GEOLOGICAL SURVEY CIRCULAR 623

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ABSTRACT

Geochemical sampling in the Drum Mountains of Utah has revealed anomalous concentrations of gold in jasperoid outcrops. One jasperoid sample contains 100 parts per million of gold, and 20 samples from an outcrop about 50 feet wide and 300 feet long average about 10 parts per million gold. The gold-bearing jasperoids also contain anomalous amounts of other ore-stage metals and may be useful guides to further exploration.

INTRODUCTION

Several samples of jasperoid similar to that which is commonly found in highly productive mining districts were collected in the Drum Mountains of Utah in 1963 as part of a study of the significance of jasperoid related to ore deposits (Lovering and Hamilton, 1962). Later chemical analysis revealed that some of these samples contain as much as one-fourth of an ounce of gold per ton (Lovering and others, 1968) as well as anomalous concentrations of other metals. Earlier reports (Butler and others, 1920; Crittenden and others, 1961) indicated that gold production in the area was largely confined to the jasperoid. Additional sampling has revealed high concentrations of gold in a number of jasperoid bodies in the district. In this report the distribution of gold in jasperoid is shown and briefly discussed. The geochemical anomalies for gold may be useful as guides to further exploration, and some of the jasperoid bodies, if they extend to reasonable depths, may in themselves, constitute marginal-grade ore bodies.

GEOLOGY AND ORE DEPOSITS

The Detroit mining district straddles the Juab-Millard County line in the Drum Mountains, approximately 25 miles northwest of Delta, Utah. The geology and the manganese deposits of this district have been described by Crittenden, Straczek, and Roberts (1961). The range forms a westward-dipping monocline, in which about 10,000 feet of Cambrian quartzite is overlain by 3,000 feet of Cambrian limestone and dolomite. In the mineralized area, these rocks are cut by many eastward- to northeastward-trending steeply dipping normal and reverse faults. Lower Paleozoic carbonate rocks are cut off on the north by the Joy fault, which has a displacement of about 2,000 feet and strikes eastward across the district but changes to a northwestward strike just west of it. This fault is traceable for many miles northwest of the district but is concealed by alluvium on the east. North of the Joy fault the sedimentary rocks are concealed by alluvium and Tertiary volcanic rocks.

Gold and copper were discovered in the Drum Mountains in 1872, and from 1904 to 1917, gold, silver, and copper, having a total value of about $46,000 (Butler and others, 1920, p. 464), were produced from siliceous replacement fissure deposits in limestone and dolomite. Manganese ore has been mined sporadically since 1924, with peak production during World War II. Total production of manganese ore from 1924 to 1954 was 72,462 tons (Crittenden and others, 1961, p. 508). There appears to have been little activity in the district in recent years other than sporadic prospecting. Manganese deposits and copper-gold deposits, though apparently related in origin, are distinct in occurrence. The manganese ore bodies are largely in the lower carbonate beds above the basal quartzite, and contain little copper or gold (Crittenden and others, 1961, p. 507–508). The copper-gold ore is chiefly associated with ferruginous jasperoid bodies that replaced carbonate beds higher in the section along faults and fractures; it contains little manganese (Butler and others, 1920, p. 464).

GEOCHEMICAL SAMPLING

During the present study, approximately 600 rock samples were collected in the area. Most of the samples were collected from jasperoid outcrops. More than one sample was collected from many of the localities shown, but only the highest gold content from the outcrop is plotted in figure 1. Plotting the highest gold content emphasizes the geochemical distribution of gold in the district and may indicate local areas in which mineralization was more intense.

CHARACTER AND DISTRIBUTION OF JASPEROID BODIES

Masses of jasperoid are widely distributed through the carbonate rocks of the region. Most of them are localized along faults and fractures where they have replaced the adjacent host rock and commonly form prominent dikelike bodies locally called "reefs." Some jasperoid bodies are small pods a few feet in diameter, and others are masses several hundred feet long and as much as a hundred feet wide. The jasperoid ranges in color from gray through various shades of red and brown. Some varieties are dense and aphanitic, resembling chert; others are vuggy with a saccharoidal texture resembling quartzite. Most of the larger masses consist of several distinctive varieties, each with different colors and textures. High gold contents are not restricted to any one particular type of jasperoid; some of the brown vuggy saccharoidal varieties contain appreciable amounts of gold, but some dense gray varieties contain even more. Many of the jasperoid samples have characteristics similar to those of jasperoid found in the Bingham, Tintic, and Ely mining districts.

PETROGRAPHIC DESCRIPTION OF GOLD-BEARING JASPEROID SAMPLES

Petrographic examination of thin sections cut from several jasperoid samples that assay more than 10 ppm (parts per million) gold shows that they vary greatly both in mineralogy and microtexture. Most of the samples examined exhibit an older generation of presumably hypogene quartz with xenomorphic texture and average grain diameter ranging from about 0.02 mm to 0.08 mm. This quartz typically contains abundant inclusions of hematite, ilmenite, goethite, and unidentified opaque mineral particles all averaging about 5 microns in diameter. Microvugs, ranging from a fraction of millimeter to several millimeters in diameter, are also characteristic; the larger vugs are associated with the coarser grained quartz. In some samples these microvugs form open voids, in others they are filled with supergene hydrous iron oxides, jarosite, and malachite, or with a late generation of aphanitic quartz. Although some samples containing abundant dark-brown limonite, jarosite, and malachite yield relatively high gold assays, others that do not contain these oxidation products contain even higher concentrations of gold. The richest gold-bearing jasperoid sample analyzed thus far assays 100 ppm in gold. It is a medium gray fine-grained dense rock, whose only visible indication of mineralization is that it weathers to a dark chocolate brown on the outcrop. In thin section it is seen to consist largely of xenomorphic quartz grains with diameters averaging about 0.02 mm and containing numerous mineral particle inclusions; the jasperoid also contains many open microvugs approximately 0.3 mm in diameter. Examination of a polished section under a metalographic microscrope reveals the presence of free gold particles imbedded in the quartz and hematite (B. F. Leonard, written commun., 1968). The presence of native gold has been further confirmed by electron microprobe analysis, which also showed a few small grains of pyrite in addition to the iron oxides (G. A. Desborough, written commun., 1968). An area about 0.6 square centimeter of the polished section was examined microscopically to determine the size and distribution of gold particles. Of 4,000 particles of gold counted, all but 12 were found to be less than 1 micron in diameter; the largest particle is 6 microns in diameter. Thus, the gold in this sample would escape detection unless examined microscopically or assayed. The small size of the gold particles in this sample is similar to that found in the gold deposit at Carlin, Nev., where no pannable gold was found in samples containing as much as 4 ounces of gold per ton (Hardie, 1966).

ABUNDANCE AND DISTRIBUTION OF GOLD

Jasperoid outcrops containing greater than 5 ppm of gold appear to be confined to an irregular north-northwestward-trending belt or zone approximately a mile wide and 2½ miles long (fig. 1). Within this zone, the highest gold contents obtained were in jasperoids adjacent to the Joy and Staats faults (fig. 1). Anomalous gold contents were also obtained from jasperoids localized by the Last Chance and Ibex faults, and others near the Copperhead, Martha, EPH, and Charm mines. Jasperoid outcrops with high gold content appear to be most abundant along faults that have east to northeast trends.

In order to determine the variability of gold content of individual jasperoid outcrops, two of these bodies were sampled at about 15-foot intervals. These sites are near Joy townsite in sec. 26, T. 14 S., R. 11 E. The gold content of each sample is shown in figure 2. The average gold content of the 20 samples at site 200 is 9.9 ppm with individual values ranging from 0.7 to 100 ppm gold. The average gold content of the six samples at site 240 is 6.9 ppm with individual values ranging from 2.0 to 19 ppm gold. The variability in gold content of these as well as other outcrops shows that the gold is erratically distributed.

Although structural localization of mineralization is apparent, some stratigraphic control may be indicated because most of the gold-bearing outcrops occur in four stratigraphic units as mapped by Crittenden, Straczek, and Roberts (1961). The average gold content of jasperoid samples within the mapped area is shown by stratigraphic unit in table.

Other rock types sampled included quartz monzonite dikes and quartz diorite plugs. Although most of these bodies were moderately to strongly altered and some are rich in pyrite, their gold content is <0.04 ppm. Some samples of strongly altered quartz latite and andesite, collected north of the Joy fault (fig. 1), also contain <0.04 ppm gold.

The highest gold content was found in samples of jasperoid that replaces limestones e and f, which are equivalent to the Dome Limestone and Swazey Formation. Jasperoids replacing dolomite h and limestone i,

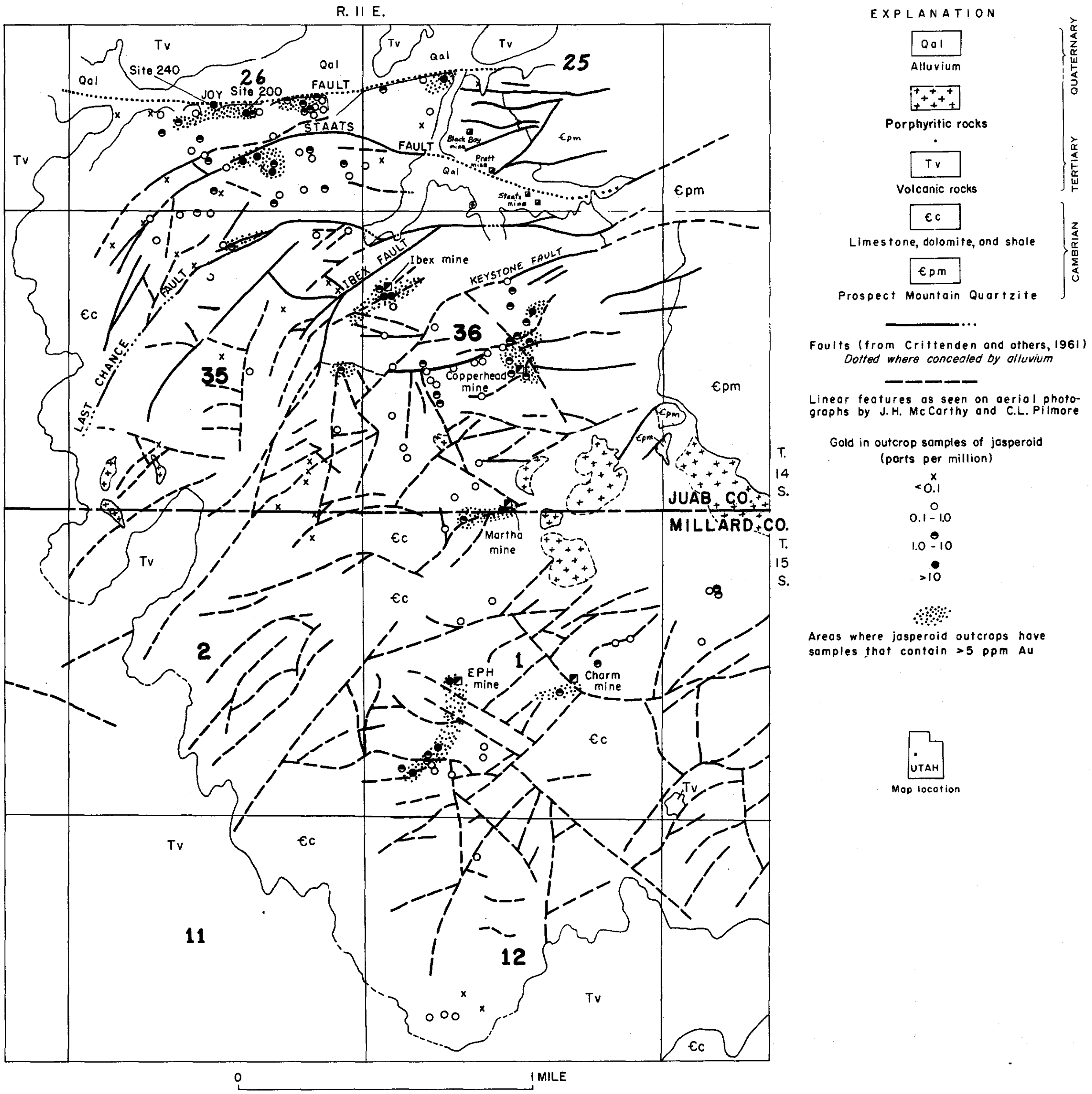

Figure 1.—Geochemical map showing distribution of gold in outcrop samples of jasperoid, Drum Mountains, Utah.

Table 1.--*Average gold content of jasperoid samples by stratigraphic unit*

Stratigraphic unit: Drum Mountain[1]	Stratigraphic unit: House Range[1]	Number of samples	Average gold content (ppm)
Dolomite a------	Howell Formation	3	0.04
Limestone e-----	Dome Limestone	6	4.63
Limestone f-----	Swazey Formation	19	4.28
Limestone g-----	Wheeler Formation	17	1.39
Dolomite h------	Marjum Limestone	93	3.26
Limestone i-----	------do--------	68	3.78
Dolomite k------	Weeks Limestone	44	.18
Dolomite n------	------do--------	2	.35

[1]Crittenden, Straczek, and Roberts (1961, p.497).

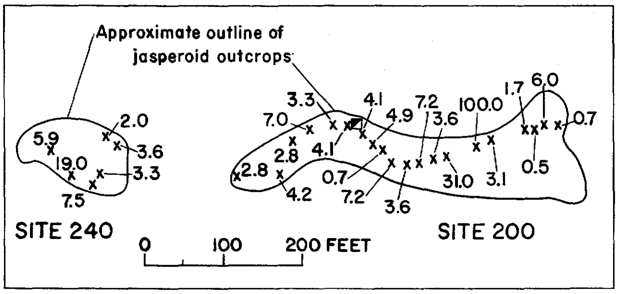

Figure 2.—Gold content (in parts per million) of chip samples of jasperoid at sites 200 and 240.

the Marjum Limestone, also contain substantial gold, and most of the areas with high gold content are in the Marjum.

OTHER ELEMENTS IN JASPEROIDS

Several elements other than gold were found to be concentrated in the jasperoid samples. Maximum concentrations of other elements detected include: 1,000 ppm silver, 1 1/2 percent bismuth, 5 percent arsenic, 2 percent antimony, 1.5 percent tin, 1 percent lead, 10 percent copper, >100 ppm mercury, and 700 ppm yttrium. None of these elements correlates strongly with the gold on a sample for sample basis. Areally, however, all give distribution patterns similar to that of gold. The similarity of geochemical patterns suggests a common origin of mineralizing solution or solutions throughout the area sampled.

ANALYTICAL METHODS

All the samples were analyzed for gold in a mobile laboratory by the atomic-absorption method of Thompson, Nakagawa, and VanSickle (1968). The analysts were: R. L. Turner, J. R. Watterson, and Eric Welsch. The other elements were determined by a semiquantitative spectrographic method (Ward and others, 1963). The analysts were David Grimes, Elwin Mosier, and R. T. Hopkins.

DISCUSSION

Apparently gold was introduced in the same silica-rich solutions that replaced the carbonate rocks to form the jasperoid. This persistence of gold in jasperoid outcrops suggests a common source of gold-bearing solutions throughout the entire area. The similarity in geochemical distribution of several elements of dissimilar geochemical behavior also suggests a common origin. The association of hypothermal and epithermal elements, and apparent lack of zoning, may indicate a relatively shallow source.

The numerous outcrops of gold-bearing jasperoid along the Joy fault may indicate that it is a promising structure for additional exploration. Several other areas in the district, as shown in figure 1, are also attractive targets for further exploration.

REFERENCES

Butler, B. S., Loughlin, G. F., and Heikes, V. C., 1920, Ore deposits of Utah: U.S. Geol. Survey Prof. Paper 111, p. 463–465.

Crittenden, M. D., Jr., Straczek, J. A., and Roberts, R. J., 1961, Manganese deposits in the Drum Mountains, Juab and Millard Counties, Utah: U.S. Geol. Survey Bull. 1082-H, p. 493–544.

Hardie, Byron S., 1966, Carlin gold mine, Lynn district, Nevada, *in* Nevada Bureau of Mines Report 13, Mackay School of Mines, University of Nevada, Reno, Nev.: p. 73–83.

Lovering, T. G., and Hamilton, J. C., 1962, Criteria for the recognition of jasperoid associated with sulfide ore, *in* Short papers in geology and hydrology: U.S. Geol. Survey Prof. Paper 450–C, p. C9–C11.

Lovering, T. G., Lakin, H. W., and Hubert, A. E., 1968, Concentration and minor element association of gold in ore-related jasperoid samples, *in* Geological Survey research 1968: U.S. Geol. Survey Prof. Paper 600–B, p. B112–B114.

Thompson, C. E., Nakagawa, H. M., and VanSickle, G. H., 1968, Rapid analysis for gold in geologic materials, *in* Geological Survey research 1968: U.S. Geol. Survey Prof. Paper 600–B, p. B130–B132.

Ward, F. N., Lakin, H. W., Canney, F. C., and others, 1963, Analytical methods used in geochemical exploration by the U.S. Geological Survey: U.S. Geol. Survey Bull. 1152, 100 p.