Jasperoid as a Guide to Mineralization in the Taylor Mining District and Vicinity near Ely, Nevada *

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Abstract

Samples of mineralized jasperoid from the central part of the Taylor silver mining district, near Ely, Nevada, and of unmineralized jasperoid from outlying bodies exhibit characteristics that seem to be useful as guides to the center of mineralization and also to clarify the genesis of the ore deposits. The most reliable indicators of proximity to mineralization centers are a change in color of jasperoid bodies from dominantly brown to dominantly dark gray, an increase in the grainsize and in the abundance of vugs in the matrix quartz, and an increase in the ratio of copper to chromium. The presence of relict sulfides disseminated in the matrix quartz of the jasperoid and the tendency for the concentrations of all the ore metals to fluctuate together in a series of samples taken across a mineralized body of jasperoid suggest that the ore metals were introduced before jasperoid formation ceased and that the ore metals and jasperoid are penecontemporaneous. Both silica and metals are inferred to have been derived from a buried stock that underlies the district. Maps of anomalies for the ore metals suggest the possibility of an eastern extension of the main mineralized area and of small separate centers of mineralization in both the northern and southern parts of the district.

The ores of this district are unusual in that they consist largely of jasperoid containing abundant tiny disseminated grains of ore and gangue minerals, although there are also a few bodies of coarse-grained ore in the jasperoid. These jasperoid ores are most abundant in the central part of the district, grading outward into unmineralized jasperoid.

The ore-bearing jasperoid in the central part of the Taylor district plus the wide distribution of apparently unmineralized bodies of jasperoid around it (Drewes, 1967, p. 80–82) prompted the present study. The primary objective of this investigation was to describe this unusual type of ore and to find out which properties of these outlying bodies of barren jasperoid change systematically toward the boundaries of the area of intense mineralization. The detection of these properties might be useful as prospecting guides. Other objectives were to see whether the patterns of minor-element distribution in the jasperoid offered clues to the position of a probable buried intrusive parent stock for the dikes, the siliceous alteration, and the ore metallization and to compare the suite of anomalous trace elements, which characterize mineralized jasperoid of the Taylor district, with those of jasperoid samples collected from other nearby mining districts and areas of siliceous alteration.

Introduction

The Taylor silver mining district of Nevada is in foothills on the western side of the Schell Creek Range about 16 miles southeast of Ely, White Pine County. Slightly more than one million dollars worth of silver and subordinate amounts of antimony, gold, copper, lead, and zinc were produced from the district between its discovery, in 1872, and 1962. The most productive mines of the district are in the northern part of section 16, T. 14 N., R. 65 E.

General Geology

The geology of the Taylor district (Fig. 1) was briefly summarized by Hill (1916, p. 200–202) and Lincoln (1923); it has been more recently discussed

by Drewes (1962; 1967, p. 77–82). Sedimentary rocks of Devonian to Permian age, consisting of limestone and dolomite beds alternating with beds of shale, dip regionally eastward. Many short, thick, granophyric rhyolite porphyry dikes, probably of Tertiary age (Drewes, 1967, p. 88) with northerly to northeasterly trends, are exposed in a belt about half a mile wide and two miles long extending from just north of the main mining district southward to about one mile beyond it. The feldspar in these dike rocks is strongly argillized, but the rocks are not silicified or mineralized. The dike rocks fill older parallel fractures and are cut by a complex network of north-, northwest-, and northeast-trending normal faults, which constitute the Taylor fault and its branches. Beginning in the late Mesozoic, these faults moved several times, according to Drewes

114°40'

EXPLANATION

Gravel — TERTIARY QUATERNARY

Latite and dacite flows and tuffs — TERTIARY

Granophyric rhyolite dikes — MESOZOIC OR TERTIARY

Ely Limestone — PENNSYL- VANIAN

Chainman Shale — MISSISSIPPIAN

Joana Limestone — MISSISSIPPIAN

Pilot Shale — DEVONIAN AND MISSISSIPPIAN

Dgc
Dgb
Dga

Guilmette Formation
Dgc, member c
Dgb, member b
Dga, member a

Simonson Dolomite

Sevy Dolomite — DEVONIAN

Silicified rock

Contact

⎯ ⎯ U/D ⎯ ⎯
Fault
Dotted where concealed. U, upthrown side; D, downthrown side

▲▲▲
Thrust fault
Teeth on overriding block

40⟋
Strike and dip of beds

70
Strike and dip of overturned beds

▪
Shaft

⚒
Large pit

x
Prospect and small pit

⊤
Adit

27
Jasperoid sample locality

39° 45'

T. 14 N.

R. 65 E.

NEVADA

Ely
Taylor district

N

0   2000 FEET

0   500 M

FIG. 1.   Geologic map of the Taylor mining district near Ely, Nevada, showing jasperoid sample localities. Geology from Drewes (1962).

(1967, pl. 2, fig. 13, p. 71–73). However, he considered the later movements along the Taylor fault to have been in the late Tertiary and early Pleistocene. Within the Taylor district most of the fault segments that branch northward and northeastward from the Taylor fault form a connecting imbricate system which suggests a normal fault system, west side down relative to the east side, combined with a slight left-lateral wrench component (Drewes, 1967, fig. 13). The main Taylor fault zone is a part of the Basin and Range fault system on the west flank of the Schell Creek Range and thus is a relatively young zone. The bodies of silicified rock (jasperoid) and some granophyric rhyolite dikes closely follow the faults, including those of middle or late Tertiary age, as shown by Drewes (1967, pl. 2).

Drewes believed that the buried stock and the mineralization in the district were of late Cretaceous or early Tertiary age (1967, p. 82), older than the Taylor fault. If this is true, the Taylor fault and related faults could not have furnished the plumbing system along which both jasperoid and ore minerals were introduced.

We suggest that not only the main Taylor fault (Drewes, 1967, pl. 2), but all the normal faults in the district, are the result of Tertiary fault movement and that they form a common interconnected system. North of the district the Taylor fault cuts Tertiary latite tuffs and thus most of the fault movement is Tertiary in age. We also suggest that the mineralization and dikes are Tertiary features that used the Taylor fault system as a channelway. For example, the western part of the largest body of silicified rock in the main Taylor district (NW half section 16, Fig. 1) follows and almost certainly fed out of the Taylor fault. Likewise, the small body southwest of the center of section 16 lies against and is elongated along the downfaulted side of the main Taylor fault, a position not likely unless the Taylor fault of middle or late Tertiary age (Drewes, 1967, pl. 2) provided the feeding channel. Similarly, the two dikes adjacent to this fault in the NW quarter section 16 (Fig. 1) are elongated parallel to it, suggesting that the shear zone along this fault was the main structural control. We suggest that the mineralization was relatively young, middle or late Tertiary, and that a granitic stock buried not too deeply beneath the Taylor district provided the dikes, the silica, and the ore, all of which used the Taylor fault system as the feeding channel. Drewes (1967, p. 82) believed that silicification of the rocks preceded mineralization and that both events were related to the emplacement of a buried stock in the late Mesozoic or early Tertiary. As the main ore is mineralized jasperoid, the silicification and most of

the mineralization are one and the same. As this jasperoid appears to be a shallow-depth, low-temperature type of mineral deposit, its abundance and the absence of coarse-grained quartz suggests that no large amount of erosion has taken place since the deposition of the mineralized jasperoid along the Taylor fault system.

Remnants of a large thrust fault are also exposed east and south of the district; this thrust fault is older than the normal faults and affects only the unmineralized upper part of the geologic section.

Silicification of the limestone resulting in the formation of abundant bodies of jasperoid is the only conspicuous rock alteration feature, and mineralized jasperoid forms most of the ore bodies in the district. By "jasperoid" we refer to an epigenetic rock body formed largely by fine-grained, chert-like siliceous replacements of a pre-existing rock. Chert, in contrast, means a siliceous rock body formed at or near the time of sedimentation. The jasperoid bodies, range in size from small pods up to huge masses more than a thousand feet long and several hundred feet wide and are present throughout the district. Most of them are controlled structurally by the normal faults of the Taylor fault zone and stratigraphically by the contact of carbonate rocks with overlying shale beds. Most of the jasperoid bodies are irregular pod-like bodies of northerly trend; a few trend northeastward. Many dip nearly vertically along the Taylor fault system and were deposited by solutions which fed out of this system. The large reef in the south part of section 16 is a blanket-like body 15 feet thick lying along a gently eastward-dipping branch fracture of the Taylor system. Most of the jasperoid bodies extend irregularly downward along the faults or plunge gently towards the north or south.

Sample Collection, Preparation, and Analysis

Ninety-five jasperoid samples were collected at 23 localities in and around the Taylor district (nos. 8–30, Fig. 1). Most of these samples were taken from outcrops; some came from exposures in open cuts and prospect pits. Many types of jasperoid can commonly be recognized at a single locality (an area of no more than 100 sq ft), and an effort was made to obtain a representative sample of each type. Consequently, the number of samples taken at a locality ranges from one, where the rock appears homogeneous, to as many as six, where many types are present. At one locality (no. 14) in the main district, a systematic series of eight samples was taken across a jasperoid body from the conduit fault on one side to the edge of the unsilicified limestone host rock on the other side.

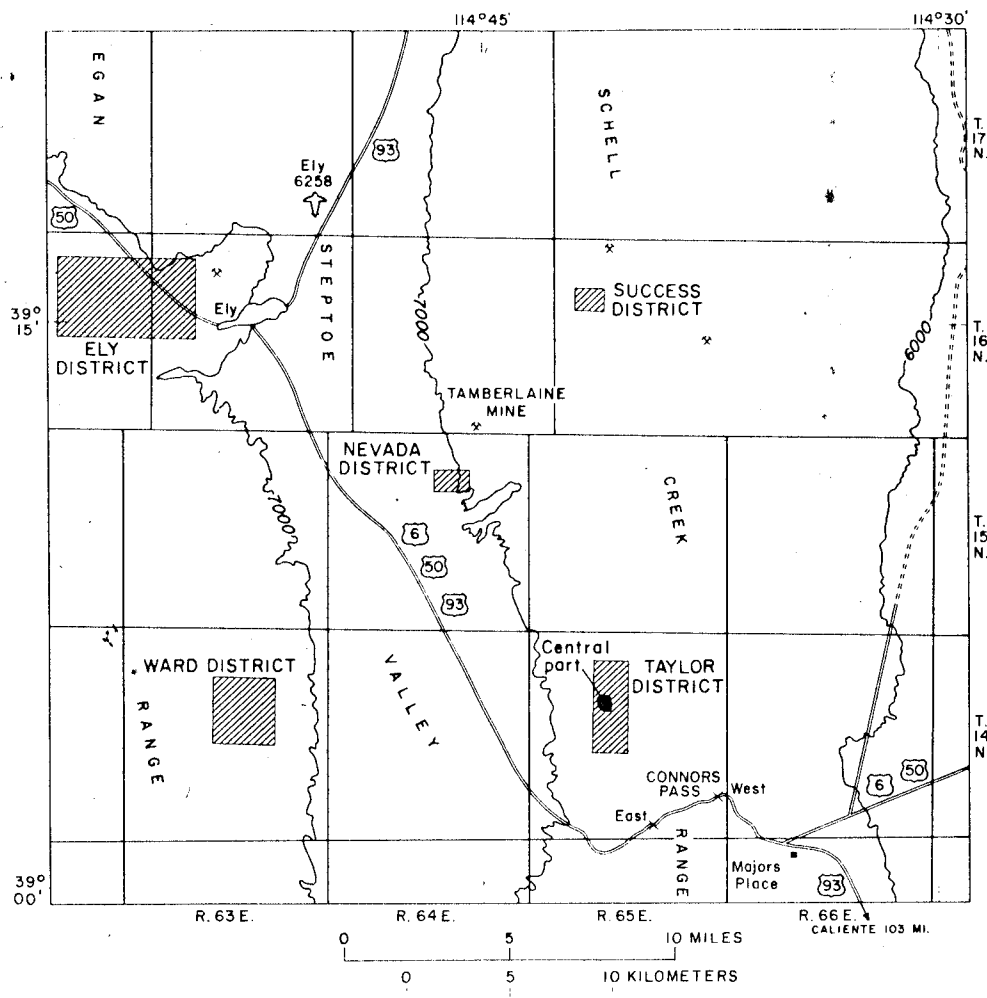The additional jasperoid samples, for comparison

Fig. 2. Index map of central White Pine County showing Taylor mining district and nearby jasperoid-bearing areas that were sampled.

with those in the Taylor district, were collected along U. S. Highway 6 near Conners Pass, near Majors Place, in the Nevada manganese district, Tamberlaine and Success mine areas, farther north in the Schell Creek Range, and from the Ward and Ely districts in the Egan Range (Fig. 2).

Each sample was split; one portion was spectrographically and chemically analyzed and the other portion was thin sectioned. Spectrographic analyses were made by means of the six-step semiquantitative method described by Myers et al. (1961), which gives results in geometric intervals, the midpoints of which are reported as the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, etc. The precision of a reported value is approximately plus or minus one interval at 68 percent confidence or two intervals at 95 percent confidence. Chemical analyses were made for silver, gold, mercury, and tellurium; silver was determined by fire assay, gold by a combination of fire assay and atomic-absorption methods, mercury by an instrumental method (Vaughn and McCarthy, 1964), and tellurium by atomic absorption.

The microscopic mineral association and the microtexture of the quartz were examined by T. G. Lovering, and the outcrops and hand-specimen features were examined by A. V. Heyl and C. N. Bozion.

Description of Jasperoid

Jasperoid is most abundant in the heavily mineralized central part of the district and is also present in scattered smaller bodies in a zone about two miles wide to the north, east, and south of the central part of the area (Fig. 1). Most of these bodies outside the central district are long narrow "reefs," controlled by fault contacts between carbonate host rock and shale (Fig. 1).

Individual masses of jasperoid are strongly brec-

ciated in most places and fragments of different types of jasperoid are commonly present in a single breccia body. These fragments are commonly cemented by younger quartz, though locally the cement is coarse calcite. The rock is in general aphanitic to very fine grained and exhibits a variety of colors. Shades of gray-black, gray, grayish brown, light brown, yellowish brown, and reddish brown are most common. Much of the jasperoid within the main mineralized and productive part of the district is fine grained and very dark gray to medium gray. In small samples it could be mistaken for chert. Its true nature is revealed by its content of numerous small vugs, its variegated and brecciated character, and its structural control by faults and fracture zones. Jasperoid bodies outside of the central part of the district are commonly aphanitic, less vuggy than those in the central part, and are dominantly brown, pink, yellow, or white.

Mineralogy and Microtexture

The ore in the Taylor district consists almost entirely of mineralized jasperoid; although very locally small bodies of supergene lead and copper minerals replace limestone. Nearly all metallic and associated gangue minerals are very fine grained. They form micrograins irregularly disseminated through the gray to gray-black group of jasperoids. They consist, where unoxidized, mainly of stibnite, sphalerite, tetrahedrite, chalcopyrite, pyrite, galena, ruby silver (pyrargyrite?), calcite, dolomite, sericite, and hydrocarbon, with local accessory tourmaline, monazite, barite, fluorite, and apatite. In a very few bodies, coarse-grained blades of stibnite are abundant. Locally small and scattered but identifiable bunches of other coarse-grained minerals are visible in the jasperoids, but veins of ore cutting the jasperoids are absent. The gray to nearly black color of this variety of jasperoid may largely result from abundant microinclusions of hydrocarbons but also results to some extent from sulfides in micrograins.

In addition to the disseminated minerals the jasperoids also contain some veinlets and breccia zones cemented by nonmetallic minerals. The veinlets generally consist of calcite, white quartz, barite, and dolomite; in places they also contain manganese minerals and fluorite.

Most of the ore is unoxidized except within a few feet of the surface. Supergene minerals identified in this zone of oxidation consist of hematite, limonite, pyrolusite, bindheimite, cervantite, smithsonite, cerussite, cerargyrite, azurite, malachite, jarosite, hemimorphite, conichalcite, anglesite, wulfenite, willemite, tenorite, chrysocolla, "antimony ochre," kaolinite, and leucoxene. These oxidation products are thus restricted to shallow depths or to post-

mineral fracture and breccia zones within the jasperoid bodies or along the limestone and fault walls of the bodies. The microscopic grainsize of most of the ore minerals has prevented proper mineralogic studies in the past.

No wall-rock alteration aureoles, except for the jasperoids, are visible. The minerals of the porphyritic rhyolite dikes, however, have been altered after intrusion as pointed out by Drewes (1967, p. 51–52).

The jasperoid quartz contains a variety of accessory minerals. In thin sections of highly mineralized samples from the main part of the district the quartz is seen to be heavily clouded with minute inclusions of carbon, stibnite, limonite, antimony ochre, cerargyrite, and swarms of tiny specks of various other oxidation products of the primary ore minerals. Calcite and limonite are present in all of the samples, mineralized and unmineralized alike. Sericite, kaolinite, and pyrite or its oxidized pseudomorphs are common accessories in jasperoid samples from many localities. Barite, fluorite, tourmaline, and monazite are present in a few samples.

Jasperoid samples from all of the sample localities have various textures. Commonly, breccia frag-
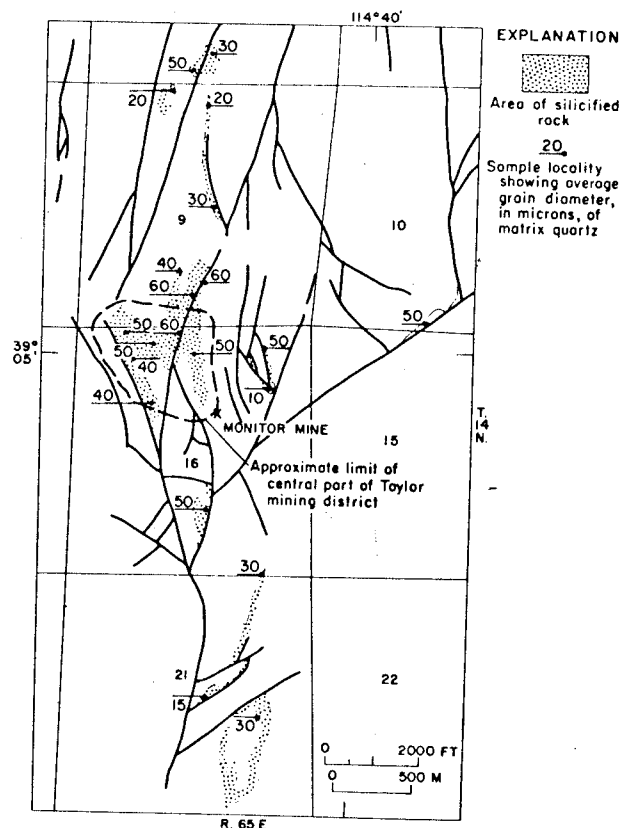

Fig. 3. Sample-locality map of T. 14 N., R. 65 E., Taylor district, showing average grain diameter of matrix quartz in jasperoid samples.

TABLE 1. Analyses of Representative Samples in and near the Taylor District (in parts per million)*

	1	2	3	4	5	6	7	8
Iron	50,000	70,000	10,000	3,000	7,000	1,500	700	20,000
Magnesium	70	500	2,000	700	2,000	300	5,000	1,000
Calcium	3,000	1,500	70,000	7,000	100,000	30,000	200,000	15,000
Titanium	150	3,000	1,500	200	700	70	70	700
Manganese	15	200	100	1,500	30	*20	70	20
Silver	2,000	10	7	<0.5	<0.5	<0.5	0.7	<0.5
Arsenic	15,000	1,500	<150	<150	<150	<150	<150	300
Gold	0.2	10.4	0.2	<0.05	<0.05	<0.05	<0.05	0.1
Boron	<10	<10	<10	20	100	<10	<10	30
Barium	70	70	200	500	150	300	70	70
Cadmium	300	<30	<30	<30	<30	<30	<30	<30
Cobalt	<2	7	<2	15	5	<2	<2	7
Chromium	3	30	70	30	200	2	15	70
Copper	2,000	10	30	30	20	2	<1	<1
Mercury	380	5.2	3.2	0.4	0.07	0.07	0.3	0.2
Lanthanum	<20	30	50	<20	150	<20	<20	20
Molybdenum	15	10	<2	5	<2	<2	<2	15
Nickel	<2	150	15	150	30	<2	<2	100
Phosphorus	<3,000	<3,000	<3,000	10,000	20,000	<3,000	<3,000	—
Lead	10,000	10	50	20	20	<7	20	<7
Antimony	20,000	200	700	<150	<150	<150	<150	<150
Scandium	<3	<3	5	<3	5	<3	<3	<3
Strontium	7	100	500	150	150	70	500	150
Tellurium	10	0.5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Vanadium	7	50	50	30	50	<5	<5	50
Yttrium	<7	30	30	50	150	<7	15	15
Zinc	700	500	<150	200	<150	<150	<150	<150
Zirconium	50	30	70	20	150	20	<7	100

* Concentrations of elements not detected are given as < one reporting interval below their detection limit.
1. Ore jasperoid sample from central Taylor district.
2. Jasperoid sample from north end of Taylor district.
3. Jasperoid sample from south end of Taylor district.
4. Jasperoid sample from highway cut 0.7 mile west of Connors Pass.
5. Jasperoid sample from highway cut 1 mile east of Connors Pass.
6. Unmineralized jasperoid sample from 1 mile east of Taylor district.
7. Joana Limestone sample from southern part of Taylor district.
8. Altered limestone composite sample 0.2 mile east of Connors Pass.

ments of two or three different types are cemented by a silica matrix of a different type, which in turn contains vug linings and crosscutting quartz veinlets with yet another texture.

The matrix quartz that cements the breccia fragments has characteristics that are fairly consistent among samples from a single locality. In most samples this matrix quartz varies somewhat in grain-size and contains scattered tiny vugs, which may be open or may be lined with late quartz, limonite, or calcite.

The range in diameter of quartz grains in the matrix is small enough so that a representative grain diameter may be estimated for the purpose of comparing different localities by counting grains across a microscope field and dividing the field diameter by this count. Average matrix grain diameters obtained from several samples at a single locality commonly agree to within ±10 microns and rarely differs by more than 20 microns. A plot of these average matrix grain diameters on an index map of the area (Fig. 3) shows that samples with coarser grained matrix (50 to 60 microns) are largely con-

centrated at localities in, or close to, the main part of the mining district.

There seems to be a general sequence in the paragenesis of the various types of quartz that compose the jasperoid of this district, although many local variations and reversals tend to complicate the picture. The oldest (type 1) is probably coarse-grained barren vein quartz, which is present as small corroded white fragments in a younger jasperoid matrix of types 3 and 4 close to major fault conduits. Another old type of quartz (type 2) is a dense aphanitic dark-gray to black cherty variety that commonly forms breccia fragments in a younger matrix but also locally forms massive replacement bodies which follow faults and fractures in the carbonate rocks. It apparently is the product of the preore-stage silicifying solutions that first attacked the carbonate rocks. The next younger common jasperoid (type 3) forms the matrix in most places. Its color varies from shades of brown and light gray in unmineralized areas to dark gray in mineralized areas. It is characterized by: (1) variable grain diameter (from 0.01 to 0.1 mm), (2) numerous tiny

TABLE 2. Elements with Anomalously High Concentrations in Mineralized Jasperoid Samples
from Taylor District and Other Nearby Areas

Locality	Distance and Direction from Taylor	Anomalous Elements
Taylor district	—	Ag, Au, Cu, Hg, Pb, Sb, Te, Zn
West Connors Pass area	2½ miles SSE	Co, Mn, Ni, P, Y, Zn
East Connors Pass area	3 miles SE	B, Cr, La, P, Y, Yb, Zr
Majors Place	6 miles ESE	Ag, Au, Co, Cr, Cu, Ga, V
Nevada district	7 miles NNW	As, Cr, Ga, Ge, Hg, La, Mn, Sn, V, Zn
Tamberlaine mine	10 miles NNW	Ag, Au, Sb, Zn
Success district	13 miles N	Ag, Au, Mn, Pb, Zn
Ward district	10 miles W	Ag, Au, As, Bi, Cr, Cu, Mo, Pb, Sn, V, Zn
Ely (Robinson) district	17 miles NW	Ag, Au, Bi, Cu, Hg, Pb, Sn, V, Zn

vugs and abundant fine-grained, disseminated opaque mineral inclusions which consist dominantly of pyrite or iron oxides replacing pyrite, and (3) various ore-sulfide minerals or their oxidation products in the ore zones. Type 3 apparently is part of the main stage of mineralization. A younger variety of jasperoid (type 4) that locally forms the matrix is a light-gray, fairly coarse-grained aggregate of lath-shaped quartz grains from 0.05 to 0.4 mm in length; it contains few opaque mineral grains except for a little disseminated pyrite. The youngest common type of silica (type 5) consists of veinlets and vug fillings of coarse, clean, white xenomorphic quartz that locally exhibits crystal faces.

Geochemical Anomalies

The normal (median) concentrations of minor elements in jasperoid unrelated to ore deposits has been estimated (Lovering, 1972, p. 34–35). Reference to anomalously high concentration of certain elements, in the following discussion, means anomalous in comparison to these estimated normal concentrations. Many samples of jasperoid from the Taylor district contain anomalously high concentrations of silver, gold, copper, mercury, lead, antimony, and zinc relative to barren jasperoid and to barren limestone wall rocks. Analyses of typical jasperoid samples from the Taylor district and from the possibly related areas of alteration west (no. 4) and east (no. 5) of Connors Pass are given in Table 1.

The jasperoid-bearing area of alteration closest to the Taylor district west of Connors Pass does not contain any known ore deposits. To the southeast, near the crest and on the east side of Connors Pass, is a possibly related altered area several miles in extent of jasperoid, low-temperature bleached limestones, and of residue shales, which were formed by the partial solution of argilliceous limestone, leaving sericitic residue shales. This area is centered on three porphyritic rhyolite dikes of petrology similar to that of the dikes exposed in the Taylor district. Drewes (1967) mapped and described these dikes which lie along U. S. Highway 6 northwest of

Majors Place within the several-mile area of low-temperature hydrothermally altered rocks. Somewhat anomalous quantities of gold, arsenic, phosphorous, molybdenum, mercury, zinc, and rare earths are present in preliminary samples of altered limestone and jasperoid from this alteration area (Table 1, nos. 5 and 8). On the fringes of the area, near Majors Place and to the west across Connors Pass, gray, chert-like jasperoids similar in appearance to those in the Taylor district are exposed. The westernmost silica reefs lie west of the pass and near northward-trending faults that are eastern members of the Taylor fault system. Samples of altered rock from the eastern part of the area west of Majors Place also show traces of tungsten.

A comparison of the suite of anomalous elements from jasperoids of the Taylor district with those characteristic of mineralized jasperoid samples from other mining districts is given in Table 2; localities are shown in Figure 2. All the samples from mining districts except the Nevada district (not including the Connors Pass samples) show anomalously high gold and silver in mineralized jasperoid samples, and all but Majors Place also show high zinc. The two districts in the Egan Range west of Taylor (Ward and Ely) both show anomalous concentrations of bismuth, an element that does not appear in samples from Taylor and the other districts in the Schell Creek Range. Furthermore, samples from Taylor and the three mineralized areas north of it (Nevada, Tamberlaine, and Success) all show high concentrations of either antimony or manganese, elements that are not appreciably concentrated in samples from Ward and Ely. The other elements vary considerably from district to district and show no consistent pattern in their regional distribution. Only the samples from the Taylor district were analyzed by a sensitive method for tellurium content; thus, this element may also be present in anomalous amounts in samples from other districts, inasmuch as it is detected by the semiquantitative spectrographic method of analysis only when present in very high concentration.

Plotting geochemical anomaly maps for minor elements in our jasperoid samples from the Taylor district (Fig. 4) is complicated by large variations in the content of most elements in a suite of samples from any given sample locality and the necessity of characterizing each such locality by a single value for each element. In order to standardize the treatment for all elements, we have computed an "enrichment factor" (E) for each locality by the following formula:

$$ E = \frac{\Sigma x_i}{nm} $$

where $x_i \ldots x_n$ are the concentrations of an element in n samples at a locality, and m is the median value of the element in all jasperoids of the Taylor district. This factor is a measure of the concentration of an element in all of the samples from a single locality relative to its median concentration in the entire suite of samples. For example, the median content of silver in 100 jasperoid samples from the Taylor district is 10 ppm. Five samples taken at locality no. 24 assayed, 2, 1.5, 7, 1.5, and 3 ppm Ag. The enrichment factor for silver at this locality is therefore

$$ \frac{(2 + 1.5 + 7 + 1.5 + 3)}{5 \times 10} = 15/50 = 0.30. $$

Maps of enrichment factors contoured at values of 1 and 5 are shown in Figure 4.

All of the base and precious metals have areas of strong enrichment anomalies within the main central part of the district, but the shapes and distributions of the anomalous areas for the ore elements show differing patterns. The northward-trending anomalies are apparently controlled by the Taylor fault system. The nature of the control for the eastward trending anomaly patterns is not known, but it is probably related to an underlying intrusion which was the hearth and perhaps part of the source of the mineralizing solutions.

TABLE 3. Ranges and Median Concentrations of Base and Precious Metals in 100 Jasperoid Samples from the Taylor District and Vicinity, Nevada (All values in parts per million)

Element	Concentration Range			Median Concentration
Cu	2	–	15,000	20
Pb	<7	–	10,000	15
Zn	<200	–	30,000	200
Sb	<150	–>	100,000	200
Ag	<1	–	3,000	10
Au	<0.05–		10.4	0.07
Hg	0.1	–	380	1
Te	<0.05–		700	0.3

The marked similarity in the high anomaly areas covered by silver, copper, and tellurium and the rather close correspondence between these high anomalies and the limits of the main central part of the mining district suggests a close association among these three elements, and also that they represent the main stage of mineralization at Taylor.

Many of the other minor elements in the jasperoid samples, which are reported in the spectrographic analyses, show concentration patterns related to the ore mineralization in the Taylor district. High boron values are largely restricted to a narrow belt trending northerly through the eastern part of the main area of the district and extending from the northernmost sample locality in section 4 to the southernmost locality in section 21. Molybdenum, however, is largely concentrated in a narrow belt that trends eastward across the northern part of the main area of the district to the easternmost locality on the line between sections 10 and 15, with a subsidiary concentration at sample localities 20, 21, and 23 at the northern end of the district. High zirconium values are also largely restricted to an eastward trending belt lying just north of the main part of the mining district with a tongue projecting southeastward from the northwest edge of the central area to the Monitor mine. Strontium, vanadium, titanium, and chromium all show broad irregular north-trending belts of high values lying east of the main part of the district and wrapping around it to the north and south. Barium content is high in jasperoid samples east of the central part of the main district and in those one half to one mile south of it but is anomalously low in most of the samples from within it.

The ratio of total copper to total chromium seems to be closely related to the main center of mineralization in the Taylor district (Fig. 5). In general, this ratio is less than one for sample localities more than half a mile from the main center of mineralization. Within half a mile of this center it increases to greater than one, and in the central mineralized area it is greater than ten.

Silver-to-gold ratios in these samples exhibit a somewhat similar pattern, but one that is less well defined, partly because of the absence of one or both of these elements in detectable concentrations at some sample localities. All of the sample localities within the main district yield silver to gold ratios greater than 100. Sample localities in the outer parts of the district, where both metals were reported, gave Ag/Au ratios of >10 but <100, with the exception of two localities at the north end of the district (nos. 20 and 23), in which total silver is less than 10 times total gold.
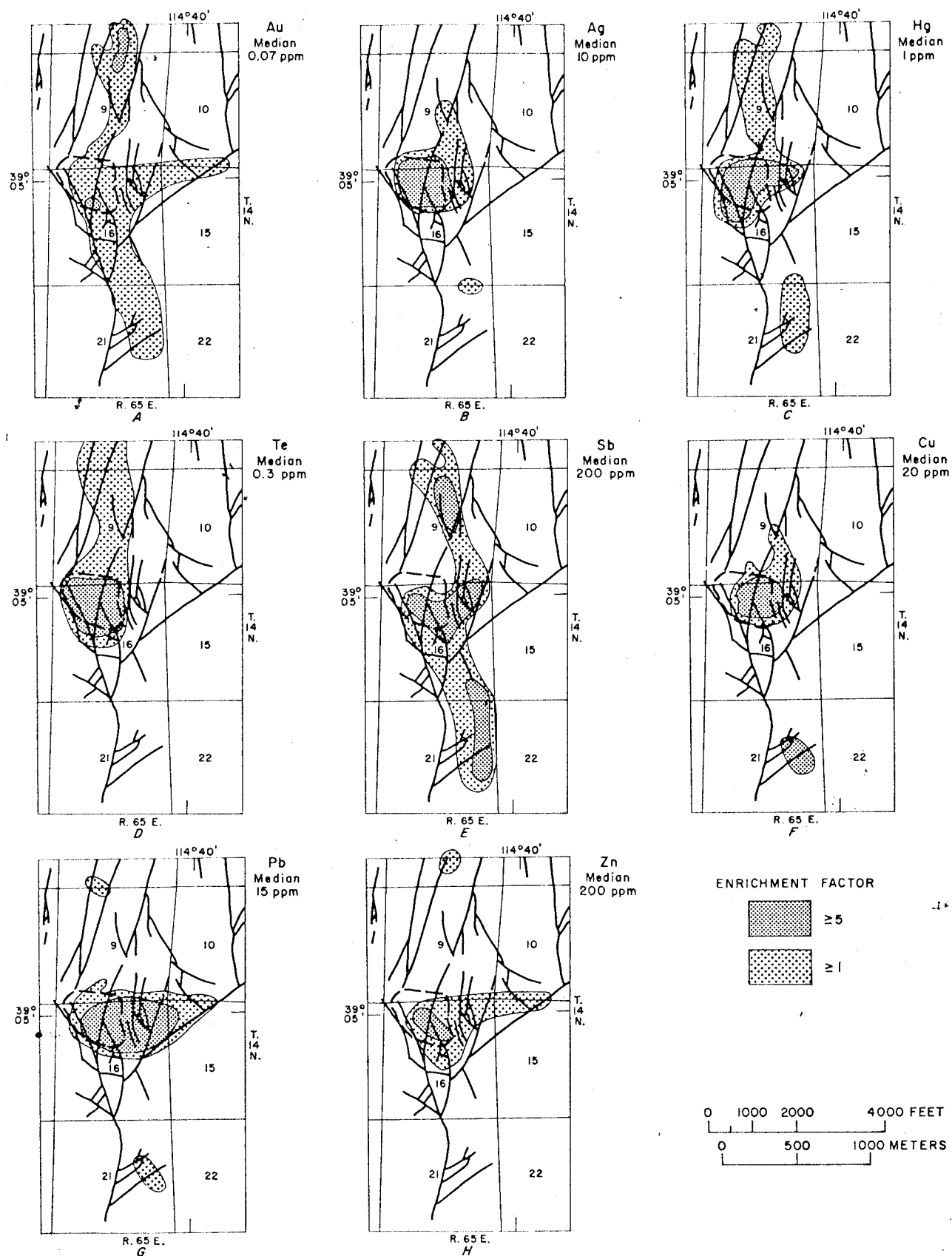
FIG. 4. Enrichment factor anomaly maps of base and precious metals in the Taylor mining district area.

Variations in Concentration of Minor Elements across a Jasperoid Body

A single body of ore-bearing jasperoid (locality no. 14) in the main central part of the district was sampled at approximately three-foot intervals from the fault along the west margin of the body that was presumably the source of the silicifying and mineralizing solutions (that formed this jasperoid body) to the outer contact with the unsilicified limestone host rock east of the body. We anticipated that the analyses of these samples would show systematic variations in the concentrations of the ore metals and some of the other minor elements with distance away from the fault conduit, but contrary to our expectations, variations in the concentration of ore metals and most other minor elements (Fig. 6) do not change systematically with distance from the fault. The only elements that show a relation to the fault are titanium, aluminum, strontium, and possibly barium (Fig. 6A), all of which decrease away from the fault, although not systematically. The ore elements follow a pattern of increase in concentration outward from the fault for about the first six feet, declining sharply at nine feet, then rising abruptly to a maximum at twelve feet (approximately in the middle of the body), declining steadily outward from this point toward the limestone contact, and increasing again at this contact to a concentration similar to that adjacent to the fault conduit. The similarity in the distribution pattern of the ore elements suggests that they were all introduced at the same time as the gray jasperoid by a single complicated mineralizing solution. Although these elements show similar patterns, they do not fluctuate by the same amount. Gold, silver, and tellurium show the greatest contrasts, spanning two orders of magnitude; mercury is only slightly less variable. Copper, lead, zinc, and antimony all show a concentration range of approximately one order of magnitude. Chromium is consistently low and shows little change in concentration across this jasperoid body It is plotted on Figure 6B only to corroborate the high copper-to-chromium ratio that is characteristic of the mineralized jasperoids from this area

The lack of a regular pattern in the variation of the ore elements across this body is difficult to interpret. All of the samples contain abundant angular inclusions of limestone and the fluctuations in ore-element concentration may merely reflect varying amounts of barren limestone in the portion of the ground rock sample that was analyzed. However, both the sample poorest in ore elements (D) and the sample richest in ore elements (E) have abundant limestone fragments and contain calcium as a major constituent; the sample at (H) is
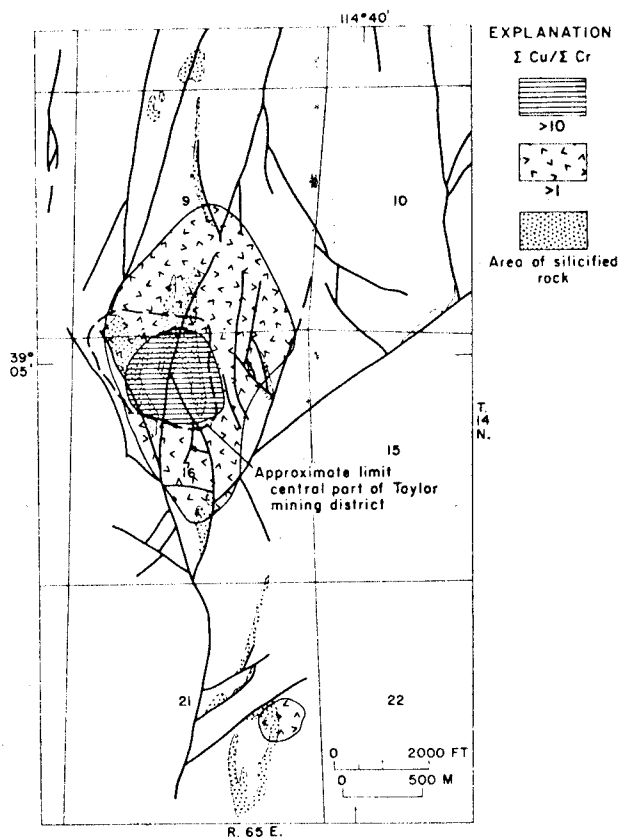

FIG. 5. Map showing copper-chromium ratios in the Taylor district area.

virtually free of limestone fragments, contains <10 percent calcium but is considerably less rich in the ore elements than the sample at (E). Furthermore, thin sections of these samples show that the limestone fragments are recrystallized, riddled with scattered quartz crystals, and contain disseminated opaque grains of oxidized ore minerals. The siliceous portion of all the samples consists dominantly of a single generation of gray matrix ore-phase quartz; although samples taken close to the fault also contain sparse corroded particles of coarse quartz that were probably carried upward by silica-bearing solutions emanating from this conduit. The gray matrix jasperoid quartz does show variations in texture and grainsize that seem to be related to the richness of the sample. The richer samples tend to have conspicuous vugs and a somewhat coarser grained matrix quartz with a large range in the diameter of individual grains. Most of the poorer samples have a finer grained, relatively homogeneous matrix with few vugs.

The variation in metal content across this body of jasperoid can be explained by a theory that the fluid which formed it first precipitated a protojasperoid directly, as a mush of small quartz crystals in certain

A—Al, Ti, Ba and Sr

B—Ag, Cr, Cu, Pb, Sb and Zn

C—Au, Hg and Te
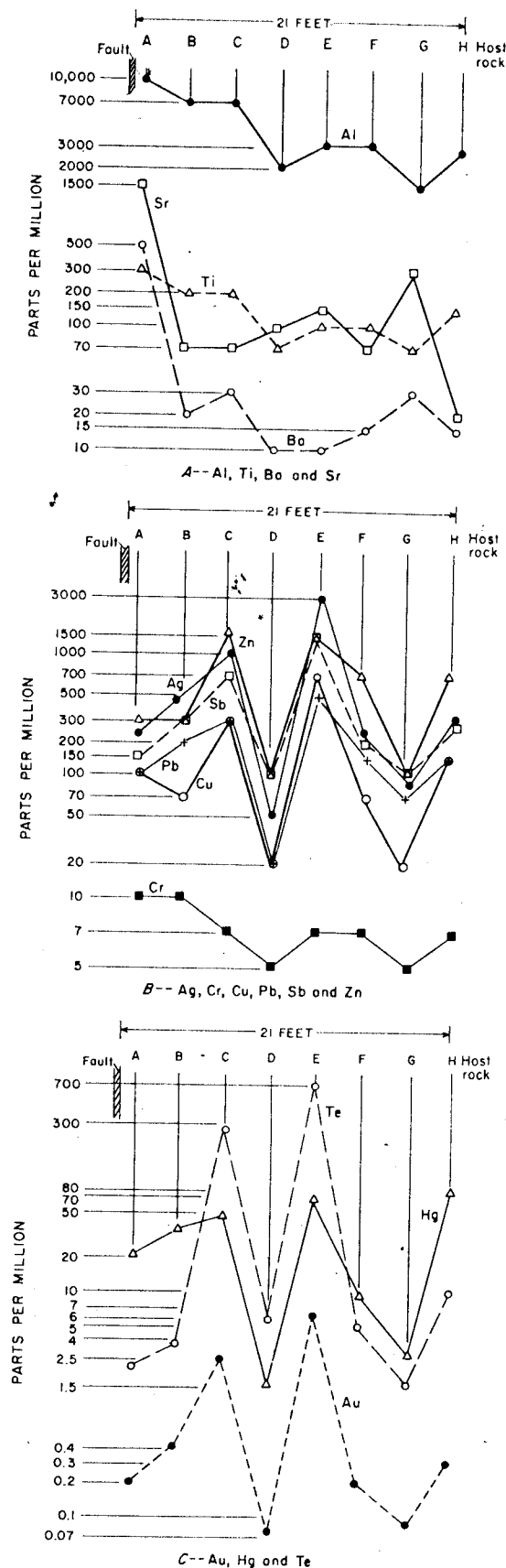
zones and as a fairly impervious silica gel in others (Lovering, 1972, p. 43–46). Then, slightly later, the ore minerals were deposited in the more permeable zones of this protojasperoid. The remaining postmineralization voids in the permeable zones were then largely sealed by the precipitation of smaller quartz grains during the final stage of silicification.

Brecciation and recrystallization of the limestone apparently preceded silicification and mineralization. The presence of a single major type of jasperoid quartz containing disseminated particles of ore minerals and the similarity in the distribution pattern of the ore elements suggest that only one major phase of hydrothermal alteration occurred. During this phase both the silica and the primary ore minerals were introduced at this locality.

Interpretation of Distribution Patterns of Jasperoid Characteristics

The distribution of jasperoid bodies in the Taylor district coincides in part with the more restricted distribution of granophyric rhyolite porphyry dikes in a north-trending belt extending from about one and one half miles south of the main part of the district to about one quarter mile north of it. This coincidence probably indicates the presence of a buried intrusive source for the dikes, which was also the hearth for the jasperoid, as was also suggested by Drewes (1967, p. 82). He further noted that the dikes are not mineralized, and he concluded that siliceous solutions emanating from the buried magma chamber along faults and fractures first replaced some of the impure limestones, and the silicified rocks were then fractured and invaded by mineralizing solutions that deposited the primary ore minerals. At a slightly later time, after the close of mineralization, the dikes were emplaced.

We suggest that the disseminated ore minerals in the matrix quartz of the jasperoid in the main district indicate nearly contemporaneous and closely related silicification and metallization.

Copper and lead anomalies in jasperoid associated with rhyolite dikes at localities 9 and 12, about one mile south of the central part of the district, may indicate a small separate center of mineralization closer to a cupola of the buried intrusive than most of the main part of the district. The possibility of another mineralized center, more remote from its genetic source, is also suggested by the relatively high gold values in jasperoids about one mile north of the main part of the district in sections 4 and 9 (Fig. 4). Other related centers may occur along

FIG. 6. Graph showing variations in ore metals and other selected minor elements across a jasperoid body from fault conduit to limestone contact.

U. S. Highway 6 northwest of Majors Place in the area of a few similar dikes and a large low-temperature alteration zone that contains interesting metal anomalies both in the altered rock and in the peripheral light-gray jasperoid. Perhaps another area of interest lies west of Connors Pass along U. S. Highway 6 where reefs of gray, slightly mineralized jasperoid outcrop.

The presence of a mineralization control between sections 16 and 15 and sections 9 and 10 is suggested by a belt of high zirconium and molybdenum anomalies, by the rather abrupt northern boundary of the lead and zinc anomalies, and by the apparent eastward offset of the north-trending antimony belt at this latitude, based on 14 samples within and adjacent to this zone (Fig. 4). This zone lies nearly at right angles to the trend of the major faults that served as conduits for the mineralizing solutions, but it does coincide approximately with the northern limit of the abundant felsite dikes. The most logical explanation for this cross-trending zone seems to be that it marks a change, either in the character or in the depth of intrusion, of the parent stock.

Crystals of accessory monazite and tourmaline were identified in the matrix jasperoid only in samples from localities 18, 27, 28, and 30 (Fig. 1) in the northern tongue of the large jasperoid mass that covers most of the eastern part of the Taylor district, an area that is also marked by a sharp drop in antimony (Fig. 4). This suggests a possibly higher formation temperature and greater proximity to the source for jasperoid in this area.

Summary and Conclusions

The characteristics of jasperoid in the Taylor district that appear to be most useful as guides to the center of mineralization are: (1) a change from dominantly brown to dominantly gray to dark gray to nearly black, (2) a coarsening in texture of the matrix jasperoid, (3) an increase in the number of vugs, and (4) an increase in the ratio of copper to chromium.

All the metals that have been produced from the Taylor district exhibit strong anomalies in jasperoid samples from the central part of the district—in fact, the ore is mineralized jasperoid—but the metals show no consistent zonal distribution relative to each other. They tend to vary considerably in concentration among samples from the same locality and tend to increase and decrease simultaneously as shown by samples collected across a mineralized body. However, they exhibit a variety of patterns in their regional anomalies.

The ore metals, the jasperoid, and the rhyolite porphyry dikes all appear to be genetically related to a buried intrusive body which acted as a central hearth for the fluids and perhaps, in part, a metal source. The ore metals seem to have been introduced, penecontemporaneously with late stages of the silicification that formed the jasperoid bodies, by solutions moving upward along faults and fracture zones.

District-wide studies of anomalies for the various metals suggest the possibility of an eastern extension of ore mineralization from the northeast edge of the main part of the district, and also of two small isolated centers of mineralization, one about one mile south of the central part of the district and the other about one mile north of it. The southern area is suggested by high copper, lead, and antimony in samples from localities 9 and 12; the northern one by high gold values in samples from localities 20, 22, and 23 (Fig. 1).

Other areas in the Schell Creek Range near the district, which contain similar gray to dark-gray jasperoids and several of the same anomalous trace elements, such as silver, arsenic, antimony, zinc, gold, copper, and mercury, are: (1) on the east and west peripheries of a large low-temperature hydrothermally altered rock area east of Connors Pass, (2) at the Tamberlaine and Success mines, and (3) at the Nevada manganese district northwest of the Taylor district. If the silver-antimony ores of the Taylor district are related to a buried intrusive hearth, it seems probable that deeper exploration will reveal a change in the composition of the ore toward higher copper and gold and lower antimony and silver adjacent to, or within, the stock. To the southeast of the district east of Connors Pass the large altered, unprospected area might be examined for gold, tellurium, and tungsten deposits.

Acknowledgments

REFERENCES

Drewes, Harald, 1962, Stratigraphic and structural controls of mineralization in the Taylor mining district near Ely,