Geology of the Ord Mine Mazatzal Mountains Quicksilver District Arizona

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GEOLOGY OF THE ORD MINE, MAZATZAL MOUNTAINS QUICKSILVER DISTRICT, ARIZONA

By John N. Faick

ABSTRACT

The Ord mine property comprises 20 patented claims situated on the eastern slope of the Mazatzal Mountains in central Arizona. This is one of several mines and prospects in a quicksilver district that crosses the middle part of the Mazatzal Mountains and occupies part of Gila County on the east and Maricopa County on the west. The Ord claims were established in 1925, and intermittent production to the end of 1955 is estimated at about 2,100 flasks of quicksilver, produced mostly during periods of favorable prices. On the Ord property, ore has been mined from 4 separate localities; these are at hill *B*, hill *C*, workings 1, and at the Indian workings.

The rocks in the Ord mine area are metamorphosed formations of the Alder group of the Precambrian Yavapai series. They consist of gray and maroon slates and phyllites, some of which are gradational into or are interbedded with grit, and conglomerate and quartzite beds. The beds strike N. 60°–80° E. and dip steeply north or are nearly vertical. The slates and phyllites are conspicuously foliated about parallel to the bedding. A few dikes, both felsic and mafic, are exposed in the area.

Quicksilver ore occurs in the phyllites and is closely associated with conspicuous zones of bleaching and alteration in which the phyllite has been converted to sericite schist, seemingly by processes associated with ore deposition. These altered zones, called ore zones if they contain appreciable amounts of quicksilver, are localized along inconspicuous shear zones and bedding-plane faults that are approximately conformable to the foliation of the phyllites. The ore occurs as small, narrow, lenticular bodies most of which strike east-northeast, stand nearly vertical, and rake steeply west. The ore bodies are irregular in shape, and few have definite walls; some have central parts of comparatively high-grade ore which grades outward into submarginal ore or barren wallrock. Most of the ore consists of cinnabar disseminated in altered phyllite; however, cinnabar also is present in narrow quartz veins, some of which contain considerable amounts of siderite. A little native mercury is found in the upper parts of the ore bodies, and mercurian tennantite is abundant in the ore exposed in the lower workings of the Ord mine.

Undiscovered ore bodies might exist in structurally deformed zones in which the slates and phyllites have been bleached and altered, but, if present, the ore bodies are likely to resemble those now known and are apt to be expensive to discover and explore. The deepest ore found at the Ord mine is about 375

feet below the outcrop, and this relatively shallow depth indicates that considerable caution should be used in future exploration for downward extensions of the ore bodies.

INTRODUCTION

The Ord mine in central Arizona (fig. 61) is on the eastern slopes

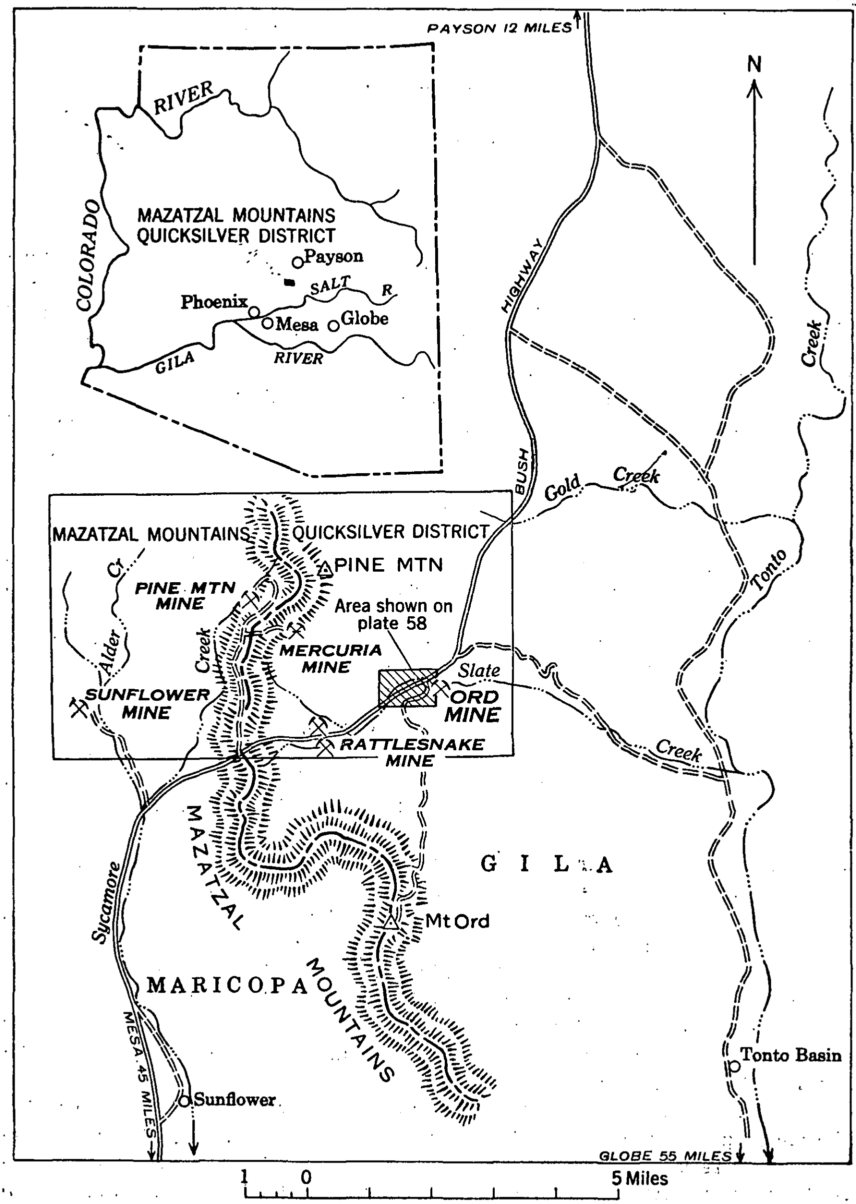

FIGURE 61.—Index map showing location of the Mazatzal Mountains quicksilver district and the Ord mine area, Arizona.

of the Mazatzal Mountains, the crest of which is the boundary between Gila County on the east and Maricopa County on the west. This range, which trends about N. 30° W., is about 50 miles long and from 12 to 18 miles wide, and culminates in Mount Ord, Pine Mountain, and several other prominent peaks. Extending across the middle part of the Mazatzal range is a district about 7 miles long and 4 miles wide, which contains several quicksilver mines and prospects. This district is in rough, mountainous country characterized by intermittent streams that follow narrow steep-sided canyons separated by high ridges, most of which are covered with dense brush. Altitudes range from about 3,000 feet in the larger canyons to 7,155 feet at Mount Ord. The western part of the district is drained by Sycamore and Alder Creeks, which join about 5 miles north of Sunflower and thence flow southward to the Verde River. The eastern part of the district is drained principally by Slate Creek, a tributary to Tonto Creek, which in turn empties into Lake Roosevelt, on the Salt River.

The Bush highway, which passes only a few hundred feet north of the Ord mine, connects the district with the nearest supply centers. From the Ord mine it is 23 miles by road north to Payson, about 55 miles south to the nearest railhead at Mesa, and about 75 miles southeast to Globe, by way of Lake Roosevelt.

The Ord property consists of 20 patented claims that have yielded ore from 4 separate mineralized zones. The ore has been treated on the property either in retorts or in a 25-ton furnace that was designed by L. E. Foster and constructed under his supervision. Living accommodations for employees consist of several houses on the property. Water is obtained from a spring.

FIELDWORK AND ACKNOWLEDGMENTS

This report on the Ord mine area embodies the results of studies made by several geologists, each working at different times and with slightly different objectives. In 1914 the quicksilver deposits of the Mazatzal Mountains were examined by F. L. Ransome (1915), and from 1924 to 1926 the district was studied intermittently by Lausen and Gardner (1927). An important contribution to the knowledge of the regional geology of the Mazatzal Mountains was made by Wilson (1939) as a result of his work in 1920 and the early thirties. The quicksilver deposits were described later by Wilson (1941). During the early forties, C. A. Rasor, geologist, Reconstruction Finance Corporation, studied the geology of the mine and mapped some of the workings. As part of the Strategic Minerals Investigation program of the U. S. Geological Survey, J. F. McAllister, in 1945, prepared by planetable methods a geologic and topographic map (pl. 58) of an area about 2,500 feet long and 500 feet wide in the vicinity of the Ord mine and mapped the geology of the accessible mine working. On behalf of the Defense Minerals Exploration Administration the writer examined the mine in 1952 and subsequently visited the property to observe the results of exploration in the lower part of the mine. Of the accompanying maps, those illustrating the mine workings below the 100-foot level of zone *B* were made by the writer; the others were prepared principally by McAllister.

To T. J. Russell, manager and part owner of the property from 1942 to 1955, is due much credit for supplying pertinent data regarding the mine and for extending many courtesies while the geological studies were in progress. Uranium Enterprises, Inc., which completed purchase of the property in 1955, made it possible to complete the investigation, and their cooperation is gratefully acknowledged.

HISTORY AND PRODUCTION

The first discovery of cinnabar in the Mazatzal Mountains was made on Alder Creek in 1911 by E. H. Bowman, but it was not until 1925 that Wesley Goswick located the Ord group of 20 claims, the locations of which were subsequently amended and patented. In October 1925 the claims were optioned to the Arizona Quicksilver Corp., which subsequently engaged in development of the property. In 1926 an access road was built to connect the property with the Globe-Payson road at the east end of the Mazatzal Mountains. Ord camp, then known as Stalker village, was built on Slate Creek, near the east end of the Ord group of claims. This company explored 4 separate mineralized zones: zone *B* at hill *B;* zone *C* at hill *C;* workings 1, which are about 450 feet southwest of hill *C* (pl. 58); and the Indian workings, which are about 1,200 feet west of the area shown on plate 58.

Apparently no quicksilver was produced by the Arizona Quicksilver Corp., but during the latter part of 1927 the mine was operated by the Tonto Mining Co. According to newspaper accounts this company shipped 20 flasks of quicksilver, the first to be produced from the Ord deposits. In August 1928 the Ord, Red Bird, and Tonto Mining Co. properties were consolidated, and these 3 contiguous properties were operated as the Mercury Mines of America. During the latter part of 1928 and most of 1929, this company mined deposits from the Indian workings, workings 1, (pl. 59), tunnel *C* (pl. 59), and tunnel *B* (pl. 60) and above it. The Rattlesnake mine, which adjoins the west end of the Ord property, also was worked by the

Company and the ore produced was added to the ore mined from the Ord deposits. Attempts to operate the Ord mine in 1930 were unsuccessful, and in December 1930 the claims were sold at public auction to A. E. Richardson.

Assay records of the 1928–29 period of operations, which were made available to the writer by T. J. Russell, indicate a quicksilver content of 0.25 percent in the ore mined from the Indian workings, and 0.43 percent in the ore from workings 1, but the amount of ore produced is not known. In a private report dated August 15, 1931, B. N. Webber and L. E. Foster state that the combined production of the Ord and Rattlesnake mines amounted to 1,078 flasks of quicksilver, and the ore treated during a year of operation contained an average of about 0.4 percent quicksilver. The writer estimates that about 765 flasks of quicksilver, or about 70 percent of the 1928–29 production, was obtained from the Ord deposits.

From 1930 to 1942 intermittent operation by lessees resulted in production of about 100 flasks of quicksilver by retorting selectively mined high-grade ore. In 1937 the property was acquired at a tax sale by W. V. Ranney, who in 1940 and 1941 mined ore from tunnel *B* and from the 50- and 100-foot levels (pl. 60) and from the Rattlesnake mine, which reportedly supplied most of the ore. Newspaper accounts indicate that from March 1940 to about mid-1941, 700 flasks of quicksilver was produced from these 2 properties. It is believed that about 40 percent of this production, or about 280 flasks of quicksilver, was obtained from the Ord mine. In 1941 control of the property passed to the Pacific Tungsten Co., which reportedly produced about 50 flasks of quicksilver from development workings, but they did little or no stoping.

In 1942 the Ord property was purchased by H. Grady Harrison, T. J. Russell, and Tyree Trobaugh, who worked it under the name of Mercury Mines Co. With the aid of a loan from the Reconstruction Finance Corporation, a new adit was driven at workings 1, and zone *B* was developed to the 200-foot level. The mine was operated more or less continuously until June 1946. Production for this period, as compiled from data supplied by Russell, indicates that 812 flasks of quicksilver was obtained by treating 9,082 tons of ore with an average recovery of 6.8 pounds of quicksilver per ton of ore. Production for this period is summarized in table 1.

The relatively small production of quicksilver after 1943, as shown in table 1, reflects selective mining of high-grade ores to meet economic conditions existing under depressed prices. This ore was not upgraded by hand sorting before treatment.

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TABLE 1.—*Quicksilver produced from the Ord mine, 1942–46* [1]

Year	Tons of ore produced	Quicksilver [2] produced in flasks	Quicksilver recovered (pounds per ton)	Average [3] sales price per flask	Gross value [3]
1942	1,728	132	5.8	$186.33	$24,595.00
1943	4,760	294	4.7	186.15	54,730.00
1944	945	171	13.7	132.92	22,729.00
1945	889	120	10.3	132.29	15,875.00
1946	760	95	9.5	115.07	8,745.00
Totals	9,082	812			$126,674.00

[1] Data supplied by T. J. Russell, manager, Mercury Mines Co. Data is published with permission of Uranium Enterprises, Inc., owners of the Ord mine in 1955.
[2] Seventy-six pounds of quicksilver per flask.
[3] Company's gross receipts exclusive of marketing costs.

The property was inactive from 1946 to 1952, when Russell and his associates reopened the mine and started exploration below the 200-foot level with financial aid from the Defense Minerals Exploration Administration, the work being done under DMEA contract Idm–460. About 8 flasks of quicksilver was recovered by retorting 14 tons of hand-sorted high-grade "black" ore obtained from the 240-foot level during the progress of the exploration work. On July 1, 1954, Uranium Enterprises, Inc., secured a lease and option on the property and completed purchase of it on May 9, 1955, after mining readily available ore mostly below the 200-foot level. Uranium Enterprises, Inc., mined and treated about 2,530 tons of ore, from which was recovered 148 flasks of quicksilver, for an average recovery of 4.48 pounds of quicksilver per ton of ore.[1] The mine was again closed in March 1955.

Total production from the Ord mine is estimated from incomplete records to be about 2,100 flasks of quicksilver. This does not include ore from the Rattlesnake mine or other mines that may have been treated in the Ord furnace.

GENERAL GEOLOGY

ROCKS

The Ord mine area (pl. 58) is underlain by a thick sequence of metamorphosed shale, grit, sandstone, and conglomerate that was described by Wilson (1939, p. 1119–1121) at a typical occurrence in the vicinity of Alder creek (fig. 61) in the western part of the district. These rocks are assigned to the Alder group of the Precambrian Yavapai series. In the Ord area the Alder group is composed mostly

[1] Data furnished by Uranium Enterprises, Inc.

of fine-grained shaly units, which have been metamorphosed to slate and phyllite and locally to schist. In some places they grade into or are interbedded with coarser grained quartzites and conglomerates. A few layers or zones appear to be composed of materials of igneous origin. A few felsic and mafic dikes, of underternined ages, are exposed in the area. Old gravels, possibly of Tertiary(?) age, and younger alluvium, probably of Quaternary age, are exposed in places along the canyon of Slate Creek.

Slate and phyllite.—The slates and phyllites which represent metamorphosed shaly units of the Alder group are prevailingly fine-grained, moderately soft, cleavable, and irregular to splintery on fractured surfaces. In many places the rocks are distinctly contorted and crumpled. The most common variety consists mainly of dark-gray to black locally arenaceous slate or phyllite; however, a maroon to brownish-red variety, the color of which is due to the presence of hematite, is conspicuous in the Ord mine area. Most of the rocks are coarser and more lustrous than normal slate and are called phyllite. Sericite schist, formed locally by alteration of the phyllite, is conspicuous in places in the Ord area. Quartz, calcite, and siderite are common in these schistose rocks.

Brown quartzite.—Thick masses of fine-grained quartzite crop out for a few thousand feet along the north side of the Bush highway from Ord camp to a point a short distance west of the Rattlesnake mine. Near the camp, and thence eastward along Slate Creek, this quartzite is capped mostly by old gravel. The fresh quartzite is light gray, light buff, or almost white, but weathers to various shades of brown.

Gray quartzite.—Part of hill *B*, hill *C*, and the craggy outcrops along the south slopes of Slate Creek consist of moderately fine-grained light-gray quartzite, some of which is tinted maroon; a central band of it is brownish. In a few places, particularly on the higher knobs, thin gash veins of white quartz are abundant in the gray quartzite. Two beds of the light-gray quartzite are conspicuous in the eastern and western parts of the area, but only one bed is conspicuous in the central part—in the vicinity of hills *B* and *C*.

The gray quartzite beds have been disturbed by faulting and possibly also by folding, and the outcrops exhibit considerable irregularity and lack of continuity as shown on plate 58. The gray quartzites are useful marker beds, although in many places in the central part of the area contact relations are masked by large blocks that have broken off and moved away from the outcrop.

Conglomerate and grit.—In places the slates and phyllites grade into or are interbedded with coarse-grained or grit-bearing beds that have appreciable amounts of coarse sand and fine pebbles of quartz, quartzite, jasper, and rhyolite in a slaty or phyllitic matrix. In a few places, as on hill *B* and the south slope of hill *C*, pebbles predominate, and the rock is a true conglomerate. Conglomerate beds also are exposed in many places in the mine workings in zone *B* between level *B* (pl. 60, 0-foot level) and the 240-foot level. The pebbles in the conglomerates are conspicuously almond or augen shaped, and the greatest dimensions are parallel to the planes of foliation. The axes of elongation generally plunge steeply west.

Alluvium and old gravels.—The eroded surfaces of the Alder group are partly covered by old gravel of Tertiary(?) age which is exposed in the hills north of the highway in the northeastern part of the area and which underlies the hill where the furnace is situated (pl. 58). The gravel is coarse, heterogeneous in composition, and moderately consolidated. Alluvium that is younger (probably Quaternary) than the old gravel occupies the floor of Slate Creek and the lower reaches of its tributaries, and it is typically exposed in the flat area upon which the camp is situated.

Dikes.—A few narrow, discontinuous dikes are exposed in the area. A light-colored fine-grained quartz-bearing felsic dike, possibly rhyolite, crops out along the Mount Ord road south of hill *B* (pl. 58); and a similar rock is exposed about 250 feet southeast of shaft 1. Dark mafic dikes, with buff or dark-brown weathered surfaces, are prevalent in the vicinity of workings 1. For field use these dikes are tentatively named basalt. One of the dikes is cut by the new adit at workings 1 (pl. 59), and another, or possibly the same dike, is exposed in a road cut just below the old inaccessible shaft 1. Similar rock is exposed at the caved portal of the old adit about 125 feet east-northeast of the caved shaft 1 (pl. 58). The dikes have inconspicuous outcrops and consequently have been mapped only in the few places where they are readily recognized.

STRUCTURE

The most obvious structural feature in the Alder group is the foliation of the slates and phyllite which generally strikes east-northeasterly and dips steeply north; however, other attitudes can be found locally. Foliation apparently is nearly parallel to the bedding in most places, but in some of the gritty zones the strike of the beds is more northerly than the foliation and has a gentler dip.

The rocks undoubtedly have undergone considerable deformation as is indicated by the crumpled nature of the phyllite, by displacement of the quartzite and conglomerate beds, and by inconspicuous faults and shear zones that are about parallel to the foliation. These faults and shear zones are important structural features because of the influence they have had on the localization of the ore deposits. Cross faults that strike northerly or northwesterly, and generally dip steeply west, cut obliquely across the foliation and in a few places displace the marker beds. Detailed mapping in tunnel *B* and Mercury adit indicates that some of these cross faults terminate by merging with faults or shear zones that are parallel to the foliation, whereas others appear to be displaced by the faults that are parallel to the foliation.

MINERAL DEPOSITS

Most of the ore from the Ord property was obtained from 4 areas: beneath hill *B;* hill *C;* at workings 1, which are about 450 feet southwest of hill *C* (pl. 58); and at the Indian workings, which are about a mile west of the Ord camp. At these localities, bodies of quicksilver ore occur in relatively extensive zones of bleached and altered host rock, which are referred to as ore zones in those places where they contain appreciable amounts of mercury-bearing minerals. The largest, or zone *B* (pl. 60), from which several small ore bodies were mined, has been productive to a depth of about 375 feet below the surface. Zone *C* (pl. 59) has been mined to a depth of about 200 feet below the outcrop on the east side of hill *C*. At workings 1 (fig. 59) an ore body has been mined from the surface to the 50-foot sublevel below the new adit; and in 1955 cinnabar was exposed on the 90-foot sublevel, a depth of about 225 feet below the outcrop. The Indian workings are inaccessible, but according to an old map an ore body having a strike length of about 70 feet was mined to a depth of about 100 feet through the Indian tunnel and a sublevel about 48 feet below it.

The ore occurred in phyllites and schists as narrow, lenticular bodies that strike east-northeast, stand nearly vertical, and rake steeply west. The ore is of two different types: the most abundant type is composed of very fine-grained cinnabar disseminated in whitish sericitized phyllite or schist; and the other type is composed of coarser grained cinnabar embedded in quartz-siderite veins. A little cinnabar occurs in the conglomerate in the upper workings in zone *B*.

Ore zone *B*, which has been the most productive, is typical of the Ord deposits. This zone consists of a group of closely spaced small ore bodies, each separated from the others by fault gouge, barren schist, or mineralized host rocks of submarginal grade. Individual ore bodies in zone *B* range from about 15 to 150 feet in strike length and generally from 2 to about 8 feet in width; however, disseminated ore of relatively low grade attains exceptional widths as great as 20 or 25 feet in a few places above the 200-foot level. Below this level most of the ore occurs in a zone from 3 to 6 feet wide, although the estimated average width of all ore is about 3½ feet. The vertical dimension of the ore bodies is usually greater than the horizontal dimension.

In places only the richer parts of the ore bodies are of commercial grade, and much submarginal material is left after mining.

STRUCTURE

The ore deposits are in zones of pronounced structural deformation formed by many faults of diverse attitudes and by flexures, joints, and shears of the host rocks. The ore bodies are localized in altered zones along inconspicuous shear zones and bedding-plane faults that normally correspond to the district attitude of the foliation. The strike of the productive part of zone *B* ranges from east-northeast to slightly south of east.

The age of many of the faults relative to formation of the ore is not determinable in most places, but movement undoubtedly has taken place along some of the faults both before and after emplacement of the ore. The bedding-plane faults and shear zones that are about parallel to the foliation existed before mineralization as is indicated by zones of alteration and mineralization that are localized along them. For this same reason some of the more northward-trending faults, the Winze fault for example, also are believed to have existed before mineralization.

A conspicuous northeastward-trending west-dipping fault, referred to as the Winze fault because of its proximity to winze *B*, is exposed on level *B*, and the 50-, 100-, and 150-foot levels. If projected to the surface, the location of the fault would correspond approximately to that of a northward-trending fault that displaces the conglomerate bed on hill *B* (pl. 58). That the fault was in existence before mineralization is shown by zones of altered schist, small quicksilver ore bodies, and quartz-siderite veinlets, which are localized along or near it. The Winze fault, where exposed near winze *B* on the 50-foot level (pl. 60), contains fragments of brecciated schist impregnated with cinnabar, indicating that movement after the ore was deposited has taken place along the fault; this displacement as shown on plate 60, however, is not large. In the upper workings, ore has been mined on both sides of the fault; but because the fault is steeper than the plunge of the ore body, the east segment of ore terminates at the fault slightly above the Mercury adit (pl. 60), and only the west segment exists on the 200-foot level and the 240-foot level.

A poorly defined zone of brecciated and altered phyllite that marks the position of a conspicuous fault was penetrated by the Adit winze below the 240-foot level and also by the 300-foot level drift (pl. 60). This fault is believed by some investigators to have displaced the ore zone between the 240- and 300-foot levels, but this interpretation is not supported by evidence of mineralization and alteration exposed on the 300-foot level.

ALTERATION

Several conspicuous zones in which the slates and phyllites display the effects of bleaching and alteration in various degrees of intensity occur in the Ord area and are typicaly exposed in several places along the road to Mount Ord. The altered zones, which are schistose in most places, are whitish or yellowish or satiny in appearance, in sharp contrast with the gray or maroon of the original phyllite. Most of the zones are apparently formed along inconspicuous east-northeastward-trending shear zones and bedding-plane faults and are conformable to the foliation of the area. These altered zones consist of fine-grained sericite; specimens collected near the ore contain quartz and siderite. Soft red hematite, which may represent residual iron from the altered phyllite, is present in small amounts and is abundant in a few scattered places near the ore. It is noteworthy that all known ore bodies at the Ord mine occur in these altered zones; however, large parts of the zones are not known to contain mercury-bearing minerals.

MINERALOGY

Cinnabar is the only important mercury-bearing mineral in the ore; however, mercurian tennantite and native mercury are present in small amounts. Associated metallic minerals in the ore are sparse chalcocite, pyrite, and chalcopyrite. The principal gangue minerals are quartz and an iron-rich carbonate, which spectroscopic tests indicate is magnesian siderite. Barite, in microscopic amounts, was identified in specimens collected from the 240-foot level. Tourmaline was reported by Lausen (1926) to be present in many quartz veins near the area, but it has not been identified at the Ord mine. Sericite is the principal constitutent of the altered host rocks, which in many places contain minor amounts of soft red hematite. In the zone of oxidation the most abundant mineral is limonite, formed by the oxidation of siderite. Supergene copper minerals occur sparingly in many places but generally only as stains or thin coatings.

Quicksilver ore different from any previously discovered at the Ord property was encountered on the 240-foot level (pl. 60), where a small shoot containing an abundance of black mercurian tennantite and small amounts of cinnabar was exposed in the drift from 10 to 35 feet west of the Adit winze. That this black ore is comparatively rich is indicated by recovery of 8 flasks of quicksilver by retorting about 14 tons of sorted ore obtained from the 240-foot level drift. A few discontinuous veinlets about an inch wide or less, that are mineralogically similar to the black ore on the 240-foot level, were found in an intensely altered zone penetrated by the 300-foot level drift (pl. 60) about 80 to 120 feet west of the Adit winze; but exploration at this depth failed to find minable ore.

The black ore consists of extremely fine-grained mercurian tennantite intergrown with scattered grains of chalcocite, in a gangue of quartz, siderite, and sparse amounts of barite. The mercurian tennantite produces a red streak which aids in identifying the mineral in the field. Identification of the minerals in the black ore was made by L. G. Evans, and a confirmatory chemical analysis of the mercurian tennantite was made by R. E. Stiles, both of the U. S. Bureau of Mines, Tucson, Ariz. The analysis is given in table 2.

TABLE 2—Analysis of mercurian tennantite from the 240-foot level of the *Ord* mine

[Analysis by R. E. Stiles, U. S. Bureau of Mines]

Element	*Percent*
Hg	16.8
Cu	31.8
S	20.0
As	9.6
Sb	6.8
Fe	3.7
MgO	1.1
Insol.	3.5
Total	93.3

The concentrates analyzed were slightly contaminated by the associated minerals because of the difficulty encountered in making a separation of the fine grains. Evans and Stiles indicate that if most of the iron and magnesium in the above analysis is calculated as a carbonate (siderite) and allowance is made for trace amounts of zinc, calcium, alumina, manganese, and potassium, then the total of the elements given in the analysis would approach 100 percent.

CHARACTER OF THE ORE

The ore bodies in zone *B*, which are typical of the ores mined at other places on the Ord property, consist principally of fine-grained cinnabar disseminated in bleached sericite schist in such abundance as to give it a pinkish color. This is often referred to as paint ore by the miners. In a few places in the ore zone many small, paper-thin veinlets of cinnabar occupy partings along foliation planes, and in other places veinlets cut obliquely across the foliation. Along a few faults, cinnabar is smeared by movement after the ore was deposited.

Most of the ore occurs in irregular bodies in which the quicksilver is not uniformly distributed, and the ore boundaries are gradational. A few of the ore bodies have central parts of comparatively high-grade ore surrounded by a shell of lower grade ore which, at the margins, grades into barren wallrock. Although in most places the walls are not distinct, in the lower part of zone *B*, developed through the Mercury adit, there is a definite wall that appears to be a bedding-plane fault with ore-bearing schist on the south side and with conglomerate forming the north limits of the ore. Discontinuous cinnabar-bearing quartz veins, some of which contain siderite, have formed along this fault in a few places. One of the quartz veins containing cinnabar is exposed on the Mercury adit or the 150-foot level near the Adit winze.

ORIGIN OF THE ORE

Only the broadest generalizations can be made regarding the origin of the Ord quicksilver deposits. Apparently hydrothermal solutions rising along inconspicuous shear zones and bedding-plane faults caused relatively extensive bleaching and alteration of the phyllites, principally by converting the phyllite to sericite schist and by addition of quartz and ferruginous carbonate. Processes of sericitization, silicification, and carbonation were accompanied or closely followed by introduction of tourmaline on nearby properties and additional quartz, and finally cinnabar. Intergrowths of the gangue minerals and their close association with the metallic minerals indicate that these are genetically related; however, contemporaneous deposition is not indicated, and the minerals were probably deposited in an orderly sequence during a short time interval as suggested by Lausen and Gardner (1927, p. 110).

The occurrence of mercurian tennantite in the ore leads to the interesting speculation that the deposits originally may have consisted mostly of this mineral and that it was reworked by hydrothermal solutions to produce cinnabar. Such an origin for the cinnabar in the Ord deposits deserves consideration because it has been shown in several places that cinnabar developed by alteration of mercury-bearing sulfosalts such as tetrahedrite (schwatzite), a species akin to mercurian tennantite. The presence of tourmaline in close association with the cinnabar in the quartz veins in the district was interpreted by Lausen and Gardner (1927, p. 109) to indicate formation of the deposits in a deep vein zone under high-temperature conditions. That the deposits are characteristic of those formed at greater depths and at higher temperatures than usually assigned to most mercury deposits is reasonably inferred from the mineral assemblage and the texture of the quartz-siderite-cinnabar veins.

Origin of the quicksilver deposits in the Mazatzal Mountains is attributed to Tertiary igneous activity, the evidence of which lies in extensive flows and tuffs west of the district. In discussing the origin of deposits in the northwestern part of the district, Ransome (1915,

p. 126) conjectured "that the cinnabar found its way into the schists in Tertiary time and its deposition was merely one phase of the volcanic activity of that period." In the same area, Wilson (1939, p. 1140) assigned a Tertiary age to a carbonate-jasper deposit which he stated "may represent a phase of the hydrothermal activity that gave rise to the quicksilver deposits of this immediate region." Dikes in the Ord area, some of which were formed before the ore was deposited, attest to former igneous activity; but their age and relation to the ore is not established. Regarding the genesis of the ore, little can be added now to the suggestion of Lausen and Gardner (1927, p. 110) that the mercury deposits were formed by solutions derived from a magma that invaded the region in Tertiary time.

ECONOMIC CONCLUSIONS

A thorough evaluation of the opportunities for making future discoveries of quicksilver ores in the Ord area is beyond the scope of this brief report; however, a few general conclusions may be drawn from the investigation. Undiscovered ore bodies, if present in the Ord area, are likely to resemble those now known in size, form, and tenor. Such ore bodies are scattered and are apt to be expensive to discover and develop. They should be sought in structurally deformed zones in which the slates and phyllites have been bleached and altered to sericitic schist, as such zones contained all the productive ore bodies found so far. As the vertical dimension of the known ore bodies usually is considerably greater than the horizontal dimension, it should be practical to explore by drifting along the altered or mineralized zones. Not all the known ore bodies cropped out at the surface, and it is possible that other concealed bodies may be discovered in favorable areas. Exploration on the 300-foot level in zone *B* met with failure, and this limited exploration may indicate that the ore bodies are shallow and do not extend to depths greater than a few hundred feet below the present erosion surface. Thus, considerable caution should be used in exploration for downward extensions of the ore bodies.

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