Jasperoids of the Lake Valley Mining District, New Mexico

By E. J. YOUNG and T. G. LOVERING

CONTRIBUTIONS TO ECONOMIC GEOLOGY

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Application of criteria for recognition of ore-associated jasperoids has revealed a new potentially mineralized area in a famous silver mining district

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JASPEROIDS OF THE LAKE VALLEY MINING DISTRICT NEW MEXICO

By E. J. Young and T. G. Lovering

ABSTRACT

A study in the Lake Valley mining district, New Mexico, of selected bodies of jasperoid involved the application of criteria for distinguishing between jasperoid which is favorable for association with silver and base metal mineralization and that which is not. The study revealed some favorable bodies in an unprospected area more than half a mile from known silver and manganese ore.

Three jasperoid bodies and one bedded chert in the unprospected part of the Lake Valley district were studied, mapped, and sampled in detail. Representative samples of jasperoid were also collected from within the mined area in the district, as well as from the nearby mining districts of Hadley, Cooks Peak, Jose, Kingston, Hillsboro, and Organ. Comparisons were made between host rock and jasperoid along two traverses, and changes within the contact zone were investigated by petrographic and spectrographic analyses. The samples showed more iron, titanium, aluminum, and barium in the jasperoid than in the host dolomite. They also showed more calcium and magnesium on the jasperoid side of the contact and correspondingly more silica on the dolomite side, which indicates that major elements are diffused in both directions from the contact.

The presence of favorable jasperoid in Fusselman Dolomite at some distance from known ore bodies in the Lake Valley district, in conjunction with other evidence, suggests the possibility that sulfide minerals associated with jasperoid may be present in the Fusselman Dolomite near the Berenda fault.

INTRODUCTION

The field study that formed the basis of this report was undertaken to investigate the chemical composition, texture, mineralogy, and appearance of several jasperoid (silicified carbonate rock) bodies and to relate the characteristics to structure, stratigraphy, lithology, and composition of the host rocks, and to proximity of silver and manganese ore deposits. All samples were classified as either favorable type (probably related to ore mineralization) or unfavorable type (probably unrelated to mineralization) in the hope that the distribution of favorable type jasperoid samples might furnish a guide for future exploration for ore in the district.

The Lake Valley district is in the southwestern part of Sierra County, N. Mex. (fig. 1), near the center of T. 18 S., R. 7 W. It is about 40 miles by road north-northeast of the town of Deming and about 15 miles west of the Rio Grande. The district was famous during the 1880's for silver mining; during World Wars I and II, it also produced some manganese ore. However, the bonanza silver ore bodies have long been mined out, and the manganese deposits are too siliceous for profitable exploitation under current market conditions.

Representative jasperoid bodies were mapped by use of planetable and alidade, and samples were collected by Young during March and April 1962. In addition, small suites of representative jasperoid samples were collected for comparative purposes from several other districts in the same region, but the bodies from which these samples were taken were not mapped.

Semiquantitative spectrographic analyses of the samples were made by J. C. Hamilton. Maps, photographs, and field descriptions were prepared by Young; petrographic studies of the samples were made

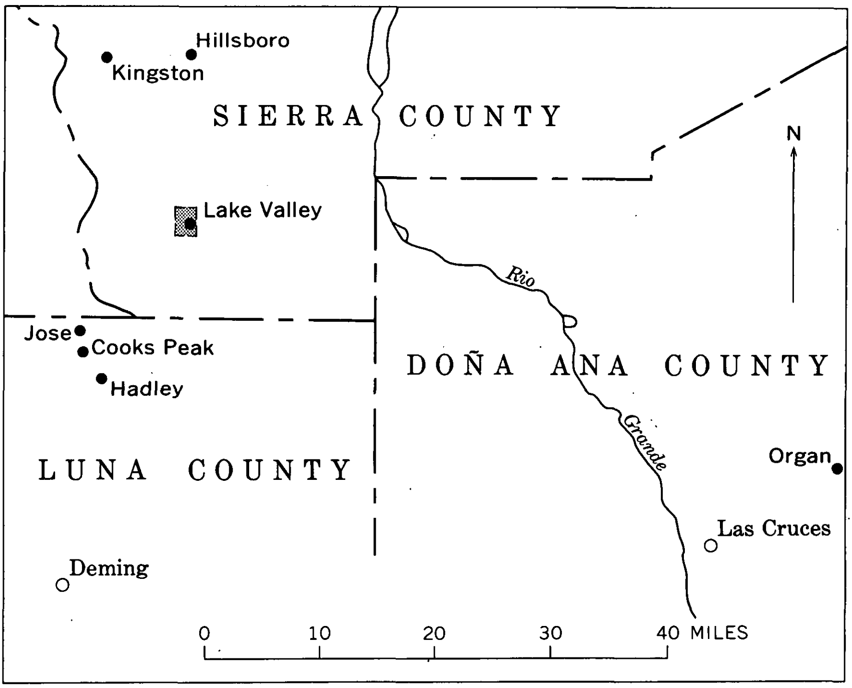


FIGURE 1.—Part of southwestern New Mexico showing outline of Lake Valley Mining district (fig. 2), and location of adjacent mining districts (black dots).

by both Young and Lovering; and the résumé of the history and geology of the district and the statistical studies of the sample data were done by Lovering.

HISTORY AND PRODUCTION

Ore in the Lake Valley mining district was discovered in 1878 by G. W. Lufkin, and the major part of the district was soon claimed by three mining companies—the Sierra Grande, the Sierra Bella, and the Sierra Apache. The silver boom that followed reached its peak in the early 1880's after the discovery and exploitation of the famous Bridal Chamber ore body, which yielded 2½ million ounces of silver. By 1893 the depletion of most of the high-grade ore bodies, coupled with a decline in the price of silver, caused the virtual abandonment of mining in the area. During the brief 15-year period of mining activity (1878–93), the district produced 5 million ounces of silver. From 1893 to 1964 approximately 800,000 ounces of silver was produced. Thus, by 1964 the Lake Valley district had produced a total of approximately 5.8 million ounces of silver, of which about 40 percent had come from one ore body in the Lake Valley Limestone.

In 1928 and 1929 the lower beds of the Lake Valley Limestone were explored by drilling, but the contact with the underlying Percha Shale was barren of ore, and the project was abandoned. Harley (1934, p. 179) reported that one drill hole "near the old Virginia Shaft" penetrated through the Percha Shale into a thin bed of brecciated and partly silicified limestone, which was also barren. This record of exploration below the Percha is the only one published for the district, and the site of this exploration cannot be found because the Virginia shaft is not shown on published maps of the district.

During World War I the district yielded nearly 8,000 tons of manganese ore. During World War II, in 1942 and 1943, over 37,000 tons of manganese ore, averaging 20.8 percent manganese, was shipped from the Lake Valley district to the U.S. Government stockpile at Deming. In 1953 the Haile Mines Co. built a 200-ton-per-day concentrating plant in the district to beneficiate siliceous manganese ore mined from opencuts; this work terminated prior to 1960.

Although much of the rich silver ore was associated with cerussite, the amount of lead produced as a byproduct of silver was not recorded.

The main mineralized area of the district was about a mile long from southwest to northeast, and half a mile wide; it was most intensely mineralized adjacent to the Berenda fault at the southwest end and least mineralized at the northeast. Mines in this area (fig. 2) were designated as belonging to three groups: the Grande Group at the southwest—the richest—which included the Boiler shaft, Office shaft, Twenty-five cut, Thirty stope, and Bridal Chamber workings; the Bella Group in the center, which included the Emporia incline, Bunkhouse, Strieby, Harrison, and Bella Chute workings; and the Apache Group at the northeast, which was made up of small mines whose principal yield was iron flux (Harley, 1934; Creasey and Granger, 1953). All the mine workings were shallow. The deepest in the district was the Emporia incline, which penetrated 150 feet beneath the surface.

GEOLOGY AND ORE DEPOSITS

The map of the district (fig. 2) was modified from Jicha's map (1954). The district is in a tilted fault block of sedimentary rocks of Paleozoic age (Ordovician to Mississippian (table 1)), which is surrounded by volcanic rocks of Tertiary age. The strata within the block strike northeast and dip 15°–20° SE. The block is cut off on the west by the Berenda fault and on the southwest by a northwest-trending fault, which was shown by Jicha (1954, pl. 1) as a continuation of the Berenda fault, but which was called the Lake Valley fault by Creasey and Granger (1953). We refer to both faults as the Berenda fault.

The exposed sedimentary rocks include approximately 800 feet of limestone, dolomite, and shale (table 1). The volcanic rocks surrounding the block are predominantly andesite in the lower and middle parts of the volcanic rock series and rhyolite in the upper part.

Most ore bodies in the district were irregular replacements in the Alamogordo and the Nunn Members of the Lake Valley Limestone. In some places the top of the Andrecito Member was also replaced by ore (Lindgren and others, 1910, p. 280). Hypogene mineralizing solutions which circulated along faults and fractures produced vein deposits locally; the ore was thoroughly oxidized and secondarily enriched by ground water. Ore deposits were localized stratigraphically by favorable limestone beds in the Alamogordo Member and structurally by small faults and fractures, by a drag zone along the major southwest boundary fault, and by small warps and open folds in the beds on the dip slope of the Berenda fault block.

The two types of ore mined in the district were spatially related, but separate. Silver ore was more restricted in distribution than manganese ore and was confined largely to the southern part of the district. Most of the bonanza silver ore (>50 oz per ton) was not highly manganiferous, and manganese ore was poor in silver. Where the two types were associated, manganese ore commonly formed a floor beneath the silver-ore bodies. The silver-ore bodies of the Grande Group were highly siliceous, rich in silver, and relatively poor in manganese. Those of the Bella Group were less siliceous and con-

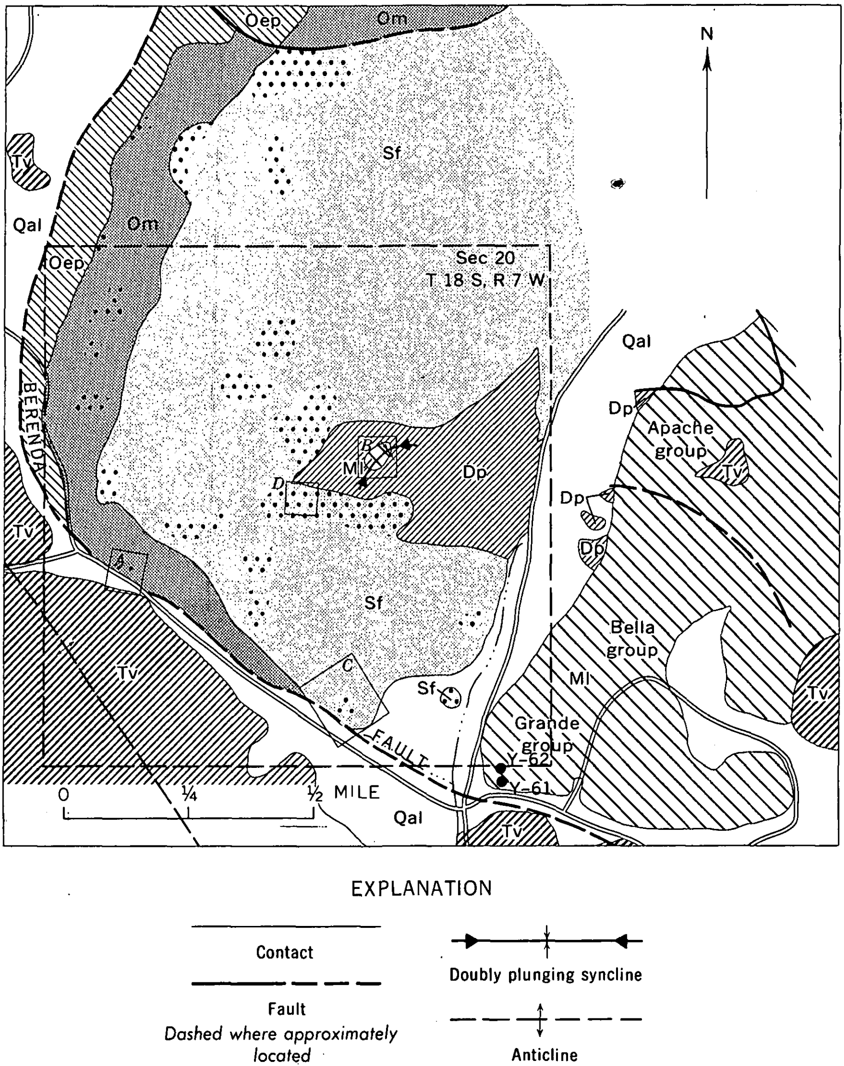


FIGURE 2.—Generalized geology of the Lake Valley district, Sierra County, N. Mex. (Modified from Jicha, 1954.) Dotted pattern indicates jasperoid outcrops, which were sampled in *A*, *B*, *C*, and *D* areas (shown in detail in fig. 3). General location of the three mine groups is shown. Y–61 and Y–62 are jasperoid sample sites. Quaternary alluvium (Qal); Tertiary volcanics, tuffs, and flows (Tv); Mississippian Lake Valley Limestone (Ml); Devonian Percha Shale (Dp); Silurian Fusselman Dolomite (Sf); Ordovician Montoya Dolomite (Om); and El Paso Limestone (Oep).

TABLE 1.—*Generalized stratigraphic section of rocks exposed in the Lake Valley mining district*

System	Stratigraphic unit		Thickness [1] (feet)	Character
Tertiary	Volcanic flows and tuffs			
	Unconformity			
Mississippian	Lake Valley Limestone	Tierra Blanca Member	55±	Limestone, containing white chert.
		Nunn Member	110±	Limestone, blue-gray.
		Alamogordo Member	25±	Limestone, blue-gray.
		Andrecito Member	55±	Limestone, containing black chert nodules.
	Caballero Formation [2]		35±	Shale and very sandy limestone.
Devonian	Percha Shale		200±	Black and greenish-gray shale.
Silurian	Fusselman Dolomite		215±	Dolomite, medium-grained.
Ordovician	Montoya Dolomite	Cutter Member	75±	Dolomite, sublithographic.
		Aleman Chert Member	40±	Dolomitic limestone, fine-grained.
		Upham Member	55±	Dolomite, medium-grained.
		Cable Canyon Sandstone Member	30±	Sandstone, dolomitic matrix.
	El Paso Limestone		200±	Limestone and dolomite.

[1] Jicha (1954).
[2] Laudon and Bowsher (1941).

tained more manganese and more calcite and gypsum. In the northeastern and central parts of the district, a prominent "chert" (or jasperoid) layer at the top of the Alamogordo Member formed the footwall of the replacement deposits. In the southwestern part of the district, where beds had been dragged and fractured close to the Berenda fault, this layer was brecciated and then cemented by younger jasperoid moderately rich in silver and rich in iron and manganese. In this area, stringers and small pockets of manganese oxides occurred in massive red, green, yellow, and white jasperoid, which filled fractures in the older chert. According to Clark (1895, p. 148) this jasperoid ore averaged 65 percent SiO_2, 12 percent MnO, 6 percent FeO, and 20 ounces of silver per ton. In the central part of the district, the ore generally averaged about 8 percent SiO_2, 24 percent MnO, 12 percent FeO, and 20–30 ounces of silver per ton, and the remainder was limestone and gypsum. The following vertical section through the famous Bridal Chamber ore body has been modified from Jicha (1954, p. 72):

Surface.	*Feet*
Detritus	4
Iron- and manganese-stained limestone	20
Silver ore (40 oz per ton)	5
Silver ore (60 oz per ton)	3
Silver ore (150 oz per ton)	4
Open cavity	1⅙
Cerargyrite (15,900 oz per ton)	4
Cerussite sand (40 percent lead, 500 oz silver per ton)	5
Iron- and manganese-stained decomposed limestone	3

According to Silliman (in Lindgren and others, 1910, p. 279) ore and gangue minerals from the Lake Valley district consist of ankerite, apatite, calcite, cerargyrite, cerussite (argentiferous), embolite, galena (argentiferous), hematite, limonite, manganite, native silver, psilomelane, pyrolusite, quartz, and vanadinite. Creasey and Granger (1953) reported that manganese ore from the district consists largely of manganite and pyrolusite but includes subordinate psilomelane and minor braunite and cryptomelane.

Clark (1895, p. 165–167) thought that silver was originally disseminated in the Tertiary volcanic rocks that once covered the area, and was leached by ground water during subsequent erosion to be precipitated and concentrated at favorable sites in the underlying limestone. Subsequent investigators, however, attributed the primary mineralization to hydrothermal solutions that rose along faults and subsidiary fractures, later to spread laterally along favorable zones in the Lake Valley Limestone. According to Harley (1934, p. 177), the early primary solutions were rich in silica and contained minor amounts of manganese, iron, and silver; these solutions formed the chert layer at the base of the ore bodies and also a few siliceous low-grade silver deposits. Later solutions—preceded or accompanied by renewed movement on some of the faults—were richer in lime, silver, and manganese and poorer in silica; they deposited ankerite, manganiferous calcite, ruby silver, argentiferous galena, and a little pyrite along cracks and fractures in the older siliceous replacement bodies. The mined ore bodies had been subject to supergene enrichment caused by oxidizing solutions migrating down the dipslope of the major fault block, over and through the "chert layer." Where this layer was fractured the ores were siliceous, but where it was undisturbed the overlying ore bodies were calcareous but relatively poor in silica.

Harley (1934, p. 173–177) recognized three distinct types of epigenetic silica in the district: the early "chert layer" at the top of the "Blue Limestone" (Alamogordo Member of the Lake Valley Limestone); the variegated silver-bearing silica that fills fractures in this layer in the southwestern part of the district; and brecciated siliceous replacement bodies in the Fusselman Dolomite west of the mineralized area. He described the jasperoid bodies in the Fusselman Dolomite as milky colored and granular, resembling quartzite, and as highly brecciated and cemented by vuggy late quartz. These bodies are most abundant near the Berenda fault, but some are as much as a mile distant. They form prominent rough, craggy outcrops that are surrounded by a talus of angular blocks and fragments. Clark (1934, p. 148) also mentioned the late silver-bearing "flint" ores from the workings in the Grande Group. He described the ore from the Thirty stope as consisting principally of gray, brown, chocolate, pearl, and green flint, brecciated, and cemented by veins of transparent quartz. He reported that the green flint was much richer in silver than were the other types of flint.

The proximity of favorable and supposedly unfavorable jasperoid bodies in the Fusselman Dolomite and the presence of ore-bearing jasperoid bodies in the Lake Valley Limestone, as described by Harley, prompted the choice of the Lake Valley district for this study. The original intent was to map and sample representative jasperoid bodies and their adjacent host rocks, both in the Lake Valley Limestone within the main mineralized area and in the Fusselman Dolomite at a distance from it, so that the two types of jasperoid bodies could be compared in detail. Unfortunately, only the outcrops in the Fusselman Dolomite were amenable to study; those in the Lake Valley Limestone had been either mined out or covered by mine dumps, so that only small scattered outcrops of jasperoid remained.

METHOD OF CLASSIFICATION OF JASPEROID SAMPLES

Classification of jasperoid samples from this area as favorable or as unfavorable was based on the statistical comparison of various properties, or criteria, such as color, texture, mineralogy, and chemical composition. Large groups of samples representing more than 20 mining districts were first classified, on the basis of their field relations, into two groups: those closely associated with ore bodies (favorable), and those not associated with ore bodies (unfavorable). The distribution of the various properties between these groups was then compared by the Chi Square test and the Kolmogorov-Smirnov two-sample test (Siegel, 1956, p. 104–111, 127–135; Lovering and Hamilton, 1962). Those properties whose distributions showed a statistically significant difference between the two groups were then given point scores that corresponded to the level of significance obtained: one, for the 90-percent level; two, for the 95-percent level; and three, for the 99-percent level. For the chemical elements the significance test was applied at the concentration which showed the greatest difference between the cumulative distributions for the two groups. If the difference was significant at this level, one scoring point was added for each order of magnitude of increase in the concentration of the element. Thus, for silver, the greatest difference in the cumulative distributions between unfavorable and favorable samples occurred at 0.0001 percent silver, and this difference was statistically significant at the 99-percent level. Points were assigned to samples containing more than 0.0001 percent silver on the following basis: Three points, if content was more than 0.0001 percent silver; four points, if more than 0.001 percent silver; and five points, if more than 0.01 percent silver. Plus scores were assigned to characteristics that were more common in jasperoids associated with ore; minus scores, to those more common in japeroids not associated with ore.

The scores for each sample in both groups were then totaled algebraically, and the resulting distribution of scores was compared with the original classification of the samples to arrive at a cutoff score between unfavorable and favorable that would result in misclassification of the fewest possible samples in both groups. This point was found to be +5. About 90 percent of the samples originally classified as favorable gave scores of $\geqq +5$, and about 80 percent of those originally classified as unfavorable gave scores of $\leqq +5$. The classification system was further refined by grouping the scores in increments of five as indicative of unfavorable, probably unfavorable, possibly favorable, favorable, and highly favorable jasperoid samples. Table 2 lists the characteristics used as criteria, the scoring points awarded to each, and the classifications as based on the total scores.

All jasperoid samples collected in the Lake Valley mining district, as well as those taken from other mining districts in the region, were classified on the basis of their total scores; their proximity to known ore was disregarded. All samples of jasperoids known to be associated with ore bodies gave favorable scores; several samples from jasperoid bodies some distance from any known ore in the Lake Valley district also gave favorable scores.

TABLE 2.—*Criteria used in classifying jasperoid samples as favorable or unfavorable*

Criterion	Score
Color [1]	
Pale red $5R\frac{6-8}{2-6}$	−1
Moderate red $5R\frac{4-5}{4-6}$	−2
Light brown $5YR\frac{6}{4}$	+1
Dark brown $5YR\frac{2-4}{2-4}$	+1
Megatexture	
Phaneritic	+2
Vuggy	+2
Microtexture	
Ratio of largest quartz grain diameter to smallest quartz grain diameter >10	+2
Reticulated	+2
"Jigsaw puzzle"	−2
Hypogene minerals	
Clay, montmorillonite group	−1
Pyrite	+1
Sericite or hydromica	−1
Supergene minerals	
Calcite	−1
Goethite	+2
Jarosite	+2
Yellow-orange limonite	−1
Element and concentration (percent)	
Fe >1	+2
Mg >.01	−1
Cu >.002	+3
Pb >.001	+3
Ag >.0001	+3
Mo >.0005	+3
Zn >.01	+3
Mg >0.1	−2
Cu >.02	+4
Pb >.01	+4
Ag >.001	+4
Mo >.005	+4
Zn >.1	+4
Mg >1.5	−3
Cu >.2	+5
Pb >.1	+5
Ag >.01	+5
Mo >.05	+5
Zn >1	+5

[1] Rock colors are from the National Research Council "Rock-Color Chart" (Goddard and others, 1948).

TABLE 2.—*Criteria used in classifying jasperoid samples as favorable or unfavorable*—Continued

Total score	Classification	
$<+1$	Unfavorable	Unfavorable
$+1$ to $<+5$	Probably unfavorable	
$+5$ to $<+10$	Possibly favorable	Favorable
$+10$ to $<+15$	Probably favorable	
$\geq+15$	Highly favorable	

JASPEROID BODIES IN THE LAKE VALLEY DISTRICT

Two of the four bodies mapped are jasperoid in the Silurian Fusselman Dolomite; these show favorable characteristics. The third, a jasperoid in the Ordovician Montoya Dolomite, shows unfavorable characteristics, as does the fourth, a bedded chert in the Mississippian Lake Valley Limestone. These bodies, as well as five favorable jasperoid samples that were taken from the "Blue Limestone" in the mined area—apparently from the Alamogordo and Nunn Members of the Lake Valley Limestone—will be discussed next.

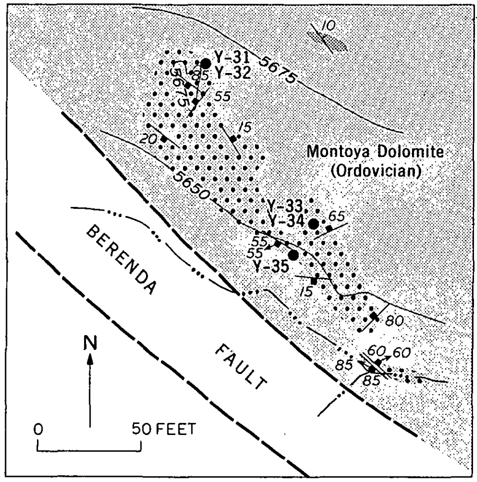
UNFAVORABLE JASPEROID IN MONTOYA DOLOMITE

An elongate body of jasperoid about 170 feet long is present in the Ordovician Montoya Dolomite in the NW¼SW¼ sec. 20, adjacent to the Berenda fault (fig. 3*A*). The jasperoid in this body is mottled red and gray and seemingly has two textures: brecciated and massive. It is massive only by contrast, however, for brecciation can be seen on close inspection (fig. 4). The Montoya Dolomite is light olive gray to light brownish gray and is lithographic; it is presumably the Cutter Member. Rhyolite of Tertiary age crops out south of the Berenda fault.

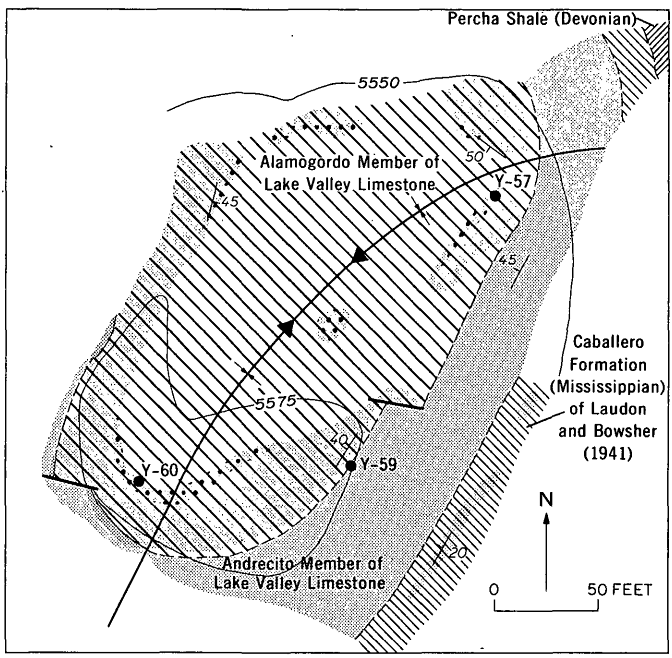
Five samples were taken from the jasperoid body, and all were found to be unfavorable. (See table 3.) Proximity to the Berenda fault apparently had no positive mineralizing effect on the Montoya Dolomite, because the jasperoid shows no characteristics indicative of association with ore.

BEDDED CHERT IN THE LAKE VALLEY LIMESTONE

A small knob in the SW¼NE¼ sec. 20 was mapped by Jicha (1954) as jasperoid, but the knob is actually underlain by a doubly-plunging syncline of Lake Valley Limestone that contains chert. The knob, according to Jicha, is surrounded by Quaternary alluvium; however, field evidence suggests that the base of the knob is underlain by Percha Shale of Devonian age. Figure 2 has been modified accordingly. (See also fig. 3*B*.)

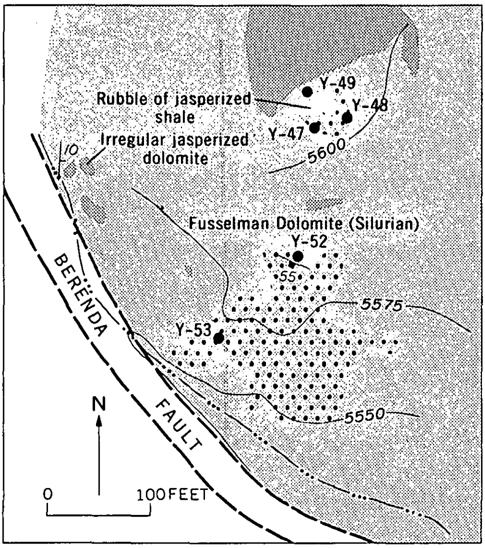


A. Unfavorable jasperoid body (dotted) in Montoya Dolomite

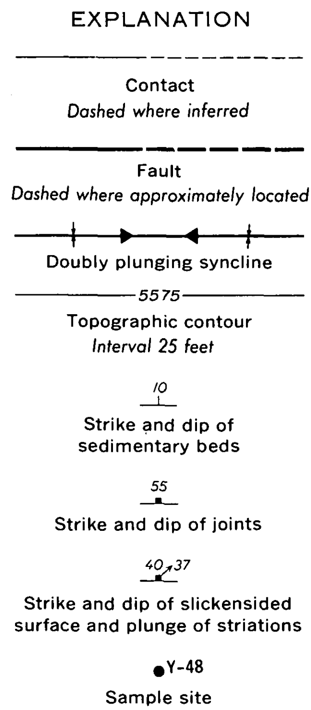


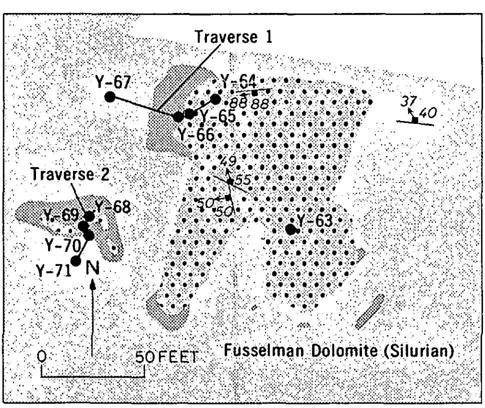
B. Bedded chert body (dotted) in Lake Valley Limestone (Mississippian)

FIGURE 3.—Areas in which outcrops of jasperoid



C. Favorable jasperoid body (dotted) in Fusselman Dolomite adjacent to Berenda fault.





D. Favorable jasperoid body (dotted) in Fusselman Dolomite 1,500 feet from Berenda fault.

and chert bodies were sampled, and sample sites.

FIGURE 4.—Unfavorable jasperoid in Ordovician Montoya Dolomite, showing brecciated and seemingly massive textures.

Three chert samples were taken from this knob for comparison with the jasperoid samples; samples Y–57 and Y–60 are from the Alamogordo Member, and sample Y–59 is a black chert from the Andrecito Member. All samples were classified as unfavorable. (See table 3 for significant features of the chert samples and their scores.)

FAVORABLE JASPEROID IN FUSSELMAN DOLOMITE NEAR THE BERENDA FAULT

A jasperoid body, irregular in form and about 200 feet wide, lies in the SW¼SE¼ sec. 20 and is very near the Berenda fault (figs. 2, 3, 5*A*); there is a small outlier 100 feet to the north. The larger jasperoid body is very similar to that in the Montoya Dolomite previously described. A small part of the outlier has milky-white fragments of jasperoid in a dark-reddish-black hematitic matrix. (See fig. 5*B*.)

TABLE 3.—*Significant features and tabulated scores of jasperoid samples from the Lake Valley mining district (fig. 3)*

[Numbers in parentheses (+2) indicate scores. Analyst: J. C. Hamilton]

Sample [a]	Criteria: Megascopic examination	Criteria: Microscopic examination	Criteria: Spectrographic analyses	Total score	Classification
JASPEROID BODY IN ORDOVICIAN MONTOYA DOLOMITE [Average, +1; probably unfavorable]					
Y-31	----------	----------	Mg ------ 0.1 ---(−1)	−1	Unfavorable.
Y-32	----------	"Jigsaw puzzle" texture --------(−2) Calcite ----------(−1)	Mg ------ .1 ---(−1)	−4	Do.
Y-33	Vuggy ---------(+2)	"Jigsaw puzzle" texture --------(−2) Goethite --------(+2) Calcite ----------(−1)	Mg ------ .3 ---(−2) Zn ------ .05 ---(+4)	+3	Probably unfavorable.
Y-34	----------	----------	Mg ------ .1 ---(−1) Zn ------ .05 ---(+4)	+3	Do.
Y-35	Vuggy ---------(+2)	"Jigsaw puzzle" texture --------(−2)	Mg ------ .03 ---(−1)	−1	Unfavorable.
BEDDED CHERT IN MISSISSIPPIAN ALAMOGORDO AND ANDRECITO MEMBERS OF LAKE VALLEY LIMESTONE [Average, −⅔; unfavorable]					
Y-57	Vuggy ---------(+2)	"Jigsaw puzzle" texture --------(−2)	Mg ------ 0.03 ---(−1)	−1	Unfavorable.
Y-59	Light brown (5*YR* 6/4).[b] (+1)	"Jigsaw puzzle" texture --------(−2) Late calcite ------(−1)	Mg ------ .15 ---(−2) Cu ------ .005 ---(+3)	−1	Do.
Y-60	Vuggy ---------(+2) Grayish orange pink (5*YR* 7/2).[b] (+1)	"Jigsaw puzzle" texture ---------(−2)	Mg ------ .07 ---(−1)	0	Do.
JASPEROID BODY IN SILURIAN FUSSELMAN DOLOMITE CLOSE TO BERENDA FAULT [Average, +12; favorable]					
Y-47	Vuggy --------(+2)	Size range >10 [c] -(+2)	Pb ------ 0.002 --(+3)	+7	Possibly favorable.
Y-48	-----do --------(+2)	Size range >10 [c] -(+2)	Fe ------ 5.0 --(+2) Ag ------ .003 --(+4) Mo ----- .003 --(+3) Pb ------ .07 --(+4) Zn ------ .05 --(+3)	+20	Highly favorable.
Y-49A	-----do --------(+2)	Size range >10 [c] -(+2) Reticulated texture -----------(+2) Grain size >0.1 mm -----------(+2) Montmorillonite -----------(−1)	Mg ----- .05 --(−1) Pb ------ .002 --(+3)	+9	Possibly favorable.
Y-49B	----------	Size range >10 [c] -(+2) Grain size >0.1 mm -----------(+2) "Jigsaw puzzle" texture --------(−2)	Fe ------ 5.0 --(+2) Pb ------ .02 --(+4)	+8	Do.
Y-49C	----------	Size range >10 [c] -(+2) Grain size >0.1 mm -----------(+2)	Mg ----- .1 --(−1) Fe ------ 3.0 --(+2) Pb ------ .015 --(+4)	+9	Do.
Y-52A	Vuggy --------(+2)	Size range >10 [c] -(+2) Grain size >0.1 mm -----------(+2) Goethite --------(+2) Jarosite ---------(+2) "Jigsaw puzzle" texture --------(−2)	Pb ------ .015 --(+4) Mo ----- .007 --(+4) Ag ------ .002 --(+4)	+20	Highly favorable.
Y-52B	-----do --------(+2)	Size range >10 [c] -(+2) Goethite --------(+2) "Jigsaw puzzle" texture --------(−2)	Fe ------ 2.0 --(+2) Pb ------ .015 --(+4) Mo ----- .003 --(+3) Ag ------ .003 --(+4)	+17	Do.
Y-53	----do --------(+2) Brown (YR 3/4) [b] -------(+1)	Size range >10 [c] -(+2) Grain size >0.1 mm -----------(+2)	Mg ----- .05 --(−1)	+6	Possibly favorable.

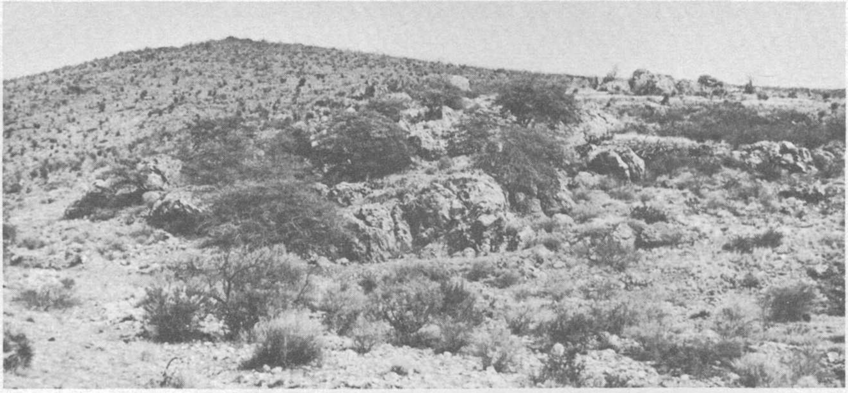
See footnotes at end of table.

TABLE 3.—*Significant features and tabulated scores of jasperoid samples from the Lake Valley mining district (fig. 3)*—Continued

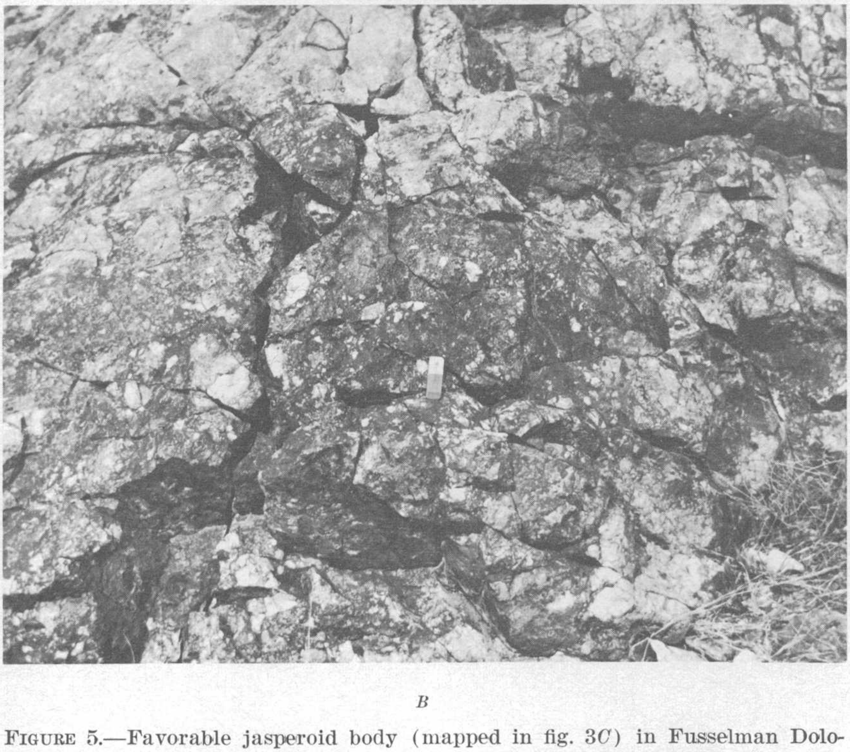
Sample [a]	Criteria: Megascopic examination	Criteria: Microscopic examination	Criteria: Spectrographic analyses	Total score	Classification
JASPEROID BODY IN FUSSELMAN DOLOMITE AWAY FROM BERENDA FAULT [Average, +7⅘; possibly favorable]					
Y-63	Vuggy.........(+2)	Size range>10[c]...(+2) Grain size >0.1 mm. (+2) "Jigsaw puzzle" texture. (−2) Yellow-orange limonite. (−1)	Mg... 0.05 ....(−1) Pb.... .005 ....(+3) Zn.... .07 ....(+3) Mo.... .002 ....(+3)	+11	Probably favorable.
Y-64	....do.........(+2) Pale red (−1) (5*R* 6/2)[b].	Size range >10[c]...(+2) Grain size >0.1 mm. (+2)	Mg.... .02 ....(−1) Pb.... .01 ....(+3)	+7	Possibly favorable.
Y-65		Size range >10[c]...(+2) Supergene calcite..(−1)	Mg.... 1.5 ....(−2) Pb.... .003 ....(+3)	+2	Probably unfavorable.
Y-68	Vuggy.........(+2)	Sizerange >10[c]...(+2) Grain size >0.1 mm. (+2)	Mg.... .03 ....(−1) Pb.... .007 ....(+3)	+8	Possibly favorable.
Y-69	.....do.........(+2)	Size range >10[c]...(+2) Grain size >0.1 mm. (+2)	Mg.... .07 ....(−1) Pb.... .005 ....(+3) Zn.... .07 ....(+3)	+11	Probably favorable.
JASPEROID FROM THE MINED AREA IN THE LAKE VALLEY DISTRICT [Average, +8⅓; possibly favorable]					
Green and gray jasperoid					
Y-61A		"Jigsaw puzzle" texture. (−2)	Ag.... 0.03 ....(+5) Pb.... .003 ....(+3)	+6	Possibly favorable.
Y-61B		Reticulated texture. (+2) Late calcite........(−1)	Mg.... .02 ....(−1) Pb.... .003 ....(+3) Ag.... .01 ....(+4)	+7	Do.
Y-61C	Vuggy.........(+2) Light brown (+1) (5*YR* 6/4).[b]		Mg.... .2 ....(−2) Ag.... .0007....(+3)	+4	Probably unfavorable.
Red jasperoid					
Y-62A	Vuggy.........(+2)	"Jigsaw puzzle" texture. (−2)	Mg.... 0.02 ....(−1) Fe..... 7.0 ....(+2) Pb.... .03 ....(+4) Ag.... .005 ....(+4) Zn.... .05 ....(+3)	+12	Probably favorable.
Y-62B			Mg.... .05 ....(−1) Fe..... 7.0 ....(+2) Zn.... .1 ....(+3) Pb.... .05 ....(+4) Ag.... .005 ....(+4)	+12	Do.

[a] A, B, or C suffix denotes a variant of a sample.
[b] Rock colors are from the National Research Council "Rock-Color Chart" (Goddard and others, 1948).
[c] Ratio of largest quartz-grain diameter to smallest quartz-grain diameter >10.

Eight samples were taken from the jasperoid body and its outlier; one sample from the outlier (fig. 5*B*) yielded a +20 score. Significant features and tabulated scores of the samples, as shown in table 3, indicate the average of the samples to be "favorable."



A



B

FIGURE 5.—Favorable jasperoid body (mapped in fig. 3*C*) in Fusselman Dolomite adjacent to Berenda fault. *A*, Prominent jasperoid outcrops. *B*, Angular white jasperoid-breccia fragments in a dark siliceous hematite matrix

FAVORABLE JASPEROID IN FUSSELMAN DOLOMITE 1,500 FEET FROM THE BERENDA FAULT

An outcrop of jasperoid about 150 feet wide (fig. 3*D*) is in Fusselman Dolomite in the center of sec. 20, about a quarter of a mile north of the jasperoid body in Fusselman Dolomite near the Berenda fault. This jasperoid has the same appearance as that in jasperoid bodies in other areas. A part of the smaller arcuate body in figure 3*D* is shown in figure 6, which also shows the fretted surface-weathering characteristic common to the Fusselman Dolomite in other areas.

Five samples were taken from this body, and they have an average score of +7⅘ (table 3), which classes them as "possibly favorable."

FAVORABLE JASPEROID FROM THE MINED AREA

Five samples of "favorable" jasperoid were taken from the mined area at points 61 and 62 shown in figure 2. The three green and gray samples are relatively less "favorable" than the two red samples, as is indicated in table 3.

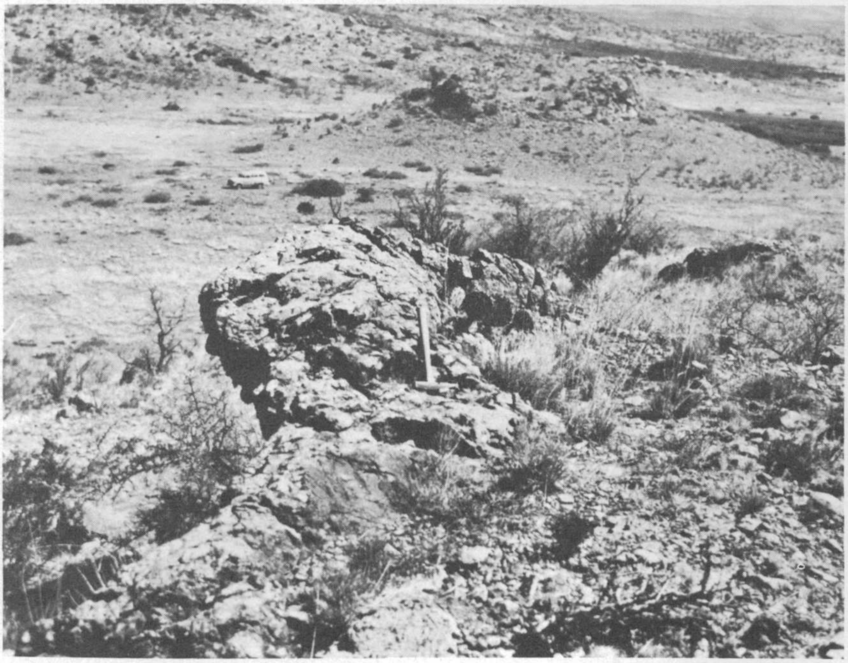


FIGURE 6.—Favorable jasperoid body in Fusselman Dolomite 1,500 feet from Berenda fault; note contact between jasperoid and dolomite in foreground. Synclinal body of Lake Valley Limestone containing mapped body of chert is in middle distance.

PHYSICAL-CHEMICAL RELATIONS IN TRAVERSES ACROSS JASPEROID-FUSSELMAN DOLOMITE CONTACT

Samples were collected from two jasperoid bodies along two traverses that extended from jasperoid into apparently fresh dolomite (fig. 3*D*). These samples were analyzed to evaluate the physical, chemical, and mineralogical changes that accompany replacement of dolomite by jasperoid.

The contact between the larger body of jasperoid and the fresh dolomite (fig. 3*D*, traverse 1) is very irregular and exhibits a transitional contact zone, whereas the contact between the smaller arcuate body of jasperoid and the dolomite (fig. 3*D*, traverse 2) is abrupt. Both bodies show increases in calcium and magnesium in the jasperoid as the dolomite contact is approached and a corresponding increase in silica in the dolomite as the jasperoid is approached. The jasperoid in both traverses also contains more iron, aluminum, titanium, and barium than does the dolomite (table 4).

The contact zone crossed in traverse 1 has little iron, vanadium, chromium, and lead; whereas in traverse 2, across the arcuate body, the jasperoid near the contact zone contains considerable iron, vanadium, and manganese. This fact is probably a reflection, however, of the hematite-rich jasperoid near the contact. Considerable diffusion of certain elements appears to have occurred across the contact.

Megascopic and microscopic descriptions of the samples collected along the two traverses are given in table 4.

The older, original jasperoid in traverse 1 preserves in large measure the color and texture of the dolomite it replaces. Changes in texture of the dolomite outward from the contact suggest that brecciation and partial recrystallization occurred prior to silicification. The fact that the abundance of disseminated epigenetic quartz grains in the dolomite gradually diminishes away from the contact also suggests that the older jasperoid was formed by expansion and coalescence of isolated centers of quartz precipitation rather than by a wave of silicification that advanced from the feeding channels. Veinlets of younger, coarse grained clean quartz, which cut both the older jasperoid and the host rock, probably represent direct precipitation in these channels by late-stage silica-bearing solutions that were more nearly in chemical equilibrium with the host rock and, thus, were unable to replace it.

Chemically, the contact zone seems to contain less iron, vanadium, chromium, and lead than do either the jasperoid or the dolomite. Strontium increases in abundance from the jasperoid to the dolomite. Copper content decreases slightly from the jasperoid to the dolomite,

TABLE 4.—*Characteristics of samples taken in two traverses across jasperoid–Fusselman Dolomite contacts (fig. 3D)*

[Elements in percent; M, >10 percent. Analyst: J. C. Hamilton]

	Traverse 1					Traverse 2			
Sample	Y-64	Y-65	Y-65A	Y-66	Y-67	Y-68	Y-69	Y-70	Y-71
Rock type	Jasperoid	Jasperoid	Silicified dolomite	Dolomite	Dolomite	Jasperoid	Jasperoid	Dolomite	Dolomite
Distance from contact (ft)	12	1	0	1	25	5	<1	<1	15
Determinations by spectrographic analyses									
Si	M	M	7.0	1.5	0.3	M	M	0.7	0.07
Al	0.15	0.07	.07	.015	.03	0.15	0.15	.015	.015
Fe	1.5	.15	.2	.3	.5	.3	1.5	.15	.2
Mg	.02	1.5	M	M	M	.03	.07	7	M
Ca	.15	5	M	M	M	.1	.15	M	M
Na	0	0	0	0	0	0	0	.05	.05
Ti	.005	.001	.002	<.001	.0015	.015	.007	<.001	<.001
Mn	.03	.03	.02	.15	.02	.005	.03	.01	.05
B	0	0	0	0	0	0	0	0	0
Ba	.01	.002	.001	.0005	.0005	.007	.005	.0003	.0003
Ce	0	0	0	<.05	<.05	0	0	<.05	<.05
Cr	.0007	.0003	.0005	.0007	.0007	0	.0003	.0003	.0003
Cu	.002	.0015	.0015	.0007	.0007	.001	.0007	.0007	.0005
Mo	0	0	0	0	0	0	0	0	0
Ni	0	0	0	0	0	0	.0007	0	0
Pb	.01	.003	.003	.003	.01	.007	.005	.0015	.002
Sr	0	.002	.003	.003	.005	.003	.001	.003	.002
V	.005	.001	.0015	.002	.003	.001	.002	.001	.001
Zn	0	0	0	0	0	0	.07	0	0
Zr	0	0	0	0	0	0	0	0	0

Determinations by megascopic and microscopic examination

Y-64. Jasperoid, massive, mottled light-gray and red (5*R* 8/2 and 5*R* 6/2), vuggy. Two generations. Older is heterogeneous and xenomorphic and has a range in grain size of 0.005to0.2 mm; it contains sparse carbonate dust, abundant red-hematite dust, and, locally, abundant microvugs. It has been brecciated and cemented by a younger coarser relatively homogeneous quartz, which has an average grain size of 0.15 mm and forms prominent zonal overgrowths outlining pyramidal forms.

Y-65. Jasperoid, pinkish-gray (5*YR* 8/1); contains some carbonate; a few vugs. Equal amounts of jasperoid and dolomite. The dolomite is fine grained and contains local coarse grains and aggregates of coarse grains, all of which are very irregularly replaced by heterogeneous xenomorphic jasperoid. Veinlets of clean xenomorphic quartz, younger than the jasperoid, are cut by still younger veinlets of calcite.

Y-65A. Silicified dolomite; grayish orange pink (5*YR* 7/2) on weathered surface. Heterogeneous coarse- and fine-grained dolomite, partly replaced by coarse- and fine-grained xenomorphic quartz. The rock is brecciated and filled with younger clean coarse homogeneous xenomorphic quartz that contains numerous vugs.

Y-66. Dolomite, light-brownish-gray (5*YR* 6/1), bioclastic, fine- to medium-grained. Heterogeneous coarse- and fine-grained dolomite cut by thin irregular and discontinuous veinlets of heterogeneous xenomorphic quartz (avg grain size, 0.15 mm), which show incipient replacement along the walls. The dolomite between the veinlets also contains sparse disseminated interstitial quartz grains.

Y-67. Dolomite, grayish-orange-pink (5*YR* 7/2), very fine grained. Fine-grained homogeneous dolomite—locally contains coarse grains of dolomite and aggregates of coarse-grained dolomite and very sparse tiny interstitial grains of quartz.

Y-68. Jasperoid, mottled light-gray to very light gray (*N* 7–N 8), vuggy; light gray to pinkish gray (5*YR* 8/1) on weathered surface. Heterogeneous, medium grained, xenomorphic; contains carbonate dust inclusions, breccia fragments of older coarse xenomorphic quartz, and euhedral zonal overgrowths. It is cut by red hematite in irregular veinlets and is in irregular concentrations locally.

Y-69. Jasperoid, mottled medium-light-gray to blackish-red (*N* 6–5*R* 2/2), vuggy; light olive gray to blackish red (5*Y* 5/2–5*R* 2/2) on weathered surface. Similar to Y-68, but brecciation is more intense and rock contains more of the younger hematite; much is in large irregular opaque masses.

Y-70. Dolomite, pinkish-gray (5*YR* 8/1), fine- to medium-grained; grayish orange pink (5*YR* 7/2) on weathered surface. Fine- to medium-grained homogeneous dolomite containing very sparse tiny interstitial quartz grains which have been introduced and are not detrital.

Y-71. Dolomite. Same as Y-70.

as does titanium, except that titanium increases slightly at the contact. Manganese content remains virtually the same throughout the traverse, except where it unexplainedly increases in the dolomite within a foot of the contact. Chemical changes are shown by spectrographic analyses of the suite. (See table 4.)

Traverse 2 shows a much more abrupt transition across the contact into fresh wallrock than does traverse 1. The host dolomite adjacent to the contact lacks the brecciation and local recrystallization which characterizes that in traverse 1, nor does it contain abundant disseminated quartz. The jasperoid body sampled along traverse 2 is a small outlier of the one sampled along traverse 1, and it also differs from the larger mass by being long and narrow (figs. 3*D;* 6). A possible explanation for the observed differences in the contact zones may be that the silica-bearing solutions that formed the jasperoid in the small outlier welled up along an open fissure which contained a rubble of breccia fragments. The wallrock on either side of this fissure was not highly fractured and was relatively impermeable; hence, the alteration was largely concentrated in the rubble between the walls of the fissure.

The larger irregular body, sampled in traverse 1, may represent a zone, originally shattered by many small fractures, through which solutions seeped more slowly.

An estimate of the overall chemical changes brought about by the replacement of dolomite by jasperoid can be made by comparing the analyses of the two jasperoid samples taken farthest from the contact with the analyses of the two fresh dolomite samples taken farthest from the contact (table 4). Comparison indicates that, in addition to the silica, the jasperoid samples contain significantly larger amounts of aluminum, titanium, barium, and copper than do the dolomite samples. Cerium is the only element besides calcium and magnesium that is in consistently larger amounts in the dolomite samples. During the silicification process then, probably only the carbonate-forming cations were flushed out, so that many trace-element impurities in the dolomite remained in the replacing jasperoid, in substantially their original concentrations.

COMPARISON OF LAKE VALLEY JASPEROID SAMPLES WITH THOSE FROM NEARBY DISTRICTS

Jasperoid samples from six districts other than the Lake Valley district were collected, studied, and given scores. (See fig. 1.) Significant features and tabulated scores of these jasperoids are given in table 5.

TABLE 5.—*Significant features and tabulated scores of jasperoid samples from mining districts near Lake Valley*

[Numbers in parentheses (+2) indicate scores. Spectrographic analyses by J. C. Hamilton]

District	Sample [a]	Criteria: Megascopic examination	Criteria: Microscopic examination	Criteria: Spectrographic analyses	Total	Classification
Organ (Dona Ana County).	Y-46A	Vuggy (+2)	Size range >10 [b] (+2)	Mg 0.02 (−1) Cu .007 (+3)	+6	Possibly favorable.
Jose (Luna County)	Y-39	Moderate pink (5*R* 7/4)[c] (−1) Vuggy (+2)	Sericite (−1) "Jigsaw puzzle" texture (−2) Reticulated texture (+2)	Mg .3 (−2)	−2	Unfavorable.
Kingston (Sierra County)	Y-21		Size range >10 [b] (+2)	Mg .15 (−2)	0	Do.
Cooks Peak (Luna County).	Y-18A	Medium brown (5*YR* 3/4)[c] (+1) Vuggy (+2)	Reticulated texture (+2)	Mg .15 (−2) Pb .003 (+3) Zn .05 (+3)	+9	Possibly favorable.
	Y-18B	Medium brown (5*YR* 3/4)[c] (+1) Vuggy (+2)	do	Mg .15 (−2) Pb .005 (+3)	+6	Do.
	Y-19	Brown (5*YR* 4/4)[c] (+1) Vuggy (+2)	Montmorillonite (−1)	Mg .15 (−2)	0	Unfavorable.
Hillsboro (Sierra County)	Y-22A	Vuggy (+2)	Size range >10 [b] (+2) Yellow limonite (−1)	Mg .07 (−1) Pb .002 (+3)	+5	Possibly favorable.
	Y-22B	Moderate red (5*R* 5/4)[c] (−2) Vuggy (+2)		Mg .1 (−1) Cu .005 (+3) Pb .007 (+3) Zn .07 (+3)	+8	Do.
	Y-22C	Vuggy (+2)	Yellow limonite (−1)	Fe 3.0 (+2) Mg .05 (−1) Pb .003 (+3) Zn .1 (+3)	+8	Do.
Hadley (Luna County)	Y-6		do	Mg .02 (−1) Pb .0015 (+3)	+1	Probably unfavorable.
	Y-6A	Light brown (5*YR* 6/4)[c] (+1) Vuggy (+2)	do	Pb .002 (+3)	+5	Possibly favorable.
	Y-7B	Light brown (5*YR* 6/4)[c] (+1)	do "Jigsaw puzzle" texture (−2) Sericite (−1)	Fe 3.0 (+2) Mg .02 (−1) Cu .01 (+3) Pb .0015 (+3)	+4	Probably unfavorable.

Y-8B	Vuggy (+2)	"Jigsaw puzzle" texture (−2)		0	Unfavorable.
Y-9	Grayish pink (5R 8/2)[c] (−1) Vuggy (+2)	do	Mg .07 (−1) Cu .003 (+3) Pb .003 (+3)	+4	Probably unfavorable.
Y-10	Vuggy (+2)	do		0	Unfavorable.
Y-16A		do	Fe 2.0 (+2) Mg .1 (−1) Ag .0003 (+3) Cu .003 (+3) Pb .002 (+3)	+8	Possibly favorable.

[a] A, B, or C suffix denotes a variant of a sample.
[b] Ratio of largest quartz-grain diameter to smallest quartz-grain diameter >10.
[c] Rock colors are from the National Research Council "Rock-Color Chart" (Goddard and others, 1948).

SAMPLE LOCALITY

Y-46A. 1,600 ft east of U.S. Highway 70, sec. 2, T. 22 S., R. 3 E.
Y-39. Center NE¼ sec. 11, T. 20 S., R. 9 W.
Y-21. Between North and South Percha Creeks, 1 mile east of Kingston.
Y-18A. Near east end of Othello fault, SW¼NE¼ sec. 24, T. 20 S., R. 9 W.
Y-18B. Same as Y-18A.
Y-19. 500 ft north of Y-18A and Y-18B.
Y-22A. Top of fault scarp 1 mile east of Hillsboro.
Y-22B. Same as Y-22A.
Y-22C. Same as Y-22A and Y-22B.
Y-6. Near center sec. 32, T. 20 S., R. 8 W.
Y-6A. Same as Y-6.
Y-7B. Same as Y-6 and Y-6A.
Y-8B. Center south boundary sec. 32, T. 20 S., R. 8 W.
Y-9. Near SW. cor. sec. 32, T. 20 S., R. 8 W.
Y-10. Same as Y-9.
Y-16A. 1,000 ft north of center sec. 32, T. 20 S., R. 8 W.

Most samples were taken from jasperoid bodies that are not close to any known ore bodies. Only samples Y–18A and Y–18B, from the Cooks Peak district, represent jasperoid that is apparently related both spatially and genetically to sulfide ore. Both of these favorable samples from the Fusselman Dolomite are vuggy and contain anomalously high concentrations of lead—characteristics also of most jasperoid samples taken from the Fusselman Dolomite in the Lake Valley area, particularly those from the jasperoid body close to the Berenda fault.

The three samples taken from the large jasperoid body in Fusselman Dolomite along a strong north-trending fault a mile east of Hillsboro show anomalously high concentrations of lead and zinc. No ore deposits are known to be associated with this body, however.

The seven samples from the Hadley district were taken at intervals along a strong north-trending silicified zone in Tertiary volcanic rock. No mineral deposits have been discovered in this zone, although, locally, its small faults and fracture zones are enriched by manganese oxide.

The single random grab samples from each of the three remaining districts (Organ, Jose, and Kingston) were collected merely to check the possibility of some regional similarity in jasperoid bodies in southwestern New Mexico. No such similarity was apparent; accordingly, no particular significance can be ascribed to these single samples.

INTERPRETATION

Replacement of carbonate rocks by jasperoid in the Lake Valley district was controlled structurally by faults and fracture zones and stratigraphically by the contact of the Fusselman Dolomite with the overlying Percha Shale. Exposed jasperoid bodies in all the formations except the Fusselman Dolomite are concentrated near the Berenda fault, whereas large masses of jasperoid are present in the upper part of the Fusselman Dolomite more than a mile from this fault.

Carbonate host rocks were locally brecciated, shattered, and partially recrystallized before they were silicified. Several minor elements were brought in by silicifying solutions, and many others that were originally present in the carbonate rocks remained in the jasperoid. Only the carbonate-forming cations—calcium, magnesium, and cerium—were largely removed during silicification.

The widespread distribution of jasperoid bodies in the Fusselman Dolomite exposed in the fault block at Lake Valley can possibly be attributed to the fact that a 200-foot-thick section of Percha Shale originally overlay the Fusselman and formed a relatively impermeable barrier to the upward migration of silica-bearing solutions, forcing them to spread out and deposit their load in the Fusselman. This hypothesis is supported by the conclusions of Harley (1934, p. 177) and of Jicha (1954, p. 70) that the early mineralizing solutions in the Lake Valley district were rich in silica and comparatively poor in calcium carbonate, but that a reverse relationship existed in the later mineralizing solutions that carried the lead and silver, which formed the primary ore. Replacement of carbonate rock in the Fusselman Dolomite by jasperoid would contribute calcium carbonate to the upward-moving solutions and would thus provide a logical source for calcium carbonate in the late ore solutions that penetrated the Lake Valley Limestone in the main mining district. The presence of favorable jasperoid in the Fusselman Dolomite at some distance from the center of the mined area in the Lake Valley district suggests the possibility that primary sulfide-ore bodies of argentiferous lead and zinc formed in association with jasperoid in the Fusselman Dolomite beneath the Percha Shale near the Berenda fault. This zone is the host rock for sulfide-replacement ore bodies in the Cooks Peak district a few miles southwest of Lake Valley and in the Kingston district a few miles northwest of it. The two jasperoid bodies at a distance from the mined area in the district which yielded the most favorable jasperoid samples are both in the upper part of the Fusselman Dolomite.

Two locations seem most favorable for exploration in the Fusselman. One is at the Fusselman-Percha contact beneath the alluvium adjacent to the Berenda fault about midway between the jasperoid body (fig. 3*C*) and the road intersection about 1,500 feet southeast of the body (fig. 2). The other is in the same stratigraphic zone beneath the Grande group workings, close to the fault in the main district.

The first location has apparent potential as a possible area for prospecting because of three considerations:

1. It is close to the jasperoid body that yielded the samples with the highest scores.
2. Water moving through the alluvium along and near the buried Fusselman-Percha contact may have caused supergene enrichment of any ore bodies that existed in this area.
3. The contact is close to the surface at this point; hence, exploration would be relatively inexpensive.

The second location has apparent potential because of the known presence of ore bodies, in part contemporaneous with late calcite, in the overlying Lake Valley Limestone. Late calcite was probably brought upward in solution by hydrothermal fluids moving along the Berenda fault, and its most logical source is the Fusselman Dolomite.

If the Fusselman had been dissolved, it seems quite possible that the sulfides and silica were precipitated simultaneously.

CONCLUSIONS

Jasperoid bodies having favorable characteristics that suggest proximity to ore deposits are present in the Lake Valley district not only in the Lake Valley Limestone in the mined area but also in the Fusselman Dolomite near the Berenda fault in a hitherto unexplored area. This fact, together with the known presence of sulfide ore in the Fusselman Dolomite in nearby districts and the conclusion of Harley (1934, p. 177) that ore-stage solutions in the mined area were high in calcium carbonate, suggests the possible existence of sulfide-ore bodies in the Fusselman Dolomite beneath the Percha Shale and close to the Berenda fault.

Detailed examination and chemical analysis of samples taken along two traverses across the contact between jasperoid and dolomite show incipient silicification of the dolomite for several feet beyond the apparent contact. The elements aluminum, titanium, barium, and copper were probably introduced with silica during the replacement of dolomite by jasperoid; the carbonate-forming cations calcium, magnesium and cerium were probably the only ones expelled. Iron, manganese, chromium, lead, strontium, and vanadium, present as impurities in the dolomite, seem to have remained in the jasperoid in substantially their original concentrations.

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