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LEAD-ZINC MINERALIZATION IN THE MOYIE YAAK DISTRICT NEAR BONNERS FERRY, BOUNDARY COUNTY

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Lead-Zinc Mineralization in the Moyie Yaak District near Bonners Ferry, Boundary County, Idaho

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ABSTRACT

The report describes a new occurrence of the Coeur d'Alene type of mineralization in the Moyie Yaak district in Boundary County, Idaho, in the Purcell Mountains about 14 miles by road north-northeast of Bonners Ferry, the county seat. The deposits are fillings and replacements along high-angle reverse faults in the granitic rock of the Nelson batholith and contain in addition to lead and zinc appreciable quantities of silver and gold. The lead and zinc are associated with siderite, the gold with arsenopyrite, which was added later. The presence of gold and arsenopyrite marks the only essential difference between these veins and the lead-silver siderite veins in the Coeur d'Alene region.

The Nelson batholith is probably Cretaceous but the mineralization is more than likely related to early Tertiary magmas associated with Laramide deformation which locally fractured the batholith and provided channels for the upward circulation of ore-bearing solutions. Geologic conditions suggest a moderate vertical range for the ore and a possible wider distribution for the mineralization than at the place where the deposits are now found. The part of the district particularly worthy of exploration may be that in and along the sides of the broad valley of Meadow Creek, a transverse valley which may mark a possible east-west zone of structural weakness.

INTRODUCTION

This study deals with some rather recently discovered lead-zinc deposits in the large, but little developed, Moyie Yaak district, which includes most of Boundary County east of the Kootenai River in the extreme north part of Idaho. These deposits were not known when Kirkham and Ellis[1] made their study of Boundary County in 1924 and 1925 but were found not long thereafter. Since 1936 they have been actively developed and brought into production by Silver Crescent, Inc. The discovery of these deposits in a part of the district, which previously had not been known to be particularly mineralized, has attracted considerable attention and has prompted inquires for geologic data that might bear on the persistence of the mineralization with depth and on the possible presence of other deposits in the immediate region.

The deposits include two closely spaced lead-zinc veins, both at the Regal mine of Silver Crescent, Inc. Although the study is confined to this single mine, the findings may apply more widely and may prove of use in the search for and development of other deposits.

The mineralization turns out to be similar to that exemplified by the lead-siderite veins in the Coeur d'Alene region and may be localized along a zone of structural weakness not unlike those that control the mineralization in the Clark Fork[2] and Coeur d'Alene[3] regions.

Except for the studies of Kirkham and Ellis, there has been little previous geological work in the district. Publications that touch on economic aspects of the geology are listed below.

1. Calkins, F. C., and MacDonald, D. F., "A geological reconnaissance in northern Idaho and northwestern Montana; with notes on the economic geology": U. S. Geol. Survey Bull. 384, 1909.

2. Kirkham, V. R. D., and Ellis, E. W., "Geology and ore deposits of Boundary County, Idaho": Idaho Bur. Mines and Geology Bull. 10, 1926.

3. Kirkham, V. R. D., "The Moyie-Lenia overthrust fault": Jour. of Geology, vol. 38, pp. 364-374, 1930.

4. Livingston, D. C., "Tungsten, cinnabar, manganese, molybdenum, and tin deposits of Idaho": University of Idaho School of Mines Bull. 2, vol. 14, 1919.

5. MacDonald, D. F., "Economic features of northern Idaho and northwestern Montana": U. S. Geol. Survey Bull. 285, pp. 41-52, 1905.

6. Shannon, E. V., "The minerals of Idaho": U. S. Nat. Museum Bull. 131, pp. I-483, 1926.

7. Soper, E. K., "The mining districts of northern Idaho": Min. and Sci. Press, vol. 116, pp. 121-127, 1918.

8. Varley, Thomas, et al., "A preliminary report on the mining districts of Idaho": U. S. Bur. Mines Bull. 166, 1919.

[1]Kirkham, V. R. D., and Ellis, E. W., "Geology and ore deposits of Boundary County, Idaho": Idaho Bur. Mines and Geology Bull. 10, 1926.
[2]Anderson, A. L., "Geology of the lead-silver deposits of the Clark Fork district, Bonner County, Idaho": U. S. Geol. Survey Bull. 944-b, 1945.
[3]Umpleby, J. B., and Jones, E. L. Jr., "Geology and ore deposits of Shoshone County, Idaho": U. S. Geol. Survey Bull. 732, 1923.

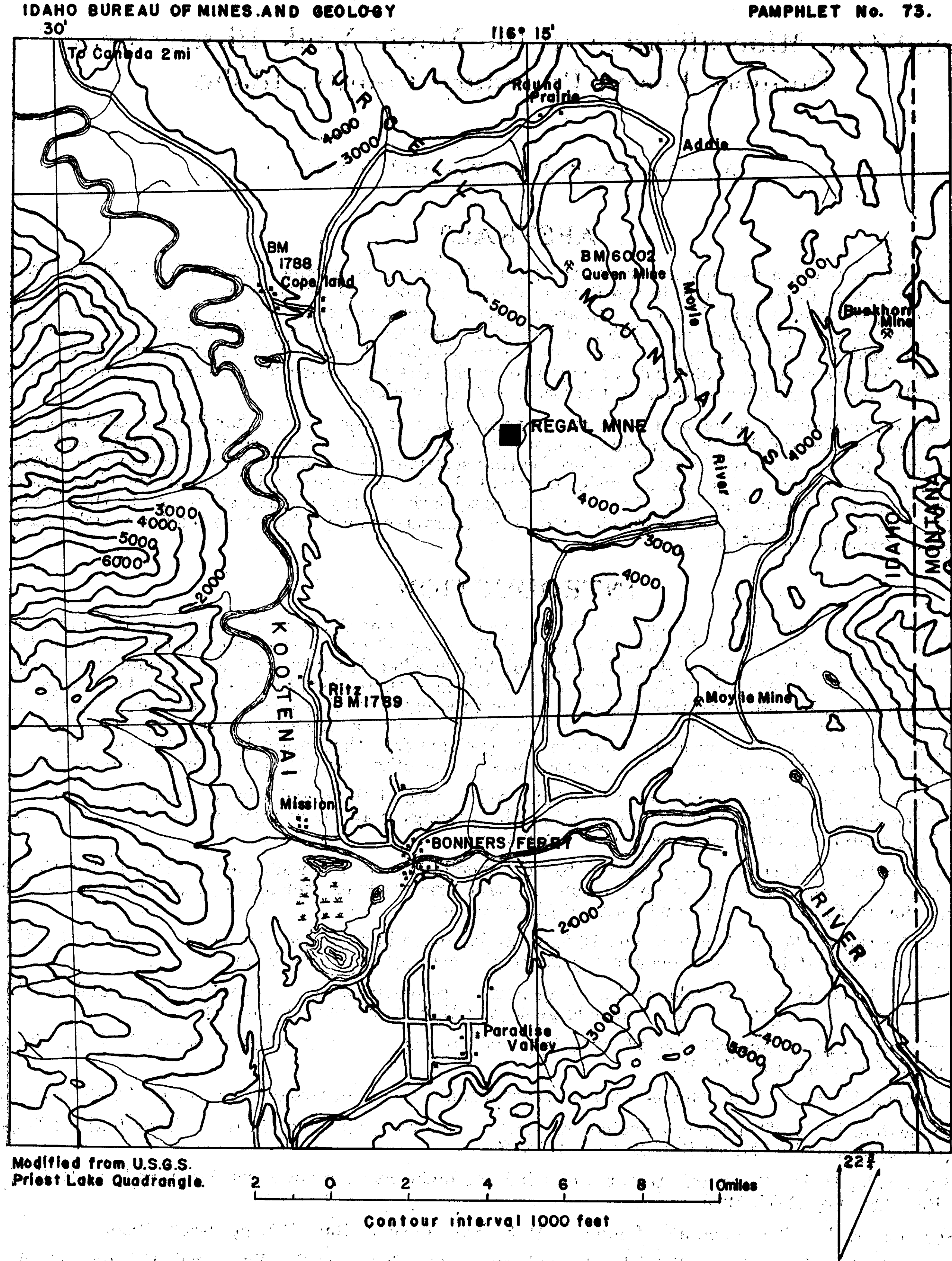

Fig. 1. Map showing topographic features of the Moyie Yaak district and location of Regal mine

GEOGRAPHIC SKETCH

LOCATION

The deposits are located in the SW¼, Sec. 31, T. 64N., R. 2E., Boise meridian, about 15 miles by road or 11 miles by air north-northeast of Bonners Ferry, the county seat (Fig. 1). About half the distance by road is over paved U. S. Highway 95; the remainder is over a good graded road. These roads are used throughout the year by mine officials and workers who live in Bonners Ferry and commute to the mine by bus. Bonners Ferry (population about 1500) is on the main lines of the Great Northern and Spokane International railways.

SURFACE FEATURES

As shown in Figure 1, much of Boundary County is mountainous and contains parts of three important mountain groups separated one from another by broad intermontane valleys or trenches. The Selkirk Mountains on the west are separated from the Purcell and Cabinet Mountains on the east by the generally broad and topographically prominent Purcell Trench which extends southward from Canada through Boundary and Bonner Counties into Kootenai County. The Purcell Mountains, which lie east and north of the Kootenai River, are separated from the Cabinet Mountains on the south by the broad valley of the Kootenai River, which enters Idaho from Montana and extends in a general northwesterly direction to the Purcell Trench where the river swings north along the Trench into Canada.

The Moyie Yaak district, defined as the part of Boundary County east of the Kootenai River, embraces all the Purcell Mountain group in Idaho and also includes a lower glacially planed plateau-like area between the Kootenai River and the mountains. The Purcell Mountains are divided naturally into smaller units by relatively broad valleys, particularly those of the Moyie River, which flows southward from Canada to the Kootenai River, and by Round Prairie and Meadow Creek valleys, broad straight valleys which extend transversely across the mountain segment between the Moyie River and the Purcell Trench.

The lead-zinc deposits are along the west margin of the mountain segment enclosed by the Moyie River valley, Round Prairie valley, Meadow Creek valley, and the Purcell Trench. They are at an altitude of about 3,400 feet and stand approximately 600 feet above the planed, plateau-like surface that lies between the mountains and the Kootenai River and about 2,700 feet below the 6,141-foot summit of Queen Mountain, the highest point in the segment. Slopes locally are neither steep nor rugged but show the smoothing effect of overriding continental glaciers.

Drainage of this part of the district is to Meadows Creek which rises about 3 miles to the north and flows in a southerly direction along the western margin of the mountains, almost upon the bordering plateau surface, and then crosses the mountains through the low broad Meadow Creek valley, after which it joins the Moyie River.

The area formerly was heavily timbered but much of the timber has been logged or consumed by forest fires and the slopes are now largely covered by brush and second-growth. An annual precipitation in excess of 27 inches, much of it as rain in the autumn and spring and as snow in winter, has been conducive to timber growth.

For a more complete discussion of the surface features of the region and for other geographic data the reader is referred to the report by Kirkham and Ellis[4].

GEOLOGIC SKETCH

GEOLOGIC SETTING

Much of the Moyie Yaak district is underlain by various members of the Belt series (pre-Cambrian), the lowest member, which Kirkham and Ellis have designated locally as the Aldridge-Prichard formation[5], being the most widespread. Associated with it and to lesser extent with the middle members of the Belt series are numerous sills of great length and thickness which have been correlated with the Purcell or Moyie sills in the mountains north of the International boundary. Both the sills and the intruded Belt strata have been folded and faulted and subsequently invaded by huge masses of granitic rock which have been correlated with the Nelson batholith in British Columbia. All rocks since have been broken by faults, some of which have had a profound influence in delineating the present mountain groups. In the lower parts of the district the bedrock is obscured and structural relations masked by moraine, valley train, and lake beds, all of which are associated with Pleistocene glaciation.

In the part of the district containing the lead-zinc deposits the only rock exposed is the granitic rock of the Nelson batholith, which locally has been fractured, apparently by regional stresses. This part of the district has been shown by Kirkham and Ellis[6] to be underlain by Belt strata and intercalated Purcell sills, but apparently they erred in the location of the contact, for the nearest sedimentary strata are 4 miles away.

[4]Op. cit. pp. 10-14.
[5]Kirkham, V. R. D., and Ellis, E. W., op. cit. pp. 15-16.
[6]Op. cit. plate 3.

COUNTRY ROCK (Nelson Batholith)

The Nelson batholith has been shown by Kirkham and Ellis[7] to compose most of the rock of the Selkirk Mountains and much of the rock along the west margin of the Purcell Mountains including the lower plateau-like area to the west. Further mapping must be carried on to determine the precise location of the eastern margin of the batholith.

Locally the granitic rock of the batholith is conspicuously porphyritic with phenocrysts of pinkish microcline as much as two inches wide and four inches long generously distributed through a moderately coarse-grained granular rock of white feldspar (andesine), hornblende, biotite, microcline, and quartz. The hornblende and biotite together compose about 15 per cent of the rock, the quartz an equal amount, the andesine from 20 to 30 per cent, and the microcline most of the remainder. Present but not visible without the microscope are scattered small grains of sphene, allanite, apatite, zircon, and magnetite. The composition of the rock ranges locally from granite to quartz monzonite depending on the abundance of microcline phenocrysts. If phenocrysts were absent, some of the rock would probably have the composition of granodiorite. Numerous remnant inclusions of the matrix minerals in the microcline suggest that the microcline was added to the rock during late stages of consolidation and was formed largely by replacement of the earlier minerals.

Because of the deep glacial scouring, the rock is fresh and, except for slight disintegration at the surface, due chiefly to frost action, shows little evidence of weathering.

Kirkham and Ellis regard the age of the granitic rock as Cretaceous[8].

STRUCTURAL FEATURES

Regional Structure

The dominant structural features of the region have been ascribed by Kirkham and Ellis[9] to faulting which has not only controlled the drainage but has also set off the mountain groups as tilted blocks. They present evidence for a great normal fault with downthrow on the east (Kootenai fault) which controls the course of the Purcell Trench from Bonners Ferry to and beyond the Canadian border[10]. They present evidence of another fault (Moyie-Lenia fault), an overthrust with steep easterly dip, along the Kootenai and Moyie Rivers from the Montana line to the Canadian Boundary[11]. They also present evidence for an east-west strike-slip fault (Round Prairie fault) along the glaciated valley of Round Prairie Creek. For this fault they give a horizontal displacement of 3 miles and a vertical throw to the south of not less than 1,000 feet[12]. No fault is shown or postulated along the east-west Meadow Creek Valley, which has the same topographic characteristics as Round Prairie Valley.

Local Structure

In the area containing the lead-zinc deposits the granitic rock is broken by faults of minor magnitude, none of which is reflected in the topography. These faults fall into four well defined, possibly genetically related groups or sets, each with a distinctive trend and dip. The most prominent and most important of these sets is distinguished by faults of general east-northeast trend and steep southeast dip; another of lesser prominence by faults of west-northwest trend and moderately steep southwest dip; a third by faults of north-northeast trend and steep northwest dip; and the fourth (a single fault) by a northwest trend and southwest dip. These are all exposed underground and are shown on the geologic map of the mine workings (Fig. 2).

The faults of east-northeast trend show considerable local variation in strike and dip, the strike of a given fault ranging from N.40°E. to N.70°E. but averaging N.60-70°E., and the dip ranging between 50°-60°SE. These faults persist for lengths of not less than 700 or 800 feet and terminate just beyond the point where they change their strike to east-southeast and become aligned with the west-northwest set of faults. These faults have served as the chief channels for the circulation of the ore-bearing solutions and contain the mineable ore shoots. The ore shoots are contained in the less steeply dipping parts of the fault fractures, a fact which suggests that these faults may be reverse faults.

The west-northwest faults also show some variation in strike and dip but not to the same extent as the faults described above. Their average strike is about N.75°W. and their dip 40°-45°SW. They are not as prominent nor as persistent as the east-northeast faults and no fault has been traced for more than 120 feet. They show a very close association with the faults of the east-northeast set, for not only do they curve and change their strike to that of the east-northeast set but they also branch from the east-northeast faults and link one east-northeast fault with another. Walls are generally tight and in most places ore-bearing solutions were unable to enter and leave appreciable amounts of ore. Despite their rel-

[7] Op. cit. plate 3.
[8] Kirkham, V. R. D., and Ellis, E. W., op. cit. p. 35.
[9] Op. cit. p. 72.
[10] Op. cit. pp. 32-33.
[11] Op. cit. pp. 34-35.
[12] Op. cit. pp. 33-34.

atively low angle of dip, it is likely that these faults are strike-slip faults and were formed as a result of shear at the same time that the reverse faults developed in response to compression.

The north-northeast faults strike about N.15°-20°E. and dip 80°-85°NW. They are the most inconspicuous of all faults and nowhere have been explored by drifts. They are exposed in crosscuts which have penetrated through them at about right angles to their strike. They have little gouge and apparently very little displacement. Absence of marker horizons makes it impossible to determine the kind of fault but the very high dip suggests that they may be strike-slip, complementary to the west-northwest strike-slip faults.

The fault of northwest trend shows some variation in strike but the average is about N.30°W. with local departures ranging from N.20°W. to N.50°W. The dip is also variable and ranges from 40° to 57° SW. This fault has been drifted on underground for 190 feet. It is a fairly conspicuous feature on the upper level of the mine but was not recognized on lower levels.

If the east-northeast faults are reverse faults as the relations of the ore shoots suggest, the west-northwest and north-northeast faults strike-slip faults, and the northwest fault a normal fault, they make up a structural pattern which may be interpreted in terms of regional shearing stresses. Such a fault pattern would develop if horizontal shearing stresses were applied from the east-southeast and west-northwest directions, the east-northeast faults forming in response to the compressive components of the stress, the west-northwest and north-northeast faults in response to the shearing components, and the northwest fault in response to the tensional component. In this case the fault pattern would be interpreted in exactly the same way as the fault pattern in the Clark Fork district where shearing stresses similarly applied have been responsible for producing the great Hope fault and its host of associated reverse, strike-slip, and normal faults[13]. That this may be so is suggested by the near presence of the nearly east-west Meadow Creek Valley, which like Round Prairie Valley farther north, may be structurally controlled and carved along an east-west or west-northwest strike-slip fault of probable no great displacement. In any event the faulting in the mineralized area is probably the result of regional rather than of locally applied stresses.

The local faulting is probably in no way related to the emplacement of the Nelson batholith (Cretaceous). On the other hand the fault pattern is so much like that in the Clark Fork district that the faulting, as in the Clark Fork district, must be associated with early Tertiary (Laramide) diastrophism[14].

CHARACTER OF MINERALIZATION

NATURE OF DEPOSITS

The lead-zinc deposits resemble those in the Coeur d'Alene region and may be classed as lead-zinc-siderite veins[15], but unlike the Coeur d'Alene veins, they also contain considerable arsenopyrite and appreciable quantities of gold, both added apparently during a later stage of mineralization. As in the Coeur d'Alene region, the veins also have been formed largely by replacement along high-angle reverse faults, but replacement has been of granitic rock, not quartzite as in the type locality. However, despite the local abundance of arsenopyrite and the presence of considerable gold, there is no mistaking the Coeur d'Alene aspect of the mineralization.

STRUCTURAL RELATIONS

The deposits are contained along the east-northeast high-angle reverse faults because these faults appear to have offered the most suitable channels for the circulation of the ore-bearing solutions. Ore in them is localized along the less steeply dipping parts of the fault where the relative upward movement of the hanging wall has lifted the walls apart, creating easily permeable openings. As these faults show much broader undulations than the others, the openings produced by separation of the walls are relatively long and have permitted the formation of ore bodies of considerable length. Solutions also entered some of the west-northwest faults, but in some places the walls are so straight and pressed together so tightly that the solutions could not enter. In other places, the warping of the fault surface has been on such a scale that only minor openings could form.

MINERALOGY

Minerals that make up the lead-zinc deposits include galena, sphalerite, pyrite, arsenopyrite, siderite, and quartz. Each of these is conspicuous in the ore and any one may predominate locally, though galena, siderite, and arsenopyrite tend to be the most widely and uniformly distributed. The silver and gold in the ore suggest that tetrahedrite and native gold may be present, but to identify them would require the use of the microscope.

Most of the minerals, except the arsenopyrite and a very little of the pyrite, sphalerite, and galena, are moderately coarse grained; those excluded are fine-grained. The fine-grained minerals occur either in seams or veinlets which cut or lie alongside the masses of more coarsely crystalline minerals or they are in irregular masses or groups that embay the others.

[13]Anderson, A. L., "Geology of the lead-silver deposits of the Clark Fork district, Bonner County, Idaho": U. S. Geol. Survey Bull. 944-b, 1945.
[14]Anderson, A. L., U. S. Geol. Survey Bull. 944-b op. cit.
[15]Umpleby, J. B., and Jones, E. L. Jr., "Geology and ore deposits of Shoshone County, Idaho": U. S. Geol. Survey Bull. 732, pp. 41-48, 1923.

The minerals show no exceptional features. The siderite has the usual buff color and because it is somewhat manganiferous blackens on oxidation. Some of it forms crystalline crusts coated by quartz or sulfides but much of it occurs as massive aggregates, broken and penetrated by quartz and sulfides. Much of the quartz has a milky white color but a little forms small colorless crystals. Pyrite occurs as striated, cubic-pyritohedral crystals as well as irregular granular masses. Some of it is associated with the siderite, some with the sphalerite and galena, and some with the arsenopyrite. Most of the galena shows flowage and has a gneissic structure; otherwise it tends to be coarse cubic. That which is associated with the arsenopyrite has a finely granular structure. Most of the sphalerite forms coarse dark reddish brown grains and granular aggregates; associated with arsenopyrite it is finely crystalline and grayish. Where individual grains of arsenopyrite are not crowded they show rhombic crystal outlines, otherwise they form crystalline aggregates composed generally of small interlocking grains.

As in the Coeur d'Alene region, the siderite is one of the earliest minerals and has filled openings along the faults and has also penetrated into and replaced the bordering, more or less extensively sericitized granitic wall rock. In some places the siderite has not since been disturbed by structural movements during the period of mineralization and no other minerals, except a little contemporaneous pyrite, are found with it. In most places, however, the siderite has been extensively fractured and locally brecciated. In part, the fractures have been filled, and the fragments almost completely replaced by quartz and pyrite, sphalerite, and galena. The sulfides also penetrate and replace the quartz and country rock.

Arsenopyrite, which in places is accompanied by quartz, pyrite, and a little galena and sphalerite, forms seams, veinlets and impregnations in the siderite-galena-sphalerite filling. It is found throughout much of the ore, in places in larger quantity than the other minerals. Gold in the ore appears to be associated with it rather than with other minerals.

DISTRIBUTION OF THE ORE

The ore is contained in two east-northeast faults, known as the North and South veins, which are linked together on the No. 2 level by a lightly mineralized west-northwest fault (Fig. 2). In each vein the ore is confined to well defined shoots ranging from 50 to 190 feet long and up to 6 feet wide, each shoot apparently plunging about 65°SW. The ore bodies tend to be somewhat lenticular and pinch on the dip as well as on the strike. Those that pinch downward may rewiden again at greater depth. As pointed out earlier much of the ore is along the less steeply dipping parts of the fault where the hanging wall has been lifted from the foot-wall. Hence, as the dip steepens, openings close and locally the fault becomes structurally unsuited to contain ore. The widest ore bodies have been found in those places where the footwall has a more gentle dip than the hanging wall and the two walls have become widely separated. Locally the difference in dip of the two walls may be as much as 25 degrees.

The North vein extends beyond the ends of the drifts on both the No. 2 and No. 3 levels. The mineralization is fairly persistent on each level, but only one ore body has actually been uncovered on the No. 2 level. This body as shown in Figure 3 has been stoped along the strike for about 90 feet to a height of 25 feet, increasing to 60 feet at the northeast end. The stope averages about 5 feet wide. There seems to be more ore on the No. 3 level than on the No. 2 level and stoping has been carried on along two main ore shoots. One near the southwest end of the drift has a stope length of about 50 feet and the other near the northeast end, a stope length of about 70 feet and stope height of 55 feet. There is also a small stope about 10 feet long and a few feet high about midway between them. No stope has been carried from one level to the other. The ore shoot at the northeast end of the drift on the No. 3 level apparently does not extend up to the No. 2 level. Ore above the No. 2 level as well as most of that between the No. 3 and No. 2 levels seems to have been mined.

The South vein appears to contain somewhat more ore than does the North vein and has been exposed on all three levels of the mine over a vertical range of about 260 feet. Stopes have been carried from the No. 3 level almost to the No. 2 level and from the No. 2 level to the No. 1 level. The ore is contained in essentially one shoot, which on the No. 2 level is almost 200 feet long. The stope on the No. 3 level is about 100 feet long but the limit of the ore shoot has not been reached either on the strike or up the dip. On the No. 1 level the ore body is about 2 feet wide; on the No. 2 and No. 3 levels its width measures about 4 feet. The South vein is restricted in length by changes in strike and dip of the fault. At the southwest end it appears to end by changing its strike to west-northwest, forming a link with the North vein. At its northeast end its strike changes to east-southeast and the fault gradually dies out. Something of this change in trend from east-southeast to east-northeast is also shown on the No. 1 level. There, however, the part which strikes west-northwest contains small scattered bodies of quartz and oxidized sulfides.

TENOR OF THE ORE

As broken in the stopes the ore is diluted with much waste from the hanging wall; consequently, the mill feed averages but 3 per cent lead, 3.5 per cent zinc, and 10 per cent iron and carries about 3 ounces of silver and 0.12 ounces of gold per ton. Analyses based on sampling of the ore in place were not available.

ORIGIN OF THE DEPOSITS

The mineralization is so much like that in the Coeur d'Alene and Clark Fork districts that the deposits locally must have originated in the same way and at the same time as the others and from related magmatic sources. In the Clark Fork district the senior author[16] has pointed out the close association of the lead-silver mineralization with Laramide structural features and early Tertiary magmas, which are manifested in and along a zone of structural weakness dominated by the Hope fault, a great transverse earth fracture which provides the same sort of structural background for the district that the famous Osborn fault does for the Coeur d'Alene region[17]. No search was made for intrusive dikes in the vicinity of the Regal mine but dikes of early Tertiary age may be expected in the region, particularly in or near the broad east-west valley of Meadow Creek, which, as inferred earlier, may be structurally controlled by a zone of transverse faulting, perhaps more or less similar to the one containing the Hope and associated faults in the Clark Fork district. All this accords with the senior author's concept of the regional structural control of mineralization over much of north Idaho.

The ore solutions undoubtedly ascended from a deep magmatic source, on reaching moderate depths below the earth's surface they cooled to moderate temperatures and deposited siderite, quartz, and the closely associated sphalerite and galena under essentially mesothermal conditions[18]. Later the deposits were reopened by renewed structural adjustments and circulation of mineralizing solutions was resumed; but the solutions deposited arsenopyrite and minor amounts of quartz, sphalerite, galena, and probably gold under conditions of more rapid cooling than existed when the earlier ore was deposited.

HISTORY AND PRODUCTION

Just when the veins at the Regal mine were discovered was not learned. They were not known to Kirkham and Ellis at the time of their work in Boundary County in 1924 and 1925 but probably were discovered not long after. For a time the mine was known as the Commercial, but when it was bonded and leased to Silver Crescent, Inc., in 1936, it was renamed the Regal. Work got underway by Silver Crescent in 1937 and has continued to the present.

Production data were not available to the writers. However, the management reports that until shortage of workers became serious during the war period, the mine, operating three shifts a day, produced 90 tons of lead and 30 tons of zinc concentrates monthly. In 1945 the force had been reduced to one shift in the mine and two shifts in the mill. The mill then was operated at 3/5 of its capacity, treating 30 tons of ore a day.

PROPERTY AND DEVELOPMENT

The property consists of 52 unpatented claims; it has all buildings and equipment essential to mining and milling. The development comprises more than 3,800 feet of drifts and crosscuts on three levels. The upper two are adit levels which are connected far back in the mine by a raise. The third level is reached by a vertical shaft, sunk well back on the No. 2 level. The upper or No. 1 level has about 845 feet of drifts and crosscuts, the intermediate or No. 2 level, 2,235 feet, and the lower or No. 3 level, 735 feet. The No. 1 level is 145 feet above the No. 2 level and the No. 2 level 125 feet above the No. 3 level.

CONCLUSIONS

The part of the Moyie Yaak district that contains the Coeur d'Alene type of lead-zinc siderite veins is worthy of further exploration. The veins should have a moderate vertical range measured in some hundreds of feet. Although individual shoots may pinch with changes in the controlling structure, other shoots may be expected at greater depths as structures may again become favorable. The marked changes in dip and strike of the guiding fractures at the Regal mine favor ore shoots of small to moderate size with recurrent pinching and swelling on the dip. The occurrence of the veins in the granitic rock of the Nelson batholith affords no basis for condemning the district, because the mineralization is not genetically related to the batholith but to probably younger magma, whose presence locally may not yet have been revealed by erosion.

Mineralization is probably not restricted entirely to the Regal mine. The silver-bearing galena and gold-bearing pyrite veins mentioned by Kirkham and Ellis[19] at the Moran property in Sec. 19, T. 64N., R. 2E., about 2 miles north of the Regal mine suggest that the mineralization may extend over a considerable area. The part of the district that may prove most worthy of prospecting may be that along and on either side of Meadow Creek valley where mention has been made of a possible zone of structural weakness along which igneous intrusion and mineralization may have been localized. As much of the valley floor and lower slopes are beneath outwash and morainal debris, discovery of veins may prove difficult.

The district as a whole is in need of detailed geologic study.

[16] Anderson, A. L., U. S. Geol. Survey Bull. 944-b, op. cit.

[17] Umpleby, J. B., "The Osborn fault": Jour. Geol. vol. 32, pp. 601-614, 1924.

[18] Lindgren, Waldemar, "Mineral Deposits"; McGraw-Hill Book Company, fourth ed. pp. 529-636, 1933.

[19] Idaho Bur. Mines and Geology Bull. 10, op. cit. p. 60.

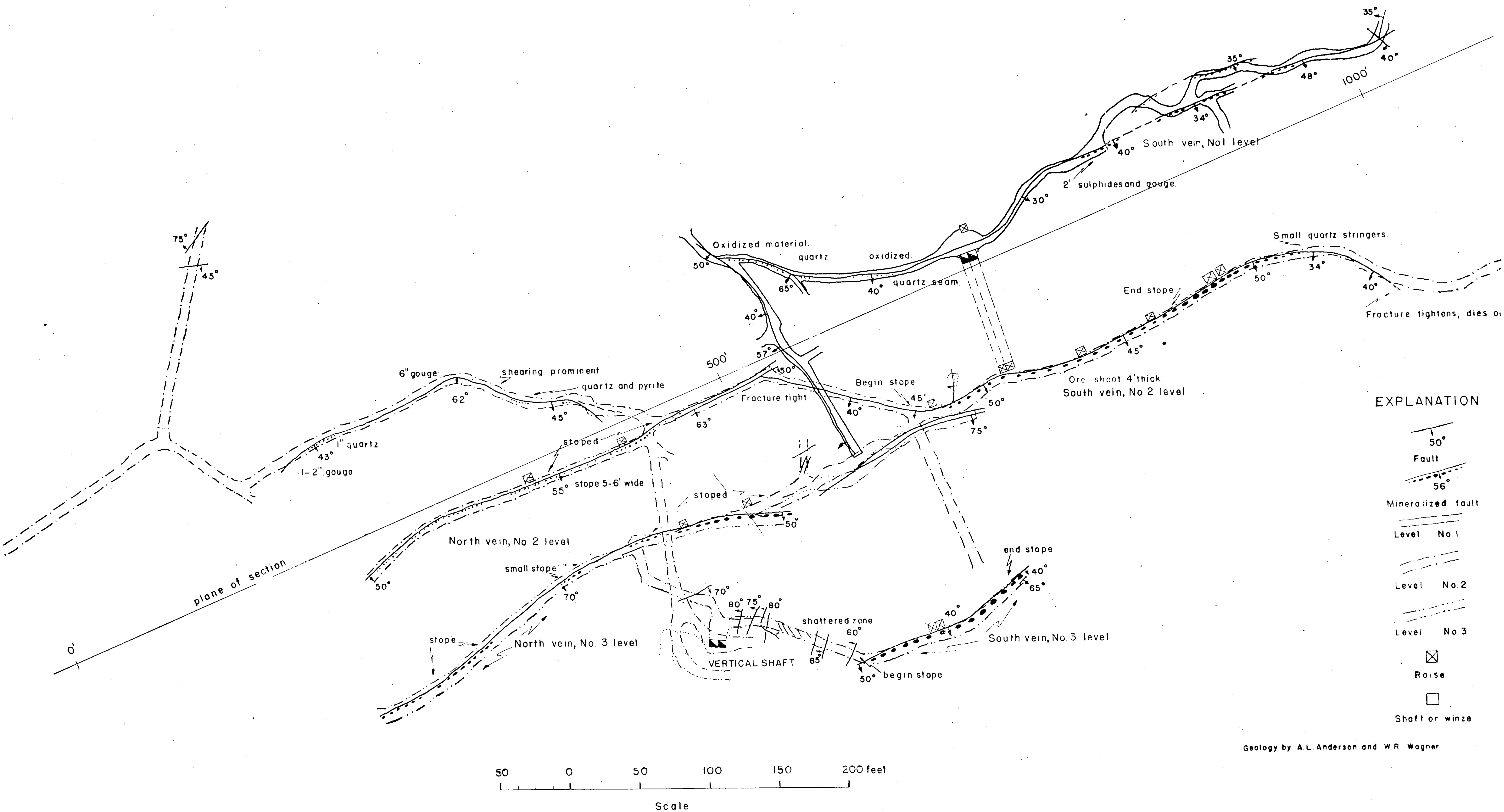

Fig. 2. Geologic map of underground workings of the Regal Mine, Boundary Co.

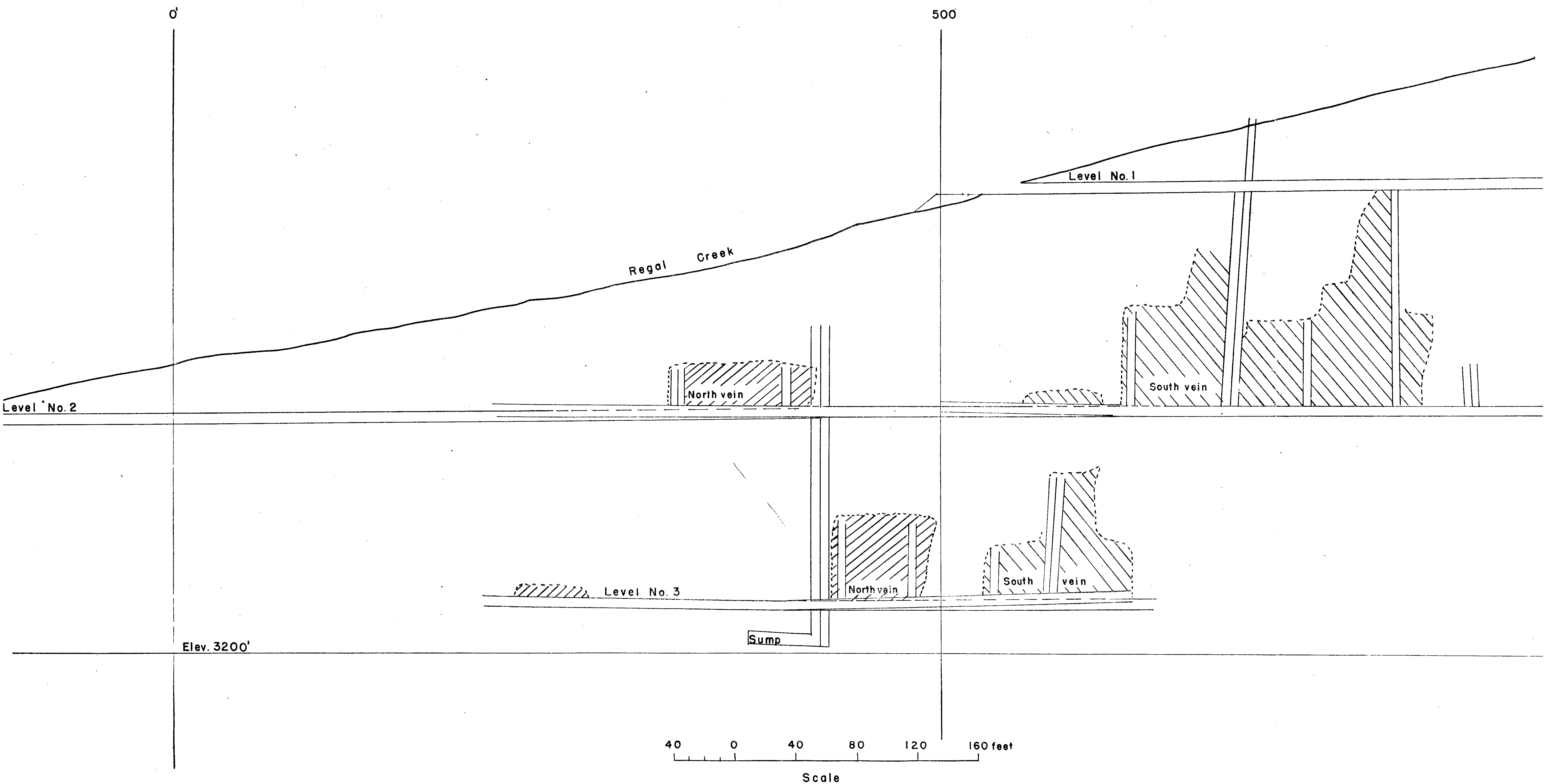

Fig.3. Longitudinal section through Regal Mine showing stopes on North and South veins.