UNITED STATES DEPARTMENT OF THE INTERIOR
Harold L. Ickes, Secretary

GEOLOGICAL SURVEY
W. E. Wrather, Director

Bulletin 945-D

TUNGSTEN DEPOSITS IN BEAVER COUNTY, UTAH

BY

S. W. HOBBS

Strategic Minerals Investigations, 1944
(Pages 81-111)

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1945

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.
Price 65 cents

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By S. W. Hobbs

ABSTRACT

Although mining activity in Beaver County, Utah, has extended from 1860 to the present, the scheelite deposits in this area were not discovered until the spring of 1940. The deposits discussed in this report are all within a radius of 20 miles of the town of Milford in Beaver County. The scheelite occurs in metamorphosed limestones along the contacts with intrusive quartz monzonite and granite. Most of it shows a strong yellow fluorescence color, which indicates that it probably contains several percent of calcium molybdate. Of the many scattered occurrences of the mineral, the most important are mentioned below.

One of these occurrences is on a part of the Cupric Mines Co. property in the San Francisco district. A large quartz monzonite stock has here been intruded into limestones of varied composition. A pure white limestone shows hardly any replacement metamorphism even at the immediate contact, but dark-gray impure limestones are metamorphosed in different degrees to rocks containing garnet, diopside, wollastonite, and other silicates, and it is these metamorphic rocks that contain most of the scheelite. The scheelite is always associated with the more highly garnetized rocks, and its localization is apparently determined (1) by the proximity of an intrusive contact, (2) by the composition of the limestone, and (3) by fracturing and brecciation. The property contains several small but moderately good surface exposures of scheelite ore. Exploration work by private companies, the Bureau of Mines, United States Department of the Interior, and the Desert Silver Mining Co. for Metals Reserve Co., however, failed to prove any tonnage of scheelite-bearing rock that could be considered ore at market prices current in 1943.

At the Old Hickory mine, in the Rocky mining district, there is a deposit similar to those at the Cupric mine. Certain layers in a sequence of limestone, quartzite, and shale, standing vertical, have been replaced by magnetite, garnet, diopside, sulfides, and scheelite near an intrusive contact with quartz monzonite. The scheelite is in a magnetite-rich layer, which ranges in width from 8 to 25 feet, has an outcrop about 450 feet long, and extends downward for at least 300 feet. The ore is somewhat faulted. All the scheelite of commercial importance occurs near the igneous contact. Some ore shoots in the mine are localized by dikes, but most of the scheelite is in pockets scattered through the magnetite. Most of the higher-grade ore was mined out by the fall of 1943, and the mine was closed. Some lower-grade material, not economic at prices current in 1943, remains in the mine.

The Copper Ranch mine, also in the Rocky mining district, contains scheelite having the same general mode of occurrence as

at the other localities. Small grains and clusters of grains of scheelite occur in metamorphosed limestone to a depth of at least 400 feet and for a horizontal distance of several hundred feet. The concentrations of the mineral are controlled both by bedding and by igneous contacts. Much of the mineral is soft and has a marked yellow fluorescence that suggests a high molybdenum content. The mine probably contains at least 2,200 tons of ore that will average ½ percent of WO_3, and it may contain several times this amount.

The Copper King mine contains some irregular bodies of scheelite ore in an occurrence similar to that at the Old Hickory mine. Twenty-three hundred tons of ore averaging 0.53 percent WO_3 had been mined from this property by March 1944.

Numerous occurrences of scheelite have also been found in the Mineral Mountains between Milford and Beaver. The three most important of these deposits are at the Creole mine near Minersville, and at the Strategic Metal and Garnet properties on the east side of the range near Adamsville. The Creole mine supplied several hundred tons of ore containing an average of 0.75 percent WO_3, but this had been mined out by May 1944 and no more has been found. The Daily Metal mines has developed an extensive tactite zone at the Garnet claim on the east side of the Mineral Mountains. About 750 tons of ore which contained approximately 0.65 percent WO_3 had been shipped from this property by March 1944. The Strategic Metals mine near the mouth of Pass Canyon and northwest of Adamsville contains a small amount of ore, but this property was still in the prospect stage of development in the spring of 1944. Scheelite occurs here both in tactite immediately adjacent to the granite contact and in shear zones which extend into the limestone 100 feet or more from the contact. Small pockets of high-grade tactite ore may contain several percent WO_3. A shipment of 150 tons of ore from the principal shear zone contained an average of 0.95 percent WO_3.

INTRODUCTION

Location, accessibility, and transportation

Scheelite occurs at scattered localities in the central and northcentral parts of Beaver County, Utah, between Beaver Valley on the east and Wah Wah Valley on the west. All the localities are within a radius of 20 miles from the town of Milford. The first scheelite occurrence was discovered west of the town in the Rocky and San Francisco Ranges, but other scheelite-bearing areas have been discovered more recently in the Mineral Range to the east. Plate 32 shows the location of these deposits and the general geology of the districts.

Transportation facilities for the area are good, as the town of Milford is on the main line of the Union Pacific Railroad, and only 245 miles by a good highway from Salt Lake City. Most of the deposits are within short distances of good graded or surfaced roads that connect with the railroad at Milford or with U. S. Highway 91 at the town of Beaver.

History of the area

Ore deposits in Beaver County were first discovered in 1860, but mining did not become an important industry in the area until about 1870. The principal metals of the district were copper, zinc, lead, and silver. The discovery in 1875 of the ore deposit developed in the Horn Silver mine greatly stimulated mining activity and the development of railroad facilities and distributing centers for the districts. Since 1918, mining has been done only now and then and on a small scale, and all of the big mines are now closed.

The discovery of scheelite in the Milford area in 1940 led to an intensive search for the mineral throughout the region, and it was soon found to be rather widespread. In 1940 and 1941, the Prosper Mining Co. of Milford attempted to develop scheelite ore found in the Old Hickory mine northwest of the town of Milford. In 1941 C. H. Segerstrom leased the property and mining was started. At about the same time, scheelite was discovered in the contact zone on the Cupric property, and intensive work with an ultraviolet lamp outlined a considerable area of scheelite-bearing ground. No development work had yet been done on this property, however, in the fall of 1941. Scheelite was subsequently discovered at the nearby Copper Ranch, Montreal, and Copper King properties, all to the west of Milford, and at the Creole, Garnet (Daily Metal mines), Pass Canyon (Strategic Metals mines), and several adjacent properties in the Mineral Mountains east of Milford.

Previous work

A very complete and comprehensive account of the geology and mineral resources of the San Francisco region, Utah, has been given by B. S. Butler.1/ A brief description of the Mineral Range is given by Butler in Professional Paper 111.2/ The Cactus, Delamar, and Horn Silver mines in this area have been described by Emmons,3/ and Rohlfing 4/ has described the Horn Silver veins. A number of other authors have described various minerals from the district.

None of the previous workers has mentioned the occurrence of scheelite in the district, and they probably did not even suspect its presence, for it is almost impossible to detect the mineral in most of the ore without special methods of determination, and it is only since the advent of the ultraviolet lamp that the mineral could be readily detected.

Field work

During the month of November 1941, the author, assisted by Mr. Frank Byers, studied the principal scheelite occurrences of Beaver County. Detailed topographic and geologic maps were made

1/ Butler, B. S., Geology and ore deposits of the San Francisco and adjacent districts, Utah: U. S. Geol. Survey Prof. Paper 80, 212 pp., 1913.

2/ Butler, B. S., Loughlin, G. F., Heikes, V. C., and others, The ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, pp. 529-536, 1920.

3/ Emmons, S. F., The Cactus Copper mine, Utah: U. S. Geol. Survey Bull. 260, pp. 242-248, 1905; The Delamar and Horn Silver mines, two types of ore deposits in the deserts of Nevada and Utah: Am. Inst. Min. Met. Eng. Trans., vol. 31, pp. 658-683, 1902.

4/ Rohlfing, D. P., The great Horn Silver vein in Beaver County, Utah: Salt Lake Min. Rev. 1, no. 12, pp. 23-24, 1917.

of the tungsten-bearing areas of the Cupric, Old Hickory, and Copper Ranch properties, and several less promising properties were visited but not mapped. Much of the area was studied at night with an ultraviolet lamp to determine the outlines of the possible scheelite ore bodies, but because of the scattered and erratic distribution of the scheelite in the deposits, no systematic sampling was attempted at that time. Subsequent exploration work by private companies, the Bureau of Mines, and the Metals Reserve Co. has supplied much information on grade of ore and reserves. The writer revisited the area in January 1943, and with the assistance of Mr. S. E. Clabaugh revised some of the previous work; in addition, he mapped several of the newly developed properties in the Mineral Range. Some additional work was done in March 1944.

The writer gratefully acknowledges the cooperation and assistance of Mr. Paul H. Hunt, of the Park Utah Consolidated Mines, Keetley, Utah, and of Mr. Karl Hanney, of Frisco, in connection with the work on the Cupric and Copper Ranch properties. Mr. Hanney spent much time as guide on these properties and on other prospects in the district. Mr. E. Nash, engineer for Mr. Segerstrom at the Old Hickory mine, gave all possible assistance during the work there; he also accompanied the author to a number of nearby localities and assisted in obtaining samples and specimens. Mr. Donald Segerstrom gave much assistance to the writer during visits to the properties in 1943 and 1944.

GEOLOGY

Topography and regional setting

The tungsten deposits herein discussed are on the flanks of a series of mountain ranges near the eastern border of the Basin and Range province. One of these ranges, the San Francisco Mountains, extends in a north-south direction across the western part of the area. These mountains have a maximum altitude of 9,725 feet. They are bordered on the west by the wide Wah Wah Valley, whose floor is at an altitude of about 5,000 feet, and on the east by a broad plain, which slopes from an altitude of 6,500 feet at the old town of Frisco to one of about 5,000 feet in Milford Valley, 14 miles to the east. Four miles west of Milford Valley the plain is narrowed to 2½ miles between two small north-trending ranges, the Beaver Lake Mountains to the north and the Star Range to the south. A southeast extension of the Beaver Lake Mountains forms the small isolated Rocky Range, 5 miles northwest of the town of Milford. The Mineral Mountains form an equally prominent north-trending range on the east side of the Milford Valley and separate it from the valley in which the town of Beaver is located.

Rocks

The rocks of the area consist of sedimentary formations, lava flows, and intrusives. Butler 5/ has given an extensive and thorough description of these rocks, and only a brief summary of their characteristics will be presented here, emphasis being placed on the types that are directly related to the tungsten deposits.

5/ Butler, B. S., op. cit., (1913).

Sedimentary rocks.—The following table, taken from Butler's report, summarizes the sequence of sedimentary rocks in the district. The most important members of the sequence are the Grampian limestone, in which the scheelite of the San Francisco Mountains occurs, and the Harrington formation and the Elephant limestone, which contain the scheelite in the Rocky Range, Star Range, and Mineral Range. It is possible that some deposits occur at other stratigraphic horizons which could not be definitely determined.

Sedimentary formations in the San Francisco and adjacent mining districts, Utah. After Butler.

Thickness in feet	Name and description	Age	
5,000±	Harrington formation. Thin-bedded shales with interbedded limestones and lenses of quartzite.	Triassic	
1,000±	Elephant limestone. Heavy-bedded dolomitic and siliceous limestone.	Pennsylvanian	Carboniferous
400	Talisman quartzite. Fine-grained pink quartzite.	- - - -(?)- - -	
1,500	Topache limestone. Heavy-bedded blue limestone with beds of shale and chert.	Mississippian (?)	
50	Mowitza shale. Calcareous shale interstratified with thin beds of limestone.	Devonian	
1,500	Red Warrior limestone. Heavy-bedded blue and gray limestone, in part dolomitic; lenses of quartzite near base.	- - - -(?)- - - -	
2,500±	Morehouse (?) quartzite. Fine-grained pinkish quartzite containing some fine siliceous shale. This quartzite in the Star district is believed to be represented, at least in part, in the upper portion of the Morehouse quartzite of the Frisco district.	Silurian (?) - - - -(?)- - - -	
2,000±	Morehouse quartzite. Fine-grained pink and white quartzite with some shale beds.		
300	Shale in upper Grampian.	Ordovician	
4,000	Grampian limestone. Heavy-bedded blue and gray limestone, in part dolomitic, with limy shale at the top.	- - - -(?)- - - - Cambrian(?)	

Igneous rocks.—The igneous rocks of the Beaver County area comprise rhyolite tuff, lavas that range in composition from rhyolite through andesite to basalt, and intrusive granite,

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quartz monzonite, and granodiorite porphyry. The effusive rocks are at least in part older than the intrusives, for in a number of places the quartz monzonite has intruded and crosscut them. They have no relation to the scheelite deposits, although many of the copper, lead, zinc, and silver deposits of the districts occur in brecciated volcanic rocks.

The main mineralized areas in the San Francisco, Star, and Beaver Ranges are associated with stocks of granodiorite porphyry and quartz monzonite and with dikes attendant upon these stocks. In the Mineral Mountains the main intrusive rocks are more nearly true granites. The granodiorite porphyry appears to be the oldest of the intrusives. Butler describes it as a dark, fine-grained porphyritic rock of dioritic appearance, whose character varies considerably from place to place, the phenocrysts being few in some places and numerous in others. Phenocrysts of plagioclase, hornblende, and occasionally quartz are usually the only minerals recognizable in hand specimens. Variation in the proportion of mafic minerals causes much variation in the color of the rock, which ranges from a light gray through gray and gray-green to a very dark gray. The granodiorite occurs only in the eastern part of the area described by Butler and is most abundant in the Rocky Range and in the nearby knolls and hills that project above the surrounding alluvial plain.

The quartz monzonite is much more widely distributed than the granodiorite porphyry. One large body of the rock occupies an area of about 6½ square miles in the San Francisco Range, northwest of Frisco. There are two stocks in the Beaver Lake Mountains, having a combined area of about 4 square miles, and smaller masses occur in the Rocky and Star Ranges. Quartz monzonite and granite form the core of the Mineral Mountains and extend from the vicinity of Adamsville northward for more than 15 miles. Numerous dikes of related composition are associated with this mass.

The rock mapped as quartz monzonite ranges in composition from quartz diorite to granite, but the largest part of each of the masses thus mapped has the composition of quartz monzonite. The fresh rock is medium-grained and gray in color, and is composed of plagioclase, orthoclase, quartz, biotite, augite, and hornblende. The proportions of the minerals vary considerably, depending on the position of the rock with respect to the contact. In places, though not everywhere, the rock becomes finer-grained and more porphyritic toward the margins of the stock. The dark minerals are commonly more abundant at the contact than elsewhere, and dikes that extend for short distances from the contact into the sedimentary rocks are darker and finer-grained than the stocks. Hornblende, which is abundant in the central part of the San Francisco Mountains stock, is very scarce in the border zone, where biotite and augite are abundant.

The geologic age of the igneous rocks cannot be definitely determined from relations observable in this area. On the basis of comparison with surrounding areas, Butler concluded that the igneous rocks of these districts are Tertiary in age, but he was unable to date them more precisely.

Structure

The region here described, located as it is near the eastern border of the Basin and Range structural province, is characterized by fault-block mountains. The San Francisco Range and the

Mineral Mountains are known to be such blocks. The Beaver Lake Mountains and the Star Range may also be fault blocks, but they have undergone erosion so profound as to destroy any striking evidence of such an origin.

There was little pre-intrusion folding, and much of the locally complex structure around the plutonic igneous rock bodies is probably related to their intrusion. Strong evidence of such a relation is shown by the accommodation of the bedding to the contacts in the Frisco area, and by the fact that much brecciation and fracturing was developed in the sedimentary rocks near the border of the intrusive before any intense contact metamorphism had occurred.

Faulting has not only outlined the principal mountain ranges but has also localized important sulfide mineralization. The relation of faulting to tungsten mineralization is not clear, but apparently it is not close. Large faults extending parallel to the trend of the San Francisco Mountains occur on the east and west sides of the range, and several large transverse faults in the Star Range produce notable offsets in the strata. A large fault is probably present also along the west face of the Mineral Mountains. Local areas of complex faulting and folding are numerous but are on too small a scale for discussion here.

TUNGSTEN DEPOSITS

The tungsten deposits of Beaver County occur in a number of separate and widely scattered localities. Nearly all of the deposits are in tactite formed at or near the contacts of limestone and intrusive rocks. The principal areas of localization are around the south end of the San Francisco Mountains stock, in the Rocky Range, and on the eastern and southern borders of the Mineral Range stock. Minor deposits occur in other areas. The geologic relationships are slightly different for each area, and the deposits will therefore be discussed separately.

Cupric Mines Co. tungsten deposit

The tungsten deposit of the Cupric Mines Co. is on the west side of the San Francisco Mountains at the southern contact of the main quartz monzonite stock of those mountains with the sedimentary rocks. State Highway 21, which extends through Squaw Springs Pass, lies within a mile and a half of the deposit, and a side road, built in 1943, connects the highway with it.

The San Francisco Mountains near this locality reach an altitude of 8,200 feet, having a relief of about 2,500 feet. The tungsten deposits occur on the lower slopes of the mountains at altitudes between 6,200 feet and 6,700 feet. They are scattered through a zone of contact-metamorphic rock produced by the intrusion of a large quartz monzonite stock into limestone. The scheelite was discovered in 1941 on almost entirely undeveloped and unexplored parts of the Cupric property. Following the preliminary geologic work by the Geological Survey in 1941, the property was examined and explored by a number of private companies and other government agencies. Early in 1942 the U. S. Vanadium Corporation trenched the surface and did a small amount of drilling. The Homestake Mining Co. briefly examined the property shortly thereafter. Neither of these examinations led to further work by these companies. The prospect was explored further in the winter of 1942-43 by the Bureau of Mines and the Desert Silver Mining Co. for Metals Reserve Co. The Desert Silver Mining Co. drove an adit into the south side of the deposit at the same time that the Bureau of Mines drove an adit under the ore zone from the west. Plate 33 shows the local geology and the extent of the deposits; plate 34, the main ore body and the extent of the exploration work.

Geology

Sedimentary rocks.—The limestones invaded by the stock in the Cupric district consist of two distinct members. The thicker member, which contains the tungsten deposits, occupies the eastern three-quarters of the limestone area mapped. It consists of rather heavy-bedded limestone, mostly of a dark blue-gray color but including some lighter-colored layers. The unaltered rock is composed of beds a foot or more thick. Some of the metamorphosed limestone, however, is well banded in half-inch to one-inch layers that probably differ slightly in composition.

Stratigraphically above the gray limestone is a considerable thickness of a white or light-buff, very massive, relatively pure limestone. This rock is much less affected by contact metamorphism than the underlying rock, being replaced by silicates only along a narrow zone at the contact, beyond which the rock is unreplaced but is recrystallized for a considerable distance.

Igneous rocks.—The igneous rock adjacent to the contact in the Cupric area differs slightly from the average rock of the stock as described by Butler, being lower in quartz and amphibole. The essential minerals are orthoclase, plagioclase, augite, biotite, and a little quartz, together with some apatite, sphene, and magnetite. Quartz forms less than 5 percent of the rock, which is nearer to monzonite in composition than to any other type.

Structure.—At a distance of about half a mile from the contact the limestones strike N. 10° to 40° E. and dip 30° to 60° NW. This attitude is general in the area, but the intrusion of the quartz monzonite has distorted the rocks near the contact, where the bedding is steepened and twisted and appears locally to be overturned. The beds tend to swing parallel to the contact, and on the southeastern side of the stock the original strike has thus been shifted from north to northeasterly. Strong zones of brecciation in this vicinity attest the folding and breaking of the beds by intrusive action. On the southwest side of the stock, however, the beds strike more directly into the igneous contact. This fact may have a strong bearing on the localization of the scheelite, for practically all the scheelite occurs in this zone where the limestone beds are perpendicular to the quartz monzonite contact.

Several zones, 10 to 20 feet wide, of iron-stained rock in the limestone at distances of 300 to 400 feet from the contact, represent mineralized fissures that probably were formed during the same period of mineralization as the scheelite. The old Washington mine, which supplied some lead, copper, and zinc, was developed on one of these fissures. The alinement of some of these zones suggests the presence of fairly persistent northeast-striking fissures. The strike of these fissures is generally parallel to the contact, but no one of them can be traced for any great distance on the surface. Some smaller fissures, more nearly perpendicular to the contact, may have influenced the localization of the scheelite by affording channelways for mineralizing solutions.

Contact metamorphism.—The intrusion of the quartz monzonite stock into the limestones produced extensive contact metamorphism, especially in the dark members of the limestone series. In the Cupric area this metamorphism extends for more than a quarter of a mile on the surface from the contact, but the distance from the outer edge of the metamorphic zone at the surface to the nearest quartz monzonite beneath the surface is probably much less than a quarter of a mile. The monzonite contact is very irregular, with numerous offshoots, apophyses, and embayments. The dip of the contact, where directly observed, is always very steep, but the small isolated monzonite masses projecting through the metamorphosed limestone at distances of 300 to 500 feet from the main contact are probably projections rising from the main mass below, and they indicate that the average dip of the contact is much lower than that at individual exposures.

Many minerals have been developed in the contact zone. The most abundant are garnet, wollastonite, diopside, quartz, and carbonates. Less abundant are muscovite, chlorite, epidote, fluorite, idocrase, scheelite, and the sulfides pyrite, chalcopyrite, and molybdenite. Veins in the limestone, at some distance from the contact, contain galena and sphalerite.

The intensity of the contact metamorphism and the character of its products are variable throughout the area. In general, the effects of metamorphism decrease gradually away from the contact; silicated contact rocks grade into recrystallized limestone, which grades into unchanged limestone. But in some small areas far from the outcrop of any intrusive contact, the limestone is more intensely metamorphosed than most of that immediately adjacent to exposed intrusive rock. These areas are probably at places where intersecting fissures allowed free access to metasomatizing solutions, or where small igneous offshoots were close to the surface, or where both conditions existed.

It is impossible to trace individual groups of limestone beds from places where they are unaltered into the contact-metamorphic zone, and thus to determine in what degree the varied composition of the contact rocks is due to differences in original characteristics of the limestones. The general distribution of minerals and the general structure suggest, however, that original differences of composition and porosity are reflected in the contact zones to a rather large extent.

The most abundant and widespread of the minerals in the contact rock is a garnet of the andradite-grossularite variety. Large volumes of the limestone have been altered to a garnet-carbonate rock, and the garnet is always more abundant upon closer approach to the contact. Wollastonite is very abundant in many parts of the contact zone, in some places forming crystals 6 inches or more in length. It is particularly abundant on the hill crest extending due south from the contact in the center of the area mapped (pl. 33). Other minerals are locally abundant, but the greater part of the contact rock in most of the area is composed of garnet, wollastonite, and recrystallized residual carbonate.

Occurrence of scheelite.—The scheelite in the deposit is nearly all in the garnet rock, or tactite. On the Cupric property, specks of scheelite are scattered widely throughout the metamorphic rocks, but the significant concentrations of the mineral are localized in three main bodies and several minor ones. The largest of these, designated on plate 33 as the "A" ore body, straddles the nose of a ridge at the contact of the light and the dark limestone near the southwest side of the area mapped. The areal extent of the tungsten mineralization here is about 100,000 square feet. The "B" ore body, which is second in importance, is about 700 feet northeast of the first, against the contact in the reentrant on the north side of a prong of quartz monzonite. The third, or "C" ore body, is south of the "B," on the south side of the monzonite prong, and is also tight against the contact. Of the two minor ore bodies, one occurs on the nose of the prominent ridge 500 feet southeast of the "A" ore body, the other on the northeast flank of this same nose, some 800 feet farther northeast.

The general mode of occurrence of the scheelite is the same throughout the district. The mineral occurs most frequently as isolated grains or small clusters of grains in places where garnet is abundant. The stippled areas on the map (pl. 33) represent scheelite-bearing rock. Some of the scheelite is in the form of large euhedral crystals as much as 2 inches in diameter, but there are all gradations of size between such crystals and specks barely visible to the unaided eye. In any given area, the amount of scheelite in these almost invisible specks appears to be nearly as great as that in the larger grains, even though the latter are more widely spaced. Not all of the intensely garnetized rock contains scheelite, nor is all the scheelite associated with the garnet.

Most of the scheelite in the Cupric deposit fluoresces with a cream-white or slightly yellowish color, which is distinct from the blue-white color given by scheelite from many other localities; this yellowish color indicates that the mineral contains a good deal of molybdenum. The fluorescence color of the mineral varies considerably, however, and the molybdenum content must likewise be variable. The color varies, indeed, not only from place to place but also within single crystals, some of which fluoresce blue-white at the center and yellowish at the border. Two high-grade samples of scheelite were collected from the Bureau of Mines adit and were assayed in the Geological Survey laboratory for contained WO_3 and MoO_3. The results are given in the following table:

Sample	Weight percent MoO_3	Weight percent WO_3	Weight percent $CaMoO_4$ in scheelite molecule
No. 1. High-grade material selected from zone between 136 and 170 feet from portal.	0.28	19.83	1.56
No. 2. High-grade material selected from zone between 240 and 258 feet from portal.	.38	5.54	7.13

The ore bodies are irregular in outline with ill-defined boundaries where they grade into barren rock. Their limits as shown on the maps are merely rough outlines of areas within which the principal scheelite mineralization is concentrated. Sparsely scattered scheelite can be found outside these boundaries.

An understanding of the conditions favoring the deposition of scheelite should be very helpful in the search for ore. Three conditions appear to be propitious: the first is the proximity of an igneous contact; the second is some favorable element, not fully understood, in the original character of the limestone; and the third is fracturing or brecciation of the host rock.

The most important of the three is evidently the relation of the ore to intrusive contacts. This is true not only of the Beaver County deposits but of many similar deposits at other localities. But although the contact must be relatively near, the chance of finding scheelite is not in direct ratio to its nearness.

Variation in the original composition of the limestones and their permeability to mineralizing solutions make some beds more susceptible to alteration than others. The great influence that may be exerted by the original character of the limestone is illustrated on a large scale by the absence of scheelite in the white limestone. Scheelite mineralization in the gray limestone ceases abruptly at contacts with the white limestone, and there is little replacement of the white limestone even where it is in immediate contact with igneous rocks. On a smaller scale, the slight variations within the dark limestone are expressed, where the rock is metamorphosed, by distinct layering, and these layers evidently differ in their susceptibility to alteration. There is little evidence, however—such as would be given by local unevenness in the distribution of scheelite—that these minor differences in the original character of the limestone beds have had much influence on scheelite deposition.

The third factor, structural control, is of great importance, but its extent and influence are not easily determined. Just east of the main "A" ore body are two elongate masses of garnet rock that appear to be localized along zones of fissuring and brecciation. These masses, together with another, 800 feet farther east, are obviously connected with fissure zones. Exposures in the adits emphasize the intense brecciation, faulting, and shearing of the rock in the mineralized area, and the intimate relation of the scheelite to such broken zones. The structure is best described as a complex of irregular breaks and shears in which local zones or areas of more intense brecciation are formed, most commonly at intersections of the fractures. Such areas are more susceptible to mineralization, but exploration work has emphasized the fact that none of the favorable structures has sufficient continuity or extent to localize a large body of ore. Favorable structure, however, is not alone sufficient to localize ore. To the east of the "A" ore body along the monzonite contact there are broad zones of breccia in strongly metamorphosed dark limestone that are completely barren of scheelite, even though most of the metamorphism was post-brecciation. It is thus difficult to evaluate the effect of early brecciation on ore formation in the "A" ore body, although it has undoubtedly exerted considerable influence. Some shearing, however, took place considerably later than the deposition of the scheelite, for certain zones of scheelite mineralization are crosscut at small angles by sulfide veins deposited in the fissures formed by this later shearing.

Ore bodies "B" and "C" (pl. 33) are good examples of deposits formed at the igneous contact. The contact rock comprising the "B" body forms a mere skin on the monzonite, and very small dikes of monzonite, hardly noticeable except on close examination, extend through much of the garnet rock. Ore body "C" is likewise close to a contact, and here too the scheelite-bearing metamorphic rock is penetrated by small tongues and offshoots of monzonite.

The "A" ore body, on the other hand, which is larger than the "B" and "C" ore bodies, appears to lie away from the contact. Its position was probably determined by a combination of the three favorable conditions already mentioned, but structure probably has had a dominant influence on the localization of the scheelite here. However, the contact-metamorphic rock comprising the "A" body is probably much nearer the actual contact than appears on the surface. A long dike of quartz monzonite extends westward from the main mass toward the head of the "A" body, east of which, moreover, there are several small croppings of quartz monzonite on the hillside; and within the ore body itself there is a mass of greisenized material rather rich in scheelite. All of these facts indicate that the igneous mass, or small offshoots from it, are not far below the ore, although no monzonite was found in the adits driven beneath the ore body.

Distribution, grade, and volume of ore

The Cupric deposit was explored extensively during the period between its discovery in 1941 and the spring of 1943. All of the exploration work was done on the "A" ore body, the most promising area, and has demonstrated that the distribution of scheelite is very irregular and erratic, and that the deposit as a whole is of too low grade to be mined under the economic conditions prevalent in 1943.

Preliminary determinations of the distribution and volume of ore, made in the fall of 1941, were based on an examination of the surface of the area with an ultraviolet lamp along equally spaced traverse lines. By this method about 11,500 square feet of the 112,000 square feet of surface area of the "A" ore body were outlined as underlain by potential ore with a grade of 0.5 percent WO_3 or better. These areas are shown in plate 33. Subsequent trenching of the deposit disclosed the scheelite distribution to be even more erratic and discontinuous than was indicated from surface exposures (pl. 34). The adits driven by the Bureau of Mines and the Desert Silver Mining Co. beneath the best surface indications of the ore have further emphasized the spotty nature and low grade of the deposit. Indeed, the mineralized material exposed in the adits is much inferior both as to grade and volume to that exposed on the surface.

The grade of the deposit has been established by means of extensive sampling of the adits by the Bureau of Mines at the time the adits were being driven. Channel samples and muck-pile samples were collected as well as bulk samples for mill tests. The muck-pile samples and the bulk samples are the most accurate, the erratic character of the mineralization making channel or grab samples nearly worthless for establishing an average grade. Only a few very limited zones in the workings contain sufficient tungsten to be listed as possible ore zones. The following table gives the detailed assays for the best zones encountered. The location of these zones is shown on the adit maps, plate 35.

It is apparent from the assays that very little if any of the rock can be considered ore under present economic conditions. Furthermore, the demonstrated erratic and pockety nature of the tungsten mineralization makes the determination or blocking out

Table 5.—Sample data from the Bureau of Mines adit on the Cupric Mines Co. property.1/

Sample	Location (feet from portal)	Length of drift sampled (feet)	Percent WO_3
Muck-pile samples	0-147	147	0-0.10
	147-175	3.5	.22
		3.5	.12
		5.5	.15
		28 {4.0	.17
		4.0	.38
		4.0	.09
		3.5	.09
			Av. .175
	175-253	78	0-0.10
	253-266	5.0	.13
		13 {5.0	.10
		3.0	.51
			Av. .21
	Drift north from main adit between 253 and 266 feet.	2.0	.36
		9 {4.0	.20
		3.0	.16
			Av. .22
	Drift south from main adit between 253 and 266 feet.	4.0	.09
		4.0	.06
		21.5 {3.0	.14
		3.0	.14
		3.5	.11
		4.0	.17
			Av. .12
		43.5	Av. .168
Sample mined on south side of main drift for mill test	150-163	76 mine carloads ore.	Av. from samples 0.33 Mill-run tests 0.21

1/ All sample data and tungsten analyses from the Bureau of Mines, United States Department of the Interior.

of the ore reserves very difficult. The pockets of ore are discontinuous and follow no definite structural pattern, and the character of ore more than a few feet beyond the present faces is unpredictable. For these reasons it is nearly impossible to outline any measured or indicated ore, and only about 4,000 tons of inferred ore containing about 0.3 percent WO_3 is estimated to be available.

No other ore body on the property has been explored as thoroughly as the "A," and none has shown more than a fraction of the original promise of the "A" ore body. The "B" deposit is low in grade and obviously close to the contact. Its downward extent is undetermined. A tunnel that penetrates the hillside just below the lower contact of this ore body discloses no scheelite, and the rock in the tunnel is less metamorphosed than that on the

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Table 6.—Sample data from the Metals Reserve Co. adit on the Cupric Mines Co. property.1/

Sample	Location (feet from portal)	Length of drift sampled (feet)	Percent WO_3
Muck-pile samples	0-54	54	<0.10
	54-97	9.0	.31
		2.0	.23
		3.0	.21
		4.0	.14
		3.0	.08
		6.0	.18
		43 4.0	1.02
		2.0	.58
		3.5	.17
		3.5	.41
		3.0	.31
			Av. 0.325
	97-152	55	<.10
Sample mined from main and side drifts for mill test.	80	57 mine car-loads ore.	Av. 0.35

1/ All sample data and tungsten analyses from the Bureau of Mines, United States Department of the Interior.

surface above it. It is entirely possible that the "B" ore body is in a block of the lower gray limestone resting with faulted contact upon the white limestone, and that the quantity of tactite here is limited by the size of this block.

The "C" ore body contains scattered scheelite but only a small quantity of material which may be considered as inferred ore. The rock richest in scheelite is adjacent to some small aplitic dikes at the lower end of the mineralized area. This material is limited in amount and is rather intimately mixed with the igneous rock.

Other areas contain scheelite, but all of it is rather widely disseminated. Unless further exploration finds material of higher scheelite content, these smaller bodies cannot be considered as probable sources of ore.

Old Hickory mine

The Old Hickory mine is on a southern spur of the Rocky Range, about 5 miles northwest of Milford (pl. 32). This spur consists of a group of low hills, the highest of which rises only 300 feet above the alluvial plain, and the mine lies just south of a low saddle which nearly separates these hills from the main body of the range. The mine is reached by good roads from the town and consequently has easy access to both main highways and railroads.

The Old Hickory mine, though long known to contain a body of copper-magnetite ore, was never extensively worked except in

1906-07, when the high price of copper made it commercially profitable to mine the ore for copper. In 1917-18, when the mine was again worked, it was only because the magnetite in the ore was needed as a flux at the smelters.

The old mine consisted of a shaft 300 feet deep, a tunnel, called the second level, which cuts the ore body about 100 feet below the shaft collar, and four other levels, the first or 80-foot level about 20 feet above the tunnel, and the third, fourth, and fifth levels below the tunnel at depths of 150, 200, and 300 feet respectively. Most of the ore above the 80-foot level has been stoped out to the surface, leaving a deep, long, glory hole. The original timbering was burned out of the mine and completely destroyed, but the shaft and the workings immediately adjacent to it were retimbered and placed in good working order by C. H. Segerstrom in 1941 in preparation for mining the newly discovered tungsten ore. The mine was worked by Mr. Segerstrom for tungsten from the fall of 1941 to December 1943, when the operation was closed and the mine was turned back to E. J. Schoo, the former owner.

Geology

The Old Hickory mine lies in a belt of Triassic rocks at a place where they are rather complexly intruded by stocks and dikes of quartz monzonite. Plate 36 shows the topography and geology in the vicinity of the mine. The Triassic rocks, which belong to the Harrington formation, are composed of thin-bedded shales with beds of limestone and lenses of quartzite. The contact-metamorphic rocks around the intrusive bodies include one zone that is composed largely of magnetite, and it is in this zone that the best scheelite ore has been found. In the vicinity of the Old Hickory, the rocks strike nearly north-south, directly toward the main masses of intrusive quartz monzonite and granodiorite porphyry, which lie about 1,100 feet north of the shaft. Surface exposures close to the mine workings are poor, but small scattered outcrops of quartz monzonite and abundant exposures of it in the mine indicate that the scheelite occurs close to igneous contacts.

Sedimentary rocks.—At the mine the lithologic sequence from west to east in the Harrington formation is as follows: a massive layer of quartzite, variable in thickness, on the west side, is followed by the ore body, which is in a completely replaced limestone layer, probably more susceptible to alteration because of original impurities and porosity, and now composed chiefly of magnetite accompanied by some silicate, sulfide, and scheelite. To the east of the ore body the rocks are thoroughly metamorphosed, but it is inferred from their present composition that they originally consisted of impure shaly limestones and calcareous shales with lenses of quartzite and pure limestone. A few dikes of granodiorite porphyry are intruded parallel to the bedding.

This series of altered sedimentary rocks displayed near the mine and shaft may be traced southward for at least 1,500 feet along the strike, despite considerable variations in the intensity of the metamorphism, which depends on the varying relation of the sedimentary to the igneous rocks. The zone containing magnetite and scheelite extends for only about 500 feet south of the shaft. Beyond the shaft, there is garnet rock with only sparse and scattered showings of scheelite.

Igneous rocks.—The igneous rocks in and near the Old Hickory mine are quartz monzonite and granodiorite porphyry. The quartz monzonite seems to be more abundant and to be more closely related to the ore deposit than the porphyry, and, in both its coarse- and fine-grained phases, it forms dikes, sills, and small irregular intrusive masses in the limestone. The general character of the igneous rock indicates that the sedimentary rocks at the Old Hickory probably constitute a large roof pendant in the quartz monzonite.

Structure.—The sedimentary strata in general stand nearly vertical and strike nearly north, with little variation in dip or strike. The principal structure complications are due to the irregular intrusion of the igneous rocks, which follow the bedding planes of the sedimentary rocks for the most part but frequently cut across them as rather gently dipping dikes or as irregular masses.

One dike, striking nearly east and dipping gently to the south, separates the sedimentary rocks, including the ore body, into two segments. The upper segment is displaced, relative to the lower, about 50 or 60 feet to the east as is shown in the structure sections (pl. 37). The measure of the displacement is based entirely upon the offset produced in the magnetite zone and the vertical igneous contact west of the ore body. This offset may have been caused by a fault along which the dike was later intruded, or by movement along the dike either before or after it solidified. Possibly the offset is not due to faulting at all but marks a jog in a zone of alteration formed along an irregular igneous contact, at the place where the horizontal dike was by chance injected. Faulting, however, seems the most probable cause of the offset, for in one place the quartzite, the one member of the series that can be identified both above and below the dike, is apparently displaced. Other faults are of minor importance in the immediate vicinity of the mine, where post-mineral movement, although it has produced gouge along some of the contacts of the ore body, has nowhere significantly offset the contacts.

Ore deposit

Mineralogy.—The scheelite of the Old Hickory mine occurs in a contact-metamorphic deposit produced by the intrusion of quartz monzonite into calcareous sediments. The ore appears to be localized principally in one or more beds of limestone that are especially susceptible to replacement. The main deposit is in an elongate tabular body, 15 to 25 feet wide, consisting chiefly of magnetite and silicates, the most abundant of which are garnet and diopside. Gradual changes of composition may be observed not only in crossing the strike but also along it, and in many places the deposit is made up of thin layers evidently differing in composition. The proportion of magnetite to silicates varies widely —from about 90 percent magnetite and 10 percent silicates to 90 percent silicates and 10 percent magnetite. Minor constituents of the deposit are the sulfides pyrite, chalcopyrite, and bornite, some secondary copper minerals, and scheelite. The scheelite is generally most abundant in rock that contains abundant magnetite, and such rock occurs mainly at or very close to igneous contacts. Most of the magnetite is localized in the 15- to 25-foot tabular zone adjoining the quartzite and monzonite on the west, but scattered grains of magnetite and scheelite are found in garnet-diopside rock 100 feet or more from the contact. Still farther from the main contact certain favorable layers are completely altered to garnet-diopside-magnetite rock containing little or no scheelite, but most of the rest of the sedimentary series is only recrystallized or slightly altered.

The primary copper sulfides are so sparsely scattered that the rock containing them can have no value as an ore of copper, but a small amount of copper has been obtained from some rock near the surface where copper carbonate is concentrated in the numerous fractures.

The scheelite in the magnetite-garnet rock occurs in two forms. A few 2- to 3-inch veins of nearly solid scheelite in large, translucent, greenish-gray crystals have been found at the base of the open cut 50 feet south of the main shaft, but these veins are traceable for only 10 to 15 feet. Most of the scheelite occurs in small grains, or more commonly in clusters of small grains, 0.5 to 1 inch long in the magnetite. Each cluster appears superficially to be a single large crystal, but close examination reveals its composite character. All gradations are found between rock in which these clusters are widely scattered and zones 10 to 15 feet long in which the clusters are crowded together.

All of the scheelite in the Old Hickory mine, like that in the Cupric property, has a yellowish-white to yellowish fluorescence color, indicating that it contains a good deal of calcium molybdate. The color varies considerably from place to place, and assays of the mineral are said to show that some of it contains only a few percent and some of it 20 or 30 percent of calcium molybdate. None of the mineral in the Old Hickory mine has a blue-white fluorescence color.

The minerals in the deposit are probably almost contemporaneous. In some places magnetite and sulfides cut earlier garnet and diopside, and veins of scheelite cutting magnetite show that some of it is later than magnetite, although some is earlier or of the same age. The whole sequence, however, is related to the same period of igneous activity.

At the Old Hickory mine, as at the Cupric mine, the important factors in localization of the scheelite and primary sulfides are country rock of favorable composition and the immediate proximity of the igneous intrusive contact. Fracturing played a minor part, although it prepared the ground for the deposition of oxidized copper ore near the surface.

<u>Ore shoots and limits of ore</u>.—Scheelite is not only associated with magnetite, as already noted, but is concentrated in rather definite ore shoots within the rock rich in magnetite. One of these ore shoots, which extends from the 200-foot to the 150-foot level, lies beneath the low-dipping quartz monzonite dike already mentioned (p. 96), and extends along the junction of the dike with the vertical contact of the monzonite body on the west. The contacts between the ore shoot and the igneous rocks are sharp. It is possible that the ore minerals were derived directly from the adjacent igneous rock, but it is more likely that the inverted trough formed by the intrusive contacts directed solutions from below and thus concentrated them in definite shoots.

Other prominent shoots have been found in the mine, but much of the scheelite is irregularly distributed through the magnetite rock. Small quantities of scheelite have been noted in zones east of the main contact deposit, but igneous rock has always been found nearby when it was looked for.

Both the abundance of igneous rock in the mine and its distribution strongly suggest that the sedimentary rocks in which the ore occurs form a large roof pendant in the igneous rock. This view is further substantiated by the fact that the abundance of igneous rock in general increases with depth. It seems likely, indeed, that the sedimentary rocks and consequently the ore deposit will be completely cut out at no great distance below the present 300-foot level of the mine.

Five hundred feet south of the shaft the strike of the sedimentary rocks swings slightly to the east and a thick band of quartzite comes in on the surface between the limestone and the igneous rock. This is probably the reason for the scarcity of magnetite in surface exposures to the south. Underground the 100-foot level extends along the strike of some magnetite lenses, associated with dike rocks, to a point 750 feet south of the shaft, but scheelite is here very sparse or entirely lacking.

Production and reserves

Although a little of the garnet-diopside rock south of the open cut contains scheelite, all the ore that had been mined by early 1944 was in rock that contained at least 50 percent of magnetite, so the amount of indicated ore available depends primarily upon the amount of magnetite-rich rock in the mine. Not all of this rock, however, is scheelite ore, and it is therefore necessary, in calculating reserves, to take account of the distribution of scheelite within the magnetite rock.

The localization of the scheelite ore is controlled mainly by two factors, whose relative importance varies from place to place. The more important factor is proximity to a contact. The other is control of the movements of the ore-bearing solutions by impervious igneous rock. The low-angle dike already noted, for example, apparently has acted in at least one place to concentrate solutions on its lower side. In general, however, the magnetite above the low-angle dike is more uniformly impregnated with scheelite than that below, where the scheelite is more spotty.

The structure sections and the longitudinal projection of the ore body in plate 37 give a picture of the extent and distribution of the ore that is helpful in calculating reserves. The zone rich in magnetite extends for several hundred feet north of the shaft, but very little scheelite has been found in the old mine workings that explore this part of the zone and it is not included in the estimates of reserves.

The structure sections in plate 37 illustrate the decrease in thickness of the magnetite zone toward the south and show that it seems to be ore-bearing for only a short distance in that direction. On the surface, very little scheelite-bearing magnetite was found beyond a point about 100 feet south of the open cut, and on the 100-foot level the ore disappears almost directly beneath this point. The scheelite ore tends also to pinch out in depth, and below the 300-foot level there is probably very little ore. This is partly because the magnetite body narrows downward, partly because the scheelite content of the magnetite rock diminishes downward.

Most of the pockets of higher-grade ore were mined out by December 1943, and mining was discontinued. Between the fall of 1941 and December 1943 the mine supplied 18,000 tons of rock from which 6,800 tons of ore containing 0.6 percent WO_3 was sorted. The average grade of the rock removed from the mine thus is 0.226 percent WO_3.

Most of the possible scheelite ore in the mine is contained in a block of magnetite-rich contact rock roughly 300 feet deep, 450 feet long, and 6 to 30 feet wide. From its volume, about 75,000 cubic yards, there must be subtracted the volume of included igneous rock and that of the empty stopes, estimated at 51,000 cubic yards. The net volume of magnetite-rich rock would be 24,000 cubic yards, which at 7,210 pounds per cubic yard would weigh approximately 86,500 tons. To this may be added 20,000 tons of ore calculated from surface exposures beyond the limits of the underground workings, making a total of 106,500 tons of magnetite-rich rock in the deposit. It is known from direct observation that a large part of this material is barren. The erratic distribution of the scheelite in the magnetite may be regarded, by a liberal construction, as making all unexplored parts of the magnetite body potential sources of ore, but there is no reason to suppose that they will be any richer on the average than the parts that have been mined.

By December 1943, all of the better ore shoots had been mined out and any ore left in the ground was either of lower grade or in as yet undiscovered ore shoots. At the beginning of operations in 1941, ore reserves at the Old Hickory mine were estimated by the writer to be about 15,000 tons of measured and indicated ore containing approximately 0.5 percent WO_3, and 43,000 tons of inferred ore containing 0.25 percent WO_3. Actual production has amounted to 18,000 tons which averaged slightly under 0.25 percent WO_3. This production has essentially removed all of the ore formerly classed as measured and indicated.

Mining activity in 1943 opened more of the mine for examination, permitted a more accurate appraisal of ore reserves, and showed the distribution of scheelite-bearing rock to be quite restricted. Thus, it does not seem probable that there are any large potential reserves of ore in high-grade pockets or of large tonnages of low-grade material.

It is estimated that about 400 tons of ore containing from 0.75 to 1.00 percent of WO_3 could be sorted from scheelite-bearing material left in the mine. This amount of ore is classed as indicated as much of it is partly exposed by underground workings. It is possible that some undiscovered pockets of ore, minable under conditions existing in 1944, are present, but there is no basis on which to estimate the tonnage. About 5,000 tons of rock containing approximately 0.1 to 0.2 percent WO_3 may be inferred. This is not ore, but could possibly be a source of small production under emergency conditions.

Copper Ranch mine

The Copper Ranch mine, 2½ miles northwest of the Old Hickory mine, is connected by dirt roads with the Old Hickory mine and with State Highway No. 26 (pl. 32). The mine openings are on the south side of a low rounded knoll of bedrock which projects from the alluvial plain. The workings consist of an inclined shaft 315 feet deep, 425 feet of drifts branching from the shaft, a stope which is now filled, and three small shafts immediately south of the main shaft. Plate 38 shows a plan and longitudinal section of the mine. The mine was originally worked for copper, and a small amount of commercial copper ore was taken from the upper workings. Scheelite was not discovered in the mine until 1941.

Geology

The Copper Ranch mine, like the Old Hickory and Cupric mines, is in a contact-metamorphic deposit formed where limestones have been invaded by quartz monzonite and granodiorite porphyry. Here, as at the other mines, pure massive limestone grades into shaly and sandy limestone, and certain beds of the impure limestone have been metamorphosed to form garnet-diopside-magnetite rock; but the rocks here, unlike those at the other mines, contain remnants of biotite, which was once abundant in some layers but has since been altered in large part to chlorite and talc or some closely related mineral. Mica-rich layers are particularly abundant in the upper part of the deposit, and the scheelite is frequently associated with the mica.

The granodiorite porphyry is abundantly exposed on the surface of the hill, and the quartz monzonite is the predominant igneous rock underground. The relations between the two types of igneous rock at this deposit were not observed at any place in the mine.

The principal structural features of the deposit are the results of igneous intrusion and a small amount of faulting. The limestone series strikes N. 75° W. and dips 25° to 35° NE., its attitude being fairly constant throughout the mine. The igneous rocks are intruded into the limestones as sills and as dikes. The main sill is in the upper part of the mine, and the main dikes cut the limestones in the lower part of the shaft, with a strike of N. 20° to 25° W., and a dip of 60° to 70° NE.

A series of steeply dipping faults, which strike northwest and dip both to the northeast and to the southwest, cut both the limestones and igneous rocks. Some of the faults follow the contacts of the igneous bodies, but others cut across these contacts and offset them. The extent of this offsetting could not be accurately determined, but it is probably not very great.

Ore deposit

The mineralization in the mine is controlled both by the bedding in the limestone and by the contact of the igneous rock with the limestone. In the upper part of the mine (pl. 38) the distribution of the drifts and stopes illustrates the dependence on bedding. The material mined from these workings was all secondary copper carbonate ore, but scheelite has been found to be widely scattered through the adjacent ground, mostly in one or two rather well defined beds 2 to 3 feet in thickness. The debris, also, which fills the large stopes east of and below the upper section of the shaft might possibly contain enough scheelite to be considered a low-grade ore. In the lower workings the scheelite is more closely associated with the contacts of quartz monzonite than with particular beds of limestone. It occurs only in small pockets, which probably contain altogether only a small quantity of the mineral.

Here as elsewhere in the district, the scheelite fluoresces with a marked yellowish color. This is especially true in the upper part of the workings, where the mineral is soft and in large part powdery. All these characteristics suggest a high molybdenum content.

Reserves

Assays of material from the pits in front of the main shaft are reported to show 1 to 2 percent of WO_3, but this material was probably hand-picked. The distribution of the material in the mine, together with its relatively high molybdenum content, would probably reduce the average grade of any considerable amount of the ore to 0.25 or 0.5 percent WO_3. A conservative estimate would give about 2,200 tons of measured ore of this grade. On the basis of the exposures immediately south of the main shaft, there is probably two to three times this amount of indicated ore. Any plan to work such ore, however, must take into account a high and quite variable molybdenum content which not only reduces the amount of WO_3 in the ore but also makes necessary the separation of these two components in preparing the final product.

Copper King mine

The Copper King mine is a small scheelite-bearing property located approximately 4½ miles southwest of the Old Hickory mine, and a short distance south of State Highway No. 21 (pl. 32). This property was leased by C. H. Segerstrom and was operated by him on a small scale from 1942 to 1944. Operations at the mine are reported to have ceased in April 1944. The property is served by a good gravel road. The workings consist of a 93-foot steeply inclined shaft and about 350 feet of drifts on the 30-, 65-, and 93-foot levels.

Geology

The mine is on the upper part of a gently sloping surface, well covered with slope wash, where rock outcrops are poor. Some trenches and pits have been dug to expose the bedrock, but the surface geology is obscure. Altered limestones occur in the vicinity of the shaft and quartz monzonite is exposed a short distance to the east and west, but igneous rock was found in the underground workings only at the end of a 60-foot crosscut to the west from the shaft. The shaft and drifts are opened in a series of limestones and quartzites which strike N. 70° W., and dip 30° to 35° NE. The upper parts of the workings are in the limestone and the lower parts are in quartzite. Parts of the limestones have been altered to a garnet-magnetite contact-metamorphic rock containing scheelite.

Ore deposit

The tactite containing the richest scheelite ore appears to be formed by the alteration of one bed of limestone. One stope of ore, 30 feet wide by 35 feet long and about 6 feet thick, was mined from this zone between the 30-foot and 65-foot levels, but irregular pockets and stringers of ore also occur stratigraphically below the stope area. The 93-foot level of the mine is in quartzite in which little or no scheelite has been found. The main ore zone, following the bedding of the limestone, appears to dip gently to the north and has not been intersected in the lowest workings. The distribution of scheelite in this zone, however, is not uniform and the presence of the zone is no guarantee of the presence of scheelite ore within it. The scheelite contains an appreciable amount of molybdenum which varies considerably in amount from place to place.

The faulting observed in the workings probably affects the distribution of the ore. The stope mentioned above is terminated on its east side by a prominent slip plane, but no evidence was found on which to base the age of this structure and its relation to the age of the mineralization.

Production and reserves

Much of the material removed during development work contained sufficient scheelite to make its recovery worth while. About 1,200 tons of ore averaging 0.35 percent WO_3, and 1,100 tons averaging about 0.72 percent WO_3 had been mined to March 1944.

Reserves in the mine are in irregular pockets and very little ore is blocked out.

Tungsten reserves in the Copper King mine

	Tons	Units WO_3
Measured ore	Very small amount	
Indicated ore	400	300
Inferred ore	500	375
Low-grade material	1,000	350

Daily Metal Mines property

Tungsten-bearing tactite, formed along a granite-limestone contact, occurs on the Daily Metal Mines property and on the adjacent Contact and Oak claims. The Garnet No. 1 claim, the most fully developed in this area and the only one that had supplied any ore by March 1944, is about 15 miles due west of the town of Beaver, on the east side of the Mineral Mountains. The property is easily accessible by means of a road recently constructed along the east base of the range. Plate 32 shows the location and plate 39 the geology of this deposit and that of the adjacent claims.

The Garnet claims Nos. 1 and 2 and the Contact Fraction claim, owned by Ambrose McGarry of Beaver, were under lease to Daily Metal Mines, Inc., in March 1944. The company was active on the property in the early spring of 1944, but operations were reported to have ceased in May of the same year. Mine workings consist of two shafts, one 40 feet deep and the other 96 feet deep, 700 feet of drifts and crosscuts from the shafts, and about 20 surface trenches. Development work on the 40-foot level, about 330 feet, was done before the Daily Metal Mines, Inc., leased the property.

Geology

The Garnet and Contact Fraction claims are on the Upper part of a gently sloping pediment some distance east of the steeper slopes of the main mountain front. The surface is slightly dissected and only a few natural outcrops of bedrock are to be found. Most of the ground is mantled by a thick layer of granitic sand and slope wash derived from areas of bedrock granite to the west. Numerous trenches and underground workings provide sufficient exposures for accurate mapping of the deposit in the immediate vicinity of the main workings.

Scheelite occurs in tactite layers adjacent to a granite mass. The limestone is a fairly massive rock which strikes about N. 36° E., and dips 75° to 85° NW. The width of the limestone is unknown as most of it is covered by slope wash. It is bounded by the granite on the northwest, where the contact appears to be nearly parallel to the bedding of the limestone. The granite is a medium-grained porphyritic rock which is only slightly finer-grained at the contact with the limestone than within the mass. Minor amounts of pegmatitic material and quartz veins are associated with its border facies.

The strike of the limestone-granite contact is remarkably straight for a distance of nearly half a mile on the Garnet and Contact claims. Minor cross-faults and low-angle shears produce minor irregularities and a small amount of offsetting, but these are generally too small to affect the continuity of the limestones and their included tactite layers. One low-angle fault on the 96-foot level has a reverse displacement of 15 to 20 feet—a distance sufficient to cut out the tactite layer at the place where an exploratory crosscut intersects the granite-limestone contact (see pl. 39, sec. B-B'). Considerable shearing parallel to the bedding and the contact may be seen in the underground workings. No other structural complications have been observed in the area.

Ore deposits

The scheelite occurs in layers of tactite or garnet rock formed by the replacement of certain zones in the limestones. On the Garnet No. 1 claim, there are at least four layers, ranging in width from a few inches to 40 feet, within a zone 130 feet wide parallel to the granite contact. These layers, separated by essentially unmetamorphosed limestone, are not uniformly replaced and vary in their scheelite content both across the garnet-rich zones and along their strike.

These layers, from the contact outward, are as follows: Layer No. 1, immediately adjacent to the contact, is quite irregular and discontinuous. The relatively few openings along it are in the thicker parts which reach a maximum known thickness of 18 feet. In places in the underground workings the layer divides into several thin stringers of garnet rock in limestone. Layer No. 2 is about 50 feet from the contact. It is the most persistent and best explored of all the tactite zones; it averages about 30 feet in width, and may be traced along the strike for at least 800 feet. This zone is probably coextensive with a tactite zone on the Contact claim 600 feet farther northeast. Layer No. 3 is exposed only in trenches Nos. 14 and 17 (pl. 39); it is from 10 to 12 feet wide and may be traced on the surface for only 150 feet, although it is probably much more extensive beneath the cover. Layer No. 4 is only partly exposed in trench No. 14 (pl. 39), and its width and length are unknown. Although the granite contact has been located nearly 800 feet along its strike to the southwest of the main exposures of the garnet rock, the tactite layers are apparently not present or well developed here.

All four of the tactite layers contain some scheelite, but only layer No. 2 has so far been found to contain ore. Most of the garnet rock is thinly laminated parallel to the bedding of the limestone, crumbles easily, and is easily broken into small fragments. These characteristics are partly the result of the original bedding of the limestone, partly the result of later shearing. Locally the tactite layers contain some hard solid ribs of garnet rock.

Distribution of scheelite

Scheelite occurs in the garnet rock as small disseminated grains or as coarser crystals along occasional fracture planes which cut across the layering of the garnet rock. Although most of the tactite contains some scheelite, the distribution of the mineral is not uniform, and only certain zones are rich enough to be considered ore.

The richest ore in the mine was found in the small crosscut immediately south of the main shaft on the 40-foot level (see underground workings, pl. 39). A tabular pocket of ore, 2 to 3 feet thick and about 15 feet in diameter, containing in excess of 1 percent WO_3, was mined from this area. This locality is notable for a series of fractures that cut across the strike of the tactite layers. Several of these fractures are heavily mineralized and appear to have acted as channelways for the introduction of the scheelite. It is probable that such intersections of cross fractures and the garnet-rich zones may localize shoots of better-grade ore. A much larger mass of ore 100 feet north of the shaft has been mined from the 96-foot level. This material averaged about 0.65 percent WO_3 although higher-grade streaks were present in it.

The richest scheelite mineralization observed in the workings and in the surface trenches is localized in that part of tactite layer No. 2 extending 50 feet south and about 150 feet north of the main shaft. This segment of the garnet zone is bulged slightly to the east, parallel to a similar bulge in the granite contact (pl. 39). This slight structure may be related to sufficient cross-fracturing to account for the more intense mineralization in this area, and may indicate that significant mineralization occurs only where the tactite zones are cut by such cross-fracturing. Some scheelite is found in pegmatite in the granite in pit No. 8, due west of the main shaft, and this alines with some scheelite-bearing pegmatite in pit No. 10, as well as with the trend of the cross-fracturing in the underground workings. This structure may represent a channelway for tungsten-bearing solutions from the granite into the tactite. Limited available evidence suggests that the scheelite introduction took place during a very late magmatic stage, after garnetization of the limestones. The only scheelite-bearing material of any possible economic significance outside of the areas outlined above occurs in trench No. 20 near the south end of the central area.

Grade of scheelite ore

The grades of material given for the surface trenches are based on reported assays and estimates from visual observation. On the surface of the area, the first four trenches north of the main shaft (trenches Nos. 5, 6, 7, and 9, pl. 39) contain the best and most persistent scheelite mineralization. Trench No. 5 is estimated to average 0.1 to 0.2 percent WO_3 over a width of 40 feet. Trench No. 6 contains an estimated average of 0.3 percent WO_3 over a width of 22 feet. Trench No. 7 contains a 21-foot mineralized zone of which 10 feet is estimated to average 0.3 to 0.4 percent WO_3, and trench No. 9 is mineralized for 30 feet of which one 3-foot band may average 0.75 percent WO_3 or more. South of the shaft, trench No. 11 is entirely in alluvium and trench No. 12 shows very little scheelite. Small amounts of scheelite are present in trenches 13 to 23, but very little material of ore-grade is present.

All of the underground workings on the 40-foot level are south of the shaft. The highest assay reported from the district (4 percent WO_3) was obtained from a channel sample taken in the small crosscut 10 feet south of the main shaft on the 40-foot level of the mine. This sample probably was cut in the plane of one of the narrow, rich cross fractures and is of little significance. An assay of a sample taken by the writer from a 2- to 3-foot zone in the north wall of this crosscut showed a content of 1.7 percent WO_3. This pocket of ore has subsequently been mined out, yielding about 40 tons of ore which averaged more than 1 percent WO_3. The drift on the 40-foot level is rather uniformly mineralized for about 50 feet south from the center of the shaft, but the grade is low. A chip sample from the east wall of the drift contained 0.12 percent WO_3. The rest of the 40-foot level shows sporadic occurrences of scheelite, but none possess proved continuity or uniform grade.

The 96-foot level is developed on the same tactite zone, but for the most part on its extension to the north of the shaft. A shoot of ore was found about 100 feet north of the shaft and a few feet west of the main drift in a zone of sheeted or sheared tactite which parallels the structure of the whole tactite body. This shoot, now mined out, measured 30 feet in length, 70 feet in height, and about 3 feet in average thickness, although at one place it expanded to a thickness of 9 feet. The average grade of the ore from this shoot was 0.65 percent WO_3. A winze north of this shoot contains tactite that averages 0.4 percent WO_3, and, although this is not of high enough grade to be ore, its presence may indicate another ore body nearby. Likewise, a small raise near the beginning of the long crosscut (pl. 39), contains 0.3 percent WO_3 in a shear zone which appears to be continuous with the one which contained the large ore shoot. No other places exposed on the 96-foot level contain more than 0.1 or 0.2 percent WO_3. The crosscut to the granite contact unfortunately cut the granite at the one place where the tactite, if present, is cut out by faulting. Nothing is known therefore about the character of mineralization against the granite on the 96-foot level. Plate 39 shows the general distribution of the scheelite in the mine workings.

Reserves

The deposits as a whole are rather sparsely mineralized, and much of the tactite is barren. Parts of the garnet zones have been proved to be rich enough to be considered ore but no appreciable tonnage of such material is blocked out. By March 1944, about 750 tons of ore with an averate WO_3 content of about 0.65 percent had been produced from the mine.

Estimates of available tonnages of scheelite-bearing material were based on visual observation with an ultraviolet lamp of exposures in surface trenches and in underground workings, and were guided by production statistics and a few samples. It was estimated that there is 500 tons of material containing 375 units of WO_3, which may be classed as indicated ore. In addition there is 15,000 tons of material containing 3,750 units of WO_3 and 50,000 tons containing 7,500 units which is too low in grade to be classed even as inferred ore.

Contact claim

The Contact claim, adjoining the Garnet and Contact Fraction claims on the northeast, is owned and operated by Ambrose McGarry of Beaver, Utah. Development work, which is not beyond the prospecting stage, consists of four trenches and three shafts, one of which has been reconditioned for use as the main opening to the underground workings.

The geology is essentially the same as on the Garnet claims (pl. 39), but the exposures are poorer and less can be learned about the potentialities of the property. Two garnet zones are indicated by the trenching. Trench No. 2 exposes the edge of one zone at a distance of about 30 feet from the contact. Trench No. 4 exposes another zone 13 feet wide at a distance of about 100 feet from the contact. The three shafts are not in tactite, the southern one being in a limonite-stained shear zone in the limestone and the other two being in unmetamorphosed limestone.

Scheelite is not abundant in the tactite layers and none of the material so far uncovered contains more than 0.1 or 0.2 percent WO_3. The only consistent showings are in trench No. 4 and this material is estimated to average about 0.1 percent WO_3. No ore reserves can be estimated for this property.

Oak claim

The Oak claim is southwest of the Garnet claims and is shown in part on the map of the district (pl. 39). The claim is leased by the Beaver Tungsten Mines, Inc., the principal interest in which is held by Mr. James McGarry of Beaver, Utah. Development work consists of two shafts 45 feet apart, connected by a crosscut. The west shaft is about 25 feet deep and the east shaft is nearly 90 feet deep. A 120-foot crosscut has been driven to the east from the bottom of the east shaft.

This occurrence is farther to the west than the straight granite contact of the Garnet and Contact deposits and is not related to it. The Oak deposit is apparently on the west border of a granite tongue and is not related to the granite contact of the Garnet and Contact deposits. A straight projection of the Garnet and Contact veins to the southwest would cross the east end of the Oak claim, but the ground is covered with debris and no prospecting has been done in an attempt to find an extension of these deposits.

Outcrops are poor in the vicinity of the mine and the geologic relations are obscure. The two shafts are sunk on mineralized zones in limestone, and some garnet rock with sparsely disseminated scheelite has been found. The veins cannot be traced with certainty on the surface, but they appear to strike nearly north-south. An irregular tactite zone discovered in the 25-foot shaft and in the upper part of the 90-foot shaft was not found at greater depth. The scheelite content of the exposed tactite is less than 0.2 percent WO_3 although a few small pockets of material containing from 0.5 to 1.00 percent WO_3 have been discovered. A few specks of scheelite occur in a shear zone at the end of the 120-foot crosscut, but there are few indications to suggest the presence of any appreciable body of ore in the deposit.

The property was at the prospect state of development in March 1944 and had offered very little encouragement to the operators.

Strategic Metals mine

The Strategic Metals mine is on the east side of the Mineral Mountains near the south end of the granitic stock and close to the mouth of Pass Canyon, about 4 miles north of the town of Adamsville. The location and the roads to the deposit are shown on plate 32.

The deposit is owned by Ambrose McGarry and others of Beaver, Utah. Scheelite was discovered in old workings from which a small amount of lead-silver ore was mined years ago. Subsequent examination of the surface showed that the scheelite occurs in tactite along the granite contact and in shear zones which extend out from the contact into the limestone for distances of 100 feet or more. Development work on the scheelite ore in March 1944 consisted of a small amount of new drifting from the end of the old level workings, extending them to a total of about 250 feet, a shaft about 60 feet deep on the main shear zone, and a few small surface trenches. A small shipment of ore has been made from the property to the Metals Reserve Co. in Salt Lake City, Utah.

Geology

The geology at the mine is shown in plate 40. A series of marbleized limestones of Triassic age are in contact with coarse-grained granite. The sedimentary rocks include some layers of shaly impure limestone, and certain areas of the limestones are intensely silicified to a rock which closely resembles a fine-grained quartzite. A small area of a fine-grained diorite or related basic rock occurs in the limestones near the south-central part of the area, but has no apparent relation to the scheelite mineralization. The composition of the main intrusive rock is close to that of a true granite, although there are local variations in composition. The intrusion of the granite produced contact metamorphism in the adjacent limestones accompanied by the development of zones of massive tactite which range in width from a fraction of a foot to 30 feet or more. Thin stringers of tactite in limestone or partly replaced limestone may extend as far as 200 feet from the contact. The variation in the amount of tactite is controlled in part by the composition and physical character of the limestone layers, in part by the structural relations of the contact to the structure of the limestone beds, and in part by fractures, faults, and shear zones which afforded passage for the mineralizing solutions.

The sedimentary rocks strike about N. 35° E. and dip 75° to 80° SE. In contrast to other previously described deposits on the east side of the Mineral Mountains the limestones strike directly into the granite contact which is here somewhat irregular and forms a local reentrant within which the deposit is located. The borders of the granite mass dip rather steeply and everywhere truncate the structure of the limestone.

Ore deposit

The scheelite deposits at this locality are of two distinct types although the time of formation and the general mode of origin are probably the same for both. The first of these comprises tactite deposits formed for the most part in limestone immediately adjacent to the granite contact; the second is a deposit of scheelite in a shear zone which is nearly parallel to the bedding of the limestone and at right angles to the granite contact.

The tactite is composed essentially of garnet with minor amounts of other silicates, residual carbonate, and local concentrations of pyrite. Scheelite occurs scattered throughout the metamorphic rocks but generally in negligible amounts. Concentrations of commercial-grade scheelite occur in the tactite usually within a few feet of the contact, but such areas of higher-grade ore are localized in relatively small discontinuous pockets.

Two such isolated, discontinuous pockets of ore were found in the underground workings (pl. 40) along a rather prominent fissure relatively close to the contact. The pocket closest to the contact contained considerable sulfide—mainly pyrite. Twenty or 30 tons of ore containing nearly 2 percent WO_3 was removed from these areas. A sublevel, about 20 feet below the main level, intersects the same fault fissure directly below one of the high-grade pockets of ore, but it contains only a few specks of scheelite.

On the surface, the tactite zone can be traced almost continuously for about 900 feet along the contact. There are a few gaps in this distance which show little or no tactite at places where unfavorable beds adjoin the granite or where surface debris covers the contact. The thickness of the tactite ranges from a few inches to 30 feet or more. Much of the exposed tactite contains a few scattered specks of scheelite, but here again, as underground, only local pockets of higher-grade material occur. A series of trenches along the east-west segment of tactite near the north end of the zone disclosed one pocket from which several tons of 1 percent WO_3 ore has been removed. The tactite exposed in the road cut immediately above the highest switchback is 3 feet thick and is estimated to contain from 0.75 to 1.00 percent WO_3. The lateral extent of this ore is covered by the road material below and surface debris above. A third showing of possible significance occurs in the small pit and surrounding outcrops about 200 feet west and slightly lower than the portal of the mail adit. A small area against the contact here is estimated to contain 0.5 percent WO_3 and a much larger area to average 0.20 percent WO_3. Most of the scheelite in the tactite fluoresces with a pronounced yellow color and probably contains considerable molybdenum.

The occurrence of scheelite in a zone of sheared, thin-bedded limestone which has been partly altered by contact metamorphism represents the second type of deposit. This zone is in the northern part of the mapped area immediately east of the principal tactite zone. The zone of shearing is 70 feet wide and strikes from the contact through the upper end of the road; it may be coextensive with a zone of unbroken but thin-bedded and partly metamorphosed limestones exposed in the first road cuts below the upper end of the road. The shear zone is bordered on the east by massive white crystalline limestone, and on the west by massive limestone and some tactite.

The most important concentration of scheelite occurs in 2 to 12 feet of more intensely sheared limestone near the eastern side of the 70-foot zone. An open cut and a 60-foot shaft at one end were opened in the mineralized area. The mineralized zone appears to dip parallel to the bedding, but the rocks in the zone are intensely broken and show no strong, continuous structures. The area of scheelite mineralization can not be traced on the surface for more than 20 feet because of overburden, but the shear zone is well exposed in the road cut 120 feet south of the shaft, where, however, only a very few specks of scheelite are to be found. It is more likely that the mineralized area continues northward toward the contact of the granite and that its scheelite content is less variable in that direction. Scheelite occurs in thin seams and crystals scattered through the sheared and brecciated rock. Near the top of the shaft the best ore is concentrated in a 2-foot zone of parallel fractures, but at greater depth the mineralized rock is more irregular and dispersed over a wider area, apparently being controlled more by irregular breccia zones or branch fractures than by bedding shears. Much of the ore is soft and crumbly although some layers of hard, unbroken rock are present. The scheelite fluoresces with a white or only very slightly yellow color and apparently contains less molybdenum than the tactite ores. Approximately 150 tons of ore averaging 0.95 percent WO_3 has been shipped from the shaft.

Reserves and future of the deposit

Ore reserves are calculated separately for the two classes of deposits represented at the mine. These estimates represent the amounts of ore of the various grades that the deposit might reasonably be expected to contain. Much of the material is not commercial ore under the economic conditions of 1943-44. A small amount could be profitably shipped if a nearby market were available, more may be considered milling ore, and a larger part would probably be non-commercial except under emergency conditions and at a greatly increased price.

Ore reserves

	Shear zone		Tactite	
	Tons	Units	Tons	Units
Measured	Negligible	amount	50	25
Indicated	1,500	1,200	500	250
Inferred	1,200	900	2,700	550
Totals	2,700	2,100	3,250	825
Grand total	5,950 tons		2,925 units	

Creole mine

The Creole mine is on the west slope of the Mineral Mountains, about 5 miles northeast of the town of Minersville, Utah. It was leased in 1943 by C. H. Segerstrom who mined out most of the scheelite ore. The mine is an old property previously worked for lead and silver, and extensive workings were opened during these operations. The main ore bodies consist of massive sulfide replacements in limestone along the contact of a wide quartz monzonite or granite dike. Scheelite was found at the surface a short distance south of the main adit, in a large, irregular mass of limonitic material which apparently represents the oxidized outcrop of one of the sulfide replacement bodies.

Scheelite occurred as crystals scattered through the very irregular bodies of light porous limonite. Mining operations have shown that the limonite zone, 10 or more feet wide in places, narrows down and pinches out into a series of irregular fissures in limestone at a very shallow depth. Scheelite mineralization was not uniform in the limonite.

A search through the old workings of the Creole mine, which extend to depths of 400 feet and laterally in primary sulfides beneath the oxidized outcrop, failed to show more than a few specks of scheelite.

Several hundred tons of good ore was removed from the pockets of limonite, but very little ore remained in 1944 and there are no indications where more may be found.

Minor occurrences of scheelite

A number of other occurrences of scheelite have been reported from Beaver County, but most of them are of very minor importance. A small amount of scheelite occurs in contact rock on the property of the Little May Lilly Mining Co. in the Star mining district, about 5 miles west of Milford. Only a small amount of scheelite is shown in the shallow workings and it is improbable that any appreciable amount of ore will be developed.

Some small pockets of ore occur in the upper part of the old Imperial mine property, a short distance east of the Cupric tungsten deposit. This property was leased in 1944 to Mr. M. P. Lewis of Milford, Utah. The deposit is about 1½ miles from the end of a road, and is relatively inaccessible. Scheelite occurs in a small tactite body exposed near an igneous contact high above the old mine workings. Exposures indicate approximately 1,000 tons of ore which is estimated to contain about 0.75 percent WO_3, but the inaccessibility of the deposit reduces the probability of a successful operation.

The Two R's Mining Co. property, owned by Mr. Reese Griffiths and Mr. R. Myers of Minersville, Utah, is on the west side of the Mineral Mountains, about 8 miles east of Milford. A 2- to 6-foot zone of scheelite-bearing tactite in limestone is exposed in an open cut. The grade of the ore is low and no appreciable tonnage has been developed. It is reported that mill-head assays on 58 tons of ore sent to Milford for a mill test averaged 0.58 percent WO_3.

Other minor occurrences are found on several groups of claims, including the undeveloped Julesburg claim, which are located along the granite contact on the east side of the Mineral Mountains, between the Strategic Metals mine and the Oak claims. Considerable exploratory work was done on one group of claims, but no ore was found. Scheelite occurs in small amounts on several properties northeast of the Contact claim, but no ore had been developed on them by the spring of 1944. These include the King of the Hills mine, the Major Fault claim, and the Rattler claim. The King of the Hills mine is an old property with some scheelite in dump material.

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