A GEOLOGIC RECONNAISSANCE
OF THE
MINERAL AND CUDDY MOUNTAIN MINING DISTRICT
WASHINGTON AND ADAMS COUNTIES, IDAHO.

By
D. C. Livingston.

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by the Idaho Geological Survey

The original publication was no longer of reproducible quality. Geological and English usage appear as in the original. Only minor typographical errors have been corrected.
FOREWORD

This report represents a grouping together of several studies made at various intervals from 1920 to 1923, of different areas immediately adjacent to that part of Snake River between Burnt River on the south and Indian Creek on the North.

The Oregon side of the river has been included in these studies only in-so-far as was essential to a proper elucidation of geologic features on the Idaho side.

In the same manner, the studies which Prof. D. C. Livingston has made under other auspices, of the Bayhorse and other mining districts on the Oregon side of the river, have been of material assistance in the interpretation of similar Idaho deposits discussed in the present report.

Two rather well known districts, Mineral and Cuddy Mountain, which have produced significant amounts of silver ore in the past, appear from this report to have further possibilities.

Throughout the entire area similar geologic conditions prevail and the main economic possibilities appear to lie in the development of the silver deposits and of the copper deposits which, however, lie in different geologic horizons.

Francis A. Thomson.
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A geologic reconnaissance of the Mineral and Cuddy Mountain Mining districts, Washington and Adams Counties, Idaho

By D. C. Livingston.

LOCATION OF THE AREA.

The region described in this report is adjacent to Snake River and extends northward from Huntington, Oregon, along that stream to the "Oxbow" at the mouth of Indian Creek; it is a narrow belt some 50 miles long and 15 miles or less wide. Snake River, throughout this distance, forms the boundary between the States of Idaho and Oregon. The region includes the mining districts of Mineral and Cuddy Mountain in Idaho, the Bay Horse district in Oregon, and the intervening terrane.

PREVIOUS GEOLOGIC WORK.

The literature dealing with this region is not extensive. Lindgren (1) well describes the principal topographic and geologic features. Swartley (2) also presents some of the more general features of the region. In an earlier publication, the writer (3) discusses the geology and mineral deposits of parts of the region and of the larger Seven Devils district some miles to the northeast.

SCOPE OF THE SURVEY.

The present report covers in some detail the several mineral districts of the region as well as a reconnaissance of geologic conditions along Snake River between Burnt River, near Huntington, and Indian Creek. The trunk route of the reconnaissance followed the Homestead branch of the Oregon Short Line Railroad, which parallels Snake River, but side trips were made up several of the tributary creeks in both Idaho and Oregon in order to supply necessary detail of information. This work served as a skeleton uniting the several mineral districts and disclosing the remarkable similarity that exists between them.

The mineral districts are treated as similar parts of an extensive geologic province, and not as separate and distinct areas. In 1920 a topographic map was prepared of the Cuddy Mountain mining district, also known as the Heath district, and the main geologic features were mapped by the writer to supplement the work that had been done previously in the Seven Devils district. The information gained from the Snake River reconnaissance, pursued during the summer of 1923, made it very evident that a detailed survey of the geology of the entire Cuddy Mountain area was out of the question in the short time available. Accordingly the geologic map of the Cuddy Mountain district presents detail for those areas where ore deposits occur, but only general relationships elsewhere. This generalized presentation is enforced by the frequency of faulting in the district, a complex geologic structure that could be solved in detail only after an impracticable amount of work. The Mineral and Bay Horse districts were also examined in 1923, and their relations to one another and to the regional geology were established.

**TOPOGRAPHY.**

Near Huntington, Oregon, Snake River leaves the comparatively flat plains of southern Idaho, makes an abrupt bend to the northward, and pursues its way through a high, rugged mountainous region. The general topographic features of this region have been partly described by Lindgren (4) and by the writer (5). On the Idaho side of the river there are three high mountain masses, which are known in order from north to south as the Seven Devils, Cuddy, and Hitt Mountains, respectively. They are separated from one another by portions of the great basaltic plain, which extends southward into Nevada and northward into Canada, and covers large areas in Idaho, Washington, and Oregon. The larger area of plateau lies between the Seven Devils Range and Cuddy Mountain. These three mountain masses are evidently due to folding or doming of the strata, about a northeasterly axis accompanied by faulting; each of them contains a core of granite or granodiorite.

Cuddy Mountain is a portion of the basalt plain which has been lifted up to an elevation nearly 8,000 feet above sea level. As a consequence, the top of the mountain is almost flat in places. To the west it breaks abruptly away into Wildhorse Creek and the canyon of Snake River, and the view from this rim of the plateau is as stirring as can be seen in any part of the west. To the north the mountain drops off to the lava plateau by a steep escarpment which probably marks a fault; to the east it is bounded by the Welsey Valley and to the south by a narrow strip of plateau which separates it from Hitt Mountain. There are many places on the top of Cuddy Mountain which are flat enough for airplanes to alight upon, being absolutely smooth and level over many acres. This plateau-like mountain is sparsely timbered with Alpine fir and during the summer

(4)Lindgren, Waldemar, op. cit.
months is covered with a fine but luxuriant growth of grass making it a beautiful park-like spot. The relief is considerable—the west end of Cuddy Mountain is nearly 6,000 feet above the level of Snake River, at the mouth of Wildhorse Creek.

On the slopes of Cuddy Mountain the work of ice had greatly modified the topography. During the glacial period masses of ice accumulated on the mountain top and flowed down the numerous stream channels in the form of glaciers, which ate their way some distance into the heart of the plateau. As the glaciers dwindled with the passing of time, great cirques or rocky amphitheaters were left at their heads. The largest of these cirques, which occurs at the head of No Business Creek, presents a sheer semicircular bluff encircling the head of the canyon like a far-flung wall. The work of glaciers may be seen about the heads of nearly all the other streams, Hornet Creek, Brownlee Creek, and Grade Creek, but the No Business Cirque is by far the most impressive example of the glacial handiwork.

GENERAL GEOLOGY.

Snake River in its course between Huntington, Oregon, and Lewiston, Idaho, had exposed a series of rocks which are chiefly of Permian and Triassic age. These rocks have been intruded by younger granodiorite and are locally concealed by overlying basaltic flows.

Permian rocks.

The Permian rocks, though in many places sedimentary, in other are made up of a bewildering accumulation of igneous flows, fluffs, agglomerates, and intrusives. The igneous members are generally andesitic in character, but often consist of acidic rocks, such as rhyolites. Lenses of intercalated limestone are occasionally found. The Permian rocks are exposed in a number of places in the Snake Canyon and its tributaries, and on the flanks of the adjacent mountains. They occur well stratified near Homestead and on Cuddy Mountain, but their lithology is highly complex in the Seven Devils mountains. They are also exposed for a distance of more than six miles along the Snake between the mouth of Burnt River and the Bay Horse mine. Although bedded material and even carbonaceous shale are occasionally found, the rocks at this locality are chiefly heterogeneous and unstratified; they evidently represent a period of intense volcanic activity during which the material ejected was chiefly andesitic. South of the Bay Horse mine between mileposts 6 and 7 on the homestead branch of the Oregon Short Line Railroad, the Permian rocks consist of an andesitic agglomerate, which grades into a fine tuff without any apparent regularity. Fragments in the agglomerate reach a maximum of several feet across. On Cuddy Mountain these rocks consist of andesitic and rhyolitic tuffs, flows, and occasional included lenses of limestone and some beds of conglomerate. In this district they are usually well stratified, strike northeasterly, and dip 25 - 60 degrees N.W. The topmost member of the agglomerates usually consist of a reddish conglomerate made up of
water-worn pebbles and boulders, with an occasional angular fragment. These Permian volcanic rocks are often called greenstones, a somewhat general name which conveys little idea of their origin. They are usually volcanic, but often sedimentary, and they speak of past igneous activity alternating between violence and quiescence accompanied by sedimentation of terrigenous and marine material.

Triassic rocks.

The Triassic rocks, which overlie the Permian, also include both igneous and sedimentary types. At the base of the Triassic lies a flow or sheet of fine textured rhyolite or trachyte. This rock is widely distributed, is invariably uniform in character, and occurs between the Permian series below and the well stratified Triassic sediments above. At the Bay Horse mine, near railroad milepost 7, it has a thickness of about 200 feet, a red stained outcrop, and a somewhat cubical fracture. It is fairly resistant to erosion, often forming bluffs. The same rhyolite flow in the Mineral district, Idaho, had a thickness of over 600 feet and is considerably stained with manganese oxide as well as iron oxide. It shows also in the valley of Camp Creek, on the south flank of Cuddy Mountain; at this locality it is between 300 and 400 feet thick and is very heavily stained with manganese. On top of Cuddy Mountain it shows at the Galena mine, at the head of a small gulch opening into the canyon of No Business Creek. The striking feature of this rhyolite is the large area which it must have covered, a feature which in itself is fairly good proof that this igneous rock was poured out as a surface flow. On Cuddy Mountain and at Homestead there are other rhyolites occurring in the Permian series, but this Triassic flow can usually be distinguished by its stratigraphic position; it invariably lies above the conglomeratic andesite and below the schists, shales, and limestones of the Triassic. It is often overlain by a reddish schist consisting of flattened pebbles from the Permian andesite series, the red color undoubtedly being due to the fine fragments of andesite it contains. Occasionally it is overlain by limestone, a condition which may be due to faulting.

Overlying the rhyolite at the Bay Horse mine are sediments, also Triassic in age. The base and section of this group are well exposed as follows: rhyolite, 200 feet thick; purplish conglomeratic schist, which grades into fine shaly limestone, about 500 feet; greenstone, evidently a fine volcanic tuff, 375 feet; fine gray, yellowish, and purplish shales containing beds of gypsum, 1,000 feet; limestone, 50 feet; purple conglomeratic schists, about 200 feet. Above this group lies a great thickness of clay slates, at least 20,000 feet, which occasionally contain intercalated beds of limestone and are overlain by massive limestone of unknown thickness. This massive limestone is exposed on Connor Creek about four miles above the mouth. The clay slates or schists are exposed along Snake River with an average northeasterly strike and a northwesterly or westerly dip. The strike varies between N. 20 degrees E. and S. 70 degrees E., but the dip is universally westerly. The region of the
reconnaissance, therefore, lies along the limb of a huge fold. Snake River has cut a course nearly parallel to the axis of this fold and in places parallels the strike of the slates for distances of a mile or more. This explains the uninterrupted exposure of these slates from the mouth of Rock Creek (between railroad mile posts 7 and 8) to Sturgill at milepost 27, a distance of 20 miles. Below Sturgill the slates are apparently more massive and probably tuffaceous, and the strike and dip are difficult to determine.

The Permian and Triassic strata are apparently conformable in strike and dip at some places but true conformity does not exist. The plane of non-conformity could be determined accurately only by a search for fossils in the different beds, a study for which time was not available. The writer believes that the extensive rhyolite flow described above is close to the plane of division, but belongs to the Triassic series above rather than to the Permian below. This belief has sprung from the fact that at Mineral, Idaho, certain veins in the Permian andesites do not extend into the overlying rhyolite, while other veins cut both. These facts indicate that some time elapsed between the formation of the andesite series and the pouring out of the rhyolite—time enough for mineral-bearing veins to be formed and probably considerably eroded.

With the exception of glacial deposits in the high mountains and recent soils there does not appear to be any extensive area of sedimentary rocks younger than the Triassic in this region. Most of the region must, therefore, have been subjected to continuous erosion since the early part of the Mesozoic era.

Post-Triassic igneous and metamorphic rocks.

In addition to the andesite and rhyolite flows in the Permian and Triassic series, there are igneous rocks of later age occurring in this region. These fall into three main classes: (1) intrusions of granodiorite or associated rocks; (2) quartz porphyry intrusives; and (3) flows and dikes of basaltic lava. The granodiorite intrudes all the older rocks and has been considered to be of Cretaceous age; some doubt arises, however, as to the correctness of this correlation in this particular region. The basalts both intrude and overlie all the other rocks except the recent alluvial deposits; they have been classified as Miocene and fully described in other literature.

Granodiorite and associated intrusives.—The granodiorite and associated intrusives have extensive exposures in the Hitt, Cuddy, and Seven Devils mountains—in fact these rocks form the cores of these mountain systems. They also occur in many places along Snake River in small isolated areas, representing high points protruding into the overlying rocks. The largest of these isolated areas occur below Burnt River at railroad milepost 3 and at Eagle Island, more than 40 miles lower down the river. In each case the granodiorite crops out over only a few square miles, although the area near milepost 3 may extend some distance on either side

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of Snake River. Near Eagle Island this rock protrudes above the basalt between milepost 45 and 47; a fine display of its intrusive contact with the overlying rocks is exposed in the cuts along the railroad.

Quartz porphyry.--There are in the Cuddy Mountain district several exposures of a reddish-stained quartz porphyry. The largest of these constitutes Pock Mountain, between Hornet Creek and the North Fork of that stream. The rock is rather dense; light colored, and contains medium sized phenocrysts of quartz; originally it contained crystals and grains of pyrite and other sulphides as witnessed by its dense staining with iron oxide and its persistent reddish color on the surface. It is evidently an intrusive and is one of the youngest rocks of the region, inasmuch as it clearly intrudes the granodiorite near the Hornet Creek Ranger Station. This area of quartz porphyry will be more fully discussed under the caption Mineral deposits since it seems to possess economic possibilities if one may judge from the results of development work which has been done in similar rocks at other places.

Another outcrop of this rock in the Cuddy Mountain district occurs on a ridge between Brownlee Creek and Camp Creek about two miles from their heads, at an elevation between 6,000 and 7,000 feet. The rock is very similar to that which occurs on Pock Mountain, though it is not so heavily stained with iron oxide.

Serpentine.--In the vicinity of Robinette, serpentine crops out for more than two miles along the railroad, from milepost 31 to milepost 33. The rock is exposed in several railroad cuts, but its contact with the slates could not be definitely located. A small area of serpentine, completely surrounded by basalt, is exposed on the railroad between mileposts 37 and 38. A very similar rock also occurs several miles above the mouth of Connor Creek, in Oregon; from this last exposure chromite was mined and shipped during the war. It is probable that the three occurrences described are but points on a belt of serpentine rocks that is very extensive beneath the cover of basaltic lava.

Columbia River basalt.--Basaltic lavas of the Columbia River series cover large areas along Snake River and the adjacent mountains and render the work of deciphering the structure of the older rocks far more difficult than it otherwise would be. In some places, where erosion has removed the flows, the channels through which the fluid lava reached the surface are plainly marked by dikes. These dikes vary in width from two feet to more than a hundred, though most of them are far less than this maximum figure. Southward from Robinette, the basalts are perched high above Snake River on either slope of the canyon; north of that settlement the basaltic flows descend to the level of the river and completely mask the older rocks as far as the extent of the reconnaissance, with the exception of the serpentine near milepost 37 and the exposure of older rocks at Eagle Island.
STRUCTURAL GEOLOGY
Major structural features.

The entire region covered by the reconnaissance might be considered by the school of geologists as a great roof pendent of older sedimentary and volcanic rocks intruded by a westward extension of the Idaho granitic batholith. The areas where these older rocks occur are the Hitt, Cuddy, and Seven Devils mountains. These three mountains systems form a range which trends north-northeasterly, nearly parallel to the average strike of the stratified beds and to the course of Snake River. This range is broken between the Hitt and Cuddy mountains, also between the latter and the Seven Devils, by abrupt descents to portions of the basaltic plateau. The mountains lie along the axis of a major anticline or dome, with the stratified beds dipping in a northwesterly direction from this axis towards Snake River, where they have been exposed by the erosion of the basaltic capping. On its eastern flank, the fold is still covered with basalt, and the dip cannot be determined. There is evidence on Cuddy Mountain, however, to show that the Permian rocks are folded or domed and dip both easterly and westerly from the granite core.

Faulting.

Wherever well-bedded stratified formations occur, faulting is plainly visible; this condition holds true in the Mineral and Cuddy Mountain mining districts and at the Bay Horse Mine. The inference would naturally be that faulting occurs also in the Triassic slates and schists, but dislocations are not evident on account of the homogeneity of these formations. At the Bay Horse mine faulting has caused the stratified rocks, of which the rhyolite flow is the most prominent, to lie parallel to themselves with a resultant repetition of the strata. This parallel repetition is due to thrust faulting under compressive stresses acting in an easterly direction, about normal to the course of Snake River. The same compressive stresses, if active throughout the region, would account for the upfolding of the strata along the axis marked by the Hitt, Cuddy, and Seven Devils mountains. Most of the faults encountered in the Snake River region are of the normal type; in the case of the Bay Horse district, however, the faults are overthrusts in that the beds have been shortened by doubling back upon one another. Faulting of the Permian-Triassic rocks is also present at Mineral and on Cuddy Mountain, but the time available did not permit of a complete study of the fault problem in either of these districts.

Faulting has displaced the basalt flows at different points in the Cuddy Mountain district. The general appearance and relative position of the basalt on either side of Wildhorse Creek seem to indicate a fault coinciding with the general direction of that stream. No effort was made to study these faults, however, as they do not appear to be of economic significance.

Near milepost 47 a small creek flows into Snake River on the Oregon side, and at its mouth limestones, slates, and massive limestone are exposed. These rocks have an almost vertical dip and strike N. 50 degrees E. About half a mile above the mouth of the Creek,
a rock possessing all the characteristics of the lower Permian andesites is exposed, lying next to the lime and limey shales. The line of contact between these rocks is a wide zone of crushing undoubtedly a fault contact. The fault strikes diagonally across the railroad and river in a northeasterly direction with the Permian andesites on the upthrown side. According to Laney (6) the rocks at the Oxbow, some five miles below this point, are Permian. If the condition which Lindgren (7) shows on his map of the Blue Mountain is correct, the slates and limestone are Triassic in age, and the same is confirmed by Laney. It is impossible to account for the Permian beds at the Oxbow apparently lying above the Triassic milepost 47, except by a fault of large displacement, because the dip of the beds does not change between the two points. This fault at milepost 47, is probably but one of several strike faults. The writer believes that the abnormal streams, such as Indian Creek, Salt Creek, and Wildhorse Creek, have had their courses controlled by some such structural feature as these faults. This belief is confirmed, though not proven, by the fact that the courses of the streams are approximately parallel to the average strike of the strata.

SUMMARY OF GEOLOGIC CONDITIONS.

The geology of the region along Snake River between Burnt River and Indian Creek, 52 miles to the north, may be summarized as follows: Snake River has cut through a series of Permian and Triassic rocks nearly parallel to their average strike, and has consequently exposed a fairly complete section where these rocks are not covered by the basalt flow. As one proceeds down Snake River from the mouth of Burnt River, the oldest rocks are encountered first and then successively younger beds until milepost 47 is reached. At this point the older rocks again appear, due undoubtedly to a fault of great throw, and evidently continue below the basalt capping to the Oxbow and onward to Homestead. These stratified Permian and Triassic rocks dip westward away from the granodiorite which forms the core of Hitt and Cuddy mountains. Recent basalt flows have covered these older rocks for many miles and often cap the higherlands on both sides of the river. At Robinette the basalt comes to the river level and, with the exception of about three miles below Eagle Island, this condition prevails as far north as the Oxbow, a distance of nearly 20 miles.

(6)Laney, F. B., verbal communication.
MINERAL DEPOSITS.

The mineral deposits of the region may be classed in one of several different types: first, disseminations in granodiorite or monzonite, and segregations or disseminations in or associated with quartz porphyry; second, contact metamorphic deposits in limestone lenses that are close to granodiorite; third, veins and replacements in andesite and rhyolite, associated with the rhyolite flow at the base of the Triassic series; fourth, gold bearing quartz veins in different types of rock and wide gold bearing zones in slates.

DISSEMINATIONS IN GRANODIORITE.

I. X. L. group

The more important of the two mineral deposits that fall under this classification comprises the I. X. L. group of claims and several claims owned by Paul Raymond and his son of Heath, Idaho. The I. X. L. group, on which most of the exploratory work has been done, was owned and probably is still owned by Senator Stanfield and associates.

Location.—to quote from an earlier publication by the writer (8):

"The I.X.L. mine is situated on the west side of one of the higher points of Cuddy Mountain at an elevation of about 6300 feet. The mountain in which the mine is located lies at the head of the East Fork of Brownlee Creek and is a prominent landmark, as it consists of a dome of light-colored granite rock, which contrasts sharply with the dark basaltic, and flat summit of Cuddy Mountain to the north."

The property is about 16 miles from Cambridge, Idaho, and is reached by a wagon road which climbs to the ridge above the mine cabins; the road can be traveled by an automobile, if both happen to be in good condition at the same time. The property can also be reached by trail from the Brownlee Ranger Station, where saddle horses can usually be obtained. Its location and the broader geologic features of the region are shown on the geologic map (Pl.11).

Character of the deposit.—The deposit occurs in the so called granodiorite or monzonite which forms the core of Cuddy Mountain. Two distinct phases of the intrusive crop out—the one acidic, the other more basic. These two phases are best described by a second quotation. (9)


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"A phase of these intrusives is exposed along the graded wagon road which comes down into the East fork of Brownlee Creek between Heath and Donart's cabin. This is a rather coarsely-textured white rock made up entirely of feldspar and quartz, and somewhat stained with iron in the seams. As one follows the trail which goes up the right hand fork of the creek to the I.X.L. mine, this rock becomes more heavily stained with iron oxide and forms prominent red bluffs along the sides of the creek, but particularly on the north side. Under the microscope it is seen to be a coarsely crystalline rock consisting almost entirely of quartz and feldspar in about equal amounts with practically no ferromagnesian minerals present. The feldspars have been considerably altered to sericite and a little kaolin and are harder to determine than if they were fresh. The principal feldspar is orthoclase, but microcline is also present in small amounts as well as a few crystals of plagioclase, probably albite. There are a number of irregular grains and masses of pyrite disseminated through the rock, which appear to be of secondary origin and not a primary accessory mineral. The rock is best classified as a medium coarse-grained hydrothermal alteration of the original rock."

"On the way up the creek toward the I.X.L. mine the rock becomes darker in color and more basic in appearance with a decidedly porphyritic texture, showing well defined quartz phenocrysts. Under the microscope the porphyritic texture is more pronounced and the rock is seen to be made up of phenocrysts of orthoclase feldspar and quartz in a groundmass consisting of the same material finely crystallized. A few plagioclase crystals, probably albite, are also visible. Some shreds of biotite are present and some sericite, filling seams, as well as a few specks of chalcopyrite. The rock can be classified as a granite porphyry bordering on a quartzlatite or monzonite porphyry and containing a small amount of disseminated chalcopyrite in minute grains. Whether this rock is intruded into the split or is simply a phase of that rock is not entirely clear, but the latter theory seems the more probable."

Later studies point out the fact that the aplite is an acidic phase of the more basic monzonite.

The ore deposit occurs within the more basic monzonite, which has been fractured and mineralized with pyrite, chalcopyrite, and pyrrhotite over an oval-shaped area approximately 8,000 feet long and 4,000 feet wide. The longitudinal axis of this 700-acre mineralized zone bears northeast. The sulphide content of the ore is by no means uniform, as in certain zones the concentration is far above the average, and in others it is very low. A typical gossan and copper stained rocks, however, occur over the entire 700 acres of the outcrop. The mineralized zone seems to extend northeastward under the basalt cap, but a heavy cover of slide rock and soil prevents definite analysis of the structure. An interesting geologic feature of the deposit is a great basaltic dike which intrudes the mineralized
monzonite and stands, a prominent landmark, some 50 feet above the
general surface. To quote again from the writer's earlier publication (10):

"Under the microscope the mineralized monzonite is seen
to be a highly altered rock in which the feldspars have been
partly changed to a very fine-grained sericite. There are a
number of shreds of biotite in the rock, and a little
chlorite is also present. The rock in general is slightly
more basic than the monzonite described from down on the
creek. There is a considerable amount of secondary quartz in
the section observed, and both sericitization and
silificication have been at work upon the rock to such an
extent that its original condition has been obscured, but its
general appearance suggests that it was entirely similar to
the monzonite previously described. It is full of metallic
grains which have in many cases a hexagonal outline, and
their color by reflected light is more suggestive of
pyrrhotite than chalcopyrite, and it is possible that the
mineral is an isomorphous mixture of chalcopyrite and
pyrrhotite which would account for its copper content being
so much lower than its appearance would indicate. This is
further borne out by the fact that the powdered mineral is
slightly magnetic."

Genesis of the ore.--The mode of genesis of the ore is not
definitely known but the writer believes that the intrusive quartz
porphry which crops out close to the mineralized zone in the
monzonite has been the source of the sulphides. It is highly probable
that more detailed work will prove this belief. In other parts of the
region the quartz porphry or rhyolite porphry contains segregations
of copper ore--at the Red Ledge property on Deep Creek for example--or
is associated with copper in other rocks--as at Homestead, Oregon.
Owing to some unexplained mineral association, the porphry shows
little evidence at the surface of the presence of copper but is
heavily iron stained. In the case of the I.X.L. mine, the copper
mineralization may have extended from the quartz porphry, which lies
to the northwest, into the shattered monzonite and produced strong
surface indications of copper.

Suggested exploratory work.--The writer believes that the ore
deposit on which is located the I.X.L. group of claims is worthy of
more extensive development. At the Red Ledge property in the nearby
Seven Devils district, bodies of copper ore were disclosed by diamond
drilling below an iron stained non-cupriferous outcrop of rhyolite
porphry of quartz porphry. At I.X.L., the quartz porphry and the
monzonite are very similar in appearance and it may be that the heavily
iron stained bluff between the forks of Brownlee Creek includes a good
deal of quartz porphry. In such case the bluff may, like the similar
rock at the Red Ledge, overlie an ore body although it carries no copper
minerals at the surface. The possibility is worthy of investigation.
The disseminated sulphides in the monzonite have a low average

(10)Livingston, D. C., and Laney, F. B., op. cit., p.86.
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copper content when the whole area is considered; however, zones of higher grade material occur through the deposit. Intelligent diamond drilling based upon detailed geologic investigation, might disclose bodies of ore in the monzonite.

Peck Mountain.

Location.—The second mineral deposit of the disseminated type occurs in quartz porphyry on Peck Mountain between Hornet Creek and the North Fork of that Stream. The porphyry outcrop is more than three miles long and one mile wide; the longer axis of the area bears northeast. A description of the general features of the deposit is quoted (11) below.

"On the North Fork of Hornet Creek there is an area of mineralized and iron-stained rhyolite in which some chalcopyrite is exposed in a few open cuts along the side of the creek. The rhyolite at this place is part of an extensive area covering most of Peck Mountain and possibly extending on to the north end of Cuddy Mountain. It is situated about fourteen miles northwest of Council, on the Seven Devils wagon road, the hornet ranger station being located in this mineralized rhyolite zone and the wagon road cutting across it."

"The only workings in the district are a few open cuts on Peck Mountain and also along the North Fork of Hornet Creek in the canyon that cuts across the northeast border of Peck Mountain. The workings along the creek are best reached by taking a trail from Hanson's ranch, which is about thirteen miles from Council. This trail crosses a low divide between the main fork of Hornet Creek and the North Fork and then follows up the latter. The distance from Hanson's ranch is about three miles, and the elevation of the creek bed where the workings are situated about 4,000 feet.

Character of the deposit.—"At this place the North fork of Hornet Creek has exposed the iron-stained rhyolite which is covered by a thin flow of basalt on the east side of the canyon. There are several small cuts and short tunnels on both sides of the creek which have exposed what appears to be a silicified zone in the rhyolite. This is about twenty feet wide and strikes about north and south with a steep dip to the east, following the general direction of the creek for several hundred feet. This particular part of the rhyolite in disseminated with chalcopyrite and probably runs better than 1% in copper. Under the microscope the section shows an almost complete replacement of the rhyolite by quartz and chalcopyrite. As at the Red Ledge, surface indications of copper are almost negligible and the appearance of the rock where the open cuts have been made differs very little from the general run of the rhyolite except that it is slightly more silicified."

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A more careful study of the area made in 1920 shows that this rhyolite or quartz porphyry is intrusive in all the rocks of the region except the basalt. It is capped with basalt to the west of the road near the Hornet ranger station, and is in contact with granodiorite to the east. The geologic relations are clearly shown on the geologic map and structure sections (pl. II). The quartz porphyry is evidently more extensive below the surface than the area of this outcrop, as a small area of it protrudes through the andesite series about two miles farther north. The porphyry is everywhere stained with iron oxide, but in places the stain is more intense than in others. Evidently the areas of intense iron staining contained a greater amount of sulphide mineral, probably pyrite before being oxidized and perhaps leached by the surface waters.

Development.—The exploratory work that has been done on this deposit would not equal 200 feet of underground workings in the aggregate. There are a few small open cuts along the North Fork of Hornet Creek, and from them have been taken samples that carried gold and silver in association with chalcopyrite. Some shallow pits in the more intensively iron stained areas on Peck Mountain, two short tunnels near the ranger station, and some open cuts and tunnels on the east side of the mountain not far from the wagon road, constitute the remainder of the development work.

The meager exploratory work does not disclose the character of the deposit below the oxidized zone and its possibilities can only be inferred from surface indications. The similarity between the outcrop of porphyry on Peck Mountain and that at the proven Red Ledge property in the Seven Devils, coupled with the fact that chalcopyrite containing gold and some silver has been taken from the open cuts on the North Fork of Hornet Creek, suggests that zones of extensive mineralization may occur below the outcrop of iron stained porphyry. The writer believes that exploratory development, if carried on in an intelligent and conservative manner based upon careful geologic investigation, might lead to the discovery of important ore deposits. If bodies of ore should be discovered, the Peck Mountain porphyry would possess the advantage over the Red Ledge of easier accessibility, in that it is but 13 miles from the Pacific and Idaho Northern Railway and in the center of a farming and stock country. A branch line railroad could be built to Peck Mountain with ease, probably at less expense than one of the 18 miles of railroad that would be required through Snake River Canyon to reach the mouth of Deep Creek below the Red Ledge property.

CONTACT METAMORPHIC DEPOSITS.

On the southern slopes of Cuddy Mountain lenses of limestone, generally not more than a few feet thick, occur in the Permian andesites. In the neighborhood of the granodiorite these limestone lenses have been metamorphosed to masses of garnet, accompanied by sulphide minerals. Chalcopyrite is probably the most abundant of these sulphides. There area a number of these contact metamorphic deposits, most of them small, from which it is reported that some high-grade silver-bearing copper ore has been taken. The two largest properties are the Climax group of claims and the Railroad mine.
The Climax group of claims, owned by Paul Raymond of Heath, extends along a ridge which lies east to Brownlee Creek and trends northeasterly toward the I.X.L. mine. Several large garnet zones crop out along this ridge at intervals of several hundred feet, and lie at altitudes varying between 5,000 and 6,000 feet. These zones exceed 30 feet in width on the surface and are probably much wider in some places. More than 1,000 feet of underground development work has been done by Mr. Raymond, but unfortunately, the tunnels were inaccessible at the time the property was visited. These workings consist of a crosscut tunnel 820 feet long driven from the Brownlee, or west side of the ridge, to intersect a garnet zone 540 feet below the surface. From the end of the crosscut, drifts follow the mineral zone 100 feet to the southwest end 60 feet to the northeast. On the eastern side of the ridge there is a shaft, 230 feet deep, which was put down a good many years ago. It is reported that this shaft penetrated 30 feet of copper sulphide ore at a depth of 100 feet and that a drift followed the ore a distance of 40 feet. This shaft was sunk by Lewis Hall, a prominent figure in the early history of the Seven Devils district. An interesting structural feature of the deposit is that it lies near the top of an anticline, as the stratified Permian beds dip southeastward at a low angle.

The outcrop of the ore zone at the railroad mine consists of a partially garnetized belt of limestone between 35 and 50 feet thick, which is interbedded with Permian andesites. Hydrothermal amounts have altered the limestone to garnet, edidote, and crystalline calcite and have deposited chalcopyrite and pyrite; unlike the smaller lenses in other parts of the district, however, the limestone has not been entirely metamorphosed on account of its thickness. The andesites have also been intensely altered in the vicinity of the mine and mineralized by pyrite. Pyritization is well developed in andesite beds which dip 20-25 degrees NW. on the road below the mine. Both the ore zone and the surrounding rocks have been intensely fractured by a series of roughly parallel faults at intervals of a few feet. Several partially caved tunnels are located on the property, which has evidently been inactive for a number of years.

Veins and replacements in andesite and rhyolite.

Perhaps the most important mineral deposits in the region are the high-grade silver veins and replacement deposits which occur in andesite and rhyolite. Their importance is derived, not from the size of the ore bodies, but from the fact that they occur in several camps at no great distance above or below the plane of contact between the Permian andesite series and the Triassic sediment. This is a significant fact, because there is a large territory in which the contact is to well exposed and it is probable that intelligent prospecting therein would disclose other similar deposits. It would be an extraordinary coincidence if stream erosion had
exposed this horizon at the only place where mineral deposits occurred. The postulation of such a perfect coincidence is an absurdity. The Permian-Triassic contact certainly offers inducements for more intensive prospecting than it has received in the past.

The properties which occur at this horizon are the Bay Horse mine in Oregon (near railroad milepost 7), the veins of the Mineral district in Idaho, and several mines and prospects in the Cuddy Mountain district. Of these, only the Bay Horse mine is now active following a long period of idleness; all the others have been producers in the past. A total past production exceeding a million ounces of silver can probably be credited to the mineral deposits of this type.

Bay Horse mine.

The Bay Horse mine is situated in Oregon on Snake River seven miles below the mouth of Burnt River. It is 10 miles from Huntington on the Homestead branch of the Oregon Short Line Railroad, the mine workings being only 300 or 400 feet from the track. A good though narrow automobile road connects the mine with the town of Huntington; it is open to travel throughout the year.

Silver bearing tetrahedrite, or rather the arsenical variety tennantite, is generally the sole ore mineral, but it is associated in places with rather small quantities of other sulphides. The ore occurs in a fractured zone close to the contact between the Permian andesite and the rhyolite flow, and probably does not extend into the overlying Triassic sediments. It occurs both as an impregnation in the rhyolite and as replacement of the andesite. In the impregnations mineralization extends some distance into the rhyolite and forms a low grade ore. The replacements in andesite are somewhat irregular in outline, but appear to be persistent in strike, and dip westward into the mountain. They are highly silicified masses which are similar in appearance to the overlying rhyolite, and contain numerous equi-spaced veinlets or stringers of tennantite. The general strike of the ore bodies is about N. 70 degrees W., parallel to the stratified rock and the rhyolite. The ore body on which most of the mining has been done has a maximum width between 40 and 50 feet. It is badly faulted on the main tunnel level, and much of the ore mined during 1922 was drag ore, lying in a flat fault plane which dipped to the south; this faulting obscured the nature of the ore occurrence to a considerable extent. A good deal of the ore was shipped as it came from the stopes, though sorting was practiced to a considerable extent. The westward limit of the ore body has not yet been reached and the present development is outlined to follow it into the mountain. Recent developments indicate that the ore shoot occurs at the junction of two faults, that it strikes roughly west, and dips into the mountain on a grade of 10 feet in every hundred.

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The mine is opened by two tunnels, both of which were started years ago. The present operators have pursued development in the upper one which has been driven into the mountain about 800 feet. A number of crosscuts and stopes connect with it. A winze from a level about 60 feet below this tunnel is now opening up a body of excellent ore in the andesite below the fault on the upper tunnel level. The lowest tunnel, which is about 130 feet below the uppermost, has not yet been reopened by the present company, although work in the tunnel is contemplated in the near future. The property is owned by the U.S. Metals Company of Portland, Oregon.

The outcrop is very small and its only indication of mineral is an azurite stain. As the ore zone contains practically no vein quartz, it is impossible to distinguish the weathered outcrop from the country rock except by the copper stain. This fact should be borne in mind when prospecting in other places along this mineralized horizon. Copper staining occurs opposite the Bay Horse on the Idaho side of the Snake near the andesite-rhyolite contact, but no extensive development has been carried on at this point. Similar evidence of mineralization is reported to occur on Rock Creek, also in Idaho, but time was not available to investigate the geology of this area.

Mineral district.

The Mineral district, Idaho, is located on Dennett or Mineral Creek about three miles from Snake River. The district was visited in 1900 by Lindgren (12), who estimated at that time a total production of 600,000 ounces of silver from the different properties. It is reached by an excellent wagon road from the ferry at Still, which is near railroad milepost 16.

The geology is almost an exact duplication of that at the Bay Horse mine. At the base of the section are the Permian andesites, which are covered by a flow of rhyolite at least 600 feet thick; the rhyolite is overlain in turn by schists, limestone, gypsum formation, and slates. Granodiorite intrusions also occur in the district, and a number of basaltic dikes. The stratified formations strike northeast and dip 20 to 35 degrees NW. The dip of the rhyolite corresponds very closely to the slope of the hill, with the result that a large territory is covered by this rhyolite and the underlying andesites are exposed only along the east fork of the creek. Although the sequence of sediments lying between the rhyolite and the slates is the same, their thickness is much less and that of the rhyolite is much greater at Mineral than at the Bay Horse mine. Otherwise, geologic conditions are identical at the two camps, which indicates some 12 miles of intervening country through which the same horizon extends and which is practically unprospected. The map and section (Pl. III) shows the geologic conditions in as great detail as it was possible to achieve in the short time available.


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The principal silver bearing mineral in this district is tetrahedrite, or more likely tennantite. The mineralization, however, is more complex than at the Bay Horse, and tennantite occurs with chalcopyrite, pyrite, galena, and sphalerite.

There are two sets of veins: The first set strikes northwesterly and its members appear in almost every case to be associated with basalt dikes; the second set strikes northeasterly, almost at right angles to the first set and to the basalt dikes. The veins of the first set cut both the rhyolite and underlying andesite, and contain all the ore deposits that have produced silver. So far as could be determined the veins of the second set do not extend upward into the rhyolite; they seem to occur only in the vicinity of the granodiorite intrusion. If the relations between the veins of the second set and the other rocks have been correctly interpreted, the veins are older than the rhyolite flow of Triassic age, but younger than the granodiorite, whose age has been accepted as Cretaceous. These two relations of age constitute a dilemma which suggests that the granodiorite of the Snake River region is older than Cretaceous.

The silver-bearing veins of the first set appear to be replacements along fracture lines, and the same lines of weakness were followed by the basaltic dikes which are younger than the veins. The veins vary greatly in width up to a reported maximum of 40 feet or more; in the Eagan the vein is nearly 20 feet wide, but the majority appear to be narrower. The veins of the second set, which strike northeasterly, apparently contain little silver; chalcopyrite intermingled with considerable pyrite with a quartz gangue is the principal mineralization. They are also reported to contain a little gold. There are somethings like nine of these veins which occur along the hillside northwest of the town of Mineral and which vary in width from four up to a reported maximum of 68 feet.

At the present time there are very few producing properties in the camp, the North Star being the only one that shipped any ore during 1923; the Eagan produced both ore and concentrates in 1922 and at the present time is in good condition to continue production. Most of the properties which were producing at the time Lindgren visited the camp are now idle and many of the workings are caved and inaccessible. This is true of the Silver Bell group. The Silver Bell deposit is a mineralized zone that strikes northwest through the rhyolite; its maximum width is 40 feet. Some high grade silver ore has been shipped, although the vein as a whole is rather low grade.

Maria property.—At the time of the writer's visit, the workings of the Maria were inaccessible and the following description of the property is quoted from Lindgren (13):

"The Maria is located on the hillside south of the town, and is developed by several tunnels for a vertical distance 200 feet. The vein is fairly well defined, from 2 to 4 feet wide, and dips northeasterly. The dip decreases in depth to 20 degrees. A dike basalt similar to

that found in the Jessie cut the vein. The oxidized ore is confined to within 50 feet of the surface. In depth the sulphide consists of pyrite, chalcopyrite, tetrahedrite, galena, and zinc blends, all fine grained and intimately intergrown with calcite gangue. The percentage of copper is small—from 1 to 2 per cent. The average silver content is said to be 25 to 30 ounces per ton. The zinc blends and galena, which are not very abundant, are most intimately intergrown in concentric masses. A specimen of richer ore assayed contained 0.28 ounces of gold and 55.92 ounces of silver per ton. The production of the Maria is reported as 150,000 ounces silver."

Eagan property.—The Eagan property is situated on the North Fork of Dennett Creek. A persistent vein nearly 20 feet wide, striking N. 30 degrees W. and dipping about 60 degrees NE has been opened up by several tunnels. The vein is associated with a basalt dike and seems to pinch out against the dike as one proceeds toward the southeast. The upper part of the vein in the oxidized zone has been almost completely mined out. In the intermediate tunnel just above the level of the mill, the vein is well exposed and shows a quantity of sulphide minerals, chief of which is chalcopyrite, in a quartz gangue with some calcite. A small concentration and flotation mill was erected on the property by the Wymans of Boise when they had the property under bond from Mr. Weitser of Baker, Oregon.

North Star property.—The North Star property, owned by Peter Davis, is under bond by Mrs. E. J. Burnham. It is location on the hillside northeast of Mineral and is opened by a tunnel about 150 feet above the creek, and a raise to the surface. This tunnel passes through a basalt dike into a broad, crushed zone, which is probably a fault. Ore occurs on the northeast side of the crushed zone but the size and position of the ore body are not shown by the scanty development work. The visible features suggest a zone of sparse mineralization, as much as 50 feet wide, within which occur streaks of high grade sulphide ore about one foot wide. These ore streaks strike a little west of north and are almost vertical. A crosscut in the oxidized portion of the zone of sparse mineralization shows about 50 feet of low grade ore, which has been reported to carry 10 to 12 ounces of silver per ton.

There are a number of other properties in the camp, which could not be visited in the time available. The purpose of visiting the Mineral district was to effect a correlation of the general geologic features with those of the Bay Horse, Cuddy Mountain, and Seven Devils districts, rather than to make a detailed examination of the mineral deposits. The correlation effected leaves little doubt that the same mineral horizon is common to all districts.

Cuddy Mountain district.

Belmont group.—The Belmont group of claims lies on the south slope of Cuddy Mountain between Camp Creek and Grade Creek, at an elevation of about 4,000 feet. The claims are owned by Paul Raymond and his son. The property can be reached by wagon road from the Brownlee ranger station, which is about two miles distant. The geology is very similar to that of the Bay Horse and Mineral
districts. A very thick conglomeratic phase of the Permian and andesite is overlain by a thick flow of rhyolite. This rock is overlain by limestone, schists, and slates, which undoubtedly belong to the Triassic series. The horizon is the same as that which occurs at the Mineral and Bay Horse districts. The rhyolite is exposed over a large area due to the fact that its dip almost parallels the slope of the hill.

Oxidized silver-lead ore occurs at the surface in what appears to be a wide but irregular zone of replacement in rhyolite. The underground workings are caved or in an extremely dilapidated condition and very little geologic information can be gleaned from them. The ore bearing zone strikes approximately northeast. According to reports, the best grade of ore was encountered in the andesitic conglomerate below the rhyolite. The amount of ore which has been produced is not known, inasmuch as the property was worked in the late eighties, and no records of production were kept so far as the writer could determine. A mill was operated on Camp Creek for concentration of the ore, also during the eighties.

There is probably more than 2,000 feet of underground work on this property, half of it in a tunnel driven from the creek level. This tunnel was driven northward into the hill for 800 feet then eastward 200 feet, and finally northward 50 feet. It is caved near the mouth and inaccessible, and unfortunate fact that withholds a great deal of a valuable information which could otherwise be obtained. It is reported that ore was encountered in the crosscut to the east, and that andesitic conglomerate forms the face of the tunnel. It is unfortunate that the workings in this property are in such bad shape, as reports favor the occurrence of large bodies of silver-bearing lead ore. Nothing can be told, however, of the geologic features of the deposit without cleaning out the tunnels. The rhyolite in the vicinity of the mine is heavily stained with manganese, a fact of no economic significance in that such staining is quite general over a large part of the district.

Grade Creek property.—The Grade Creek property is located on Grade Creek at an elevation of about 5,000 feet. It can be reached by either of two trails—one which is rather steep proceeds up the Grade Creek from the Belmont claims; the other follows the contour of the mountain from Brownlee Creek near the ranger station. The basal Triassic (?) rhyolite flow crosses Grade Creek, dipping down the Creek at an angle of about thirty degrees. It is overlain by andesitic conglomerates and overlain by limestone and schists. West of Grade Creek the rhyolite is cut off by a fault which extends up Grade Creek for some distance; this dislocation has thrown the higher part of the Triassic slates against the older rhyolite and conglomerate. Time did not permit of tracing these beds on the other side of the fault.

The Bunker Hill and Sullivan Mining & Concentrating Company required the Grade Creek and Belmont properties under bond and leases a few years ago, and has pushed the development of the Grade Creek. Their tunnel has a general course of N. 30 degrees W.; it passes through rhyolite for 450 feet, then generates the schists and limestone 400 feet farther. It partly crosscuts the heavily manganese
stained rhyolite flow, which appears to be 800 or 900 feet wide and to
stike N. 0 - 20 degrees W. and to dip about 30 degrees W. It is
reported that a little galena was found in this tunnel, but no large
body of ore appears to have been struck. The rhyolite at the Grade
Creek property is a continuation of the flow in which the Belmont mine
is situated, a relation that is shown by the geologic map (Pl. III).
As the ore at the Belmont mine appears to be in the lower part of the
rhyolite and in the underlying conglomerate, it would seem that a crosscut
driven up the creek from the Grade Creek tunnel would stand a better
chance of encountering a continuation of the Belmont ore zone.

Hercules group.--The group of claims known as the Hercules lies
about half a mile west of the Belmont. They are owned by William
Allison. The rocks consist of the persistent Triassic (?) rhyolite
flow overlain by limestones and shales. Two tunnels have been driven
on the property--one starts in the rhyolite; the other starts in the
limey shales and, to quote verbal reports, reaches rhyolite. Both of
these tunnels are inaccessible. It is reported that ore similar in
character to that at the Belmont mine has been taken from them.

Alex. Houlanah's property.--The Houlanah property lies on the
hillside above the Hercules group, and although higher up the hill is
in the same rock formations. Most of the exploratory work has been
done in the rhyolite close to its contact with the overlying
limestone. A good deal of sulphide mineral, chiefly pyrite, lies on
the dump at the mouth of one of the tunnels; it is reported, however,
that galena ore, similar to that in the other mines and prospects, has
been found.

Metheny group.--Another group of claims owned by W. F. Metheny
lies near a gulch which runs into Camp Creek, at an elevation of about
5,000 feet. Most of the development work on these claims has been
done in the andesites and conglomerates which underlie the rhyolite
flow. The mineralization in these rocks seems to be entirely
different from that of the Belmont. Seams and stringers of copper-
stained material, intermixed with specular hematite extend irregularly
through the conglomerates in a number of places.

Galena property.--The Galena property is situated near the summit
of Cuddy Mountain at the north rim of No Business Canyon. It can be
reached by a rather rough wagon road up Hornet Creek. The geology of
the property is very similar to that at Mineral and at other prospects
on Cuddy Mountain. The Triassic (?) rhyolite lies between andesite
below and schists and slates above. A replacement vein between three
and five feet wide strikes northeasterly through the rhyolite and dips
about 65 degrees NW. The vein has been opened up by three shafts
between 100 and 150 feet apart along the outcrop. The underground
workings were dangerous at the time of the writer's visit and were not
explored. The vein contains a very good grade of fine-grained galena
which occurs as streaks and bunches in the altered, replaced country
rock of the vein. Its silver content is not known. A good many tons
of ore have been shipped from the property and if it were not for its
inaccessible locality, it could undoubtedly be operated at a profit, at
the present time.

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GOLD QUARTZ AND OTHER VEIN DEPOSITS.

Freeze property.--On the head of Hornet Creek only a short distance below the Old Forest Service cabin on Cuddy Mountain is a gold bearing quartz vein, which was located some years ago by Mr. Freeze of Council. The country rock is granodiorite. The vein, a typical gold bearing quartz vein three or four feet wide, has a rather flat dip. It has been opened for a distance of several hundred feet by several pits and shafts which in each case show highly oxidized material reported to carry a high gold content. The property lies on a low ridge extending up from a flat, swampy glaciated basin. Deep tunneling is therefore, impossible. The property was visited by the writer in 1918 for the first time; several visits have been made since, but little new development has been seen. There is probably a considerable tonnage of oxidized ore which could be profitably handled with a small amalgamation mill.

J. C. Riley property.--The J. C. Riley property is situated on the top of Cuddy Mountain at the head of the middle fork of No Business Creek, in the Permian andesite series. An almost vertical vein strikes N. 30 - 40 degrees W. through the andesite rock; its width varies between one and four feet. Seams of barite containing fine native or wire silver extend through the rather crushed and altered vein filling. At the time the property was visited, the development consisted of only a few open cuts and short tunnels. The vein seemed to be fairly persistent, however, and to possess possibilities.

SUMMARY OF MINERALIZATION AND ORE DEPOSITION.

Two striking generalizations may be drawn in relation to the ore deposits and their association with different types of rock. Firstly, silver bearing minerals are found abundantly in stratigraphic proximity to the rhyolite flow which lies between the Permian andesites and the Triassic sediments over an extensive area. Secondly, the disseminated copper mineralization observed at the Red Ledge property on Deep Creek, on Cuddy Mountain, and elsewhere, occurs in or near intrusions of quartz porphyry or rhyolite, although it is not an established fact that the two are genetically related.