PRELIMINARY GEOLOGIC MAP OF THE SUMPTER QUADRANGLE, OREGON

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Field work and preparation of the map

The field work on which the areal geology shown on the reverse hereof is based was partly done by the United States Geological Survey in the years 1908 and 1909 and was completed by the Survey in 1913 and 1914 under a cooperative agreement with the Oregon Bureau of Mines and Geology. The work was begun by J. T. Pardee, who, under the supervision of F. C. Calkins, covered the north-central part of the quadrangle in the fall of 1908 and summer of 1909. In the fall of 1913 an area in the Elkhorn range east of Sumpter was mapped by F. J. Katz and in the summer and fall of 1914 the remainder of the quadrangle was covered by J. T. Pardee and D. F. Hewett with T. H. Rosenkranz as assistant. The map has been prepared by Pardee and Hewett from their original field notes. The following summary descriptions are based on their unpublished notes and on published reports, listed at the end of the text, to which the reader is referred for additional details.

Geography

The Sumpter quadrangle is an area of about 850 square miles in Baker, Grant, and Union Counties, northeastern Oregon, that includes several of the more productive mining districts, viz.--Cracker Creek (Bourne), Elkhorn, Cable Cove, Granite, Bonanza, and Greenhorn. It lies near the middle of the Blue Mountains, a chain of ridges and mountain groups of different trends and altitudes that extends southwestward from the northeast corner almost to the center of the State. The higher summits in the Sumpter quadrangle are along Elkhorn Ridge and its northern continuation which is called the John Day-Powder River divide. Several summits within the quadrangle range in altitude from 8,500 to 9,000 feet above sea level and from 4,000 to 5,000 feet above adjacent valleys. To the southwest the mountains decrease in height until they finally disappear in the plains of central Oregon. Lowlands that occupy not more than 5 or 6 per cent of the total area of the quadrangle include, in the northeast corner, a small part of Baker valley and, in the southern half, Sumpter valley along the upper course of Powder River and smaller valleys along the north and middle forks of Burnt River. Access to these valleys and to most of the mountainous areas is afforded by automobile roads. U. S. Highway 26 crosses the southern part of the quadrangle from east to west. Sumpter at the head of Sumpter valley is the principal settlement and Bourne, Granite, and several other more or less intermittent or "ghost" mining camps are in the north-central and western parts of the quadrangle. Farming and stock raising are carried on in the valleys. Much of the quadrangle is within the Whitman National Forest, and lumbering is one of the chief industries.

Geology

The rocks of the Sumpter quadrangle comprise an older and a younger series separated from each other by a major unconformity and otherwise distinguished by marked differences in their character, occurrence, and relations to the metalliferous deposits.

The older series consists of pre-Tertiary rocks, most of them severely deformed and conspicuously altered formations of sedimentary and volcanic origin, such as argillite, greenstone, and schist, with relatively small amounts of limestone or marble. Into these formations several bodies of granitic rock have been intruded. Fragments of fossils, such as corals and the foraminifer Fusulina, found in some of the limestone bodies, indicate a Carboniferous (Pennsylvanian) age. Great thicknesses of rocks lie above and below the fossiliferous limestone, however, and may include both Mesozoic and pre-Carboniferous beds. The bedded rocks of this group show a prevailing westerly strike and appear everywhere to be closely folded. They are more or less schistose and commonly show evidence of faulting, but the main structural features are generally obscured by the smaller features and have not been satisfactorily worked out. The known metalliferous lodes are confined to rocks of this (pre-Tertiary) series.

The younger series includes formations of Tertiary and Quaternary age. The Tertiary rocks consist chiefly of lava flows and other volcanic materials with interbedded sedimentary rocks of Miocene and probably Pliocene ages. They have been slightly tilted or warped and broken by many normal faults, most of which strike northwestward and thus cross the structural trends of the older rocks at considerable angles. The Quaternary deposits, composed mainly of unconsolidated alluvial and glacial material, occupy several large valley areas. They are not noticeably deformed. Placer gravels are found at different horizons in both the Tertiary and Quaternary formations.

Pre-Tertiary formations

Argillite group

The areas mapped as argillite group are underlain by light to dark gray, fine-grained, siliceous and argillaceous sedimentary rocks with interbedded layers of greenish hue that are altered volcanic rock. All are fine-grained and, commonly, only the more siliceous varieties are resistant enough to form prominent outcrops. The best exposures are found in glacial cirques on the northeast side of Elkhorn Ridge and along some of the streams that drain the southwest slope. Cracker Creek, which crosses the strike of the beds for a distance of about 8 miles, gives exposures, mostly of siliceous beds, at intervals between Sumpter and Pole Creeks. Above Pole Creek the exposures are nearly continuous and show the formation to consist of alternating siliceous and argillaceous layers that range in thickness from a fraction of an inch to several feet. Some of the harder gray siliceous layers resemble chert and some of the softer argillaceous layers resemble slate. All gradations between the two occur. Commonly the gray, siliceous layers are not more than an inch thick and the argillaceous layers that separate them are merely black seams. The interbedded volcanic rocks are dull greenish-gray and indistinctly stratified. They are well exposed on the southwest slope of Elkhorn Ridge from Rock Creek Butte southeastward. In the argillite areas south of Sumpter valley the exposures are commonly poor, but, so far as observed, the rocks are similar to those described. All appear to be the metamorphosed representatives of intermingled fine-grained sediments and volcanic flows and tuffs. Similar rocks that occur in adjoining parts of the Baker quadrangle have been recently studied and iescribed by Gilluly (12).

Limestone

Limestone interbedded with the argillite group forms many outcrops, most of them small, on the slopes of Elkhorn Ridge, and in a few widely scattered areas elsewhere. Those on Elkhorn Ridge are mostly within two rather narrow belts, one extending along the lower south slope from Deer Creek eastward to Marble Point and the other occupying a corresponding position on the upper northeast slope. Marble Point, the largest outcrop, is aboue three fourths of a mile long from east to west, half a mile wide, and 1,000 feet high. Its boundaries are irregular zig-zag lines and the mass appears to be an aggregate of separate angular blocks. Few other bodies approach this one in size. The most are from 50 to 500 feet wide and not more than 1,000 feet long. In order to make them plainly visible on the map the smaller ones have been exaggerated. A rather remarkable feature of these bodies is their angular form. In composition they appear to be almost pure calcium carbonate. Many have been metamorphosed to a white or pale blue crystalline marble and in general bedding planes are indistinguishable.

Metagabbro

Before the argillite group had been extensively deformed it was invaded by a magma, which formed sills, dikes, and irregular crystalline bodies, now appearing as a greenish-gray metagabbro. The largest exposure of this rock forms a belt, from a quarter of a mile to a mile and a half wide, which extends from the vicinity of Bourne eastward to the border of the quadrangle and beyond. Between Bourne and Maxwell basin this body has the form of a sill from 700 to 1,500 feet thick. East of Maxwell its outlines suggest dike-like and irregular forms. In the glacial cirques on the northeast side of Elkhorn Ridge, its granitic texture is plainly shown. The rock was originally a gabbro composed mainly of plagioclase feldspars and augite. Since it came to place these minerals have been largely changed to epidote, chlorite and green hornblende which give the rock its greenish color.

Peridotite and serpentine

Irregular bodies of peridotite, a coarsely crystalline dark green or black rock, have been intruded into the argillite and the metagabbro along McCully Fork west of Sumpter and in the basins of Corral and Boundary Creeks. It is composed largely of iron-magnesium silicates and its weathered outcrops are characteristically dark brown. Serpentine, an alteration product of the periodotite, is found in the areas mentioned and is particularly abundant in the vicinity of Greenhorn City and to the southwest of the Ibex mine. It ranges from light green to black in color and is characterized by a smooth or soapy feel and a network of fractures along which it breaks into fragments with curved outlines.

Granodiorite

Granitic rocks, which were intruded later than the metagabbro and the peridotite, underlie much of the northern half of the quadrangle and rather large areas in the mountains south of Sumpter valley. The main body, which forms Bald Mountain and the bold and rocky Powder River-John Day divide north of the head of Cracker Creek, was named the Bald Mountain batholith and described as granodiorite by Lindgren (1), and this term is retained on the map although the batholith or parts of it may be more precisely classified as quartz-diorite. In its most extensive outcrops the granodiorite is a light gray, medium-grained crystalline rock that resembles granite. As seen from a distance it appears nearly white. Outcrops long exposed to ordinary weathering develop characteristic rounded forms but on the higher summits they have been frost rifted to masses of angular fragments. The granodiorite bodies extend to unknown depths and tend to be enlarged downward, and probably all that are shown on the map are connected in depth. Near the La Belleview mine the granodiorite and the rocks that it invades interlace in an intricate manner, and at places, particularly near the Baisley Elkhorn and Bald Mountain mines, branches or apophyses from 100 to 500 feet in width project short distances from the main body. Elsewhere the contacts are fairly even or regular.

Representative specimens of the granodiorite from Bald Mountain and the peaks north of Cracker Creek consist chiefly of plagioclase feldspar, quartz, hornblende, and biotite together with noteworthy amounts of orthoclase feldspar. Marginal facies contain relatively more of the dark minerals, hornblende and biotite, and less of quartz and orthoclase. Throughout most of its area, however, the larger body shows little variation in composition and texture. Dikes of aplite and pegmatite are sparingly distributed through the batholith. Some narrow dikes in the northern part are composed chiefly of flesh-pink feldspar, quartz, and a long-bladed mica. Locally the granodiorite contains dark spots a few inches in diameter caused by the segregation of brown mica or other dark minerals. The batholith came to place after the argillite group and metagabbro had been deformed, and it was exposed and partly cut away by erosion before the Tertiary lavas were erupted. In most exposures the batholith is cut by three sets of fractures that stand approximately at right angles to one another. Two of them are vertical or nearly so and the third nearly horizontal. From place to place, however, the spacing and relative dominance of the different fracture systems vary. Over wide areas the vertical or steeply dipping fractures are closely spaced and the more prominent. In other areas they are subordinate to the horizontal fractures.

Dikes

Except those of Quaternary age all the formations mapped are cut by igneous dikes. These dikes are most numerous in the argillite, group and successively younger formations contain fewer and fewer of them. They range from less than a foot to 100 feet or more in width and a few are a mile or more in length, but most are relatively narrow and non-persistent. In composition they range from ultra-basic to extremely siliceous.

In areas of the argillite group the most common dikes are formed of a dense fine-grained light gray rock that is apparently a granodiorite porphyry. Along parts of Elkhorn Ridge these dikes are so numerous that they form as much as 20 per cent of the rock mass. In areas where exposures are poor the presence of the dikes is indicated by fragments in the soil. In general the dikes differ widely in strike and dip, but along Elkhorn Ridge most of them strike northeast, dip steeply, and accompany fractures along which faulting appears to have occurred.

Greenish-gray dikes that range in composition from diorite to pyroxenite are rather widespread, and aplite and pegmatite dikes comparatively few. In the areas of Tertiary volcanic rocks in the Burnt River drainage, east of China Creek, dikes of dark-colored porphyritic rocks are fairly common.

Structure

Severe deformation has imposed on the argillite group an exceedingly intricate structure which may be readily seen in any of the cleaner exposures, especially those afforded by the glacial cirques of Elkhorn Ridge. Nearly everywhere innumerable small folds and contortions involve the beds. Strong compression and shearing have broken the more brittle siliceous layers into small fragments, and so kneaded them into the softer argillitic layers that the rock resembles conglomerate. Particularly good exposures of this pseudo-conglomerate may be seen in cirques at the heads of Pine Creek and Goodrich Creek. The prevailing strike of the bedding, shear planes, and axes of small folds is west and their dip is generally 45° or more. The larger structural features are obscure. Probably they include a number of isoclinal east-west folds. The metagabbro sill seems to have resisted crumpling but in the vicinity of Bourne it has been bent into a large open east-west synclinal fold.

Rather closely spaced fractures are general in the argillite group and cause its outcrops to be characterized by small jagged forms. Faulting distributed among the fractures is indicated in several places. Larger faults displace both the argillite group and the metagabbro in the vicinity of Bourne. They include the North Pole-Columbia vein or "Mother Lode", several other veins, and a number of barren fractures, all of which strike northeastward and cut a less prominent set that strikes northwest.

Metamorphism

The argillite, schist, and other varieties that compose the argillite group are rocks that have been transformed from original fine-grained sedimentary rocks, such as clay-shales and sandstones, by the pressure and chemical action incident to deep burial mountain building, and igneous intrusion. In the same way what were originally lava flows and tuffs have been changed to greenstone. The most striking effects of the regional metamorphism are the production of schists and pseudo-conglomerate. Less noticeable but even more widespread is the compaction to argillite and cementation to chert-like rocks. Contact metamorphism by the invading granitic bodies has further changed the rocks adjoining them according to their composition. Unmixed or pure limestones have been changed to marble, impure varieties to hornstone. Argillaceous beds have been altered to mica schists, containing hornblende and other silicates. Around the Bald Mountain batholith the argillitic rocks have been thus metamorphosed in a belt ranging from a quarter of a mile to 2 miles in width. The smaller granodiorite bodies exposed south of Sumpter valley and elsewhere are surrounded by similar but narrower metamorphic collars. The alteration of gabbro to metagabbro is chiefly the result of regional metamorphism. The contact effects produced in other rocks by the intrusions of gabbro, peridotite and dikes are hardly noticeable. The Tertiary and Quaternary formations except as they may be locally modified by dikes or other intrusive bodies of the same age are free of metamorphic features.

Age

Only small and fragmentary collections of fossils have so far been obtained from the pre-Tertiary rocks of the quadrangle, and these are confined to the limestones. The best collection, from a small body exposed in a railroad cut 3 miles south of Sumpter, contains a few poorly preserved brachiopods, bryozoans and crinoids and the Carboniferous foraminifer, Fusulina. A great thickness of sedimentary beds underlies the limestone, however, and how far these descend in the geologic time scale is not known. In the non-fossiliferous beds above the Fusulina stratum conglomerates occur that contain limestone pebbles, a fact that indicates them to be younger, possibly Mesozoic in age. From their relations to the argillite group and to one another, it appears probable that the metagabbro, granodiorite, and periodtite are of Mesozoic age.

Tertiary formations

Gravels

Alluvial deposits of Tertiary age are widely distributed in the Sumpter quadrangle. Though of relatively small volume compared to the other formations mapped these deposits are of particular interest because they have yielded considerable placer gold. Natural exposures are poor and most of them are confined to areas from which protective lava covers have been recently stripped by erosion. The best exposures are in artificial excavations at the French Diggings, Weaver, Griffith, Winterville, and Barton mines. The gravel is characterized by very smooth, stream-worn cobbles and boulders which are imbedded in a sandy clay matrix that commonly shows bright red and bluish-gray tints. The cobbles and boulders are composed of cherty-appearing quartz, dense, fine-grained porphyries, and other resistant rocks. All have lain undisturbed for a long time exposed to the agents of rock decay, as shown by the fact that their outer layers or shells have become bleached and softened. Many boulders of the less resistant rocks such as argillite, greenstone, and granodiorite have completely decayed in place. Excavations at the different mines show the gravel to be from 30 to 50 feet or more thick and displaced by faults that also cut the bedrock and the lava cover.

The surface on which the gravel deposits lie cuts across the deformed pre-Tertiary rocks including the granitic intrusions. It therefore represents the end of a long cycle of erosion during which a great thickness of rocks were removed. During this period many lodes were uncovered, their upper parts worn away, and much of their gold transferred to the gravels.

The distribution of existing remnants of the Tertiary gravel suggests that one of the streams depositing it flowed southward from the present site of Bald Mountain across Griffith Diggings, Buck Gulch, and the head of Three Cent Gulch. Another stream, heading in what is now the Greenhorn Mountains, took an easterly course across the sites of the present Parkerville and Winterville "diggings" and probably joined the first one. Other streams, heading in the area north of Sumpter, flowed northwestward over French Diggings and southeastward past the site of Minersville.

Tuff breccias and andesite flows

Andesite tuff-breccias and flows occupy large areas in the Sumpter quadrangle. Tuff-breccias formed by explosive volcanic eruptions underlie extensive areas north of Granite Creek below the town of Granite and in the vicinity of Chicken Hill, and constitute the prevailing formation in the drainage basin of Burnt River. At the head of Three Cent Gulch and on the south slope of Kings Mountain and other localities where erosion has been accelerated, the tuff-breccias tend to form jagged cliffs and pinnacles, but other areas underlain by them have smooth contours except that the surface is usually strewn with fragments of all sizes.

The tuff-breccias are composed of angular and subangular fragments that range in size from sand grains to boulders or blocks 6 feet or more in cross section. In places the formation is a mass of unsorted fragments of different sizes and in places it is made up of alternating beds of coarser and finer textures that show an obscure stratification such as would be produced by running water. The sandy matrix of these beds is light gray; the fragments range from gray to black; rarely they are a dull red. Roughly these rocks are separable into a lower, more persistent group characterized by several varieties of pyroxene andesite, and an upper, less persistent group that consists chiefly of hornblende andesite with small amounts of the pyroxene varieties. On the slope northeast of Burnt River below Trout Creek alternating beds of coarse and fine material are exposed. In the lower beds the larger fragments are chiefly of vesicular black lava with small but conspicuous laths of light gray feldspar. Some layers consist of closely packed small angular fragments, others contain boulders as much as 3 feet in diameter, and still others consist almost wholly of fine waterlaid sand. A section exposed at the south end of Kings Mountain includes 1,200 feet of drab-colored porphyritic hornblende andesite fragments imbedded in a matrix of drab tuff. Above this is a layer 150 feet thick containing water-worn cobbles, which in turn is overlain by 400 feet of breccia with some blocks as large as 10 feet in their longer dimensions.

The cliff on the north side of Granite Creek opposite Clear Creek shows stratified tuff-breccias with medium or small water-worn fragments of vesicular light-gray andesite in an abundant light-gray sandy matrix. Layers exposed in the slope above contain large fragments, some of them being a red porphyritic rock. In beds exposed on the south slope of Chicken Hill both the fragments and the matrix are brick red.

Older basic flows

Following the tuff-breccias extensive flows of basalt and pyroxene andesite were erupted. Existing remnants indicate that the flows were confined mainly to that part of the quadrangle south of Sumpter valley and a portion along the west in what is now the drainage basin of Granite Creek. Typical exposures are of dark dense rock that weathers brown. Vesicular layers occur along the North Fork of Burnt River between China Creek and Third Creek. Locally the rock shows a columnar structure and it tends to form cliffs, of which Sheep Rock is an example.

Rhyolite flows and tuffs

Light-colored lavas and tuffs that were erupted after the older basic flows form a group 50 to 200 feet thick that originally extended over a considerable area in the southeastern part of the quadrangle. Remnants of this group underlie the northeast slope of Kings Mountain and parts of the bordering slopes and terraces of Whitney, Sumpter, and Burnt River valleys. In color and other features the rhyolite group contrasts strongly with the other lavas and therefore affords a ready means of determining geologic structure. The group includes five different varieties, of which the lowest is gray, glassy, and locally laminated. Above this is a gray stony variety, with local zones of black pumice. Above this is the most persistent and typical variety, white to pale red, pumiceous, and locally vesicular rock with here and there a phenocryst of plagioclase feldspar. This variety is succeeded by a darker flow breccia, and above which is a gray to pale brown tuffaceous layer with here and there rounded knobs of dark glass.

Dacite

In the extreme southeastern part of the quadrangle an extensive area is underlain by light-gray crystalline rocks that are closely associated with the andesite tuff-breccias. West of Big Creek near Rattlesnake Gulch are exposures of a light-gray and pale-pink rock that is coarsely porphyritic, weathers to rounded forms like granite, and readily disintegrates to a coarse sand. This rock is associated with the lower part of the tuff-breccias, and preliminary microscopic examination indicates it to be a dacite. The eastward extension of this rock into the Baker quadrangle is described by Gilluly (12) as a light gray porphyry containing phenocrysts of plagioclase and hornblende in a finely crystalline ground mass. The area north of Alkali Springs and east of Beaverdam Creek is largely underlain by dense, light greenish-gray porphyritic rocks, which in the vicinity of Alkali Springs have been hydrothermally altered to a soft, white clay-like mass. All these rocks are provisionally grouped under the head of dacite.

Lake beds

In the southern third of the quadrangle Tertiary beds deposited both in ponds and along stream beds, underlie an area of half a township or more in the benchlands or terraces along Burnt River below China Creek and occupy small areas near Austin, Tipton, and Whitney. Natural exposures of these rocks are poor and most of them are found on the sides of narrow ravines that cut the terraces. In the Burnt River basin they consist chiefly of light-colored, soft, fine-grained beds of clay, sand, and volcanic ash. The best exposure seen in the quadrangle is in the westernmost part of an artificial cut on the "loop" of the Sumpter Valley railroad 1 mile south of Tipton. At that place the formation consists of thin layers of nearly white diatomaceous earth (diatomite) and volcanic sand in alternating layers. The beds dip 8° S. and are overlain by a basic lava flow. Fossil leaves of oaks, willows, maples, redwoods, and other plants contained in them are of Miocene species similar to those of the Mascall formation of central Oregon. The same species were collected from exposures west of Austin, and poorly preserved fragments indicate the beds along Burnt River to be of the same age. In addition to diatomaceous earth and volcanic sand the beds along Burnt River contain some stream alluvium. The formation is estimated to be several hundred feet thick.

Younger basic lavas

Basic lavas erupted after the rhyolite group occupy the drainage basin of the Middle Fork of John Day River almost exclusively and are widely distributed over other parts of the Sumpter quadrangle except the northeast quarter. Most of them are dense to vesicular, dark-colored rocks that weather to shades of gray. Many contain phenocrysts of plagioclase feldspar or olivine. Over some areas they show a platy structure. They commonly weather to small cliffs and bare knobs, and lands underlain by them are likely to be covered with a red clay soil. They appear to consist of many separate flows of local origin and limited extent and of about the same age. Eroded volcanic necks that appear to have been the sources of some of these lavas are represented by a hill on the divide about a mile north of Geiser and by the 6,106 foot summit west of Trout Creek in the northwest corner of the quadrangle. For the most part the basic flows lie directly upon the rhyolite group, but a time interval between them is indicated in places by evidences of erosion.

Structure

In contrast to the complex deformation of the argillite group the structure of the Tertiary rocks is characterized by broad folds and by normal faults that trend northwest and have largely controlled the development of the present topography. In the northern part of the quadrangle the elevation of the rocks into a large dome elongated northwestward is suggested by the attitude of the surrounding lava remnants. A small anticline forms the divide between Sumpter valley and Burnt River; others are indicated on the divide between Whitney valley and the Middle Fork of John Day River, and in the area between Whitney and the Greenhorn district. Intervening areas appear to be wide synclinal troughs.

The folds are greatly modified by normal faults of steep dip, most of which vary little from an average strike of about N. 55° W. Where contrasting formations are fortuitously associated as, for example, in the southeastern part of the quadrangle, the amounts of faulting are readily determined. In that area displacements ranging from one hundred to several hundred feet are shown on individual faults.

Terrace gravels

Stream gravels deposited after the period of Tertiary deformation underlie extensive areas of terraces or benchlands of Sumpter and Whitney valleys where they attain a thickness of as much as 100 feet. Thinner sheets cover Crane Flats, parts of the terraces north of Burnt River below Second Creek, and the smaller terraces along Trout Creek north of the North Fork of John Day River. As a whole these gravels are not coarse and their cobbles not well rounded. Considerable age is indicated by decomposition in place of some cobbles of the less resistant rocks. In Whitney valley the terrace gravels dip rather persistently 5° E. and appear to be elevated on the east sides of faults of small throw which are marked by scarp-like slopes trending northward at right angles to the direction of dip. The gravels described are probably of Pliocene or early Quaternary age and locally contain placer gold.

Glacial drift

Rather large areas in the northern part of the quadrangle are covered by the deposits of glaciers that originated in the higher mountains. The most extensive were formed by glaciers that moved down the valleys of Rock Creek, North Powder River, and North Fork of John Day River. These consist of typical unsorted rock debris including large fragments and boulders. The glaciers ended at moderately low altitudes and there piled up much drift in the form of morainal hillocks, some of them several hundred feet high. Upstream the deposits become thin and patchy. Two layers of drift are shown in the valley of the North Fork of John Day River. The older extends rather far downstream and is characterized by many rust-stained and partly decomposed granodiorite boulders; the newer ends some distance farther upstream and its boulders are practically all fresh and firm. Two drift sheets can be distinguished in the same way along Cracker Creek in the vicinity of Bourne, and it is probable also that two drift sheets exist in the other glaciated valleys, although in most of them only the later one has been recognized. Locally the North Fork drift. as described further on under "Placers" contains gold.

Alluvium

The areas mapped as Quaternary alluvium are confined to flood plains and low bordering terraces. They consist mainly of glacial outwash and later stream deposits, but in some areas, particularly the basins of Burnt River and the Middle Fork of John Day River, may include some deposits of Tertiary age. They form the most valuable of the agricultural lands of the quadrangle and have yielded much of the placer gold that has been produced.

Mineral resources

The most valuable deposits in the Sumpter quadrangle to date are metal-bearing lodes and placers. Resources of potential or prospective value include beds or formations of limestone, diatomite, and other nonmetallic materials.

Lodes

In the Sumpter quadrangle lodes are irregularly distributed through a wide west-trending belt. This belt lies, for the most part, a little north of the middle of the quadrangle, but at the west edge it spreads somewhat to the south. The largest lode, the North role-Columbia vein or "Mother Lode" is a single vein or mineralized fracture that is shown by exploratory workings to be certainly 12,000 feet and probably 15,000 feet or more long. Its greatest explored depth, as shown by the Columbia shaft, is 819 feet, but the total vertical distance between the highest outcrop and the bottom of this shaft is 2,500 feet. Other veins show explored lengths and depths ranging from a few hundred to 3,000 feet. Many of the veins are alined so as to form systems as, for example, the Cougar, Independence, Magnolia, Buffalo, and La Bellevue veins north of Granite, which form a group of nearly continuous and parallel fractures about 6 miles long. Similar less extensive groups are formed by the Ibex, Bald Mountain, Belle of Baker, and Mammoth, and the Highland, Maxwell, and Baisley Elkhorn. In all the groups and the Mother Lode the prevailing strike is northeastward and most of the veins dip steeply southeast. The veins are emplaced mostly in the zone of sedimentary rocks (argillite group) that adjoins the granodiorite batholith; some of them cross the contact and a few are entirely within the intrusive body. The veins in the Greenhorn and adjacent districts at the west edge of the quadrangle show considerable variation in strike and dip. Most of them are at the contacts between gabbro or metagabbro and serpentine or peridotite, though they are probably genetically related to a granodiorite batholith a short distance to the west just outside the quadrangle.

The veins are largely composed of quartz accompanied by different amounts of pyrite, arsenopyrite, sphalerite, and galena; however some veins in the Greenhorn district contain much carbonate (dolomite). Complex silver-bearing sulphides and the sulphides of antimony and mercury are found less commonly. Gold is present in all the lodes. It occurs most commonly as fine metallic specks and threads. Ore shoots or parts of the veins that contain enough gold or other metals to be valuable vary greatly in size and form. Most of them range from a few feet to 1,000 feet or more in length and depth and from a few inches to 4 or 5 feet in average width. A maximum width of 30 feet occurs at places in the "Mother Lode". Likewise the gold content of the ore varies from place to place. Much ore containing less than 1 ounce to the ton has been profitably mined and good-sized shoots averaging from 5 to 10 ounces to the ton have not been uncommon. Some value is added to many of the lodes by minerals containing silver and lead. The amounts of sphalerite (zinc sulphide) present in several ores is sufficient to add to their value provided suitable methods for treating the ore can be applied. Several of the mines have produced from $40,000 to $4,000,000 each, chiefly in gold, and the aggregate value of the gold and other metals produced by the Mother Lode is estimated at more than $8,000,000.

Placers

A placer deposit, as generally understood, is a body of alluvial or other superficial material containing gold or some other valuable mineral that may be profitably extracted by simple washing. Placer gravels have a more general distribution in the Sumpter quadrangle than metalliferous lodes. Some of them, for example those of Miners Creek, Buck Gulch and upper Bull Run Creek, are well removed from known areas of lode mineralization, but in general the placer deposits form a fringe closely associated with such areas and extending beyond them in the direction of drainage.

Most of the remnants of Tertiary gravels in the quadrangle are gold-bearing and, in fact, it is probable that they have produced as much if not more than the later deposits. In the past the Tertiary gravels were extensively mined at French Diggings on the divide between Trail creek and the North Fork of John Day River, at the "ghost" mining camps of Winterville and Parkerville east of Greenhorn, and at the Weaver and Griffith mines near the divide at the head of Buck Gulch west of Sumpter.

In places the early Quaternary terrace gravels contain enough gold to form placers and they have been mined to a small extent at Crane Flats and near Sumpter. Many of the placer gravels in the Sumpter quadrangle are in the same drainage basins as the lodes and not far below them. This association is illustrated by the deposits along Olive Creek and other streams that drain the Greenhorn district, and by those along Bennett Creek and Granite Creek, which drain respectively the Bonanza district and the area containing the Monumental, Buffalo, and other mines. The material composing these deposits is ordinary stream alluvium of Quaternary age and, near the lode outcrops, it may also include surface mantle not classified or rearranged by stream action. In the glaciated areas ice action has interrupted and modified the ordinary process of placer deposition as illustrated in the vicinity of Bourne. In that district the upper course of Cracker Creek, which drains an area containing the outcrops of the rich Mother Lode and other gold veins and would therefore be expected to contain placers, is practically barren. This condition is the result of glaciation which repeatedly scoured the valley of its placer gravels, transported them farther downstream, and diluted them with much unsorted drift. Since the ice disappeared, time has been relatively so brief that the stream has been able only to rework the mixed material into the lean placers found along its lower course. In the same way is to be explained the absence of placers or the presence of lean deposits only, along the glaciated valleys of Rock Creek, Silver Creek, upper McCully Fork, and other streams that drain areas of lode mineralization.

An exceptional placer deposit includes the North Fork or Klopp mine and other workings situated along the North Fork of John Day River near the mouth of Trail Creek. It is a heterogeneous bouldery mass forming the terminal moraine of the earlier glacier that descended the North Fork. Extensive workings made in it before 1909 show the material to be of low grade, but an abundant water supply and other favorable conditions have made possible the profitable working of a large part of the mass. Apparently the gold was derived from older placer gravels that lay in the path of the glacier and were plowed up and incorporated in the moraine.

In several of the valleys Quaternary gravels that were too poor or too difficult for the "early day" miners to work have, in later years, yielded much gold by dredging. A large deposit of this type in Sumpter valley was actively mined for a number of years after 1914 and again since 1936.

Chromite

The "black sand" residues of placer mining in and near the Greenhorn district contain grains of chromite, and cobbles of the same mineral are said to have been found in the gravel. The serpentine and peridotite masses are indicated as the probable sources of the chromite, but information is lacking as to the size of the bodies that they may contain.

Quicksilver

Cinnabar and other quicksilver minerals have been found in several of the lodes, particularly those of the Greenhorn district. So far as known the amounts of these minerals are too small to be worthwhile sources of the metal.

Limestone

Lime has been burned from small bodies of limestone a mile and a half southeast of Sumpter and at a point on Marble Creek near the eastern limit of the quadrangle. The large exposure of marbleized limestone at Marble Point and the numerous smaller bodies on Elkhorn Ridge and elsewhere have not been developed. Superficial examinations indicate that many of them are free from chert or other noticeable impurities and composed of essentially pure calcium carbonate.

Iron ore

In the years 1904 and 1905 about 100 tons of iron oxide ore, used for fluxing by the Sumpter smelter, was said to have been mined on the Lazy Jim claim at the pass in the divide south of Sumpter valley, which is traversed by the Sumpter Valley Railway. The ore occurs in altered peridotite and gabbro near an outcrop of limestone and its texture suggests it to be the oxidized outcrop of a contact-metamorphic body. Analyses reported by the smelter show an iron content of 40 to 48 percent, silica 10 to 15 percent, and from 0.04 to 0.12 ounce of gold and 0.18 to 0.38 ounce of silver to a ton.

Diatomite

Diatomaceous earth more or less mixed with other materials forms a considerable part of the volume of the Tertiary lake beds in the Sumpter quadrangle. White, loosely coherent beds of the unmixed diatomite are exposed to a thickness of 10 feet by a cut on the logging railway 3 miles northwest of Whitney and half a mile north of Irvines Ranch on Burnt River. Elsewhere, relatively pure diatomite forms portions of a 40-foot bank of soft light-colored beds exposed by the westernmost cut on the "loop" of the Sumpter Valley Railway south of Tipton, and is found a short distance west of Austin and along the road south of the ranger station on the Middle Fork of John Day River. It is probable that diatomite is to be found also in the Tertiary beds of the Burnt River Valley.

Volcanic ash

Volcanic sand and dust, composed essentially of splinters of volcanic glass, constitutes a large part of the Tertiary lake beds and is the chief component of a widely distributed fine, dusty, light-colored top-soil. In places this material is several feet thick, as shown in the banks of placer mines along Granite Creek, near the Independence Mill, along the stage road half a mile below Bourne, and elsewhere.

Building stone

The vast bodies of granite and other rocks in Sumpter quadrangle suitable for building purposes have not been developed except for local needs. A light-gray andesite that is easily dressed and resembles granite has been quarried along the road 1½ miles southeast of Granite and used for a few buildings in that town and Sumpter. The rock mass affords sound columnar blocks from 1 to 2 feet in diameter and 6 feet or more in length. The rhyolite that occurs extensively in the south half of the quadrangle apparently could be exploited for gray tuffs like those quarried at Pleasant Valley near Baker, and for stone that, because of its pleasing pink and terra cotta shades, might be suitable for ornamental purposes.

Road metal

A coarse sand that mantles the areas of dacite along Big Creek in the southeast corner of the quadrangle has been used locally as a road-surfacing material. It appears to bind well and to form a hard smooth surface that does not wash easily or become muddy.

Published reports

Below, arranged in chronologic order, is a selected list of reports that describe the Sumpter quadrangle or adjacent areas.

(1) Lindgren, Waldemar, The Gold Belt of the Blue Mountains of Oregon: U. S. Geol. Survey 22d Ann. Rept., part 2, pp. 551-776, 1900.

(2) Pardee, J. T., Faulting and vein structure in the Cracker Creek gold district, Baker County, Oregon: U. S. Geol. Survey Bull. 380, pp. 85-94, 1909.

(3) Pardee, J. T., Placer gravels of the Sumpter and Granite districts, eastern Oregon: U. S. Geol. Survey Bull. 430, pp. 59-65, 1910.

(4) Pardee, J. T., and Hewett, D. F., Geology and mineral resources of the Sumpter quadrangle: Oregon Bur. Mines and Geology, "The Mineral Resources of Oregon." vol. 1, no. 6, pp. 6-130, Oct. 1914.

(5) Grant, U. S., and Cady, G. H., Preliminary report on the general and economic geology of the Baker District of eastern Oregon: Oregon Bur. Mines and Geology, "The Mineral Resources of Oregon," vol. 1, no. 6, pp. 131-161, Oct. 1914.

(6) Swartley, Arthur M., Ore deposits of northeastern Oregon: Oregon Bur. Mines and Geology, "The Mineral Resources of Oregon," vol. 1, no. 8, pp. 1-229, Dec. 1914.

(7) Parks, H. M., and Swartley, A. M., Handbook of the mining industry of Oregon, "The Mineral Resources of Oregon," vol. 2, no. 4, pp. 1-306, Dec. 1916.

(8) Westgate, L. G., Deposits of chromite in eastern Oregon: U. S. Geol. Survey Bull. 725, pp. 37-60, 1922.

(9) Hewett, D. F., Zonal relations of the lodes of the Sumpter quadrangle (eastern Oregon): Trans. Am. Inst. Min. Met. Eng. 1931, pp. 305-346, 1931.

(10) Gilluly, James, Copper deposits near Keating, Oregon: U. S. Geol. Survey Bull. 830, pp. 1-32, 1933.

(11) Gilluly, James, Reed, J. C., and Park, C. F., Jr., Some mining districts of eastern Oregon: U. S. Geol. Survey Bull. 846, pp. 1-140, 1933.

(12) Gilluly, James, Geology and mineral resources of the Baker quadrangle, Oregon: U. S. Geol. Survey Bull. 879, 1937.

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