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STRAWBERRY MINE, MADERA CO., CALIFORNIA

By
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INTRODUCTION

The Strawberry mine is about 2 miles NNW of Clover Meadow, in the south-central part of the Mt. Lyell quadrangle (N½ sec. 36, T. 4 S., R. 24 E., MD B & M). It is reached by 31 miles of fair mountain road from Bass Lake, which is about 70 miles by paved highway northeast of Fresno.

The mine is at an altitude of 7,200 feet, and the road to the mine crosses a pass over 8,000 feet high. Snow blocks the road and seriously hinders mining operations for six months of the year. An attempt was made to keep the mine open through one winter (1943-44), but the operation was unprofitable.

Workings consist of four open cuts, adits and drifts totaling about 550 feet, and several small stopes.

The original claims were located by J. E. Cobb and J. A. McDougald in 1941, and were leased to Haggerty and Madden of Fresno (at one time called "Northumberland Mining Company"; the name seems to have been dropped). The general superintendent is Walter R. Lenhart. Production was continuous from June 1943 to November 1944 and was resumed in July 1945.

Several other tungsten claims (Jimmie, Cloverleaf Nos. 1 and 2, Hilltop, and Ward Brothers) have been located near the Strawberry mine, but none except the Jimmie claim has produced ore or gives much promise of future production.

The Strawberry area was investigated by D. H. Wyant in 1942, before active production had started. The writer spent three weeks at the mine in August and September 1945. The work consisted of (1) areal mapping on

airplane photographs (pl. 1), (2) a plane-table survey around the principal workings (pl. 2), and (3) detailed maps of the workings themselves (pls. 3 and 4).

Geology

The mine and adjacent claims are near the north end of a large pendant of metasedimentary and metavolcanic rocks which extends for an unknown distance southward beyond Clover Meadow. Intrusive rocks surround and embay the pendant, cuttin it in innumerable dikes too small to show on the scale of Plate 1. Except where locally concealed by basalt and glacial debris, exposures of the older rocks are excellent.

The metamorphic rocks south of Granite Creek consist chiefly of fine-grained quartz and feldspar, with streaks and small lenses of biotite which give a conspicuous foliation. These rocks are intricately dissected by aplite and alaskite in dikes and irregular masses. So similar in composition are the metamorphic and intrusive rocks that a distinction between them is difficult wherever the metamorphic foliation is faint. Time was not available to map the two carefully, so the area is simply labeled "aplite-metarhyolite migmatite" to indicate that the rocks are the equivalents of siliceous tuffs and lavas intimately mixed with siliceous intrusive material.

North of Granite Creek the commonest metamorphic rocks are fine quartzites, siliceous hornfelses, and quartz-sericite schists. Interbedded with these are discontinuous layers and lenses of biotite schist and lime-silicate hornfels. The latter is normally a fine-grained, greenish-gray rock with rough and fluted surfaces where exposed to the weather; it changes to a great variety of garnet-pyroxene-wollastonite-calcite rocks near intrusive contacts. Pure calcite limestone or marble is scarce, appearing only in thin layers and lenses; it is most abundant at the Strawberry No. 4 claim (pl. 4). The south-to-north change from metavolcanic to metasedimentary rocks is not as abrupt as

it appears on the map, and probably represents a facies change from dominantly tuffaceous sediments to dominantly sandy, clayey, and limy material.

The intrusive rocks are grouped as (1) granodiorite, including hornblende-biotite granodiorite, fine biotite granodiorite, and a number of peculiar textural types; (2) migmatite, meaning chiefly granodiorite with abundant dark xenoliths but including also dark, structureless intrusive rocks with the composition of diorite or mafic quartz diorite; and (3) aplite, including not only true aplite but alaskite and locally a little pegmatite. This division gives an inadequate picture of the actual multiplicity of intrusive types; and the sharp boundaries shown on the map are a great simplification of the frequently complex or gradational contacts between intrusives and between intrusive and metamorphic rocks. In general the sequence of intrusives is migmatite-granodiorite-aplite, but the times of intrusion were probably not far apart. No evidence was found that any one intrusive is more closely associated with tungsten mineralization than another.

Foliation in the metamorphic rocks trends dominantly north-south in the central part of the area diverging to the northwest on the western side of the pendant and to the northeast on the east side. Foliation dips steeply in both directions, generally eastward on the east side and westward on the west side of the pendant. In general foliation parallels bedding; but in schist west of Strawberry No. 4 claim, foliation cuts the bedding at a high angle; in lime hornfels near intrusive contacts extreme deformation often gives banding in directions unrelated to original beds. Foliation in migmatite is commonly about parallel to that in adjacent schist, but on Strawberry No. 1 claim cuts it at a high angle.

The general structure of the north end of the pendant may be pictured as four radiating fingers of lime hornfels with crumpled schist between--as

if the granodiorite, pushing its way into the pendant from the north, had forced the more resistant layers apart and crushed the weaker beds between.

Tungsten deposits

Scheelite-bearing tactite appears chiefly near the north ends of the lime-hornfels "fingers." In the westernmost finger, west of Granite Creek, a little scheelite is found in a small body of tactite on the Cloverleaf claims. The Strawberry No. 1 claim and the Jimmie claim are at the north end of the discontinuous second finger. The Strawberry No. 4 deposit is at the end of the main part of the third finger; a bent and intricately crumpled extension of the third finger extends north beyond the tungsten deposit. Near the tip of the easternmost finger are the tiny pockets of richly mineralized tactite which make up the Hilltop claim. The Ward Brothers claim, at which no scheelite was observed, is in a small lens of limy rocks to the south of the Hilltop claim.

The tungsten-bearing tactite is an alteration of lime-silicate hornfels at intrusive contacts and along certain beds of the hornfels near contacts (pls. 2, 3, 4). Locally the tactite cuts across beds in irregular masses and stringers. No evidence was found for control of tactite formation by faults or shear zones.

Several varieties of tactite can be distinguished. Commonly progressive alteration of lime hornfels gives (1) fine garnet-pyroxene-calcite rock in light pastel shades; (2) dark-green pyroxene-epidote rock; (3) dark pyroxene-garnet-quartz rock. Most of the scheelite is in the third type, but locally some appears in the other two. The distribution of scheelite in the tactite is erratic; about the only safe generalization is that ore is often richest near small dikes cutting tactite. These dikes may be entirely granodiorite or aplite, but more commonly change in character from normal granodiorite to

aplite or pegmatite and even to quartz veins. Most commonly tactite for the first few inches from an intrusive contact is barren, but locally scheelite appears in quartz veinlets cutting granodiorite and even as an apparently essential mineral of the intrusive.

Scheelite is mostly in small crystals (less than 1/16 inch in diameter), locally in large crystals as much as 2 inches long. Some fluoresces yellow, some white; a large crystal often shows both colors. Sulfides commonly present with scheelite are pyrite and black sphalerite; chalcopyrite and pyrrhotite are rare. Molybdenite appears locally close to intrusive contacts. The ore is said to be fairly high in phosphorus.

No. 1 Claim (pls. 2 and 3). Three principal ore bodies have been explored at the north end of the No. 1 claim: (1) In the "main workings" (pls. 2, 3a, b, e, f, h) ore follows a lime hornfels bed for 80 feet from the migmatite contact. The ore has averaged about 2 percent WO_3 over a 12-foot width for nearly 50 feet from the surface. A southward extension of the ore body seems unlikely since on both underground levels the tactite grows thin and lean in that direction, and since the open cut 200 feet south along the strike of the bed (pl. 2) exposes only barren tactite. (2) In the large open cut east of the main workings (pls. 2, 3d, e) a pocket of rich ore (4 percent WO_3) was found at the migmatite contact. Here the metamorphic rocks are crumpled and broken, in contrast to the regular bedding at the main workings. The ore body was apparently bottomed by a flat granodiorite dike, although recent exploration has found what may be a downward extension at the bottom of the face. (3) In the caved adit running east from near the shaft, (main workings, pl. 2, 3a, d, f) an ore body was found on the migmatite contact approximately beneath the entrance to the large open cut. The adit caved before the ore was completely removed and before its possible downward

extension was tested.

At the south end of the No. 1 claim (pls. 2, 3c, g, h) scheelite occurs in a tactite bed which may be a continuation of the lime hornfels in the large open cut. The tactite is cut by granodiorite dikes, but there is no exposed contact with a major intrusive body as there is at the north end. The ore averaged 1 percent WO_3 over a 5- or 6-foot width, but was discontinuous and pinched out about 15 feet below the surface. There is some chance that the small body at the south end will continue downward, but elsewhere downward exploration seems futile.

Small outcrops of scheelite-bearing tactite elsewhere on the No. 1c claim give little promise of important production.

No. 4 Claim (pls. 4a, b, e). Assays of ore from the tactite outcrops at the north end of the No. 4 deposit average about 0.7 percent WO_3, but recovery from ore mined in the small open cut was only 0.3 percent or 0.4 percent. Under ultraviolet light most of the ore at the south end appears to be slightly poorer, perhaps 0.5 percent. Exploration is not sufficient to test downward extent of the ore bodies, but it seems probable that several thousand tons of 0.5-0.7 percent ore are present. Ore of this grade cannot be handled profitably at the present mill.

Equipment and operation

By running the mill continuously, 30 to 35 tons of ore can be treated daily. About 60 percent of the scheelite is recovered on tables; tails are reground and treated in flotation cells, which give tailings containing about 0.2 percent WO_3. Heads from the tables are further concentrated with a magnetic separator which raises the WO_3 content to 55-60 percent, then are sent to the Twining Laboratories in Fresno for additional treatment. Flotation heads, containing about 30 percent WO_3, are likewise sent to Twining.

About 1,500 tons of tailings averaging 0.9 percent WO_3 remain from the first 4 months of operation, and about 15,000 tons of 0.3-0.4 percent material from the next 12 months. The richer tailings were milled with ore from the mine in October 1945.

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Illustrations