[redacted] [redacted]

PE-068-01

THE GEOLOGY AND ORE DEPOSITS OF PRATMIGAN CREEK, MT. HAYES DISTRICT, ALASKA

146° 31'
63° 47' N

Abstract

Ptarmigan Creek is a small, non-glacial stream that drains the foothills north of Mt. Hayes. Its upper valley is underlain by soft sedimentary rocks and is broad and open while below this the stream has cut a deep canyon into hard granodiorite. This anomaly is explainable partly by differences in rock-types, but it is believed that there are other contributing causes. They are: local elevation of the granodiorite and downwarping of the rocks in the upper valley - related to the main elevation of the Alaska Range - and the damming of Ptarmigan Creek by large glaciers, which once covered the lower hills to heights of at least 1,000 feet above the present valley floors.

In the vicinity of Ptarmigan Creek the oldest rocks are highly contorted pre-Cambriam schists, overlain in the uper valey by early Tertiary coal-bearing sediments and by a thin covering of glaciofluvial deposits. Tertiary deposits containing coal beds are also exposed near the mouth of Ptarmigan Creek.

Intruded into the schist, but probably younger than the Tertiary rocks, is a large mass of granodiorite. Along its south contact the granodiorite overlies the schist at a low angle. It is believed to have been originally intruded at a relatively low angle, although the position of the contact may have been affected to some extent by subsequent overthrust faulting.

The granodiorite is cut by aplite dikes, by small stockworks of quartz stringers containing molybdenite, and by larger quartz veins containing arsenopyrite, pyrite, galena, and gold. They were introduced in the order listed and are believed to be related to the late stages of the granodiorite intrusion.

The molybdenite deposits, which are well exposed along the walls of Ptarmigan Creek Canyon, are not sufficiently high-grade to work at the present time. One fairly large quartz vein was found that deserves additional prospecting.

Introduction

A total of eight days, from May 19 - 26, 1941, was spent by the writer and R. D. Ohrenschall in examining and mapping the molybdenite deposits on Ptarmigan Creek in the Mt. Hayes District and in making a geologic reconnaissance of the surrounding region. Because the season was later than usual there was still much snow at altitudes above 4000 feet and consequently most of the higher ground could not be examined.

Previous Investigations

A reconnaissance of the northern flank of the Alaska Range, between the Delta and the Nenana Rivers, was made in 1910 by S. R. Capps,[1] but Ptarmigan Creek was probably not visited.

[1] Capps, S. R., The Bonnifield Region: U.S. Geol. Survey Bull. 501, 1912

In 1940 the molybdenum prospects on Ptarmigan Creek were examined and sampled by Ray J. Barber, of Fairbanks. Sampling data from Barber's report were made available by A. W. Conradt of Fairbanks, the owner of the prospects. They are reproduced here in Table II.

Location and Accessibility

The prospects occur in a deep canyon of Ptarmigan Creek about two miles above its mouth (Fig. 1).

A landing field, known as Conradt Field, has been built on a level bar on the east side of Dry Delta Creek, just above the mouth of Ptarmigan Creek. Its dimensions are about 30 by 1200 feet and its elevation is about 2380 feet above sea level. Conradt Field is about 90 miles southeast of Fairbanks. From the field a foot trail leads to the prospect.

Heavy freight could be brought in by tractor during the winter from the Fairbanks - Valdez highway up the valley of Dry Delta Creek.

Mining Claims

A total of 19 lode claims has been located by A. W. Conradt of Fairbanks, in his own name and in the name of John Hajdukovich (Plate I). In addition, Conradt and Hajdukovich have located six 40-acre association placer claims on Ptarmigan Creek below the canyon.

Topography

Mt. Hayes, the highest peak in the district, has an altitude of 13,740 feet, while Dry Delta Creek, only 15 miles away, is a little over 2,000 feet above sea level. The maximum relief of the district is therefore over 11,000 feet. The relief of the locality immediately adjacent to the canyon of Ptarmigan Creek is, however, only about 1,200 feet, since the altitude of Molybdenum Ridge, the highest point overlooking the canyon, is about 3,950 feet, while that of the creek just below is 2,700 feet.

Geomorphology

A striking feature of Ptarmigan Creek is the abrupt change from a broad, open valley in its upper course to a narrow, deep canyon in its middle course. Similar anomalous conditions have been observed in other valleys that drain the North slope of the Alaska Range. Since the open portions of these valleys invariably occupy basin-like areas underlain by soft rocks, while the canyons are cut through hard rocks, the most obvious explanation is that this condition is the result of differential erosion. In Ptarmigan Creek the upper valley is underlain by soft, easily eroded sandstone, while the canyon has been cut into hard granodiorite. On emerging from the canyon the creek crsses the wide glaciated valley of Dry Delta Creek, where it has deposited an inconspicuous alluvial fan.

Elevation of the granodiorite in the middle valley and downwarping of the sediments in the upper valley are also believed to have been contributing factors to the anomalous conditions in Ptarmigan Creek valley. These local changes in base level, probably contemporaneous to the main elevation of the Alaska Range, have resulted in the rejuvenation of the stream in its middle course.

An additional factor in the formation of the canyon is believed to have been the blocking of Ptarmigan Creek by large glaciers in Hayes and Dry Delta Creeks, which forced it to seek a new outlet. At the height of the last glacial period the glaciers in the Mt. Hayes District were much more extensive than now. Evidence of this is found in moraines and lakes of glacial origin in the broad ridge between Ptarmigan and Hayes Creeks, at heights at least 1,000 feet above the present streams. Instead of forming several separate valley glaciers, as at present, the ice on emerging from the high mountains combined in a single sheet that filled Hayes and Ptarmigan Creek valleys and spread over the high ground between the two valleys. This ice sheet was coextensive with a similar sheet to the east, formed by the emergence of the Dry Delta glacier from the high mountains.

As the ice retreated the high ground between the two creeks was left bare, while the main glaciers still filled the valleys and extended many miles past their present fronts. Since Ptarmigan Creek does not head into the high Alaska Range, it contained only the overflow ice from the main Mt. Hayes glacier and consequently its upper valley became ice-free comparatively early. Normal drainage was thus resumed in the upper creek while the lower part was still dammed by the glaciers in Hayes and Dry Delta Creeks. Drainage in other directions was obstructed by high ridges, so that at one stage during the regression of the ice, upper Ptarmigan Creek must have contained a sizeable lake. This lake was probably short-lived, for when the glacier in Dry Delta Creek retreated to somewhere near the present mouth of Ptarmigan Creek sufficiently low ground was uncovered to enable the present drainage to establish itself by cutting a canyon through the thin covering of morainal material and into the hard granodiorite. Because the initial gradient was steep, Ptarmigan Creek Canyon was cut in a relatively short time. Apparently the pre-glacial creek flowed almost east into Hayes Creek instead of southeast into Dry Delta Creek. Its valley is filled by glacial material.

Water Supply

During the latter part of May the water was at near-flood level in Ptarmigan Creek, because most of the snow melts at this time. Since the creek has a small drainage area it probably carries little water later in the summer and is probably dry in winter. No glaciers drain into it, consequently the water is usually clear.

Just above the canyon the grade of Ptarmigan Creek is less than three percent. In the canyon the creek drops 270 feet in about 6,000 feet; the average grade is, therefore about 4-1/2 percent. Below the canyon the grade again decreases to slightly less than three percent.

Timber

Good-sized spruce, sufficient for mining purposes, grows in the valley of Dry Delta Creek, within two miles of the prospects. Smaller spruce, some of it a foot in diameter, is found in the canyon at altitudes up to 3,000 feet. This growth is sufficient to supply fuel and timber needed in prospecting.

Geology

Character and Distribution of Rocks

Schists that are correlated by Capps[1] with the pre-Cambrian Birch Creek Schist

Capps, S. R., op.cit

are the oldest rocks in the region (Fig. 1). In the Ptarmigan Creek area they are probably overlain unconformably by poorly consolidated sandstones and related rocks of early Tertiary age, although the relations are obscured by glacial deposits. These deposits, partly modified by later stream action, cover much of the area. Intruded into the schist, but probably younger than the Tertiary sediments, is a large mass of granodiorite. Numerous smaller intrusions of granodiorite and related rocks are also found in the vicnity. Their age cannot be determined from local relationships, but according to evidence from other parts of the Alaska Range, they were intruded during the Mesozoic era.

Birch Creek Schist

In the vicinity of Ptarmigan Creek, Birch Creek Schist occurs only in a narrow wedge at the upper end of the canyon. (Plate I). Here it is highly contorted, gray quartzite and quartz-mica schist. Near the contact with the granodiorite the schist has been considerably silicified. This is mainly caused by the introduction of numerous quartz veinlets, rather than by contact metamorphism. In No. 2 Tunnel, near a fault contact with the granodiorite, the schist contains, in addition to the quartz, minute veinlets of pyrite that fill joints crossing the schistosity and are also parallel to it. Most of the quartz, which is older than the pyrite and is apparently unmineralized, is parallel to the schistosity.

Tertiary Rocks

Soft sandstones, conglomerates and clays of early Tertiary age are exposed in a bluff on the east bank of Dry Delta Creek at the mouth of Ptarmigan Creek (Fig. 1). This bluff was inaccessible because of high water, but two beds of lignitic coal, each said to be over 10 feet thick, are visible from across the creek. Although no outcrops were seen, float consisting of coal and soft sandstone indicates that Tertiary coal-bearing beds underlie a good part of the wide upper valley of Ptarmigan Creek. Because of the cover of glacial deposits the relationship of the Tertiary rocks to older formations could not be determined, but it is probable that they directly overlie Birch Creek schist.

Quaternary Deposits

Glacial deposits cover the upper valley of Ptarmigan Creek as well as most of the broad ridge between Ptarmigan and Hayes Creeks. They are generally thin and inconspicuous, since they were deposited by a relatively inactive part of the Mt. Hayes glacier system. On the ridge between Ptarmigan and Hayes Creeks they have been modified by water action.

Following the retreat of the ice, a new drainage pattern was superimposed on the glacial deposits of Ptarmigan Creek Valley. The new valleys were rapidly cut through the unconsolidated gravels and into the underlying formations.

Stream gravel deposited in Ptarmigan Creek consists partly of reworked glacial deposits, but also to a large extent of material eroded and deposited since the retreat of the ice. In the valley of Dry Delta Creek, on the other hand, the gravel deposits are mainly re-sorted glacial material.

Granodiorite

In the canyon of Ptarmigan Creek the intrusive rock is a medium-grained equigranular granodiorite. On fresh fractures its color is light gray, but on exposed surfaces the rock weathers brown. The essential minerals are: feldspars, quartz, brown biotite and green hornblende, listed in the order of their abundance. Minor amounts of magnetite, apatite, and zircon are also present. The feldspars are predominantly zoned plagioclases, varying between albite and andesina, with a mean composition close to oligoclase. A small proportion of orthoclase was present in most of the specimens studied. In some places, however, pink orthoclase feldspar was relatively abundant; here the rock should be termed a biotite granite.

An aplite dike 20 feet thick cuts the granodiorite on the Quail Claim (Plate I). This rock consits of equal parts of quartz and orthoclase with a very small amount of magnetite. It is doubtless a late differentiate of the main intrusion. Quartz stringers containing molybdenite cut the dike.

Structure

The long and complex structural history preceding the intrusion of granodiorite has no direct bearing on the mineralization and will not be discussed here. Subsequent to the intrusion, aplite dikes and small stockworks of molybdenum-bearing quartz veins filled tension joints and gash fractures in the granodiorite. There has been little faulting along these fractures, either before or after mineralization. Several true fissure veins were also observed. They carry arsenopyrite and gold and are apparently later than the molybdenite veins. Most of the veins strike northwest and dip nearly vertically (Plate I).

Considerable faulting, most of it later than the mineralization, is associated with the schist-granodiorite contact on Ptarmigan Creek. The contact dips northeast, or downstream, at an average angle of about 20 degrees; and the granodiorite overrides the schist. For this reason the schist is exposed as a narrow wedge in the bottom of the canyon, while the granodiorite forms the walls of the canyon and towers hundreds of feet above the schist. Near No. 2 Tunnel the schist narrows and finally passes under the granodiorite. The contact is for the most part covered by slide rock, but where exposed it is quite irregular.

Thrust faulting from the northeast forced the granodiorite over the schist, but it cannot be stated definitely whether the nearly flat attitude of the contact was determined primarily by thrust faulting, or whether the granodiorite was originally intruded at a low angle. From evidence on hand, however, it appears likely that the thrust faulting may have been relatively small-scale, and that the rock was intruded at a low angle.

No. 2 Tunnel follows a low-angle fault where the granodiorite has been thrust over the schist (Fig. 2). Here a nearly vertical normal fault preceded the thrust fault, but both faults are later than the molybdenite veins. High up on the Quail Claim is a wide fault zone that contains numerous barren, glassy quartz stringers; these are obviously later than the fault. However, since this fault displaces a gold-quartz vein, it is considered to be later than the mineralized veins.

In addition to thrust faulting, normal faulting was observed in both the schist and granodiorite on the northwest side of the creek. Much of it is parallel to the contact, but the scarcity of good exposures prevented detailed observations. Near the contact the schist strikes generally east-west, or parallel to the contact, and dips steeply north.

Ore Deposits

The molybdenite occurs in numerous white to glassy quartz stringers, in the granodiorite. It is found in thin flakes, usually along the walls of the veins. In some places the veins, which are seldom over a few inches thick, are sufficiently numerous to constitute small stockworks. Most of these are shown on Plate I. No high-grade ore was seen.

Except for a few scattered cubes of pyrite, molybdenite is the only primary ore mineral found in these stringers. Small amounts of powellite, a calcium molybdate derived from the oxidation of the molybdenite, occur along the walls and on exposed parts of the veins.

The areal distribution of prospects would appear to indicate that the molybdenite occurs in a zone running approximately parallel to the creek. However, it is more likely that the positions of the prospects simply coincide with the excellent exposures in Ptarmigan Creek canyon. Prospects are probably just as likely to exist away from the canyon, but because of the presence of overburden they are less likely to be discovered.

Several small veins were found which contained pyrite as the only sulfide mineral. These occur in joints similar to those containing the molybdenite veins. One of them, near No. 3 Tunnel, assayed a trace of molybdenum and $2.10 per ton in gold.

Veins that represent a mineralization distinct from the molybdenite also are found in the granodiorite. On the Quail Claim, nearly 1,000 feet above the creek, is a large gold-bearing vein that contains arsenopyrite, pyrite and galena in soft iron-stained quartz. A similar but smaller vein was followed by the Gillespie Tunnel.

It is believed that these veins are later than the molybdenite veins, since above No. 2 Tunnel a stockwork of molybdenite veins is cut by a badly weathered, iron-stained vein that is probably similar to the arsenopyrite veins. The molybdenite veins are in turn younger than the aplite dikes, since the dike on the Ptarmigan

Claim contains several of these veins. All of the veins, as well as the dikes, are apparently related to a late stage of the intrusion of granodiorite.

Chalcopyrite and cinnabar have been reported to occur in the canyon of Ptarmigan Creek, but these minerals were not observed by the writer. Chemical tests made on panned concentrates of vein material showed that only minute traces of copper are associated with the sulfide minerals.

Mining Development

In addition to surface prospecting consisting of a number of pits and trenches, four adits have been run into the sides of the canyon. Starting at the downstream end of the claims they are: Conradt No. 1 Tunnel, Gillespie Tunnel, Conradt No. 3 Tunnel and Conradt No. 2 Tunnel (Plate I).

The portal of Conradt No. 1 Tunnel is at the foot of the right limit slope, only a few feet above the creek. The tunnel is said to be 34 feet long. It is timbered for 24 feet; the rest wascaved and inaccessible. Several quartz stringers carrying small amounts of molybdenite were seen in the roof.

Gillespie Tunnel was driven in the steep right limit sidehill, about 150 feet above the creek. It is said to be 34 feet long, but only the first 14 feet is timbered; the remainder was inaccessible. The tunnel follows a small quartz vein carrying arsenopyrite and some pyrite.

Conradt No. 3 Tunnel is on the left limit of the creek, about 15 feet above the water. It is 24 feet long and the first 12 feet is timbered. The tunnel follows several quzrtz stringers carrying molybdenum and pyrite that occur in joints and small faults in very hard granodiorite.

Conradt No. 2 Tunnel is the last tunnel upstream. It is on the left limit, about 20 feet above the creek. The length of the tunnel is 106 feet, of which the first 70 feet is timbered (Fig. 2). The tunnel is driven partly along a nearly flat fault and crosses hard quartzite schist, decomposed granodiorite and fault breccia. In the granodiorite are numerous quartz stringers containing molybdenite.

The camp consists of two log cabins on the Home Claim at the lower end of the canyon. They are about 20 years old, but corrugated iron roofs were added several years ago and the cabins are still serviceable and comfortable. A nearby shed contains a forge for sharpening hand steel.

Sampling

A total of 19 samples was taken from the various molybdenum and gold prospects. Excepting two picked molybdenite samples, all of the samples were taken from channels cut across mineable widths. The results are shown in Table I.

TABLE I[1]

Sample Number	Location	Molybdenite Percent	Gold Ounces per Ton	Silver Ounces per Ton	Remarks
1	No. 2 Tunnel, cut from 32' to 43' from portal	Trace	Trace	Trace	Crosses many quartz stringers
2	No. 2 Tunnel, cut from 43' to 55' from portal	Trace	Trace	Nil	Crosses many quartz stringers
3	No. 2 Tunnel, cut from 55' to 65' from portal	Nil	0.04	Nil	
4	No. 2 Tunnel	0.17	Nil	Nil	Sample by A. W. Conradt
5	No. 2 Tunnel, 90' from Portal	0.15	Nil	Nil	" " "
6	No. 2 Tunnel, at face, 106' from Portal	Trace	Nil	Nil	" " "
7	Dump, No. 2 Tunnel	3.35	Trace	Trace	Picked high-grade
8	Ptarmigan Claim; 6' N of Discovery	Trace	Trace	Nil	12' channel across many quartz stringers
9	Ptarmigan Claim; 6' SW of Discovery	Trace	Trace	Nil	10' channel across many quartz stringers
10	Ptarmigan Claim; 30' SW of Discovery	Trace	Trace	Trace	2' Wide iron-stained zone

TABLE I[1] (Concluded)

Sample Number	Location	Molybdenite Percent	Gold Ounces	Silver per Ton	Remarks
11	No. 3 Tunnel, at face	Trace	Nil	Nil	Channel across several quartz stringers.
12	Face of cliff, 20' N of No. 3 Portal	Trace	0.06	Nil	Small vein containing pyrite
13	Dump at No. 3 Tunnel	0.33	Trace	Nil	Picked high-grade
14	Pit on Dove Claim, opposite No. 3 Tunnel	Trace	Trace	Trace	Quartz float
15	Hillside 300' upstream from No. 3 Tunnel	----	Trace	Trace	Channel across several quartz stringers.
16	Quail Claim, near Discovery	----	Trace	Nil	S half of 3' vertical vein.
17	Quail Claim, near Discovery	----	0.02	Nil	N half of 3' vertical vein
18	Quail claim, on ridge above Discovery	Trace	Trace	Trace	Sample by A. W. Conradt
19	Quail Claim at Discovery	Trace	0.13	Trace	Sample by A. W. Conradt

1 Analyses were made by A. E. Glover, Territorial Assayer, College, Alaska

The results of sampling by Ray J. Barber in June, 1940 were made available by A. W. Conradt. They are reproduced in Table II because some of the prospects that were open in 1940 were inaccessible the following year. The first five samples in Table II were taken from small veins and do not represent values across mineable widths.

TABLE II[1]

Sample Number	Location	Molybdenite Percent	Gold Ounces per Ton	Remarks
B-1	No. 1 Tunnel, 22' from Portal	Trace	Trace	From 3-1/2" Quartz vein
B-2	No. 1 Tunnel, in stope 10' above B-1	0.26	0.03	From 5" width of same vein as B-1
B-3	Cliff on Robin Claim, 450' above creek	1.43	0.29	From 1-1/2" quartz vein
B-6	Cliff on Pintail Claim 300' above creek	0.67	Trace	From 1" quartz vein
B-8	Open cut on Grouse Claim, 30' above Creek	0.63	Trace	3"-5" quartz vein
B-4	No. 2 Tunnel, cut from 42' to 68.5' from portal	Trace	Trace	Crosses 20 Mo-bearing stringers. Compare with Nos. 1-3, Table I.
B-9	Same as B-8	Trace	Trace	5" channel across 6-8 stringers with rock partings
B-10	Open cut on Grouse Claim 90' upstream and 25' above B-8	Trace	Trace	10' channel; includes 8 quartz stringers, up to 4" wide
B-5	Face of Gillespie Tunnel	Trace	0.06	Small quartz vein
B-7	2 Pits on Dove Claim, 30' and 50' above creek	Trace	0.04	Float, no ore in place

1 Analyses were made by A. E. Glover, Territorial Assayer, College, Alaska

Conclusions

According to analyses made on a reasonably complete group of samples, no workable deposits of molybdenite are exposed. Picked samples from small stringers contain as much as several percent molybdenite, but none of those taken across mineable widths contains more than 0.2 percent molybdenite. Under favorable conditions, the cost of mining, concentrating and shipping would be about $15 per ton of ore mined.

This would require a sizeable deposit containing at least 2 percent molybdenite.

The best prospects are found in and above No. 2 Tunnel, where there are a large number of molybdenite-bearing quartz stringers in decomposed granodiorite. Even here, however, the molybdenite content is very low. In addition, no ore may be anticipated at greater depths, since the veins are cut off by a low-angle fault.

Although its gold content was low where sampled, the quartz vein near Discovery on the Quail Claim is relatively large and deserves additional surface prospecting.

Much underground prospecting might have been avoided by a preliminary geological examination. Many hundreds of feet of molybdenite-bearing quartz stringers are exposed on the canyon walls, where they may be better examined than in the tunnels. At no place was high-grade ore seen. With the possible exception of the prospect at No. 2 Tunnel, where the stringers are part ly covered with slide and cannot be fully observed, there are no apparent reasons for anticipating higher values underground than on the surface.

Acknowledgements

Grateful acknowledgement is made of the hospitality of A. W. Conradt while this examination was being made. Mr. Conradt, and Mr. Calvin Cripe of Fairbanks, also supplied much information concerning the district.

Eskil Anderson of the Territorial Department of Mines identified the accessory minerals in specimens of igneous rocks from Ptarmigan Creek and checked the writer's identifications of the feldspars.

Henry R. Joesting
Assoc. Mining Engineer
Territorial Department of Mines
March 30, 1942

Territory of Alaska
DEPARTMENT OF MINES

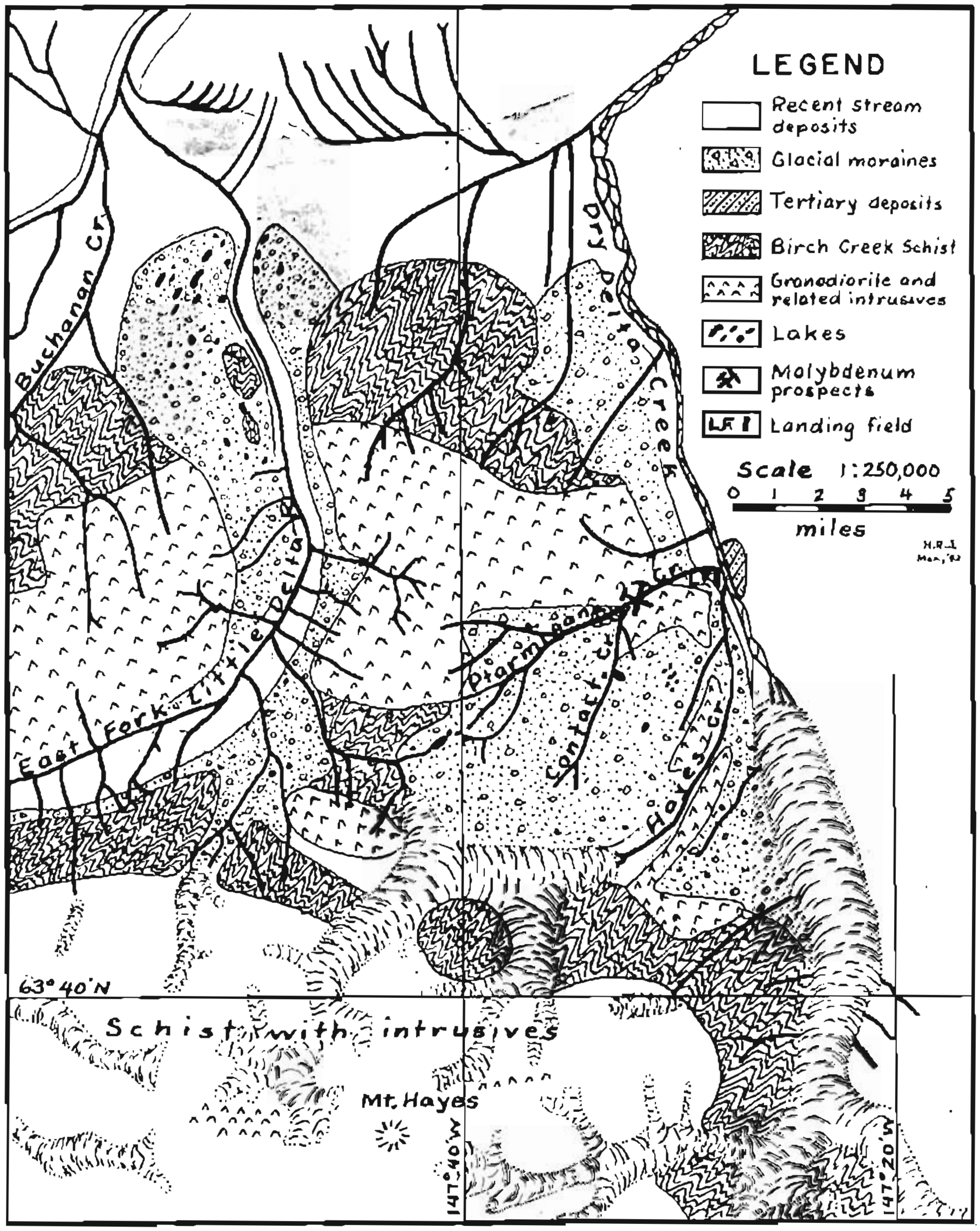

Fig. 1.— Geologic map of Mt. Hayes District. From Plate II, U.S. Geol. Survey Bull. 501, with modifications and additions.

Conradt Molybdenite prospect. Ptarmigan Creek.

Territory of Alaska
DEPARTMENT OF MINES

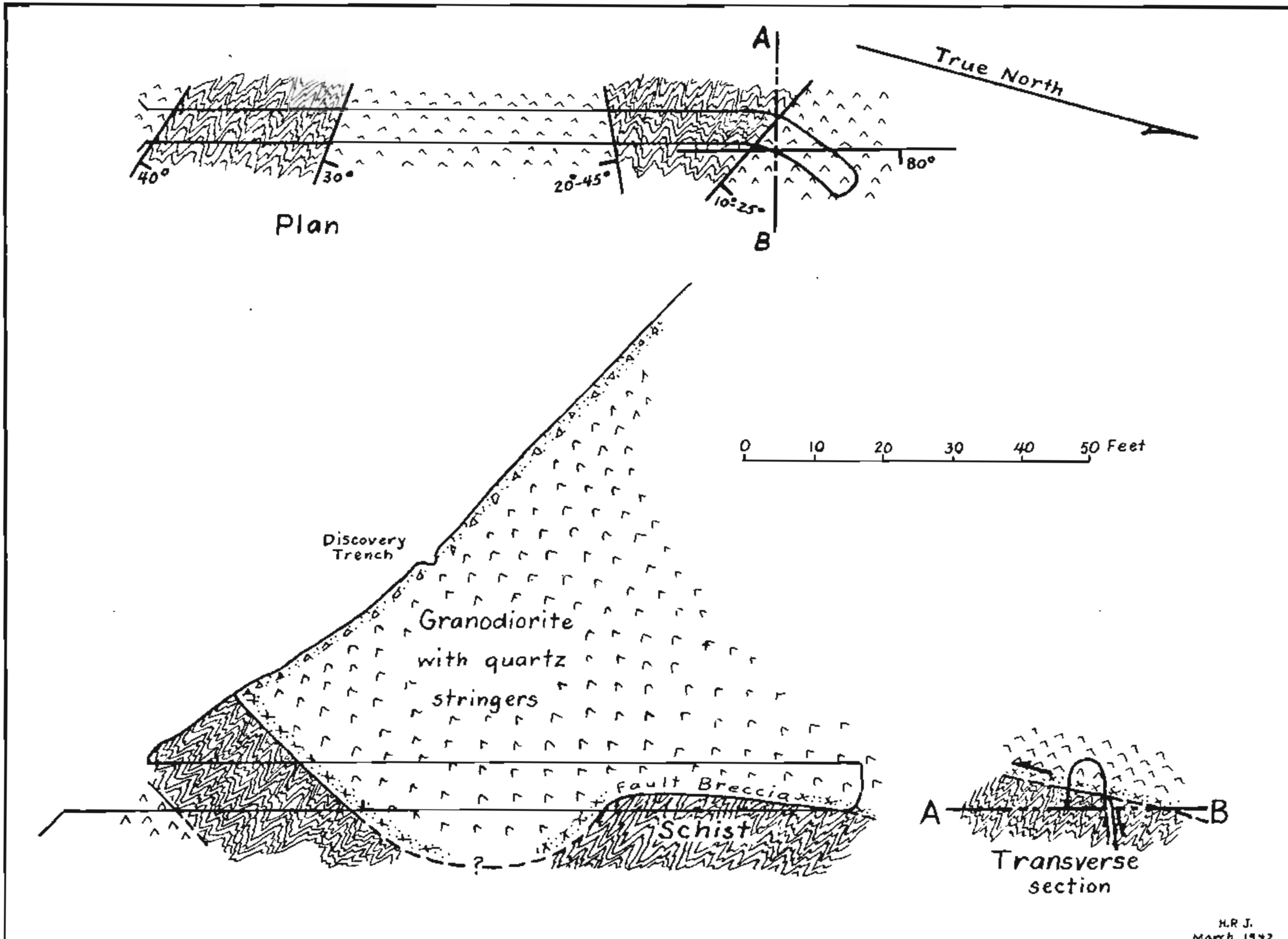

Fig. 2.- Plan and sections of No. 2 Tunnel.