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DESCRIPTIONS OF SOME ORE DEPOSITS AND THEIR RELATIONSHIPS TO THE PURCELL SILLS, BOUNDARY COUNTY, IDAHO

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DESCRIPTIONS OF SOME ORE DEPOSITS AND THEIR RELATIONSHIPS TO THE PURCELL SILLS, BOUNDARY COUNTY, IDAHO

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ABSTRACT

This report covers a study of some mineral deposits, largely base-metal ores, located in the western segment of the Purcall Mountain Range, Boundary County, Idaho. Most of the mineralized deposits occur either within or adjacent to the contacts of large, basic, igneous sills and metamorphosed sediments, both rock types being pre-Cambrian in age. The deposits occur in fracture openings which have formed in several ways; however, the most common type is the result of structural deformation, probably early Tertiary in age, which has created compressive stress in host rocks. The contact of sill and sediments has provided a favorable zone for the location of these fractures because it is a plane of weakness; this is due partly to the intrusion of the sill, and partly to the fact that the contact was initially a weakened bedding plane. These fracture openings have provided avenues of approach as well as receptables for the migrating mineralizing solutions. The occurrence of ore deposits over a wide lateral and vertical range suggest an extensive mineralized zone.

Although mineral production from the various properties in the area has been slight, several of the deposits warrant further exploration.

INTRODUCTION

PURPOSE AND SCOPE

Many parts of Boundary County, Idaho, have long been of interest to mine operators because of their mineral possibilities. Some properties, such as the Continental and the Silver Crescent, have been renumerative in the past; others, although many are only prospects, are worthy of future exploration. The many requests for geologic data, coupled with the comparatively unknown qualities of the various properties, interested the Director of the Idaho Bureau of Mines and Geology, who, acting accordingly, sent a field party into the area in June, 1948.

Three weeks were spent in the field. This time was devoted to collecting data, and to the preparation of maps. The short field season compelled studies to be confined to those properties located in that section of the Purcell Mountain Range lying between the Moyie and Kootenai Rivers. Two exceptions are the Jane Silver-Lead (the old Two-Tail), and the Idamont Lead-Zinc mines, both located on the south side of the Kootenai River. (See Fig. 1.)

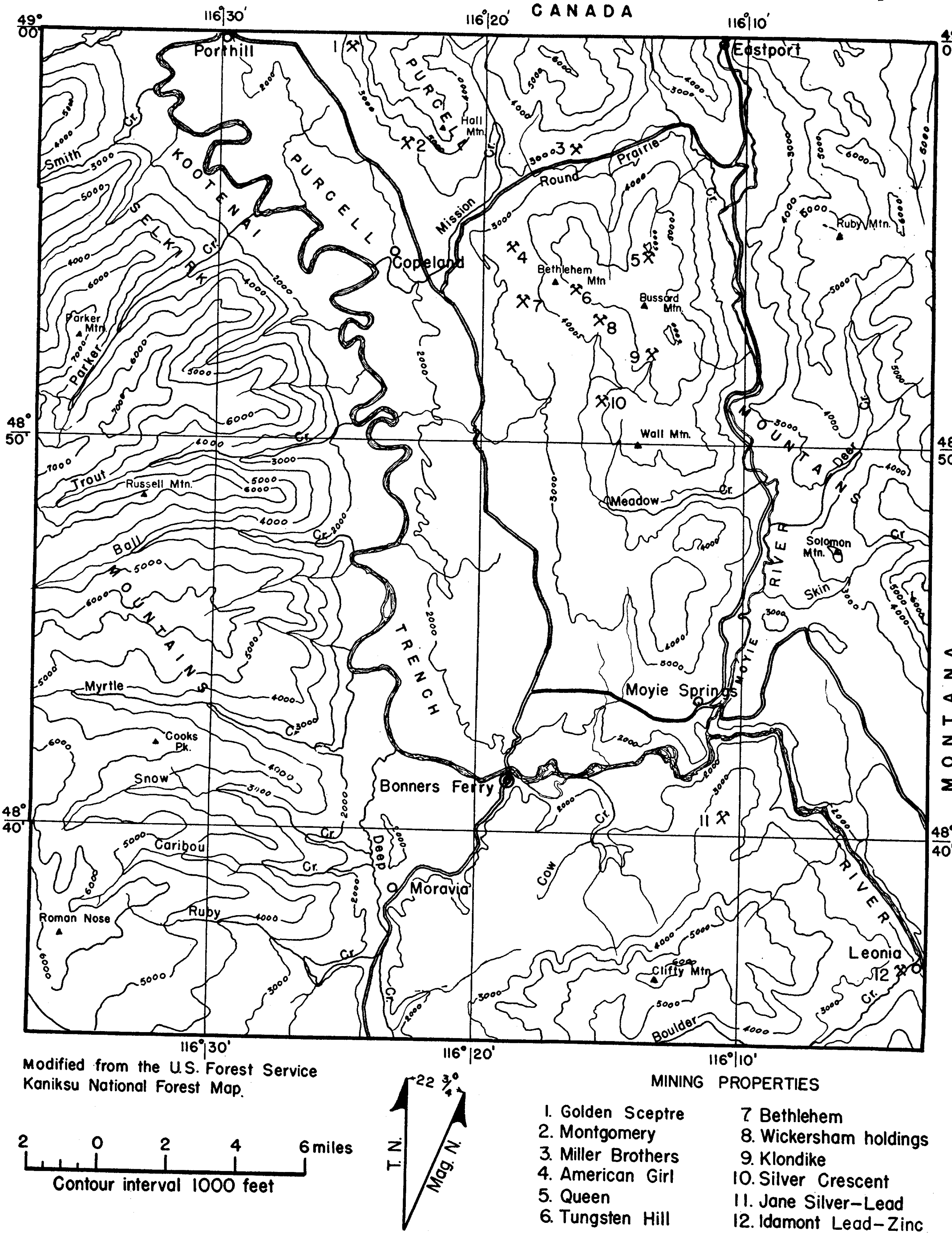

Fig 1. Topographic map of a portion of Boundary County, Idaho, showing the location of various mining properties.

Detailed field work was handicapped by the lack of a suitable base map. The only map available was one issued by the U. S. Forest Service: The Kaniksu National Forest (east half). Many topographic details are missing on this base map because the topography was taken from the old, small-scale (1:250,000) map of the Priest Lake Quadrangle issued by the U. S. Geological Survey.

ACKNOWLEDGMENTS

During the field season the writer was ably and efficiently assisted by Mr. George Glarborg, a student at the University of Idaho, School of Mines. Many thanks are extended to Mr. Jack Berry for his information on the Montgomery mine and nearby properties. Mr. Sven Anderson was most generous in allowing the field party to use his cabin during their stay on Queen Mountain. Mr. William Tilley was very helpful in supplying information on properties located in the Queen Mountain district.

PREVIOUS GEOLOGICAL INVESTIGATIONS

The following bibliography represents those publications which touch on the economic aspects of Boundary County geology. Of these studies those by Kirkham and Ellis, and by Anderson and Wagner are the most informative.

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Daly, R. A., Geology of the North America Cordillera at the Forty-ninth parallel: Memoir No. 38, Canadian Geological Survey, Ottawa, 1915.

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Shannon, E. V., The Minerals of Idaho: U. S. Nat. Museum Bull. 131, 1926.

GEOGRAPHY

LOCATION

The region studied lies entirely within Boundary County, the northern-most county in Idaho. It falls within the western segment of the Purcell Mountains and is bounded on the north by the Canadian border; on the west by the Kootenai River; on the east by the Moyie River; and extends about two miles south of the westward flowing part of the Kootenai River. Except for the more mountainous portions, the area is easily accessible by automobile and may be reached by several state and county roads from Bonners Ferry, the county seat of Boundary County.

PHYSIOGRAPHY

The portion of the Purcell Mountain group under consideration is a dissected, tilted fault block. It ranges in altitude from 1790 feet on its lower western limb, near Copeland, to 6141 feet on Queen Mountain, its highest point, a difference in elevation of 4351 feet in a horizontal distance of four miles. Continental glaciation has scoured these mountains giving them a smooth rounded appearance. This is particularly true of those areas bordering the Kootenai Valley.

The region is drained by the Kootenai River, which enters the county from the eastern side and flows northwest into Canada where it empties into Kootenai Lake. The Queen Mountain area, comprising the major portion of the district studied, is drained chiefly by Meadow and Round Prairie Creeks, which flow eastward to the Moyie River, and south to the Kootenai River.

Within the area are many small lakes, formed by glacial scouring and morainal damming.

The higher points in the mountains are frequently composed of igneous basic sills, which, being more resistant to erosion than are the more prevalent metamorphosed sediments, stand out with noticeable relief.

GEOLOGY

SUMMARY STATEMENT

The dominant rocks in the eastern part of Boundary County are members of the Belt series (pre-Cambrian metamorphosed sediments), of these the Aldridge-Prichard formation* 1/ is the most abundant. Interbedded in the metamorphosed rocks are countless diorite and gabbro sills. The sills range in thickness from a few to several hundred feet, and are continuous in their exposures.

*/ All references quoted are listed at the end of this paper

These sills and metamorphosed rocks have been invaded by granitic rocks--outlying portions of the Nelson batholith.

METAMORPHIC ROCKS

Aldridge-Prichard Formation

This formation, a sequence of eastward dipping quartzites, argillaceous quartzites, and argillites is exposed throughout the studied area. The rocks have fairly constant regional attitudes, striking north-northwest and dipping at angles varying from 14° to 80° to the east. Where exposed near the old Two-Tail mine, the quartzites strike N. 32° E., dip 50° to the east, are light gray, and massive with beds five feet thick being not uncommon. Farther north on Queen Mountain, the rocks are argillaceous quartzites, which strike N. 16° W. and dip 80° to the east. They are dark gray, thinly-bedded, and locally contain thin intercalated beds of argillite. In this area, the rocks have a reddish-brown color on their weathered surfaces.

An interesting exposure of the formation occurs on Bussard Mountain where argillaceous quartzite is in contact with a granitic stock. Here, in an irregular aureole about the contact, is a variety of rocks which have resulted from progressive metamorphism. In the outer part of the aureole, near the argillaceous quartzite, is a spotted gneiss which has resulted from lower temperatures during metamorphism. As the granite contact is approached, the rocks change to a migmatite or a mixed gneiss with small irregular stringers of granite penetrating outward into the gneissic zone. These rocks have been more strongly affected by the temperatures of the invading granitic magma.

In the northern part of the county, near the Montgomery mine, the formation retains its north-northwest strike but the eastward dip flattens to 14°. Medium-gray quartzite is the most common rock exposed but there are some thin intercalated argillites and slates.

No attempt was made to determine either the stratigraphic position or the thickness of this formation; however, Kirkham and Ellis 1/ describe it as the oldest formation of the Belt series outcropping in this area, and estimate its thickness as more than 10,000 feet, exclusive of the intruded basic sills.

IGNEOUS ROCKS

Purcell or Moyie Sills

The most common igneous rocks exposed in the region occur in large basic sills, which have intruded the flat-lying Belt series, especially the Aldridge-Prichard formation. Subsequent structural adjustments have tilted the beds and sills, thus exposing them over large areas. Individually, they range in thickness from 10 to 2000 feet, have widely variable outcrops, and have been traced, in a northwest direction, completely across the county, extending well into Canada on the north and into Bonner County, Idaho, and Montana on the south 1/. Kirkham and Ellis list 14 sills as occuring in the Aldridge-Prichard formation; however, detailed mapping of these members would undoubtedly reveal a great many more.

The Moyie sills have been described by Daly 2/, who refers to a hornblende gabbro sill located just west of the Moyie River near the Canadian border. Other writers who have studied the sills include: Schofield 3 4/, Calkins and MacDonald 5/, and Kirkham and Ellis 1/. They point out that the lithology of the sills is variable, but that they are essentially altered gabbros and diorites.

In some cases there appears to be a differentiation of various rock types within the same sill. Such is the case in a sill cut by the lower tunnel in the Bethlehem mine.

The sill, where first entered on its lower side, is a hornblende diorite, but as the tunnel is followed to the up er side, it changes to a granophyre. The transition is not sharp but gradual, and in its field occurrence is best distinguished by the change in texture, i.e., from a fine-grained, holocrystalline texture to a more coarse-grained porphyritic type in which fresh plagioclase phenocrysts are plainly visible. A somewhat similar differentiation in the Canadian Purcell sills (equivalents of the Moyie sills) is described by Schofield 4/ who explains it as resulting from gravitional stratification of the material according to its density. The more basic minerals composing the diorite, being heavier, have sunk to the bottom of the sill during its cooling, leaving the lighter granophyric materials resting on top.

At the old Two-Tail mine, a specimen of uralitized diorite was taken from a diamond drill core, which came from 260 feet below the surface. The rock is dark green and has a fine-grained phaneritic texture. It is composed chiefly of hornblende and labradorite. Very commonly the hornblende crystals contain relict cores of augite showing that they are deuterically altered from the augite. Other accessory minerals include: orthoclase, hypersthene, olivine, magnetite, and pyrrhotite.

There is a sharp line of demarcation between the sills and the enclosing country rock; this is especially true in those areas where the sills have intruded quartzites and argillaceous quartzites. In these areas the zone affected by contact metamorphism is rarely more than one foot wide. This zone is usually indurated but does not contain stress minerals, thereby suggesting that during intrusion the encroaching magma replaced the host rock without exerting much stress upon its enclosing walls.

In all exposures studied, the sills contain two or more sets of joints or parting planes, which have originated during cooling and recrystallization. Wherever examined, the joints were found to be confined to the sills and did not penetrate the adjacent country rock. The joints are commonly filled with quartz and in some cases calcite; some also contain sulphides. A few of the joints have been explored by prospectors in the hope of revealing ore deposits. A typiecal example is the gold vein at the Queen mine.

Further detailed mapping is needed before the total thickness of these sills can be computed. The present thickness is estimated at 10,000 feet 1/, but is undoubtedly much more.

According to Schofield 4/ the sills are pre-Cambrian in age.

Granitic Rocks

Under the heading "granitic rocks" are listed those rock types which are characteristic of the Nelson batholith; these include granite, quartz monzonite, and granodiorite. These rocks are exposed along the western edge of the area, extending from the bench-like plateau east of the Kootenai River, well up onto the western mountain slopes. In the area near Brush Lake, the granitic rocks may be traced eastward to Bussard Mountain, thence southeast and west to Wall Mountain. This area contains approximately 10 square miles of granitic rock exposure and is of interest because of the various mining properties within its borders (the Silver Crescent, the Klondike claims, the Howard Wickersham holdings and others). The granitic stock is undoubtedly an outlying part of the extensive granitic region located in the Selkirk Mountains west of the Kootenai River. Like that region it has been exposed by erosion, but not over such extensive areas.

Megascopically, the rocks are light gray, have a porphyritic texture, and are characterized by the presence of large pink orothoclase phenocrysts. These phenocrysts are sometimes three inches long, elongated parallel to the C axis, and as much as two inches wide. On the more weathered surfaces these resistant phenocrysts stand out in relief, producing a sharp, jagged surface.

A granite specimen taken from the northern slope of Wall Mountain contains orthoclase (60 per cent), albite-oligoclase, An_7 to An_{12} (20 per cent), hornblende (10 per cent), quartz (5 per cent), Augite (3 per cent) and sphene, myremekite, apatite and magnetite as accessories.

Jointing is well developed in these granitic areas. On the southwestern side of the ridge connecting Bussard and Bethlehem Mountains, there is a conspicuous joint system containing two, and in some places three, separate sets of joints. The most prominent set strikes N. 60° E. and dips at steep angles to the south. It commonly contains aplite dikes and in some cases narrow quartz veins which show traces of mineralization.

Kirkham and Ellis 1/ list the age of the Nelson batholith as Mesozoic (Cretaceous ?). They point out similarities of this intrusive mass with those of the Idaho batholith, of Central Idaho, which is believed to be of the same age.

Aplite dikes

Aplite dikes are common in the granitic rocks, particularly along the western sides of Bussard and Queen Mountains. These dikes are noticeably evident in joint planes. They are small, their thickness being measured in inches rather than feet, and their contact with the enclosing rock is sharp.

The aplites are light gray or nearly white, and very fine grained; the average grain being about 1 millimeter in diameter. They are composed of nearly equal amounts of quartz, oligoclase, and orthoclase. Accessory minerals include sphene, muscovite, sericite, and chlorite. In those specimens studied, the orthoclase and oligoclase are present in nearly equal amounts, therefore the dike rock is classed as a quartz monzonite.

QUATERNARY ALLUVIUM

Alluvium deposits are abundant along the major drainage channels. These silts, sands, and gravels are extensive, and in places they attain a thickness of several hundred feet. Kirkham and Ellis 1/ class them chiefly as lake deposits and they point out that these lakes resulted from glacial invasion during Pleistocene time. Of these lakes, Kootenai Lake, occupying the Kootenai River Valley, was the largest. The stratified sediments of this old lake are very evident in the quarried hillside, on the south side of the Great Northern Railroad tracks, in Bonners Ferry. Other lakes formerly occupied the region around Addie, Round Prairie, and Snyder; Meadow Creek; Grass and Cow Creeks, and Boulder Creek. Continued stream erosion has breached the confining dams of these old lakes and their residual alluvium is now exposed as terraces and as mantles on the older bedrock formations. In places, the old lake sediments form fertile soil, e. g., the Kootenai Valley farming districts, many of the bench farms, and the upland stream meadows along Meadow Creek.

REGIONAL STRUCTURE

Kirkham and Ellis 1/ consider faulting to be the structural factor which has most affected the regional geology in this area. The location of major faults is reflected in the local drainage patterns and also by the tilted attitudes of the mountain blocks. In a general way, the major faults may be placed in two regional patterns: north-south-trending master faults which appear to have originated from compressional stress accumulated during mountain folding; and east-west-trending complementary faults which transverse the strike of the regional country rock and in all probability were contemporaneous with the master faults.

The prominent major faults include: The Kootenai, the Round Prarie and the Moyie-Lenia overthrust. The Kootenai fault 1/ has been mapped along the western side of the Kootenai River and is described as an overthrust fault with the downthrown side on the east. The Moyie-Lenia overthrust fault 6/ controls the course of the Moyie River. It is a large fault that has been traced for 118 miles, extending into Canada on the north, and into Montana on the southeast. The Round Prarie fault controls the course of Round Prarie Creek 1/. It shows a horizontal displacement of three miles and a vertical throw of 1000 feet, with the down-throw side on the south. Anderson and Wagner 7/ postulate a possible east-west fault along the eastward-flowing section of Meadow Creek.

In the vicinity of the Queen mine, sharp variation in country rock attitudes, abrupt termination of a diorite sill, and a small entrenched stream channel, all suggest that an easternly transverse fault closely follows Little Hellroaring Creek. This fault is of smaller magnitude than the Round Prarie fault.

There are numerous faults of smaller magnitude which do not conform with the above mentioned faults. Many of these involve local structures within individual mines and prospects and as such will be discussed with these properties.

The major faults are thought to have accompanied the structural deformation that was contemporaneous with the intrusion of the Nelson batholith. This would place the age of major faulting as Mesozoic (Cretaceous ?).

MINERAL DEPOSITS

CHARACTER OF THE DEPOSITS

The most interesting feature of the Boundary County ore deposits is their close association with the intruded basic sills. In all the deposits studied, with the exception of those within the Bussard Mountain granitic area, the veins occur either within, on the contact, or immediately adjacent to the contact of these sills. Very rarely do these veins pass from the sills into the adjacent country rocks or vice versa; instead, they parallel the general strike of the sills. The veins do not have long continuous strike lengths, but are quite short. Locally they swell to a thickness of several feet, elsewhere they narrow to mere stringers or even pinch out completely. In places the broad, short veins are more like lenses or elongated pods.

The veins are located in fractures in the country rock which have resulted from both shearing and tensional stresses. Ore within the veins has resulted from deposition in open fissures and from replacement of the material originally present in the fractured areas by the mineralizing solutions. An exception to this type of mineral deposition is the segregation deposit at the Montgomery Mine.

MODES OF VEIN ORIGIN

Fractures of dilation

In considering the origin of the veins, several factors must be noted. The close vein and sill associations imply that one of the dominant controlling factors in vein location has been the volume changes in the intruded sills. This is most certainly true of those veins that cut obliquely across sills, e.g., the Queen mine gold vein. Veins of this type lie in joint planes within the sills. The joints originated during cooling and crystallization of the intrusive sills, and are, therefore, dilation joints resulting from shrinkage of the cooling igneous rock body. The stresses which accumulated during shrinkage exceeded the elastic limit of the sill-rock with ensuing rupture. The fracture planes have established definite patterns, which as a rule trend diagonally across the sill, leaving enclosed blocks of unfractured sill-rock. The resulting joint planes have subsequently formed permeable channel ways for migrating mineralizing solutions, thus in places they have been filled with quartz and calcite and sometimes with minor amounts of various sulphide ores. As such they attract the prospector and many of them have been rather extensively explored, but such efforts to date have proved fruitless.

In the field, these joint-filled veins are best recognized by their oblique strike across the sills and the fact that they do not penetrate the adjacent wall rocks. Another characteristic of this type of vein is the manner in which the ore is frozen to the vein walls. The absence of gouge or selvage on these walls implies that there has been little, if any shearing in the joint plane and that the fracture has resulted from simple dilation. Future exploration in this type of deposit should be discouraged for they do not present encouraging prospects.

Faults along contacts

The most common vein type in the area studied is represented by veins that occur within shear zones that border the contacts between basic sills and sedimentary rocks. These fracture zones usually are parallel and conformable with the contact; however, occasionally they strike and dip at moderate angles away from the contact. They do not have long continuous strikes nor do they exhibit excessive displacement. In all cases noted the faults were pre-mineral, and as such have provided avenues of approach for the mineralizing solutions. In some instances brecciated vein material suggests minor post-mineral movement within the plane of the vein but in no case was there evidence of post-mineralization vein displacement.

This type of vein has resulted from structural readjustment of the enclosing country rock. The faulting has resulted from stresses that accumulated during regional uplift and folding of the metamorphosed sediments and their intruded sills. The homogeneous sill rocks, being more competent, have withstood the stresses better than the adjacent bedded, metamorphosed sediments. Therefore, those areas along the contact and in the nearby country rock, since they already possessed zones of weakness in the bedding planes and along the contact, have been affected not only from stress accumulated in their surrounding rock body but also from those stresses accumulated in the nearby sill. This concentration of stress in the contact area has resulted in fracture. That the Purcell sills have effected a structural control upon the location of the veins is proven by the veins similar characteristics and occurrences over such a wide area. Notable examples of this vein type include: the upper Montgomery vein, the Queen mine shaft vein, and the vein exposed in the No. 3 adit of the Idamont-Lead-Zinc Mines Co.

Joint Planes in Granite

On the southwestern slopes of Bussard and Queen Mountains there are a number of deposits which have similar characteristics. The ore of these properties, the old Tommy Moran prospects, some of Howard Wickersham's holdings, and others, occurs in joints in the granitic rocks. The joints were formed during solidification of the intrusive granite, and although most of them have remained as simple joint planes, some have been filled with aplite dikes and others with quartz and minor amounts of sulphides. There are at least two sets of mineralized joints in this area. The most prominent set strikes in an easternly direction and dips steeply to the south. Joints in the latter set commonly contain narrow veins whose width is usually measured in terms of inches and are rarely more than 16 inches in width. They have proved unproductive during their past mining exploration.

Immiscible liquid segregation deposits

A rather unusual type of deposit is located in the lower workings of the Montgomery Mine. It occurs along the lower side of a basic sill that passes directly beneath the compressor house at the mine. The sill, which is about 250 feet thick, may be traced along the side hill where it outcrops as small bluffs and minor promontory points. It is cut by a tunnel located a few feet north of the compressor house. The sill varies in composition from a hypersthene gabbro to a uralitized diorite, but its outstanding characteristic is the abundance of pyrrhotite and minor amounts of other sulphides which are contained throughout the basal section of the sill.

The sulphides do not occur as a vein or lode but are disseminated throughout the sill rock. Under the microscope they are seen to penetrate, corrode, and replace the surrounding silicate gangue minerals, commonly leaving corroded remnants of these minerals locked within the sulphide grains. In silicates that have good cleavage, e.g., augite, the sulphides, during replacement, have closely followed the cleavage planes or lines of least resistance. These microscopic observations present good evidence that the sulphides are younger than the enclosed silicates.

Since there is no field evidence of structure which might have allowed introduction of the younger sulphides into the sill, it becomes apparent that they originated from the same magma and concurrent with the host sill. It may be postulated that, as the intruded sill cooled, the sulphides separated out as immiscible drops and due to their greater specific gravity settled toward the bottom, thus increasing their concentration in that area. The low melting point of the sulphides caused them to remain in solution after the silicates (with higher melting points) had crystallized, giving them the opportunity to concentrate by gravity separation, and to affect the older silicates as previously described.

Ordinarily, deposits of this type occur as disconnected bodies along the lower margins of the intrusive, especially where there are depressions in the floor. Whether such a depression occurs at the Montgomery mine is not known. The limited amount of geologic field mapping did not prove or disprove its existence. Certainly a warp in the bedding in this area would not be unusual, particularly since bedding flexures were noted in other parts of the studied area.

Although other cases of gravitational segregation within the sills were noted, the Montgomery area is the only known example that has resulted in a concentration of ore minerals.

MINERALOGY

The minerals which make up the ore deposits can be divided into three groups: (1) primary minerals, deposited by ascending hydrothermal solutions; (2) secondary minerals, derived from alteration of the primary minerals; (3) gangue minerals which make up the bulk of the deposits.

Primary Minerals

Galena --- Lead sulphide (PbS) is the principal ore mineral of the area and it accounts for almost all of the commercial values. It is present in all of the deposits studied. An unusual feature of most of the Boundary County galena is the unoxidized condition of the mineral-bearing vein outcrops. Normally galena is one of the first sulphides to undergo oxidation; thus its unusual fresh appearance in most of the outcrops indicates that it has been exposed to oxidation for a relatively short time.

In the hand specimen, the galena is coarsely crystalline. In polished surfaces, embayments and stringers of galena are commonly seen cutting and replacing older pyrite and sphalerite. The galena that assays silver usually contains tetrahedrite, a common silver-bearing mineral, and it is the tetrahedrite that contains the silver, not the galena.

Pyrite --- Iron pyrite (FeS_2) is widely distributed throughout the mineral deposits. It is present not only in the veins but often in the adjacent wall rocks. In the deposits studied, the pyrite was the first sulphide to be deposited, and often contains shattered fractures and other openings which have been filled with younger sulphides. In many instances younger sulphides have partially and sometimes completely replaced the pyrite.

Sphalerite --- Zinc sulphide (ZnS) commonly referred to as "zinc-blende" or "black-jack" is present in most properties, although usually in insufficient quantities to be of commercial value. It is closely associated with the galena but may be differentiated by its dark reddish-brown color and by the brown streak it gives when scratched. Under the microscope it is seen replacing pyrite but in turn being replaced by galena and chalcopyrite. The chalcopyrite replacement is distinctive in that it occurs as microscopic blebs and particles following the sphalerite cleavage.

Chalcopyrite --- Copper iron sulphide ($CuFeS_2$) is the chief copper ore in the district. It may be differentiated from pyrite by its different crystal system and its lesser hardness. It has been recovered at the Silver Crescent mine; however, at other properties it occurs in such minor quantities that it has been of no commercial value.

Tetrahedrite --- The mineral tetrahedrite ($5Cu_2S.\ 2(Cu,Fe)S,\ 2Sb_2S_3$) commonly known as "gray copper" is the source of most of the silver produced in the area. It occurs in such minute amounts that it cannot be recognized in the hand specimen; however, in polished surfaces it is seen as thin streaks and phantom veinlets, many of which have replaced galena. It usually follows the cleavage planes of the galena but occasionally is seen in crosscutting fractures.

Arsenopyrite --- The sulpharsenide of iron (FeAsS), sometimes referred to by the prospector as "arsenical pyrites", is quite rare in most ores, but is abundant at the Bethlehem mine. It is often hard to distinguish from pyrite, but may be differentiated by its lighter color, its garlic-like odor when heated, and by the fact that it does not occur as cubes but as diamond-shaped tabular crystals or in a massive granular form. It has no economic value.

Pyrrhotite --- Iron sulphide (Fe_nS_n) has a varying composition, is present in small amounts in most ores, but is very common in the basic sills. It is the dominant sulphide at the Montgomery mine. Pyrrhotite has a bronze color, does not show cleavage, and is faintly magnetic. At the Montgomery mine, assays have been made on this mineral that have given positive reactions for nickel; however, a microscopic study reveals that the nickel minerals pentlandite and gersdorffite are present within the pyrrhotite and they account for the presence of the nickel.

Pentlandite --- A sulphide of iron and nickel($(FeNi)_9S_8$)occurs in the Montgomery pyrrhotite ores. It is recognizable only in polished sections where it is seen to form minute scattered intergrowths with the pyrrhotite. The intergrowth relationship presumably resulted from an exsolution of the nickel-rich constituent. The mineral has a bronze-yellow color and forms granular aggregates with no trace of cleavage.

Gersdorffite --- A sulphide-arsenide of nickel (FeAsS) is associated with the pyrrhotite and pentlandite in the Montgomery ores. It is recognizable only in polished surfaces where it forms scattered subangular crystals. It has a very light yellow, almost white, color, is very hard, and often exhibits zonal growth banding, probably due to differences in composition within the individual zones.

Gold --- Minor traces of gold were obtained by panning the placer deposits on lower Boulder Creek, but free gold was not recognized in any of the ore samples. Several properties have given positive gold assays, but the gold is evidently so fine, and so widely disseminated throughout the ores, that it is hard to locate.

Scheelite --- The calcium tungstate ($CaWO_4$) is present in the ores of the old Tungsten Hill mine, located near Bethlehem Mountain. It occurs in a quartz vein that also contains limonite-filled druses and siderite. When hurriedly examined, the scheelite may be mistaken for siderite, but may be distinguished by its greater specific gravity, and by its pronounced fluorescence.

Secondary Minerals

Secondary minerals are not abundant in the Boundary County area. The continental glaciers that were active during Pleistocene time scoured most of the area, removing the weathered and oxidized mantle and exposing fresh rock. Since secondary minerals normally occur in the upper parts of the veins, in the oxidized zone, many of these minerals were removed by glacial action. There has not elapsed sufficient time since the Pleistocene glaciation for oxidation to notably affect the sulphides now exposed in the vein outcrops. Those secondary minerals that were noted do not form extensive deposits but are present as more scattered traces.

Anglesite --- This ash-gray mineral ($PbSO_4$) is formed by the oxidation of galena. It is the first oxidation product formed, and frequently occurs as a fine compact coating or shell on the residual galena crystals. Some excellent samples were obtained from the Jane Silver-Lead mine in which the anglesite is replacing, and still retaining, the cubic structure of the galena.

Cerussite --- Occasional traces of the yellow, vitreous, lead carbonate ($PbCO_3$) were found as a coating on the anglesite obtained at the Jane Silver-Lead mine. Its occurrence in such minor amounts indicates that oxidation is still in its earlier stages. With continued oxidation the anglesite will convert to cerussite.

Malachite --- A green copper carbonate ($CuCO_3.CU(OH)_2$) commonly known as "copper stain" is occasionally seen in some of the joint plane deposits in the granitic rocks on southwestern Bussard Mountain. It is a secondary product formed by the oxidation of copper sulphides.

Limonite --- Hydrated iron oxide ($2Fe_2O_3.3H_2O$) is common on the more oxidized vein outcrops. It is a brownish-red to yellow material which forms stains and minor masses about the unoxidized sulphides. It results from the oxidation and decomposition of the iron-bearing minerals, particularly the sulphides.

Psilomelane --- Psilomelane is a hydrous manganese oxide of doubtful composition; it has a widespread occurrence on the various vein outcrops. It is a black, impure, earthy material, probably an oxidation product of manganiferous siderite.

Gangue Minerals

Quartz --- Silicon dioxide (SiO_2) is the most widespread gangue mineral and the principal filling of most of the veins. It has been introduced during several stages of mineralization as evidenced by its different types of crystallinity, brecciation, and crosscutting relationships with other minerals. Its most common occurrence is as white to colorless massive vein quartz.

Siderite --- Iron carbonate ($FeCO_3$) is a very common gangue mineral in most of the deposits. It is normally massive, pale to dark brown, fine to coarse granular, and occasionally it shows well developed crystals of the rhombohedral habit. Although a gangue mineral, it commonly shows replacement by sphalerite, galena, and chalcopyrite, thus proving that it is older than those sulphides. It is manganiferous and when exposed to weathering it becomes dark, almost black, in color.

Calcite --- Calcium carbonate ($CaCO_3$) is abundant in most of the properties. It is the most common gangue mineral in the Golden Sceptre mine, where it occurs as coarse pale white rhombohedral crystals, often replaced by later sulphides.

Sericite --- Sericite is a variety of moscovite or white mica. It is a replacement mineral usually formed by the action of ascending hydrothermal solutions on the surrounding country rock. Sericite is most prominent in those areas adjacent to mineralized veins, where it gives a bleached appearance to the rock. It has a greasy or soapy feel when wet. This type of mica is very fine grained and imparts a silky luster to the rock. It closely resembles some types of fault gouge and is often confused with that material.

Chlorite --- The term "chlorite" is the name given a group of minerals of varying composition. The minerals of the group are hydrous silicates of ferrous and ferric iron, alumina and magnesia. They are closely related to the micas in structure and composition, but are characterized by their green color. Chlorite is abundant in the adjacent wall rocks of most properties, particularly those deposits in argillaceous quartzites.

PARAGENESIS OF THE MINERALS

A study of the ores reveals a definite order of mineral deposition which holds for those deposits having similar characteristics. This is true for veins carrying lead, zinc, and silver, as well as for those whose future value depends upon their nickel content.

In the lead-zinc-silver ores, the sequence of deposition established by this investigation is as follows: quartz and siderite, pyrite, arsenopyrite, sphalerite galena, chalcopyrite, and tetrahedrite. Gold, where present, would probably be one of the latter if not the last mineral to be deposited. The succession, siderite, pyrite, sphalerite, and galena appears to be invariable; quartz, although generally the first to be deposited, has certainly been deposited at several stages and in some cases throughout the entire period of vein deposition. Structural and mineralogical relationships suggest that mineral deposition was not continuous but took place in successive stages. Structural readjustment has, at different times, reopened fissures, thus creating passageways for the ascending mineralizing solutions. Where these ascending mineralizing solutions have encountered the proper physio-chemical conditions, they have become supersaturated in the mineral constituents held in solution. Mineral deposition commenced when the ascending solutions reached the supersaturated condition and progressed as long as the solutions continued to deliver the mineral ingredients being deposited at that particular time.

At the Montgomery mine, mineral depositions of the nickel-bearing ores and associated sulphides was practically simultaneous. These ores are immiscible liquid segregation products that were deposited during the crystallization and solidification of the intrusive basic sill. Although originating from the same magma and emplaced by the same sill, the minerals crystallized in the following order: silicates (augite, hypersthene, etc.); gersdoriffite, pyrrhotite, and pentlandite; sphalerite; and chalcopyrite.

TENOR OF THE ORES

No samples were taken by the field party for assay. Wherever possible, notes on the assay values of various properties were obtained from the mine operators, but some of these values are probably inaccurate. As a general rule, the ores from this region give high assays for lead and fair assays for silver. Good assays for other metals are also reported. For the most part, it has been the small tonnage of ore in sight and not the tenor of the ore which has discouraged mineral exploration in the area.

GENESIS OF THE DEPOSITS

Ore deposition is generally regarded as a late phase of plutonic activity. Thus many of the Idaho ore deposits are thought to be genetically related to the Idaho batholith or to offshoots of that batholith. Other deposits are thought to be genetically related to plutonic activity that was widespread in the Rocky Mountain region during late Cretaceous or early Tertiary time. Anderson 8,9/ who has devoted a great deal of study to ores from the Coeur d'Alene and the Clark Fork districts, and to the ores from the Silver Crescent mine in Boundary County, considers these ores to be affiliated with the Laramide orogeny of early Tertiary time. Since other Boundary County lead-silver-zinc ores are characteristically similar to ores from the above mentioned regions, it seems reasonable to assume that they originated from the same sources and at about the same time.

The mineral association, the textures, and the types of deposits, all suggest that the ores have been deposited from hot ascending solutions that were derived from a deep magmatic source. The solutions have followed fractures and upon reaching favorable sites for deposition at moderate depths below the earth's crust, have cooled, become supersaturated, and deposited the mineral constituents held in solution, thus forming ore deposits of the mesothermal type.

FUTURE OUTLOOK

Many of those veins that follow shear zones, and which contain lead-silver-zinc ores in a siderite gangue are worthy of further exploration. The fact that this type of deposit is found continuously throughout the region and that they exist over such a range in altitude (there is 3200 feet difference in elevation between the Queen Mountain mine and the Miller Brothers' property on Round Prarie Creek) suggests that mineralization is extensive throughout the area. Locally, changes in the controlling structure may pinch the width of the veins, but such changes can just as easily widen the vein, thus creating favorable ore shoots. The range in elevation between deposits of similar characteristics implies that many of the present exposures continue with depth. Properly conducted diamond drilling programs would yield much valuable information on the extensions of these deposits.

The future of the immiscible liquid segretation, nickel-copper deposits, such as the Montgomery mine, will depend upon numerous economic factors plus the development of a large tonnage of ore. This type of ore is not high-grade but commonly forms large disseminated deposits.

MINING PROPERTIES

HISTORY AND MINE DEVELOPMENT

Little is known about the early day mining history of this part of Boundary County. This is undoubtedly due to the fact that most of the mineral deposits have been, and still are, chiefly prospects. Their limited production has caused them to remain unrecognized. There are exceptions: some properties have produced noteworthy amounts of lead and silver, and minor amounts of zinc, copper, gold and tungsten. The largest producer has been the Silver Crescent mine; others include the old Two-Tail, the Miller Brothers' property, and the old Tungsten Hill mine.

Mining activities were almost non-existent in this area during the summer of 1948. Diamond drilling campaigns were in progress at the old Two-Tail mine and on Sven Anderson's Queen Mountain property. Exploration work was being conducted on the Klondike property and some mining claim location work was underway at the Howard Wickersham holdings. All other properties were idle.

QUEEN MINE

The Queen Mine comprises 8 unpatented mining claims held by Sven Anderson of Bonners Ferry, Idaho. The mine is in Sec. 8, T. 64 N., R. 2 E., Boise Meridian, about 5 miles east of the old Tungsten Hill mine. It is accessible by forest service trails which lead up to Bussard and Queen Mountain Lookouts. These trails are usually open to travel only during the summer months.

Three separate veins occur on this property. They range in size from quartz stringers a few inches wide to a broad silicified zone 15 or more feet in width. They have been explored by 5 crosscut tunnels and one inclined shaft; most of these workings are now caved and inaccessible. Two of these are base-metal veins which occur in shear zones parallel to the attitude of the quartzitic country rock. The third, a quartz-filled joint plane in a basic sill, yields some gold values.

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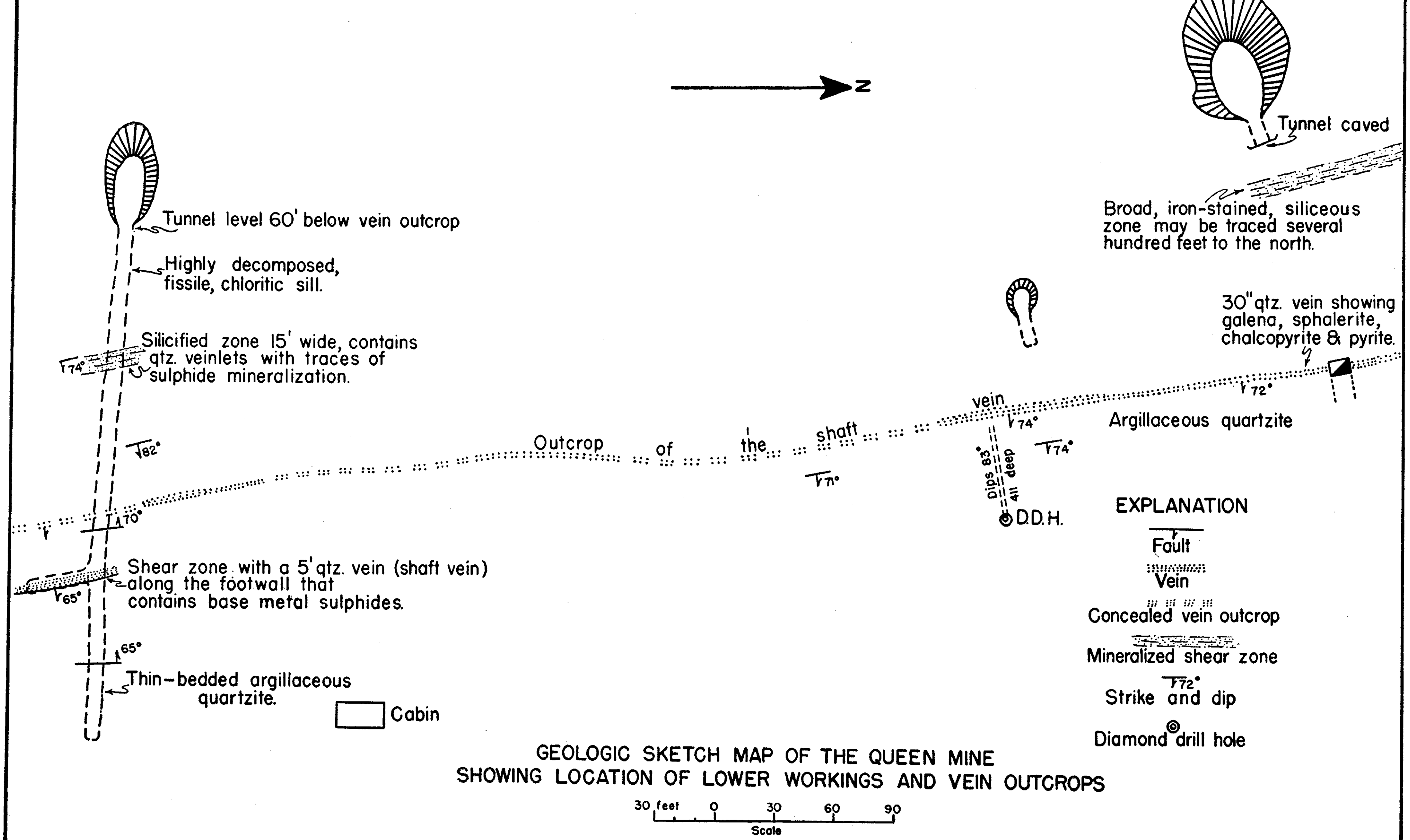
PLATE 3



GEOLOGIC SKETCH MAP OF THE QUEEN MINE
SHOWING LOCATION OF LOWER WORKINGS AND VEIN OUTCROPS

Of the two base-metal veins, the westernmost or lower vein is a broad silicified zone that strikes N. 8° W. and dips 80° E. It is cut by the crosscut tunnel located immediately west of the mine cabin and again by a more northern crosscut tunnel. (See Plate 3). The zone may be traced several hundred feet to the north where, due to its resistance to erosion and the presence of a small resistant basic sill on its footwall side, it forms a small but prominent ridge. At the surface the zone is partially oxidized and iron-stained; the adjacent wall rocks have been bleached and altered by hydrothermal alteration. Good ore samples are unobtainable at the outcrop, but ore taken from the tunnels contain galena, tetrahedrite, sphalerite, chalcopyrite and pyrite that yield an average assay of 0.14 oz. of gold and 3.4 oz. of silver. The lead and zinc assayw are not known.

The eastern vein (shaft vein) parallels the trend of the larger, western silicified zone, occurring 110 feet to the east. The vein varies from 3 to 5 feet in width and contains good exposures of galena, tetrahedrite, sphalerite, chalcopyrite and pyrite, in a quartz and siderite gangue. Although assays on this vein are not known, judging from the character of the galena, the lead assays should be high. The vein is explored by the same crosscut tunnels which intersect the previously described silicified zone. Unfortunately, only the southern tunnel was accessible during the investigation and underground examinations had to be confined to that area.

The third vein, the gold vein, occurs in a large dioritic sill located about 400 feet northeast of the mine cabin. It has been explored by 160 feet of adit and 70 feet of inclined winze. Where exposed, the vein varies from 3 to 6 inches in width, and is predominantly quartz but with some disseminated pyrite crystals. No gold is visible in the polished sections. The vein is a quartz-filled joint, striking N. 76° E. and dipping 38° to 44° S.

Although the property has lain idle for several years, in June 1948, an exploration program was inaugurated to investigate the two base-metal veins. A diamond drill was transported to the property and set up 54 feet east of a prominent outcrop of the shaft vein. The hole was inclined 83 degrees to the west, the target being an intersection with both previously described base-metal veins. The inclined length of the hole was approximately 411 feet, the greater part being in quartzite but ending in a dioritic sill. There were some faint traces of vein material present. (No log of the drilling was recorded; the core was strewn over the hillside, and the drill-sludge was discarded.) This neglect nullified any attempt at drill-core interpretation. Following completion of the hole, the drilling program was suspended.

Of the three veins, the two bearing base-metal ores contain geologic structure and mineral associations which are favorable for continued exploration. Their past development has undoubtedly been hindered by the isolated location of the property.

JANE SILVER-LEAD MINING CO.

This mine, formerly known as the Two-Tail, comprises 7 unpatented claims in Secs. 34 and 35, T. 62 N. R 2, E., Boise Meridian, about 12 miles east of Bonners Ferry, on the south side of the Kootenai River. Mine development consists of a 975-foot tunnel near the base of the mountain, which was full of water and inaccessible during the past summer's visit; a shorter tunnel near the

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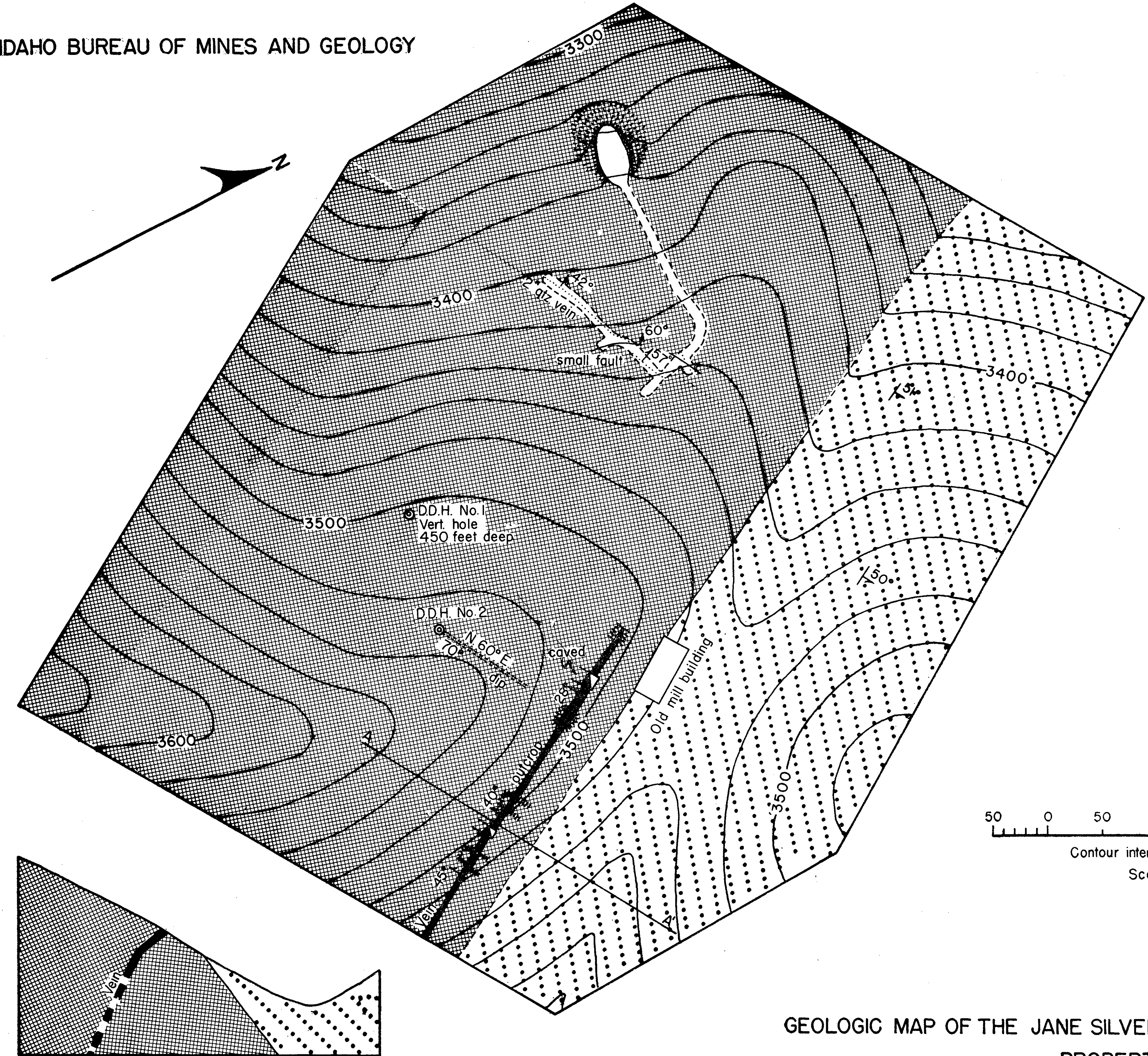
PLATE 4



Cross section A–A'

EXPLANATION

COUNTRY ROCK

PRE–CAMBRIAN

Basic sill
Dark, dense, igneous sill, variable composition but chiefly diorite.

Aldridge–prichard formation
Grayish, massive quartzites, some thin, interbedded, argillaceous quartzites.

52°
Attitude

Shaft

Open cut

Diamond drill hole
Hole No. 2 was 146 feet deep on June 29, 1948. Drilling was still in progress at that time.

Underground workings

Known contact

Inferred contact

Brunton compass survey with topography taken from the Forest Service, Kaniksu National Forest, base map.

50 0 50 100 200 feet

Contour interval = 20 feet

Scale

GEOLOGIC MAP OF THE JANE SILVER–LEAD MINING COMPANY'S PROPERTY hill top; a 25-foot inclined shaft with 2 short drifts leading from it; and some open cuts. A caved inclined shaft and some evidence of adjacent underhand stoping is located near the old mill building. The mine is supposed to have produced both shipping ore and mill feed during the early days but there are no records of production. All buildings are now demolished and the mine has been inactive for many years.

The vein, composed predominantly of iron-stained brecciated quartz, ranges in width from 9 inches to 8 feet. It occurs in a dioritic sill. At the outcrop, near the old mill building, the vein strikes N. 28° W. and dips 28° SW.; however, it increases in dip as it progresses downward. The increase in dip is very noticeable in a short inclined shaft located 190 feet southeast of the outcrop near the old mill building. At the bottom of the 25-foot inclined shaft, the vein is 6 feet wide and dips 61° SW. Heavy gouge on both the hanging and footwalls indicates that the vein follows a pre-mineral normal faul. and that recurrent movement in the fault plane has provided openings which were later filled by mineralizers.

At the outcrop the vein presents an interesting exposure of coarsely crystalline galena in a quartz gangue. The galena is relatively fresh and unoxodized except for the more exposed portions where oxidation has created a shell of anglesite and cerrussite about the galena crystals. Four assays taken from the outcrop show lead to range from 12.7 to 23.8 per cent and silver from 3.0 to 6.4 oz. per ton. At the bottom of the shaft, the quartz vein remains strong but the sulphides are not so noticeable.

Although the outcrop has been thoroughly explored, the underground position of the vein has remained in doubt. Heavy overburden prevented tracing the outcrop northwest beyond the old mill building; however, the upper tunnel should have intersected the northwest extension of the vein, but failed to do so. (See Plate 4). During the past summer the property was diamond drilled by the Jane Silver-Lead Mining Co. Their No. 1 hole, which should have intersected the southwest-dipping vein, remained in the dioritic sill from the collar to its completion, a distance of 450 feet. The hole gave negative results. The No. 2 hole should have intersected the vein at a comparatively shallow depth but failed to do so, as did a third hole, collared on the northeast side of the vein.

The above mentioned exploration, both tunneling and diamond drilling, indicate that the vein does not continue to the northwest beyond its outcrop near the old mill building. Since there is no evidence of a transverse fault which might displace the vein in that area, it is quite probable that the vein pinches out. Probably the pre-mineral fault which controls the vein's attitude was too tight in this area to permit emplacement of the mineralizing solutions.

The fact that the vein is so strong at the outcrop near the mill building but remains hidden at depth is interesting. It is unlikely that the upper portion of the vein could have been removed by glaciation and erosion, leaving only the roots. However, it is quite possible that since past exploration on the northwestern end of the vein outcrop has proved negative, that either the vein dies out a short distance down the dip or that its downward continuation is controlled by structure. Such a structure is suggested by the change in the attitude of the vein, and, as such, could give a decided rake to the ore body. At its northwest outcrop, near the old mill building, the vein strikes N. 28° W. and dips 28° SW., whereas southeast of the inclined shaft, the vein strikes N. 34° W. and dips 45° SW. At the bottom of the inclined shaft, 25 feet below the surface, the vein dips 61° SW. These attitudes indicate that the dip not only steepens with depth but also that the southeastern outcrops dip steeper than do the northwestern ones. Since evidence on the hanging wall gouge of the vein indicates that it follows a normal fault, it falls within reason that the northwestern end i.e., the flat-dipping portion, would remain tight during normal fault movement, whereas the steeper dipping southeast and deeper portions would be opened, thus providing receptables for ore emplacement. Fault movement of this nature would create a structure which would rake from the tight areas, that is from the flat-dipping northwestern portions, to the more open areas, the southeast steeper-dipping and deeper portions. The latter area would be a likely target for future diamond drilling exploration.

IDAMONT LEAD-ZINC MINES CO.

The Idamont Lead-Zinc property comprises 44 unpatented quartz and placer claims in T's. 60 and 61 N., R's. 2 and 3 E., Boise Meridian, near the mouth of Boulder Creek, about 25 miles east of Bonners Ferry. The small settlement of Leonia, on the Great Northern railroad, is located 2 miles to the northeast.

The property was extensively developed for placer mining purposes during the early 1900's by the Idaho Gold and Ruby Mining Co., under the management of J. M. Schnatterly. Good roads were constructed from Leonia to the mine. Ditches, flumes, and dams were built to provide water for the hydraulic placer mining operations. A large concentration plant was constructed to extract the gold from the gravels. A small settlement was built that included, among other things, 35 individual homes for mine workers, a schoolhouse, and a church. All developments were based on an elaborate scheme to extract gold from relatively unsampled and unprospected gravel banks.

The method employed by the Idaho Gold and Ruby Mining Co. for separation of the gold from the gravel was advised by Schnatterly. It was unique and grandiose in its proceedings, but makes an interesting story. In many ways it typifies some of the wild and imaginative mining ventures that were prominent during early-day western mining.

The gold recovery centered about the concentrating plant located at the bottom of the Boulder Creek gorge, near the lower limits of the gravel banks. It consisted of 800 feet of longitudinal riffles made of standard railroad rails, set a few inches apart, and extending from one wall of the gorge to the other. Beneath the riffles was the "blue hole", a large catchment basin that impounded the finer material dropping between the riffles. An elevator lifted the fines to overlying concentrating tables for the final separation. Upstream from the concentrating plant, the bottom of the gorge was concreted for several hundred feet. This was to prevent gold from settling in the stream bed before reaching the plant.

Hydraulic giants were stationed upstream near the center of the larger gravel banks. These giants were to wash the gravel from the nearby hillsides into the adjacent gorge. When the gravel-filled gorge was loaded to capacity (an estimated 800,000 cubic yards) the gates of an upstream dam were lifted. This action released a tremendous volume of water which was supposed to rush down the gorge, pick up the 800,000 yards of gravel, and carry them downstream to the concentrating plant for treatment.

The plan did not prove practicable. During the initial operating attempts, rolling boulders damaged the riffles in the concentrating plant and the spring floods of surging Boulder Creek soon completed their destruction. The old placer pits and gravel-filled gulleys indicate that several thousand yards of gravel were mined but there are no records of production. According to men who worked at the plant there was little, if any, gold produced.

There are enormous gravel banks on the property. They are as much as 400 feet deep, from 500 to 1000 feet wide, and extend laterally along Boulder Creek for a mile or more. The theory has been advanced that the gravels were laid down in a Pleistocene lake, formed during recession of the glacial period 1/. Kirkham and Ellis 1/ list gold analyses made on the placer sands, and they point out that there have been several periods of deposition in the various gravel banks. As a possible source of gold, they propose the erosion of gold-bearing veins and basic sills in the Boulder Creek area, and the transportation of gold, from outside areas, by glacial action. Whether these gravel banks are of any present economic value is unknown. The property should be thoroughly and systematically explored and tested before any future mining development is commenced.

In addition to the placer development, there are about 2500 feet of tunnels, adits, and shafts on several quartz veins. These veins transverse Boulder Creek and all development on them is located in the immediate vicinity of that stream. The No. 1 and 2 adits, i.e., the older workings are now inaccessible. The No. 3 adit, located on the east bank of Boulder Creek immediately east of the old power house, follows a quartz vein, which strikes almost due north and dips from 70° to 77° W. The vein lies on the contact of a basic sill and sericitic quartzite. It varies in width from 4 to 13 inches and has yielded values ranging from $6.72 to $112.00 a ton in silver, lead, and zinc 10/. Shattered quartz within the vein suggests that faulting, both pre-mineral and post-mineral, has been active.

At a point 505 feet from the No. 3 adit portal, a 113-foot winze has been sunk on the vein. Near the bottom of the winze, drifts have been driven to the north and south and a crosscut driven to the east. These lower workings are now flooded but are reported by R. M. King 10/ to contain good showings of silver, lead, and zinc ore. Mining on this lower level was active during the early 1930's but was stopped by the inability of the compressor to supply air to both the pumps and the rock drills.

The No. 4 tunnel is situated on the west side of Boulder Creek directly opposite the No. 3 adit. It follows a small northeast-trending quartz vein but veers away from the vein about 300 feet from the portal. At the tunnel face, about 800 feet from the portal, there is a large northwest-trending quartz vein. The vein has been drifted on to the northwest and southeast, but appears to be barren.

There is insufficient prospecting on the quartz and placer deposits to provide an opinion. The vein exposed in the No. 3 adit is a favorable structure for ore deposition. Further exploration is needed to determine its possible value.

The mine has been inactive for several years and all buildings are now in disrepair. Most mining equipment has been either carried away or demolished by vandals.

MONTGOMERY MINE

The Montgomery mine comprises 15 unpatented claims in Sec. 30 T. 65 N., R. 1 W., Boise Meridian, about 6 miles southeast of Porthill, Idaho. It is accessible by good roads, being situated about one mile east of State Highway No. 1. The property is developed by 7 tunnels whose total length approximates 3200 feet. Mine equipment consists of a compressor house and blacksmith shop, miscellaneous mining tools, and cabins.

The 3 upper tunnels, situated high on the hillside and reached only by trails, explore a prominent quartz vein that follows the footwall contact of a basic sill and argillaceous quartzite. (See Plate 5). The vein varies slightly in attitude but generally strikes N. 15° to 30° W., and dips 25° to 40° NE. It ranges in width from 10 inches to 5 feet and, although heavily iron-stained in certain portions, is relatively barren of noticeable amounts of sulphides. Occassional samples taken on this vein have indicated good lead, zinc, and silver values but there is no evidence of ore production.

The tunnel located a few feet northwest of the compressor house explores the lower portion of a basic uralite-diorite sill, whose thickness approaches 250 feet. (See Plate 6). Although the tunnel cuts several minor slips and seams, it does not expose a definite vein. Instead, the walls are heavily pyrrhotitized and appear to be components of an extensive low-grade ore body. Three 30-foot diamond drill holes, 2 drilled from the tunnel level, yielded drill cores which indicate that the grade of the ore body remains fairly constant and that it is quite large. Assays made on the drill cores contain as much as 3.5 per cent copper and 1.1 per cent nickel, according to Mr. J. A. Berry, President of the mine. Minerals obtained from wall rock samples and drill cores include pyrrhotite, chalcopyrite, pentlandite, and gersdorffite. Conclusions derived from a study of the ores and their field occurrence are that the deposit has resulted from immiscible liquid segregation of the above mentioned sulphides during emplacement of the basic sill.

A lower tunnel, located about 400 feet down the hill from the sill tunnel, has been advanced to intersect the overlying, eastward-dipping, mineralized sill at a deeper level. It did not reach its objective and is now caved at the portal; however, the company plans to continue its advancement.

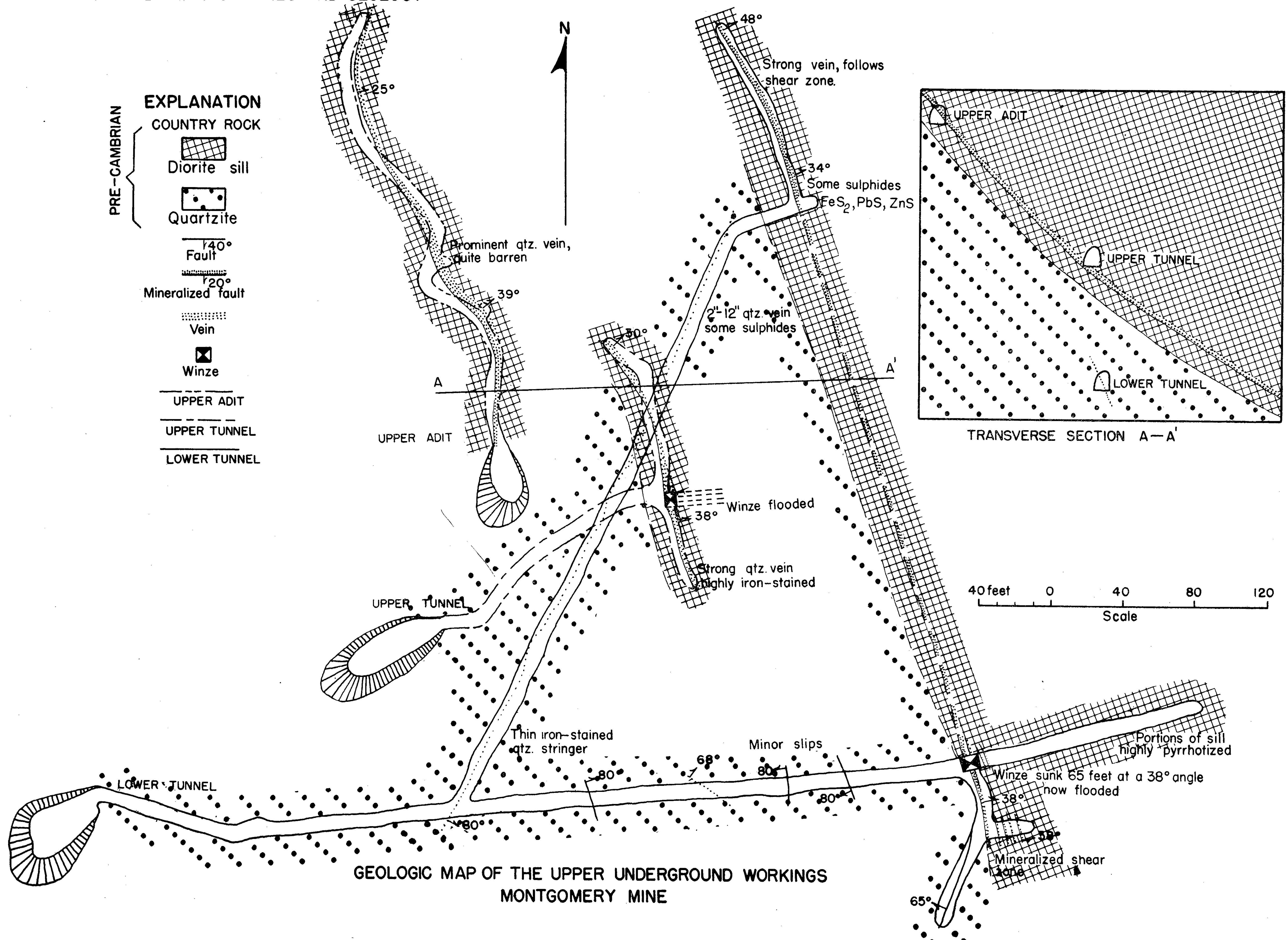
The occurrence of nickel in the ores makes this mine interesting. Furthermore, the character of the deposit and the exposures noted in the sill tunnel imply that it may be quite extensive.

AMERICAN GIRL

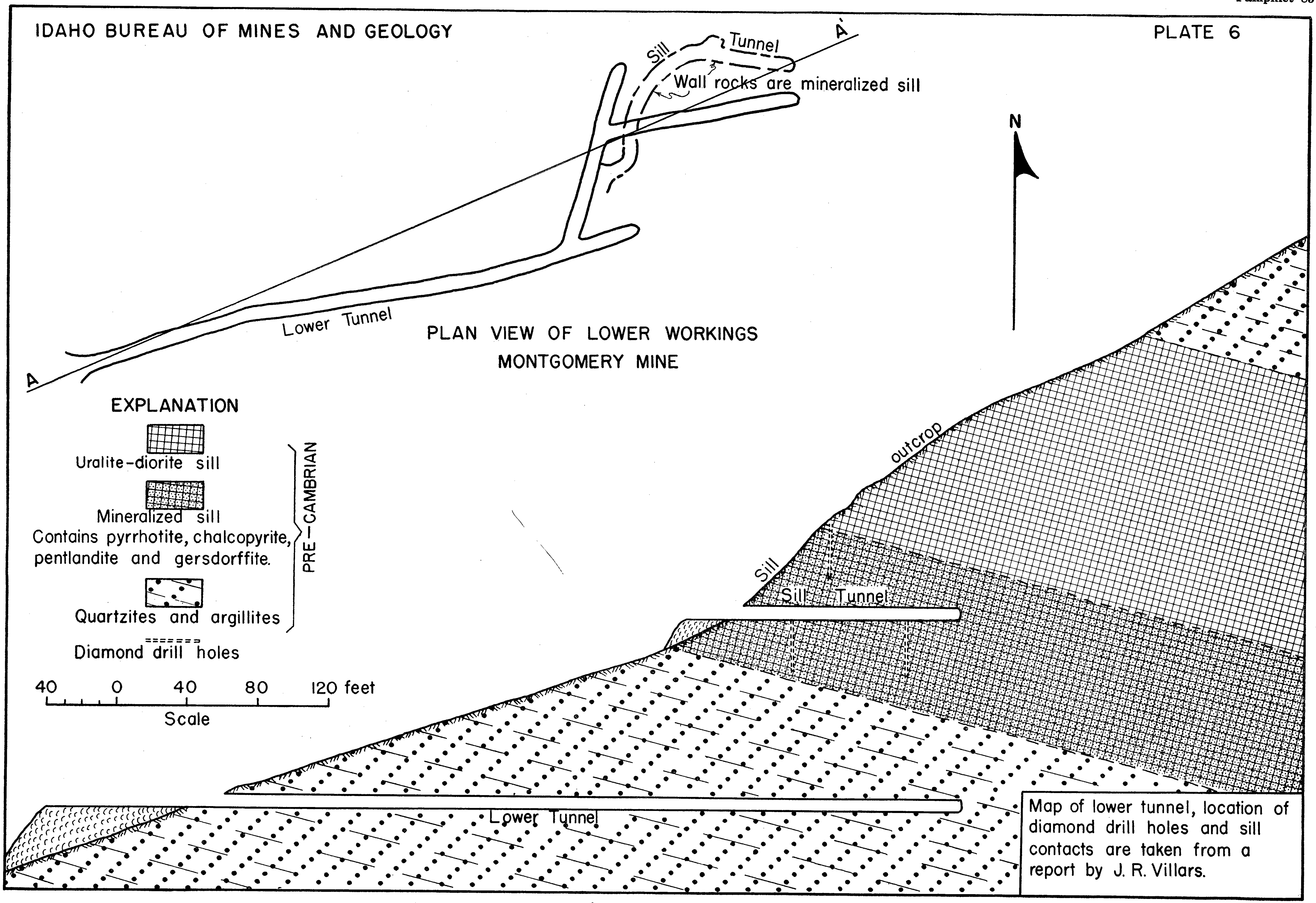
This mine, formerly known as the American Girl but now nameless, consists of 13 unpatented claims held by Mr. John Anderson of Bonners Ferry, Idaho. It is in Sec. 10, T. 64 N., R. 1 E., Boise Meridian, one and one-half miles north of Brush Lake, and about 16 miles north of Bonners Ferry.

This property is developed by 2200 feet of tunnel, crosscuts and drifts, all on the same level. The tunnel is located near the mine cabin. It intersects the vein 920 feet from the portal. At this point the vein strikes N. 42° E. and dips 69° to the east. It is a quartz vein containing minor amounts of ore minerals and its most notable feature is the abundance of siderite in the gangue. The vein varies in width from 4 inches to 1 foot, although in one particular area it swells to 8 feet in width, maintaining this width for about 20 feet along the strike. Where examined, the vein follows a minor fault in the quartzitic

PLATE 5



GEOLOGIC MAP OF THE UPPER UNDERGROUND WORKINGS
MONTGOMERY MINE



PROFILE OF SECTION A—A'. LOWER WORKINGS MONTGOMERY MINE

Although the property has been quite thoroughly explored, it has never produced enough ore either for shipment or for milling purposes.

During the recent summer a cross cut was being advanced, by hand drilling, to intersect the southern extension of the vein.

BETHLEHEM

The Bethlehem mine is about 1 mile east of Brush Lake in Sec. 14, T. 64 N., R. 1 E., Boise Meridian, about 15 miles north of Bonners Ferry.

Practically all of the 350 feet of development work has been concentrated on the lower, main level of this mine. At the portal of the main adit, the vein strikes N. 61° E. and dips 70° SE. It is a massive quartz vein, occurring in a fault plane, and ranging in thickness from a few inches to two feet. Near the portal the vein is in granite, but when followed inward for 160 feet it passes into a basic sill where it pinches to a small stringer 2 or 3 inches wide, finally disappearing into the wall. At a point 225 feet from the portal, the adit intersects a small quartz vein that follows the contact of a metamorphosed basic sill and fresh unaltered granite. The vein strikes N. 50° W and dips 43° to 53° SW. It has been drifted on to the northwest and to the southeast but no ore bodies have been exposed. As the drift continues to the southeast it leaves the vein and re-enters the basic sill where it crosscuts several small quartz-filled joint planes. (See Plate 8).

O ther development work consists of a caved shaft a few feet south of the main adit portal, some open cuts, and 2 short adits about 700 feet up the hillside above the main adit portal. These upper adits explore small quartz-filled joint planes in the basic sill.

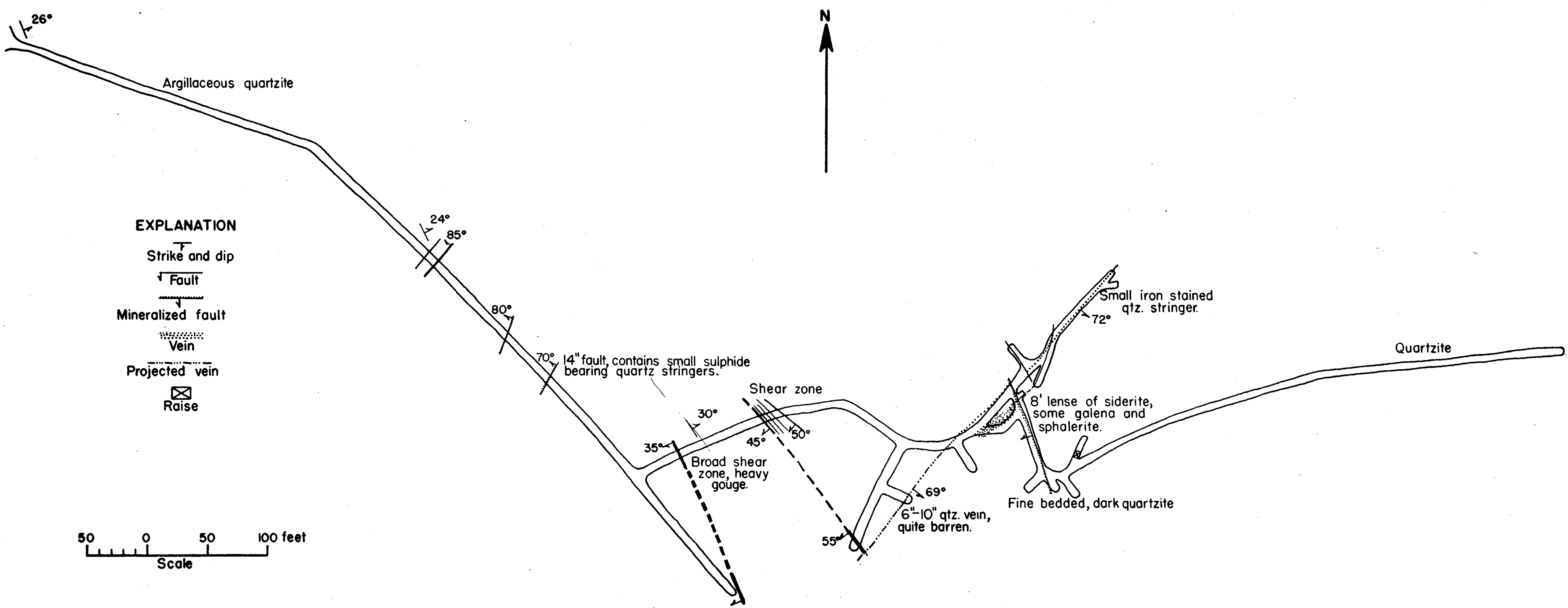
Selected ore samples taken from the adit dumps contzin pyrite, arseno-pyrite, galena, and sphalerite, in a quartz and siderite gangue. There are no records of mine production, but judging from the mine development work, little, if any, ore has been produced.

The mine has been idle for several years.

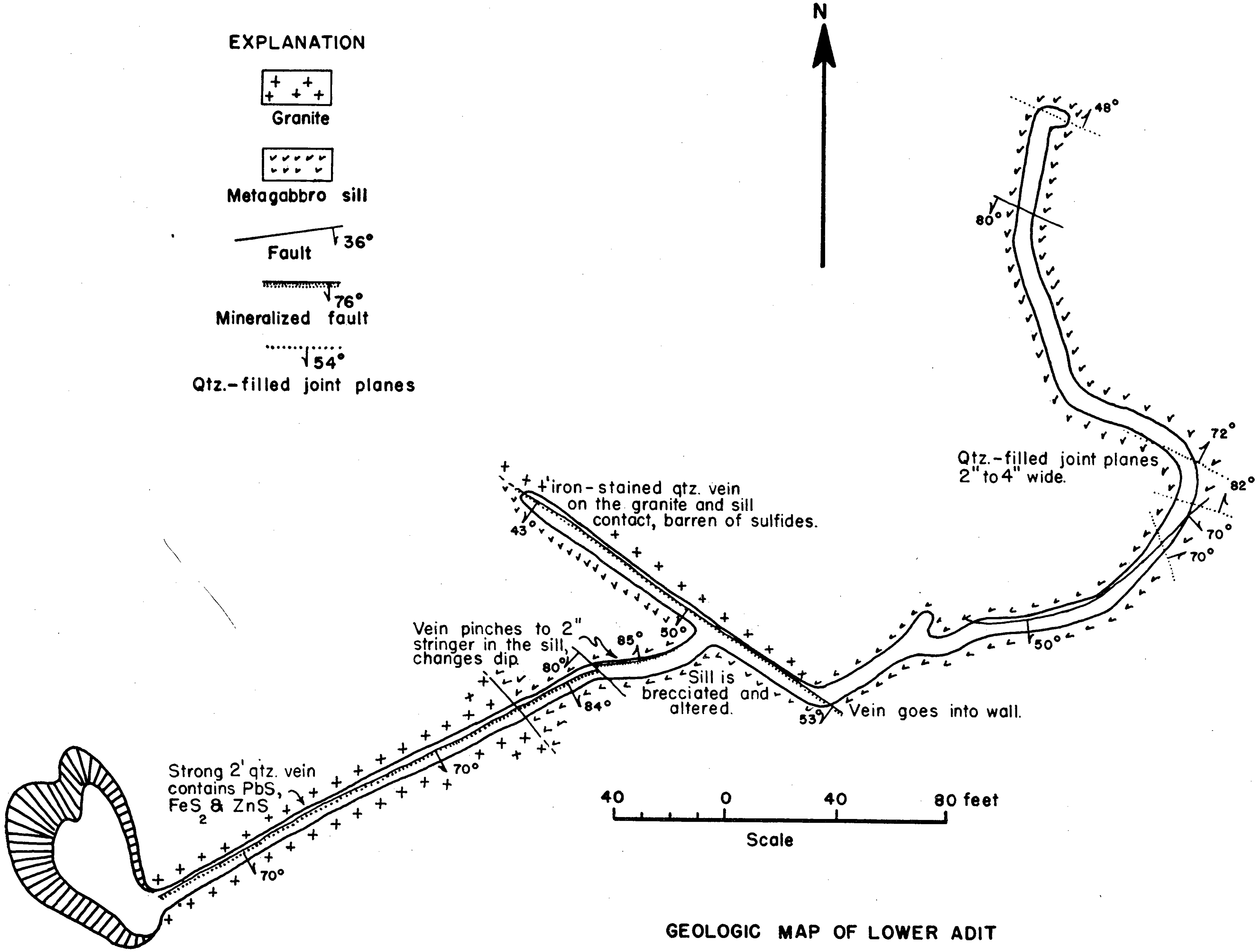
KLONDIKE

The Klondike property, owned by Mr. William Tilley of Bonners Ferry, consists of 8 unpatented claims in Sec. 29, T. 63 N., R. 1 E., Boise Meridian, about 2 miles northeast of the Silver Crescent mine, on the headwaters of Meadow Creek. Development comprises several open cuts on the vein outcrop and about 800 feet of tunnel. The property is in the prospect stage and has no record of production.

The open cuts explore an 18-to 30-inch well-defined quartz vein that cuts granodiorite. The vein traverses a southwest-trending ridge and has been traced for approximately one-half of a mile along the strike. Development has been concentrated on the southeast side of the ridge where the vein strikes N. 54° E. and dips 75° E. Gouge and salvage on the vein walls indicate that it is confined within a fault plane, although the nature of the fault was not determined.



GEOLOGIC MAP OF THE UNDERGROUND WORKINGS, AMERICAN GIRL MINE



GEOLOGIC MAP OF LOWER ADIT
BETHLEHEM MINE

For the most part the vein outcrop contains few ore minerals; however, occasional exposures contain galena, sphalerite, and tetrahedrite. A selected sample assayed 72 per cent lead, 70 ozs. in silver and a trace of gold. General assays made on the vein outcrops, in the late 1930's, averaged about $10.00 per ton in combined metal values.

In 1948, the main tunnel was being advanced, by hand steel tools in a N. 26° W. direction, in an attempt to intersect the vein 240 feet (vertical distance) below its uppermost outcrop.

GOLDEN SCEPTER

The Golden Sceptre mine is in Sec. 12, T. 65 N., R. 1 W., Boise Meridian, about 4 miles due east of Porthill. The old mill building and lower tunnel portal are near the foot of the westerly-sloping mountain front; a second tunnel portal is a few hundred feet on up the mountain side above the lower one. These two tunnels comprise the total mine development, one being 1850 feet in length, the other 1250 feet in length. In 1941 a small (25-ton) mill was installed to handle ores from the lower tunnel; however, there is no record of its production. All milling and mining equipment has since been removed.

During the 1948 field season both tunnels were partially caved and flooded, making complete mapping of the mine impossible. Where available for examination, within the mine workings, the vein strikes N. 10° W. and dips 35° E. It is about 3 feet thick, composed mainly of quartz and calcite, and appears to be a fissure filling since it shows little or no movement along the vein walls. The vein follows the footwall contact of a large basic sill and underlying quartzite. Ore exposed on the dump consists of galena, chalcopyrite, and sphalerite, in a calcite and quartz gangue. Gold has been reported in the ores, but was not observed in the specimens studied.

The property has been inactive for several years.

MILLER BROTHERS

The Miller Brothers' property is in Sec. 25, T. 65 N., R. 1 E., Boise Meridian, on Round Prarie Creek, approximately 6 miles east of the junction of U. S. Highway 95 and State Highway No. 1. It is developed by several open cuts and a 200-foot inclined shaft, now flooded. The property is reported to have made several shipments of lead-silver ores in the late 1930's, but no production records could be obtained.

The vein follows the contact of a massive quartzite member and a basic sill. Inaccessible mine workings and heavy overburden made further observations impossible. Ore exposed on the dump contains highly-lustrous, coarsely-crystalline galena, chalcopyrite, sphalerite, and pyrite in a massive quartz gangue.

The property has been inactive for several years.

HOWARD WICKERSHAM HOLDINGS

A number of mining claims held by Howard Wickersham and his partner, Sam Hash, are located along the southwest and western slopes of Bussard Mountain. The claims cover a large area but are mainly located about 2 miles north of the Silver Crescent mine. They include, among others, the old

Tommy Moran properties, the former Tungsten Hill mine, the Buckskin group of claims, and others. These properties have been idle for many years; however, in 1948, attempts were made to develop the Buckskin property.

Most of the above mentioned claims are located on veins which occur in joints in the granitic country rock. There are several sets of joints present in the rocks of this area. The most prominent set strikes at varying angles to the northeast and dips to the southeast. For the most part, the joints are filled with aplite dikes but locally they contain quartz and various sulphide ore minerals.

The former Tommy Moran properties lie on the high ridge near Bussard Mountain Lookout. In this area there are several minor quartz-filled joints which have been explored by open cuts and small shafts. Some galena and pyrite are noticeable in the ores but, judging from the extent of the development, it is doubtful if the property was ever productive.

The Buckskin property lies near the foot of the ridge below and slightly west of the Tommy Moran property. It is developed by several open cuts and 2 short crosscut tunnels. All development is on a quartz vein, which, at the outcrop, is 30 inches wide, strikes N. 70° E. and dips 48° SE. Assays of outcrop samples ranged from a few to about $30 a ton in combined lead, silver, and gold values. Unfortunately, continued advancement of the cross cut tunnel commenced in 1948 will lead to its intersection with the older tunnel without developing any amount of "backs" and without exploring very much of the veins strike length. If the older crosscut tunnel continues to drift on the vein, which, at the face has narrowed to 8 inches, it will soon reach the surface of the hillside opposite the portal without adding much information on the vein in question. Thus, future development will require shaft sinking operations, and it is doubtful if present ore exposures warrant such expenditures.

The old Tungsten Hill mine, which is described by Livingston 11/ is situated in Sec. 13, T. 64 N., R. 1 E., about 17 miles north of Bonners Ferry. All workings in this property are now caved and inaccessible; however, they originally explored a tungsten-bearing quartz vein that cuts a large diorite sill. The mine has been idle since the termination of World War I.

SILVER CRESCENT

The Silver Crescent, sometimes locally known as the Regal mine, is about 14 miles north of Bonners Ferry. It is the most completely equipped and productive mine in the region. Mining operations commenced in 1937 and continued uninterruptedly through 1946. The mine is currently idle, but, according to the watchman stationed at the property, active mining operations are planned for the near future.

The geology of the mine has been thoroughly described by Anderson and Wagner 7/.

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