THE GEOLOGY OF THE STANDARD MINE

OF THE WESTERN EXPLORATION CO. LTD.

The Standard mine is situated in the Slocan Mining Division 2½ miles east of the town of Silverton, B. C. The central mine workings and the camp are at 3600 feet elevation, or 1840 feet above Slocan Lake.

The Company's 250 ton flotation mill, built in 1929, is situated on the lake shore and treats ores from their Standard, Mammoth, and Enterprise mines. In the following notes the Standard mine only is considered.

HISTORY

The Alpha, Standard, and Emily Edith claims, the nucleus of what is now the Standard Group, were located in 1892 under separate ownerships. Production from the Alpha began almost at once from an outcrop of high grade galena, but comparatively little development work was done on it before 1910. The claim was amalgamated with the Standard about 1895.

About 1908 the Emily Edith group was amalgamated with the Standard, and in 1913 the Standard Silver-Lead Mining Company was formed and operated the property until 1921 when the whole district was shut down by a strike. From 1921 until 1928, when the property was acquired by the present company, the mine was operated in a small way by leasers.

The main Standard orebody did not outcrop and was found during 1909 in No. 4 tunnel. Previous to this there had been a small production, but heavy production began immediately after. Up to the end of 1947 the production of the group was 410,374 tons of ore of a gross value of $11,495,832.00, the highest production of any property in the Slocan district. Dividends paid were $2,700,000.00.

Since 1928 the present company operated the mine a short time in 1937 and from 1940 to the summer of 1946 when it was shut down by a strike. Work was resumed in 1947 and the mine is now operating.

The ratio of ounces of silver to the percent of lead has averaged about 1½ to 1. No figures are available on the relative proportions of lead and zinc. In the early days zinc was of no value and was discarded, but gradually became more valuable until at present the value of the zinc produced exceeds that of the lead.

GENERAL

The productive part of the mine is in an area of highly crumpled, sheared and faulted rocks, and tunnels

mostly require timbering; most stopes require square-sets and filling.

When the Western Exploration Co. Ltd. first started work in the mine more than half of the tunnels were caved at the portals and in places underground and were in large part inaccessible through raises from the tunnels which were still open. Also all the main stopes were filled or caved and have never been reopened. Ore production since 1937 has been obtained from extensions of old stopes and from the discovery of new veins in the lode. Due to heavy ground and the generally erratic nature of the orebodies it has never been feasible to develop any great amount of ore reserves ahead of stoping.

Geological records covering the old caved portions of the mine are decidedly sketchy or entirely lacking, and since the writer has been familiar with the mine only since 1937, the following notes are of necessity based on what workings were accessible at that time, a few re-opened crosscuts and drifts, and new work.

DEVELOPMENT

The Alpha claim has been developed by seven adits on the lode, of which the highest is at 4800 feet altitude and the lowest at 4200 feet. In length these adits vary from 170 feet to 1000 feet, and total about 4700 feet exclusive of crosscuts and raises. Most of the tunnels are now partly caved and inaccessible.

The remainder of the Standard group, including the Emily Edith, has been opened by twelve tunnels, from the Y tunnel at 4060 feet altitude through Nos. 1 to 7, 7-A, 7-B, 7-C, and 8, the latter, the lowest, at 2760 feet altitude. Tunnels were generally started on the lode but a few began with a short crosscut. Nos. Y, 1 and 2 are short; Nos. 3, 4, 5, and 6 are progressively longer from No. 3, 1000 feet, to No. 6 which follows the lode for 4400 feet from the portal, exclusive of numerous crosscuts and secondary drifts on minor veins. No. 7 follows the lode for 4500 feet, plus numerous crosscuts. Nos. 7-A, -B, and -C average about 1200 feet in length and No. 8 is about 2700 feet, both exclusive of crosscuts of which there are many. At one time raises connected all levels from No. 7-C to No. 2 but at present only a few raises from No. 6 through 5 to No. 4 are open. No 7 tunnel is now being opened and at the present time is about two thirds completed but has not yet reached the most promising section. Total drifts and crosscuts on the property approximate 7½ miles. Commercial ore has been found over a vertical range of about 2000 feet, although

nowhere more than 1000 feet vertically below the surface directly above. Probably upwards of 90% of the ore extracted has been found within a vertical range of 500 feet, between elevations 3350 and 3850.

GENERAL GEOLOGY See also C.G.S. Memoir 184.

The claims are underlain by the Slocan sediments which are of late Triassic age which are intruded by a small stock of granodiorite which outcrops in Emily creek, just east of the Standard claim, at 4000 feet altitude. The sediments are also cut by numerous salic dikes and rather rare mafic dikes.

The sediments in the vicinity of the mine consist of dark gray to black, silicious, carbonaceous, and sometimes slightly calcareous argillites, generally moderately massive, and minor dark quartzites. The structure is extremely complex due to intricate folding, crushing and faulting and has never been satisfactorily worked out in the mine workings in so far as the folding is concerned. The general strike of the strata in the surrounding region is northwest and, according to Dr. Cairnes (Memoir 184), anticlinal on the Alpha claim and dominantly synclinal on the Emily Edith.

There are, however, in some of the intermediate and lower workings strong indications of a general easterly to northeasterly strike, slightly more easterly than the main ore trend, and a southerly dip at moderate angles. This statement is made on the strength of the trend of a somewhat vague belt of quartzite which occurs in the hanging wall of the lode, and on the observation of a few scattered bedding planes. No stratum has been found which is distinctive enough to be used as a marker.

The small granodiorite stock with its numerous apophyses and the dikes are believed to be genetically connected with the Nelson granite batholith of probable Jurassic age which outcrops within a quarter of a mile southwest of the No. 8 tunnel, and is presumed to underlie the mine at some depth.

LOCAL GEOLOGY

In the vicinity of the mine workings the apophyses and dikes are usually highly altered to a soft rock of light gray or pinkish color with generally granules of quartz, some feldspar, scanty altered biotite and hornblende and much sericite. The rock is usually more or less porphyritic and is locally called "porphyry". In the footwall of the lode the porphyry usually appears as definite dikes with definite strike and dip but within the lode it is extremely irregular and faulted, dragged and mixed into the argillites like plums in a pudding. It was intruded prior to the main faulting and the mineralization and is host to a very considerable, though minor, proportion of the ore.

The chief host of the ore is argillite which occasionally grades up to an impure quartzite. It has been extensively sheared and varies from moderately solid areas through all stages to small, unstable, lenticular fragments surrounded by graphitic slips, and to strong gouges.

The lode is a sheared and broken zone whose footwall coincides with the footwall of a major post-porphyry pre-mineral fault along which movement continued well into the period of mineralization. Its strike, while somewhat sinuous, is about N 65° E, and the dip from 20° to 80° southeast, with an average of about 45°; it is steeper to the west and flatter to the east. The width of the lode varies from 30 feet or less to a maximum of nearly 200 feet in the productive part of the mine. Minor graphitic shears, parallel or intersecting at small angles, occur within the lode.

The lode has been followed underground in the Standard group for nearly a mile and a half, and on the surface (See Fig. 1) has been traced through the Echo and Tiger groups, and is believed to join up with the Idaho and Queen Bess lode, a distance of over four miles.

The Robin shear and lode lies in the hanging wall of the Standard lode, appears to dip considerably steeper and should intersect it in depth, but has not been identified in the Standard workings. The tunnels are caved and little is known about it, except that it has been traced with a fair degree of centainty into the Mammoth mine.

Figure 2 shows the central and most productive parts of tunnels No. 5 and No. 6 and an intermediate level between them; these are fairly typical of other parts of the productive area. To avoid confusion drifts and crosscuts are omitted but orebodies, veins, faults, and shears and porphyry are shown in so far as they can be determined, for parts of the older workings are inaccessible. In the drawing the Intermediate and No. 6 levels have been moved southeast at right angles to the strike 300 and 600 feet, respectively, from their true positions with respect to No. 5 so that the drawings will not overlie and confuse each other.

At 1500 feet in from the portal of No. 6 tunnel the lode is cut and faulted to the left about 100 feet by a pre-mineral fault which was re-opened during mineralization. Its strike is approximately north and south, and the dip 40° east. It is rather obscure in No. 6 tunnel but is well exposed in No. 5 tunnel, and its surface trace is indicated between the portals of tunnels Nos. 3 and 4 by a natural trench in the overburden and lower down by a draw. On No. 4 and No. 7 tunnels it cannot be seen on account of caving. It consists of a sheared and crushed zone about 15 feet in width in which there is sparse disseminated mineralization,

with a few lenses and small veins which were in part stoped.

The block of ground, the most productive part of the lode, bounded for 1200 feet by the main footwall shear and by the cross-fault and extending vertically from about No. 3 tunnel to an unknown distance below No. 6 is strongly sheared and crushed and contained the "Big" rich Standard orebody, sometimes called the "Million Dollar Stope", and many other orebodies and veins, and has produced perhaps 90% of the ore extracted to date.

The erratic nature of the orebodies is well shown on the sketch, but there is a definite tendency for the larger ones especially to follow along or close to the main footwall gouge. Between the larger orebodies along the footwall there may be either a definite profitable vein, a vein too narrow or low grade to work, a series of small disconnected lenses of ore, or nothing of sufficient definition to follow. It is not unlikely that the locus and shapes of the orebodies is in part determined by the structure of the argillites, but proof of this has not been obtained. It is certain, however, that complex fracturing and brecciation have had a strong effect.

The ores consist of a mixture of brecciated country rock, quartz, sphalerite usually in disseminated grains, and galena in grains and stringers which often cut the quartz-sphalerite aggregates or lie between them. In detail the internal make-up of the "main" type of orebody is as erratic as their distribution and shape. Boundaries, except where the footwall is on the main shear, are usually marked by intersecting or curving slips of quite local extent with small gouges. There is a tendency for the better ore within an orebody to occur in irregular lenses or boulders separated by lower grade ore or waste and small gouges. The writer has never seen the ore from the old "Big" stope which at one time is said to have shown twenty feet of "clean galena" but it is to be presumed that in general the above description of the ore will fit that stope also.

"I" Vein is somewhat in the nature of a blister on the hanging wall of the main vein. (See also Fig. 3). On tunnel No. 5 it starts out from the "Big" stope, swings in a flat arc and disappears near the main footwall. In tunnel No. 4 it starts out of a stope on the west, swings almost a semi-circle of 150 feet radius and disappears shortly before reaching the main footwall. Its downward continuation below tunnel No. 5 is apparently ended by the "660" fault, for it has never been found underneath it; there is a poor barren slip or vein underneath the fault on No. 5 level but a crosscut a few feet lower shows no sign of it. "I" vein is distinguished by an unusual amount of quartz containing scattered and bunchy sphalerite and galena and carries a higher content of silver than the main orebodies.

It varies from a few inches to fifteen feet in width and has produced a considerable tonnage of ore.

"640" Vein is a split off from "I" vein which strikes nearly parallel to the main footwall and dips 75° south. Downward it ends against the "660" fault where it spreads out to several times its normal width. To the eastward and upward its limits are not known but it is expected to join "I" vein again in both directions. It varies from six inches to three or four feet in width and carries comparatively high silver-lead-zinc ore in a quartz gangue. In part it occupies a fissure in argillite and porphyry and in part lies between argillite and a wide band of quartz into which irregular sphalerite filled fractures extend.

The "620" vein, No. 5 tunnel, is very similar to the "640" vein in size, attitude, and filling. Its extent in any direction is as yet unknown.

The "Spur" vein (Fig. 3 Section B) is typical of several others which are not shown but which in the aggregate have furnished a moderate tonnage of high grade sphalerite, sometimes beautifully banded. They vary from a few inches to three feet in width and are accompanied by very little gangue. They branch off from larger orebodies at various angles, contain little galena or rock-fragments, and usually pinch out within a hundred feet.

The "660" fault has approximately the same dip and strike as the Cross-fault, previously mentioned, it does not, however, cut the footwall shear but appears to be an offshoot from it and does not fault the footwall orebody on the Intermediate shown in Fig. 2 although it can be traced through it. It forms the footwall of the "660" orebody, acted as a dam stopping the downward continuation of the "640" vein, and apparently "I" vein also. It therefore must be essentially pre-mineral. On account of passing into caved country it cannot be traced very far upwards, and has not been definitely identified below the Intermediate, although there is a strong suggestion that it may account for the abrupt end of the ore shown in Fig. 3 Section C. There are one or two other faults in the mine which seem to be of similar type but which are not yet well enough exposed to allow definite conclusions.

There are many other small faults of widely varying strikes and dips in the mine which are not known to cut the main footwall shear or the footwall orebodies but which do fault some of the minor veins up to a maximum of ten or fifteen feet, usually but not invariably to the right.

MINERALOGY

The chief ore minerals are sphalerite and galena, each of which may occur comparatively pure in veins, stringers or lenses, or they may be intimately mixed. With these occur small and varying amounts of pyrite, chalcopyrite, gray-copper, and rarely ruby-silver. The gangue consists of crushed rock, - either argillite, quartzite, or porphyry - quartz, calcite, and siderite. The relative amounts vary widely from place to place. The ore character varies not only in the proportions of lead and zinc but also from massive to disseminated, and in the amount and character of the gangue. Comparatively clean galena is reported to have been mined from the Alpha, from the "Big" orebody of the Standard as well as parts of some veins, and from the Emily Edith, a vertical range of nearly 2000 feet. The great bulk of the ore that has been mined in recent years has been mixed sphalerite and galena, with the former strongly predominating, and some nearly clean sphalerite.

Massive white quartz appears to have been the first mineral deposited and typically occurs in large lenses and sometimes as veins. Metallic minerals are sometimes absent but sphalerite accompanied by small amounts of pyrite usually occurs in widely varying amount disseminated through the quartz. The location of the quartz bodies does not appear to follow any regular pattern but they are scattered from the highest to the lowest accessible workings of the mine. The period of quartz deposition is believed to have continued in decreasing intensity throughout the period of mineralization.

Sphalerite with minor amounts of galena and pyrite and quartz was next in order and occurs as stringers in minor fractures in the rocks and in re-fractured quartz, and in a few instances in short narrow veins up to four feet in width consisting of massive sphalerite with very minor blebs of glassy qqartz. In some of these veins there is a little galena, in others none. Sphalerite occurs from the highest to the lowest parts of the mine but increases in relative importance with depth, although not uniformly for some of the higher level stopes have been worked for zinc and showed very little lead; it is also strongly predominant around the eastern limit of the oreshoots.

Galena occurs sparsely disseminated with the sphalerite in places, but generally occurs in more massive form in stringers, small veins, and lenses in fractures in country rock, quartz, and sphalerite. For instance stringers and lenses of galena occur frequently in fractured quartz-sphalerite bodies, either as a narrow band along one wall or in irregular fractures in the quartz itself. In many localities it is quite evident that the bulk of the galena was deposited later than the sphalerite.

Grey-copper is not usually visible to the naked eye, but wherever noted it is generally associated with the galena, but sometimes with the sphalerite both as grains and tiny seams within the other minerals, and in the form of films along cracks. It is probably contemporaneous with the galena in large part with its deposition possibly extending a little later.

Calcite and siderite are rarely found in any important amounts, but in small amount they are present in the ore from all parts of the mine, generally as small seams and stringers. Siderite increases slightly in amount with depth and has a tendency to occur in association with sphalerite rather than with galena. Calcite is more uniformly distributed so far as depth is concerned, and a considerable proportion of it appears to have been deposited after all other mineralization had ceased.

The sequence of events leading to the formation of the Standard orebodies is indicated to have been as follows:-

1. Folding and fracturing of the sedimentary rocks during the intrusion of the Nelson batholith, and the injaction of the porphyry stock with its dikes and irregular apophyses.

2. Faulting, probably due to differential cooling of the underlying magma.

3. The entrance of mineralizing solutions of high temperature depositing chiefly quartz at first, followed by quartz, sphalerite, siderite, and a little galena.

4. Re-opening of old fractures and perhaps the formation of some new ones.

5. The entrance of cooler mineralizing solutions which deposited the bulk of the galena, a little sphalerite and gangue minerals.

6. Final calcite deposition and weak post-mineral fracturing.

ORE CONTROLS

If certain beds of the sedimentary rocks, or their folding, have had any influence on the location of the orebodies it has escaped the writer's notice. The extent of the shearing, crushing, and faulting and to a minor extent the presence of porphyry appear to have been the governing factors. Some of this fracturing was undoubtedly caused by the change in dip from around 70° to 30° such as occurs between No. 6 and No. 4 tunnels in the central and western part of the productive zone.

Probably the mineralizing solutions ascended

from the underlying granite batholith along the trough formed by the intersection of the main footwall gouge with that of the cross-fault, and possibly also along the trough between the main shear and faults of the "660" type, and deposited their minerals in the crushed and fissured rocks above the trough wherever they could penetrate.

The downward extension of these troughs and the broken block of ground has been very inadequately explored on No. 7 tunnel level, judging by the old maps of that area, and favorable developments are expected after No. 7 is completely re-opened.

Chas. C. Starr

March 20, 1948.

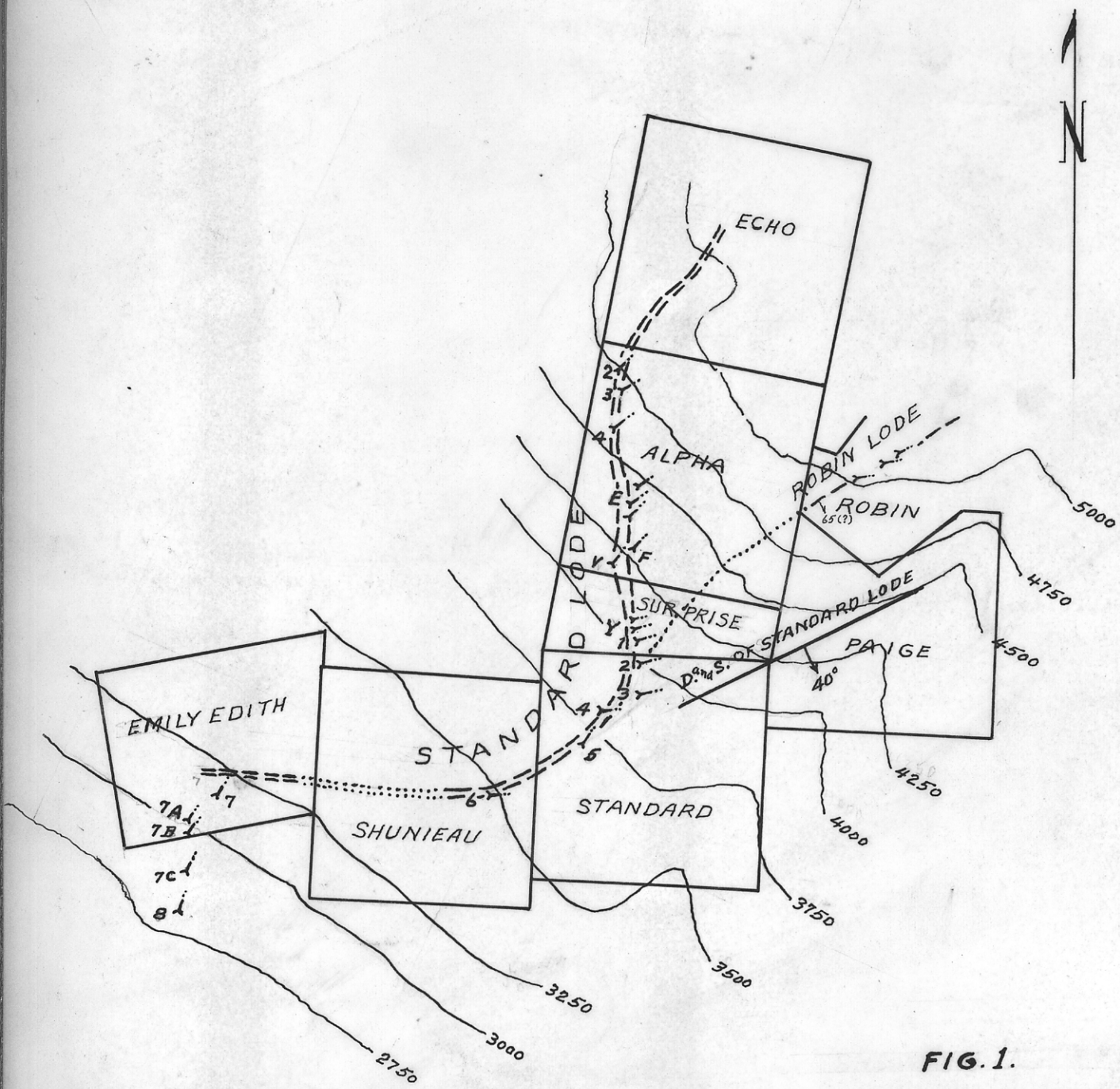

FIG. 1.

SHOWING OUTCROP OF STANDARD LODE

500 0 1000

Adit Entrance

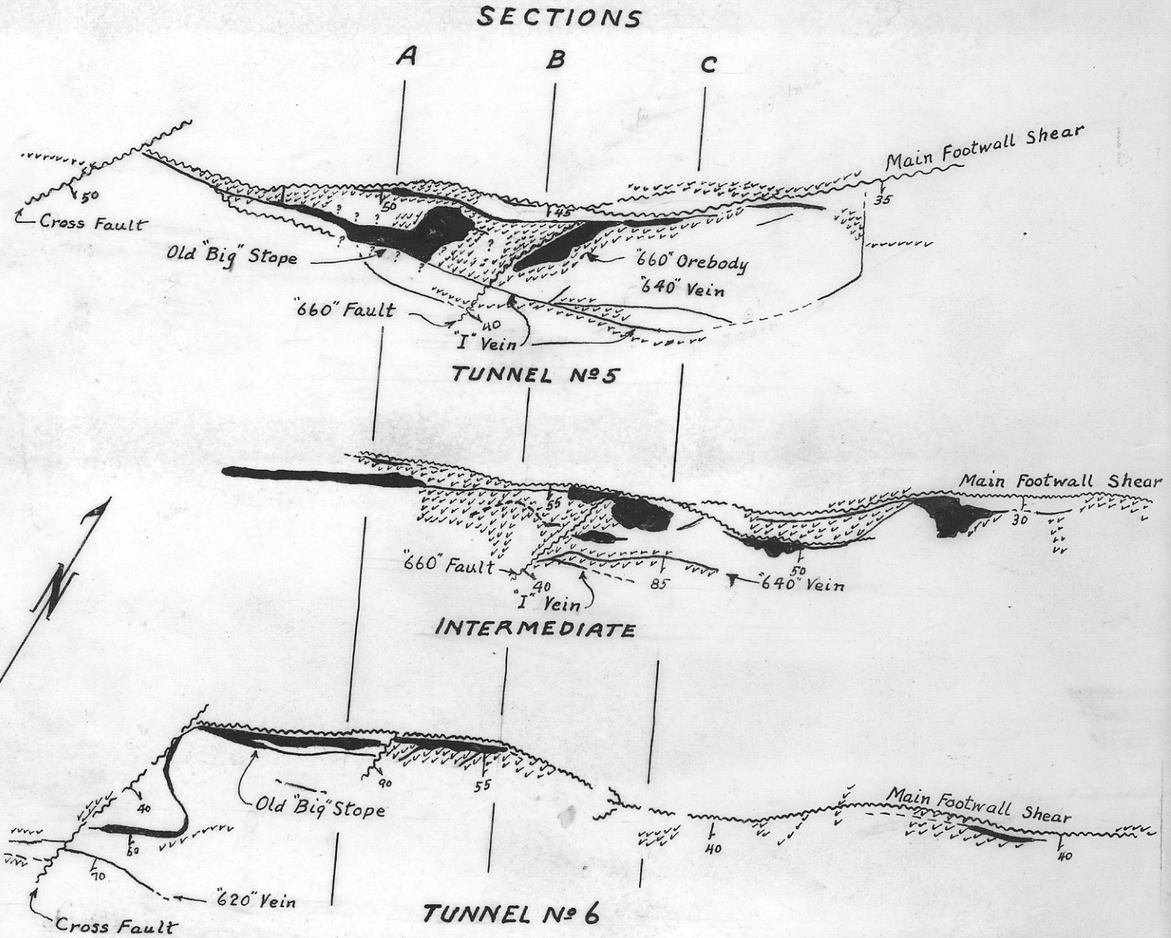

FIG. 2.

Showing Plan of Geology of Central Part of Standard Mine

100 0 100 200 300 400 500

Orebodies and Veins — Faults and Shears

Argillite — No Marking — Porphyry

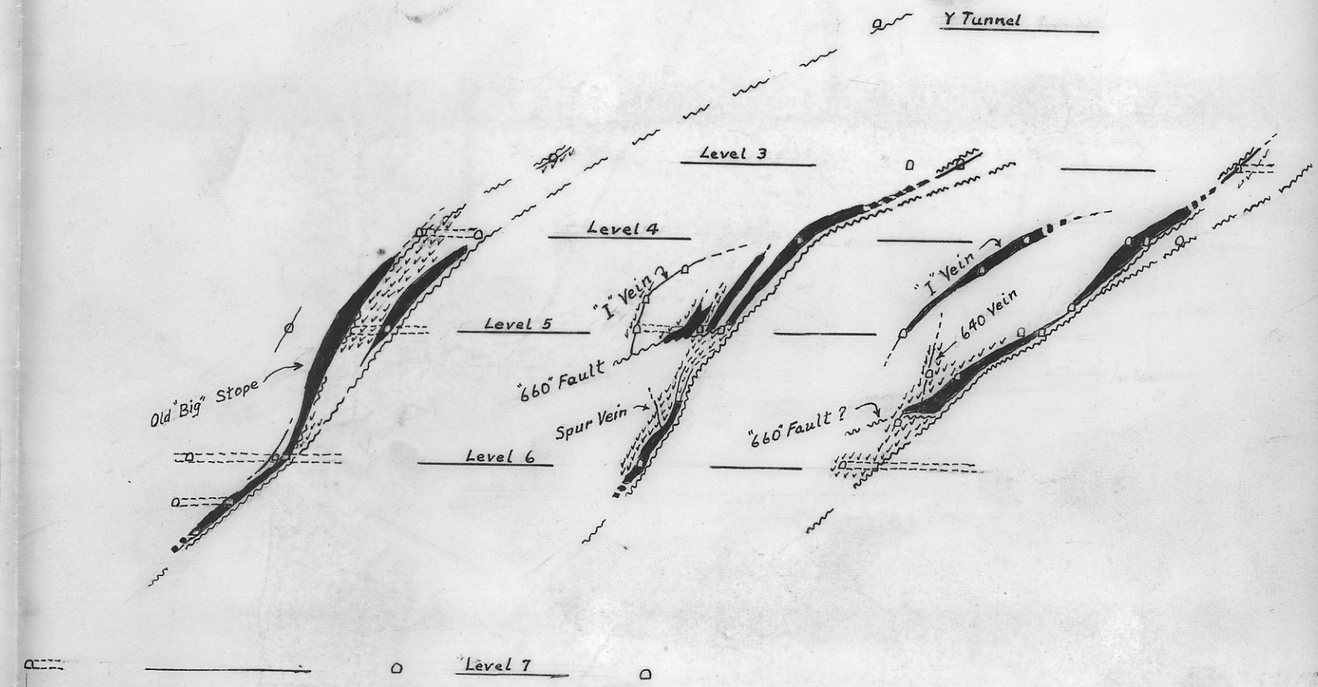

FIG. 3.

Refer to Fig. 2 for Position, Scale, and Legend.

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