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GEOLOGICAL SURVEY

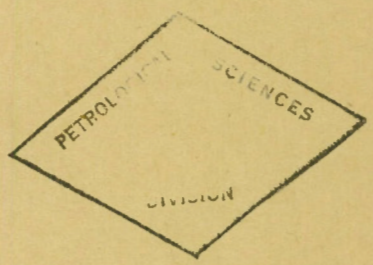
PAPER 44-5

NORTHERN PART OF THE PINCHI LAKE MERCURY BELT, BRITISH COLUMBIA

(Report and map)

BY

J. E. Armstrong



OTTAWA

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C A N A D A

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INTRODUCTION

The Pinchi Lake mercury belt is in central British Columbia. It is at least 130 miles long, extending northwest from Jumping Lake, 15 miles southeast of Fort St. James, to Omineca River. During the field season of 1937 cinnabar was discovered by J. G. Gray[1] in Permian limestone on the north shore of Pinchi Lake where the main showings of the Pinchi Lake mercury mine were later developed. The production of mercury from this deposit is far in excess of Canadian requirements, and Canada is able to supply the United Kingdom and the United States with part of their needs.

[1] Geol. Surv., Canada, Paper 38-10.

Since 1940 other occurrences of cinnabar have been found northwest and southeast of Pinchi Lake. During 1941 and 1943 the writer made a geological investigation of the known cinnabar deposits and of the belt in which they occur. The present report deals with the northern 45 miles of the belt; an earlier report[2] dealing with the southern part was issued in 1942.

[2] Geol. Surv., Canada, Paper 42-11.

The northern part of the mercury belt is accessible by truck road, 30 miles long, from Takla Landing. Motor launches tow 20-ton scows to Takla Landing from Fort St. James at the foot of Stuart Lake, a distance of 110 miles. Fort St. James, in turn, is reached by a good motor road, 41 miles long, from Vanderhoof on the Canadian National Railway. The minimum freight charge from the railway into the district is 3 cents a pound.

The writer is indebted to officials of Consolidated Mining and Smelting Company and Bralorne Mines, Limited, for their generous co-operation, and to the prospectors of the district for many courtesies extended. In the field work he was ably assisted by Messrs. G. W. Sinclair, E. F. Roots, and K. A. Matheson.

PHYSICAL FEATURES

The area explored has an average relief of 2,500 to 3,000 feet. Above timberline, at an elevation of about 5,000 feet, much of the bedrock is exposed, but elsewhere rock outcrops occupy less than 5 per cent of the map-area. Drift deposits, chiefly of glacial origin, mantle the timbered slopes and spread out widely and deeply over most of the lowland areas. Many of the creeks cut through drift to bedrock.

GENERAL GEOLOGY

The Pinchi Lake fault zone bisects the area from northwest to southeast. A thick succession of steeply folded Permian limestones and other interbedded sedimentary rocks outcrops on the southwest side of the

fault zone. Upper Triassic and Jurassic sedimentary and volcanic rocks, cut by a variety of intrusive types, predominate on the northeast side. All formations trend northwesterly.

Permian

Permian formations comprise not less than 10,000 feet of interbedded limestone, quartzite, chert, argillite, slate, greywacke, and derived schists. The limestone occurs chiefly in northwesterly trending bands near the Pinchi fault zone, and most of it appears to lie in the lower part of the Permian section. The bands pinch and swell along their strike and at depth, and in places disappear. The maximum single thickness of limestone is probably 5,000 feet or more. Smaller, irregular bands, as much as 1,000 feet thick, occur at intervals throughout the Permian section. The normal rock is blue-grey, grey weathering, medium-grained to dense, and massively bedded. In places the beds grade from blue-grey to white and cream across widths of from 15 to 20 feet. Many of the bands are iron stained and carry abundant minute stringers and specks of red and brown hematite and limonite. Near the Pinchi fault zone some of the grey limestone has been altered to buff weathering dolomite.

Associated non-calcareous strata appear to be much more closely folded than the limestones and their thicknesses are difficult to estimate, but represent a minimum total of at least 5,000 feet. The most characteristic of these rocks are thinly bedded ribbon cherts, and argillites. The cherts are generally blue-grey, but vary from cream grey to black. They consist of beds of chert, $\frac{1}{2}$ inch to 6 inches thick, commonly minutely crumpled, separated by partings of black, lustrous, carbonaceous argillite. In many places the partings have a slaty cleavage and have been partly metamorphosed to graphite and mica. Other argillaceous members are grey to black carbonaceous rocks, in beds that are rarely more than 6 inches thick. They are commonly schistose and in places show a slaty cleavage. Interstratified with the argillites and cherts are beds of dark grey schistose greywacke and conglomerate from a few inches to 10 feet thick. Pebbles in the conglomerate are predominantly of chert and quartz and rarely exceed $\frac{1}{2}$ inch in diameter.

Near the junction of Silver and Kenny Creeks lenticular beds of reddish tuff, up to 50 feet thick, are interbedded with argillaceous quartzite and limestone.

Bands of greenstone, up to 1,500 feet wide, and lenticular bodies of greenstone, up to 3 square miles in area, are intercalated with the Permian sedimentary rocks. They consist mainly of grey-green to dark green, fine- to medium-grained, chloritic andesites, amphibolites, and chlorite schists. In places they cut across adjacent Permian strata; in other places they appear to be interbedded with them. They probably comprise flows, tuffs, and minor intrusive rocks.

Southeast of the map-area the limestones carry the diagnostic fossils Neoschwagerina, Cancellina, Parafusulina, Verbeekina, and Misellina, of Middle Permian age.[1] The following fossil collections

[1] Geol. Surv., Canada, Paper 42-11, p. 3.

were made during 1943 and identified by A. E. Wilson of the Geological Survey:

Collection 1FA, from limestone outcrop at first bend of Nation River below Indata Lake; includes Dielasma n. sp. Age: probably late Carboniferous or Permian.

Collection 3FA, from quartzite outcrop on south shore of Tsayta Lake, approximately 1 mile west of the narrows; includes Rustula sp. and a large striated brachiopod suggestive of Meekella kueichowensis Huang. Age: probably Permian.

Upper Triassic

The Upper Triassic rocks consist essentially of interbedded argillite, greywacke, and tuff with, here and there, beds of conglomerate and limestone. The argillites are black, carbonaceous rocks in beds a fraction of an inch to 6 inches thick. The tuffs and greywackes weather blue-grey to buff, are fine- to medium-grained, and form beds that vary from less than an inch to 10 feet in thickness. They consist largely of fragments of cherty and volcanic rocks, quartz and feldspar, in varying proportions. Intermediate types, best termed tuffaceous greywackes, are the most widespread. Many beds grade from coarse-grained, tuffaceous greywacke at the bottom to argillite at the top. These rocks also exhibit good crossbedding. Beds of conglomerate, 10 to 25 feet thick, outcrop on Halobia Creek. Pebbles in the conglomerate are angular to rounded, and up to 3 inches in diameter. Most of them are of grey chert and black argillite; a few are of greywacke, limestone and volcanic rocks. The matrix is gritty. Beds of grey limestone, 15 to 20 feet thick, outcrop along Rottacker Creek.

The maximum thickness of the Upper Triassic section is probably well over 2,000 feet. The diagnostic Upper Triassic fossil Halobia was identified from argillite outcropping along Halobia Creek.

Jurassic

The Jurassic formations consist of lavas, tuffs, and sedimentary rocks. The lavas are best exposed in the mountains east of Silver Creek, and are green, grey, black, and red porphyritic and non-porphyritic andesites and basalts. The porphyritic types contain phenocrysts of feldspar, pyroxene and amphibole. Intercalated with the lavas are green and grey andesitic tuffs and breccias. About 4 miles south of Omineca River opposite Duckling Creek, a lens of grey, massive limestone, 2,200 feet long and 400 feet thick, is interbedded with lavas.

A medium-grained, green andesitic tuff outcrops east of Indata Lake. It consists of angular fragments of andesite, basalt, volcanic glass, pyroxene, amphibole, pink and white feldspar, chlorite, and quartz. Fragments of volcanic glass constitute more than 50 per cent of the rock. In places the tuff grades into an andesitic breccia, in which the larger fragments range from $\frac{1}{2}$ to 1 inch in diameter and include a few of limestone and chert.

The section exposed along Silver Creek consists of at least 200 feet of limestone and shale overlain conformably by 1,000 feet or more of tuffs and lavas with intercalated sandstone, shale, and conglomerate. The basal limestone is a compact, lavender-grey rock in a bed 150 feet thick. Associated shales are black, carbonaceous rocks in beds 1 to 6 inches thick. These rocks may be of Upper Triassic age. The overlying volcanic rocks comprise buff, red, green, purple, grey and black, compact tuffs and red and green porphyritic andesites. At least 300 feet of conglomerate, sandstone, and shale are interbedded with them. The conglomerate consists chiefly of sub-rounded to angular pebbles of argillite and quartzite in a pinkish grey siliceous matrix. Pebbles up to 4 inches across were observed. The sandstone and shales are grey and black, thinly bedded rocks. Beds average $\frac{1}{2}$ inch to 4 inches in thickness, the sandy beds being the thicker.

Fossils collected from this series were reported on by F. H. McLearn of the Geological Survey as follows:

Collection 5FA, from sandstone outcropping on Snell group of claims at junction of Silver and Kenny Creeks; includes 'Belemnites' sp. The belemnitids appear to be without furrows. If this is so, they may be of Lower Jurassic age.

Collection 6FA, from shale outcropping on Discovery Creek approximately 2 miles from mouth; includes 'Harpoceras' sp. It appears to be a Hildoceratid and, therefore, of upper Lower Jurassic age.

Collection 9FA, from limestone interbedded with volcanic rocks about 4 miles south of Omineca River opposite mouth of Duckling Creek; includes an obscure Hydromedusa of the order Tubulariae. These specimens resemble, but are not identical with, the Triassic genus Heterastridium. They likely belong to a new genus. A tentative Triassic age is suggested.

Fossils collected from the same series north of the area mapped include a species of Arnioceras that is of early Jurassic age.

From the above descriptions it may be concluded that this series contains strata of Jurassic and perhaps also of Triassic age.

Jurassic and (or) Later

Serpentine. Small bodies of serpentine and altered serpentine rocks are exposed along the Pinchi fault zone. Their original composition is uncertain. Most of the serpentine is altered to buff-coloured carbonate-quartz-mariposite rocks.

Granodiorite, Quartz Diorite, and Related Rocks. The Omineca batholith follows the east side of the Pinchi fault zone, and in the area mapped occupies about 360 square miles. West of Tsayta and Indata Lakes a stock, about 5 miles square in surface area, cuts Permian rocks. Medium- to coarse-grained, pink and light green granodiorite and quartz diorite are common, but grade into coarse-grained, darker green diorite gabbro, and pyroxenite. The more basic rocks predominate in the border zone of the Omineca batholith, and near the centre of the stock. In addition to the intrusive rocks mapped there are many acid to basic dykes and sills up to 25 feet wide. It was probably intruded in late Jurassic or early Cretaceous time.

Conglomerate. At two localities on Kwanika Creek, and at three localities on or near Rottacker Creek, outcrops of reddish brown conglomerate were observed. The rock is made up of well-rounded pebbles and boulders ranging from a fraction of an inch to 18 inches in diameter and embedded in a rusty red, arkosic matrix. They consist of pink and green quartz diorite and diorite, dark grey chert, black argillite, grey and buff arkose and greywacke, and white quartz and feldspar. All pebbles and boulders are coated with limonite and have glistening reddish brown surfaces. Beds of red-brown arkose a few feet thick occur with the conglomerate on Rottacker Creek. The total thickness there is unknown, but is over 100 feet. On Kwanika Creek conglomerate overlies quartz diorite. Its age is probably Cretaceous or younger.

STRUCTURAL GEOLOGY

Faulting

In 1941 the writer traced the Pinchi fault zone from southeast of Fort St. James to Kwanika Creek[1]. In 1943 the fault zone was traced

[1]Geol. Surv., Canada, Paper 42-11.

northwesterly to Omineca River Valley, and is now known to be at least 130 miles long. This zone varies in width from 200 feet, near the mouth of Vital Creek, to 5,000 feet, east of Indata Lake, but in most places does not exceed 1,000 feet. Its eastern margin represents the contact between stratified Permian rocks on the west and Mesozoic formations and the Omineca batholith on the east. Although the fault contact between Permian and Mesozoic strata was nowhere observed, it seems probable that the Pinchi fault zone marks the site of major thrust faulting from the west, and that the Permian rocks have moved up with respect to the Mesozoic formations. Intense faulting was, however, observed in the Permian rocks within the fault zone. There, the more important faults trend northwesterly, dip steeply southwest, and may join a major low angle thrust fault at depth. In most places it is difficult to recognize these thrust faults because of numerous minor faults that strike and dip in all directions, but along which offsets are relatively small. Along most of the faults, major and minor, the wall-rocks are brecciated across widths varying from a few inches to 30 feet, but, in places where the faults are closely spaced brecciation may be continuous across several hundred feet. Some of the breccia zones lie between slickensided walls.

Deposits of cinnabar occur along, or near, the Pinchi fault zone, and the wall-rocks are commonly carbonatized or silicified.

Folding

The Permian sedimentary rocks exposed between the Pinchi fault zone and Takla Lake, 20 miles to the west, appear to represent part of a great anticlinorium plunging northwest and widening to the southeast. The rocks exposed near Quartz Creek and Fall River appear to lie near the north end of this structure. One component synclinal fold has been traced from near Fall River, where it is terminated by the Pinchi fault zone, for 60 miles southeasterly to Trembleur Lake. Other parallel folds were observed in the mountains at the heads of Dream and Canyon Creeks, but were not traced far. Each of them is from 1 to 4 or more miles wide. During the period of folding the limestone beds acted as relatively competent strata and are not folded to nearly the same extent as the associated strata. The latter are compressed into many minor anticlines and synclines, and are in part overturned. The minor folds are from 100 to 700 feet wide and their axes are approximately parallel to those of the major folds. Many drag folds were observed in the argillaceous quartzites and ribbon cherts. These generally plunge in the same direction as that part of the major fold on which they lie.

The Jurassic strata along Silver Creek form a series of northwesterly trending folds, 500 to 1,200 feet wide.

CARBONATIZATION

Many of the crushed and sheared rocks in the Pinchi fault zone have been hydrothermally altered. Grey limestones have been partly to completely changed to buff dolomites, argillaceous quartzites and ribbon cherts to quartz-carbonate schists, greenstones to chlorite-carbonate

schists, and serpentines to quartz-carbonate-mariposite (green mica) rocks. The alteration consists mainly of the replacement of all original minerals, except quartz, with ankeritic carbonates; as a result limestones and serpentine rocks show the most complete replacement and quartzose rocks the least. Carbonatization preceded the period of cinnabar mineralization along the Pinchi fault zone and both processes were facilitated by the channelways provided by the faulting.

ECONOMIC GEOLOGY

Cinnabar Deposits

Cinnabar occurs at many places within the northern part of the Pinchi Lake mercury belt, but the only known deposits of workable size and grade are those of Bralorne Takla mercury mine. The deposits occur in rocks of quite different character, and all have been found in crushed rocks of, or related to, the Pinchi fault zone.

The cinnabar deposits may be classified on the basis of associated rocks as follows: (1) limestone type; (2) serpentine type; (3) other types.

Limestone Type. The principal cinnabar deposits are found in brecciated fault zones in Permian limestone. Solution cavities, ranging in size from mere pits to openings several feet across and partly filled with calcite, are common in the limestone. The cinnabar occurs as veinlets, blebs, and individual grains filling pre-existing openings such as fissures, solution cavities, and interstices between grains and breccia fragments. Most of the cinnabar is the red, massive variety that weathers purplish red. Some bright red, earthy, "paint" variety films fracture surfaces in the ore-bodies. It occurs mainly near the surface. Scattered grains of pyrite are found in most deposits. The common gangue minerals are quartz and calcite. Quartz and cinnabar seem to have been deposited contemporaneously, and the calcite both earlier and later. Most of the quartz is fine-grained, but crystals have also formed in open cavities. The amount of quartz varies greatly from one deposit to another; in the deposits of the Bralorne Takla mercury mine it is only a minor constituent. There has been some replacement of limestone by cinnabar, especially along minute fractures in the rock. In solution cavities, on the other hand, cinnabar forms on the faces and cleavage planes of calcite crystals, and shows no evidence of replacement. In general the relative amount of limestone replacement by cinnabar varies indirectly with the size of pre-existing openings, the smaller the openings the greater the proportion of replaced wall-rock. Replacement, however, is not an important factor in the grade of the ore, and the best ore occurs in limestone that contains the greatest percentage of openings available for cinnabar deposition.

Serpentine Type. Cinnabar deposits are commonly associated with small, sill-like bodies of serpentine rock. Zones of shearing and brecciation along the contacts of many of these bodies have provided channelways for hydrothermal solutions. At an early stage this has resulted in extensive carbonatization of the fractured rocks, in which process much of the serpentine has been replaced by quartz and chalcedony, ankeritic carbonate, and mariposite, in widely varying proportions. At a later stage, following further brecciation, mineralizing solutions deposited cinnabar and chalcedonic quartz in the carbonatized and fractured rocks. The cinnabar and chalcedony occur in minute veinlets filling the fractures and coating the breccia fragments. No replacement of the wall-rock is evident, and no other metallic minerals were observed. The cinnabar-chalcedony veinlets are cut by calcite stringers. In many places it is difficult to distinguish carbonates and silica formed at various stages.

Other Types. A few, small, non-commercial deposits of cinnabar were observed in relatively massive, non-calcareous, sedimentary rocks. In these the cinnabar occurs in stringers of dolomite at or near the contacts of sills or dykes, these contacts acting as channelways for the mineralizing solutions.

Arquerite, an amalgam of mercury and silver containing 86.6 per cent silver, has been panned on most of the creeks in the area.

Origin of the Cinnabar Deposits. Schuette[1] has pointed out

[1]Schuette, C. N.: The Geology of Quicksilver Ore Deposits; Calif. Jour. Mines and Geol., No. 1, vol. 33, p. 49.

that mercury deposits are usually found under a cap rock or gouge more dense than the receptacle rock in which the ore forms. In many places along the Pinchi fault zone relatively impervious cap rock and fault gouge have acted as traps to rising mercury-bearing solutions and have induced concentrations of cinnabar. At the Pinchi Lake mercury mine the larger cinnabar deposits are in limestone overlain by schists. More detailed underground study may reveal similar conditions in other deposits. Although "trapping" is undoubtedly an important factor in localizing ore, the relative permeability of solution channels is of equal or greater importance.

No genetic relationship is apparent between the mercury deposits and any nearby volcanic or intrusive rocks. The source of the ore-forming solutions is not known, but is probably connected with some deep-seated intrusion. The Pinchi fault zone provided abundant channelways for mineralizing solutions, and deposition occurred wherever other conditions were favourable. In many mercury deposits there is evidence to indicate that cinnabar is precipitated at temperatures varying between 100 and 150 degrees centigrade; at nearly atmospheric pressures; and from mineral-bearing alkaline solutions. Chemical analyses of the Pinchi Lake mercury mine limestones show a considerable increase in sodium and potassium where they have been mineralized with cinnabar[2].

[2]Geol. Surv., Canada, Paper 42-11, p. 9.

Presumably the mercury deposits of the Pinchi Lake belt formed in Tertiary time as they are later than the faulting, and faulting has involved all the rocks in the area except those of Pleistocene and Recent age.

Other Deposits

A vein of braunite (manganese silicate) and psilomelane (manganese oxide) occurs in Permian limestone about 1 mile west of the south end of Indata Lake. The seam varies from a few inches to 2 feet wide and has been traced for 60 feet.

Placer gold has been recovered from Vital, Harrison, Silver, Kenny, Kwanika, Tom, and Quartz Creeks. At no time has the recovery been large, but it has been sufficient to sustain interest in the placer possibilities of the area for the past 75 years.

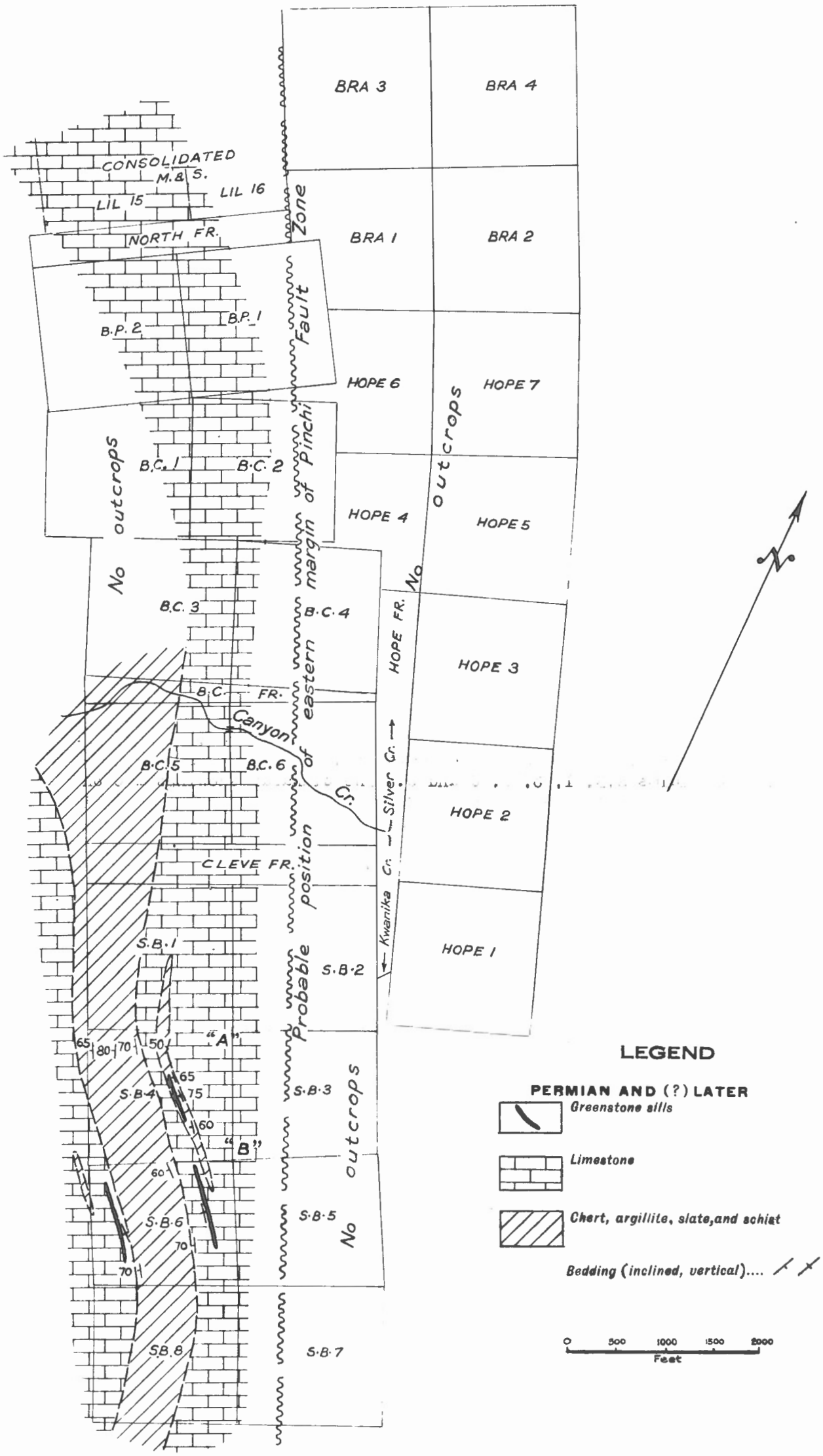

Figure 1: Geology of BRALORNE TAKLA MERCURY MINE, Omineca Mining Division, British Columbia

By J. E. Armstrong, Geological Survey, Canada

DESCRIPTIONS OF PROPERTIES

Bralorne Takla Mercury Mine

The Bralorne Takla mercury mine (See Figure 1) is on the divide between Silver and Kwanika Creeks at an elevation of about 3,600 feet. The property consists of twenty-seven claims and four fractions. They were staked in September 1941 by Mr. W. A. Prout of the exploration department of Bralorne Mines, Limited. Cinnabar was discovered on the claims in July 1942. A program of development work was commenced in August of that year and during the following winter 6,000 feet of diamond drilling was completed and a shaft started. Considerable ore was thereby blocked out, and by November 1943 a small mill was in operation.

Freighting from the railway at Vanderhoof to the property is slow and expensive. Supplies are trucked from Vanderhoof to Fort St. James over 41 miles of good gravel road. At Fort St. James they are transferred to scows and hauled by water 110 miles to Takla Landing. During seasonal periods of high water the scows can carry up to 20 tons, but in low water freight has to be transferred to small boats in order to navigate the rapids of Tache River. At Takla Landing the freight is once again loaded on trucks and hauled 36 miles to the mine over a secondary road. The cost of freighting from Vanderhoof to the property is approximately 3 cents a pound. During the winter some supplies are flown from Fort St. James to the property at a cost of 7 cents a pound. The planes land on skis in a meadow near the mine.

A mantle of drift, up to 100 feet or more thick, blankets much of the property, and there are few outcrops. Most of these have been found on claims S.B. 1, 3, 4, 6 and 8. The cinnabar showings are on claims S.B. 3 and 4. These claims (See Figure 1) are underlain by interbedded Permian limestone, argillite, slate, chert, and derived schists. The strata strike approximately north 30 degrees west and dip 60 to 80 degrees southwest. The argillaceous and siliceous strata occur mainly in a band 600 feet wide, cutting across claims S. B. 1, 4, 6, and 8, and B. C. 5. Other bands of similar rocks also outcrop, but are less than 100 feet wide. Three greenstone sills, each about 25 feet wide, were observed.

The limestone is the normal blue-grey variety. Along and near faults it has been brecciated and the breccia fragments are cemented with buff-coloured, ankeritic carbonate. Solution cavities, up to several feet across, are common in the limestone and are partly to completely filled with coarsely crystalline, cream-coloured calcite. The chert occurs in beds, $\frac{1}{2}$ to 2 inches thick, commonly minutely crumpled, and separated by thin partings of argillite. The argillites and slates are grey to black, carbonaceous, and schistose rocks.

The Pinchi fault zone traverses the property from north to south and its eastern margin, which represents a fault contact between Permian and Mesozoic rocks, probably underlies the drift east of the limestone ridge containing the cinnabar deposits. Many subsidiary faults have been encountered in the limestone in the vicinity of the "A" and "B" cinnabar showings, both on the surface and underground. Their attitudes are quite variable, but the more pronounced faults strike north to northwesterly and dip steeply to the southwest. The displacements effected are not known. Along the faults the limestone has been brecciated across zones 1 foot to 20 or more feet wide, and where the faults are closely spaced the limestone is completely brecciated. Gouge seams up to 2 feet wide and slickensided surfaces mark many of the faults. More than one period of movement is in evidence, and some of the faults carry veinlets of calcite.

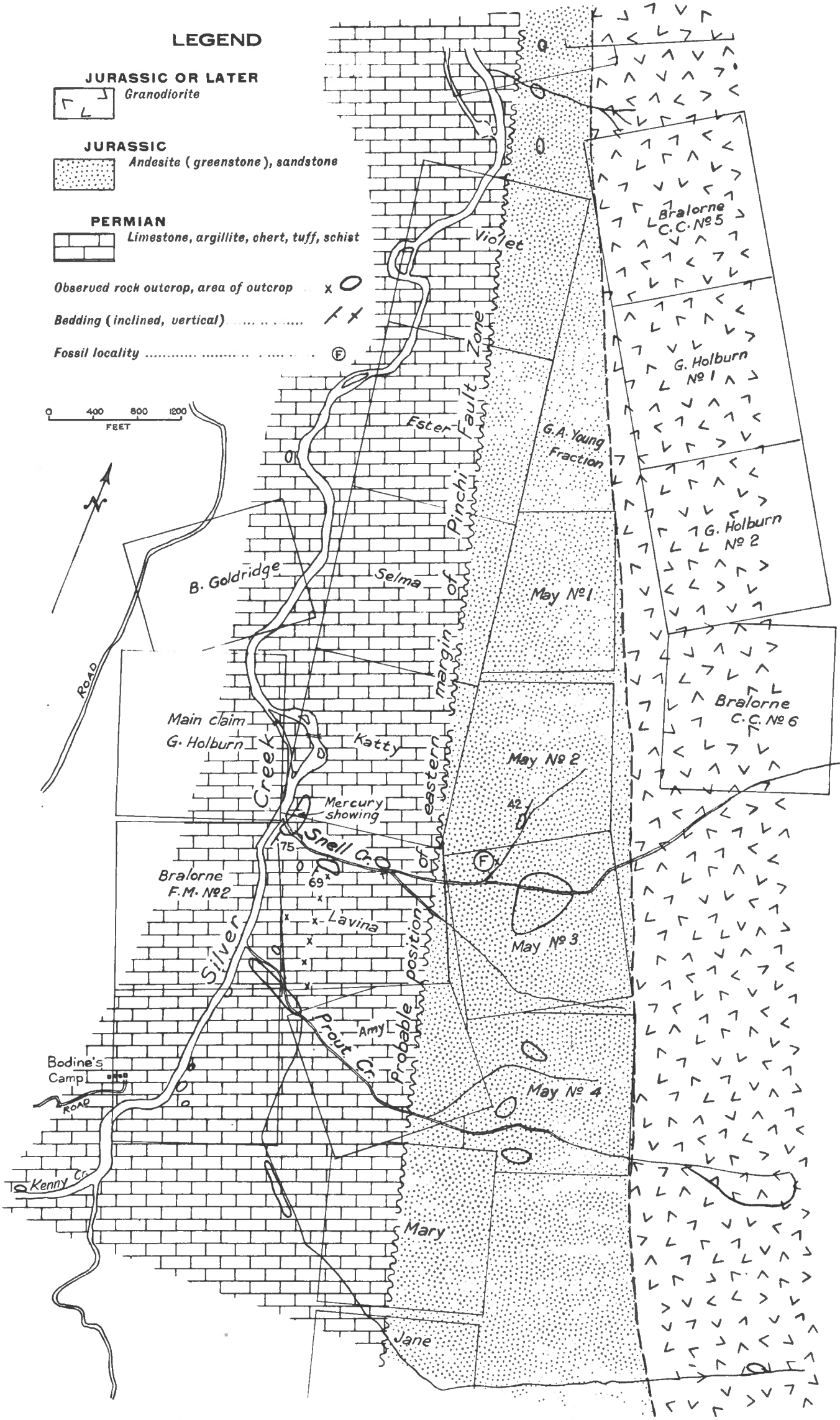

Figure 2: Geology of SNELL MERCURY PROPERTY, Omineca Mining Division, British Columbia

By J. E. Armstrong, Geological Survey, Canada

Two ore-bodies "A" and "B" have been discovered to date. They are both in limestone breccia. Cinnabar is the only mineral of economic importance and the best ore is found in the breccia nearest the fault planes. Much of the cinnabar occurs as veinlets, blebs, and individual grains filling minute fissures, and in places the cinnabar forms the breccia cement. Cinnabar also occurs in solution cavities, as coatings on the cleavage planes and faces of the calcite crystals. The limestone has also been partly replaced by cinnabar, especially where the wall-rock is finely fractured. The resultant ore-bodies are quite irregular in outline.

The cinnabar is the massive red variety. Gangue minerals are calcite and quartz. Coarsely-crystalline, pre-cinnabar calcite occurs along fault planes and fills solution cavities and veinlets of post-cinnabar calcite intersect the ore. Very little quartz was observed in the ore. Most of it is fine-grained, but a few crystals were observed in open cavities. Quartz and cinnabar were deposited contemporaneously.

Snell Property

The Snell property (See Figure 2) is at the junction of Silver and Kenny Creeks, 26 miles by road from Takla Landing and 10 miles north of Bralorne mercury mine. The claims were staked in the summer of 1941 by Mr. G. Snell and associates. Bralorne Gold Mines, Limited, acquired an option on the property in the autumn of 1941 but, following some surface exploration, allowed it to expire later in the year. Consolidated Mining and Smelting Company has held the property under option since and has undertaken extensive surface development and diamond drilling.

Outcrops are scarce except along the creeks, as most of the property is overlain by a heavy mantle of drift. About 1,000 feet south of Snell Creek the drift deposits include at least 120 feet of stratified sand and gravel. Interbedded limestone, argillaceous quartzite, tuff, slate, and schist of Permian age are exposed along Silver Creek and on the lower part of Snell and Prout Creeks. The beds strike northerly and dip steeply to the east. The various lithologic units occur in lenses up to 50 feet thick and several hundred feet long. The limestone and argillaceous rocks are the normal Permian types. The tuffs are cream and purple schistose rocks.

About 1,000 feet up Snell and Prout Creeks green andesites and brownish sandstones of Jurassic age are exposed. They appear to trend northerly and dip about 45 degrees to the west. Near the lower forks of Snell Creek interbedded red hematitic tuff and stratified limestone outcrop. These rocks are thought to be part of the Permian series, although they may possibly be of Upper Triassic age.

The Pinchi fault zone crosses the property from north to south and the fault contact between Permian and Mesozoic strata probably lies just east of the lower forks of Snell Creek. However, if the rocks outcropping at the lower forks of Snell Creek are Upper Triassic, and not Permian as believed, this fault contact would probably lie just west of the forks of Snell Creek. Many subsidiary faults, striking and dipping in various directions, cut the Permian strata. The more important of these strike north to northwesterly and dip 45 to 75 degrees south to southwest. They are well exposed at the mouth of Snell Creek. The crush zones along the faults are usually less than 6 feet wide.

Cinnabar is the only mineral of economic importance on the property. It is associated with minor amounts of stibnite. An ore-body about 40 feet long by 6 feet wide, and carrying 4 to 6 pounds of mercury a ton, occurs in limestone outcropping along Silver Creek at the mouth of Snell Creek. This body ends at a depth of 12 feet against a fault that strikes north 10 degrees east and dips 45 degrees southwest. Most of the ore in this deposit is contained in a siliceous paystreak 4 to 6 inches wide that follows a slip plane.

One good width of low-grade ore has been intersected in a diamond drill hole on Silver Creek. The cinnabar is in cherty limestone and carbonate-quartz-mariposite rock at the contact of limestone with altered serpentine.

At the north end of the stripping along Silver Creek, a bed, 10 feet thick, of rusty Tertiary gravel has been uncovered. This gravel rests on bedrock and is overlain by boulder clay. Boulders of rich cinnabar ore occur in the gravel. Some of these are as much as 2 feet in diameter. The source of this float is unknown, but if the Tertiary gravel represents an old channel of Snell Creek the source is farther up this channel.

Bron Group

The Bron group lies between the west fork of Kwanika Creek and Bralorne Takla mine, and may be reached by trail from this mine. It is owned by Consolidated Mining and Smelting Company.

Except for one small sill of greenstone, the only bedrock exposed on the claims is Permian limestone. This is the normal grey variety containing numerous solution cavities up to 3 feet across and patches of coarsely crystalline calcite. In most places it has been brecciated along fault planes and partly altered to dolomite. Commonly the fragments of the breccia are grey limestone, and the cement is buff dolomite. On the west fork of Kwanika Creek the breccia zone is 125 feet wide.

The Pinchi fault zone traverses the group from north to south and includes all the exposed limestone. The eastern border of the limestone outcrops forms a scarp and probably marks the eastern margin of the Pinchi fault zone.

Cinnabar is exposed in a mineralized zone 10 feet wide on the west fork of Kwanika Creek. It occurs as minute crystals in brecciated limestone and as films on slip surfaces. Diamond drilling failed to reveal any cinnabar at depth.

Lil Group

The Lil group, owned by the Consolidated Mining and Smelting Company, joins Bralorne Takla holdings on the north and is crossed by the road to that property. The group consists of sixteen claims, but work has been confined to the "Lil" No. 15, immediately north of the Bralorne property.

The only rock outcropping on the group is Permian limestone, and at most places it is brecciated. The limestone lies in the Pinchi fault zone, which crosses the property from north to south. The eastern margin of the zone is drift covered and one drill hole penetrated more than 60 feet of overburden.

The discovery is reported to have yielded high-grade cinnabar ore from an outcrop, 10 feet in diameter, of brecciated limestone. When visited, this ore had been removed and diamond drilling had revealed that the deposit petered out at a depth of 15 feet. Further extensive drilling failed to discover more than an occasional speck of cinnabar.

Dan Group

The Dan group lies south of the west fork of Kwanika Creek. It is approximately 4 miles by trail from Bralorne Takla mercury mine, or 6 miles by trail from Tsayta Lake. The group is owned by the Consolidated Mining and Smelting Company.

When visited, very little exploratory work had been done, and only a few scattered outcrops could be seen. These indicated that the claims are underlain by a sill-like body of serpentine intruding blue-grey Permian limestone. The sill contacts are apparently along zones of shearing and brecciation. The serpentine in these shear zones has been altered to buff, quartz-carbonate-mariposite rock and is mineralized with cinnabar.

When examined, the only showing was a mineralized zone about 3 feet wide exposed in a trench. Within it most of the cinnabar was concentrated in a width of 3 inches and consisted of bright red cinnabar associated with veins of chalcedonic quartz in quartz-carbonate-mariposite rock. Further discoveries are since reported to have been made.

Kwanika Group

The Kwanika group of claims is on the west side of Kwanika Creek and is accessible by trail, about 3 miles long, from Tsayta Lake. The lake is 130 miles by water and road, or 90 miles by air, from Fort St. James. The claims were staked by the Rottacker Brothers and associates in the summer of 1941, and were acquired under option by Consolidated Mining and Smelting Company in the autumn of the same year. Following a program of surface exploration and diamond drilling the option was relinquished, in 1942.

A belt of northerly trending Permian limestone crosses Kwanika Creek at a sharp bend 2 miles above its mouth, and upstream diverges to the west. Thinly-bedded, Upper Triassic greywacke, argillite, and tuff are exposed along the creek above the bend. Tongues of the granodiorite-diorite batholith lying east of Kwanika Creek cut Upper Triassic and Permian rocks exposed along the creek. The Pinchi fault zone crosses Kwanika Creek at the bend. The limestone in the fault zone has been partly brecciated and altered to a buff-coloured, dolomitic limestone. North of the bend the fault zone is covered by at least 25 feet of drift, but probably marks the contact between Permian rocks on the west and Upper Triassic rocks on the east. One diamond drill hole crosses this fault contact. Jurassic sandstone, greywacke, and tuff outcrop west of the Permian-Triassic fault contact, in the southwest part of the Kwanika group on Trump Nos. 1 and 2 claims. Although no contacts are exposed, diamond drilling indicates that these Jurassic rocks occupy a triangular shaped fault block in the Permian limestone.

A little cinnabar was discovered on Kwanika Creek, about $4\frac{1}{2}$ miles from its mouth. It occurs in a dolomite stringer, $\frac{1}{4}$ inch wide, traversing Upper Triassic argillite. The stringer lies about an inch from the contact of a narrow granodiorite sill that strikes north 5 degrees west and dips nearly vertically, and is exposed for 6 feet on the west bank of the creek. Surface work failed to uncover more cinnabar. Approximately $\frac{1}{2}$ mile farther upstream, dolomite stringers, $\frac{1}{4}$ inch wide, containing realgar, native arsenic, and pyrite, occur in Upper Triassic argillite and greywacke. One-quarter mile above this showing another dolomite stringer contains specks of cinnabar. Arquerite, cinnabar, and native gold can be panned from the gravels of Kwanika Creek.

A boulder of carbonatized serpentine and limestone containing cinnabar in commercial quantities was found on Trump No. 1 claim. It is at least 8 feet in diameter. Extensive diamond drilling in the vicinity of the boulder has encountered carbonatized serpentine, carrying a few specks of cinnabar, that may represent the source rock of the boulder. The altered serpentine lies between beds of Jurassic and Permian age and probably follows a fault contact.

Bowleg Group

The Bowleg group of claims joins the Kwanika group on the west, and is owned by Consolidated Mining and Smelting Company. Stripping and diamond drilling indicate that these claims are underlain by brecciated Permian limestone intruded by serpentine sills. Exploration was undertaken in an attempt to discover the source of the cinnabar float on the Trump claim of the Kwanika group 400 feet east of the Bowleg property. Nothing has yet been found.

Victory Group

The Victory group of claims joins the Kwanika group on the south and was staked by Consolidated Mining and Smelting Company. The Pinchi fault zone crosses the property from north to south. Brecciated and dolomitized Permian limestone lies west of the fault zone and Upper Triassic sedimentary rocks and granodiorite to the east. Stripping carried out during the summer of 1942 failed to discover any cinnabar.

Indata Lake Mercury Showing

This property is on the east side of Indata Lake, about 1 mile from the south end. It may be reached by road from Fort St. James to the east end of Chuchi Lake (first Nation Lake), a distance of 75 miles, and thence by water up the Nation Lakes for an additional 40 miles. The property comprises nine claims, staked in the summer of 1940 by Messrs. D. and M. Rottacker and associates. Consolidated Mining and Smelting Company obtained an option on the group in the autumn of 1940, but relinquished it in the autumn of 1941 after doing some exploratory work.

Outcrops indicate that these claims are underlain almost entirely by blue-grey Permian limestone. Several small dykes and sills of serpentine cut the limestone. A major branch fault of the Pinchi fault zone extends along the eastern boundary of the claims.

A brecciated fault zone, 10 to 20 feet wide, is exposed on the Sunrise claim on the east shore of Indata Lake and contains the main cinnabar showing. The fault strikes north, dips west at about 70 degrees, and has been traced for 1,000 feet from the lake to where it disappears under 25 feet of boulder clay and gravel. It is offset for a few inches to 10 feet along a series of cross faults striking north 55 degrees east. At its north end the fault follows the contact of a serpentine dyke with limestone for 175 feet. Along the fault the normal grey limestone has been changed to buff-coloured carbonate across a width of 30 feet. A chemical analysis shows a small increase in the silica, iron, and magnesium content. The serpentine dyke has also been altered across its entire width of 15 feet to a reddish buff, ankeritic carbonate with minor amounts of cherty material and green mica. The cherty material occurs in irregular nodules a few inches in diameter. Stringers of magnesite and of quartz, 1/8 inch to 2 inches wide, cut the altered dyke.

Most of the cinnabar occurs as scattered grains, either in the cherty fragments in the serpentine dyke or in similar fragments in the fault breccia, and is not sufficiently concentrated to constitute ore.

Indata Group

The Indata group of claims is east of the Indata Lake mercury showing. The group comprises the Indata Nos. 1 to 6 claims, and is owned by Consolidated Mining and Smelting Company. It may be reached by a trail

about $\frac{3}{4}$ mile long from the south end of Indata Lake. Claim No. 4 straddles Rottacker Creek, and the others adjoin it to the north.

A fault strikes approximately north 25 degrees west across claims 1 and 4 and lies about 200 feet west of claims 2, 3, 5, and 6. Permian limestone occurs west of this fault and Permian argillite, chert, and tuff east of the fault. Another fault, 800 feet to the east, was observed on claim 5. It strikes approximately north 15 degrees west, and forms a contact between Permian rocks on the west and Jurassic flows and tuffs on the east. Both faults are thought to branch from the main Pinchi fault zone and both are marked by carbonatized and brecciated zones carrying specks of cinnabar. Stripping, trenching, and diamond drilling, during the summer of 1941, failed to discover cinnabar in commercial quantities on the property.

Bralorne BB and Related Groups

These claims are along Silver Creek, near the mouth of Vital Creek, 30 miles by road from Takla Landing. The claims were staked in the autumn of 1940 by Mr. W. A. Prout of the exploration department of Bralorne Mines, Limited.

The Pinchi fault zone strikes north 25 degrees east through the property, the Permian-Mesozoic fault contact crossing Silver Creek at the Snell placer camp about $\frac{1}{2}$ mile below the mouth of Vital Creek. A carbonatized serpentine sill, about 75 feet wide, follows this fault contact. Many subsidiary faults, striking and dipping in various directions, intersect the Permian limestone and along them the rock has been brecciated and dolomitized. Traces of cinnabar have been found in the limestone and altered serpentine, but extensive surface work has not uncovered mineralization of economic significance.

Other Cinnabar Occurrences

Crystals of cinnabar were found in carbonatized serpentine outcropping on Mariposite Creek, and traces of cinnabar are reported in carbonatized serpentine outcropping on the lower part of Fall River.

Several groups of claims, in addition to those already described, have been staked along the Pinchi fault zone, but to date cinnabar has not been found on them.