1952/32
Copy 2

COMMONW... ... ...TRALIA.

DEPARTMENT OF SUPPLY AND DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

~~REPORT No.~~
RECORDS 1952/~~32~~. 32

THE MOUNT ELLIOTT MINE

SELWYN, QUEENSLAND

by

C. J. Sullivan.

THE MOUNT ELLIOTT. MINE

SELWYN, QUEENSLAND

by

C.J. SULLIVAN.

---oOo---

C O N T E N T S

---oOo---

LIST OF PLATES.

THE MOUNT ELLIOTT MINE, SELWYN

QUEENSLAND

by

C.J. SULLIVAN

Records 1952/32.

SUMMARY

The period 7th to 28th January, 1951 was spent at Selwyn by the writer: approximately one week was spent in preparing a semi-regional map at a scale of 1 inch to 400 feet (Plate 1); one week was given to mapping a smaller area at a scale of 1 inch to 200 feet (Plate 2); and the remaining time was used in preparing a geological map of the mine area at a scale of 1 inch to 40 feet (Plate 3). Level plans have been constructed showing what are considered to be the broad outlines of ore arrangement and structure and a number of sections have been constructed. Nineteen plans and sections illustrate this report.

Twelve typical ore and rock specimens were studied in thin section and the information obtained has been incorporated in this report.

As a result of the work outlined above, it was found that the primary ore is a diopside - scapolite-calcite rock, carrying chalcopyrite and small quantities of pyrrhotite. It is considered that the ore has been produced probably by the metamorphism of lime and magnesian carbonates which were introduced into the ore-zone, probably by the agency of a basic intrusive, now a hornblende rock. The copper and gold are also thought to have been introduced by this dyke.

The ore is localised in a crushed zone, probably produced by faulting. The ore obtained from the surface to a depth of approximately 200 feet, filled a fracture in black slates and cherts and yielded 250 to 300 tons per vertical foot. Little replacement of the beds took place. From the 200 ft. level to the 600 ft. level, copper-bearing material replaces beds within the crush zone, and, in places, the known copper-bearing lode aggregates 5,000 tons per vertical foot. The plans and sections show that the ore may be arranged in beds (within the crush zone) and that these beds dip and pitch in accordance with mapped bedding structures in the vicinity. The work carried out strongly suggests that an older group of rocks, lying beneath the black slate-chert group, has been selectively replaced. The unfavourable younger rocks crop out in most of the crush zone, but, over a length of more than 1000 feet, mostly to the south of the mine, it seems that the underlying group could be tested relatively cheaply.

The longitudinal projection (plate 18) shows that mining and exploration were probably carried out without an adequate knowledge of the factors controlling ore deposition and that the drilling at No.6 level (bottom) did not test the beds which had been most productive above.

The sections show that copper mineralization has occurred in beds aggregating more than 500 feet in thickness and that in most cases, some mineralization was found in these beds where they were tested within the crush zor
Since much of the testing was apparently not guided

adequate understanding of the orebody, there is a marked possibility that, where the older rock group intersects the crush zone, there may be very extensive copper mineralization in areas not yet tested. From the sections it will be seen that there is ample space for deposits of the order of 10,000 tons per foot or more.. Over some of the "likely" areas, copper staining and marked crushing lend encouragement, but there are no outcrops of an importance comparable to that over the known lens. Additionally, small copper deposits are much more common than large ones, a point which needs little emphasis.

The structural analysis of the deposits worked show that much of the production must have come from one rich lens (No. 3) which was formed by the replacement of a particular group of beds. It has been assumed by previous investigators, including the mine operators, that the high-grade ore won at Nos. 2, 3 and 4 levels was due to secondary enrichment. However, No.3 lens, the main producer, was comparatively high-grade even at No. 4 level, where, it seems, the ore was entirely primary. The exploration at Nos. 5 and 6 levels did not test the downward extension of No. 3 lens and thus, it may not be correct to assume that the ore revealed in these levels represents the overall primary grade. The general characteristics of the deposit are not favourable for secondary sulphide enrichment (McKinstry, 1948, pp.251-257). As far as could be observed in the ore from dumps and for diamond drill cores, the pyrite content is low and abundant calcite was undoubtedly present at the rich No. 3 level and above.

There is strong evidence that the main orebodies did not outcrop, yet, a simple calculation will show that, for the ore mined at Nos. 2 and 3 levels to have been formed by secondary enrichment from ore of the grade exposed in Nos. 5 and 6 levels, the denudation of a very considerable column of ore would have been required. The analysis suggests that this column of ore has never existed.

With copper deposits, there is always the possibility, even probability, that at least some secondary enrichment has taken place. Probably there was some enrichment at Mount Elliott. However, it is probable that No. 3 lens had a primary grade in both copper and gold well above that of the ore exposed in Nos. 5 and 6 levels. Additionally, the gold : copper ratio may have been higher in this ore than in other lenses exposed in the mine workings.

Variation in the metal ratios of different replaced beds has been well authenticated at Broken Hill and is perhaps to be expected on account of the fact than an environment favourable to the deposition of one element, is not necessarily favourable for the deposition of another. These considerations suggest that high-grade primary ore may be found down pitch in the beds which yielded No. 3 lens, and that other high-grade primary lenses could exist in the area.

The above considerations are of importance in assessing the possibilities of the area, but the examination carried out to date has been relatively brief and the following points call for further study.

(1) The relationship between the ore and the younger and older rock groups must be checked. If, as is suggested at present, the replacement ore is largley confined to the older group, chances of finding more ore are thereby increased.

(2) The nature of the "crush zone" requires further investigation. At present it is surmised that the crush zone is a normal fault, but this requires further study. The zone is wide and it would be important to establish more accurately the line or lines along which the major dislocations may have occurred.

(3) Further information on the relationship of the amphibolite "dyke" to the ore is required.

It cannot be doubted that, if further study, and possibly exploration, are undertaken at Mount Elliott, a much clearer picture of the ore deposits will be obtained, and some of the present deductions may have to be revised.

However, on present knowledge, the area is distincly promising and warrants further attention. It is promising in the sense that large non-outcropping orebodies could occur here and this possibility has not been adequately tested.

INTRODUCTION

The Mount Elliott Mine, near Selwyn, Queensland, has produced 264,007 tons of ore containing 9.3% copper and 4.2 dwts. gold per ton (Honman, 1941). Investigation of the Mt. Elliott Company's assay plans as well as of all other known data by A.H. Dutton (1950), on behalf of Broken Hill South Limited, showed that at the 400ft. and 550 ft. levels, copper mineralization occurred over an area approximately 400 ft. x 300 ft., the grade being somewhat below 3% copper. The richest ore was won from above these levels. The report contains much basic factual information which will not be recapitulated in the present description. Much of the information has been used in the preparation of the mine plans and sections accompanying this report.

Since it is not now possible to enter the mine, reliance had to be placed on surface mapping and on such limited geological information as was recorded on the old plans.

An area 9,000 feet in length and 3,000 feet in width was mapped on aerial photographs enlarged to a scale of 1 inch to 400 feet (Plate 1). An area 3,600 feet by approximately 3,000 feet was mapped at 1 inch to 200 feet (Plate 2) and a smaller area around the mine itself was mapped at 1 inch to 40 feet.

REGIONAL GEOLOGY

Geological maps on a scale of 1 inch to 50 chains (Honman, 1941) are available. The mapping is of good standard for the time spent in the area and was mostly carried out by Dickinson and Clappison. A large number of faults, postulated by Honman, are only diagrammatic representations of an idea and can rarely be found in the positions shown on the plan.

Of major interest from the point of view of the present investigation is Honman's (pp. 4 - 5) classification of the main rock groups of the area. His classification is:-

Recent		Alluvium etc.	
Cretaceous		Sandstones, slates and conglomerates.	
	(Intrusive	Younger granite and pegmatite	
	(	(Contact rocks	)Resembling
	(	(Altered Sandstone	)Mount Isa Series
	(	(Limestone	)

Pre-Cambrian	Sedimentary and Igneous rocks	Hematite quartzite Slates Amphibolites and schists	Resembling Soldiers Cap Series
		Schists Gneisses	Resembling Kalkadoon-Argylla Series

During the present examination it was found in agreement with Honman, that the group mapped by him as schist and gneiss is certainly older than the amphibolites and black slates of Honman's Soldiers Cap series. The schists and gneisses have been subjected to much metamorphism, faulting, folding and quartz injection; these processes have been much less active in the black slate volcanic group. It also seems likely that there is an unconformity between the two groups. This point, which is important, has not been finally established and requires further investigation in the field. The importance of this matter lies in the fact that it is thought that the ore deposits may be confined to the older group of rocks and that the younger group, which outcrops along the ore-bearing zone, may thus prevent ore from outcropping.

It is now proposed to describe the semi-regional mapping carried out during the present examination.

Shown on Plate 1, are two distinctly different rock units.

<u>Older Group</u>

This is exposed in the south-western portion of the area. The rocks here, may perhaps be correlated with the rocks mapped along the eastern portion of the area, but this correlation is not finally established.

The oldest mapped member of the group is a quartz-felspar rock. The rock was definitely originally sedimentary and occurs in beds, usually about 6 inches thick. During the field mapping it was thought that the rock might be an altered dolomite and it will be appreciated later that this would have had much significance. However, microscopic examination (specimens 20, 22, 26, 62) reveals no sign of carbonate minerals and shows that the rocks consists of quartz and a very cloudy altered mineral, taken to be felspar. In some cases, the felspar content is as high as 80 per cent. The origin of this rock is not clear. Only very weathered specimens from the surface have been obtained, a fact which hampers microscopic examination. The rock could be regarded as a sandy shale which had been felspathized by granite-forming agencies, as an altered tuffaceous rock, (specimens were shown to A.A. Öpik, and he says they are the Swedish halleflinta, akin to leptite or altered tuff), or as an adinole-like rock, formed by the albitization and felspathization of shaly sediments by the influence of basic intrusives. Specimen 9, collected along the western margin of an amphibolite, about the 5400 feet north-west of the mine, shows the same felspathization effect. At this point, which is in the younger group of rocks described below, the zone of rock alteration on the edge of the dyke is only about 2 feet wide. It is possible that the basic rocks, which have effected only limited felspathization in the younger group, have had a wider influence in the underlying group. This point will be explained later.

Conformably overlying the quartz-felspar beds is a mica schist formation (Specimen 27). Some of it is quartz-muscovite schist, some contains well developed crystals, metamorphic in form, of what may have been chiastolite. These crystals are now replaced by hematite.

Some members of the mica schist formation contain up to 60 per cent. muscovite and may be regarded as phyllites.

The beds occupying the eastern portion of Plate 1 were called phyllites by Clappison. They are rather more massive than the beds just described and, in places, may be sheared quartzite. They are resistant to weathering and form prominent lines of hills. It seems probable however, that, as suggested by Honman, they belong to the older rock group.

Younger Group

This group is in marked contrast to the other and is characterised by its volcanic affinites. The rocks shown broadly as "volcanics" (Plate 1) consist of flows, 5 to 20 feet in thickness, alternating with cherts and black slates. The flows exhibit pillow structure and hence are probably of submarine origin. One specimen (No.47) examined under the microscope contained fresh acid plagioclase, quartz, biotite, and chlorite and is thus a comparatively acid type of rock. The rock is notable for the fresh state of the felspar and the relatively unaltered state of the rock generally, as compared with specimens from the older group.

The lavas predominate in the lower portion of this group, and the higher members of the sequence contain alternating bands of chert and black slate, flow rocks becoming much less prominent. Typical specimens were examined in thin section and nothing unexpected was revealed. The black slates are very fine-grained and contain a high proportion of graphite. Very fine quartz and some mica form the major part of the rest of the rock (specimen 6). Chiastolite is common in these rocks. The presence of chiastolite (or andalusite) in the black slate group is direct evidence that the lime content of these rocks is low; no lime minerals are found. The rocks called cherts (specimen 35) are extremely fine-grained and their general appearance under the microscope is consistent with that of chemically precipitated cherts. The association of chert with volcanic rocks is widespread.

The Relationship between Younger and Older Groups.

The relationship between the Younger and Older Groups has been mentioned and some further discussion of this may now be undertaken. The relative ages of the two groups is beyond question, but it would be important if their junction was unconformable. This is suspected, but may not be considered proved. Some evidence is given below:-

The volcanic group junctions with the quartz-mica schist in the south-western portion of Plate 1. Only portion of this contact is shown on Plate 1, but the position of the contact may be clearly seen on 2 aerial photos; 8636, run 20; and 8710, run 22. The light colour indicates quartz-mica schist on which spinifex and sparse mallee grow; the dark colour represents volcanic rock, the soil from which produces thick low green scrub and abundant grass. It may be observed from the photograph as well as from plate 1, that the structural trends in the old rocks are markedly discordant to the contact. However, the junction in this section is vertually a straight line for some distance and the first impression was that the junction was a faulted one. However, the evidence for faulting apart from the proved existence of the discordant contact, is somewhat indefinite and it may well be that this is simply an unconformable junction between the two rock groups. One certainly gets the impression that, in places, the junction is uncommonly flat. Low-angle thrust faulting was suspected.

In places, the detailed mapping reveals relationships which are difficult to reconcile with the concept of conformity between the two rock groups. On Plate 2 (scale 1 inch to 200 feet) the mapping shows a discordant relationship about 500 feet west of the mine. This area was mapped at 1" to 200' and 1" to 40' (Plate 3) and each time the same discordant picture emerged.

Again, in Plate 3, in the vicinity of pegs 403, 390 and 402, the mapping seemed to show the younger volcanic rocks, distinctly overlapping the older quartz-felspar beds. Copper-bearing gossanous material occurs along this contact. (Although the mapping was done with all possible care, and the probable significance of the overlapping relationship was appreciated at the time of mapping, it is difficult to be absolutely certain of the rock classifications at this point owing to the effects of crushing, mineralization and weathering. However, a general discordance again shows itself to the south of these pegs (Plate 3).

Near pegs 37 and 38 (Plate 3) a peculiar discordance was again mapped. Here a marked lineation dipping at 30 degrees to the east suggests thrust faulting near the contact.

The overall evidence strongly suggests that the two rock groups are unconformable. As can be seen from Plate 3, however, the mapping shows that a pitch change in one group is represented by a pitch change in the second group and that there is considerable agreement in pitch readings in the two groups. This is not fully understood at present. Further mapping may reveal discordances of pitch.

Basic Intrusive -

The rocks marked "Basic Intrusive" is no younger than the volcanic group and may be slightly older than some members of that group. In the A.G.G.S.N.A. maps this rock is shown as belonging to the volcanic group, but it has a number of points of dissimilarity. Petrographically it is quite different. It is a coarse to medium grained rock and commonly has the texture of a dolerite. Some coarse-grained specimens (e.g. Specimen 11) consist almost entirely of hornblende. Such rocks may once have been gabbros or pyroxenites. No volcanic textures such as vesicles or flow structure are seen in this rock, and in addition, no sedimentary beds are found within the mass. In contract, vesicles, flow structure, pillow and interbedded sediments are common in the undoubted volcanic group occurring to the west. The dyke is more basic in composition than the flow rocks. Magnetic surveys by A.H. Dutton (1951) indicated that the "basic intrusive" was highly magnetic and numerous segregations of magnetite were noted in this body, especially along or near its western margin.

All of the copper showings in the area mapped are in or near the "basic intrusive" and dithizone tests show that the rock is relatively high in copper content; it is thought that this rock may be genetically related to the mineralization. For this reason, the dyke is of particular interest and will be discussed in some further detail below.

It will be noted, that, at the present surface, the "dyke" narrows and thickens and, in some places, cuts out entirely. A short distance beyond the northern limit of Plate 1, the dyke disappears entirely (A.G.G.S.N.A., Plate 1, sheet 2 and plate 2). Although the present mapping was not carried quite far enough to include this, a brief walk over the ground appeared to show that the disappearance actually takes place. Although A.G.G.S.N.A. mapping did not show it, careful mapping in the area about 3,200 feet north-west of the mine indicates that here also, the "dyke" does not outcrop. Much alluvium occurs here, but sufficient outcrops can be found to indicate a definite break. Finally, the dyke definitely ceases to outcrop about 1200 feet south-east of the mine. In this area, where it is possible to map in some detail (Plates 1, 2, 3) it is seen that the "dyke" is disappearing apparently conformably beneath cherts and black slates pitching at approximately 35 degrees to the south-east. It is conceivable however, that this effect was caused by an intrusive tending to make intruded beds wrap around its resistant nose. It is thus probable that the "dyke" is older than at least some of the cherts and black slates. This is important because, if the "basic dyke" introduced the ore, the cherts and black slates which are younger than the "dyke" would not be mineralized and might obscure ore-bearing beds lying below them.

Since it seems to be established that the basic rock is, in places, overlain by members of the volcanic group, it may be asked what evidence is there that the body is essentially dyke-like. Is it perhaps a flow or a sill? Some evidence is:-

(1) The contact of the body with the quartz-mica schist and other rocks around in the eastern portion of the area (Plate 1 and 2) seems, from the mapping carried out, to be transgressive.

(2) The totally dissimilar rocks to east and west of the body suggest that it occupies a zone of movement parallel to others mapped on the field (Plate 2).

(3) For the reasons already given, it is difficult to correlate this rock with others found on the field.

(4) It is difficult to draw cross sections which look logical when the body is treated as a sill or flow (See sections through mine). This might be just feasible for section E - F, but it would not work out in longitudinal section. Thus as shown in Plate 3, the flow rocks pitch out into the air near the anticlinal pitch change, whereas the "dyke" continues northward indefinitely.

The conclusion which has been reached tentatively, is that the body is intrusive into the older group and into some of the younger group. Its age may correspond to that of the main volcanic flows of the younger group. It may be older than some of the cherts and black slates of the younger group. Further detailed mapping is required.

<u>General Structure</u>

Structural information is given on Plates 1 to 3, and is interpretated on a number of cross sections and a longitudinal projection. For the most part, strikes, dips and pitches can be measured in this area with considerable accuracy.

The general picture in the older group is that of a north pitching anticline, flanked in the east by a small overturned syncline in the phyllites. As shown in Plate 2 and Section J - K, the generally synclinal folding in the phyllites continues into the cherts, volcanics and black slates. A definitely mappable anticlinal pitch change occurs about 500 feet south of the mine (Plates 2 and 3). South of this change, the folding in the black slate group, which can be mapped very well, shows definite south pitch. Immediately north of the change, north pitch may be mapped with equal certainty. Especially fine examples of north-pitching folds are exposed in the road cutting about 300 feet south-east of the Main Shaft. The north pitch continues to the mine area in both the older and younger rock groups.

In the north-west section of Plate 2 (and also in Plate 1) a series of southerly pitch readings is shown in the chert-volcanic-black slate group. Some are lineation pitches and some are fold pitches (distinguished on the plans).

They were first noted on a ridge which commenced about 400 feet W.N.W. of the Main Shaft (Plate 2). The ridge trends W.N.W. and consists of highly puckered cherts and black slates. The small puckers, usually 1 to 6 inches in amplitude, pitch consistently southward. Further to the west-north-west, the flat south pitch becomes general. To the east of the ridge however, northerly pitch readings were obtained. In the older rock group, most pitch readings obtained were to the north.

Faults mapped are shown on Plates 2 and 3. Two main sets appear to be developed. Major faults strike at about 325 degrees. (Examples are Faults A and B and the crush zone). If the basic amphibolite occupies a fault zone it would be one of this type. The crush (or fault) zone which contains the main ore-shoots is known from underground development to have a steep (81°) easterly dip. By analogy, the same dip has been attributed to the other examples of this fault-type mapped. However, this may not be entirely correct. The quartz which fills fault A, for example, appeared to dip quite flatly (32°) to the N.E., and it is possible that this is a flat thrust.

Because the quartz-felspar rocks appear to be repeated to the north-east of Fault B, it has been assumed that this is a reverse fault (Plates 2 and 3 and Section J - K). However, some doubt is felt about this correlation. The assumption could be wrong, but it fits with the general picture of folding overturned to the east.

As will be seen from the cross sections, it appears as though the "crush zone" containing the ore deposits, represents a normal fault with considerable displacement. At present, this seems to be the only interpretation which can be given to the conclusion which must be reached from the longitudinal section L - M, that there is a very considerable thickness of cherts and black slates on the north-eastern side of the crush zone although cross sections show that only a limited cover of the younger rocks is to be expected on the south-western side of the crush zone.

There is a second set of faults trending at 290 to 310 degrees. Examples are shown on the north-western portion Plate 2. These are flat-dipping thrust faults. Some of them are filled with ferruginous cherty material which, in places, contains traces of copper. Some have been tested by shallow pits and costeans. As will be seen below, the flatly dipping faults have not yet been given any great significance in connection with ore deposition but later investigation might show that they play a more important part than can be attributed to them on present knowledge.

G E O L O G Y O F T H E O R E-D E P O S I T S

Most of what has been written so far has a bearing on the problem of ore occurrence and repetition, but in the present chapter it is proposed to examine the ore deposits themselves in further detail.

Ore Type

During the period of mining operations, no petrological or mineragraphic work appears to have been done on the ore deposits and associated rocks. The Company's reports contain terms such as "altered sulphides" "hornstone" and "hornblende rock" which, at present, convey no precise meaning.

Specimens of ore forwarded to the writer by A.H. Dutton, prior to the field work, were examined in thin section. From the primary zone, specimens were found to contain diopside, scapolite, plagioclase, calcite, sphene, apatite, prehnite, magnetite together with the sulphide minerals chalcopyrite and pyrrhotite. The order of abundance of the non-sulphide minerals in the specimens examined was approximately that in which the minerals are enumerated above. Actinolite is found in some of the specimens and is associated with veinlets of fine-grained quartz and sulphides. Subsequent inspection of the ore dumps at Mount Elliott has shown that this type of ore is widespread.

The ore has a metamorphic texture, and, apart from the sulphides, is a typical calc-silicate rock, normally produced by the thermal and metasomatic alteration of a magnesian limestone containing some clay and silica (Harker, 1951 pp.84-92, 252-268). In the field mapping therefore, continuous search was made for dolomites or calc-silicate rocks as it was thought that these would be the ore-bearing beds.

However, rocks which were regarded in the field as possible dolomites appear to have no such character under microscopic examination and are quartz-felspar rocks - possibly altered sandy shales or tuffs. Although adequate specimens of all rock types in the area mapped are thought to have been collected and representative examples have been examined in thin section or in powdered form by optical means, no rock which would yield such an ore-type by metamorphism has been identified. A chemical check on suspected rocks for lime and magnesium gave quite low results.

It is thus strongly suspected at present that the "dolomite" which, by metamorphism, yielded the bulk of the minerals now found in the ore, must have been of hydrothermal origin i.e. dolomitization of certain beds took place as a result of igneous activity and this was subsequently metamorphosed to a lime silicate rock. The widespread occurrence in the ore of scapolite with its chlorine content suggests that the basic "dyke", which, on projection, would occur from 150 to 200 feet from the hanging wall of the ore deposit, may have been responsible for the dolomitization.

What seems to be confirmatory evidence for this hypothesis was obtained during the examination of Specimen 76, collected from a costean near peg 402, Plate 2. In this area, gossaneous material occurs near the junction of an igneous rock and the rock mapped as a dolomite and now known to consist largely of quartz and altered felspar. In the footwall of the gossan exposed in the costean, a 2 ft. wide zone of altered rock was noticed and thought to be a possible calc-silicate rock which might have affinities with the ore. Microscopic examination shows that the rock (Specimen 76) contains abundant scapolite. It thus appears very likely that the introduction of lime is connected with igneous activity. (Ignoring for the present the question of the origin of the Ca and Mg, the deposit now has the general character of a contact-metamorphic orebody of the Ducktown type (Lindgren, 1933, p.736).

It is just possible that the lode represents a highly altered igneous rock, affiliated with the amphibolite. This idea has something to recommend it in the general basic character of the ore and in the fact that "diorite" was reported in the lode channel. It is thought however that the "diorite" is probably a calc-silicate (diopside) rock.*

---

* Specimen 4, a piece of drill core, whose exact locality is unknown, was forwarded by A.H. Dutton for examination. The specimen is an amphibolite, of a texture corresponding to that found in the dyke. It suggests strongly that the igneous rock was intersected by one drill hole, somewhere in the mine.

General evidence seems to be opposed to the suggestion that the ore was originally a basic igneous rock.

(The petrology of the area has very important implications and further study of the rock collection would be desirable before additional field work is undertaken. It would be preferable if this could be done by someone having access to all mapping data and who is familiar with the nature of the problem).

Structure

The mine plans left behind by the original operating company show little geological information (apart from assays) and, without the geological knowledge gathered during the present visit, the ore shown on the Company's assay plans presented a somewhat incoherent overall picture. It is now possible to present in plan and section what is thought to be a logical rationalization and it is thought that this picture may have considerable prospecting significance.. The data relevant to this section are shown on the 1 inch to 40 ft. plans, surface to 650 ft. level, on the cross sections through the workings (5) and on the longitudinal projection through the workings. The scale of the sections is 1 inch to 40 ft.

From the surface mapping (Plate 3) it was known that ore is confined to a crushed zone (probably resulting from faulting) with a trend near the mine of about 320°M. Bedding was known to strike at 290° to 320° to dip generally to the N.E. at 50° to 70° and to pitch northerly at 50° to 60°. These are rather broad generalisations but the detail is shown on the surface plans. Around the mine itself, dumps obscure critical areas but it is thought that fuller information than is shown could be gathered in the open cut.

On the assay plans of the levels the ore has been arranged into bands or zones in accordance with the geological information known from surface mapping and from the small amount of data recorded by the Company.

Since this process of "arrangement" involves a degree of interpretation and since the cross sections and longitudinal projection follow directly from what was done on the plans, it is proposed to describe below, as briefly as possible, the process of interpretation and integration from level to level. The reader will then be in a position to make his own assessment of the probable truth or otherwise of the interpretation presented.

L.C. Ball(1908) mapped the ore showing at the surface and this is shown in Plate 4. When this plate is superimposed on the mapping shown on Plate 3, it is seen that the ore transgresses the bedding and that it is not parallel to the general trend of the crush zone. The eastern margin of the outcrop appears to correspond with the northerly continuation of the line shown on Plate 3 as the hanging wall of a zone of intensive brecciation, within which copper staining and gossanous material are found to the south of the open cut. It was concluded that the outcropping ore filled a cross - cutting fracture. The ore was called No. 1 lens.

At No. 1 level (125') No. 1 lens is still present, but has pitched northward and dipped to the east. Mapping by L.C. Ball recorded on Plan No. 1 by A.H. Dutton (1950) combined with geological mapping in the open cut, was interpreted as shown in the cross section through the Main Shaft. The position recorded by Ball for the dense limonite at No.1 level gives the dip of the fracture-filling shown on the section. At some point below the surface, mineralisation apparently spread into the bedding planes.

The Main Shaft was apparently sunk with this knowledge and was designed to remain below No. 1 lens where it spread into the bedding.

A separate lens, No. 2, appears at No. 1 level.

At No. 2 level, No. 1 lens is still present, and a new lens, called No. 3, appears. The shape and trend of the ore shown on Plate 6 is that given by the assay plans and is in accord with the east-west trend mentioned in Company reports. This trend is intepretated as that of the bedding and it is difficult to see what else it can be; it corresponds fairly closely to bedding trends mapped to the south of the open cut. The sudden commencement of ore with this trend, which is typical of the N.E. limb of the N.W. pitching anticline mapped on Plate 3, is undoubtedly of great importance and suggests that non-outcropping favourable beds are now being intersected by the crush zone. A possible solution is shown on Section C - D. This section contains interpretations as shown on the section itself, but the principle suggested, namely that No. 1 Lens fills a break through the black slates, while the main orebody, No. 3 lens, is a replacement of the quartz-felspar beds, seems to have quite a lot to recommend it. The section is consistent with the pitch readings around station 44 and with the (thrust?) lineations found near pegs 37 and 38. However, this touches on one side of the main points of the investigation which will again be discussed below.

No. 3 level ore (Plate 7) is evidently a continuation of No. 3 lens found at No.2 level. One reason for the widening of the orebody at No. 3 level is shown, at a glance, in the cross section at 200' N. of the shaft; lower stratigraphic horizons, carrying ore, enter the crush zone. An abundance of calcite is mentioned with descriptions of this level (A.H. Dutton, 1950, Plate 3a) and it is noteworthy that no limestone or calcite was found at the surface or in the open cut during the present inspection.

At No. 4 level (Plate [illegible]) lower stratigraphic horizons again make ore. Drill-core logging appears to confirm that the east-west trending ore is parallel to the bedding. Comparison of No[illegible] and No. 4 levels shows that the ore (and the bedding) tends to assume with depth a more definitely westerly strike. This suggests that the ore is passing at increasing depth from the right flank to the nose of an anti-clinal fold. No. 5 level shows the vertual disappearance into the hanging wall of the crush zone of the rich No. 3 lens. New lenses of ore, mostly low-grade, but with one high-spot, dip in from the footwall of the crush zone. The east-west trend of the ore is maintained.

For No. 6 level, similar strikes to those found at No. 5 were assumed.

For the construction of the cross sections and longitudinal sections, the lenses of ore shown on the plans were projected, where required, along the strikes assumed for the reasons given above. The projection was rarely carried more than 20 feet for the cross sections. The strike assumed for the walls of the crush zones was the strike observed at the surface.

Implications of Structure

The sections have a number of important implications:-

(1) If No. 3 lens is a replacement ofabed, its relatively high grade may not be due to secondary enrichment so much as to the primarily higher grade of this particular lens. In this orebody, pyrite content is low and the environment would quickly neutralise any acid formed. It is an environment within which secondary sulphide enrichment is unusual. The lens did not outcrop and hence no large body was apparently present, which, by erosion, could yield the copper required for great enrichment. Apparently, the main

secondary mineral at the rich No. 3 level was black oxide not chalcocite. It is also considered open to question as to whether the higher gold content of the No. 3 level ore was due to secondary enrichment. Variation in the metal content of replaced beds of varying composition is to be expected, a point which is well illustrated in the Broken Hill lode.

(2) It is thus possible that other high-grade beds might be found stratigraphically below No. 3 lens. Suggestions to this appear on No. 5 level and in the winze from that level to No. 6 level. This is shown on the cross section through the Main Shaft.

(3) The Cross sections at 100 N and 200N. illustrate clearly that the major ore deposits do not outcrop. This was discussed when considering the level plans;the cross sections again bring up the question of favourable beds. Had dolomite beds been found, the answer would have been clear. However, even without this, it appears very likely from the cross sections that, whatever may be detailed relationship between the two rock groups (i.e. where separated by thrust or unconformity) it is the older rocks which are making the ore. This seems to be borne out by the rather striking fact that, as shown on Plate 3, the older felspathized beds, are stained with copper for 350 feet to the south of the crush zone. In fact, in looking for outcrops of these beds, their copper content is, in many instances the property which draws attention to them. On the other hand the younger cherts and slates never show copper staining outside the crush zone.
The development of gossans and copper staining near pegs 305, 318, 317 Plate 3, is also very suggestive. These gossans were noted by the former owners and were tested by costeans and by one shaft. The association of the gossans with scapolitized rock (Specimen 76) shows the association with the known orebody.

Cross sections A-B, C-D, E-F show known structural information together with interpretations of the behaviour of the contact below the surface. Although other interpretations could be drawn, they all add up to the marked suggestion that there is a good chance of finding further ore beneath the unfavourable chert and slate outcropping in most of the crush zone. At the surface, along the line of section at 200 N , only very modest signs of crushing may be observed over quite a narrow zone. Yet it is evident that, with increasing depth, mineralization, and presumably the crush zone, occur over very substantial widths. It seems as though the chert group is considerably less susceptible to crushing than are the older rocks.

The longitudinal projection on the mine co-ordinate, 150' N.E. of the Main Shaft may now be considered. For the mine area, the ore lenses were projected along their strike on to the 150 N.E. co-ordinate and they yield the picture shown. Most of the testing at No. 6 level was carried out in beds which had not previously yielded high-grade ore. It seems very likely that the sub-vertical pitch which has been suggested for the southern part of the orebody may not have much significance. It may really be an expression of the fact that engineers tend to test vertically below known ore. Testing has also been governed, perhaps, by the matter of accessibility from the Main Shaft. If the structure shown is at all correct, it seems doubtful whether the mine operators understood the factors controlling their deposit.

The section does suggest that a thickness of more than 500 feet of beds contains some copper, at least, and much of the material remains untested up-pitch. Apart from the projection of the ore positions and of the pitch values shown, the projection is somewhat sketchy. This arises mainly from the fact that the relationship between the two rock groups is inadequately known.

For present purposes, however, pitch lines have been drawn as though the black slates did not exist. Known pitch values show that the beds which contained the most ore in the mine would pitch back into the surface at approximately the position shown. It is interesting to note that in the crush zone in this area, copper staining is marked and the crush zone has a "likely" look, even though the outcropping rocks are beleived to be unfavourable. A possible cross section through this area is known in section E-F. The longitudinal projection suggests the thought that little, if anything, is known to disprove the suggestion, that the whole of the cross-anticline, beneath the unproductive chert group, may carry some ore.

DISCUSSION AND CONCLUSION

The account of the prospect given in the foregoing pages is, in general, a favourable one and it is certainly considered that, in so far as present knowledge permits a judgement to be made, there are quite good chances of finding further ore.

However, good mineral deposits are quite scarce and, even for this reason alone, there is a big risk factor involved in any prospecting program.

As is usual in most areas, one big worry at Mount Elliott concerns the "supply of ore-bearing solutions". From the mine sections, one gains a distinct impression that the total copper available must have been large in the mine area alone. In addition, there are signs of copper mineralization to the south. However, the problem as to whether sufficient copper and gold were available to form payable deposits in the apparently favourable positions to the south of the mine(and to the north of it) can probably only be answered by exploration.

It is considered very likely that the introduction of the metals is related to the basic dyke. Some reasons for this belief have already been given. An additional one is the fact that the ore has a very low silica content. Assuming this is the case, further study of the basic dyke is well warranted. The area occupied by the dyke is low-lying and much of it is covered by soil. However, it was noted that there was a considerable variation in the texture and composition of the "dyke". Although no detailed study of the dyke was made it was noted that coarse textured basic forms occurred in the neighbourhood of the mine and were not commonly noted elsewhere. In carrying out the mapping shown in Plate 1, it appeared as though the dyke became more "lively" at pitch changes i.e. it tended to form segregations, some of them carrying magnetite and some being cupriferous. Small bends in the dyke appeared to correspond with the presence of mineralization. These points require further study as it would be of primary importance if the dyke could be divided into "favourable" or "unfavourable" sections.

The point which can be made at present is that it is considered unlikely that the dyke could supply ore over the whole of its length, for example, and this introduces some uncertainty into the prospecting. It would seem quite permissable to regard the "dyke", not as the source of all the copper and gold required by the deposit, but rather, as a channelway, connected to larger bodies of gabbroic material below.

An additional "worry" at the moment is the possible effect of the zone of buckling and pitch reversals found to the north-west of the mine. This zone heads directly for the ore deposits, but to date, it has not been possible to give it much importance. Nevertheless, it could be that this zone of disturbance is of prime importance and that the orebody formed at the intersection of this zone with the main crush zone. In this case other deposits might be quite scarce, or non-existent. However, little evidence could be found on the underground plans for such an interpretation.

Summing Up

It is considered that Mt. Elliott is a distinctly promising prospect from the point of view of the search for ore by geological and diamond drilling methods. Magnetic results obtained by A.H. Dutton suggest also that geophysical work in the area would be well worthwhile. The present work has highlighted a number of problems, some of which may be solved by further geological study. Some of them could probably be solved only by actual sub-surface exploration.

R E F E R E N C E S

Dutton, A.H.,	1950:	The Mount Elliott Mine, Selwyn, Queensland. Unpublished Report, Broken Hill South Limited.
Harker, A.,	1950:	Metamorphism. Methuen, London.
Honman, C.S.,	1941:	The Mount Elliott-Hampden Area, Cloncurry District. Aer.Geol. and Geophys.Surv. Nth. Aust. Rept. Queensl. No. 22 .
Lindgren, W.,	1933:	Mineral Deposits. McGraw Hill, New York.
McKinstry, H.E.,	1948:	Mining Geology. Prentice Hall, New York.

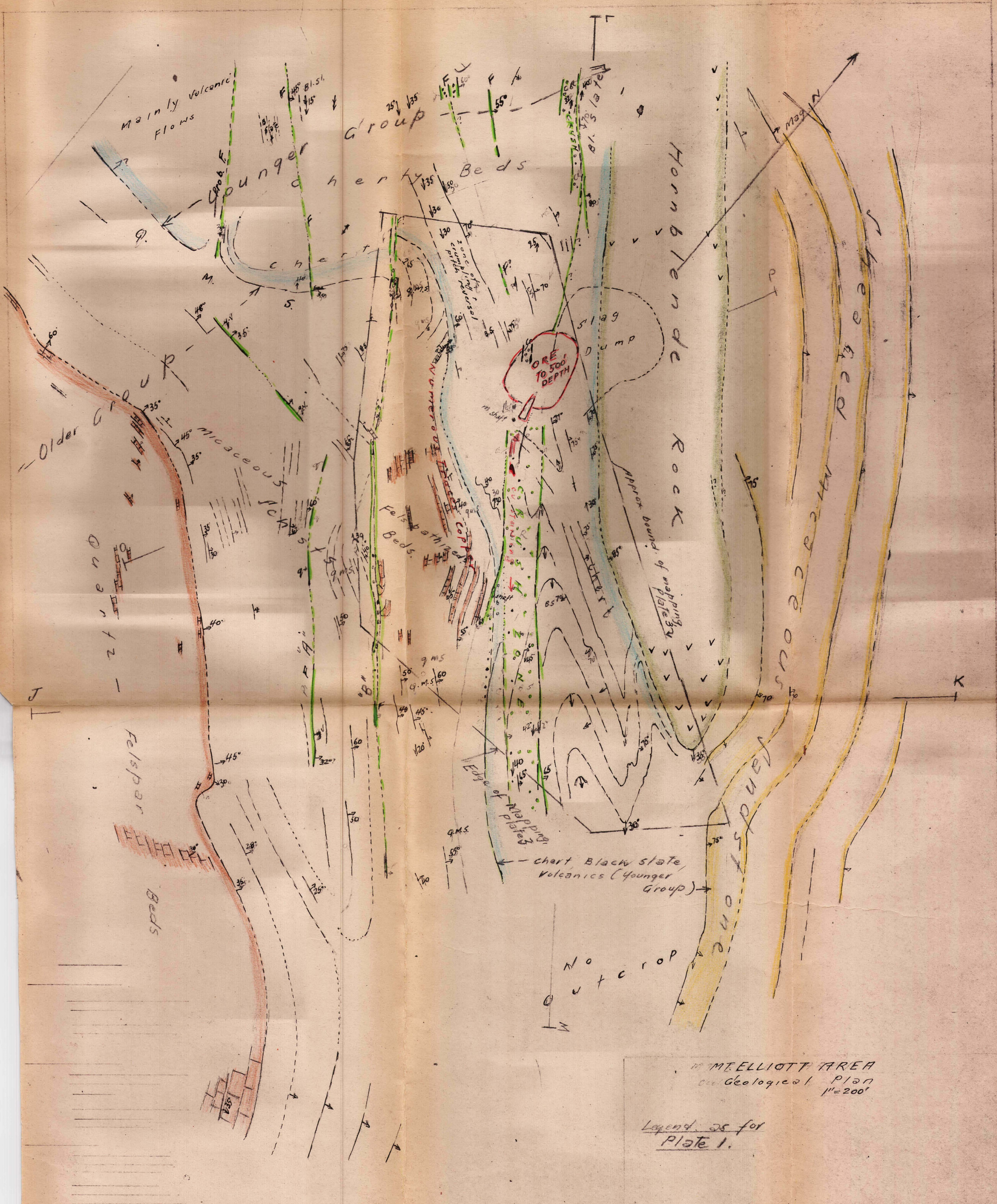
----oOo----

Plate I

Note: This map incomplete to limited time in field. could be elaborated and improved.

C. J. Sullivan
Feb,

Plate 2


Mainly Volcanic Flows
Younger Group
Cherty Beds
Older Group
Micaceous Schists
Quartz Felspar Beds
Felspathised Beds
Slag Dump
ORE TO 500' DEPTH
Hornblende Rock
Approx bound. of mapping plate 3A
Edge of mapping plate 3
chert Black slate, Volcanics (Younger Group)
No Outcrop
Mag. N
J
K
MT. ELLIOTT AREA
Geological Plan
1" = 200'
Legend as for Plate 1.

[redacted]

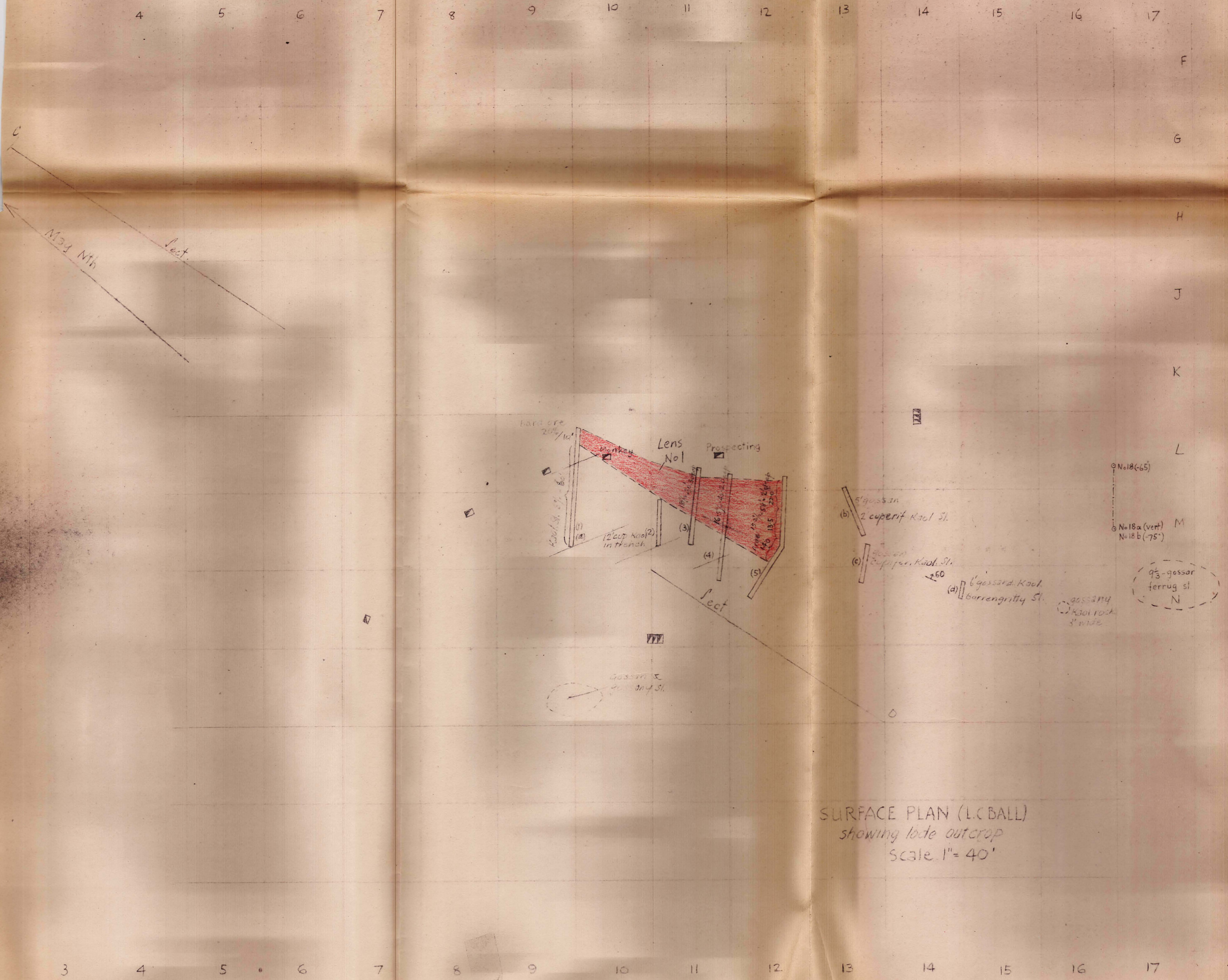
FIELD INVESTIGATION

MT. ELLIOTT MINE
CLONCURRY DISTRICT

Surveyed			Traced	E.D.K.	5-4-51
Mapped			Checked		

Scale 1 inch = 40 feet

Plate 4



SURFACE PLAN (L.C BALL)
showing lode outcrop
Scale 1"= 40'

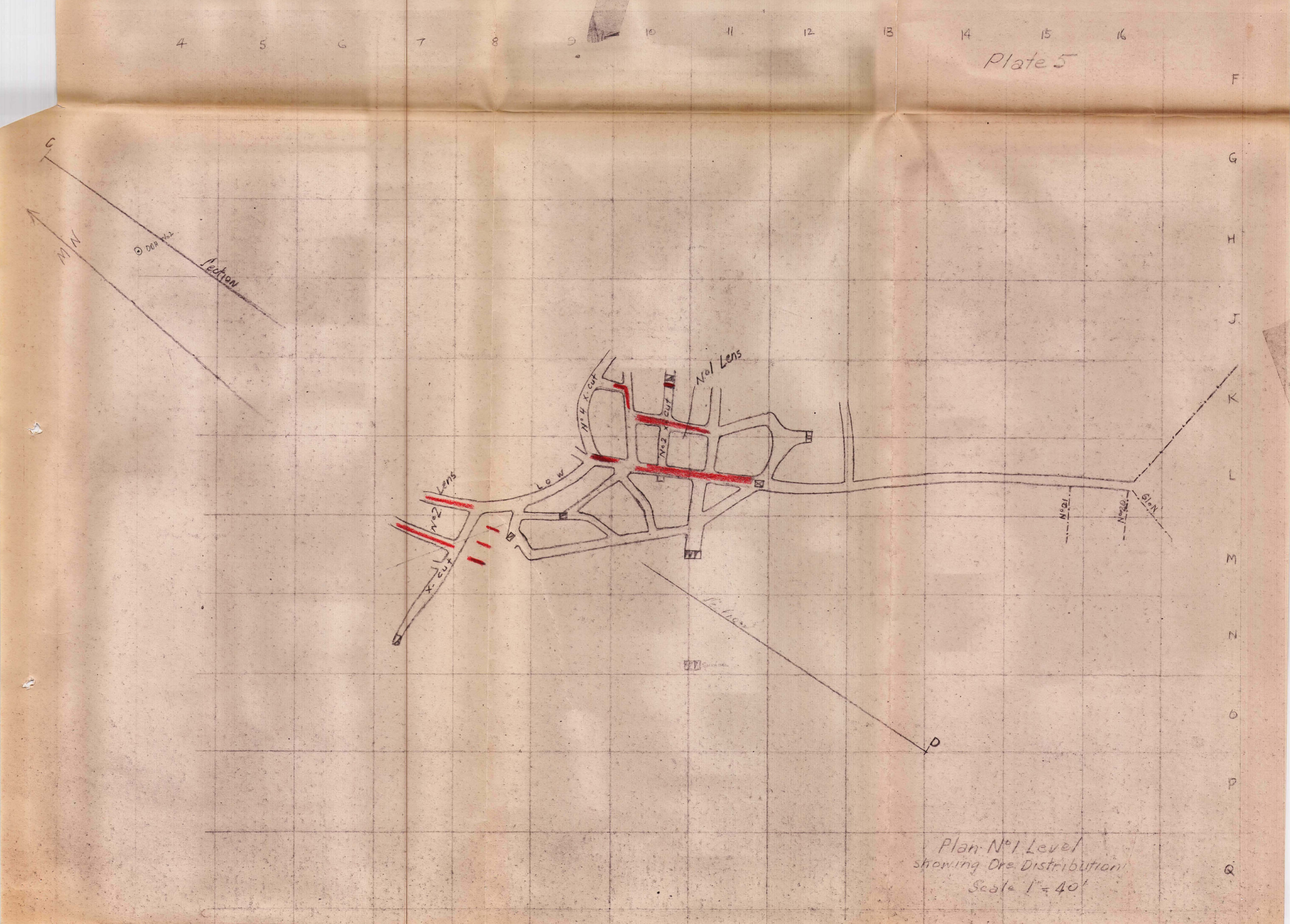


Plate 5
4
5
6
7
8
9
10
11
12
13
14
15
16
F
G
H
J
K
L
M
N
O
P
Q
C
MN
Section
No 1 Lens
No 4 X-cut
No 2 X-cut
Low
Lens
No 2
X-cut
No 21
No 20
D
Plan No 1 Level
showing Ore Distribution
Scale 1" = 40'

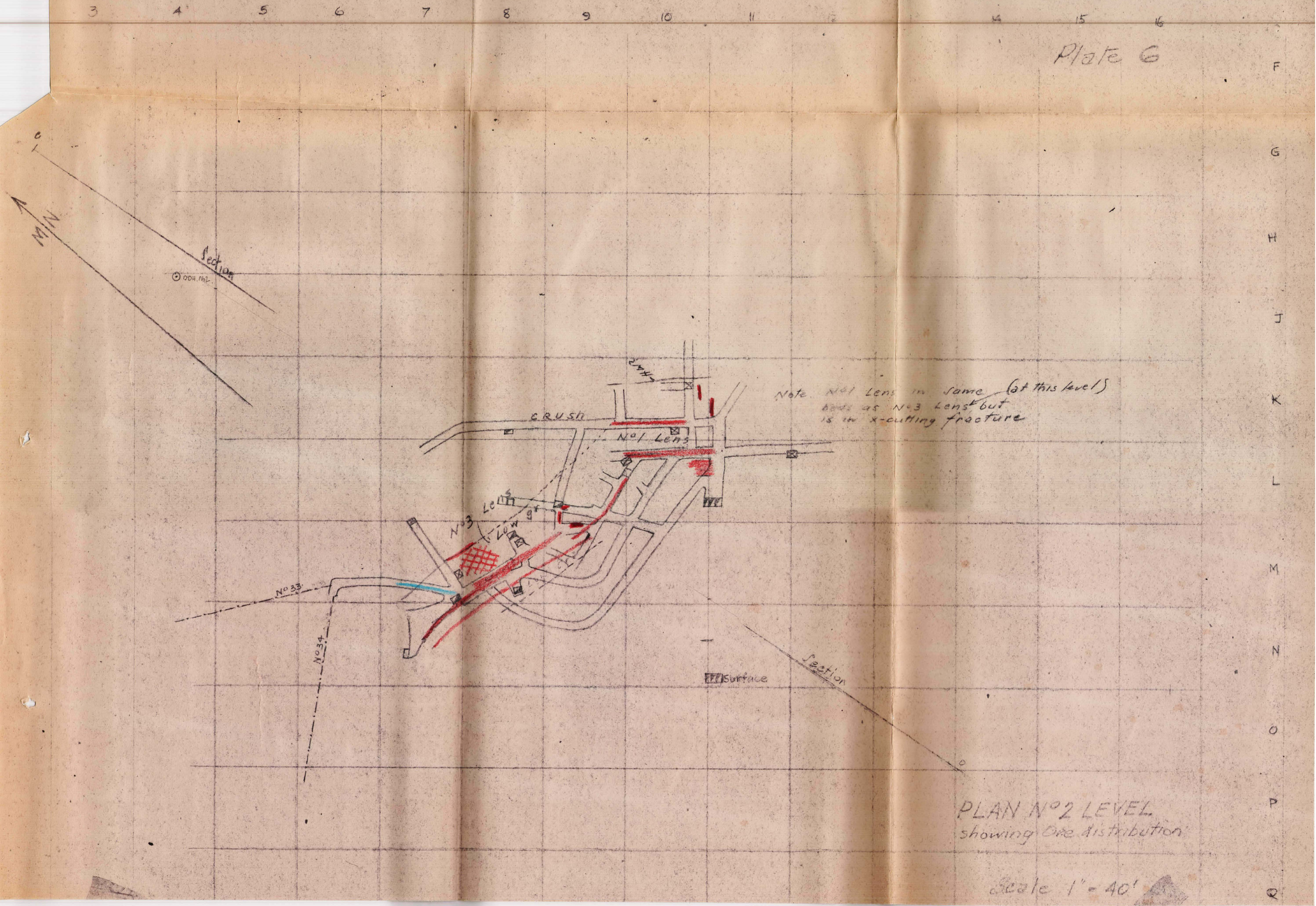
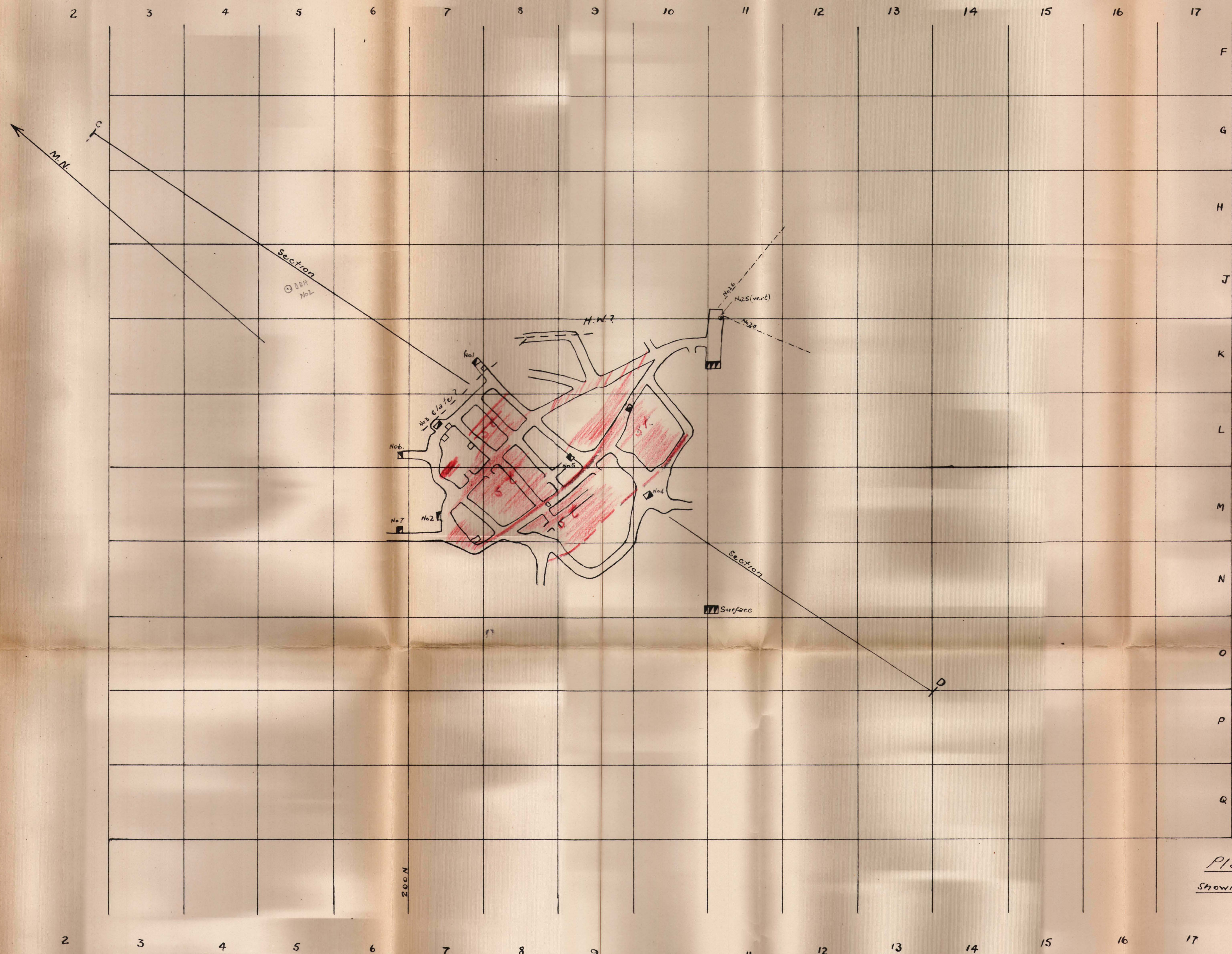


Plate 6
M/N
Section
DDH. No2
CRUSH
No1 Lens
No3 Lens
Low gr
No33
No34
Surface
Section
Note No1 Lens in same (at this level)
beds as No3 Lens but
is in x-cutting fracture
PLAN No2 LEVEL
showing Ore distribution
Scale 1" = 40'

PLATE 7



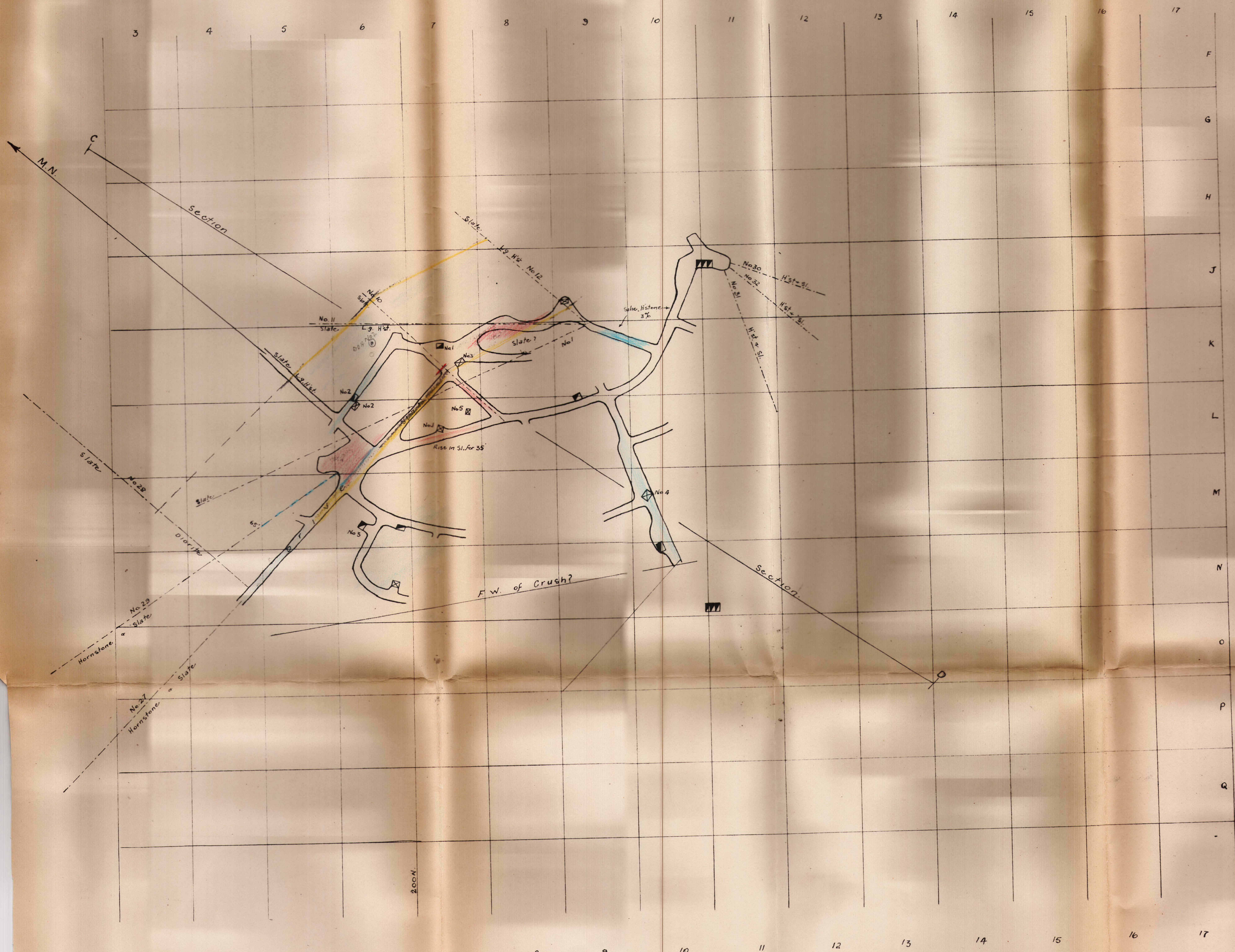
Mt Elliott.

Plan No 3 Level

Showing Ore Distribution

Scale 1" = 40'

PLATE 8



Mt. Elliott
Plan No. 4 Level
Showing Ore Distribution
Scale 1" = 40'

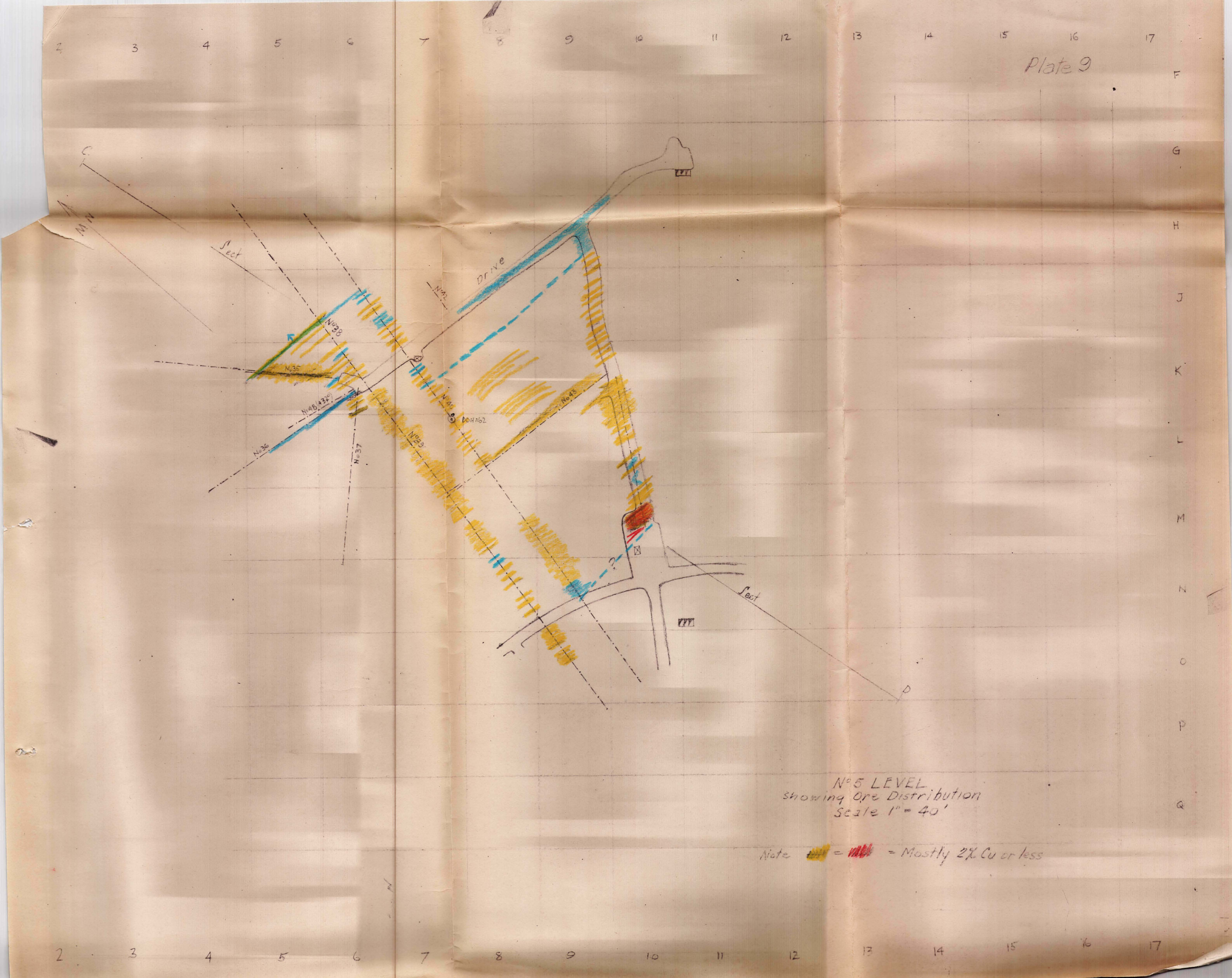


Plate 9
Drive
Sect
Sect
No 38
No 35
No 36
No 37
No 39
No 43
DDH No 2
C
D
No 5 LEVEL
showing Ore Distribution
Scale 1" = 40'
Note = = Mostly 2% Cu or less

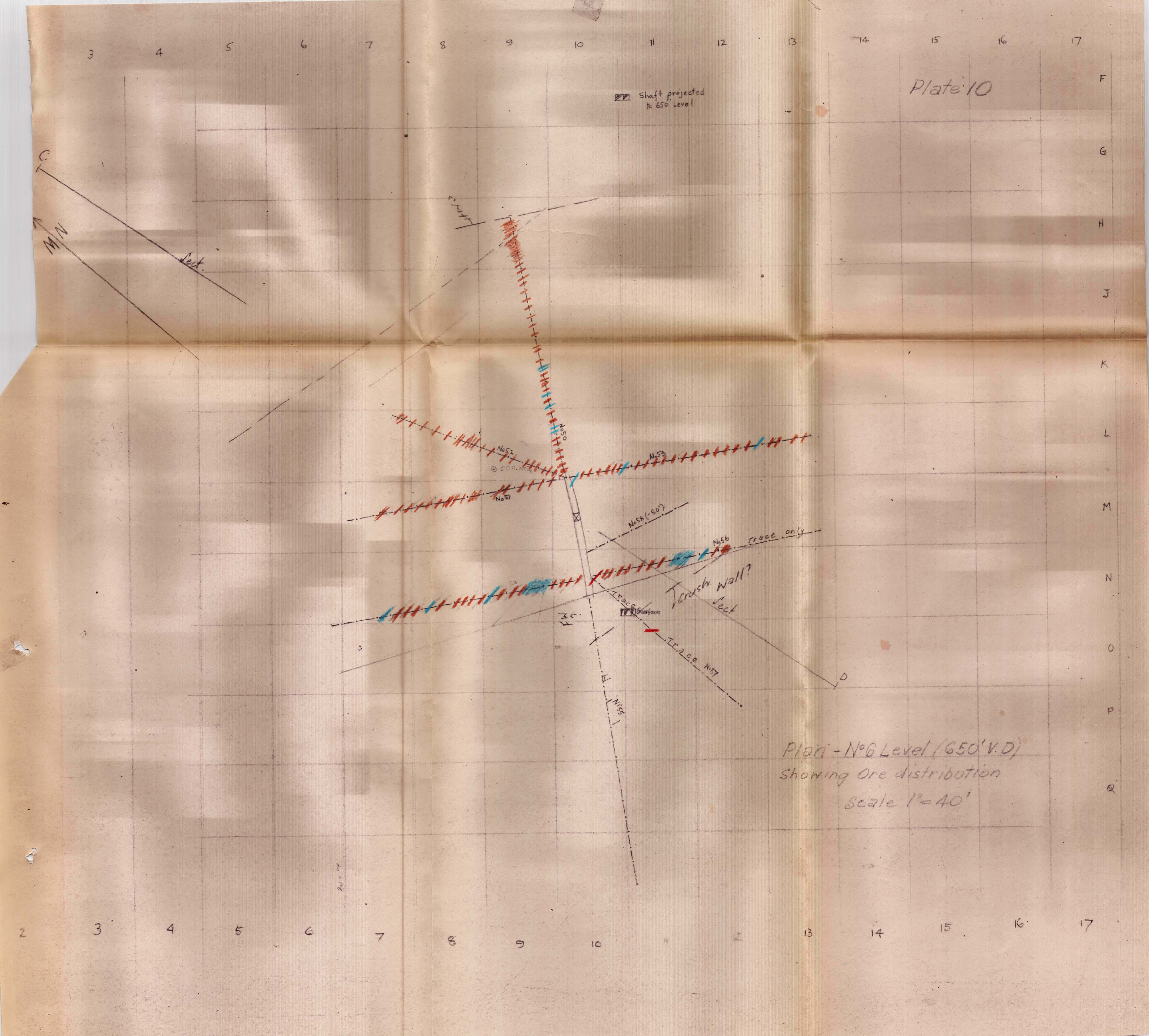
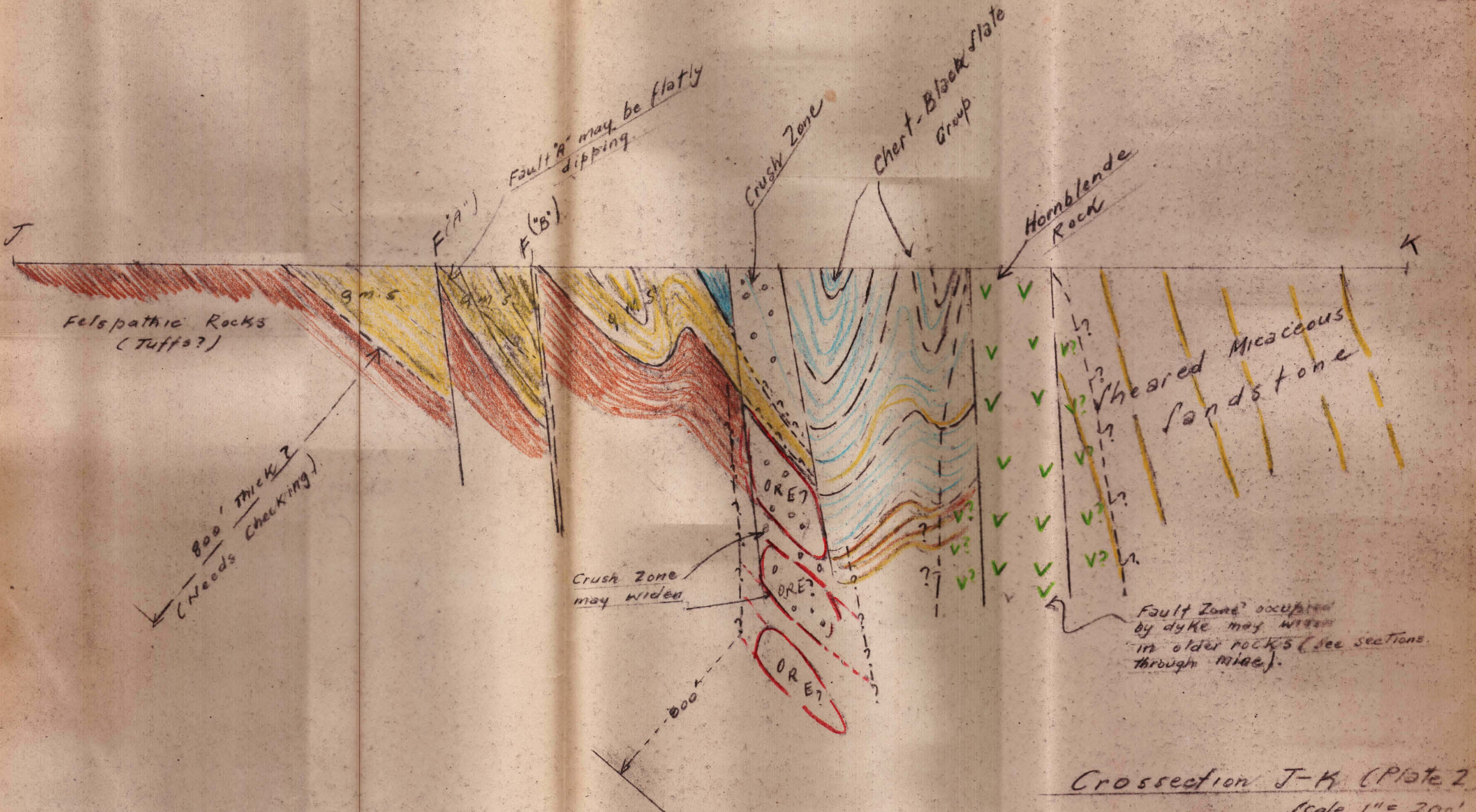


Plate 10
Shaft projected to 650 Level
Plan - No6 Level (650' V.D)
Showing Ore distribution
Scale 1" = 40'
Sect.
Sect
C
D
N
No52
No53
No51
No50
No58 (-50')
No56
Trace only
Trace
Trace No57
Crush wall?
Surface
No55
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
F G H J K L M N O P Q

Plate 11



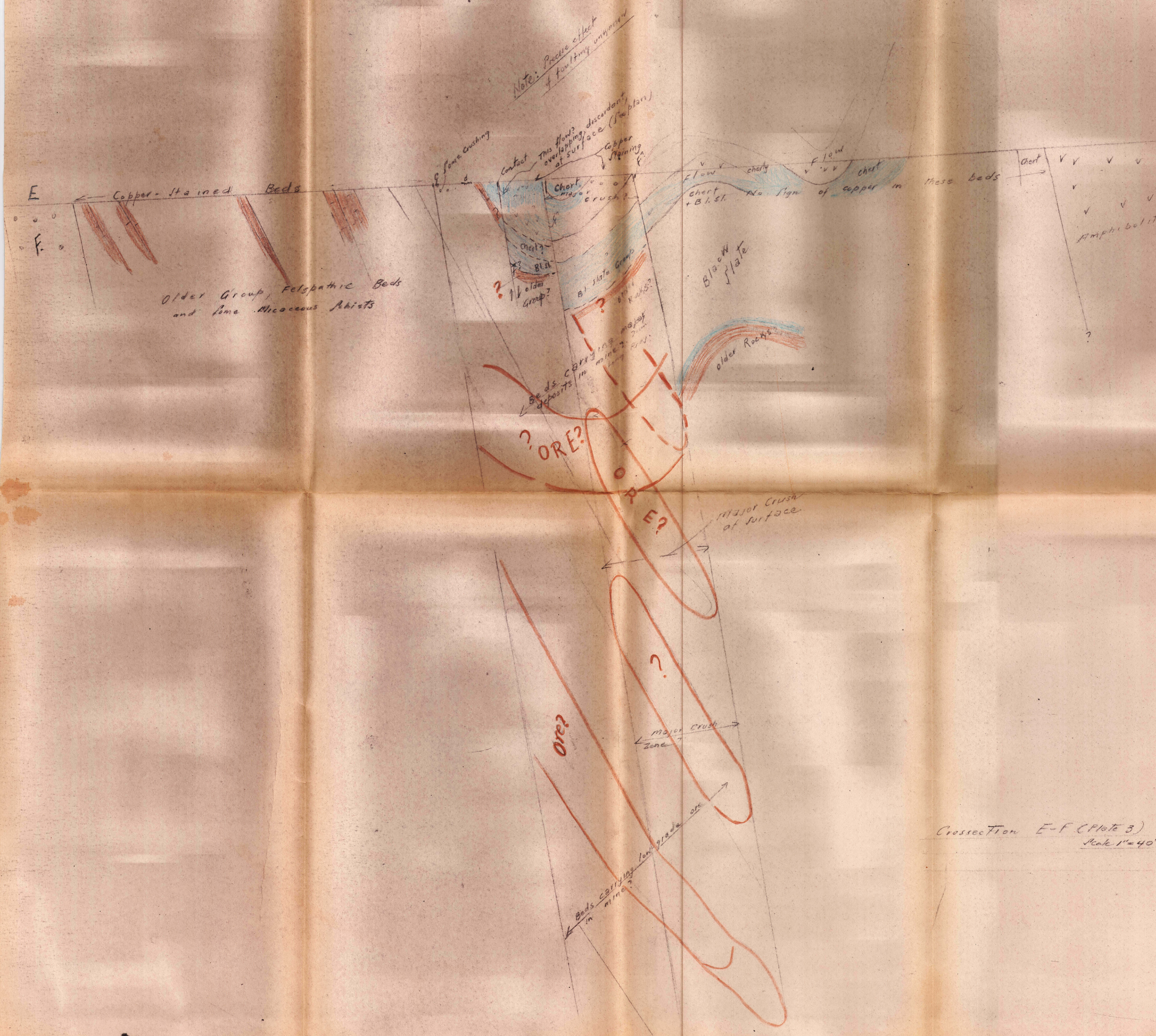
Crossection J-K (Plate 2)

Scale 1" = 200'

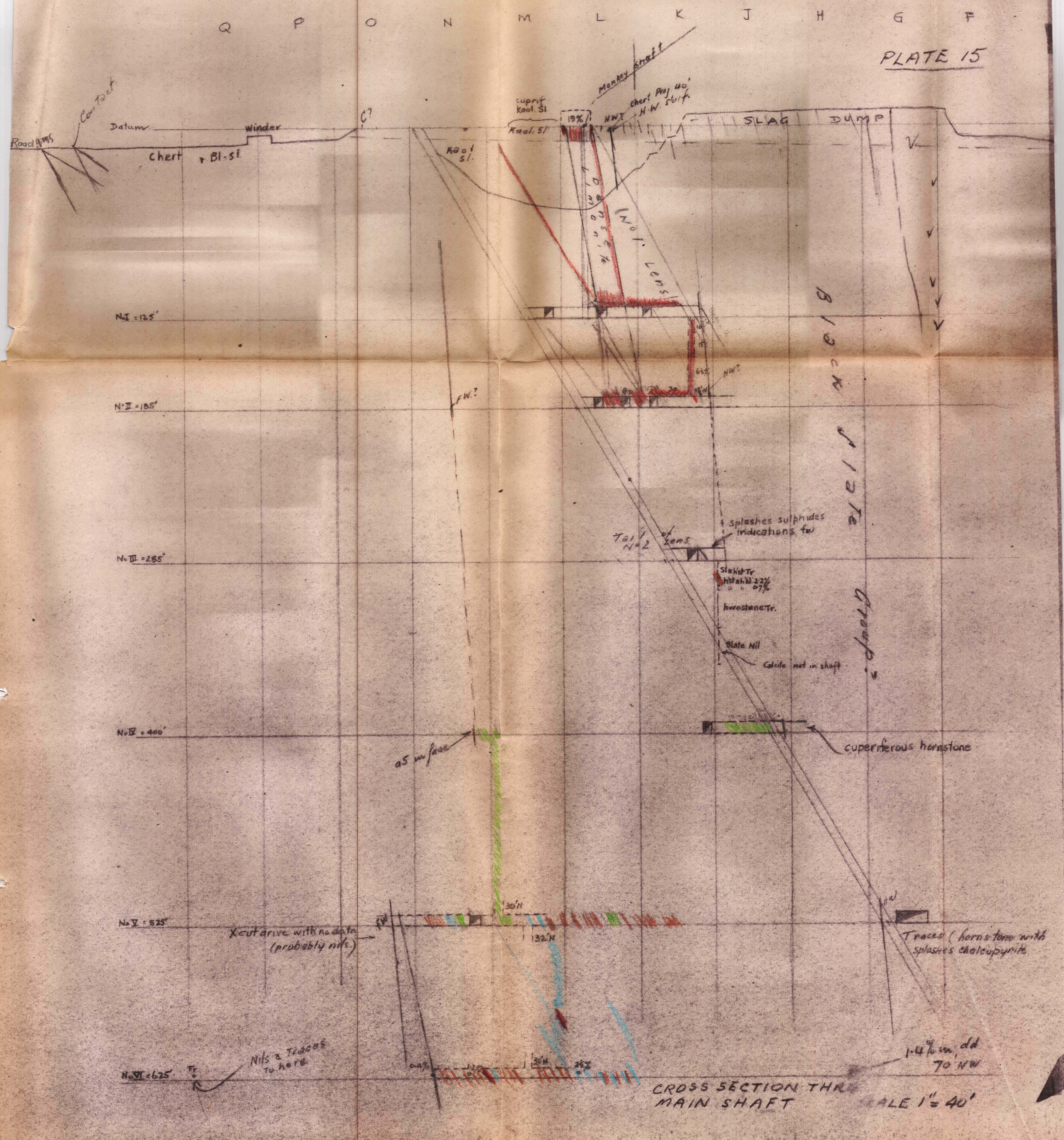
Note. Q.M.S = quartz-mica-schists, phyllites and allied meta-sediments.

MT ELLIOTT MINE
CROSS-SECTION A-B
SCALE 1" = 40'

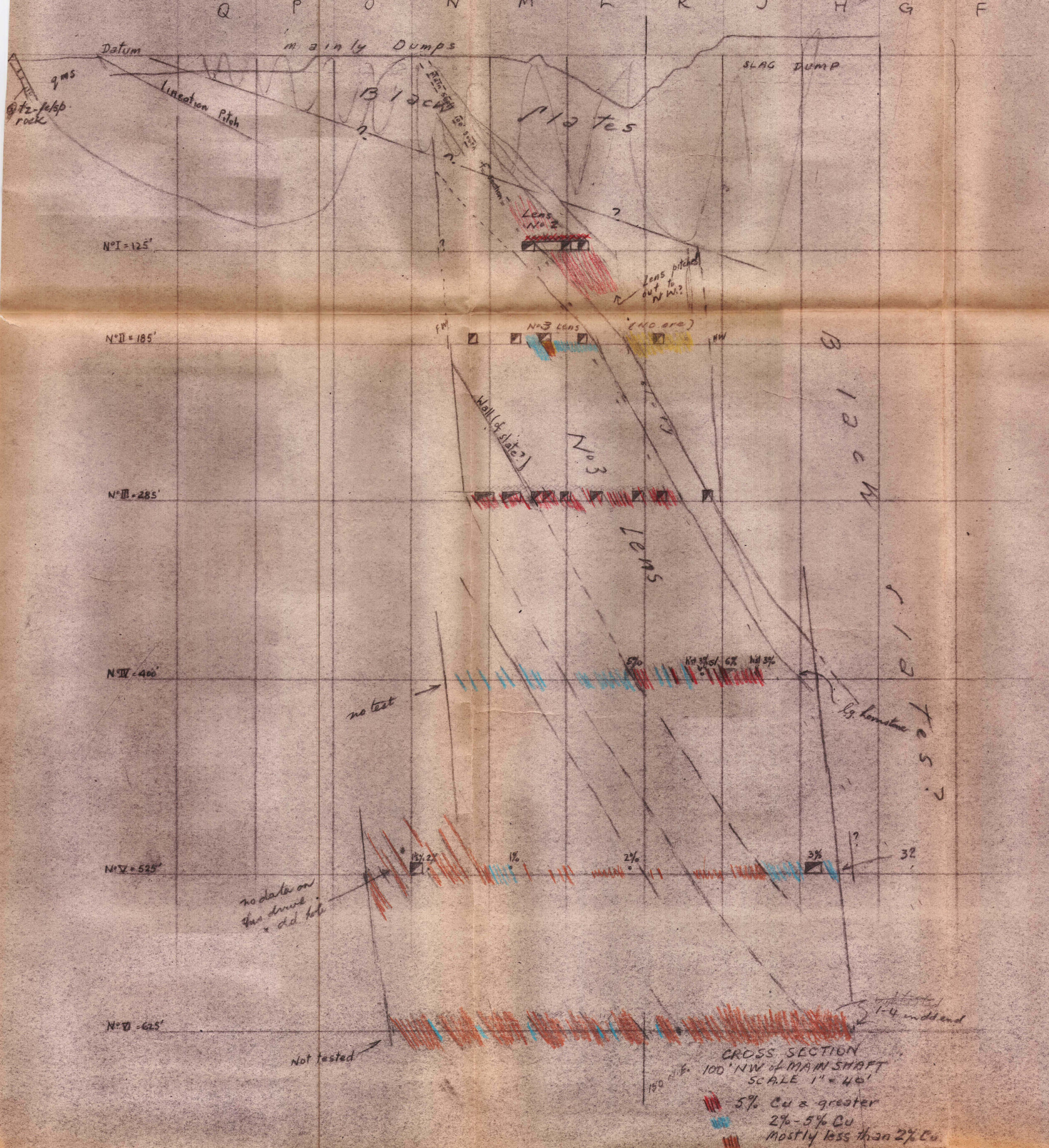

Plate 13
"Basic Intrusive"
(Hornblendite)
Pitch of Rock
No 1 Lens
No 2 Lens
No 3 Lens
Cherts
Black slates
Quartz
Felspar
Rocks
Contact
H wall?
Black Slate Group?
FW of Crush
"slate" ddh 28
No 1
No 2
No 3
No 4
No 5
No 6
Section along C-D (Plate 2)
Scale 1"=40'



Crossection E-F (Plate 3)
Scale 1" = 40'

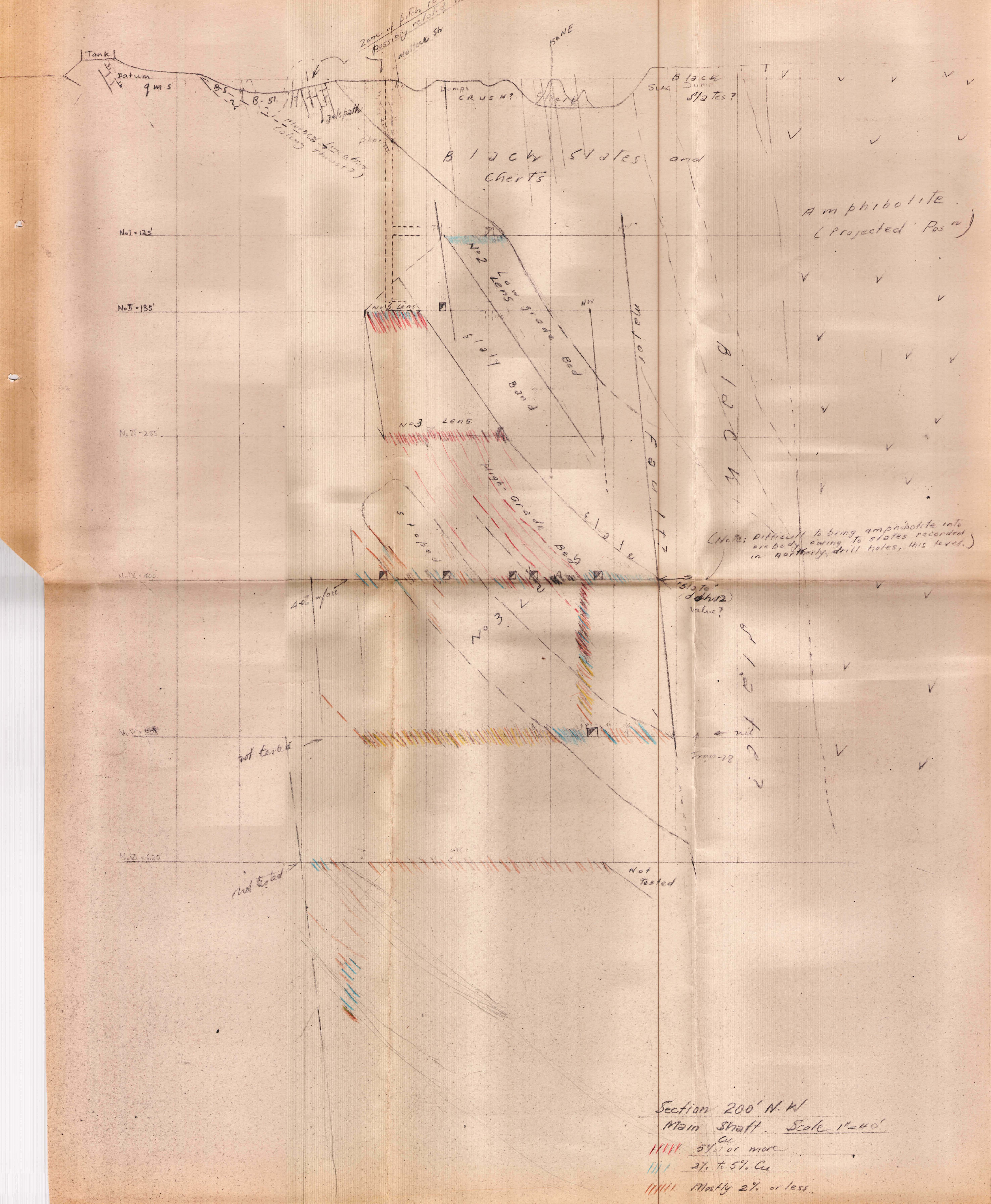


Q P O N M L K J H G F
PLATE 15
Monkey Shaft
cuprif Kaol. Sl
19%
HWT
SLAG DUMP
Datum
Winder
Contact
C?
Road
Chert + Bl-Sl
Kaol Sl.
Kaol. Sl
Lens
Black Slate Group
No I = 125'
No II = 185'
F.W.?
No III = 285'
Tail of No 1 Lens
splashes sulphides indications fair
Slate Nil
Calcite not in shaft
No IV = 400'
cuperiferous hornstone
No V = 525'
X cut drive with no data (probably nils)
30'N
132'N
Traces (hornstone with splashes chalcopyrite
No VI = 625'
Nils & Traces To here
70' NW
CROSS SECTION THRU MAIN SHAFT
SCALE 1" = 40'



Q P O N M L K J H G F
Datum
mainly Dumps
SLAG DUMP
qms
Qtz-felsp. rock
Lineation Pitch
Black Slates
Lens No 2
Lens pitches out to N.W.?
No. I = 125'
No. II = 185'
F.W.
No. 3 Lens
(no ore)
H.W.
Wall (of slate?)
No. 3 Lens
No. III = 285'
No. IV = 400'
5%
6%
3%
no test
lg. hornstone
Black Slates?
No. V = 525'
1%
2%
3%
32
no data on this drive x d.d. hole
No. VI = 625'
1-4 midd end
Not tested
CROSS SECTION
100' NW of MAIN SHAFT
SCALE 1" = 40'
5% Cu & greater
2% - 5% Cu
Mostly less than 2% Cu

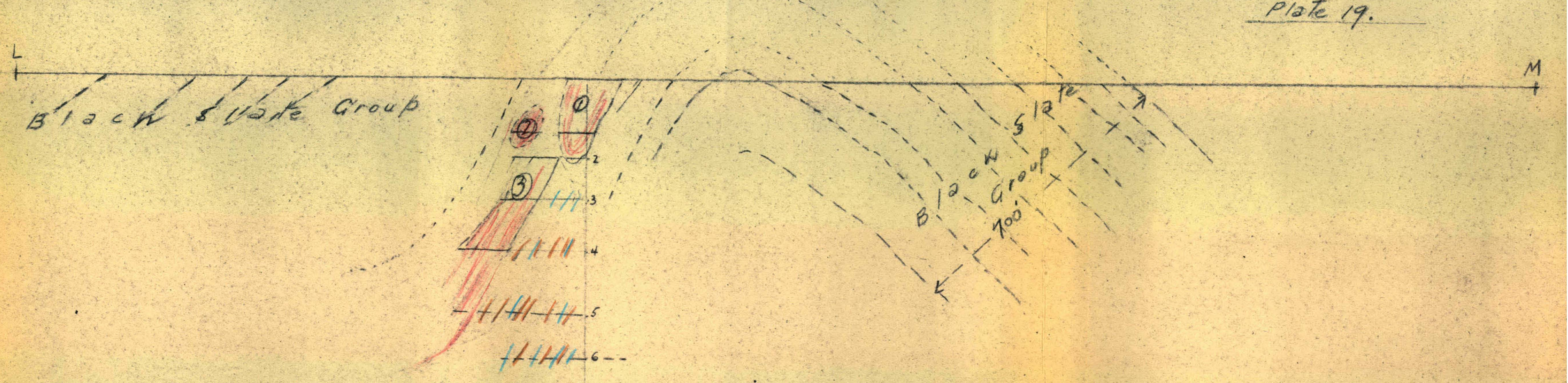
PLATE 17



Zone of pitch reversals possibly related to thrusting
mullock shaft
150 NE
Tank
Datum
q.m.s.
B.S.
B.S.
feldspathic
Dumps
CRUSH?
Chert
Black
Slag Dump
Slates?
Black slates and Cherts
Amphibolite (Projected Posn)
No I - 125'
No II - 185'
No III - 285'
No IV - 400'
No V - 525
No VI - 625'
No 2 Low grade Lens
HW
No 3 Lens
slaty Band
Bed
No 3 Lens
High grade Bed
Major Fault?
Blind Wall
stoped
slate
(Note: Difficult to bring amphibolite into orebody owing to slates recorded in northerly drill holes, this level.)
4-6" w/ore
"slate" (ddh 12) value?
No 3
not tested
nil
not tested
Not Tested
Section 200' N.W
Main Shaft Scale 1" = 40'
5% Cu or more
2% to 5% Cu
Mostly 2% or less

Plate 18

Major Ore Beds
200 N
100 N
Shaft Minion
Gossan
Chert's Black Sl. Group?
No 1 Lens in X-cutting Fracture
Suggested Contact Chert and Jamgarr Groups
Black Slate Group
Repetition of Major Ore bearing beds under black slate cover to South?
drive
ddh
1 Level
No's 1 + 3 Lenses Overlap
See No 2 Level Plan
2 Level
Not Tested? Slaty Beds
slate
Bedding?
No 3 Lens
Low Grade Ore?
3 Level
slate
projected from surface area
4 Level
Scale 1" = 40'
MT ELLIOTT MINE
Longitudinal projection on mine coordinate 150' N.E. of MAINSHAFT. Ore bearing beds projected where necessary or to this coordinate, using strikes shown on level plans.
NOTE:- To south of mine section may be section may be considered as drawn thro southern extension of crush zone. For this section position of Black Slate group to south of mine is imperfectly known & requires further study
5 Level
ore body may 'break' on pitch change
6 Level

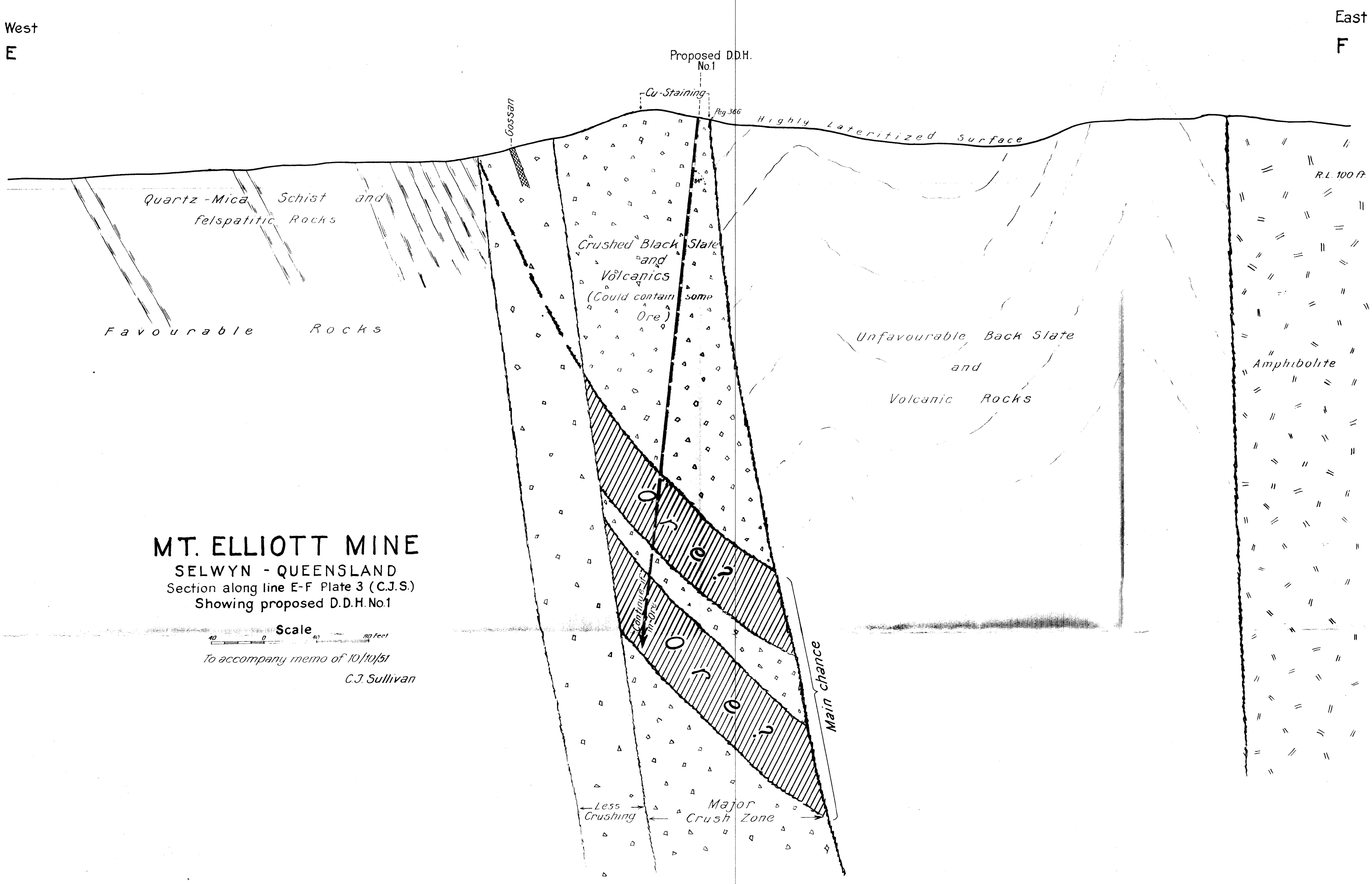


Section L-M (Plate 2)

(Looking N.E) Scale 1" = 200'

Pitch lines observed in black slate group projected on vertical section N.E. of crush zone. Orebodies projected N.E. on to line of section

Notes More detailed pitch readings in younger and older beds required if possible. Possible effect of zone of pitch reversals west of Mine (plate 2) not shown in section.



MT. ELLIOTT MINE

SELWYN - QUEENSLAND

Section along line E-F Plate 3 (C.J.S.)
Showing proposed D.D.H. No.1

Scale
40 0 40 80 feet

To accompany memo of 10/10/51

C.J. Sullivan