859	503 943	£204 969	£92 555	
FEBRUARY	"	5 371		912		6 283	17	5 004	7.5	7.2	2 563	10.25	£32-0-0	34					
MARCH	"	5 320		979		6 307	16	5 112	7.2	6.9	4 601	18	£34-0-0	34					
APRIL	"	4 268		1 170		5 438	17	4 282	7.3	7	1 650	7.7	£30-0-0	34					
MAY	"	4 625		1 170		5 795	16	4 818	7.2	6.8	4 000	16.6	£27-10-0	36					
JUNE	"	4 317		881	48	5 246	17	4 199	7.8	7.5	7 992	38.06	£30-0-0	36					
JULY	"																		
AUGUST	"	4 314		734	19	5 067	10	4 264	10.8	11.3	12 485	58.56	£31-10-0	36					
SEPTEMBER	"	4 956		15		4 971	10	4 184	12.6	13.1	13 614	65.07	£32-15-0	37½					
OCTOBER	"	3 989		184	410	4 583	12	3 768	8.3	8.2	15 558	82.56	£35-10-0	38					
NOVEMBER	"	4 358			1,053	5 411	13	4 409	6.7	6.2	10 637	48.25	£37-10-0	36					
DECEMBER	"	4 382			610	4 992	10	4 198	6.7	6.5	13 965	66.53	£40-0-0	35					
JANUARY	1925																		
FEBRUARY	"	2 413					10	4 273			2 597	12.16	£37-0-0	34					
MARCH	"							4 534			1 366	6.02	34-10-0	34					
APRIL	"	916			60	976		2 586			2 335	11.45	£32-10-0	33	no output given				
MAY	"										1 133	4.5	£32-10-0	33					
JUNE	"																		
JULY	"					218			10.4	5.6	3 460	58.49	£34-0-0	34					
AUGUST	"										5 521		£36-10-0	34					
SEPTEMBER	"																		
OCTOBER	"										65		£38-0-0	35					

7.4 A look at the capital costs of TSBM mine

The Transvaal Silver and Base Metals (TSBM) Company was registered towards the end of 1919, and launched on the Stock Exchange in December 1919 with a nominal capital of £70 000 under the auspices of the mining house General Mining.[32] The chairman of TSBM, Sir George Albu, and many of the directors were the same as the senior management of General Mining.[33] It was never stated in the press that General Mining had been prospecting the farm Dwarsfontein before the launch of TSBM, however, in earlier research 'a small operator' named *Dwarsfontein Galena* was shown to have started to work in the area in 1919 (Reeks 2012). Further attempts to find details on this 'company' have not produced any results, but as it appears that their work was related to the launch of TSBM, one can only assume that they were part of the General Mining Company (Reeks 2012). At a meeting of the company in April 1920 the acting chairman, Arthur French, stated the level of surface exploration of the company's various holdings was well advanced as "this work was already in progress prior to the flotation of TSBM", this statement by French tends to support the suggested link with *Dwarsfontein Galena.*[34]

The initial base levels of profitability for the new company were set in 1919 at £15 per ton for lead and 3s per ounce for silver.[35] The launch of the TSBM company was at a time when silver was at a price of 5s 8d per ounce and lead had risen to £34 per ton.[36] Eight days later the two metals had risen to £37 12s 6d per ton for lead and 6s 2d for silver.[37]

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32 'Abridged prospectus of the TSBM', *SA Mining & Engineering Journal,* (6 December 1919).

33 'Important silver and base metal flotation', *The SA Mining & Engineering Journal,* (29 November 1919), p. 250.

34 'The outlook for Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (24 April 1920) p.190.

35 'Transvaal Silver', *The SA Mining & Engineering Journal,* (5 February 1921), p. 604.

36 'Important silver and base metal flotation', *The SA Mining & Engineering Journal,* (29 November 1919), p. 250.

37 'Abridged prospectus of the TSBM', *SA Mining & Engineering Journal,* (6 December 1919).

It was most probably a mere pipe dream that in 1919 they were talking of not only producing fine lead, but also de-silvering the bullion to produce metallic silver as well, a development that the company never ultimately followed.[38] By the end of February 1920 the prices of the two metals had reached new elevated levels with lead reaching £50 per ton and silver 84.75d per ounce.[39]

From the records it appears that virtually the whole of 1920 was spent prospecting the surface of the various farm options it had secured along with de-watering and re-equipping the shafts of some of the old silver mines. As part of the operation they re-sampled the old dumps at the old TSM property - 'Main mine' - and the results indicated that the gross value of the dumps was calculated to be about £108 000. The greatest portion of this value was made up of approximately 30 000 tons of jig residues from the 1894 concentration plant, the assay value was 3.25% lead and 5.7 ounces silver per ton and it was valued at £77 000.[40] A comment was made that "these residues will be capable of treatment by oil flotation when the permanent plant is erected." [41] This implies that the residues were crushed fine enough for flotation, which for fines from 1895, is doubtful, or that the requirements for flotation were not fully understood at the time. It is possible that the first condition was recognised, because the quotation from the 1st AGM and quoted in Chapter 5 (5.3) mentions a second Hardinge Ball mill and Dorr classifier to treat the jig residues of the TSM.[42]

7.5 How effective was the beneficiation process in the 1920s?

How does one measure or rate effectiveness of a process? From an engineer's perspective it is based on the efficiency of the design capacity. This can be measured against what the designer of the plant, in this case Dr Edward Heberlein, predicted would be the maximum

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38 'Important silver and base metal flotation', *The SA Mining & Engineering Journal,* (29 November 1919), p. 250.

39 'Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (21 February 1920), p. 551.

40 'Progress of the Transvaal Silver & Base Metals', *The SA Mining & Engineering Journal,* (30 October 1920), p. 187.

41 Ibid.

42 'Report of 1st AGM of TSBM Ltd', *The SA Mining & Engineering Journal,* (1 January 1921), p. 463-465.

capacity of each of the major beneficiation processes. Secondly were there operational problems with the machinery – excessive downtime, maintenance, parts replacements or did they run smoothly and were they easy to operate? From the metallurgist's point of view it is based on effectiveness of beneficiation of the ores. Ore in and bullion out equals a productivity value that can be measured and over time compared with other periods. At the same time the value of the concentrates in terms of silver content in the lead, can determine what the smelter should be able to produce from the concentrates. Thus if the concentrates are running at values of 60% lead and 60 ozs silver per ton of concentrates and the smelter only produces 30% lead bullion, then the smelting process is clearly at fault for the deficiency and that process is controlled by the smelter.

I think it is fair to say that the beneficiation plant installed in 1920-21 provided the company with outstanding productivity for the time. What cannot be explained in the original Manager's table is the lack of figures for 1922. The total tonnages of ore raised are missing and therefore the monthly throughput of the crusher operation has to be based on 1923 and 1924 figures only. However, the average value per month for the two years amounts to 5,912 short tons, which meant that the crushing operation was running at about 79% of design capacity over the two years. The throughput was based on a crushing and sorting operation design output of 7,500 short tons per month (Clayden 1922).

The concentration plant was designed to run with a capacity of 6,000 short tons per month (Clayden 1922) and the average milled tonnage over the three years from April 1922 – April 1925 was 4,796 short tons. This gives an operational average throughput of 80% of design capacity, which considering the extent of the new technologies such as the conical ball mill, flotation plant, and the new types of classification is an outstanding level of efficiency in such a new plant.[43] Especially when one considers that this level includes any downtime due to maintenance, or problems on the new machinery.

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[43] Again this statement is based on my past experience as an Engineering Project Manager in the installation and commissioning of high technology production plants, where in most production industries utilising such equipment a nominal design efficiency value of 70% is placed on a production plant as a benchmark. This takes into account downtime due to maintenance, breakdowns and operator training/efficiency.

The final process of roasting and smelting was designed to have a capacity of 500 tons output of bullion per month (Clayden 1922:21). Unfortunately the lack of monthly bullion production figures has created analysis problems, for example the year 1924 is given as one consolidated value for the year at 4 859 tons. In order to try and get some degree of monthly average, such figures have been divided by the number of months that they represent, thus 4 859 tons is over 11 months and equals 441.7 tons per month. The first production of 91 tons was not included as it was a commissioning run. Thus the total recorded amounts are based on the 22 recorded values in the column 'Amount of bullion produced' and total 9 291 tons. This produces an average of 418.18 tons per month giving an operational average output percentage of design capacity of smelted bullion at 83.6%.

The tabulated values of tons milled and the percentages of metallic content in the ore are perhaps the most telling in the life of the mine, as they reflect the trends in the main period of operation of the mine and these trends are reflected in the graphs in section 7.5. It is known that the TSBM properties were being prospected and developed underground in 1920-1921 at three sites, 'main mine' or no 1 shaft and the no 2 shaft on the farm Dwarsfontein and the Brakfontein mine or 'no 3 mine' on the farm Brakfontein. During this time ore was dumped on surface, but not treated other than some hand high-grading of the ore. By 1922 the beneficiation plant was completed and ready for full operation. This is clearly reflected in output figures for 'tons milled' and the values are indicated in Table 7.

7.6 Graphs of milled ore outputs and values of metals in the ore

The two graphs (Figures 71 & 72) were created to see if there was any possible relationship between tons milled and assay values of the ore. The results are, I believe, inconclusive. The only impression with the tons of ore milled is that there were a few peaks. Namely Oct 1922; Jan 1923; Aug 1923; Jan 1924 and May 1924. It was thought there may have been a link with the assay values falling below an ideal level or 'mill grade' and thus a need to mine more ore or richer pockets of ore to bring the values up for the month. The results are inconclusive. As can be seen in Oct 1922 and Jan 1923 the values rose marginally, but in Aug 1923 the value of lead had been flat since May, although there was a slight rise in silver. In Jan 1924 there was an increase in tonnage milled, but a significant drop in the values of

both metals, followed by a return in Feb – May 1924. Then in Sep 1924 despite very high peak values for lead and silver the amount of ore milled was fairly flat at around 4 000 tons.

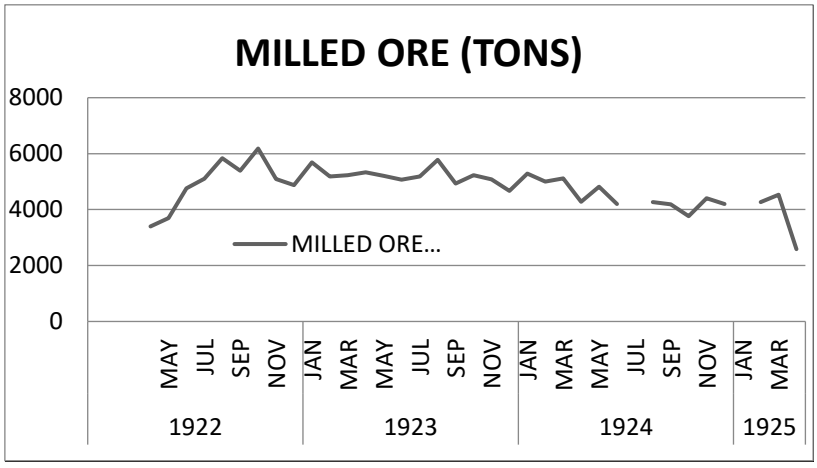


Figure 71. Graph showing milled ore at the TSBM mine, 1922 – 1925

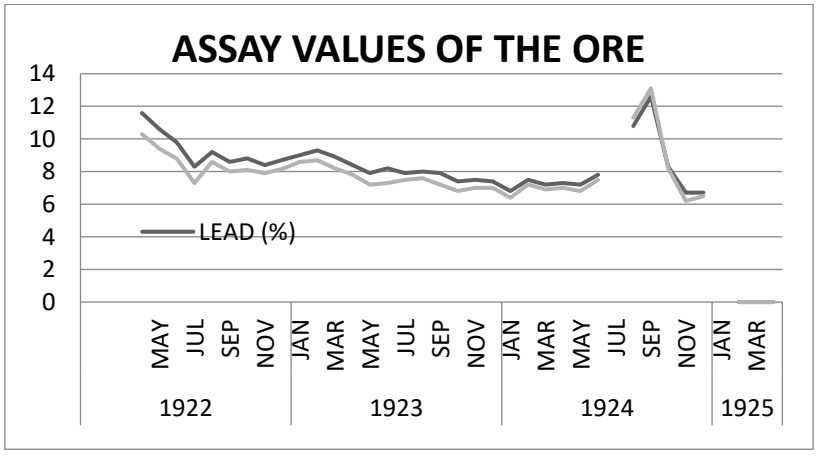


Figure 72. Graph showing assay values of lead and silver at the TSBM mine 1922-1925

Table 8. Comparison of SAMEJ and PH Allport's 1940 report on the outputs of lead and silver.

YEAR	SAMEJ outputs (Table 7)		Allport outputs	
	Lead (tons)	**Silver (ozs)**	**Lead (tons)**	**Silver (ozs)**
1919	no detail	no detail	188	20 049
1920	"	"	66	15 487
1921	"	"	92	9 266
1922	"	220 025	4 425	379 041
1923	"	222 830	5 277	485 848
1924	"	503 943	4 773	463 096
1925	"	---	1 362	227 216
Totals		**946 798**	**16 183 tons**	**1 600 883 = 44.67 tons**

Source for data (Allport 1940).

7.7 Conclusion

The analysis of mining outputs and profitability of the operation clearly showed that the processes installed at TSBM were very effective in terms of designed output. Not only did they produce a finished product – bullion – but it was done profitably. The mine milled 186 810 tons of ore according to the Mine manager's report. However, this is incomplete as it does not reflect the missing amounts of ore that were produced or recovered from old dumps of the TSM mine or from prospecting activities undertaken from 1919 through to March 1922. There are records reflected above that show 'high graded' ore and concentrates were produced prior to smelting and this would have required ore recovery, even if technically it had not been raised from the operations underground, it did produce an output of silver/lead which was recorded in Allport (1940). Unfortunately, the actual outputs of bullion or of the two metals, is - as can be seen from (Table 7) is far from complete.

The source, written by Allport, gave far more detail, most probably gained from the records of General Mining in 1940 when it was written. I believe that Allport's figures are most likely more accurate than utilising the ones from the *SA Mining & Engineering Journal*, as there are significant gaps in the SAMEJ reports. As Allport's sources are un-named, I have to take them at face value. A table showing both sets of values is shown in Table 8. Both the

figures in Table 7 and the reports in the SAMEJ, especially the AGM of 1924, reflect a gloomy picture for the mine. The ore-body was clearly pinching out at depth and the vein in the upper level had been fully exploited by 1924. The result was a cycle of reduced ore raised and thus reduced beneficiation in 1925. The figures in Table 7 show this very clearly.

Technologically, the mine can be described as a success, and a leader in its day, in the mining and beneficiation of base bi-metallic deposits in South Africa. It produced just over 18 000 tons of lead, 45 tons of silver 177 tons of copper and 704 ounces of fine gold. Financially, the TSBM mine, despite having a shorter life, than had been predicted in 1919 and unlike its predecessor of the 1890s - the Transvaal Silver Mine - was not a financial disaster. The TSBM mine ended its life with a liquidity of £150 000 which was distributed to the shareholders at half a guinea (ten shilling and six pence) per share.[44] [45]

Finally Sir George Albu, at the launching of the mine at a less than optimal time, wanted to do it as a way to uplift the country and its people. Was he successful? I think all of those who got to work at the mine equipped with the latest technology and were part of a well-run mine would have felt that – yes the mine had been a success.[46]

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[44] 'Transvaal Silver & Base Metals Ltd', *The SA Mining & Engineering Journal,* (27 November 1926), p. 341.

[45] 'Transvaal Silver & Base Metals Ltd', *The SA Mining & Engineering Journal,* (18 December 1926), p. 2.

[46] 'Report of 1st AGM of TSBM Ltd', *The SA Mining & Engineering Journal,* (1 January 1921), p. 463-465.

Chapter 8

The Black Mineworkers of the 1890s and 1920s

8.1 Introduction

This chapter is designed to provide a link between the industrial archaeology features discussed in the previous chapters and the social or historical archaeological features resulting from the physical excavations of areas of the silver mine. This is done by looking at the black mine workers of the 1890s TSM and 1920s TSBM mines, whilst referring to documented conditions at the diamond and gold mines in the same periods. One of the aims of this chapter is to try and go back to both time periods, and describe the life of the miners - unfortunately some of the results do not make for pleasant reading.

8.2 Focal Points on the blacks mine workers of Argent

The living conditions of the black mine workers on the mine was investigated through historical records and archaeological excavations. There are a multitude of sources, for example Callinicos (1981); Moroney (1982); Earles (1988); Breckenridge (1990); Allen (1992); Crush (1994) Nkosi (2011) Weiss (2011a; 2011b) that refer to living conditions and recruitment on the gold and diamond mines and these have been used in developing the text of this chapter.

The origins of the compounds, where the miners lived and how the compound system developed are discussed. The term ‘native location’, which was used at TSBM, and what it meant for social structures, forms part of this chapter. The living facilities for the black mineworkers at the Argent mine in the 1890s and for the 1920s is mentioned in company records, however the records only discuss the number of accommodation structures and not the conditions inside them. The records from the mine provide very little detail of the black miners in either time period, other than approximate numbers employed at certain times and in fact more details are available for the 1890s period than for the 1920s.

With the detailed evidence of the mine and beneficiation operation, was it possible to convert the numbers into three dimensional people, in other words what jobs were they doing? What were the pay scales? Could the job descriptions and numbers be used as a link between the industrial archaeology and the social archaeology of the compound excavations? A question associated with the investigation into social structures was whether the company or national records show any evidence of industrial disputes or strikes at the Argent silver mines?

With the on-going field excavations in 2016-17 and the finding of a number of apparent female items in the middens, it is postulated that females may have been present on the mine property. If so, could they have been employed as domestic workers in the married quarters of the white mine officials' (management) houses? From the excavations, details emerged of possible foods eaten and utensils used and some of these results were also compared with the company records.

In attempting to gather data on how the black mineworkers were recruited I approached the Chamber of Mines library to ascertain if I could access their records of recruitment and wages paid. I was informed by Mr Luke Ngubane, of the technical library, that such records were not available to researchers. Sadly, this mirrors the research period of (Allen 1992), and the problems that he encountered in trying to research various aspects of the black mineworkers for his book *The History of Black Mineworkers in South Africa,* (Allen 1992:18-24). He was blocked both by the Chamber of Mines and certain mining companies from gaining information from their historical sources. I have therefore had to rely on secondary sources for such details. Considering that the records that I was interested in, date from one hundred to one hundred and thirty years ago, I found the rejection by the Chamber unhelpful, as they hold such records in the form of annual reports.

The recruitment techniques employed in the mining industries and the majority of job descriptions, coupled with the wage levels paid to the employees was set by the Chamber of Mines for those mining companies that were in fact members of the Chamber. I have had to rely on two books (Allen 1992 and Nkosi 2011) for the data. As both the H. Eckstein & Company, later the Corner House Group and General Mining were members of the Chamber of Mines, it is safe to assume that they abided by the conditions of work and pay set by the Chamber in the 1920s, and its predecessor in the 1890s.

Details were also revealed that the Transvaal Silver & Base Metals Mine Ltd was admitted to membership of the Witwatersrand Native Labour Association (WNLA) in 1920.[1] This organisation was part of the Chamber of Mines and acted as the black miner recruitment agency and it was the successor to a similar organisation of the 1890s called the Rand Native Labour Association[2] (Fraser & Jeeves 1977:90; Lang 1986; Allen 1992:154). One of the senior partners in the Eckstein Company – Lionel Phillips – was involved from 1890, trying to get the Chamber of Mines to create a body whose role was to recruit labour, coordinate payment scales among the member mining companies and settle labour disputes on the mines.

8.3 The differences between a compound and a native location

8.3.1 The background to the compound system

The mine compound system started in Kimberley on the various diamond mines. These origins have been well covered by authors such as (McNish 1970; Worger 1987; Weiss 2009). Some of the black workers on the early diamond-mines were tempted to steal the diamonds when they found them. This was both to rob the white miners and to also gain money through the Illicit Diamond Buying (IDB) trade by selling the stones to buyers in the town (McNish 1968:163-166; Worger 1987:134). Drunkenness and desertion among the black mineworkers was also problematic for the mine owners.

In 1885, confined housing consisting of a rectangular or square building was constructed as a solution to the drunkenness, diamond theft and desertion of the black mine workers at Kimberley. It was designed to have no openings on outside walls and all the doors to the rooms faced inwards to an open courtyard and access to the outside world, was removed

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1 NASA. Depot TAB. Source GNLB. Type LEER. Volume no 226. System 01. Reference 494/15. *Conditions of employment of Natives on mines outside labour districts: Transvaal Silver and Base Metals Limited, Dwarsfontein, Pretoria district.* Letter dated 23rd November 1920. From WNLA advising Department of Native Affairs that the TSBM company had been admitted to membership of WNLA.

2 Although this organisation was only created in 1897 and was independent of the Chamber, it had a predecessor in the Chamber of Mines when in 1890 they established the Native Labour Department (Lang 1986:81).

(McNish 1970:33; Maylem 1990). At the diamond mines, the mineworkers went to work through a tunnel system directly to the shaft and underground. In short, for the period of time that they worked for the mining company, they were effectively 'prisoners' in the so called *closed compounds* (Moroney 1978; Worger 1987:139). Crush describes the compound as a means of labour control and coercion; of complete control over the lives of the black mine workers Crush (1994).

As the majority of the leaders of the gold mining industry came from a diamond industry background, it was natural for them to think of housing their gold mining black workers in similar structures. The major difference for the new industry was that gold in its raw state was not as easy to steal as diamonds. Therefore when the compounds for the gold miners were constructed, the general trend was to build them as *open compounds* or a structure with an entrance, such that the mine workers could leave the compound to visit the outside world provided that they were given a pass by the compound manager. Moroney (1978) cites a very interesting statement made during the Mining Industry Commission hearing in 1907, and it is relevant to repeat it here:

> Mr H.M. Taberer, at the time an inspector for the Department of Native Affairs, admitted in 1907 that the compound manager, with his force of "police" was the de facto ruler over the workers' lives, having complete control over their freedom of movement through the pass system.[3]

Of course, in reality the ability of the black mineworkers to leave the compound system of the Witwatersrand was at the behest of the Compound Manager. This ubiquitous system of management control over a labour force ultimately led to resistance to working conditions.

With the fall of the Kruger government in 1901, a revision of many of the gold mine compounds and working conditions of the black mineworkers took place under the Milner administration. The mines of Johannesburg during and after the Anglo-Boer War were such that there was a severe labour shortage with many of the potential black mineworkers being

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[3] The quote originated from Transvaal Colony Mining Industry Commission – minutes of evidence: NASA, Pretoria. Depot TAB, Source LA. Type LEER. Volume no 9, Ref. 17/08 part 1 – Report of the Mining Industry Commission – minutes of evidence with appendices and index parts 1-4. 1907-1908.

employed by the British military. After the war the shortage of labour continued, due of the cuts to wages, which in turn led to absenteeism and desertion of those who did work on the mines (Maylem 1990). In order to combat this, mine managements began to convert the 'open compounds' of the gold mines to 'closed compounds' which became places of oppression and management control. These points have been covered by (Moroney 1978; Allen 1992; Crush 1994).

According to Allen (1992:252) the mine owners wanted the gold mines to have closed compounds. However, this was one of those cases where motives are often hidden behind other arguments. The mines saw the closed compounds as a means of stopping desertion, reducing gold theft and doing away with the possibility of the illegal liquor trade. Although these may have been valid reasons for the mine managements, there was also the threat to loss of sales from their black mineworkers at the company's stores. Sales of extra food and drink returned to the company an average of 40% of the workers monthly wages, which in the case of the black mineworkers in 1907 could amount to £1 each per month (Allen 1992:252).

Opposition to this form of internal trade came from the outside traders, storekeepers who had developed their businesses on the back of trade with black and white mineworkers (Allen 1992:252). Following the Native Grievances Inquiry of 1913, the concept of closed compounds on the gold mines was finally removed. This covered not only the gold mines, but also the coal mines and by 1919 would have included the TSBM mine.

The concept of the company store was in fact a type of oppressive debt bondage or social economic blackmail, but it was not unique to South Africa. It had been a mechanism of enforcement of a company's control over its workforce in both the various mines and mills of the USA and it is remembered in the 1930/40s song from the USA 'Sixteen Tons', about life as a miner in a coal mining town owned and controlled by a company store.[4]

In the UK, copper and tin mines of South West England and the cotton and woollen mills of Lancashire and Yorkshire the practice of 'company ownership' was also prevalent. In

[4] (https://www.songfacts.com/lyrics/tennessee-ernie-ford/sixteen-tons), (accessed on 14 March 2018).

essence, the ‘company’ provided employment, housing, shops, and in some cases schools, and medical facilities, for their employees, but such facilities tied these employees to the company. Thompson’s (1966) classic work on the English Working Class and Alfrey & Clark’s (1993) work on the development of the Ironbridge George industrial centre in England in the late 18th and 19th centuries provide clear evidence of how the upper middle class entrepreneurs often saw themselves as natural leaders to whom the lower working classes should be grateful to for providing better working conditions than the more common oppressive factory.

The concept of a company in South Africa being a ‘paternalistic entity’, where the self-made men of the diamond and gold mines became the entrepreneurs, is not fully comparable with the UK, where many of the entrepreneurs such as Cadbury, Darby and Wedgewood were followers of Quaker or Non-conformist Christian beliefs (Cossons 1973:43). If one looks closely at most of the South African mining giants of the 1890s, far from being paternalistic, they were autocratic. They treated their white workers as necessary evils to make them money and the black workers as a labour force whose social conditions and wages counted for nought.

The isolated geographical location of the TSBM mine would have discouraged the miners from deserting, as the nearest settlement was Delmas – 15 km south west of Argent or the town of Springs 50 km to the south-west – both places being relatively new in 1920. Desertion was a possibility among the black workers, but no records of such events occurring at the mine have been found. The construction of the compound at the TSM mine in the 1890s appears to have been a series of structures rather than a single building, in effect an ‘open compound’. It is not clear from the sources if the 1890s compound buildings were still in existence in 1919/20. It is assumed that they were not, because when the 1920 mine plan was recently re-evaluated, the area where the 1890s compound buildings stood, was shown as not having any structures. During the satellite survey of the mine and the 1890s ‘compound’ area, remains of disturbed foundations of dressed stone - coupled with the remains of an extended, but low, midden - were found in the approximate area of the ‘compound,’ shown on the 1890s plan. The midden covered an area of about 10 m x 3 m, but was only about 5-10 cm thick. More details on the archaeology of this feature are given in Chapter 10.

It is unclear if there was a black male compound in the 1920s. There is an area to the south of the general mine buildings marked ‘compound’ on the 1920s mine plan. The plan does not show any structures that tie in to the description of compound buildings given in Chapter 6 and it appears to be a strange place to locate it, because it is relatively close to the white married quarters – not something that was generally done in this time period**.** During a pedestrian survey of the area marked ‘compound’ on the 1920s plan, no remains were found.

The 1920s plan (Figure 73) clearly shows the area marked ‘native location’ and on reading Moroney (1982) and Eales (1988) the concept of a single quarters for men only was defined as a compound. After 1903, when the mines began to re-commence working on a large scale, apart from the resumption of migrant workers returning to find employment, there was also the start of a migration of young women who were attracted to a life in the Johannesburg area. There are many social studies that have been carried out on this migration with van Onselen’s (1982) classic studies being some of the most important. The migration created two primary requirements for survival of these women. They had a need for housing of some sort and to find sources of income to support themselves. Women were not allowed by the mine companies to occupy mine land and so the concept of informal shelters close to, but not on, mine property developed (Moroney 1982:260; Eales 1988).

From around 1902 the development of these informal shacks or huts, on the edges of mine property, began to house families of ‘wives’ and children of the black miners. Moroney (1982) outlines how the mine managements began to see such areas of ‘family’ housing as sources of a happier workforce that was prepared to stay in employment (Allen 1992:252). The mines allowed married workers to leave the compounds to live in such informal native locations, provided they could prove marriage. How this was done in the early 1900s seems unclear and was probably based on a loose swearing of marriage to the compound manager (Eales 1988:7).

As many researchers such as Moroney (1982); van Onselen (1982); Earles (1988) and Allen (1992) have stated, these ‘informal settlements’ became sources of illegal liquor brewed by the women. Prostitution was also a serious problem. However, the trend of married black workers bringing families with them to the mine had begun and from it the eventual development of the black townships on mine property. The informal native locations were

initially outside of mine managerial control and so the associated problems of vice as mentioned, coupled with these locations becoming ‘homes’ for criminal elements became problematic not only for the mines, but also for the Milner and later Union governments (Moroney 1982:260; van Onselen 1982).

By 1906 the mines and the Responsible Government period (1907-10) and later the Union Government were concerned with these informal shack locations (Moroney 1982:263). It was felt by both mine management and government that there was a need for all types of worker accommodation to be controlled and the state began a programme of systematic removal of the informal settlements (Moroney 1982:262). In 1907 J.M. Pritchard, Chief of the Department of Native Affairs (NAD), stated that the desired policy was for all native workers to be resident on the property of their employers or in a licensed location (Moroney 1982:262). The problem for many mines in 1907 was that they had little financial incentive to rehouse their employees and informal settlements provided sources of labour, at little or no cost to the mines. In 1908 a meeting was held between the Chamber of Mines, South African Police Service and representatives of the Government’s Native Labour Bureau. A decision was taken to abolish all informal settlements on or close to mines. This became enforced policy through regulations drafted in terms of the 1908 Gold Law and Townships Act. It took a number of years to follow through with the removal of the informal settlements and the creation of so called ‘married quarters’ where black women could live as ‘wives’ on mine property.

The shacks began to be demolished in order to remove the criminal elements, but within a few years many of the mining companies had established their own regulated married quarters on mine properties (Moroney 1982:263). Problems arose between the compound workers and the married quarters workers. In theory, the former were not allowed in the married quarter areas, but the attraction of alcohol and woman became the spark and there were many incidents of violence from 1910 and 1914, when the mines - to counter the problems - began erecting fences around the married quarters (Moroney 1982:267).

The problem of non-compound workers was raised by mine managements at the 1913 Native Grievances Inquiry, and the companies again raised their objections to mixed gender locations outside of the single gender compounds (Allen 1992:253). It appears that the mines

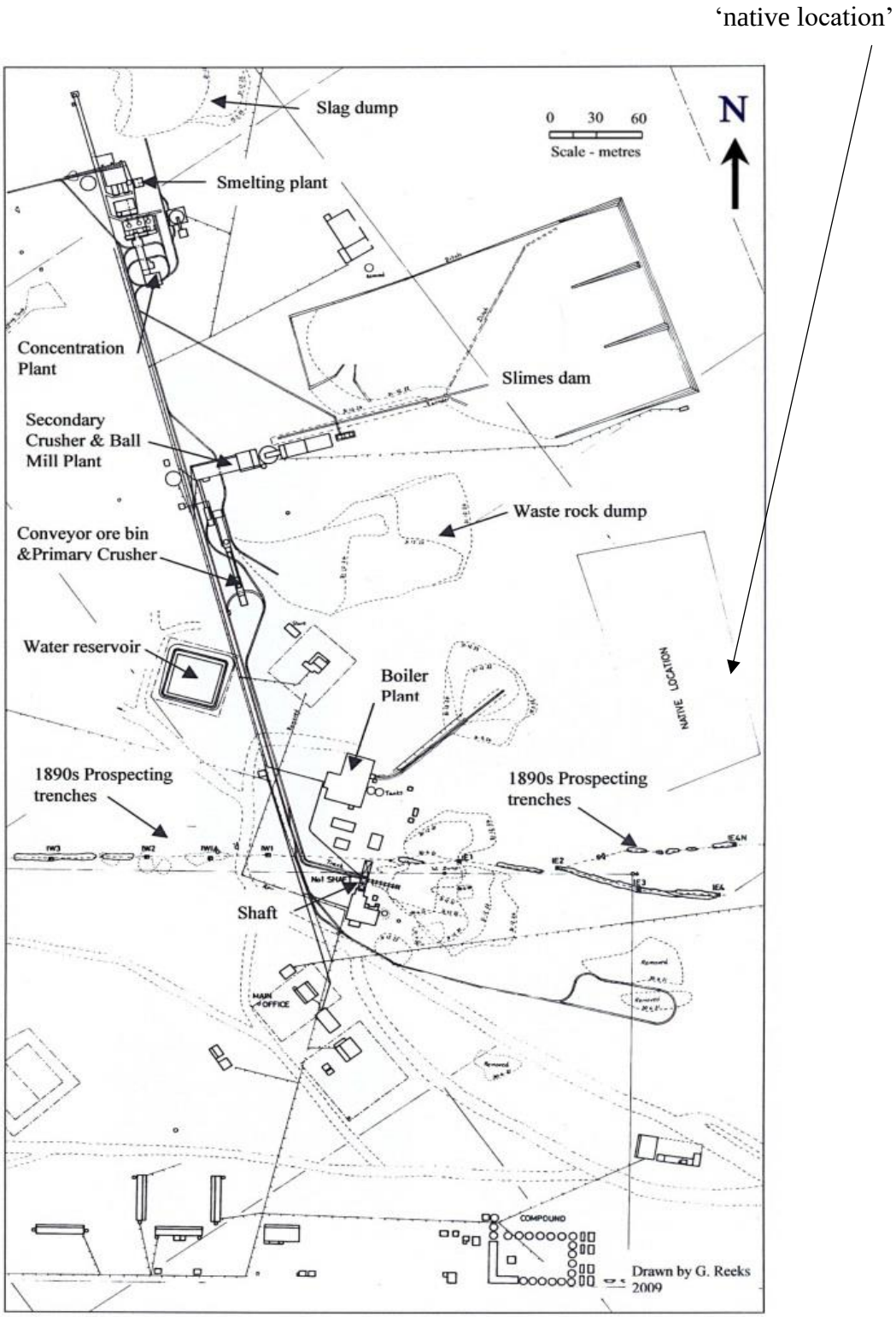


Figure 73. Part of the 1920s surface plan of the TSBM mine plan (Drawn G. Reeks).

It shows the 'native location' and an area marked compound at the southern boundary of the plan. As is explained in the text the plan of the compound does not relate well with the descriptions of the buildings in the TSBM reports. It is believed that this was possibly proposed and laid out on the plan, but never constructed, as no remains of foundations were found in the area shown.

During research into black mineworker compounds, the paper on the Witwatersrand gold mine married quarters by Moroney (1982) discussed the terminological difference between a mine compound and mine location (Moroney 1982:260; Marks & Rathbone 1982). The mention of mine or native location brought to mind that there was such an area clearly defined as such on the 1920s Transvaal Silver and Base Metals mine plan (Figure 73). He discusses the development in post-1908 South Africa of what became known as mine or native locations - usually on mine property - where accommodation in the form of clusters of shacks or huts was built and which housed both the miners and their 'wives'.

In a paper by Landon discussing the social structures in the 1840-1850s at the Ohio Trap Rock mine in Michigan, USA,[5] he reveals how on excavation of the social areas of the Michigan mine they discovered 'female' items in what had previously been thought of as an all-male mining camp. An exciting idea and a significant question developed - were there females at the Argent mine in the 1920s, living in 'married quarters'?

The mines stated that the wives living in the locations were more often 'temporary concubines' used in the alcohol and prostitution trade (Earles 1988; Allen 1992:253). A consideration at the inquiry was the practical implications of providing a location for the married quarters and of proving a *bona fide* marriage. The Native Labour Regulations Act of 1911 had made it obligatory for all compound plans to be approved by the Department of Native Affairs (Allen 1992:253). With such laws in place the mines felt that despite the outcomes of the 1913 inquiry, the laws of the country restricted the construction of married quarters. Of course this did not stop illegal or 'blind eye' approaches to the erection of the informal shanty married quarters close to the mines and there were legal married quarters erected by some mining companies for such people as the compound police and office clerks. As far as the general mine labour force of the gold mines was concerned however, even by 1930, the percentage of mineworkers in married quarters was as low as 0.7% of 200 000 black mineworkers (Allen 1992:253).

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5 Landon, D.B. 1999. Interpreting Social Organisation at Industrial Sites: An example from the Ohio Trap Rock Mine, *Northeast Historical Archaeology*: Vol. 28 (1) Article 7.

8.3.2 Complexities behind the term ‘native location’

Why did a mine, literally ‘miles from anywhere,’ have what may have been a black miner ‘compound’ and a clearly marked ‘native location’ area? From the various sources it is possible to define them as a ‘compound’, where the male black mineworkers were housed and fed under the jurisdiction of the mine management and its compound manager. The native location, in its original mining definition, being an informal settlement close to mine property or at some stage on mine property, or a legal married quarters area for those black mineworkers who could prove marriage of some form and thus the potential for family living area on the mine property (Moroney 1982; Allen 1992).

Unfortunately, no TSBM records have been found providing evidence of the company’s approach to native location areas. As the area in question is clearly defined on the 1920 mine plan and it is relatively close to the mining beneficiation plant and waste dumps it is concluded that it was a legal location. The general layout, as shown on the aerial photograph of the foundation structures and potential middens (Figure 74), also lends credence to the idea that it was a planned area. The foundation materials vary from dressed stone to brick to just rocks. A number of water pipe outlets have also been found within the area, leading to the belief that there may have been some form of water reticulation system in the area.

Six rows of foundations are clearly identifiable in (Figure 74). The image has been manipulated to enhance the foundations and the colour contrast altered which resulted in areas with a turquoise colour. When these areas were compared with the pedestrian survey records, there appears to be a degree of assimilation with the known middens. The row of foundations on the extreme left have the major middens of all sizes effectively outside or west of the structures. The foundations on the extreme right show a similar pattern, but with the middens to the east. To the north, or top of the picture, two features are visible - a turquoise area, which is in the position of M8, and a large rectangular structure just north of it. The latter was investigated, but apart from a large rectangular hole approximately 1 m deep, no foundations or bricks were observed. The light area of soil in the picture may indicate disturbed soil, such as you would have around deep foundations. If it was a structure, bearing in mind that the hole is approximately 15-20 m x 10 m. it could possibly

have been the black mine workers hospital or as is proposed in 5.13, the original single quarters with the additional accommodation forming the six rows of structures.

The primary archaeological site is at the top half of the image. This image shows that the original ground based satellite survey conducted in 2014, during which 33 foundation structures and 49 middens were mapped, along with areas where nothing was located, was actually incomplete. The aerial image showing both surface and sub-surface features raises the count of potential foundations to 93 and middens to 57.



Figure 74. An aerial image of the 1920s ‘native location’ at the remains of the TSBM mine. Aerial image taken from Google Earth ™ satellite image of the region.

The spatial layout of the 1920s ‘native location’ as shown on (Figure 74) clearly shows six rows of foundation structures. What is unclear is why the lines diverge or converge as there are no rock outcrops or variations in topography were seen that could have been the primary influence. What is clear from the mine plan (Figure 73) is that even with the ‘native location’

being located on the mine property it was largely hidden by the mine dumps and mine buildings from the European officials housing and the white miner single quarters which were located to the south west of the mine shaft. Thus despite apparent relaxations on some of the 'compound norms' there was still a high degree of segregation of the black and white accommodation areas.

8.4 Recruitment of black mine-workers

The source of black labour for the TSM mine in the 1890s is unclear. The population of the area surrounding the mine would have been very sparse and it was unlikely that sufficient black males were living in the area to supply the labour requirements for the mine in 1889-1895. In the 2nd AGM report it is stated that "…the country had roughly one man to every 1 000 acres".[6]

It is assumed that the several hundred black miners employed at the time of the general manager - Otto H. Hahn - at the TSM in 1892/93 were most likely supplied via the Chamber of Mines recruitment agency or alternatively private recruiters. In a letter by Phillips in September 1890 he writes:

> The sources of supply are as follows:
> 3 486 K…… from East Coast [Mozambique]
> 864 " from Basutoland
> 588 " from Natal & Zululand
> 1 458 " from Northern Transvaal
> This shows that our chief labour supply comes from the East (Inhambane)[7] and the North.[8]

Unfortunately, no records have been found accurately detailing the source of TSM's black labour force in the 1890s. Contrary to Phillips statement, modern researchers have indicated

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6 BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM Report. April 9 1891:4.

7 Town located on the Mozambique coast around Latitude 24º south.

8 BRA. Archives of H. Eckstein & Co HE 149 – Chamber of Mines September 13 1890.

that there was a high recruitment of 'Shangaan-Tsonga' from Mozambique for the gold mines, although significant numbers of black mine workers came from the Eastern Cape and Lesotho (Callinicos 1981; Allen 1992;).

In 1890 there was a concerted effort by the Chamber of Mines to reduce the cost of labour. Phillips seems to have been one of the driving forces behind this campaign, as his letters in the file HE 149 of the Eckstein Archives attest.[9] As wages were reduced for black mine workers in August 1890, it resulted in an insufficient supply of labour (Lang 1986:80; Jones & Muller 1992).

Historical records indicate that there was a clear pattern of potential reasons for the cyclical shortage of black labour to the mines. In the period up to 1914 there were a series of downturns in the economy of South Africa that impacted on both the profitability of the mines and the supply of labour. "The most important periods of speculative inflow before 1914 occurred in 1889-1890; 1895-1896; 1899; 1902-1903 and 1909-1910" (Richardson & Van-Helten 1982; Marks & Rathbone 1982). The period between 1890 and 1895 was to see a world financial downturn (Brinkley 2004). This was followed by a similar depression in 1897, and from 1899 to 1902 the gold mines were closed due to the Anglo Boer War. Political uncertainty, both in South Africa and overseas, coupled with the beginnings of unionism and yet another economic depression in 1907, all led to a period of economic rise and fall (Fraser and Jeeves 1977:99-101).

To counter the deficit in recruitment after 1902, the mines - in conjunction with the Chamber of Mines and the Milner government - imported Chinese indentured workers at low wage costs. There was antagonism by the black mine workers towards the Chinese. This was coupled with the General Election win in the UK in 1906, bringing a Liberal Government to power that was opposed to the use of Chinese labour on the South African mines (Davenport 1987:238). By 1907 no more Chinese workers were recruited and those in South Africa were repatriated over the next two years. The appalling living conditions under which these Chinese workers lived, worked and slept in the 'closed compounds' of the gold mines is disgusting and has been well documented by (Callinicos 1981 and Allen 1992). Not, of

9 BRA. Archives of H. Eckstein & Co HE 149.

course, that the conditions for the black mineworkers, before or after, were much better. For example on the Crown Mines, the concrete sleeping coffin-like structures used by the Chinese were merely re-used by the later black mine workers up to as late as 1979 (Callinicos 1981:102 & 108). It is impossible to know the conditions of the sleeping arrangements in the 1890s compound of TSM, as no records exist.

In 1910 the workers from Mozambique accounted for over 50% of the mining industry's labour force (Nkosi 2011:226). By comparison in 1919/1920 it appears that although Mozambique was possibly still the dominant source of labour, such jobs as the black mine security personnel 'police' were dominated by 'Zulus' (Callinicos 1981:48). There are minimal records listing the black employees and their ethnic origins. The NASA[10] file contains a letter to the Nyasaland Native Congress, which has led to the inference that some of the black mine workers were recruited in what is now known as Malawi. The letter, written by the Inspector for Native Affairs, raises a number of interrelated issues involving the black mine workers, where mention is made of representations by executive members of the Nyasaland Native Congress (NNC). This is probably a reference to the Nyasaland African Congress, an organisation formed in 1907 that appears to have been both a labour organisation and an infant political party, which gained strength and by the 1950s was an independence movement. I believe that its earlier role is relevant to Argent and in the Inspector's letter reference is made to the manager having no objections to meeting NNC executives to discuss the members of the NNC employed by the TSBM.

In the NASA file, cited in section 8.2, detailing information that the TSBM was admitted to membership of the WNLA in November 1920, there was also a letter showing that another organisation was also involved recruiting black mine workers for the TSBM in the 1920s, namely C.A. Hadley – Native Labour Contractor.[11] It is interesting that Hadley's address on the letterhead is in the General Mining Buildings and so one is led to speculate that they may

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[10] NASA, Pretoria. Depot TAB, Source GNLB. Type LEER. Volume no 226, System 01. Ref. 494/154 part 1 – Conditions of employment of natives on mines outside labour districts: Transvaal Silver and Base Metals Limited, Dwarsfontein, Pretoria District. 1920-1921. - letter from Inspector for Native Affairs dated 26 October 1920.

[11] NASA, Pretoria. Depot TAB, Source GNLB. Type LEER. Volume no 226, System 01. Ref. 494/15 part 1 – Conditions of employment of natives on mines outside labour districts: Transvaal Silver and Base Metals Limited, Dwarsfontein, Pretoria District. 1920-1921.

have been part of the General Mining Company which was also the parent company of the TSBM Company in the 1920s.

The methods employed to lure workers to the gold mines were tragic and are very well described by (Callinicos 1981 and Allen 1992). Part of the reason for the Chamber of Mines to set up its own recruiting organisation, both in the 1890s and 1900s, was to overcome the alternative of using independent 'labour touts.' The touts were groups of white men, and in some cases recruiting companies, who would in effect prey on those migration routes used by the black workers trying to get to the gold fields. Towards the end of their journey, many were sick or starving and often ignorant of how to acquire work and would fall prey to all sorts of promises by the touts. Often such workers would be rounded up, travel passes would be taken, small amounts of money might be given, but with the condition, that it was paid back and they would then be escorted to the mines where they were sold – reminiscent of historical practices of slavery (Callinicos 1981:33-34).

Many of the appalling practices used by these touts in the post-1910 period to recruit workers are described by Allen (1902:160-170). Possibly, one of the most unsettling, is his description of how these touts rarely, if ever, went to the kraal areas themselves, but instead employed black runners, whose sole task was to recruit black workers from the kraals. One of the largest of these tout organisations was A. M. Mostert, employing hundreds of white agents who in turn employed hundreds of black runners (Crush 1987). A method used, was to approach a headman or chief, stating the need for 'so many black mineworkers' and then offering bribes to the chiefs to in effect 'sell' their tribesmen to these touts. Allen (1902:161) cites evidence from the Transvaal Labour Commission of 1904 in which "a recruiter offered £100 and a horse to a Tsonga chief in return for the services of 100 of his tribesmen who were required to work for 6 months." A tout's methodology was to sell these workers to the mining company that paid the most, and to often play one company of against another, thus raising the costs to the mine. The concept behind the WNLA was to out-market the touts, but it would seem from Allen's analysis that this was not always successful.

8.5 Black miner rates of pay 1897 through to 1920

Nkosi (2011) was the only source that was found providing job descriptions and pay scales from 1897. This source formed the basis for the development of the job positions at the TSBM mine. When looking into the history of the black mine workers of South Africa, a question that arises is how over the past one hundred and twenty years have they been forced to accept pay cuts or a lack of wage increases over extended periods of time? When investigating how much the black miners were paid at the TSBM mine, one is drawn to the pay scales of the gold mines. The Chamber of Mines in effect set the pay scales by which the mining companies had to adhere. The mining industry of the greater Witwatersrand area included not only gold mines, but also coal and the silver mines. The Chamber of Mines was formed approximately three years after the finding of gold on the Witwatersrand in 1886. Its stated purpose was the reduction of African wages on the mines (Allen 1992:153). What is known is that "…in the first five or six years after the discovery of gold K….. wages rose rapidly. By 1890 they had reached 63s 10d [£3 3s 10d] a month" (Allen 1992:355-356).[12]

The rates of pay were always a serious bone of contention among the black workforce, but there seemed to be little that they could do about it. If the mine management wanted cost cuts to take place, the black wages were always one area that was affected. In letters by Phillips in September 1890, one begins to understand the extent to which mine managements and the Chamber of Mines would go in order to reduce costs.[13] He argued, for a reduction in black miner wages of 33%, bringing the average monthly wage to £2 a month. The main problem Phillips had was convincing other managements to comply with the cut and although it worked for the first year, production pressures gradually grew after 1890 and labour became a supply and demand problem, with wage costs being the lever to gain employment. In 1890 the Chamber of Mines introduced a wage cut of 23% (Lang 1986:80). A group of mining companies agreed to pay a nominal monthly wage of £2 per month bringing the actual average monthly wage down "from £3 3s 4d. in August 1890 to £2 8s 10d in October 1890" (Lang 1986:80).

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12 For those not familiar with the now disused British currency of Pounds Shillings and Pence. Within £1 there are 20 shillings (s) and each shilling is made up from 12 pence (d).

13 BRA. Archives of H. Eckstein & Co HE 149 – Chamber of Mines. August 9 and September 27 1890.

Gradually, some mines or groups of mines - such as those of the Robinson group - increased wages, to be in a better position to attract potential miners. The result was that by 1893 the wage agreement to limit wages to around £2 had broken down and the average pay on mines had increased to £2 17s 6d (Lang 1986:81). By 1896, with the falling value of gold and with the mining of lower grade ores, there was a need to reduce overheads yet again, which included black mine worker wages. It was agreed to reduce wages by 25% from 1 October 1896, effectively reducing the average wage down to £2 3s. (Lang 1986:81).

There was no gold mining carried out during the early stages of the Anglo-Boer War. Once the British forces captured Johannesburg and Pretoria, they began the task of re-opening the mines, with the first one starting up again on the 4th May 1901 (Lang 1986:125). During the war the British military authorities imposed a reduction on the black mine worker's average rate of pay, which before the war had reached £2 3s a month, and it was reduced to £1 a month (Lang 1986:126). After 1902, recruitment of black labour again hit many problems, a significant factor being the adjustment of the wage structure. With the war over in 1902, the Chamber set about increasing it to £1 10s a month with the hope that it and the prospect of work would attract the mine workers back (Lang 1986:125-127: Allen 1992:356).[14] The revised rate was a dismal failure and for many years there was a very slow return to the mines by black labour. This led to some limited increases in the wages offered, but not to the pre-war levels.

In 1912 the Chamber of Mines, as the mouthpiece of the mining industry, began its control of mineworker wages and set a schedule that in effect pegged wages of black mineworkers at 2s a shift for a 30 shift month, and this schedule was introduced at every mine whose company was a member of the Chamber of Mines (Allen 1992:356). It was designed to stop mines from competing for labour and was in force from 1912 until 1941, when the average wage of 86% of black mineworkers was less than 2s 6d per shift (Allen 1992:356). Naturally the mining companies adopted a mechanism that seemed to enforce wage control as it maintained low wage costs for an industry that was dependent upon cheap labour. "The logic

[14] There are some minor differences in monetary amounts between sources and so they have been used as per the citation.

of their argument was that the cheaper that they could obtain black labour the more prosperous South African society would be*"* (Allen 1992:144).

It must be realised that low cost black labour was not the only goal of mining companies in the early twentieth century. The cost of white labour was similarly under threat and resulted in a number of large strikes such as in 1907, 1913 and culminated in the 1922 general strike. A strike that was not only costly to the country, but also in lives lost – over 200 – and led to a drastic cut in wages for the white miners (Krikler 2005). Politically, the 1922 strike was damaging for the Smuts Government, but it also led to relative peace on the mines. In effect the mining companies had won the day and wages were suppressed for years. The 1922 strike did have a mild impact on the TSBM mine.

The white miners' ceased work from the 8th to 20th March 1922.[15] What happened with the black mineworkers during the strike at TSBM is not recorded. Before being registered as TSBM in the years 1919-1920 the mine employed approximately 55 black mine workers, as cited in a letter dated 8 December 1919.[16] By 1921-1925 the numbers had risen to 260-500 black mine workers. Initially this seemed a very high number, but development of potential job positions has shown that such numbers were possible.[17] What were not disclosed in any of the company records, were the actual job positions and rates of pay for the black miners at this time.

Knowing the approximate number of black mine workers employed at the TSM and TSBM has led to an idea; is it possible to list job descriptions and allocate numbers of black employees to those jobs? It was mentioned in the first paragraph of this section that there was an unlikely high number of black mineworkers at the TSBM mine in the period 1922-25. We may not know their names except for Jacob Dubeni, as chief Induna (see 8.9), but by re-creating the positions they occupied, I will attempt to present them as three

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15 'Transvaal Silvers progress', *The SA Mining & Engineering Journal,* (29 April 1922), p. 1167.

16 NASA, Pretoria. Depot TAB, Source GNLB. Type LEER. Volume no 181, System 01. Ref. 815/14 part 1 – Transvaal Silver and Base Metals: Application to Brew K….. Beer. 1921.

17 NASA, Pretoria. Depot TAB, Source GNLB. Type LEER. Volume no 226, System 01. Ref. 494/15 part 1 – Conditions of employment of natives on mines outside labour districts: Transvaal Silver and Base Metals Limited, Dwarsfontein, Pretoria District. 1920-1921.

dimensional characters and try to confirm the high number of black mineworkers at the TSBM mine.

Only one source has been found where details are given of job positions and rates of pay for black mineworkers as established on 1 June 1897 by the Witwatersrand Chamber of Mines and the Association of Mines of the South African Republic (later united as the Chamber of Mines (Nkosi 2011:148-149). In turn Nkosi had converted the per shift rates as defined in a book by (Hatch & Chalmers 1895; Nkosi 2011) to monthly rates. Nkosi's table of job descriptions and monthly rates has been partially reproduced below. Of the two companies, TSM and TSBM, the latter was perhaps the more stable in operation, in that the processes were designed, installed and operated, rather than the multiple ideas and production systems installed under the TSM Company of the 1890s. Therefore the same exercise has not been carried out for TSM. It should also be pointed out that Nkosi's table includes positions within a cyanide plant which did not exist at TSBM, and so such positions have been omitted from (Table 9). Nkosi's list, unfortunately, refers to black men in the old derogatory term of 'boys'.

8.5.1 Schedule of job descriptions and monthly wages for black mine workers c1897 - c1920s

The following list of job categories in (Table 9.0), presents a list of known positions and the wage associated with the position as laid down by the Transvaal Chamber of Mines in 1897. As has been shown in section 8.5 there was very little upward adjustment to these pay scales between 1897 and the 1920s the time of the TSBM mining operation.

At the TSBM roaster and smelting furnaces there were sub-operations such as the hand sorters of ore, bullion bar handlers, coal and limestone labourers. In addition to the furnace operation, there would have been additional black mineworkers for the Godfrey furnace, the flotation plant, the concentrators, riggers, electricians, and telephone installers employed at the mine. The rates agreed to in 1897, and shown in (Table 9) were drastically reduced around 1900, rose slightly in 1907 and changed little for the next 20-30 years (Allen 1992:433-437).

Table 9.0 List of potential job categories and pay scales for Black mine worker in 1897.
(Nkosi 2011: 148-149; Hatch & Chalmers 1895)

Mine (Underground)	£	s			Mill	£	s
Machine helpers	2	0			Elevator boys	2	8
Hammer boys	1	16			Vanner boys	2	8
Shovel boys	1	10			Mill boys (12 hours)	2	8
Tram boys (10 feet trucks)	1	8			Blanket and sluice boys	2	8
Tram boys (16 feet trucks)	1	16			Crusher boys	1	12
Dry shaft and winze boys	2	0			Surface trammers	2	2
Wet shaft boys	2	8			**General**		
Wet shaft boys when developing	3	0			Fitter's boys	1	16
Boys cutting hitches for timber	1	16			Blacksmith's boys – strikers	3	0
Timber boys	1	8			Blacksmith's boys - helpers	1	12
Stope ganger's assistants	2	8			Carpenter's boys	1	8
Station boys where white man employed	1	8			Mason's boys	1	12
Station boys where no white man employed	3	0			Police	3	0
Air hoist drivers	2	8			Compound cooks	2	8
Pumpman's assistants	2	0			Drill packers	1	4
Pipelayer's assistants	1	16			Drill sorters	1	16
Pipemane's assistants	1	16			Surface labourers	1	8
Surface					Office and store boys	3	0
Stokers (12 hours)	3	0			Assay office boys	3	0
Engine cleaners	1	16			Coal boys, off loading	1	16
Sorting boys	2	8			Mule drivers	3	0
Headgear boys where white man employed	1	12					
Headgear boys where no white man employed	3	0					

What stands out from the list of wages in the above table is that 52% of the positions are on or below the benchmark wage of £2 per month. These are certainly not all of the categories of positions for the black mineworkers, but they represent those that were described by Nkosi.

It is very difficult to assign precise numbers of black staff to each operation. The use of black labour even up to the 1980s was very high and often a fitter in industry could have as many as 3 or 4 helpers.

By 1913 the white miner's union, MWU, had become very strong and militant and the use of white skilled labour had become obligatory. The table below presents a list of trades and work stations that would more than likely been present at the TSBM mine in 1919-1926 and is based on data by Richardson & Van Heltan (1982.82); Marks & Rathbone (1982).

In the list below of hypothetical positions, W stands for white mine worker and the B for black mine worker. The need for more than two assistants is based on the number of machines or the complexity of the operation. The term 'overseer' is used as a generic term in most cases, but his exact title is not necessarily known. The general descriptions or machine processes listed below are in most cases tied in with the schematic diagrams of the main sections of the beneficiation plant discussed in Chapter 5.

8.6 Transvaal Silver and Base Metals Ltd potential black labour force. (Main mine only)

Shaft headgear	- 1 W engine driver 2 B assistants
Boiler house - 3 engines + generator + 2 boilers	- 1 W electrician, 2 W engine drivers + 2 W boiler men + 10 B assistants.
Primary crusher house with incline feeder	- 1 W overseer + 6 B assistants
Hand sorting belt	- 1 W overseer + 6 B assistants
Secondary crusher house with incline feeder (2 roll crushers)	- 2W overseers + 10 B assistants
Return feeder conveyor	- 2 B assistants
Elevator to Trommels	- 2 B assistants
Return feeder to elevator to trommels	- 2 B assistants
Classifier	- 1 W + 4 B assistants
Harz jigs	- 1 W + 10 B assistants
Hardinge Conical Ball mills	- 1 W overseers + 8 B assistants
Spitzkasten classifier	- 1 W overseer + 3 B assistants
Dorr Classifiers	- 1 W overseer + 8 B assistants
Dorr Thickeners	- 1W overseer + 4 B assistants
Flotation plant	- 1 W overseer + 8 B assistants
Incline conveyor	- 2 B assistants
Blast roasters (two units)	- 4 W overseers + 16 B assistants
2 Incline feeder conveyors ore/limestone/coke	- 16 B assistants
Blast furnace	- 4 W overseers + 16 B assistants
Bullion handlers	- 1 W overseer + 6 B + 4 B slag men
Stores	- 3 W overseers + 12 B assistants
Assay office	- 1 W assayer + 4 B assistants
Wagon drivers – assume 6 wagons	- 4 B drivers + 4 B oxen handlers
Blacksmiths	- 2 W blacksmiths + 4 B hammer assistants + 4 B helpers
Mason/bricklayers	- 2 W bricklayers and 8 B assistants
Fitters	- 5 W fitters + 20 B fitter assistants
Electricians	- 5 W electricians + 20 B assistants
Surface trammers	- 10 B trammers
Carpenter	- 1 W carpenter + 3 B assistants
Police mine	- say 6 B Police
Mine clerks, there was a W secretary and he probably had	- 4 B assistants
'Compound' Manager and he would have had police plus say total of	- 6 B assistants

Mine surveyor	- 1 W + 2 B assistants
Rigger	- 2 W + 8 B assistants
Plumber	- 1W + 3 B assistants
Painter	- 1 W + 3 B assistants
Drill Sharpener	- 1 W + 2 B Assistants
Stable hands	- 2 B
Farm workers	- 4 B

This equates to 270 black surface employees and is probably conservative in places. If one includes the underground black miners, which would have included such positions as driller's assistants, timbermen, trammers, tracklayer's assistants, fitter assistants, stope ganger assistants, shovel 'boys', pipeman's assistants and onsetter assistants, then the number of underground employees can be assumed to be around 100, giving a total number of employees on the Main mine of TSBM of easily around 400.

In a letter to the Director of Native Labour dated 26 October 1920, it stated that: "…at present 260 natives employed principally drawn from farms in the near vicinity".[18] I am not sure if this statement is true, as the area in the 1920s would have been very sparsely populated. Even in 2018 there are few farms, and they are spaced widely apart. There was activity by TSBM at other mine sites such as the Brakfontein mine and the number 2 shaft of the Main mine and this could account for the difference between the stated 500 employees and the calculated 400 above. It is difficult to balance the need for accommodation with what was available according to the records, as outlined in Chapter 6. Chapter 9 will show that the 'native location' area grew to cover an area of approximately 250 square metres, where at least 90 foundation structures can be seen on the aerial photograph of the 1920 'native location' (Figure 74). Further details in the 26 October 1920 letter to the Director of Native Labour are that "…a compound consisting of 7 rooms built of brick with flat iron roof accommodating 168 natives the balance of the natives are housed in a Location on the property".[19]

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[18] NASA, Pretoria. Depot TAB, Source GNLB. Type LEER. Volume no 226, System 01. Ref. 494/15 part 1 – Conditions of employment of natives on mines outside labour districts: Transvaal Silver and Base Metals Limited, Dwarsfontein, Pretoria District. 1920-1921. Letter dated 26 October 1920.

[19] Ibid

Despite the letter saying that "…a further 500 natives…will be necessary within the next twelve months", it is believed that this never happened, as in 1921 they were still reporting a black workforce of over 250 blacks plus over 40 whites.[20] However, by 7 November 1921, when the plant was in its final commissioning phase, it was stated by Ritchie - the mine manager - in a letter to the Director of Native Labour that "The number of boys we have at present is about 550".[21]

8.7 Working hours

Again no records exist for the TSBM mine, but it is assumed that they operated under the guidelines of the Chamber of Mines, which generally expected its black mine workers to be woken at 3 am to report for the shift by between 4 and 6 am, generally without food (Allen 1992). The white miner - whatever his position - would not go underground until 6.30-7am, at which point he and his black miners would start working. The shift of the white miner would end some 8-10 hours later leaving his black workers underground until all of the white miners were on surface. The black mine workers would then go to surface and this could be as late as 7pm, giving them potentially a 15 hour day (Callinicos 1981:52). The TSBM, at a depth of 300m, meant that lengthy times were not involved in going down in the mine or up the shaft at the end of the shift. Once underground, the distances from shaft to stope were not as great on TSBM, as on the gold mines.

8.8 Trouble with the black mineworkers at TSBM

During research at NASA, in Pretoria, one file was located which contained the records of a dispute with one of the workers on TSBM. The file included details of his pay, job description and name. There was a letter dated 5 September 1920 from the mine manager, J. Ritchie, to the Inspector of Mines in Pretoria requesting a visit to discuss "minor troubles

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20 'Report of 1st AGM of TSBM Ltd', *The SA Mining & Engineering Journal*, (1 January 1921), p. 463-465.

21 NASA, Pretoria. Depot TAB, Source GNLB. Type LEER. Volume no 226, System 01. Ref. 494/15 part 1 – Conditions of employment of natives on mines outside labour districts: Transvaal Silver and Base Metals Limited, Dwarsfontein, Pretoria District. 1920-1921. Letter dated 26 October 1920.

with 'natives'".[22] The file is confusing as it appears to also deal with correspondence between the mine and the Inspector of Native Affairs, regarding a dispute over underpayment of wages to a specific worker. It contained a letter allegedly from the worker, one Jacob Dubeni, complaining of non-payment of 7 shifts and of being fired, without notice being given or being paid a month's wages in lieu of notice.

A report from the Inspector of Native Labour to the Director of Native Labour on the 26 October 1920, states:

Regarding Jacob Dubeni's complaint, the manager informs me that this native was employed by him as Head Induna principally to assist him in turning out the shifts and generally to assist in the discipline of the Compound as he had no Compound Manager at the time, but he proved very unsatisfactory and was eventually discharged without notice for being drunk on duty, and the Manager admits the claim for 7 shifts, which has been paid to Messrs, Meyer, Levy and Fowley Solicitors, Benoni from whom he received a letter of demand on behalf of Jacob, but does not admit the claim for wages in lieu of notice…[23]

One of the letters in the file states that Dubeni was paid £3 per 30 shift month and this compares favourably with the highest paid positions in (Table 9). A further labour dispute erupted in July 1921 when the black miners threatened to strike because the rate of pay was less than they had contracted for. In the end the Acting Director of Native Labour ruled that the mine had contracted to pay a given amount and they were therefore ordered to comply with the contract and pay the black workers the contracted sum. The TSBM was advised that if they wished to change the employment conditions then they had to give one months' notice to the employees of their intention to do so.[24]

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22 NASA, Pretoria. Depot TAB, Source GNLB. Type LEER. Volume no 226, System 01. Ref. 494/15 part 1 – Conditions of employment of natives on mines outside labour districts: Transvaal Silver and Base Metals Limited, Dwarsfontein, Pretoria District. 1920-1921.

23 Ibid.

24 Ibid.

8.9 Food and living conditions at the Argent mine

The major problem in determining what foods were eaten by the black mineworkers at Argent is the complete lack of records apart from those mentioning the keeping of sheep and cattle and the growing of maize and vegetables. The only source of data being the archaeological excavations. This leaves a serious gap in the knowledge with respect to types of vegetables or crops other than maize.

In the 1890s the TSM mine kept cattle and sheep to feed the men on the mine - both black and white workers.[25] The cattle kraal is stated as having been built in the 3rd AGM Mine Manager's report.[26] It is also reported that maize and vegetables were grown at the mine. As the TSM mine grew vegetables and maize in the 1890s it can be assumed that a similar procedure was followed in the 1920s. Many of the complaints of the black gold mine workers at the 1913 Inquiry was the lack of food, with poor quality, mouldy or weevil ridden corn all of which often led to scurvy. Although there is a mention in the TSM 3rd AGM General Manager's report that during the years 1891-92 "…the growing of vegetables had only been a moderate success, the vermin getting the lion's share".[27] It is unclear if the black mine workers at Argent suffered a similar fate of poor foods as the 1913 gold miners.

Mention is made of maize in the first paragraph of this section, however another traditional grain is sorghum. This was grown in the fields in the Argent area in 2017, and is a major cyclical crop with the maize. Similarly, greens such as African wild spinach may have grown close to the river to the east of the 'native location' and that could have been used to make a dish called morogo (Jansen van Rensburg 2007).[28] Morogo is an interesting traditional food, as recipes describe it as a specific green-leaf plant such as spinach or pumpkin leaves. Basemzansi (2004:19) mentions there being "24 types of indigenous morogo." Other staples were sugar beans and samp - made from coarsely ground maize kernals. Obviously this

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25 BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM General Manager's Report. 9 April 1891.

26 BRA. Archives of H. Eckstein & Co HE 5 TSM – 3rd AGM General Manager's Report. 21 April 1892.

27 Ibid.

28 For information on Marogo see https://www.definitions.net/definition/morogo, (Accessed on 17 January 2019).

description of traditional foods is very general and each ethnic group would have had modifications to the dishes.

Mention is made in Chapter 3 - c1890 - of a 'meat-house' at the Argent mine, which may have meant a butchery. Although no mention is made of such a facility in the 1920s period it is most likely that such a facility existed as it is known that they kept domestic animals.

8.10 The brewing and supply of traditional African beer at the Argent mine

In a NASA file, reference is made in connection with the application and the granting of a licence for the company to brew traditional African Beer. The letters in the NASA file mention the mine on the Ferguson portion of the farm Dwarsfontein, which is the Argent 'main mine.' A letter dated 8 December 1919 applies for a permit to brew beer for the 55 'natives' present on the mine.[29] A problem comes with the letter head which is hand written and headed "Silver Mine, Dwarsfontein". What was not immediately clear was if this referred to the TSBM mine. On re-looking at the record evidence, the apparent mix up of mine names can be explained by realising that for most of 1919 there was no TSBM as it was only registered in late December 1919, yet the company records do show that prospecting and development work started in 1919 (Reeks 2012).

The first letter by the company, dated 12 December 1919, states that the company will provide the employees with one quart [900 ml] of beer on a Saturday afternoon.[30] An additional licence application was made and granted towards the end of 1921 in which mention is made of 500 'natives' being employed by the company. The licence letter stipulates the beer will be supplied free to their black employees only.[31]

There is no company record showing that they grew sorghum along with the maize. Most sources indicate that traditional African beer is made with sorghum rather than maize,

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29 NASA, Pretoria. Depot TAB, Source GNLB. Type LEER. Volume no 181, System 01. Ref. 815/14 part 1. Transvaal Silver and Base Metals: Application to Brew K….. Beer. 1921. Dated 8 December 1919

30 Ibid.

31 Ibid.

although the Zulu do make a beer with the latter grain.[32] If the mine grew sorghum and maize, it would have made sense both as a product for the beer as well as a secondary protein food source.

8.11 Use of black females in domestic duties of white married residencies on the TSBM mine

Delport (1995:10-11) showed that the original domestic servants in the Witwatersrand of the 1890s and early 1900s were black men. These men were dominantly Zulu speaking, having been driven from Natal in the 1890s due to the imposition of the hut tax, severe droughts and the Rinderpest cattle disease, which decimated the herds (Demissie 1998:452). When news of work on the early gold mines spread, a migration of these Zulu men took place and they became the amawasha or men providing a laundry service to the single white unmarried miners. By 1914, steam laundries had begun to make an appearance on the Witwatersrand and a large percentage of the amawasha men found themselves out of regular work (van Onselen 2001:275). There was, however, also an influx of young women to the Rand this time. The domestic market became flooded with potential workers and a fear of the black male domestic workers rose among white females, there was a shift in attitudes by the white housewives who began employing the black women as domestic workers (Callinicos 1981:53-57; Delport 1995:10).

Eales (1988:1) states, from evidence before a Commission of Inquiry into Assaults on Women in 1912, that as many as 60 000 black men were employed on the Witwatersrand as domestic servants. The situation of some serious assaults on white women by black domestic servants raised a warning that perhaps black females should be trained and employed in such roles instead. The major problem of this proposal appears to have been a common belief at the time that the black women living close to the mine compounds or in informal settlements were of low morals, as they were involved in prostitution and the illegal liquor trade. Unfortunately, such generalisations always seem to dominate in one population's beliefs of another and it is always the negative that appears to become the stronger viewpoint.

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[32] Brewing traditional African beer at https://beerandbrewing.com/dictionary/izd8yFIQEc/ (Accessed on 20 February 2019)

One of the major hypotheses for this thesis is that the change in designation of compound to native location could provide a site on the TSBM mine for one of the early mine living areas for blacks that also included woman and possibly children up to the age of 14.

8.12 Conclusion

This chapter has covered a large number of issues related to black mineworkers. Their history tends to be one of the unspoken masses. We do not know who these individuals - at the Argent mine - were, where they came from, or what happened to them when the mine closed down. They lived and worked on the TSM or TSBM mine for a short period of history and all that is left of their presence - as in so many cases with archaeological sites - are foundations of housing structures and some of the remains of what they had eaten of animal products coupled with some personal items of clothing, domestic crockery, bottles and various metal items.

I have tried to show the harsh conditions that the black mineworkers were subjected to in the mining industry of the 1890s and through the 20th century. The methods used to recruit them from tribal lands, their living conditions on the mines including food and the types of work or employment conditions under which they survived. It is not a proud record for South Africa and its mining industry. In trying to recreate the potential job positions of the black mineworkers based on the processes installed in the 1920s, it has been shown that it was possible, for the mine did have close to between 400 and 500 black mineworkers.

Hopefully, this chapter has provided evidence that by studying both the industrial and social archaeologies of a site holistically one is better able to understand the interrelated aspects of a site such as the silver mine at Argent.

The table of wages paid was included to merely show some of the positions and the appalling wage levels that were paid for what was in most cases very hard manual labour. The most exciting aspect to come from this study has been the recognition of the ‘native location’ and its potential for woman to be present on the mine.

Chapter 9

Archaeological survey and excavation methodology

9.1 Introduction

Industrial archaeology relies principally on foundation remains and hopefully photographs, company records, and newspaper articles coupled with an understanding of the industry and its machinery or processes. In this project all such sources have been used and by cross-referencing the one with the other it has been possible to not only understand the remains of concrete foundations at the site, but to re-create the process from mined ore to finished bullion. As the majority of the industrial foundations are above normal ground level, it became relatively straightforward to survey them and to later match them with historical photographs and mine plans.

The other major component of the study - the historical or social archaeology - has been to try and recreate the lifeways of the black mineworkers at the Argent mine. In most similar cases around the world, the only evidence of the people that worked on a mine are the structures in which they lived and possibly the middens associated with their household waste. Rarely do documents survive presenting details of individuals or groups of these so called ‘underclasses’. This sad state of affairs is a reflection upon the societal norms of the industrial period, in most countries, from historical times to present day. The underclasses were there to provide the muscle in the manufacture or processing of products and to most managements and historians of the time, not a resource to retain as a record.

This was very true at the Argent silver mine; both in the 1890s and 1920s. The approximate number of black mineworkers present on the mine is known; where they lived, and in general terms, what they ate. To provide more details, this project has had to carry out extensive surveys, followed by excavations over a large area and the results have produced a number of surprises and a range of assertions have been formed. This chapter details the planned surveys and the excavation methodologies of the specific excavation sites.

As was stated in the preface to this thesis, this project was about holistically merging two divisions in archaeology – Industrial archaeology and Historical or Social archaeology.

9.2 Site description

The mine site covers an area approximately 0.6 km wide x 0.9 km long. Within this area are the extensive concrete remains of the 1920s mine beneficiation plant structures, and a few stone foundations of the 1890s mine buildings. Also visible are the original 1890s prospecting trenches, the prospecting shaft and the main or number one shaft and its foundations – which date from the 1920s. A large areas is covered with the slag dump and it is close to the remains of the smelting plant. The slimes dump/dam is alongside the foundations of the concentration plant and the waste rock dump is next to the crushing plant foundations. There is also the partial remains of a shaft waste dump, which probably represents waste rock taken directly from the shaft and not put through the separation/crushing process. It is known that this dump dates from the 1920s, as the contemporary mine plan indicates profiles and dumping dates.

9.3 Pedestrian survey – The industrial archaeology 1890s

The only significant feature above surface dating from the 1890s is the dressed stone foundation for the 1890s Blake Jaw Crushers, located on the north wall of the concentration plant and shown in the photograph dated 1892/3 (Figure 19). On inspection of this site, limited trowelling soon revealed the foundations of the columns of the building and the position of these columns matched those shown in the photograph. Once some of the vegetation was cleared, two deep pits suitable for large flywheels used as part of the driving machinery of the overhead belt drives - some of which can also be seen in the photograph - were found.

9.4 Pedestrian survey – The industrial archaeology 1920s

The surveys have often led to the finding and understanding of various miscellaneous foundations or features. For example, the remains of a mine railway track was recognised. It consisted of a line of raised ground, approximately 10-15 cm above normal ground level

and about 0.5 metres wide. By following such a feature it was seen to match the line of the railway track on the mine plan. A small rectangular sunken concrete foundation at the apparent junction of two of these raised lines was discovered and it was eventually recognised as the location of a mechanical switching point for the rail tracks.

One of the most important features of the 1920s foundations, is that they were formed using reinforced concrete and this was discussed in Chapter 6. This has led to a high degree of preservation of the foundations, which in turn, when used in conjunction with the historical photographs of the plant and the mine plan, has enabled me to fully reconstruct the beneficiation plant of the Transvaal Silver and Base Metals Mine of the 1920s.

A number of the foundations show the cut off stubs of 'foundation bolts.' The configuration of these bolts has helped identify of the machines mounted on the foundations, as the patterns were unique to specific machines. This has been done where possible with historical catalogues of the machinery in which the dimensions for the positions of the foundation bolts are indicated, such as in the Blake Jaw Crusher catalogue.

During the pedestrian survey, a number of features indicated on the 1920s mine plan were looked for, such as the short rail line going out from the boiler house and the long straight rail line connecting the various parts of the plant. Evidence for both of these features was identified on the site and the results are discussed in Chapter 12. Once the 1920 beneficiation process was re-created, a number of the foundations became identified to a specific part of the process and two very good examples of this were the location of the mineral flotation plant and the Dorr classifier.

9.5 Pedestrian survey – Social archaeology 1890s

The finding of the 1890s and 1920s mine plans was of significant importance to this aspect of the project. The 1890 plan of the Transvaal Silver Mine indicates the positions of a number of buildings, such as the black mine workers compound, which was located to the west of the main prospecting trench. Very few of the foundations of the 1890s structures can be seen above the surface.

One of the original hopes of this project was to find and excavate the 1890s black mineworker compound. A pedestrian survey of the approximate area revealed a number of stone foundations which gave the general impression of a U shaped building or three buildings constructed in a U-shape layout. At the same time a very shallow midden area approximately 3 m x 10 m x 0.05 m above ngl, was located. Although some surface bone material was found, it was badly degraded due to weathering.

Before the site could be excavated, an external fertiliser contractor cleared and levelled the area in the latter part of 2016, including the midden and most of the foundation blocks, to cater for a dump of farm fertiliser. Fortunately the satellite survey had been completed before this destruction. After the levelling, a detailed pedestrian collection of all surface finds was carried out over the levelled area which measured approximately 70 x 70 m. Many items of broken glass, ceramic and metal were collected. This point is discussed in greater detail in the next chapter along with the glass and ceramic artefacts that were recovered.

9.6 Pedestrian survey – Social archaeology 1920s

The 1920 mine plan shows two areas of initial interest. One part of the plan symbolically shows a series of round and rectangular structures, with the annotation ‘compound’ located close to the present day service road for the area. Was this the site of a black mineworkers ‘compound’? When the area was searched by pedestrian survey nothing was found in any form of foundation material or potential middens and it was abandoned as a potential site. The other area of interest was designated on the plan as the ‘native location’.

The name led to a specific line of research into what the etymology of the term native location, in comparison with compound. This aspect was dealt with in Chapter 8. Once it was known that it had potential for residential structures and possibly middens, with the further potential to study the lifeways of the 1920s black mineworkers, it became the main focus of a historical/social archaeological research component for this project.

In 2013, a pedestrian survey was conducted over the area between the current slimes dam, the river and farm dam to the east and the 1890s prospecting trenches to the south. A modern fence line at the base of the waste rock dump and boiler ash dump formed the western

boundary. Thus an area approximately 200 m wide x 250 m long was covered with a basic pedestrian survey of walking in east - west - east directions about 5 m apart to assess if anything was present. It became clear, once the area had been surveyed, that a large number of potential foundations and middens were visible at surface level. It also became evident that a large number of artefacts were present on the surface.

It was decided that sufficient evidence existed to propose a detailed excavation program as part of this project and it formed part of the proposal.

9.7 Satellite survey

The most significant problem in surveying the 1920s mine area is the extent of the mine boundaries. In general terms as was stated in 9.1 the area is 0.6 km wide x 0.9 km long. Fortunately, good quality aerial photographs along with Google Earth ™ images are available for the mine and have been used in conjunction with the detailed satellite surveys which are discussed below.

Towards the end of 2013 it was decided to survey the proposed excavation area and a friend of mine offered to help utilising his satellite surveying equipment.[1] Through him we acquired three days, free satellite link-up time, from the company OmniSTAR based in Cape Town. The time allowed us to not only fully survey the surface features of the 'native location' area, but we were also able to survey most of the foundations of the 1920 structures. We also utilised the opportunity to put in permanent marked beacon points at several parts around the plant for future reference of any further archaeological work using survey equipment. Such points are indicated on the site plans (Chapter 10) along with the grid co-ordinates (Appendix 11).

9.8 Satellite survey methodology

Full details of the equipment used for the survey, the accuracies of measurement, the base trigonometric beacon that was utilised in the area for setting up the equipment and details of

[1] Mr José Clara - a registered surveyor.

the geo-referenced photographs utilised in the digitalisation of the results of the survey is presented in the appendices (Appendix 10).

The selection of survey points was noted in my field notes, along with the detailed results presented in conjunction with the final set of survey drawings. In surveying the 'native location' area, a set of temporary flag beacons were set up on the eastern and western boundaries approximately 10 metres apart north-south. Thus an area of 100 m x approximately 200 m was walked and each feature surveyed and annotated as indicated below. The final strip approaching the prospecting trenches was largely empty of surface features and was approximately 30-40 m wide due to the tapered shape of the area.

Annotations

Middens = M;

Brick Structure = BS;

Un-Diagnostic Feature = UDF;

Stone Structure = SS.

The greatest percentage of features was in the northern part of the 'native location' area and these were surveyed in detail. We also included the 1890s black miner compound, three foundations to the south of the shaft, the shaft/boiler house area, the 1890s jaw crusher foundations and associated foundations of the 1893 concentration plant – also the associated sink-hole periphery and 1920s shaft waste rock dump profile. Further to the north of the main mine building area the survey included the 1920s water reservoir, the 1920s ore passes, the line of the rail track where visible, the incline conveyor foundations, the primary crusher, secondary crusher and tube mill foundations.

The slimes dam, main crusher waste rock dump, the slag dump and foundations associated with the roasting and smelting plant were digitised from the geo-referenced photographs. The set of survey plans and associated survey points appear in the (Appendix 11). In order to keep the plans as geographically simple as possible it was decided to utilise the National Grid pattern to geo locate the features of the mine and associated roads. The overall primary national grid pattern is 100 m x 100 m.

9.9 What were the features that led to the individual sub-sites being chosen?

The 1890s black miner compound area has already been discussed; both the original plan behind its excavation and the eventual problems of excavation. The other areas to be investigated from a foundation or feature aspect were the 1920s roasting and smelting plant. The pedestrian surveys conducted in this area resulted in some surface artefacts being recovered and the area was given the designation of Area A. Similarly the same process was conducted in and around the 1890s concentration plant designated Area B and the 1920s crushing plant foundations; designated Area C. During the final stages of excavation of the 1920 'native location' middens, it was decided to carry out an intense surface collection over a large surface area of the 1920 native location area. The squares chosen were B3-B12, an area measuring 10 m x 100 m. The results from this random selection of an area for surface collection were quite surprising in terms of the number of artefacts, and the mass of metal artefacts at just over 9 kg. More detail will be presented in the next chapter. A similar random search of a primary grid area measuring 10 m x 10 m and designated A6, was also conducted towards the end of the excavations. This area was chosen to test the quantity of surface artefacts. The results in terms of number of artefacts were lower than expected and this point is also discussed in more detail in the next chapter.

The primary area of the 1920s 'native location' was an area measuring 100 m x 100 m. After completing the survey, it was determined that it contained the highest concentration of middens and foundation structures. During the satellite survey of the middens and structures, notes were taken of any apparent concentrations of surface artefacts. During the pedestrian survey of this area, it was noted that the foundations of structures were constructed using different types of foundation material, namely dressed stone, brick and rock. Three of these structures were identified for excavation.

The middens were categorised into three approximate sizes, 'large' - of which there was only one at 9 x 13 m; 'medium' - of which there were about four, approximately 2 m to 4 m diameter, and 'small' - less than 2 m and more generally around 1.5 m in diameter. The height above normal ground level ngl, for the small middens was generally around 20 cm compared to the medium size which varied between 40 cm to 80 cm. The large midden, later

designated M8 was different in that its height above ngl was around 70 cm, but excavations showed that it had initially been excavated below ngl to approximately 70 cm.

The best source for historical and social artefacts proved to be the middens. It was decided that the large one, M8, needed a long trench of 5 m x 1 m. Although the trench only represented a small portion of its total area, it was considered adequate for this study as the depth was unknown. Two medium size middens, M15 and M16, were selected along with 12 small middens as indicated in Chapter 10 on (Figure 76). M16 was initially set at 5 m x 0.5 m, but it changed during the course of excavation as is explained in the next chapter. Over the entire 'native location' site, a total of 49 middens were recognised and mapped during the survey. Also noted were 12 stone foundations, 5 brick foundations 3 un-diagnostic brick wall foundations and 11 un-diagnostic features. It was decided to excavate to the base of the foundation of one of each of the structures namely SS2, a dressed stone structure; BS4, a brick foundation which is the only one on site clearly showing the potential for two rooms; and SS3 a small un-diagnostic rock type structure. The results of these excavations are presented in the next chapter.

9.10 Design of 'native location' excavation area

Once the survey plan of the 'native location' features had been produced, it was decided to focus on the area that gave the highest concentration of features. To this end an area measuring 100 m x 100 m was selected and subdivided into a primary grid of 10 m x 10 m. A master drawing of this grid (Appendix 10) was produced and the digital location of the corner points and 50 m midway points as well as a centre point of the square were calculated. It was decided to number the excavation area primary 10 m x 10 m squares with the primary south-west corner designated as B3. This was a deliberate choice to allow for the grid to be retroactively started at A0 should it be decided to excavate minor middens and structures at a later date that occur outside of the chosen boundary line. From B3 the numbering is increasing numerically from west to east to B12 and going north alphabetically from B to K.

Each of the 10 x 10 m squares is then further divisible to 10 x 10 one metre squares, again in an alpha numeric system of 1 to 10 and a to j. Within the 1 x 1 m square, smaller sub divisions of 1 x 0.5 m or 0.25 x 0.25 m were also made.

Once the primary grid points had been calculated a further site visit was made to put in (with the farmer's permission) permanent concreted tubes to mark and allow the insertion of flag beacon points on the days of the excavations. These allowed for very quick and accurate setting up of primary grid lines, as in general it only requires 4 such poles to be present.

9.11 Conclusion

The techniques used, not only to locate potential sites for excavation, but to also define the outlines of surface structures and features have been defined in this chapter. A significant problem during the satellite survey period was the sheer size of the overall mine site. The major features - foundations and structures - were relatively easy to map, although it did take several days, because of the distances involved at the site. The main problem was the mapping of the structures and middens in the 1920s 'native location'. The number of middens mapped was eventually 49, but each one had to be checked for surface material to ascertain if it was a likely candidate for excavation.

In the next chapter, details of the sub-site excavations are presented, with plans of the individual sub-sites, plus profile sections where they were carried out.

Chapter 10

Detailed description of the individual archaeological sub-sites

10.1 Introduction

This chapter presents information on each sub-site, a plan drawing of each sub-site and in two cases, M8 and M16 a detailed drawing and analysis of the stratigraphy exposed. Each site is presented with a plan drawing showing the profile of the midden or site as surveyed. Details of the excavation, the reasons for the type of excavation and the general details of the significant finds related to the sub-site are discussed. In all cases the first stages of work after the surface collection was the clearing of any grass cover and the setting up of a grid. For simplicity these points are not repeated in the text for each site. The descriptions below are in numerical order of midden number followed by the structure and surface collection sites. This does not represent the order in which they were excavated. All excavations went down in 10 cm spits or layers. Upon completion of work at a site the site was backfilled and rehabilitated with the grass roots.

On the next page (Figure 75) is the survey plan of the Argent silver mine. It shows a grid area which is the archaeological excavation area of the ‘native location’ of the TSBM mine period. Most of the other features shown are the dumps of waste rock, slag from the smelter and the slimes dam from the concentration process. The concrete foundations and various miscellaneous features that were noted during the satellite and pedestrian surveys are also indicated. The only features of the 1890s period shown on the plan are the concentration plant, c1893 and the positions of the compound, Manager’s house and single quarters.

A detailed map of the mine has been produced showing the main features of both the TSM and TSBM periods. The dirt roads shown in orange are modern. The rectangular back line blocks at the southern boundary represent the sites or areas where the 1920s management housing was located. The green rings represent areas of trees and bush.

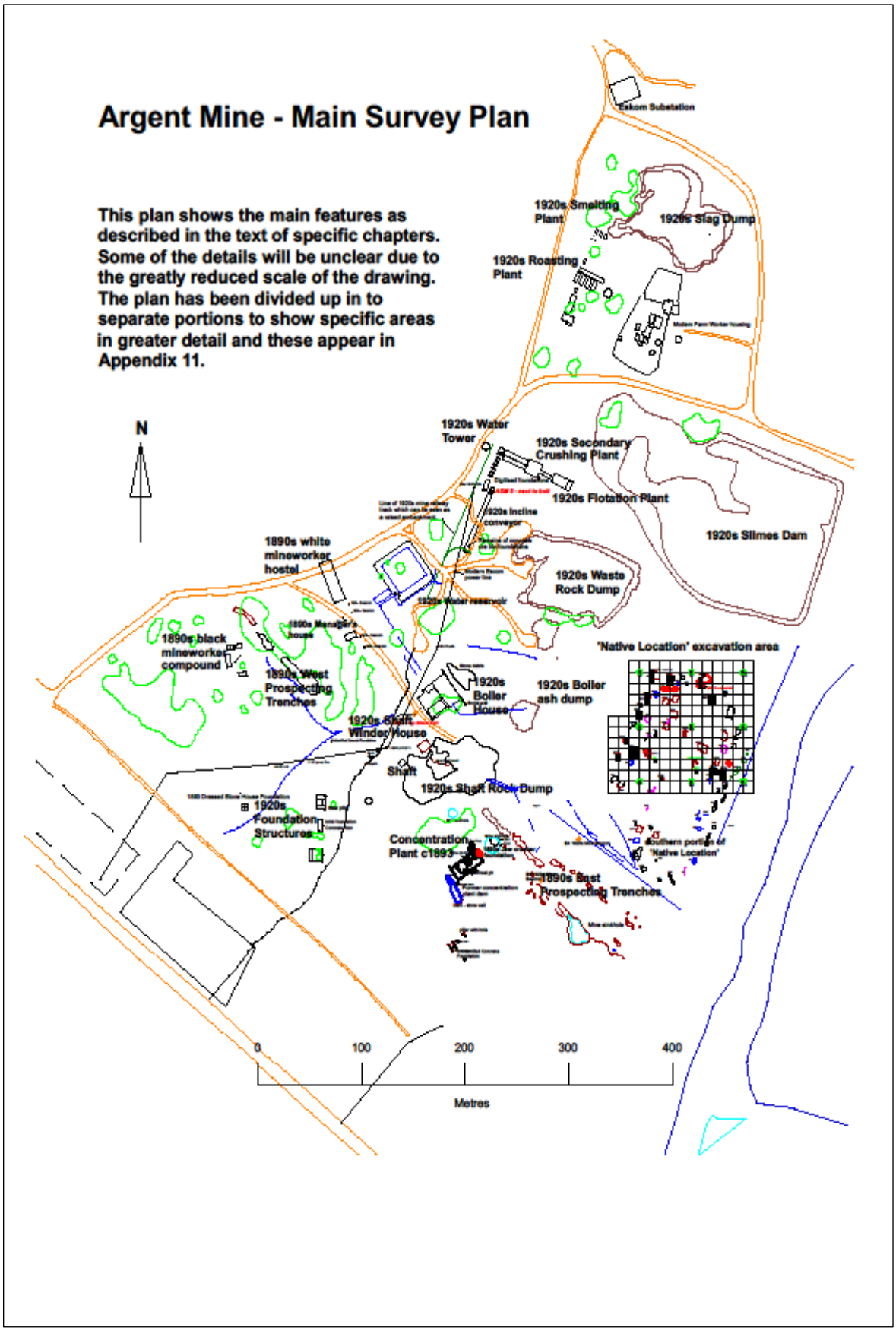


Figure 75. Argent mine – main survey plan of surface features and main excavation area.

Fifteen middens were excavated by 0.5 m wide trenching, 1 x 1 m excavations, combinations of 1 x 1 m areas and 0.5 x 0.5 m areas. Shovel Test Pit (STP) excavations were used if the midden was small, or if it seemed to produce very little and needed to be tested in depth. In all cases, a general surface collection took place first, although not all middens produced surface finds. Some of the areas drawn in the following pages were defined as surface collection areas. For example, the area surrounding the concrete foundations of the secondary crushing and concentration plant of the TSBM mine. Such areas were demarcated for pedestrian collecting to test if artefacts existed on surface of such areas or not, as an indicator for sub-surface excavations.

A detailed map of the positions of the sub-sites of the 1920s ‘native location’ area is shown on the next page (Figure 76). Excavation of the various sub-sites took place over an eighteen month period.[1]

The preceding chapters have shown that the documentary records regarding the black mineworkers are severely limited in extent. This has resulted in the need to conduct a wide number of archaeological excavations which are detailed in this chapter in an attempt to reconstruct in some parts the lifeways and food ways of the black mineworkers on the 'native location' at the Argent mine.

It should again be mentioned that the primary focus of the social archaeology was the black mineworkers ‘native location’. The remains of some of the European officials housing do exist and it is believed from a pedestrian survey that some of the foundations of the European single quarters can be located through excavation work. It is unknown if any middens exist and an extensive and detailed survey of the area would be required to determine this.

On relooking at the aerial photograph (Figure 74), the mention of the accommodation block for the 168 black mineworkers provides a possible reason for the large, potentially communal midden of M8, as well as the large rectangular shadow on the northern boundary of the site. The lack of middens in the middle of the site can best be explained that if they exist, they are small.

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1 This was primarily due to the fact that all members of my excavation team had full time occupations during the week, and so excavations could only be carried out over a weekend.

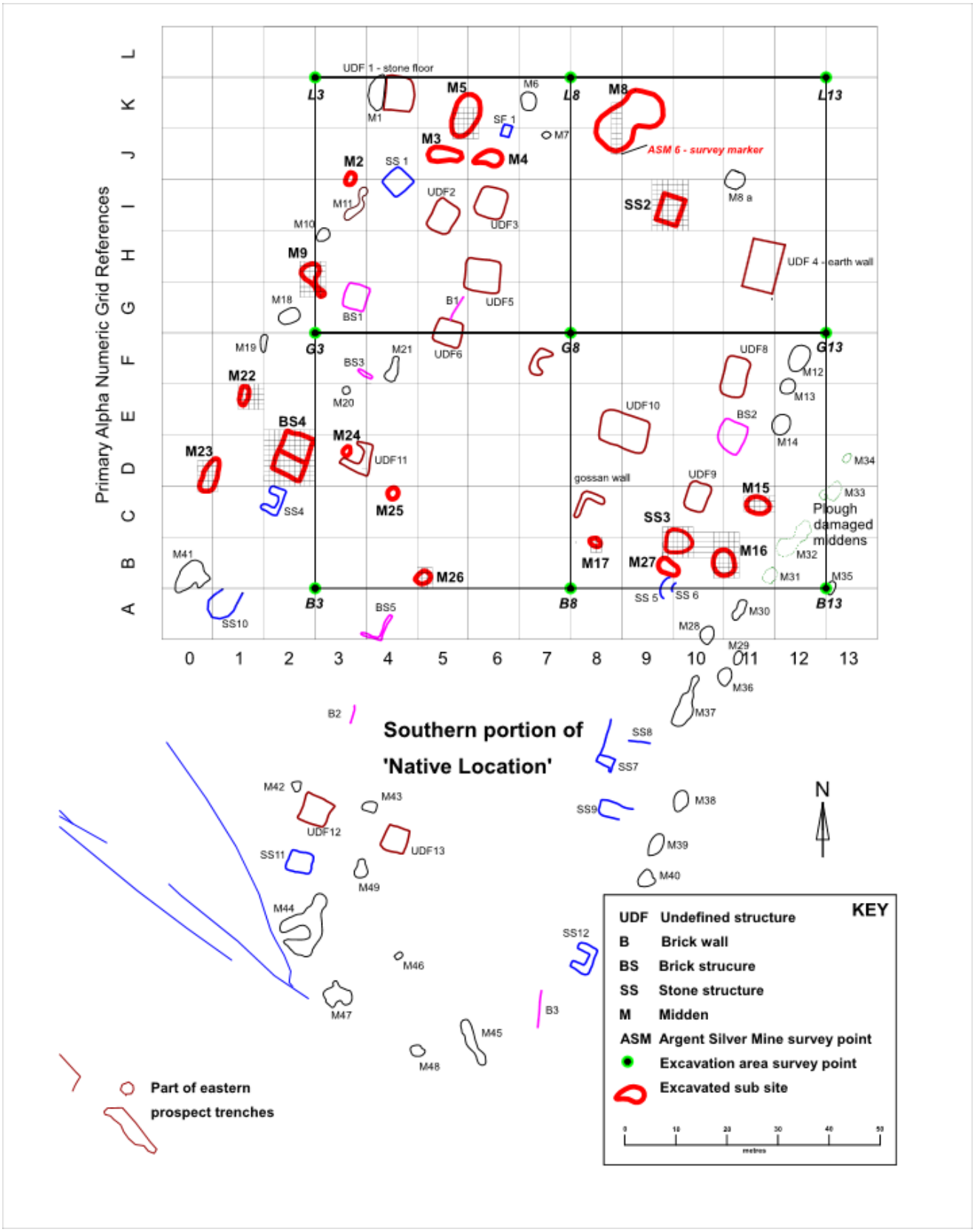


Figure 76. Argent Mine 1920s 'Native Location' excavation area and excavated sub-sites.

10.2 Detailed descriptions of each sub-site

Midden M2

This small midden was investigated, but not excavated and only 4 items of glass were found on the surface during the pedestrian survey.

Middens M3, M4 and M5

The primary focus was initially midden M5. This was seen as a potentially medium size classification midden covering an area 9 x 5 m. The reason why the three middens were investigated together via STP type excavation is explained below.

After pegging out a 3 x 1 m area the central square (a9) looked to be the most likely source for artefacts. This assessment was based solely on the grade and colour of the ash, which had produced artefacts on other middens. The soil was a very fine, light grey ash. Layer 1 produced nothing and it looked as if the midden was barren. A 25 x 25 cm STP was put down in the middle of the square, reaching another 20 cm and this also produced nothing. At this point a similar randomly positioned STP was put down 20 cm in square (a10). Once again nothing was found. The height of the midden above ngl was measured to be approximately 50 cm. It was decided to abandon M5 at this point and an STP was excavated in each of the two adjacent small middens, M3 and M4.

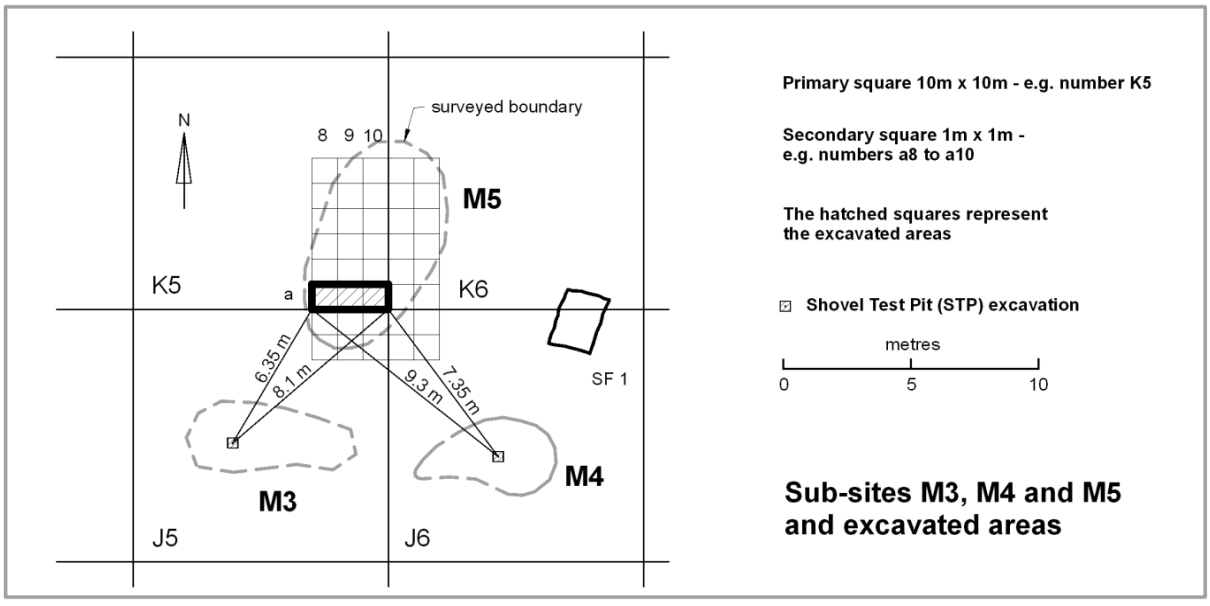


Figure 77. Sub-sites M3, M4 and M5 and excavated areas

In M3 it went to approximately 20 cm deep and in M4 the STP reached a depth of 30 cm, in both cases the depths reached ngl.

These three middens were the only ones excavated where no artefacts were recovered. Considering the area covered by M5 it seems unlikely – based on the other middens that were excavated – that M5 is totally barren and the choice of squares for this excavation was merely in error. Although M3 and M4 were relatively small and low and were very ashy, it was hoped that they would yield some artefacts. Of course, STPs by their very nature are random approaches.

Midden M8

This midden was classified as large, the only one with such a categorisation. It measures approximately 13 m long x 8 to 9 m wide and is about 70 to 80 cm above ngl. It was decided to put in a 5 x 1 m trench, as shown below, the main reason being the size of the midden, and the need to test as large a sample of the midden as possible within time and labour availability constraints. The area at squares (a10) and (b10) were the highest points of the midden and at (e10), the edge of the midden, it was almost at ngl.

Midden M8 was the deepest excavation at 1.4m at the base of the STP in square (c10), and the greatest volumetrically at 3.7 m^3. When another shallow STP was put down in (e10) it became evident that the original soil had been excavated below ngl in a trough shape (see stratigraphic drawing (Figure 79). As an excavation, it eventually produced 4 172 artefacts, with a combined mass of 45.606 kg. This represents about two thirds of the total collection and half the mass of all of the sub-sites.

M8 became the deposit that answered many of the research questions in terms of a significant bone collection numbering 1851 individual bones and pieces and which amounted to 7.3 kg. It was the first place where chicken leg bones were recovered, along with sheep jaw bones and several obvious pieces of a Bov 3 (*Bos Taurus*) leg bones. Some of the bones show indications of axe marks as well as saw cutting – the latter more possibly by a butcher.

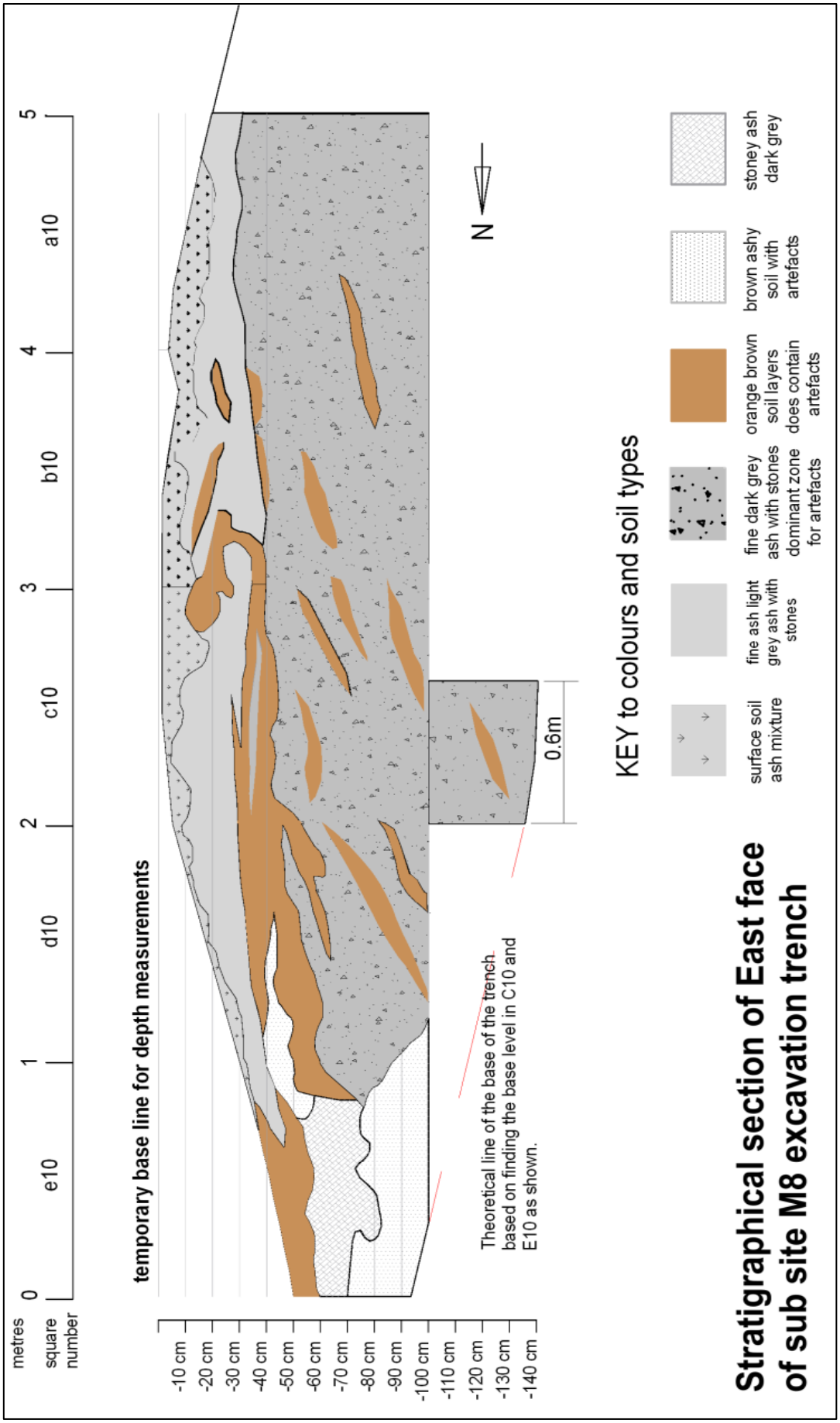


Figure 78. Stratigraphical section of the East face of sub-site M8 excavation trench

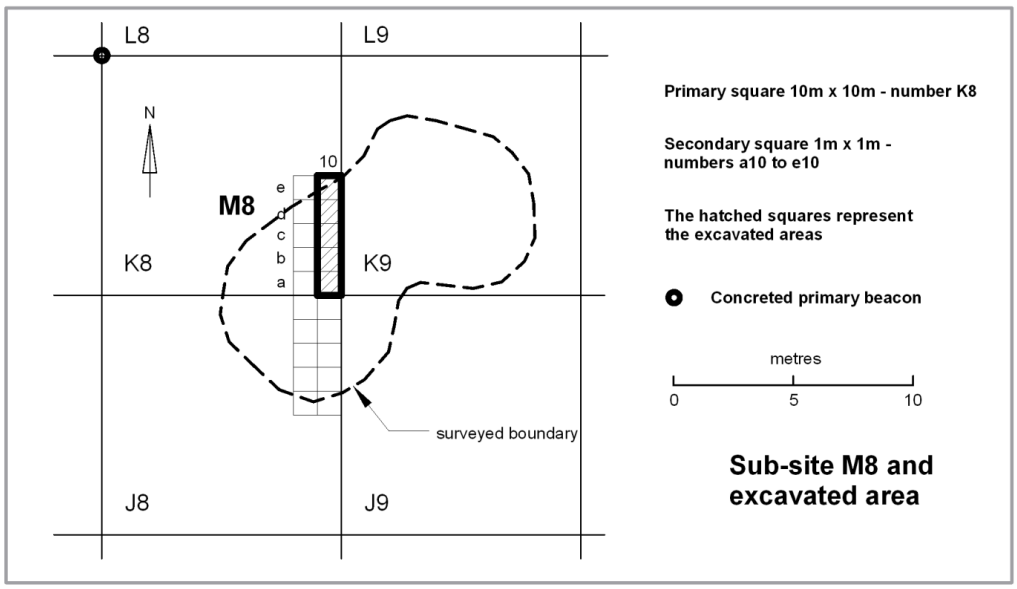


Figure 79. Sub-site M8 and excavated area

The glass collection of 300 items, or 4 kg, was mainly in the form of broken shards, however a few complete and undamaged bottles were recovered at depth. This sub-site yielded some of the Vaseline jars found in various middens. Part of a green square shaped bottle with the embossed names Walker and Whiskey on the base was found, presumably the brand Johnny Walker Whiskey of Scotland. Some of the clear glass was related to bottled water with one being embossed with part of the name as '….Water and Witbank'. The undamaged Holbrook's Sauce bottle with part of the paper label still intact came from this midden. It was found in very fine light grey ash at a depth of 60 -70 cm. At a deeper layer, 80 cm, an aqua coloured glass bottle stopper was found with raised letters 'Holbrook and Co' on the top face. Also at this depth, the undamaged, small, pale green rectangular 'DAVIS' patent medicine bottle was found.

A total of 271 ceramic shards were recovered with a total mass of 1.6 kg. Some of the items had decoration or writing on them and one had a maker's mark of a crown with the partial name JOHNSON BROS ENGL*and*. Another has the partial word TRENT which would most likely be Stoke on Trent – hub of the pottery industry in England. More details of the ceramic items are given in in Chapter 11. Examples of some of the artefacts recovered dominantly from M8 as well as some of the other sites are illustrated as (Plate 1) a more complete selection is illustrated in Appendix 5.

Plate 1 Photographs of artefacts typical of those collected from the excavations

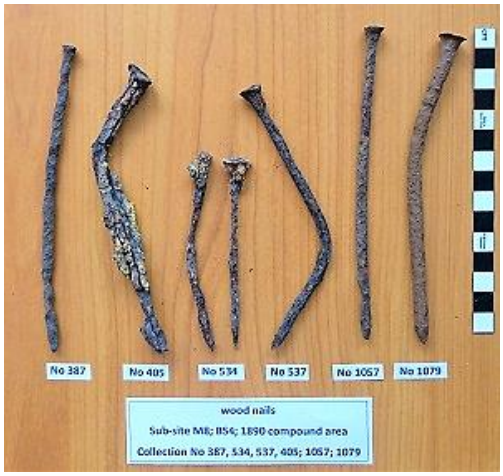
For a more complete selection refer to Appendix 5



Hand forged nails some dating from 1890s



Hand forged rail nails c 1920s



Round head wire nails



Industrial metal mesh found in many of the middens. Re purposed for use on fires.



Metal shovel with part of wooden handle in place from M8



Can kettle with handle from M8



Various tins and lids found



Hardinge Ball Mill steel ball – Area A



Femur and Tarsometartasus – *Gallus domesticus* M16



Metatarsal & 1st Phalanx – *Ovis aries* M8



Mandible + EPM4, M1, M2 EM3 – *Ovis aries* M8



Three undamaged Vaseline Jars M8 and B3-B12



Kruschem Salts glass jar M26



Davis vegetable pain killer bottle M8



Holbrook & Co glass bottle M8



Glass Bottle stoppers M8 & Area C



Stoneware jug or bottle c1920s M8



European earthenware with maker's name M8



The ony near complete item of ceramic found M27



Leather shoe and pieces of upper with lace holes M8

Close up of woollen garment M8



Apart from a large collection of oxidised metal cans and corrugate metal fragments, nails, screws and bolts, there was also a selection of hand forged rail nails found in various parts of the excavation. Also found were several pieces of woven metal mesh with the wire diameters generally around 3 mm and mesh square sizes at 5-8 mm. While it is most likely that the original use may have been part of the sieving plant in the crushing stations, it is almost certain that as these sieves were replaced with new ones, the secondary use was as a grill above individual fires used for cooking in the 'native location'. Most of the round metal cans or lids were typical of a modern 'baked bean' tin in size i.e. 7.5 cm in diameter x 11 cm high. The more recognisable metal cans were the flat square with round corners like modern 'sardine' tins. None of the tins had any form of labelling. Apart from 100 years of damp conditions which would have generally destroyed any paper labelling on the tin, another scenario is that the tin was opened and used on the grill of the fire as a form of cooking pot – the very action of which would have burnt any paper labelling. Other items included plumbing fittings and in one case a horse shoe and a metal stirrup.

In the stratigraphical section of M8 (Figure 79), of significance are the bands of orange brown soil. Note how they follow an upward curved direction which possibly indicates that it was localised soil dumped on top of hot or burning ash. The slope possibly also indicates the growth of the dump not only in curved layers, but also in lateral extent, with significantly more soil in a series of bands in (c10) and (d10).

The range of miscellaneous items includes personal items such as buttons, shirt studs, parts of plastic combs, a leather handle possibly from a knife, metal belt buckle and metal belt rings. Peach pips were also found, which indicates the eating of fruit, possibly supplied from local farms. Significant finds in M8 were the remains of shoes, either as the leather upper or the sole/heal parts. Clearly, most were men's size shoes/boots, but one is too small for anything other than a child of about 6-10 years old. The items are photographed and measurements are given in Appendix 5 Another shoe is believed to be that of a woman as the width and length is too small for a man or even a teenage boy. This is discussed in chapter 12 and is shown in Appendix 5. Some of the shoe leather uppers have the metal eyelets and in one case the laces.

One of the most intriguing finds from this midden, is part of a black hand-knitted woollen jersey. It was found at a depth of 60 cm in a small cavity under the remains of an upturned

shovel in a layer fine grey ash. Naturally it is very fragile and is believed to have survived only because of its depth, the ash and the protection of the shovel. This item has also been photographed and is shown in Appendix 5.

Midden M9

M9 was looked at because of its middle-west position in the main site. It was a low, small midden approximately 25 cm high at the highest point above ngl and in plan 7 m long x 4 m wide. As can be seen on the plan drawing it narrowed down at the one end to approximately 1 m wide. It was decided to excavate a 1 x 1 m square. Within the first 10 cm of excavation only 12 artefacts were found, mostly small ceramic shards of industrial whiteware and porcelain or semi-porcelain tea cups. The one item that did seem totally out of place was a star head jumper drill with very little or no wear to the carbide tips. With a low artefact count and only approximately 15 cm to ngl, a STP was put down in in the middle of the square, but nothing was found and it was decided to close up M9. The significance of the Jumper drill is discussed in Chapter 12

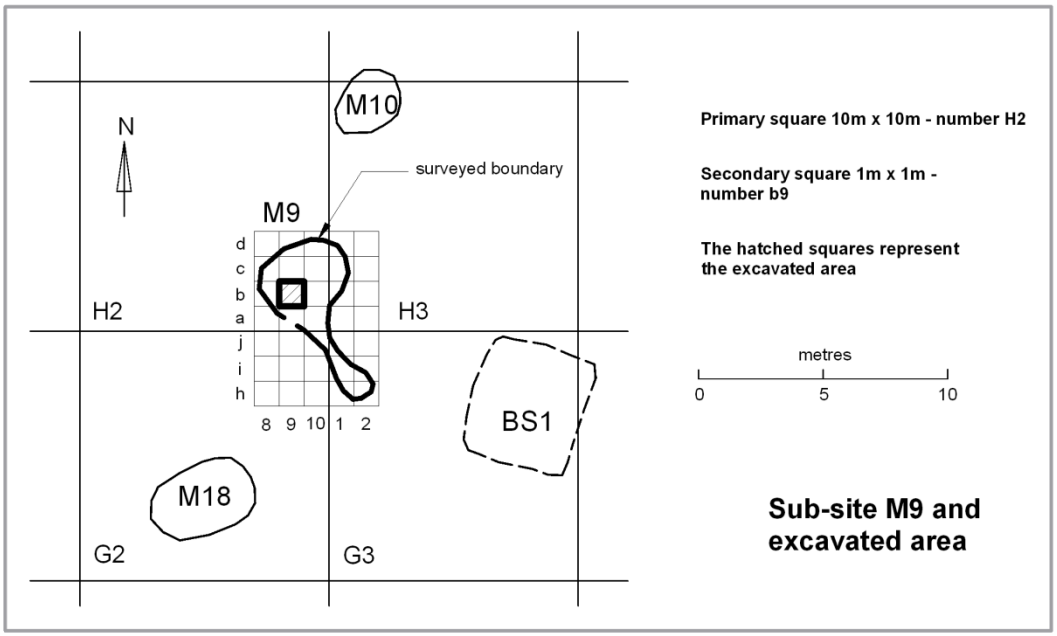


Figure 80. Sub-site M9 and excavated area

Midden M15

This midden had not been on the original excavation list, mainly because of its relative closeness to M16 and SS2. The plan was altered due to the chance find of a large number of nails on the surface, including a hand forged rail nail and a range of other metal fragments, nuts, metal pins and large steel rivets. Also found on the surface were bone fragments, glass shards, and a number of shards of ceramic white ware - a total of 32 artefacts. A significant find was an undamaged white 'milk glass' jar with a screw top rim.[1] The jar has raised lettering on the base with the word OATINE. More detail on this find is given in Chapter 11 and 12.

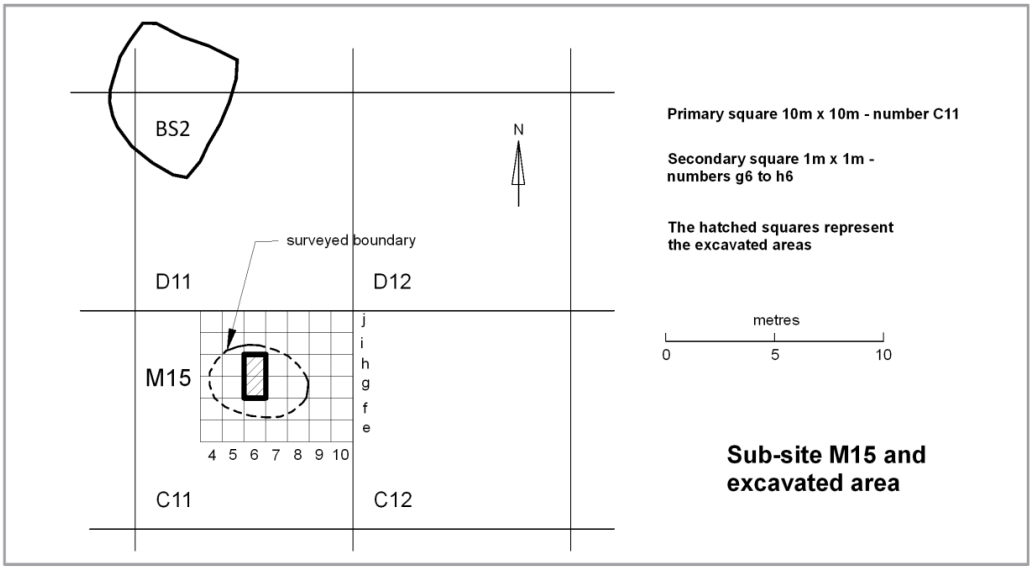


Figure 81. Sub-site M15 and excavated area

The midden is approximately 4 m in diameter and was therefore placed in the category of small/medium size. It measured 35 cm above ngl in the middle. It was decided to excavate a 2 m x 1 m area. Initially this was done with the first layer 0-10 cm. As very little was found in the one square (g6) it was decided to stop at the first level, but to continue excavating (h6). This square, eventually via a 60 cm x 25 cm excavation, reached a depth of 40 cm below ngl. A total of 189 bones and bone fragments were recovered with a mass of 0.6 kg. The metal artefact count was also high at 74 artefacts. The total count from such a relatively small excavation was 310 artefacts with a combined mass of 1.2 kg. The excavation of this

[1] White 'Milk Glass' – this term is discussed in Chapter 11 under ceramics.

midden showed that in such a small volume all 5 major categories of artefact were found. The midden was wholly of a light grey fine ash with no detailed stratigraphy.

Midden M16

M16 was classified as a medium size midden and although the surface collection was very poor, with only 1 item of glass being recovered, the excavation of the midden developed into the second largest collection of all 5 categories. Volumetrically, it also became the second largest excavation at 1.42 m^3. It was one of the first middens to be excavated and so led to high expectations regarding artefact count and variety from other middens. The plan below shows that the midden covered an area approximately oval in shape, measuring 5.5 m long x 4.5 m wide and 55 cm above ngl. The profile north - south is interesting in that it appears to have developed as a 'ramp up and dump shape' with all of the different strata following a similar pattern (Figure 83). The material of the midden varied from several soil layers to interlaminated layers of fine grey ash to a brown ashy soil. Just above the ngl, at about 60 cm, there was a stony soil layer with ash, but it was largely barren of artefacts.

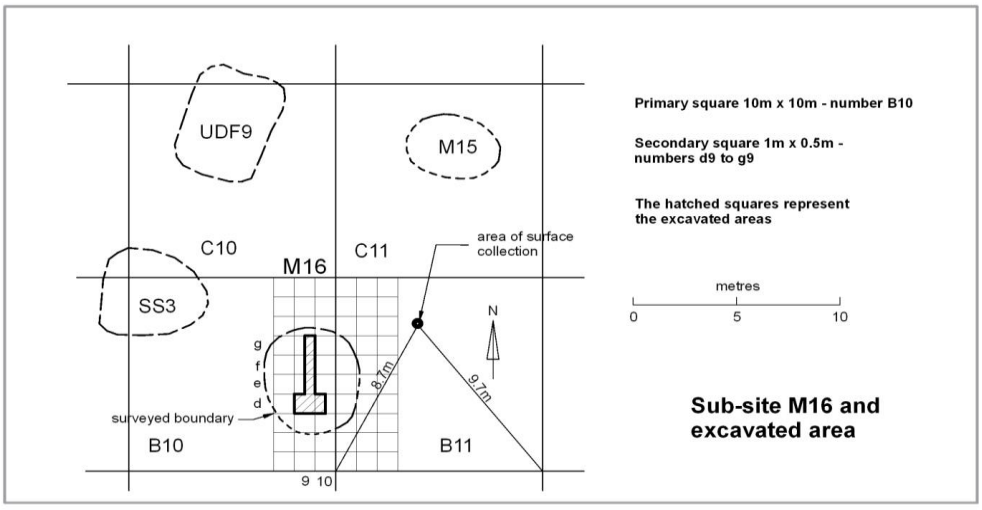


Figure 82. Sub-site M16 and excavated area

Because this was the first medium size midden to be excavated, it was decided to dig a trench 4 m long x 0.5 m wide. While it showed that the recovered material was significantly high for the volume removed and all 5 primary categories of artefact were recovered, due to the physical restrictions of the width at depth, it was decided to open the deepest part of the trench (d9) in M16 to a width of 1.5 m to understand the spread of artefacts and the results are shown statistically in Chapter 11.

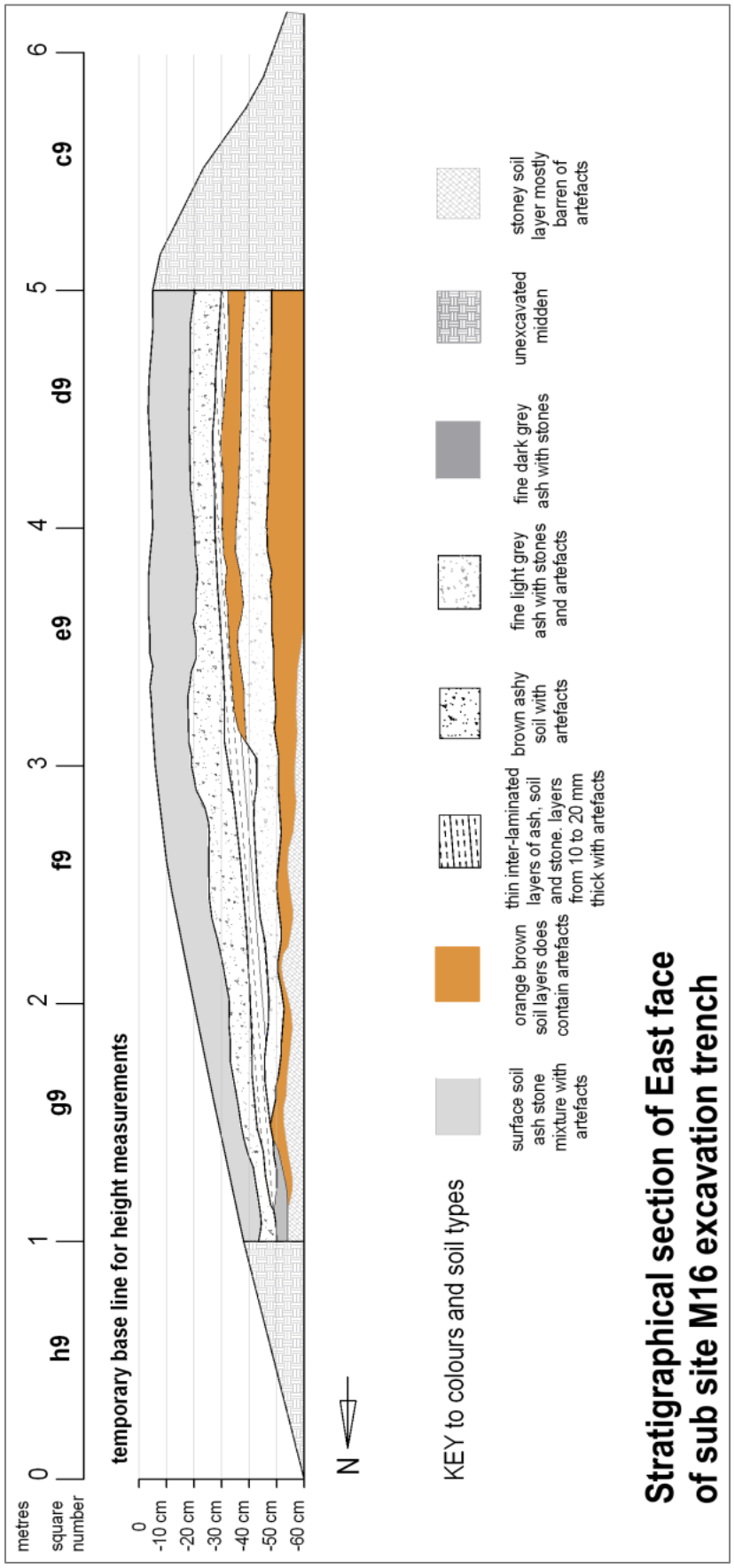


Figure 83. Stratigraphical section of East face of sub-site M16 excavation trench

The eventual collection of artefacts from M16 amounted to 581 items, with a mass of 4 kg. The two highest categories were bones at 335 individual items, at a mass of 1.2 kg, and metal artefacts numbering 160 items with a mass of 1.6 kg. The metal items consisted dominantly of nails and oxidised flat metal fragments. The ceramic artefacts consisted of a wide range of porcelain, stoneware, glazed white ware fragments, some of which were decorated or had maker's marks. There were 15 glass shards showing a range of colours.

Midden M17

This midden measured less than 4 m^2 in area with a height of 20 cm above ngl. It was chosen for excavation because a partially buried neck and top rim of a bottle were noted. Secondly it was one of the few obvious middens in the south central part of the main excavation area. It was decided to grid the midden with two adjoining 0.25 x 0.25 m squares in grid squares (b2) and (c2), an area which included an eventual 39 bottle fragments. The fragments were cleaned and temporarily reconstructed into a bottle with a deep base recess. Other items recovered from this small excavation were 57 ceramic shards, a few bone fragments and some oxidised nails. Considering the very low volume at 0.025 m^3 of light grey ash that was excavated, reaching ngl at 20 cm the number of recovered artefacts was high.

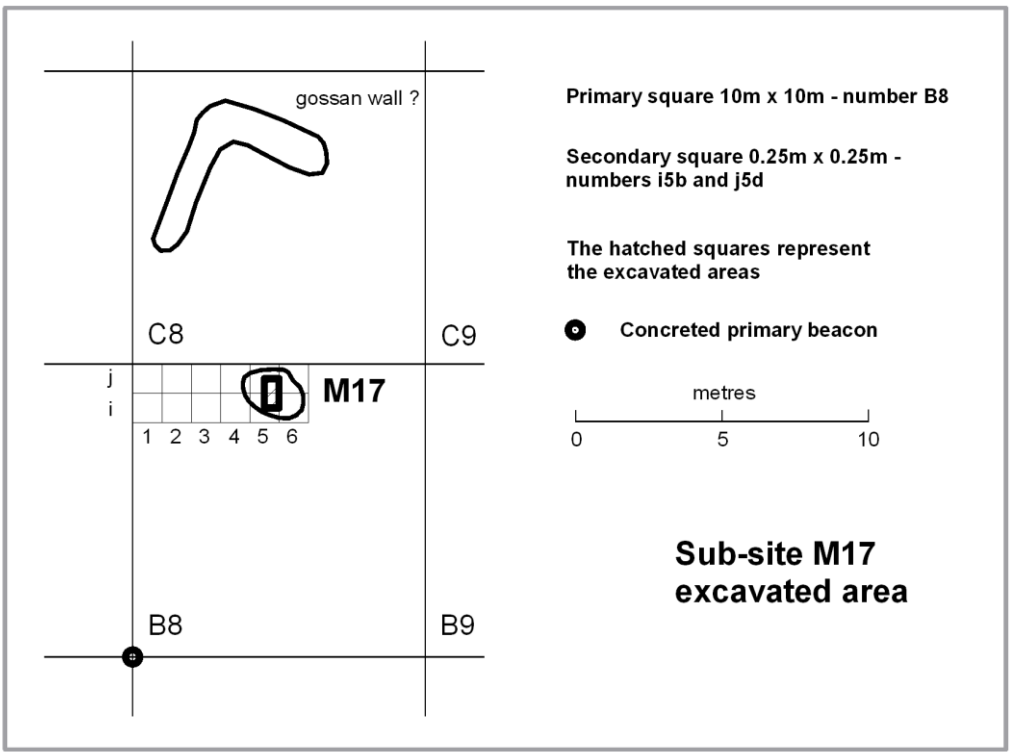


Figure 84. Sub-site M17 and excavated area

Midden M22

This midden was investigated, but nothing was found on surface. The midden measured 3 m x 1.5 m x 20 cm above ngl. Some surface trowelling was done in a few places, but very little was seen or recovered apart from 7 pieces of glass with a mass of 0.7 kg. One of the pieces was a thick bottle base with the letters UGB and A239 S4. The UGB stands for United Glass Bottle Manufacturers, a UK company dating from about 1913. The material of the midden was mainly soil with traces of grey ash.

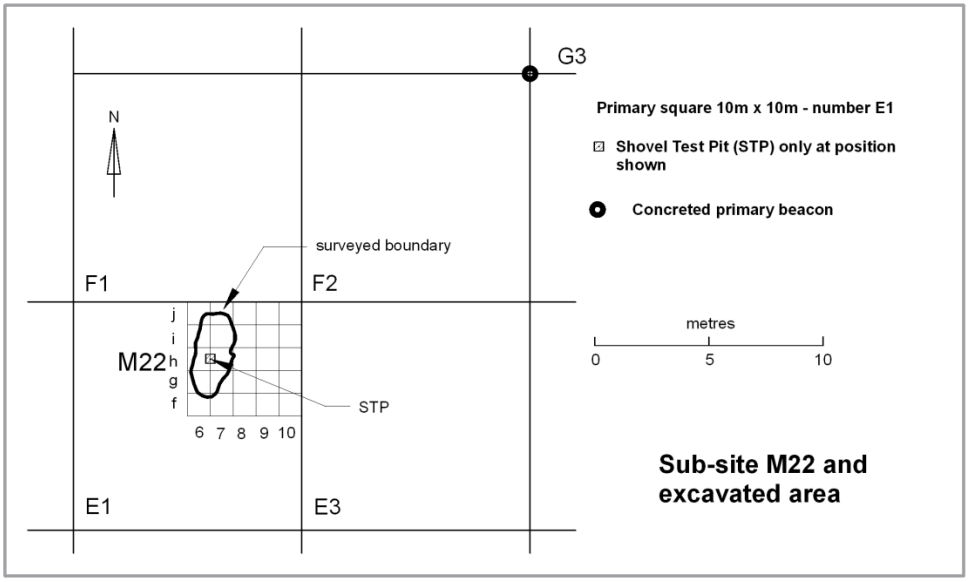


Figure 85. Sub-site M22 and excavated area

Midden M23

This was the first midden to be excavated. This site, although small, provided evidence that excavating the middens could provide a wide selection of artefacts. Categorised as a small midden, it was pear shaped in plan being 6 m long but only 2.5 m wide at its widest point and about 15 cm above ngl. The material consisted of ashy light brown soil. No stratification was observed. A 1 x 1 m square was excavated over a nominal depth of 15 cm before ngl. Some bone fragments including a sheep (*Ovis aries*) jaw bone were found, along with various nails, glass and ceramic shards - a total of 25 artefacts.

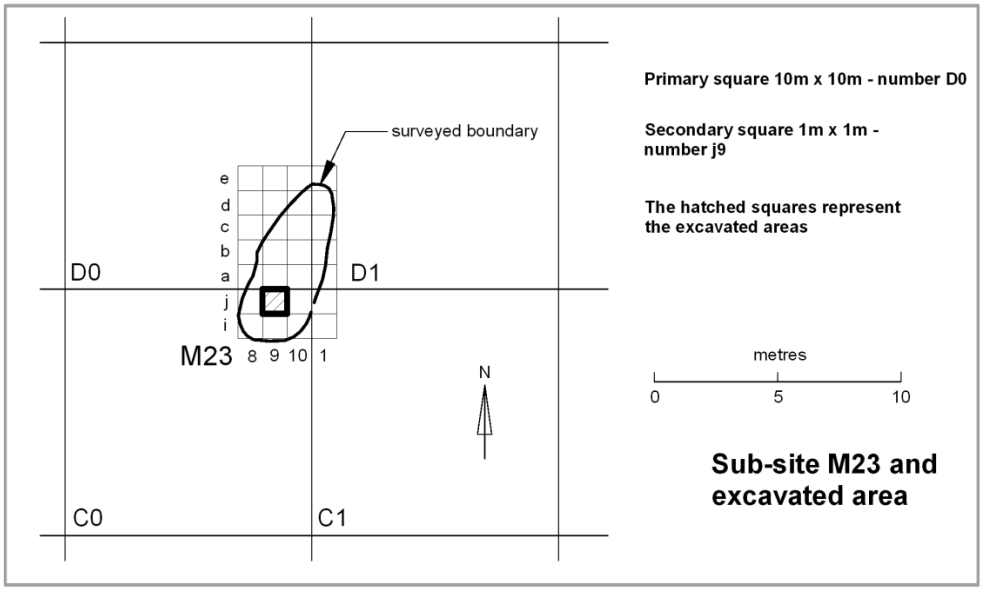


Figure 86. Sub-site M23 and excavated area

Midden M24

This midden is described under the BS4 excavation.

Midden M25

During the period when M24 was excavated, another small midden M25 was also investigated. This midden was only about 1 m in diameter and 20 cm above ngl. No excavation was carried out and only one item of ceramic was recovered as a surface find.

Midden M26

This was another of the small middens originally considered of little significance until two bottles were found. The first was found partially buried during the survey period. It consists of a clear glass bottle and is the only bottle or top/neck of a bottle found with the partial remains of a cork. It is only 31 mm diameter, has a short neck and is only 87 mm high. The second bottle was also partially buried and had not been seen during the survey period. It was a brown screw cap bottle, with the raised embossed name KRUSCHEM SALTS on it. When research was conducted on this make it was found to be a patent medicine as is discussed in Chapter 11 and 12.

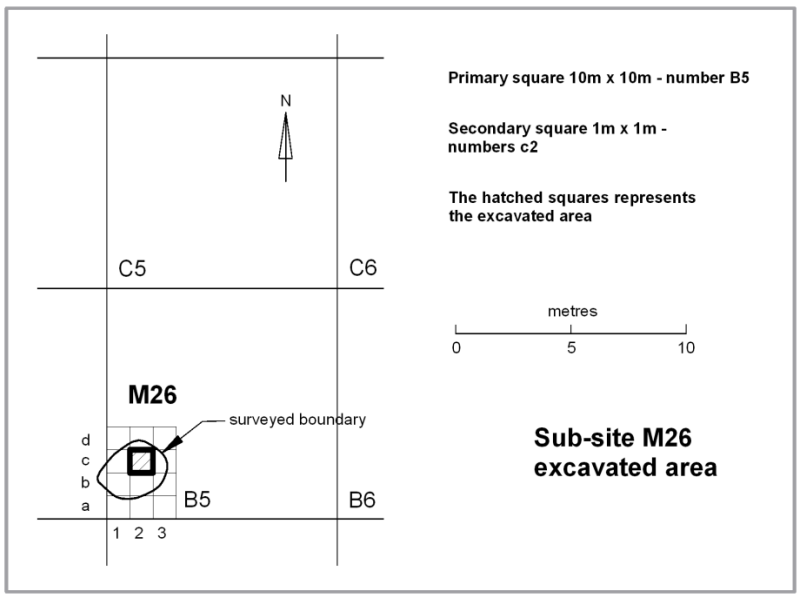


Figure 87. Sub-site M26 and excavated area.

The material of the midden appeared to be a mixture of light grey ash and orange soil. The midden is about 1.5 m diameter and 30 cm above ngl. Only surface recovery was undertaken on this midden.

Midden M27

This midden was close to the SS2 foundation structure and during the setting up of the grid lines for SS2 this relatively small 2 m diameter midden was inspected for surface artefacts. Two surface finds were made; a large square metal nut with a 1 inch diameter thread and a rim piece of decorated porcelain tea cup with thin parallel blue bands.

Structure Foundation SS2

This structure was partially visible as a dressed stone foundation, rectangular in plan. It was decided to try and delineate the walls by exposing three corners and extrapolating the third. When the satellite survey had been conducted, the shape of the mound indicated a rectangular structure. When the excavation proceeded it was found that the walls did not match the shape of the mound. This can be seen on the plan drawing below. As the west wall of the structure was cleared of grass and soil the north-west and south-west corners were found as shown on the plan. It became clear that the structure was more to the east than the mound profile had indicated and the north wall was exposed revealing the eastern corner.

A series of 1 x 1 m to 1.2 x 1.2 m squares were excavated to 20 cm below ngl thereby exposing the lowest row of dressed stone blocks of rock approximately 20 x 20 x 20 cm in size. The line of the eastern wall was tested by STPs but no trace of a foundation was found.

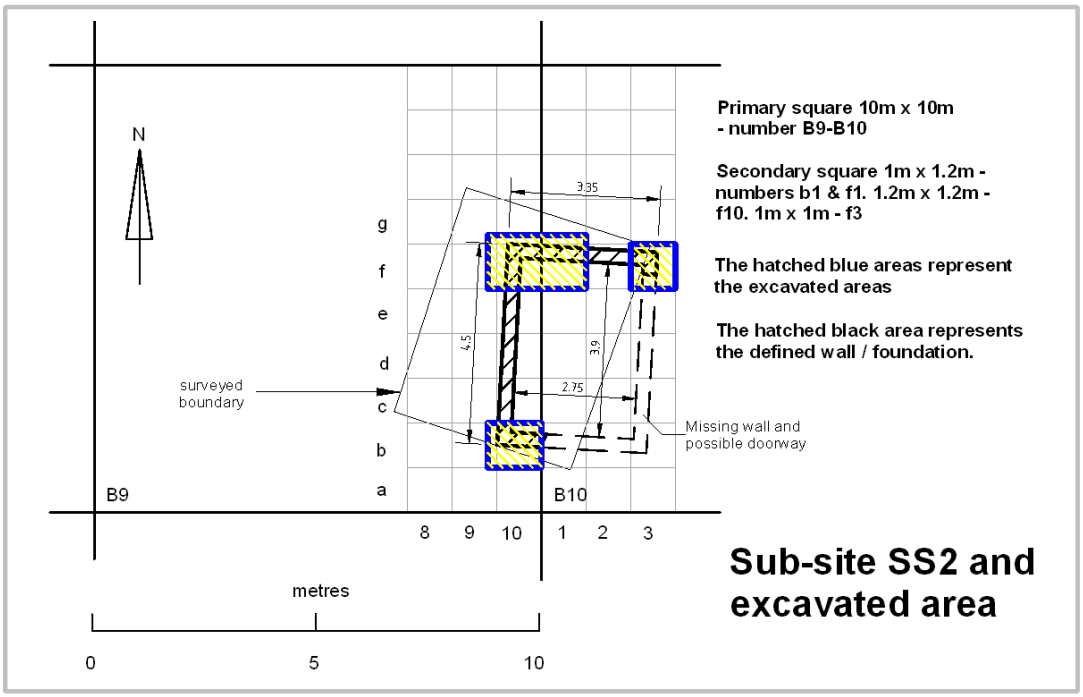


Figure 88. Sub-site SS2 and excavated area

A total of 12 artefacts were recovered consisting of a nail, part of a metal can lid, and some glass shards. Part of a dressed stone wall was developed with only the eastern wall and south-eastern corner not being found. No doorway was found in the foundation that was excavated, and so it has to be assumed that it was originally on the eastern wall of the structure. The use of dressed stone in this structure probably meant that some of the stonework of the TSM buildings was re-purposed. 13 clay bricks lying flat on the inside of the north-west corner of the structure may have been a floor, but no more were found in any other part of the structure and so it is inconclusive as to their purpose.

Structure Foundation SS3

This was one of the most noticeable foundations, built seemingly from large ± 20 cm chunks of local rock. The rock seen on SS3 was mainly gossan – a type of iron oxide rock typically found covering the surfaces of ore veins and it would have been present on the veins at Argent. The foundation was raised above ngl, and measured approximately 4 x 2.75 m with the height above ngl averaging 60 cm.

During the initial survey period of this part of the primary excavation area, part of a metal hoop was seen. It was decided to excavate the metal object to ascertain what it was. After a lengthy excavation period it became clear that it was the remains of a riveted metal band around and still attached to a wheelbarrow bucket. The bucket part was mostly unrecoverable due to its complete oxidation making it friable to the touch. The metal hoop and some parts of the attached bucket were recovered.

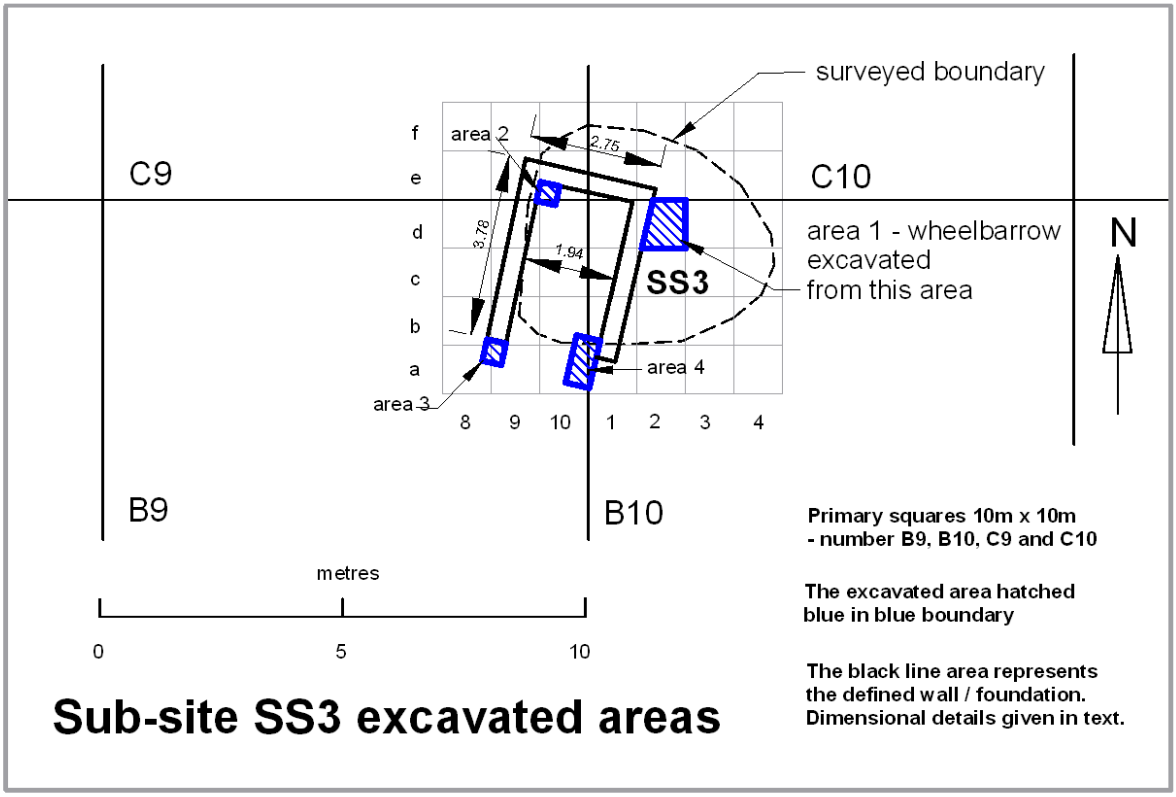


Figure 89. Sub-site SS3 and excavated area

It was decided to test the site in three separate areas of the foundation labelled 2, 3 and 4. Area 2 was excavated as a 0.5 x 0.5 m STP to a depth of 60 cm, at which point the remains of a round metal lid were found. The wall was found to continue to this depth which placed it at ngl. The wall at this point formed a corner and was reasonably well built, considering the material used was rough rock, generally round in shape. Area 3 measured 0.25 x 0.25 m and was aimed to test the possibility of a floor and extension to the wall below visible ground level. On reaching a depth of 10 cm below the grass/soil level, hard compact ground was found with the wall layer just below its surface. No artefacts were found in this area. Area 4 was 1 x 0.5 m in area. It also reached a depth of 10 cm below the grass roots level and indicated compacted ground similar to area 3.

The base of the wall was also seen to be 20-60 mm below the compacted ground level. The floor area of the structure sloped up from areas 3 and 4 to the closed end at area 2. No wall was found closing off the south end of the structure and there was no evidence of poles or corrugate sheeting fragments. The size of the foundation was considerably smaller than structures in the centre and western half of the 'native location'. It is also located downhill from the majority of the structures in the 'native location' and coupled with its small size it is postulated that it may have been the residence of a member of the poorer section of this community. Although some artefacts were recovered namely glass, bones and metal, apart from the wheelbarrow frame nothing was of significance.

Structure Foundation BS4

Of all of the visible surface foundations in the 'native location' area, BS4 represents one of the largest. It is considered to be unique from another aspect, namely that it is the only two roomed structure found mostly above surface. This does not preclude the possibility of more being sub-surface. On clearing of the grass roots partially covering the foundations the initial excavations were at the corners of the middle wall as these were the most obvious. From these two points, it became clear that the walls did not follow the outline of the raised area as plotted during the satellite survey, although in general terms the variation was within 1 m. The foundation was constructed wholly of fired clay brick and from the visible surface there were only two or three courses to a soil level foundation. No concrete foundation existed. The brick walls were exposed on both sides of the wall to a spade width trench. In some cases mortar was seen between courses. On one corner of the structure (i9) clear evidence of floated plaster was found on the outside of the wall indicating that this structure may have been externally plastered, although there was no evidence of plaster on the remaining parts of the internal brickwork.

On day two of the excavation, it was decided to expose all of the walls and during this period it was discovered that a doorway existed in the external eastern wall of the northern room. No inter-connecting doorway opening was found in the middle wall. Similarly, no doorway was found in the external wall of the southern room. However, there was a gap in the brickwork of approximately 3 m on the east side of the wall and it may be that either no doorway existed or the foundation bricks were 'robbed', thus destroying that part of the wall.

A thin layer of semi-mouldable clay between 3 and 6 mm thick was found by the brickwork of the middle wall in the southern area. An STP was put down in the area as shown on the plan (Figure 90) but apart from a thin area of the same clay nothing else was found.

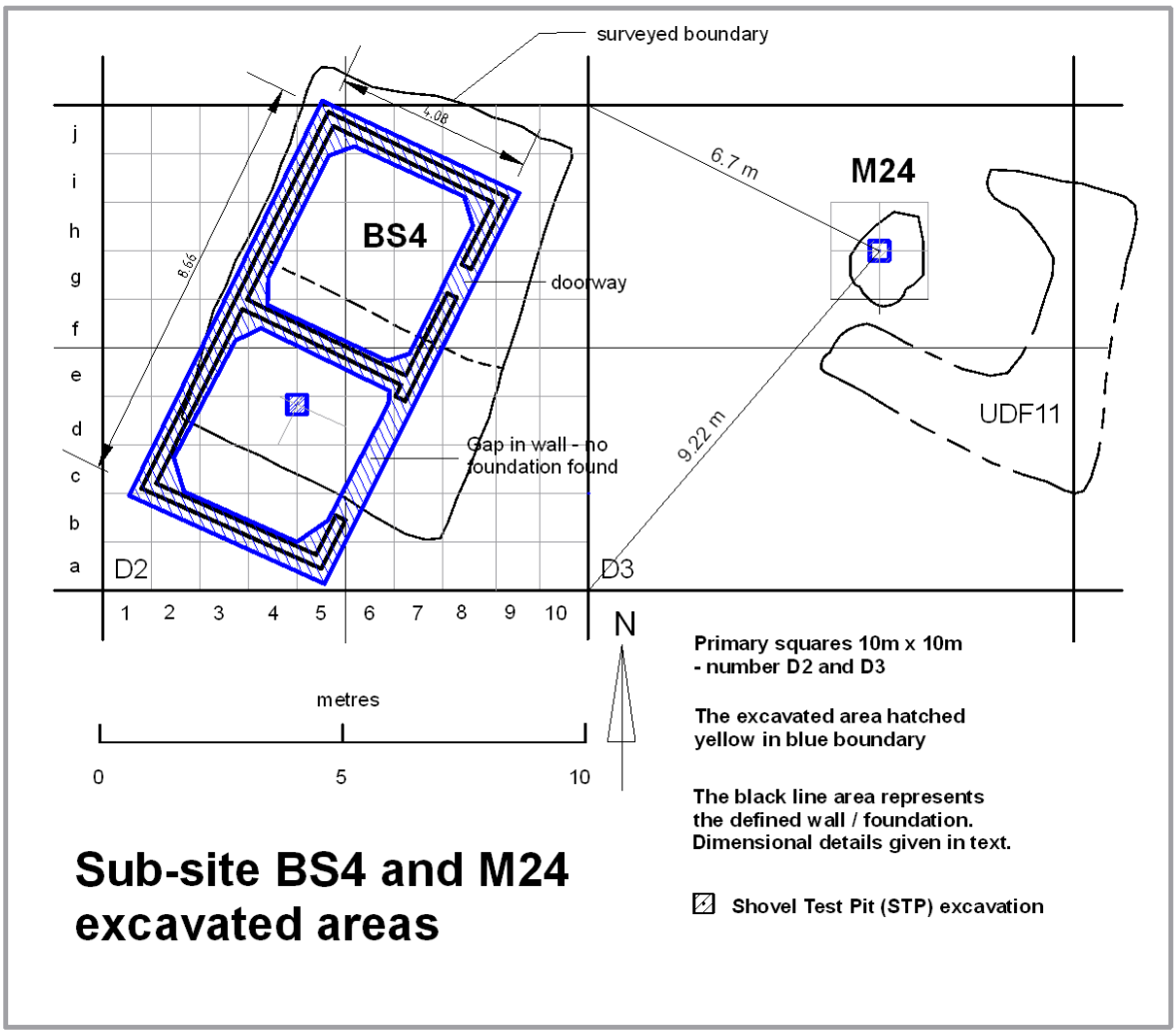


Figure 90. Sub-site BS4 and M24 excavated areas

No bone fragments were found in this excavation. Metal artefacts consisted of nails, flat and corrugate metal fragments. Ceramics was limited to 2 items of glazed stoneware and glass recovered consisted of shards of green bottle glass. The miscellaneous category provided some interesting, but unclear artefacts. They consist of metal springs with wooden pegs in the middle of the spring and in some cases an outer sheath. They may have been the spring parts of a chair, which I believe is more likely than a bed.

Surface area collection in B3-B12

This was conducted on the last day of excavations to try and ascertain if there was a pattern of surface artefacts over a given, wide demarcated area, in this case 10 x 100m. Although the area chosen did include three category small middens and one medium size midden and the SS3 foundation, the surface artefact count on all five, combined, totalled 10 items of glass, 1 of ceramic and 1 of metal. By comparison, the count of artefacts for the area as a whole was glass: 29, ceramic: 35, metal: 13 and miscellaneous: 4, giving a total count of 81.

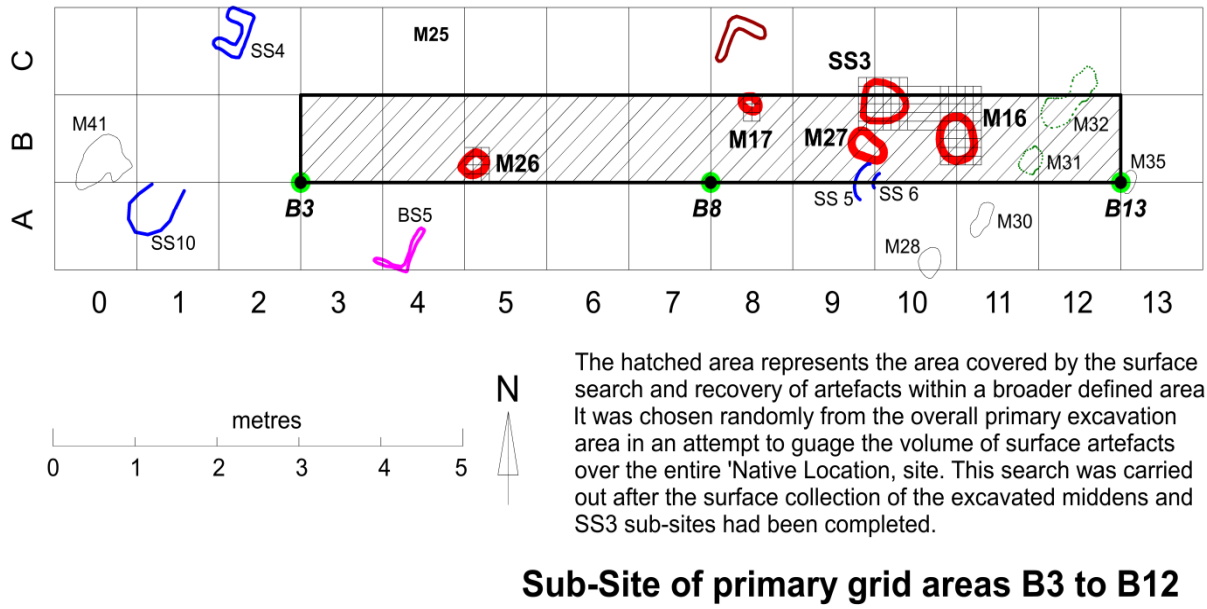


Figure 91. Sub-site of primary grid areas B3 to B12

If the combined area of the 5 sub-sites is taken at approximately 40 m^2 with the surface yield of 10 artefacts, and the larger area of 1 000 m^2 yielded only 81 artefacts it means that the average yield for the large area was 1 artefact per 12.4 m^2 compared to the middens at 1 artefact per 4 m^2. The problem associated with the general surface collections, is that bone or bone fragments are rarely found close to the surface as they degrade in the open air or close to surface environments. Metal objects seem to vary in survival, with thin metal - cans for example - rarely surviving due to oxidation eventually leading to destruction and the heavier objects merely rusting. The glass fragments consisted of clear, brown, green and cobalt blue glass. One piece had a clear purple tint to it, but this is most probably glass that has been affected by sunlight. One undamaged Vaseline jar was found, as was a small rectangular bottle typical of patent medicine shape and size - with raised letter of ‘Blain’s

or Plain's' - on the side. The ceramic found consisted of much the same variety as the middens, porcelain, earthenware and stoneware items of plates and cups. The metal items from this area were interesting and consisted of nails, plumbing fittings a very large piece of thick metal plate, part of a metal shovel and a steel rail sleeper which is discussed in more detail in chapter 11. One of the most interesting miscellaneous items - more so for its human story - was a coin - a 1918 King George V penny.

CR Area

This area was found by one of my team members[1] and it produced a strange anomaly of surface and sub-surface finds in between middens M15 and M16. Although a range of glass, ceramic and metal artefacts were found in this area, three finds of significance were discovered. One was a near complete but broken clear glass hexagonal shaped bottle consisting of 26 pieces.

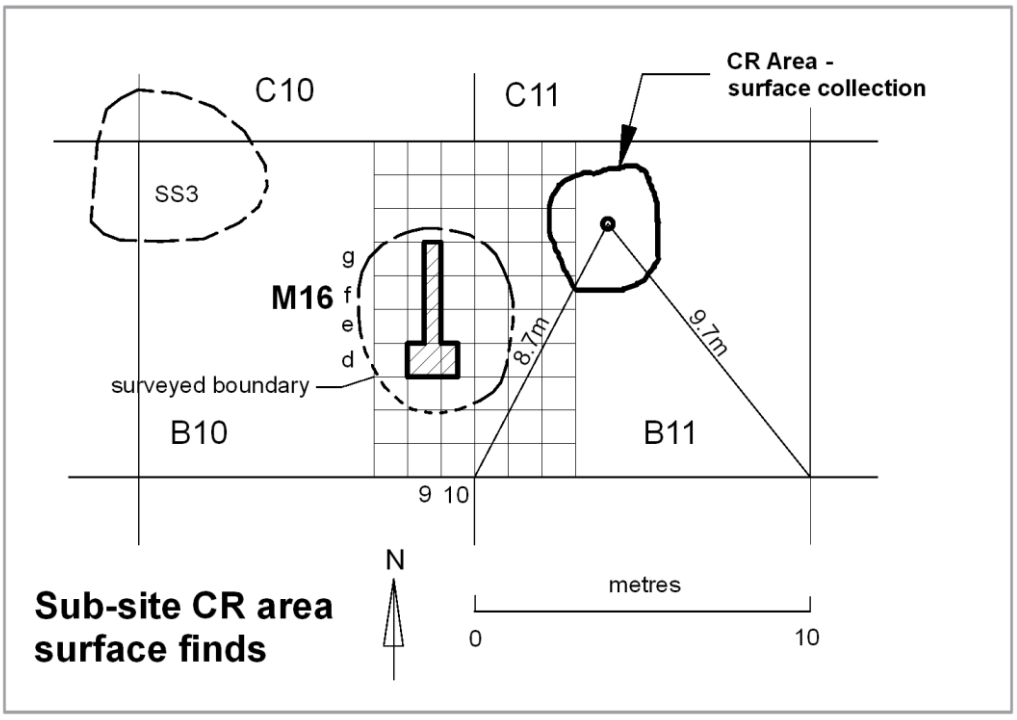


Figure 92. Sub-site CR area surface finds

This bottle was temporarily reconstructed and a search was carried out on the internet to try and identify it. The closest look alike was a Holbrook's chutney jar. Another item consisted

[1] My Daughter in Law - Christine Reeks (CR) - although not a trained archaeologist, quickly became adept at finding some of the most interesting bottles.

of a piece of clear moulded fluted glass with the name Roses on the side. This could only be part of a Roses cordial glass bottle. These two items are photographed and discussed further in Chapter 12 Also found was a large cast steel pipe fitting with an internal thread approximately 130mm diameter and a wall thickness of 15mm.

The following areas are sections of the mine where, during various pedestrian surveys, artefacts were seen on the surface.

During such searches and mapping, artefacts were collected and catalogued with respect to a defined area. The main object of such searches was to try and present an overall picture of the archaeological evidence of the mine as a whole. There was not a specific program of searching of these areas. The areas were not surveyed and searched at the same time and this is the reason that the one area, namely B, seems out of order with the other two:
A and C.

Area A – 1920s Roasting and Smelting plant

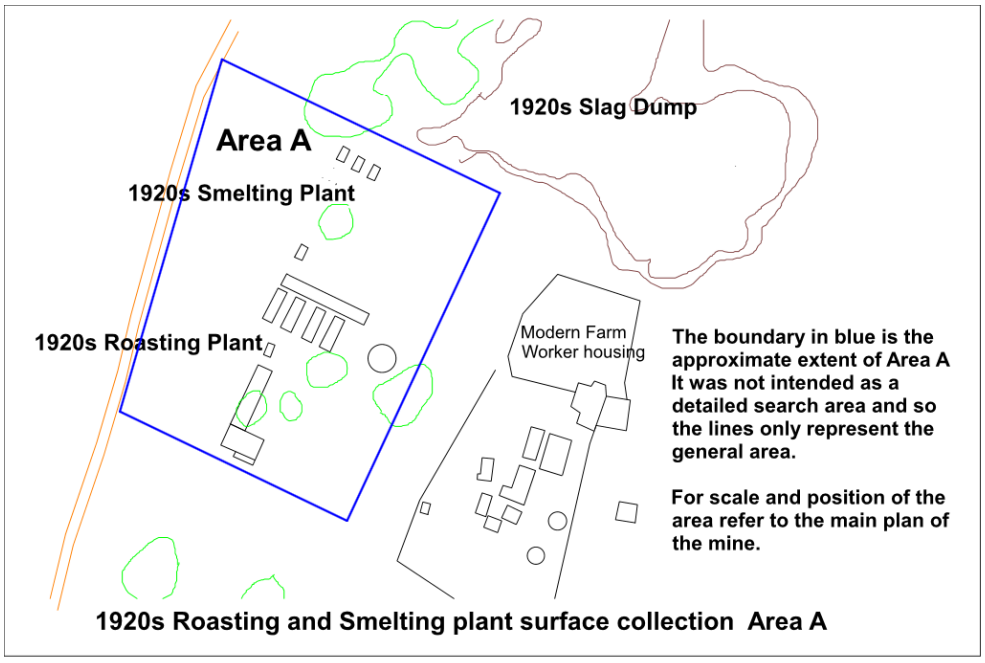


Figure 93. Roasting and Smelting plants surface collection

The main focus of investigating this large area was to understand the foundations in relation to the known machinery used in this plant. A total of 37 artefacts were collected from this

area. These were 6 hand forged rail nails. Bottle fragments consisted of bases or neck shards, some with raised lettering, but in all cases only some of the lettering remaining. The colours of glass ranged from clear to various shades of green to brown and typical medicinal cobalt blue glass. The ceramic collection has the base of a small, diameter 55mm, brown salt glazed stoneware pot - but the top part is missing. The other items are porcelain, semi-porcelain or earthenware shards. The miscellaneous collection consists of solidified lead samples and a ceramic sampling cup.

Area B – 1890s Concentration plant

It was thought that there was a lot of potential on this sub-site. Certainly with the help of the historical photograph[2] it was possible to locate the foundation areas for each wooden column of the original building (Figure 19). Internal dressed stone foundations indicated a potential office area possibly for the sub-manager of the concentration plant. Trowelling exposed a stone step up into this structure. It measured approximately 8 x 8 m, and can be seen on the survey plan below. A few miscellaneous items were found, such as two ceramic sampling cups and underneath one of the foundation dressed stones the remains of a leather shoe sole.

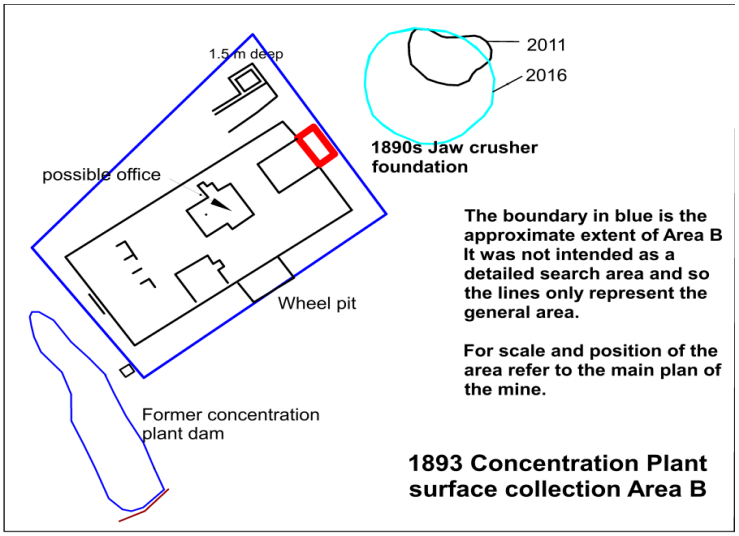


Figure 94. 1893 Concentration plant surface collection Area B

How this shoe or boot sole survived is difficult to explain other than most of it was buried under the dressed stone which at the time seemed out of place where it was and thus was lifted to investigate.

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[2] NASA, Pretoria. Depot TAB, Source CJC. Volume no 43, Ref. CJC796 – Claims for Compensation British Subject Transvaal. Pretoria. Transvaal Silver Mines Limited. 1903-1904. The photograph of the 1893 Concentration plant was one of 4 negatives in the file and is reproduced as (Figure 19).

The dressed stone foundation block is discussed under the 1890s Jaw crusher area later in the chapter. The other features of this sub-site are the large wheel pit – the location for a large flywheel which would either have been on the output shaft of an engine - probably steam – or mounted on an intermediate shaft driving overhead belts which would have been used to drive the various machines in the building. A flywheel was used to store rotational energy. Because flywheels have what is defined as the moment of inertia they resist changes in rotational speed. The steam engine that would have been the driving source for the belt driven machinery in the plant, by its nature, provides intermittent torque output, but this is balanced out by a flywheel. Also recognised at this sub-site were the remains of a small dam wall and a hollow area that would have contained the water for the plant.

Area C – 1920s crushing plant foundation area

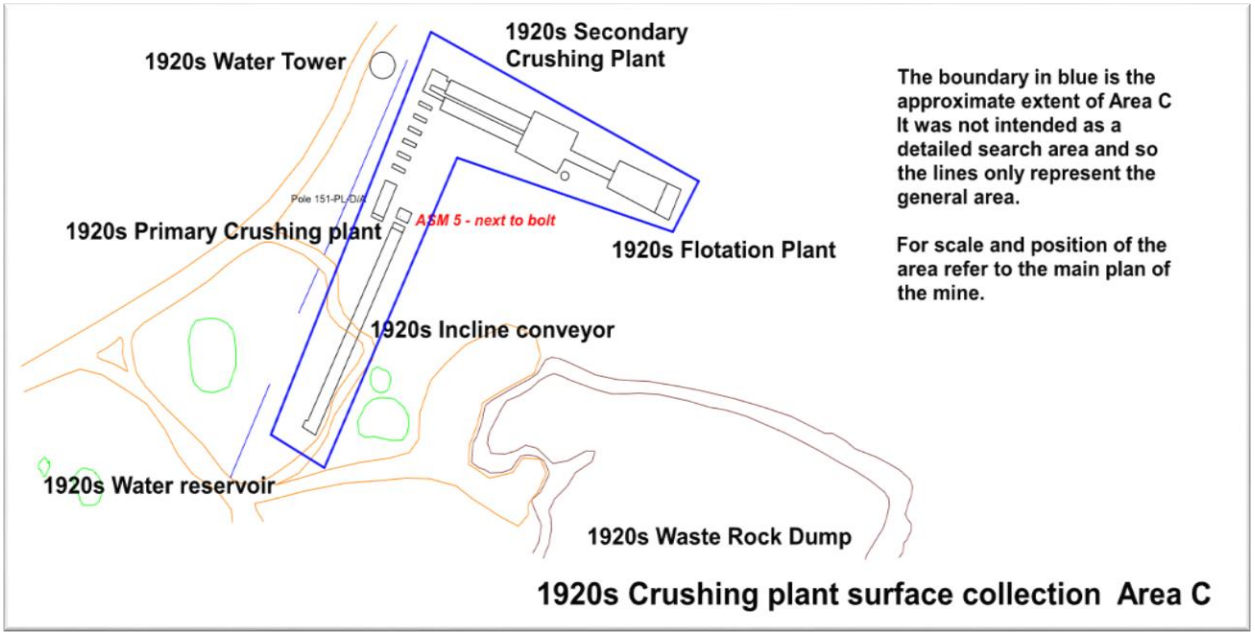


Figure 95. 1920s crushing plant surface collection Area C

As can be seen from the plan (Figure 95) and the historical photographs in Chapter 5 this area consists of an L shaped series of structures. It is dominated by the Hardinge Ball mill and the flotation plant foundations, which is the area where all of the artefacts were found. The one interesting artefact, as it was the only one of its kind found during the entire survey and excavation period, was an enamel metal drinking cup. Recovery of more of this type of utensil was expected, especially in the middens of the 'native location', but none were found. Although natural decay through oxidation could explain the lack of such vessels, it is

negated by the fact that metal can remains were found and they would be more susceptible to decay than enamelled ware. Eleven ceramic artefacts were found, mostly fragments of earthenware cups. The most noticeable metal item found in the remains of the Hardinge ball mill area, was one of the metal grinding balls 65mm in diameter. Other items found were typical of an area with machinery i.e. bolts, nuts and large rivets. As with the roasting plant area there were also bottle glass shards ranging in colour from clear to green to cobalt blue.

1890s black miner compound and midden area

From the surface survey, the compound apparently consisted of three buildings laid out in a u-shape formation with one midden to the west of the one building. The foundations had been constructed using dressed stone blocks, on average a 20 cm cube. The midden was located during the survey and it appeared to cover an area of roughly 6 x 6 m, although it was only about 5-10 cm above ngl in the middle. During the survey period only one midden was found and delineated. No other middens were found, but high grass cover prevented visual identification of other low middens associated with the three buildings. Before any additional closer sampling could take place the one midden and the foundations were destroyed as outlined in the next paragraph.

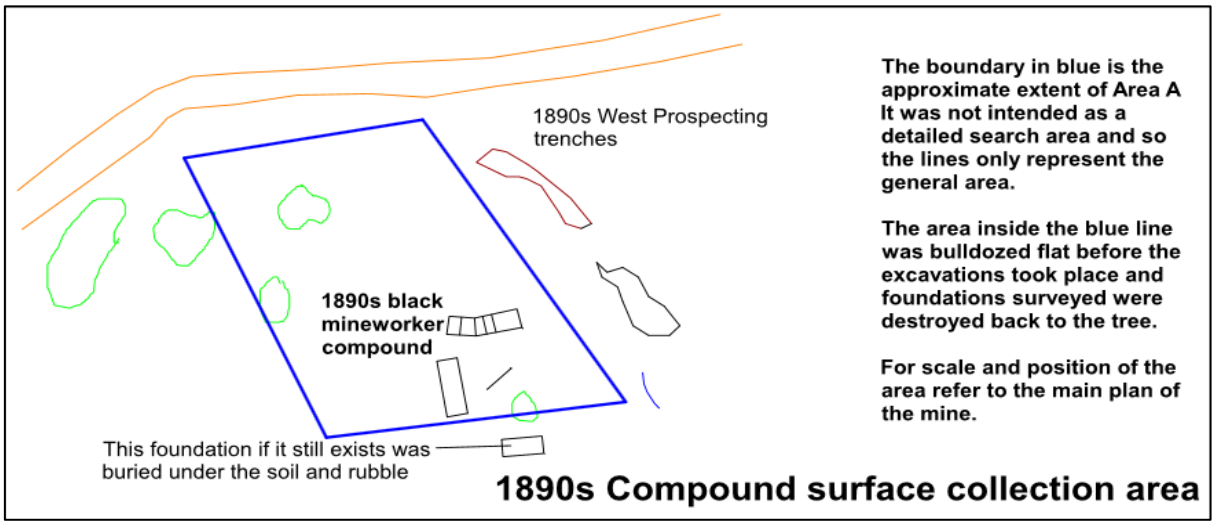


Figure 96. 1890s black mineworker compound surface collection

Unfortunately, before excavations could take place the farmer had fertiliser delivered by a contractor and the area had been levelled with a bulldozer destroying the remains of the foundations of the 1890s compound and associated midden. In an attempt to recover as much artefact material as possible it was decided to map the area and carry out a detailed pedestrian

collection of all artefacts remaining on the scraped surface. Although all ‘specific area context’ has been lost, the artefacts that were recovered from this area can comfortably be defined as being from the 1890s black miner compound, as according to the 1890 and 1920 mine plans there was no other structure or midden close to this particular area in the 1890s or 1920s.

A total of 381 artefacts were recovered, amounting to just over 7 kg. The area yielded all five of the major categories of artefact including 10 very weathered and fragile bone fragments. There were 136 ceramic artefacts recovered, the materials included porcelain, white glazed earthenware and glazed and unglazed stoneware. Some of the items were decorated and consisted largely of rim pieces of cups or plates, but only in four cases did some of the pieces match together, but never more than 3 shards.

The glass artefacts amounted to a total of 181 pieces. Many of the individual pieces had some name/word or letters as part of a word. One glass bottle base had the name KILMARNOC WHISKEY on it in raised letters and Kilmarnoc is the town in Scotland where the Johnny Walker Whiskey distillery is located. Another good quality item was a clear glass bottle stopper with the raised letters HOLBROOK on the top face. Again these items are photographed and discussed in (Appendix 5). It is interesting that similar named items were recovered from the 1920s ‘native location’. One of the items found was a clear glass bottle base, but the shape and radius of the bottom indicated that it may have been a Codd bottle – the only potential one found in the excavations. Apart from the clear glass shards, also present was cobalt blue medicinal glass, brown, green and aqua coloured glass, again very similar shades to the 1920s glass.

There were only six miscellaneous items found, of which three were interesting. A collar or shirt sleeve button – 10 mm in diameter. A low fired, coarse grained brick, possibly an example of the type made by the Transvaal Silver Mine company in the 1890s. Also found was a piece of wall plaster which may indicate that the structures were possibly plastered. Apart from the seemingly common - at Argent - hand forged rail nails, which were found on surface and in the excavations, other metal items included large plumbing fittings, a vee pulley wheel, metal flakes of cans, and normal ferrous metal nails.

1890s Jaw crusher area (see Figure 94 for location of sub-site)

In conjunction with Area B the 1890s concentration plant, one metal item was found at the foot of the 1890s dressed stone foundation on which the Blake Jaw crushers were mounted.

The item was a 30 mm diameter x 200 mm long square headed bolt and this may have been part of one of the jaw crushers.

Primary Grid square A6 (see Figure 91 for location of sub-site)

In walking over the area surrounding the main excavation site a very interesting and near perfect artefact was seen on surface and is catalogued as a 'saw metal warranty peg'. It would have been fitted in the handle of a saw by the manufacturer as a symbol of quality. Once again it was researched on the Internet as support for its identification and is photographed (Appendix 5) and discussed in Chapter 12.

10.3 Conclusion

This completes the description of each sub-site and the associated significant finds of artefacts from those sub-sites. Naturally, space precludes the detailing of each artefact and for the majority of the artefacts they were fragments of bones, or shards of glass and ceramic or hundreds of flakes/pieces of oxidised metal cans or roofing material. The next chapter looks at the sites with the significant numbers or types of artefacts, to determine statistically if there are any mathematical trends in the assemblages. Individual artefacts of significance, including references to information downloaded from the Internet detailing such items and photographs of the artefacts described are presented in (Appendix 5).

A total of 6 148 artefacts were recovered from the sub-sites with the total mass amounting to 91.909 kg. Virtually every midden excavated, by whatever means as described above, produced at least two or more of the primary categories of artefacts.

The two tables which follow present a combined analysis of the archaeological finds from the various sub sites. NOTE: for full details of each excavation see the plans and individual site descriptions.

Table 10. Showing the sub sites and the detailed analysis of the five categories of artefact recovered by surface collection or excavated material.

Site ID		Category										TOTALS PER SUB-SITE	
		Bones		Glass		Ceramic		Metal		Miscellaneous			
		grams	quantity	grams	quantity	grams	quantity	grams	quantity	grams	quantity	grams	quantity
M2 M3: M4: M5	**surface**			98	4							98	4
	excavate												
M8	**surface**	62	7	889	70	60	10	794	19	232	7	2037	113
	excavate	7237	1851	3967	300	1607	271	24635	1269	8160	481	45606	4172
M9	**surface**			35	1							35	1
	excavate			25	1	71	9	1707	2			1803	12
M15	**surface**	16	3	93	1	151	18	404	9	2	1	666	32
	excavate	583	189	95	26	65	15	418	74	18	6	1179	310
M16	**surface**			53	1							53	1
	excavate	1154	335		15	368	40	1543	160	743	31	3943	581
M17	**excavate**	27	2	601	39	201	57	38	5			867	103
M22	**surface**			666	7							666	7
M23	**excavate**	125	9	55	6	24	7	58	3			262	25
M24	**excavate**	8	1	9	3							17	4
M25	**surface**					5	1					5	1
M26	**surface**			257	2							257	2
M27	**surface**					3	1	252	1			255	2
SS2	**excavate**	3	2	60	4			73	3	5	3	141	12
SS3	**excavate**	12	4	4	7			5646	54			5662	65
BS4	**excavate**			302	10	11	2	720	69	443	14	1476	95
B3-B13	**surface**			441	29	241	35	8091	13	277	4	9050	81
CR area	**excavate**			1024	43	45	15	1340	1			2409	59
Area a	**surface**			321	13	248	13	276	7	2237	4	3082	37
Area b	**surface**									221	4	221	4
Area c	**surface**			206	17	92	11	1310	6	1538	4	3146	38
Area d	**surface**									296	4	296	4
1890	**surface**	50	10	2586	181	730	136	2366	48	1604	6	7336	381
jaw crusher	**surface**							1326	1			1326	1
grid A6	**surface**									15	1	15	1
TOTALS		**9277**	**2413**	**11922**	**780**	**3922**	**641**	**50997**	**1744**	**15791**	**570**	**91909**	**6148**

Table 11. Showing approximate areas and volumes of each excavation

Excavated volumes			approximate excavation dimensions - length x width x depth for full details see site plans	additional excavation	TOTALS PER SUB-SITE	
Site ID	collection area	volumes excavated			grams	quantity
M2	surface	0			98	4
M3: M4: M5	excavate	0.18 m³	1 x 0.1+3 x 0.3 m x o.3 m x 0.3 m	as STP's		
M8	surface	0			2037	113
	excavate	4.0 m³	5 m x 1 m x 0.8 m	STP	45606	4172
M9	surface	0			35	1
	excavate	0.2 m³	2 m x 1 m x 0.1 m		1803	12
M15	surface	0			666	32
	excavate	0.34 m³	2 m x 1 m x 0.17 m	STP	1179	310
M16	surface	0			53	1
	excavate	1.8 m³	1 m x 1.5 m + 3 m x 0.5 m x 0.6m	STP	3943	581
M17	excavate	0.025 m³	0.5 m x 0.25 m x 0.2 m		867	103
M22	surface	0			666	7
M23	excavate	0.1 m³	1 m x 1 m x 0.1 m		262	25
M24	excavate	0.027 m³	0.3 m x 0.3 m x 0.3 m	STP	17	4
M25	surface	0			5	1
M26	surface	0			257	2
M27	surface	0			255	2
SS2	excavate	0.823 m³	variable - see plan		141	12
SS3	excavate	0.575 m³	variable - see plan	STP	5662	65
BS4	excavate	2.8 m³	variable - see plan		1476	95
B3-B13	surface	0			9050	81
CR area	excavate	0.081 m³	variable - see plan	STP	2409	59
Area a	surface	0			3082	37
Area b	surface	0			221	4
Area c	surface	0			3146	38
Area d	surface	0			296	4
1890 jaw	surface	0			7336	381
crusher	surface	0			1326	1
grid A6	surface	0			15	1
TOTALS		**10.951 m³**			**91909**	**6148**

Tables 10 and 11 were placed at the end of the chapter to avoid the potential for splitting text details on a site.

Chapter 11

Statistical analysis of the five major categories of artefact

11.1 Introduction

The initial analysis of the artefacts recovered indicated five primary categories. These were glass, ceramic, bone, metal and miscellaneous - which covered all artefacts not falling into a convenient general material category. Ironically, as can be seen in (Table 12), the last category was eventually applied to 9% of the total collection.

In compiling the analysis of the various sites and the five primary categories of artefacts (Table 12), it became clear that there were patterns that could be statistically analysed. An analysis of the five primary categories of artefact for all sites was completed, combining the surface and excavated material for each site and the results are presented below.

Of the 27 sub-sites, where excavations or surface collections took place, all five primary categories of artefact were only recovered in three excavated sites and three sites with surface collection. Four primary categories of artefact were recovered from four excavations and three additional sites where only surface collection took place. Sites with less than four categories of artefact were not considered in the analysis due to the lack of statistically comparable data in sites with less than four categories of artefact.

Of all of the sub-sites only two were excavated to any significant depth, thus providing a further option of analysis, namely, comparing the categories of artefact by layer. In each of these options there is also a simple comparison, namely the total number of artefacts in each category.

A number of vertical bar graphs were drawn from the data. With the comparison of each level in the two deeper excavations, the horizontal bar chart was the most suitable as it indicated the richest levels of artefacts more effectively.

The results do indicate some interesting trends or features of the major sites, especially in the results for bone material and metal artefacts. Each table of sub-sites is associated with two graphs, one showing the quantity of artefacts within the five categories, and the other, the percentage of artefacts per category.

The majority of the excavation sub-sites can be classified as 'domestic'. Only in section 11.4 are there two industrial areas associated with a domestic area. Under section 11.6 an analysis has been conducted to look at the breakdown of the range of artefacts from all sub-sites by their primary use. In other words, were the items obviously industrial, domestic or architectural? A further analysis in 11.7 looks at the sub-sub categories of the ceramic types and uses and the glass types, colour and uses. In 11.8 an analysis of the metal and significant miscellaneous items is presented. The bones or bone fragments were analysed by Karin Scott, a freelance professional archaeozoologist, and her analysis and report is Appendix 4.0 and is commented on in Chapter 12.

11.2 Comparison of the totals of Primary artefacts for all sites

(Table 12) indicates the total quantities of artefacts and the total mass for each of the five major categories. The totals are for both surface and excavated artefacts from all 27 sub-sites.

Table 12. Total quantities of the five primary categories of artefacts recovered

CATEGORY	Quantity of artefacts	% of artefacts	Mass total in grams	Mass %
bones	2 413	39.2	9 277	10.1
glass	782	12.7	11 922	13
ceramic	641	10.4	3 922	4.3
metal	1 744	28.4	50 997	55.5
miscellaneous	570	9.2	15 791	17.2

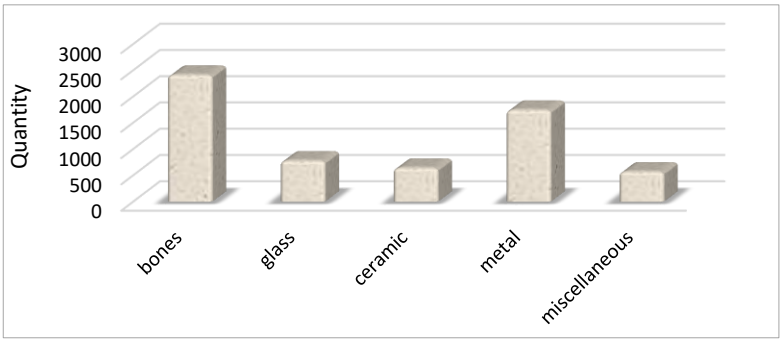


Figure 97. Total quantity of primary artefacts recovered

Interpretation of the results for totals of Primary artefacts for all sites

Clearly the largest collection by quantity are bones and bone fragments with metallic items being the next largest. The other three categories do not show a great variation between them (Figure 97). There will be an analysis below of sub sites M8, M15, M16 and the 1890s compound area, these being the only sites where all five categories of artefacts were found during surface collection or excavation or both. However, surface and excavated material are analysed separately.

11.3 Analysis of surface and excavated collections - three sites with all five categories of artefact.

Only three excavation sub-sites yielded artefacts of all five primary categories, (Table 13) presents the results for each site.

Table 13. Surface collections – the three sites with all five primary categories

CATEGORY	M8 surface		M15 surface		1890 surface	
	Quantity of artefacts	% of artefacts	Quantity of artefacts	% of artefacts	Quantity of artefacts	% of artefacts
bones	7	6.19	3	9.37	10	2.62
glass	70	61.95	1	3.12	181	47.51
ceramic	10	8.85	18	56.25	136	35.70
metal	19	16.81	9	28.12	48	12.60
miscellaneous	7	6.19	1	3.12	6	1.57
TOTAL	113		32		381	

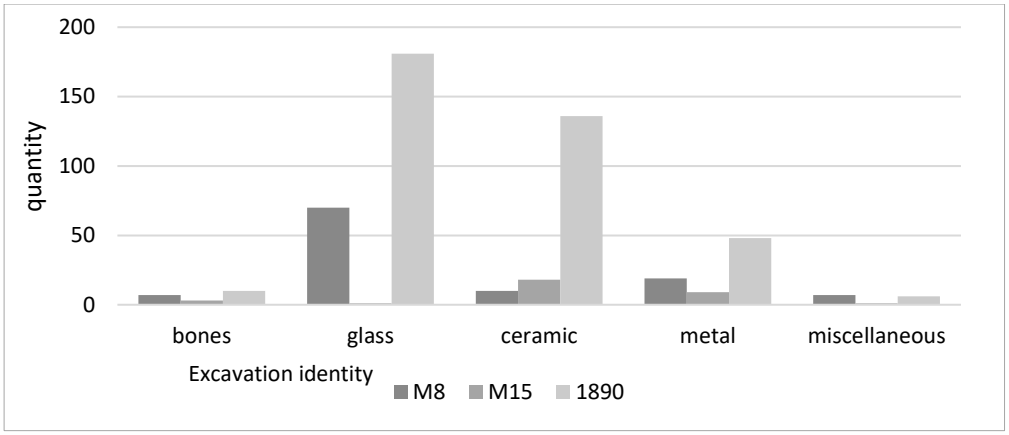


Figure 98. Analysis of the surface collections - quantities of the primary categories of artefacts from M8, M15 and 1890s Compound area.

The '1890 surface' column refers to the large surface area where the 1890s compound foundations and a midden had been before being bulldozed by the farmer. A lengthy pedestrian survey and collection was undertaken to assess if anything remained in the area. The results in terms of quantity and category of artefacts was surprisingly good.

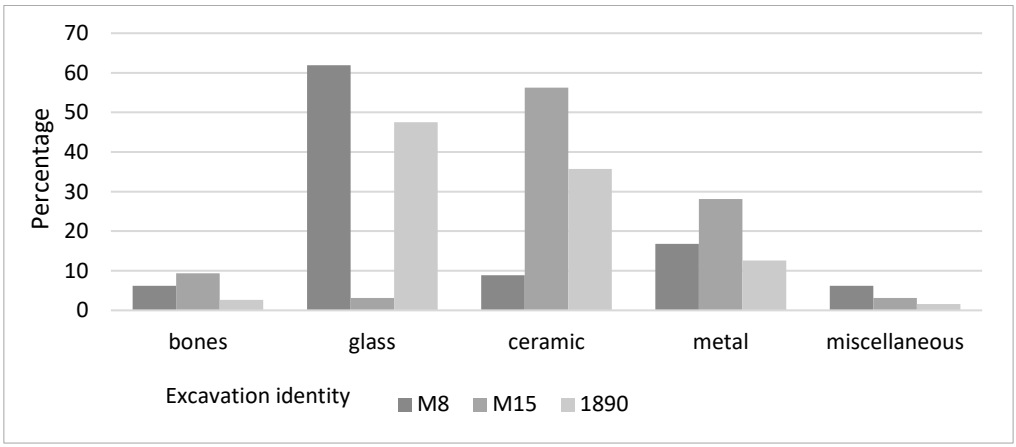


Figure 99. Percentage of artefacts recovered from surface collections of M8, M15 and 1890s Compound area.

Interpretation of the results

The graph of quantity of artefacts recovered does show certain comparable values. The two categories with the higher values are glass and ceramics. This is relatively easy to explain. Bone material, soft items such a leather and clothing and metal - especially thin metal such as cans - are hugely affected by the decaying action of atmospheric conditions. The low recovery of such items at these sub–sites is an indication of such conditions. The other factor,

to consider is the soil condition. The geology of the area, and in particular the mined rock, is of volcanic origin, namely – granite, gabbro and diabase - which tend to be acidic and thus the soil conditions can be said to have an acidic nature, which would be detrimental to the survival of bone and metal.

A small amount of bone material was recovered from the 1890s compound area. The midden was known at the time of the satellite survey, to be no more than 20cm thick at its highest point. This was established at survey by STP. Although it is not known if all of the artefacts were originally surface or sub surface material, the very fragile nature of the bones indicated long and severe weathering. The same reasons can be given for the low recovery of metal and miscellaneous artefacts. The metal that was recovered, generally nails and industrial items such as bolts, shows severe corrosion. The shallowness of the midden and subsequent exposure to weathering could account for the extreme decay of metal and bone artefacts.

The glass and ceramic categories show peaks in sites M8 and the 1890 compound areas. Because the graph is looking at recovered quantities, the explanation for such peaks is the surface collection area relationship. Approximately 100 m^2 for M8, and approximately 1 000 m^2 for the 1890s site, compared to the area of M15 which was approximately 20m^2. Secondly, glass - and to a slightly lesser degree - ceramics are impervious to normal weathering conditions.

The graph showing percentage of artefact categories per site does indicate a partial trend in the overall number of each category collected. The possible exceptions of the glass in M15 and the ceramic in M8, where they were lower in percentage than the other two sites, has to be taken as anomalies for the particular sites (Figures 98 & 99).

Excavated collections - three sites with all five primary categories

Only three sub-sites on which excavations were carried out yielded all five primary categories of artefact.

Table 14. Excavated collections - three sites with all five primary categories

CATEGORY	M8 excavated		M15 excavation		M16 excavation	
	Quantity of artefacts	% of artefacts	Quantity of artefacts	% of artefacts	Quantity of artefacts	% of artefacts
bones	1 851	44.3	189	60.96	335	57.66
glass	300	7.2	26	8.38	15	2.58
ceramic	271	6.5	15	4.84	40	6.88
metal	1 269	30.4	74	23.87	160	27.53
miscellaneous	481	11.5	6	1.94	31	5.33
TOTAL	4 172		310		581	

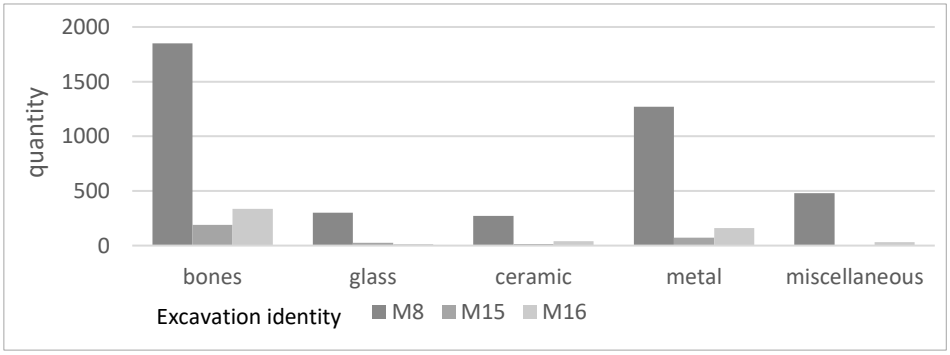


Figure 100. Analysis of the excavated collections - quantities of the primary categories of artefacts from M8, M15 and M16 areas.

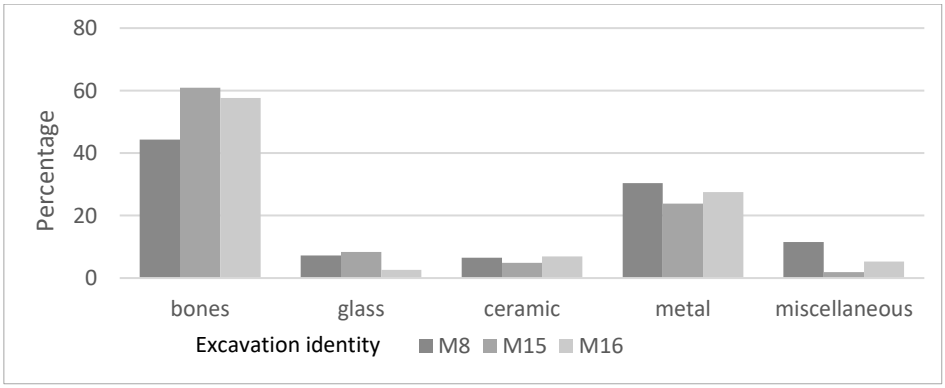


Figure 101. Analysis of the excavated collections - percentage of the primary categories of artefacts from M8, M15 and M16 areas.

Interpretation of the results

The three sites indicated, were those with the highest number of recovered artefacts in all five categories. They were also the most extensively excavated. The reason for M8 having the highest number of recovered bones and metal artefacts could be attributed to it being the most extensively excavated, both in area and depth, with a final volume of 3.7 m^3. It also yielded approximately two thirds of the total recovered collection of artefacts for the entire project. What is not understood is why it was relatively much larger than any of the other middens. The only possible suggestion is that it may have been the original midden and in its early years was more of a communal midden. What is more revealing from an overall perspective is the graph of percentages of artefacts recovered from the three sites. Although the number of bone and metal artefacts recovered from M8 was considerably higher than M15 or M16, when the three sites are compared by percentage of each category recovered, there is a high degree of similarity for each of the five categories (Figures 100 & 101).

Because of this result it was decided to carry out a similar analysis for those sites where only four categories of artefact were recovered. The quantity of artefacts recovered on the surface from the sites was minimal or none at all, and any such artefacts recovered were placed in the excavated collection of the site.

11.4 Analysis of the four sites where four categories of artefact were recovered by excavation

Table 15. Four sites with four categories of artefact

CATEGORY	M17 excavation		M23 excavation		SS2 excavation		BS4 excavation	
	Quantity of artefacts	% of artefacts	Quantity of artefacts	% of artefacts	Quantity of artefacts	% of artefacts	Quantity of artefacts	% of artefacts
bones	2	1.94	9	36.00	2	16.67		
glass	39	37.86	6	24.00	4	33.33	10	10.53
ceramic	57	55.34	7	28.00			2	2.11
metal	5	4.85	3	12.00	3	25.00	69	72.63
miscellaneous					3	25.00	14	14.73
TOTAL	103		25		12		95	

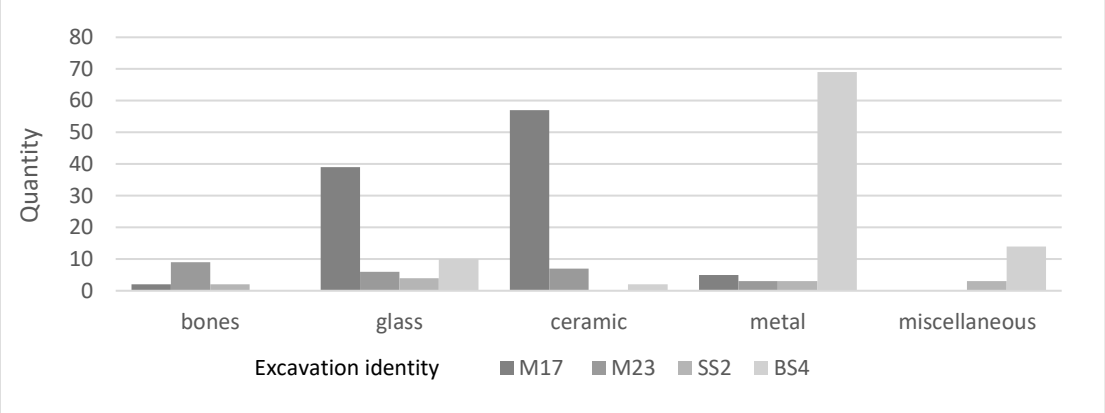


Figure 102. Analysis of the excavated collections - quantities of the primary categories of artefacts from M17, M23, SS2 and BS4 areas.

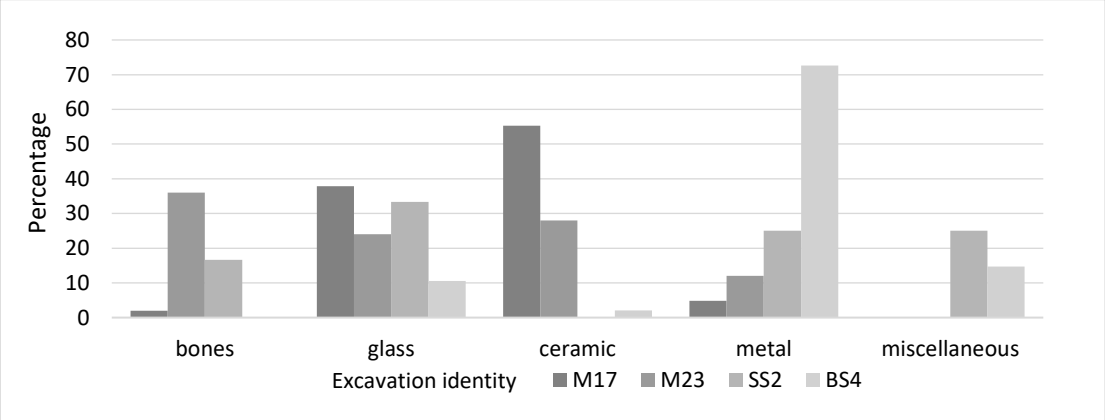


Figure 103. Analysis of the excavated collections - percentages of the primary categories of artefacts from M17, M23, SS2 and BS4 areas.

Interpretation of the results

Although there are four categories of artefact as the defining relationship in each of the sub-sites, there is a different combination of the four categories in each sub-site. Three anomalies distort the results of the two charts above. In BS4 a number of metal springs, either from a bed or chair were recovered and these inflated the quantity number and hence the percentage value of metal as is shown. In M17 the only significant categories recovered were ceramic and glass. These are therefore reflected as peaks in the quantity graph. The other two categories, of bones and metal, were in single figure percentages (Figures 102 & 103).

The quantity of artefacts recovered graph, excluding the anomalies discussed above, shows that there is a general trend for all five categories to be approximately the same for all five

sites. Similarly in the percentage of artefact types per site, given that there are anomalies, the general trend is a comparable percentage of each category across the five sites.

11.5 Analysis of the four sites where four categories of artefact were recovered from large surface areas

A pedestrian surface collection exercise was carried out over four large areas. These were conducted to ascertain the potential for artefacts in the respective areas. Areas A, B and C are industrial areas and loosely represent respectively the Roasting and Smelting plant c1920s, the Concentration plant c1893, and the Crushing plant c1920s. Area B is not analysed in this section as only four items were recovered from it – 2 ceramic assay cups and 2 pieces of a leather shoe. The large area of B3 to B12 at 10 x 100 m represents 10% of the total defined excavation area of the 1920s 'native location'. The strip was chosen at random and although there had been a total of three middens and one foundation structure that had been excavated within the boundaries of B3 to B12 the number of surface collected items from those excavated sites was in single figures.

Table 16. Four large areas with surface collections with four categories of artefact

CATEGORY	B3-B12 surface		Area A surface		Area C surface	
	Quantity of artefacts	% of artefacts	Quantity of artefacts	% of artefacts	Quantity of artefacts	% of artefacts
	B3-B12	B3-B12	Area A	Area A	Area C	Area C
bones						
glass	29	35.80	13	35.14	17	40.48
ceramic	35	43.21	13	35.14	11	26.19
metal	13	16.05	7	18.92	6	14.28
miscellaneous	4	4.94	4	10.80	8	19.05
TOTAL	81		37		42	

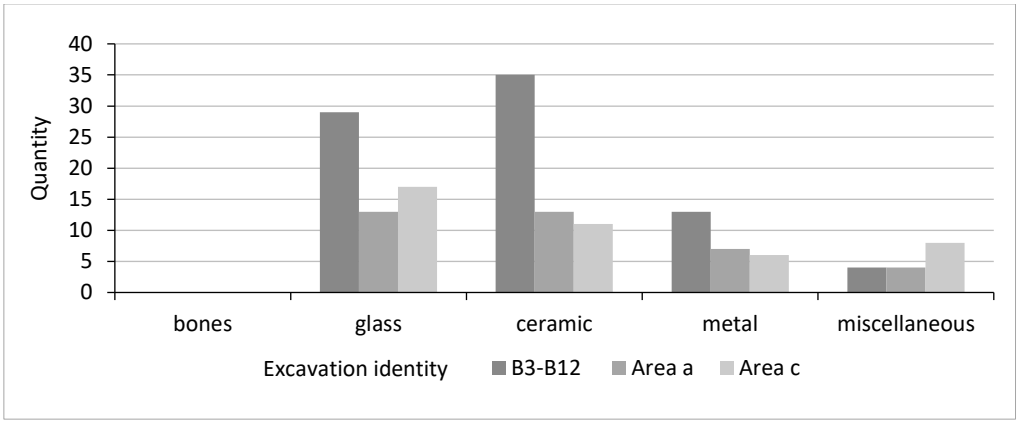


Figure 104. Analysis of the surface collections - quantities of the primary categories of artefacts from B3 – B12, Area A and Area C.

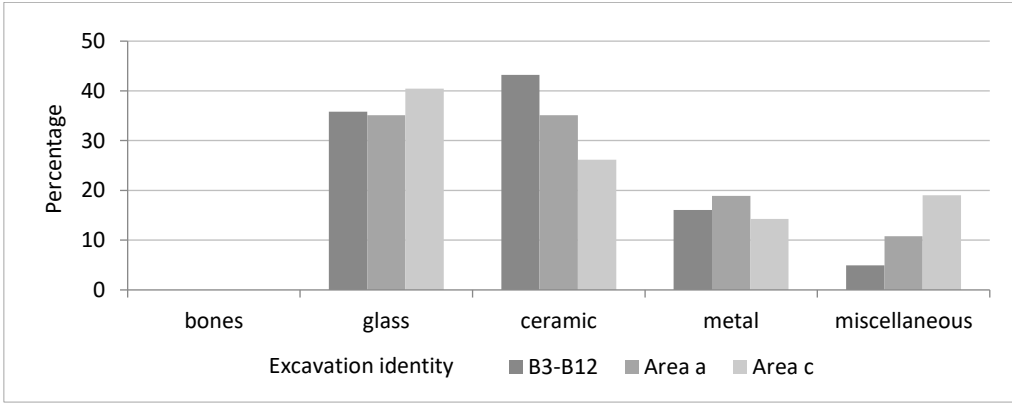


Figure 105. Analysis of the surface collections - percentages of the primary categories of artefacts from B3 – B12, Area A and Area C.

The idea behind the surface collection of the large areas was to see if they could be shown to yield trends of categories of artefacts comparable with the smaller surface collections on the middens. The potential problem with a pure surface collection is that the yield will vary with time and is reliant upon exposure of the artefacts to surface erosion of the soils. It is also dependent upon the time of year when the collection is carried out, as there is a narrow window of opportunity when the grass cover is dead at the end of winter (September to October) or a veld fire has burnt off all grasses. A slow moving grass fire could and may also destroy dry bone fragments on the surface.

The graph of quantity of artefacts for area B3 to B12 show two anomalies of glass and ceramic. As this surface site is effectively part of the former 1920s ‘native location’ it is understandable that they are present in this area. The other two surface sites, A and C, did not yield high values of glass or ceramic artefacts. The principal reason for this can be attributed to food and liquids not generally being allowed in production areas.

It is interesting that once again the general trend of each site is to reflect comparable percentages for the four categories. This is especially true for glass and metal. The miscellaneous category percentage apparently varies widely, but only has a difference of four items between them (Figures 104 & 105).

11.6 Stratigraphic analysis of M8

Although only two deep and long excavations were completed, namely M8 and M16, the results from a stratigraphic perspective are very interesting. Once the table of where the artefacts had been found, was constructed, certain patterns of concentration were noted. It was decided to attempt to represent these concentrations in graphical format. The graphs were produced with horizontal bars, each bar representing a spit or level 10cm thick.

From the graphs it is clear that with M8, levels 6 and 7 had the highest concentration of artefacts by quantity with layer 8 having the highest mass of artefacts because of a higher mass of metal artefacts. Additional features are discussed in the interpretation section.

The graphs show the concentrations of artefacts for both M8 and M16, albeit in the excavated portion of each midden only.

Table 17. M8 – Quantity of artefacts recovered by primary category in each level

Levels	1m x 0.5m areas (squares)																								Totals
	square a10				square b10					square c10					square d10					square e10					
	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	
Level 1		7	7		2	21	1		13													1				**52**
Level 2	20	17	12	8	3		9	6	8	4	72	18	13	146	22			35	4	2	2					**401**
Level 3	25	2	6	1	3	74	10	5	18	4	98	13	4	74	13	76	10	9	4	41					2	**492**
Level 4	50			15										19	1	53	29	10	5	4	20	1	5	1	1	**214**
Level 5	59	8	8	38	3	100	11	11	81	12	77	16	10	32	10	44	6	4	29	26	2	9	25	1		**622**
Level 6	126	8	4	60	8	42	6	2	51	88	35	3	4	26	2	134	7	6	48	26	52	3	8	53	1	**803**
Level 7	3	16	13	2	2	59	4	4	12	11	62	4	5	28	11	176	13	11	130	43	111	2	27	78	14	**828**
Level 8	29	5	23	66	47	60	10	6	71	34	40	13	9	60	18	66			71	3	1			4		**636**
Level 9										4											29	3	10	14	2	**62**
Level 14						35					35															**35**

Table 18. M8 – Mass of artefacts recovered by primary category in each level

Levels	1m x 0.5m areas (squares)																								Totals
	square a10				square b10					square c10					square d10					square e10					
	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	
Level 1		12	17		172	134	6		145	233												155				**874**
Level 2	45	114	48	163	42		25	27	23	25	472	92	62	1664	425		67	13	53	60						**3420**
Level 3	65	9	43	78	134	151	48	20	179	14	246	52	17	185	817	283	60	41	8	266					21	**2737**
Level 4	186			50										102	4	316	517	96	16	63	13	3	31	4	1	**1402**
Level 5	115	103	28	568	43	352	153	60	1230	590	59	99	25	389	38	172	51	61	560	675	19	27	52	60		**5529**
Level 6	641	60	34	1903	97	195	266	4	1271	448	152	44	42	101	3	313	74	77	195	52	122	316	44	638	1	**7093**
Level 7	18	669	143	91	36	209	235	23	183	184	205	80	40	1800	35	394	101	143	3232	111	381	10	126	1387	48	**9884**
Level 8	616	77	3820	3397	87	562	265	51	1238	71	207	163	98	2145	3179	219			1316	8	27			244		**17790**
Level 9										162											83	14	20	17	4	**300**
Level 14											265															**265**

Sub-site M8 - stratigraphic analysis of the individual levels

Blank areas in levels 9-14 which are conflated indicate no excavation work, Refer to note on next page.



Figure 106. M8 stratigraphic section – sections e10 and d10 showing the layers of orange brown soil between layers of ash and ash with stones and lumps of coal.

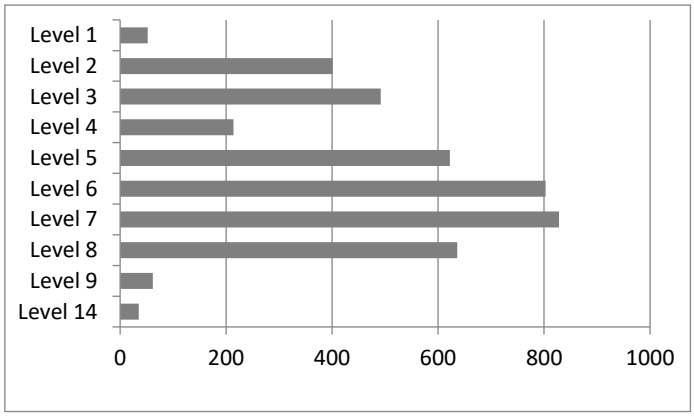


Figure 107 Quantity of artefacts at each level in M8

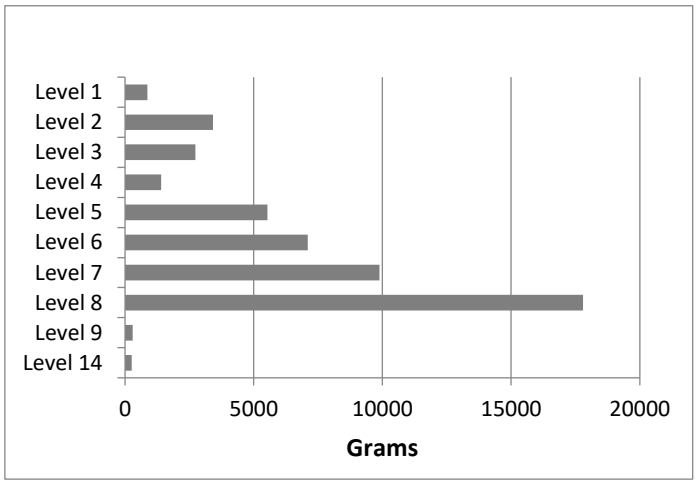


Figure 108 Mass of artefacts at each level in M8

Note:- Tables 17 and 18 on the previous page show generally blank boxes for the levels 9 - 14. If one refers to Figure 79 – the Stratigraphical drawing on page 214 one can clearly see that in levels 9-14 only the STP on C10 went through all of these levels, therefore the tables only reflect the finds in the STP and the same applies to the graphs above Fig. 107 and 108.

Interpretation of the results

From the two horizontal bar graphs (Figures 107 & 108) a number of points of interest can be inferred. Firstly in level 4, there is a definite decline both in the number of artefacts recovered and in the final mass of recovered artefacts in the level. The two tables (17 & 18) indicate that in squares (a10), (b10) and part of (c10) virtually no artefacts were found. It was not clear during the excavation why this should be so, but on completing the stratigraphic drawing (Figure 79) it became clear that the layer varies significantly in soil types with a large portion being a loamy top soil that appears to have been spread over the fine dark ash immediately below it. It is therefore possible that the deposited artefacts that should have been present in layer 4 had been dragged or relocated during the action of covering the ash with the soil.

The most productive layers in terms of quantity of artefacts were levels 6 and 7. In terms of mass, layer 8 was 45% higher than layer 7 and 60% higher that layer 6. The variation is due to a much higher mass of ceramic and metal artefacts in layer 8.

The one outstanding feature of M8, is that although no stratigraphy could be determined in the fine dark grey ash that formed the bulk of the excavation, within it there were small patches of orange brown loamy soil and these followed an incline pattern almost certainly following the slope profile of the midden as it grew in height, and they are clearly illustrated in (Figures 79 & 106).

11.7 Stratigraphic analysis of M16

Table 19. M16 - Quantity of artefacts recovered by category in each level

Levels	1m x 0.5m areas (squares)																										Totals
	square d10(a)					square d9(a)					square d9(b)					square e9(b)					square f9(b)					
	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	
Level 1	15			2							5		3	5	1	9		1								**41**
Level 2	16	1	8			4	1	3		1	32		1	13	1	7	2	3	27	3	12	2		2		**139**
Level 3	11			2		1	1	2	15	1	36	3	2	2	1	9	4	5	18	7	16		1	28	13	**178**
Level 4	19			15		36		1	13	2	37	1	1	12	1	22		4	1		38		3			**206**
Level 5	5					5			5									2								**17**
TOTALS	66	1	8	19	0	46	2	6	33	4	110	4	7	32	4	47	6	15	46	10	66	2	4	30	13	

Table 20. M16 - Mass of artefacts recovered by primary category in each level

Levels	1m x 0.5m areas (squares)																									Totals
	square d10(a)					square d9(a)					square d9(b)					square e9(b)					square f9(b)					
	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	bone	glass	ceramic	metal	misc	
Level 1	15			2							5		3	5	1	9		1								**41**
Level 2	16	1	8			4	1	3		1	32		1	13	1	7	2	3	27	3	12	2		2		**139**
Level 3	11			2		1	1	2	15	1	36	3	2	2	1	9	4	5	18	7	16		1	28	13	**178**
Level 4	19			15		36		1	13	2	37	1	1	12	1	22		4	1		38		3			**206**
Level 5	5					5			5									2								**17**
TOTALS	66	1	8	19	0	46	2	6	33	4	110	4	7	32	4	47	6	15	46	10	66	2	4	30	13	

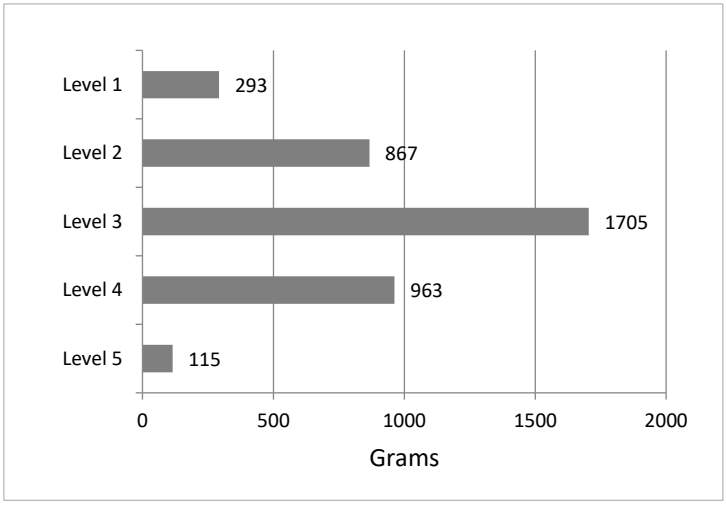


Figure 109. M 16 - Mass of artefacts at each level in M16

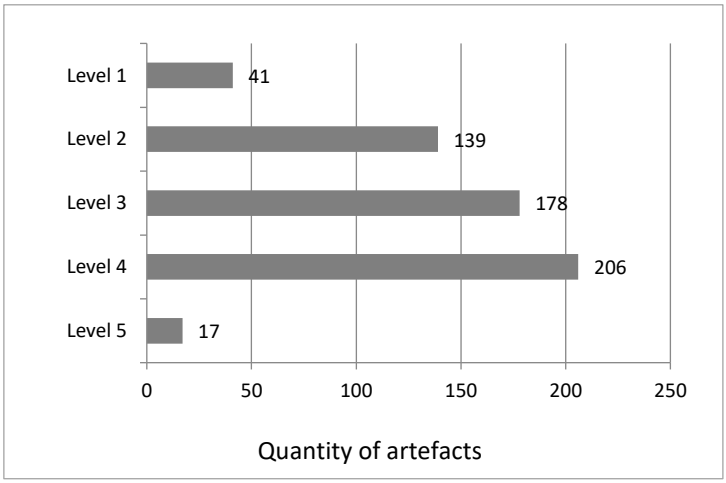


Figure 110. M16 - Quantity of artefacts at each level in M16

Interpretation of the results

From the two graphs (Figures 109 & 110) it is possible to determine that the most productive levels in terms of quantity of artefacts were levels 3 and 4. However, level 3 had a much higher value for mass with a value of 742 grams higher than level 4. Although the quantity of bone and metal artefacts recovered from the two levels was almost the same, and for once the mass was also almost the same, another factor was involved, namely the miscellaneous artefacts. In layer 4 there were 22 such artefacts compared to 3 in layer 4. The difference in mass though was significant, with the 22 artefacts having a mass of 652 grams.

11.8 Breakdown of the Glass and Ceramic primary categories and their respective sub-categories

During the analysis, it became necessary to sub-categorise items within each of the primary categories. This was carried out primarily as many of the artefacts had the same characteristics and it was seen as a means of carrying out a later comparative analysis. Glass and Ceramics were the easiest to create such sub-categories in, with glass being classified by colour and then the part of a bottle. The ceramics was classified by material type using five principal divisions of porcelain, stoneware, whiteware earthenware and 'milk glass', followed by additional characteristics, for example – 'porcelain - cup - decorated rim.'

Primary category: GLASS

Comments on the collection of glass shards and fragments in the table above

The collection of shards and fragments shown above, totals 758 pieces, but being only shards and fragments, it is almost impossible in most cases to define what the original contents could have been. It is possible to suggest original contents in broad terms such as the cobalt blue glass would clearly have been a medicine, as it is generally known as medicinal glass. The cobalt blue glass was found in both the 1890s and 1920s sites. There are only a few shards and bases of the brown glass, and these were most likely to have been beer

container/s. Although designated orange glass, I believe that the colour is due to soil staining.

Table 21. Analysis of the glass colours with the part of a bottle

Area of fragment of bottle	Colours of the glass							
	Pale green	Green	Olive to dark green	Purple	Brown	Orange	Blue	Clear
Shards	155	60	85	1	5	37	44	76
Embossed shards								24
Rims	19		23	1		11		19
Base	19	1	70			1		13
Embossed base	5				2			3
Neck no rim	8							
Embossed side	10							
Shoulder & side	7							4
Totals	223	61	178	2	7	49	44	139
% of collection	**32%**	**9%**	**25%**	**0.3%**	**1%**	**7%**	**6%**	**19.7%**

Total collection 758 fragments

Apart from colour, of which there were eight shades present, the majority of the glass shards and fragments were strictly undiagnostic, although they were recognisable as bottle glass. The total of plain shards, of all 8 colours, represent 61% of the total bottle fragments, omitting those that are included in the bottle or re-fitting bottle category. The next largest sub-categories that were found, were non embossed bases at 14%, followed by bottle rim pieces at 10%. The balance is made up as shown in Chapter 11.7. It can be seen from the table that the pale green bottles - at 32% - is the main bottle colour, followed by green at 9% and olive to dark green at 25%. The dominant colours - the various shades of green - which account for over 66% of the glass fragment collection, appear to be from beer bottles. There are a number of light green rectangular fragments that were most likely patent medicine bottles. The clear glass fragments – typically food/sauce bottles, mineral water bottles and body creams bottles – such as Vaseline jar fragments - accounts for 20% of the glassware.

Table 22. Major items in the glassware collection including complete bottles, glass bottle stoppers, re-fitted glassware and various significant items of broken glass.

Description	Quantity	Comment
Holbrook Worcestershire Sauce bottle with part label	1	Undamaged
Holbrook Worcestershire Sauce bottle with top half missing	1	Part damaged
Dark green bottle with crown cap top	1	Undamaged
Pale green bottle with crown cap top	1	Undamaged
One brown glass screw cap bottle with KRUSCHEM on side	1	Undamaged
Bell shaped small glass bottle rimmed and with ribs on outside	1	Undamaged
Very small clear glass round shape bottle with cork necked top	1	Some damage
Clear glass VASELINE petroleum jelly screw top jars	3	Undamaged
Rectangular small pale green patent medicine bottle DAVIS Painkiller	1	Undamaged
Engraved clear glass drinking glass/ beaker top rim missing	1	Some damage
Hexagonal shaped chutney jar clear glass with large mouth opening	26 fragments	Needs refitting
Dark brown bottle	13 fragments	Needs refitting
Green glass bottle stopper with embossed HOLBROOK on top face	2	Undamaged
Green glass bottle stopper no name on top face	2	Undamaged
Pale green glass small diameter laboratory tubing	2	Some damage
Possible base or tip of a CODD bottle	1	Some damage
Small diameter green glass bottle with fluted side in spirals	1	Some Damage
Part of a mineral water bottle with words WATER and WITBANK	1	One curved piece
Extremely thick (15mm) round dark olive green bottle base	1	Damaged
Square base and body of part of a bottle pale green with WHISKEY and WALKERS on base. See comment below re colour.	1	Damaged
Fragments of clear window glass	17	
TOTAL	**79**	

Comments on some of the above finds

The major glassware finds are listed in (Table 22). Vaseline petroleum jelly created by chemist Robert Chesebrough who in 1859 visited the Pennsylvania oil fields and noticed the men working on the rigs using a substance called ‘rod wax’, a type of greasy substance that built up on the rigs to rub into wounds. Synthesising this grease, by 1870 he had patented the product in 1872 and began marketing it as Vaseline, a protective first aid remedy for cuts to the skin. Stahl (2010:152-153) describes the Vaseline jar fragments as the “quintessential example of what James Deetz refers to as one of archaeology’s *small things forgotten*”

(Deetz 1977). The story it provides, in the case of Argent, is one of African and European cultures merging in the field of first aid. The source of such products and the number of complete jars and fragments indicates that it was readily available from a Company store on the TSBM mine.

The finding of the glass bottle stoppers pointed to the fact that Holbrook bottles had not changed over to a screw type of cap at that time. Two interesting finds were the Kruschem salts bottle, a medicine that is still available and is used to treat painful joints and muscles and the Davis patent medicine bottle. The latter has the words VEGETABLE PAINKILLER embossed down the one narrow side of the bottle. On researching the product, it was found to be a 19th century patent medicine – 'a wonderful painkiller', but in fact it appears to have been a mixture of opiates and ethyl alcohol.[1] At the bottom of Table 22 is a note in connection with the pale green glass Johnny Walker Whiskey bottle. The colour is interesting as the modern bottles are clear glass. I contacted the company and got an anonymous reply stating that yes, they know that there was a period roughly from 1910 to 1923 when they produced the bottles in pale green, but there are no records as to why and they do not even have a sample of such a bottle in their collection. The 17 fragments of clear window glass, which range in thickness from 1,2 mm to 2.5 mm, were recovered from five of the excavation sites, all of which were the main sites.

The glassware collection of 758 fragments and complete items is derived from practically the entire set of surface and excavation sites, but as with the ceramics collection discussed below, the glassware recovered was naturally greater in the more extensive excavation or surface collection sites.

Primary category: CERAMIC

The ceramic fragments proved to be some of the most interesting cultural artefacts, but at the same time, ones that presented a problem of association. The time of 1920-1925 was not one generally associated with an improvement in the lifestyle and living conditions of South Africa's black population and yet here was a collection of ceramic artefacts – the remains

[1] https://www.opioids.com/painkiller.html. (Accessed on 31 January 2019).

of identifiable cups, saucers and plates - some with maker's marks that clearly identify the country of origin as the UK.

Some comments were made in Chapter 8 regarding the finding of so much ceramic in the 'native location' area and this is discussed in Chapter 12.

Use of the term 'Milk Glass' in the tables

On cleaning some of the shards/fragments - a total of ten pieces and the Oatine jar – were eventually identified as a category termed 'milk glass'.'[2] This was a late nineteenth century product manufactured as a simulant for porcelain. It has been placed under ceramic, rather than glassware, due to its apparent similarity to porcelain. As a category, it forms a very small percentage of the total ceramic collection. The Oatine jar is a very good example of the material. The material closely resembles porcelain, yet seems glass-like to the touch and it is this tactile property that can be confusing. Its popularity waned during the Great Depression, but saw a revival in the 1950s-1960s.

[2] https://www.countryliving.com/shopping/antiques/g2965/milk-glass-facts/ (Accessed on 20th February 2019).

Table 23. Form, Function and Ware type – ceramic collection

Ware material	Ware item description									TOTAL
	Rim – decorated	Rim - undecorated	Foot ring/mould	Shard - decorated	Shard - undecorated	Jar base	Cup/handle/ bowl	Miscellaneous	Re-fitted	
	No	No	No	No	No	No	No	No	No	No
Milk Glass		2	2		2			5		11
Stoneware		4	3	4	50	2	5			68
Porcelain	32	34	46	5	84		10	3		214
Earthenware	16	16	30	18	92		3	2		177
Whiteware	12	26	27	8	75		2		29	179
									TOTALS	**649**

Re-fitted whiteware saucer and plates	No
Saucer	18
Plate	2
Plate	3
Plate	2
Plate	4
Totals inserted in the table above	**29**

Table 24. Summary of total values for each material expressed as a percentage of the total collection

Total collection = 649 pieces		
Ware material	Calculated sub totals	
	No	%
Milk Glass	11	1.7
Stoneware	68	10.5
Porcelain	214	32.9
Earthenware	177	27.3
Whiteware	179	27.6

The designations of Earthenware[1] and Whiteware, although shown separately, could be treated as one - namely earthenware and in doing so it does present a more balanced picture of the dominant ceramic within the black miner areas of both the 1890 and 1920s periods of the operation of the Argent mine. This would present a total of a utility ware of around 51%, with the balance in the collection being made up from three other ware materials. The Porcelain at 37% of the ceramic collection could also be the lower grade or so called semi-porcelain, or possibly the 'milk glass' and has been kept as a separate category at 1.7% and which was also intended as a form of utility ware.

Table 25. Summary of ware materials and the most significant sites

Ware material	M8	1890s compound	M16	M15	B3-B12 surface area
Milk Glass	-	-	2	1	-
Stoneware	8	29	3	5	2
Porcelain	66	54	17	7	26
Earthenware	78	15	8	4	8
Whiteware	98	28	2	13	6
Total	**250**	**126**	**32**	**30**	**42**

[1] To reduce the confusion over ceramic terms and as the recovered artefacts from Argent appear to be one general type; when referring to 'earthenware' in the text it is referring to European earthenware. The additional type named is refined earthenware, also European and defining a better quality of product.

From (Table 25) it is possible to see that the most significant sites for the collection of ceramics were Middens M8, M15 and M16, coupled with the large area surface collection sites of the 1890s compound and the B3-B12 site. The combined total of pieces is 480, which represents 88% of the total ceramics collection. The balance being found as small quantities in the other excavation sites.

11.9 Breakdown of the Metal and Miscellaneous primary categories and their respective sub-categories.

The metals collection was greater than expected and not only consisted of nails, screws and metal fragments, but also recognisable, although often badly oxidised, specific items as well as the largest single item – the buried remains of a wheelbarrow. The list below only reflects the major items in the metals collection. It should also be pointed out that the fifth primary category which is dealt with after the metals also contains some metallic items, but it was decided to place them under the primary category of miscellaneous, which will be explained below.

Primary category: METAL

Sub categories	**quantity**
Hand forged rail nails	20
Hand forged non rail nails	5
Wood nails	62
Large severe oxidised	4
Oxidised nails	566
Wood screws	8
Industrial bolts	7
Miscellaneous bolts and pins	11
Steel washers	8
Miscellaneous metal wire	4
Copper wire	14
Possible jewellery in copper wire	5
Solidified poured lead	12

Undiagnostic metal fragments	960
Metal cans and fragments	156
Corrugate metal fragments	87
Metal wheelbarrow	1
Metal shovel	1

The metal components were more complex, because the artefacts fell into the sub categories of industrial, architectural, personal and were then put in sub-sub categories such as ‘hand forged rail nails’ A total of 657 nails, of different varieties, were found. The rail nails were the most interesting, as they were hand forged. The head has an angular face forged to the underside, such that it is a perfect match with the angle of the foot of the rail (Figure 111).



Figure 111. Argent rail nail fitting on the foot of a mine rail.

The range of 156 metal cans and can flakes showed that a large percentage of the food supplies probably came in as canned goods. There is a very large collection of undiagnostic metallic flakes – a total of 960 pieces.

The finding of the buried remains of a large metal wheelbarrow was one of those “what do we have moments’ during the excavation. The hole kept on getting bigger and the metal remains kept going deeper. Eventually it was recognised for what it was, but unfortunately only the forged and riveted metal rim on the bucket part could be saved. The bucket was *in situ,* but as it was exposed and touched so it disintegrated to small rusty flakes.

The excavation of a metal shovel was interesting, and I believe vital in the preservation of woollen items found beneath it. In effect, it acted as a steel cap to any migrating fluids (atmospheric water) that would have destroyed the wool.

The level of oxidation and corrosion seen on metal artefacts varied widely from just rusty to complete decay and potential powder or flake residues if touched. A few artefacts were found made from very thin diameter copper wire, which appears to have been turned into items of jewellery and this will be discussed in the next chapter.

Primary category: MISCELLANEOUS ARTEFACTS

The last primary category discussed in this chapter, is one that grew to a total of 193 items. Included, are several items of woollen clothing, and approximately 130 items of leather some identified as parts of boots or shoes.

A variety of buttons were also found, typically shirt and trouser buttons along with some decorative ones.

Items expected to be found were enamel mugs or plates. Despite the extensive surveys and excavations, only one such mug was found at the Argent mine site.

By its very nature, a category such as miscellaneous includes random items as coal, charcoal, insect and fruit remains - such as peanut husk and peach stones. Also included are wood fragments, samples of the different bricks found on the site, large metal springs, a George 5^{th} penny and assay ceramic sampling cups.

11.10 Conclusion

The significant differences between the surface and excavated material collections can be explained through the soil conditions found in the excavations and the depth at which the artefacts were found. The fact that glass forms the highest number of artefacts on surface material is most probably due to its greater resistance to decay due to atmospheric conditions. It also has to be pointed out that several large power stations exist within a 20km

radius of Argent and so the potential for acid rain exists, further enhancing natural and human origin environmental damage factors leading to the decay of the surface and sub-surface artefacts. Even the ceramic artefacts, because they are broken, tend to decay as the non-glazed surface is accessible to weathering, which is clearly seen leading to the cracked or crazed nature of the glazing.

Bone, because it is a mixture of collagen and calcium phosphate, is very susceptible to atmospheric or acid soil decay. In places where bone fragments were found on surface they were found to be very fragile, compared to those found 20 cm or more below the surface, the latter of which were generally in a very good state of preservation.

The middens contained a variety of soil types, the most common of which was a fine grey ash typical of that left over from fires. Lumps and fragments of coal were found in the ash indicating that the ash was in fact coal ash. This was most likely the cooking fire medium. The small middens consisted almost totally of this ash, with small amounts of loamy soil, typical of the surface soil of the area, and this sometimes occurred as a thin layer in the ash. When the two major middens of M8 and M16 were excavated, very detailed stratigraphic patterns were seen and they were drawn in the previous chapter. M16 displayed a layering process which seemed to show that the material was dumped from north to south. The profile of the dump indicates this, as does the sub-surface layers. It is interesting that virtually all varieties of ash or soil, or soil and ash mixtures, contained artefacts.

When the stratigraphic section of M8 was examined and drawn, it provided an even more complicated scenario – a dumping pattern, with patches of soil interlayered in the ash. The possible conclusion is that soil was spread on a fresh dumping of hot ash, either to prevent burning by stepping on it or to prevent hot ash being blown around the area. M8 was excavated below normal ground level first, and then the midden material was deposited in the hole. Eventually a mound developed and continued to grow above normal ground level. Statistically, M8 was not only the largest excavation, but it also produced the greatest amount of artefacts and some of the most important ones.

Chapter 12

Discussion

This study has shown how the TSM and the TSBM mines embraced new mining beneficiation technologies, in both the 1890s and the 1920s, coupled with new civil engineering practices and construction technologies in the 1920s. Records have allowed the financial profitability of both mining companies to be assessed. By applying historical research and evaluating archaeological evidence, the lifeways and social conditions of the black mine workers is mapped as far as possible. Specific elements such as accommodation, pay scales, job positions, food and the consumption of alcohol will be focussed on. A progressive approach to the black accommodation suggests black women and possibly children may have lived on the mine property.

There is at this stage, no conclusive proof that women and possibly children were present within the 'native compound' at Argent. A great deal more excavation work within the 'native location' area - and specifically the middens - would need to be carried out with the hope of finding the artefactual evidence proving the assertion made in this thesis that women were present. The artefacts found so far, that offer the idea of women being present, were two very small shoes, the decorative glass button and the Oatine face cream jar.

The more one reads about the Randlords, the more one comes to realise that their major skill, or more likely luck, was being in the right place at the right time. They were speculators and they became the ‘new capitalists’. Certainly, they acquired a degree of mining knowledge with time, but it is unlikely that they possessed the skill to choose a particular beneficiation system for treating metallic ores. They had to rely, very strongly, on the expertise of American, British and German mining engineers, who had the understanding of the new technologies. The mining engineers, having trained in the new science, honed their skills on new ore deposits which were being found in South and Central America and became ideal training grounds for these young engineers (Fell 2009:99).[1] Many of these new mining

[1] https://www.s2a3.org.za/bio/Biograph_final.php?serial=1439 Biographical notes on Hennen Jennings (accessed on 20th February 2019).

engineers helped develop early mining in South Africa, on the diamond mines of Kimberley and the gold fields of eastern Mpumalanga province.[2]

The main method by which these mining engineers became employed by the Randlords, appears to have been by word of mouth. Phillips, in his reference to Hahn at the 1891 Annual General Meeting, stated how he came with the highest recommendations as a metallurgist with over twenty years' experience in the smelting of lead and silver ores (Reeks 2012).[3] [4] Fell (2009:99)[5], in his biographical notes on Hahn revealed that he had been involved with several mining companies in the USA and Mexico, upgrading their smelting facilities, where he seems to have improved their output. One has to question what happened at the Argent mine, where Hahn failed to implement a successful smelting operation. We will never know the answer, unfortunately. It is pure speculation, but perhaps two seemingly strong willed men - Phillips and Hahn - were incompatible and eventually developed into total adversaries, and that spelt the end for Hahn.

Wertheman is a difficult person to discuss, due to the minimal biographical information on him. Phillips, at the 1893 Annual General Meeting of TSM, in talking about Wertheman stated "…a gentleman who had considerable experience in the treatment of that class [Argent] of ore" (Reeks 2012).[6] Wertheman was trained in Germany as a metallurgist, but does not appear to have been a smelter, hence the possible change in direction for TSM by closing Hahn's smelting operation down in favour of a fine crushing and concentrating one.

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2 This province was renamed in 1995. Previously named the eastern Transvaal, many of the references prior to 1995 refer to the 'Eastern Transvaal gold fields.'

3 BRA Archives of H Eckstein & Co Volume HE 5, Annual General Meeting to 2nd AGM of Shareholders. 9 April 1891.

4 BRA. Archives of H. Eckstein & Co HE 5 TSM – 2nd AGM Report. April 9 1891:2.

5 Fell (2009) states that Hahn, after studying mining engineering at the mining academy of Clausthal, Germany, immigrated to the USA in 1863 and worked on silver-lead deposits, eventually introducing the first economically remunerative use of blast furnaces. In 1879 he apparently introduced two blast furnaces to the American Mining and Smelting Co, which proved successful and his skills were in high demand (Fell 2009:99).

6 BRA Archives of H Eckstein & Co Volume HE 5, Annual General Meeting to 4th AGM of Shareholders. 9 April 1893.

It becomes clear in the personal correspondence between Phillips and Beit, that the former had lost all confidence in Hahn and could not wait to get rid of him.[7]

The one American mining engineer that seems to have held Phillips, Eckstein and Beit's respect is Hennen Jennings. There are indications in Chapter 3 that perhaps Jennings and Hahn may have had a confrontational history before coming to South Africa, because when Hahn was appointed, Jennings resigned from TSM, although he retained his more senior position as the Eckstein group technical manager. No explanation appears in the records, so the interpretation is subjective. With Jennings in the group position, the question arises as to how Hahn miscalculated the amount of sulphur in the ore, without action by Jennings? I would have expected Phillips to insist on Hahn's calculations and proposals to be approved by the parent company's most senior mining engineer. On Hahn's recommendation and overall design, an entire beneficiation plant was ordered, which turned out to be the incorrect equipment or process for the type of ore at Argent. Amazingly, when it was discovered during the roasting and smelting process, Hahn's response was to advocate spending more capital, by purchasing ten more of the same type of roasting furnaces, to improve the output. This seemingly ignored the fact that it would require ten times more coal, more labour for each furnace, more fluxing agents and longer roasting times, resulting in a considerably higher operational cost and not exponentially a greater output.

Wertheman promised a beneficiation plant at an installed capital cost of less than £10 000, but the true landed cost was £17 638. What he purchased beyond his original design proposal is not clear, as the proposal has not survived in the records. I speculate that he may have purchased a newly developed machine at a greater cost, possibly the Lührig Vanner, merely to test it out. Knowing that he was on a short term contract with TSM it would help him gain additional knowledge and experience – a marketable commodity. No records have been found on where he went after TSM or why he spent three months touring Europe before arriving back in South Africa with the new machines. He refused to extend his stay in South

[7] BRA. Archives of H. Eckstein & Co files HE 149 p. 869 27 December 1891.

Africa beyond his one year contract with TSM, despite Phillips requesting that he stay on.[8] That seems to indicate that he had a new position to go to – possibly back in Germany.[9]

It became clear from this research that poor management of capital expenditure at Board management level, and allowing decisions on process to be made by one person, without any due process of questioning, can result in problems and uncertain costs. This is clearly what happened at the TSM under the management of Hahn and Wertheman, where Phillips as chairman in the head office seems to have merely signed the cheques, without necessarily knowing if his managers were providing the correct equipment or beneficiation process to produce the highest financial returns for the company.

In the 1920s, General Mining was a company chaired by Sir George Albu, a Randlord from the 1890s. In launching the TSBM in 1919 under the direct control of General Mining, Albu became chairman of TSBM. The technical control of TSBM was not placed under the control of one person, as was the practice with TSM. This led to a stronger management team of specialists, such as Harold Clayden (mechanical & electrical engineering; Errol Hay (mining engineering) and J.A. Ritchie who was the general manager of the mine.

The establishment of a multi-disciplinary senior management team for the Argent mine c1920, followed a move away from the singular mode of control that was present in the mining industry of the 1890s and the early twentieth century. Ultimately the two periods viewed the economics of the mine differently. In the 1890s the Randlords were speculative and autocratic, while in the 1920s there was a move towards a disciplined approach taken on sound economic principles.

Three changes of general manager in six years, as occurred at the TSM, is not a healthy scenario for any business, especially as each of the appointments brought significant changes in beneficiation to produce a saleable and profitable product, be it bullion or high grade concentrates. I suspect the initial method, under Chas Gay as manager, of crushing and hand sorting to a bagged coarse concentrate, was possibly due to lack of expert knowledge

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8 BRA. Archives of H. Eckstein & Co HE 5. TSM 5th AGM report. 29 March 1894.

9 Searches on Wertheman on the internet failed to reveal any biographical information, either before coming to South Africa or after leaving TSM.

regarding roasting and smelting technology or even the process of concentration in South Africa in the 1880s. The process appears to have been a labour intensive one, rather than a mechanised one. It was also a period of shaft and drive development underground, but this was potentially non-productive in terms of ore output. This is borne out by the low output of saleable product from 1889 through to the middle of 1890, as only 25 tons of high graded hand sorted ore is recorded.

Hahn wanted to crush, roast and smelt to a bullion product. There were two principal grades of ore at Argent, as described in previous chapters. The high grade ore, which could be crushed and smelted to produce bars of bullion, or it could be bagged and shipped as bullion grade ore. There was, however, a medium to low grade ore in the mine, and it required roasting to reduce the sulphur content first, before it could be efficiently smelted. In theory, that would have been acceptable, but Hahn's cardinal mistake was miscalculating the amount of sulphur present and designing the furnaces for a lower sulphur content than was the actual case. It is difficult to understand why he did not concentrate the ore first, especially as he was apparently familiar with such a process from his experiences of the silver and lead ores of Colorado, Nevada and Mexico (Fell 2009:99).

Wertheman, by contrast, removed the smelting operation and went into a high grade fines concentrating operation, thus selling bullion grade concentrates. The three operations produced finished saleable product, but as was shown in Chapter 4 only Wertheman's operation made a profit unfortunately his calculations did not include the recovery of capital expenditure. In the period before Hahn, no profits were recorded, but the shipping costs in 1889 and 1890 most probably destroyed any chance of potential profit.

The TSM and its successor, the TSBM, never installed the most common primary crushing machine in South Africa at the time of their respective operations - the Stamp Mill - but used Blake Jaw Crushers as primary crushers. Unfortunately no evidence has been found relating to the decision as to why they went to Jaw Crushers.

A flow diagram has been produced in Chapter 4 from the descriptive records of several sources, coupled with an interpretation of what would most probably have been present in Wertheman's process. It is from this point that Wertheman introduced the 'new' technology.

In Chapter 4, it is mentioned that a process known as jigging, using Harz Jigs, was employed. The exact date of this invention could not be found, but all the c1890s textbooks (Milne 1893; Ihlseng 1896; Davies 1902; Richards 1903), on beneficiation that were read - when researching the old processes - seemed to imply that it was an 1880s technology. From these machines a very fine product was eventually produced.

The final, very new technology that Wertheman installed was a Vanner, or moving belt, concentrator. This technology had only been patented in May 1892 and Wertheman purchased such a machine in early 1893. This was a significant leap forward in fines concentration technology and so TSM must have been one of the first to adopt this technology.

It appears from some of their gold mining decisions, that Eckstein and Phillips were forward thinkers. For example, the Macarthur-Forrest cyanidation process for gold recovery from low grade ore was first installed on one of their gold mines – the Salisbury mine - and was successfully used (Cartwright 1965). I believe Phillips was led by Wertheman in the change in the method of beneficiation at TSM. Clearly From his choices it appears Wertheman was a proponent of modern technology and new machines, but it would seem that the technology also appealed to Phillip's sense of being the first in the mining industry to use it.

The jump in time to the 1920s is not only one of huge technological advances in beneficiation technology, but also one of political and social change in the country. Before discussing the technological advances in beneficiation of the ores I want to discuss what has become one of the greatest developments in civil engineering – the use of reinforced concrete. As is discussed in Chapter 6, when I finished surveying the mine structures dating from the 1920s period, I realised that all of the structural foundations were constructed using reinforced concrete, identified by reinforcing steel bars seen in many places.

As a technology, it provided engineers with a stronger material and greater scope for innovative design of structures. In 1919, the TSBM mine used reinforced concrete technology, but it did not come into significant use on gold mines until much later, when a new wave of construction began in the 1930s. So here was the TSBM using reinforced

concrete and steel framed building construction on a large scale in 1920, and I believe this puts the Argent mine as the first significant user of the technology in South Africa.

The new developments in beneficiation technology in the early part of the twentieth century were built into the new plant of the TSBM. These developments were discussed individually in Chapter 4 and 5 and they led to a greatly improved and more efficient/cost effective method if treating base metal ores – this is borne out by the fact that the mine made profits. It would appear the reason Argent silver mine was chosen is a simple one, because silver was on the rise in 1920 and gold was in decline. There was also a need to test new processes and machines and the new mine of Argent was the ideal candidate.

Early patents of the Hardinge Conical Ball Mill, dated 1910 and 1915 used pebbles as the grinding medium. The 1919 patent design used steel balls to crush particles finer than any prior machine or process. During the surface survey/excavations of the area around the secondary crushing plant, one such steel ball was found, confirming the use of the most contemporary patent on this machine at Argent. As so often happens with new technological production breakthroughs, new inventions to accommodate the improved output and quality of the product are required. So it was with the processes linked to the Hardinge Ball Mill. A new method of classification was required to handle the higher and finer particle size output of the mill. For this the mine utilised the Dorr Rake Classifier - new technology with patents dating from 1912 and 1915 - which sorted the fines out faster than the Lührig Vanner utilised by Wertheman in 1893.

With a high volume of fines of high grade material, another new process was needed to treat them efficiently and that was the MS Sub-Aeration Flotation plant. This seems to have had many iterations in design, but the Minerals Separation Ltd (MS) machines - used at the TSBM - appear to have dated from 1915 patents. Flotation technology was so new, that on researching the history of the various plants that were installed in South Africa by the early 1920s, it is my belief that the TSBM plant - installed in 1921 - was the second plant of its kind in Africa and the first in South Africa to be commissioned. The final piece of new technology was the Dorr thickener, a type of machine or process still widely used on most ore mines today. In effect, it is a ‘water from fine grit’ separation machine in which the

waste sludge forms the slimes dams seen around most metal ore mines and the overflow of industrial grade water is recycled back to the beneficiation plant.

TSBM pre-roasted the ore to reduce the sulphur content of the concentrate, which simultaneously created a roasted clinker - more suitable for transfer into the smelter. The use of a patented process and machine known as the Huntington-Heberlein roasting pot for this stage was yet another innovation installed by the TSBM. In effect, it replaced, and was more efficient, than what Hahn had introduced in 1891, namely the reverberatory furnace.

When one examines the beneficiation process at TSBM, it is clear that recovery of possible valuable product was the goal at all times and to this end even the mineral dust was collected. Such dust was then roasted in the Huntington-Heberlein roasting pot and a clinker was created, which was then added to the charge in the smelting furnaces. Both mining operations successfully utilised technological innovations, but this did not necessarily translate into economic success, as is shown in the following discussion on the profit and loss figures for the capital expenditure and sales of the of the TSM mine.

The historical photographs (Figures 33, 36, 37 & 42) show some of the TSBM plant as it was in the 1920s, although all that remains now are the concrete foundations. General Mining, after trying to sell the beneficiation plant to smelting companies and upon receiving no interest, purchased the surface plant from the TSBM Company for a stated amount of £14 000 (Reeks 2012). It can therefore be assumed that the beneficiation plant machines, conveyors, along with motors, generators, boilers and various items of moveable property were transferred and reused by some of the gold mines within the General Mining group. In a similar way the corrugate sheet cladding on the roof and sides of the various buildings, along with the structural steel would have been transferred for reuse. This was a common practice among mining companies from the 1920s and has continued to modern times. A CRM project showed me that this was done with a building dating from the 1890s going from the Crown Mines in Johannesburg to PPC, a sister Cement Company based just north of Mafikeng, several hundred kilometres west of Johannesburg (Reeks & Coetzee 2012).

It is known from the records that during the life of the TSM mine, it raised approximately 60 000 tons of ore, which was converted into 6 000 tons of lead and 17.5 tons of silver.

Unfortunately, the smelting process, under Hahn, was a complete financial failure, making **a net loss of £8 577**. One could say that the greatest crime was the expenditure of £25 024 on 'state of the art' machinery, which was then only in use for about two and half months, before being shut down.

The next stage was a concentration process. Once again the capital expenditure was greater than had been budgeted for. Wertheman stated that he would put in a plant for less than £10 000, ultimately the landed cost was £17 638 and despite successfully operating with the new process for about 17.5 months, with sales at approximately £11 027, the TSM made **a net loss of £6 611** on the process and in effect no profit, because the capital cost of the beneficiation plant was never recovered.

The third process that the mine management hoped to make a profit on, was the sale of bullion grade lead ore direct to the smelter/refinery in Swansea, Wales and/or Germany. Ironically the shipment of bullion grade ore has been shown to be the most profitable of the three processes at the TSM. It was also the only process that was utilised for virtually the whole period that the mine was in operation. In the six years that bullion grade ore was shipped, it made a **net profit of £17 023.**

When Hahn was employed he promised huge profits of about £100 000 per year from the smelting and ore shipment processes. Wertheman promised profits of £30 000 from the concentration process, but no such profit figures from either man were ever realised. The major loss maker was Hahn's smelting process. Wertheman stated that he expected to process the ore at a cost not exceeding £1/ton.[10] (Table 1) shows there was a considerable difference in the cost of mining between 1893 @ £1.3/ton and 1894 @ £0.5/ton. However, the difference was offset to some extent by the grade of the ore declining, such that although more ore per ton of concentrates was needed in 1894/5 it was cheaper to mine. Unfortunately, Wertheman's cost per ton was never realised and so the returns were never what he predicted.

[10] BRA. Archives of H. Eckstein & Co HE 5. TSM 5th AGM report. 29 March 1894.

Between the two processes, Hahn's would never had made a profit, because his primary calculations were incorrect and his selected process of beneficiation was erroneous. Wertheman's process was shown to be functional, but did not yield the profits that he predicted for the management of the TSM Company primarily because it did not operate long enough to recover the capital outlay.

In comparison the TSBM was a profitable mine, returning profits in the years 1922 – 1925. In the earlier years, 1919 – 1920, the company appears to have been primarily an exploratory one. By 1921 some production was taking place, although the sale of processed ore raised £1 800, the output in tons of ore or grade is not recorded and therefore it is impossible to calculate profitability. I believe that 1921 was occupied with underground development and the finalisation of the beneficiation plant. If the mine manager's figures are used, the mine made a profit of £227 630 in the four years, excluding the 1921 figure. The final extraordinary general meeting held on the 22 November 1926, stated that the company closed down with the entire assets of the company totalling £159 000 and a final dividend of 10 shillings and 6 pence per share was paid.[11] [12]

The ore was mined, brought to the surface and processed and all of this was done by black and white mine workers. As the greater number of employees were the black mine workers - it is their lifeways that were examined in more detail.

The beneficiation plant had been re-created via various flow diagrams. The machines used were identified, as were the other ancillary facilities such as the boiler and power plant, shaft head and winder station and plant services. In an attempt to populate the mine workings of TSBM, a list of potential jobs was created and the number of black workers allocated in each position based on various descriptions (Allen 1992; Nkosi 2011). The infrastructure included, for example: farm hands, farriers, manual cocopan,[13] operators, and assistants to

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11 'Transvaal Silver & Base Metals Ltd', *The SA Mining & Engineering Journal,* (27 November 1926), p. 341.

12 'Transvaal Silver & Base Metals Ltd', *The SA Mining & Engineering Journal,* (18 December 1926), p. 2.

13 A term used in South Africa to describe the tipping type of ore cart used underground and on surface and which was manually pushed along rails at the TSBM mine.

fitters, boiler makers, electricians and telephone linesmen (Reeks 2012: Thrush 1968). Each machine, or part of the process, including plant services was allocated a number of white and black personnel, based, to a certain extent, on my personal experiences as a manager in the mining industry. The intention was to see if the approximate figures for personnel given in the sources could be accounted for or had been inflated. The exercise showed that the calculated numbers were relatively close to the figures cited in various letters in the NASA file[14] and the variances can be explained as positions overlooked or the numbers allocated to a particular machine or part of the process being in error.

Pay records do not exist in the company records anymore and so I had to rely on two sources (Allen 1992; Nkosi 2011) to present the likely pay scales for the black mine workers and a table modified after Nkosi (2011) was created with these scales. Monthly wages cited in the table in Nkosi (2011:148-149) were inserted alongside the proposed job descriptions in (Table 9.0) and it can be seen that over 50% of the black mine workers were paid less than £2 per month, compared to white mineworkers who earnt between £18 and £27 per month (Nkosi 2011:147). The only black mineworker whose name has survived in NASA records was that of Jacob Dubeni, who held the position of Chief Induna on the Argent mine. Despite holding the most senior position among the black mine workers, he was only paid £3 per 30 shift month.[15]

Only two labour disputes were sourced in the NASA and the TSBM records. The first was in 1920 when Jacob Dubeni, chief induna, was summarily dismissed without pay in lieu of notice or for the seven shifts that he had worked, for being caught drunk on duty.[16] This interesting story on the only named black person in the records, not only provides details covering the treatment of black people in the 1920s, but also serves to confirm the potential wage rates in the list of job positions at the Argent mine and their pay scales. The case was referred to the Department of Native Affairs and they ruled that although the dismissal was legal, the non-payment for hours worked was not. Despite Dubeni being dismissed, he was

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14 NASA, Pretoria. Depot TAB, Source GNLB. Type LEER. Volume no 226, System 01. Ref. 494/154 part 1 – Conditions of employment of natives on mines outside labour districts: Transvaal Silver and Base Metals Limited, Dwarsfontein, Pretoria District. 1920-1921.

15 Ibid.

16 Ibid.

successful in obtaining his payment for the seven shifts worked. Considering that the labour laws for all workers in the 1920s were considerably more in favour of managements than they are now this was a partially favourable outcome for Jacob.

The second dispute that was raised in Chapter 8, occurred in July 1921, with a threatened strike by the black mineworkers over rates of pay was only resolved when the Acting Director of the Department of Native Affairs ruled on the case[17]. The mine was instructed that the black mineworkers were employed on specific contractual terms and therefore the mine had to abide by such terms and could not unilaterally decrease their pay. In some respects this does indicate a quantum leap in black mineworker rights, considering that twenty years earlier wage rates had been cut by huge percentages without any consideration of the impact. It was also a victory for the black mine workers, in that they had used the power of potential striking – despite its illegality for them – to gain there contractual rights.

When Jacob Dubeni left the mine, after being dismissed, he not only lost his income, he would also have lost his accommodation and his daily food ration that would have been supplied by TSBM, as was the practice on the gold mines (Callinicos 1981:44-45). The NASA record dealing with Dubeni and indicated on the previous page helped in an understanding of a black mineworker at Argent in the 1920s. The accommodation that he lived in bore no resemblance to that of the living quarters of the 1890s TSM mine, which appears to have been more of a traditional open compound. The open compound system developed on the Witwatersrand – dominantly on the gold mines – was an improvement on the closed compound of the diamond mines as discussed by Worger (1987); McNish (1970); Weiss (2009).

Before the unfortunate loss of the 1890s compound and associated midden, the satellite survey showed three rectangular, free standing buildings, built in a U shape that had to house 50 men. The midden was situated alongside the one building. It is presumed that the compound was men only with multiple tiered wooden bunks. No other details regarding the 1890s compounds were found.

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[17] NASA, Pretoria. Depot TAB, Source GNLB. Type LEER. Volume no 226, System 01. Ref. 494/154 part 1 – Conditions of employment of natives on mines outside labour districts: Transvaal Silver and Base Metals Limited, Dwarsfontein, Pretoria District. 1920-1921.

The destruction of the 1890s compound foundations and the associated single midden was unfortunate. However, the good result is that the satellite survey was able to confirm the prior existence of three structures, which confirms the 1892 TSM company report which it is states that there were “three black mineworker compounds”. The finding of midden material on surface was pure luck. No obvious mound was seen during the survey period and it was only during a post survey period that a few items of ceramic were found. This led to a few Shovel Test Pits (STPs) being conducted in the area alongside the westernmost foundation in an area that was recognised as midden - although it only proved to be 50-100cm above ngl. Sadly, before the foundations and midden area could be excavated or explored further - in the hope of finding more middens or if they existed at all – the area was bulldozed for a fertiliser dump.

The number of compound buildings discussed and cited in chapter 4, does not agree with the notation on the 1890 mine plan,[18] which appears as a single building annotated ‘compound’. No other details appear on this plan. The discrepancy in the number of buildings could be due to the decision to build more compound buildings after the plan was drawn. Other scenarios could be that the additional compound buildings were levelled and built over by the TSBM mine in the 1920s or were never built at all as the additional accommodation was never required. There was no evidence of walling or poles for fencing found during the satellite and pedestrian surveys. With only evidence of three buildings and one open side one can postulate that this was a further evolution of the open compound system. One is unable to make any further assumptions regarding cooking and eating facilities at the 1890s compound.

The 1890s TSM Company records of building use as defined in Chapter 3, pages 48-49, indicate that the white mineworker’s accommodation consisted of a boarding house …with 24 rooms for two workmen each attached to a dining hall, associated with a separate building that housed the kitchen. In contrast the mention of the black mineworker’s accommodation simply describes three black mineworker compounds, followed by dimensions and building material details. No mention of dining or cooking facilities is given in the account. Such

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18 BRA. Archives of H. Eckstein & Co. Plans File:
Plan of the surface and underground of the Transvaal Silver Mine – 1890

differentiated details have to be taken in the context of the institutional social conditioning and oppression of the 1890s. It is more than likely that the cooking of food in the 1890s was carried out by the black mineworkers in the open area associated with their accommodation rooms (Harries 1994:196).

In Chapter 8 there is a mention of the fact that the rows of structures in the 'native location' can be seen on Figure 74 to diverge or converge. It is impossible to know if this was a mine surveyor plan or an organic plan created by the black mineworkers themselves. The fact that the aerial photograph shows six rows of structural foundations indicates some degree of planning or at least incremental growth. It is known from the TSBM company records, and as discussed in 5.3, that there was a seven room building and it has been shown that the large midden (M8), was more than likely associated with that structure as a communal midden. As the numbers of black mineworkers grew in the 1920s it is now believed that the concept of ‘native location’ was adopted for the other workers. There are no records of when the rows of structures were built, but it seems likely that they grew southwards, from a starting date of 1919 because the numbers of structures does diminish as this direction is followed.

The drawing (Figure 76) derived from the results of the satellite survey indicates a lack of structures in the middle rows, yet (Figure 74) clearly shows what has now been interpreted as sub-surface foundations. There is one outstanding feature of the rows of structures and that is that they either diverge or converge as they align north-south. There is no logical explanation to this such as contour deviations or rock outcrops. As only three foundation structures were selected for excavation and the main reason for their selection was to investigate the three obvious choices of foundation material namely dressed stone, clay brick and gossan rock it is impossible at this stage to state if there is a commonality of structure size. Certainly if future research is carried out on the site this could well be one of the points of investigation.

The accommodation where Jacob Dubeni lived is presumed to have been a structure in the ‘native location’ on the 1920s TSBM mine. Situated on the upper part of the slope is a two roomed brick structure that shows external plasterwork, and was excavated as BS4. It is possible that Dubeni, as chief induna, was provided with this more spacious accommodation.

Such a title implies the presence of lower levels of Induna and this may account for the spatial location of some of the better foundations. Only two such foundations were excavated - BS4 and SS2 - but a few more were seen and recorded. It is possible the Indunas were located specifically with their people, for example all Malawians would be located in one part of the site and so on with the other ethnic groupings, in order to lower racial tensions between the different ethnic groups. Research suggests “society organises itself into hierarchically ordered groups, implicitly or explicitly reflecting this through built spaces, internal divisions and symbolism – spatial control is a significant factor in this”. (Parker Pearson and Richards 1993 in Campion 1996:847).

The Argent mine site can be said to epitomise the mining industry of South Africa in both the 1890s and the 1920s. For the black mineworkers and in fact black people in general it was a time of inequality and social engineering. Unfortunately, the period before and during apartheid times was a mixture of social injustice, violations of basic human rights and job reservation on the mines. Where a black mineworker was forced into conditions of very low pay for very long hours of work both above and underground. What can be said about the 1920s Argent mine is that part from advancing the use of modern beneficiation technologies the management also appears to have adopted a relatively new concept of accommodation facilities for many of their black employees in the form of the 'native location' within the boundaries of the mining operation rather than as the squatter camp located outside of mine boundaries. This was a move away from the more oppressive open or closed compounds of the gold or diamond mines. The lives of the black mineworkers were rarely recorded in company documents and this fact is very true of the Argent mine. This means that the only potential source of data on these people is what they left behind as an archaeological record.

Unfortunately, no historical photographs have been found of the area so it is impossible to discuss the above surface buildings, though it is presumed that they were corrugate steel sheeting on wooden frames. The large quantity of window glass shards in the middens, indicates that at least some of the windows were glazed. Between rows of structures cut off water pipes (found during the satellite survey) suggest some degree of water reticulation in the ‘native location’. Some of the housing structures had foundations of low curved walls which were also several metres from the individual foundations and could have been a low screen wall to protect a fire/cooking area from the wind. The excavated middens all

consisted primarily of fine grey ash, indicative of there being a large number of individual fires. This supports the idea that the occupants cooked their own food – and each housing structure would have ash to dump. The finding of small size shoes which could be female and or a child's shoe in the one case, a few buttons, one of which is glass, coupled with the finding of an Oatine face cream jar - in the ash of the middens - are suspected of being female items, and hint at the presence of woman on the site. This would be consistent with the establishment of a 'native location' which eased the restrictions on black woman living on mine property. A great deal more excavation work of the middens would be necessary, with the intention of finding, hopefully, more items clearly of female use or origin, to determine if there was a female population on the site.

The significant political changes and hardening of segregationist beliefs in the 1920s and 1930s impacted on how black mine workers were accommodated on mines, with the re-establishment of compounds. In 1923 The National Party and the Labour Party formed a pact to oppose the more liberal South African Party of General Smuts. The gold mines established in the 1930s however, appear to have discontinued using the idea of black married quarters or native locations. Economically South Africa, much like the rest of the world, was badly hit in the 1920s and 1930s (Jones & Muller 1992). Segregation laws placed huge restrictions on urban residential areas, which included the mine compounds.[19]

Having determined that the TSBM established a 'native location' as a possible 'married quarters' raises the question of where the single men lived as it would have been unlikely that they lived in the married quarters area. With the possibility of each housing structure having its own cooking fire, the question of what was cooked on those fires is raised.

In their various company records, both the TSM and TSBM, recorded growing maize for consumption by the mine workers. The grist mill mentioned in the TSM Company records in Chapter 3 would have produced maize meal and possibly samp[20] which would have been cooked into a porridge (Quin 1959). Usually the meat was cooked into gravy and served

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19 https://www.sahistory.org.za/article/state-policies-and-social-protest-1924-1939 (accessed on 21 January 2018).

20 Samp is a food made by roughly cracking kernels of maize or corn https://www.wisegeek.com/what-is-samp.htm (accessed on 27th February 2019).

over the maize porridge. The bones recovered from the middens did not show burn marks (Scott 2018), strengthening the boiling in a stew, scenario. Vegetables may have been added to the gravy and those would have been supplied from the mine's own vegetable growing area as defined in 3.3.1 of 25 acres under vegetable cultivation. The TSM records mention a Mr Pitt, in charge of management of the cultivation of crops, and it can be assumed that he was also in charge of the livestock.[21]

Unfortunately faunal remains at the site of the 1890s midden were limited to a few bones. The bones were in a very poor state of preservation due, it is believed, to the midden being very shallow, ± 5 cm and so allowing for a faster rate of decay than in a deeper deposit. There is mention of a cattle kraal being built, but from the archaeozoological report it is known that they also kept sheep and chickens. There is also faunal evidence of wild and domestic pig, guinea fowl (*Numida meleagris*) and duiker. A detailed archaeozoological analysis of the 1920s faunal remains appears Appendix 4. Apart from animal bones, the 2016/17 excavations did not recover any maize cobs, however some eggshell pieces, peach stones and a peanut shell fragment were found.

Domestic animals, namely cattle (*Bos taurus*), sheep (*Ovis aries*) and chickens (*Gallus domesticus*), were kept at the mine during both periods of mining. The archaeozoological report (Appendix 4) mentions that butchering of meat consisted of saw cuts most likely from a band-saw followed in many cases with additional chop marks indicating secondary reduction of meat portions. The meat would have been distributed among the workers and subsequent chopping marks may well have been made by them. The presence of both male and female chicken bones and egg shell (Chapter 8) suggests a successful breeding stock that provided two sources of food – meat and eggs.

Cattle and sheep were confirmed through archaeozoological analysis, which showed that there were both European and indigenous species (Scott 2018). This was based on a comparative analysis with bones in the Ditsong Museum zoological collection, Pretoria. Although impossible to prove, it maybe that European breeds of the animals were purchased

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21 'Transvaal Silver Mines', *The South African Mining Journal*, Vol. 1, (3 September 1892), pp. 863-866.

from city markets in Johannesburg and indigenous breeds came from farms in the surrounding districts.

The supplied foods would have formed an adequate diet – if a rather bland one. The finding of several Holbrook sauce bottles could possibly have provided a solution to this problem. This sauce may have been purchased from a store run by the mining company. As there are no references to there being a store, or what could have been available for purchase this is pure speculation.

Clearly, in both the Argent and the study on Modderfontein (Behrens 1999) archaeological sites, the black workers supplemented their food source with small non-domestic species, probably trapped in snares (Siberbauer 1981; Scott 2018:259) or possibly being hunted using a digging stick or club (Knobkerrie), (Kent 1993; Scott 2018:259) This would explain the faunal remains of the guinea fowl (*Numida meleagris*) but its identification was inconclusive. Bov 2 bones were provisionally identified as those of a small antelope, commonly known as a Duiker (*Sylvicapra grimmia)*.

There were limited numbers of domestic pig (*Sus scrofa domesticus*) bones. Most southern African ethnic people, including those from Zimbabwe, Malawi and the southern part of Mozambique, eat pork. There are two exceptions, the Venda people from the northern part of South Africa, who refuse to eat pork believing in one of their traditions that they are the 'lost tribe of Israel'.[22] The other exception are the African people from the northern part of Mozambique, who follow Islamic traditions. The region was semi-colonised under the Sultanate of Kilwa in the 11th to 14th centuries bringing Islam to the coastal regions of east Africa as far as Beira in Mozambique.[23] Another reason for the paucity of pork bones could have been that it was traditionally only slaughtered and eaten in winter, as it was a carrier of tape worm (*Taenia solium*) which could infect humans.[24]

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22 Background to the Venda people http://www.krugerpark.co.za/africa_venda.html (accessed on 16 February 2019).

23 https://www.globalsecurity.org/military/world/africa/kilwa.htm information on the Sultanate of Kilwa (accessed on 28 February 2019).

24 https://www.medicinenet.com detail on tape worm (accessed on 28 February 2019).

The TSBM brewed traditional African beer on the mine under licence[25] and issued a quart to its black mine workers on Saturday afternoon. There is no indication in the company records as to how it was distributed and the suggestion is that the high number of glass beer bottles found as shards in the middens, could account for this process. There is evidence that South African Breweries bottled beer in green glass bottles prior to and during the 1920s and established 'beer in green bottles' as a norm.[26] [27] More intriguing was the finding of two shards of whiskey bottles in the middens of both TSM and TSBM and suggested reasons for their presence were put forward in Chapter 11.

There were an inordinate number of metal food tins recovered from most of the middens excavated. Some were identifiable by their shape as typical sardine tins, others were more like modern day 400 g round food tins. The large quantity recovered as whole or partial tins implies that there were alternative food sources available.

In analysing the data recovered as archaeological artefacts from the black mineworker 'native location' at Argent and returning to Behrens (1999) and Weiss (2009), the Argent collection was also divided into five primary categories, namely:- ceramic, glass, bone, metal and miscellaneous. Within each of these categories some similarity of individual artefacts was found, especially with the first three, even if the sub-categories of artefact and quantities from Argent did exceed the other works. The variety of artefacts recovered in the metal and miscellaneous categories varied considerably with Behrens and Weiss although there were some common items.

The research by Behrens (1999) and Weiss (2009) can be classified in broad terms as being on industrial sites. However, the work by Behrens at the Modderfontein Dynamite factory dealt with residential areas and middens in the European villages surrounding the factory

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25 NASA, Pretoria. Depot TAB, Source GNLB. Type LEER. Volume no 181, System 01. Ref. 815/14 part 1. Transvaal Silver and Base Metals: Application to Brew K….. Beer. 1921. Dated 8 December 1919

26 http://www.antiquebottles.co.za/brands.php (accessed on 16 February 2019) showing detail of historical SA breweries green glass bottles.

27 http://www.worldofbeer.co.za/news/whats-in-a-beer-bottle (accessed on 16 February 2019) why is beer in dark glass – brown or green? The answer is simple, it prevents ultra violet light altering the flavour of the beer. The use of green glass has varied over the last 100 years and many breweries including SA Breweries bottled beer in green glass.

complex and a black squatter settlement on a 'bywoner'[28] farm adjoining the land of the factory where a family group of blacks lived, with the male occupants mainly employed on the local farms. With Behrens' work I feel the only comparable detail is her work on the sub-site 'Sophie's' Place', thus comparing black labourer artefacts with black mine worker ones at Argent. I do not feel there is a valid cultural agency line of comparisons between the European village middens at Modderfontein and the Argent 'native location'.

Records indicate that a Doctor visited the TSBM mine twice a week and a supply of medicines and first aid appliances were kept in the Compound Manager's office.[29] Whether it was the doctor who suggested or provided the Vaseline, Davis Pain Killer and Kruschem Salts is unknown. However, it does offer an explanation for the large number of shards of cobalt blue medicine bottle glass. If there was a company store then it is conceivable that such items may have been available to all of the TSBM employees. Unfortunately as the documentary evidence does not exist regarding such a store, the assertions have to be speculative. By the 1920s Vaseline was used elsewhere on the African continent and it was known as a skin ointment for dry skin and a medicinal treatment for cuts such as in a nineteenth to early twentieth century village in west-central Ghana (Stahl 2010). The wide range of glass containers demonstrates that glass was one of the primary storage mediums of the times. In Chapter 11 there is an analysis of the glassware from Argent, which includes the colours of the glass as well as the description of the 758 shards/fragments. Recovery of complete or partial bottles was rare, but a few were found and they are described in Chapter 11. The majority of the recovered glass artefacts consisted of fragments of bottles with only a very small percentage capable of being re-fitted to some degree.

The ceramic collection from the 1890s black mine worker compound area and the 1920s 'native location' area is interesting in that neither area, or any other part of the surface collection areas of the Argent mine, yielded any shards of traditional African earthenware. There were clay sources on the farm, because bricks were manufactured at the TSM and TSBM mines as mentioned in earlier chapters so it is presumed the raw material for African

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[28] 'Bywoner – South African term for a poor tenant farmer.

[29] NASA, Pretoria. Depot TAB, Source GNLB. Type LEER. Volume no 226, System 01. Ref. 494/154 part 1 – Conditions of employment of natives on mines outside labour districts: Transvaal Silver and Base Metals Limited, Dwarsfontein, Pretoria District. 1920-1921. (26 October 1920).

earthenware was available. The lack of traditional decorated or undecorated earthenware can be explained by the fact that it is normally a woman's role to make such domestic items of fired clay, however, it does take a long time to train in the various skills necessary to make such ceramic. It speaks to the isolation of the mine with possibly no African homesteads or settlements close enough to trade or obtain local ceramics and that is assuming that it was required. Also a large part of the workforce were from far afield which would also have been an isolating factor and made them reliant on whatever the mine provided as eating utensils. Breakage of the 'European' ceramic was a very real risk and this is borne out by the hundreds of shards found in the excavations, with very few matching pieces resulting in a high count for the total collection.

The TSM or the TSBM company records do not specify if crockery was provided to their black mine workers. Behrens (1999) mentions that the Modderfontein dynamite factory had a company store where employees could purchase "basic household items (including crockery)" There is no record that the TSBM had a similar household goods store, but considering the distance from Johannesburg at 80-100 km it is highly likely that goods were purchased in bulk by the TSBM Company for distribution to the black mine workers, and were possibly also available for purchase by the white mine workers. The possibility of such a store for a variety of goods including household items and tinned foods seems a very real possibility considering the isolation of the TSBM mine.

What was found at the sites of both the 1890s compound and the 1920s 'native location' and to a lesser extent on surface collection areas, was a wide selection of glazed and unglazed commercial earthenware/whiteware,[30] stoneware and porcelain along with some decorated earthenware/whiteware and porcelain.

There were a few shards from the base of cups or saucers which had identifying maker's names or marks, these linked the item to a Staffordshire pottery maker with the name JOHNSON BROS, a firm based in Hanley, Stoke on Trent, Staffordshire, England

[30] To reduce the confusion over ceramic terms and as the recovered artefacts from Argent appear to be one general type when referring to 'earthenware' in the text it is referring to European earthenware The additional type named is refined earthenware, also European and defining a better quality of product..

(Zanucchi 2018).[31] As the footnote states the company made a product called Ironstone Ware and one of the shards has the printed name IRONESTONE W… on its base. Another piece has part of a coat of arms with the word TRENT and this also seems to match one of the Johnson marks.

The origins of the porcelain is not clear, but various Staffordshire pottery companies like Johnson Brothers were producing porcelain and they had a cheap to mid-price range product of plain porcelain as well as a product called 'flow blue porcelain'.[32] There is the higher than expected quantity of shards and fragments and a possible explanation is the period of 1920s was one when semi-porcelain utility-ware was being mass produced, and so what has been identified as porcelain, may be semi-porcelain

In 1918 Johnson Brothers began manufacturing and exporting what they termed 'utility ware'. It would appear, from the artefacts, that part of the exports of this company were delivered to TSBM, maybe as part of their export drive to parts of the British Empire in 1919-20 which would have included South Africa (Zanucchi 2018). From the descriptions in the sources, it would seems to be a semi-porcelain or refined whiteware product. The shards found at Argent are generally undecorated, but some rim or flat ware fragments are lined, moulded or show transfer printing underglaze. Not all of the shards or fragments are Johnson Bothers ceramic or their utility ware, but their shards are the only ones positively identified.

A few fragments of white 'milk glass',[33] such as rims or foot mouldings, were found along with the undamaged Oatine face cream jar. On researching the Oatine product it was discovered that it was sold in a milky white container that is defined as 'milk glass.' This is

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31 Possibly because the firm closed down in 2003, there is very little historical information on the web with the exception of a Wikipedia article. The article is referenced, but for the purposes of this footnote The Company was created in 1883 and became one of the largest pottery companies in the world developing mass produced WHITEWARE which was also at one stage called 'granite ware'. They went on to develop a so called semi porcelain and another brand name IRONSTONE WARE. From 1918 the company began exporting its products throughout the British Empire and released a range of 'utility ware' at that time. http://www.thepotteries.org/allpotters/607.htm (accessed on 30 January 2019).

32 https://www.collectorsweekly.com/china-and-dinnerware/johnson-brothers, (accessed on 30 January 2019).

33 Milk glass is defined in https://www.countryliving.com/shopping/antiques/g2965/milk-glass-facts/ (accessed on 26 February 2019).

an opaque glass, usually white in colour but can also be pink, yellow, blue or light brown. As is mentioned in Chapter 11 this ware type although a glass was yet another Victorian simulant for porcelain and was moulded into a wide variety of ornate household items such as plates, vases and decorative bowls.

The base/bottom half of a stoneware jar or possibly ginger ale bottle and the base part of a smaller diameter stoneware bottle - reminiscent of the stoneware gin bottles - were the most significant stoneware finds. There were fewer shards of stoneware than the other major types of ceramic and this could be attributed to a possible decline in their use as a container in the 1920s.

The collection of 649 pieces of ceramic was categorised into five types of ware material - see (Table 24) - the main ones were earthenware and whiteware, followed by porcelain ware, most of which is possibly the utility variety or semi-porcelain issued to the black mine workers. The balance of milk glass and stoneware percentages are very low representing just over 10% of the collection, therefore, although interesting materials, they must be considered of much lesser importance. By comparison Behrens (1999) most of her ceramic collection consisted of earthenware or whiteware. The important difference is the low number amount of porcelain at her excavations. In positive comparison with Behrens (1999), the Argent ceramics are strikingly similar in vessels, with flatware forms dominating over drinking vessels. A possible explanation for the complete lack of the semi-porcelain utility ware flat ware and cups at the Modderfontein sites is that this product was only exported from England just after 1918. This coincided with the opening of the TSBM operation and use of the new product.

Only one set of eighteen shards found at Argent were refitted to form about 75% of a whiteware saucer. Other refitting was generally of only two to four pieces, as is indicated in (Table 23). This indicates a wider distribution of broken vessels than one would normally expect when a plate or cup, when broken, is disposed of. It could also be due to the method of excavation, where the trench or square was excavated in one area, but the broken plate was distributed in another direction from that which was excavated.

I believe the most significant feature of the collection is the combined total of earthenware and its derivative or development in the pottery industry - namely refined whiteware. With a combined percentage of the two material types being just over 50% of the total collection. It is proposed that this was most probably supplied at the mine as a general utility ware for the black mineworkers. The large number of broken shards is surely testament to the fragility of this ware.

The majority of the metal assemblage as listed in 11.7 can be defined as housing construction materials – fragments of corrugate sheeting, coupled with a large number of ferrous nails, plus washers and screws used in the construction of the framework, most probably of wood for the various housing units in the 'native location'. The list in 11.7 does not cover all metal or miscellaneous items recovered, as many of both categories were single finds. Thus potential items from the water reticulation system such as a plumbing tee connection or a large section of cast iron or steel water pipe are not indicated, but appear in the artefact list in (Appendix 14).

The mine had approximately 1 to 1.5 km of narrow gauge 457 mm (18 inches) surface rail track for transporting ore and materials. It was therefore not surprising to find typical hand forged rail nails and a total of 20 were found in the various middens and surface sites. The layout of the tracks is indicated on the 1920s mine plan and during the pedestrian surveys of the mine site after an extensive grass fire, it was possible to see a raised line of ground approximately 0.7 m wide. In several areas this raised ground was seen to coincide with were the tracks were indicated on the plan. Also found were several hand forged non-rail nails which may have been used in the mine structures. A range of different diameter and length industrial bolts and pins were also found, mostly in the middens.

The largest category was the undiagnostic metal fragments found in all sites. The origins of such fragments can be metal sheeting or metal food cans. As was discussed under food, above, there were a large number of recognisable metal cans and fragments typical food tins. It is not known if the tins were provided by the mine or the mine workers had to buy such foods from a possible company store.

Copper wire was not a surprise as it would have formed part of the electrical reticulation. Various diameters from less than 1 mm and up to 4 mm were found, but the most fascinating were the coils of the fine wire reminiscent of historical African jewellery, that had possibly been made as ear rings. In essence the thin copper wire is coiled around an object such as a stick to form a spiral and a loop, possibly for the ear. Such objects could have been deliberately made for a specific end user or may just represent a recreational activity. Similarly, what appears to be a bracelet made from 4 mm diameter copper wire is more typical of a male bracelet. Many items of different diameters of copper wire were found in the middens and therefore the supply of the wire does not appear to have been a problem.

Vegetable crops were grown by the company and there would have been jobs for labourers to handle such crops. This could be the origin of the metal wheel barrow which was found partially buried near the one midden and the remains of a shovel that was found buried in M8. Simply put, they represent gardening tools.

A wide variety of items do not necessarily fall into one of the previous categories and form in effect a category of their own under the title of ‘miscellaneous’. The large number of leather shoes or parts of leather shoes fall into this category. A wide variety of these were found and are photographed in (Appendix 5). It was the finding of the very small shoe - inner - and measuring only 14 cm long and 4 cm wide that presented the possibility of a small woman or teenager inhabitant in the ‘native location’. The leather artefacts have survived being buried for 100 years including, in some cases, the eyelets and laces, but the cotton thread used to stitch the leather together has not survived. This indicates that the ash layers of the middens at Argent provided a perfect preservation medium for the leather.

A stirrup was found and a similar find is mentioned by Behrens (1999:114). Her interpretation, which appears viable, was that it may have been used on horses or mules when such animals were used as plough animals. It is known from the records that the companies grew crops and therefore, there would have been ploughing at Argent, but I am sure there were also horses for mine personnel to use in order to travel to Johannesburg on business. As there would have been blacksmith or his assistant on the TSBM mine, the stirrup along with the horse shoe, which was found in one of the middens, could have originated via him.

Parts of a knitted woollen garment and a woollen sock were found underneath an upturned shovel in a fine grey fire ash. Although very fragile, it is most probably the depth it was buried at in the midden - over one metre below surface that has led to preservation of these 100 year old garments.

Two of the seemingly most insignificant artefacts were also two of the smallest – peach stones and peanut husk. The former indicates the eating of fruit, the source of which is unknown but may have come from one of the surrounding farms. It is the remains of a peanut husk that has become of interest since gaining a better understanding of traditional foods and the use of peanuts or crushed peanuts in such foods as an additional source of protein. But the finding of only one husk does not provide sufficient evidence of its use. No remains of maize cobs were found at Argent, unlike Behrens (1999:114) who found some evidence of cobs. It is possible that the cob remains were used as fuel for the 'native location' fires and this could account for them not being found.

Typical shirt or collar buttons to trouser buttons of male clothing were expected, and were found. there was also the larger more decorative glass button with a single hoop on its reverse side which may be more typical of a female button , and was mentioned above in the discussions on the possibility of females being present on the 'native location'

By their very nature a collection of miscellaneous items are generally single items with no apparent connections, but which in turn convey information about a site as defined by Deetz (1996:4), *In small things forgotten*. Argent has yielded such 'small things'; a George V penny coin, parts of broken plastic comb, a wood saw metal warranty peg, bed or chair springs, a ceramic telephone pole insulator, various pieces of heavy woven wire mesh and many pieces of unburnt or partially burnt coal. These are some of the miscellaneous items of humanity.

The coin could have been part of a black mine worker's pay. The pink comb, made of plastic, most probably PVC as the age of nylon had not begun in 1920, provides possible further evidence for the presence of females at the 'native location'. The two parts were found in adjoining excavation squares in midden M8, thus indicating the process of fragment distribution in disposal. The saw warranty peg appears to be new –it could just have fallen

out of the saw or it was removed in error because its importance not recognised. Bed or chair springs indicate that furniture of some sort was in use in the ‘native location’, and the telephone pole insulator confirms the company records that they had telephones at the Argent mine. The finding of so many fragments of industrial metal mesh in the middens is presented as evidence that fires and potential cooking was conducted in the ‘native location’ with the mesh being used as a grill. The unburnt or partially burnt coal, far from being mundane, providing further evidence of self-cooking in the ‘native location’. The few natural trees that may have existed in the 1920s would not have been sufficient fuel for cooking and heating, so imported coal - which would also have been used in the boilers, roasters and smelters of the TSBM Company - would have been used by both black and white inhabitants of the mine for domestic use.

The strange array of miscellaneous artefacts found in the various middens is difficult to explain. Included in this category are such items as the telephone pole insulator, the jumper drill, large bolts and nuts, large pieces of metal plate and rail nails. One possible scenario is that on finding such items the black mineworker felt the need to take ownership, his personal agency of the item. On leaving the Argent mine he realised that it was of no use or it was too heavy to carry along with his other items and so it got left behind. This could explain some of the items found on surface, but other items such as the jumper drill or rail nails were found buried within the middens and had no use outside of their industrial use. For example rail nails have too big a cross section (10-12mm) to be of any structural use in - for example - the construction of housing.

The re-use of discarded industrial items is demonstrated by the various types of heavy to medium metal meshes found in the ash middens. The most obvious re-use is to place the mesh over fires to support re-purposed tins used for cooking food, or to put 'can' kettles or tins (Appendix 5 page 11 item number 924) on when boiling water.

It is almost certain that the black mineworkers on returning home after leaving the employ of the Argent mine would have taken items such three legged cast iron pots (if they had them and there are no records that they did), unbroken ceramic crockery, copper wire jewellery made from the electrical wire, personal clothing and boots/shoes and such miscellaneous items of industrial scrap such as nails or screws that they felt could be of use. There is no

clear evidence from the TSM or TSBM company records that some form of on-site "mine shop or general store" existed. If there was such a mine shop it is possible that the mineworkers could also have purchased items to take home. Unlike the gold mine workers of greater Johannesburg those at Argent did not have general dealer shops close to the mine where they could have purchased items (Harries 1994:174). The geographical isolation of Argent precluded the purchases that would have been made by the gold mine workers at general dealer shops in Johannesburg.

Chapter 13

Conclusions

> *Palmer (2005:10) argued that "the full meaning of a site can only be extracted if the material evidence is considered within a framework of inference which seeks to establish social as well as economic and technological significance."*

The TSBM site is unique in South Africa, as I believe it is the only base metals mine where a series of historical photographs, extensive primary and secondary documents and historical mine plans, coupled with a large number of physical foundations exist to enable a reconstruction of the mine in its operating periods of 1890s and 1920s.

In the 1890s it seems as if the Vanner installed by Wertheman, may have been the first of its kind installed in South Africa. Argent mine was clearly the first place in South Africa where reinforced concrete was used on a massive scale. As previously stated, all of the 1920s foundations were built using it. This was followed by Argent being, almost certainly, the first mine in Africa to install Hardinge Conical Ball Mills, along with the Dorr Rake Classifier and - most probably - the Dorr Thickener. The final new technology of the 1920s was the Mineral Separation Sub-Aeration Flotation plant, which, although one was commissioned in Zimbabwe prior to, the Argent one was the first in South Africa, just ahead of the Messina plant by several months. Potentially, in the two time periods of the 1890s and 1920s, the Argent mine introduced six different, but ground breaking technologies, into South African mining. From a social perspective, the mine followed a new method in which its black workforce was accommodated. They moved away from the formal structure of a compound to the more open individual housing units laid out in six straight lines in what was designated a 'native location'. This social experiment - like the TSBM mine itself - did not last, but it has been discussed in detail and was clearly a forward thinking idea in social management.

The study of the beneficiation plants showed that this mine appears to have been used as a testing ground for new inventions and patented machines or processes in the field of mineral beneficiation. No records were found in terms of managerial decisions regarding the direction to go in, in developing the processes to install at the Argent mine in the 1890s. In modern engineering, such decisions would involve a team of engineers, metallurgists and, more than likely, financial managers. The pro and cons of each process or machine would be discussed and the decisions minuted. One wonders at the motivation behind the earlier decisions.

It appears that Wertheman was employed by Phillips in London, in the latter part of 1892, although he only arrived in South Africa in February 1893. It is conjecture that he was busy designing the new concentration plant during these months and came up with the price of "less than £10 000" as stated in an earlier chapter. Books by Fraser & Jeeves (1977, Wheatcroft (1985, Jones (1995), and Rosenthal (1970) to name a few, all seem to imply that the Randlords were the decision makers in the 1890s. Hahn and Wertheman seem to have been the ones, in their respective cases, making the decisions on not only the processes, but also the machines to be employed in their designs. Hennen Jennings did not appear to be involved in any of the decisions. Surely, as group technical manager for the Eckstein Group and a more famous international mining engineer than either Hahn or Wertheman, he should have been involved. In simple terms, it appears that both engineers effectively said to Phillips, as chairman of the TSM, - this is the design, this is what it will cost - to which they went ahead and purchased and installed their respective plants.

In the 1920s there appears to have been a more collective approach with General Mining group engineers and metallurgists designing the plant, most probably along with the involvement of civil engineers and architects', who would have been the ones designing the support structures and plant layout. The final decision would most probably have been Sir George Albu's and ratified in a General Mining Board meeting. Certainly there were group personnel involved with the TSBM operation, such as Errol Hay, group technical advisor to General Mining, Harold Clayden, group mechanical and electrical engineer, and FAG Maxwell, group consulting metallurgist. These where the men who made the decisions on the technical side of General Mining.

It is my belief the men named in the previous paragraph, seeing as they would have also been involved in the gold mining operations, saw the start-up of the TSBM as an opportunity to purchase and test the new processes and machines outlined in the opening paragraph. As was stated in (Chapter 5), gold mining in 1920 had hit a new economic low. Mines had closed, the market was depressed and much of the technology in the group's gold mines pre-dated the First World War. Here was an opportunity to test these new machines and processes that, in theory, could be adapted to gold beneficiation when the gold market improved, when new gold mines were started or other mines within the group - that were processing metallic ores - were developed.

By understanding the Argent mine site and the processes of beneficiation that were installed in the 1890s and 1920s, it has been possible to match foundations with the historical photographs, and then match certain foundations with specific machines, or parts of the process. A very good example of this was the identification of the foundations of the MS Flotation plant during a site visit by Professor Rodney Jones of Mintek and Wits when after discussions he pointed out the foundations to me. Similarly historical photographs can provide one with clues to environmental problems, such as the stunted maize growth discussed in (Chapter 5), in which the historical photograph (Figure 42) shows a dump of white material close to the smelting plant, where limestone would be used. Lumps of limestone were found associated with the stunted maize and the conclusion was the pH of the soil had been dramatically changed to a more alkaline level and upon investigation it was found that maize prefers acidic soils. The historical photograph of the 1893 TSM concentration plant was also utilised in the ground survey of the site and matching foundations were found for virtually all of the wooden columns of the building.

The primary reason for conducting a series of random excavations within a defined area of the 'native location' was to test a set of questions outlined in earlier chapters. The evidence, on review, of a possible black female presence in the 'native location' is inconclusive at this stage. Certainly the Oatine face cream bottle was one used primarily by females, but apart from finding it in the residential area, there is no associated female context. The glass button appears more of a female type button – white glass approximately 2cm in diameter with a

single metal hoop shank[1] on the back - and with a pattern of squares on the front face - but again found in a different location from the Oatine jar in the residential area and thus presents a problem of context.

The copper wire jewellery could just as easily have been one of the men making it for fun or for a female companion for when he returned home. Lastly the shoes possibly the hardest to put into a male category. Its physical size - length and width - is definitely too small for a male foot, but once again the additional lack of contextual evidence means that it is too early to confirm black females being present at the Transvaal Silver and Base Metals mine in the 1920s. The woollen items found could most definitely be for males and the sock that was recovered was a typical male sock.

The collection of bones proved several facts regarding what was eaten by the black mine workers. It was known from the company records that cattle and sheep were kept on the mine. Bones of both species were found, but European, Nguni and Pedi breeds of the animals were present. The reason for the mixture of breeds being was suggested in Chapter 12 as market sources for the livestock. The archaeological report states that most bone parts of an animal were present in the collection, indicating that the whole animal was distributed among the black mine workers. There is evidence of two types of butchering, band-saw and axe/chop marks. Company records indicate that they had a butchery and meat store, which would account for the obvious band saw marks some of which showed partial melting of the bone. It is proposed that the animal was cut up into manageable pieces – quartered - and distributed whereupon the black mine workers used axes or choppers to reduce the pieces further. It was also predicted when excavations were started that chicken and goat bones would be found. As the faunal collection grew and chicken bones were confirmed in the archaeozoological analysis, the one species completely absent from these excavations was goat.

It is not clear what vegetables they ate, as no remains have been found, although it is known from company records that maize and vegetables were grown. The large collection of tin

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[1] Known as shank buttons with a metal loop or shaft with a hole for sewing the button onto the garment. http://textilelearner.blogspot.com/2011/08/button-what-is-button-define-button_7213.html. (Accessed on 1 February 2019).

cans suggests that much of the food was supplied tinned. Certainly they used Holbrook sauce, as many bottles were recovered. There is no clear documentary evidence that they drank commercial beer, but the large amount of beer bottle glass suggests otherwise or alternatively that the company used commercial beer bottles and filled them for distribution to the black staff. The mine had applied for and received a permit to brew African beer at the mine in the 1920s,

Personal medicines and creams were found, such as the three undamaged Vaseline jars along with many broken fragments of the same type of glass jar. The Kruschem Salts jar and a large amount of medicinal cobalt blue glass and patent medicine bottles were found. The company reports confirmed that a Doctor did visit the mine regularly and was a possible source for some of the medicines and its glass.

The possibility of a hierarchal social structure existing in the ‘native location’ cannot be proven, however the fact that different types of housing foundation were found provides the basis for this hypothesis, but more work would have to be carried out to determine the location of the better quality foundations and hence one assumes structures which may determine ‘class’ or position within the ‘native location’.

The Argent mine is unique in South Africa, as it is the only silver-lead mine where the remains of two distinct time periods of mineral beneficiation can be studied and is therefore of value to the world of industrial archaeology. For the social or historical archaeologist it also offers a wealth of potential sites for further excavation of social structures of black mine workers dating from the 1920s and the foundations of the white mine worker living areas - both management houses and the remains of the single quarters close to the entrance of the mine property on the edge of the road in from the N12 highway, coupled with the ruins of what I suspect was the manager’s house. All have been looked at during the pedestrian survey, but have been left undisturbed as they were outside of the scope of this project. The potential for middens close to either of these two sites still exists. The placement of permanent beacons on the ‘native location’ area and on the boiler house and primary crushing plant foundations will offer anyone in the future an easy means with which to correlate the information in this thesis with any future work.

To conclude, the value of this old mine site is in its preservation for future generations. We have lost so much of our early mining heritage in Johannesburg, due to the ever expanding residential and commercial growth, needing land for development left vacant by old mining operations. Our modern attitude is ‘oh it is old and outdated’, without realising that it is where we have come from. My hope is that the Argent mine is preserved as is, for future generations to visit and understand the importance that this mine seems to have played in South African mining development.

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Appendices

1 Portion of the 1920s Surface Mine Plan

2 Plan of the surface and underground of the Transvaal Silver Mine – 1890

3 Plan of the surface and underground of the Transvaal Silver Mine – 1892

4 Archaeozoological Report

5 Analysis of specific artefacts and discussions

6 Pound Stirling conversion table

7 Mass and length conversion table

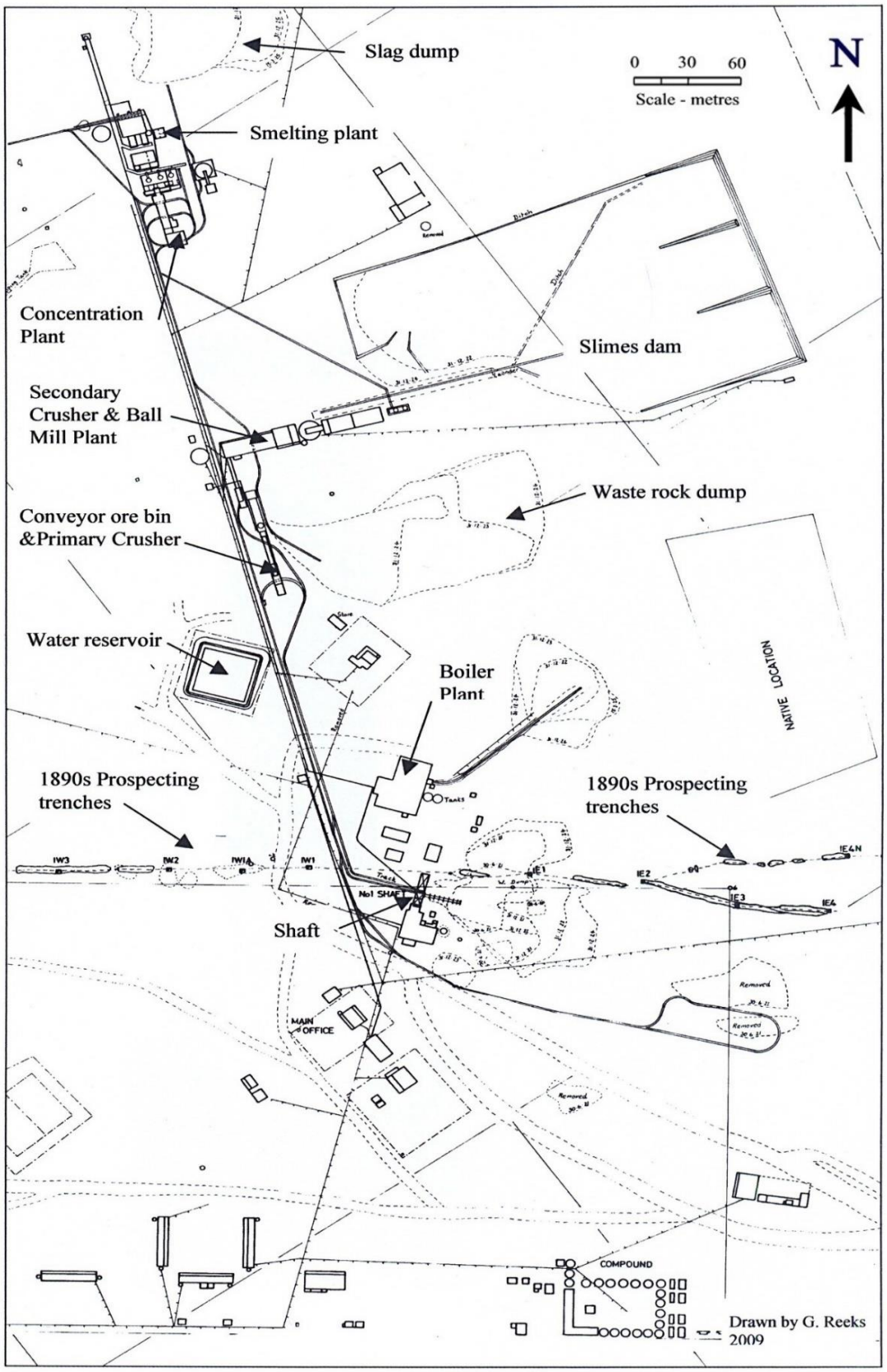
8 Photographs of the stone foundations c1890 and the concrete foundations c1920

9 Photographs of the excavation sites

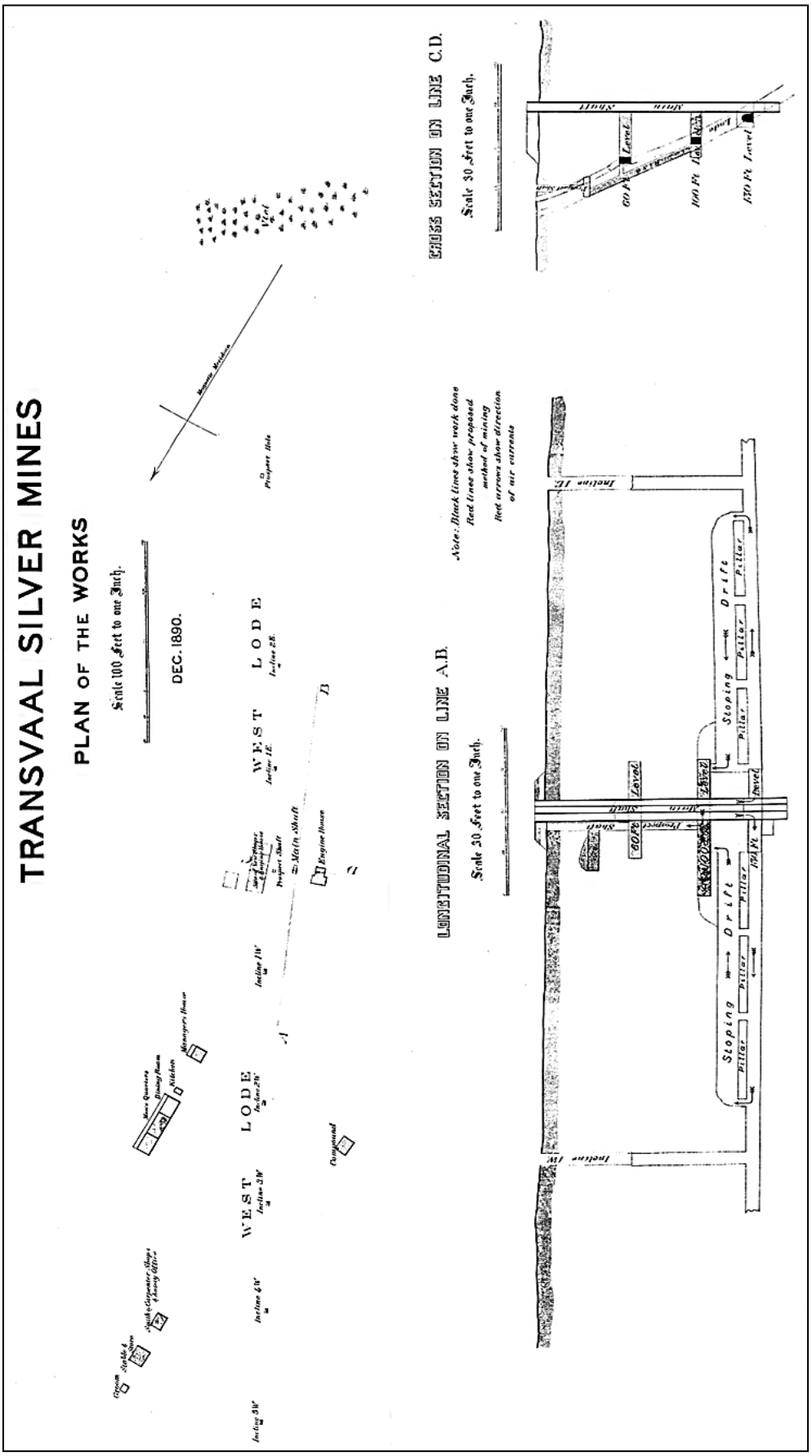
10 Satellite survey details

11 Satellite survey drawings of co-ordinates

12 Analysis of Argent artefacts by site and material type

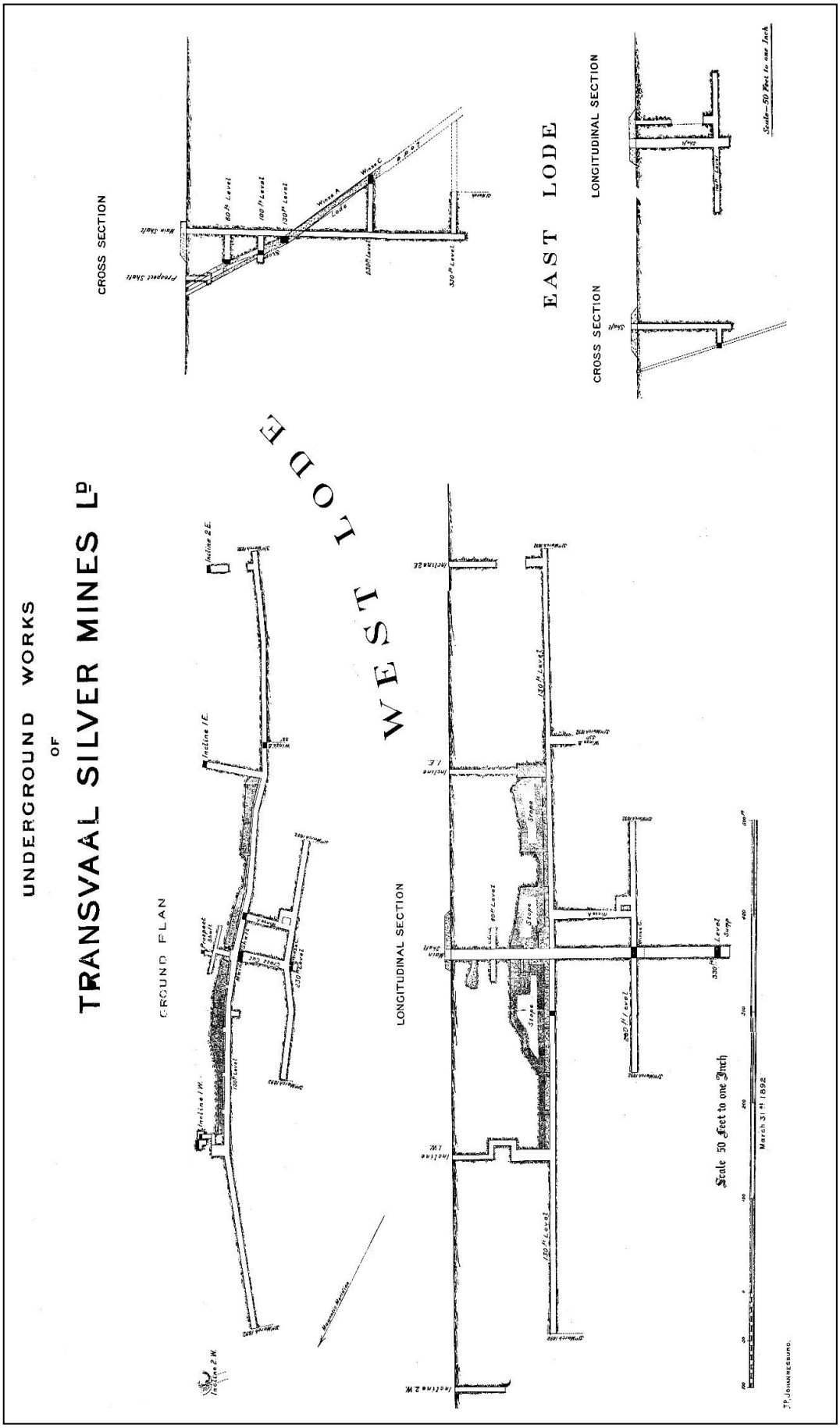


Appendix 1 Central portion of the re-drawn 1920s plan of the surface plant of the Transvaal Silver and Base Metals Ltd mine. Traced from the original plan.



Appendix 2 1890 mine plan of the Transvaal Silver Mines Ltd., Dwarsfontein 209IR

Appendix 3 1892 mine plan of the Transvaal Silver Mines Ltd., Dwarsfontein 209IR



Argent Silver Mine

Karin Scott
P.O. Box 61547; Pierre van Ryneveld; Pretoria; South Africa; 0045; kayscott@mweb.co.za

Introduction

Cultural Artefacts found

Refer to the report by Mr Reeks.

Excavation Methods and Methods used in Faunal Analysis

7 excavation blocks were submitted for analysis. All excavated material was sieved through 10 mm mesh.

The faunal material was sorted into identifiable and not identifiable fragments. The identifiable analysis was done with the help of the Ditsong National Museum of Natural History's (former Transvaal Museum) Archaeozoology Department skeletal collection and the authors' private skeletal collection. All analysis was completed in the accepted international standards as promoted by ICAZ (International Council of Archaeozoology)

Age class determination where applicable was done according to Voigt (1983) and Plug (1988). The quantification methods NISP and MNI are used in accordance to the methods set out by Plug, I (1988).

Complete articulation facets and bones as well as worked bones were measured using a calliper with an accuracy of 0.1mm as part of the standard archaeological analytical methodology; these measurements are not included here but are kept on file. The measurements were taken using the standard points of measurements described by Von den Driesch (1976) and Peters (1986).

Weathering was estimated by comparison to the rest of the sample.

Faunal Sample

- **Unidentifiable**

The total sample bones that could not be identified were 892 with a mass of 2034.2 g.

- **Identifiable**

The total sample bones that could be identified were 320 with a mass of 2552 g. All species identified occur and did occur in the region.

A variety of 12 species were identified. Most commonly found was *Ovis aries* with an NISP count of 112. *Bos taurus* produced the next highest NISP count of 28 followed by *Gallus domesticus* with a count of 26.

The excavation that yielded the highest NISP is M8 with a count of 236. M16 yielded the highest number of species – 8.

- **Age classes identified**

Block and layer	Species	Age / Age class	Amount
M8 C10 Layer 5 30-50cm	Non-ID	Juvenile	4
M15 H6 Layer 2 10-20 cm	Non-ID	Neonate	1
M15 H6 STP 20 40 cm	Non-ID	Juvenile	1
M16 D9(a) Layer 2 10-20cm	Non-ID	Juvenile	2

Block and layer	Species	Age / Age class	Amount
M8 C10 Layer 8 70-80 cm	Small mammal	Juvenile	1
M8 C10 Layer 1-2 0-20 cm	*Sus scrofa domesticus*	Juvenile	2
M8 A10 Layer 4 30-40 cm	cf. *Ovis aries*	Juvenile	1
M8 B10 Layer 8 70-80 cm	*Ovis aries*	Juvenile Class II	1
M8 E10 Layer 7 60-70 cm	*Ovis aries*	Sub-adult	1
M8 E10 Layer 6 50-60 cm	*Ovis aries* (larger than Pedi)	Juvenile	1
M8 B10 Layer 8 70-80 cm	*Ovis aries* (not Pedi)	Juvenile	1
M8 C10 Layer 1-2 0-20 cm	*Ovis aries* (not Pedi)	Juvenile	1
M8 C10 Layer 3 20-35 cm	Bov II	Juvenile	1
M8 A10 Layer 6 50-60 cm	Bov II	Sub-adult	3
M8 A10 Layer 8 70-80 cm	*Bos taurus*	Sub-adult	1
M8 A10 Layer 8 70-80 cm	Bov III	Neonate	1
M8 C10 Layer 5 35-50cm	Bov III	Sub-adult	1
M8 A10 Layer 4 30-40 cm	Bov III	Older sub-adult	1
M8 D10 Layer 6 50-60 cm	Pathology	Juvenile	1
M16 E9(b) Layer 1 0-10 cm	*Sus scrofa domesticus*	Sub-adult	1
M16 D9(a) Layer 1 0-10 cm	*Ovis aries*	Juvenile Class I/II	1
M16 F9(b) Layer 3 20-30 cm	*Ovis aries*	Older sub-adult Class IV	1

- **Taphonomy**

Out of the total number of unidentifiable specimens a 199 bones were burnt, 136 displayed mineralisation, 13 were weathered, 1 with carnivore gnaw marks , 12 with saw marks and 179 cut or chop marks were identified.

Out of the total number of identifiable specimens 16 bones were burnt black, 2 white and 1 grey, 1 appeared to have been only partially burnt while 7 exhibited more severe heat damage. In addition 7 bones were weathered, 13 displayed mineralisation, 1 bleached, 1 with acid damage and 3 displaying heavy root etching. 14 bones displayed saw marks, 29 cut or chop marks and 1 displaying a pressure fracture. 1 rib displayed a possible human bite mark on the top and bottom of the cortex.

- **Worked bone**

1 worked bone was identified in M8 D10(a) Layer 2. It proved to be a mid-shaft piece which exhibited smooth polishing on the sides next to the marrow cavity and polished to a tip on one of the edges.

For full measurements and descriptions, refer to the measurements document attached.

- **Sex and Pathology**

Only 3 bones could be used for sexing, M8 B10 layer 5 (36-50 cm) a *Bos taurus* left pelvic pubis was identified as female. An *Ovis aries* left pelvic pubis was found in layer 8 (70-80 cm) of the same square and proved to be male. In layer 2 (10-20cm) of M16 D9(a) a *Gallus domesticus* right tarsometatarsus was found with a very distinctive spur thus proving it to have originated from a male.

Block and layer	**Species**	**Skeletal element**	**Pathology**	**Amount**
M8 A10 layer 6 50-60cm	*Ovis aries*	Mandible and teeth	Uneven wear upper tooth row	5
M8 B10 layer 5 36-50 cm	*Bos taurus*	Pelvis	Exostosis	1
M8 B10 layer 6 50-60 cm	Pathology	No element	Exostosis	1
M8 B10 layer 7 60-70 cm	*Ovis aries*	Maxilla and teeth	PM2 &3 PM2 uneven wear on upper tooth path	3
M8 B10 layer 8 70 – 80 cm	*Ovis aries*	Maxilla and teeth	PM3. 4 heavy wear & M1 wear	3
M8 C10 layer 1-2 0-20 cm	*Sus scrofa domesticus*	Maxilla with teeth	Wear on PM 3 & 4	2
M8 C10 layer 3 20-35 cm	Bov III	Femur dist	Exostosis	1

M8 C10 layer 5 35-50 cm	Pathology	Rib	Exostosis + bone loss	1
M8 C10 layer 6 50-60 cm	Bov III	Scapula	Pathology	1
M8 D10 layer 6 50-60 cm	Pathology (cf. Bov II)	Vertebrae	Lipping around articulation	1
M8 D10 layer 7 60-70 cm	*Ovis aries*	Maxilla with teeth	Uneven wear M2 & M3	2
		Lower molar	Uneven wear	1
	Bov II	LL2I	Uneven wear	1
M15 G6 layer 1 0-10 cm	*Ovis aries* (Pedi size)	1st phalanx	Exostosis	1
M15 H6 STP 20-40 cm	Bov III	Pelvis	Exostosis	1

In total 3 pieces of ossified cartilage was identified, 1 in layer 6 (50-60cm) of M8 C10 and 2 in layer 5 (40-50cm) of M16 D9(a).

Discussions and Conclusions

Argent Silver Mine is an industrial archaeological site. It would stand to reason and is supported by the historical documentation that the workers were provided with meat and were not required to procure their own sustenance. The fauna analyses support the historical documentation to a point.

The analysis clearly shows that there was a heavy reliance on sheep (*Ovis aries*). It has to be noted that there seems to be 2 breeds present on site. This conclusion is reached due to the size difference within the archaeological remains. Some of the specimens were comparable in size with the modern comparison Pedi sheep material in the DNMNH, while others clearly originated from larger and stockier animals. This could indicate that there were both indigenous sheep as well as European sheep being utilised.

The same argument can be made for the other domestic animal - Cattle. Some of the archaeological material proved to be almost a 1/3 larger than AZ 1 a specimen that originated from the indigenous Nguni breed. In light of the above arguments regarding the domestics and given the time period in question it raises interesting possibilities to investigate the origins of the animals and the farming practices in the surrounding area.

The neonate and juvenile domestics identified could indicate the presence of breeding herds on the mine, further supporting the historical record.

The presence of 2 other domestic species was surprising although not unexpected in the case of the chicken. Chickens are easily kept and provide both meat and eggs. The identification of eggshells supports this theory. Humans usually enjoy a varied diet and it stands to reason that they would supplement the provided staples with other sources of nutrition. Their remains were the third most common identified which could indicate their importance in the diet.

The one guinea fowl element can be a misidentification although it compared favourably with the specimens in the comparative collections. This species is widely distributed in the area of the mine and they are snared without any effort. Their possible presence is further supported by the wild animals identified.

The domestic pig remains in M8 and M16 are interesting but unfortunately not enough to draw any conclusions from. The bones originated from at least 2 age classes (juvenile and sub-adult) and were found in various layers. An MNI of 5 indicates that several individuals were consumed. This was thus not an unusual species but rather a semi-regular addition to the diet.

No archaeological evidence for plant use was presented, it is reflected in the historical record that crops were cultivated. Due to the excavation, sifting and sorting methods used it is very likely that the remains of small animals were not collected. This unfortunately creates a gap in the faunal record and a holistic recreation of the protein subsistence cannot be formed. As certain species of small mammal and animals are attracted to agricultural uses of land the absence of their remains is problematic. The historical record indicates crop farming and this opens the possibility of garden hunting. The steenbok identified as well as the other small mammals' supports this supposition. Please note that although the term 'hunting' is used it should not be interpreted in the traditional use of that word. All the wild species identified could have been caught in snares which also constitute a hunting practice.

Further supporting the problematically incomplete faunal sample submitted for analysis is the complete absence of rodents is in the faunal sample. These animals are commensal to humans and are ever present. During analyses of the unidentifiable material several ribs that due to their size could not have originated from sheep were found. The ribs could have belonged to one or more of the small mammals identified in M15 H6 STP and M15 H6 Layer 2.

The one fish skeletal element identified hints that the diet was partially substituted through river resources. Unfortunately due to the above mentioned excavation practices this remains speculation.

Tortoises are easily caught and provide a lot of nutrition relative to their size. They are widely distributed and the singular specimen found is not surprising in light of the other hunted or gathered species identified.

Most of the pathological bones occurred in the lower layers of the deposit i.e. layers 5 - 8. There is a distinct difference in the pathologies identified between the species. In the sheep the pathologies mainly manifest in the teeth. The uneven tooth wear can be attributed to the type of feeding that was available i.e. high silica grass. The cattle on the other hand exhibited bone exostosis which could be found in working animals. This possibly squares with the historical record of oxen being used to haul heavy loads. The researchers are unsure as to the reasons for there being such a distinction between the upper and lower levels. The decline in pathology may be linked to the economics of the mine as the mine flourished a better class of animal could be purchased and or better farming practices could be employed.

Interesting to note that for an industrial age assemblage the chop marks (29) still outnumber the mechanical saw marks (14). It can be put forward that the carcases were only sectioned into manageable pieces and then distributed for further processing by hand tools. A long bone midshaft was found with a saw mark on the edge that appears to be melted possibly as a result of the heat of the saw.

Only a small number of bones exhibited burning taphonomy which leads the researchers to speculate that the preferred cooking method for meat was boiling and not roasting.

The skeletal element profile argues strongly to whole carcass processing. No evidence could be found for preferential sectioning or distribution of the cut meat.

One shovel shaped incisor was identified in layer 2 (10-20cm) of M16 D10(a) and the nearest comparative specimen was that of a baboon. The specimen was not human in origin. Any conclusion drawn from this single specimen will be purely speculation.

The analysis does open very interesting avenues of exploration. As this is the first, to our knowledge, industrial archaeological site of this time period that has had the fauna analysed most of the conclusions reached are speculative. It is very interesting that species were identified that were not mentioned in the historical documentation. Further research on this and other contemporary archaeological sites are needed to test the conclusions reached in this analysis.

Acknowledgements
I wish to thank Mr Reeks for the opportunity to analyse this terrain. Ms Brits for her help with the initial sorting, identification and report writing.

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Tables

Argent – Summary of the identified species

Identification	NISP	MNI	Mass
Non-bov (Possible primate)	1	1	1
Viveradae	1	1	0,2
Small mammal	4	4	1,3
Sus scrofa domesticus	10	5	132
cf. Bos taurus	4	2	194
Bos taurus	24	9	478,8
cf. *Ovis aries*	9	7	16
Ovis aries	95	27	646,3
Ovis aries (Pedi size)	4	2	13,1
Ovis aries (not Pedi)	2	2	17
Ovis aries (larger than Pedi)	2	2	7
Raphicerus campestrus	3	1	13
Bov I	6	5	27,1
Bov II	61	33	282,8
Bov III	31	17	446
Pedetus / Sciuridae size	1	1	0,1
cf. *Gallus domesticus*	1	1	0,5
Gallus domesticus	25	10	28,5
cf. *Numididae*	1	1	5
Medium Aves	15	9	26,6
Geocephalone pardalis	1	1	0,2
Synodontis sp.	1	1	2
Shell	1		0,5
Eggshell	7		0,1
Pathology	2		1,1
Human taphonomy	1		2
Worked Bone	1		4

Argent – Summary of identifiable faunal species per sub site and square

Identification	NISP	MNI	Mass
Surface collection			
Bos taurus	1	1	10
M8			
A10			
Sus scrofa domesticus	2	2	18
Bos taurus	4	2	170
cf. *Ovis aries*	1	1	4
Ovis aries	26	5	163
Bov II	13	7	87,2
Bov III	7	4	154
Medium Aves	4	1	0,5
Synodontis sp.	1	1	2
M8			
B10			
Small mammal	1	1	0,1
Bos taurus	8	3	157,8
cf. *Ovis aries*	2	1	4
Ovis aries	24	4	186
Ovis aries (not Pedi)	1	1	8
Bov II	9	4	36,3
Bov III	2	1	10
Gallus domesticus	1	1	0,2
Medium Aves	7	4	25,6
Pathology	1		0,1
Eggshell	7		0,1
M8			
C10			
Small mammal	2	2	0,2
Sus scrofa domesticus	7	2	44
Bos taurus	7	1	110
Ovis aries	13	4	110
Ovis aries (not Pedi)	1	1	9
Bov II	10	6	37,9
Bov III	12	6	199
Gallus domesticus	10	2	17,8
Medium Aves	1	1	0,1
M8			
D10			
Bos taurus	2	1	21

Ovis aries	15	4	68,3
Ovis aries (Pedi size)	3	1	9,1
Bov II	12	5	64,2
Bov III	2	1	44
Gallus domesticus	6	3	5,3
Medium Aves	1	1	0,1
Pathology	1	1	1
M8			
E10			
Ovis aries	2	2	21
Ovis aries (larger than Pedi)	2	1	7
Bov II	3	3	14
Bov III	3	1	14
M15			
G6			
cf. Bos taurus	2	1	186
cf. Ovis aries	1	1	1
Ovis aries (Pedi size)	1	1	4
Bov III	1	1	5
cf. *Numididae*	1	1	5
M15			
H6			
cf. Bos taurus	2	1	8
Ovis aries	6	2	13
Raphicerus campestrus	3	1	13
Bov I	1	1	4
Bov III	2	1	8
Pedetus / Sciuridae size	1	1	0,1
M16			
D10			
Bov I	1	1	3
Bov II	1	1	2
M16			
D9(a)			
Viverradae	1	1	0,2
cf. Ovis aries	4	2	5
Ovis aries	3	3	20
Bov I	3	2	20
Bov II	7	2	25,2
Bov III	1	1	10
cf. *Gallus domesticus*	1	1	0,5
Gallus domesticus	6	2	2,2

Medium Aves	2	2	0,3
M16			
D10(a)			
Small mammal	1	1	1
Ovis aries	1	1	1
Bov I	1	1	0,1
Bov II	1	1	1
Gallus domesticus	1	1	2
Geocephalone pardalis	1	1	0,2
Human taphonomy	1		2
Worked bone	1		4
M16			
E9(b)			
Non-bov (Possible primate)	1	1	1
Sus scrofa domesticus	1	1	70
cf. Ovis aries	1	1	2
Ovis aries	2	1	9
Bov II	2	2	2,5
Bov III	1	1	2
Gallus domesticus	1	1	1
Shell	1	1	0,5
M16			
F9(b)			
Ovis aries	1	1	5
Bov II	2	2	4,5
M16			
G9(b)			
Bos taurus	2	1	10
M23			
J9			
Ovis aries	2	1	50
M27			
J5d			
Bov II	1	1	8
Surface collection			
Bos taurus	1	1	10
M8			
Small mammal	3	3	0,3
Sus scrofa domesticus	9	4	62
Bos taurus	21	7	458,8

cf. *Ovis aries*	3	2	8
Ovis aries	80	19	548,3
Ovis aries (Pedi size)	3	1	9,1
Ovis aries (not Pedi)	2	2	17
Ovis aries (Larger than Pedi)	2	1	7
Bov II	47	25	239,6
Bov III	26	13	421
Gallus domesticus	17	6	23,3
Medium Aves	13	7	26,3
Synodontis sp.	1	1	2
Eggshell	7		0,1
Pathology	2		1,1
M15			
Bov I	1	1	4
cf*. Bos taurus*	4	2	194
cf. *Ovis aries*	1	1	1
Ovis aries	6	2	13
Ovis aries (Pedi size)	1	1	4
Raphicerus campestrus	3	1	13
Bov III	3	2	13
Pedetus / Sciuridae size	1	1	0,1
cf. *Numididae*	1	1	0,5
M16			
Viveradae	1	1	0,2
Small mammal	1	1	1
Non-bov (Possible primate)	1	1	1
Sus scrofa domesticus	1	1	70
Bos taurus	2	1	10
cf. *Ovis aries*	5	3	7
Ovis aries	7	6	35
Bov I	5	4	23,1
Bov II	13	8	35,2
Bov III	2	2	12
cf. *Gallus domesticus*	1	1	0,5
Gallus domesticus	8	4	5,2
Medium Aves	2	2	0,3
Geocephalone pardalis	1	1	0,2
Shell	1		0,5
Human taphonomy	1		2
Worked Bone	1		4
M23			
Ovis aries	2	1	50

M27

Bov II	1	1	8

Appendix 5 - Analysis of specific artefacts

The following pages of this appendix provide a pictorial guide to a selection of the artefacts recovered from the Argent excavations. They have been selected on the basis of identifiable artefacts, such as the metal fragments and nails found, as well as some of the most significant artefacts that were recovered. These include metal object such as nails, screws and bolts. Many metal food cans, or parts thereof such as rims and lids, were recovered. The selection illustrated on the first page represents some of the better quality pieces. Over 20 hand forged rail nails were recovered and the photograph illustrates some of them. To show how effective the shape of the head was, a piece of mine rail is photographed (Figure 111) in conjunction with one of the nails. Note how the shape of the rail foot and nail head match.

A selection of metal and plastic personal items are shown, which include buttons, part of a comb, a King George 5th penny, and various items of copper wire that appear to have been made into jewellery, various components of belts and an enamel drinking cup.

A wide selection of industrial items, which include a telephone ceramic insulator various large metal plumbing components, a saw warranty badge, a metal scythe, ceramic assay cups, various types of metal mesh and an example of the metal straps, that were found. Two of the most interesting artefacts are at the top of page 4, a large piece of steel mesh with part of a Vaseline bottle fused to it along with pieces of coal. The other item is the steel ball found next to the foundations of the Hardinge Conical Ball mill.

The six photographs of bones represent only a very small percentage of those recovered. Of interest are the bones exhibiting clear band saw cutting coupled with chop marks.

Among the many items of glassware recovered were complete Holbrook Worcestershire sauce bottle, A Davis vegetable pain killer bottle, an Oatine face cream jar, three complete Vaseline ointment jars and many shards of such jars, a Kruschem Salts bottle, a patterned drinking glass and four green glass bottle stoppers two with the name Holbrook on the top face.

A large number of shards of undecorated and decorated porcelain and earthenware were recovered, relatively few pieces could be re-fitted. Some of the patterned pieces are illustrated. Only two incomplete stoneware jugs or bottles were found and they are illustrated on page 6. Three shards were found with maker's identification marks and these have been discussed in Chapter 12.

The recovery of so many items of leather was most exciting. At least five recognisable shoes were recovered along with many fragments of leather uppers and in the one case a significant part of the leather upper along with the lace eyelets. Some of the leather shows the original stitching holes and some have the original nails still attached.

Possibly, the most important finds were the two items of woollen clothing. A single woollen sock was found buried in an ash layer at site M8 and very close to it was a metal shovel (also shown) under which, laying in fine grey ash, was the knitted woollen garment shown. It is amazing that this item survived 100 years of burial without decay and it is thought that the depth, the ash and the cover of the shovel protected it from ground water. Although incomplete, it was most probably part of a woollen jersey. A close-up presents details of the stitching. Alongside the shovel, is what appears to have been a 'can-kettle' used for boiling-water. The handle did swivel at one stage and one of the pivots was found next to the can.

The numbers refer to the artefact identification number in Appendix 12.



No's 2, 3, 4, 16, 96, 104, 522, 712, 870 - Some of the various tins and lids found



No's 525, 539, 540, 932 – Hand forged rail nails of various lengths



No 3 part of metal can, approximate such size being a modern 400g can



No's 50, 227 & 1073 Typical miscellaneous metal artefacts found in the excavations



No 140 Approximately 600 nails and fragments were recovered



No 16 - 'Sardine' shape tin



No 680 – typical appearance of the extremely oxidised nails and bolts



No's 899, 900 & 930
hand forged nails



No's 528 & 535 wood screws



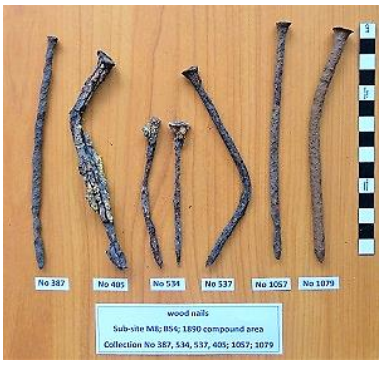
No's 249 1094 & 1132
washers and nuts



Rail nail fitting on mine rail
1079



No's 420 & 423 copper wire 1 piece attached to oxidised metal



No's 387, 534, 537, 405, 1057,
round head wire nails



No's 358, 359 & 404 copper wire possible jewellery items



No 111 Large square headed bolt or pin



No 998 one example of many pieces recovered



No's 217, 312, 344, 653 & 880
Glass, plastic and metal buttons



No 356 part of a plastic comb



No 963 King George 5th penny

APPENDIX 5



No 1022 ceramic telephone wire insulator



No 1072 enamel ware drinking cup



No 1021 Ceramic assay cups



No 896 industrial plumbing valve



No's 545, 953 and 957 industrial mesh



No 1101 Saw warranty stud



No 929 Furnace brick make common Boksburg Brick Co.



No 1113 half of an industrial pipe end



No 129 Flat Metal strip - type of artefact



No 960 belt buckle



No 999 Steel scythe



No 868 Braces strap buckle



No 108 Metal mesh or grating with attached Vaseline jar fragment



No 994 Hardinge Ball Mill steel ball



No 286 Metatarsal & 1st Phalanx – *Ovis aries*



No's 828 & 832 Femur and Tarsometartasus – *Gallus domesticus*



No 379 Mandible + EPM4, M1, M2 EM3 – *Ovis aries*



No 837 Humerus distal aries articulation – *Sus scroda domesticus*



No 123 Humerus distal mid shaft - *Ovis aries*. Note the sawn ends and chop marks



No 837 Tooth LRE2M – Ovis



No 584 Very thick olive green bottle Base



No's 512 & 1010 Glass bottle stoppers. Two had name Holbrooks



No 499 glass bottle with name WITBANK WATER



No 906 Green glass bottle with spiral moulding



No's 314, 579 & 986 three undamaged Vaseline jars



No 315 undamaged HOLBROOKS sauce bottle with part of label visible



No 1164 Part of patterned drinking glass





No 907 base and side view of KRUSCHEM SALTS glass jar



No 693 base of OATINE face cream jar shards



No 659 Base of glass or porcelain Hexagonal shape jar



No's 177, 1017 & 1018 decorated earthenware c 1920s



No's 30, 178 & 346 shards of decorated earthenware c 1920s



No's 628, 629 & 644 shards of decorated earthenware c 1890s



No's 351, 631 & 622 shards of decorated porcelain rims c 1890s

Three examples of Staffordshire Ware shards with identifiable maker's marks as discussed in Chapters 8 & 12



No 911 with Ironstone Ware and top part of a crown



No 340 with Johnson Bros England and crown



No 339 with the word TRENT and part of word UVRE' possible range name



No 764 The only near complete item of crockery and temporarily re-fitted.



No's 432 & 433 Glass tubes more typical of laboratory ware



No 927 Pale green glass bottle with the name DAVIS and on the sides VEGETABLE PAIN KILLER



No 435 Base of whiskey bottle with WALKER KILMARNOC and WHISKEY embossed on base



No 365 stoneware jug or bottle c1920s



No 952 stoneware jug or bottle c 1920s



No 345 Shoe leather showing stitching holes



No 350 shoe leather with stitching holes leather



No's 342 & 317 typical pieces of shoe leather that were recovered



No 1162 shoe or boot upper





No 580 underside and top view of heel of a shoe or boot with part of upper



No 362 leather shoe heel and middle part



No 925 leather shoe and pieces of upper with lace holes



No 692 leather shoe sole and piece of upper



No 726 Heel and pieces of inner and upper leather attached



No 350 Piece of heel leather with nail still



No 1165 Part of canvas shoe or inner lining with nail attached



No 727 pieces of shoe leather



No 876 large leather washer



No 926 Male woollen sock



No 361 fibres of black wool



No 934 part of a knitted woollen garment



No 934 close up of the woollen garment showing the stitching pattern



No 923 Shovel with part of wooden handle in place



No 924 can kettle with handle



No's 921 and 922 contiguous parts of corrugate sheeting



No 1024 Large piece of metal sheet 470mm x 270mm x 10mm thick





No 1025 Steel rail sleeper complete with bolted cleats shown with length of mine rail fitting perfectly





No 1160 Oblique and plan views of the largest artefact recovered - A steel wheelbarrow frame forged and riveted with part of the steel bucket, which was badly oxidised, still attached in 3 places.

Appendix 6 - Pound Sterling conversion over time

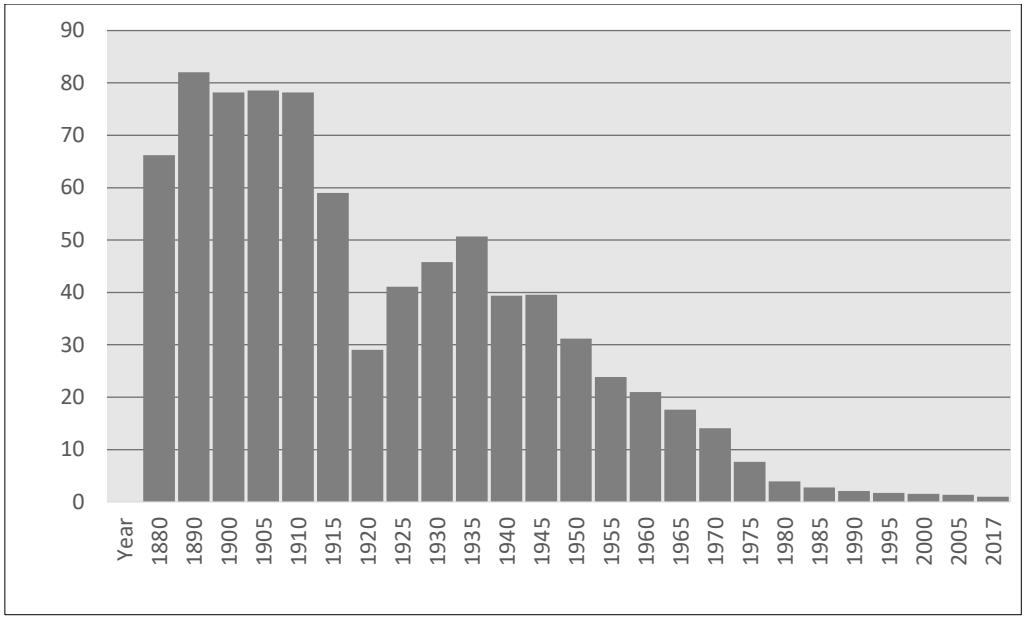
The majority of quotations used in this thesis cite the Pound Sterling (£), as this was the currency in general use in South Africa during most of the mining activities of the two periods. At the time the price of metals was also controlled by the London Metals Exchange and thus prices were quoted in historical sterling values of Pounds, Shillings and Pence. The original values have been retained and not converted to current South African Rands, because the volatility of world currency markets in the 2017-2018 years has made it impossible for the text to be accurate with such conversions. During the period from 1889 to 2018 the value of the Pound has changed enormously. The value of one Pound in 1890 was worth approximately 82 times more than it is worth in 2018. The variations in the value of the Pound over the years is reflected in graphic form in

Conversion table of one pound sterling in the year shown to a value in 2017

Year	Value (£)		Year	Value (£)
1880	66.18		1955	23.87
1890	82.05		1960	20.96
1900	78.17		1965	17.62
1905	78.57		1970	14.08
1910	78.17		1975	7.63
1915	58.99		1980	3.90
1920	29.06		1985	2.75
1925	41.06		1990	2.07
1930	45.79		1995	1.75
1935	50.66		2000	1.53
1940	39.35		2005	1.37
1945	35.55		2017	1.00
1950	31.21			

These values are taken from the National Archive London website. No explanation is given for the gap between 2005 and 2017 and the automatic calculator does not permit intermediate values.[474]

[474] http://www.nationalarchives.gov.uk/currency-converter/#mid



The value of the pound sterling has changed dramatically since 1880. In order to calculate the relative value of an amount quoted in the dissertation look at the value for the year or nearest year and multiply the value by the figure stated above. For example £35 000 in 1890 is the equivalent of 35 000 x 82.05 £2 871 750 in 2017.

Appendix 7 – Conversion of imperial to metric mass and distance units

The historical, direct quotations often include mentions of specific measurements or mass. I have decided to retain the original values of ounces, pounds or feet rather than converting them to metric values of grams, kilograms or metres or placing the metric values in brackets after the quoted value as I feel this often detracts from the appearance and flow of the original quote. Where the text is my own I have made use of metric units. Measurements of length or distance are given in metres (m) or kilometres (km). Units of mass are given in grams (g) or kilograms (km). Where a mass is given in tons it is assumed that the British long ton of 2240lbs (1016kg) and the metric ton of 1000kg are the same. The two columns below present simple conversions for both mass and length. Lengths in Imperial units are shown as feet and in metric units as metres (m).

1 foot (12 inches) = 0.304 m.

Feet	***Metre***
1	**0.3**
5	**1.5**
10	**3**
30	**9**
50	**15**
100	**30**
200	**60**

Mass in Imperial units is ounces (ozs) or pounds (lbs) and in metric units as grams (g).

1 ounce = 28.35 grams and 16 ounces = 1 pound with 2240 lbs = 1 long ton or 1 metric ton (1000 kg)

Ounces	***Grams***
1	**28.35**
5	**142**
10	**283.5**
30	**850.5**
50	**1420**
100	**2835**
1 lb	**453.6**

Appendix 10 Photographs of the foundations additional to those in text

The following photographs show some of the 1890s foundations and features



Remains of the 1890s Blake Jaw Crushers



Wheel pit foundation in the 1893 foundation in the concentration plant



Foundations remains in the 1893 concentration plant area



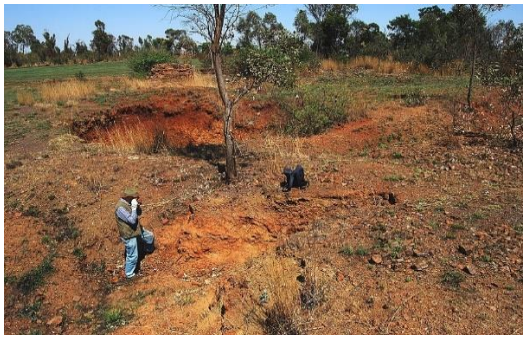
1890s east prospecting trenches



Foundation of the 1890s prospecting shaft headgear and engine house



1890s motor or engine foundation for the Blake jaw crusher



Part of the 1890s east prospecting trench close to the sink hole



Remains of the 1890s Prospecting shaft – now filled in to about 2m below surface

The following remains are of the 1920s foundations and structures



Foundations of the shaft head gear motors and winder



Boilers charge floor area



Generator foundation inside the boiler house foundations



Column and wall foundations of the boiler house



Foundations for two parallel mounted boilers



Ash discharge plates and coco pan tunnel underneath



Wall and column foundations of boiler house



1920s water reservoir



Foundation for manual rail points unit



Ore chute to feed first conveyor to primary crusher plant



Ore chute and foundations of rail line feeding over the chute



Discharge end with foundations for trestles of conveyor



Line of trestles foundations for incline conveyor chute to crusher



Very large foundation blocks and incline ore of the primary crusher



Part of the foundation complex of the secondary crushing plant



Foundations of the large water tower seen in figure 33



Initial feed area of secondary crushing plant crusher



Feed from primary crusher to secondary



Foundation plinths of the Hardinge Ball Mill machines



Complex concrete foundations in the secondary crushing area



Wide view of the primary and secondary crushing plants



Foundation blocks of the primary crusher plant



Motor and column foundations in receiving area jigs of secondary crusher



Foundations for hydraulic classifier and Harz



Harz jig foundations looking towards Hardinge Ball mill area



Concrete plinths for Hardinge Ball mill



Door Rake classifier foundation area looking towards Flotation plant



Large concrete trough feeding to MS Flotation plant foundations



Close up of 1m deep trough between classifiers flotation and MS plant



Foundations of two banks of 10 cell MS machines



Various collection troughs beyond the MS flotation plant



Remains and foundations of the Dorr thickener (circular depression)



Slimes dam - top surface



Concrete foundation for Huntington- Hubelein roasting pots



Feeder area to the roasting pot area



Part of the feeder station to the roasting plant



Feeder area foundations for the smelting plant



Support foundations for floors and smelting furnaces



Support foundation looking from where the inclined feed conveyor would have been. The grassy mound has three concrete foundations in it which supported the trestles for the conveyor seen in Figure 42. Note the lumps of white limestone present on the soil in the foreground.

Appendix 9 Photographs of the excavations and some of the sites

Some before excavation, some during, some on completion and things in situ or just removed



Site SS3 before – note the foundation wall of before natural rocks and small midden at open end of structure



Dressed stone and brick foundation structure excavation



Midden M3 during excavation



BS4 Brick foundation partially exposed before excavation



Middens and structure foundation



M8 midden before excavation



Excavation and STP in M19



Excavation and STP in M15



Partial excavation of north-west corner of SS2 showing dressed stone foundation wall



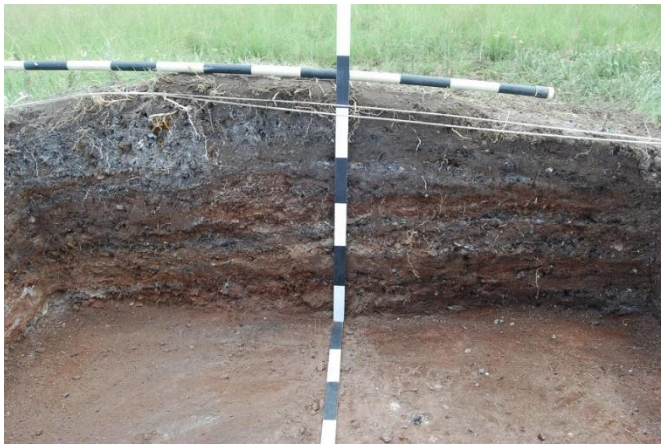
Bulldozed area of the 1890s midden and compound. Surface collection conducted



SS3 foundation built using blocks of gossan rock The internal area was delineated but no floor was Found. It was one of the smallest structures



Excavation of BS4 all brick foundation



M16 south end face showing stratification of the soil, ash and stoney ash layers



M16 showing stratification of soil and ashy layers



SS3 excavated remains of a wheelbarrow bucket metal



M8 excavation of a large piece of



M8 excavation and recovery of a Holbrook bottle



M8 recovery of an undamaged Vaseline jar



M8 remains of leather shoe in situ



M8 fibres of black wool in a brown soil layer



M8 recovery Davis medicine bottle and metal can in situ



M8 metal shovel with part of wooden handle in the tube part of the shovel.



M8 remains of a plate in situ recovered



M8 remains of one of the many shoes



BS4 large two room brick foundation



M8 Holbrook Worcestershire sauce bottle in situ



BS4 south-west corner



BS4 middle wall intersection on west side



BS4 middle wall intersection on east side



BS4 north-west corner



BS4 door opening in north east corner



BS4 excavations in progress



BS4 north east corner – note plastered face on the brick both in situ and fallen. Several others were also found at this site



BS4 middle wall looking west



SS3 before excavation – note mound in middle

Appendix 10 - Argent Silver Mine Satellite Survey documents

SITE SURVEY DONE ON THE 11th AND 12th DECEMBER 2013

Conducted by José Clara and Graham Reeks

-Equipment: GPS OmniSTAR MODEL 8305 HP – Serial no. 7-0120032

-Precision: HP FIXING = 10 -15 CM accuracy in X and Y and 15-20 cm in Z

-Satellite Signal: offered by OmniSTAR (Cape Town) and facilitated by Zuhayr Harricombe, part of Trimble Navigation Technology SA (Pty) Ltd

- Before the beginning of the site survey, the OmniSTAR was set up on the trigonometric beacon no. 2628-499 to the East of the site and the reading compared favourably. Plan of beacons in documentation.

-The projection used was the following:

- Transverse Mercator
- Datum : WGS 84
- Central Meridian: 29
- Planar units: meters
- Co-ordinates in degrees/ minutes/ seconds (*dms*)

Map reference and general co-ordinates:

DWARSFONTEIN 209 IR
Delmas District
Mpumalanga

S 26º 01’ 58.49’’ – E 28º 47’ 57.21’’

Map Reference: 2628BB Kendal

-Aerial photography – geo-referenced orthophotos were supplied by Julile Sihlangu of Rural Development Department, Cape Town:

- Orthophoto no. 2628BB -07-2010-236-RGB-Rect – 2. Tif – Image 1
- Orthophoto no. 2628BB -01-2010-236-RGB-Rect – 1. Tif – Image 2
- Orthophoto no. 2628BB -07-2010-236-RGB-Rect – 2. Tif – Image 1a
- Orthophoto no. 2628BB -06-2010-236-RGB-Rect – . Tif – Image 3

- **Digitalisation** was done of the existing and discernible information on the aerial images, using the software programme Global Mapper V. 13 2.1.

- The 1920 Mine Compound ruins are seen on the aerial images by soil change of colour, although on the ground this is not visible.
- When consulting the Microsoft **Bing Maps and Google Earth ™** images below http://www.bing.com/maps/?v=2&cp=25.619830~-19.971181&lvl=3&dir=0&sty=h&form=LMLTCC as well as later Google Earth™ image in 2018 (See figure 74),

the 1920 Mine Compound soil variation is clearly seen.

- After the field work it was noticed a shift North-South of about 1.5 m between the field data results and the aerial photography in the area of the 1920 Mine Compound.

-This silver mine was worked during two periods: 1893 and 1920.

-Graham Reeks has divided the site into the following sectors:

- **1893** Mine compound
  - Manager's House
  - Concentration Plant
  - 1893 dressed stoned house foundation

- **1920** Mine compound
  - Boiler House
  - Shaft Winder House
  - Shaft Headgear
  - 1920 Water Reservoir Miscellaneous structures
  - Unidentified concrete foundation – SW
  - Unidentified concrete foundation – East
  - 1920 Reduction Plant
    - Secondary Crusher Station
    - Tube Mill Foundation
    - 1920 Waste Rock Dump
    - 1920 Slimes Dam
    -
  - 1920 Concentration Plant
-
- 2014 Farm workers housing

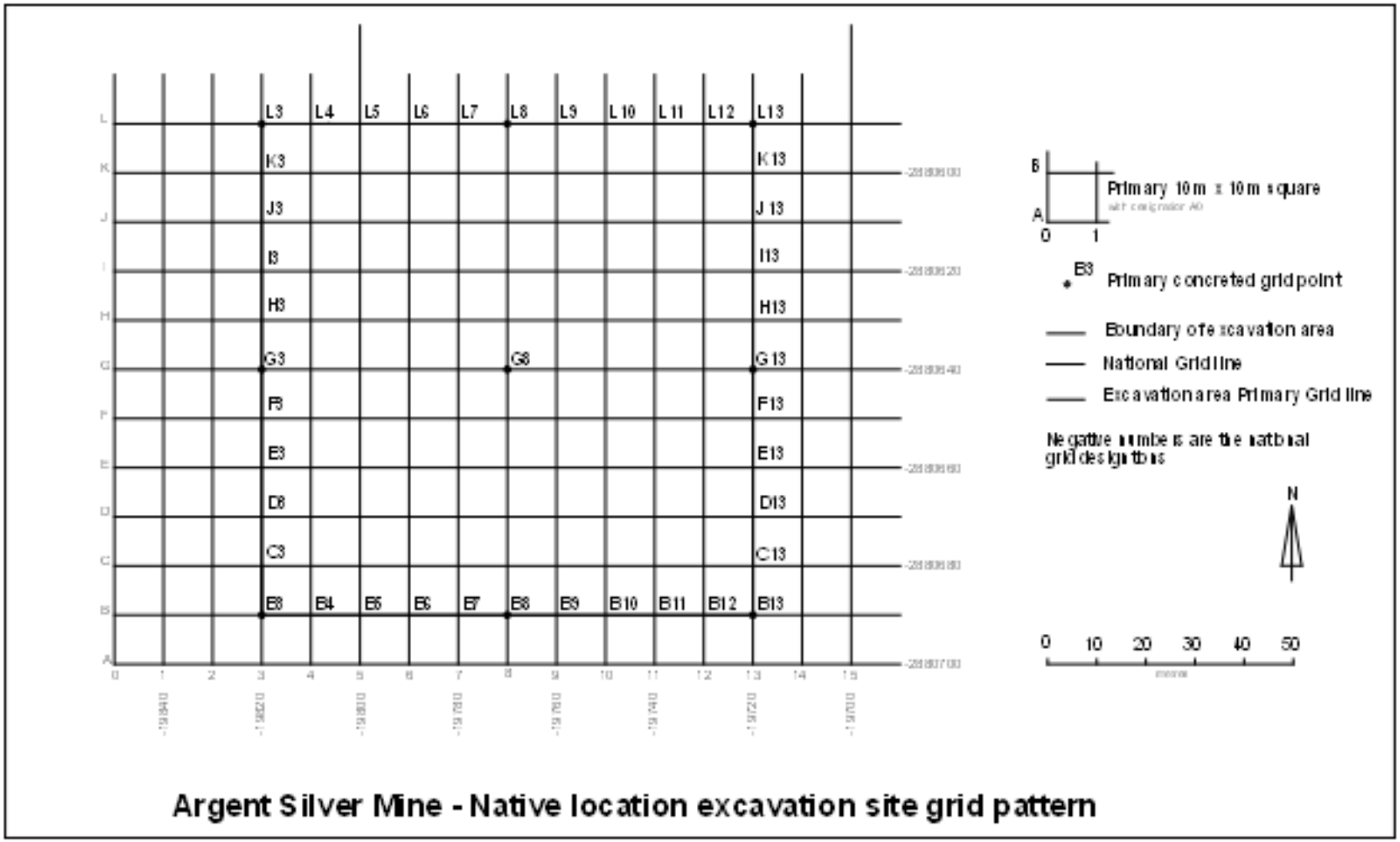
Argent mine – 1920s Native Location primary grid layout co-ordinates

The following table lists the co-ordinates measure during the satellite survey and presents the positions of the permanent beacon point in the defined area.

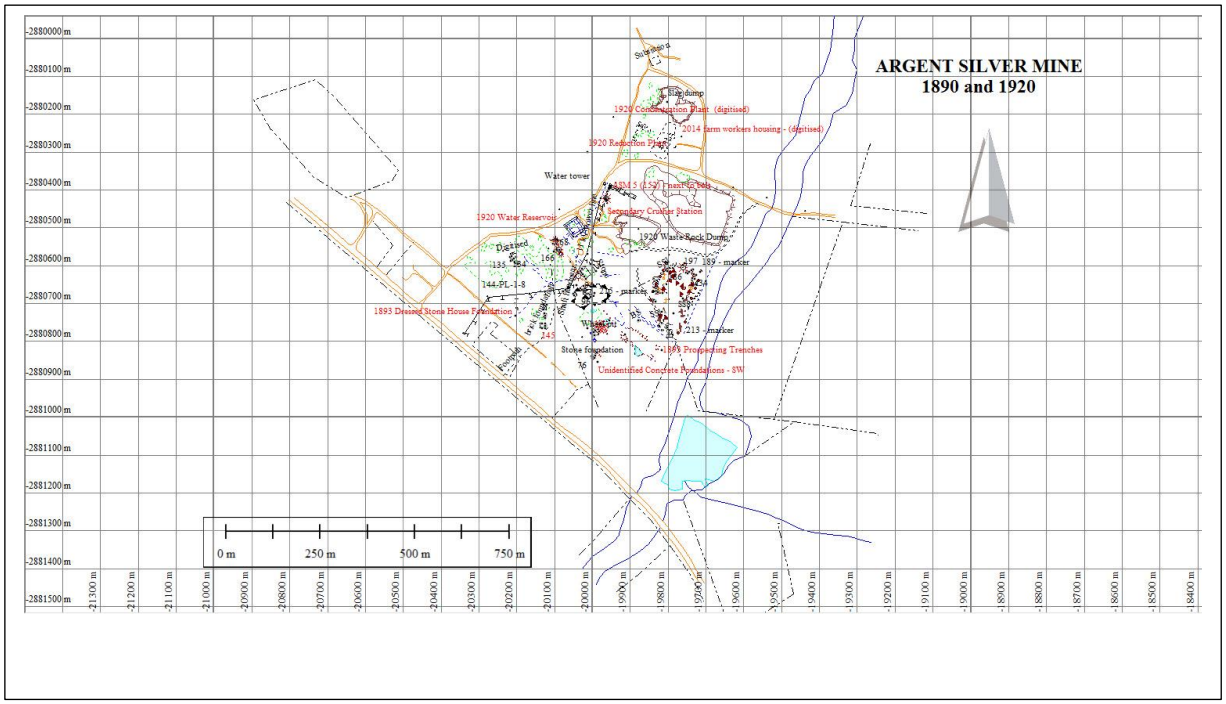
Grid at 10m intervals
Permanent Pegs placed on the outside corners: B3, L3, L13 and B13
Permanent Pegs placed on the middle of outside square sides: G3, L8, B8 an G13
Permanent Peg placed on the centre of square: G8

	Datum= WGS84				
Grid point	**LO co-ordinates**		**Geographic co-ordinates**		**Remarks**
	Y	**X**	**S**	**E**	
	Central meridian = 29		**d.dddddd °**		
B3	**19820,00**	**2880690,00**	**26,03466427**	**28,8019751**	Western side boundary
C3	**19820,00**	**2880680,00**	**26,03457401**	**28,8019753**	Western side boundary
D3	**19820,00**	**2880670,00**	**26,03448375**	**28,8019754**	Western side boundary
E3	**19820,00**	**2880660,00**	**26,03439349**	**28,8019756**	Western side boundary
F3	**19820,00**	**2880650,00**	**26,03430323**	**28,8019757**	Western side boundary
G3	**19820,00**	**2880640,00**	**26,03421296**	**28,8019759**	Western side boundary
H3	**19820,00**	**2880630,00**	**26,0341227**	**28,801976**	Western side boundary
I3	**19820,00**	**2880620,00**	**26,03403244**	**28,8019762**	Western side boundary
J3	**19820,00**	**2880610,00**	**26,03394218**	**28,8019763**	Western side boundary
K3	**19820,00**	**2880600,00**	**26,03385192**	**28,8019765**	Western side boundary
L3	**19820,00**	**2880590,00**	**26,03376166**	**28,8019766**	Western side boundary
B3	19820,00	2880690,00	26,03466427	28,8019751	Southern side boundary
B4	**19810,00**	**2880690,00**	**26,03466441**	**28,802075**	Southern side boundary
B5	**19800,00**	**2880690,00**	**26,03466455**	**28,802175**	Southern side boundary
B6	**19790,00**	**2880690,00**	**26,03466468**	**28,8022749**	Southern side boundary
B7	**19780,00**	**2880690,00**	**26,03466482**	**28,8023748**	Southern side boundary
B8	**19770,00**	**2880690,00**	**26,03466496**	**28,8024747**	Southern side boundary
B9	**19760,00**	**2880690,00**	**26,03466509**	**28,8025746**	Southern side boundary
B10	**19750,00**	**2880690,00**	**26,03466523**	**28,8026745**	Southern side boundary
B11	**19740,00**	**2880690,00**	**26,03466537**	**28,8027744**	Southern side boundary
B12	**19730,00**	**2880690,00**	**26,0346655**	**28,8028743**	Southern side boundary
B13	**19720,00**	**2880690,00**	**26,03466564**	**28,8029742**	Southern side boundary

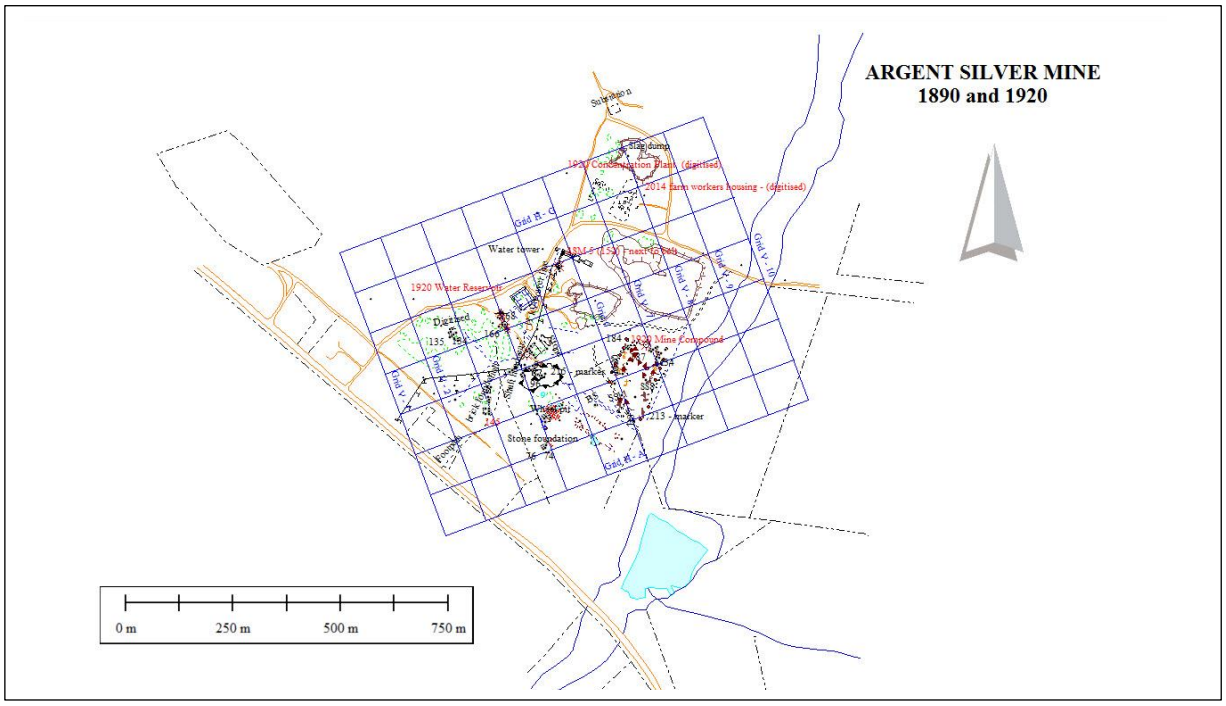
L3	19820,00	2880590,00	26,03376166	28,8019766	Northern side boundary
L4	**19810,00**	**2880590,00**	**26,03376179**	**28,8020766**	Northern side boundary
L5	**19800,00**	**2880590,00**	**26,03376193**	**28,8021765**	Northern side boundary
L6	**19790,00**	**2880590,00**	**26,03376207**	**28,8022764**	Northern side boundary
L7	**19780,00**	**2880590,00**	**26,0337622**	**28,8023763**	Northern side boundary
L8	**19770,00**	**2880590,00**	**26,03376234**	**28,8024762**	Northern side boundary
L9	**19760,00**	**2880590,00**	**26,03376248**	**28,8025761**	Northern side boundary
L10	**19750,00**	**2880590,00**	**26,03376261**	**28,802676**	Northern side boundary
L11	**19740,00**	**2880590,00**	**26,03376275**	**28,8027759**	Northern side boundary
L12	**19730,00**	**2880590,00**	**26,03376289**	**28,8028758**	Northern side boundary
L13	**19720,00**	**2880590,00**	**26,03376302**	**28,8029758**	Northern side boundary
B13	19720,00	2880690,00	26,03466564	28,8029742	Eastern side boundary
C13	**19720,00**	**2880680,00**	**26,03457538**	**28,8029744**	Eastern side boundary
D13	**19720,00**	**2880670,00**	**26,03448512**	**28,8029745**	Eastern side boundary
E13	**19720,00**	**2880660,00**	**26,03439485**	**28,8029747**	Eastern side boundary
F13	**19720,00**	**2880650,00**	**26,03430459**	**28,8029748**	Eastern side boundary
G13	**19720,00**	**2880640,00**	**26,03421433**	**28,802975**	Eastern side boundary
H13	**19720,00**	**2880630,00**	**26,03412407**	**28,8029751**	Eastern side boundary
I13	**19720,00**	**2880620,00**	**26,03403381**	**28,8029753**	Eastern side boundary
J13	**19720,00**	**2880610,00**	**26,03394355**	**28,8029755**	Eastern side boundary
K13	**19720,00**	**2880600,00**	**26,03385328**	**28,8029756**	Eastern side boundary
L13	19720,00	2880590,00	26,03376302	28,8029758	Eastern side boundary
G8	**19770,00**	**2880640,00**	**26,03421365**	**28,8024754**	Centre of square



Argent Silver Mine - Native location excavation site grid pattern



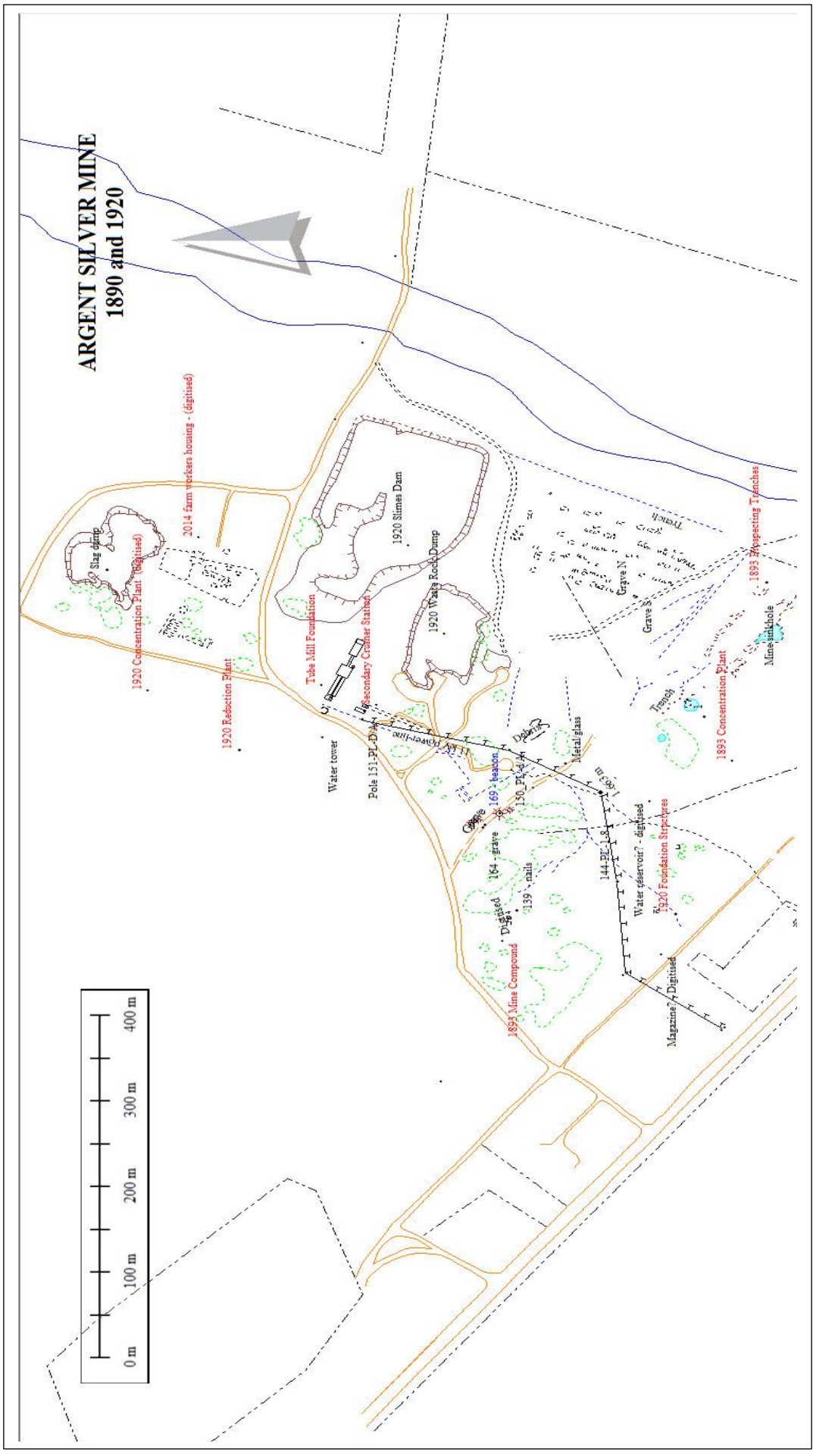
Argent Mine with overlay of South African National Grid



Argent Mine with overlay of Magnetic North Grid Lines

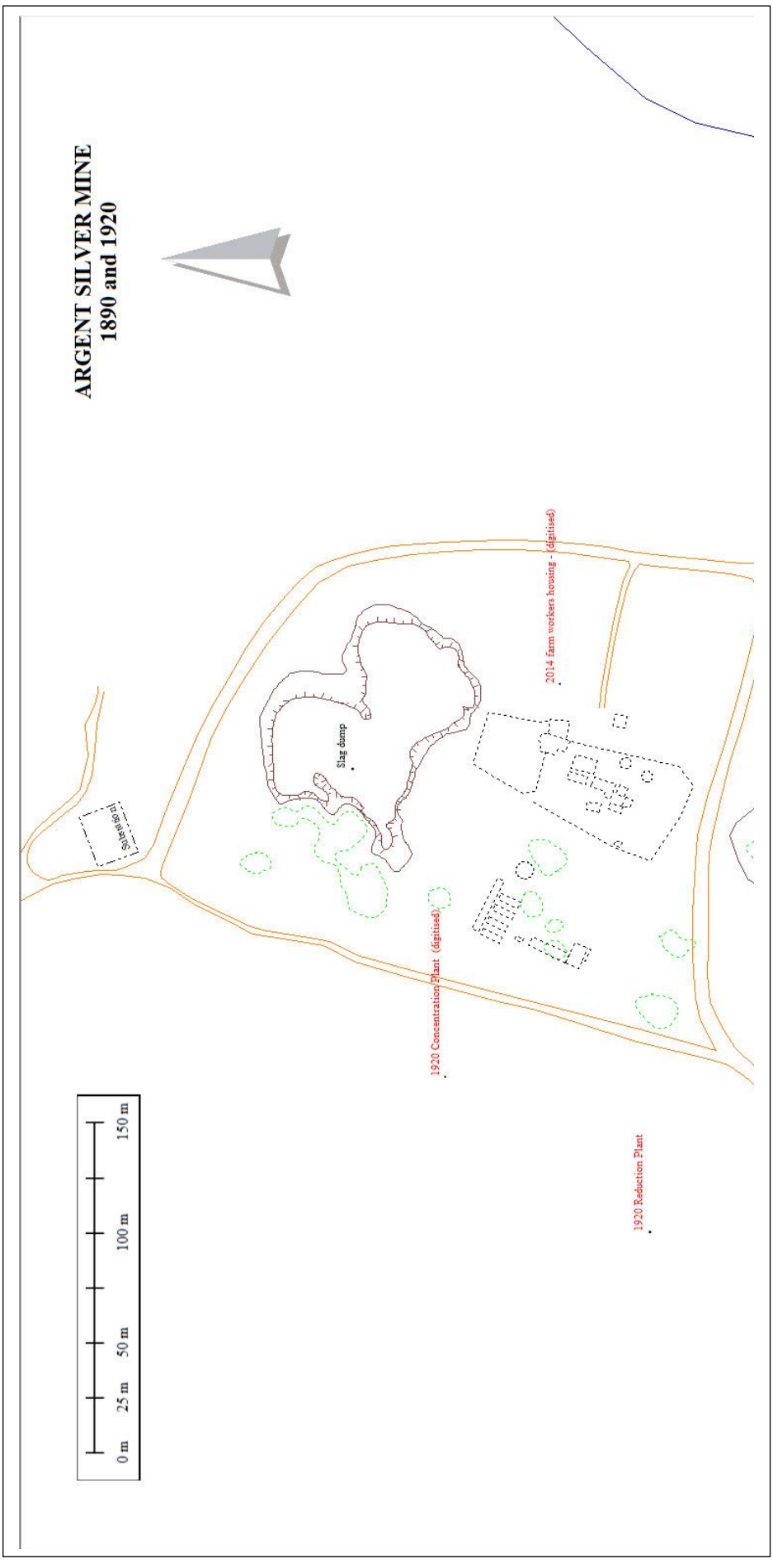
Appendix 11 – Set of eight maps drawn as part of the satellite survey

The following pages of eight maps show individual areas of the Argent Silver mine and can be read in conjunction with the plan Figure 75 which shows the main features of the mine. The numbers on the individual plans refer to survey reference points made during the pedestrian satellite survey.

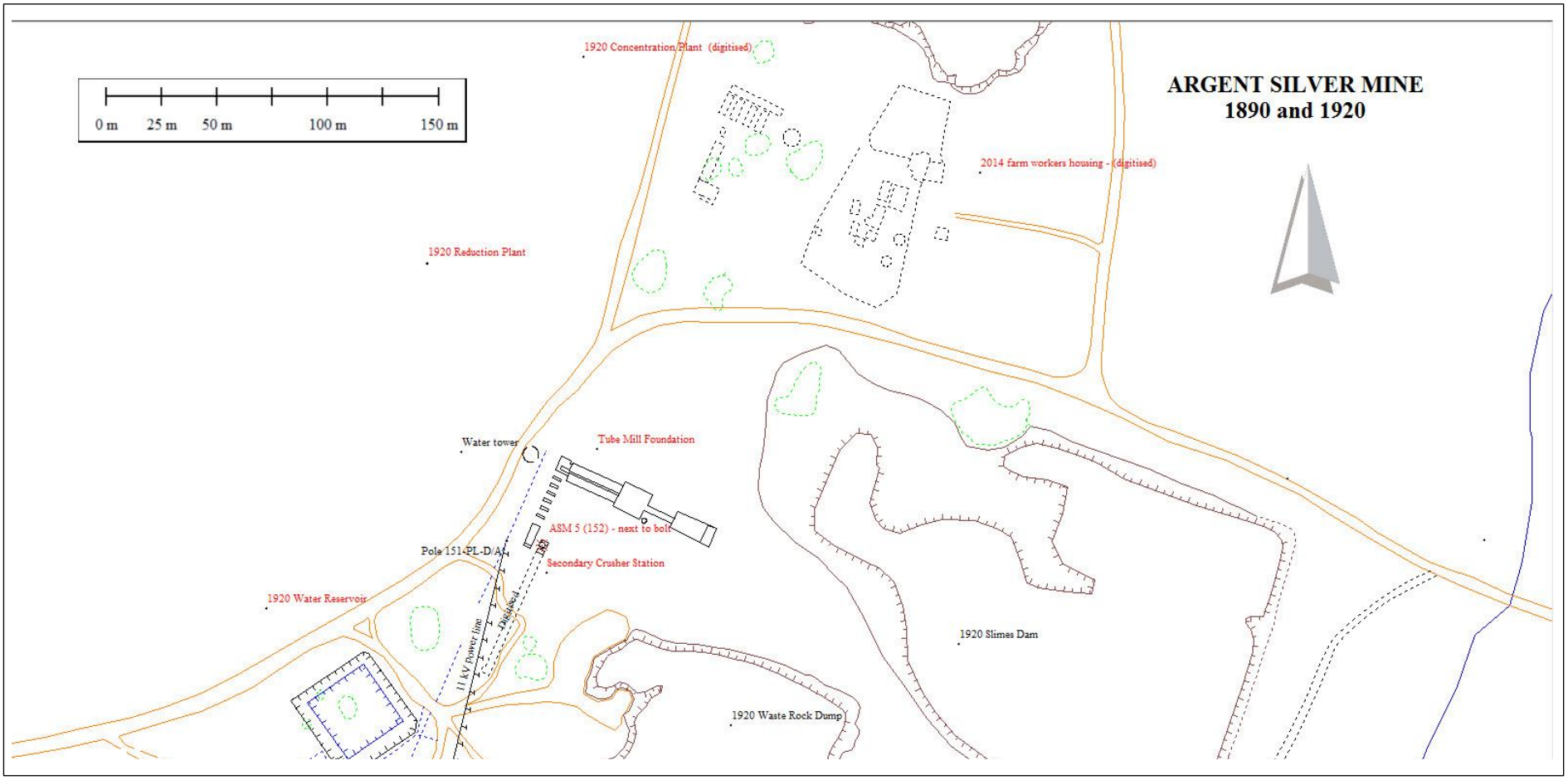


Surveyed by Jose Clara & Graham Reeks. Drawn by Jose

Map 1 Overall satellite survey of the Argent Mine showing the digitisation of the geo-referenced ortho-photograph.

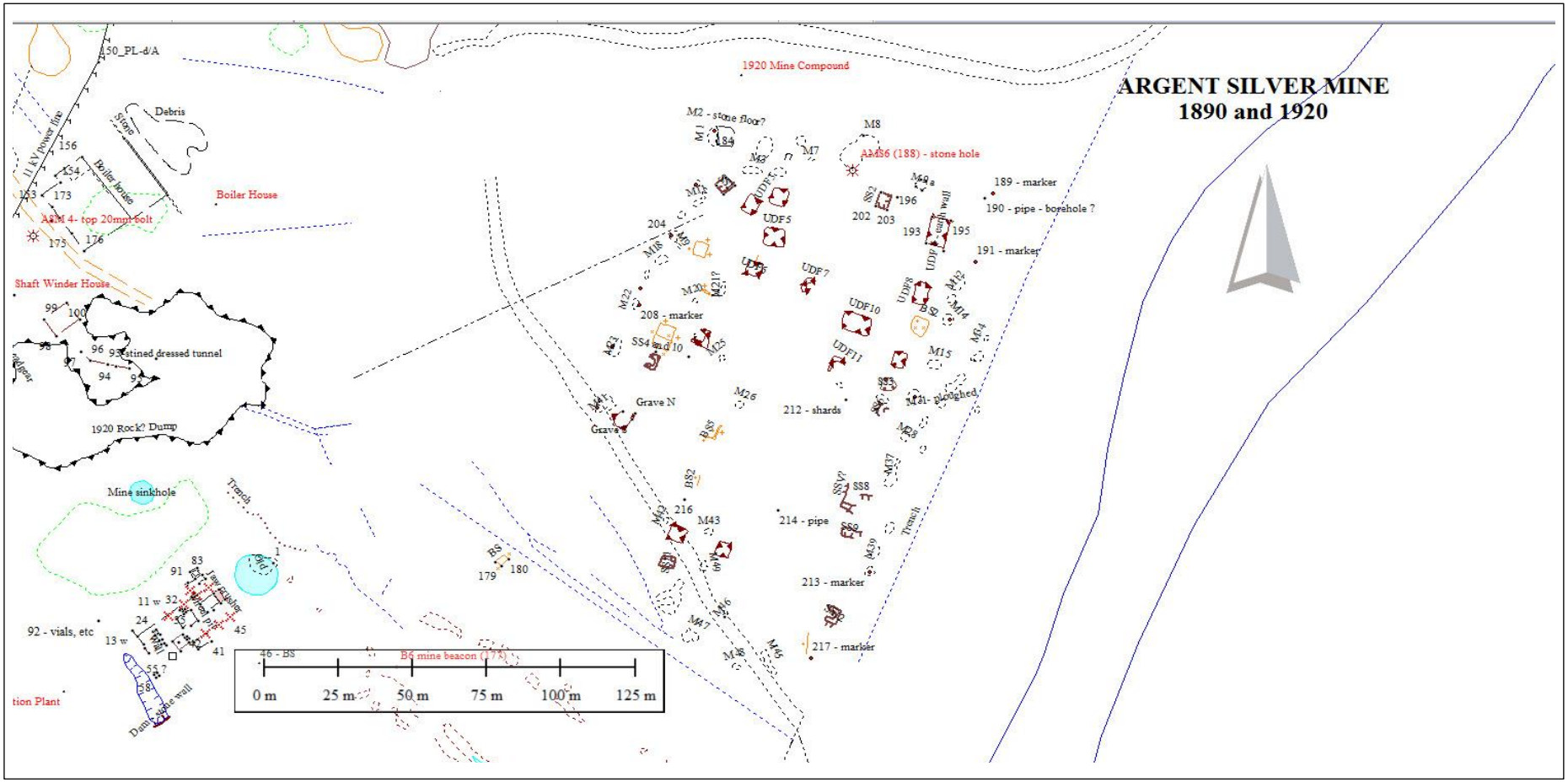


Map 2 North end of the Argent Mine showing the slag dump and smelting roasting plant foundations drawn from the digitisation of the geo-referenced ortho-photograph.



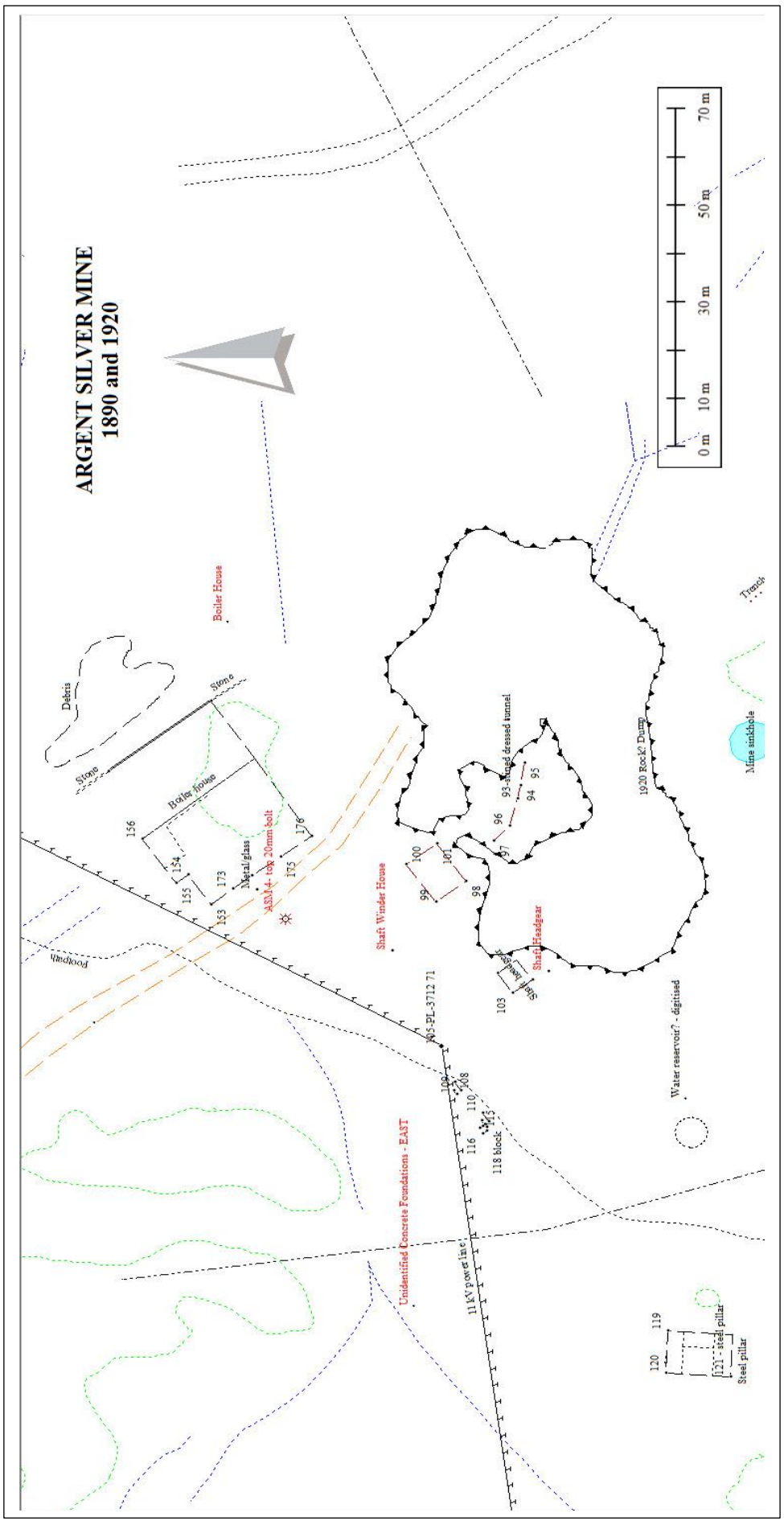
Surveyed by Jose Clara & Graham Reeks. Drawn by Jose

Map 3 North end of the Argent Mine showing the crushing plant foundations, slimes dam and part of the waste rock dump drawn from the digitisation of the geo-referenced ortho-photograph.

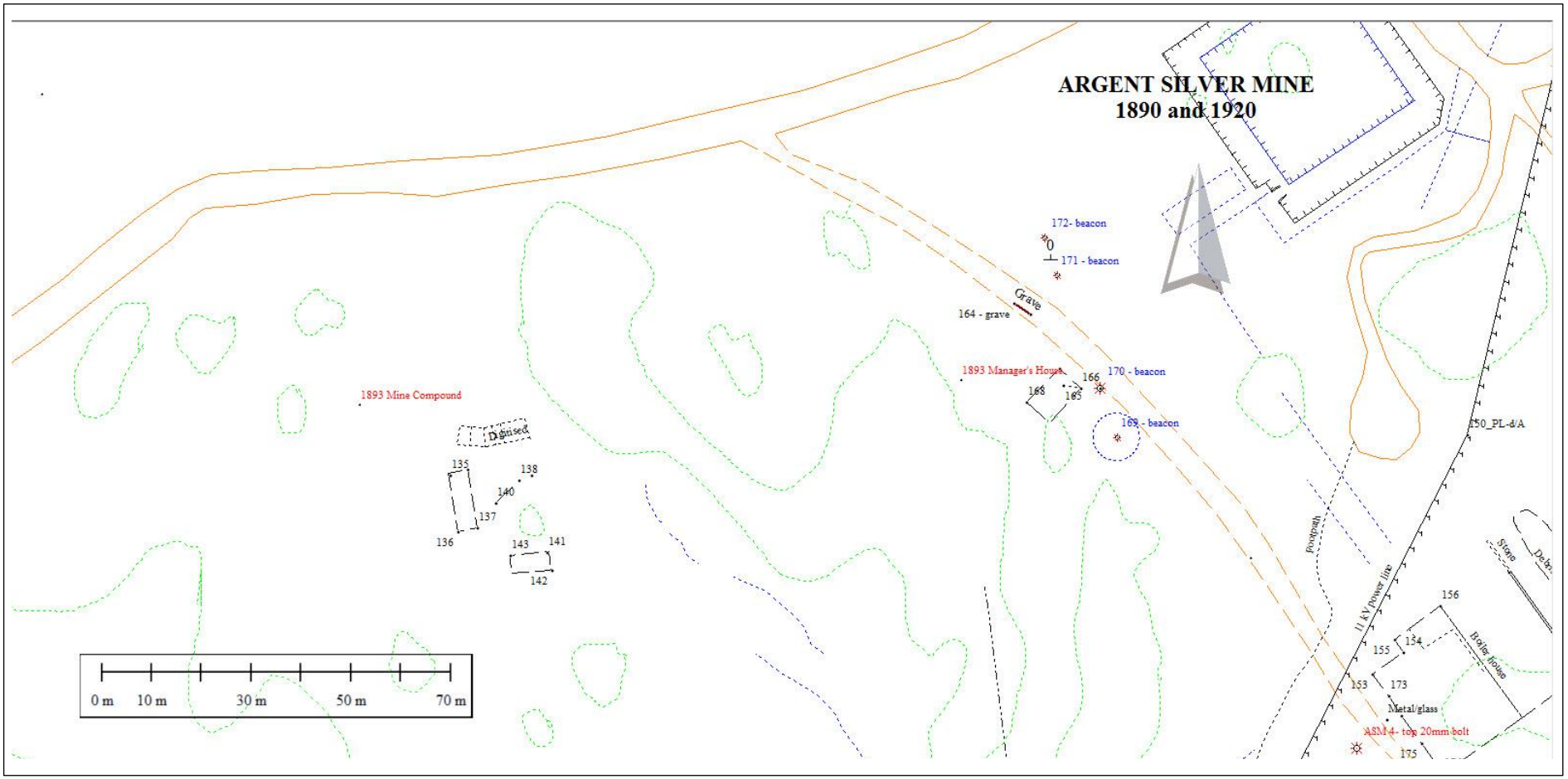


Surveyed by Jose Clara & Graham Reeks. Drawn by Jose

Map 4 central area of the Argent Mine showing the surveyed area of the Native Location with some features drawn from the digitisation of the geo-referenced ortho-photograph.

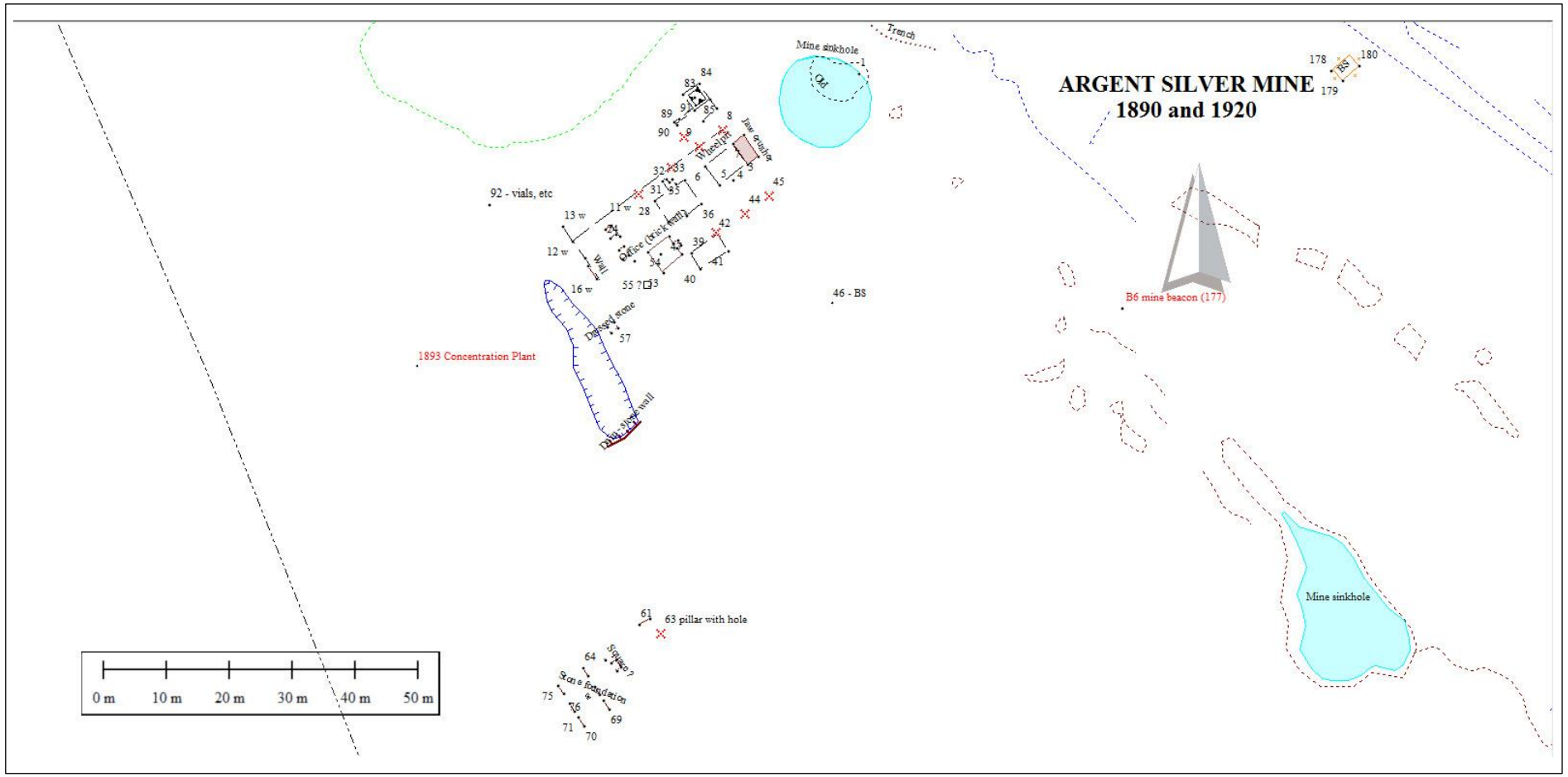


Map 5 central area of the Argent Mine showing the surveyed area of the Main Shaft, shaft waste rock dump and Boiler house foundations with some features drawn from the digitisation of the geo-referenced ortho-photograph.



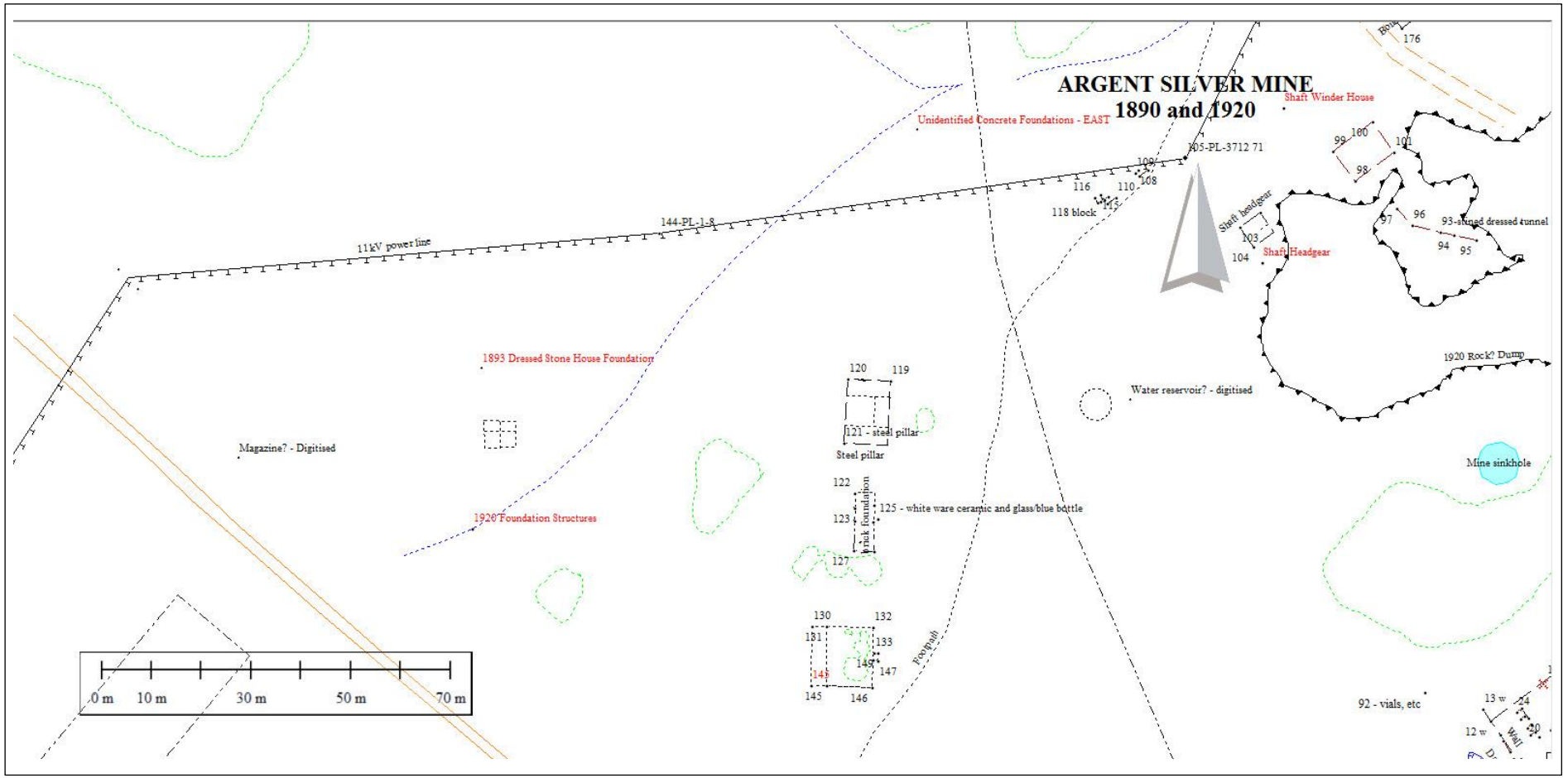
Surveyed by Jose Clara & Graham Reeks. Drawn by Jose

Map 6 west area of the Argent Mine showing the surveyed area of the 1890s compound structure foundations and position of the 1890s manager's house foundations coupled with some features drawn from the digitisation of the geo-referenced ortho-photograph.



Surveyed by Jose Clara & Graham Reeks. Drawn by Jose

Map 7 south area of the Argent Mine showing the surveyed area of the 1890s concentration plant foundations and position and extent of the old dam, 1890s trenches and 1920s miscellaneous foundations with some features drawn from the digitisation of the geo-referenced ortho-



Surveyed by Jose Clara & Graham Reeks. Drawn by Jose

Map 8 south area of the Argent Mine showing the surveyed area of the 1890s and 1920s office foundations with some features drawn from the digitisation of the geo-referenced ortho-photograph.

Appendix 12 - Complete list of artefacts

Analysis of Argent artefacts by site and material type - consisting of 26 pages

This Appendix presents the artefact identification number along with the site, depth, description of artefact, quantity of items, use category, sub-category details and date of excavation.

There are five major material categories, and they are colour coded as follows –

Metal – orange

Glass – blue

Ceramic – yellow

Bone – green

Miscellaneous – white

In the list, use has been made of certain abbreviations in order save space:

Diameter - dia
Thickness - thk
Long - lg
Miscellaneous - misc
Hexagonal - hex
Nominal - nom
Outside diameter - od
Inside diameter - id
Square - sq
Average - ave

Note there are 26 continuous pages of tables of artefact which have been created in Excel and are in Landscape mode in order to reduce the complication of having two or more pages per data per artefact. Each page is identified as APPENDIX 12 PAGE no

In order to print this electronic document it is marked as a separate file as follows :

APPENDIX – 12 Complete Artefact List – Analysis of Argent artefacts by site and type - Excel

Table of variable entry descriptions in collection catalogue Appendix 12								
Secondary category		**Depths cm**		**Sub category**		**Ceramic & glass decoration**		**Dates of excavation**
Animal		0-10		bolt		decorated		05 Nov. 2017
Architectural		0-30		bone		edge moulding		29 Oct. 2017
Domestic items		0-60		bottle		external mould pattern		28 Oct. 2017
Drinking		10-20		bottle or can lid		maker's mark		26 Aug. 2017
Industrial/mining		20 -40		brick		mould marks		24 Jun. 2017
Miscellaneous		20-30		bullet or case		rim piece		21 May. 2017
Personal items		30-40		button		rim piece decorated		20 May. 2017
Unknown		35-50		ceramic - earthenware, coarse		rim piece with moulding		23 Apr. 2017
		40-50		ceramic- earthenware, refined				26 Mar. 2017
		50-60		ceramic - opaque glassware				19 Mar. 2017
		50-90		ceramic - porcelain				18 Mar. 2017
		60-70		ceramic - stoneware				16 Dec. 2016
		70-80		ceramic porcelain decorated				13 Nov. 2016
		80-90		ceramic vitrified stoneware				16 Sep. 2016
		surface		coal/coke				18 Jun. 2016
				cosmetic				08 Jun. 2016
				electrical				16 Jun. 2016
				enamel ware				
				floor tile				
				food bottle				
				food can				
				footwear				
				fruit/vegetable				
				glass				
				glass - aqua				
				glass - blue				
				glass - brown				
				glass - clear				
				glass - clear window				
				glass - dark green				
				glass - green				
				glass - purple				
				glass - Vaseline bottle				
				glass - yellow				
				glass stained orange by soil				
				jewellery				
				lead				
				leather				
				medicinal				
				metal				
				mineralogical specimen				
				mining tool				
				miscellaneous				
				monetary				
				nail/screw				
				plaster				
				plastic				
				plumbing				
				soil				
				textile				
				unknown				
				wood				

The Excel list of artefacts follows on from here