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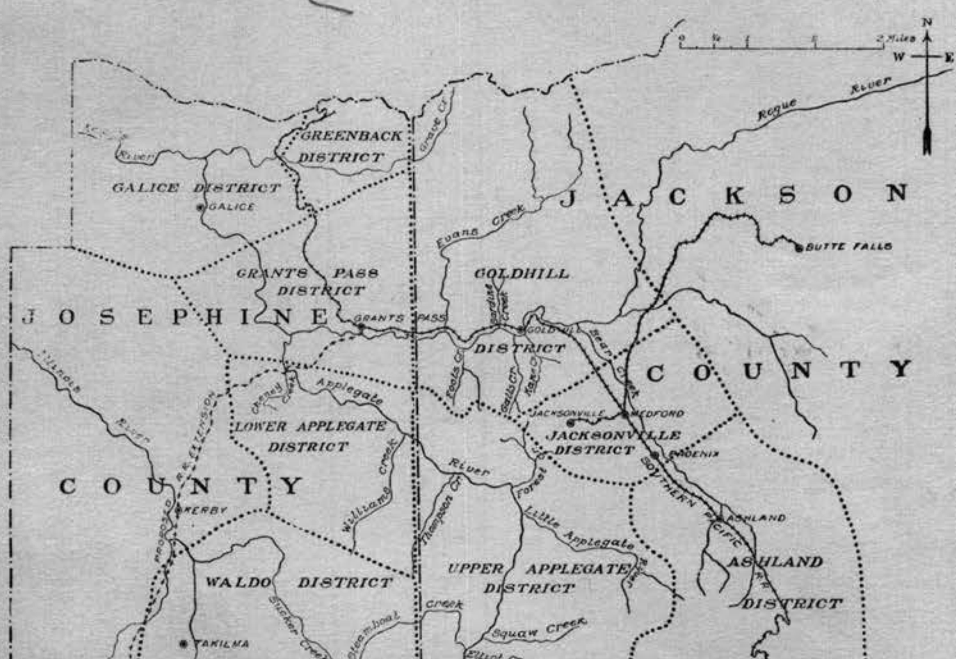

Figure 1. Sketch map of Jackson and Josephine counties, showing location of the mining districts.

Petrology and Mineral Resources of Jackson and Josephine Counties, Oregon.

By A. N. WINCHELL

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THE MINERAL RESOURCES OF OREGON

A Periodical Devoted to the Development of all her Minerals

PUBLISHED MONTHLY AT CORVALLIS BY
THE OREGON BUREAU OF MINES AND GEOLOGY
H. M. PARKS, Director

PETROLOGY AND MINERAL RESOURCES OF JACKSON AND JOSEPHINE COUNTIES, OREGON

By A. N. Winchell.

INTRODUCTION

The field work on which the following report is based was done during the summer of 1913, between June 10 and September 18. The main purpose in view was an examination of the mineral resources of the region and their relation to the country rocks, rather than a detailed study of areal geology or stratigraphy. All of the mining districts in Jackson and Josephine counties were visited with the exception of the Elk creek district in Jackson county and the region west of the Illinois river in Josephine county. In view of the fact that the relations between country rocks and placer deposits are only indirect, little attention was directed to the latter. It is hoped that a careful study of the placer deposits and their sources, extent, and value, may be made at a later date.

The field party was made up as follows: A. N. Winchell, geologist, who was in charge; S. W. French, metallurgist, who made detailed studies of methods of treating certain ores; L. E. Reber, Jr., assistant geologist, who examined certain mines and made topographic maps, C. B. Watson, of Ashland, whose knowledge of the mines of the region, the local geography, and the prominent men of the mining communities was always helpful, and Harley Hall, of Little Applegate, who served as cook and general utility man. All the

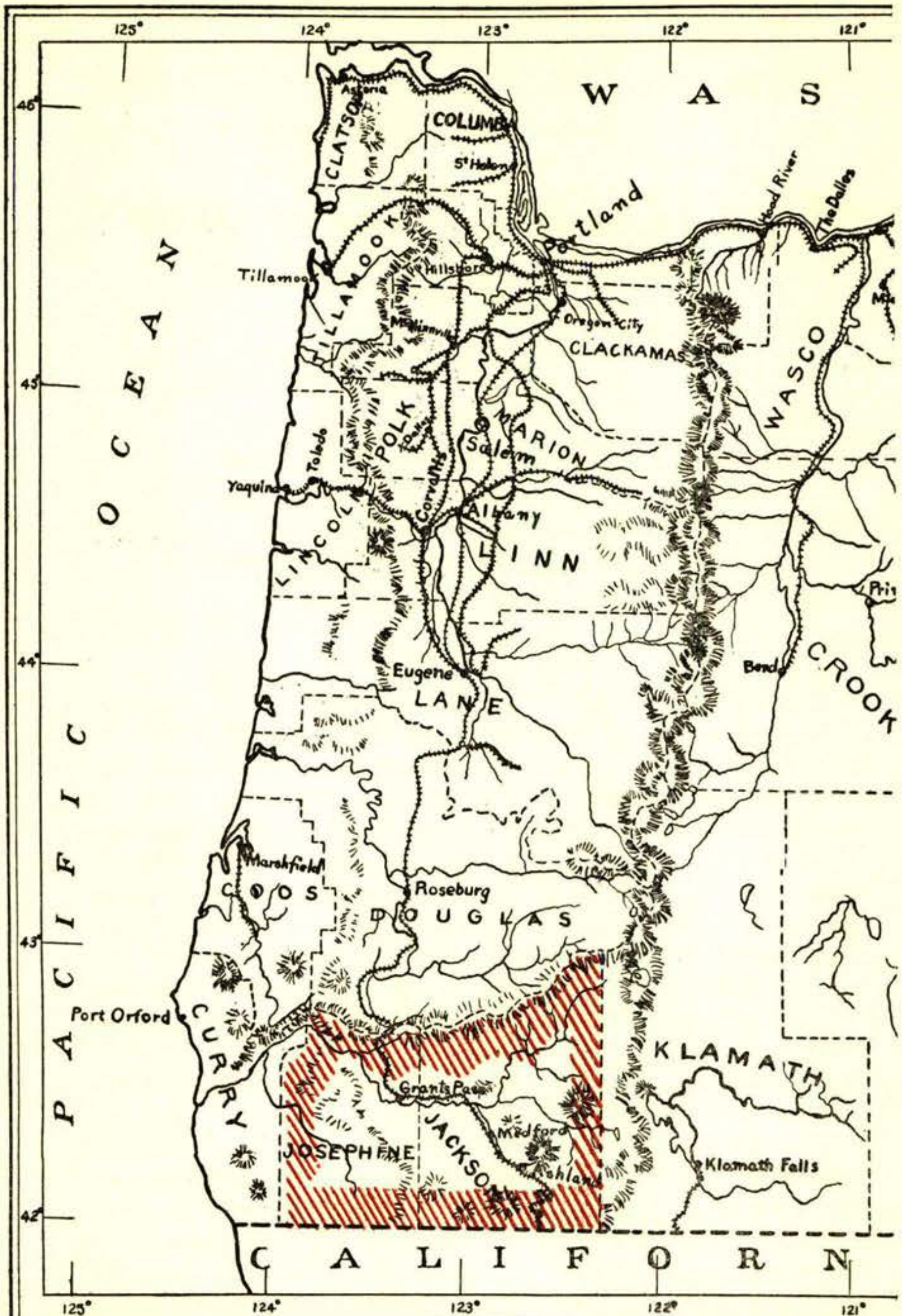
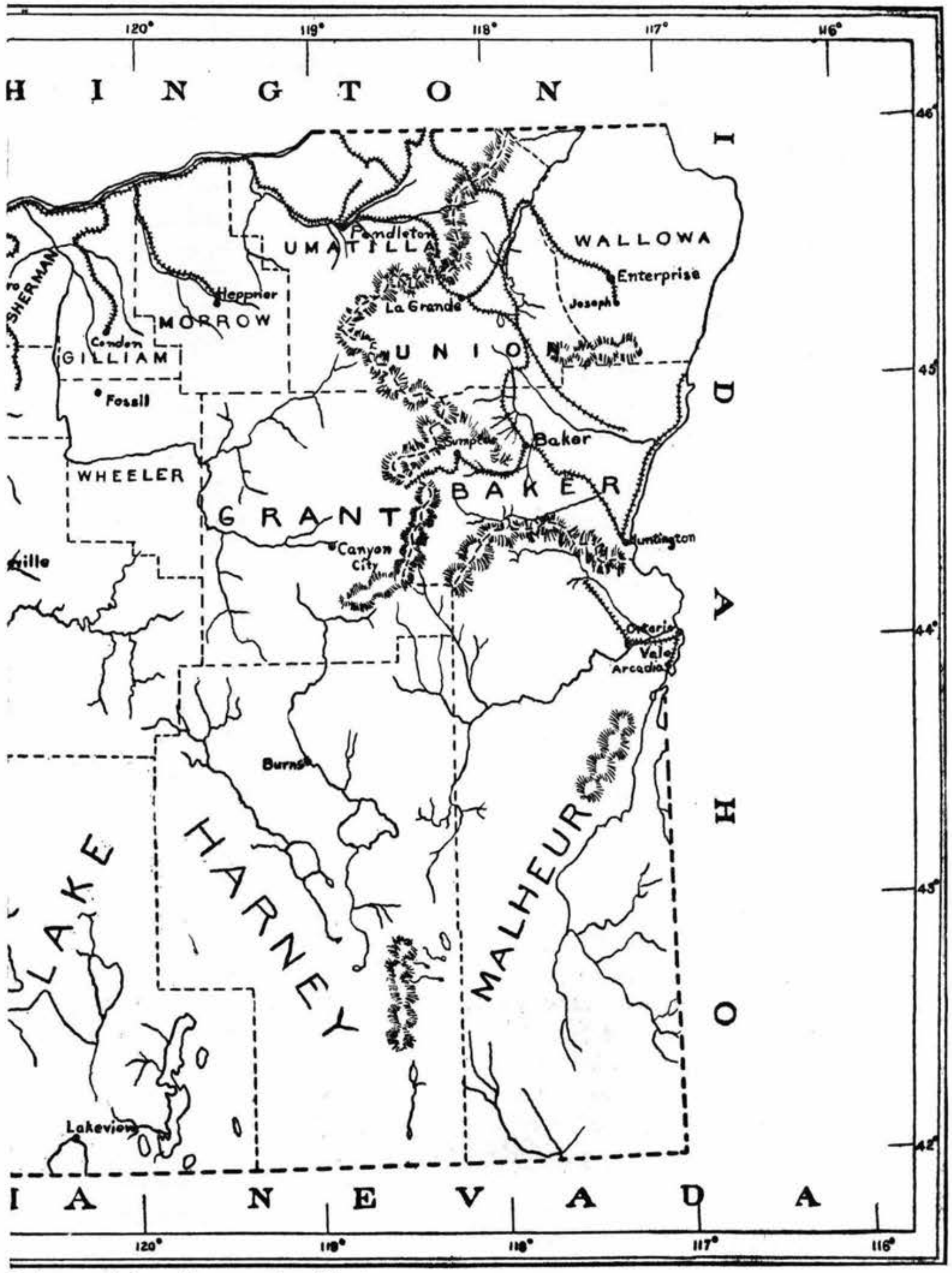


Figure 2. Key map showing location of



Jackson and Josephine counties, Oregon

members of the party were active and zealous in carrying forward the common work.

It is a pleasure to acknowledge hereby the numerous courtesies received from residents of the region during the progress of the field work. Among many others the following gentlemen were very generous in giving of their time and information: Emmett Beeson, of Talent, Charles Hooper, of Ashland, R. L. Burdic, of Ashland, Dr. J. F. Reddy, of Medford and Grants Pass, Dr. E. H. French of Medford, F. J. Newman, of Medford, Frank Carnahan, of Hutton, Alfred Lewis, of Gold Hill, S. B. Gorbutt, of Grants Pass, J. Ross, of Almeda, J. C. Hubbard, of Galice, A. H. Gunnell, of Grants Pass, John Opp, of Jacksonville, J. H. Beeman, of Gold Hill, A. L. Mangum, of Grants Pass, Dr. C. R. Ray, of Medford, and Wm. A. Burr, of Gold Hill.

Throughout the progress of the field work and of the office work necessary in the preparation of this report the writer has received the helpful cooperation of Professor H. M. Parks, Director of the Oregon Bureau of Mines and Geology.

LOCATION

The location of the region examined is shown on the accompanying key map (figure 2). Jackson and Josephine counties are in the southwestern part of Oregon, occupying a large part of the two quadrangles between 42 and 43 degrees north latitude and 122 and 124 degrees west longitude. Josephine county is separated from the Pacific Ocean only by the breadth of Curry county, that is, by about thirty miles. Jackson and Josephine counties are limited at the state boundary to the south by Siskiyou and Del Norte counties of California. On the north they extend to the summit line of the Umpqua mountains where they are bordered by Douglas county, Oregon. On the east they are bounded by Klamath county, Oregon, and near their east boundary is that wonderfully picturesque lake in a mountain top known as Crater Lake.

Both counties are traversed by the Oregon and California division of the Southern Pacific railway, and occupy about the middle of the line between San Francisco to Portland. The most important cities in the counties are Ashland and Medford in Jackson county and Grants Pass in Josephine county, all three of which are on the main line of the railroad.

LOCATION OF MINING DISTRICTS IN JACKSON AND JOSEPHINE COUNTIES

The location of the mining districts in Jackson and Josephine counties as described in this report, is shown in figure 1 (front cover), which also illustrates the relations of each district to streams and railroads.

The Ashland district includes the region of Mount Ashland (or Siskiyou Peak), Pilot Knob and Grizzly Peak, and the intervening Bear Creek valley with its tributaries (Sampson, Emigrant, Walker, Ashland, Wagner and Anderson creeks) as far north as Phoenix.

The Upper Applegate district includes the area drained by the Applegate river in Jackson county.

The Jacksonville or Medford district adjoins the Ashland district on the northwest and includes all of Bear Creek valley between Phoenix and Central Point; to the southwest it extends to the divide between Bear creek and Little Applegate river; to the northeast it is limited by Antelope creek.

The Gold Hill district includes the Rogue river valley from Central Point and Table Rock westward to Josephine county; it is limited on the south by the divide between Rogue and Applegate rivers and on the north by Douglas county.

The Greenback district includes the area drained by Grave and Wolf creeks east of the Southern Pacific railroad in Josephine county.

The Galice district lies west of the Greenback district and occupies the Rogue river valley northwest of the mouth of Jump-off-Joe creek to the west line of Josephine county.

The Grants Pass district occupies the Rogue river valley southeast of the mouth of Jump-off-Joe creek (except the Applegate valley) so far as it lies in Josephine county.

The Lower Applegate district includes the area drained by the Applegate river in Josephine county.

The Waldo district occupies the southeast corner of Josephine county, an area drained chiefly by Althouse and Sucker creeks and the east fork of the Illinois river.

TOPOGRAPHY

Jackson and Josephine counties are situated in a mountainous region, containing one major and several minor valleys. The chief valley of the area is that of the Rogue river which crosses the region from east to west in an irregular course, flowing first to the southwest, then to the west, and finally to the northwest. The minor valleys are those of Bear creek, of Applegate river and of Illinois river. Bear creek has its sources near the volcanic neck or plug (pelelith) known as Pilot Knob and flows northwest through a fertile valley to a junction with Rogue river near the western border of Jackson county a few miles north of Central Point. Applegate river rises in mountains south of Josephine county in California, receives numerous tributaries from Mount Ashland, Dutchman's Peak, Grayback Mountain and other parts of the Siskiyou range and after flowing north and northwest empties into the Rogue river a few miles west of Grants Pass. The Applegate river valley is fertile, but quite narrow, except near Williams creek and its lower end. Illinois river also rises in California, but flows promptly into Oregon and drains a large share of the western half of Josephine county on its course to the north and northwest; it empties into Rogue river about 8 miles northwest of the point where it crosses from Josephine into Curry county. Near Kerby the Illinois valley is not narrow, but it has not been as productive as the other valleys.

On the eastern border of Jackson county the Cascade range extends in a general northerly direction. The numerous head-water forks of the Rogue river drain the entire western slope of the range in Klamath county, including the west side of Mount Mazama; and, after their gradual confluence in the main stream, the latter flows westward to a point about 10 miles west of Grants Pass, where it turns to the north on a rudely semi-circular loop (having a diameter of about 30 miles), near the northern point of which it passes out of Josephine county. In this part of its journey to the sea the river follows a meandering course which was probably inherited from a time when the elevation of the whole region was considerably less than at present, since the stream is now intrenched in a narrow gorge 2000 feet (or more) lower than the nearly level surface of an old plain which is now at an altitude of about 3000 feet above sea level. Above this canyon the river occupies a valley several miles wide near Grants Pass. Still farther up, the stream crosses a resistant ledge near Gold Hill, above which is the broad basin-like valley within which tributaries from the north, the east, and the south reach the Rogue river. It is in this basin and the tributary valleys that horticulture has been so successful that the fruits of the Rogue river valley are now famous wherever the choicest products are demanded.

The basin has been made by erosion of the relatively soft sediments of Tertiary age; isolated remnants of the former filling of the basin form two high flat-top hills north of Central Point known as Upper and Lower Table Rock. These two hills furnish silent, but convincing evidence that several hundred feet of sediments have been removed from the basin. For the hills are capped by nearly horizontal lava flows, having a total thickness of more than 200 feet, which must have formed a continuous sheet of lava over the whole basin when they were first poured out from a neighboring volcano.

Elevations within the two counties range from about 750 feet near Galice to about 7500 feet above sea level on Mount Ashland or Siskiyou Peak. In general the valleys are at elevations of 1000 to 1500 feet, and the mountains reach an altitude of 5000 to 7000 feet.

From the physiographic point of view Josephine county is wholly within the Klamath mountain region, while Jackson county extends from the western flank of the Cascade range westward into the Klamath mountains. The Cascade mountains are largely of volcanic origin and are of relatively recent date, while the Klamath mountains are much older and consist of rocks of different origin. That portion of the Klamaths within Jackson and Josephine counties is properly called the Siskiyou mountains; the latter are formed largely of plutonic igneous rocks, that is, those which consolidated from fusion at considerable depth. In this region these rocks were raised above sea level long before the birth of the Coast or Cascade Ranges. By their erosion they furnished much of the material of the sedimentary rocks deposited along their borders, and now forming the land surface about them, as, for example, in the Bear creek valley.

LITERATURE AND MAPS

In addition to maps of certain individual mines or small groups of mining claims, the maps of any portion or all of Jackson and Josephine counties which have been available during the preparation of this report are the following:

Ashland sheet. A topographic reconnaissance map of the quadrangle between 42° and 43° north latitude and between 122° and 123° west longitude prepared by Kerr, Riecksecker, and Perkins in 1886 and 1887, and published by the U. S. Geological Survey. It is on a scale of 1 to 250,000 or about 4 miles to the inch, and the contour interval is 200 feet.

Grants Pass quadrangle. A topographic map of the area between 42° and 42° 30′ north latitude and between 123° and 123° 30′ west longitude prepared by Davis, Gayetty, Nelson, Oliver, and Stoner in 1904 and 1905, and published by the U. S. Geological Survey. It is on a scale of 1 to 125,000 or about 2 miles to the inch, and the contour interval is 100 feet.

Riddles quadrangle. A topographic map of the area between 42° 30′ and 43° north latitude and between 123° and 123° 30′ west longitude prepared by Searle and Hefty in 1901 and 1902, and published by the U. S. Geological Survey. It is on a scale of 1 to 125,000 or about 2 miles to the inch, and the contour interval is 100 feet.

Jackson county. A township map of the county issued by the Medford Commercial Club. It is on a scale of 4 miles to the inch, and designed to show the geography and resources.

Josephine county. A township map of the county prepared by H. V. Anderson in 1913. It is on a scale of 2 miles to the inch and designed to show the geography.

Siskiyou National Forest. A township map of an irregular area from the ocean to range 7 west, and, in part, to range 3 west, extending from town 29 south in Oregon to town 13 north in California, issued by the U. S. Forest Service in 1911. It is on a scale of about 4 miles to the inch and is designed to show especially the the boundaries of national forests.

Grants Pass quadrangle and bordering districts. A sketch map showing limestones, mines, and prospects in the area, prepared by G. F. Kay in 1908 and published by the U. S. Geological Survey as plate II of Bulletin 380. It is on a scale of about 5 miles to the inch.

Southern Oregon. A sketch map of the area between towns 30 and 40 north and between ranges 4 east and 9 west, prepared and issued by Foster and Gunnell in 1904. It is on a scale of about 3 miles to the inch and designed to show mining claims and operations.

Mining districts of Oregon. An outline map of Oregon showing the location of the chief mining districts prepared by James M. Hill and issued by the U. S. Geological Survey as plate XI of Bulletin 507 in 1912.

Jackson county. A township map of the county published by Cole and Peebler of Ashland, Oregon. It is on a scale of 3 miles to the inch and designed to show the streams, roads, and lands devoted to horticulture near Ashland.

Crater National Forest. A township map of an irregular area in Oregon and California from town 28 south in Oregon to town 18 north in California and from range 6 west to 6 east. It is on a scale of 4 miles to the inch and shows the geography and forest boundaries.

Geologic Reconnaissance map of the Galice-Kerby-Waldo region. Map showing the distribution of rock formations, and of the chief mines, prepared by J. S. Diller and published by the U. S. Geological

Survey as plate VI of Bulletin 546 in 1914. It is on a scale of about 4 miles to the inch.

The following publications contain more or less information in regard to the geology and mineral resources of Jackson and Josephine counties:

J. R. Browne: Mineral Resources of the United States (for 1866). Washington, 1867. Oregon, pp. 129–130, 247–248.

Same report for 1867. Oregon, pp. 576–596.

Thomas Condon: The Two Islands and What Came of Them. 1902.

Thomas Condon: Oregon Geology; a revision of "The Two Islands," edited by Ellen Condon McCornack, Portland, Ore., 1910.

J. S. Diller: The Rogue River Coal Field, Oregon. U. S. Geol. Survey Bulletin 341, 1909, pp. 401–405.

J. S. Diller: The Topographic Development of the Klamath Mountains. U. S. Geol. Survey, Bulletin 196, 1902, 70 pp.

J. S. Diller: Placer Mines of Riddles Quadrangle, Oregon. U. S. Geol. Survey, Bulletin 340, 1908, pp. 147–151.

J. S. Diller: Notes on the Structure and Age of the Cascade Range. U. S. Geol. Survey, Twentieth Ann. Rept., Part III, 1900, pp. 32–36.

J. S. Diller: Mineral Resources of Southwestern Oregon. U. S. Geol. Survey Bulletin 546, 1914.

J. S. Diller and G. F. Kay: Mineral Resources of the Grants Pass Quadrangle and Neighboring Districts, Oregon. U. S. Geol. Survey, Bulletin 380, 1909, pp. 48–79.

Director of the U. S. Mint: Production of Gold and Silver in United States for 1880. Chas. G. Yale: Oregon, pp. 117–120.

Same report for 1881. Jackson and Josephine Cos., pp. 164–166.

Same report for 1882. Jackson and Josephine Cos., pp. 191–192.

Same report for 1883. Jackson and Josephine Cos., pp. 611–616.

Same report for 1884. Jackson and Josephine Cos., pp. 397–399.

Same report for 1886. Israel Lawton: Jackson and Josephine Cos., pp. 214–216.

Same report for 1897. E. B. Braden: Jackson and Josephine Cos., pp. 183, 188, 189.

Same report for 1898. E. B. Braden: Jackson and Josephine Cos., pp. 124–125.

Same report for 1899. F. A. Wing: Jackson and Josephine Cos., pp. 160, 164, 165.

Same report for 1900. F. A. Wing: Jackson and Josephine Cos., pp. 175–177.

Same report for 1901. F. A. Wing: Jackson and Josephine Cos., p. 187.

Same report for 1902, F. A. Wing: Jackson and Josephine Cos., p. 184.

Same report for 1903. F. A. Wing: Jackson and Josephine Cos., pp. 106–107.
Same report for 1904. F. A. Wing: Jackson and Josephine Cos., pp. 159–161.
Same report for 1905. F. A. Wing: Jackson and Josephine Cos., pp. 100–101.
James M. Hill: Mining Districts of Oregon. U. S. Geol. Survey Bulletin 507, 1912, pp. 245–256.
G. F. Kay: Gold-Quartz Mines of the Riddles Quadrangle, Oregon. U. S. Geol. Survey Bulletin 340, 1908, pp. 134–147.
F. H. Knowlton: Fossil Plants Associated with the Lavas of the Cascade Range. U. S. Geol. Survey, Twentieth Ann. Rept., Part III, 1900, pp. 37–64.
H. M. Parks: The Economic Geological Resources of Oregon. Issued by the Oregon State Bureau of Mines, Corvallis, Oregon, 1912, See pp. 26–31, 45, 46, 79-92, 97-99.
H. M. Parks: Mineral Resources of Oregon, volume 1, number 1, Jan. 1914. Issued by Oregon Bureau of Mines and Geology. See pp. 4–7.
R. W. Raymond: Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains for 1869. Washington, 1870, Oregon, pp. 203–233. Jackson county, pp. 214-217. Josephine County, pp. 217–218.
Same report for 1870. Oregon, pp. 176–186.
Same report for 1871. Oregon, p. 257.
Same report for 1872. Oregon, pp. 206–213.
Same report for 1873. Oregon, pp. 252–255.
Same report for 1874. Oregon, pp. 315–323.
Same report for 1875. Oregon, pp. 232–235.
O. F. Stafford: Mineral Resources and Mineral Industries of Oregon. Issued by University of Oregon, 1903. See pp. 15, 17, 70–96, 98, 104, 107.
C. B. Watson: Prehistoric Siskiyou Island and the Marble Halls of Oregon, published by Ashland Tidings Publishing Company, 1909.
Albert Williams: Mineral Resources of United States for 1882. Washington, 1883. Oregon, pp. 403–404, 387, 550, 773.
Same report for 1883 and 1884. Oregon, pp. 287, 581, 576, 984.
Same report for 1885. Oregon, pp. 182, 199, 200, 412, 540.
Same report for 1886. Oregon, pp. 18, 104, 171, 718.
Same report for 1887. Oregon, pp. 58, 59, 125, 127, 142, 785, 778.
Same report for 1888. Oregon, pp. 15, 36, 37, 109, 171, 206, 301, 581, 628.
Same report for 1889 and 1890. Oregon, pp. 10, 17, 24, 35, 40, 49, 373, 418, 522.
Same report for 1891. Oregon, pp. 12, 27, 75–79, 168, 528, 536, 607.

Same report for 1892. Oregon, pp. 26, 34, 51, 80, 706, 710, 773, 776, 830.
Same report for 1893. Oregon, pp. 26–35, 50–57, 170, 546, 555, 774, 781, 791.
Same report for 1894. Oregon, part IV, pp. 161, 461, 468, 717.
Same report for 1895. Oregon, part III, pp. 472, 1037.
Same report for 1896. Oregon, part V, pp. 330, 570, 971, 1382.
Same report for 1897. Oregon, part VI, pp. 264, 266, 277, 477, 661, 673.
Same report for 1898. Oregon, part VI, pp. 124, 341, 434, 453, 762.
Same report for 1899. Oregon, part VI, pp. 123, 229, 301, 335, 353, 362, 453, 481, 614.
Same report for 1900. Oregon, pp. 109, 196, 235, 245, 662, 901.
Same report for 1901. Oregon, pp. 103, 121, 201, 231, 235, 242, 263, 644, 755, 892, 963.
Same report for 1902. Oregon, pp. 123, 181, 239, 255, 263, 670, 996.
Same report for 1903. Chas. G. Yale: Oregon, pp. 184–186. Also pp. 499, 1156.
Same report for 1904. Chas. G. Yale: Oregon, pp. 203–206, 240, 295, 314, 349, 359, 804, 1187.
Same report for 1905. Chas. G. Yale: Jackson and Josephine Counties, pp. 291, 292.
Same report for 1906. Chas. G. Yale: Jackson and Josephine Counties, pp. 313–318.
Same report for 1907. Part I. Chas. G. Yale: Jackson and Josephine Counties, pp. 416–427.
Same report for 1908. Part I. Chas. G. Yale: Jackson and Josephine Counties, pp. 521–525, 530–533.
Same report for 1909. Part I. Chas. G. Yale: Jackson and Josephine Counties, pp. 443–446, 448–449.
Same report for 1910. Part I. Chas. G. Yale: Jackson and Josephine Counties, pp. 555–559, 563–564.
Same report for 1911. Part I. Chas. G. Yale: Jackson and Josephine Counties, pp. 721–728, 731–733.
Same report for 1912. Part I. Chas. G. Yale: Jackson and Josephine Counties, pp. 847–860, 864–866.

HISTORY

DISCOVERY

The earliest discoveries of gold in Oregon were made in Jackson and Josephine counties where placer gold ores were found as early as 1852. In the same year the Jacksonville district was organized as a political unit as a direct result of the discovery of placer gold on Rich Gulch, a tributary of Jackson creek. The discovery is said to have been made by James Cluggage. During the same year gold was found on Josephine creek and a great rush resulted in the spring of 1853 to Althouse creek where the bed of the stream was found to be uniformly rich. Sailor Diggings was a famous placer region which had a ditch about 15 miles long, built at a cost of about $75,000, which paid for itself in one year. In 1853 Applegate district in Jackson county was organized on the river of that name about 10 miles south of Jacksonville. Placer deposits were found in bars along the river and were worked by means of water supplied by a ditch 4 miles long owned by Kasper Kubli. During the same year the Foots creek district was organized as a result of the discovery of coarse placer gold in that stream. In 1854 extensive placer mining was in progress on Sucker creek in Josephine county; other placer work was in progress at about the same time on Canon creek, Slate creek, Galice creek, Williams creek and the Illinois river. In Jackson county the Sterling district was organized in 1854; it was on a small stream of that name about 8 miles south of Jacksonville where coarse placer gold was found. In 1856 the Evans creek and Pleasant creek districts were organized; in both the placer deposits were worked by hydraulic methods. About the same time the Buncom district was organized near the mouth of Little Applegate river; the water supply was provided by three ditches. In 1858 a district called Forty-nine Diggings, where water was obtained from Wagner and even from Anderson creek, was organized about 3 miles northwest of the site now occupied by the town of Ashland. The gold in this district contained a large amount of silver and was worth about twelve dollars an ounce.

DEVELOPMENT

After the most accessible gravel deposits were taken up and largely exhausted, placer miners turned to bench deposits and similar "high level" gravels which could be worked only by water brought considerable distances in ditches and flumes. Wherever these were high enough above the deposit the water could be brought down to the latter in pipe lines and discharged under great pressure through great nozzles, called giants, under mechanical control. Great streams of water handled in this way not only furnish the water necessary for sluicing out the gold, but also supply the power to tear down gravel banks and carry the material into the sluice boxes where the gold is separated by means of riffles, sometimes supplied with quicksilver. Placer mining carried on in this way is often called hydraulic mining. The method was used in southern Oregon as early as 1856, and has been employed more or less continuously ever since. The placer mines are by no means exhausted in Jackson and Josephine counties, but the output has been decreasing slowly for some time. In 1904 a dredge was installed in Jackson county, but the results were not entirely satisfactory. A dredge on Foots creek and another near Waldo were successful for a time, but are now abandoned.

Soon after the discovery of gold-bearing gravels the source of the precious metal of the placers was found to be, in southern Oregon as elsewhere, in quartz veins and other gold deposits in the solid country rocks. The white quartz deposits carrying free gold at Gold Hill were not discovered until 1859, but the ore was so rich that $400,000 is said to have been taken out during 1860. The rich deposit at Steamboat was found about the same time and gold worth $350,000 was quickly obtained. These and similar extremely rich "strikes" of bonanza ore which was quickly exhausted gave the region the reputation of being a "pockety" country, that is, of containing small bodies of very rich ore, but no large bodies of valuable ore. Southern Oregon is still suffering from this reputation. It is very truly a region where many very rich deposits have been found to be quite small, but recent developments indicate that it also contains large bodies of lower grade but still very valuable ore.

Early in the sixties an 8-stamp mill was installed at the Jewett mine on the south side of Rogue river near Grants Pass. It had a steam boiler developing 32 horsepower. But the gold was not easily recovered and the equipment was used as a saw mill in 1869. The Hopkins mill on Jackson creek met a similar fate. The Occidental mill on the right fork of Jackson creek cost $10,000; it had 10 stamps and a 40 horsepower boiler with a crushing capacity of 20 tons a day. It was equipped with two rotary pans.

The copper ores near Waldo in Josephine county were discovered in 1860 by Mr. Hawes, but very little development work was done till many years later.

During the seventies placer mining continued on a rather restricted scale, and underground mining was not yet developed beyond the stage of searching for rich ore near the surface.

Early in the eighties the Horsehead was the chief mine on Williams creek; the Josephine mine on Slate creek changed owners; and the Sugar Pine mine in the Galice district made a small production. In 1880 the Waldo Hydraulic Mining Company began placer mining at that place, and was successful at once. The Portland Company erected a 15-stamp mill in the Kerby district. In 1883 several new mines were opened especially in the Waldo and Althouse districts of Josephine county. In 1884 mining activity in Jackson county was centered around Willow Springs, Ashland, and Applegate; most of the output came from placers. In Josephine county mining was notably successful in the Galice and Waldo districts, and preliminary developments in the Beaver creek district resulted favorably. The Green Brothers mine near Galice was opened as early as 1877; work on it continued more or less steadily for at least eight years, the average yield of the ore being reported as forty dollars a ton. In 1885 the chief production from Jackson county came from placer mining near Jacksonville, and the output of Josephine county was derived especially from the Grants Pass and Wolf creek districts. In 1886 the most important placer mines in the Applegate valley belonged to the Sterling Mining Company, the Gin Lin Company, and I. T. Layton. The chief underground or "quartz" mines in Jackson county were in the Ashland and Willow Springs districts. A 10-stamp mill was erected on the Lucky Queen mine near Grants Pass and development of quartz mines in the Galice district continued. During the later part of the eighties placer mining continued but with a slowly decreasing output. Many efforts were made to open quartz mines, but for the most part they were not well directed and obtained only indifferent results.

Early in the nineties the quartz mines were more successful, as illustrated by the Rising Star mine in the Applegate district, which produced over $15,000 in 1891, and the Ashland mine whose output exceeded $10,000 in 1892. In 1897 the Mount Reuben district in Josephine county first attained some prominence; at this time the Ajax mine was opened by a tunnel and was equipped with an improved Hammond mill, while the Copper Strain and Sandoz mines had Tremain mills. Later in the nineties the Ashland district in Jackson county was especially active, and gold ores were successfully treated from quartz veins on the Ashland, the Mattern, and the Shorty Hope mines. Other producers included the Columbia Gold Mining and Milling Company and the McMurtry Mining Company.

In Josephine county in 1898 the chief underground gold mines were the Gold Bug, the Greenback, the Jewett, the Requital, and the Golden Wedge. The Greenback and Golden Wedge ores were treated in arrastres; the Requital and Jewett mines were equipped with stamp mills. The sulphide ores of the Baby mine were sent to a smelter. The Lawrence Mining Company used a 50-ton Griffin mill.

Just before the opening of the twentieth century the Greenback mine was equipped with a stamp mill under the ownership of the Victor Jr. Gold Mining Company. About the same time the Rising Star mine was owned by the Champion Gold Mining Company, and other active mines included the Golden Wedge, Little Dandy, Jupiter, Gold Bug, Rocky Gulch, and Treasurer Trove. The Waldo copper mine was also productive. By 1902 the Greenback was supplied with a 40-stamp mill and a 150-ton cyanide plant. About the same time the Almeda mine had 1400 feet of underground development work completed, and other productive mines included the Oregonian, Knickerbocker, Gold Drift, Martha, Granite Hill, and Oregon Belle. In 1904 the Greenback produced more gold than any other mine in Oregon (except the North Pole). The same year the Queen of Bronze mine near Waldo produced some copper ore. In 1905 a smelter recently built at Takilma produced matte containing 60 per cent copper with 1 ounce of gold and 4-5 ounces of silver per ton. In 1906 the Greenback mine was closed; its equipment included electric power, 12 concentrators, crushers, 40 stamps, and a cyanide plant. The same year the Granite Hill mine operated a 20-stamp mill and the Mountain Lion a 5-stamp mill.

In the early years of the twentieth century the chief producing underground mines in Jackson county were the Opp and Oregon Belle near Jacksonville, the Pacific American Gold Mining Company, the Bill Nye and Millionaire mines near Gold Hill and the Little Wonder mine developed by the Enterprise Mining Company. In 1905-1909 the Opp was the most productive mine in the county and other active mines were the Bill Nye and Braden near Gold Hill, Corporal G, and Lucky Bart on Sardine creek, the Star mine on Wagner creek, and the Tin Pan, Maid of the Mist and Forest creek mines. In 1911 the Norling mine near Jacksonville was worked about two months, and machinery for a 10-stamp mill was obtained for the Shattuck mine in the Applegate district.

In Josephine county the Mountain Lion mine operated its 5-stamp mill in 1907; a 50-ton cyanide plant was installed at the

Mount Pitt mine on Jump-off-Joe creek. The Hammersley mine at the head of the same creek had a 5-stamp mill with concentrators and a cyanide plant. In 1908 the Martha mine was worked about half the year. In 1910 the Mountain Lion mine in the Davidson district had about 2000 feet of tunnels and drifts with a 5-stamp mill using electrolytic chlorination and amalgamation. The same year the Gold Road, Oriole, Sugar Pine and Nesbit mines in the Galice district were productive. In 1908 the Almeda Company built a 100-ton matting furnace and continued underground development work.

In 1912 El Senora Company erected a 10-stamp mill in the Applegate district in Jackson county; the Gold Ridge mine sent shipping ore from Foots creek district to the Mammoth smelter in California and built a 2-stamp mill. The Lucky Bart mine on Sardine creek was productive, as well as the Medford and Buzzard mines near Jacksonville. In Josephine county the active underground mines in 1912 included the Almeda and the Elder Mining and Smelting Company, both having local smelters and producing ore containing copper with more or less gold and silver.

PRODUCTION

The production of gold in the early years of placer mining in Jackson and Josephine counties is not accurately known. No satisfactory basis is available even for estimates of the output before 1864. During the five years from 1864 to 1868, inclusive, R. W. Raymond reported that the average annual production from Jackson county was $210,000. The output for 1869 probably amounted to about $200,000. During these years the amount of gold won from mines in Josephine county was probably not very different from the output of Jackson county. As early as 1870 placer mining in southern Oregon became relatively unprofitable for the individual miners and small operators, and the industry gradually passed into the hands of Chinamen, except as it was handled more profitably on a larger scale by long ditches, large flumes, powerful giants and similar devices. The production of precious metals for the whole State decreased steadily until it amounted (including the output of Washington — perhaps $100,000) to only $800,000 in 1874, as compared with $4,000,000 in 1868. In 1875 the production of Oregon (including a small amount from Washington) was about $1,250,000; during the next five years statistics of output are lacking, but the amount

PRODUCTION OF GOLD AND SILVER IN JACKSON AND JOSEPHINE COUNTIES, OREGON, 1852-1912

Years	Jackson County		Josephine County		Total value
	Gold	Silver	Gold	Silver	
1852–1863	$1,500,000	$75,000	$1,000,000	$50,000	$2,625,000
1864–1869	1,200,000	60,000	1,000,000	50,000	2,310,000
1870–1879	800,000	40,000	800,000	40,000	1,680,000
1880	180,000	8,800	195,000	6,200	390,000
1881	240,000	10,000	195,000	5,000	450,000
1882	135,000	2,000	175,000	2,000	314,000
1883	100,000	1,000	110,000	1,000	212,000
1884	100,000	1,000	110,000	1,000	212,000
1885	57,000	1,000	70,000	1,000	129,000
1886	105,000	840	150,000	2,500	258,340
1887	238,000	900	140,000	5,400	384,300
1888	195,000	1,000	130,000	5,000	331,000
1889	59,000	5,250	38,000	1,000	103,250
1890	85,000	1,275	85,000	255	171,530
1891	140,000	2,000	47,000	1,000	190,000
1892	41,000	1,000	72,000	300	114,300
1893	107,000	500	113,000	400	220,900
1894	107,000	650	123,000	700	231,350
1895	142,800	2,200	282,000	500	427,500
1896	100,000	1,000	200,000	1,000	302,000
1897	28,000	1,500	132,000	4,700	166,200
1898	29,300	1,800	147,000	3,900	182,000
1899	103,400	3,100	236,000	7,000	349,500
1900	100,000	3,000	250,000	7,000	360,000
1901	100,000	3,000	300,000	9,000	413,000
1902	120,000	3,000	350,000	14,000	487,000
1903	122,000	1,000	342,000	13,000	478,000
1904	109,553	91	[1]373,670	[1]385	[1]482,699
1905	90,100	542	[1]401,986	[1]3,908	[1]496,536
1906	178,561	2,123	[1]362,289	[1]11,181	[1]554,154
1907	179,490	2,157	160,668	1,122	343,437
1908	66,933	718	132,722	3,184	203,557
1909	100,218	1,008	148,997	855	251,078
1910	42,466	582	150,048	521	192,617
1911	46,527	401	99,363	5,531	151,822
1912	62,985	891	76,061	6,626	146,563
Total	$7,110,333	$240,328	$ 8,697,804	$266,168	$16,314,633

[1]Includes Lane County, separate figures not being available.

was probably about $1,000,000 annually. During this decade from 1870 to 1879 eastern Oregon probably produced about three-fourths of the gold won in the State, and the output from Jackson and Josephine counties together probably ranged between $100,000 and $200,000 annually. From 1880 to the present time more precise figures of production are available, except for the years 1896 and 1900-1902. For these years an estimate may be based upon the production in the counties during preceding and following years, and the output of the State during the years in question. Since 1904 the statistics are based upon detailed reports collected by the U.S. Geological Survey from the individual mines. The accompanying table p. 29 shows the production from the beginning of mining in the counties to the close of 1912; as already explained the figures are in part merely estimates.

The following table shows the production of copper from the mines near Waldo in Josephine county since 1904. A considerable output of copper was made in 1902, and some was obtained in 1903 and perhaps in earlier years, but no statistics for these years are available.

PRODUCTION OF COPPER IN JOSEPHINE COUNTY

Year	Pounds	Value
1904	263,000	$ 34,190
1905	842,615	131,447
1906	372,732	71,937
1907	499,664	99,933
1908	289,645	38,233
1909	235,000	30,550
1910	....	....
1911	82,808	10,351
1912	254,380	41,973
Total	2,839,844	$458,614

Since 1904 the U. S. Geological Survey has published annual reports giving the number of underground mines, the total tonnage of ore from the mines which was treated during the year, and data from which the total average value per ton may be calculated. The following table gives these figures, and shows that the number of underground mines operating in Jackson county has varied from 3 to 13 with an average of 8 while the average value per ton has varied from \$2.34 to \$15.72 with an average for the whole period of \$5.39. The number of underground mines in operation in Josephine county has varied from 6 to 18 with an average of 13, while the average value per ton has varied from \$3.87 to \$23.33 with an average for the last six years of \$10.81. The ores treated in Josephine county have a higher average value than those treated in Jackson county because, being much farther from transportation (especially the copper ores near Waldo), only higher grade ores can be profitably treated. The statistics show that Josephine county contains considerable bodies of these higher grade ores; if cheap transportation is afforded these ores should be very profitable. The following table gives the data concerning the number of operating underground mines, the tons of ore treated, and the average total value per ton in each county since 1904.

NUMBER OF OPERATING DEEP MINES, TONNAGE TREATED, AND AVERAGE TOTAL VALUE PER TON

Year	Jackson County			Josephine County		
	No. of mines	Tonnage	Average value per ton	No. of mines	Tonnage	Average value per ton
1904	8	1,489	\$15.72	15	[1] 34,827	[1] \$7.58
1905	8	5,919	7.78	15	[1] 52,207	[1] 7.81
1906	13	9,644	5.06	16	[1] 63,848	[1] 4.94
1907	8	14,923	4.98	16	5,995	23.33
1908	10	3,293	4.62	18	3,567	21.20
1909	5	5,329	5.66	10	5,962	12.31
1910	3	63	7.87	10	16,415	3.87
1911	6	8,980	2.34	8	5,324	5.35
1912	8	3,375	6.08	6	4,081	16.22
Average	8	5,891	\$ 5.39	13	[2] 6,891	[2] \$10.81

[1] Includes mines in Lane County, separate figures not being available.
[2] Average for the years 1907–1912 only; including 1904–1906 the average tonnage is 21,358, and the average value per ton is \$7.16.

It is encouraging to note that the average value per ton was higher in 1912 than the mean value during the nine years from 1904 to 1912.

GEOLOGY

The sedimentary rocks present in Jackson and Josephine counties are related in age as shown in the following table.

GENERALIZED STRATIGRAPHIC SECTION IN JACKSON AND JOSEPHINE COUNTIES

System	Series	Group	Lithologic character	Estimated thickness
				Feet
Quaternary	Recent Pleistocene		Stream deposits of clay, sand, and gravel	100
Tertiary	Pliocene to Oligocene (?) Unconformity		Sand, clay, and gravel	100
	Eocene		Sandstone with some shale, conglomerate, and coal	500–
Unconformity				
Cretaceous	Upper Cretaceous	Chico	Conglomerate and sandstone	100
	Lower Cretaceous	Horsetown	Conglomerate and sandstone	100
Unconformity				
Jurassic		Dothan	Argillite, shale, and sandstone	5000
		Galice	Argillite, shale, and sandstone	5000
Unconformity?				
Carboniferous			Argillite, tuff, sandstone, and limestone lenses	5000
Devonian Silurian?			Argillite, tuff, sandstone, and limestone lenses	5000
Unconformity?				
(?)		Salmon	Hornblende schist	500
		Abrams	Mica schist	500

QUATERNARY SYSTEM

The recent and Pleistocene formations in Jackson and Josephine counties consist of alluvium and outwash of clay, sand, and gravel in the broader portions of the valleys, especially in the Bear creek valley between Ashland and Table Rock and along Williams creek, Applegate river, and Rogue river near Grants Pass. They are not extensive deposits areally and only in a few places more than a few rods thick. They are, nevertheless, important as the source of much placer gold.

TERTIARY SYSTEM

Pliocene to Oligocene (?) Series

Some of the stream deposits of the broader valleys are believed to be in part older than the Pleistocene, and may even represent the whole succession later than the Eocene. But there is at present no conclusive evidence on this point.

Eocene Series

The northeast slope of Bear creek valley and the whole Rogue river valley northwest of Medford are occupied by feldspathic and slightly conglomeratic sandstones with some beds of coal and some of shale, all of which are referred provisionally to the Eocene by paleontologists of the U. S. Geological Survey. These beds have a thickness of at least 500 feet on Bear creek, forming cliffs on the northeast side with the peculiar forms characteristic of wind erosion. A low cliff is shown in plate II in which the bedding is distinct on account of a layer of conglomerate near the middle of the cliff. These beds strike northwestward and dip at an angle of 10° to 30° northeastward beneath the lavas of the Cascade Range. All of the coal beds of the Rogue river valley are found in this formation, which has suffered some faulting and been intruded by dikes and sills associated with the Cascade lavas. The unusually close relation between a seam of coal and a lava flow is illustrated in plate I. The Eocene formation is distinctly unconformable with the overlying alluvial deposits; it is also more or less unconformable with the underlying Cretaceous conglomerates.

CRETACEOUS SYSTEM

Conglomerates with some sandstones and shales, which have been referred to the Cretaceous system, are found in a few small areas in Jackson and Josephine counties. They were undoubtedly once much more widespread than they are at present, but there seems to the writer to be insufficient evidence that they "once formed a continuous blanket[1] for the older rocks over almost the whole of the Klamath mountains." From fossils found in this system the conglomerate at Forty-nine diggings near Ashland has been referred to the Chico group of the Upper Cretaceous by F. M. Anderson, and conglomerate found near Jacksonville is referred to the same horizon by paleontologists of the U. S. Geological Survey on the basis of fossils collected by the writer. In these outcrops the conglomerate is generally very coarse and composed largely of older rocks of the same vicinity. The bowlders are considerably altered and the whole conglomerate goes to pieces readily under the action of the weather. Near Jacksonville the formation is now thin and nearly horizontal; it seems to be only approximately conformable with the overlying Eocene, while it is in marked unconformity upon the underlying formations.

Lithologically similar rocks occupy a small area northwest of Takilma, being found in all three of the large placer mines of the area, and furnishing the ore itself in one of them. They are here somewhat decomposed reddish or purplish conglomerates composed largely of greenstone with some granitic bowlders. The formation is nearly 100 feet in thickness and dips about 35° westward. The upper portion consists of sandstone, the fossils from which have been classed as belonging to the Horsetown [2] group. The relation between the Chico and Horsetown groups is known only from the fossils they contain, as they are not found, so far as known, in juxtaposition in southwestern Oregon. The Horsetown formation, like the Chico, is markedly unconformable upon underlying formations. These Cretaceous conglomerates are believed to be shore deposits, indicating the existence of an island in the Cretaceous ocean in the region now occupied by the Siskiyou mountains. This is the "Siskiyou Island" of Condon [3] and Watson.[4]

JURASSIC SYSTEM

In the northwestern part of Josephine county argillites, grading into shales and slates, and interbedded with some sandstones, are

[1] U. S. Geological Survey Bulletin 546, p. 18; 1914.

[2] U. S. Geological Survey Bulletin 546, plate VI, 1914.

[3] Thomas Condon: The Two Islands and What Came of Them, Portland, 1902.

[4] C. B. Watson: Prehistoric Siskiyou Island and the Marble Halls of Oregon, Ashland, 1909.

very abundant. These rocks are dark colored, locally black, but weather gray, yellowish or brown. Thin beds of fine quartzose conglomerate and of chert are found in some places. Intrusive and extrusive igneous rocks, especially andesites and serpentines, are intimately associated with these argillites. Fossils occurring in this formation at the Almeda mine have been referred to the Jurassic period by paleontologists of the U. S. Geological Survey. Diller [1] has designated these argillites the Galice formation, and thus separated them from very similar beds found farther west in the same county, which he calls the Dothan formation. The two are separated by a belt of igneous rocks which averages about five miles in width. The differences existing between the two formations which justify their separation are unknown to the writer.

The Jurassic formations have been tilted and probably folded so that the beds now at the surface are somewhat overturned, the younger beds being under the older. They stand nearly on edge, striking about N. 20° E., and dipping about 70° S. E. They are separated from the Cretaceous rocks not only by their nearly vertical attitude, but also by igneous masses of volcanic origin. Along a line extending from the vicinity of Wilderville southwestward to Waldo they are in contact with older Paleozoic rocks which now lie in apparent conformity above them, a position acquired by means of faulting or because the Paleozoic beds have been overturned with the Jurassic. In the latter case faulting along the contact may also be present.

PALEOZOIC SYSTEMS

Since the Paleozoic systems have not yet been classified with accuracy in this region they may be considered together. They consist of argillites (shales and slates), interbedded with some fine sandstone and conglomerate, volcanic tuffs, and lenses of limestone. Igneous rocks of various types, especially andesite, are associated in large quantity with these sediments; the former are partly extrusive flows and partly intrusive dikes and sills, as well as larger masses of the type of batholiths and stocks.

According to Diller,[2] the Paleozoic sediments are of marine origin since they contain many siliceous beds which are flinty and abundantly supplied with the remains of microscopic radiolarians.

The Paleozoic rocks (with the associated igneous rocks) occupy

[1] U. S. Geological Survey Bulletin 546, p. 17; 1914.
[2] Loc. cit., p. 15.

much of the Waldo district, most of the Grants Pass quadrangle (except the northwest quarter), and much of the area south and west of Ashland and Jacksonville in the Ashland quadrangle. That is, they occupy all but the western fourth of the Waldo district, the southeastern half of the Lower Applegate district, the eastern third of the Grants Pass district, the southwestern quarter of the Gold Hill district, a small southwestern part of the Jacksonville and Ashland districts, and most of the Upper Applegate district.

The Paleozoic rocks are apparently structurally conformable both with older formations and with more recent beds, but there seems to be a hiatus in deposition both before and after the period. There is no unconformity known between the formations included in the Paleozoic. Like the Jurassic, the Paleozoic beds are nearly on edge, striking northeast and dipping steeply southeast. Elsewhere in this report the writer has suggested that these beds are all overturned so that the Carboniferous beds are structurally beneath to the northwest and the Devonian (and Silurian?) are above to the southeast.

The classification of these Paleozoic rocks is based on fossils found in the limestone lenses, each of which has a maximum thickness of about 200 feet and a maximum length of about 2000 feet. They have been assigned to four chief belts.

Beginning on the west the first belt includes lenses on Cheney creek, others near Kerby, and some near Waldo. In this belt fossils collected by the writer have been considered to be probably Carboniferous in age by paleontologists of the U. S. Geological Survey.

The second belt includes outcrops southwest of Gold Hill, also some west of Provolt, those at Oregon Caves, and one on Sucker creek. So far as known no fossils have been found in this group of outcrops.

The third belt comprises the lime quarries on Kane creek, the outcrops near Applegate, and those west of Steamboat. Fossils obtained on Kane and Steamboat creeks consist merely of fragments of round crinoid stems.

The fourth belt of lenses is found in several outcrops on Little Applegate river (and across the divide on Anderson and Coleman creeks) and in one (or more) exposures near Watkins on Applegate river. In the former, well preserved round and pentagonal crinoid stems have been found. The fossils do not definitely determine the age of the third and fourth belts, and it seems possible that they should be referred to the Silurian, or an earlier period.

These limestone lenses are of considerable importance because limestone is so scarce in Oregon that the supply for cement and other uses must be sought in them or in similar outcrops. That they are well adapted to such use is shown by the analyses given in the descriptions of the various districts.

The origin of the limestone lenses is an unsolved problem of much interest and importance. They do not seem to be of the proper shape to represent coral reefs, and it seems quite improbable that pure limestone should be deposited in such small areas while mud and sand formed all around it. Mr. L. E. Reber has suggested that the lenses of each belt once formed a continuous belt about 150 feet thick which was sliced diagonally during great tectonic movements along many planes about 500 to 2000 feet apart. The fragments of the bed were then separated by rock flowage and possibly by horizontal faulting during prolonged and important earth movements. The theory fits the known facts very well and deserves careful investigation to determine its validity.

SALMON AND ABRAMS GROUPS

Along the southeastern border of the Paleozoic rocks of Jackson county certain schists commonly intervene between the distinct sediments and the Siskiyou tonalite batholith. West of Wagner creek the schists are hornblendic and grade into amphibolites. In the ridge north of Elliott creek the schists are soft and micaceous or even talcose. In this region some hornblende schists are also found, as well as a layer which appears graphitic. In the region of Red mountain these schists are so mingled with intrusives as to make stratigraphic study nearly hopeless. So far as observed by the writer the relative age of these schists is an unsolved question, but whichever is the older, they both seem to be older than the Paleozoic rocks which adjoin them on the west. They are lithologically and in stratigraphic position identical with the rocks which Hershey [1] has tentatively classed as Precambrian and named the Salmon and Abrams formations. He has found evidence in California that the Abrams formation (the mica schist) is older than the Salmon, or the hornblende schist. These rocks have a banding

[1] Amer. Geologist, Vol. 27, p. 226; 1901.

which is apparently conformable with the adjoining Paleozoic rocks, striking east of north and dipping steeply southeastward in general. Near the Blue Ledge mine a study of the relation between cleavage and banding in certain slates associated with these schists suggests that the series is overturned.

IGNEOUS ROCKS

Igneous rocks are abundant in Jackson and Josephine counties covering areas at least equal to those occupied by the sediments. They are intimately associated with the latter so that their age is closely known in some cases. They intrude, underlie, or cover the sedimentary rocks in various instances. They are also of varied types petrographically, including abundant andesite and tonalite, some serpentine, auganite, rhyolite, and basalt, and less abundant pyroxenite, peridotite, vogesite, and still other types. Some of these rocks flowed out at the surface or formed masses of volcanic fragments which are interbedded with sediments. Others formed stocks, dikes, or sills at varying depths beneath the surface of previously formed sediments.

The earliest igneous rocks seem to be the Paleozoic interbedded andesites. These show their age quite clearly by their highly altered condition as "greenstones" as well as by their interbedded position. Bowlders derived from them form a large part of the overlying Cretaceous conglomerates.

There seem to be some interbedded flows and beds of andesitic type in the Jurassic sediments of Josephine county, but it is possible that these andesites are really sills rather than lavas or tuffs.

At the close of the Jurassic period igneous activity was very pronounced in this region. It began with the intrusion and extrusion of more andesitic greenstones and these were followed by very basic rocks now largely altered to serpentine. Then came the formation of the great Siskiyou tonalite batholith followed by minor intrusions of dacite and auganite. The last rock (called augite andesite) is reported to cut the Horsetown formation of the Lower Cretaceous in some places.

PETROLOGY

The rocks found in Jackson and Josephine counties belong to many different types and include representatives of all the four chief divisions of rocks, that is, the igneous, the katamorphic, the sedimentary, and the anamorphic. These will be described in regular order after a brief statement of the methods used in studying them.

METHODS OF STUDY

The rocks were first studied in the field with special reference to their relationships, their gross structure, their extent, and their present and possible uses.

The samples collected were later studied in detail chiefly by microscopic methods. That is, a chip from each sample was ground down to a plate so thin that it would take a dozen or more to equal the thickness of ordinary paper. This extremely thin plate or section was then mounted between glass plates and examined under the microscope. By this means it is not only possible to greatly magnify the portion observed and see the texture or mode of contact of the constituents, but it is also possible to determine the nature of each mineral present by means of special optical tests, chiefly dependent upon nicols and polarized light.

A few of the samples were also subjected to chemical analysis to determine the quantity of the several oxides present. This supplements but does not displace the microscopic study, since the chemical analysis gives no information concerning the way in which the oxides are combined into the minerals which form the rock. All analyses were carried out in the laboratory of the Oregon Bureau of Mines and Geology by S. W. French, who describes the methods used as follows:

In preparing samples for analysis they were broken to about one-half inch size in a small laboratory crusher and clean fragments of about that size selected so as to avoid contamination. These fragments were then broken to pass a 40-mesh screen, pounding them with the muller on an ordinary bucking board. During this process care was taken to avoid all of the usual grinding movement. The samples from that stage were ground by hand in an agate mortar.

In carrying out the analyses the methods used were those of Hillebrand [1] or of Washington [2] in so far as the equipment of the laboratory would permit. In some of the details the operations were varied to suit the conditions, notably in evaporating solutions in porcelain vessels instead of platinum ware.

Silica was determined by two consecutive evaporations to dry-

[1] U. S. Geological Survey Bulletin 422, 1910.
[2] Chemical Analysis of Igneous Rocks, 1904.

ness, heating each time to 120° C. for an hour, driving off the silica with hydrofluoric acid, and adding to the amount lost the small quantity later recovered from the precipitate of iron and aluminum.

The aluminum and iron were precipitated with ammonia, using a double precipitation. A volumetric determination of the total iron by reduction with zinc then permitted the calculation of the alumina. In the case of samples especially high in titanium, hydrogen sulphide was used in place of zinc.

The ferrous iron was determined by heating one-half gram of the sample, especially powdered, for seven or eight minutes in a mixture of hydrofluoric and sulphuric acids in a well covered platinum crucible, keeping a continuous stream of steam issuing from the crucible to prevent oxidation, no other precautions being taken. The solution thus obtained was diluted with boiled water and titrated with the same solution used for lime and for total iron.

No attempt was made to determine or remove manganese whose presence was indicated by the color of some of the fusions. It probably makes some of the results for magnesia a little high.

The magnesia was precipitated twice as the phosphate and weighed in the usual manner.

The lime was precipitated and dissolved and precipitated a second time, but instead of being ignited it was measured volumetrically, using a rather weak solution of potassium permanganate, one cubic centimeter being equivalent to .001275 grams of lime.

The alkalies were determined by the J. Lawrence Smith method, the potassium being precipitated as K_2PtCl_6 in alcoholic solution, dried at about 130° C., and weighed. The sodium was then determined by difference.

The water driven off below 100° C.(H_2O-) was determined simply by drying the sample at that temperature and measuring the loss in weight.

The water driven off above 100° C. (H_2O+) was measured by ignition in a glass tube through which a stream of air was being drawn constantly by an aspirator, the air passing through calcium chloride both before and after going through the ignition tube. The moisture was determined by the increase in weight of the second calcium chloride tube.

The titanic oxide was determined colorimetrically in ordinary beakers and roughly devised apparatus, but duplicate determinations check to one or two tenths per cent.

The carbonic acid was determined by a titration method recently described by Bowser,[1] which consists in boiling the sample in acid and catching the CO_2 in an absorption tube containing caustic potash solution; the latter is then titrated with sulphuric acid until it is no longer alkaline to phenolphthalein; finally, using methyl orange as an indicator, acid is run in to a change of color.

No other elements were determined.

For convenience all the analyses made for this report are tabulated below.

I. ANALYSES OF VOLCANIC ROCKS FROM SOUTHWESTERN OREGON

[S. W. French, analyst.]

Sample No.	328	358	102	98	189	246	314	228
SiO_2	73.70	55.92	55.76	51.38	47.40	49.02	48.68	37.92
Al_2O_3	13.70	19.16	15.68	17.15	20.14	15.02	17.84	4.38
Fe_2O_3	.70	1.94	1.49	1.12	.58	2.00	3.44	12.76
FeO	2.14	4.76	6.43	6.54	6.64	8.40	6.54	11.18
MgO	.74	5.27	6.36	6.18	6.34	7.06	7.94	16.60
CaO	1.76	5.77	8.71	9.24	7.78	10.46	7.17	13.63
Na_2O	4.28	3.26	1.86	2.72	2.76	3.12	4.06	.29
K_2O	1.42	.38	1.18	.80	2.65	.27	.16	.08
H_2O+	.60	2.90	1.23	1.57	2.98	2.94	3.48	1.14
H_2O-	.04	.06	.10	.10	.12	.08	.07	.06
CO_2				.84				
TiO_2	.34	.75	1.22	1.25	1.54	1.64	1.04	2.22
	99.42	100.67	100.02	98.89	98.93	99.91	100.42	100.26

No. 328. Rhyodacite, Oriole mine, Josephine Co., Ore.
No. 358. Dacite porphyry, Almeda mine, Josephine Co., Ore.
No. 102. Andesite, Opp mine, Jacksonville, Ore.
No. 98. Spessartite, Jacksonville quarry, Ore.
No. 189. Spessartite, Braden mine, Jackson Co., Ore.
No. 246. Auganite, Queen of Bronze mine, Josephine Co., Ore.
No. 314. Auganite, Greenback mine, Josephine Co., Ore.
No. 228. Magnetite pyroxenite, Whitney mine, Gold Hill, Ore.

[1] Jour. Ind. Eng. Chem., March, 1912.

II. ANALYSES OF OTHER ROCKS FROM SOUTHWESTERN OREGON

[S. W. French, analyst.]

Sample No.	10	291	44	9	164	180	221
SiO_2	72.76	60.04	81.10	67.78	65.98	47.42	53.24
Al_2O_3	15.97	17.14	12.89	19.14	17.20	20.56	18.36
Fe_2O_3	.90	2.00	1.64	.56	1.49	1.19	.64
FeO	.52	3.68	.15	2.68	2.68	5.10	7.84
MgO	.06	4.78	.07	.52	2.46	7.08	5.04
CaO	1.26	6.25	.10	1.57	.11	14.04	9.67
Na_2O	3.74	3.96	.28	1.65	2.18	1.80	3.47
K_2O	3.34	1.04	.30	1.46	3.96	.66	.58
H_2O+	.86	.88	4.16	3.12	2.56	1.36	.40
H_2O-	.10	.06	.12	.38	.12	.08	.04
CO_2				.70			
TiO_2		.78			1.40	1.01	.70
	99.51	100.61	100.81	99.56	100.14	100.30	99.98

No. 10. Granite, White Point, Jackson Co., Ore.
No. 291. Tonalite, near Wilderville, Josephine Co., Ore.
No. 44. Laterite, or kaolinized rhyolite, Walker creek, Jackson Co., Ore.
No. 9. Argillite, south of Siskiyou tunnel, Jackson Co., Ore.
No. 164. Argillite, Opp mine, Jackson Co., Ore.
No. 180. Contact rock, Galls creek, Jackson Co., Ore.
No. 221. "Greenstone," Harth and Ryan mine, Jackson Co., Ore.

The rocks of Jackson and Josephine counties are of many different types representing all the chief divisions. One of the most important rock masses is the granitic intrusive which occupies large areas near Ashland, Medford, and Grants Pass. Since it forms the cover of the Siskiyou mountains it is here called the Siskiyou batholith. It forced its way into the region at or near the close of Jurassic time, but before the deposition of the Cretaceous and Tertiary conglomerates and sandstones. The granitic intrusive mass seems to be chiefly tonalite (or quartz diorite), but it varies to granodiorite and even to granite by increase of orthoclase and to diorite by decrease of silica. It is cut by dikes, probably derived from the same magma by differentation, which are of many different kinds. The undifferentiated magma seems to have reached the surface as a volcanic rock in a few places.

There are many other igneous rocks, both older and younger than the Siskiyou batholith; among these andesite is especially abundant.

Katamorphic rocks are more abundant in Josephine County than usual, the type of special importance being serpentine. Residual rocks (of little coherence) are found in many places in both counties, as there has been no glaciation to sweep them away, except about the summits of the highest mountains.

Sedimentary rocks include conglomerates, sandstones, and shales, with limestones present in remarkably small quantities. Some beds of coal are interstratified with the sandstones, which are in many places feldspathic, and in a few places carbonaceous. Some of the sandstones and limestones are cemented and more coarsely crystallized to quartzite and marble.

Anamorphic rocks are found at the base of the plainly sedimentary series, and also about igneous intrusions. They consist of hornblende and mica schists, slates and argillites, contact rocks, and others.

These rocks and their occurence in the area studied are described in the following paragraphs. Igneous rocks are referred to a classification published elsewhere by the writer,[1] and the other rocks are described in the simplest possible terms.

IGNEOUS ROCKS

Igneous rocks belong to three chief classes, namely, those which crystallized with coarse grain at considerable depth, called plutonic rocks; those which solidified at or near the surface with finer, often porphyritic, texture, called volcanic rocks; and those which formed dikes or similar intrusions, having aplitic or similar textures, called hypabyssal (or dike-) rocks.

PLUTONIC ROCKS

Granite in the strict sense is a plutonic rock consisting essentially of orthoclase or microcline with subordinate plagioclase and some quartz and usually mica or hornblende, or both. A sample from White Point about 17 miles by rail south of Ashland consists of abundant orthoclase, some microcline, some plagioclase, quartz, biotite, and muscovite. Much of the muscovite is secondary, flecking the surface of the plagioclase. The rock contains also a little magnetite and secondary hematite, limonite, and kaolinite.

A chemical analysis of this granite shows more soda than potassa, while the reverse condition is indicated by microscopic study of the

[1] Jour. of Geol., Vol. XXI, pp. 208–223, 1913.

minerals. The analysis follows, as well as the mineral composition computed from it.

COMPOSITION OF GRANITE FROM WHITE POINT, OREGON

[S. W. French, analyst.]

		Calculated mineral composition	
SiO_2	72.76		
Al_2O_3	15.97		
Fe_2O_3	.90	Quartz	32.80
FeO	.52	Soda-orthoclase	25.75
MgO	.06	Oligoclase(Ab_4An_1)	31.20
CaO	1.26	Kaolinite	5.85
Na_2O	3.74	Biotite	1.07
K_2O	3.34	Magnetite	1.23
H_2O-	.10	Al_2O_3, H_2O	1.62
H_2O+	.86		
			99.52
	99.51		

The calculated mineral composition is in error in not including muscovite, which according to the analysis may be present to the extent of 11.87 percent; in the thin section there is much less than 12 percent, but the analysis gives no method of determining how much less is actually present.

From a commercial and economic point of view "granite" includes not only granite proper, but also syenite, granodiorite, quartz monzonite, tonalite, diorite, and even gabbro, that is, it means any coarse-grained igneous rock. The granitic intrusive mass in the Ashland district is altered in a few places to a nearly white friable mass; this alteration changes a rock of massive solidity to a granular aggregate that crumbles very easily; the resulting material has been found to make excellent railroad ballast and large quantities have been used by the Southern Pacific railway in this way. The alteration has extended to depths as great as 50 feet in some places while in other places the igneous mass is very little altered even at the surface. It seems possible that one reason for this great difference in the depth of alteration is that the altered rock is a true granite and the unaltered rock is a granodiorite or a tonalite. The granite contains much more orthoclase, which furnishes the potassa necessary to the formation of the most important of the secondary minerals, that is, the sericite or muscovite. But this is probably not the only reason for the difference in the depth of alteration, because similar formation of secondary mica takes place in some igneous rocks without destroying their coherence.

Granite is found not only at White Point, but also on the ridge north of Elliott creek in section 4 or 5, T. 41 S., R. 2 W., where the rock is poor in quartz, grading toward a syenite, and in another sample so deficient in dark colored minerals as to approach an alaskite in composition.

Granodiorite is a plutonic igneous rock consisting essentially of sodic plagioclase feldspar with subordinate potash feldspar (orthoclase or microcline) and some quartz and hornblende or biotite or both. A sample from the "granite" quarry on Neal creek contains abundant plagioclase, both orthoclase and microcline, some quartz, and biotite altering to chlorite; accessory minerals include apatite, titanite, magnetite, zoisite, and calcite. A porphyritic granodiorite was collected about 4 miles south of Ashland on the ditch line. It contains abundant oligoclase-albite, some microcline and quartz, and both biotite and hornblende, with a little titanite and apatite.

Tonalite is a plutonic rock consisting essentially of sodic plagioclase feldspar, quartz, and more or less hornblende or biotite or both. A sample from the Ashland mine consists of plagioclase, abundant green hornblende, quartz, brown biotite, and a little apatite, magnetite, and titanite; the feldspar is considerably altered. Other samples from the same place contain a little pyrite or a little augite. Tonalite from the Cleveland adit on Wagner creek consists of abundant coarsely crystalline plagioclase, flecked with sericite, abundant chlorite, some brown biotite, some quartz, and accessory titanite, pyrite, and calcite. Tonalite has been quarried about 2 miles north of Jacksonville by the Oregon Granite Company; here the rock consists chiefly of coarse plagioclase feldspar, with some quartz, brown mica, green hornblende, and a little titanite and magnetite. The hornblende is partly altered to chlorite, and most of the plagioclase is developed in zones, showing partial alteration to sericite at one stage of growth, and external borders wholly unaltered. A view of the quarry is given in plate III. Tonalite has been quarried also at Ray Gold where the Gold Ray Granite Company has a plant on the Southern Pacific railway about two miles west of Tolo. Here again the rock consists largely of plagioclase with some brown biotite, green hornblende, and quartz, and a little titanite, magnetite, and chlorite. Much of the feldspar is zonal, and was partly altered to sericite and other material at one stage in its growth, the outer zone being fresh and unaltered.

The rock is very coarse grained and hornblende is prominent. This quarry is illustrated in plate IV.

Tonalite occupies a large area, not only at Mount Ashland, but also from west of Jacksonville to Central Point and thence by way of Ray Gold to Sams valley. It forms another important area between Grants Pass, the mouth of Applegate river, and the station called Hugo. A tongue of tonalite extends south to the Granite Hill mine from a large outcrop in the Riddles quadrangle. Other important exposures of the rock are described in this report in the valley of Williams creek, on Mount Reuben, and elsewhere. The rock is widespread in this part of Oregon, and is believed to be of significance in relation to the origin of the ore deposits. Analyses of this rock follow.

COMPOSITION OF TONALITE FROM SOUTHWESTERN OREGON

	I	II
SiO_2	58.25	60.04
Al_2O_3	20.52	17.14
Fe_2O_3	.68	2.00
FeO	3.88	3.68
MgO	2.03	4.78
CaO	7.88	6.25
Na_2O	4.25	3.96
K_2O	.50	1.04
H_2O+	1.10	.88
H_2O-	.24	.06
TiO_2	.57	......
ZrO_2	.01	......
P_2O_5	.16	......
MnO	.10	......
	100.17	100.61

Approximate mineral composition	I	II
Andesine (near Ab_1An_1)	62.9	......
Andesine (Ab_3An_2)	......	45.6
Quartz	13.8	18.0
Hornblende	16.0	22.9
Biotite	5.6	11.9
Titanite	......	.5
Magnetite	......	.3
Apatite, ilmenite, alumina, water	1.6	1.4
	99.9	100.6

I. Tonalite from Umpqua river, Ore. G. Steiger, analyst. U. S. Geological Survey Bulletin 419, p. 167.

II. Tonalite (sheared) near Wilderville, Ore. S. W. French, analyst.

Diorite is a plutonic rock consisting of sodic plagioclase feldspar and hornblende or biotite or both. It is found along the borders of the Siskiyou batholith where the latter comes in contact with shales. Thus, at the very contact of the tonalite with metamorphosed shale now chiefly hornblende, at the Burdic mine on Wagner creek, a small amount of diorite occurs, which is a rather coarse, slightly porphyritic aggregate of plagioclase and green hornblende with unusually large crystals of titanite and a little magnetite. Another sample from the Mattern adit near the Ashland mine contains abundant bluish green hornblende, plagioclase, some brown biotite and magnetite with titanite, chlorite, and apatite. A fine grained diorite is the country rock of the south glory hole adit of the Queen of Bronze mine at Takilma; it contains much plagioclase and green hornblende with some titanite, calcite, and zoisite. Diorite is one of the country rocks of the Buckeye mine on Slate creek where it contains some pyrrhotite and a little chalcopyrite. A similar rock with a texture somewhat aplitic is found at the Rising Star mine near Powell creek and another near the Gold Bug mine on Mount Reuben. On Walker mountain about half way between the Cramer and Eagle mines a rock outcrops which has so much augite (with some sodic plagioclase) that it is intermediate between augite diorite and pyroxenite.

Gabbro is a plutonic rock consisting essentially of calcic plagioclase and pyroxene. It forms the country rock of the Baby and Gopher mines on Walker mountain; and is found in many other places, usually much altered, as at the Star mine near Placer where the rock is now a saussurite, and in section 29, T. 35 S., R. 5 W., where the rock contains abundant augite (mostly altered to green hornblende) and some bytownite, and illustrates Diller's "metagabbro." At Chisholm's copper mine on upper Evans creek, the country rock is in part a variety of gabbro called norite, containing abundant hypersthene poikilitically enclosed by plagioclase and both intergrown with much pyrrhotite and some chalcopyrite, as well as some biotite, hornblende, and magnetite. An analysis of gabbro

COMPOSITION OF GABBRO FROM SOUTHWESTERN OREGON
[H. N. Stokes, analyst.[1]]

SiO_2	56.45
Al_2O_3	13.81
Fe_2O_3	1.73
FeO	3.95
MgO	8.67
CaO	6.69
Na_2O	5.03
K_2O	.46
H_2O+	2.02
H_2O-	.67
TiO_2	.31
P_2O_5	.02
SrO	.02
	99.83

[1] U. S. Geological Survey Bulletin 419, p. 170.

from near the summit of the divide between Brush and Mussel creeks in Curry county, Oregon, is given (p. 47). The rock consists largely of feldspar and pyroxene, the latter being partly altered to hornblende; a little quartz is also present.

Pyroxenite is a plutonic rock consisting essentially of pyroxene. It is associated with the serpentine country rock of adit No. 4 of the Waldo mine at Takilma. It is here composed of abundant colorless augite altering to pale brownish green hornblende and green chlorite in a sort of groundmass of nearly colorless bastite or lamellar chrysotile. On the north end of Walker mountain serpentine is forming from pyroxenite. A similar rock is the country rock of the Marvine mine about a mile west of the Peavine ranger station. A pyroxenite rich in magnetite occurs at the Whitney mine on Gold Hill, an analysis of which is given in connection with the description of the mine.

Peridotite is a plutonic rock consisting essentially of olivine usually with pyroxene or amphibole or both. The variety called dunite, containing only negligible quantities of pyroxene or amphibole, is found on Red mountain and also on Peavine mountain at the Black Bear and Mayflower mines. At the Black Bear mine the rock is largely olivine, altering to serpentine and magnetite, with some tremolite, altering to chlorite. On Red mountain dunite occurs in dikes and consists of olivine about three fourths altered, partly to serpentine with magnetite and partly to minerals suggesting thermophyllite and siderite. This is a fine grained dunite whose texture and mode of occurence is aplitic. An analysis of a peridotite from Riddle, Douglas county, Oregon, follows.

COMPOSITION OF PERIDOTITE FROM SOUTHWESTERN OREGON

[F. W. Clarke, (?) analyst.[1]]

		Approximate mineral composition	
SiO_2	41.43		
Al_2O_3	.04		
Fe_2O_3	2.52	Olivine	70.7
FeO	6.25	Pyroxene	19.9
MgO	43.74	Magnetite, Chromite	4.7
CaO	.55		
Ignition	4.41	Water, etc.	4.5
Cr_2O_3	.76		
NiO	.10		99.8
	99.80		

[1] U. S. Geol. Survey Bull. 60, p. 23, 1890.

VOLCANIC ROCKS

Rhyolite is a volcanic rock composed chiefly of orthoclase feldspar, quartz, and more or less mica, hornblende, or augite. The samples obtained from the rhyolite flows which are interbedded with more basic lavas on Walker creek and in the mountains northeast of Bear creek are so much altered that the original condition is somewhat doubtful; they are now largely amorphous hydrous aluminum silicates with quartz. But unaltered rhyolites are abundant in the same region. The same rock was found as pebbles in the stream in Oregon Caves, and other samples were obtained from Bummer gulch near the Hammersley mine where the rock is brecciated and agglomerated, and from near the Oriole mine in the Galice district, where the rock occurs in dikes with an aplitic matrix, and also varies to a rock too rich in hornblende for typical rhyolite. The last type contains only a little quartz and may be designated a quartz trachyte.

Rhyodacite is a volcanic rock containing abundant plagioclase and subordinate orthoclase and quartz, with more or less mica, amphibole, or pyroxene. A sample from the Oriole mine in the Galice district contains partly broken phenocrysts of plagioclase with some orthoclase in a matrix of fine granular quartz. The phenocrysts are partly altered to zoisite and epidote. The matrix contains some sericite and seems to have suffered shearing. An analysis of this rock is given in connection with the description of the Oriole mine. Similar rocks have been found at the Argo mine, in the Galice district, at the Greenback mine, and at the Lone Pine mine on Forest creek.

Dacite is a volcanic rock consisting essentially of plagioclase and quartz with more or less mica, amphibole or pyroxene. A sample was obtained at the Alameda mine which contains phenocrysts of plagioclase and quartz in a matrix of plagioclase, quartz, epidote, chlorite, magnetite, hematite and kaolin. Similar rocks occur at the Golden Wedge and Gold Bug mines in the Galice district. An analysis of the rock found at the Alameda mine is given in connection with the description of that mine.

Andesite is a volcanic rock containing abundant sodic plagioclase and some biotite, hornblende, or pyroxene. It occurs about a mile and a half west of Hooper and Reeser's sawmill on Walker creek in cliffs overlooking Bear creek valley. Here the lava contained gas bubbles while cooling and the cavities once occupied by the gas are now filled by layers of minerals deposited from circulating waters. The minerals were formed in the following order. (1) fine granular quartz, (2) coarse granular to radiating quartz, (3) fine fibrous penninite, (4) coarsely crystalline calcite. The order is distinct and invariable, but in a single cavity any one or two minerals may be lacking. Away from these amygdaloidal fillings of cavities the rock consists of sodic plagioclase and some chlorite (derived from hornblende) with a little magnetite; there is also a sprinkling of secondary siderite.

Andesite also occurs in the bedrock of "49 Diggings" about 2 miles northwest of Ashland. Here it forms flows which are apparently older than the granitic intrusive mass of Mount Ashland since they lie unconformably beneath the Cretaceous conglomerate. This rock contains abundant colorless to pale brown hornblende in small grains or plates, abundant coarser plagioclase, some biotite and magnetite, a little titanite and apatite, and secondary calcite. A sample from a railroad cut nearby is less altered and contains no biotite, and a few hornblende phenocrysts.

Andesite, altered and more or less sheared to the condition called "greenstone," is an important and abundant rock in many parts of Josephine county, and in some parts of Jackson county. It is not worth while to enumerate all the places where it has been collected, but some of the more prominent are at the Sterling placer mine, at the Mineral Hill mine, at the Opp mine (an analysis being given in connection with the description of that mine), on the ridge north of Little Applegate river, at Steamboat, about 10 miles north of Watkins, at the Blossom and Grey Eagle mines on Sardine creek, on Table Rock, at the Daisy mine near Takilma, at mines on Slate creek, at the Mountain Lion mine, the Oro Fino mine, the Greenback mine, the Sugar Pine mine, and the Gold Bug mine. At the Mineral Hill mine and near Steamboat the rock has been much broken (by vulcanism?) and recemented by andesitic material.

Auganite is a volcanic rock consisting essentially of calcic plagioclase and pyroxene. The lava above a coal seam in section 28, town 40 north, range 2 east, near Pilot Knob, contains abundant phenocrysts of altered zonal labradorite, some pale greenish augite, some hypersthene altering to bastite, and a little magnetite. Pilot Knob itself consists at least in part of auganite, which contains phenocrysts of labradorite and augite and smaller ones of magnetite.

The footwall of the Barron mine vein is probably auganite in which the augite is altered so as to leave only a skeleton of magnetite. The lava flows on top of Grizzly mountain are largely auganite containing phenocrysts of labradorite or of augite in a felsitic groundmass of the same minerals with magnetite.

Auganite is known also at Bollon lake, at the Greenback mine, and at the Queen of Bronze mine. At the Greenback mine the rock contains abundant labradorite and augite (the latter altering to green hornblende and chlorite) and some leucoxene, calcite, and sericite. The following analyses illustrate the composition of auganite from southwestern Oregon.

COMPOSITION OF AUGANITE FROM SOUTHWESTERN OREGON

	I	II	III
SiO_2	48.68	58.41	49.02
Al_2O_3	17.84	17.85	15.02
Fe_2O_3	3.44	2.67	2.00
FeO	6.54	3.29	8.40
MgO	7.94	3.61	7.06
CaO	7.17	6.81	10.46
Na_2O	4.06	3.77	3.12
K_2O	.16	1.23	.27
H_2O+	3.48	.86	2.94
H_2O-	.07	.34	.08
TiO_2	......	.69	1.64
P_2O_5	......	.24	......
SrO	......	.05	......
BaO	......	.05	......
	100.42	99.87	100.01

I. Auganite, 5th level, Greenback mine. S. W. French, analyst.

II. Auganite ("hypersthene-augite andesite"), Llao Rock, Crater lake, Oregon. H. N. Stokes, analyst. U. S. Geol. Survey Bull. 419, p. 168.

III. Auganite, north end adit, Queen of Bronze mine. S. W. French, analyst.

Basalt is a volcanic rock containing calcic plagioclase, pyroxene and olivine. Some of the flows forming the mass of Grizzly mountain and the hills northeast of Bear creek are basalt. A sample from the southwest slope of Grizzly mountain contains abundant phenocrysts of labradorite and some of the olivine altered to serpentine with a few of augite in a felsitic groundmass of the same minerals. A sill about 200 feet north of Bear creek near Mountain avenue bridge north of Ashland contains abundant phenocrysts of augite and smaller ones of magnetite with remnants of olivine altering to serpentine in a groundmass of plagioclase and the other minerals. A sill (or flow) immediately above a coal seam in section 13, township 38 north, range 2 west contains abundant plagioclase, some augite and some serpentinized olivine in black glassy groundmass. Some of the rock forming the top of Lower Table Rock is a basalt containing very abundant plagioclase, some augite, and some olivine altering to bowlingite, with some magnetite.

Augitite is a volcanic rock consisting essentially of pyroxene. It forms a dike at adit No. 4 of the Waldo mine near Takilma where it consists of much broken phenocrysts of augite and smaller crystals of colorless amphibole in a matrix of rock glass. The rock also contains a little serpentine. In hand samples it is remarkable for its light color, probably due to a low tenor of iron, both ferrous and ferric.

HYPABYSSAL OR DIKE ROCKS

Pegmatite is a coarse textured rock of variable composition formed under hydrothermal conditions usually in dikes. A sample from the S. W. ¼ Sec. 18. T, 34 S., R. 2 W. near Evans creek contains coarse muscovite and intergrown quartz and microcline with a little plagioclase. In some places the rock contains valuable quantities of isinglass (mica) and other minerals, but no such occurrences are yet known in Jackson or Josephine county, Oregon.

Aplite proper or granite-aplite is an igneous rock, occuring in dikes, consisting of abundant orthoclase or microcline and quartz, with some plagioclase. A sample from the top of the ridge at the Ashland mine contains abundant microcline, a vermicular intergrowth of orthoclase and quartz and a little plagioclase and biotite. An aplite from the ditch line on Ashland creek about 4 miles south of the city contains abundant quartz and orthoclase, some plagioclase and microcline and a little muscovite and biotite. A sample from the upper intake on the west fork of Ashland creek represents a 1-foot band just above a 2-foot band of hornblende schist in an anticlinal fold in tonalite country rock. It consists of abundant orthoclase, plagioclase, and quartz with a little biotite, epidote, magnetite, and chlorite. A sample from the ridge north of Elliott creek is a biotite aplite containing abundant feldspar, quartz and mica. The dike near the Lucky Bart mill on Sardine creek contains very large abundant anhedra of microcline in a matrix of fine quartz and feldspar with a little muscovite and biotite. The country rock below the Gold Ridge mine on Kane creek contains abundant vermicular to graphic intergrowth of quartz and feldspar, abundant quartz, partly in rounded phenocrysts; much orthoclase, some sericite, little plagioclase, biotite, pyrite, and chlorite. The aplite from the top of the Greenback mine ridge is chiefly a graphic intergrowth of quartz and orthoclase with some plagioclase and quartz and accessory epidote, zoisite, titanite, chlorite, and magnetite. Other outcrops of aplite are known near Coster's mine on Foots creek and at the Bone of Contention mine on Williams creek.

Tonalite-aplite or plagiaplite is a dike rock consisting of plagioclase and quartz with little biotite or hornblende. Samples from the Shorty Hope mine contain abundant quartz and plagioclase with little brown biotite, muscovite, zoisite, chlorite, and rare microcline. Similar rocks are known at the Jewett mine near Grants Pass, and at the Homestake mine on Miller gulch, while a related rock, called granodiorite-aplite, containing subordinate orthoclase and a little microcline occurs at the Ashland mine; the latter contains abundant sodic andesine, considerably altered to sericite; a similar rock outcrops on the new road up Ashland creek in section 32, T. 39 S., R. 1 E.

Malchite is a dike rock consisting of abundant sodic plagioclase with a little hornblende. The wall rock of the Mattern adit near the Ashland mine is composed of abundant plagioclase and some chlorite derived from hornblende; it has aplitic texture. It contains also a little titanite and some secondary calcite. A dike in the Burdic mine on Wagner creek is very similar. A dike in the Gold Pick mine on Bollon creek contains phenocrysts of colorless to pale greenish brown hornblende and of plagioclase (?) altered to opaque masses of kaolin, etc.; in an aplitic matrix of plagioclase, come (secondary?) quartz, and sericite; the rock contains also some titanite, zoisite or clinozoisite, magnetite, partly altered to hematite, and secondary feldspar, apparently both orthoclase and plagioclase. A rock at the Rising Star mine near Powell creek is somewhat similar, as is also a rock near the Gold Bug mine on Mount Reuben.

Kersantite is a dike rock consisting of abundant biotite and plagioclase. A sample from the divide between Sardine and Ward creeks on the Lucky Bart group is not a typical kersantite, but is related to it in mineral composition. It is probably a recrystallized volcanic agglomerate, and as such might be classed with the anamorphic rocks. It has a peculiar spotty arrangement of constituents as well as a rude and indistinct banding, the plagioclase (probably oligoclase) being abundant in spots, biotite in other spots and green hornblende in others. The texture is fine granular aplitic, with phenocrysts of much twinned plagioclase and others of green hornblende.

Spessartite is related to kersantite in composition; it is a dike rock consisting of abundant hornblende and some plagioclase. It occurs at an elevation of about 1900 feet in the N. W. $\frac{1}{4}$ Sec. 6, T. 38 S., R. 2 W. near Jacksonville and also at the quarry near the same town where it is composed largely of hornblende with little plagioclase, titanite, magnetite and calcite, some of the hornblende being zonal, the inner brownish center grading into the second green zone and that into the third colorless zone. A similar rock from the Perkeypile mine on Galls creek contains interstitial plagioclase laths and some pale brown mica as well as seams of fine grained quartz and coarse calcite. Spessartite forms the hanging wall of the Braden vein under the incline shaft. Analyses of these rocks are given in connection with the descriptions of the Jacksonville quarry and the Braden mine.

KATAMORPHIC ROCKS

Katamorphic rocks are those which are produced by processes of oxidation, hydration, and carbonation without simultaneous very high temperature or pressure. They are produced by processes which commonly result in chemical simplification and physical disintegration; therefore, katamorphic rocks are in general more or less incoherent. They include residual and weathered masses of all sorts such as, serpentine, bauxite, and laterite.

Serpentine is a thoroughly hydrated rock derived usually from very dark colored subsiliceous igneous rocks such as peridotite. It is more coherent than most of the katamorphic rocks, but is easily broken along surfaces commonly curved, like those of shale. Serpentine is abundant in Josephine county, and not rare in Jackson county. It is found on the ridge north of Elliott creek, on the east peak of Red mountain, at Siskiyou gap, at the Ramsey mine on Slate creek, on Walker mountain, at the Mt. Pitt mine on Jump-off-Joe creek, at the Gold Coin mine on Coyote creek, on Peavine mountain, and at the Gold Bug mine on Mount Reuben. The following analyses illustrate the composition of serpentine from southwestern Oregon.

COMPOSITION OF SERPENTINE FROM SOUTHWESTERN OREGON

[H. N. Stokes, analyst.]

	I	II
SiO_2	39.42	38.55
Al_2O_3	1.39	1.32
Fe_2O_3	3.42	5.55
FeO	4.29	2.17
MgO	39.68	39.06
CaO	1.10	.85
Na_2O	none	.10
K_2O	none	.05
H_2O+	9.53	10.14
H_2O-	.36	1.14
CO_2	......	.51
S	......	.03
Cr_2O_3	.58	.48
NiO	......	.13
MnO	......	.05
	99.77	100.13

I. Serpentine, 12 miles north of mouth of Boulder creek, Curry Co., Ore. U. S. Geol. Survey Bull. 419, p. 170.

II. Serpentine, crest of Iron mountain, Curry Co., Ore., U. S. Geol. Survey Bull. 419, p. 170.

Laterite is a katamorphic rock usually derived from siliceous igneous rocks. Originally the name was applied to red ferruginous residual masses, but it is now extended to include clay-like masses, such as are found interbedded with more basic lava flows on Walker creek. The following analysis represents the material which parties in the vicinity have proposed to use as high grade pottery clay.

COMPOSITION OF LATERITE FROM WALKER CREEK

[S. W. French, analyst.]

		Calculated mineral composition	
SiO_2	81.10		
Al_2O_3	12.89		
Fe_2O_3	1.64	Quartz	63.91
FeO	.15	Kaolinite	30.30
MgO	.07	Hematite and	
CaO	.10	magnetite	1.79
Na_2O	.28	Feldspar	4.51
K_2O	.30	Enstatite, etc	.30
H_2O-	.12		
H_2O+	4.16		100.81
	100.81		

This analysis shows that the rock, as it is found, probably contains too much silica for the best pottery clay. All high grade kaolins are, however, washed for the market and a washing trial, besides actual burning tests should be made to determine the color, refractory character, and other qualities of this deposit. In this way only can its suitability for making pottery or china ware, or for fire clay purposes, be ascertained. The Oregon Bureau of Mines and Geology has under way an investigation of the materials of this same general type from a number of localities in the state. The laterite from Walker creek will thus receive at an early date the detailed attention which its nature and its occurrence warrant.

SEDIMENTARY ROCKS

Sedimentary rocks are those which have been deposited from solution or suspension in water (or air). They occupy large areas in southwestern Oregon, but are less abundant than the igneous rocks.

Breccia is a consolidated aggregate of large angular rock and mineral fragments. It may be produced by volcanic activity or by faulting. A fault breccia consisting of fragments of quartzite and some limestone cemented by kaolin, limonite, etc., was collected on upper Evans creek, and another found at the Hammersley mine consists of fragments of argillite, quartz, calcite, and serpentine cemented by epidote, quartz, calcite, and kaolin. Volcanic breccias are not uncommon in southwestern Oregon, but they have not been studied.

Conglomerate is a consolidated mixture of coarse gravel and sand. The cliffs northeast of Bear creek at an elevation of about 3000 feet consists of conglomerate in part. The coarse material is partly quartzose, but includes rounded fragments of andesite and other rocks; the sand is both quartz and feldspar with a small amount of other minerals. An older conglomerate containing boulders chiefly of andesite and "greenstone" is found southwest of Bear creek about 2 miles northwest of Ashland. A similar conglomerate occurs near Jacksonville, and also near Waldo. A conglomerate with more quartz forms the lower part of the placer deposit at the Sterling mine south of Jacksonville. There are many other outcrops of conglomerate which are of little importance and need not be enumerated.

Arkose is a cemented or coherent sand the grains of which consist essentially of feldspar and quartz. Some of the Tertiary rocks of Bear creek valley contain enough feldspar to be called arkose. An older rock from Bummer gulch is an arkose grading toward a greywacke through partial recrystallization.

Sandstone is a cemented or coherent sand the grains of which are chiefly or wholly quartz. Sandstone is very abundant on the northeast side of Bear creek; it outcrops at the Alice mine on Kane creek, at the Lone Pine mine on Forest creek, at the Opp mine near Jacksonville, at the Bill Nye mine on Galls creek, and at many other places in Jackson and Josephine counties. Quartzite is either a variety of sandstone which has a siliceous cement or an anamorphic rock which results from the recrystallization of sandstone. It may be distinguished from sandstone by the fact that a break passes through the constituent quartz grains rather than between them. Some of the Paleozoic sandstones of the region have been cemented with silica to form quartzite, as on Red mountain, on Powell creek, and on Peavine mountain.

Tuff is a cemented or coherent mass of fragments of volcanic origin. Rocks of this kind are reported in southwestern Oregon, but have not been studied by the writer.

Mud and clay are plastic sediments deposited from suspension in water; they are composed of hydrated silicates usually with some very fine particles of unhydrated minerals. Such sediments are abundant along the chief streams of the region, and have been used in some places. An indurated or hardened clay occurs beneath some coal seams, as at Beeson's coal mine near Talent. A partly indurated ferruginous clay or ochre outcrops in section 9, T. 38 S., R. 1 E. near Ashland.

Shale is a dry mud usually having such coherence as to break under the hammer into many rudely lenticular fragments. Typical shale is rare in Jackson and Josephine counties, but is abundant near Hilt, California, only a few miles south of Ashland. Shale and clay found on Cheney creek near the limestone deposit controlled by the Rogue River Lime Company have been analyzed; the results are given in connection with the description of the deposits. By dehydration and recrystallization shales grade into argillites; by the development of secondary cleavages they become slates. Argillites are very abundant in the region studied, especially among the Paleozoic rocks.

COMPOSITION OF LIMESTONES FROM SOUTHWESTERN OREGON

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
SiO_2	.31	.37	25.21	.92	23.86	3.1	.23	2.1			.13	.06	.53
Al_2O_3, Fe_2O_3	.44	.20			.32	2.2	.28	1.2	.2	.4	.38	.62	.52
MgO	.03	.01	.62	.40	trace	2.5	.03	trace	.1	.4		trace	trace
CaO	55.34	55.71	39.02	55.00	41.83	50.0	55.28	54.3	55.6	55.3	55.55	55.38	55.05
H_2O	.56	.37			.46		.50				.20	.40	.50
CO_2	43.23	43.54	31.48	43.66	32.57	42.2	43.57	42.6	43.8	43.7	43.63	43.51	43.25
	99.91	100.20	96.33	99.98	99.04	100.0	98.89	100.2	99.7	99.8	99.95	99.97	99.85

I. Householder's quarry on Kane creek in Sec. 2, T. 37 S., R. 3 W.
II. Hughes' (Carter's) quarry on Kane creek in Sec. 2, T. 37 S., R. 3 W.
III. One-fourth mile west of Gold Hill in Sec. 16, T. 36 S., R. 3 W.
IV. One mile N. W. of Gold Hill in Sec. 16, T. 36 S., R. 3 W.
V. One and a half miles S. W. of Gold Hill in Sec. 20, T. 36 S., R. 3 W.
VI. Near Rock Point, probably in Sec. 23, T. 36 S., R. 3 W.
VII. Rogue River Lime Co. on Cheney creek in Sec. 19, T. 37 S., R. 6 W.
VIII. Face of cliff in same locality.
IX. Croppings in same locality.
X. Beneath stripping in same locality.
XI. Jones' marble quarry on Williams creek in Sec. 31, T. 38 S., R. 5 W.
XII. Three miles S. 70° E. of Kerby.
XIII. Near Watkins on Applegate river in Sec. 7, T. 41 S., R. 5 W.

Analyses I, II, V, VII, XI, XII and XIII are by R. C. Wells of the U. S. Geological Survey, published in Bulletin 419, p. 209. Analyses III and IV are by P. H. Bates of the U. S. Geological Survey, published in Bulletin 387, p. 29. Analysis VI is by J. S. Phillips, published in Bulletin 387, p. 29. Analyses VIII, IX and X are reported by S. B. Gorbutt of Grants Pass, made for the Rogue River Lime Company.

Limestone is a coherent sedimentary rock derived from material in solution and composed chiefly or wholly of calcium carbonate, usually in the form of calcite. It occurs in lenticular masses more fully described elsewhere in this report. Analyses of this rock are given on page 58; they show that it is well adapted for making cement or other products in which calcium carbonate is used.

ANAMORPHIC ROCKS

Anamorphic rocks are those which have been under conditions of decarbonation, dehydration, and deoxidation. They have recrystallized under high temperature or high pressure or both with resultant chemical complication and probable physical increase of density.

Argillite is an indurated and more or less recrystallized shale; it is not common in the Ashland district, but outcrops at an elevation of about 3100 feet in a railroad rock cut about 200 feet south of the south end of the Siskiyou tunnel, where it is of a light gray color and very well bedded, the strike being N. 30° E. and the dip 23° E.S.E. The argillite was deposited on an old eroded and weathered surface of andesite. The former is so extremely fine grained that its nature was not easily established; in thin section it is found to contain abundant very minute crystalline flakes and particles in an amorphous groundmass with a few veinlets of calcite. But the following chemical analysis shows that the rock is an argillite, since calculation into igneous minerals yields 12 per cent of corundum and 46 per cent of quartz.

ANALYSIS OF ARGILLITE FROM SOUTH OF SISKIYOU TUNNEL

[S. W. French, analyst.]

SiO_2	67.78
Al_2O_3	19.14
Fe_2O_3	.56
FeO	2.68
MgO	.52
CaO	1.57
Na_2O	1.65
K_2O	1.46
H_2O-	.38
H_2O+	3.12
CO_2	.70
	99.56

Argillites are very abundant in the area occupied by old Paleozoic rocks in southwest Jackson and southeast Josephine counties. They form the bedrock of the placer near Jacksonville, and are found at the Opp mine, at the Buckeye mine on Slate creek, etc.

Greywacke is a dense rock produced by partial recrystallization of arkose; it may contain fragments of rocks as well as minerals. A sample from Bummer gulch near the Daisy mine contains abundant poorly rounded fine grains of quartz and some grains of plagioclase and of orthoclase cemented by reddish brown biotite, and, in other parts, by nearly colorless mica.

Hornblende schist is a rock often of uncertain origin consisting of hornblende in layers usually separated roughly by layers of quartz with other minerals such as biotite and feldspar. It may be the result of recrystallization of argillite or greywacke under conditions of unequal pressure. A dark schistose band two feet thick forming an anticline in tonalite beside the upper intake on the west fork of Ashland creek is a hornblende schist which consists of a fine grained banded aggregate of green hornblende, quartz, biotite, plagioclase, and a little titanite.

A similar rock occurs at several places on Wagner creek and the outcrop extends more or less continuously southward to Red mountain and Dutchman's peak.

Chlorite schist is similar to hornblende schist in its mode of origin, but implies the presence of more water. Chlorite schist may be produced from hornblende schist by the katamorphic process of hydration, but apparently it is not always produced in this way. It occurs at the Granite Hill mine near Grants Pass, the Michigan mine near Murphy, and the Bradbury mine near Galice.

Talc schist is a rare rock of doubtful origin, that is probably produced at times by recrystallization of serpentine under unequal pressures. A sample was obtained at the north end of the top of Walker mountain.

Quartzite is an anamorphic rock in case it has been recrystallized, as seems to be the fact in many instances in southwestern Oregon. Quartzite of this type is associated in Oregon with quartz schist which is usually produced by recrystallization of sandstone (or quartzite) under conditions of unequal pressure. Such rocks grade into mica schists in which one or two micas have been developed during recrystallization. Quartzite, quartz schist, and mica schist are all found on Elliott creek and extend south to the Blue

Ledge mine. Quartzite is also known on Red mountain, on the Applegate river near Watkins, at the Bill Nye mine on Galls creek, at the Alice group on Kane creek, and on Peavine mountain. Mica schist outcrops near the Opp mine, at the Queen of Bronze mine near Takilma, at Ingrams' mine on Oscar creek, and near the Mayflower mine on Peavine mountain.

Marble is often the result of recrystallization of limestone. Very pure marble exists on Williams creek, and similar material is found on Cave creek and on Cheney creek associated with the limestone deposits into which the rock may grade. A marble containing irregularly distributed masses of serpentine is called an ophicalcite; such a rock forms a small outcrop on top of Red mountain.

Contact rocks are produced by the effects of igneous magmas in modifying rocks, especially limestones, with which they come in contact. A contact rock in the main adit of the Shorty Hope mine about 1000 feet from the portal contains some plagioclase, epidote, magnetite, hornblende, calcite, chlorite, quartz, orthoclase, zoisite, muscovite and a mineral resembling wollastonite. A contact rock on Red mountain has a sort of matrix of green hornblende, fine granular quartz, coarser altered plagioclase, some biotite, orthoclase, and apatite, in which are large radiating prisms of actinolite. Another rock from Squaw creek contains abundant zoisite, clinozoisite, and pale epidote with quartz, plagioclase, augite, titanite, and sericite. A rock from near the Lucky Bart mill on Sardine creek has a globulitic texture and a distinct banding; it contains abundant feldspar, green hornblende, and quartz, with little calcite, magnetite, zoisite and titanite. A contact rock from near the Kubli mill on Galls creek is described with an analysis, in connection with the description of gold mines in that district. Another rock from Gold Hill contains abundant garnet, some diopside, some plagioclase, and little clinozoisite and titanite. A contact rock consisting wholly or largely of epidote is known as epidosite; such a rock occurs at the Sugar Pine mine in the Galice district and also near the Gold Bug mine on Mount Reuben. The former contains some plagioclase, but is probably a much altered limestone; the latter seems to be an epidotized andesite.

MINERAL RESOURCES

The mineral resources of Jackson and Josephine counties include road metal, building stone, marble, limestone, shale, clay, mineral paint, mineral water, iodine, coal, graphite, asbestus, mica, gypsum, barite, and celestite, as well as ores of platinum, iridium, gold, silver, copper, lead, zinc, iron, manganese, chromium, molybdenum, mercury, arsenic, and antimony.

NON-METALLIFEROUS DEPOSITS

Road metal, or rock suitable for use in building roads, is found in nearly all parts of the two counties, but the material especially useful on account of its qualities and location is found in the Ashland, Jacksonville, Gold Hill, and Grants Pass districts. Good road metal, not at present as accessible as other deposits, is found in the Upper Applegate district, and elsewhere. The lavas and "greenstones" found in nearly all parts of the two counties include much material which after crushing makes very goood macadamized roads. The disintegrated granite at White Point and near Grants Pass is a good railroad ballast and makes a suitable surface material for walks and drives.

Building stone of some kind is available in every district in Jackson and Josephine counties, but the stones especially well suited by their qualities and location for use in buildings are found chiefly in the Ashland, Jacksonville, and Gold Hill districts. Granite is found in all these districts and sandstone is obtained near Jacksonville. Marble, suitable for use as a building or ornamental stone, has been quarried near Williams in the Lower Applegate district.

As far as our present knowledge goes there is more limestone in the Grants Pass quadrangle than in any other area of equal size in the western part of the state. It is found in lenses in Paleozoic rocks in the Upper Applegate, Gold Hill, Lower Applegate, and Waldo districts. It has been used for lime, and will probably soon be used for the manufacture of Portland cement. The quality is excellent for both purposes, and the quantity in certain deposits is sufficient for many years.

Shale, in its technical petrographic sense, is rare in Jackson and Josephine counties, but in its commercial sense it is very abundant, because much of the rock accurately called argillite can be used as shale. Such material is abundant in the Upper and Lower

Applegate and the Waldo and Gold Hill districts, and is found also in the other districts. Near Gold Hill and on Cheney creek plans have been made to use it in making Portland cement.

Clay is almost as varied in type and use as stone. Ordinary alluvial clay is found at many points along the chief streams, and has been used extensively for making brick and tile near Tolo on Rogue river. Another brick plant is in operation near Jacksonville. A bed of pottery clay exists on Upper Evans creek in the Gold Hill district. A fire clay forms a bed underlying coal as at Beeson's mine in the Ashland district. A residual clay, which may be used as a refractory material, is known on Walker creek in the same district. A red clay, perhaps useful as a mineral pigment, outcrops in section 9, township 38 north, range 1 east, at an elevation of about 3000 feet above sea level.

Mineral water of several different kinds forms springs in several parts of the Ashland district. Its use as a drinking water and for medicinal purposes should increase very largely. The most important springs are near or to the southeast of the city of Ashland where health resorts making use of the springs are being established. One of these springs is reported to contain important quantities of iodine, and it may be possible to recover this substance on a commercial scale.

Coal is found in Tertiary beds in the Ashland, Jacksonville, and Gold Hill districts in an area extending from the California line near Pilot Rock northwestward along the northeastern side of Bear creek to the Rogue river and thence northward (beneath lava flows) to upper Evans creek. The most promising part of this outcrop is near Medford and Ashland. The coal is bituminous and carries a large amount of ash as broken in the mine, but it may be of use in local industries, or in gas producing plants for power.

Graphite is reported near Buncom in the Upper Applegate district and a graphitic schist outcrops at the Blue Ledge mine in the same region as well as at the Mayflower and Golden Wedge mines in the Galice district. No deposits of commercial value are known at present.

Asbestos is found in small quantity in serpentine in the Gold Hill district. No workable deposits have as yet been discovered.

Mica is a constituent of certain pegmatite dikes in the Gold Hill district on upper Evans creek. The quality is satisfactory, but the quantity known does not justify development.

Gypsum, barite, and celestite are part of the gangue in the ores of the Alameda mine. No important quantities have been opened.

ORE DEPOSITS

Aside from the mineral resources already enumerated, which are mined or obtained for use in their natural state, there are important resources which are mined for the purpose of extracting from them some constituent of value. In general, the valuable constituent is a metal and the substance mined is a metallic ore. In most ores the metal is chemically combined with one or more other elements; less commonly, as in some ores of gold and platinum, the metal is pure (or alloyed with other metals) and is said to occur native or free. But even in this case it is usually not used as taken from the ore, being first carefully purified.

The less important ore deposits of Jackson and Josephine counties are those of platinum, chromium, molybdenum, iron, manganese, silver, lead, zinc, antimony, arsenic, and mercury. The more important ores are those of copper and gold.

Platinum, usually alloyed with a little iridium and osmium, is found in placer gravels in the Waldo district. It is probable that, as in the Ural mountains, it is derived from the serpentine of the region.

Chromium ore in the form of chromite is found in the serpentine of the Lower Applegate and Waldo districts. It was used at the Takilma smelter as a non-metallic mineral resource because chromite is a good refractory material. It may be used as a source of chromium for the manufacture of alloys with iron or nickel.

Molybdenum ore occurs in small quantity at the Blue Bell mine in the Galice district and in a dike on Ashland creek. So far as known the amount is insignificant. The ore consists of molybdenite.

Iron ore is known in the Gold Hill, Lower Applegate, and Waldo districts. Near Gold Hill the ore is a magnetite pyroxenite; near Waldo it is magnetite occurring in serpentine; on Powell creek in the Lower Applegate district it is a quartzite having a cement of hematite with some magnetite. The Gold Hill and Powell creek deposits are of no value as known at present, but deserve further investigation.

Manganese ore, in the form of rhodonite and rhodochrosite with some surface alteration to pyrolusite, exists on Cave creek in the Waldo district, but the known quantity is unimportant.

Silver ore is found in Jackson and Josephine counties only in association with other more important ores, as of gold, copper, or lead. Silver occurs in small amount in nearly all the gold ores of the area; it is also known with the copper ores, especially at the Almeda mine in the Galice district. Finally, it is rather abundant at the lead mines on Emigrant and Elk creeks in the Ashland and Rogue river districts. On Emigrant creek it is found at the Barron mine with lead, zinc, and copper.

Lead ore is important at the Barron mine in the Ashland district and at the Buzzard mine on Elk creek. It is found in the Alameda and other mines near Galice, both those important for copper and those whose chief value is gold. It is often closely associated with silver ore. At the Yellow Horn mine in the Greenback district it is associated with gold ore.

Zinc ore is far more important at the Barron mine in the Ashland district than anywhere else in Jackson and Josephine counties, though it is known also at the Buzzard mine on Elk creek and at the Treasury and Alameda mines in the Galice district. Selected ore from the Barron mine is reported to carry 44 per cent of zinc.

Antimony ore is found in some quantity at a mine near Watkins in the Upper Applegate district and it is reported at a mine on Forest creek in the same district. The ore consists of stibnite altering to yellow oxide of antimony, and is said to contain $25 in gold and silver per ton. Antimony ore also occurs in small quantity associated with other ores, as at the Barron mine in the Ashland district.

Arsenic ore is found in southern Oregon only in very small quantities associated with ores of other metals. Thus, in the form of arsenopyrite, it is associated with gold ore at the Silent Friend mine in the Greenback district, the Maid of the Mist, and Wright and Myer mines in the Upper Applegate district, and the Braden mine in the Gold Hill district.

Mercury ore occurs in the Ashland and Gold Hill districts, and in both cases it consists of native quicksilver and cinnabar. Considerable mercury is reported to have been obtained from a mine in Seven-mile ridge in the Upper Applegate district. In the Ashland district cinnabar occurs in calcite veins in the bedrock of a placer mine. On upper Evans creek it occurs in "granite" and along its contact with quartzite as well as in calcite veins.

Copper ore exists in small quantities associated with gold ores in the Greenback, Grants Pass, Lower Applegate, and Ashland districts. It occurs in quantities sufficient to form the object of mining operations primarily for copper in the Gold Hill, Galice, Upper Applegate, and Waldo districts. At the Chisholm mine in the Gold Hill district it is found chiefly as chalcopyrite in quartz veins in quartzite and also as a primary mineral of the norite intrusive rock. In the Upper Applegate district chalcopyrite occurs in quartz veins; no important deposits are known except at the Blue Ledge mine south of the district in California. In the Galice district the copper ores are in veins produced at least in part by replacement. The most important deposit lies next to a well marked fault at the contact between slates and dacite porphyry. In the Waldo district the copper ores are intimately associated with serpentine, in which they form irregular masses near the surface; in the Waldo and Queen of Bronze mines the deposits do not occur in well defined veins. Some quartz veins are known in other mines of the district, but they do not contain important quantities of copper ore, so far as known.

Gold ore is the most important mineral resource of Jackson and Josephine counties, at least so far as affecting the life of the people up to the present time is concerned. It is known in every district treated in this report; it was the cause of the first immigration into the region, and has been an important factor in localizing population and developing new areas. Placer gold miners organized the first mining districts in the region, adopting with little change the form of government and laws of districts in northern California. Later, the same miners participated in the organization of county and territorial governments.

The gold ores are of two chief types, namely, those in stream and beach gravels and sands, and those in veins and deposits in solid rocks. The former are derived from the latter; they are found along most of the streams flowing over or from the pre-Tertiary rocks of the region; in general, they are not found on streams draining Tertiary areas.

The gold ores in veins are found in many kinds of rocks older than Tertiary, but are not found in later formations. They are frequently in "greenstone," and in most cases are not far from intrusions of tonalite. The following table presents the facts of mode of occurrence in the briefest possible manner.

MODE OF OCCURRENCE OF GOLD ORES IN SOUTHWESTERN OREGON

Ashland District

Mine	Important vein minerals	Country rock	Probable age of country rock
Ashland....	Gold, pyrite, pyrrhotite, quartz, sericite	Tonalite, etc	Jurassic
Mattern...	Gold, pyrite, quartz, calcite	Malchite.......	Jurassic
Reeder....	Gold, pyrite quartz, calcite, chlorite	Tonalite, aplite	Jurassic
Shorty Hope	Gold, pyrite, chalcopyrite, pyrrhotite, galena, quartz, calcite	Tonalite, etc....	Jurassic
Burdic.....	Gold, pyrite, quartz.........	Tonalite, diorite, malchite	Jurassic
Ruth......	Gold, pyrite, quartz, calcite, pyrolusite	Hornblendite....	Precambrian?
Little Pittsburg	Gold, pyrite, quartz, calcite	Hornblendite....	Precambrian?
Snapshot	Gold, pyrrhotite, quartz.....	Tonalite........	Jurassic
Columbine	Gold, pyrite, marcasite, chalcopyrite, quartz, pyrolusite	Diorite..........	Jurassic?
Pilgrim....	Gold, pyrite, quartz.........	Quartz schist...	Precambrian?
Cracker-Jack	Gold, pyrite, chalcopyrite, bornite, quartz, calcite...	Hornblende quartz schist	Precambrian?
Bula.......	Gold, pyrite, quartz, "clay"	Tonalite........	Jurassic

Upper Applegate District

Mine	Important vein minerals	Country rock	Probable age of country rock
Sterling	Gold, pyrite, quartz, calcite	Andesite?.......	Paleozoic?
Queen Anne	Gold, pyrite, quartz.........	Argillite........	Paleozoic
Lone Pine .	Gold, pyrite, quartz.........	Argillite........	Paleozoic
Oregon Belle	Gold, pyrite, quartz.........	Andesite, argillite	Paleozoic
Wright....	Gold, galena, sphalerite, quartz	Tonalite, greenstone	Jurassic
Afterthought	Gold, pyrite, quartz.........	Argillite........	Paleozoic
Maid of the Mist	Gold, arsenopyrite, pyrite, quartz, calcite	"Greenstone"...	Paleozoic?
El Senor...	Gold, pyrite, quartz........	Argillite........	Paleozoic
Steamboat	Gold, pyrite, quartz........	Andesite........	Jurassic?
Wright & Meyer	Gold, chalcopyrite, pyrite, arsenopyrite, pyrrhotite, quartz	Andesite........	Jurassic?
Edwards & Garrison	Gold, pyrite, quartz, "clay"	Chlorite schist..	Precambrian?

Jacksonville District

Mine	Important vein minerals	Country rock	Probable age of country rock
Town......	Gold, pyrite, quartz........	Argillite........	Paleozoic
Yellow King	Gold, pyrite, quartz, "clay"	Andesite........	Jurassic?
Norling....	Gold, pyrite, quartz........	Andesite........	Jurassic?
Opp.......	Gold, pyrite, telluride, (petzite?), quartz, chlorite, calcite.	Argillite, quartzite, andesite	Paleozoic (andesite Jurassic?)

Gold Hill District

Mine	Important vein minerals	Country rock	Probable age of country rock
Trust Buster	Gold, (pyrite?), quartz......	Tonalite........	Jurassic
Sylvanite..	Gold, pyrite, galena, quartz.	Argillite........	Paleozoic
Revenue...	Gold, quartz...............	Argillite, limestone	Paleozoic
Gold Hill..	Gold, quartz, pyrite, calcite	Tonalite? pyroxenite?	Jurassic?
Whitney...	Gold, chalcopyrite, quartz, "clay"	Pyroxenite......	Jurassic?
Nellie Wright	Gold, pyrite, chalcopyrite, (galena?), quartz	Tonalite........	Jurassic
Bowden. ..	Gold, (pyrite?), quartz......	Tonalite........	Jurassic
Millionaire	Gold, pyrite, chalcopyrite, galena, (sylvanite?), quartz, calcite	Argillite, andesite	Paleozoic, (andesite later?)
Eagle......	Gold, quartz...............	Argillite, andesite	Paleozoic, (andesite later?)
Alice......	Gold, pyrite, pyrolusite, quartz	Argillite, andesite	Paleozoic, (andesite later?)
Gold Ridge	Gold, quartz...............	Quartzite? andesite	Paleozoic?
Braden....	Gold, pyrite, arsenopyrite, chalcopyrite, galena, quartz, calcite	Argillite, spessartite	Paleozoic (spessartite later?)
Last Chance	Gold, quartz...............	Andesite........	Jurassic?
Bill Nye...	Gold, pyrite, quartz.........	Quartzite.......	Paleozoic
Tin Pan....	Gold, pyrite, galena, quartz	Andesite, limestone, argillite	Paleozoic (andesite later?)

Gold Hill District (continued)

Mine	Important vein minerals	Country rock	Probable age of country rock
Dixie Queen	Gold, quartz...............	Argillite........	Paleozoic
Bertha....	Gold, quartz................	Quartzite, limestone, andesite	Paleozoic (andesite later?)
Harth & Ryan	Gold, quartz, "clay"........	"Greenstone" ..	Paleozoic
Homestake	Gold, pyrite, galena, sphalerite, quartz	Quartzite, argillite	Paleozoic
Cartinell .	Gold, chalcopyrite, quartz	Andesite........	Jurassic?
Blossom...	Gold, pyrite, chalcopyrite, galena, pyrrhotite, quartz, calcite, sericite	"Greenstone"...	Paleozoic?
Corporal G	Gold, pyrite, pyrrhotite, chalcopyrite, bornite, sphalerite, galena, quartz	Quartzite, andesite, spessartite	Paleozoic (andesite later?)
Lucky Bart	Gold, pyrite, sphalerite, galena, quartz, calcite	Argillite, quartzite spessartite	Paleozoic (spessartite later?)
Grey Eagle	Gold, pyrite, quartz.........	Andesite, quartzite	Jurassic?

Galice District

Mine	Important vein minerals	Country rock	Probable age of country rock
Benton....	Gold, pyrite, quartz.........	Tonalite, "greenstone"	Jurassic
Gold Bug	Gold, pyrite, chalcopyrite, bornite, quartz, calcite	Andesite, dacite, serpentine	Jurassic
Copper Stain	Gold, pyrite, quartz.........	Serpentine......	Jurassic
Kramer....	Gold, pyrite, telluride, quartz, calcite	"Greenstone"...	Jurassic?
Keystone..	Gold, pyrite, quartz.........	"Greenstone" ..	Jurassic?
Argo.......	Gold, pyrite, quartz.........	Dacite	Jurassic
Bradbury..	Gold, pyrite, quartz.........	"Greenstone"...	Jurassic?
Golden Wedge	Gold, pyrite, quartz, siderite, sericite, (graphite?)	"Greenstone", dacite	Jurassic
Friday.....	Gold, pyrite, galena, quartz	"Greenstone"...	Jurassic?

Galice District (continued)

Mine	Important vein minerals	Country rock	Probable age of country rock
Oriole.....	Gold, pyrite, chalcopyrite, quartz	"Greenstone" rhyodacite	Jurassic
Buffalo....	Gold, pyrite, chalcopyrite, quartz	Quartzite, serpentine "greenstone"	Jurassic
Mayflower	Gold, pyrite, chalcopyrite, quartz	Serpentine, mica schist	Jurassic
Spokane...	Gold, pyrite, quartz.........	Mica schist, serpentine	Jurassic
Black Bear	Gold, pyrite, chalcopyrite, quartz	"Greenstone," serpentine, dunite	Jurassic
Nesbit.....	Gold, pyrite, quartz.........	"Greenstone", talc schist, serpentine	Jurassic
Sugar Pine	Gold, pyrite, chalcopyrite, Galena, quartz	Amphibole schist	Jurassic?
Silent Friend	Gold, pyrite, arsenopyrite, chalcopyrite, quartz, calcite, chlorite	"Greenstone"	Jurassic?
Martha....	Gold, pyrite, quartz.........	"Greenstone"...	Jurassic?
Gold Coin	Gold, pyrite, quartz, calcite	"Greenstone" serpentine	Jurassic?
Marshall .	Gold, pyrite, quartz.........	Serpentine diorite	Jurassic
Greenback	Gold, pyrite, quartz, calcite	Andesite, serpentine	Jurassic
Yellowhorn	Gold, pyrite, pyrrhotite, chalcopyrite, galena, quartz, calcite	"Greenstone"	Jurassic?

Grants Pass District

Mine	Important vein minerals	Country rock	Probable age of country rock
Jewett.....	Gold, pyrite, sylvanite, pyrrhotite, quartz, calcite	Tonalite, "greenstone"	Jurassic
May Queen	Gold, pyrite, quartz.........	"Greenstone"...	Paleozoic?
Ten Spot. .	Gold, pyrite, quartz	Tonalite........	Jurassic
Granite Hill	Gold, pyrite, chalcopyrite, galena, quartz	Tonalite, "greenstone"	Jurassic

Grants Pass District (continued)

Mine	Important vein minerals	Country rock	Probable age of country rock
Cramer....	Gold, pyrite, quartz.........	"Greenstone"...	Paleozoic?
Baby......	Gold, pyrite, quartz, calcite	Gabbro.........	Jurassic
Gopher....	Gold, pyrite, quartz, calcite	Gabbro.........	Jurassic
Eagle......	Gold, pyrite, quartz........	Argillite, pyroxenite	Paleozoic?
Lucky Queen	Gold, pyrite, quartz.........	Quartzite.......	Paleozoic?
Oro Fino	Gold, pyrite, quartz, calcite	Andesite........	Jurassic?
Mt. Pitt	Gold, pyrite, quartz, calcite	Argillite, serpentine	Paleozoic?
Daisy......	Gold, pyrite, quartz, calcite, epidote	Andesite........	Jurassic

Lower Applegate District

Mine	Important vein minerals	Country rock	Probable age of country rock
Ramsey...	Gold, quartz, "clay"........	"Greenstone," serpentine	Jurassic
Michigan	Gold, pyrite, quartz.........	Chloritic "green stone"	Jurassic?
Ingram....	Gold, pyrite, quartz.........	Argillite, sandstone, limestone, andesite, serpentine	Paleozoic with later intrusives
Golconda..	Gold, pyrite, quartz.........	Quartzite, argillite, tonalite, aplite	Paleozoic with later intrusives
Exchequer	Gold, pyrite, quartz.........	"Greenstone"...	Jurassic
Mountain Lion	Gold, pyrite, quartz, calcite	Andesite, argillite, tonalite	Jurassic
Oregon Bonanza	Gold, quartz................	"Greenstone," aplite	Jurassic
Rising Star	Gold, pyrite, quartz.........	Diorite, hornblende, schist	Jurassic?
Humdinger	Gold, quartz................	Argillite, quartzite	Paleozoic
Arrowhead	Gold, pyrite, quartz.........	"Greenstone"...	Jurassic?
Bone of Contention	Gold, pyrite, quartz.........	Tonalite, argillite, aplite	Jurassic

Waldo District

Mine	Important vein minerals	Country rock	Probable age of country rock
January First	Gold, pyrite, (galena?) quartz	Argillite, quartzite	Paleozoic
Little Gem	Gold, pyrite, quartz.........	Andesite........	Jurassic?
Brooklyn	Gold, pyrite, quartz.........	Argillite, amphibolite, malchite	Paleozoic with later intrusives
Camp Bird	Gold, pyrite, quartz.........	Auganite	Jurassic?

ORIGIN OF ORE DEPOSITS.

The origin of the less important ores will receive only incidental discussion, the emphasis being placed on copper and gold deposits.

The copper deposits of Jackson and Josephine counties are all closely associated with igneous rocks.

At the Chisholm mine in the Gold Hill district the copper ore is in part a primary constituent of the norite country rock, and the vein deposits were probably derived from the same source. That is, magmatic waters, after concentration through crystallization of the main magma, probably carried copper ores (simultaneously concentrated) into fissures and there deposited them with other vein forming minerals. At this mine there is no evidence that surface waters have produced any important effects; the veins are not leached nor oxidized, and there is no indication of secondary enrichment by meteoric waters.

In regard to the Almeda copper ore the writer is in harmony with the views of Diller[1], except that he discovered evidence of only one igneous rock, which is a dacite. This rock is much altered in an irregular way in places for distances of more than 100 feet from the main vein-forming activity, which occurred along a fault plane following closely the contact between the dacite and Jurassic sediments. The amount of alteration and pyritization in general increases toward the contact, where the rock is locally completely replaced by vein minerals to a distance of 10 to 20 feet. The ore body has only one well defined wall, which is the fault plane, where that has sedimentary material on one side. Dacite dikes penetrate the Jurassic sediments in some places, and, according to Diller, "one that is greatly altered and full of vein quartz with disseminated pyrite may

[1] U. S. Geol. Survey Bulletin 546, p. 79; 1914.

be seen in the slates of the mine on the crosscut to the 100-foot level. The close relation of the dikes of dacite porphyry and the ore body is regarded as indicating that the ore deposits is the final term in the series of changes started by the intrusion of the porphyry dike. This intrusion heated the rocks and initiated the circulation of heated solvents, which, while dissolving some minerals, deposited others in their stead," and the process may have been carried on until the intrusive porphyry itself was in places completely replaced by various ores.

The copper ores in the mines near Takilma are closely associated with serpentine and other subsiliceous igneous rocks. They do not occur in well defined veins, but in irregular masses apparently related to the present erosion surface. Their primary concentration was accomplished by processes which are not fully known; it may have been accomplished by magmatic differentiation, or by solutions probably derived from, and certainly caused to flow by the heat of, an igneous magma. But their present position and form seem to be due to the work of meteoric (or surface) waters. The origin of these ores is more fully discussed in connection with the description of the mines.

The platinum and chromium ores are closely associated with serpentine and are probably derived directly from it. That is, they are believed to have been primary constituents of the igneous rock which has altered to serpentine.

In regard to the origin of the gold ores of southwestern Oregon it is worth while to call attention to several special features.

1. They are remarkably uniform in their mineralogy. In all cases they are found in quartz veins, and, so far as these have been studied carefully, they contain also some pyrite and very little chalcopyrite, galena, and calcite, with minute amounts of arsenopyrite, sphalerite, telluride, and bornite. In some cases pyrite is accompanied by pyrrhotite and marcasite.

2. The gold is everywhere found, not only in the sulphides but also in the quartz. This may be due to the well known action of surface waters in oxidizing the sulphides and leaving the gold in the leached quartz, but in the few mines where unoxidized ores have been reached the same condition seems to exist.

3. In all cases where clear evidence is available part at least of the mineralization has been accomplished after the formation of the main quartz vein, which has been fractured and the fractures filled by later calcite, quartz and pyrite.

4. In harmony with the marked scarcity of manganese[1] minerals of any kind, is the fact that these gold quartz veins throughout the district have given rise to rich placer deposits. Secondary concentration by surface waters has, however, produced a number of "pockets" of extraordinary richness, which are always confined to very shallow depths.

5. The gold ores are everywhere closely associated with igneous rocks. They may occur in veins cutting igneous or sedimentary rocks; in the latter case igneous dikes or other intrusions are present in the immediate vicinity.

6. The gold veins are not found in rocks of Cretaceous, Tertiary, or later age, but are found in sedimentary rocks of earlier periods including Precambrian (?), Paleozoic, and Jurassic.

7. Important auriferous vein deposits already existed in the region when the basal conglomerates of the Cretaceous were formed, since these conglomerates are yielding large amounts of placer gold in some places.

8. The gold ores are found in igneous rocks of the following types: "greenstone," andesite, serpentine (probably originally peridotite), and tonalite (with its associated aplites). As stated by Diller the relative age of the igneous rocks of southwest Oregon is well known. The greenstones are the oldest, followed in order by the serpentine, tonalite, dacite, and "augite andesite." Some of the greenstones are Paleozoic, but most of the igneous rocks, including greenstones, serpentine, tonalite, and dacite belong near the close of the Jurassic. The "augite andesite" is Lower Cretaceous or still younger. The auganite, basalt, and rhyolite (or perhaps rhyodacite) of the Cascade Range are the latest igneous rocks of the region, being of Tertiary age.

From this group of facts it seems probable to the writer that the following inferences may be drawn:

1. The gold ores are probably from a single source and formed at about the same time.

2. The gold ores probably owe their origin to some igneous rock. This conclusion seems more securely founded when larger areas are considered; for example, gold ores are found in southwestern and northeastern Oregon, the only parts of the State where intrusive igneous rocks are known to be widespread.

[1] W. H. Emmons has proved the importance of manganese in the secondary concentration of gold ores; see Amer. Inst. Min. Eng. Bull. 46, p. 767; 1910.

3. Since the gold ores are found in sedimentary rocks of the Jurassic (and earlier ages) they can not be due to igneous rocks which are older than the Jurassic.

4. Since the gold ores are found in tonalite (and older rocks) of the series of igneous rocks already given they can not be due to igneous rocks which are older than the tonalite.

5. Since the gold ores were formed before the Cretaceous and are not found in sedimentary or igneous rocks of Cretaceous or younger age they can not be due to igneous rocks of Cretaceous or younger age.

6. The gold ores are probably due to the tonalite which forms the Siskiyou batholith, with which they are usually intimately associated. In those cases in which the presence of the tonalite is not evident in the immediate vicinity, further exploration may disclose it either at the surface or at no great depth below the surface.

7. While the tonalite is thus held to be responsible for the activity of the solutions which deposited the gold ores, the sources of those solutions is a more difficult problem. They may have come from the tonalite magma or from surface waters, which penetrated the earth near the magma and thus obtained the heat necessary to cause their ascent again to the surface. The writer believes that the solutions came from the magma itself because of the following difficulties to be met by one who accepts the alternative view, and also the more direct evidence of magmatic origin stated below.

(a) Surface waters rarely obtain the temperatures possessed by solutions which form veins.

(b) There is no adequate known source whence surface water could obtain the gold which was deposited in these veins.

(c) If surface waters, stimulated by the tonalite intrusion, deposited the gold ores it is difficult to understand why there is no evidence that surface waters formed similar deposits when the region was intruded by other magmas, especially during the Paleozoic period.

The following evidence directly supports the view that the solutions came from the tonalite magma:

(a) The solutions which formed the gold ores were associated with (if not identical with) solutions which deposited ores of mercury and antimony. There is no known adequate source whence surface waters could obtain these elements, whereas they are known to be formed from the gases of volcanoes.

(b) The solutions which formed the gold ores apparently invariably contained small amounts of copper, lead, zinc, antimony, arsenic, and tellurium, all elements known to be derived at times from magmatic sources.

(c) In some cases as at the Ashland, Shorty Hope, Burdic, and Mattern mines in the Ashland district, the Bone of Contention and Rising Star mines in the Lower Applegate district, the Greenback mine, and the Kramer mine in the Galice district the gold ores are intimately associated with various kinds of aplite dikes which are believed to be direct differentiation products from the tonalite magma.

(d) The solutions which formed the gold ores also deposited tourmaline in a few rare cases, as at the lower adit of the Mineral Hill mine in the Upper Applegate district and at a mine near the Braden in the Gold Hill district; tourmaline is a mineral often found in pegmatites and other deposits known to be produced from solutions from magmas, and never found (so far as known) in deposits not derived from magmas.

If the gold ores of southwestern Oregon are derived from the tonalite magma, which now forms the Siskiyou batholith, it is important to learn the exact boundaries of that batholith in all its outcrops. The boundaries should be mapped and information collected regarding the existence of the batholith below the surface where it does not outcrop. By such means future exploration would have a valuable guide since the ores should not occur far from the batholith, though they may be associated with dikes (or faults) extending some distance away from the main body of the tonalite.

THE FUTURE OF MINING IN SOUTHWESTERN OREGON

The mineral resources of Jackson and Josephine counties are varied and extensive; they will supply large demands for many years. But dealing more particularly with the metal mines, what are the prospects?

The small and very rich placer mines of the region are nearly or wholly exhausted and there is no reason to believe that new deposits will be found to replace those which first attracted white men to the region. On the contrary, certain large deposits of lower grade worked by hydraulic or dredging methods will continue to yield large returns for several decades at least. And it is probably true that there are still opportunities for developing profitable placer mines of this type.

The extremely rich "pockets" of gold due to surface concentration are probably also discovered and worked out, at least for the most part. Being close to the surface they are the first of the vein deposits to be discovered; being small and high grade they are quickly exhausted. But the low grade ores which will yield rich returns when treated economically on a large scale have not yet been extracted; indeed in only a very few mines in the region have developments gone deep enough to open such deposits. There is very good reason to believe that such ores will be worked successfully in the future in some parts of the region. They should be of value to the community, not only in producing new wealth, but also in creating industrial activities far more stable than the placer and "pocket" mining of the past.

THE ASHLAND DISTRICT

LOCATION

The Ashland mining district is situated near the town of that name about twelve miles north of the California boundary in Jackson county, Oregon. The most important mines in the district are on the ridge a few miles west of Ashland, but other mines of note are situated farther west on Wagner creek, to the south of Ashland creek, and to the east southeast on Sampson creek. The district varies in elevation from about 1900 to over 4000 feet above sea level.

HISTORY

The earliest mining in the Ashland district was probably done in 1858; it was in that year that the mining district called Forty-nine Diggings was organized. For about two decades the chief mining activity was in the placer deposits, but the interest gradually shifted to underground mines, and as early as 1880 several of these had been discovered and opened in a small way. About 1890 the Ashland mine was worked more actively and during 1892-1899 its output was about $150,000. About the same time the Shorty Hope and Mattern mines were productive. During the following decade development work continued more or less regularly at the Shorty Hope mine on Wagner creek, but the production of the district decreased considerably.

GEOLOGY

The town of Ashland is located on the border of the intrusive igneous mass which forms the heart of the Siskiyou mountains. To the north and east of Ashland, Bear creek valley is eroded in Cretaceous and Tertiary sediments which lie in beds dipping to the northeast away from the igneous intrusion. To the south and west of Ashland the central part of the mountains is formed of a coarse grained rock which solidified from fusion while a great mass of fused rock material was at considerable depth below the surface. On the east side of Bear creek valley the mountains are formed of nearly horizontal layers of volcanic rocks which took their present position by flowing over the surface as great floods of lava.

The oldest rocks of the Ashland district are those found along Wagner creek (especially in the ridge to the west), which consist of amphibolites and hornblende and quartz mica schists probably produced by the effects upon sedimentary formations of the intrusion of the (once) hot and liquid rock mass composing the mountains to the east. These rocks may be correlated with the Salmon and Abrams formations of Hershey,[1] which he assigns tentatively to the Precambrian. East of Wagner creek are sandstones and argillites with some limestone lenses, which are probably of Paleozoic age.

The next younger series of rocks consists of the great intrusive mass in its various phases. This rock is chiefly tonalite or quartz diorite, that is, it is a coarse grained igneous rock composed of sodic plagioclase feldspar, quartz, and hornblende or biotite or both. The plagioclase feldspar is accompanied in some parts of the mass by orthoclase feldspar; the rock is then called a granodiorite. In other places the plagioclase is largely replaced by orthoclase and the rock is a true granite. Commercially all these rock types pass as granite, and one kind is just as good as any other for use as a building or ornamental stone. Associated with these massive igneous rocks and probably from the same source there are numerous dikes of fine grained igneous rocks of the same general composition as the former, but containing a larger proportion of light colored minerals. They are called aplites in general, some varieties present in this region being tonalite-aplite, plagiaplite, and diorite-aplite or malchite. Near the borders of the igneous intrusion it is less siliceous in some places and contains no quartz; it is then a diorite.

[1]Amer. Geologist, Vol. XXVII, p. 225, 1901.

After the intrusion of these igneous rocks there was a long period of erosion during which the surface was gradually lowered hundreds and perhaps thousands of feet, just as it is being slowly worn away today. The materials removed by erosion were carried away by the streams and deposited in quiet water at some distance. For a long time the region of deposition included the area now occupied by Bear creek valley. At the beginning of this time the rocks formed were conglomerates, which were succeeded by sandstones, in large part containing abundant fragments of feldspars and called feldpathic sandstone or arkose. Some of these rocks contain fossils which give silent testimony that they were formed in Cretaceous times. Later the material deposited included finer sands and even clays. At one time the region was swampy or controlled by other conditions favorable to the development of luxuriant vegetation, which accumulated under water (without weathering) and gradually formed thick beds of peat which finally turned into coal. Near the close of this period of deposition the formation of ordinary sediments was interrupted one or more times by volcanic activity in the mountains to the east, which produced great quantities of volcanic ash that was brought by winds (and water) into beds resembling the finer sedimentary rocks derived from erosion. Fossil leaves found in the coal and in the adjoining rocks show that these deposits were formed in the Tertiary period.[1]

At the close of this period the sedimentary beds were somewhat tilted by elevation of the Siskiyou range or depression of the Cascades so that they dipped at an angle of 10° to 25° toward the northeast. At about the same time the great lava flows from the volcanic vents of the Cascade range covered the sediments which then filled the present site of Bear creek valley, and flowed westward to the slopes of the Siskiyou mountains. These lavas are commonly called basalts, but for the most part they are auganites, andesites, and rhyolites, that is, they contain more silica and alkalies and less iron and magnesia and lime than do the basalts. All of these rocks furnish excellent road materials. In some places the rhyolite has been much altered to a clay which may be of value.

[1] In 1900 these fossils were assigned to the Miocene by Dr. Knowlton (F. H. Knowlton: U. S. Geol. Survey, 20th Ann. Rept., Pt. III, pp. 37-52, 1900) of the U. S. Geological Survey, but in 1909 he regarded them as Eocene (U. S. Geol. Survey Bulletin 341, p. 405, 1909) according to J. S. Diller. In either case they belong to the Tertiary period. Fossils collected by the writer in 1913 and submitted to Dr. Knowlton in 1914 are again referred by him to the Eocene, though with some doubt.

After the cessation of volcanic activity there followed a long period of erosion during which the lava flows were slowly worn away. Along the margin of the flows they were somewhat less compact and were therefore removed a little more rapidly. Thus Bear creek valley originated, and was gradually deepened and widened to its present size, not only cutting through the lavas but also through about a thousand feet of the underlying sedimentary rocks. As an incident of this erosion there are shallow temporary deposits of river gravel and silt of recent formation in various places near water level in the valley. These stream deposits are the most recent formations in the region; indeed, they are still in process of deposition more or less irregularly.

MINERAL RESOURCES

The mineral resources of the Ashland district include building stone, road metal, clay, mineral paint, mineral water, iodine, coal, gold, and some silver, copper, lead, zinc, mercury, and molybdenum.

Building Stone

The chief building stone is "granite," which forms the mass of Mount Ashland (or Siskiyou Peak). A small amount has been quarried on Neal creek about 8 miles southeast of Ashland, and it may be obtained on Ashland creek and elsewhere in the region south of the city. In selecting a site for a quarry the important considerations are: (1) quality of the stone, (2) number and character of joints and rifts, (3) thickness of overburden of soil or weathered rock, (4) accessibility to cheap transportation to market. In the Ashland district the last consideration is of capital importance because stone of good quality with some joints and rifts and very little overburden can be found in many places. Some of the "granite" of the district is less desirable because of the presence in it of irregular bunches of much darker color composed largely of ferromagnesian silicates. Wherever the rock contains sulphides it should not be used because such minerals decompose quickly and not only discolor the rock, but reduce its strength and durability.

Other igneous rocks are sometimes used as building stones, but granite is usually preferred on account of its pleasing color and durability.

Road Materials

The lavas which are so abundant in the northeastern part of the district are too dark colored to find a ready market as building stones although in other respects they are suitable for such use. But they make good paving blocks and are exceptionally valuable as a source of crushed rock for road construction. Such "road metal" is coming into use in many parts of the country and experience has shown repeatedly that better material for surfacing roads can not be obtained. At the same time the various lavas are not all equally good, and the best material in each locality should be carefully selected. Since the different kinds of lava are named from their chief mineral constituents and the minor constituents may have important effects on the durability as road metal, the same kind of lava is not equally good in all localities. Materials of road construction will not bear heavy transportaion charges; therefore the rocks to be used must be selected in each locality, and the only safe basis of selection is furnished by actual experience or practical tests. Commonly it takes too long and is too costly to determine the relative value as road metal of the different kinds of available rocks in a given locality. Therefore the lavas and other possible road materials of each locality should be studied experimentally by laboratory methods and the best kind selected for the various traffic conditions to be expected in the community. At White Point there are valuable deposits of decomposed granite which is useful as railroad ballast and as a surface for walks and drives. The deposits have already been used on the Southern Pacific railroad near the Siskiyou divide.

Clay

Various kinds of clay are found in the Ashland district, but those of special importance are the residual clays produced by profound alteration of rhyolitic lava and the flood plain clay formed by deposition of fine "mud" on lowlands bordering a stream at times of high water. Also, some fire clay is found below coal seams on the northeast side of Bear creek valley. This is a light gray compact rock which contains abundant very fine particles of quartz and also some of calcite with others which are probably of kaolin. The argillite found near the Siskiyou tunnel is an indurated siliceous clay.

Mineral Paint

A bed of red clay is exposed in the bed of a small stream in section 9, township 38 north, range 1 east, at an elevation of about 3000 feet above sea level. The clay contains much hematite, but contains also grains and crystals of magnetite, quartz, chlorite, and (andesine?)

Limonite is associated with the hematite and makes the color somewhat lighter. The impurities in this bed impair its value as a pigment for use in paint, but in spite of them it could be used with fairly good results. Furthermore, if the bed is of sufficient extent to warrant development and use, it will doubtless be possible to eliminate most of the impurities by washing or other methods. When wet the material is quite plastic; to prepare it for use it should be dried, powdered, and probably dehydrated at a high temperature.

Mineral Waters

Mineral springs are numerous in the vicinity of Ashland. Some of them have been productive commercially for many years, and some are improved so as to be used for bathing, for the establishment of health resorts and for medicinal purposes. But they are not used as much as they deserve to be nor as much as they will be in the future. The mineral spring waters are varied in composition and resultant qualities, and their merits are not widely known. Some of them are natural "soda water" charged with their own carbonic acid gas. Others are rich in chlorine and should be used for other purposes. A single instance is known of a water rich in iodine and bromine.

The mineral water containing much iodine was collected by Harry Silver in the Ashland district in August, 1909. Unfortunately no complete analysis is available, but it is known that this sample contained very much sodium chloride ($NaCl$) and calcium chloride ($CaCl_2$), and according to L. A. Bundy, assistant chemist at the Oregon Agricultural College, it also contained 476 parts of iodine and 107 parts of bromine per million parts of water. Mineral waters[1] from deep wells in southern Michigan contain much more bromine than found in this water from southern Oregon, but the writer knows of no water containing as much iodine as that from the Ashland district. In view of the fact that most of the iodine used in this country is now obtained as a by-product of the purification of soda niter imported from South America, and that it is worth about two dollars a pound in New York City, it seems desirable to investigate carefully the possibility of producing iodine in southern Oregon on a commercial scale.

Analyses of mineral waters are stated in many different ways. The salts dissolved in the water are probably more or less divided

[1] Geol. Survey Mich., Vol. V, Pt. 2, pp. 46 and 82.

into their acidic and basic constituents and just what salts are present it is often impossible to state with certainty. Therefore such analyses should not be expressed merely in terms of the compounds supposed to exist in solution, but primarily in terms of the substances obtained by the analytical chemist. It may be useful for some purposes to supplement this by a statement of the salts which are believed to be present.

Furthermore, the results of chemical analysis are stated in parts per million of water, or in grains per U. S. gallon, or in percent of total salts, the total amount of dissolved salts being added in parts per million. For purposes of ready comparison and since each is useful for certain purposes the following analytical results are expressed in these three ways.

COMPOSITION OF "ASHLAND LITHIA" SPRING WATER

[Analysis by A. L. Knisely of Oregon Agricultural College. Collected by Harry Silver, November, 1906.]

Constituent	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Chlorine	Cl	2386.5	138.4	28.84
Carbonic acid radical	CO_3	2494.0	144.6	30.14
Sodium	Na	2543.4	147.5	30.73
Potassium	K	135.8	7.9	1.64
Lithium	Li	9.7	.6	.12
Calcium	Ca	391.1	22.7	4.73
Magnesium	Mg	188.3	10.9	2.28
Iron oxide	Fe_2O_3	} 126.0	7.3	1.52
Alumina	Al_2O_3			
Silica	SiO_2			
		8274.8	479.9	100.00
Salinity, parts per million				8274.8
Theoretical combination	**Chemical symbol**	**Parts per million of water**	**Grains per U. S. gallon**	**Per cent of total salts**
Sodium chloride	$NaCl$	3657.5	212.1	44.20
Potassium chloride	KCl	260.2	15.1	3.14
Lithium chloride	$LiCl$	51.7	3.0	.62
Sodium carbonate	Na_2CO_3	2548.5	147.8	30.80
Calcium carbonate	$CaCO_3$	977.8	56.7	11.82
Magnesium carbonate	$MgCO_3$	653.1	37.9	7.90
Iron oxide	Fe_2O_3	} 126.0	7.3	1.52
Alumina	Al_2O_3			
Silica	SiO_2			
		8274.8	479.9	100.00

COMPOSITION OF "OLD LITHIA" SPRING WATER

[Analysis by Smith, Emery & Co., San Francisco. Sample taken by A. L. Emery, 1914.]

Constituent	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Chlorine	Cl	2422.00	140.48	22.08
Bromine	Br	2.00	.12	.02
Bicarbonic acid radical	HCO_3	4916.61	285.16	44.81
Nitric acid radical	NO_3	.27	.01	.00
Nitrous acid radical	NO_2	.02	.00	.00
Phosphoric acid radical	PO_4	.32	.02	.00
Arsenic acid radical	AsO_4	Trace	....	....
Metaboric acid radical	BO_2	291.31	16.89	2.66
Sodium	Na	2438.92	141.46	22.23
Potassium	K	91.40	5.30	.83
Lithium	Li	7.90	.46	.07
Ammonium	NH_4	6.04	.35	.01
Calcium	Ca	354.46	20.57	3.23
Barium	Ba	1.70	.10	.02
Magnesium	Mg	338.63	19.64	3.09
Iron	Fe	10.20	.59	.09
Manganese oxide	Mn_2O_3	.70	.04	.00
Alumina	Al_2O_3	1.30	.07	.00
Silica	SiO_2	87.82	5.09	.81
		10971.60	636.35	100.00
Salinity, parts per million				10971.60

Theoretical combination	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Sodium Chloride	$NaCl$	3908.27	226.68	35.62
Lithium chloride	$LiCl$	47.92	2.78	.44
Ammonium chloride	NH_4Cl	17.93	1.04	.16
Potassium bromide	KBr	2.98	.17	.03
Sodium bicarbonate	$NaHCO_3$	2719.96	157.75	24.79
Potassium bicarbonate	$KHCO_3$	231.48	13.43	2.11
Calcium bicarbonate	$Ca(HCO_3)_2$	1432.15	83.07	13.06
Barium bicarbonate	$Ba(HCO_3)_2$	3.30	.19	.03
Magnesium bicarbonate	$Mg(HCO_3)_2$	2037.20	118.16	18.57
Iron bicarbonate	$Fe(HCO_3)_2$	32.48	1.88	.30
Sodium nitrate	$NaNO_3$	.37	.02	.00
Calcium phosphate	$Ca_3(PO_4)_2$	.55	.03	.00
Sodium metaborate	$NaBO_2$	447.16	25.94	4.08
Manganese oxide	Mn_2O_3	.70	.04	.00
Alumina	Al_2O_3	1.30	.07	.01
Silica	SiO_2	87.82	5.09	.80
		10971.60	636.35	100.00

COMPOSITION OF "NEW LITHIA" SPRING WATER

[Analysis by Smith, Emery & Co., San Francisco. Sample taken by A. L. Emery, 1914.]

Constituent	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Chlorine	Cl	2076.00	120.41	21.70
Bromine	Br	2.00	.12	.02
Sulphuric acid radical	SO_4	Trace	Trace	Trace
Bicarbonic acid radical	HCO_3	4270.73	247.70	44.64
Nitric acid radical	NO_3	0.27	.02	.00
Nitrous acid radical	NO_2	0.01	.00	.00
Phosphoric acid radical	PO_4	0.21	.01	.00
Arsenic acid radical	AsO_4	Trace	Trace	Trace
Metaboric acid radical	BO_2	272.38	15.80	2.87
Sodium	Na	2193.71	127.23	22.93
Potassium	K	112.32	6.51	1.17
Lithium	Li	8.42	.49	.09
Ammonium	NH_4	5.29	.31	.05
Calcium	Ca	291.92	16.93	3.05
Barium	Ba	1.70	.10	.02
Magnesium	Mg	246.68	14.31	2.58
Iron	Fe	8.60	.50	.09
Manganese oxide	Mn_2O_3	.70	.04	.01
Alumina	Al_2O_3	4.75	.27	.05
Silica	SiO_2	70.90	4.11	.73
		9566.59	554.86	100.00
Salinity, parts per million				9566.59

Free carbon dioxide gas (CO_2) present.

Theoretical combination	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Sodium chloride	NaCl	3168.54	183.78	33.12
Potassium chloride	KCl	212.32	12.31	2.22
Lithium chloride	LiCl	51.07	2.96	.53
Ammonium chloride	NH_4Cl	15.70	.91	.16
Potassium bromide	KBr	2.98	.17	.03
Sodium bicarbonate	$NaHCO_3$	2926.47	169.74	30.59
Calcium bicarbonate	$Ca(HCO_3)_2$	1179.58	68.42	12.33
Barium bicarbonate	$Ba(HCO_3)_2$	3.30	.19	.03
Magnesium bicarbonate	$Mg(HCO_3)_2$	1484.03	86.07	15.52
Iron bicarbonate	$Fe(HCO_3)_2$	27.39	1.59	.29
Sodium nitrate	$NaNO_3$	.37	.02	.00
Sodium nitrite	$NaNO_2$	.02	.00	.00
Calcium phosphate	$Ca_3(PO_4)_2$	.37	.02	.00
Sodium metaborate	$NaBO_2$	418.10	24.25	4.39
Manganese oxide	Mn_2O_3	.70	.04	.00
Alumina	Al_2O_3	4.75	.28	.05
Silica	SiO_2	70.90	4.11	.74
		9566.59	554.86	100.00

COMPOSITION OF SPRING WATER NEAR "ASHLAND LITHIA SPRINGS"

[Analysis by B. Pilkington of Oregon Agricultural College. Sample taken by E. P. Hughes, July 1, 1909]

Constituent	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Chlorine	Cl	2344.45	135.98	25.62
Bromine	Br	None	None	None
Iodine	I	None	None	None
Sulphuric acid radical	SO_4	304.81	17.68	3.33
Bicarbonic acid radical	HCO_3	3515.60	203.90	38.41
Phosphoric acid radical	PO_4	Trace	Trace	Trace
Boric acid radical	B_4O_7	Trace	Trace	Trace
Sodium	Na	2190.79	127.07	23.93
Potassium	K	266.00	15.43	2.91
Lithium	Li	0.56	.03	.01
Ammonium	NH_4	1.13	.07	.01
Calcium	Ca	276.64	16.05	3.02
Magnesium	Mg	166.70	9.67	1.82
Iron oxide Alumina	Fe_2O_3 Al_2O_3	10.00	.58	.11
Silica	SiO_2	76.20	4.42	.83
		9152.88	530.88	100.00

Salinity, parts per million 9152.88

Theoretical combination	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Sodium chloride	$NaCl$	3452.00	200.21	37.71
Potassium chloride	KCl	510.00	29.58	5.57
Lithium chloride	$LiCl$	3.39	.20	.04
Ammonium chloride	NH_4Cl	3.39	.20	.04
Potassium iodide	KI	None	None	None
Potassium bromide	KBr	None	None	None
Sodium sulphate	Na_2SO_4	450.90	26.15	4.93
Sodium bicarbonate	$NaHCO_3$	2513.00	145.75	27.45
Calcium bicarbonate	$Ca(HCO_3)_2$	1120.00	64.96	12.24
Magnesium bicarbonate	$Mg(HCO_3)_2$	1014.00	58.81	11.08
Calcium phosphate	$Ca_3(PO_4)_2$	Trace	Trace	Trace
Sodium borate	$Na_2B_4O_7$	Trace	Trace	Trace
Iron oxide Alumina	Fe_2O_3 Al_2O_3	10.00	.58	.11
Silica	SiO_2	76.20	4.42	.83
		9152.88	530.86	100.00

COMPOSITION OF ARTESIAN WELL WATER

[Analysis by Smith, Emery & Co., San Francisco. Sample taken by A. L. Emery, 1914.]

Constituent	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Chlorine	Cl	560.52	32.51	8.08
Bromine	Br	.50	.03	.01
Bicarbonic acid radical	HCO_3	4290.82	248.87	61.83
Nitric acid radical	NO_3	.55	.03	.01
Nitrous acid radical	NO_2	.04	....	....
Arsenic acid radical	AsO_4	Trace	Trace	....
Metaboric acid radical	BO_2	66.31	3.85	.96
Sodium	Na	1734.17	100.58	24.99
Potassium	K	28.64	1.66	.41
Lithium	Li	2.18	.13	.03
Ammonium	NH_4	6.20	.36	.09
Calcium	Ca	144.58	8.38	2.08
Barium	Ba	.46	.03	.01
Magnesium	Mg	58.37	3.38	.83
Manganese	Mn	1.08	.06	.01
Iron	Fe	.32	.02	.00
Alumina	Al_2O_3	1.72	.10	.02
Silica	SiO_2	34.60	2.01	.50
Oxygen (calculated)	O	9.60	.56	.14
		6940.66	402.56	100.00

Salinity, parts per million.. 6940.66

Theoretical combination	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Sodium chloride	$NaCl$	843.32	48.91	12.15
Potassium chloride	KCl	54.15	3.14	.78
Lithium chloride	$LiCl$	13.22	.77	.19
Ammonium chloride	NH_4Cl	18.39	1.07	.27
Potassium bromide	KBr	.75	.04	.01
Sodium bicarbonate	$NaHCO_3$	4993.75	289.64	71.95
Calcium bicarbonate	$Ca(HCO_3)_2$	491.56	28.51	7.08
Barium bicarbonate	$Ba(HCO_3)_2$	1.54	.09	.02
Magnesium bicarbonate	$Mg(HCO_3)_2$	351.18	20.37	5.07
Iron bicarbonate	$Fe(HCO_3)_2$	.73	.04	.01
Sodium nitrate	$NaNO_3$	.76	.04	.01
Sodium nitrite	$NaNO_2$	.06	.00	.00
Calcium phosphate	$Ca_3(PO_4)_2$	Trace	Trace	....
Sodium metaborate	$NaBO_2$	101.26	5.87	1.46
Calcium silicate	$CaSiO_3$	66.78	3.87	.96
Manganese oxide	Mn_2O_3	1.50	.09	.02
Alumina	Al_2O_3	1.72	.10	.02
		6940.67	402.55	100.00

COMPOSITION OF "ASHLAND SULPHUR SPRING" WATER

[Analysis by B. Pilkington of Oregon Agricultural College. Sample taken by E. P. Hughes July 1, 1909.]

Constituent	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Chlorine	Cl	32.72	1.90	12.48
Sulphuric acid radical	SO_4	10.21	.59	3.89
Silicic acid radical	SiO_3	54.57	3.17	20.81
Bicarbonic acid radical	HCO_3	62.60	3.63	23.87
Sodium	Na	26.09	1.51	9.95
Potassium	K	63.07	3.66	24.05
Calcium	Ca	7.12	.41	2.71
Magnesium	Mg	5.87	.34	2.24
Iron oxide	Fe_2O_3	None	None	None
Alumina	Al_2O_3	None	None	None
		262.25	15.21	100.00

Salinity, parts per million 262.25

Theoretical combination	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Sodium chloride	$NaCl$	53.91	3.13	20.56
Sodium sulphate	Na_2SO_4	15.11	.88	5.76
Potassium silicate	K_2SiO_3	45.51	2.64	17.35
Calcium silicate	$CaSiO_3$	20.66	1.20	7.88
Magnesium silicate	$MgSiO_3$	24.44	1.41	9.32
Potassium bicarbonate	$KHCO_3$	102.62	5.95	39.13
Iron oxide	Fe_2O_3	None	None	None
Alumina	Al_2O_3	None	None	None
		262.25	15.21	100.00

F. A. Kormann reports 3.5 to 5.5 grams of sulphur per liter of "Ashland Sulphur Spring" water, and a trace of ammonium.

COMPOSITION OF "WHITE SULPHUR SPRING" WATER

Analysis by B. Pilkington of Oregon Agricultural College. Sample taken by O. O. Helman, July 8, 1909.]

Constituent	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Chlorine	Cl	128.26	7.44	31.30
Iodine	I	None	None	None
Sulphuric acid radical	SO_4	11.86	.69	2.89
Carbonic acid radical	CO_3	29.79	1.73	7.28
Bicarbonic acid radical	HCO_3	23.94	1.39	5.84
Phosphoric acid radical	PO_4	None	None	None
Boric acid radical	B_4O_7	None	None	None
Sodium	Na	45.79	2.65	11.17
Potassium	K	116.93	6.78	28.54
Ammonium	NH_4	.22	.01	.05
Calcium	Ca	2.61	.15	.64
Magnesium	Mg	1.14	.07	.28
Iron oxide	Fe_2O_3	None	None	None
Alumina	Al_2O_3	None	None	None
Silica	SiO_2	49.20	2.85	12.01
		409.74	23.76	100.00
Salinity, parts per million				409.74

The gas evolving from the springs is nitrogen

Theoretical combination	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Sodium chloride	$NaCl$	34.17	1.98	8.34
Potassium chloride	KCl	224.00	12.99	54.67
Ammonium chloride	NH_4Cl	.67	.04	.16
Potassium iodide	KI	None	None	None
Sodium sulphate	Na_2SO_4	17.55	1.02	4.28
Sodium carbonate	Na_2CO_3	52.63	3.05	12.84
Sodium bicarbonate	$NaHCO_3$	14.00	.81	3.42
Calcium bicarbonate	$Ca(HCO_3)_2$	10.56	.61	2.58
Magnesium bicarbonate	$Mg(HCO_3)_2$	6.96	.41	1.70
Calcium phosphate	$Ca_3(PO_4)_2$	None	None	None
Sodium borate	$Na_2B_4O_7$	None	None	None
Iron oxide	Fe_2O_3	None	None	None
Alumina	Al_2O_3	None	None	None
Silica	SiO_2	49.20	2.85	12.01
		409.74	23.76	100.00

COMPOSITION OF "BERKELEY" HOT SPRING WATER

[Analysis by Smith, Emery & Co., San Francisco. Sample taken by A. L. Emery, 1914.]

Constituent	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Chlorine	Cl	46.97	2.72	13.00
Bromine	Br	.25	.01	.05
Sulphuric acid radical	SO_4	15.31	.89	4.26
Hydrogen sulphide	H_2S	.40	.02	.10
Bicarbonic acid radical	HCO_3	122.43	7.10	33.94
Nitric acid radical	NO_3	.11	.01	.05
Phosphoric acid radical	PO_4	Trace	Trace	....
Arsenic acid radical	AsO_4	Trace	Trace	....
Metaboric acid radical	BO_2	7.55	.44	2.10
Sodium	Na	81.50	4.73	22.61
Potassium	K	.87	.05	.24
Ammonium	NH_4	.08	.00	....
Calcium	Ca	5.47	.32	1.53
Magnesium	Mg	1.30	.08	.38
Iron	Fe	2.90	.17	.81
Alumina	Al_2O_3	5.42	.31	1.48
Silica	SiO_2	67.60	3.92	18.73
Titanium oxide	TiO_2	.40	.02	.10
Oxygen (calculated)	O	2.19	.13	.62
		360.75	20.92	100.00

Salinity, parts per million 360.75

Theoretical combination	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Sodium chloride	$NaCl$	76.05	4.41	21.08
Potassium chloride	KCl	1.43	.08	.38
Ammonium chloride	NH_4Cl	.25	.01	.05
Potassium bromide	KBr	.37	.02	.10
Sodium sulphate	Na_2SO_4	21.48	1.25	5.97
Sodium bicarbonate	$NaHCO_3$	150.94	8.75	41.83
Magnesium bicarbonate	$Mg(HCO_3)_2$	7.80	.45	2.15
Iron bicarbonate	$Fe(HCO_3)_2$	9.22	.54	2.58
Sodium nitrate	$NaNO_3$	.15	.01	.05
Calcium phosphate	$Ca_3(PO_4)_2$	Trace	Trace	Trace
Sodium metaborate	$NaBO_2$	11.59	.67	3.20
Calcium silicate	$CaSiO_3$	15.86	.92	4.39
Hydrogen sulphide	H_2S	.40	.02	.10
Alumina	Al_2O_3	5.42	.32	1.53
Silica	SiO_2	59.39	3.45	16.49
Titanium oxide	TiO_2	.40	.02	.10
		360.75	20.92	100.00

COMPOSITION OF "SHEPHERD" SPRING WATER

[Analysis by Smith, Emery & Co., San Francisco. Sample taken by A. L. Emery, 1914.]

Constituent	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Chlorine	Cl	435.96	25.28	15.43
Bromine	Br	.50	.03	.02
Sulphuric acid radical	SO_4	214.50	12.44	7.59
Bicarbonic acid radical	HCO_3	1372.47	79.60	48.57
Nitric acid radical	NO_3	.27	.02	.01
Nitrous acid radical	NO_2	.02	.00	.00
Phosphoric acid radical	PO_4	Trace	Trace	Trace
Arsenic acid radical	AsO_4	.01	.00	.00
Metaboric acid radical	BO_2	26.83	1.56	.95
Sodium	Na	223.41	12.96	7.91
Potassium	K	11.16	.65	.40
Ammonium	NH_4	.88	.05	.03
Calcium	Ca	236.59	13.72	8.37
Magnesium	Mg	231.02	13.40	8.18
Iron	Fe	6.40	.37	.22
Alumina	Al_2O_3	2.46	.14	.09
Silica	SiO_2	52.75	3.06	1.86
Oxygen (calculated)	O	10.52	.51	.37
		2825.75	163.89	100.00
Salinity, parts per million				2825.75

Theoretical combination	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Sodium chloride	$NaCl$	531.24	30.81	18.80
Potassium chloride	KCl	20.82	1.21	.74
Ammonium chloride	NH_4Cl	2.58	.15	.09
Magnesium chloride	$MgCl_2$	137.13	7.95	4.85
Potassium bromide	KBr	.74	.04	.02
Magnesium sulphate	$MgSO_4$	268.83	15.59	9.51
Calcium bicarbonate	$Ca(HCO_3)_2$	878.91	50.98	31.11
Magnesium bicarbonate	$Mg(HCO_3)_2$	852.34	49.44	30.17
Sodium nitrate	$NaNO_3$	.37	.02	.01
Sodium nitrite	$NaNO_2$	.03	.00	.00
Calcium arsenate	$Ca(AsO_4)_2$	.01	.00	.00
Sodium metaborate	$NaBO_2$	41.13	2.39	1.46
Calcium silicate	$CaSiO_3$	56.61	3.28	2.00
Iron oxide	Fe_2O_3	9.15	.53	.32
Alumina	Al_2O_3	2.46	.14	.09
Silica	SiO_2	23.41	1.36	.83
		2825.75	163.89	100.00

757 cubic centimeters of free carbon dioxide gas (CO_2) in 1000 cubic centimeters of water.

COMPOSITION OF PEAT MARSH SULPHUR SPRING WATER

[Analysis by Smith, Emery & Co., San Francisco. Sample taken by A. L. Emery (?), 1914.]

Constituent	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Chlorine	Cl	44.99	2.61	15.43
Sulphuric acid radical	SO_4	4.77	.28	1.66
Bicarbonic acid radical	HCO_3	125.64	7.29	43.11
Nitrous acid radical	NO_2	.02	.00	.00
Phosphoric acid radical	PO_4	Trace	....	....
Metaboric acid radical	BO_2	2.79	.16	.95
Sodium	Na	51.40	2.98	17.62
Potassium	K	2.80	.16	.95
Ammonium	NH_4	.10	.00	.00
Calcium	Ca	15.80	.92	5.44
Magnesium	Mg	4.79	.28	1.66
Iron	Fe	Trace	Trace	....
Alumina	Al_2O_3	1.00	.06	.35
Silica	SiO_2	37.42	2.17	12.83
		291.52	16.91	100.00
Salinity, parts per million				291.52

Theoretical combination	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Sodium chloride	$NaCl$	69.70	4.04	23.89
Potassium chloride	KCl	5.32	.31	1.83
Ammonium chloride	NH_4Cl	.30	.02	.12
Sodium sulphate	Na_2SO_4	7.06	.41	2.42
Sodium bicarbonate	$NaHCO_3$	73.73	4.28	25.31
Calcium bicarbonate	$Ca(HCO_3)_2$	63.88	3.70	21.88
Magnesium bicarbonate	$Mg(HCO_3)_2$	28.81	1.67	9.88
Sodium nitrite	$NaNO_2$	.03	.00	.00
Calcium phosphate	$Ca_3(PO_4)_2$	Trace	....	....
Sodium metaborate	$NaBO_2$	4.27	.25	1.48
Iron oxide	Fe_2O_3	Trace	....	....
Alumina	Al_2O_3	1.00	.06	.36
Silica	SiO_2	37.42	2.17	12.83
		291.52	16.91	100.00

COMPOSITION OF "SODA SPRINGS" WATER KNOWN AS "SISKIYOU NATURAL MINERAL WATER"

[Sample taken by J. M. Wagner (?) about 1900.]

Constituent	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Chlorine	Cl	320.6	18.59	11.26
Carbonic acid radical	CO_3	1209.6	70.15	42.46
Bicarbonic acid radical	HCO_3	308.9	17.92	10.85
Boric acid radical	B_4O_7	15.9	.92	.56
Sodium	Na	324.1	18.80	11.38
Calcium	Ca	145.7	8.45	5.11
Magnesium	Mg	391.7	22.72	13.75
Iron	Fe	21.3	1.24	.75
Alumina	Al_2O_3	15.9	.92	.56
Silica	SiO_2	68.0	3.95	2.39
Titanium dioxide	TiO_2	26.5	1.54	.93
		2848.2	165.20	100.00
Salinity, parts per million				2848.2

Theoretical combination	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Sodium chloride	NaCl	528.1	30.63	18.54
Calcium carbonate	$CaCO_3$	364.3	21.13	12.79
Magnesium carbonate	$MgCO_3$	1360.0	78.88	47.75
Iron carbonate	$FeCO_3$	44.0	2.55	1.54
Sodium bicarbonate	$NaHCO_3$	425.5	24.68	14.94
Boric acid	B_4O_7	15.9	.92	.56
Alumina	Al_2O_3	15.9	.92	.56
Silica	SiO_2	68.0	3.95	2.39
Titanic acid	TiO_2	26.5	1.54	.93
		2848.2	165.20	100.00

COMPOSITION OF "SODA SPRINGS" WATER, KNOWN AS "SISKIYOU NATURAL MINERAL WATER"

[Analysis by B. Pilkington of Oregon Agricultural College. Sample taken by J. F. Hendricks, July 8, 1909.]

Constituent	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Chlorine	Cl	None	None	None
Sulphuric acid radical	SO_4	20.17	1.17	1.47
Bicarbonic acid radical	HCO_3	921.40	53.44	67.11
Sodium	Na	11.84	.68	.86
Potassium	K	114.08	6.62	8.31
Lithium	Li	None	None	None
Calcium	Ca	111.90	6.49	8.15
Magnesium	Mg	77.92	4.52	5.67
Iron oxide Alumina	Fe_2O_3 Al_2O_3	45.50	2.64	3.32
Silica	SiO_2	70.20	4.07	5.11
		1373.01	79.63	100.00
Salinity, parts per million				1373.01

Theoretical combination	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Lithium chloride	$LiCl$	None	None	None
Sodium sulphate	Na_2SO_4	29.83	1.73	2.17
Sodium bicarbonate	$NaHCO_3$	7.96	.46	.58
Potassium bicarbonate	$KHCO_3$	292.50	16.96	21.30
Calcium bicarbonate	$Ca(HCO_3)_2$	453.03	26.28	33.00
Magnesium bicarbonate	$Mg(HCO_3)_2$	473.99	27.49	34.53
Iron oxide Alumina	Fe_2O_3 Al_2O_3	45.50	2.64	3.32
Silica	SiO_2	70.20	4.07	5.11
		1373.01	79.63	100.00

COMPOSITION OF MURPHY SODA SPRINGS WATER

[Analysis by Smith, Emery & Co., San Francisco. Sample taken by A. L. Emery (?), 1914.]

Constituent	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Chlorine	Cl	643.56	37.32	20.30
Sulphuric acid radical	SO_4	4.11	.24	.13
Bicarbonic acid radical	HCO_3	1537.20	89.16	48.53
Nitric acid radical	NO_3	.13	.01	Trace
Sodium Potassium	Na K	746.36	43.29	23.59
Lithium	Li	Present		
Ammonium	NH_4	3.45	.20	.11
Calcium	Ca	108.86	6.31	3.44
Magnesium	Mg	59.99	3.48	1.90
Iron oxide Alumina Titanium oxide	Fe_2O_3 Al_2O_3 TiO_2	8.60	.50	.27
Silica	SiO_2	51.70	3.00	1.63
		3163.96	183.51	100.00

Salinity, parts per million 3163.96

Theoretical combination	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Sodium chloride	NaCl	1049.60	60.88	33.18
Potassium chloride Ammonium chloride	KCl NH_4Cl	10.35	.60	.33
Sodium sulphate	Na_2SO_4	6.08	.35	.19
Sodium bicarbonate	$NaHCO_3$	1236.40	71.71	39.07
Calcium bicarbonate	$Ca(HCO_3)_2$	440.13	25.53	13.91
Magnesium bicarbonate	$Mg(HCO_3)_2$	360.92	20.93	11.41
Sodium nitrate	$NaNO_3$	.18	.01	.00
Iron oxide Alumina Titanium oxide	Fe_2O_3 Al_2O_3 TiO_2	8.60	.50	.27
Silica	SiO_2	51.70	3.00	1.64
		3163.96	183.51	100.00

COMPOSITION OF COLESTIN SPRING WATER

[Analysis by B. Pilkington of Oregon Agricultural College. Sample taken by H. B. Cole, July 14, 1909.]

Constituent	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Chlorine	Cl	401.27	23.27	8.22
Sulphuric acid radical	SO_4	6.16	.36	.13
Bicarbonic acid radical	HCO_3	2910.87	168.83	59.62
Phosphoric acid radical	PO_4	Trace	Trace	Trace
Boric acid radical	B_4O_7	Trace	Trace	Trace
Sodium	Na	13.38	.78	.28
Potassium	K	732.79	42.50	15.01
Lithium	Li	None	None	None
Ammonium	NH_4	.72	.04	.01
Calcium	Ca	627.87	36.42	12.86
Magnesium	Mg	99.58	5.78	2.04
Iron oxide	Fe_2O_3	None	None	None
Alumina	Al_2O_3	None	None	None
Silica	SiO_2	89.20	5.17	1.83
		4881.84	283.15	100.00
Salinity, parts per million				4881.84

Gas evolved from the springs is carbon dioxide or CO_2.

Theoretical combination	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Sodium chloride	NaCl	26.48	1.54	.54
Potassium chloride	KCl	802.90	46.57	16.44
Lithium chloride	LiCl	None	None	None
Ammonium chloride	NH_4Cl	2.14	.12	.04
Sodium sulphate	Na_2SO_4	9.12	.53	.19
Potassium bicarbonate	$KHCO_3$	804.30	46.65	16.47
Calcium bicarbonate	$Ca(HCO_3)_2$	2542.00	147.44	52.07
Magnesium bicarbonate	$Mg(HCO_3)_2$	605.70	35.13	12.42
Calcium phosphate	$Ca_3(PO_4)_2$	Trace	Trace	Trace
Sodium borate	$Na_2B_4O_7$	Trace	Trace	Trace
Iron oxide	Fe_2O_3	None	None	None
Alumina	Al_2O_3	None	None	None
Silica	SiO_2	89.20	5.17	1.83
		4881.84	283.15	100.00

COMPOSITION OF COLESTIN SPRING WATER

[Analysis by G. W. Shaw of Oregon Agricultural College. Sample taken by H. B. Cole (?) about 1898.]

Constituent	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Chlorine	Cl	417.05	24.19	14.78
Sulphuric acid radical	SO_4	844.68	49.00	29.95
Carbonic acid radical	CO_3	528.44	30.65	18.73
Sodium	Na	536.26	31.10	19.01
Potassium	K	8.16	.47	.29
Lithium	Li	Trace	Trace	Trace
Calcium	Ca	286.41	16.61	10.15
Magnesium	Mg	109.69	6.36	3.89
Iron oxide Alumina	Fe_2O_3 Al_2O_3	6.72	.39	.24
Silica	SiO_2	83.45	4.84	2.96
		2820.86	163.61	100.00

Salinity, parts per million 2820.86

Theoretical combination	Chemical symbol	Parts per million of water	Grains per U. S. gallon	Per cent of total salts
Sodium chloride	$NaCl$	687.07	39.85	24.36
Sodium sulphate	Na_2SO_4	821.73	47.66	29.13
Potassium sulphate	K_2SO_4	18.45	1.07	.65
Magnesium sulphate	$MgSO_4$	348.62	20.22	12.36
Lithium carbonate	Li_2CO_3	Trace	Trace	Trace
Calcium carbonate	$CaCO_3$	716.03	41.53	25.38
Magnesium carbonate	$MgCO_3$	138.79	8.05	4.92
Iron oxide Alumina	Fe_2O_3 Al_2O_3	6.72	.39	.24
Silica	SiO_2	83.45	4.84	2.96
		2820.86	163.61	100.00

For purposes of comparison it is convenient to use the percentage of total salts, with the salinity added. The following table shows the percentage composition of the salts in solution in each of the mineral waters from the Ashland district, and also the total "salinity" or the total quantity of dissolved salts in parts per million of water.

These analyses serve to bring out many facts. The two analyses from Colestin either came from different springs or indicate a very marked change in the composition of the water there (assuming that both are accurate). The same conclusion must apply to the two analyses of the water from the Soda Springs.

All of the springs in the Ashland region contain notable amounts of chlorine, with the exception of one at Soda Springs, the "White Sulphur" spring being especially rich in this element. One of the analyses of the Colestin water shows a large amount of sulphuric acid radical, but the other mineral waters of this region contain very little. Carbonic acid is most abundant at Soda Springs, the artesian well, and Colestin; it is present in unusually small amount at White Sulphur Springs. Sodium is very abundant in the Lithia Springs and is surprisingly scanty in one analysis of Colestin and one of Soda Springs water. Potassium is important in the Ashland Sulphur Springs and in the White Sulphur Springs and is found in the Colestin water. But according to Professor H. V. Tartar of the Oregon Agricultural College the analyses which show more potassium than sodium are probably incorrect in that respect. This throws doubt on the results for sodium and potassium in analyses 6, 7, 11, and 14. Omitting these analyses the least sodium is found in the Shepard sulphur spring water and the most potassium in the various lithia spring waters. Lithium is most abundant in the Ashland lithia spring water and is surprisingly abundant in the artesian well water. Calcium is most abundant at Colestin, where the mineral water is constantly depositing calcite or calcium carbonate; it is also abundant at Soda Springs and Shepard sulphur springs; very little calcium is present in the waters of Berkeley and White Sulphur Springs. Magnesium is especially important at Soda Springs and Shepard Sulphur Springs, and deficient at Berkeley and White Sulphur Springs and in the artesian well water. Iron oxide and alumina are relatively abundant at Soda Springs and lacking at Colestin, Ashland Sulphur, White Sulphur, and Old Lithia Springs. Silica is very abundant in all the sulphur waters except the Shepard and is notably low in amount in all the lithia waters including the artesian water.

COMPOSITION OF MINERAL WATERS FROM THE ASHLAND DISTRICT

Constituent	Chemical Symbol	"Ashland Lithia"	"Old Lithia"	"New Lithia"	Near "Ashland Lithia"	Artesian Well	"Ashland Sulphur"	"White Sulphur"	"Berkeley Sulphur"	"Shepard" Sulphur	"Peat Marsh" Sulphur	Soda Springs	"Soda Springs"	"Murphy Soda Springs"	"Colestin" Springs	"Colestin" Springs
Chlorine	Cl	28.84	22.08	21.70	25.62	8.08	12.48	31.30	13.00	15.43	15.43	11.26	None	20.30	8.22	14.78
Bromine	Br	......	.02	.02	......	.01	......	......	.05	.02	......	......	......	......	......	......
Sulphuric acid radical	SO_4	......	......	trace	3.33	......	3.89	2.89	4.26	7.59	1.66	......	1.47	.13	.13	29.95
Hydrogen sulphide	H_2S	......	......	......	......	......	......	......	.10	......	......	......	......	......	......	......
Carbonic acid radical	CO_3	30.14	......	......	......	......	......	7.28	......	......	......	42.46	......	......	......	18 73
Bicarbonic acid radical	HCO_3	......	44.81	44.64	38.41	61.83	23.87	5.84	33.94	48.57	43.11	10.85	67.11	48.53	59.62	......
Nitric acid radical	NO_3	......	.00	.00	......	.01	......	......	.05	.01	......	......	......	......	......	......
Nitrous acid radical	NO_2	......	.00	.00	......	......	......	......	......	.00	......	......	......	......	......	......
Phosphoric acid radical	PO_4	......	.00	.00	......	......	......	......	......	Trace	......	......	......	......	......	......
Arsenic acid radical	AsO_4	......	......	trace	......	......	......	......	......	.00	......	......	......	......	......	......
Boric acid radical	B_4O_7	......	......	......	......	......	......	......	......	......	......	.56	......	......	trace	......
Metaboric acid radical	BO_2	......	2.66	2.87	trace	.96	......	None	2.10	.95	.95	......	......	......	......	......
Sodium	Na	30.73	22.63	22.93	23.93	24.99	9.95	11.17	22.61	7.91	17.62	11.38	.86	23.59	.28	19.01
Potassium	K	1.64	.83	1.17	2.91	.41	24.05	28.54	.24	.40	.95	......	8.31		15.01	.29
Lithium	Li	.12	.07	.09	.01	.03	......	......	......	......	......	......	None	†	None	trace
Ammonium	NH_4	......	.01	.05	.01	.09	......	.05	......	.03	......	......	......	.11	.01	......
Calcium	Ca	4.73	3.23	3.05	3.02	2.08	2.71	.64	1.53	8.37	5.44	5.11	8.15	3.44	12.86	10.15
Barium	Ba	......	.02	.02	......	.01	......	......	......	......	......	......	......	......	......	......
Magnesium	Mg	2.28	3.09	2.58	1.82	.83	2.24	.28	.38	8.18	1.66	13.75	5.67	1.90	2.04	3.89
Iron	Fe	......	.09	.09	......	.00	......	......	.81	.23	......	.75	......	......	......	......
Manganese oxide	Mn_2O_3	......	.00	.01	......	.01	......	......	......	......	......	......	......	......	......	......
Iron oxide	Fe_2O_3				.11				.....			.....				
Alumina	Al_2O_3	1.52	.00	.05		.02	None	None	1.48	.09	.35	.56	3.32	.27	None	.24
Titanium oxide	TiO_2				......				.10			.99				
Silica	SiO_2	......	.81	.73	......	.50	*20.81	12.01	18.73	1.86	12.83	2.39	5.11	1.63	1.83	2.96
Oxygen	O	......	......	......	......	.14	......	......	.62	.37	......	......	......	......	......	......
		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.0 0
Salinity, parts per million	....	8275.	10972.	9567.	9153.	6941.	262.	410.	361.	2826.	292.	2848.	1373.	3164.	4882.	2881.

*Reported as SiO_3. †Present.

In the tables which are added to permit a ready comparison of the composition of Ashland mineral waters with waters from other localities the lithia waters are shown first, followed by the "sulphur" spring waters, and these by the soda and Colestin spring waters. Analyses of waters not from Oregon are quoted from F. W. Clarke of the U. S. Geological Survey (Bulletin 491, 1911) and from J. K. Haywood of the U. S. Bureau of Chemistry (Bulletin 91, 1905).

It is noteworthy that the total amount of salts dissolved in the lithia waters is much greater than the salinity of the sulphur or soda spring waters. Indeed the average salinity of the Ashland lithia water is 8982 parts per million, while the average of the Ashland sulphur waters is only 830 parts per million and the average of the Soda and Colestin spring waters is 3030 parts per million. That is, the salinity of the Ashland lithia waters is nearly three times that of the Colestin and Soda Spring waters and more than ten times that of the Ashland sulphur waters. Furthermore, the average salinity of Ashland lithia waters is about 30 percent greater than the average salinity of the prominent lithia waters from other localities. As shown in the table

LITHIUM CONTENTS OF ASHLAND AND OTHER WATERS

	Lithium content in parts per million of water	Lithium per cent of total solids
White Rock Lithia, Waukesha, Wis	12.63	1.05
Ashland Lithia, Ashland, Ore	9.70	.12
New Lithia, Ashland, Ore	8.42	.09
Old Lithia, Ashland, Ore	7.90	.07
Steamboat Springs, Nev	7.70	.27
Hathorn Springs, Saratoga, N. Y	7.40	.06
Old Faithful Geyser, Yellowstone Park	5.50	.40
Congress Springs, Saratoga, N. Y	5.40	.05
Carlsbad Spring, Saratoga, N. Y	5.3	.04
Geyser Spring, Saratoga, N. Y	3.6	.05
Magnetic Spring, Saratoga, N. Y	3.2	.07
Ojo Caliente Spring, New Mexico	3.14	.12
Chief Spring, Saratoga, N. Y	2.8	.03
Avondack Spring, Saratoga, N. Y	2.5	.08
Artesian Lithia, Ashland, Ore	2.18	.03
Excelsior geyser, Yellowstone Park	2.00	.15
Blue Lick Springs, Kentucky	1.80	.02
Lincoln Spring, Saratoga, N. Y	1.8	.01
Champion Spring, Saratoga, N. Y	.90	.01
Sheboygan Springs, Sheboygan, Wis	.20	.006

COMPARISON OF ASHLAND AND OTHER MINERAL WATERS

Constituent	Symbol	"Ashland Lithia"	Stanislawa Galicia	Old Lithia	White Rock Lithia, Wis.	New Lithia	Hathorn, Saratoga, N. Y.	Near Ashland Lithia	Congress, Saratoga, N. Y.	Artesian Well	Blue Lick, Kentucky
Chlorine	Cl	28.84	34.60	22.08	36.06	21.70	42.42	25.62	42.00	8.08	54.31
Bromine	Br	......	} .02	{ .02	None	.02	.16	......	1.13	.01	.25
Iodine	I	......	}	{	None	......	.02	......	.02	......	trace
Sulphuric acid radical	SO_4	......	.82	......	3.29	trace	......	3.38	.08	......	3.77
Carbonic acid radical	CO_3	30.14	19.96	......	......	......	19.28	......	18.59	......	......
Bicarbonic acid radical	HCO_3	......	......	44.81	29.18	44.64	......	38.41	......	61.83	4.56
Nitric acid radical	NO_3	......	......	.00	.37	.00	......	......	......	.01	.02
Nitrous acid radical	NO_2	......	......	.00	trace	.00	......	......	......	......	trace
Phosphoric acid radical	PO_4	......	......	.00	None	.00	trace	......	trace	......	trace
Arsenic acid radical	AsO_4	......	......	......	None	trace	......	......	......	......	......
Metaboric acid radical	BO_2	......	......	2.66	None	2.87	trace	trace	trace	.96	trace
Sodium	Na	30.73	37.29	22.63	18.88	22.93	27.29	23.93	27.62	24.99	30.12
Potassium	K	1.64	.53	.83	.25	1.17	.68	2.91	.78	.41	.90
Lithium	Li	.12	.01	.07	1.05	.09	.16	.01	.08	.03	.02
Ammonium	NH_4	......	......	.01	trace	.05	......	......	......	.09	.01
Calcium	Ca	4.73	3.64	3.23	6.72	3.05	5.69	3.02	6.03	2.08	3.80
Strontium	Sr	......	1.44	......	......	......	trace	......	trace	......	......
Barium	Ba	......	.82	.02	......	.02	.12	......	.09	.01	......
Magnesium	Mg	2.28	......	3.09	3.12	2.58	3.92	1.82	3.41	.83	1.98
Iron	Fe	......	.01	.09	......	.09	......	......	......	.00	......
Manganese oxide	Mn_2O_3	......	......	.00	None	.01	......	......	......	.01	.05
Iron oxide	Fe_2O_3	......	.17	......	......	......	.07	......	.03	......	......
Alumina	Al_2O_3	1.52	......	.00	.05	.05	.02	.11	trace	.02	.02
Silica	SiO_2	......	.69	.81	1.03	.73	.17	.83	.14	.50	.20
Oxygen	O	......	......	......	......	......	......	......	......	.14	......
		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Salinity, parts per million	....	8275.	7639.	10972.	1204.	9567.	15238.	9153.	1200.	6941.	9022.

COMPARISON OF ASHLAND AND OTHER MINERAL WATERS

Constituent	Symbol	Ashland Sulphur	Excelsior geyser	White Sulphur.	Old Faithful geyser	Berkeley Sulphur	Ojo Caliente, New Mexico	Shepard Sulphur	Grand-Grille, Vichy, France	Peat Marsh Sulphur	Steamboat Springs, Nev.
Chlorine	Cl	12.48	20.91	31.30	31.64	13.00	8.85	15.43	6.17	15.43	35.00
Bromine	Br	......	trace	......	.25	.05	......	.02	......	......	......
Fluorine	F	......	......	......	......	......	.19	......	......	......	......
Sulphuric acid radical	SO_4	3.89	1.31	2.89	1.30	4.26	5.77	7.59	3.75	1.66	4.58
Hydrogen sulphide	H_2S	......	......	......	......	.10	......	......	......	......	.24
Carbonic acid radical	CO_3	......	25.01	7.28	8.78	......	41.91	......	45.57	......	5.08
Bicarbonic acid radical	HCO_3	23.87	......	5.84	......	33.94	......	48.57	......	43.11	......
Nitric acid radical	NO_3	......	......	......	......	.05	......	.01	......	......	......
Nitrous acid radical	NO_2	......	......	......	......	......	......	.00	......	......	......
Phosphoric acid radical	PO_4	......	......	......	......	......	.01	trace	1.52	......	.03
Arsenic acid radical	AsO_4	......	.29	......	.24	......	......	.00	.04	......	(As).10
Metaboric acid radical	BO_2	......	1.34	None	1.19	2.10	.16	.95	......	.95	8.88
Sodium	Na	9.95	31.34	11.17	26.42	22.61	38.08	7.91	35.27	17.62	30.35
Potassium	K	24.04	2.43	28.54	1.93	.24	1.20	.40	2.88	.95	3.79
Lithium	Li	......	.15	......	.40	......	.12	......	......	......	.27
Ammonium	NH_4	......	trace	.05	trace	......	......	.03	......	......	......
Calcium	Ca	2.71	.17	.64	.11	1.53	.87	8.37	2.29	5.44	.25
Strontium	Sr	......	......	......	......	......	.05	......	.04	......	......
Magnesium	Mg	2.24	.17	.28	.04	.38	.41	8.18	1.11	1.66	.01
Iron	Fe	......	.13	......	trace	.81	......	2.2	......	......	trace
Iron oxide	Fe_2O_3	......	......	......	......	......	.06	......	.04	......	......
Alumina	Al_2O_3	None	.17	None	.12	1.48	.02	.09	......	.35	.01
Silica	SiO_2	a20.81	16.58	12.01	27.58	18.73	2.30	1.86	1.32	12.83	11.41
Titanium oxide	TiO_2	......	......	......	......	.10	......	......	......	......	......
Oxygen	O	......	......	......	......	.62	......	.37	......	......	......
		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Salinity, parts per million	....	262.	1336.	410.	1388.	361.	2614.	2826.	5249.	292.	2850.

a Reported as SiO_3.

COMPARISON OF ASHLAND AND OTHER MINERAL WATERS

Constituent	Symbol	Soda Springs	Excelsior Springs	Soda Springs	Wilhelmsquelle, Karlsbrunn, Austria	Murphy Soda Springs	McClelland Well, Cass Co., Mo.	Colestin Springs	Hikutaia, New Zealand.	Colestin Springs	The Sprudel, Carlsbad, Bohemia
Chlorine	Cl	11.26	2.42	None	0.28	20.30	6.63	8.22	3.84	14.78	11.52
Bromine	Br										
Fluorine	F										.03
Sulphuric acid radical	SO_4		.54	1.47	1.68	.13	6.21	.13	.98	29.95	31.19
Sulphur	S						.06				
Carbonic acid radical	CO_3	42.46	55.92		38.72		44.76		52.09	18.73	19.15
Bicarbonic acid radical	HCO_3	10.85		67.11		48.53		59.62			
Nitric acid radical	NO_3										
Nitrous acid radical	NO_2										
Phosphoric acid radical	PO_4				.14						.01
Arsenic acid radical	AsO_4				trace						
Metaboric acid radical	BO_2	.56						trace			
Sodium	Na	11.38	1.92	.86	1.36		41.07	.28	38.39	19.01	32.49
Potassium	K		.73	8.31	.46	23.59		15.01	.64	.29	1.35
Lithium	Li			None	trace	Present		None		trace	
Ammonium	NH_4					.11		.01			
Calcium	Ca	5.11	29.28	8.15	17.18	3.44	.30	12.86	2.04	10.15	2.23
Strontium	Sr				trace						.01
Magnesium	Mg	13.75	3.15	5.67	4.89	1.90	.12	2.04	1.22	3.89	.65
Manganese	Mn		.91		.01						.01
Iron	Fe	.75	2.28						trace		.02
Iron oxide	Fe_2O_3			3.32	17.24	.27		None		.24	
Alumina	Al_2O_3	.56	.43		.07						
Titanium oxide	TiO_2	.93									
Silica	SiO_2	2.39	2.42	5.11	17.97	1.63	.85	1.83	.80	2.96	1.34
		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Salinity, parts per million		2848.	489.	1373.	622.	3164.	2069.	4882.	7673.	2881.	5431.

(page 100) some geyser waters and springs associated with igneous intrusions have a surprisingly high percentage of lithium, but when expressed in parts per million of water they do not rank so high as the Ashland lithia waters. According to the owners the White Rock water contains very little lithium in its natural state; but is put on the market after the addition of lithium chloride; accordingly the Ashland lithia waters seem to be richer in lithium than any other potable mineral waters in their natural state.

The Ashland lithia waters are chemically much like the water of the Stanislawa spring near Karlsdorf, Galicia, but the latter contains much less lithium, not as much carbonic acid, no magnesium, and more chlorine and sodium, as well as a little strontium and barium. The lithia waters from Saratoga Springs, N. Y., contain much more chlorine and bromine, more calcium, more magnesium, more barium, much less carbonic acid, and less silica than the Ashland lithia waters. The Blue Lick Spring water of Kentucky contains very little carbonic acid and is essentially a sodium chloride (and magnesium sulphate) water.

The sulphur waters of Ashland are charged chiefly with carbonic acid, sodium, calcium, magnesium, and silica, in addition to the characteristic sulphur, which is present, not only in the sulphates, but as hydrogen sulphur or free sulphur or both. These waters also contain a notable quantity of boric acid, probably combined in sodium borate (aside from that present in ionic form). The Yellowstone Park geyser waters contain about twice as much chlorine and half as much carbonic acid with less sulphuric acid, calcium, and magnesium, and more sodium and lithium than the Ashland sulphur waters. But it should be noted that the latter are decidedly variable in composition not only in regard to sodium and potassium (possibly due to analytical errors), but also as to carbonic acid, and especially calcium, magnesium, and silica. The Shepard sulphur springs is very high in magnesium and low in silica; both the Shepard and the Peat Marsh Sulphur Springs contain abundant calcium. The mineral water from Ojo Caliente in New Mexico and that from Vichy in France are low in chlorine and high in sodium; both contain a little strontium. The water from Steamboat Springs, Nevada, is remarkably rich in boric acid; it contains very little carbonic acid and abundant chlorine, sodium, potassium, and silica.

The waters from Soda Springs, Oregon, resemble that from the Excelsior springs in Missouri, but they have greater salinity and contain much less calcium and more magnesium and sodium. The Wilhelmsquelle water contains much less chlorine and alkalies and much more iron, calcium and silica than the Soda Springs water of Oregon. The water from the McClelland well in Missouri is charged with sodium carbonate and some chloride and sulphate, and almost nothing else. One of the analyses of the Colestin water is much like that of the Spruedel water of Carlsbad, Bohemia, though the former contains more calcium and magnesium and less sodium. The other sample of Colestin water resembles the Hikutaia water from near Auckland, New Zealand, but the latter contains less chlorine, calcium, and potassium and much more sodium.

In summary, the mineral waters of the Ashland district belong to two chief classes; the Colestin and Soda Springs waters are dominantly carbonate, while the Lithia and Sulphur spring waters are chloro-carbonate. As compared with similar waters found elsewhere many of the Oregon springs show an unusual quantity of potassium; the salinity of the sulphur springs is low, but that of the Lithia springs is high. The Sulphur springs are quite rich in silica and the Soda springs in magnesium. Finally, the Ashland lithia waters are remarkably high in their tenor of lithium, and deserve recognition for that fact.

J. K. Haywood [1] has collected from such works as he considered reliable, such as Crook's Mineral Waters of the United States, Schweitzer's Mineral Waters of Missouri, and Cohen's System of Physiologic Therapeutics, data concerning the physiological action and therapeutic applications of the various classes of mineral waters. These data are given below, so far as they relate to waters available in the Ashland district.

Carbonated or bicarbonated alkaline waters. This is one of the most important groups of mineral waters. As a class these waters are used to stimulate the secretions of the digestive tract, dissolve uric acid, increase the flow of urine, correct acidity of the urine, and dissolve uric acid deposits. They are therefore of value in catarrhal conditions of the mucous membranes, rheumatism, gout, diabetes, etc.

Sodic carbonated and bicarbonated alkaline waters. Sodium carbonate or bicarbonate appears as a normal constituent of the blood, lymph, and nearly all secretions of the mucous membrane. Where conditions arise that cause any of these fluids to become acid, this class of waters is of great value in counteracting the effect. The sodic carbonated waters increase metabolism, dissolve uric acid,

[1] U. S. Bureau of Chemistry Bulletin 91, pp. 12–16, 1905.

and allay irritation of the mucous membrane of the urinary tract. They have therefore been used with excellent results in treating acid dyspepsia, rheumatism, gout, and diabetes. Such waters are also of value in breaking up and eliminating uric acid deposits and uric acid sand and gravel.

Lithic carbonated and bicarbonated alkaline waters. While lithium seldom or never occurs in waters in large enough quantities to be a predominating basic constituent, still it does often appear in sufficient quantities to have a decided therapeutic action. These compounds are active diuretics and form a very soluble urate which is easily eliminated from the system. Waters of the above class therefore find their greatest application in the treatment of rheumatism, rheumatic tendencies, and gout. In cases of gravel and calculi they are also valuable disintegrating agents.

Calcic carbonated and bicarbonated alkaline waters. This class of waters is quite different in its effect from the carbonated waters previously mentioned. While the foregoing waters are evacuant and promote secretions, this class of waters constipates and decreases the secretions. Very obstinate cases of chronic diarrhea have been cured by a sojourn at a spring rich in calcium bicarbonate. Uric acid gravel and calculi are also disintegrated and eliminated by the free use of the above waters.

Muriated alkaline-saline waters. These waters are especially valuable in the treatment of catarrhal conditions of the mucous membrane of the stomach, intestines, and biliary passages, and urinary tract. They increase the flow of urine and the excretion of uric acid. The stronger ones are often used as a gargle.

Sodic muriated saline waters. Where these waters are very heavily charged with sodium chloride they are often used for baths, to increase the action of the skin, and by absorption act as a tonic. Such waters when taken internally are usually diluted. They increase the flow of gastric juice, improve the appetite, increase the flow of urine, and the urea in the same. They also prevent putrefactive changes in the intestines.

Siliceous waters. The medicinal value of these waters has not been thoroughly investigated, although one or two investigations have been made which seem to show that they would be of value in the treatment of cancer. It has been stated that silica taken internally has caused albumin and sugar to disappear from the urine.

Carbonated waters. These waters contain free carbon dioxide as distinguished from the carbonated or bicarbonated waters which contain carbon dioxide in combination. Usually the heavily carbondioxated waters are also bicarbonated, but this is not necessarily true. Free carbon dioxide is present in practically all natural waters to some extent, but in some waters, notably the Saratoga, it is present in very large quantities. Such waters are extremely palatable and large quantities can be drunk without causing a "full feeling." These waters tend to increase the flow of saliva and intestinal fluids, also to increase the peristaltic movements of the stomach, and therefore increase digestion. They also tend to increase the flow of urine. Obstinate cases of nausea are often relieved by the use of this class of waters.

Sulphureted waters. These waters increase the action of the skin, intestines, and kidneys. They also possess a decided alterative effect. They have been used in the treatment of syphilis, chronic metallic poisoning, rheumatism, and gout. They have also given excellent results in many skin diseases, hyperaemia of the liver, and in cararrhal conditions of the pharynx, larynx, and bronchi.

Coal

Aside from the bountiful supply of timber the chief fuel provided by nature in the Ashland district consists of coal found in seams of varying thickness interbedded with the Tertiary sediments of Bear creek valley. This coal occurs in seams more or less continuous from Evans creek southeast to the vicinity of Ager, California, that is, for a distance of about 50 miles. The central portion of this distance for about 20 miles is within the Ashland district. Near Pilot Knob the coal outcrop passes southward into California. About 2 miles north of the Knob the coal has been opened by several adits, now completely caved near the surface, three of which are reported to have been 200, 270, and 300 feet long. The coal here is in sandstone and shale which have been covered by extensive lava flows. The coal is now visible only in the dumps at the portals of the adits; it is said to have been in seams having a maximum thickness of two feet. It is mixed with carbonaceous shale. In driving the adits the owner is said to have encountered in one of them a fault having a vertical displacement of about ten feet downward on the east side. One of the adits starts in a direction N. 80° E., another in a direction S. 65° E., and a third in a direction S. 35° E. They are all at an elevation of about 4300 feet above sea level, and about 2 miles from Siskiyou station at a place S. 42° E. from the station. The coal dips gently to the eastward so that the adits slowly filled with water. This coal outcrop was prospected about twenty years ago by H. C. Dollarhide; it is now said to be owned by D. T. Loring.

Coal on the north side of Emigrant creek has been opened by two incline shafts which are said to reach a depth of about 400 feet. They are now caved and filled with water. Near the surface the shafts dip about 25° in a direction N. 50° E., apparently following the dip of the coal. This outcrop is about 4 miles east of Ashland,

and about a quarter mile east of Lithia Springs, which are on the south side of Emigrant creek. This coal is said to be owned by the Ashland Coal Mining Company; it is in Sec. 7, town 39 N., range 2 E. At the bottom of one incline shaft, which was said to be 425 feet deep on an incline of 27°, the following section was reported by E. D. Briggs of Ashland.

SECTION AT SLOPE OF ASHLAND COAL MINING CO.

	Feet	*Inches*
Coal	1	
Coaly shale		3–5
Coal		6
Coaly shale		3–5
Coal		6
Shale with thin seams of coal	8	6
Hard smooth coal		10–12
Coaly shale		2–5
Soft coal		10–12
Section exposed	13 feet.	

The coal at this locality was said to be of a good grade. It was apparently sub-bituminous in character. In a report issued in 1909 J. S. Diller [1] mentions this mine as in active development and states that the slopes opened two coal beds, one 12 feet and the lower 5½ feet thick, separated by 50 feet of slippery shale and shaly sandstone. He says further:

"The coal beds are made up of streaks of good coal locally 6 inches thick, and separated by coaly shale. The coal breaks out in blocks and contains a considerable percentage of sulphur. The disturbing feature at this prospect are irregular masses of old lavas, which appear not only in all the entries, but at various levels on the surface and in bluffs nearby along the creek. Where the coal is in contact with the lava the latter appears to be the older. The abundance and irregularity of these lava masses render the extent of the coal beds a matter of doubt."

Outside of the main area of coal-bearing rocks a seam of lignite outcrops below a cliff in section 13, town 38 N., range 2 E. at an elevation of about 5000 feet above sea level. A very remarkable fact in regard to this outcrop is that a lava flow of basalt lies within two feet of its upper surface, and yet the coal seems to have been not only not burned out, but not even noticeably modified in texture or composition by the heat of the lava. This would seem to be an

[1] U. S. Geological Survey Bulletin 341, pp. 401–405.

example of the remarkably good heat-insulation accomplished at times by rather loosely compacted sedimentary rocks. Since the lava almost certainly crossed the outcrop of the coal seam along a line not far from this exposure it suggests further that a basalt flow may act like a blanket in excluding all air and therefore preventing combustion of underlying materials. The coal bed and the overlying lava flow are shown in plate I. At this outcrop the section exposed is as follows:

	Feet.
Basaltic lava flows	150+
Shaly material	2
Coal (3 to 8 inches)	½
Brownish black shale	1
Brown shale	2
Covered by talus	15
Shale	8
Rhyolitic ash	10+

This coal outcrop is only a short distance above a small lake which seems to occupy a depression at the base of a fault scrap. Another lake close by occupies a similar depression, the fault cutting through much volcanic agglomerate with rhyolitic matrix. Such a rock has been formed by the action of volcanoes in breaking volcanic and other rocks to pieces and then cementing the fragments with lava or compacted volcanic ash. The cemented fragmental rock is now partly in blocks of all sizes, up to the size of a log cabin, which have been broken off the main mass apparently by the faulting. The lower lake has no surface outlet, but apparently escapes slowly underground to a good sized spring about a quarter mile to the southeast, which is said to flow at a nearly uniform rate the year around. In this region some trunks of trees have been carbonized nearly to coal and others have been changed to opal or quartz. It seems probable that those changed to coal were buried beneath lava just as the bed of lignite was, and the ordinary processes of decay thus prevented.

In section 17, township 38 south, range 1 east, carbonaceous shale outcrops at an elevation of about 2600 feet, about 3 miles northeast of Talent; it has been prospected by William Van Dyke by means of shallow openings. The sedimentary series consists of sandstones and shales which strike N. 60° E. and dip about 40° N. W. The workings have not yet disclosed any important coal seams. In the same section at an elevation of about 2400 feet some thin seams of coal have been opened by J. F. Mundy of Medford. The development work included several drill holes and the results indicate the presence of at least two coal seams about 500 feet apart.

In section 16, township 38 south, range 1 east, a coal seam has been opened by Emmett Beeson of Talent by means of a slope or incline shaft following the coal nearly on its dip. This coal outcrops in a ravine at the foot of a sandstone cliff at an elevation of about 2600 feet. Fossil impressions of leaves were collected from shaly sandstone at an elevation of about 3050 feet near the top of the cliff a little south of east of the coal seam. The sandstone strikes about S. 45° E. and dips about 25° N. E. at the place where the fossils are found. The coal seam has a strike of N. 53° W. and a dip of about 16° N. E. The slope opening this coal discloses a fault at 70 feet from the portal which strikes N. 10° W. and dips about 62° E. The hanging wall of the fault is displaced vertically downward about 6 feet. At about 120 feet from the portal the coal seam is narrowed to about 3 inches by the doming up of the floor; at the breast, about 130 feet from the portal, the coal is again nearly 2 feet thick.

The section at this outcrop follows.

SECTION AT BEESON'S SLOPE IN SEC. 16-38-1 E

	Feet	*Inches*
Feldspathic sandstone..................	10	
Shaly sandstone with fossil leaves.......		6–8
Feldspathic conglomeratic sandstone....	400	
Covered................................	5	
Feldspathic conglomeratic sandstone.....	6	
Fine grained sandstone.................		2–4
Coal...................................		1
Coal and coaly shale...................	1	3
Coal...................................		3
Fine grained sandstone.................	8	
Feldspathic conglomeratic sandstone....	42	
Coarse quartzose conglomerate..........	10	
Feldspathic conglomeratic sandstone....	20	

According to J. S. Diller [1] several coal seams have been opened by D. P. Greninger by means of shallow workings about 4 miles north of Ashland. He states that the coal seams increase in thickness and improve in quality to the northeast although the openings are not sufficiently extensive to determine their value. No lavas nor faults were disclosed by these workings, which furnished a few tons of coal for local use.

There is a coal prospect on W. C. Butler's ranch in township

[1] U. S. Geological Survey Bulletin 341, p. 404.

38 north, range 1 east; it is opened by an adit, now caved, said to be about 200 feet long. The croppings show thin seams of coal in a shale and shaly sandstone. A few impressions of leaves were observed in the shale, but they were too imperfect to be useful in determining the age of the beds.

Summarizing these observations, it appears that coal seams are found more or less continuously from northwest to southeast across the Ashland district. There are several seams of coal, of thicknesses varying from an inch to several feet. The coal improves in quality and quantity down the dip which is toward the northeast. It is not now in use, but by means of further development it may become a source of fuel for local use and perhaps a source of power through its use in making gas.

METALLIFEROUS DEPOSITS

The metal mines of the Ashland district are of several types. There are placer mines, gold quartz mines, sphalerite quartz mines, and less important deposits of quicksilver and molybdenum.

Placer Mines

The best known placer mine in the district is called the "Forty-nine diggings." It is about 2½ miles northwest of Ashland at the north end of the ridge between Wagner and Ashland creeks. Here the placer operations have extended at least 20 feet into an old conglomerate bedrock and the same distance into an older bedrock consisting of a series of andesitic flows, now much altered.

Upon weathering the rock becomes lighter colored, and curving lines of iron stain surround and accentuate lenticular or spheroidal forms of more compact material. In places the andesite seems to be amygdaloidal containing cavities filled by later calcite and other material. The flows strike S. 60° W. and dip steeply westward and are overlaid by the nearly horizontal conglomerate, probably of Cretaceous age, which strikes S. 40° E. and dips about 70° N. E. This placer has not been in operation for several years.

The following description of the Forty-nine diggings was written by Frank M. Anderson.[1]

Historical sketch. The old placer mines near Phoenix, Oregon, were the property of the late E. K. Anderson, who formerly lived near Talent, Jackson county. They form a group lying about the northern end of a ridge of hills which constitute a spur of the Siskiyou mountains. Mining has been done along the eastern and northwestern flanks of this ridge, and gold in small quantities is found in all the alluvial gravels of the vicinity. From about 1860 until recent years

[1] U. S. Geol. Survey Bulletin 546, 1914, pp. 90–93.

these mines were worked regularly for a few months during the winter and spring. Until 1895 they yielded generally from 60 to 150 ounces of gold annually, which ranged in value from $16 to $18 an ounce.

The gold was generally accompanied by considerable "black sand" (magnetic iron and other dark minerals) and some grains and nuggets of cinnabar. For the most part the gold was fine, ranging in size from "dust" to "flaxseed" gold, though a few nuggets of gold were found which weighed as much as 3 ounces or even more.

Much of the gold was more or less "rusty" and would not amalgamate freely, so that after all the gold obtainable by this means was removed from the black sand it still had a value of $5 to $8 a ton in gold.

Geology of the district. Most of the mining was done in the alluvial deposits of Quaternary age which have accumulated along the lower slopes and in the shallow drainage lines radiating from the hills. These alluvial deposits range in thickness from 3 or 4 to 30 or 40 feet, being thickest along the eastern slope in the older workings. For the most part the alluvial deposits consist of yellow earthy material containing a minor part of gravel and subangular fragments of the older rocks of the hills. Where thickest they are firmly cemented by lime carbonate, so that their mining required the use of powder, and even their reduction has been difficult and in some places prohibitive. This was one of the causes leading to the abandonment of mining on the east slope of the ridge. Though the alluvial gravels everywhere contain gold in some quantity they were found to be richer along certain lines which were generally called "channels," not, however, with the idea that any stream of considerable size ever existed in those places, except perhaps during the season of rainfall. Most of the gold, however, was found near the bedrock, and in so far as the term "channel" had any proper application is referred to ravines cut in the prealluvial rocks. It may well be that a concentration of gold took place during the early part of the Quaternary period under the atmospheric erosion of the times when precipitation was at its maximum and when alluviation of the slopes was slight. In later Quaternary time, when the rainfall was less, the gravels could accumulate more freely. In the thicker deposits on the eastern slope the remains of various Quaternary mammals have been found buried in the cemented earthy gravels, as also in other parts of the Rogue river valley. In 1872 or 1873 the remains of an elephant were found buried 8 to 12 feet below the surface. When first taken out the bones and teeth were apparently in firm condition, but within a few weeks they had become chalky and soon crumbled. As these bones were nearly intact and the skeleton almost complete, their burial must have been accomplished by some unusual means, more rapid than the normal accumulation of alluvial matter under present atmospheric erosion.

The "Bedrock series." In their greater areas the "Bedrock series" consist of a complex of metamorphic rocks overlain along the foothills by Cretaceous sediments which dip generally toward the northeast, or toward the valley. In the various excavations made by mining, these rocks are all well exposed in a manner to be studied advantageously.

These pre-Cretaceous rocks, which may be either Triassic or older in age, are generally slaty or siliceous, are cut by many intrusive dikes, and are much crushed and faulted. Some small areas of dioritic or gabbroid rocks also occur on the northern slopes of the ridge. The slaty and siliceous rocks are commonly veined and seamed in an intricate manner by secondary silica, which is usually white and more or less crystalline, though stained in many places with iron oxide. Along the ridge crest these pre-Cretaceous rocks contain some small veins and stringers of quartz, more or less filled with pyrite and containing a little gold and other metals or their compounds. In many places prospecting has been done along the ridge and some small auriferous veins have been found, though none of sufficient size and value to warrant mining. Formerly these rocks were classed indiscriminately as belonging to the "auriferous slate series," and obviously they are to a small extent auriferous and have been the source of the gold and other metalliferous compounds found in mining. Presumably all the gold in the various deposits herein described was derived from the veins, seams, or pockets that existed in the eroded portions of these rocks.

Cretaceous rocks surround the northern end of the ridge and cover all of its lower flanks. In the placer workings on the eastern slope of the ridge only Cretaceous rocks have been uncovered and the bedrock is composed of clay shales and sandstones, whereas on the opposite side shales, sandstones, and conglomerates of Cretaceous age are exposed and below them the older complex mentioned above.

The conglomerates are generally very coarse, and are composed of rocks found in the underlying complex. Many of the bowlders and pebbles are only slightly rounded or subangular, and when exposed to the weather they readily separate and fall to pieces, the sandy matrix crumbling to sand and clay. The shales are yellowish concretionary clay shales that quickly pass into clay when exposed to the weather. They are thinly stratified and generally unfossiliferous.

A thin layer of very fossiliferous sandstone is present above the shales in many places in the old placers on the northwest slope of the ridge. This is the locality from which many of the Cretaceous fossils were obtained that were described or listed in Anderson's paper on the Cretaceous deposits of the Pacific coast.[1] Both the concretions and sandy layers connected with the shales carry the fossils found in these beds.

[1] Anderson, F. M., Cretaceous deposits of the Pacific coast: California Acad. Sci. Proc., 3d ser., vol. 2, No. 1, 1902

Post-Cretaceous erosion has broken up the sandstone into blocks and irregular bowlders, which are left in some confusion, though a little search readily reveals their place of origin. As the position of the mines is along the extreme edge of the Cretaceous, naturally the thickness of these beds is variable in the vicinity of the old workings.

On the northern side of the ridge the conglomerates are locally from 15 to 35 feet thick, and the shales do not exceed a few hundred feet. Both conglomerates and shales thin out toward their borders to a thickness of only a few feet. Their thickness in the opposite direction can not be readily told from the exposures.

The Cretaceous conglomerates of this locality have long been known to carry gold, and in the past have been mined as a part of the auriferous deposits.

The quantity of gold contained in these conglomerates was not very great, probably not exceeding 60 cents a cubic yard, but as the conglomerate was not very hard, and also tended to disintegrate on exposure, the surface uncovered each year could always be mined economically during the following season, and this was done in connection with other mining.

No other method of working than ordinary hydraulic mining was ever attempted on these conglomerates, as they were not considered rich enough to warrant crushing by stamp mills.

The extent of the deposits that are rich enough to be mined economically by any process is unknown and may in fact be confined to the pre-Cretaceous drainage lines of this vicinity. Very probably these auriferous conglomerates have contributed to the enrichment of the overlying alluvial gravels under the conditions of their formation. No doubt if large areas of this conglomerate were uncovered and exposed to the weather its natural disintegration would render it minable to some extent, or if they were sufficiently explored it is not unlikely that some portions would be found rich enough to be reduced profitably by improved methods.

The practical abandonment of the Forty-nine mines was partly due to objections raised as to the disposition of the debris, and partly on account of the increased value of the water for other purposes than mining.

Gold Quartz Mines

The gold quartz mines are more numerous; they include the Ashland, the Mattern, the Reeder, the Shorty Hope, the Burdic, and others.

As shown in figure 3, the Ashland mine is opened by means of the West shaft, about 900 feet deep as measured on the incline of about 38°, reaching a vertical depth of about 800 feet beneath the top of the ridge. It is opened, further, by an adit, cross cutting

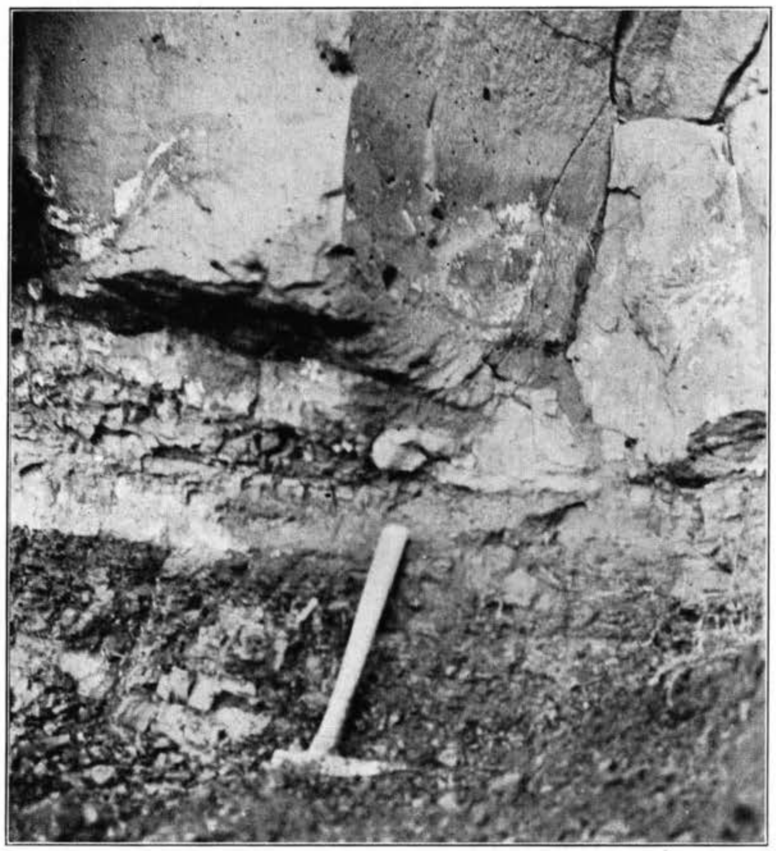


Plate I. Coal bed beneath lava, T. 38 N., R. 2. E., Oregon.

westward about 500 feet to the vein and drifting on the vein about 1500 feet to the shaft at a depth of 250 feet on the incline. The vein is also reached by the York shaft and an upper adit connected therewith. The chief vein has an average strike of N. 19° E. and a dip of about 40° E. There are two important ore shoots in the vein, one being opened by the York shaft and the other by the West shaft. Both pitch to the south, and seem to converge downward. Most of the ore above the adit level has been removed. The vein is regular and persistent, varying in thickness from 2 to 12 feet; the quartz varies in thickness from 0 to 10 feet and occurs in lenses reported to pitch to the south. The vein varies only gently in strike and dip and is not faulted so far as open to inspection. It is in a country rock of coarse tonalite, fine grained diorite, hornblendite, and mica schist cut by a few dikes of aplite. The aplite is much more abundant on the hillside east of the mine than it is in the workings.

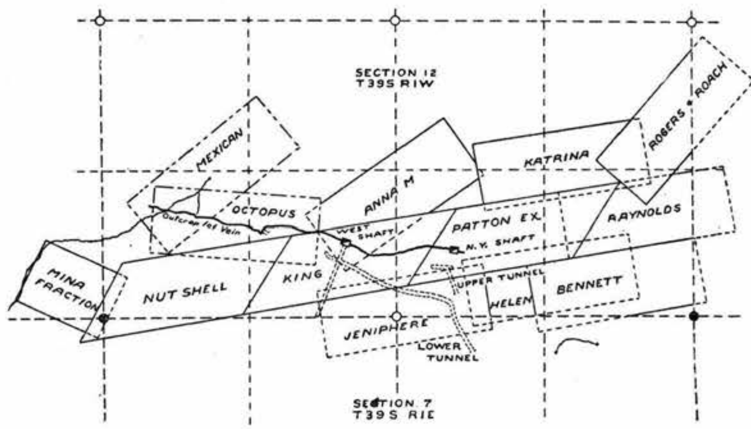


Figure 3. Ashland mine, showing outcrop and main workings.

According to information received from H. V. Winchell of Minneapolis, who examined this mine in 1899, there are several quartz veins on the Ashland ground only two of which have been developed. "In size the veins vary from a foot to ten or twelve feet in thickness and some of their outcrops can be traced for considerable distances across the Ashland claims. Near the surface and to a depth of one hundred feet or more the veins are oxidized and the sulphides have been removed by leaching. Below this depth, however, the ore is still free-milling, showing that the gold is mechanically associated with the pyrite instead of occurring in such an intimate admixture or combination that the ore is refractory and only to be treated by some chemical process like smelting or cyaniding.

The vein filling is quartz and pyrite with more or less country rock. The walls are very smooth and well defined and there is always a gouge or selvage that makes easy mining or stoping of the ore.

The vein on which the greatest amount of development work and mining has been done varies in thickness from two to twelve feet. The ore is of two grades, shipping ore and milling ore. The shipping ore occurs in somewhat irregular shoots and bunches throughout the mine, and runs from $50 to $200 per ton in gold, averaging about $100. The milling ore carries from $3 to $30 per ton in gold and during the year 1898 averaged about $13 per ton. About 55 per cent of the gold is recovered from the plates, and about 10 per cent is obtained from the concentrates. The last ore milled produced concentrates worth about $75 per ton as compared with an average value of $50 to $60 per ton, indicating increased value with depth.

Two principal ore shoots are known in the mine, although a large portion of the ore outside of these shoots would pay for treatment, and although more or less scattered bodies of shipping ore are encountered everywhere in the vein, suggestive of similar and more continuous as well as larger bodies in depth.

The best defined and most regular ore shoot is that formerly worked through the York shaft and now producing ore in the upper and lower adits. This ore is largely oxidized and is worth from $25 to $40 per ton; the shoot pitches toward the south at an angle which decreases considerably about 200 feet above the lower adit.

Another ore shoot has been worked in the West shaft, and produced shipping and milling ores to the lowest levels reached. This ore was not so much oxidized, but in places it was very rich, some large masses showing free gold and rich sulphides all over the fractured surfaces.

These two ore shoots seem to converge downwards and there is good reason to believe that they are either upward branches of one large ore body or that they will be found close together forming a large and rice deposit at greater depth."

According to J. P. Burrall of New York the ore north of the shaft was regular in quantity but of rather low grade; south of the shaft the ore contained more quartz and pyrite and was of higher grade. Large bunches of pyrite were sorted out for shipment to a smelter. Near the shaft the ore was irregular both in quantity and value, but evidently grew better in both respects as the work progressed to the south. A mill run made in March 1899 yielded about $40 a ton on the plates and a concentrate carrying about $325 a ton. At that date the development work was reaching an important ore shoot which pitched to the south. The high grade pyritic sulphide ore contained free gold recoverable by panning, while low grade ore of similar appearance yielded nothing on panning.

Soon afterward the mine was closed by injunction proceedings brought by owners of adjoining ground, and very little work, aside from the construction of a 10-stamp mill, has been done since.

In 1898 and 1899 the ore from the Ashland mine was treated in a 5-stamp mill operated by water power. It was located at the city of Ashland about four miles from the mine. The cost of hauling ore from the mine to the mill was between $0.75 and $1.00 per ton. Since then a 10-stamp mill has been erected at the mouth of the West shaft at an elevation of 3350 feet by aneroid. It is equipped with a 6 by 10 Blake crusher, two 5-stamp batteries, Challenge feeders, two 5 by 15 feet amalgamating plates in sections of 7½ feet, and two 6-foot Johnston vanners. The mill has been but slightly used. Both mill and hoist were operated by steam from a horizontal fire-tube boiler which is still on the ground.

The prospects for making a valuable and important gold mine at the Ashland are very unusually good and it is to be hoped that difficulties in regard to ownership may be adjusted so that development may proceed.

An adit known as the Mattern is near the Ashland mine on the west side of the ridge. It is supposed to be on the Ashland vein. The adit extends 85 paces, S. 20° W. and then 40 paces S. 22° W., all the way on a vein which dips about 40° E. Where observed the east or hanging wall is tonalite and west or footwall is a dark colored diorite.

At the north end of the ridge between Wagner and Ashland creeks and only about a mile northwest of Ashland is another adit called the Mattern. This has a total length of about 325 feet and a general southerly course. At about 50 feet from the portal it reaches the ledge which strikes nearly north and dips about 40° E. The ledge follows an important fault in which the country rock is much shattered and altered and cemented by calcite and quartz. The wall rock of the ledge is a diorite-aplite or malchite. At about 275 feet from the portal a chute extends upward into a stope and at about 230 feet from the portal an incline winze follows the vein downward; it could not be explored because it was filled with water.

The Reeder mine is on the ridge about half a mile northwest of the forks of Ashland creek. It is opened by a lower adit at an elevation (determined by aneroid barometer) of 2900, a second at

3040, and a third at 3320 feet above sea level. The lower adit is a drift 350 feet long on the vein which here strikes N. 45° W. to N. 51° W. and dips about 80° N. E. This vein consists of numerous small fissures and shear zones, somewhat discontinuous, filled with quartz and green siliceous and chloritic material. The country rock of all the openings is tonalite. The second adit is a drift about 180 feet long on the same vein. One wall seems to be a large aplite dike with pegmatitic phases having a very irregular contact with the tonalite. The vein in this working is more clearly defined and averages about 4 feet in thickness. The third adit is about 300 yards northwest of the others on the northeasterly instead of the southeasterly slope of the hill. It consists of a crosscut entry running S. 50° W. for 70 feet to the vein, on which drifts run in both directions, one being S. 48° E. for 40 feet, and one N. 50° W. for 150 feet; the latter is terminated by a raise inclined at an angle of 37° reaching the surface. In this adit fault gouge is conspicuous with a small amount of white vein quartz. Narrow veins of sheared feldspar are characteristic of that portion of the ore which is said to be especially rich. The vein is about 4 feet thick in this adit, from which some ore was shipped a few years ago.

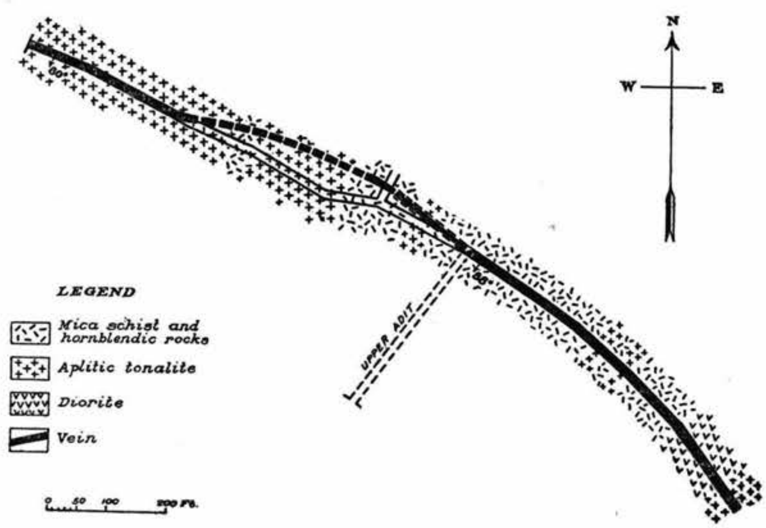


Figure 4. Shorty Hope mine, main adit and upper adit.

The Shorty Hope mine is in section 12, township 39 south, range 1 west, about four miles up Wagner creek from Talent and about a mile west of the Ashland mine. The long lower adit of the mine is at an elevation, determined by aneroid barometer, of 2450 feet; it is 1480 feet long and is said to reach a maximum depth of 160 feet; it follows a vein containing shoots of quartz some of which contains some pyrite and a very little chalcopyrite and galena. The vein varies from 3 to 10 feet in thickness; it strikes about N. 55° W. and dips nearly vertically. At 800 feet from the portal a vertical shaft leads to an upper tunnel level communicating with the surface through a crosscut adit 80 feet long. On the upper level drifts are opened on the vein in both directions and some stoping has been done. The country rocks are tonalite, diorite, plagiaplite, and biotite hornblende contact rock. The relation of the vein to these rocks is shown in figure 4. Some ore has been obtained from these workings, but the chief efforts of the owners were directed not to removing but to opening up the ore. The mine is equipped with a mill well located on a hill side of enough slope to permit ore to pass through without being elevated. The ore passes over grizzly bars $1\frac{1}{2}$ inches apart to a 5 by 8 inch Dodge crusher placed over a bin from which it is fed by Challenge feeders to ten stamps of about 1000 pounds weight each. The discharge is through a slotted metal screen of about 20 mesh to silvered amalgamating plates, one being 4 by 11 feet, and the other 4 feet wide and in three steps of 4, 4 and 3 feet respectively. From the plates the ore goes to two Frue vanners, 6 feet wide, which yield a high grade concentrate containing some galena. The mill was operated by water power, but has been used very little.

Other adits nearby give additional data concerning the veins in this region. One opening at an elevation of 2750 feet extends N. 30° W. about 90 feet following a zone of crushed rock about 3 feet thick with some vein quartz. The wall rock is a spotted diorite grading into a dark biotite hornblende rock. A second adit extends S. 24° E. about 120 feet at an elevation of about 2800 feet on the Hope claim; it is supposed to be on the southeast extension of the Shorty Hope vein. The vein here is small; the wall rock is diorite, with a little pegmatite near the portal.

The Burdic mine is near the center of section 13, township 39 south, range 1 west, on a hill east of Wagner creek; it is owned by Burdic and Grant of Ashland. The lower adit at an elevation of about 3140 feet follows small fissures and quartz stringers for about 60 feet southeasterly into the hill. About 100 yards to the southeast the upper adit at an elevation of about 3270 feet follows a southeasterly course as shown in figure 5. The adit enters on a slip show-

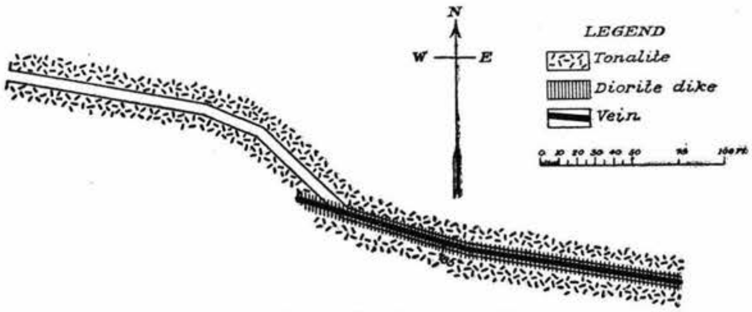


Figure 5. Burdic mine, main adit.

ing some fault gouge, but very little vein material; the nearly vertical fissure turns to the south before playing out. The adit continues and turns at a point about 100 feet from the portal to follow for about 150 feet a vein in a diorite dike in tonalite. The vein is narrow, but the dike which is silicified, chloritized, and mineralized is about 4 to 10 feet thick. The mineralization extends especially into the hanging wall and the footwall is chloritized. The dike seems to vary from a dark basic diorite to a diorite-aplite or malchite. The water circulation followed a fault gouge about an inch thick. The strike of the vein is N. 80° W. and the dip is about 85° S. Assays of the ore are reported to have been higher at the surface than in the adit below.

The Ruth mine is about 500 feet east of Wagner creek in section 13 at an elevation of 2750 feet, as measured by aneroid barometer. The Ruth adit extends from the portal S. 2° E. 90 feet, then S. 5° E. 40 feet, and finally S. 2° E. 20 feet to the breast. At the portal the adit is in the footwall; at 60 to 80 feet from the portal it is in the vein; beyond that it follows a branch or stringer of the vein into the hanging wall. The vein strikes nearly due south and dips about 80° E. It consists of quartz and calcite with some gold and pyrolusite in hornblende rock. Tonalite is abundant in the hills nearby but was not seen in the adit. The Ruth mine belongs to J. A. Kane of Talent.

The Little Pittsburg mine is about 700 feet east of the Ruth on a parallel vein which strikes N. 3° E. and dips about 70° E. The country rock is like that at the Ruth but contains some mica. The vein contains some quartz and calcite. An adit said to be 150 feet long is now caved shut at the portal. The vein is also opened by an incline shaft about 50 feet deep and by a few open cuts. The shaft is at an elevation of about 3000 feet.

The Snapshot claim, formerly called the Cleveland, is located on Wagner creek near the north side of section 23, township 39 south, range 1 west, at an elevation of about 3000 feet. It is now owned by R. W. Dunlap of Ashland. It is opened by an adit about 50 feet long running N. 31° W. in tonalite on a quartz vein varying in thickness from 1 to 4 feet. A branch vein or stringer joins the main vein at 20 feet from the portal. The latter strikes N. 20° W. and dips about 56° E.NE. while the former has a strike of N. 20° W. and a dip of 66° E.NE. and carries quartz and pyrrhotite. The tonalite adjoining the vein is much mineralized in some places. Another adit on the same claim was not visited.

The Columbine claim, also owned by R. W. Dunlap, is west of Wagner creek in section 14, township 39 south, range 1 west. It is opened at an elevation of about 2600 feet by an adit crosscut in diorite running S. 84° W. 85 feet to the vein on which a drift extends N. 36° W. about 100 feet. The vein contains four to six feet of massive white quartz with some pyrite and a little marcasite and chalcopyrite, and some fault gouge; it dips 55° N. E. The vein seems to contain also a little pyrolusite. The marcasite alters rapidly under atmospheric conditions producing sulphuric acid and iron sulphates, especially melanterite.

The Pilgrim claim is on the ridge west of Wagner creek at an elevation of about 3000 feet in section 14, township 39 south, range 1 west. It is now owned by C. Halstead of Talent. It is opened by an adit drift extending N. 10° E. about 170 feet on a vein containing about 3 feet of quartz in a quartz schist. The vein dips 62° W. At 50 feet from the portal a raise extends upward about 30 feet on the vein to the surface. The country rock has well defined bands, marking sedimentary layers, now much contorted, but in general crossing the adit at a large angle and dipping steeply. A small sample examined microscopically proves to be a fine, even-grained quartzite with seams of siderite and disseminated muscovite.

The Crackerjack claim is about 600 feet southeast of the Pilgrim. It is opened by a crosscut at an elevation of about 3000 feet and by an incline shaft about 75 feet higher up. The vein strikes N. 10° W. and dips 55° S. W. The country rock is a metamorphosed sandy shale now containing layers of quartz separated by layers of zoisite and some pale green hornblende with some disseminated calcite and a few isolated crystals of chalcopyrite, films of bornite and rare pyrite.

On the ridge west of Wagner creek there are several other claims which were prospected by shallow workings years ago; they include the Doublejack, Lynchpin, Black Bear and Humdinger. No recent work has been done on them except a little at the Humdinger, now owned by C. Halstead of Talent. Farther south up Wagner creek at an elevation of about 3800 feet an incline shaft and an adit mark the site of a claim now owned by J. W. Bickner. The 30-foot shaft is inclined at an angle of 45° in a direction N. 40° W. while the adit runs south about 150 feet. The veins are narrow and contain some quartz and feldspar; they cut hornblende rock. A siliceous limestone was worked at the same place by Mr. Adams years ago. Neither the quantity nor the quality of the limestone at this place seems to be satisfactory.

The Bula mine, sometimes called the Lamb mine because it is now owned by Coachman and Lamb of Ashland, is situated 4 miles south of Ashland and about half a mile east of Ashland creek on a ridge at an elevation of about 3700 feet as measured by aneroid barometer. It consists of five claims on one or more veins which are opened by a shaft and two adits about a quarter mile apart, as well as some surface trenches or "pot holes." The southeasterly adit at which an ore bin has been erected consists of a crosscut entry about 100 feet long to the vein and a drift extending S. 30° E. about 200 feet. The country rock is tonalite and the vein is an altered zone in a dike and along the contact between the dike and the country rock. The vein contains some quartz and so much "clay" (probably sericite) that it gives trouble by caking about the die in the milling, which has been done in a Lane Chilian mill. The clay is also the probable cause of the poor extraction reported from this ore. The northerly adit consists of a crosscut entry extending southeast 125 feet to a vertical dike which was followed S. 35° E. 325 feet. As this disclosed no ore and only a little vein material the tunnel was turned due east to cut another vertical dike disclosed by surface prospecting about 200 feet eastward. This parallel dike has not yet been reached by the tunnel which now extends about 120 feet from the first dike.

About a mile south of Lamb's house on the east fork of Ashland creek a prospect adit extends S. 60° E. about 45 feet in a slightly porphyritic tonalite following fissures which contain a little vein quartz, some altered feldspathic material and some fault gouge. About a mile above the forks of Ashland creek on the east branch the coarse tonalite is displaced by an intrusive finer-grained aplite with pegmatitic variations. On the south fork of Ashland creek the tonalite is similarly intruded by aplite and pegmatite.

Sphalerite Quartz Mine

The only important deep mine in the Ashland district which is not chiefly valuable for its gold is the Alton or Barron mine which contains much zinc and some lead, copper, and silver. This mine is situated about 3 miles north of Soda Springs on a branch of Emigrant creek locally known as Sampson creek. It is opened by a crosscut entry extending N. 50° E. about 210 feet to the vein on which drifts are driven both ways, that to the eastward for 235 feet and that to the westward about 270 feet. The vein material is about 16 feet thick where it is cut by the crosscut which extends beyond about 80 feet. The vein contains much quartz, fault gouge, and sulphides of iron and zinc with occasional stibnite and realgar. It occupies a fault with a series of volcanic flows on the northeast side and a massive igneous rock (probably auganite) on the southwest or footwall side. The vein strikes S. 55° E. and dips about 80° N. E.; about 30 feet southeast of the crosscut it is cut off at a sharp angle by a vein which strikes S. 25° E. and dips about 80° N. E. The later vein is said to contain stibnite along the footwall and realgar along the hanging wall. The intersection of the two veins seems to pitch steeply to the southeast. A selected sample of ore from this mine is reported to have yielded 44 percent of zinc, 29 percent of sulphur, 14 percent of silica, 5 percent of lead, 1.5 percent of copper, 1.4 percent of iron, 1 percent of alumina, 0.6 percent of manganese, 268 ounces of silver, 14.20 ounces of gold, and a trace of antimony. But sixty tons of ore sold for about $530. The minerals observed in this ore include quartz, calcite, sphalerite, pyrite, galena, chalcopyrite, stibnite, realgar, malachite, native gold, wire silver, gypsum, and probable pyrargyrite. The tunnel reaches a depth said to be 200 feet; a winze extends 50 feet deeper, and a raise runs to the surface. Near the surface the ore is richer and much thicker, perhaps due to mineralization between the two veins. Very little stoping has been done at this mine.

Mercury

Quicksilver ore in the form of cinnabar occurs in veins in the bedrock of the "Forty-nine diggings" about 4 miles northwest of Ashland. The vein filling is chiefly calcite, but there is also siderite, cinnabar and a little quartz, perhaps of later origin. The amount of mercury ore at present disclosed is not considerable, but with development the quantity should be increased.

Molybdenum

Molybdenite occurs in the aplitic dikes south of Ashland. For example, it is found in a plagiaplite dike about 30 feet thick cutting tonalite on Ashland creek about 2 miles from the city. So far as known the amount is quite limited.

In general, the most important ore deposits in the Ashland district are the gold bearing quartz veins between Wagner and Ashland creeks. These cut a granitic intrusive mass with which they are probably genetically related. Manganese minerals are sparse or absent from them, and in harmony with this fact the veins have yielded some placer deposits, but do not show evidence of any important amount of enrichment by surface waters. Therefore it is to be expected that the ores will continue of approximately the same grade until the ore shoots are exhausted. Successful gold mines will probably result from further development of this area if the work is done under favorable conditions and skilled guidance.

UPPER APPLEGATE DISTRICT

LOCATION

In this report the Upper Applegate district includes all that part of Jackson county which is drained by the Applegate river. On the north and east it extends to the divide between Rogue and Applegate rivers, on the south it is limited by the California state line. and on the west by the Josephine county line. As thus limited the district is a large one, being some 25 miles north and south on the west side and the same distance east and west on the south side. The district has no railways, but stages run from Grants Pass by way of Murphy and Provolt to Applegate and Steamboat, and also from Jacksonville by way of Ruch up the Applegate river to Watkins and Hutton. The region is very mountainous, varying in elevation from about 1200 feet where Applegate river enters Josephine county to

3000 to 5000 feet everywhere except along the water courses and to 7377 feet at the summit of Dutchman's Peak (also called Sterling Peak) about 20 miles south of Medford. The largest valley lands are near Ruch and Applegate, where some very rich farming land is under cultivation. Elsewhere the region is used as a stock range, or for timber or mining.

HISTORY

The Upper Applegate district was organized by placer miners in 1853, but at that time it included only the region within a few miles of the mouth of Forest creek. The Sterling district was organized the following year; it included the region of the creek of the same name. Soon afterward the Buncom district was established to serve the placer miners along the lower part of Little Applegate river. Before 1865 the rich gold ore at Steamboat was discovered and removed. As early as 1870 much of the placer ground had passed into the possession of Chinese, who were content with small returns and continued for at least ten years reworking the gravels left after the first work of the white men. In 1882 Beck and Epperson were using hydraulic methods near Steamboat and finding coarse gold. The same year Berryman and Hansen ran drifts in consolidated gravels near Applegate. J. T. Layton was operating a placer mine on Ferris gulch as early as 1884; in 1886 he had a ditch 23 miles long with a giant operated under a head of 300 feet. The Sterling placer mine had a ditch of the same length with a head of 250 feet and 2 giants operating all the year. During the next five years the Layton and Sterling placers were the most important mines in the district. In 1891 the Sturgis placer on Forest creek became the leading producer, but in 1895 the Layton was again the leader, and in 1901 the Pearse placer on a branch of Forest creek near Jacksonville was very active. In 1903 the Sterling mine was again the most successful while the Sturgis and Pearse were active. Since then the placers have declined in importance and no large quartz vein mines have as yet taken their place in this district.

GEOLOGY

The oldest rocks in the Upper Applegate district are probably the hornblende and mica schists in the ridge north of Elliott creek and on Dutchman's (Sterling) peak and Red mountain. They are intruded by andesitic and serpentinized dikes and also modified by intrusions of tonalite. These schists may be correlated with the Salmon and Abrams formations of Hershey,[1] who has considered the mica schist to be the older, and has tentatively placed both groups in the Precambrian. The mica schist is well shown on the road from Hutton to the Blue Ledge mine, where a graphitic layer with minor folds is exposed at an elevation of about 3800 feet. The hornblende schist, or Salmon group, is well displayed on Red mountain where it is intruded by basic dikes and considerably recrystallized, in places developing a bladed actinolite rock. About a mile and a half north of Red mountain on 7-mile ridge an amphibole schist contains bands of fine grained quartz and some epidote. On the eastern peak of Red Mountain some of the serpentine seems to be an alteration product from amphibolite.

Both the Salmon and Abrams formations apparently conform in strike and dip with the Paleozoic rocks. A study of the relation of the bedding and cleavage in a banded slate at the Blue Ledge mine seems to indicate that the series is overturned.

The Upper Applegate district is occupied in large part by old Paleozoic sedimentary rocks with interbedded sills or flows of andesitic character. In places these bedded rocks are penetrated by dikes of dark igneous rocks and also by larger irregular masses of tonalite. The sediments in general strike about N. 20° E. and dip at a high angle to the eastward. As elsewhere shown for this entire region they have perhaps been overturned so that the oldest beds now lie above the younger. On this basis the oldest Paleozoic rocks are the argillites and sandstones containing limestone lenses near Watkins and on Little Applegate river and its tributaries. They have been intruded by andesitic and serpentinized dikes, and are in places highly altered. They are also modified by intrusions of tonalite. Serpentine, derived in part from dunite, is abundant on Red Mountain, which obtained its name from the color of the thoroughly oxidized soils derived from it and similar highly ferruginous rocks. The serpentine is cut by seams, some of which are occupied by chlorite and others by talc. It is also marked in some places by long conspicuous needles of actinolite. On the eastern peak some of the serpentine is derived from the alteration of amphibolite.

The Siskiyou tonalite batholith extends southward to Siskiyou gap between Mount Ashland and Red Mountain. Smaller tonalite intrusive masses outcrop near the batholith, as on Dutchman's Peak, and less than 2 miles to the southwest on Elliott creek ridge

[1] Am. Geol. vol. 27, p. 226; 1901.

north of Silver fork. Tonalite was also observed in masses of various sizes at other places in the district; the largest mass noted was on both sides of Applegate river at Watkins and for about a mile to the southwest; the same mass may be continuous with an outcrop in section 32, T. 40 S., R. 3 W. between Squaw creek and French gulch. Other masses were observed in sections 26 and 35, T. 40 S., R. 4 W. West of Grouse creek, in section 34, T. 40 S., R. 3 W. along Lyman creek, and in sections 29 and 31, T. 40 S., R. 2 W. north of Squaw creek, as well as in sections 7, 8, and 18, T. 40 S., R. 2 W. north of Beaver creek and in sections 18 and 19, T. 40 S., R. 2 W. west of Glade creek. Finally, outcrops of tonalite were observed in sections 10, 15, and 27, T. 38 S., R. 4 W. north and south of Applegate, and a mass noted in section 24, T. 38 S., R. 5 W. probably extends eastward at least to the slopes of Ferris gulch. The wide distribution of the tonalite makes it reasonable to believe that the Siskiyou batholith underlies a large part or all of the district, a deduction of much importance in considering the probable source of the ore deposits.

Deposits of Mesozoic and Tertiary age are unknown in the Upper Applegate district although Cretaceous conglomerates are reported on the border of the region on the ridge west of Jacksonville, and it may well be that such rocks once covered a much larger area.

Pleistocene and Recent stream gravels and silts are not abundant in the district because most of the gradients are too steep and the valleys too narrow to permit their accumulation, but such deposits are found along the Applegate river and some of its tributaries, and in some places they have proved of value as a source of placer gold.

MINERAL RESOURCES

The mineral resources of the Upper Applegate district include building stone, road material, limestone, shale, clay, graphite, mercury, antimony, copper, silver, and gold. Unfortunately they are for the most part comparatively inaccessible, and mining developments have proceeded slowly in consequence.

Building Stone

The chief building stones of the district are "granite" and sandstone, but they have not been used because they are too far from markets and from transportation. There is no probability that they will be used in the near future.

Road Materials

On the road up the Applegate river it may be observed that "greenstones" and argillites of local origin have been used as road metal with good results. So far as these are available already broken in the long talus slopes they are good enough to justify some expense in hauling reasonable distances, but the demand is very limited.

Limestone

Limestone in this district will not be used for making Portland cement and for other purposes requiring large amounts until it is rendered accessible by new railroad construction. There is considerable limestone in section 19, T. 40 S., R. 4 W. about 2 miles west of Steamboat; here the strike is N. 20° E. and the dip is 85° E., but both strike and dip vary considerably in different outcrops. The limestone here occurs in masses 50 to 100 feet thick and as much as 600 feet long. Other outcrops are known near Watkins, not only along the river to the south in section 11, T. 41 S., R. 4 W., but also in Collins mountain in section 35, T. 40 S., R. 4 W. There are several limestone lenses near the Applegate river in T. 36 S., R. 4 W., and others along the Little Applegate river in T. 39 S., R. 2 W.; one of these is on 7-mile ridge about a mile and a half south of the mouth of Glade creek; another is on Yale creek in section 32, T. 39 S., R. 2 W.; other outcrops striking N. 15° E. occur on the ridge north of Little Applegate in sections 19 and 20, T. 39 S., R. 2 W.

An analysis of the limestone outcropping south of Watkins made by R. C. Wells [1] of the U. S. Geological Survey resulted as follows:

COMPOSITION OF LIMESTONE FROM SECTION 7, T. 41 S., R. 4 W. ON THE APPLEGATE RIVER

SiO_2	0.53
Al_2O_3, Fe_2O_3	.52
MgO	trace
CaO	55.05
H_2O	.50
CO_2	43.25
	99.85

[1] U. S. Geological Survey Bulletin 380, p. 51, 1909.

Shale and Clay

Shale and argillite are abundant in many parts of the Upper Applegate district. In case the limestone of the area becomes available for making cement the shale will be useful for the same purpose. Clay is not abundant, but recent alluvial deposits of no great extent are found along the Applegate river.

Graphite

Graphite is reported on the hill side east of Sterling. A sample said to have come from this locality showed graphite in a basic rock with no evidence of a vein. The exact locality being unknown, the material was not seen in place.

Mercury

Mercury ore was reported on the east side of 7-mile ridge in an adit which extends about 100 feet S. 34° W. at an elevation of 4200 feet as measured by barometer. The adit was run years ago and probably opened some mercury ore though none is now visible. The country rock is limestone, somewhat siliceous and ferruginous.

Antimony

A deposit of antimony ore is known near Watkins and another one is reported on Forest creek. The former is in the N. E. ¼ Sec. 35, T. 40 S., R. 4 W.; it is opened by an adit said to be a drift 250 feet long, which enters in a direction N. 56° E.; it is on Grouse creek at an elevation of 2160 feet by barometer. The dump shows stibnite altering to yellow oxide (cervantite?); the former is accompanied by some quartz and feldspathic material in a vein in andesite. The ore is said to carry $19 in gold and $8 in silver per ton.

Copper

There are only small copper prospects known in the Upper Applegate district, but more important deposits have been developed in the Blue Ledge district about 3 miles south of the state line in California.

A copper prospect on Bear gulch at an elevation of about 3000 feet is opened by an adit which extends 85 feet N. 30° W. and thence 60 feet N. 10° W. following a small fissure. The adit penetrates a silicified phase of the andesitic country rock which varies to a chloritic schist in shear zones, and contains sparsely disseminated pyrite and very little chalcopyrite. Another prospect is near the south line of section 21, T. 39 S., R. 2 W. below the Sterling ditch: here there is an outcrop of about 10 feet of nearly solid pyrite with some chalcopyrite. The vein is apparently nearly vertical and strikes with the country rocks, about N. 20° E. On the west side of the vein the greenstone is silicified and pyritized; on the east side there is abundant chlorite. A third copper prospect is in section 11, T. 40 S., R. 2 W. where a large quartz vein in "granite" strikes about N. 35° W. and dips steeply N. E.; a relatively flat cross seam contains chalcopyrite. The same mineral is found in a similar occurrence in section 14 at an elevation of about 3400 feet as measured by the barometer.

The Blue Ledge district is outside of Oregon, but it may be briefly described because its natural outlet is by way of the Applegate river to Medford or Grants Pass.

The Blue Ledge mine is about 3 miles south of Hutton (formerly called Joe Bar) in the S. E. $\frac{1}{4}$ Sec. 34, T. 48 N., R. 11 W. at an elevation of about 4000 feet. The copper deposit is opened by a series of adits on the face of a cliff at different elevations; with the winzes and raises this gives a vertical exposure of the ore for about 800 feet, and a horizontal exposure for about 2000 feet. The ore consists of nearly solid pyrite and chalcopyrite with a little pyrrhotite and rare sphalerite or galena. Microscopically the ore contains also primary tourmaline and a little biotite. The first fissures were cemented by coarse vein quartz; after shearing the second fissures were filled with calcite, chlorite and sulphides. According to numerous assays the ore contains 3 to 4 percent copper with about $1.50 to $2.00 in gold and silver. The veins average about 2 feet in thickness; so far as observed the veins are somewhat narrower and lower in grade in the lower levels. The veins strike nearly due north and dip about 65° W.; they are generally parallel with the banding of the sericite schist country rock, but locally cut across it. There are at least three veins which are roughly lenticular in form; one lens succeeds another along the strike, usually with a small offset. The hanging wall is a soft white sericite schist near the vein, but elsewhere it is a mineralized quartzite charged with some muscovite. The footwall is a bluish black hornblende schist. The position of the bedding and rock cleavage seem to indicate that the mine is on the east side of an anticline (overturned to the east) which pitches to the south. Faults are common in the workings but usually the offset is only 1 to 5 feet so that there is no difficulty in following the vein. The "pyrite" vein is one of the latest as it cuts off some faults which offset the "main" vein. Pyrite in big cubes occurs replacing the wall rocks especially in the hanging wall.

The Blue Ledge has several thousand tons of ore blocked out; it is equipped with two air compressors and is reached by a good wagon road of very uniform grade from Hutton.

The St. Albans, Bloomfield, and Copper King groups are not far from the Blue Ledge and present similar features, but are not as well opened and have not disclosed as much ore. At the Copper King the vein strikes N. 12° E. and dips 80° W.

Gold and Silver

The precious metal mines of the district include those in placer deposits and those which are located on ore in veins. The former have thus far been much more productive than the latter.

Placer Deposits

The Sterling placer mine is on Sterling creek from 1 to 4 miles above its mouth, which is at Buncom on Little Applegate river. The present workings are on the south line of section 33, T. 38 S., R. 2 W. at an elevation of about 2300 feet. It is planned to repair the long ditch bringing water from Little Applegate river, and then increase the head by raising the water nearly 200 feet by electric power. The gravel is so thoroughly cemented that much of it must be broken with powder before using the giants. The deposit is 20 to 40 feet thick and about 400 feet wide. Drifts have been run on bedrock ahead of the giants about 100 feet. The gravel contains boulders of andesite and some quartz. According to G. F. Kay:[1] "The values are found across a width of nearly 200 feet. In these gravels the tusks and jaws of a mammoth, as well as other mammalian bones, have been found. The bed rock at the mine is greenstone, in which are patches of slaty tuffs, whose strike is N. 8° E. and dip is about 60° W. The slope of the bedrock is about 2 feet in 100 feet. In 1908 mining was in progress from March until August, during which time about 1 acre was mined. The value of the gravels was about 40 cents to the cubic yard. The total production of the mine is said to exceed $3,000,000."

In regard to other placer mines of this district the following brief notes are from Kay.[2]

The Pearce mine is on the east fork of Forest creek in section 11, T. 38 S., R. 3 W. The gravels have an average thickness of about

[1] U. S. Geological Survey Bulletin 380, p. 68, 1909. Parts of the original description are omitted.

[2] U. S. Geol. Survey Bulletin 380, pp. 66–70, 1909. Parts of the original description are omitted.

12 feet, but in places they have been 45 feet thick. In the lowest 6 feet of the deposit there are many large undecomposed boulders, but above this zone the material is gravel and sand not very strongly cemented. The best values are at and near the bottom. Some of the ground has run as high as $7000 to the acre. The bed rock is greenstone, the slope of which is not more than 2 feet in 100 feet. The mine is equipped for hydraulicking, three giants being used. The pressure of the water is only about 85 feet. The property consists of 240 acres, a large part of which remains to be worked.

The Sturgis mine is on Forest creek in section 10, T. 38 S., R. 3 W. It is now owned by the Sterling Mining Company. The deposit has an average thickness of about 30 feet. In the lowest 10 feet are gravels and sand containing rounded and subangular boulders, which are chiefly of greenstone, although some are of granodiorite. The bedrock is greenstone much fractured and veined; in places it is very slaty, the strike being N. 30° E. and the dip 48° S. E. The mine is equipped with giants, and a derrick is used for handling the boulders. About 1 acre a year is mined. For many years the mine was owned by the Vance Mining Company.

The Spaulding mine is on Forest creek in section 4, T. 38 S., R. 3 W. The maximum thickness of the deposit in the present workings is more than 40 feet, but the average thickness does not exceed 25 feet. The lowest 10 feet consists of gravels containing boulders; the upper part of the deposit is hardpan. Even in the lower part there are but few boulders, and these are usually less than 1 foot in diameter. They are rounded or subangular and are usually of greenstone, although some are of granodiorite. The mine is equipped for hydraulicking.

The Johnston mine is in section 11, T. 38 S., R. 4 W. at the junction of the west branch with the main Humbug creek. The bank averages about 8 feet in thickness and contains considerable clay, in which the main values are found. Boulders of greenstone and granodiorite, from 6 inches to more than 8 feet in diameter, are present. The bed rock consists of fine grained greenstone, much fractured and veined. The mine is equipped for hydraulicking, the water being brought from Humbug creek.

The Layton mine is part of the estate of J. F. Layton. The average thickness of the gravels is about 25 feet and the width is more than 200 feet. The best values are found in an old channel about 15 feet below the level of the present stream bed. The bedrock is greenstone, which in places is distinctly vesicular and greatly fractured and veined. Mr. Layton put in two ditches, the upper of which is 21 miles long and the lower 18 miles. Two giants are used under a head of about 300 feet. A considerable area of good ground remains to be washed.

The Brantner mine is on Applegate river, near the mouth of Keeler creek. In the present workings the sands and gravels have a thickness of 30 to 35 feet and show distinct stratification. Many large angular and subangular boulders (chiefly of greenstone) are found at and near the base of deposit. The bedrock is decomposed greenstone. The mine is equipped for hydraulicking, the water used having a pressure of about 100 feet.

Gold Quartz Deposits

The Sterling Gold Quartz and Milling Company has developed a group of claims near the north line of section 33, T. 38 S., R. 2 W. at an elevation of about 2800 feet by barometer. The lower adit is about 240 feet long following a vertical quartz vein 1 foot or less in thickness associated with fissuring filled by calcite and sulphides. The middle adit is about 60 feet long following quartz stringers which strike S. 70° E. and dip about 50° N. E. The upper adit is about 400 feet long; it enters as a crosscut, and then drifts on crushed zones in the country rock, one of which strikes N. 15° W. and is nearly vertical. Seams of calcite, quartz, and some pyrite run in all directions. The main crushed zone strikes N. 45° W. and dips about 80° S. W. Some stoping has been done irregularly in this zone. No work has been done for the last few years.

The Queen Anne mine is in the N. E. ¼ Sec. 3, T. 39 S., R. 2 W. on Deming creek near the Sterling placer mine at an elevation of 2750 feet by barometer. It is owned by W. H. Simmons who has a mill at the mine consisting of a boiler, engine and 3-stamp battery of 250 lb. stamps. It is opened by an adit extending 75 feet N. 20° E. along the bedding of the schistose argillites which contain some pyrite but no vein quartz. To the northwest there are three shafts the deepest following a quartz vein for 40 feet. The 4-foot quartz vein strikes N. 45° W. and dips 80° N. E.

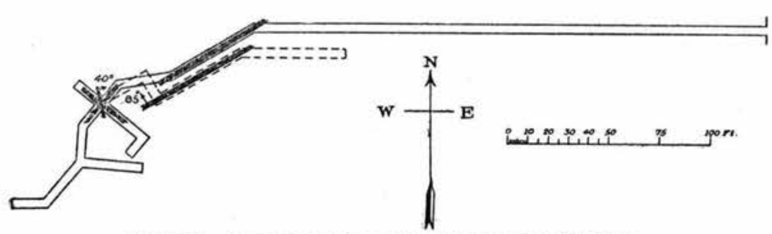


Figure 6. Lone Pine mine, main adit and one adit above.

The Lone Pine mine is near the north line of section 15, T. 38 S., R. 3 W. on Forest creek at an elevation of 2200 to 2600 feet by barometer. It is opened by three adits which are supposed to reach the same ore body. As shown in the illustration (figure 6) the main entry is a crosscut adit striking the vein about 250 feet from the portal. The vein strikes S. 60° W. and dips 85° N. W., but it does not seem to be continuous to the southwest, being replaced in that direction by veins of white quartz in slate in various directions. On top of the ridge at an elevation of about 2600 feet shallow workings show a vein striking S. 80° W. and dipping 80° N. in a black argillite. This mine is equipped with a Beers mill having a plate and a jig. It is owned by G. L. Huff of Gold Hill.

The Oregon Belle mine is in the south half of section 6, T. 38 S., R. 3 W. near the head of Forest creek at an elevation of about 3000 feet. It is opened by several adits, the main one being shown in the illustration (figure 7) so far as at present open. The country rock is andesite and argillite. The vein is well defined and reaches a thickness of at least 8 feet in some of the stopes; it strikes S. 72° W. and dips 52° N.W.; it is cut off by a fault which strikes N. 64° W. and dips 74° N.E. The rock within and beyond the big fault 20 feet wide crossing the entry about 220 feet from the portal and dipping 75° S. W. is much altered by vein solutions. There are several adits above the main entry but they are caved and closed. One of them has a large dump at an elevation of 3250 feet. The mine was operated several years ago by a stock company. It is now owned by Minnie Leonard of Grants Pass.

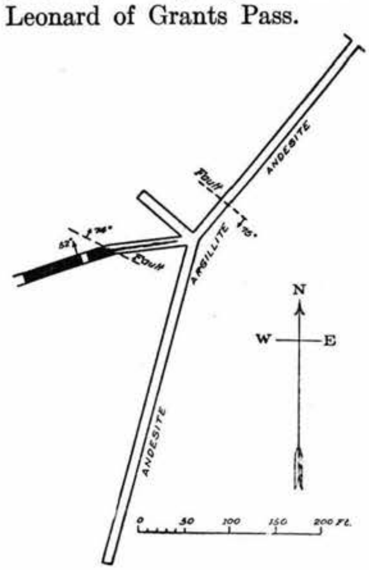


Figure 7. Oregon Belle mine, main adit.

The Wright mine is near the south line of section 14, T. 38 S., R. 4 W. near Humbug creek. It is opened by two adits, the upper running 80 feet north in decomposed "granite" to dense hard greenstone while the lower runs 150 feet north and thence 20 feet west; it enters in decomposed "granite" which becomes harder as the contact is approached. At the turn, and beyond, the adit is in hard greenstone with quartz here and there apparently produced by replacement. No well defined vein is visible. The ore consists of mineralized greenstone containing free gold, galena, and sphalerite.

The None Such mine is half a

mile east of Humbug creek and about as far north of Applegate river. It is owned by Longwell and Company, who report that it is opened by a shaft and about 200 feet of workings on a quartz vein. The ore is hauled to the Applegate river and treated in a 3-stamp mill run by water power, which was in operation in September, 1913.

The Afterthought mine is in section 27, T. 38 S., R. 4 W. near the top of a ridge at an elevation of about 2300 feet. It is owned by J. R. and F. L. Bailey. The country rock is a dark gray or green to black argillite. The ore is white to bluish quartz with some sulphides and rare calcite. The vein is nearly vertical and strikes N. 70° E. The walls are not clearly defined and they show no gouge. The vein is opened by an adit crosscutting N. 20° E. 50 feet and then drifting N. 70° E. 150 feet. The ore has been milled in an arrastre in the gulch below. A granitic intrusion outcrops on the southwest slope of the ridge about 600 feet from the mine.

The Maid of the Mist mine is in the south half of section 4, T. 39 S., R. 4 W. on a branch of Thompson creek. The country rock is greenstone in which there are several auriferous quartz veins, the most important striking east and dipping about 55° S. It is opened by a shaft 200 feet deep and about 500 feet of other workings now full of water. It has not been in operation for several years. According to Kay,[1] "the values are irregularly distributed through the quartz, which is fairly free from sulphides. Of the latter, arsenopyrite appears to be more prevalent than pyrite. Calcite is subordinate."

El Senora Gold Mining and Milling Company has a mine about 2 miles north of the Maid of the Mist in the north part of section 34 T. 38 S., R. 4 W. The workings total about 1000 feet, part of which is caved and closed. The lowest entry was a shaft 130 feet deep and a level said to follow a 4-foot vein of low grade quartz ore for 200 feet. The next entry is an adit which crosscuts N. 60° E. for 80 feet and then drifts S. 45° E. for 70 feet. The vein shows 2 feet of quartz in argillite. Some gold is found also in seams in the country rock. About 100 yards to the southeast the next higher adit follows the vein S. 55° E. for 220 feet. Above this are two short adits and a shaft where a pocket of ore was removed. The strike of the vein is not constant in all the adits, but it is apparently continuous; in one place it narrows to 1 inch of fault gouge. The company owns a 10-stamp mill which is on the ground but not erected. It was obtained from the Oregon Belle mine.

[1] U. S. Geol. Survey Bulletin 380, p. 61, 1909.

Moses and Collins have gold prospects in quartz veins in greenstone on Collins Mountain in section 35, T. 40 S., R. 4 W. Most of the veins are small and rather irregular; one of the largest is 1 to 3 feet thick and contains streaks of pyrolusite. The ore is a surface concentration occurring in rich bunches at or very near the surface.

G. P. Wagner has several claims about a mile west of Steamboat where he is removing ore brought to its present position by surface waters. In Rich Gulch, which was mined by placer methods years ago, small quartz veins are known in the bed rock; one of them is nearly vertical and strikes N. 55° E. They are said to produce high grade ore.

William Schwartzfader has a claim east of the famous Steamboat pocket which has bunches of auriferous quartz in andesite at an elevation of 3100 feet by barometer. The veins contain a little calcite and pyrite. The ore is treated in Scheerer's 4-stamp mill located at the Steamboat pocket. So far as seen this ore is also the product of surface enrichment.

The Steamboat pocket was mined out before 1869; it is said to have produced $350,000, which came from a shallow surface working in andesite. Scheerer has explored the andesite under the Steamboat pocket by several adits, two entering from the south and one from the north side of the hill. The upper adit is at an elevation of about 3000 feet in section 20, T. 40 S., R. 4 W., entering N. 10° E. and opening into several crosscuts and drifts following small veins and fractures. A little stoping has been done chiefly on two veins. The country rock is andesite which is faulted in several directions like a system of joints on a large scale. One vein containing 18 inches of quartz strikes north and dips 45° W. Another with 10 inches of quartz (on which the pocket was located) strikes N. 10° W. and dips 45° E. Another with 5 inches of quartz strikes N. 80° W. and dips 75° N. Another with the same thickness of quartz strikes N. 45° W. and dips 55° N.E. Still another with 3 inches of quartz strikes N. 55° E. and dips 75° N.W. The adit from the north extends S. 70° E. into the other workings. At the present face of the main adit there is a pyritized shear zone.

Wright and Myer have a mine in the S. W. ¼ Sec. 17, T. 40 S., R. 4 W. at an elevation of about 3200 feet as measured by barometer. An adit crosscuts 30 feet to a vein which is followed 70 feet N. 60° W. The vein contains a little chalcopyrite and is said to average $28 in gold per ton. Pyrite disseminated in the andesite wall rock is said to carry $16 a ton in gold and very little copper. The vein plays out upward but the surface workings are on a vein dipping 50° N.E. while the lower vein dips 75° S.W. Adjoining claims have ore containing arsenopyrite, pyrrhotite, and chalcopyrite in quartz. Wright and Myer have a 2-stamp mill with an 8-foot plate and one jig operated by a gasoline engine.

Edwards and Garrison have a prospect about 2 miles from the head of Elliott creek and half a mile north of the California line. Small bunches of ore have been obtained from surface workings. The main vein is parallel with the schistosity of the chlorite schist country rock and is 9 to 12 inches thick. It consists largely of pyrite and gouge with only a little quartz; it strikes N. 55° E. and dips 30° N.W. An incline shaft goes down at an angle of 23° about 60 feet N. 60° W. The ore is said to assay about $40 a ton, but some of the gold does not amalgamate readily. A fault striking N.E. cuts the vein but the displacement is only about 1 foot.

Haskins and Traverso have a prospect in the N. W. ¼ Sec. 6, T. 41 S., R. 2 W. on the north side of Squaw creek at an elevation of 3450 feet by barometer. It is opened by two short adits and a 20-foot shaft. The vein is 1 to 3 feet thick, striking N. 71° W. and dipping 60° N.E. in old andesite. The quartz near the surface shows a little copper stain.

THE JACKSONVILLE OR MEDFORD DISTRICT

LOCATION

For the purposes of this report the Jacksonville or Medford district is bounded to the southeast by the Ashland district, and includes all of Bear Creek valley between Phoenix and Central Point; to the southwest it extends to the divide between Bear creek and Little Applegate river; to the northeast it is limited by Antelope creek. The most important mines in the area are near Jacksonville, and that town has been a mining center for five decades. It is still the county seat, but Medford, only four miles away on the main line of the Southern Pacific railway, has grown so rapidly that Jacksonville commercially is only a suburb of the larger city. The district varies in elevation from about 1400 feet above sea level near Medford to about 4400 feet on a spur of Grizzly Mountain, about 3 miles west of the Sunnyside coal mine.

HISTORY

Gold was discovered near the present site of Jacksonville in the fall of 1851 and mining in the region began as early as 1852, in which year the district was organized as a result of the first influx of miners from California. Jacksonville was for a time the seat of a county government which extended nominally from the Pacific ocean to the Rocky Mountains and actually exercised legal authority from the ocean to the interior of Oregon. The placer mines on both forks of Jackson creek were the object of the first mining operations. and furnished large returns for several years. As early as 1870 the industry became less profitable and gradually passed into the hands of Chinese.

Two quartz mills were erected during the 60's; the Hopkins mill on the left fork of Jackson creek was not successful, and as early as 1869 it had been converted into a sawmill. The Occidental mill on the right fork of Jackson creek cost $10,000; it was equipped with 10 stamps, 2 rotary pans, and 40 horse power, and had a crushing capacity of 20 tons a day.

GEOLOGY

The geology of the Jacksonville district is in some respects more complicated than that of the Ashland region. As in the latter, the chief valley (Bear creek) is occupied by Cretaceous and Tertiary sedimentary rocks, overridden on the northeast by lava flows, but the mountains to the southwest are formed by much altered Paleozoic sediments and old andesitic rocks. The great igneous mass forming Mount Ashland has its counterpart only in an area of granitic rock in the hills west of Central Point extending from the forks of Jackson creek northeast nearly to Central Point and thence northwest to Tolo and Ray Gold in the Gold Hill district.

The geological history of the Jacksonville district is very similar to that of the Ashland area. The oldest rocks of the region are highly altered Paleozoic sediments in the mountains south of Medford; they are closely associated with old andesitic rocks. Near Jacksonville these sediments consist chiefly of shales which strike N. 10°-20° E. and dip 75°-90° W. These formations were intruded by a granitic mass which occupies a huge irregular dike-like area extending northeastward from the forks of Jackson creek. After a long period of erosion had uncovered and partly removed these rocks the deposition of Cretaceous conglomerates occurred, covering much

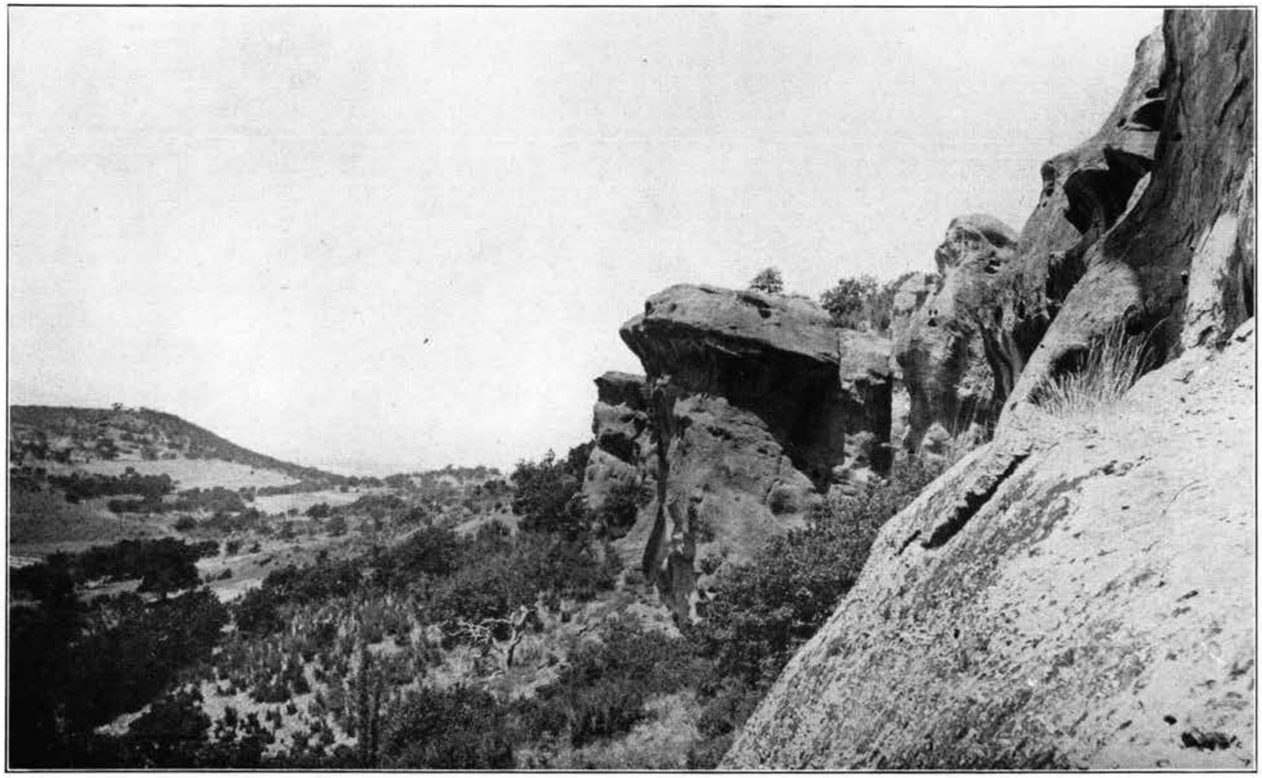


Plate II. Sandstone cliffs with softer conglomerate layers. About 7 miles S. E. of Medford.

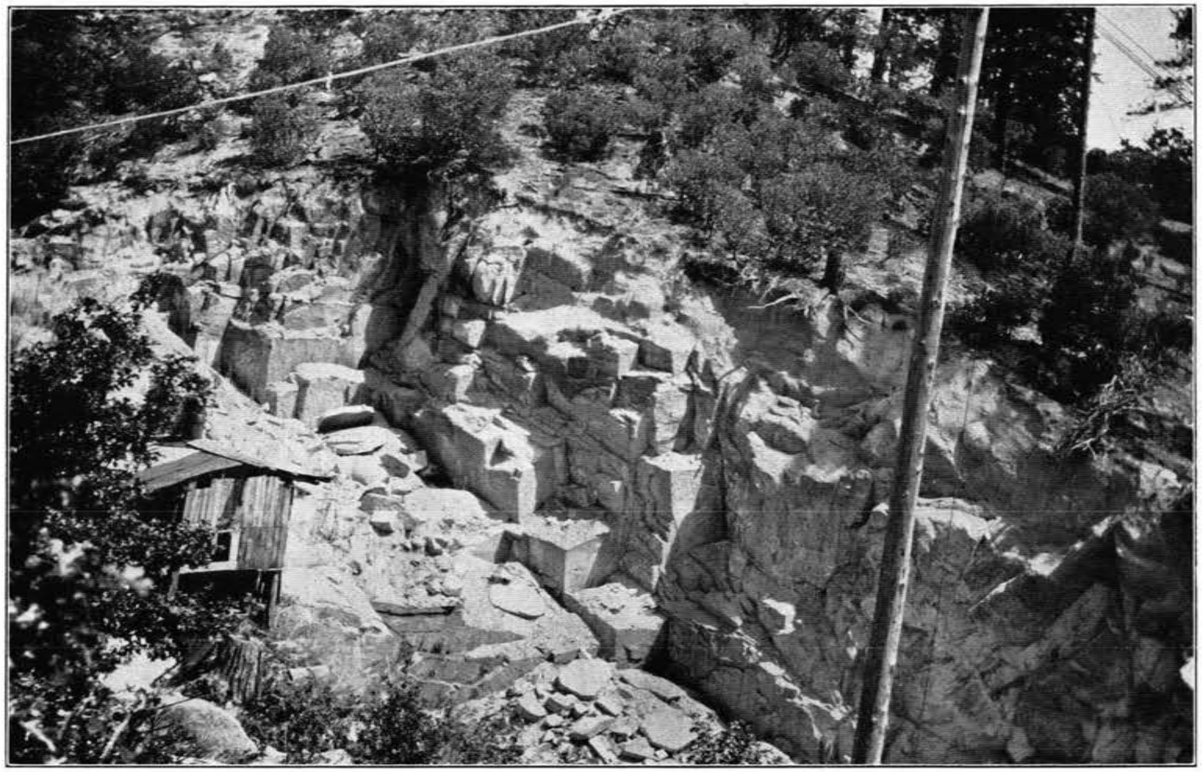


Plate III. Oregon Granite Company's quarry near Jacksonville.

of this district with a layer of which only fragments now remain. According to paleontologists of the U. S. Geological Survey fossils collected by the writer from this conglomerate include specimens of *Trigonia leana* Gabb, *Modiola siskiyouensis* Gabb and *Dentalium*, which show that the rock belongs to the basal beds of the Chico formation of the Cretaceous. A thin nearly horizontal layer of this conglomerate is still left at points along Jackson creek; it is reported on top of the ridge west of Jacksonville. The whole of Bear creek valley was apparently a region of deposition (with one interruption) from the time of the Chico at least to the close of the Eocene. The formation of the basal conglomerate was followed by the gradual deposition of at least 500 feet of feldspathic sandstones containing some conglomerates, and also some beds of coal. These rocks occupy the whole of Bear creek valley and form the lower cliffs on the northeast side. Fossil plants collected by the writer at the Cascade and Sunnyside coal mines and also from a shaly sandstone about half a mile easterly and 500 feet higher than Beeson's coal mine include, according to F. H. Knowlton of the U. S. Geological Survey, samples of laurel, poplar, fig-tree, linden, brake, and fern (*Laurus similis?* Kn, *Populus Zaddachi?* Heer, *Ficus* sp. cf. *sordida* Lesq., *Grewia* sp. cf. *G. celastroides* Ward, *Pteris* sp.? and *Anemia* sp.?) which "appear to indicate reference to the Eocene."

The peculiar erosion forms produced by the action of wind and water on these rocks in some places are illustrated in plate II.

After the deposition of these sedimentary rocks they were covered by great lava flows from volcanoes in the Cascade range. The lavas consist of auganite, andesite, basalt, and rhyolite; they covered the whole of Bear creek valley to a depth of hundreds if not thousands of feet, but they probably did not extend far beyond the divide south of Jacksonville. Erosion has now removed them from the valley except for the remnants forming the tops of Upper and Lower Table Rocks. The same cycle of erosion has also removed much of the sedimentary rocks which were covered by the lavas, thus forming Bear creek valley.

The latest rock formations in the district are the shallow stream gravels which may shift repeatedly as the years pass, but under favorable conditions may be more permanent and of greater thickness and importance.

MINERAL RESOURCES

The mineral resources of the Jacksonville or Medford district include building stone, road metal, clay, coal, gold, and some silver.

Building Stone

The chief building stone is "granite" which outcrops in cliffs about two miles north of Jacksonville at an elevation of about 2000 feet, as measured by aneroid barometer. The "granite" here is weathered to a depth of only 10-20 feet, and the underlying rock is solid with joints well spaced. In a gulch near the quarry of the Oregon Granite Company weathering extends to somewhat greater depth. The rock is quite coarse in grain and of a mottled bluish gray color. Bunches of much darker color are present, but they are not abundant; they seem to be due to incomplete assimilation of fragments of foreign rocks caught in the granitic magma before its crystallization. Microscopically this rock consists chiefly of coarse plagioclase feldspar with some quartz, brown biotite, green hornblende, and a little titanite and magnetite. The hornblende is partly altered to chlorite, and most of the plagioclase is zonal, showing partial alteration to sericite at one stage of growth and external borders wholly unaltered. Petrographically the rock is a typical tonalite, or quartz diorite. The joints along which the rock breaks in quarrying are well shown in the photograph of the quarry (Plate III).

Sandstone is also available as a building stone in the district. A quarry southeast of Jacksonville supplies the local demand. Samples said to represent this quarry, which the writer found no opportunity to visit, are of a greenish gray color, of medium and rather even grain, and only moderately hard. This sandstone can be much more easily quarried and worked than the "granite," but it is not nearly as durable.

Road Metal

About half a mile west of Jacksonville a quarry has been opened from which considerable road material has been obtained. The rock in the quarry and the adjoining outcrops is of a dark grayish to greenish color and fine grain with occasional larger crystals of hornblende. In one part of the quarry the rock is of greenish black color and very fine grained, but this type seems to grade into the preceding. Microscopically the first type is a lamprophyric andesite or a spessartite with gradations toward a more normal andesite containing phenocrysts of plagioclase in a vitrophyric matrix. The spessartite is largely composed of hornblende which is partly colorless and partly zonal, the innermost brownish zone grading into a second green zone, and that into the outer colorless zone; the rock contains a little plagioclase, titanite, magnetite, and calcite. The darkest variety is also spessartite of similar composition but finer grained and containing some rock glass.

The chemical composition of this dark variety is given below; the high percentages of lime, ferrous iron, and magnesia are especially notable. It is not possible to calculate the mineral composition from this analysis; therefore it has been estimated from the thin section as checked by the chemical analysis.

COMPOSITION OF SPESSARTITE FROM QUARRY AT JACKSONVILLE
(S. W. French, analyst.)

		Approximate mineral composition	
SiO_2	51.38		
TiO_2	1.25		
Al_2O_3	17.15		
Fe_2O_3	1.12	Hornblende	65
FeO	6.54	Feldspar	20
MgO	6.18	Rock glass	10
CaO	9.24	Calcite, Titanite, Magnetite	5
Na_2O	2.72		
K_2O	.80		
H_2O+	1.57		
H_2O-	.10		100
CO_2	.84		
	98.89		

The geological relationships of this rock are not clear, but it seems to be a lamprophyric dike related in age and origin to the older andesites. It is certainly pre-Cretaceous in age. The rock is cut by some quartz veins, but these seem to be barren.

An unusual kind of road material is obtained from the Opp mine near Jacksonville. The tailings from the mill have been found to make very good dressing for roads, and a small portion has been sold locally for such use. Since these tailings still contain unrecovered gold (about $1.80 per ton) the roads on which they are used are literally paved with gold (ore).

Clay

A clay deposit about a mile west of Jacksonville has been used for making brick with good results. The deposit and equipment are owned by the Jacksonville Brick & Tile Co., Mr. A. Scholl, of Jacksonville, president. The plant has a capacity of 35,000 brick per day or their equivalent in drain tile. It is equipped with a set of geared rolls, pug mill and auger machine, a series of dry-sheds and a down-draft kiln for burning drain and sewer tile. The brick are burned in open cased kilns. The clay is red and contains small particles of quartz which render the brick somewhat rough. The accessible supply of clay seems to be limited and the owners now grind weathered schistose argillite, which occurs in the hill directly beneath the clay, as a partial substitute. The argillite strikes N. 20° E. and dips nearly vertically; it is probably of Paleozioc age.

About a mile up the creek to the south is a lime quarry and kiln belonging to Peter Ensele in the N. W. ¼, Sec. 6, T. 38 S., R. 2 W. The limestone appears to be a lens-shaped mass whose greatest dimensions correspond with the dip and strike of the argillite of the region. However, the deposit was so small that after an attempt to find it at greater depth by a cross cut adit had failed, the work stopped.

Coal

The largest supply of fuel provided by nature in the Jacksonville district is to be found in the deposits of coal interbedded with Tertiary sediments, probably of Eocene age. There are several seams of coal in the district and some of them have been opened by incline adits or slopes of notable length. Thus, the Cascade coal mine about 5 miles northeast of Medford is opened by a double track entry running in N. 87° E., said to be 900 feet long with a slope at right angles to the adit inclined at an angle of 15° to 18°, and said to be 250 feet on the incline. The workings were nearly full of water when visited in June, 1913. The coal occurs in seams up to 6 inches thick, and is somewhat lenticular or irregular; it is re-

SECTION AT CASCADE COAL MINE

	Feet	*Inches*
Sandstone	2+	
Coal		6
Coaly shale	4	6
Coal		2
Coaly shale		2
Coal		2
Coaly shale		4
Coal		3

ported to be better with depth. The mine is in section 3, township 37 south, range 1 west at an elevation of 1470 feet as measured by aneroid barometer. Nearby a small incline has been run N. 40° E. showing a coal-bearing seam about 2 feet thick which strikes N. 50° W. and dips about 10° N. E. A section near the portal of the west tunnel is given on page 142.

By sorting, some coal has been obtained from the Cascade mine for local uses. Fossils, said to indicate Eocene age, were obtained from the dump.

The Hansen coal mine is less than 1 mile north of the Cascade and at an elevation of 1650 feet as measured by aneroid barometer. The entry is irregular and shows only a little coal; 130 paces from the portal a 2-inch seam of coal strikes N. 30° W. and dips 20° N. E. At 140 paces from the portal a raise to the surface exposed the following section:

SECTION AT HANSEN COAL MINE

	Feet	*Inches*
Surface.		
Shale	30	
Clay		1–3
Coaly shale		1
Coal, with thin shaly partings		12
Carbonaceous shale		2
Coal		½
Carbonaceous shale		2½
Coal		1
Coaly shale		3
Coal		½
Carbonaceous shale with thin seams of coal		18
Covered.		

The coal here strikes N. 40° W., and dips 10° N. E.

The Sunnyside coal mine is in section 36, township 37 south, range 1 west, about 5 miles east-southeast of Medford. Two entries have been made; the entry to the northwest is an incline equipped with a boiler and steam hoist. It was not inspected, being full of water. The other is horizontal and accessible; it is at an elevation of 1970 feet, as measured by aneroid barometer, and extends S. 34° E. about 650 feet. In places the roof has caved, but the entry is nowhere caved shut. Nearly the entire length of this adit the coal bed extends from the floor to the roof without showing its entire thickness, which was found to be about 12 feet at one point where caving permitted measurement. At the face of the adit the coal seam is 8 feet 3 inches thick, and in a branch passage to the south it is 15 feet thick. The quantity of coal in the seam varies remarkably so that a section at one point may show much more coal than at another. The maximum amount of coal in the seam is about 75 percent and the minimum in the main entry is about 30 to 40 percent. The coal bed has a strike of N. 72° W. and a dip of 13° N. E. The coal is brittle and slacks to small fragments upon exposure to the weather.

About 130 feet from the face of the adit, branch tunnels leave the main entry on both sides. Those extending to the northeast follow down the dip of the coal and are therefore full of water and inaccessible. On the other side one branch extends S. 84° W. about 500 feet; from this laterals extend northward to a parallel tunnel and other workings whose extent was not determined. Following the main branch to the west the coal seams in the coal-bearing bed become thinner and the shale bands thicker until at the face the bed contains only a little pure gold.

There are several faults disclosed in these workings, but they are not important as the displacement is only 1 to 4 feet.

J. S. Diller[1] of the U. S. Geological Survey described explorations for coal, probably at this mine, in 1909, as follows:

"The coal 6 miles east of Medford lies along the steeper slope, which rises from the edge of the valley, 600 feet above the town, to the bold front of the Cascade range. Some years ago the Southern Pacific Company prospected a coal bed at this point, and the size of the dump indicates that the trial drifts must have been about 100 feet in length. Since then R. P. Little has discovered a number of other coal beds a short distance farther up on the same hillside and opened two of them by slopes, tunnels, and drifts aggregating nearly 900 feet in length. Drainage is effected by a lateral tunnel into an adjacent ravine. Considerable coal has been hauled to Medford and sold at $8 per ton.

The principal bed prospected is about 12 feet thick, and the striking feature at the entrance of the gentle slope is the large number of clay and sand partings with very little coal between them. The partings weathering whitish are strongly contrasted with the darker bands. As the slope is descended along the bed there appears a decided increase in the quantity and improvement in the quality of the coal toward the northeast. The bands of black lustrous coal, generally not over 6 to 8 inches thick, locally swell to more than a foot and furnish the source of supply for the local demand. The intermed-

[1] U. S. Geol. Survey Bull. 341, 1909, pp. 401–405.

iate shaly coal and coaly shale is abundant and requires much picking to obtain satisfactory results. Several faults striking N. 40° E. and dipping 26° to 42° S. E. have been encountered in the tunnels. The direction of movement and the amount of displacement could not be definitely determined. No lavas were seen in the mine, but they appear higher up, covering the whole succession of coal beds. The decided improvement in the coal down the dip suggested that as the most favorable direction in which to prospect.

Since the examination on which the foregoing statement is based was made, the Pacific Coal Company has purchased this mine and has developed the openings to the northeast along the dip of the coal bed for more than 1000 feet. The prediction that the coal would be found of better quality and in larger quantity has been confirmed. A few small faults have been encountered, but these are all of the normal type and easily overcome. The mine is now (1907) producing coal and supplies the local market. The development of this mine has greatly stimulated prospecting in other parts of the field.

J. A. Holmes of the Geological Survey collected a sample of coal at this locality last summer (1907) and has kindly furnished the following results of an analysis made in the laboratory of the Survey fuel-testing plant.

ANALYSIS OF COAL OBTAINED NEAR MEDFORD, OREGON

[F. M. Stanton, chemist in charge.]

	As received	Air dried
Laboratory No.	5346	5346
Loss of moisture on air drying	....	2.00
Moisture	11.30	9.49
Volatile matter	23.39	23.87
Fixed carbon	31.89	32.54
Ash	33.42	34.10
Sulphur	1.16	1.18
Calories	4,183	4,268
British thermal units	7,529	7,683

The sample taken is a complete section of the coal bed exposed and represents what has to be removed in working the coal. It contains not only the good coal but all the shaly partings. The high percentage of ash indicates that the bed contains much that would have to be thrown away in mining. The ash is about four times as great as that of the bed mined at Libby in the Coos Bay region."

METALLIFEROUS DEPOSITS

The metalliferous deposits of the Jacksonville or Medford district consist of placer mines and gold-bearing quartz veins.

Placer Mines

The chief placer deposit is along Jackson creek where one of the early discoveries of gold in Oregon was made in the fall of 1851, and the Jacksonville district, including both forks of the creek and its tributaries was organized the following year. Both forks were worked as placer from the town up stream for a mile or more; some gravel was worked within the town limits. The bedrock of the placer on the south fork is a rock consisting of very fine quartz, pale brown mica and a black dust resembling magnetite; it seems to be an anamorphosed siliceous shale of pre-Cretaceous age. More important placer mines are southwest of Jacksonville on tributaries of Little Applegate river, and therefore outside of the Medford district.

Gold Quartz Mines

The chief gold-bearing quartz veins in the district are along the west fork of Jackson creek within three or four miles from the county seat.

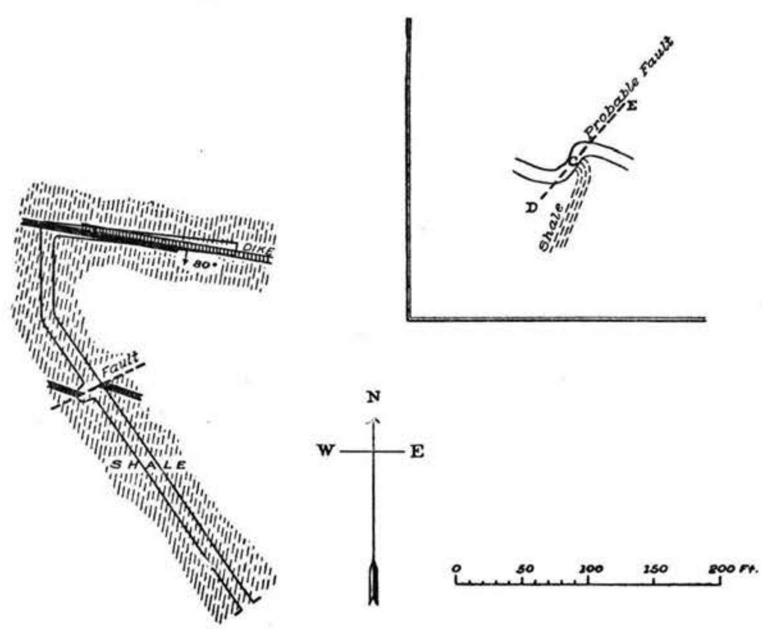


Figure 8. Town mine, main adit and surface working.

The Town mine is on a ridge about 800 feet west of the reservoir on Jackson creek at an elevation of 2200 feet as determined by aneroid barometer. It is owned by J. G. Rinehart. A bunch of rich gold ore known as the Johnson pocket and reported to have yielded $30,000, was taken from a shallow cut in a quartz vein in micaceous shales near the top of the ridge. The old partly filled opening marking the site of the pocket is curved like a circumflex as shown in the drawing (figure 8). At the point C the shaly layers are curved, probably as a result of faulting in a direction DE, which seems to have offset the vein about 16 feet. A crosscut adit was driven from a point about 300 feet down the hillside to the southeast to cut the veins under the pocket. It was run N. 35° W. 265 feet, and then north 70 feet and easterly about 150 feet as shown in the drawing. At 200 feet from the portal a mass of quartz was cut in the northeast wall, but as it did not continue across the adit it was not recognized as the vein, and the adit was continued. More recent work at this point discloses a narrow band of quartz in an apparent fault leading southerly to more quartz which is probably the faulted continuation of the main vein, the offset being similar to that observed on the surface. The vein strikes north of west and has a nearly vertical dip. The extension of the adit opened a second nearly parallel vein which pinched out to the east, the tunnel then following a dike along the south side of which the vein was formed. The country rock is a shaly argillite which strikes N. 10° E. and dips 80° E. A dike present in the adit consists largely of hornblende and is a mafic diorite or a spessartite.

About 600 feet to the north on the northeast slope of the ridge at about the same elevation another adit runs S. 15° W. nearly 200 feet. At 185 feet from the portal it cuts a 2-foot vein of quartz which strikes S. 85° W. and dips steeply to the north. A drift of 20 feet to the west on the vein shows no important change in character. This is apparently below a shallow pit on the surface, about 120 feet higher, made in taking out the "Bowden" pocket which is reported to have yielded $60,000.

Beside the reservoir on Jackson creek another vein called the Reservoir ledge is worked by two men who break ore by hand mortar and pan out the gold. The vein is 1 to 3 feet wide and strikes N. 85° W. with a dip of about 85° N. It is opened only on the surface.

The Yellow King mine on Jackson creek is owned by the Medford Mining and Milling Company; it is in section 26, township 37 south, range 3 west, at an elevation of 2800 feet, as measured by aneroid barometer. A cross cut adit extends N. 17° E. about 240 feet; at the face drifts run about 20 feet in a 3-foot vein with quartz seams and some sulphides. The country rock is a dark massive andesitic rock; all the vein matter is hard and impervious. At 197 feet from the portal the adit cuts a vein marked by much fault gouge and very wet; the walls are well defined, but there is little quartz and less pyrite in this vein, which strikes S. 83° E. and dips 77° S. At a shaft on the hillside to the south at an elevation of about 2900 feet free gold is visible in iron-stained quartz.

The Norling mine is half a mile southwest of the Yellow King and is owned by the same company. During June and July, 1913, Mr. Butterly was driving a crosscut adit for the company, his compensation being the right to stope a given area. During development in 1905-1907 the Norling is reported to have produced 120 tons of ore worth $6400. The main adit is at an elevation of 3130 feet as measured by aneroid barometer. For 240 feet it follows a vein which dips 75° S. with minor irregularities. The gold is said to be chiefly in the quartz; the pyrite is even more abundant in the rock adjoining the vein than in the vein itself. Considerable ore has been stoped out above this adit. The vein is 8 to 18 inches wide containing much quartz. The country rock is like that at the Yellow King. A new crosscut adit has been driven S. 13° E. about 215 feet at an

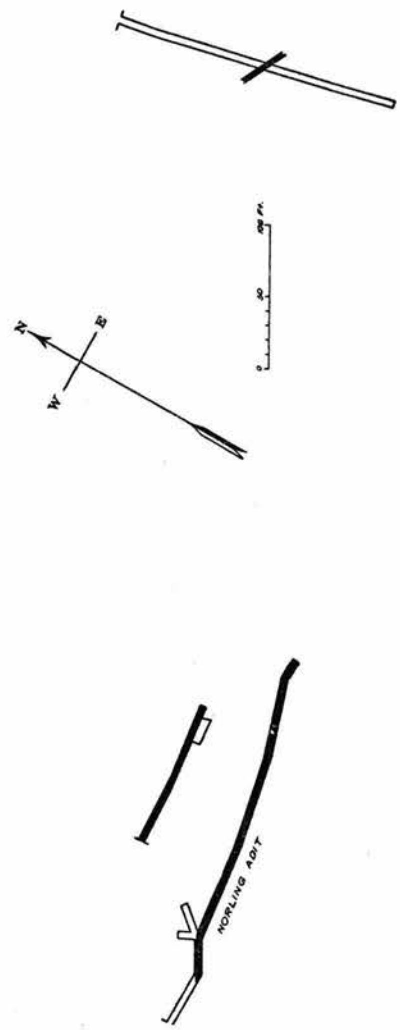


Figure 9. Norling mine, main adits and veins

elevation of about 3115 feet; it is expected that this entry will strike the vein when driven about 100 feet farther. It intersects one vein at 125 feet from the portal, which strikes N. 65° W. and dips about 65° N. These workings and veins are shown in figure 9. A stringer at 150 feet from the portal strikes N. 83° W. and dips about 65° N., and another at 200 feet from the portal strikes N. 87° W. and dips 70° N.

This mine is equipped with a 5-stamp mill having plates and vanner, run by engine; it has not been in operation since 1911.

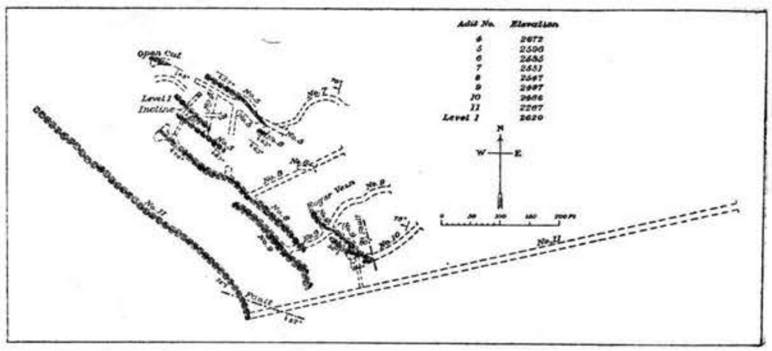


Figure 10. Opp mine, east workings.

The Opp mine was discovered many years ago, but its chief development has taken place within the past ten years. According to Mr. Beekman, the banker at Jacksonville, the mine produced about $100,000 while controlled by him. Since then it has been operated by a company, by Mr. J. W. Opp, and by lessees. The mine is located in section 36, township 37 south, range 3 west about 1½ miles west of Jacksonville at elevations ranging from about 1850 to 2850 feet above sea level. The land held by the mining company includes nine 40-acre plots and 1 mining claim, making a total of 373 acres. It is opened by 18 adits disclosing three main veins. The longest crosscut entry is about 850 feet; another is 550 feet long. The total underground workings amount to about 7000 feet, the distribution of which is shown in figures 10 and 11. The surface equipment consists of about 3600 feet of tram line, a 20-stamp mill with concentrator, a 125-ton cyanide plant, and other buildings. The mill has a crusher, a Dorr classifier, one Wilfley and 6 Johnson concentrators, 20 stamps and 4 plates.

The adit 10 or Roger vein is apparently the same as the adit

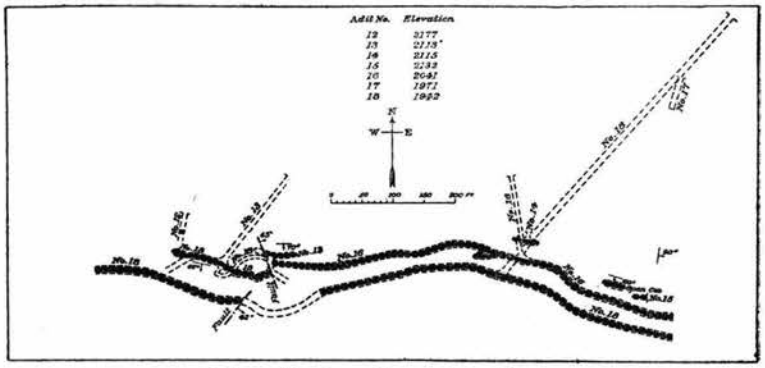


Figure 11. Opp mine, west workings.

By placing figure 11 due west of figure 10 a single map of all the important workings may be made.

7 vein, although it is not easily seen in adit 8 which it should cross at a point about 60 feet from the portal. At the breast of adit 7 a slip or fault strikes north and dips 50° E.; its effect on the vein is not clear because of lack of development work. The Roger vein strikes N. 60° W. and dips 50°-63° S. W. It has a thickness of 3 to 12 feet of which 2 to 4 feet usually contain most of the gold. The hanging wall is well defined, but the vein grades into the footwall, which is replaced or impregnated with ore. The footwall in adit 10 is a dark shaly rock which strikes N. 5° W. and dips about 84° E. Near the portal of adit 7 the footwall shale strikes N. 15° E. and dips about 70° W. This shaly rock is interbedded with quartzite samples of which from the hanging wall of adit 10 consist of fine granular quartz in places in bands of varying size with more or less yellowish brown iron stain and rare crystals of pyrite; less commonly the stain is chloritic. In some places the ore is brecciated, and the original quartz is coarse and contains very little pyrite, which is found especially in the cementing material of calcite and quartz and also in fragments of carbonaceous shale. This is evidence that the ore was formed not at the time when the veins were first produced, but at a later time when they were fractured and new solutions brought in cementing materials. According to Mr. Opp the pay shoots are usually where the veins are thickest; in other mines when the ore is deposited simultaneously with the gangue this rule is usually reversed, and the condition at this mine is another indication that the gold was introduced after the deposition of the primary quartz of the veins.

The adit 8 vein is the southwest vein in adits 5 and 9 and is also seen in incline shaft 2 and probably in the old surface stopes. On adit 5 level this vein has a thickness of about 4 feet; it strikes about N. 50° W. and dips about 60° S. W. The country rock is a siliceous argillite containing some chlorite and pyrite. The chemical composition of this rock is given below, with the approximate mineral

COMPOSITION OF ARGILLITE, OPP MINE, JACKSONVILLE
[Analysis by S. W. French.]

		Approximate mineral composition	
SiO_2	65.98		
TiO_2	1.40		
Al_2O_3	17.20		
Fe_2O_3	1.49	Quartz	35.8
FeO	2.68	Muscovite	33.6
MgO	2.46	Feldspar	18.0
CaO	.11	Chlorite	6.8
Na_2O	2.18	Magnetite, Ilmenite	4.8
K_2O	3.96		
H_2O+	2.56	Pyrite, etc	1.2
H_2O-	.12		
	100.14		100.2

composition as derived from the analysis in the light of the fact that microscopic study shows that the sample contains abundant sericite and quartz with some chlorite, magnetite, and pyrite.

The adit 1 vein is probably the same as the vein near the breast of adit 2; it may be continuous with the adit 8 vein, but there are no workings to prove the connection. In adit 1 the vein strikes N. 57° W. and dips about 75°-80° S. W.; it has a thickness of 14 feet, 8 or 10 feet of which on the footwall have been stoped out to the surface. The country rock of the vein is an andesite rich in ferromagnesian minerals. A sample from near the portal contains abundant green hornblende, some brown hornblende, some plagioclase, some biotite, titanite, and a little quartz. This andesite is so intimately associated (as an intrusive sill?) with the old Paleozoic sediments that upon weathering it develops a schistosity nearly parallel with the bedding of the latter; near the portal of adit 1 this schistosity strikes N. 10° W. and dips 70° E. The chemical composition of the andesite is given below, together with the mineral composition as derived therefrom by assigning all the potassa of a biotite of average composition to that mineral, all the remaining magnesia to an average hornblende, and the other oxides to their respective minerals as usual. The thin section indicates that the calculation yields too high a percentage of quartz, but otherwise is nearly correct.

COMPOSITION OF ANDESITE, OPP MINE, JACKSONVILLE

[S. W. French, analyst.]

		Approximate mineral composition	
SiO_2	55.76		
TiO_2	1.22		
Al_2O_3	15.68		
Fe_2O_3	1.49	Hornblende	41.9
FeO	6.43	Feldspar	24.9
MgO	6.36	Biotite	13.4
CaO	8.71	Quartz	17.8
Na_2O	1.86	Titanite	2.1
K_2O	1.18		
H_2O+	1.23		100.1
H_2O-	.10		
	100.02		

The adit 2 vein (near the portal) has not been traced elsewhere; it strikes N. 65° W. where cut by the adit about 50 feet from the portal. It is possible, but not probable, that this is the same as the Roger vein.

The adit 11 vein is probably the downward continuation of the adit 8 vein, or possibly of the Roger vein. If the former interpretation is correct the Roger vein is probably represented by the small vein about 85 feet east of the main vein. The small vein strikes N. 53° W. and dips about 54° S. W.; it contains about one foot of quartz and 2 or 3 feet of sheared country rock. About 10 feet farther in a shear zone strikes N. 72° W. and dips 54° S. This is visible again where it crosses the drift not far from the crosscut; here it has the same strike and dip and a thickness of about 10 inches, but produces no apparent offset in the main vein. The latter is opened by a drift said to be 500 feet long disclosing a vein varying in thickness from 5 feet to a maximum said to be 25 feet. It strikes about N. 45° W. and dips about 75° S. W. Too much water prevented its inspection.

The adit 18 vein is shown by continuous stoping above that level to extend upward to adits 16, 15, 14, and 13. It varies in strike from N. 70° W. to S. 75° W., averaging nearly west, and dips about 68° S. The vein is continuous on the strike except where cut by a fault, shown clearly in the east drift from adit 13, which strikes

N. 20° W. and dips about 65° E. On level 18 a fault block seems to separate the two parts of the vein and the west side of the block is marked by a fault which strikes about N. 38° E. and dips 42° S. E. The vein is largely quartz and averages about 5 feet thick. The value is said to increase where the thickness increases, being about $5.00 a ton in the ore shoots. One ore shoot is about 300 feet long on this level; another is about 150 feet long. The longer one did not reach the surface by 40 or 50 feet in its middle half. After amalgamation ore from this vein concentrates about 40 into 1 and the heavy sulphides are worth about $60 a ton. A rock sample from the crosscut entry (adit 18) contains abundant pale hornblende, some zoisite, calcite, and quartz, with a dark staining material; it is a much altered rock, probably originally a quartzose shale.

THE GOLD HILL DISTRICT

LOCATION

In this report the Gold Hill district includes the whole Rogue river valley from Central Point and Table Rock westward to Josephine county. It is limited on the south by the divide between Rogue and Applegate rivers and includes tributaries of Rogue river from the south, namely Kane, Galls, and Foots creeks, and from the north, namely, Sams, Sardine, Wards, and Evans creeks. There are many placer and auriferous quartz mines in the district and other mineral resources of various kinds. There are no large cities in the area, but the town of Gold Hill, on the Southern Pacific railway, is headquarters for the most active part of the region. Near Central Point and Table Rock the Rogue river occupies a wide valley; only a few miles to the west it enters a narrow valley from which it does not emerge until it reaches Josephine county. The Gold Hill district is a mountainous region cut by one narrow east-west valley and its tributaries from the north and south. The elevation varies from less than 1000 feet at the mouths of Evans and Savage creeks to nearly 4000 feet on top of Fielder Mountain, and similar elevations both north and south of Rogue river.

HISTORY

The Gold Hill district, as the name is here used, includes half a dozen areas which were at one time organized as mining districts.

Thus, the Foots creek district was formed in 1853; the placer gold here was unusually coarse. The Evans creek and Pleasant creek districts were organized in 1856, but the rich pocket from which the town of Gold Hill takes its name was not discovered until January, 1859. It is said that $400,000 was taken out the first year. During the seventies placer mining continued somewhat less actively, about half the miners being Chinese. In 1884 placers on Galls creek were notably successful, while gold bearing gravels on Foots creek were profitable throughout the decade. During the nineties the output of the placers decreased, but work continued on many creeks of the region. During the first decade of the twentieth century placer mining continued on Foots, Galls, Sams, Sardine, and Pleasant creeks, one dredge being used on Foots creek, a 7-mile ditch constructed on Sams creek, and other improvements made in the district. On the whole, the production of the placer mines has been maintained for a long time, but is slowly decreasing, and no large auriferous vein deposits have yet been developed to adequately take their place, although several have been opened near the surface during the last ten years. Thus, the Millionaire mine about 3 miles southeast of Gold Hill was opened by a vertical shaft to a depth reported to be 400 feet, the Bill Nye mine about 3 miles south of Gold Hill was opened by several adits, and considerable work was done on the Tinpan, the Lucky Bart, and other mines. These and other mines were more or less productive at various times during recent years.

GEOLOGY

The Gold Hill district is a region occupied chiefly by old Paleozoic sediments interbedded with sills or flows of andesite and greenstone. Everywhere the sedimentary rocks strike northerly, usually about N. 15° E. and dip eastward at angles ranging from 65° to nearly 90°. Diller [1] has shown that Jurassic beds near Waldo have been overturned so that the oldest strata now overlie the younger formations. It seems probable to the writer that the Paleozoic sediments are also overturned, and that limestones found on Kane creek are probably of early Paleozoic age, and fossils found in limestone lenses on this creek indicate [2] that they are not Devonian; the writer would suggest that they are Silurian rather than Carboniferous in age.

[1] J. S. Diller: U. S. Geol. Survey Bulletin 546, pp. 18 and 22, Washington, 1914.

[2] J. S. Diller: U. S. Geol. Survey Bulletin 380, p. 50, Washington, 1909.

Fossils found in limestone lenses on Cheney creek and south of Waldo were considered as probably Devonian in age by E. M. Kindle[2] of the U. S. Geological Survey in 1909; others collected by the writer on Cheney creek in 1913 were considered by the paleontologists of the U. S. Geological Survey to belong probably to the Carboniferous. Accordingly the Paleozoic sediments west of Kane creek in the Gold Hill district are referred to the Devonian or Carboniferous or to both periods.

Long after the formation of these Paleozoic sedimentary rocks the region was intruded from below by a mass of molten igneous rock; at about the same time and perhaps by the same agency the bedded rocks were closely folded and overthrust to the westward. The intrusive rock solidified beneath a considerable thickness of sediments or other rocks, which has since been removed in some places. Thus, the igneous mass is now exposed to view in the mountains at the head of Kane creek, and extends thence northeastward nearly to Central Point and thence northwestward past Tolo and Ray Gold to the west side of Blackwell Hill; the same rock outcrops in the N. E. $\frac{1}{4}$ of Sec. 35, T. 35 S., R. 3 W., on the west side of Sams valley; a similar rock of aplitic texture outcrops near the south line of section 15, T. 37 S., R. 4 W., on the right fork of Foots creek, and it seems probable to the writer that it underlies at considerable depth a large part (or all) of the Gold Hill district.

This igneous intrusion and intense folding seems to have elevated the region enough to cause a new cycle of erosion and the formation of coarse sediments which could not be transported far by ordinary agencies. Therefore conglomerates were produced. and these were succeeded by feldspathic sandstones during part of Cretaceous time. Rocks produced in this way are now found between Evans creek and the headwaters of Sams and Sneider creeks; similar rocks are doubtless covered by later lava flows near the Table Rocks. Along Evans creek from the "Meadows" northward these Cretaceous sandstones are overlain by a considerable thickness of Tertiary sandstones which contain some thin beds of coal.

The latest rock formations in the district consist of stream deposits some of which are very valuable on account of the gold they contain. They are formed along all the streams of the district, but are not abundant along Rogue river in this region because the latter is here in a narrow rock-cut portion of its course to the sea.

[2] J. S. Diller: U. S. Geol. Survey Bulletin 380, p. 50, Washington, 1909.

MINERAL RESOURCES

The mineral resources of the Gold Hill district include building stone, road material, limestone, shale, clay, coal, asbestus, mica, mercury, iron, copper, silver, and gold. They are varied and important, as well as, for the most part, readily accessible from the railroad, which crosses the district from east to west.

Building Stone

There are several kinds of building stones available in the Gold Hill district. There is limestone on Kane and Galls creeks as well as north of Rogue river; there is basalt in the Table Rocks and northward in the valley of the river; and there is "granite" at Ray Gold and elsewhere to the southeast. The limestone and basalt have not yet been used as building materials to any extent, because other materials have been available, and the basalt is not commonly regarded as of suitable color.

The Gold Ray Granite Company's quarry is situated about two miles west of Tolo on the line of the Southern Pacific railway. The rock consists chiefly of plagioclase with some brown biotite, green hornblende, and quartz and a little titanite, magnetite, and chlorite. Much of the feldspar is zonal and was partly altered to sericite and other material at one stage in its growth, the outer zone being fresh and unaltered. Petrographically the rock is a tonalite or quartz diorite. The condition of the quarry is shown in the photograph (Plate IV A). The rock is very coarse grained and hornblende is prominent. Dark spots are quite rare, but a large one of sharp angular outline is shown in a photograph of a large block now at the quarry (Plate IV B). It is clearly a fragment of a foreign rock and not a segregation. This "granite" is remarkably well located for cheap transportation, but it is said to be somewhat unsatisfactory, probably because the joints, though for the most part widely enough spaced, are irregular in spacing and angular position. The quarry was idle for some years; according to Professor Ira A. Williams, of the Bureau of Mines and Geology, it was leased by the county and in operation in 1914, producing crushed rock for use as road material.

It is probable that the granitic intrusion which forms Mount Ashland and also outcrops from the headwaters of Jackson creek to Gold Ray and is found again on Evans creek is a very extensive batholith now uncovered only in small part; the granitic rock on the Umpqua river in section 26, T. 30 S., R. 3 W., doubtless belongs to the same formation. It has been analyzed by G. Steiger[1] of the U. S. Geological Survey; it is the belief of the writer that the following analysis represents fairly well the composition of the whole Siskiyou batholith, and therefore of all the "granite" used as a building stone in southern Oregon.

COMPOSITION OF TONALITE, UMPQUA RIVER, OREGON

[G. Steiger, analyst]

		Approximate mineral composition	
SiO_2	58.25		
Al_2O_3	20.52		
Fe_2O_3	.68		
FeO	3.88	Andesine (near	
MgO	2.03	Ab_1An_1)	62.9
CaO	7.88	Quartz	13.8
Na_2O	4.25	Hornblende	16.0
K_2O	.50	Biotite	5.6
H_2O-	.24	Apatite, ilmenite,	
H_2O+	1.10	water	1.6
TiO_2	.57		
ZrO_2	.01		99.9
P_2O_5	.16		
MnO	.10		
	100.17		

Road Materials

The Gold Hill district has abundant road materials of several kinds. In addition to the "granite" which may be used in blocks for paving, both limestone and shale are available for macadamizing roads or for use in making cement. Finally the basaltic lavas of Rogue river valley are especially desirable for making macadam pavements and their use should be encouraged.

Limestone and Shale

It is an uncommon condition in the United States that an area as large as the state of Oregon, with as much limestone as it possesses, has undertaken to develop so few of its deposits of both limestone and shale for the manufacture of Portland cement. Elsewhere in the country, where limestone is abundant, the choice of a site for a cement plant depends upon finding suitable shale, the limestone of best quality being selected, together with a good market and adequate transportation facilities. But in some large sections of

[1] F. W. Clarke: U. S. Geol. Survey Bulletin 419, p. 167.

Oregon limestone is less abundant and the place of manufacture of cement must be determined chiefly by its presence. Fortunately shales are not uncommon in the region under consideration and some limestone beds are very close to railroad lines. Therefore the limestone deposits of the Gold Hill district are an important mineral resource.

The Paleozoic sedimentary rocks of the region include much sandstone or quartzite and shale or argillite, but only a small amount of limestone or marble. The latter occurs in lenses whose usual thickness is 50 to 200 feet and whose ordinary length is only 500 to 1000 feet. These lenses are interbedded with the other sediments and strike about north and dip steeply eastward.

The chief limestone lenses of the Gold Hill district are as follows:

On Kane creek in section 11, T. 37 S., R. 3 W., a limestone lens of unusually large size, or perhaps two or more lenses, extend from north to south across the section with a measured thickness varying from 200 to 300 feet. The enclosing rocks are slates or argillites, though the Siskiyou granitic batholith approaches within 100 feet of the limestone in one place. The sedimentary rocks strike N. 10°-17° E. and dip 80°-85° E. A smaller lens of limestone less than half a mile to the northwest in section 2 is the site of lime quarries owned by Hughes and Householder. Here the limestone is probably more than 100 feet thick and has the same strike and dip as in the preceding outcrops.

Near Gold Hill in section 16, T. 36 S., R. 3 W., a limestone lens has a thickness of 50 to 100 feet and a length of at least 1000 feet; it strikes about N. 20° E. and dips about 65°-80° E. It is interbedded with argillaceous shales. At this location the Beaver Portland Cement Company is erecting a cement plant having a capacity of 1000 barrels a day.

On Galls creek in section 21, T. 36 S., R. 3 W., at an elevation of about 1300 feet above sea level limestone outcrops, but the extent of the deposit is unknown. It seems to be of good quality. On the west side of Galls creek near the south side of section 20 at an elevation of about 1400 feet a lens of limestone has a thickness of about 200 and a length of at least 500 feet. It strikes about N. 10° E. and dips about 85° E. To the southwest a few hundred feet two more lenses of limestone are found parallel to the first and separated by quartzite.

On Wilson creek in section 30, T. 36 S., R. 3 W., a conspicuous white ridge-like outcrop consists of limestone and white quartzite. It is about 300 feet wide and a quarter of a mile long and rudely lenticular. The strike is N. 30° E. and the dip is nearly vertical.

On Rogue river in the S. E. ¼ of Sec. 23, T. 36 S., R. 4 W. about two miles west of Rock Point at an elevation varying from 1500 to 1900 feet a lens of limestone about 100 feet thick strikes N. 35° E. and dips about 70° S. E. This is on land owned by M. S. Johnson of Gold Hill.

There are undoubtedly still other lenses of limestone in the district, but they are probably less accessible than the deposits described.

Numerous analyses have been made to show that these limestones are suitable for use in making cement. There is little doubt that by suitably mixing them with shale or clay of the region a good cement can be made, perhaps by the use of coal obtained in the Rogue river valley. The following analyses are of importance in this connection.

COMPOSITION OF LIMESTONE NEAR GOLD HILL

	A	B	C	D	E	F
SiO_2	.31	.37	25.21	.92	23.86	3.1
$Al_2O_3 + Fe_2O_3$	.44	.20	......	......	.32	2.2
MgO	.03	.01	.62	.40	Trace	2.5
CaO	55.34	55.71	39.02	55.00	41.83	50.0
H_2O	.56	.37	......	......	.46	......
CO_2	43.23	43.54	31.48	43.66	32.57	42.2
	99.91	100.20	96.33	99.98	99.04	100.0

A. Householder's quarry on Kane creek in sec. 2, T. 37 S., R. 3 W.
B. Hughes' (Carter's) quarry on Kane creek in sec. 2, T. 37 S., R. 3 W.
C. ½ mile west of Gold Hill in sec. 16, T. 36 S., R. 3 W.
D. 1 mile northwest of Gold Hill in sec. 16, T. 36 S., R. 3 W.
E. 1½ miles southwest of Gold Hill in sec. 20, T. 36 S., R. 3 W.
F. Near Rock Point, probably in sec. 23, T. 36 S., R. 3 W.

[Analyses A, B, and E made by R. C. Wells, U. S. Geol. Survey Bulletin 419, p. 209. Analyses C and D made by P. H. Bates, U. S. Geol. Survey Bulletin 387, p. 29. Analysis F made by J. S. Phillips, U. S. Geol. Survey Bulletin 387, p. 29.]

Clay

The alluvial clay deposits along Rogue river have been used to make brick at Tolo where a brick plant was built by the Gold Ray Granite Company having a capacity of 30,000 brick a day. The clay is obtained about one mile east of the plant to which it is transported by an electric trolley line. The equipment is quite complete and in good condition and includes not only the brick kilns and an up-to-date drying system, but also repressing machines and kilns for burning drainage tile. The brick produced here sell for $10.00 or $12.00 a thousand; the repressed brick bring twice as much. The plant was idle during 1912 and 1913, but the company is selling its reserve stock and will operate again when the demand requires it.

A bed of potter's clay is reported on Gardiner's farm (formerly owned by Runnell) on the road between Evans creek and Trail creek. The bed is said to be 12 to 18 inches thick and obtained just below the soil; the stratum used contained somewhat too much iron; an underlying layer was free from iron but cracked on cooling. Mr. Hanna made pottery from this source for several years and sold it locally. The deposit is not now in use.

Coal

The only coal in the Gold Hill district is in the extreme northeastern part on upper Evans creek and thence southeastward.

Thin seams of bituminous coal are separated by coaly shale in a bed 6 feet thick in the S. W. ¼ Sec. 33, T. 34 S., R. 2 W. The floor is shaly and the roof is sandstone. The beds strike N. 20° W. and dip only 10° E.

Thin seams of coal are found in a bed about 3 feet thick in the N. W. ¼ Sec. 33, T. 34 S., R. 2 W. This coal is nearly horizontal, but seems to dip gently to the west-southwest.

Coal in thin layers is reported in the N. E. ¼ Sec. 32, T. 34 S., R. 2 W. Here it is said to occur in a rock which is highly recrystallized containing abundant green hornblende, abundant granular andesine, some brown biotite, magnetite, and titanite. The andesine contains numerous granular inclusions of magnetite, hornblende, and biotite, and the whole texture of the rock is globulitic and implies recrystallization under metamorphic conditions.

Coal in thin seams in a bed about 3 feet thick is reported in the S. E. ¼ Sec. 29, T. 34 S., R. 2 W. in the "meadows" on upper Evans creek. This coal is said to be nearly flat, dipping gently west-southwest. This is on land owned by Alfred Lewis of Gold Hill.

A coal seam about one foot thick outcrops east of Evans creek near the east line of Sec. 16, T. 33 S., R. 2 W. at an elevation of 2850 feet as measured by aneroid barometer. This seam has not been explored.

Some trenching and tunneling for coal has been done in section

21, T. 33 S., R. 2 W. A small amount of coal has been obtained here, but the workings are now full of water. In the creek bottom near by the sandstone strikes N. 8° E. and dips about 15° E.

So far as developments have shown as yet there is no coal of importance in the Gold Hill district, but further exploration may disclose thicker seams of coal similar to those in the Medford district.

Asbestos and Mica

A small amount of asbestos is known in a serpentine rock probably in section 7, T. 34 S., R. 2 W., at an elevation of 3300 feet as determined by aneroid barometer.

Asbestos is also reported to occur near the coal in T. 33 S., R. 2 W. but in a rapid trip through the region it was not seen.

Mica in small amount occurs in a pegmatite dike near the south line of section 18, T. 34 S., R. 2 W. at an elevation of about 2000 feet as measured by aneroid barometer. This is a colorless mica suitable for isinglass, but the sheets are small and the quantity present does not seem to be important.

Mercury

Quicksilver ore is found on the Mt. King claim owned by J. R. Hayes of Detroit in the S. E. $\frac{1}{4}$ Sec. 36, T. 34 S., R. 3 W. It occurs along a granite-sandstone contact where the granite is in part represented by pegmatite. Native mercury is seen in calcite at an elevation of 2500 feet as measured by aneroid barometer in an open cut near the main adit (No. 1). In the latter there is no well-defined vein but some mineralization along an irregular contact. The ore contains cinnabar, native mercury, pyrite, and a heavy black mineral resembling metacinnabarite. The same contact (with some cinnabar) is visible also at an open cut up the hill N. 70° E. and 140 feet higher than adit 1. In another entry about 100 feet lower than the main adit native mercury is abundant in a much decomposed granite in the floor where the adit forks about 20 feet from the portal. The granite also contains a little cinnabar. The adit extends S. 11° E. 170 feet, the last 90 feet in solid micaceous quartzite; a branch tunnel extends irregularly south about 30° E. 75 feet. Except in the solid quartzite much faulting is in evidence in all directions.

Another outcrop containing cinnabar was discovered by members of the party on the south side of Evans creek in section 19, T. 34 S., R. 2 W.

It seems quite possible that this region may produce important quantities of quicksilver.

Iron

A deposit of iron-bearing material has been opened by shallow workings in section 3, T. 36 S., R. 3 W. at elevations ranging from 1950 to 2250 feet as measured by aneroid barometer. The ferruginous material occurs in bunches or lenses in Paleozoic sediments which include some limestone and abundant argillite. The sediments are cut by a dike of "granite," as indicated by surface float on top of the ridge at an elevation of about 2000 feet. The sedimentary rocks strike N. 20° E. and dip about 70°-80° E. The ferruginous material includes some limonite, hematite, and magnetite, but there is no evidence of iron ore in any important quantity in this place.

The rock at the Whitney mine, of which an analysis is given in connection with the description of the mine, approaches an iron ore in composition. The quantity of this rock available is not known.

Copper

Copper ore has been developed by adits run by Dr. Chisholm of Gold Hill in S. E. ¼, Sec. 19, T. 34 S., R. 2 W. A crosscut entry extends S. 45° E. about 30 feet and thence S. 63° E. about 170 feet through quartzitic rock. It does not disclose ore. At 150 feet from the portal a fault strikes N. 31° W. and dips 55° N. E.; it has a maximum thickness of about 18 inches and contains fragments of quartzite. Near the fault the country rock changes from a micaceous to an ordinary quartzite. There are two other older adits which show more ore. The lower and southern entry is in micaceous quartzite banded and locally contorted. About halfway to the breast a 6 to 8 inch pegmatite vein crosses the adit, which is at an elevation of 1760 feet by barometer. The upper adit is about 100 feet higher; it discloses ore which consists of chalcopyrite and arsenopyrite. Surface waters have formed some gypsum and melanterite by oxidation of the sulphides. The ore at this mine is very interesting; it occurs in part as a primary constituent of a basic igneous rock, and in part as a vein filling. The rock is a norite containing abundant hypersthene partly poikilitically enclosed by plagioclase, both minerals intergrown with pyrrhotite and chalcopyrite as well as a little brown biotite, hornblende, and magnetite. Some secondary chlorite and calcite are also present. As a vein filling the sulphides occur inter-

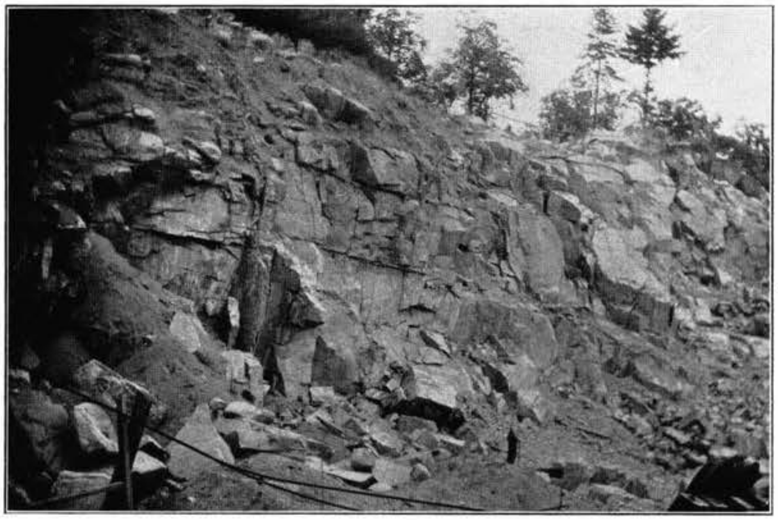


Plate IV A. Gold Ray Granite Company's quarry near Tolo, Jackson Co., Ore.

Plate IV B. Foreign rock fragment in tonalite at Gold Ray Granite Company's quarry near Tolo.

Plate V A. Hornblende with curved cleavages separated by elongated quartz. Photograph of thin section.

Plate V B. Vein quartz sliced, with some granulation, by shearing. Photograph of thin section.

grown with quartz, which may fill fissures or serve as a cement of broken material (fault breccia) consisting of pegmatitic andesine with some quartz. The vein filling has been sheared since formation as shown in the illustrations (Plate V A and V B), one of which shows a crystal of hornblende first bent so that the cleavages are sharply curved, then opened along the curved cleavages and the spaces filled by quartz crystallized in somewhat elongated forms to fill the spaces open. The other shows vein quartz so sheared that it is broken into thin nearly parallel slices of considerable length.

It seems clear that the copper ore at this place was derived from the norite magma.

Gold and Silver

The precious metal mines of the district are of two classes, the gravel deposits and the gold-bearing quartz veins.

Placer Deposits

The placer deposits are all closely associated with existing streams, being either in the present stream beds or on terraces not many feet above them. Mining is carried on chiefly during the wet season of "winter" or early spring. A few of the placers have been equipped with dredges, but hydraulic mining is the prevalent method.

On Kane creek placers have never been extensive, but an electric dredge was under construction in 1908 for use in the S. E. ¼ Sec. 36. T. 36 S., R. 3 W. The capacity was 500 cubic yards in a ten hour day; the power was obtained from the dam on Rogue river at Ray Gold; the material of the deposit is fine-grained clay and gravel with few boulders; the bed rock is an altered slate. Since 1908 very little has been done on this project.

On Sams creek some placer mining has been attempted from time to time, in general with only moderate success. In 1901 the Iron Mountain placer was productive, in 1904 a 7-mile ditch was constructed to furnish it water. In 1913 it was reported that a farm in the lower part of the valley had been purchased by parties who planned to install a dredge.

On Sardine creek placer mining has generally been conducted on a small scale, but it has been fairly continuous for many years. In 1901 the Vroman placer was productive; in 1908 mining was still in progress.

On Galls creek the stream gravels have yielded gold since the early days of mining in southern Oregon. Much of the mining has been by ground sluicing; hydraulic methods have also been used. Placer miners having headquarters at Rock Point near the mouth of Galls creek about 1890 included Hayes and Magruder, Wm. Caldwell, Hasmer and Sanders, and Pfeil Bros.

On Foots creek placer miners were so numerous and successful that a mining district was organized as early as 1853 and the gravels have been yielding steadily ever since. The gold first found was unusually coarse. The Lance family, now in Gold Hill, has operated on Foots creek for several decades. In 1903 Mr. Lance sold some placer ground to the Champlin Dredging Company of Chicago, and a bucket dredge was built and installed the same year. In 1905 electric power was substituted for steam power. According to G. F. Kay,[1] "the average depth of the pay gravel is about 35 feet, but deposits to depths of 46 feet have been mined without reaching bedrock. Much of the material is less than 5 inches in diameter, but bowlders of large size are numerous. The best values are found in a bluish gravel, which is generally reached at a depth of about 12 feet. This gravel is from 8 to 18 feet in thickness. Below it is a fine plastic clay which is difficult to handle, and which carries practically no gold. In the present workings this clay is not being mined. The property contains more than 1200 acres of placer ground, much of which has been thoroughly prospected and found to carry gold." In 1911 the dredge was sunk and it has been nearly buried by sand; all work on this ground has been discontinued.

At the Swacker Flat placer mine on the left fork of Foots creek in the N. E. ¼ Sec. 12, T. 37 S., R. 4 W. there is a fault which is later than the formation of the placer gravel. The fault strikes N. 40° W. and dips about 65° N. E. The vertical displacement is at least 10 feet. The region is being carefully tested for placer gold in the gravels.

The following notes on placer mines on Foots creek are also quoted from Kay.[2]

"The Black Gold Channel mine is on the left fork of Foots creek, in Sec. 12, T. 37 S., R. 4 W. It is leased at the present time. In the bank is exposed about 15 feet of unstratified gravels, coarsest below, and containing bowlders up to 18 inches in diameter. There is very little fine material; the bowlders, which are almost all of greenstone, are subangular to fairly well rounded. The large bowlders are handled by a derrick. Two giants are used under a head

[1] U. S. Geol. Survey Bulletin 380, pp. 65-66, 1909.

[2] U. S. Geol Survey Bulletin 380, p. 65, 1909.

of several hundred feet. The gravels are forced upward for 15 feet over an elevator, but the sluice takes the material 2½ feet above bed rock. The mine pit of the present workings has an area of 1½ acres. A large area down the stream has already been worked over. The bed rock is slate cut by dikes of greenstone. The strike of the slates is N. 10° E.; distinct joints run about N. 70° W. Numerous small veins are present, and have a general northeast-southwest direction.

The Cook mine is in the S. ½ Sec. 13, T. 37 S., R. 4 W. The pay gravel is, in places, plainly stratified, and consists mainly of fine gravel and clay. The stream bed has been mined for one-fourth of a mile. The bed rock is made up of greenstone and slates cut by numerous greenstone dikes. It has been greatly sheared and faulted. One fault runs N. 75° W. and dips 31° N.; another runs N. 53° E. and has been traced nearly one-fourth of a mile.

The Lance mine is on the right fork of Foots creek, in the S. E. ¼ Sec. 22, T. 37 S., R. 4 W. It is owned by the Lance Brothers, but is leased at present. The bank has in places a thickness of 20 feet; much of the material is fine. The bed rock consists of lenses of limestone in slates, which are cut by dikes of greenstone. The bed of the stream has been mined for about one-third of a mile, and there is still considerable good ground to be mined.

The Glen Ditch mine is near the head of the right fork of Foots creek. It is owned by Boling Brothers. The stream bed has been followed for some distance, but much good ground remains to be worked. The gravels are about 15 feet thick."

On Evans creek a mining district was organized by placer miners in 1856, and the same year another district was organized on Pleasant creek, which is a tributary of Evans creek from the north. As early as 1868 hydraulic methods were in use on these creeks. The production on Pleasant creek has exceeded that from Evans creek for many years but both have continued active to the present time. About 1890 Taylor, Son & Co. operated a placer near Woodville (at the mouth of Evans creek) for several years. According to J. S. Diller,[1] "For over 3 miles the bed of Pleasant creek was almost completely mined out years ago, and later efforts have been directed to the benches rising up to 100 feet. The largest amount of work has been done at Harris Gulch, where an area of rotten gravel about 8 acres in extent has lately been removed. A smaller cut has been made in a well-marked terrace at Jamison Gulch, and farther up, between the forks, Thompson Brothers have washed off the residual material of a serpentine point 200 feet above the stream. All the placers on Pleasant creek except the one last mentioned are on granodiorite, but near the contact with both slate and greenstone, which may be the source of the gold."

[1] U. S. Geol. Survey Bulletin 340, p. 150, 1909.

On Rogue river some placer mining has been done at various points in the Gold Hill district, but for the most part the river valley is too narrow to permit the development of gravel deposits. A dredge was installed near Tolo in 1898, but it was not long in operation.

Auriferous Quartz Mines

The gold-bearing quartz mines of the Gold Hill district are found in the mountains about the placer deposits and their veins have been the source of the metals in the gravels.

The Trust Buster mine is a few hundred feet south of the N. W. corner of section 36, T. 35 S., R. 3 W. at an elevation of 1700 feet by barometer. It is equipped with a Beers mill having a crusher, a plate, a concentrating table, and a 15 H. P. gas engine. An adit shows several quartz veins in tonalite; the junction of two veins gives a small shoot of ore which has been mined out to the surface, and about 20 feet below the adit level. The workings are too shallow to show sulphide ore. The main vein strikes N. 50° W. and dips 46° S. W. The mine was leased by the Pacific Coast Mining Company about 2 years ago.

The Sylvanite or Last Chance mine is in section 2, T. 36 S., R. 3 W. about 3 miles northeast of Gold Hill. It is owned by E. T. Simons. The vein strikes N. 22° E. and dips about 65° E. and the country rocks have the same attitude; they are argillite partly altered to chlorite and serpentine. The vein contains quartz carrying some pyrite. The workings, now badly caved, are reported to consist of a drift 1200 feet long at an elevation of 1360 feet by barometer and a crosscut to the vein at an elevation of 1650 feet, with a shaft to the lower level. According to W. A. Marvin, who was in charge of the mine at one time, the ore contained no telluride, but a little galena and much pyrite in quartz; the fault gouge contained about $3.00 worth of gold and silver per ton; high grade gold ore occurred in "boulders" not in place at depths from 80 to 160 feet; sulphide ore began to appear at about 160 feet depth and was 5 feet wide at 225 feet depth; the hanging wall was a slate and the footwall a limestone.

The Revenue "pocket" is near the center of section 11, T. 37 S., R. 3 W., nearly at the top of the ridge at an elevation of 2570 feet as measured by barometer. It is about 100 feet east of an outcrop of limestone interbedded with argillite which strikes N.

10° E. and dips 70° E. This "pocket" was worked out years ago; it is said to have produced $100,000. At present the vein is being explored by Butler and Higinbotham; the vein is opened for about 35 feet and shows about 2 feet of quartz.

The Gold Hill "pocket" is near the top of the hill of that name in the S. W. ¼ N. E. ¼ Sec. 14, T. 36 S., R. 3 W. at an elevation of about 2000 feet. According to E. W. Liljegran,[1] of Medford, "It was discovered in 1857 on top of the mountain about 2 miles east from the town of Gold Hill. The outcropping rock was so full of gold that it could scarcely be broken by sledging. The crystallized quartz associated with the gold was not honeycombed as it generally is where sulphides have leached out of the rock, leaving sprays of gold in the cavity. The gold in this pocket went down only 15 feet and occurred in a fissure vein, strike about S. 20° E.; dip about 80° E.; with a gash vein cutting the fissure nearly due east and west and dipping vertically. The fissure vein averages fully 5 feet between walls with 1 to 2 feet of gouge on the foot wall, which contains some calcite and quartz mixed with a little sulphide of iron, in spots containing free gold. A mass of micaless granite, about 5 feet wide by possibly 200 feet long, outcrops in the footwall side of the fissure. The country rock is pyroxenite. It is said that this pocket produced at least $700,000."

The Whitney mine is in the N. E. ¼ S. W. ¼ Sec. 13, T. 36 S., R. 3 W. in a coarse subsiliceous rock not far west of the tonalite border. The main entry at an elevation of 1375 feet, is a crosscut for 130 feet; at 10 feet from the portal a vein said to have produced high grade ore strikes N. 50° W. and dips 60° S. W. At 70 feet from the portal a drift follows vein No. 1 for 290 feet; this vein contains 2 to 5 feet of soft material with stringers of quartz; it strikes N. 67° W. and dips 55° to 75° S. W. At the breast of the crosscut a raise follows vein No. 2 which has a 3-foot vein-filling like the preceding and is about parallel with it. In these workings small stringers of aplite are common generally standing about vertical and trending north. In another adit only 20 feet vertically higher, the No 2 vein is found to be in a granitic dike while the No. 1 vein is on the granite contact about 30 feet distant. At this level the latter is a shear zone carrying a little quartz. Several smaller veins have been explored for short distances. One of them contains some chalcopyrite in places. At the intersections of these veins with the larger ones good ore has been found. A subsiliceous rock containing considerable magnetite is associated with these veins and not

[1] U. S. Geol. Survey Bulletin 546, p. 45, 1914.

found elsewhere on the hill. It appears to be a contact phase rather than a separate intrusion. In thin section it is found to consist of coarse augite and magnetite with a little olivine and brown hornblende. The chemical composition of this rock is given below.

COMPOSITION OF MAGNETITE PYROXENITE FROM THE WHITNEY MINE NEAR GOLD HILL

[S. W. French, analyst]

		Approximate mineral composition	
SiO_2	37.92		
TiO_2	2.22		
Al_2O_3	4.38		
Fe_2O_3	12.76	Augite	60
FeO	11.18	Hornblende	16
MgO	16.60	Magnetite	13
CaO	13.63	Olivine	11
Na_2O	.29		
K_2O	.08		100
H_2O+	1.14		
H_2O-	.06		
	100.26		

The Nellie Wright mine is on the south slope of Blackwell hill about 2 miles east of Gold Hill in the S. W. ¼ Sec. 24, T. 36 S., R. 3 W. A Beers mill to be operated by electric power is under construction; it is provided with plates and a Johnson concentrator. The vein is opened by two shafts 50 and 60 feet deep connected by a drift 130 feet long which extends 30 feet beyond one shaft. The ore is chiefly quartz with some pyrite, chalcopyrite, and a dark sulphide resembling galena. The veins strikes about N. 75° W. and dips about 87° N.; it varies in thickness from 1 to 4 feet. The country rock is the Siskiyou tonalite which is here cut by a dyke of andesite, while the vein cuts both the tonalite and the dike. A few men are (1913) opening the vein farther. It is owned by Donovan and Ray.

The Schaffer claim is northwest of the Nellie Wright; an adit 150 feet long discloses a vertical quartz vein 4 feet wide near the portal, but lost at the breast; the vein strikes N. 65° W. in tonalite.

The Blanche or May Belle claim adjoins the Schaffer; it is owned by Guy D. Kinney. An adit follows a quartz vein in tonalite N. 65° W. 250 feet, then N. 75° W. about 100 feet. The vein is narrow; it dips 85° S. and contains quartz with some pyrite and chalcopyrite.

The Bowden claim is on the southeast slope of Blackwell hill near the top of the grade on the road. It has a quartz vein in tonalite, shown by an adit now open about 150 feet, and said to have extended 500 feet, and also by a shaft, where the vein strikes N. 75° E. and dips about 85° N. The shaft is said to be 185 feet deep and to have yielded free gold at 100 feet. The vein was apparently 2 to 3 feet thick where stoped.

The Millionaire mine is in S. W. ¼ Sec. 30, T. 36 S., R. 2 W. on nearly level ground at an elevation of 1730 feet as measured by aneroid barometer. It is opened by two vertical shafts, the deeper one said to be 400 feet deep, with levels opened a short distance each way at each hundred feet. The vein strikes east and dips about 60° N.; there are three veins reported to be nearly parallel, all four containing quartz with pyrite and rare galena and chalcopyrite. Two more veins are said to strike north and dip east; these contain calcite, quartz, pyrite, and a mineral resembling sylvanite. The country rock consists of dark argillite with bands of andesitic material. The other shaft (called the Johnson) is probably on the same vein; it is 120 feet deep and has a crosscut to the vein at a depth of 30 feet. Here the vein contains 2 to 3 feet of quartz with some fault gouge and a little manganese. It strikes S. 72° E. and dips 85° N., but it is stepped north going down so as to give a smaller apparent dip (about 60°). About 600 feet along the strike of the formation (N. 20° E.) there is a small outcrop of limestone and an old kiln. A fragment of limestone was found on the Johnson shaft dump. The Siskiyou tonalite outcrops about a mile to the northward, and may extend under this region.

The Millionaire mine is owned by the McKeen National bank of Terre Haute, Ind.; it is equipped with a mill which has never been operated although substantially complete and in good condition. The mill has 2 Nissen 1500-pound stamps with circular discharge and two 10-foot amalgamating plates; it has a rock crusher and a Standard concentrating table. The mine has been idle for several years.

The Eagle mine adjoins the Millionaire on the west. It is opened by 4 shafts and at least 2 adits, but the workings are not extensive. An adit reveals stringers of quartz in black argillite and andesitic material. The mine is said to have produced some very high grade ore. It is now under lease, but not in operation.

The Alice group, owned by J. H. Beeman of Gold Hill, is in N. E. ¼ Sec. 11, T. 37 S., R. 3 W., not far from limestone quarries, at an elevation of 2300 to 2400 feet by barometer. Lessees are now (1913) taking out a footwall streak of high grade oxidized ore near the surface next to old workings. The main vein consisting of solid quartz is not being mined as it is too low grade for lessees; it strikes N. 12° E. and dips about 60° E. An old adit about a quarter mile to the northeast discloses about 250 feet of workings

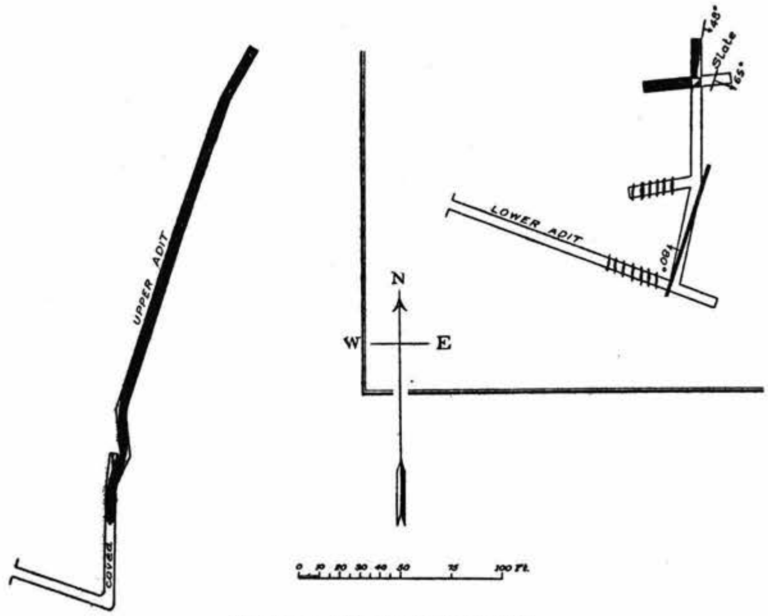


Figure 12. Alice mine, main adits.

on a vertical quartz vein averaging 2 to 3 feet in thickness, containing some pyrite, abundant pyrolusite, and some gypsum. A lower adit opens a 3-foot quartz vein which strikes north and dips 48° E.; it is on or near an irregular contact between dark argillite and an andesitic intrusive. As shown in the drawing (figure 12) the crosscuts from the main drift are wholly or partly in quartz which is supposed to be part of a large vein which is represented in the main crosscut entry by quartz seams in wall rock.

The Gold Ridge mine is in the N. E. ¼ Sec. 3, T. 37 S., R. 3 W. on the west slope of Kane creek valley at an elevation of 2100 feet by barometer. Some oxidized ore has been taken from a 1 to 2-foot fissure which varies in strike from about north to east in an arc concave to the southeast and dipping steeply northwest. The country rock is schistose and weathered. Nearer the mill an open cut has been made on a 12-inch quartz vein which strikes N. 63° W. and dips 73° S. W.; the hanging wall is an andesitic rock; the footwall is siliceous and contains a little biotite. The mine is equipped with a 2-stamp mill having a plate $2\frac{1}{2}$ by 8 feet, run by a 7 horsepower gas engine.

The Braden mine is in the S. E. $\frac{1}{4}$ Sec. 9, T. 36 S., R. 3 W., at an elevation of 1350 feet about 2 miles south of Gold Hill. It is at present (1913) one of the important mines of Jackson county. It has a 10-stamp mill equipped with a crusher, two 10-foot plates. 4 Johnson vanners and electric motors, one of 85 horsepower being used to operate an air compressor. A view of the Braden mill and hoist is given in plate VI. According to E. W. Liljegran of Medford, the mine was located about 30 years ago by B. A. Knott of Gold Hill who began development, treating the ores in an arrastre. After several transfers the mine passed to Dr. James Braden after whom it has since been called. It was sold to C. R. Ray of Medford in 1900; seven years later it was leased to the Opp Mining Company; it is now operated by Dr. Ray. In 1907 the mine produced more than $30,000.

There are several quartz veins opened by 6 adits and an incline shaft. The important veins strike about N. 30° E. and dip about 25° S. E. There are four main levels opened by adits at different elevations on the sidehill and connected with one another by raises and winzes. The workings have a total length of more than 3000 feet, but the greatest depth reached is less than 250 feet. The lowest adit (No. 6) has a length of more than 1200 feet, and has yielded considerable high grade ore.

The country rocks of the Braden mine are Paleozoic sediments and interbedded andesites. A rock from the dump of adit No. 2 is plainly banded, some bands being chiefly green hornblende with some quartz, chlorite, zoisite, and pyrite, and other bands being chiefly calcite or, rarely, quartz; it is a calcareous hornblende schist. Another sample from the same adit is an amphibolite, containing abundant green hornblende, some pale yellow epidote, some zoisite, some interstitial plagioclase, some garnet, and a little magnetite. But the hanging wall of the vein under the incline shaft is apparently a spessartite, containing abundant hornblende grading from brown to green, abundant plagioclase, some zoisite, calcite, sericite, magnetite, and siderite. A chemical analysis of this rock follows. (p.172.)

The ore is highly quartzose, containing a little calcite and some pyrite as well as a little arsenopyrite, chalcopyrite, and galena. About 65 percent of the gold and silver is recovered on the plates

COMPOSITION OF SPESSARTITE FROM BRADEN MINE

[S. W. French, analyst.]

		Approximate mineral composition			
		From analysis		From section	
SiO_2	47.40	Hornblende	55.7	Hornblende	41
TiO_2	1.54	Plagioclase	22.3	Plagioclase	51
Al_2O_3	20.14	Sericite	18.5	Calcite	3
Fe_2O_3	.58	Alumina, water, etc	2.7	Zoisite	2
FeO	6.64		98.9	Sericite	1
MgO	6.34			Magnetite	1
CaO	7.78			Siderite	1
Na_2O	2.76				100
K_2O	2.65				
H_2O+	2.98				
H_2O-	.12				
	98.93				

and about 25 percent is saved in concentrates, which are sent to a smelter at Selby or Tacoma. Concentration is about in the ratio 12 to 1; the assay value of the ore is $8 to $10 a ton and of the concentrates about $25 a ton.

According to G. F. Kay:[1]

"Most of the production of the mine has come from two shoots nearly 600 feet apart, on the lowest drift of the mine. One of the shoots extended along the vein in this drift for about 55 feet, but in a winze its width increased to about 80 feet, below which it narrowed abruptly. The direction of the shoot was the same as that of the dip of the vein. The other shoot had a length along the strike of the vein of 75 feet; in a winze from it the length increased to 125 feet; at the bottom of the winze, which was run 200 feet below the drift, the ore was low in grade. The direction of this shoot was about S. 50° E. Usually the best ore was found along the footwall of this shoot, although in places the gold and silver were uniformly distributed across the vein, which here had an average width of about 18 inches. The zone of oxidation does not extend farther than about 100 feet below the surface, and in parts of the vein sulphide ores are found at depths considerably less. Along the fault planes the ores show enrichment."

Since the date of Professor Kay's examination of the Braden mine another shoot of ore has been opened on another vein by means of an incline shaft. The vein strikes about N. 55° E. and has an average dip of about 25° S. E. with a thickness of 2 to 5 feet of quartz. In the lowest drift at 190 feet depth on the incline a second vein seems to swing into the main later vein from a direction about N. 10° E. and a dip of about 35° E.; it has been followed back under

[1] U. S. Geol. Survey Bulletin 380, p. 58, 1909; Bulletin 546, p. 41, 1914.

the incline shaft and shows about 2 feet of quartz. The structure is shown in the illustration (figure 13). To the southwest the vein seems to be cut off by a fault which strikes N. 27° W. and dips about 60° N. E. The drawing shows only a small part of the older workings which were caved so as to be mostly inaccessible when the mine was visited.

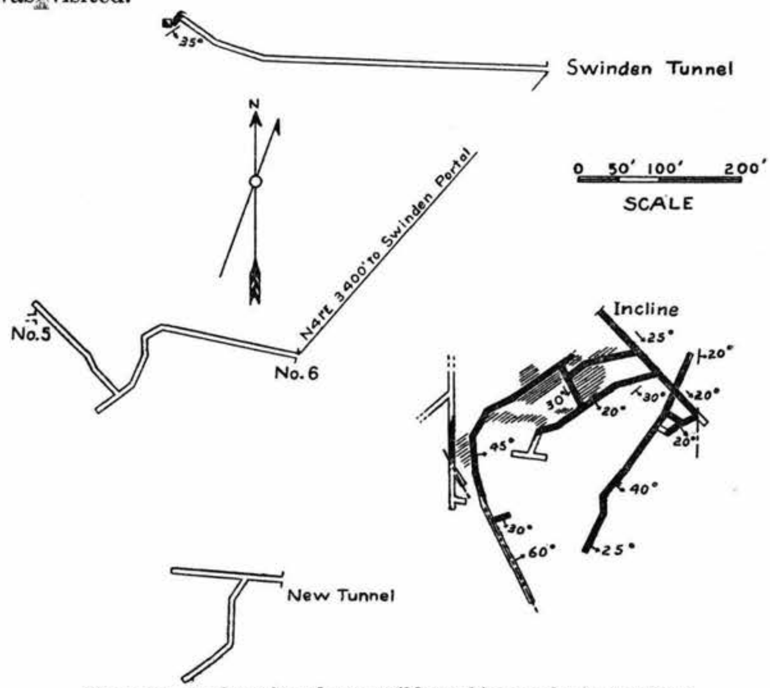


Figure 13. Braden mine, the accessible workings and vein structure.

The Last Chance mine is in the N. E. ¼ Sec. 33, T. 36 S., R. 3 W. over the divide from the Braden on the slope of Galls creek, at an elevation of 1800 feet by barometer. It is opened by an adit, extending about 250 feet nearly due east, which discloses an irregular quartz vein 6 to 30 inches thick. Near the breast the vein strikes N. 74° W. and dips about 15° N. E. The country rock is a fine grained andesite containing some secondary chlorite and calcite. A 2-stamp mill has just been installed which is equipped with the Perkeypile device to revolve the stamps; it has a 4-by 8-foot plate and electric power.

The Bill Nye mine is in sections 33 and 34, T. 34 S., R. 3 W. on Galls creek about a mile nearly due south of the Braden. It is opened by several adits and a vertical shaft. A considerably anamorphosed impure quartzite is a common country rock; it contains abundant fine grained quartz in patches and layers, and abundant green hornblende and brown biotite with some untwinned interstitial and enclosing plagioclase and a little magnetite; the texture is globulitic to irregular. The vein on which the shaft is located strikes N. 52° E. and is nearly vertical; it contains about 2 feet of quartz. The main adit is about 400 feet long; it is on small veins and stringers near the portal, but crosscuts to the northwest open a somewhat larger vein of quartz which strikes S. 60° E. and dips 80° N. E. The country rock is pyritized and somewhat silicified. In the Bliss adit a vein striking N. 75° E. is cut off about 80 feet from the portal by a fault which strikes N. 30° E. and dips about 40° S. E. Another fault in the same working on a level 80 feet higher produces a horizontal offset of 6 feet to the north, the fault striking N. 14° W. and dipping 55° E. as shown in the illustration. (See figure 14.)

The Tin Pan mine is in the S. W. ¼ Sec. 31, T. 36 S., R. 3 W., on the ridge between Galls and Foots creeks. It was located many

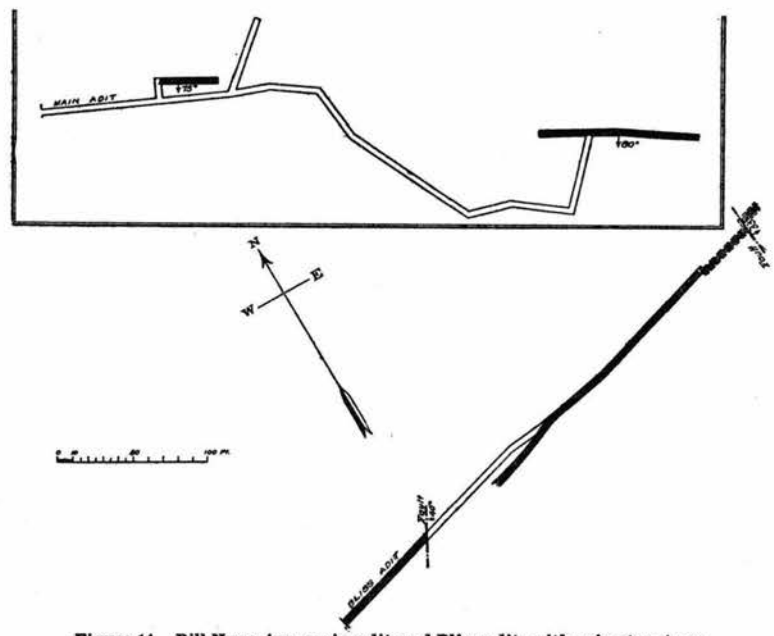


Figure 14. Bill Nye mine, main adit and Bliss adit, with vein structure.

years ago; in 1908 it was owned by the Pacific American Gold Mining Company and prospected by more than 1200 feet of drifts, shafts, and other workings on the vein without finding any large body of good ore. At that time the mine was equipped with a 10-stamp mill (since removed) having a Blake crusher and two concentrating tables. The country rock on top of the ridge west of the mine is an andesite porphyry containing abundant much altered phenocrysts of plagioclase, and bunches of green hornblende or brown biotite as well as some magnetite, epidote and siderite in a fine granular groundmass. In 1913 the workings were badly caved and inspection was impossible. It was relocated in July, 1913, by M. L. Hall. According to G. F. Kay:[1]

"The country rock in which the ores occur are slates, limestones, and greenstones, the greenstones apparently being intrusive in the sedimentary rocks although some of them may be volcanic. The sedimentary rocks strike about N. 13° E. The strike of the vein is between northeast and east and the dip is nearly vertical. The vein varies in width from less than 18 inches to more than 6 feet of solid quartz between definite walls, which are in general but slightly altered. In places there is a gouge from 1 to 3 inches in width. This material is clay-like, but it contains carbonates and sulphides. Most of the gold content of the vein is in the sulphides, which run about $60 to the ton. The sulphides are pyrite and galena which together constitute less than 2 per cent of the ores. Some faulting has occurred. The zone of oxidation reaches a depth of more than 100 feet."

The Perkeypile mine is in the S. W. ¼ Sec. 5, T. 37 S., R. 3 W. near the top of the ridge between Galls and Foots creeks. A crosscut strikes the vein at 90 feet and a drift follows it about 300 feet. The vein strikes S. 60° E. and dips 72° S. W.

The Kubli mine is in the N. W. ¼ Sec. 5, T. 37 S., R. 3 W. at an elevation of 2700 feet by barometer. A narrow vein said to have been very rich is opened for about 200 feet; it is 1 to 18 inches wide but only 1 to 6 inches is quartz; the vein strikes about east and dips 60° N. The Kubli mill is to the east near the bottom of the hill; it has two stamps with triple discharge, a divided plate 4 by 10 feet, and a concentrating table. In the gully nearby there is a small outcrop of tonalite and a border of contact hornblende rock. The composition of this contact phase is given below. (p. 176.)

The Fairview claim, owned by Dr. C. R. Ray of Medford, is in the N. W. ¼ Sec. 5, T. 37 S., R. 3 W. near the top of the ridge between Galls and Foots creeks at an elevation of 2950 feet by barometer.

[1] U. S. Geol. Survey Bulletin 380, p. 60, 1909; Bulletin 546, p. 43, 1914.

COMPOSITION OF CONTACT ROCK, NEAR KUBLI MILL, GALLS CREEK

[S. W. French, analyst.]

SiO_2	47.42	Approximate mineral composition	
TiO_2	1.01		
Al_2O_3	20.56		
Fe_2O_3	1.19	Hornblende	57.5
FeO	5.10	Plagioclase (Ab_1An_4)	42.4
MgO	7.08		
CaO	14.04		99.9
Na_2O	1.80		
K_2O	.66		
H_2O+	1.36		
H_2O-	.08		
	100.30		

High grade ore is reported near the surface where a narrow vein of quartz with a little calcite, pyrite, and galena strikes N. 50° W. and dips 77° N. E. into the hillside. Very little development has been accomplished here.

McMahon's claim is in the N. W. ¼ S. W. ¼ Sec. 6, T. 37 S., R. 3 W. on the left fork of Foots creek at an elevation of 1850 feet by barometer. Here a quartz vein about 18 inches wide strikes N. 55° W. and dips about 40° N. E., the dip increasing somewhat with depth. It is opened by an incline shaft about 75 feet deep, and a drift running S. 55° E. about 50 feet ending in a winze 30 feet deep.

McLemore and Hampson's claims are in the S. E. ¼ Sec. 7, T. 37 S., R. 3 W. on the left fork of Foots creek; they report a vein of quartz 6 to 16 inches wide carrying free gold, pyrite, pyrolusite and galena.

The Dixie Queen mine is on the left fork of Foots creek in the N. W. ¼ Sec. 18, T. 37 S., R. 3 W. at an elevation of 1850 feet by barometer. It is opened by three adits having a total length of about 450 feet. The lowest extends west about 100 feet and northwest about the same distance, with minor openings. The next tunnel above extends northeast, but is caved at 65 feet from the portal. It is a drift on a vertical quartz vein in a lead 6 to 30 inches wide in a country rock which is a calcareous argillite. In the upper tunnel a crushed zone dips about 75° N. E.; it has a thickness of nearly a foot.

The Bertha claim (locally known as the "Bertha" pocket) is in the S. E. ¼ Sec. 12, T. 37 S., R. 4 W. on the left fork of Foots creek at an elevation of 1600 feet by barometer. The country rocks here are impure banded and locally schistose quartzites, some limestone, and apparently small intrusions of an andesitic type. The workings are small and now caved.

The Big Buck or Hicks claim is near the center of section 1, T. 37 S., R. 4 W. on the left fork of Foots creek. The workings are on a vertical fissure zone in massive bluish quartzite containing some vein quartz and sulphide of iron.

The Highland claim is in the S. W. ¼ Sec. 22, T. 37 S., R. 4 W. on the right fork of Foots creek at an elevation of 2600 feet by barometer. It was worked about 20 years ago by Fuller and Bayington; it is now owned by Cook and Swacker. The present workings are confined to the oxidized zone; the old workings were more extensive. The ledge is said to strike N. E. and dip about 35° S. E.; the country rock is a micaceous sandstone.

Coster and Catton's claim is in the S. W. ¼ Sec. 21, T. 37 S., R. 4 W. on the right fork of Foots creek at an elevation of 2550 feet by barometer. A 1 to 2-foot quartz vein here strikes N. 85° E. and dips 70° N. in greenstone. One stamp has been erected in the gulch to be operated by an overshot water wheel, but water is insufficient in summer time. The vein is opened by shallow workings for about 25 feet. About a mile to the northeast near the N. ¼ corner Sec. 22 an intrusion of aplite is visible for 200 feet along the ditch line running around the point.

The Harth and Ryan mine is in section 33 about 3 miles south of Woodville at elevations of 2350 to 2600 feet by barometer. It is opened by 4 adits, having a total length of 500 feet, at different elevations on a steep mountain side. The lowest adit discloses two crushed zones which strike west and dip toward each other at angles of about 70°; they contain very little quartz. The next adit is the main entry; it extends south and then southeast for 300 feet; about 100 feet from the portal a vein strikes N. 22° E. and dips 45° S. E. At the end of a branch to the southwest a raise discloses a vein striking N. 10° W. and dipping 80° N.; probably the same vein is found at the face of the uppermost adit where it contains 6 to 12 inches of quartz. The country rock at this mine is a "greenstone" containing patches and irregular bands of varying composition, some being chiefly fine granular quartz, others plagioclase, and others hornblende with a few pseudocrysts of the latter mineral. The composition of this rock is given below.

Liken's prospect is near the S. W. ¼ Sec. 26, T. 36 S., R. 4 W.

COMPOSITION OF "GREENSTONE" FROM HARTH AND RYAN MINE
[S. W. French, analyst.]

SiO_2	53.24	Approximate mineral composition	
TiO_2	.70		
Al_2O_3	18.36		
Fe_2O_3	.64	Plagioclase	46
FeO	7.84	Hornblende	44
MgO	5.04	Quartz, etc	10
CaO	9.67		
Na_2O	3.47		100
K_2O	.58		
H_2O+	.40		
H_2O-	.04		
	99.98		

about 2 miles south of Woodville at an elevation of 1850 feet by barometer. A crosscut entry extends southeast about 100 feet and thence a drift follows the vein about 40 feet. In the breast the vein is vertical and contains only 2 to 6 inches of quartz. The dump shows fragments of white vein quartz frozen to the country rock and containing a little pyrite and a metallic mineral which may be a telluride. The country rock is a "greenstone" similar to that at the Harth and Ryan mine.

The Owl Hollow mine near the source of Little Savage creek in section 32, T. 36 S., R. 4 W. was not visited; it has been idle for several years.

The Homestake mine is in the N. W. ¼ Sec. 16, T. 36 S., R. 4 W., about 1 mile northwest of Woodville at an elevation of 1600 feet by barometer. The main entry extends northeast about 300 feet and thence northwest about 200 feet crossing numerous small quartz veins and stringers. The country rocks are impure quartzites and argillites. The upper adit strikes a well defined quartz vein about 12 to 18 inches thick which strikes N. 35° W. and dips 35° N. E. Caved ground prevented learning how far the vein was followed. The mine is equipped with a 5-stamp mill having a concentrator and slime table. The ore contains pyrite and a little galena and sphalerite; telluride of gold is reported in it, but it was not observed.

The Cartinell mine is near the center of section 9, T. 36 S., R. 4 W. less than 2 miles northwest of Woodville at an elevation of 1250 feet by barometer. An adit extends due northwest about 150 feet and thence N. 55° W. about 50 feet in a fissured zone containing short offsetting lenses of quartz with bunches of chalcopyrite.

Plate VI. Braden 10-stamp mill and hoist. Near Gold Hill, Oregon.

The vein dips to the northeast at an angle of 50° to 60°; in the weathered zone it contains malachite and azurite. The country rock is andesite in which the curved cleavages of phenocrysts of pale green hornblende show evidence that the rock has been under considerable differential pressures.

The Blossom mine is in the northern part of sections 19 and 20, township 35 south, range 3 west, near the head of the left fork of Sardine Creek at an elevation of about 2400 feet above sea level. An adit on the No Name claim extends northwestward about 200 feet in an andesitic country rock. The vein strikes N. 37° W. and dips 55° N. E.; it contains some sulphide and very little quartz, being mostly crushed country rock. Near the face of the adit there are two parallel veins. An upper adit (about 85 feet long) opens the same ore body, 75 feet higher up; it is connected with the lower adit by means of a raise on the vein. On the Blossom claim the lower adit extends about 135 feet N. 40° W. as a crosscut, thence drifts on the vein about 110 feet. The deposit strikes N. 75° W. and dips about 80° S.; it consists of a vein about 15 to 20 feet thick, in which one quarter to one tenth of the filling is quartz and ore. The country rock is an andesitic "greenstone." The vein minerals include pyrite, chalcopyrite, gold, galena, pyrrhotite, (and sphalerite?) with quartz, calcite, and sericite. An upper adit about 85 feet long discloses the same deposit with the same position and size. On this level the ore is thoroughly oxidized.

The Corporal G mine is in the southern part of section 19, T. 35 S., R. 3 W. at an elevation of about 2600 feet above sea level. It is said to have been discovered in 1904 by J. R. McKay, who took out some ore and sold it to Mrs. N. M. Smith of Gold Hill. It was operated under lease by J. E. Kirk in 1907. It is opened by three adits on the main vein one above another, on the hillside, and one adit to one side. The adits are about 100 feet long and the vein has been stoped out above the upper adits; the lowest adit was not open to inspection. The vein has a width of 3 to 12 inches and strikes S. 85° W. with a dip of 60° N. The country rock is a micaceous slaty quartzite cut by andesite and spessartite. The ore contains quartz, calcite, pyrite, pyrrhotite, and a little chalcopyrite, bornite, sphalerite, galena, and rare free gold. The adit to one side of the main vein opens a parallel stringer on the Volunteer claim; it pinched out at 135 feet.

The Lucky Bart group includes eleven claims in sections 29 and

30, T. 35 S., R. 3 W. at elevations ranging from 2200 to 2900 feet above sea level. The chief claim was discovered about 1890 by Joseph Cox; it is now owned with the others by J. H. Beeman of Gold Hill. According to the owner ore has been mined from five veins on the group, all of them striking nearly east and west. At one of the adits about a quarter mile west of Sardine creek a vein of quartz 6 to 24 inches thick strikes east and dips about 80° N., thus being roughly parallel with the side hill here, as a "blanket vein". The country rock here is argillite and quartzite. The ore is said to be of high grade in the oxidized part of the vein. According to Kay,[1] the veins on the Lucky Bart group "have an average width of less than 2 feet; the country rock is metamorphosed sediment, mainly slates and micaceous quartzites. The general strike of these rocks in this vicinity is somewhat east of north; the dip is to the southeast and is usually at fairly high angles. The total amount of ore that has been milled exceeds 14,000 tons, which gave values ranging from $4.80 to $100.00 a ton of free milling ore. The ore from the Lucky Bart claim carried an average of 3 per cent of sulphides, which ran from 4 to 8 ounces of gold to the ton and a like amount of silver. Nine tons of ore from the deepest workings of this claim were shipped to the Tacoma smelter and gave returns of $130.00 to the ton. Practically all the ores from the group have been treated at a mill on Sardine creek. At the Yours Truly claim, where work is now being done by J. E. Kirk, the workings consist of an entrance tunnel of 75 feet to the vein, 100 feet of drifting on the vein, and a shaft of 30 feet. The country rock is a mica slate. The vein has an average width of about 1 foot and runs S. 85° W. At the end of the drift there are two veinlets of 8 inches and 4 inches in width and also a small seam. Within the workings there is evidence of considerable faulting; the directions of the fault planes observed were somewhat east of north. Mr. Kirk states that the veins carry more gold adjacent to the fault planes than elsewhere. The ores of the Yours Truly are highly oxidized and carry an average value of more than $30 to the ton."

A small outcrop of "granite" was observed just north of the point where the Lucky Bart vein seems to cross Sardine creek in section 29.

The mine is equipped with a 5-stamp mill on Sardine creek at an elevation of about 1900 feet above sea level. It has a boiler burning wood, a $2\frac{1}{2}$ H. P. engine, a plate 4 by 11 feet, and a Johnson canvas covered table for concentration.

The Gray Eagle mine is in the S. E. $\frac{1}{4}$ Sec. 29, T. 35 S., R. 3 W. on the east side of Sardine creek at an elevation of about 1850

[1] U. S. Geol. Survey Bulletin 340, p. 146; 1908; Bulletin 546, p. 38; 1914.

feet above sea level. The vein is opened by three adits on the hill side; the main adit is nearly 400 feet long, over 300 feet being on the vein, which is chiefly quartz and 9 to 12 feet thick. It strikes

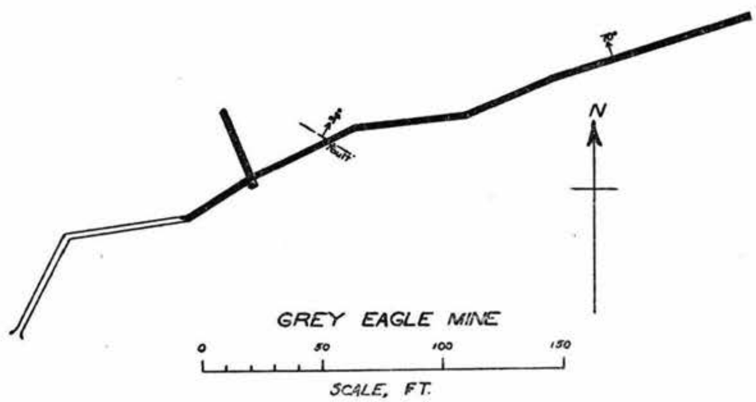


Figure 15. Grey Eagle mine, main adit and vein structure. Vein in solid black.

about N. 70° E. and dips 70° N. W. Beneath a fault, which strikes N. 60° W. and dips 34° N. E., but produces little offset, the vein is locally 35 feet in width; it is said to carry $22 a ton in gold at this place where a winze has been sunk 85 feet deep, and a raise extends to the surface. The workings are shown in figure 15. The vein is associated with an andesite dike in recrystallized quartzite. The Grey Eagle mine is now owned by Mr. Van Houten. It is equipped with an aerial tramway from the main adit to a 10-stamp mill on Sardine creek which has a 30 H. P. and 10 H. P. gasoline engine, two amalgamating plates each $4\frac{1}{2}$ by 10 feet, a rock crusher, and two concentrating tables. The mine has been idle since 1911.

THE GREENBACK DISTRICT

LOCATION

The Greenback district occupies the northeast corner of Josephine county and includes the area east of the Southern Pacific railroad which is drained by Grave, Coyote, and Wolf creeks. Parts of this district have in the past been known by the following names: Wolf creek, Grave creek, Coyote creek, and Leland districts. Leland is the most accessible railroad station for points on Grave creek and Wolf creek station serves the rest of the district. The Hammersley mine is just outside of the district, being south of the divide between Grave and Jump-off Joe creeks. The whole region is very mountainous, varying in elevation from 1000 feet at the confluence of Wolf and Grave creeks to altitudes commonly reaching 3000 feet and attaining 4000 in a few places, such as a peak about a mile west of the Hammersley mine and another about a mile northeast of the Greenback mine. But the highest point in the district is on the eastern border at Onion Springs Mountain whose summit reaches an altitude of 5274 feet above sea level. The mountains are well covered with timber; the only arable land of consequence is along Grave creek.

HISTORY

So far as the published records show Grave creek was not one of the regions early worked by the placer miners and the date of the discovery of gold in the region is unknown. But the auriferous gravel deposits of Grave and Wolf creeks were probably discovered as early as 1860 and it is known that the Grave creek placers alone produced $20,000 in gold in 1883. During the rest of that decade there was a variable but continuous output from Grave and Wolf creeks. In 1895 there were small mines near Leland and Grave and others somewhat more important on Coyote and Wolf creeks including one placer and two gold-bearing quartz vein mines. As early as 1898 the Greenback mine was a producer of some importance although at that time its ores were treated in an arrastre. In 1900 the Greenback was owned by the Victor Junior Gold Mining Company and its development was more rapid. In 1902 and 1903 a 40-stamp mill was built at the Greenback as well as a 100-ton cyanide plant. In 1904 it was excelled in production by only one mine in Oregon. About the same time the Martha mine was productive. The Lewis placer near Leland and the Columbia placer on Grave creek were operated in 1905, while the Greenback continued its large production. The latter was closed in August, 1906, and was idle for the next three years. In 1910 it was again a large producer, but soon after it closed and has not since then reopened. In 1912 the production came almost entirely from 10 placers on Grave creek and 4 placers on Wolf creek.

GEOLOGY

The Greenback district is occupied largely by rocks which are either shales (or argillites) or igneous masses. The argillites are probably of Jurassic age according to Diller,[1] and are assigned to the Galice formation. The various types of igneous rocks range in age from Paleozoic to Cretaceous according to Kay.[2] The andesites are probably Paleozoic, or Jurassic, while serpentine intrudes Jurassic sediments and certain coarse grained plutonic rocks are referred to the Lower Cretaceous.

A sample of greenstone from the face of the crosscut into the hanging wall on the 9th level of the Greenback mine contains rounded crystals of quartz and phenocrysts of plagioclase, partly altered to sericite and epidote in a fine matrix of granular feldspar, quartz, sericite (or talc), fine needles of hornblende and titanite. It shows very distinct banding or flow structure and contains some later vein quartz and calcite.

A sample of greenstone from the face of a crosscut into the footwall from the 9th level of the Greenback mine contains abundant lath-shaped plagioclase, a little orthoclase, and some hornblende altering to chlorite, as well as much epidote and veinlets of calcite, siderite, epidote and pyrite.

A sample of greenstone from the breast of the long crosscut into the footwall from the 5th level of the Greenback mine contains abundant augite altering to green hornblende and chlorite, abundant labradorite, and some calcite and leucoxene. It is a coarse grained auganite.

A sample of rock largely altered to serpentine taken from a point near the breast of the main drift on the 9th level of the Greenback mine is too much altered to permit identification of the primary minerals; it contains abundant secondary calcite, some nearly colorless serpentine, some feldspar (which may be secondary adularia as it shows only simple twining), some isotropic chloritic material, and some kaolin.

In general the greenstone at the Greenback mine is of an andesitic type with variations to auganite and to dacite. A later intrusion of serpentine was originally a more basic rock than andesite. Another intrusion forming a dike on top of the Greenback ridge in the N. W. ¼, Sec. 4, T. 34 N., R. 5 W. is an aplite or micrographic granite consisting chiefly of a graphic intergrowth of quartz and orthoclase with some plagioclase and quartz, and also a little zoisite, chlorite, epidote, titanite, and magnetite.

[1] U. S. Geol. Survey Bulletin 546, p. 17, 1914.
[2] U. S. Geol. Survey Bulletin 340, p. 137, 1908.

At the Star mine near Placer on Grave creek greenstone is abundant, and it is intruded by saussurite, which is probably derived from a gabbro. The saussurite contains many crystals of colorless augite, two types of zoisite, calcite, sericite, magnetite, and an isotropic colorless mineral having good cleavage, and a refringence higher than that of balsam, which may be a colorless chlorite; it is in phenocrysts (of the form of feldspar) some of which have a border of pale green hornblende.

Maloney's mine near Grave is also in greenstone.

MINERAL RESOURCES

The mineral resources of the Greenback district are not diversified, but the metal mines have yielded a large production. The district contains placer deposits and metalliferous deep mines.

Placer Mines

The most important placer mines in the district are along Grave creek, which is in fact one of the most productive placer mining gulches in the state of Oregon.

The Lewis placer near Leland was in operation in 1905, but has not been worked recently. The Goff mine, served by the same ditch, has had a similar history. The water of their main ditch is now used at the Columbia mine near Placer.

The Columbia Placer is owned by L. A. Lewis of Portland. It is supplied with water by two ditches from Grave creek, one giving a head of 100 feet and the other of 600 feet. The deposit occupies the valley of Tom East creek, a tributary of Grave creek, heading near the Greenback mine, and the workings have now nearly reached the Greenback mill. The gravel attains a thickness of 50 feet and is coarsest near the bedrock, which is largely greenstone like the bowlders. According to Diller,[1] "the gold is fine and nuggets are rare. Three 5-inch giants are in use and nearly 6 acres are washed over annually. The grade is low and to keep the sluice clear the tailings are washed aside from the end of the sluice by a powerful side stream which piles up the gravel in a prominent heap."

Several other placers have been in operation both above and below the mouth of Tom East creek on Grave creek for at least 30 years more or less continuously and it is estimated that the gulch has made an aggregate yield of more than $400,000 in gold.

Payne's placer mine is near Foley gulch on Coyote creek.

[1] U. S. Geol. Survey Bulletin 340, p. 149, 1908.

According to Diller:[1] "The mine stretches up from the creek level to the terrace nearly 100 feet above. Coyote creek has but little fall, and the Ruble elevator has been used to advantage. The greenstone pebbles are completely rotten; those of slate are not so thoroughly decomposed." An underlying dark gray gravel is fresh and unaltered.

Diller [1] reports that "the Steam Beer placer, owned by H. K. Miller, has continued in full operation for a number of years. The ditch is about 9 miles in length and supplies a head of 200 feet. The gravel terrace is 50 feet above Grave creek, which affords excellent dumping ground. The mine exposes 25 feet of gravel, generally coarse below, and made up largely of greenstone with scarcely any quartz. The bed rock is slate."

Deep Mines

The Silent Friend mine was not visited by the writer. According to Kay [2] it "is in the southern part of section 15, T. 33 S., R. 5 W., on the north slope of Post Mountain. The chief development has been by two adits. The lower of these is 320 feet in length and crosscuts several small stringers. The upper is 75 feet in length, and has an upraise to the surface. The country rock is greenstone, which is strongly chloritized adjacent to the veins. The ores are found in veinlets and stringers which run in various directions, but the majority of them have a general trend between southwest and west. The filling consists of quartz, calcite, pyrite, arsenopyrite, and, locally, chalcopyrite. Some specimens of ore, which were found to consist largely of calcite, chlorite, and arsenopyrite, showed considerable free gold visible to the unaided eye."

The Martha mine is in the S. W. ¼ Sec. 28, T. 33 S., R. 5 W. about 1 mile north of the Greenback mine. It is on the steep western slope of St. Peter mountain overlooking Coyote creek. It is opened by four adits at different elevations, having a total length of about 3000 feet. It was opened as a separate mine, but in 1904 it was purchased by the Greenback Company and developed more fully by means of electric power from the Greenback mine. In 1906 the Martha was connected with the Greenback mill by means of an aerial tramway. After the Greenback mine was closed the Martha was leased to J. M. Clarke of Golden, Oregon, who erected a 5-stamp mill on the ground and treated ore previously developed and partly mined.

[1] Loc. cit., p. 149.
[2] U. S. Geol. Survey Bulletin 340, p. 143, 1908. Not quoted in full.

The country rock is greenstone and the ore is similar to that of the Greenback, though not as rich. It occurs in veins and stringers in zones of shearing. In adit 2 the chief vein strikes N. 70° W. and dips at an angle of 55° to 60°; it varies in width from a few inches to about 4 feet with an average of about 2 feet for the first 600 feet; the adit beyond was not accessible; it was said to extend 800 feet. At about 350 feet from the portal a fault which strikes about N. 60° W. causes an offset of about 15 feet toward the north.

The Gold Coin mine is about half a mile northeast of the Martha and lower on the mountain slope. It is opened by 3 adits having a total length of about 450 feet; all three are in greenstone and serpentine and disclose no well defined vein, but instead numerous bunches and stringers of pyritic ore in calcite and quartz in serpentine. The pyrite also extends into the serpentine irregularly. In places the serpentine is so penetrated by calcite that the rock is properly designated an ophicalcite. This mine is equipped with a 3-stamp mill.

The Marshall mine is on the north side of Coyote creek near the N. W. corner of section 22, T. 33 S., R. 5 W. It has been opened by several adits and a shaft. A crosscut adit is reported to be about 500 feet long wholly in serpentine. A shaft about 100 feet deep has yielded considerable white quartz. The vein has been stoped from the level of the adit to the surface. A dioritic rock from this mine contains abundant large crystals of hornblende cemented by a mass of zoisite, epidote, isotropic chloritic material, quartz, and kaolin.

The Greenback mine is situated near the head of Tom East creek, a tributary of Grave creek, and its presence has probably had much to do with making the former the site of one of the most important placer mines in Oregon. The mine was discovered in 1897 and yielded rich returns from the first. In 1898 it was a producer of some importance although at that time its ores were treated in an arrastre at Placer. The mine was then sold to the Victor Junior Gold Mining Company from which it passed in 1902 to the Greenback Gold Mining and Milling Company. It is now owned largely or wholly by R. C. Robinson of Parish, N. Y. It has the largest milling equipment in southern Oregon, consisting of 40 stamps, operated first by steam and later by electric power, and the following additional machinery: one 12 by 14 air compressor, three large Risdon crushers, eight amalgamating plates each 12 feet long (now removed), 5 Frue vanners

Plate VII. 40-stamp mill at the Greenback mine, Josephine County, Oregon.

and 7 other concentrating tables, several Pelton wheels, 4 cyanide tanks each 4½ by 30 feet, besides solution and sump tanks, and an aerial tramway about 7000 feet long. A view of the mill is given in plate VII.

The mine is opened on 12 levels as shown in the accompanying plan (figure 16). Above the 9th level most of the ore is stoped out to the surface. Below that level it is opened only by a winze which is full of water, and these lower workings shown in the drawing are taken from a map at the mine. The vein strikes about east and west and varies in dip from about 30° to 60° N. The average dip from the 1st level to the 9th is about 45° N.; it is less above the 5th level and about 55° to 60° below that level. The vertical depth reached by the 9th level is less than 500 feet. The vein averages about 20 inches in width, but varies from less than 6 inches to more than 4 feet. The vein filling consists of quartz, calcite, and pyrite, with quartz dominant in most places. The average content of the ore mined from the first and second levels was more than $8 per ton and 75 percent of this ore was free-milling according to Captain

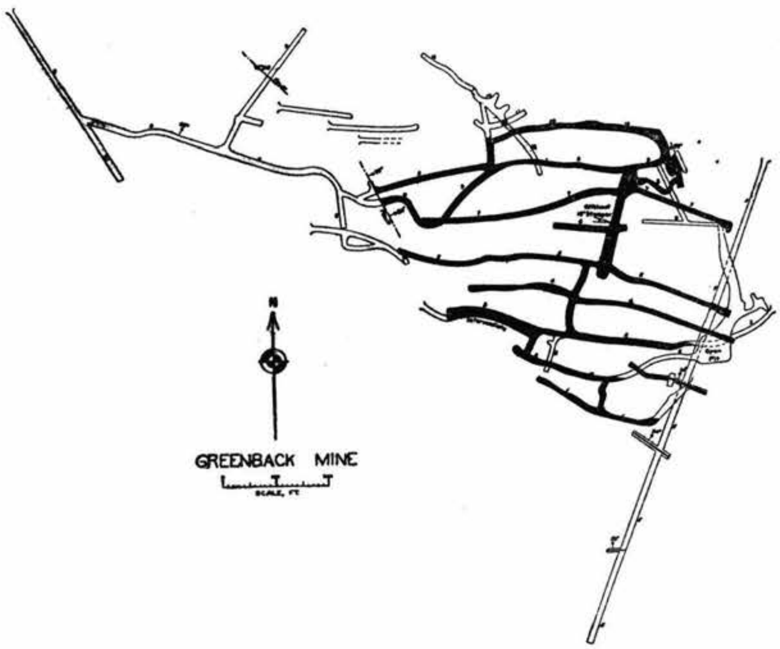


Figure 16. Greenback mine, workings and ore body; workings on ore in solid black.

Buck.[1] The concentrates ran about 75 dollars a ton, and after cyaniding the waste product contained less than one dollar to the ton.

The country rock at the Greenback mine is largely greenstone, which is the result of alteration of an andesitic mass. Southeast of the mine serpentine is abundant while an area of argillites lies to the north. The vein is cut off to the eastward by serpentine, which is apparently later than the mineralization, since the latter is not known to extend into the serpentine, either with or without faulting at the contact. To the westward the main vein is cut off by an important fault which strikes N. 35°-40° W. and dips 75°-80° N. E. Between these two limits, which are about 600 feet apart on the 9th level, the vein is continuous, although exhibiting variations in both strike and dip. Outside of these limits it has nowhere been found. In the stopes on the 6th level there is some indication of a branch vein or stringer going downward into the footwall and diverging also on the strike to the westward, but it has not been explored.

About 80 feet south of the Greenback vein on the 5th level the Irish Girl vein strikes N. 70° W., almost exactly parallel with the former, and dips about 60° N. Where opened it is a vein similar to the Greenback in mineral contents, but only 1 to 3 feet thick and lower in grade. It has been opened only by a drift 75 feet long and a short raise. The long crosscut into the footwall discloses two more veins which are about parallel, but they are still smaller.

The Jim Blaine mine is in the N. W. ¼ Sec. 4, T. 34 S., R. 5 W. about half a mile south of the Greenback. It is opened by two adits and shaft having a total length of about 150 feet. One adit discloses 1 to 2 feet of white quartz which dips toward the northeast at 70° to 85°.

The Yellowhorn mine is in the S. W. ¼ Sec. 4, T. 34 S., R. 5 W. about a mile south of the Greenback. It is opened by an adit about 800 feet long in greenstone which follows a vein for 650 feet. The vein varies in thickness from 6 inches to 4 feet with an average of about 10 inches, and is in a rock which contains many stringers. The vein filling is chiefly white quartz with some calcite, pyrrhotite, chalcopyrite, pyrite, and galena. A thin section shows that the calcite is of later origin than the quartz. Pyrite is more abundant in the wall rocks near the vein than in the vein itself. The vein strikes nearly east and west.

[1] U. S. Geol. Survey Bulletin 340, p. 141, 1908.

The Star mine is in the S. E. $\frac{1}{4}$ Sec. 7, T. 34 S., R. 5 W., about half a mile south of Placer. It was opened by two shafts about 250 feet apart, but as the workings are full of water no examination was possible. From the dumps and trenches the vein evidently strikes about east and west in a greenstone country rock, while the ore is gold-bearing quartz.

THE GALICE DISTRICT

LOCATION

As the name is used in this report the Galice district includes the whole northwest corner of Josephine county; that is, it is the area (within the county) drained by Rogue river that lies north and west of the mouth of Jump-off-Joe creek and also west of the Southern Pacific railroad.

The Galice district, as thus defined, includes areas which have been known under various names in the past, especially, Galice, Mt. Reuben, Merlin, Glendale, and Rogue river. Except for a few placer deposits the mines of the district are confined to townships 33, 34, and 35 in range 8 west of the Willamette meridian. The region is mountainous, and yet the topographic features are dominated by a high-level peneplain deeply dissected by the canon of Rogue river and less deeply cut by the numerous tributaries of that stream. The old peneplain is too much dissected to be recognized by any large level surfaces, but it is inferred from the accordance of summit levels on both sides of Rogue river and the uniformity of sky-line in other parts of the district. Elevations in the area vary from about 600 feet along Rogue river to the level of the peneplain (somewhat above 3000 feet) and to higher altitudes on more or less isolated peaks of 4000 feet or more.

HISTORY

Placer mining on Galice creek began about 1854 and has continued more or less steadily ever since, although with irregularly diminishing activity. During the fifties the work was directed especially to the most accessible and richest deposits. On account of the partial exhaustion of such gravel beds there was some decrease in activity during the sixties. In the next decade some of the slightly less accessible deposits were opened by means of ditches and flumes, some of them of considerable length. By 1880 the small placers were chiefly in the hands of Chinese, who reworked and extended old workings with some profit. In 1883 Galice creek district made an output estimated at $8000. In 1886 quartz mines increased in activity in this area. In the nineties the quartz mines of the Mt. Reuben district became prominent, and in 1897 the principal quartz mining in southern Oregon was in this district. In 1898 the Gold Bug mine had a 5-stamp mill which was yielding good returns, while the Golden Wedge mine put its ores through an arrastre. These mines continued active during the next five years. In 1905 the Almeda mine was already in course of development and in 1908 a 100-ton matting furnace was built at the mine. In 1907 the Oriole was the scene of some activity which has continued with minor interruptions to the present time. In 1908, 3000 feet of underground development work was done at the Almeda and three quartz mines in the district produced $23,580 worth of metals. In 1910 the producing mines included the Oriole, Gold Road, Nesbit, and Sugar Pine, the last one using a 10-stamp mill. In 1912 the Almeda smelter was operated for thirty days, and the following year it was in operation about the same length of time.

GEOLOGY

The geology of the Galice district is relatively simple. Aside from small deposits of stream gravels the rocks of the area are either Jurassic sediments or igneous intrusives (possibly with some extrusives). The general strike of the sediments and also of the contact between the sediments and the igneous rocks is about N. 20° E.; the sediments dip steeply to the eastward, but are overturned according to Diller,[1] so that the strata to the west are younger than those near Galice. He has designated the Jurassic sediments at Galice by the name of that town, while those west of Whiskey creek he calls the Dothan formation.

The oldest rocks of the district therefore belong to the Galice formation, a conclusion which is supported by a report of a study by paleontologists of the U. S. Geological Survey of fossils collected at the Almeda mine by the writer. Director Smith of the Survey writes that these fossils all belong to the species *Aucella erringtoni* (Gabb), "which indicates Jurassic age and probably the Galice formation." The Galice formation consists of argillites, slates, and thin bedded argillaceous sandstones. In the region where the county road

[1] U. S. Geol. Survey Bulletin 546, p. 18, 1914.

crosses Rogue river (in T. 35 N., R. 7 W.), and elsewhere, it is intruded by greenstones of various kinds. Igneous rocks between the Almeda mine and Tyee bar also separate the Galice formation from the Dothan formation, which occupies the whole northwest third of the Galice district, according to Diller.[1] The Galice and Dothan formations are strikingly similar, if not identical, lithologically, and the reasons for separating them from one another are not apparent.

Near the footbridge across Rogue river between Grave and Whiskey creeks the cliff along which the river trail runs is composed of very light colored quartzose rocks with distinct and numerous parting planes resembling bedding. Here the cleavages strike N. 35° E. and dip about 60° S. E. About a mile up stream (south) a similar siliceous fine grained banded rock strikes N. 10° E. and dips very steeply eastward. With these exceptions Rogue river cuts through serpentine and various andesites and porphyries (more or less altered and locally called greenstone) between the Almeda and the Kramer or Elwilda mines. This mass of "greenstones" has been penetrated by instrusions of basic igneous rocks, now altered to serpentine, and also by dikes and more irregular masses of more siliceous igneous rocks. All of these rocks have been sheared and altered as a result of later earth movements, some of which were part of great mountain building processes. This shearing produced many fissures later filled by vein-materials which include ores in many places.

After this complex of Jurassic sediments and igneous intrusives took approximately its present position erosion and sedimentation began to modify its surface. Before the present gorges were cut out streams flowed over the surface in positions differing somewhat from their present courses. Here and there these streams deposited gravels which have not since been removed by erosion and form the "high level" placer deposits. Later the eroding power of the streams seems to have been increased, perhaps by uplift of the region, and they cut their present gorges and deposited gravels here and there along them, not only at their present levels, but also at higher levels within their existing narrow valleys. All of these gravels have been more or less useful as placer deposits.

MINERAL RESOURCES

The mineral resources of the Galice district are not varied, but

[1] U. S. Geol. Survey, loc. cit., Plate VI.

they are of considerable importance. They include gold placer deposits and gold and copper vein deposits. According to Diller[1] the district has produced about $5,000,000 in gold alone; only in recent years has the output of vein deposits exceeded that from placers.

Placer Deposits

The Tyee Bar placer mine is on the south bank of Rogue river about a mile below Whiskey creek. It was worked years ago and reopened in 1911. The bedrock is argillite.

The Scandinavian-American Company installed a dredge to work gravels about 2 miles below the Almeda mine on Rogue river, but it was evidently not successful as it was not in operation in 1913.

Dean and Corliss at one time operated a placer on Rogue river about 2 miles below Galice on a bar 25 feet above water level; it was idle in 1913.

Jewell and Lewis own a placer mine on Rogue river about 1 mile below Galice at the mouth of Rocky gulch. It was worked by hydraulic methods with water from Rocky gulch, but was inactive in 1913. The gravel forms a bar in the river and also rises to a bench about 15 feet above water level. The gravel has been raised by a steam shovel and then washed by a giant through a revolving screen to remove the coarse material after which the fine sand passes into the sluice boxes.

The Old Channel Hydraulic Mining Company controls a large area of "high level" placer deposits near Galice; they form a gravel terrace parallel to Galice creek and Rogue river and more than 2 miles long. The terrace is about 600 feet above the creek and has a thickness of over 100 feet. The bedrock consists chiefly of argillites of the Galice formation. The main ditch from Galice creek is said to supply 5000 miner's inches of water during the rainy season; the giants work under a head of about 350 feet. According to Diller,[2] who gives a detailed description of this deposit with several drawings, "The coarse gravel at the bottom is well rounded and composed largely of greenstone with considerable quartz. Cobblestones as large as 8 inches in diameter are common. North of Rich gulch bowlders are numerous, but on the south side bowlders are few, and the gravel is quite firmly cemented. This coarse bottom layer of gravel and bowlders is limited to the main channel and contains

[1] U. S. Geol. Survey Bulletin 546, p. 47, 1914.
[2] U. S. Geol. Survey Bulletin 546, pp. 98–101, 1914. Not quoted in full.

most of the gold, although some gold is said to be distributed throughout the great thickness of overlying fine gravel and sand. A large body of available gravel lies south of Rich gulch where most of the recent work has been carried on. The bedrock is chiefly slate with some sandstone but near the western border of the mine north of Rich gulch the slates are cut by dikes and both rocks are affected by a small fault that strikes N. 80° W. and dips 72° S. W." Other faults are believed to exist in the bedrock of these deposits.

The Galice Consolidated Mines Company owns most of the placer ground along Galice creek. These deposits were rich, but have been exhausted except a portion belonging to the Galice Placer Mines Company.

The Hell Gate Mining and Development Company has done considerable work on a deposit of gravel on the southwest side of Rogue river near the mouth of Hog creek at a level high above the present stream. The resultant excavations are in plain view from the county road across the river.

Gold-bearing Vein Deposits

The Benton group consists of 8 claims, as shown in figure 18, situated on Drain creek, a branch of Whiskey creek in T. 33 S., R. 8 W. near Mount Reuben. There is a good camp of half a dozen buildings, at the mouth of Drain creek, which are still in good repair although the last work done here was in 1905. The group is now owned by the Valley Development Company of Portland, Ore-

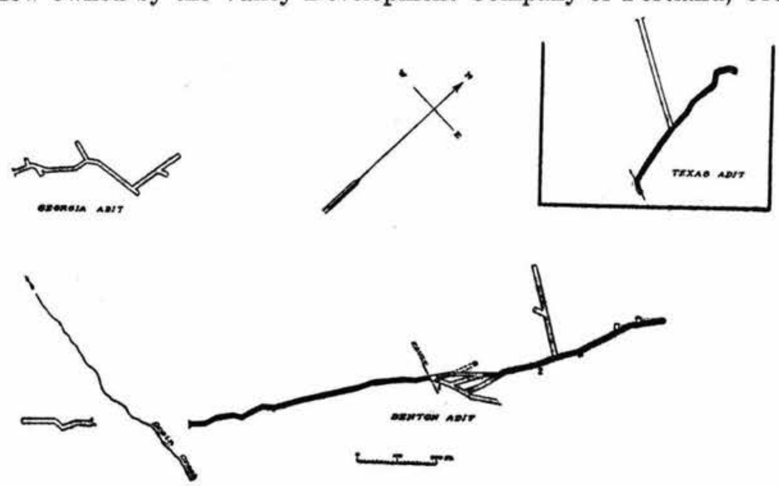


Figure 17. Benton Group, chief workings and veins, the latter in solid black. Galice district, Oregon.

gon. It is connected with Glendale, by way of Reuben Spur, by a good wagon road. The workings except the upper adit on the Benton vein, are shown in figure 17; and the claims are shown in figure 18.

The main adit is a drift following a vein for 600 feet to a fault which strikes N. 70° W. and dips 85° S.; about 100 feet farther on the adit picks up a vein again which it follows for about 500 feet. This vein is also opened by an upper adit for about 800 feet. The ore has not been removed. Assays said to have been made by Mr. Bishop, former superintendent of the Greenback mine are reported as follows:

Upper adit, 40 samples taken.	
Average value of ore from portal to raise 2	$5.32 per ton.
Average value of ore from raise 2 to breast	4.42 " "
Main Benton adit, 127 samples taken.	
Average value of 34 samples between portal and point 47 feet N. E. of raise 1	2.75 " "
Average value of 43 samples between same point and main crosscut	4.30 " "
Average value of 50 samples between main crosscut and breast	1.80 " "

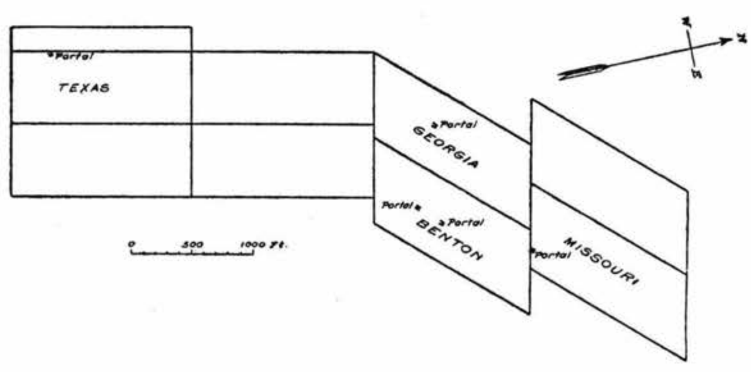


Figure 18. Location of adits and claims of Benton group, Galice district, Oregon.

The Texas adit of the Benton group crosscuts 300 feet to the vein, which is opened by a drift each way; to the south it is cut off by a fault (dipping 50° northerly) about 150 feet from the crosscut entry; to the north it is displaced slightly by another fault about 50 feet from the crosscut. While the latter fault causes little displacement it twists the hanging wall so much as to locally cause reversal of the dip of the vein; normally this vein dips about 40° east, locally it dips west. The strike of the fault is not shown in the drawing because it is somewhat indeterminate; in one place it seems to strike N. 47° W. and dip about 60° N. E. Near and for some distance south of this fault the vein has 1 to 3 feet of solid quartz; northward a much smaller vein is exposed. The raise shown in the drawing inclines upward at an angle of 30° and reaches the surface about 100 feet above the adit level. The country rock of this adit is tonalite.

The Georgia adit of the Benton group is quite irregular, as shown in the drawing, and discloses no important vein. Its longest straight course is along a sheared zone about 3 feet wide showing very little quartz.

Tonalite (locally called "gabbro") is present in this region not only in the Texas adit, but also at the face of the long cross-cut (called "Georgia crosscut") from the main Benton adit where the rock is sheared and contains quartz stringers running in various directions. The minerals present include abundant plagioclase and quartz with some chlorite, epidote, rutile, calcite, sericite, and pyrite.

The Gold Bug mine is on Whiskey creek in T. 33 S., R. 8 W. near Mount Reuben at elevations of 2400 to 2600 feet as measured by aneroid barometer. The old main adit is now completely blocked by fallen timbers at about 350 feet from the portal. The vein contained gold-bearing quartz with some pyrite and chalcopyrite. The vein was only 1 to 2 feet wide where seen, but even this was stoped out, and thicker vein quartz was reported farther in. The country rock of the old main adit is an andesite containing phenocrysts of plagioclase feldspar in a matrix of plagioclase, green biotite, isotropic chloritic material, and a little magnetite and epidote. The illustration (figure 19) is a copy of an old mine map showing a plan and a vertical section of the old workings.

A narrow dike of serpentine may be observed crossing the road within a quarter mile of the mine. Next to the dike the enclosing andesite is considerably altered to epidote, chlorite, and quartz. An adit near this outcrop drifts 100 feet on a fissure 1 to 4 feet wide containing 6 inches to 2 feet of quartz striking N. 5° E. and dipping 45° E. The mine is now owned by Romig and Neal. A new incline shaft shows a quartz vein striking N. 35° W. and dipping 70° S. W. The vein-filling here is 12 to 14 inches thick and chiefly quartz stained by chrysocolla. A new crosscut adit extends N. 21° E. about 100 feet in andesite. Work was in progress here in the

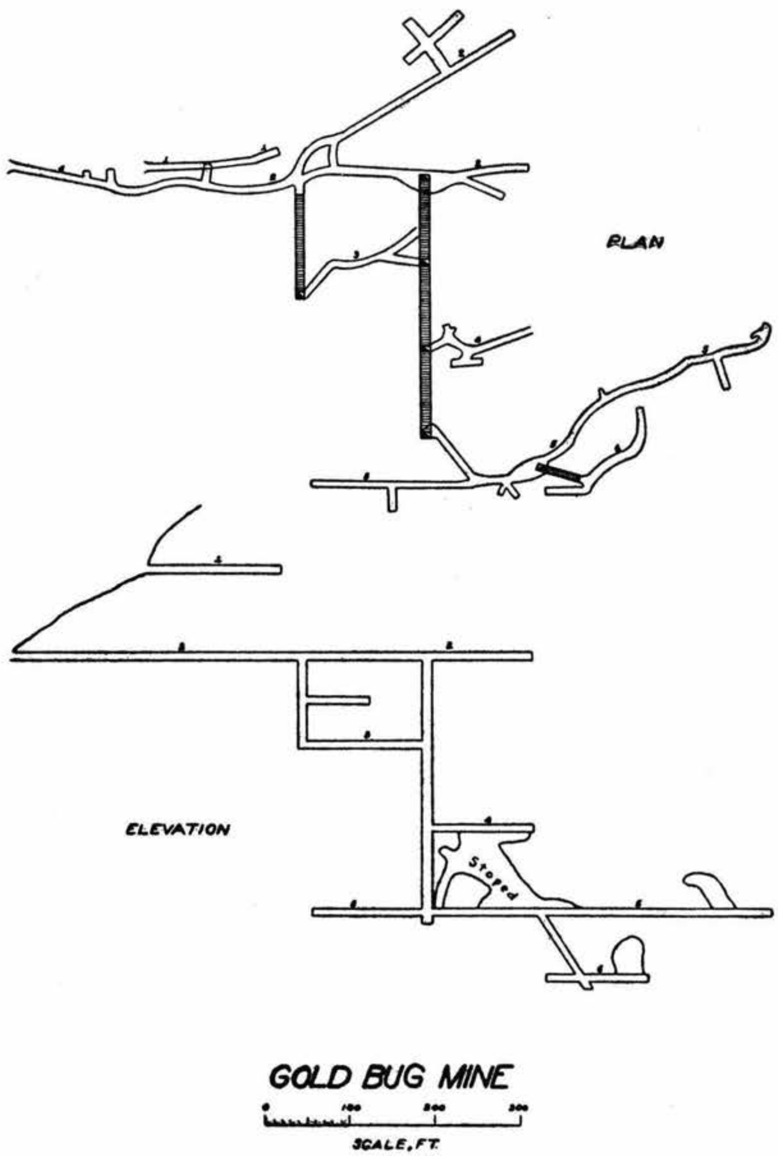


Figure 19. Plan and elevation of old workings of the Gold Bug mine.

summer of 1913. The mine is connected with the railroad at Reuben Spur by a good mountain road.

The Copper Stain group is not far from the Gold Bug in the Mount Reuben district. It consists of 7 claims owned by Mrs. S. L. Dana, of Springfield, Illinois. The main adit is caved at the portal but may be entered through stopes reaching the surface. The ore is white quartz with some pyrite, and free gold in a few samples. As at the Gold Bug that part of the ore which is stained by copper minerals is said to be richest in gold. The country rock, at least near the vein, seems to be largely serpentine. There has been no work done here for several years. The equipment (now incomplete) consisted of a Tremayne 2-stamp mill with a crusher, a 3 by 10 foot amalgamating plate and a "cannon-ball" amalgamator.

The Elwilda or Kramer group was recently sold by J. C. Hubbert to M. C. Page. It is about 8 miles by trail from the Almeda mine and consists of 11 claims extending from Rogue river up Whiskey creek. The mill was formerly a rotary 4-stamp Parker mill; it is now an arrastre run by a Pelton wheel. The group is opened chiefly at two places called the north and south "works." In both places the country rock is greenstone; at the latter it is cut by a dike of quartz monzonite aplite. At the south "works" two short adits disclose a quartz vein about 3 feet thick which is much crushed and faulted. One fault strikes N. 67° E. and dips about 55° S. E. The chief vein strikes nearly east and dips about 60° northward. At the north "works" two adits open one or more veins which vary considerably in strike and dip. The richest portion has a strike of N. 4° E. and a dip varying from 45° W. above the level to 78° W. below in a 40-foot winze. Near the breast a quartz vein strikes N. 20° E. and dips 70° N. W. The gold in the ore from this adit is reported to amount to $5 a ton.

The Keystone group, belonging to the Akron Gold Mining and Milling Company, is on the south slope of Rogue river nearly opposite the mouth of Whiskey creek. It was not visited by the writer. According to Diller,[1] "There are two openings far above the river. One of them 115 feet in length, cuts the ledge at a depth of 100 feet; the other, 160 feet lower, is only partly completed. The country rock is greenstone near its contact with intruded serpentine. The gold occurs in irregular quartz veins or stringers, forming a belt about 3 feet in thickness and approximately parallel to the serpentine

[1] U. S. Geol. Survey Bulletin 546, pp. 51, 53, 1914.

contact. The ore appears to be pyrite in fine particles sparsely disseminated through the quartz."

The Legal Tender group on the east fork of Rum creek at an elevation of 2850 feet and the Kramer claim at the head of the west branch of Rocky gulch at an elevation of nearly 3000 feet are noteworthy because they are said by Diller[1] to be in a banded quartzite with or without dikes of serpentine. He also reports two belts of vertically banded siliceous rocks, probably quartzites, running N. 15° W., and forming prominent bluffs at the Strenuous Teddy claim about 3½ miles southwest of Galice at an elevation of about 1600 feet on the west fork of Galice creek. Each belt is about 150 feet thick and bounded by intrusive greenstone.

The Seven-thirty mine is about 2 miles northwest of the Almeda mine and 1 mile west of Rogue river. It is said to have produced good ore, but has been closed for some years.

The Argo group of claims is on the west side of Rogue river about 2 miles below the Almeda mine. It is opened by 3 short adits near the river level, two of which are now caved shut. The other adit extends S. 37° W. about 70 feet and thence S. 57° W. about 20 feet. The country rock is a light colored somewhat schistose "greenstone" which on microscopic examination appears to be a dacite, probably tuffaceous. According to Diller[1] "irregular quartz veins, stringers and kidneys occur in a belt about 3½ feet wide. They strike N. 28°-35° E. and are generally vertical, but in some places dip 76° N. W." In the workings still open no distinct vein was seen by the writer. The Argo is equipped with a 16-ton rotary ball and tube mill and a water wheel; it has been idle for several years.

The Bradbury mine is on the east side of Rogue river about 1¼ miles below the Almeda. It is opened by 3 adits at elevations about 150, 420, and 525 feet above the river. The upper adit enters as a crosscut in schistose country rock extending N. 90° E. 160 feet where it turns southward to drift about 70 feet on a lead varying from 1 to 50 inches wide which strikes N. 17° E. and contains 0 to 40 inches of quartz. The middle adit is caved shut at the portal; from the dump it is clear that this adit is several hundred feet long in schistose greenstone containing a vein of white quartz carrying a little pyrite and rare free gold. The lower adit extends N. 8° E. about 120 feet in greenstone containing thin seams and a few bunches of quartzose ore.

[1] U. S. Geol. Survey Bulletin 546, pp. 52, 54, 59, 1914.

The Treasury group, about 4½ miles northwest of Galice, is noteworthy because its ore contains not only quartz and pyrite, but also chalcopyrite, malachite, and sphalerite.

The Red Elephant claims, about 7 miles northwest of Galice mountain trail, are reported by Diller to be located where dacite porphyries cut greenstones and serpentines.

At the Blue Bill prospect about 6 miles northwest of Galice the ore is said to be chiefly pyrite, but contains also some chalcopyrite and a little molybdenite.

The Golden Wedge mine is about 4 miles northwest of Galice on Bailey gulch; it is said to have been discovered by Mr. Hutchins in 1893. About 1908 the mine passed into the control of the Gold Road Mining & Milling Company which was reorganized about 1911 as the Bailey Gulch Mining & Milling Company. Diller suggests that the total production of this mine may have reached $50,000 and that future production may result if the Oriole fault is found. The main ore body is opened by about 1200 feet of underground workings reaching a depth of about 500 feet on the incline, as shown in the

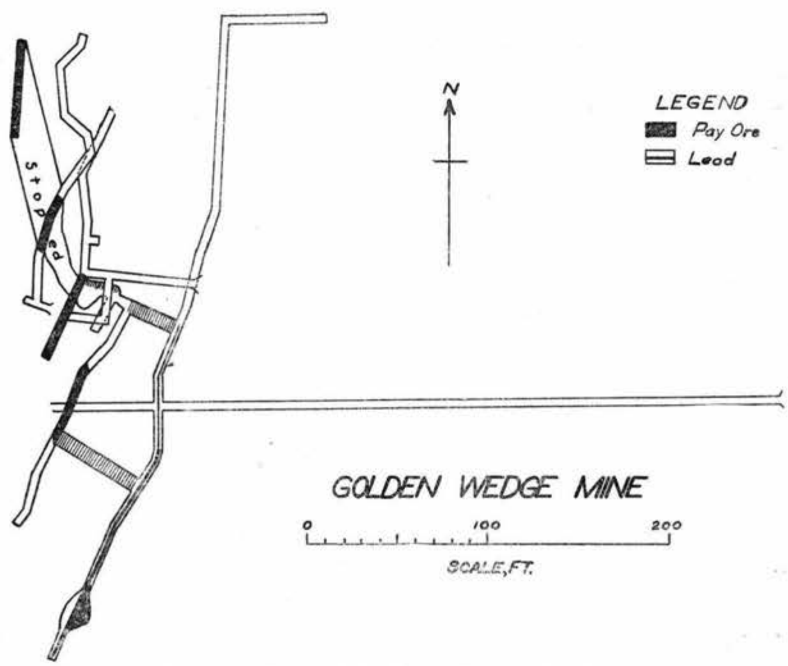


Figure 20. Plan of main workings of the Golden Wedge mine, Galice district, Oregon

illustration (figure 20). The lode strikes about N. 20° E. and dips 50°-60° E. The ore body pitches southward at an angle of about 20°. According to Diller,[1] the "quartz veins and lenses in the sheared greenstone are irregular, as if folded, and many of the quartz lenses or kidneys that have a covering of graphitic material with grains of pyrite are said to average $10 to $20 a ton in gold. Considerable ore has been stoped out of a belt ranging from 16 inches to 5 feet. The graphitic material interferes with handling the ore." The country rock here is a greenstone with intrusions of dacite, containing abundant dark green hornblende with fine granular quartz, sericitized plagioclase, and unusually abundant granular titanite.

An adit near the mill on Bailey gulch is now (1913) being extended. It exposes a thick fault gouge which suggests an important fault. The gouge is grayish blue when dry and nearly black and soft when wet. It consists chiefly of quartz, siderite, pyrite, and sericite, and is therefore finely divided vein material. The hanging wall is serpentine; on the other side the same rock is sheared and mineralized containing bunches and stringers of quartz. When seen this adit extended southerly about 220 feet; the vein near the breast strikes N. 10° W. and dips 88° E.

The Golden Wedge is equipped with a 10-stamp mill, having two more 2-stamp batteries not in condition to use, and also 7-foot amalgamating plates, a crusher, an air compressor, 2 Pelton wheels, and 12 tanks used as a 25-ton cyanide plant. Power is available only during the wet season.

Harry Sordy's claim is about half a mile north of the Oriole at an elevation of 3000 feet as measured by barometer. It is N. 31° W. of Galice at least 2 miles. The vein is opened by an adit and several shorter workings. The former is about 150 feet long, and the vein, in small lenses, strikes N. 40° E. and dips 55° northwest. The country rocks are serpentine and greenstone. This claim was formerly owned by John Carlson.

The Friday or Richmond group lies between the Oriole mine and the Golden Wedge. Several adits have been driven in altered greenstone, the longer ones being about 200 feet each. One is a crosscut which stops in 1 foot of fault gouge that strikes N. 7° W. and dips about 70° E. A ball mill and an old arrastre are now almost hidden by underbrush. Ore supposed to come from an adit on this group shows free gold and a little galena in quartz veins

[1] U. S. Geol. Survey Bull. 546, p. 51, 1914.

in serpentine. The gold extends also into the serpentine. Diller states that most of the gold was found with quartz near the summit on both sides of the divide.

The Oriole mine is about 2 miles northwest of Galice on Rocky gulch at an elevation of about 1100 to 1400 feet above sea level and 300 to 600 feet above Galice. The Oriole Gold Mining Company, which was organized in 1909, owns 9 claims, 8 of which are arranged in 2 tiers with common end lines extending about 3000 feet north and south and 2400 feet east and west. The illustration (figure 21)

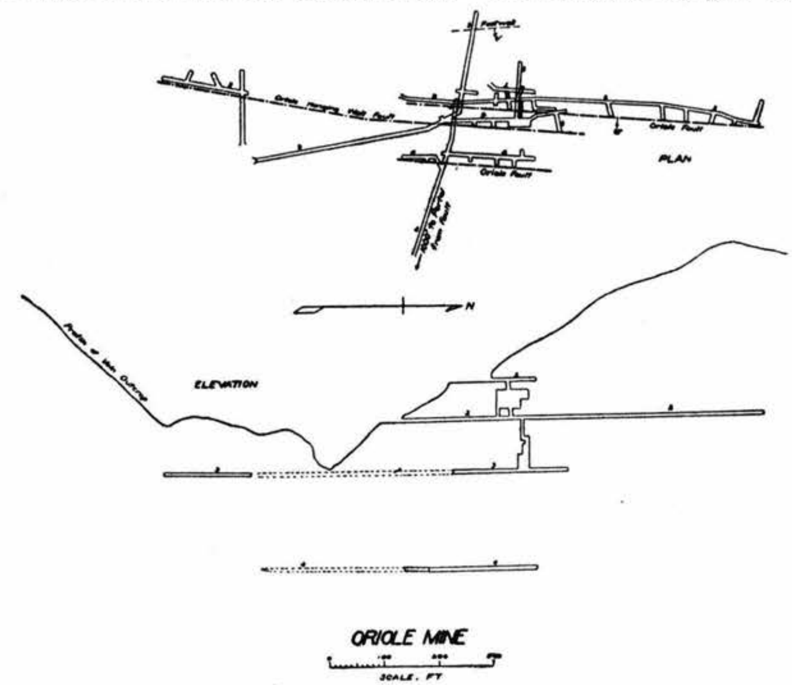


Figure 21. Plan and elevation of the main workings of the Oriole mine, Galice district, Oregon.

shows a plan and section of the workings as prepared in 1911 by F. A. Jones, who had charge of the development. As shown in the section the vein is opened on 4 levels to a maximum depth of about 500 feet below the outcrop and 325 feet between levels. The total length of underground workings on the four levels is more than 3200 feet.

The Company has installed a power plant consisting of a Pelton wheel under a head of 350 feet; sufficient water is available, at least in the wet season, to run a 12x12 air compressor for two drills and a 7½ kilowatt D. C. generator at 115 volts. Stamp mill machinery was on the ground, but not yet installed in 1913. It included a jaw crusher, 10 stamps of 1000 pounds each, two plates, and 2 vanners.

The Oriole workings disclose a fault marked by 6 to 12 inches of soft bluish-gray to dark green gouge and continuous with little variation in strike and dip for considerable distances. The average strike of the fault is N. 5° E.; the walls vary locally to N. 7° W. and N. 12° E.; the average dip is about 75° E. and the variations are usually between 65° and 80°. The fault is on the contact between greenstone and a rhyodacite porphyry, showing evidence of brecciation, apparently due to flowage while cooling. In thin section the rock shows phenocrysts of quartz and of more or less broken orthoclase and plagioclase, partly altered to zoisite and epidote, in a finely granular partly banded matrix of quartz, feldspar, sericite, and biotite.

The following analysis of this rock presents some unusual features. It is more siliceous than an average quartz latite or rhyodacite and too high in soda and too low in potassa for a granite. But the alkali ratio combined with the microscopic study make it clear that the rock must be considered a silicified rhyodacite.

Composition of rhyodacite from Oriole mine

[S. W. French, analyst.]

		Approximate mineral composition			
SiO_2	73.70	[redacted]		[redacted]	
TiO_2	.34	Quartz	35.2	Quartz	35.2
Al_2O_3	13.70	Orthoclase	8.4	Soda-orthoclase	12.7
Fe_2O_3	.70	Albite	36.3	Plagioclase	40.8
FeO	2.14	Anorthite	8.8	(Ab_4An_1)	
MgO	.74	Kaolinite	4.3	Kaolinite	4.3
CaO	1.76	Magnetite	1.0	Magnetite	1.0
Na_2O	4.28	Ilmenite	.7	Ilmenite	.7
K_2O	1.42	Pyroxene	4.7	Pyroxene	4.7
H_2O+	.60				
H_2O-	.04				
	99.42		99.4		99.4

The greenstone near the vein is much sheared and chloritized. The ore is a milky to grayish quartz which occurs in lenses near the fault in the greenstone footwall, and carries a little pyrite and chalcopyrite. The ore is said to average $15 to $20 a ton. According to Diller it seems to occur in shoots which have not yet been found on the lowest level.

The Buffalo group is at the head of Quartz creek on the slope of Peavine mountain at an elevation of about 4000 feet. The Chieftain claim, owned by Mr. Wayment is about 2 miles west of the Oriole mine. According to Diller, a belt of quartzite about 300 feet wide passes through this group; it has serpentine to the west and greenstone to the east of it. On the Dixie claim irregular veins and bunches of quartz carrying pyrite and chalcopyrite strike N. 23° E. and dip 68° N. W.

The Marvin mine is near the top of Peavine mountain at an elevation of 3400 feet as measured by barometer. A lode 30 feet wide, containing some quartz with chalcopyrite in pyroxenite somewhat altered to chlorite and serpentine, is opened by an adit which extends N. 40° W. about 150 feet. The lode strikes north of east and dips about 45° S.

The Mayflower group is on the south fork of Rocky gulch at an elevation of about 2800 feet about 1½ miles west of the Oriole mine. It is a group of 3 claims located in 1910 and now owned by Robertson and Sutherland. The garnetiferous mica schist here strikes N. 10° E. and locally dips only 35° E. An adit in chloritic serpentine discloses many small lenses and stringers of quartz. Other small openings are on a fault east of which is a hard banded rock, succeeded westward by 3 feet of radiating light green amphibole, platy serpentine, and fault gouge. West of the fault is massive gray talc (?) followed by black chloritic serpentine. The general strike of the rock formations on Peavine mountain is N. 15° to 20° W. with a steep dip to the east. The banded rocks include quartzite, quartz mica schist, fine and coarse amphibole schist, and graphitic mica schist. The Mayflower group is equipped with a Chilian quartz mill run by a Pelton wheel. Diller[1] states that "the gold is free or is in the pyrite, and chiefly, if not wholly, in the rotten quartz of the greenstone schist adjoining the contact. There is little, if any, gold in the white quartz. A small amount of chalcopyrite is present."

The Spokane group is near the head of Rich gulch at an elevation of about 2200 feet, as measured by barometer. An adit extends N. 10° W. about 190 feet in a serpentinous rock containing irregular

[1] U. S. Geol. Survey Bull. 546, p. 56, 1914.

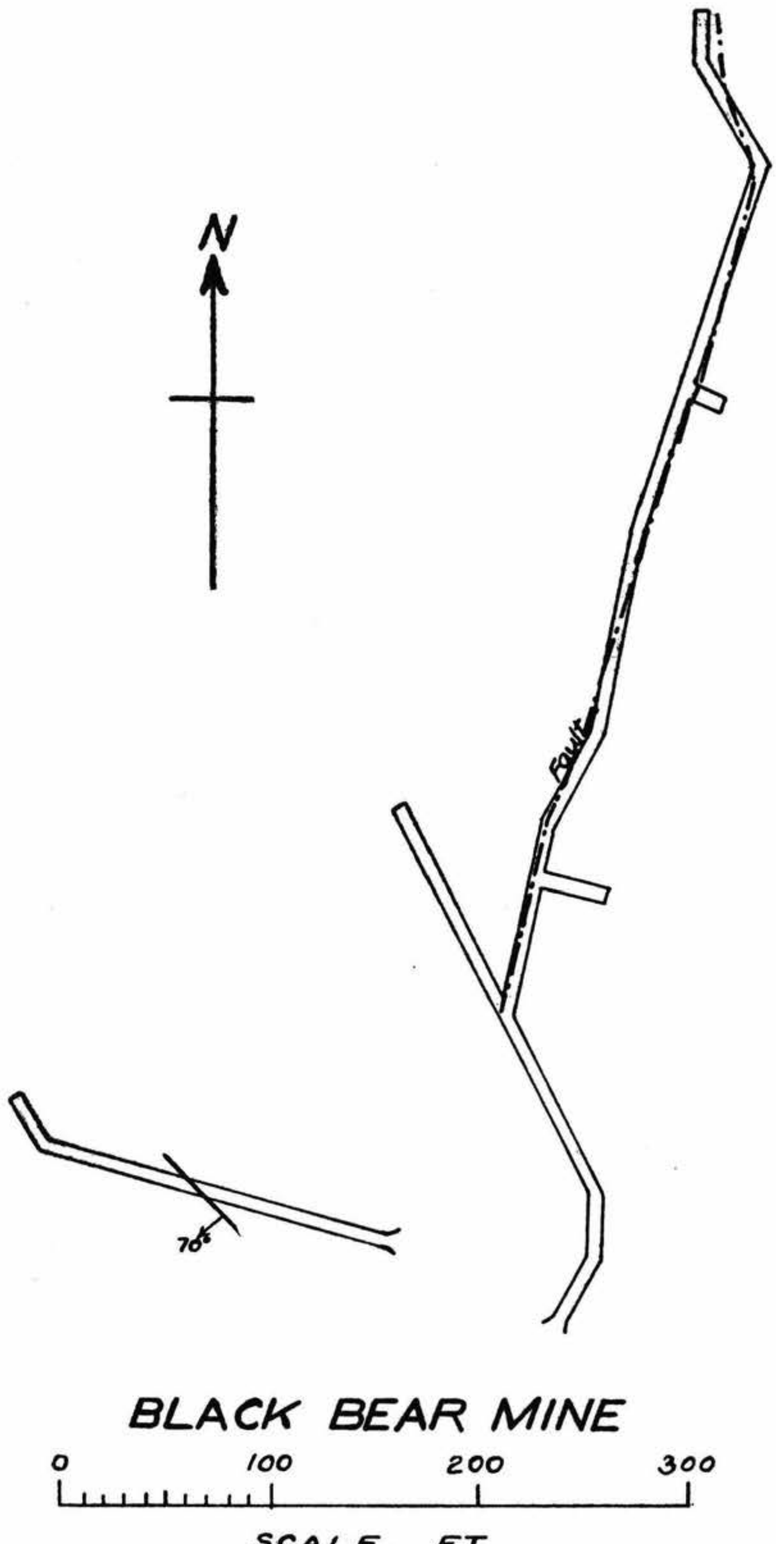


Figure 22. Main workings of the Black Bear mine, Galice district, Oregon.

kidneys and stringers of pyritiferous quartz, associated with a fault marked by soft gouge. The footwall of the lode is a garnetiferous mica schist. The group is owned by Robertson and Sutherland.

The Black Bear mine is on the south fork of Rocky gulch, about 2½ miles northwest of Galice, at an elevation of about 1650 feet, as measured by barometer. It was formerly owned by the Black Bear Mining & Milling Company, but is now controlled by the Highland Improvement Company. The main adit is over 700 feet in length and follows a well defined fault for more than 500 feet, as shown in the drawing of the workings (figure 22). The fault is marked by 12 to 20 inches of soft gouge which strikes about N. 15° E. and dips about 80° E. The ore consists of lenticular bodies of quartz with pyrite and greenstone which are found on both sides of the fault gouge. No ore has been milled from the main adit, though about 4 tons of rich surface ore was mined from old workings above it. The shorter adit discloses a zone showing scattered quartz near the breast as well as stringers crossing the main course as shown; one is about 2 feet wide and strikes S. 45° E. with a dip of 70° S. W. The country rock is a hard amphibolite, schistose in places, and containing many small quartz stringers or lenses. One to two hundred yards southwest of the Black Bear adits the country rock is dunite (or cortlandite) consisting of granular olivine with patches of tremolite and antigorite and a sprinkling of magnetite. Diller[1] states that at the Black Bear: "A vertical belt of quartz veinlets and kidneys 2½ feet in width runs nearly north and south. The ore, which is rich in pyrite, with some chalcopyrite, is scattered rather irregularly in the vein belt. Some of the ore is cut by shearing planes, on which the slickensided ore shows decided movement since the ore was deposited."

The Nesbit group is about 2 miles west of Galice and at least 2 miles southwest of the Oriole mine at an elevation of about 175 feet above sea level. The group is prospected by three adits, the lowest being a crosscut S. 50° W. about 75 feet showing no vein. The middle adit is a drift extending N. 65° W. about 30 feet in a lode in a talc schist at an elevation of about 1900 feet. The upper adit runs N. 42° W. and at the face discloses the contact between talc schist and a dark bluish rock resembling dunite. The contact is marked by a fault which dips 60° N. W. Diller[1] states that the mountain slopes at the Nesbit are covered by a deep capping of yellowish iron-stained residual material which in places yields free gold. Considerable gold

[1] U. S. Geol. Survey Bull. 546, p. 56, 1914.

has been won from this residual material by panning. The average of a number of assays is said to be $6.50 a ton, and it seems probable that it would pay well to hydraulic the whole slope.

The Three Lodes and Golden Pheasant groups are about 2 miles west of Galice on a contact between greenstone and serpentine. Local assayers reported tin ore at both these mines. The following

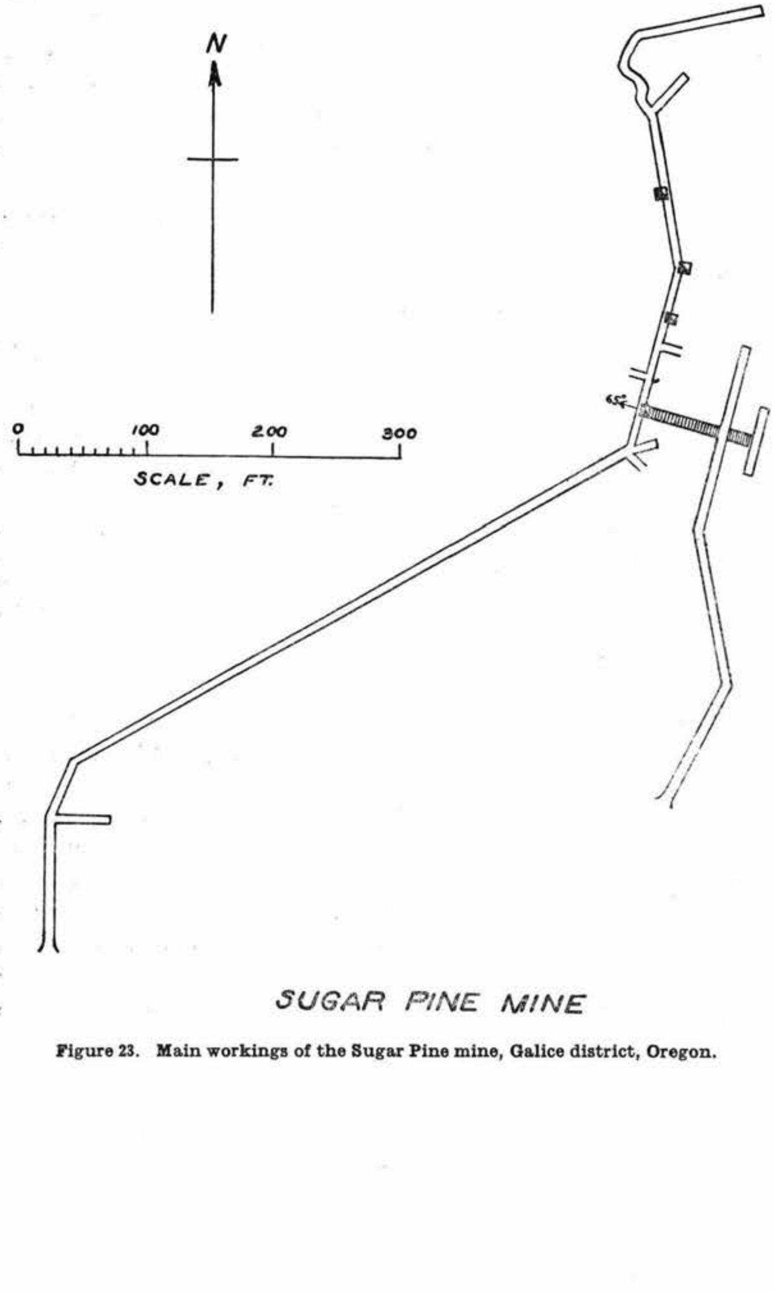


Figure 23. Main workings of the Sugar Pine mine, Galice district, Oregon.

statements quoted from J. S. Diller[1] of the U. S. Geological Survey are therefore of importance. "Under the guidance of the general manager, F. F. Johnson, five samples of the reported tin-bearing rock were collected (at the Three Lodes group) for testing. Mr. Chase Palmer tested them in the chemical laboratory of the Survey and reports on every sample 'no tin found.' These tests simply confirm the tests previously made by Professors Parks and Swartley, of the Oregon Bureau of Mines and the Agricultural College at Corvallis. From a pile of chloritic schist containing films of calcite on the shearing planes samples of the reported tin ore were taken (at the Golden Pheasant group), but careful tests by Dr. Palmer in the chemical laboratory of the Survey failed to show any tin."

The Sugar Pine mine was one of the earliest quartz mines discovered in the Galice district. It is said to have been opened by Cassidy and Draper in 1860 and worked by Green Brothers from about 1875 to 1887 when it was sold to the Sugar Pine Mining & Milling Company. It is on the north fork of Galice creek about 2½ miles southwest of Galice. It is opened by nearly 3000 feet of underground workings. At the lower adit at an elevation of about 1700 feet the vein seems to be a narrow dike intrusive in amphibole schist. This entry has a length of about 1100 feet of which about half is following one or more veins. The main lode is 1 to 5 feet in width and contains many stringers and lenses of quartz; it strikes about north and dips 65° to 70° W. The workings are shown as platted from a rapid Brunton compass survey in the illustration (figure 23). In one place on the upper adit level, 150 feet above the lower, the lode is widened to about 5 feet and crossed diagonally by quartz veins. The ore consists of quartz, often adhering solidly to greenstone, and carrying a little pyrite, chalcopyrite, and galena. The ore from a rich shoot mined out by the Green brothers is said to have yielded more than $25,000 when treated in an arrastre. A 10-stamp mill, erected in 1908, was run a few months and later moved to the Oriole mine.

Copper-bearing Vein Deposits

The Almeda mine is on the north bank of Rogue river in the S. E. ¼ of section 13, T. 34 S., R. 8 W., about 26 miles below Grant's Pass at an elevation of 600 to 1600 feet above sea level, the most important workings being at an altitude of about 750 feet. The mine is reached by a good stage road of 17 miles from Merlin, a station on the Southern Pacific railroad.

[1] Loc. cit., pp. 57, 58.

The ore deposit on which the mine is located is especially valuable for its tenor of copper, but it contains also gold, silver, lead, and a little zinc. The deposit occupies a zone of faulting along a contact between dacite porphyry, and argillite, being confined chiefly to the former. The argillite or slate has been assigned to the Galice formation of the Jurassic period by means of fossils (*aucella erringtoni*) found about 100 feet east of the Almeda mine. The contact between this argillite (in places a true slate) and igneous intrusive rocks (including dacite porphyry in places) has been traced by Diller from Briggs creek valley in T. 36 S., R. 8 W., for more than 20 miles to Reuben spur on the north line of T. 33 S., R. 7 W. In general its course is north-northeast and it dips steeply to the east, as the sedimentary formations do in this region. The fault on which the mine is located has not been traced continuously more than about 3000 feet, but it is so prominent it is locally known as the Big Yank lode. It strikes nearly due north and has a steep dip to the east.

The Almeda mine is more fully developed than any other mine in southern Oregon; this is due in part to the fact that it is remarkably well situated for systematic development, being in the narrow, but traversable, canon of a river which here gives a natural transverse section of the lode to a depth of at least 500 feet. The development which consists of over 6000 feet of underground work, is therefore largely in the form of drift adits at five different levels. These are supplemented by a vertical shaft reaching a depth of 500 feet, with levels (not fully opened) at each 100 feet. The workings are shown in plan and in longitudinal section in the drawing (figure 24). They open the deposit for about 1000 feet horizontally and about 800 feet vertically.

Although classified by Diller[1] as quartz porphyry or alaskite, the porphyritic footwall rock of the Almeda mine contains phenocrysts of plagioclase and quartz in a matrix of plagioclase, quartz, epidote, chlorite, magnetite (ilmenite?), and possibly a little orthoclase, but clearly not much. Mineralogically it is therefore a dacite porphyry. The chemical analysis which follows fully confirms the microscopic classification.

Adit No. 4 enters in porphyry; at 40 feet from the portal it passes into the vein which here strikes N. 48° E.; the first crosscut to the west terminates in the vein, which here strikes N. 4° E. and dips 86° W.; the crosscut eastward ends in a small porphyry dike in argillite,

[1] Loc. cit., p. 79.

COMPOSITION OF DACITE PORPHYRY FOOTWALL FROM ALMEDA MINE

[S. W. French, analyst.]

		Approximate mineral composition	
SiO_2	55.92		
TiO_2	.75		
Al_2O_3	19.66		
Fe_2O_3	1.94	Quartz	15.6
FeO	4.76	Orthoclase	2.3
MgO	5.27	Plagioclase	56.4
CaO	5.77	Chlorite }	22.1
Na_2O	3.26	Epidote }	
K_2O	.38	Magnetite	2.8
H_2O+	2.90	Ilmenite	1.4
H_2O-	.06		
	100.67		100.6

the dike striking N.30° W.and dipping 60° N.E.; at about 150 ft. from the portal the adit passes through a fault which strikes N. 55° W. and dips 60° N. E.; at about 120 feet farther on the adit again enters the vein with its normal argillite hanging wall; the same vein is doubtless continuous to the breast of the adit as shown in the drawing although it is not followed all the way by the working.

Adit No. 3 is in vein material on much of its course; 20 feet from the breast it cuts a fault with 2 to 3 feet of soft gouge which strikes N. 36° W. and dips 60° N. E.; the crosscut westward is in vein material and mineralized porphyry all the way; the crosscut eastward passes through 40 feet of porphyry and then enters vein material which grades into a stoped ore body.

Adit No. 3 East passes from argillite to porphyry at about 55 feet from the portal; the contact here strikes N. 20° E.

Adit No. 2 enters in vein material which opens into stoped ground at 140 feet from the portal; 120 feet farther on the argillite hanging wall comes into view beyond a fault which strikes N. 50° W. and dips 55° N. E.; 75 feet beyond the hanging wall is offset about 20 feet eastward by a fault which strikes N. 68° W. and dips 36° N. E.; at the breast the hanging wall of the main vein strikes N. 30° E. and dips 75° eastward.

Adit No. 1 enters in porphyry, passes through low grade ore between 40 and 75 feet from the portal; passes a fault which cuts off the porphyry 195 feet from the portal, the fault striking N. 89° W. and dipping 45° S.; and encounters the main slate hanging wall at about 525 feet from the portal; here the hanging wall strikes N. 15° E. and dips 40° E.; about 120 feet farther on the drift turns to follow a fault, which strikes N. 42° W. and dips 55° N. E., offsetting the hanging wall about 125 feet northwestward as measured along the fault plane. The crosscuts westward from this adit are in altered porphyry, probably somewhat mineralized; the longest one discloses a vertical wall at the breast which strikes N. 4° W. The southernmost crosscut to the east passes through porphyry into low grade ore about 15 feet from the main entry. The next crosscut to the east enters the argillite hanging wall, striking N. 10° E., about 30 feet from the main drift.

Adit No. 1 East passes into ore at 70 feet from the portal by penetrating the argillite hanging wall which here strikes N. 12° E. and

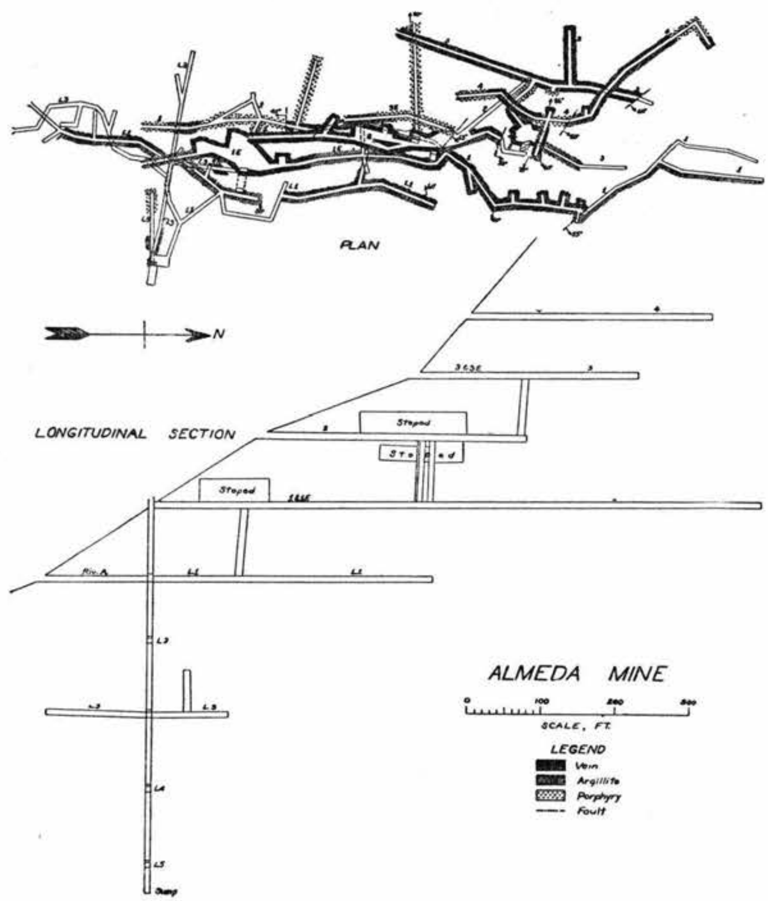


Figure 24. Plan and longitudinal section of the Almeda mine, Galice district, Oregon.

dips 70° E.; 150 feet farther on the entry passes into the hanging wall from which it emerges into the vein material at about 350 feet from the portal; north of a raise nearby the hanging wall dips only 48° E. It is worthy of note that the lower the level the farther south are the stopes; indeed, the main ore shoot seems to be roughly parallel with the present surface.

Level No. 1 on the river adit is driven in argillite and slate for the most part; at 50 feet from the portal it reaches the hanging wall which it follows to the breast, except for two stretches of 60 and 120 feet, respectively, which are in the argillite. On this level the hanging wall has an average dip of about 80° E.; near the breast it is locally overturned to a dip of 60° W.; the average strike is about N. 10° E., but it varies from N. 50° E. to N. 30° W. Very little stoping has been done on this level.

When the Almeda mine was visited by the writer in September, 1913, the levels below the river adit were inaccessible because they were filled with water. Therefore the following description of these levels is quoted from Diller's report[1].

"On the 300 foot level, within a foot of the contact, the slates, usually dark, are baked light gray, and very hard. They are seamed with calcite, especially on the shearing planes. Rich copper ore was noted near the indurated slates on the 300 foot level, a short distance north of the crosscut from the shaft. The thickness of the principal ore body on the 300 foot level is about 15 feet.

"I visited the 500 foot level and followed the crosscut from the shaft westward 96 feet to the end, collecting samples at both ends and at two intermediate points. By the shaft the rock is in some places impregnated with pyrite to such an extent that nearly one-fourth of the mass is pyrite. There is much less pyrite 12 feet from the shaft, and from that point to the western end of the crosscut pyrite, though present, is less conspicuous. The samples taken on the 500 foot level near the shaft and 12 feet west of the shaft were assayed by E. E. Burlingame & Company, who report a gold content of 20 cents a ton in each. One of the samples contained a trace of silver. The rock traversed by the crosscut for 96 feet west from the shaft on the 500 foot level is highly siliceous. The contact of the quartz porphyry with the slates on the 500 foot level appears to me to be at the foot of the shaft. In this view I have been confirmed by a microscopic study of thin sections of the rocks collected along the crosscut. The rocks still retain much of the original structure of the quartz porphyry impregnated with pyrite and are strongly contrasted with samples of the indurated slate found elsewhere in

[1] U. S. Geol. Survey Bull. 546, pp. 75–79, 1914. Not quoted in full.

the mine. The absence of a considerable body of ore at the contact by the shaft on the 500 foot level does not necessarily mean that ore does not go down to greater depths, for according to the pitch of the ore shoots the ore should be looked for in the contact along the 500 foot level south of the shaft."

The ore of the Almeda mine has been produced wholly, or almost wholly, by replacement of porphyry. The argillite hanging wall is definite and in many places marked by 6 to 12 inches of fault gouge, but the footwall is quite indefinite, the ore grading into less and less replaced porphyry. The most important ore body is in general next to the argillite but in places some ore is found in the porphyry, in which case both walls are indefinite, unless one wall has been produced by faulting.

The copper ore near the hanging wall has a gangue of barite with very little quartz and occasional seams of calcite. This ore contains the following minerals: pyrite, chalcopyrite, bornite, chalcocite, sphalerite, (pyrrhotite?) galena, malachite, azurite, melaconite (?), native copper, native gold, barite, quartz, calcite, sericite, serpentine (?) and celestite (?). The last mineral seems to be in zones intergrown with barite in certain samples. Mr. Crouch, assayer at the Almeda in 1913, reported a little strontium in some of the ore. A sample from stope 1, adit 2, has barite, calcite, chalcopyrite, and pyrite so intergrown as to be probably simultaneous in origin. A sample from adit 1 shows a veinlet of pyrite later than chalcopyrite and barite; another sample from the same adit shows veinlets and cement of later barite, doubtless "secondary." A sample from level 1 or the river adit shows primary intergrown barite, pyrite, sphalerite, and galena, which completed crystallization in the order named. A sample of gypsum obtained from Mr. Crouch, the assayer, and said to come from the 300 foot level of the Almeda, is in thin section partly granular to subhedral and partly in long prisms; twinning is present but not abundant.

The baritic copper ore is found in lenses or shoots lying near the hanging wall and generally 6 to 15 feet thick. But pyrite has penetrated the porphyry to much greater distances, and in some places it contains enough gold to make a low grade ore. Such ore is quite different from the baritic copper ore, being a siliceous pyritic gold-silver ore found west of the former, and more irregular in occurrence. If the whole mass of pyritized porphyry could be mined at a profit the future of the Almeda would be assured, because the pyrite extends in places at least 150 feet into the porphyry, but most of this material is too low grade to work.

According to Mr. P. H. Holdsworth[1], engineer for the Almeda Company in 1911, average analyses of the two types of Almeda ore are as follows:

AVERAGE ANALYSES OF ORES FROM THE ALMEDA MINE

	Baritic copper ore	Siliceous gold-silver ore
SiO_2	8.8 to 5.1	62.9
Al_2O_3	8.0 to 10.9	5.6
FeO		11.5
CaO	0.8 to trace	2.1
BaO		8.1
$BaSO_4$	47.8 to 28.2	
FeS_2	27.0 to 48.1	
$CuFeS_2$	6.4 to 6.8	
S		8.3

ASSAYS OF ALMEDA ORES

Copper	1.5 to 4.5 per cent	0.3 per cent.
Silver	3.3 to 12.2 ounces per ton	6.4 ounces per ton.
Gold	0.12 to 0.42 ounces per ton	0.14 ounces per ton.

The Almeda Consolidated Mines Company, owning the Almeda mine, built a 100-ton matting furnace at the mine in 1908. The first attempts to smelt the ore were not successful, but later results were more satisfactory. According to Mr. Holdsworth[2]: "The furnace is 36 inches by 72 inches at the tuyeres and we averaged a little over 100 tons a day—that is, 100 tons of ore besides the coke and slag. Ran semipyritic smelting ore from 6 to 7 per cent coke. As the iron and barium occur as sulphide and sulphate respectively, there was about 26 per cent sulphur in the charge. Could average about 30 tons a day more when running semipyritic smelting than when running straight coke smelting. The following are typical slags:

[1] U. S. Geol. Survey Bull. 546, pp. 76–77, 1914.
[2] Loc. cit., p. 80.

COMPOSITION OF SLAGS FROM ALMEDA MATTING FURNACE

	1	2	3	4
SiO_2	30.9	31.8	31.1	38.9
Al_2O_3	10.6	13.5	9.9	4.7
FeO	24.9	24.0	25.3	22.3
CaO	3.1	3.9	4.8	1.3
BaO	30.4	26.9	29.1	32.9

Though the percentage of BaO and alumina is high, they run very well, with seldom a loss of 0.3 per cent copper; usually from 0.15 to 0.2 per cent copper. The ratio of concentration is from 12 to 1 to 20 to 1."

The Almeda mine is equipped with 3 gasoline engines of 175 H. P. and two air compressors having a capacity to run 23 drills, as well as an engine at the shaft to run the hoist.

The mine passed into the hands of Thomas S. Burley, receiver for the Almeda Consolidated Mines Company, on August 23, 1913. The company owns the Rand mine, across the river and south of the Almeda, and a placer mine near the Almeda. At one time it had an option on the Cold Spring claim near the Sugar Pine mine. The receiver opened the Almeda and ran the smelter for 3 weeks, producing 3 carloads of copper matte. He then shut down the furnace to make concentration tests on the ores and to build a concentrating plant.

The total production of the smelter during 1913 is reported to have been 6 carloads of matte, worth about $40,000.

THE GRANTS PASS DISTRICT

LOCATION

As the name is used in this report the Grants Pass district embraces the area in Josephine county, south and east of the mouth of Jump-off Joe creek, which is drained by the Rogue river, exclusive of the Applegate river. It is limited to the northwest by the Greenback and Galice districts, to the east by the county line and the Gold Hill districts, to the south by the Lower Applegate district. It includes districts which have been known by the following names: Jump-off Joe creek, Winona, Merlin, Louse creek, Rogue river, Dry Diggings, Pickett creek, and Grants Pass. The district is about 18

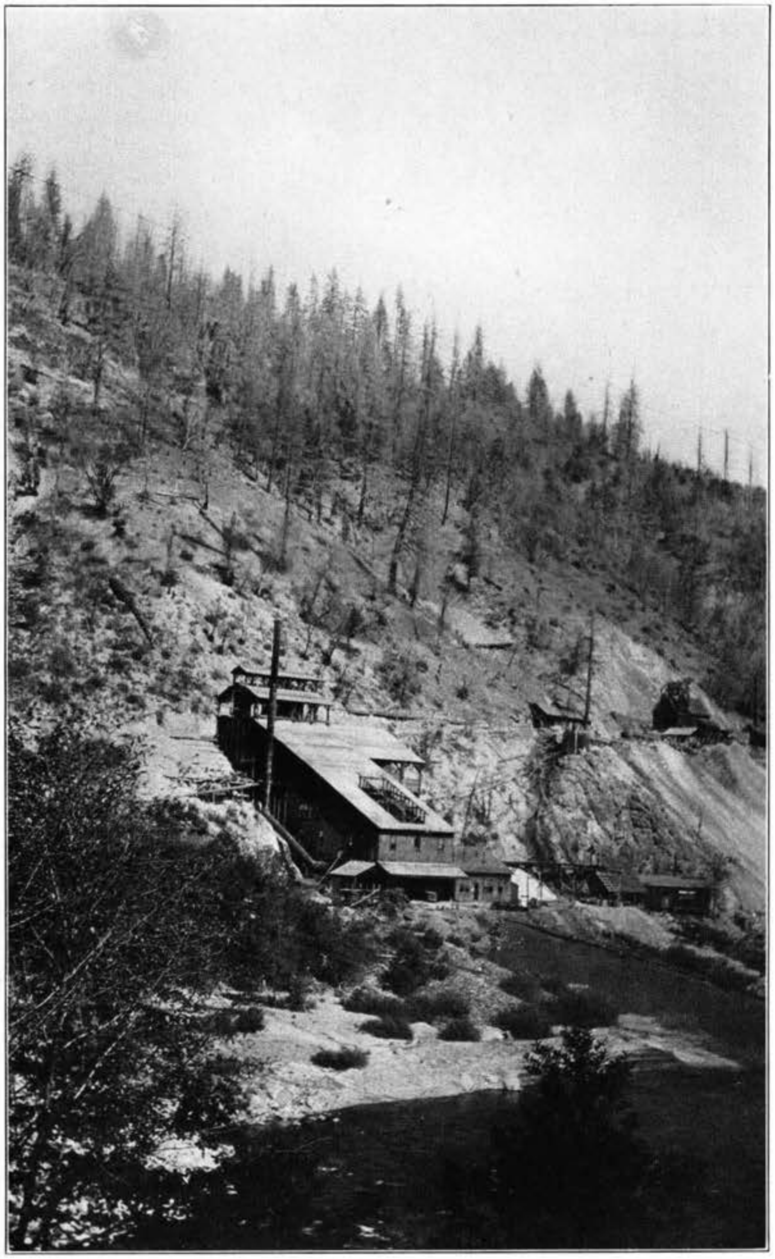


Plate VIII. General view Almeda mine. Galice district, Oregon.

miles long east and west and averages 12 miles broad north and south. The city of Grants Pass gives its name to the district, being not only its commercial headquarters and railroad shipping point, but also the county seat and chief mining center of southern Oregon. The district is mountainous, ranging in elevation from about 800 feet above sea level at the mouth of Jump-off Joe creek to peaks reaching altitudes above 3000 and even 4000 feet. The highest point in the district is the top of Elk mountain about 1½ miles southeast of the Oro Fino mine and 7 miles northeast of Grants Pass. But the area between the county seat and the mouth of Applegate river on the south and the station named Hugo on the north, which forms a triangle cutting the Grants Pass district in two parts as a wedge, driven northward, would do, is distinctly gentler in relief, presenting the aspect of a hilly region with wide and gently sloping valleys.

HISTORY

Mining began in southern Oregon in 1852, but during the first years the industry was apparently wholly outside of the Grants Pass district. Mining began on Josephine creek, west of Kerby, and spread to the Waldo and Lower Applegate districts, and even to the Galice district before there is any record of work closer to Grants Pass. Finally the placer miners spread to Pickett and Jump-off Joe creeks. But the mining industry did not become important in the Grants Pass district until the placer gravels were largely exhausted and attention was directed to the quartz-vein deposits. An 8-stamp mill was built at the Jewett mine[1] in 1863; failure to make a success here seems to have delayed mining development in the region at least a decade. The Lucky Queen mine north of Walker mountain was equipped with a 10-stamp mill in 1886; the Fidelity mine made a small output in 1889; the Hammersley or Daisy mine on Bummer gulch was discovered in 1890, and the Baby mine on Walker mountain seven years later. The W. H. Flanagan mine on Pickett creek produced $18,500 in gold in 1891. In 1898 the Jewett mine was an important producer using its own mill, while the Baby mine sent its ores to a smelter. The Granite Hill mine was purchased by the American Goldfields Company in 1901, and three years later the

[1] R. W. Raymond: Statistics of Mines and Mining west of the Rocky Mountains for 1869. Washington, 1870. The statement of Kay (U. S. G. S. Bull. 380, p. 61) repeated by Diller (U. S. G. S. Bull. 546, p. 44; 1914) that the Jewett mine "was discovered about 1880 by Thomas Jewett" is evidently inaccurate; the discovery was probably about 1860.

Hammersley and Granite Hill were important producers. In 1902 extensive plans were made to construct a big dam across Rogue river about 3 miles above Grants Pass in order to develop on a large scale the Golden Drift or Dry Diggings placer mine. In 1906 the latter was developed to a depth of 400 feet and equipped with a 20-stamp mill. In 1908 the Mountain Treasure put in a 2800-foot pipe line to develop power for mining and milling purposes. In 1909 the Swastika hydraulic placer mine near Winona produced about $10,000 in gold. In 1911 three placer mines were productive in the Jump-off Joe district, namely, the Swastika, the Sexton, and the Cook and Howland. Most of the output of the Grants Pass district during 1912 came from placer and deep mines along Jump-off Joe creek.

GEOLOGY

The oldest rocks of the Grants Pass district are in the eastern part where the Paleozoic sediments of the Gold Hill district extend across the county line westward into Josephine county. In this region they consist of argillites and some argillaceous sandstones. The Galice formation (of the Jurassic period) is the name given by Diller[1] to the argillites and thin-bedded sandstones occupying the eastern part of range 7 west, north and south of the mouth of Jump-off Joe creek. A rudely triangular area forming about the middle third of the Grants Pass district from the county seat and the mouth of Applegate river on the south to the station named Hugo on the north is occupied by a large outcrop of tonalite. An outlier of this tonalite is one of the country rocks of the Granite Hill mine; here it grades over toward granodiorite. On Walker mountain at the Gopher and Baby mines a gabbro is found which may be another phase of the tonalite. An analysis of one phase of the tonalite from the bridge over the Applegate river near Wilderville is given in the description of the Lower Appegate district on page 232. The rock at this place is in large masses distinctly schistose; in thin section it is clear that the tonalite has been sheared, even the feldspar showing curvature in its cleavages and twinning. It contains abundant plagioclase and quartz, some green amphibole and brown biotite, with a little magnetite and titanite. Alteration products are not important; they include some sericite, epidote, and kaolin. The gabbro on Walker mountain contains abundant labradorite and augite with some chlorite, clinozoisite, sericite, and serpentine.

[1] Loc. cit., p. 17, and Plate VI, 1914.

Less than half a mile down Bummer gulch from the Daisy or Hammersley mine the country rock is a micaceous arkose consisting of fine granular, poorly rounded quartz with some grains of plagioclase and orthoclase cemented by reddish brown biotite, or, elsewhere, by nearly colorless mica, probably muscovite. These quartzose sediments are associated here with volcanic rhyolitic breccias, containing fragments of quartzite, rhyolite, plagioclase, quartz, sericite, magnetite and volcanic dust.

At the Eagle mine on Walker mountain the country rock is argillitic, containing very fine grained quartz, pale brown mica, magnetite, and an opaque groundmass suggesting carbonaceous material.

The sedimentary rocks of the eastern part of the Grants Pass district are intimately associated with andesites at many places. These andesitic rocks seem to be interbedded with the argillites and sandstones, and probably occur both as sills and as flows. Both the argillites and the andesites are so much altered that it is difficult to distinguish them in the field. At the Mt. Pitt mine there is also some serpentine. In a few places the sediments are also associated with some rhyolite, often rhyolite breccia, whose intrusive or extrusive character has not been fully determined, though the available evidence favors the latter mode of formation.

The sedimentary rocks are not known to contain any limestone in the Grants Pass district.

The only rocks in the district younger than the Galice and Dothan formations of the Jurassic are the gravels of the various streams. These are of recent origin and belong to the present cycle of erosion. They are of some importance as sources of placer gold along Jump-off Joe and Louse creeks; the more extensive gravels of Rogue river near Grants Pass have also yielded gold, but not in proportion to their extent.

MINERAL RESOURCES

The mineral resources of the Grants Pass district include building stone, road material, clay, copper, silver and gold. The deposits of the yellow metal are decidedly the most important; they occur both in veins and in gravels. They are readily accessible from the county seat and commercial headquarters at Grants Pass and from other stations on the railroad which traverses the district from southeast to northwest.

Building Stone

Tonalite, commercially known as "granite", is very abundant in the Grants Pass district occupying an area estimated at 50 square miles or more. But in general the rock is more or less extensively disintegrated at the outcrop and wholly unsuitable for building stone. Accordingly, it has never been used, although the solid rock can be obtained in some places with little difficulty. The chemical composition of this rock is given elsewhere in this report; in mineral composition it consists of abundant plagioclase feldspar, some quartz, some biotite or hornblende, and in some samples a little orthoclase. It is probable that "granite" will some day be quarried near Grants Pass, at least for local uses.

Road Material

The very properties that prevent the use of the "granite" as it occurs near the surface in the Grants Pass district as a building stone facilitate its use as road material. That is, the surface material which is easily broken down to angular fragments is unfit for use as a building stone, but is in excellent condition for use on roads. It is extensively employed as railroad ballast along the Southern Pacific railroad, and is also used to some extent in surfacing wagon roads. The amount available is so great and the quality so good that its use will probably considerably increase in the future.

Clay

Extensive deposits of alluvial clay are available along Rogue river east and west of Grants Pass. Unfortunately they were not investigated by the writer, but it is very probable that unused clay suitable for making brick and tile can be found in the district. According to O. F. Stafford[1], James Carter and Colvin Bros. were interested in the clay industry at Grants Pass in 1903.

Copper

There are no mines in the Grants Pass district which are chiefly important for their copper ores. But in the Oak mine in the S. W. ¼, Sec. 4, T. 5 S., R. 5 W. on Jump-off Joe creek northwest of Walker mountain, one or two veins contain good copper ore.

The Oak mine, owned by G. A. Baker and George Buell, is equipped with a 20-horsepower gasoline engine and an 8 by 8 air

[1] Univ. Oregon Bulletin, Vol. 1, No. 4, 1904.

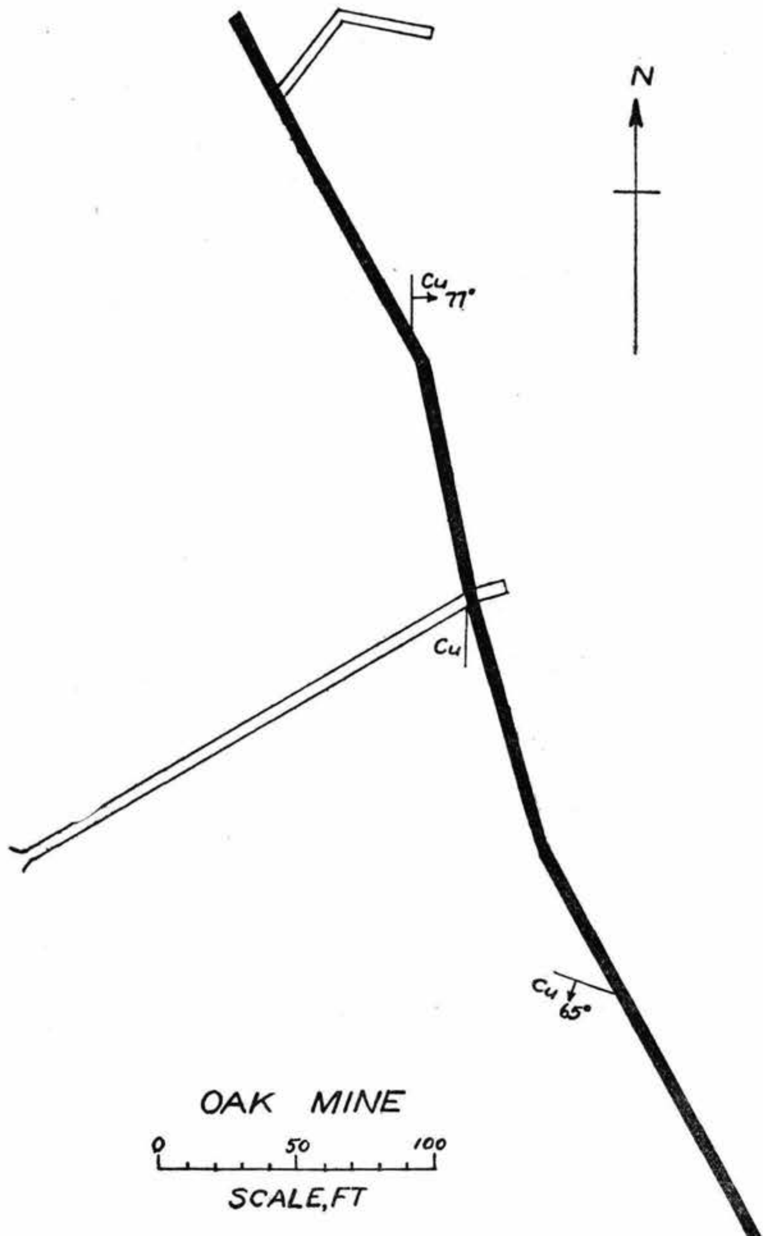


Figure 25. Main adit of the Oak mine, Grants Pass district, Oregon. Vein in solid black

compressor. The main adit enters as a crosscut in greenstone (probably an altered andesite); N. 60° E. about 200 feet from the portal a winze follows the vein down about 50 feet. At the winze solid chalcopyrite ore is visible in the footwall on the main gold-bearing vein which here strikes N. 13° W. and is nearly vertical. At three other points along the drift following the gold-bearing vein small veins of copper ore are visible in the walls. The workings, which have a total length of about 800 feet, are shown in the accompanying sketch (figure 25). The minerals present in ore of the Oak mine include chalcopyrite, pyrite, pyrrhotite, sphalerite, galena, quartz, and rare malachite and pyrolusite.

Gold and Silver

The precious metal deposits of the Grants Pass district occur in placer gravels and also in quartz veins. For many years the latter have been the more important in this region.

Placer Deposits

The placer gravels of Rogue river have been exploited as a source of gold for many years, but work has ceased almost entirely in the Grants Pass district. About 10 years ago the "Dry Diggings" a short distance above the county seat were the scene of considerable activity and a big dam across the river was constructed to aid in the work; after a few years of considerable output work ceased and very little has been done since that time. There are several other placer mines at various points along the river, but none of them has been a large producer. One difficulty in the way of developing important placer mines in this area has been the fact that in many deposits the rich gravel just above bedrock was buried too deeply by later sands and bowlders.

About 10 miles west and 3 miles north of Grants Pass the Flanagan and Emerson placer mine is located on a gravel terrace on the west side of Rogue river about 30 feet above the water. According to Diller,[1] "the mine face exposes 50 feet of fine gravel containing a small amount of sand near the middle and top. On the river side of the mine a portion of the gravel appears to have been washed away and replaced by a later deposit. The slate bedrock is much twisted and faulted. The strike is N. 20° E. and the dip is 45° S. E."

Near this mine to the south in sections 2 and 11, T. 36 S., R. 7 W., there are extensive deposits of alluvial gravels which have been tested

[1] U. S. Geol. Survey Bulletin 546, p. 112, 1914.

by Clarence H. Mace[1]. He reported 25 cents to $1.60 per cubic yard with a channel 600 to 700 feet wide and the richest streaks on the concave side of the river. Conditions here seem to be favorable for the introduction of dredging. The gold is coarse with rough edges, which indicates that it has not traveled far. For the most part the bowlders are small, averaging under 6 inches in diameter, and there is no clay except in part of the overburden. There are places along the present channel where the gravel is only 4 feet thick, and others where it is evidently at least 30 feet, but where the ancient channel is exposed by hydraulic operations it varies from 75 to 150 feet in thickness. Bedrock consists of upturned slate beds.

Pickett creek flows from the west into Rogue river in T. 35 S., R. 7 W., about 10 miles west-northwest of Grants Pass. The Big Four placer mine is about half a mile from the mouth of this creek on a gravel bench overlooking Pickett creek and about 300 feet above Rogue river. According to Diller[2], the mine is owned by M. J. Merrill, of Portland, Oregon, and embraces about 200 acres, chiefly on a bedrock of slate. "The gravel ranges from 30 to 70 feet in thickness, and is in part clearly stratified. The 14 feet of red earthy sand and clay overburden is said to contain fine gold that can be saved, but the larger pieces are in the bottom gravel. The lower twelve feet of gravel contains well-rounded cobblestones, the largest being 6 inches in diameter. At the bottom a few bowlders, generally slate, rest on bedrock, and from 2 to 4 feet of the bottom gravel is partly cemented. The rim rock rises abruptly and slates are much crushed and faulted, forming a terrace on the northwest toward Pickett creek. The old channel is 250 feet in width and 30 feet deep below the slate-rim terrace, from which the gravel capping has been in part mined away. The water is supplied from Pickett creek at a head of 200 feet, two giants being run for a large portion of the year. The mine has been operated, during the season when water is obtainable, for many years."

The placer mines on Jump-off-Joe creek are chiefly confined to the eastern upper portion of the valley near the source of the gold. At one time the Cook and Howland mine was the most important on this stream; later the Swastika attained prominence.

The Cook and Howland mine is very near the line between Jackson and Josephine counties about 4 miles southeast of the Hammersley mine. It was an active producer about 10 years ago, when half a mile of slate rock was uncovered for a width of 100 to 200 feet.

The Swastika placer mine is exploiting a low gravel bank in the

[1] Min. Sci. Press, p. 437, Mar. 23, 1912.
[2] U. S. Geol. Survey Bulletin 546, p. 111, 1914.

forks where Jack creek flows into Jump-off Joe. It was operated for several years before 1910; since then very little has been done, aside from work on a small scale by lessees. During the operation of the mine by the company two 18-inch pipes were used, one under a head of 150 feet and the other of about 75 feet. According to Diller[1]: "the gravel is 15 to 30 feet deep and is composed of greenstone pebbles. It is coarsest below, the largest bowlders being 2 feet in diameter. In many places the whole mass is rotten, so that many of the bowlders go to pieces under the stream from the giant. The bedrock in the Swastika mine and throughout the slopes of Jack creek is greenstone."

Auriferous Vein Deposits

The Jewett mine is near the north line of section 34, T. 36 S., R. 5 W. about 4 miles by wagon road from Grants Pass. It was discovered about 1860 by Thomas Jewett, and was recently sold to Carl Schmidt of Grants Pass. In 1863 it was provided with an 8-stamp mill, which proved a failure and was converted into a sawmill. At present it is equipped with a 5-stamp mill, but is not in operation. The accompanying sketch (figure 26) gives a section

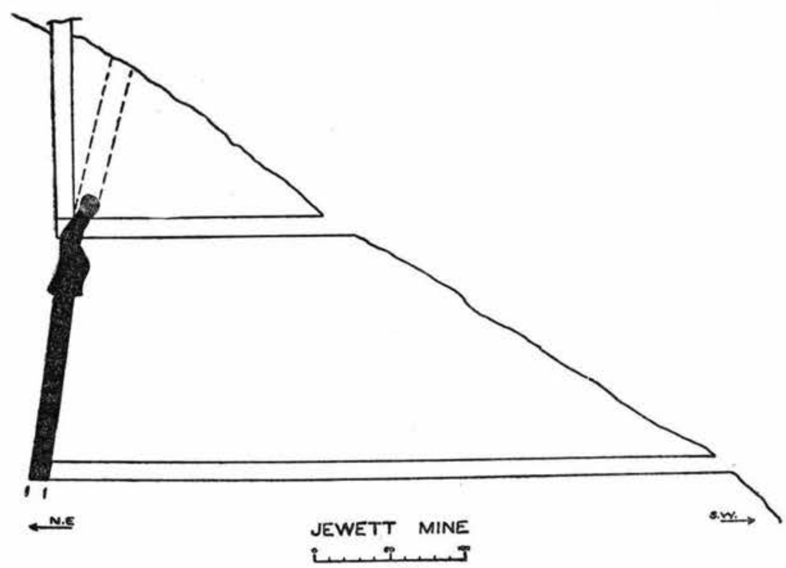


Figure 26. Section through the Jewett mine near Grants Pass, Oregon. Ore body in solid black.

[1] U. S. Geol. Survey Bulletin 546, p. 105, 1914.

through the mine and affords an idea of the ore body and the workings.

The country rock is often called greenstone, but much of it is fine-grained tonalite, containing abundant plagioclase, quartz and pale green hornblende. Coarse grained tonalite forms a large outcrop on the north side of Baldy mountain, on the south side of which the Jewett mine is situated, and a dike of the same rock is visible at the portal to the main adit. The ore body in general has no definite walls but occupies a sheared and brecciated zone which is irregular in thickness and direction. The general direction of the ore body is N. 20° to 55° W. with an average dip of about 75° N. E. The ore has been produced partly by replacement and partly by deposition as a cement of the breccia. The gangue minerals are chiefly quartz and calcite (with the former dominant), with some chlorite and pale brown mica. The ore minerals include native gold, pyrite, sylvanite and pyrrhotite. Considerable ore was mined and milled. In portions of the mine the ore body is more than 8 feet wide. For some years past the mine has not been in operation.

The May Queen mine is on the east slope of Baldy mountain in sections 26 and 27, T. 36 S., R. 5 W. on the west side of Green creek, at an elevation of about 1500 feet as measured by barometer. It is owned by N. C. Boynton. The country rock is a hard dense greenstone in which the vein strikes N. 55° W. and dips 30° N. E. A drift on the vein extends 280 feet to the northwest; about 100 feet from the breast a raise on the vein extends 125 feet to the surface. Some ore was stoped out near the raise. There are no very distinct walls or fault gouge; the vein quartz varies from a mere stringer to a foot in width. At the southern end the vein seems to fork into two smaller veins. The mine is equipped with a small 2-stamp mill run by a gasoline engine.

The Ten Spot claim is near the north side of section 27, T. 36 S., R. 5 W. on Baldy mountain. It is owned by G. E. Everson and R. E. McDaniels of Creswell, Oregon. The country rock is decomposed or "rotten" tonalite, locally called granite. The vein is not now exposed, but is said to be a small quartz vein which has been prospected by surface pits and a shaft 30 feet deep all in "rotten granite." The vein seems to strike N. 58° E. A crosscut adit is being driven by contract; it extends 140 feet S., 40° E. in "rotten granite" so soft as to be dug with pick and shovel and to require careful lagging to hold the ground. The vein has not yet been reached by the crosscut.

The Granite Hill mine is in the S. W. ¼ Sec. 29, T. 35 S., R. 5 W. about 9 miles northeast of Grants Pass by wagon road. The mine was bought in 1901 by the American Goldfields Company, and developed extensively between 1902 and 1907 with a resultant production of about $75,000. It was closed early in 1908, and is now owned by the Oregon Gold Mines Company. (Plate IX.)

The mine is equipped with a 20-stamp mill, shown in plate IX, having four 10-foot amalgamating plates, 6 Frue vanners installed and 2 more vanners available, a crusher, a 150 H. P. electric motor, and other accessories. The mine has also an air compressor, a steam hoist, and 5 machine drills.

The mine is opened by a vertical shaft said to be 430 feet deep, now filled with water. It is reported to be developed by about 5000 feet of workings on the 2nd level and about 7000 feet on the other levels. The vein is said to attain a width of 12 feet on the 3rd level and 14 feet on the 4th level; it has an average width of about 5 feet, and strikes about east and west and dips about 70° S. The vein filling consists of quartz, chalcopyrite, galena, and pyrite, carrying gold. The sulphides make up less than one percent of the ore and as concentrates they carry from $75 to $100 a ton, and are shipped to the smelter at Selby. The average value of all the ores treated in 1907 was about $5 a ton.

The country rock is a tonalite grading toward granodiorite containing abundant plagioclase and quartz with some orthoclase, and pale green hornblende altering to chlorite. According to Kay[1] this outcrop is part of a narrow tongue which extends southward into the Grants Pass quadrangle from a larger area of tonalite in the Riddles quadrangle. To the east of the tongue is greenstone, to the west is serpentine. At the Granite Hill mine the ores are found in a vein in tonalite; at the neighboring Red Jacket and Ida mines, owned by the same company, they occur in greenstone.

According to C. M. Morphy[2], former superintendent of the mine, the richest ores were found in three shoots each having a length along the vein of about 150 feet and a pitch to the west of south. The zone of oxidation extends to a depth of more than 200 feet from the surface, and the oxidized ores were more valuable than the sulphide ores.

The Red Jacket claim has quartzose ore carrying chalcopyrite,

[1] U. S. Geol. Survey Bulletin 380, p. 59, 1909.
[2] Loc. cit.

galena and pyrite; alteration produces malachite and chrysocollea. The vein is said to be about 18 inches wide and of high grade in gold. It is reported to strike about northeast and dip about 45° N. W.

The main adit on the Ida claim is at an elevation of 2300 feet as measured by barometer; a quartz vein here strikes N. 65° W. and dips 70° S. W.; the vein is 3 to 30 inches thick and nearly pure quartz; it is cut off at 46 paces from the portal by a fault which strikes N. 25° W. and dips 45° S. W.

The Cramer prospect is on Walker mountain in section 18, T. 35 S., R. 5 W., at an elevation of about 2350 feet above sea level. It is opened by an adit in greenstone which extends N. 55° E. 60 paces to a shaft to the surface. There are other minor workings. The main fissure vein strikes N. 55° E. and dips 40° N. W. There is only a little vein material disclosed, and there has been no work done for several years.

The Baby mine is in the N. W. ¼ Sec. 16, T. 35 S., R. 5 W., on the east side of Walker mountain. It is owned by the Capital City Gold Mining Company, of California. It was located in 1897, and is said to have yielded more than $20,000 worth of gold. In 1904 it was productive; in 1907 it was under lease to R. S. Moore, of Grants Pass.

The mine is equipped with a 2-stamp mill (formerly 5 stamps), with an 8-foot plate, a crusher, 2 concentrating tables, and 2 boilers. It is opened by 2 adits with about 1500 feet of underground work. The main adit is a crosscut for more than 300 feet leading to about 500 feet of drifts. There are several quartz veins in gabbro country rock. The most important vein averages about 4 feet in width, but varies to fissure zones more than 10 feet wide. The vein strikes northwest and dips to the northeast usually at high angles, but locally at much lower angles. Faults are abundant; certain prominent faults strike N. 80° E. with a dip of about 50° W. or strike N. 45° E. and dip 50° S. E. The vein material consists of coarse vein quartz, partly brecciated, with a little calcite and some pyrite. Free gold occurs in the quartz. Sulphide concentrates are said to contain $75 a ton in gold. The gabbro country rock contains abundant labradorite and augite with some chlorite, clinozoisite, sericite, and serpentine, and very little chalcopyrite. The mine has been idle for several years.

The Gopher mine is on the northeast side of Walker mountain, in the S. E. ¼, Sec. 8, T. 35. S., R. 5 W. at an elevation of 2300 feet, as measured by barometer. It is owned by the Gopher Gold Mining Company. The main level has about 600 feet of crosscuts and drifts besides raises, winzes and stopes. The vein material is similar to that of the Baby mine and the country rock is also similar. Several veins run in various directions in gabbro. In some places stopes are 7 feet wide. A crushed fault zone strikes N. 20° E. near the breast. The mine has been idle for several years.

The Dick mine is in the N. E. ¼, Sec. 8, T. 35 S., R. 5 W. on the northeast side of Walker mountain at an elevation of about 2400 feet, as measured by barometer. It belongs to Fetch and Long. An adit has been driven about 200 feet in a westerly direction in quartzite. Gold ore taken out has been run down the hill in a flume to an arrastre.

The Eagle mine is on the east side of Walker mountain in the S. W. ¼, Sec. 6, T. 35 S., R. 5 W. at an elevation of 2550 feet, as measured by barometer. The country rocks here include argillite and a sheared pryoxenite or augite diorite rich in dark minerals, as well as some talc schist and black material, probably carbonaceous. The ore is quartzose vein material with very little sulphide. A vein strikes southwest and dips about 40° S. E. The mine has been opened by shafts and adits which are now caved and inaccessible. From the size of dumps it is probable that several hundred feet of underground work was done, but the mine has been idle for several years.

The Lucky Queen mine is near the north line of section 31, T. 34 S., R. 5 W. between Jack creek and Shorthorn gulch. It is owned by Rush Bros. A 10-stamp mill was built here in 1886, but it has since been removed. The ore is in quartz veins in argillaceous quartzite. At the face of a crosscut on the lower level the sediments strike N. 40° E. and dip 50° S. E. The auriferous veins strike and dip in about the same directions. On the lower level the main vein is cut off to the northeastward by a fault which strikes N. 70° W. and dips 65° N. E. The vein varies in thickness from about 6 to 30 inches, and the ore is said to average $10 a ton in gold. The mine has been idle for many years, but two of the adits are still in good condition.

About 1908 the Mountain Treasure Mining Company put in a 2800-foot pipe line to develop power to open their mine which is in section 34 or 35, T. 34 S., R. 5 W., north of Jump-off Joe creek. Apparently only an overshot wheel was installed, and an arrastre built. The underground development accomplished by the company

Plate IX. 20-stamp mill and hoist at the Granite Hill mine near Grants Pass, Oregon.

was not seen by the writer. No work has been done for some years.

The Oro Fino mine is in the southeast corner of section 3, T. 35 S., R. 5 W., south of Jump-off Joe creek, at an elevation of about 2800 feet, as measured by barometer. It has recently been renamed the Gold Drift mine; it is equipped with a 5-stamp mill having a 10-foot amalgamating plate, a concentrating table, and suitable boiler and engine. It is only about half a mile southwest of a ridge of "granite" which is probably part of the tongue of tonalite extending southward to the Granite Hill mine.

The main adit of the Oro Fino leads to about 1300 feet of cross-cuts and drifts, nearly 1000 feet being on one or more veins which are persistent and fairly regular in their course. The country rock is a greenstone, which seems to be an altered andesite, containing abundant small crystals of hornblende, some plagioclase phenocrysts, some epidote, little pyrite, quartz and chlorite. The workings on the main level are shown in figure 27. The vein filling consists of

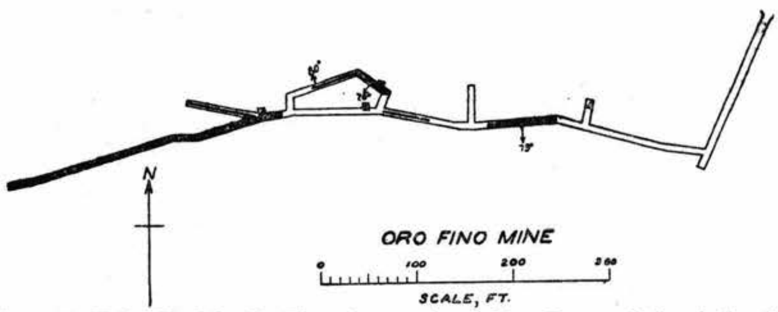


Figure 27. Main adit of the Oro Fino mine near Grants Pass, Oregon. Main vein in solid black.

quartz which has been broken in many places with later introduction of calcite and pyrite. The iron sulphide is also found commonly scattered through the country rock, especially in fragments of the latter, which are in or near the veins. Work was in progress at the Oro Fino in 1913, but for the most part it was in shallow workings some distance from the main adit.

The Mount Pitt mine, now known as the County Line mine, is owned by G. E. Howland, of Grants Pass. It is located almost on the line between Jackson and Josephine counties in section 31, T. 34 S., R. 4 W. (and in section 36 adjoining) at an elevation of about 3050 feet, as measured by barometer. It is equipped with a 5-stamp mill with 2 boilers, a 40 H. P. engine, a crusher, a Frue vanner, an

11-foot Pinder concentrator, a 10-foot amalgamating plate, an air compressor, and a cyanide plant. It is opened by about 800 feet of underground work of which more than 500 feet is in the main adit which enters as a crosscut S. 75° E. for 190 feet, and continues as a drift S. about 10° E. some 300 feet. It terminates in a fault or slip containing no ore. The ore consists of pyrite in quartz and calcite forming a vein in plicated argillite associated with serpentine.

The Daisy mine was known at one time as the Hammersley mine, and is still frequently so called. It is just east of the divide between Jack creek and Bummer gulch at the head of the latter, at an elevation of 3800 feet, as measured by barometer. It is owned by G. R. Smith, of Grants Pass. It was discovered in 1890 and has produced more than $200,000 in gold, according to the owner. It is equipped with a 5-stamp mill having a 14-foot amalgamating plate and one concentrating table as well as steam boiler and engine. The workings are shown in the illustration (figure 28), which is a section in the plane of the vein based on a similar drawing made by A. H. Gunnell,

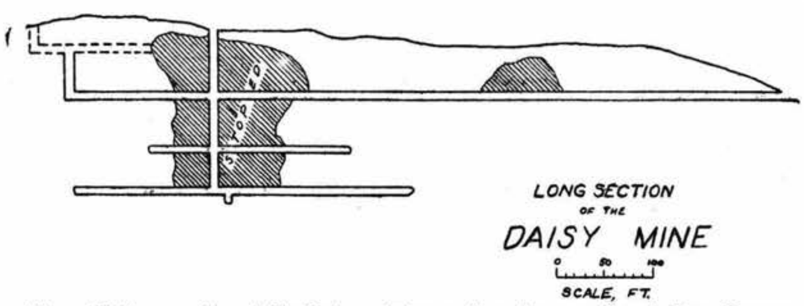


Figure 28. Long section of the Daisy or Hammersley mine near Grants Pass, Oregon.

of Grants Pass, in 1908. A long crosscut adit is now being driven to reach the ore body at considerably greater depth. The vein strikes nearly east and west in andesitic country rock. The main shaft follows the vein on a steep incline. The ore consists of vein quartz with some calcite and brecciated fragments of argillite, serpentine, and quartz cemented by epidote, quartz, calcite and kaolin.

There are several other veins in the vicinity, some of which are now being developed in a small way.

LOWER APPLEGATE DISTRICT

LOCATION

In this report the Lower Applegate district includes all the territory in Josephine county which is drained by the Applegate river and its northward and southward flowing tributaries. It is limited on the north by the Grants Pass district of the Rogue river valley, on the east by the county line and the Upper Applegate district, on the south by the Waldo district, and on the west by the Illinois river valley. It includes areas which have been called districts of the following names: Applegate, Davidson or Missouri Flat, Murphy, Oscar creek, Powell creek, Slate creek, Williamsburg or Williams creek. The district is of irregular shape, but has a maximum length of about 20 miles east and west, and only slightly less north and south. In the region of Cheney creek and westward it is only 6 miles across, north and south. The district is very mountainous, but contains the northward sloping valley of Williams creek and the northwestward flowing Applegate river. The highest point in the district north of the river is at the top of Grants Pass peak which is 3835 feet above sea level, but Mungers butte, south of the river, rises to more than 5200 feet, and several other peaks exceed 4500 feet in altitude. Williams creek valley varies from 1150 to 1650 feet in altitude while the Applegate valley is between 900 and 1200 feet above sea level.

HISTORY

Mining began in the Lower Applegate district very soon after the discovery of gold on Josephine creek in 1852. The first mining in the district was probably in the gravels of Williams creek. But veins were discovered in Slate creek valley about 1860, and their exploration continued during that decade. However, the chief mining in the district continued to be confined to the placers all through the seventies. The Horsehead placer mine was the next important one on Williams creek in 1882; the following year it produced $3000 in gold. The Watts placer near Murphy was also productive at about this time, while the Josephine mine on Slate creek was sold for $3740 in 1882. The Mountain Lion mine near Davidson was discovered in 1889, and its development, with some output, continued during the next decade. Powell creek placers and the Rising Star quartz mine were productive in 1900. The next year the Savage and Mellen placer on Missouri Flat near Davidson was active and the Sunshine and Combination mines in the same region were developed soon afterward. In 1910 the Mountain Lion mine had 2000 feet of underground work and was equipped with a 5-stamp mill having electrolytic chlorination and amalgamation. Placer mining has continued on Williams creek, Oscar creek, and elsewhere up to the present, but there is now very little activity in the deep mines of the district.

GEOLOGY

The rocks of the Lower Applegate district include argillites, sandstones, quartzites, limestones, marbles, greenstones, serpentine, and tonalite, as well as alluvial deposits. The oldest rocks are Paleozoic sediments including argillites, sandstones, limestones, and some interbedded greenstones. The next younger series consists of argillites and sandstones of Jurassic age. The great tonalite intrusion probably came at the close of the Jurassic period; the only later rocks are the recent alluvial deposits.

Structurally, the Paleozoic and Jurassic sedimentary rocks have been tilted till they dip at high angles, and the Jurassic beds have even been overturned according to Diller[1], so that while they dip eastward the overlying beds to the east are actually the oldest of the series. It seems probable to the writer that the Paleozoic rocks are also overturned so that the rocks at the eastern border of the district are the oldest rocks in the area. They consist of argillites, sandstones, and interbedded andesitic greenstones, which may be provisionally assigned to the Silurian period. The next younger rocks are found at present underlying these to the westward; they include argillites, sandstones and lenses of limestone. These lenses contain some fossils by means of which the enclosing rocks on Powell and Oscar creeks have been referred to the Devonian by Diller[2]. A similar series of rocks on Cheney creek, still farther west, has been referred provisionally to the same period (Devonian) by Diller, but it seems possible that it represents the Carboniferous, as fossils from this locality collected by the writer in 1913 are reported by the paleontologists of the U. S. Geological Survey to be "poorly preserved crinoid stems which indicate Paleozoic and probably Carboniferous age." In this region shales and argillites are abundant, and there are some greenstones.

[1] U. S. Geological Survey Bulletin 546, pp. 18 and 22, 1914.

[2] Loc. cit., pp. 15 and 16.

The youngest consolidated sedimentary rocks are the argillites and sandstones of the Galice formation of the Jurassic period, which are found on Slate creek in the extreme western part of the Lower Applegate district. They are intimately associated with greenstones, which upon careful study are found to be andesite and diorite; some serpentine, derived from peridotite, is found in the same area.

If any rocks of the Cretaceous or Tertiary periods were deposited in this region they have been removed by later erosion so completely that no trace of them is now known. The latest rocks of the district are the unconsolidated gravels deposited by existing streams along their courses. These have been the scene of placer mining since the first days of gold mining in the state.

MINERAL RESOURCES

The mineral resources of the Lower Applegate district include building stone, marble, limestone and shale, chromium, iron, copper, silver and gold. They are readily accessible by means of good wagon roads from Grants Pass. The proposed railroad from Grants Pass to Crescent City, California, will follow Slate creek valley nearly to the west side of T. 37 S., R. 7 W., thus making Cheney and Slate creek deposits still more accessible.

Building Stone

Aside from the marble and limestone, which may be used for buildings, there are large deposits of "granite" in the Lower Applegate district. These occur not only northwest of Murphy, but also near the source of Powell creek, and both northeast and southwest of Williams. They have not yet been used in any way because they are either considerably decomposed, as near Murphy, or they are at least 15 miles from a railroad, as near Provolt. If this handicap should be removed, it is possible that the mass southwest of Provolt may be utilized to a considerable extent. At the bridge over Applegate river near Wilderville the "granite" has been sheared and somewhat altered; a sample from this locality was analyzed by S. W. French, of the Oregon Bureau of Mines and Geology, with the following results. (p. 232.)

In thin section this rock contains abundant plagioclase and quartz, some green amphibole and brown biotite, a little magnetite and titanite, and some secondary minerals, especially sericite, epidote, and a little kaolinite. The rock has plainly been sheared,

COMPOSITION OF SHEARED "GRANITE" NEAR WILDERVILLE

[S. W. French, analyst.]

		Approximate mineral composition			
		Norm		"Mode"	
SiO_2	60.04	Quartz	11.7	Quartz	18.0
TiO_2	.78	Orthoclose	6.2	Plagioclase (Ab_3An_2)	45.6
Al_2O_3	17.14	Albite	33.6	Hornblende	22.9
Fe_2O_3	2.00	Anorthite	25.8	Biotite	11.9
FeO	3.68	Diopside	4.2	Titanite	.5
MgO	4.78	Hypersthene	13.8	Magnetite	.3
CaO	6.25	Magnetite	2.9	Alumina, etc	1.4
Na_2O	3.96	Ilmenite	1.5		100.6
K_2O	1.04	Water, etc	.9		
H_2O+	.88		100.6		
H_2O-	.06				
	100.61				

even the feldspar showing curved cleavages and twinning. The estimate of the "mode" is based on assigning the potassa to biotite and the ferrous iron to hornblende; it is only a rough approximation. Petrographically the rock is a tonalite.

Marble

For several years a deposit of marble about 4 miles west of Williams has been exploited by a man named Jones, so that the deposit has come to be known as the Jones marble quarry. It is in section 31, T. 38 S., R. 5 W., at an elevation of about 2650 feet, as measured by barometer. The limestone here strikes N. 45° E. and dips about 65° S. E. The rock is a variegated marble in this opening, being white and blue; in some places it is stained by limonite derived from the alteration of pyrite. The marble forms a lens which is about 2000 feet long and about 300 feet wide as a maximum. At the northeast end it is cut off abruptly; at the southwest end it tapers to a point. It forms a cliff on the side away from the dip, that is, on the northwest side. It contains argillaceous streaks and "knots" in some places. It is said to be on railroad land.

This deposit has been used under very unfavorable conditions. It is about an eighth of a mile from the nearest wagon road, and it is about 6 miles from the place where the stone cutting and polishing has been done. Naturally the results have not been satisfactory, although the stone is of good quality.

An analysis of this marble made by R. C. Wells[1] of the U. S. Geological Survey resulted as follows:

COMPOSITION OF MARBLE NEAR WILLIAMS

SiO_2	.13
Al_2O_3 } Fe_2O_3 }	.38
MgO	none
CaO	55.55
H_2O	.26
CO_2	43.63
	99.95

The analysis shows that the marble is over 99 per cent pure calcite.

Limestone and Shale

The most important deposits of limestone in the district are on Cheney creek although other deposits are known on Oscar creek and Williams creek. On the land of the Rogue River Lime Company in the S. W. ¼ Sec. 19, T. 37 S., R. 6 W. limestone forms a cliff the base of which is at an elevation of 2660 feet, as measured by barometer; near the southern end of the limestone outcrop about 2000 feet from the cliff the elevation is 3060 feet. The outcrop of the limestone has a rudely lenticular outline with a blunt end at the southwest, being 120 feet wide within 100 feet of the end and 400 feet wide about 500 feet northeast of the end. About 1200 feet from the end the limestone is about 600 feet wide. At the northeast end the limestone terminates in a sharper point, being about 50 feet wide within a short distance of the end. At about 150 feet from this end, along the trail, 30 feet of sandy shale lie between 50 and 150 feet of limestone. Measured across the strike the last distance would probably be about 100 feet.

The limestone deposit as a whole consists of two lenses, or a compound lens, separated by about 30 feet of sandy shale. It strikes to the northeast and dips to the southeast. One exposure of this deposit is shown in plate X. Analyses of the limestone follow.

The analyses show that the deposit is a remarkably pure limestone, well suited for use with suitable shale in the manufacture of Portland cement.

[1] U. S. Geol. Survey Bulletin 419, p. 209, 1910.

COMPOSITION OF LIMESTONE ON CHENEY CREEK

	A	B	C	D
SiO_2	.23	.2	.4	2.1
$Al_2O_3 + Fe_2O_3$	.28			1.2
MgO	.03	.1	.4	trace
CaO	55.28	55.6	55.3	54.3
H_2O	.50			
CO_2	43.57	43.8	43.7	42.6
	98.89	99.7	99.8	100.2

A. Rogue River Lime Co. quarry on Cheney creek in section 19, T. 37 S., R. 6. W.
B. Face of cliff in section 19, T. 37 S., R. 6 W.
C. Croppings in section 19, T. 37 S., R. 6 W.
D. Stripping in section 19, T. 37 S., R. 6 W.
Analysis A made by R. C. Wells, U. S. Geological Survey Bulletin 419, p. 209. Analyses B, C and D made for the Rogue River Lime Company and reported by S. B Gorbutt, of Grants Pass.

Over the divide to the southwest in the west quarter of section 30, T. 37 S., R. 6 W. there are two more outcrops of limestone, one in the form of a cliff at least 100 feet in height. This has been opened in a small way by Mr. Sorenson of Portland; it is also claimed by Conger & Co. This limestone also strikes about N. 45° E. with a steep dip to the southeast. So far as visible on the surface the outcrops in section 30 are much smaller than that already described in section 19. They seem to be portions of the lens in section 19 cut off its southern end and displaced to the south by a fault striking nearly north.

Shale and clay outcrop on the land controlled by the Rogue River Lime Company in section 19, T. 37 S., R. 6 W. very near the limestone of which analyses are given above. The shale strikes N. 50° E. with a nearly vertical dip near the center of the section. Elsewhere in the same vicinity the strike varies from N. 30° to 55° E. and the dip varies from 50° to 80° to the southeast. Analyses made for the Rogue River Lime Company and reported by S. B. Gorbutt, of Grants Pass, are as follows.

COMPOSITION OF SHALE AND CLAY ON CHENEY CREEK

SiO_2	63.96	62.90	58.58	63.08	64.1
$Al_2O_3+Fe_2O_3$	27.28	27.42	31.52	27.94	27.0
MgO	2.26	2.08	1.42	1.70	.2
CaO	.82	1.28	1.04	.94	1.2
Ignition	5.85	6.42	7.21	6.02	7.6
	100.17	100.10	99.77	99.68	100.1

Plate X. Limestone exposure on Cheney Creek, Josephine county, Oregon. Land of Rogue River Lime Company.

Chromium

Chromite, the only important ore of chromium, has been found in small isolated masses in serpentine on Slate creek by W. H. Ramsey. No commercial quantities are known at present, but the conditions are favorable and more may be discovered at any time. Magnetite and platinum are reported to occur in the same region, as well as an ore said to carry quicksilver, but these could not be verified, though the conditions are such that magnetite in non-commercial quantities is almost certainly present, and platinum is probably present.

Iron

The Carpathia Mining Company controls claims on the upper part of Powell creek which contain some low grade iron ore. The northeast corner of the Carpathia group is at a small reservoir on the creek at an elevation of 2000 feet as measured by barometer. The east end line runs S. 15° W.; the ore outcrops about a quarter mile from the northeast corner near the east center at an elevation of about 2500 feet. For the most part the outcrop is a ferruginous quartzite; in places this varies to a low grade iron ore. There has been no development work whatever done, and it is impossible to state what would result from such work, though the conditions warrant a limited amount of development. A sample of the iron-bearing quartzite from this locality gave the following results on analysis:

COMPOSITION OF FERRUGINOUS QUARTZITE FROM POWELL CREEK

[S. W. French, analyst.]

Silica, SiO_2	77.74
Ferric iron, Fe_2O_3	11.16
Ferrous iron, FeO	0.96
Other oxides	10.14
	100.00

By elimination of silica this rock may grade into iron ore. A gradation to low grade iron ore is known to occur at this locality; higher grade ore may exist here.

Copper

Two mines on Slate creek contain some copper ore, and may be described as copper mines, although gold is also obtained from them, and is perhaps more important.

The Buckeye mine is owned by an Ohio company; it is about 5 miles northwest of Wonder on the east fork of Slate creek at an elevation of about 2650 feet as measured by barometer. An adit extends N. 20° W. 65 paces without disclosing any ore or any distinct vein. At 50 paces crosscuts have been run both ways a few feet. A cyclone drill has been used. The ore on the dump contains pyrite, pyrrhotite, chalcopyrite, bornite, malachite, and chrysocolla. The country rocks are serpentine, andesite, diorite, and shale grading toward argillite. The shale strikes east of north and dips about 45° S. E. Two adits higher up are said to be 60 and 70 feet long respectively. The ore is in the andesite near the contact.

The Queen gold and copper mine is about 3½ miles northwest of Wonder on the divide between Water and Limpey creeks, the former being a tributary of Slate creek. The country rocks are reported to be greenstones, argillites, and serpentine by Diller[1] who says further: "A small placer at the head of one of the forks of Water creek near the contact between greenstone and serpentine yielded $3000 in gold some years ago and started prospecting to find its source. A number of tunnels and crosscuts aggregating over 800 feet of underground workings have been run in the greenstone. An interesting breccia of greenstone, cemented by quartz and about 12 feet in thickness, is exposed by the tunnel on the Limpey creek side of the divide and may be locally mineralized. Outcrops of this breccia were seen as far west as Slate creek, 2 miles below the Buckeye mine."

Gold and Silver

The Ramsey mine is near the Buckeye and Queen mines in the Slate creek region; the ore at the Ramsey carries gold with little or no copper; the mine is located on the west fork of Slate creek about 6 miles northwest of Wonder and 1½ miles above the forks at an elevation of about 2800 feet, as measured by barometer. The workings are shallow and disclose no regular vein. The ore is due to surface enrichment, and much of it has been treated by placer sluicing methods. The mine is owned by W. H. Ramsey who has an arrastre in which some ore has been treated on the creek just below the workings. According to Diller,[2] "In the upper tunnel the fault contact of the serpentine overlying the greenstone is well exposed, striking N. 25° W. and dipping 62° N. E. That is, however, in a bend of the contact, for the general trend of the contact of serpentine and greenstone is N. 30° E. and the dip is 40° S. E. Some distance west of the contact toward the creek another tunnel has been run

[1] U. S. Geological Survey Bulletin 546, p. 60, 1914.
[2] Loc. cit. p. 62.

into crushed greenstone, and the iron-stained rock has been reported by local assayers to contain a small percentage of tungsten. A sample selected by Mr. Ramsey and myself to test this matter was sent to the laboratory of the Geological Survey where it was tested by R. C. Wells and found to contain no tungsten, but a small fraction of one per cent of vanadium."

The Michigan mine is about 1½ miles west of Murphy near the mouth of Board Shanty creek at an elevation of about 1300 feet as measured by barometer. It is equipped with a 64 H. P. engine, a hoist, and an air compressor operated by steam power, as well as a 5-stamp mill having a rock crusher, an 8-foot amalgamating plate, 2 jigs, 3 settling tanks and 1 slimer. The ore has been concentrated 10 into 1, and the concentrates sent to a smelter. The vertical shaft is said to be 130 feet deep with two levels; being full of water it could not be inspected when the mine was visited in August, 1913. The main vein strikes S. 73° E. and dips about 75° N. E.; it is 1 to 3 feet wide and contains pyritized quartz. It has been stoped out for about 100 feet from the surface to a depth of about 60 feet. An adit has been driven N. 38° W. about 45 paces to tap another vein which has not yet been reached. Work was in progress at the Michigan mine during the first part of the year 1913.

The Ingram claims are on Oscar creek and across the divide on Savage creek. On Oscar creek in section 14, T. 37 S., R. 5 W. the country rocks are Paleozoic argillites, sandstones, and limestone cut by porphyry and serpentine. The limestone near Ingram's cabin strikes N. 10° E. and dips about 45° E. Ingram's adit No. 1, at an elevation of about 3100 feet, shows some porphyry in its 150 feet of length, but does not reach unoxidized ore. His adit No. 2, at an elevation of about 2900 feet, is about 120 feet in length, the last 20 feet being in a green shaly rock with black indurated talc or gouge in seams, while the adit elsewhere is in andesitic porphyry. Ingram's adit No. 3, at an elevation of about 2300 feet, is only 30 feet long; it discloses gold ore, said to be high grade, but no well defined vein. A sample reported to come from Bailey's claims at the head of Oscar creek proves to be an argillaceous limestone.

The Golconda mine is about 2½ miles northwest of Provolt in section 34, T. 37 S., R. 5 W. at an elevation of about 1500 feet. It is equipped with a 3-stamp mill with a plate, now partly dismantled. Two adits were run into the hill, but they are now caved shut. The country rocks are quartzite and argillite cut by intrusions of aplite and tonalite, the main area of the latter being apparently to the south.

The Exchequer mine is in section 35, T. 37 S., R. 5 W. on a hill near the Applegate river. The lower adit is about 150 feet long in argillite; the drift is on a small vein which strikes N. 60° W. and dips about 70° N. E. Nearby a vertical shaft said to be 200 feet deep is now caved and full of water. The dump shows pyritized quartz and a vein at least a foot wide. The country rock here is greenstone. The Exchequer mine is owned by W. H. Flanagan, of Grants Pass. It was formerly equipped with a Huntington mill and a concentrator.

The Mountain Lion is near Davidson in section 25, T. 37 S., R. 5 W. When visited in August, 1913, the main adit was caved and could not be seen; the upper adit (No. 2) is about 500 feet long, with more than 300 feet on the vein which is 4 to 36 inches wide with 0 to 24 inches of quartz and the remainder crushed greenstone. A sample of the country rock contains rare phenocrysts of augite in a matrix of abundant green hornblende (altering to serpentine) and plagioclase, almost wholly sericitized with the production of some secondary calcite and quartz. The main adit is said to be more than 1200 feet long with the ore stoped out above.

The Mountain Lion mine is equipped with a boiler, engine, air compressor, and a 5-stamp mill having 900-pound stamps, a crusher, an 8-foot plate with riffles below, and a concentrator. Adolf Meyer experimented here with a magneto-electric process which is no longer in use. According to Kay,[1] the mine "was discovered in 1889 by Messrs. Bailey, who with Davidson, Jewell, and Harmon, are the present owners. The property has been extensively developed, there being about 8000 feet of crosscuts, drifts and other workings. Work has been done on two veins which are in greenstone and slates and which are close to the contact of these rocks within an area of granodiorite. The slates occur as narrow lenses in the greenstones and the best ore of the veins has been obtained near the contacts of the greenstones and the slates. The better-defined vein of the two strikes N. 80° W. and dips 65° S. It averages about 1 foot in width and is faulted at many places. The vein filling consists chiefly of quartz, calcite, and sulphides, the sulphides constituting about 1 per cent of the whole. Owing to the prevalence of faults the vein has been difficult to follow." The mine has been idle during the last few years.

The Oregon Bonanza mine is in the S. W. ¼ Sec. 16, T. 38 S., R. 5 W., south of Powell creek at an elevation of 2100 feet as measured by barometer. The country rock is greenstone cut by aplite

[1] U. S. Geol. Survey Bulletin 380, p. 59, 1909.

dikes. All the adits are caved shut and the mine buildings are in ruins.

The Rising Star mine is in the northern part of section 21, T. 38 S., R. 5 W. about half a mile southwest of the Oregon Bonanza at an elevation of about 2200 feet, as measured by barometer. The mine is owned by Mr. St. John who has kept the main adit open. The latter is about 1500 feet long as shown in the sketch (figure 29).

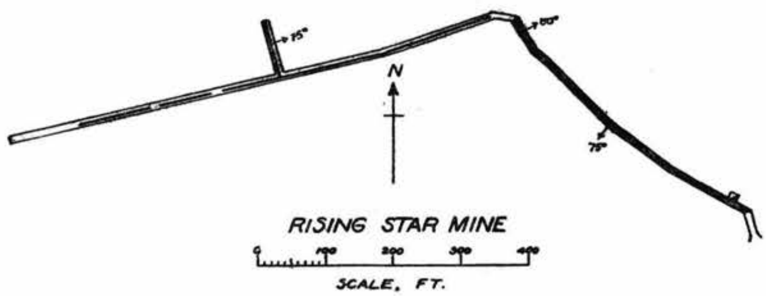


Figure 29. Main adit of the Rising Star mine near Powell Creek, Oregon. Main vein in solid black.

The first part of the adit, going northwest, discloses a vein striking northeast and dipping about 75° S. W. which contains quartz varying from 0 to 48 inches thick. The thicker portions have been stoped out. In the second part of the adit, running southwest, only quartz stringers are found, and even these are less abundant near the face. The country rocks here include diorite and hornblende schist. The Rising Star mine was formerly equipped with an air compressor, a 5-stamp mill with a concentrator, and other machinery, now removed. In 1900 it was owned and operated by the Champion Gold Mining Company. Very little work has been done recently.

The Humdinger mine, very near the Rising Star, is owned by Scroggins and Mascall. The country rock is quartzite and argillite. An adit extends N. 75° W. 40 feet on a small vein of quartz which dips about 70° N. E. The quartz is high grade gold ore in places. Work in progress in 1913 was near the surface.

The Arrowhead mine, owned by Mr. Wooster, is at an elevation of about 2900 feet, as measured by barometer, near the headwaters of Powell creek; the trail to the mine leaves Powell creek at a small reservoir. An adit extends S. 52° W. 58 paces, and thence S. 35° W. 20 paces to the breast. The last course is on a vein of quartz which is 4 to 15 inches wide; pyrite occurs in the quartz and also in the greenstone wall rocks.

The Bone of Contention mine is on the line between sections 24 and 25, T. 38 S., R. 5 W. on the east side of Williams creek at an elevation of about 1700 feet, as measured by barometer. It is near the border of an area of tonalite which extends northward about 2 miles. The tonalite is here in contact with argillite; it is also cut by dikes of aplite. The mine is equipped with two ore bins, water power, obtained from a ditch and Pelton wheel, a 15-stamp mill with 2 amalgamating plates each 42 by 120 inches, and a concentrating table. The main adit enters S. 77° E., but contains too much water to permit inspection. It is evident from the dump that it leads to several thousand feet of workings. The mine has been idle for several years.

THE WALDO DISTRICT

LOCATION

As the name is used in this report, the Waldo district includes the area in Josephine county south of the Kerby and Lower Applegate districts and east of the west fork of the Illinois river. It is limited on the east by the county line and on the south by the state boundary. It includes districts described heretofore under the following names Sucker creek, Browntown, Althouse creek, Holland, Sailor Diggings, Takilma, Bollon creek, and Indian creek. The Waldo district is about 25 miles long east and west and about 10 miles wide north and south. It is a region of rugged mountains except on the western border where the Illinois river valley is relatively remarkably flat. The valley varies in elevation from 1400 to 1700 feet while the mountains reach elevations ranging from 4000 feet to considerably more than 6000 feet. In the eastern two-thirds of the district among the mountains the valleys are narrow and deep, though not like canons. Besides the area drained by the Illinois river the Waldo district includes about 50 square miles of territory drained by the upper portions of Sturges fork and Steamboat creek. This portion of the district was not visited by the writer because no mines are known in it. Topographically it is very mountainous, like the area drained by Althouse and Sucker creeks on the other side of the Siskiyou mountains.

HISTORY

Mining began in the Waldo district in the spring of 1853 when a placer miners' "stampede" to Althouse creek occurred. At about the same time sailors are said to have abandoned a ship on the coast and travelled overland to the "Sailor Diggings" near Waldo where a ditch costing $75,000 is reported to have paid for itself in one year. The gravels on Sucker creek were extensively mined from 1854 to 1860, though the results were not very satisfactory. In the latter year the Waldo copper mine was discovered by Mr. Hawes, and quartz veins on Althouse creek were opened soon afterward. The early work at the Waldo mine gave poor returns on account of the extrmeely high cost of transportation and materials. Work in the gravel of Scott's gulch near Waldo began in 1861 and continued for about 35 years. The Waldo Hydraulic Mining Company began work in 1877, and the ground is not yet exhausted. Simmons Brothers opened the Deep Gravel mine more than 40 years ago; in 1878 Wimer and Sons bought a half interest, and in 1888 they secured the remaining half of the property. The Deep Gravel Mining Company became the owner in 1900, and later sold to the Waldo Consolidated Gold Mining Company. The chief mining activity in the district has been in the placers ever since mining began, and unlike other districts in southern Oregon these gravel deposits are still productive and give promise of continuing to yield for many years. However, the small placer mines on Althouse and Sucker creeks are now largely exhausted and most of the placer gold at present comes from the extensive and deep deposits in the Illinois river valley near Waldo. Browntown, once the center of placer mining on Althouse creek, is now deserted, and only a few placer miners still remain on Sucker creek.

Of recent years the development of lode mining has progressed more or less steadily. Harry Siskron has met with success in operating the January First mine near Holland. The copper mines near Takilma have been opened and a smelter erected, and other mines have been more or less prospected.

GEOLOGY

The Waldo district is occupied chiefly by old sedimentary rocks including argillites, quartzites, and limestones, and by dark colored subsiliceous igneous rocks, including andesite, serpentine, auganite, pyroxenite, etc. Smaller areas of other rocks are known, such as Cretaceous gravels and sands.

The oldest rocks known in the district are the Paleozoic argillites and limestones which occupy much of the mountainous portion, not only that drained westward to the Illinois river, but also that drained eastward to the Applegate river. In general, these rocks strike east of north and dip steeply eastward. They are interbedded with andesitic greenstones in many places. It has been suggested elsewhere in this report that they are overturned so that the oldest beds of the series are on the eastern border lying above the younger beds to the westward. The whole of the Paleozoic series lies above the still younger Galice formation of the Jurassic period near Waldo and Kerby; according to Diller[1] the overlying position of the Paleozoic rocks is due to faulting in this locality. Andesites and basic igneous rocks largely altered to serpentine are associated with the argillites of the Galice formation.

Nowhere in the Waldo district are any intrusions of tonalite known, although some may exist in the mountainous portions which were seen only along a single rapid traverse.

Near Waldo there is still a small area of Cretaceous gravels and conglomerate, which has served as a source of placer gold. It lies unconformably above the Jurassic argillites; the latter are steeply inclined to the east while the Cretaceous gravels are nearly flat. On the basis of fossils these have been referred to the Horsetown formation of the Lower Cretaceous, or Comanchean. It is probable that these gravels were formerly much more widespread in this region than they are at present.

The youngest rocks in the Waldo district are the alluvial gravels still in process of formation by existing streams. In the mountainous portion of the district they are confined to very narrow strips along the water courses, but in the Illinois river valley near Waldo they are somewhat more extensive.

MINERAL RESOURCES

The mineral resources of the Waldo district include limestone and shale, chromium, iron, manganese, gold, silver, and copper. In general, they are not readily accessible, being from 35 to 50 miles by wagon road from the railroad at Grants Pass. Furthermore, the deposits which are in the mountainous portion not close to Takilma or Holland are reached only by trails.

[1] U. S. Geol. Survey Bull. 546, p. 22, 1914.

Plate XI. Stalactites and stalagmites in a room called "Paradise Lost" in Oregon Caves.

Limestone and Shale

Argillite, the partly anamorphosed equivalent of shale, is so abundant in the Waldo district that no detailed descriptions of occurrences are needed.

One of the most important deposits of limestone in the area is probably that on Elder creek near Takilma, because it is relatively accessible. It was used as a source of lime flux when the Takilma smelter was in operation.

Another deposit, located 3 miles S. 70° E. of Kerby, which is just outside of the Waldo district, is known to be very pure calcium carbonate.

Several other outcrops of limestone are known in the central and eastern parts of the Waldo district. Thus there is a small exposure on Sucker creek between Grizzly gulch and Limestone creek, and outcrops are reported near Swan mountain and on the west flank of Whiskey peak, but the largest and most interesting occurrence is on and near Cave creek. Here the limestone is remarkable for its extensive caves, and the Federal Government has set apart three fourths of a square mile as a national "monument." Thus, the caves will be protected and preserved for the benefit of the people for an indefinite period. A plan and elevation of the caves, made from a rough survey with a Brunton compass by S. W. French,

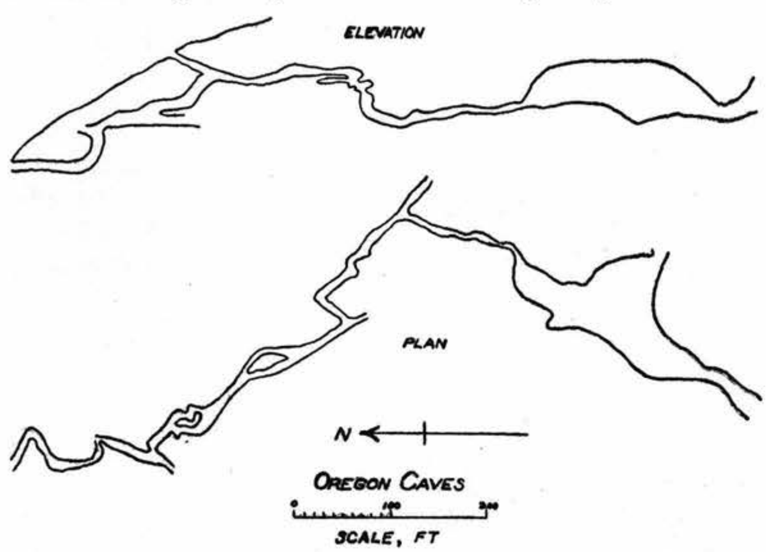


Figure 30. Plan and elevation of the Oregon Caves, south of Grants Pass, Oregon.

are given in figure 30. A view of a detail of the stalactites and stalagmites in a portion of the caves known as "Paradise Lost" is reproduced in plate XI. This limestone is not available for commercial purposes because of its reservation as a national "monument."

Chromium

Chromite, the only important ore of chromium, occurs in nearly pure masses up to several pounds in weight in serpentine near Takilma. So far as observed these masses are scattered irregularly in the rock mass and considerable exploration would be necessary to insure any important output. It was used at the copper furnace as a refractory lining for which it is an excellent material. As found in the S. W. $\frac{1}{4}$ of S. E. $\frac{1}{4}$ Sec. 35, T. 40 S., R. 8 W. it contains a little nickel. A similar mineral in serpentine is reported to occur on Eight Dollar mountain north of Kerby.

Iron

Magnetite is found in some places in the serpentine, but no large masses are known. It is possible that more important deposits may be found.

A deposit of iron ore is reported to occur on the south side of Buck point but an effort to locate it was unsuccessful. There is some serpentine in the region and it may be that the deposit consists of magnetite masses in that rock.

Manganese

A small outcrop of manganese ore was observed about 3 miles below Oregon Caves on the trail down Cave creek. It consists of rhodonite and rhodochrosite forming a vein in quartzite. The manganese carbonate (rhodochrosite) is altered superficially to pyrolusite. It does not seem probable that this is a deposit of economic importance.

Gold and Silver

The gold and silver deposits occur both as placer gravels and as metalliferous quartz veins. The placer deposits have been worked successfully for sixty years and are still far from exhaustion; the veins have received relatively little attention, and may prove more important in the future.

Placer Deposits

At present the chief placer deposits of the Waldo district are in the Takilma area; formerly there were important placer mines on Althouse and Sucker creeks, although the latter were always small mines. The production from both these gulches has varied from $1000 to $10,000 annually during the past six years, the largest yield being in 1911. The small mines include the Jumbo, Mountain Slide, Yeager, and Layman. In 1913 a placer mine said to be owned by Dr. Pickrel of Spokane, was in operation near the mouth of Grizzly gulch. It is equipped with a ditch, pipe line, saw mill, derrick and giant. A miner named Arndt is taking out a little gold and platinum from gravel at the mouth of Limestone creek. Placer miners were also at work at two points on Cave creek, one being about 3 miles below the caves at a small waterfall. Tests were also in progress in 1913 on ground near Holland to determine whether it was rich enough to warrant the installation of a dredge.

Near Waldo there are three important placer mines, namely: Logan, Simmons and Cameron mine, the Deep Gravel or Wimer mine, and the High Gravel or Osgood mine. These three properties are now controlled by the Waldo Consolidated Gold Mining Company of Oregon and operated under the management of Mr. J. M. Logan, who states that the company owns sufficient placer ground to maintain operations for an indefinite period in the future.

Several long ditches carry water from the higher portions of the east and west forks of the Illinois river to the placer ground. The water supply permits mining for about eight months of the year. The placer gold here, which is generally very fine, is accompanied by some platinum as well as a little osmium and iridium.

The Logan, Simmons and Cameron mine is one of the largest placer mines in the state. The oldest workings on this property are in Carroll slough, extending for more than a mile north from near the southwest corner of section 5, T. 40 S., R. 8 W. The area mined varies greatly in width, averaging nearly an eighth of a mile. The pit is from 10 to 25 feet in depth and the bedrock is conglomerate and sandstone with some serpentine. Beginning over 25 years ago, mining in this vicinity was carried on for more than 15 years. More recently several acres have been mined on French Flat, where the workings are in the southern part of section 22, T. 40 S., R. 8 W. The material here mined includes a good deal of clay as well as gravel and sand. A hydraulic elevator was used to remove material from the pit, which had a maximum depth of about 15 feet, now largely filled with water. There are only a few bowlders visible in the material removed, and most of them are less than 6 inches in diameter. According to Kay,[1] the gravel in Carroll slough averaged about 12½ cents a cubic yard, and the bed rock sediments belong to the Cretaceous period. The bedrock in French flat is a purplish conglomerate, also Cretaceous, which has been fractured, fissured, and even somewhat veined. There are three ditches, the water from one being used in the elevator under a head of 325 feet, that from another being employed in two giants, and that from the third being used to clear away the tailings from the end of the sluice at the head of the elevator.

The Deep Gravel mine was first opened by George and Walter Simmons, passing to Wimer and Sons in 1888, then to the Deep Gravel Mining Company, and finally to the Waldo Consolidated Company. According to Mr. Wimer about $130,000 had been expended on the property and about $250,000 taken out of it before 1908. It embraced about 560 acres in sections 20, 22, and 28 of T. 40 S., R. 8 W., the chief workings being in Butcher gulch and its tributaries about a mile northwest of Waldo. According to Kay,[2] "the gravels of these gulches are included in a bench which extends from the head of the Butcher gulch to the west fork of the Illinois river. The upper limit of the bench is about 1½ miles from the west fork and about 125 feet higher than the bed of this stream. The most recent workings are in Joe Smith gulch, where an area of more than 10 acres has been mined. At the upper end of these workings the gravels are about 12 feet in thickness; at the lower end they are more than 60 feet, and the bank consists of gravel and sand containing practically no bowlders except small ones in the lowest 10 feet. Stratification is well shown. The bed rocks in Joe Smith gulch consist of purplish conglomerates of Cretaceous age, similar to the conglomerates that are being mined in the High Gravel mine." The pay gravel is washed through a sluice, elevated by hydraulic pressure, and carried through another long sluice with steel lined riffles. "A clean-up is made about once a month. The gold is saved by amalgamation and is very fine. The concentrates are sold for their values in platinum, osmium, and iridium. Mr. Wimer stated that the average value of the pay gravels during the years 1903–1907 was about 25 cents to the cubic yard. The water used in the pit and in the elevator is brought by two ditches from the east fork of Illinois river. The longer of the two ditches is about 4 miles in length."

[1] U. S. Geol. Survey Bull. 380, p. 74, 1909.
[2] Loc. cit., p. 73.

The High Gravel mine is in sections 33 and 34, T. 40 S., R. 8 W., a little less than a mile south of Waldo. The principal workings are at the head of Allen gulch on both sides of the divide between the east and west forks of Illinois river. Most of the material mined is the conglomerate, determined to be of Cretaceous age by Diller,[1] which forms the bedrock of the other placer mines in the region; it occurs here as a small remnant of a formation once much more widespread. On the west slope the deposits mined extend for about an eighth of a mile along the ridge with an average width of about 100 feet. A strip less than 100 feet wide separates the cuts on the two sides of the hill. In the cut on the east side of the ridge a maximum thickness of about 60 feet is exposed. Mining has been discontinued here. There has been some mining of the recent gravels all along Allen gulch. According to Kay,[2] the conglomerates "are not strongly cemented and the bowlders are rather uniformly distributed throughout the section. Distinct joints are present in the conglomerates and a few small veinlets occur. The bed rock is a fractured, fissured, decomposed, and veined greenstone, which, owing to the presence of iron oxides, has a decidedly purplish tint. These Cretaceous conglomerates are shore deposits, derived from older rocks, similar to those on which they now lie. As stringers carrying values are fairly widespread in these old rocks, some gold is probably present in much of the conglomerate which has been derived from them. But whether or not these values are sufficiently concentrated, as at the High Gravel mine, to be profitably mined can be determined only by prospecting."

Gold-bearing Quartz Veins

The January First mine is owned by Harry Siskron who has operated it successfully on a small scale for several years. It is on the southwest side of Sucker creek at an elevation of about 2400 feet, a little more than a mile from the "mountain ranch," and about the same distance from California bar. The mine is opened by a crosscut adit extending N. 75° W. about 110 feet to a quartz vein about 18 inches thick which strikes north and dips 45° W. A drift runs north 30 feet and south 100 feet; at the south breast a 3-inch vein of quartz strikes east and dips 60° N.; here the main vein is nearly pinched out and contains no ore of value. From the drift stoping has been carried up to the surface. The ore is packed on burros to an arrastre on Sucker creek; the tailings are saved and concentrated on a canvas table.

[1] U. S. Geol. Survey Bull. 380, p. 72, 1909. Bull. 546, p. 94, 1914.
[2] Loc. cit., p. 72.

The Little Gem mine, owned by D. K. Sutherland, is in the S. W. $\frac{1}{4}$ of Section 36, T. 39 S., R. 7 W. on the west side of Sucker creek at elevations ranging from 2300 to 2900 feet, as measured by barometer. It is opened by several adits having a total length of more than 800 feet. The lower adits are shorter and do not disclose a vein in the greenstone country rock. The upper adits reach a quartz vein which strikes N. 65° E. and dips about 85° S. E., which seems to finger out downward. The uppermost and longest adit was being reopened and extended in 1913. The country rock here is andesite containing abundant pale green hornblende, lath-shaped oligoclase, some nearly colorless epidote, dirty gray siderite, and greenish chlorite.

The Brooklyn mine, formerly known as the Gold Pick, is about three quarters of a mile, as the crow flies, from the mouth of Bollon creek at an elevation of about 3500 feet. The main adit is about 300 feet long entering in a direction west of north; it opens a vein about 12 to 20 inches thick containing 2 to 12 inches of quartz which strikes N. 35° W. and dips 55° N. E. This adit is connected by a tramway with a mill on Bollon creek about 600 feet lower. Near the mine Paleozoic argillitic rocks are intruded by amphibolite, diorite, and diorite aplite. The ore is white quartz with very little pyrite; there is more pyrite in the adjoining greenstone. The ore is stoped out above the adit level, but the stopes have a short length horizontally. The ore was apparently of higher grade near the surface.

The Camp Bird claim, owned by Herz and Tibbitts is near Bollon lake at the place formerly called Gold Center at an elevation of about 5300 feet, as measured by barometer. The adit extends S. 70° W. 50 paces in a fine-grained auganite containing phenocrysts of labradorite and colorless augite with rare pale brown hornblende in a felsitic matrix of the same minerals with chlorite and a black mineral suggesting ilmenite. At the face of the adit a quartz stringer strikes N. 65° W. and dips about 80° S. W. At the discovery shaft a quartz vein about 6 inches wide strikes west and dips about 75° S.; this shaft is about 300 feet N. 60° W. of the portal of the main adit, and about 120 feet higher.

Copper

The copper mines near Takilma are far more important than any others in the Waldo district and they are described below in a section of this report written by L. E. Reber, Jr. The other copper prospects in the district are near Bollon mountain, one being on Grizzly gulch and the other on Indian creek.

The copper prospect on top of the ridge east of Grizzly gulch is at an elevation of about 4850 feet as measured by barometer. It was being opened in 1913 by Tomlinson, Gates, and Thomas. At the upper shaft the vein strikes N. 60° W. and dips about 75° S. W. It is about 18 inches wide, but the adjoining ground contains quartz and some copper minerals to a width of about 4 feet. The copper occurs in chalcopyrite, bornite, chalcocite, chrysocolla, and malachite. Pyrite is also abundant.

The Grey Eagle mine is on Indian creek southeast of Gold Center. According to A. H. Gunnell of Grants Pass, about 4000 feet of development have been driven on this mine to open a deposit of sulphide ore 30 to 80 feet wide, with 12 feet of material carrying 4.8 per cent copper and $1.50 in gold. It is reported that a large quantity of such ore has been blocked out.

THE TAKILMA AREA

By L. E. Reber, Jr.

The copper belt of the Takilma area of southern Josephine county lies between Althouse creek and the east fork of the Illinois river and is said to extend southward into California. This area is included in Townships 40 and 41 south and ranges 7 and 8 west.

TOPOGRAPHIC MAP

The accompanying topographic map (figure 31) shows the location of the principal lode mines and prospects of the Takilma area.

The configuration of the surface is indicated by contour lines with a 200 foot interval. A large part of the area included in this map lies within the Siskiyou National Forest. The topography of the portion of this area outside of the forest reserve was mapped by the writer, while that within the reserve is taken from a map made some time ago by the U. S. Geological Survey for the Forest Service. Though this latter map was found to be somewhat inaccurate for our purpose. it was impossible to revise it to any considerable extent.

GENERAL DESCRIPTION

As can be seen from the map the area is made up partly of the flat plains of the Illinois river and its larger tributaries and partly of the northwest slope of the Klamath mountains. It is these gravel flats that furnish much of the rich placer ground of this district, though gravels of earlier erosion cycles furnish their share, and the oldest date back to the Cretaceous period. Much of the valley land is

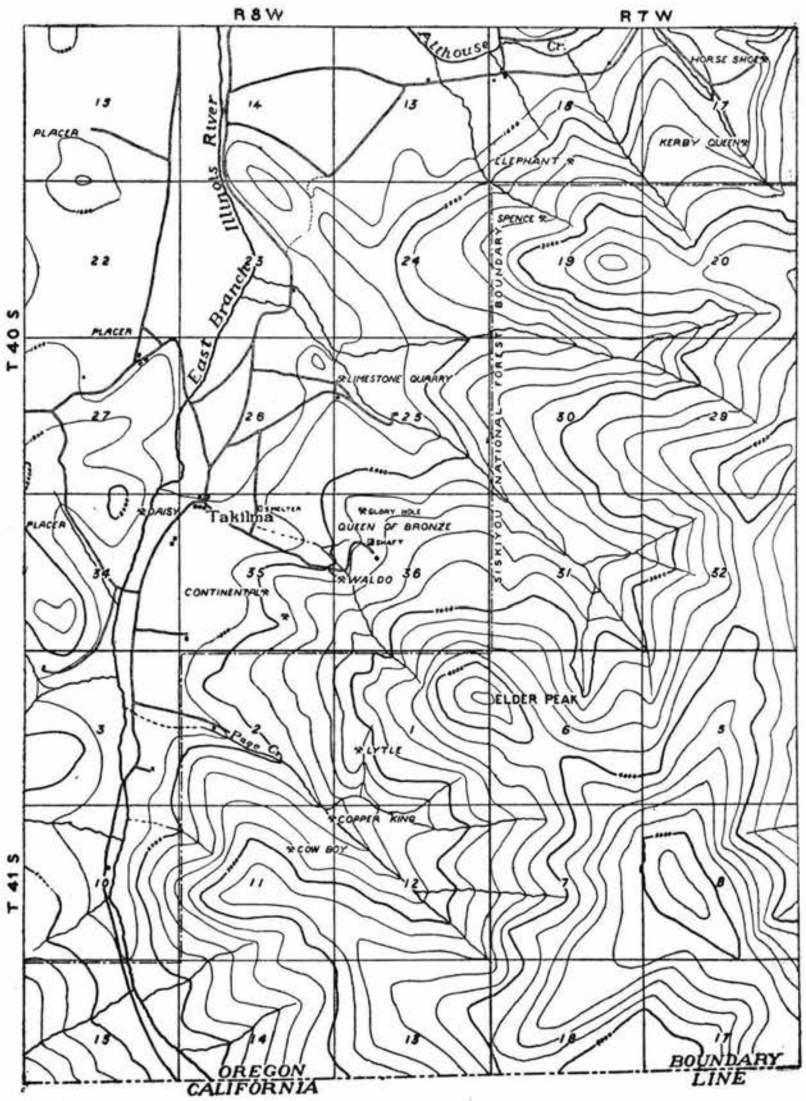


Figure 31. Topographic map of the Takilma Area.

valuable for agriculture, especially where there is water available for irrigation. The preemption of the water rights by the placer companies prevents the utilization of a great deal of this land. A conspicuous feature of the topography is the abrupt transition from the very flat river plains to the mountain slopes. Even small hills or isolated outliers of the mountains show this sudden change of slope to a marked degree. In the immediate vicinity of Takilma, Mt. Hood or Elder Peak, which seems to be the approved local name, is the dominating feature. This outpost of the Klamaths rises nearly 3000 feet above the nearby flats. The forest covering of the mountain slopes is rather open or scattering and accompanied by dense and bristly undergrowth which renders large areas very difficult to prospect.

There are two towns in the Takilma area, Waldo and Takilma. Waldo lies in the middle of the west half of Section 28, T. 40 S., R. 8 W. (just off the edge of the topographic map); it is on the stage road and serves as a way station for the large placer mines of that vicinity. Takilma (in the N. W. $\frac{1}{4}$ of Sec. 35, T. 40 S., R. 8 W.), which was a flourishing little town when the smelter was in operation, is now relatively quiet, though still maintaining a post-office and store. At present the chief occupations of the people of that portion of the county are farming and placer mining. The placer mining is largely confined to the winter months.

INDIVIDUAL MINES

The Queen of Bronze mine is located in the N. W. $\frac{1}{4}$ of section 36, T. 40 S., R. 8 W., about a mile east of Takilma and two and one-half miles east and south of Waldo. It is about four miles by wagon road from Waldo. This mine has furnished the greatest production of any in the district. It is the property of the Takilma Smelting Company, which is owned by Messrs. Tutt, Hull and McNeil. Mining operations were carried on more or less continuously from 1906 to 1909 inclusive. This company also operated a 100-ton smelter of the pyritic matte type, in which the ore produced was reduced to copper matte. The smelter is located near the north quarter corner of section 35, T. 40 S., R. 8 W., which is at the foot of the slope on which the mine is located and about half a mile west of the workings. The ore was trammed to bins and hauled to the smelter, a distance of about a mile by the road. The limestone for the smelter was hauled from the quarry in the northwest quarter of section 25, T. 40 S., R. 8 W., a distance of about one and a half miles, while the coke as well as all machinery and other equipment had to be hauled from Grants Pass. Though the road from Grants Pass is well constructed there are some heavy grades which add to the difficulty of wagon transportation. According to Mr. Tutt over 20,000 tons of ore have been smelted, which averaged over eight percent copper, three dollars in gold, and a little silver.[1]

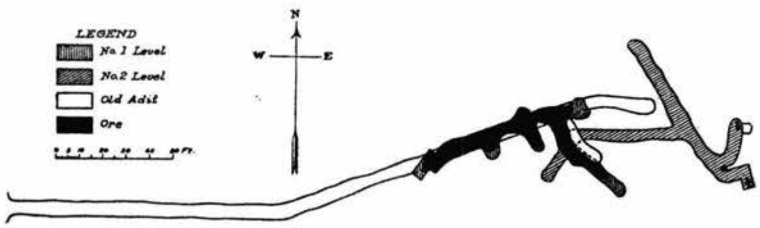


Figure 32. Chief workings of the Queen of Bronze mine at Takilma, Oregon.

The equipment of the mine included several boilers, an air compressor, hoist, and machine drills. A large amount of development work has been done on the property and mining has been prosecuted by means of tunnels, shafts, and open cuts. Large surface ore bodies have been mined by the so-called glory hole method, in which the ore is mined by overhead stoping clear to the surface, passed down a chute and removed through a tunnel below. The accompanying figure (figure 31) is reproduced from a drawing made in 1904 and shows most of the south workings, though a large body of sulphide ore was subsequently mined by the glory hole method. These workings are at the point marked "shaft" on the topographic map. At that time very little had been done on the north workings which are located about a thousand feet to the north of the south workings at the point marked "Glory Hole" on the map. The most conspicuous outcrop of gossan occurred at this point and a large body of oxidized ore has been mined. Here the pit shows fairly definite walls, though its length is less than twice the width and the walls are not parallel. One (the footwall?) strikes N. 70° W., and dips 50° S., and the other (the hanging wall?) strikes N. 20° W., and dips 70° E. Both apparently make a large angle with the strike of the sedimentary rocks of the vicinity. This indicates the irregular character of the ore bodies as the walls are more definite here than is usually the case. The composition of this footwall rock is given below:

[1] G. F. Kay: U. S. Geol. Survey Bulletin 380, p. 78, 1909.

COMPOSITION OF FOOTWALL ROCK, NORTH END ADIT, QUEEN OF BRONZE MINE, TAKILMA

[S. W. French, analyst]

		Approximate mineral composition		
			From analysis	From section
SiO_2	49.02			
TiO_2	1.64			
Al_2O_3	15.02			
Fe_2O_3	2.00	Plagioclase	52.7	55
FeO	8.40	Augite	35.0	30
MgO	7.06	Chlorite	....	8
CaO	10.46	Magnetite }	6.0	} 4
Na_2O	3.12	Ilmenite }		
K_2O	.27	Siderite	....	}
H_2O+	2.94	Quartz	....	3
H_2O-	.08	Olivine	3.5	....
		(Water)	2.8	....
	100.01			
			100.0	100

Calculation of the norm of this rock indicates the presence of olivine, while the microscope reveals (secondary?) quartz without olivine. In mineral composition this rock is an auganite.

Below the open cut two long adits have been driven. The ore from the Glory Hole was removed through the upper of the two. The lower is about 225 feet below the level of the outcrop and includes a large amount of work (over 1,100 feet) though very little ore was developed at this level.

The Waldo mine is located in section 36, T. 40 S., R. 8 W., near the west quarter corner. This mine was operated by the Waldo Smelting and Mining Company and considerable ore was shipped through Grants Pass after the smelter at Takilma had ceased operations. The accompanying figure (figure 33) shows the earlier workings of the Waldo mine and gives some idea of the character of the chief ore body. In one of the levels an ore body of vaguely vein-like form has a trend about N. 60° E. and dips about 45° to the southeast, while in a stope 30 feet above the strike is apparently N. 70° W., and the dip 50° to the S. W. At a higher level ore occurs in a well-defined fissure striking about N. 75° E., and dipping 55° to the southeast.

The Lytle mine is located on the east slope of a small spur of Elder Peak in the S. W. ¼ of Sec. 1, T. 41 S., R. 8 W. The Copper King or Mabel mine is located on Page creek south of the N. E.

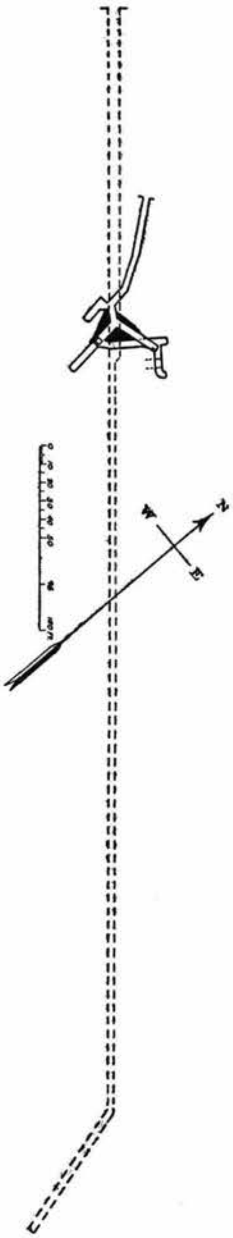


Figure 33. Early workings of the Waldo copper mine at Takilma, Oregon.

corner of section 11, T. 41 S., R. 8 W. The Cow Boy mine is located in the N. E. ¼ of section 11, T. 41 S., R. 8 W. Together these three mines comprise several thousand feet of workings. They were controlled by the owners of the Queen of Bronze and furnished ore to the smelter. According to Kay,[1] these mines are similar to the Queen of Bronze in the character of their ores, their modes of occurrence and their associations.

The Kerby Queen or Sowell mine is located in the S. E. ¼ of section 17, T. 40 S., R. 7 W. The workings consist of two adits; the upper is about 240 feet in length and is mostly in weathered rock. The ore is a mixture of the sulphide and oxide minerals. Ore on the dump shows pyrite and a small amount of marcasite, associated with the chalcopyrite, and pyrrhotite. The ore is said to run $6 in gold in carload lots.

The lower adit is about 700 feet long (August, 1913) and in serpentine all the way. Ore is expected when the limit of the serpentine is reached, estimated to be 60 or 70 feet further.

Twelve or thirteen years ago a ten ton smelter was installed in connection with this property and operated for 26 days, producing 32 tons of matte carrying copper and gold to the value of $2000.

The Horse Shoe property is in the N. E. ¼ of section 17, T. 40 S., R. 7 W. These workings were not examined. The size of the dump indicates several hundred feet of development.

The Spence property is in section 19, T. 40 S., R. 7 W. The size of the dump at the main adit indicates 500 feet to 700 feet of workings. It could not be entered

[1] U. S. Geol. Survey Bulletin 380, p. 79, 1909.

because of a cave near the portal. The ore on the dump is chiefly pyrite. A 60 foot tunnel in the vicinity is a cross cut and does not show any ore. Another tunnel not examined is said to be 200 feet long and shows somewhat better ore than that on the dump of the long tunnel.

The Elephant or Ducommun property is located in the S. E. ¼ of section 18, T. 40 S., R. 7 W. A 440 foot adit on this property shows some copper ore. The minerals found in the ore are marcasite, pyrite, chalcopyrite, chalcanthite, and gypsum.

The Continental mine of the Copper Mountain Mining Company is located in the S. E. ¼ of section 35, T. 40 S., R. 8 W. The workings comprise three adits, one with 180 feet of drift following a very slightly mineralized fissure zone. Some distance north of this is another adit with about 100 feet of work. Some ore observed here was chiefly pyrrhotite with some chalcopyrite. West of this working and at about 100 feet lower elevation a cross cut was being driven to intersect the mineralized zone at greater depth. This was 100 feet long when examined. It is said that some good ore has been hauled to Grants Pass from this property.

The Daisy Mining Company has two adits in the N. E. ¼ of section 34, T. 40 S., R. 8 W. A large fault crosses the lower adit striking N. 10° W. and dipping 75° to the west. The upper adit is about 45 feet above the lower. The ore observed here was chiefly pyrite with pyrolusite, hematite and serpentine, and traces of bornite and malachite. It is said to carry gold and chalcopyrite in valuable amounts.

ORE DEPOSITS

Most of the copper mines and prospects of this district lie in a belt about a mile wide, which tends approximately N. 30° E. This is not far different from the strike of the sedimentary rocks of the district (which Diller classifies as of Paleozoic age.)[1] At the limestone quarry just east of the copper belt the strike is N. 15° E. with a dip of 65° to the east. This alignment of the copper mines may be merely due to the trend of the mountain slopes where the rocks are exposed, though it is certain that the attitude of the sedimentary formations had some influence on the fracturing and intrusion with which the ore bodies are associated.

The rocks with which the ore bodies are directly associated are for the most part or entirely of igneous origin. It is probable

[1] U. S. Geol. Survey Bull. 546, pp. 20, 81-86.

that extrusives as well as intrusives are represented. Among the thin sections of the samples collected from this district, Dr. Winchell identifies andesite, auganite, diorite, augitite and pyroxenite, as well as serpentine, which is perhaps the most commonly associated rock. Mr. Diller [1] refers to peridotite as of common occurrence in this locality, and finds that the serpentines of the serpentine belt of southwestern Oregon and northern California are most commonly the result of the alteration of peridotite, though other rocks also alter to serpentine. The specimen which the writer believed to represent the unaltered serpentine rock proved to be pyroxenite, possibly a phase of a peridotite intrusive. The serpentine of this locality may represent more than one original rock type. The augitite occurs as small light colored dikes cutting the serpentine in the lower adit of the Waldo mine. The rocks exposed in the mine workings are extensively fractured, fissured, and jointed, and locally brecciated. The serpentine in particular is characteristically full of fissures and partings of all orders of magnitude. It is very permeable and usually saturated with water, requiring very thorough timbering where it is penetrated in mining. These rocks generally alter to a red soil which supports a scant vegetation.

The ore occurs in extremely irregular masses without any very definite relation to one another. Locally they have an indistinct vein-like form where the foot and hanging walls can be dubiously recognized. Most of the ore mined has come from within 125 feet of the surface, though exploration has been carried considerably deeper. On the Queen of Bronze property there were conspicuous outcrops of gossan and much oxidized material has been mined. The depth of the oxide zone varies greatly, oxidized material having been found at depths of about 100 feet though most of the oxidized ore came from within less than thirty feet of the surface.

The minerals of the oxidized ore are black sooty tenorite (or chalcocite?), malachite, azurite, chrysocolla and cuprite. The black oxide or sulphide is most abundant. Locally the black oxide(?) was found associated with a small amount of native copper. The oxidized copper minerals are associated with clay and limonite as is usual in gossan deposits.

The unoxidized ore is made up of chalcopyrite associated with pyrrhotite and minor amounts of quartz and calcite. In some localities pyrite is an important constituent of the ore and mar-

[1] U. S. Geol. Survey Bull. 546, pp. 20, 81–86.

casite is rarely found. The sulphides are in general intergrown though sometimes the pyrrhotite occurs as veins and stringers cutting the chalcopyrite. The calcite and some of the quartz is later than the sulphides, indicating a period of fracturing after the ore deposition. There seems to be some quartz intergrown with the sulphides.

ORIGIN OF THE ORE

It is probable that the copper ores were first deposited from solutions related to the cooling of an intrusive igneous magma, as most of the sulphide copper deposits where they have been thoroughly studied have been ascribed to such a source. An alternative view is that the deposits were formed by circulating ground water solutions which collected their metallic burden from minutely disseminated particles in the associated igneous rocks. The former is the most generally accepted view, and is favored by the evidence observed in the Takilma area. The association of the ores with intrusives which comprise only a small portion of the rocks of the district and contain original copper-bearing sulphides in extremely disseminated minute particles is against the latter view. The leaching of copper from the massive rocks is very improbable and slickensides in the sulphide bodies are taken by G. F. Kay [1] to indicate that the chalcopyrite has been subjected to the shearing which accompanied the development of the serpentine, and thus was present before the serpentinization took place.

That these ore bodies are not the product of magmatic differentiation, that is, are not actually part of a solidified magma as some pyrrhotite ore bodies are believed to be, seems reasonably certain because of the intimate relation of the ore bodies to igneous rocks of several types, though this possibility can not be entirely eliminated. The deposits may have been associated in origin with any of the intrusive rocks in which they occur.

The apparent relation of the ore bodies to the present erosion surface suggests that they owe their final position to the work of downward percolating surface waters. This may explain the apparent lack of connection and somewhat blanket-like occurrence of the ore bodies. Perhaps the fissuring which made room for the original deposition of the ores was of the clean cut type usually associated with moderately deep-seated intrusive bodies and the ores were first

[1] U. S. Geol. Survey Bull. 380, 1909, p. 77.

deposited as mineralized vein fillings of the ordinary type, and then when erosion had lessened the overburden, later movements produced the complex fracturing and jointing more characteristic of conditions relatively near the surface, preparing the way for the transfer of the ores to their present position by downward percolating surface waters.

If the ores have reached their present position by deposition from ground water solutions, as seems to be the case, it is necessary to consider the pyrrhotite as well as the chalcopyrite as having been transferred in this manner. While chalcocite is the most typical mineral of secondary sulphide ore deposits in other districts chalcopyrite has been recognized as occurring in this manner. Pyrrhotite, however, has generally been considered as indicating somewhat different conditions of deposition.

FUTURE POSSIBILITIES

As to the possibilities of future development in this district it is extremely difficult to predict. The quite general mineralization of the area would lead to the expectation of some valuable ore bodies while the fact that the surface has already been somewhat thoroughly explored and that the ore bodies already mined failed to persist to any depth are decidedly unfavorable. It is probable that there is considerable low grade material developed by the present mine workings which could be profitably handled with railroad facilities. The former production of this district has been entirely accomplished with the handicap of a wagon haul of over twenty miles to Grants Pass, the most accessible point on a railroad.