RECONNAISSANCE OF THE CONCONULLY AND RUBY MINING DISTRICTS, WASHINGTON.

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INTRODUCTION.

FIELD WORK AND ACKNOWLEDGMENTS.

This report is based on a hasty examination of the Conconully and Ruby mining districts, in Okanogan County, Wash., made during two weeks in June, 1915. In the short time available for the work detailed geologic mapping of the complex rock formations was impossible. The districts are included in the Okanogan and Chopaka quadrangles, which have been topographically mapped by the United States Geological Survey. The maps of these quadrangles form the base for the map of the districts given herewith (Pl. I), on which the locations of mines and prospects are shown and the contact between the granite and metamorphosed rocks is indicated for a distance of 10 miles.

The writer expresses his thanks to the members of the Conconully Miners' Association for data and assistance in the field, and to Prof. Francis A. Thomson, of the State College of Washington, who has furnished a preliminary report on the metallurgic treatment of the ores which is largely incorporated in this paper. Data on the Arlington mine were kindly supplied by Mr. H. S. Stoolfire, of Spokane, Wash.

PUBLICATIONS.

G. A. Bethune, the first State geologist of Washington, in his report for 1890 first describes the Ruby and Salmon River mining districts. Henry Landes, in volume 1 of the State Geological Survey of Washington, gives a brief economic account of the Conconully district. J. B. Umpleby, in Bulletin 5 of the State Geological Survey, gives a report on the Oroville-Nighthawk area, of which the Palmer Mountain district, lying immediately north of the Conconully district, is a part. The region to the north and west along the international boundary has been described also by Smith and

Calkins[1] and by Daly.[2] Bailey Willis[3] passed through the Okanogan Valley in 1887 and made many notes on its physiographic features.

HISTORY.

Okanogan County west of Okanogan River comprised part of the Moses Indian Reservation. Although the reservation was known to contain mineral deposits, it was not opened to prospecting until 1886. In that year, because of the discoveries of high-grade silver-lead ores, the Salmon River district was organized and in the year following the Ruby mining district. For several years development was active, and the Ruby, Arlington, First Thought, Fourth of July, and Last Chance mines in the Ruby district are estimated from reports to have produced $200,000 worth of ore. The Salmon River district, centering about Conconully, is also credited with a small production. Many factors contributed to the decay of these districts, such as the lack of railroad facilities and the decline in the price of silver. Of the town of Ruby there remain only old foundations and two dismantled mills, which were reported to have had little success in the concentration of the low-grade ores.

With the completion of the railroad interest in mining has revived, and several companies are now engaged in the development of their properties. One, the Arlington, has made several shipments of smelting ores. Natural conditions are very favorable for mining in these districts. Wood for mine timbers and fuel is abundant, and electric power could be generated from Salmon Creek or purchased from the plant on Similkameen River near Oroville.

GEOGRAPHY.

LOCATION AND ACCESSIBILITY.

The Conconully and Ruby mining districts lie in the central part of Okanogan County, Wash. (See fig. 3.) Conconully, formerly the county seat, a town of 200 inhabitants, is situated at the southern end of the Conconully district and is best reached from Riverside, a station 12 miles east on the recently constructed branch of the Great Northern Railway that traverses the Columbia and Okanogan river valleys between Wenatchee and Oroville. Good wagon roads lead from Conconully to points in the Okanogan Valley. The old town site of Ruby, 5 miles south of Conconully, is near the center of the Ruby district, which, however, is not very definitely bounded.

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[1] Smith, G. O., and Calkins, F. C., A geological reconnaissance across the Cascade Range near the forty-ninth parallel: U. S. Geol. Survey Bull. 235, 1904.

[2] Daly, R. A., The Okanogan composite batholith of the Cascade Mountain system: Geol. Soc. America Bull., vol. 17, pp. 329–376, 1906.

[3] Willis, Bailey, Changes in river courses in Washington Territory due to glaciation: U. S. Geol. Survey Bull. 40, 1887.

TOPOGRAPHY.

RELIEF.

The Ruby and Conconully districts lie in the borderland between the Okanogan Mountains, the eastern division of the Cascade Mountain system, on the west, and the old erosion surface, later uplifted and now designated the Okanogan highlands, which flanks this range on the east. The Okanogan Mountains lie between Okanogan and Methow rivers. Their highest peak, Tiffany Mountain, is 8,275 feet

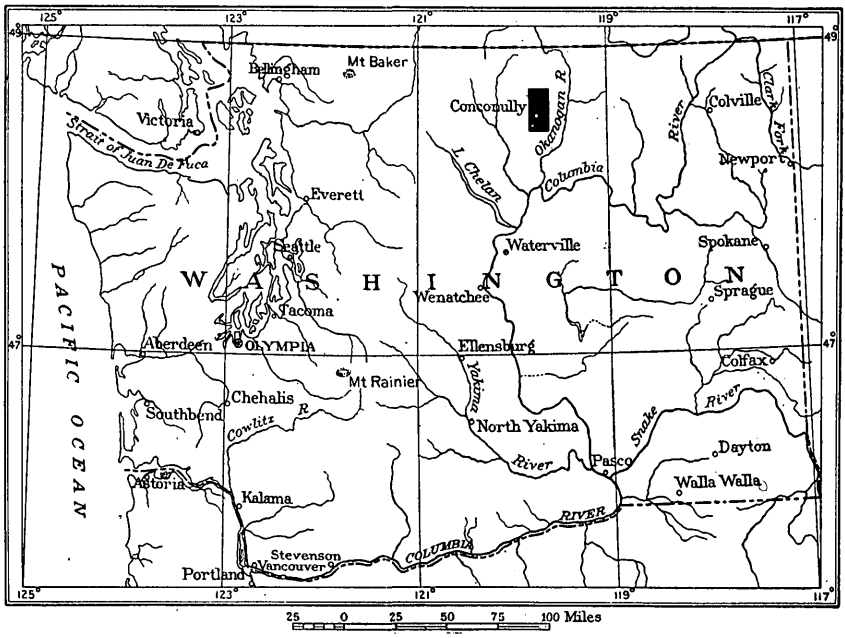

FIGURE 3.—Index map showing location of the Conconully and Ruby mining districts, Wash.

above sea level. Altitudes near Conconully range from that of Conconully Lake, 2,287 feet, to the summit of Mineral Hill, 5,500 feet, but few of the higher summits of the rolling country east of Conconully exceed 3,500 feet in elevation.

PENEPLANATION.

The old erosion surface of the Okanogan highlands has been correlated by Umpleby[1] with the interior plateau region of Canada, which has been described by Dawson,[2] and also with an erosion surface near Republic, Wash.[1] Umpleby regards the age of this surface

[1] Umpleby, J. B., Washington Geol. Survey Bull. 5, pp. 61–62, 1911.
[2] Dawson, G. M., Roy. Soc. Canada Trans., vol. 8, sec. 4, p. 11, 1890.

as essentially Eocene. Dawson, however, recognized two erosion cycles which gave to the interior plateau its topographic form. The older cycle he regards as Eocene and the younger as post-Miocene. Smith and Calkins[2] and Smith and Willis[3] have described an erosion surface which truncates Miocene lavas in the Cascade Mountains to the west and south, respectively, of the area. The post-Miocene plantation in adjacent areas and the occurrence near Oroville of Miocene lake beds that are now a part of the upland surface are regarded by Smith as evidence that the Okanogan highland surface was formed for the most part in post-Miocene time. The determination of the age of the peneplain throws light on the age of the granite intrusions and the ore deposits. Umpleby observed near Oroville that the eastern borders of the batholith have been carved by this erosion, although the peneplain is not recognized in the more rugged parts of the Okanogan Mountains. The age of the Similkameen granite is therefore pre-Miocene and possibly pre-Eocene.

DRAINAGE.

The mountainous and highland areas are deeply incised by valleys which contain actively flowing streams, and by others, locally termed "coulees," which contain no streams at present but were former drainage channels. These channels have been ascribed to stream cutting during the occupation of this area by the Okanogan Glacier and during the time of its retreat. Salmon Creek, which flows southward, drains the larger part of the area covered by this reconnaissance; Sinlahekin Creek, which flows northward to Similkameen River, bounds the area at the north, and Johnson Creek flows across the central part and turns south along the eastern limit of the area examined.

Conconully Lake, a long, narrow body of water, lies in a north-south depression which extends from Conconully northward beyond this area to Similkameen River. Glacial débris has been deposited in this depression, and several small lakes that have no surface outlets occur at the north end of the area a short distance south of the point where Sinlahekin Creek turns and flows northward in this valley.

About 2 miles south of Conconully the United States Reclamation Service has dammed Salmon Creek at a point where the stream enters a narrow canyon. The reservoir thus formed extends northward to the town and covers a part of Graveyard Flat to a reported maximum depth of 100 feet. The flood waters of spring are thus

[1] Umpleby, J. B., Washington Geol. Survey Bull. 1, pp. 19–20, 1910.
[2] Smith, G. O., and Calkins, F. C., U. S. Geol. Survey Bull. 235, p. 90, 1904.
[3] Smith, G. O., and Willis, Bailey, U. S. Geol. Survey Prof. Paper 19, 1903.

conserved for the irrigation of bench lands overlooking Okanogan River.

GLACIATION.

Evidences of extensive continental glaciation in this region are apparent to elevations of 7,500 feet. Over the Okanogan highlands much glacial débris has been deposited, so that in many places small lakes have been formed and stream courses changed. Similkameen River is thought to have been deflected by glacial agencies and now joins Okanogan River at a point many miles north of its former confluence. Deposits of sand in the Salmon Creek canyon near Conconully were probably formed during a temporary ponding of the stream, and large drift bowlders and smooth, bare surfaces of the granite high up on Ruby and Mineral hills are further evidences of glaciation.

VEGETATION.

Much of the drift-covered highlands area east of the Conconully-Sinlahekin depression is devoid of timber and is largely used for agriculture, but west of this depression the higher slopes are covered with good growths of timber, of which yellow pine and fir are the most abundant varieties. Rock outcrops are well exposed on the steep hillsides of the drainage channels, but are sparsely distributed over the greater part of the highlands area.

GEOLOGY.

ROCKS OF THE AREA.

The geology of this area is complex, and a satisfactory solution of the problems involved would require a thorough study of the surrounding region. In general the rocks comprise an older series of metamorphic rocks which has been intruded by later granite masses, the largest of which is the great batholith west of Conconully. The metamorphic rocks are schists derived from sedimentary rocks, quartzite, and marble, associated with schistose or gneissoid igneous rocks of varying composition. The highlands area contains no large intrusive masses, but is underlain chiefly by the metamorphosed rocks.

SEDIMENTARY ROCKS.

KINDS AND DISTRIBUTION.

The sedimentary rocks and their metamorphic derivatives consist of schists, quartzites, and limestones. The schists are prominently developed along the eastern border of the batholith from Ruby Hill to Conconully and west of the Conconully-Sinlahekin

depression to the north boundary of the district. They are of different kinds. Some are fine grained and thinly laminated in shades of black, gray, and brown; others are coarse banded micaceous rocks that are evidently altered sandstones and in some localities grade into or include fine-grained sericitic quartzites. Mica is the mineral most commonly developed in metamorphism, but locally hornblende, epidote, and garnet are abundant. Large masses of limestone were noted on the east side of Johnson Creek, and small limestone knolls are found here and there in the rolling country southeast of Conconully. The most schistose and gneissoid rocks, including small marble lenses, are those which border the granite batholith. Eastward from the granite the schistosity and metamorphism are less intense. The limestone masses of Johnson Creek and the smaller limestone knolls are crystalline, though not marmarized, and still retain their light-blue color. Closely associated with this sedimentary series are dike rocks and lavas that have undergone the same metamorphism and are probably of the same age.

AGE.

This series, because of its lithologic resemblance to rocks in near-by areas to the north and east to whose age there is some clue, is correlated with the Cache Creek formation of Dawson,[1] which is supposed to be of Carboniferous age.

STRUCTURE.

Owing to the intense metamorphism and deformation of the sediments, no well-defined structure can be recognized, nor can the thickness of the series be estimated. On Ruby Hill the schists strike northwest and dip steeply northeast; near Conconully they strike in different directions but generally dip west; at the north end of the area they strike northeast and are vertical or dip steeply southeast. On the Dorian claims, 2 miles east of Ruby, the schists and quartzites strike generally northwest and are vertical. The bedding planes in the limestone are generally obscure and the attitude of these rocks was not determined, although they appear to occur higher in the stratigraphic series than the rocks to the west. No large faults were recognized in the district, although their detection would prove difficult in the schists. Small faults which displace some of the veins along the granite contact were noted, but their throw is not great. They trend nearly east, transverse to the vein system, but there has also been movement along the walls of several of the veins.

[1] Dawson, G. M., Canada Geol. Survey Ann. Rept., new ser., vol. 7, pp. 37B–49B, 1894.

IGNEOUS ROCKS.

YOUNGER INTRUSIVES.

SIMILKAMEEN BATHOLITH.

The batholith which composes the Okanogan Mountains west of Conconully is probably part of the intrusion called by Daly[1] the Similkameen batholith and noted by Smith[2] and Umpleby[3] along Similkameen River near Nighthawk.

Age.—The age of the Similkameen granite has not been definitely determined, but Daly considers it to be of early Tertiary age, and Umpleby, on the evidence of erosion cycles, as previously stated, considers it pre-Tertiary or late Mesozoic. It is certainly older than the Tertiary lake beds, assigned to the Miocene period, which occur in Similkameen valley near Oroville, for both Smith and Umpleby say that these beds are in part composed of granite fragments in an arkose matrix. In the Conconully and Ruby districts there is little evidence on which to determine the age.

Contact.—The contact of the granite with the metamorphic rocks was traced in an undulating north-and-south line for 10 miles from Ruby Hill to a point 2 miles north of Conconully.

Character.—The rock presents different aspects, but the most common variety is a medium-grained gray biotite-hornblende granite. In places it is coarse grained and over a considerable area shows a phenocrystic development of feldspar. Of the ferromagnesian minerals biotite is more abundant and more widely distributed. In places the hornblende is absent or is present in small amounts.

Petrography.—The granite differs in appearance and composition from place to place. Where it is cut by the tunnel of the Washington Consolidated Mines & Reduction Co., 1 mile north of Conconully, it is a gray, medium-grained rock composed of hornblende, quartz, feldspars, and biotite. The feldspars are orthoclase and more abundant calcic plagioclases, ranging from andesine to labradorite. The rock at this point, which is near the contact, can probably be classed as a quartz diorite. Westward from this point toward the summit of Mineral Hill there is a gradual transition to a medium-grained biotite granite. At the northwest end of Peacock Mountain, along an old road, the biotite granite is porphyritic in texture and contains large feldspar phenocrysts. On Ruby Hill, also near the contact with the schists to the east, the rock is essentially a biotite granite composed of quartz, orthoclase, oligoclase, and an inter-

[1] Daly, R. A., The Okanogan composite batholith of the Cascade Mountain system: Geol. Soc. America Bull., vol. 17, p. 334, 1906.

[2] Smith, G. O., and Calkins, F. C., A geological reconnaissance across the Cascade Range near the forty-ninth parallel: U. S. Geol. Survey Bull. 235, pp. 32–33 and 47, 1904.

[3] Umpleby, J. B., Geology and ore deposits of the Oroville-Nighthawk mining district: Washington Geol. Survey Bull. 5, p. 69, 1911.

growth of quartz and feldspar; biotite is the principal ferromagnesian mineral.

OTHER INTRUSIVES.

Other areas of intrusive igneous rocks, of considerable extent but not mapped, occur at the north end of the Conconully district. Goat Mountain or Old Baldy, east of Blue Lake, is composed chiefly of a dark granitic rock closely allied to the large batholithic mass to the west. This rock is made up of orthoclase, green hornblende, andesine, microcline, quartz, and accessory titanite and apatite. It is classed as granodiorite or quartz diorite. Between the forks of Sinlahekin Creek and south of the south fork is an altered green porphyry containing quartz phenocrysts. The extent of this intrusion was not determined.

DIKE ROCKS.

Dike rocks are abundant in these districts and are particularly numerous along the contact of the batholith with the metamorphic rocks. In the schists and gneisses of Ruby Hill and Peacock Mountain granite, diorite, pegmatite, and aplite dikes and irregular masses are numerous and similar intrusives occur in the schists north of Conconully. The dikes are not confined to the schistose rocks but occur in the granite also, and several were noted that were intruded into the fissures in which veins were deposited. These dikes probably represent the most recent stage of igneous activity in the district. Pegmatites and small basic dikes are most abundant in the granite, though a pegmatite dike inclosed in schist on the steep mountain slope east of the old Ruby town site is approximately 100 feet wide. Near the summit of Mineral Hill there is a pegmatite dike that contains molybdenite. In the upper tunnel of the Washington Consolidated Mines & Reduction Co. there is a small, dark dike rich in biotite which is probably the rock known as minette, and in a tunnel near Salmon Creek a similar dike is intruded in a fissure that contains a quartz vein. In the workings of the Q. S. Copper Co. there are altered dike rocks that are closely allied to diorite in composition.

OLDER IGNEOUS ROCKS.

The older igneous rocks are those previously mentioned as associated with the sediments and regionally metamorphosed with them. The composition and texture of these rocks, which are due to the metamorphism, have therefore been greatly changed. The dark-colored dike and flow rocks, which originally were probably diabase and basalt, are generalized under the term "greenstones." A schistose porphyritic rock several hundred feet wide is intruded in metamorphosed clay shales on both sides of Sinlahekin Creek at the

northern end of the district. This rock is a reddish-brown schist spotted with white nodules. Under the microscope the groundmass is seen to be composed of shreds of brown mica and quartz granules which inclose rounded phenocrysts of a zonal plagioclase, tests of which show its composition to be that of labradorite.

In addition to these rocks, there are gneissoid dike rocks on Ruby Hill and Peacock Mountain, along the contact of the granite with the metamorphic rocks which, notwithstanding their structure, may have originated from the granite, and the secondary structure may have been produced by movements due to shrinking on the borders of the batholith as the interior of the mass cooled. The composition of these rocks is that of granodiorite or quartz diorite.

ORE DEPOSITS.

CLASSIFICATION AND DISTRIBUTION.

The ore deposits are principally of two types, quartz veins and disseminated or replacement deposits. In addition there is an isolated occurrence of a molybdenite-bearing pegmatite. The quartz veins are generally distributed throughout the area, but those most abundantly developed and of proved value are grouped in a north-south zone along the contact of granite with schist and gneiss from Ruby Hill to a point approximately 2 miles north of Conconully. The replacement deposits occur principally in a small area at the northern end of the Conconully district. The quartz veins are valuable for their silver-lead content, and the production of the district has been from deposits of this type. The replacement deposits contain small amounts of copper and gold, but as yet no ore has been produced from these sources on a commercial scale.

QUARTZ VEINS.

Occurrence.—The veins on Ruby Hill occur in the schists or at the contact of the schist and granite; those on Peacock Mountain have similar relations for the most part, except a few small veins in the granite. The veins near Conconully, however, are found in a zone 2½ miles wide, and the westernmost ones occur 2 miles from the contact and are abundantly developed along the contact both in the granite and in the schists.

The general trend of the quartz veins follows the contact of the granite and schists, and the veins commonly conform to the structure of the wall rocks, but in places they cut the schists and dip both to the east and to the west. Most of the veins near Ruby dip to the east, but those north of Conconully dip to the west. The veins range from mere stringers to those 30 or 40 feet wide. In general, they can not be continually traced on the surface for any

considerable distance, in part because of the extensive mantle of soil on the more gentle hill slopes. Some of the mine workings expose veins for 600 feet or more and probably in some of the old workings now inaccessible still greater lengths were exposed. Elsewhere the veins form lenses that may pinch out abruptly in the fissure that contains them. The vertical extent of the veins has not been proved, owing to the little development in the district. They are believed, however, to be persistent, for a range of elevation of 2,500 feet is shown by the veins exposed near the level of Salmon Creek and those which outcrop near the summit of Mineral Hill. Erosion has removed parts of the veins, and those exposed at the lower elevations near the borders of the batholith have probably had several thousand feet removed. The minerals now found in them at the lower elevations represent deposition in the central or lower parts of the veins, whereas those at the higher elevations represent deposition in the upper parts.

Mineralogy.—The ore minerals deposited in the veins are galena, pyrite, sphalerite, chalcopyrite, and tetrahedrite, or gray copper ore, associated with quartz gangue and, in a few places, with calcite in addition. The minerals differ from place to place in the vein and from one part of the area to another; galena, sphalerite, chalcopyrite, or tetrahedrite may predominate at different places in the vein, but pyrite is nearly everywhere present. On Ruby Hill and near the summit of Mineral Hill tetrahedrite is abundant, whereas veins in the schist north of Conconully contain little tetrahedrite but abundant galena and sphalerite. These occurrences suggest that tetrahedrite was deposited above the other minerals of the veins. Chalcopyrite is an abundant constituent in places in the Arlington vein. In general, however, galena is the most abundant mineral in the districts, and sphalerite is probably in excess of chalcopyrite and tetrahedrite.

A study of the ores from Mineral Hill and north of Conconully, where there has been no movement in the veins subsequent to the mineral deposition, shows a contemporaneous development of the minerals in granular quartz. Some of the veins show successive enlargements in places where small fragments of the wall rocks and black streaks parallel to the walls represent former walls of the vein inclosed by the vein quartz. On Ruby Hill the veins have undergone extensive postmineral fracturing, and whatever may have been the conditions of the original mineral deposition chalcopyrite and tetrahedrite are now in part deposited in fine seams in the brecciated vein matter and apparently replace the quartz to a slight extent. The association of vein minerals indicates, according to extensive studies on the subject, that they were deposited under moderate conditions of temperature and pressure.

Ore shoots.—The ore minerals have a sporadic occurrence in the veins. On Ruby Hill a vein showing barren white quartz at the outcrop contains shipping ore at a depth of 100 feet. In places the quartz for a width of 10 feet or more is practically barren of ore, but elsewhere the ore occurs along the foot or hanging wall, or in narrow parts of the vein it may be equally distributed across the width. Ore shoots from 100 to 300 feet long have been developed in some of the veins, but as far as the writer is aware their extent in depth has not been determined. The shipping ore of the Arlington mine has a gross value of $30 to $40 a ton, and smelter payment on a small shipment from the Key mine was approximately $37 a ton. The valuable metals of the Key ore were silver, 55½ ounces to the ton, and lead, 12½ per cent.

Oxidation and enrichment.—Oxidation has affected the veins to only a slight extent; the primary vein minerals extend to a point a few feet below the surface. Extensive downward enrichment, therefore, is not to be expected. The reports by the first State geologist mention the rich silver ores of the Ruby district and the occurrence of pyrargyrite (ruby silver), argentite (silver glance), and cerargyrite (horn silver), but none of these minerals were noted in the ore from the present development work, and they were probably secondary minerals formed by the oxidation of tetrahedrite and redeposited at shallow depths.

Age.—The distribution, occurrence, and mineral composition of the veins in the north-south zone, along the contact of the granite and schist, all lead to the conclusion that they owe their origin to the granite intrusion. The age of these veins consequently should be very nearly that of the granite, and they are therefore late Cretaceous or early Tertiary.

MOLYBDENUM-BEARING DIKE.

A pegmatite dike containing molybdenite crops out on Mineral Hill and in part has been explored by the upper tunnel of the Washington Consolidated Mines & Reduction Co. The dike or vein trends nearly north, and is about 100 feet wide where cut by the tunnel, and it is said can be traced on the surface for nearly 4,000 feet. The dike differs in character from place to place. Quartz in places is the chief mineral, in other places cellular quartz contains much sericite in fine druses, and in still others the rock is a coarse granite in which the feldspars are unaltered. The molybdenite occurs in this rock in thin flakes and radial nodules about a quarter of an inch in diameter. It is more abundant in association with quartz and sericite, but was also noted in the less altered granite or pegmatite. Its occurrence in the pegmatite is sporadic and nowhere is it abundant enough to mine.

DEPOSITS FORMED BY IMPREGNATION AND DISSEMINATION.

Occurrence.—Deposits formed by impregnation and dissemination were noted at the northern end of the Conconully district and on the Dorian claims 2 miles east of Ruby. The mineralization near Goat Mountain consists of pyritic impregnations and disseminations in metamorphosed shales and associated dark igneous rocks that were intruded by later diorite dikes, which are probably offshoots from the Goat Mountain intrusive mass. The deposits are of low grade and contain copper and gold, chalcopyrite being the chief copper-bearing mineral. No shipments of ore have been made from these deposits, and most of the development work on them is superficial.

Age.—The age of these ore deposits is uncertain, and there is also some doubt as to the agencies which caused the mineral deposition. The proximity of some of these deposits to the Goat Mountain intrusive mass suggests there a genetic relationship, but, on the other hand, disseminated copper minerals may have been derived from the older dike and flow rocks associated with the supposed Carboniferous sediments. The pyritic replacements are also believed to have taken place during the general metamorphism of the region before the granitic intrusions.

METALLURGIC INVESTIGATIONS.

The development of these districts has been greatly hampered by the unsuccessful attempts to concentrate the low-grade vein ores. Recently Prof. Francis A. Thomson, of the State College of Washington, has conducted laboratory tests on the treatment of these ores, and the following data are taken from his preliminary report:

Assay of ores from Conconully and Ruby districts, Wash.

Sample No.	Source.	Gold.	Silver.	Copper.	Lead.
		Ounce.	*Ounces.*	*Per cent.*	*Per cent.*
1	Hargrove (Key mine)	0.04	26.1	1.55	3.70
2	Arlington, 450-foot level	.035	58.9	1.52	2.05
3	Columbia vein	.03	20.1	1.43	4.00
4	Tough Nut	.03	23.8	1.67	(a)

[a] Not determined.

The minerals of sample No. 1 were carefully segregated and each segregate was assayed for gold and silver, thus indicating the minerals that carried the precious metals. The results are given in the following table:

Assay of segregated minerals of sample No. 1.

Mineral.	Gold.	Silver.
	Ounce.	*Ounces.*
Quartz	None.	None.
Pyrite	0.02	26.4
Sphalerite	None.	29.5
Galena	.16	71.1
Tetrahedrite	.12	347.6

From this test it is evident that the gold is carried almost entirely by the galena and the gray copper. In the main this is true also of the silver, but the gray copper, as one would anticipate, is the chief silver carrier.

TREATMENT OF THE ORES.

Two methods of treatment suggest themselves as probably suited to an ore of this character—leaching for ultimate extraction and concentration with the object of producing a high-grade product.

Leaching tests.—As would be expected, cyanidation of the raw ore proved impracticable, less than 50 per cent of the precious metals being extracted with excessive consumption of cyanide. Preliminary treatment of the ore with a solution of caustic alkali and metallic aluminum, as practiced on the complex silver ores of Cobalt, Ontario, gave little or no help.

Chloridizing and roasting the ore, followed by cyaniding, resulted in a total extraction of approximately 65 per cent of the valuable constituents, the loss being 15 per cent in roasting and 20 per cent in the tailing.

Oxidizing the sulphides to sulphates by roasting and then washing the ore with water to remove copper sulphate proved entirely unsuitable as a means of preparation for recovery of silver by cyanidation.

Light chloridizing and roasting the ore for 30 minutes, then washing it with water and cyaniding resulted in a total extraction of 88 per cent, the losses being 7 per cent in roasting and 5 per cent in cyaniding. The extraction of copper by leaching with water in this experiment was above 80 per cent.

Oxychloridizing and roasting the ore, then washing it with water, followed by leaching with a solution of sodium hyposulphite (thiosulphate), resulted in the extraction of approximately 70 per cent of the silver. The extraction of copper by leaching with water was similar to that obtained in the preceding experiment.

Concentration tests.—Concentration by treating each screen size of the sample in a glass sorting column yielded an extraction of 70 per cent with a ratio of concentration of 10 to 1. The tailing from

this treatment, when crushed to pass 150-mesh screen and cyanided, yielded a further extraction of 18 per cent of the original amount, making the total extraction by combined concentration and cyanidation 88 per cent.

Concentration on a small Wilfley table, all ore crushed to pass 40-mesh screen, yielded an extraction of 80 per cent, the ratio of concentration being 4 to 1.

Concentration on a small Wilfley table aided by flotation gave the following results: All ore was crushed to 40-mesh size, and material coarser than 100-mesh was sent to the Wilfley table. This treatment yielded an extraction of 80 per cent, the ratio of concentration being 4½ to 1. Material finer than 100-mesh size was sent to a froth flotation machine using eucalyptus oil in acid solution, and this treatment yielded an extraction of 73 per cent and a ratio of concentration of 3½ to 1.

Concentration by flotation alone after crushing ore to pass an 80-mesh screen, eucalyptus oil and wood creosote being used in a non-acid solution, yielded an extraction of 91 per cent silver and 95 per cent copper. The ratio of concentration was about 2½ to 1.

CONCLUSIONS.

Although this investigation has not yet been carried far enough to justify final conclusions or specific recommendations, it is evident that local treatment can be made to yield satisfactory results.

The choice at present appears to lie between (1) the light chloridizing and roasting of the ore, followed by cyaniding after washing it with water, and (2) the flotation concentration of the entire ore after crushing to 80-mesh. Each of these methods by laboratory test shows an extraction of approximately 90 per cent of the silver and a large proportion of the copper. The flotation method, of course, yields a concentrate which must be either shipped to a smelter or treated further at the mine. It seems probable that an application of the light chloridizing and roasting, washing with water, and cyaniding, which has proved successful with the ore, might be applied to the flotation concentrate with equal or greater success. This point will shortly be investigated.

Credit for most of the detailed laboratory work in these investigations should be given to Mr. Henry E. Doelle and for much of the analytical work to Mr. Edgar H. Schuneman.

FUTURE OF THE DISTRICTS.

The future of these districts as a whole will depend largely on the development of ore reserves and economical mill treatment. With regard to ore reserves, several of the properties have ore

shoots of milling grade from 100 to 300 feet long, but their vertical extent has not been determined in any of the workings now accessible, though in the Arlington mine good ore is disclosed 450 feet below the vein outcrop. Most of the properties have directed their development along the strike of the veins rather than on the dip. Though ore shoots of considerable extent will probably be developed, the variability of metal content in the shoots must be considered, and the ore bodies should be explored at several points before the erection of elaborate mill equipment is undertaken. The experiments by Prof. Thomson indicate that successful mill treatment will be accomplished.

MINES AND PROSPECTS.

KEY MINE.

The Key mine (1)[1] is located three-quarters of a mile north of Conconully, on the east side of Salmon Creek, at an elevation of 2,500 feet. The property is developed by a tunnel 300 feet long, a shaft 45 feet deep, and a drift 105 feet long. The tunnel and drift follow the vein, which trends N. 25° E. and dips about 60° W. The wall rocks are granite and mica schists; some of the schists are metamorphosed igneous rocks. The vein is 3 to 10 feet wide and contains some ore minerals as far as developed by the tunnel. Galena, pyrite, chalcopyrite, and a little sphalerite occur in the ore, in places in sufficient abundance to make a low-grade shipping ore, and much of the vein is of concentrating grade. In 1914 a shipment of 12 tons was made to the smelter at Trail, British Columbia, and payment for the silver and lead content was made at the rate of $37 a ton.

TOUGH NUT.

The Tough Nut (2) was discovered in 1886 and is located on the same vein as the Key. It is developed by a tunnel the portal of which is 1,100 feet north from the Key shaft. The workings were not accessible, but the tunnel is said to be 250 feet long and a winze 40 feet deep is sunk on the vein. The vein is 3 to 10 feet wide and the wall rock is a sandy-textured quartz-mica schist that strikes N. 25° W. and dips 60° W. Between the Tough Nut and the Key there are small granite dikes in the schist. About 40 tons of ore lie on the dump, and galena, pyrite, chalcopyrite, and sphalerite were noted. No recent ore shipments have been made from this property.

[1] The mines and prospects are numbered to correspond with their locations indicated on pl. 1.

SALMON RIVER CHIEF.

The Salmon River Chief (3) is a patented claim that lies a short distance southeast of the Tough Nut. The property is developed by a crosscut tunnel 150 feet long to its intersection with the vein and drifts to north and south of approximately 250 feet in each direction. The vein trends N. 35° W. and dips 35°–60° SW. It is inclosed in sandy mica schists, and its attitude corresponds to that of the schists. The schists are foliated in places and contain small stringers of aplite and pegmatite. The vein is 4 feet wide at one place, but near the end of the north drift it pinches out and in the south drift is but 8 inches wide. There has been considerable post-mineral movement along the fissure, and in places gouge material several inches thick is composed of ground-up minerals of the vein. The minerals are galena, sphalerite, chalcopyrite, and pyrite contained in a massive white quartz. The tenor of the ore was not learned, although it appears to be equal to that of the other veins near by.

COPPER KING.

The Copper King claim (4) adjoins the Salmon River Chief to the northwest, and the development work on both properties is probably on the same vein. Two drifts 100 feet and 50 feet long, on the north and south sides, respectively, of a small gulch, comprise the development work on this claim. The vein is about 7 feet wide, trends N. 40° W. and dips 55° SW. At the surface the quartz is honeycombed, but at depths of a few feet sulphides appear in a mineralized zone 3 feet wide. The ore minerals are galena, sphalerite, chalcopyrite, and pyrite, and the value of the ore in silver, lead, and copper is said to be $38 a ton.

ESTHER.

Northeast of the Copper King tunnel and 180 feet higher is the Esther claim (5). This claim is developed by a tunnel 74 feet long, which follows a north-south quartz vein from 1 to 3 feet wide that dips 70° W. The vein cuts fine-grained mica schists at a small angle and contains a rather sparse mineralization of galena, sphalerite, pyrite, and chalcopyrite.

HOMESTAKE.

The Homestake (6) is a patented claim near the Salmon River Chief. The tunnel which developed the property is now caved, and no work has been done for many years. No ore has been shipped from the property, but it is said that attempts to concentrate the ore

in an old mill on Salmon Creek proved failures. The country rocks are schists and small granitic intrusives.

MONITOR.

The Monitor property (7), located north of the Key mine, is developed by a tunnel 200 feet long, driven N. 20° E. along a fissure which for most of its course contains a quartz vein that dips 70° W. The quartz vein has an average width of 2 feet and is contained in contorted schists. At the face the vein is apparently faulted out. The mineralization consists of a rather scanty deposition of sphalerite and chalcopyrite, with more abundant pyrite.

STAR.

The Star (8) is a patented claim that lies west of Salmon Creek and north of the Washington Consolidated Mines & Reduction Co.'s group. The mine has not been worked for many years, but it is reported that in 1913 a carload of ore was sorted and shipped from the dump. The development is directed along a quartz vein, which has apparently been displaced 50 feet or more by an easterly fault. An incline shaft No. 1, now filled with water to the tunnel level, 90 feet below the collar, is sunk on the northern part of the vein. The tunnel starts from a point near the west bank of the creek and comprises a crosscut of 125 feet to the vein and a drift south of 290 feet. The vein ranges from 18 inches in width at the north end of the drift to 3 feet at the shaft and dips at an average of 45° W. South of the shaft the vein and wall rocks are greatly sheared, and the vein is faulted out near the face of the drift. The wall rocks are sericitized granite. Some ore has been stoped for a distance of 50 feet north of the shaft and several feet above the tunnel level. Incline No. 2, about 150 feet southwest of No. 1 and 50 feet higher, is sunk on a quartz vein 10 feet wide, which is evidently the faulted continuation of the vein to the north. A cross-cut tunnel, about 150 feet southeast of incline No. 1 and 50 feet lower, is driven west 185 feet and intersects the quartz vein of incline No. 2. The vein trends N. 5° E. and dips 50° W., as shown by drifts to the north and south, 50 feet each way. The vein is crushed and stained with copper, but contains a rather sparse primary mineralization of pyrite and chalcopyrite.

WASHINGTON CONSOLIDATED MINES & REDUCTION CO.

The Washington Consolidated Mines & Reduction Co. (9) owns numerous claims, some of which are patented, that extend from Salmon Creek westward nearly to the summit of Mineral Hill. The claims are developed principally by two tunnels, one on the west

bank of Salmon Creek at an elevation of 2,300 feet and the other on Mineral Hall at an elevation of 3,700 feet. The lower tunnel is driven westward to intersect the numerous veins that outcrop on Mineral Hill between the two tunnels. It is reported that at least 30 veins have been found between these points. The lower tunnel is now 800 feet long, and work was being done at the time of the examination, but the progress of the tunnel, which is driven through hard granite by hand drills, is necessarily slow. Two veins have already been intersected by this tunnel, one 11 feet wide 88 feet from the portal and another of equal width 380 feet from the portal. The first vein strikes N. 5° W. and dips 46° W.; the second vein has a parallel strike, but dips more steeply to the west than the first. Drifts have been driven to the north and south along the second vein, each 100 feet long. At the face in the north drift the vein is about 5 feet wide. There has been considerable movement along this vein, and gouge on the walls contains much comminuted sulphide mineral. The ore is a mixture of galena, sphalerite, pyrite, and chalcopyrite, deposited contemporaneously in the fissure with granular white quartz. The ore observed in the second vein occurs principally along the hanging wall or from the center of the vein to the hanging wall. Between the upper and lower tunnels granite is the dominant rock.

The upper tunnel (10) of the Washington Consolidated Mines & Reduction Co. contains over 2,000 feet of development and 400 feet from its portal connects with an inclined shaft from the surface. From the portal to the shaft and 600 feet beyond the drift is in the Columbia vein, which trends N. 10° E. and dips 60° E. The vein is 6 inches to 3 feet wide and contains galena, pyrite, sphalerite, chalcopyrite, and gray copper. From the shaft the tunnel continues to the northwest and intersects several small veins, one of which, the Frankie Boy, contains high-grade silver ore. This vein trends N. 25° E., dips 60° W., and its average width is 1 foot. The ore is an intergrowth of granular quartz, galena, tetrahedrite, pyrite, and chalcopyrite. The granite wall rocks are bleached and contain much secondary mica, or sericite. Beyond the Frankie Boy vein the crosscut tunnel intersects and follows for a distance the molybdenite-bearing pegmatite dike described on page 21.

LEUENA.

The Leuena claim (11) is located on Mineral Hill northwest of the upper tunnel of the Washington Consolidated Mines & Reduction Co. at an elevation of 4,600 feet. The property is one of the first discovered in the district, but no work has been done for many years. Two shallow shafts and a short tunnel were inaccessible.

The vein apparently trends N. 55° E. and dips vertically. It is reported that several carloads of high-grade silver ore containing much tetrahedrite were shipped from this property to a San Francisco smelter.

LADY OF THE LAKE.

The Lady of the Lake prospect (12) is located about half a mile northeast of Conconully and a short distance above Conconully Lake. A vein 3 feet wide, which trends N. 10° E. and dips 45° W., inclosed in schist and sheared dike rocks, is explored by a tunnel 125 feet long. The vein at the face of the tunnel is faulted in blocks with small offsets. The vein matter is granular white quartz and calcite, which contains bands of good ore consisting of pyrite, galena, chalcopyrite, and a little sphalerite, but the ore as a whole is low grade. The deposition of gangue and metallic minerals is apparently contemporaneous. The occurrence of calcite is unusual in the veins of the district.

Other prospects are located north and west of Conconully, but information regarding their names was not obtained. Most of them are located on veins that have been previously described.

PEACOCK MINING & MILLING CO. CLAIMS.

The Peacock Mining & Milling Co. controls 33 claims (13), including two mill sites, which occupy the greater part of the easterly slopes of Peacock Mountain, extending to Salmon Creek. At the time of the writer's examination these claims were being surveyed for patent. At the southern end of this group are some old shafts and tunnels on the Nevada, Wyoming, and Kansas claims, work on which has been suspended for many years, and only parts of the Nevada workings were accessible. The company is now engaged in driving a large cross-cut tunnel westward from the west bank of Salmon Creek to intersect the veins of the group; this tunnel will attain a depth of approximately 2,000 feet below the surface of the westernmost vein, which outcrops on the Republic and Marguerite claims. The tunnel has been driven about 700 feet of the total estimated distance of 2,100 feet to intersect the westernmost vein. The principal rock of this tunnel is a gneissoid granodiorite or quartz diorite. Schists intruded by pegmatite and aplite dikes outcrop above the tunnel and extend westward to an elevation of 4,200 feet, beyond which is the granite. Several veins are exposed on this group, but apparently the largest and most persistent are those near the contact of the granite and schists, on which the early development work was done. In a recent communication Mr. G. H. Wheeler, of Conconully, reports that in December, 1915, a vein was cut 709 feet

from the portal of the crosscut tunnel. The vein or shear zone was not observed on the surface, but in the tunnel it strikes about north, dips 30° W., and is 6 feet wide. A sample of ore from this vein, sent by Mr. Wheeler, is chiefly massive pyrrhotite and quartz, but no assays have been made. This is the only occurrence of pyrrhotite reported or observed in these districts. The mineral is characteristic of deep-seated deposits.

The Nevada claim (14) is developed by a shaft 216 feet deep which connects with tunnel No. 2, 1,300 feet long, and from which drifts are opened on the 40 and 100 foot levels. The vein on the surface is composed of iron-stained vesicular quartz about 8 feet wide; it trends N. 20° W. and dips 65° E. The footwall is mainly granite and the hanging wall schist and gneiss. On the 40-foot level a drift extends 50 feet south of the shaft. The vein here is 6 feet wide, and the best ore streaks have a maximum width of 1 foot on the walls. On the 100-foot level a drift extends 50 feet south and 120 feet north of the shaft. In the south drift the vein is 6 feet wide near the shaft but narrows near the south end, where several slip planes that cut the vein at a slight angle have ground up the vein to a brittle aggregate of quartz and vein minerals that contains inclusions of schist and granite wall rocks. In the north drift 30 feet from the shaft the vein is cut off by a fault, which trends N. 70° W. and dips 60° S. Exploration to find the continuation of the vein has apparently been successful in a crosscut driven westward on the footwall side of the fault, where with an approximate displacement of 30 feet the vein is inclosed by sheared and sericitized granite. In the tunnel level at the bottom of the shaft the vein is cut off about 25 feet south of the shaft by the fault noted on the 100-foot level. South of this fault the vein to the caved part of the tunnel about 100 feet distant is from 10 to 15 feet wide, but to the north the continuation of the vein has not been found, for the prospecting work has been poorly advised, as the drift to the west, which logically would cut the vein in the footwall, has been driven in the hanging-wall side of the fault. The vein on this level is composed of a massive white quartz, rather sparsely mineralized along the walls. The ore is a mixture of quartz, galena, pyrite, chalcopyrite, sphalerite, and probably a little tetrahedrite. It is essentially a milling ore, and it is reported that two samples of the ore from the drift in the shaft and from the face of the vein at the bottom of the shaft, presumably from enriched parts, assayed as follows: Copper, 0.5 and 0.8 per cent; lead, 18 and 2.2 per cent; and silver, 19.2 and 10.4 ounces to the ton. According to Mr. McDaniel, of Conconully, a carload of ore shipped 15 years ago to a smelter netted $10 a ton in silver and lead, the assay value of the ore being about $27 a ton.

Near the summit of the east ridge of Peacock Mountain, at an elevation of 4,050 feet, an old shaft on the Republic claim is sunk on a quartz vein 2 feet wide that strikes N. 20° W. and dips 70° E. The vein is near the granite contact and the wall rocks on the east are schist and sheared dike rocks. The vein is mineralized with pyrite and galena and stained with copper salts. North of the shaft, on the ridge, the vein at one place is 20 feet wide, but in a short distance narrows to a few feet. The vein at the outcrop is composed of honeycombed quartz slightly copper stained. On the Blue Grouse claim of this group a shallow tunnel in schist and gneiss cuts vein material of sheared quartz and country rock 10 feet wide, which trends N. 20° E. and dips 70° E. The vein contains sparse galena and is stained with copper but can be traced only a short distance.

BUCKHORN GROUP.

The Buckhorn group (15) of several claims lies west of Salmon Creek and adjoins on the east the south end of the Peacock group. A tunnel 175 feet long penetrates highly contorted schist and dikes of aplite and pegmatite. A shear zone 40 feet from the face contains black gouge and bunches of white quartz, but no metallic minerals were noted.

PLANT-CALLAHAN GROUP.

The Plant-Callahan group (16) consists of several claims on the steep hillside east of Ruby. The property is one of the first discovered in the district, and it is reported that in 1886 a small shipment of rich silver ore from the surface yielded $6,000, but no shipments have been made since. The development consists of a tunnel 65 feet long that connects with a shallow shaft, open cuts, and a lower tunnel 175 feet long, which is 500 feet below the upper workings on the vein outcrop. In the upper tunnel the mineralization occurs in a shear zone in fine-grained biotite schists and consists of stringers and bunches of quartz which range from mere seams to masses several feet wide. One stringer about 2 feet wide trends N. 45° W. and dips steeply northeast. It contained much tetrahedrite, and selected samples yielded over $1,000 a ton in silver. A pegmatite dike 100 feet wide outcrops between the upper and lower tunnels.

FIRST THOUGHT.

The First Thought mine (17) is mentioned in the report of the first State geologist of Washington as being one of the first discoveries of the district. It is reported by Mr. McDaniel, of Conconully, to have produced ore valued at $66,000 and was worked continuously for a period of five or six months. Its production, which

was concentrated in a mill on Salmon Creek, was 40 tons a day. The property is developed by three long tunnels, all of which are flooded because of caving near each portal. The vertical distance between the upper and lower tunnel probably does not exceed 200 feet. Above the upper tunnel some open cuts expose a quartz vein 10 feet or more wide that trends N. 10° E and dips 60° E. The wall rocks are gneiss and schist.

LAST CHANCE.

The Last Chance (18) is located at the north end of Ruby Hill at an elevation of 3,500 feet. The property is developed by a shaft that is reported to be 400 feet deep and by a tunnel that is accessible only for 400 feet. The workings have been abandoned for many years, and the shaft contains water to the tunnel level. The tunnel follows the vein, which, near the portal, trends N. 50° W. and dips 50° W., but toward the caved part of the drift is overturned and dips 60° E. The vein in places is greatly crushed and displaced by several easterly slips. The ore consists of galena, pyrite, chalcopyrite, and sphalerite, with a little tetrahedrite, and has generally been crushed. At the shaft the ore is 4 feet wide, but the shoot gradually narrows and pinches out 200 feet southeast of the shaft. Beyond this point to the caved part of the drift, 200 feet farther, the fissure is occupied by a pure quartz vein from 8 to 12 feet wide. The vein occurs at the contact, with granite on the west and schist and gneiss on the east wall. No shipments of ore are reported from this mine, although the ore on the tunnel level is apparently of good concentrating grade.

FOURTH OF JULY.

The Fourth of July property (19) lies about half a mile north of the Arlington mine at an elevation of 4,500 feet. An old shaft is on the property, but the workings have long been abandoned and little information regarding them could be obtained. The first State geologist of Washington says in his first annual report that the vein is 10 feet wide and contains a pay streak 18 to 24 inches wide. The ore had a high silver content, and several shipments were reported, the total production being $36,000. The vein is probably the continuation of the Arlington fissure, as it is in alignment with that fissure and occurs in schist near the contact with granite.

ARLINGTON MINE.

The Arlington group (20) consists of 10 patented and several unpatented claims on the crest of Ruby Hill. The old shaft of the Arlington mine is located on the west slope of Ruby Hill about 200

feet below its summit. The vein is one of the first discoveries of the Ruby district. Two years ago the mine was reopened after a long period of inactivity. Prior to 1901 the returns on 1,000 tons of ore are reported[1] to have been $25,000. Since October, 1914, 15 carloads of ore containing 583.44 tons were shipped, from which the net returns were $17,021.71, or about $29 a ton. The average content of metals in this shipment paid for by the smelter was as follows: Gold, 0.025 ounce to the ton; silver, 75.96 ounces to the ton; and copper, 1.3 per cent.

The property is developed by two tunnels at levels 240 feet apart, which have a total development over 3,000 feet. The upper tunnel connects with the old shaft that is 200 feet deep and is now being reopened for an airway. The early production of the mine came from drifts from the old shaft above the upper tunnel level, but recent shipments have been made principally from stopes in the lower tunnel. Extensive improvements have recently been made at the mine. The company erected a pole line, and electric current is transmitted from the plant of the Okanogan Valley Power Co., at Okanogan, 12 miles distant. Motors have been installed to operate the compressor and station pump used in sinking a shaft on the vein from the lower tunnel. Several mine buildings were being erected during the writer's visit. The upper tunnel is driven eastward 420 feet to the first vein and the lower crosscut tunnel is 975 feet to the vein.

The outcrop of the Arlington vein on which the shaft was sunk shows iron-stained vesicular quartz several feet wide, inclosed in schists and gneisses, trending about N. 10° E. and dipping steeply east. In the upper tunnel two parallel northerly veins about 30 feet apart have been cut. The eastern vein has been explored for 350 feet along its strike and dips 60°–75° E. The vein is from 6 inches to 5 feet wide, but contains little ore. The wall rocks are greatly foliated schists, which are hydrothermally altered and show an abundant development of sericite. The western vein encountered by the upper tunnel is that on which the shaft is sunk. This vein is explored for 700 feet, but differs greatly in character at different points. Its maximum width is 10 feet, but it pinches out in the fissure near the north and south ends of the drifts. The vein, which at the collar of the shaft dips to the east, on this level is vertical or dips steeply west. Near the north end of the drift the vein is 8 to 10 feet wide and consists of pure white quartz, but toward the shaft and in the south drift it narrows and is sporadically mineralized. The wall rocks are schists, gneiss, and granite. The lower tunnel of the Arlington has encountered but one vein, which is probably

[1] Landes, Henry, Washington Geol. Survey Ann. Rept., vol. 1, p. 72, 1901.

the continuation of the westernmost one of the upper tunnel. This vein is explored for 600 feet in drifts north and south from the crosscut. It is 1 foot to 6 feet wide and is inclosed in contorted schist and granite. In the north drift the vein is displaced by an easterly fault which throws it 8 feet to the west. At the intersection of the tunnel and vein the quartz is 6 feet wide and contains ore that carries $30 a ton in valuable metals. To the north the vein narrows to 3 feet, but the ore is of high grade and the principal mineral is tetrahedrite or gray copper.

The ore differs in different parts of the vein. In places the quartz contains abundant chalcopyrite, with galena and sphalerite in slightly smaller amounts, but in other places gray copper largely predominates. Extensive movements along the walls of the vein have resulted in a granulation of the quartz and probably a redeposition of the chalcopyrite and gray copper, as these minerals occur in thin filaments that penetrate the quartz and other metalliferous minerals of the vein. Elsewhere all the minerals occur in granular aggregates and intergrowths that indicate contemporaneous deposition. Observations at different parts of the vein show that the ore occurs in shoots. Above the upper tunnel level a considerable quantity of ore has been removed, but on that level the ore minerals are rather scattered. At the lower tunnel level an ore shoot of considerable promise is exposed.

Q. S. COPPER CO.

The Q. S. Copper Co. controls 24 claims (21) which lie on the steep mountain slope east of Blue Lake. Two crosscut tunnels 1,200 feet apart are directed to intersect the deposit, whose copper-stained outcrop is about 1,600 feet above the lower tunnel level. The upper tunnel is 1,060 feet long and is beneath the outcrop of the vein; the lower tunnel, 600 feet long, is still 2,000 feet or more from a point beneath the outcrop. The country rocks are metamorphosed dark-colored clay shales and basic igneous rocks intruded by diorite dikes. All are hard, tough rocks that are difficult to drill. In the lower tunnel a dark-greenish rock that contains feldspar phenocrysts in a groundmass of biotite and altered ferromagnesian minerals is probably an altered diorite. Some of the feldspars are near labradorite in composition. In the upper tunnel a dappled green, gray, and black schistose igneous rock is composed of biotite, epidote, quartz, and altered feldspars, together with sparsely disseminated pyrite. The metamorphosed sediments are massive clay shales in which secondary minerals, such as hornblende, epidote, and biotite, are abundantly developed. The sedimentary rocks trend about N. 45° E. and are vertical in the lower tunnel; their strike in the upper tunnel

LEGEND

Boundary partly traced between granitic intrusives of probable Mesozoic age and metamorphosed sedimentary and igneous rocks, most of which are of Carboniferous age

Strike and dip (a)
Vertical bed (b)

Quartz vein with dip

- Tunnel
- Mine
- Prospect

MINES AND PROSPECTS

1 Key
2 Tough Nut
3 Salmon River Chief
4 Copper King
5 Esther
6 Homestake
7 Monitor
8 Star
9 Washington Consolidated Mines & Reduction Co.
10 Upper tunnel W. C. M. & R.
11 Leuena
12 Lady of the Lake
13, 13a, 13b Peacock Mtn. M. & M.Co.
14 Nevada shaft, Peacock Mtn
15 Buckhorn M. & M. Co.
16 Plant-Callahan
17 First Thought
18 Last Chance
19 Fourth of July
20 Arlington
21, 21a Q. S. Copper
22 Blue Lake
23 Okanogan Copper
24 Gold Quarry
25 Dorian

TOPOGRAPHIC AND RECONNAISSANCE GEOLOGIC MAP OF CONCONULLY AND RUBY DISTRICTS, WASHINGTON

WITH LOCATION OF MINES AND PROSPECTS

Scale 1/125,000

1 ½ 0 1 2 3 4 5 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 100 feet.

Datum is mean sea level.

1916

is N. 20° E. and their dip is also vertical. Pyrite and chalcopyrite are disseminated throughout the rocks, though generally in very small amounts. In the lower tunnel this mineralization is very sparse and nowhere abundant enough to constitute an ore. For a distance of 230 feet from the face of the upper tunnel there is a sparse mineralization in seams and disseminations of pyrite and chalcopyrite. About 40 feet of this zone is claimed by Mr. Dewey, manager of the company, to be ore with a copper content of 2½ per cent, but the deposit as a whole probably contains less than 1 per cent of copper. The ore commonly contains only traces of gold and silver, but a table of assays published by the company gives a gold content as high as $37 a ton from surface ores.

BLUE LAKE.

The Blue Lake prospect (22) lies on the east side of the northward-trending ridge from Goat Mountain at an elevation of 3,100 feet. A tunnel driven west 300 feet in granite was the only development noted on the property, and apparently no work has been done for several years. Several small quartz stringers were seen in the tunnel section, but there is no well-defined vein, and apparently little to encourage further development. Vein material on the dump contains a little chalcopyrite.

OKANOGAN COPPER CO.

The Okanogan Copper Co. (23) has done some slight development work on a group of claims north of Sinlahekin Creek. From the creek level a tunnel has been driven north 500 feet along the contact of the Goat Mountain intrusive rock with metamorphosed massive green and blue shales, the rock being extremely hard and tough. The tunnel intersects a fault and shear zone containing much black gouge and bunches of quartz that are reported to contain small quantities of gold. Another tunnel a short distance northwest and 200 feet higher than the tunnel on the creek level is driven in massive shales which strike N. 40° E. and dip 80° SE. A shear zone 20 feet wide that is crosscut contains contorted shales and iron-stained quartz stringers or veins 1 to 3 feet wide, which lie along the walls. The quartz veins are said to contain gold. The shales contain sparsely disseminated pyrite and near the entrance of the tunnel a yellowish efflorescence with astringent taste is probably alum formed by the action of sulphate waters with the wall rocks. At an elevation of 3,000 feet a short tunnel explores massive heavily pyritized shales which are said to contain a little copper and gold, though chalcopyrite was not observed in the sulphide material.

GOLD QUARRY GROUP.

The Gold Quarry group (24), consisting of 20 claims, lies on either side of Sinlahekin Creek, west of the Okanogan Copper Co. group. The development work conists of open cuts, short tunnels, and shallow shafts. Laminated quartz-mica schists, which contain abundant hornblende and epidote, and carbonaceous schists, which contain, in addition to the other secondary minerals, numerous pink garnets, are the principal sedimentary rocks. They are associated with greenstones and a schistose feldspathic porphyry that forms a prominent band which extends east and west on the north side of Sinlahekin Creek. The metamorphosed shales are in general sparsely mineralized with pyrite along the lamination planes, but locally the mineralization is more intense and in these places the reddish-brown outcrop is exploited by the shallow workings. The pyritized shales are said to carry considerable gold, but no assays were made, and before work is continued on this property careful sampling should be done and reliable assays obtained. Enrichment of the ore bodies in depth is not probable.

DORIAN CLAIMS.

The Dorian claims (25) are in the NW. ¼ SE. ¼ sec. 34, T. 35 N., R. 25 E. Several open cuts have recently been made in a bed of fine-grained sericitic quartzite about 50 feet wide which is inclosed by sandy mica schists or grades into them. The formations strike northwest and dip from 45° SW. to vertical. The quartzite for a distance of 100 feet along its strike is of a light-green color, which is due to the deposition of small flakes of a green mineral in the bedding planes. This color was at first thought to be due to minute crystals of malachite (copper carbonate), but a chemical test of the mineral gave a large chromium content, and on microscopic examination the mineral was determined to be mariposite, a chromium mica. Near the quartzite a small prospect is opened in black quartzose schist and shale that is impregnated with pyrite, but no valuable minerals were noted.