THE GEOLOGY

OF

THE CAM AND MOTOR MINE

THESIS SUBMITTED FOR THE DEGREE OF DOCTOR OF PHILOSOPHY
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THE GEOLOGY OF THE CAM AND MOTOR MINE.

CHAPTER I

INTRODUCTION.

The Cam and Motor Mine is located on the Eiffel Flats some four and one half miles East Northeast of Gatooma, Southern Rhodesia, at an elevation of 3978 Feet above mean sea level, and is the largest gold producer in the country. (See Diagram SX-I). It is situated on all-weather surfaced roads from both Hartley and Gatooma and by unsurfaced roads through Concession Hill to Enkledoorn. In addition it is served by a branch line of the Rhodesia Railways and has its own facilities for light company aircraft.

The Eiffel Flats area is monotonously level, being broken to the Northeast and East by low ridges composed mainly of silicous banded ironstones and coarse arkose of Upper Bulawayan and Shamvaian ages respectively. Drainage is accomplished by numerous small intermittent vleis which by and large find their way South and Southwest into the Umsweswe River and thence into the Umniati, the Sanyati and finally the Zambesi River. There are no perennial streams in the area, although several sizeable permanent pools may be found along the Umsweswe River in the area to the Southwest. Subsurface water is reasonably plentiful but rather haphazardly distributed as regards depth, and can only be said to maintain an average depth of perhaps eighty feet from the surface. On the Cam and Motor Mine proper, water was in short supply until operation reached a depth of one hundred feet, where it was found in sufficient quantities for all needs.

Indigenous vegetation has been cleared from the Eiffel Flats for many years, either to prepare the land for cultivation or for fuel and mine timbers. In the sandy vleis to the South and Southeast, abundant Mopani (Coapaifera Mopani) can be found, but it becomes rarer with the passage of time due to its popularity as a mine timber. It seems to favour granite soils. Brachystegia are found in the hilly areas to the East and Northeast and so seem to favour iron rich soils derived from banded ironstones and other ferruginous sediments. Diospyrus may still be found in the lighter soils of the Eiffel Flats, while by far the most abundant plants are the second growth thorn, which seem to thrive on iron rich clayey soils derived from the basic volcanic rocks. These are largely Acaciae of several varieties, the most common of which are probably Acacia Heteracantha and Dicstrachys Glomerata. Cultivation of iron rich soils has produced abundant mealie crops, and is practiced on a relatively large scale hereabouts, as well as vegetable raising to a lesser degree. In the granite soils to the East, Northeast and South, tobacco thrives and is cultivated vigorously.

Most of the area surrounding the Cam and Motor Mine is rather thickly covered with dark to pale red iron rich soil, with lesser patches of buff coloured loam; the former in allusion to the underlying greenstones and dolerites and the latter to acidic sediments and fragmentary volcanics. As a result, outcrops are scarce and surface study quite tedious. The Cam and Motor Mine is situated mainly on Bulawayan greenstones of original basic (largely basalt and epidiorite) composition which have to a great extent been so extremely sheared and carbonated as to make determination difficult. Minor sedimentary lenses of similar age are present throughout these greenstones, and it is upon one of these that the Mine and its rather unique structure have developed. In keeping with the majority of the country's (and the world's) lode gold mines, this deposit is located within a few (surface) miles of a major granitic batholith.

The surface geology of the Hartley District, which includes the Eiffel Flats area, has been studied by Mr. J. Wiles[1] of the Southern Rhodesia Geological Survey, and the following historical data are excerpts from his forthcoming bulletin: Before their incorporation into a single company, the Cam and Motor lodes were operated as separate mines under different managements. The Cam claims first started production in March 1907 working under Government Notice 212 of 1904. In 1909 the Cam was operated in conjunction with the Good Shepherd which latter is adjacent to and on the same strike as the Cam.
A.E.V. Zealley[2], a geologist of the Southern Rhodesia Geological Survey referred to this reef as the Cam-Good Shepherd-Eileen Alannah-Arizona-Eglantine ore deposit,

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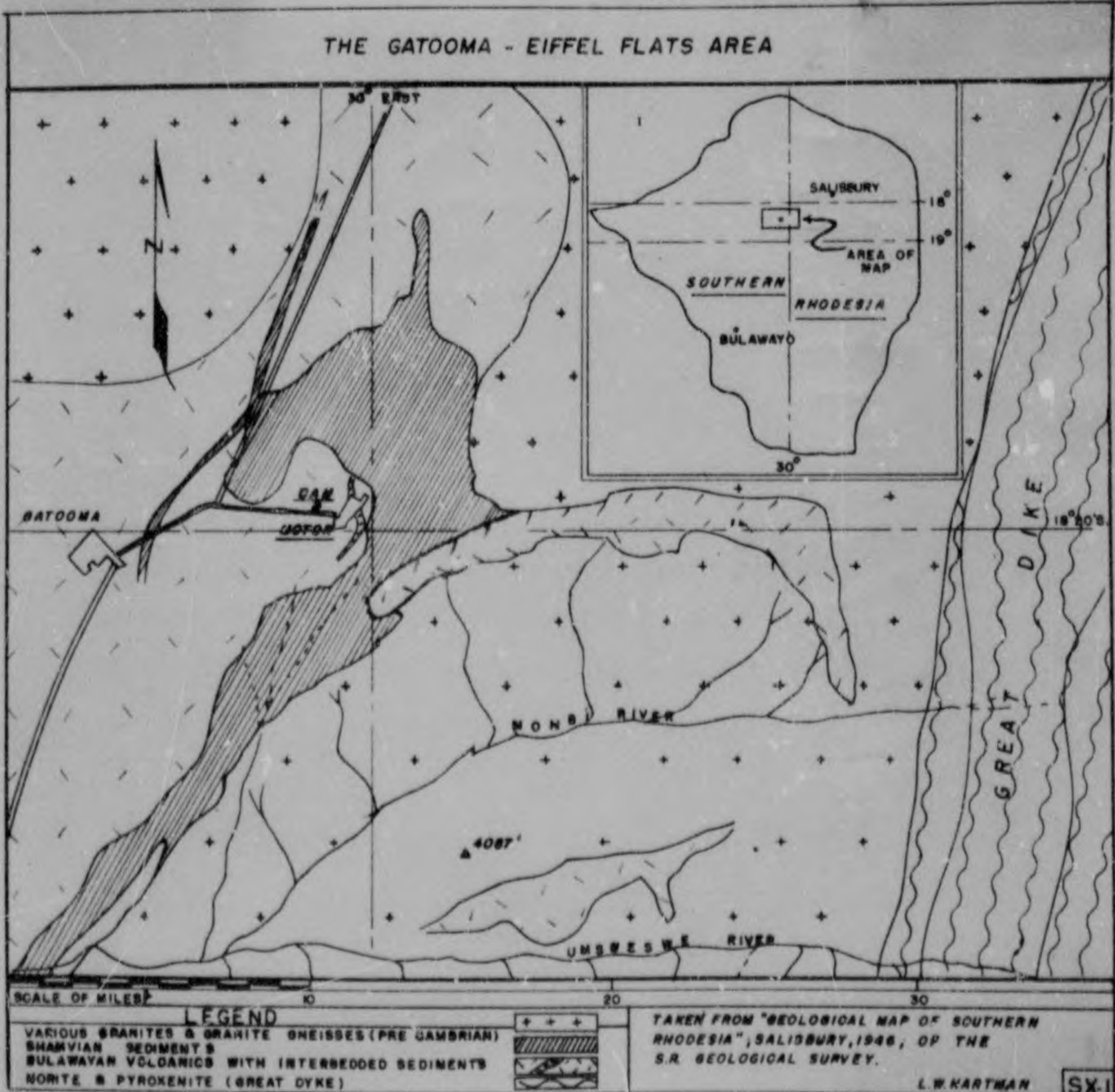
1. Wiles, J.W. Pending bulletin on the Hartley District of Southern Rhodesia.
2. Zealley, A.E.V., and B. Lightfoot, The Geology of the Country around Gatooma: Southern Rhodesia Geol. Survey Bull. 5, pp. 17-21, 1918.

and at surface the strike of this single lode was nearly a mile. The Cam and Motor Gold Mining Company was formed before the end of the year 1910 to take over the Cam, Motor and adjoining properties from the London and Rhodesian Mining and Land Company, under whose auspices it was floated. All production ceased and vigorous development work was undertaken. The Company was reformed in 1919 and has continued under the same management up to the present.

No reference will be made herewith to the development of the lodes or treatment facilities as they will be treated under separate heading. The Cam and Motor now consists of 836 claims, two tailing sites and one pebble site. A large number of interconnected lodes are now being worked with central haulage and hoisting facilities and a vertical depth of over 5400 feet has been attained, at which depth the values still prove satisfactory.


THE GATOOMA - EIFFEL FLATS AREA
30° EAST
N
SALISBURY
18°
19°
AREA OF MAP
SOUTHERN
RHODESIA
BULAWAYO
30°
GATOOMA
DAM
UOTOR
18°20'S.
GREAT DIKE
MONGI RIVER
4087'
UMSWESWE RIVER
SCALE OF MILES
10
20
30
LEGEND
VARIOUS GRANITES & GRANITE GNEISSES (PRE CAMBRIAN)
SHAMVIAN SEDIMENTS
BULAWAYAN VOLCANICS WITH INTERBEDDED SEDIMENTS
NORITE & PYROXENITE (GREAT DYKE)
TAKEN FROM "GEOLOGICAL MAP OF SOUTHERN RHODESIA", SALISBURY, 1946, OF THE S.R. GEOLOGICAL SURVEY.
L.W. KARTMAN
SX-1

CHAPTER II

REGIONAL STRATIGRAPHY.

The Gem and Motor Mine and its environs lie in the area designated by Maufe[3] as the "High Veld". To the East, remnant of the "Primitive Surface" would be represented by the Mhlaba Hills of the Great Dyke; some 27 miles East Southeast of the area under discussion. Exposed on the "High Veld" surface are various members of the Pre-Cambrian Systems, which may be arranged in the following order.

Note: The following stratigraphic table[4] lists only such formations as are encountered in the area being discussed, and is in no wise to be considered as complete.

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3. Maufe, H.B., Some Problems in Rhodesian Physical Geology: South African Journal of Science, Vol. XXIV pp. 30-36, 1927.
4. MacGregor, A.M., Anniversary Address to Geol. Soc. S.A. Trans., Geol. Soc. South Africa Trans. Vol. LIV, pp. 68, 1951.

GEOLOGICAL FORMATIONS AND EVENTS	MINERALS	AGE IN MILLIONS OF YEARS (Ahrens and others)
JURASSIC Karroo Dolerite Dikes & Sills (F)		
UPPER PRE-CAMBRIAN <u>Post Lomagundi</u> Intrusion of Great Dyke; Folding; Intrusion of Dolerite, (E)	Chrome ore Platinum	550-600
ARCHEAN Younger Granite (B) Younger Gneiss (B)	Major S-Au	2,100-2,150
<u>[illegible]AIAN</u> Mai[illegible]ents (D)		
--[illegible]NCONFORMITY --------		
<u>Bul[illegible]wayan</u> Lavas and interbedded Sediments Old Doleritic Greenstones (C)	Iron Ores	
-------- UNCONFORMITY --------		
Older Gneiss (A) (Rhodesdale Gneissic Granite)		2,950 (?)

CHAPTER III

REGIONAL PETROLOGY.

THE RHODESDALE GRANITE.

The Rhodesdale Granite covers an area of some 3300 square miles in extent. As observed, most of this area consists of a monotonously level plain covered with relatively thick scrub and a light coloured sandy soil, in which outcrops are not plentiful. In general the rock consists of biotite granite of varying composition which at most times shows distinct banding which Zealley[5] considered an original feature rather than "one induced by forces acting subsequent to consolidation". "The banded nature of the rock is its most prominent feature, and is due to the alternation of bands rich in, and poor in or devoid of black mica --- this banding is usually parallel to the edge of the mass and the planes dip outwards at high angles (6)-80°)."

Where the granites lose their banded and finely granular nature and become massive or porphyritic, the change can be immediately noted in the topography: the former (banded Gneisses) having flat to gently rolling

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5. Zealley, A.E.V., op. cit., pp. 17 - 21

terrain and the latter almost invariably building "castle" koppies, as a result of spheroidal weathering. This granite mass contains Pegmatites, Aplites, gold quartz veins and large irregular masses of barren quartz. In addition a very large number of inclusions of older Greenstones and a few of serpentine have been noted within the Granite.

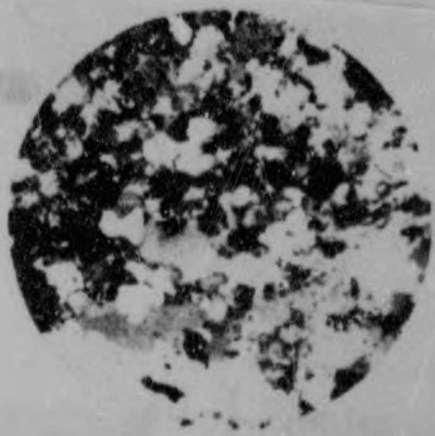
A.—Pegmatite veins injected into banded granite.
[illegible] River, [illegible] Farm.

From Bulletin 5: Southern Rhodesia
Geological Survey : Page 18.

With reference to the origin of this Granite and other such ovoidal masses of like age and nature in Southern Rhodesia, it has been suggested that this type of batholith was formed through the consolidation of homogeneous magmas as Granite Gneiss. The structure and stratification of sediments (Sebakwian) earlier than these Granites is considered to be so unlike that of the resulting banded gneiss that the origin of these gneisses through granitisation is considered highly improbable. Unfortunately, the paucity of outcrops of this rock made it necessary to collect specimens from mine workings, and as a result only a small amount of fresh material was available for study.

Observed specimens of this Granite can be described as grey to greenish hard, finely granular Granite Gneisses in which the banding can be seen to consist of aligned flakes of black to greenish black biotite. The more distinctly green varieties have abundant microline in lieu of the usual andesine to albite content.

Some of the less gneissic varieties would correspond to the classification of a tonalite. As regards the banding, the writer feels that since the bands are oriented parallel to the margins of the Granite, crystallisation must have begun while the mass was still under tectonic pressure.



Rhodesdale gneissic granite.

B. RHODESDALE GNEISSIC GRANITE.

The rock consists essentially of slightly Sericitised Felspar and Quartz.

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Crossed Nicol X 14.

From Bulletin 17 : Southern Rhodesia Geological Survey: Page 62. (X Nicol X 14).

MacGregor[6] described this rock as consisting "essentially of quartz and andesine and crowded with flakes of secondary mica; about 6 percent of microline and 6 percent of idiomorphic green biotite, forming an equi-granular structure". The following is the approximate Mineral composition as given by MacGregor:[7]

Quartz	41.2 %
Plagioclase (Andesine) ...	46.7
Microline	6.0
Biotite	6.1
	100.0 %

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6. MacGregor, A.M., The Geology of the Country between Gatooma and Battlefields : Southern Rhodesia Geol. Survey Bull. 17, pp. 51-54, 1930.

7. MacGregor, A.M., op. cit. pp. 54.

This rock was chemically analysed to accompany MacGregor's report.

Analysis 218 (S.R. Geol. Surv.)
Rhodesdale Granite.

	%	Molecular Prop.	
SiO_2	73.49	1.225	
Al_2O_3	12.28	0.120	
Fe_2O_3	0.14	0.001	
FeO	1.98	0.028	
MgO	0.52	0.013	
CaO	4.32	0.077	
Na_2O	3.01	0.049	
K_2O	1.72	0.018	
H_2O (+)	0.64	-----	
H_2O (-)	0.13	-----	
CO_2	0.68	0.015	
TiO_2	0.22	0.003	
ZrO_2	nil	-----	
P_2O_5	0.31	0.002	
SO_3	nil	-----	
Cl	Trace	-----	
S	0.13	0.004	
MnO	0.03	-----	
BaO	0.03	-----	
SrO	0.22	0.002	ANALYST: E. GOLDING.
TOTAL	99.85	99.68	

The specimen described above is more or less typical of the Rhodesdale mass as a whole, and since it was collected in the vicinity of Gatooma it has been included. The nearest granite to the Cam and Motor proper is some two and one half miles distant.

THE BULAWAYAN GREENSTONES.

The Bulawayan Greenstones in this district outcrop as a belt some twenty miles in width which crosses the area from Southwest to Northeast. In general, these ancient greenstones may be best described as slightly altered basic lavas of fine grain, and there is little doubt that in spite of their great age they have suffered little effect from dynamic forces. In many cases the vesicular members contain amygdules which are not in the least distorted. These "greenstones" fall into two general classes; those of basaltic composition and those approximating to epidiorite. The basaltic varieties composition is, in general, largely carbonates (Ca, Mg, Fe), chlorite, a variable amount of quartz, and at times unaltered felspar. There are many types, largely due to great age and regional metamorphism. The more altered varieties contain usually a larger percentage of carbonates, sericite and chlorite in a variable proportion, and are often highly sheared and schistose. The "Epidiorites" usually contain a large percentage of secondary hornblende, considerable plagioclase, and occasionally, unaltered augite, as well as quartz and minor magnetite or ilmenite and epidote. In nearly all cases the low grade of thermal metamorphism of these greenstones may be noted, and without exception, only those lavas which are in the immediate vicinity of later intrusives are affected thus. The Basaltic varieties are found at considerable distances from the granite contacts, whereas Epidiorites are nearly always close to the edge of the Granite mass.

The alteration of the greenstones in the workings of the Cam and Motor Mine is inversely proportional to the distance from the nearest lode or dike, and in places virtually unaltered basaltic lavas (as regards thermal metamorphism) can be seen with perfectly preserved "pillow" structure at distances of less than three hundred feet from a major lode. This pillow structure is rather common in the basaltic lavas and is often of invaluable assistance in determining the original upper surface of the steeply dipping beds in the mines.

C. BULAWAYAN LAVA EXHIBITING PILLOW STRUCTURE.

MacGregor, A.M.; Southern Rhodesia Geol. Surv., Bull. 17.

On Page 17 is given the mean of seven chemical analyses of Bulawayan greenstones from various localities; some of which came from the Cam and Motor Mine, and others which came from various localities in the district. Certain of the analyses were made by E. Golding for the Southern Rhodesia Geológical Survey; others by the author,

MEAN OF SEVEN CHEMICAL ANALYSES OF BULAWAYAN GREENSTONES.

	%	Mol. Prop.
SiO_2	52.37	8.690
Al_2O_3	12.35	0.120
Fe_2O_3	2.48	0.014
FeO	7.34	0.080
MgO	5.11	0.128
CaO	11.64	0.207
Na_2O	1.93	0.031
K_2O	0.48	0.005
H_2O +	1.85	0.112
H_2O -	0.29	0.016
CO_2	2.80	0.064
TiO_2	0.94	0.012
ZrO_2	nil	nil
P_2O_5	0.29	0.002
SO_3	nil	nil
Cl	nil	nil
S	0.06	0.011
Cr_2O_3	nil	nil
MnO	0.14	0.002
NiO	nil	nil
SrO	0.06	---
TOTAL	100.13	
Specific Gravity		2.87

Greenstones of comparable nature and most probably of similar origin may be found throughout the Southern Rhodesian "Gold Belt" as well as at Murchison, Barberton, Manica, Mount Mare and elsewhere. The composition of these greenstones will be more thoroughly discussed under the petrology section of the mine proper.

THE INTERBEDDED SEDIMENTS.

The interbedded sediments within the Bulawayan greenstones, although minor in volume when compared with the enclosing lavas, are, as often as not, highly important as regards mineral deposits found therein. The individual sedimentary body seldom exceeds one thousand feet in thickness, but there are cases where they have been reported as being nearly a m[illegible] dimension. Length of strike and thickness are always highly variable and nearly all such beds are of lens[illegible]. The members usually consist of arkose, greywacke and lesser shale with infrequent calcareous strata, and rarer pyroclastic bodies and banded ironstone. Conglomerates consisting of quartz pebbles in a matrix of grit are also not uncommon. Rather than forming a continuous belt such as the enclosing greenstones, these sediments are disposed haphazardly, in small and large lenses, and are at times amazingly fresh and unaltered. The banded ironstones usually form ridges, due to their very resistant nature and particular situation, and in some cases can be traced for over one hundred miles. In the area of the Cam and Motor the only lens shown (Diagram 3x-1a) is that upon which the Mine is located. As observed in the upper levels of the mine, this lens is now oriented with its original upper surface to the west, and dips at an average of 85° to the West, to a depth greater than the deepest penetration (5400 feet below surface) in the area. In reality, this formation is not one consistent lens but rather a series of smaller lenticles along a common (mutual) horizon, and is not believed to have been of sufficient lateral extent to form a continuous unit of the main synclinal fold of the greenstones in which it is interbedded. It probably exists in one limb only of the fold.

The following succession was noted on an upper level of the Cam and Motor Mine and is the mean of four traverses.

Doleritic Greenstones	?
WEST (Original Upper Surface)	
Greywacke	40-70 feet
Shale (Carbonaceous)	0-20 feet
Arkose and Greywacke	350-500 feet
Shale (Carbonaceous)	0-15 feet
Arkose	111-230 feet
Breccia (Various)	0-25 feet
Slate and Graphitic schist	10-60 feet
EAST (Original Lower Surface)	
Doleritic or Chloritic Greenstone	?

As the individual facies of this succession will be discussed under the section on petrology, it is unnecessary to consider them at this stage.

DOLERITIC GREENSTONES.

Doleritic Greenstones of Bulawayan age are widespread throughout the lavas and form sills, dykes, basal sheets, and, rarely, irregular shaped intrusive masses. There are dolerites of three ages (?) in the Hartley district, and they are usually found in situations and circumstances peculiar to their period of intrusion. The youngest of these are the Karroo dykes, which are nearly always found striking either due North-South or East-West, and are sufficiently characteristic in thin sections to be almost immediately distinguishable from their earlier counterparts. The member intermediate in age would be those dykes which have a general Northeast-Southwest strike and are probably connected with the intrusion of the Great Dyke. These lie usually within an area not more than twentyfive miles West of the Great Dyke, and at times have been noted to have certain characteristics other than bearing in common with this structure.

The oldest intrusions of dolerite are those which are more or less contemporaneous with the Bulawayan greenstones. Distinguishing these dolerites in the hand specimen is never a simple matter, since they so closely resemble those greenstones which they intrude, and have by and large undergone precisely the same cycle of alteration. This is especially true when the dolerites invade the more hornblendic greenstones, in which case determination without the aid of a thin section or polished surface is virtually impossible. The entire Bulawayan greenstone area in the environs of the Cam and Motor is so carbonitised that it is often impossible to delimit a contact that is known to exist between the two members, namely the B asaltic greenstone and Doleritic greenstone. At times the dolerites have been altered very extensively, but as in the case of the greenstones, only a surprisingly low grade of wet metamorphism has been effected.

In the areas shown upon the geologic plans of the Cam and Motor Mine, where a medium grained basic rock which has been intensely sheared was encountered, it was mapped as a greenstone, (i.e. altered lava), rather than dolerite, although possibly a more correct term would have been Annamesites. A change in wall rock from greenstone to dolerite, or vice versa, does not seem to have had adverse (or any) effect on the tenor of the crossing lode. However, on bottom levels it sometimes appears that certain of the lode channels "veered" away from entering the relatively unaltered dolerites, and assumed a course at times almost at right angles to their original bearing in order to remain in the greenstones. This will be discussed in the section on the lodes.

As this member of the igneous suite of the mine was so generally altered, it was felt that little could be gained through chemical analysis. Below is given a hypothetical composition, determined by geometric means under the microscope, which was the mean of fourteen of the fresher samples of dolerite collected; all were carbonatised extensively:

	Original % Composition	Alteration Products.
Plagioclase (Labradorite-Andesine) usually saussuritised.	47-55 %	Mainly sericite, carbonate and kaolin.
Orthopyroxene	30-35%	Amphibole and chlorite, etc.
Quartz	-5 %	
Iron ore, Zoisite, epidote	-5%	Iron to leucoxene.

As regards the nature of these rocks it may be said that they are, in general, darkish green, hard dolerites with sub-ophitic to ophitic texture, sometimes approaching diabase, the plagioclase generally being replaced by carbonates, and the orthopyroxene altering to amphiboles. Chlorite is nearly always present in small amounts as are leucoxene after titaniferous iron ores, and usually a little epidote and other minor accessory minerals. Although retaining much of their original texture, they have undergone the same alteration as their enclosing greenstones.

THE SHAMVAIAN SEDIMENTS.

The Shamvaian sediments occupy an area averaging three miles (East-West) in width, and overlying the contact between the Rhodesdale granite to the East and the Bulawayan Greenstones to the West. In the area shown on the map (Sx-1), the composition of these sediments is rather uniform, indicating perhaps continental conditions as regards mode of deposition. South of the Southern margin of the map Sx-1, this is not the case, and the formation is divided into three rather unlike groups. These are named: Battlefields Group, Pebbly Quartz Group and Barton Farm Group. In the Eiffel Flats area, the pebbly quartzites form a low ridge of hills some three miles East of the Cam and Motor Mine. These (quartzites) in this area are associated with the banded ironstone ranges, and usually consist of several bands of grit. The strike is roughly Northeast-Southwest, with Southeast dips averaging about 70°. The grits are usually fine grained, but not uncommonly contain pebbles of quartz and flakes of mica, the pebbles being well rounded and averaging about ½ inch in diameter. As regards mineral deposits in the Shamvaian series in the Eiffel Flats area, only a few of the bodies of "Banded Ironstone" have been prospected, and with no outstanding results, although the writer feels that there is a possibility that the Mid-Winter mine might be associated with ironstones of this age. The conglomerates in the Eldorado "Banket" can, however, be correlated with this system, in that it is a metamorphosed basal conglomerate of like age. Other occurrences of sediments of similar age occur near Gwelo, Mazoe, Bulawayo, Bubi, Gwanda, Umtali and elsewhere.

THE YOUNGER GRANITES.

The Younger Granites occur in the Hartley district in several localities. The particular bodies in the area under discussion have been named the Whitewaters, Sessombi and Zwimba masses. The Easternmost (Whitewaters) is located in the central part of the area, and will be discussed here. This body has an elongated and offset hourglass shape with the long axis from North-Northeast to South-Southwest. It is about twenty miles in length, and of variable width, averaging about two miles. The Southern portion, known as the Grandeur Granite, covers an area of about ten square miles. It is porphyritic in nature, and with small cupolas of this granite outcrop at varying distances in several directions. In the area along the Western contact there is little relief and outcrops are sparse, the nature of the rock being a grey massive granite containing biotite, which intruded the Bulawayan greenstones. Lightfoot[8] says, regarding the relations of the Whitewaters mass with the greenstones which it invades: " ---- the junction of the granite and the greenstones is not always visible, but ---- where exposed ---- becomes rather fine grained, and very much banded, and the greenstones become rather flinty. There are also numerous fine grained apophyses from the Granite. There are ---- remarkable few inclusions of greenstone on the granite mass. Some large masses of white quartz are found in the granite and usually form well marked koppies ---- it is likely that these represent a late ultra acid phase in the consolidation of the Granite."

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8. Lightfoot, B., op. cit. pp. 20-22.

MacGregor[9] describes the petrology of eight specimens collected at various localities as follows: "They are soda granites characterised by idiomorphic crystals of strongly zoned plagioclase, and biotite, and sometimes hornblende, cemented by allotriomorphic quartz and microline". The following analysis of a typical specimen of the Whitewaters granite is taken from MacGregor's report.[10]

ANALYSIS OF WHITEWATERS GRANITE BY A.M. MacGREGOR.

	(by weight)	(by area)
Albite	45.26%	51.9%
Anorthite	5.03	
Quartz	19.68	20.0
Biotite and Hornblende	18.12	15.8
Microline	11.17	11.9
Pyrite, etc.	.74	.4
	100.00	100.0.

A few gold mines are found within this granite mass as are the only large scheelite mines in the district. In the marginal greenstones surrounding the circular cupola to the North, are found a considerable number of gold mines and additional scheelite deposits. Three miles to the Northwest of the area lies the Golden Valley mine, the second largest gold producer in the district, which also produces a large amount of scheelite. In general, there are a large

9. MacGregor, A.M. op. cit. pp. 61-62
10. MacGregor, A.M., op. cit., pp. 62.

number of mines surrounding this mass at various distances, and surrounding the numerous cupola structures of the same age. It will be noted that this granite mass is offset approximately on line XY shown on Diagram SX-1a.

5. Sessombi granite (grey tonalite).

6. Grandeur granite (red tonalite).

Southern Rhodesia Geol. Survey, Bull. 17: Crossed Nicol, X 14.

THE GREAT DYKE AND ASSOCIATED DOLERITES.

This unusual and interesting structure and its associated dolerite dykes are shown on Diagram SX-1a (in part). The singular nature of this long narrow mass of basic to ultrabasic rocks, its striking composite structure and its unique mineral wealth, have been widely written of and discussed. In addition, its contemporaneous origin with that of the Bushveld Igneous Complex and the identical rock types of the two intrusions are of especial interest.

In describing the dolerite dykes believed to be associated with the intrusion of the Great Dyke, MacGregor[11] states: "The most frequent trend is between 20° - 30° East of North --- at the time they were formed, important tensional stresses perpendicular to this strike must have effected the country --- this strike is within 10 degrees of the mean strike of the Great Dyke --- dykes (of dolerite) with this strike stand up as ridges 20 to 40 feet above the level of the country and are frequently large".

It is not known that any of the dolerites upon the Eiffel Flats can be retaled with any degree of assurance to this period of intrusion, and it would be well to state that it is very doubtful that the dolerites of

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11. MacGregor, A.M., op. cit. pp 71.

later age (than the Bulawayan greenstones) which are encountered on the Cam and Motor Mine could conceivably be considered to be of this age.

THE LOMAGUNDI SYSTEM.

The Lomagundi System includes both sediments and lavas, and has been correlated with the Transvaal formation of South Africa. These beds are present on the extreme West a.. Northwest sides of the area, as shown on Diagram SX-1a and rest unconformably upon the underlying basement complex. The lower series consisting of basal conglomerate is overlain by basaltic lava flows to a thickness of up to 3000 feet. These lavas have been compared, as regards petrographic characteristics, with the Ventersdorp lavas. The upper series consists of sediments, largely arkose, and quartzite, and are shown in turn overlain by dolomites. As no rocks related to this series have been recognised as existing upon the Eiffel Flats proper, they will not be discussed further.

THE KARROO SYSTEM.

No sediments of Karroo age are known to occur in the general area, but a number of dolerite dykes, which might possibly be of similar age to the Karroo dolerites of Southern Africa are present, some 15 miles west of the Cam and Motor Mine. These dykes are narrow bodies and are less altered than the numerous dolerite bodies seen in the underground workings of the Cam and Motor Mine. The strike direction of these dykes, which occur as swarms, is either North-South or East-West, which is not the usual direction of the strike of those dolerite dykes associated with the intrusion of the Great Dyke.

A number of specimens have been collected from outcrops of moderately fresh dolerite occurring as dykes in the Eiffel Flats area, which do not show the usual characteristics of Karroo Dolerites, and it is possible that their age might correspond to that of the intrusive bodies encountered in the Mine workings.

Wiles[12] has mapped the area and taken specimens of a large number of these outcrops, and it is hoped that, as a result of his studies, it may be possible to determine if any of these dykes might be of Karroo age.

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12. Wiles, J.W., op. cit.

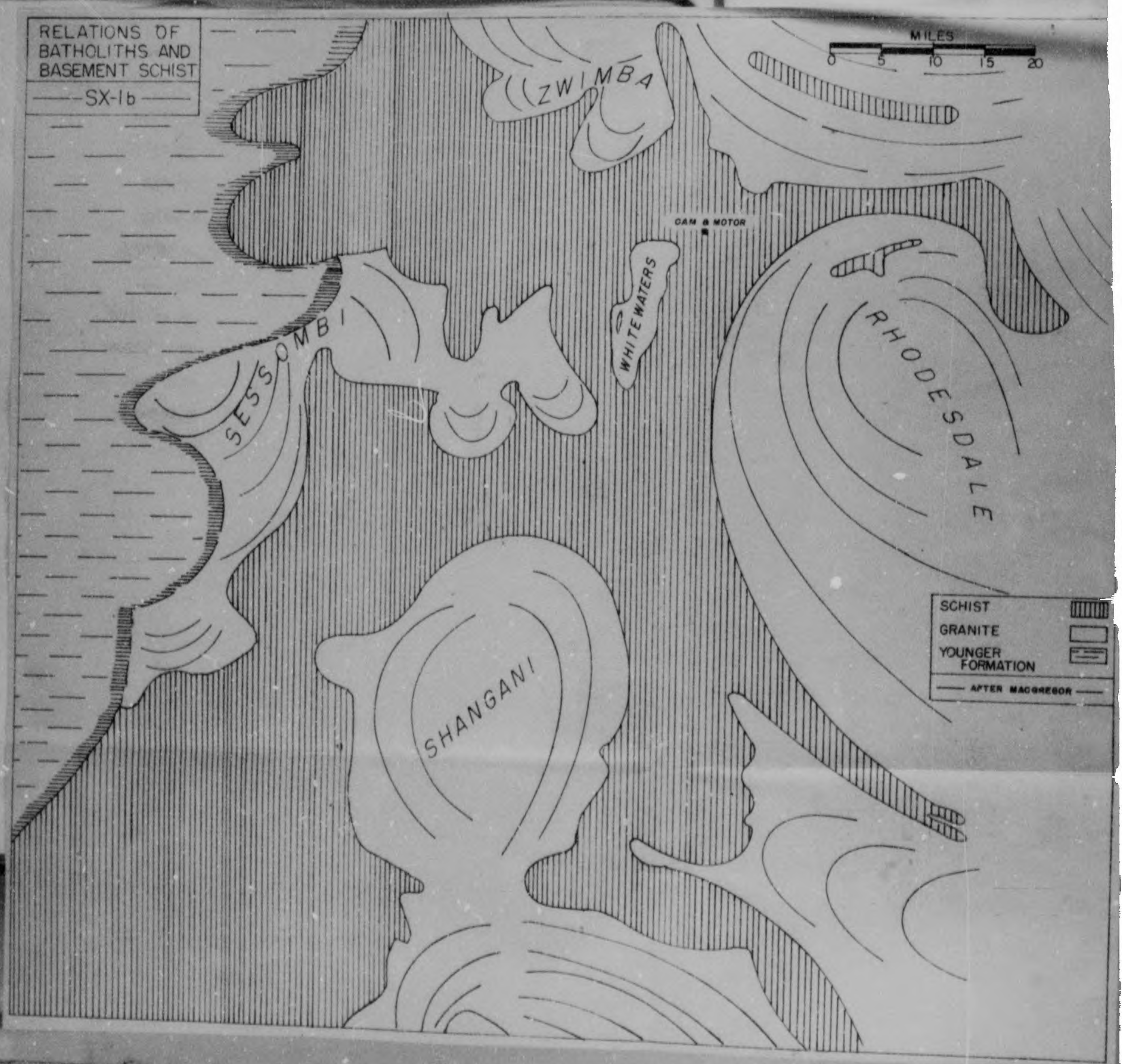
CHAPTER IV

REGIONAL STRUCTURE

It is not the intention of the writer to attempt to relate the geology of development of the Rhodesian Gold Belt, as such, and the following information is given only as a preliminary account in order to clarify such minor tectonics as governed the origin of the structure of the Eiffel Flats mining area.

As illustrated on Diagram 3X-1a, only a very small portion of the area under consideration is formed of sediments, whereas, by and large, the basement complex consisting of Bulawayan Greenstones, and surrounding granitic batholiths makes up the bulk of the exposed surface.

The case of the particular body of greenstones which occupies the area including theCam and Motor Mine cannot be taken as typical, due to the fact that a mass of later (Shamvaian) sediments overlies the granite-greenstone contact, and often masks valuable information as regards relation between the two. In addition, the granite masses to the West and North (Whitewaters-Sessombi, Zwimba) are of later age than those to the East (Rhodesdale).



RELATIONS OF BATHOLITHS AND BASEMENT SCHIST
SX-1b
MILES
0 5 10 15 20
ZWIMBA
CAM & MOTOR
WHITEWATERS
SESSOMBI
RHODESDALE
SHANGANI
SCHIST
GRANITE
YOUNGER FORMATION
AFTER MACGREGOR

Maufe[13] says in reference to a similar area near Selukwe: "the larger structure --- the schist belt of metamorphic rocks lying between granite batholiths is typical of the metamorphic region of Southern Rhodesia. It is a general rule -- that the strike of the schists and of their foliation is parallel to the edge of the batholiths and to the banding of the gneissic granite. Secondly, the batholiths being roughly (see diagram SX-1b) oval bodies have curving margins, there being no general direction of strike throughout the country independent of the granite batholiths. Thirdly, the schists almost always dip away from the margins of the batholiths, thus appearing to be synclinal areas. These constant relations between the granite batholiths and the structure of the schists imply some connection between the upwelling of the granite and the folding of the schists". (See Diagram SX-1b).

The schists (Bulawayan Greenstones) are the oldest rocks exposed in the area of diagram SX-1a; no rocks of the Sebakwian System having been observed in the immediate vicinity. As already mentioned, these ancient lavas are little altered as regards dynamic metamorphism, and vary from intermediate to basic in composition, and the formation in this area consists of a single series (with

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13. Maufe, H.B., The Geology of the Selukwe Mineral Belt. Southern Rhodesia Geol. Surv., Bull.113 SALISBURY: GOVERNMENT PRINTERS, 1919

intermittent lulls during which sedimentary beds were deposited). In other areas, however, the aforementioned Bulawayan System may be separated into an upper and lower greenstone series with an intervening unconformity and a total thickness of up to 30,000 feet. A basal conglomerate containing granite pebbles which at times overlies the granite to the East, shows a period of denudation before the initial extrusion of these lavas, but in some cases an intrusive contact is observed between the granite and the greenstone.

Following the extrusion of this great volume of lavas upon the ocean floor, the folding commenced, and the result of folding affected the surrounding granite. In general, the accepted view concerning this folding is that, by sheer weight and force of gravity, the (heavier) greenstones tended to sink into the still fluid (lighter) substrata which in turn was accompanied by a corresponding rise in the granites (to the East), with the resultant lines of "sag" representing the heavier portions of the lava flows. As the dips of the greenstones are now largely vertical, this must have been a very extended process.

MacGregor[14] says concerning the resultant form

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14. MacGregor, A.M., Anniversary Address to Geological Society of South Africa. Geol. Soc. S.A. Trans. Vol. LIV. JOHANNESBURG 1951.

assumed by the granite masses: "Convection currents set up in the granite may account for the circular or eliptical form of the batholiths --- the granites appear to have remained plastic over a very long stretch of time". As regards correlation of the older gneisses, he continues: "similar ages (between Rhodesian and Canadian granites) of a little over two billion years have been determined by the uranium/lead and rubidium/strontium methods (Holmes, 1948; Ahrens, 1950)". In [illegible]on mention was made of comparison with an [illegible] in Finland[15] which would represent an earlier stage of geomorphological development than the Canadian or Rhodesian areas.

The writer might mention at this point that an even earlier stage of such development of a like situation might be represented by the invasion and folding of the Pinal Schists by Pre-Cambrian Granites and Granite-gneisses in the mineral rich area South of Globe, Arizona, which was studied during 1947. Dissimilar climatological history, however, has brought about a strikingly different variety of topographical expression than any case previously mentioned and would constitute a most interesting study.

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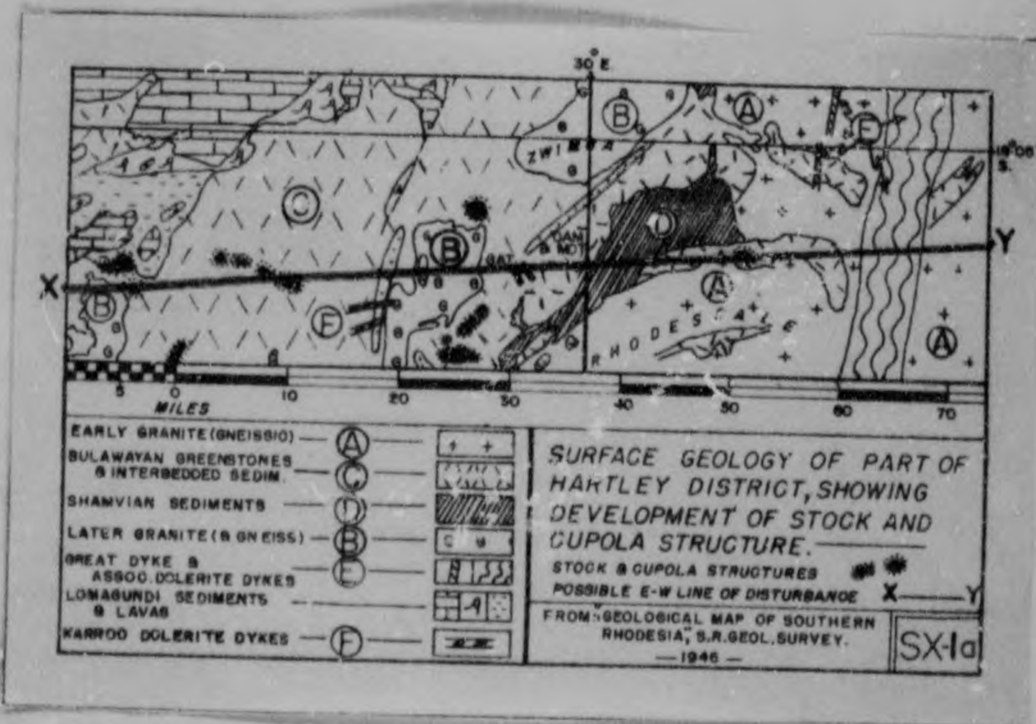
15. MacGregor, A.M., op.cit. pp. Xli



Following line X-Y (Diagram SX-la some seven miles to the East of the Cam and Motor Mine, an elongated, narrow, synclinal "belt" or greenstone penetrates the Rhodesdale granite for a distance of some 15 miles, curving round to the South at its Eastern extremity. If the suggestion made in the following chapter that the "Main Fold" of the (Cam and Motor) mine was pre-downfolding (of the main greenstone formation), it is most probable that the origin of this pendant was a contemporaneous expression of the same deep-seated cause. This will be further referred to.

Subsequent to the development of the major portion of the synclinal structure of the schists and consequent rise of the granite batholiths, would have been the erosion of the expsed surface and deposition of the Shamvaian sediments, the nature of which has already been discussed. At no time is the relation of this "infolded" belt very clear as regards the development of the general structure, and it is hoped that Wiles[16] will be able to clarify this somewhat in his forthcoming bulletin.

The intrusion of the younger granites to the West and North, represents the subsequent stage in the development of the structure and can be considered as of prime importance, as it was during this period that the majority of the gold lodes in Rhodesia were formed. The nature of these invading masses has already been referred to, but since the relation of this period of activity is

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16. Wiles, J.W., op. cit.

is intimately linked with the mineralisation, it would be well to deviate at this point. Line X-Y on diagram SX-1a may be seen to originate in an area on the Western margin of the sketch, in a mass of granite of this age (Sessombi Batholith). Following Eastwards, the line passes through a group of minor cupolas (of granite of like age), and thence through the Whitewaters mass along a line roughly corresponding to the axis along which the Northern and Southern portions of this body are offset, and through the only sizeable inclusion of Bulawayan Greenstone in this mass. Thence the line passes through the Cam and Motor Mine and approximates in position to what may have been the original centre-line of the "Main Fold" of the Cam and Motor Mine. From there it passes through the elongated greenstone mass already mentioned, and a cupola therein. The existence of these features along this line and the corresponding development of mineral deposits thereupon suggests to the writer that this "line" might conceivably represent a zone along which stresses were developed, which was at an angle to the main line of original sag representing the synclinal axis of the downfolded Bulawayan lavas. Several anomalies along this line can be noted upon Wiles'[17] surface map of the Cam and Motor area. (Plan Surf.)

With reference to this stock and cupola structure, it must be kept in mind that this period of activity also includes the bulk of the gold mineralisation. It was most probably contemparaneous with the "vein intrusives" of various natures upon Eiffel Flats and elsewhere throughout the country, even though actual granite is often at considerable distance from the location of mining areas. The intermediate to moderately basic nature of many of these intrusives would agree with Emmons[18].

At a much later period, the intrusion of the Great Dyke and minor associated dolerite dykes contemporaneous with it took place.

The only rocks present in this area directly under consideration, which are representative of a still later period of geological activity are the possible Karroo Dolerites, following the intrusion of which uplift and erosion have exposed the "Basement Complex" formation. This process continues at the present time.

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17 Wiles, J.W., op. cit.

18. Emmons, W.H., Gold Deposits of the World. New York McGraw-Hill Book Co., Inc., 1937.

CHAPTER V

TECTONICS OF THE CAM AND MOTOR AREA

Examination of the diagram SX-1a brings forth several significant features as regards the unique position of the Cam and Motor Mine, with reference to its geological surroundings. In brief the picture presented is one of a relatively small lens of sediments interbedded in volcanics of like (Bulawayan) age, which are in turn surrounded by granites and partially covered by later (Shavaian) sediments.

The location of this lens of sediments, and the structural sequence which brought about their rather unique present form and state, may be regarded as of prime importance to the origin and remarkable continuity of such lodes as are found in the Cam and Motor Mine.

In discussing the structure shown on diagram SX-2, it must be kept in mind that it is an idealised sketch, and can neither be considered to apply to surface structure, nor at any particular horizon within the workings. In addition, the interbedded sediments are shown as a single continuous formation, whereas in reality they consist of numerous smaller lenticular bodies in a somewhat discontinuous belt, which further complicates the problem of mapping and sorting out the structure. Also, the positions of the lodes are only relative insofar as their mutual relations are concerned, and their actual positions are more clearly brought out upon diagram SX-3 and the Geological Plans of the individual levels of the mine. With regard to he relative size of the body of interbedded sediments, it is entirely possible that it (at present(may represent one (the East) limb of a continuous stratum in the general synclinal trough formation of the lavas, but in view of their (sediment's) irregularity and lenticular nature, it is highly improbable.

Preceding sketch No. 1, of Diagram SX-2 would have been the extrusion of some thousand of feet thickness of pillow lavas, of general basaltic nature, and the possible deposition of minor sedimentary lenses which would lie to the East of the Area upon which the sketch is based.

Sketch No. 1

This represents the surface at the end of a lull in the Bulawayan volcanic activity, during which some 750-1000 feet of sediments, largely arkose, greywacke, and with some shale were deposited in a rather lenticular shape.

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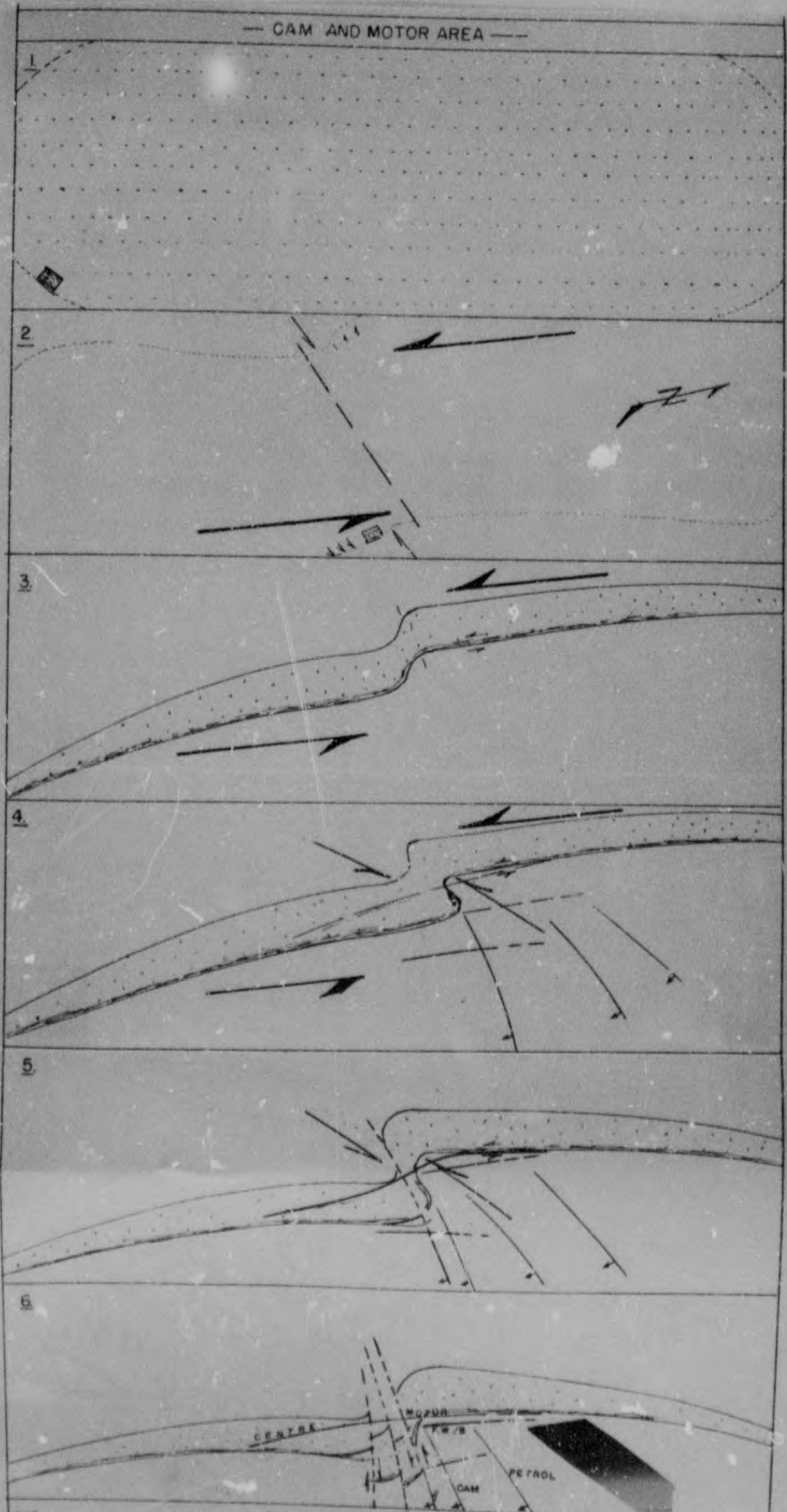
involved

lot


— CAM AND MOTOR AREA —
1.
2.
3.
4.
5.
6.
CENTRE
MOTOR
PETROL
CAM
SCALE GROSSLY EXAGGERATED
SX-2

Following this, the extrusion of additional pillow lavas took place, and was most probably accompanied by intrusion of sheets and basal bodies of dolerites into the underlying lavas. During this process, the nearby granites were possibly rising in accordance with the great mass of lavas sinking into the plastic substratum. It is possible that the processes were related in some fashion other than gravitational adjustment.

Sketch No. 2

This represents the initial stage of deformation which was probably assumed by the lavas and interbedded sediments. The nature of this deformation appears to have been monoclinal, but may possibly have been sharply anticlinal in nature.

not shown on SX-2

Line X-Y shown on diagrams SX-1a and SX-2 is the supposed original centre-line of the fold, and of a hypothetical line of weakness through a zone some 80 miles long (East-West) upon which the stocks, cupolas and elongated greenstone masses exist in relative abundance. This probably represents a zone of incompetency along which forces acting upon the sinking greenstones and interbedded sediments were transmitted. The original folding appears to have taken place while the greenstones were still in approximately horizontal (original) attitude, and was further complicated by the intermittent downfolding of the main mass.which was due to sag along a line over 300 miles long. Evidence for the case of a monoclinal, rather than an anticlinal nature of the original fold may be alluded to, in that had the fold been anticlinal, the later Cam shear zone would have cut the sediments - a case which never occurs. Also, the obvious monoclinal nature of the fold exposed at the Western end of the Petrol lode on levels 5 through to 15 (see plans of 8 and 14 levels), when coupled with the similarity between the two (Cam and Petrol) shear zones, is almost indisputable evidence. During the formation of this fold, shortening of the beds as a result of folding must have resulted in bedding plans (strike slip) faulting along with shale beds in the enclosed sediments, in addition to crumpling, brecciation and other like phenomena. Although this cannot be considered as a definite opening of the embryo strike slip lode channels, it is worthy of consideration in that of all the rocks exposed in the Cam and Motor Mine, these shales have been subjected to the greatest degree of metamorphism, <u>and</u> show evidence of numerous stages of movement.

Sketch No. 3

This represents a stage at which the regional synclinal downfolding of the lavas reached or was approaching its present attitude. The original upper surface of the lavas is now to the West, dipping from about 80° (WNW) to vertical. Consequent rise in the granites to the East must have been taking place intermittently, to compensate for the sinking in the substrata underlying the newly formed greenstone trough, and it is probably that additional activity occurred along the aforementioned line of weakness (line X-Y) causing additional deformation of the minor fold formed during stage 2. Since the downfolding of the main limb of greenstones had by this time occurred, as mentioned, the shale beds most probably acted as glide planes for bedding plane slip which was this time to the West (and down), in addition to the intermittent North@South horizontal movements engendered during continued folding. It may be considered that by this time, the major North-South channels (Motor-Centre system, and Footwall "A") had developed considerably towards becoming major openings. It is perhaps significant that these, the oldest systems of "fissuring", are also the most consistent as regards economic considerations, and contain the only lodes to continue past the lowest working horizon of the mine. During this stage of the deformation of the enclosed sediments, it is possible that the East-West zones of radial relief were formed, but it is more probable that they followed at a later stage, as such stresses created in the greenstones to the East would have been relieved, in the first instance, by apex faulting in the following stage. Repeated intrusion of dolerite sheets may have continued during this stage, as evidence of intrusion which became static during early "sag" is found, but it is possible that all such activity may have been ceased prior to initial tilt.

Following stage No. 3 there would have been continued sag along the main gold belt synclinal axis, and resulting near vertical attitude of the lavas and interbedded sediments. In addition, continued distortion of the "Main Fold" area would probably have resulted in overturning. No evidence has been encountered which would indicate the time relations between final stages of downfolding of the major synclinal greenstone structure, and the stage of overturning attained by the Main Fold of the Cam and Motor Mine, but it is perhaps safe to say that apex faulting and possibly the final stages of recumbency assumed were subsequent to the major downfolding, although there can be little doubt that the two processes were, in a sense, contemporaneous.

Sketch No. 4

This represents a late stage of overturning resolving into recumbency. It is most probable that the rotational and compressional stresses created by the couple acting on the area involved had, at this stage, caused the initial shearing of the area to the Northeast and East, and although impossible to observe, like shearing must have occurred to the West and Southwest of the Western contact of the sediments. It would seem, therefore, that there would be an excellent opportunity for the occurrence of deposits of similar nature to this section as those to the East and Northeast of the Eastern contact. As illustrated upon the surface plan (Wiles), however, it can be seen that not a single deposit has even been prospected in that area.

If fracture zones of origin similar to the Cam, Motor and other lodes do lie in the greenstones to the West of the Interbedded Sedimentary lens, an explanation of their lack of mineralisation should be apparent. It has been shown that the ore bodies to the East of the sediments were invariably fed from sources lying in a like location, and that the extensions of the lodes which passed into these sediments for any considerable distance were found to become unpayable. The dip of the country is steeply to the West and there are definite indications that the rising solutions (from East sources) found the Sediments an impermeable and impenetrable barrier. This is illustrated in the behaviour of the deep-seated lodes in theGreenstone which, by virtue of the dip of the country, intersected the Sediments up dip and rather than entering the lens continued upwards as a single lode, which is localised along the Eastern Sedimentary-Greenstone contact.

It would be incorrect, however, to say that there was no mineralisation on the Western margin of the Sediments and contact of the Greenstone thereat. Small lodes were prospected on both the 23rd (2797 feet) and 35th (4560 foot) levels and were seen to be lying in Shale andDoleritic Greenstone respectively. As the intervening sediments between the Eastern lodes and the Western lodes are for all practical purposes barren, these lodes were evidently fed from an independent source to the West of the Sediments.

The shear zones which exist to the East and North-east of the sediments have been designated as the "Radial Relief Zones", with the Cam lode being the main point of said relief. In addition to embryonic movement along these East-West zones, additional stresses would have been set up in such a manner as to further open the "Strike Slip" channels along bedding planes, in the shales. It is most likely that the maximum folding had taken place before the opening of theCentre Lode channels, as, by and large, these channels cut across the bedding at low angles and are in general contiguous with their bedding plane counterparts, and although several different channels can be seen to exist at times, it is highly probable that they originated as adjustment complements during and after subsequent apex faulting. In addition, shearing stresses were set up in the Southern limb of the Main Fold, which by virtue of position would have been continued Northward into the greenstones, forming the initial Cam Spur andFootwall "B" channels.

Following Stage No. 4 there would have been a period of continued application of force along the lines of the couple, which through the resultant recumbency of the fold created, would have the effect of causing Apex rupture. This was, no doubt, in part due to the inequality of resultant stresses in the homogenous (greenstone) and heterogeneous (Sedimentary) formations respectively.

Sketch No. 5

This diagram represents a stage where the initial apex rupture of the recumbent fold had progressed considerably and now constituted true faulting. Hereafter, the term "Main Fault" will be utilised in order to refer to the zone or area affected by the said apex fault structure and does not apply to any particular trace. During the latter period of application of pressure along the couple, the resultant direction was apparently Northeast-Southwest and Southwest-Northeast. Evidence on behalf of this postulation is seen in the strike of the main point of radian relief: The Cam (or initial) shear zone strikes 80° West of North and dips at 65° to the South, being opposed a matter of some 10° to the general pitch of the Main Fold; The Main Fault zone strikes slightly South of East with a vertical dip and if (as believed) is subsequent to the Cam shearing, would represent the resultant direction of relief after initial relief had been assumed by the Cam. Additional illustrations can be seen in the strike and dip of the Petrol Lode as regards its monoclinal structure.

(See diagram SX-3).

In addition, further support of the age relations between the Cam and Main Fault are seen in the significant structural bottoming of the Cam channel, which although over a mile in length at the surface, loses continuity upon intersecting the Main Fault near the 30th level

(3560 feet). This fault at surface is of small importance. The possibility of contemporaneous origin, however, must not be overlooked, regarding the relations of the two features, if they are considered as having continued above the present surface for perhaps an additional distance equal to the deepest penetration of the mine, and when viewed in three dimensional or "spherical" sense.

In this stage of the development of the structure, the Motor-Centre Zone was further developed and intermittent movements along the newly created "Main Fault" zone, acting with intermittent slip along the North-South strike of the sediments caused continual openings. This, when coupled with the branching and conjugate system of fracturing in the bottom levels (see plans of 36-39 levels) may be said to have operated in conjunction with the further displacements of the faulted zone. Additional opening of the other channels also should have continued. No evidence of the injection is indicated until final adjustment took place, but it is possible that early fugitive solutions from the deep seated sources which produced the later granites (Whitewaters, etc.) ascended along the line X-Y (see diagram SM-1a) and began to percolate through the rock causing early alterations in the conditions.

Following Stage No. 5 there would have been a period of continued Apex faulting, resulting in blocks from the sediments being forced to the East along the main lines of weakness already created. As can be seen on the underground plans of the Cam and Motor Mine, the displacement of these segments of sedimentary rock was accompanied by a considerable shortening of the North-South axis of the formation as a whole, which in some cases forced these blocks to assume elongated and contorted "fingers" often penetrating far out into the greenstones. (See plan No. 23 level). A large proportion of the brecciation existing along the Main Fault is also assumed to have occurred near the end of this stage, as the angular breccia found associated with the Cam Parallel and elsewhere indicates that it was formed only slightly before the influx of the minor basic intrusives along the lode channels. The intrusive breccia along the Motor Channel of No. 8 level was probably also of this stage. For the sake of simplicity only two displaced blocks, bounded by three faults are shown on Diagrams SX-2 and SX-3. In reality there are any number of irregular and discontinuous portions, and it is often very difficult to follow an individual portion from one level to the next, or at times even along the same level, as this entire "Main Fault" zone is crumpled, broken, contorted and faulted by innumerable adjustment slips, elongated, intruded and even doubled and trebled in a very short distance. The Cam drives from 23 to 27 level will serve to illustrate this confusion, and as a case in point the writer attempted to follow a particular four foot bed of shale from 23 level downwards, only to find that it had been "squeezed" into a schistose mass within twelve feet of a practically unmetamorphosed exposure. The same band when followed upwards into a stope, became thirty five feet wide, showed a number of shale partings, and was sheared at right angles to the bedding, so that upon cross section it appeared to be a rather common occurrence of graphitic schist.

Relief along the Main Fault zone would also have resulted in additional movements upon the channels of all systems, and the Apex Faulting would have relieved the main thrust and resultant compressional and shearing stresses which were set up. This most probably operated in a reverse manner to the original directions of relief created, and would assist in explaining the almost negligible displacement along some of the channels which neverthe;ess show signs of considerable movement. This would apply to the Petrol lode which has at its Western end a minor monoclinal structure, which evidently is the reason of this channel's existence.

. Also, at the

far Eastern (unproductive) extremity of the Petrol lode, its channel may be seen to consist of numerous minute parallel fractures,

indicating that opening of the channel rather than distance from source may have been the cause for the apparent difference in magnitude.

Sketch No. 6

This diagram represents the present stage of structure upon the Cam and Motor Mine, and is perhaps more completely illustrated by diagram SX-3. Movement, consisting of displacement, folding and relief of stresses through shearing, strike slip, etc. had become static. The lode channels had reached their near final stage of opening, and were moving only in minor adjustment cycles. The stage was set for mineralisation. The first step would have been the injection along the lode channels of basic intrusive bodies, which produced a certain amount of replacement of the wall rocks along the channels. It is feasible that the intrusion of these minor bodies could have occurred at a time considerably preceeding that of the mineralisation, but it is doubtful, as in almost every instance (with notable exceptions) that the adjustment movements experienced by the intrusive bodies was felt by the lodes to the same extent. The injection of and replacement by the mineral bearing solutions occurred in at least three stages and was followed (and perhaps preceeded) and accompanied by carbonitising and the formation of carbonate veinlets. Further evidence as regards the intrusion of the basic bodies along the lode channels leaves little doubt that they preceeded the mineralisation only slightly so as to make the two processes almost simultaneous.

The final stage on the development of the deposit and other features of the deposit is represented by minor adjustment, uplift and denudation; and the extensive oxidation of the minerals, along with the formation of rather extensive residual deposits of quartz rubble and gold bearing country rock.

Considerable time was devoted to the study of dolerites and doleritic greenstones in an effort to determine their age. Unfortunately relatively few specimens sufficiently fresh for careful observation were obtainable, due to lack of long crosscuts away from the vicinity of the lodes. With a few exceptions, study was confined to the more sheared and carbonated areas surrounding the more highly minerlised areas and little was accomplished. It can be seen from Wiles' map [19] that there are possibly bodies upon the Eiffel Flats (meta-dolerites) which are related in age to the intrusion of the Great Dyke. The bodies exposed in the Cam and Motor

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19. Wiles, J.W., op. cit.

Mine are believed to be of Bulawayan age, with the exception of the minor basic intrusives along the lodes and fault zones, which are most probably of an entirely different nature.

The position of the rather large irregular body of dolerite which occupies the area South of the Main Fold-Fault on 23 level provides evidence that the major portion of the Apex faulting had taken place prior to the intrusion. On the other hand the obviously altered nature of the dolerite sheet on the 34th level or its associations with the greenstones make it rather conclusively Bulawayan. The mass exposed to the South of the Main Fold Contact on 38 level and its possible relation to older dolerites to the North, or younger "vein intrusive" is rather a problem. (See plans of 23, 34 and 38 levels).

— CAM AND MOTOR GOLD MINE —

DIAGRAM ILLUSTRATING INTERELATION OF THE LODE SYSTEMS AS REGARDS FRACTURE STRUCTURE

① — STRIKE SLIP OPENINGS ② — COMPLEMENTARY FRACTURE ZONES ③ — RADIAL RELIEF ZONES ④ — SHATTER ZONES	GREENSTONE SHALE & SLATE ARKOSE, etc. SLIPS & FAULTS	TEXT ON PAGES SX-3

CHAPTER VI

THE LODE CHARACTERISTICS.

The origin of the lodes has been discussed in a broad sense in the foregoing section on tectonics. As there are numerous, apparently interconnected lodes in the Cam and Motor Mine, it is felt that the next step in the presentation of their characteristics, and individual natures, must necessarily be the description of the features which individual lodes may display in comparison with other lodes of this group.

In the past, constant emphasis has been placed on the strike of the various lodes in the Eiffel Flats area, and the effects of the strike upon the type of mineralisation. Zealley [20] contended that the lodes with a general North-South strike were almost always "fissure veins" while East-West, South dipping lodes were arsenical replacements. The writer does not disagree with this in principle, but from cautious careful examination of the ores and lodes of the Cam and Motor Mine, it can be plainly seen that such a postulation, _when_ true, is a result of the rock type in which the lode is situated

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20. Zealley, A.E.V., op. cit., pp. 6-10.

rather than the orientation of the strike of the particular lode involved. Wiles'[21] surface map shows the sediments as having a strike almost invariably North-South, and the lodes situated therein contain considerably more quartz than the East-West lodes located in the Greenstones, although both are in reality replacement deposits insofar as the Cam and Motor Mine is concerned.

Other lodes upon the Eiffel Flats related to this theory of strike grouping amount to thirty smaller deposits which by and large were exhausted many years ago. These will be discussed at the end of this section. In short, it may be said that if such a "strike grouping" exists it is of no particular significance, as regards type of mineralisation, unless one is to consider that virtually all lodes with a North-South strike (on Eiffel Flats) are located along strike of the interbedded sediments, and not a single case of a major lode crossing these sedimentary lenticles on their North-South strike has been encountered.

The following diagram has been prepared to illustrate the effect of host rock and resulting environment upon the various lodes. (See diagram SX-4). The terms

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21. Wiles, J.W., op cit.

Footwall "A" North or South etc. are herewith used to indicate that portion of the particular lode which lies North of the Main Fold-Fault (and, therefore, in greenstone) as opposed to the portion of the same lode lying South of said feature (and, therefore, in the sediments). Locations of the various lodes can be seen by referring to Diagram SX-3 and the various geological plans of the different levels. It will be subsequently brought out, however, that although the host rock was of tremendous influence upon the mineralisation, it was not the only important factor thereof, and sometimes had peculiarly converse effects upon the enrichment and continuity of the respective lodes.

All the major lodes of the Eiffel Flats may be said to fall into the arsenical impregnation-replacement classification, and nearly all, in addition, have undergone quartz filling to a greater or lesser degree, but beyond this point, similarity between the respective bodies becomes less clear cut. It may be said that there are numerous methods of "grouping" various lodes, but the rather unique set of circumstances as regards structure which resulted in the formation of the lode system in the Cam and Motor, makes it most difficult to define such niches as these lodes would fall into naturally. For example; some lodes which are in no wise connected with the sediments in the upper reaches of the workings become so in depth, and vice versa; toehrs which are connected solely with accessory or complementary shears in the upper levels, become a vital link in the apex fault pattern in the very bottom of the workings; some change strike without converse effects, while others lose all continuity with only a slight altering of bearing, etc., etc.

The first natural grouping which will be made is that showing the host rock association as compared with a number of cardinal features:

This diagram, (SK-4) is indicative in a broad sense of the wall rock effect upon mineralisation, but must not be considered as particularly vital in establishment of lode behaviour beyond this scope.

LODE CHARACTERISTICS

FEATURE		LODES SITUATED IN GREENSTONE	LODES SITUATED IN SEDIMENTS OR UPON SEDIMENTARY CONTACTS
HEAVILY IMPREGNATED WALLS	NS	5,4,1	
	EW	2,3,6,7	
MODERATELY TO SLIGHTLY IMPREGNATED WALLS	NS		1 3 4 5
	EW		3 6
FOOT & HANGING WALLS (2) WELL DEFINED	NS	5,4,1	4
	EW	3,2	
ONE WELL DEFINED WALL ONLY	NS		1 3 5
	EW	7,6	2 6
FeAsS) FeS_2	NS	5,4,1	
	EW	7,6,3,2	
FeS_2) FeAsS	NS		1 3 4 5
	EW		2 6
FREQUENT Cu-Au MINERALIZATION	NS		1 3 4 5
	EW		2
ZnS	NS		1 3 4 5
	EW		2
MASSIVE Sb_2S_3	NS		
	EW	7,6,3,2	
ABUNDANT CARBONATES WITH LODE	NS	5,4,1	1
	EW	2,6,3,1	2 6

5 4 3 2 1 0 1 2 3 4 5

STRIKE	NO.	NAME OF LODE	STRIKE	NO.	NAME OF LODE
NS	1	CAM [illegible] (NORTH)	NS	1	CAM SPUR (SOUTH)
EW	2	CAM (UPPER LEVELS)	EW	2	CAM (LOWER LEVELS)
EW	3	PETRIA	NS	3	FOOTWALL "A" (SOUTH)
NS	4	FOOTWALL "A" (NORTH)	NS	4	" "B" "
NS	5	" "B" "	NS	5	CENTRE
EW	6		EW	6	CAM PARALLEL
EW	7	CAM HANGING WALL			

LMN

SX-4

The following table is presented with the intention of establishing the relations of the various lodes with the Main Fold-Fault structure, as regards their economic range and ability to persist beyond the line of intersection with that structure.

(Table Page 6[illegible]).

Attitude of Lodes in relation to Main Fold-Fault	Name of Lode	Maximum Vertical Range as regards Payability From to Vert. Range	Maximum Horizontal Pay Length	Average Horizontal Pay Length
Lodes which are located in the Fold-Fault	Cam Parallel	2510' 2870' 360'	110'	100'
	585 W.F'wall	1950' 2375' 425'	195'	30'
Lodes which do not tend to inter-sect Main Fold-Fault	Cam H/Wall	780' 1625' 845'	350'	210'
	Eileen-Alannah	*SURF 1100'1100'	1200'	?
	Balantine	SURF 450 ?		
Lodes which tend to intersect Main Fold-Fault : Down Dip	Petrel	*Surf.3430'3430'	645'(?)	365'
	Cam	*Surf.3560'3560'	1400'	890'
Lodes which tend to intersect Main Fold-Fault: Along Strike.	/Cam Spur	*Surf.5360'5360'	470'	220'
	Motor	*Surf.2375'2375'	855'?	250'
	Centre	*1025'4400'3375'	1005'?	460'
	/Footwall"A"	*2070'5360'3290'	730'	435'
	/Footwall"B"	*2125'5360'3235'	710'	390'
	1585 So.F/W	3310'3960' 650'	310'	120'
	/Motor East	4800'5360' ?	?	?

* Indicates Major Lode
/ Indicates continuing in Depth beyond lowest Working Horizon

It may be noted from the foregoing table that of the nine major lodes of this deposit, none save possibly the Cam Spur is found to survive from the surface to the lowest present working horizon. Regarding this, it must be remembered that without exception, each individual lode is only a member of the greater interconnected system, and that as lodes bottom, others are usually found to apex near the same horizon. A case in support of this will be shown in the systematic search and discovery of a completely new and hitherto unsuspected lode upon the 39th (deepest) level of the mine (Motor East). Another most significant feature may be seen in that only those lodes which tend to intersect the Main Fold-Fault along strike appear to have the ability to survive such association. There is no indication of mineralogical bottoming of the lodes, and all lodes which have been observed to bottom do so in some structural sense: either by intersecting the Main Fold-Fault, or by passing into inhospitable host rock.

The third and final grouping of the lodes which will be attempted is that in which the characteristics of the respective lode channels as regards fracture structure, are considered.

STRIKE SLIPS.

Although the term is not applicable in the strict sense, the Motor Centre Lode System, and the Footwall "A"

Lode will be called "strike slips".

These ~~loads~~ LODES, as illustrated on Diagram SX-4 (See ALSO Diagram SX-3) are replacement-impregnation bodies along narrow "shale bands" in an near the contact of the Eastern margin of the interbedded sediments with the enclosing greenstones. They probably had the following mode of origin.

A. Strike slip during formation of Main Fold, while the interbedded sedimentary beds were still in a horizontal position. This occurred in a North-South direction along beds of Carbonaceous shale and accounts for the earliest set of horizontal slickensides seen in the walls of these lodes.

B. Dip slip during major downfolding of the greenstones and enclosed sediments. This occured in an East-West direction along the same shale beds. and is shown by near-vertical slickensiding of intermediate age between the two sets which are horizontal.

C. Strike slip during further development of the "Main Fold" after formation had been downfolded into near vertical position. This would account for the later horizontal slickensides and "drag Breccia" along the contact of the sediments with the greenstones.

These periods are probably not separate entities, and most likely were a number of intermingled movements with the first and final adjustments being near horizontal.

As the Footwall "A" is on occasion in greenstone this hypothesis is not at all times apparent, but it is significant that the area in which the Footwall "A" reef is in greenstone, lies in a portion of the vertical "S" bend of the sediments and in a highly faulted zone. The Footwall "A" reef in this portion probably represents a further adjustment which cut the axis of this "S" bend. This is well illustrated on Section 1200 South.

The Motor Centre lode system outcropped and was followed to 4400 feet below surface. The Motor proper bottomed (structurally) at about 2400 feet, (see diagram 3X-5) with an abrupt change in the dip of the sediments, and the advent of the Footwall "A" and "B", which were most probably the feeders (See Section A).

The Footwall "A" lode in many ways does not at all resemble the Centre lode, but as it is obviously of a similar, if not identical origin, it will be included in this section. This lode apexed just below 17 (?) level (1999 feet) and was apparently a feeder for the Motor-Centre lode system. It has, with a few notable exceptions been exceedingly rich, and still persists at the lowest working horizon of the mine, where it follows a carbonaceous slate bed and forms a member of a reticulate lode system with the Footwall "B" and the Cam Spur.

A search of vertical slickensides to support the postulation that a minor amount of movement took place during major downfolding of the greenstones, is somewhat of a problem, but highly carbonated nature of the chloritised rock near the fissures suggests

Further similarity between these lodes is well illustrated on Diagram SX-4, and the nature of the shoots will be discussed under the individual lodes.

"THE [illegible] ELEMENTARY TENSION FRACTURES".

Th[illegible] [illegible]e the Footwall "B", the Cam Spur, and certain of the branching fissures of Footwall "A". These lodes are located along channels in the Greenstone with a strike generally North-South, the payable portion of which lies in the Greenstones to the North of the Main Fold-Fault, while their portion which penetrate and cross this feature are in general unpayable. They possess the characteristics of replacements in greenstone as given in Diagram SX-4. These probably had the following mode of origin:

A. Formation as tension cracks during horizontal movement.

B. Subsequent adjustments, both vertical and horizontal during downfolding, and continued formation of the Main Fold.

A dearth of vertical slickensides to support the postulation that a minor amount of movement took place during major downfolding of the greenstones, is somewhat of a problem, but highly carbonated nature of the chloritised rock near the fissures suggests that considerable grade replacement may have removed the bulk of such evidence during formation of the lodes proper.

The most astounding feature of these lodes is that in every instance in which they cross the Main Fold-Fault, their channel is <u>invariably</u> found to be continued in a "shale bed" past the said structure. This would suggest that adjustments along these beds after folding, and not horizontal tension stresses, had been the prime factor in the origin of the channels, e.g. adjustment shearing of the greenstone along a continuation of a plane of lubricant of the adjacent sediments. If this is true, then subsequent opening of these fissures must have occurre during the down-folding of the greenstones; but if we follow this, there must have been subsequent horizontal movements along these shale beds to account for the dearth of vertical slickensides within the continuation of the fissures in the greenstones, since there are numerous sets of slickensides (vertical and horizontal) in the shales. An excellent example of this phenomenon may be seen on the plan of level No. 30. To further the foregoing postulation, it is put forth that the greenstones have constantly shown little or no resistance to replacement, whereas large "horses" of unreplaced and only mildly impregnated sediments are seen to occupy the central portion of lodes in some cases over 60 feet wide (see plan of level No. 8). Such occurrences are so rare in lodes located in the greenstones as to be practically non-existent, and when like cases occur they are found (the "horses") to consist of chlorite and carbonates rather than recognised rocks. It follows, therefore, that such evidence of two or more distinctly opposed stages of movement along the channels in the shales could easily have been destroyed by extensive replacement along the continuations (of these channels) in the adjacent greenstones to the immediate North of the Main Fold-Fault.

The Cam Spur shoot apexes just above the 300 foot elevation (3rd level) and continues to the deepest working horizon of the mine, where it shows of bottoming. It is, therefore, the most persistent lode as regards vertical range. The Footwall "B" lode apexes below 2000 feet and also continues to and beyond the present bottom of the workings. As illustrated on Diagram SX-7 and SX-8, the shoots of these two lodes are seen to pitch with the axis of the Main Fold-Fault, which they intersect at high angles. The major difference between the two lodes lies in the fact that the Footwall "B" apexed under the Motor lode and in all probability acted as a feeder thereof. The Cam Spur lode was at times, apparently, a conjugate "fissure" of the Cam lode, but as seen on the plans of levels 30 and 32, the Cam lode, although of greater horizontal range, was at least in part fed by the Cam Spur. The intersection and mutual relations of the Cam and Cam Spur lodes is well illustrated on Diagram SX-9 and SX-12. The Cam Spur lode in the intermediate levels (20-23 elevation) consists of two channels. The westerly one of these dips nearly vertical and was barren above 23 level, while it continued to the bottom of the mine as a pay shoot. The easterly of the two was followed upwards from 23 level to the 3rd level with the westerly shoot being barren thereat. About/40 feet below 23 level these joined forming a body of very high grade ore. This will be discussed further on the section on the individual lodes. (See Section "A"). On examination of Diagrams SX-6, 7 and 8 it might appear that the shoot of the Footwall "A" and those of the above-mentioned lodes are very similar. But of the three lodes only the Footwall "A" contains workable values South of the Main Fold-Fault.

Minor lodes which may be said to belong to this grouping are the 1585 South Footwall lode which is a feeder lode to the Cam, the network of branching lodes in the bottom levels (see plans of levels 36, 37, 38, 39) which are seen to connect the Footwall "A", "B" and Cam Spur, and the Motor East Lode.

RADIAL RELIEF ZONES.

This group includes the Cam (with Eileen Alannah and Eglantine)+ Petrol. . These lodes are highly divergent and various of the branches have been given individual names: Cam Hanging Wall, Cam extension, etc. These lodes "radiate" from the Main Fold-Fault, the Petrol Monocline.

. These lodes are situated along very strong, well marked channels in the greenstones, at high angles to the contact with the sediments to the West. They are arsenical replacements with little impregnation of the walls beyond their clearly defined shoots, and contain, at times, considerable lenses of carbonated wall rock inclusions. The radial relief zones probably had the following mode of origin:

A. Shortening of the North-South axis of the sediments and consequent "gliding" along the contact shales to the West which resulted in compressional stresses being set up in the adjoining (homogeneous) greenstones. Folding of the sediments as a result of the North-South pressure produced the Main Fold-Fault zone to the West of the Cam and the monocline to the West of the Petrol (see plan of level No. 8), and perhaps similar structures elsewhere.

B. Accumulated compressional stresses were relieved by fissuring and slight adjustment along the main peripheral block between the Cam and the Petrol and perhaps on a lesser scale between the Petrol.

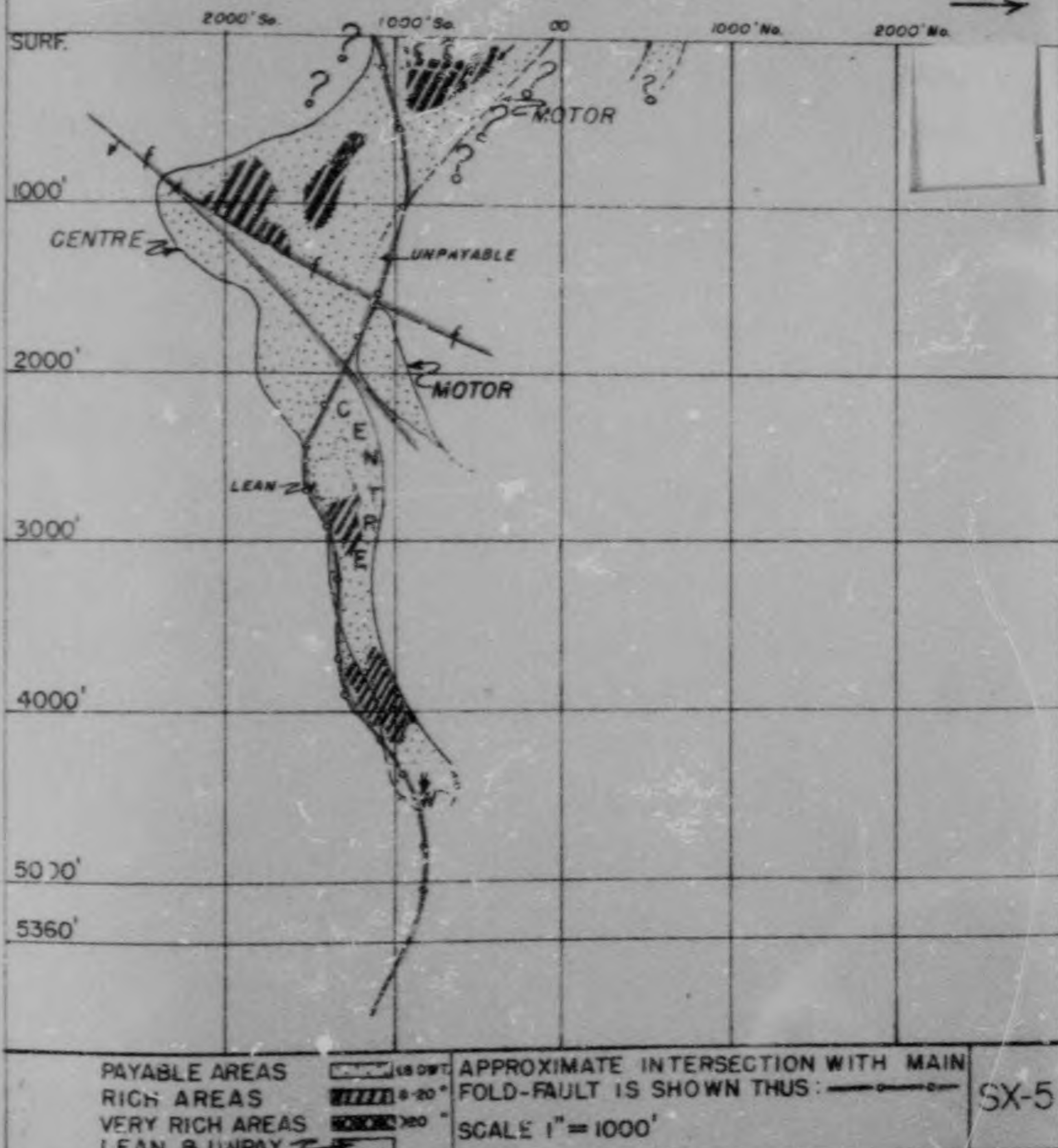
A perusal of the plan of the 14th level of the Cam and Motor mine will show that there are three sets of shears: NS. to NNE-SSW, dipping from 70° West to Vertical; WSW-ENE dipping 60-70° SSE; WNW-ESE to NW-SE dipping 65-80° Southwest. It is reasonable to assume that the Cam Spur, Footwall "B" lodes, and the minor East West and North West Southeast portions of the interconnected Footwall "A", "B" and Cam Spur systems (of the bottom levels; plans of levels 36-39) should have received additional motivating forces for further opening of their channels, as a result of this system of relief.

The shoots of these lodes are illustrated on diagrams SX-9 and SX-1) and it may be noted that pay shoots pitch to the West, or towards the area of major disturbance. The Cam lode bottomed at 3960 feet below surface upon intersecting the Main Fold-Fault. The Petrol lode bottomed about 300 feet above this by becoming a narrow constricted zone of shears. The Eileen Alannah and Eglantine lodes bottomed in a flat (Eastern) margin, which corresponded to the same margin of pitch of the neighbouring side of the Cam shoot.

THE SHATTER ZONES.

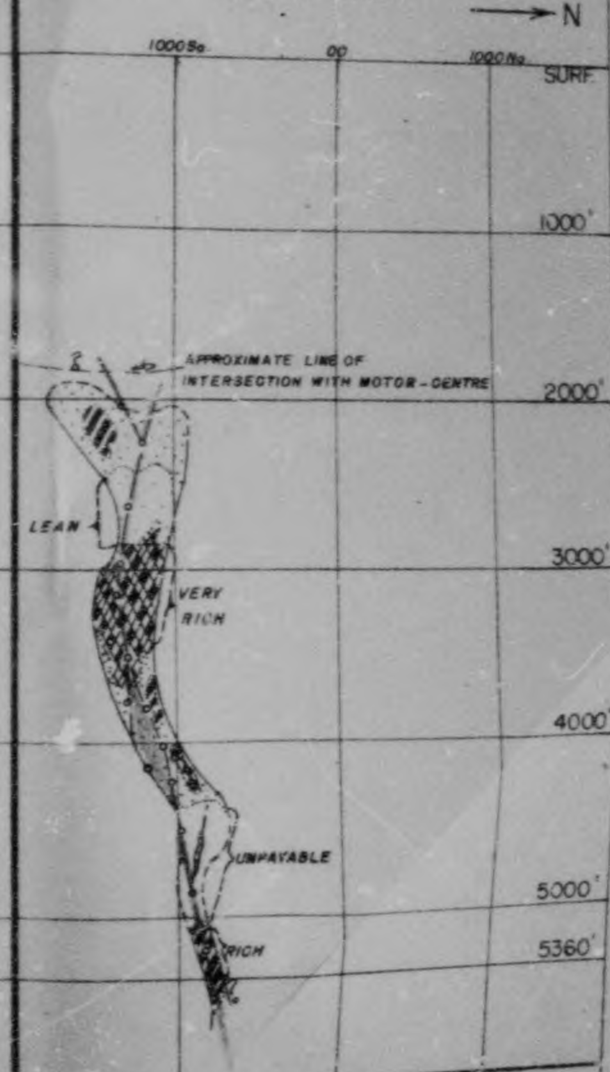
This group includes the Cam Parallel lode, and the 585 West Footwall lode, plus other minor bodies. These lodes are sinuous narrow bodies with poorly defined pay shoots and short irregular strikes which end as divergent fissures, and result from one of several causes. The Cam Parallel apex elevation is not as yet known, as it was intersected in prospecting the Cam Spur lode on the 23rd level and is now being followed upwards. Its pay length on 23 level was approximately 150 feet and it was found to have shortened somewhat on the 21st level. The 585 West Footwall lode apexed just below 17 level and died out above the 20th level. The lodes are not identical in nature but both exist along zones of fracture either in or South of the zone affected by the main line of apex faulting. The Shatter Zones probably owe their origin to healing of brecciated zones in and about this fault by late intrusive, and subsequent reopening of these healed areas by further adjustment along the line of faulting. (See plans of 19th and 23rd levels).

NORTH-SOUTH SECTION OF THE PAY SHOOTS OF THE MOTOR-CENTRE LODE SYSTEMS, SHOWN IN THE PLANE OF THE SHOOTS; LOOKING WEST



SX-5

NORTH-SOUTH SECTION OF THE PAY SHOOT OF THE FOOTWALL "A" LODE SYSTEM, SHOWN IN THE PLANE OF THE PRINCIPAL SHOOT, LOOKING WEST



SEE LEGEND ON PLATE SX-5

SX-6

CHAPTER VII

THE INDIVIDUAL LODES.

The lodes will be discussed in order of decreasing importance as regards structural significance, rather than relative productivity. Little definite information regarding the nature of the lodes in top levels of the mine is available, and consists largely of personal communications and inference.

THE MOTOR-CENTRE LODE (SYSTEM).

Although this is a system of lodes rather than an individual, their obvious close relation and mutual origin makes them inseparable for individual consideration.

This system outcropped as a saprolite and in situ eluvial deposit, and as mentioned, bottomed near 4400 feet. Its general characteristics have already been noted in the section on "Lode Relations". The form of the shoot is illustrated on Diagram SX-5, and the great continuity of this lode, as well as its local anomalies may be almost totally attributed to its constant intimate relation with the Main Fold-Fault Zone.

Little information regarding the nature of the discovery and prospecting of this system is available, but it is known that there were sizeable "Ancient's workings" probably consisting of a number of pits and open workings from which the rubble and outcrop had been selected. It is most likely that these were also the site of the first European interest in the lode. During early surface development, a large amount of rich (6-15 Dwt.) rubble was unearthed in an area some 200-300' west of the Petrol lode outcrop, and removal of the overburden covering this area exposed a number of "reefs" having various strikes and dips, and which were evidently located in the arkose, along strike of the Motor Sediments. These "reefs", although locally rich, appear to have bottomed at depths of less than 100 feet, and have not been, as far as is known, followed beyond this depth. Although no examination of this area is at present possible, it would appear that these minor (?) bodies represented a shatter belt localised in the Arkose directly West of the Petrol monocline and might therefore be considered as a counterpart of the Petrol disturbance. The main body of the Motor which was found to outcrop some 250 feet South of the Cam was a strong quartz body up to 20 feet in width and averaged over 6 Dwt., but was very broken, branching and divergent. This area, in addition to the "reef" proper, contained a large amount of mineralised wall rock which Zealley[22] described as "schistose" and "stained a deep purplish red --- revealing the unmistakable hollow casts of the small mispickel crystals and the limonite pseudomorphs of the pyrite". In addition "copper staining" was noted, showing that the copper bearing minerals which are peculiar to this system (of the Cam and Motor) in depth, had persisted at least to the present surface.

Diagram SX-3 illustrates the general characteristics of the wall rock and structural relations of this lode. It may be said, in review, that the Motor lode lies upon, and dips conformably with, a bed of metamorphosed and schistose carbonaceous shale which is by and large either a slate or a graphitic schist containing considerable carbonate and introduced quartz along the bedding and slipped planes. This "shale" bed lies along the contact of the greenstones to the East, which at times consists of a sill of dolerite and at other times of pillow lava, and is always rather severely carbonated. The Centre lode lies to the South of the Motor Lode in "shale" of the nature mentioned or in arkose as befit the

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22. Zealley, A.E.V., op. cit. pp. 15

whims of its origin. This lode has for a channel a Southward continuation of the Motor "strike slip" zone which, after reaching the Main Fold-Fault contact, continues along strike as a tortuous, branching system of irregular fractures in whatever formation happened to be in line with that particular structure (strike-slip). When in arenaceous sediments, it is in general lean or unpayable, but when in "shale" it is often rich. In no case is the Centre lode on or near the Contact with the greenstones to the East (as is the Motor) and its relative position depends entirely upon the amount of displacement of the sediments by folding and resultant apex faulting. The most apparent difference between the Motor and the Centre Lodes is perhaps their opposed strikes. Their juncture (and the intersection of the Main Fold-Fault) can be immediately recognised. The Motor has a net strike of 20° East of North, while that of the Centre is about North-South.

Near the surface the Motor-Centre lode can be seen to have a strike of almost 1200 feet, of which nearly all is North of the Main Fold-Fault intersection, and, therefore, represents the Motor lode. This section was rich and continued to about 500 feet in depth with an average width of perhaps thirty feet (of which a considerable portion was oxidised and mineralised wall rock) and an average tenor upwards of 8 Dwt. The shoot (Diagram SX-5) in this area (surface - 500 feet depth) can be seen to have both North and South margins pitching equally at about 50^0 to the South. The relation of the richer shoots within the payable limits can not, in the case of the surface shoot, be ascribed to the incidence of the fault and is believed to have been a result of a certain amount of secondary enrichment. This will be discussed at a later stage. Unfortunately the top four levels of the mine were, by and large, inaccessible due to opencast methods of working and sheer age of the workings, plus, perhaps the lack of necessity, at that far removed period, of having to observe enforced safety regulations. On the 5th level (500 foot) the Motor lode averages about twelve feet in width, including oxidised arsenically impregnated wall rock, and is in general of rather desultory tenor, the richer patches being short, and consisting of the tops, or downward projections, of underlying or overlying zones of richer ore. At a point just West of the Main Shaft, the division between the Motor and Centre sections is quite clear cut both as regards tenor of the ore and change of formation. The Main Fault crosses through the shaft station and all South of this fault is the Centre section which is : lean, narrow, sinuous and wandering from shale to arkose, but never near the Sediment-greenstone contact. North of the shaft station is the Motor section which is: wide, rich and consistently upon the greenstone contact.

Between levels 5 and 8 (500' - 890') the Southerly pitch of the shoot, as opposed to the steep Northerly hade of the fault, caused the Motor section to become shorter while the Centre section was lengthened, and enriched. This unfavourable pitch-plunge relation reached the point of intersection just above the 11th level (1230') at which point the Motor section ceased to be payable and the Centre section only was worked from there to the 15th level, at which point the plunge of the fold changed from roughly vertical to steeply South. Near the Southern end of the shoot (Centre) on No. 8 level, a Northwest-Southeast fault may be seen dipping at moderate angles to the Southwest, while the peculiarly shaped ore body is more or less localised along this slip and one of like strike some 150 feet to the West. The enrichment along this zone between the two features intersected the Centre lode some 600 feet to the South of the Main Shaft, and widths of up to 80 feet of ore and partially replaced shale and arkose were common along some 300 feet of strike in two different places. Some uncommonly large blocks of unreplaced shale and arkose (horses) can be seen in the centre of the area, and were themselves found to carry economic gold values, whereas the more completely replaced material and quartz was fantastically rich. As will be noted on the plan of No. 8. level, considerable basic intrusive is seen for a distance of several hundred feet along the lode. As is often the case, the intrusive is here less replaced than the sediments, and appears to have been injected at only a very short time preceding the replacement and mineralisation. No occurence of this dyke material has been observed in the area of the Motor lode proper. The abovementioned faults along which enrichment occurred so intersected the Centre lode that their influence upon the shape of the shoot diminished downwards and had ceased to be of any effect just below the 16yh level (1870 feet). From the 15th level (1740 feet) to below the 20th level (2375 feet) a body of moderately enriched ore which was called the Motor was worked. Its position and attitude are shown on Diagram SX-5 and it can be seen as an isolated body of ore lying to the North of the main shoot of the Centre lode. This body is definitely related to the Motor of the upper levels, and is believed to be an isolated shoot of moderate size which was localised between the zone of the faults, or slips, which were seen from the 8th level downwards. In support of this view is the fast that the channel of this lode is seen to dip away into the arkose to the West. (See diagram.

SX-11) once the faults referred to have passed their line of intersection with the Cen... lode. As it is North of the Main Fold-Fault zone, this lode will be considered as the Motor, since it exhibits characteristics of that lode as it is known in the upper levels. This "Motor" body is payable over a strike of 70 feet on 20th level; 100 feet on 19th level; 154 feet on 17th level; 290 feet on 16th level; and 78 feet on 15th level (depths 2375'; 2250'; 1999'; 1870' and 1740' respectively). The form of this isolated shoot is well illustrated on Diagram SX-5 and can be seen to bottom away to the North, following the same general direction of pitch as the Centre lode further to the South. The basic difference between this lode and the upper levels Motor lode proper is that it seems to have utter disregard for following the contact between the greenstones and the Sediments, and wanders into the Sediments at will, finally bottoming in a rather odd monoclinal bend between the 19th and 20th levels, the form of which is illustrated upon the GeoO logical plan of the 19th level. From the surface to the 20th level (2375 feet) the dip of the sediments and the dip of the contact thereof with the greenstones to the East, averaged about 70° to the West Northwest, with both the Motor and Centre lodes having roughly corresponding dips. Near the 20th level the dip of the sediments is seen to alter radically and change in a very sharp bend to nearly vertical. On the other hand, the Main Fold-Fault plunges Northerly to the 9th (1010 feet) level, whereupon it alters course plunging vertically for a short distance and altering its plunge to a course steeply Southwards. In the meantime the pitch of the shoot after the 1000 feet level "South Bulge" (which was most obviously caused through the localising influence of the two minor slips illustrated) has changed from the South (on both margins) to over vertical (North margin) and flatly North (South margin) until near the 1500 foot mark at which point both margins of the shoot change to vertical and have corresponding dips, thereafter to the point where the shoot bottoms out at 4400 feet. Between the 2000 foot depth and the 2400 level the Main Fold-Fault crosses the shoot by reason of the Southerly plunge of the fold and adverse pitch of the shoot, and thereafter is seen to be the Southern limit of the shoot. (See Diagram SX-11).

EAST-WEST SECTION ALONG 1000' SOUTH COORDIN. SHOWING ANOMALIES IN DIP OF SEDIMENTS AND RESULTANT AFFECT UPON LODE SYSTEMS

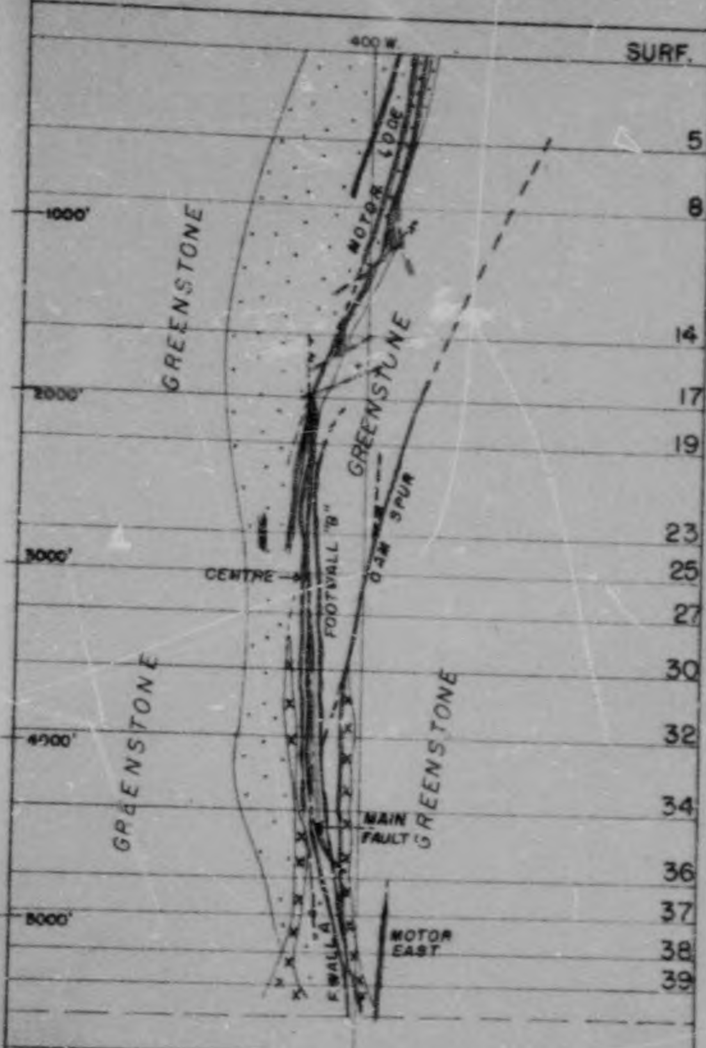
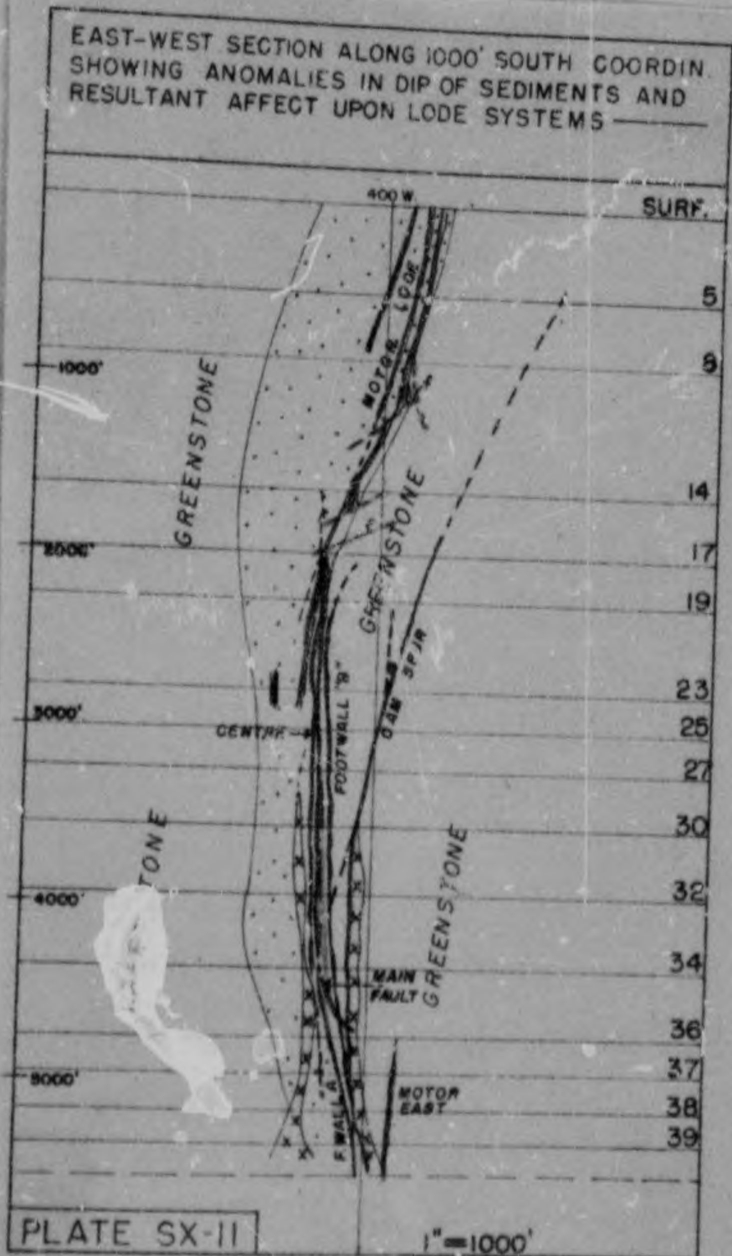


PLATE SX-11

1" = 1000'


EAST-WEST SECTION ALONG 1000' SOUTH COORDIN.
SHOWING ANOMALIES IN DIP OF SEDIMENTS AND
RESULTANT AFFECT UPON LODE SYSTEMS
400 W.
SURF.
5
8
14
17
19
23
25
27
30
32
34
36
37
38
39
1000'
2000'
3000'
4000'
5000'
GREENSTONE
MOTOR LODE
GREENSTONE
FOOTWALL "B"
CENTRE
MAIN FAULT
GREENSTONE
MOTOR EAST
F. WALL A
1"=1000'
PLATE SX-11

After the advent of the Footwall "A", Footwall "B" and their various branches, near the 18th level (2126 feet) the Motor is seen to dip away into the hanging wall of the sedimentary formation and apparently dies in arkose. This was most probably due to the abrupt change of dip of the sediments already mentioned. It would appear, therefore, that the Footwall "A", Footwall "B" and the centre lode (below this horizon) acted as feeder channels to the large and super enriched Motor body of the zones from surface to the 11th (1253 feet) level, and from the 15th (1740 feet) to the 20th levels respectively , with the zone between being impoverished by localisation of the mineralisation through the influence of the slips as already described. This is illustrated on Section A.

Below the 24th level, the Centre and Footwall "A" lodes may be seen to join at their Northern end and to have "cross channels" and numerous branches which follow adjustment cracks in the fracture pattern. The junction of the Centre, Footwall "A" and Footwall "B" lodes must occur at the Northern end of the said lodes between the 33rd and 34th levels, (4160' and 4360' respectively) although it has not been observed. Below 4400 feet the Centre lode ceases to be payable, and the East West branches of the Footwall "A" and Footwall "B" lodes have been found to carry values, while the North-

South branches are by and large unpayable. The Centre lode can be seen to dip away from the sedimentary contact into arkose near the 36th (4760') level after which point it apparently ceases to exist. Moreover, it may be remembered that an almost identical situation occurred near the 20th level (2375') when the Motor and Footwall "A" crossed into the arkose. It would, therefore, appear that the East-West branches of the Footwall "A" and Footwall "B" lodes acted as feeder channels as in the case of the Centre Lode.

THE FOOTWALL "A" LODE.

This consists of a number of branching and interconnected lodes which extend from the 18th (2126') level to and beyond the deepest working horizon of the mine (5361'). This lode group did not outcrop, but appears to have apexed under the Motor and Centre lode system, acting as a feeder (see Section A). There is evidence that the Southern portion of the Footwall "A" may have extended upwards to a point just above the 17th level (1999').

In general, the shape of the principal pay shoot (Section SX-6) compares well with that of the Centre

(Section SX-5), having corresponding changes in pitch, and occurrence of leaner and richer patches therein. Section "A" gives a reasonable illustration of the relation between the abrupt steepening of the main sedimentary lens (Motor Contact), from 70° to the West to nearly vertical (2100' horizon) and the apex of the Footwall "A"; which ceased above this point to exist as a payable body. Of great significance is the observation that the Footwall "A" does cross this contact (Shale, West to greenstone, East) and dies upwards in arkose in the hanging wall of the Centre lode, as observed on the 17th (1999') level. On the other hand, the Centre lode upon intersecting the second abrupt change in dip of the Sediment-Greenstone contact (4300') continues on its near vertical dip, thereby bottoming in unfavourable arkose in the footwall of the Footwall "A" lode. It is possible that the Footwall "A" lode may bottom in the same manner should it encounter a further Eastward flattening of the sediments. It is more plausible, however, that the next change in dip of the sediments will be one of steepening, which could possibly be favourable for downward continuation of the Footwall "A" lode, and might conceivably expose still another lode to the West.

From the apex at 2126 feet to the 2375 foot mark, the Footwall "A" lode exists as an integral part of the great replacement-impregnation body formed by the Motor, Centre and Footwall "B" lodes (see Section A, and plan of the 19th level). A hint of localisation due to the faults mentioned in the section on the Motor-Centre lode, may be seen in the shape of the upper two or three hundred feet of the shoot of the Footwall "A" lode as compared with the same section of the Centre and Footwall "B" lodes (see Diagrams SX-5, 6 and 8). This replacement body measures up to 1000 feet, in length and at some places was found to be of payable grade over widths of 1000 feet. It is obtusely triangular in plan with the apex of the Main Fold-Fault as the bisectrix. In section, the lode may be seen to consist of quartz bodies of impregnated and partially replaced sediments. The larger quartz bodies and replacement zones invariably follow the carbonaceous "shale" bands (see plan of 19th level, and Section "A"). Such form is assumed by this body as leaves little doubt that the upward path of the solutions found, in the abrupt flattening of the sediments a suitable zone for precipitation, and that although the Footwall "A" channel continues upwards on its near vertical course, the solutions found in the shale bed, in the hanging wall of the Motor lode, an impenetrable barrier (see section SX-12).

In the zone from the 20th (2375') level to the 23rd (2797') level the Footwall "A" lode is seen to consist of several North-South striking lodes which are partially in sediments and partially in greenstone, all of which fail to penetrate the Main Fold-Fault zone and retain continuity. In this zone the lode averages perhaps 80" in width. Without fail, these bodies are connected by cross fractures or are convergent on the Northern end. It will be noted that in no circumstances were payable values found outside the contorted and affected area of the Main Fold-Fault zone. Although rich in places, the overall average of the lode between 2400 feet and 2650 feet was rather desultory, and it was felt that the lode had bottomed out. On the 23rd level, however, at the point where the main cross-cut West intersected the lode, the top of a fantastically rich shoot was cut, which continued to nearly 4,000 feet (see plan of 23rd level and Section 8X-6), and was probably the largest of the very high grade bodies to be found in the various lodes. Invariably, the richer areas are found in zones where carbonaceous shale forms the hanging wall of the body, and often are localised near the Main Fold-Fault contact. These super enriched bodies usually consist of narrow (4' - 12') quartz carbonate lodes with relicts of graphitic wall rock in all stages of replacement. Cu-Au/C associations are practically a rule, and valuable evidence regarding their association was gained in this area. This will be discussed under the section on mineralisation.

In the zone between the 23rd (2797') and 30th (3560') levels little of interest as regards the Footwall "A" lode is to be gained. Progressive downward shortening of horizontal strike may be observed and as usual, is directly attributed to the alteration in plunge of the Main Fold from steeply South, to vertical, to steeply North (going downwards), which is opposed to the generally vertical attitude of the shoot in this area.

At the 30th (3560') level, the Footwall "A" lode may be seen to bend ... following the Main Fold contact; trending more Eastwards as it progresses South. This Northwest-Southeast trend becomes progressively more decided on the 31st, 32nd and 33rd levels, until a decidedly sharp resumption of normal (north-South) strike occurs just above the 34th level. Such behaviour would be inexplicable were it not for the obvious increase in the influence of the Main Apex fault and the Northward displacement of the block of sediments along the Gem Spur lode. (See plans of 30, 32 and 34 levels). The downward trend of this fault becomes the reticulate lode system of the Footwall "A" and "B" lodes by the 36th (4760') level, and due to the unfavourable change in dip of the main body of sediments (flattening to the East, downwards) the North-South leg of the Footwall "A" lode has become mixed up in the sediments until the steepening of the sedimentary dip near the 38th (5160') level. Examination of diagram SX-11 will illustrate the mechanics of this situation as do Sections 600 South and 800 South, and the barren zone as shown on Diagram SX-6 can be seen to lie in the limits (4400-5100 feet) of the Easterly dipping leg of the sediments, becoming payable upon resumption of vertical dip. As will be noted, on section 400 West, the Main Apex faults tend to become quite flat in the barren (4400-5100 feet) zone, being steep both above and below, in the payable zones. It is, therefore, suggested that such flattening of the controlling feature may have influenced the upward course of the solutions as the dip of the lodes so affected would have had the effect of leaving their impermeable wall in the foot rather than the hanging wall. It is also possible that through the change in dip of the lodes, ... subsequent movement along their channels might have caused this portion (flatter) to become confined, while the steeper portions were opened somewhat. Observations in support of these postulations lie in the fact that excessive carbonatisation along lode channels in the near barren zone is rife, and that in no other instance were none of these lodes payable over such a vertical range. Furthermore, it will be noted that the only additional lean patch in the shoot (Diagram SX-6) is also vertical (2400-2650 feet), and that vertical portions of the shoots of the Cam Spur and Footwall "B" lodes are lean except where localised rich areas have been formed under special conditions.

From the 38th (5160') level downwards, the Footwall "A" lode ap[illegible] be recovering values in its North-South trend, w[illegible] its East-West trend becomes progressively leaner and shorter. That is, again, most probably due to the alteration of the dip of the sediments which, at the bottom (5360') level, appears to be changing from vertical to steeply West. This alteration and the converse plunge of the Main Fold is illustrated on Section 800 West. In review it may be stated concerning the failure of the Footwall "A" lode between 4400 feet and 5100 feet:

A. Abrupt alteration of plunge of Main Fold at top and again at the base of the lean zone.
B. Consequent alterations of dip in the sedimentary series and lodes dependent thereupon.
C. Vertical attitude of the shoots.

The width of the Footwall "A" lode is highly variable, but may, in all, be said to average about 70 inches. There is every indication that the Footwall "A" lode will continue for a further vertical range, as it is unquestionably the source fracture for the bulk of the mineralisation upon the Motor and Centre systems, is intimately associated and dependent upon the Main Fold and upon the sediments affected thereby, and in no wise exhibits signs of mineralogical bottoming.

THE CAM SPUR LODE.

The Cam Spur lode was evidently first developed on level No. 3, but apparently extended to surface, having most probably not been considered as other than an integral part of the very large enriched zone of the Cam lode. Since this lode (Cam Spur) continues beyond the lowest working horizon of the mine, it has the greatest vertical range of any lode developed upon the mine. As may be seen on the plan of the 8th (890') level, this lode is of very indefinite continuity and furthermore appears to possess no consistent direction of strike. On the same plan, it may be noted that there is no intersection of the Cam and Cam Spur and it is far from certain that this is the same lode followed on levels 12 and below. From the 12th to the 16th levels (1432' - 1870') the Cam and Cam Spur lodes form an intersection of distorted cruciform nature. As regards the actual lodes, there is little doubt that the mineralisation was contemporaneous. Also there are indications that a certain amount of vertical adjustment occurred along this channel during this period. From the 16th (1870') level to the 22nd (2650') level, the relation of the two lodes is that of a "tee", with large zones of replacement and frequently enrichment surrounding their intersection, with widths of up to 60 feet being observed.

Before reaching the 23rd (2795') level, the steep (70°) Westerly dip of the Cam Spur has carried it beyond the limits of the steeply pitching Western margin of the Cam shoot, and the comparatively flat (60°) dip of the Cam lode, as opposed to the pitch of the Cam Spur shoot caused the payable portions of the two lodes to change relations, as regards intersection. From the 16th (1870') level downwards, the Main Apex Fault zone may be seen to approach and parallel the Cam lode, and, apparently, to form a barrier to the

Southward trend of the Cam Spur. A comparative glance at the plans of levels No. 8 and 17 will point out, however, the possibility that an extension of said Cam Spur might lie South of this fault on the 17th and perhaps other adjacent levels. It can be seen that the lode penetrates and crosses a like fault on the 19th level plan.

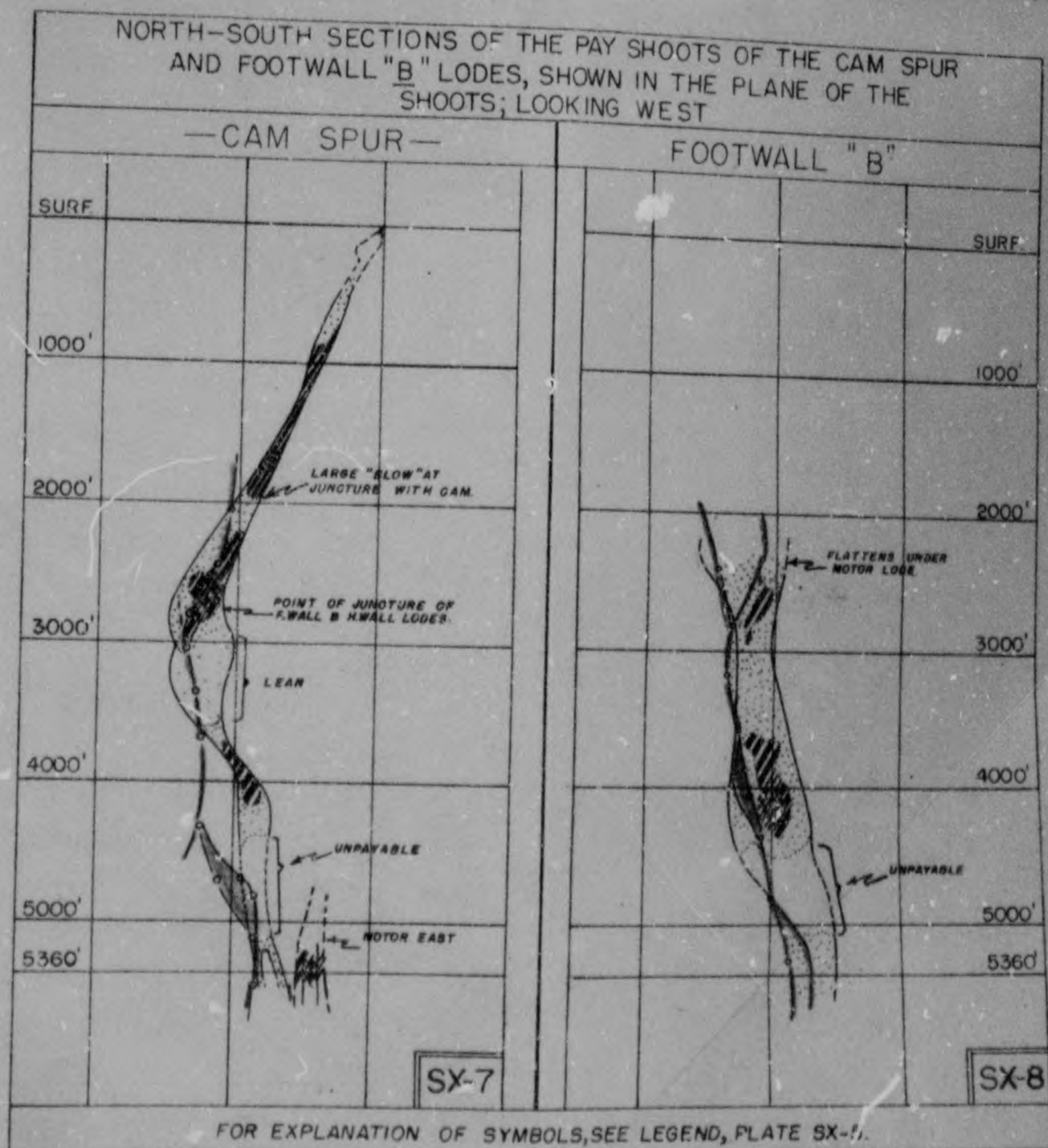
The Cam Spur is a narrow lode of compound nature insofar as its channel is concerned, and it would be well to discuss this structure at this point. In a vertical sense, the Cam Spur may be compared with the Motor-Centre structure in that its lower (5360' - 2830') level channel is near vertical. At 2830 feet (directly below level 23) this vertical fracture intersects one of flatter (65°-70°) (West) dip, which channel continues from that horizon upwards as the payable lode, while the lower (vertical) fissure ceases to be economic before reaching the 22nd (2650') level. The upper (West dipping) channel does not appear to have continued below this intersection. Evidence is seen that the lower, vertical channel continues (although barren) upwards, eventually intersecting the sediment-greenstone contact near the 9th (1010') level, but as this is inconclusive, it will not be further discussed. If such were the case, however, it would present an interesting topic for discussion: that of the striking similarity between the abrupt alteration in dip of the Cam Spur and the Motor sediment-greenstone contact. The change in dip of the sediments and impermeability of certain of its members which form hanging walls (West) of the lodes therein is ample explanation for the behaviour of the contained ore bodies (Footwall "A" and Centre lodes). Such is not the case with the Cam Spur, however, which at this point has, for both hanging and footwalls, greenstone, and it would appear incongruous that the lode should deviate from its nearly vertical course of over 2500 feet from 39 level to its intersection with a new fracture, if the previously followed channel continued upwards. Observations indicate that the flatter channel is in truth, a spur of the Cam lode, while the steeper portion is a deep level lode entirely divorced from the Cam shear zone. It may be remembered that the nature of the Centre and Footwall "A" fractures which continue above the 18th level is weak and indeterminate upwards of the abrupt flattening of the sediments, insofar as the steeper channels are concerned, and it is, therefore, possible that the flatter fractures are the original continuations of the lower level channels, while the upper level vertical channels were later adjustments. (See Section "A" and plans of 23 and 19 levels).

From the appearances of the country in the zone of intersection of the Cam Spur channels (2830' to 2930') it would seem that a large zone of brecciation occurred at a time slightly preceding the early stages of mineralization, as large-scale replacement produced a rich lode up to forty feet in width forming a triangular body between the convergent lower and upper level Cam Spur channels.

Between the above discussed intersection and the 31st level (2930'-3760') values were irregularly distributed and in general desultory, and widths not averaging over 36 inches. It will be noted that the pitch of the shoot (Diagram SX-7) is vertical in this horizon, and, as is the case with all North-South lodes, portions of shoots which pitch vertically are, as a rule, lean or unpayable. In this case the vertical posture of the shoot is attributable to a change in plunge of the Main Fold at a point where the fold begins more definitely to pass into a fault (See Diagram SD-1). With the advent of the greater Apex Faults (shown on Sections 1000, 1200 and 1400 South) just abve the 25th (3007') level, the

Cam Spur becomes a major structure lying along what, in reality, is a large North-South shear zone which has displaced a narrow segment of sediments to the North. This constitutes a compound displacement, as these sediments had already been displaced to the East along the Apex Faulting. Alteration in the behaviour of the Main Fold also heralded the end of the Cam, as will be discussed under a separate heading. In no case, have consistent values been found South of the intersection of Cam Spur and Main Fold.

From 3760 feet to 4400 feet, the pitch of the shoot is steeply (about 65°) to the North, and it will again be noticed that this section is at once rich and somewhat removed from its previous (upward) too intimate association with the Main Apex Faulting. From 4400 feet to 5100 feet, another vertical and unpayable section may be seen with additional abrupt alteration in the plunge of the Main Fold-Fault system, and flattening of dip of the adjacent sediments as has already been described. From 5100 feet to 5360 feet the values and widths are inconsistent, but payable in one or two zones of very short strike, although the channel is at least 1500 feet long. The Motor East lode is beyond doubt an associated structure, and should, through additional development, show the nature of such relation.


NORTH-SOUTH SECTIONS OF THE PAY SHOOTS OF THE CAM SPUR AND FOOTWALL "B" LODES, SHOWN IN THE PLANE OF THE SHOOTS; LOOKING WEST
—CAM SPUR—
FOOTWALL "B"
SURF.
1000'
2000'
3000'
4000'
5000'
5360'
LARGE "BLOW" AT JUNCTURE WITH CAM.
POINT OF JUNCTURE OF F.WALL B H.WALL LODES.
LEAN
UNPAYABLE
MOTOR EAST
FLATTENS UNDER MOTOR LODE
UNPAYABLE
SX-7
SX-8
FOR EXPLANATION OF SYMBOLS, SEE LEGEND, PLATE SX-

THE FOOTWALL "B" LODE.

The Footwall "B" lode apexes between the 19th (2250') and 20th (2375') levels, in part flattening and dying upwards and to the East; the other branch (Western) feeding into the greater Motor-Centre system, as seen on Section "A" and the plan of the 19th level. The nature of the junction of the footwall lodes with the Motor has already been described.

The Footwall "B" lode lies partly in greenstone (North) and partly in sediments (South), the two portions being separated by the Main Fold-Fault zone. The portions of the lode lying in the sediments are in general unpayable.

Between 2250 feet and 2600 feet, the shoot was weak and in general the values were desultory. The presence of the small rich "patch" between 2500 and 2800 feet (See Diagram SX-8) may be attributed to a moderately sized pre-mineral fault striking East-Northeast by West-Southwest which appears to have dammed the Northward path of the solutions. Also, this portion of the lode was in greenstone while the Footwall "A" and Centre lodes to the West were totally in sediments.

From 2800 feet to 4400 feet the pitch of the shoot was steeply North, as may be seen on Diagram SX-8, changing to vertical at the lower of the two figures. A zone of enrichment with widths up to 15 feet was encountered between 3700 feet and 4250 feet, being again a case of localisation due to pre-mineral faulting. The payable lode, therefore, has definite limits bounded on the South by the Main Fold-Fault and on the North by the XB fault which is also a faulted sedimentary contact. (See plan of 32nd level and Section 800 South). On the 30th (3560') level the lode channel can be seen to be at least 1200 feet in length along its normal North-South strike, the Southern 700 feet being in sediments and unpayable, while the Northern portion which is in greenstone was payable for some 460 feet. Directly upon intersecting the sediments on this (30th) level the gold values which had been upwards of 6 Dwt., averaging about 55" in width, in the greenstones (to the North) dropped to less than 2 Dwt. Although the channel was strong and the lode some three to five feet in width. South of the contact, values were practically non-existent. (See Plan of 30th level). Below the 3800 foot horizon, the Footwall "B" loses its definite North-South strike and becomes branching and sinuous, its previously vertical dip altering often to both East and West. This is in keeping with the Footwall "A" and Centre lodes at this horizon, and is seen to be a result of alteration in the plunge of the Main Fold. (See Plan of 32nd level). On the 34th (4360') level, the Northerly extremity of this lode is trending towards an intersection with the Footwall "A" and Centre, and a spur has developed along a conjugate fissure which curves to the Southwest, about two hundred feet North of the Main Fold-Fault. Below this (34th) level, the development of two sets of branching fissures may be noted; one trending NNW-SSE, the other striking WNW-ESE and dipping steeply North. The barren zone encountered in other North-South striking vertical lodes is seen also in the Footwall "B" lode between 4400 feet and 5200 feet, for the reasons already mentioned in addition to the vertical attitude of the shoot in this range. The plans of the 36th, 37th and 38th levels will show that its strike has latered to one where the East-West fractures are more important than the North-South ones, and it will be remembered that this was the unpayable zone insofar as this lode was concerned. This gives valuable evidence as to the relative stresses set up in the Main Fold zone as it shows that the East-West set of fractures was opened at the expense of those of North-South strike. On the plan of the 39th (5360') level, the strike of the lode is seen to be again changing, or swinging round to, one of North-South direction, and it is seen that values are again improved considerably. For this reason of change of strike, it is not improbable that the Footwall "B" lode will be longer and stronger when intersected upon the 44th (5560') level.

THE CAM ----- EGLANTINE LODE.

The Cam-Eglantine shear zone contains at least three ore bodies; the Cam-Good Shepherd, the Eileen Alannah-Arizona and Eglantine. At surface, the total length of these lodes was over 4400 feet, striking at about 80° East of North, and dipping approximately 65° to the South-Southeast. The origin and general characteristics of this important system have been described elsewhere. It may be said, in addition, that the major relief zone upon which these lodes are located, appears to continue even further to the East, than has been demarcated beyond the Eastern margin of the Eglantine lode.

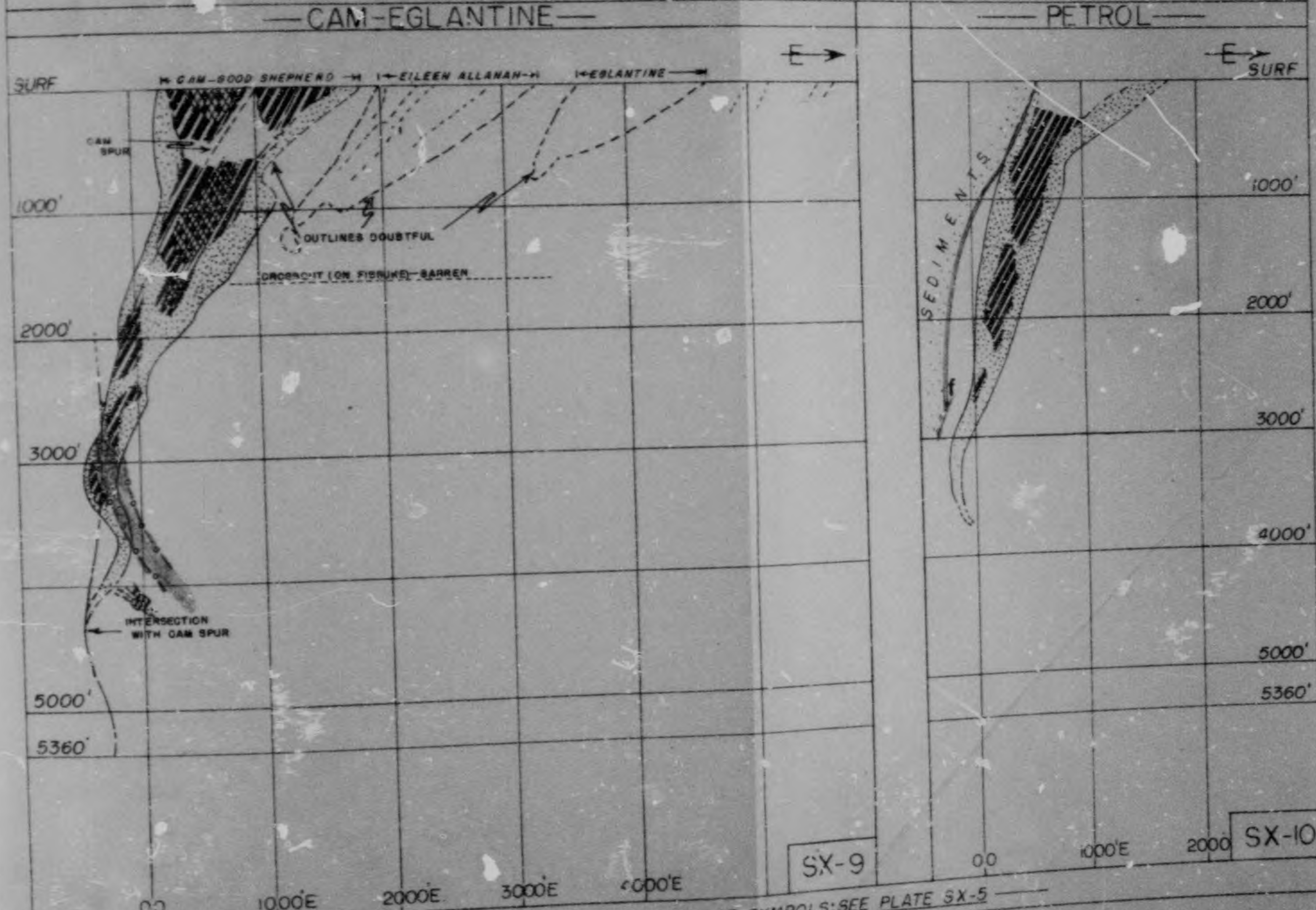
As may be noted on Diagram 3X-9, all shoots possess flatly dipping Eastern margins and are somewhat steeper at the West. Little is known of the shape of the Eileen Alannah and Eglantine shoots, and their margins are largely inferred. Both the abovementioned shoots outcropped; the Eileen Alannah bottoming near 900 feet in depth, and the Eglantine bottoming at perhaps 450 feet.

Both these shoots were quite rich and indubitably occupied the identical fracture zone, as surface quarries and prospecting work have illustrated. There is no doubt whatsoever that the Cam and Eileen Alannah are upon the same relief zone, as they have at points been one continuous shoot, although it was not possible to determine at exactly what level this occurred. Whereas the Cam and Eileen Alannah shoots were quite markedly in the arsenical impregnation-replacement classification, it appears that the Eglantine may have tended more towards a true quartz vein structure. The Eileen Alannah shoot appears to have differed from the upper level Cam lode in that it contained little or no antimonides, which were rife in the Cam.

The Cam (and Good Shepherd) shoot had a surface strike length of about 1600 feet, with a central rich portion and a super enriched patch therein. These were the earliest claims in the Eiffel Flats area to reach regular production, which started early in 1907. It is not possible to definitely state the tenor of the ore crushed during this early period, as only amalgamation was utilised, giving a recovery of 6 to 8 Dwt. of very fine gold, the ore having been quarried from soft schist and broken quartz of probable saprolitic structure.

Antimony seems to have been encountered from quite near the surface both in oxide and sulphide form, and was sorted out and rejected from treatment. Widths of the near surface ore body are not known, but from appearance of quarries must have been in the neighbourhood of 25-100 feet. Below the level of quarrying to the 5th (500') level, an East-West area was worked for an average of 1,000 feet along strike, with varying widths of from a few feet to as much as 125 feet. The proportion of quartz replaced wall rock, impregnated greenstone and waste within this wide area of enrichment is not known. As observed on the 5th level, however, this "Swell" consists of a highly fractured zone about 100 feet along strike (North-South) of the Cam Spur zone, which is bordered North and South by quartz-carbonate lodes, which are interconnected by minor bodies of the same composition and which are separated by a mass of highly carbonated and impregnated greenstone. The East-West form of this "Swell" is that of a branching lode 800 feet in length with the single conjoined lode to the East and the divergent lodes of quartz-carbonate striking West Northwest and South-west, dying out about 175 feet West of the position of the Cam Spur. The total East-West length of the "Swell" was 175 feet, and tenor averaged perhaps 6 Dwt. although rather irregularly distributed. A large body of stibnite was apparently encountered some distance above the 5th level and is reputed to have at times been in excess of 50 feet wide. Considerable stibnite is seen on the 5th level, but no body of such extent was observed.

EAST-WEST SECTIONS OF THE CAM-EGLANTINE AND THE PETROL LODE SYSTEMS; SHOWN IN THE PLANE OF THE SHOOT, LOOKING NORTH



FOR EXPLANANATION OF SYMBOLS; SEE PLATE SX-5

In the zone between the 5th and 8th levels (500-800'), the Cam is seen to be payable over a length of approximately 1000 feet along strike with an average width of 80 inches or more. This section of the lode is confined between two definite walls consisting of smooth planes not often slickensided, with little impregnation but considerable carbonatisation beyond such limits. Tenor averages about 7 Dwt. and is fairly regular, with a central, richer shoot some 700 feet in horizontal length, which apparently extends from the surface to below the 15th (1740') level. On the 8th level the lode was found to be payable over a length of 1050 feet along strike, splitting at the Eastern and beyond the intersection with the Cam hanging wall, beyond which it becomes a zone of closely spaced parallel fracture planes. On the Western end, the lode ceases to exist near the Cam Spur and there is definite, conclusive evidence that no possibility of the Cam having been a Fault in the true sense of the word should be considered; the channel simply ceasing to exist in less than 100 feet along strike. It was upon this level (8th) that the first influence of the Main Fold-Fault upon the Cam was noticed in an area some 600 feet to the West Southwest of the Western extremity of the lode being discussed. This influence consisted of one of the Main Apex Faults which was exposed while prospecting a minor lode discovered in crosscutting to the Cam lode from the main Motor drive North.

Sediments displaced to the East along this fault are exposed in a drive on this minor lode, and although there is little in the way of evidence to support such a postulation, it is entirely possible that the steeper, downwards projection of the Cam hanging wall channel might conceivably be associated with this or another such Apex Fault structure. The lode which was prospected upon the fault exposed ceased in the drive, and became payable to the North, in the greenstones exclusively, as is the case with all such North-South lodes located in greenstone upon intersecting the Main Fold-Fault contact.

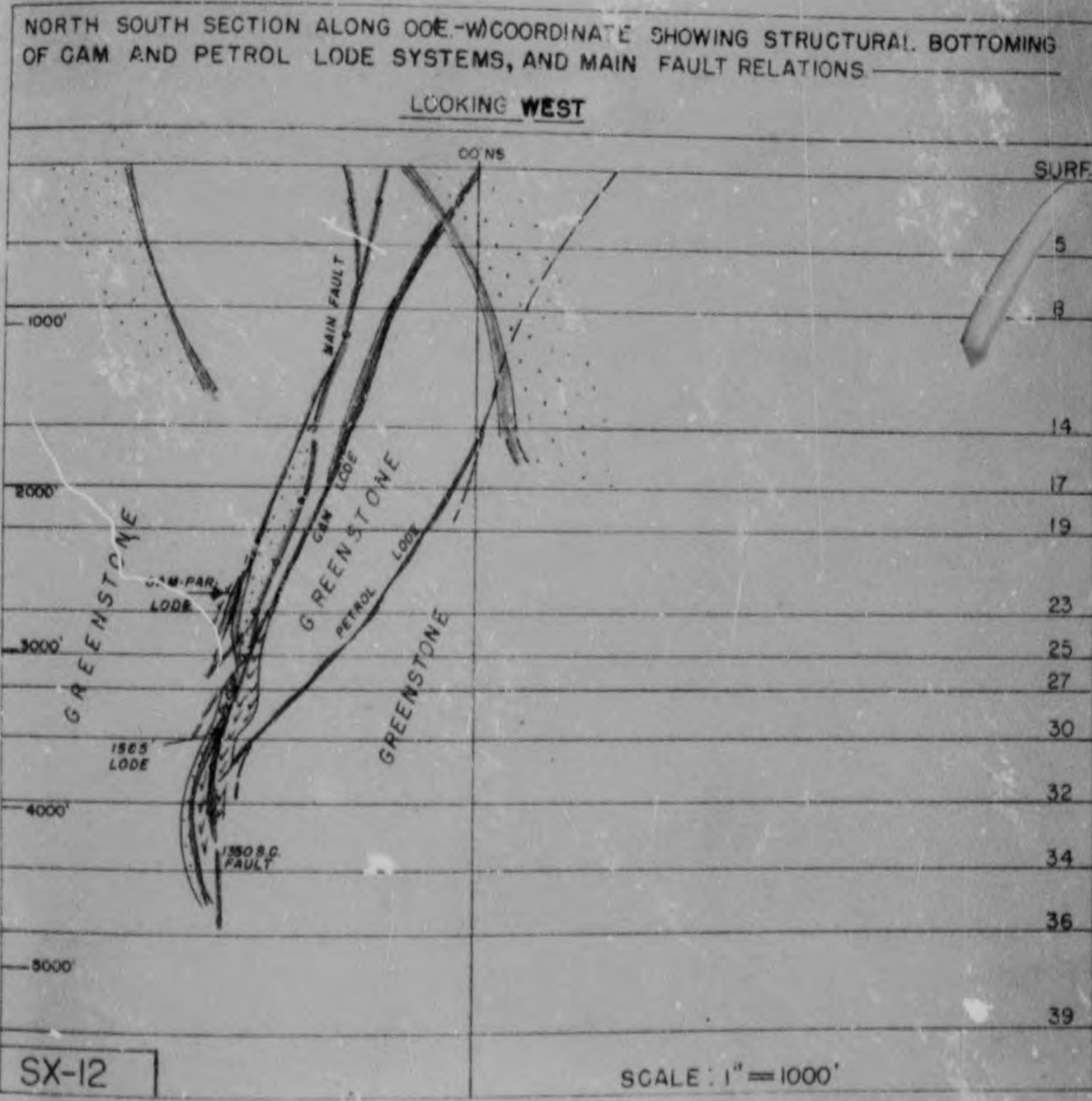
Between the levels 7 and 15 (775' - 1615') a flat lode joins the Cam body (Shoot) at its Eastern end and has been named the Cam Hanging Wall. This lode is, as far as is known, of similar origin to the Cam and may have been one of the "feeders" thereof. Its trace is curving with the radius to the North, having a net strike of East-Northeast and an average dip of 23^0 to the South - Southeast until the 1680 foot point is reached. Below 1680 feet, the channel abruptly steepens in dip (to 65^0), shortens in strike, loses continuity and ceases to exist as a payable lode as far as is known. Length of pay shoot is approximately 550 feet at the 8th (890') level; 350 feet at the 14th (1615') level, and 50 feet at the 15th (1740') level. This is yet another case of a steeper fissure enriching a flatter channel, while being unpayable itself. The shoot of the Cam Hanging Wall lode has a crudely Westerly pitch, approximating that of the Cam until the 12th level, at which point the Western margin begins to dip Eastward giving the lower portion of the shoot a thin digital dowaward projection below that point.

At the 14th level the Cam pay shoot was found to be 860 feet in length along strike, splitting in twain to the West and Southwest on its Western end, and dying soon after its intersection with the Cam Spur lode, which has been described in a previous section. To the East, the channel as usual continued beyond the end of the shoot as a zone of constricted parallel fractures. Although unpayable, this fracture zone was followed East for a further 3000 feet beyond the Eastern margin of the payshoot, the last 2400 feet of which were in the neighbouring block of claims, and which work was done for the Eileen Alannah Gold Mining Company in an attempt to locate a downward extension of that payshoot which bottomed some 700 feet above the level. This drive (cross cut) was driven on a structure consisting of a very strong zone of parallel fractures at times ten feet in width, which was mineralised with abundant carbonate and at spots, sparse quartz, but never payable ore. The fracture zone is still existent in the far East face giving it a total exposed length of nearly 4000 feet. This is a major structure, indeed, which dies to the West before reaching the sedimentary series. This crosscut drive was further utilised for diamond drilling sites and thousands of feet of holes were drilled, the results of which showed greenstone and dolerite, but neither indication of ore nor extension of the bottomed Eileen Alannah shoot was found. As can be seen on the plan of the 17th (1999') level, the Cam shoot has shortened to less than 500 feet, while a zone of enrichment has appeared, being localised along the intersection with Cam Spur, as already described. The known effects of the Main Apex Fault lying South of the Cam lode have already been described under the section on Cam Spur, and it is unfortunate that the Eastern portion of the Cam lode is caved on this level, as it might have been possible to correlate this fault with the course of the steeper, downward extension of the Cam Hanging Wall lode below the 15th level.

Before reaching the 19th (2250') level, the Cam has come into actual contact with the Main Apex Fault and the payable length has shortened to less than 300 feet. As already described, the Cam for the first time fails to continue through Cam Spur and again forms a large enriched body at the intersection point. Values within the sediments (faulted) in position at the Western end of the Cam Lode, as well as widths, are low, but it was again impossible to observe the Eastern portion of the lode due to collapse of backs. There is definite indication, however, that the fault as exposed at the Western extremity of the Cam is one and the same as the channel of the 585 West Footwall lode, at a distance of 400 feet to the West Southwest.

Above the 21st level, the shoot again splits tothe West and by the time the 23rd level is reached (2797') all values on the Cam are seen to exist West of the Main Fault intersection. On the 23rd level widths have shrunk to about 48 inches, and the major portion of the values does not extend into the section in which the sediments are encountered. It was possible, however, to see the Eastern face of the Cam drive on the 23rd level, and it was seen to consist of the usual tight zone of parallel fractures, which are beyond the Eastern extremity of the sediments displaced along the Main Apex Fault and said channel is, therefore, in greenstone.

An interesting phase of the Apex Faulting which occurred on the 23rd level, is seen at a distance of 325 feet East of the intersection of Cam and Cam Spur lodes. Here, a block of shale may be seen, which has been forced to the North between two steep faults which tend to converge at the Southern end. This segment of sediments measures at least 80 feet (North-South) by 60 feet East-West, and has been shifted from its previous location; to which it had been brought into position by being dislocated to the East along the Northernmost of the Apex Faults. The strike of the bedding of these sediments, although contorted, is about East-West with the Cam, therefore, cutting across the bedding at only 20°. Workable values were found to exist in the sediments, as well as East and West of same, over a total strike length of 280 feet, but branch lodes divergent from the main Cam lode, towards the South lost continuity upon crossing the strike of the dislocated body or the Apex Fault. Also, the Cam Parallel Lode (Channel), although barren, is seen to join the Cam lode at a point some 150 feet West of the face in the Cam drive East, constituting a second (more Southerly) Apex Fault which intersects the Cam on this level. This gives a definite East Northeasterly trend to that portion of the lode, and indicates that it is entirely within reason that the (further) Eastward trending Cam fracture zone may have been greatly influenced by the presence of the Apex structure. (See Diagram SX-12).


NORTH SOUTH SECTION ALONG 00(E.-W)COORDINATE SHOWING STRUCTURAL BOTTOMING OF CAM AND PETROL LODE SYSTEMS, AND MAIN FAULT RELATIONS
LOOKING WEST
00 NS
SURF.
5
8
14
17
19
23
25
27
30
32
34
36
39
1000'
2000'
3000'
4000'
5000'
MAIN FAULT
CAM LODE
GREENSTONE
CAM-PAR. LODE
PETROL LODE
1565 LODE
1350 S.C. FAULT
SX-12
SCALE: 1" = 1000'

The Cam Lode on the 25th (3007') level has already begun to show the influence of contact with the Apex faulting. As will be seen on the plan, two sizeable areas of sediments lie in the path of the channel, and considerable bodies of basic intrusive tend to surround these segments. This intrusive is found in minor amounts along most of the lodes, and in quantity in the vicinity of the Main Fold-Fault, Cam, Cam parallel and Cam Spur South lodes at this horizon, and is variable in composition being usually a fine grained, highly carbonated basic rock of light greenish to buff appearance, approximating a Diabase. The Easternmost of these sedimentary segments is of interest in that it appears to be the identical body intersected in the (prospecting) drive East beyond the Cam Parallel lode on level No. 23. The western of the segments is to be seen from here (25th level) to the bottom level now being worked (39th) as a North trending faulted block having been displaced; first to the East by the Main Fold-Fault sequence, and secondly to the North, apparently along the Cam Spur. The Southernmost of the Cam lodes is believed to coincide with an Apex fault which displaced a very large block of sediments into the path of the Cam Spur on the 23rd level, some 210 feet higher. The course of a new, Northwest-

Southeast trending branch of the Cam lode (below this level) is seen in a curving slip striking 48^{0} South of East, and joining the main Cam lode at a distance of 120 feet East of the Western sedimentary segment.

The length of the pay shoot on the 25th level was 290 feet; bounded by the Cam Spur on the West, and the Western margin of the Eastern block of intersected sediments on the East. Widths are narrow, averaging 38 inches.

Between the 25th and 27th levels, the Cam lode channel reaches the point of total intersection with the main Apex faults, and is for its total strike in mixed country consisting of sediments and intrusive with rather less than five percent of the wall rock being greenstone. On the 27th (3228') level the pay shoot length is 210 feet and widths average only 30 inches.

On the plan of the 30th (3560') level the Cam can be seen to have a short strike on bearing of thirty degrees West of North, of which some 160 feet is payable and which lies in greenstone, the main body of the intrusive having chosen the Cam Spur for its upwards course at this particular spot. Small lodes prospected in the footwall of the Cam on the 27th, 28th and 29th levels, have, by the time the 30th level is reached, assumed equal importance to the Cam. The largest of these is called the 1585 South Footwall lode, and may be seen lying in the footwall of the Cam and tangent to the latter in the sediments. This lode is a North-South near vertical body lying largely in greenstone, and having no defined walls, which makes it difficult to work due to falls of rock. Being first worked on the 28th level (3341'), and having been worked to the 33rd (4160') level it is worthy of description and of particular interest in that it is beyond doubt a source channel of the Cam lode. Its average payable length was under 200 feet with widths of rather less than 36 inches, average.

Before reaching the 32nd (3960') level, the Cam loses all continuity and is of short and very irregular strike, being mixed amongst various sedimentary and intrusive areas, with the 1585 lode and other minor lodes of various strikes and dips. The narrow, sinuous lode designated as the Cam, on the plan of the 34th (4360') level, is of less than 100 feet payable strike, and is believed to be the last vestige of the magnificent lode which measured nearly a mile in length at the surface.

In review, the Cam Lode's failure at depth is attributed to :

A. Disadvantageous pitch of pay shoot margins toward the area of North-South disturbance; to the West.

B. Disadvantageous dip, which caused the Cam to enter the zone influenced by the Main Apex Faults, by virtue of which it lost continuity amongst the sediments thereby faulted into position. This constitutes structural bottoming due to both fault intersection along strike and down dip, and to change of wall rock type.

THE PETROL LODE.

The origin of the Petrol relief zone has been discussed in the section dealing with tectonics and lode characteristics, and will herein be alluded to upon the basis already established. On Diagram SX-10 the pay shoot may be seen to contain a rather large central area of richer ore extending from surface to a depth of 1400 feet, and averaging about 300 feet in length along strike. Two additional like areas lie en echelon below this upper zone, being of increasingly lesser dimensions. An explanation of such features may be in part a result of the particularly sinuous nature of the channel (see plans of levels No. 8, 14 and 17) which was apparently caused by irregular movements along the North-South sedimentary-greenstone contact, and in the zone of the greenstone affected by the monoclinal structure exposed at the Western extremity of the Petrol lode in the upper levels.

Surface work on the Petrol lode consisted of a certain amount of quarrying, much the same as that upon the Cam, but the channel was only about 1100 feet in pay length and much narrower. The Petrol relief zone continues to the East beyond payable ore limits, as a constricted zone of parallel fractures, along which additional shoots were not discovered, as were the Eileen Alannah and Eglantine along strike of the Cam Channel, to the East. By virtue of a dip slightly flatter than that of the Cam (60°) the Petrol in depth approaches it, but in the case of the Cam, which owes its continuity to lower level approximation of the Main Apex Fault system, a longer stronger affected zone exists in the upper levels of the Cam. This is more simply illustrated in the comparison of the origin of the Cam and Petrol zones: the monocline that produced the fissure on which the Petrol lode is located being a lesser feature which disturbed the normal strike of the sediments only a matter of some 200 feet; as against the Main Fold which is responsible for the origin of the Cam, having a like influence amounting to a minimum of at least 700 feet. The first level upon which the Petrol lode was accessible for study was No. 8 (890'). On this level the lode was payable over a length of 480 feet and had an average width of about 80 inches. The monoclinal fold is well exposed on this level, and is seen to have an East-West offset of 110 feet with angle of incidence being about 81°. The lode was payable for the total length within the East Northeast-West Southwest trend of the disturbed sediments, while lying on their contact with the greenstone, but failed when it encountered the North Northeast (undisturbed) strike of the same.

On the 14th (1615') level, the payshoot was found to be payable for a length of 575 feet. The monoclinal structure has on this level diminished its offset to some 40 feet and the angle of incidence has accordingly dropped to about 45°. It is not again exposed below this level and apparently dies out downwards before reaching the 15th level. Unfortunately, fallen rock prevented observation of the Petrol on 14 level except for the Western 180 feet. Here it averaged only 28 inches in width and was divergent and discontinuous, the majority of the payable portion being to the East. A strong fracture zone intersecting the Petrol about 150 feet from its Western end is on the line with the Gem Spur lode some 550 feet to the South Southeast, and may be the extension of that feature.

As observed on the 17th (1999') level, the Petrol is a major body with payshoot of over 540 feet in length being an average of 90 inches in width. The lode is sinuous, divergent and affected by North-South drag along slips only slightly pre-mineral in age. At its Western end there are about five indistinct bodies in greenstone which were stoped over a width exceeding 40 feet, the intervening greenstone containing numerous quartz-carbonate bodies and constituting ore. The lode dies to the West in a divergence of fractures beyond which point the channel ceases to exist. At the face of the Eastern drive, the channel is seen to consist of one foot of tightly spaced (approximately 15 per inch) shears dipping steeper (68°) than the normal (63°) dip of the Petrol lode. This feature was invariably noticed wherever the far East face of the drives on both the Cam and the Petrol were accessible. A veinlet of stibnite was seen to cut the Petrol lode, and exist along strike of same for a distance of over 80 feet on this level, averaging 6 inches in width and being of unquestionably later origin than the bulk of the quartz-carbonate making up the lode. This stibnite was assayed and found to contain 6 Dwt. of gold. A photograph of a polished section of this mineral is seen in the section on mineralisation.

Little difference is seen in the appearance of the lode as shown on the plans of the 19th (2250') level and the 23rd (2797') level, it being a sinuous East Northeast trending lode of narrow width. The payable length upon the 19th level was 440 feet, only 315 feet being payable on level 23. A spur lode extending into the hanging wall is seen on the 23rd level having been developed for about 100 feet. This lode was first seen on the 21st (2495') level, and was extremely rich, but appears to have lost continuity before reaching the 23rd level, where values were found to be poor. Two very strong zones of shears are seen to intersect the Petrol lode on the plan of the 23rd level and it is between these zones that payable values are confined.

By virtue of its flat dip, the Petrol lode may seem to be lying directly to the East of the Cam Spur North on the plan of the 25th (3007') level. It is interesting to note that there is a definite contortion of Cam Spur at a point where Petrol would intersect it if the lode continued. This distortion is of the same nature as the upper level monoclinal structure of the sediments. The short (180 feet) pay length of the lode on the 25th level is confined on the Western end by a definite zone of fracturing of various strikes and dips, and on the Eastern end by a sizeable slip which strikes Northeast, meeting the lode at a low angle. At about this point in the vertical projection of the shoot, the margins thereof cause the shoot to pitch vertically. No explanation of this feature other than proximity to the Cam Spur is apparent.

The situation with the Petrol lode is much the same on the 27th (3228') level as on the 25th level. The length of the shoot has shortened to 100 feet, and is very narrow, being about 30 inches in average width. Extraordinarily fresh lava with perfectly preserved pillow structure was observed in the crosscut North from the Eastern end of the Petrol drive and will be described under the section on petrology.

The last level upon which the Petrol lode is exposed is the 30th, where the lode was followed Eastward for a distance of 580 feet, although it was payable for only 85 feet of this strike, at the Western end. A distinct change from normal East Northeast strike to that of East Southeast may be seen to have occurred between the 27th and 30th level. A narrow quartz-carbonate body is seen the entire developed length of nearly 100 feet, disappearing in the fashion already described, at its Eastern extremity. There is little doubt that the Cam Spur was in some fashion a source channel of the Petrol lode, and it is entirely possible that other such "feeders" exist, as workable North-South fractures of steep attitude, much the same as the 1585 Footwall lode in the ca[illegible]he Cam.

In s[illegible] failure of the Petrol lode is felt to be le[illegible]in, as to reasons, than that of the Cam, but it may be said to be due to the following:

A. Disadvantageous pitch of payshoot margins towards the Cam Spur channel, which cause its constriction at depth.

B. Disadvantageous dip which caused the Petrol lode to approach its source body; the Cam Spur (North) lode, below which its channel, although continuous, remained barren in favour of said source.

THE CAM PARALLEL LODE.

This lode was first exposed in the drive South while prospecting beyond the limits of the Shoot of the Cam Spur lode on the 23rd (2797') level. This lode is of special interest, in that it is the only lode which appears to have formed within a brecciated zone South of the Main Fold contact. As observed on the 23rd level the lode had a pay length of 145 feet with average width of 30 inches. Its strike is highly variable but roughly East Northeast- West Southwest, with a variable dip averaging about 70° to the South. Considerable basic intrusive is seen healing the brecciated greenstone and sedimentaries, with the lode being largely in greenstone, and being bounded East and West by zones of intense shearing, contortion and brecciation. The lode is quartz-carbonate which is heavi;y mineralized with pyrite and arsenopyrite. The structure around the lode is very difficult to interpret, being a result of the sediments and greenstones dragged between different Apex and cross faults all of which had been healed by intrusive and further carbonated. The age of the lode, however, is known to be the same as that of the Cam Spur with which it makes a cruciform intersection.

This lode also developed on the 22nd (2650') level but had a strike of only about 75 feet containing payable values. On this level a large "pocket" of stibnite measuring 15 feet by 5 feet was struck just North of the intersection with the Cam Spur (East) Footwall lode. The lode was not developed below the 23rd level at the time of the writer's most recent visit.

THE 585 WEST FOOTWALL LODE.

This is the second lode observed to exist in the Main Apex Fault zone. It was first noted on the 17th (1999') level, where it consisted of two very narrow lodes, of strike less than two hundred feet. These were accidentally intersected in driving the crosscut to the Sand shaft which lies about 200 feet East of the Motor lode. Only a few payable values were found. The lode was workable over a short distance on the 18th (2126') level and on the 19th (2250') level was found to be payable for a length of over 150 feet in greenstone. The strike of the lode as seen on the plan of the 19th level is about 65° East of North with a South Southeasterly dip of 70°. From the sedimentary sequence on 17 and 19 levels and the incidence of the Main Fold-Fault with the Cam lode and Centre-Motor intersection, it can be seen that this lode is coincident with the Southern margin of the Footwall "A", "B" and Centre lodes, which are cut by the Northernmost of the Apex faults. This lode is, therefore, lying in part on the major East West zone of displacement and its failure is most probably due to the dip of its channel which causes it to encounter the sediments at depth. As the lode is tangent to the sediments on its Western end at the 19th level, it is likely that it was a source channel which may have fed the greater Motor-Centre Footwall body on that level.

THE MOTOR EAST LODE.

During field work at the Cam and Motor Mine, while preparing the basis for this paper, a certain amount of development was arranged between the writer and the Mine Manager, Mr. W.H.M. Snell. In general, this work consisted of bottom level crosscutting, with the dual purpose of accomplishing protection work upon certain of the blocks of claims and of prospecting for additional lodes or extensions of known ore bodies.

Upon examination of the 38th and 39th level plans, the position of the Southeastern, South trending leg of sediments which has been forced to the North from its folded position by Cam Spur may be noted.

It will then be seen that the lode driven on to the Northeast is discontinuous with this leg of sediments, and, therefore, discontinuous with the established behaviour pattern in levels above. A crosscut was pushed East at a distance of 150 feet North of the Sub-vertical shaft in order to investigate the contact of this leg of sediments with the greenstones, and a small lode with unpayable values was exposed lying in a "shale" bed along said contact. Since this fracture was occupied by an even smaller quartz veinlet exposed in cutting the shaft station to the South, it was then felt that another crosscut further to the North would be in a more advantageous position, in that it would cut this channel at a point where it lay entirely in greenstone, since the Cam Spur had invariably been of poor grade where developed in the sediments proper. Accordingly, a cross-cut was planned at the face of the drive North, some 300 feet to the North of the previous crosscut, and a total distance of 450 feet to the North of the Sub-vertical shaft. The first 85 feet of this second crosscut lay East totally in barren greenstone. At a distance of 86 feet, a strong shear zone striking North@South with near vertical dip was intersected. This zone contained a quartz-carbonate lode with a tenor of about 5 Dwt. over a width of 5 inches, which "made" to the