UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Selected analytical results, sample locality map, and discussion of trace-element anomalies for rock samples from near Kings Canyon, Confusion Range, Millard County, west-central Utah

By

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STUDIES RELATED TO CUSMAP

These data are part of a series of data releases from on-going studies within the Delta, Utah 1° x 2 ° quadrangle prepared under the Conterminous United States Mineral Assessment Program (CUSMAP).

INTRODUCTION

In 1986 the U.S. Geological Survey began a reconnaissance geochemical survey of the Delta 1° x 2 ° quadrangle, west-central Utah. This geochemical survey is one of several geologic investigations of the quadrangle conducted as part of CUSMAP.

This report presents selected chemical analyses, and a brief discussion of results, for samples collected in the Confusion Range during 1988. Additional samples for geochemical and geologic studies were collected in conjunction with reconnaissance mapping of alteration and associated geologic features during 1989. Results from these samples are not yet completed.

We wish to thank all of the chemists who provided these data. The complete set of chemical results will be published by the analysts when results for the Delta, Utah CUSMAP study are completed. Analytical results for this study were provided by B.F. Arbogast, J.H. Bullock, D.L. Fey, P. Hageman, R.H. Hill, B. Roushey, T. Roemer, and W. Wilcoxon.

GENERAL GEOLOGIC SETTING

The geology of the Delta quadrangle has recently been mapped by Morris (1987). He shows the southern part of the Confusion Range to consist almost entirely of Devonian carbonate rocks. Hintze (1974a, 1974b) mapped the area of interest at a scale of 1:48,000. All of the samples discussed in this report were collected from close to the Devonian Simonson Dolomite and the Devonian Guilmette Formation contact. Hintze (1974a, 1974b) described these units as follows. The Simonson consists of alternating light- and dark-brownish-gray dolomite forming low ledges. It is generally fine to coarsely crystalline and underlies the Guilmette Formation. The lowermost part of the Guilmette consists of dark-gray, finely crystalline, generally massive limestone that contains large amounts of breccia. This horizon weathers into a distinctly cavernous horizon, with individual caves varying from less than a meter wide to many tens of meters wide.

ALTERATION

Although the alteration in this area has received little study, several points should be mentioned. Alteration generally consists of partial, selective silicification of either the uppermost Simonson Dolomite, the lowermost Guilmette Limestone, or both units. The alteration locally results in massive jasperoid bodies, but usually is quite selective, often comprising less than 10 percent of a 1-ton mass of rock; and only locally comprising more than 70 percent of a 1-ton mass of rock. The silicification generally occurs along bedding, and can be traced for many hundreds of meters along strike. However, silicification also cuts across bedding, apparently along fault and fracture zones. The crosscutting silicification apparently represents feeder zones for the hydrothermal fluids, and grades laterally and vertically into dominantly stratiform masses, and, finally, into delicate, stratiform layers of unaltered and altered zones. Locally, these stratiform layers are only a few millimeters apart and mimic the relict, thin bedding of the host rock. Gangue minerals that occur in the silicified carbonate rock and (or) the jasperoid include quartz, calcite, barite, and fluorite. In addition to occurring as disseminations within the quartz, much of the barite and fluorite are distinctly coarser grained than the quartz, and occur as veinlets or vug fillings within the jasperoid.

SAMPLING METHODS

Rock samples were collected at the sites shown on figure 1. Most of the samples represent chip samples composited from a single outcrop within a distance of approximately 50 m. However, where outcrops of different rock types were sampled from within a distance of approximately 50 m of one an other, these samples were given the same sample site number, but given a unique suffix, an example of which is 5700A, 5700B, 5700C, etc. The sample sites were selected because they contain silicified rock. Silicification is quite varied, where it comprises nearly 100 percent of the sample, the sample was termed jasperoid.

SAMPLE ANALYSIS

Spectrographic method

The samples were analyzed for 35 elements using a semiquantitative, direct-current arc emission spectrographic method (Grimes and Marranzino, 1968). Elements analyzed by this method that are mentioned in this report, and their lower limits of determination, are listed in table 1. Spectrographic results were obtained by visual comparison of spectra derived from the sample against spectra obtained from standards made from pure oxides and carbonates. Standard concentrations are geometrically spaced over any given order of magnitude of concentrations as follows: 100, 50, 20, 10, and so forth. Samples whose concentrations are estimated to fall between those values are assigned values of 70, 30, 15, and so forth. The precision of the analytical method is approximately plus or minus one reporting interval at the 83 percent confidence level and plus or minus two reporting intervals at the 96 percent confidence level (Motooka and Grimes, 1976).

Selected analytical data from the spectrographic analyses are listed in table 3. The emission spectrographic data also includes analyses for boron, beryllium, bismuth, cadmium, cobalt, chromium, gallium, germanium, lanthanum, manganese, molybdenum, niobium, nickel, scandium, tin, strontium, thorium, vanadium, tungsten, yttrium, and zirconium; however, preliminary interpretation of these data suggest that none of the samples discussed in this report contained anomalous amounts for any of these elements.

Chemical methods

Other methods of analysis used on the rock samples are summarized in table 2. In addition to the spectrographic analyses, the samples were analyzed for gold, arsenic, antimony, bismuth, cadmium, zinc, and fluorine by other methods. Gold analyses were done using an atomic absorption spectroscopy method described by Thompson and others, 1968. Mercury was analyzed by a modification of the atomic absorption method described by Crock and others, 1987. Arsenic, antimony, bismuth, cadmium, and zinc were analyzed by an inductively coupled plasma-atomic emission spectrometric method described by Crock and others, 1987. Fluorine was analyzed by an ion selective electrode method described by Hopkins, 1977. Preliminary interpretation of the cadmium and bismuth data suggest that none of the samples discussed in this report contained anomalous amounts for these elements, and these data are not discussed further.

Selected analytical data obtained from these methods are also listed in table 3.

ROCK ANALYSIS STORAGE SYSTEM

Upon completion of all analytical work, the analytical results were entered into a computer-based file called Rock Analysis Storage System (RASS). This data base contains both descriptive geological information and analytical data. Any or all of this information may be retrieved and converted to a binary form (STATPAC) for computerized statistical analysis or publication (VanTrump and Miesch, 1977).

DESCRIPTION OF DATA TABLE

Table 3 lists selected results of analyses for the rock samples. For the table, the data are arranged so that column 1 contains the USGS assigned sample numbers. These numbers correspond to the numbers shown on the site location map (figure 1). Columns in which the element headings show the letter "S" below the element symbol are emission spectrographic analyses; "AA" indicates atomic absorption analyses; "ICP" indicates inductively coupled plasma-atomic emission spectroscopy; and "ISE" indicates ion selective electrode method. A letter "N" in table 3 indicates that a given element was looked for but not detected at the lower limit of determination shown for that element in tables 1 or 2. If an element was observed but was below the lowest reporting interval, a letter "L" was entered in the table 3. If an element was observed but was above the highest reporting value, a "G" was entered in table 3 in front of the upper limit of determination.

Table 4 is a brief description of the rock samples.

GEOCHEMICAL OBSERVATIONS

Although it is too early to fully evaluate the significance of the data presented here, it is fair to state that these samples are highly anomalous in several elements, including gold, silver, mercury, arsenic, antimony, fluorine, barium, copper, lead, and zinc. This suite of elements commonly occurs in many types of epithermal mineral deposits (Silberman and Berger, 1985). All of the sites shown on figure 1 include samples that contained anomalous amounts of elements discussed in this report; figure 2 summarizes the elements that are anomalous at these sites, as well as provides a listing of corresponding minimum values considered anomalous for this report. Figure 2 demonstrates the widespread nature of the anomalous trace-elements, especially gold, in this area. The diversity of anomalous trace-element suites suggests that more work on this area is needed.

SUMMARY

Although the amount of alteration visible at the surface in this area is not extensive, the persistence and wide distribution of the geochemical anomalies suggests they are of considerable importance. The wide distribution of the geochemical anomalies, generally within a stratiform horizon, suggests the existence of a large hydrothermal system that affected an area of several tens of kilometers. Because the geochemically anomalous rocks are inconspicuous in outcrop, there could be a larger volume of similarly altered or mineralized rock in the subsurface or in adjacent areas.

Anomalies of the type described here would probably be difficult to identify in many regional-scale geologic investigations. Data presented in a poster at the 1989 McKelvey Forum suggested that heavy-mineral concentrate samples from the southern part of the Confusion Range in the Delta quadrangle included only one anomalous sample, which contained anomalous lead and antimony (Stoeser and others, 1989). Additional occurrences of altered and (or) mineralized rock, such as the type described here, would probably only be discovered through detailed geologic studies.

Figure 1--Sample location map

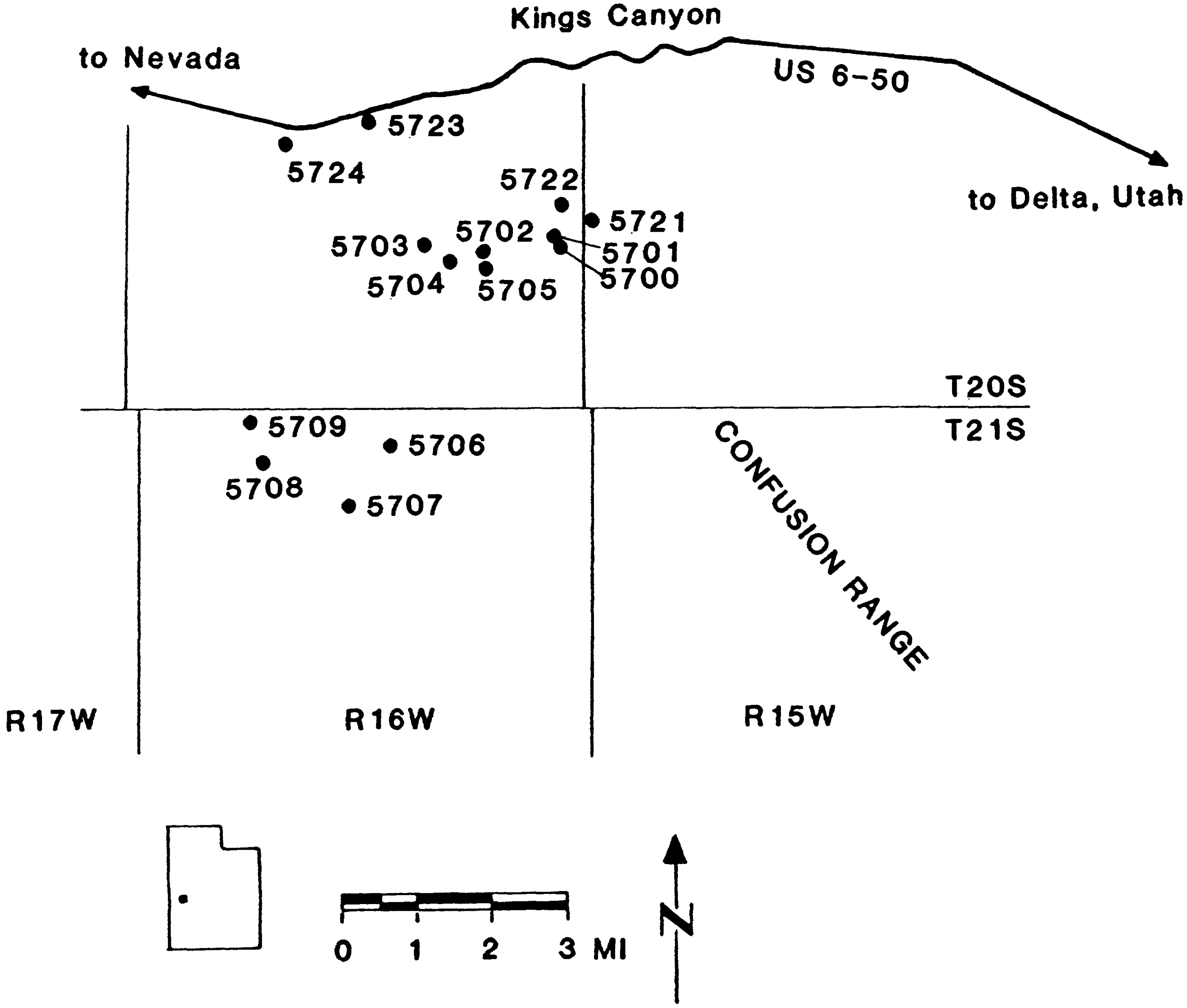

Figure 2--Selected geochemical anomalies

ELEMENT	MINIMUM VALUE CONSIDERED ANOMALOUS (ppm)
Au	.05
Ag	5
Hg	.5
As	100
Sb	90
Ba	G5000
Cu	500
Pb	500
Zn	500
F	10,000

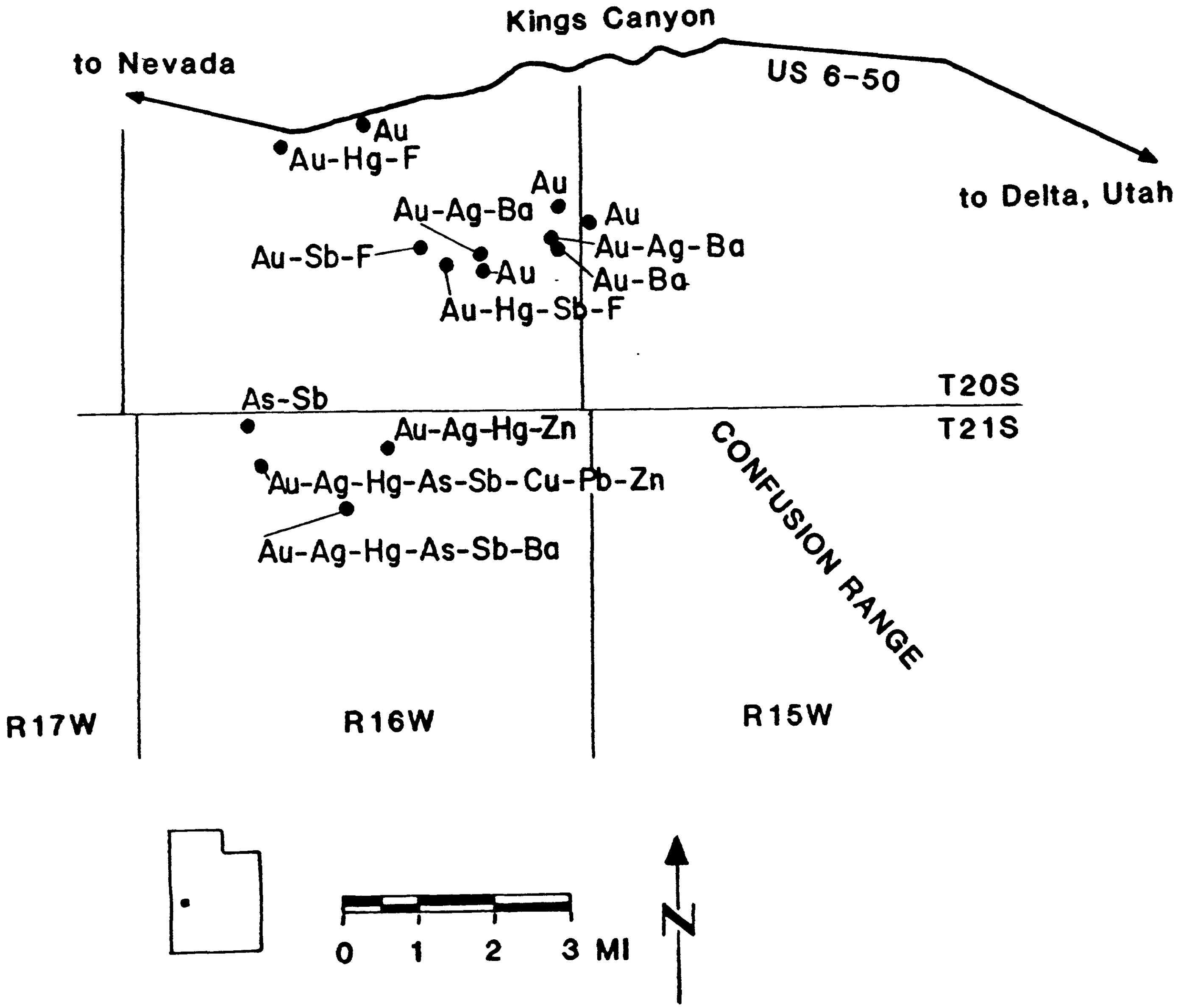

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TABLE 1.--Limits of determination for the spectrographic analysis of rock samples, based on a 10-mg sample; all values in parts per million.

Element	Lower determination limit	Upper determination limit
Silver (Ag)	0.5	5000
Barium (Ba)	20	5000
Copper (Cu)	5	20,000
Lead (Pb)	10	20,000

TABLE 2.--Chemical methods

[AA, atomic absorption; AACV, atomic absorption cold vapor; ICP, inductively coupled argon plasma-atomic emission spectrographic; ISE, ion selective electrode]

Element determined	Method	Determination limit (ppm)	Reference
Gold (Au)	AA	0.05	Thompson and others, 1968
Mercury (Hg)	AACV	0.02	Crock and others, 1987
Arsenic (As)	ICP	5	Crock and others, 1987
Antimony (Sb)	ICP	2	ditto
Zinc (Zn)	ICP	2	ditto
Fluorine (F)	ISE	0.01	Hopkins, 1977

TABLE 3-Selected results of analyses of rock samples, Kings Canyon area, Confusion Range, west-central Utah. (N, not detected; L, detected but below the limit of determination shown; G, determined to be greater than the value shown; values shown in ppm except fluoride in percent)

SAMPLE NUMBER	Au AA-0.05	Ag S-0.5	Hg AA-0.02	As ICP-5	Sb ICP-2
5700A	.10	1	.04	6	
5700B	.10	.5	.12	15	3
5700C	.10	N	N	L	L
5701A	.10	7	.10	L	L
5701B	N	N	.04	L	L
5701C	N	N	N	L	L
5702A	.10	3	.04	L	4
5702B	.20	2	.02	L	L
5702C	.10	3	.28	L	8
5702D	.20	15	.20	L	3
5703A	.20	N	.10	L	3
5703B	.10	N	.10	L	160
5703E	.10	N	.12	5	150
5704A	.40	3	.76	24	160
5705A	.60	2	.18	L	8
5706A	1.10	2	.48	12	4
5706B	1.60	L	.40	22	5
5706C	1.00	.5	.56	17	3
5706D	.40	L	.20	22	7
5706E	1.30	.5	.40	26	5
5706F	.30	L	N	6	L
5706G	.50	7	.52	L	L
5706H	.30	100	G36	16	33
5706I	.40	1	.28	17	5
5707A	.30	7	.48	110	99
5707B	.30	10	N	L	6
5707C	.20	10	.20	8	27
5707D	N	L	.20	L	L
5707E	.30	10	N	19	22
5707F	.20	50	.80	9	26
5707G	.20	3	.20	93	92

TABLE 3--continued

SAMPLE NUMBER	F ISE-0.01	Ba S-20	Cu S-5	Pb S-10	Zn ICP-2
5700A	L	G5000	L	L	43
5700B	.01	50	7	L	74
5700C	.02	20	L	15	2
5701A	L	G5000	5	L	18
5701B	.01	G5000	L	10	10
5701C	.01	70	L	15	4
5702A	.24	70	L	L	12
5702B	.01	G5000	L	10	6
5702C	.10	100	5	L	40
5702D	.79	50	L	L	3
5703A	3.78	30	L	L	4
5703B	6.78	20	L	L	7
5703E	4.38	20	L	L	8
5704A	3.38	20	10	L	6
5705A	0.01	30	L	N	11
5706A	.01	50	7	L	70
5706B	.01	30	7	L	71
5706C	.01	70	L	15	42
5706D	.02	50	7	L	19
5706E	.01	30	7	L	110
5706F	.01	3000	5	N	17
5706G	.01	50	5	10	10
5706H	L	3000	10	100	1000
5706I	.02	L	10	150	100
5707A	.02	200	30	150	110
5707B	L	50	L	L	7
5707C	.02	30	7	150	58
5707D	L	L	L	L	17
5707E	.01	100	10	30	25
5707F	.01	G5000	10	10	39
5707G	.01	150	10	30	54

TABLE 3--continued

SAMPLE NUMBER	Au AA-0.05	Ag S-0.5	Hg AA-0.02	As ICP-5	Sb ICP-2
5708A	.50	5000	G36	3900	5400
5708B	.30	1000	G36	550	690
5708C	.50	3000	G36	6100	5300
5708D	.20	70	.40	46	45
5708E	.05	20	N	14	21
5708F	.50	1000	G36	480	980
5708G	.05	10	N	6	4
5708H	N	2	.02	L	5
5708I	N	20	N	7	24
5709A	N	N	N	21	5
5709B	N	1	.04	870	140
5709C	N	N	.08	32	7
5721A	N	N	.08	65	4
5721B	.10	N	.04	16	2
5722A	.45	N	.02	29	6
5723A	.05	N	N	L	L
5724A	.30	N	.56	7	3
5724B	.10	N	.48	14	3

TABLE 3--continued

SAMPLE NUMBER	F ISE-0.01	Ba S-20	Cu S-5	Pb S-10	Zn ICP-2
5708A	.01	150	2000	5000	3300
5708B	.01	100	100	1000	1700
5708C	.01	70	3000	5000	2100
5708D	.02	50	30	200	150
5708E	.02	L	10	100	36
5708F	.01	1000	150	2000	1100
5708G	.02	20	L	30	L
5708H	.02	L	L	15	L
5708I	.01	70	5	150	47
5709A	.03	500	20	10	10
5709B	.07	5000	7	10	230
5709C	.01	L	5	L	17
5721A	.03	20	20	50	30
5721B	.03	20	5	20	16
5722A	.02	L	5	L	18
5723A	L	50	L	L	L
5724A	.27	100	5	N	L
5724B	1.35	70	5	N	L

TABLE 4--Rock descriptions

5700A	Jasperoid--gray to brown; fine- to coarse-grained; quartz and white, bladed barite.
5700B	Jasperoid--gray to brown; fine- to coarse-grained.
5700C	Carbonate Breccia--gray to yellowish-brown; carbonate clasts; carbonate and iron-oxide matrix; no noticeable secondary silica.
5701A	Jasperoid--gray; very-fine-grained, brecciated; quartz and barite.
5701B	Jasperoid--gray; very-fine-grained, brecciated; quartz and barite.
5701C	Limestone--medium-gray; very-fine-grained, brecciated; well-bedded; appears unaltered.
5702A	Jasperoid--gray; very-fine-grained, brecciated; quartz and fluorite.
5702B	Limestone--gray; very-fine-grained limestone with very-coarse-grained barite; no noticeable secondary silica.
5702C	Jasperoid--gray; very-fine-grained, brecciated with a few vugs; quartz, calcite, fluorite.
5702D	Jasperoid--gray, purple, and white; fine- to medium-grained, brecciated; quartz, calcite, fluorite.
5703A,B,E	Jasperoid--gray, purple, white, brown; fine- to medium-grained, brecciated; quartz, calcite, fluorite.
5704A	Jasperoid--gray, purple, white, brown; fine- to medium-grained, brecciated; quartz, calcite, fluorite.
5705A	Jasperoid--gray and brown; very-fine-grained; quartz, calcite.
5706A,B,C,G	Jasperoid--gray, brown; fine-grained, brecciated; quartz, calcite.
5706D,E,F,H,I	Limestone--gray; fine-grained, well-bedded; unaltered looking limestone, except occasional pocket of barite.
5707A,B,G	Jasperoid--gray, brown; very-fine-grained, intensely brecciated; quartz, minor iron-oxide stainings.
5707C,D,E	Carbonate Breccia--gray; breccia, with angular clasts generally less than 10 cm in length; quartz, calcite, iron-oxides.
5707F	Jasperoid--gray, brown, white; intensely brecciated; quartz, barite, iron-oxides.
5708A,B,C,F,I	Jasperoid--gray, brown; medium- to very-coarse-grained with scattered vugs; quartz, cerargyrite, malachite.
5708D,E	Limestone--gray; fine-grained; no visible alteration.

TABLE 4--continued

5708G,H	Dolomite--dark gray; medium-grained; no visible alteration.
5709A,B	Igneous Rock--pale yellowish-brown; porphyritic, pheonocrysts to 3-4 mm; highly altered, mostly clays; occurs as clasts within fault breccia.
5709C	Limestone--gray; fine-grained; calcite with less than 5% secondary silicification.
5721A,B	Dolomite--gray, yellowish-brown; fine- to coarse-grained dolomite cut by gougey and brecciated fault zone material; contains calcite veinlets, iron-oxides, and pyrite; fault zone occurs parallel and cross-cutting to bedding.
5722A	Limestone--gray, yellowish-brown; fine- to medium-grained limestone cut by gougey and brecciated fault zone material; heavily stained and sanded carbonate exposed in roadcut, not visible in surface exposures.
5723A	Carbonate Breccia--gray, brown; fine-grained; dolomite cut by varying amounts of lacey, networking silica zones.
5724A	Jasperoid--gray, brown; fine-grained, brecciated; quartz, iron-oxide, fluorite.
5724B	Carbonate Breccia--gray, brown; fine-grained, brecciated; dolomite, calcite, quartz, fluorite.