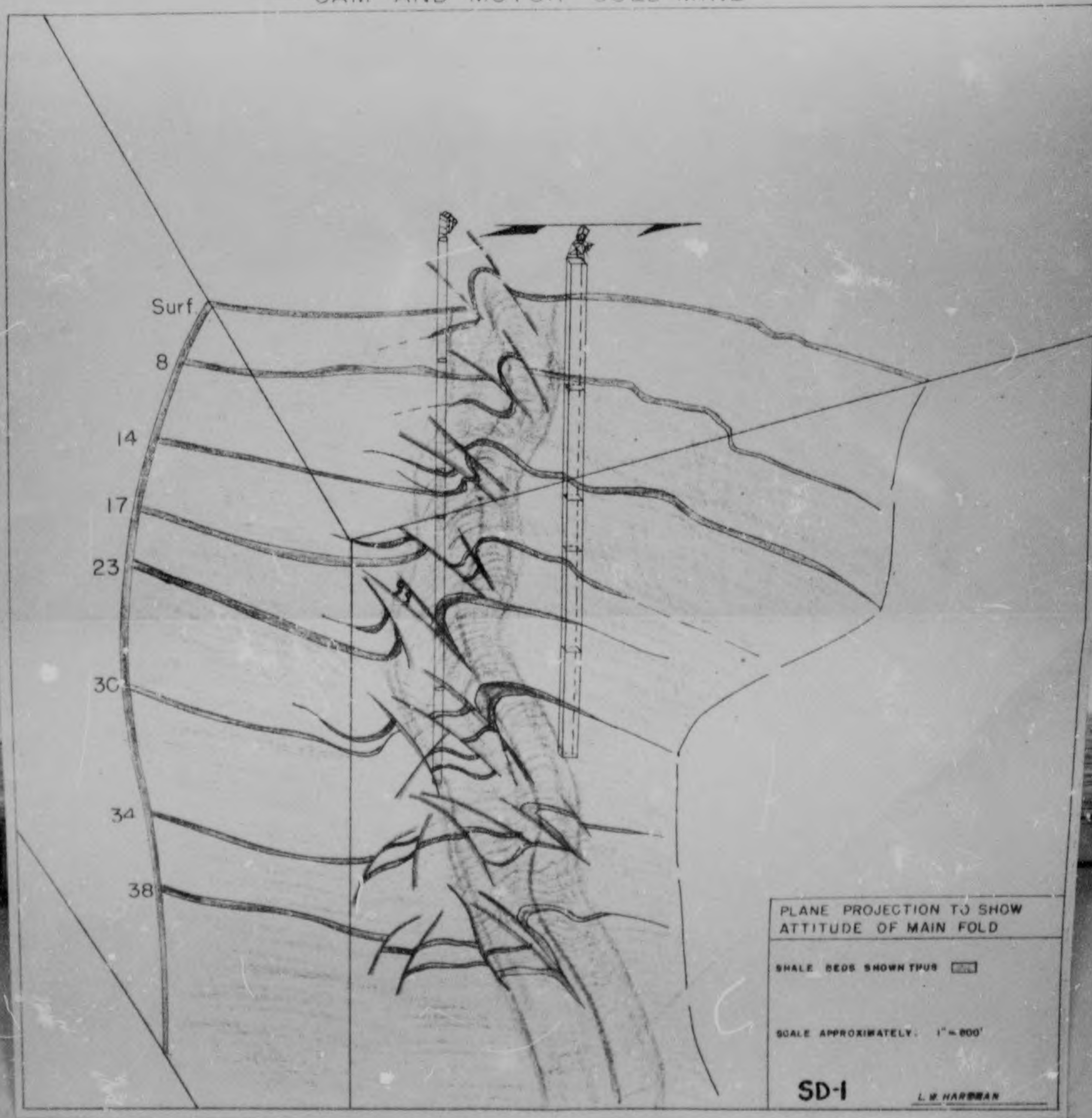
North and pinched to the South. In driving North, the lode assumed widths of 6 to 8 feet, being highly lenticular and very rich. At the time of the writer's most recent visit, the lode had been driven a distance of 180 feet to the North, the face still being in values, and the same lode has been developed on levels 37 and 38 with gratifying results, the nature of which are not known.

Most interesting amongst the various observations upon this lode was the fracture pattern, which composed the channel and consisted of a cymoid curve structure surrounded by considerable replacement and impregnation of greenstone wall rock, making a sizeable ore body of excellent grade. In addition, the nature of the lode itself is unique, being of composite structure. On either or both of its steep walls, a quartz body containing a little ankerite and other carbonates is fractured, healed with later quartz and native gold often forming a veritable network of very fine gold veinlets. Between these lodes on the walls, a wider zone of brecciated quartz is seen to be healed with veinlets of barren quartz up to .75 inches in width. Whereas the outer sections of the channel are often very rich, the centre portion is of rather desultory grade, averaging perhaps 4 Dwt.

This lode, being of such deep seated origin, and apparently apexing below 4500 feet, should be in an excellent environment as it lies along the downward extension of the upper level Cam Spur lode. The lode should continue in depth until the Southerly pitch (which is normal for North-South lodes) brings the shoot into the influence of the sediments lying some 160 feet to the South.

— CAM AND MOTOR GOLD MINE —



CHAPTER VIII

THE MAIN FOLD STRUCTURE.

All lodes of the Cam and Motor Mine are in some manner dependent upon the Main Fold, the origin of which has been discussed at length in an earlier portion of this paper. In review, the regional picture is seen as one of a major East-West zone of disturbance passing through the interbedded sedimentary lens which are the sediments of the Motor Lode system. Diagram SX-1a shows the regional picture on an overall scale, whereas Diagram SX-2 demonstrates the probable local sequence experienced by the particular sedimentary body in question. It is then established that the horizontal folding and subsequent downfolding into synclinal attitude of the formation produced a steeply plunging fold of monoclinal nature which occupied the position in:

A. The general North-South belt of influence felt throughout the length of the "Rhodesian Gold Belt"; in that its situation corresponded to that of all downfolded Bulawayan volcanic "troughs".

B. A major East-West zone of deep seated igneous activity which produced cupola, stock and other structures for a distance of at least 80 miles.

C. An area not too far removed from a major granitic intrusion.

With reservations, it may be stated that no lode, , could conceivably have had for its original source of mineralising solutions a location other than the Main Fold and associated Apex Faulting.

As it was impossible to observe properly the Fold at surface, it is believed that it was most probably as mapped by Wiles[25]; a rather gentle bending of the sediments to the Southeast, going South with, as noted by the writer, a minor amount of apex faulting as observed in the area Northeast of the Circular Shaft. Levels above 500 feet in depth were, by and large, inaccessible insofar as the area affected by the Fold is concerned, and the first detailed observation of the feature was made on the 5th (480') level. Here the Fold is seen to disturb the Southerly continuity of the sediments by an offset of at least 300 feet to the East, in a gentle monoclinal (?) structure, its axis bearing 70° West of South; opposed to the general strike (20° West of South) of the affected sediments, a matter of 50°. Apex Faulting in connection with the Main Fold is of minor consequence upon this level, and appears to have

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25. Wiles, J.W. op. cit.

consisted solely of two rather indistinct zones which have displaced a block having North-South dimension of 430 feet, for a matter of perhaps 200 feet to the East Northeast.

On the 8th (890') level, both Fold and Fault structures are well exposed. The bearing of the axis of the fold is near 67° West of South and the plunge is steeply to the West-Southwest, with a radius of the arc lengthened to the East-Northeast, giving the impression of overturning when viewed in plan. The normal sedimentary strike remains 20° West of South and this trend is interrupted by the fold for a matter of about 280 feet to the East.

At least two sets of Apex Faults displace blocks of sediments to the East. Of these, the Northernmost is most impressive, displacing a segment of shales and arkose for a distance of over 500 feet (8th level) to East North-east, showing drag along the margins of the block and transforming slightly metamorphosed shales to carbonaceous schists and brittle slates. This displaced sedimentary series is seen in a crosscut in the hanging wall of the Gem Lode and was observed to be of extremely contorted and brecciated nature. South of the aforementioned faults are a number of minor features consisting of contorted shale beds, and bands of intrusive which have risen along lines of weakness resultant from folding and faulting. In a crosscut driven West from the Motor lode to the Sand Transfer Shaft, arkose lying in the faulted block of sediments showed shearing nearly parallel to the direction of displacement.

The structure of the Fold upon the 14th (1615') level is difficult to interpret, as the area to the South of the feature appears to be a different sedimentary lens from that exposed to the North of the fault, rather than the single bed observed on higher levels. As this continues to be the case in depth, correlation of beds lying on opposite sides of the feature is often highly uncertain. As observed on the plan of this level, the arc of the fold has become sharper, and overturning is definitely indicated in the near 90° bend made by the Northwest trend of the feature. The change of the course of the sediments, although somewhat less than above, remains at about 400 feet and is seen to have been roughly East-West before the Apex rupture interference. The plunge of the Fold is so steeply to the Southwest as to be nearly vertical between this level and the next lower level. The trend of the Apex Faulting is from Southwest swinging through to East going Northwards, and three definite zones were detected. The plunge of the Fold from the preceding (8th) level has caused the Faulted zone to be some 400 feet more to the South on the 14th level, thereby not affecting the Cam lode. Strong zones of shearing in the greenstones exposed in the crosscut to Cam Hanging Wall, however, are directly in line with the larger of the Apex Fault zones, thereby joining the Cam at a point near the Eastern limit of the payshoot; possibly delimiting the margin thereof as seen at deeper horizons. The Motor lode on this level was poor, while the Centre section was payable, and this may in some manner be related to the alteration in plunge of the Fold, although as already stated, it is most likely a result of theSoutherly pitch of the payshoot as opposed to Fault interference.

The 17th (1999') level illustrates the uppermost instance of a lode lying in an Apex Fault as already described (1585 South Footwall Lode). The arc of the Fold here observed is seen to have increased somewhat to that noted on the 14th level, with Apex Faulting becoming much more pronounced, again affecting the Cam and Cam Spur lodes, the former of which it joins along strike, and the latter of which it appears to delimit. Surprisingly, the total disturbance of the trend of the Sediments on this level is only 200 feet East-West, most probably being due to the maintenance of a steep South-westerly plunge. This was shown in the additional influence of the Apex Faults.

The plan of the 19th (2250') level is indicative of the changing dip of the sediments, and of primary importance in that the nature of the plunging fold is excellently illustrated at this point where the lodes are but little disturbed by the influence of the Apex Faulting as such. The shape of the great Motor-Centre-Footwall replacement body is therefore a result of the abrupt change of dip of the sediments where distorted by the Main Fold. There can be little doubt that the 1585 South Footwall lode lies along one of the Southerly Apex Faults, and that the extension of the Fault to the East crosses the Cam Spur lode near its Southern end. A more Northerly Apex Fault zone has become a tangent to the Cam lode and has displaced sediments from an apparently independent lens into its zone of influence. From the 19th to the 23rd levels the plunge of the Fold is steeply South, with the net strike of the Apex Faults East-West, dipping 70° Southwards.

As regards study of the Fold-Fault structure, the 23rd (2795') level was perhaps the best level on the Mine. Most striking is the long and sinuous, but definite, contact between the Greenstones to the North and the Sediments to the South, which consists in part of the Fold (West) and in part of a very tight Apex Fault (East). The Main Fold exerts a net West to East displacement of the normal trend of the sediments to the extent of 450 feet, with the Apex Fault mentioned displacing some of the sediments an additional 300 feet.

Further Apex Faults are seen to be numerous, and are often occupied by large intrusive-healed brecciated zones, or, as in one case, a payable lode (Cam Parallel). The Apex Faults having affected the Cam and Cam Spur lodes on higher levels, exert a much more definite influence on level 23, displacing large masses of sediments directly into the paths of the

Cam and Cam Spur lodes. Overturning of the folded sediments in the Southern portions of the Centre and Footwall "A" lodes resulted in a greater opening of the channelways and enrichment thereof, while a very definite cessation of payable ore upon these lodes was noted at their intersection with the change of strike of the Main Fold. Of additional significance is the definite alteration in normal strike of the sediments (20° East of North) which in the portion North of the Main Fold-Fault have swung a further 15° to the East; a trend that is maintained to the lowest working horizon of the mine. The Southern Leg of the sediments is seen, however, to have altered strike to the North-South and it was upon the basis of this anomaly that the existence of a further zone of faulting well to the South of the Main Fold was suspected. Also, this level is the first instance upon which post-Apex Fault movement was noted. This movement consisted of the displacement to the North of a minor segment of sediments which had already been faulted to the East along with Main Apex Fault. The plunge of the fold from 23 level down is steeply Northwest, with the dip of the Apex Fault zone nearly vertical.

By the time the Main Fold had reached the 25th (3007') level, its arc had sharpened sufficiently that its influence as a fold was lessened, and in recumbency showed signs of passing into a Fault Zone. The West to East disturbance of the sediments directly affected by the main fold, if taken as the me n of the distances from the normal Northeasterly trend of the main lens (of sediments) to the dislocated segments of the same sediments lying along the Cam Spur, may be said to exceed 500 feet. The additional sediments lying some 200 feet further to the East are without doubt the identical body struck in the drive East on the 23rd level Cam Parallel channel. It is not definitely known that this particular segment of sediments (Easternmost) originated from the same lens as the Westerly block, but in view of the increased faulting in the succeedingly lower levels, this opinion would seem in order. A definite result of the constriction of the arc of the Fold is seen in highly contorted and shortened nature of the Centre and Footwall "A" lodes, and a marked change from the folded Southern portions of these lodes observed on 23 level, to the well defined faulted nature of the identical channels on the 25th level is conclusive evidence that the Fold, is, in reality, assuming a minor role in comparison with the Main Northern Apex Fault structure. As on 23 level, considerable basic intrusive is noted in the vicinity of the Fault and Fold-affected portions of the Cam, Cam Spur and the Footwall lodes. The downwards plunge of the fold from 25 level is nearly vertical, with the dip of the East-West trending Apex Faults steeply South.

On the plan of the 27th (3228') level, the situation can be seen to have changed only slightly from the preceeding level discussed. As mentioned under the section dealing with the failure of the Cam lode, it is upon this level that the Cam and Main Apex Fault approach total unity, with disastrous effect upon the former. Of special significance on this level is the position and nature of the Cam Spur and Footwall "B" channels which have assumed the proportions of major North-South structural features. It has already been shown that the Cam Spur acted as a virtual fault, forcing sediments to the North, which had already been dislocated East by the Main Apex Fault, and it is upon this level that the 1250 South Contact Fault is seen to make its first appearance, as a curving structure forming the Northern boundary of these sediments. In addition, the Centre and Footwall "A" lodes swing around to the Southeast, going South, and approximate the folded contact of the greenstones to the North, while the Southern portions of these lodes are seen to be surrounded by a sizeable body of basic untrusive which indubitably found this opened contact area an excellent location for invasion and alteration of the sediments. This intrusive is post faulting age and only slightly pre-mineralisation, and is of great hindrance in the interpretation of the structure, often masking important minor evidence which would assist in the proper completion of the overall picture. The plunge of the Main Fold downwards from 27 level is nearly vertical, while the faulting along Cam Spur of the 1250 structure disrupts the net course of the Apex faults so greatly that their Eastern portions may be of various dips and strikes.

From level 30 (3560') to level 39 (5360'), a series of North-South and East-West structure sections were drawn to assist in the interpretating the complicated Fault structure in this zone. Unfortunately, the bulk of the movement and displacement effected by the Main Fold-Fault and other structures is in a quasi-horizontal direction rather than vertical and the sections, if used without constant reference to the plans, are of little value.

As may be seen on Diagram SD-1, the form assumed by the Main Fold at the 30th (3560') level is obviously of greater complexity than that of any of the higher levels. A large amount of development and prospecting was done on this level, and vital information regarding the behaviour of the major structural features was gained through a tedious thirty eight days study of the level. Here the Cam Spur and Footwall "B" lodes are seen to have assumed even greater magnitude (structurally) then that noted on the 27th level. Northward displacement of a minor body of "shales" is seen to have occurred along the Footwall "B" for a distance of some 200 feet, thereby shortening the Southern extension of the payable length of this lode, which was found to be very poor in the sediments. This also applies to Cam Spur in an identical manner. The Southern portion of the Centre and Footwall "A" lodes have swung further to the East going South, and now approximate the trend of the folded contact between the greenstones and the sediments. The far South extensions of these lodes, which are continuous with totally independent fracture zones in the sediments, are unpayable, and of a broken and discontinuous nature. The Cam lode is seen to be bottoming in the area to the South of the Northern Apex Faulting, and to end upon a rather large segment of the faulted sediments lying to the South. The Cam Spur in the area directly West of the Cam lies in greenstone and basic intrusive, and some 180 feet to the South enters a block of sediments believed to have been displaced by a fault continuous with the 1350 Fault seen on sections 200 and 400 West. This 1350 South Contact Fault is apparently divergent from the 1250 South Contact Fault in the area South of the Circular Shaft, but may possibly be parallel thereto. The exact role played by these two Faults is not known, but they apparently constitute a Northwest to Southeast zone of movement indirectly connected with the trend direction of the like leg of the Main Fold, lying at high angles to the Main Apex Faulting. Further effects of the 1250 South Contact Fault are seen in the area surrounding the Circular Shaft, but the structure in this area is additionally complicated by the presence of large amounts of basic intrusive, which are sometimes injected along closely spaced bedding planes into the displaced shales and arkose. Lying in the 1250 Fault trace in this vicinity was a lode unique amongst those on the mine. This small body (12" width) consisted of a quartz-carbonate lode containing tetrahedrite, sphalerite, chalcopyrite, arsenopyrite and covellite with 1 Dwt. (or less) gold. The country rock was slate, the strike of which was cut by the lode at an angle of 55^{0}. On the Northern end of the Footwall "A" and "B" lodes, a rather odd situation of an apparently isolated sedimentary segment is seen. This will be discussed in the following levels. The plunge of the fold from 30 level downwards is steeply North-Northeast, while the main trends of Apex Faulting are East-West, and Southeast-Northwest, being of vertical and steeply Northerly dip, respectively.

Folding is again seen to be of consequence on the plan of the 32nd (3960') level, with the 1250 and 1350South Contact Faults being of far greater relative importance than the original East@West Main Apex Faults. Definite recognisable change in the overall structural pattern from that of the preceding (30th) level discussed, may be seen in the much greater Northward displacement of the sediments along the Cam Spur channel. It may also be noted that the 1250 and 1350 Faults have been used as branch lode channels by both the Footwall "A" and Foot wall "B" lodes. The Centre lode is seen to have dipped away into the arkose and to have a very short strike. The Footwall "A" lode is at this point occupying the contact (Folded) of the greenstone for its total length, as it swings around to the Southeast going South.

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The Cam lode has, for mining purposes, bottomed at this level in a very complicated jumble of sediments, intrusive and fault structure, which on section 200 West is seen to be bounded by two distinct faults and a sharp reversal of dip of the sediments. The sum of the effect of Folding and Faulting upon this section of the level can be said to consist of a lengthening of the zone affected by original Folding of the Main Fold. For the first time there is a hint of vertical as well as horizontal displacement by the South Contact Faults, wherein the sediments in the vicinity of the Cam and Cam Spur South appear to have been displaced downwards in relation to the greenstones to the North. This postulation is brought out in the appearance of the Southern portion of Section 400 West. The plunge of the fold below 32 level is decidedly Northeast.

As a result of the abrupt alteration in plunge of the Main Fold, the picture is seen to have almost completely changed on the plan of the 34th level (4360'). Diagram SD-1 illustrates this basic difference which may be seen to consist of a recumbent fold, to the South of which a very large amount of faulting has taken place. The arc of this fold is so sharp that it virtually constitutes a thrust feature, and would be considered thus if it were not for the independent movements along Cam Spur and Footwall "B" lodes, which must have occurred at a later stage. The 1250 and 1350 South Contact Faults are seen to displace sediments to the East a matter of 300 feet, as shown on the plan. The situation upon the Cam lode as regards sequence of sediments, greenstone and intrusive is, at best, extremely complicated, but leaves little doubt that these sediments were most probably part of a separate lens lying to the South and East of the main lens which was seen on higher levels. A Southeast trending fault is seen to displace sediments from the Northern end of the Footwall "B" lode for a matter of some 200 feet to the East. This fault also affects the Northerly displaced sediments along Cam Spur, by displacing them to the East, where they are seen in the vicinity of the Sub-vertical Shaft. Below 34 level, the Main Fold pitches steeply North, with the numerous faults trending East-Southeast and Southeast.

On the 36th level, no development was undertaken South of the Sub Circular Shaft, and the Cam lode is not again seen. The lodes can be seen to be following a jointlike East-Southeast- West-Northwest, and North-Northwest - South-Southeast pattern which in fact consists of the major fault structures seen on level 34. The dolorite seen in the Southwest portion of the area mapped is very fresh, and if, as is believed, of later age than the old Bulawayan intrusion, would help to explain numerous anomalies of the structure below the 27th level. The fold has become very sharp and the total area occupied by the development of lodes occupies less than half that seen on the 34th level. From 36th level to the 37th level the plunge of the Main Fold is Northerly and little change is seen in either the lodes or the Fault structure.

Just above the 38th (5160') level the plunge of the fold changed abruptly to vertical, and the lodes were again payable after a very lean and unprofitable zone of vertical distance of over 600 feet. The nature of the impoverishment of the lodes has been discussed, as has been the steepening of the dip of the sediments, and the reasons therefore. The basic difference between the structure of the 38th and 39th levels is that the bulk of the payable lodes on the former are seen to occupy East-West channels, while the North-South channels are increasing in importance on the latter. Such a restricted area is developed on these levels that the structure remains vague, but it is plainly seen that Folding rather than Faulting is of prime importance, both as regards the lodes, and the resultant structure.

In brief, the Main Fold, and associated Fault structure may be seen to have not only produced the Lode channels, but to have furnished their source as well. Lodes that persist beyond the deepest working horizon are invariably found to be in the immediate vicinity of the Main Fold-Fault, and lodes which bottom at higher horizo[illegible] [illegible]re in a like location.

CHAPTER IX

PETROGRAPHY

The outline of the petrography and general characteristics of the rocks seen in the Cam and Motor Mine, have been described under the sections on Regional Geology and Petrology, and will not be repeated herewith.

In the following chapter, only those features of the rock types which have been observed in thin and polished section will be discussed.

All rocks within the mine workings have been exposed to a greater orlesser degree of hydro-thermal alteration, and few fresh specimens were available for study. In all, 148 thin sections were stûdied. These were collected from various parts of the Mine and from the surface outcrops in the immediate vicinity.

The following types have been observed:

BULAWAYAN SYSTEM

Sedimentary (Undifferentiated)

Arkose
Quartzite
Shale
Greywacke

Igneous

Dolerite	(Greenstone)
Basalt	"
Andesite	"
Trachyte	(?)
Dacite	(?)

POST BULAWAYAN

Igneous Intrusive (Presumably of late Archean Age)

Dolerite	(Irregular bodies, sheets)
Diabase	("Vein intrusive, minor dykes)

EXACT AGE UNKNOWN

Igneous Intrusive (Surface Exposures Only)

Meta-dolerite
Dolerite
Peridotite

THE BULAWAYAN (INTERBEDDED) SEDIMENTS

As stated in an earlier section, the thickness of the lens of Interbedded Sediments averages about 300 feet. Exposure shows that the Arkose comprises about 80% of this lens, with Greywacke about 15%, and Shale, Chert etc. about 5%.

Distinct bedding is a notable feature of the sediments on the Mine, and can be seen in most thin sections to consist of alternating medium and fine grained beds of varying widths. In some cases' these bands are only a fraction of an inch thick, but the greater beds of Arkose are often of regular grain size for a distance of up to 50 feet in thickness.

All sediments observed are barbonatised to a certain degree, and are often sheared and converted to metamorphic types in the vicinity of zones of weakness.

ARKOSE

Arkose has been stated to be the most abundant of the sedimentary rock types observed in the Cam and Motor Mine, and is seen at all horizons of the workings from surface to the deepest penetration.

In comparison with the other sedimentary types the Arkose has undergone little in the way of dynamic metamorphism, but was somewhat affected by hydrothermal alteration.

P L A T E I.

THIN SECTIONS : PHOTOMICROGRAPHS

and

DESCRIPTIONS

PLATE I. Descriptions of Thin Section.

A. (Slide: U-6). 38th Level; Footwall "A" Lode.

Andesine Feldspar, showing polysynthetic twinning, in coarse grained Bulawayan Arkose. Matrix consist of fine Feldspar, Quartz, and Carbonates. Crossed Nicol, X 14.

B. (Slide: 16). 38th Level L; Main Crosscut North.

Hydrothermally altered fine grained Arkose. Plagioclase and Quartz grains in matrix of Carbonate minerals, Quartz, and Sericite. Crossed Nicol, X 80.

C. (Slide: U-1). 27th Level, Gem Lode Far East.

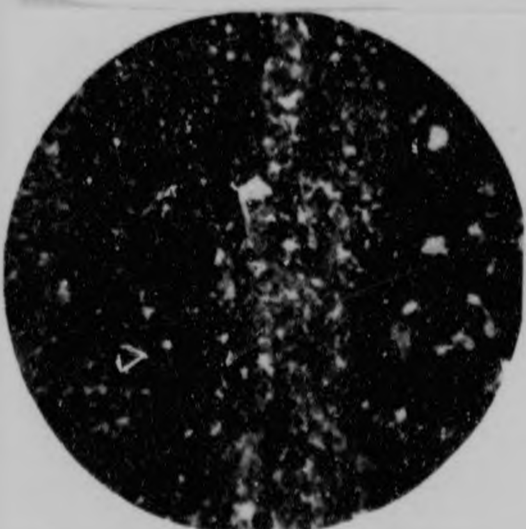
Thin bedded Bulawayan Sediment consisting of alternating bands of Graphitic Shale and fine grained Arkose. The Arkose is highly carbonatized. Ordinary Light, X 25.

D. Sheared and hydrothermally altered thin bedded Sediments, (Bulawayan), consisting of alternating fine bands of Graphitic nature and coarser bands of carbonatized Arkose. Shearing at 30 degrees with the bedding contains strings and lenses of Carbonates, as well as minor Pyrite and Arsenopyrite, and Graphite. The central band is largely unplaced by Carbonates and contains fine Pyrite and a cruciform twin, (012), of FeAsS Ordinary Light, X 25.

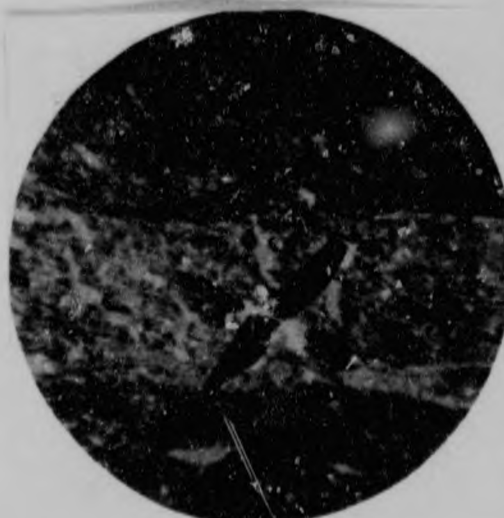
PLATE I.

A. Twinning in Andesine Feldspar,

B. Hydrothermally Altered Arkose.



C. Thin Bedded Arkose in Shale.



D. Arsenopyrite in Sheared Arkose.

The most common variety of Arkose which has been observed is a rather uniform massive rock of pale to buff colour, which shows little or no bedding in the hand specimen. In thin sections, this rock is seen to consist largely of poorly sorted Feldspar and Quartz grains of size up to .10 inch, averaging perhaps .03 inch in diameter, which lie in a groundmass of exceedingly fine crystalline fragments of the same material.

The larger Feldspars exhibit angular cleavage, often well preserved, but the Quartz grains are more rounded and appear to have been corroded somewhat more than the Feldspar. The Plagioclase is generally albite to andesine and often shows twinning. Orthoclase is not uncommon. (Plate I-A). The Quartz is usually a clear crystalline variety which was most probably derived from the underlying Pre-Bulawayan Granites, but on occasion, it is seen to possess minute inclusions, or show signs of strain.

Calcite and other carbonate minerals, Graphite, original mica, occasional pyroxene, and fragments of earlier Arkose and other rock types are observed.

The groundmass is usually carbonated to a greater or lesser degree, and Sericite can be observed in most specimens.

In addition to the massive variety described, an impure Arkose occurs as very narrow bands in the "Shales", sometimes being less than .25" in thickness, and grading into other types. A much greater percentage of Graphite is present than in the massive variety, and is seen to be wispy, and to weave in and about the grains, generally following bedding planes. The Quartz and Feldspar grains are small, seldom exceeding .02 inch, and are sub-rounded to rounded, being usually more or less replaced by Carbonate minerals. Abundant Sericite and Carbonate minerals occur in the groundmass, as well as pyrite and other products of hydrothermal alteration.

Hydrothermal alterations of the Arkose present near the lode structures, contain a much greater percentage of Carbonate minerals and Sericite, and show corrosion of edges of the larger grains. Much of the Feldspar has been converted to Albite, and the rock nearly always shows signs of strain. Sulphide minerals have been introduced, and shearing has often occurred at angles to the original bedding. In the occurrences of the thin bands of Arkose within the "Shales", the arenaceous beds are sometimes carbonatised, while the "Shale" is only slightly affected.

The hydrothermally altered coarser variety is seen

seen in Plate I-B, where the addition of Carbonate minerals may be seen to have progressed somewhat, but to have terminated shortly before the complete assimilation of the Feldspars.

The hydrothermally altered thin bedded variety is illustrated on Plate I-C, in which the arenaceous band is seen to be somewhat carbonatised.

Shearing and mineralisation by Arsenopyrite are shown on Plate I-D, in which shearing at thirty degrees to the bedding, is pronounced.

The approximate mineralogical content of the Arkose, as calculated by geometric methods is as follows:

Feldspar	30% - 60%
Quartz	20% - 50%
Carbonates	5% - 25%
Sericite	1% - 5%
Sulphides, Graphite, Pyroxene, etc...	- 1%.

QUARTZITE.

Quartzites are present in the Bulawayan Series upon the Cam and Motor Mine, but are rare in comparison with the occurrence of Arkose.

These beds are composed of Impure Arkose which grades into quartzite at times, but those exposures studied were in the vicinity of Intrusive and Lode structures and little could be gained through the thin section study.

As observed, the Quartzites are composed of rather small angular fragments of Quartz, evenly disposed through a ground mass of Carbonate minerals and Sericite, with considerable Carbon in the form of wispy Graphite, which undulates along and cuts across the bedding planes. (Plate II-A). Some specimens of this rock which have been greatly altered by hydrothermal solutions, resemble tuffaceous rocks of like age which are seen four miles to the West of the Mine.

P L A T E II.

THIN SECTIONS : PHOTOMICROGRAPHS

and

DESCRIPTIONS.

PLATE II. Descriptions of Thin Sections

A. (Slide: U-13). 31st Level, near Circular Shaft.

Intrusive contact between Bulawayan Arkose and later Diabase. The Quartzite consists of rounded grains of Quartz in a matrix of Quartz, Carbonates and Sericite. A little wispy Carbon follows bedding planes. The Diabase is described on page 182. Ordinary Light, X 25.

B. (Slide: 85). 23rd Level. Centre Lode.

Altered and carbonatised Bulawayan Greywacke. Angular to sub-rounded Quartz grains and fragments of Lavas lie in a matrix of Carbonates, Sericite and Quartz. Wispy Graphite and Pyrite are present.
Plane Pol. Light, X 25.

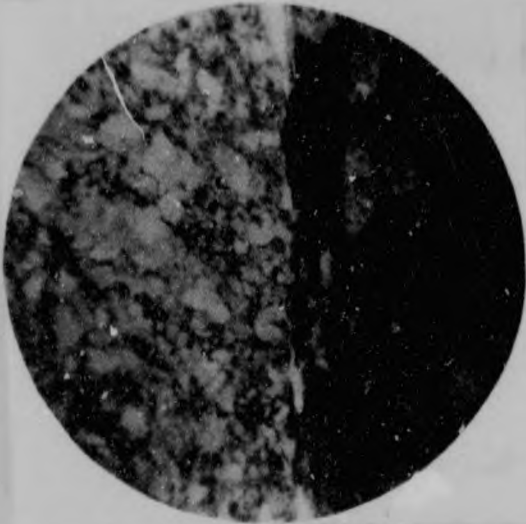
C. (Slide: 123). 34th Level Far South.

Bulawayan Doleritic Greenstone. Description on page 170. Crossed Nicol X 25.

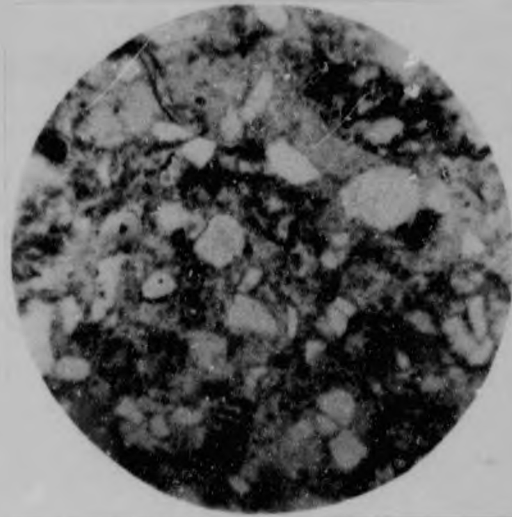
D. (Slide : 50). 37th Level, Far South Crossout.

Altered and carbonatised Bulawayan Doleritic Greenstone. Description on page 170 and 171 .
Plane Pol. Light, X 25.

PLATE XI.

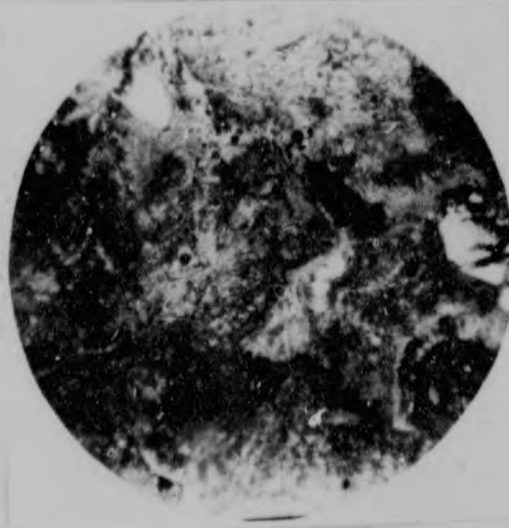


A. Contact Between Quartzite and Diabase.



B. Altered Greywacke.

C. Doleritic Greenstone.



D. Altered Doleritic Greenstone.

" SHALE ".

"Shale" is found in narrow and discontinuous beds in the Arkose, and along all lode channels which lie in the Sediments upon the Cam and Motor Mine, and is almost invariably an altered rock which is charged with Carbonate and Sulphide minerals.

As stated, the original texture of the shales has been largely destroyed, and the present nature approximates that of Slate and Graphite Schist. The infrequent occurrence in which the texture has been preserved consists of narrow (.1 inch to 2 inch) beds of medium to fine grained arenaceous nature, which alternate with very fine grained black Carbonaceous bands of similar width.

The coarser beds are seen to consist of sub-rounded Quartz grains with lesser Feldspar, lying in a ground mass of Carbonate minerals and Sericite with a small amount of Graphite, original mica and occasional Chlorite. The finer bands are composed of Graphite and other opaque minerals, very fine well rounded quartz grains, Chlorite and Sericite. The Graphite is abundant, but poorly dispersed, usually following bedding in discontinuous wisps.

The Shale beds in the Cam and Motor Mine are generally thin, seldom exceeding thirty feet in breadth, and averaging rather less than ten feet. Within these thicknesses the actual Shale content is perhaps only 10%, the remainder being composed of fine grained Arkose or Quartzite. These Shale beds grade into other sediments along strike and dip and greatly complicate Geological mapping as they are often the only formation upon which correlation may be based.

Of all the sediments exposed on the Mine, the Shales have been subjected to the greatest degree of hydrothermal alteration. This is due to their position as channelways for the ascent of the solutions which formed the Lodes and to intrusive bodies. In addition, dynamic metamorphism consisting of gliding along bedding planes and shearing occurred. Quartz and Carbonates were introduced along bedding planes, and were observed to have effected more complete replacement of the Arenaceous facies.

Impregnations along the walls and relicts within the Lodes, by pyrite, arsenopyrite and sulphides of Copper will be more fully discussed under the section on mineralisation. (Plate I - D).

The approximate mineralogical composition of the Shales (altered), as calculated by micrometric methods, is as follows:

Quartz..................	10% - 35%
Graphite................	15% - 60%
Carbonates..............	10% - 40%
Sericite and Mica......	1% - 10%
Chlorite and Sulphides.	0 - 5%

GREYWACKE.

Indefinite beds of Greywacke are seen on rare occasions, in the more massive portions of the Arkose. They resemble sheared Greenstones and usually consist of chips of Basalt and other lava with a little Quartz and Carbonate minerals. This rock type was highly altered where observed and little can be said of its original nature. (Plate II - B).

TH E BULAWAYAN IGNEOUS ROCKS.

Bulawayan lavas were intruded by sills and sheets of Dolerite and possibly other rock types. Although the nature of the intrusions is not always clearly defined, it is nevertheless often possible to see interelations between intrusive and extrusive types.

The lavas in the Mine are intruded by sheets of Dolerite of similar age, and have, as a rule, been altered and carbonatised to a considerable degree, but both Lava and Dolerites are surprisingly fresh as regards effects of dynamic metamorphism.

DOLERITIC GREENSTONE.

The Bulawayan Dolerites consist of sills and basal sheets which were intruded at approximately the same period as the extrusion of the lavas. They are usually altered to approximately the same extent as the Greenstones which they intrude, and it is often difficult to distinguish between Dolerite and Lava without the use of a microscope.

There are apparently two ages of Dolerite present in the Cam and Motor Mine-workings. For this reason, a number of specimens were prepared for thin section study, in an effort to find distinguishing features which would enable a relative age determination.

The older Dolerite (Greenstone) of Late Bulawayan age, is distinguished from the younger Dolerite by more altered nature, and lack of fresh pyroxene, and less definite ophitic texture. The most common texture observed in the Cam and Motor Mine is shown on Plate II-G and is seen to be Sub-Ophitic to Ophitic.

Slide No. 123 (Plate II-D); laths of altered Feldspar penetrate elongated Pyroxene, in a ground mass of altered Pyroxene and Carbonate minerals. Hornblende has replaced some of the Pyroxene. Fine reticulate masses of Leucoxene after Titaniferous Iron Minerals, and occasional Epidote are seen. In its present altered condition, this rock might be said to approximate to a Diabase.

Slide No. 50 (Plate II-D); a more altered specimen of the same nature shows a finer texture and contains hornblende and Carbonate Minerals, with considerably more Quartz and Chlorite. The original Feldspar appears to have constituted at least 50% of the rock, and has been saussuritised. Minor Leucoxene, Epidote and Sericite are present. This rock now approximates a Diabase.

Geometric analyses of the fresher Bulawayan Doleritic Greenstones are given on Page 22 .

PLATE III.

THIN SECTIONS : PHOTOMICROGRAPHS

AND

DESCRIPTIONS

PLATE XII. Descriptions of Thin Sections.

A. (Slide: 80). 23rd Level, Crosscut, Far West.

Altered Basaltic Greenstone.
Description on Page 173.
Crossed Nicol, X 80.

B. (Slide: 129). 35th Level. Far South.

Bulawayan Andesitic Greenstone.
Description on page 174.
Crossed Nicol, X 80.

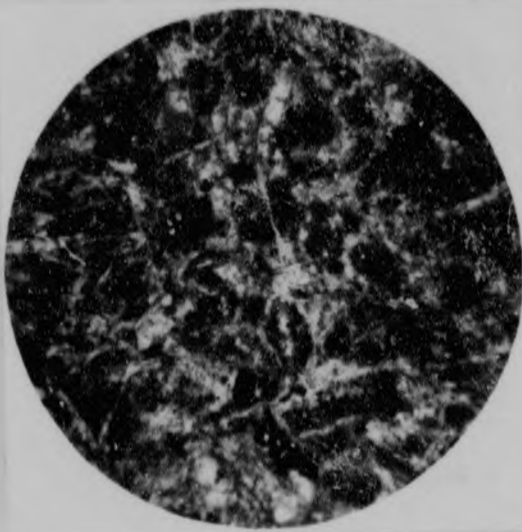
C. (Slide: 127). 34th Level, near Circular Shaft.

Bulawayan Andesitic Greenstone.
Description on page 174.
Crossed Nicol, X80.

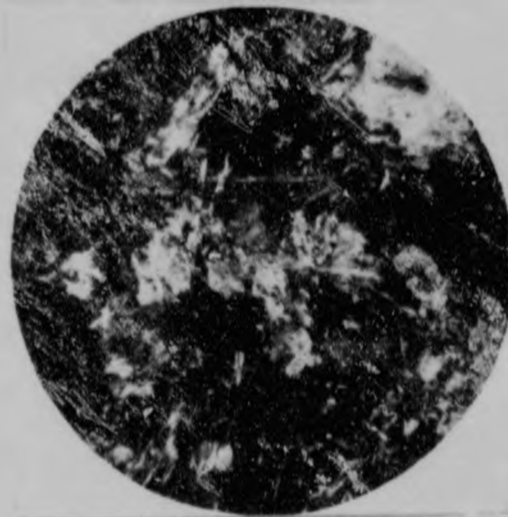
D. (Slide: 57). 37th Level. Cam Spur, Crosscut East.

Extremely altered Bulawayan Greenstone.
Description on page 175.
Crossed Nicol, X 80.

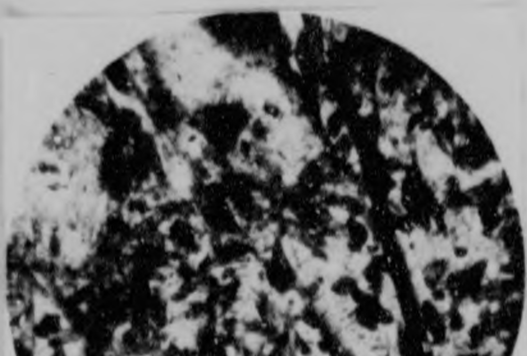
PLATE III.



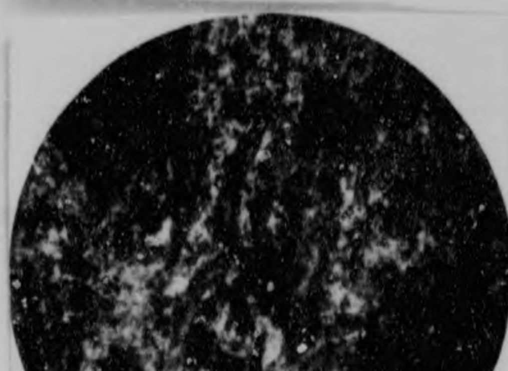
A. Basaltic Greenstone.



B. Andesitic Greenstone.



C. Andesitic Greenstone.



D. Extremely Altered Greenstone.

BASALTIC GREENSTONE

There are a variety of textures amongst the Basaltic Greenstones exposed in the Cam and Motor Mine, and Basalt was evidently the most abundant Lava extruded in this particular area during the period of Bulawayan Volcanic activity. Unfortunately, the high degree of carbonatisation which was experienced by the Greenstones, makes study difficult.

Minerals present in the Basaltic Greenstones are observed, in thin section, to consist essentially of Carbonate minerals, Chlorite, Serpentine, and a little Leucoxene and altered Feldspar. In some specimens, colourless Amphibole is present, and pseudomorphs original Augite. Serpentine appears to have replaced original stumpy Olivine crystals, while Plagioclase is replaced by Carbonate. The groundmass is usually composed of a glassy, pale network of long laths of altered Feldspar. Kaolin is seen in some instances, as is Leucoxene after Ilmenite or other Titaniferous Iron minerals. (Plate III-A).

ANDESITIC GREENSTONE

Andesitic Greenstone is nearly as abundant as that of Basaltic composition, and in some cases is exceptionally fresh and unaltered and is suitable for study in thin section, as the texture is often well preserved.

A most common type observed in the Andesitic Greenstones, is shown on Plate III-B. A "feathery" texture is exhibited and the mineralogical content consists of fine Orthopyroxene, Altered Plagioclase Feldspar, Uralite, Chlorite and Carbonate. The specimen shown on Plate III-B is exceptionally well preserved, as the usual Andesitic Lava of this type consists of little more than Carbonate minerals and Chlorite.

A second type is illustrated on Plate III-C. A Pilotaxitic texture is suggested; the ground mass consisting of fine microliths of altered Feldspar (Anhedral to Subhedral) which are penetrated by Hornblende. Carbonate minerals are present to the extent of 30% and a little Epidote has developed. In a few cases, Scapolite-filled vesicles are preserved.

The Andesitic lavas are usually extremely altered, carbonatised and chloritised, and when found in the vicinity of the Lode channelways, appear to have been rendered more schistose than are the Basaltic types.

TRACHYTE.

A Greenstone distinctly different from those described above, is on rare occasion seen in the Cam and Motor Mine. Although highly altered and carbonatised where observed, it nevertheless shows the signs of flow structure. This rock is perhaps a Trachyte, as some of the longer Feldspars are arranged parallel.

Another Greenstone, consisting almost entirely of Quartz, Carbonate minerals, and Sericite was observed on rare occasions. It appears to have consisted of Feldspar and Amphibole in a "glassy" groundmass, and may have been a Dacite.

The hydrothermal alteration of the Bulawayan Greenstones is discussed in the Chapter on Mineralisation, and it will suffice to say that Carbonate Mineral content of lavas is usually a definite indication of the relative proximity of the Lode or Intrusive body. An extremely altered Greenstone is shown on Plate III-D, and is seen to consist entirely of Chlorite, Carbonate Minerals and Quartz, with a small amount of introduced Sulphides. Analyses of Greenstones are given on Page 17.

IGNEOUS INTRUSIVE OF POST BULAWAYAN AND PRESUMABLY LATE ARCHEAN AGE.

An intrusion of the Dolerite and Diabase of Post Bulawayan age appears to have occurred at a relatively short time before the initial mineralisation of the Lodes in the Cam and Motor Mine. This view is supported by the observation that all Diabase dykes and bodies which occupy lode channelways are traversed or penetrated by the latter lodes, and that the lodes in these bodies appear to have experienced practically the same amount of fracturing and other stresses as did the intrusive.

It is generally accepted that the bulk of the mineralisation of the Lode Gold deposits, lying in the Pre-Cambrian formations of Southern Rhodesia, occurred at some late stage in the intrusion of the "Younger Granites and Gneisses" (see Stratigraphic Table, page 8), and would place the age of mineralisation in the Late Archean.

There can be little doubt that the later intrusion of Dolerite and that of the later Diabase which occur in the Cam and Motor Mine are of like age. This is illustrated on the Plan of the 38th level of the mine. In this exposure, a relatively large irregular body of Dolerite lies to the South of the Western end of the Main Fold, being bounded on three sides by Bulawayan Sediments. The main body of Dolerite showed characteristic ophitic texture, whereas specimens from the small dykes were typical Diabase which exhibited a fine porphyritic texture, soon after entering the sediments.

In other instances where dykes of Diabase intruded the sediments, a definite intrusive contact was often observed (Plate II - A). Instances of meta-dolerite invasion into Bulawayan Greenstones, however, do not often show intrusive contacts, and are difficult to detect, and the intrusive appears to "grade" into the earlier rock.

DOLERITE.

Dolerites of this age are distinguished from those of Bulawayan age by several criteria. The later Dolerite is almost invariably the fresher appearing and has a much more definite ophitic texture than its earlier counterpart. The forms of the Late Archean Dolerite intrusions are irregular bodies and relatively large sheets and dykes.

A further hint as to age relations may be observed in the form assumed by some of the larger irregular intrusions, such as the one in the vicinity of the Circular Shaft shown on the plans of the 30th and 32nd levels. From the shape of this body alone, its age is indicated as Post-Apex Faulting.

The first of the following descriptions concerns a typical, fresh, Late Archean Dolerite from the 32nd level of the Cam and Motor Mine. The second description is of a specimen collected from a surface outcrop some four miles to the Southwest of Eiffel Flats, and is included in this section for the purpose of illustrating the similarity with the first specimen.

Slide No. 45 (Plate IV-A) is a relatively unaltered Dolerite from an intrusive body of irregular shape. A typical ophitic texture is exhibited. The rock consists of approximately 55% of fresh and unaltered Andesine Feldspar, and Orthopyroxene in the form of Hypersthene is present to the extent of 32%. About 10% of Hornblende is seen and lesser amounts of Leucoxene, Epidote, Chlorite and Carbonate minerals are present.

Slide No. S-1 (Plate IV-B) is a fresh Dolerite collected on the surface and strongly resembles the specimen described above. Coarse laths of Labradorite Feldspar penetrate and enclose Orthopyroxene, and are seen to be lying in a ground mass of fine Plagioclase and Pyroxene with lesser Epidote. Considerable Leucoxene is observed, and a minor amount of Chlorite is present.

PLATE IV.

THIN SECTIONS : PHOTOMICROGRAPHS

AND

DESCRIPTIONS.

PLATE IV. Description of Thin Sections.

A. (Slide: 45). 32nd Level, Crosscut to Circular Shaft.

Late Archean Dolerite.
Description on page 178.
Plane Pol. Light, X25.

B. (Slide: S-1). Surface Outcrop.

Fresh Dolerite.
Description on page 178.
Plane Pol. Light, X 25.

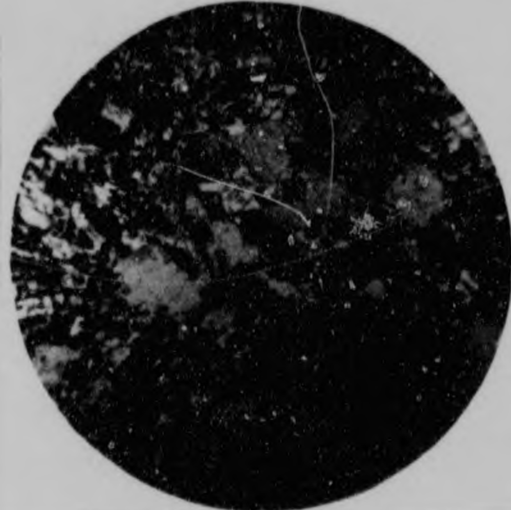
C. (Slide: 54). 37th Level, Footwall "A" North.

Highly altered Diabase.
Description on page 183.
Plane Pol. Light, X 25.

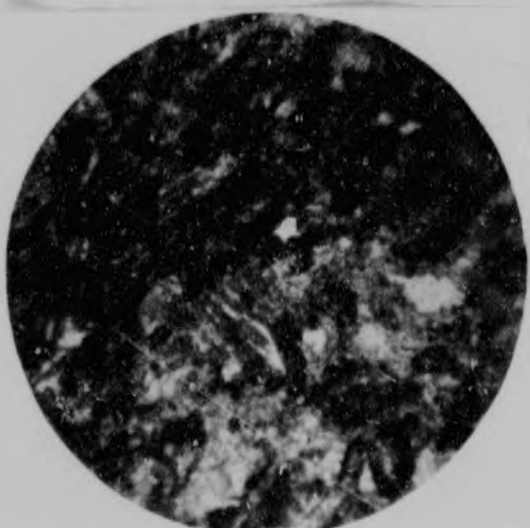
D. (Slide: S - 2). Surface Outcrop.

Dolerite.
Description on page 184.
Crossed Nicol, X 25.

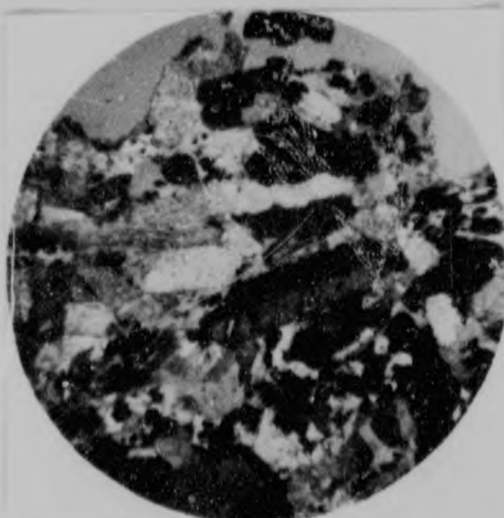
A. Late Archean Dolerite.



B. Fresh Dolerite From Surface.



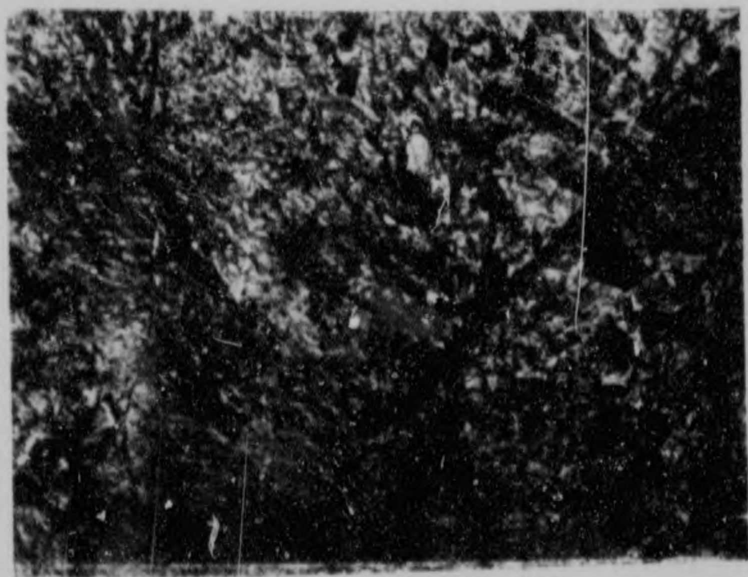
C. Highly Altered Diabase.



D. Dolerite From Surface.

DIABASE.

These rocks designated as "Vein Intrusives" are here discussed as Diabases, and were seen to occur as small dykes in Lode channelways and zones of weakness, and were occasionally observed healing brecciated Sediments and Greenstones.



DIABASE HEALING BRECCIATED BULAWAYAN SEDIMENTS : CAM AND MOTOR MINE.

Zealley, A.E.V. Bulletin 5, Southern Rhodesia Geol. Survey 1918.

The Diabase which occurs along the Lode channelways has been altered, Carbonatised and Sericitised to a high degree, through hydrothermal alteration during the formation of the Lodes, and through shearing caused by movements along the channelways which occurred after their intrusion.

In contrast to the Dolerites of like age, which show ophitic texture, the Diabase is of a finely porphyritic nature.

Slide No. U-13 (Plate II-A) consists of two rocks; the portion to the right being Diabase, and the left hand being impure Quartzite of Bulawayan age. Both types contain a considerable amount of Carbonate minerals. The Diabase is observed to form an intrusive contact with the Quartzite and to contain a small amount of pyrite near the contact.

The Diabase is so severely Sericitised that the texture is virtually obliterated. Nevertheless, it resembles nearly all the exposures on the Cam and Motor Mine. Some crystals of Saussurite exhibit a form remnant of Feldspar, and Carbonate minerals may be seen pseudomorphing stubby crystals that were probably original Augite. In its present state, the rock is little more than an extremely altered minor intrusive, and except for its proximity to the major intrusive body of later Dolerite the particular level from which it was collected, its origin would be questionable.

Slide No. 54 (Plate IV - C) is an extremely altered and carbonatised specimen which may be said to show the usual characteristics of the Diabase found in the vicinity of the Lodes in the Cam and Motor Mine. A remnant of Sub-ophitic texture is suggested, but the rock now consists largely of Chlorite, Carbonate minerals and a little Quartz and Leucoxene.

IGNEOUS INTRUSIVE OF POST BULAWAYAN AGE: EXACT AGE UNKNOWN.

Wiles[26] shows Meta-dolerite to be present in an area some few miles to the Northwest of the Cam and Motor M[illegible]s outcrop was not examined by the writer.

DOLERITE AND PERIDOTITE.

Dolerite and Peridotite of unknown age were examined by the writer in an area not shown on the Surface Map, lying about five miles Southwest of the Cam and Motor Mine. Thin sections of these rocks were prepared, and

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26. Wiles, J.W., op. cit.

studied in an effort to relate them with one or other of the ages of Dolerite observed in the underground workings on the Cam and Motor Mine. A thin section of the Dolerite is given below. Its similarity to the coarser Dolerites of Late Archean age is impressive.

Slide S-2 (Plate IV - D) is a relatively coarse Dolerite with definite ophitic texture. Labradorite to Andesine Feldspar constitutes approximately 50% of the volume, and is seen as long laths penetrating Pyroxene. Hypersthene is present to the extent of 35% and sometimes exhibits Schiller lustre. Leucoxene with Titaniferous Iron minerals occurs and little Carbonate mineral is seen.

Slide S-3 (Plate V-A) is a peridotite which occurred in the same intrusive body as the foregoing Dolerite. It consists of about 60% of Olivine, which is being altered to Serpentine and is sometimes surrounded thereby. Some of the Olivine crystals lie in larger masses of Pyroxene and show Poikilitic texture. The Pyroxene present is a Hypersthene which is low in iron and constitutes about 30% of the total volume of the rock. Some 2% of Phlogopite is present, and a little iron ore is seen. The composition of this rock approaches that of a Harzburgite.

All rock types in the Eiffel Flats area are of Pre-Cambrian age insofar as is known. There is a possibility that certain of the Dolerite dykes which were studied by Wiles may be proven to be of Great Dyke and/or Karroo age, when his (Wiles') forthcoming Bulletin on the Hartley District is completed.

PLATE V.

THIN AND POLISHED SECTIONS PHOTOMICROGRAPHS

AND

DESCRIPTIONS.

PLATE V. Description of Thin and Polished Sections.

A. (Slide: S - 3). Surface Outcrop.

Peridotite.
Description on page 184.
Crossed Nicol, X 25

B. (Slide: 15). 39th Level. Shaft Station.

Sheared and carbonatised fine grained impure Quartzite, Angular to sub-rounded Quartz grains lie in Carbonate, Sericite and Graphite matrix. The larger dark areas are clay minerals replacing Feldspars. Carbonate glide planes have developed and the matrix contains about 1% of Pyrite. Crossed Nicol, X80.

C. (Polished Section Xm - 30). 23rd Level. 715 Lode.

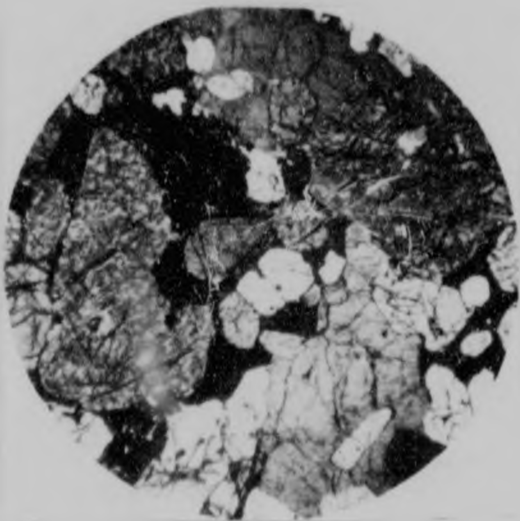
Quartz-Carbonate Ore, containing : Gold, Tetrahedrite, Pyrite and Arsenopyrite.

The left side of the illustration, a very fine sinuous fracture follows wispy Carbon, and is mineralised with Arsenopyrite.

The dark lines to the right of the centre are phantom structure of bedding planes in replaced Graphitic Shale, some of which contains late Quartz and Gold.

At the far right, Tetrahedrite fills fractures and replaces Gangue, and is associated with coarse Gold. Ordinary Light, X 2.

PLATE V.



A. Peridotite From Surface.

B. Hydrothermally Altered Sediment.

C. Quartz Carbonate Ore with Carbonaceous Relicts and Copper Sulphides.

CHAPTER X

MINERALISATION.

The general characteristics and basic differences between the mineralisation of the various Lode groups has been described in the Section entitled "Lode Characteristics". In the section referred to it was shown that the peculiarities of each particular Lode group were largely dependent on the host rock type encountered. Consequently, the Lode groups herein described will be classified as to the type of rock which their channel occupies. All mineralisation upon the mine is of mesothermal classification.

A. Lodes located in the Interbedded (Bulawayan) Sediments.

B. Lodes located in the Bulawayan Greenstone Series.

LODES LOCATED IN THE INTERBEDDED SEDIMENTS.

The great majority of the lodes which are located in the Interbedded Sediments are almost invariably payable only when the channel lies in beds of Carbona-

— CAM AND MOTOR GOLD MINE —

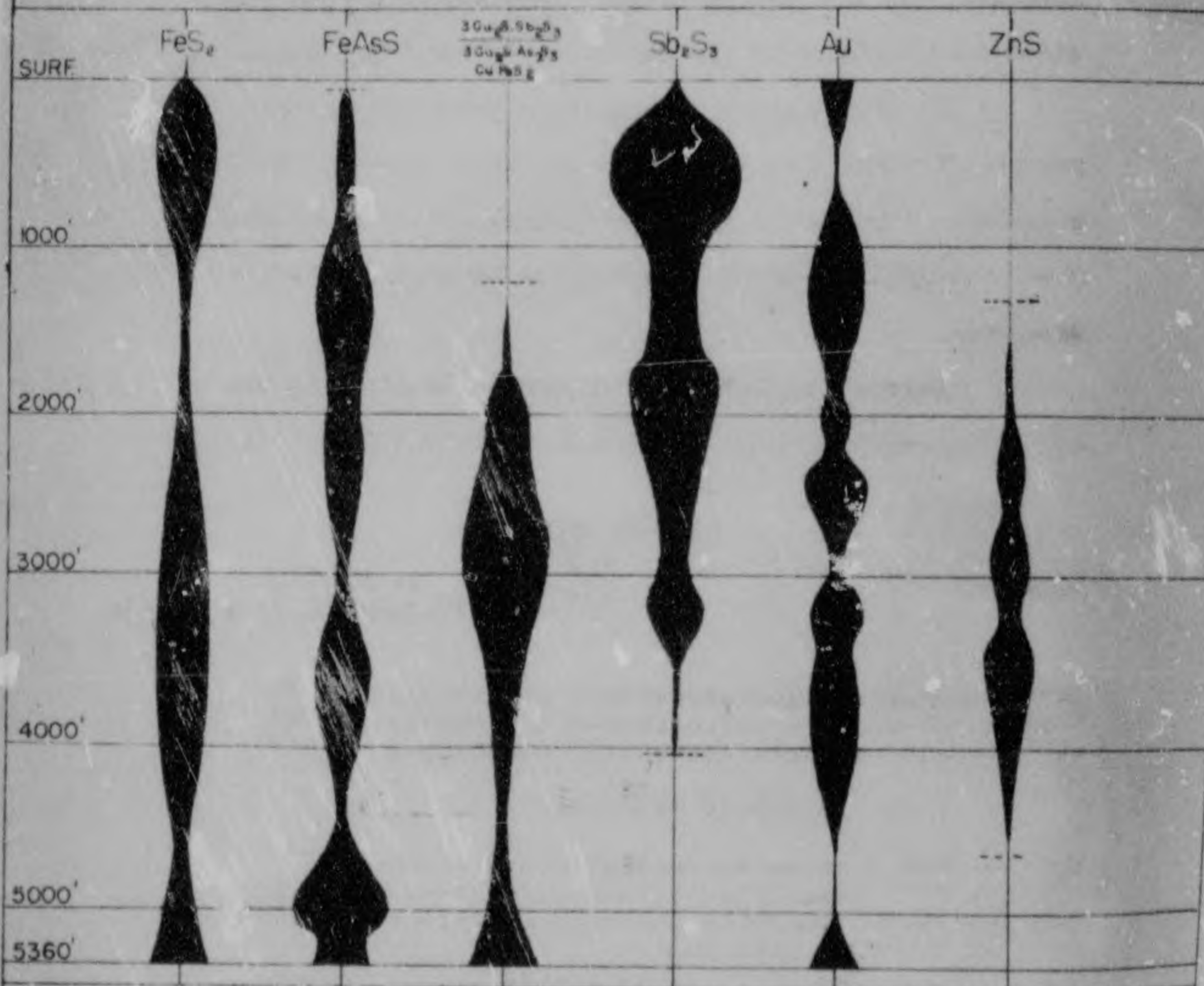


DIAGRAM ILLUSTRATING VERTICAL DISTRIBUTION AND RELATIVE FREQUENCY OF GOLD AND SULPHIDE MINERALS

RATIO APPROXIMATELY: 1 DWT./Au = .1% SULPHIDE

Min. - 1

ceous Shale and hydrothermally and/or dynamically altered products thereof. The individual lodes in this category are the Motor, Centre, Footwall "A" and incidental portions of the Footwall "B" and Cam Spur.

As the general information relative to the nature of these Lodes has already been stated, the data below are restricted to those characteristics of the ores and Wall Rocks as observed in thin and polished section.

Gangue and Metallic Minerals observed in the Lodes located in the Sediments include the following:

GANGUE MINERALS.

Mineral.	Proportion (By Volume: Estimated).
Quartz	80.00%
Carbonates	16.00%
Carbon	2.00%

METALLIC MINERALS.

Pyrite (FeS_2)	0.20%
Arsenopyrite (FeAsS)	0.20%
Tetrahedrite-Tennantite ($3\ Cu_2S\ Sb_2A_3$ with As)	0.05% (?)
Sphalerite (ZnS) less than	0.05%
Chalcopyrite ($CuFeS_2$) less than	0.05%
Bornite (Cu_5FeS_4) less than	0.05%
Gold (Au)	Variable
Stibnite (Sb_2S_3)	Rare
Scheelite ($CaWO_4$)	Upper levels
	Very Rare.

QUARTZ.

The Quartz of the Lodes located in the Sediments (and in the Wall Rocks), is perhaps best described as a dull grey to white Quartz, usually in a rather coarse aggregate with the various Carbonates, giving it a mosaic-like appearance in thin section. The grey colour has been observed to be a result of fine wispy Carbon which was incompletely replaced. In other cases, there is rather less than 10% of actual Carbonate inthe Lodes, and it is in these sections of the Lodes that little in the way of metallic minerals appear to have been deposited. Where wholesale replacement of Shales has occurred, as upon the Centre Lode at the 19th (2250 ft.) level, great relicts of Arkose (Plate V - B) with lesser Shale were observed to contain up to 40% of Carbonates, while the introduced Quartz content was less than 5%. Quartz does not appear to have penetrated the walls of the Lodes to any considerable distance, but is often seen lying along bedding and shear planes therein. As previously mentioned, the hanging wall of these lodes is almost invariably a very smooth slipped plane of high Carbon content, with the foot wall less distinct. In a few occasions, Branch Lodes have followed minor Fault structures into the hanging wall, and the Shales thus crossed show closely spaced injections along bedding planes.

At least three ages of Quartz are recognised, one of which was the earliest form of mineralisation on the Mine. A second age of Quartz with Carbonates is seen forming the greater portion of the Gangue, and a third late stage of Quartz in the form of minute veinlets, healing fractures (in its earlier counterparts) and containing native Gold is observed.

CARBONATES.

The Carbonates in the Lodes located in the Sediments consists of Ankerite and Calcite with minor amounts of other common members. As stated, it is seen to occur in a mosaic-like structure with the Quartz, making up about 16% of the total volume of the Lodes.

The replacement of the rocks was largely dependent upon carbonate content of the Lodes, ~~as~~ far as the arenaceous facies are concerned, portions of Lodes in the Sediment which lie in Arkose, being intensely carbonatised along the walls. The loss of this carbonate to the host rock greatly increases the percentage of Quartz present in the Lode proper, as very few cases of actual silicification of Sediments has been observed.

A very large number of small veinlets of Carbonate are seen in the walls of the Lodes and in a few cases, these veinlets have been seen to cross from hanging to foot wall, actually cutting the earlier Quartz-Carbonate replacement body. This is an indication that the bulk of the minor Carbonate veinlets which do not contain much Quartz, are of a distinctly later period of mineralisation than that which produced the Carbonates of the Lodes.

No association of metallic minerals with the late carbonates has been noted, but as is indicated by thin section study, there can be little doubt that the Arsenopyrite was associated with the replacement of the Quartz-Carbonate period.

CARBON.

The Carbon in the Lodes located in the Sediments consists of relicts of incompletely replaced carbonaceous Shale, and is present in variable proportion. In general, the proportion of this Carbon may be said to be directly dependent upon the degree of replacement suffered by the rock in any particular location. This would in turn, depend upon the width of the original channel, the amount of carbonaceous Shale lying within the path of the solutions, and the nature of the hanging wall as regard permeability.

In richer portions of the Lodes, the Carbon plays an important role, as it is very often seen to be surrounded by the cupriferous sulphides and by native Gold. The relicts in such a case as quoted, usually consist of thin, discontinuous partings within the Quartz-Carbonate Gangue, located near the hanging wall. These partings, in general, do not exceed one inch in width, and are almost always aligned with the walls of the Lode, giving a banded appearance. In the leaner sections of the same Lode at the identical horizon, large relicts of Shale and Arkose may occupy portions of the channel, but it would appear that only the lesser Carbon relicts played an important part in the actual sulphide mineralisation.

Aside from the Shale relicts of microscopic size, innumerable minute wisps of Carbon are nearly always visible in Quartz-Carbonate Gangue of payable ores, giving the body a greyish to nearly opaque tint, at times. Although the occurence of Gold and cupriferous sulphides is definitely related to the presence of relicts in the Lodes, the assumption that there has been a definite chemical precipitation by Carbon (of Gold and base metal sulphides) would not necessarily follow. If precipitation by the Carbon actually occurred, it is equally probable that it was physical, rather than chemical, in nature.

In observations on the 23rd (2797 ft.) level, of the very rich 715 (Footwall "A") Lode (Plate V - C) it has been indicated that the presence of Gold and sulphides of Copper in an around relicts of carbonaceous Schist is a result of re-opening and adjustments along the channel, which caused planes of weakness to be created in the vicinity of these relicts. If the adjustment were, in fact, largely horizontal (as appears to be the case), there is a definite possibility that some of the resultant movement might have occurred along the aligned relicts. On the other hand, mineralisation of cupriferous sulphides is almost completely confined to the occurences with Carbon, and it is also noted that Arsenopyrite and Pyrite are seen in abundance in the relicts, whereas their presence in the Quartz-Carbonate Gangue is sparse and irregular.

PYRITE.

Pyrite (FeS_2) is always present in the ores of the Lodes found in the Sediments. As regards the metallic minerals, the Pyrite was, without doubt, the earliest to be precipitated. This is shown in several of the thin sections, as well as the polished sections. It is also indicated that there were at least two distinct periods of Pyrite mineralisation, as some of the Pyrite appears to have appeared in the very early stages of the replacement, and is corroded, replaced, and retains little crystal form. Other Pyrite is of a similar age to the Arsenopyrite, being only infinitesimally earlier than the latter. This would place the Pyrite in the category of an associate of the Quartz-Carbonate period of replacement. Fine Pyrite (and Arsenopyrite) can nearly always be seen in small amounts in the Quartz-Carbonate when viewed in thin or polished section, but reaches macroscopic size only when impregnating the walls or relicts. Common forms observed are intergrown aggregates, rough cubes, pyritohedra and amorphous grains. (Plate VI - C).

In several cases, Arsenopyrite and Pyrite are found occurring together, in general the Arsenopyrite appears to be slightly later than the Pyrite, and is often seen replacing the latter. Pyrite of two distinct periods has been observed in the same specimen, part of the Pyrite appearing very fresh and exhibiting cubic crystal form, while accompanying Pyrite is corroded and partly replaced by Carbonates. (Plate VI - A).

In diagram Min-1, Pyrite is shown to persist from the surface to the lowest working level of the Mine. In the zone from a depth of 900 feet to 2000 feet, a lower percentage of Pyrite was present than the usual hypothetical proportion of 0.20%. This was also observed in the zone from 4400 feet depth to 5000 feet, and is not confined to those Lodes in the Sediments, but applies to all Lodes upon the Cam and Motor Mine. No explanation of this phenomena is applicable in the case of the upper zone, but in the lower zone it has been observed that all Lodes lacked metallic minerals thereat, and that the Lodes consisted of a greater proportion of Carbonates in comparison with the usually predominant Quartz.

PLATE VI

THIN AND POLISHED

SECTIONS

PHOTOMICROGRAPHS

AND

DESCRIPTIONS

PLATE VI. Description of Thin and Polished Sections.

A. (Slide : U - 12). 19th Level Motor Lode, South.

Altered carbonatised and mineralised Arkose. The rock consists of sub-rounded Quartz grains and altered Feldspar in a groundmass of fine grained quartz, Carbonate minerals and Sericite. Pyrite of two ages is seen, some of which surrounds and replaces Quartz grains. The rock contained about 8% of Sulphide minerals, largely Pyrite and Arsenopyrite. Plane Pol. Light, X 25.

B. (Polished Section XM - 3). 23rd Level, Footwall "A" Lode.

Chalcopyrite (light grey) is seen replacing Tetrahedrite (dark grey), while the Arsenopyrite (white) remains relatively unaltered. Small "Gash Veins" of Chalcopyrite are in the Tetrahedrite to the right. Plane Pol. Light, X 14.

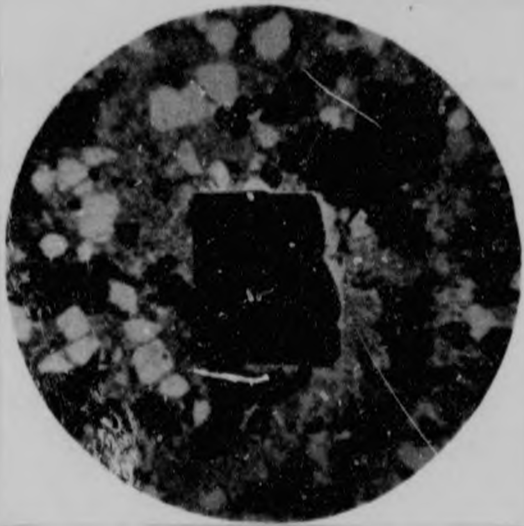
C. (Polished Section XM - 11). 39th Level, Footwall "A" Lode.

Gold associated with older Pyrite, in Quartz. Small inclusions of Quartz are present in the Pyrite. Ordinary Light, X 120.

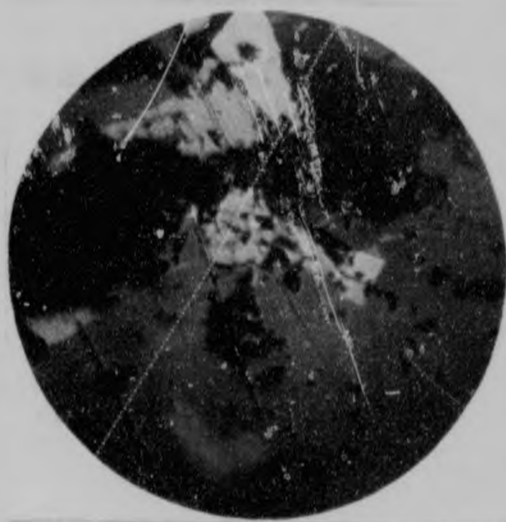
D. (Polished Section XM - 1). 23rd Level. Cam Spur, Far South.

Corroded euhedral crystals of Arsenopyrite with Pyrite in carbonatised and silicified Graphitic Slate. In the centre of the Photo, Arsenopyrite is replacing Pyrite. (Plane Pol. Light. X 50).

PLATE VI.



A. Pyrite of Two Ages in Arkose.



B. Arsenopyrite with Chalcopyrite and Tetrahedrite.

C. Gold associated with Coarser Pyrite.

D. Arsenopyrite in Earlier Pyrite.

ARSENOPYRITE.

Arsenopyrite (FeAsS) of two ages is equal in abundance to Pyrite in the Lodes in the Sediments, but it is present in lesser proportion than in the Lodes located in the Greenstones. As stated, the Arsenopyrite was most probably the next mineral to precipitate after the Pyrite. It is often found with (and replacing) the Pyrite and in earlier than the earliest of the cupriferous sulphides. Like the Pyrite, Arsenopyrite is found in fine crystalline aggregates in the walls, and around the relicts of wall rocks within the Lodes. The most common form of crystallisation observed, is Euhedral crystals consisting of the (pseudo) Ortherhombic prism and Basal Pinacoid. Twin groups are not scarce and twinning producing the usual prismatic form is on (100) and (0[illegible]). Cruciform groups and combined forms are not uncommon (Plate I - D).

Crystals are well formed and lustrous white in colour being generally of small (less than .05 inches) size and forming an intergrowth with the quartz-Carbonate Gangue at places where the wall rock has been incompletely replaced. In a few cases, crystals up to .25 inches were observed, and are considered to be of later age than the fine altered masses in the Gangue. Pyrite was, as stated, of earlier origin than the early Arsenopyrite, and in no instance was the former seen to be replacing the latter. Numerous cases of the reverse were observed. (Plate VI - D). In nearly all instances, one or more of the faces of the crystals of Arsenopyrite are corroded and partially replaced, while other faces remain fresh. It was often observed in both thin and polished section that the faces of the crystals which were corroded, lay along minute cracks which were filled with later Quartz and Carbonates. Certain of these later Quartz veinlets cross and cement prisms of Arsenopyrite which were broken into two or more parts.

In the relicts of carbonaceous Shale within the Lodes, highly altered but incompletely replaced Arsenopyrite of irregular outline lies within and about the bodies of Copper sulphides, and rarely within bodies of native Gold. (Plate VI - B). Little Pyrite has been observed in like circumstances. This would indicate that the Pyrite was susceptible to replacement by the later solutions which produced the cupriferous sulphides, while the Arsenopyrite was more resistant. Other indications of this feature and of the relative age of the Pyrite and the Arsenopyrite, will be discussed in the section dealing with the mineralisation of Lodes in the Greenstone series.

There is no distinct "depth zoning" as regards relative abundance of Arsenopyrite in the Lodes in the Sediments, and as noted on Diagram Min-1, this mineral was encountered throughout the entire vertical range of the Mine, although oxidised above depths of 100 feet. The situation is somewhat different, however, in the case of the Lodes located in the Greenstones.

TETRAHEDRITE-TENNANTITE.

Tetrahedrite-Tennantite is the most abundant of the cupriferous sulphides and is found to be associated with carbonaceous wall rock relicts located in the Lodes. Oddly enough, no occurrence of this mineral was noted in the walls of the Lodes.

In no instance has any crystalline form of Tetrahedrite-Tennantite been observed, its occurrence being as compact masses and irregular grains. With two notable exceptions, this mineral is found only in the richer portions of those lodes located in the Sediments.

The largest individual masses of this mineral which have been observed on the Cam and Motor Mine, occurred in the rich 715 (Footwall "A") Lode on the 23rd (2797 ft.) level at a point 75 feet North of the intersection of the Lode with the Northern Apex Fault. Here, the mineral lies along a narrow (.01 inch to 3 inch) relict of altered and incompletely replaced carbonaceous Schist which lies in Quartz-Carbonate, parallel to and some 15 inches below the hanging wall of the body. Rather than lying entirely in the relict, the Tetrahedrite-Tennantite (and associated sulphides) was observed to form a discontinuous line which either occupied one or the other of the relict's contacts with the Quartz-Carbonate, or cut across the relict at a low angle. At places where the relict had been more completely replaced, and represented little more than a parting in the Quartz-Carbonate, a very fine line of sulphides was produced. Although the Tetrahedrite-Tennantite is the most abundant of the metallic minerals present in the relict in this location, it is accompanied by considerable amounts of other sulphides. Most abundant amongst the associated minerals is Sphalerite, which is earlier, than the Tetrahedrite-Tennantine and has been observed to be veined thereby (Plate VII -A-B).

Next in abundance is Chalcopyrite which, in turn, veins the Tetrahedrite-Tennantite (Plate VII - C). Gold is associated with late Quartz veinlets and sometimes surrounds a small mass of Tetrahedrite-Tennantite or other sulphide of Copper (Plate VII - D). Small fractures in the Quartz-Carbonate Gangue near the relict are also healed with late Quartz and Gold, and several of these minute Quartz veinlets were observed to cut the Tetrahedrite-Tennantite as well as all other minerals. Arsenopyrite occurs as ragged, corroded grains, generally lacking crystal outline, and has been noted as rounded inclusions within the Tetrahedrite-Tennantine. Pyrite was conspicuously absent, and if present originally, was apparently completely replaced.

The most striking exception to the rather exclusive occurence of the Tetrahedrite-Tennantite in the Lodes in Sediments, was observed on the 39th (5360 ft.) level, where the mineral accompanied coarse Gold in the later Quartz veinlets which are healing and replacing the highly shattered Motor East Lode, located entirely in the Greenstones. Very fine wispy Carbon, however, occurs in the Quartz-Carbonate Gangue of this Lode, and there is a possibility that the downward continuation of development now in progress, will expose Sediments. A small amount of Sphalerite and Arsenopyrite were noted in a polished section from this Lode. (Plate VII - D).

A small Lode was encountered in cutting the circular Shaft station on the 30th (3560)ft. level, and contains the same suite of minerals noted in the description of the 715 Lode, with the exception that less than 2 Dwt of Gold and up to 15% of sulphides were present. This Lode lies in carbonaceous Shale. (Plate VI-D).

No Tetrahedrite-Tennantite was observed above the 10th (1115 ft.) level of the Mine, but Copper staining of the Lodes located in the Sediments (near the surface) are an indication that sulphides of Copper were present before oxidation.

PLATE VII.

POLISHED SECTION

PHOTOMICROGRAPHS

AND

DESCRIPTIONS ,

PLATE VII. Description of Polished Sections.

A. (Polished Section : XM-7). 30th Level. Circular Shaft.

Veinlets of Tetrahedrite-Tennantite (white) traversing and replacing earlier Sphalerite. Ordinary Light, X 25.

B. (Polished Section: XM - 20). 21st Level. Centre Lode.

Veinlets of Tetrahedrite traversing earlier Sphalerite. The veinlets has "matching" walls, and does not replace the Sphalerite, but cuts the Quartz-Carbonate Gangue. Ordinary Light, X 25.

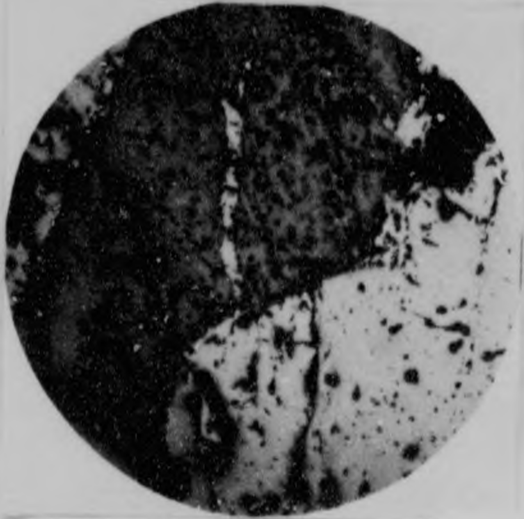
C. (Polished Section: XM-13). 21st Level. Footwall "A" Lode.

Veinlets of Chalcopyrite (white) traversing and replacing earlier Tetrahedrite-Tennantite. Arsenopyrite is seen on the upper right. The Gangue is Quartz. Ordinary Light, X 25.

D. (Polished Section XM - 11) 39th Level. Footwall "A" Lode.

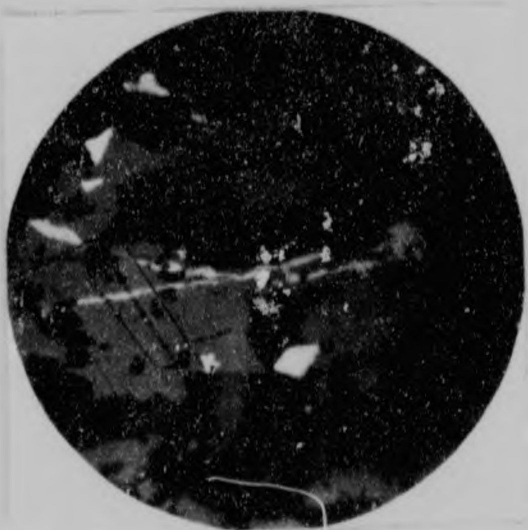
Gold encloses rounded globule of Tetrahedrite -Tennantite. The Gangue is Quartz. This is Gold of the late Gold-Quartz period, and can be seen following fractures. Ordinary Light, X 14.

PLATE VII.

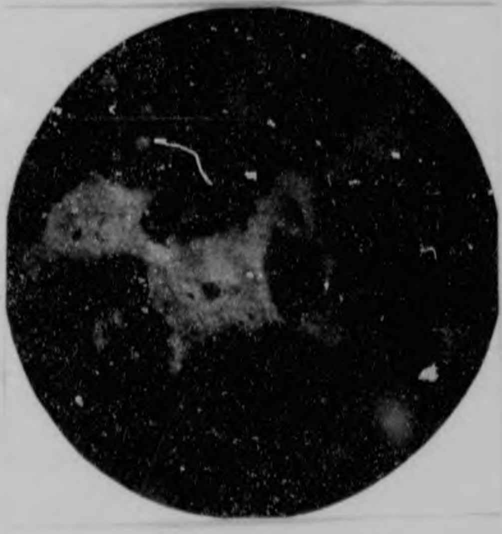


A. Tetrahedrite Vein [illegible] Earlier Sphalerite [illegible] Quartz.

B, Tetrahedrite Veining Sphalerite.



C. Chalcopyrite Veining Earlier Tetrahedrite.



D. Gold Surrounding Tetrahedrite.

SPHALERITE.

Sphalerite is not nearly so abundant as is Tetrahedrite-Tennantite, as there are numerous occurences of the latter without the former. In no case has Sphalerite been observed, independent of the sulphides of copper, upon any of the Lodes located in the Sediments. No crystal form was noted in the Sphalerite, and it was observed to occur as irregular masses and as coarsely granular aggregates, usually somewhat rolled. From the age relations stated before, it appears that Sphalerite was not directly associated with any other sulphide mineral.

Tetrahedrite-Tennantite veinlets are often observed cutting across the Sphalerite, and the latter is at times being replaced by the former. (Plate VII-A).

Sphalerite was not observed above the 12th (1430 ft.) level, and was not present in appreciable quantities between depths of 4400 and 5100 feet.

CHALCOPYRITE AND BORNITE.

Chalcopyrite ($CuFeS_2$) and Bornite (Cu_5FeS_4) have been stated to occur only at locations where Tetrahedrite-Tennantite has been observed. No exceptions to this rule are known. As in other Copper Sulphides, no crystalline form has been observed in Chalcopyrite, and the usual occurence upon the Lodes located in Sediments is as compact masses and veinlets. Bornite is associated with the Chalcopyrite, though not always present, and no difference in age of mineralisation has been suggested. (Plate VIII - A).

In a number of instances, veinlets of Chalcopyrite are found cutting across earlier Tetrahedrite-Tennantite, but in no case has the reverse been observed. This leaves little doubt as to their relative ages.

Chalcopyrite has not been observed to be directly associated with Gold, and the period of mineralisation which produced the later Gold is believed to have been only slightly later than that which produced the Chalcopyrite.

These minerals have the same vertical distribution and affinities as does the Tetrahedrite-Tennantite.

GOLD.

Gold (Au) is seen only in native form, and is believed to have been deposited during at least two different stages. Its associations are manifold, but its relative frequency of occurence is believed to be limited by several particular circumstances, in the case of the Lodes in the Sediments upon the Cam and Motor Mine.

No hint of crystalline form has been recorded, the Gold being of massive nature and assuming lammelar, tabular and granular form. It often occurs in veinlets and plates, usually with the latest Quartz. "Invisible" *Gold is beyond doubt present in the Pyrite, Arsenopyrite, and at times in the Stibnite, being very finely divided and more or less regularly distributed.

The "Invisible" Gold is estimated to be present in the bulk of the Ore to the extent of perhaps 2 Dwt., being largely associated with the early stages of mineralisation which produced the majority of the Arsenopyrite. The presence of Gold in the very early Quartz-Pyrite period is unquestioned, but it is believed to be in much smaller proportion than the Gold-Arsenopyrite-Quartz-Carbonate association.

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* "Invisible" Gold refers to Gold in very finely divided state in Sulphide minerals, but not chemically combined.

PLATE VIII

THIN AND POLISHED SECTIONS

PHOTOMICROGRAPHS

AND

DESCRIPTIONS.

PLATE VIII. <u>Descriptions of Thin and Polished Sections.</u>

A. (Polished Section XM-13) 21st Level.
Footwall "A" Lode.

Chalcopyrite (light) and Bornite (dark) in Quartz. This may represent exsolution. Ordinary Light X 25.

B. (Polished Section XM -11). 39th Level.
Footwall "A" Lode.

Tetrahedrite-Tennantite (light grey) is being replaced by Gold, (centre of Photo). The Gangue is Quartz. A small fracture in the earlier Quartz cuts Tetrahedrite-Tennantite and contains fine Gold and later Quartz. Ordinary Light. X 25.

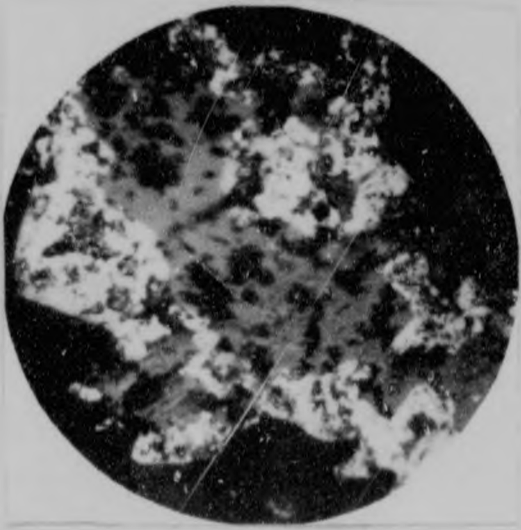
C. (Slide : 14). 39th Level. Shaft Station.

A small (.015") Quartz-Carbonate veinlet containing Arsenopyrite traverses highly carbonatised Greenstone. The Greenstone contains fine Pyrite and Arsenopyrite. Crossed Nicol, X 25.

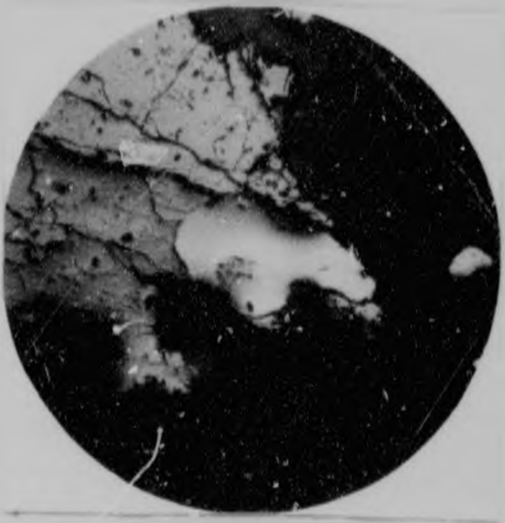
D. (Slide : 81). 23rd Level. Crosscut West,

Fine Quartz-Carbonate veinlets traverse an extremely carbonatised rock which appears to have been an Andesitic Lava. Dendroids of an unknown black mineral follow cleavage planes in the Calcite. (They probably are MnO_2).
Plane Pol. Light. X 25.

PLATE VIII.



A. Bornite in Chalcopyrite.



B. Gold along Fracture in Tetrahedrite and Quartz.

C. Quartz Veinlet Cutting Extremely Altered Greenstone.

D. Quartz-Carbonate Veinlet cutting Previously Replaced Greenstone.

Relative tenor was indicated by numerous assays of Quartz-Pyrite Ore (unpayable), as compared with other assays of Quartz-Carbonate-Arsenopyrite Ore which was marginal. These samples were collected at varying distances from the shoots of the Lodes, and it was noted that the Arsenic-Lean material was invariably found to be lying in the zone further away from the shoot, while the Arsenic-Rich Ore lay in the marginal areas of the shoot. Polished sections of rich Gold Ore show no association of free Gold (visible) with either Pyrite or Arsenopyrite. In cases where these sulphide minerals occur with visible Gold, the Gold is almost invariably of later origin.

As there appear to be two rather distinct ages of both Arsenopyrite and Pyrite, a classification as regards Gold content of each particular period is difficult. It may be stated, however, in the case of the Arsenopyrite, that the lack of presence of (coarser) variety appears to have no affect upon the Gold content of the Lodes. The heavy mineralisation of the later period which includes coarse Arsenopyrite is often seen in areas which are unpayable.

A possible variation of the occurence of Gold with the Quartz-Carbonate-Arsenopyrite period of mineralisation has been observed on numerous occasions in all lodes upon the Cam and Motor Mine. This consists of fine and coarse grains and masses of free Gold which are isolated in the Quartz-Carbonate-Gangue of the Lodes. No additional minerals accompany the Gold observed in these circumstances, and there is no hint of Carbon affinity. Neither are minute Quartz healed fractures necessarily present in the vicinity. It is entirely possible that this particular type of Gold occurence is dissociated from the Quartz-Carbonate-Arsenopyrite period, but the rather obvious lack of selectivity of the Gold for any included matter in the Lode would tend to indicate that it was connected with the mineralisation, suggested.

Coarse and fine free Gold which occurs in the vicinity of the cupriferous sulphides and carbonaceous relicts has been referred to in a previous section. Gold in this period of mineralisation, occupies cracks and minute fractures in the Quartz-Carbonate Gangue, and is associated with Quartz of a like age. At times the Gold replaces the walls of the fractures, as well as appearing to replace the cupriferous sulphides with which it nearly always occurs. (Plate VII - B). The Pyrite and Arsenopyrite found alongside these Quartz filled fractures, is often attacked and somewhat replaced.

It has been stated that evidence which might indicate a definite Carbon precipitation of the Gold in this stage of the mineralisation, is at best inconclusive. Cases of apparent affinity of the Gold for Carbonaceous matter, are most certainly numerous, however, and there is little doubt that the Gold associated with the Carbon, is a late primary stage of auriferous mineralisation.

Gold is found throughout the entire vertical range of the Mine insofar as the Lodes in the Sediments are concerned. It is not the opinion of the writer that downward enrichment below the zone of oxidation was an important factor. In the case of the near surface zone, residual enrichment of Gold may have occurred. A possible examination of this is that the majority of the Arsenopyrite may have been freed of its "invisible" Gold content upon oxidation, reducing the refractory character of Ores worked during the early period of operations, thereby making payable Ores, which, if unoxidised, would have been marginal at best.

STIBNITE.

Stibnite (Sb_2S_3) is reported to have been of common occurrence in the uppermost levels of the Motor Lode, but was not seen by the writer. A few isolated occurrences of small irregular masses have been seen at times.

A small (6 inches) Lode of Quartz and massive Stibnite was observed on the 27th. (3228 ft.) level in carbonaceous Shales, just South of the intersection of the Cam Spur Lode with the Cam Lode. This Lode contained up to 6 Dwt. of Gold, but in a polished section of the massive Stibnite, none of the Gold was visible.

SCHEELITE

Scheelite has been observed as small crystals, on rare occasions in the Motor Lode of the 5th. (480ft.) level. It is reported from several smaller Lodes upon the Eiffel Flats, but apparently does not occur in quantity. The occurrence of a number of sizeable bodies of this mineral has been referred to in the section dealing with the Whitewaters Granitic Stock. (Page 26)

LODES LOCATED IN THE BULAWAYAN GREENSTONES.

The underlying reasons for the relative productivity and arrangement of the pay shoots of the Lodes located in the Bulawayan Greenstones have been stated, in a previous section, to be a result of their position relative to that of the Main-Fold-Fault Structure . The individual Lodes in this category are, the Cam, Petrol, [illegible], Cam Spur, and Footwall "B" (in part) and various minor Lodes associated with those named.

In general, the information in the section on Gangue and Mettallic Minerals found in the, "Lodes in the Sediments," is also applicable in the case of the Lodes located in the Greenstones. Therefore, only such data as is necessary to illustrate basic differences between the suites of minerals in the Lodes in Greenstones, as compared with Lodes in the Sediments, is given in this section.

The following Table lists the Gangue and Metallic minerals observed in the Lodes located in the Greenstones.

GANGUE MINERALS.

Minerals.	Proportion: By Volume: Estimated
Quartz	70%
Carbonates	25%
Chlorite (and Paragonite)	2%
	97%

METALLIC MINERALS.

Arsenopyrite (FeAsS)	00.40%	
Pyrite (FeS_2)	00.15%	
Stibnite (Sb_2S_3)	00.10%.	(Upper Levels.)
Gold (Au)	Variable	
Scheelite ($CaWO_4$) (Less than)	00.01%.	(Upper Levels - Rare).

Sulphides of Copper and Zinc.......... Rare.

PLATE IX

THIN AND POLISHED SECTIONS

PHOTOMICROGRAPHS

AND

DESCRIPTIONS.

PLATE IX. Description of Thin and Polished Sections.

A. (Polished Section XM - 39). 23rd Level. Footwall "A" North.

Early Arsenopyrite prisms are corroded; some exhibiting both fresh and ragged edges. At the left a broken prism is recemented by later Quartz-Carbonate. The Gangue is Chloritic Schist. Crossed Nicol, X 20.

B. (Polished Section XM - 24). 31st Level, Cam Spur.

Earlier Pyrite is being replaced by prisms of late Arsenopyrite. The Arsenopyrite is in turn being attacked by Quartz. The Gangue is Chlorite, Paragonite and Carbonates. Crossed Nicol, X 120.

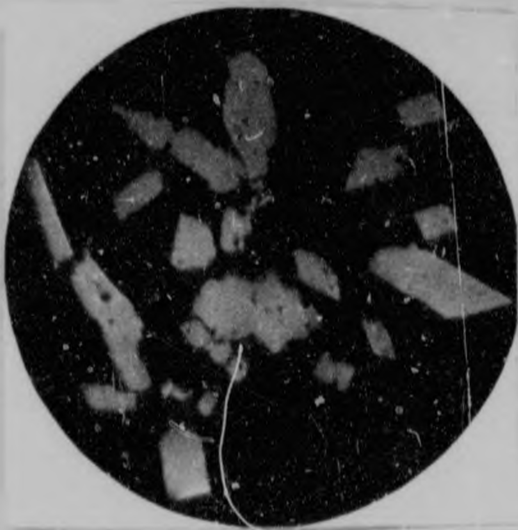
C. (Slide: U - 4). 30th Level. Cam Spur North.

Sheared and Schistose Greenstone contains fine Arsenopyrite and lenses of Carbonate minerals, and is highly sericitised and chloritised. Quartz-Calcite veinlets follow schistosity, and contain coarse Arsenopyrite crystals which are replacing earlier Pyrite. At the right, Quartz with "comb" structure is attacking a slender prism of Arsenopyrite. Ordinary Light X 14.

D. (Polished Section XM- 2). 17th Level. Petrol Lode.

Stibnite showing polysynthetic twinning. Crossed Nicol, X 25.

PLATE IX.



A. Arsenopyrite in Quartz.

B. Twinned Arsenopyrite Crystals Replacing Pyrite.

C. Quartz and Late Arsenopyrite in Schistose Greenstone.

D. Polysynthetic Twinning in Stibnite.

GANGUE MINERALS.
- QUARTZ -

The Quartz of the Lodes located in the Greenstones maybe described as being milky white in colour, inclining to greenish in allusion to the relative amount of Chlorite and Paragonite present as relicts in the Lode. Those relicts consist of incompletely replaced Chloritised Greenstone wall rocks, and are always present in the payable portions of the Lodes. In contrast to the Lodes in Sediments, those located in the Greenstones seldom contain large relicts. There is little or no actual silicification of the Greenstones beyond the well-defined walls of the Lode, although small branch "veins" leading into the foot and hanging walls often are of greater Quartz content than the Lodes proper.

Although a figure of 70% is given for the proportion (by volume) of Quartz present in the Lodes in the Greenstone, the percentage would decrease in favour of higher Carbonate percentage at times. In one exposure at the North end of the Cam Spur Lode on the 36th (4760.ft) level, brilliant white Carbonate approximating to Calcite was present to the extent of over 90% at a point where the Lode was 40 inches in width. Similar cases have been noted in the upper levels of the Cam. In cases where the Lodes are both narrow and rich, the Quartz content may range as high as 85%.

It was stated that in the case of the Sedimentary Lodes, three ages of Quartz were recognised. This does not appear to be true in the case of Lodes in the Greenstones where only two different periods during which Quartz was deposited, are recognised. The first of these periods was that during which the Quartz Carbonate of the replacement stage was introduced. The second, and apparently last, period of Quartz mineralisation was that during which the shattered Quartz Carbonate was healed by later Quartz with minor Carbonate and Free Gold. (Plate VIII - C). It is apparent that in the majority of cases the Lodes in the Greenstones did not receive the very early Quartz, although replacement may have removed every trace of its existence. This is not strictly applicable, however, as the replaced Sediments most certainly contained considerably more Quartz than the original Basic Greenstones.

As in the case of the Lodes in the Sediments, the Quartz of the Lodes in the Greenstones contains little in the way of sulphide minerals. These are usually concentrated in the Chloritic relicts.

CARBONATES.

The Carbonates of the Lodes located in the Greenstones consist of Calcite and lesser Ankerite as well as small amounts of other Carbonates. A mosaic of Quartz and Carbonates comprise the bulk of the Gangue and their relative proportions have been discussed in the preceeding section. Although there is little silicification of wall rock beyond the well-defined walls of the bodies, there is nevertheless intense Carbonâtisation which often amounts to virtual replacement of the Greenstone. (Plate VIII-D). This is not the case, however, when the Lodes are in Bulawayan Dolerites, and although the Dolerite is always more or less carbonated, it appears to be somewhat more resistant than the Greenstones of extrusive origin.

Alteration of the Greenstones by carbonatisation, extends for considerable distances beyond the well defined walls of the Lodes. A suite of Greenstones was collected by the writer upon the 32nd (3960 ft.) level, and the amount of carbonatisation suffered by the individual specimen, was found always to be inversely proportional to the relative distance from the nearest Lode or Intrusive Body. This is discussed elsewhere.

The theorum that the Pyrite and Arsenopyrite were associated with Quartz-Carbonate replacement period, applies in the case of the Lodes in the Greenstones as well as those located in Sediments.

CHLORITE AND PARAGONITE.

Chlorite with lesser Paragonite are prolific as hydrothermal alterations of Greenstone, along the walls of the Lode and in the relicts of incompletely replaced rock of the same nature lying within the Lodes.

Paragonite has not been observed in circumstances other than those related in the foregoing paragraph. The Chlorite, however, occurs as a constituent of nearly all volcanic rocks in the area, and originated, in part, dependently of the mineralisation which produced the Lodes. The Chlorite and Paragonite which is of hydrothermal origin exists in a proportion varying inversely with the distance from the nearest lode or intrusive body, as observed in the case of the Carbonate content of the Greenstones.

The Chloritic relicts within the Lodes are highly altered and contain strings and lenticles of Carbonate and Quartz. Relicts of all sizes consistently contain

Arsenopyrite and Pyrite, being at times so heavily impregnated as to represent almost complete replacement.

In no case was free Gold actually noted in the Chlorites. If present in quantity, in a particular portion of a Lode, however, the Gold is usually of greater concentration in the areas immediately surrounding relicts and in minute fractures either in the Quartz-Carbonate Gangue or actually traversing the relicts.

The origin of the Paragonite may be considered as a normal hydrothermal alteration of Greenstone. Plagioclase present in the rocks was first attacked by solutions containing CO_2, as a result of which Al_2O_3 and SiO_2 were liberated, and $CaCO_3$ was formed. The Al_2O_3 subsequently reacted with Soda rich Feldspar in the presence of water, producing $H_2NaAl_3Si_3O_{12}$. The ratio of occurrence between Chlorite and Paragonite would probably exceed 1000 : 1 in favour of the former.

Although the relicts of Chloritic nature which are present in the Quartz-Carbonate Gangue of the Lodes are usually of relatively small size, they have on occasion been observed to reach considerable dimensions. One large relict observed in the Cam Spur of the 23rd (2797 feet) level, measured over 150 feet in strike length while only 4 feet at the widest point. Thin inclusions of lesser size are sometimes arranged parallel to the walls and to each other, giving the Lode a "sheeted" appearance. This would constitute another indication of arrested replacement.

ARSENOPYRITE.

The Arsenopyrite is consistently present in the Lodes in the Greenstone, and is found in greatest abundance in and around inclusions and relicts of Chloritic wall rock and Paragonite. As indicated in the table on Page 62 , the ratio of occurence of Arsenopyrite to Pyrite is greater in the Greenstones than in the Sediments.

This mineral exhibits the identical forms of crystallisation as noted in the Lodes in the Sediments, but the occurence of rather large crystals (up to .8 inches in length) shows that they experienced a more favourable environment for development in the Lodes located in the Greenstones. In addition, abundant groups of minute crystals are sometimes seen to form veinlets in the Gangue, some of which exceed one half inch in width, and constitute nearly solid aggregates of Arsenopyrite with only a small amount of Pyrite being present.

An age distinction between older, ragged, pitted, corroded and partially replaced crystals (small) and fresher coarse crystals with clear cut faces may be made. (Plate IV - A). Although Pyrite is present in the vicinity of both the types of Arsenopyrite, it can not definitely be stated that there are two ages of Pyrite in the Lodes in the Greenstone.

Many of the prisms of Arsenopyrite of both ages are broken and recemented by later Quartz and Carbonate (Plate IX - A) and exhibit one or more faces of ragged outline, and one or more fresh faces.

When occuring in the same specimen with Pyrite, the Arsenopyrite is often seen to be replacing the Pyrite (Plate IX - B). No case of Pyrite replacing Arsenopyrite has been observed.

The uneconomic portions of pay shoots in Lodes in the Greenstone, appear to contain nearly the same amount of Arsenopyrite as do the payable sections. It would, therefore, be probable that the Gold content of the Arsenopyrite (Invisible Gold) is fairly constant, while the additional Gold in free and visible state, might constitute the sole enrichment of the Lode. The presense of, or absence of, later, coarse Arsenopyrite does not appear to have effected the Gold Tenor of the ore, and in several instances where there has been an intense mineralisation by the coarse variety, no difference in the Gold content of the Lode is detectable.

The majority of the Lodes located in the Greenstone have been stated to have both well-defined hanging and footwalls, between which the bulk of the replacement and impregnation has taken place. The boundaries of the more complete replacement by Quartz-Carbonate does not always coincide with these planes, however, and at times the edge of the Lode proper is several feet inside a particular "wall". In this case the highly Carbonatised Greenstone lying between the edge of the lode and the wall is impregnated with Arsenopyrite and lesser Pyrite, associated with Quartz and Carbonate. At times, this zone is impregnated to a much greater degree than normally, and as much as 15% of the rock (by volume), consists of the Sulphide minerals referred to. The Arsenopyrite in these cases is largely fresh and coarsely crystalline, indicating that the impregnation occurred during the several stages, of mineralisation. On a number of occasions, these crystals are aligned along the induced schistosity of the Greenstone, giving the rock a rather striking "Banded" appearance.

A rather interesting feature of these occurences is the presence of indubitably older Pyrite, which is being replaced by the Arsenopyrite and its Quartz-Carbonate associates. The Arsenopyrite is in turn altered and exhibits some edges of ragged outline, apparently being so affected by the late Quartz which often exhibits comb structure, and is seen attacking the margins of the earlier minerals. (Plate IX - C).

With the exception of the greater relative proportion of the Arsenopyrite in the Chloritic association, and intense impregnation of the Wall rock, the behaviour of this mineral in the Lodes located in the Greenstone, is comparable with that of the Lodes located in the Sediments.

PYRITE.

The Pyrite is observed to be present in the Greenstone Lodes in a considerably smaller proportion than to the Arsenopyrite in the Lodes in the Sediments.

The majority of the Pyrite appears to have been precipitated at an earlier period than the Arsenopyrite and is almost invariably the more corroded and altered. Crystal form shown by Pyrite in the Sedimentary Lodes is identical with that observed in Greenstone, but very little fresh Pyrite is seen, and it is doubtful that there is more than one age represented.

Pyrite is common as wall rock impregnation in Greenstones and in Chloritic relicts within the Lodes, being often replaced by Arsenopyrite.

Other than relative frequency of occurence, and doubt concerning a second period of mineralisation, there is little difference in the Pyrite observed in Greenstone as compared with that in the Sedimentary Lodes.

STIBNITE.

Although found only in sparse quantities in present working horizons, stibnite was nevertheless of considerable importance in the upper levels of the Cam and Motor where it at times formed large bodies in the Lodes in the Greenstones. Bodies of widths up to nearly one hundred feet have been reported, but the section of the near surface workings where they are alleged to have existed, is now inaccessible.

Form shown by the Stibnite is usually massive to coarsely granular and rarely bladed. In polished section, it is observed to be an aggregate of intergrown plates and masses, usually showing polysynthetic twinning. (plate IX-D)

Age relations of the Stibnite are rather clear, as it appears to be later than all other mineralization (Metallic), such as the vein described cutting the Petrol at the 17th (1999 ft.) level.

Accompanying this mineral and lying in its boundaries is considerably clear to glassy quartz of a type similar to that which occurs with the later Gold-Quartz (veinlets) period. This Quartz makes up as much as 15% of the volume of the observed bodies, and is seen to be of the same age as the Stibnite.

In most places where Stibnite occurs, there is an appreciably higher Gold Tenor in the Lode. This is brought out by assays of the Crude Ore as a whole, Stibnite alone, and the Quartz-Carbonate ore alone. The glassy Quartz present in the Stibnite does not appear to contain much of the Gold, as was shown by assays of crude Stibnite ore and panned concentrates of the same ore. The tenor was so slightly affected by concentration that it is not felt that the quartz contains any appreciable amount of the Gold. No Gold was visible in any of the polished sections of stibnite which were studied, and it is thought to be of the "invisible" variety.

In upper level oxidised ores of the Gam, etc., the mineral has altered to either a hard yellowish crust with centre of Stibnite, or an earthy powder. This mineral probably approximates Stibiconite ($H_2Sb_2O_5$).

Free Gold was reported to have occurred in quantity near the larger bodies of Stibnite and its Oxidised products, this might possibly represent secondary concentration of the "invisible" gold content.

Little Stibnite appears to have been encountered below the 32nd (3960 ft.) level, and this may represent a form of Mineralogical Bottoming. It was very abundant between the surface and the 9th (1010 ft.) level, in the Lodes in the Greenstones, particularly the Gam and Petrol Lodes.

Of rather surprising nature is information which would indicate that only traces of Antimony were present in the near-surface ores of the Eileen Alannah Lode, and that at no place in depth was it encountered in quantities of any consequence.

A sample collected on the 27th (3228 ft.) level and studied in polished section did not differ in any detectable manner from one collected upon the 17th level.

SULPHIDES OF COPPER.

The known occurrences of Cupriferous Sulphides in the Lodes in the Greenstones, has been noted in the like section of the Lodes of the Sediments. (Plate X-A)

A metallic mineral strongly resembling Tetrahedrite-Tennantite has been observed in some of the polished sections of specimens collected from the portions of the Cam Spur and Footwall "B" Lodes which lie in the Greenstone. Unfortunately, this mineral is very fine and is present in such minute quantities that it was not possible to make a positive optical identification, although Copper was detected by micro-chemical means upon one occasion.

The scarcity of the Sulphides of Copper in the Lodes in the Greenstones, as compared with their relative frequency of occurrence in the Sedimentary Lodes presents a problem of especial interest. If the mineral in the ores of the Cam Spur and Footwall "B" could be proven to be Tetrahedrite-Tennantite, as it is believed to be, the problem might be simplified to the following extent:

1. The Motor East (Cu minerals proven to be present) is a North-South striking near vertical Lode of deep seated origin, as are the Cam Spur

and Footwall "B" Lodes. Although lying in the Greenstone in part(North), each of these lodes has a counterpart in the Sediments, constituting a Southward extension.

2. Those Lodes located in the Sediments upon which Tetrahedrite-Tennantite has been observed (Motor, Centre, Footwall "A") are North-South striking, near-vertical Lodes of deep seated origin.
3. All Lodes (channels) mentioned in the two preseeding paragraphs, originated through the development and relief of similar stresses.
4. Subsequent stresses of minor nature which developed and were relieved in a like manner, would not necessarily have been transmitted into the Radial Relief Zones (Cam, Petrol, etc,). As a result, development of fracturing at a particuler time, in the North-South Lodes, could have occurred independently of the East-West Lodes.
5. Lack of fracturing of the Radial Relief Zones could have inhibited the ascent of a particular period of mineral bearing solutions.

The fact cannot be overlooked, however, that the rock type must have played an important role in the resultant mineralisation, and it is entirely feasible that other explanations for the singular dearth of Copper Sulphides in the Lodes in the Greenstones, may exist.

PLATE X.

THIN AND POLISHED SECTIONS

PHOTOMICROGRAPHS

AND

DESCRIPTIONS.

PLATE X. Description of Thin and Polished Sections.

A. (Polished Section XM - 12). 39th Level Motor East Lode.

Tetrahedrite (grey) and Gold from a later Gold-Quartz veinlet in Quartz-Carbonate Gangue. The Gold has replaced the walls, of the fracture, both in the Gangue and the Tetrahedrite.
Plane Pol Light, X 25.

B. (Slide: M-8) 25th Level, Petrol Lode.

Vein Quartz with Carbonates, Sericite, with the central (Black) portion being Chlorite and constituting an unreplaced relict of Schistose Greenstone. Crossed Nicol, X 14.

PLATE X.

A. Gold and Tetrahedrite in Quartz.

B. Petrol Lode Quartz with Chlorite.

SPHALERITE.

Sphalerite was noted in only a few instances in the Greenstones, and is of even less frequent occurrence than Copper Sulphides. One such occurrence was noted on the Cam Spur of the 22nd (2650 ft.) level, in the Greenstones at a distance of 47 feet from the nearest Sediments. This consisted of a lenticular mass of the mineral measuring eight inches by three feet which persisted over the full height of the drive (five feet). Here, the Sphalerite had been rolled and minutely shattered, and contained sparse minute inclusions of Arsenopyrite which it appeared to be replacing. It was also traversed by numerous minute Quartz veinlets which cemented the fractures.

GOLD.

The occurrence of Gold in the Greenstone Lodes is only slightly disimilar to that of the lodes in the Sediments. This consists largely of the affinity of the Gold for the Chlorite of the Greenstones, relative to the Carbon of the Sediments.

The Greenstones do not appear to have experienced the very early period of Quartz injection, which contained, possibly, a small amount of Gold, but the evidence is not entirely convincing.

In addition, the Gold which exists in appreciable quantities in the Stibnite may be said to have been, in general, of much greater total benefit to the Greenstone Lodes than to those in the Sediments, in which the occurrence of Stibnite is relatively scarce.

Apart from the foregoing, no additional description of consequence need be given, as such statements as refer to the occurrence in the Sediments, also apply to Greenstone Lodes.

...different, they are grouped to avoid repetition.

1. Formation of embryonic channels through various causes, and dynamic alteration of the adjacent Wall Rocks.
2. Injection of "Vein Intrusive" along portions of the Channels and other zones of weakness.
3. Adjustment which reopened channels and fractured the intrusive bodies therein.

OTHER METALLIC MINERALS NOT SEEN IN THE ORE.

Nickel, Bismuth and Manganese are noted in the Tables of Concentrate Assays and apparently exist in small quantities as accessory metals in the minerals described. Zealley mentions Tellurides as having been detected in Motor ore, but gives no hint as to the location, amount, or nature of the "Detection." In no analysis known to the writer has this metal been shown to exist.

SEQUENCE OF EVENTS RESULTING IN THE FORMATION OF THE LODES.

As the difference between the sequence of events resulting in the formation of the Lodes in the Sediments and that of the Lodes in the Greenstones is but slightly different, they are grouped to avoid repetition.

1. Formation of embryonic channels through various causes, and dynamic alteration of the adjacent Wall Rocks.
2. Injection of "Vein Intrusive" along portions of the Channels and other zones of weakness.
3. Adjustment which reopened channels and fractured the intrusive bodies therein.
4. Ascent of solutions of high silica, but low carbonate content, along fractured and reopened channels. This process resulted in the formation of narrow discontinuous Quartz replacement bodies and perhaps involved minor filling. These bodies were very low in Carbonate.

   Pyrite was probably formed in the process, being partly a produc. of alteration of the dark minerals present in the walls. A very minor amount of free Gold was probably precipitated.

It cannot be stated with any degree of assurance, that the majority of the Greenstone Lodes experienced this stage.

5. Adjustment of considerable magnitude which reopened all channels and caused contortion and shattering of the previously deposited Quartz and adjacent wall rocks.
6. Ascent of Solutions rich in Silica and Carbonate which accomplished replacement of wall rocks and partial to complete assimilation of the shattered earlier Quartz bodies in the channels. Processes of replacement which occurred include Carbonatisation, Chloritisation, and lesser Silicification and Sericitisation. At times a certain amount of Albitisation appears to have occurred. At least one of the ages of Pyrite and probably both the ages of Arsenopyrite occurred during this stage, and Gold in both visible and "invisible" form was precipitated. Alterations appears to have been arrested at a time shortly before the adjacent wall rock and older Quartz lying along the channels had been completely altered. This is illustrated by the presence of incompletely replaced relicts lying completely within the channels occupied

by Quartz-Carbonate Gangue, and is probably a result of depletion, interruption or a change in chemical nature of the solutions.

This was a prolonged and probably an intermittent process, which recurred by indistinctly separated stages, and overlapped into both the preceeding and following periods of activity.

7. Adjustment of minor consequence. It is indicated that this disturbance might have been transmitted only along North-South Lines of weakness, irregularly fracturing the previously deposited Quartz-Carbonate lodes therein. In this instance, the Radial Relief Zones (East-West) would have been effected only slightly.

8. Ascent of solutions rich in Silica and base metals (Cu , Zn, Sb) along shattered North-South striking Lodes. Formation of the following minerals: Sphalerite, Tetrahedrite-Tennantite, and Chalcopyrite with Bornite, occurred in the sequence named.

These minerals occur in small quantities along Carbonaceous relicts and inclusions within the Lodes in the Sediments, and to a far lesser degree, the North-South Lodes in the Greenstones.

In view of the sparse occurence of this type of mineralisation, it is possible that this period was of short duration. Appreciable Gold was introduced during the final stages of this period since very high Gold values are almost invariably associated with occurences of copper minerals.

9. Adjustment of minor consequence affecting all Lodes.
10. Ascent of solutions rich in Silica and Gold. This process healed the fractures produced during the previous period of adjustment, forming a veritable network of minute Quartz-Gold veinlets of inferior Carbonate content.

Generally these veinlets consist of Quartz which cements and replaces the fractured Quartz-Carbonate Gangue. At times, the Gold is seen occupying the entire width of the fractures, and also replaces the Gangue as well as metallic minerals of earlier genesis.

11. Adjustment of Minor Consequence.
12. Ascent of solutions rich in Antimony and Silica with Gold. This produced Stibnite, glassy Quartz and Gold. The bulk of the Stibnite lies in the Zone above a depth of 1000 feet and is of greatest concentration in the Cam and Petrol Lodes.

In contrast to the bulk of previous mineralisation, this period consisted generally of filling with only minor replacement being involved.

13. Adjustments of minor consequence.

14. Formation of barren Carbonate veinlets, largely Calcite.

15. Formation of eluvial (Rubble) and saprolitic deposits. This occurred after considerable lapse of Geologic time, during the latter part of which, denudation and oxidation of near surface ores occurred.

CHAPTER XI

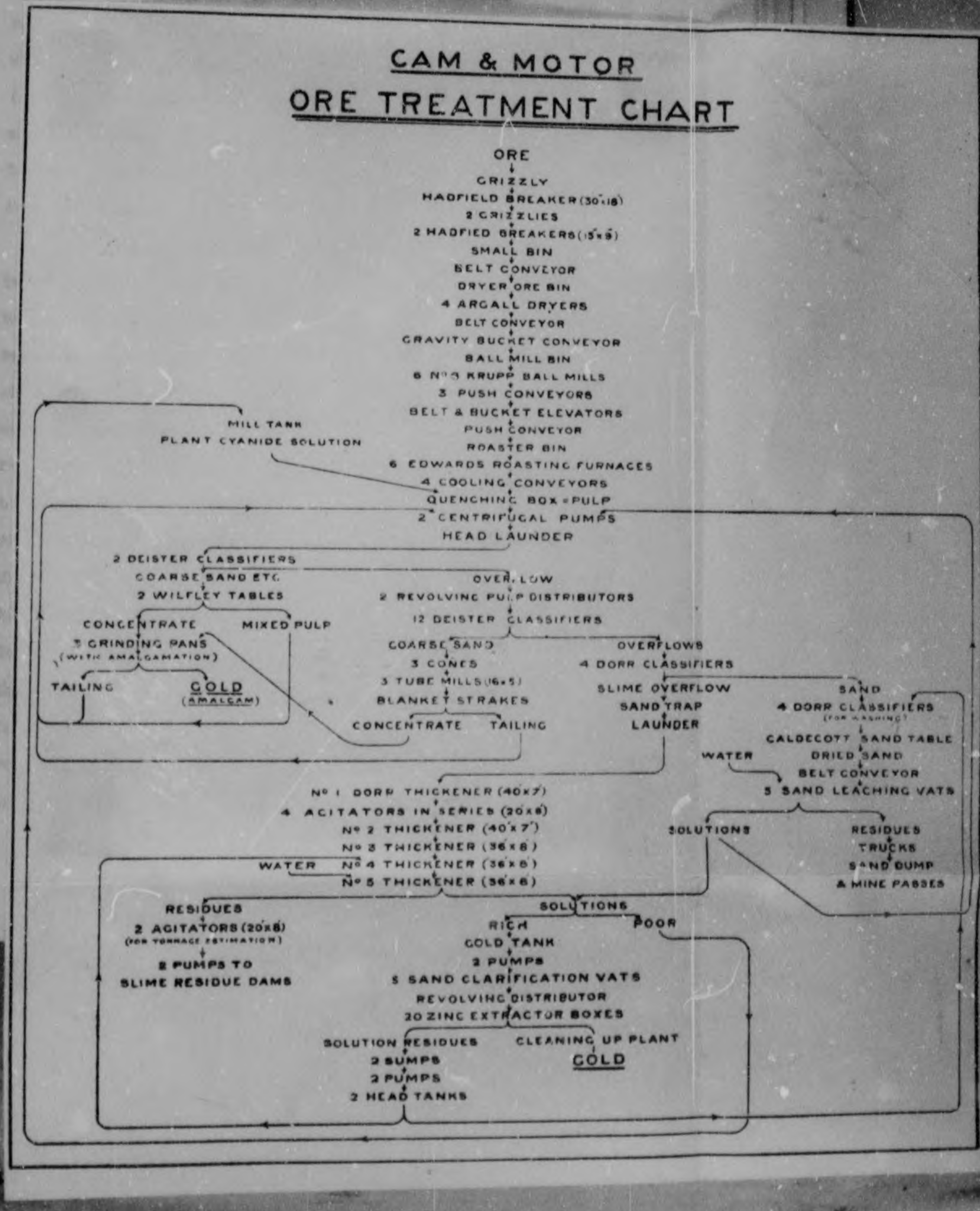
TREATMENT.

The first recorded production of Gold from the Cam and Motor Area was in 1907, during which year, rock from the Cam Claims was treated. This consisted of a small amount of material from the 100 foot level, but was mainly from quarrying operations in soft Schist and broken Quartz. The treatment facilities consisted of two Huntington Mills, and a cyanide plant was under construction. During 1908, when quarrying operations had ceased and the underground ore being crushed was found to be somewhat refractory, Gold recovered, came chiefly from the cyanide and slimes plants. Material milled during 1909 was found to contain a considerable amount of Antimony, both as sulphide, and as oxidation products, which was cobbed and not sent to the Mill. The plant then consisted of three Marshall boilers (12, 14 and 16 h.p.), a rock breaker, two Huntington Mills, and a third in the course of erection, and a complete sands and slimes plant. Water was being pumped from the Cam Shaft which provided 7000 gallons per hour. The Motor Claims also started production in 1907, when a considerable amount of rubble, milling as high as 10 Dwt.

was treated from various sections. Antimony again proved disadvantageous to treatment processes, and a major portion of it was sorted out before the remaining material went to the Mill. Seventeen tons of this antimony (both as sulphide and oxides) were shipped to England and one sample assayed contained 67.5% Sb. Treatment facilities for the Motor Claims consisted of a five stamp Sandycroft Mill, and steam rig. During 1908 and 1909, additional treatment facilities were added to the plant consisting of heavier five stamp gravity mill with gas engine, and a 450 ton capacity cyanide plant.

After the formation of the Cam and Motor Gold Mining Co. Ltd., in 1910, which amalgamated the Cam, Good Shepherd, Motor and some additional adjoining properties, production ceased, and the construction of a new experimental plant was started. This plant, which began production in October 1911, consisted of a ball mill, roaster, and cyanide plant and was found to be well adapted to the treatment of sulphide ore, which is reported to have averaged 10 Dwt. Experiments to determine the type of treatment to which the ore was most amenable continued; and it was found to be roasting. The then modern reduction works which was officially opened in January 1914, was erected at a cost of ≠ 2,000,000 and was felt to be satisfactory for all needs.

CAM AND MOTOR FLOW SHEET : 1914.



PROCESS : 1914 : CAM AND MOTOR MINE.

Not shown on the 1914 Flow Sheet are the power source and sundry minor features. Four water tube boilers with fire-boxes designed for wood, which was supplied (by cutting 10-15 miles distant) from a light railway, and which were so constructed as to facilitate conversion to coal, operated two turbines which generated electricity for all needs.

Upon examination of the 1914 Flow Sheet, it will be noted that the mill suffered under the handicap of having to handle the entire product of grinding from the beginning of the process to the end. As there was little or no sorting, and no material was wasted in underground use, a considerable proportion of the (run of mine) ore reaching the mill was either barren, or so nearly so, as to render it uneconomical even in the company of the smaller proportion of richer ore encountered. A glance at the preceeding Flow Sheet will show that although only the simplest operations (e.g. Dry crushing; Roasting; Concentration; Amalgamation; Cyanidation) were utilised, the treatment was long and tedious; obviously due to the fact that the entire product had to be prepared for roasting, roasted and subsequently separated from the much smaller proportion of sulphides and native Gold which have with a very few notable exceptions, comprised far less than one percent (1%) of the material treated.

In addition, it will be noted that this method of treatment avoided any attempt to concentrate valuable heavy minerals in the slimes. When one considers the highly friable nature of the sulphide minerals in the ore, this would begin to appear as a rather serious oversight; one which was to be regretted at a later date when the accumulated slimes from this plant were let out on tribute.

Treatment continued along the lines shown on the 1914 Flow Sheet during the war years to 1919, at which time the company was reorganised, (Cam and Motor Gold Mining Company (1919) Ltd.) after which the unsatisfactory method of Dry crushing; Roasting, Wetting; Classification; and Cyanidation, was abandoned, and experimental work was instituted to find a more suitable treatment. This proved to be Wet crushing and Concentration, and on this basis crushing again started in 1921, with good returns.
During this period, cobbing of antimony rich material apparently continued, as a Mining Commissioner's report dated 1926 shows that shipments (of same) containing considerable Gold were being sent to England for treatment. Slimes had been treated during the period from 1914-1925, with good results, but it is not known whether this was

done by the Company or a Tributor. In 1926, an outside firm obtained a tribute to treat Cam and Motor slimes and during this year, 2990 ounces of Gold; from 15,255 tons treated; an extraction of 3.9 Dwt., were recovered. Seven additional outputs from 1927 to 1933 totalled 18,234 ounces from cyanidation of 102,775 tons of slimes and 1250 tons of sands; a recovery of 3.5 Dwt. Since 1933, no slimes appear to have been treated.

PROCESS: 1929. CAM AND MOTOR MINE.

The following notes were prepared by J.C. Stokoe[29] for the International Geological Congress, with reference to the 1929 Flow Sheet.

"--Now only concentrates are roasted. Stage crushing is adopted, one set of record tables receiving pulp from the stamps direct, while other tables work on the further product from tube mills. The pulp passes through a closed tube mill circuit, escaping only when sufficiently slimed. Mechanical gravity concentration having proved inefficient on the slime, a Mineral Separation flotation plant has been adopted. The ore contains a considerable amount of stibnite, which mineral being very frieble escaped the gravity tables, but is readily caught by flotation."

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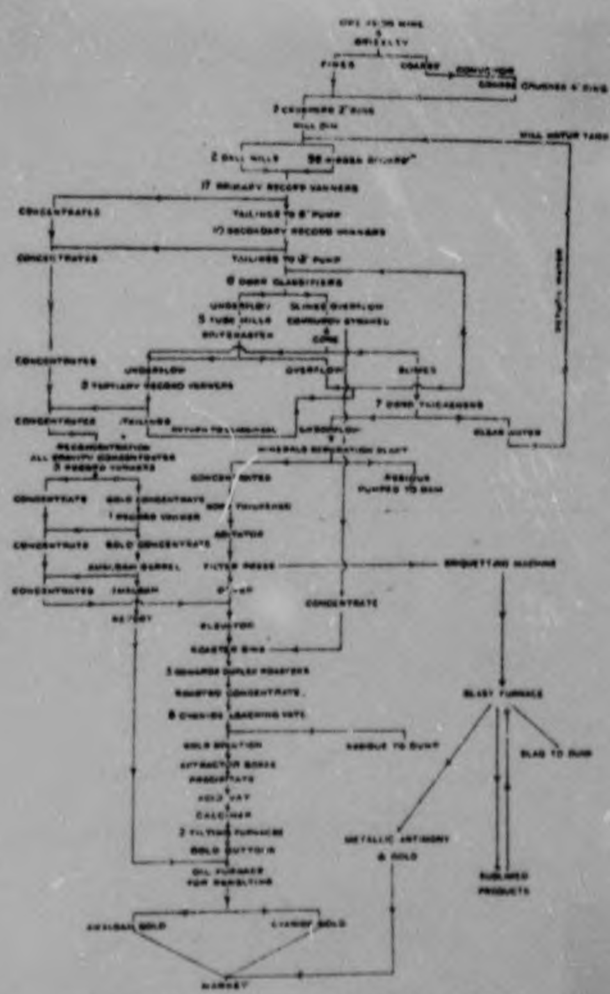
29. Stokoe, J.C. "Notes on the Cam and Motor Mine." Southern Rhodesia, Guide Book. XV Session, pp. 29-31. Pretoria; 1929.

"The richest of the recleaned gravity concentrates are amalgamated in barrels, the remainder being treated with cyanide."

"Flotation concentrates are briquetted to avoid dusting, and smelted in a water jacketted blast furnace of the copper smelting type. The metallic antimony acts as an efficient collector of the Gold, the resulting auriferous antimony being sent to market."



Flow Sheet. Cam & Motor Mine, 1929.

It is interesting to note at this point, that the flotation cells, for some reason proved unsatisfactory and were discarded in preference of additional James and Record slimes tables. During 1951 further experiments were being carried out with flotation cells, as it was again felt that flotation might prove more satisfactory than gravity concentration.

Not shown on the Flow Sheet for 1929, is the change-Over from wood as fuel, for power generation, to Wankie coal. Breakdown of coal deliveries at frequent intervals caused the Cam and Motor to switch over to Electricity Supply Commission Power in late 1951.

PROCESS: 1952 CAM AND MOTOR MINE

A 1952 Flow Sheet for the Cam and Motor Mine will be found in the Annexures, and as can be seen upon comparison with the 1929 Flow Sheet, only relatively few major changes have been made in the process. Noteworthy is the removal of the ball mills from primary grinding, and the removal of the flotation circuit in favour of slimes concentration tables. Weathering and retreatment of cyanide discharge of roasted product and discontinuance of marketing of antimony and antimonial Gold may also be seen.

Recent information indicates that a decision to re-adopt flotation has been made.

GOLD PRODUCTION CHART: CAM AND MOTOR MINE:

1907--1952.

	YEARS	TONS	FINE OUNCES	REMARKS.
Cam Claims.........	1907-8 ..	24,903..	6,753..	Original Owners.
Motor Claims.......	1907-12..	16,654..	7,047..	Original Owners.
Cam and Motor Gold Mining Co. Ltd....	1914-19..	691,226..	239,990..	Mill closed 1919-21 for reconstructi
Cam and Motor Gold Mining Co. (1919) Ltd...............	1921-52.. (Jan.)	8,734,111..	3,088,124..	Not including cyanidation of slimes.
Blythe and Moore.. (Tributors)	1927-33..	104,025..	18,234..	From cyanidatio of Motor slimes.

GRAND TOTAL ...... 1907-52.. (Jan.) ..9,570,919..3,360,148..(i.e. 7.02 Dwt.

The fineness of the Gold produced has consistently exceeded 900, and for 1951 averaged 946.

EILEEN ALANNAH MINE ORE TREATMENT

The Eileen Alannah Mining Co. was operating solely upon that section of the Cam Lode which lies East of the East end line of the Cam block (i.e. Eileen Alannah, Arizona No. 3, and Eglantine), and upon the ore from the which, although slightly different from the aforementioned, was nevertheless high Arsenopyrite, free Gold ore, resembling in effect the Petrol ore. A glance at the attached Flow Sheet shows that wet grinding of the ore took place, followed by classification and concentration. Only the concentrates were roasted, rather than the entire product; a satisfactory scheme which was not basically changed throughout the life of the mine. It is interesting to note, at this point, that the expensive and unsatisfactory results of dry crushing and roasting, used in the Cam and Motor Mine at about the same time, eventually evolved in a like system being adopted by that Company. It would be well to state that in the opinion of the writer, the only major difference between the ores treated at this (Eileen) plant and those treated by the Cam and Motor, lay in the rather desultory Copper content of the Motor reefs and perhaps a lesser amount of antimony in the Eileen section of the Cam reef.

The following Diagram is of approximately the same period as that of the 1914, Cam and Motor Flow Sheet. It must be remembered that although the Eileen Alannah was treating a much smaller amount of ore, the metallurgical problems were by and large, identical. The obviously simple approach to the treatment problems taken by the Eileen Company, is seen to include several ridically different circuits from that taken by the Cam and Motor. Amongst these, probably the most noticeable was the attention paid to concentration and to treatment of the slimes.

The Eileen Alannah's Flow Sheet for 1914 is given here for the sake of comparison with the Cam and Motor's Flow Sheet of the same date.

(1914 Eileen Alannah Flow Sheet on the following page, (255).)

of the Cam reef.

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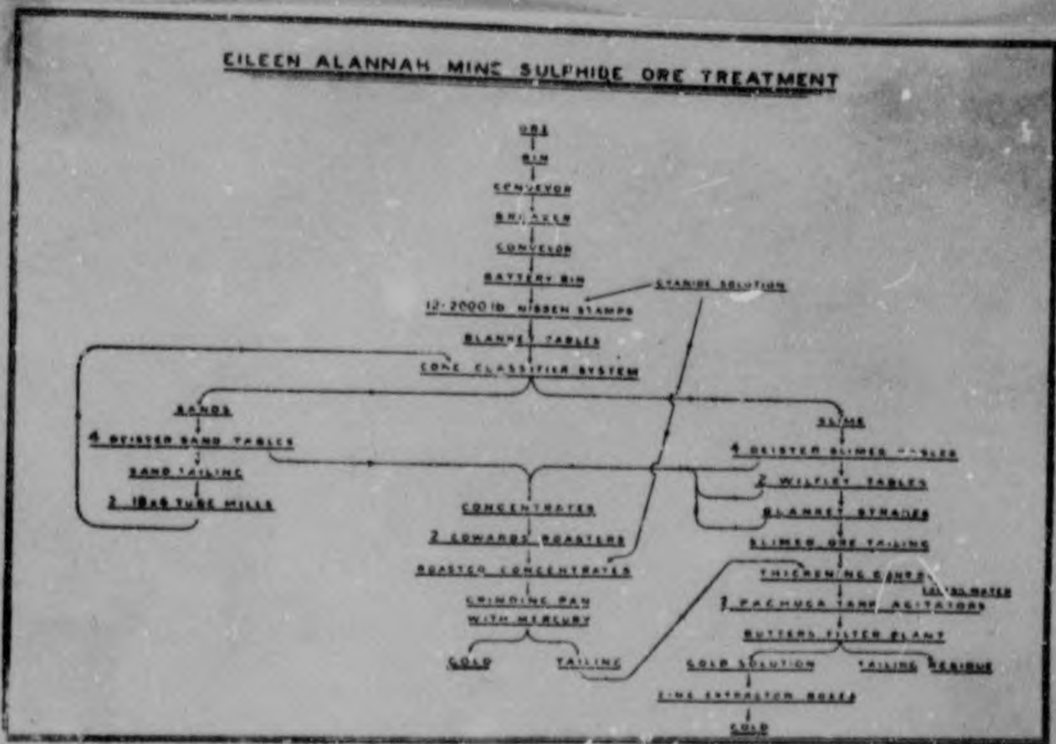

EILEEN ALANNAH FLOW SHEET: 1914

ANALYSES OF ORES AND PRODUCTS.

Cam and Motor Mine.

The following analyses were furnished by the Cam and Motor Mining Company, and consist of records from old Files. Dates, where known are indicated, but the name of the Analyst is missing.

CAM AND MOTOR MINE : DATE UNKNOWN : CIRCA 19255.

	Ore.	Table Concentrates.	Flotation. Concentrates.	Roasted Concentrates.	
SiO_2	58.77	49.97	24.90	SiO_2	61.15
As	0.51	2.86	4.80	Fe_2O_3	12.55
Sb	1.19	1.36	1.80	Al_2O_3	5.60
S	2.13	7.63	18.30	CaO	5.65
Fe_2O_3	4.50	9.80	17.55	MgO	2.45
Al_2O_3	7.35	7.79	5.65	AsO	0.73
CaO	6.16	5.33	5.90	SbO	0.82
MgO	4.32	3.89	4.65	SO_2	4.07
CO_2	8.58	7.77	Undet.	CO_2, H_2O, etc.	6.98
TiO_2	0.20	0.17	9.45		
MnO_2	Trace	Trace	Trace.		
H_2O	5.17	3.10	Undet.		
	98.88%	99.67%	100.00%		100.00%

Analyses of Ores and Products continued .....

CAM AND MOTOR MINE : 1937.

	Flotation Concentrates		Roaster Discharge.
Au	20.1 (Dwt/Ton)	....	17.5 (Dwt/Ton)
Ag	5.8 (Dwt/Ton)	....	7.1 (Dwt/Ton)
As	1.48%	....	1.325%
** Sb	3.14	....	2.43
SiO_2	27.48	....	43.40
Fe_2O_3	13.68	....	14.49
Al_2O_3	10.61	....	15.52
MnO	0.09	....	0.46
Ni	0.13	....	Nil.
CaO	8.46	....	5.03
MgO	5.79	....	6.44
Alkalie Oxides	7.39	....	4.21
P_2O_5	0.20	....	Nil
C and CO_2	13.63	....	2.21
CuO	Undet.	....	0.315
BiO	Undet.	....	0.242
S	7.83	....	2.97
	91.91%		99.042%

** The Antimony in the samples analysed during 1952 averaged less than 0.5%, and may be taken as an indication that deeper ores (below the "Stibnite" zone) were being treated.

EILEEN ALANNAH MINE.

The following is quoted from Zealley 30, and represents a very early analysis made of the ore and concentrate at a date preceeding 1913. The Analyst was a W.H. Goodchild.

	Anaysis of general sample of Eileen Alannah Ore.	Analysis of Concentrate of Eileen Alannah Ore
Insoluble in Acids ...	43.58	.... 35.05
Iron combined with S and As	3.40	.... 12.11
Iron as FeO in Silicates	5.91.	.... 4.63
Al_2O_3	13.24	.... 7.46
Arsenic	1.20	.... 6.25
Sulphur	3.36	............11.18
CaO	16.10	.... 11.20
CO_2	12.60	.... 8.80
MgO	.80	.... .30
Loss at 212° Fahrenheit	.25	20
Tungstic Acid: (As Scheelite)	Trace	.... .25
	100.44%	97.43%

"Small quantities of Ilmenite, Zircon and Rutile were present in the Concentrates. A trace of Lead was indicated, but NO ANTIMONY was present".

30. Zealley, A.E.V., op. cit.

A separate sample of Antimonial ore gave the following result :

Sb	17. 1
S	7. 4
Fe_2O_3 and Al_2O_3	3.8
CaO	4.27
CO_2	3.3
Insoluble in Acids (Mainly Quartz)	66.27
Total	102.12%

The treatment processes which have been employed on the Cam and Motor Mine and the Eileen Alannah Mine, have undergone only slight alterations in the fifty year period that they have been operating. This is additional proof that the mineralogical composition of the ores of these Mines has remained reasonably unchanged through a vertical range of over 5,360 feet of depth, below the present surface. The only possible exception to the foregoing, is the case of the temperature-range decrease in the stibnite content of the ore, as indicated in the decline of the antimony present, as shown by recent analyses of Ores and Products.

CHAPTER XII

CONCLUSIONS.

The present structure of the Cam and Motor Mine originated through a rather complex series of Geologic and Tectonic disturbances. Certain stages in the development of the structure were obviously of regional nature, while others were of local significance only.

The origin of the East-West zone of deep seated activity, and its relations to the overall structure of the district are of considerable interest, in the study of the distribution and control of granites which have intruded the Pre-Cambrian crystalline rocks in the ancient shield areas of the world. The precise influence which this zone exerted upon the original folding of the Sedimentary series of the Cam and Motor Mine is not clear, but there can be little doubt that the later phases of Igneous activity which were experienced by the deposit originated, and were controlled, in the downward plunge of the Main-Fold, and its deep seated connection with the lower portion of the greater regional synclinal trough.

The constriction of the area influenced by post-folding Igneous activity becomes more pronounced in the deeper levels of the Mine, and it is inconceivable that the later dolerites and mineral bearing solution should have originated from a source other than the connection of the Main-Fold with the deeper zones.

The localisation of mineralisation by a plunging fold structure is a feature not uncommon amongst the various Pre-Cambrian mining areas of the world, and is well illustrated in the example of the Cam and Motor Mine. Other deposits which may be cited for comparison, are the Homestake Mine (U.S.A.), and the Kalgoorlie Deposit (Australia).

The mineral association seen in the ores at the Cam and Motor Mine, is ample evidence of its mesothermal conditions of origin. With the exception of the decrease of stibnite in depth, the Lodes show little in the way of mineralogical bottoming in a vertical range of 5360 feet. The absence of lead is noteworthy. Control of mineralisation exerted by variance of wall rock type is well illustrated in the instances of Lodes in greenstones, which pass into sediments along their strike, ceasing to be payable in the process. The precipitation of gold and other minerals by included matter in the Lodes and the selectivity of certain of the sulphide minerals for specific wall rock types is, also, of interest.

The somewhat confused Fold-Fault sequence of successive off-sets and displacements is perhaps the most interesting feature of the deposit, as a whole, and is an example of an overturned monoclinal fold upon which apex faulting was complicated by an abrupt alteration in the resolved direction of the application of force.

In review, the structure and mineralisation of the Cam and M[illegible] Zone may be considered a typical mesothermal [illegible]cement-impregnation deposit in Pre-Cambrian extrusive and Sedimentary rocks.

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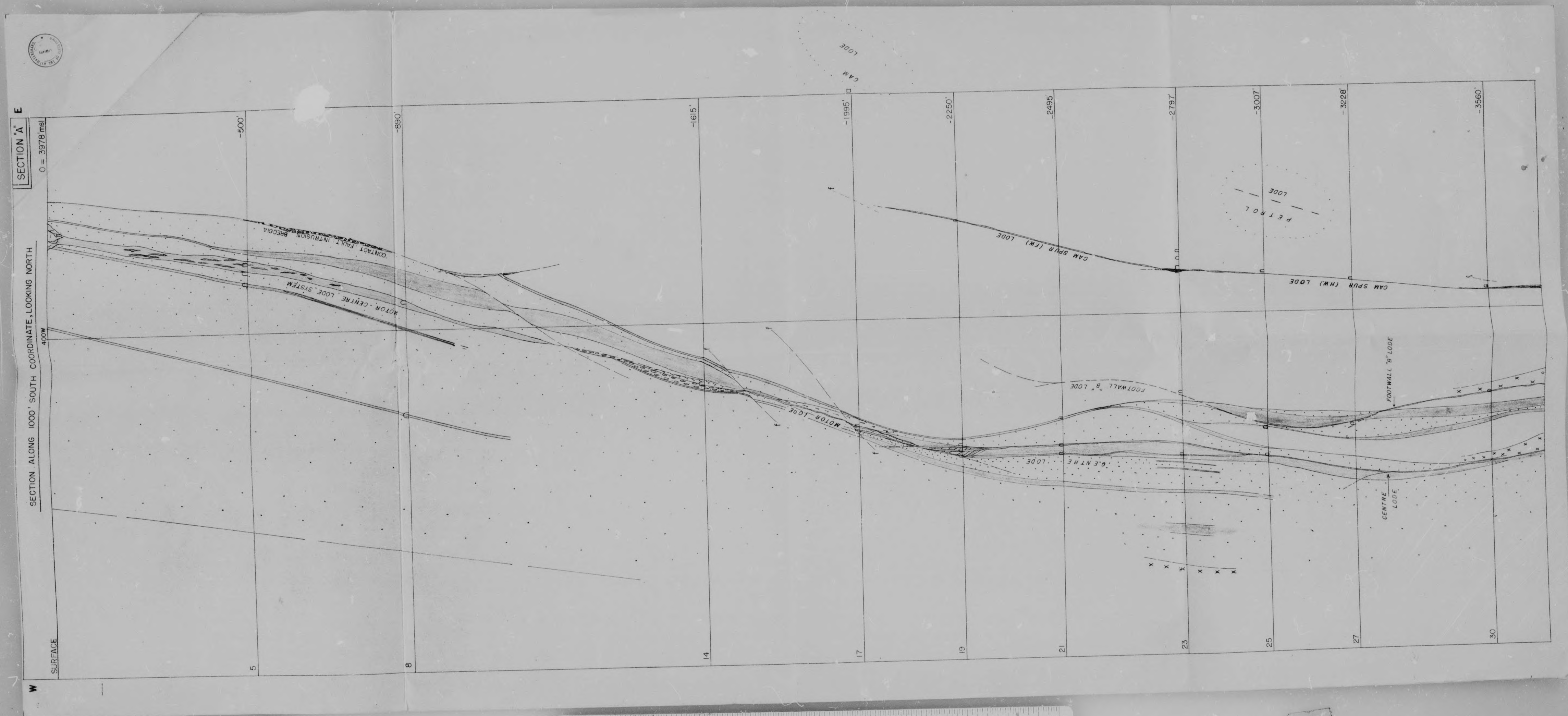
SECTION 'A'
0 = 3978' msl
SECTION ALONG 1000' SOUTH COORDINATE, LOOKING NORTH
W
E
SURFACE
400W
-500'
-890'
-1615'
-1995'
-2250'
-2495'
-2797'
-3007'
-3228'
-3560'
5
8
14
17
19
21
23
25
27
30
CAM LODE
PETROL LODE
CAM SPUR (FW) LODE
CAM SPUR (HW) LODE
CONTACT FAULT INTRUSIVE BRECCIA
MOTOR-CENTRE LODE SYSTEM
MOTOR LODE
FOOTWALL 'B' LODE
CENTRE LODE
FOOTWALL 'B' LODE
CENTRE LODE