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GEOLOGY OF THE MOUNT ELLIOTT COPPER MINE, SELWYN, QUEENSLAND.

by

R. A. SEARL.

THE GEOLOGY OF THE MOUNT ELLIOTT COPPER MINE.

ILLUSTRATIONS.*

* At back of report.

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by

R. A. Searl.

SUMMARY.

This report presents the results of detailed geological mapping of an area of approximately seven square miles surrounding the Mount Elliott copper mine, Selwyn, Queensland. The survey was made to determine the relationship between the geological structure and the mineralized zone containing the Mount Elliott copper deposit.

A geological map of the actual exposures has been compiled (Plate 1) and interpretations of this data are shown on one plan (Plate 2) and eight sections (Plates 3, 4, 5 and 6).

The area consists of folded, metamorphosed, Pre-Cambrian sediments which have been intruded by basic and acid igneous rocks. Faulting in two directions occurred in the area; the major faults trend N.N.W. and subsidiary faults trend E.N.E. The ore deposit at Mount Elliott occurs in a shear zone parallel to the main direction of faulting (N.N.W.).

The regional plunge of the sediments is probably north-west; axes of minor crossfolds trend generally north-east.

At the surface the ore deposit outcropped in black slates and was 110 feet in length and 50 feet in average width. Copper mineralization has been shown to extend for 650 feet below the surface, and at the 400 feet level it extends over a width of 220 feet and a length of 320 feet.

The oxidized ore minerals are malachite, azurite, chrysocolla and red and black oxides of copper; the main copper mineral of the primary zone is chalcopyrite. The average grade of ore mined within the oxidized zone was about 12 per cent copper and 5 dwts. of gold per ton of ore whereas the grade of the ore found at deeper levels was much lower, averaging 4 per cent copper and 1 dwt. of gold at the 400 feet level and 2 per cent copper and probably ½ dwt. (not adequately tested) of gold on the 550 and 650 feet levels. Although this drop in grade is, no doubt, partly due to secondary enrichment, structural analysis of the deposit shows that the lens of ore which was high-grade in the secondary zone was also of very good grade in the primary zone.

The ore has been formed mainly by replacement of certain beds where these have been crushed. A dolerite dyke, which probably introduced the metals, comes in contact with these beds and the ore of the primary zone has a metamorphic texture and contains calc-silicate minerals.

The prospects of ore repetitions near the mine are reasonably favourable. Diamond drilling is recommended as a means of (i) testing for concealed mineralization, and (ii) gaining more information regarding the sub-surface geology.

INTRODUCTION.

Purpose of Survey.

The purpose of the present survey was to carry out detailed mapping in the Mount Elliott area, Selwyn, Queensland, and to assess the chances of the occurrence of concealed mineralization other than the ore deposit mined at Mount Elliott.

This report is intended as a supplement to the report by C. J. Sullivan (1951) and should be read in conjunction with it.

An area of about seven square miles, in the vicinity of the Mount Elliott mine (Plate 1) was mapped by the present survey party. The mapping was carried out using enlarged aerial photographs of a scale of 1 inch to 400 feet.

The field work was carried out between the 31st May and 10th August, 1951, by K. W. B. Iten and R. A. Searl of the Bureau of Mineral Resources, and J. H. Brooks of the Geological Survey of Queensland.

Situation and Access.

The Mount Elliott mine is situated one mile south of Selwyn in the Cloncurry district, Queensland. Selwyn, a rail terminus, 71 miles south of Cloncurry, is connected to Cloncurry by a branch line joining the Cloncurry-Mt. Isa railway at Malbon. A road, running from Cloncurry to Selwyn, closely follows the railway and continues past Selwyn to Boulia and Mackinlay.

Climate and Vegetation.

Selwyn is 1,230 feet above sea level and is situated in the centre of the Selwyn Range, an elongated tableland which trends east-south-east (Honman, 1938). The average annual rainfall is 15 inches and approximately 80 per cent. of the rain falls during the summer months. The water supply at Selwyn is poor and at present the two residents depend on the weekly train service which brings potable water from Cloncurry. In the past, the mine was supplied from a bore on Maggies Creek, six miles north of Selwyn.

Vegetation consists of predominant spinifex grasses and eucalypts; the latter are of little use in mining operations.

Mining History.

Dutton's report (1950) contains details of the mining history of which a brief outline is given below. The outcrop of the Mount Elliott lode was discovered between 1895 and 1900 and mining commenced in 1901. In this year a shaft was sunk to 50 feet and in 1906 it was deepened to 100 feet. Later mining operations proved the lode to a depth of 650 feet.

The oxidized ore averaged about 12 per cent. copper and 5 dwts. of gold per ton of ore and came from above the 125, 185 and 285 feet levels. The grade of ore from the primary zone was about 4 per cent. copper and 1 dwt. of gold above the 400 feet level and below this level to the 650 feet level it averaged about 2 per cent. copper and very little gold. The gold content of the ore between the 400 and 650 feet levels was not determined precisely but Dutton (1950) considers that it is probably of the order of 0.5 dwt. of gold per ton.

A small smelter was erected in 1906 and was replaced by a larger smelter in 1910 when Selwyn was linked by rail to Cloncurry. The smelter was operated intermittently from 1910 to 1919 but production ceased in 1920. A decrease in the price of copper from £160 per ton in 1916 to £80 per ton in 1919 and the sudden decline in grade below the 300 ft. level were major factors that contributed to the closure of the Mount Elliott mine.

Honman (1938) states that a total of 264,007 tons of ore averaging 9.3 per cent copper and 4.2 dwts. of gold per ton of ore were extracted from the mine. Production figures as given by other authors are quoted below:-

(1) Nye and Rayner (1940):-

Total Ore	Ore with Copper Content only.			Ore with Gold and Copper Content.					Gold-Copper Ratio.
	Ore	Copper	Copper Content	Ore	Copper	Copper Content	Gold	Gold	
Tons	Tons	Per Cent.	Tons	Tons	Per Cent.	Tons	Oz. per ton	Content	
264,007.46	101,860.0	5.17	5,253.35	161,861.85	11.85	19,177.83	0.210	33,892.50	0.0177

(May include some small parcels from other of the Mount Elliott Company's mines).

(2) Yeatman and Berry (1920):-

180,000 tons - no grade reported.

(3) H. S. MacKay (1926).

Smelter treated 300,967 tons of ore, containing 9.1 per cent. of copper. Of this 140,000 tons came from Mt. Elliott Mine. (includes 10,300 tons from Consols Mine; 25,700 tons from Great Australia Mine; 2,600 tons from Dobbyn).

The mine operators on 30/6/19, gave the ore reserves as 680,000 tons of 3 per cent. copper and 4,000 tons of 10 per cent. copper. Yeatman and Berry (1920) estimated the reserves as 360,000 tons of ore containing 3 per cent. copper and Honman (1938), computed the reserves to be 439,793 tons of ore with an approximate grade of 3 per cent. copper. All of these estimates refer to the ore available above the 650 ft. level. No check could be made as the mine is filled with water and the underground workings may have partly collapsed due to pressure from a slag dump.

Previous Investigations.

The Mine operators made little attempt to record underground geological observations (apart from assay results) and as it is now impossible to enter the workings much valuable information, which could perhaps have been used in the search for ore repetition near this mine has been lost.

Some observations made at Mount Elliott mine have been recorded by Ball (1908); Yeatman and Berry (1920); and Mackay (1926).

The area between Kuridala and Mt. Cobalt, which includes the Mount Elliott deposit, has been mapped at a scale of 1 inch to 50 chains (Honman, 1938). Clappison and Dickinson did most of the mapping, which is quite good for the time spent in the field, and Honman reported on the general structural and mining geology of the area.

A report on the relationship between ore occurrence and geological structure at Mount Elliott has been prepared by Sullivan (1951). The work here described was a continuation of the investigation carried out by Sullivan.

GENERAL GEOLOGY.

The mapping carried out by the present investigators is presented on Plate 1. The predominant rocks of the area are folded Pre-Cambrian schists, slates, quartzites and a rock which has been classified (Sullivan, 1951) as quartz-felspar rock (possibly an altered tuff). These rocks have been intruded by three basic dykes, and in the north-east portion of the area by acid dykes. Small mesas with ferruginous laterite cappings are present and represent a former land surface which is probably Tertiary in age.

The metamorphosed sediments of the area have been divided into four stratigraphical units which, for the purpose of this report, have been called groups, Group I being the oldest group.

Group I:- Group I outcrops in the western marginal section of the area (Plates 1 and 2) and it consists of intensely folded slates, schists and quartzites. Amphibolite-schists occur in the south-west along the contact with an amphibolite (not mapped).

The contact of Group I with Group II is faulted in some places. Regional mapping may prove that Group II unconformably overlies Group I.

The position of Group I in the stratigraphical sequence (Plate 2) and the distance of the outcrops from the zone of mineralization indicate that this group is not closely related to the Mt. Elliott copper deposit.

Group II:- This Group is equivalent to the Older Group of Sullivan (1951) who did not map Group I. It crops out in the central and southern portion of the area; two small outliers occur, south of the mine, in Group III rocks. The rocks of Group II consist of folded and metamorphosed quartz-felspar rock (Plate 8, Fig. 2) overlain conformably by sediments which have been converted to quartz-mica-schists.

The quartz-felspar rock is commonly impregnated with limonite and the iron content increases greatly near the contact with the younger mica-schists. The rock is very weathered and no definite conclusion has been made as to its origin. Sullivan (1951, pp.8,9) states that the rock may be an altered tuff or an altered shale and the writer, from field observations, agrees that it may be an altered tuffaceous rock.

The quartz-mica-schists contains a high proportion of iron-stained muscovite. There is a gradual transition from green foliated schists to sericitic phyllites in the upper parts of the group. Phyllites, in the outliers of Group II and within a few feet of the junction with Group III, show a gradual change into slaty phyllites and Group III slates (Plate 5, Fig. 1). The contact of groups II and III which was thoroughly investigated throughout the area is definitely conformable.

Group III:- The ore deposit at Mt. Elliott is found in this group which is equivalent to the Younger Group of Sullivan (1951). Group III outcrops in the central portion of the area, and as a narrow inlier which contacts an amphibolite dyke on the western side of Group II rocks on the eastern side.

The rocks of this group are fine-grained, grey to black, slates which have been folded (Plate 9, Fig. 2). Included in this group are rocks which were formerly thought to be cherts. These are a silicified equivalent of the normal black slates. The silicification is confined to the more elevated outcrops of slates on the hills.

These outcrops, in many places, can be traced along the strike into valleys where normal slate is exposed.

Thin section examination showed the slate, to the west of the ore deposit, to be composed of quartz, clay minerals, a high proportion of graphite, and some hematite. Three types of clay minerals occur in veinlets. One type parallel to the bedding, is probably kaolin. Other veinlets lie at an angle of 10 to 20 degrees to the bedding and are parallel to the fracture cleavage which is poorly developed. The veinlets seldom cross from one bed to another. The rock may have been originally a carbonaceous siltstone and it is probable that some of the veinlets of clay minerals were introduced at the time of the mineralization in the area.

Group III is intruded by an amphibolite dyke and the contact zone contains a white tabular mineral, andalusite, which fluoresces under ultra-violet light. Sullivan (1951, p. 10) reported andalusite in the black slates and suggested that its presence probably indicates an original low lime content of the black slates.

Group IV, the youngest group mapped, conformably overlies Group III. The junction between the groups was mapped over a distance of 3,200 feet and the contact is normal with the exception of a few quartz stringers which probably represent loca faulting of the contact. As the copper deposit at Mount Elliott outcrops in Group III rocks the overlying rocks of Group IV have no close relationship to the mineralization.

Group IV: The rocks of this group were mapped by Honman (1938) as being equivalent to the rocks of Group II of this report. Sullivan (1951) recorded a difference in lithological characteristics but was unable to carry out detailed field observations and assumed that these rocks probably belonged to the Older Group (Group II of this report).

Group IV crops out in the eastern section of the area. It consists of folded quartzites and micaceous sandstones with subordinate schists (Plate 10, Fig. 1 and Fig. 2). The rocks of Group IV have been intruded by an amphibolite dyke.

Honman (1938) mapped rocks equivalent to Groups I, II and IV of this report as resembling the Kalkadoon-Argylla Series; he mapped rocks equivalent to Group III was resembling the Soldiers Cap Series. However, Honman (1938) states that this is only a tentative correlation and it has been shown by the present mapping that Group IV is younger than Group III. The regional geological survey now in progress will correlate the geology of the Mount Elliott area with the regional geology of the Cloncurry district.

Basic Intrusives.

The basic intrusives which occur in the Mount Elliott area have been designated Dyke A, Dyke B and Dyke C (Plates 1 and 2).

Dyke A:- Dyke A crops out in the north-west of the area. The width ofthe dyke at the northern end of the Plate 1 is approximately 3,500 feet. The dyke decreases in size to the south-east and terminates 2,400 feet north-west of the mine. Small outcrops of basic intrusives are found 1800 feet west of the mine. These outcrops are separated from the main body of Dyke A by mica schists, but similarity in mineral composition and texture suggest that they are closely related to Dyke A.

The dyke rock is a fine-grained basic intrusive composed mainly of hornblende and felspar; epidote is present in some places. An outcrop of hornblendite has been observed 600 feet north of the old hospital (Plate 1). Associated with the hornblendite are veins of pink calcite containing minor quantities of magnetite and pyrite.

Where observed, the contact zone of dyke A with the rocks of Groups II and III is composed of hornfels with some hornblende segregations.

Dyke B:- An altered basic dyke, with hornblende segregations, outcrops in the central portion of the area as two lens-shaped bodies 2,300 feet and 1,800 feet in length respectively. The average width of these outcrops is 150 feet.

Generally, the rock is medium-to fine-grained but in some places is coarse-grained. Medium- and fine-grained specimens are composed of hornblende with subordinate felspar, quartz, iron ore and apatite whereas the coarse type consists almost entirely of hornblende. The dyke rock shows no volcanic textures and it is considered that the dyke was originally a dolerite intrusion.

South-east from the mine, very weathered dyke crops out on hills. Lateritic weathering processes have destroyed the original texture of the dyke rock which is brown in colour due to iron-staining. Thin section examination of specimens from this area showed the rock to be composed mainly of clay minerals and hematite with a small amount of quartz; however, this rock, as indicated by field relationships, could have been derived from unweathered dyke-rock by lateritic weathering processes.

Weathered rocks, which are considered to have originated from the intrusion of basic material from dyke B into the slates of Group III, crop out in the slates 1,000 feet south-east of the mine (Plate 1 and 2); the probably structural character of the intrusive rocks is shown on Plate IV, Cross-section 5, which represents the basic material as apophyses of Dyke B. The rocks of the apophyses, thought by Sullivan to be volcanics, are considered to be closely related to dykes B rocks for reasons set out below:-

(i) Outcropping weathered specimens of the apophyses can be matched with rocks of the weathered contact zone of Dyke B and slates which occurs 200 feet east of the apophyses (Plates 1 and 2);

(ii) contact altered slates containing andalusite occur along the margins of the apophyses and they are identical with contact altered slates found north of the mine along the western contact of Dyke B and slates.

Weathering processes have formed rounded surfaces and concentric iron-stainings (leisogang rings) in the rocks of the apophyses (Plate II, Fig. I).

In some places along the eastern margin of Dyke B (Plate 1) thin beds of slates alternate with dyke rocks. The slates along this junction are contact altered and the contact metamorphic zone can be traced, at intervals, over a distance of 2,000 feet. Contact metamorphism along the western margin of the dyke, north of the mine, has resulted in the formation of limonite-rich jasper and andalusite-bearing slates.

Dyke B intrudes the complete succession of Group III rocks and is therefore younger in age. The introduction of the mineralization is considered to be closely related to this dyke.

Interpretation of level plans suggests that Dyke B is in close proximity to the workings from the surface to the 650 feet level, and therefore, it is considered that the dyke transgresses the bedding of the slates; the sub-surface character of Dyke B is similar to its character at the surface where apophyses and alternating dyke rock and slate beds occur (Plates 3, 4 and 5). On the cross sections apophyses have been shown in an arbitrary manner to illustrate their probable structural character.

Dyke C:- This basic intrusive is found in Group IV rocks in the eastern portion of the area (Plates 1 and 2). It is approximately 800 feet wide at the surface and extends, north and south, beyond the limits of the mapping. The dyke rock consists of hornblende and subordinate felspar. In contrast to Dyke A and Dyke B this intrusive is intersected by acid dykes (Plate 11, Fig. 2). Contact metamorphism has occurred along the junctions with Group IV rocks. As the dyke intrudes Group IV rocks it is younger than this group.

Acid Intrusives.

Small aplite and pegmatite dykes intrude Dyke C. A small outcrop of granite (part of a large granite outside the area mapped) is found in the north-eastern corner of Plate 1. The granite and the associated dykes are younger than Dyke C and they are probably younger than Dyke B but proof of this was not found.

Ferruginous Cappings.

Some Pre-Cambrian rocks and rocks of the land surface that has been described by Honman (1938) as being Cretaceous in age have been altered by later lateritic weathering processes and have formed ferruginous cappings which occur in the Mount Elliott area (Plate 1). It was possible to recognize three general zones within the cappings and these are described below:-

(i) A basal zone where some iron impregnation has occurred. The texture and structure of the original rock is retained in this zone;

(ii) a middle zone where the rock is strongly iron-stained and the texture and structure of the original rock has been destroyed.

(iii) an upper zone of highly weathered rock which has been intensely silicified and shows no original texture or structure.

Near the base of the cappings, where they were known to occur over basic intrusives, rocks similar to outcropping weathered rocks of dyke B (See Dyke B above) were found.

Structure.

Interpretations of the general structure of the Mount Elliott area, based on the detailed mapping, are given on one plan (Plate 2) and in seven sections (Plates 3, 4 and 5). The rocks in the area are strongly folded and isoclinal folding is common. The axes of folding trend N30W. The regional pitch of the folds appears to be north-west but reversals of pitch occur, generally along lines which trend north-east. The axes of pitch change are not necessarily of regional dimensions but they are important in regard to the geology of the ore deposit.

Where observed, Group I rocks are isoclinally folded and this suggests that the major part of this group is similarly folded.

A north pitching syncline is indicated by the structure of the mica-schists (Group II) in the central south-western section of the area (Plate 2). Inliers of mica-schists (Group II) occur where crossfolding has taken place.

Group II rocks near the centre of Plate 2 are folded into an anticline which is divided into two minor anticlines. On the eastern limb of the anticline the outcropping mica-schists (Group II) and slates (Group III) are intensely folded and crumpled. The folding in Group IV rocks, farther to the east is more moderate.

Thus the intensity of folding of the metamorphosed sediments increases from west to east, reaching a maximum in group III rocks; farther to the east in Group IV focks folding decreases. The intensity of folding appears to be closely related to the different response of the rock types to folding. The quartz-felspar rock (Group II) and the quartzites (Group IV) are comparatively competent but the mica-schists (Group II) and slates (Group III) are much less competent and so are more likely to be folded.

The intense folding makes it impossible to determine the true thickness of the individual groups and these can be assessed only approximately.

Faulting.

Two sets of faults or shears trending N.N.W. and E.N.E. respectively were established by the present mapping. Honman recognised this pattern (1938, p.7) and stated that the faults were caused by compression from the S.S.W.

Faults in rocks of Group II and Group III have been mapped but the amount of movement connected with the faulting could not be established and this prevents accurate construction of cross sections. However, the faults bearing N.N.W. are probably thrust faults (Sullivan, 1951). The faults are post folding in age; one fault occurs for some distance along the junction of Group II and Group III (Plate 2).

For the present investigation the most important shear is that containing the Mount Elliott lode. According to Honman (1938) this shear is part of a regional shear which he called the Labour Victory-Mount Elliott shear. The shear parallels the N.N.W. trending faults and dips east at 75°. At the surface it occurs in Group III rocks and a crushed zone can be easily traced south from the mine, over a distance of 1100 feet; the greatest width of the crush zone is at the open cut of the mine where is it 120 feet wide. To the north of the mine surface indications of the shear diminish although traces of its continuation have been observed, at some places, over a distance of 1½ miles.

ECONOMIC GEOLOGY.

In the preceding chapters it has been shown that the mineralized zone is confined to Group III rocks at the surface. It is here postulated that at depth, mineralization occurred in Group II and Group III rocks.

The reports of Dutton (1950) and Sullivan (1951) were continually referred to, and alternative suggestions to some interpretations of Sullivan are submitted in this section.

Size of the Lode.

The length of the outcropping orebody was about 110 feet with a maximum width of 50 feet. The mineralized zone extends to a depth of, at least, 650 feet. It widens with depth and approximate dimensions of the mineralized zone and average grade of the ore of different levels are given below:-

Level No.	Distance from surface (feet)	Approximate Diminsions of mineralized zone worked (feet)	Average Grade (Approx.)		
			Copper (%)	Gold (dwts. per ton of ore)	Ore Type
1	125	160 x 70	12+	4 to 5	Oxidised
2	185	200 x 70	12	4 to 5	Oxidised (a little altered sulphide)
3	285	180 x 160	12	4	Primary & oxidised
4	400	320 x 220	6	$1\frac{1}{4}$ possibly.	Primary
5	550	320 x 300	2	Abt. $\frac{1}{2}$	Primary
6	650	Not worked	Low Grade probably 1 to 2	No information possibly traces to $\frac{1}{2}$dwt.	Primary

Sullivan (1951, pp. 23-24) interpreted the ore as occurring in a number of lenses which generally dip east and pitch north and are confin ed to the crush zone. The lenses of ore pass through the different levels and are arranged in an "en echelon" fashion in section. Mine records show that the grade within the lenses was not uniform.

Character of the Ore.

The ore of the oxidized zone is chiefly malachite with some red and black co per oxides, azurite and chrysocolla. Specimens from the primary ore zone, found on the mine dumps, contain chalcopyrite, pyrite, magnetite and pyrrhotite with diopside, scapolite, calcite, sphene and prehnite. The primary ore specimens have a metamorphic texture and the mineral compoisition shows that the ore has been formed in a calc-silicate environment.

Structure of the Ore Deposit.

It is considered that the ore has been formed in the crush zone; the width of the crush zone at the open cut of the mine is approximately 120 feet. The dip of the footwall of the crush zone has been interpreted from level plans to be 75° to 80° east. However, the hanging-wall must have a flatter dip than the footwall if the ore is contained within the crush zone at depth as the width of the mineralized zone at the 400 and 550 ft. levels is 220 and 300 feet respectively.

The rocks of Group II and Group III dip east and are interesected by the crush zone. Slates are exposed in the crush zone and are more crushed in the centre of the zone than at the margins. Accurate indication of the depth at which the different rock types are intersected by the crush zone is not possible because of the intense folding and the unknown amount of movement by faulting.

Sullivan (1951, p.23) postulated that the ore in the vicinity of the 285 ft. level was probably formed by replacement of quartz-felspar rock. The present investigators offer an alternative interpretation of the position of the quartz-felspar rock within the crush zone and this is illustrated on Plate 5. Slates outcrop (Group II) around the mine and "slates" (interpreted as being equivalent to Group II slates) have been recorded by the mine operators down to the 400 ft. level. Underlying the slates the considerable thickness of the conformable mica-schists must be taken into account. Therefore, it is suggested that the quartz-felspar rock may not have been entered during mining operations. The present investigators postulate that the lower grade ore of the primary zone is mainly related to the mica-schists of Group II and that the higher grade ore of the oxidized zone and the upper portion of the primary zone is associated with the slates of Group III. Sullivan (1951, p.22) interpreted the outcropping orebody as transgressing the bedding and stated that it probably filled a cross-cutting fracture in crushed slates. The ore lenses below the 185 ft. level probably follow the general strike, dip and pitch of the beds.

At the mine the outcropping slates pitch to the north and the ore lenses have been interpreted (Sullivan, 1951) as pitching in this direction. Reversals of pitch along lines trending north-east are indicated near the mine (Plate 1).

600 feet south from the mine the pitch changes from north to south and the position of the axis of pitch change can be determined accurately where it crosses the crush zone (Plates 2 and 6). This pitch change has caused beds which contain ore in the mine to occur south of the pitch change.

A reversal of pitch has been mapped 150 feet N.N.W. of the main shaft of the mine (Plate 6). The structural relationship of this pitch change to the ore deposit could not be determined as the axis of pitch change could not be traced into the area above the mine workings.

The structural character of Dyke B is postulated to have been a major control of ore localization within the crush zone. Apophyses from the dyke are postulated to occur at depth and although these have been mainly shown in an arbitrary manner on the sections, the apophyses shown between the 285 and 400 ft. levels on Plate 5 have been interpreted from level plans and mine records; they represent rocks which the mine operators called "hornblende" and "hornstone".

No calcic rock types were found in the area around the mine. The mine operators recorded the occurrence of masses of calcite in the mine; they frequently referred to "hornstone" and "hornblende" being associated with the primary ore. "Berry stated in referring to the primary orebody that the very hard, tough, fine-grained hornstone carried chalcopyrite in spots associated with masses of calcite and hornblende" (Dutton, 1951).

The introduction of the metals is considered to be closely related to the intrusion of the basic dyke and the calcic minerals associated with the ore were probably introduced prior to, or at the time of mineralization (Sullivan, 1951).

In the preceding sections of the economic geology it has been postulated that the ore is confined to the crush zone and is associated with the contact metamorphic zones of Dyke B and the dyke apophyses with the beds of Groups II and III. A generalized hypotheses to explain the introduction of the metals is submitted below.

At depth and probably below the 185 feet level apophyses of the dyke, entering the crush zone, may have formed channelways for ore-bearing solutions. The introduction of the basic material and calcic solutions may have created, in certain beds, a favourable environment for the deposition of ore by replacement; the ore below the 185 feet level may have formed in this manner. Crusched slate beds above the 185' level were not greatly altered by introduced basic material and calcic solutions were probably mineralised along fractures. This would account for the transgression of the outcropping orebody across the bedding.

The difference in the grade of the ore from the oxidised and primary zones may be due, in part, to processes of secondary enrichment but it is considered that the structural controls described in this section caused some difference in grade at the time of ore deposition.

Prospects of Ore Repetition.

The area to the south of the mine is considered to be the most favourable area for ore repetitions. Here ore may occur at depth, within the crush zone. It is also possible that payable ore may be found below the limits of the workings of the present mine.

The structure and lithology of the metamorphosed sediments near the crush zone, south of the mine, are similar to those existing at the mine with the exception of the pitch change which occurs 600 feet south of the mine.

Some copper staining is present in the crush zone south of the mine and due to weathering processes, it is probable that some indications of mineralization may have been destroyed.

From comparison of the areas north and south of the pitch change 600 feet south of the mine (Plate 1), it is considered that the more favourable area for possible concealed ore is that between the pitch change and the mine. In the area south of the pitch change:-

(i) the crush zone is not very wide at the surface; it ranges from 5 feet to 30 feet in width;

(ii) the pitch is to the south; although beds which contain ore in the mine occur in the crush zone no evidence is available either confirming or denying the occurrence of ore in south pitching structures.

(iii) apophyses (or sills) from the dyke outcrop in the slates of Group III near the crush zone; their sub-surface character is not known but there may be a general widening of dyke rocks, at depth, which could preclude the occurrence of payable ore.

By comparison, in the area north of the pitch change:-

(i) the crush zone is 60 feet wide at the surface, and could contain a deposit of considerable size.

(ii) the pitch is north as it is in the mine and beds which contain ore in the mine occur in the crush zone.

(iii) the sub-surface relationship of the dyke to the crush zone and groups I and II is not known but due to the proximity of this area to the mine area the relationship may be similar to that existing in the mine.

Nothing is known of the beds below the mine workings; it is possible that they consist of quartz-felspar rock which may have been mineralized. Diamond drilling is recommended as the best method of obtaining more information about these beds.

Drilling.

The results of the present investigation suggest that further exploration by diamond drilling should be undertaken.

Locations of drill sites have been discussed with Sullivan and Dutton. The selection of sites by Dutton resulted from an analysis of the work of Dutton, Sullivan and the present investigators. Diamond drilling by Broken Hill South Limited will probably be carried out early in 1952.

Three drill holes are proposed and D.D.H. No. 1 is situated 10 feet south of peg No. 366, Plate 3 (Sullivan, 1951). This position is not considered as favourable by the present investigators (see Prospects of Ore Repetition) as the position of D.D.H. No. 2 which is situated 5 feet south-east of peg 62, Plate 3, (Sullivan, 1951). These two holes are to be drilled vertically in crushed slates to test for concealed mineralization.

D.D.H. No. 3 is situated 483', on a bearing 351° M, from the main shaft. This hole is to be inclined in order to intersect beds within the crush zone below the present workings. The drill core may also yield some information regarding the character of the ore, the type of beds present and the structural relationships between Dyke B, Groups I and II, and the crush zone.

CONCLUSION.

Payable copper mineralization may still occur in the Mount Elliott area. Geological investigations to date have shown the possibility of ore repetition.

The geology of the ore deposit mined has been interpreted to a great extent and sub-surface evidence is very limited. Therefore, in the search for ore repetition by drilling a considerable risk factor is involved.

A geophysical reconnaissance has been made by the Geophysical Section of the Bureau. The results of the geophysical work, carried out by Dr. S. Horvath, were not very promising but a detailed geophysical investigation has been recommended.

Diamond drilling of favourable areas is recommended for the purpose of locating possible concealed mineralization and also to yield underground geological information.

ACKNOWLEDGMENTS.

The writer is indebted to Dr. Iten for the preparation of the plates accompanying this report. The hypotheses expressed in the report originate, to a large degree, from discussions between the members of the field party. Monthly reports submitted by Dr. Iten, while the party was in the field, have been continually consulted. The petrological work mentioned in the report was done by Mr. Dallwitz, of the Bureau, assisted by the writer.

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EXPLANATION OF PHOTOGRAPHIC PLATES.

Plate 7: Panoramic view of the Mt. Elliott area looking eastward toward the Mt. Elliott Mine. Ferruginous cappings occur on the hills; the alluvial flats in the foreground cover Group II rocks.

Plate 8: Fig. 1 - The open cut at the Mt. Elliott mine looking southwards. The hill in the upper left section of the photograph consists of crushed slates of Group II.

Fig. 2 - Iron-stained quartz-felspar rock (Group II) outcropping in the west of the Mt. Elliott area.

Plate 9: Fig. 1 - Moderately folded slates of Group II exposed in a road cutting 250 feet south-east of the main shaft of the Mt. Elliott mine.

Fig. 2 - Contorted rocks which occur in an outlier of Group II near the Mt. Elliott Mine. The rocks in the upper section of the photograph are unaltered slates of Group II; towards the lower right hand corner the slates are schistose.

Plate 10: Fig. 1 - Folded Group IV rocks outcropping in the north-east of the Mt. Elliott area.

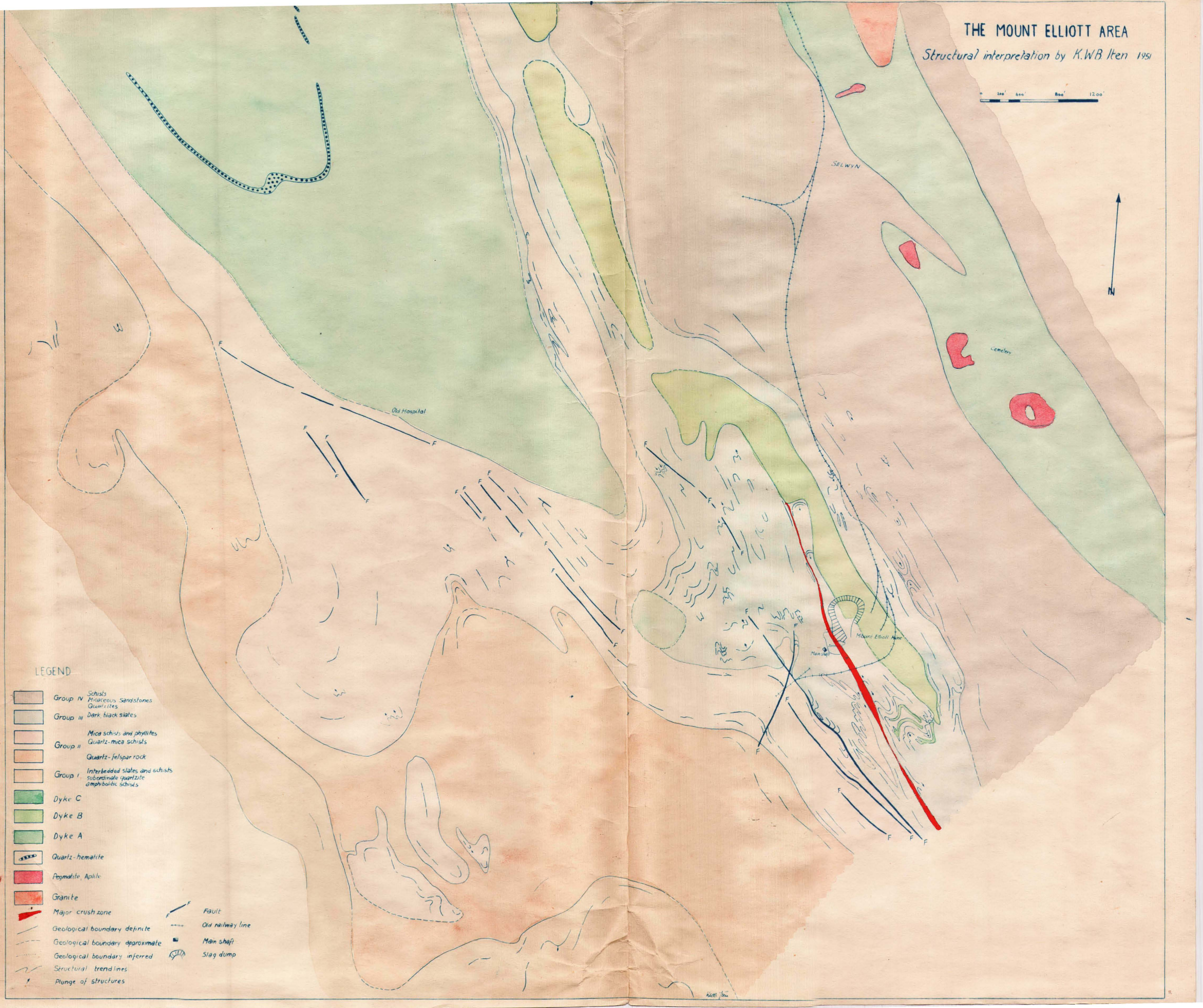
Fig. 2 - Steeply dipping Group IV rocks exposed in a cutting south of the Selwyn railway station.

Plate 11: Fig. 1 - Weathered rocks of Dyke B apophyses; block jointing, rounded surfaces and leisogang rings shown in this photograph have resulted from the processes of weathering.

Fig. 2 - View looking westward from dyke C; Selwyn railway station is shown in the background at the right of the photograph. The large boulders are weathered acid dyke rocks which have intruded dyke C which is represented by the small dark boulders in the foreground.

Plate 12: Quartz-hematite in the west of the Mt. Elliott area, outcropping in alluvium which covers rocks of dyke A.

Plate I
THE MOUNT ELLIOTT AREA
GEOLOGY BY K.W.B. ITEN, R.A. SEARL, J.H. BROOKS
JULY 1951
0
200'
400'
800'
1200'
N
Selwyn
Cemetery
Old Hospital
Mount Elliott Mine
Slag
Old well
To Boulia road
Amphibolite
LEGEND
Sediments
Soil and Alluvium
Ferruginous cappings
Schists
Micaceous sandstones
Quartzites
Group IV
Dark black slates
Sericitic slates
Contact altered slates
kaolinic and amphibolitic
Group III
Mica schists and phyllites
Quartz-mica schists
Group II
Quartz-felspar rock
Interbedded slates and schists
Subordinate quartzite
amphibolitic schists
Group I
Mineralization
Gossan, cellular limonite, mainly Jasper and earthy, structurless limonite.
Limonitic Jasper
Malachite, copper-staining
Magnetite - Pyrite disseminated in Epidote - Calcite (pink) - Hornblende rock
Mt. Py
Quartz glassy, white
Intrusives
Pegmatite
Aplite
Amphibolite
Dyke C
Amphibolitic schists
Hornblendite - Amphibolite
Dyke B
Quartz - hematite
Dyke A
Epidote - calcite - hornblende rock
Hornfels, Hornblendite (Diorite ?)
Granite
Trendlines representing structures
Strike and dip
Pitch measured on minor folds
Pitch obtained from lineation and cleavage - bedding intersection
Geological boundary, definite
Geological boundary, approximate
Fault and fault zone, definite
Fault and fault zone, approximate
Shearzone, Crush zone
minor shear zone
old tracks
Old buildings, ruines
Creek beds
Old watertank
Old railway line
Crossection No. 1-6



THE MOUNT ELLIOTT AREA
Structural interpretation by K.W.B. Iten 1951
0 200' 400' 800' 1200'
SELWYN
Cemetery
Old Hospital
Mount Elliott Mine
Main shaft
LEGEND
Group IV Schists Micaceous sandstones Quartzites
Group III Dark black slates
Group II Mica schists and phyllites Quartz-mica schists
Quartz-felspar rock
Group I Interbedded slates and schists subordinate quartzite amphibolitic schists
Dyke C
Dyke B
Dyke A
Quartz-hematite
Pegmatite, Aplite
Granite
Major crush zone
Geological boundary definite
Geological boundary approximate
Geological boundary inferred
Structural trend lines
Plunge of structures
Fault
Old railway line
Main shaft
Slag dump

Plate 3

Crossections - Mount Elliott Area

by K.W.B. Iten

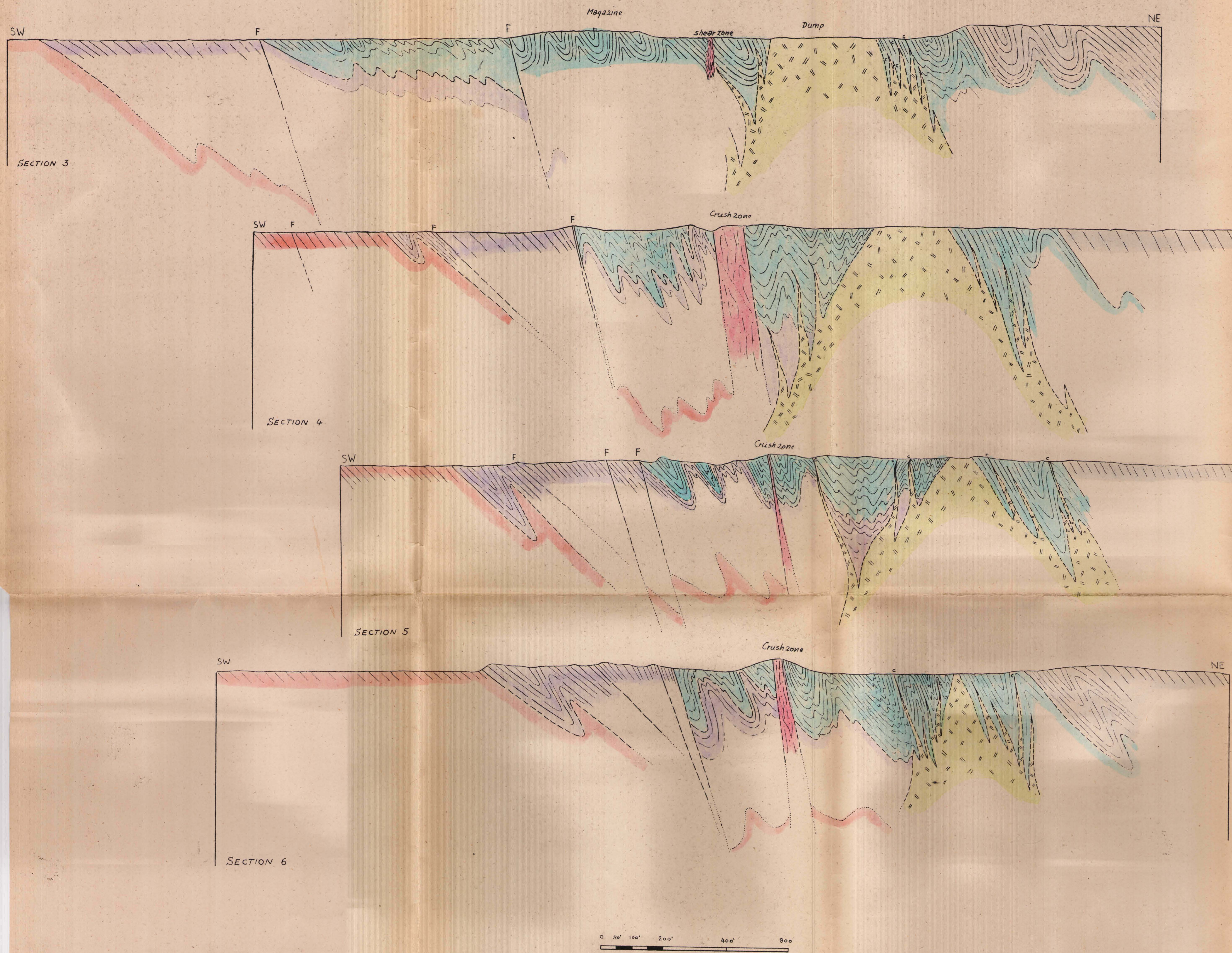
For legend see plate 1

Plate 4

Crossections - Mount Elliott Area

by K.W.B. Iten

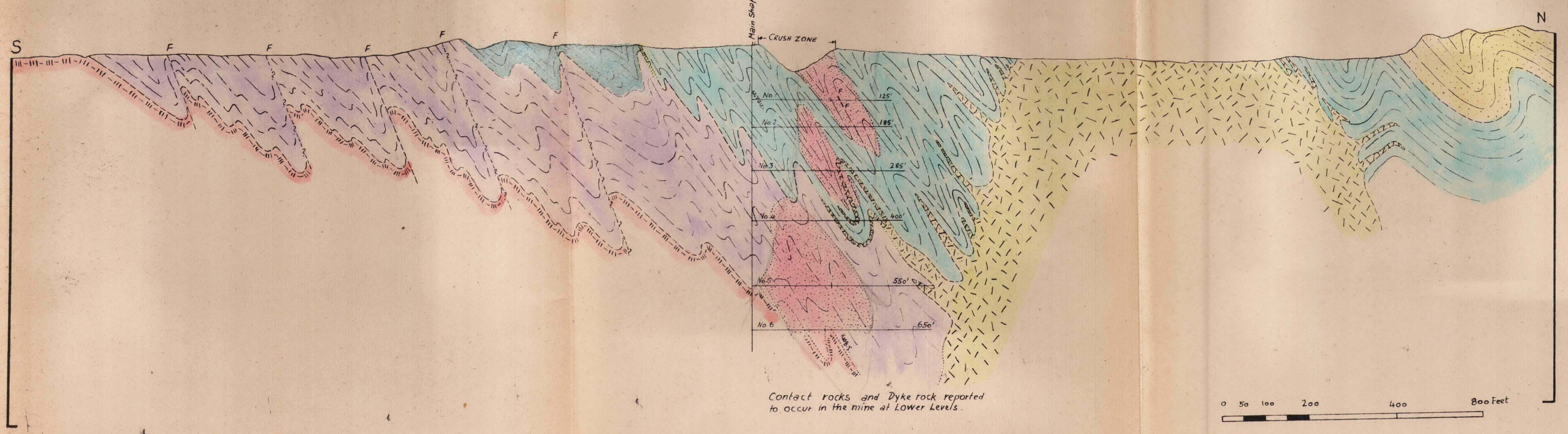
for legend see plate 1



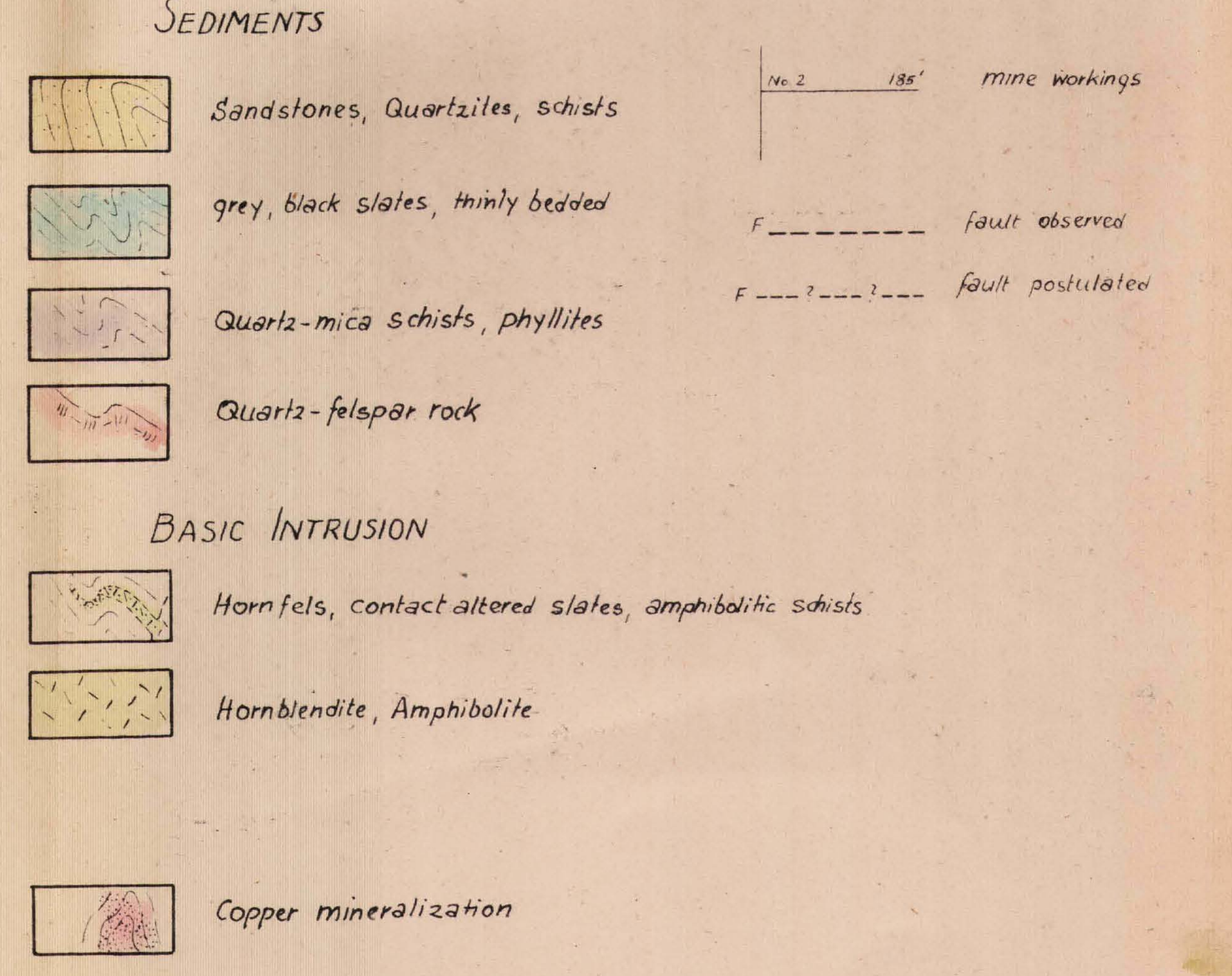
CROSS SECTION 7 – MT. ELLIOTT COPPER MINE

Line of section 005 m – 185 m through main shaft to correspond with plan No. 9 B.H.S. Ltd. field investigation.

constructed by R.A. Searl, July 1951



LEGEND



LONGITUDINAL SECTION - MT. ELLIOTT COPPER MINE

Scale 1" : 40'

August 1951

PLATE 7

Fig. 1

Fig. 2

Fig. 1

Fig. 2

Fig. 1

Fig. 2

Fig. 1

Fig. 2