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IDAHO BUREAU OF MINES AND GEOLOGY
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GEOLOGY OF THE PEARL-HORSESHOE BEND GOLD BELT, IDAHO

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ABSTRACT

The gold belt stretching from Pearl to Horseshoe Bend in Gem and Boise counties, about 18 miles north-northwest of Boise, has not received the attention that it deserves. The district formerly had a large number of mines that were compelled to close, apparently not because of exhaustion of ore reserves, but because a profitable gold extraction could not be made from the sulphide ores with the ore dressing methods then current. Many of these lodes are of comparatively great length and well mineralized throughout with ore averaging from 0.65 to 0.50 ounces of gold per ton. Most of them also have appreciable amounts of silver.

The gold-bearing lodes are distributed along a prominent dike zone or "porphyry belt" in batholithic rock of presumably late Jurassic (?), age. The lodes and dikes, however, are much younger and were formed along a prominent fracture zone in the batholith near the middle of the Tertiary, probably during lower Miocene time. Recurrent adjustments or movements along this zone of weakness near the end of dike intrusion provided the fissures or openings for the movement of the gold-bearing ore solutions and permitted the formation of the mineral lodes. By the mid-part of the Miocene the lodes had been bevelled by erosion to nearly their present levels. They were then covered by flows of Columbia River basalt and sedimentary beds of the Fayette formation (middle or upper Miocene) and after a period of erosion of relatively brief duration by rhyolite and sediments of the Idaho formation (Pliocene and Pleistocene). The lodes and dikes have since been bared by erosion following younger epochs of crustal unrest during which the region was warped and segments tilted by normal faults.

The lodes are complex and are composed largely of sulphide seams, lenses, and stringers in highly altered, sheared or fractured batholithic and younger dike rock. The sulphides consist dominantly of arsenopyrite and pyrite, and usually subordinate amounts of sphalerite and galena, generally with microscopic grains of chalcocite and tetrahedrite, locally boulangerite and stibnite. The gangue is mainly the altered country rock and scant amounts of vein quartz, dolomite, and calcite. Some lodes are more siliceous than the others also contain variable amounts of ruby silver and owyheeite(?).

There is no evidence that the gold metallization is shallow or that the bottom of the commercial ore zone has been reached. On the contrary, the lodes were formed under moderate conditions of temperature and pressure, some thousands of feet below the formerly existing surface, and, so long as the governing structural conditions continue to be persistent at depth, except for local interruptions, the lodes may be similarly as persistent.
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INTRODUCTION

SCOPE OF THE REPORT

During field studies in the Boise Basin it became apparent that a clear understanding of local conditions of mineralization, structure, and igneous activity in the Basin required investigation of a wider region. To aid in an understanding of these conditions a reconnaissance was made to the west of Boise Basin and a few days were spent late in June, 1933, along the gold belt extending from Horseshoe Bend southwestward to Pearl. This brief investigation disclosed that the area held a key to the solution of several of the regional problems; accordingly, the area was revisited later in the summer and studied in greater detail.

Since then numerous requests have been directed to the Idaho Bureau of Mines and Geology for information concerning the area, and this report is written in answer to those requests and to make available data bearing on regional geologic problems.

CONDITIONS AFFECTING FIELD WORK

The preliminary survey of the district was made from June 21 to June 24 inclusive; the detailed survey between July 31 and August 30. No adequate maps were available and it was therefore necessary to prepare a topographic and geologic sketch map based on a stadia traverse along the gold belt. The writer was ably assisted in this work by Mr. Charles A. Haseg, graduate student in the Idaho School of Mines, and for part of the time by Mr. John T. Carpenter of Boise, Idaho. Mr. Raymond V. Lundquist, analyst for the Idaho Bureau of Mines and Geology, made many of the assays quoted in this report.

The study of the lodes of the district was hampered by the lack of accessible underground workings and by the mantle of soil and disintegrated rock. Although many of the lodes had formerly been exposed by both underground workings and a large number of open cuts, most of the openings are now caved and the open cuts are so filled in that they reveal little. The outcrops were examined wherever accessible and ores were collected for assay and microscopic examination from outcrops and dumps.

EARLIER GEOLOGIC INVESTIGATION

Little has been published on the geology of the district since Lindgren's work in 1898. Some data on underground development and geologic conditions have been given in the annual reports of the State Inspector of Mines by Robert N. Bell, Mine Inspector, for the years 1906 and 1907. General problems of the region have been more recently discussed in reports by Dr. Virgil R. D. Kirkham.

Papers having a bearing on the Pearl-Horseshoe Bend district are listed in the bibliography below and to each title is appended a brief statement of contents.


Bell, R. N., "Annual reports of the State Inspector of Mines of the Mining Industry of Idaho;" particularly for the years 1906, 1907, and 1912. Discusses several of the properties with notes on geology and development.


Campbell, Stewart, "Annual reports of the State Inspector of Mines of the Mining Industry of Idaho;" for the years 1921 to 1932 inclusive. Contains lists of properties and notes on active development.


"Igneous geology of southwestern Idaho," Jour. Geol., vol. XXIX, No. 6, pp. 564-591, 1931. Describes Miocene (?) granitic rock near Horseshoe Bend, also basaltic and rhyolitic extrusives.


INDEX MAP

Fig. 1. Map showing location of the Pearl-Horseshoe Bend district.
The Pearl-Horseshoe Bend gold belt lies partly in Gem County and partly in Boise County, about 18 miles north-northwest of Boise (Fig. 1). The belt is about equally divided between the two counties and extends east-northeasterly from a point a mile or two west of Pearl to the town of Horseshoe Bend, a distance of about 9 miles. It includes the former mining districts of Willow Creek and Rock Creek, as defined by Lindgren 1, now known as the Pearl or West View districts. 2 As shown on the geologic sketch map (Plate 1), the belt is from 1 to 2 miles wide and covers about 18 square miles.

TOPOGRAPHY

The Pearl district lies along a prominent ridge trending east-northeast near the western edge of the mountainous area drained by the Boise and Payette rivers. This ridge has been cut in two by the deep, narrow valley of Rock Creek, a tributary of the Payette River. The part on the west is the higher and culminates in Crown Point at an elevation above 5,100 feet. From Crown Point the ridge slopes gently westward toward the Snake River Plain and separates the drainage of the Boise River from that of the Payette. Much of the ridge west of Crown Point is wide with a somewhat undulating surface (Plate II,A), which resembles one produced by prolonged erosion, later tilted. The slope north of Crown Point is steep; that on the south is less abrupt. Willow Creek heads near the summit of Crown Point and flows southwestward to the Boise River.

The segment east of Rock Creek extends as a sharp ridge to Horseshoe Bend (Plate II,B). Here it is cut by the Payette River which has carved a deep, narrow canyon diagonally across its northeast end. The canyon slopes rise very steeply for almost a thousand feet and then abruptly flatten out to form narrow, well-defined, although somewhat dissected, rock terraces.

The narrow Payette Canyon is in striking contrast with the open upper valley comprising Horseshoe Bend and Jerusalem Valley immediately to the east (Plate II,B). Here the Payette River has a flood plain nearly a mile wide and swings in broad curves. Just before entering the canyon it completes a nearly perfect horseshoe curve from which the basin and town have derived their names. The elevation at Horseshoe Bend near the river bank is about 2,600 feet.

CLIMATE AND VEGETATION

The region is semi-arid (Plate II). It lies from 4 to 12 miles west of the forested slopes of Boise Ridge. Except for sage brush and grasses, the hills are devoid of vegetation. The summers are generally hot and dry, and there is usually little snow during the winter months. The district is therefore readily accessible throughout the year, and climate is no handicap to mining operations.

SETTLEMENTS AND INDUSTRIES

The towns of Horseshoe Bend at the east end of the district and Pearl near the west end are the only settlements. Horseshoe Bend lies in Boise County, of which Idaho City is the county seat, and Pearl in Gem County, of which Emmett is the county seat.

Horseshoe Bend and Jerusalem Valley are primarily agricultural. Most of the farming is done by irrigation, but there are some dry farms on the higher

A. Photograph of the exhumed old erosion surface that borders the dike zone a short distance northwest of Pearl. Remnants of the basal flow of Columbia River basalt may be seen capping the old erosion surface on the left and middle foreground.

B. Picture from the northeast end of the district to the southwest in the direction of the dike and mineral zone. Culminating peak in the background is Crown Point near Pearl. The view is across the wide basin at Horseshoe Bend and shows the Fayette River in the foreground and its broad loop as outlined by the line of trees and brush, also the head of the narrow canyon in the middle of the picture through which the river leaves the basin and flows across the dissected mountain on the west. The Lower Mesa gravel terrace is shown in the right of the picture across the river. Photograph by John C. Reed.
alopes. Pearl owes its existence entirely to mining, and for many years has been practically a ghost camp.

Hydroelectric power is developed along the Payette River and a power plant is located about 3 miles below Horseshoe Bend. The plant supplies power to users at or near Pearl.

ACCESSIBILITY

The district is easily accessible. An excellent state highway (No. 15, Boise-McCall) skirts the east end of the district and links the town of Horseshoe Bend with Boise. A graded road follows the Payette River from Horseshoe Bend to Emmett and another passes eastward over the mountains to Idaho City and other parts in the Boise Basin.

Pearl may be reached from the Boise-McCall highway over an unimproved country road that joins the main highway near the summit of the divide between Boise Valley and Horseshoe Bend. A somewhat longer but easier route is by way of the Boise-Emmett highway whence a well graded, sandy, country road begins about 8 or 9 miles from Emmett, extends to the Lincoln mine, and then on to Pearl. A short distance west of Pearl another road continues to Montour on the Payette River and joins the road from Emmett to Horseshoe Bend.

A branch of the Oregon Short Line Railroad (Union Pacific System) extends along the Payette River from Emmett to McCall and crosses the northeast end of the gold belt.

GEOLOGY

SUMMARY STATEMENT

The geology of the Pearl-Horseshoe Bend gold belt is much like that of the Quartzburg-Grimes Pass gold belt in Boise Basin a few miles to the east. Each has a prominent dike zone or "porphyry belt" controlled by lines or zones of structural weakness in older batholithic rock and each contains lodes in association with the younger dikes. The fracture and dike patterns in each of the structural belts are much the same and most of the dikes are similar. The two belts are apparently separate entities, but they are broadly similar in trend and their surface termini are not very far apart.

The older batholithic rock has largely the composition of quartz diorite, subordinately granodiorite. It is correlated with the batholiths of late Jurassic age in Washington and Oregon. The batholith is the host for many of the lodes, but the body itself has no genetic affiliations with the mineralization.

A structural disturbance probably rather early in the Miocene produced a prominent fracture zone of east-northeast trend. Some of the younger intrusive bodies which took advantage of this zone of weakness are now aligned in the direction of the zone, others transversely across. Renewed movement along the fracture zone near the end of dike intrusion apparently provided the openings for the ore solutions.

Following the igneous activity associated with the early Miocene crustal disturbance, the region was eroded to a surface of low relief, which exposed the

younger intrusives and the lodes to depths about the same as exist at the present
time. Columbia River basalt and Payette sediments of middle or upper Miocene age
were then spread over the old eroded surface and protected the intrusive rocks
and lodes from further erosion. Crustal disturbance near the close of the epoch,
however, caused renewed erosion and the basalt and Payette strata were partly
stripped from the dike zone. This disturbance and subsequent erosion was follow-
ed by the extrusion of rhyolitic lava over part of the area, and, after further
erosion, by deposition of Pliocene and Pleistocene Idaho formation, mainly in the
nearby Snake River Plain area, which was undergoing subsidence.

Probably late in the Pliocene and early in the Pleistocene the region was
again uplifted with normal faulting and tilting of fault-block segments, partic-
ularly along the northeast end of the belt. This movement was apparently
accompanied by further subsidence of the Snake River region which caused the
southwest end of the dike zone to be tilted westward. The later record has been
one of recurrent uplift and canyon development with sporadic pauses revealed by
deposition of Upper and Lower Mesa gravels on rock terraces.

BATHOLITHIC ROCK

The batholithic rock is the most widely distributed rock in the map area.
It is largely quartz diorite, but some of it is as alkaline as granodiorite
and a very small part on upper Rock Creek east of Pearl has the composition of quartz
monzonite. The quartz diorite and granodiorite cannot be separately distinguish-
ed except by microscopic examination and are not differentiated on the geologic
map.

Minerals visible in the hand specimen are quartz, feldspar (andesine and
microcline), biotite, hornblende, titanite, and epidote, rarely muscovite. Others
recognized with the microscope are allanite, magnetite, zircon, chlorite, zoisite,
and minute flakes of secondary white mica. The quartz ordinarily comprises about
25 per cent of the rock with observed limits of 15 to 35 per cent, the andesine
from 35 to 70 per cent, mostly about 50 per cent, and the microcline from 5 to
10 per cent, although the latter may also be entirely absent or locally oxooed
the amount of andesine. Biotite is the most common dark mineral and forms from
8 to 15 per cent of the rock, usually about 12 per cent. Hornblende may be
absent, may occur as scattered crystals, or locally comprise as much as 12 per
cent of the rock, but as the hornblende increases in abundance the biotite
proportionally decreases so that the total content of dark minerals rarely ex-
ceeds 15 per cent. Both titanite and epidote are notably abundant. The titanite
commonly forms as much as 3 per cent of the rock and the epidote as much as 2
per cent. Other minerals are merely minor accessories, each comprising less than
1 per cent of the rock. The batholithic rock is ordinarily quite fresh, except
in the vicinity of the lodes where it has been altered by the mineralizing
solutions.

The rock is grayish in color, or mottled white and black, shows little var-
iation in grain diameter, the average light colored grains ranging from 4 to 7
millimeters, and the dark about half as large, and, except for a more or less
prominent gneissic banding, resembles ordinary granitic rock. On upper Rock
Creek it is locally porphyritic. The rock in general differs considerably from
the quartz monzonite and granodiorite of the Idaho batholith to the east in con-
taining more than twice the quantity of dark minerals and therefore having a
much darker color, in containing a more calcic plagioclase, and in having a
rather high titanium content which is reflected in its conspicuous yellowish-
brown titanite crystals.

The batholithic rock in the Pearl-Horseshoe Bend area shows a striking
similarity in composition and mineralogy to the batholithic rocks of late Jurassic age in Oregon and Washington, which are likewise characterized by rather calcic compositions and high titanium contents. It was probably intruded near the close of the Jurassic (?) at the time of invasion of the Coast Range batholiths. The age of the batholith is to be treated in detail in a paper now in preparation in which additional data obtained from a more extensive study of the batholithic rock along the west margin of the state are to be included.

YOUNGER INTRUSIVE ROCKS

Diorite

Granitoid rock mainly of dioritic composition is the oldest of the younger intrusives which invade the batholith. The largest body is stock-like in its proportions and is elongated east-northeast in the direction of the dike zone. This body extends for about 8 miles from a point not far north of Crown Point to about 2 miles northeast of Horseshoe Bend. It is irregular in width; from the west end it expands to about 3,000 feet across on Rock Creek, pinches to about 500 feet where it enters the Payette River Canyon, and then attains its maximum width of about 1 1/2 miles less than a half mile below Horseshoe Bend. It lies wholly in the batholith, but on the northeast end it is in part in contact with Payette strata. Two small dikes with west-northwest trend lie a short distance northwest of Crown Point.

Much of the diorite has a composition near gabbro, but locally there are minor seams or zones of somewhat different composition, apparently differentiated aplite products with marked resemblance to granite or granophyre. There are also minor parts with the composition of quartz diorite and granodiorite.

Minerals of the diorite are biotite, hornblende, hypersthene, augite, calcic andesine, usually a little quartz and orthoclase, and the accessories zircon, apatite, and magnetite, and generally variable but small amounts of secondary chloride, epidote, zoisite, and fine shreds of white mica. Few of these minerals, except biotite, can be positively identified in hand specimens. Biotite is always visible and in some places forms rather large crystals which may give the rock a porphyritic appearance, although in thin section the phenocrysts are found to be made up of clusters of small grains, all with the same orientation. The dark minerals range from 20 to 46 per cent, normally about 30 per cent, of the rock. Hypersthene is generally the most abundant of the dark minerals and its content ranges from 2 to 20 per cent. Augite is generally less abundant, from 2 to 15 per cent, and hornblende and biotite each comprise from 5 to 15 per cent of the rock. Calcic andesine normally forms from 60 to 70 per cent of the rock. Quartz is rarely absent, but usually forms less than 4 per cent of the rock, although in some places the content increases to 8 per cent, and locally as much as 25 per cent. Orthoclase rarely exceeds 2 per cent, but as the quartz content increases the orthoclase, and also the biotite, tend to show a similar increase. Quartz and orthoclase are notably abundant only at the east end of the stock.

The rock is dark gray to nearly black, mostly even-grained with the individual minerals about 2 millimeters in diameter. It is easily distinguished from the quartz diorite and granodiorite of the batholith by its darker color, finer-grain (its minerals are from one-half to one-fourth the size of the constituents of the batholith), and, on weathering by the abundance of biotite in the dark feldspathic soil. In a few places the texture of the rock is slightly porphyritic although rarely noticeable except under the microscope, and the early minerals,

\[\text{Waters, A. C., "Summary of the sedimentary, tectonic, igneous, and metalliferous history of Washington and Oregon"; Ore Deposits of the Western States, A.I.M.M.E., p. 26, 1935.} \]
the plagioclase, pyroxenes, and hornblende, appear as phenocrysts in a somewhat finer matrix of plagioclase, biotite, quartz, and in some places orthoclase. These porphyritic facies show a pronounced resemblance to some of the younger porphyry dikes classed as dacite porphyry.

Certain parts of the larger diorite body, as along lower Rock Creek and near the Lucky Boy mine in the Fayette River Canyon, have minor facies of a finer grained, light gray to pinkish rock which shades into the diorite, but has largely the composition of granite. The dark minerals, mainly small biotite crystals with widely scattered grains of hornblende, comprise 6 per cent or less of the constituents. Some of the rock is inconspicuously porphyritic and contains andesine and dark minerals as phenocrysts in a microgranular and often granophyric groundmass of orthoclase and quartz along with accessory magnetite, zircon, apatite, and allanite. The andesine is less calcic than that in the diorite, but otherwise has all the characteristics of the latter. Ordinarily the andesine composes 10 to 20 per cent of the rock, the quartz about 35 per cent, and the orthoclase 40 to 45 per cent. Secondary minerals are chlorite, epidote, and fine shreds of white mica.

Variation in the diorite body is also shown elsewhere. Granite dikes less than 6 inches thick are conspicuous along joint planes in the diorite northeast of Horsehoe Bend. This granite, which closely resembles the gradational facies, is slightly coarser-grained with perhaps somewhat less biotite. It is non-porphyritic with granular to granophyric texture. The rock is more altered than the gradational facies and the biotite is generally converted to chlorite and the feldspars to sericite. The plagioclase may be sodic andesine or oligoclase. Other small dikes or apophyses occur on the east slope of Crown Point as independent apophyses in the country rock, possibly above unexposed dioritic bodies. The rock is pinkish and coarser-grained than the others and contains streaks of pegmatite. Dark minerals are scant (less than 5 per cent) and consist exclusively of chloritized biotite. Other minerals are oligoclase (10 per cent), quartz (25 per cent), orthoclase (60 per cent), and accessories, magnetite, zircon, and the secondary minerals, chlorite and sericite.

The diorite and its facies are ordinarily quite fresh except in the vicinity of lodes or veins where the rock is bleached and extensively sericitized.

Porphyry dikes

The porphyry dikes are many in number and include a long succession from dacite porphyry to lamprophyre. They are concentrated in a belt of east-northeast trend and their distribution shown on the geologic map is an excellent clue to the regional structure. Most of the dikes are in the batholith, but many cut the diorite stock. Some of the dikes are too small to appear on the map and have been omitted. They range up to 400 feet in thickness and 8,000 feet in length. The list includes dacite porphyry, granite porphyry, syenite porphyry, rhyolite porphyry, certain moderately basic dikes apparently intermediate between rhyolite porphyry and lamprophyre, andesite, and lamprophyre. Their succession from oldest to youngest appears to be in about the order given. Most of the succession is established by dike intersections and in part by inference from observations of the relations between similar dikes in the Boise Basin porphyry belt.

Dacite porphyry

Dacite porphyries are the most numerous and most widely distributed of the dike series. There they are difficult to distinguish from the local porphyritic facies of the diorite. The dikes range from a few feet to as much as 400 feet thick and from several hundred feet to as much as 5,000 feet long; their average
thickness is between 100 and 200 feet and length above 1,000 feet.

The dacite porphyries are moderately dark gray to dark greenish gray, porphyritic rocks containing from 40 to 60 per cent phenocrysts of which 30 to 40 per cent are twinned glassy plagioclase laths and about 15 per cent extensively chloritized hornblende and biotite. These and sporadic rounded quartz and large magnetite grains are commonly about 2 millimeters long, but some range up to 4 and even 6 millimeters. They are embedded in a finely granular, in patches finely granophyric, groundmass of oligoclase and variable but appreciable quantities of quartz and orthoclase, and accessory zircon, apatite, and magnetite. The quartz composes about 10 to 20 per cent of the rock. Augite and hypersthene occur in some of the rocks, mostly as remnants in hornblende. Usually the hornblende and biotite are partly or completely altered to chlorite, but some grains are also partly changed to epidote. The phenocrystic plagioclase is calcic andesine-like that in the diorite. It shows, especially near the margins, irregular conversion to sericite. Near veins the rock is extensively altered and the plagioclase wholly converted to sericite and calcite.

Granite porphyry

Granite porphyry is the name assigned to a gradational series of rocks of similar characteristics actually ranging in composition from granite porphyry to granodiorite porphyry. Most of them perhaps are equivalent to quartz monzonite. One of the dikes, a granodiorite porphyry, grades into a typical dacite porphyry.

The granite porphyry dikes are widely distributed along the dike zone. They are from 30 to about 400 feet thick and as much as 8,000 feet long, but the average approximates 100 feet by 2,000 feet. Few of them form conspicuous outcrops and most of them are recognized from soil fragments.

Most of the granite porphyries are conspicuously mottled with strangely contrasting white, black, and dull greenish phenocrysts from 1 to 12 millimeters long in fine-grained pinkish groundmasses. They have the mottled appearance or the rock which miners sometimes refer to as "birdseye porphyry." The white phenocrysts are composed of andesine crystals similar to those in the dacite porphyry, the black phenocrysts of smaller hexagonally-shaped biotite crystals, and the greenish ones of hornblende, rarely augite. Large quartz grains are also commonly observed. These phenocrysts compose from 25 to more than 50 per cent of the different rocks. In the porphyries, which are more strictly granodiorite porphyries, the andesine comprises 45 to 50 per cent of the rock, the biotite 10 to 15 per cent, and the hornblende 5 to 10 per cent. In the quartz monzonite porphyries the andesine ordinarily forms 25 to 45 per cent of the rock (usually about 30 per cent), biotite 5 to 15 per cent, and hornblende 5 to 15 per cent. The strictly granite porphyry has 15 to 25 per cent andesine and about 10 per cent biotite and 5 per cent hornblende. In some of the dikes, particularly those of the diorite, particularly those of morealkaline character, orthoclase as well as quartz become fairly prominent as phenocrysts. The groundmasses in most cases are micro-gneissic to granophyric and are composed largely of orthoclase and quartz, locally plagioclase, and accessory magnetite, zircon, and apatite. In the granodiorite porphyries the orthoclase constitutes about 25 to 30 per cent of the rock, the quartz about 15 per cent. In the quartz monzonite porphyries the orthoclase content ranges from 25 to 45 per cent, the quartz from 10 to 25 per cent, whereas the typical granite porphyry has 35 to 50 per cent orthoclase and 25 to 35 per cent quartz. These rocks are usually considerably altered, the feldspars sericitized and the biotite and hornblende in large part altered to chlorite and large grains of epidote. The andesine crystals commonly have clear centers and wide rims of sericite.

As the quartz phenocrysts increase in abundance and orthoclase crystals of large size become prominent, the granite porphyry grades into a variety of rhyolite.
porphyry to be described later. Several granite porphyry dikes north of Pearl differ markedly from the others in that they resemble the syenite porphyry, described next, but have about 35 per cent quartz in the groundmass.

**Syenite porphyry**

Several long narrow dikes along the northwestern margin of the dike zone are classified as syenite porphyries. These, except for their low quartz content, can not be distinguished from certain of the rhyolite porphyry dikes. The outcrops are usually brownish from weathering and unlike those of dikes previously described are prominent and easily traced.

The syenite porphyry is grayish or pinkish gray, somewhat porphyritic, with scattered white feldspar phenocrysts about 3 millimeters long in a granular groundmass almost as coarse as the phenocrysts. The phenocrysts, sodic andesine, comprise about 20 per cent of the rock. Scattered muscovite grains of somewhat smaller size are probably a replacement of original biotite. The groundmass is composed almost wholly of orthoclase in interlocking grains, accompanied by a little accessory quartz (about 3 per cent) and zircon, apatite, and magnetite. Sericitization of the rock is conspicuous.

**Rhyolite porphyry**

Rhyolite porphyry dikes are comparatively widespread along the dike zone. The individual dikes are ordinarily narrow, less than 50 feet, but are of considerable length, measuring as much as 7,000 feet long. Their outcrops are usually prominent and produce ledges several feet high.

The rock varies considerably in appearance, but always has an aphanitic groundmass. Three main varieties may be distinguished; two of them very like the syenite porphyry and the third somewhat similar to the granite porphyry. The first variety, a light colored, slightly porphyritic rock of moderate grain, differs from the syenite porphyry only in containing considerable groundmass quartz. The second contains quartz phenocrysts and a little quartz in the groundmass, but is otherwise like the syenite. The third contains very large orthoclase phenocrysts and conspicuous quartz crystals in an otherwise aphanitic rock. All contain between 15 and 20 per cent of plagioclase as phenocrysts. The varieties have not been differentiated in mapping.

The first variety is represented by two dikes, one not far west of Crown Point, the other on the southwest slope. The second is the larger and is as much as 200 feet thick and 4,000 feet long. The phenocrysts are greatly altered andesine crystals and biotite grains (mostly converted to muscovite) in a microgranular groundmass of orthoclase grains of more or less indefinite or confused outlines and scattered quartz grains with magnetite and apatite as accessories. The quartz comprises from 10 to 20 per cent of the rock, the orthoclase from 60 to 70 per cent. Hematite, limonite, and sericite occur as secondary minerals.

The second variety forms a dike north of the Osborne mine near the east end of the district. It is light pinkish to brownish gray and contains plagioclase phenocrysts (2 to 4 millimeters long) and quartz grains (2 millimeters in diameter) in a fine-grained, essentially aphanitic groundmass of confused orthoclase aggregates and a little sodic quartz, zircon and apatite. Original biotite crystals have changed completely to muscovite with the liberation of hematite. The quartz grains are in part rounded and embayed, but in part have good crystal outlines. The plagioclase comprises about 25 per cent, muscovite 5 per cent, quartz 10 per cent, and orthoclase about 60 per cent of the rock.

The third variety is the most abundant and forms the most prominent outcrops in the district. The dikes are narrow, ordinarily 10 to 50 feet, but are usually very long. This variety is believed to be somewhat younger than the other
Rhyolite porphyries because at Quartzburg in northwestern Boise Basin a dike of this variety cuts dikes of the second. The most striking feature of this variety is the large size of the orthoclase phenocrysts which range from a few millimeters up to 35 millimeters or more. These, as well as quartz grains, from 1 to 5 millimeters in diameter, exceptionally 10 millimeters, are generously distributed through the rock. White plagioclase crystals 2 to 3 millimeters and altered biotite grains of slightly smaller size are also present. The former comprises about 20 per cent, the latter about 5 per cent of the rock. The groundmass is euhedral, light gray, some places pinkish, and is composed mainly of minute orthoclase aggregates with a little accessory quartz, magnetite, apatite, zircon, locally a little biotite and plagioclase. Some of the groundmasses suggest poorly formed microspherulitic intergrowths of orthoclase and quartz, but generally they are dominantly feldspathic. The quartz comprises from 10 to 20 per cent of the rock, the orthoclase about 60 per cent. The orthoclase phenocrysts are little altered, but the plagioclase (andesine), in common with the plagioclase in all the rhyolite porphyries, is converted almost wholly to sericite and the biotite almost entirely to muscovite.

Andesite

The single andesite occurrence is a dike about 2,000 feet long and 200 feet across, along the north side of the porphyry belt not far west of Rock Creek. The rock is very fine-grained, fairly light gray, and breaks with a conchoidal and splintery fracture. It resembles no other rock in the district. It is composed almost wholly of tiny, poorly twinned, oligoclase laths and a little accessory quartz (less than 5 per cent). The texture is typically "andesitic" with swarms of more or less oriented feldspar laths. There is a little magnetite, sericite, and chlorite, but no original dark minerals. Were the plagioclase somewhat less calcic the rock might be classed as a keratophyre.

Moderately basic dike rocks

Many dikes of moderately basic composition, mostly small but some larger enough to be mapped, occur along the dike zone between Rock Creek and Horseshoe Bend. They resemble the rhyolite and dacite porphyries in containing the same kinds of phenocrysts, but differ in having groundmasses of much more basic composition with hornblende and biotite nearly as abundant as in lamprophyric varieties. They vary considerably in composition and appearance, and several varieties may be distinguished.

The most abundant of the dike rocks is a strikingly porphyritic rock with plentiful pinkish orthoclase phenocrysts from 4 to 10 millimeters long, widely scattered quartz grains from 1 to 3 millimeters in diameter, and black hornblende crystals 1 to 3 millimeters long in a fine-grained grayish groundmass, much darker than the groundmasses of the rhyolite porphyries. The quartz and feldspar phenocrysts are partly recrystallized, but the hornblendes occur as large, well-shaped, greenish-brown crystals in thin sections. The groundmass is composed largely of short orthoclase crystals and hornblende needles with accessory zircon, magnetite, apatite, and quartz. The quartz phenocrysts comprise about 5 per cent of the rock, the plagioclase (andesine) about 12 per cent, orthoclase about 8 per cent, and hornblende about 10 per cent. In the groundmass, orthoclase comprises about 45 per cent of the rock and the hornblende about 20 per cent. The andesine is partly to almost completely sericitized, the orthoclase only slightly so. On the basis of composition the rock might be classed as a moderately basic trachyte porphyry. The relations of the groundmass orthoclase and hornblende are much like those in a lamprophyre (vogesite), each of the minerals showing a marked tendency to assume its own crystal shape.

10.
Several dikes on the high ridge above Horseshoe Bend differ from those just described in the absence of orthoclase phenocrysts and in containing more plagioclase and dark minerals. These contain numerous plagioclase phenocrysts from 1 to 10 millimeters long, scattered quartz grains 1 to 2 millimeters in diameter, and some hornblende and biotite crystals in a fine-grained, dark gray groundmass. The plagioclase (andesine) and quartz phenocrysts are rounded and embayed, but the hornblende and biotite crystals are perfectly shaped and reappear in the groundmass, the hornblende as needles and the biotite in small grains. Other minerals of the groundmass are andesine and orthoclase and the accessories apatite and magnetite. Somewhat less than half of the rock is composed of dark minerals. Orthoclase is more abundant than plagioclase in the groundmass and biotite exceeds the hornblende. The rock is considerably altered and contains much calcite as well as considerable chlorite and sericitic mica. The texture of the groundmass with the tendency of its minerals to assume good crystal outline is suggestive of the texture of lamprophyres, but the rock might well be classed as a latite porphyry of moderate basicity.

Another variety forms a large dike along Rock Creek. It is moderately grayish and contains scattered andesine crystals from 1 to 4 millimeters long, scattered inclusions quartz grains, and brilliant black hornblende and occasionally augite crystals 1 to 3 millimeters long in a finely granular groundmass consisting of plagioclase, hornblende, orthoclase, magnetite, and a little quartz, zircon, and apatite. Plagioclase predominates over orthoclase and the two only slightly exceed the dark minerals. This rock might be classed as an andesite porphyry.

Lamprophyre

Lamprophyric dikes are numerous along the mineral belt and they lie most commonly in fissures occupied by veins. The dikes are narrow, rarely more than 5 or 6 feet thick, and are seldom seen except in underground workings. They have been intruded in and along side the lodes, but in places cut across the lodes.

Several varieties of lamprophyre occur, including minette, kersantite, and spessartite. As all dike rocks were not examined, there may be additional varieties. The rock is fine-grained in all varieties, grayish to greenish black, and inconspicuously porphyritic. The phenocrysts are altered dark minerals of about the same color as the constituents of the groundmass and therefore difficult to distinguish except in thin sections. The dark minerals comprise fully two-thirds of the minerals in each of the rock varieties. Some dikes contain scattered orthoclase, plagioclase, and quartz crystals as in the moderately basic dike rock. These crystals are partly resorbed and embayed.

Spessartite is apparently the most abundant and most widespread of the lamprophyric varieties. The dark minerals composing the scattered phenocrysts are usually completely altered to chlorite, epidote, and calcite, but shapes indicate pyroxene or amphibole and not biotite. In one rock less altered than the others partly chloritized pyroxene crystals remain and are embedded in a microcrystalline groundmass of brown hornblende needles, colorless augite, and zoned and twinned andesine laths. The plagioclase (sodic andesine) is still determinable in the more altered rocks, but the dark minerals are extensively chloritized. Magnetite and apatite are each fairly abundant in this variety.

Kersantite is much less abundant. This variety has some small inconspicuous biotite phenocrysts of excellent crystal outline embedded in a groundmass composed largely of biotite hornblende abundant twinned plagioclase laths (sodic andesine) a little interstitial quartz, and scattered magnetite grains. Sericite, chlorite, and calcite are each rather abundant. Some of the rock also contains occasional rounded and embayed quartz and plagioclase grains.
One dike of minette was observed. It has a few large orthoclase, plagioclase, and quartz grains, but the dominant phenocystals consist of scattered biotite and hornblende crystals in a fine-grained groundmass of abundant biotite and less abundant hornblende and orthoclase. Like the other varieties the rock is considerably altered and contains much calcite, chlorite, and sericite.

Age of the younger intrusives

The age of the dioritic and porphyry intrusives in the Pearl-Horseshoe Bend district is believed to be Tertiary, probably lower Miocene. This belief is based on data obtained in part in the district, but also in part on relations known to exist in other parts of the state. Although the intrusives in the Pearl-Horseshoe Bend district invade only the batholith rock (probably late Jurassic (?) or early Cretaceous (?)), they may be correlated on the basis of petrographic resemblance and structural relations with dikes and rocks elsewhere in Idaho that are known to be of Tertiary (probably Miocene) age.

The dikes and rocks along the Pearl-Horseshoe Bend dike zone are exactly like those along the Quartzburg-Grimes Pass "porphyry belt" in the Boise Basin. 1/ Not only are the varieties indistinguishable, but the dikes are also intruded along a similar zone or structural weakness. Ross 2/ has pointed out that the trend of the "porphyry belt" in Boise Basin approximately accords in trend with one of the major components of deformation affecting the Challis volcanics (lower Miocene or upper Oligocene) in south-central Idaho and that the rocks of the "porphyry belt" are petrographically similar to those which are known to be involved in the post-Challis disturbance. He points out further that the dikes in the Challis volcanics are probably of lower Miocene age and that those of the "porphyry belt" of the Boise Basin may consequently be tentatively regarded as lower Miocene also.

Dikes in the Pearl-Horseshoe belt, which are correlated with the similar intrusive rocks in Boise Basin and elsewhere in south-central Idaho, likewise may be tentatively regarded as lower Miocene. These dikes can be no younger than middle Miocene, for Columbia River basalts and beds of the Payette formation (considered to be middle or upper Miocene by Kirkham 3/) were spread over them and still remain as a partial cap near Pearl (Plate II, A).

Kirkham 4/ interpreted relations at the northeast end of the dike zone as indicative of contact metamorphism and quaquaversal dips in the Payette beds resulting from intrusion of the diorite stock into the Payette, a conclusion opposed to the one above offered for the southwest end of the dike zone. Data obtained in several visits to the area described by Kirkham show that wherever the Payette strata are in contact with the Tertiary diorite they are comparatively deeply eroded, but not otherwise metamorphosed. The only resistant strata suggestive of possible metamorphism (steeply dipping ledge-forming quartzitic beds) are separated by a wedge of Mesozoic quartz diorite. The attitude of the Payette beds is more suggestive of orogenic movement than doming by intrusion. Faulting of the Payette strata against the diorite with attendant downward drag of the beds is more likely the true explanation (particularly as faulting is much in evidence nearby). On this basis the diorite could be older than the Payette formation in agreement with the relations observed at the southwest end of the porphyry belt.

1/ Statement based on detailed study by the writer of both dike zones.
Intrusion of the dioritic stock and porphyry dikes are probably closely related events and occurred in the same epoch, for all bodies fit into the complex structural pattern determined by the regional Miocene deformation. It is evident that the porphyries are all younger than the diorite and its minor dikes and zones of affilitated granite because the dike varieties intrude the diorite. The dacite porphyry is probably the oldest of the porphyry dikes for not only does it show a rather marked resemblance to certain of the porphyritic facies of the diorite, but it is cut by the other porphyry dikes. The granite porphyry includes a gradational series ranging from granodiorite porphyry through quartz monzonite porphyry. In some places these merge with zones of dacite porphyry, in other places the dikes penetrate the dacite porphyry. All are about the same age, although the more silicic rocks may be the youngest of the sequence. Rhyolite porphyry dikes are younger than granite porphyries, for here, as well as in Boise Basin, they cut granite porphyry. The rhyolite porphyries differ slightly among themselves in age. The variety with the large orthoclase crystals among the phenocrysts is known to cut the other varieties of rhyolite porphyry in Boise Basin. The andesite porphyry, although not in contact with other dikes, is so much like some of the rhyolite and granite porphyry that its age and source must be the same and its age can not be much different. All dikes so far mentioned are apparently older than the mineralization, for most of them are either cut by veins or are more or less altered by thermal solutions. Only the lamprophyric dikes are younger than the mineralization and cut the lodes. The latitic dikes are pre-mineral, but apparently not much older because of their close affiliation with the lamprophyres. The place of the andesite in the sequence is unknown, but it was probably intruded during the same epoch inasmuch as it is controlled by the same structural pattern as the other dikes.

**PAYETTE FORMATION**

The Payette formation is widely distributed in the region around Horsehoe Bend, but only a relatively narrow strip appears along the eastern and southeastern parts of the map area and only minor patch near the Lincoln mine southwest of Pearl. The formation is cut by none of the intrusive dikes already described, but contains flows of basalt both at the base and top, as well as within. Flows at the base of the sedimentary strata are classified by Kirkham as the lower series of Columbia River basalt and those at the top as the upper series of Columbia River basalt. He redefines the Payette formation as the sedimentary strata between these two basalt series. No lodes have been observed in this formation.

The Payette formation was not examined in detail, but it consists of 800 feet or more of well stratified beds of granitic sand, clay, shale, volcanic ash, and thin beds of coal. Some of the well indurated arkosic sand is difficult to distinguish from the granitic rock of the batholith.

According to Kirkham, the beds carry a middle or upper Miocene flora.

**COLUMBIA RIVER BASALT**

Basalt is widely distributed over the general region, particularly to the north and northwest, but only scattered erosional remnants remain in the map area, mainly along the south and southwest margin of the dike zone from Rock Creek to

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Pearl, also east of Horseshoe Bend. Much of this basalt rests on an extensive
erosion surface cut across the batholithic rock and its contained dioritic and
porphyry intrusives (Plate II, A). Erosion has subsequently removed most of the
overlying Payette beds and has left only scattered patches of the basalt over
the dike zone west and southwest of Pearl, in places over the dacite and granite
porphyry dikes. Remnants of flows intercalated in the Payette formation or be-
longing to the upper series remain on the summit of the ridge south of Pearl and
also at several places between Rock Creek and Horseshoe Bend.

The basalt in the district is apparently of two kinds; olivine-free basalt
which comprises the basal flows near the Lincoln mine, and olivine basalt which
is much more widespread and forms all the other exposures. The olivine-free
basalt is strikingly porphyritic and contains from 10 to 20 per cent labradorite
phenocrysts in narrow tabular crystals ranging up to 10 millimeters long embedded
in a rather dense, fine-grained, dark gray groundmass. Many of the phenocrysts
have a pronounced brownish color because of groundmass inclusions. The ground-
mass consists of a matrix of small labradorite laths of essentially the same
composition as the phenocrysts, pale brownish titanianous augite, brownish glass,
ilmenite and magnetite grains, and long apatite needles. Near the margin of the
flow, where cooling was more rapid, the augite grains and brownish glass lie be-
tween the small plagioclase laths, but in rock near the center of the flows the
augite forms large grains enclosing one or more of the feldspar crystals. Ilmen-
ite and magnetite comprise as much as 5 per cent of the rock.

The olivine basalt is dark gray to black, fine to medium-grained, and may
be vesicular or non-vesicular. It weathers a brownish red. It usually has a
uniform grain, but in thin sections it may appear somewhat porphyritic because
of scattered olivine crystals a little larger than the grains of the groundmass.
The olivine crystals are well shaped and comprise from 5 to 10 per cent of the
rock. The remainder consists of augite (40 per cent), labradorite (45 per cent),
hypersthene (about 5 per cent), and magnetite (5 to 8 per cent). Apatite and
ilmenite are very minor accessories.

Because of its relations to the Payette formation the basalt has essentially
the same age, middle or upper Miocene. Ash beds in the Payette and in some
places intercalated flows indicate recurrent igneous activity during the epoch
of sedimentation as well as before and after. The flows and intercalated sed-
iments serve a very useful purpose in limiting the youngest possible age of the
diorite and porphyry dikes and affiliated mineralization, which are older than
the basalt and sediments.

RHYOLITE

Rhyolite lies mainly south and southeast of Pearl. It rests in part on
Payette formation and in part on Columbia River basalt. The rhyolite was appar-
tently poured out on an eroded surface of considerable relief after the Payette
formation and basalt had been partly removed from the dike zone. The rhyolite
ranges from a few feet to several hundred feet thick.

The rock is generally reddish-brown, pinkish, or lavender, and character-
istically shows a prominent fluidal banding with pinkish or lavender bands alter-
nating with grayish bands, each about a millimeter thick, or with alternately dark
red and light red bands and more widely spaced brownish and black bands. Litho-
physe and perlitic structures may also be observed. The rock is ordinarily com-
pact and aphanitic, but it usually has scattered quartz and feldspar phenocrysts
about one millimeter long which comprise from 5 to 10 per cent of the rock. The
feldspar is mainly orthoclase, but there is an occasional oligoclase crystal.
The phenocrysts are usually rounded and embayed by the groundmass, but some pre-
serve perfect crystal outline. The groundmass consists largely of aggregates of
closely packed microspherulites, which accentuate fluidal lines, and of scattered streaks or patches of a granular crystallization of quartz and orthoclase. Accessories include scattered grains of magnetite and occasional small crystals of zircon. The color of the rock is mainly due to disseminated reddish and brownish iron oxides.

The rhyolite was extruded after the basalt and Payette formation had been considerably eroded. Southward the rhyolite passes beneath beds of the Idaho formation. According to Kirkham 2, an unconformity of lesser magnitude separates the rhyolite from the overlying Idaho formation. He regards the rhyolite as either late Miocene or early Pliocene, and correlates it with what he calls the Owyhee rhyolite in the Silver City district. 2

**IDaho formation**

The Idaho formation has been redefined by Kirkham 2 to include all the sedimentary strata above the Columbia River basalt and rhyolite, and below the Upper Mesa and Lower Mesa gravel formations (originally designated by Lindgren 2), which are Pleistocene. This formation is not shown on the map area, but lies a short distance to the south and west, where it rests on rhyolite, basalt, and batholithic rock and spreads over the porphyry belt.

The basal beds and upper beds are reported to be preponderantly sandy, but the greater part of the formation consists of light colored shale with scattered beds of volcanic ash and diatomite. Most of the formation is well stratified, but poorly consolidated. These beds dip toward the Snake River Plain from the Pearl area.

According to Kirkham 5, the Idaho formation is Pliocene and Pleistocene.

**Lower Mesa Gravels**

Two distinct levels of terrace gravels are represented in the general region, but only the lower, the Lower Mesa gravels, appear in the map area. Remnants of the Lower Mesa gravels may be observed along the Payette River and form an interrupted but well-defined terrace rising to 100 feet above the water. The largest remnant flanks the open valley north of Horseshoe Bend (Plate II,B). Smaller remnants remain in the canyon below.

The deposits consist of coarse, bouldery gravel beneath a few feet of sandy loam or sand.

The distribution of the terrace gravels is related to the present canyon system. The gravels rest on eroded Idaho formation as well as on older rock and

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ALLUVIUM

Recent alluvium consisting of unconsolidated sands and gravels lies along the Payette River. The most extensive deposits are at Horseshoe Bend and form a strip one-half to a mile wide, stretching upstream for about 4 miles above the town. Below Horseshoe Bend the strip of alluvium is narrow, in some places absent, in other places in part concealed by slope wash or stream wash from tributary gulches.

STRUCTURE

Pre-Tertiary structures

The granitic rock belonging to the batholith has irregular but locally pronounced jointing and foliation. The most persistent joints trend about west-northwest, the foliation at about right angles. These have exerted no control on mineral deposition, except insofar as the jointing may have tended to guide subsequent fractures of different origin.

Miocene structures

The most conspicuous structural feature of the Pearl-Horseshoe Bend district is the dike zone or "porphyry belt." Although this dike zone is similar to the Quartzburg-Grimes Pass "porphyry belt" in Boise Basin, it is not nearly so long, although fully as complex. The Pearl-Horseshoe Bend belt is about 9 miles long and 2 miles wide. The belt as a whole trends about N. 60° E., and were its strike projected to the northwest would pass several miles north of the one mentioned in Boise Basin. The two dike belts, however, do not overlap.

As in the Quartzburg-Grimes Pass belt, the dikes are rarely aligned in the direction of the belt as a whole, but cut obliquely across. The diorite stock is an exception. Several dikes near the northeast end of the zone are also similarly aligned in the direction of the dike zone, but elsewhere the prevailing trends are about N. 80° W., east and west, and less commonly N. 60° to 70° E. and N. 30° E. The distribution of the dikes is apparently systematic and under definite control. Almost all at the west end of the belt, except for a few near Pearl, trend about N. 80° W. South and east of Pearl the trends change to the east and northeast of Rock Creek to the east-northeast. The change in the dike trends is particularly noticeable and abrupt between the crest of Crown Point and Rock Creek, and continues less abruptly around the south side of Crown Point to and beyond the town of Pearl. The medial line or zone of changing dike trends is probably the most significant feature of the dike zone, although its cause is not yet fully understood. Insofar as the sub-surface relations of the dikes can be observed, they dip to the north.

Close accordance exists between the dike and lode patterns. The strikes of the largest and most persistent of the mineralized fractures, like those of the dikes, approach but rarely coincide with that of the zone as a whole. Lodes are more or less closely parallel to the dikes in their own vicinity. Those near the west end of the district strike west-northwest or east-northeast, those elsewhere from east to northeast. The fracturing that furnished the channels for the ore-bearing solutions is doubtless to be attributed to a recurrence of movement

along this zone of major structural weakness which earlier provided for the intrusion of the dikes. Subsequent adjustments have taken place in and along the veins and dikes.

The crustal disturbance responsible for the dike intrusion and mineralization did not affect the Payette formation or Columbia River basalt and is therefore older than middle or upper Miocene. The dikes have been correlated with those in Boise Basin and in Challis volcanics elsewhere and the deformation is therefore likely to be a part of the general disturbance affecting the Challis volcanics (upper Oligocene or lower Miocene) and thus probably lower Miocene.

Post-Miocene structures

More recent structural disturbance has acted independently of the earlier movements. This disturbance has produced normal faulting and gentle warping here and in the general region. A prominent fault of this kind lies immediately west of Horshoee Bend and is largely the cause of that topographic depression. This fault is shown on the geologic map. It extends from a southwesterly direction to Horshoee Bend and from there curves to the north and continues on for many miles. It parallels the dike zone for a distance, but at Horshoee Bend cuts diagonally across. On the southeast and east sides of the fault the Payette beds dip 15° to 30° westward and lie against the granitic and dike rocks (Plate 1). This fault has caused the Payette River to meander widely in the soft Payette sediments of the apparently down-dropped segment to produce the "horshoee bend" in the river and then to cause the narrow canyon in the resistant granitic rock across the higher block on the west. It displaces the Miocene Payette beds, but is older than the Lower Mesa terrace gravels which extend uninterruptedly across the segments. Like other normal faults in the general region, this one is believed to be late Pleistocene or early Pleistocene.

Similar faults of lesser magnitude have also been observed in the Horshoee Bend Basin wherein basalt and Payette strata lie against the older granitic rock, but none of these is in the map area except one at the extreme northeast end of the dike belt where Payette beds are dragged against batholithic rock and the diorite stock. Other unmapped faults of minor size have also been observed near the southwest end of the dike belt near Pearl where Payette strata, basalt, and rhyolite appear to have been dropped as a segment into the dike zone. Many of the dikes have been off-set from a few inches to a few feet by faults of northerly trend, but the small size of these faults did not permit their mapping.

Warping has affected Horshoee Bend Basin to slight extent, mainly because of moderate differences in the amount of displacement along the fault plane. Warping has also tilted the southwest part of the area from the summit of Crown Point to the margin of the Snake River Plain. This latter movement is to be associated with the subsidence related to the Snake River downwarp.

ONE DEPOSITS

HISTORICAL SKETCH

Lode discoveries were made in the Pearl-Horshoee Bend area in the early sixties not long after the discovery of gold in Boise Basin, but the first development of record was on the Red Warrior at Pearl in 1870. Most of the lode locations were made between 1894 and 1896. The district underwent rapid development during the following decade and probably reached its greatest activity be-

tween 1900 and 1907. Most of the production during that time was from free-milling oxidized ores, but with increasing depth increasingly greater difficulty was experienced in making gold recovery from the sulphide ores. By then several of the deposits had been mined to depths of from 400 to 500 feet. Most of the mines were then compelled to shut down because the current ore dressing methods were not successful and the grade of the crude ore did not justify the cost of railway transportation and smelting. Some of the properties continued to operate intermittently for many years after, but, except for several attempts to work the Lincoln mine, the district has been generally inactive since 1915.

Records of production were not obtained, but Lindgren 1/ gives a total of $80,000 up to 1896, and Bell 2/ in the annual reports of the State Inspector of Mines aggregates a total of more than $1,000,000, but offers no basis for his figures.

GENERAL CHARACTER

The ore deposits consist essentially of sulphide stringers and seams in complex fracture or fissure zones and are valued chiefly for their precious metals, particularly gold. Much of the ore occurs as fracture fillings in the shattered rock or as bands or lenses along the plane of the fissure, usually both. The lodes differ somewhat in their mineralogy and in the relative proportions of gold and silver, and of base metals, but no classification other than gold lode deposits is necessary.

STRUCTURAL RELATIONS

The lodes lie along the dike zone, mainly in the late-Jurassic (?) quartz diorite and granodiorite of the batholith, but also in the dark Tertiary diorite and in and along the contacts of porphyry dikes. Most of them are concentrated in a narrow belt from Pearl to Rock Creek, which about coincides with the zone through which the dike trends change from west-northwest to northeast. Others are generally at or near the face of intersecting or divergent dike trends. Attention has already been directed (page 16) to the close accordance between the dike and fissure trends. The fissure zones have about the same strikes and dips as the dikes in their own vicinity, and as the dikes change in direction the mineralized fissures act likewise. Dikes and subsequent fissures have apparently each reacted to the same or similar structural control.

North and west of Pearl the lodes strike mainly about N. 80° W., but at and south of Pearl the curvature changes to nearly east. Northeast of Pearl on upper Willow Creek and Rock Creek, and in the remainder of the dike belt, the trend is commonly about N. 70° E. Most of the lodes dip north, but a few dip in the opposite direction. Those with northerly dip are generally the most extensively mineralized.

The mineralized fissures are long. The Lincoln lode alone has been mined for over 1,300 feet on the 300-foot level and has been exposed on the surface for at least a distance twice as great. Other fissure zones near Pearl are equally as long. The lodes along Willow Creek including those at Pearl are comparatively narrow and range from a few inches to several feet wide, many of them from 3 to


18.
Fig. 2. Diagrammatic section of a typical Pearl ore body (adapted from Bell, Ninth Ann. Rept. of Mining Industry of Idaho for the year 1907, p. 30.)

Stippled area represents altered country rock, sericitized and impregnated with pyrite.
Ore indicated by cross-hatched and black areas.

-18-4
feet over great lengths. Locally some are 8 to 10 feet wide and exceptionally as much as 30 feet. The lodes on Rock Creek and other parts of the district commonly range from 4 to 10 feet with an average of from 6 to 8 feet. None of the lodes is uniformly thick, but they characteristically pinch and swell with the best ore shoots in the swells.

Structurally the lodes are complex. They are ordinarily made up of several more or less closely spaced parallel slipage planes with broken or fractured rock between, or, if there has been but one prominent plane of movement, a border of shattered rock in the hanging wall. The nature of the fissuring has been in part determined by the character of the rock involved. The sharpest fissuring is ordinarily in the granitic rock of the batholith. Where the fissuring extends into or across porphyry dikes, it usually loses its sharpness and instead is replaced by splintering or more widely spaced fractures.

The ore lies along the fractures throughout the fissure or fracture zones and its position aids in defining the original fracture pattern as replacement of the country rock has played a subordinate role. The whole disturbed zone usually constitutes the lode. Near Pearl the ordinary lode consists of narrow seams and stringers of ore in the fractured rock, commonly with a thicker and heavier band along the footwall. In some there is a second band of sulphides in the hanging wall with a zone of stringers between, as illustrated in Figure 2.

Some of the compact bands along the main fractures form narrow high grade veins as much as 6 or 8 inches thick. In the thicker deposits of medium-to-low-grade ore the compact seams or lenticular bands are lacking and the entire fracture zone is traversed irregularly by numerous small seams carrying sulphides. In most deposits throughout the district these sulphide stringers ordinarily comprise from about one-fourth to one-eighth of the lode width. Recurrent movement along the same fracture planes has usually sheared through the ore stringers, particularly along the footwall, and has incorporated part of the ore in wide gouge bands, either as crushed ore particles or as larger pebbles or boulders, or usually both. Most lodes are now sharply defined by the post-mineral gouge bands.

MINERALOGY

The ore bands and stringers consist largely of sulphides, particularly arsenopyrite and pyrite and subordinate sphalerite and galena, with additional scant amounts of chalcopyrite, tetrahedrite or tennantite, boulangerite, stibnite, cymophene (?), and pyrrhotite in some deposits. These sulphides are accompanied usually by small amounts of quartz, dolomite, and calcite, the latter in some places somewhat manganiferous, but the chief gangue is the broken and altered country rock in which the sulphide seams occur. Gold invariably accompanies the ore and appears in assays, but is rarely observed even in microscopic particles. It is the most widely distributed constituent of the lodes.

Lodes on upper Willow Creek above Pearl and on Rock Creek have the simplest mineral assemblages. Most of them contain mainly arsenopyrite and pyrite with subordinate, but in places with equally abundant, sphalerite and galena. Quartz, dolomite, and calcite are only minor ingredients. The sphalerite is steel-gray to black in color, rarely greenish-yellow. The dark-colored sphalerite invariably contains swarms of microscopic chalcopyrite inclusions. The sulphides are associated with and largely replace vein quartz, much of which is massive and only rarely drusy. The sulphides were deposited after movement had fractured the quartz. Pyrite and arsenopyrite were deposited first and then, after further crushing of the quartz, pyrite, and arsenopyrite by repeated or continued movements, the sphalerite and galena were deposited apparently without intervening periods of shattering. The carbonates were introduced only after the quartz-sulphide seams had been fractured and in some places thoroughly brecciated by renewed movement along the fissure zones (Pl. III). Dolomite was first to cement.
A. Photomicrograph showing a common feature in the ore near Pearl. White arsenopyrite crystals (A) and dark gray sphalerite grains (S) are in a matrix of light gray galena (G). x 122.

B. Photomicrograph showing the characteristic brecciation of much of the ore with angular galena fragments (G) and sphalerite (S) in a cement of dolomite (black). x 122.
the crushed ore fragments, and calcite was deposited only after further movement of lesser intensity had caused rather widely spaced fractures in the sulphides and dolomite. In places calcite crystals line open clefts.

The character of the mineralization changes somewhat west and northwest of Pearl. Arsenopyrite is still relatively abundant, and pyrite, sphalerite, and galena locally so, but the ore is in general much more siliceous and drusy structures are much more common. In addition the lodes contain variable although minor amounts of tetrahedrite or tennantite, owyheeite (?) and pyrrygrite. In consequence, the ore has much higher silver value. The gold content also appears to increase somewhat. Much of the quartz is fine-grained, almost chalcedonic, but some is locally coarse and drusy or forms combs. The sulphides have in part replaced the fine-grained quartz, but have been deposited more or less contemporaneously with the coarse, in part between or on the quartz crystals. In some places the quartz also forms drusy surfaces on the sulphides, indicating that the period of quartz deposition in part outlasted the sulphides. Some of this late quartz fills fractures in the sulphide ore. The sulphides are generally not so coarse-grained as they are on Upper Willow Creek and on Rock Creek, and the relative amount of arsenopyrite appears to increase at the expense of the pyrite. Late dolomite and calcite are present in these lodes and have the same relations as before, although both show a greater tendency to form drusy surfaces. Much of the calcite is manganiferous and faintly to decidedly pinkish.

Ore at the Obornor mine near Horseshoe Bend is much like that above Pearl and consists dominantly of arsenopyrite, pyrite, and much sphalerite and galena, with minor quartz and carbonates, but it also contains small amounts, usually microscopic grains, of tetrahedrite or tennantite, boulangerite, and stibnite. The boulangerite and stibnite are younger than the other sulphides and appear to be more or less closely associated with the carbonates. Much of the stibnite is confined to a single lode on the property, which has only arsenopyrite, pyrite, and a little sphalerite. Wherever galena occurs in any of the lodes, little curved laths of boulangerite appear in place of the stibnite either in the carbonate or in the galena.

Surface weathering has converted the tops of many of the lodes into brownish and blackish stained gossans which contain partly decomposed sulphides, lead carbonate and sulphate, iron oxides, greenish scorodite, and more or less black manganese oxides. Such matter is reported to carry free gold and to have furnished much of the richer ore in the early days of the camp. This type of ore, however, did not extend downward for more than 100 feet and usually very much less. Argentite and native silver were observed in some of the lodes as secondary minerals associated with galena and ruby silver.

**TENOR OF THE ORE**

According to past records, some of the crude ore that was shipped in the early days contained from 1.5 to 5 ounces gold per ton. Much ore was also milled that averaged about 0.5 ounce per ton. So far as the writer can learn, gold values were little higher near the surface than at greater depths and there is no proof of secondary gold enrichment, although gold that was more or less freed by the decomposition of the sulphides was in a condition to be saved by amalgamation.

Assays were made of numerous selected samples of ore collected by the writer from as many lodes as possible. Much of the ore had been exposed on the surface for many years and in most places was that last mined and therefore probably from the deeper workings. Those assays reveal that the more or less clean sulphides contain from about 0.1 ounce to 2.2 ounces gold per ton and from 1 to as much as 56 ounces of silver. These values are not representative of the lodes.
as a whole, but only of the selected sulphides contained in the individual stringers. The tenor of the ore mined is therefore ordinarily considerably less depending on the proportion of sulphide stringers to country rock. But from old assay records it is evident that 0.26 to 0.80 ounce gold values represent the tenor of much of the ore. So far as the writer's assays reveal, the lodes with ruby silver carry higher gold values than those through the remainder of the belt.

WALL ROCK ALTERATION

The country rock in the lode and for a few feet on either side has invariably been thoroughly altered by the ore solutions. The rock has been bleached by extensive sericitization and impregnated with small crystals of pyrite. The sericitization has resulted from the reaction of the mineralizing solutions with the feldspathic country rock. The sericite constitutes most of the gouge or "talo" in the lodes. The abundance of the sericite is in general related to the intensity of mineralization and the richest and largest ore bodies usually occur where the sericitization of the wall rock has been most pronounced. Such altered rock may serve as a guide to ore, but does not guarantee the occurrence of profitable ore bodies. The altered rock, although studded with pyrite crystals, usually contains less than 0.1 ounce in gold, or, more generally, scarcely more than a trace. The sericitized rock that is thus altered tends to soften or weaken on exposure, and, if there has been subsequent movement along the lode, the ground is difficult to hold.

GENESIS OF THE DEPOSITS

The concentration of the lodes along the dike zone, in some cases in and along the dikes themselves, and their distribution along fissure zones of the same trend as those that directed the intrusion of the dikes suggest a close relation of the lodes and dikes to the controlling structural forces and to each other. It is apparent that recurrence of movement along the zone of structural weakness provided the openings for the access of the mineralizing solutions near the close of dike intrusion, but before igneous activity had entirely ceased, for some of the basic dikes which are presumably differentiates of the primary parent magma to which the other dikes are believed to be related were intruded into the lodes themselves at the close of mineralization. A genetic relationship is thus inferred between the parent deep-seated magma to which the Tertiary dikes are related and the mineralization, and particularly between the lodes and the rhyolitic magmas, for the rhyolite porphyry dikes show a marked sericitization that is not unlike that along and in the lodes. Movement of the ore solutions is thought to have followed near the end or shortly after the intrusion of the rhyolite porphyries. Like the dikes, the lodes herein discussed were beveled by erosion before the extrusion of the Columbia River basalt and the deposition of the Fayette formation. The mineralization, therefore, belongs to the younger of the two main epochs of metasomatism recognized in south-central Idaho 2 and has no genetic connection whatsoever with the Jurassic (?) batholithic magma.

As mentioned before, structure has had a marked influence on the distribution of the ore bodies. Mineralization was especially localized along the dike belt from Willow Creek to Rock Creek where the structural trend lines curved from west to northeast, and at other places near the foot of divergent dike trends or near dike and fracture intersections. The greater shattering of the rocks at such places provided more favorable channels for the movement of the ore solutions, and therefore for the localization of ore bodies.

The mineralogic and textural characteristics of the lodes indicate that they are of mesothermal type 3, formed at intermediate temperatures and at depths of


21.
some thousands of feet below the existing surface, now independent of the present surface. This type is suggested both from the extensive sericitization of the country rock and from the absence of diagnostic high temperature and low temperature minerals in the ore seams. The lodes have since been eroded to their present depths with the probable removal of several thousand feet of rock. During the interval of mineral deposition the temperatures were probably not uniformly the same at the depth now exposed for deposits on upper Willow Creek and on Rock Creek were apparently formed at somewhat higher temperatures than those west of Pearl where fine-grained quartz, drusy structures, tendency for more finely crystalline sulphides, and presence of ruby silver might suggest somewhat lower temperature or cooler surroundings during the ore formation. This change from the base metal type of lode with characteristic arsenopyrite-pyrite-sphalerite-galena mineral assemblage to one with more quartz, a lesser proportion of the base metals, and with a higher proportion of silver might indicate that the lodes a short distance northeast of Pearl were formed nearer the main ascending ore channels where the country rock had been appreciably heated by the flow or the mineralizing solutions and that the lodes west and northwest of Pearl were formed from the solutions that spread laterally into fractures in the cooler rock away from the well-heated main ore channels. Since the deposits were formed several thousand feet of rock have been eroded from the dike and minor belt, most of it, as mentioned earlier, before the extrusion of the Columbia River basalt and the deposition of the Fayette formation.

ECONOMIC POSSIBILITIES

The results of this study appear to indicate that the gold belt justifies more extensive investigation than it has been receiving. The district formerly had a large number of mines that were compelled to close, apparently not because of exhaustion of ore reserves, but because the ore dressing methods then in vogue were not able to make an adequate recovery from the sulphide ores. According to past accounts, many of the mines have also suffered severely from mismanagement, inadequate financing, and gouging or gobbing. Future development should be undertaken only by well financed mining companies.

Many lodes of proven great length and of thickness of from 3 to 8 feet have been demonstrated to contain ore assaying from 0.25 ounce to 0.50 ounce, and even higher. The values are apparently fairly uniformly distributed, although there are shoots richer than the average, particularly in the swells. The district has no record of bonanzas and the deposits are such that none need be expected with depth. There is no evidence that the gold metallization is shallow and that the bottom of the commercial zones have been reached. On the contrary, the deposits were formed at intermediate temperatures and at depths of some thousands of feet, and it is reasonable to expect that the grades of ore found in the present deep-low levels might be expected to continue to greater depths with little change. The fact that the mineral zone is within a batholith should not serve as a prejudic against the lodes on the belief that they represent merely the "roots" of lodes largely eroded away for there is no genetic relationship between the lodes and the batholith. On the contrary, the mineralization is known to be mid-Tertiary in age and related to the dike magmas, and so long as the governing structural conditions continue to be persistent at depth the lodes may be similarly as persistent, except for local interruptions. Much of the gold recovery in the early days of mining was from the oxidized or partly oxidized ores near the surface, but there is little or no evidence at present that the ore near or at the surface was any richer than that in the sulphide zone below.

The district has the advantage of being in an easily accessible region, adjacent to good highways and a railroad, and in a place where weather is no handicap as the ground is usually free of snow throughout most of the year. Its semi-arid climate does not sustain tree growth, but the necessary mining timbers may
be easily and cheaply brought in by rail and truck, or from the forest a few miles to the east. Electric power is already available. Underground mining presents some difficulties because of the sericitic and post-mineral movement that makes heavy ground along the lodes, but this is not an insurmountable obstacle, and the increase in timbering cost may be in large part off-set by lower drilling and powder costs and absence of troublesome underground water.

MINES AND PROSPECTS

Lincoln

The Lincoln mine is near the extreme west end of the gold belt about a mile southwest of Pearl. According to Bell, it has been one of the chief producers in the district and is credited with a total production of between a half and a million dollars, principally in gold. The property includes 5 patented claims and consists of more than 3,000 feet of underground workings, including a vertical shaft 540 feet deep and an inclined shaft 186 feet long. It has a fully equipped surface plant, including a 100-ton flotation concentrator.

The Lincoln has been worked more or less continuously from the earliest days of the district. In 1897 the development consisted of a crosscut 200 feet long, drifts on the vein, and a small winze. Subsequently an inclined shaft was sunk to a depth of 300 feet, but by 1907 this shaft had been abandoned and the mine was worked through a three-compartment, vertical shaft then 430 feet deep with the main work on the 300-foot and 400-foot levels. By 1919 the shaft had been extended to 540 feet. A 75-foot shaft had also been sunk in the lode east of the deep shaft and considerable drifting was done therefrom. In 1926 the mine was acquired by the Lincoln Mine Operating Company, which in 1927 reconstructed the mill and produced a few tons of high grade concentrate from ore mined from the upper part of the lode. Stopping was then suspended and work started in reopening the main shaft. The shaft was unwatered and repaired during the following year (1928) and a large amount of exploratory work was done on intermediate levels. This work was continued until October, 1929, when operations were again suspended and the equipment partly dismantled. The mine was idle during 1930 and 1931, but in 1932 the property was acquired by the Ojus Mining Company, which began work on a new inclined shaft. At 196 feet a short crosscut was driven to the lode and ore encountered that had been missed in former operations. The mill was rehabilitated and a small tonnage of concentrate produced and marketed. More drifting was carried on through the old workings from this incline during the early part of 1933 and other small bodies of ore loft in former operations were found. Later in the summer underground exploration was discontinued and activities transferred to surface prospecting.

The Lincoln lode is one of the longest in the district and has been opened on the surface for more than a quarter of a mile. It is near the southern margin of the dike zone and lies in the batholith in the footwall of a small dacite porphyry body and several hundred feet south of a large granite (granodiorite) porphyry dike. The lode has barely been disclosed by erosion of the younger


Campbell, Stewart, Thirty-fourth Ann. Rept. of the Mining Industry of Idaho for the year 1932, p. 141, 1933.
overlying sedimentary and extrusive volcanic rocks, and patches of these rocks lie near and probably conceal the fissuring beyond the present limits of development. Its easterly continuation is abruptly concealed by Fayette strata and basalt not far from the main shaft. Westward the fissuring in one place passes beneath a small remnant of basalt and then reappears.

The lode strikes approximately N. 75° W. and dips 60° N. Its thickness ranges from a minimum of 1 foot to a maximum of about 30 feet, but the average is between 3 and 4 feet. It shows remarkably persistent mineralization along the strike and is reported to have a continuous ore shoot 1200 feet long and 4 feet thick on the second level, and ore matter for 1600 feet on the 300-foot level with the face in good ore. In one place east of the shaft the lode is reported to swell to 30 feet (Log Cabin shoot) and at that point to contain the richest ore in the mine. On the 400-foot level the lode is reported to be as much as 15 feet thick and on the lowest level to range from 1 to 10 feet, and to average about 4 feet for 600 feet. The Log Cabin shoot pitches steeply to the east.

The lode is more or less typical of those in the Pearl district and consists of bleached and sericitized country rock impregnated with pyrite crystals and cut by small seams, streaks, and lenses of ore 1 to 6 inches thick. Post-mineral movement along the fissure zone has been particularly conspicuous and the lode contains a gouge band several inches thick and is otherwise greatly broken. Much ore is incorporated in the gouge as crushed particles or rolled boulders and pebbles.

Ore in the stringers and lenses, and that incorporated in the gouge, is composed mainly of arsenopyrite, but includes also pyrite, sphalerite, and galena, and more or less quartz and calcite, the latter frequently druzy. Small amounts of ruby silver (pyrrhotite) also occur in parts of the lode. Some of the quartz is fine-grained, but some is coarse and druzy. Much of the sphalerite is dark, but some is reddish and has yellow centers.

The ore maintains a fairly even tenor. Although Lindgren reports that 15 tons of ore shipped in 1897 averaged $100 to the ton, the average for the mine as a whole has been near 0.5 ounce per ton. According to Bell, the 1200-foot ore shoot on the second level contained 0.5 ounce ore, and that ore on the 300 and 400 levels averaged only slightly lower, whereas the ore on the 500-foot level averaged somewhat higher. These values were obtained from systematic sampling of the lode, not picked ore from the sulphide seams.

Post-mineral movement in and along the lode has made the ground difficult to hold. Much ore has been lost because of this condition and it has been the "lost" ore that has been mined during the more recent operations. According to Bell, the old survey and mine maps show that the soft, heavy ground had closed drifts and stopes before mining had progressed more than one-third of the way from one

Bell, R. N., Ninth Ann. Rept. of the Mining Industry of Idaho for the year 1907, pp. 35-36, 1908.


level to another, and that not more than one-third to one-half of the ore under-cut was ever mined. Recent work through the old workings gives credence to the statement that the workings would cave before much of the ore could be removed.

Checkmate

The Checkmate mine is in Pearl on the south side of Willow Creek. It has been one of the most productive properties in the district with a total output, according to Bell ⅓, of nearly a million dollars. The mine has been developed by a 58-foot shaft and the ore has been stope from the bottom level to the surface. The property was formerly equipped with a mill, but it was destroyed by fire long ago and the mine has been idle, at least since 1915.

Little data on the history of development are available. During Lindgren’s visit in 1906 ⅔, the mine was developed by a tunnel 100 feet long at the level of the creek, but by 1907 the mine had five extensive levels and some exploratory work had been done on the sixth. ⅔ During the same year the Hucla-Checkmate Mining Company, that had taken over the old Checkmate group, was driving a long crosscut tunnel, then in 900 feet from the Checkmate mill on Willow Creek for the purpose of intersecting other lodes, particularly the Rod Warrior and Levithan, which were believed to extend the full length of the group. Nothing further was learned of the operations.

The Checkmate lode is well within the dike zone. It is enclosed in the Jurassic (?) quartz diorite, but a dike is reported alongside, in places in the hanging wall, in other places in the footwall. Dike rock on the waste dump has the composition of lamprophyre and is probably from the dike along the lode. dacite porphyry dikes outcrop nearby, but apparently none has been cut in the underground workings. Payette beds and rhyolite cover the surface several hundred yards to the west and south.

The lode strikes about N. 84° W. and dips 60° N. It is reported to average about 4 feet thick and to show the usual pinching and swelling on the strike and dip. Its entire length was not learned, but Bell ⅔ reports practically continuous ore bodies for 900 feet on the No. 5 level. He also reports that the lode was lost on the sixth level either because of faulting or because the lode pinched and the small vein found on this level was not believed to be the downward continuation of the larger one above. Whether this small vein on the sixth level was subsequently explored was not learned.

The lode, according to reports, consists of a zone of sericitized and pyritic quartz diorite with stringers and relatively thick seams and bands of massive sulphides. Some of the seams that were mined, judging from fragments on the dump at the present time, were as much as 4 to 6 inches and locally as much as 12 inches thick. Aside from the compact ore in the stringers, bands, and lenses, much ore was also incorporated as crushed fragments or particles in post-mineral gouge, and may be observed in the hard gouge on the dump at the present time.

The ore seams consist largely of arsenopyrite, pyrite, galena, and sphalerite, and only scant amounts of chalcopyrite, quartz, dolomite, and calcite. The

⅓ Bell, R. N., Ninth Ann. Rept. of the Mining Industry of Idaho for the year 1907, p. 32, 1908.
⅔ Bell, R. N., Ninth Ann. Rept. of the Mining Industry of Idaho for the year 1907, pp. 32-33, 1906.
⅔ Bell, R. N., Ninth Ann. Rept. of the Mining Industry of Idaho for the year 1907, pp. 32-33, 1906.

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Some of the arsenopyrite-rich ore from the dump was assayed and the returns were 2.19 ounces in gold and 12.8 ounces in silver. Assays of the ore with considerable sphalerite and a little galena were 0.68 ounces in gold and 7.1 ounces in silver per ton. According to Lindgren, 3/ 300 tons of ore shipped in 1896 averaged $90 per ton. No other data were obtained on the tenor of the ore mined.

Work in the long crosscut from the mill on Willow Creek driven to intersect the Leviathan believed to be 900 feet south of the Checkmate lode exposed three parallel lodes in addition to the Checkmate 2/, but had not reached the Red Warrior and Leviathan in 1907. Whether these were subsequently encountered was not learned. One of the lodes penetrated by the crosscut is reported to have been 8 feet thick with a 2-foot shoot of the usual base ore containing about 0.5 ounce in gold.

Leviathan

The Leviathan, known also as the Whitman mine, lies immediately above the town of Pearl on the south side of Willow Creek. Prior to 1910 it was extensively operated by the Whitman Mining Company. The workings are now inaccessible, but, according to Bell 2/, the mine was worked in the early days of the camp through a shaft 152 feet deep. Since then the lode was crosscut at a depth of 90 feet near the west end line of the group and followed by drifts to the east for 1,300 feet to the Black Pearl line, gaining a maximum depth of 363 feet and an average depth of 200 feet. By 1909 the lode had been developed to a depth of approximately 400 feet. 2/ Details of any later development have not been learned.

The Leviathan lode cuts only the Jurassic (? ) batholith, but, like the others near Pearl, is not far from dacite porphyry dikes nor far from the cover of rhyolite and Payette beds. The lode is one of the most pronounced mineralized fissure zones in the district. It strikes slightly north of east and dips 30° N. It extends entirely across the property into the Checkmate group on the west and the Black Pearl on the east. Its average thickness has been about 3 feet and is reported to have ranged from 1 to 7 feet.

The lode is reported to be well mineralized throughout its length. The footwall is said to be especially well defined and usually has, immediately above, a band of nearly clean sulphides and generally a similar but smaller band next to the hanging wall with a coarse network of sulphide stringers between, and, in places, also, a finer network in the hanging wall. The lode is reported to pinch in places, apparently in more or less defined horizons, but the pinches are reported to be of small extent, and development has shown that a short raise or drift in the narrow part of the lode would promptly encounter the fully expanded lode either above or ahead.

The ore is much like that on the Checkmate and consists mainly of compact sulphides, particularly arsenopyrite and pyrite, with lesser sphalerite and galena, and only scant quartz and carbonates. Some of the ore is faintly banded because of movement concurrent with mineral deposition. The sphalerite and galena most commonly form scattered nests, lenticular masses, and granules in or cutting the pyrite and arsenopyrite.

2/Bell, R.N., Ninth Ann. Rept. of the Mining Industry of Idaho for the year 1907, p. 31, 1908.
Bell reports that the lode assayed from 0.25 to 5.00 ounces per ton and that 600 tons of roughly sorted ore obtained in drifting the length of the property, without any stoping, assayed $281.31 per ton as follows: Gold, $21.91; silver, $3.58; lead, a trace; copper, 0.2 per cent; zinc, 2 per cent. He also reports that during development in 1907 the Whitman Mining Company shipped a half dozen cars of hand-picked crude ore which netted from $40 to $80 per ton. Four hundred tons of concentrates with average values of $65 per ton (85 per cent in gold) and 100 tons of hand-sorted ore with a $90 average were shipped in 1909.

The Red Warrior lode also extends across the Leviathan property. This lode is parallel to the Leviathan and lies 60 feet to the north. According to Bell, a drift had in 1907 been driven along the Red Warrior lode for 600 feet with crosscuts every 50 feet. This work, he reports, had disclosed a mineralized zone 15 feet thick for the full length of the drift composed of altered granitic rock with more or less disseminated pyrite, arsenopyrite, sphalerite, and galena, and with about 0.2 ounce in gold per ton.

**Black Pearl**

The Black Pearl joins the Leviathan on the east about a mile southeast of Pearl. The mine was opened through a vertical shaft about 400 feet deep sunk in the valley bottom and from it between 5,000 and 10,000 feet of drifts had been driven, mainly from three crosscuts. The shaft is now closed and none of the workings is accessible except some surface cuts and shallow shafts on the hill slope to the south. There has apparently been no work on the property for many years except on the cappings, and the mill has long been dismantled. Nothing was learned about the past production, although the mine was worked at intervals until the increasing baseness of the ore made gold recovery difficult and unprofitable.

Three lodes cross the property, each of which strikes about N, 80° W, and dips about 50° to 90° N. Two of these are the Leviathan and the Red Warrior. All are in the Jurassic (?) quartz diorite in the vicinity of dacite porphyry dikes and are not far from an erosional remnant of basalt and from a cover of Fayette beds and overlying rhyolite. The Red Warrior was encountered about 300 feet from the shaft, but the development was largely confined to the second of the three lodes, the Leviathan. These lie well within the mineral belt.

The Leviathan is much the same as in the adjoining properties on the west, and the other lodes are reported to be not unlike the Leviathan. One of the lodes is well exposed in the side of an abandoned shaft on the hill slope. It consists of about 3 feet of fractured and altered granitic rock with iron-stained quartz seams or iron-stained seams alone lying above a band of hard gouge. Unoxidized ore on the dump consists largely of sulphides and some of the fragments are from seams as much as 6 inches thick.

The ore on the several dumps is composed largely of arsenopyrite with a scant quartz gangue and variable but minor amounts of other sulphides, also a little dolomite and calcite. Some of the quartz is coarse and druzy, but part is fine-grained and dense. It is reported that the ore from the Leviathan contained less lead and zinc than from the other lodes on the property.

Old assay records show that the mill heads consistently averaged about 0.63 ounce of gold per ton or better, and that sorted ore often contained more than an ounce of gold per ton. Assays of picked samples of narrow sulphide seams selected for this report gave 1.16 ounces gold and 2.5 ounces in silver per ton on a

1/ Bell, H.N., Ninth Ann. Rept. of the Mining Industry of Idaho For the year 1907, p. 22, 1908.
quartz-pyrite-arsenopyrite seam and 0.62 ounce gold and 4.0 ounces in silver on ore composed largely of arsenopyrite with a little sphalerite and galena.

Large ore reserves are reported to have been blocked out, but left unmined because of inability to make satisfactory recovery of the gold.

Friday

The Friday lies a short distance south of the Leviathan and somewhat higher on the valley slope. Little could be learned about the property except that it had been developed by a shaft and drifts, none of which is now accessible. From the size of the dump, the underground workings must have been rather extensive.

The lode lies in the Jurassic (?) batholithic rock very near the outcrop of Payette strata. Two dacite porphyry dikes lie not far to the north.

The lode is like others in its own vicinity and consists of as much as 8 feet of altered granitic rock with seams of massive sulphides on the foot and hanging walls. Soams and stringers of ore still remaining on the dump measure as much as 4 inches thick. The size and other characteristics of the ore shoots were not learned.

Ore on the dump contains sulphide seams associated with quartz and calcite in fractured and brecciated rock. The sulphides include pyrite, arsenopyrite, sphalerite, and galena, each about equally abundant. Calcite is more abundant than in the nearby lodes. Selected sulphides and quartz assayed 0.36 ounce gold and 17.8 ounces silver per ton.

Basque

The Basque property adjoins the Checkmate on the west and lies almost in the old town of Pearl. Little was learned about its history or development. It has a main working shaft and several tunnels, but the shaft was filled with water in 1933 and the tunnels were only partly accessible.

Two lodes extend into or across the property; one, the Basque, is said to be an extension of the Checkmate lode, the other, the North Basque, is a parallel lode 500 feet to the north. The country rock is much fractured Jurassic (?) quartz diorite, but the North Basque also cuts a dacite porphyry. Both lodes apparently pass beneath or abut against rhyolite. Their strike is about N. 80° W and their dip is steeply north.

These lodes differ from the others described in containing appreciable quantities of ruby silver. The ore is much more siliceous than in the lodes a short distance to the east and is composed largely of fine-grained, essentially chalcedonic quartz with scattered patches and grains of finely crystalline sulphides, also in part of coarser quartz aggregates and sulphides. Some of the quartz is also drusy and some has a comb structure. The sulphides consist usually of scattered small pyrite and arsenopyrite crystals, small grains and granules of brownish sphalerite, lesser galena, and in places small amounts of pyargyrite and owyheeite (?)..

The ore is appreciably gold-bearing. Some of the siliceous seams from the North Basque in which no ruby silver was visible assayed 0.21 ounce gold and 23.7 ounces silver per ton. Selected seams from the Basque lode assayed 2.28 ounces gold and 10.0 ounces silver per ton.
Smith

The Smith property lies a short distance above Pearl on the north side of Willow Creek across from the Leviathan or Whitman mine. The property has been developed during recent years and was active during 1933. It has three tunnels, two at creek level and one higher on the slope, aggregating more than 700 feet of workings. Some hand-sorted ore has been shipped.

The property has several small lodes, each in the Jurassic (?) quartz diorite. These lodes are comparatively narrow, strike N. 70° W. to N. 85° W., and dip mostly north. The lowest crosscut is about 310 feet long and exposes three lodes. One in the face is very lightly mineralized and was followed by drifts for only 45 feet. The fissuring is very prominent and the width of crushed and fractured rock ranges from 10 inches to 5 feet. The fissure strikes N. 85° W. and dips 50° N. The rock in its course shows little hydrothermal alteration and contains very little ore. The main lode lies to the south and was cut about 240 feet from the portal and drifted on for 150 feet. It strikes N. 70° W. and dips 70° N. The lode splits about 100 feet from the crosscut. It is more or less lightly mineralized throughout, but the main ore shoot is at the split. Another small lode lies 10 feet to the south of the middle lode.

Much of the ore that has been mined is from the adit and drifts higher on the creek. There the fissuring strikes N. 85° W. and dips steeply south, but in the ore shoot the dip changes to steeply north. The ore shoot is 15 feet long on the strike and about 4 feet thick, but the winze had only sunk about 14 feet.

The ore consists largely of quartz and sulphide stringers and seams in the fissured rock. In the main lode in the first tunnel the quartz seams and stringers are from 4 to 8 inches thick with scant to moderate amounts of arsenopyrite and locally small lenses or nests of sphalerite, galena, dolomite, and calcite. Galena and sphalerite occur in considerable quantity in the shoot at the split in the lode. The small lode in the footwall has 2 to 10 inches of quartz, pyrite, arsenopyrite, and a little sphalerite. The ore shoot in the drift from the second tunnel has less quartz and is composed of more compact sulphides, mainly steel-gray sphalerite and sphalerite, with only minor amounts of pyrite, arsenopyrite, chalcopyrite, tetrahedrite or tennantite, dolomite, and calcite. The hand-sorted ore is reported to have yielded about $30 per ton.

Dewey

The Dewey property lies a short distance north of Pearl. It had about 180 feet of accessible workings in 1933.

Two lodes were observed in the underground workings. These cut the batholithic rock and lie not far from dacite porphyry dikes. The more mineralized lode strikes N. 80° W. and dips 40° to 50° N. Another strikes about N. 70° W. and dips 75° N., but shows very little mineralization. The lodes are narrow, no more than a few feet at the most. The first has a narrow gouge seam on the hanging wall, the remainder consisting of fractured rock with ore seams.

The ore is siliceous, mainly of fine-grain, and contains some arsenopyrite and pyrite, also scattered grains of sphalerite. Much of the ore is oxidized, porous, and crust with sericite and iron, and manganese sulphides.

Gold Digger

The Gold Digger property is about a quarter of a mile north of Pearl. It consists of 5 claims. Part of the property was held during the early-day
activity and a continuous lode was exposed by open cuts and several short tunnels for fully two claim lengths. A short tunnel is now accessible on the Gold Digger No. 1 claim and another on the Gold Digger No. 2, which lies to the east. The latter had an old crosscut tunnel 210 feet long and drifts for 75 feet on the lode. Very little work has been done on the most westerly claim, Gold Digger No. 4. At one time, many years ago, a long crosscut tunnel was driven in a north-easterly direction, but was started on the north side of the lode and encountered nothing of consequence.

The several lodes are well within the dike belt, but all, except one, lie wholly in the quartz diorite of the batholith. Five small dacite porphyry dikes are penetrated in the crosscut tunnel on the Gold Digger No. 2, but only the lode on Gold Digger No. 1 appears to cut any of the dikes. The main lode is reported to strike about N. 85° E. and to dip 85° to 80° N. It is like others in the district and is reported to be composed of a zone of crushed and altered rock about 5 feet thick with some gouge and stringers of ore. In other places the lode is said to be from 10 to 20 inches thick.

In some places the lode is reported to have stringers of massive sulphides, in other places large pockets or lenses of compact ore. The sulphides are mainly galena, pyrite, arsenopyrite, and sphalerite; the gangue, altered rock, and scaly quartz, dolomite, and calcite. The sulphides normally contain from 0.10 to 0.34 ounce in gold per ton and considerable silver.

**Double Eagle**

Bell, in his annual report for 1919, mentioned that the Zulu Pearl had taken over the Double Eagle group of claims north of the Lincoln mine and during the year had driven 1,500 feet of drifts and had shipped 441 tons of crude ore to Salt Lake. This ore contained 14 frente ounces of silver and 44 ounces of gold. None of the ore was acquired for study.

**King Tut**

The King Tut (Mace) group is on the upper southwest slope of Crown Point about three-quarters of a mile northeast of Pearl. It has two adits and a shaft, none of which was accessible, although only recently in use.

The lode has an easterly trend and steep northerly dip. It lies mainly in the batholithic rock, but also cuts a dacite porphyry dike. Porphyry dikes are particularly abundant in the vicinity of the lode.

The ore is more siliceous than in nearby lodes and the sulphides therefore do not form as compact bands or seams as in most of the other lodes in the district. Much of the quartz has a comb structure. The sulphides include abundant sphalerite and minor amounts of pyrite, arsenopyrite, and galena. The sphalerite is both brownish-black and yellowish. Part of the ore is essentially an ore breccia cemented by calcite. There are also compact sulphide seams, small lenses, and irregular nests. Some of the selected more or less typical sulphide seams assayed 0.23 ounce gold and 7.9 ounces silver per ton.

**Lucky Strike**

The Lucky Strike lies about a half mile west of Pearl on the north side of Willow Creek. Development has not been extensive and consists of a short tunnel and open cuts. No ore has been shipped.

The lode is in the batholithic rock in the near presence of a large rhyolite porphyry dike and several smaller dacite porphyries. It strikes about N. 80° W. and dips 40° N. Its length was not learned, but its thickness in the tunnel face is about 3 feet, of which apparently not more than 6 inches is actually ore.

The ore is exceptionally siliceous and consists largely of fine-grained, almost chaledonic quartz, with grayish patches of finely disseminated sulphides, apparently mainly arsenopyrite and occasionally pyrite and sphalerite. Much of the quartz ore has been greatly fractured and then cemented by manganiferous calcite. The values are chiefly in silver and gold, and sorted ore is reported to range from 12 to 120 ounces silver per ton and about 0.5 ounce gold. Some of the seams collected at the property was assayed and gave 0.29 ounce gold and 21 ounces silver per ton. The outcrop is black from the oxidation of the manganiferous calcite.

**Florence**

The Florence mine lies about a mile and a quarter west of Crown Point, or slightly less than a mile northwest of Pearl. It has extensive underground workings, including a shaft and tunnels, but those are not now accessible.

The lode strikes about N. 70° to 80° W. and dips steeply north. It lies mainly along the contact between the quartz diorite of the batholith and a narrow dacite porphyry dike, in places cutting the dike and in places lying wholly in the quartz diorite. Several bodies of granite porphyry crop out not far south of the lode. The lode is reported to be about 3 feet thick on the bottom level; its length was not learned. The ore shoots are reported to pitch to the east and to be richest in the quartz diorite rock and poorest where in, or in contact with, the porphyry where the lode tends to splinter.

The lode is composed largely of quartzose stringers and seams in the fractured and altered rock. Arsenopyrite is the most abundant sulphide in ore fragments on the dump, but there are also lesser amounts of pyrite, sphalerite, tetrathedrite, and galena, and locally ruby silver. Much of the quartz is of the comb variety with sulphides between the quartz crystals, but some of it is fine-grained or chaledonic, and part of it is drusy. The ore is reported to be mainly valuable for its silver content and in the upper workings is said to have contained argentite and horn silver.

**Lucky Ridge**

The Lucky Ridge property lies a short distance west-northwest of Crown Point near the crest of the ridge facing the Payette River. A shaft, reported to be 250 feet deep, is now caved and none of the underground workings is accessible at present.

Like the other lodes near the west end of the mineral belt the Lucky Ridge lode apparently strikes about N. 80° W. and dips steeply north. It lies a short distance south of a dacite porphyry dike and is wholly within the Jurassic (?) quartz diorite. The intrusive zone comprising the lode is also occupied by a younger lamprophyro dike.

The ore is siliceous and forms stringers and seams as much as 3 or 4 inches thick in the fractured quartz diorite. The sulphides are mainly galena and sphalerite with lesser pyrite and arsenopyrite, and occur as granules, granular aggregates, and lenticular bands in the quartz. Some of the ore seams have a comb structure and frequently contain open cloths lined with drusy quartz crystals in part coated with sulphides. Calcite is also present. The lode is reported to carry its values mainly in silver and lead. Some of the galena-rich seams on assay gave 0.03 ounce gold and 13.8 ounces silver per ton.
The Osborne mine is at the northeast end of the gold belt about 2 miles below Horsecreek Bend on the south side of the Payette River. The mine has been developed by several minor openings on the surface and a vertical shaft and incline. The shaft is 400 feet deep and has crosscuts to the lodes on the 200, 300, and 400 foot levels; the bottom level about 325 feet below the river bed. The incline is 275 feet long. It is sunk at an angle of about 30° and attains a vertical depth of about 135 feet. The underground workings total about 5,000 feet of drifts, crosscuts, and raises, one drift alone measuring about 1,300 feet.

Much of the development was done prior to 1910. Mining was discontinued then, or earlier, and again in 1919 because of low recovery, less than half of the gold reported saved by amalgamation and cyaniding. During the last operation less than 2,000 tons of ore were mined. The mine has not been worked since 1919 and was not accessible underground in 1923 because of water in the shaft which stood within about 60 feet of the surface.

Several lodes cross the property, each striking about N. 70° E. and one at least dipping steeply south and the others as steeply to the north. These are in the dark-colored Miocene diorite near the face of several diverging dacite porphyry dikes, some of which are too small to be shown on the map. Some of the dikes strike northeast, others west-northwest. Apparently only one of the lodes comes in contact with a dacite porphyry. The lodes are persistent, for shallow workings in the gulch several hundred yards above the main workings are aligned with those at the shaft, and similar mineralization is shown at both places. The lodes are from 2 to 12 feet thick and have the complex structures of those characteristic of the district. The fracture zones are prominent and the shearing is well defined in the dark diorite as the rock in and bordering the lodes has been intensively altered. There has been much post-mineral movement and the gouge bands are thick and the ground difficult to hold.

One of the main lodes lies on the north side of the shaft. It has been drifted on for about 400 feet on the 200-foot level and 100 feet on the 400-foot level. It is exposed a short distance west of the shaft in a short tunnel and incline. There the lode dips 70° S. The diorite is intensively sheared through a zone 3 to 4 feet wide and less prominently through an additional 6 or 7 feet. Post-mineral movement along the lode has produced a gouge band several inches thick which contains rounded boulders of ore. Only iron-stained quartz seams and stringers appear at the outcrop, but ore from the deeper workings consists of broken sulphide seams from a fraction of an inch to several inches thick composed largely of arsenopyrite and pyrite, locally with small bunches or lenses of sphalerite, also small pods of cubical galena. This ore is associated with scant amounts of fine-grained, greyish quartz and with a minor amount of dolomite and calcite. In addition there are microscopic grains of tetrahedrite or tennantite, and boulangerite. Ore from this lode is reported to have the highest values. A mixture of picked sulphides assayed 1.83 ounces gold and 9.7 ounces silver per ton. According to early reports, the average assays were about 0.40 ounces gold per ton. 1

An opening has been made on apparently the same lode about 400 yards up the gulch to the east-northeast. It has a similar strike and dip, and about 3 feet or more of altered rock with ore seams. The lode also has a lamprobry diké in the hanging wall. The outcrop is heavily iron-stained. The primary ore consists largely of arsenopyrite, but also contains pyrite, sphalerite, galena, and microscopic grains of tetrahedrite or tennantite, laths of boulangerite in or near the

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1 Bell, R. N., Ninth Ann. Rept. of the Mining Industry of Idaho for the year 1907, p. 41, 1908.
galena, and tiny blebs of chalcopyrite in the sphalerite. It also has some quartz and a little calcite. The sulphide ore assays 1.01 ounces in gold and 12.5 ounces in silver per ton.

The second main lode lies south of the shaft. It has had the most development and has one drift 1,300 feet long, all in ore. The lode is reported to be like the first in size, but it dips to the north and carries only a trace of zinc and lead in an ore otherwise containing abundant arsenopyrite and pyrite. It lies about 275 feet from the other lode near the surface, but, as the two dip toward each other, they should eventually intersect.

A third lode in the bottom of the gulch about 100 yards north of the shaft has been opened by short tunnels and shallow cuts. This lode dips about 40° N. and at least in part lies along the contact between the diorite and a dacite porphyry dike. The fissure zone is probably large, but only about 3 feet of lode matter may be observed, for a post-ore lemporphry dike follows the same fissure. The altered diorite contains quartz seams and stringers with arsenopyrite and stibnite. The quartz seams range from a fraction of an inch to several inches across, locally with nests or lenses 6 to 12 inches thick, all with scattered arsenopyrite crystals. Some of the stibnite is fibrous, some occurs as narrow blades, but most of it forms radiating groups. It may also occur without quartz or may be associated with dolomite.

Nellie

The Nellie mine is on the south side of the Payette River about 2½ miles below Horsehoe Bend or about half a mile southwest of the Osborne mine. This property has not been worked for many years and the underground workings are inaccessible. According to reports the workings included a long crosscut tunnel (approximately 1,800 feet long), which gave a depth of about 800 or 900 feet below the outcrop. A 10-stamp mill, which formerly treated the ores from the mine, has been dismantled.

The lode lies in the dark Miocene diorite along a prominent fissure zone of east-northeastern trend, not far from some fairly large dacite porphyry dikes. This lode is from 8 to 10 feet thick on the surface, and, according to Bell 1/, is well filled with good milling ore which assays about 0.80 ounce gold per ton. Several smaller lodes occur nearby, three of them penetrated in the long crosscut. These are from 2 to 10 inches thick, and, according to Bell 2/, assay between 0.65 and 1.50 ounces gold per ton, each containing abundant stringers of pyrite and arsenopyrite.

Bell, in a later report 3/, writes that the Nellie Bloom Mining Company explored a shoot of oxidized ore 500 feet long and 3 to 5 feet thick at a maximum depth of 300 feet, but it is not known whether the reference is to the Nellie mine or to one of the other lodes in the vicinity. The ore is said to have assayed 0.50 to 0.75 ounce gold per ton.

Kentuck

The Kentuck mine is in the Payette River Canyon a short distance southwest of the Nellie. The lode is exposed about 1,000 feet above the river and has been

2/ Bell, R. N., Ninth Ann. Rept. of the Mining Industry of Idaho for the year 1907, pp. 41-42, 1908.
intercepted by a long crosscut tunnel about 900 feet below the outcrop. The long
crosscut and intermediate levels are no longer accessible.

The lode cuts the dark Miocene diorite in the vicinity of several dacite and
granite porphyry dikes of east-northeasterly and west-northwesterly trends. The
lode is reported to be badly broken at the level of the crosscut 1/2, but on the
intermediate levels less disturbed and had attractive ore bodies 4 to 9 feet
thick.

The ore consists for the most part of stringers, seams, and lenses of sul-
phides in the sheared and altered diorite. The sulphides are dominantly arseno-
pyrite and pyrite, and a little sphalerite and galena in a scant quartz-carbonate
gangue.

Lucky Boy

The Lucky Boy is near the Payette River across from the power plant about 4
miles below Horseshoe Bend. Several lodes have been prospected by open cuts and
short tunnels, but only one of the tunnels is now accessible. The property has
been abandoned, the land declared non-mineral-bearing and no longer subject to
entry.

There are at least three lodes on the property, each of which strikes about
N. 85° W. and dips steeply north. Each is in the dark Miocene diorite near the
north margin of the stock. The upper lode is a zone of sheared diorite 6 to 8
feet thick dipping about 75° S. with a few mineralized seams and an unaltered
laminophyre dike ranging up to 3 feet in thickness. The second lies a short dis-
tance to the north and is from 4 to 6 feet thick. It has a band of gouge and
scattered small seams of quartz with sulphides. The third was not accessible, but
ore on one of the dumps is rather silicious, containing fine-grained and drusy
quartz, and minor amounts of arsenopyrite, pyrite, calcite, and scattered granules
of sphalerite and galena. A mixture of selected ore fragments assayed 0.15 ounce
gold and 64 ounces silver per ton.

El Paso

The El Paso is on the east and northeast side of Crown Point at the heads of
gulches tributary to the Payette River and Rock Creek. The group is owned by the
Granite State Mining Company and includes 20 patented and 18 unpatented claims
with more than 10,000 feet of underground workings. The main working adit from
the Payette River slope is 2,350 feet long and passes about 700 feet below the
outcrop of the principal lode. This tunnel was opened at the portal and little
could be learned about the underground geologic relations. Active development
was more or less continuously in progress from 1900 to 1920, but no work has been
done since about 1924.

Several lodes cross the property, each apparently in the Jurassic (? quartz
diorite, but none of them is far from dacite porphyry dikes. Some of the dikes
were penetrated by the long crosscut and several were observed on the surface
above. The mineralization is as it is elsewhere along the gold belt and consists
of pyrite and arsenopyrite seams and stringers. According to Bell 2/, the lodes
contain extensive reserves of milling ore averaging from 0.40 to 0.50 ounce gold
per ton.

1/ Bell, R.N., Eighth Ann. Rept. of the Mining Industry of Idaho for the year
1906, p. 43, 1907.

2/ Bell, R.N., Twenty-first Ann. Rept. of the Mining Industry of Idaho for the
Alexander

The Alexander lies high on the divide between Willow Creek and Rock Creek not far below the summit of Crown Point. It was worked in the late nineties and shipped some ore in 1896. The last work was in 1932. The old workings are caved and the most recent development has been a shaft about 50 feet deep approximately 25 feet west of the collar of an older shaft.

The Alexander lode is near the convergence of a number of dacite and granite porphyry dikes. It lies, however, along the contact of a small Miocene diorite dike and the Jurassic (?) quartz diorite. The lode strikes about N. 70° E. and dips steeply north, with most of the shearing and the mineralization in the diorite dike. The lode is reported to be about 4 feet thick. The dump shows a great deal of gouge with crushed ore. The sulphides are mainly pyrite and arsenopyrite, lesser galena, and some sphalerite, chalcopyrite, tetrahedrite, pyrrhotite, and a little secondary argentite. Some of the gouge collected by the writer assayed 1.14 ounces gold and 1.7 ounces silver per ton.

I. X. L.

The I. X. L. group of claims is on the Rock Creek slope about three-quarters of a mile east-southeast of Crown Point. It is on the southeast side of the El Paso group. The workings were formerly extensive, but none is now accessible. Lindgren mentioned an incline shaft 200 feet deep at the time of his visit in 1896, also a tunnel 900 feet east of the incline. Later a long crosscut was driven beneath the workings and intersected the main lode about 1,000 feet under the outcrop.

The principal lode strikes approximately N. 70° E. and dips about 50° N. It is in the Jurassic (?) quartz diorite, but has a porphyry dike in the hanging wall. It is one of the longest lodes in the district and is reported to have been traced for at least 2,000 feet. Lindgren mentioned that 4 feet of oxidized ore of medium grade was exposed in the bottom of the 200-foot inclined shaft, also that there were several ore shoots between the shaft and the tunnel 900 feet to the east. The deep crosscut, however, was disappointing as no ore of commercial value was developed at that depth.

The ore now exposed on the dumps consists largely of arsenopyrite, pyrite, galena, and sphalerite in a scant gangue of quartz and calcite. The sulphides form compact seams measuring up to several inches thick. Galena appears to be more abundant here than in most other lodes.

McCarty

The McCarty lies east of the I. X. L. on Rock Creek. There has apparently been no development for many years and the workings are now caved.

The lode lies mainly in the Jurassic (?) quartz diorite, but also comes in contact with a dacite porphyry dike. The ore consists largely of arsenopyrite and pyrite with considerable sphalerite and galena associated with a minor amount of quartz, dolomite, and calcite.

Wonder

The Wonder claim lies above and somewhat to the southwest of the I. X. L. It has a lode in which four openings have been made. In the lower tunnel the

lode strikes about N. 70° W., and dips steeply south. It ranges from about 2 inches to 6 feet thick, and lies partly in batholithic rock and partly in rhyolite porphyry. The lode also contains an unaltered lamprophyre dike along part of its course. The lode shows the usual complex relations of its kind and is made up of sulphide stringers and altered containing rock. Some of the sulphide stringers are as much as 3 and 4 inches thick. The sulphides are mostly sphalerite with less pyrite and arsenopyrite, and small scattered grains of galena and chalcopyrite, the latter as inclusions in the sphalerite. Some seem have scant quartz and carbonate, others are without either.

Other properties

The district has other properties, but apparently little or nothing has been done on them since 1896 and there is little to add to Lindgren's descriptions. Some of the older properties may have been relocated since then and now have other names.

Lindgren mentions the Shamrock, Pinto, Dynamite, Easter, Iron Dollar, and Judas at or near Pearl, each of which produced some ore in the early days. East of the Checkmate were the Silver Spray and the Golden Chest, and on upper Willow Creek and Rock Creek the Emmett, Ida, Blaine, Silver Wreath, Zona, Stella, Ella, and Birthday. Other lodes on Rock Creek were the Black Crook and Blue Bucket. Several lodes also extended along the ridge between Rock Creek and Horseshoe Bend. These included the Antidotal, Lambertine, Bobtail, Mint, Sunny Side, Ballentine, Mammoth, Apex, Atlanta, Claggett, and Topoka.