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GEOLOGY AND ORE DEPOSITS
OF THE
BIRCH CREEK DISTRICT, IDAHO

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by

P. J. Shenon

University of Idaho
Moscow, Idaho

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I N T R O D U C T I O N

PURPOSE AND SCOPE OF THE INVESTIGATION

From 1881 to 1890 the mines of Birch Creek were among the most important producers of lead and silver in Idaho, but since that time there has been a marked decrease in production until at present only two or three cars of ore are shipped annually. Interest in prospecting has likewise declined, and it was partly with the hope of reviving interest in prospecting, and partly for the purpose of helping the already operating properties that the present work was undertaken.

The field work showed several features that should prove important in the search for ore. The "suggestions for prospecting" that follow later are based upon characteristics exhibited by the known ore deposits, and upon relationships determined by surface mapping. It is to be regretted that the workings of the most important producer in the district, the old Viola mine, are no longer accessible, as valuable information could, no doubt, have been secured through a study of the underground geology.

Twenty-five days were spent in the field during the latter part of September and the first part of October of 1927. Snow covered the ground above an elevation of 8,000 feet while the field work was in progress, and snow storms prohibited surface work for several periods of two or three days.

The surface map (Pl.II) covers an area of approximately 150 square miles which lies on the east side of Birch Creek, partly within Lemhi County, and partly within Clark County. A geologic sketch map was also made of 6 square miles in the vicinity of the Scott mine, which is situated about 8 miles southeast of the area included in Plate II. Control points for both maps were located by triangulation from section corners with a Brunton compass, and secondary points by resection with the same instrument. While the topography cannot be considered accurate, it has more than sketch value and represents fairly well the larger topographic features.

Brunton surveys served as controls for the geologic maps of three of the mines. The Brunton map of the Worthing and Weaver mine was later checked with a new map furnished by Mr. Robert N. Bell of Boise.

Four geologic units were mapped-Cambrian(?) quartzite, a thick series of limestones with some inter-bedded quartzites and shales of Ordovician(?), Devonian, and Carboniferous age, basalt flows of Tertiary age, and Miocene(?) gravels and recent alluvium. No attempt was made to map the Ordovician(?), Devonian, and Carboniferous beds in detail in the limited time available because of intense folding and faulting. The Cambrian(?) quartzite was, however, delineated on account of the important relationship between it and the ore bodies. Faulting made even this problematical in the vicinity of the Viola mine.

ACKNOWLEDGEMENTS

The writer wishes to acknowledge the many courtesies extended by the mining men of the district. Particularly does he wish to express his appreciation to Messrs. F. G. Worthing, R. A. Connell, Henry Eidelman, George Goddard and John Peterson. Valuable field assistance was rendered by Mr. O. S. Stratton of Salmon City. Mr. D. C. Carrol of the Idaho Bureau of Mines and Geology made analyses of the ores and credit is due Mr. Stewart Udell for the drafting.

LITERATURE

The following is a list of the more important articles and publications pertaining to the Birch Creek district. Reference throughout the following pages is made by parenthetical number followed by specific page reference-- thus (7b:pp.23) refers to page 23 of Professional Paper 97 of the Us. Geological Survey entitled "Geology and Ore Deposits of the Mackay Region, Idaho", by Joseph B. Umpleby.

1. Atwood, Wallace W., The physiographic conditions at Butte, Montana, and Bingham Canyon, Utah, when the copper ores in these districts were enriched: Economic Geol., Vol XI, No. 8, 1916, pp. 697-740. Describes the physiographic development of western Montana and eastern Idaho during the Cenozoic Era and discusses the formation of the "Miocene Lake Beds" and ancient stream gravels. An explanation is advanced for the origin of the numerous intermontane trenches including Lemhi and Birch Creek valleys.

2. Bell, Robert N., Annual reports of the mining industry of Idaho. Principally for 1906, 1907, and 1917. Include short descriptions of the geology of the mines of the Birch Creek district.

2b. ________________, An outline of Idaho geology and of the principal ore deposits of Lemhi and Custer Counties: Proc. Int. Min. Cong., 4th sess. pp. 64-80, 1901.

3. Campbell, Stewart, Annual report of the mining industry of Idaho, 1918-1927. Gives a short description of the mining activities in the various mining districts of Idaho and includes a list of mining companies and officers.

4. Kirkham, V.R.D., A geologic reconnaissance of Clark and Jefferson and parts of Butte, Custer, Fremont, Lemhi and Madison Counties, Idaho. The report covers a reconnaissance of a large area in southeastern Idaho. Discusses the broader topographic and structural features and differentiates three lava series in the Snake River plains. An economic discussion of coal, building stone and road-material possibilities is included.

5. Shannon, Earl V., Minerals of Idaho: Smithsonian Institution, United States National Museum, Bul. No. 131, Describes several minerals from the Birch Creek district.

6. Stearns, H. T., and Bryan, L. L., Preliminary report on the geology and water resources of the Mud Lake Basin, Idaho: U. S. Geol. Survey Water Supply Paper 560-D in cooperation with U. S. Gen. Land Office, Idaho Dept of Recl. and Idaho Bureau of Mines and Geology. Describes briefly the geology and topography of the Mud Lake Drainage Basin, including the Birch Creek district.

7. Umpleby, Joseph B., Geology and ore deposits of Lemhi County, Idaho: U. S. Geol. Survey Bul. No. 528, 1913. Reconnaissance map and description of the

geology of Lemhi County, Idaho and a short description of the Viola mine.

7b. ______________., Geology and ore deposits of the Mackay region, Idaho; U. S. Geol. Survey Prof. Paper, No. 97, 1917. Description and reconnaissance map of the geology of parts of Custer, Fremont, Jefferson, and Blaine counties. Includes a short description of the Worthing and Weaver, Weimer, and Scott mines.

G E O G R A P H Y

LOCATION AND ACCESS

The mapped area is situated in central eastern Idaho and lies partly in Lemhi County and partly in Clark County. Reno, the only post-office in the district, is located about 20 miles southeast of Gilmore and 50 miles northwest of Dubois.

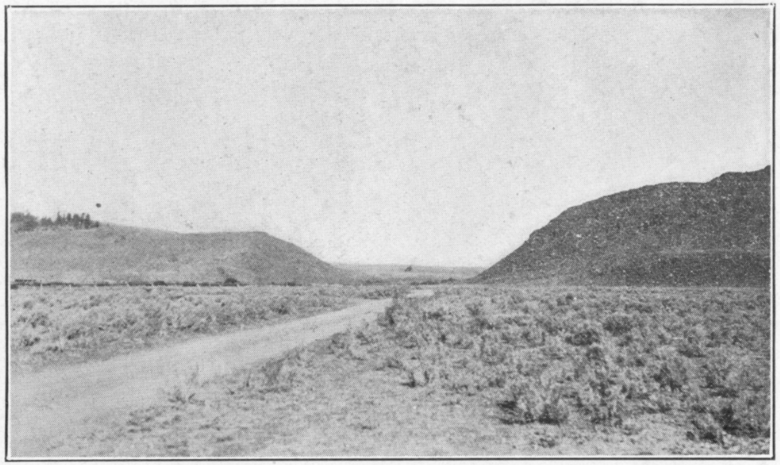
The district is served with a bi-weekly mail from Dubois, and supplies are trucked in from both Dubois and Idaho Falls. Ore from the northern part of the area is trucked to Gilmore and shipped over the Gilmore and Pittsburg railroad, and the ore from the vicinity of the Scott mine is trucked to Dubois and thence shipped by rail over the Oregon Short Line.

TOPOGRAPHY AND CLIMATE

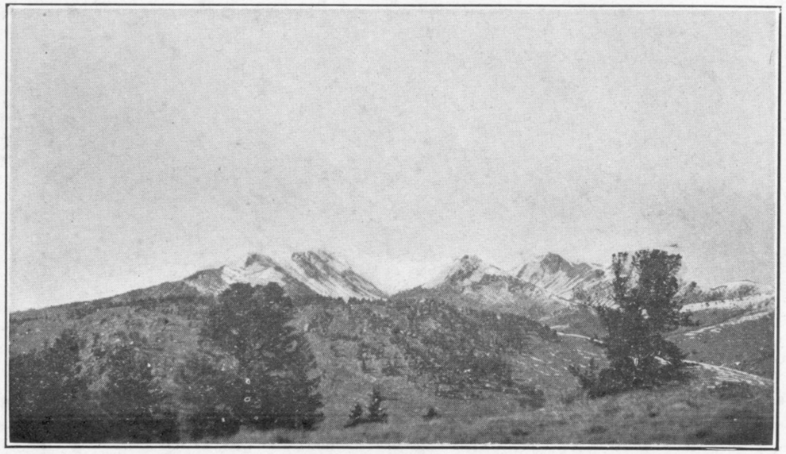
Birch Creek Valley is an arid, gravel-covered plain, from 5 to 8 miles wide and with an average elevation of about 7,000 feet. Occasional projecting lava hills break the topographic sameness, while here and there a green field relieves the monotony of the sage covered flats. On either side grand mountain ranges rise sharply above the valley floor to elevations of over 10,000 feet. The mountains on the west have been termed the Lemhi Range, and those on the east the Beaverhead Range. Deep valleys with almost precipitous walls have been carved into both mountain masses by streams and ice, but in general the Beaverhead mountains are characterized by much smoother slopes than the mountains on the west side of the valley.

Near the south end of the area a fault block of the older sedimentary rocks with flat-top ridges characteristic of the summit areas of the main mountain mass, projects into Birch Creek Valley for several miles. The canyons dissecting this fault block are less mature in their development than the canyons to the east of it. Skull Canyon, for example, is a narrow box-like gorge with vertical walls rising over 1,000 feet above the canyon floor, which at a point 3 miles northeast of Kaufman opens into the rolling topography typical of the highlands of the Beaverhead Mountains. The evidence suggests that subsequent to the faulting the lower part of the Skull Canyon drainage flowed northward into Birch Creek until tapped by the narrow precipitous canyon that joins the main valley ½ mile north of Kaufman.

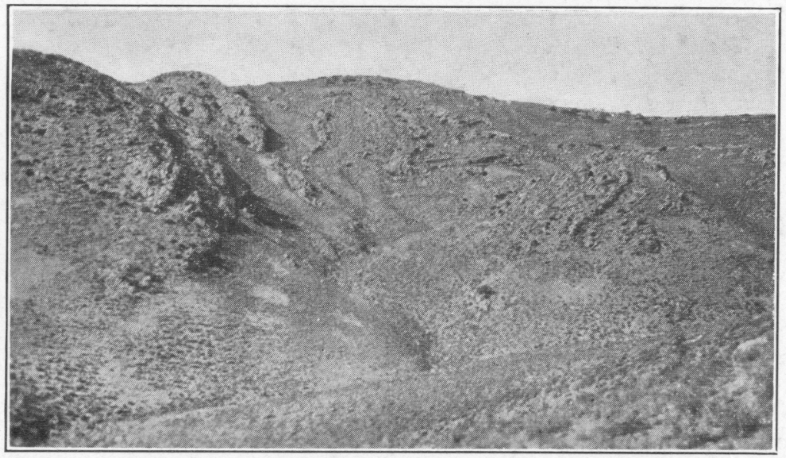
The stream from which the district derives its name rises north of Nicholia. Smelter Creek, Blue Creek, and Willow Creek constitute the permanent headwaters. All other canyons tributary to it are occupied by intermittent streams that flow only during the spring or after heavy rains. In general these canyons have a noticeable southward trend whereas the smaller gulches tributary to them have a tendency to follow the quartzite-limestone contact, where it is exposed. About a mile from its source Cedar Canyon is deflected some distance to the south before it finally cuts through the quartzite. Smelter Gulch, on the other hand, follows the contact throughout its entire course. Birch Creek is not a continuous stream but sinks and reappears several times before it is lost upon the Snake River plains. Just south of Reno it has cut through several lava dams to form the "Birch Creek Narrows".



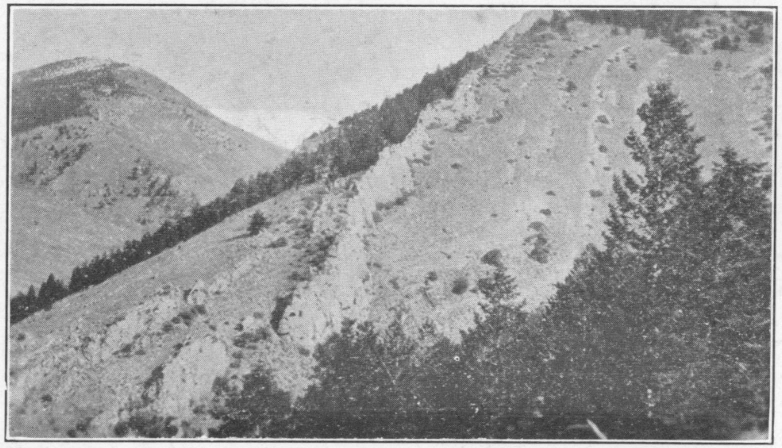
"BIRCH CREEK NARROWS" ABOUT 2½ MILES SOUTH OF RENO POSTOFFICE.



GLACIATED VALLEY NEAR THE HEAD OF WILLOW CREEK, JUST NORTH OF THE MAPPED AREA.



LOOKING NORTH ALONG AXIS OF FOLDING IN SECTION 30, T. 9 N., R. 31 E., NORTHWEST OF SCOTT MINE.



MINOR FOLDING DEVELOPED ALONG LIMB OF MAJOR FOLD NEAR THE MOUTH OF SCOTT CANYON.

No records of rainfall or temperature changes are available. Both are variable throughout the area. The high peaks are snow-capped during most of the year, yet snow lies on the valley floor for less than five months. The sage covered valley indicates an arid climate, whereas the evergreen trees and mountain mahogany farther up the mountain slopes suggests considerably more precipitation. The average yearly rainfall at Mackay, which lies in a similar valley 30 miles to the west, is 9.40* inches, while the average temperature is about 41 degrees. The monthly temperature variation is marked. The summers are moderately warm, whereas the winter temperatures sometimes fall below minus 30 degrees.

PHYSIOGRAPHIC HISTORY

Birch Creek has cut a narrow and shallow course into the wide gravel-filled valley through which it flows and, in a feeble manner, is still degrading its channel. It is at once strikingly evident that this stream is not responsible for the wide gravel-filled valley through which it flows.

Broader studies have shown that an ancient drainage once existed, and that an old stream occupying Lemhi Valley flowed southward by way of Birch Creek to join the Snake River near Idaho Falls. Umpleby (7:p.30) suggested the southward course of the old drainage and Atwood (1:pp.706-721), after making a particular study of this drainage in western Montana and eastern Idaho, reached the same conclusion. Kirkham (4: p.11) has studied the problem in southeastern Idaho and believes part of the ancient drainage flowed northward. On Birch Creek he advocates a drainage divide just south of Kaufman. The writer has been over most of the area in question and after carefully reviewing the literature pertaining to the subject favors the view of Umpleby and Atwood. There is, however, some contradictory evidence against a southward flowing drainage system. Several re-entrant valleys in Little Lost River and Pahsimeroi Valleys have a decided northward trend. Kirkham (4:p.11) has used this as evidence of an old northward flowing drainage. Broader evidence apparently fails to support this conception. The gravels of Pahsimeroi Valley have not been traced farther north than the Salmon River and there is no evidence of a channel to the northward. A southward drainage, as postulated by Atwood, seems to be in accordance with the distribution of the ancient gravels and also more satisfactorly explains the peculiar course of the Big Hole River of Montana. Umpleby believes the ancient valleys, such as the one through which Birch Creek now flows, were developed in a peneplain of Eocene age by stream erosion. Atwood assumes the same age for the peneplain but stresses warping and faulting in explaining the development of these valleys.

Blackwelder**, Rich***, and Buwalda****, advocate a post-Middle Miocene age for the peneplain. According to Blackwelder weak Tertiary beds have been down-faulted between masses of harder rock and subsequently eroded to lowlands on account of difference of rexistance to denuding process. A second possibility postulated by Blackwelder is that "the broad valleys occupied by the sediments were excavated and filled before the old peneplain was made". Kirkham (4:p.12) suggests that possibly an early Tertiary peneplain existed which

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*Meinzer, Oscar E., Ground water in Pahsimeroi Valley, Idaho: Idaho. Bur. of Mines and Geol. Pamphlet No. 9, p. 16, 1924.
**Blackwelder, Eliot, Jour. of Geol. Vol. 32, pp. 410-414, 1924.
***Rich, J. L., Economic Geol. Vol. XIII, pp. 120-136, 1918.
****Buwalda, J. P., Science, Vol. 60, pp. 572-573, 1924.

was succeeded by a Pliocene peneplain. Mansfield* gives an excellent summary of this controversy and concludes that the evidence in southeastern Idaho favors a pre-Middle Miocene planation.

The vicinity just east of Kaufman affords convincing evidence that the region occupied by Birch Creek Valley was once a portion of the broad peneplain represented now by the flat-topped summit areas, and that block faulting, in places with a vertical displacement of over 3,500 feet, defined the wide valley through which Birch Creek flows. The relatively straight, clean-cut valley front, with well defined faceted spurs extending northward into Lemhi County, indicates extensive development of the faulting. Meinzer** calls attention to the contrast between the straight, well defined valley front on the east side of Pahsimeroi Valley, and the indefinite border on the west, and suggests faulting as the chief cause of the valley depression. Further study will probably show that most of the wide intermontane troughs of western Montana and eastern Idaho have been defined by block faulting.

The faulting in the vicinity of Birch Creek has probably been recurrent. There is little doubt that it has followed the deposition of the gravels as "Miocene Lake Beds" are in fault-contact with Paleozoic rocks in the Leadville mine, three miles northeast of Leadore, Idaho. The first adjustment probably defined the valleys that controlled the ancient drainage, and later movements brought the gravels into fault-contact with the older rocks. The dendritic distribution of the old gravels seems to preclude the possibility that these Tertiary beds are down-faulted remnants of a once wide-spread gravel deposit.

G E O L O G Y

GENERAL FEATURES

The region is underlain by a thick series of quartzites, limestones, dolomites and shales of Paleozoic age. These rocks are well exposed in the mountainous areas but are covered with gravels and lava in Birch Creek Valley.

Quartzites of Cambrian(?) age are the oldest rocks in the mapped area. Above this formation rests a succession of limestones, dolomites, shales and quartzites, at least 4,000 feet thick, of Ordovician(?), Devonian, and Carboniferous age. Neither the massive white dolomite nor the thick quartzite formation of Ordovician age described by Umpleby (7b:pp.24) as lying on the west side of Birch Creek were noted above the Cambrian(?) quartzite on the east side. No Mesozoic rocks were observed. Granitic rocks do not outcrop within the limits of the map but have been noted on Willow Creek about four miles north of Nicholia. Several Tertiary dikes cut the Paleozoic sediments in the vicinity of the Scott mine.

Intense folding and faulting have so complicated the relation-ships of the several formations that it was not possible to measure a reliable section in the time available.

SEDIMENTARY ROCKS

Cambrian(?) Quartzite

A belt of quartzite trending north and south is exposed intermittently from one end of the mapped area to the other (see Pl.II). The best exposure

*Mansfield,G.R., Tertiary Planation in Idaho:Jour. of Geol Vol 32, pp472-488,1924
**Meinzer, Oscar E., Op. Cit., p.15.

outcrops in Skull Canyon near the Weimer mine. Here it is in fault-contact on the West with Lower Pennsylvanian beds. Skull Canyon exposes a vertical section of nearly 600 feet of quartzite, yet the base of the formation is not exposed. The lower 400 feet includes mostly maroon and pink quartzites that show well defined bedding. These beds grade upward into a massive white, vitreous quartzite which in turn becomes sandy in the upper 75 feet.

Only the white quartzite member is exposed in the vicinity of Nicholia where it is intensely fractured and shows well developed slickensiding along numerous planes of movement. This formation makes up the two sharp peaks just south and west of the Viola mine where the quartzite weathers into extremely rugged topographic features. Several large faults interrupt the continuity of the beds near Nicholia. One of them exposes a strip of the quartzite as far south as Scott Canyon. It outcrops near the bottom of Eidelman, Italian, and Irish Canyons but is overlain on the inter-canyon spurs by limestone beds. The limestone beds are intensely folded west of the fault but less severely folded east of it.

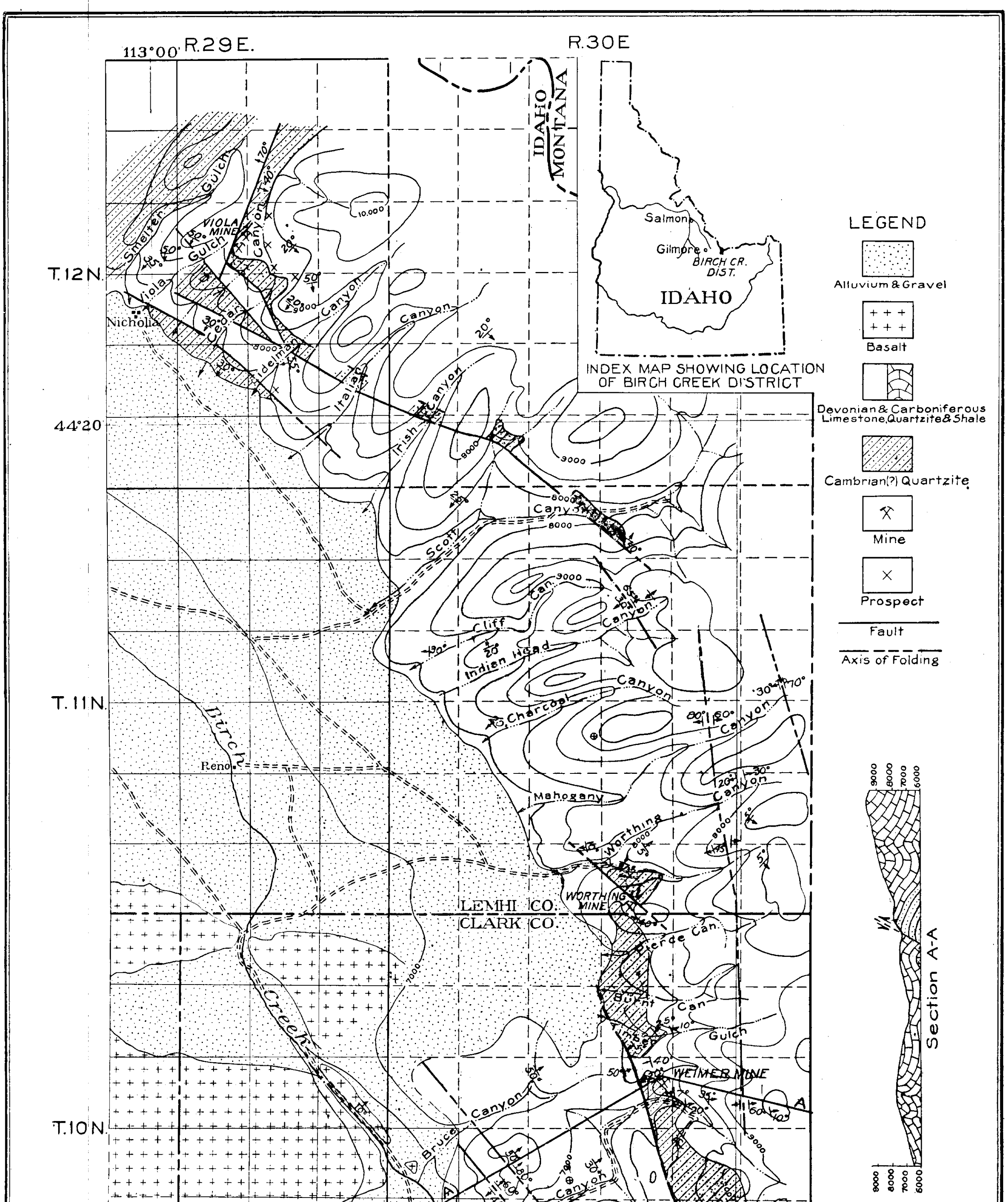
At the Worthing mine a bluish-gray limestone apparently grades into the white quartzite member. Two hundred feet from the portal of the Bell tunnel a sandstone bed 3 feet thick underlies a thin-bedded bluish-gray, limestone. Another thin-bedded bluish-gray limestone about 3 feet thick underlies the sandstone, and, in turn, is underlain by a coarse grained brownish sandstone about 75 feet thick. This sandstone grades into the white, vitreous quartzite. Fossils collected 400 feet southwest of the north shaft from a cherty, dark gray limestone bed overlying the thin-bedded, bluish-gray limestone have been identified as Upper Devonian by Mr. Edwin Kirk of the United States Geological Survey.

No thick quartzite formations have been described in the Devonian sections of western Montana or eastern Idaho. Umpleby (7b:pp.23) assigns a Cambrian(?) age to a series of rocks near the Wilbert mine on the west side of Birch Creek that probably correspond with the quartzites on the east side of the valley. He divides the series into the lower quartzite, shale, middle quartzite, and upper quartzite.

> "The lower member is predominantly a white pebbly quartzite. Only the upper 200 feet is exposed. The shale formation consists of about 150 feet of greenish-gray platy rocks. Above the shale formation is the middle quartzite. At the Wilbert mine it is composed of 475 feet of nearly vertical beds of maroon color that are intricately cross-bedded. The upper quartzite is at least 800 feet thick and is predominantly white and light gray in color."

The lower member described by Umpleby was not observed in place on the east side of Birch Creek but is probably present, as conglomerate boulders were noted in a talus slope below the quartzite workings of the Weimer mine. The maroon and pink quartzites that outcrop from Long Canyon to the Worthing mine probably correlate with Umpleby's middle quartzite, and the white quartzite member, although much thinner, seems to correspond with his upper quartzite.

The fossils found at the Worthing mine apparently assign the quartzite to either the Middle or Lower Devonian. However, since no described sections in adjacent areas include a thick series of quartzites in the Devonian, and since the quartzites apparently correspond with the Cambrian(?) quartzites



GEOLOGIC SKETCH MAP AND SECTION OF THE BIRCH CREEK DISTRICT

Lemhi and Clark Counties, Idaho. Topography and Geology by P. J. Shenon

October 1927.

described in the Mackay region, the old classification will be adhered to until more detailed work can be done.

Ordovician System

The Ordovician rocks described by Umpleby (7b:p.24) in the Mackay region were not observed on the east side of Birch Creek. In Elbow Canyon, just east of Mackay, Richmond fossils are found in two dolomite beds overlying a white quartzite. The upper dolomite is white in color and 530 feet thick, and the lower dolomite is dark blue and 420 feet thick. The base of the system is not exposed, but near Mackay there are at least 1600 feet of quartzite beds.

Devonian System

The Upper Devonian beds exposed above the Cambrian(?) quartzite include several hundred feet of dark fissile shale and thin-bedded bluish-gray magnesian limestone. Fossils collected on the ridge just southwest of the No. 2 shaft at the Worthing mine from a cherty dark-gray limestone bed 400 feet above the quartzite have been assigned to the Upper Devonian by Mr. Edwin Kirk of the United States Geological Survey and correlate with the Three Forks formation of Montana. The following fossils were identified:

Productella sp.
Athyris ap.
Pugnax cf. altus Calvin
Spirifer whitneyi Hall var.
Euomphalus sp.

According to Umpleby (7:p.34) 2,000 feet of Devonian beds are exposed just south of Gilmore on the divide between Meadow Lake and Liberty Gulches, whereas 3,950 feet comprising three distinct formations were recognized in the Mackay region (7b:.26). The two lower members were not noted in the Birch Creek district.

The basal beds of the Devonian just east of Mackay as described by Umpleby comprise 1,950 feet of massive dark-blue and gray dolomite separated by thinner beds of similar but less resistant material containing fossils with Jefferson affinities.

The middle member is 1,500 feet thick, and, as indicated by fragments in the soil and piled about gopher holes, is rather uniformly of brown calcareous material.

The uppermost Devonian bed consists of 500 feet of massively bedded blue and dark-gray limestone and dolomite, of which a few beds stand in much stronger relief than the others, though all are strongly resistant to erosion. At several horizons there are layers of reddish brown shaly limestone that contains abundant fossils.

Carboniferous System

Mississippian Series: A series of Mississippian beds at least 3,500 feet thick are exposed in the Birch Creek district. The section in the vicinity of Skull Canyon comprises a monotonous succession of bluish-gray massive and thin-bedded limestone and a few beds of dark gray shale. Some horizons contain considerable black chert in streaks and nodules. Some beds contain numerous cup corals, but others, although largely recrystallized, are composed almost wholly of crinoid remains. The rocks effervesce very readily with cold dilute hydrochloric acid and the specimens tested in the laboratory showed only small amounts of magnesium. A distinct fetid odor results when the rocks are struck with a hammer. Mr. George Girty of the United States Geological Survey tentatively assigned the bluish-gray limestones described above to the Upper Mississippian on the basis of cup corals that were identified as Zaphrentis stansburyi(?).

In the vicinity of Mackay (7b:p.27) the Mississippian beds are probably much more than 6,000 feet thick and consist of a succession of thick-bedded and thin-bedded limestones, with variation in the color of widely separated beds.

<u>Pennsylvanian Series</u>: A thick succession of rocks belonging to the Pennsylvanian Series outcrop in several localities on the east side of Birch Creek. Only the lower members were observed, but the upper beds are no doubt present east of the Scott mine where they have not been removed by erosion. The lower members are very well exposed about one mile above the Peterson cabin. A good section of the Pennsylvanian Series could probably be measured at this locality.

Sandstone and quartzite beds, all predominantly buff colored, and interbedded with gray sandy limestones outcrop above the bluish-gray massive limestone beds of Mississippian age. A series of pink shales and thin-bedded pinkish limestones lie between the two, but the basal conglomerate described by Umpleby (7b:p.30) in the Mackay region, although possibly present, was not observed during the cursory examination. The "quartzite series" as exposed west of the Scott Mine is about 350 feet and includes 200-250 feet of buff colored sandstones and quartzites interbedded with some sandy limestones. Above these rocks follow 30-40 feet of bluish-gray sandy limestone beds overlain by about 50 feet of sandy quartzite. Above the sandy quartzites are massive bluish-gray limestone beds with numerous bands of black chert. Lower Pennsylvanian fossils were found in the bluish gray sandy limestone member just below the upper sandy quartzite.

The same series of rocks outcrop in Skull Canyon just west of the Cambrian (?) quartzite and are again exposed near the summit on the ridge above the Paymaster Workings of the Weimer mine.

The following fossils have been identified by Mr. George Girty of the United States Geological Survey:

Stenopora aff. ramosa
Fenestella sp.
Rhombopora lepidodendroides
Productus aff. coloradoensis
Pustula aff. wallaciana
Spirifer cameratus
Spirifer opimus var. occidentalis
Squamularia perplexa
Hustedia multicostata

Over 7,000 feet of Pennsylvanian beds principally sandstones but with some interbedded limestones are exposed in the vicinity of Mackay (7b:p.30). A conglomerate bed 210 feet thick composed of well rounded chert pebbles one inch or less in diameter with interstices filled with coarsely granular silica is believed to be the basal member.

Gravel and Alluvium

The floor of Birch Creek Valley is overlain with stream gravels and recent alluvium. The gravels extend continuously over the divide into Lemhi County and represent the course of an ancient stream of considerable size. The alluvium is built into broad fan-shaped deposits near the mouth of the canyons opening into Birch Creek Valley.

The gravels are principally rounded pebbles and boulders of various colored quartzites and chert with lesser amounts of igneous rocks and limestone. The alluvium includes fragments of the consolidated rocks of the district.

IGNEOUS ROCKS

The igneous rocks in the mapped areas include basic dikes and surface flows of Tertiary age. Granite outcrops on Willow Creek about 2 miles north of map limits (7:p.42).

Granite

Umpleby describes the granite on Willow Creek as a light-gray medium textured rock with some phenocrystic development of feldspars. The persistent constituents are orthoclase, quartz, and biotite. Among the accessory minerals zircon, apatite, and magnetite are usually present.

Dike Rocks

Two dikes occur in the vicinity of the Scott mine. A dacite porphyry is exposed in the canyon just east of the Peterson cabin. When fresh it is a brown glassy porphyritic rock with numerous white phenocrysts usually less than one millimeter in length. Upon weathering, the rock becomes devitrified and develops a peculiar perlitic structure that somewhat resembles a bunch of grapes. Under the microscope the rock shows a decided glassy groundmass with prominent flow structures. The index of refraction for the glass is less than that of balsam. Laboradorite feldspar is the most abundant phenocryst, and quartz makes up less than 5 per cent of the larger crystals. A pyroxene with the composition of augite-aegerite is present as scattered phenocrysts. Magnetite is the most common accessory mineral. All of the phenocrysts show marked resorption effects.

A dark-gray fine grained basalt dike about 3 feet wide is exposed on three levels of the Scott mine. The texture becomes slightly coarser toward the center and numerous partly filled vesicules give the rock a mottled appearance. Near the borders the dike is dense and fine grained. Slickensiding on the north wall indicates movement following the intrusion of the magma. Thin sections show the rock to have a diabasic texture. Lath-shaped plagioclase crystals crystals comprise over 70 per cent of the rock, and most of the remainder is made up of irregular shaped crystals of augite. The plagioclase has a composition of andesine-laboradorite, Ab_{50}-An_{50}. Magnetite is the most common accessory mineral, and the alteration products include calcite, limonite, iddingsite, limonite, talc, and kaolin. The vesicles are filled with calcite some of which show beautiful banded patterns due to the presence of iron oxide.

Surface Flows

A number of square miles of lava are exposed in Birch Creek just northwest of Kaufman. Three smaller patches cap mesas in the vicinity of the Scott mine. All of the lavas observed were fine-grained, dark-colored basalts. The field relationship and the similarity in texture and mineral composition between the basalt dike and the lava at the Scott mine is almost conclusive evidence that the lava has reached the surface through fissures.

The lava from the Scott mine is a dark-gray, fine-grained vesicular basalt that has developed pronounced jointing. The microscope shows it to have a fine grained basaltic texture with a few well developed plagioclase phenocrysts. The rock is composed largely of a felty-appearing mass of lath-shaped feldspars associated with a lesser amount of augite. The feldspars have a composition of laboradorite. A very small amount of olivine is present, and magnetite is the most common accessory mineral.

D E F O R M A T I O N

About 70 miles southeast of the Birch Creek district rocks of Carboniferous age have been thrust at least 12 miles over beds which are normally 6,000 to 12,000 feet higher in the geologic column. This fault is known as the Bannock Overthrust.* The fault trace has a sinuous trend, but in general the strike is to the northwest. Kirkham (4:p.26) believes the Medicine Lodge fault to be the northward extension of the Bannock Overthrust. For a number of miles in the vicinity of large overthrust faults the rocks are intensely folded and displaced by numerous faults of less magnitude. It would therefore be expected that the rocks of the Beaverhead range, which lies just west of the Medicine Lodge Overthrust, would be considerably folded and faulted.

In the Birch Creek region the folding and faulting has a northwest trend. At the southern end of the area the rocks have been folded into a broad anticline with numerous minor folds developed along the flanks of the major limbs (See sec. A-A,Pl.II). Further north the general structure is not so evident.

A fault has exposed the older beds near the crest of the anticline near the Weimer mine. This may be termed the Skull Canyon fault. The vertical displacement is probably over 3,500 feet, because beds identified as Lower Pennsylvanian on fossil evidence are now in contact with the Cambrian(?) quartzite. The same beds are exposed on the ridge above the Paymaster workings of the Weimer mine near the summit of the Beaverhead range. The straight valley front and faceted spurs are continuous features northward into Lemhi County and indicate the extensive nature of the faulting.

A number of faults complicate the structure in the vicinity of Nicholia. One of these faults exposes the Cambrian (?) quartzite intermittently for 6 miles southeast of the Viola mine. The only fault observed underground at the Viola mine is intersected by the working tunnel about 500 feet from the portal. It strikes N. 15° E. and dips 70° N. and has a throw of 80 feet. According to Bell** the Viola ore body was terminated by a fault.

At the Worthing mine a fault of considerable magnitude and with a N.50° W. strike exposes the Cambrian(?) quartzite after it plunges beneath the limestone beds. A tunnel run to intersect the quartzite failed to cut the contact because of the fault. Another fault of less magnitude is exposed underground on two levels. It strikes N. 80° W. and dips 60° S. A number of small faults cause displacements of 2 or 3 feet.

Several pre-mineral faults occur at the Scott mine. Considerable gouge is developed along some of the ore bearing fissures. A clean-cut fault surface with well developed striae is exposed by a drift at the north end of the Hadley stope. It is believed to be pre-mineral. Slickensiding also indicates movement along the basalt dike after solidification.

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*Richards, R.W. and Mansfield, G.R., U.S. Geol. Sur. Bull. No. 577, pp.35-38, 1914.
______________________________, The Bannock Overthrust: A major fault in southeastern Idaho and northeastern Utah: Jour. of Geol., Vol.20, pp.681-707, 1912.

**Bell, R.N., Min. Industry of Idaho, 9th An. Report, pp.131, 1907.

ORE DEPOSITS

GENERAL DISCUSSION

The ore deposits of the Birch Creek district are believed to belong to the same epoch of mineralization, following closely the intrusion of the Cretaceous (?) granite that is exposed at the surface 3 miles northeast of Nicholia.

The ore occurs as replacement veins in limestone and quartzite, and as irregular replacements along bedding planes in limestone. Two types of deposits are known, those valuable essentially for copper, and those valuable for the lead and silver content. The marked differences in the nature of the ore deposits are probably due to, (1) the character of the wall rock; (2) the nature of the openings that permitted the introduction of the mineralizing solutions; and (3) the distance from the intrusive body.

The character of the rock through which the mineralizing solutions passed was doubtless an important factor in determining the situation and type of the ore deposits. A solution would more readily replace the wall rock along a fissure in a soluble limestone than it would in passing through a dense quartzite. This difference probably accounts for the larger ore shoots in limestone just above the quartzite.

Should a clean-cut fissure be developed in limestone the ore bearing solutions would tend to follow along the fissure, and a vein would result. Ore bodies of this type occur at the Scott mine. Irregular deposits with numerous fingers and spurs, similar to the ore shoots at the Worthing and Weaver mine, would be expected should a number of fissures develop along a fold or zone of fracturing in limestone susceptible to replacement. A limestone produces considerable gouge along surfaces of movement, while a quartzite tends to shatter. A solution would therefore encounter a more resistant course upon passing from a quartzite into a limestone. The gouge could act as a dam thus causing the solutions to pass out along bedding planes to form bedding plane deposits in favorable limestones similar to the Paymaster deposits of the Weimer mine.

Emmons* states that the ore minerals are deposited in a definite sequence from the parent magma outward. According to his sequence, the copper deposits in the Birch Creek district should be nearer the parent magma, and lead and silver should occur farther away. On the basis of this hypothesis, the intrusive rocks from which the ore deposits have originated should be nearest the surface in the vicinity of the Weimer mine.

In this paper the ore deposits of the district are not grouped on a basis of age but are taken up in geographic order, from south to north.

THE SCOTT MINE

General Features

The Scott mine, sometimes called the Birch Creek mine, is located in the Blackburn mining district of Clark County about 10 miles southeast of Kaufman and approximately 35 miles west of Dubois. The property is situated at an elevation of 6100 feet and is over 1000 feet lower than Nicholia. The winters are moderately severe, but the snowfall is rarely sufficient to block the roads. At the present time water for mining and domestic purposes must be hauled a distance of nearly two miles. The construction of a three-mile pipe line from Brown Creek Spring is under consideration and if completed will offset

*Emmons, W. H., Primary downward changes in ore deposits; Trans. A.I.M.E., Vol. LXX, pp. 964-992, 1924.

this handicap. Thick stands of timber suitable for mining purposes grow on the mountain slopes within five miles of the mine. Ore is trucked over a good highway to Dubois on the Oregon Short Line rail-road at a cost of $8 per ton and thence shipped to custom smelters in Utah at an additional cost of $5 per ton.

History and Development

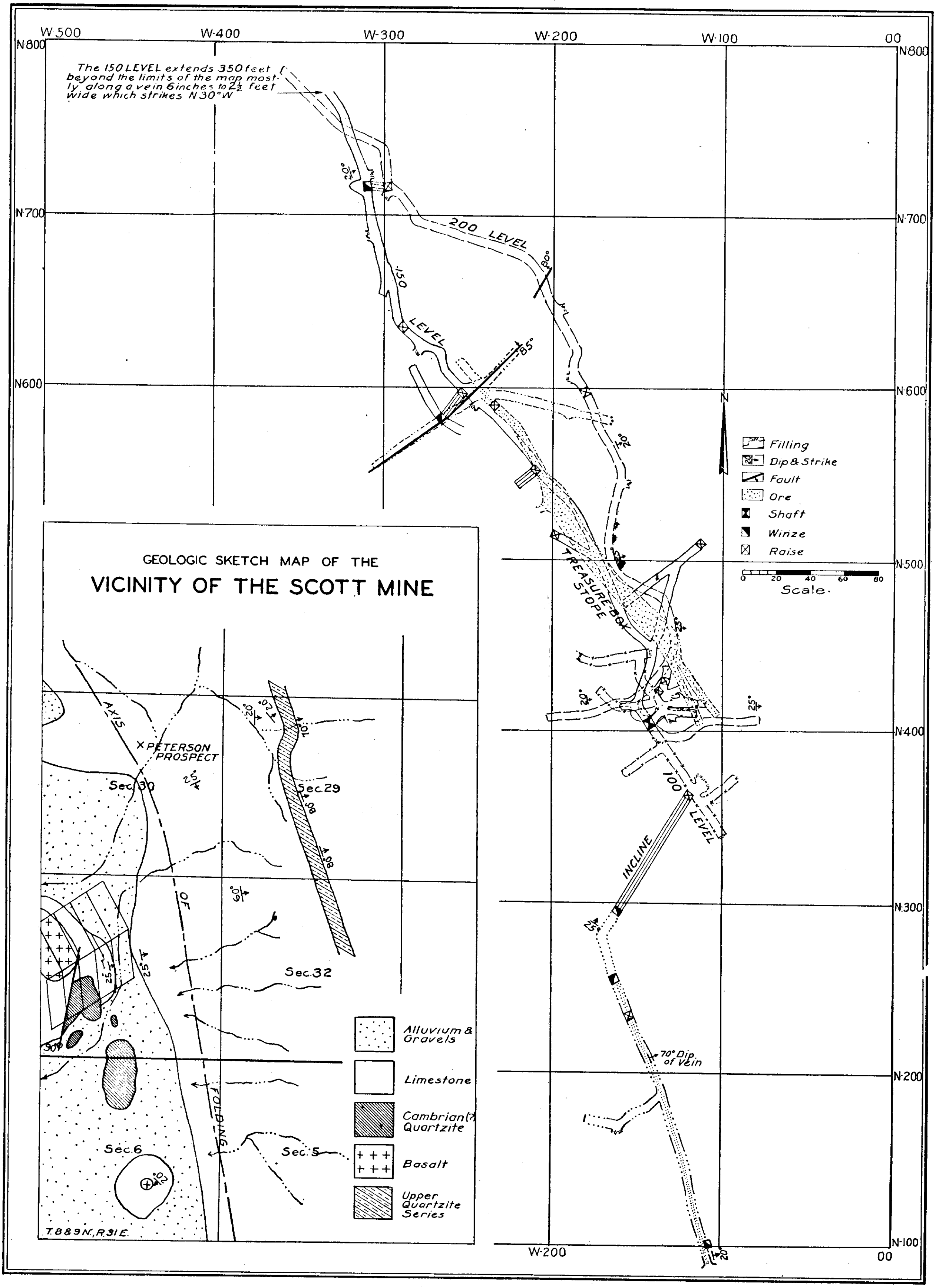
The history of the Scott mine dates back to the boom days of the Nicholia district when prospectors swarmed over the hills in search for other Viola mines. A prospector named Blackburn located the Scott mine in 1885 and probably made some shipments. It was relocated in 1888 by W. A. Scott who mined considerable ore. In 1908 the property was sold to the Birch Creek Mining Company. In all, this company has shipped 60 cars of ore to smelters in Salt Lake. Twenty-two cars of lead ore were shipped from the "Treasure Box" stope alone in 1910 and 1911. These shipments assayed from 45% to 71% in lead and carried from 5 to 7 ounces in silver per ton. The zinc values were usually less than 1%. In 1925 the property was leased to the Idaho Lead Mines Company for a period of 18 months. This company constructed a small concentrating plant 1½ miles south of the mine but had very mediocre success in their milling operations. About 50 tons of concentrates and less than 20 tons of crude ore were shipped to smelters during the period this company operated. The concentrates assayed 58% lead, 4.8 ounces of silver and 1% zinc per ton. The total production of the Scott mine is estimated to have been $65,000.

The Scott group consists of 9 patented and several unpatented claims. The Indiana and Indianapolis lodes include the most important workings. A substantial 3-room boarding house, an office building and a store house are about centrally located on the Indiana property, while the shaft house is situated not far from the north end line. The development consists of a vertical shaft 191 feet deep from which levels have been driven at depths of 108, 139 and 191 feet. They are known as the 100, 150 and 200 levels. A tunnel on a level 31 feet below the collar of the shaft enters the hill from the south and is connected with it on the 100 level by means of a winze and an incline. About 300 feet of drifts are accessible on the tunnel level, approximately the same on the 100 level, 1300 feet on the 150 level, and about 600 feet on the 200 level. Numerous raises and winzes have been run for exploration purposes and ore passes. A considerable number of drifts are filled but with the exception of the Treasure Box and Hadley stopes those that remain open are in good condition. Steel rails and ventilating pipes are still in place on the 150 and 200 levels.

The Treasure Box and Hadley stopes are responsible for much of the production of the Scott mine. The north end is known as the Hadley stope while the south end is called the "Treasure Box". Dangerous slabs of rock prevented a complete exploration of the stope, but it is quite certain that the ore was continuous throughout.

Geology

The Scott mine is situated in a cove-like valley near the southern extremity of the Beaverhead Range. About 3 miles south of the mine the mountains plunge beneath the lavas of the Snake River plains. The older rocks of the region include Cambrian(?) quartzite and limestones, and shales and quartzites of Ordovician(?), Devonian and Carboniferous age. A pinkish conglomerate composed largely of bluish gray limestone pebbles outcrops on a hill just west of the mapped area. Basalt lava caps several mesas in the



MAP OF THE SCOTT MINE

Clark County, Idaho. From Brunton Survey by P. J. Shenon.

October 1927.

vicinity of the mine, whereas alluvium and gravel cover much of the valley floor.

The Cambrian(?) quartzite is an extension of the older quartzite that outcrops at the Weimer mine a few miles to the north. It is terminated by a vertical fault striking nearly north and south, just west of the Scott property. The interbedded quartzites and siliceous limestones mapped as the "upper Quartzite Series" are lower Pennsylvanian in age. This series is about 350 feet thick and where examined east of the Peterson prospect stands at steep angles. About ½ mile east of the mine the sedimentary rocks are intensely folded along a north-south axis (See Pl.1,Fig.3). Throughout the mine workings, however, the dip of the beds s unusually constant.

The ore deposits occur in veins and along bedding planes in a thin-bedded pink magnesian limestone that dips 20-30 degrees to the northeast. Near the ore bodies the color of the limestone is intensified, probably due in part to the original mineralizing solutions and in part to oxidation. A well defined vein with irregular offshoots along the bedding planes has been mined on the tunnel level. It strikes N. 20° W. and dips 70° to the northeast. In some places the vein has been stoped 30 feet above the drift, but access could not be gained to workings that may extend along the ore beneath the floor of the tunnel. The incline to the 100 level follows down a brecciated zone that terminates the ore. Some of the breccia fragments are rounded, and most of them have been considerably altered. Beside the "Treasure Box" ore body several small oxidized deposits occur on the 100 level. All have a general N. 30° W. strike. The Treasure Box ore shoot was a pipelike body from 4 to 10 feet wide, with an average height of probably 4 feet. The general rake from the south end to the Hadley workings is about 13° N. To the south the ore body splits into two narrow, nearly vertical veins that pinch down to narrow seams of galena and cerrusite 40 feet from the stope. Numerous drifts and raises have been run beneath the "Treasure Box" on the 150 and 200 levels, but no other large ore bodies have been discovered. A small body of ore has been mined just northeast of the shaft, and mineralized fissuring with a N. 30° W. trend continues to the end of the level. The ore along the final 300 feet averages about 1 foot in width and is said to assay 12% lead. The major part of the 200 level has been run to the northeast of the fissuring and encountered very little mineralized material. A pre-mineral fault is exposed in the Hadley workings and is cut on both the 150 and 200 levels. The mineralized fissuring is continuous to the north of it, and an oxidized ore seam 2 feet wide runs along it on the 150 level. The fault surface shows marked striations and slickensiding.

Galena, cerrusite, and anglesite are the principal ore minerals. All the ores show oxidation, but it is more intense in the upper workings. Manganese and iron oxides are abundant throughout the mine, and Umpleby (7b:p.119) mentions the presence of wulfenite.

A vertical post-mineral basalt dike 2½ feet wide and striking east and west cuts the limestone beds just north of the shaft. This dike and probably other similar ones are the avenues through which the surface lavas reached their present positions. A thin section study shows the dike rock to be almost identical in appearance with the surface lava. Both are fine grained, olivine free, basalts. The dike rock is coarser grained and has a tendency to be diabasic in texture. Near the walls the dike is extremely fine grained while numerous calcite filled vesicules occur toward the center. The fine grained borders are about 8 inches wide and pass sharply into the coarser material at the center. The limestones are stained a cherry red for two or three feet on both sides of the dike. Slickensiding and fracturing show that movements have followed the intrusion of the dike material.

PETERSON PROSPECT

The Peterson prospect is situated a mile north of the Scott mine. It was located during the productive period of the Viola mine and is said to have been the source of some of the iron oxide flux used at the Nicholia smelter. John Peterson relocated the claims in 1925 and is still operating on a small scale.

The Paleozoic formations in the vicinity consist of bluish-gray limestone, shale, and quartzite. All have been intensely folded and faulted. A dacite porphyry is exposed at several places in the canyon just east of the Peterson cabin. It is a brown glassy porphyritic rock with numerous white phenocrysts usually less than 1 millimeter in length. When weathered the rock shows a peculiar perlitic structure that somewhat resembles a cluster of grapes.

A wide mineralized belt has been explored along the strike for a distance of ½ mile by several tunnels and shafts. At the present time some work is being done on an iron-stained gossan just east of the cabin. To date no shipping ore has been encountered.

WORTHING PROSPECT

The Worthing prospect is located near the mouth of Long Canyon about 3 miles north of the Scott mine. It is owned by C. H. Worthing of Nicholia and Frank G. Worthing of the Worthing and Weaver mine.

The Cambrian(?) quartzite plunges just north of the Worthing prospect. It is overlain by gray, massive and thin-bedded limestones probably of Upper Devonian age. A drift 50 feet long has been run in a shaly limestone bed from the bottom of an inclined shaft 25 feet deep. Pieces of galena are scattered around the dump but no ore was observed in place.

THE WEIMER MINE

General Features

The Weimer property includes 17 patented claims that extend from Skull canyon southward to the southern extremity of the mapped area in Plate II. Copper ore bodies have been worked on the north side of Skull Canyon, where they occur in limestone, and on the south side, where they are inclosed in quartzite. Some development work has been done on a lead prospect on the divide between Goddard Canyon and Long Canyon.

The copper mines are located about 5 miles northeast of Kaufman and are connected with the main highway by a wagon road. Ore is hauled on wagons to a platform near the mouth of Skull Canyon where it is loaded on trucks and transported 45 miles to the Oregon Short Line rail-road at Dubois. Cabins to accommodate 50 men are located in Skull Canyon just below the limestone workings. The lead prospect is reached by a wagon road up Long Canyon.

History and Development

Copper was discovered in the Skull Canyon vicinity in 1885 by Peter Towlgreen who shipped considerable high grade ore that is said to have averaged from 40-45% copper. The mine was acquired by J. B. Weimer who shipped ore from both the limestone and quartzite workings worth $40,000 previous to 1907. Judge Timlen of Milwaukee bought the property from Mr. Weimer and later optioned it to Stacy and Young of Mackay, Idaho for $40,000. Stacy and Young shipped considerable ore but were unable to meet their financial obligations so that the property reverted to Judge Timlen. Jesse Knight of Provo, Utah, later acquired the property. Until recently it has been worked by leasers but is now idle. The total production is estimated at $70,000.

The ore deposits in limestone are located on the Paymaster No. 3 claim, and the quartzite deposits on the Valley View claim. The Paymaster workings are situated on the north side of Skull Canyon at an elevation of 7600 feet. The development consists of an open cut and about 800 feet of tunnels on the hill side just above the camp, and several tunnels and cross-cuts on top of the ridge. A short tramway has been built to convey the ore to the loading bin on the wagon road.

The Valley View ore bodies have been developed by two shafts, and possibly 2,500 feet of tunnels, but only part are now accessible. The main workings are located in a thick stand of pine trees at an elevation of 7,700 feet.

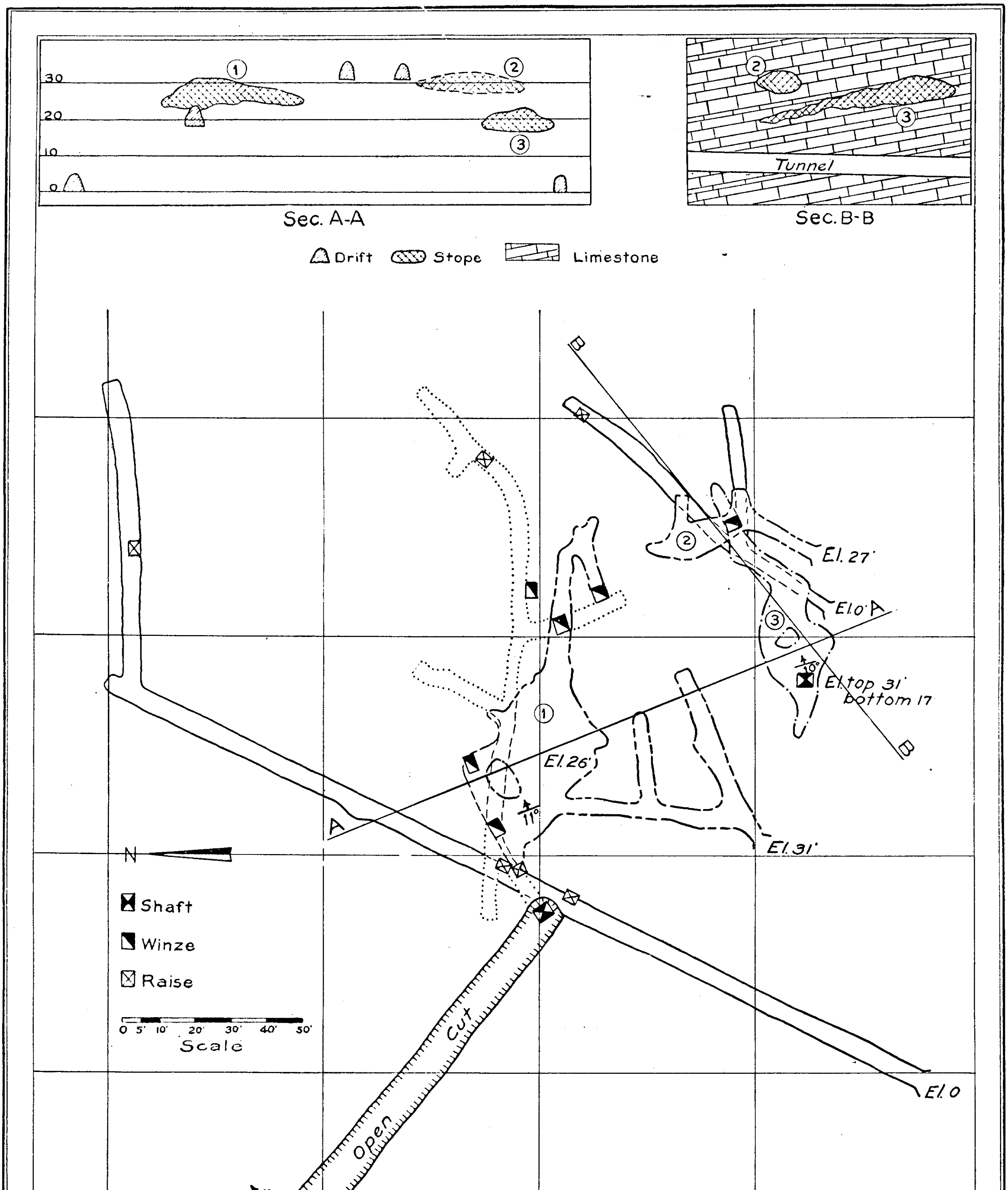
Geology

The Paymaster ore bodies occur as irregular lens-like deposits in a thin-bedded bluish-gray limestone about 150 feet above the quartzite contact. The limestone beds dip at flat angles to the northeast and are believed to belong to the Upper Devonian series identified at the Worthing mine. In the vicinity of the ore deposits the limestones have acquired a peculiar zebra-like pattern that is probably the result of solution and introduction of silica. Four distinct ore bodies are exposed on the hillside above the camp. One occurs at the surface and has been mined as an open cut. The strike is northwest, and the ore apparently did not extend below the surface. The ore body labeled No. 1 on the map (Pl.III) has an east-west trend and rakes to the east at an angle of about 10°. It does not follow directly down the bedding but is dependent on east-west fracturing. The ore varies in width from 2-30 feet and averages 3 feet in thickness. The No. 3 ore body follows east-west fissuring for a short distance and then runs directly down the limestone bedding. Fissuring that may have controlled the deposition of the No. 2 ore shoot was not observed.

Chalcocite and malachite are the most conspicuous ore minerals. Malachite occurs around partly oxidized chalcocite, as incrustations along openings, and as stains along fractures in the wall rock. Calcite crystals as large as an inch in length occur in masses along the walls and may represent recrystallization of the limestone. Twenty tons of the ore shipped from the paymaster workings by Henry Eidelman averaged 35% copper and 6 ounces of silver per ton.

The Valley View ore bodies occur in a dense white quartzite as veins along shear zones and as irregular deposits beneath bands of gouge along bedding planes. The deposits along shear zones strike N. 60° E. and dip 80° N. and cut the bedding at steep angles. The quartzite is badly crushed and considerably altered along the zones of shearing. In the main drift the ore is said to have averaged 3 feet in width and extends about 15 feet above the drift, but the downard extension has not been prospected.

The irregular deposits occur in quartzite beneath a soft brown gouge that contains a high percentage of calcite. Thin sections show a few rounded



PLAN AND SECTIONS OF THE PAYMASTER WORKINGS OF THE WEIMER COPPER MINE
Clark County, Idaho. From Brunton Survey by P. J. Shenon.
October 1927.

quartz grains, but the major part of the rock is composed of fine grained calcite and kaolin and probably represents an interbedded limestone. The gouge bands have an undulating surface and vary considerably in dip from place to place. Drifts indicate that ore bodies were pipe-like in form and probably did not average over 2 feet in diameter.

The ore minerals include chalcopyrite, chalcocite, malachite, azurite, copper pitch ore, and chrysocolla. Chalcopyrite, the primary copper mineral, has been deposited along planes of shearing as parallel bands and around fragments of the shattered quartzite. Chalcocite, sometimes including an inner band of copper pitch ore, occurs along fractures in chalcopyrite. Malachite and azurite are the commonest oxidized ore minerals. The gangue minerals include, beside the crushed quartzite, barite, limonite, and a dark-brown jaspery material. Masses of white barite are usually associated with the copper pitch ore. It has a well developed crested structure and makes a sharp color contrast with the green and blue of the malachite and azurite, and the glossy black of the copper pitch ore. The barite is believed to be primary although the evidence is not conclusive.

Economic Considerations

The deposition of the high grade copper ore on the Paymaster claim has been controlled by fracturing, and the bedding of the limestone. At least two limestone horizons, and probably others, are favorable for ore deposition. A careful study of the controlling fissures should lead to the discovery of other ore bodies. Because of the nature of the deposits, the driving of long tunnels to intersect the ore at depth is very likely to be disappointing.

A shallow winze sunk in the mineralized shear zone in the Valley View workings just north of the point where the main tunnel intersects the vein should prove good prospecting when the copper market warrants the risk.

THE WORTHING AND WEAVER MINE

General Features

The Worthing and Weaver (Kaufman) claims are situated 5 miles east of Reno Postoffice about 2½ miles north of the Weimer Copper mine and lie partly within Lemhi County and partly within Clark County. The county line divides the property about equally into two parts. The principal workings lie within Lemhi County. Ore is trucked 25 miles over a good road to Gilmore on the Gilmore and Pittsburg railroad and thence shipped by rail to semlters in Utah. The mine is located at an elevation of 8,300 feet, approximately 800 feet above the floor of Worthing Canyon. At present the sorted ore is tediously dragged down the hill on sleds to a loading platform but if sufficient ore is developed an inexpensive tramway can be easily constructed. All water used for mining and domestic purposes is hauled from Birch Creek a distance of 5 miles. There is little likelihood that water will be struck in the mine above the canyon floor. No water has been encountered in a 650 foot tunnel that runs into the hill 350 feet below the Bell level. Pine and fir trees suitable for mining purposes grow in abundance within a half mile of the mine.

History and Development

The original claims of the Worthing and Weaver mine were located in 1904 by John Weaver and Edward Kaufman. They opened up some ore near the surface but little work was done until 1906 when Robert N. Bell and associates drove the lower tunnel with the expectation of encountering the ore shoots at depth. The tunnel opened up considerable low grade oxidized material but did not intersect the higher grade ore bodies. The work had to be discontinued in spite of the favorable showing when the bond and lease could not be renewed. In 1913 F. G. Worthing purchased the Kaufman interest and has worked the mine intermittently ever since. Leasers shipped 5 or 6 cars of ore in 1915 and received net returns of about $1,000 per car. Mr. Worthing continued to ship one or two cars yearly until 1927 when Robert N. Bell secured a second bond and lease. The lower tunnel is once again being put into shape for further prospecting. Mr. Worthing estimates the total production of the mine at $22,000.00.

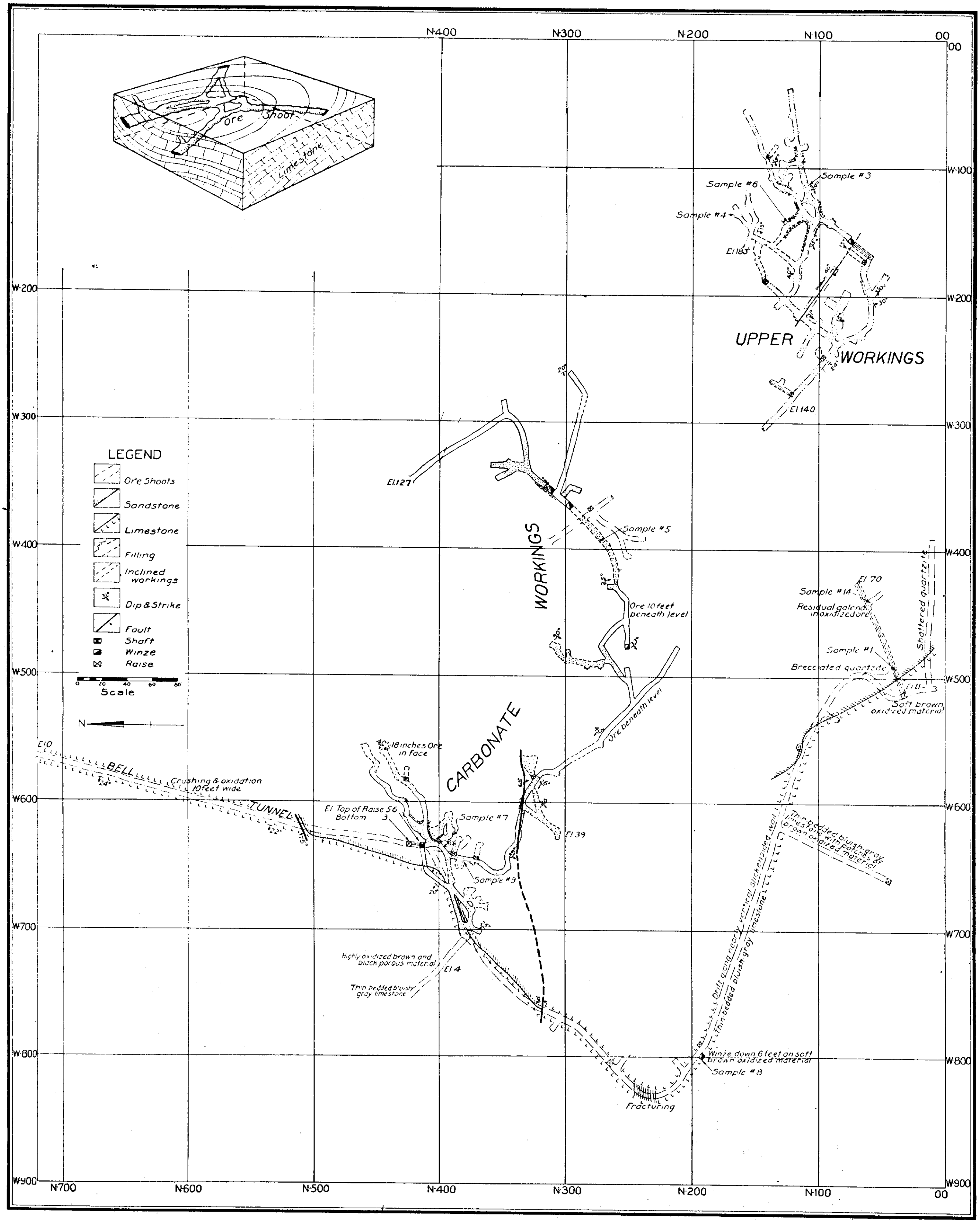
The property comprises 15 claims. The Cabin Nos. 1, 2, and 3, Dewdrop Nos. 1, and 2, and the Quartzite Nos. 1, and 2, are owned jointly by F. G. Worthing and Edward Kaufman. Six of the claims are owned individually by Mr. Worthing and two others by Mr. P. C. Weaver. The important ore bodies are located on the Cabin No. 2 claim. Nearly 4,000 feet of drifts and inclines have been driven including the tunnel on the Dewdrop No. 1 claim. Approximately 900 feet of drifting has been done in the Upper Workings, 1,000 feet in the Carbonate Workings, 1,300 feet of drifts and laterals in the lower or Bell level and about 660 feet on the Dewdrop claim. The drifts in the Carbonate and Upper Workings are extremely irregular because of the sinuous nature of the ore shoots and folding and faulting along the limestone sandstone contact is responsible for the L-shape of the Bell Tunnel.

Geology

The ore deposits occur in limestones of Upper Devonian age that overlie the massive white upper member of the Cambrian(?) quartzite series. The pink and maroon beds of the middle quartzite member is exposed in a canyon just south of the mine. In general, the quartzites have been folded into a broad anticline that outcrops almost continuously for 7 miles south of the Worthing and Weaver property. Just north of the mine the quartzite plunges beneath the limestone beds.

The ore in the Upper Workings is usually found in a thin-bedded bluish gray magnesian limestone that lies beneath a massive limestone bed of about the same color. The ore from the Carbonate Workings contains considerable more insoluble material which probably indicates the replacement of more siliceous beds. In general, the dip is to the northwest, but minor folding and some faulting cause many local irregularities. One well defined fault has displaced the ore some distance and smaller displacements of two or three feet are common. In the Bell Tunnel the contact between the thin-bedded limestone and the quartzite is not a clean cut one but is apparently gradational through a sandy limestone and sandstone into a white vitreous quartzite.

The ore occurs in irregular pipe-like shoots that extend by the bedding planes of the limestone. The irregular trend of the ore bodies is due in part to minor folding and probably in part to fracturing although it is difficult to discern the fractures because of the oxidized nature of the ore. Two distinct and nearly parallel ore shoots, known as the Upper and Carbonate ore bodies, have been developed in the mine. The ore bodies are not complete replacements of the limestone beds but consist of a network of separate shoots that split and rejoin up the dip. One large pipe is generally more persistent than the other whereas numerous arms extend away from the main shoot at steep



MAP OF THE WORTHING AND WEAVER MINE WITH BLOCK DIAGRAM

Lemhi County, Idaho. From Brunton Survey by P. J. Shenon.

October 1927.

angles. The pipes are elliptical in cross-section, the long axis being parallel with the strike of the bedding. The values drop abruptly at the edges of the ore although oxidation sometimes extends for some distance beyond.

Cerrusite, anglesite, and galena are the principal ore minerals. Galena, the primary lead mineral, occurs as cores in the partly oxidized ore. Umpleby (7b;p.84) mentions the occurence of plumbojarosite, the rare hydrous lead-iron sulphate. Polished sections of sulphide ore, from location No. 14 at the top of the raise near the end of the Bell Tunnel, included galena, pyrite, sphalerite tetrahedrite, anglesite, and covellite. The relationships showed the pyrite to be the oldest mineral. In several places it was partly replaced by galena. Sphalerite and tetrahedrite occur as small isolated patches through the galena and were probably introduced with it. The rounded tetrahedrite grains are less than .04 of a millimeter in diameter. The galena is partly replaced by anglesite and covellite along fractures and cleavage planes.

The ore from the Upper Workings differs considerably from that of the Carbonate Workings in appearance and chemical and mineralogical composition. In his study of replacement limestone deposits of Mexico Prescott* has found that ore pipes from the same source usually have distinctive characteristics. The ore from the Upper Workings is predominantly a reddish-brown sandy ore with numerous cores of partly oxidized galena scattered throughout whereas the ore from the Carbonate Workings is much lighter in color and contains little if any galena. The incline 150 feet south of the portal to the Carbonate Workings is run in a grayish white to gray bedded ore that is said to average 20 percent lead. The gray color is dependent upon the amount of lead carbonate present. A sample of the grayish-white material from location No. 5 assayed 13.4 percent lead.

Smelter returns on 4 carloads of hand-sorted ore are given below:

UPPER WORKINGS

Silver	Gold	Lead	Zinc	Iron	Insol.	Sulphur
5.2 oz		49.75%		9.6%	3.5%	3.7%
4.8 "		44.20		8.3	3.7	2.05

CARBONATE WORKINGS

Silver	Gold	Lead	Zinc	Iron	Insol.	Sulphur
8.0 oz.		42.52%	1.5%	8.6%	23.2%	1.4%
6.9	0.01 oz.	50.5		8.6	12.8	

The Carbonate ore shows an increase of soluble material, a decrease in sulphur, and an increase in zinc. The decrease in sulphur is the result of more complete oxidation whereas the marked increase of insoluble material probably results from the replacement of more siliceous beds. Polished sections and analyses show that the sulphide ore from the Upper Workings carries less than 1 percent zinc and no doubt the primary ore from the Carbonate ore shoot was also low in zinc.

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* Prescott, Basil, Underlying principles of the limestone replacement deposits of the Mexican province, Eng. and Min'g. Jour., Vol. 122, No. 7, pp. 247, 1926.

Economic Considerations

In the Upper Workings most of the ore has been mined because the values are largely limited to well defined shoots. Assays of the oxidized material near the walls carried less than 1 percent lead. The sample from location No. 3 carried 0.5 percent lead, 0.7 percent zinc and no silver. A sample from near the edge of the main ore shoot at location No. 6 assayed 9.7 percent lead, 0.1 percent zinc, and a trace of silver. The ore continues beneath the lowest level in the Upper Workings and is picked up in the long raise near the end of the Bell Tunnel. A sample of the lean-appearing oxidized material at location No. 1 assayed 2 percent lead and 0.1 percent zinc.

The Carbonate ore body offers considerably more promise than the Upper ore shoot. It is not sufficiently explored to determine its size or extent but a cross-cut driven southeast from the Big incline shows the ore to be at least 20 feet wide at that place. Both the width and thickness of the shoot no doubt varies from place to place but wherever exposed it is apparently a good sized body. Faulting is largely responsible for the fact that the ore has not been picked up in the Bell Tunnel. Samples of the brown oxidized material from a winze on the Bell level at location No. 8 assayed 6 percent lead and probably indicates that the main ore body is not far distant. The Carbonate ore shoot could be easily prospected for by drifting northeast from coordinate point N-130, W-620.

Unless faulting interferes, the type of ore body exposed at the Worthing and Weaver (Kaufman) mine is not difficult to follow downward but because of the sinuous nature is sometimes extremely difficult to intersect by long tunnels or crosscuts. Should the ore continue downward for some distance an oxidized condition can be expected for several more hundred feet.

At the present time the ore is sorted in the mine and the low grade material used for filling. Several years ago an attempt was made to concentrate this lower grade ore by means of a jig but without success. In recent years oxidized lead ores have been successfully treated by selective flotation and gravity concentration* and should the present prospecting campaign develop sufficient low grade ore a suitable process could, no doubt, be worked out.

THE VIOLA MINE

General Features

The Viola mine is located 1½ miles east of Nicholia at an elevation of 8600 feet. The town of Nicholia is situated at the mouth of Smelter Gulch and is only 2 miles from the highway between Salmon City and Idaho Falls. Gilmore, 15 miles to the northwest, is the nearest railroad point. At present Nicholia has a population of less than 10 people, and only 5 or 6 buildings remain as reminders of a once prosperous and thriving smelter town of over 1000 population. Two substantial cabins have been built on the Viola claim in recent years. Water and timber are hauled from the head of Willow Creek two or three miles to the north. Only a limited part of the workings is now accessible. The working tunnel is open for about 700 feet beyond the portal, but caves prevented the exploration of the stopes and the ground in the vicinity of the ore bodies.

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* Varley, Thomas, Flotation of oxidized ores; Reports of Investigations, Dept. of Commerce, Bureau of Mines, Serial No. 2811, 1927.

History and Production

The bonanza ore bodies of the Viola mine were accidently discovered by a horse wrangler in 1881 who sold the property to Captain Rustin of Omaha in the same year for $6,000. In the early part of 1883 Captain Rustin sold the mine to a British corporation, known as the Viola Mining Company, for $117,000. All the ore was hauled to Camas and shipped by rail to smelters in Omaha and Kansas City previous to 1885. In 1885 two lead stacks were blown in at Nicholia and were operated until 1889 when the ore body was depleted. The ore was almost self fluxing, and little difficulty was experienced in the smelting process. Charcoal was burned in the vicinity, and iron ore and limestone were hauled from nearby sources. Ore from the mine was transported by aerial tramway to the smelter near the mouth of Smelter Gulch. According to Mr. Eidelman* 130 tons of ore were smelted daily at Nicholia during the most active period. The Viola Mining Company suspended operations in 1889, and little was done until 1905 when the old workings were reopened, and an unsuccessful search made for the continuation of the ore bodies, Several unsuccessful attempts have since been made to operate the property. In 1925-26 high grade zinc ore was found near the north end of the Viola ore shoot and several carload shipments were made. The mine has recently been idle.

Umpleby (7:p.84) estimates the production previous to 1885 at about $500,000 and a total production of $2,500,000. Bell** states that 60,000 tons of 60 percent crude ore was shipped before the smelter was completed, and while lead was less than 3 cents per pound, and makes an estimate of $5,000,000 for the total production.

Geology

The Viola mine is situated on a high terrace near the tip of a limestone neck that projects into a cove-like indenture in the Cambrian(?) quartzite. West of the mine the limestone is in fault contact with the quartzite, while several other less well defined faults complicate the geology in the immediate vicinity. Cedar Canyon turns south and flows along the normal contact about a mile from its source.

The ore occured in a thin bedded bluish gray magnesian limestone as three large irregular masses connected by stringers. According to Bell*** the ore deposits were 900 feet long and varied from a foot to 30 feet in thickness. The caved stopes at the surface show that the ore in some places was at least 50 feet wide. It did not occur as a continuous mass but split around horses of limestone and varied considerably in width and thickness both laterally and horizontally. According to Bell**** the ore body was cut off by a fault in the lower workings.

The ore was chiefly a sandy lead carbonate, predominantly a yellowish-brown in color, and is said to have carried from 20-60 per cent lead and 5-15 ounces in silver per ton. Several carloads of concentrates secured by jigging old dumps

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*Henry Eidelman of Nicholia furnished much of the early day history.
**Bell, R. N., Mining Industry of Idaho, 9th Annual Report, p.131 (1907)
***Bell, R. N., Op. Cit. 19th Annual Report, p. 45, (1917)
****Bell, R. N., Op. Cit.

and low grade material left in the stopes were shipped in 1924-25, and gave average smelter returns of 31 per cent lead, 7.5 per cent zinc, and 7.5 ounces in silver. Much of the low grade material was mined from the edges of the old ore bodies where the zinc values are no doubt abnormally high.

Deposits of high grade zinc carbonate occur near the edges of the large ore bodies. The zinc carbonate is the reddish-brown iron-bearing variety of smithsonite and is normally a woody textured rock with numerous complicated lamellar cavities. In one specimen, a light green variety of zinc silicate partly filled some of the openings. A specimen of the smithsonite assayed 45 per cent zinc, 0.5 per cent lead, and a trace in silver.

Economic Considerations

Hundreds of feet of drifts have been run in an attempt to pick up additional ore bodies but without success. Because of the inaccessible condition of the underground workings very little information could be gained that might have a bearing on this subject, or on the amount of low grade material left in the mine. However, the presence of oxidized zinc ore should be considered.

When zinc sulphate waters, usually derived from the oxidation of sphalerite, attack limestone, smithsonite is deposited and calcium sulphate goes into solution. Buehler* has shown that sphalerite in the presence of pyrite is oxidized six times as readily as galena under the same conditions. The sulphate of lead is relatively insoluble, while the sulphate of iron although very soluble is three or four times less so than zinc. It is therefore to be expected that the zinc and iron upon oxidation would migrate downward, while the relatively insoluble lead would remain behind. The zinc and iron sulphates upon coming into contact with the limestone walls surrounding the ore body would precipitate as carbonates, while the replaced calcium would go into solution as calcium sulphate. The molecular replacement of calcium carbonate by zinc sulphate represents a shrinkage in volume of 37 per cent which can easily account for the porosity of the smithsonite ore at the Viola mine. The lamellar structure is due to replacement along fractures. Simple fractures produce simple lamellae, whereas complicated fracturing produces more intricate patterns.** According to Laughlin the dense zinc carbonate is formed under different geologic conditions than the porous variety. He believes the waters that caused the replacement of the massive zinc carbonate had already absorbed considerable carbon dioxide before replacement of the limestone or other related rock began, and that more zinc carbonate could thus be deposited than would have resulted from the simple reaction between zinc sulphate and carbonate rock; and that furthermore, replacement took place near and even below the general or local ground-water level, where the rocks could become thoroughly permeated with zinc solution. He believes the cellular variety represents precipitation of zinc carbonate above ground water level.

A study of polished sections of sulphide ore from a prospect near the old smelter indicate that only a small amount of pyrite and sphalerite were associated with the primary ore in the Viola district. In the specimens studied the galena contained less than 1 per cent of sphalerite. However, should even this small per cent of zinc be concentrated from a large ore body a valuable deposit could result.

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*Buehler, H. A., and Gottachalk, V. H., Oxidation of Sulphides: Ec. Geol., Vol. 5, pp. 30-31, 1910.

**Laughlin, G. F., U. S. Geol. Sur. Bul., No. 690-A, 1907.

Water level at the Viola mine has been for a long period of time at a considerable distance below the Viola ore bodies, and the porous nature of the ore does not suggest an excess of carbon dioxide in replacing solutions. It therefore follows that only small high grade zinc carbonate ore bodies can be expected near the border of the lead deposits and particularly along zones of fracturing.

CLARK AND ROSSI PROPERTY

Two claims, the Pride of the Hills and the Jerry, comprise the Clark and Rossi property. They are owned by Clark Brothers and H. J. Rossi. The property is situated at an elevation of 8850 feet on the east side of Cedar Canyon about ½ mile northwest of the Viola mine. An incline shaft has been sunk to a depth of 175 feet and some drifts extended out from it. No ore has been shipped.

The country rock is a bluish gray magnesian limestone that strikes N. 35° W. and dips 43° N.E. at the collar of the shaft. At a depth of 150 feet the dip flattens to less than 30°. Some lead ore is piled on the dump, and some low grade material is exposed in the shaft. The incline runs down an oxidized bed from 2 to 3 feet thick that carries low values in lead.

CLIPPER PROPERTY

The Clipper property is owned by Al Shears and is located just west and across Cedar Canyon from the Viola mine. It is situated at an elevation of 8700 feet and lies about half way between the Clark and Rossi property and the Nicholia Fraction. The property is explored by a shaft and two tunnels, but only the upper tunnel is now accessible. The property is now idle.

A large body of highly oxidized porous material about 20 feet wide is exposed near the portal of the upper tunnel. It is reddish brown to yellowish brown in color and occurs in a bluish gray magnesian limestone. Only one sample was cut. It carried low values in both lead and zinc. The deposit is said to average 4% in lead.

IDA PROPERTY

The Ida claim joins the Viola on the south. It includes part of the old Salmon lode, one of the productive ore bodies of the Viola property. It was discovered late in the history of the mine and served to prolong its life for a considerable period.

The Ida claim owned by Al Shears who has done considerable prospecting but it is at present being leased by Milo Zook. The property is worked through an inclined shaft about 250 feet deep. Numerous laterals and raises have been run, but little new ore has been discovered. Mr. Zook expects to continue sinking operations in the near future.

NICHOLIA FRACTION

The Nicholia Fraction was located about 1922, by Mr. C. H. Stallings and Mr. William Dunn of Bannack, Montana. The claim is located about ½ mile southeast of the Viola mine, just east of the limestone-quartzite contact. A shaft house, blacksmith shop, and an excellent boarding house were built in 1924, but the latter was destroyed by fire during the past summer. Light sinking equipment is still in place.

In 1924-25 a two-compartment shaft was sunk 124 feet to the quartzite-limestone contact. Some drifts were run along the contact, and a 130 foot incline run down the dip of the limestone just above the quartzite. No ore was encountered.

The shaft is situated on the east side of Cedar Canyon where the limestone makes a small indenture into the quartzite. The contact strikes N. 50° E. and dips 30° S.E. where it is encountered in the shaft.

ENTERPRISE PROPERTY

The Enterprise property is owned by Milo Zook and is situated about 1/2 mile southeast of the Nicholia Fraction. The property was located during the 80's and has been worked intermittently since. The property is explored by two shafts, about 400 feet of drifts and 70 feet of inclines. One shaft is 90 feet deep, and the second has been sunk to a depth of 60 feet. No ore has been shipped.

EIDELMAN PROPERTY

The Eidelman property is owned by Henry Eidelman of Nicholia and is located near the mouth of Eidelman Canyon. The property was located during the 80's and has been worked ever since by Mr. Eidelman. Over 2,000 feet of drifts have been run on two levels, and several cuts and shallow workings are scattered over the surface. One shipment of ore has been made.

The country rock is a bluish gray limestone that has a general northwest strike. The workings are situated just east of the quartzite where it is in fault contact with the limestone beds. The limestones are considerably folded in the vicinity of the mine.

ECONOMIC CONCLUSIONS

The four widely spaced mines on the east side of Birch Creek are credited with a production of from $2,500,000 to $5,000,000. Most of the output came from the viola mine during its early day productive period, yet the more recent activity of the other three mines has accounted for a sum of over $150,000. Any mining district with the production record of the Birch Creek mines is worthy of consideration.

All of the mines are located just above the Cambrian(?) quartzite that outcrops almost continuously from Nicholia to the Scott mine. The ore bodies occur predominantly in limestone as lenses or pipe-like shoots and because of the earthy character of their outcrops are very inconspicuous. Except in the vicinity of Nicholia there is little evidence of prospecting, hence new discoveries can be expected, particularly from the Worthing and Weaver mine southward.

The shipping ore from the lead-silver mines is carefully sorted and usually assays over 40 per cent in lead whereas the run of mine ore probably averages about 20 per cent. The second class material is stored in the mines or used for filling. Should enough of the lower grade material accumulate to justify a mill the most serious handicap would probably be the shortage of water in the vicinity of the mines. Practically all of the copper ore developed has been of a shipping grade.

Most of the known ore deposits show as much promise near the surface as they do at depth. The pipe-like ore shoots, however, can be expected to show convergence on their downward extension.

The driving of long tunnels to intersect the lenslike ore bodies, as developed in limestone at the Weimer mine, has not proven successful. A careful study of the controlling fissures, however, should lead to the discovery of other high grade copper deposits.

Most of the lead-silver ore developed has been highly oxidized. At the Worthing and Weaver mine this condition can be expected for some distance below the present workings. The ore from the Scott mine contains a considerable amount of partly oxidized galena, even near the surface.

The polished sections of the sulphide ore from the lead-silver mines contained very small amounts of primary (hypogene) zinc, usually considerably less than one per cent. Small bodies of high grade zinc carbonate ore can be expected around the borders of the larger oxidized lead deposits should even this amount migrate outward. Very little additional value can be expected from the secondary deposition of zinc in the smaller mines. The silver values may increase should the zone of secondary enrichment be encountered. The specimens of copper ore from the Weimer Mine showed some secondary enrichment along fractures.

SUGGESTIONS FOR PROSPECTING

When a mining district is first discovered there is little chance to study the underground relationships, but as the development progresses more and more opportunity is afforded for geologic observations. Several mines in the Birch Creek district are sufficiently developed to furnish geologic data upon which some general conclusions may be based to serve as prospecting guides. The following "suggestions for prospecting" are based upon characteristics exhibited by the developed mines, and upon relationships determined by surface mapping:

1. The known ore deposits are generally found just above the Cambrian(?) quartzite in a thin-bedded, bluish-gray limestone. They usually occur within 200 feet of the limestone-quartzite contact. Copper deposits along shear zones in quartzite are exceptions.

2. In the vicinity of the copper deposits the rocks usually show green and blue stains along fractures.

3. The outcrops of the lead-silver deposits have little surface expression because of the earthy nature of the gossan minerals. A cherty appearing brown "ore casing" is, usually found, however, near the outcrops.

4. The lead-silver deposits occur predominantly as lenses or pipes. For this reason a tunnel driven to intersect the ore beneath a surface showing is apt to disappoint. Should a careful search reveal the ore in place, it should be followed downward until sufficiently developed

to determine the position of its downward extension.

5. The vicinity from the Worthing and Weaver mine southward and just above the east contact of the quartzite is especially favorable for prospecting.