ECSTALL RIVER MINE

Reports, Etc.

VOL II

GEOLOGY OF THE ECSTALL MINE

ECSTALL RIVER, B.C.

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I. INTRODUCTION

During the summer of 1952 a geologic study was made of the region around the Ecstall River and of the mine itself. The chief purpose of the investigation was to extend the known ore reserves and to determine those areas which might be favorable for mineralization, as well as a general prospecting of the area. Such a study, in the detail in which it was undertaken, had not been done before.

The greater part of the regional geology was mapped by W. Holyk with the assistance of Messrs. D. Lowrie and D. Webster of the University of British Columbia. Mr. Holyk has submitted his report on the geology. I assisted also in the regional mapping and undertook a detailed study of the mine.

This report, then, concerns the results of this study and my conclusions regarding mineralization and structure in the setting of the regional geology.

The regional geologic map enclosed with this report has been compiled from the field sheets of W. Holyk and my own notes. The map of the east plateau is based on the work of Messrs. Lowrie and Webster. All other maps and diagrams are my own.

The work of W. Holyk and these two men is gratefully acknowledged.

Mr. E. E. Mason, through his long knowledge of the Ecstall River, provided valuable assistance and advice.

II. GEOGRAPHY

The area of the Ecstall River, British Columbia, lies in the belt of Coast Range mountains bordering the Pacific Ocean. These mountains are high and rugged and are divided by many deep U-shaped valleys and fjords. The slopes are long and steep and rise almost vertically to sharp peaks and ridges. On the floors of the valleys and partially up their flanks, underbrush and tall conifers grow in abundance due to the annual rainfall of 180 inches.

Outcrops in the valleys do not exist, and on the plateaus immediately below the uppermost peaks, where the vegetation is not so plentiful, the moss, grass, and soil further obscure the geology. In a few cases errosion has laid bare the outcrops on these plateaus. The only rock exposures remaining, therefore, are the steep bluffs, which are largely inaccessible, the beds of small creeks and streams, the shores of small lakes, and the upper ridges.

Geologic interpretation is, therefore, difficult.

III. GEOLOGY

A. General geology of the Coast Ranges.

The main rocks in the Coast Ranges are those of the large batholithic intrusions composed chiefly of quartz-diorite and granodiorite. They range in age from Upper Jurassic to Upper Cretaceous. The batholiths have intruded sediments and volcanics of unknown age and left them as residual roof pendants. These intruded rocks have been intensely metamorphosed and folded; as a rule the older formations are more deformed and have dips exceeding 60°, whereas the younger formations are less deformed and altered. Also, as a general rule, those sediments which are nearest to the batholiths are more metamorphosed and disturbed than those farther away.

The general strike of all the rocks is northwest, and the elongation of the batholiths conforms to this direction (Armstrong, 1946).

most areas where there is a high degree of metamorphism, the exposures are more plentiful and the structure of the region, if any, is more apparent. It should be further emphasized that the regional geology was mapped on a scale of 1000 feet to the inch, and that the largest outcrops averaged about five feet in width. On this basis, therefore, an exposure on the map would be represented by .005 of an inch, or very much less than the width of a thin pencil line. Of course, this is inherent in any geologic mapping on a large scale, but at the Ecstall River this point assumes more importance. Geologically it is extremely difficult to extend single formations over any great distance.

Holyk points out that, broadly speaking, the belt of metamorphics can be divided into two units: The Johnson Lake group and the Mine group. The Johnson Lake rocks are largely confined to the drainage of that lake and to the south of it, and the Mine group of rocks lie on the western side of the belt.

The Johnson Lake rocks are more easily mapped in the field because of the small number of lithologic units. Quartzite, argillite and hornblendite are the predominate rocks. They form well-defined bands and do not vary a great deal from their normal appearance. The structure, therefore, is more apparent in the aerial photographs and is more easily discernible in the field.

The Mine group of rocks has a decidedly different character. The main rock types are chlorite schist and quartz-chlorite schist (both with varying amounts of biotite, hornblende and garnet), quartzite, argillite and limestone. In addition to these are a host of rocks which are varieties of the standard types. They are difficult to place in any one group. Furthermore, these varieties occur as a banded complex with the basic units. The result is to make the geology difficult to interpret.

One example will point out this problem. Examination of the regional geologic map shows that there is a fairly continuous outcrop across the strike on Red Gulch Ridge. The lithology and sequence of rocks are easily identified. However, on the west plateau and on the slopes south of the ridge, the same rocks and their relationships to each other cannot be found.

Igneous rocks, mainly basic in composition, are intruded into the Johnson Lake and

Mine groups. One set is parallel to the strike of its host rock and has been metamorphosed to the same degree. The other set cuts across the cleavage and schistosity of the host rock and is unmetamorphosed. This latter group, therefore, is the younger, and antedates the regional metamorphism and deformation.

A group of rocks, which can neither be placed in the Johnson Lake rocks nor the Mine rocks, is located around the contact areas of the batholithic intrusions. The sediments appear to have been "granitized." The texture is strongly gneissic and the rocks are cross-cut with a network of pegmatite dykes. Large limestone lenses with no continuity are frequent. The impressive thing about the rocks is that they have been folded, contorted and bent into such a variety of shapes and forms that the mapping of them would be almost impossible. The schistosity of the rocks is parallel to the axial planes of the folds, and since the folding has no regularity, neither has the direction of schistosity.

b. The "granite" gneiss.

Two theories on the origin of the "granite" * gneiss have been advanced. The rock was originally either igneous or sedimentary. Thin sections of the rock from various localities indicate that the rock is sedimentary. Examination of the hand specimen finds proponents for both theories, while the field relationships are equally uncertain. I favor a sedimentary origin for the rock.

The bearing the origin of the rock has on the geology is found in the structural implications. Should the rock be igneous in origin, then its shape, size and extent can be accounted for. However, if the rock is sedimentary, then its form must be derived through deformation. Since all of the metamorphics at the Ecstall River are, in my opinion, highly deformed, the granite gneiss, being sedimentary, is no exception.

The rock is gneissic in texture, and has varying amounts of biotite and chlorite.

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* Although the adjective "granite" alludes to an igneous origin for the rock, it will be retained in this report but with the quotation marks deleted.

These platy minerals have a rough parallelism. Quartz is the predominate mineral and feldspar is found in small quantities.

The granite gneiss is easily distinguished in the field and for this reason can readily be traced from exposure to exposure. It lies off the hanging wall of the two main sulphide lenses and continues erratically some 500 feet north of the northern pyrite body. South of the Third outcrop it begins again, and near the headwaters of Red Gulch Creek it swells to an enormous size. On the high bluffs farther north it completely disappears for no trace of it can be found on Red Gulch Ridge.

Discordant strikes and relationships are noted. Immediately below the Third outcrop the gneiss strikes N. 40° E. whereas the neighboring schists strike N. 05° E. On the north fork of the second creek north of the Third outcrop on the west side of Red Gulch, the granite gneiss was found to alternate with bands of chlorite schist; on some of the exposures the bands were up to 5 feet in width. The contacts were fairly well defined and had a strike of N. 10° W. On Swinerton Creek the gneiss occurred as large irregular lenses with chlorite-biotite schist "flowing" around the lenses. Directly north of the North Lens, on favors an igneous theory for the granite gneiss. Other writers have reasoned that this type of rock is purely tectonic in origin (the Alpine school), has been formed from phyllites through igneous injection (V.M. Goldschmidt) and is created by the shearing of porphyritic rocks (C.W. Carstens). I favor the tectonic origin for the rock and believe that it was formed through strong movements while the rocks were in the process of metamorphosis.

2. Structure.

a. Shearing and alteration.

In the field of structural geology there are two types of shearing recognized: first, shear breaks; and second, fracture and brecciation.

Shear breaks result where the rock is under such pressure that it does not expand readily and deformation approaches flow.

Fracture and brecciation result where the rock fails under stress and expands; the rock breaks under light load.

The shear zones at the Ecstall River belong to the first type-shear breaks.

The sericite shears find their greatest development in the Mine group of rocks. They are often localized along argillites, but this is not a general rule. They are composed of sericite principally, and pale green mariposite (identified by W. Holyk). The widths and strike lengths vary. The widest zone mapped is the so-called Red Bluff shear found on the south flank of the west plateau; it is 100 feet wide but has a strike length of only a few hundred feet. It cannot be correlated across the Ecstall River, nor can it be located northward on the west plateau.

The schistosity within the shear zones parallels the cleavage in the neighboring rocks, but it is thought that in some cases the zone may cut across the schistosity of the other rocks at a very small angle, although there is no evidence for this. More usually the sericite schist is highly foliated: small drag folds, z-folds, and large folds up to five feet across the limbs are found, and within the main bodies of sulphide, bands of sericite schist have been folded and contorted.

The sericite is an alteration product, and not only do the zones represent areas of stress but also alteration. Alteration and shearing appear to be interdependent. The shear zones represent lines of high pressure and they have provided suitable channelways for ascending hydrothermal solutions which altered the rocks. The alteration process was undoubtedly complicated and resulted in a thorough sericitization and the formation of sericite schists with small percentages of pyrite. In the formation of the sericite, FeO, MgO, and CaO were liberated and partly migrated into the surrounding rocks to form additional plagioclase, hornblende, and basic feldspar. This would account for the higher concentration of these minerals in the rocks around the main orebodies.

During alteration the zones remained under pressure and it was through these same channels that the ore solutions travelled. It is possible that the tectonic forces shifted and the sulphides favored only certain shears, or the solutions favored a sericitized host rock in conjunction with a change in structural deformation.

From the relationships of the massive sulphides to the sericite schists it is evident that the altered rock was formed before the solutions deposited the ore, although further alteration took place during the ore emplacement.

b. Structural features.

The structural history of the Ecstall River has followed closely the intrusions of the large batholiths. Originally there was a series of unmetamorphosed sediments. The sediments may have been disturbed prior to the intrusion of the batholiths, but it is more likely that they were tilted, folded, metamorphosed and intruded at the same time. The important point is that at the Ecstall River all the intruded rocks were metamorphosed and deformed. In no case can they be divided structurally according to the two lithologic groups outlined.

This deformation is most apparent in the contact gneisses previously described, and more easily seen because of the lack of vegetation on the upper ridges.

The Johnson Lake group, as has been pointed out, is easily identified because of the simplicity of the lithologic units. At the top of Red Gulch Ridge the group is narrow and has a north strike. Extending to the south it fans out to a greater width and complexity and strikes northwest. On the top of the east plateau, where there are numerous outcrops, the rocks are complicated by drag folding (see map of east plateau). On the east side of the plateau the rocks dip to the east and folds plunge to the north; on the central part of the plateau the dip is west and the plunge north; and on the west side, or Red Gulch Creek, the rocks dip east and the structure plunges south. The structure around the orebodies follows this latter pattern.

Farther south from the plateau, following the Johnson Lake group across the shores of the Lake and into the mountains south of it, the strike of quartzites vary widely. On the edge of the intrusive a large fold has been mapped that measures several hundreds of feet across its limbs. In the first creek south of the Lake, a wide argillite band is seen expanding to the south and decreasing to the north.

These are but a few examples to bring to the attention of the reader that the Johnson Lake group has been deformed and folded to a high degree.

Although folding in the Mine series is not as readily apparent, nevertheless, there are discordant strikes, evidences of folded structures, and obvious folding in the orebodies and in the rocks surrounding them (refer to the underground sheets and the surface map of the two lenses).

A few localities in the Mine group will serve as examples of deformation in the series. The granite gneiss has already been discussed.

Small drag folds bearing east-west have weathered out immediately above the Falls, but the schistosity in the rock is north. On the footwall of the Five Foot vein lying to the east of the two lenses, the chlorite schist is contorted. On an exposure of quartz-biotite schist on the west side of Red Gulch Creek a faint lineation in the rock strikes N. 40° E., but the cleavage strikes north. In Phoebe Creek a large fold was visible on the wall at elevation 665 feet, and the rock exposures in the Creek varied from N. 05° W. to N. 40° W. A folded quartz vein striking east lies to the east of the South Lens and similarly folded quartz veins are found throughout the area (Illustration No. 7). Although these quartz veins are clearly younger than their host rock, they are still indicative of a differential movement which produces folding.

The cleavage or schistosity in all the rocks vary widely. In some cases it actually follows the folded contacts of the different rock units, but usually it is parallel to the axial planes of the folds. Underground, where the mapping was done in greater detail, shearing occurred parallel to these axial planes (Illustration No. 5).

Shearing and schistosity are more highly developed in the Mine group of rocks, since they are generally more incompetent than the Johnson Lake group. It is in this rock group, therefore, that ore deposits are likely to occur.

I suggest that the Mine series of rocks were folded at the same time as the Johnson Lake group, although perhaps not to the same degree. It is likely that the Mine group, under continued pressure, folded, but was more likely to shear through failure of the rocks, and that the schistosity has been superimposed on an already folded structure.

This does not in any way give a clue to the over-all structure. There is a suggestion, however, that the Johnson Lake group has been folded in a tight syncline with its eastern limb plunging to the south and its western limb plunging to the north; the Mine group, which should repeat to the east of the axis of the syncline, has been taken away by the intrusion of the diorite. Whether this is the case or not would most easily be determined by further mapping to the north across Lockaby Creek-a valley almost impossible to get into from Red Gulch Ridge.

The over-all structure becomes further obscured by the question of whether the drag folds seen are, in fact, flowage folds. If this were the case, the folds would pitch in the opposite direction from the major structure.

The mapping was done on only a reconnaissance basis. The rocks are exceedingly complex in their structure, and there is, at present, no way of determining the larger picture without further detailed study; but, even then, I doubt, with the outcrops as few and far between as they are, that a definite conclusion could be reached.

Therefore, no relationship can be found, at this time, between the ore deposits and the regional structure. The structural interpretation of the two main lenses is only local in scope and will be dealt with in the following section.

IV. ORE DEPOSITS

A. General Character and Situation.

The relationship of the two main orebodies at Ecstall River are best shown by the accompanying isometric diagram. The average strike is N. 05° E. and the dip about 80° E. The red color represents the North Lens, and mauve its hanging wall stringers; the limits of the North Lens are accurately shown to scale, but the orebody has been arbitrarily cut off at 500 feet above sea level whereas some of its outcrops lie at over 600 feet above sea level. The South Lens is shown in orange; it extends farther to the south than drawn and its depth is unlimited; however, the southward plunging north pinch-out has been determined by diamond drilling and structural interpretation. Near the surface the two lenses have a considerable overlap, but with depth they become farther apart.

Other mineralization of interest includes the Third outcrop, a five-foot vein of massive sulphides exposed at the surface and to the east of the two main lenses, and the Frizzell outcrop.

The Third outcrop, lying near the headwaters of Red Gulch Creek, showed up to 7 feet of sulphides exposed at the surface. The outcrop was drilled extensively within the capabilities of the small X-ray drill and mineralization proved to be spotty and intermittent. However, it should be remembered that drilling intersections were around 1000 feet <u>above</u> sea level and the South Lens is known to extend 1000 feet <u>below</u> sea level. The depth-range for mineralization in the shear zone has hardly been explored therefore.

The five-foot vein was explored underground with two drill holes, but only sericite shear and disseminated pyrite were found. The shear at the surface dies out to the north against the granite gneiss which lies between it and the North Lens, but continues to the south.

Small stringers of sulphides were found throughout the area mapped; some, however, were not associated with sericite schist. Of particular note is a 10 inch sulphide vein in sericite schist located west of the South Lens. This same mineralized shear is found in the large bend in the main adit and was picked up again in Drill Hole No. 60 drilled 500 feet south and downward from the No. 1 Crosscut.

The Frizzell outcrop was found, after a great deal of difficulty, by W. Holyk near the headwaters of Hanna Creek. The mineralization was weak and erratic and the assays of the sample taken were disappointing. The sulphides strike northwest and the surrounding quartzites strike due east. This anomalous situation cannot adequately be explained.

B. Metamorphics around North and South Lenses.

The rocks adjacent to the two lenses include quartz-chlorite schists, chlorite-biotite schists, with hornblende or garnet as accessory minerals, highly hornblendic schists, granite gneiss with chlorite or biotite being the predominate mineral, quartzites, argillite and sericite schist.

The granite gneiss lies off the hanging wall of the two lenses. Other rocks are not easily correlated through the mine for any great distance. Quartzites predominate in the southern end of the mine but give way to dominantly chloritic rock around the North Lens. For greater detail the reader is referred to W. Holyk's underground map and my underground sheets found in this report.

Of special interest is the so-called crumpled chlorite schist. The name accurately describes it. Sericite is sometimes highly developed. It lies on the hanging wall side of the South Lens, cuts between the two lenses and continues on the footwall of the North Lens. At the surface the zone is close to the North Lens, but underground it bears sharply away from and to the west of the North Lens. Small zones of crumpled chlorite schist are developed locally elsewhere. These will be discussed under the structure of the orebodies.

The sericite schist is developed around the two lenses, but is not always present. The North Lens sericite shear disappears with depth and to the south, but not northwards. The South Lens sericite shear joins with the North Lens to the north and dies out at its most southerly end.

C. Mineralogy and Classification.

The sulphides at Ecstall include pyrite, chalcopyrite, small amounts of sphalerite and pyrrhotite, in a gangue of calcite, quartz and sericite.

The highest copper values are confined to the footwall of the North Lens (Illustration No. 10); zinc is largely found in the South Lens.

The sulphides occur as bands of equigranular minerals ranging from coarse to extremely fine and massive. The sulphides produce no gossan or oxide, other than a local staining of rocks in the creeks, and it weathers to a sand made up of sulphide mineral crystals. Sulphides lying on the dump for nearly twenty years show no sign of oxidation.

The nature of the banding, which in some places is contorted and folded, and the massiveness of the sulphides, indicate that the deposit is a replacement of a favorable rock. Bateman (1951) lists the criteria for a replacement as follows:

(1) Unsupported nuclei (if the deposit is a cavity filling then such residuals tend to lie on the floor of the deposit).

(2) Bedding planes in alignment with the wall rock.

(3) Pre-existing rock structures that continue on either side of the orebody, and especially if they continue into the ore.

The Ecstall deposit meets all these requirements, but the last point is not so readily discernible and examples of this are not common.

There is some evidence that the banded sulphides form apophyses in the sericite schist, thereby indicating that the schist had been "displaced" (Illustration No. 4). This process, as well as replacement, is part of the ore deposition.

D. Structure.

1. North Lens.

The dominant structure in the North Lens is a southward plunge with the axis migrating in a southeast direction (Illustrations Nos. 8, 9, 10). Small striations or undulations on shear walls, the plunge of folds, and an isograd of the thickness of the lens, and of the copper values follow the same southerly pattern (Illustrations Nos. 8, 9, 10). Only the south end of the North Lens, which plunges northward, is the exception.

With regard to the striations and undulations seen on shear walls, I do not regard these as indications of a dip-slip movement. For example, the crest of the undulations may plunge 80° S. measured in the plane of the shear wall dipping east and striking north. Here the movement is not up and down in the plane of the shear, but rather in a direction at right angles to the striations. These small folds are produced by rotational forces much like the making of ripple marks on a beach. When the rotational stresses become more pronounced, folding, more particularly drag folding, results, and this is in evidence throughout the mine.

Folding is evident, especially on the surface of the deposit. Going across the North Lens the folds in the sericite schist waste bands reverse themselves several times across the deposit. Folds are observed in the sericite schist on the hanging wall and footwall of the sulphides and in unreplaced quartzite (surface map and underground sheets). This unsystematic direction of folding leads me to postulate that the favorable replaced host rock, or sericitic rock, had doubled over on itself.

The bottoming of the North Lens is particularly perplexing. Drill holes under the lens contacted neither mineralization nor shearing. The lens had completely disappeared. Those holes which were blanks have been plotted on semi-logarithmic paper (Illustrations Nos. 1, 2, 3), the angle of hole dip against the depth. None of the holes deviated more than 3° in strike so that this is a constant factor. Also plotted is the angle of schistosity of the rock in the drill core against the hole depth.

In the ideal case, in uniformly dipping or striking schists, the schistosity curve should change with the curve for the dip of the hole. As can be seen from the graphs, this is not the case.

Either the dip or strike in the rocks underneath the North Lens is changing markedly. As elsewhere in the mine, this is indicative of disturbed or folded rocks.

The probable cause of bottoming in the North Lens is two-fold: first, the ore deposition is dependent on the development of the sericite schist; these shears are zones of maximum stress where rocks have approached flowage and allowed altering solution to migrate; second, shearing is regarded as the end product where the rocks could no longer be deformed. Folding controlled and caused the thickening in the North Lens, and conversely, the lack of folding, shearing and deformation has been responsible for the pinch-out in the North Lens.

It is my belief that just as shearing and folding may reappear along the strike it can also do so with depth. The North Lens could reopen with depth and would most likely be found to the southeast of the orebody.

2. <u>South Lens.</u>

The South Lens is regular in shape and continuity, and roughly resembles a parallelogram with its sides plunging 70° to the south. This is conformable with the structure underground and on the surface; striations, undulations and folds generally plunge 70° southward, although there is a tendency for the angle to be steeper at the north end than at the south end.

Of particular note is the wide-scale folding around the No. 2 Crosscut-the widest part of the South Lens. As in the case of the North Lens, the folding has been responsible for this expansion in the lens.

Further on the matter of folding, drawings of structures on the backs and walls of the drift strongly indicate highly disturbed strata, and in the mid-portion of the mine the pinching-out of the quartzites to the north is evidence of tight folding.

Small shears where there is a development of gnarled and rolled-up quartz, pyrite and "creamy" swirled chloritic rock might represent rupture down the axial plane of tight folds; in a few cases this is very apparent, but more usually the rock is so textureless as to make any determination of the lineation impossible.

The crumpled chlorite schists might represent this axial plane shearing; from the highly folded and distorted nature of the large shear zone around the No. 6 Crosscut, one can observe the limbs of folds sliced off by the shearing (Illustration No. 5 and underground sheets).

3. Summary.

Mapping of the two lenses on a scale of 30 feet to the inch shows that all the rocks-the wall rocks and sericite schist-and the massive pyrite ore are greatly disturbed. Rock units are difficult to trace through. The crumpled chlorite schists appear to represent breaking along the axial plane of folds and might be due to a different structural phenomenon from the sericite shears which are largely an alteration product. The sericite is folded in the same manner as unaltered rocks.

The juxtaposition of the two lenses is regarded as fortuitous, although the three alteration zones-North Lens, South Lens, and the Southwestern shear with small mineralization-have an en echelon pattern which may indicate a greater over-all structural pattern not yet perceived.

E. Comparison with Other Deposits.

A search through the geologic literature for pyrite replacement deposits was not too fruitful. Such deposits have not, in the past, been economic in North America, but in Europe some reports have been written on such ores, especially those in Sweden.

Per Geijer (1924) has summarized the Swedish pyrite replacement deposits. The orebodies were formed during an epoch of folding and are a replacement in pronounced schistose layers in steeply inclined formations and fissure zones. The minerals formed by replacement show schistosity by crystallization and pronounced banding. Folding in the orebodies and pre-mineralization folding in the host rock can be seen; the folding continued until gradual solidification made the mass rigid. There are places where anticlinal and synclinal structures have controlled the form of the orebodies which generally follow the pitch of the folds.

George Hanson (1920) compared the pyrite deposits in metamorphic rocks in Northern Manitoba, Weedon, Stratford and Capelton in Quebec, and Kyshtin, Russia. The degree of schistosity is of primary importance in determining the size of the orebodies which are generally parallel to the country rock. Ore was formed after the development of schistosity and the degree of foliation determines their size.

Bateman (1951), in speaking of replacement type deposits, states that "the chemical character of the host rock alone may be the controlling factor in localizing ore, but the structural features generally operate in conjunction with other factors ..... Pitching folds and drag folds have been important in localizing ore in many places."

The Boliden deposit (Odman, 1941) in northern Sweden is particularly interesting; to me, it closely resembles the deposit at Ecstall River.

In this case the bedrock is Pre-Cambrian in age and consists of phyllites, greywackes and greenstones. Granite has been intruded and lies south of the mine. The rocks are strongly folded and strike east-west and dip steeply south. There are two orebodies 600 meters long and maximum 40 meters wide and are en echelon position and overlap to the right. There are three types of ore. A drag fold lies between the contact of the sediments and volcanics. The structure is caused by shearing stresses, and the axis of the fold pitches 50°-60° E.

In the drag fold the stress formed suitable channelways for ascending hydrothermal solutions which altered the volcanic rocks, and resulted in their sericitization. Further shearing along alteration zones produced a schisted rock which was replaced by ore solutions. Alteration continued after ore emplacement. The pitch of the ore follows the axis of the drag fold. Folding in the sericite schist probably formed by local movement during the mise en place of the ores.

Banding in the ores does not always correspond to the foliation in the schists and often forms apophyses.

The Melanas deposits in Sweden (Gavelin, 1939) occur in the same age and type of rocks. All have been intensely folded and regional metamorphism and shearing have altered the rock so that often the original texture is indiscernible. The ores are replacements of sericitic schists and consist of pyrite, pyrrhotite with chalcopyrite, galena and sphalerite. The ores are contorted and folded with the schists, and the shape conforms to, and is controlled by, the degree of folding. Gavelin alludes to an over-all structure, but he states that the lack of outcrops in the region makes its identification impossible.

Further research in the literature would undoubtedly produce more examples similar to those outlined, and to the numerous pyrite deposits not herein described. I have visited many pyrite prospects and nearly all conform to the same pattern. Replacement deposits invariably occur in folded metamorphics along zones of alteration; the shape, size, and control of the orebodies are determined by the folding, and its structural attitude in space.

The point is made, therefore, that all the evidence at Ecstall River indicates that the deposits there are similar, and that their geologic and structural history conform, in essence, to the general pattern of pyrite replacement deposits.

V. CONCLUSIONS

A. Geologic and Structural Features.

1. All the metamorphic rocks in the roof pendant have been folded. Metamorphism and structural deformation were contemporaneous. The marginal gneisses, becasuse of their proximity to the batholiths, are more contorted. The swelling of the granite gneiss in the headwaters of Red Gulch Creek is probably due to folding.

2. Shear zones developed in areas of high pressure; the regional schistosity and cleavage are parallel to the axial planes of the structures.

3. Shear breaks provided suitable channels for hydrothermal solutions; the rocks were thereby altered to sericite.

4. The ore solutions migrated through the same zones and both "replaced" and "displaced" the sericitic favorable host rock.

5. Folding and sericitization continued until the sulphide mass was too rigid.

B. Ore Controls.

1. Shear zones are confined to the Mine group of rocks; other ore deposits are, therefore, likely to be found with the association of these two features.

2. Folding has controlled the size and shape of the North Lens, and, to a lesser extent, the South Lens.

3. The juxtaposition of the granite gneiss possibly caused the doubling up of the North Lens and the thickening in the South Lens. It is not a controlling factor in the deposition of ore, but merely over the shape of the orebodies.

4. A determination of the over-all structure should yield a further control over the location of the orebodies much in the same manner as the other pyritic replacement deposits which have been described in the report.

C. Practical Applications.

1. Since the shape of the North Lens has been determined by the folding, those forces which caused its pinching-out with depth may reopen the lens with depth. This would have to be accompanied by shearing and the development of sericite. The structure of the North Lens is plunging 70° at about S. 40° E., and any new orebody would lie along this direction.

2. The South Lens should continue farther in depth. However, the folding about the No. 2 Crosscut could either thicken the lens or reduce it in width.

3. The Third outcrop is favorably located along a shear and near the granite gneiss (if this is a control), and an orebody could develop along the strike and with depth.

4. The shear to the southwest of the South Lens is well developed with depth and could show mineralization either along the strike or down the dip.

5. This makes the flat ground between Red Gulch and the Ecstall River south of the mine a favorable prospecting area. It is not felt that the South Lens will continue southwards at its present levels. Rather the lens will continue its plunge in the southeasterly direction and will be at greater depth.

D. General Considerations.

The underground workings have been fully utilized both in diamond drilling and in mapping the geology. If the orebodies are to be extended in depth, the workings will have to be further developed for there is no longer any practical way to drill deeper from the present locations. Most of the underground geology lies along the main adit-which does not give much of a cross section-and the crosscuts which give an average section of about 60 feet. The geology is extremely limited in scope therefore.

When the underground workings are extended, the utmost practicability should be used for the mining of the ore, the situation of future drill hole stations for deep drilling, and for the use of the geologist, in that order.

No further geologic work is recommended until the mine comes into operation. At that time, as the workings are extended, it would be practical to work in further detail on the surface and underground geology.

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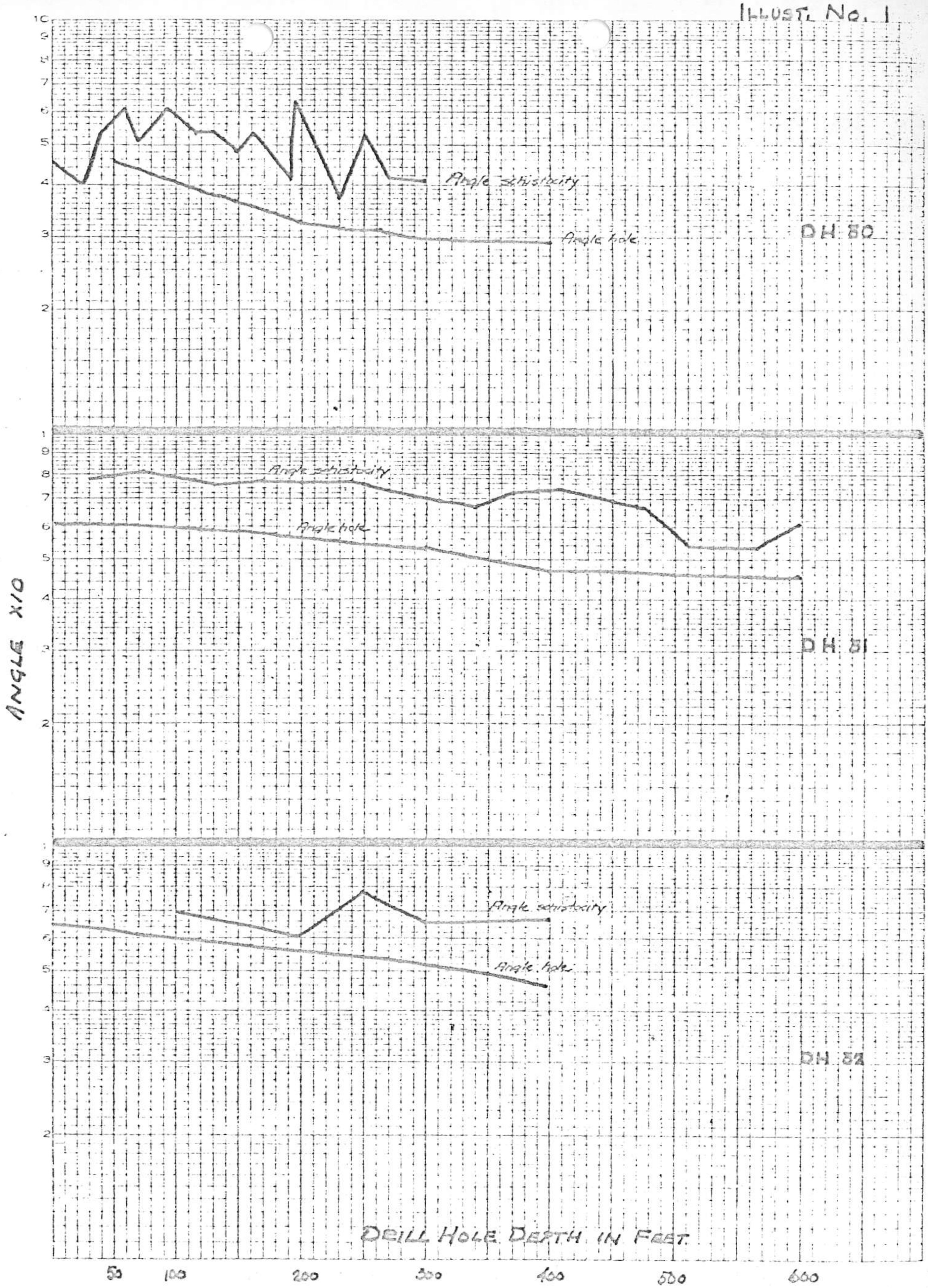
Hugh Douglas
20 April 1953
New York, New York

HD:GMO

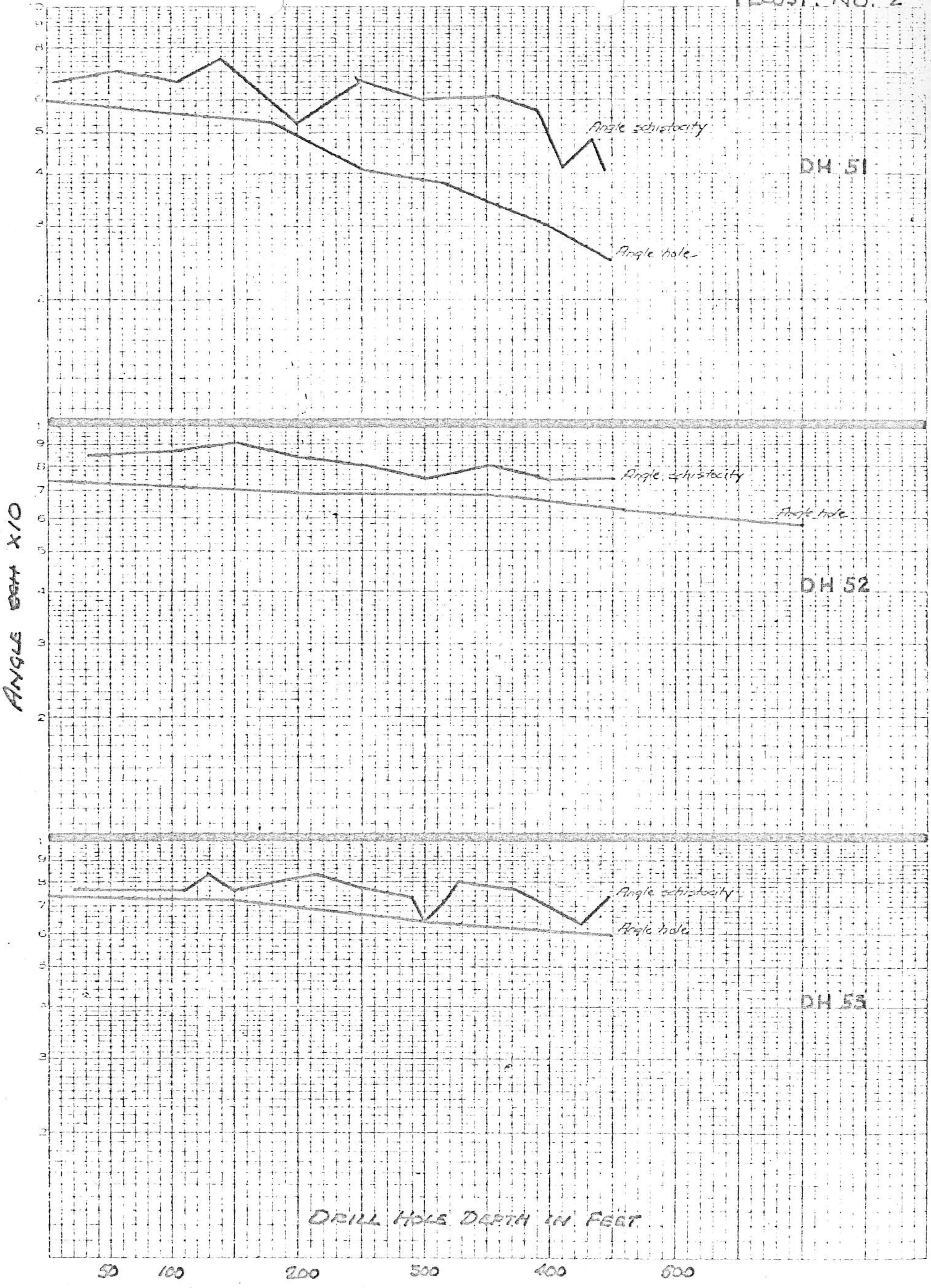
0+5

ILLUST. No. 1



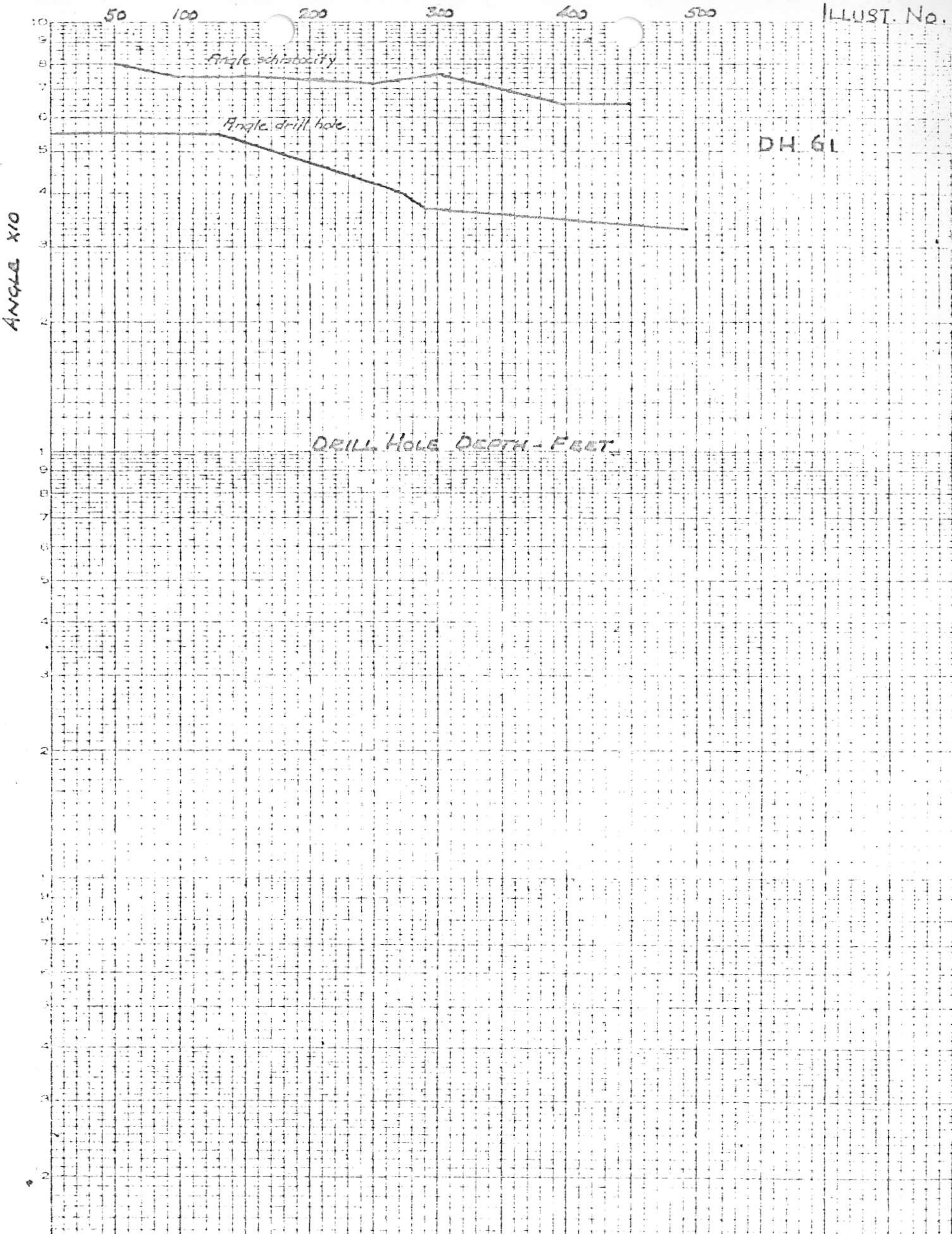
ANGLE X10
Angle schistosity
Angle hole
DH 80
DH 81
DH 82
DRILL HOLE DEPTH IN FEET
50
100
200
300
400
500
600

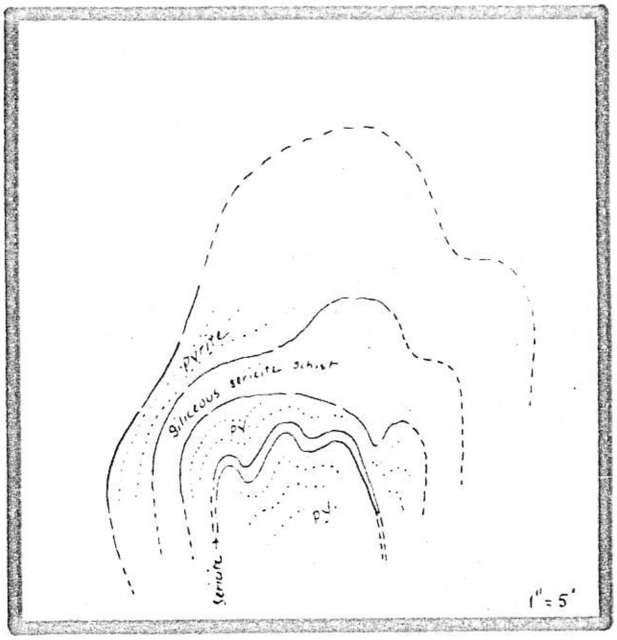
ILLUST. No. 2



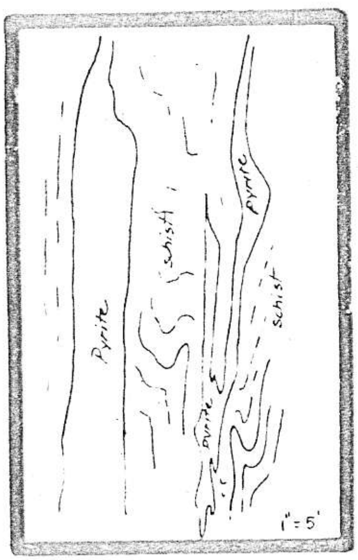
Angle schistocity
Angle hole
DH 51
Angle schistocity
Angle hole
DH 52
Angle schistocity
Angle hole
DH 55
ANGLE X/10
DRILL HOLE DEPTH IN FEET
50
100
200
300
400
600

ILLUST. No. 3

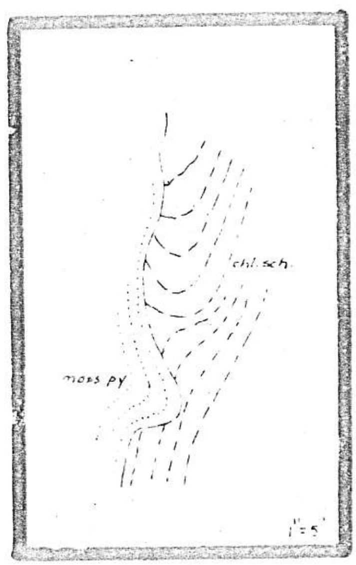

50
100
200
300
400
500
Angle schistocity
Angle drill hole
DH 61
ANGLE X10
DRILL HOLE DEPTH - FEET
EUGENE DIETZGEN CO.



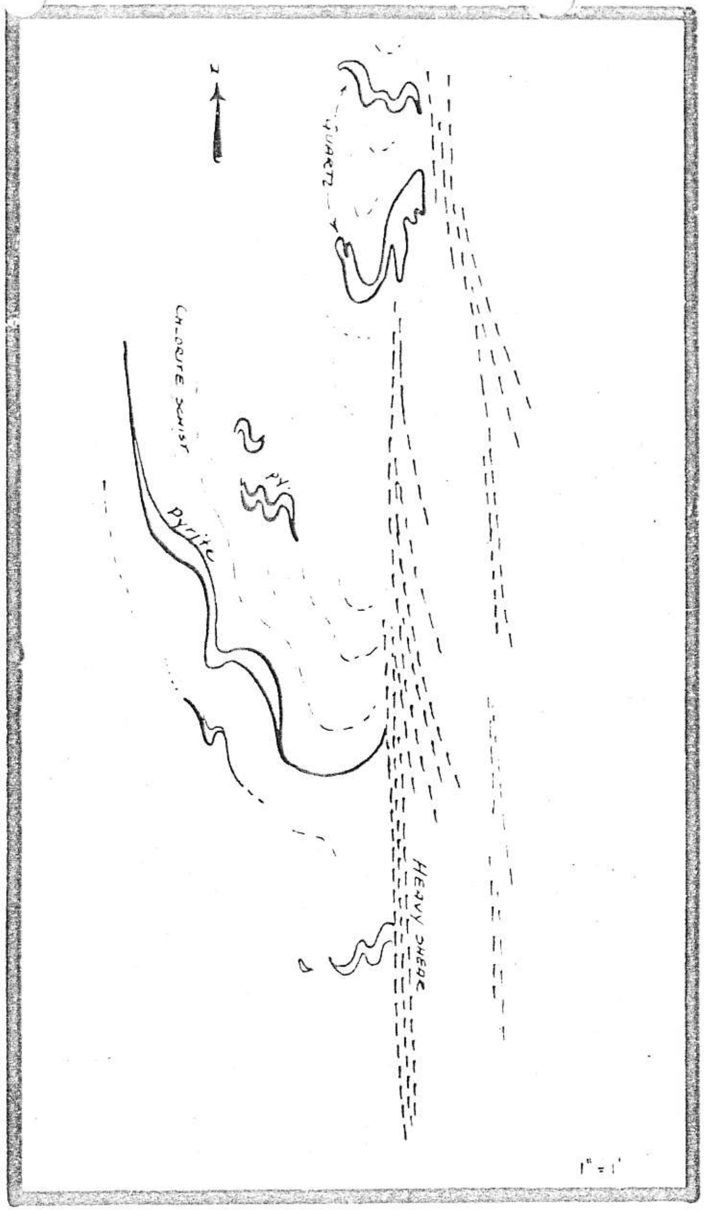
FOLDED STRUCTURES, NORTH LENS
NEAR ADIT BELOW FALLS



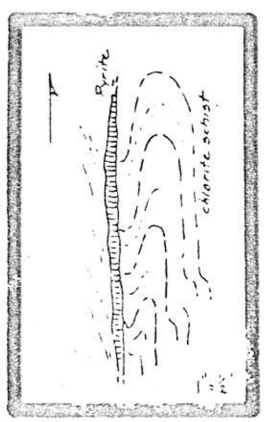
NORTH END
OF THIRD OUTCROP



APOPHYSIS OF
PYRITE IN SCHIST

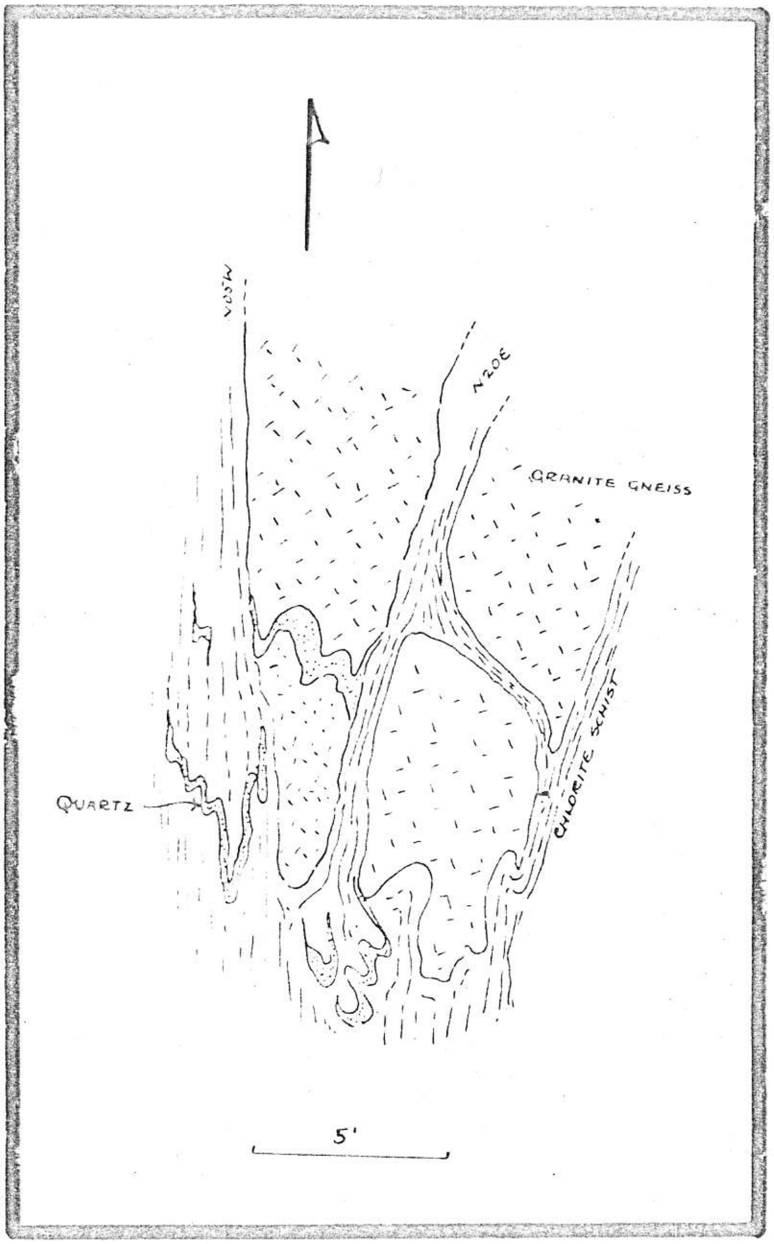


Back main adit, 25' south No. 6 crosscut.

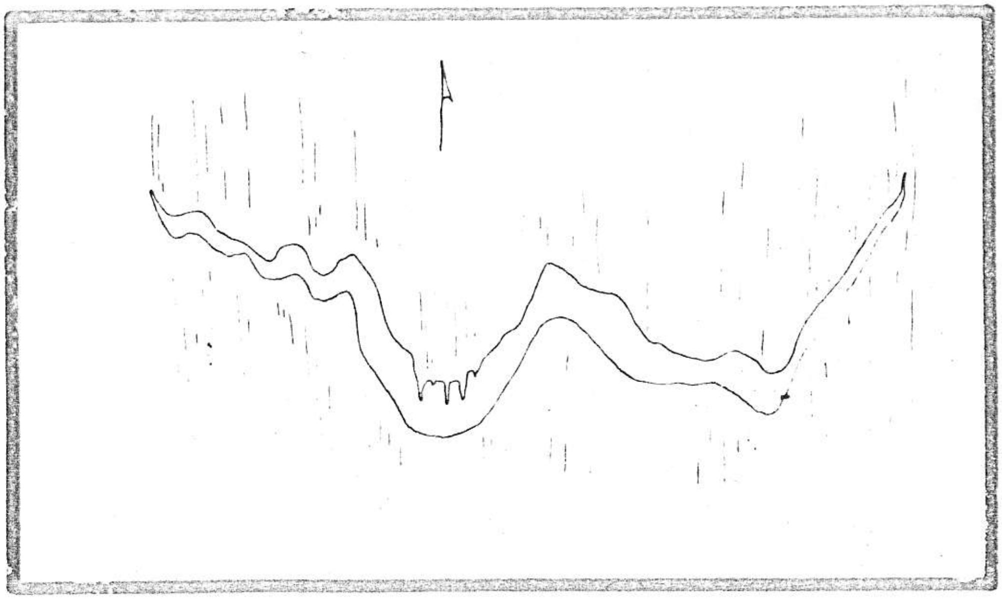


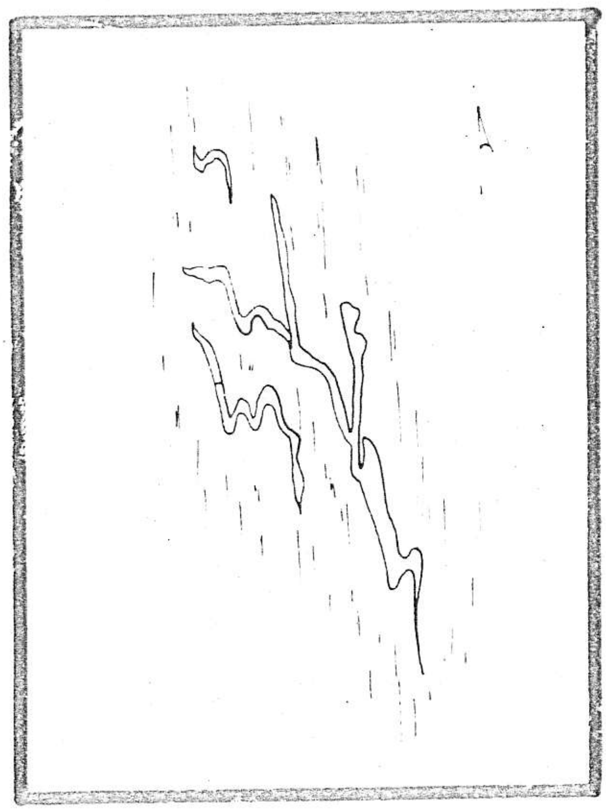
First stream N. of falls

EXAMPLES OF SHEARING ALONG AXIAL PLANE OR LIMB OF FOLDS, UNDERGROUND AND SURFACE.

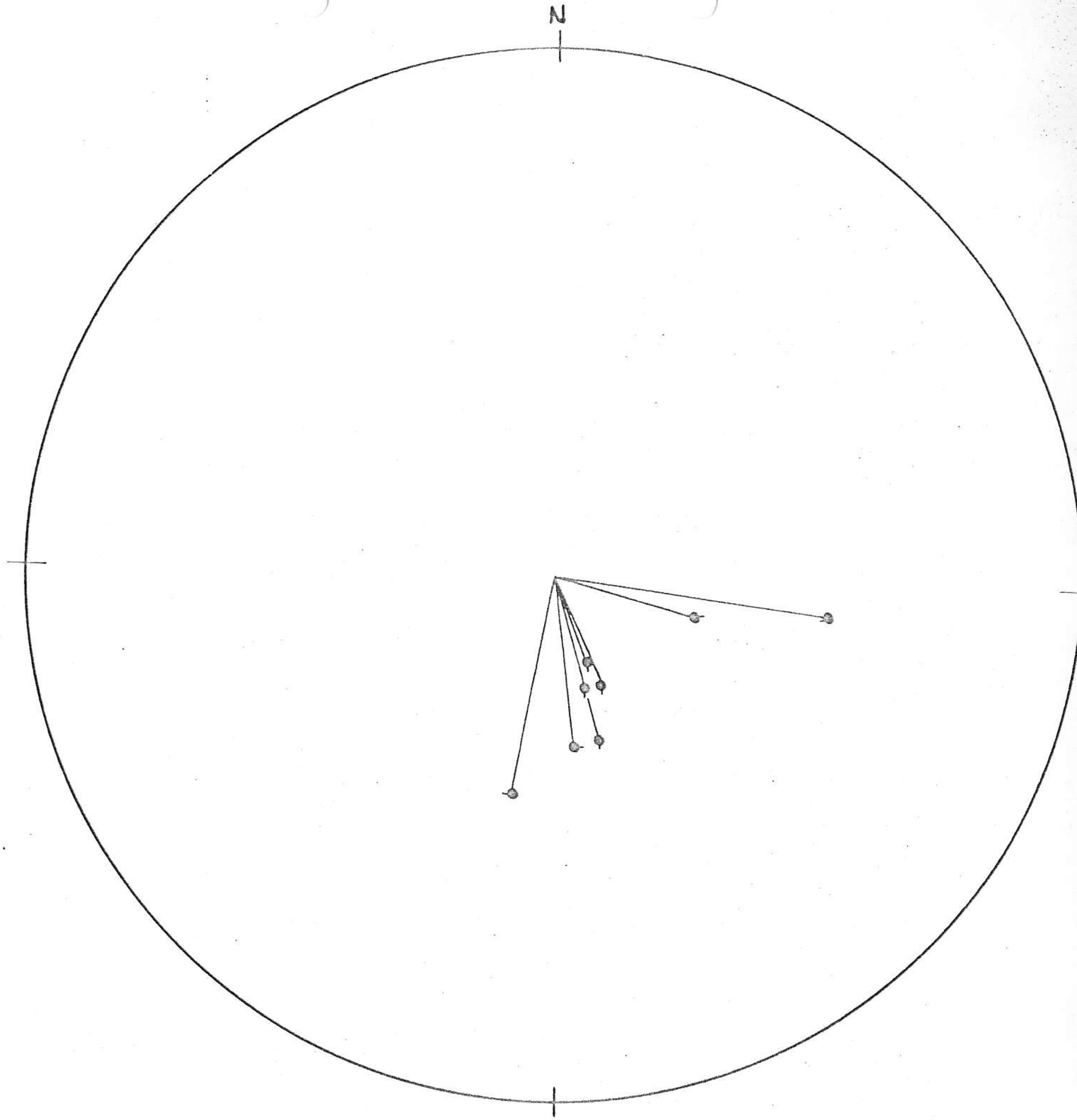


"GRANITE" GNEISS,
NORTH OF NORTH LENS





EXAMPLES OF FOLDED QUARTZ IN SCHIST

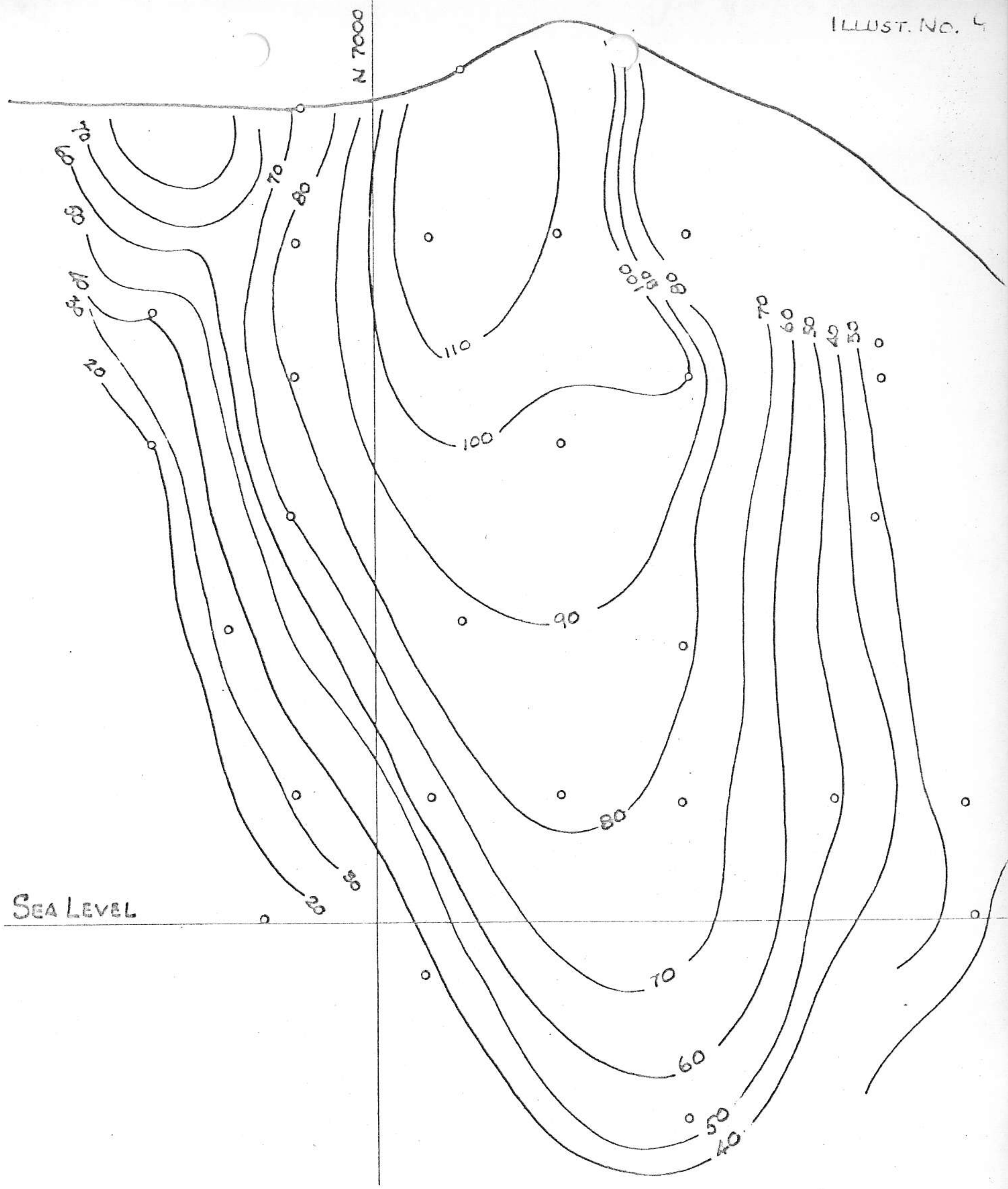


PLOT OF FOLD AXES, NORTH LENS

ON STEREOGRAPHIC PROJECTION

= 5 to 10 meas axes   = $<$ 5 measured axes   = one measured axis

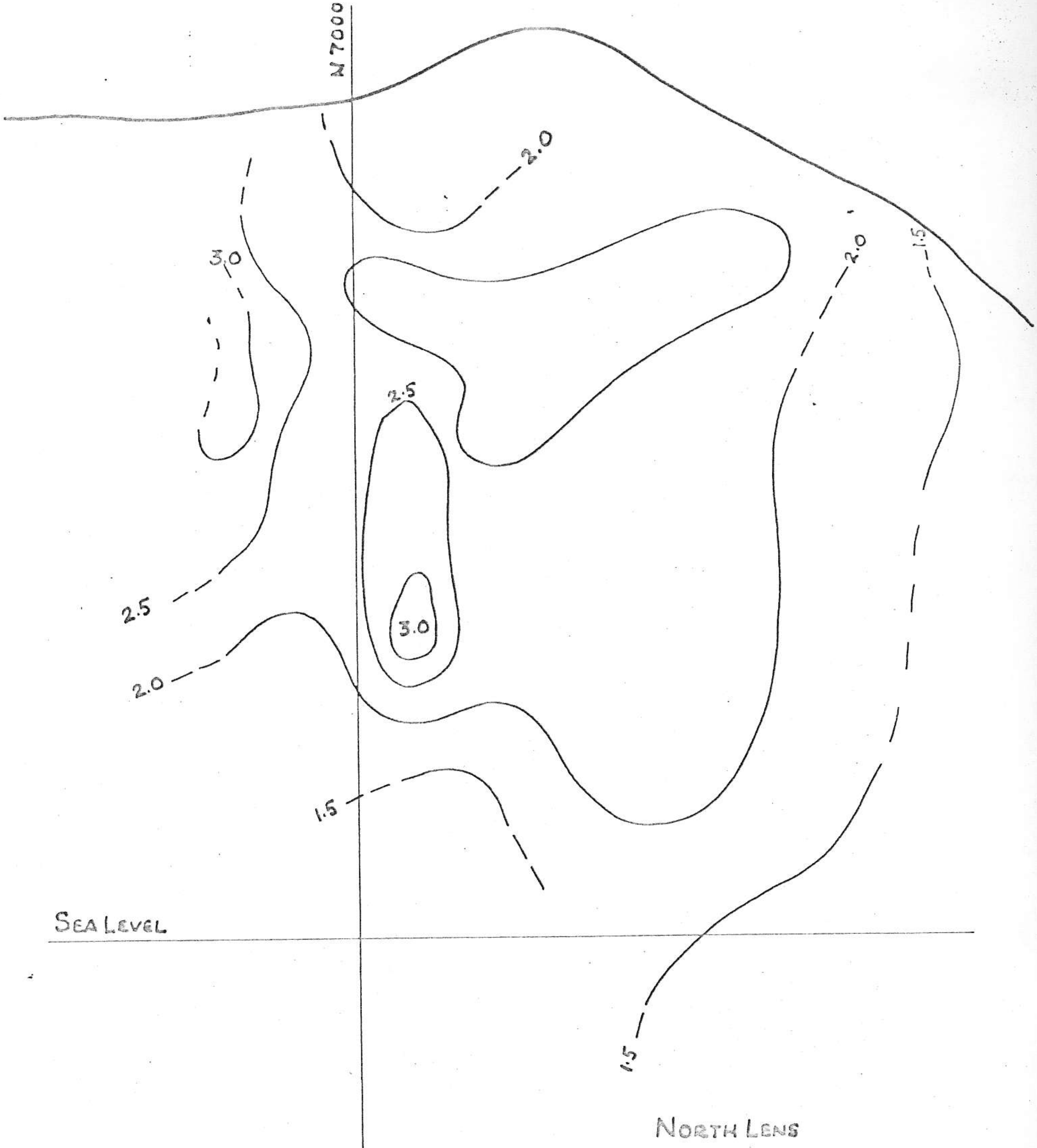
ILLUST. NO. 4



NORTH LENS

CONTOURED THICKNESS

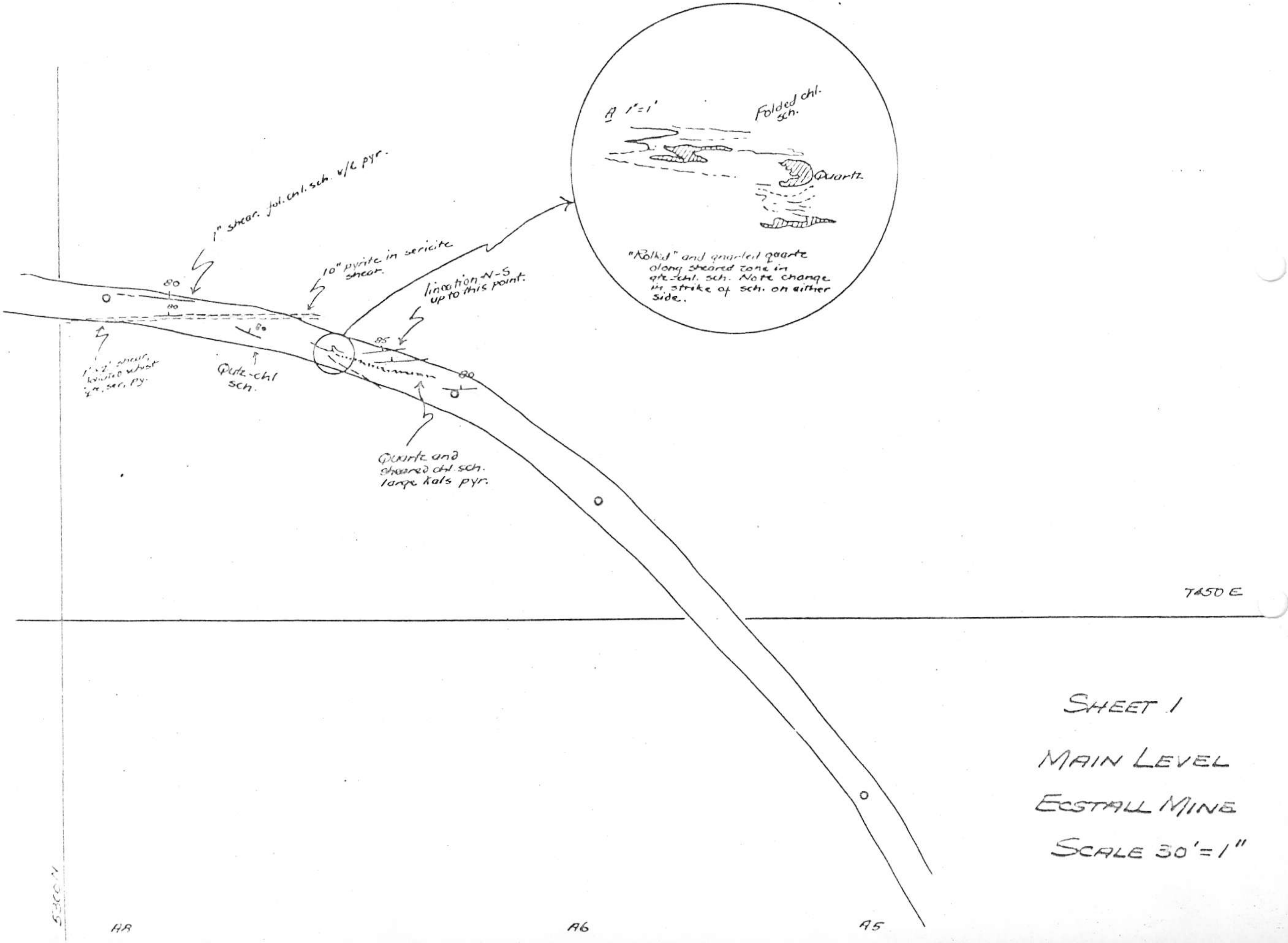
SCALE: 1" = 100'



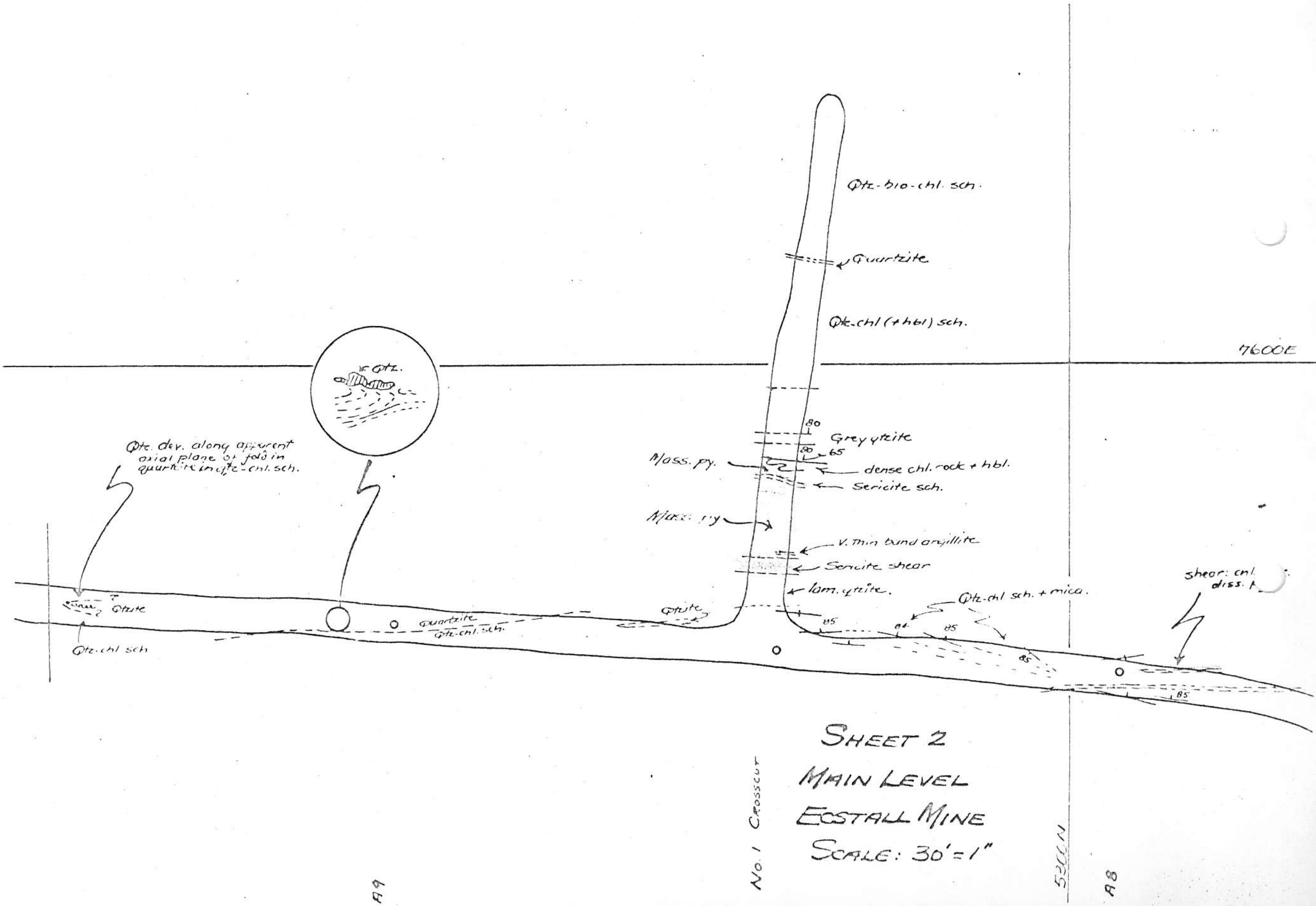
NORTH LENS

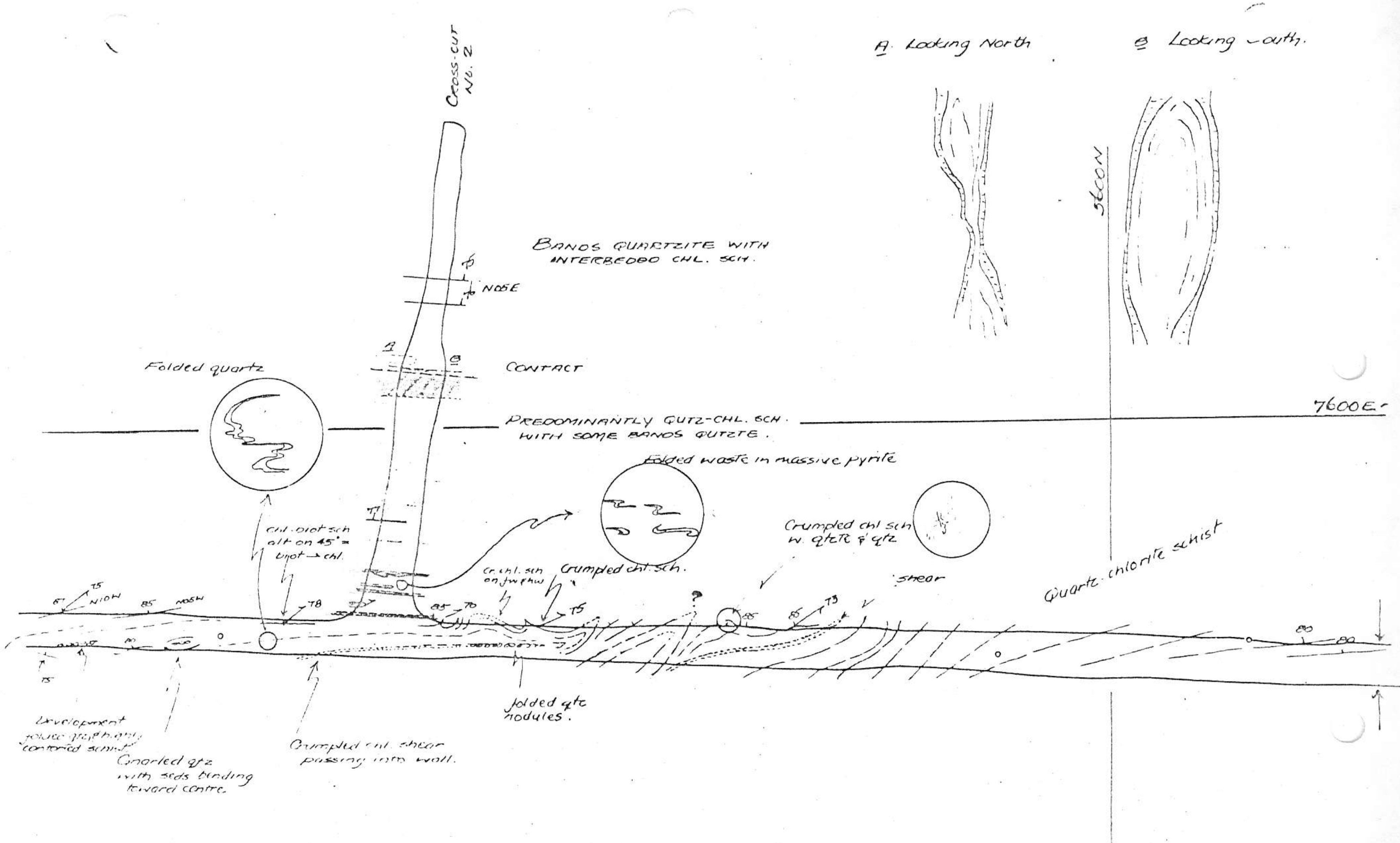
CONTOURS % CU. ON FOOTWALL

SCALE: 1" = 100'



1" shear. fol. chl. sch. w/c pyr.
10" pyrite in sericite shear.
lineation N-S up to this point.
A 1"=1'
Folded chl. sch.
Quartz
"Rolled" and quartz quartz along sheared zone in qtz-chl. sch. Note change in strike of sch. on either side.
80
80
80
85
80
Qtz-chl sch.
Quartz and sheared chl. sch. large xals pyr.
7450 E
5300 N
A8
A6
A5
SHEET 1
MAIN LEVEL
ECSTALL MINE
SCALE 30'=1"


Qtz-bio-chl. sch.
Quartzite
Qtz-chl (+hbl) sch.
7600E
Qtz.
80
Grey qtzite
80
65
Mass. py.
dense chl. rock + hbl.
Sericite sch.
Mass. py
V. thin band argillite
Sericite shear
lam. qtzite.
Qtz-chl sch. + mica.
shear: chl.
diss.
Qtz. dev. along apparent axial plane of fold in quartzite in qtz-chl. sch.
Qtzite
Qtz-chl sch
Quartzite
Qtz-chl. sch.
Qtzite
85
84
85
85
85
SHEET 2
MAIN LEVEL
ECSTALL MINE
SCALE: 30'=1"
No. 1 CROSSCUT
5200N
A9
A8



SHEET 3

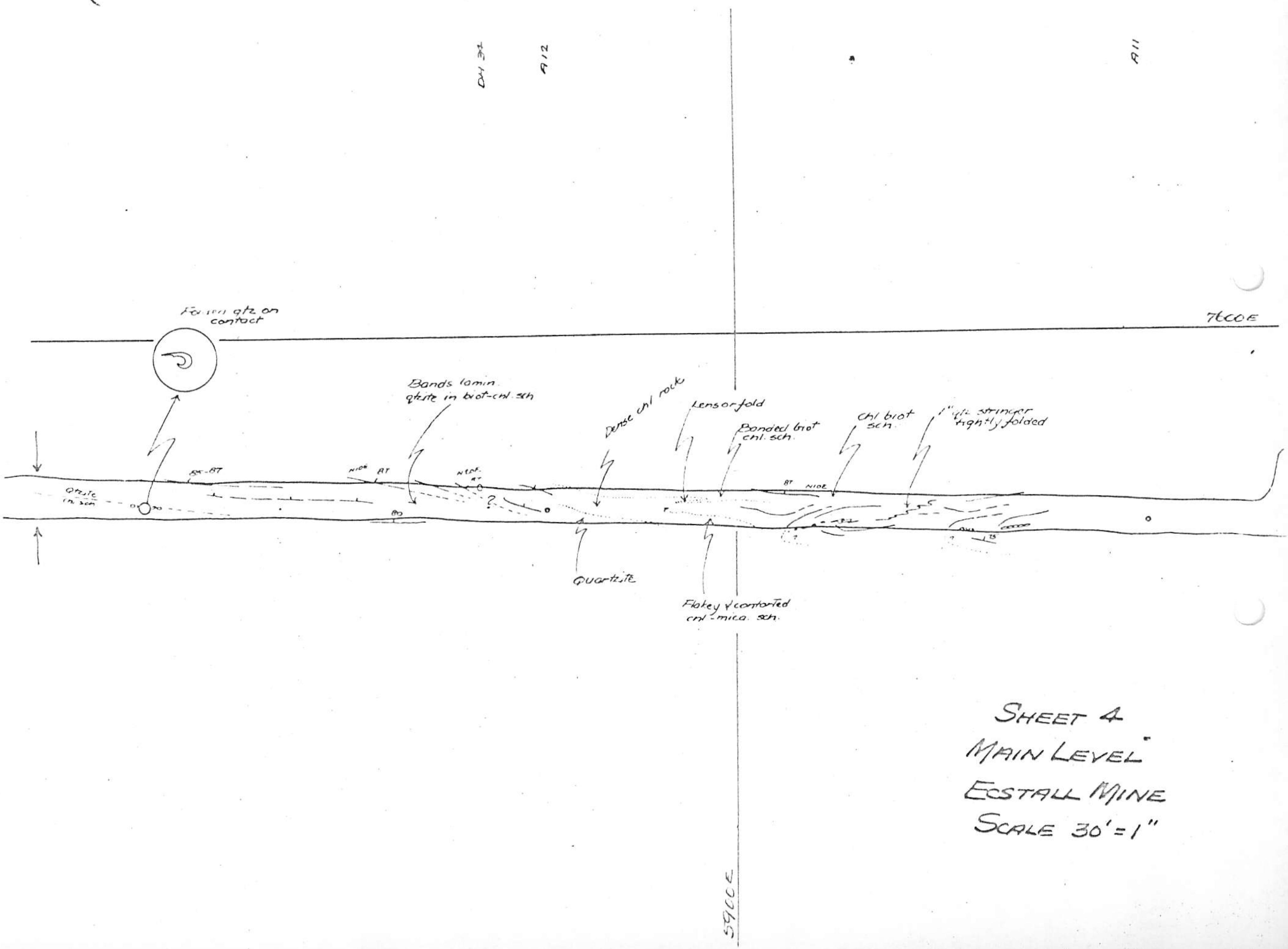
MAIN LEVEL

ECSTALL RIVER MINE

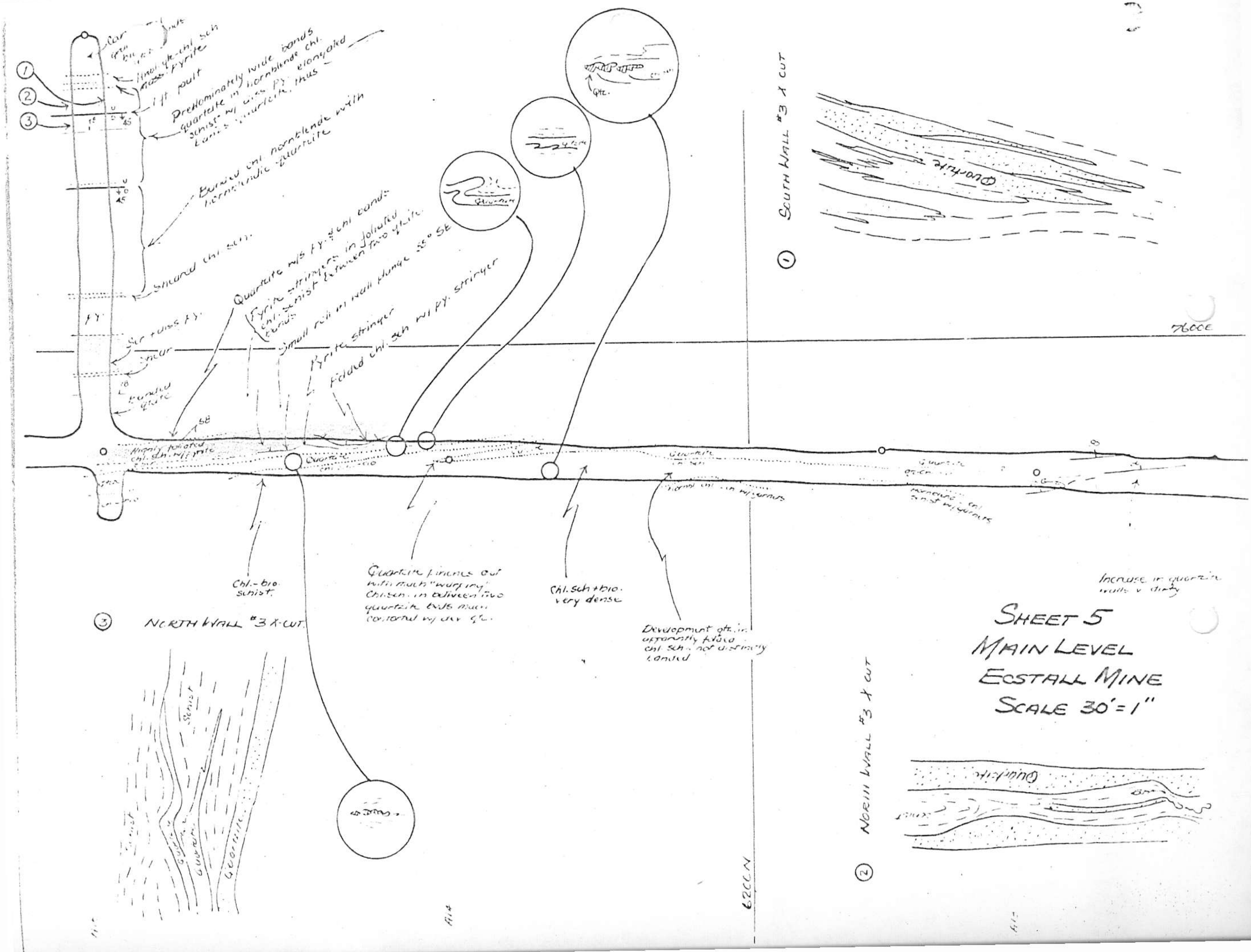
30 FT = 1 INCH

A10

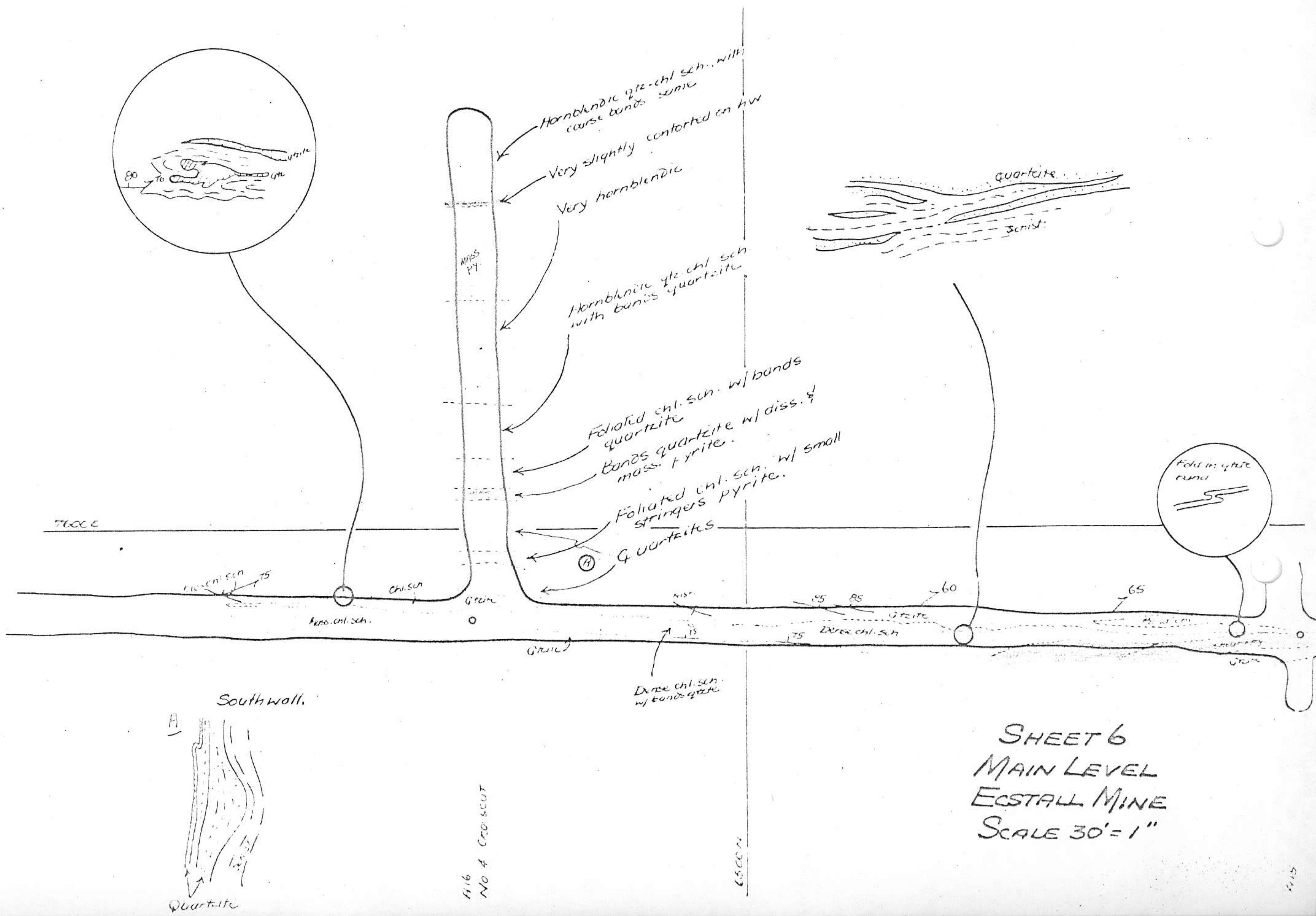
A11



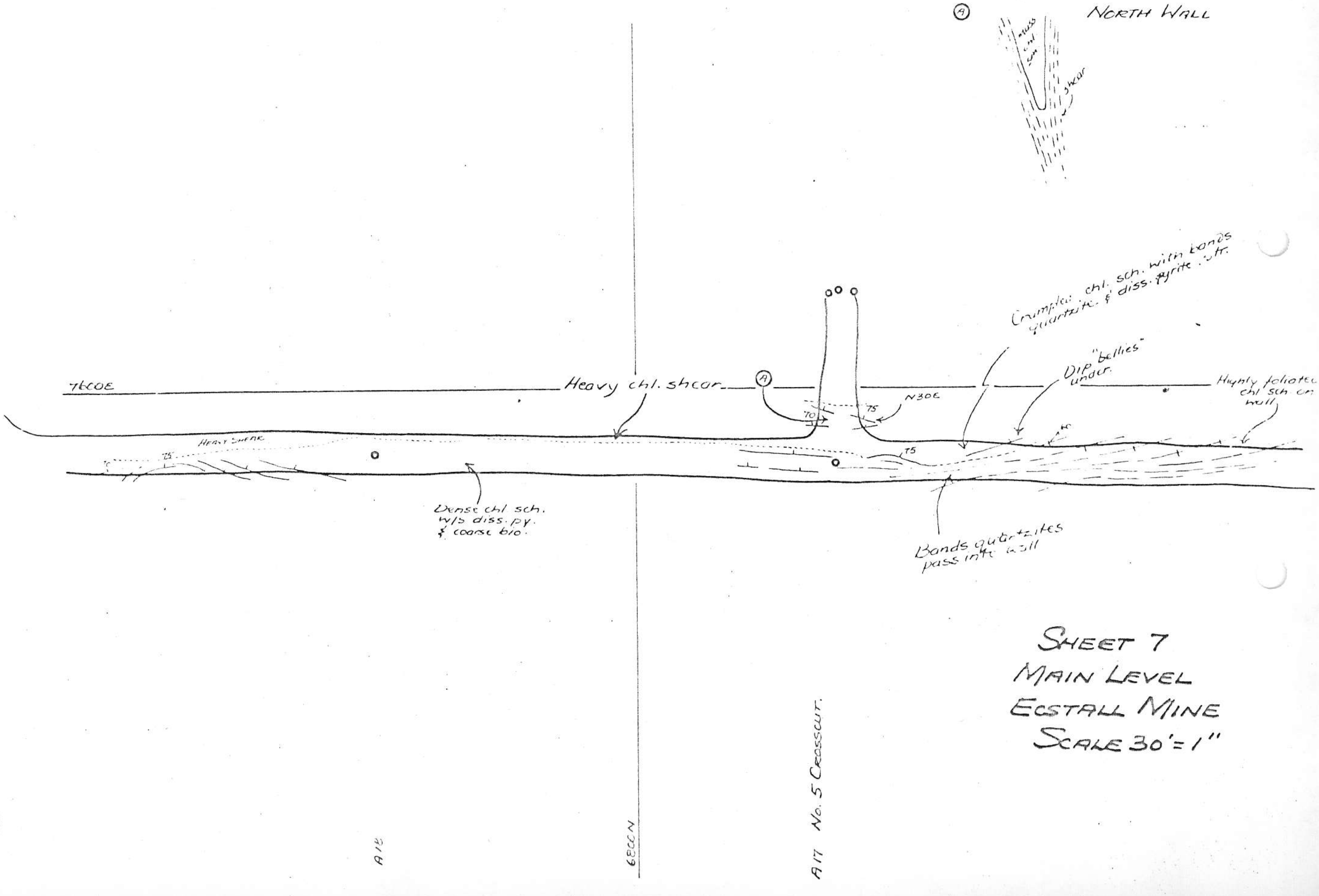
SHEET 4
MAIN LEVEL
ECSTALL MINE
SCALE 30'=1"



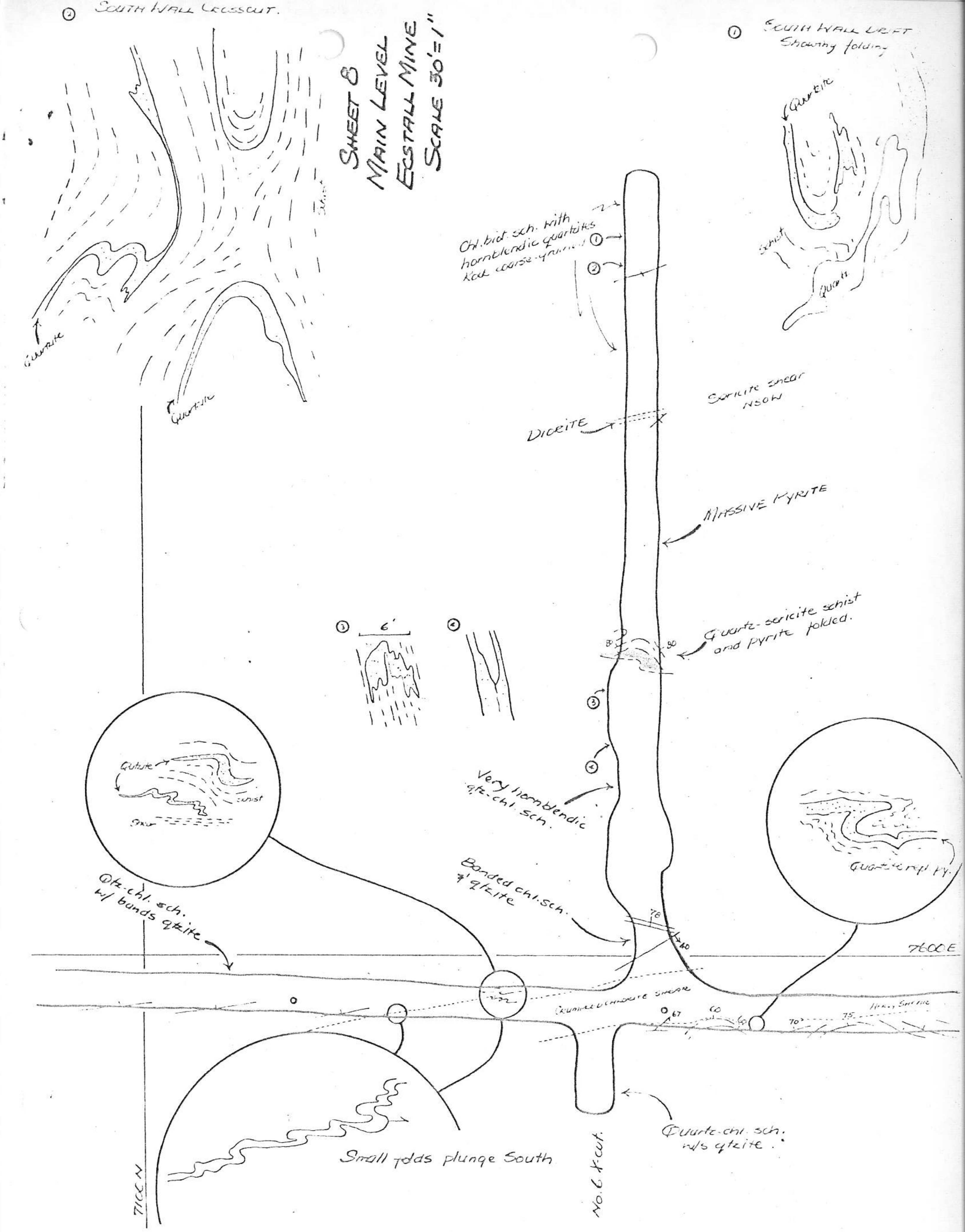
Sheet 5
Main Level
Ecstall Mine
Scale 30' = 1"



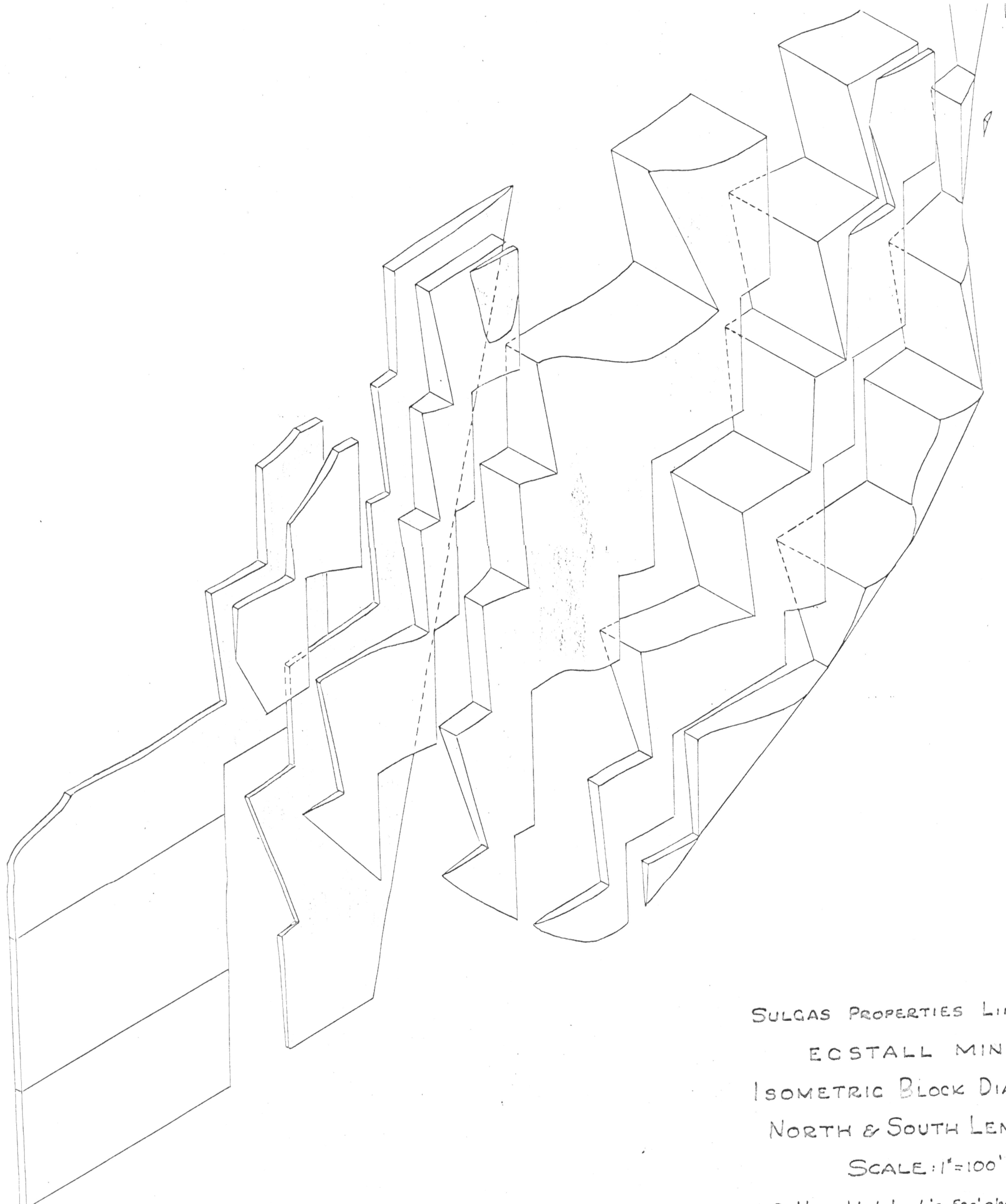
SHEET 6
MAIN LEVEL
ECSTALL MINE
SCALE 30' = 1"



A
NORTH WALL
shear
Crumpled chl. sch. with bands quartzite & diss. pyrite str.
Dip "bellies" under.
Highly foliated chl sch on wall
7600E
Heavy chl. shear
A
N30E
70
75
75
HEAVY SHEAR
75
Dense chl sch. w/s diss. py. & coarse bio.
Bands quartzites pass into wall
SHEET 7
MAIN LEVEL
ECSTALL MINE
SCALE 30'=1"
A18
6800N
A17 No. 5 CROSSCUT.



② South Wall Crosscut.
① South Wall Drift Showing folding
Sheet 8
Main Level
Ecstall Mine
Scale 30'=1"
Quartzite
Schist
Quartz
Chl. biot. sch. with hornblendic quartzites Rat coarse-grained
Sericite shear N50W
Diorite
Massive Pyrite
Quartz-sericite schist and pyrite folded.
6'
Very hornblendic qtz-chl. sch.
Banded chl. sch. 4' qtzite
Qtz-chl. sch. w/ bands qtzite
Quartzite repl py.
7600E
Small folds plunge South
Quartz-chl. sch. w/s qtzite.
No. 6 X-cut.
7100N



SULGAS PROPERTIES LIMITED

ECSTALL MINE

ISOMETRIC BLOCK DIAGRAM

NORTH & SOUTH LENSES

SCALE: 1" = 100'

N.B. Upper block level is 500' elevation; lower block level is -100' el. North arrow = coörd. 7600 E.

April 1955

inches
0 1 2
0 1 2 3 4 5
centimetres

G E O L O G Y

of

ECSTALL RIVER MINE AREA

W. Holyk
1952

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

MAPS ACCOMPANYING REPORT

INTRODUCTION

This report and enclosed maps summarize the results of the geological investigations of the Ecstall River Mine area, Prince Rupert, B. C., carried out during the summer of 1952.

The ultimate objective of this geological programme was to extend the known ore bodies and to aid in the search for new ore bodies. Regional and detailed geological mapping were therefore undertaken to determine the structural controls of the ore. Once these controls are established, similar structural conditions can be sought for elsewhere in the area and thereby narrow the target for new ore bodies as well as aid in the extension of the known bodies.

The geological work has been carried out by a number of individuals. The bulk of the reconnaissance geology (1000' to the inch regional map), the local geology of the mine area (300' to the inch map), and the underground geology was undertaken by the writer. Mr. Hugh Douglas undertook the detailed geology of the surface along Red Gulch Creek in the vicinity of the north and south lenses, as well as part of the regional and underground geology. The diamond drilling programme was laid out and supervised by Messrs. E.E. Mason, R. D. Mollison, and H. Douglas. Messrs. D. Lowrie and D. Webster aided in the regional mapping and in the drill hole logging.

The regional mapping (1000' to the inch) was made on topographic maps prepared from aerial photographs by Fairchild Aerial Surveys, Inc. Positions were fixed by topography and aneroid elevations.

The local geology of the mine area was made on a base topographic map prepared by E.E. Mason (1937) and positions were fixed by aneroid.

With the exception of the east plateau the rocks are generally obscured by overburden. Rock outcrops are limited, being largely confined to creek ravines and mountain ridges. Despite this handicap, a fair degree of correlation of rock units can be achieved.

The problem of rock correlation is greatly facilitated by stereoscopic examination of the aerial photographs. Lineaments attributed to bedding or lithologic variations are prominent. The north-south trend of the rocks of the mine area, as well as the north-west trend of the Johnson Lake area are clearly visible in the photographs.

The results of Mr. Douglas' work and his interpretations are presented in a separate report. New cross sections of the ore bodies in the light of this season's diamond drilling programme are also presented in his report.

The interpretations of the geology, structure, ore controls, and the recommendations for further work presented herein are the responsibility of the writer. The ideas may be at variance with those entertained by other investigators in the past and again during the present field season. These ideas, however, are presented for the record, being based upon the writer's interpretations of the geological facts.

GENERAL GEOLOGY

Introductory Statement

The rocks of the Ecstall River Mine area consist of a highly metamorphosed complex believed to be originally dominantly sedimentary in origin. This complex is approximately 4 miles wide, has a dominant north-south strike, and is bounded to the east and west by granitic rocks of the Coast Range batholith. The sedimentary complex has been traced to the north as far as Red Gulch Ridge and to the south as far as Balan Creek. Although not examined, the complex extends both to the north and south of the map limits stated above.

This complex is regarded as a roof pendant in the coast range batholith. However, it may very well be considered to be a septa of sedimentary rocks extending to an unknown depth and bounded to the east and west by very large sill-like bodies of granitics belonging to the main coast range batholith.

Regional Geology

The rock formations of the area have been divided into two series: the Mine series, and the Johnson Lake series. This division is based upon lithological differences as well as structural reasons which will become evident in sections which follow.

A summary of the rock formations of both series is shown in Table 1. Descriptions of rock types are presented in Appendix A.

The division of the two series lies approximately along a line striking N 15°W through the junction of Johnson Creek and the Ecstall River (see Map 1.). The rocks to the west of this line contain the known massive sulphide deposits and are referred to as the Mine series. The rocks east of this line are called the Johnson Lake series.

TABLE I

SEDIMENTARY ROCKS

Mine Series:

Chlorite Schists
Quartz Chlorite Schists; gneissic; silty; quartzitic.
Quartzites
Argillite
Limestone
Arenaceous Limestone

Johnson Lake Series

Quartzites; massive; thin banded; argillaceous.
Greywackes
Argillite
Limestone (minor)

TABLE II

IGNEOUS ROCKS

Quartz diorite
Gabbro
Diorite
Hornblende
"Granite" Gneiss
Hornblende Lamprophyre
Biotite Porphyry
Hornblende Syenite
Pegmatites
Aplites.

The above complex has been intruded by a variety of igneous rocks generally basic in composition but ranging to more acidic types. These intrusions generally occur as a series of sill-like bodies parallel to the bedding planes of the sediments. A number of lamprophyre dykes cutting across the sediments are also present.

The igneous rocks observed and mapped in the area under discussion are shown in Table 2. Descriptions and discussion of the igneous rocks appear in Appendix B.

The complex has been highly metamorphosed imparting to the rocks a regional schistosity, foliation, or cleavage parallel to the original bedding. Secondary chlorite is abundantly developed throughout the complex and imparts to the rocks a dominant green colour of variable intensity. The dominant green colour has been responsible for the term "greenstones" which has been applied to the complex in the past. The term "greenstone" should be restricted to rocks of volcanic origin having a composition ranging from basaltic to andesitic. Rocks of definite volcanic origin (apart from the possibility of tuffaceous sediments) have not been observed in the area, and hence further use of the term "greenstone" as a rock unit in regional mapping is discouraged.

All of the rocks with the exception of the intrusives have a well banded appearance and include beds of obvious sedimentary origin such as quartzites, argillites, and limestones. Both the Johnson Lake and Mine series are therefore believed to be dominantly sedimentary rocks.

The distribution of the rock types is shown in Map 1. Rock units indicated are those actually observed. The dotted lines indicate the projection and correlation of the formations as inferred from the writer's observations and from examination of the lineaments appearing in the aerial photographs.

STRUCTURAL GEOLOGY

Regional Structure

Two general structural attitudes are dominant. The rocks of the Mine series have an overall north-south strike dipping steeply to the east. The rocks of the Johnson Lake series have a general northwest strike and dip steeply to the east.

The rocks of these two series also differ lithologically (See Table 1.). Varieties of chlorite schists with interbeds of quartzites, argillites, and limestones comprise the Mine series. On the other hand, the rocks of the Johnson Lake series are chiefly thin banded to massive quartzites, greywackes, and argillites. Of greatest significance is the fact that chlorite schists such as are found in the Mine series are absent in the Johnson Lake series.

Similarly intrusive hornblendite sills are absent in the former and abundant in the latter series.

A positive explanation of the two dominant structural attitudes is not available at present. The idea of a major fold with its apex pointing to the north and having a nearly vertical fold axis is suggested but is not borne out by geological facts. Indeed, there is some evidence to support such a fold. In Garnet Creek thin banded quartzites extend up to 800' elevation at which point an argillite horizon is encountered. Both the quartzites and argillites have a northerly strike and steep eastern dip. Small drag folds are numerous in the quartzites, plunge 85°to the south, and drag folded beds are offset from East to West proceeding to the south.

At 1000' el. an argillite horizon strikes NNW, and dips steeply to the NE. Drag folds in the quartzites above the argillite plunge 85° to the north and indicate an opposite direction sense of movement to the drag folds of lower elevations.

It would follow then from considerations of the abrupt change of attitude and drag folds that a major fold may exist here with the apex of the fold pointing to the north, having an axial plane striking about N 15° W and dipping steeply to the east.

A projection of the theoretical axial plane to the north cuts across the east plateau. However, mapping of this plateau has failed to indicate that such a fold is present.

If such a major fold existed, then the chlorite schists of the Mine series which appear 1000' west of the axial plane should be repeated to the east. However, quartzites, "greywacke" schists, and associated intrusive hornblendites continue for a thickness of 7000' to the east and chlorite schists are entirely absent.

The possibility of a major fold thus appears untenable.

Mapping by Lowrie and Webster on the east plateau showed the presence of a zone of shearing accompanied by gouge along an argillite horizon at 2600' elevation. Drag folding of beds, and differences of strike by as much as 20° were observed on either side of the shear. However, the continuation of such a shear has not been observed in Garnet Creek where continuous outcrops occur. Furthermore, the general attitudes of the formations on either side of the observed shear on the east plateau are parallel. It seems then that a shear zone by itself cannot account for the two general attitudes of the Mine and Johnson Lake series.

Consideration of the outcrops of quartzites on Red Gulch ridge and the east plateau indicates a general attitude of N 15° W.

The "greywacke" schists of Red Gulch ridge strike N 10-15° W and are correlated with the "greywacke" schists of Johnson Lake area where they strike N 45° W. There thus appears to be a gentle swing from north to northwest. This trend, however, is not present in the mine series where the general strike is north-south.

A primary sedimentary process may account for the discrepancy between the attitudes of the two series. The sediments of the Mine series may have originally been deposited in a sedimentary basin yielding the argillites, limestones, quartzites, and chlorite schists which are probably metamorphosed equivalents of impure shales. Subsequent tilting of this basin with continued deposition resulted in the Johnson Lake sediments being deposited at varying angles relative to the Mine series. Later tilting associated with the intrusions of the coast range batholith accounted for the present nearly vertical attitudes of the two series.

The regional structure seems to resolve to two series of sediments each of which consists of a conformable succession of sedimentary rocks. The lithological differences between the two series as emphasized above add support to such a structural interpretation. The conformable succession of each of the series is indicated by the general regional strike of the sediments, the continuation of individual formations along strike, as well as the non repetition of strata which would occur if any isoclinal folding were present.

Folds: With the exception of a possible major fold mentioned above, folding is almost entirely restricted to minor drag folds. That folding is of minor importance is indicated by the extension of individual formations along strike as well as the lack of any evidence in the aerial photographs where structural lineaments are pronounced in a N-S direction in the Mine series and a N-W direction of the Johnson Lake series.

A fairly large open fold, having a vertical axial plane and axis plunging 70° to the north, has been observed on the ridge south of Johnson Lake. The southern extensions of the folded beds have not been examined but it appeared from distant field observations that the quartzite beds which are folded to the east, swing, and again continue to the S.E.

Minor drag folding where beds have been offset by as much as ten feet but more commonly by several feet or less are most common in the thin banded quartzites. Drag folding is usually more prominent near intrusive masses and occasionally along shear zones. Dragfolds observed in the mine area generally plunge 60-70° to the south. Most of the drag folds of the Johnson Lake series plunge steeply to the north.

Opposing movement directions have been observed on drag folds going across strike of the sediments. However, it was not possible to correlate these drag folds to a regional structure such as isoclinal folding. As mentioned above, the continuation of formations along strike, the difference of lithology across strike, and the non repetition of strata preclude the possibility of isoclinal folding. The area has, however, a superficial resemblance to regions having undergone isoclinal folding.

Shear Zones:

Superimposed upon the regional schistosity and cleavage are zones of fissile, sericitic schists, zones of highly foliated chlorite schists, or a combination of both. These zones are interpreted, as well as have been in the past by other investigators, to be shear zones.

Disseminated pyrite normally occurs in the shears in amounts generally less than 1-2%. Pale green mariposite (a chromium enriched variety of the white mica, muscovite) is frequently present and locally imparts a greenish tinge to the rocks somewhat resembling copper stain. The sericite and mariposite are believed to be hydrothermal alterations of pre-existing rocks.

The shear zones vary from several feet to more than a hundred feet in width. Of notable widths are the Red Gulch, Allaire Ridge, and Red Bluff shear zones where outcrops in excess of 100' widths have been observed. The shear zones are fairly resistant zones and often stand up in relief relative to the adjoining rock.

The notable characteristic of the shear zones is their common localization along argillite horizons. Thus the shear zones of Red Gulch Creek, the 3'd outcrop shear, Allaire Creek shear, 6 shear zones observed in Allaire Creek, and others are localized along argilite horizons. The shears may be within, near, or along the walls of the argillite beds. It would appear that the argillites have been a relatively weak member of the rocks during deformation and have served as a locus of shearing.

The shear zones, however, are not entirely nor necessarily restricted to argillite horizons. Notable exceptions are the Red Bluff shear, Swinnerton Creek shear and its counterpart south of the Bostell River and the northern extension of Red Gulch shear.

It has not been possible to determine the amount of displacement along the shear zones because of the general parallelism between the shear zones and bedding of the sediments. Distinctive horizon markers to indicate the relative displacement are therefore lacking.

It is felt that the displacement has not been very great. Shear zones often become weaker along strike. For instance, the Red Gulch shear can be traced along its northern extension to the west plateau to 2600' el. Widths up to 100' or more outcrop along its extension whereas at 2600' el. the shear is resolved into two zones of sericitic schist 5' and 1' wide. Similarly, the Red Bluff shear cannot be traced along the east plateau; however, overburden obscures most of the rocks in this area. The 3'd outcrop shear also appears to weaken progressing northward.

All striations along Red Gulch shear in the mine vicinity plunge steeply to the south. Striations in the Allaire Creek shear are vertical or plunge steeply to the north. There is some evidence such as dragfolds and slickensided surfaces that the hanging wall has moved up relative to the footwall on the Allaire Creek and Red Gulch shears. These striations, however, may reflect only the most recent movements.

It may be stated at this point, and this will become evident from discussion of the North lens shear, that the shear zone may not be continuous with depth. If such is the case, then the shear zones may have more of the nature of dilation rather than componental movement.

MINERAL OCCURRENCES

Westall River Mine

Local Geology of Mine Area

The lithology, rock distribution, and structure of the immediate mine area is summarized in map #2. From examination of this map it is evident that the rocks consist of a conformable succession of sediments striking north to south and dipping steeply to the east. An ideal cross section of the rocks is shown in Figure 1.

The north and south pyrite lenses are localized along shear zones which extend along a competent horizon of quartzites and thin bedded quartz chlorite schists (which are interbedded with narrow beds of quartzite). Less competent chlorite schists occur to the east and west of this horizon. This competent formation is referred to as the "Mine formation", for convenience.

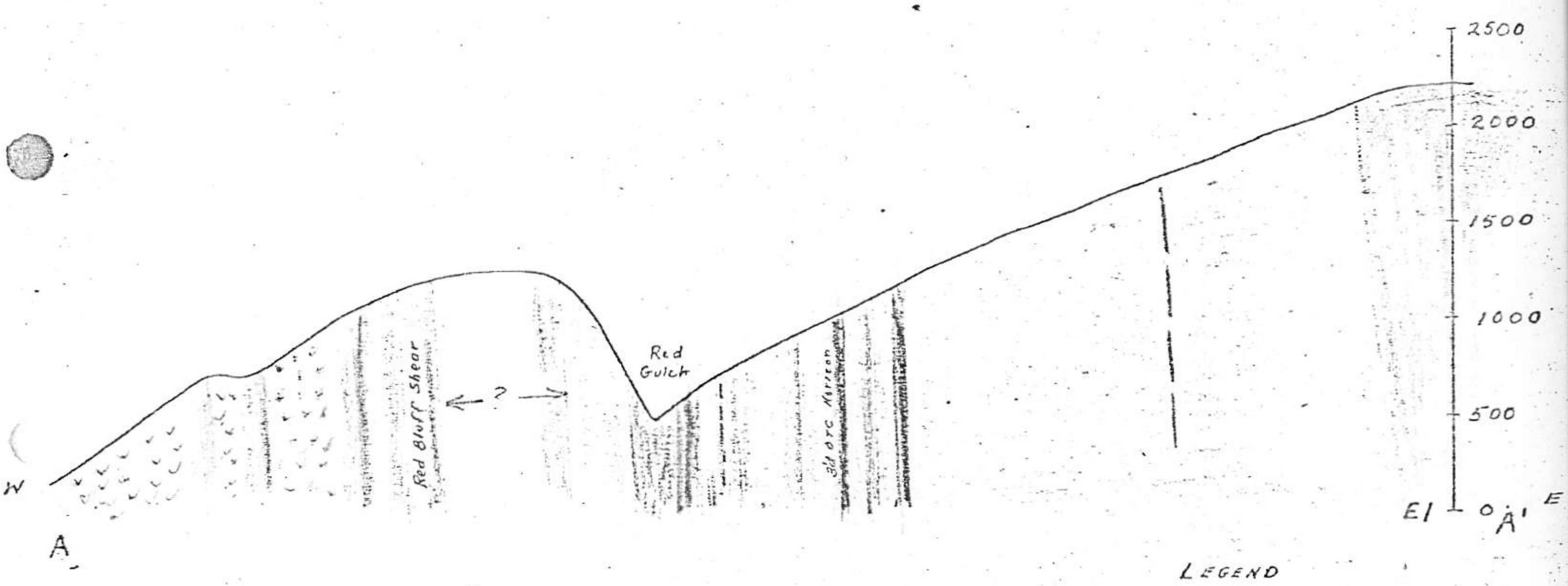
A body of "granite" gneiss extends along the hanging wall side of the pyrite lenses and can be traced along the eastern slope of Red Gulch creek from near the mine campsite to a point 300' north of the north lens. The "granite" gneiss does not outcrop along the same horizon north of this position. However, several feet of the gneiss were observed along the same horizon in the core of Granby D.D.H. #22 about 500' north of the north lens.

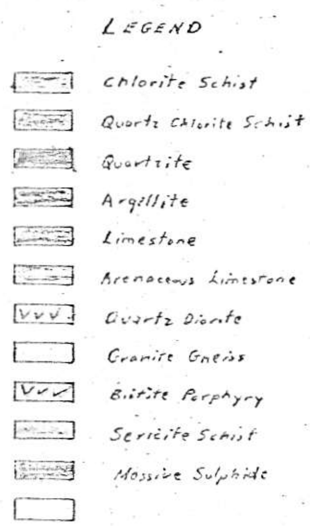
The shear zones of the north and south lens appear to coalesce in the vicinity of the north lens on the surface. A continuation of this shear zone can be traced by occasional outcrops along the western slopes of Red Gulch Creek to the West plateau.

The 3'd outcrop pyrite body occurs along a shear zone which in turn localized near the footwall of an argillite horizon and cuts through quartzitic like quartz chlorite schists. This argillite horizon and associated zones of sericite schist extend south along the eastern slope of Red Gulch Creek and are approximately 1250' stratigraphically above and east of the Mine formation. This shear can be traced by occasional outcrops to the north as far as Red Gulch Ridge. The argillite horizon thins out to the north, is not present in Red Gulch Creek, but is occasionally observed on the hanging wall side of the shear towards Red Gulch ridge.

A massif of granite gneiss occurs approximately 100' west of the 3'd outcrop pyrite body and extends to the north for about 750' along Red Gulch Creek. This body is some 100' wide, immediately below the 3'd outcrop but swells rapidly to the west proceeding northward attaining widths up to 750'. As reference to Map #2 shows, the body is of irregular shape in comparison to the tabular north-south formations observed elsewhere in the area

FIGURE 1





IDEAL CROSS SECTION ACROSS

RED GULCH CREEK

Scale: 1" = 1000 ft.

and appears to be an intrusive mass which transects the north striking sediments. The contact of the "granite" gneiss with the quartz chlorite schists along Red Gulch creek is sharp and distinct. Intrusive relationships with irregular apophyses of the gneiss extending into the chlorite schists are observed in one of the creeks at the western contact. The unusual shape of the massif, the granitic texture of the rock, and some evidence of intrusive relationships attest to an igneous origin of the gneiss.

North and South Lenses

Two massive pyrite deposits, referred to as the north and south lenses, form the main ore bodies of the Bostall River mine. The surface outcrops of these orebodies are shown in Map #2, and relationships underground in Map #3. Plans, vertical sections, and descriptions of the ore bodies will be treated in more detail in a report being prepared by H. Douglas.

The two orebodies are of the replacement type occurring along shear zones which are nearly parallel and separated by a distance of 50' or less. The south lens is tabular in shape, being approximately 1300 feet long, varying in widths up to 49 ft. and extending an unknown distance in depth. Diamond drilling up to the present time has indicated a vertical extent as much as 1125' below the surface outcrops.

The north lens is lenticular in shape with a pronounced swelling at its northern extension. The lens can be traced for 950' on the surface and has a maximum depth of approximately 750' below the surface outcrop.

An outcrop of massive pyrite up to 5' wide and 20' long is exposed on the steep slope 150' east of Red Gulch Creek 200' below the falls. D.D.H. 36 drilled underground to explore the downward continuation of this zone showed only a shear zone containing disseminated pyrite.

About 10 inches of massive pyrite is exposed in a surface trench on the west slope of Red Gulch Creek about 300' north of the mine campsite. Widths up to 10 inches of massive pyrite have been observed underground (at the bend of the main haulage drift) at the downward projection of the surface outcrop. Diamond drilling indicates a weakening of this mineralization to the south.

The massive pyrite deposits are of the replacement type occurring in shear zones and presumably have more or less completely replaced the sericite schists. The pyrite is generally fine to medium grained, massive, and very uniform in texture. Minor amounts of sphalerite, and occasionally chalcopyrite are associated minerals.

Inclusions of unreplaced rock are rare being most common near the walls of the orebody. The inclusions where observed consist essentially of highly fissile sericite schist and are believed to be unreplaced portions of the sericitic schists of the shear zones. The walls are generally fairly sharply defined and gouge is absent.

Pseudomorphs of original foliation are occasionally prominent in the massive pyrite and especially so in the surface exposures of the north lens. This foliation is exhibited by somewhat coarser grained pyrite, a higher proportion of gangue (quartz) along narrow zones, or by more highly pitted or eroded planes accentuated on the weathered surface.

Shear Zones of Red Gulch Creek

This section is devoted to more detailed discussions of the shear zones appearing in Red Gulch Creek. It is felt that the nature of the shears is important in the understanding of the occurrence as well as the shape of both the north and south lenses.

It may be said at the outset that these shear zones are not a simple zone of shearing but consist of 4 separate shears which appear in different horizons and which appear to, or do die out along their north and south extremities. There is also some evidence to suggest that the north lens shear may have been originally a subsidiary of the south lens shear coalescing at a position near to, but above, the present erosion surface of Red Gulch Creek.

The south lens shear zone first outcrops several hundred feet north of the caved in adit 300' north of the mine campsite. The shear zone, consisting of fissile sericite schist, follows an argillite horizon several feet wide, which can be traced as far north as the old Dunsmuir Tunnel. The argillite does not reappear to the north but the shear zone, however, continues northward and crosses Red Gulch Creek below the falls.

The shear zone of the north lens first appears on the surface as a narrow zone of sericite schist tapering to the south at a point 200' below the falls and about 15' east of the south lens shear (c.f. underground distance of 50 feet separating the two shears). The north lens shear parallels the south shear and both extend under the overburden to the north and west of the falls. A thin argillite bed less than 1' in width again extends on the hanging wall side of the north shear for 150'.

Two zones of sericite schist outcrop in the creek 150' north of the falls and are correlated with the north and south shears. Outcrops are again obscured by overburden. In the vicinity of the north lens sericitic schists form the hanging wall and foot wall of the pyrite body, and are believed to be surface expressions of the south and north shear.

The sericite schists on the hanging wall are dragfolded with offsets to the west proceeding northward. The pyrite body extends across the creek and presumably the sericite schists which have been completely replaced by pyrite have originally extended in this direction. The north lens shows a pronounced tapering across the creek and narrows to several feet which continues northward and was last seen extending into a sheer bluff. The sericite schists become more prominent at the northern extension of the north lens. The area north of this bluff is largely obscured by overburden. The shear zone, however, can be traced by occasional outcrops appearing in creek bottoms up to 2600' el. on the west plateau. At this point the shear has narrowed to two zones of 5' and 1' widths. A continuation of the shear zone has not been observed north of this position and it appears that the shear zone becomes weaker and finally non-existent to the north.

In the underground workings (see Map #3) the south lens shear is first observed in No. 1 X-cut. It follows a general northerly course with gentle undulations and is last seen at No. 6 X-cut where it swings to the west of the main drift. It is significant that the south shear shows no weakening to the north. It is, however, at this point composed essentially of highly crenulated chlorite and sericite is minor or absent. Several weak minor shears tapering to the north are present along the main drift and appear to be subsidiary branches of the main south shear. The south shear appears to become weaker in the area south of No. 1 X-cut as indicated by diamond drilling in that area.

The north lens shear is first observed in No. 3 X-cut. Sericite schist is very minor at this point and presumably the pyrite body which is 2' wide at this position has almost completely replaced the original sericite schist. Similarly the sericite schists at the ore walls in other X-cuts are very minor. Inclusions observed within the massive pyrite of No. 6 X-cut consist of sericite schist. The sericite is more prominent in D.D.H.'s #15 and #25.

It is significant that the north lens is about 50' east of the south lens underground whereas the two are considerably closer on the surface as well as straddling the surface outcrop of the north lens. Of greater significance is the fact that no shear zone whatsoever occurs in Nos. 1 and 2 X-cuts, and D.D.H. #36 at the position of the southward projection of the north shear.

Again the north shear has not been observed in D.D.H's #24 and #26 at its northward projection. Similarly the shear has not been detected in D.D.H's 51, 52 and 53 drilled to intersect the downward projection of the north lens about 300' below the adit level.

In view of this the north lens shear appears to be a lens shaped zone having a diameter of approximately 1000' with its upper surface extending above the present erosion surface of Red Gulch Creek. There is also some evidence to indicate that the north shear may have been a subsidiary of the south shear, the two coalescing above the present erosion surface.

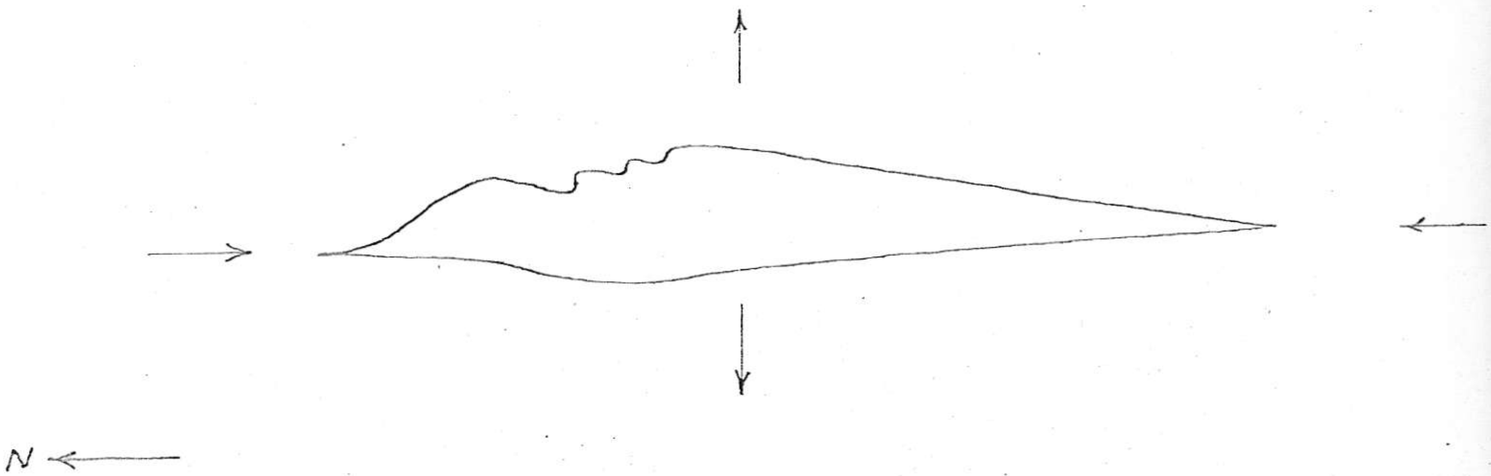
It also appears that no great displacement has taken place along the north shear but rather the movement has been one of dilation in which the walls have been pushed outward both to the east and west as appearing in Fig. 2. Such a dilationary movement may account for the large drag folds seen on the east wall of the north lens.

The north, south, and downward continuation of the north pyrite lens is primarily dependent upon the continuation of the shear zone rather than being a function of the drag folds. The shear zone becomes non-existent in these directions and this is attended by the non continuance of the pyrite body. The drag folds are important, however, in determining the shape of the ore body.

A third zone of sericite schist occurs 150' east of Red Gulch Creek. This shear, which is parallel to the sediments, can be traced on the east slope from a point 300' south of the Dunsmuir tunnel to a position due east of the falls. It follows an argillite horizon for 500' in the southern end. The shear zone narrows and pinches out at some position on the inaccessible bluffs east of the falls and is not observed 200' to the north where continuous outcrops exist. A lenticular body of pyrite up to 5' wide and 20' long outcrops in this shear east of the falls. "Granite" gneiss, highly altered by seconardy quartz, forms the footwall of this shear zone along a portion of its exposed length. The shear zone is observed in D.D.H. #36 but contains only disseminated pyrite.

A zone of sericite schist is observed on the west slope of Red Gulch creek in a trench occurring alongside a foot trail 300' north of the old caved in adit. Extensions of this shear are obscured by overburden to the north and south. This shear is correlated to that occurring at the bend of the main drift underground south and east of No. 1 X-cut. The shear zone narrows down to non-existence in its northward extension underground and weakens to the south from drill core observations.

FIG. 2



TYPE of DILATIONARY MOVEMENT THAT MAY ACCOUNT FOR THE NORTH SHEAR.

Underground Geology:

The geology and structure of the underground workings are shown in Map #3. The main haulage drift extends largely along strike of the sediments. The crosscuts as well as the S.W. portion of the main drift cut across the strike of the rocks and yield a stratigraphic cross section about 850' wide. The geology of the flat drill holes has also been plotted to give additional information of the rock structure.

Lithologic units are similar to those observed on the surface. A relatively competent horizon approximately 480' wide strikes in a northerly direction and is bounded to the east and west by less competent chlorite schists.

The competent horizon consists of the following rocks progressing from west to east: massive grey quartzites, quartzitic like quartz chlorite schists, thin bedded quartz chlorite schists (which consist of quartzites up to 2' wide but generally several inches or less in width interbedded with quartz chlorite schist), and a quartz chlorite gneiss containing variable amounts of hornblende or biotite. Argillite has been observed in No. 1 X-cut and in drill holes to the south. Sill-like bodies of "granite" gneiss occur to the east.

The massive grey quartzites form the best horizon marker. They first appear at the bend of the main drift (survey station A6) and in No. 1 X-cut. They extend more or less parallel to the main drift to the north as far as No. 5 X-cut. The beds are lenticular along strike. Although gentle undulations are present where beds are offset from an arbitrary planar horizon by as much as 15 feet, the sediments continue along strike in a northerly direction. No major folding is present or indicated. Minor dragfolds with offsets of several feet are, however, present.

A formation up to 100' wide of the thin bedded quartz chlorite schists occurs to the east of the grey massive quartzites in Nos. 4, 5, and 6 X-cuts. The same formation occurs in Nos. 1, 2, and 3 X-cuts on the hanging wall side of the south pyrite body in widths varying from 30-50'.

The south lens shear reflects the undulation of the massive grey quartzites and apparently has been localized in the thin bedded quartz chlorite schist formation adjacent to the massive grey quartzites. The shear had been subsequently largely replaced by massive pyrite.

The thin bedded quartz chlorite schist formation is gradational to the east into a green quartz chlorite gneiss. Biotite and hornblende in variable amounts is abundant in this rock. The gneiss is observed in the eastern extremities of most cross-cuts. The rock, although having a gneissic texture is distinct from the brown "granite" gneiss which is discussed below.

The north pyrite lens has been formed in a shear zone which appears to be localized at or near the gradational contact of the thin bedded and the gneissic quartz chlorite schists. This contact is gradational and it is difficult to decide to which unit the rocks adjacent to the north lens belong. Granite gneiss occurs at the face of No. 1 X-cut and in narrow sill-like bodies in Nos. 4 and 6 X-cuts. In No. 6 X-cut the gneiss has somewhat of an intrusive relationship in that it has irregular apophyses and also transects the foliation at a small angle. The gneiss also occurs in the longer diamond drill holes to the east in a number of sill-like bodies.

With the exception of the parallel north and south shear zones there are no major faults in the underground workings. There is, therefore, no indication of possible dislocated ore-bodies.

Minor displacement to several feet has occurred along joints (minor faults) having a northerly strike and 30-40° dip to the west. The hanging wall has moved up and to the west relative to the footwall along the joints.

<u>Ore Controls</u>:

The following factors appear to be important in the localization of ore and are discussed briefly below:

1. Shear zones
2. Competent rocks
3. "Granite" gneiss
4. Undulations and drag folds
5. Argillite.

1. The massive pyrite bodies occur as replacement deposits along zones of sericite schist which are interpreted to be shear zones. Other shear zones are numerous in the area but contain only disseminated pyrite in amounts generally from 1-2%. The pinching out of the north lens is a consequence of the pinching out of the shear zone.

2. The north and south lenses occur in shear zones localized along competent rocks consisting of quartzites and thin bedded quartz chlorite schists. This competent formation is bounded to the east and west by less competent chlorite schists.

The third outcrop occurs in a shear which passes through a competent quartzite like quartz chlorite schist. This formation is bounded to the east by argillite and less competent chlorite schist and to the west by "granite" gneiss.

Massive pyrite has not been observed along the numerous shear zones passing through the incompetent chlorite schists observed elsewhere in the area

3. "Granite" gneiss extends along the hanging wall side of the north and south lenses, and an irregular massif of the gneiss occurs near the footwall side of the 3'd outcrop. It is significant that this rock has not been observed elsewhere along the same horizon and with one exception has not been observed elsewhere in the area. It seems that the association of the granite gneiss with the massive pyrite may be an important control rather than being fortuitous.

This of course does not imply that mineralizing solutions have been derived from these intrusive masses. Indeed, the theory that mineralizing solutions are derived by fractional differentiation of nearby granitic masses is not one to which the writer subscribes. Intrusive masses, however, very often appear to have the role of purveyors of heat, thus enabling mineralizing solutions to ascend from depth.

"Granite" gneiss similar in appearance to the aforementioned occurrences was observed only in the vicinity of Phoebe Creek on the S.W. plateau where it occurs in sill-like bodies up to 500' wide. The gneiss in this area is not unlike the nearby granitics of the main batholithic masses extending to the west. The granitics become more gneissic near the contact of the sedimentary complex throughout the area. Again massive sulphides in the form of pyrite, pyrrhotite, and chalcopyrite were observed in this area in two stringers 4" and 3" wide.

Similarly several small stringers of massive pyrite were seen in joints in quartzites south of Johnson Lake near the main granite contact. The "Frizzell outcrop" of Hanna valley which is discussed in detail in succeeding sections also occurs near the granitic contact.

4. Undulations in the shear zone appear to be an important control in the formation of the deposits. Attention is drawn to the undulations of the quartzites underground and the reflection of the south lens of these undulations. The greatest offset of the beds underground occurs at No. 2 X-cut (see Map #3). The importance of the undulations at this point is indicated by the greatest width of the south lens pyrite body. Again, the large drag folds on the surface mark the north-east limit of the north lens.

These undulations and drag folds cannot be considered to be the only ore control as dragfolds and undulations are present along other shear zones where massive pyrite is entirely lacking.

They appear to be, however, one of the main controls in the localizing and determining of the shape of the orebodies.

5. The role of the argillites in the localization of the massive pyrite bodies appears to be important only in that they serve as loci for shear zones. As discussed hitherto the shear zones are generally associated with argillite beds. The argillites have served as incompetent horizons susceptible to shearing during orogenic disturbances.

The argillites themselves, as seen underground, in drill holes, and on the surface, do not seem to be a favourable rock for replacement and form well defined contacts with the massive pyrite. Although several percent of disseminated pyrite in the argillites is invariably the rule, greater amounts of massive pyrite have not been observed.

There is no indication that limestone, which is a frequent sedimentary associate of argillite, has served as a host rock amenable to replacement. Calcite is abundant as an accessory gangue mineral in the massive sulphide of D.D.H. #57. However the calcite may very well be an introduced gangue rather than being residuals of original limestone. Limestone as such has not been observed anywhere in association with the massive pyrite.

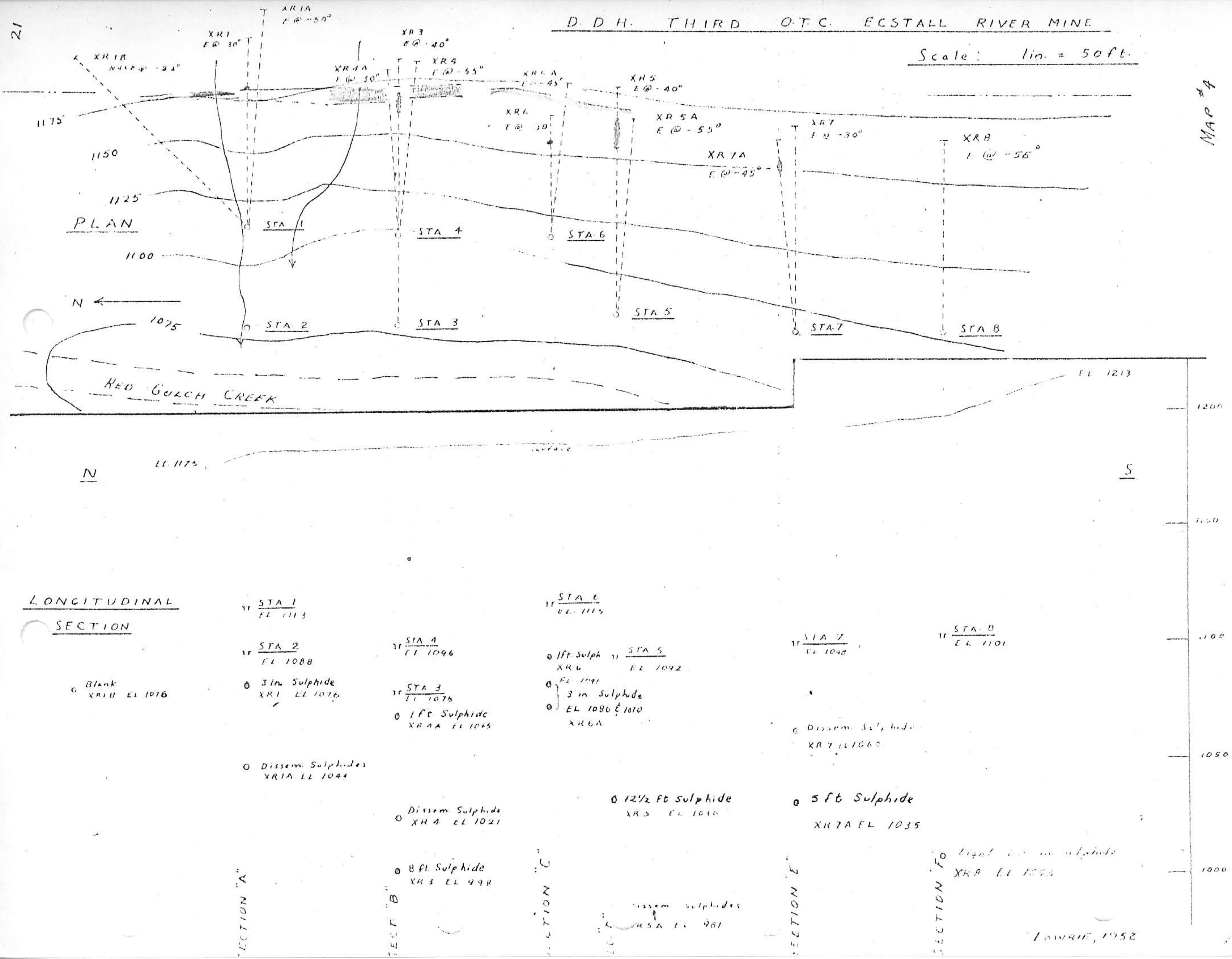
To summarize - the known ore deposits of economic interest occur as replacements of shear zones which are commonly localized along argillite horizons. Although sericite schists and associated disseminated pyrite are developed in all rock types, the ore bodies are restricted in occurrence to competent quartzitic rocks. "granite" gneiss has been observed near the pyrite bodies, and it seems that the relationship cannot be merely fortuitous. Undulations and drag folds are important in localizing and determining the shape of the orebodies.

Third Outcrop

The outcrops of massive pyrite referred to as the "3'd outcrop" occur on the steep slope about 150' east of Red Gulch Creek 2500' north of the north lens pyrite body. Several outcrops of massive pyrite from 5' to 7' wide occur along a length of 110' on the surface. The deposit is a replacement of a shear zone which is in turn localized near the footwall of an argillite horizon 1250' stratigraphically east of the north and south shears.

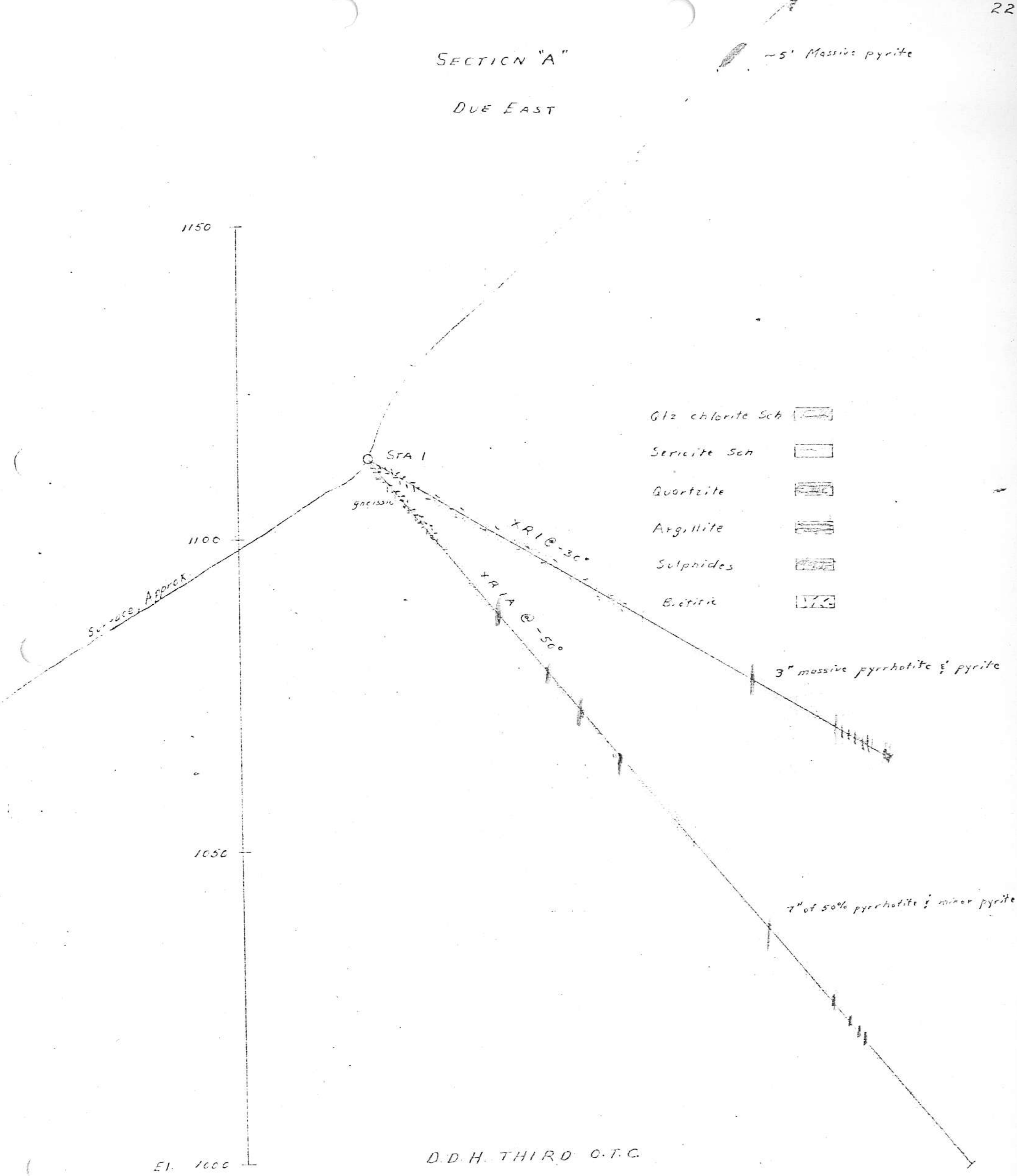
The pyrite body thins out to the north. The shear zone, however, continues and can be traced to the top of Red Gulch ridge. Widths up to 3 inches of massive pyrite occur along the shear zone at the point where the shear crosses Red Gulch creek. Overburden obscures the southward continuation of the pyrite lens.

A plan and vertical sections of the 3rd outcrop are shown in Map #4 and Figures 3-9.


D.D.H. THIRD O.T.C. ECSTALL RIVER MINE
Scale: 1in. = 50 ft.
MAP #4
XR 1A E @ -50°
XR 1 E @ 30°
XR 1B
XR 3 E @ -40°
XR 4A E @ 30°
XR 4 E @ -55°
XR 6A E @ -45°
XR 5 E @ -40°
XR 6 E @ 30°
XR 5A E @ -55°
XR 7 E @ -30°
XR 7A E @ -45°
XR 8 E @ -56°
1175
1150
1125
1100
1075
PLAN
STA 1
STA 4
STA 6
STA 2
STA 3
STA 5
STA 7
STA 8
N
RED GULCH CREEK
EL 1213
1200
EL 1175
N
S
1150
1100
1050
1000
LONGITUDINAL SECTION
STA 1 EL 1113
STA 6 EL 1115
STA 2 EL 1088
STA 4 EL 1096
1ft Sulph XR 6
STA 5 EL 1092
STA 7 EL 1098
STA 8 EL 1101
Blank XR 1B EL 1076
3 in. Sulphide XR 1 EL 1076
STA 3 EL 1078
3 in Sulphide EL 1090 & 1010 XR 6A
1 ft Sulphide XR 4A EL 1065
Dissem. Sulphides XR 1A EL 1044
12½ ft Sulphide XR 5 EL 1030
5 ft Sulphide XR 7A EL 1035
Dissem. Sulphide XR 4 EL 1021
8 ft. Sulphide XR 3 EL 998
SECTION "A"
SECT "B"
SECTION "C"
SECTION "E"
SECTION "F"
LOWRIE, 1952

SECTION "A"

DUE EAST



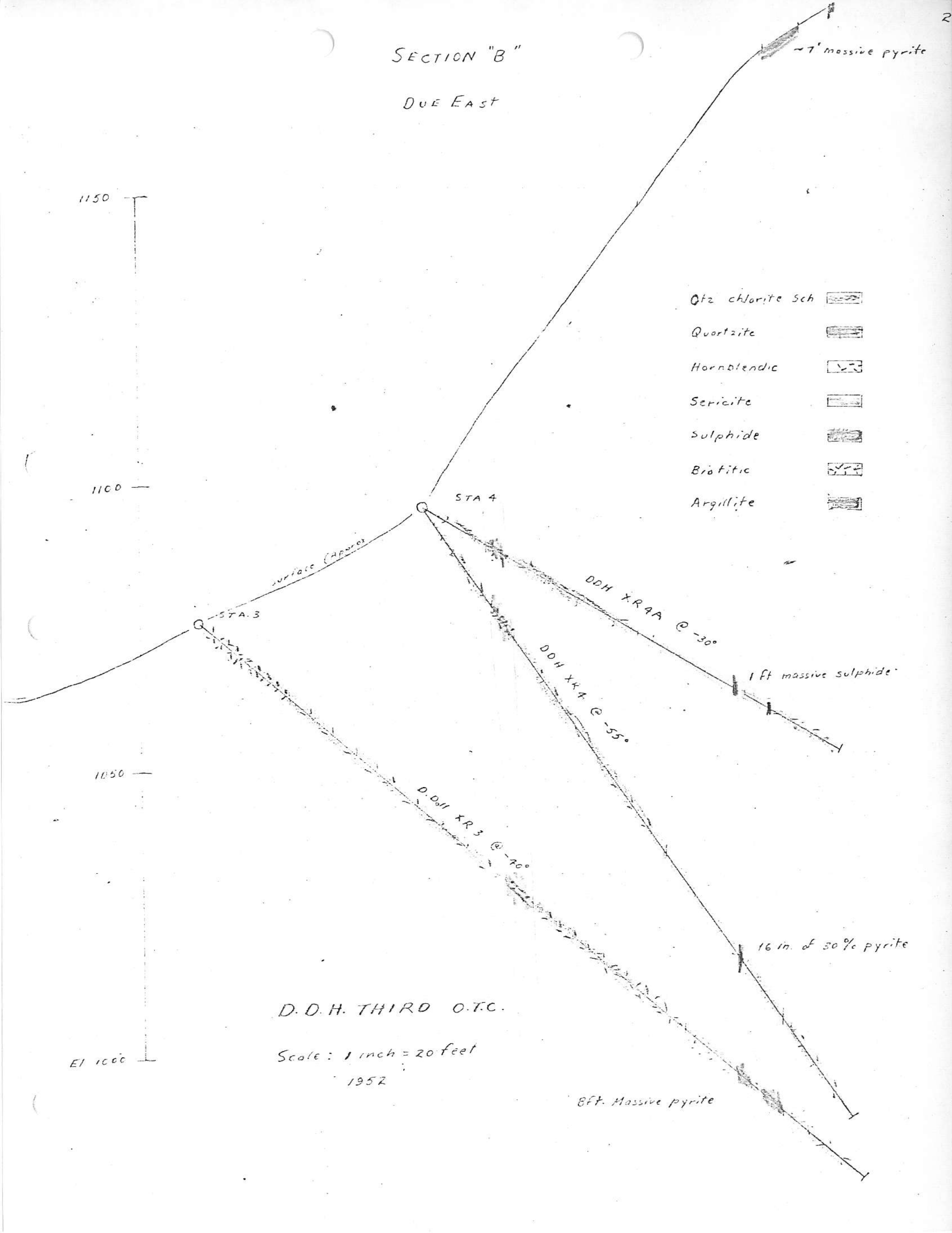
D.D.H. THIRD O.T.C.

Scale: 1" = 20 feet

1952

SECTION "B"

DUE EAST



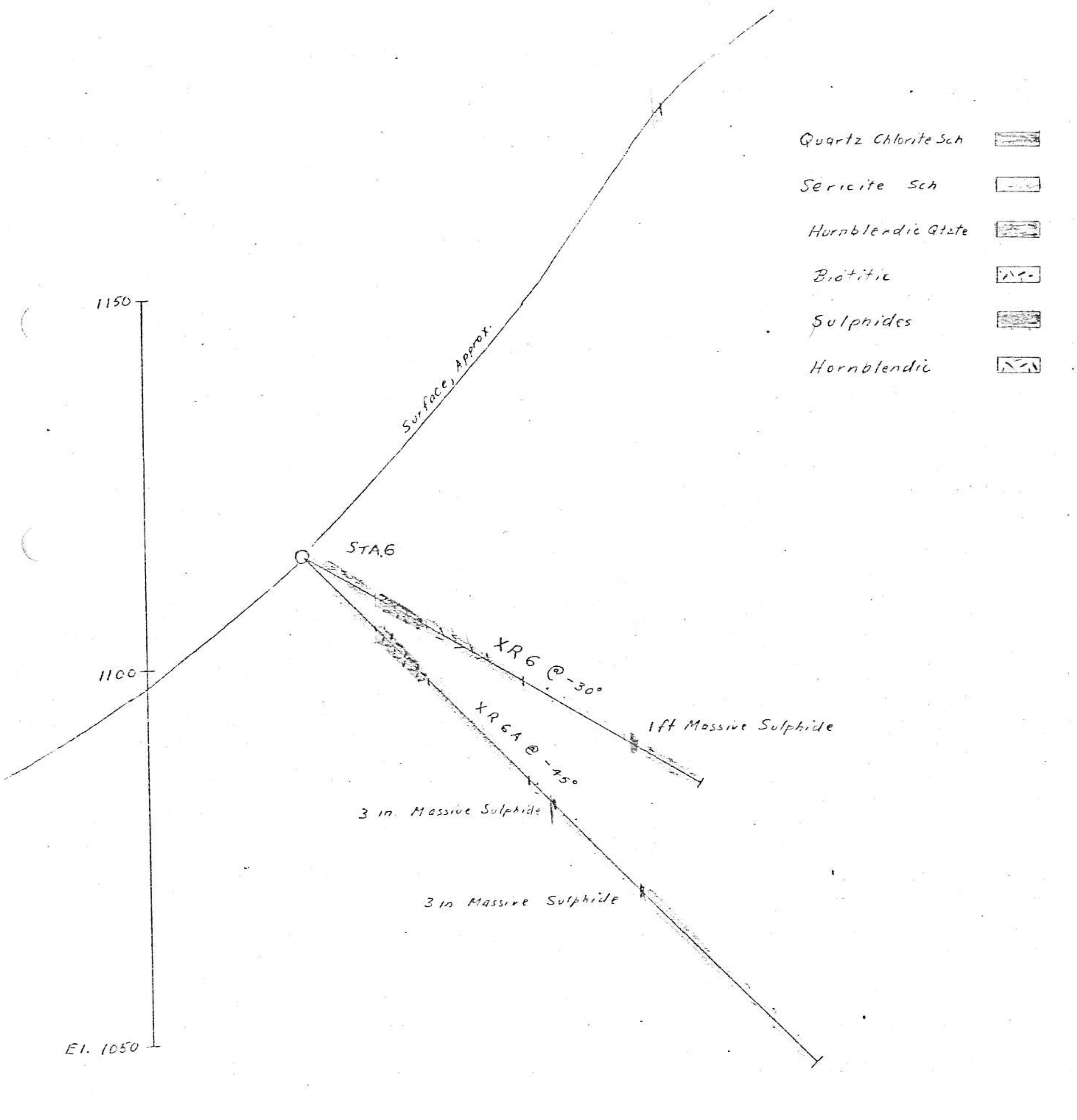
D.D.H. THIRD O.T.C.

Scale: 1 inch = 20 feet

1952

SECTION "C"

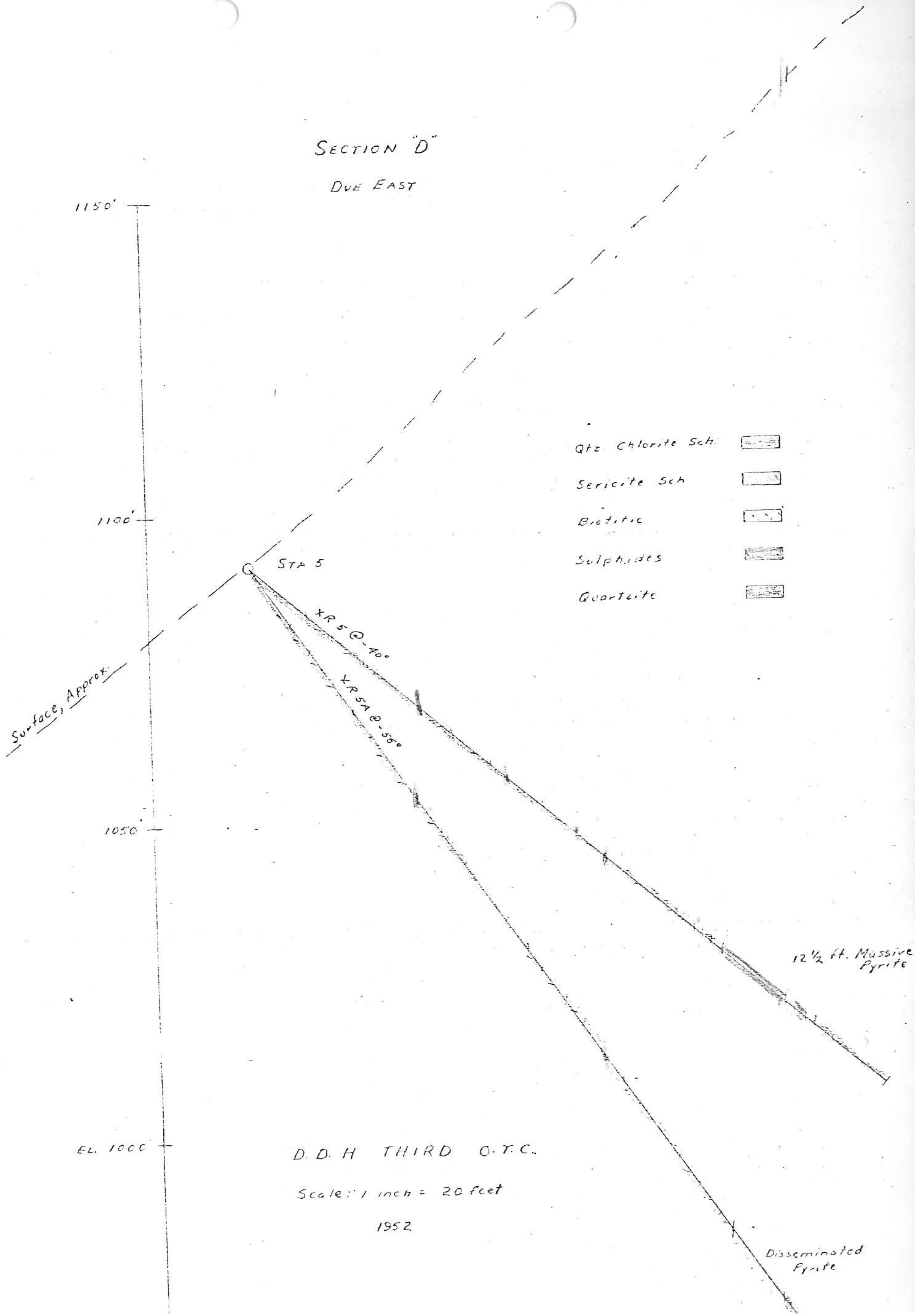
DUE EAST

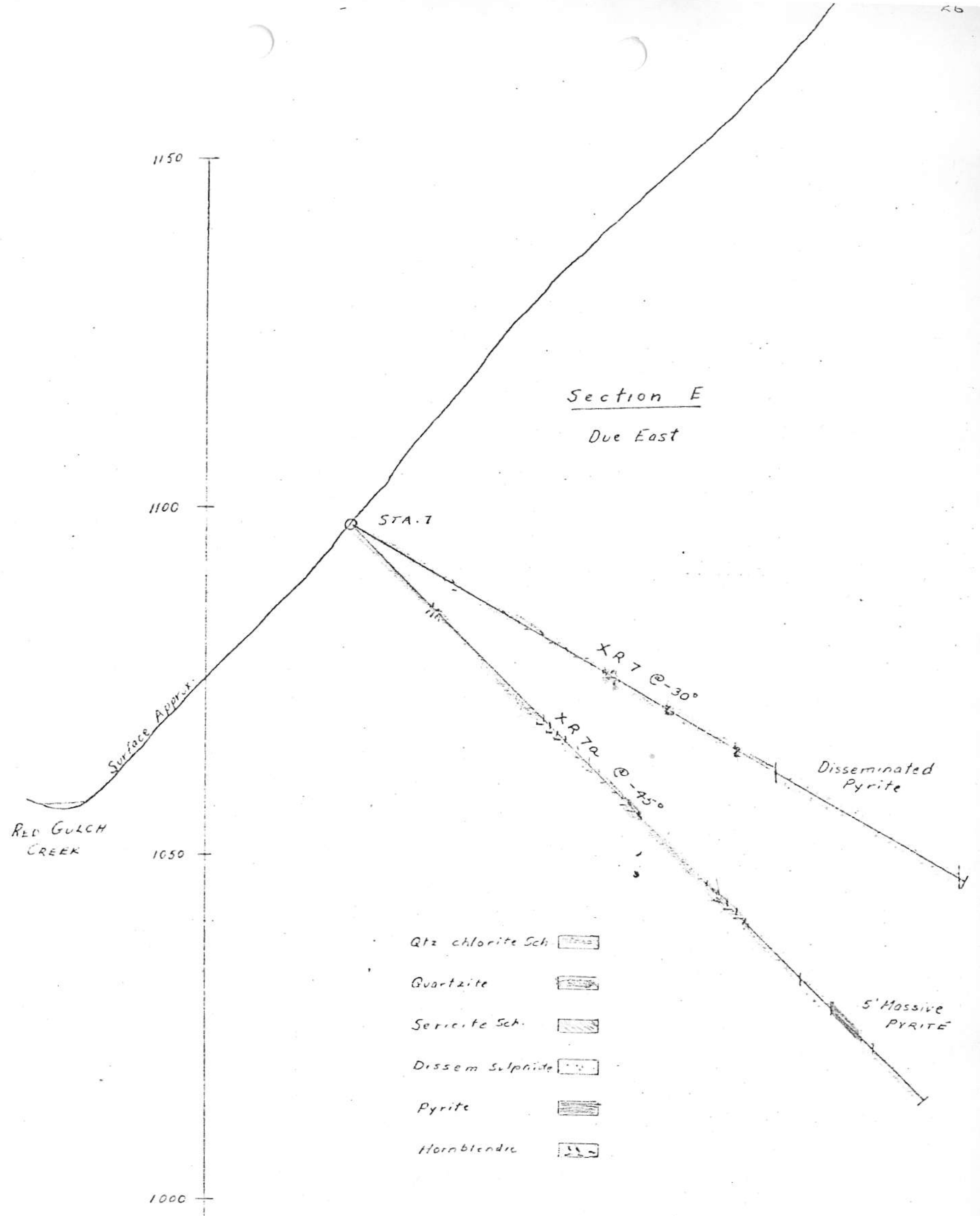


D. D. H. THIRD O.T. C

Scale : 1" = 20 feet

1952


SECTION "D"
DUE EAST
1150'
1100'
1050'
EL. 1000
STA 5
Surface, Approx.
XR 5 @ -40°
XR 5A @ -55°
Qtz Chlorite Sch.
Sericite Sch
Biotitic
Sulphides
Quartzite
12½ ft. Massive Pyrite
Disseminated Pyrite
D. D. H THIRD O.T.C.
Scale: 1 inch = 20 feet
1952



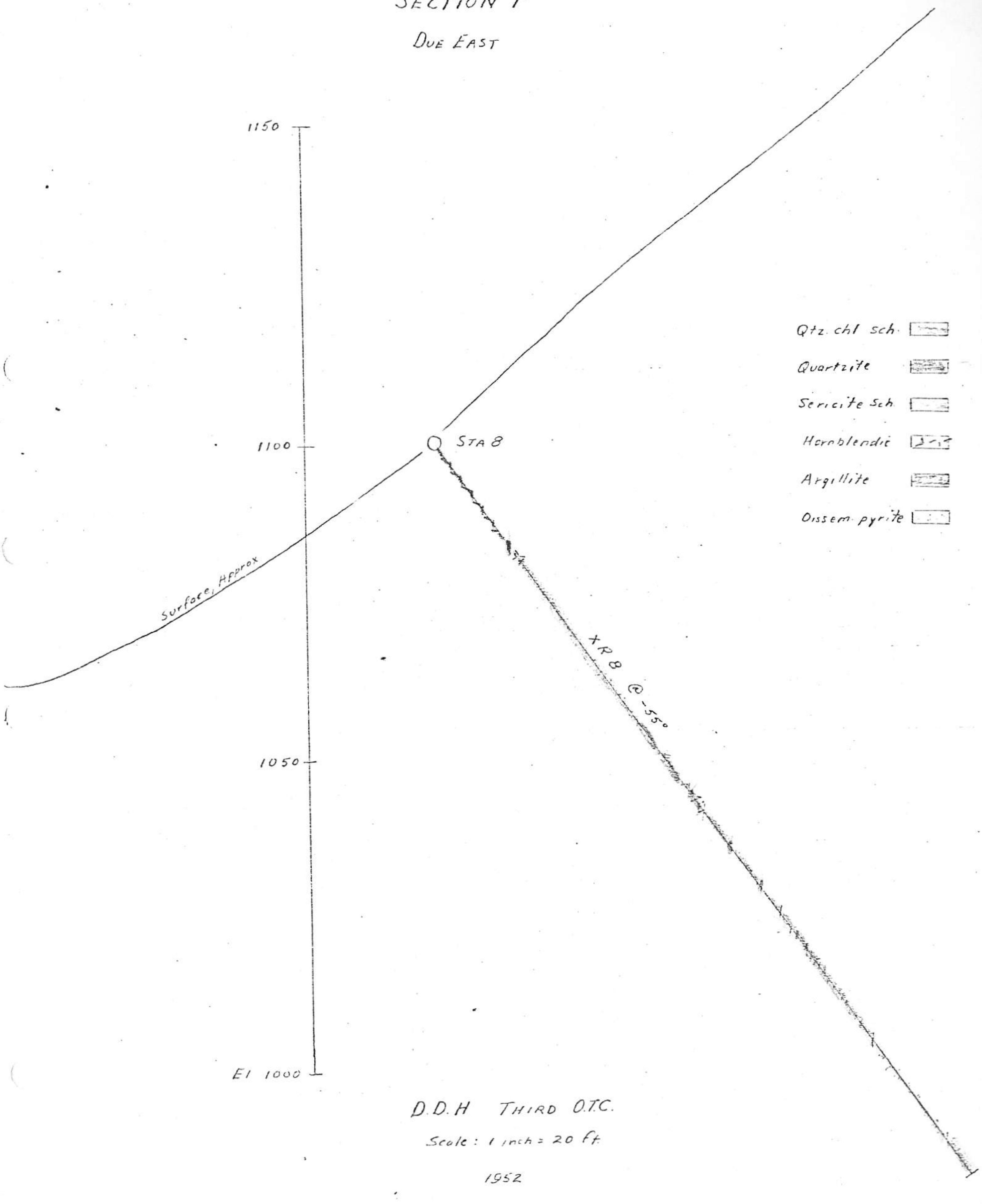
D. D H. THIRD O.T.C.

Scale: 1 inch = 20 feet

1952

SECTION "F"

DUE EAST



D.D.H THIRD O.T.C.

Scale: 1 inch = 20 ft.

1952

Hanna Creek

Massive sulphide deposits were found in the upper reaches of Hanna Creek. The deposits are located on the west side of Hanna Creek about 600' about the main valley floor and alongside an intermittent stream which flows into Hanna Creek at 1300' el. This position is approximately ½ mile from the head of Hanna valley (see Map #1). The deposit occurs at a position corresponding with one of Frizzell's photographs and is believed to be the deposit reported by D. Frizzell, Prince Rupert, B. C. to occur in the area. Five of the photographs obtained from Frizzell were positively identified as being taken in Hanna valley.

The sulphide deposits occur as four separate lenticular bodies along a horizon of argillaceous quartzite and are replacements of this bed. Unlike the deposit of Red Gulch Creek, these bodies do not occur along shear zones. No shears, faults, or fissures are present along the horizon.

The largest body is 40 feet long, has a maximum true width of 3 feet at its mid portion, pinches out along strike at both ends, and is exposed along a dip slope (55°) distance from 10 to 15 feet. Three other lenticular bodies occur along strike of the quartzite horizon above the largest lens. They are 10 feet or less in length and have a true width of 1 foot or less. The four bodies are exposed along a slope distance of 200 feet. See Fig. 10.

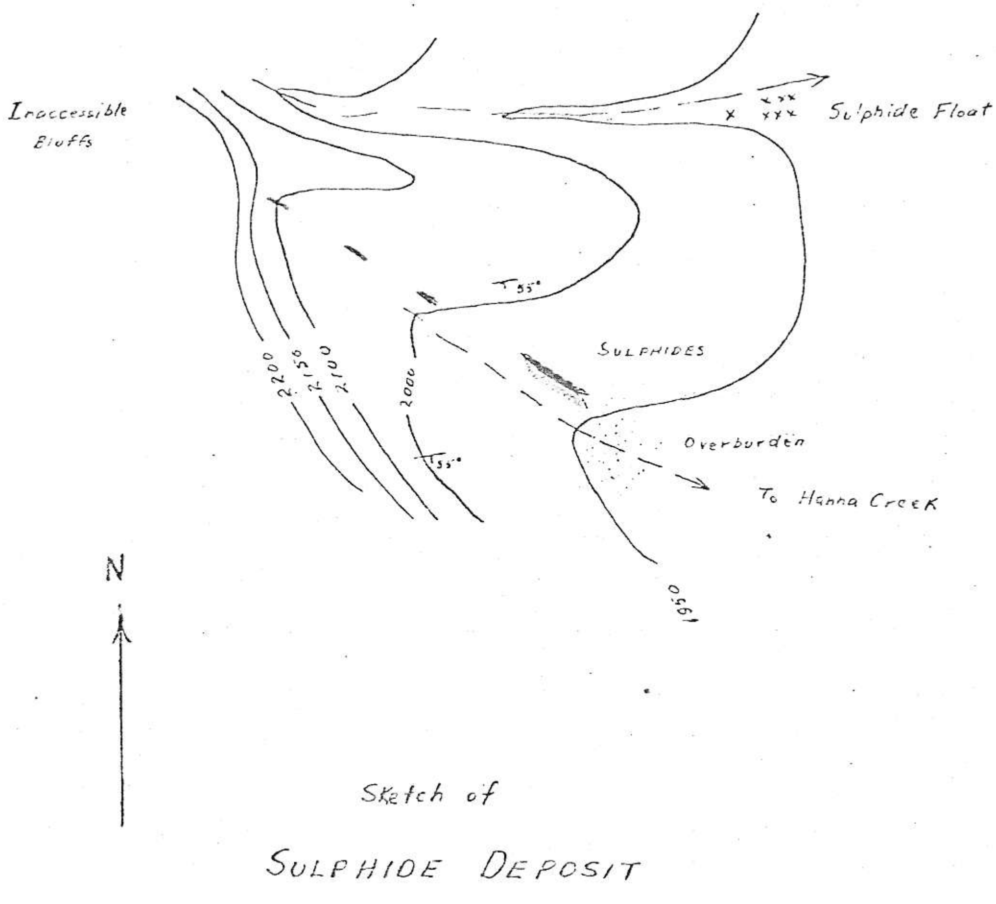
The lenticular bodies are sulphide replacements of the quartzites and generally the sulphides form about 20-30% of the rock but irregular plums of massive sulphide occur. Pyrrhotite is the dominant mineral . Sphalerite and chalcopyrite are locally abundant.

A chip sample of the largest body assayed as follows:- Sample 71:- Au. - Tr., Ag. - 0.2 oz., Pb. - Tr., Zn. - 0.6%, Cu. - 0.5%, Fe. - 35.6%, S - 23.4%.

Overburden conceals the mineralized horizon east of the sulphide outcrops to Hanna Valley 600' below. The same horizon extends to the west and occurs near the top of sheer bluffs. This area is not accessible. Sulphide float was observed in a creek below these bluffs indicating that other lenses of sulphide may be present. The same horizon was investigated 1000' higher in elevation above the sulphide showing, but no mineralization was found.

Most of the rocks in the Hanna Creek area are granites with the exception of a quartzite wedge approximately 1000' wide in the upper reaches of the valley and in which the sulphides occur. The writer feels that the favourable area (non granite) has been adequately prospected and that no major deposit in the area has been overlooked.

FIGURE 10



Sketch of

SULPHIDE DEPOSIT
HANNA CREEK
Scale 1" = 100 ft.

The large granitic masses of the area become more gneissic upon approaching the sedimentary contact. A zone of the gneiss approximately 2000' wide contains pyrite as an accessory mineral in amounts generally less than 1%. The location of the disseminated pyrite reported by Hull, 1951, indicate he observed a portion of this gneissic granite. The pyrite mineralization is not of economic interest.

In view of the weak and erratic mineralization as well as the discouraging assays the deposit does not appear to be promising.

One claim, the "Billy Goat" Mineral Claim, was staked in this area and recorded at Prince Rupert, B. C. No. 1 post is located 400' south of the intermittent stream in which the deposits occur at 1400' el. on the west slope. The location line bears S 12° W and 1500' of the claim lie to the west of the location line. The claim covers most of the area favourable to further sulphide occurrences.

Johnson Lake Area

Several small stringers of massive pyrite up to 6 ft. long and 4 inches wide were observed in argillaceous quartzites at 700' el. alongside a creek which drains into Johnson Lake from the south (see Map 1). These stringers are not of economic interest. There are no indications to suggest larger deposits may be found in this locality.

Several percent of pyrite occur as disseminations in a bed of massive quartzite across a width of 20' alongside an argillite horizon in the NW end of Johnson Lake (see Map 1). The argillite at this position is sheared and intruded by a 20' sill of hornblende syenite. Although the disseminated pyrite is not of economic interest, several days' prospecting along the steep northward extension of the argillite horizon may be warranted. This area, however, is largely obscured by overburden.

Phoebe Creek Area

Two small stringers of massive pyrite and pyrrhotite 4" and 3" wide were observed in the bottom of Elaine Creek in chlorite schists at 1400' el. The veins are parallel to the schistosity of the rocks and appear to be very local in extent.

Mineralization consisting of 20% pyrrhotite and minor associated chalcopyrite across several inches was observed in the shear zone of Phoebe and Elaine Creeks. This shear zone, consisting of highly foliated chlorite schist, is correlated with the Swinnerton Creek shear where minor amounts of coarse disseminated pyrite occur.

Disseminated Pyrite

Disseminated pyrite in amounts generally between 1-2% is invariably present in each zone of fissile, sericite schist. Green mariposite (a chromian mica) is a frequent associate.

Minor amounts of disseminated pyrite are also invariably present in the argillite formations of the area. The pyrite is responsible for the rusty appearance of the argillites on the weathered surface.

The disseminated pyrite is not of economic interest.

Limonite "Boils"

Several limonite boils were reported on the east and S.E. plateau. Examination of the areas revealed thin superficial accumulations of boggy limonite in local depressions. This limonite is derived by weathering of the nearby rocks such as argillite or granitics containing disseminated pyrite, migration, oxidation, and accumulation in areas of somewhat restricted drainage.

They are not gossans of underlying massive sulphide bodies nor indications of nearby sulphide bodies.

Quartz Veins

Small quartz veins are numerous in the area but are essentially barren of visible mineralization. A large quartz vein up to 10' wide and 200' long occurs in Midway Creek at 500' el. The quartz contains minor amounts of finely disseminated pyrite and a trace of chalcopyrite. A grab sample showing strongest mineralization (Sample 50?) shows only a trace of Au.

RECOMMENDATIONS FOR FURTHER WORK

This section is devoted to recommendations for future work in the search of new orebodies as based upon the writer's observations of the geology of the area and evaluation of ore controls.

1. Exploration of area South of Campsite

An area outlined in Fig. 11 approximately 1000' wide and extending across the Eostall River is considered most worthy of further exploration. This area is obscured by overburden of an unknown depth and hence exploration would have to be restricted to diamond drilling or a combination of diamond drilling and geophysical work.

The competent formation of quartzites and associated rocks, as well as the "granite" gneiss are known to extend as far south as D.D.H. 5 and 6. The importance of the rocks has been discussed under the section dealing with ore controls. An argillite horizon correlated with the argillite bed associated with the south lens is also observed in these drill holes. Zones of sericitic schist occur nearby the argillite horizon and are believed to be southerly continuations of the south lens shear. The zones of sericite schist are, however, much narrower, being only several feet wide and it appears that the south shear weakens to the south. The sulphide mineralization is also weaker with 6" of pyrrhotite and 2" of pyrite occurring in D.D.H. 6.

However, it is brought to attention that a very strong shear zone (Allaire Creek shear) occurs on the plateau south of the Eostall river. The location, strike, as well as lineaments observed in aerial photographs, indicate that the shear is striking for Red Gulch creek. It is, of course, not possible to state definitely that the Allaire Creek shear is a continuation of the shears observed in Red Gulch creek; nor can it be positively correlated with either of the three shears occurring in the southern area of Red Gulch Creek. Thus it may be that the Allaire Creek shear is correlated with the shear zone occurring 150' east of Red Gulch and in which the 5' outcrop of massive pyrite occurs. It does seem likely, however, in view of the extent of the shear on the S.E. plateau, that the zones of shearing will increase in widths progressing south of the campsite.

A point to be borne in mind is that a formation of quartzites correlated with the Mine formation was observed in Thirteen Creek about 1000' west of the Allaire Creek shear. There thus appears to be a departure of this competent horizon from the shear zone progressing to the south if the Allaire Creek shear is the southerly continuation of the Red Gulch shears. The competent rocks appear to have an important role in ore controls, and therefore, it may be that the possibility of finding ore becomes more and more

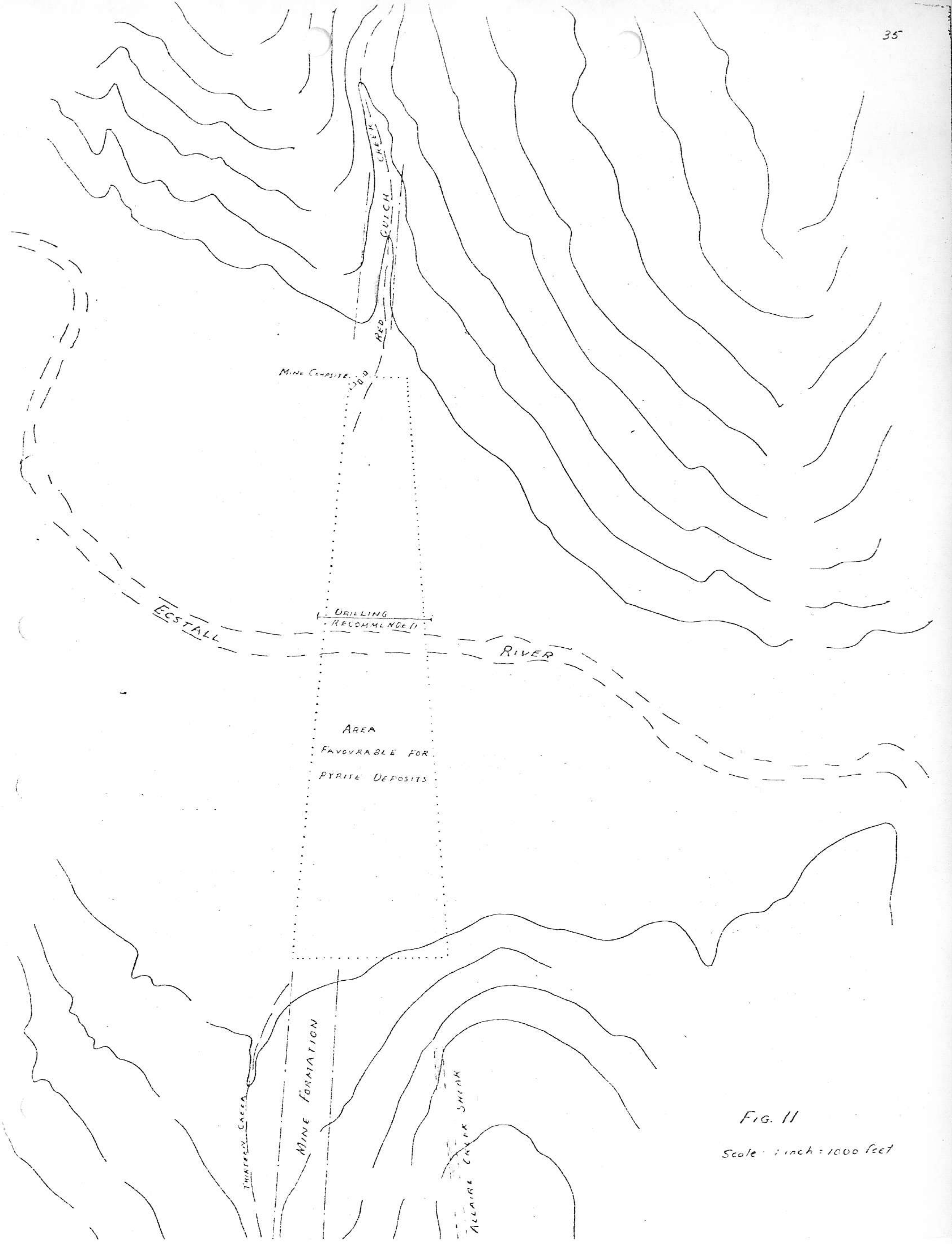


Fig. 11

Scale: 1 inch = 1000 feet

remote progressing southward because of the departure of the shear and competent horizon. As mentioned beforehand, the Allaire Creek shear passes through incompetent chlorite schists which appear unfavourable to massive pyrite localization.

Several E-W drill holes in the area south of Red Gulch Creek and in the vicinity of the Ecstall River are recommended (See Fig. 11). These drill holes would yield valuable information regarding the structure beneath the overburden of the Ecstall River valley as well as indicate further courses of exploration to follow.

Several drill holes drilled eastward in the campsite area (south of D.D.H. Number 3) to intersect the shear zone appearing on the east slope of Red Gulch creek (the shear containing the 5' outcrop of massive pyrite) are also recommended.

The extent of the southerly continuation of the Red Bluff shear is not known. The shear observed at 600' el. in Thirteen Creek may be correlated with the Red Bluff shear. If such is the case, then the possibility of finding ore along the Red Bluff shear seems remote as the shear would continue along somewhat silty quartz chlorite schists.

2. Exploration of Area North of North Lens.

Any exploration work along the northward extension of the Red Gulch shear should be preceded by a program of detailed geological mapping of the area along and west of Red Gulch Creek.

It has not proved possible to correlate any of the rock units outcropping in the creek cuts on the basis of 300' to the inch mapping. Mapping by plane table supplemented by chain and compass in less accessible areas on a scale of 30' to the inch is recommended. Particular attention should be paid to lithologic units in addition to structural attitudes. It has been shown that undulations of the sediments are important underground in localization of the ore. By a course of detailed mapping, it should prove possible to detect any such undulations that may be present and thus narrow the target for ore occurrences.

The Red Gulch shear zone in the vicinity of the 3rd outcrop "granite" gneiss seems particularly favourable for further exploration, as it is felt that the nearby presence of "granite" gneiss is an important ore control. Detailed mapping may indicate targets for diamond drilling.

3. Drilling of 3'd Outcrop

The X-Ray drilling program of the third outcrop has indicated a number of lenticular pyrite replacement bodies occurring along a zone of sericite schist. The lowest intersection of massive sulphide is about 180' below the surface outcrop of the pyrite lens. The 3'd outcrop thus still remains a prospect.

The shear zone can be traced for a considerable distance to the north as well as to the south. It can be therefore inferred that the shear zone will continue for a considerable distance in depth.

It would seem advisable to explore the mineralized zone at depth with long diamond drill holes. The area as far north as the position where the 3'd outcrop shear zone crosses Red Gulch Creek should be investigated as several inches of massive pyrite have been observed within the shear in this area.

4. Prospecting

The area south of Balsa Creek has not been examined. The sedimentary complex as well as shear zones extend in this direction. The area thus seems worthy of prospecting. In this connection the ore controls mentioned above should be kept in mind.

The sediments also extend north to Lockaby Creek. The shear zones appear to weaken in this direction. However, prospecting of this area also seems advisable.

Respectfully submitted

W. Holyk, Ph.D.
November, 1952.

APPENDIX A

Description of Rock Types

Sedimentary Rocks

Chlorite Schists

The rock, typically exposed on the eastern slope of Red Gulch Creek, is dark green in colour, fine grained, schistose, and consists essentially of chlorite.

Hornblende or biotite may be present in varying amounts depending upon the degree of metamorphism. For purposes of detailed mapping the rock can be distinguished by prefixing the appropriate accessory mineral name to the chlorite schists - e.g. hornblende chlorite schist, biotite chlorite schists, etc.

Because of local vaiations of accessory mineral content it has not generally proved possible to make these distinctions in regional mapping.

Thin beds of grey quartzite up to several feet in thickness are occasionally present.

Calcareous chlorite schist.

This rock resembles the above, but contains variable amounts of calcite, readily detectable with dilute hydrochloric acid. The calcite varies from fine to medium grained and is intimately associated with the chlorite. Locally the calcite is sufficiently abundant to warrant the term chloritic limestone schist. This calcite is believed to be primary.

Calcite also occurs as fillings of numerous tiny joints crisscrossing the chlorite schist and is hence secondary. It is believed, however, to be generally formed by solution and redeposition of the primary calcite along openings.

Quartz chlorite schists.

This rock, typically exposed in Thirteen Creek at 500-750' el., is fine to medium grained, coloured green of varying intensity, and consists essentially of quartz and chlorite. Hornblende and mica are frequent associates.

The rock varies in texture from silty to a more massive quartzitic-like form.

Quartz-Chlorite Gneiss

The rock is green in colour, fine to medium grained, consists essentially of quartz and chlorite, and has a gneissic texture. Hornblende or biotite may be locally abundant. It is typically exposed in the eastern underground workings as well as on the east slope of the lower reaches of Thirteen Creek. The rock differs from the schist in that the rock fractures across the foliation rather than being entirely restricted to planes of schistosity.

Thin beds of quartzite are occasionally present in the rock betraying its sedimentary origin.

Quartzites

Several types of quartzites varying in texture occur in this area.

The thin quartzite beds of Red Gulch Creek are massive, medium to light grey in colour, and aphanitic to fine grained. The rock has somewhat of a feldspathic or tuffaceous appearance. Examination of a thin section of a quartzite bed underground shows the rock to consist essentially of microcrystalline to fine grained, clear, recrystallized quartz. The quartz forms about 90% of the rock. Sericite is the chief accessory mineral oriented parallel to the schistosity. Minor amounts of epidote, some carbonate, and pyrite are associated.

Several inches of black argillite were observed in one of the quartzite beds on Thirteen Creek (mine formation) attesting to its sedimentary origin.

Massive quartzites absent of any evidence of schistosity are generally rare, being found chiefly near the top of the mountains south of Johnson Lake. The rock here consists essentially of aphanitic quartz. Generally speaking, the massive quartzites have a certain amount of schistosity developed with micas or chlorite occuring along the foliation. Garnets, chloritoid, and kyanite have been observed in the quartzitic schists in Johnson Lake.

Thin bedded quartzites, consisting of alternating light and darker beds of massive quartzites are typically exposed on the east plateau and in Garnet Creek. The individual beds seldom exceed several inches in thickness. Thin beds of argillite or limestone up to several inches thick may be associated locally.

Rocks referred to as "greywackes" occur near the granite contact of the Johnson Lake area. These rocks consist of fine to medium grained quartz and biotite in approximately equal amounts. The rock has a texture commonly referred to as the "salt and pepper" type and posses a variable degree of schistosity.

Argillite

The argillite is a black, dense, aphanitic rock, occasionally having a prominent cleavage developed, in which case it may be termed a slate. The rock is often highly sheared. Disseminated pyrite in minor amounts is invariably present and is responsible for the typical rusty brown colour of the weathered surface.

A bed of argillite observed on Garnet Creek contained minute elliptical porphyroblasts of biotite and has been called a biotitic argillite schist.

Limestone

Limestones in the area vary in texture as well as in colour.

The limestones on Allaire Ridge are coarse-grained, massive, and consist entirely of intimately interlocked calcite crystals up to ½ inch in size.

Limestones in other areas are massive, crystalline and grey in colour. Other limestones are thinly banded and consist of alternating bands of grey calcite and greenish chlorite rich bands.

Chlorite is also common in some of the massive limestones.

A calcite enriched formation extending along the east slope of Red Gulch Creek has been referred to as an arenaceous limestone. This rock has a typical pale brown colour on the weathered surface. The rock has a high carbonate content in addition to arenaceous, chloritic, and argillaceous material. This formation is thinly laminated as a rule.

Anhydrite (?)

A bed, some 150' thick, observed in Bolan Creek, is very fine grained, massive, light grey in colour, and weathers to a light rusty brown colour. The rock showed no reaction with concentrated hydrochloric acid, and is believed to be anhydrite.

APPENDIX B

Igneous Rocks

Quartz diorite

Granitic rocks of the main coast range batholith occuring to the east and west of the sedimentary complex are believed to be quartz diorite in composition. The rock consists of approximately equal amounts of quartz and mafic minerals. The mafics are either hornblende, or biotite, or both . The rock is medium to coarse grained, has a granitic texture, and generally becomes more gneissic towards the sedimentary contact. The contact of the granitics with the sediments may be sharp but is generally gradational.

On Allaire Ridge large blocks of limestones and silty quartz chlorite schists are engulfed in the granitic masses.

A sample of granitic rock from the Johnson Lake area was examined petrographically by Miss Deane, Texas Gulf Sulphur, N.Y., and her report is as follows:

"No. 4. Hornblende--biotite quartz--monzonite gneiss.

Medium-grained rock showing good parallel elongation of its ferromagnesian minerals.

Quartz consitutes about 25% of rock; orthoclase about 20%; plagioclase 10%; biotite,hornblende, and epidote about 40%. There is also some sphene, apatite and sericite.

Myrmekitic structure is conspicuous on the edges of some of the orthoclase crystals which it is replacing. The orthoclase is only slightly altered as evidenced by its faintly dusty appearance. The plagioclase is of a medium variety, probably oligoclase. It is corroded, though still clear.

The three mafic minerals are present in about equal proportions. The hornblende is replaced in part by the biotite and epidote.

There are no relick igneous structures to be seen, the rock having a fairly uniform grain size. However, the presence of sphene, myrmekite, a fair amount of feldspar, would indicate an igneous origin for the rock. "

"Granite" Gneiss

This term has been applied to two masses of quartz biotite gneiss which are exposed along Red Gulch Creek. The intrusive origin of the rock is controversial.

The rock has a granitic gneissic texture containing approximately equal amounts of quartz and mafic minerals of which biotite is the dominant mineral. The rock is medium grained, and has a light, greenish-brown colour. Chlorite is invariably present in minor amounts. The rock is readily recognized in diamond drill cores by its typical mottled texture.

Three samples of the granite gneiss have been examined petrographically by Miss Deane. Her report is quoted below:

1. Gneiss from D.D.H. (no number)

"Medium-grained chlorite biotite granite gneiss. The "ground mass" has fairly uniform-sized quartz grains. In this are embedded Flaser-like structures composed of sutured quartz and of larger grain size. Quartz constitutes about 65% of the rock.

Biotite, chlorite and hornblende make up another 25%. There are also some small chloritoid crystals. The above four minerals are elongated in a direction parallel to each other.

Garnet, pyrite, and apatite are the accessories. They are corroded and found scattered through the slide at random.

Some calcite is present. An altering plagioclase of medium composition is found in small amounts.

Although it has some of the textural characteristics of a metamorphosed igneous rock (Flaser structure?), the preponderance of quartz and low feldspar content places the rock in the metamorphosed sediments category.

2. Gneiss from 3rd Outcrop.

"Banded metamorphic rock—most likely to have been sedimentary in origin. A chlorite-biotite granite gneiss.

Bands of chlorite-rich material which are persistent and uniform along their length, vary in a direction perpendicular to their length. They alternate with quartz-rich and chlorite-poor bands which are equally persistent.

The quartz is present in large amounts—probably 70% of the total. It tends to be coarser-grained in the quartz-rich bands.

Fairly fine-grained biotite is common and is closely associated with the chlorite to which it is altering. Some very small needles of biotite and chlorite are present in the quartz-rich layers and these are in alignment.

Pyrite is present in a variety of crystal sizes. Although it is not restricted to either one of the two types of bands, it seems to be more abundant in the chlorite layer.

Coarse-grained calcite veins cut across the bands at steep angles. They have been replaced by quartz and biotite.

2. Gneiss from 5' Outcrop (Cont'd.)

"The banding, the abundance of quartz, and the absence of igneous structures indicate that this rock has been derived from a sediment, probably a sandstone with impure shaly layers."

3. Gneiss from 41 X-Cut

"A highly quartzose chlorite-biotite-granite gneiss.

Fairly fine-grained rock, showing a uniform texture throughout the slide (that is, not banded). The minerals do tend to be in alignment.

The most predominant mineral is quartz. It is in two sizes--most of it being fine-grained but some of it being coarser and in Flaser structures. Quartz constitutes about 60% of the rock.

Biotite and chlorite are fairly abundant (25%) and in alignment with each other and with the slight, but noticeable, direction of elongation of the quartz.

A mineral which is assumed to be chloritoid is scattered in small crystals.

The plagioclase is extremely dusty and replaced by quartz and sericite.

Pyrite is present in irregular crystals and is replaced by quartz.

Small amounts of calcite are scattered through the mass.

A corroded garnet is present. It has been altered to biotite and chlorite and is of the Almandine variety.

The high quartz, low feldspar content would tend to put this in the metamorphosed sediment class."

5. Gneiss from D.D.H. 57

"Medium-grained biotite-chlorite granite gneiss.

The quartz, which constitutes about 65% of the rock is of medium-grain size. In a few places there is a little Flaser structure.

Biotite is scattered in small flakes which are fairly well aligned with each other. It replaces the hornblende and garnet and is being replaced by chlorite.

A very much altered and dusty plagioclase is present in small amounts. Some sericite is found outlining the altered plagioclase.

There are a few corroded garnets, some apatite and a little orthoclase. Pyrite is present in slightly greater amounts.

Again, the preponderance of quartz and scarcity

5. Gneiss from D.D.H. 57 (Cont'd.)

of feldspars and other minerals typical of igneous rocks places this rock in the metamorphosed sediments category."

The reports of Miss Deane thus offer a tentative sedimentary origin for the rocks which have been highly altered by subsequent metamorphism.

It may be stated at this point that the origin of granite is still a very controversial and unsettled problem in geological circles. A positive statement as to a granitic origin is thus not possible from petrographic investigations.

Two samples of the "granite" gneiss were studied by the writer. The results are summarized below:-

1. "Granite" gneiss from D.D.H. NO. 3

Thin section examination showed the following mineralogical composition:

Quartz	40%
Biotite	30%
Feldspar	20%
Chlorite	5%
Epidote	4%
Pyrite, Sericite	1%

The feldspar has been tentatively identified as the plagioclase-andesine. It occurs in phenocrysts up to 1/8" in size, and is largely replaced by microcrystalline quartz, epidote, and chlorite. All the quartz is fine grained to microcrystalline, and seems to be entirely recrystallized. Epidote occurs in minute grains and is largely restricted to the feldspar.

The rock is probably a metamorphosed quartz diorite gneiss.

2. "Granite" gneiss from 3rd Outcrop.

Thin section examination reveals the following mineralogical composition:

Quartz	60%
Biotite	25%
Epidote	10%
Chlorite	5%
Pyrite	Minor accessory

2. "Granite" gneiss from 3rd Outcrop (Cont'd.)

The quartz is completely recrystallized and occurs in microcrystalline grains. The epidote is evenly distributed throughout the rock.

Feldspar has not been observed. The high proportion of epidote may be indicative of former plagioclase which has been completely altered.

There thus seems to be also some indications that the "granite" gneiss from D.D.H. 3 may be an igneous rock.

The writer tends to place emphasis on the field relationship and occurrences of the gneiss and thus favours an intrusive origin. The field evidence to support such a belief has been discussed in previous sections.

Hornblendite

The hornblendites are typical in the Johnson Lake area, and consist of medium grained, dark purplish green rocks. The rock consists essentially of hornblende with minor amounts of visible quartz and feldspar. Garnets are occasionally prominent.

Thin section examination revealed the following composition:

Hornblende	80%
Quartz	14%
Feldspar	5%
Carbonate)	
Black Opaques)	Accessory

Gabbro

The rock is again typically exposed in the Johnson Lake area. It is dark green in colour, massive, and very coarse grained. The rock consists essentially of coarse pyroxene crystals up to ½ inch in size. White feldspar is occasionally observed as a minor accessory. The composition would vary between gabbro and pyroxenite.

Diorite

Several diorite sills have been observed in the area, one of which is typically exposed in Thirteen Creek. The rock is medium grained, dark green in colour, and consists of pyroxene and feldspar in approximately equal amounts.

Aplite

Several small sill-like dikes have been observed on the east slope of Red Gulch Creek. The rock is light cream coloured, has a sugary texture, and appears to consist essentially of quartz with minor amounts of biotite.

Hornblende Lamprophyres

The rock is fine grained, dark greyish-green in colour, containing about 20% of hornblende phenocrysts up to ¼" in length. It is typically exposed in several creek cuts on the east and west slopes of Red Gulch Creek, where the dikes cut directly across the sediments.

Biotite Porphyry

This rock was observed to the west of the Red Bluff shear. It is fine grained, massive, dark green in colour, and contains about 15% of biotite phenocrysts up to 1/8" in length. The rock is grouped with the intrusive rocks although its exact nature is not known.

Hornblende Syenite

This rock was observed only in the Johnson Lake area as a sill like body occurring in sheared argillite. The rock is medium grained, consists of equal amounts of hornblende and white feldspar. The rock has distinct chilled borders at its contact with the argillite.

DESCRIPTIONS OF THIN SECTIONS MADE FROM

SAMPLES 1, 2, 3, 4 AND 5, ECSTALL, B.C.

No. 4 Hornblende--biotite quartz--monzonite gneiss

Medium-grained rock showing good parallel elongation of its ferromagnesian minerals.

Quartz constitutes about 25% of rock; orthoclase about 20%; plagioclase 10%; biotite, hornblende, and epidote about 40%. There is also some sphene, apatite and sericite.

Myrmekitic structure is conspicuous on the edges of some of the orthoclase crystals which it is replacing. The orthoclase is only slightly altered as evidenced by its faintly dusty appearance. The plagioclase is of a medium variety, probably oligoclase. It is corroded, though still clear.

The three mafic minerals are present in about equal proportions. The hornblende is replaced in part by the biotite and epidote.

There are no relick igneous structures to be seen, the rock having a fairly uniform grain size. However, the presence of sphene, myrmekite, a fair amount of feldspar, would indicate an igneous origin for the rock.

No. 2 Banded metamorphic rock--most likely to have been sedimentary in origin. A chlorite-biotite granite gneiss.

Bands of chlorite-rich material which are persistent and uniform along their length, vary in a direction perpendicular to their length. They alternate with quartz-rich and chlorite-poor bands which are equally persistent.

The quartz is present in large amounts--probably 70% of the total. It tends to be coarser-grained in the quartz-rich bands.

Fairly fine-grained biotite is common and is closely associated with the chlorite to which it is altering. Some very small needles of biotite and chlorite are present in the quartz-rich layers and these are in alignment.

Pyrite is present in a variety of crystal sizes. Although it is not restricted to either one of the two types of bands, it seems to be more abundant in the chlorite layer.

Coarse-grained calcite veins cut across the bands at steep angles. They have been replaced by quartz and biotite.

The banding, the abundance of quartz, and the absence of igneous structures indicate that this rock has been derived from a sediment, probably a sandstone with impure shaly layers.

No. 1 Numbers 1, 3, and 5 are very alike in composition and structure.

Medium-grained chlorite biotite granite gneiss.

The "ground mass" has fairly uniform-sized quartz grains. In this are embedded Flaser-like structures composed of sutured quartz and of larger grain size. Quartz constitutes about 65%

. 1 (continued) of the rock.

Biotite, chlorite and hornblende make up another 25%. There are also some small chloritoid crystals. The above four minerals are elongated in a direction parallel to each other.

Garnet, pyrite, and apatite are the accessories. They are corroded and found scattered through the slide at random.

Some calcite is present. An altering plagioclase of medium composition is found in small amounts.

Although it has some of the textural characteristics of a metamorphosed igneous rock (Flaser structure?), the preponderance of quartz and low feldspar content places the rock in the metamorphosed sediments category.

No. 3 A highly quartzose chlorite-biotite-granite gneiss.

Fairly fine-grained rock, showing a uniform texture throughout the slide (that is, not banded). The minerals do tend to be in alignment.

The most predominant mineral is quartz. It is in two sizes--most of it being fine-grained but some of it being coarser and in Flaser structures. Quartz constitutes about 60% of the rock.

Biotite and chlorite are fairly abundant (25%) and in alignment with each other and with the slight, but noticeable, direction of elongation of the quartz.

A mineral which is assumed to be chloritoid is scattered in small crystals.

The plagioclase is extremely dusty and replaced by quartz and sericite.

Pyrite is present in irregular crystals and is replaced by quartz.

Small amounts of calcite are scattered through the mass.

A corroded garnet is present. It has been altered to biotite and chlorite and is of the Almandine variety.

The high quartz, low feldspar content would tend to put this in the metamorphosed sediment class.

No. 5 Medium-grained biotite-chlorite granite gneiss.

The quartz, which constitutes about 65% of the rock is of medium-grain size. In a few places there is a little Flaser structure.

Biotite is scattered in small flakes which are fairly well aligned with each other. It replaces the hornblende and garnet and is being replaced by chlorite.

A very much altered and dusty plagioclase is present in small amounts. Some sericite is found outlining the altered plagioclase.

There are a few corroded garnets, some apatite and a little orthoclase. Pyrite is present in slightly greater amounts.

Again, the preponderance of quartz and scarcity of feldspars and other minerals typicsl of igneous rocks places this rock in the metamorphosed sediments category.

Miss Dean

March 19, 1953

E C S T A L L

Ore Reserves:

The 1952 work brings the ore estimates up to about 7,000,000 long tons. Mr. Douglas' figures, including indicated ore, come out somewhat higher at 7,786,000. Mr. Guernsey estimates that the 1952 drilling campaign added over 2,000,000 tons to the 1940 figures.

This 1952 drilling confirmed that the dimensions of the North Lens are fairly accurately known. No limit, however, can be placed on the depth of the South Lens, and it is probable that this orebody extends in depth to the south and east. It can be regarded as certain that more ore will be found there.

Grade:

The grade of the North Lens was not re-determined and remains at the 1940 figures, as follows:-

Sulphur %	Iron %	Copper %	Zinc %	Gold oz.	Silver oz.
49.5	43.5	0.8	2	0.015	0.5

Of the approximately 3,000,000 tons of ore in the North Lens, it is believed reasonable that from 300,000 to 500,000 tons approximate 2% copper in the footwall above adit level. It is believed that a good proportion of this ore could be mined selectively if desirable.

The ore in the South Lens is somewhat lower in sulphur content but higher in zinc, average assay being about:-

Sulphur %	Copper %	Zinc %
47.5	.40	3.20

The precious metals contents in the South Lens ore are similar to those in the North Lens.

Exploration:

Drilling was carried out on a third outcrop to the north of the North Lens. Pyrite was found here but not enough work was done at depth to establish if the orebody is important.

Prospecting in the general area produced a good deal of information, some of which indicated other sections which appear worthy of further work.

The so-called Frizzell outcrop appears to have been identified at a point about half a mile from the head of Hanna Valley (see Holyk's report, page 29). One claim was staked in this area as recorded at Prince Rupert.

Geophysical work proved unsatisfactory and gave no concrete results, local and climatic conditions placing too great a strain on the apparatus being used.

The mine area was adequately mapped during the campaign, aerial photographs having been a great help in this connection.

Development of the Property:

Even before the additional reserves were found in 1952, Mr. Pat Stewart held the opinion that the mine should be put to work if an adequate pyrites market was available. It is now generally thought that the ore should move from the property over to the Douglas Channel, this involving some means of haulage over the distance of about twenty-four miles. Road haulage had been discussed and investigated, but Mr. Stewart believed that a railroad was the proper answer. The route has not been accurately surveyed, but it is believed that no paramount difficulties will be met with.

The ore can clearly be mined and shipped without treatment if circumstances should indicate this as the proper approach. However, it would seem that, upon any reasonable zinc market, the zinc contents should be recovered, and this could be carried out either at the mine, in which case a flotation pyrite would remain for sale, or at or near the point at which the pyrites is ultimately consumed. Conditions in the market in which the pyrite is to be sold will determine which of these alternatives is the proper one to follow.

A third possibility arises when the new hydroelectric installation at Kitimat is put to work. The Kitimat scheme for water power and aluminum production is a large one and we are told that power will be available for industry and that a large townsite will ultimately be constructed. Kitimat is about forty miles from the point at which the Ecstall ore would reach the Douglas Channel.

There appears to be a good deal of promise in some of the schemes now being worked out in Europe for the recovery of sulphur from pyrite, and one of these methods will recover the iron content in the form of electrolytic iron. If the process proves out, it is obviously on the cards that the Ecstall ore should logically move to Kitimat, where power is available, in which case all of the metallic content, together with the sulphur, will be recovered there. Further alternatives in this connection lie in the very considerable quantities of water available for power production near the property if this proved to be more attractive than taking the ore to the Kitimat hydroelectric plant. All of these alternatives are being studied, together with possible plans for selling the ore directly to consumers with recovery of metals from the calcines in the traditional manner.

C. T. Hill

CTH:AO
O+4

TONNAGE

The work of crosscutting and diamond drilling during 1940 has practically confirmed the former tonnage estimates.

The following gives the results based on the work done in 1940:

	North Lens	South Lens	Total
Above Adit Level	2,814,257	824,409	3,638,666
Adit to Sea Level	366,381	287,070	653,451
Sea Level to 100 ft. Below Sea	219,618	358,835	578,453
	3,400,256	1,470,314	4,870,570

The average analysis of the above is as follows:

	Sulphur %	Iron %	Copper %	Zinc %	Gold oz.	Silver oz.
GENERAL AVERAGE	49.0	43.0	0.8	2.0	0.015	0.6
Diamond Drill Cores						
North Lens, Average	49.5	43.5	0.8	2.0	0.015	0.5
South Lens, Average	47.5	41.	0.9	3.1	0.013	0.8
Crosscuts						
North Lens #4 Crosscut 15'	48.3	42.2	1.0	1.3	0.02	0.26
" " #6 " 90'	49.4	43.8	0.6	1.4	0.012	0.45
South Lens #1 " 19'	43.1	37.0	0.3	-	0.03	-
" " #2 " 49'	47.7	41.3	0.13	2.7	0.04	0.56
" " #3 " 10'	44.3	39.0	1.4	2.2	0.04	0.97

Analyses for Selenium, Arsenic and Phosphorous were made on Average Samples with the following results:

	Selenium Parts per Million	Arsenic Parts per Million	Phosphorous Parts per Million
North Lens			
No. 6 Crosscut 90'	60	430	10
Footwall Side 20'	100	625	
Hanging Wall Side 60'	50	360	
Across Orebody 70'	60	500	
Across Orebody 100'	40	420	

2,871,000
994,

ECSTALL ESTIMATES

7.85 CUBIC FEET PER LONG TON

SOUTH LENS

M.S.D.		E.E.M. Vancouver 1940*	M.D. →	New York 1953**	
below 85'	215 ft. to surface	(734,000		342,000	811,0
2,271,000	85 " " 215	(		469,000	
	-100 " " 85	576,000		688,000	
	Total -100 to surface	1,310,000		1,499,000	
	Below -100			2,280,000	
	Total	3,734,286	4,756,000	3,779,000	

E.E.M. **NORTH LENS** M.D.

Vancouver 1940*

3,035,714 3,030,000 3,030,000

COMBINED NORTH AND SOUTH LENSES

Total 6,809,000

North lens from Vancouver estimate
South lens from New York estimate

* Recalculated at 7.85 cubic feet instead of 7.0
** Provisional figures

GRADED TONNAGE OF THE ORE BELOW THE ADIT LEVEL IN THE SOUTH LENS AT THE ECSTALL MINE.

1952

In order to determine the grade of the ore in the South Lens, the orebody was divided into blocks to a depth of minus 950'. The Lens was considered to be tabular and the blocks to lie in the plane of the orebody which dips 80° from the horizontal. The centers of the drill cores which cut the orebody were joined in such a manner that the plane of the Lens was divided into approximately equilateral triangles. Because it was deemed unlikely that the orebody ended abruptly at the limits outlined by the drill holes, the boundaries were extended 100' horizontally beyond and 100' vertically below the outer drill holes. The thickness of the orebody at this point was considered to be 2/3 of that at the corresponding inner drill holes. These outer points were also joined in such a manner that triangles were formed in the plane of the orebody.

To determine the tonnage and assays of the blocks represented in each triangle, the average thickness and assays shown in the three corresponding drill holes were taken. This then gave a fairly reliable estimate of the grade and amount of ore in the block. In the last calculation the weighted average assay of the whole orebody was determined. The results are as follows:

Long Tons below the adit level and above minus 950' -------- 2,882,562

Assay ---- 47.4%S ------ .40%Cu ------ 3.20%Zn.

March 25, 1953

M.Sheila Deane

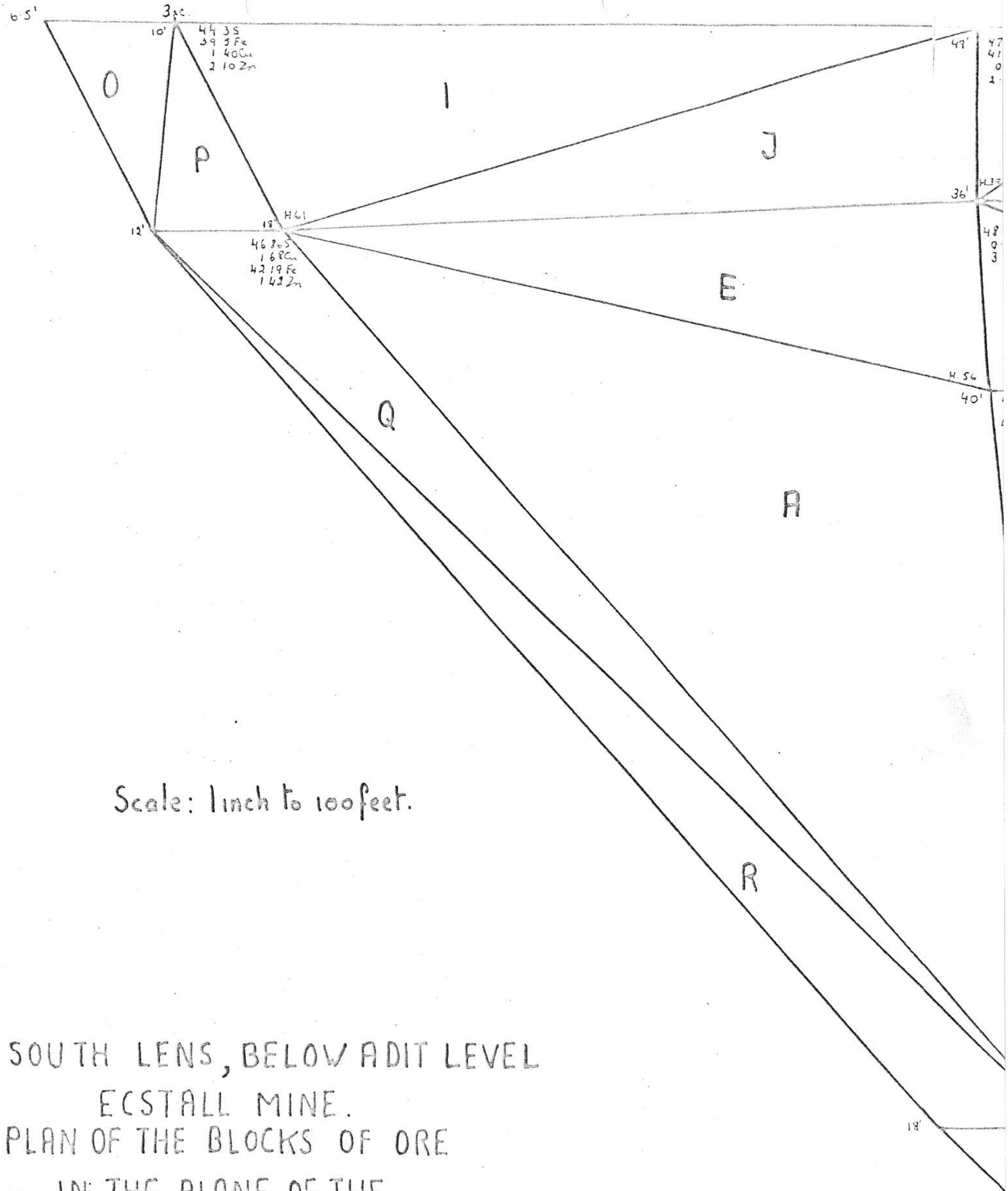
O+3

MSD:GMO

RESULTS OF CALCULATIONS OF TONNAGE AND ASSAYS OF EACH BLOCK
(7.85 Cubic Feet to the Long Ton)

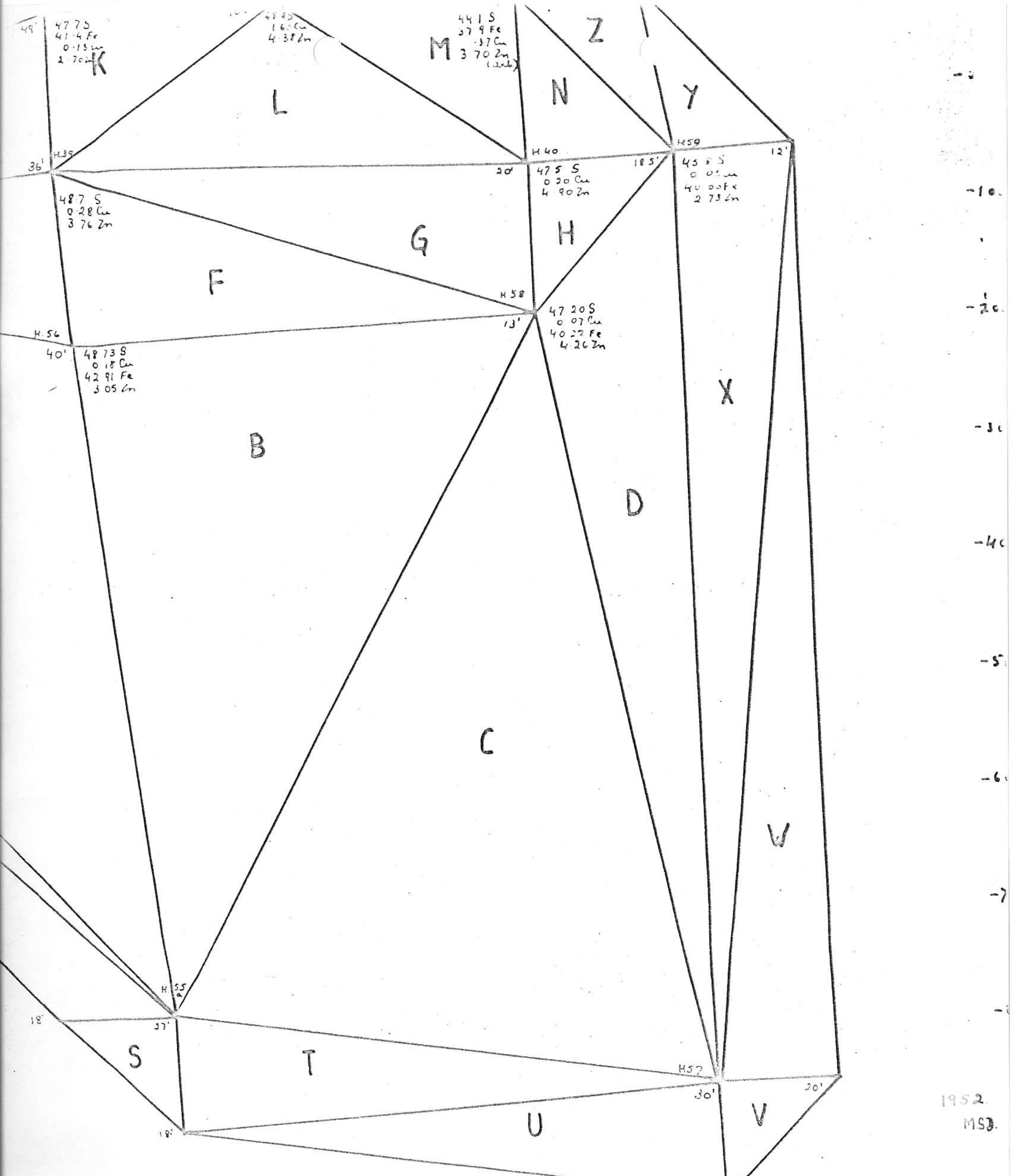
Blocks A-N Inner Group	Area Sq.Ft.	Thickness Feet	Volume Cu.Ft.	Long Tons	%S	%Fe	%Cu	%Zn	
A	151,500	28	4,242,000	540,382	47.9	42.2	0.67	2.62	
B	109,800	26	2,854,800	363,668	48.1	41.5	0.13	3.56	
C	140,490	23	3,231,270	411,626	47.2	40.6	0.08	3.46	
D	48,840	20.5	1,001,220	127,543	46.3	40.1	0.04	3.24	
E	39,300	31.5	1,237,950	157,700	48.0		.71	2.74	
F	28,400	29	823,600	104,917	48.2		.17	3.69	
G	25,200	23	579,600	73,834	47.8		0.18	4.30	
H	8,000	17.1	136,800	17,426	46.8		0.10	3.96	
I	48,460	25	1,211,500	154,331	46.2	41.0	1.07	2.07	
J	35,360	34	1,202,240	153,151	47.7		.69	2.62	
K	14,100	33.8	476,580	60,710	48.4		.67	3.58	
L	27,700	24.1	667,570	85,040	48.3		.69	4.32	
M	13,700	17.1	234,270	29,843	46.8		.07	4.3	app.
N	8,280	17.8	147,384	18,775	45.8		.20	3.7	app.
Total				2,298,946					

Blocks O-Z Outer Group	Area Sq.Ft.	Thickness Feet	Volume Cu.Ft.	Long Tons	%S	%Fe	%Cu	%Zn
O	8,000	9.5	76,000	9,681	45.1	39.0	1.49	1.87
P	8,100	13	105,300	13,414	45.9	41.2	1.58	1.64
Q	33,300	19	632,700	80,598	47.3	42.0	1.17	2.17
R	33,700	19	640,300	81,566	47.8	41.7	0.66	2.73
S	4,970	21	104,370	13,295	48.4	41.6	0.16	3.39
T	22,000	25	550,000	70,063	47.6	41.1	0.11	3.17
U	22,000	22	484,000	61,656	46.8	40.6	0.06	2.95
V	5,100	23	117,300	14,942	46.1	40.2	0.02	2.74
W	39,800	20	796,000	101,401	46.0	40.1	0.02	2.73
X	39,600	20.1	795,960	101,396	45.9	40.0	0.02	2.73
Y	11,900	13.5	160,650	22,675	45.8	40.0	0.03	2.73
Z	7,000	14.5	101,500	12,929	44.6	38.6	0.25	3.30
Total				583,616				
Total and Assays for all Blocks below Adit				2,882,562	47.4		.40	3.20



Scale: 1 inch to 100 feet.

SOUTH LENS, BELOW ADIT LEVEL
ECSTALL MINE.
PLAN OF THE BLOCKS OF ORE
IN THE PLANE OF THE
ORE BODY.


K
L
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H39
H 40
H59
H 58
H 56
H 57
36'
20'
18 5'
12'
13'
40'
18'
30'
20'
48 7 S
0 28 Cu
3 76 Zn
47 5 S
0 20 Cu
4 90 Zn
47 20 S
0 07 Cu
4 26 Zn
48 73 S
0 18 Cu
42 91 Fe
3 05 Zn
44 1 S
37 9 Fe
3 70 Zn
47 7 S
41 4 Fe
-10
-20
-40

1952.
MSB.

vol 123, No. –

E & M J 11 June 1927 H J C MacDonald

"two elongated overlapping lenses of pyrites dipping 80° E east and striking north and south with the schists. .

— then take from report.

diamond drilling

- wedging -

- drilling tonnages -

- est. $5.89 for 1927 prices.

cu	16 lb	@	.24½	=
Zinc	46	@	.19½	=
Silver	0.7 oz	@	.88	=
Gold	.02	@ $35		=

---

7 November 1936

Report on Extall properties by F.W. Guernsey. Mr. Guernsey reported favourably on the Extall ~~deposit~~ property. On the basis of the drilling done by MacDonald for Granby Company in 1917 and 1918, and the cross-sections prepared by that gentleman. Mr Guernsey estimated for the North lens 3.24 million Tons and for the South lens 3.9 million Tons.

The average of eleven samples he took from both d.d. core and

	Av	Max	Min
outcrop exposures were as follows:			
Sulphur	48.3 %.	50.4	44.8
Copper	0.61	1.20	0.17
Zinc	2.15	3.56	0.87

Extall Pass Route - 5 Sept 1939 E.E. Mason

Of the opinion that a pass is feasible between mine, ~~upstream~~ and Douglas Channel by way of Extall River. Height of pass through mountains is a maximum of 130' above sea level. The terminus at Kitkiata Inlet presented the biggest problem at that time = it had not been mapped or charted and was extremely shallow at its upper end.

Report 1937

(1) Tonnages of Granby Co. confirmed:

~~A. lens.~~	N. lens	S. lens
Tons	3,076,690	840,000
S	49.2	48.0
Cu	.0.85	0.30
Zn	1.76	
Fe	43.1	
Au	0.023	

The Climate and condition ~~of the~~ for mining ~~mine~~ are good. Ore of 50% S can be produced

Hydroelectric power 13 miles away
Railway feasible for large tonnages
Largest deposit on the Pacific coast.

---

(1) North lens copper content greater on the fw side and zinc greater on hw in centre: mixed pyrite and rock with an assay below 40% sulphur.

(2) South lens: six holes to pick up southern extension. Didn't; only 18" pyrite

∴ 1000' long 40 max (d.d.) → 7' (surface)

M E M O R A N D U M

To: R. D. Mollison
From: F. E. Tippie

Re: STUDY AND DEVELOPMENT OF SULPHIDE MINES OWNED BY TEXAS GULF SULPHUR COMPANY WITH SPECIAL REFERENCE TO ECSTALL AND COPPER KING MINES

Recent valuations of various sizeable massive sulphide reserves owned by Texas Gulf Sulphur Co. suggest to the writer the need of careful reviews of the Ecstall and Copper King mines in particular, because it appears feasible to operate these properties at a reasonable profit. It is suggested that

1) Ore reserves be carefully checked to determine the need, if any, of additional drilling to establish proven reserves.

2) A system of development and mining be carefully outlined, complete with maps and estimates of time and costs. Consideration be given to the possibility of developing these mines for production in the near future.

3) A careful estimate of capital investments and time required for placing these properties into operation be prepared.

4) Metallurgical tests of fresh samples of the ores be conducted, particularly in the case of the Ecstall mine where important base metal and precious metal values are present. Such tests might include: burning of the pyrite for sulphuric acid production, leaching of the cinder for base metals, etc. and sintering in preparation for a saleable iron product.

5) A careful estimate of operating costs be prepared for both properties.

6) Estimates of capital costs and operating costs be prepared for leaching and sintering operations.

7) If suitable processes for direct recovery of elemental sulphur, base metals, and iron are available, tests might be conducted on these ores and estimates of capital and operating costs be prepared.

8) A market study of the Pacific area be made for the sale of pyrite, cupreous pyrite and zinc concentrates.

The above recommendations are made with the thought of placing these mines and others, if warranted, in readiness for operation in the shortest time possible, should world economic conditions improve to the point where excellent profits might be realized.

August 11, 1958

CC to Dr. C. F. Fogarty

DATA AND CALCULATIONS
FOR
ECSTALL MINE, BRITISH COLUMBIA, CANADA

Reserves:	Proven	6,551,653 long tons
	Inferred	1,473,181 " "

Grade:	Sulphur	48.3%	
	Iron	41.8	
	Copper	0.55	.83
	Zinc	2.75	2.3
	Gold	0.015 oz./ton	.014
	Silver	0.5 " "	.6

Recovery and ratio of concentration

	Grade	Recovery	Rec.grade	R.C.
Cu	0.55	80%	0.44	68.2
Zn	2.75	89	2.45	24.5

Tail will consist mainly of pyrite with R. C. = 1.05 and the following approximate grade:

Iron	43.2%
Sulphur	49.2%

Smelter prices for concentrates

			Metal
Copper	30%	$145.00/long ton	$0.25/lb.
Zinc	60%	62.50 " "	0.10 "

Value of pyrite	
Japanese pyrite placed consumer ports - est.	$0.243/unit
Ecstall pyrite placed Japan 49.2 x 0.243 =	$11.96
Less freight	6.00
f.o.b. Kitkiata	5.96
Recoverable value per ton of ore	5.68

Value of zinc concentrates (60% placed smelter)	$56.00/short ton
Less ocean and rail freight to Trail, B. C.	14.00
f.o.b. Kitkiata	$42.00 " "
Recoverable value per long ton of ore	1.92

Value of copper concentrates (30% placed Tacoma smelter)	$110.00/short ton
Less freight to Tacoma	5.00
f.o.b. Kitkiata	105.00
Recoverable value per long ton of ore	1.73

Total value of ore	$9.33
Costs f.o.b. Kitkiata	6.76
PROFIT	$2.57

Plant capacity - 1000 tons/day 300,000 tons/year

Capital costs	
Present book value	$ 741,000
Railroad and equipment (mine to Kitkiata)	2,000,000
Mill	2,000,000
Mine and services	800,000
Dock	300,000
Weighing and loading equipment	450,000
Power plants	300,000
Total	$6,591,000

Operating costs (per ton of ore)	
Mining	$2.00
Freight to mill	0.50
Milling	1.50
Administration and general	0.75
Amortization and depreciation	1.01
Loading	1.00
Total	$6.76

VALUATION AND COMMENTS ON
ECSTALL MINE, BRITISH COLUMBIA, CANADA

Reserves:	Proven	6,551,653 long tons
	Inferred	1,473,181
Grade:	Sulphur	48.3%
	Iron	41.8
	Copper	0.55
	Zinc	2.75

Mining rate	1,000 tons/day	
Capital investment	$6,591,000	
Period of operation	22 years	
Total value per long ton of ore as recoverable concentrates, f.o.b. Kitkiata -		
Pyrite		$5.68
Copper		1.73
Zinc		1.92
		$9.33
Less operating, administration, depreciation, and amortization costs		6.76
Profit per long ton of ore		$2.57

Total profit over 22 years	$16,837,748
Annual rate	765,352
Present value (8% discount)	7,807,159
Present book value	741,185

Comments regarding valuation

Japan has been figured as the only available market for pyrite from the Ecstall Mine under present conditions, though it is improbable that Japan could take the entire production. The value in Japan has been figured from the 1952 price of low-grade Japanese pyrite.

The market for copper concentrates has been figured at the Tacoma smelter and for zinc concentrates at the Trail smelter. No value has been figured for precious metals because of insufficient metallurgical data. The total value of gold and silver in the ore is $0.97. What portion of this is recoverable is not known. If zinc concentrates could be sold in Japan, undoubtedly a greater value would be received because of lower shipping costs.

F. E. Tippie

August 11, 1958

November 30, 1962

Mr. Wallace Bruce
Rio Tinto Canadian Exploration
Suite 1000
355 Bay Street
Toronto, Ontario

Dear Wally:

With reference to our telephone conversation earlier today the following is the reserve picture of our Ecstall deposit near Prince Rupert, British Columbia:

> 4,870,000 tons 0.85% Cu, 2.2% Zn. Of this amount a small tonnage of 400,000 - 600,000 tons is calculated at 0.5 Ag, .028 Av, 1.9% Cu. An additional 2,700,000 tons contain 0.3% Cu, 2.9% Zn.

You will note the above figures are at variance from figures recalled over telephone for which my apologies.

I would see no objection to your examining our information on the Half Mile Lake deposit in New Brunswick. In this connection, however, I would consider it difficult to arrive at any realistic terms acceptable to us in the light of present metal prices and present value considerations. In other words, unless very attractive terms were presented we would be reluctant to make a deal on the property.

With best wishes,

Sincerely,

W. Holyk
Assistant Manager
of Exploration

WH:pl

Owner of 16, 17, 21, 22

Kinning of 10, 11, 12, 12A, 12B,
16, 17, 20, 21, 22

1/4 in Samuel S. Davis 20

1/4 and min. rts. 25, 31, 33, 35

---

land included in taxsale: —

land which should have been: —

Purchase price $62,000

Down payment $2400 ded. from p.p.t
1st July.

3 years.

[illegible] IS [illegible] 2 STRANAHAN – ONE
LIVING IN N. MEXICO – OTHER NOT KNOWN
BY US

F. W. GUERNSEY
744 WEST HASTINGS STREET
VANCOUVER, B.C.

Nov. 3rd, 1951.

Mr. C. T. Hill,
Vice President,
Texas Gulf Sulphur Co.,
75 East 45th St.,
New York 17, N. Y.

My dear Mr. Hill:

I attach herewith memos from Mr. Hull:

1. Recommendations for prospecting in the Ecstall Mine area.

2. Description of the Biochemical method of determining the presence of certain minerals in the overburden.

I have discussed the matter of Mr. Hull's employment with him, and the present arrangement will maintain through the month of November.

I have written for further information regarding the pyrite deposits in the State of Washington and may send Mr. Hull down to inspect those that look promising.

Yours sincerely,

F W Guernsey

FWG/m
Encl.

NORTHERN PYRITES LTD.
ROOM XXX 717,
744 WEST HASTINGS STREET
VANCOUVER, B.C.

Nov. 1st, 1951.

PROSPECTING IN THE ECSTALL MINE AREA

GENERAL The following remarks are in the nature of a digest for use in discussion as to the best methods of prospecting in the Ecstall country.

From previous experience it would appear that a small crew engaged in prospecting over a large area in this type of country is not liable to obtain satisfactory results.

The ground immediately adjacent to the known ore-bodies has been covered extensively by surface prospecting, and no large outcrops of pyrite have been discovered.

From these two points it would appear that, (a) - intensive search by individual parties is required, and (b) - some additional method is required to assist prospecting.

1 - GROUND PARTIES

Until the base map, now under construction, is completed, it is difficult to estimate the size of ground party required. However, it should be borne in mind that a crew of a size capable of being split up into two, three or more groups is considered desirable. These parties could be assigned a particular area of search, based on a grid system, and detailed examination and geological mapping carried out.

In connection with ground parties, the following should be borne in mind:

(a) As stated above, surface examination to date has had negative results. The amount of overburden and paucity of rock outcrops is partly responsible, and it is impossible, so far, to say if ground covered with overburden contains an ore-body or not. Reports merely show that none is visible.

(b) It is therefore felt that additional means must be utilized by the ground parties. The area to be covered is large and frequently steep and rugged, and hence it is impracticable to use geophysical methods in many places. This is discussed later.

(c) Two prospecting aids that have not yet been tried out in the area are:

Dip Needle

Geochemistry or Biogeochemistry

neither of which run to great expense, unless the latter is done on an extensive scale.

With regard to the Dip Needle, it would be a simple matter to find out, by taking readings over the known ore, if differences in dip are caused by the pyrite, and if so, what degree of anomaly can be expected. The ground parties could, if favourable results were obtained from control, be equipped with dip needles and run these in conjunction with ordinary ground examination.

Biogeochemistry, (see attached notes), is still in the experimental stage, but it is thought that a few samples could be taken to establish if there is a marked increase in the Iron or Sulphur content of plants over the known ore, and, if this is the case, samples could be taken by the ground parties in the normal course of coverage. It must be pointed out that, if the process is to be of any value, systematic and thorough sampling must be carried out.

2 - <u>BULLDOZING</u>

Surface stripping by bulldozer could, it is felt, be carried out with advantage on both the East and West plateaux, and possibly other plateaux to the south of the mine.

The rental price of a bulldozer is high, ($10.00 per hour if hired on a daily rate, though this might be reduced on a contract) but if stripping or trenching is to be done, it is thought that this would be the most economical method.

3 - <u>GROUND SLUICING</u>

This has been carried out with satisfactory results in many parts of the province, but the distances over which lumber and/or pipe would have to be transported, and the difficulties entailed, would probably preclude its use.

4 - <u>DIAMOND DRILLING</u>

Drilling should be carried out to determine the possible extent and pitch of the South Lense; and possibly the 4' showing on the Sulphide #3 M.C. should be drilled.

5 - UNDERGROUND EXPLORATION

This work, coincident with mining on either a large or small scale is felt to be beyond the scope of this memo.

6 - GEOPHYSICAL EXPLORATION

It must be remembered that geophysical results can only be expected to show anomalies which might be caused by the presence of an ore-body. (Jakosky, A.I.M.M.E. Sept. 1949). Its purpose should be regarded as a step towards localizing direct prospecting, by drilling or trenching, etc. Modern practice tends to the use of two methods to cross-check each other, and in this case an electrical method for determining areas of better conductivity and a gravitational method would seem to be most suitable.

Keep this copy downstairs. All copies were sent upstairs.

March 19, 1953

ECSTALL

Ore Reserves:

The 1952 work brings the ore estimates up to about 7,000,000 long tons. Mr. Douglas' figures, including indicated ore, come out somewhat higher at 7,786,000. Mr. Guernsey estimates that the 1952 drilling campaign added over 2,000,000 tons to the 1940 figures.

This 1952 drilling confirmed that the dimensions of the North Lens are fairly accurately known. No limit, however, can be placed on the depth of the South Lens, and it is probable that this orebody extends in depth to the south and east. It can be regarded as certain that more ore will be found there.

Grade:

The grade of the North Lens was not re-determined and remains at the 1940 figures, as follows:-

Sulphur %	Iron %	Copper %	Zinc %	Gold oz.	Silver oz.
49.5	43.5	0.8	2	0.015	0.5

Of the approximately 3,000,000 tons of ore in the North Lens, it is believed reasonable that from 300,000 to 500,000 tons approximate 2% copper in the footwall above adit level. It is believed that a good proportion of this ore could be mined selectively if desirable.

The ore in the South Lens is somewhat lower in sulphur content but higher in zinc, average assay being about:-

Sulphur %	Copper %	Zinc %
47.5	.40	3.20

The precious metals contents in the South Lens ore are similar to those in the North Lens.

Exploration:

Drilling was carried out on a third outcrop to the north of the North Lens. Pyrite was found here but not enough work was done at depth to establish if the orebody is important.

Prospecting in the general area produced a good deal of information, some of which indicated other sections which appear worthy of further work.

The so-called Frizzell outcrop appears to have been identified at a point about half a mile from the head of Hanna Valley (see Holyk's report,page 29). One claim was staked in this area as recorded at Prince Rupert.

Geophysical work proved unsatisfactory and gave no concrete results, local and climatic conditions placing too great a strain on the apparatus being used.

The mine area was adequately mapped during the campaign, aerial photographs having been a great help in this connection.

Development of the Property:

Even before the additional reserves were found in 1952, Mr. Pat Stewart held the opinion that the mine should be put to work if an adequate pyrites market was available. It is now generally thought that the ore should move from the property over to the Douglas Channel, this involving some means of haulage over the distance of about twenty-four miles. Road haulage had been discussed and investigated, but Mr. Stewart believed that a railroad was the proper answer. The route has not been accurately surveyed, but it is believed that no paramount difficulties will be met with.

The ore can clearly be mined and shipped without treatment if circumstances should indicate this as the proper approach. However, it would seem that, upon any reasonable zinc market, the zinc contents should be recovered, and this could be carried out either at the mine, in which case a flotation pyrite would remain for sale, or at or near the point at which the pyrites is ultimately consumed. Conditions in the market in which the pyrite is to be sold will determine which of these alternatives is the proper one to follow.

A third possibility arises when the new hydroelectric installation at Kitimat is put to work. The Kitimat scheme for water power and aluminum production is a large one and we are told that power will be available for industry and that a large townsite will ultimately be constructed. Kitimat is about forty miles from the point at which the Ecstall ore would reach the Douglas Channel.

There appears to be a good deal of promise in some of the schemes now being worked out in Europe for the recovery of sulphur from pyrite, and one of these methods will recover the iron content in the form of electrolytic iron. If the process proves out, it is obviously on the cards that the Ecstall ore should logically move to Kitimat, where power is available, in which case all of the metallic content, together with the sulphur, will be recovered there. Further alternatives in this connection lie in the very considerable quantities of water available for power production near the property if this proved to be more attractive than taking the ore to the Kitimat hydroelectric plant. All of these alternatives are being studied, together with possible plans for selling the ore directly to consumers with recovery of metals from the calcines in the traditional manner.

C. T. Hill

CTH:AO
0+4

Keep this
Confirms our
expectations

LEDOUX & COMPANY

REPORT OF ANALYSIS

No. 689285 April 7, 1953

BY SPECTROGRAPHIC ANALYSIS:-

	T.G.S. ASSAY No. 12	T.G.S. ASSAY No. 13	T.G.S. ASSAY No. 14
	COMPOSITE DDH #56	ECSTALL #6 CROSSCUT N. R. 6 1940	ECSTALL LUMP ORE 1942
Silver	Faint Trace	Faint Trace	Faint Trace
Copper	Low	Low	Low
Iron	High	High	High
Silicon	Trace	Trace	Trace
Zinc	Low	Low	Low
Calcium	Trace	Trace	Trace
Germanium	None	None	None
Magnesium	Faint Trace	Faint Trace	Faint Trace

* * * * * * * * * * * * *

High 10-100%. Medium 1-10%. Low 0.1-1%. Trace less than 0.1%

Oct. 27th, 1951.

BIOGEOCHEMICAL PROSPECTING

While a relatively small amount of work has been done in this field, especially from a commercial viewpoint, experiments carried out in several countries over a period of some years prove that the normal metal content of plants and trees varies with the type of bedrock, and also varies irregularly, within certain limits, in areas underlain by only one type of rock. These limits must be determined by tests.

It has also been proved that, in the base metal field with relation to Copper and Zinc especially, there is a modification, sometimes to a conspicuous degree, of the normal ratio of Copper to Zinc by the presence nearby of Copper or Zinc mineralization, and, having determined these normals, it is possible to discover and plot anomalies. These may, under some conditions, be used to indicate the presence of nearby concentrations of Copper and Zinc. (Warren, Delavault, White).

The work is still in the experimental stage, but normal values are known well enough to enable any significant "highs" to be noticed immediately. Any systematic investigation will contain enough normal samples to enable normals to be established for that area.

No experiments have yet been carried out in B. C. or anywhere else, as far as can be ascertained, on deposits of Pyrite, and hence it is virtually impossible to foretell what results, if any, could be obtained from samples taken over this mineral. The cost of obtaining samples is not high, and it is suggested that a few might be taken as an experiment.

Samples taken could be analyzed for Copper and Zinc, as minor amounts are present in the ore, and might be sufficient in quantity to show an anomaly. A different method of analysis from the Dithizone neutral colour end point used for Copper and Zinc would have to be used for Sulphur.

Tests could be carried out for Iron, but this mineral is so general in distribution that in other places it has not proved satisfactory. However, the major concentration present in a large body of massive pyrite could, presumably, produce anomalies. Previous work on the Biogeochemistry of Iron has also produced the fact that Iron is not a satisfactory mineral, chemically, with which to work.

Sampling is carried out in two stages - 1, controls are established over known mineralized and non-mineralized areas; 2, unknown areas are sampled systematically, preferably on a grid system.

As has been mentioned, the majority of work has been in the field of Base Metals, and hence, in the following remarks, Copper and Zinc are taken as examples, though possibly similar methods could be applied for testing for Iron and Sulphur.

In a given area in which control has been established, one species generally available is selected, and young twigs are cut for each sample (half a dozen suffice). Sampling must be consistent, twigs of the same age from the same species being taken.

The Geological Department of the University of British Columbia are prepared to issue instructions for routine field analysis, if desired.

Up to the present it is not known exactly what is the maximum thickness of overburden over which satisfactory samples may be taken, though a figure of 30' is thought reasonable. The survey will merely reflect that part of the ground reached by roots, or possibly that part where ionized water reaches the roots.

All investigations point to the existence of a "metal shadow" above an ore-body, traceable in the metal content of the plant organs, and it has been proved that this shadow is essentially stationary in position, uninfluenced by the movement of ground water.

The width of this shadow has been shown to increase as the depth of overburden increases.

There are certain elements to be taken into consideration in proposing work of this experimental nature:

1. Cost
2. Practicability.
3. Likelihood of results.

1. The initial cost of apparatus and reagents sufficient for 200 samples is in the neighborhood of $100.00. 2 men can collect from 15 to 60 samples a day, depending on the terrain and precision demanded.

2. One species should be collected for each group of samples, and groups of trees of approximately the same age should be taken.

   Samples in any group should be taken from a relatively small area, in which, as far as possible, slope, drainage and pH are constant.

   Paper bags have been found to be the most suitable for collecting, as they eliminate salting. No difficulties have been experienced in this respect due to weather. Depth of overburden is a factor to be taken into consideration. The collecting of samples can be carried out in winter. Analysing is not necessarily a job for a skilled chemist. Good results can be obtained by an unskilled operator, but trouble may arise if some unexpected difficulty occurs, and difficulty may be experienced in spotting accidental salting promptly.

3. The possibility of obtaining results of more than academic interest is impossible to foresee. It must be emphasized that any work undertaken would be purely experimental, and, as such, no immediate positive results should be expected. Taking a broad view, however, it would appear that any method, of reasonable practicability, which might assist in the discovery of further ore-bodies, is worthy of some thought, and especially a method such as this, in which terrain and overburden are not disadvantages.

E. E. MASON

Mining Engineer.

White Rock, B. C.
Sept. 29th, 1951.

F. W. Guernsey, Esqre.,
744 West Hastings St.,
Vancouver, B. C.

Ecstall River Reconnaissance

Dear Mr. Guernsey:

Mr. Hull has furnished a general resume of the season's work. The party was smaller than was contemplated, necessarily limiting the scope of its objectives. These had been expressed as primarily the location and reconnaissance of the greenstone belt north and south of the property; and secondly, location of the Frizzell outcrop in the Clearwater watershed. Map knowledge of the area was meagre, being limited to the general course of the Ecstall river to the Quaal divide, and the topography of the property area.

Due to the late snow, work was confined to below the 2000-foot elevation until the end of July. It consisted chiefly of an exploratory traverse up the Clearwater River, finally establishing access to greenstone occurrences in Hanna creek; and of trail work preparatory to gaining the high relief north and south of the mine. Nothing such as the Frizzell outcrop was encountered in the limited reconnaissance done.

Subsequent work on this high ground served to clarify:

(1) the extent and structural trends of the greenstone belt in the "Mine Area" (between Lockaby and Allaire Creeks), and the position of the Hanna valley greenstones as within the former;

(2) the persistence of shear zones in repetition relative to the mine shears, from one ridge exposure to another;

(3) the general nature of the terrain occupied by the greenstone belt between Lockaby creek and the Quaal divide, the means of approach and possibilities of specific examination.

In the nature of the massive vegetation and the abrupt and difficult valley slopes, travel was inclined to be limited to individual courses aimed at gaining ridge elevations. Coverage of the area was thus scanty, and in the time allotted failed to include investigation of obvious shear possibilities. These are found chiefly in cliff exposures, and are equally obscured at upper elevations by alpine vegetation.

The work thus resolved itself into a preliminary reconnaissance, aimed to gain adequate planning of the scale and possibilities of future investigation of the area as a whole, or the immediate vicinity of the mine. Aerial maps and photographs of the area have also latterly become available.

Mine Area

so-called, is the area of the $\frac{1}{4}$-mile scale map currently under preparation, of the extent of the season's coverage.

The general nature of the topography has been made evident: consisting of deeply overburdened glacial valleys, with sharp slopes leading through upper bench remnants to high ridges and mountain peaks. The massive vegetation of the valley bottoms has been noted, continuing with dense underbrush about the 2000-foot elevation. Slopes above are thickly carpeted with low-lying alpine vegetation, until the range of major outcropping is reached about the 3000-foot elevation. Hence, rock exposures below this elevation are scanty, except where they form cliff exposures usually difficult of negotiation.

Examination of this country is thus best performed upon the high relief, where mineral bodies are least likely of occurrence. The valley bottoms are almost lacking in outcrops, and are commonly 300-500 feet in overburden. Cliff exposures at various intermediate elevations have yielded the sulphide orebodies; and the location of occasional pyritized shear zones, persisting to the extreme south of the map area.

These structures offer the likeliest localization of similar ore occurrences. The difficulties of adequate investigation along their length is self-evident, however; as also the odds against such an occurrence coming to significant outcrop.

In this reference, the 4-foot sulphide occurrence located in the upper reaches of Red Gulch canyon might be noted. It occurs in a sericitic shear zone in right-hand offset to the orebodies, and would seem at least 100 feet in length in almost inaccessible cliffs. A similar offset is evident between the South and North Orebodies, and their respective talcose and sericitic shear zones (as mapped by D.P.Wheeler). Limonite boils were also encountered in the limited reconnaissance of the East Plateau.

South of the mine workings, two shear zones were noted; the one presumably extending from the Red Bluff M.C. across the valley bottom and across the canyon of Allaire creek; and the second southerly from Swinnerton creek to Jensen Mt. The second occurrence requires clarification, and would seem to be located in the marginal phase, partially enclosed by granite. Limonite boils were noted in two places on creek exposures along the West entry to Allaire Ridge.

The question of relative importance of investigation as along the continuity of strike of the orebodies, and upon the major offsets of the shears noted, is one that can only be resolved as adequate knowledge of the structures is gained. Observed cleavages, however, indicate a pattern of flexture in the greenstones offsetting westerly to the south, to the bottom of the map area at least. It is particularly marked on Allaire Ridge south against Jensen Mt., furnishing the greenstone continuity into upper Hanna valley. A thickening of the "belt" is also indicated across this section, reaching into the ridge flanking the Ecstall river on the east.

Lockaby Creek - North

This stream occupies a valley largely below the 1000-foot elevation, at the north end of the map area. The presumed continuity of the greenstone belt to its north is occupied by a pyramidical peak of about 4200 feet elevation. In its southerly exposure, it is largely covered by alpine vegetation and lacking in rock exposures.

Drainage is northerly, offering the probability of lower relief in that direction. Only visible access from Lockaby creek is by sharp climbing to a valley in granites (about 2800 feet elevation), flanking the peak on the west. A preliminary reconnaissance from the air would resolve the question of alternative access, and the extent of committment required to investigate the "belt" in this direction.

Mine Area - South

A length of 6 miles of greenstone belt is presumed available to examination from the Ecstall river valley, in its course south from the Johnston creek junction to the Quaal divide (see 1-mile scale map). Greenstones have been observed on Upper Ecstall Lake and the divide.

The river hugs the base of a ridge striking southerly from Peak "A", with broad valley bottoms to the west. Three or four wooded spurs rise westerly into bench remnants before joining the mountain massif between the Ecstall and Clearwater watersheds. Separation is effected by Allaire, Balan, Cox and Durham creeks. The spurs or ridges are similarly named, upon the north of each creek. As observed on Allaire Ridge, the bench remnants are further chopped up by intervening watercourses. A relative chain of such are also found on the west slopes of Jensen Mt.

Two or more base camps will be required on the valley bottoms to cover this area, with kicker conveyance to each spur. Temporary location at upper bench elevations will further extend the performance of working parties in the areas of maximum visibility. The limitations to observation both above and below the timbered zone have already been noted, however. Application of geophysical methods if practicable, would hence seem indicated.

Geophysical Investigation

A geophysical survey was conducted in 1937, on the valley flats south of the mine workings. It had the appearance of lacking responsible direction, competent supervision arriving only near its completion. Suspicion was also voiced by the operators as to the competence of the "self-potential" method as applied. In view of the tendency towards commercialization of these methods, their application by salaried employees of the Company would seem more satisfactory.

Cross-sectioning of the mountain slopes for this purpose was not considered practicable at that time; nor was it in relation to the expense and formalized schedules of such contracts. A broad patchwork of such work is possible, however; specifically about the bench remnants, and on a lesser scale upon interconnected plots in the path of such as the shear structures.

Air Surveys & Services

The question of airborne geophysical surveys has been raised. The sharp high cliffs of the Ecstall Valley walls and narrow canyons formed by tributary valleys, yield an impression of extreme hazard from down-drafts to both airplane and heliocopter, as viewed from the valley bottoms.

Reviewing the length of the greenstone belt from Lockaby creek to the Quaal divide from ridge elevations, there would seem small necessity of incurring these hazards in the course of such work. The tendency of cloud formations to rest about the 2500-foot elevation would indicate greater usefulness of the heliocopter. Further, the broad distribution and nature of the upper bench remnants offer numerous landing points for same.

The extensive use of the heliocopter on the Kemano-Kitimat projects of Aluminum Corporation, is in adjacent and similar terrain. Tariffs as supplied by the Federal Department of Fisheries at Prince Rupert, of either vehicle, is $80. per hour from point of base, or for a season's charter of 300 hours. Cost in relation to usefulness hence requires consideration.

Frizzell Outcrop

The existence of a sulphide outcrop in the Clearwater watershed was described by the late George Frizzell and J. B. Roerig. These were responsible persons; and while its value might be questionable, of the existence of the occurrence as such there should be little doubt.

Roerig described its location as within a day's journey from the Ecstall river; and supplied a sketch indicating the valley of Roerig Creek. This country is in granits, however; and lacks the grassland shown in two photographs of the outcrop bench.

Opening of a trail into Hanna valley brings it into the range described, and into the west flank of the greenstone belt. In all respects, it would seem the likeliest location.

The valley is thick in underbrush, and with numerous snow and rock slides. It has been estimated that from four to six weeks would be required to scout it thoroughly, with the crew as was constituted. Relative to its moderate elevation, October would provide the ideal month in normal years.

Yours very truly,

"E. E. Mason"

PRODUCTION POSSIBILITIES

ECSTALL MINE

Dolmage, Mason and Stewart Ltd.

July 11, 1961

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GEOLOGICAL AND MINING ENGINEERS
1119 MARINE BUILDING
VANCOUVER 1, B.C.

VICTOR DOLMAGE
E. E. MASON
J. W. STEWART

PART I - INTRODUCTION

The property consists of 21 crown granted mineral claims, 920 acres total area, and adjoining surface rights to two land purchase lots 104.9 acres in area. It is located on the Ecstall river, 34.5 miles upstream from its junction with the Skeena river estuary. The Skeena is the second of the two major rivers of British Columbia, entering the Pacific Ocean about 15 miles south of the port of Prince Rupert, B. C. (See Dwg. 1).

The Ecstall river flows northerly, through a broad, low glacial valley in the Coast Range mountains, paralleling the coast line 16 miles to the east. The southerly portion of this trench is occupied by the Quaal river, a lesser stream, meandering southerly into the Douglas Channel. This latter is a deep-sea indentation from the open Pacific at the head of which is located the Kitimat plant of the Aluminum Company of Canada.

The topography is extremely rugged, the mountains rising sharply from the valley floor to a general elevation of 4000 feet. There is ample low ground on the property, however, to accommodate major plant and camp installations.

Precipitation is heavy, ranging from 130 inches to 200 inches annually. The low ground thus is thickly timbered with big spruce, fir, hemlock and cedar, and with dense underbrush, typical "rain forest". The valley walls rise sharply to timber line between 3000 feet and 3500 feet elevation above sea level, however, with widespread cliff exposures bare of soil or vegetation. Runoff therefore is high, quickly affecting water

PART I – INTRODUCTION (cont'd):

levels of the upper Ecstall and its tributaries. Winters on the whole are mild, but very heavy falls of wet snow occur, usually followed by rising temperatures and rain. From two to three feet of wet snow may lie on the river flats as late as March.

Access to the property is by water route from Prince Rupert 30 miles to the Skeena–Ecstall junction, thence 34.5 miles to the property. The lower 28.7 miles of the Ecstall is available to boats of five to six feet draught within 4 hours about the peak of a 16–foot tide. A boat of 42–inch draught can reach within 3½ miles of the mine wharf on a 16–foot tide. Tidal highs range from 14 feet to 22 feet with lows down to zero as gauged at Prince Rupert harbour. Tides of 16–feet height and over form about 75 per cent of all tides. During the winter, however, the river is closed to navigation for an average of six weeks by drift ice packed by the motion of the tides. For the last six miles below the property this closure may extend through December, January and February, and occasionally for short periods in November and March.

The property was diamond drilled by the Granby Consolidated Mining, Smelting & Power Company Ltd., in 1917, 1918 and 1919. It was acquired for the Texas Gulf Sulphur Company in 1937, and check drilled that summer. Camps were erected and a plant installed the following summer. An 8' x 9' adit was driven to examine the ore occurrences underground some 300 – 450 feet below the outcrops during the succeeding two seasons, and further diamond drilling done from this working. Subsequently, additional diamond drilling was done from underground in 1952 which traced the South Lense to a depth of roughly 1000 feet below the adit level. Several sets of plans and sections of the orebodies have been made at various times and are in the Company files. These have been drawn upon to estimate the figures of ore reserves used in this report.

ORE OCCURRENCES

They have been described in detail in the Granby and Texas Gulf Sulphur Company's records. Briefly, the ore occurs as massive pyrite replacement in the form of two lenses said to be localized by folding along a major shear. These lenses are 1000 and 1750 feet long north and south lenses respectively, from 75 - 150 feet wide in the first instance and 20 - 50 feet wide in the second. They occur in echelon as shown in the attached Dwg. 5, which also shows the development done upon them. The North Lense has bottomed about -100 feet sea level, while the South Lense remains open at -960 feet elevation.

The pyrite occurs in equigranular grains, and comprises from 90 to 95 per cent of the ore mass. Associated are chalcopyrite, sphalerite and some pyrrhotite. A little lead and traces of arsenic are found also. A calcite-quartz-sericite gangue constitutes about 5 per cent of the whole.

A feature of this occurrence is its failure to produce a gossan in weathering. It breaks down rather into a sand composed of pyrite grains, which seem to retain their identity indefinitely. An ore dump left by Granby appeared thuswise 20 years later. Same can also be observed along the outcrops on Red Gulch creek.

ORE TONNAGES

These have been severally estimated on the basis of the Texas Gulf Sulphur Company's work with minor variations in total. The following figures can be considered representative:

	North Lense	South Lense	Total
Above Adit Level	2,814,000	824,500	3,638,500
Adit Level to -100' elev.	586,000	646,000	1,232,000
-100' elev. to -960' elev.	-	2,712,500	2,712,500
Totals	3,400,000	4,183,000	7,583,000

ORE GRADES

The following lists the number and source of diamond drill ore intersections from which the ore grades are estimated, including the Granby figures:

	North Lense		South Lense (to -100' el.)		South Lense (-100' to -960' el.)
	T.G.S.	Granby	T.G.S.	Granby	T.G.S. Only
Holes Drilled	33	22	6	5	11
Ore Intersections	23	21	6	5	6
Feet Drilled	9481	8365	1009	885	5943
Feet in Ore	3140	4276	172	265	281
Assays, Au. ozs.	.015	.02	.013	.01	(?)
Ag. ozs.	.50	.74	.80	.60	(?)
Cu.%	.80	.85	.90	.50	.28
Zn.%	2.0	2.2	3.1	2.9	2.9
Fe.%	43.5		41.0		41.5
S%	49.5		47.5		47.6

Development since 1937 has been aimed primarily at evaluating the pyrite potential, other metal values being considered incidental. The above data is adequate for the purpose having regard to the uniformity of the pyrite occurrence throughout the deposit. It cannot be considered equally so in relation to the irregularities of copper and zinc distribution, and the gold and silver values that report largely with the chalcopyrite.

However, examination of the drill sections (including Granby's) suggest that a reasonably characteristic analysis of the North Lense as a whole can be obtained from averaging the drill cores. Drilling of the South Lense is less extensive, and relatively scanty below -100 feet elevation. Some additional drill intersections at and above the adit level would be useful to confirm the current ore grade estimate or otherwise. Estimates below the -100 feet elevation are based on four intersections only, and require more detailed investigation.

ORE GRADES (cont'd):

The following are the ore grades used in this report:

	Au.	Ag.	%Cu.	%Zn.	%Fe.	%S.
North Lense	.015	.50	.80	2.0	43.5	49.5
South Lense, above -100'	.013	.80	.90	3.1	41.0	47.5
South Lense, below -100'	(?)	(?)	.28	2.9	41.5	47.6

(?) Lacking assays.

PRODUCTION POSSIBILITIES

World sulphur production in relation to markets present and forecast is such as to preclude profitable production of pyrite from this deposit. Massive tonnages are reported stockpiled elsewhere as sales outlets are becoming more difficult to find. Current quotations range about $4 per ton, less commissions.

Failing profitable pyrite production there remains the following possibilities:

PROPOSAL A — Production of a copper and a zinc concentrate, or a combined copper-zinc concentrate.

PROPOSAL B — Production of a copper concentrate frommining selected sections of the orebodies containing higher copper values.

PROPOSAL C — Reduction of pyrite residues from each of the above to iron and sulphur products for separate sale or disposal.

There appears to be an increasing market for copper and zinc concentrates and iron ores in Japan. Several major Japanese trading companies now maintain offices and technical representatives in Vancouver. They are responsible currently for the existence of British Columbia's iron production and have contracted for the bulk of its production of copper concentrates.

PRODUCTION POSSIBILITIES (cont'd):

In some instances they have provided funds for capital outlays in advance of contracted production.

Quotations were asked of the Sumitomo Metal Mining Company Limited and Ataka (Canada) Limited specifically in connection with quantities and grades of concentrates estimated in this report. Terms of existing contracts and shipping facilities were also considered. These included the published smelter schedules of the Trail Smelter of the Consolidated Mining & Smelting Company of Canada for zinc, and of the Tacoma Smelter of American Smelting & Refining Company for copper.

Stanley Gray P ENG.
METALLURGICAL CONSULTANT
PHONE: FAIRFAX 7-1208

196 WEST 44TH. AVENUE
VANCOUVER 15, B. C.

May 31, 1961.

NOTES ON ECSTALL RIVER MINE ORE

SUMMARY:

Treatment of this ore, as advocated by Mr. H. MacDonald, would not be economic, even with the higher copper and zinc prices.

Treatment recommended for the recovery of the copper, zinc, gold and silver is floatation of all the tonnage after it has been crushed and ground to pass a 40 mesh or, if found necessary, a 65 mesh screen. As shown later on, the estimated or probable production from average feed grade of .86% Cu., 2.2% Zn., and .2% Pb. would be as follows -

29.25 tons Copper concentrate assaying 25% Cu., .45 oz. Au. and 17 oz. Ag.
30 tons Zinc concentrates of 55% grade.

Value of this at a shipping point would amount to $5.10 per ton of ore mined, as shown later on in the report.

Production of high grade iron, assaying 66% or more, can be made by roasting of floatation tailing. This grade of iron would be worth about $9.00 per ton at shipping point provided copper content could be kept at .1% Cu. or lower. As roasting to either magnetite or hematite would lower tonnage of tailing by about 30%, the copper content of tails would have to be kept at .07%. No trouble would be experienced in making a calcine of 2% S. The Dorr Fluo-Solid roaster, or mostly any type of roaster, can produce a low sulphur calcine. However, roasted calcine would have to be sintered before shipping to Japan. Cost of this, plus transporting from the mine to Prince Rupert, would be about $5.50 per ton.

Sulphur would almost certainly have to be removed from the roasting gas, either as elemental sulphur, acid or liquid dioxide.

Capital cost of a plant for roasting and sintering iron would run about a million dollars. For removal of the sulphur, cost of plant would depend on method of recovery in the form which could be sold.

(1) ORE RESERVES:

Tons	Au. oz.	Ag. oz.	Cu. %	Zn. %	Pb. %	As. %	Fe.	S.
3,800,000	.02	.74	.86	2.2	.2	.07	42.7	49.3
450,000	.028	.52	2.0					

The description of the ore body, as set out in the report of H. MacDonald, is as follows:

90% of pure recrystallized pyrite of even sized grains makes up the bulk of the body, with the remaining 10% carrying the Cu., Zn., Pb., Au. and Ag. This small fraction occurs in the interstices between the relatively coarse pyrite crystals. On account of this the report suggests the whole mass be lightly crushed to free the crystals of pyrite, at the same time grinding these as little as possible so they can be screened out, leaving a fine residue containing the bulk of the economic minerals.

(2) PRELIMINARY TREATMENT:

The preliminary treatment, as outlined, is to crush and grind fine enough to discard about 80% of the tonnage mined. Laboratory crushing to minus 10 mesh on .7% Cu. shows the following:

	% Wt.	% Cu.	Cu. Dist.
(+40 M.	53	.5	38.0
(-40 M.	47	.93	62.0
(+100 M.	85.4	.48	60.0
(-100 M.	14.6	1.96	40.0
(+120 M.	91.0	.52	68.0
(-120 M.	9.0	2.5	32.0

The above figures show that grinding as coarse as this, i.e. -10 M., is of no value whatsoever.

Lab. testing, grinding dry and screening everything through 40 mesh and then rescreening through 100 mesh showed the 33.3% of minus 100 mesh to contain 70% of the copper at 1.96% grade from a .73% Cu. head assay.

Further tests run by water classification, and I assume, of about the same screen analysis, gave similar results as dry screening. The metallurgical balance shown below is about what could be expected when crushing and grinding the ore to all minus forty mesh and then screening out or washing out the minus 100 mesh to concentrate the copper, zinc, gold and silver.

			Assay					Distribution			
	Tons	% Wt.	Cu.	Au.	Ag.	Zn.	Cu.	Au.	Ag.	Zn.
Feed	3,800,000	100	.86	.02	.74	2.2	100	100	100	100
Conct.	760,000	20	3.22	.047	2.6	7.7	75	47	70	70
Tails	3,040,000	80	.27	.011	.27	.62	25	53	30	30
Products		100	.86	.02	.74	2.2	100	100	100	100

The results of these tests indicated it would mean that only 200 tons a day would have to be treated from mining, crushing, grinding 1,000 tons a day and, while the eighty percent discarded is high in both Copper and Zinc, it was advantageous as treatment by floatation was not considered possible. Direct smelting, or roasting, followed by leaching and production of sulphuric acid were the two methods contemplated, and hence capital costs would be so much lessened as to make this treatment very attractive.

RECOMMENDED TREATMENT:

While grinding this ore all minus 40 mesh may not be fine enough to give optimum recoveries of Copper and Zinc, it certainly can be floated at this grind. This means that the only additional capital expenditure will be for the extra float capacity. To crush and grind 1,000 tons somewhat finer, say to minus 65 mesh, will cost very little more than the 40 mesh.

Of course it is absolutely essential that much more floatation testing be carried out than has been done. The few tests run have all been on feeds differing widely from the average Copper, Zinc, assay. The three tests run by the Bureau of Mines in 1948 convey the most information, but were run on ore assaying 1.26% Cu. and .65% Zinc and ground to 74% minus 200 mesh.

Results follow:

TEST NO. 2

	% Wt.	Cu.	Zn.	Cu.	Zn.
Rougher Cu. Conc.	9.23	13.2	2.7	96.5	39.1
Rougher Zn. Conc.	2.76	1.7	14.3	3.5	55.6
Tails	88.01	-	.04	-	5.3
Computed	100.0	1.26	.65	100.0	100.0

The above shows excellent recoveries in the roughing circuit but reagent consumption, especially lime, is very high. The cleaning work was poor. The results of these and also of earlier tests show the need for an extensive floatation campaign.

From these few tests I judge a Copper grade of 25% with 85% recovery, and of Zinc a 55% grade with a 75% recovery can be achieved. The following metallurgical balance shows a probable mill run.

Due to high pyrite content of the ore, floatation will require higher reagent consumption than a normal ore, so that the cost of milling may run from $1.40 to $1.50 per ton for a 1,000 ton operation.

ESTIMATED METALLURGY - 1,000 TON .86% CU. ORE

			Assay					Distribution				
	Tons	% Wt.	Au.	Ag.	Cu.	Pb.	Zn.	Au.	Ag.	Cu.	Pb.	
Feed	1,000	100.0	.02	.74	.86	.2	2.2	100.0	100.0	100.0	100.0	10[illegible]
Cu. conc.	29.25	2.925	.47	17.0	25.0	3.5	7.0	68.6	70.0	85.0	50.0	[illegible]
Zn. conc.	30.00	3.00	.03	1.0	2.2	1.0	55.0	4.5	4.0	7.9	15.0	75
Tails	940.75	94.08	.006	.2	.065	.07	.34	26.9	26.0	7.1	35.0	[illegible]
		100.00	.02	.74	.86	.2	2.2	100.0	100.0	100.0	100.0	100

ESTIMATED VALUE CU. AND ZN. CONCENTRATE

1,000 tons of .86% Cu., milled as above

29.25 tons Cu. Concentrates	=	$ 3,864.00
30 tons Zn. Concentrates	=	$ 1,320.00
		$ 5,184.00

Copper figured at 20¢ per pound
Zinc figured at 4¢ per pound
Au. at $35.00 per oz.
Ag. at 90¢ per oz.

1,000 TON MILL:

The attached flow sheet covers the equipment necessary to float 1,000 tons per day. The rod and ball mill shown should provide a feed of minus 65 mesh if this is found to be necessary.

Cost of such a plant, if equipped with new equipment, will run at least $1,250.00 per ton, or $1,250,000.00. This price could be lowered to, perhaps, half of this or from six to seven hundred thousand dollars if used equipment is bought.

Power consumed will run about 16 K.W. hrs. per ton, and water requirements will be 410 Imp. G. M.

Two men will be needed for the one shift crushing and two operators and one helper on each of the floatation shifts, i.e. a total of eleven men.

Cost of treating a Copper, Zinc ore with smaller amounts of pyrite, say 10 to 15%, should not exceed $1.15 to $1.20, but the extra reagents which may be needed in treating a 90% pyritic ore such as this might increase milling costs to $1.40 to $1.50 per ton. For this reason it is essential that a thorough testing programme be carried out to establish the most economic grind and reagent balance.

TEXAS GULF SULPHUR COMPANY, NEW YORK, NEW YORK

INTER-OFFICE COMMUNICATION

MEMORANDUM

Date: September 5, 1961

To: Mr. R. D. Mollison

From: W. Holyk

Subject: Report by Dolmage, Mason and Stewart, Ecstall River Mine July, 1961.

In their report on the Ecstall River sulphide deposit, Dolmage, Mason and Stewart have considered three proposals for the mining of the ore bodies.

One proposal (B) to mine 400,000 tons of roughly 2% copper ore from selected portions of the ore body, 200 tons daily rate, total life 5.5 years, fails to recover total capital outlay.

The second proposal (A) of mining 5,386,000 tons readily recoverable ore to 500 feet below adit level, at the rate of 1000 tons per day, over a period of 15 years, and producing copper and zinc concentrates, would recover total capital outlay and provide slightly more than 9% return on capital investment. Using their figures of estimated profits the following figures apply:

Present Value Future Earnings at 9%		$3,330,100
Capital Outlay		
Immediate	$2,200,000	
Present Value $576,500 in yrs. @6%	351,460	
Present Book Value	728,170	
		$3,279,630
Balance		50,470

The third proposal (C) is based upon roasting 160 tons of pyrite daily in addition to producing copper and zinc concentrates from a 1000 ton daily operation over 15 years as above. This calls for disposal of the sulphur products to the atmosphere or water and the roast limit of 160 tons per day considered to be the maximum allowable. Capital is recovered in 15 years providing nearly 13% return on capital investment. The following figures apply:

Present Value Future Earnings at 13%		4,310,840
New Capital	3,622,150	
Present Book Value	728,170	
Total Capital		4,350,320
Balance		(39,480)

It is interesting to note that an increment of nearly 4% return arises by roasting 160 tons of pyrite daily. Approval of discharge of the resulting sulphur products to the atmosphere or water shed is dubious. It would be of interest, however, to study the economics for total processing of pyrite using the TGS-Inco method, or the Hill process and recover both sulphur and iron.

SUMMARY OF REPORTS ON THE ECSTALL MINE

R. H. CLAYTON

January, 1962

SUMMARY OF REPORTS ON THE ECSTALL MINE

R. H. CLAYTON

January, 1962

INTRODUCTION

This report is a synthesis of previous reports on the Ecstall property. Excerpts and information from the following reports have been included. They have not necessarily been acknowledged.

Production Possibilities, E.E. Mason (Dolmadge, Mason and Stewart Ltd.) 1961
Geology, H. Douglas (T.G.S.) 1953
Geologic Report, W. Holyk (T.G.S.) 1952
Ore Estimates, H. Douglas, 1953
Northern Pyrites, 2% Copper Ore, E. E. Mason, 1941
Transportation and Tonnage Possibilities, E.E. Mason, 1941
Granby Reports, H.J.C. MacDonald (Granby) 1917, 1918, 1920

DESCRIPTION OF THE PROPERTY

Location

The property consists of 21 patented claims, 920 acres in area, plus 105 acres adjoining surface rights. It is located on the Ecstall River 34½ miles south from its junction with the Skeena River about 6 miles from its mouth. The mouth of the Skeena is about 15 miles south of Prince Rupert, B.C. (Drawing 1)

Transportation

The Ecstall River flows N.N.W. into the Skeena in a broad low glacial valley. The valley extends southerly from the mine about 30 miles to Douglas Channel where there is deep water.

The Ecstall is not navigable at the mine. Distances from the mine at which vessels of different drafts can travel are as follows:

Place	Distance	Draft	With tide of	Time
Mine wharf	0	16 in.	18 ft.	
" "	0	30 in.	18 ft.	1 hr.
Frizzell's	3½ mi.	42 in.	18 ft.	
Clearwater	5	5 to 6 ft.	19 ft.	2 hr.
Terminal B	6¼	" " "	16 ft.	4 hr.
Spalding's	10	" " "	low water	
Balmorel	35	48 ft.	" "	

75% of tides are over 16 ft.

The transportation alternatives are thus:

1. a Rail or road from mine to scow landing, $3\frac{1}{2}$ to 10 miles or 10 miles depending on draft of scow and the degree of independence from tides required. Occasional pack ice just below the mine in winter might also be a factor in making the railway longer rather than shorter.

   b Scow from Ecstall River rail terminal to deep water at Balmorel or Prince Rupert.

   c Ship from Balmorel or Prince Rupert.

2. a Rail or road 23 miles south to connect with Douglas Channel.

   b Ship from Douglas Channel.

Climate

Precipitation is heavy, from 130 to 200 inches. Flash floods are common. Winters are mild so that snow cover rarely exceeds 3 feet except immediately after snow-storms. Pack ice is brought in by tidal action during the winter from the Skeena, closing the whole river for about 6 weeks, and the 6 mile stretch immediately below the mine for 3 months or more.

History

The property was diamond-drilled by Granby Consolidated in 1917, 1918 and 1919. It was acquired by the Texas Gulf Sulphur Company in 1937 and further drilling was carried out from that time until 1940. An 8' x 9' adit was driven some 300-450 ft. below the outcrop and 80 ft. above sea level. It extends 2,760 ft., with an additional 642 ft. of crosscuts and 562 ft. of raise. Further drilling was carried out in 1952.

Ore Occurrences

The ore occurs in two en echelon lenses. They strike N-S and dip about 80°E, and are known as the North and South Lenses. There are indications of a third lens to the east of the North Lens. (See isometric block diagram, Drawing 2.) The North Lens outcrops at about 600 ft. above sea level and bottoms out at 100 ft. below sea level. It is 1,000 ft. along strike and has a maximum width of 150 ft. The thickness is contoured in Drawing 3. It bottoms out abruptly with no continuation of structure. The South Lens measures 1,750 ft. along strike and has a maximum thickness of 50 ft. It remains open at 960 ft. below sea level. The third lens is spotty near the outcrop but has not been tested at depth.

The pyrite occurs in equigranular grains ranging from coarse to extremely fine and massive. It does not form a gossan, but disintegrates to a pyrite sand. About 90% of the ore is pyrite, 5% pyrrhotite, sphalerite, chalcopyrite and galena, and 5% calcite-quartz-sericite gangue.

Tonnages

Mason's latest figures (thickness 10 ft. or greater) are (short tons)

	North Lens	South Lens	Total
Above adit level	2,814,000	824,500	3,638,500
Adit to -100ft.	586,000	646,000	1,232,000
-100 ft. to -960 ft.	0	2,712,500	2,712,500
	3,400,000	4,183,000	7,583,000

Douglas arrived at a figure of 7,786,000 tons. With the South Lens open at depth it seems safe to assume a total of more than 8,000,000 tons.

Grades (Mason)

	Au	Ag	Cu	Zn	Fe	S
North Lens	0.015	0.50	0.80	2.0	43.5	49.5
S.Lens above -100'	0.013	0.80	0.90	3.1	41.0	47.5
S.Lens below -100'	?	?	0.28	2.9	41.5	47.6

Grades (Douglas)

	Cu	Zn
S.Lens above -100'	0.9	3.1
S.Lens below -100'	0.28	2.9
S.Lens Average	0.44	2.95

Remainder similar to Mason's.

It can be seen that the ore can be divided into two sections, 4,870,000 tons with around 0.85% Cu and 2.2% Zn and 2,700,000 in the lower part of the South Lens with 0.3% Cu and 2.9% Zn. However, drilling at depth was aimed primarily at developing pyrite potential. There are only six ore intersections below -100 ft. in the South Lens, and while these are reasonably adequate to assess the pyrite, which is apparently continuous, they are not enough to give a reliable estimate of the somewhat erratic copper values.

Information Available

	North Lens		South Lens to -100'		Below -100'
	TGS	Granby	TGS	Granby	TGS
Holes Drilled	33	22	6	5	11
Holes in ore	23	21	6	5	6
Feet drilled	9481	8365	1009	885	5948
Feet in ore	3140	4276	172	265	281

It can be seen that the North Lens, with 44 intersections and 7,416 ft. in ore, is well established.

High Grade Copper Ore (2%)

Copper values tend to a greater concentration in the footwall of the North Lens (Drawing 4). This ore could be mined selectively without endangering the remainder of the deposit. The quantity and grade of this ore are variously estimated as:

	Tons	Ag	Au	Cu
Mason	400,000	0.028	0.5	1.9
	425,000	0.028	0.52	1.85
MacDonald	623,200	0.03	0.80	1.89

DEVELOPMENT PROPOSALS

Proposal A (Mason)

Production of a copper and a zinc concentrate or a combined copper-zinc concentrate.

Primary Development

Primary development is largely completed, but about 46,000 ft. of diamond-drilling is recommended.

Stope Development

The mining method proposed is sub-level stoping using percussion drills to ring-drill 3 in. diameter blast holes. No more than three rings need be blasted at any one time to maintain broken ore requirements so the risk of spontaneous combustion will be very small.

The pattern of stope development or preparation is laid down in Dwg. 5. These layouts are shown applied to a central block of the orebody comprising the major bulk of the North Lens. Remaining to this orebody north and south of this initial stope block are lesser tonnages for separate development of similar pattern. This disproportionate division of the orebody is made to yield optimum extraction performance and costs for the greatest part of the orebody; and, ground conditions permitting, limit the necessity of "slotting" to the development of the initial stope block.

The initial stope block is estimated to contain 1,643,000 tons. Of this, 168,000 tons is tied up in the floor pillar, and another 354,000 tons in the 50-foot central pillar shown on the plan. Such a pillar is a sensible precaution in an excavation of this size in untested ground. There is every reason to believe it will be successfully extracted, however. Similar precautionary support probably is necessary in the north and south stope blocks. These latter would not appear required beyond half the vertical distances in each instance. The three stope blocks are shown divided vertically. It may be found to greater advantage in the distribution and extent of pillar support to mine parallel to the plunge angle of the orebody. Such would not alter development ratios and costs to any practical extent, however.

About 8,545 feet of stope development work would be required to mine the 1,475,000 tons involved above the floor pillar. Of this 5,995 will need to be completed before production begins.

A further 2,846 ft. of development would be needed to recover the 168,000 tons in the floor pillar.

STOPE DEVELOPMENT

	Initial Stope Block	North Remnant	South Lens	South Lens
Tons ore above adit	1,643,000	681,000	490,000	824,500
Tons floor pillar	168,000	37,000	69,000	40,000
Net tons above adit	1,475,000	644,000	421,000	784,500
Central pillar, tons	354,000	78,000	54,000	-

(Continued)

STOPE DEVELOPMENT (cont)

	Initial Stope Block	North Remnant	South Remnant	South Lens
Tons per Foot				
With Central Pillar	173	150	140	100
Without Central Pillar	130	112	105	-
Cost Per Ton				
With Central Pillar	$0.20	0.24	0.25	0.34
Without Central Pillar	0.30	0.31	0.33	-

The foregoing tonnage figures represent the ore from adit to outcrop. To extract complete to outcrop Red Gulch Creek will need to be diverted. Otherwise creek pillars of 190,000 tons and 75,000 tons are estimated necessary to protect mining of the North and South Lenses respectively. Deducting these quantities, and excluding the floor pillars to be mined from stopes initiated below adit level, there remains 3,059,000 tons for extraction above the adit level; roughly 8.5 years supply at 1000 tons daily.

Ore Treatment and Returns

There has been very little metallurgical work done on this ore. Such mill tests as have been run used random samples not necessarily representative of the average grade of copper, zinc and precious metals estimated. These minerals have been found to occur preponderantly in the interstices between the pyrite grains and rarely within them, nor are the copper and zinc minerals intimately associated. Thus, it appears that moderate fine grinding will serve to release the great bulk of the ore minerals; secondly, that it will not be difficult to make relatively clean concentrates. Usually included in the mill tests have been certain lead recoveries. For metallurgical purposes, therefore, an average lead content of 0.2 per cent is assumed, and which reports with the copper concentrate. No value is attached to lead recoveries in these estimates, however.

Stanley Gray, Consulting Metallurgist, of Vancouver was requested to study the existing data and write an opinion on the metallurgical possibilities of this ore and costs of treatment.

Estimated Metallurgy

			Assays					% Distribution				
	Tons	%Wght.	Au	Ag	Cu	Pb	Zn	Au	Ag	Cu	Pb	Zn
Feed	1000	100	.015	.50	.80	.20	2.0	100	100	100	100	100
Copper Conc.	27.2	2.72	.344	12.9	25.0	3.7	7.0	63.0	70.0	85.0	50.0	9.5
Zinc Conc.	27.2	2.72	.03	1.0	2.2	1.1	55.0	5.4	5.4	7.5	15.0	75.0
Tails	945.6	94.6	.005	.13	.064	.07	.32	31.6	24.6	17.5	85.0	15.5
	1000	1000	.015	0.5	.80	.20	2.0	100	100	100	100	100

Recoveries of copper and zinc concentrates are reported totalling 54.4 dry tons. Copper concentrates from British Columbia usually go for treatment to the Tacoma, Washington smelter of the American Smelting and Refining Company, and Zinc concentrates to the Trail, B. C., smelter of the Consolidated Mining & Smelting Company of Canada Ltd., or the Kellog, Idaho plant of Bunker Hill & Sullivan.

Concentrate Shipment

Two routes are possible. One is by land south to deep-sea dockage at Kitkiata Inlet on Douglas Channel. The alternative is by water via the Ecstall River to the Skeena estuary, and thence to deep-sea docks at or near Prince Rupert (Drawing 2). The quantity entailed amounts to 54.4 dry tons, say 60 gross tons for shipment daily or 1800 tons per month, half as copper concentrates and the remainder as zinc concentrates.

The Douglas Channel terminal would be open to deep sea shipping at all times of the year. It will require the construction of from 21 to 22 miles of road, however, to connect to the property. The greater part of this distance is through valley deposits, chiefly sand with silt filling, and much of it is swampy. The road would rise about 100 feet in the first 10 to 11 miles to Ecstall lake and thence 60 feet to the summit of the divide between the Ecstall and Quaal River watersheds, in the next 1½ to 2 miles. Descent from the summit would be 130 feet to elevation 80 feet above sea level in the next 1½ miles. There would remain 8 miles of the descend to sea level at the Douglas Channel. From 2 to 3 miles of the route will require some rock excavation.

The type of road needed would be analagous to that constructed by logging companies to move 8 to 10 loads daily grossing 30 to 35 tons per load. Such a road when routed through the coastal swamps is being built on punching topped with two to three feet of gravel. The punching consists of logs laid longitudinally, anything from six to forty feet lengths, often tree tops of a logging operation. A small shovel is used to handle them, and of course gas-saws.

B. C. Forest Products engineering department reports a direct cost of $8,000 per mile for such construction in the Port Hardy and Prince Rupert areas, exclusive of camp expenses and equipment write-offs. Humphrey Construction of North Vancouver quoted a price of from $8,000 to $10,000 per mile for construction to the load standards described, and their preparedness to contract the subsequent trucking.

Rock work for such a road through the Ecstall-Quaal valley would not be heavy. The rock slopes are easy, and excavations would be limited largely to grading of the right-of-way. Cost is not expected to exceed $10,000 per mile. Thus, cost of this road 21.5 miles in length can be estimated at $215,000, plus allowance for trestle bridge work. A good dock location can be obtained on either shore of Kitkiata Inlet, offering sand foundations for piling against deep water. Cost of a loading dock and dolphins has been estimated at $125,000 roughly. Thus, total cost of the Douglas Channel road and dock in the range of $370,000.

If the Ecstall River route is to be used, first requirement would be a similar road constructed to a terminal 6 miles below the property (Terminal B. Drawing 3). This terminal would be closed by ice to navigation an average of 6 weeks each winter. At other times, two 500-ton scows can be handled by suitable tug between the river terminal and Prince Rupert on any 16 foot tide or better.

Thus, the concentrates would move by 10 ton truck 6 miles to the river terminal and be loaded on scows. These would be hauled to an ocean dock at or near Prince Rupert, and the concentrates be transferred with a clamshell or bucket elevator to a stockpile. Final transfer then is necessary to shipboard. As much as 20 foot tide differentials and more exist in Prince Rupert harbour and vicinity. Installations necessary include docks at the river and ocean terminals and the necessary equipment at each.

Several alternative methods of handling concentrates have been considered. Most promising is the palletizing of 2.5 ton packages of concentrates as practised by United Keno Hill Mines Limited. They ship lead and zinc concentrates via White Pass & Yukon Railway to Skagway, thence by coastal vessel to Vancouver, and then in Canadian Pacific Railway box-cars or gondolas to Trail, B. C. The containers are handled by fork-lifts to dump into the railway cars, torn down, serviced and packaged for return to Keno Hill. Off loading from vessel to wharf is accomplished at a rate of 90 tons per hour with a crew of 8 men, using the ship's slings and winch and forklifts. Reloading from wharf to gondolas is reported at a rate of 65 tons per hour, 8 men again.

The containers consist of a 3' x 6' plywood box on a steel frame, both designed to break down for packaging for return shipment. When loaded, the concentrate is covered with polyethylene pliofilm, and the whole is strapped to a pallet. Cutting the straps releases the load to dump. These packages can be handled by either fork lift or ship's sling.

Proposal B (Mason)

Mine the high-grade copper ore selectively.

A 200 tpd operation would mine 400,000 tons of 1.9% in 5.5 years.

The total profit would be of the same order as the present book value and would therefore be tax-free.

Proposal C (Mason)

Produce copper and zinc concentrates from a 1,000 tpd operation. Roast as much of the pyrite tailings as will enable the sulphur dioxide to be safely dissipated.

A roast of 150 tpd would produce 100 tons of iron products and 160 tons of sulphur dioxide. If this were passed through a spray tower 60 to 80 tons would be dissolved and 80 to 100 tons would pass into the atmosphere. This is a safe amount. The acid water would react with the alkaline mill tailing water to form a liquid with a p.H. of 5 to 6. This could safely be discharged.

The coarsest fraction of the tailings could be used. At plus 65 mesh it is believed that the roast could be shipped without sintering. A 70 to 71% iron product should be obtainable using a Dorr-Oliver roaster.

Proposal D (Clayton)

Although it is not economic to produce sulphur from pyrite, the combined value of sulphur and iron ore can be large enough to make the overall treatment of pyrite profitable, especially when the pyrite is already on the surface in the form of tailings.

A 1,000 tpd operation would produce about 120,000 tons of sulphur annually. Of this amount it would be possible to dispose of about 60,000 tons as waste according to Proposal C. If the remainder were converted to elemental sulphur using the T.G.S. - Inco method it could be marketed locally using barge transportation. The large freight advantage would enable a modest profit to be made on sulphur sales.

MEMORANDUM

Date: February 1, 1962

To: Mr. R. D. Mollison

From: R. H. Clayton

Subject: Treatment of Ecstall Ore

SUMMARY

Mr. E. E. Mason of Dolmage, Mason and Stewart, Ltd., in his report of July 11, 1961, has estimated that profitable exploitation of the Ecstall ore can be achieved by producing copper and zinc concentrates and roasting as much pyrite to produce iron ore as can be done without causing air and water pollution problems. His estimates give a return of 6 3/4% over a 15 year period on total initial capital, or 10.3% over the same period on net capital, i.e. the original total minus amortization paid to date. This latter figure seems to me the best measure of true interest rate. These rates are after all taxes and full amortization.

The profit rate could be considerably improved if more pyrite could be roasted. There appear to be several ways of achieving this; one is to roast the pyrite in oxygen and recover sulphur from the gas. Most of the sulphur could be disposed of in local markets. This factor, together with the profits from iron ore would make the process profitable at Ecstall although it was considered to be marginal at Copper Cliff. The net rates of return would be 7¼% on total initial investment and 11.0% on net investment. If all the pyrite could be roasted and the gases disposed of without extracting the sulphur the rates

would be 10.4% and 14.9%.

INTRODUCTION

Mason (1961) estimates that the Ecstall ore can be mined for its copper, zinc, gold and silver content on the following basis:

New Capital Outlay	Net Return	Period of Years
$2,200,000	$1,826,000	8.5
2,500,000	2,619,484	13
2,776,550	2,994,366	15

On the face of it, these would be profitable operations, especially for a Canadian company, but U.S. taxes during the tax-free first 3 years and the 15% dividend tax make them of doubtful attraction for this company. For this type of operation, outright sale to a Canadian company would be the most mutually profitable outcome.

The only way to establish a more profitable operation would be to find a market for the pyrite, which forms over 90% of the ore. Although pyrite is not worth mining (what little is sold is quoted at $4 to $5 at mine in Canada) the pyrite at Ecstall would be already mined and milled, so that if it could be sold for even $1 net, overall profits would be increased by over 50%. It might be possible to sell the pyrite to the Japanese. They seem very willing to buy all B.C. iron ore, and since they produce all their sulphur from pyrite they should be able to utilize the sulphur. Perhaps our present correspondence with Ataka will clarify this point. Alternately we could process the pyrite ourselves.

ROASTING

Mason proposes to roast 150 tpd out of a total mine production of 1,000 tpd, which he considers the maximum possible if pollution is to be kept within bounds. This will leave about 800 tpd in the tailings. Of course these tailings can be roasted at 150 tpd after the mine is worked out, but the present value of such an operation is very small. For this process Mason estimates a net return of $5,366,439 over 15 years on $3,665,000 capital investment. These figures are for a Canadian company.

For T.G.S. the situation would be:

Federal income tax (Mason)	$1,382,370
Provincial tax (Mason)	433,002
15% dividend tax	757,489
U.S. tax, first 3 years, less 15%	253,920
Total tax	$2,826,781

Gross income	$10,803,960
Taxes	2,826,781
Net income	7,977,179
Capital outlay	3,961,801
Net profit	4,016,378

This is 6-3/4% [7.4] on total investment and 10.3% [11.2] on net investment, assuming a steady income. Actually the latter figure would be larger because of accelerated amortization in the early years.

Mason bases his figures on a 150 tpd plant because that is the maximum which can be roasted without introducing pollution problems. However it might be possible to roast considerably more ore by one of the following methods:

1. Have two roasters, one at the mine and the other at the deep-sea dock.

2. Install the roaster on an offshore island.

3. Discharge the gas above the treeline by means of a pipeline.

Using two roasters the situation would be:

Capital outlay	$4,866,000
Net profit	5,868,000

This is 8.0% on total investment and 12.0% on net investment.

If all the ore could be roasted the figures would be:

Capital outlay	$8,485,000
Net profit	13,276,500

This is 10.4% on total investment and 14.9% on net investment.

The above figures are a projection of Mason's figures with adjustment for the extra taxes. It is assumed that the cost advantage of having a larger roasting capacity would be balanced by the added difficulties involved in dealing with the larger quantities of waste. If there were two roasters, one at the deep-sea port and one at the mine, the cost of installation would be almost double that of one roaster, but production costs would not be affected greatly because the bulk of the material would have to be shipped to the deep-sea port in any case.

A 10,000 ft. 30" x $\frac{1}{4}$" pipeline would cost about $500,000. Ancillaries and construction costs might double this figure. The assumption of equal cost thus implies that a roaster of six times the capacity would result in a saving of 18$\frac{1}{2}$% on construction costs per unit.

Alternately it would be possible to roast the whole of the pyrite and produce elemental sulphur from the excess sulphur dioxide using the T.G.S. method developed in conjunction with Inco at Copper Cliff. This is described by Barr, Buscemi, Conroy, and West, 1961, Vol I & II.

The pyrite may be roasted in air to produce a "roaster gas" or in oxygen to produce a "rich gas."

SULPHUR FROM ROASTER GAS

Barr, et. al. have estimated the costs of roaster gas plant to produce 110,200 tpy of sulphur, about the amount from a 1,000 tpd operation at Strathcona as follows:

Capital	\$14,275,000
Cost/ton	\$27.10
Gas composition	
SO_2 11%	
O_2 3%	

The cost per ton includes amortization, including amortization of working capital but no return on capital. It also includes 20% engineering and construction, plus contractors fee and contingency of 6% and 15% on the 120%.

The cost of production is probably a little less than the sale price in local markets (marketing is discussed below). The question then becomes one of whether profits from the sale of iron ore will justify the capital expenditure on sulphur production. A return of 10% on net invested capital with straight line amortization over 20 years would require an annual net income of \$1,264,000. The sale of iron ore would bring in about \$1,250,000. Thus the process is close to being economically feasable. Actually costs could certainly be improved because they have been worked out for Inco pyrrhotite ore, rather than for Ecstall pyrite ore.

The theoretical yield when roasting pyrrhotite in air is a gas containing 12% SO_2. In practice this is diluted to 11% SO_2 and 3% O_2. For pyrite the theoretical figure is 15.3% SO_2. It is reasonable to assume that the actual figure would be about 14% SO_2 and 3% O_2. This comparatively small increase could make a substantial difference to operating costs, and at least some difference to capital costs. If we extrapolate Giusti's graph (Barr et.al., Vol.II, p.88) it can be seen that a 3% increase in SO_2 content would reduce costs by about \$5 per ton. This would bring the process within range of being economically feasable. However oxygen roasting appears to be a more profitable process.

SULPHUR FROM RICH GAS

Barr et.al. have also estimated costs for the production of sulphur from rich gas containing 70% SO_2. A plant to produce 35,640 tpy of sulphur would cost \$2,401,000 and production costs, including amortization but no interest, would total, \$18.71. It is stated that "If, as seems possible, the annual production from this plant could be increased to 45,000 long tons, the manufacturing cost would be reduced to \$16.59 per long ton." Eliminating interest this figure becomes \$15.55. Let us assume that a plant to treat

100,000 tpy could be constructed for $4,800,000 and that the cost per ton would be $15.50 plus the cost of the oxygen. There is ample hydroelectric power in the area, and as this is the main factor in oxygen production it is assumed that it could be produced for the price quoted at Copper Cliff, $5.00 per ton.

Assuming a mine producing 1,000 tpd on a 6 day week to give 300,000 tpy and a roaster capacity of 900 tpd on a 7-day week roasting the whole 300,000 tons annually, of which the sulphur from 50,000 would go to waste and that from the remaining 250,000 would be treated in the sulphur recovery plant to produce 100,000 tons of sulphur and 125,000 tons of iron ore:

Production Cost of Sulphur	$15.50 per ton
Oxygen	4.45
	19.95
Selling Price	27.75
Profit	7.80

Profit on iron ore $8.00 per ton (Mason's figure)

Gross income, 15 year operation

Mason's "Proposal C" (Cu, Zn & waste-gas Fe)	$10,804,000
Sulphur, 100,000 tpy at $7.80	11,700,000
Iron Ore 125,000 tpy @ $8.00	15,000,000
	$37,504,000

Capital Expenditures

Mason's "Proposal C"	$3,962,000
Sulphur Plant	4,800,000
Additional roasters*	3,620,000
	$12,382.000

* Assumes a 20% saving per unit on Mason's estimates for six times the capacity.

Taxes

Gross Income		$37,504,000
Capital expenditure	$12,382,000	
Book value	728,000	
Amortization		13,110,000
Net income		24,394,000
Depletion		8,131,000
Subject to income tax, 50% + 17 2/3%		16,263,000
Income tax, Federal and Provincial		11,004,000
Net income	24,394,000	
Income tax	11,004,000	
Subject to 15% tax	13,390,000	
15% tax		2,009,000
Total taxes		13,013,000
Less advantage in first 3 years (41 2/3% of income)		1,355,000
Net Taxes		11,658,000
Gross Income		$37,504,000
Capital invested		12,382,000
Net income		25,122,000
Taxes		11,658,000
Net profit		13,464,000

This is $7\frac{1}{4}$% on total capital and 11.0% on net capital.

The figure for return on net capital could be increased substantially by fast write-offs in the first few years.

MARKETS

Sulphur sells at $27.75 in Seattle. About 60,000 tons is sold on the B.C. coast. It has been assumed that the Vancouver price is the same as the Seattle price and that handling costs would be the same from Ecstall or Vancouver.

There appears to be a ready market for iron ore and copper concentrates in Japan.

REFERENCES:

Barr, Buscemi, Conroy and West, Report on Sulphur Recovery from Pyrrhotite Roaster Gas, Research Dept., March 31, 1961, Vol. I and II.

Mason, E. E., Production Possibilities, Ecstall Mine, July 11, 1961.

RHC

TEXAS GULF SULPHUR COMPANY, NEW YORK, NEW YORK

INTER-OFFICE COMMUNICATION

MEMORANDUM

Date: February 8, 1962

To: Mr. R. D. Mollison

From: R. H. Clayton

Subject: Treatment of Ecstall Ore - Addendum.

One possibility was not covered in the previous memorandum. It consists of Mason's Proposal B (Mining the high grade copper ore over 5½ years) with Proposal C (roast 160 tpd to produce iron ore). Using Mason's figures, the profit situation is as follows:

	Capital	Income
Proposal B	$500,000	$470,000
Roaster	905,000	1,584,000
Book value	728,000	
	$2,233,000	$2,054,000
Income taxes		nil
Dividend tax 15%		308,000
Net income		1,746,000
On new capital of		1,405,000 in 5½ years.

22.5% on gross capital investment

35% on net invested capital.

It would also pay to mine and roast pyrite after the high-grade copper had been exhausted.

RHC

TEX GULF SULPHUR COMPANY, METALS DIVISION
TIMMINS, ONTARIO
INTER-OFFICE COMMUNICATION

MEMORANDUM

Date: January 7th, 1966

To: R. D. Mollison

From: R. H. Clayton

Subject: Proposal to mine 500,000 tons per year from the Ecstall Mine

The ore reserves fall into two categories, those above 100 ft. below adit level with 0.8% copper and those below that level which contain 0.28% copper. However, these lower reserves have been intersected by only 6 holes and the copper values are erratic throughout the orebody so the latter grade may not be representative.

Ore reserves above the - 100 ft. level are 4,870,500 tons of the following grade:

	Au	Ag	Cu	Zu	Fe	S	Py 50% S
Ore grade	0.0144	0.59	0.83	2.83	42.75	48.90	87.8
Mill rec. %	63	70	85	75			90
Cut grade	0.0091	0.41	0.706	1.75			79.0
Value f.o.b. mine	0.27	0.48	3.42	2.31			3.95

Total value f.o.b. mine $10.43

Below - 100 ft. there are 2,712,500 tons of the following grade:

	Au	Ag	Cu Pb	Zu	Fe	S	Py 50% S
Ore grade	No assays		0.28	2.9	41.5	47.6	88.0
Mill rec.			85	75			90
Cut grade			0.24	2.18			79.2
Value f.o.b. mine			1.16	2.88			3.96

Total value f.o.b. mine $8.00/ton ore.

Values are calculated as follows:

Zinc:

Price 13¢/ lb.
Con. 55%
Shipped to Japan

1100 lbs. - 15% @ 13¢		$121.55
Treatment charge	$41.41	
Freight	8.00	49.00
		$ 72.55

Per pound zinc in concentrate	6.60¢
" " " " ore	4.95¢

Copper

Price 32¢/lb
Con 25%
Shipped to Japan

500 lbs. - 4% @ 32¢		$153.60
Treatment	$12.50	
Refining	12.00	
Freight	8.00	32.50
		$121.10

Per pound copper in concentrate	24.22¢
" " " " ore	20.59¢

Silver

90% @ $1.29 = $1.16 per oz Ag in con.

Pyrite

$5.00/ton f.o.b. mine dock.

Capital Costs

In order to produce 500,000 tpy pyrite it would be necessary to mine 635,000 tpy ore. This would involve 1,750 tpd mill capacity and 2,000 tpd mine capacity. Capital costs would be approximately as follows:

Dock &	$200,000
Engineering/Construction	100,000
Loading facilities	150,000
Engineering & Construction	25,000
Road 25 miles @ $20,000.	500,000
Trucks	800,000
Mine buildings, erected	350,000
Mine and surface equipment & construction	3,400,000
Pre-production development	1,000,000
Mill building & equipment	4,000,000
Engineering & construction	1,000,000
Total	$11,525,000
Present book value	730,000
	$12,255,000

Operating Costs

Mining labor	$1.25	
Mining supplies	.90	2.15
Milling labor	.25	
Milling supplies	1.30	
Mill power finish	.60	2.10
Haulage, mine to dock		0.50
Local Overhead		0.50
General overhead		0.25
		$5.50

Operating profit $4.93/ton for ore above - 100'
$3,135,000 per year
$2.50/ton for ore below - 100'
$1,590,000 per year

Taxes

The 30% Canadian depletion allowance can be deferred until the fourth year because of the tax-free period. The U.S. depletion allowance of 20% declining balance is down to 8% of the initial capital expenditure by the fourth year. This difference is enough to offset the higher Canadian tax rate (including the B.C. tax of 10%), so taxes will be paid at the U.S. rate of 28.9% throughout.

Cash Flow ($000)

Yr.	Operating Profit	Depreciation & Pre-prod.	Taxable 28.9%	Cash Flow
1	3,135	3,135	0	3,135
2	3,135	2,384	751	2,917
3	3,135	1,347	1,788	2,618
4	3,135	1,078	1,305	2,541
5	3,135	862	1,443	2,478
6	3,135	690	1,553	2,428-
7	3,135	552	1,639	2,388
9	2,620	441	1,384	1,990
9	1,590	353	784	1,233
10	1,590	282	820	1,212
11	1,590	226	866	1,196

	$24,136,000
Discount 10%	15,436,000
New capital required	11,525,000
Present value @ 10%	3,911,000

D.C.F. rate of return 18%

Payout 6.1 years

Early selective mining of the high grade ore could increase the D.C.F. return and decrease the payout period.

Comparison with Dolmage, Mason & Stewart Reports

A report by E. E. Mason dated July, 1961 quoted operating costs of $3.60 to $3.80 per ton and capital costs of $2,775,000 for a 1,000 tpd operation.

The present estimates of $5.50/ton and $11,525,000 refer to an operation nearly twice as big and include extra costs to cover production and shipping of a pyrite concentrate. These assume moderately difficult milling problems and a somewhat poor recovery. There is a good possibility that costs will be lower in practice.

Milling Tests

Very little metallurgical test work has been done. More will be needed before a decision is made on production.

RDM

REPORT ON THE

FLOTATION TESTING OF

ECSTALL RIVER ORE

TESTWORK DONE DURING APRIL AND MAY 1967

November 15, 1967

By: J.H. Starkey,
Sr. Research Engineer.

TABLE OF CONTENTS

REPORT ON THE

FLOTATION TESTING OF

ECSTALL RIVER ORE

1. INTRODUCTION:

The ore used in this investigation, was a composite sample from six mine cross cuts, mixed in the ratio of bulk weights which were received, (see p. A2). The grade of this composite was as follows:

0.20% Pb	0.04 oz per ton Au
0.89% Cu	39.21% Fe
2.38% Zn	45.50% S
0.83 oz per ton Ag	7.79% SiO_2

The bulk material as received, was massively pyritic, very friable, and very coarse, the majority of it being plus 3 inches. Large samples were hand picked from each cross cut sample and these in turn, were crushed and riffled to give the desired weight for the composite mix. Further crushing in the rolls gave a minus 8 mesh product which was riffled and bagged in 2000 gm. lots for flotation testing.

The purpose of the test work was to determine the optimum grind as reflected by the best metallurgical results which could be achieved and to determine what reagents, in kind and amount, would be required. The flowsheet used in all of the tests, was very basic, consisting of a one stage grind followed by successive roughings of copper, zinc and pyrite concentrates in order. Open circuit water cleanings of the various rougher concentrates were added to some tests in order to reach maximum concentrate grades.

11. DISCUSSION OF RESULTS.

The results of this testwork are presented in the appendix to this report. The optimum laboratory results are tabled on page A15. These results show that a cleaned copper concentrate grading 27.0% Cu, 3% Pb, and 16 ozs per ton Ag was made with recoveries being 74, 37, and 47%, for the copper, lead and silver respectively. Rougher grades for these metals were 10% Cu, 1.6% Pb, and 7.5 ozs per ton Ag, with recoveries of 90, 65, and 72% respectively. Zinc results showed that a cleaned concentrate grading 60% Zn was made with a recovery of 75%. Roughing results for zinc showed the production of a 29% Zn rougher concentrate with 6% of the zinc remaining in the tails. By treating the zinc tailings for pyrite, a cleaned concentrate grading 53% S was made with a recovery of approximately 95% of the contained sulphur in the zinc tailings.

There are several points of interest to note with regard to the above mentioned cleaned concentrates. The copper concentrate assayed 1.3% Zn and 0.04 ozs per ton Au. The zinc concentrate assayed 0.29% Cd and the pyrite concentrate assayed 46% Fe, 0.05% Pb, 0.06% Cu, 0.15% Zn, and 0.20 ozs per ton Ag. These grades of minor elements refer only to open circuit laboratory work and could change radically in a closed circuit mill, if middlings were allowed to pass from circuit to circuit by the production of high grade concentrates.

Both 10 and 15 min. grinds appeared to give optimum recoveries of copper. However, the finer grind gave a slight improvement in rougher grade and cleaner selectivity. On the other hand, silver recovery was lower at the finer grind. The problem of optimum grind is confounded further by analyzing the zinc metallurgy. The best rougher recoveries were made at the finer grind but the most selective cleaning and highest grade of concentrates were produced using the coarser grind. The contamination of pyrite with base metals at these two grinds is almost identical so no preference can be made on this basis. At grinds coarser than 10 min. and finer than 15 min. results were quite inferior so it can be assumed that the optimum grind lies in this range. Reference to page A7 shows this range to lie approximately between 42 and 59% passing 325 mesh.

Copper flotation was unsuccessful in soda ash but worked very well in lime to a pH of 8.5 providing that aeration was used before conditioning. Reagents required for this operation were as follows: 1.0 lbs per ton of lime; 0.5 lbs per ton of $Zn\ SO_4$; 0.02 lbs per ton of NaCN and 0.20 lbs per ton of R208.

Zinc flotation was very successful using lime to a pH of 12 and Z200 as collector. Reagents required here were as follows: 3.0 lbs per ton of lime; 0.5 lbs per ton of $CuSO_4$; and 0.02 lbs per ton of Z200.

Very little experimentation was done with pyrite flotation but the reagents used seemed to do an adequate job. The reagents used were: 1.0 lbs per ton of H_2SO_4; 2.0 lbs per ton of soda ash; and 1.0 lbs per ton of potassium amyl xanthate. Dowfroth 250 was used as the frother in all of the testwork.

111. CONCLUSIONS.

Two projected mill balances are presented on page 116. The first assumes that high grade concentrates are to be made (26% Cu and 55% Zn), while the second assumes that lower grades (20% Cu and 50% Zn), will be made. Projected recoveries at these grades are 80 and 85% for copper and 85 and 87% for zinc for the high and low grades respectively. The assay grades for minor constituents shown in the table are only approximate and can be controlled to some extent by the addition of more depressants or collectors.

The optimum grind is approximately 50% passing 325 mesh. Perhaps more significant, however, is the consideration that nearly all of the coarse pyrite grains must be broken apart in order to release the values contained along grain boundaries. This degree of grinding is essential while further grinding accomplishes nothing because the pyrite grains are nearly barren (as shown by the assay of a pyrite concentrate).

If further work is required, it should be approached in the following order of priorities:

1. Investigate ways to remove lead from the copper concentrate as this normally is a very underirable element in such a concentrate.

2. Optimize reagent additions to give the lowest possible projected cost.

3. Evaluate the possible metallurgical benefit of regrinding middling products.

These results and conclusions refer only to the ore which is represented by the samples received. Variances in grade of heads should not have a large effect on the quality of concentrates produced but could drastically alter the cost of reagents needed because of the high sulphide content.

Respectfully submitted,

Starkey

J. H. Starkey,
Sr. Research Engineer.

A P P E N D I X T O T H E

REPORT ON THE

FLOTATION TESTING OF

ECSTALL RIVER ORE

APPENDIX A

[illegible]

SAMPLE DATE APRIL 17th, 1967 REPORTED

SAMPLE	LOT NO.	% LEAD	% COPPER	% ZINC	OZS./TON SILVER	% IRON	% SULPHUR	% [illegible]	[illegible]
[illegible] RIVER								[illegible]	[illegible]
1 x cut 1 ton		0.40	0.40	3.98	0.68	35.07	0.7	[illegible]	0.02
2 x cut 2 ton		0.4	0.3	4.02	1.09	39.55	46.10	5.27	0.02
3 x cut 1 ton		0.20	1.27	1.55	0.70	36.24	0.27	17.42	0.03
4 x cut 1/2 ton		0.22	1.00	1.10	0.88	41.78	47.32	5.47	0.04
4 x cut 2 ton		0.21	1.14	1.85	0.76	40.01	45.5	8.3	0.04
6 x cut 2 ton		0.22	1.25	1.42	0.58	42.47	47.78	4.40	0.04

ASSAYED BY

CHIEF CHEMIST

ANA. LAB.-1-6M-9-66

TEXAS GULF SULPHUR COMPANY, NEW YORK N. Y. 10017

INTER-OFFICE COMMUNICATION

MEMORANDUM

Date: August 31, 1964

To: R. D. Mollison

From: A. N. Myers

Subject:

On Thursday, the 27th, I visited with Mr. Saotome and Mr. Hirano, as you suggested. I showed them the report of Dolmage, Mason and Stewart Ltd. on the ECSTALL property, together with the map.

Mr. Saotome made a great many notes. They are extremely interested in buying concentrates on five to ten year contracts. They are willing to participate in the venture. They are definitely interested in the ECSTALL property and indicated a desire to have their geologists visit the property. They maintain an office in Vancouver which is staffed with two geologists.

I indicated that we had no one at the property and that he would have to make arrangements with you to see ECSTALL, which he said he would do in writing in the near future.

A. N. Myers

cc. Dr. C.F.Fogarty

DOLMAGE, MASON AND STEWART LTD.
GEOLOGICAL AND MINING ENGINEERS
1115 MARINE BUILDING
VANCOUVER, B.C.

VICTOR DOLMAGE
E. E. MASON
J. W. STEWART

PART I - INTRODUCTION

The property consists of 21 crown granted mineral claims, 920 acres total area, and adjoining surface rights to two land purchase lots 104.9 acres in area. It is located on the Ecstall river, 34.5 miles upstream from its junction with the Skeena river estuary. The Skeena is the second of the two major rivers of British Columbia, entering the Pacific Ocean about 15 miles south of the port of Prince Rupert, B. C. (See Dwg. 1).

The Ecstall river flows northerly, through a broad, low glacial valley in the Coast Range mountains, paralleling the coast line 15 miles to the east. The southerly portion of this trench is occupied by the Quaal river, a lesser stream, entering southerly into the Douglas Channel. This latter is a deep-water indentation from the open Pacific at the head of which is located the Kitimat plant of the Aluminum Company of Canada.

The topography is extremely rugged, the mountains rising sharply from the valley floor to a general elevation of 4000 feet. There is ample low ground on the property, however, to accommodate major plant and camp installations.

Precipitation is heavy, ranging from 130 inches to 200 inches annually. The low ground thus is thickly timbered with big spruce, fir, hemlock and cedar, and with dense underbrush, typical "rain forest". The valley walls rise sharply to timber line between 3000 feet and 3500 feet elevation above sea level, however, with widespread cliff exposures bare of soil or vegetation. Runoff therefore is high, quickly affecting water

PART I - INTRODUCTION (cont'd):

levels of the upper Ecstall and its tributaries. Winters on the whole are mild, but very heavy falls of wet snow occur, usually followed by rising temperatures and rain. From two to three feet of wet snow may lie on the river flats as late as March.

Access to the property is by water route from Prince Rupert 30 miles to the Skeena-Ecstall junction, thence 34.5 miles to the property. The lower 28.7 miles of the Ecstall is available to boats of five to six feet draught within 4 hours about the peak of a 16-foot tide. A boat of 42-inch draught can reach within 3½ miles of the mine wharf on a 16-foot tide. Tidal highs range from 14 feet to 22 feet with lows down to zero as gauged at Prince Rupert harbour. Tides of 16-feet height and over form about 75 per cent of all tides. During the winter, however, the river is closed to navigation for an average of six weeks by drift ice packed by the motion of the tides. For the last six miles below the property this closure may extend through December, January and February, and occasionally for short periods in November and March.

The property was diamond drilled by the Granby Consolidated Mining, Smelting & Power Company Ltd., in 1917, 1918 and 1919. It was acquired for the Texas Gulf Sulphur Company in 1937, and check drilled that summer. Camps were erected and a plant installed the following summer. An 8' x 9' adit was driven to examine the ore occurrences underground some 300 - 450 feet below the outcrops during the succeeding two seasons, and further diamond drilling done from this working. Subsequently, additional diamond drilling was done from underground in 1952 which traced the South Lense to a depth of roughly 1000 feet below the adit level. Several sets of plans and sections of the orebodies have been made at various times and are in the Company files. These have been drawn upon to estimate the figures of ore reserves used in this report.

ORE OCCURRENCES

They have been described in detail in the Granby and Texas Gulf Sulphur Company's records. Briefly, the ore occurs as massive pyrite replacement in the form of two lenses said to be localized by folding along a major shear. These lenses are 1000 and 1750 feet long north and south lenses respectively, from 75 - 150 feet wide in the first instance and 20 - 50 feet wide in the second. They occur in echelon as shown in the attached Dwg. 5, which also shows the development done upon them. The North Lense has bottomed about -100 feet sea level, while the South Lense remains open at -960 feet elevation.

The pyrite occurs in [illegible] granular grains, and comprises from 90 to 95 per cent of the ore mass. Associated are chalcopyrite, sphalerite and some pyrrhotite. A little [illegible] and traces of arsenic are found also. A calcite-quartz-sericite gangue constitutes about 5 per cent of the whole.

A feature of this occurrence is its failure to produce a gossan in weathering. It breaks down rather into a sand composed of pyrite grains, which seem to retain their identity indefinitely. An ore dump left by Granby appeared thuswise 20 years later. Same can also be observed along the outcrops on Red Gulch creek.

ORE TONNAGES

These have been severally estimated on the basis of the Texas Gulf Sulphur Company's work with minor variations in total. The following figures can be considered representative:

	North Lense	South Lense	Total
Above Adit Level	2,814,000	824,500	3,638,500
Adit Level to -100' elev.	586,000	646,000	1,232,000
-100' elev. to -960' elev.	-	2,712,500	2,712,500
Totals	3,400,000	4,183,000	7,583,000

ORE GRADES

The following lists the number and source of diamond drill ore intersections from which the ore grades are estimated, including the Granby figures:

	North Lense		South Lense (to –100' el.)		South Lense (–100' to –960' el)
	T.G.S.	Granby	T.G.S.	Granby	T.G.S. Only
Holes Drilled	33	22	6	5	11
Ore Intersections	23	21	6	5	6
Feet Drilled	9481	8365	1009	885	5948
Feet in Ore	3140	4276	172	265	281
Assays, Au. ozs.	.015	.02	.013	.01	(?)
Ag. ozs.	.50	.74	.80	.60	(?)
Cu.%	.80	.85	.90	.50	.28
Zn.%	2.0	2.2	3.1	2.9	2.9
Fe.%	43.5		41.0		41.5
S%	49.5		47.5		47.6

Development since 1937 has been aimed primarily at evaluating the pyrite potential, other metal values being considered incidental. The above data is adequate for the purpose having regard to the uniformity of the pyrite occurrence throughout the deposit. It cannot be considered equally so in relation to the irregularities of copper and zinc distribution, and the gold and silver values that report largely with the chalcopyrite.

However, examination of the drill sections (including Granby's) suggest that a reasonably characteristic analysis of the North Lense as a whole can be obtained from averaging the drill cores. Drilling of the South Lense is less extensive, and relatively scanty below–100 feet elevation. Some additional drill intersections at and above the adit level would be useful to confirm the current ore grade estimate or otherwise. Estimates below the –100 feet elevation are based on four intersections only, and require more detailed investigation.

ORE GRADES (cont'd):

The following are the ore grades used in this report:

	Au.	Ag.	%Cu.	%Zn.	%Fe.	%S.
North Lense	.015	.50	.80	2.0	43.5	49.5
South Lense, above -100'	.013	.80	.90	3.1	41.0	47.5
South Lense, below -100'	(?)	(?)	.28	2.9	41.5	47.6

(?) Lacking assays.

ECSTALL MINING LIMITED
A SUBSIDIARY OF
TEXAS GULF SULPHUR COMPANY
TIMMINS, ONTARIO

INTER-OFFICE MEMORANDUM

Date: September 4, 1970

To: M. Marshall

From: E. Belford

Subject: ECSTALL RIVER PROPERTY

The ore reserves for this property have been calculated frequently by assorted individuals and generally, the deposit has been estimated to contain about 7.8 million tons of sulphides in two zones designated the north lense and south lense.

The north lense has been well defined and estimated to be the richer zone approximating 3.3 million tons of 0.8% Cu. & 2% Zn. of which about 40% of the mineral value is contained in 15% of the sulphides. The footwall and hangingwall of this zone approach values in the order of 3% Cu. over 5 foot widths.

The south lense which is open at depth and to the south was estimated to contain the remainder grading 0.4% Cu. & 3.2% Zn. The upper portion of this zone is of somewhat better Cu. grade than the lower portion which is of better Zn. grade. The Cu. mineralization is not confined to a specific sub-zone and selective mining is impractical.

The wall rock of the sulphide zone is described as rather incompetent and heavy dilution would be anticipated.

Flotation testing on the ore at Timmins indicated concentrates of 26% Cu. @ 80% recovery and 55% Zn. @ 85% recovery, the precious metals ending up in the copper concentrate.

The location of the deposit is rather remote and the capital investment would be quite high and I expect the return on investment altogether unattractive.

The property as it stands, is a pyrite deposit. If there is a Pacific market for cuprous pyrite, then perhaps the deposit should be evaluated more closely. Otherwise, we should dispose of or forget about the property unless additional economical reserves can be found to help defray the capital cost requirements. A considerable amount of geological work has been done in the immediate area. Perhaps some of the leads should be pursued more vigorously.

J.E. Belford,
Chief Mine Engineer.

Copies: AGP, PRC,
RDM, File ✓

Texasgulf memo

Date February 12, 1980.

To Mr. R.D. Mollison Location Stamford

From G.R. Peatfield Location Vancouver

Subject ECSTALL RIVER DEPOSIT - SUMMARY

Dr. Mannard has requested that I provide you with a brief summary of our data on the Ecstall River deposit. There is a wealth of information both in this office and at Kidd Creek, and I would be pleased to provide further data or discuss the property with your staff.

The Ecstall River deposit comprises two or more massive pyrite lenses contained in highgrade metamorphic rocks in a pendant or screen in the Coast Plutonic Complex. Our present interpretation is that the rocks have a significant volcanic component and that the deposit is volcanogenic. The massive sulphides are coarse granular pyrite with small amounts of interstitial chalcopyrite, sphalerite, pyrrhotite and galena.

There have been several tonnage and grade estimates made for the deposit. The figures quoted in a 1961 report prepared by the consulting firm of Dolmage, Mason and Stewart are:

	Au (oz/ton)	Ag (oz/ton)	Cu%	Zn%	Fe%	S%
North Lens (3,400,000 tons)	0.015	0.50	0.80	2.0	43.5	49.5
South Lens (above-100') (1,570,000 tons)	0.013	0.80	0.90	3.1	41.0	47.5
South Lens (below-100') (2,712,500 tons)	?	?	0.28	2.9	41.5	47.6

The North Lens contains a coherent higher-grade section which has been variously estimated to contain:

	tons	Au (oz/ton)	Ag (oz/ton)	Cu%
E.E. Mason (1941)	425,000	0.028	0.52	1.85
H. MacDonald (Granby)	623,200	0.03	0.80	1.89

Cont'd...

The South Lens also appears to contain a small tonnage grading between 1% and 2% Cu.

The above figures are based on considerable drilling and underground work. The following table indicates the drilling density:

	No. of holes	Holes in ore	Ft. of inters.
North Lens			
T.G.S.	33	23	3140
Granby	22	21	4276
Total	55	44	7416
South Lens (above-100')			
T.G.S.	6	6	172
Granby	5	5	265
Total	11	11	437
South Lens (below-100')			
T.G.S.	11	6	281

It is obvious that the North Lens is well tested but the South Lens, while sufficiently drilled to give a reasonable estimate of the Fe and S contents, has not been properly evaluated for its base and precious metal contents. The South Lens is open both at depth and to the south.

Some mill testing work has been completed. Perhaps the most significant observation is that the pyrite grains are remarkably clean, with almost all the base and precious metal values occurring interstitially.

My feeling is that further work would be justified, both on the deposit itself and within the district. I enclose some summary data from our files.

G. R. Peatfield

G.R. Peatfield

GRP:kdl
encl.

cc: Dr. G.W. Mannard - Golden
Dr. P.L. Money - Toronto