ROYAL.

This group consists of six claims situated in the western half of sec. 28, T. 33 N., R. 41 E., on the western slope and near the summit of Eagle Mountain. The formation exposed on the property consists of a light-collored massive to slightly banded quartzite having a strike of N. 20° E. and a nearly vertical dip. In places certain bands in the quartzite are very calcareous. The property is developed by a crosscut tunnel driven in a direction S. 80° E. for a distance of 460 feet. No vein had been encountered within the tunnel at the time of the examination made in 1914.

HECLA.

This property is situated three and one-half miles northeast of Chewelah in the western part of sec. 4, T. 32 N., R. 41 E. At the time of examination, in June, 1914, the development work consisted of a lower crosscut tunnel driven in a direction N. 70° E. for a distance of 40 feet on a 4-foot vein of quartz with a nearly vertical dip. Near the portal a shallow shaft has been sunk. A little higher on the hillside a cross vein strikes N. 40° E. and also has a vertical dip. The country rock is a medium-grained granite. The ore minerals in the vein are chalcopyrite with its oxidized products, azurite, cuprite and malachite. Micaceous hematite and some sphalerite were observed.

WINDFALL.

The Windfall prospect is situated in sec. 18, T. 32 N., R. 41 E., about one-quarter mile south of the U. S. Copper-Gold property, at an elevation of 2,650 feet. It embraces two claims, the Evening Star and the Nickel Plate, located in 1900 and incorporated in 1904 as the Windfall Mining Company. The formations as exposed on the

property include interbedded quartzite and quartz-mica schist, having a strike of N. 10° E. and a nearly vertical dip. Numerous dikes of granite and diorite cut these strata. A vein of white quartz, varying from 3 to 8 feet in width cuts the formation, with a strike of N. 20° E. and a vertical dip. About 1,400 feet of development work has been done, including a crosscut tunnel, drifts and a shaft. The country rock containing the vein is a silicified limestone. The ore minerals are chalcopyrite, pyrite and arsenopyrite, which occur not only in the vein but are sparsely scattered through the wall rock. A shaft has been sunk on the vein at the outcrop and a lower tunnel has been driven S. 65° E. as a crosscut for at least 800 feet. This was caved at the time of examination and inaccessible. Values in gold, silver and nickel are reported from the ore.

U. S. COPPER-GOLD.

This mine is situated in sec. 17, T. 32 N., R. 41 E. There are two claims in the group, known as the Expert and Grace, which were located in 1906 and were incorporated in 1907 as the Copper-Gold Mining Company, with head offices in Chewelah. The formations exposed in this area consist of interbedded quartzite, silicified argillite and limestone, having an average strike of N. 40° E., with a dip of 75° to the southeast. These strata are cut by numerous granite and diorite dikes. A vein of quartz about four feet in width and having a trend of N. 10° E., with a dip to the southeast of 45°, cuts the formation. A crosscut tunnel has been driven 400 feet, where it cuts the vein 200 feet below the surface. The ore minerals are pyrite and chalcopyrite, which are said to carry some gold and silver. In 1917 one car of ore was shipped to a smelter in British Columbia, which is said to have yielded the following values: Copper 4 per cent, silver 20 ounces, gold $2.50 per ton.

CHEWELAH CONSOLIDATED.

This mine is situated in the northern part of sec. 25, T. 34 N., R. 40 E., on a branch of the north fork of Chewelah Creek and on the divide with Bear Creek. It is approximately 12 miles due north of Chewelah. The property consists of four claims: the Mountain Lion, Snowshoe, Rosebud and Big Joe. These are owned by local people in Chewelah.

The formation involved in this property is the northern extension of the Chewelah argillites. The mine is located only a short distance east of the Addy quartzite. About two miles to the north, both of these formations have been cut off by intrusions of the Loon Lake granite. The strata have been greatly disturbed in this vicinity and are cut by small apophyses of the granite. Locally the formation consists of interbedded quartz-mica schist, conglomerate, quartzite and metamorphic greenstones. The veins are composed of quartz containing galena and subordinate amounts of chalcopyrite. The values are chiefly in lead and silver. At the time of examination in 1914 the property was being developed by a shaft, but at present is idle.

The principal development is on the Rosebud claim, where a shaft has been sunk to a depth of 125 feet, on a slope of 75° to the southeast. At the 45-foot level from the surface the shaft intersects a drift tunnel 200 feet in from the portal. Both the tunnel and the shaft are driven on a six-foot vein of quartz carrying galena. The prevailing strike of the vein is N. 60° E. and the dip 75° to the southeast.

About 50 feet to the northeast of the main shaft is an open cut on a quartz vein said to have yielded assays of $51.00 in gold. In the near vicinity are several open cuts and shafts showing stringers of quartz with varying amounts of galena.

On the Mountain Lion claim there has been some development in the form of shallow shafts, short tunnels and open cuts. Veins and stringers of quartz were encountered containing galena, chalcopyrite, pyrite and arsenopyrite. Development work of a similar character has been performed upon the other claims of the group.

To the north of this property is the main contact between the Loon Lake granite and the metamorphic formations. It is probable that the ores on this property have been derived from solutions given off from the granite. Insufficient development has been performed to determine the probable future character of the ores in depth. The veins are in the nature of fissure fillings in the metamorphic formations which do not conform to the bedding planes.

WEST CHEWELAH DISTRICT.

LIBERTY COPPER.

This property is situated in the northeast quarter of sec. 2, T. 32 N., R. 39 E. It is at an elevation of 2,800 feet and by wagon road about two and one-half miles from the town of Blue Creek. The property embraces six claims which are incorporated as the Liberty Copper Mining Company, with head offices in Spokane. The formations exposed are a part of the Chewelah argillite and consist of argillite, calcareous argillite, phyllite and quartzite. These are cut by dark-colored diorite dikes. The strike of the formation is about N. 4° W., with a dip of 60° to the northeast although there are many variations from this. The mine is developed by two main working-tunnels, together with many surface cuts, shafts, and short tunnels.

The lower or main working-tunnel has been driven into the mountain in a direction S. 30° E. for a distance of 825 feet. Five hundred and seventy feet beyond the portal of the tunnel a branch has been driven S. 40° W.

for 620 feet. Two hundred and fifty feet beyond the junction a main working-shaft has been sunk 160 feet below the tunnel level, on a quartz vein averaging four feet in width and having a strike nearly north and south, with a dip of about 75° to the east. At the time of examination this shaft was filled with water and was inac-

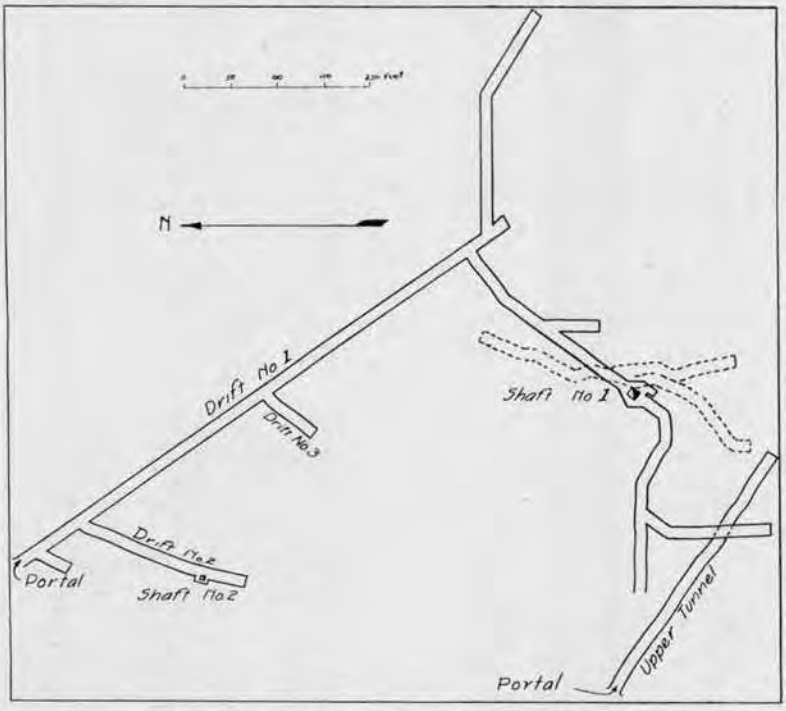


FIG. 7. Plan view of workings, Liberty Copper Mine, West Chewelah District.

cessible. It is reported by the management that eight inches of the quartz averaged in value $60.00 per ton and that on either side of this there was good milling ore. The chief mineral is chalcopyrite. At a depth of 110 feet three drifts have been run. One of these trends north for 126 feet and the other to the south for 160 feet. A crosscut was extended to the southwest for 125 feet where it intersected a dike. The main tunnel has

been continued beyond the collar of the shaft and passes through schist and argillite which has been cut by two diorite dikes having a strike of N. 15° W. A similar dike crosses the main tunnel about 200 feet from the portal. At this point it has suffered deformation but may be the continuation of the dike at the face of the tunnel.

An upper tunnel has been driven in a direction S. 47° E. for a distance of nearly 300 feet. At the time of examination this tunnel was caved and inaccessible. Farther up the hill at an elevation of 3,010 feet a quartz vein is exposed having a width of six feet and a strike of N. 5° E., with a vertical dip. Both walls are composed of phyllite.

The property is equipped with a 120-h. p. boiler and two 60-h. p. engines which drive the hoist, air compressor and other related machinery.

ALANADALE.

This property is in sec. 36, T. 33 N., R. 39 E., at an elevation of 2,680 feet. The formation exposed is a phyllite belonging to the Chewelah argillite formation. A lower tunnel at an elevation of 2,600 feet has been driven S. 40° W. for a distance of 570 feet. Two hundred feet in from the portal of the tunnel a light acidic dike about 40 feet in width cuts the schist formation and has a strike of N. 40° W. About four feet back from the face of the tunnel there is a 4-foot vein of quartz having a strike of S. 10° W. and a dip of 80° to the northeast. The tunnel is being driven to cut the vein exposed higher up on the hillside beyond.

A second tunnel at an elevation of 2,680 feet has been driven S. 70° W. for 83 feet through schist but at the face a quartz vein is intersected having a width of 10 inches and a strike of N. 66° E., with a dip of 55° to the northwest. A short tunnel has been driven on the Platsburg claim for 40 feet along a quartz vein having a width of four feet and a strike of N. 5° W., with a vertical dip.

Both walls are in schist. This vein is said to have been cut and drifted on in the bottom of the main shaft where it is 10 inches in width and carries chalcopyrite and secondary copper. The shaft is at an elevation of 2,650 feet and is 110 feet in depth. It was filled with water at the time of examination.

PACIFIC COPPER.

This property is situated in the S.E.¼ of the S.W.¼ of sec. 13, T. 32 N., R. 39 E. It is reached by a rather poor wagon road from Blue Creek. The formation is quartzite and phyllite cut by a diabase dike. At an elevation of 2,700 feet a tunnel has been driven for a distance of 460 feet in a direction S. 70° E. The formation is a greatly altered diabase which has been largely converted to chlorite. Seventy feet from the portal a shaft has been sunk to an unknown depth and extends up to the surface for a distance of 30 feet. Below the level of the tunnel it is filled with water and is inaccessible for examination. Near the face of the tunnel a three-inch seam of quartz containing a small amount of chalcopyrite was observed, having a strike of N. 70° E. Three hundred feet north of the tunnel on the surface white quartzite is exposed.

An open cut 12 feet in length, situated about 70 feet north of the tunnel has been made, and in it is a small gash seam about 10 to 14 inches in width filled with a quartz and calcite gangue containing some chalcopyrite. It has a strike of S. 78° E. and a dip which is nearly vertical. Within 12 feet from either end it pinches out. About 600 feet east and just beyond the saddle there is a shaft whose collar is at an elevation of 2,820 feet and which is said to be 125 feet in depth. The formation on the north is white massive quartzite. On the south within 50 feet of the shaft there is exposed a part of the diabase dike, which has been altered to greenstone. This green-

stone dike is at least 500 feet in width and has an apparent strike of N. 40° W. On the dump at the shaft only quartzite was observed. About 400 feet south of this shaft on a knoll at an elevation of 2,900 feet is an old two-compartment shaft about 40 feet in depth. The work is at the contact between diabase and greatly crumpled phyllitic schist. No ore was observed.

CHECOPS.

This prospect is located in sec. 24, T. 32 N., R. 39 E., and joins the Pacific Copper Company's ground on the west. The formation is quartzite, interbedded phyllite and argillite which have been cut by a wide diabase dike. The development work consists of a shaft which at the time of examination was filled with water. Its collar is at an elevation of 2,950 feet. Upon the dump there is some quartz and calcite gangue containing a very small amount of chalcopyrite. Some distance down the canyon a tunnel has been driven S. 65° W. for a distance of 200 feet. The rock intersected is entirely diabase and no ore was observed. Higher on the mountain side to the southwest, at an elevation of 2,990 feet, a tunnel was being started in a mass of iron-stained argillite and near the contact with the diabase dike.

This property was formerly known as the Sprague Copper Mine but has been reorganized as the Checops Copper Mining Company, with offices in Spokane.

KRUG.

This property is situated in sec. 26, T. 33 N., R. 39 E., about one and one-half miles northwest of Blue Creek. It is sometimes known as the Hartford group and consists of eight full claims and a fraction. These are known as the Saturn, Jupiter, Morning Star, Hartford, Bismarck, Midnight, Diana, Venus, Aurora and Henrietta Fraction. These claims were located in 1884. They are now incorporated as the Krug Gold and Copper Mining

Company. The formations exposed in the vicinity consist of argillite, phyllite, chlorite schist, greenstone, limestone, quartzite and dikes of diabase cutting these formations. All of these formations have been subjected to crushing and squeezing so that the structure is difficult to determine. The ore deposits occur as gash veins in the diabase or greenstone and are made up of quartz gangue with copper minerals.

The veins have a general northeast and southwest direction. The development consists of one long tunnel, several short tunnels, three shafts and numerous open cuts and trenches.

Diana claim. The formation exposed is an altered diabase which is cut by a quartz vein having a strike of N. 10° E. and a dip of 35° to the northwest. The thickness of the vein varies from four to six feet. A shaft has been sunk for a distance of 60 feet on the slope of the vein and nearby is an open cut 40 feet in length. The quartz contains azurite and cuprite. Assays yielding gold, silver and copper are said to have been obtained from ore taken from the bottom of the shaft.

Farther to the northeast on the same claim a shaft has been sunk to a depth of 60 feet on a parallel vein of quartz having a width of 21 inches and a strike of N. 10° E., with a dip of 30° to the northwest. The ore minerals are azurite, galena and cuprite in a white quartz gangue.

Venus claim. Near the middle of this claim an incline shaft has been sunk on a quartz vein 38 inches in width with a strike of N. 38° W. and a dip of 50° to the southwest. The ore observed is quartz containing galena and cuprite.

Aurora claim. Near the northwest side of this claim a tunnel has been driven due west for 340 feet through a chlorite schist and greenstone. About 100 feet from the portal is a black crushed zone in the chlorite schist

which is said to have yielded $7.00 per ton in gold, silver and copper. Near the north end of the claim an open cut has exposed a quartz vein 34 inches in width, with a strike of N. 10° E. and a dip of 30° to the northwest. Fifty feet west of this cut is a second cut showing a quartz vein 14 inches in width. Higher on the hill to the north at an elevation of 2,500 feet is a vein 18 inches in width striking N. 20° E. and dipping 60° to the northwest. It is composed of white quartz containing some pyrite, chalcopyrite and galena. About 15 feet to the east is a vein of quartz four feet wide, having a strike of N. 10° E. and a vertical dip. This vein is said to give small values in silver. A short tunnel has been driven on this vein.

Hartford claim. A small vein of quartz varying in width from 13 to 18 inches has been opened with a 20-foot tunnel and a 15-foot shaft. The shaft was filled with water and could not be examined. There is considerable quartz on the dump and it is reported that assays as high as 250 ounces in silver were obtained.

MONTEZUMA.

This prospect is located in the southwest quarter of sec. 13, T. 32 N., R. 39 E., about seven miles due west of Chewelah. The formation is mainly a pinkish quartzite with schistose argillite interbedded. A tunnel has been driven into the hillside from the valley for a distance of 150 feet in a direction S. 70° E. Sixty feet from the portal a drift has been extended S. 10° W. for 110 feet on a vertical vein of quartz having a width of four inches. No ore was seen. The property is said to be owned by P. A. Peterson of Blue Creek.

NEVADA.

This property is situated in the southwest quarter of sec. 23, T. 32 N., R. 39 E., about seven miles due west of Chewelah, at an elevation of 3,400 feet. The forma-

tion exposed is mainly quartz-mica schist, phyllite, argillite, limestone and quartzite. The strata have been subjected to great stresses and are badly contorted and twisted so that there is considerable variation in strike and dip. They lie in the nose of the syncline between Dunn Mountain and Addy and the formation is a part of the Chewelah argillite. East of the mine workings the strike is N. 30° E. and the dip to the northwest at an angle of 45°. West of the workings the strike is more nearly east and west with an overturned dip to the south. The ore deposits are in a dolomitic limestone situated on the top of an east and west ridge forming the divide between the drainage southerly to Admiral Creek and that northerly to Blue Creek. Pockets of ore of irregular shape but of small size are scattered through a zone of fracturing in the limestone. The minerals present are chiefly galena, together with sphalerite, chalcopyrite and pyrite. These are reported to carry considerable quantities of silver. To the north, in the southwest quarter of Section 14, there is an exposure of intrusive granite which is greatly altered and partly covered with deposits of glacial drift. It is possible that solutions derived from similar masses beneath the limestone and phyllite have brought the mineral content to the zone of fracturing where the limestone has been partly replaced.

The development work consists of three shallow shafts sunk at 20-foot intervals near the summit of the ridge. The one on the west was caved at the time of examination. The middle one was filled with water. The eastern shaft is 20 feet deep and is in dolomitic limestone. The limestone is impregnated with galena in small bunches and a smaller amount of chalcopyrite. A little sphalerite was observed. Much of the limestone in the vicinity of the workings has been greatly silicified.

COLVILLE DISTRICT.

OLD DOMINION.

The Old Dominion Mine is one of the best known mines in northeastern Washington. It is situated by wagon road about seven and one-half miles northeast of Colville, on the southern slope of Old Dominion Mountain, in sec. 4, T. 35 N., R. 40 E. There are 10 patented claims and several others which were formerly held by assessment work.

This property was first located in 1883. For the following six years work was actively carried on in mining the rich high-grade lead-silver ores occurring in a large lens near the surface. The rich ores were packed by horses to Spokane, a distance of nearly 90 miles, and were shipped to the Tacoma smelter. In 1880 the property was taken over by Spokane interests and a mill was constructed. In 1892 the property passed into the hands of Mr. G. B. Dennis of Spokane who had charge of the operations for several years. The property is reported to have produced over $625,000.00 in lead-silver ores. Over $400,000.00 is said to have come from within 75 feet of the surface. The property is equipped with buildings, and a mill having a daily capacity of 60 tons, including crusher, jigs, tables and vanners. There is also an 80-h. p. engine, an 80-h. p. boiler, a 6-drill air compressor and a blower.

The property is developed by three main adit tunnels, the lower of which is on the wagon road at the level of the gulch at an elevation of 2,975 feet. The portal of this tunnel is on the Reeves claim. The tunnel extends the entire length of the Old Dominion claim in a general direction of N. 40° E., and on into the Buda claim for a distance of 2,100 feet. From the face of the tunnel in the Buda claim a second tunnel has been driven in a northwesterly direction for a reported distance of 3,100 feet. At various places along the course of the

lower adit tunnel short side tunnels and raises have been driven. The second tunnel is at an elevation of 3,130 feet and is 500 feet in length. The upper tunnel, at an elevation of 3,225 feet, is about 500 feet in length. The last two tunnels were caved at the time of examination. On the surface are many open cuts, shafts, and short tunnels. Altogether over 13,000 feet of tunnel work is reported to have been done.

The formations exposed upon this property consist of limestone, argillite, quartzite and intrusive granite. The limestone belt is about 4,000 feet wide and trends N. 60° E., with a dip varying from vertical to 20° to the northwest. On the northwest it is bordered by the Chewelah argillite which is in places very calcareous. On the east and south it is bordered by the Loon Lake granite which is intruded into it. On the northeast it rests against the massive quartzite and phyllite which compose the bulk of Old Dominion Mountain. The limestone and quartzite appear to be separated by a nearly east and west fault.

The limestone has been greatly fractured. Along its southeastern side and near the contact with the granite are a series of fractures striking approximately parallel to the granite-limestone contact. These fractures have a low dip to the northwest. They appear to intersect a main fracture zone having a similar strike but a steeper dip. Some of the low dipping fracture planes which intersect the major fracture planes have been mineralized. One of the large ore bodies from which much of the high-grade silver-lead ore was obtained in the early days of development, occupied one of these low dipping fracture planes. An examination of the stope shows it to have had a thickness of six to eight feet and a length of 300 feet. The ore body appears to have wedged out when followed down along the fracture plane. Other fractures were noted having the same strike and general

northwesterly dip but containing no rich ore bodies. It is possible that other fracture zones intersecting the main zone and existing farther down and as yet unknown may contain large and high-grade ore bodies.

It is believed that the origin of the mineral-bearing solutions was from the Loon Lake granite which is intrusive into the limestone. It is possible that the solutions ascended along the main steeply dipping fracture zone and that the metallic contents were precipitated in some of the low dipping northwesterly pitching and intersecting fracture zones. There was an irregular replacement of the limestone in these fracture zones. The ore minerals are galena and sulphides of silver which have been altered in part to cerussite and anglesite. The gangue minerals are quartz, calcite and siderite. It is reported that the ore contains from 100 to 400 ounces of silver to the ton, and from 13 to 60 per cent lead.

The Ella shaft has been sunk upon a chimney of limonite in the white crystalline limestone. There has been considerable drifting upon the ore body. It appears to have suffered considerable secondary faulting and contains numerous intersecting fractures which are filled with iron-stained clay. Complete alteration of the primary minerals extends down to the lowest workings of the Ella shaft. It is possible that the primary ore may have been a large fracture zone filled with pyrite.

ORE CACHE.

This property is situated in sec. 9, T. 35 N., R. 40 E., about one-half mile south of the Old Dominion Mine. The formation is entirely in a white massive crystalline limestone which in places is banded. A deep canyon has been carved into the limestone and trends northwesterly to the canyon where the Old Dominion Mine is situated. In the limestone are zones of fracture which have been locally mineralized. There has been replacement along

the fractures and especially at the intersections of fractures. Small quantities of galena were observed in these zones but insufficient development work has as yet been done to determine the possibilities for future ore bodies of importance.

On the southwest side of the canyon, at an elevation of 2,800 feet, a short tunnel has been driven on a fracture zone in a general direction S. 5° E. for a distance of 55 feet. The main fracture is N. 20° W., with a dip to the northeast of 55°. Within the tunnel this fracture is intersected by a cross fracture having a strike of N. 60° W. At the intersection of these fractures there are six inches of galena and it is reported that an ore body three feet in width was taken out at the time the work was being done. The fractures away from the intersections contain small quantities of galena spotted in the rock. About 85 feet to the southeast, and 45 feet lower in elevation, a crosscut tunnel is being driven nearly due west for a distance of 83 feet. It is entirely in limestone which in places is cut by fracture zones having a strike of N. 20° W. Specks of galena were observed wherever these slips or fractures were noted.

On the opposite side of the canyon to the southeast there are several open cuts and short tunnels in the limestone but not far from the contact with the granite. One of these tunnels has been driven N. 63° E. for 85 feet as a crosscut in bluish-gray limestone. Higher on the hillside, at an elevation of 2,990 feet, there is a shaft 40 feet in depth in limestone and 100 feet from the granite contact. It has been sunk on a vein of quartz having a strike of N. 50° E. and a vertical dip.

BONANZA.

The Bonanza Mine is situated just north of the south line of sec. 2, T. 37 N., R. 38 E., at an elevation of 2,250 feet and about five miles east of Bossburg by road. This

property along with the Young America was located in 1885. The nearest shipping point is at Evans Siding, on the Great Northern Railroad, about three miles to the southwest and down grade.

The property has been developed by an inclined shaft said to be 700 feet in length and sloping at an angle of 40 to 45 degrees to the northwest. The elevation at the collar of the shaft is 2,200 feet above sea level. From the shaft seven levels at varying distances apart have been driven. From the surface to No. 3 level, on the west side of the shaft, the largest ore bodies were found. On the east side of the shaft ore has been stoped from the surface to the sixth level. The largest ore bodies are found between the surface and the fourth level.

The formations exposed in this locality are a part of the Mission argillite and consist of argillite, calcareous argillite, argillaceous limestone, carbonaceous argillite and quartz-mica schist. The prevailing strike of these strata is N. 60° W., with a dip to the northeast of 35° to 45°.

On the fourth level a fine-grained greatly altered siliceous dike has been intruded into the formation. This dike or a similar one may be seen on the sixth level, 250 feet east of the shaft. The dikes where exposed show no regularity in either strike or dip and vary in width from two to four feet. The ore consists of galena and iron pyrites intimately combined. They occur in bunches and lenses in the folds of the argillites and are generally in contact with gray or black argillite. The shipping ore contains 20 to 25 per cent lead with an iron content of about equal value. The ore bodies appear to have a pitch to the north or northeast in the plane of the vein or zone of mineralization. It is probable that the mineral-bearing solutions were derived from the underlying granite shortly after its consolidation, although the accompanying lamprophyre and acidic dikes may have

had some influence in their deposition. Considerable quantities of ore have been shipped from this property.

YOUNG AMERICA.

The Young America Mine is situated in sec. 28, T. 38 N., R. 38 E., about 2,000 feet northeast of the town of Bossburg, a station on the Great Northern Railroad. This property was one of the first to be located in Stevens County, about 1885.

The formation exposed in this region consists of massive bluish-gray to white limestone belonging to the Northport limestone formation. This limestone has been subjected to considerable disturbance and joint planes have been developed having a general east and west strike and a low angle of dip to the north. The ore deposits are replacements along the joint or fracture planes and form a zone varying from mere seams up to five feet in thickness. The ore minerals are galena and sphalerite carrying silver in a gangue of quartz and limestone. Sharp walls are characterized by their absence. The ore minerals are usually finely crystallized and occur often in wavy bands. Post mineral faulting occurs and in places offsets the veins.

The property has been developed by four short tunnels driven into the high bluff of limestone on the east side of Columbia River and just northeast of Bossburg. From these there has been some drifting and stoping.

MONDAY MORNING.

This prospect is situated near the head of Deep Creek, northeast of Aladdin, in sec. 4, T. 37 N., R. 41 E., at an elevation of 2,900 feet. It was located and development begun in the winter of 1917. The formation exposed is argillite and quartz-mica schist belonging to the Chelewah argillite formation. The average strike of the formation is N. 50° to 60° E., with a dip varying from 40° to 60° to the northwest. The property is developed by a series

of open cuts made along the course of a vein lying parallel to the bedding planes of the schist. The vein varies in width from two inches to four feet. The ore minerals are galena in a gangue of quartz and limonite. The wall rock adjacent to the vein is either a thinly bedded schist or a quartzite, which are interbedded. The galena lies both in the quartz and also between the laminations of the schist. In places the schist becomes calcareous. It probably represents a zone of fracturing and fissuring parallel to the bedding planes of the formation into which mineral-bearing solutions have entered. Possibly they were derived from the granite which underlies the schist and in places projects through it as apophyses from the main mass. Open cuts, shallow shafts and trenches have been made along the course of the vein for more than 400 feet. About 135 feet west of the vein and down the hillside from it a crosscut tunnel is being driven to tap the vein. At the time of examination the tunnel had been driven for a distance of 72 feet.

AMERICAN.

This claim is located at the head of Bruce Creek, in the southwest quarter of sec. 16, T. 38 N., R. 39 E. It is said to have been first located in 1896. It can be reached from Bossburg by wagon road, a distance of 15 miles, or from Colville 26 miles. The formations exposed in this area are the Mission argillite and the large area of intrusive granite which occurs to the east and northeast. About 10 feet east of the granite and schist contact, and in the granite, is a quartz vein having a width of four feet and a strike of N. 20° E., with a dip of 10° to the southeast. The quartz is milky-white and brittle and scattered through it are flakes and minute masses of molybdenite. In the wall rock on either side of the quartz vein small crystals and masses of molybdenite occur in the granite, apparently as original minerals. Away from

the vein they gradually diminish in amount and finally only traces of the mineral may be seen. The vein may be followed to the north for about 2,000 feet where it outcrops at intervals. About 1,200 feet north of the main discovery it is said to have a width of 18 feet and a dip nearly vertical.

At the discovery a short distance northeast of Phalen Lake a series of open cuts have been made on the vein. No data are available as to the percentage of mineral in the rock, but from appearances at the exposed portion in the open cuts the molybdenite is probably in the ratio of one part of the mineral to 99 parts of quartz.

VALLEY DISTRICT.

The Valley district lies to the south of the Chewelah district, in the south central portion of the county. It includes a group of mining properties situated in the foothills west of the town of Valley as well as a number of small prospects about three miles east of Valley. These properties are all reached by wagon road from Valley. Many of the locations were made shortly after the opening of the Colville Reservation and have been worked on a small scale rather spasmodically. The development work consists chiefly of tunnels on the higher slopes of the mountains but in the relatively flat areas the veins are worked by shafts.

The formations consist almost entirely of limestone and argillite which have been intruded occasionally by small masses of granite which are presumably apophyses of larger batholithic masses beneath. These rock formations have a prevailing northeasterly strike and a westerly dip. The ore deposits are largely of the replacement type and occupy zones of fracturing in the limestone or the calcareous argillite. The zones conform largely to the general strike of the formation but are usually transverse to the dip. The limonite deposits east

of Valley lie in the limestone but in contact with basaltic lavas or monzonite dikes. The ores are chiefly lead, silver and copper. The gangue is primarily quartz although calcite occurs occasionally.

DOUBLE EAGLE.

This property lies in the southeast quarter of sec. 18, T. 31 N., R. 39 E., on the eastern slopes of the Huckleberry Mountains, at an elevation of 4,400 feet. It embraces four claims known as the Wilson, Wilson No. 2, Marshall and Marshall No. 2. The mine was located in 1902 by John Kizer, and is now owned by the Double Eagle Mining Company with headquarters at Valley.

In the early days several tunnels were driven through debris and loose rock which yielded boulders of lead-silver ore in such quantity as to frequently pay for the expense of the work. Many of these boulders were four feet in diameter and composed of solid ore. It is said that much of the ore thus mined and shipped yielded 100 ounces in silver to the ton, and that some of the boulders went as high as 1,000 ounces to the ton.

The formation exposed in the vicinity of the workings is a part of the Deer Trail argillite and is composed of calcareous argillite, quartz-mica schist, limestone and quartzite. The Addy quartzite lies to the north and west and overlies the argillite and limestone.

The development work consists of several tunnels driven into the hill in a northerly direction. The most important of these, known as No. 2 tunnel, is at an elevation of 4,400 feet and has been driven in a general direction N. 25° E. for a distance of 750 feet to the face. From this several drift tunnels have been run with some stoping and sinking. Above this is a second tunnel, known as No. 1 tunnel, which has also been driven in a northerly direction for a distance of about 300 feet.

There are in addition several short tunnels and open cuts. The No. 2 tunnel for the first 100 feet from the portal passes through wash material. Beyond this it passes through broken limestone and argillite in an area of clay and gouge. This condition continues for 200 feet to the first long drift to the northwest. Beyond this drift the rock encountered in the main tunnel is largely white limestone which becomes very siliceous. That portion of the tunnel back from the face for 100 feet is an

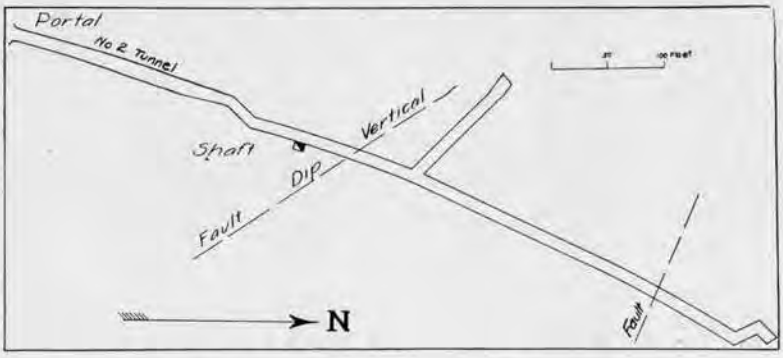


FIG. 8. Plan view of No. 2 tunnel, Double Eagle Mine, Valley District.

argillite with a strike of N. 25° W. and a dip of 77° to the northeast. At the face of the tunnel a belt of quartzite is exposed. This quartzite belt lies in a horseshoe shape and appears to swing around the nose of a northerly pitching anticline. Along the course of the tunnel are several slip zones striking to the northeast and dipping to the northwest. Along these slips are traces of ore in the form of seams of galena and pyrite. The drift to the northwest, about 370 feet from the portal of the tunnel, is along a slip zone in a mixture of crushed schist and limestone in a clay gouge. The source of the ore from which the high grade argentiferous galena came has not as yet been located.

EDNA.

The Edna Mine is located in the southeast quarter of sec. 9, T. 31 N., R. 39 E., on the eastern side of the Huckleberry Mountains. The group embraces four claims known as the Alpine, Log Cabin, Log Cabin Extension and the Mother Lode. The mine is reached by wagon road from Valley, and is owned by the Valley Mining Company of Spokane. It was first located in 1896 by Axel Herman. During 1898 and 1899 a shaft was sunk on the Log Cabin Extension claim to a depth of 100 feet, and three cars of ore were shipped to the smelter. This ore came from near the surface where it was highly oxidized and leached and is said to have scarcely paid expenses.

In September, 1901, the property was taken over by J. B. Tuttle and Sons. Machinery was installed and active development carried on till June, 1904, during which time the shaft was sunk to the 370-foot level and about 750 feet of drifting was done on the ore body. About 150 tons of ore are said to have been shipped to the smelter which carried seven per cent copper, four ounces of silver and $2.75 in gold to the ton.

The property was idle from June, 1904, to April, 1917, when it was reopened. The shaft was retimbered and the machinery overhauled. Plans are now being made to sink the shaft an additional 200 feet. The equipment of the property now consists of good camp buildings, shaft and engine house, two 60-h. p. boilers, 3-drill air compressor, Sullivan air drills, etc.

The country rock exposed in this locality is a part of the Deer Trail argillite and consists chiefly of argillite, quartz-mica schist and siliceous limestone. The strata have a prevailing strike of N. 10° E. and a dip of 80° to the northwest. The vein lies parallel to the bedding planes of the schist and has the same strike and dip. The shaft has been sunk on the vein and is the principal

working development of the property. At the 300-foot level a drift has been made for 235 feet to the south and a crosscut for 108 feet to the west. On the 200-foot level there is a 135-foot drift and on the 135-foot level a 100-foot drift to the south. At the time of visit to the property it was impossible to examine the underground workings but there is said to be a zone somewhat mineralized for a width of 80 feet. On the footwall side of this 80-foot zone there are four feet of shipping ore and six feet of milling ore. The values are chiefly in copper and the chief ore mineral is chalcopyrite.

ADMIRAL.

This property is situated in the west part of sec. 28, T. 31 N., R. 39 E., on the eastern side of the Huckleberry Mountains, near the junction of Deer and Meadow creeks. The group embraces eight claims known as the Imperial, Spokane Belle, New York, Copper Cent, Orient, American Boy, South Pacific Fraction and the National Fraction. In addition there is a small area in the extreme northeastern part of Section 29, same range and township. The property is developed by three tunnels and a shaft and several open cuts and shallow shafts.

The Admiral Mine was located in 1894 by unknown parties. In 1896 Phillip Creasor of Republic acquired the property and actively developed it during the following two years in a search for gold. During this time a shaft was sunk on the vein, near the north end of the property, to a depth of 90 feet, and a crosscut tunnel was driven near the south end of the property for a distance of 350 feet. This tunnel cut the vein about 250 feet below the outcrop. Two other short prospect tunnels were also driven on the vein. Some chalcopyrite was encountered in the vein but as there were no roads to the property at that time no attempt was made to ship it. In 1900 the property was taken over by

T. R. Tate and T. H. Greenway, who held it until 1916. During this period they sorted over the ore from the dumps and mined some ore from one of the old tunnels. This ore was shipped to the Granby smelter and is said to have yielded the following returns:

Car No. 1. Copper 4½%, Silver 4 oz. per ton, Gold .04 oz. per ton.
Car No. 2. Copper 4%, Silver 2.5 oz. per ton, Gold none.
Car No. 3. Copper 5½%, Silver 4.5 oz. per ton, Gold none.

In April, 1916, the property was taken over by J. Richard Brown and associates of Spokane and active developments begun. During the ensuing year the vein was opened by a crosscut tunnel, 400 feet below the outcrop, and an upper tunnel was driven along the vein for a distance of 355 feet. Three cars of ore were shipped to the Trail Smelter which are said to have given returns as follows:

Car No. 1. Copper 6.5%, Silver 4 oz. per ton, Gold none.
Car No. 2. Copper 6.6%, Silver 3 oz. per ton, Gold none, Iron 4.6%, Lime 3.5%.
Car No. 3. Copper 6.4%, Silver 3 oz. per ton, Gold .02 oz. per ton, Iron 6%.

The formation exposed in this locality is a part of the Deer Trail argillite. The crosscut tunnel on Sand Creek has been driven in a direction N. 65° E. for a distance of at least 600 feet. The formation in the first 155 feet of the tunnel from the portal is concealed. At a point 155 feet from the portal a quartz vein was encountered and a drift was run along it for a distance of 300 feet, in a direction N. 10° E. The vein is parallel to the bedding of the schist and argillite which are greatly altered and dip at an angle of 70° to the northwest. Near the face of the drift the vein matter is nearly 14 inches wide but back from the face it narrows and in places is only two inches in width. It is definitely a mineralized zone along a fissure parallel to the bedding of the schist. The ore minerals are chalcopyrite, together with a little chalcocite and black oxide of copper.

Near the face of the tunnel a dike, having a trend of N. 10° W. and a vertical dip, crosses the tunnel. This

rock is probably a greatly altered diabase which has now largely been converted to a mass of chlorite.

DENVER.

This property is situated in the east half of sec. 29, T. 31 N., R. 39 E., on Deer Creek and west of the property of the Admiral Mining Company. It was located about 1899 and a shaft was sunk to a depth of 15 feet on a quartz vein lying parallel to the bedding of the schist formation. In the quartz as well as in the lamination planes of the schist is some chalcopyrite which is said to have yielded assays in copper varying from five to nine per cent. The strike of the formation is N. 10° E. and the dip 65° to the northwest. The elevation at the shaft is 3,100 feet.

About 500 feet down the creek north of the shaft is a crosscut tunnel which is being driven in a direction S. 70° W. to intersect the vein. At present it is in 65 feet to the face and the rock encountered is largely slide rock but at the face schist is exposed with a strike of N. 20° E. and a dip of 50° to the northwest.

In June, 1917, this property was incorporated as the Denver Copper Mining Company, with offices in Spokane.

VULCAN.

This property is situated in the central part of sec. 16, T. 31 N., R. 39 E., and due south of the Edna Mine. The property was discovered and located in 1901 by L. E. Beach. During 1901 two 40-foot shafts were sunk on the vein which lies in calcareous argillite and schist. This vein was highly oxidized and leached but showed some good copper ore. In 1903 a 112-foot tunnel was driven which crosscut the vein 80 feet below the outcrop but showed little copper. In 1914 the property was taken over by J. Richard Brown of Spokane. A deep crosscut tunnel is being driven from Meadow Creek and it is expected to cut the vein 320 feet below the outcrop. This

tunnel has been driven for a distance of 630 feet in a direction N. 78° E. The formations encountered in the tunnel are chiefly well-bedded calcareous schist and argillite. In places the schist grades into an argillaceous limestone and often these are somewhat silicified. The strike of this formation averages N. 15° E. and the dip is 56° to the northwest. The portal of this tunnel is only slightly above the level of Meadow Creek, at an elevation of 3,050 feet.

The ores, as exposed in the outcropping of the vein and in the surface workings at an elevation of 3,400 feet, are composed largely of azurite, malachite, with some cuprite and chalcopyrite. These are said to carry some silver. The strike of the vein is N. 10° W. and the dip 70° to the southwest.

WABASH-DETROIT.

This prospect is situated in the northwest corner of sec. 10, T. 31 N., R. 39 E., about one-half mile east of the Vulcan property. The formation exposed in this vicinity is a part of the Deer Trail argillite and consists largely of calcareous argillite and schist, having a northeast strike and a dip to the northwest. The vein is composed of quartz of a reddish color and contains chalcopyrite as its ore mineral. Upon this a shaft has been sunk to a depth of 60 feet.

B. AND B.

This property is situated in the southwest quarter of sec. 32, T. 32 N., R. 40 E., about one-half mile southeast of Brown's Lake. It lies along the western side of the Addy quartzite on the eastern limb of the anticline. A crosscut tunnel 28 feet long has been driven into the low hill projecting up from the drift-covered valley. The rock formation is a buff-colored siliceous dolomitic limestone which may be the equivalent of the Stensgar dolomite exposed on the eastern flank of the anticline. Ten

feet in from the portal, a drift has been run S. 30° E. for 42 feet on the vein. From the tunnel level stopes extend to the surface for 30 feet. On the surface deep trenches have been cut down to the stopes for a distance of over 100 feet. The gangue minerals are quartz and calcite containing cuprite, azurite, malachite and iron oxide. The strike of the vein is N. 30° W. and the dip is to the southwest 53°. The values are in copper with a little gold and silver. A large amount of ore has been taken out considering the small amount of development work so far completed.

IRON PROSPECTS.

East of Valley about three miles, in sec. 18, T. 31 N., R. 41 E., at an elevation of 2,100 feet, are deposits of limonite and hematite which have been worked and the ores shipped to the Tacoma smelter as a flux. The ores occur as replacements in a zone of white limestone lying beneath the Camas basalt. Along the contact the lavas have been greatly altered and the limestone belt more or less replaced for a zone 50 feet in width adjacent to the contact. The ore occurs in bunches and chambers of varying size and connected one with another.

On the Vigilant claim the mineralized zone trends nearly north and south and the basalt rests upon one of the limestone belts interstratified with the argillite and dips to the west at an angle of 45°. Along the contact a dike of granite has been intruded and this has been extensively altered. A tunnel has been driven due west on the vein and from it drifts and stopes have been made along the mineralized zone. The Capitol claim is a northerly continuation of the exposures on the Vigilant property and the deposits are similar.

About 1,500 feet to the east of these workings, at an elevation of 2,600 feet, similar deposits occur along the contact between underlying limestone of the Stevens

group and Tertiary basalts which overlie the limestone. These deposits have been developed by short crosscut tunnels, drifts, stopes and open cuts. Several shafts have been sunk on the deposits.

BUCK CANYON DISTRICT.

MONOHAN.

This property is located at the head of Buck Canyon, in the southwest quarter of sec. 18, T. 32 N., R. 40 E. The formation is quartzite, calcareous argillite and dolomitic limestone which in places has been greatly silicified. These have a prevailing strike of N. 35° W. and a dip to the southwest of 60°. Several tunnels have been driven into these formations but no vein or ore was observed. One tunnel at an elevation of 2,820 feet has been driven to the north for a distance of 885 feet. The rock encountered was mostly quartzite of light color and somewhat calcareous. Five hundred feet west of this tunnel a second tunnel has been driven for 250 feet in a calcareous quartzite but no ore was observed.

McKALE.

This prospect is situated in the northwest quarter of sec. 19, T. 32 N., R. 40 E., on the west side of Buck Canyon. A tunnel at an elevation of 2,550 feet has been driven in a direction S. 72° W. for 40 feet. Beyond this point it is caved and inaccessible. The formation is quartzite and siliceous limestone. No ore was seen on the surface nor on the dump. The formation higher up the hill to the west is massive quartzite and presumably a part of the Addy quartzite as it swings around the nose of a northerly pitching anticline.

WASHINGTON.

This prospect is situated 600 feet north of the Uncle Sam prospect, on the west side of the same canyon. The development work consists of a tunnel driven into the

hill in a direction N. 25° E., at an elevation of 2,350 feet. Altogether there are 415 feet of tunnel. Near the face of the east branch a six-inch quartz seam was cut lying parallel to the planes of schistosity of the formation. It has a strike of N. 15° W. and a dip of 50° to the southwest. No ore was seen in it. The formation is a well-banded argillite whose bedding planes are nearly at right angles to the well defined planes of schistosity.

UNCLE SAM.

This prospect is situated about one-third mile north of the Superior Copper property in Buck Canyon, on the east side of the road. The rock formation is argillite and schist, having a strike of N. 35° W. and a dip of 37° to the southwest. These observations were taken on the planes of cleavage which are at an angle to the true bedding planes. Scattered through the schist are cubes of pyrite. No ore was seen. A tunnel has been driven into the hill in a direction N. 15° W. for a distance of 50 feet.

SUPERIOR COPPER.

This property is situated in sec. 29, T. 32 N., R. 40 E., in the lower part of Buck Canyon. The property is developed by a crosscut tunnel driven from the level of the valley at an elevation of 2,245 feet in a direction S. 77° W. for a distance of 420 feet. At the face a shaft has been sunk for an unknown distance upon a vein of quartz containing chalcopyrite. At the time of examination the shaft was filled with water. From the shaft on the tunnel level a drift has been extended S. 37° W. for a distance of 30 feet on the vein. The vein has a dip of 50° to the northwest. The rock formation is a finely laminated dark and light-colored argillite with interbedded bands of quartzite and schist, having a strike of N. 35° W. and a dip to the southwest of 40°. The bedding planes are at an angle to the planes of schistosity and the true bedding strikes more nearly N. 30° E. The vein at the

face of the tunnel is five feet in width and lies parallel to the schistosity planes. There is about one foot of schist in the center of the vein. Little patches of chalcopyrite are scattered through the quartz. Several carloads of ore have been shipped from this property but no data are available as to the values.

DEER TRAIL DISTRICT.

GENERAL STATEMENT.

The Deer Trail district lies in the southwestern corner of the county, on the crest of the Huckleberry Range. The principal mines are situated in Cedar Canyon and the district is sometimes known as the Cedar Canyon district. Several other properties which lie some distance from Cedar Canyon are described in this report in connection with those in the Deer Trail district as in the case of the O-lo-lim Copper Mine and the tungsten properties. The early locations in the region were made by farmers from the Big Bend country and by army men stationed at old Fort Spokane. The district may be reached by wagon road from Springdale, a distance of 25 miles. Springdale is on the Great Northern Railroad, 47 miles north of Spokane. From the west it may be reached from Fruitland, a point in the Columbia River valley, on the stage line between Myers Falls and Davenport. Turk is the post office for the district. At the present time the camp is almost inactive except for a small amount of development being carried on at five of the properties. Twenty years ago this camp was one of the most active in the state. A copper smelter was erected at Turk but proved unsuccessful. A mill was also built to treat the tungsten ores of the Germania Mine but it was burned several years ago during the forest fires.

The formations exposed in the Deer Trail district consist of quartzite, argillite, calcareous argillite and lime-

stone of the Deer Trail formation. These are cut by dikes of granite which are apophyses of an extensive batholith underlying the formations of the district. The ore deposits represent the filling and replacement of the wall rock along fissures and fracture zones in the limestone argillite. In general the veins or zones of mineralization lie parallel to the prevailing strike of the formation although in places they are slightly diagonal to them. At the intersections of the minor cross-fractures with the major ones the richest and largest ore bodies occur. The ore minerals are largely galena, carrying considerable amounts of silver. On the north side of Cedar Canyon copper ores prevail, the minerals consisting of chalcopyrite, bornite, pyrite and the carbonates and oxides of these minerals. The mineralization has been along the zones of major fracturing which are nearly parallel to the bedding planes.

The tungsten deposits occurring in the southern part of the district are confined entirely to the quartz veins in the granite mass. They are near the roof of the batholith where it comes in contact with the argillite and quartzite.

The properties are developed by numerous crosscut tunnels which after cutting the vein or ore deposits are connected with shafts, drifts and considerable amount of stoping. Large quantities of high-grade silver ore have been shipped from the camp but no data are available concerning the values.

SATURDAY NIGHT AND SUNDAY MORNING.

This group includes the Saturday Night, Sunday Morning, Plata Fino and Plata Rico claims. The claims were located in 1895. They are now incorporated as the Plata Fino Mining Company, with offices in Spokane. The claims join end to end on the north of the Brooks claim. They have not been worked to any extent for several years and are in part inaccessible.

Lower Sunday Morning Tunnel. This tunnel, at an elevation of 3,500 feet, is situated near the head of the canyon just below the camp. It has been driven for a distance of 50 feet in a direction S. 20° W. through a decomposed and iron-stained limestone, then through a white crystalline limestone for 95 feet in a direction S. 60° W., then along the same bearing for 15 feet through a black carbonaceous argillite and then into a black calcareous argillite. Several branch tunnels extend from this point. The strike and dip of the formation could not be determined. No ore was to be seen in the tunnel nor was there any evidence of it on the dump.

Middle Sunday Morning Tunnel. This tunnel, at an elevation of 3,550 feet, has been driven in a direction N. 65° W. for 145 feet. From the portal the first 50 feet of the formation consists of a light calcareous argillite. This is followed by a dark calcareous argillite for 35 feet. Beyond this is an impure limestone and at the face is exposed a white crystalline limestone. No ore was in evidence.

Upper Sunday Morning Tunnel and Shaft. This tunnel, at an elevation of 3,575 feet, is situated about 150 feet north of the middle tunnel. It has been driven in a direction N. 65° W. for about 25 feet, where it intersects a vertical two-compartment shaft which could not be examined. The only ore seen was a few tons in the ore house consisting of quartz and lime carrying a little galena and some copper stain.

Saturday Night Tunnel. This tunnel, at an elevation of 3,600 feet, is situated 360 feet south of the Sunday Morning shaft. It has been driven in a direction N. 65° W. for 50 feet, at which point it is caved.

The formation exposed in the first 50 feet of the tunnel is a decomposed iron-stained calcareous argillite. Beyond the cave the tunnel enters the white crystalline

limestone. In the ore house a few tons of ore are piled up consisting of quartz carrying a little galena and sphalerite which is said to assay well in silver. The ore presumably occurs in the crystalline limestone and probably represents a replacement along the line of fracturing.

Forty feet above the main tunnel and possibly 100 feet to the south of it is a vertical single-compartment shaft equipped with a horse whim. Several smaller openings have been made in the vicinity but these are largely caved.

BROOKS.

The Brooks claim is situated just north of the Queen in the saddle between the headwaters of Cedar Canyon and the east branch of Oroshunton Creek. The property is developed by a shaft and two tunnels. No. 1 tunnel, at an elevation of 3,760 feet, has been driven in a direction S. 55° E. for a distance of 80 feet. Sixty-five feet from the portal a drift was run N. 55° E. for 75 feet and a shorter one S. 10° W. for 15 feet. No. 2 tunnel, at an elevation 3,700 feet, has been driven in a direction S. 25° E. One hundred feet from the portal the tunnel is caved and inaccessible. The shaft in the saddle is at an elevation of 3,900 feet.

The rocks exposed in the workings are white crystalline limestone, calcareous argillite and a dark carbonaceous argillite. The strike of the formation is about N. 20° E. A black basic lamprophyre dike, having the composition of camptonite, was cut in the lower tunnel No. 2. On the trail, about 200 feet to the southeast, a similar dike is exposed. The ore deposits consist of quartz veins lying parallel to the bedding of the formation. The rocks of the hanging-wall are a siliceous argillite and those of the footwall a dark-colored argillite. No ore of importance was seen in any of the workings.

On No. 2 tunnel dump a few tons of slightly oxidized iron sulphides in quartz were piled up.

QUEEN.

The Queen group is situated in sec. 11, T. 29 N., R. 37 E., about three-fourths of a mile southwest of the Deer Trail Mine and about 25 miles southwest of Springdale. It lies south and over the divide at the head of the South Fork of Cedar Creek, at an elevation of about 3,800 feet. The group consists of the following claims: Log Cabin, Silver Seal Fraction and the Queen. The Queen was located in 1895 by L. E. and Frank Van Horn. The Log Cabin was located by William Johnson, and the Silver Seal in 1899 by F. M. Van Horn. These claims were incorporated about 1899 as the Silver Basin Mining Company. The metamorphosed sedimentary formations of this locality are a part of the Deer Trail argillite including the Stensgar dolomitic limestone member. The strata have a prevailing strike varying from N. 10° E. to N. 15° E. and a dip at a high angle to the west. About one-fourth of a mile east of the main shaft is the western contact of a large mass of intrusive granite. West of this contact and adjacent to it is a dark-colored argillite alternating with banded limestone. West of the argillite is a white crystalline limestone and west of the limestone are exposures of the southwestern extension of the Addy quartzite.

The property is developed by a crosscut tunnel about 460 feet in length, and having a direction of N. 30° W. for a distance of 115 feet and N. 50° W. for 345 feet. Besides this tunnel there are two vertical shafts. One of these is on the Silver Seal claim and has been sunk to a depth of 300 feet. The other is situated on the Queen claim about 500 feet to the north and is 206 feet in depth. From the Silver Seal shaft four levels have been run. No. 1 level is 75 feet below the collar of the

shaft and on the level of the main crosscut tunnel. This level is connected with the Queen shaft about 500 feet to the north. The other three levels were inaccessible at the time of examination as the shaft was filled with water up to the level of the main tunnel.

The Queen shaft is opened up by one level about 125 feet below the collar. At the time of examination the Queen shaft was being unwatered below the tunnel level and preparations were being made to cut a station about 45 feet below the tunnel level.

Besides the development mentioned above considerable stoping has been done on the Queen claim above the tunnel level and on the Seal above the tunnel level as well as in two of the three levels below.

The ore consists of white quartz, often iron stained, carrying as its chief value silver in the forms of argentite and chloride together with subordinate amounts of pyrite, galena and sphalerite. Sometimes azurite and malachite are present. The ore occurs in shoots having a predominating pitch to the northeast.

The strike of the formation in the Queen claim is N. 10° E. and N. 15° E., with a nearly vertical dip. The vein has a strike of N. 25° E. in the south end of the property and N. 35° E. at the north end. The hanging wall of the vein is persistent and well defined and dips at 75° to the northwest. It is the best defined wall in the camp. The country rock on the hanging-wall side is a white massive limestone which has been impregnated with quartz and somewhat silicified. Fractures and seams extend out from the vein into the wall rock and these have been mineralized. The vein is of the fissure type and cuts across the formation into the limestone where replacement has taken place. Where the vein enters the argillite on the east side of the limestones it is less well defined and less mineralized.

The ore shipped from this mine in the early days is reported to have been quite rich and to have yielded assays of 400 ounces in silver. The average was perhaps 150 to 200 ounces. Several hundred tons of ore have been shipped in the past but at the time of examination no considerable tonnage was available. Here and there in the old stopes some ore still remains that was too low-grade to ship in the early days. At the Silver Seal shaft about 250 to 300 tons of low-grade ore is piled up near the sorting house. Some of the low-grade ore may be profitably shipped at the present high price of silver. It formerly cost from $8.00 to $10.00 per ton to haul the ore from the mine to Springdale. Freight and treatment cost $14.00 and the mining cost was possibly $5.00 per ton.

The Queen prospect tunnel is situated at the north end of the property at an elevation of 3,850 feet. The tunnel has been driven in a direction N. 45° W. for a distance of 125 feet. At the face of the tunnel a quartz vein was intersected having a width of about three feet and a strike of N. 35° E., with a steep dip to the southeast. The formation exposed within the tunnel for the first 100 feet is white limestone. This is followed to the face by 25 feet of calcareous argillite.

DEER TRAIL.

This property is situated near the head of the South Fork of Cedar Canyon, in secs. 1 and 12, T. 29 N., R. 37 E. It embraces the following claims: Idaho, Hoodoo, Runyon Fraction, Jolly Boy, Moonshine, Elephant, Legal Tender, Deer Trail, Hoodoo Extension, Victor Fraction, Providence, Royal Extension, Happy Home, Splawn and Deen claims. These claims have been incorporated as the Deer Trail Mining Company, with headquarters in Spokane. The property is situated about 25 miles southwest of Springdale, the nearest railway and shipping point. The mine may be reached from Springdale over a road

much of which is of poor construction and with steep grades.

The bed-rock exposed on this property consists of the argillite and limestone of the Deer Trail argillite formation. At the head of Cedar Canyon this formation is cut off by a large mass of granite which outcrops for

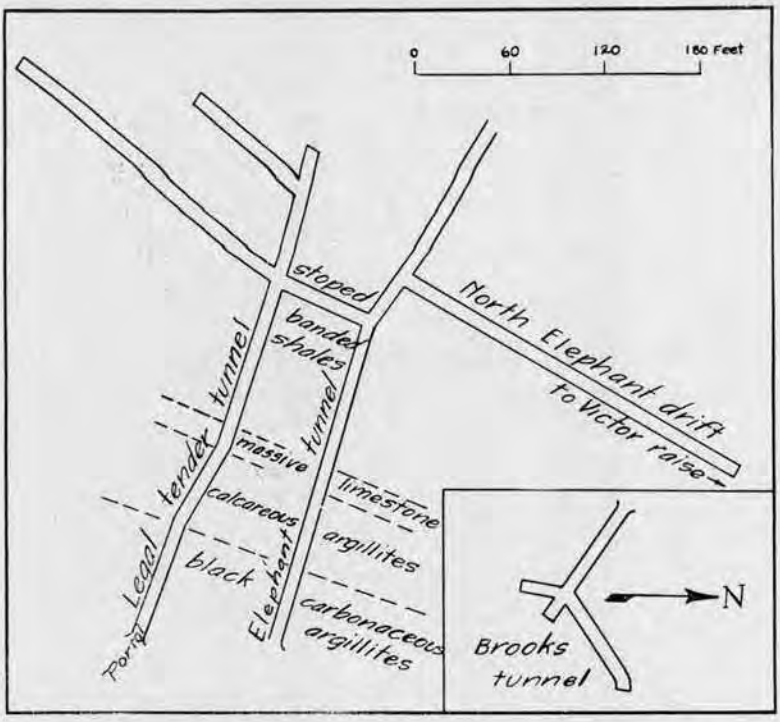


FIG. 9. Plan of chief accessible workings, Deer Trail Mine.

a long distance to the south. The strata have been greatly disturbed in this region but have a prevailing strike ranging from N. 30° E. to N. 40° E. and a dip to the northwest of about 60°. The main vein strikes approximately parallel to that of the formation and dips to the east. It is situated on the west side of the canyon and dips down toward the canyon. The ore minerals are argentiferous galena, sphalerite, silver sulphide and silver chloride. The gangue is primarily quartz together

with calcite and fragments of the silicified argillite. The deposits occur along a fissure zone in which there has been replacement along the intersecting fractures.

The property has been opened by a number of tunnels driven as crosscuts westerly to the vein and by drifting, sinking and stoping along the vein. The majority of the tunnels are caved and only partly accessible although some of them are being opened and retimbered at the present time. The following tunnels were examined as far as their condition would permit: Legal Tender, Cameron, Hoodoo, Deer Trail No. 1, Deer Trail No. 2, Deer Trail No. 3, Legal Tender No. 2, Victor, Providence No. 1 and Providence No. 3.

The first discovery on this property was made in 1894 by W. D. Van Horn, who located the Deer Trail claim and ran a short tunnel to cut the vein. The next claim located was the Legal Tender by W. B. Runyon and William Yarwood.

Legal Tender Tunnel. This is one of the principal working tunnels of the Deer Trail Company and is now being retimbered to open up some of the old stopes. From the portal this tunnel has been driven in a direction N. 70° W. for a distance of 75 feet, then N. 60° W. for a distance of 55 feet, and finally N. 70° W. for a distance of 110 feet. At this point the tunnel intersects an iron-stained decomposed quartz vein having a strike of N. 25° E. From this intersection a drift has been driven to the north on the vein for a distance of 55 feet to the junction with the Elephant tunnel. From this point the drift continues and makes an abrupt turn to N. 55° W. for a distance of 35 feet, where a side drift has been extended in a direction N. 30° E. for a distance of 50 feet to where it is caved. The drift having the direction N. 55° W. continues for 45 feet beyond to the bottom of a flat raise to the surface. From the intersection of the main Legal Tender crosscut tunnel and the vein a

drift has been extended to the south in a direction S. 35° W. for a distance of 100 feet where the drift is caved. Sixty feet from the crosscut a raise has been made on the vein and a stope opened up.

The formations exposed in these workings in which the ore bodies occur are black carbonaceous argillite forming a hanging-wall and argillite forming the footwall. The argillite forming the footwall is composed of alternating light and dark green bands varying in thickness from one-eighth to one-fourth of an inch.

The ore deposits occur in bunches and lenses in a brecciated zone conforming to the bedding of the argillite. The beds are frequently faulted and folded and sometimes lie nearly horizontal. The ore consists of iron-stained milky quartz carrying silver sulphide and possibly chloride. There are present also silver-bearing galena, lead-carbonate and sphalerite, together with subordinate amounts of azurite, malachite and possibly enargite and polybasite. Very little ore of consequence is now to be seen in the old workings which are accessible although it is claimed that considerable ore of a milling grade was at one time taken out of the stopes.

Cameron Tunnel. The Cameron tunnel, at an elevation of 3,625 feet, starts within the boundaries of the Hoodoo claim. From the portal it has a direction of N. 55° W. for a distance of 20 feet, then N. 10° W. for 12 feet, and N. 55° W. for 108 feet, at which point it intersects a drift having a direction N. 35° E. on a quartz vein. This vein dips at an angle of 60° to the southeast and conforms to the bedding of the formation. Along the north drift, at a point 30 feet from the crosscut, a raise connects with the Hoodoo tunnel about 80 feet below. The drift is caved at this point and is now inaccessible. At the point where the main Cameron crosscut intersects the vein a fault having a direction of N. 53° W. to N. 60° W. occurs and displaces the vein to the west

about 10 feet. The drift south of the crosscut has a direction of S. 35° W. and follows a vein which dips 55° to 60° to the east. This vein appears to conform to the bedding of the formation and is three to four and one-half feet in thickness. At a point 175 feet from the crosscut intersection on the south drift a pronounced fault, having a direction of N. 55° W. to N. 60° W. and a nearly vertical dip, cuts off the vein completely. This fault plane was followed by a crosscut tunnel for a distance of 35 feet into the hanging-wall but without results. No prospecting has been done in the footwall and it is here that the vein may possibly occur. The fault plane shows evidence of extensive movement and the walls are smooth.

The footwall of the vein is a light-colored rather massive calcareous argillite. The hanging-wall is a black carbonaceous argillite. The vein is composed of a milky rather granular quartz which appears to have silicified the light-colored argillite and also to have filled small cavities in the folds of the argillite.

The ore minerals are sphalerite and galena together with a little copper. The gangue is quartz with some calcite and fragments of the silicified argillite.

Hoodoo Tunnel. This tunnel, at an elevation of 3,550 feet, is the lowest working tunnel on the Deer Trail property and is situated near the bottom of the gulch on the Hoodoo claim. The portal is located on the west side of the gulch and the tunnel has a direction of N. 65° W. for a distance of 60 feet, then it turns S. 10° W. for 90 feet and then S. 35° W. for an unknown distance as it is caved and filled with water at this point. According to Mr. Newell, foreman for the Deer Trail Company, this tunnel is about 400 feet in length. About 350 feet to the southwest a raise about 80 feet in length taps the north drift of the Cameron tunnel. Judging from the material of the dump no ore of consequence was en-

countered in the Hoodoo workings. A small quantity of milky quartz carrying some galena may be seen on the dump near the portal of the tunnel.

Deer Trail No. 1 Tunnel. This tunnel is at an elevation of 3775 feet. It is caved but has been recently reopened for a distance of 20 feet. Its bearing from the portal is N. 65° W. A quartz vein, which was discovered in 1894 by W. O. Van Horn, outcrops at this point.

Deer Trail No. 2 Tunnel. This tunnel, at an elevation of 3,765 feet, is situated 140 feet north of Tunnel No. 1. It has been driven in a direction N. 65° W. but at 110 feet from the portal it has caved. Sixty-five feet from the portal, drifts were run both to the north and south. The north drift is caved at a distance of 40 feet and the south drift at 25 feet. The formation encountered is composed of thin-bedded light and dark-colored calcareous argillite that has been subjected to considerable fracturing and shearing. The general strike of the formation is N. 40° E. and the dip about 54° to the northwest.

Deer Trail tunnel No. 3 is caved. It is at an elevation of 3,765 feet and extends in a direction of N. 65° W.

The Legal Tender tunnels Nos. 2 and 3, at elevations of 3,850 feet and 3,900 feet, are both inaccessible. They are situated 75 feet and 150 feet, respectively, south of Tunnel No. 1.

Victor Tunnel. This tunnel, at an elevation of 3,700 feet, is situated 250 feet north of the Legal Tender tunnel. It has been driven in a direction N. 50° W., but at a point 60 feet from the portal it is caved and inaccessible. The portal of the tunnel is driven from the Royal claim. From the Victor No. 1 tunnel a considerable tonnage of rich silver ore was mined in the early days. It is claimed by those familiar with the property that an easterly and westerly fault caused a displacement of the vein about 40 feet vertically near the north end line of the Victor claim.

The Victor No. 1 and the Victor No. 2 tunnels, at elevations of 3,750 feet and 3,765 feet, are both inaccessible.

Providence No. 1 Tunnel. This tunnel, at an elevation of 3,650 feet, has been driven in a direction N. 85° W. Fifty feet from the portal the tunnel is caved. Judging from the size of the dump several hundred feet of development work has been done at this point. The country rock from material exposed on the dump is a calcareous and siliceous argillite and a more massive dark drab schistose rock.

Providence No. 2 Tunnel. About 75 feet north and 50 feet lower at an elevation of 3,600 feet is Providence No. 2 tunnel, which has been driven in a direction N. 80° W. One hundred and eighty feet from the portal of the tunnel the vein is intersected and drifts have been driven both to the north and south. The crosscut tunnel is continued beyond the intersection but is caved. The formations exposed for the first 75 feet in the tunnel are decomposed argillite. Following this is a rather bluish-gray massive impure quartzite which has a strike of N. 45° E. and a dip of 60° to the northwest. Beyond the belt of impure quartzite is a belt of calcareous argillite in which the ore bodies occur. The ore bodies are found in a highly brecciated zone in the argillite and occur as tabular deposits and lenses conforming to the bedding of the strata. The ore is quartz carrying silver, galena, sphalerite and pyrite. The gangue is composed of quartz and calcite. An important tonnage of silver ore was taken from the workings of this tunnel about twenty years ago. A dike of granite prophyry occurs about 100 feet north of the Providence No. 2 tunnel and appears on the trail about midway between Providence No. 2 and No. 1 tunnels.

TOGO.

The Togo Mine is situated at the head of the east branch of Cedar Canyon, in sec. 31, T. 30 N., R. 38 E.

This property embraces nine claims which have been incorporated as the Consolidated Copper Company, with offices in Spokane.

The geologic formations at the head of this canyon are a part of the Deer Trail argillite. The rocks exposed in the vicinity of the workings are mainly calcareous argillite and argillaceous limestone having a predominant strike of N. 17° E. and a dip of 68° to the southeast. The strata have been somewhat locally disturbed.

The ore minerals consist of chalcopyrite, pyrite, and carbonates of copper in a gangue of quartz and calcite. The carbonates were observed only in the upper workings. The country rock in the immediate vicinity of the ore deposits is a decomposed iron-stained calcareous shale containing veinlets and laminations of quartz and calcite. The zone of mineralization strikes N. 17° E. and dips to the southeast at an angle of 60°. The ore deposits occur in small irregular bunches in a shear or brecciated zone.

This property has been developed by two crosscut tunnels, the lower of which, at an elevation of 3,650 feet, has been driven a distance of 1,150 feet in a direction N. 33° E. Two hundred and fifty feet from the portal a crosscut tunnel has been driven to the east, where it cuts a massive calcareous argillite showing veinlets of calcite. Beyond this point the formation exposed along the main tunnel for a distance of about 200 feet is a carbonaceous argillite. The face of the tunnel is in an impure siliceous limestone. The upper tunnel, at an elevation of 3,150 feet, has been driven to the northeast and at about 200 feet from the portal encounters a number of small lenses of ore occurring in the argillite. These have been greatly disturbed and faulted. Much of the ore has been stoped. About 50 feet in elevation above the upper tunnel is the discovery shaft which connects

with the upper tunnel. Other development work upon this property consists of open cuts and prospect holes.

HIGH GRADE.

This mine is situated a short distance west of the summit of the Huckleberry Range, in sec. 6, T. 29 N., R. 38 E. It is about 25 miles west of Springdale by wagon road and 42 miles north of Davenport, at an elevation of about 3,300 feet. The property consists of nine full claims and a mill site and 160 acres of patented land which have been incorporated as the High Grade Mining Company, with head offices in Spokane. The first location made on this property was in 1881, when the Blue Grass claim, now known as the Copper Butte, was staked. A road was built into the region by army officers stationed at Fort Spokane and mining was carried on by farmers from the Big Bend country.

The country rock in the vicinity of the mine is quartz-mica schist, argillite, calcareous and siliceous argillite and limestone. About one mile to the south and west these rocks have been intruded by large masses of granite and undoubtedly similar intrusive granite lies not far beneath the surface in this area. As seen in the underground workings of the mine the rock is a light-colored siliceous argillite which has been greatly shattered and fractured. The strike of the formation varies from N. 10° W. to N. 30° E., while the dip averages 60° with many variations.

The ore deposits occur in a shear zone along a zone of marked faulting and fracturing. They occur in the form of lenses partly filling the fracture zones and partly replacing the country rock. The ore minerals consist chiefly of chalcopyrite and pyrite, but in the upper workings a small amount of azurite, malachite and red and black oxides were noted. In one place a few specimens of native copper were observed.

The principal development work on this property consists of three crosscut tunnels driven into the hill to the northwest until they intersect the vein. Considerable drifting and stoping has been done along the vein. Altogether there is a total of about 4,000 feet of underground tunnel work, of which about 1,500 is on the Turk claim and the remainder on the Copper Butte. The three tunnels are designated as No. 3, the lower, at an elevation of 3,190 feet; No. 2, the intermediate, at an elevation of 3,300 feet; and No. 1, the upper, at an elevation of 3,340 feet. Along the vein these are all connected by stopes and raises.

The main ore shoots along the course of the vein are situated at the intersections of the northeast and southwest fracture zones and the cross faults whose direction is predominantly N. 40° W.

SPRINGDALE DISTRICT.

GENERAL STATEMENT.

About 14 miles west of Springdale and near the summit of the Huckleberry Mountains, there are several mining properties which are reached directly from Springdale. Among these are the Cleveland and Chamokane mines. To the northeast of Springdale are two copper properties which are usually reached from Loon Lake but which for convenience are included within the Springdale district.

The formations west of Springdale in the Huckleberry Mountains belong to the Addy quartzite, Deer Trail argillite and the Stensgar dolomitic limestone. The ore deposits in the Cleveland, Wells-Fargo and Chamokane mines lie in zones of fracturing in the argillite and limestone. The fractures are approximately parallel to the strike and bedding of the formation. The gangue material, consisting chiefly of quartz and the ore minerals including pyrite, galena, chalcopyrite and sphalerite, represent a filling of the fissures and a replacement of the

adjacent wall rock. At the junctions of the cross fractures with the major fractures small chimney-like ore bodies have been formed. In between these intersections along the main line of fracturing the veins become much leaner and sometimes are barren of ore.

The development consists of tunnels, drifts and open cuts. Shallow shafts have been made but are not so common a feature of the development as in many of the other districts. A mill has recently been built at the Cleveland Mine and was in operation during the summer of 1917. The properties on Chamokane Creek consist of small open cuts, short tunnels and shallow shafts.

The copper properties about six miles north of Loon Lake lie in argillite and quartzite although granitic dikes occur only a short distance away. It is believed that the ores of the district have been derived from the granitic magmas underlying the region and that they were formed at or near the close of the Jurassic period.

CLEVELAND.

This property embraces 12 patented claims and fractions as follows: Cleveland, Ona, Triangle Fraction, Etta, Stewart Fraction, Lucky Boy, Etta Fraction, Copper King, Copper Queen, Copper Bell, Tom Sawyer and the Olympia. The mine is situated in secs. 3, 4, 9 and 10, T. 30 N., R. 38 E. From the mine to the nearest point on the Phœnix Lumber Company's logging railroad is about seven miles. It is proposed to haul the ore and concentrates to this logging railroad, on the east side of the Huckleberry Mountains. The road over the mountain is steep and poorly constructed and travel is frequently difficult. It is estimated that the cost per ton for hauling ore over the mountain to the railroad will be $4.00. The freight over the logging road to Springdale is $0.50 per ton.

This mine was first located about 1892 by Mr. F. R. Tinsby and W. L. Falter. It is reported that it has paid

approximately $250,000.00 in dividends. However, this statement could not be verified as no records were available at the time of examination. The mine is developed by a main lower tunnel at an elevation of 2,950 feet, from which several hundred feet of drifts and crosscuts have been driven. About 150 feet north of the portal of this tunnel and 40 feet higher in elevation an incline shaft has been sunk at an angle of 67° for 200 feet. At a point 60 feet below the collar a drift has been run to the northeast about 250 feet. There has been no drifting in the shaft below this point. About 250 feet southeast of this inclined shaft and at an elevation of approximately 50 feet higher a prospect shaft has been sunk to a depth of 50 feet. From this shaft there has been considerable drifting and stoping during the early days of development. Besides the above development there are a number of short prospect tunnels and shafts at various places.

The rocks exposed on the property are principally dolomitic limestone and argillite which belong to the Deer Trail argillite formation and the Stensgar dolomite member. About 400 feet west of the main tunnel a belt of light-colored crystalline quartzite occurs which is a part of the Addy quartzite formation. About 100 feet east of the tunnel there is a belt of greenish thin-bedded schist. The formation in general has a strike varying from N. 15° E. to N. 20° E. and a dip to the southeast at a very high angle. The rocks exposed in the underground workings are fine-grained crystalline bluish dolomitic limestone with occasional interbedded bands of greenish argillite. These formations are cut by a series of prominent faults having a direction ranging from N. 25° E. to N. 35° E. and dipping from 75° to 80° to the southeast. Another series of less prominent faults cut the formation and have a direction of N. 40° W. and a nearly vertical dip. The rocks show evidence of considerable fracturing and small veinlets filled with calcite

Concentrating mill and mine openings, Cleveland Mine.

ramify in all directions. Another unusual feature is the thin banding observed in the limestone where bands having the thickness of a knife blade up to one-eighth of an inch are developed.

The ore deposits occur in chambers and chimneys as replacement deposits in the limestone. The principal ore bodies were found from the surface to a depth of 100 feet. Below this depth the ore became more complex and of a lower grade. The main faults do not appear to have had very much bearing on the deposition of the ores as no evidence of ore is to be seen in them. The minor faults and fractures are probably the channels which afforded avenues for the circulation of the ore-bearing solutions. The ore minerals in the upper zones consist of the carbonates of lead and galena carrying silver together with sphalerite and pyrite. On the walls of the deposits partly decomposed sphalerite may be seen. In depth the carbonate ores pass into more complex sulphides consisting of pyrite, arsenopyrite, galena, sphalerite, and stibnite. The galena is mostly fine-grained and often assumes a needle-like structure. The sphalerite is of the black to brownish variety and is massive to crystalline. One peculiar feature observed is the banding of the zinc ore in which the sphalerite forms alternate bands from one-sixteenth to one-eighth of an inch in thickness with calcite. Another striking feature is the fine needle-like structure of the iron pyrites. The ore minerals are intricately associated and give considerable difficulty in their separation. The gangue minerals are calcite, siderite, quartz and country rock.

There is no ore of importance to be seen in the main tunnel. In the face some pyrite and sphalerite may be seen. In the old stopes there is a small tonnage of second-grade ore as a filling and on the walls of the old stopes there is some zinc blende occurring in thin shells. In the old stopes and on the dumps the management

estimates there are about 10,000 tons of lead-zinc-iron ore of a milling grade.

A new 50-ton concentrator has just been completed and was being given its trial run at the time of examination of the property. The mill was built primarily to treat the old Cleveland Mine dumps which consist of zinc, lead and iron ores that were sorted out from the shipping ores during the early days of development. The mill is located on a side hill at a lower elevation than the dump. The ore is trammed by mine cars from the dump to the head of the mill, where it is discharged into a 65-ton bin. From this bin the ore is fed over a 6½-foot grizzly with bars spaced one inch apart. The coarse ore goes to a 7 by 10-inch Blake crusher and the fines to a pair of 14 by 24-inch rolls. The entire crushed product is elevated to a 36 by 90-inch trommel. The coarse product from the trommel goes to a four-compartment coarse jig. The fines are led to a three-compartment classifier where three sizes are made. The coarse classifier product goes to the fine jigs, the intermediate to a Wilfley sand table, and the slimes to a slime classifier, the slime from the classifier goes to a Deister slime table.

The middlings from the coarse jig, fine jigs and Wilfley tables are sent to a 36-inch Huntington mill, reground and returned to the box classifier by a 6 by 8-inch elevator. The mill is driven by two Fairbanks-Morse gasoline engines, one 32 h. p. and the other 25 h. p., using distillate.

COPPER BUTTE.

This property is situated in the northwest corner of sec. 11, T. 30 N., R. 38 E., at an elevation of 3,610 feet. The formation is quartz-mica schist and argillite which in places is calcareous. The development work on the property consists of a tunnel about 180 feet in length driven in a direction N. 35° E. At the face is a shaft said to be 150 feet in depth, which was filled with water

at the time of examination. Above the shaft several stopes have been opened but were not examined because of their caved condition. The ores examined on the dump were composed of chalcopyrite, bornite and pyrrhotite with a quartz gangue.

RAMBLER.

This property is situated in the northeast quarter of sec. 15, T. 30 N., R. 38 E., on the eastern slopes of the Huckleberry Mountains at an elevation of 3,200 feet. Three claims, known as the Morning Star, Evening Star and Rambler No. 2, belong to this group and are owned by John Wolf and associates of Springdale. The formations exposed in this vicinity are a part of the Deer Trail argillite, which is composed of quartz-mica schist, argillite and dolomitic limestone. The property has been developed by several tunnels, the largest of which is on the Rambler claim on the south side of a branch of Chamokane Creek, at an elevation of 3,200 feet. This tunnel has been driven in a general direction S. 26° W. for a distance of 265 feet. About 40 feet from the portal of the tunnel a badly broken and ill-defined quartz vein occurs parallel to the bedding of the schists which are also much crumpled. The main tunnel follows this vein in a somewhat sinuous fashion to the face. A well-defined wall is present and about 115 feet back from the face a winze has been sunk to a depth of 18 feet on a slope of 55° to the west. Eighty-five feet back from the face a raise has been made on the vein for 65 feet. At the bottom of the winze the vein is said to be four feet wide but badly broken by faulting and squeezing. Several other short tunnels have been driven in the near vicinity on the level of the gulch. About 30 feet east a tunnel has been driven into a belt of dolomitic limestone about 20 feet. The rock is greatly disturbed and in it are small bunches of chalcopyrite. Twenty feet farther

east is a tunnel 20 feet long cutting interbedded argillite and blue dolomitic limestone. About 20 feet still farther east is another tunnel 15 feet in length which has been driven along a quartz vein lying in the schist formation. This vein is composed of white milky quartz with a strike of N. 20° E. It is badly broken and probably out of place.

All of the development work so far done is in a zone where the formation is greatly broken and within a few feet of the surface.

CHAMOKANE.

This property, consisting of a group of 38 claims, lies in secs. 9, 10, 11 and 15, T. 30 N., R. 38 E., near the headwaters of Chamokane Creek. They are reached by wagon road from Springdale. The formation exposed is a part of the Deer Trail argillite, including belts of limestone. It is developed by several tunnels, shallow shafts and numerous open cuts. On the Alice M. No. 1 claim, near the southeast corner of sec. 10, a tunnel has been driven northeasterly for a distance of 50 feet on a quartz vein striking N. 15° E. and dipping vertical. The vein consists of four feet of white milky quartz, separated by 18 inches of dike rock from 18 inches of similar quartz. Chalcopyrite and pyrite were noted in the quartz. About 700 feet to the northwest, along the road on the Copper Valley No. 2 claim, a tunnel has been driven to the southwest for 170 feet on a four-foot quartz vein lying parallel to the bedding of the quartz-mica schist. The ore minerals are chalcopyrite and its oxidized products.

A short distance above the main camp a tunnel has been driven in schist N. 40° E. for 130 feet. Near the face bunches of quartz occur in the bedding planes of the schist. A quartz vein is exposed from two to eight inches in width, containing a little chalcopyrite. The strike of the formation is N. 40° E. and the dip 70° to the northwest. Along the wagon road above the main

camp several open cuts have been made on fractured and mineralized zones in the quartz-mica schist and argillite.

A vein of barite outcrops on this property and is lying parallel to the bedding of the argillite. A few small open cuts have been made upon it but no development work has been done.

WELLS-FARGO.

This property is situated in the northwest quarter of sec. 36, T. 31 N., R. 38 E., at an elevation of 4,000 feet, on the east slope of the Huckleberry Range not far from the summit. The property was originally located in 1890 and the principal development work has been done since 1897. The property is now owned by the Wells-Fargo Mining Company, with headquarters in Springdale. The formation exposed is a part of the Deer Trail argillite, consisting of quartz-mica schist, argillite, calcareous argillite and limestone. The planes of schistosity in the schist have a direction of strike N. 30° E. and a dip of 85° to the southeast. The property has been developed by two crosscut tunnels and a shaft. The ore mineral is stibnite in a quartz vein having a thickness of three to five feet. The vein has a strike of N. 25° E. and a dip to the northwest of 60°.

The lower tunnel, whose portal is at an elevation of 3,955 feet and situated on the north side of a canyon, has been driven into the hill as a crosscut a distance of 125 feet along a direction N. 30° W. The first 70 feet of the tunnel passes through a calcareous argillite and schist. Beyond this for a distance of 55 feet to the face, the rock is a light creamy-colored quartzite or completely silicified limestone.

The upper tunnel is situated higher on the hillside at an elevation of 4,100 feet in a direction N. 25° W. from the lower tunnel and about 200 feet distant. This tunnel has been driven N. 20° W. for 155 feet, where the

vein is intersected. From the vein it has been extended 25 feet farther in a direction N. 65° W. to the face. The formation exposed in the tunnel for a distance of 115 feet from the portal is argillite and schist. Beyond this for 40 feet to the vein the rock is a dolomite, and the rock exposed on the face is of the same character. One hundred and fifteen feet from the portal a tunnel has been driven N. 15° E. for 60 feet along the contact between the schist and dolomite. This tunnel is connected with the vein by a short tunnel 35 feet in length. A stope has been made upward for a distance of 15 feet where the vein is exposed, having a strike of N. 25° E. and a dip of 32° to the northwest and an average thickness of four feet and six inches. The gangue is white milky quartz, containing bunches of stibnite with subordinate amounts of pyrite.

About 35 feet elevation above the tunnel and 60 feet north of its portal is the discovery shaft which connects with the workings of the upper tunnel. At the outcrop the vein has a strike of N. 25° E. and a dip of 60° to the northwest.

This property is worked for a short time each year. Sufficient work has not yet been done to determine the probable character of the ore bodies in depth.

GERMANIA.

The Germania Mine is situated about 17 miles in an air line southwest of Springdale, or 26 miles by wagon road. It is also about four miles south of Turk post office by road. The mine is in sec. 13, T. 29 N., R. 37 E. Springdale is the shipping point by railroad. This property was originally located by Messrs. McCoy and Horn in 1894. About 1906 three claims were acquired by W. Schenk which he afterward incorporated into the Germania Mining Company. Later they secured a lease on the Roselle claim. Later this company was reorganized as the American Tungsten Consolidated Corporation,

with head offices in New York City. The Roselle Mining Company has the southwest extension of the Germania vein, comprising one full claim and a fraction.

The development work consists of three tunnels, No. 1 at an elevation of 3,593 feet, No. 2 at an elevation of 3,472 feet, and No. 3 at an elevation of 3,400 feet. No. 1 tunnel is 590 feet in length, No. 2 is 820 feet, and No. 3 is 845 feet. From Nos. 1 and 2 tunnels probably 5,000

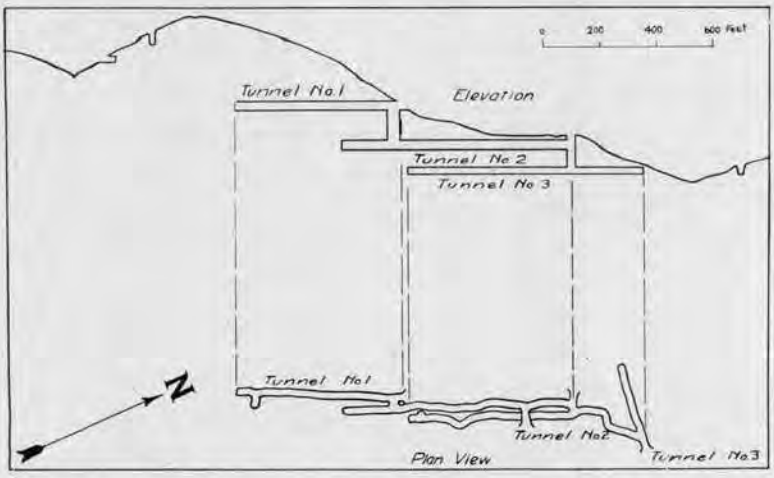


FIG. 10. Plan and section of Germania Mine, Springdale District.

tons of ore have been mined, from which 140 tons of concentrates were made averaging about 65 per cent of tungstic acid. In addition there are many open cuts, trenches and short tunnels scattered over the property. The three main tunnels are on the same vein and are connected by shafts, raises and stopes.

The country rock exposed in the vicinity of this property is chiefly normal biotite-granite which varies greatly in granularity from place to place. It is intruded into the Deer Trail argillite and the Addy quartzite and in places residuals of these formations are present. The ore occurs in a quartz vein varying in width from a few inches to five feet, with an average of 20 inches. The

ore minerals are wolframite, with which are associated pyrite, galenobismutite, arsenopyrite, molybdenite and chalcopyrite. This vein has a prevailing strike of N. 25° E. and a dip of 75° to the southeast. On the level of No. 3 tunnel the vein is exposed for a distance of over 550 feet. From the intersection of the No. 3 tunnel and the raise to No. 2 tunnel the vein is exposed continuously along the former for a distance of 350 feet, where it is terminated by a fault having a strike of N. 40° W. and a dip of 67° to the southwest. The tunnel has been driven on from this point for 35 feet in barren granite when the vein again reappears along a fault plane having a strike of east and west and a dip of 53° to the south. The tunnel continues to the left or east of the vein through barren granite for a distance of 75 feet, when the vein is again intersected. The tunnel then continues along the vein for 55 feet, when it again passes to the left or east and is in barren granite to the face. At a point 60 feet from the face a crosscut tunnel has been driven to the west for 25 feet and the vein was again intersected. The tunnel should be continued from this point.

In the stopes of No. 2 tunnel the vein splits into branches which diverge at an angle of about 45°. Looking south the right-hand vein has a strike of S. 35° W. and a dip of 66° to the southeast, with a width of three feet. The ore is about six inches thick and lies on the footwall. The left-hand vein has a strike of north and south and a dip of 70° to the east. The tunnel has been driven on the right-hand portion of the vein and a crosscut tunnel has been driven to the left-hand portion of the split vein. The ores of value are contained in the right-hand vein. The stope from No. 2 tunnel goes up at the junction of the two veins. The best ore in the mine was observed at this point.

On the surface are several open cuts in which quartz veins have been uncovered. In some of these tungsten minerals occur. The ore deposits occur in veins in the granite near the roof of a batholith. They probably were derived from solutions given off from the cooling magma shortly after its consolidation, under high pressures and temperatures, as evidenced by the presence of such minerals as tourmaline and fluorite. The solutions were precipitated in the fractures and fissures formed in the granite.

SAND CREEK TUNGSTEN.

This property is situated on one of the branches of Sand Creek, in sec. 3, T. 28 N., R. 37 E. It lies to the southwest of the Germania Mine, over the divide in another canyon, and is reached by wagon road from Davenport. The country rock is largely granite but scattered through it are isolated remnants of the surrounding argillite and schist. At several places in the granite are small stringers of quartz. In three places these have been opened by small surface cuts, pits and trenches. In one of the open cuts, at an elevation of 3,600 feet, there is a quartz vein 18 inches in width having a strike of N. 15° E. and dipping vertically. The quartz is milky-white and contains some pyrite and a few scattered small crystals of wolframite.

Further down the ridge near the valley of one of the branches of Sand Creek, at an elevation of 3,200 feet, a short tunnel has been driven in a direction N. 15° E. for a distance of 25 feet. A quartz vein along with a zone of altered granite dips to the southeast at the face of the tunnel. No tungsten ore was seen at the time of examination although several sacks were said to have been taken out only a short time before. The work on this property was done during the year 1917.

LOON LAKE BLUE BIRD COPPER.

This property is situated in the northeast quarter and the northwest quarter of sec. 34, T. 31 N., R. 41 E., and about five and one-half miles north of the town of Loon Lake. There are four claims in the group, known as the Bluebird, Wonder, Dupont and Juno.

This property is developed by two shafts and a tunnel. Shaft No. 1 is situated near the west end line of the Bluebird claim and has been sunk to a depth of 40 feet on a quartz vein carrying malachite and chalcopyrite.

No. 2 shaft has been sunk to a depth of 82 feet and is situated 125 feet east of No. 1 shaft. Its collar is at an elevation of 2,550 feet. This shaft has also been sunk upon the quartz vein and the copper minerals are similar to those in shaft No. 1. On the 82-foot level, at the bottom of the shaft, a drift has been run to the east for 30 feet and to the west for the same distance. The copper minerals occurring in these workings are chalcopyrite, bornite, azurite, malachite, chalcocite and cuprite in a quartz gangue.

About 475 feet east of shaft No. 2 there is a tunnel which has been driven nearly due east for a distance of 215 feet on a large white quartz vein which dips at an angle of 60° to the north. The minerals occurring in the quartz are chalcopyrite, chalcocite, and azurite. The vein is between six and eight feet in width and is said to assay 3.87 per cent in copper.

The formation is a part of the Deer Lake argillite and consists of argillite, quartz-mica schist and quartzite. The average strike is about N. 40° E., with a varying dip. The formation is greatly disturbed and the observations on strike and dip vary greatly.

LOON LAKE COPPER.

This property is situated in the north half of sec. 33, T. 31 N., R. 41 E. It is about six miles north of

New all-flotation mill and surface plant of the Loon Lake Copper Mine.

Loon Lake, and 38 miles north of Spokane. The property is incorporated and the head offices are in Spokane.

The formations exposed in this locality are light and dark argillites having a strike ranging from north and south to N. 35° W. and dipping from 60° to 70° to the west. The argillites have undergone intense movements and are folded and crushed to a marked degree. About 500 feet west of the belt of argillites exposed at the mine is a belt of quartzite.

The ore deposits occur in an east-west fissure or fracture zone and consist of crushed quartz carrying copper ore. The ore is chiefly secondary and consists of malachite and azurite with some cuprite, as exposed on the second level. On the third level the ore is chiefly chalcopyrite associated with iron pyrite. A subordinate amount of gray mineral resembling gray copper is present in small quantities in the upper zones.

About 50 carloads of ore have been shipped, averaging 12 per cent copper. The vein as exposed in the stopes will average about five to six feet in width. The ledge matter attains a width of 20 or more feet.

The property has been developed by two shafts and a large amount of drifting. No. 1 shaft had been sunk to a depth of about 480 feet at the time of examination and was being continued to the 500-foot level, where a station is to be made. At a depth of 200 feet below the collar a drift has been extended to the east for a distance of 330 feet and to the west for 40 feet. From this level stoping has been done nearly to the surface on a shoot of high-grade copper ore. This shoot of ore is about 150 feet long. No. 3 level is about 100 feet below No. 2 level, and has been driven 300 feet east of the shaft and 50 feet to the west. The ore on this level is principally chalcopyrite.

A second shaft, known as No. 2, is situated about 420 feet east of No. 1 shaft, at an elevation of 2,625 feet. It is an old shaft and is about 60 feet in depth. It has a slope of 60° to the north and has been sunk on the vein. A few feet east of this shaft and on the same level as the collar is an old tunnel about 200 feet in length. Eighty feet from the portal there is a crosscut nearly 60 feet long.

In the No. 2 drift, east from No. 1 shaft about 200 feet, the vein is cut by the Morgan fault which strikes N. 14° W. and dips 52° to the southeast. The throw of the vein is about 50 feet to the north. The vein on the level No. 3, west of the south crosscut, has a strike of N. 85° E. and a northerly dip. On the second level beyond the Morgan fault the vein has a strike of N. 85° E. and dips to the north at an angle varying from 50° to 60°.

TUNGSTEN KING GROUP.

This property is situated at the head of a small canyon on the south slopes of Blue Grouse Mountain, at an ele-

vation of about 3,600 feet, in sec. 16, T. 30 N., R. 42 E. It is located about 10 miles north of Deer Park and 30 miles north of Spokane, and is reached by wagon road from the former place. Grouse Mountain is a westerly spur from the Calispell Range and forms the divide between the canyon in which Deer Lake lies and the level gravel-covered plains north of Spokane River.

The formations exposed in this locality are mainly the Loon Lake granite and an irregular shaped mass of quartz-mica schist, argillite and quartzite. This area of metamorphic rocks embraces nearly two square miles and is a residual of a much more extensive formation which has been removed by erosion but which was probably a part of the Deer Lake formation. It has been intruded by the Loon Lake granite and near the contact the granite becomes a pegmatite or aplite. In places, as on the northeast side of Big Blue Grouse Mountain, large areas of the granite are entirely composed of quartz and bluish-pink mica with only a small amount of orthoclase.

The ore deposits consist of well-defined quartz veins containing crystals of the tungsten mineral hübnerite, the bismuth mineral cosalite, pyrite and its alteration products, hematite and limonite, in the form of pseudomorphs. The quartz is usually of the milky-white variety but locally is dark colored. The veins vary in thickness from a few inches to five feet. They are usually barren but in places contain zones in which lenses and bunches of the tungsten and iron minerals occur. Often the ore minerals are evenly scattered through the quartz or along the walls of the vein in thin seams up to six inches. Tungsten minerals were not seen in the country rock although hematite and limonite pseudomorphs after pyrite are quite common in the schists in the near vicinity of the quartz veins.

At the time of examination of these properties, in 1914, the camp was inactive and many of the tunnels

and shafts were caved. Development work consists of several shafts, drifts, crosscut tunnels and open cuts and trenches.

Tungsten King. This property, situated at the head of the canyon on the south slope of Blue Grouse Mountain, is owned by the Tungsten King Mining Company, with headquarters in Deer Park. A vein of quartz containing tungsten minerals outcrops in the canyon and trends approximately N. 45° W. to the summit of the mountain. The greater part of the area is covered with glacial drift, especially in the canyons. Tunnel No. 1, at an elevation of 2,570 feet, has been driven to the northeast for a distance of 600 feet through metamorphic rock. At a point 60 feet from the portal a quartz vein one foot in thickness was encountered having a northwest trend. A drift was run on this to the northwest for a distance of 180 feet. About 500 feet from the mouth a second quartz vein was cut having a strike of N. 45° W. and a dip to the southwest of 45°. This vein is composed of a white milky quartz having a thickness of 36 inches, and carrying tungsten minerals in a belt six inches wide. A drift has been run on this vein to the northwest for a distance of 30 feet. This vein is locally known as No. 2. Beneath the quartz is a band of stiff clay gouge material carrying cubes of pyrite and having a thickness of 18 inches.

No. 2 tunnel is situated a short distance to the northwest of No. 1, and has been driven in on No. 2 vein in a direction N. 45° W. The vein material is composed of white milky quartz containing about four inches of tungsten mineral in places on the foot-wall and small bunches of cosalite on the hanging-wall. This vein dips 45° to the southwest. Several other shafts have been sunk on this property and small amounts of tungsten exposed.

Harrison. This property embraces the east half of the northeast quarter of sec. 16, T. 30 N., R. 42 E. The de-

velopment work consists of a shaft sunk on a vein of white quartz about 24 inches in width and having a strike of N. 45° W. The country rock is pegmatitic granite, which is greatly decomposed, and nearly two-thirds composed of white mica. The shaft is 15 feet in depth. There is a tunnel on the north end of the property several hundred feet in length but inaccessible at the time of examination.

Blue Grouse. This property involves 80 acres lying immediately west of the Harrison claim. The workings are situated on the north slope of Blue Grouse Mountain and are reached by wagon road. A crosscut tunnel has been driven to the south for a distance of 520 feet, where a vein of quartz was intersected. From the surface a shaft connects with the face of the tunnel. The country rock is granite. At the time of examination it was impossible to enter the workings. The ore on the dump consists of quartz containing hematite and a small amount of hübnerite crystals.

S. L. This property lies east of the Tungsten King, in section 15. The country rock is quartzite. A tunnel has been driven to the west for a distance of 190 feet, where a vein of white quartz was intersected having a strike of N. 45° E. and a dip of 45° to the southwest. Over 100 feet of drifting has been done on this vein. The minerals in the vein are hübnerite and cosalite in small quantities. At the intersection of the shaft and drift an inclined shaft has been sunk to a depth of 30 feet. This shaft was filled with water but is said to have produced some good ore.

The ores of this camp are directly associated with quartz veins which are in the near vicinity of the Loon Lake granite. The mineral content has probably been derived from solutions given off from the granite magma shortly after its consolidation and under high pressure and temperature.

O-LO-LIM COPPER.

This mine is situated in the northwest quarter of the southeast quarter of sec. 9, T. 28 N., R. 37 E., about three miles north of Spokane River. It is reached by wagon road from Davenport, a distance of 35 miles. The first work on this property was done about 20 years ago, when a small 10-foot shaft was sunk. The present company was recently organized with headquarters in Spokane, and began development work in January, 1917. A shaft has been sunk to a depth of 100 feet and from this depth a drift has been run to the north for 35 feet and to the south for 15 feet. At the time of examination the property was working but the shaft was temporarily filled with water. The vein has a strike of N. 20° E., with a dip to the east. It is said to be seven feet wide at the bottom of the shaft and three feet near the surface. The country rock is argillite, which in places is slightly calcareous. A short distance to the east there are outcrops of granite. The ore minerals consist of chalcopyrite, bornite, pyrite and small amounts of the secondary copper minerals. Ten tons of ore are said to have been shipped to the Granby and Tacoma smelters, which yielded 7½ per cent of copper. Three cars were shipped to the Granby smelter which are reported to have yielded, respectively, 9.8 per cent copper and one ounce of silver, 6.5 per cent copper and 1.4 ounces of silver, and the third car gave returns of 7.5 per cent copper.

KETTLE RIVER DISTRICT.

GENERAL STATEMENT.

The name Kettle River district is used to embrace that area lying west of the Huckleberry Range and east of Columbia River, from Kettle Falls southward to Daisy. Six properties were seen in this district, one of which was carrying on development work at the time of examination. These claims were located just after the Colville Reservation was thrown open to settlement and develop-

ment work has been carried on at intervals during the last 24 years. All the mines are accessible by roads which extend up and down the Columbia River valley and such ore as has been shipped has been sent either direct to Myers Falls or over the old Daisy Mine road to Addy.

The formations exposed are argillite and limestone belonging to the Mission argillite formation. They are cut by granite and diorite masses. The ore deposits consist of lead, silver and copper ores, with a quartz gangue lying in a zone of fracturing in the argillite and granite. There is no prevailing direction to the veins but commonly they lie parallel to the planes of bedding in the argillite. They are typically fissure fillings although there has been occasional replacement. In the early days of development considerable ore was hauled by wagon road to Addy and Colville but no data are available as to the value of production.

ACME.

This property is situated in the western part of sec. 27, T. 35 N., R. 37 E., on the western slopes of the Huckleberry Mountains, overlooking Columbia River. The formation is argillite, limestone and quartz-mica schist. These are cut by granitic and basic peridotite dikes. The ores are partly in the dikes or in the argillite in the near vicinity. At an elevation of 2,610 feet on the Acme claim a tunnel has been driven 210 feet in a southeasterly direction and at the face there is a shaft which at the time of examination was filled with water. It has been sunk upon a quartz vein trending north and south, with a westerly dip of 40°. A short distance higher on the hillside several short tunnels and shallow shafts have been made but are caved and inaccessible. Farther down the hill to the west, at an elevation of 2,100 feet, a long crosscut tunnel has been started from the center of the Compromise claim and has been driven in a direction N. 60° W. for over 700 feet, where the face is beneath the

center of the Acme claim. This tunnel was also caved at the time of examination and inaccessible. The rock exposed on the dump which came from the tunnel is composed of micaceous granite and silicified argillite. Similar formations are exposed on the surface between the portal of the upper tunnel and that of the lower tunnel. Fifty feet west of the mouth of the tunnel is a belt of bluish-gray limestone with a north and south trend and having a width of about 50 feet.

E. M. C.

This property joins the Silver Queen on the north and lies in secs. 11 and 12, T. 35 N., R. 37 E., at an elevation of 2,000 feet. The formation exposed is the same as on the Silver Queen ground. The property is developed by a tunnel whose portal is about 500 feet north of the Silver Queen shaft and across the canyon. At the time of examination it was caved and inaccessible. From the portal it has been driven S. 60° E. for at least 50 feet in a calcareous argillite. About 300 feet to the north and at an elevation of 2,160 feet a shaft has been sunk in a series of interbedded limestone and argillite to a depth of 35 feet. Upon the dump about the collar of the shaft there is quartz containing galena and a little chalcopyrite.

ALMA.

This claim lies immediately east of the Acme at an elevation of 2,640 feet. It was located in 1896 and was formerly known as the Black Witch. The formation is greatly altered silicified argillite and quartz-mica schist, which is cut by granite and basic dikes. Several open cuts and tunnels have been made. At an elevation of 2,700 feet there is a shaft 30 feet in depth in a badly altered micaceous granite. Nearby, in quartzite, is a combined shaft and tunnel which is caved. Pyrite in a quartz gangue occurs among the materials on the dump.

SILVER QUEEN.

This property is situated on the eastern slopes above Columbia River, at an elevation of 1,650 feet, in sec. 11, T. 35 N., R. 37 E. It embraces a group of seven claims which were located in 1892 and 1896, and were incorporated in 1905 as the Art Group Mining and Milling Company. The formations exposed are a part of the Mission argillite and consist of argillite, calcareous argillite, quartz-mica schist and dolomitic limestone.

The property is developed by two shafts near together and at an elevation of 1,900 feet, with several drifts and open cuts and a main lower tunnel at an elevation of 1,650 feet, which is being driven to intersect the vein exposed in the shaft above. The vein as exposed in the shaft consists of quartz varying in width from a few inches to several feet and following the bedding planes of the argillite. It carries as its ore minerals small quantities of tetrahedrite, galena, sphalerite, chalcopyrite and pyrite which are said to carry values in silver. The prevailing strike of the formation varies from north and south to N. 35° W., with a westerly dip of 40°. One shaft, sunk in 1909 on a slope of 45°, is said to have a depth of 150 feet. The vein exposed is white quartz lying parallel to the planes of bedding of the dark calcareous argillite, which in the vicinity of the collar of the shaft is greatly twisted and broken. Some tetrahedrite was observed in the vein. A short distance away and at the same elevation is an old shaft said to be 150 feet deep which has been sunk on the bedding planes of the formation at an angle of 43° in a direction S. 45° W. The vein exposed carries iron-stained rusty quartz with some limonite present, which is said to have assayed $5.00 in gold.

Farther down the hillside to the west a tunnel has been driven as a crosscut in a direction S. 32° E. for 815 feet through a dark carbonaceous argillite having a strike

of N. 40° W. and a dip of 32° to the southwest. No ore occurs in the tunnel but stringers of barren quartz follow along the bedding planes of the formation.

One trial shipment of 14 tons in 1915 was sent to the Northport smelter and is reported to have yielded values in silver, copper and gold, with a little zinc.

DAISY.

The Daisy Mine is located in sec. 7, T. 33 N., R. 38 E., on the western slope of the Huckleberry Mountains,

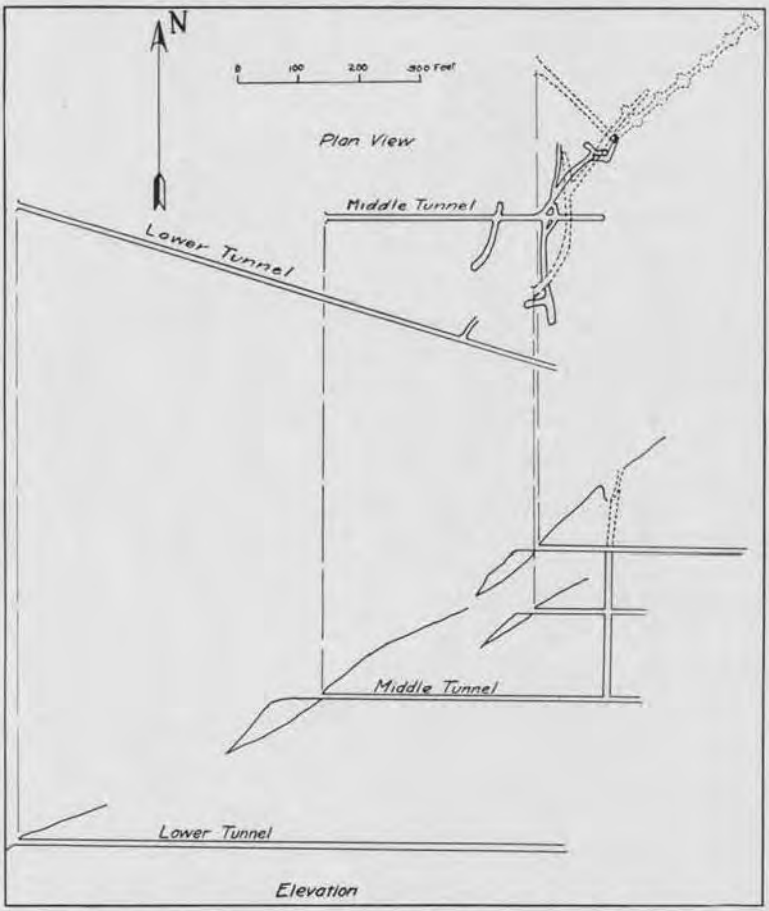


FIG. 11. Map of workings of Daisy Mine, Kettle River District.

overlooking Columbia River, at an elevation of 3,400 feet. The formations exposed consist of banded calcareous argillite and quartzite, cut by a mass of granite. The property is developed by a lower tunnel at an elevation of 3,150 feet and three tunnels above, all of which are connected by raises.

The lower tunnel has been driven nearly due east for a distance of over 1,000 feet. The first 500 feet is in

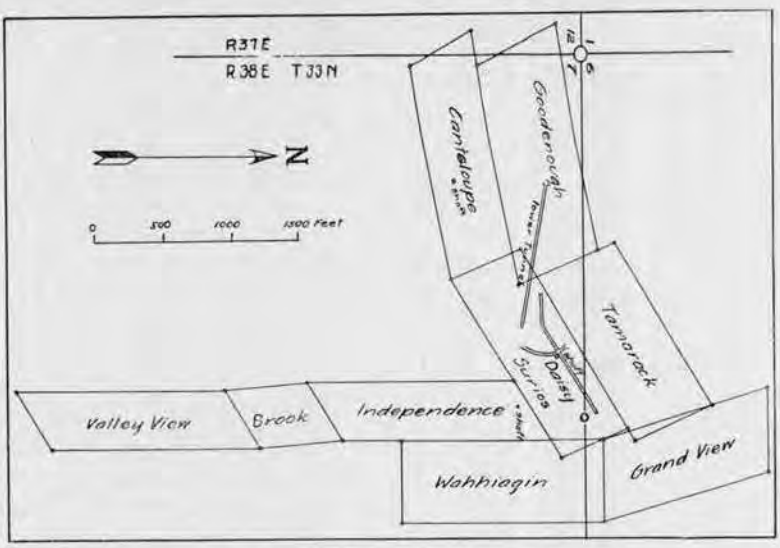


FIG. 12. Map of Daisy Mine, Kettle River District, showing location of claims and principal workings.

quartzite and beyond this in granite. The tunnel was caved at the time of examination beyond a point 500 feet from the portal. The quartzite is banded and has a strike of N. 35° W. and a vertical dip. Tunnel No. 2 is just above at an elevation of 3,400 feet and almost due east. The rock exposed in the tunnel 300 feet from the portal is banded argillite and calcareous argillite. At this point the strata lie along an intrusive contact with granite trending N. 40° E. Granite is then the rock exposed in the tunnel for 240 feet, when quartzite ap-

pears on the eastern side. About 120 feet from the portal a vein of quartz six feet wide was encountered, having a strike of S. 40° W. and a southwest dip of 70°. This has been drifted on for 150 feet. About 200 feet from the portal a second vein of quartz was encountered, lying nearly parallel to the granite-quartzite contact, having a nearly north and south strike with a dip of 80° to the west. This vein has been drifted on for over 300 feet and several large stopes have been made. The ore minerals observed here are chalcopyrite and pyrite.

From the north drift a crosscut tunnel was driven 100 feet, where a 12-inch quartz vein carrying chalcopyrite was cut. This vein has a strike of N. 20° E. and a vertical dip. At this point a raise has been extended to the tunnels above, within which no examinations were made.

TEMPEST.

This property is located on the western slopes of the Huckleberry Mountains, four miles east of Daisy, in sec. 7, T. 39 N., R. 38 E., at an elevation of 2,920 feet. There are six claims in the group, which were located in 1888. These have been incorporated and are owned by the Tempest Mining and Milling Company. The formations exposed on the property are argillite and quartz-mica schist, which have been intruded by a mass of granite and diorite. The development work consists of a main working tunnel, at an elevation of 2,920 feet, which has been driven easterly into the mountain. There are about 2,400 feet of underground tunnel work in the mine. On the surface there are open cuts and short tunnels. The rock exposed in the main tunnel is a gray, medium-grained diorite, and 215 feet from the portal a vein of quartz was intersected having a trend of N. 15° E. and a width of 12 feet. This was drifted on for 90 feet and stopes were extended to the surface. About 130 feet from the portal a long tunnel has been driven

as a drift to the northeast and north, following approximately the contact between the diorite on the west and the argillites and quartzites on the east. Along the contact, but more often occurring in the diorite, is a quartz vein varying in width from eight inches to four feet and occurring as a fissure, with an average strike of N. 20° E. and a dip to the northwest of 70°. The ore minerals are

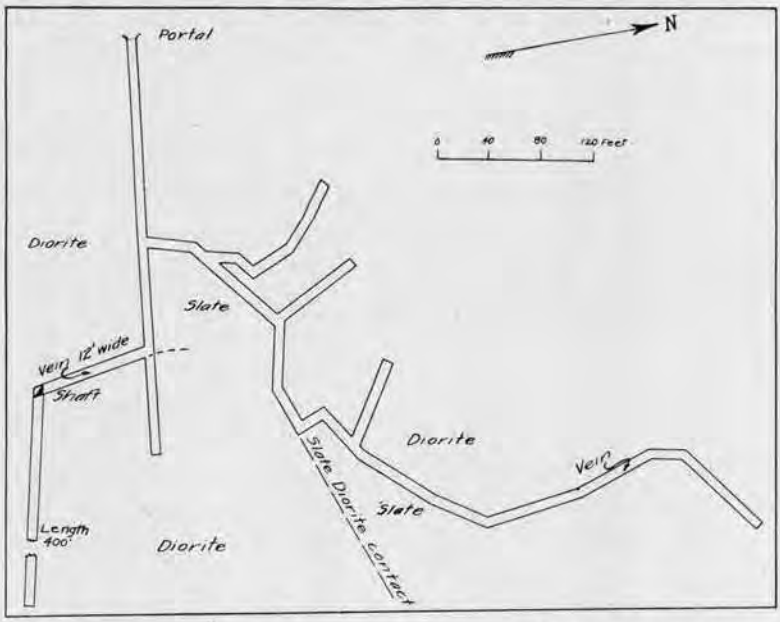


FIG. 13. Plan view of workings of the Tempest Mine, Kettle River District.

chalcopyrite, galena, tetrahedrite and sphalerite, carrying values in silver from 1 to 20 ounces. This vein has been drifted on for over 700 feet, although the tunnel does not always follow the vein. The greater part of the development work was done during 1902-1904.

MYERS FALLS DISTRICT.

GENERAL STATEMENT.

This district lies in the north and western portions of the county, east of the junctions of Colville and Kettle rivers with the Columbia. Not over 50 square miles

are involved in the district. Myers Falls and Marcus are the two principal towns in the area and all the properties are located only a short distance from them. At the present time the camp is inactive. The majority of the properties are situated north of Myers Falls and only a small amount of development has been done. One long crosscut tunnel has been driven. The other work consists of inclined shafts, open cuts and short tunnels.

The formation is mainly the Mission argillite with interbedded narrow limestone bands. These are cut by monzonite, granite and diabase dikes. The ore deposits consist of fissure and fracture zones in the diabase and argillite as well as in the granite dikes which have been filled with quartz veins of varying width together with chalcopyrite, pyrite, pyrrhotite, galena and sphalerite. A small amount of ore has been shipped but the total production of the camp has not been large.

GRAY EAGLE.

This prospect consists of two claims formerly known as the Right Side and Right Side No. 2, situated in the center of sec. 17, T. 36 N., R. 38 E. The prevailing formation exposed consists of argillite and interbedded quartzite, cut by granite dikes. The argillite has a prevailing strike of N. 30° E., with a dip of 70° to the northwest. The property is developed by a shaft sunk on a slope of 45° to the west. At the time of examination this shaft was filled with water and could not be examined. Several other shallow shafts, short tunnels and open cuts have been made. The ore observed upon the dump consists of a gangue containing quartz, calcite and gypsum with considerable quantities of chalcopyrite.

BENVENUE.

This prospect is situated in sec. 9, T. 36 N., R. 38 E., at an elevation of 3,340 feet. There are two claims in the group, known as the Alba and the Benvenue. The

formation exposed is a part of the Mission argillite with the included intrusive granite dikes. One of these dikes occurs at the summit of the divide between Pingstone and Colville creeks. It has a width of 900 feet and strikes N. 30° E. The ore body lies in quartz following the western side of the dike. Upon this a shaft has been sunk on a slope to the northwest at an angle of 40°. About 60 feet down from the collar a drift has been run to the north for 40 feet. The property was inaccessible at the time of examination.

BIG BEAR.

The Big Bear prospect is located in the northeast quarter of sec. 4, T. 36 N., R. 38 E., on the north side of Pingstone Creek, about five miles from Marcus. The formation exposed in the vicinity is a part of the Mission argillite, which is cut by diorite and granite dikes. The property is developed by a lower tunnel about 50 feet in elevation above the road. It has been driven in argillite for a distance of 300 feet in a direction almost due north. About 150 feet from the portal a dike of diorite six feet in width was cut having a strike nearly east and west. An upper tunnel, at an elevation of 2,630 feet, has been driven in a direction N. 25° E. for a distance of 195 feet. At the face a winze has been sunk to a depth of 28 feet. About 120 feet from the portal a stringer of quartz has been intersected and at this point a shaft connects with the surface a distance of 105 feet.

I. O. U.

This claim lies on the southeast side of the Sunday claim, in sec. 7, T. 36 N., R. 38 E. The formation is similar to that common throughout the area. A tunnel has been driven in a direction N. 30° E. for 150 feet on a quartz vein in a granite dike. Higher on the hillside two shafts have been sunk 60 feet to the level of the tunnel and for some distance below it. The quartz vein

is one foot in thickness and, as exposed in the tunnel, pitches to the southeast at a low angle of 20°. No ore was seen at the time of examination but a small lens is said to have been taken out which contained some native silver.

SUNDAY.

This claim is situated in the southeast corner of sec. 7, T. 36 N., R. 38 E. The formation is interbedded argillite and limestone cut by numerous granite dikes. The mine is developed by three tunnels, the lowest of which has been driven to the northeast for 350 feet along a quartz vein eight inches wide on the footwall and six inches on the hanging-wall, with four feet of rock between. It has a strike of N. 54° E. and a dip of 40° to the southeast. Tunnel No. 2 above, at an elevation of 2,150 feet, has been driven N. 10° E. on the vein which dips from 45° to 65° to the southeast. This vein is composed of quartz varying from four to six inches in width, and has been stoped to the surface. Higher on the hill to the northeast there is a shaft said to be 150 feet in depth and at an elevation of 2,300 feet. Near by are several shallow shafts and open cuts.

COLUMBIA RIVER.

This prospect lies at an elevation of 1,700 feet above sea level on the east side of Colville Valley, between Myers Falls and Marcus, in sec. 7, T. 36 N., R. 38 E. The formation exposed consists of argillite, carbonaceous argillite, quartzite and limestone cut by intrusive dikes of fine-grained granite. The strike of the strata averages N. 55° E., with a dip to the northwest of 65°. The property is developed by a long crosscut tunnel driven to the northeast for 2,700 feet. The rock exposed in the tunnel is largely carbonaceous argillite cut by granite dikes. It is being driven to intersect at the supposed downward extension of a quartz vein higher on the hillside at an elevation of 2,600 feet. At this point

a shaft has been sunk on a slope of 45° to the northwest on a vein whose strike is N. 20° E., with a dip to the northwest of 45°. It lies along the contact between an intrusive granite dike and the argillite, and consists of quartz gangue containing chalcopyrite, tetrahedrite and pyrite. The shaft is said to be 300 feet in depth but all of the workings were caved at the time of examination. The lower crosscut tunnel was open for examination.

CITY VIEW.

This prospect is situated about one mile east of Myers Falls, on the north side of Colville Valley, at an elevation of 2,330 feet, in the southwest quarter of sec. 16, T. 36 N., R. 38 E. The formation exposed is a badly contorted argillite with an interbedded band of limestone about 200 feet in width and trending N. 30° E., with a dip of 45° to the northwest. The property is developed by a lower crosscut tunnel at an elevation of 2,330 feet, driven N. 30° W. for 60 feet. Twenty feet higher and to the east a second tunnel has been driven N. 40° W. for a distance of 50 feet. Near the portal a quartz vein was cut having a width of five inches, with a strike of N. 30° E. and a dip of 45° to the northwest. Twenty-five feet higher and over the face of the second tunnel, a shaft has been sunk for a distance of 12 feet on a vein of quartz three feet in width. This vein strikes N. 50° E. and dips 80° to the northwest. It, as well as the wall rock, carries pyrite. The ore is said to give values of $9.00 in gold, as well as values in lead and silver.

CLUGSTON CREEK DISTRICT.

GENERAL STATEMENT.

This district lies in the north central part of the county, near the divide between Onion and Clugston creeks. The first locations were made shortly after the opening of the Colville Reservation. Following the opening the district became active and a considerable amount

of development work was undertaken. The formations exposed in the region are limestone and argillite which to the north of the headwaters of Onion Creek are cut by a large area of granite. The greater part of the mineralized zone lies in the Clugston limestone although some ore occurs in the argillite. The limestone belt as indicated upon the geologic map appears to have been greatly squeezed so that at the divide between Onion and Clugston creeks it is double its normal thickness. This contortion may have been produced at the time of the granitic intrusion. The limestone is greatly fractured and both the major, as well as the minor slips, have been more or less mineralized. The ore deposits fall under the general class of replacements. The ore minerals are chiefly galena, carrying varying amounts of silver, together with minor amounts of pyrite, chalcopyrite, sphalerite, calamine, cerusite, malachite, azurite and limonite. The fractures as a rule are not persistent for great distances and they are scattered at random through the limestone. The result is that the ore bodies are usually of small size and are not continuous for great distances. The ores may have been derived from solutions given off from the underlying granites. The greater part of the development work consists of shallow open cuts, short tunnels, and shallow shafts. Usually the ore bodies pinch out both horizontally and vertically in short distances. During the early days a small mill was erected near the old Dead Medicine property on Bruce Creek but it was afterward dismantled and removed. No data are available as to the mineral production of the district.

CHLORIDE QUEEN.

This mine is situated in secs. 23 and 24, T. 37 N., R. 39 E., on one of the east branches of Clugston Creek, at an elevation of 3,400 feet. There are five claims in this group, known as the Chloride Queen, Chloride Queen Extension, Tamarack, Mother Lode and Center Star,

which were originally located in 1887. The formations exposed are limestone and quartzite, which are a part of the Colville quartzite and the Clugston Creek limestone. The ore deposits occur in a zone of fracturing having a general strike of N. 65° W. and a dip of 70° to the northeast. The ore minerals are galena and cerusite, together with a small amount of sphalerite and chalcopyrite in a quartz gangue. The vein has a width of five feet but has been greatly oxidized.

The property has been developed by a long crosscut tunnel which is being driven to intersect the vein exposed on the hillside above. Near the outcrop a shaft has been sunk on the vein, and several open cuts made. In the early days considerable work was done on exposures of limonite in a limestone formation occurring to the east of the present tunnel. Several shafts, tunnels and drifts were made and the ore, which consists of limonite and said to carry some lead ore, was shipped to the old smelter formerly in existence at Colville. These workings are now caved and inaccessible.

The main tunnel, at an elevation of 3,400 feet, has been driven in a general direction N. 65° W. for a distance of 350 feet. Near the portal the material encountered is glacial drift for about six feet. Underlying this is quartzite. Forty feet beyond the portal a lamprophyre dike about 18 inches in width crosses the tunnel with a strike of N. 75° E. and a dip of 70° to the southeast. This dike is displaced by a fault following the course of the tunnel with a northeasterly dip for a distance of 30 feet, when it reappears on the opposite side of the tunnel. About 160 feet from the portal a drift has been run for 30 feet along a slip plane having a strike of east and west, with a dip to the south of 70°. The hanging-wall is quartzite. At the face of the drift a shaft has been sunk and some ore is said to have been taken out. From this point the tunnel follows along a

mineralized zone and 200 feet from the portal there has been considerable stoping in which galena and lead carbonate ore have been taken out. From the footwall of this stope the ore is said to have carried 18 to 20 per cent zinc, three per cent copper and the upper three feet to have yielded 16 per cent lead and three ounces of silver. An altered lamprophyre dike follows the vein as shown in the stope. Two hundred and fifty feet from the portal a shaft has been sunk for 40 feet on an 80° slope along the footwall. The ore is a mass of limonite, carbonate of lead and galena, which is said to assay $13.00 in lead and silver. From the shaft to the face the tunnel continues along a mineralized fracture zone filled with quartz, limonite and galena. On the hillside above at an elevation of 3,515 feet the limestone is exposed as the country rock and in this there is a zone of fracturing which has been mineralized to a greater extent for a width of 20 feet. The ore minerals are copper and lead carbonates. The general strike of the zone is N. 60° W. Four carloads of ore are said to have been shipped from the property to the Tacoma and Everett smelters which yielded values in silver and lead. In the early days 400 tons of limonite ore were shipped to the Colville smelter.

BIG CHIEF.

This mine, formerly known as the Tenderfoot, is located in sec. 14, T. 37 N., R. 39 E., on a branch of Clugston Creek. The property embraces four claims which were located many years ago. The formation exposed in this area is on the western side of the Clugston limestone near the contact with the Mission argillite. The limestone is massive, white and crystalline and in places banded. Within it are zones of fracture and brecciation into which mineral-bearing solutions have penetrated and deposited sulphides of iron, lead, zinc, and silver. These deposits are lens-like in form and show great variation

in size. Galena and sphalerite are the chief ore minerals. Galena occurs in seams, in small pockets and in nodules. They are widely scattered through the limestone and do not appear to exist in the form of well-defined continuous veins.

The development work consists of a shaft and many open cuts on the summit of the spur and several cuts and one crosscut tunnel at a lower elevation. In the early days many small excavations were made over the surface of the mountain but these are mostly caved at present. At the south side of the canyon leading up to the Jefferson marble quarry a crosscut tunnel, at an elevation of 3,550 feet, has been driven in a direction S. 65° E. for over 200 feet. Sixty-five feet from the portal a side tunnel has been driven about 120 feet in a southwesterly direction. The rocks encountered are interbedded argillite, limestone and silicified limestone. At this point a vein about six inches wide of lead carbonate and limonite in a gangue of quartz about five feet in width and greatly broken was intersected. This has been drifted on for some distance. Several faults were encountered in the tunnel and along these there are usually seams of red clay, three or four inches in thickness. The tunnel is being driven as a crosscut to the vein exposed higher on the hillside.

Higher on the same slope of the hill, at an elevation of 3,220 feet, is a yellowish-white banded limestone which has been locally silicified. An open cut has been made along the trail in a zone of local fracturing which is mineralized with small nodules of galena and a little carbonate of lead. This zone appears to trend N. 30° E. and to dip 60° to the southeast.

Still higher on the hillside, at an elevation of 4,200 feet, is a shaft 50 feet in depth. From the bottom a drift has been driven to the west. This was inaccessible at the time of examination. The ore which came out of it

as seen on the dump is a red iron-stained oxide of iron, carbonate of lead and nodules of galena. This ore is said to have averaged 14 per cent in lead. The country rock is limestone and the ore body appears to be a small chimney possibly at the intersection of two fracture zones. South of the shaft are several open cuts in limestone showing galena which is said to assay high in silver.

AVONDALE-DOME.

This property is situated on the south side of the canyon from the Chloride Queen property and consists of three claims joined end to end in a general north and south direction. These are incorporated and are owned by the Orient Metals Mining and Smelting Company, with head offices in Syracuse, New York. The property was formerly known as the Tenderfoot Mine, and is situated at an elevation of 3,600 feet. The camp, at an elevation of 3,200 feet, is reached by wagon road from Colville. The formation exposed in this vicinity is a belt of the Clugston limestone having a general north and south direction, with a width of three-fourths of a mile. On the eastern side of the belt is a part of the Colville quartzite and on the western side is the Mission argillite. The ore deposits lie in a zone of fracturing and alteration along the western side of the limestone belt and within the belt. The limestones have been shattered and along the shattered zones mineral-bearing solutions have penetrated and replaced the limestones along the fractures. The ore minerals are galena, cerusite, pyrite, and a little calamine. Galena predominates as the ore-bearing mineral. Accompanying it are large quantities of limonite which have replaced certain areas of the limestone. The ore zones have been subjected to much secondary brecciation of a later age than the original mineralization. Presumably the source of the mineral solutions was the underlying granites which in this camp have not as yet been exposed by erosion.

The property has been developed by several tunnels and open cuts. The main tunnel, formerly started by the Tenderfoot Company, is at an elevation of 3,615 feet and has been driven in the limestone in a general direction S. 60° W. for a distance of 108 feet to the face. Forty feet from the portal a drift has been driven S. 65° E. for 35 feet along a zone of intense fracturing and crushing, which is filled with iron-stained clay and gouge mixed with angular fragments of limestone ranging from two to eight inches in diameter. In the soft clay are small kidney-shaped nodules of galena. Along the drift is a winze 18 feet in depth. Twenty feet from the portal is a winze 12 feet in depth sunk in a zone of limonite, clay, and gouge matter containing kidneys and nodules of galena and cerusite which are said to average two per cent of lead and a trace of silver. From this point on for over 30 feet the vein has been stoped. The true pitch of the vein in the shafts is to the southeast, but above the tunnel level it bends over and in the stopes dips at a very low angle to the northwest. As seen in the stopes it varies from three to six feet in thickness and is nearly flat. Near the face of the main tunnel the rock encountered is crushed limestone with reddish clay and gouge material containing disseminated nodules of galena. Specimens occasionally show small quantities of wulfenite and anglesite.

About 150 feet in a southwesterly direction from the main tunnel and at an elevation of 3,640 feet, a second tunnel has been driven S. 35° E. for 125 feet. The formation and ore are similar to that in the lower tunnel. The zone of mineralization strikes N. 60° E., with a dip of 62° to the southeast, and has a width of about six feet.

Seventy feet southeast from this tunnel there is an open cut situated at the contact between the iron-stained gangue and the crushed argillite on the west. At this

point the vein turns over and goes down almost vertically. It is apparently only a local fold and is involved in a pronounced fault whereby the Mission argillite lies against the Clugston limestone. All the ore deposits exposed in these workings are in a zone of faulting and crushing subsequent to that which accompanied the original mineralization.

On the Dome No. 2 claim, higher up the mountain side to the south, there is said to be a vein containing copper ore in the form of azurite along with galena. The country rock is reported to be limestone with a quartz gangue. This claim was not examined by the writer.

NEGLECTED.

This property is situated in secs. 10 and 11, T. 37 N., R. 39 E., on the upper portion of Clugston Creek. The formations exposed in this locality consist of the Mission argillite and the Clugston limestone. The property is situated on a high spur between two branches of Clugston Creek and embraces four claims known as the Neglected No. 1, the Pine Tree, the New Discovery and the Maty. These were located in 1902 and are owned by A. W. Miles of Colville. The development work consists of a main tunnel on the Neglected No. 1 claim, a 100-foot shaft, a 25-foot shaft and several open cuts, shafts and short tunnels.

A AND C.

This claim is situated in the northeast quarter of sec. 3, T. 37 N., R. 39 E., on the divide between Clugston Creek and the east branch of Bruce Creek. It was located in September, 1915. The ore deposits consist of a mineralized zone trending nearly east and west along the contact between the Clugston limestone on the south and the granite on the north. The ores are in the limestone and about six feet south of the granite contact. They consist of chalcopyrite, sphalerite and pyrite

replacing the limestone along a zone varying from 2 to 12 feet in width. The limestone has been greatly silicified and the amount of mineralization varies and in places gradually disappears so that it is not possible to determine where the walls are situated or where the vein ceases to become ore and passes into the country rock. The property is developed by two tunnels. The lower tunnel, at an elevation of 3,450 feet, has been driven into the hill in a direction N. 60° E. for a distance of 220 feet to the face. The rock encountered is entirely a white to blue marbleized limestone. Higher up the hillside to the northeast a second tunnel has been driven S. 75° E. for 110 feet. From this tunnel there has been some drifting on the ore body. Twenty feet above the upper tunnel is the discovery shaft and a large open cut on the vein or ore deposit.

BOTTS.

This property consists of a group of three or more claims situated near the headwaters of Clugston Creek, in secs. 3 and 10, T. 37 N., R. 39 E. They lie on the east side of the creek along the belt of Clugston limestone, forming high cliffs. The ore deposits are small replacement deposits in zones of fracturing in the limestone. No prevailing direction could be determined for the veins. Several short tunnels, open cuts and shallow shafts have been made at elevations ranging from 3,200 feet to 3,350 feet. The country rock is a bluish-gray limestone which has been shattered and recemented. In some of the zones of fracturing there has been replacement with quartz in pockets and with small nodules of irregular shapes composed of galena carrying silver.

R. J.

This prospect is in sec. 3, T. 37 N., R. 39 E., and about 400 feet southeast of the Uncle Sam Mine. The formation is a bluish-white limestone forming a high bluff

on the east side of Clugston Creek. Veins in the form of replacement deposits occur in fracture zones and contain galena said to carry silver. The property has been developed by several open cuts, shallow shafts and short tunnels. The vein as exposed in a short tunnel on the hillside, at an elevation of 3,800 feet, is a mineralized zone along a line of fracture and brecciation having a general direction of N. 25° W. and a dip of 70° to the southwest. This belt is 10 feet wide and is thoroughly brecciated. It is cemented with quartz containing iron carbonate, lead carbonate and galena in nodules. Considerable stoping has been done at this place. Two carloads of ore are said to have been shipped which yielded values in silver and lead. This property was located about 20 years ago.

UNCLE SAM.

This mine is situated in sec. 3, T. 37 N., R. 39 E., near the head of Clugston Creek. Along the east side of the creek there is a high cliff formed in the massive Clugston limestone. Within this limestone belt are small fracture zones in which there has been some replacement with galena said to carry values in silver. The development work consists of two tunnels driven into the hill to the east to tap these veins. The lower tunnel, at an elevation of 3,000 feet, to the east and slightly above the level of the wagon road, has been driven for at least 400 feet in a direction S. 85° E. This tunnel was caved at the time of examination but all the rock exposed upon the dump is limestone.

The upper tunnel, at an elevation of 3,125 feet, has been driven in a direction S. 75° E. for 65 feet into the limestone cliff. Near the face of the tunnel a shaft goes down and is said to connect with the level of the lower tunnel. From the upper tunnel there has been considerable stoping. The limestone is of a bluish-gray

color. The ore exposed in the stopes is limonite, cerusite and galena. It occurs in a zone of fracture parallel to the strike of the formation. The galena is in the form of small nodules of irregular shape scattered in the fracture zone. The gangue is a mixture of iron-stained quartz and limestone.

IBEX.

This property embraces a group of four claims located in 1917. They are situated in sec. 7, T. 39 N., R. 40 E., north of the divide between Onion and Clugston creeks. The formation consists of calcareous argillite and interbedded limestone having a strike of N. 25° E. and a vertical dip. A shaft, at an elevation of 4,700 feet, has been excavated to a depth of eight feet on a quartz vein about four feet in width. The ore mineral is galena, said to assay in silver. Between this shaft and the Galena Farm shaft there is a shallow shaft sunk in the schist formation.

LUCKY BOY.

This prospect lies about one-fourth mile east of the Galena Farm Mine, in sec. 7, T. 37 N., R. 40 E., north of the divide between Onion and Clugston creeks. There are five claims in the group. The formation exposed is similar to that on the Galena Farm property and is a part of the Clugston Creek formation and includes both limestone and argillaceous limestone, with a strike of N. 25° E. and a dip of 60° to the northwest.

The property is developed by a shaft which at the time of examination was 40 feet in depth. The rock exposed in the shaft is a banded limestone containing a three-foot zone which is somewhat mineralized. The elevation at the collar of the shaft is 4,300 feet. In addition to the shaft a tunnel has been driven for a distance of 38 feet to tap a vein higher on the hillside. The formation exposed is calcareous schist. About 130 feet northwest from the tunnel is an eight-foot shaft in

limestone exposing a fracture zone containing copper carbonate ore along the fractures. This is said to yield values in silver. Two other small open cuts on the property show galena, cuprite, azurite and malachite in a gangue of quartz and limestone.

Sufficient development work has not yet been done to determine the extent or general character of the veins. The ores appear to fill small fracture zones in the limestone parallel to the strike of the formation. The source of these ores is probably solutions from the underlying granite.

GALENA FARM.

This mine is situated in sec. 7, T. 37 N., R. 40 E., just north of the divide between Onion and Clugston creeks, at an altitude of 4,700 feet. It is 16 miles southeast from Northport and 11 miles by wagon road to Kane Siding on the Nelson branch of the S. F. and N. Railroad. The property consists of six unpatented claims located along the strike of the vein. These were located in 1916, and during the same year were incorporated as the Galena Farm Mining Company, with head offices in Spokane.

The geologic formations exposed in this region consist of white dolomitic limestone and calcareous argillite which to the south pass into argillite. About two-thirds of a mile to the north these rocks are intruded by a large mass of granite. The strata have a prevailing strike of N. 25° E. and a dip of 70° to the northwest. The vein is exposed at an elevation of approximately 5,000 feet, and consists of replacements of quartz in a zone of fracturing in the dolomitic limestone, having about the same strike as the formation. Silver-bearing galena is the chief ore mineral. The vein varies in width from two to five feet but in places there is mineralization in the wall rock so that the contact between country rock and the vein is not sharp and well-defined.

The development work consists of a series of open cuts made upon the surface exposures of the vein and a crosscut tunnel which is being driven in a direction N. 80° W. to cut the downward extension of the vein. At the time of examination, in September, 1917, this tunnel had been driven a distance of 250 feet. The vein has not as yet been cut. The formation encountered is banded calcareous argillite for the first 160 feet. Beyond this is 40 feet of dark siliceous argillaceous limestone. The remainder of the tunnel is in a white crystalline limestone which in places shows minute impregnations of pyrite. It is planned to continue the tunnel 50 feet farther to intersect the vein.

The values in the ores are said to be in lead, silver and gold, and to have yielded the following values: Silver, 9 ounces; gold, $2.00 to $10.00. It is probable that the mineral solutions which furnished the ores were derived from the underlying masses of granite so well exposed to the north.

SILVER TRAIL.

This mine is situated in the northern part of sec. 33, T. 38 N., R. 39 E., near the head of the east branch of Bruce Creek. It embraces four claims which were incorporated in 1913 as the Silver Trail Mining Company, with headquarters in Spokane. This property was formerly known as the Dead Medicine Mine. It was first discovered and located in 1886 by John Keough. During the years 1889 and 1890 two shafts were sunk and about 120 tons of ore were taken out and shipped to the smelter. This ore is said to have yielded returns of 20 per cent lead and 129 ounces of silver per ton. In 1891 a five-stamp mill was installed, with crusher and tables. A tunnel was driven which opened the vein about 125 feet below the outcrop. Approximately 5,000 tons of milling ore are said to have been taken out and milled during the years 1891 and 1892 and to have yielded

values of seven ounces per ton in silver and one and one-half per cent in lead. During this time about 100 tons of high-grade ore were also mined and shipped which gave returns of approximately 15 per cent in lead and 70 ounces in silver. In 1893 the mill was removed to Rossland, B. C. The property remained idle until 1910 when work was carried on intermittently until the present time.

Two tunnels have been driven on the property. The lower one, at an elevation of 3,025 feet, has been driven in a general northwesterly direction for a distance of 850 feet to the face. The formation encountered is argillite and quartzite having a strike of nearly north and south, with a dip of 50° to the west. About 400 feet from the portal a raise has been extended to within 35 feet of the upper tunnel. About 435 feet from the portal a quartz vein was encountered which has an average strike of N. 30° W. and a dip of 50° to the northeast. This vein averages five feet in width and is composed of quartz carrying chalcopyrite, galena and sphalerite as the ore minerals. No ore has been shipped from this tunnel.

The upper tunnel has been driven 320 feet in a general northerly direction on a quartz vein varying in width from 18 inches to eight feet. It has been stoped over much of this area to the surface and it is from these stopes that much of the ore shipped in the early days was obtained. The vein pitches to the northeast at an angle of 45° and lies in quartzite and silicified argillite parallel to and about 600 feet west of the granite contact. It is probable that the solutions carrying the ore were derived from the granite and entered a zone of fissuring parallel to and adjacent to the contact.

It is estimated that the production of this property has been approximately 220 tons of high-grade ore and about 5,000 tons of milling ore. The returns from a

shipment of a carload of ore made in 1912 representing 42,560 pounds are said to have been: Gold, none; silver, 54.5 ounces per ton; lead, 14.1 per cent; zinc, 9.5 per cent; CaO, 1.7 per cent; sulphur, 16 per cent; iron, 11 per cent; insoluble, 43.4 per cent.

A shipment of ore made in September, 1917, representing 40,860 pounds, is reported to have assayed as follows: Silver, 40.8 ounces per ton; lead, 12 per cent; zinc, 8 per cent. (Other elements approximately as above.)

FIFTEEN MILE CREEK DISTRICT.

GENERAL STATEMENT.

The Fifteen Mile Creek district is situated in the triangle between Kettle River, Columbia River and the international boundary. To the west it extends as far as the divide between Pierre Creek and Columbia River. On the north it is bounded by Sheep Creek, and on the south and east by Columbia River. It embraces roughly 80 square miles of territory.

The first claims were located in 1896, when the reservation was thrown open. Among the first claims to be located were the Ibex and Antelope, by John Hill. Following these were the Orpha group and the Minorca group, by Messrs. King and Wells. In 1898, 23 prospectors met at the Flat Creek store on Flat Creek and organized the district. Since that time many claims have been located and some abandoned. Several claims have been patented. A few shipments of ore are reported to have been made but no data are at hand concerning the total amount mined and shipped. The development work was mostly done several years ago and at the present time most of it is confined to yearly assessment work.

The formations of the district consist of the limestone, argillite, and quartzite of the Mission argillite which are overlaid with andesitic and latite lavas of the Jumbo volcanics. These are cut by dikes of monzonite, diabase

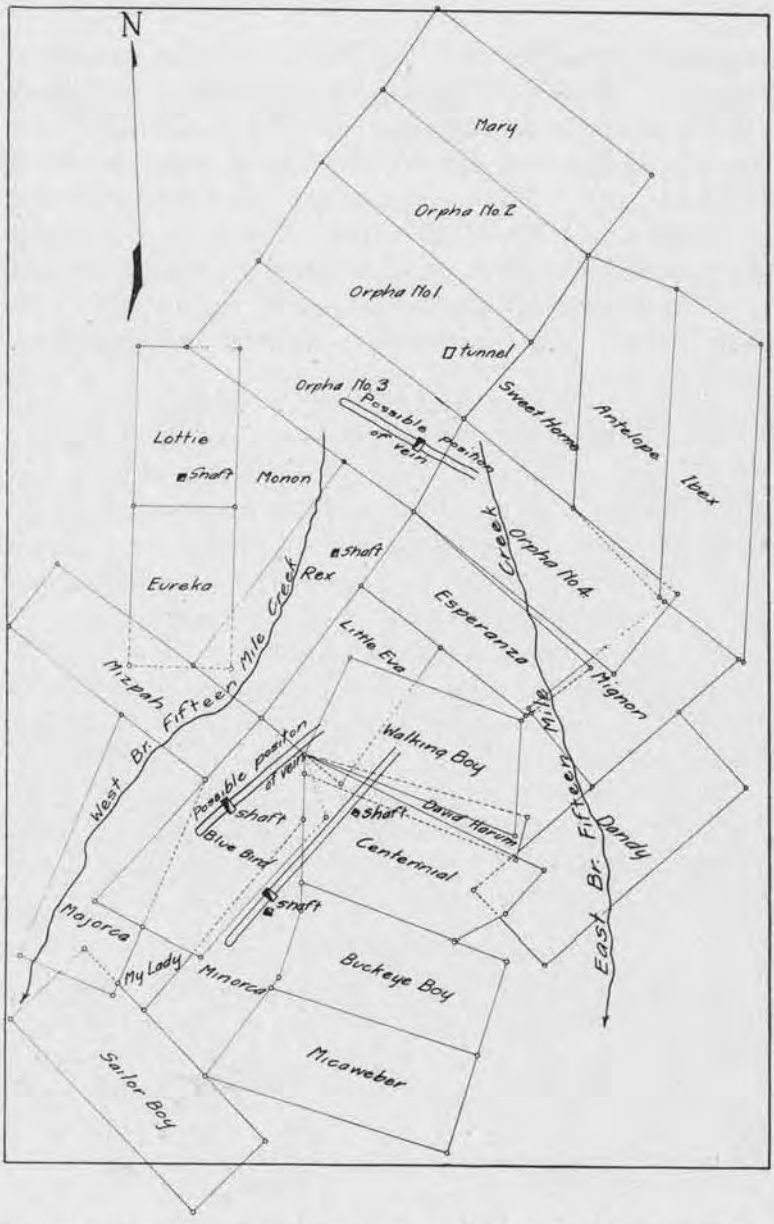


FIG. 14. Map showing location of some of the principal mining claims, Fifteen Mile District, Stevens County.

and lamprophyre types. The veins constitute fracture zones and slips in the lavas and dike rocks which have been invaded by ore-bearing solutions presumably derived from Tertiary granitic and dioritic magmas underlying the area. The ore minerals are chiefly pyrite and pyrrhotite with small amounts of chalcopyrite which carry small values in gold. Occasionally galena and sphalerite occur but they are rare. These deposits have been developed by shafts, short tunnels and open cuts.

MINORCA.

This claim is situated on the west branch of Fifteen Mile Creek, in sec. 19, T. 39 N., R. 38 E., at an elevation of 3,200 feet. It is a part of the Minorca group and was located in 1897. The formations are limestone and calcalreous argillite, which have been cut by greatly altered basic igneous dikes. The vein has a general trend of N. 35° E. and along it several open cuts have been made. Two shafts have been sunk, one of which is said to be 165 feet in depth. This was filled with water at the time of examination, but the ore exposed on the dump and in the open cuts is largely pyrite, pyrrhotite, and chalcopyrite in a quartz gangue. The ore is said to yield values in gold, silver and copper. About 100 tons of ore are reported to have been shipped from the claim.

BLUE BIRD AND DAVID HARUM.

These claims lie in the central part of the Fifteen Mile Creek district, in sec. 19, T. 39 N., R. 38 E. The formations are limestone and calcareous argillite cut by basic dikes and residual areas of the Jumbo volcanic rocks. Several open cuts and shallow shafts have been made.

LOG CABIN.

This claim lies south of the Blue Bird, in a similar formation. It has been developed by shallow shafts and open cuts.

ANTELOPE.

This claim lies northeast of the Orpha and west of the Ibex, at an elevation of 3,650 feet. It was located in 1898. Bedrock outcrops are largely covered with deposits of glacial drift but where exposed are a part of the Jumbo volcanic formation. A vein, averaging in width from two and one-half to four feet, with a nearly north and south strike, consists of pyrrhotite, pyrite and chalcopyrite which is said to give assays as high as $65.00 per ton. A sample taken across the vein several years ago is reported to have yielded an assay of $26.25. An inclined shaft has been sunk on the vein at a slope of 30°. In pockets in the vein as exposed in the shaft, there occur small quantities of melanterite. Fifty tons of ore are said to have been mined.

PEDRO.

This claim lies to the east of the Antelope, in sec. 20, T. 39 N., R. 38 E., at an elevation of 3,600 feet. It was located in 1898. A small outcrop of a vein in the Jumbo volcanic formation shows the presence of pyrite carrying a small amount of chalcopyrite. A shaft has been sunk to a depth of eight feet on the vein. Several open cuts have been made. The ore is said to assay $8.20 in gold, silver and copper.

HOMESTAKE NO. 1.

This claim is situated at the north end of the Fifteen Mile Creek district, in sec. 19, T. 39 N., R. 38 E., at an elevation of 3,800 feet. The formation is a part of the basic Jumbo volcanics. A vein four and one-half feet in width trends N. 30° W. through the formations and dips 50° to the southwest. The ore consists of chalcopyrite, pyrrhotite and pyrite, which is said to yield values of $17.00 in gold, $8.60 in copper and $3.15 in silver. It is estimated that 100 tons of ore have been mined and shipped. For a distance of over 100 feet along the vein there has been

trenching and open cut work. Two shafts have been sunk, one to a depth of 27 feet, and the other to a depth of 12 feet.

BIG JIM FRACTION.

This fraction of a claim lies between the Orpha and the Antelope claims, and was formerly known as the Sweet Home. It is in sec. 19, T. 39 N., R. 38 E., at an elevation of 3,720 feet. A vein outcrops in a dark basic rock with a strike of N. 30° W. and a dip of 60° to the southwest. A shaft has been sunk to a depth of 10 feet and several open cuts have been made. The ores are said to assay $4.00 in gold and $1.00 in copper.

ORPHA

This group consists of three claims known as Orpha Nos. 1, 2, and 3, situated in sec. 19, T. 39 N., R. 38 E., at an elevation of 3,750 feet. The claims were located in 1896. The formation exposed on these claims is a part of the Jumbo volcanics consisting of basic andesites. The lavas are cut by rhyolite porphyry dikes. Upon the Orpha claim a shaft has been sunk upon the vein to a reported depth of 150 feet. On the Orpha No. 2 claim a tunnel, at an elevation of 3,875 feet, has been driven in the Jumbo volcanic formation due west for a distance of 55 feet. About 150 feet west from the tunnel and up the hillside, at an elevation of 3,950 feet, a shaft has been sunk to a depth of 15 feet on a vein composed of pyrite, pyrrhotite and chalcopyrite, said to assay in gold and copper. One hundred feet due west of the tunnel a large open cut and a 20-foot shaft has been made upon a vein 12 feet in width of pyrite and chalcopyrite which are greatly oxidized. The tunnel is being driven to cut this ore body.

LOTTIE.

This claim is situated in sec. 19, T. 39 N., R. 38 E., at an elevation of 3,900 feet. It was first located in 1898 and has been developed by a shaft about 50 feet in depth

and a large amount of open cut work and trenching for a distance of over 500 feet along the course of the vein. The formation consists of quartzite and andesitic volcanic rock, cut by granite and diorite dikes. The general trend of the mineralized zone is N. 80° E., with a width of at least eight feet. The wall rock is rhyolite porphyry. The ore minerals are pyrrhotite, pyrite and chalcopyrite, which are said to assay in gold, copper and silver. About 50 tons are said to have been mined averaging $18.00 per ton.

HOPE AND TWIN CABINS.

These are situated in sec. 18, T. 39 N., R. 38 E., at an elevation of 3,800 feet. The formations exposed are quartzite and the overlying Jumbo volcanic formation which are cut by granite and diorite dikes. The ore deposits consist of pyrrhotite containing some chalcopyrite in a mineralized zone about seven feet wide and lying in the acidic dioritic dike rock. The ore is said to yield values in gold, copper and silver, and to average $9.20 per ton. About 100 tons are said to have been shipped. The claim is developed by two tunnels driven S. 40° E. and about 30 feet apart. They are each about 30 feet in length and are being driven to cut the vein exposed on the surface. In addition there are several open cuts and shallow shafts.

ORA.

This claim lies on the east side of the Tramp claim, at an elevation of 3,400 feet. The country rock is a part of the Jumbo volcanic formation and is cut by diorite and granite dikes. In one of the badly altered fine-grained diorite rocks, a vein about seven feet in width trends N. 75° W., and the ore minerals, which are pyrrhotite and chalcopyrite, are said to give assays of $11.00 in copper, silver and gold. The claim is developed by a shallow shaft and a large amount of surface stripping

along the vein and a few open cuts. About 50 tons of ore have been mined and shipped.

TRAMP.

This claim lies to the northwest of the Fifteen Mile Creek area, at an elevation of 3,100 feet. The country rock exposed is a part of the Jumbo volcanic formation and is cut by narrow dikes of rhyolite porphyry and fine-grained diorite dikes. The vein on this claim lies in the greatly altered rhyolite porphyry and is about five feet in width with a general east and west strike. The minerals showing are pyrrhotite, pyrite and chalcopyrite. Mineralization extends out into the wall rock to a minor extent. Several small open cuts have been made on the surface exposures and a tunnel has been driven at a lower elevation of about 20 feet in a direction N. 30° E. for 70 feet to cut the downward extension of the surface exposure of the ore deposit. At the face there is 35 feet of drifting.

MAJORCA.

This claim lies about 800 feet west of the Centennial claim and 200 feet west of the Minorca. The rock exposed is a bluish-gray argillaceous limestone which is cut by basic igneous dikes. The mineralized zone consists of a little pyrite with stains of copper and iron trending N. 30° E. An inclined shaft has been sunk on a slope of 55° in a direction S. 60° E. for a distance of 40 feet.

WALKING BOY.

The Walking Boy claim lies to the northeast and parallel to the Centennial, with the David Harum Fraction intervening. The formation is a part of the argillite which is cut by numerous dikes of aplite and kersantite. The vein exposed on the Centennial appears to extend northeasterly into the Walking Boy claim,

where it occurs in the igneous dike. A little pyrite containing small specks of chalcopyrite was observed in the vein. The claim is developed by several shallow shafts and small open cuts.

CENTENNIAL.

This claim joins the Minorca on the northeast. The formation consists of argillite and limestone cut by a dike of andesite porphyry. The vein lies along the contact between the dike and the limestone. It is about four feet wide and has a strike of N. 65° E. Upon the vein an inclined shaft has been sunk at an angle of 50° for a distance of 65 feet. The ore minerals are a mixture of pyrrhotite and chalcopyrite with a quartz gangue.

GALENA HILL.

This area lies in sec. 22, T. 39 N., R. 38 E., and on the northeastern side of the Fifteen Mile Creek district proper. The formations are argillite and limestone with a general northeast strike, which have been cut by basic igneous dikes. Several outcrops of quartz occur intimately associated with the basic dikes or along the contact with the dikes and the argillites. Some galena was observed in the quartz. Several shafts and open cuts were made many years ago but are now caved and in most cases abandoned.

BULLION.

This property is situated on the hillside overlooking Rattlesnake Valley, in sec. 8, T. 39 N., R. 39 E., at an elevation of 3,800 feet. The formations exposed in the vicinity are a quartz-mica schist and argillite having a general northeasterly strike, with a northwesterly dip. There is a quartz vein carrying galena and bornite, sphalerite and chalcopyrite. The gangue is quartz and the ore is said to carry silver. A shaft has been sunk to a reported depth of 100 feet. At the time of examination it was filled with water.

McKINLEY.

This prospect is located on Crown Creek, in sec. 34, T. 39 N., R. 38 E., at an elevation of 3,500 feet. The country rock exposed is a part of the southern extension of the Rossland volcanic formation. The workings lie in the canyon of Crown Creek but at the time of examination were caved and almost inaccessible. Only a little development work has been done. A tunnel has been driven due west and southwest for a distance of 52 feet. Twenty-five feet in elevation above the tunnel there is an exposure of four feet of ledge matter carrying a little galena. It is reported that selected samples assayed $200 in silver.

MONTANA.

This prospect is situated in sec. 20, T. 39 N., R. 38 E. The formation is the northeastern extension of that in the Fifteen Mile Creek district. A vein is exposed on the surface at an elevation of 3,475 feet, with a general strike of N. 70° E. A little pyrite was observed as well as oxidized iron. A few open cuts and a small shaft have been made. It is reported that assays were obtained in gold and copper.

ORIENT DISTRICT.

GENERAL STATEMENT.

The Orient district occupies the western portion of the triangle between Kettle River, Columbia River and the international boundary. A portion of it lies on the western side of Kettle River, in Ferry County. The majority of the mining properties are situated in Tps. 39 and 40 N., Rs. 36 and 37 E. The principal settlement in the district is the town of Orient with a population of 300 people. It is situated in Ferry County on the west side of Kettle River and on the Grand Forks branch of the Great Northern Railroad. Other towns which serve as shipping points for the district are Laurier, at the

international boundary; Rock Cut, three miles north of Orient; and Boyds, twelve miles south of Orient.

Shortly after the opening of the Colville Reservation, prospectors swarmed into the region and numerous locations were made. Among the first were the Napoleon and First Thought. Since that time a large number of claims have been located, many of which have been patented. During the past few years mining activity has been confined largely to annual assessment work. Several properties, such as the Copper Butte, International, Titanic, F. H. & C., and the Montana and Washington, have built their own roads, although in many cases these are in a bad state of repair owing to disuse. Many of the properties are equipped with mills, aerial tramways, and the necessary buildings for the camps.

The investigation of the ore deposits in the underground workings was greatly hampered because of the fact that the majority of the properties were inactive and the shafts filled with water and the tunnels caved.

The rock formations exposed in the district consist chiefly of latite and andesite lava flows belonging to the Rossland volcanic formation. These overlie argillite, calcareous argillite, limestone, schist, quartzite and amphibolite of the Stevens group. The latter are cut by numerous dikes of monzonite and granite-porphyry, diabase and lamprophyre. The ore deposits consist of fissure and fracture zones in the volcanics which have been mineralized with pyrite and pyrrhotite carrying values in gold and silver. Galena, sphalerite and chalcopyrite are present in some of the properties but as a rule they are not characteristic of the district. Replacement of the schist and amphibolite along fractures parallel to the bedding planes are common as in the case of the Big Iron and the Napoleon mines. It is thought that the solutions which furnished the mineral content were derived from the underlying tertiary granitic and dior-

itic magmas. The dikes so common in the district are probably apophyses from the main underlying masses.

On several properties a large amount of development work has been done. Many of the other properties are merely prospects, the work consisting only of short tunnels, shallow shafts and open cuts. A large amount of ore has been shipped from the district, the greater part of which has been furnished by the First Thought Mine. No figures are available as to the actual amount of ore shipped and mined.

FIRST THOUGHT.

This property is the largest and the most thoroughly developed in the Orient district. It is situated in sec. 18, T. 39 N., R. 37 E., on the southeast slopes of First Thought Mountain. It is connected with Orient by a wagon road three and one-half miles in length. The property is well equipped with buildings but in recent years very little development work has been carried on. The property from 1904 to 1910 was an almost continuous shipper. The chief values of the ore are in gold and it is estimated that the mine has produced slightly over 40,000 tons of ore having a value of over $650,000.

The formation exposed on the property consists of the Rossland Volcanic flows embracing lavas of a latite and andesite composition, including deposits of volcanic ash and breccia of similar composition. Rhyolite was observed intercalated with these flows a short distance northwest of the main workings on the slope of First Thought Mountain. The lava flows are greatly altered so that the mineral composition in thin section is often difficult to decipher. Numerous dikes of monzonite and granite-porphyry cut the lava flows. Lamprophyre dikes were noted in several localities.

The ore deposits have been formed in fracture zones in the latite lavas and usually near the intrusive granite dikes. The main deposit on this property lies in a zone

of intense brecciation and fracturing. This zone has a general northwest and southeast trend with a pitch to the southwest of 55°. It is nearly parallel to the contact of a granite dike on the west but the ores are chiefly in the fractured latite. The width of the mineralized belt is about 100 feet with a known northwest and southeast extent of 700 feet. At either end the values decrease and the mineralized zone narrows. An examination of the formation in the underground workings shows several faults diagonal to and intersecting the main fault zone. The richer ores are said to have been encountered at these intersections and the widest portions of the main zone are also in these places of junction. The zone of fractured and brecciated rock has been cemented by siliceous and calcareous solutions which appear to have carried the gold in solution and to have precipitated it. The mineralized portion contains finely disseminated crystals of pyrite which carry the gold values. The solutions extended out into the adjacent country rock and precipitated a part of their content wherever fracture or joint planes were encountered. The ore which has been mined and shipped averaged $15.00 in gold and about one-half ounce in silver, although much higher values were obtained from portions of the deposit. The richness of the ore is difficult to determine from its general appearance. During the process of mining it was necessary to make continuous assays in order to determine which to ship and which to leave upon the dump. The probable source of the ores is from the granitic and dioritic magmas which underlie this area and from which apophyses have been injected into the volcanic rocks.

The property is developed by three tunnels driven westerly into the mineralized zone. From the lower or main working tunnel, a shaft or winze has been sunk on a steep slope to a depth of 130 feet below the level of the tunnel. From this winze three drifts have been driven

both to the right and left and the vein has been stoped from the lowermost level to the tunnel level. Above the main tunnel a raise extends to the surface a distance of over 100 feet. Two tunnels from the surface, connecting with the shaft and drifts, have been extended to the right and left upon the vein. The larger portion of the vein has been stoped from the tunnel level to the surface. Numerous open cuts, tunnels and shafts have been made on the other claims of the property.

The property is equipped with a 60-horsepower gasoline engine, a 7-drill compressor, a 15-horsepower hoist installed on the main tunnel level, a 15-horsepower gasoline engine which runs the tramway, a diamond drill having a capacity of 500 feet, and an aerial tramway 13,000 feet in length. The ore is carried in buckets on the tramway from the mine to the bunkers on the tracks of the Great Northern Railroad a short distance north of Orient.

MICHIGAN.

This property is situated in secs. 7 and 18, T. 39 N., R. 37 E. There are four claims in the group, known as the Climax, Plutaria, Moonlight and Butte. The formation is largely composed of the latite flows so well exposed on First Thought Mountain and these are cut by numerous dikes of monzonite porphyry. The ore deposits are zones of crushing and faulting in the latite adjacent to the monzonite dikes which have been mineralized with pyrite, which is reported to contain values in gold. The property is developed by two long tunnels, a shaft, and many open cuts.

The upper tunnel has been driven nearly due east for a distance of over 800 feet through latite and intrusive monzonite dikes. About 160 feet back from the face a fault zone occurs in the latite, striking N. 35° W., dipping 45° to the southwest, and showing a four-foot zone of white clayey gouge material. From this point to

the face the tunnel follows the contact between monzonite and latite, the latter being mineralized with pyrite. On the hillside above, a shaft has been sunk in the dike. A lower tunnel on the Plutaria claim has been driven to the northwest for nearly 400 feet in latite and tuff, in which a fault zone striking N. 20° W. had been altered and mineralized with pyrite.

FIRST THOUGHT EXTENSION.

This property lies to the southeast of the First Thought property. The formation is the typical latite cut by monzonite dikes. The principal development work has been done in a main tunnel in which there are 650 feet of work. Latite on the west lies in contact with monzonite on the east and along a line trending N. 30° W. and dipping 80° to the northeast. The tunnel has been driven in the formation on both sides of the contact. Numerous fault zones in both formations are slightly mineralized with pyrite, which is said to carry small values in gold.

ALICE C.

The Alice C claim lies to the east of the First Thought property about one-fourth of a mile. The formation is approximately the same as that on the First Thought, consisting of latite flows cut by dikes of monzonite. The fracture zones have been mineralized with pyrite carrying small values in gold. A double compartment shaft has been sunk to a depth of 70 feet in one of the mineral zones containing quartz and pyrite. On the Protection claim, 100 feet west of the shaft, a tunnel is being driven N. 60° E. to tap the vein. Higher on the hillside to the north a tunnel is being driven on the Alice C claim N. 70° W. through latite which is mineralized with small amounts of pyrite.

INTERNATIONAL.

This property is situated in sec. 6, T. 39 N., R. 37 E., on the north end of First Thought Mountain. It lies

two miles east of Rockcut, a station on the Great Northern Railroad. The group consists of several claims, and the formation exposed within these consists of latite lavas and interbedded shales of Tertiary age. These are cut by dikes of monzonite and granite. The development work consists of tunnels, shafts and numerous open cuts.

On the north side of First Thought Mountain the sandstones and shales, interbedded with the lavas, have a thickness of over 200 feet, with a strike of N. 80° W. and a dip of 50° to the southwest. At the summit a shaft has been sunk in the shale to a depth of 125 feet and 100 feet below there is a second one at an elevation of 3,540 feet, which is near the monzonite contact. Assays in gold and silver are reported to have been obtained varying in value from a trace to $27.00. A long tunnel is now being driven as a crosscut into the mountain in a general northeasterly direction through the lavas and interbedded sediments.

TITANIC.

This property was formerly known as the Valley Dew and is situated west of First Thought Mountain, in sec. 7, T. 39 N., R. 37 E. There are ten claims which were incorporated in 1908 as the Titanic Mining Company, with head office in Spokane. The formation exposed is latite cut by numerous monzonite dikes. The ore deposits consist of the mineralization of fracture zones with pyrite carrying small amounts of gold. The property is developed by three tunnels. The lower tunnel, at an elevation of 3,500 feet, has been driven S. 80° W. for a distance of 551 feet through latite flows and intercalated deposits of tuff, and is for the purpose of cutting a mineralized zone exposed in the Gettern tunnel. Due west and higher on the hillside is a second tunnel driven S. 80° W. for 540 feet through monzonite and latite. To the north the Gettern tunnel has been driven S. 20° W. for 400 feet through latite cut by numerous monzonite

dikes. At one point in the tunnel, in a monzonite dike near its contact with the latite, is a fault zone trending N. 35° W. which is mineralized with pyrite, and is said to give values of $8.00 in gold.

SECOND THOUGHT.

This group includes five full claims and three fractions, all of which are situated in secs. 18 and 19, T. 39 N., R. 37 E. The claims were first located in 1897 and were incorporated in 1908 as the Second Thought Gold Mining Company, with head offices in Orient. The country rock exposed is quartz latite, a part of the Rossland volcanic formation. This is cut by numerous north and south quartz-monzonite porphyry dikes. The ore deposits are mineralized zones in the fracture and joint planes and in the crushed belts in the near vicinity of the intrusive dikes. The property is developed by one double compartment shaft 64 feet in depth, one shaft 40 feet deep and a third 22 feet deep. There are five other shallow shafts. The mineral observed is mainly pyrite, which is said to yield values in gold ranging from a trace to $8.00 per ton.

On the Queen claim a dike of quartz-monzonite about 70 feet in width trends N. 20° E. and cuts the latite lavas. At the discovery a mineralized zone occurs 12 feet in width in the latite and shows some pyrite. On the Porphyry Jim claim a fracture zone, trending N. 70° W. and dipping 50° to the northeast, is mineralized with pyrite for a width of four feet. A shaft has been sunk on this material to a depth of 15 feet. Other cuts have been made on similar exposures on the eastern part of the claim as well as on the Sunbeam claim. On the latter claim a mineralized zone trends N. 50° W., with a dip of 55° to the northeast. A shallow shaft has been sunk on the zone.

On the east side line of the Searchlight claim a monzonite-porphyry dike 40 feet in width strikes N. 40° W.

The latite along the contact is mineralized with pyrite and a shaft 27 feet in depth has been sunk upon it. The mineralized portion of the rock is said to assay $7.00 in gold. Two other shafts have been sunk upon the Searchlight claim on mineralized fracture zones in the latite.

On the Second Thought claim a shaft has been sunk near the east wall of a monzonite-porphyry dike to a depth of 64 feet. This zone strikes N. 35° E. and dips to the northeast. Assays varying from $2.00 to $12.00 in gold are said to have been obtained.

OROPACUM.

This claim lies on the southeast slope of First Thought Mountain, at an elevation of 3,250 feet, just north of the First Thought mine, in sec. 7, T. 39 N., R. 37 E. The formation exposed is latite, which along the fracture zones has been mineralized to some extent with pyrite. A shaft has been sunk on a north and south zone with a vertical dip to a depth of 24 feet. Nearby a shallow shaft has been made and at the bottom a drift has been extended to the main shaft. The formation along the joint planes is greatly altered and some secondary quartz has been deposited which is said to give a general assay of $3.00 in gold. Picked samples are reported to give values as high as $47.00 in gold.

HIDDEN TREASURE.

This claim lies south of the Belmont claim, and the formation is the typical latite cut by dikes of monzonite. A fracture zone in the latite strikes N. 30° W., with a dip of 70° to the southeast. Some pyrite and irregular stringers of quartz occur along this fault, which lies in the latite but close to the monzonite contact. A shaft has been sunk upon it to a depth of 35 feet. A tunnel has been driven through the latite a distance of 25 feet in a direction N. 30° W. on a fracture zone mineralized

with pyrite to a width of four feet. This zone dips to the northeast at an angle of 60° and lies near the monzonite contact.

BELMONT.

This claim joins the First Thought property on the southwest, and is situated in sec. 18, T. 39 N., R. 36 E., on the south slope of First Thought Mountain. The formation is a part of the latite so common in this area and is cut by dikes of monzonite-porphyry. Two intersecting fractures, striking north-south and east-west, show some mineralization with pyrite. Some trenching has been done along these zones and at one place an incline shaft has been sunk to a depth of 30 feet.

NORTH STAR.

This property lies east of the Second Thought property, at an elevation of 2,350 feet. The country rock exposed is a part of the Rossland volcanic formation, consisting of latite flows. Where these have been faulted and fractured there has been some mineralization with pyrite carrying small amounts of gold. The main fault and mineralized zone trends N. 60° W. and dips 70° to the northeast. A drift has been run on the zone for a distance of 300 feet and then a crosscut extends to the right for 70 feet and the tunnel follows another fracture zone for 280 feet. On the surface a shaft has been sunk and intersects with the main tunnel at a point 300 feet from the portal.

TROPHY.

This group consists of the following four claims: Buckeye, Wild Rose, Wild Rose Fraction and Imperial. They are situated in sec. 18, T. 39 N., R. 36 E. The claims were located in 1897, and were incorporated in 1907 as the Trophy Gold Mining and Milling Company, with head offices in Orient. The formation is latite with intercalated beds of shale, all of which are cut by dikes of monzonite-porphyry. Fracture zones have been mineralized

with pyrite carrying gold. The development work consists of over 300 feet of tunnel work and 100 feet of shaft work. The ores are said to range in values from a trace to $12.00 per ton.

On the Wild Rose claim a shaft has been sunk 50 feet in a monzonite dike near the contact with the latite. Seventy-five feet lower in elevation a tunnel is being driven N. 50° W. to intersect the shaft. On the Buckeye claim several open cuts have been made near the east side line on the west side of a belt of monzonite-porphyry, along a mineralized zone. On the east side line of the Wild Rose claim a monzonite dike trends northwesterly and a tunnel has been driven to the contact where a mineralized zone contains pyrite said to carry values in gold ranging from $1.00 to $4.00. Nearby two shallow shafts have been sunk.

SCOTIA.

This property consists of a group of claims, three of which are patented and lie at an elevation of 2,950 feet on the southern end of Toulon Mountain, about four and one-half miles south of Orient. The formation exposed consists of quartzite and a greatly contorted and banded schist, both of which have been cut by monzonite dikes. The schistose rock contains numerous seams of pyrite, pyrrhotite and chalcopyrite, as well as irregular pods and aggregates of these minerals. In places they have been oxidized to a minor degree. A large open cut has been made in the schist exposing the ore, the bands of which conform to the schist formation and strike north and south. A shaft has been sunk in the quartzite close to the schist contact to a reported distance of 200 feet. It was filled with water at the time of examination and inaccessible. A short distance below the cut a tunnel has been driven N. 60° E. for 150 feet. The formation encountered consists of mineralized schist

cut by a dike of monzonite. On the Iron King claim, which is a part of this group, a shallow shaft has been sunk on a body of pyrite of irregular size and shape but of small extent.

GLOBE.

The Globe prospect lies four miles southeast of Orient, on the southwestern slopes of Toulon Mountain, at an elevation of 2,900 feet. The formations consist of argillite, limestone and calcareous argillite cut by diabase and monzonite dikes. The property is developed by a shaft and three tunnels. The lower tunnel, at an elevation of 2,600 feet, is entirely in monzonite. The middle tunnel, at an elevation of 2,700 feet, is said to be 700 feet in length, but was caved at the time of examination. The upper tunnel extends for 70 feet in a direction N. 60° E. A shaft near the lower tunnel has been sunk 15 feet on a fracture zone trending N. 65° W. and dipping steeply to the northeast. The minerals in this zone are pyrite, pyrrhotite and chalcopyrite, which are reported to give small assays in gold. In the tunnels local faults and joint planes have been slightly mineralized with pyrite.

COPPER BUTTE.

The Copper Butte property is situated three miles southeast of Orient, at an elevation of 2,930 feet. Calcareous quartzite, argillite and limestone cut by dikes of monzonite constitute the country rock. Near the monzonite and limestone contact a shaft said to be 300 feet in depth has been sunk. At the 65-foot level a drift has been driven to the north on a quartz stringer for a distance of 40 feet. Short drifts have been made on the 100-foot and the 300-foot levels. The tunnel was filled with water at the time of examination in 1914. The ore is composed of pyrite, chalcopyrite and bornite. Two hundred feet to the southeast a second shaft has been sunk to a reported depth of 100 feet with a 100-foot drift. The limestone belt exposed to the east of the workings

is at least 300 feet in width and strikes nearly north and south.

A long crosscut tunnel was being driven into the hill during the summer of 1917 to tap these deposits exposed in the upper workings. This tunnel, at an elevation of 1,800 feet, had been driven 1,200 feet in a direction N. 41° E. through black quartzite, amphibolite, greenstone and limestone cut in places by monzonite dikes. The downward extension of the ore bodies had not been reached at the time of examination.

AUDREY M.

This claim lies between the Orient and Copper Butte properties, on the western slopes of Toulon Mountain, two and one-half miles southeast of Orient. Calcareous argillite and quartzite cut by monzonite dikes constitute the country rock. A fracture zone carries pyrite, pyrrhotite and chalcopyrite which is reported to give values of $23.00. A shaft has been sunk to a depth of 18 feet on the vein.

ORIENT.

This property lies two and one-half miles southeast of Orient, on the western slopes of Toulon Mountain, overlooking Kettle River, at an altitude of 1,800 feet. The formation exposed consists of argillite and limestone cut by monzonite and diabase dikes. The ore deposits consist of mineralized fracture zones containing small quantities of pyrite and some chalcopyrite with its associated alteration products. The property is developed by several shafts on the slopes of the mountain, with open cuts and a long tunnel.

On the Deadwood claim, on the slope facing Kettle River, at an elevation of 2,050 feet, a large cut has been made on a one and one-half-foot vein of iron sulphide having a nearly east and west strike and occurring in a calcareous argillite. Nearby a shaft has been sunk to a depth of 35 feet. At a lower elevation on the hillside

a long tunnel has been driven northeasterly but was caved at the time of examination. Thirty feet to the northeast a second shaft has been sunk to a depth of 45 feet on a four-foot vein striking N. 50° W. Considerable pyrite and chalcopyrite were observed upon the dump. A shaft said to be 175 feet in depth occurs just across the line of the Orient claim but contains no values. On the Extension claim, one of this group, a 20-foot shaft has been sunk on a vein in quartzite containing pyrite and chalcopyrite and said to yield values of $9.00.

DEFENDER.

This property is situated two miles southeast of Orient, on the western slopes of Toulon Mountain, at an altitude of 2,100 feet. The formations are argillite and amphibolite or greenstone cut by numerous monzonite dikes which usually have a prevailing north and south direction. The group includes a block of six claims trending north and south. The property is developed by numerous open cuts, two shallow shafts and one deep shaft on the Defender claim. One of the shafts near the center of the property has been sunk to a depth of 10 feet on a fracture zone along the contact between monzonite on the east and argillite on the west. This belt is three feet wide, strikes nearly north and south with a westerly dip of 40°, and contains some quartz and small amounts of pyrite said to assay $3.00 in gold and two and one-half ounces in silver. About 150 feet east, on the opposite side of the dike, a second shaft has been sunk on the other contact to a depth of 22 feet. The argillite is greatly crumpled in the vicinity and a zone 20 feet wide is slightly mineralized with quartz in small vugs and scattered crystals of pyrite said to carry slight values in gold. On the main Defender claim a shaft has been sunk to a depth of 100 feet along a fracture zone trending N. 50° W. in a silicified argillaceous limestone. Near the collar of the shaft the vein pitches

70° to the east but near the bottom of the shaft it turns and dips to the northwest. Sphalerite and siderite occur in a calcareous gangue in limestone.

SURE THING.

There are four claims in this group situated in sec. 25, T. 39 N., R. 36 E., about three miles southeast of Orient. Calcareous argillite is cut by monzonite dikes, and the fracture zones have been slightly mineralized with pyrite carrying small values in gold. The prevailing direction of the fault zones is N. 20° W. Several open cuts and shallow shafts have been made on the different claims of the group, which are at an average elevation of 2,000 feet.

TROJAN.

This property lies near the summit of Toulon Mountain, at an elevation of 3,700 feet, and about two miles southeast of Orient. The formation consists of interbedded latite, andesite, tuff, shale and sandstone cut by monzonite dikes. Such mineralization as was observed consists of pyrite and pyrrhotite in fracture zones. The property is developed by three tunnels and a shaft. The shaft, at an elevation of 3,200 feet, has been sunk to a depth of 20 feet along the contact between a fine-grained monzonite dike and a badly altered basic andesite. The contact may be a fault-contact, and slight mineralization was noted. The upper tunnel has been driven N. 50° E. for 125 feet through the monzonitic rock. At the contact between the monzonite and the dark basic lava a winze has been sunk. A fracture zone containing a small amount of pyrite and a few specks of galena lies along the contact. A second tunnel has been driven nearly 800 feet in an easterly direction through monzonite and shale. The general strike of the shales is nearly east and west, with a low northerly dip but locally within the tunnel the strata have been greatly disturbed by the igneous intrusions. Near the face of the tunnel fracture

zones in the shales have been slightly mineralized with pyrite which is said to carry very small amounts of gold.

GEM.

This property is situated at the head of a small gulch on the south side of Toulon Mountain, at an elevation of 3,440 feet. The formations consist of lavas and interbedded sediments cut by monzonite and fine-grained granite dikes. The principal development work is a tunnel driven into the mountain in a general northerly and westerly direction for a distance of 720 feet through shale, latite and intrusive dikes of monzonite. About 660 feet from the portal a mineralized zone four feet in width was encountered having a strike of N. 20° E., with a dip to the northwest of 65°. In the mineralized fracture zone there are stringers and deposits of quartz containing varying amounts of pyrite carrying values in gold. The vein lies in a fine-grained granite dike.

BLUE GRASS.

This claim is situated near the top of Toulon Mountain, at an elevation of 3,000 feet. The formations exposed consist of interbedded, fine-grained conglomerate, shale, tuff and andesite and dacitic lava flows. These strike approximately north and south, with an easterly dip of about 20°. They are cut by many monzonite and granite dikes, and in the near vicinity of the dikes the fault and fracture zones have been mineralized with very small amounts of pyrite carrying small values in gold. The top of the ridge is 3,500 feet in elevation. Lower on the hillside, at an elevation of 3,000 feet, a shaft has been sunk to a depth of 40 feet on an iron-stained fracture zone three feet wide. This zone strikes north and south, with a dip of 65° to the east. Small stringers of quartz are present within it. The ore is said to average $1.00 in gold although assays as high as $16.00 have been obtained. Lower on the hillside, at an elevation of 2,740

feet, a crosscut tunnel has been driven N. 65° E. in granite and shale for a distance of 410 feet to intersect the mineralized zone exposed higher on the mountain.

POP.

This group of two claims, one of which is patented, lies in sec. 27, T. 39 N., R. 37 E., at an elevation of 4,000 feet. The two claims are known as the Populist and the Lucky Page. The formations exposed consist of argillite, limestone and quartz-mica schist, all of which are cut by monzonite dikes. On the Lucky Page claim a shaft, short tunnel, and open cut have been made upon a two-foot vein striking east and west, with a vertical dip. The ore showing upon the surface consists of limonite, pyrite and chalcopyrite, with some honeycombed quartz in an argillaceous limestone. The workings were caved at the time of examination but the ores are reported to assay as high as $41.00 in gold, copper and silver.

On the Populist claim a tunnel has been driven N. 35° E., and at 50 feet from the portal a belt 10 feet wide of pyrite and pyrrhotite was encountered with a nearly north and south strike. The formation is limestone and quartzite with a similar strike, and the ore seems to lie in the former. A short distance to the east a second tunnel has been driven N. 20° E. for 140 feet, which connects with a shaft from the surface 80 feet deep. The formation exposed is quartzite.

TWILIGHT.

This group of claims is situated in sec. 4, T. 39 N., R. 37 E., just off the road from Orient to Bossburg. The formations consist of argillite and limestone trending northeast and southwest and cut by a granite dike trending north and south. A vein, consisting of a fracture zone trending N. 30° W. and dipping 15° to the northeast, has been slightly mineralized for a width of

six feet. The ore minerals observed are azurite, malachite, limonite, pyrite and chalcopyrite, which are said to give values ranging from $6.00 to a maximum of $100.00 per ton. A main tunnel has been driven to the northeast for a distance of 475 feet through argillite and quartzite.

ELMO.

This claim is situated in sec. 28, T. 39 N., R. 37 E., at an elevation of 3,280 feet. The formations exposed are argillite and calcareous argillite. A mass of greenstone of undetermined size occurs on the claim. A vein cuts this rock with a general north and south strike and a dip to the east of 60°. The mineralized zone is nearly 15 feet in width and shows copper stains and limonite. A shaft has been sunk on the vein for 15 feet, along with several open cuts. In the bottom of the shaft there are eight inches of calcite containing pyrite, chalcopyrite and malachite.

COFFER.

This claim lies on the east side of the Elma claim, on the western slope of Jumbo Mountain, at an elevation of 2,865 feet, and was formerly known as the Copper Gold. The formation is largely argillite, in which fracture zones have been slightly mineralized with pyrite, chalcopyrite and galena. Open cuts have been made on the vein and a tunnel has been driven westerly for over 300 feet. At the face of the tunnel an inclined shaft has been sunk on a 45° slope for a distance of 60 feet and at the bottom there is a 40-foot drift.

GEORGIC.

This claim lies in sec. 27, T. 39 N., R. 37 E., on the west slope of Jumbo Mountain. The country rock is that characteristic of the area, consisting of argillite and calcareous argillite, having a strike of N. 40° E., with a northwesterly dip of 50°. The vein, consisting of quartz and calcite, contains small amounts of pyrite, chalcopy-

rite and galena. A shaft has been sunk upon the vein to a depth of 84 feet.

UNCLE SAM.

This group embraces two claims situated on the southwest slopes of Jumbo Mountain, in sec. 27, T. 39 N., R. 37 E. The rock exposed is argillite and calcareous argillite, having a general northeasterly strike. On the Quartette claim a shaft has been sunk to a depth of 80 feet on a slope of 75° to the northwest. The vein consists of a fractured zone in the rock consisting of quartz fragments and crushed rock, which have been mineralized to a minor extent. The minerals present are intersecting stringers of siderite together with pyrite, chalcopyrite and a little galena. Both limestone and a dike of monzonite occur in the near vicinity to the east. Seventy-five feet northeast of this shaft a second shallow one has been sunk to a depth of 12 feet.

EASTER SUNDAY.

The Easter Sunday property is located in sec. 22, T. 40 N., R. 37 E., at an elevation of 4,000 feet. It is 12 miles by wagon road from Orient. The formations exposed on the property consist of interbedded argillite and phyllite cut by dikes of monzonite-porphyry. The ore deposit consists of a white quartz vein striking N. 25° W. and dipping to the northeast at an angle of 50°. The vein lies parallel to the bedding planes of the argillite and conforms to them. The ore minerals in the quartz gangue are pyrite, chalcopyrite, sphalerite and galena. These carry values in silver which are said to average 12 ounces. The property is developed by an inclined shaft 130 feet in length and dipping at an angle of 55° to the northeast. Two drifts have been run from the 70 and 100-foot levels. A dike of monzonite cuts the vein in the shaft. At the time of visit the shaft was filled with water and inaccessible for examination. Sev-

eral diamond-drill holes have been made as well as short tunnels and open cuts. The property is equipped with a two-stamp mill, a Wilfley table, experimental cyanide tanks, a 100-horsepower Corliss engine and two 100-horsepower boilers. Several shipments of ore have been made for experimental purposes.

BIG IRON.

This property is situated in sec. 24, T. 40 N., R. 37 E., at an elevation of 3,750 feet, and on the east side of Sulphide Mountain. It is 12 miles by wagon road from Rock Cut and 15 miles from Orient. The formations exposed in this region consist of phyllite, amphibolite and quartzite, having a general strike of N. 80° E. They are cut by diabase dikes and these in turn are cut by diorite and monzonite dikes. The mineralization consists of lenses of pyrite and chalcopyrite interbedded with the metamorphic rocks. In the vicinity of the workings the mineralized zone forms a belt about 130 feet wide north and south by over 1,000 feet along the strike of the rock east and west. The property is developed by one main shaft, several shallow shafts and a large amount of open cut work and trenching. A large amount of pyrite carrying chalcopyrite is piled up around the workings upon the surface. The shafts were filled with water at the time of examination.

REGINA.

This property lies on the south side of Pierre Creek in secs. 33 and 34, T. 40 N., R. 37 E., at an elevation of 2,820 feet. The formations exposed are limestone, quartzite and latite, cut by granite dikes. The main development is on the south side of the creek, and 50 feet from it a tunnel has been driven southerly for 160 feet to a granite contact. At the contact a shaft has been sunk to a depth of 12 feet on a mineralized zone trending N. 25° W. and dipping 70° to the southwest. Pyrite and chalcopyrite occur in the contact zone and are said

to assay in gold. About 55 feet back from the face of the tunnel a second shaft has been sunk for 10 feet along the granite contact. The mineralization extends out into the country rock away from the contact. To the right of the portal of the tunnel a shaft has been sunk to a depth of 20 feet, and 10 feet below the collar a drift has been extended 20 feet to the south on a two and one-half foot vein mineralized with quartz, pyrite and chalcopyrite. This is probably a separate mineralized slip from that exposed in the shaft in the tunnel. Higher on the hillside to the south several shafts have been sunk on the contact between quartzite and a granite dike. The general strike of the contact is N. 30° W., with a dip of 70° to the southwest. Chalcopyrite and pyrite are the ore minerals and are said to yield values of $20.00 in gold and copper.

McNALLY.

The McNally property is situated in secs. 33 and 34, T. 40 N., R. 37 E., about six miles from Rock Cut by wagon road. The formations exposed are limestone and argillite cut by diabase dikes. The ore deposits occur in fracture zones in association with the dikes. The ore minerals are pyrite with subordinate amounts of chalcopyrite. At an elevation of 2,865 feet a shaft has been sunk to a depth of 75 feet on a vein in the blue limestone, trending N. 75° E., with a vertical dip. This vein is at least eight feet wide and is mineralized with pyrite and chalcopyrite. The general strike of the formation is N. 30° W., with a dip of 70° to the northeast. Several tunnels have been driven to cut the vein. One of these, on the Butte claim, extends for 330 feet in a general north and northwesterly direction. The rocks encountered are largely quartzite and limestone. The slip planes in the rock show slight mineralization. About 400 feet west of this tunnel a second tunnel has been

driven easterly for 250 feet. Several shorter tunnels and open cuts have been made on the property.

JAYHAWKER.

This property lies one-fourth mile northeast of the Easter Sunday Mine. The formation is composed of argillite and interbedded quartzite bands. A vein of white massive quartz, about 800 feet from the Easter Sunday vein, strikes N. 20° W. and dips 65° to the northeast. The exposure is about 50 feet higher than that at the Easter Sunday shaft and an inclined shaft has been sunk upon it. Mineralization extends into the surrounding argillite formation. The ore minerals are chiefly pyrite and a very little chalcopyrite. Several other shallow shafts and open cuts have been made.

F. H. AND C.

This property lies in sec. 30, T. 40 N., R. 37 E., at an elevation of 2,600 feet, and five miles northeast of Rock Cut. The formations are greatly metamorphosed granite and diorite and are possibly a part of the Orient gneiss. The property is developed by a shaft 160 feet deep, with some drifting at the 70-foot level. In addition, there is a large amount of open cut work. A quartz vein in the gneiss trends N. 53° E. and has a width of three feet. From the 70-foot level a drift has been driven for 75 feet N. 60° E. and for 15 feet S. 60° W. From this drift there has been a small amount of stoping. At times the vein increases locally to a thickness of five feet. At the face of the south drift the vein is cut by a fault trending N. 20° E. and dipping 35° to the southeast. Development work on this property was begun in November, 1916. One small shipment of ore was made to the Northport smelter and values of 1.9 ounces in silver and 2.36 ounces in gold are reported to have been obtained. An assay made from a one-foot zone from the vein on the footwall at the 70-foot level

in the shaft is said to have assayed 6.8 ounces in silver and 2.35 ounces in gold. Still higher values are reported from picked samples.

COPPER JACK.

This property consists of three claims located in secs. 29 and 32, T. 40 N., R. 37 E., about four miles east of Rock Cut. The claims have been recently located and only a small amount of work has been done upon them. A vein is exposed trending north and south and having a thickness of about one foot. The ore minerals are chalcopyrite and a little pyrite. One shaft has been sunk to a depth of 25 feet and a second to a depth of 10 feet.

McKINLEY.

This group of claims is situated in sec. 24, T. 40 N., R. 36 E., about three miles northeast of Rock Cut, a station on the Great Northern Railroad. The formation consists of argillite, cut by diabase and lamprophyre dikes. The region is covered with a considerable amount of glacial drift. There are several fracture zones in the altered diabase which have been mineralized with quartz and pyrite, and the latter is changed near the surface to limonite. These minerals are said to carry values in gold. The property is developed by several shafts and open cuts. A shaft 38 feet in depth has been sunk upon a vein varying in thickness from 2 to 14 inches and having a strike of N. 55° W. and a dip of 50° to the northeast. To the south about 900 feet a large open cut has been made upon a vein striking N. 18° W. and dipping 40° to the northeast. The vein is composed of quartz carrying small amounts of pyrite, azurite and malachite.

POMEROY.

This property is situated about 1,500 feet south of the Easter Sunday mine. The formations are composed of interbedded argillite, quartzite and phyllite, which are cut by diorite and diabase dikes. The main working

is a vertical shaft sunk to a depth of 220 feet, which at the time of examination was filled with water. The ore observed upon the dump consists of quartz containing galena, sphalerite, chalcopyrite and pyrite, together with some mineralized argillite. These minerals are said to assay in silver. About 150 feet to the southeast there is a shaft 27 feet in depth sunk upon an eight-foot quartz vein striking N. 20° W. and dipping 75° to the northeast. The quartz is mineralized with bornite, chalcopyrite, pyrite and a little galena, although the total amount of mineral present is not great.

MONTANA AND WASHINGTON.

This property, consisting of four claims, is situated in sec. 30, T. 40 N., R. 37 E., about four miles from Rock Cut. The principal working is a tunnel on the St. Paul claim, driven from the level of Sand Creek, at an elevation of 2,500 feet, in a direction N. 75° E. for a distance of 215 feet. The country rock is a gneissoid granite. One hundred and ten feet from the portal an 11-foot dike of andesite-porphyry crosses the tunnel and has a strike of nearly east and west, with a dip of 60° to the south. About 55 feet from the portal a quartz vein, varying from 6 to 20 inches in width, intersects the tunnel with a strike of N. 70° W. A few feet beyond, a fault was encountered with a strike of N. 45° W. and a southwesterly dip of 40°. Assays of the vein are said to have yielded values ranging from $5.90 to $95.60 in gold. At the face of the tunnel a quartz vein occurs striking N. 80° W. and dipping 38° to the northeast. Its average width is about 33 inches. Fifteen feet back from the face a fault crosses the tunnel with a strike of N. 10° W. and a dip of 55° to the northeast. To the left of the tunnel this fault intersects the vein. The continuation of the vein will be probably found to the left of the fault and drifting might well be continued in a direction N. 10° W.

Numerous open cuts, shafts and short tunnels have been made upon the other three claims. On the Green Frog claim, at an elevation of 2,750 feet, a shaft has been sunk to a depth of 12 feet on a quartz vein trending N. 20° W., with a vertical dip. A short distance beyond, on the same claim, there is a 10-foot shaft on stringers of quartz. This opening is the discovery on the claim and values of $5.20 in gold are reported. The strike is north and south with a dip of 70° to the west. Three veins of calcite cross the claim in a nearly north and south direction and small openings have been made upon these veins. On the Bisbee claim a quartz vein about 25 feet in thickness trends east and west but shows very little mineralization. Several shafts have been sunk on the main Bisbee vein which strikes N. 80° W. and dips 65° to the northeast. Chalcopyrite and pyrite occur as the ore minerals and yield varying values in gold. On the Minneapolis claim, at an elevation of 2,700 feet, a shaft has been recently sunk to a depth of 30 feet on an east-west vein 15 inches in width. At the time of examination the shaft was filled with water but some good ore was piled up on the dump. The ore minerals are chalcopyrite, galena and bornite in a quartz gangue. Copper yields the chief values but assays varying from 16 to 20 ounces in silver are said to have been obtained.

PELKEY AND DILLE.

These claims lie in secs. 28, 33 and 34, T. 40 N., R. 37 E., on the north side of Pierre Creek and east of Box Canyon. The formations exposed consist of bluish-gray limestone, quartzite, argillite cut by diorite, granite, aplite and lamprophyre dikes and in places are covered with layers of latite lava. The ore deposits consist chiefly of pyrite and chalcopyrite in fracture zones in the country rock.

COPPER BUTTE.

A shaft has been sunk in a white limestone rock on a vein trending N. 65° E. and dipping 60° to the northwest. The outcrops appear as a band of limonite 16 inches wide and a zone of fractured country rock mineralized somewhat for a width of four feet. Pyrite and chalcopyrite are exposed in the open cuts. About 50 feet to the northeast there is a second shaft 90 feet in depth which was filled with water. The vein upon which it is sunk lies in contact between limestone on the east and an aplite dike on the west. The general trend of the dike is N. 55° W. Pyrite with subordinate amounts of chalcopyrite occur in a zone of fracturing in the limestone.

AMERICAN BOY.

The discovery lies 300 feet south of the north end line in a mineralized fracture zone parallel to the bedding planes of the limestone formation. The strike is N. 25° W., with a dip of 70° to the northeast. Quartzite cut by a granite dike occurs only a short distance to the east. Near the center of the claim a series of open cuts and a 25-foot shaft have been made on a slightly mineralized fracture zone trending and dipping the same as the former. Considerable quantities of pyrite containing small amounts of chalcopyrite occur and are reported to assay $15.00 in gold.

BLUE GOOSE.

On this claim there is a vein one foot wide striking N. 55° W., dipping 60° to the southwest and occurring along the contact between quartzite and brecciated limestone. Pyrite and subordinate amounts of chalcopyrite occur. A small open cut has been made at the discovery.

YELLOW JACKET.

A vein trending N. 25° W. lies along the contact between granite on the east and a calcareous quartzite on

the west. It is mineralized with quartz and pyrite, which is said to have assayed $20.00 in gold. A large open cut has been made in the center of the claim.

TREADWELL NO. 1.

This claim lies east of the Yellow Jacket. Three hundred feet south of the north end line of the claim a shaft has been sunk 18 feet in depth through glacial wash to bedrock limestone and schist. The discovery is near the center of the claim on a fracture zone in the limestone, which has been brecciated, silicified and slightly mineralized with secondary calcite and pyrite. Small open cuts have been made on the Treadwell No. 2 claim.

IRON MASK.

This property lies just east of the Mystery group, at an elevation of 2,700 feet. The rock formations exposed are latite and limestone, both of which are cut by a granite dike. The main shaft on the Iron Mask is 60 feet deep and vertical. At the time of examination it was filled with water but on the dump large blocks of pyrite and pyrrhotite occur. This deposit lies about 30 feet west of the granite dike and is presumably a fissure zone which has been mineralized. Several open cuts have been made in which the fracture zones in the latite have been mineralized with pyrite and small quantities of chalcopyrite. A short distance to the southeast occurs blue limestone which shows slight mineralization in the fracture zones.

MONITOR.

The Monitor group lies just west of the Mystery claim in Box Canyon. On the Eagle No. 2 claim a tunnel has been driven due west for 75 feet in altered latite and is being continued to intersect a granite dike which shows some mineralization at the contact. Higher on the hillside a shaft has been sunk to a depth of 35 feet.

MYSTERY.

This property is situated in the southeast quarter of sec. 29, T. 40 N., R. 37 E., about four miles east of Rock Cut and in the lower part of Box Canyon. The formation on the property consists of greatly altered latite flows cut by dikes of granite and diorite porphyry. On the east side of Box Canyon, at an elevation of 2,680 feet, a tunnel has been driven N. 80° E. for 300 feet into the hillside. Thirty feet from the face a vein of white quartz about eight feet in width was intersected. It has a nearly north and south strike, with a dip of 40° to the east and carries some pyrite and chalcopyrite. The rock exposed in the tunnel is more or less fractured and some pyrite has been formed along these zones. About 100 feet above this tunnel a second tunnel is being driven to the east to cut the contact with a granite dike. About 600 feet to the south on the same side of the canyon a tunnel has been driven for a short distance into an aplitic dike. On the Mystery claim and near the south end an inclined shaft has been sunk on the fault-contact between blue limestone on the east and latite on the west. Seventy feet west is another shaft 25 feet in depth and in the limestone. Several other open cuts and shallow shafts have been made.

On the Mohawk claim, about 400 feet from the north end line, a tunnel has been driven 40 feet in a direction N. 20° E. along the contact between a granite dike and latite. It is a fracture zone which is somewhat mineralized with pyrite and chalcopyrite. The general strike is about N. 20° E.

UDEHARD.

This property is situated in sec. 17, T. 40 N., R. 37 E., on the divide between Box Canyon and Deep Creek, at an elevation of 2,840 feet. The group consists of four claims known as the Billiken, Commonwealth, Socialist and Dauntless, all of which are joined end to end in a

north and south direction on the western side of a small lake. The formation is a part of the Rossland volcanics cut by basic dikes. On the Commonwealth claim a tunnel has been driven S. 45° W. for a distance of 35 feet to intersect a mineralized zone exposed higher on the hillside at an elevation of 2,965 feet. It is entirely in talus rock. In the upper tunnel a fractured zone shows mineralization with chalcopyrite and pyrite but no definite walls. The mineralized zone strikes N. 30° W. and dips 70° to the southwest. Occasional signs of bornite were observed. Higher on the hillside to the west there is a high bluff and a fracture zone striking N. 65° E. and dipping 70° to the northwest, which has been mineralized with small amounts of chalcopyrite. On the surface limonite was observed containing siderite and a little malachite. This ore is said to assay $20.00 in gold and $11.00 in copper.

LAKESIDE.

This property is situated in sec. 20, T. 40 N., R. 37 E. The formation is a part of the Rossland volcanics and is cut by dioritic and diabasic dikes. A main tunnel on the west side of Box Canyon, at an elevation of 2,830 feet, has been driven for 125 feet in a direction N. 25° W. Thirty feet from the portal a branch extends to the northeast for 30 feet. A fracture zone is mineralized with chalcopyrite and pyrite in a gangue of badly altered and shattered quartz. This vein strikes N. 25° W. and dips 70° to the northeast and the thickness is about one foot. Up the hillside to the west several open cuts have been made and the rocks show some copper stain.

TOM MOORE.

This claim is situated a short distance southwest of the Little Giant property. A series of shallow open cuts have been made just north of the road on a flat. One of these openings, about eight feet deep by 15 feet long, exposes a vein one foot wide of white quartz carry-

ing considerable galena. This vein strikes N. 80° E. and has a vertical dip. Nearby is a shallow shaft.

BEECHER.

This property lies in the middle of sec. 31, T. 40 N., R. 37 E., at an elevation of 2,500 feet. It is about two miles east of Rock Cut and is reached by wagon road. The formation exposed is schist cut by diabase with thin layers of the Rossland volcanics. The property is developed by a main shaft which has been sunk on a vein of white quartz varying in thickness from four inches to two feet. It strikes N. 42° E. and has a vertical dip. Thirty feet below the surface a drift has been made to the north and the vein averages five inches in thickness. On the 60-foot level a drift has been made and the vein widens to 12 inches and in places to two feet. It carries some galena and pyrite and is said to assay about $24.00 in gold. Specimens are reported to have been found in the limonite showing considerable quantities of free gold. There has been considerable stoping on the vein and some shipments of ore have been made. Higher on the hillside, 200 feet above the collar of the shaft, a shallow shaft has been sunk upon a mineralized zone containing some pyrite and chalcopyrite said to assay $4.00 in gold. Sixty-five feet below the collar of the main shaft a tunnel has been driven S. 25° E. for 115 feet on a three-inch stringer of quartz.

SWAMP KING.

This property lies on the east of the Little Giant, in sec. 30, T. 40 N., R. 37 E., at an elevation of 2,650 feet. The rocks exposed in the vicinity are basic diorites cut by diabase and lamprophyre dikes. The ore deposits are mineralized fissures in the diorite and diabase. The main vein has a strike of N. 25° E., with a vertical dip. A tunnel has been driven as a drift in a direction N. 25° E. for a distance of at least 60 feet. Near the portal the

vein is faulted by a local east and west slip. About five feet from the portal of the tunnel a shaft has been sunk but was filled with water at the time of examination. The ore minerals are quartz with pyrite forming a belt eight inches wide. It is said to carry some values in gold.

LITTLE GIANT.

This group consists of five claims situated in the northwest quarter of sec. 30, T. 40 N., R. 37 E., at an elevation of 2,500 feet, and about two miles northeast of Rock Cut. The formation in the vicinity is schist and quartzite cut by a large and greatly altered diorite mass which in turn is cut by a narrow lamprophyre dike having the composition of camptonite and trending northeasterly. In the diorite are numerous fracture zones which are greatly altered and are mineralized to some extent. The ore minerals observed are chalcopyrite, pyrite, galena and the alteration products of copper. Calcite occurs along with the quartz gangue.

The property is developed by a main shaft sunk to a depth of 160 feet on an east and west vein. At the 80-foot level there is a 200-foot drift to the east. There is also one drift to the north. In the bottom of the shaft the vein is said to be a broad zone of crushed country rock somewhat mineralized. At the time of examination the shaft was filled with water and inaccessible. The greater part of the values occur in the east and west vein. Most of the copper comes from the north-south vein, where it occurs in bunches. Diamond drilling has been carried on in the tunnel shaft and a core 14 feet long is said to have assayed $23.00, and second core 10 feet long to have given values of $10.00. In the near vicinity of the main shaft several shallow shafts and open cuts have been made on intersecting veins in the fracture zones of the diorite. Small quantities of chalcopyrite and bornite were observed.

BALD EAGLE.

This property lies east of the Mogul, and the formations exposed in the vicinity consist of quartzite, banded schist and limestone cut by diorite dikes. On Bald Eagle No. 1 claim a shaft has been sunk to a depth of 15 feet upon a vein trending N. 60° E. and dipping 40° to the northwest. It is a fracture zone in which the country rock has been mineralized to a minor extent with chalcopyrite and pyrite, said to carry some gold values. On Bald Eagle No. 2 claim a shaft 25 feet in depth has been sunk on a vein having a strike of N. 80° E., with a dip of 80° to the northwest. This vein outcrops at an elevation of 3,650 feet and forms a fracture zone in the country rock which has been slightly mineralized for a width of 12 feet and contains quartz, pyrite and chalcopyrite, which carry values from $1.00 to $6.00 in gold and silver. A few specks of galena were observed.

MOGUL.

This group consists of eight claims situated in sec. 25, T. 40 N., R. 36 E. The formation exposed is a dike of diorite trending north and south and cutting the schist and quartzite. Near its contact the fissures within it are quartz veins which are mineralized with calcite, chalcopyrite and bornite. Several tunnels and shafts have been driven and sunk for the purpose of prospecting the vein. On the Great Divide claim of the group the vein trends N. 60° W. and dips 75° to the northeast. At an elevation of 3,600 feet a shaft has been sunk upon the vein to an unknown depth. About 500 feet east of these workings a belt of limestone occurs trending north and south, and is about 200 feet in width.

GALENA HILL.

This property lies about one-half mile north of Rock Cut, a station on the Great Northern Railroad. There are several claims whose end lines extend to Ket-

tle River. The formations consist of granitic and dioritic gneiss associated with intrusive masses of diorite and quartz-diorite. With the gneiss is a greatly metamorphosed schist which may be older than the Orient gneiss and which may have been metamorphosed along with it. The intrusive diorite is much younger. Near Kettle River a short tunnel has been driven which exposes a vein containing pyrite, sphalerite, galena and chalcopyrite. At the river's edge and close to the main wagon road a shaft has been sunk to a depth of 300 feet with a 20-foot sump. There are two crosscuts from the shaft, one of which is 170 feet and the other 76 feet in length. In addition there are over 300 feet of drifts. The vein as exposed in the drifts varies in width from two to six feet and is composed of a quartz gangue containing the above mentioned minerals.

At the 300-foot level the vein has a strike of N. 75° W. and a dip of 77° to the southwest. On the hanging-wall there is one foot of gouge, one-fourth of which is calcite. In places the pay ore swings back and forth from footwall to hanging-wall.

THREE ORPHANS.

This claim is owned by the Adrian Gold Mining and Milling Company, and is situated in sec. 26, T. 40 N., R. 36 E. The formation is a part of the Orient gneiss which is cut by a vein of quartz trending N. 50° E. and pitching to the southeast at an angle of 70°. It varies in thickness from 4 to 10 inches and is reported to give values in gold. A small amount of galena was observed. At an elevation of 2,190 feet a tunnel has been driven for a distance of 240 feet in a direction N. 50° E. upon the vein of white crystalline quartz.

COMSTOCK.

This group consists of four claims known as the Comstock, Homestake, Red Fox and Red Cross. They are situated in the western part of sec. 25, and the eastern

part of sec. 26, T. 40 N., R. 36 E., a short distance east of Kettle River.

The formation on the Homestake claim is gneissoid granite and quartzite. A mineralized zone about five feet wide follows the bedding planes of the formation in a general direction N. 30° W., with a dip of 36° to the northeast. Nearby is a large open cut and four shallow shafts. In one of these there is a four-foot vein with a strike of N. 40° W. and a dip of 70° to the northeast. The ore is pyrrhotite and chalcopyrite, said to assay from $5.00 to $35.00 in gold, copper and silver.

Several shafts have been sunk on the Comstock claim in the same kind of country rock. An old timbered shaft which at the time of examination was filled with water has been sunk to a depth of 64 feet on a vein trending N. 25° W. and dipping 70° to the northeast. Stringers of galena occur in the vein. About 50 feet to the north a 15-foot shaft has been sunk upon the same vein, which is six feet wide and contains massive pyrrhotite and chalcopyrite. This ore is reported to carry values of 22 ounces in silver, $1.30 in gold and 3½ per cent copper. A considerable amount of ore is piled upon the dump.

On the Red Fox claim a shaft has been sunk to a depth of 30 feet on a quartz vein in the banded quartzite. Galena is the ore mineral, which is said to assay $7.00 in silver. On the Red Cross claim a tunnel has been driven N. 80° E. for 60 feet in light-colored quartzite as a crosscut to reach a deposit of pyrrhotite on the hillside.

ABE LINCOLN.

This claim lies to the southeast of the Bryant and the country rock exposed is a part of the Orient gneiss cut by dioritic intrusives. On a relatively flat bench a vertical shaft has been sunk to a depth of 120 feet and at the 100-foot level there is a 40-foot crosscut. The shaft was filled with water but the rock exposed on the dump is a

fine-grained diorite with quartz containing pyrite and chalcopyrite, which is said to assay $30.00 in gold. Two other shafts have been sunk to depths of 90 feet and eight feet. Open cuts and trenches have also been made.

BRYANT.

This claim lies in the southwest quarter of sec. 36, T. 40 N., R. 36 E., and to the northeast of the Salina group. The formation consists of the Orient gneiss cut by basic dikes which have been greatly altered and even serpentinized. At an elevation of 2,120 feet a tunnel has been driven S. 75° E. for 30 feet to cut a slightly mineralized fracture zone trending N. 30° E. About 20 feet higher and the same distance to the north a second tunnel extends for 125 feet in a direction N. 75° E., through a gneissoid granite. About 100 feet north there is a 12-foot shaft sunk on the contact between the gneiss and a serpentinized basic dike. Several other small open cuts have been made. A shaft said to be 85 feet in depth has been sunk but was filled with water. Some chalcopyrite was seen on the dump surrounding the collar of the shaft.

SALINA.

This group of claims lies about 1,000 feet northeast of Rock Cut, a station on the Great Northern Railroad, and close to the main wagon road. The formation is a part of the Orient gneiss cut by dikes and masses of dark basic diorite. Within this there is a zone of crushed rock about 18 inches in width containing stringers of chalcopyrite varying in width from one-half inch to one and one-half inches. The main tunnel is on the Lina claim and extends S. 75° E. for a distance of 78 feet. At this point a drift extends N. 60° E. along the hanging-wall which dips 40° to the southeast. About 35 feet above the tunnel a second tunnel has been driven S. 80° E. in a badly altered dioritic intrusive rock.

VIKING.

This group embraces three claims lying in sec. 36, T. 40 N., R. 36 E., and sec. 1, T. 39 N., R. 36 E. The formation exposed is granitic gneiss cut by light and dark-colored diorite dikes.

Several shafts have been sunk on the Mountain Conn claim but at the time of examination were filled with water. One of these, at an elevation of 2,525 feet, has been sunk on a vein of quartz trending N. 15° W. The ore minerals as seen upon the dump are pyrite, chalcopyrite and a few specks of galena.

On the Jasperell claim a tunnel has been driven N. 80° E. for a distance of 130 feet through altered granite rock as a crosscut to a small mineralized zone higher on the hillside to the east.

The bedrock exposed on the Maid of Erin claim is a part of the Rossland volcanic formation and consists of latite flows, some of which are glassy. Three shafts have been sunk on a bench at an elevation of 1,575 feet. The main shaft is 80 feet in depth. The other two are each 12 feet.

STEMWINDER.

This claim lies 1,000 feet east of the Lucky Charlie, in a banded quartzite and schist. A shaft has been sunk to a depth of 12 feet on a vein of quartz ranging from two to four inches in width, with a strike of N. 50° E. and a nearly vertical dip. Very small amounts of galena, chalcopyrite and pyrite were observed.

LUCKY CHARLIE.

This claim lies in the northeast quarter of sec. 26, T. 40 N., R. 36 E. A tunnel has been driven for 300 feet in a direction S. 75° W., on a vein of quartz varying from two to six inches in width and dipping at an angle of 80° to the northeast. The country rock is banded quartzite and schist. Small quantities of galena, sphalerite and chalcopyrite were observed. The elevation at the portal

of the tunnel is 2,240 feet. On the hillside above there is a 40-foot shaft connecting with the tunnel. There is also a 30-foot winze.

EUREKA.

This claim is situated in sec. 25, T. 40 N., R. 36 E., at an elevation of 2,485 feet. It lies on a bench near a small lake. The rock formation in the vicinity consists of banded schist. An inclined shaft on a slope of 70° has been sunk to a depth of 20 feet on a vein striking east and west and dipping 70° to the south. At the bottom of the shaft the vein is four feet in width and contains a very little galena and chalcopyrite in a gangue of quartz. It is said to assay in gold. Twenty feet east of this shaft is a second shaft sunk upon the same vein to a depth of 10 feet. About 100 feet east is a third shaft sunk to a depth of 39 feet on the vein.

WHITE ELEPHANT.

This group consists of six claims situated near the center of sec. 19, T. 40 N., R. 37 E. The main workings are on the White Elephant claim, and consist of a shaft 225 feet in depth. From the 100-foot level there is an 85-foot crosscut and about 110 feet of drifting on a mineralized zone. On the 200-foot level there are 50 feet of drifting and 50 feet of crosscutting. At the bottom of the shaft the rock is reported to be a silicified limestone. The formations on the surface are quartzite and limestone cut by fine-grained diorite dikes. At the time of examination the shaft was filled with water and the underground workings were inaccessible.

RED LION.

This property is situated on the east side of the wagon road from Orient to Rock Cut, in sec. 1, T. 39 N., R. 38 E. The formation is a banded dioritic rock which appears to be a part of the Orient gneiss. It has been faulted and along the fractures much decomposition has taken

place and occasionally some pyrite and chalcopyrite have been deposited. Three tunnels have been driven easterly into the hillside to cut the fracture zones. One of these on the roadside extends in 275 feet along a zone of crushing and fracturing. Higher on the mountain side three other short tunnels have been driven.

NAPOLEON.

This property, consisting of two claims, is situated in the northwest quarter of sec. 3, T. 37 N., R. 37 E. The mine is reached by wagon road a distance of one and one-half miles from Boyds, a station on the Great Northern Railroad. The formation exposed is a part of the Mission argillite. Interbedded with the argillite are narnow bands of quartzite and limestone. In the vicinity of the mine a wide belt of greenstone lies parallel to the bedding of the formation. This together with the argillite is cut by dikes of monzonite. The ore deposits occupy a zone about 600 feet wide in the greenstone. Narrow bands of ore are intercalated with the bedding of the argillite and within the greenstone. The general trend of the ore deposits is approximately N. 65° E., with a dip of about 60° to the northwest. The ore minerals are pyrite, pyrrhotite, magnetite and limonite. Occasional small quantities of chalcopyrite are present. The oxidized ores predominate in the upper portion of the deposit, although pyrrhotite occurs at the surface. Values in gold are reported to occur in the limonite. The greater portion of the ore consists of pyrrhotite. The ores have been mined to a considerable extent and shipped to the smelter at Greenwood, British Columbia, where it is used as a flux. This property was one of the first to be located in Stevens County and the ores have been mined and shipped at intervals for many years.

The property is developed by three main tunnels and a large glory hole. The lower tunnel is at an elevation of 2,400 feet. The highest workings in the glory hole

are at an elevation of 2,650 feet. These workings are all connected with stopes and raises. The stoped areas in the mine are large and the ores appear as replacements of the greenstone in part. A large dike of monzonite cuts the greenstone formation as exposed in the main tunnel. It is possible that the ores may have been derived from solutions given off from the main underlying dioritic and granitic magmas. An aerial tramway has been built from the mine for a distance of one mile to the bunkers at the railroad along Kettle River.

NORTHPORT DISTRICT.

GENERAL STATEMENT.

The Northport mining district embraces the northeastern portion of Stevens County. It is bounded on the east by Pend Oreille County, on the north by the International boundary, on the south by the divide between Deep, Onion, Clugston, and Mill creeks, and on the west by the Fifteen Mile Creek and Orient districts. Approximately 375 square miles of territory are involved. The principal shipping point in the district is Northport, a town of 1,000 population situated on the Nelson branch of the Great Northern Railroad. The Northport smelter is situated here. There are two furnaces with a probable total capacity of 150,000 tons of charge per year. At the time of investigation it was in active operation and employed 400 men. Several properties in the district have carried on extensive development work but the majority were inactive at the time of examination. In the eastern part of the district several properties have been located recently, and are now the most active. These are located in Township 39 North, Range 42 East, and include the Electric Point and Gladstone mines, which are shipping ore on a considerable scale. Good wagon roads have been built to the properties and the ore is hauled to the railroad at Boundary by wagon and

Northport Smelter and the town of Northport. Note the light colored exposures of the Northport limestone on the opposite side of Columbia River.

automobile trucks. During the summer there has been considerable activity in reopening several properties which had long been dormant. This was largely because of the high prices of lead and silver.

The geological formations exposed in the district consist of limestone, argillite, carbonaceous and calcareous argillite and quartzite of the Stevens group. These are cut by a large mass of granite on the south end of the district as well as numerous small dikes of granite and monzonite. A great variety of lamprophyre dikes are present in all parts of the area.

The ore deposits are largely in the limestone and argillite which have been mineralized and replaced by silica and sulphides of the metals. Silver-bearing galena and chalcopyrite predominate as the ore minerals. In the oxidized zone limonite and the carbonates prevail as a rule. Where the fracture zones or faults intersect, ore shoots in the form of chimneys often have been formed as in the case of the ore bodies in the Electric Point and Gladstone mines.

IROQUOIS.

This mine is situated in the northeast quarter of sec. 30, T. 40 N., R. 42 E., and is about eight miles southeast of Boundary, a station on the Great Northern Railroad. It consists of three claims and 120 acres under option, which are now incorporated. It was formerly known as the Flannigan Mine.

The property is developed by a main lower tunnel at an elevation of 2,600 feet, driven in a direction S. 45° E. for a distance of 430 feet. About 290 feet in elevation above the lower tunnel there is an older upper tunnel which has been driven S. 52° E. for 111 feet. Approximately 175 feet south of the upper tunnel and 50 feet higher in elevation there is an old glory hole where considerable galena and lead carbonate ore have been mined in the past. In the bottom of the glory hole there is a

winze about 15 feet in depth which was sunk along the foot-wall of a micaceous lamprophyre dike having a thickness of 12 inches. Its course is rather irregular and undulating with a northeast and southwest strike and a dip to the southeast. The formation exposed in the glory hole is a massive gray limestone, much broken and highly disturbed, and showing no regularity in strike and dip. About 800 feet southeast of the glory hole, and at the same elevation, a short drift has been run following a diabasic dike averaging three feet in width. From this drift a small amount of galena and iron-stained carbonate of lead have been mined.

The formation in which the ores occur is a blue to grayish massive limestone, crushed and faulted and cut by numerous basic dikes, varying from 2 to 10 inches in width. Northwest of the limestone belt there is a zone of dark blackish carbonaceous argillite. The portal of the main lower tunnel begins in the argillite and continues within it for a distance of about 300 feet, where it intersects the limestone contact. Ore deposits of galena and lead carbonate occur as replacements in the limestone along the contact. Greatly altered lamprophyre dikes are intimately associated with the ore deposits. The replacements occur in irregular bunches and chimneys. In the lower tunnel some sphalerite was observed in the limestone near the argillite contact. The strike of the formation as exposed in the lower tunnel is approximately N. 45° W. and normal to the direction of the tunnel. On the prominent limestone bluff, about 500 feet southeast of the old workings, there is a basic black dike varying from 50 to 75 feet in width and having a northeast and southwest direction. It can be traced for over a mile.

SCAMEN.

This mine, situated on Red Top Mountain, in sec. 19, T. 40 N., R. 42 E., consists of four claims and a fraction, and is owned by Fred Scamen and brothers of

Wenatchee. The property is developed by a lower tunnel, at an elevation of 2,850 feet, which has been driven 340 feet in a direction S. 22° E., and an upper tunnel, at an elevation of 2,925 feet, with a direction S. 10° W. and a length of 240 feet. About 100 feet from the portal of the tunnel a drift having a direction of N. 55° W. has been driven along a slip dipping 77° to the northeast. At this point a chimney of ore was encountered consisting chiefly of galena and a small amount of lead carbonate. From this deposit about 65 tons of ore were shipped. The formation in which the ore occurs is a blue to black fine-grained limestone which shows evidences of extensive movements. It is greatly faulted and crushed. The ore occurs in chimneys as replacements in the limestone formation. The rock as exposed in the tunnels shows no uniform strike or dip and is frequently cut by slips and faults which sometimes show planes of movement. The formation exposed along the road below the Scamen camp has a strike of N. 60° E. and a dip of 50° to the southeast.

LUCILE.

This property is situated at an elevation of 3,825 feet, on the eastern slope of Red Top Mountain, in sec. 19, T. 40 N., R. 42 E. It is six miles southeast of Boundary, the nearest shipping point. The mine is developed by a main tunnel at an elevation of 3,615 feet. From the portal it has a direction of S. 70° W. for 63 feet and then N. 45° W. for 54 feet, where a drift having a direction of N. 80° E. for 30 feet was intersected. The crosscut is continued beyond this point for 36 feet in a direction N. 45° W., where a drift S. 65° W. was made 30 feet longer. The crosscut continues for 38 feet to the face. At about 50 feet from the portal of the tunnel a dark micaceous lamprophyre dike about three feet in thickness was intersected, and about 90 feet from the portal a similar three-foot dike was again cut. At 110 feet from

the entrance another similar dike occurs. All of these have a general north and south strike and an easterly dip. The formation exposed in the tunnel for the first 60 feet from the portal is hard massive quartzite interstratified with bands of argillite. Beyond this point there is a white marbleized limestone.

The ore deposits occur as replacements in limestone forming irregular bunches and chimneys, usually of small dimensions. They are intimately related to the intrusive dikes, sometimes lying in contact with them and at other times only a few feet away. The ore is chiefly argentiferous-galena. Associated with the latter are chocolate-colored sphalerite and subordinate amounts of gray copper which carry a high silver content. These are replacements in the limestone. Carbonates of lead are present but in comparatively small amounts and always iron stained. Wherever the ore is in contact with the dikes it is always soft and sooty from the decomposition of the dikes. In part, this material seems to be composed of manganese. Both the argillite and limestone formations in proximity to the ore deposits are broken and disturbed but show definite strike and dip. Elsewhere the prevailing strike is northeast and southwest, with a dip to the northwest.

COPPER KING.

This mine is situated in sec. 25, T. 40 N., R. 41 E., on the south slope of Red Top Mountain. It was originally located in 1896 by Henry and John Little, and comprises two claims known as the Copper King No. 1 and No. 2.

The property is developed by a lower tunnel at an elevation of 3,400 feet, an upper tunnel at an elevation of 3,500 feet, and a discovery shaft at 3,700 feet. The lower tunnel has been driven in a northeasterly direction for a distance of 221 feet. The formation encountered near the portal is banded quartzitic schist. Beyond this is white limestone having a strike of N. 40° E. and a north-

westerly dip of 55°. Along the contact is a vein four inches in width of sphalerite. A mineralized zone follows the schist side of the contact to the face, where there is in places 10 inches of galena ore. About 20 feet back from the face of the tunnel the formation is cut by an eight-foot lamprophyre dike striking N. 70° E. and dipping 65° to the southeast.

The upper tunnel has been driven 285 feet in a general northeasterly direction through banded limestone and calcareous argillite. The prevailing strike of the formation exposed is N. 33° E., with a northwesterly dip of 40°. About 70 feet from the portal an inclined raise goes to the surface, a distance of 50 feet, on a mineralized zone four feet wide, composed of a little quartz in decomposed argillite, resting on a foot-wall of banded white limestone. Galena and sphalerite are the gangue minerals which fill a zone four to eight inches in width. Several lamprophyre dikes cut the formations exposed in the tunnel. One of these, having a width of six inches, occurs 40 feet from the portal, with a nearly east and west strike and a dip of 55° to the south. Two similar dikes occur between this point and the face.

Higher on the hillside a shaft has been sunk on the vein to a depth of 20 feet, with a 30-foot incline. The formation exposed is a banded limestone and calcareous schist, cut by a lamprophyre dike. A greenish copper stain is prevalent in the vicinity. On the Copper King No. 2 claim a shaft is said to have been sunk to a depth of 25 feet in schist, but this was not examined.

ANACONDA.

This property is situated in the eastern part of sec. 30, T. 40 N., R. 42 E., on the southeast slope of Red Top Mountain and about five miles from Boundary, the nearest shipping point. There are two claims in the group, both of which are patented. The formations exposed consist of banded white limestone on the southeast and

quartz-mica schist and argillite on the northwest. A vein varying from two and one-half to four feet in width follows the contact. The general strike of the formation is N. 30° E., with a dip to the northwest of 60°. At an elevation of 3,960 feet a shaft with a slope of 60° has been sunk on the vein to a depth of 40 feet, and near the bottom a drift has been driven S. 35° W. for 30 feet. The vein as exposed in the shaft is composed of quartz and calcite gangue, containing galena and sphalerite. The six inches next to the limestone foot-wall is composed of galena. The remainder is made up of sphalerite scattered through the quartz and calcite gangue. A second shaft to the southeast has been sunk to a depth of 50 feet along the contact of the southeastern side of the limestone and a lamprophyre dike. It is a part of the old workings of the property and is said to have produced some galena ore. On the dump there is a small amount of galena and iron-stained quartz and limonite.

At an elevation of 3,375 feet, a crosscut tunnel has been driven N. 57° W. for a distance of 225 feet. This cuts schist and limestone, which strike N. 35° E. and dip 70° to the northwest. Forty feet from the portal an eight-foot white quartz vein was intersected, having a strike of N. 80° E. and a vertical dip, but showing no metallic minerals. About 155 feet from the portal a 10-foot lamprophyre dike crosses the tunnel, striking N. 10° W. and dipping 70° to the northeast. The face of the tunnel is in a schistose argillite in contact with a massive white limestone about 40 feet thick.

Thirty tons of ore are said to have been shipped from this property in 1902.

EVERGREEN.

This property lies partly in sec. 25, T. 40 N., R. 42 E., on the south slope of Red Top Mountain, and is situated by wagon road about five miles from Boundary, a ship-

ping point on the Great Northern Railway. The group consists of five claims, which were located in 1896.

Evergreen Claim. A belt of limestone about 500 feet wide and trending northeast and southwest, in contact with calcareous argillite and schist, follows the long direction of the claim. A vein occurs along the contact, with a quartz gangue, containing galena and sphalerite. This vein has been cut by several shallow shafts, open cuts and a tunnel. Near the center of the claim, at an elevation of 3,700 feet, an old shaft 50 feet deep has been sunk on the contact. At this point the formation has a strike of N. 60° E. and a dip of 70° to the northwest. Three hundred feet from this is a second shaft 15 feet in depth, which has been sunk on a 16-inch vein of quartz in the schist. A third shaft is 73 feet deep. A main tunnel has been driven 145 feet in a direction N. 20° W. as a crosscut to tap the vein. The rock exposed is a banded calcareous phyllite for the first 135 feet. Beyond this are 10 feet of white limestone, having a strike of N. 53° E. and a dip to the northwest of 60°. At the face a basic dike of unknown thickness was encountered. One carload of 25 tons of ore is said to have been shipped from this claim to Nelson, B. C., in 1902.

Olympia Claim. A contact, bearing N. 30° E., between white massive limestone on the northwest and calcareous schist on the southeast follows approximately along the middle line of the claim. This contact appears to be a fault plane with a dip of 80° to the northwest. A fracture zone trending N. 70° W. and dipping 55° to the southwest, diagonally cuts the bedding of both limestone and schist. This fault zone is intersected by a fracture zone having a strike of N. 35° E. and a vertical dip. At the intersection of these two fracture zones in the limestone a chimney of ore has been formed containing limonite, cerussite and some primary galena. The deposit is developed by a tunnel, at an elevation of 3,275

feet, driven in a northeasterly direction for 177 feet. About 145 feet from the portal a chimney of ore was encountered at the intersection of a northwest and northeast fracture zone in the limestone. A 90-foot shaft has been sunk on this vein and also a raise has been made connecting with a shaft and slope higher on the hillside. At the face of the tunnel a shaft has been sunk to a depth of 20 feet in limestone in an intersecting fracture zone. The ore is galena, sphalerite and pyrite in a quartz vein which is about three feet in width and dips at an angle of 55° to the southwest. In the surface exposures the pyrite has been oxidized to limonite.

At an elevation of 3,350 feet a shaft has been sunk to a depth of 100 feet on the vein and a slope from this connects with the shaft 10 feet back from the face of the tunnel below.

UNITED TREASURE.

This property lies about one mile west of the Frisco Standard Mine, in sec. 11, T. 40 N., R. 42 E., on the east side of Fish Creek, at an elevation of 3,450 feet. The property embraces three claims which have been developed by five short tunnels driven into the hill to the east on the vein. The formation exposed is a very dark-colored silicified carbonaceous argillite which has been greatly broken by fractures and cross fractures. The strata have a northwest and southeast strike with a low dip of less than 11° to the northeast. The vein is composed of a quartz gangue containing lead, copper and zinc minerals carrying silver. It lies nearly flat, being about 5° to the bedding planes of the argillites. Associated with the vein is a completely altered dike about 18 inches in thickness which apparently cuts the vein or rather has been intruded along the zone of mineralization. The mineralized zone varies in thickness from a few inches to 30 inches. Its course is more or less undulating but conforms to the planes of bedding. Six

short tunnels have been driven on the vein, for distances ranging from 20 to 180 feet. Considerable high-grade ore, more or less oxidized, has been mined and shipped, being packed out by horses to the railroad at Boundary.

FRISCO-STANDARD.

This mine is situated in sec. 12, T. 40 N., R. 42 E., at an elevation of 3,400 feet. It lies in the extreme northeastern corner of the county, in a small gulch or canyon known as Jubilee Creek. The formation exposed is termed the Fish Creek argillite, and is of probable Palæozoic age. A grayish calcareous argillite and a black carbonaceous argillite are the predominating varieties of rock exposed. The strata have a strike of N. 27° W. and a dip of 50° to the northeast.

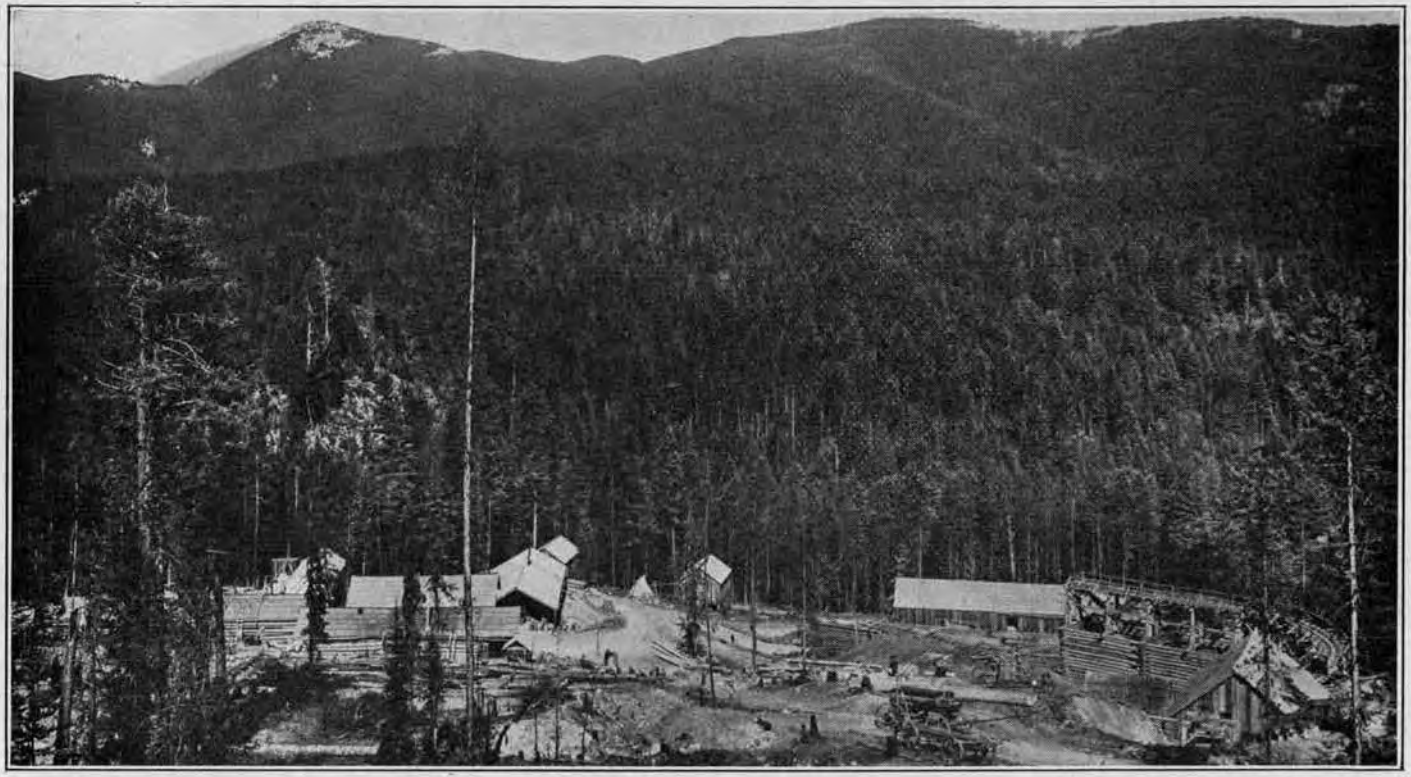
The ore body consists of a quartz vein conforming to the bedding planes of the argillite and having a general strike of N. 70° W. and a dip of 40° to the southwest. The white quartz vein contains galena associated with sphalerite, tetrahedrite, azurite and malachite. On the eastern side of the north-south canyon the vein slopes with the hill at a low angle and has been opened by five short tunnels. On the western side of the gulch, at an elevation of 3,375 feet, a long tunnel is being driven on a milky-white quartz vein which is presumably the same as that on the east side of the canyon. It is possible that the vein has been displaced by a fault following along the canyon. The vein as exposed on the west side conforms to the bedding planes of the black carbonaceous silicified argillite. The vein on the east side of the canyon is probably covered with about 250 feet of rock. In the tunnel on the western side of the gulch a lamprophyre dike having the composition of a minette was encountered about 150 feet from the portal. It varies in width from two to three feet. The same dike may be noted again on the west side of the ravine, between No. 5 and No. 6 tunnels, in a prospect pit.

ELECTRIC POINT.

This property is situated in secs. 17 and 18, T. 39 N., R. 42 E., at an elevation of 4,200 feet. It comprises five patented claims trending about N. 30° E. These were located in July, 1916, by J. E. Yoder and Chris Johnson, and have been incorporated as the Electric Point Mining Company, with head offices in Northport. A good wagon and automobile road has been constructed to the mine, which is 14 miles from Boundary, a station on the Great Northern Railroad, and 24 miles from Northport. The formation exposed in the vicinity of the workings is a dark blue to nearly black dolomitic limestone with numerous small veinlets of calcite ramifying through it. Interstratified with these are massive dark-colored dolomites along with beds of light-colored crystalline limestone. These have a strike of N. 40° W. and a low dip to the southwest of 10°. Farther to the northwest, along the wagon road recently constructed to the mine, there are excellent exposures of finely-bedded argillite, calcareous argillite, slate and siliceous argillite. These have a strike ranging from N. 40° E. to N. 60° E. and a dip to the southeast of 60°. This structure prevails to within three-fourths of a mile of the mine.

The mine is developed by an inclined shaft 250 feet in length at an angle of 80°, and levels have been run at 100 and 200-foot elevations. A lower crosscut tunnel has been driven for a distance of 920 feet to the ore bodies on the 200-foot level. The ore is mined and taken out through the shaft to bunkers. The country rock is taken out through the main crosscut mentioned above.

The ore deposits are found along a fracture or shear zone having a direction of magnetic north and south, occurring at those points where the formation has been cut by slips or faults having a southwest or southeast direction. These secondary fractures intersect the major direction of fracturing, and afford avenues for the min-



Camp of the Electric Point Mine during earlier stages of operation. View gives excellent idea of the topography of the surrounding country.

eral-bearing solutions to follow and replace the limestone and form chimneys of ore. The chimneys are from 40 to 60 feet in diameter and are, in outline, rudely circular or cylindrical with an almost vertical axis. It appears, from the development work so far accomplished, that the chimneys, four in number, are connected by slips or faults along the north-south direction of faulting. At the time of examination of the property four chimneys had been discovered but it is probable that other chimneys will be found at the intersections of the major and minor fracture zones. The chimneys so far discovered are numbered 1, 2, 3 and 4. Chimney No. 1 is 50 feet in diameter and has a shaft sunk upon it 250 feet in depth. No. 2 chimney is 50 feet due south of No. 1 chimney. There is an interval of 30 feet between the south wall of No. 1 and the north wall of No. 2. This chimney is exposed at the surface but only extends downward 100 feet. Chimney No. 3 is 150 feet north of No. 1 and extends downward 30 feet. Chimney No. 4 lies 75 feet southwest of No. 1. To date it has produced the largest amount of ore. It does not appear at the surface and its uppermost limits are 100 feet below the surface. It is called the blind chimney, and was discovered by drifting along one of the minor faults or fractures on the 200-foot level. As yet it has not been developed below the 200-foot level.

The country rock in the vicinity of the workings is greatly broken and iron-stained. The ores are carbonate of lead in which occur nodules of galena varying from the size of an egg up to boulders weighing several hundred pounds. A considerable amount of white crystallized lead may be seen in the iron-stained ore.

GLADSTONE.

This property joins the Electric Point Mine on the north and west. There are 10 claims which have been incorporated with head offices in Spokane. The forma-

tion exposed on the property is a limestone similar to that in the Electric Point Mine. The ore occurs in chimneys, as a replacement in the blue limestone, along the intersections of major and minor fracture zones. The ore consists of highly iron-stained carbonate of lead. While no galena was observed considerable white crystallized lead occurs. The chimney which is now being worked is small, not exceeding 12 or 15 feet in diameter, and extending in depth from the 100 to the 200-foot level. The walls of the chimney are made up of decomposed limestone with a soft granular sugar-like appearance.

The property is developed by a shaft 275 feet in depth from which levels have been driven at the 50-foot, 100-foot, 200-foot and 260-foot stations. From the mine, up to the time of examination in August, 1917, 125 tons of ore had been taken out and shipped. The ore is hauled by team and truck to Boundary, a station on the Great Northern Railroad, a distance of 14 miles, where it is shipped to the smelter.

RED IRON.

This property lies on the west side of the Black Cat group, in sec. 8, T. 39 N., R. 42 E., at an elevation of 3,800 feet. It consists of the following four claims: Red Dick, Red Iron No. 1, Red Iron No. 2, and Tamarack.

Red Dick Claim. Near the south end of the claim two small open cuts have been made in a red iron-stained limestone containing bunches of earthy limonite. No other ore was observed. Nearby is a 15-foot surface cut in similar rock.

Red Iron Claim No. 2. At the north end of the claim, and 60 feet from the Red Dick Claim, a shaft has been sunk to a depth of 30 feet in a similar iron-stained limestone. In the bottom of the shaft are streaks of reddish clay and gouge which may contain small amounts of impure carbonate of lead. At other places on the claim

open cuts have been made in similar material. On the same claim, at an elevation of 3,985 feet, there is a shaft 18 feet deep with a 24-foot drift at the base. The rock exposed is an iron-stained limestone containing traces of lead carbonate. The main zone of fracturing is north and south, and a small chimney exists at the fracture intersection.

Red Iron Claim No. 1. On this claim there are several open cuts and shallow shafts in limonite croppings within the limestone belt. The wall of this zone strikes N. 30° E., with a dip of 80° to the northwest. Near the south end of the claim there is a shaft 50 feet deep in limestone which has been oxidized and mineralized and which is said to have produced seven per cent lead ore. Some galena was observed as a replacement in the limestone. Nearby are several open cuts.

BLACK CAT.

This property is situated about two miles west of the Electric Point Mine, in sec. 8, T. 39 N., R. 42 E. There are four claims in the group, known as the Boot Jack, Crow, Humming Bird and Black Cat. They are joined end to end and trend north and south. The formation exposed in the vicinity is chiefly blue to gray limestone. The ores are galena and its oxidized products in a mass of limonite and quartz representing replacement at the intersections of fracture zones in limestone.

Black Cat Claim. The country rock on this claim is entirely limestone, with limonite croppings containing galena and cerussite in small amounts. A shaft has been sunk to a depth of 20 feet in the iron-stained limestone. The rock exposed in the bottom of the shaft is fractured white limestone seamed with iron oxide. No definite vein was observed.

LAST CHANCE.

This property is situated in secs. 24 and 25, T. 39 N., R. 40 E., on the eastern side of Deep Creek, at an eleva-

tion of 2,700 feet. It is developed by four tunnels and several open cuts and trenches. All of the tunnels are connected by stopes and raises. The formation exposed on this property consists largely of light and dark bluish-gray crystalline, banded limestones which grade into argillite and dark carbonaceous argillite. These strata have a prevailing strike of N. 40° E. and a dip of about 50° to the southeast.

The tramway and bunkers are located only a short distance above the level of the valley, at an elevation of 2,250 feet. The lower or No. 3 tunnel is at an elevation of 2,700 feet and has been driven in a general northeasterly direction. The ore body as exposed occupies a zone of fracturing in the limestone, having a strike of N. 15° E., with a dip of 65° to the northwest. Some of the deposits are impregnations in the limestone adjacent to the main fracture zone. Several cross fractures were observed and it is at these intersections that the ore shoots seem to have been formed. The general trend of the cross fractures is N. 35° W., although variations from this were observed. Commonly the walls of the vein are well-defined and the width of the deposits varies from one inch to five feet. Minor faulting has displaced the vein in some places to a small degree.

The upper or No. 2 tunnel, at an elevation of 3,000 feet, has been driven in a general direction S. 85° E., but is caved near the portal and was inaccessible for examination. One hundred and thirty-five feet in elevation above this tunnel is the discovery shaft. The vein as here exposed has a strike of N. 15° E. The ores of the property are chiefly galena with subordinate amounts of sphalerite and pyrite, which have in places, especially near the surface, been altered to cerussite, limonite and anglesite. Zinc carbonate is sometimes present.

GREAT WESTERN.

This property joins the Last Chance Mine on the north and is situated in sec. 24, T. 39 N., R. 40 E., at an elevation of 3,120 feet. It was located in 1888 by George Thomas, and consists of two claims known as the Great Western and the Empire. The mine is developed by a main tunnel at an elevation of 3,120 feet, which has been driven in a general direction N. 77° E. from the portal. About 100 feet from the portal a fracture or mineralized zone was intersected having a direction nearly east and west. This was followed for 40 feet when it split and one branch continued in a direction almost due east and the other approximately N. 40° E. for 60 feet, where it turns and continues N. 10° E. to a point where the tunnel was inaccessible at the time of visit. At those places in the tunnel where the fracture zones intersect there is usually some mineralization but the main mineralization zone corresponds to that in the Last Chance Mine. The country rocks exposed in the workings vary from an altered and iron-stained light gray limestone to a bluish-gray fine-grained dolomitic limestone. The walls of the ore bodies show silicification. The ore bodies occur as replacements in the fracture zones in the limestone, the principal ore bodies being found near the intersection of the main north-south and east-west fractures. The ores are chiefly carbonate of zinc with some carbonate of lead, together with a subordinate amount of galena and sphalerite.

Much of the development work done on this property was performed about 1906, when it is reported that about $20,000.00 worth of zinc ore was shipped to Pennsylvania. A similar amount of zinc carbonate ore is said to have been taken out and shipped during the years 1915 and 1916.

NEW ENGLAND.

The New England Mine is situated on the west side of Deep Creek, at an elevation of 1,900 feet, in sec. 23, T. 39 N., R. 40 E. The property consists of five claims located six miles from Northport by wagon road. It is developed by two open quarries, one of which is situated at the south end of the massive white limestone bluff, at an elevation of 1,900 feet, and the other about 250 feet north, at an elevation of 1,950 feet.

The formation exposed in this area is a massive marbleized limestone in which abundant tremolite crystals have been developed. It has been greatly fractured and presents a blocky appearance. About 300 feet southwest of the mine workings there is a large mass of granite which has been intruded into the limestone. The contact trends approximately N. 30° W. At an elevation of 2,000 feet and about 1,200 feet south of the quarry there is a tunnel which has been driven for 220 feet along this contact. At the time of examination the rock exposed was a decomposed iron-stained limestone showing no evidence of ore.

The ore occurs in limestone as a replacement along a line of fractures parallel to the planes of bedding. The mineralized zone has a direction nearly north and south and dips almost vertically. The width of the zone where crossed in the open workings is 40 feet. The west wall represented by the limestone bluff is not well-defined, but the ore gradually diminishes until it is only represented by occasional streaks. At times the ore minerals are disseminated throughout the limestone and do not follow the banded structure lines. The mineralized belt measured in the lowest workings shows a width of 40 feet with sphalerite scattered beyond that point to the west. The strongest mineralization is over a distance of 24 feet beginning at the east side of the open cut. The lower quarry has been opened along what was formerly a short

tunnel having a direction of S. 75° W. At the portal of this tunnel a shallow winze was sunk but is now filled with water.

COYOTE.

This prospect is situated three miles west of Northport, in sec. 26, T. 40 N., R. 39 E. The formations are crystalline limestone and phyllite, having a strike of N. 45° W. and a dip of 68° to the southwest. Near the eastern end of the claim there is an exposure of intrusive granite. An inclined shaft has been sunk on the contact between the limestone and argillite, and 20 feet below the collar a drift has been run 20 feet to the north. The rock exposed is a black carbonaceous argillite cut by veinlets of quartz. Parallel to the bedding of the argillite there is a mineralized zone two feet wide, which contains galena said to carry silver. Considerable trenching and open cut work were observed near the shaft. The shaft continues below the 20-foot level but was inaccessible at the time of examination.

MINERAL BELT.

This prospect is located in sec. 35, T. 40 N., R. 39 E., at an elevation of 2,450 feet. The development work consists of a tunnel driven to the west for 240 feet, as a crosscut to reach the vein exposed higher on the hillside. The formation is entirely composed of argillite and calcareous argillite. Higher on the hillside, at an elevation of 2,525 feet, a shaft has been sunk on a belt of crumpled and silicified schistose argillite having a local strike of N. 10° W. and a dip of 35° to the southwest. The footwall of the vein is a seven-foot lamprophyre dike lying parallel to the bedding of the schist. A mineralized zone in the bedding of the schist, varying in width from two to six inches, and carrying a little galena, was observed.

MOUNTAIN VIEW.

The Mountain View property lies to the northwest of the Providence, in sec. 35, T. 40 N., R. 39 E., on the north side of Squaw Creek. It comprises two claims, upon which several shafts, tunnels and open cuts have been made. The formations exposed consist of interbedded limestone and argillite, having a strike of N. 45° E. and a dip of 40° to the northwest. At an elevation of 2,600 feet a one-foot quartz vein occurs parallel to the bedding of the formation, carrying a little pyrite, chalcopyrite and sphalerite. Several hundred feet to the northeast and slightly higher in elevation two shafts have been sunk to a depth of 30 feet, on a nine-foot quartz vein. This vein is in the western border of the Northport limestone, 30 feet east of its contact with the Mission argillite. Following the foot-wall there are 13 inches of pyrite, sphalerite and galena, with some gray copper. The limestone is naturally banded and crumpled. Down the hillside a crosscut tunnel has been driven N. 60° W. for 340 feet. Limestone and argillite were cut having a strike of N. 35° E. and a dip of 60° to the northwest.

PROVIDENCE.

This prospect is situated in sec. 34, T. 40 N., R. 39 E., four miles southwest of Northport, and at an elevation of 4,000 feet. The formation exposed is a part of the Mission argillite, striking N. 34° E. to N. 60° E. and with a dip ranging from 40° to 70° to the northwest. The strata have been cut by acidic dike rocks. At the eastern end of the property, at an elevation of 4,030 feet, a shaft has been sunk on a slope of 65° to the northwest for 100 feet on a quartz vein in an acidic dike rock. The shaft was filled with water at the time of examination, but the quartz vein is reported to be one foot in width in the workings. The ore minerals are pyrite, galena, tetrahedrite, sphalerite and chalcopyrite. A second shaft, sunk many years ago and now filled with water, is lo-

cated 100 feet in a direction N. 30° E. from the former and at an elevation of 4,080 feet. It is said to be 100 feet in depth and on a slope of 40°. The formation is a banded argillite. The same dike exposed in the former shaft lies on the southeast side of the slate belt. The main development work is a tunnel 700 feet N. 60° E. from the last mentioned shaft, which is being driven N. 50° W., and at the time of examination was in 192 feet. The formation exposed in the tunnel is argillite with a strike of N. 45° E. and a dip to the northwest of 50°. Sixty-five feet from the portal a mineralized dike eight feet in width crosses the tunnel with a strike of N. 10° W. and a dip of 60° to the southwest. Higher on the hillside N. 40° W. from the portal of the tunnel and at an elevation of 4,250 feet, a shaft has been sunk on a vein in the same dike as at the eastern end of the property in the first shaft mentioned. The dike trends N. 70° E. and is at least 75 feet in width and contains a quartz vein. The formation on either side of the dike is argillite. Some galena is exposed which is said to carry silver values. No ore has yet been reached in the tunnel.

ST. CRISPIN.

This prospect is situated in sec. 25, T. 40 N., R. 39 E., on Sheep Creek, about one mile west of Northport, at an elevation of 1,400 feet. The group embraces six claims which were located in 1905 and which have been incorporated as the St. Crispin Mining, Milling, Smelting and Development Comany, with headquarters in Northport. The formation exposed in the bed of the creek is a dark, carbonaceous argillite. Away from Sheep Creek the bedrock is covered with deposits of glacial drift and river wash. A shaft has been sunk in the creek to a depth of 16 feet on a mineralized zone in the argillite, trending N. 70° E. Eight other similar mineralized zones are reported to occur to the southwest. According to Mr.

H. W. Brooks of Northport, an assay of the ore is said to have yielded copper four per cent, gold $26.00, and silver 13 ounces. Back from the creek a second shallow shaft has been sunk and from it several drifts are said to have been driven.

SUNSET.

This prospect is situated in the southwest quarter of sec. 30, T. 40 N., R. 40 E., 300 feet west of Columbia River, and a half-mile north of Northport. At the time of examination the property was idle and the underground workings inaccessible. The formations exposed on the surface consist of interbedded phyllite, calcareous argillite and bluish-gray dolomitic limestone, cut by lamprophyre dikes. These strata have a prevailing strike of N. 60° E. and a dip ranging from 50° to 80° to the northwest. The ores occur in a quartz vein carrying galena, sphalerite, pyrite, chalcopyrite and tetrahedrite. The ores are said to occur on the contact between the dikes and the metamorphosed sedimentaries in the workings of the mine. The property is developed by a 400-foot inclined shaft, from which drifts have been run at 100-foot intervals. The shaft was filled with water at the time of examination.

NORTHPORT.

This property is situated in the southwest quarter of sec. 16, T. 39 N., R. 40 E., at an elevation of 2,230 feet, on the north side of Fish Creek, three miles southeast of Northport by wagon road. The formation is argillite on the east and banded white to bluish-gray, crystalline limestone on the north and west. The development work consists of a shaft 65 feet in depth with a crosscut at the base, all in bluish-gray limestone. The shaft has been sunk on a three-foot zone of limonite replacement material, having a strike of N. 25° E. and a dip of 70° to the northwest. It lies in a zone of brecciation and crushing. No galena was observed, but it is reported

that assays of $12.00 in gold were obtained from the bottom of the shaft. One hundred and fifty feet below, on the hillside and to the south, a crosscut tunnel is being driven N. 30° W. to tap the vein. At the time of examination it had been driven 93 feet through argillite and calcareous argillite.

MORASKI.

This prospect is situated in sec. 1, T. 40 N., R. 40 E., about one mile west of Columbia River. The formation is interbedded argillite, quartzite, quartz-mica schist, and bluish-gray dolomitic limestone. These are cut by aplite, diabase, lamprophyre and granite dikes. They have a strike of N. 75° E, and a nearly vertical dip, but have in places been greatly disturbed. A short tunnel has been opened in a greatly altered aplite dike, trending nearly north and south. A little pyrite and chalcopyrite were observed. Several very small open cuts have been made.

DOUBLE STANDARD.

This property lies just north of the Great Republic and close to the international line, in sec. 3, T. 40 N., R. 39 E. The formations exposed consist of dolomitic gray limestone, argillite and black silicified carbonaceous argillite, with a general north and south strike and easterly dip. The strata are cut by numerous lamprophyre dikes. On the surface a quartz vein is exposed in the argillite conforming to the bedding planes, upon which an inclined shaft has been sunk. The ore minerals are pyrrhotite, chalcopyrite and subordinate amounts of galena and sphalerite.

The principal development work consists of a crosscut tunnel, driven from the level of the wagon road in the valley, due east into the hill for a distance of 810 feet. About 270 feet from the portal there is a shallow winze filled with water. About 350 feet from the portal a six-inch quartz vein was encountered having a strike of

N. 40° W. and a dip of 20° to the northeast. At 390 feet from the portal a 40-foot lamprophyre dike was cut.

GREAT REPUBLIC.

This property is situated a short distance north of Velvet, a station on the Rossland branch of the Great Northern Railroad, on the east side of Sheep Creek, in sec. 3, T. 40 N., R. 39 E. It lies only a few hundred feet south of the international boundary. The formations exposed in the vicinity are bluish-gray dolomite, quartz-mica schist and carbonaceous argillite, which have been cut by lamprophyre dikes. The prevailing strike of the strata is nearly north and south, with a dip of 40° to the east. The ore deposits consist of two veins of quartz containing pyrrhotite, chalcopyrite and small amounts of sphalerite and galena. The veins are in contact with lamprophyre dikes and have a north and south strike with an easterly dip of 60°. The values of the ore are in copper, silver and gold, but no records are available.

The development work consists chiefly of a crosscut tunnel driven east into the side of Sheep Creek valley, at the level of the valley floor. On the west side of a lamprophyre dike, intersected in the tunnel 195 feet from the portal, a winze has been sunk to a depth of 110 feet. Beyond the winze for a distance of nearly 200 feet the rock encountered is a greatly altered lamprophyre dike. From the eastern side of the dike to the face, the formation is argillite and quartzite. On the surface an inclined shaft has been sunk on the vein for 120 feet. Numerous other open cuts, shafts and short tunnels occur higher on the hillside to the east. These have been made on the surface exposures of the vein.

MAGNESITE.

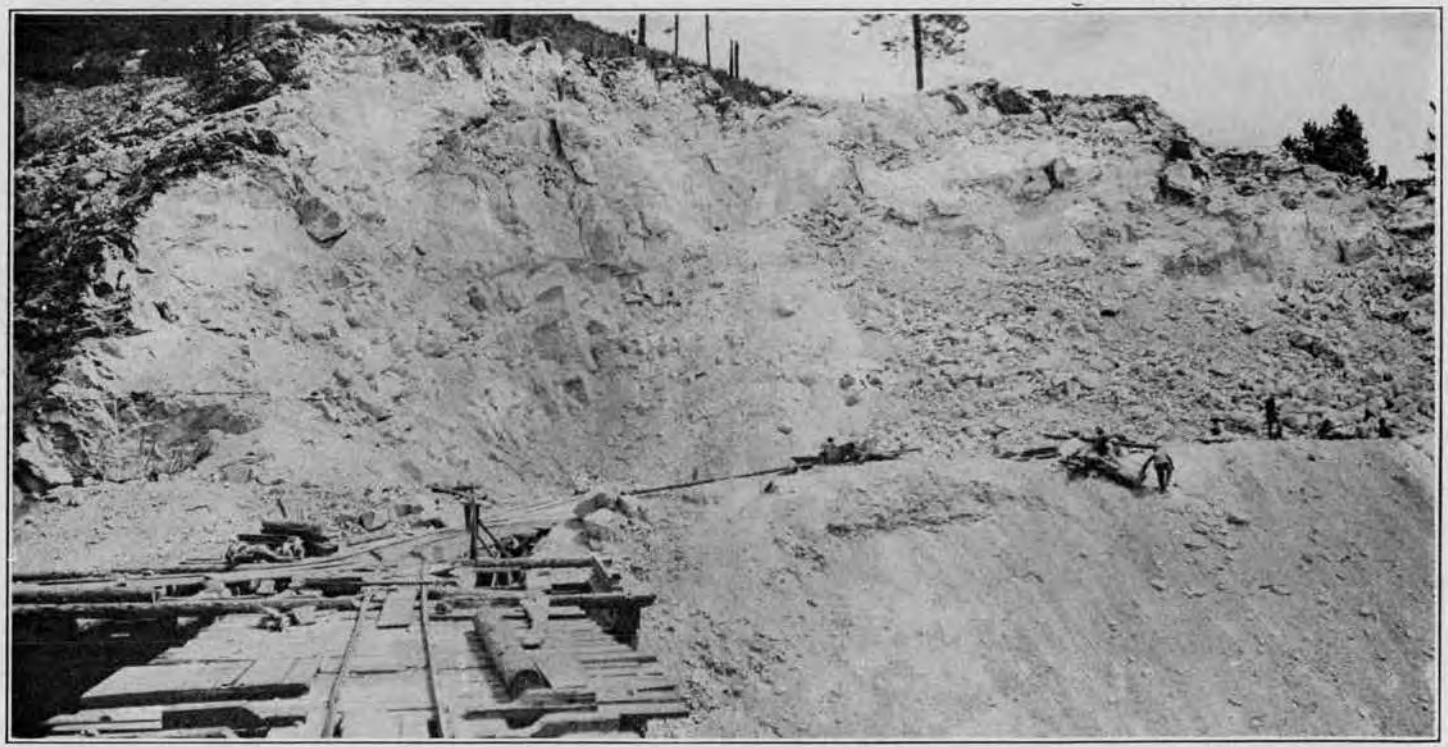
GENERAL STATEMENT.

The magnesite deposits of Stevens County were formerly located as marble claims. About 20 years ago considerable development work was done upon these properties and several quarries were opened up. The product proved unsuitable for commercial purposes and the properties remained inactive for many years.

In 1915, Mr. R. S. Talbot, of the Inland Empire Paper Company of Spokane, came into possession of samples of the rock from the abandoned quarry of the U. S. Marble Company, west of Valley. These samples proved to be brucite, a magnesium hydrate. Further examination led to the recognition that the brucite deposit was surrounded by magnesite of commercial value. Mr. Talbot at once proceeded to acquire title and prospect for further deposits. The Washington Magnesite Company was organized as a result of his efforts.

In the summer of 1916 Professor F. M. Handy, of the Washington State College at Pullman, entered the field and began actively to acquire properties. Later the American Mineral Production Company took over his holdings. The companies operating in Stevens County are: the Northwest Magnesite Company, the Valley Magnesite Company, the American Minerals Production Company and the U. S. Magnesite Company. These properties later will be individually described.

The magnesite deposits are confined to a belt of magnesian limestone averaging 1,500 feet in width and trending in a northeasterly direction for a distance of 30 miles along the eastern side of the Huckleberry Range. The general strike of this belt at its southern end is approximately N. 22° E., with a westerly dip of 45° to 80°. Proceeding northeasterly the strike of the Stensgar dolomite becomes more easterly until near its north-



Quarry face of magnesite, Finch Quarry, Northwest Magnesite Company.

ern end it is approximately N. 40° E., with a dip to the northwest varying from 10° to 50°. Minor local folds have been developed within this belt. It is overlaid by argillite and underlaid by argillite and quartz-mica schist, which are often calcareous. The overlying argillite is in turn overlaid by the massive Addy quartzite. The southern end of the dolomite belt is terminated by intrusive granite. The northern end passes beneath the nose of a northerly pitching anticline, where it is complicated by obscure faulting. This region is mountainous and the surface is heavily covered with forest and underbrush. The bedrock is largely concealed by deposits of glacial gravel and surface wash.

The magnesite occurs at several localities within the Stensgar dolomite. The deposits are of considerable size. One deposit is nearly 2,000 feet in length and 250 feet in thickness. Diamond drilling is now being carried on for the purpose of testing the extent and chemical character of the magnesite. A large number of chemical analyses have been made of the magnesite, both of the rock in the quarries and of the cores from the drill holes. These analyses show a great chemical variation. All grades of rock from calcite to dolomite and magnesite are found to occur. It is difficult to determine the grade of rock from the appearance of hand specimens. Consequently chemical analyses are continuously made of the material quarried and shipped. The variations are not confined entirely to the relative amounts of calcium and magnesium, but also to the silica and iron. The quarries show the rock to be cut by a large number of intersecting minor faults and slip planes. These seem to have had an influence on the replacement of the dolomite by magnesite. Usually along the seams magnesite prevails, but the rock is progressively richer in calcium away from the seams. Occasionally the rock between two intersecting faults is entirely commercial magnesite,

while the rock outside is dolomite. In many cases magnesite crystals are scattered at random through the dolomite masses and become more numerous and closer together as a slip plane or fault is approached, until in the vicinity of the joint or fault pure magnesite only is present.

It is not believed that the magnesite was originally formed in the muds of the sea floor because of the complete gradation from magnesite to dolomite. The former occurs in roughly lenticular masses in the dolomite and at the margins of the lenses the magnesite grades into dolomite, as well as along the numerous fault and slip planes. It is believed that the dolomites were formed on the sea floor during the time interval in which the Stensgar dolomite and Deer Trail argillite were forming. They were finally deeply buried beneath other quartzite and argillite. Later, during the epoch of uplift, folding, and igneous intrusion, the dolomite was fractured and numerous intersecting slip planes were developed. These became avenues for circulating solutions which resulted in the extraction of calcium from the dolomite and a residual enrichment of magnesia. This possible explanation may account for the peculiar conditions of replacement in their relation to the fracture planes.

The magnesite is crystalline and varies in granularity from very fine and dense to a very coarsely crystalline condition. The color ranges from white to gray, bluish-gray, reddish-gray and red. Occasionally it assumes a dark gray and even black color.

It is difficult to determine the quantity of magnesite present in Stevens County. An estimate based upon the apparent size of the known lenses would be misleading as the ratio of commercial magnesite to dolomite or non-commercial magnesite is a variable quantity. It has been estimated by the U. S. Geological Survey that there are 7,000,000 tons of magnesite in the Stevens County dis-

trict and that there may be more. During September, 1917, the shipments of crude magnesite from Stevens County averaged 700 tons daily.

All the Stevens County properties have been very active during the past year in development work. A broad-gauge railroad is being built from Valley westerly to Deer Creek, near the Red Marble quarry, a distance of 12 miles. A five-mile aerial tramway is being constructed from the Finch quarry to Chewelah. At the present time all the crude magnesite which is not calcined is being hauled from the quarries to Valley and Chewelah by motor truck and team at an average cost of from $2.50 to $4.50 per ton. The average selling price of crude magnesite delivered f. o. b. Chewelah or Valley is said to be from $7.00 to $9.00 per ton, and the calcined product from $31.00 to $35.00 per ton. The calcined product as well as the raw material is shipped to Pennsylvania.

Prior to the opening of the war, in 1914, over 70 per cent of the magnesite used in the United States was imported. About 90 per cent of these imports came from Austria and Hungary and the larger part of the remainder came from Greece. During the first year of the war the Austrian supply was greatly curtailed but that from Greece was correspondingly increased. Later, due to the decreased facilities for shipping, the supplies from Greece rapidly dwindled. The increase in demand for magnesite led to a more intensive development of the known deposits in the United States as well as a further search for new deposits.

Prior to the war the larger part of the magnesite mined in the United States came from California. This material is of a purer grade than most of the magnesite imported from Europe. However, the cost of mining and transportation to the eastern coast was greater than the cost of importing the material from Europe. As a

result the markets for the California product were confined almost entirely to the Pacific Coast, where it is used in the manufacture of paper. Since the importation of magnesite has now almost entirely stopped the demand has correspondingly increased as well as the price. The California properties are very actively engaged in development work. The discovery of magnesite in Stevens County has led to rapid development and over 700 tons of crude magnesite are being shipped east daily. Large calcining plants are being rushed to completion as rapidly as possible. The future of the development of these properties depends upon the quality, cost of production and competition with the imported material after the war.

Magnesite is used in the manufacture of bricks and furnace linings which are to withstand high temperatures. It is used also in the manufacture of cement, plaster, tiling and for the making of liquors in which wood pulp is digested to make paper. The present high cost of the material has temporarily decreased its use in the manufacture of plaster, flooring, etc., in favor of other substitutes.

The composition of the magnesite deposits shows considerable variation. In order to be of commercial value it must have the property, after calcining, of resistance to high temperatures and the corrosive action of metallic slags, as well as the property of maintaining its form after being placed in a furnace. This property is largely due to the ability of the pieces of crushed magnesite in the bricks to adhere firmly one to the other so that the effect of heat, or the chemical character of metallic slags, will cause no change. The presence of a small amount of iron appears to very slightly lower the resistance of magnesite to extreme temperatures, but has the added value of increasing its ability to hold its form.

In the calcining of magnesite the problem is to heat the crude rock and drive off the carbon dioxide and moisture. When the process has been carried to a state where these materials have been completely eliminated the resulting product of magnesia is spoken of as being in the dead-burned or sintered form. In this condition it is capable of resisting temperatures as well as chemical attack. When the process of calcining is terminated before quite all of the carbon dioxide is driven off the resulting product is spoken of as being in the caustic calcined form. When exposed to the air it recombines with moisture and carbon dioxide. It is employed in the manufacture of tile and floor cements by the addition of calcium chloride, and also in the manufacture of paper.

VALLEY MAGNESITE COMPANY.

The Valley Magnesite Company controls magnesite deposits located in secs. 17, 18 and 19, T. 31 N., R. 39 E., under lease from the Double Eagle Mining Company of Valley. Magnesite was discovered on this property in January, 1917, and work of development was begun in June of the same year. The property was taken over from Professor F. M. Handy by the Valley Magnesite Company in October, 1917.

Two calcining kilns are now in operation and a third is being built. Plans are being made for the construction of eight more. The quarry is to be connected with the kilns by an aerial tram. Up to October, 1917, ten carloads of crude magnesite had been shipped but the company is producing only the calcined product. Each kiln is turning out between 12 and 15 tons of calcined product per 24 hours. The calcined product is being shipped to Pennsylvania for the refractory trade. The selling price of the crude rock is $7.50 to $8.00 per ton (2,000 pounds) f. o. b. Valley, and calcined magnesite is sold at $32.50 f. o. b. Valley. The railroad freight from

Valley is $12.50 per ton. The crude magnesite is hauled from the quarries to Valley by teams and motor trucks. In October, 1917, about thirty men were employed.

The deposits occur near the top of Double Eagle Mountain, on the eastern slopes of Huckleberry Range, at an elevation of 3,600 feet. The quarry is situated about one mile by wagon road from the kilns, which are located near the foot of the hill and about fourteen miles from Valley. The Spokane and Northern Railroad, now under construction, will pass through the site of the new kiln plant and very close to the present kilns. The magnesite belt occurs in the Stensgar dolomite formation and is about 150 feet wide. It is overlaid by argillite and then by the Addy quartzite. One quarry face has been started in Section 17 and two in Section 18.

The following average analysis has been obtained from the quarry face in Section 18:

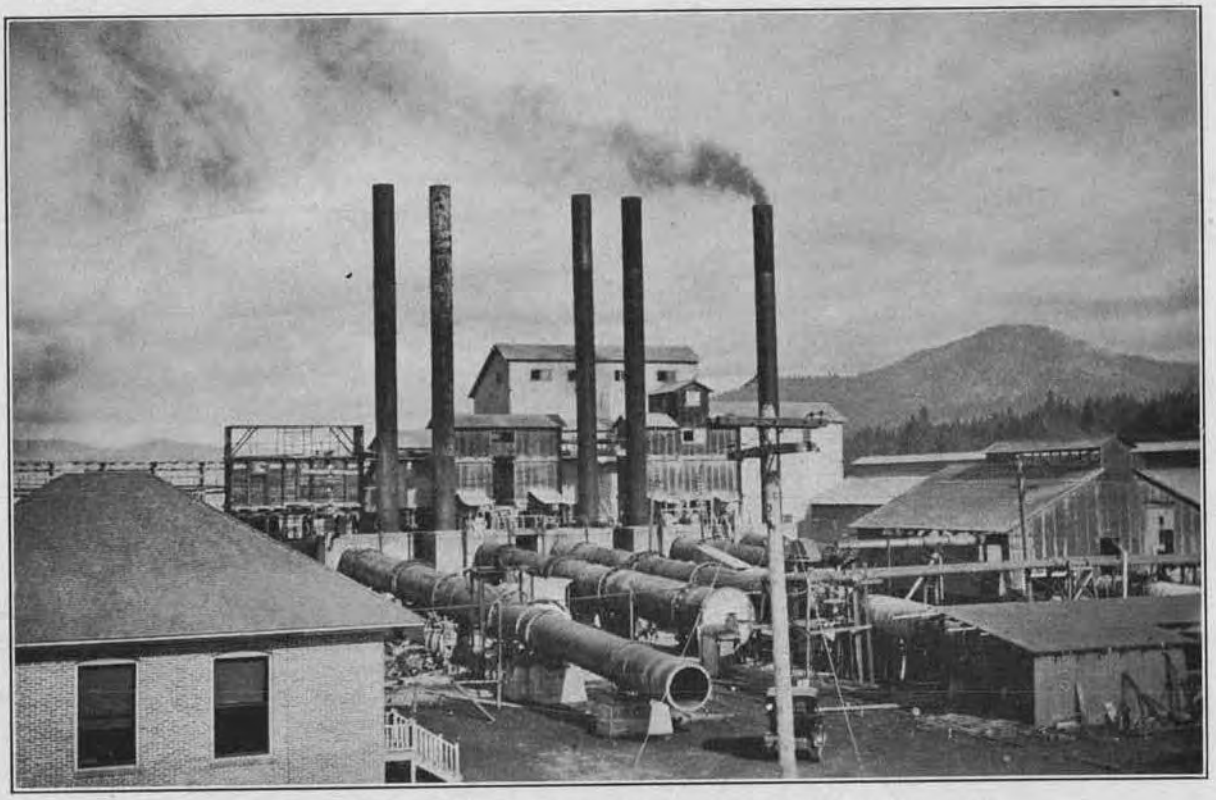
Silica	2.5% to 3.0%
Alumina and Ferric oxide	1.0% to 1.5%
Lime (CaO)	0.5% to 1.0%
$MgCO_3$	94.0% to 96.0%

NORTHWEST MAGNESITE COMPANY.

The property controlled by this company embraces the Finch Quarry, the Keystone Quarry and the Midnight Claim. The Keystone Quarry was formerly known as the U. S. Marble but the name was changed to the latter in order to avoid confusion with the Red Marble Quarry of the American Mineral Production Company of Valley.

Finch Quarry. This property embraces the N.E.¼ of the N.W.¼, the N.W.¼ of the N.W.¼, and the S.W.¼ of the N.W.¼ of sec. 30, T. 32 N., R. 40 E. The actual quarry face is situated in the S.W.¼ of the N.W.¼ of section 30, about 150 feet from the south line and 500 feet from the west line.

Keystone or U. S. Marble Quarry. This property embraces the N.E.¼ of the S.W.¼, the N.W.¼ of the



Calcining plant of the Northwest Magnesite Company at Chewelah.

S.W.¼, the S.W.¼ of the S.W.¼, and the west half of the S.W.¼ of the N.W.¼ of sec. 9, T. 31 N., R. 39 E. It includes also the N.W.¼ of the N.E.¼ of the N.E.¼, and the N.E.¼ of the N.W.¼ of the N.E.¼ of sec. 17, T. 31 N., R. 39 E.

Midnight Claim. This claim involves the west half of the S.E.¼ of sec. 7, T. 31 N., R. 39 E.

These properties are operated by agreement for a term of five years by two trustees: B. L. Thane of San Francisco, and R. S. Talbot of Spokane. Both the Finch and Keystone are developed, and the Midnight is sufficiently developed for patent.

The magnesite was first discovered in August, 1915. The Finch property was at first a ranch, but later it became a marble claim. What is now the Keystone property was tested for marble 18 or 20 years ago and considerable money was expended upon it. From November, 1916, to May, 1917, it was operated by Mr. Talbot as the Washington Magnesite Company. The present company was organized in May, 1917. The operating office is located at Chewelah.

Two kilns are being operated whose dimensions are 125 feet in length, with a diameter of seven and one-half feet at one end, and narrowing to seven feet in the last 75 feet. A third kiln of the same dimension is being installed. These are cement-type rotary kilns with a capacity of 100 tons per day of finished product. The crude magnesite is crushed and fed in a constant stream into the kilns which revolve one revolution per minute. Oil is used as a fuel with a temperature of approximately 2,000° F. The calcined material is elevated and conveyed into a concrete cooling and storage building from which it is loaded into railroad cars for shipment. The kilns are situated about two miles south of Chewelah on the Great Northern Railroad.

Up to November, 1917, there have been mined from the Finch quarry approximately 75,000 tons of crude magnesite. About 5,000 tons have been mined from the Keystone quarry. This has been shipped east to the refractory companies in Pennsylvania. The freight rate per ton from Chewelah to its destination in Pennsylvania is $12.50.

About 75 men are employed at the quarries and 100 at the calcining plant. This includes both construction and operation at each place. The magnesite is hauled by contract by both teams and auto trucks from the quarries to Chewelah at a cost of approximately $2.50 per ton. The cost of quarrying is about $0.75 per ton. The selling price of crude magnesite in November, 1917, delivered f. o. b. Chewelah, is $7.50 per ton. The price of the calcined magnesite delivered f. o. b. Chewelah is $32.50 per ton. The present cost of calcining is approximately $14.00 per ton.*

The magnesite occurs within the dolomite which has been mapped as the Stensgar dolomite formation. The product which is mined varies greatly from dolomite to magnesite. Analyses show a wide range in composition, but the magnesite which is mined falls well within the following limits:

SiO_2	0% to 3%.
Fe_2O_3	0% to 5 to 6%.
CaO	0% to 2%.
Al_2O_3	This is normally so low as to give no concern. It averages from 0.60% to 0.71%.

The commercial quality of the magnesite cannot be judged from either its texture or color. It may range from a fine-grained to a coarsely crystalline condition, and from a black to a white color including red, yet all may be equally good.

*The figures concerning cost of operation were in effect in December, 1917.

Trainload of magnesite leaving the quarry of the American Mineral Production Company.

AMERICAN MINERAL PRODUCTION COMPANY.

The property controlled by this company embraces four quarries: the Allen Quarry, Moss Quarry, Woodbury Quarry and the Red Marble Quarry. The Allen Quarry is located in the S.W.¼ of the S.W.¼ of sec. 30, T. 32 N., R. 40 E. The Moss Quarry is situated 800 feet southwest of the Allen Quarry and 800 feet along a line running S. 30° W. from the southwest corner of sec. 30, T. 32 N., R. 40 E. The Woodbury Quarry is situated in the N.W.¼ of the N.W.¼ of sec. 1, T. 31 N., R. 39 E. The Red Marble Quarry is located in the N.E.¼ of the N.E.¼ of sec. 25, T. 31 N., R. 38 E. All of these quarries are developed. The present company was organized and took over the property in December, 1916. The operating offices are in Valley and the head offices in Chicago.

Four upright kilns have been constructed at the Allen Quarry and two at the Woodbury Quarry with a capacity of 15 tons each per day under normal conditions. They

are constructed of brick with an approximate height of 35 feet and an inside diameter of six feet. Wood is being used as a fuel and a temperature of 1100°C is obtained in the fire box. The cost of hauling the crude ore from the Allen Quarry to Valley is $2.00 per ton. The cost from the Red Marble property to Valley is $4.50 per ton. The selling price for the crude magnesite delivered f. o. b. Valley ranges between $7.00 and $9.00. The price for the calcined material ranges from $25.00 to $31.00. Hauling of the magnesite from the quarries to Valley is done by contract and both motor trucks and teams are employed.

The following analysis is an average of the calcined product:

SiO_2	2.25%
Al_2O_3 } Fe_2O_3 }	1.16%
CaO	1.31%
MgO	45.98%
Loss (H_2O and CO_2)	49.30%

U. S. MAGNESITE COMPANY.

The property of this company is situated on the east slope of the Huckleberry Range, at an altitude of 3,300 feet, in sec. 10, T. 30 N., R. 38 E. The deposit strikes N. 30° E. and dips 67° to the northwest. At the time of examination a quarry was being opened up and a road constructed preparatory to shipping. The distance to the loading point on the Phœnix Lumber Company's logging road is five or six miles. The deposit is from 75 to 100 feet wide. The formation exposed above the dolomite is argillite which in turn is overlaid by limestone and quartzite. The Deer Trail argillite underlies this deposit, which is a lens in the Stensgar dolomite. There is great variation in the composition of the material as seen in the gradation from dolomite to magnesite. The following cross section was observed: Underlying the deposit is argillite; above this there is a narrow band of dolomitic limestone; this is followed by 36 feet of magnesite, six feet of dolomite, six feet of magnesite, nine feet of dolomite, 10 feet of magnesite, 24 feet concealed, 15 feet of dolomite, and finally an argillite hanging-wall.

LIMESTONE.

GENERAL STATEMENT.

The limestones of Stevens County occur in a series of narrow belts trending northeast and southwest, as shown on the geologic map accompanying this report. The lithologic character of the limestones varies greatly. They range from a pure white, fine to coarse-grained, crystalline massive limestone, to a grayish-blue, or to a blue and brown color. They become argillaceous and often distinctly banded and are commonly found as narrow bands interbedded with the argillite. In a number of cases they are greatly silicified and approach quartzites in general composition and appearance. At several places within the county plants have been erected for the burning of lime, but at the present time the only one in operation is located at Evans, on the Columbia River, between Northport and Marcus. The limestones as a rule vary greatly in the percentages of magnesium present.

About two miles southeast of Springdale a large plant for the burning of lime has been erected by the Washington Brick, Lime and Manufacturing Company. For a number of years the plant was in operation, but during the past few years it has been inactive. The limestone at this locality varies from a white to a light gray in color and is finely crystalline.

About three miles southeast of Valley, in secs. 1 and 12, T. 30 N., R. 40 E., there is an area of limestone in which a small quarry has been opened and one kiln is being operated for a part of the year. The lime is massive, fine-grained, and has a dark gray color. The magnesium content is prevailingly low and usually under one per cent. Similar areas of limestone of varying composition and texture occur to the east and southeast of Valley.

To the west of Valley numerous openings have been made in the Stensgar dolomite, but the magnesium content is too high for its use in the manufacture of Portland cement.

East of Chewelah a narrow belt of limestone occurs trending nearly north and south for a distance of six miles. It lies interbedded with the Chewelah argillite and varies in color from a pure white to a dark gray. Chemical analyses show a uniformly high percentage of magnesium to be present, indicating their dolomitic character and poor quality for the manufacture of Portland cement.

DEEP CREEK AREA.

A belt of limestone trending northeasterly crosses Deep Creek about six miles southeast of Northport. On the southwest it is cut off by a large mass of granite. Several years ago a quarry was opened in sec. 25, T. 39 N., R. 40 E. The stone was used as a marble, but it was unable to withstand weathering and the active operation of the quarry soon stopped.

The rock is very fine-grained and varies in color from a pure white to a light gray. Upon analysis it is found to contain a considerable quantity of magnesium. Apparently the magnesium content varies greatly, as samples taken from a similar appearing rock only a short distance away are nearly free from it.

BOSSBURG AREA.

The southwestern extension of the Northport limestone is well exposed on both sides of Columbia River, northeast of Bossburg. These limestones show considerable variation in texture, ranging from fine to coarse-grained and from a massive to a stratified condition. The deposits on the eastern side are prevailingly of a lighter color than those on the western side, and they also show a uniformly low percentage of magnesia. The

limestone on the western side of the river shows a greater variation in composition, where the magnesia ranges from less than one per cent to over 18 per cent.

NORTHPORT AREA.

The Northport limestone is exposed prominently on both the east and west sides of Columbia River from Bossburg northeasterly to beyond Northport. It occurs in high, bold bluffs and varies in texture and composition. About two miles southwest of Northport a quarry has been opened along the eastern side of the Great Northern Railroad and the limestone is shipped to the Northport smelter, where it is used as a flux. The rock is white, massive, and medium-grained, and the quarry face is over 300 feet long by 250 feet in height, and 150 feet deep. Analyses of the limestone show the magnesium content to range from a trace to three per cent.

KETTLE FALLS AREA.

On the western slope of the Huckleberry Mountains, south of the junction of the Kettle and Columbia rivers, there are several small areas of limestone occurring as lenses in the Mission argillite. About two miles south of Kettle Falls a medium gray-colored limestone outcrops in low knolls. It is medium-grained and distinctly stratified. A small kiln in which lime was burned was at one time in operation, but is now inactive. An analysis of the lime shows it to average less than two per cent in magnesia.

About seven miles south of Kettle Falls, in secs. 27, 34 and 35, T. 35 N., R. 37 E., and in secs. 2 and 3, T. 34 N., R. 37 E., areas of a fine-grained gray limestone occur, which upon analysis yield less than one per cent of magnesia.

STENSGAR CREEK AREA.

Several areas of limestone occur along the valley of Stensgar Creek, between Addy and the summit of the Huckleberry Range. A marble quarry has been opened

in one of these deposits situated in secs. 26, 27, 34 and 35, T. 34 N., R. 38 E., by the Crystal Marble Company. This property is reached by wagon road from Colville and Addy, but for the past 15 years has been inactive. The limestone occurs in a considerable body and ranges in color from a pure-white to a bluish-gray. It varies from a fine-grained to a coarse-grained type and is usually massive, although bedding may be noticed, especially in the bluish-gray variety. Minor crumpling is also characteristic in the darker phases. Several chemical analyses which have been made of the rock show it to range from a trace to over 24 per cent magnesia. With the exception of one analysis they all yielded over 20 per cent magnesia.

CLUGSTON CREEK AREA.

The large area of limestone shown upon the geologic map accompanying the report, and designated as the Clugston limestone, is a massive, medium-grained rock varying in color from a pure white to a dark gray. Near the head of the east branch of Clugston Creek a marble quarry was opened 20 years ago, but during the last 10 years has been inactive. This quarry was opened by the Keystone Marble Company and is situated 16 miles by wagon road northeast of Colville, in secs. 1 and 12, T. 37 N., R. 39 E. Chemical analyses of the rock from this quarry show it to average less than one per cent in magnesia, although one sample yielded over 10 per cent.

MILL CREEK AREA.

An extensive belt of limestone of a characteristic bluish-gray color and showing stratification is exposed along Mill Creek, northeast of Colville. In places it is distinctly argillaceous. In one locality a very small amount has been burned for lime. The analyses of the rock show it to average less than one per cent in silica, but about three per cent in magnesia.

COLVILLE AREA.

To the south and east of Colville limestones occur of varying degrees of purity. Two parallel belts forming the northwestern and southeastern limbs of an overturned and eroded anticline extend to Old Dominion Mountain, where the southeastern belt is cut off by granite.

About two miles south of Colville, and on the east side of the main wagon road, a long, low, north and south hill is composed largely of a fine-grained, dark, bluish-gray limestone. It varies from fine to coarse-grained and shows marked evidences of stratification. The magnesia content of this rock averages less than four per cent.

IDAHO LIME COMPANY.

The property of this company is situated in sec. 15, T. 37 N., R. 38 E. It is equipped with three kilns or draw kilns and a steel jacket lined with fire brick. Wood is used as fuel. The kilns have a diameter of ten feet on the outside and eight feet on the inside and a capacity of one carload. It is possible to take out 2,000 to 2,500 pounds of lime at each draw, with a total of six draws per day. The plant is at Evans, a station on the Great Northern Railroad, and a spur track connects with the plant for loading.

A fertilizing plant has been constructed in connection with the lime plant. The limestone is pulverized with a Jeffreys pulverizer with gasoline as a fuel. The ground material is elevated by chain buckets and screened through a 12 mesh screen set at an angle of 45° and then passes into loading buckets. The selling price of the fertilizer is $4.00 per ton f. o. b. Evans. The selling price of the lime is $1.35 per barrel delivered f. o. b. Evans. The plant employs 18 men and runs approximately nine months per year.

The quarry is situated on a ridge about one-fourth mile long and 200 yards wide. The present quarry face has a height of 25 feet but is becoming lower as it is

worked back. It is 150 yards long by 80 to 90 yards in width. The material is transported to the kilns by car and cable. The altitude of the plant is 1,350 feet. The limestone exposed is a white to bluish-gray with a probable strike of north and south and a westerly dip of 18°.

CLAY.

GENERAL STATEMENT.

The clay deposits of Stevens County consist of several types. The best known and most extensively used are horizontally-bedded clays interstratified with sands of Pleistocene age. They represent fine argillaceous material derived by weathering and erosion from rocks containing minerals rich in alumina which have been transported by streams to bodies of fresh water, where they have been deposited. These clays are usually stratified and in areal extent vary in composition. In places they become sandy so that they can be used only for the manufacture of common building brick. The finer types, which are relatively free from sand and iron, are used in the manufacture of pottery and terra cotta. The most important deposits of clay in the county are situated in the level area in the vicinity of Clayton. Certain of the argillites of the Stevens group may afford a future supply of clay, especially for the manufacture of Portland cement. These rocks vary greatly in composition. Usually they are calcareous or quartzitic. Occasionally, however, the calcium and silicia content is low and such types may have a future commercial value.

CLAYTON AREA.

Clayton is situated on the Great Northern Railroad about 23 miles north of Spokane, and in Stevens County just west of the Spokane County line. The surrounding region for several miles to the west, south and north is nearly level and the surface exposures are largely gravels of glacial origin. Interbedded with the gravels are deposits of bedded clay, presumably deposited in bodies of fresh water which occupied portions of this area during the closing stages of the glacial epoch. The bedrock wherever exposed consists of granite which has under-

gone extensive weathering. It is probable that much of the horizontally-bedded clays were originally derived from the kaolinite of the altered feldspars in the granite and were carried short distances in suspension in the streams to the fresh water ponds and then deposited. Some of the clays are stained with iron and some contain varying amounts of sand. As the result of bore holes which have been made, these clays are found to have in places a thickness of over 50 feet.

An extensive area of these clay deposits occurs at Clayton in sec. 19, T. 29 N., R. 42 E., and are owned by the Washington Brick, Lime and Sewer Pipe Company. The clay exposed in the pits which have been opened varies from a white to light gray, to deep yellow to light yellow. All the clay used is mined from large pits which are situated close by the plant. The vertical section as exposed in the pit shows a thin surface layer of gravel and soil of no value. Below this surface layer there are seven feet of a yellowish-gray sandy clay. Below this there are three feet of a light gray sandy clay and below this eight feet of white clay.

ABBOTT CLAY PIT.

This property is situated in sec. 32, T. 30 N., R. 42 E. The main pit is approximately 125 feet east and west by 160 feet north and south. Several tunnels have been driven on a low angle of slope from the walls of the pit. The depth of the pit from the surface is approximately 35 feet. The upper 12 feet is somewhat iron-stained and is used for the manufacture of pigments and brick and is mixed with other materials. The lower 24 feet is used in the manufacture of terra cotta and pottery. At the base there is a layer of limonite containing considerable clay. Several other pits occur nearby but have been less extensively developed. This clay was first known and mined 20 years ago. It is being used at the present time

Abbott clay pit.

by the Washington Brick, Lime and Sewer Pipe Company at Clayton, and by the Inland Empire Pottery Company at Hillyard.

NEFUS CLAY PIT.

This property is situated in sec. 34, T. 30 N., R. 42 E., and just north of the Spokane County line in Stevens County. It lies close to the county road. The surface of the surrounding region is nearly flat and covered with gravel, so that the clay is not exposed at the surface. The clay is white and plastic and horizontally bedded. It is developed by a tunnel driven N. 70° W. Thirty feet from the portal it is caved. Above the course of the tunnel on the surface there are numerous shallow cuts, trenches, etc. A track runs from the tunnel to the bunkers, from which the clay is loaded onto wagons. This property was not being worked at the time of examination.

CONNER CLAY PIT.

This property is situated on the farm of S. M. Conner, in sec. 4, T. 29 N., R. 42 E. The surrounding country is approximately flat. One pit has been opened up and is

85 feet in length by 55 feet in width, and is 10 feet deep. The clay is a light gray plastic variety, with some sandy phases. The property was first opened up in July, 1916, and is now being worked. The clay is loaded onto wagons at the pit and hauled by team a distance of five miles to Clayton, where it is used in the manufacture of terra cotta. Seventeen hundred and ten tons were said to have been taken from the pit up to the time of the writer's visit. The price of the clay, delivered at Clayton, was then $2.25 per ton.

KETTLE FALLS AREA.

At many places along the Columbia River valley deposits of horizontally-bedded alluvial clay occur which are often of a character suitable for the manufacture of a fair grade common building brick. One of these deposits occurring near Kettle Falls has been worked. The clay is of uniform composition, of a grayish color, and is stratified. The following chemical analysis, made by Mr. A. A. Hammer, is quoted.*

ANALYSIS OF CLAY FROM KETTLE FALLS, STEVENS COUNTY.

A. A. Hammer, Analyst.

Silica (SiO_2)	56.98
Alumina (Al_2O_3)	17.74
Iron (Fe_2O_3)	7.22
Lime (CaO)	5.25
Magnesia (MgO)	4.08
Potash (K_2O)	1.31
Soda (Na_2O)	0.86
Loss on Ignition	6.07
Total	99.51
Total fluxes	18.72

The amount of iron, lime and magnesia is large, the percentage of each being high, and would cause this clay to fuse at a low temperature.

CHEWELAH AREA.

A deposit of horizontally-bedded alluvial clay occurs in Colville Valley, in the northwestern part of the town

*Shedd, Solon. The Clays of the State of Washington, p. 219, State College of Washington publication, Pullman, 1910.

of Chewelah. A brick plant owned by the Chewelah Brick and Tile Company is now being operated. The clay pit embraces about nine acres. The equipment of the plant includes a Fate cutting machine of 30,000 capacity, a Hummer mixer, a 65-horsepower Atlas boiler and a 50-horsepower Atlas engine. The clay is elevated by a chain belt to the screen and then it passes to the mixer. There is no dry kiln; it is all air dried. There is a Clase down-draft kiln with a capacity of three-quarters of a million bricks. The clay is of a suitable quality, so that it can be used without the addition of other material. The products manufactured are drain tile, three to eight inches in diameter, brick, and hollow tile for building purposes. This property has been operated for 11 years and has shipped a total of 20,000,000 bricks. The principal markets are Stevens, Ferry and Spokane counties, as well as Canada.

COLVILLE AREA.

Two small clay pits have been operated at Colville but have been inactive for several years. These clays vary from a light, grayish-white to a grayish-yellow. The clay is horizontally bedded and somewhat sandy.

In sec. 10, T. 35 N., R. 39 E., about two miles east of Colville, a clay pit owned by George Myers of Spokane was formerly used in the manufacture of common building brick. The pit involves approximately 10 acres and is at an elevation of 1,950 feet. The clay averages from five to eight feet in depth. The deposit is horizontally-bedded and is covered with a thin veneer of glacial sand and gravel. The clay is of a light brownish-gray color and contains a considerable amount of fine sand. The property has not been operated for the past five years.

About one-fourth mile southwest of the clay pit there is a sand pit about 100 by 150 feet in area and from 10 to 20 feet in depth. This sand is rather coarse-grained

and was hauled to the brick kilns at the clay pit. Both the sand and clay are of glacial origin.

NORTHPORT AREA.

The clays exposed in the Columbia River valley between Northport and Bossburg are of alluvial origin and are interbedded with sands and sandy clays. South of Northport about two miles, deposits of this clay occur and were at one time used in the manufacture of common building brick. The plant is not now in operation. The following analyses have been made by Mr. A. A. Hammer and are here quoted.*

ANALYSES OF CLAY FROM NORTHPORT, STEVENS COUNTY.
A. A. Hammer, Analyst.

Silica (SiO_2)	56.72	59.76
Alumina (Al_2O_3)	15.69	17.29
Iron (Fe_2O_3)	9.34	5.71
Lime (CaO)	4.43	2.94
Magnesia (MgO)	3.13	4.11
Potash (K_2O)	1.19	1.51
Soda (Na_2O)	1.09	1.81
Loss on ignition	6.64	6.86
Total	98.23	99.99
Total fluxes	19.18	16.08

The most striking thing shown by the above analyses is the high percentage of fluxing substances which these clays contain. The clays would probably make building brick of fair quality, but would not be of much value for other kinds of clay products.

VALLEY AREA.

A deposit of white and reddish-brown clay occurs about three miles east of Valley in association with limonite ores. It lies at the contact between a flow of basalt and an underlying mass of the older limestone. One deposit in the vicinity lies between a granite dike and a basalt flow. These beds of clay have been tilted along with the basalt and are probably of Tertiary age. Such

*Shedd, Solon. The Clays of the State of Washington, p. 216, State College of Washington publication, Pullman, 1910.

development work as has been done has been in connection with the deposits of limestone which occur in a portion of the clay. The following analysis of this clay has been made by Mr. A. A. Hammer and is quoted.*

ANALYSIS OF CLAY FROM VALLEY, STEVENS COUNTY.

A. A. Hammer, Analyst.

Silica (SiO_2)	69.12
Alumina (Al_2O_3)	23.40
Iron (Fe_2O_3)	0.96
Lime (CaO)	trace
Magnesia (MgO)	0.92
Potash (K_2O)	0.17
Soda (Na_2O)	0.15
Loss on ignition	4.92
Total	99.64
Total fluxes	2.20

The analysis shows this clay to have a very small amount of each of the fluxing substances. The amount of iron is especially low and this clay when burned should be very light in color.

*Shedd, Solon. The Clays of the State of Washington, p. 211, State College of Washington publication, Pullman, 1910.

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Topographic Maps of the Following Quadrangles

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Summary Report.

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Power Reports.

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Water-Supply Paper No. 313: Water Powers of the Cascade Range, Part II, Southwestern Washington, Puget Sound Region.

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Water-Supply Paper No. 487: Water Powers of the Cascade Range, Part V, Chelan, Methow and Similkameen basins. In preparation.

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Water-Supply Paper No. 376: Profile Surveys, Chelan and Methow basins.

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Annual Stream-Flow Reports.

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Reconnoissance Soil Survey of the Quincy Area.

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LEGEND
QUATERNARY
Qal Alluvium
Qgd Glacial drift
TERTIARY
Tpv Palmer Volcanics
Tpl Phalen Lake Volcanics
Tc Camas basalt
Tg Gerome andesite
Ts Sheppard granite
Td Diabase
Tgp Granite porphyry
Tgd Diorite
Mj Jumbo Volcanics
CARBONIFEROUS (?) TO TERTIARY (?)
Mr Rossland Volcanic group
Msc Sheep Creek conglomerate
MESOZOIC
Mg Greenstone
Ms Serpentine
Mlg Loon Lake granite
STEVENS SERIES
CARBONIFEROUS (?) TO CAMBRIAN (?)
Pnl Northport limestone
Pma Mission argillite
Pcl Clugston limestone
Pcq Colville quartzite
Pol Old Dominion limestone
Pca Chewelah argillite
Paq Addy quartzite
Pda Deer Trail argillite
Psd Stensgar dolomite
Peq Eagle Mountain quartzite
Pdl Deer Lake argillite
UNDIFFERENTIATED STEVENS SERIES
CARBONIFEROUS (?) TO CAMBRIAN (?)
Pla Deep Lake argillite
Prl Republican Creek limestone
Pba Boundary argillite
Pcc Cedar Creek argillite
Pfa Fish Creek argillite
Prt Red Top limestone
Plp Lead Point argillite
Puq Undifferentiated quartzite
Pul Undifferentiated limestone
Pua Undifferentiated argillite
PRE-CAMBRIAN (?)
Ao Orient gneiss
LEGEND
Metal mines
Gravel pits
Magnesite and dolomite
Clay pits
Limestone quarries
Slate deposits
Hydroelectric plants
AREAL AND STRUCTURAL
GEOLOGIC MAP
OF
STEVENS COUNTY
WASHINGTON
BY
CHARLES E. WEAVER
Scale 1/125000
Miles
Kilometers
A. HOEN & CO. BALTO. MD.