OCCURRENCE OF SCHEELITE IN OREGON

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Small isolated occurrences of scheelite have been known in Oregon for many years. Scheelite was found in northeastern Oregon in the Virtue district of Baker County in 1901 according to Pratt[1] and Lindgren[2]. In southwestern Oregon, scheelite was reported to have been detected in the gold placers of Foots Creek in Jackson County as early as 1909 according to early-day miners. These occurrences and most others reported since then have attracted little attention because they seemed too small to be worth exploring. In 1949 scheelite was found in two separate places near Ashland, Jackson County, in deposits of possible economic interest and with geological associations that could be duplicated in other parts of southwestern and northeastern Oregon.

Tungsten mineralization is related to the intrusive masses of granite, granodiorite, and quartz diorite of late Jurassic or early Cretaceous age found in the Klamath Mountains of southwestern Oregon and the Blue and Wallowa Mountains of northeastern Oregon. Scheelite, the only tungsten mineral so far identified in Oregon, occurs in contact metamorphic deposits and in quartz veins and shear zones. Gangue minerals in the contact metamorphic deposits include epidote, quartz, garnet, calcite, diopside, and wollastonite. In addition to scheelite many of the contact zones in northeastern Oregon contain pyrite, chalcopyrite, and molybdenite.

Southwestern Oregon

The Oregon Department of Geology and Mineral Industries began an investigation of tungsten occurrences in southwestern Oregon in April 1949 soon after the discovery of scheelite-bearing tactite on the Bratcher property (1)* 2½ miles southwest of the city of Ashland in Jackson County. Late in 1949 attention of the Department was directed to a tactite zone carrying scheelite near the tunnel of the Mattern mine (2), one of the early gold quartz mines of the area and inactive for many years. It is approximately 3 miles north of the Bratcher property and is on the Southern Pacific Railroad right-of-way 1 mile northwest of Ashland. Subsequent discoveries of scheelite have been made at the Blue Star (5) and Lucky Strike (6) prospects in the Foots Creek area of western Jackson County about 20 miles northwest of the first two properties.

About 240 tons of ore from the Bratcher mine was shipped by the Bratcher Mining Company to the Tulare County Tungsten Mines plant at Lindsey, California, in 1949 and yielded about 174 units of WO_3. The initial shipment of about 100 tons yielded 109 units of WO_3. Early in 1950 the Bratcher property was leased to the Ashland Mining Company which milled about 350 tons of tactite and recovered about 35 units of WO_3.

General Geology: Tungsten occurrences so far found in southwestern Oregon are limited geologically to a thick series of metamorphosed volcanic and sedimentary rocks which are exposed over a broad area in Jackson and Josephine counties. These rocks have been termed the Applegate group by Wells, Hotz and Cater[3]. With few exceptions scheelite deposits are found in

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* Numbers in parentheses are the same as key numbers on index map, fig. 1.

strongly metamorphosed portions of the Applegate group that are marginal to quartz diorite intrusives.

As mapped by Wells and others[3,4,5], the Applegate group extends west about 34 miles from the overlap of Tertiary rocks in the Medford quadrangle to the contact with the Jurassic Galice formation in the northwestern part of the Grants Pass quadrangle. Based on fossil determinations by Reeside, the rocks of the Applegate group have been assigned to the Mesozoic era, probably upper Triassic, by Wells, Hotz and Cater[3].

Metavolcanics of the Applegate group consist largely of gray-green andesitic and basaltic lavas. Many of these layers contain abundant calcite, concerning which Wells and others[4] state: "The abundance of calcite in many of the layers suggests that the lavas flowed into a basin and mixed with limy mud that was accumulating there, and finally consolidated as a vesicular breccia bound together by a calcareous matrix." Metasedimentary rocks which are found as lenticular interbeds in the metavolcanics include argillite, chert, quartzite, conglomerate, and marble.

Numerous irregular masses of moderately to highly siliceous granitic rocks are intrusive into the Applegate group in both the Medford and Grants Pass quadrangles. According to Wells and others[4,5], quartz diorite is probably the most abundant type of intrusive rocks but both granodiorite and diorite are common in certain areas. Along most contacts with the intrusives, the rocks of the Applegate group show contact-metamorphism which has formed a variety of types including schist, gneiss, quartzite, amphibolite, marble, and lime-silicate rocks.

Bratcher Mine: The Bratcher mine is located both within and near the western margin of a large intrusive granitic mass called the Ashland stock.

As described by Wells and others[4], this stock is more than 18 miles long and 10 miles wide and comprises several granitic rock types of which quartz diorite is predominant and granodiorite is common. Mt. Ashland, which is near the center of the mass, is largely a porphyritic granite. Aplitic and pegmatitic dikes are numerous throughout. On the west the stock is bounded by the metavolcanic-metasedimentary rocks of the Applegate group and many inclusions of metamorphic rocks, varying widely in size, occur within the intrusive.

The rocks in the immediate area of the Bratcher mine are predominantly quartz diorite and granodiorite but also included are many small bodies of metamorphics. Distribution of principal rock types in the mine area is shown on the geologic map (fig. 2). Descriptions of these rocks follow.

The quartz diorite is a massive, medium-grained, dark gray rock composed of approximately equal amounts of dark and light minerals. It weathers readily and to great depth. Under the microscope it is seen to consist of 45 percent plagioclase feldspar (andesine Ab_{64}), 30 percent hornblende, 18 percent biotite, 5 percent quartz, and 2 percent accessory minerals, including apatite, magnetite, pyrite, and zircon.

Several granodiorite bodies crop out on the prominent ridge northeast of the main development cut. The granodiorite is a fine-grained light-gray rock frequently showing notable lineation of biotite flakes. In places the granodiorite assumes a definite gneissic character. Its relationship to adjacent rocks is not known. Under the microscope it is seen to consist essentially of the following: 55 percent oligoclase (Ab_{84}), 34 percent quartz, 10 percent microcline, and 1 percent biotite.

Pegmatite dikes are extremely common throughout the area and range from a few inches to 30 feet or more in width. The larger dikes, with few

exceptions, strike northeast and dip 50° to 60° SE. cutting all other rocks in the area. These larger dikes are composed mainly of potash feldspars and quartz but sometimes contain a minor amount of biotite. Graphic texture is frequently well developed.

A few small light-gray quartz-diorite dikes cut the main tactite lens (see fig. 3). These dikes also cut the dark-gray quartz-diorite country rock which surrounds the tactite body and are closely associated with small pegmatite dikes. Under the microscope a thin section of a sample from one of these quartz-diorite dikes is seen to consist of 65 percent plagioclase feldspar (andesine Ab_{62}), 6 percent microcline, 8 percent quartz, 20 percent hornblende, and 1 percent zircon.

Metamorphic rocks found as inclusions within the quartz diorite, are chiefly schist but also include four lenses of tactite which are described separately. These inclusions are believed to represent detached portions of the Applegate group. Schist occurs as lenses or blocks ranging in size from a few inches to a few tens of feet across. The schist bodies weather easily and are too irregular and too poorly exposed to be mapped separately from the enclosing quartz diorite. With few exceptions the schistosity shows a dip to the northwest, usually at a low angle.

The tactite was formed by replacement of small lenses of calcareous rocks, probably impure limestone. Localization of the scheelite was due probably in part to favorable texture, porosity, and chemical composition of certain portions of the calcareous lens. Fractures and cross fractures apparently have been responsible for the heavier concentrations of scheelite. Principal concentrations of scheelite occurred a few feet south and about 30 feet north of a fault zone in the largest tactite lens (see fig. 3).

Fractures are common in this section of the lens, and the more closely fractured zones are coincident with the heaviest concentrations of scheelite.

Mining has been confined to the largest or main lens of contact metamorphic rocks 150 feet long and having a maximum width of 28 feet (see fig. 3). Development work consists of one main open cut 250 feet long averaging about 25 feet in width and from 10 to 15 feet in depth. In addition there are bulldozer cuts totaling more than 4,000 lineal feet.

The main lens is composed largely of tactite but in places includes considerable amounts of dense, closely banded, green hornfels. In a few places light-colored lime silicates, largely wollastonite, are abundant. It was impractical to map and describe these portions separately, therefore they are included with tactite. The tactite consists essentially of variable amounts of epidote, quartz, garnet, and diopside. Mineralization, including scheelite concentration, in the south half of the lens is somewhat different from that in the north half.

The south half of the lens is composed mainly of diopside; garnet, probably in the grossularite-almandite range; and wollastonite. Quartz and calcite are also present in lesser amounts. In an east-trending cut about 38 feet south of the fault and north of the main cut the lens consists essentially of three bands: a narrow band of hornfels (diopside-quartz) along the eastern margin; a band of tactite composed of diopside and garnet in the central part; and a zone composed mainly of wollastonite and garnet along the west margin of the lens. Scheelite, in local concentrations, is restricted to portions of the wollastonite-garnet zone. The lens here is cut by two prominent quartz-diorite dikes and numerous small pegmatite dikes.

Tactite in the north half of the lens, which contained the highest concentration of scheelite, is a medium- to coarse-grained rock composed of

varying amounts of epidote, garnet, and quartz. In this part of the lens most of the scheelite occurred as finely disseminated grains, but within a few feet north and south of the fault, shown on fig. 3, coarse subhedral to euhedral crystals of scheelite an inch or more in diameter were abundant (now mined out) in a very coarse-grained garnet-epidote-quartz tactite.

The fault indicated on fig. 3 strikes N. 70° W. and dips 70° SW. The exact displacement could not be determined but it is believed to be rather small, possibly only a few feet. Two sets of fractures are apparent in this portion of the lens. One set, which is found south of the fault, strikes N. 70° W. and dips to the northeast at high angles. A second set of fractures, north of the fault, strikes N. 70° E. and dips to the southeast at moderate angles. Both the fault and the fractures are believed to have been formed prior to introduction of solutions which produced the tactite.

A narrow lens of tactite occurs 50 feet south of the main tactite body. It is composed of epidote and quartz and shows local concentrations of scheelite in surface cuts. To the north the lens appears to pinch out and to the south it abuts against a prominent pegmatite dike. Another small occurence of tactite was noted adjacent to a large pegmetite dike 700 feet east of the main tactite body (see fig. 3). It is but a few feet in width and contains only occasional widely scattered grains of scheelite as exposed in shallow exploration cuts. The zone is composed in part of garnet, wollastonite, and quartz.

Mattern Tungsten Deposit: The deposit occurs in a narrow frings of metavolcanic rocks of the Applegate group which are exposed along the northern margin of the Ashland stock northwest of Ashland. Scheelite occurs in a

tactite body which has been exposed by a railroad cut about 300 feet northwest of the portal of the Mattern mine tunnel. The tactite occurs in strongly metamorphosed volcanic rocks in an apparent interfingering of the metavolcanics with the granitic rocks along the margin of the stock. A vertical cross section of the tactite zone and other rocks exposed in the railroad cut is shown in fig. 4.

The principal metavolcanic rock in the section is a dark gray, porphyritic meta-andesite which is exposed on both sides of the tactite zone. To the northwest it passes into a zone of mixed types of rather strongly metamorphosed volcanic rock with some injected diorite. The meta-andesite extends southeast from the tactite body about 50 feet to the contact with diorite. The tactite zone and the adjoining porphyritic meta-andesite to the southeast are cut by a narrow meta-andesite dike which forms the southeast wall of the tactite zone for several feet.

The principal exposure of diorite in the immediate area is southeast of the tactite zone, where it is exposed along the railroad cut for about 100 feet.

Two narrow light-colored siliceous granitic dikes which cut the metavolcanics are exposed in the cut northwest of the tactite body. One of these dikes cuts the metavolcanics about 20 feet northwest of the tactite zone and, a few feet below the top of the cut, turns sharply to the southeast merging into the apex of the tactite body.

The tactite, which is exposed only in the railroad cut, is 12 feet in width at the base of the cut narrowing to possibly 2 feet in width at the top. It has not been traced at the surface along its strike either to the northeast or southwest. The tactite is composed essentially of quartz, epidote, and calcite. Scheelite occurs finely disseminated throughout the zone but in places there are concentrations of coarse grains. Individual pieces in these concentrations are as much as 2 inches in diameter. Many of the heaviest concentrations occur around the margins of small masses of calcite which are irregularly distributed throughout the tactite. Scheelite was noted in particular abundance immediately below the meta-andesite dike which cuts the tactite. A 3-foot channel sample taken near the top of the tactite exposure contained 1.15 percent WO_3 and a 7-foot channel sample taken near the middle of the exposure contained 2.43 percent WO_3.

The tactite zone has not been exposed sufficiently to permit other than a few general observations concerning the origin and localization of the scheelite. A genetic relationship is suggested between the tactite and the small siliceous granitic dike which cuts the metavolcanics about 20 feet northwest of the tactite zone. The meta-andesite dike which cuts the tactite zone appears to have been at least partially responsible for the heaviest concentrations of scheelite.

Other Scheelite Occurrences: At the Sylvanite mine (3), about 15 miles east of Grants Pass and 3 miles northeast of Gold Hill, scheelite occurs in quartz veins in metavolcanic rocks. The veins at this mine have been worked mainly for their gold content and very little, if any, development work has been done to explore the tungsten possibilities.

Three tungsten prospects, the Lady Slipper (4), the Blue Star (5), and the Lucky Strike (6), are located on Foots Creek about 12 miles southeast of Grants Pass. At the Lady Slipper strongly metamorphosed volcanics along the contact with a small quartz diorite mass in places contain disseminated grains of scheelite. The scheelite at the Blue Star and Lucky Strike prospects also occurs as scattered grains in metavolcanics and pale lime-silicate rocks marginal to a quartz-diorite intrusive. In 1951 the Cordero Mining Company completed 2,000 lineal feet of bulldozer trenches at the Blue Star prospect and the owners had previously done some test pitting.

In southwestern Jackson County on Brush Creek, scheelite is associated with cinnabar in well-defined shear zones in metavolcanic rocks at the Mocks Gulch (7) and Rattlesnake prospects (8).

Northeastern Oregon

In order to present a more complete picture of the distribution of scheelite in Oregon, a brief review of occurrences in northeastern Oregon is included. No field work on these deposits has been done by the writers, and the information below is summarized from the literature available.

Descriptions of tungsten deposits in this part of the State are sketchy. Very little exploration work has been done on these occurrences, many of which consist merely of the identification of scheelite in small amounts in

quartz veins or in tactite zones between granodiorite or quartz diorite and limestone.

Scheelite was reported by Lindgren[2] at the Cliff mine (9) about 5 miles northeast of Baker near the southwestern edge of the Farley Hills. In addition, scheelite has been identified at the Davis prospect (10) on the eastern slope of the Elkhorn Mountains; at three properties the Scheelite (11), the Tungsten claim (12), and the Chicken Creek mine (13) along the headwaters of Chicken Creek approximately 14 miles north of Huntington and 4 miles northeast of Weatherly; and at four properties Frasier (14), Le Gore (15), Wilmot (16), and Metzger (17) in the Wallowa Mountains along the northeastern edge of the Wallowa batholith. Three of these localities are in Wallowa County, one is in Union County, and five are in Baker County (see index map to localities).

According to Gilluly, Reed and Park[8] the vein at the Cliff mine consists of 1 to 3 feet of quartz with a little calcite in altered gabbro. In 1916 and later, attempts, largely unsuccessful, were made to produce scheelite.

At the Wallowa Mountains properties the scheelite is found in tactite formed along contact zones between limestone and granodiorite or quartz diorite. Garnet, epidote, calcite, and quartz are predominant minerals of the tactite, which usually contains sparsely disseminated molybdenite, pyrite, chalcopyrite, and scheelite. Hess and Larsen[10] present the following information in regard to the Frasier prospect at the head of the west fork of the Wallowa River about 18 miles south of Joseph, Oregon:

> "At the prospect a thick series of alternating marbles, quartzites, and schists are intruded by a large body of quartz diorite striking about N. 70° E. and dipping about 50° S. 20°W. Along much of the marble-diorite contact there is little tactite, but about a semicircular outcrop of marble a few hundred feet across that is nearly surrounded by diorite the tactite zone is from a few feet to 20 feet or more in width and the adjoining diorite has itself been considerably metamorphosed.

"The outcrop and geologic relations of the tactite indicate a body of moderate size. Along the borders of quartz lenses there are some bunches that are rich in scheelite."

Narrow quartz veins and seams from 1 to 16 inches in width occur in quartz diorite at the Chicken Creek prospects and have been worked for their gold content for many years. Scheelite has been noted in the veins and in adjacent placer gravels. According to Fitzsimmons[9] the scheelite occurs as incrustations on the quartz, in fractures in the quarts, and like a powder on vein walls; the amount was insignificant. No assays of samples from this area for tungsten have been recorded.

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Abstract

Scheelite was reported in the Virtue district of Baker County in northeastern Oregon about 1900. Other occurrences, eight in southwestern Oregon in Jackson County and eight in northeastern Oregon mainly in Baker and Wallowa counties, have been discovered since then. They attracted little attention until scheelite was found in tactite at two localities, the Bratcher and the Mattern, near Ashland, Jackson County, in 1949. Investigation of tungsten occurrences in southwestern Oregon was begun by the Oregon Department of Geology and Mineral Industries in April 1949 soon after the discovery of scheelite on the Bratcher property. Field investigations by the authors has been limited to the localities in southwestern Oregon with greatest emphasis on the Bratcher and Mattern deposits. Exact information pertaining to scheelite in northeastern Oregon is meager and for the most part confined to brief references in the literature.

Tungsten mineralization is apparently related to the intrusive masses of granite, granodiorite, and quartz diorite of late Jurassic or early Cretaceous age in the Klamath Mountains of southwestern Oregon and the Blue and Wallowa Mountains of northeastern Oregon. Scheelite occurs in contact metamorphic deposits of tactite and in quartz veins and shear zones. With few exceptions the deposits in southwestern Oregon consist of tactite lenses or quartz veins in strongly metamorphosed portions of the Applegate group marginal to masses of quartz diorite. A thick series of metamorphosed volcanic

and sedimentary rocks constitute the Applegate group, which is believed to be upper Triassic in age. The three tactite lenses and associated metamorphics contained within quartz diorite on the Bratcher property probably represent included portions of the Applegate group.

Predominant gangue minerals in the tactite deposits are epidote, garnet, quartz, calcite, diopside and wollastonite. In northeastern Oregon the tactite also contains pyrite, chalcopyrite, and molybdenite.

Recent exploration has been limited mainly to the Bratcher, Mattern, and Blue Star properties of Jackson County. Development work at the Bratcher mine consists of one main open cut 250 feet long averaging about 25 feet in width and from 10 to 15 feet in depth and additional bulldozer cuts totaling more than 4000 lineal feet. Not enough exploration has been done at the Mattern deposit to permit any estimate of the extent of the tactite lens. A 3-foot channel sample taken near the top of the lens and a 7-foot channel sample from the middle of the exposed portion of the lens contained 1.15 and 2.43 percent tungsten trioxide, respectively. In 1951 the Cordero Mining Company completed 2000 lineal feet of bulldozer trenches at the Blue Star prospect, one of three tungsten prospects in the Foots Creek area of western Jackson County, and the owners had previously done some test pitting.

Although attempts, largely unsuccessful, were made to produce tungsten from the Cliff mine in the Virtue district of northeastern Oregon about 1916, the only recorded production has been from the Bratcher mine. This production consisted of 240 tons of ore in 1949 and an estimated 350 tons of low-grade scheelite-bearing rock in 1950. About 174 units of tungsten trioxide were concentrated from the 240 tons mined in 1949, and the initial shipment of about 100 tons of this yielded 109 units.