Figure 4 LAND WITH SLOPE OF LESS THAN 1:50 IN THE WITWATERSRAND

Zone	% of land of less 1 : 50 within zone	% of land of less 1 : 50 in Witwatersrand
West	22.8	13.6
Central	4.8	1.7
East Central	47.0	29.2
East	67.4	55.5

the Witwatersrand of land with slope of less than I : 50, (Figure 4) the topography favours the development of large industrial sites.

Hence, despite their apparent similarities as outer zones of the Marginal Mines Region with problems deriving from a concentrated decline in mining and an unbalanced industrial structure, the factors influencing the processes of adaptation differ greatly. Adaptation in the West Rand would appear to be favoured by its proximity to Johannesburg with an increasing likelihood of it becoming a dormitory town for the Central Zone (Mellows, I96I). The East Rand in contrast can be viewed as a separate zone of the region not only in the problems of economic base adaptation it has and is facing, but in its isolation from this movement of residential development linked to the Central Zone of Johannesburg.

Suitability of Region for Economic Base Analysis

Very rarely does the urban economic base of a region decline as rapidly as has the gold mining base of the East Rand region. Of the seventeen gold mines operating in I960, only one, Marievale G.M., is expected to still be producing in I975. With such a decline and subsequent adaptation of the local economy, a unique opportunity is provided in the study of the transition of the local economy. Such a study however necessitates strict regional delimitation.

The process of delimitation is particularly important in investigations into the nature of the local economy as that delimitation is explicit in the phenomena examined. The terms 'basic' and 'non-basic' activities assume that these limits have been established. For these activities to be identified, criteria must be established for an economic-geographical demarcation between the producing

/ community ....

community and its export market (Andrews,I954).

Despite the fact that virtually all economic base studies to date have been concerned with central cities, the delimitation factors as outlined below can fit any producing and distributing areal unit. Andrews proposed that,

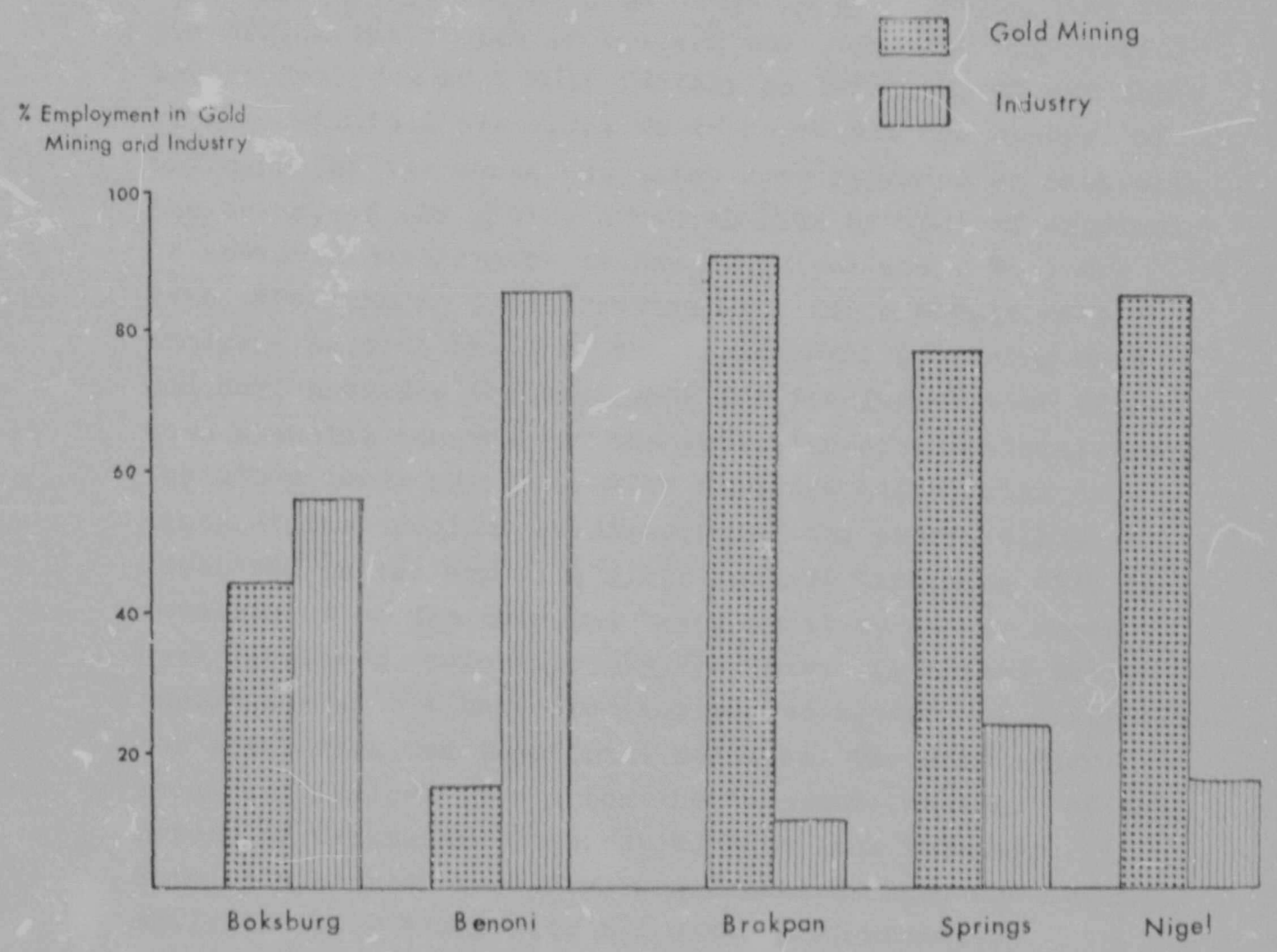
> " ...the base area should be viewed as a producing and distributing unit of goods,services and capital within the economic framework of its region and nation. It is the economically integrated geographical area which includes the principal factors of production of the basic and service activities of the community " (Andrews,I954).

The East Rand,as so far defined,although comprising three separate local authorities,forms an integral whole in its,geographical composition,the economic problems of transition,and its separateness from Johannesburg. For the purposes of economic base analysis two other local criteria need to be satisfied. Firstly,is there an economic-geographical demarcation between the East Rand and the surrounding areas,and secondly,is there a satisfactory economic demarcation line for the local area ?

In several examinations of the Witwatersrand Conurbation the East Rand has been viewed as comprising Boksburg,Benoni,Brakpan,Springs and Nigel (Cole,I96I ; Buhrmann,I959). Although Springs has a larger industrial employment than Brakpan or Nigel,and in this respect is more comparable with Boksburg and Benoni,in terms of the transition of the economic base,the more revealing statistics are those of the proportional distribution of employment between gold mining and industry as outlined in Figure 5. On this basis Boksburg and Benoni possess a very diiferent employment structure from Brakpan,Springs and Nigel. These two areas are also separated by proclaimed mining land, the historical legacy of the East Rand region,the only

/ mining ....

Figure 5 % DISTRIBUTION OF EMPLOYMENT BETWEEN GOLD MINING & INDUSTRY IN MAGISTERIAL DISTRICTS 1960



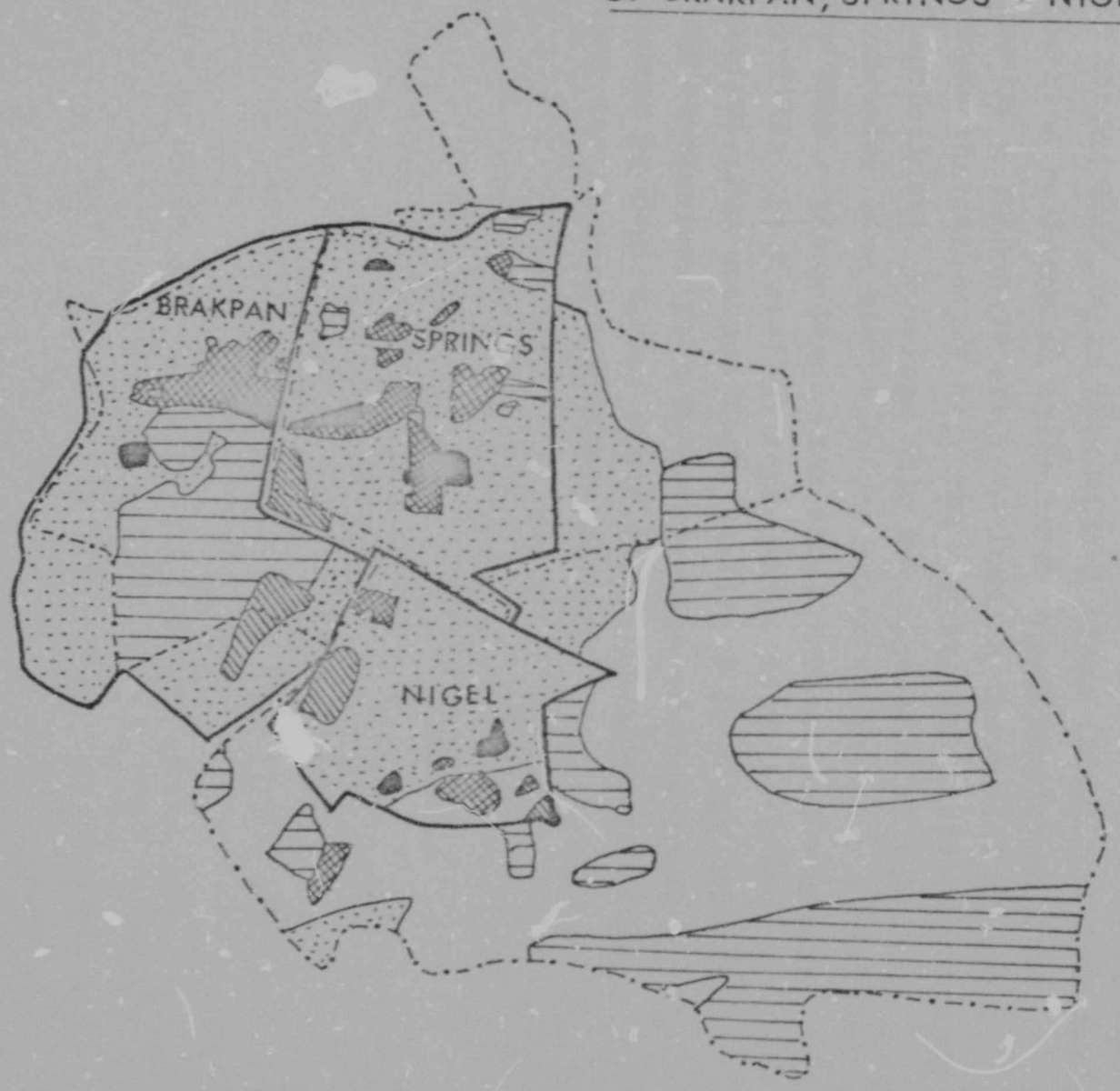
Source : Statistics from the Bureau of Census and Statistics and the MMRU Report

mining zone whose residential and industrial development has been enclosed within an area of mining land. This factor also provides a boundary for the region to the north, whilst there is little residential or industrial development to the east and south of the region (Figure 6).

For the purposes of an economic demarcation line for the region the choice is between municipal and magisterial boundaries. The most satisfactory in this respect are those of the municipal areas, set up to represent the spheres of influence of the towns and which have expanded as such with the towns, thereby giving a correlation of spatial expression of economic development to the municipal area. They are also important as a demarcation line for economic base analysis in that they are the basic local governing unit and have provided the base area for the formulation of town planning schemes and the provision of industrial areas. The other local administrative unit, the magisterial district, the original subdivision of the province, has developed in the opposite direction, not expanding with the development of the town, but being split up as new areas have developed. Unfortunately, they have maintained their importance as the base area for the collection of statistics for population and industrial censuses. The only other local statistical base being the 'economic regions' of the Bureau of Census and Statistics, which link together Germiston, Kempton Park, Boksburg, Benoni, Brakpan and Springs, whilst linking Nigel with the other predominantly agricultural magisterial districts of Delmas, Heidelberg, Bethal and Standerton. As a result of these groupings the statistics cannot be utilised in this study. This obviously presents difficulties as the magisterial district statistics are the only statistics available, and hence necessitates an examination of whether they can be utilised in a study based upon municipal boundaries.

/ The ....

Figure 6 LAND UTILISATION WITHIN THE MUNICIPAL & MAGISTERIAL BOUNDARIES OF BRAKPAN, SPRINGS & NIGEL



Magisterial Boudaries

Municipal Boundaries

White Residential Areas

Non-White

Industrial Areas

Proclaimed Mining Ground

Agricultural Holdings

Unused Land

10 mls

The relation of municipal and magisterial boundaries is shown in Figure 6. This shows that there is little difference in the boundaries as applied to Brakpan and Springs. In the case of Nigel however there is obviously a great spatial disparity between the two, the magisterial district comprising 37I square miles, whilst the municipal area only 52 square miles. The population however is largely concentrated in the municipal area, the I960 Census indicating a total population of 49,574 in the magisterial district compared to an approximate 35,000 in the municipal area, whilst a comparison of the white population between the two showed an even smaller proportional difference (Municipal Year Book, I960). As Figure 6 shows, virtually all the mining land, white residential areas (Nigel and Dunnotar), non-white residential areas (Deduza and Charterson), and industrial townships are contained in the municipal area. Outside the municipal area, the magisterial district consists of agricultural holdings with the exception of the white residential township of Jameson Park which today is little more than a ghost-town. Both Nigel's basic and non-basic activities are therefore represented totally in the municipal area and one feels justified in being able to apply conclusions from the statistics of industrial censuses by magisterial district, to the area contained within the municipal boundaries.

/ CHAPTER 2

CHAPTER 2

GOLD MINING : GROWTH AND DECLINE

The gold mining industry has caused virtually the entire development of the East Rand and until recently was the sole base of its economy. Many of the consequences of its growth and decline will be studied in later chapters. In this chapter the aim is to analyse the factors influencing the growth and decline, the resultant changing spatial patterns of gold mining development, and the consequent direct effects of the closure of the mines.

The Growth of Gold Mining in the East Rand

The East Rand forms part of the worlds greatest known goldfield, the Witwatersrand. The gold bearing conglomerate of the Witwatersrand, the banket, was not the first large gold strike in South Africa. It had hardly been considered as a potential gold mining area till the succesful prospecting of the I870's in the Northern and Eastern Transvaal led to prospecting throughout South Africa. From the year of discovery, I884, other South African gold-fields became relatively insignificant in comparison with the Witwatersrand, whilst the exploitation of the banket provided not only the basis for the whole Witwatersrand Metropolitan Area, but also made South Africa the worlds leading gold producer.

By far the most important gold containing ore is present in the Main Reef Series which constitutes part of the Upper Witwatersrand geological system. This Witwatersrand system is one of the older rock formations which form the South African mainland and is therefore usually covered by younger rocks of the Ventersdorp, Transvaal and Karoo systems.

/ Folding ....

Folding and erosion has resulted in some parts of the gold containing conglomerate being exposed, as in the Central Rand where the first Witwatersrand gold strike was made, whilst in other sections it is still overlain. In the East Rand this gold containing layer lies in a structural depression, known as the East Rand Basin, and the mining zone is consequently broader than in other parts of the Witwatersrand, though overlain by younger rocks (Antrobus and Whiteside).

Since the commencement of mining in I884 the relative importance of the producing areas of the Witwatersrand have varied considerably. The Central Rand outcrop maintained a dominant position until I923. The next most important producing area in this early period was the West Rand, until the Eastern zone took over this position in I9II and became the leading producing area from I923 until the early I950's. Figure 7 shows diagrammatically the changing patterns of gold mining development in the Witwatersrand between I900 and I950. The development of the Witwatersrand goldfield has however been amply described by other authors (Scott, I95I ; Cole, I96I), and only the developments in relation to the East Rand will be considered in this text.

Shortly after the first discoveries of the Witwatersrand gold reef, gold was discovered on the farm of Varkensfontein, near present-day Nigel (Buhrmann, I959). The Nigel Gold Mining Company Limited, as the mine was called, was the forerunner of all development in the East Rand. For many years however this mine and the mines in the north of the East Rand, New Modderfontein and Van Ryn Estates, were the only mines taking ore from the East Rand's deposits.

Before the gold reefs in the East Rand could be fully exploited the technological problems associated with depth of mining had to be overcome. The main date of significance

/ in ....

Figure 7 GOLD MINING IN THE WITWATERSRAND 1900-1950

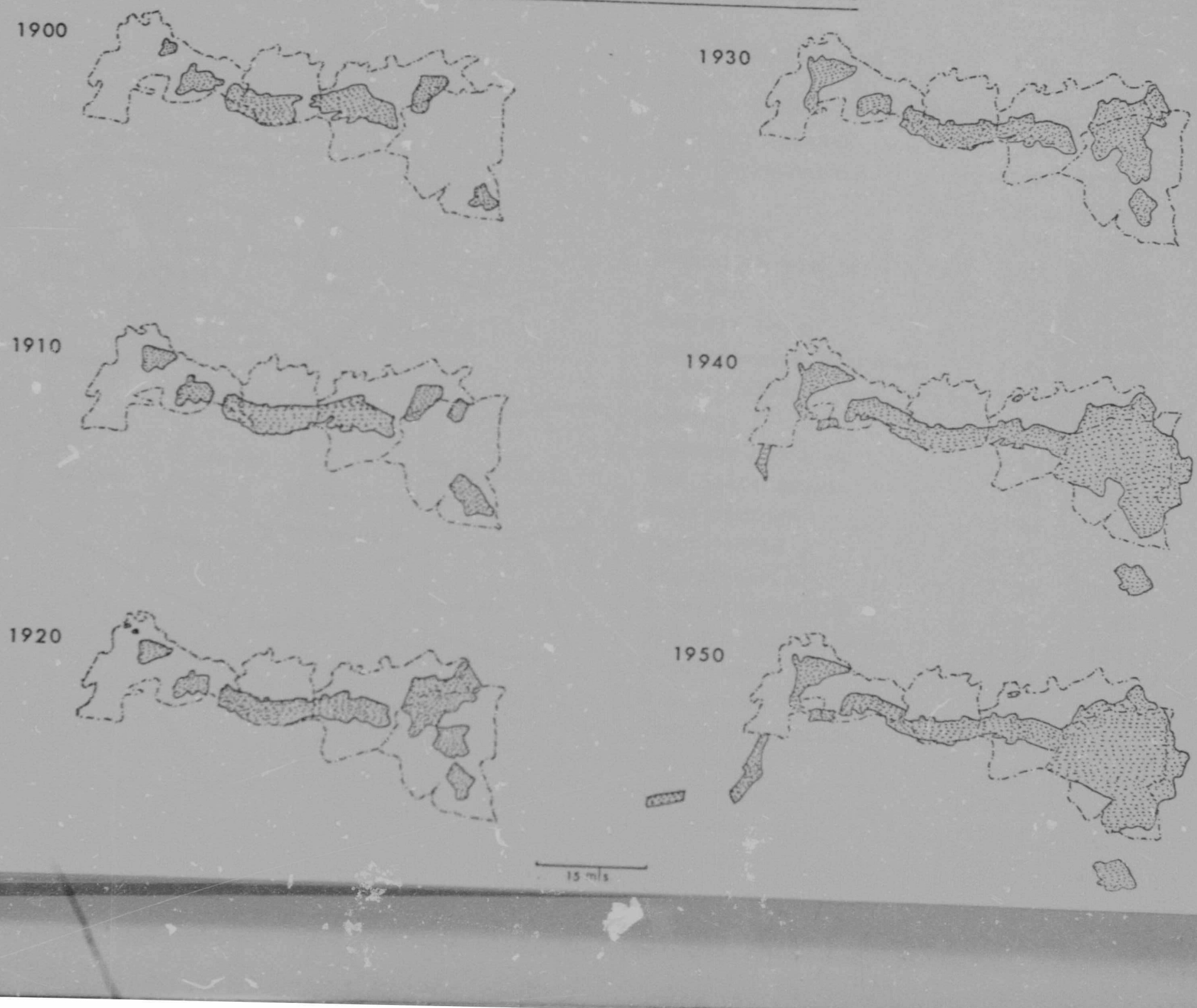


Figure 8

LOCALITY PLAN OF MINES IN THE EAST RAND

MINE	Declaration of gold	
	From	Till
New Modderfontein	I869	I952
Nigel (N.B. Ceased production between I9I8-34)	I888	I956
Van Ryn Estates	I892	I946
New Kleinfontein	I894	I967
Geduld	I908	I966
Sub-Nigel	I909	I969
Modderfontein 'B'	I9II	I956
Brakpan	I9II	I964
Van Ryn Deep	I9I3	I945
Government G.M. Areas	I9I4	I962
Modderfontein Deep Levels	I9I5	I95I
Springs	I9I7	I962
Modderfontein East	I920	I962
New State Areas	I923	I954
West Springs	I924	I948
East Geduld	I93I	
Daggafontein	I932	I967
Vogelstruisbuilt	I936	I968
Van Dyk Consolidated	I938	I967
Grootvlei	I938	
S.A. Lands	I938	
East Daggafontein	I939	
Marievale	I939	
Vlakfontein	I942	
Spaarwater	I947	I969
Wegedacht	I948	I956

in this respect was I9I6,with the introduction of the Francois cementation process,which allowed the sealing off of shafts from the water bearing fissures (Cole,I96I). Now the way was open for the East Rand Basin to be fully explored and exploited.

Several mines came into existence following this technological breakthrough,Springs,New State Areas,Modder. East and Van Dyk (see Figure 8 in relation to Figure 7), and led to the predominance of the East Rand in the mid I920's at a time when many small Central Rand mines were closing due to the exhaustion of payable ore.

Despite the fact that the gold industry was relatively unaffected by the onset of the world depression in I929, it led to little investment in new projects. These were largely initiated as a result of the increased price of gold following the abandonment of the gold standard in I932,permitting a lowering of the grade of ore mined profitably. This was the real period of the opening up of the East Rand Basin for the mining of gold,with the commencement of many of the areas most famous mines - the Daggafonteins,Geduldsa,Vogelstruisbult,S.A.Lands,Vlakfontein, Grootvlei and Marievale.

By I940 virtually all potentially payable areas of the Basin were being exploited,the only mines opening in the I940's being Spaarwater and Delgedacht,both small concerns on the perimeter of the Basin.

The situation in I950,as depicted in Figure 7,shows the zenith of gold mining in the East Rand. Production had been boosted by the £ sterling devaluation of I949,but even at this period the forces leading to its relative decline in South Africa,and its absolute decline,were apparent,namely the development of new mines in other

/ areas ....

areas, and the reduced profitability and ore reserves of the Basin.

The Factors Affecting the Decline of Mining

Mining is a 'robber industry' extracting non-renewable substances from the earth. As such it is obvious that the lifespan of any mine is limited by the finite nature of the mineral resources it is extracting. Seldom however will this situation be reached, as before total exhaustion occurs, the mineral will become unprofitable to work under prevailing economic and technological conditions.

The factors influencing the lifespan of gold mines in South Africa are twofold. Firstly, the profitability of extracting the mineral, and secondly, the ore 'reserves' within a range of this level of profitability.

Profitability

The profitability of any mining concern is represented by the surplus of revenue over costs. Figure 9 shows the changes in average working costs and revenue, per ton of ore milled, in South African gold mines between 1920 and 1968, the average profit per ton being depicted in the area between the two curves. Since the mid 1950's it can be seen that both curves are generally upward sloping, with an increase in average profitability per ton milled.

The average cost curve shows very few fluctuations due to the constant nature of the variables that influence it. If the curve were to be extended backwards to 1900 it would show a gentle upward slope representing decreasing costs between 1900 and 1920 caused by increased efficiency in the mines. Since 1920 however the decreasing costs of increased efficiency have been more than matched by an

/ increase ....

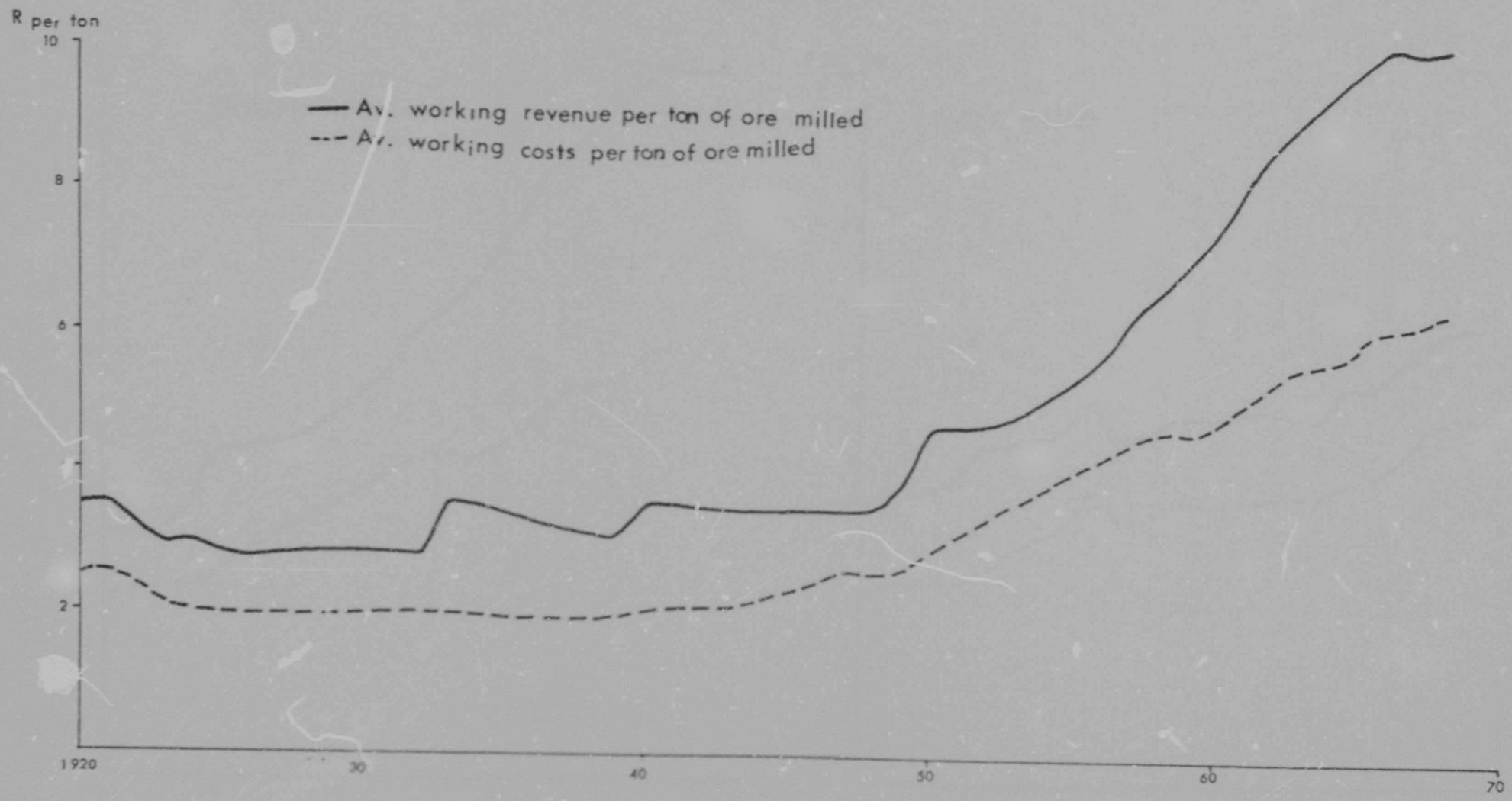
increase in labour costs and general extraction costs associated with the inflationary trend from this time.

The nature of the average revenue curve is a function of two variables, the price of gold, and the richness of the ore, that is, the dwt. of gold recovered from each ton of ore milled. In contrast to the cost curve it shows several abrupt upturns marking direct or indirect changes in the price of gold. The upswing in 1932 is a function of the abandonment of the gold standard and the resulting increased price of gold. The pre-war upswing in contrast marks the post-depression world boom conditions, whereas the 1949 upswing represents the indirect upvalueing of gold by the £ sterling devaluation. Since the mid 1950's the general upswing has not been a function of the gold price, but of the increased average richness of the ore mined in South African gold mines.

. Until the mid 1950's average costs and revenue in the East Rand mines followed very closely the national averages, being slightly above these averages. Since the mid 1950's however, as is shown in Figure 10, the average cost curves for South Africa and the East Rand have diverged, both costs and revenue now being below the norm. This has been the result of the development of new areas of gold mining in the Republic, namely the Far West Rand, Klerksdorp, Evander and the Orange Free State. These new mines incur higher costs than the older Witwatersrand mines for a variety of reasons largely associated with deep mining. The most important of these are, that in the Orange Free State it is necessary to refrigerate the ventilating air, whilst in Evander and the Far West Rand the presence of water-bearing dolomite necessitates the cementation of both shafts and underground workings. These high costs are however compensated by the high percentage payability, represented in the South African average revenue curve in Figure 10, and shown by area in Table I.

/ Table I ....

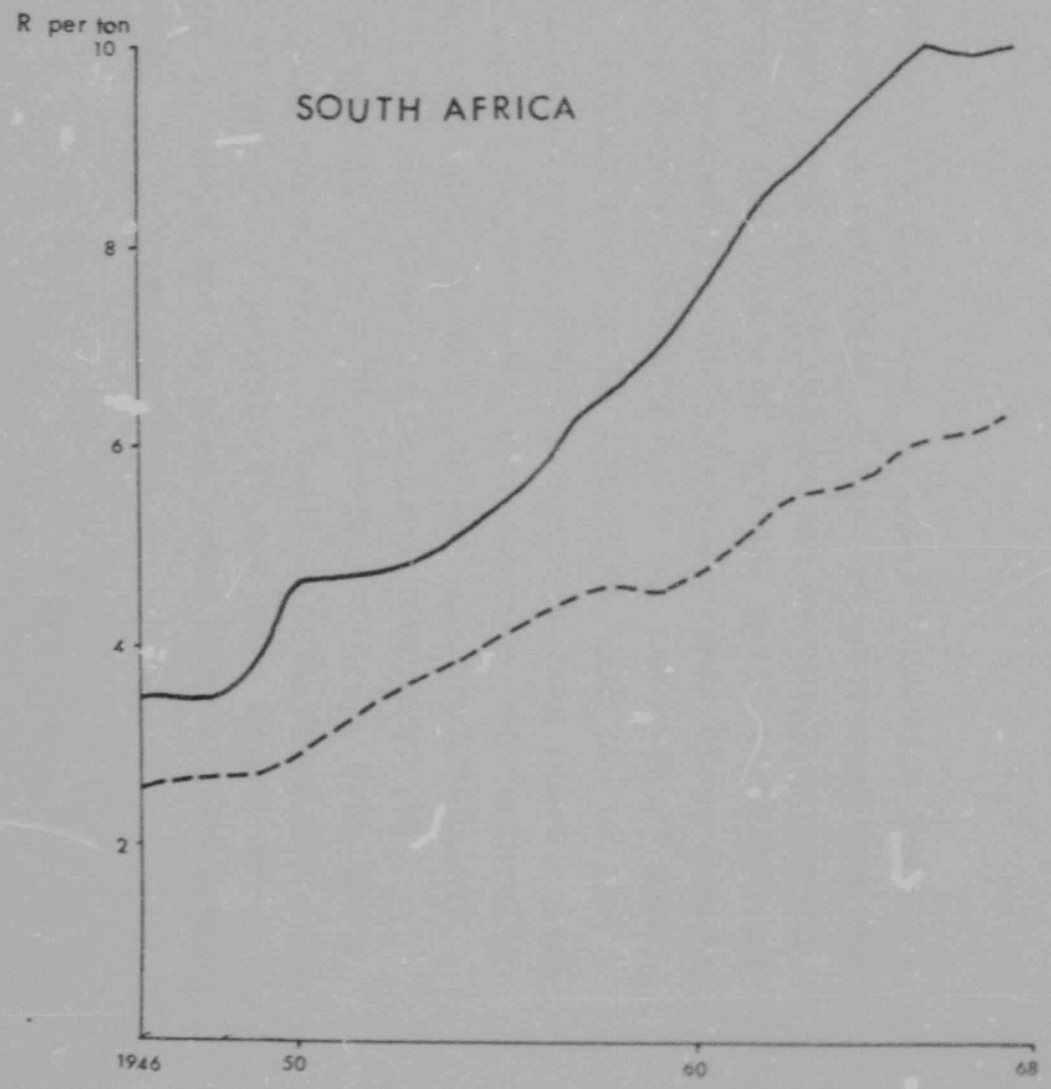
Figure 9 COSTS & REVENUE OF GOLD MINES IN SOUTH AFRICA 1920-1968

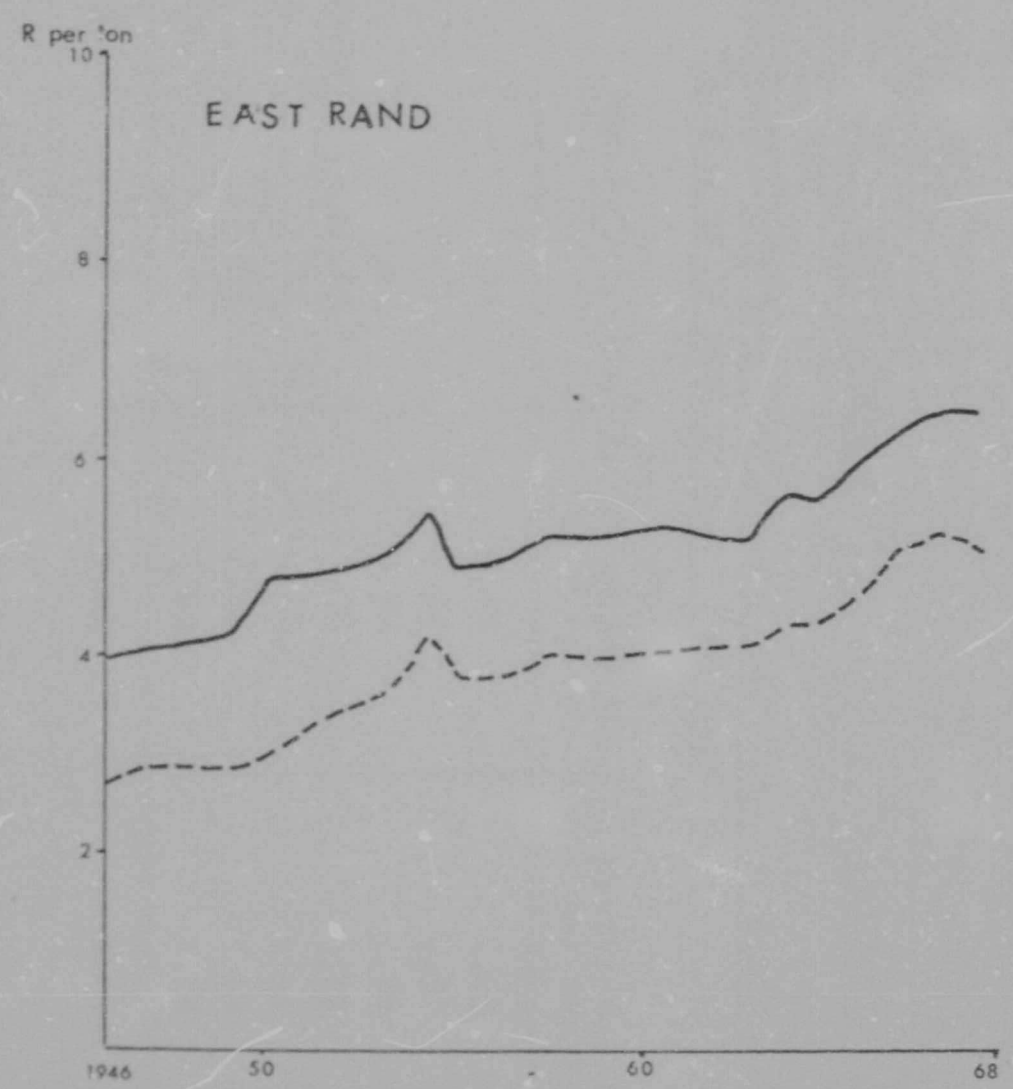


Source : Chamber of Mines Annual Reports

Figure 10

AVERAGE COSTS & REVENUE OF GOLD MINES IN THE EAST RAND COMPARED TO ALL SOUTH AFRICA 1946-1968





Source: Chamber of Mines Annual Reports

—— Av. working revenue per ton of ore milled
--- Av. working costs per ton of ore milled

TABLE I

COMPARISON OF OPERATIONS BETWEEN THE EAST RAND AND OTHER SOUTH AFRICAN GOLD MINING AREAS I968

	Av.dwt.per ton	Av.costs per ton R	Av.profitability per ton R
East Rand	5.44	5.65	I.25
Central Rand	2.93	5.6I	I.92
West Rand	3.58	5.96	I.I4
Far West Rand	I0.85	7.56	5.48
Klerksdorp	7.99	7.57	2.52
O.F.S.	9.58	6.56	5.59
Evander	7.60	6.02	4.I8
South Africa	7.79	6.42	3.48

Source : Chamber of Mines Annual Report I968

The contrast can be seen in Table I between the low-cost, low payability old mines of the Witwatersrand and the high-cost, high-payability mines in the recently developed areas. Nowhere in the East Rand can the fantastically rich ores of West Driefontein, I8.29 dwts., or Free State Geduld, 20.25 dwts., be matched, Vlakfontein being the richest mine in the area with an average of 8.38 dwts. per ton of ore milled (Chamber of Mines, I968). Despite having lower costs, these costs are rising rapidly as a function of increasing labour costs, resulting in very low average profitability in the area with some mines at minimal profitability (e.g. East Daggafontein R 0.30 per ton milled). From being the richest gold mining area in South Africa, today, the East Rand is one of the least profitable, and were it not for other factors it would not be many years before increasing costs overtook the average revenue.

/ Ore ....

Ore Reserves

The extent of ore reserves is especially important to gold mines in South Africa with the ever present possibility of a rise in the price of gold. If marginal mines have large reserves of ore just below the present level of payability they may continue to operate at very low or even negative profitability to avoid the necessary costs incurred in re-opening the mine. Whether or not this occurs however will largely depend upon the type of ore reserves.

The ore reserves of the East Rand Basin are comprised mostly of payshoots as a result of the unconformity of economic horizons caused by severe faulting in the basin. Most of this ore has already been worked out and any ore remaining would necessitate a very high revenue return were it to become economic. Only in the eastern section of the basin, at shallower depths and less affected by faulting, are there low grade deposits of ore which could conceivably become economic to mine were there an increase in the price of gold.

The Mines Closed

The concentrated nature of the closures has resulted from a combination of the factors outlined above.

The mines in the East Rand have had long operating lives in comparison with the expected lifespan of any newly opened mine today. The average lifespan for the fifteen mines closed in the East Rand since 1950 has been 48 years, with New Modderfontein a life of 83 years and New Kleinfontein, 73 years.

It is not suprising therefore, that the exhaustion of payable ore reserves is the main factor in the closure of the mines, especially due to the ore's payshoot nature.

/ Increasing ....

Increasing costs have in many cases been the deciding factor in the exact timing of the closure, with many mines obtaining a minimal profit return before shutdown. As an exception it must be noted that Sparrwater, a mine working at low levels of operation, made a loss for its first eight years of operation (I947-I954) and since then has only managed a very small profit margin, yet has continued in operation till the last quarter of I969. For the newer mines on the eastern margin of the basin with more uniform deposits, the deciding factor will be the decreasing profitability, unless the price of gold increases.

Effects of the Closures

The effects of the decline of gold mining in the East Rand will largely be dealt with in Chapter 4, in the consequences of the decline upon the local economy. In this section it is only intended to deal with the run-down of employment, and to briefly mention the nature of the other effects in general.

The major consequence which first comes to mind when thinking of the closure of mines is the unemployment created by these closures. A fall in the white labour force of over I0,000 between I945 and I968 obviously creates significant problems in readaptation to area, or job. When viewed in Table 2 or Figure II (ii) the run-down of white employment would appear gradual. In contrast the closure of an individual mine is a comparatively sudden phenomina as is indicated in Figure II (i), for Geduld and Sub Nigel gold mines, and in Table 3, below. As shown in Figure II (ii) production is normally maintained at a high level for as long as possible before closure in order to counter the high costs of keeping the mine open. Employment is similiarly kept at a high level although attempts are made to transfer some personnel before closure.

/ Table 3 ....