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Arsenic and Gold Mineralization in the McFarland Canyon–Story Mine Area, Maricopa County, Arizona

by

S. P. Marsh

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Introduction

McFarland Canyon is an east-west trending drainage in the Tonto National Forest in the northeast corner of Maricopa County, Arizona, 8 km (5-1/2 mi) north of the small town of Sunflower, Arizona. The western half of McFarland Canyon lies within the Mazatzal Wilderness area and much of the area discussed in this report lies just west or astride the eastern boundary of the wilderness. Access to the area is via State Route 87 north from Phoenix and unimproved U.S. Forest Service and mining roads (fig. 1). The area is one of high relief ranging from 1340 m (4400 ft) to 1645 m (5400 ft) with deeply incised streams. The area is densely vegetated with scrub oak and brush; occassional stands of pine occur in the canyon bottoms.

The McFarland Canyon area lies just north of the Sunflower and Story mines and most likely can be considered as part of the Sunflower mining district. Reconnaissance geology and geochemistry of the Mazatzal Wilderness area defined an area of base and precious metal resources at the Story Mine (Wrucke and others, 1983). In September 1982 the reconnaissance work was extended northward 0.8 km (0.5 mi) from the Story mine and a detailed geochemical study of McFarland Canyon was undertaken. This report discusses the results of that study and proposes a model for the observed mineralization.

McFarland Canyon cuts through a sequence of metavolcanic and metasedimentary rocks belonging to the Alder Formation of Proterozoic X age. The Alder Formation is exposed in a tightly compressed syncline and comprises weakly to stongly foliated sandstone, graywacke, shale, conglomerate, rhyodacite and rhyolite tuffs and flows, and subordinate mafic volcanic rocks (Plate 1). These rocks have been metamorphosed to the greenschist facies of regional metamorphism and intruded by rhyolite porphyry dikes and sills. The Alder Formation has been faulted off to the north by a northeast trending major structure, the Sheep Mountain Fault (Fig. 1) This fault separates the Alder Formation from the Proterozoic Payson Granite, it's extrusive rhyolite, and the overlying Proterozoic X quartzites. Payson Granite outcrops approximately 2 km (1.3 mi) northwest of McFarland Canyon. The Payson Granite outcrops in over 100 sq km (39 sq mi) of the Mazatzal Wilderness, makes up almost the entire Hells Gate Roadless Area 12 km (8 mi) to the east and is thought to underlie much of this part of Arizona. Going southwards and upsection from McFarland Canyon to the Story mine the progression is gradational from fine-grained greenish to purplish tuffaceous meta-sediments with volcanic clasts, to a coarse-grained volcanoclastic graywacke, to tuffaceous metasediments (aw) at the Story mine. Rhyolite dikes (ip) have intruded the metasediments and trend northeast, roughly parallel to, but cross cutting, foliation (bedding). The sequence of geologic events in the McFarland Canyon area, based on field observations, were as follows: (1) deposition of the volcanic and volcanogenic rocks of the Alder Formation, (2) regional metamorphism and structural deformation, (3) intrusion of mineralized rhyolite dikes, (4) introduction of quartz-arsenopyrite veins, and (5) later possible remobilization of mineralization by Tertiary (?) heating.

About 4 days in the latter part of September 1982 were spent in a geochemical study of the area to assess the potential for gold mineralization. Rock samples from prospect pits and small mines were collected and analyzed to determine the metal suite associated with the observed mineralization. Samples of metasediments and rhyolite dikes also were analyzed to determine the extent of the mineralization and alteration. Table 1 gives a brief description of all rock samples discussed in this report.

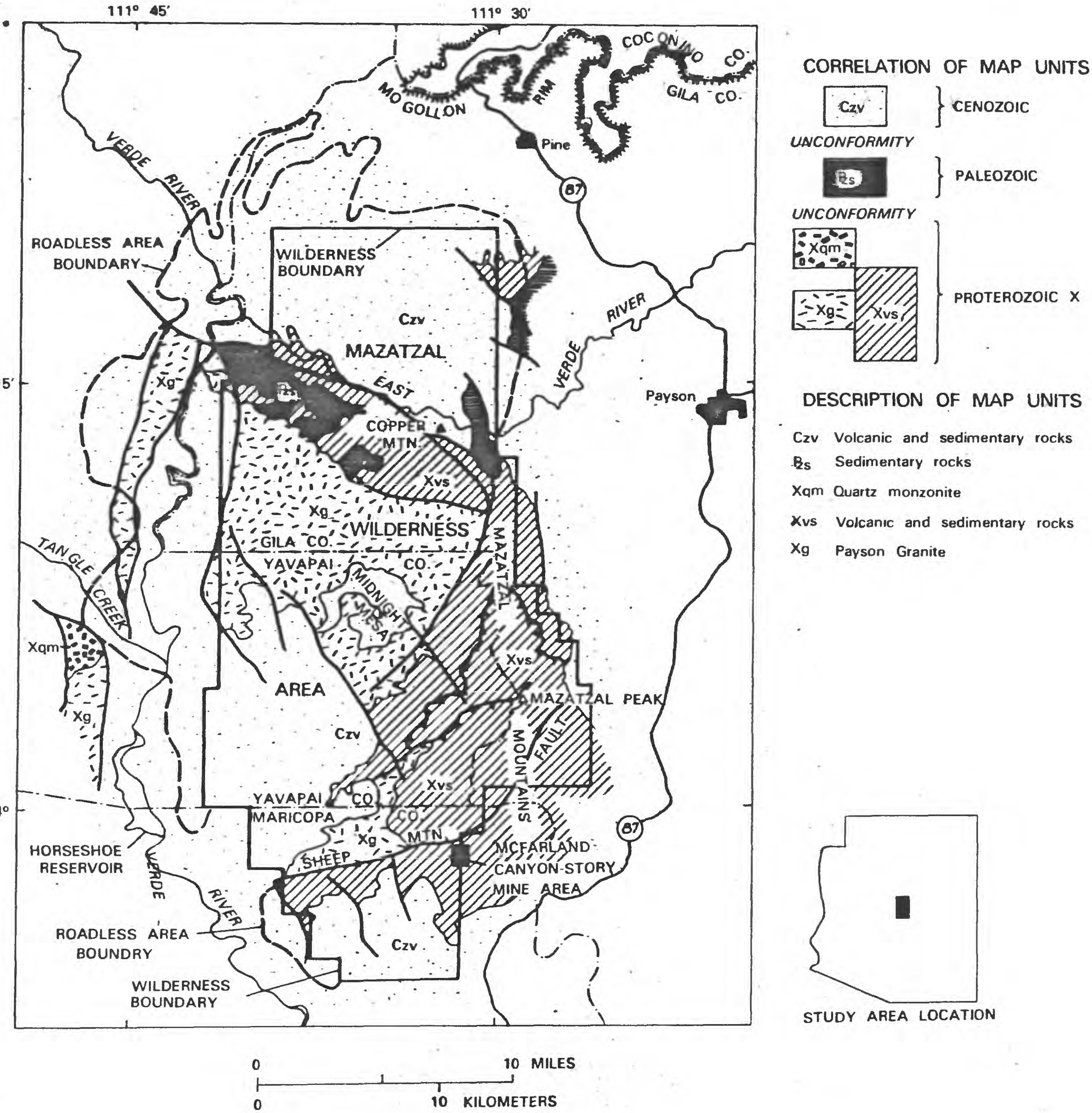

Figure 1. Map showing generalized geology of the Mazatzal Wilderness Area and the location of the McFarland Canyon-Story Mine area

Table 1.--Description of rock samples

Sample No.	Description
	McFarland Canyon-Story Mine Area
MZ495R	Altered metasediments with Fe oxides and scorodite ($FeAsO_4 \cdot 2H_2O$) from hanging wall
MZ495RA	Altered metasediments with Fe oxides and scorodite from foot wall
MZ495RB	Altered metasediments with Fe oxides and scorodite from foot wall
MZ495RC	Gossan from outcrop 50 m (150 ft) southwest from MZ495RB
MZ536R	Rhyolite from prospect; very altered with Fe oxide staining throughout; veinlets and masses of arsenopyrite.
MZ537R	Adit in McFarland Canyon; Fe oxide fracture fillings in rhyolite sill.
MZ537RA	Rhyolite pieces from dump; very altered, bleached with pyrite relics; some quartz eyes.
MZ538R	Clastic metasedimentary rock with abundant pyrite crystals and irregular masses throughout.
MZ538RA	Sample of rhyolite with abundant arsenopyrite.
MZ538RB	Relatively pure arsenopyrite from margin of vein.
MZ538RC	Vein approximately 14 cm wide; disseminated arsenopyrtie and some relic pyrite cubes.
MZ538RD	2 cm selvage on top side of vein that has mostly arsenopyrite and secondary arsenic minerals.
MZ538RE	Sedimentary rock, fine grained, very Fe oxide altered, greenish with visible pyrite and arsenopyrite.
MZ539R	Altered rhyolite with abundant limonite after pyrite and Fe oxides; some sericitic alteration.
MZ540R	Quartz vein with Fe oxides in cavities from Story mine area.
MZ540RA	Siliceous sulfide bearing vein at caved adit with abundant As and Fe oxides.
MZ541R	Large boule quartz vein, abundant cavities containing Fe oxides.
MZ542R	Gossan with sulfides and secondary arsenic minerals.
MZ543R	Rhyolite with Fe oxides, secondary copper stains, some disseminated arsenopyrite.
MZ543RA	Hard dense rhyolite, greenish with abundant disseminated arsenopyrite.
MZ544R	Siliceous green fine-grained metasediments with abundant pyrite.
MZ544RA	Quartz rich rock finely laminated with Fe oxides and secondary arsenic minerals (scorodite).
MZ544RB	Massive sulfide, arsenopyrite and pyrite.
MZ544RC	Quartz vein system with massive sulfides, both pyrite and arsenopyrite.

Table 1.--Description of rock samples--continued

Sample No.	Description
	McFarland Canyon-Story Mine Area
MZ545R	Hard dense ryholite with disseminated pyrite and arsenopyrite, Fe oxides on surface with fractures.
MZ546R	Rhyolite containing disseminated pyrite (mostly oxidized) and tiny veinlets of arsenopyrite.
MZ547R	Breccia zone with fragments of rhyolite in a black siliceous matrix with disseminated pyrite and arsenopyrite.
MZ547RA	Fracture filling with abundant Fe oxides and earthy material.
MZ548R	Metasediment with much disseminated pyrite and arsenopyrite in small veins.
MZ549R	Rhyolite with disseminated pyrite and arsenopyrite.
MZ549RA	Zone of sulfide bearing sediments; all altered to green secondary As minerals with some pyrite.
MZ549RB	Gossany material with sediments along foliation; Soft earthy red, yellow, and brown Fe oxides.
MZ550R	Sulfide bearing silicified sediments.
MZ550RA	Very siliceous vein material with abundant pyrite and arsenopyrite.
MZ550RB	Siliceous material with same character and perhaps more quartz as 350A.
MZ551R	Silicified breccia pieces in a fine grained black matrix that contains sulfides.
MZ552R	Silicified metasediments; sulfides present.
MZ553R	Altered slate-phyllite purple-red with abundant Fe oxides as secondary As minerals (scorodite)
MZ554R	Slate-phyllite; very altered with Fe oxides, pyrite relics and siliceous zones.
MZ554RA	4-cm thick quartz (red jasperoid) vein in slate phyllite.
MZ554RB	Red-to-yellow brown Fe oxide gossan with green yellow secondary As and grey sulfides in stringers and patches.
MZ555R	Jasperoid in silicified slate-phyllite.
MZ556R	Extremely silicified zone of green shale-phyllite that was pyrite bearing.
MZ557R	Quartz vein in slate-phyllite; vuggy with Fe oxides throughout and clots of chlorite.
MZ558R	Slate-phyllite totally altered and silicified; Sulfides have remobilized into stringers and patches of very fine grained black sulfides with brown FE oxides along margins.
MZ559R	Quartz veining in slate-phyllite.
MZ560	Red jasperoid, finely laminated with secondary As and Fe oxide stains; pyrite casts and zones of fine-grained black and green-black sulfides.
MZ561R	Fe stained material with quartz-carbonate veins and abundant carbonate throughout.

Table 1.--Description of rock samples--continued

Sample No.	Description
	McFarland Canyon-Story Mine Area
MZ562R	Quartz zone in greywacke with brown jasperoid, Mn(?) and fine grained chlorite, some relic pyrite along fractures.
MZ563R	Siliceous zone in dark fine-grained phyllitic material stained red and brown with Fe oxides.
MZ564R	Altered zone in phyllitic material; all Fe oxide stained with pyrite relics and casts throughout; silicified.
MZ564RA	Bands and lenses of red jasper, black fine-grained siliceous zones and yellow and brown Fe oxides, some relic pyrite.
MZ564RB	Quartz vein with gossan and cinnabar as small blebs associated with quartz veins; some evidence of As and secondary yellow-green stains.
MZ564RC	Schist with abundant silica and disseminated sulfides, mostly pyrite; pyrite is all fresh.
MZ565R	Quartz-chlorite vein with Fe oxides in black siliceous country rock.
	Mazatzal Wilderness Area
MZ442R	Arsenopyrite from Stingy Lady mine
MZ442RA	Arsenopyrite from Stingy Lady mine
MZ442RB	Arsenopyrite from Stingy Lady mine
MZ442RC	Scorodite from Stingy Lady mine
MZ442RD	Scorodite from Stingy Lady mine
MZ442RI	Scorodite from Stingy Lady mine
MZ454RB	Green and yellow secondary minerals (scorodite) from shear zone
MZ476RI	Arsenopyrite from shear zone
	Hells Gate Roadless Area
HG091RA	Arsenopyrite and secondary copper minerals.
MZ491RA	Altered metasediments with sericite and scorodite.

Geochemistry

Samples taken in this study were of two types—obviously mineralized rocks and selected rock types occurring in the area.

An examination of the chemical data (see Appendix) revealed a distinctive geochemical suite common to all mineralized areas seen in this study. This suite is one that has been recognized in samples from mineralized areas in other parts of the Mazatzal Wilderness area. Our data also indicates that the suite is most likely related to the intrusion of the Payson Granite. The suite consists of major amounts of arsenic, copper, lead, and antimony in varying proportions depending on the mineralogy of the sample, significant amounts of gold, silver, mercury, bismuth, zinc, and tellurium, and associated boron, beryllium, tin, and cadmium. The sulfide minerals observed in these areas are arsenopyrite, tetrahedrite, and tenantite, sometimes together, but, commonly as a single mineral species. The geochemical suite, however, is always present in the rocks of mineralized areas. In McFarland Canyon arsenopyrite was the observed sulfide mineral.

Genesis

Initial field observations suggested a possible volcanogenic origin for the mineralization. The host rocks offer a compelling argument for a volcanogenic model; a sequence of volcanic and volcanoclastic sediments with rhyolite dikes and sills. Also, approximately 0.8 km (0.5 mi) southeast of the Story mine, up section, lies a banded iron formation several hundred meters (feet) thick (ac). However, the volcanogenic model becomes less convincing upon close scrutiny. The rhyolite dikes are mineralized in the area of the Story mine and the central part of McFarland Canyon but are barren to the northeast. The dikes clearly postdate metamorphism and structural deformation of the Alder formation. They are not foliated themselves and cut across foliation (bedding) of the country rocks. Zones of brecciation occur at their margins. To further test the volcanogenic model, several samples of the banded iron formation were analyzed to see if it was mineralized as would be anticipated in a volcanogenic model. No mineralization was detected with the exception of mercury and, more significantly, no trace was found of the geochemical suite that occurs in the mineralized areas. It was also noted that there seemed to be two stages of sulfide mineralization in the McFarland Canyon area. The first stage was pyrite that is disseminated in and is temporally related to the intrusion of the rhyolite dikes and, in general, does not contain the favorable geochemical suite. The second stage was arsenopyrite in quartz veins. These veins cut the rhyolite dikes and the foliation (bedding) of the country rocks at low angles. If the mineralization is of volcanogenic origin, then somewhere near the center of the mineralized zone we would expect to find a breccia pipe or some fractured zone indicating venting of the system; none was found. We would expect to find mineralization in the banded iron formation as noted above, but none was found. Most of the arsenopyrite occurs in quartz veins and none of it is considered to be massive sulfide (the most massive arsenopyrite seen was in one area of quartz veining where a 10 cm (4 in.) thick vein was observed). This series of observations leads to the conclusion that the mineralization in McFarland Canyon is not volcanogenic, is younger than the country rocks, and must be related to some later mineralizing event.

Several interesting observations about the mineralization at McFarland Canyon can be made from the analyses of the rock samples (Appendix). The arsenic content is consistently high. Many samples contain arsenopyrite, but most samples without visible arsenopyrite also contain anomalously high amounts of arsenic. The lowest arsenic value obtained was 70 ppm (parts per million) in two samples; one of pyrite bearing volcanoclastic metasediment with no visible arsenopyrite (MZ538R) and one of altered rhyolite with oxidized pyrite and minor arsenopyrite (MZ546R). The rest of the values for arsenic ranged from 150 ppm to greater than 1%. High arsenic values were also found in samples from the Story mine 0.8 km (0.5 mi) to the south and in rock samples from many of the mineralized areas of the Proterozoic Payson Granite and surrounding Proterozoic metasediments during the study of the Mazatzal Wilderness (S. Marsh, unpub. data). The presence of arsenic is often manifested by greenish-yellow stains and coatings of the iron arsenate, scorodite. Arsenopyrite veins contain the highest gold values found in the McFarland Canyon area and Table 2 compares samples from McFarland Canyon with those from the Story mine and from the nearby Mazatzal Wilderness and Hells Gate Roadless Area. These samples exhibit the geochemical suite found in all mineralized areas examined.

Often high arsenic and gold values were detected in the oxidized environment where no primary sulfides were found but where secondary minerals were abundant. These areas of secondary mineralization commonly are near or adjacent to areas of sulfide-bearing rocks and they also contain arsenic, copper, lead, and antimony. The Story mine area is an example of this type of secondary arsenic mineralization. The mine workings are inaccessible, but it can be assumed that sulfides were encountered at depth. Analyses of secondary arsenic mineralization from the Story mine, McFarland Canyon, areas in the Mazatzal Wilderness and from areas just south of the Hells Gate Roadless Area (Table 3) show that gold is often more abundant in these samples than in the unoxidized sulfide samples. Gold was not visible in any of the samples.

Upon even the most casual observation, alteration and oxidation is obvious in the McFarland Canyon-Story mine area. The rocks of the area appear leached and bleached especially in and near the areas of the rhyolite dikes. This is more pervasive around the Story mine than in McFarland Canyon and is reflected in the mineralization seen. Most sulfide mineralization around the Story mine has been oxidized while most sulfide mineralization in McFarland Canyon remains unoxidized. In many places in the McFarland Canyon-Story mine area the original pyrite in the system has weathered to iron oxides, leaving relic pyrite as hematite or limonite. Often only cubic casts are left in the bleached metasediments, sometimes filled with earthy iron oxides. Sericitic alteration in the rhyolite dikes was noted at several localities. In addition to the sericitic alteration, the whole McFarland Canyon-Story mine area has undergone extreme silicification. Quartz veins and indications of quartz veining are seen everywhere. The hilltop above the Story mine contains a vertically dipping zone of silicified metasediments 3 to 5 m (10-15 ft) wide that strikes N. 50° E. for approximately 100 m (300 ft). This zone, although totally silicified, still retains much of the metasedimentary features as bedding, volcanic clasts, and pyrite casts. Quartz veins and stringers cut this unit in every direction and range from several millimeters to several centimeters (0.2 to 1.0 in.) wide. Intense chloritization of the metasediments is common in areas of silicification. Jasperoid is also common in the area of the Story mine as red and red-brown zones and bands with yellow and yellow-brown iron oxides on fractures.

The quartz veins in the McFarland Canyon-Story mine area range from discrete veins to pods and stringers. Some are sulfide bearing, vuggy, and "eaten out" appearing where the sulfides have been removed. Chloritized metasedimentary rock fragments have been caught up in the veins near the Story mine. Some fragments are further altered to earthy dark-brown iron oxides and finally the quartz veins and pods are left with voids as the iron oxides weather away. All stages of this process can be seen in the area of the mine.

The silicification in the McFarland Canyon-Story mine area extends for as much as several kilometers (miles). Silicified rocks were observed as far as 3 km (2 mi) to the south where a sample (MZ565R, Tables 1 and 6) contained traces of the geochemical suite related to the mineralization at the McFarland Canyon-Story mine area.

Table 2.--Atomic absorption analyses of arsenopyrite bearing samples from McFarland Canyon, from the Story mine, from selected areas in the Mazatzal Wilderness Area, and from an area south of the Hells Gate Roadless Area, Maricopa, Gila, and Yavapai Counties, Arizona

[All values reported in parts per million. See Table 1 for description of samples. (The following qualifiers are used in reporting the data: N, not detected at the limit of determination; <, detected, but below the limit of reproducible determination for the standards used; >1, present at greater than 1 percent and exceeded the detection limits of the method of analysis; and, ( ), interference in analysis.)]

Sample	Te	Au	Ag	Hg	Bi	Pb	Cu	Zn	Sb	Cd
McFarland Canyon										
MZ536R	0.9	0.2	0.6	0.12	N	10	60	20	N	0.2
538RB	17.0	7.0	>1	4.6	470	>1	>1	>1	>1	56
538RC	11.0	0.3	9	0.02	1,000	>1	290	80	300	2.7
538RD	16.0	3.9	31	0.16	680	>1	650	450	450	7.3
544RB	0.9	17.0	>1	0.5	350	>1	>1	250	>1	12
Story Mine										
MZ540RA	<0.1	2.8	>1	1.6	N	>1	290	500	180	10
554RB	24.0	13.0	>1	1.2	190	>1	470	140	110	11
Mazatzal Wilderness Area										
MZ442R	(9.3)	0.05	435	38.0	1600	3,000	69,000	2,400	>1	90
442RA	1.3	0.1	135	0.2	680	8,300	5,400	400	>1	25
442RB	(5.5)	0.1	575	90.0	4,300	30,000	77,000	7,800	>1	170
476RI	1.0	0.6	3	(2.0)	440	180	500	60	5,200	2
Hells Gate Roadless Area										
HG091RA	1.5	4.9	6	890	70	240	>1	400	5,800	49

Table 3.--Atomic absorption analysis of secondary arsenic mineralization in rocks from McFarland Canyon, the Story mine, from selected areas in the Mazatzal Wilderness Area, and from an area south of the Hells Gate Roadless Area, Maricopa, Gila, and Yavapai Counties, Arizona

[All values reported in parts per million. See Table 1 for description of samples. (The following qualifiers are used in reporting the data: N, not detected at the limit of determination; <, detected, but below the limit of reproducible determination for the standards used; >1, present at greater than 1 percent and exceeded the detection limits of the method of analysis; and, ( ), interference in analysis.)]

Sample	Te	Au	Ag	Hg	Bi	Pb	Cu	Zn	Sb	Cd	As
McFarland Canyon											
MZ544RA	2.7	0.25	12	0.42	120	170	75	60	200	1.3	300
547RA	0.7	0.4	0.8	0.40	4	320	70	350	210	2.2	>1
549RA	0.2	2.0	3.6	0.40	20	20	230	70	130	0.1	1,100
Story Mine											
MZ495R	1.1	2.25	85	2.5	1	3,300	290	860	1,400	34.4	>1
495RA	0.8	4.9	176	2.0	1	3,300	1,700	710	1,200	264	>1
495RB	1.2	<0.05	74	1.3	N	890	710	21,000	400	10.6	1,600
495RC	1.5	7.1	216	14.0	N	7,000	200	930	600	324	>1
553R	0.6	8.0	>1	4.0	2	>1	1,000	>1	>1	76	>1
554R	0.4	1.5	>1	0.55	<2	>1	100	1,000	>1	59	>1
Mazatzal Wilderness Area											
MZ442RC	(9.4)	0.15	790	13.0	2,200	6,500	38,000	950	>1	20	>1
442RD	(7.5)	0.05	450	50.0	1,300	4,700	58,000	2,100	>1	60	>1
442RI	(10.0)	0.10	460	24.0	730	4,900	27,000	900	>1	25	>1
454RB	2.5	0.25	>1	0.6	>1	>1	>1	320	>1	>1	>1
Hells Gate Roadless Area											
MZ491RA	0.3	N	12.8	0.9	140	17,000	65	300	48	2.35	>1

Table 4.--Atomic Absorption analysis of pyrite bearing rhyolite and metasediment rock samples from McFarland Canyon, Maricopa County, Arizona

[All values reported in parts per million. See Table 1 for description of samples. (The following qualifiers are used in reporting the data: N, not detected at the limit of determination; <, detected, but below the limit of reproducable determination for the standards used.]

Sample	Te	Au	Ag	Hg	Bi	Pb	Cu	Zn	Sb	Cd	As
					Rhyolite						
MZ539R	0.1	N	0.1	0.08	N	5	15	5	2	0.1	300
546R	<0.1	N	0.1	0.04	N	10	20	15	2	N	70
					Metasediment						
MZ538R	N	N	N	<0.02	N	<5	30	110	3	0.2	70
544R	0.1	N	0.2	0.02	N	5	55	150	18	1.1	130

Analysis of rock samples with pyrite being the only observed sulfide do not exhibit many indications of the geochemical suite associated with the arsenopyrite mineralization. Analyses of two samples of the rhyolite dikes and two samples of the meta-volcanoclastic sediments that appear to contain only pyrite showed no detectable gold and very little arsenic (Table 4). The absence of the geochemical suite associated with the gold and arsenopyrite suggests that the pyrite probably belongs to a separate mineralizing event, possibly associated with the intrusion of the rhyolite dikes. In the study of the Mazatzal Wilderness area pyrite mineralization was not commonly observed; where observed it was generally barren of the trace elements found in the mineralized areas in the Payson Granite. This also seems true in the McFarland Canyon-Story mine area.

The combination of field observations and chemical analyses of rock samples suggest another model for the mineralization seen at the McFarland Canyon-Story mine area. This model is related to the emplacement of the Proterozoic Payson Granite. Geochemical studies done during the study of the Mazatzal Wilderness indicate that the Payson Granite is a tin granite and a late hydrothermal event was part of its emplacement history. This late hydrothermal phase included the deposition of complex copper-silver sulfosalts and arsenopyrite containing antimony, lead, gold, mercury, bismuth, and tellurium; the same geochemical suite found in the McFarland Canyon-Story mine area. This suite is common to all mineralized areas found in the Payson Granite, thus it seems logical to assume that the arsenopyrite-gold mineralization seen in the McFarland Canyon-Story mine area is also related to the late hydrothermal event in the Payson Granite. Several other observations support this model. Arsenic is also the most abundant trace element in the mineralized areas observed in the Payson Granite, commonly in the form of arsenopyrite veins and as secondary scorodite. Table 2 shows the similarity of trace element content of arsenopyrite samples from mineralized areas in the Payson Granite and arsenopyrite samples from the McFarland Canyon-Story mine area. Table 3 shows this same relationship in samples of secondary mineralization from these areas. There are also structural similarities. Mineralization in the Payson Granite occurs along northeast trending structures that, for the most part, contain quartz veining; a similar situation exists in the McFarland Canyon-Story mine area. Also, mineralization related to the Payson Granite in the Mazatzal Wilderness and south of the Hells Gate Roadless Areas often extends out into the surrounding metasediments along the northeast-trending structures. The Sheep Mountain fault, less than 2 km north of the McFarland Canyon-Story mine area, is a major northeast-trending structure, that cuts the Payson Granite. Mineralized areas near the fault contain the diagnostic geochemical suite.

Two other elements related to arsenic-gold mineralization are bismuth and boron. Bismuth occurs in virtually all the arsenopyrite samples collected during this study and in arsenopyrite samples collected during the study of the Mazatzal Wilderness Area (Table 2). Bismuth is commonly found in sulfides related to tin granites (Taylor, 1979) and its presence here provides another tie between the Payson Granite mineralization and that observed at the McFarland Canyon-Story mine area. Boron was also common in samples from both areas. In areas of mineralization in and around the Payson Granite, tourmaline was observed as veinlets, large clots and rosettes, and as fracture and surface coatings. Although no tourmaline was observed in the McFarland Canyon-Story mine area, twelve of the mineralized samples contained 0.2 % or greater boron. In this geologic environment tourmaline is the only boron mineral that would be expected and it is assumed that it is present. Another element common to all these areas is mercury. Mercury occurs in amounts of as much as 90 ppm in complex copper sulfides found in mineralized zones in the Payson Granite, occurs in anomalous amounts in almost all of the samples taken in this study, and occurs as cinnabar in the Sunflower mining district, adjacent to the McFarland Canyon-Story mine area. This cinnabar mineralization, although occuring in the Proterozoic X rocks of the Alder Formation, is not thought to be Proterozoic in age. More likely the mercury mineralization is the result of mercury being distilled from earlier deposited complex polymetallic sulfides and redeposited as cinnabar. Support for this concept is found in the fact that mercurian copper sulfides occur in the lower levels of the Ord mercury mine about 10 km (7 mi) east of McFarland Canyon (J. N. Faick, 1959). This suggests that the cinnabar found in the Sunflower mining district, although Tertiary (?) in age, had its origins in the late hydrothermal phase of the Payson Granite.

Conclusions

Based on field observations and chemical data from this study and on data from the study of the Mazatzal Wilderness Area, the mineralization seen in the McFarland Canyon-Story mine area is thought to be related to a late hydrothermal phase of the Proterozoic Payson Granite. The geochemical suite of arsenic, copper, lead, and antimony with gold, silver, mercury, bismuth, and tellurium, associated with mineralization in the McFarland Canyon-Story mine area is the same elemental suite that occurs in mineralized areas in and adjacent to the Payson Granite. Similar structural trends and extensive silicification and quartz veining are common to both areas. The Payson Granite is exposed within a few kilometers (miles) to the north and east of McFarland Canyon and is thought to be in the subsurface in the McFarland Canyon area. To test this model, detailed chemistry of the rhyolite dikes to establish their relationship, if any, to the Payson Granite and alteration studies to establish the relationship of the mineralization in McFarland Canyon to mineralization at the Story mine are needed. The influence of the Sheep Mountain fault on the mineralizing system is also unknown.

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Appendix

A total of 69 rock samples were collected from the McFarland-Story mine area and analyzed. For each sample, a representative hand specimen was reserved and the remainder crushed. An 85 g (3 oz) container of the crushed material was pulverized, and reserved for analysis. The remaining crushed bulk sample was placed in storage. The pulverized sample was analyzed by spectrographic and atomic absorption techniques.

Spectrographic results were obtained by visual comparison of spectra derived from the sample against spectra obtained from standards. The matrix of the standards is made from pure oxides or carbonates. Trace elements are added to the matrix so that the concentrations are geometrically spaced over any given order of magnitude, thus the range of concentrations normally found in naturally occurring samples are bracketted. When comparisons are made with sample films for semiquantitative use, reported values are rounded to 100, 50, 20, 10, and so forth. Those samples whose concentrations are estimated to fall between the above values are arbitrarily given values of 70, 30, 15, 7, and so forth (Grimes and Marranzino, 1968). The precision of the method is approximately plus or minus one reporting unit at the 83 percent confidence level and plus or minus two reporting units at the 96 percent confidence level (Motooka and Grimes, 1976). Values determined for the major elements (magnesium, calcium, iron, and titanium) are given in weight percent; all others are given in parts per million (micrograms/gram). Atomic absorption analysis for cadmium, bismuth, antimony, zinc, arsenic, mercury, gold, copper, silver, lead, and tellurium were performed on each sample. Table 5 lists all elements determined, lower limits of detection and references for methods of analysis. Results from both spectrographic and atomic absorption analyses are given in Table 6. Sample localities are shown in Plate 1.

Table 5.--Elements determined, lower limits of detection, and references for methods of analysis for rock samples from the McFarland Canyon-Story mine area, Mazatzal Wilderness Area, and Hells Gate Roadless Area, Arizona

[pct (percent), ppm (parts per million)]

Column Designation	Lower Limit of Detection Rock	Reference
D.C. arc/spectrographic analysis by E. F. Cooley, C. Forn, and M. S. Erickson		
Fe-pct	0.05	Grimes and Marranzino (1968)
Mg-pct	0.02	-------------Do------------
Ca-pct	0.05	-------------Do------------
Ti-pct	0.002	-------------Do------------
Mn-ppm	10	-------------Do------------
Ag-ppm	0.50	-------------Do------------
As-ppm	200	-------------Do------------
Au-ppm	10	-------------Do------------
B-ppm	10	-------------Do------------
Ba-ppm	20	-------------Do------------
Be-ppm	1	-------------Do------------
Bi-ppm	10	-------------Do------------
Cd-ppm	20	-------------Do------------
Co-ppm	5	-------------Do------------
Cr-ppm	10	-------------Do------------
Cu-ppm	5	-------------Do------------
La-ppm	20	-------------Do------------
Mo-ppm	5	-------------Do------------
Nb-ppm	20	-------------Do------------
Ni-ppm	5	-------------Do------------
Pb-ppm	10	-------------Do------------
Sb-ppm	100	-------------Do------------
Sn-ppm	10	-------------Do------------
Sr-ppm	100	-------------Do------------
V-ppm	10	-------------Do------------
W-ppm	50	-------------Do------------
Y-ppm	10	-------------Do------------
Zn-ppm	200	-------------Do------------
Th-ppm	100	-------------Do------------
Atomic Absorption Spectrometry Cu, Pb, Zn, Ag, Cd, and Bi determined by R. M. O'Leary, T. Roemer, B. Arbogast, R. Leinz, and J. Grey; Au determined by S. Royse and J. Grey; Hg instrument determination by R. M. O'Leary; Te determined by T. Roemer, B. Arbogast		
Cu-ppm	5	modified from Viets (1978)
Pb-ppm	5	------------Do------------
Zn-ppm	5	------------Do------------
Ag-ppm	0.05	------------Do------------
Cd-ppm	0.1	------------Do------------
Bi-ppm	2	------------Do------------
As-ppm	5	------------Do------------
Sb-ppm	1	------------Do------------
Au-ppm	0.05	Thompson and others (1968)
Hg-ppm	0.02	modified from Vaughn & McCarthy (1964)
Te-ppm	0.1	Chao and others (1978)
Colorimetric Arsenic determined by B. Arbogast		
As-ppm	10	Ward and others (1963)

Table 6--Spectrographic and atomic absorption analyses of rock samples from McFarland Canyon, from the Story mine, from selected areas in the Mazatzal Wilderness, and from an area south of the Hell's Gate Roadless Area, Maricopa, Gila, and Yavapai Counties, Arizona

[The following qualifies are used in reporting spectrographic data: N, not detected at the limit of determination; < detected, but below the limit of reproducible determination for the standards used; >, elements present at a concentration greater than the upper calibration limit; and ( ), interference in analysis. The qualifiers used in reporting atomic absorption data was > 1 or --, elements present at greater than 1 percent and exceeded the detection limits of the method of analysis]

McFarland Canyon-Story Mine

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Mn-ppm s	Ti-pct. s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
MZ495R	33 57 38	111 30 19	20.00	.07	.05	.100	70	50.0	>10,000	N	200	70
MZ495RA	33 57 38	111 30 19	3.00	<.02	.07	.050	30	50.0	>10,000	N	100	20
MZ495RB	33 57 38	111 30 19	10.00	.70	.10	.500	>5,000	50.0	2,000	N	30	1,000
MZ495RC	33 57 38	111 30 19	20.00	.05	.10	.100	500	100.0	>10,000	N	100	200
MZ536R	33 58 7	111 30 22	5.0	.50	<.05	.700	200	1.5	>10,000	N	100	700
MZ537R	33 58 9	111 30 26	3.0	.20	<.05	<.002	70	3.0	1,000	N	150	500
MZ537RA	33 58 9	111 30 26	10.0	.05	.05	<.002	70	5.0	10,000	N	100	200
MZ538R	33 58 12	111 30 18	7.0	2.00	.50	.500	300	N	N	N	100	500
MZ538RA	33 58 13	111 30 17	2.0	.20	<.05	<.002	>5,000	7.0	5,000	N	100	500
MZ538RB	33 58 13	111 30 17	10.0	.20	<.05	.100	200	150.0	>10,000	10	>2,000	100
MZ538RC	33 58 13	111 30 17	1.0	.05	.10	<.002	1,000	5.0	>10,000	N	50	<20
MZ538RD	33 58 13	111 30 17	15.0	.20	<.05	.100	500	30.0	>10,000	N	500	200
MZ538RE	33 58 13	111 30 17	10.0	.50	<.05	.100	300	30.0	>10,000	N	1,000	300
MZ539R	33 58 3	111 30 17	1.0	.30	.05	.100	500	N	300	N	150	500
MZ540R	33 57 42	111 30 15	.2	.05	<.05	<.002	300	N	200	N	10	<20
MZ540RA	33 57 54	111 30 16	5.0	.50	<.05	.300	500	150.0	10,000	N	>2,000	200
MZ541R	33 57 49	111 30 11	.2	.05	<.05	.015	200	2.0	N	N	50	70
MZ542R	33 58 9	111 30 17	10.0	.70	.07	.500	700	2.0	10,000	N	>2,000	500
MZ543R	33 58 11	111 30 21	1.0	.07	<.05	<.002	500	N	700	N	150	200
MZ543RA	33 58 11	111 30 21	2.0	.05	.05	<.002	1,000	3.0	5,000	N	200	300
MZ544R	33 58 16	111 30 7	5.0	1.00	.50	.500	150	N	N	N	100	300
MZ544RA	33 58 16	111 30 7	2.0	.50	.07	.200	100	15.0	500	N	500	200
MZ544RB	33 58 16	111 30 7	20.0	<.02	<.05	.005	150	200.0	>10,000	15	<10	50
MZ544RC	33 58 14	111 30 7	5.0	.20	<.05	.030	100	5.0	>10,000	N	2,000	<20
MZ545R	33 58 10	111 30 0	5.0	.10	<.05	.050	70	10.0	700	N	150	300
MZ546R	33 58 10	111 30 0	2.0	.50	.10	.200	70	N	N	N	150	700
MZ547R	33 58 10	111 30 0	5.0	.70	.05	.100	200	N	3,000	N	2,000	200
MZ547RA	33 58 10	111 30 0	10.0	.20	<.05	.100	70	2.0	>10,000	N	500	500
MZ548R	33 58 8	111 29 58	7.0	.70	<.05	.700	70	2.0	1,000	N	2,000	500
MZ549R	33 58 14	111 29 52	2.0	.30	.05	.200	70	1.5	5,000	N	200	500
MZ549RA	33 58 14	111 29 52	20.0	.70	<.05	.200	1,000	5.0	1,500	N	<10	100
MZ549RB	33 58 14	111 29 52	7.0	.70	.20	.500	70	N	2,000	N	200	700
MZ550R	33 58 18	111 29 53	5.0	1.00	.50	.300	500	10.0	500	N	100	70
MZ550RA	33 58 18	111 29 53	7.0	.50	.10	.070	150	150.0	>10,000	N	>2,000	50
MZ550RB	33 58 18	111 29 53	10.0	.10	<.05	.020	50	10.0	>10,000	10	1,000	150
MZ551R	33 58 17	111 29 57	2.0	.50	.10	.070	300	10.0	1,000	N	700	150
MZ552R	33 58 15	111 29 58	5.0	.50	.20	.300	200	70.0	2,000	N	2,000	300
MZ553R	33 57 49	111 30 16	15.0	.50	.10	.200	>5,000	500.0	>10,000	10	>2,000	200
MZ554R	33 57 43	111 30 20	10.0	.50	1.00	.300	1,000	70.0	>10,000	N	500	1,000

Table 3 Continued

McFarland Canyon-Story Mine

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s
MZ495R	<1.0	<10	100	5	300	500	N	15	N	20	>20,000	3,000	10
MZ495RA	<1.0	N	[illegible]	5	300	1,000	N	7	N	20	20,000	1,500	10
MZ495RB	1.5	N	100	50	2,000	700	50	5	N	70	3,000	700	15
MZ495RC	N	N	300	<5	300	500	30	N	30	<5	>20,000	2,000	10
MZ536R	2.0	N	N	5	N	100	50	N	<20	<5	50	N	20
MZ537R	3.0	N	N	N	N	100	<20	N	<20	<5	50	200	N
MZ537RA	2.0	10	N	N	N	5	<20	N	<20	<5	70	200	N
MZ538R	1.5	N	N	70	150	50	50	N	<20	50	15	<100	30
MZ538RA	2.0	<10	N	<5	N	300	<20	N	<20	<5	50	200	N
MZ538RB	2.0	200	50	5	20	5,000	<20	N	<20	15	10,000	3,000	5
MZ538RC	<1.0	500	N	N	N	200	<20	N	<20	<5	500	500	10
MZ538RD	1.0	300	N	10	30	1,000	<20	20	<20	10	2,000	700	10
MZ538RE	2.0	200	N	15	50	1,000	30	<5	<20	30	2,000	700	N
MZ539R	2.0	N	N	N	N	20	20	N	<20	<5	50	N	7
MZ540R	N	N	N	N	N	<5	<20	N	<20	<5	10	N	5
MZ540RA	N	N	N	<5	1,000	500	20	<5	<20	10	20,000	N	10
MZ541R	<1.0	N	N	N	N	5	<20	N	<20	N	100	N	10
MZ542R	3.0	70	N	N	50	70	50	N	<20	7	500	N	10
MZ543R	2.0	N	N	N	N	50	<20	N	<20	<5	100	N	10
MZ543RA	3.0	20	N	N	N	500	<20	N	<20	<5	50	200	50
MZ544R	1.0	N	N	5	200	100	50	N	<20	100	30	N	<5
MZ544RA	1.0	200	N	<5	70	70	20	N	<20	5	500	300	N
MZ544RB	N	200	N	N	N	2,000	<20	N	<20	<5	20,000	1,500	N
MZ544RC	2.0	100	N	<5	N	100	<20	N	<20	7	1,000	200	N
MZ545R	2.0	50	N	<5	N	700	<20	N	<20	<5	150	500	N
MZ546R	1.5	N	N	<5	N	50	100	N	<20	<5	70	N	N
MZ547R	5.0	N	N	N	N	15	<20	N	<20	<5	50	N	N
MZ547RA	3.0	<10	N	N	N	150	70	N	<20	<5	1,000	300	20
MZ548R	2.0	30	N	<5	70	<5	<20	N	<20	<5	150	<100	<5
MZ549R	2.0	N	N	N	N	50	30	N	<20	<5	100	<100	N
MZ549RA	1.5	20	N	50	20	500	30	N	<20	50	50	200	30
MZ549RB	2.0	N	N	50	150	100	50	N	<20	70	30	<100	N
MZ550R	2.0	10	30	10	N	700	20	N	<20	10	500	150	10
MZ550RA	5.0	1,000	N	10	N	500	20	N	<20	10	5,000	200	5
MZ550RB	1.0	100	N	15	N	70	20	N	<20	10	500	<100	N
MZ551R	2.0	70	N	5	20	500	20	N	<20	10	100	<100	N
MZ552R	2.0	>1,000	N	20	500	700	30	5	<20	10	2,000	500	20
MZ553R	2.0	N	200	20	30	1,500	30	N	<20	100	>20,000	10,000	20
MZ554R	2.0	N	150	5	N	200	100	N	<20	7	20,000	5,000	20

Table 3 continued

McFarland Canyon-Story Mine

Sample	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	Au-ppm aa	Hg-ppm inst	Te-ppm aa	Cu-ppm aa	Pb-ppm aa
MZ495R	<10	200	100	N	<10	5,000	20	N	2.25	2.50	1.1	290	3,300
MZ495RA	N	150	50	N	N	1,500	10	N	4.90	2.00	.8	1,700	3,300
MZ495RB	30	100	150	N	20	>10,000	50	N	<.05	1.30	1.2	710	890
MZ495RC	<10	300	70	N	15	7,000	30	N	7.10	14.00	1.5	200	7,000
MZ536R	N	<100	50	<50	30	N	300	N	.20	.12	.9	60.0	10
MZ537R	N	N	<10	N	20	200	50	N	.05	.60	.5	95.0	15
MZ537RA	N	N	10	N	20	N	20	N	.40	.30	14.0	60.0	50
MZ538R	N	200	100	N	20	N	100	N	N	<.02	N	30.0	<5
MZ538RA	20	N	N	N	20	N	70	N	.10	.40	.7	170.0	15
MZ538RB	N	100	50	N	10	5,000	100	N	7.00	4.60	17.0	>1.0	>1
MZ538RC	N	N	<10	N	N	200	N	N	.30	.02	11.0	290.0	>1
MZ538RD	N	N	50	N	20	500	30	N	3.90	.16	16.0	650.0	>1
MZ538RE	10	<100	70	N	20	500	200	N	3.30	.08	6.8	620.0	>1
MZ539R	N	300	15	N	10	N	100	N	N	.08	.1	15.0	5
MZ540R	N	N	10	N	N	N	N	N	N	<.02	N	5.0	5
MZ540RA	70	100	70	N	N	1,000	50	N	2.80	1.60	<.1	290.0	3
MZ541R	N	N	10	N	N	<200	N	N	N	.02	<1.0	15.0	>1
MZ542R	70	1,000	100	N	50	<200	200	N	1.20	.50	13.0	45.0	160
MZ543R	N	100	<10	N	50	N	150	N	N	.04	.2	80.0	45
MZ543RA	10	N	<10	N	50	N	100	N	.15	.14	.7	300.0	10
MZ544R	N	N	100	N	30	N	200	N	N	.02	.1	55.0	5
MZ544RA	N	100	70	N	10	<200	100	N	.25	.42	2.7	75.0	170
MZ544RB	N	N	<10	N	N	700	N	N	17.00	.50	.9	>1.0	>1
MZ544RC	N	N	20	N	<10	<200	10	N	.70	.02	5.5	120.0	>1
MZ545R	20	<100	<10	N	100	N	300	N	.15	.34	1.4	540.0	15
MZ546R	N	N	20	N	10	N	200	N	N	.04	<.1	20.0	10
MZ547R	20	1,000	20	N	10	<200	150	N	.15	.04	.1	5.0	20
MZ547RA	20	100	20	N	<10	500	200	N	.40	.40	.7	70.0	320
MZ548R	150	<100	20	N	50	N	300	N	.25	.04	1.1	<.5	55
MZ549R	10	<100	20	N	10	N	200	N	.70	.40	.3	25.0	35
MZ549RA	N	N	50	N	10	N	50	N	2.00	.40	.2	230.0	20
MZ549RB	N	N	300	N	50	<200	100	N	.05	.10	N	100.0	20
MZ550R	10	100	70	N	10	1,000	200	N	2.20	.65	N	170.0	210
MZ550RA	N	500	50	N	N	200	20	N	4.70	.20	7.3	220.0	>1
MZ550RB	N	200	15	N	N	<200	10	N	11.00	.08	1.4	40.0	180
MZ551R	N	N	20	N	10	<200	30	N	1.20	.14	.6	370.0	75
MZ552R	30	100	100	<50	30	200	150	N	1.20	1.50	50.0	390.0	>1
MZ553R	70	500	100	N	20	10,000	100	N	8.00	4.00	.6	1,000.0	>1
MZ554R	30	1,500	100	N	30	1,500	200	N	1.50	.55	.4	100.0	>1

Table 3 Continued

McFarland Canyon-Story Mine

Sample	Zn-ppm aa	Ag-ppm aa	Cd-ppm aa	Bi-ppm aa	Sb-ppm aa	As-ppm aa	Sn-ppm aa
MZ495R	860	85.00	34.40	1	1,400	--	N
MZ495RA	710	176.00	264.00	1	1,200	--	N
MZ495RB	21,000	74.00	10.60	N	400	1,600	N
MZ495RC	930	216.00	324.00	N	600	--	N
MZ536R	20	.60	.20	N	N	--	
MZ537R	30	1.60	.10	2	100	800	
MZ537RA	45	4.50	1.10	16	180	--	
MZ538R	110	N	.20	N	3	70	
MZ538RA	10	4.60	.10	4	60	--	
MZ538RB	>1	>1.00	56.00	470	>1	>1	
MZ538RC	80	9.00	2.70	1,000	300	>1	
MZ538RD	450	31.00	7.30	680	450	>1	
MZ538RE	250	25.00	5.50	260	300	>1	
MZ539R	5	.10	.10	N	2	300	
MZ540R	5	.05	.60	N	<1	200	
MZ540RA	500	.0	10.00	N	180	>1	
MZ541R	70	1.00	.20	N	4	150	
MZ542R	90	1.80	.70	30	21	>1	
MZ543R	10	.30	.20	N	6	400	
MZ543RA	5	1.30	.10	6	40	>1	
MZ544R	150	.20	1.10	N	18	130	
MZ544RA	60	12.00	1.30	120	200	300	
MZ544RB	250	>1.00	12.00	350	>1	>1	
MZ544RC	35	52.00	3.70	90	100	>1	
MZ545R	20	3.50	.20	12	230	300	
MZ546R	15	.10	N	N	2	70	
MZ547R	25	.10	.10	N	4	>1	
MZ547RA	350	.80	2.20	4	210	>1	
MZ548R	5	1.10	N	12	5	300	
MZ549R	15	.75	.10	N	22	>1	
MZ549RA	70	3.60	.10	20	130	1,100	
MZ549RB	95	.35	.30	N	22	330	
MZ550R	320	3.40	13.00	4	58	>1	
MZ550RA	110	47.00	2.80	1,000	95	>1	
MZ550RB	20	5.30	.50	58	22	>1	
MZ551R	25	5.00	.20	42	5	200	
MZ552R	90	27.00	2.30	>1	120	1,000	
MZ553R	>1	>1.00	76.00	2	>1	>1	
MZ554R	1,000	>1.00	59.00	<2	>1	>1	

Table 3 continued

McFarland Canyon-Story Mine

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s
MZ554RA	1.0	N	N	<5	10	50	20	N	<20	7	100	100	5
MZ554RB	1.5	200	N	N	N	700	20	N	<20	N	10,000	700	10
MZ555R	N	N	N	N	N	20	<20	N	<20	10	100	<100	N
MZ556R	1.0	N	N	N	N	5	<20	N	<20	7	30	N	5
MZ557R	1.0	N	N	N	N	50	<20	N	<20	7	30	<100	<5
MZ558R	1.5	N	N	N	N	20	50	10	<20	5	5,000	1,000	20
MZ559R	<1.0	N	N	N	N	<5	<20	N	<20	5	<10	N	N
MZ560R	1.0	N	>500	N	N	1,600	<20	N	<20	5	>20,000	5,000	10
MZ561R	<1.0	N	N	50	1,500	100	<20	N	<20	500	200	700	30
MZ562R	N	N	N	<5	10	7	<20	N	<20	<5	30	N	N
MZ563R	N	N	N	<5	N	10	<20	N	<20	<5	10	N	N
MZ564R	<1.0	N	N	20	500	150	<20	N	<20	10	20	N	30
MZ564RA	N	N	N	20	<10	50	<20	N	<20	15	10	N	5
MZ564RB	N	N	N	20	<10	50	<20	N	<20	20	50	100	30
MZ564RC	<1.0	N	N	15	<10	70	<20	N	<20	20	20	N	10
MZ565R	1.5	N	N	10	N	50	<20	5	<20	10	10	N	5

Mazatzal Wilderness Area

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s
MZ442R	1.0	200	50	10	N	>20,000	30	5	70	<5	5,000	2,000	N
MZ442RA	2.0	500	100	<5	N	>20,000	70	15	<20	<5	5,000	2,000	N
MZ442RB	1.5	500	300	10	N	>20,000	30	20	50	<5	20,000	>10,000	N
MZ442RC	1.0	>1,000	50	N	N	>20,000	20	20	50	<5	7,000	5,000	N
MZ442RD	2.0	1,000	100	N	N	>20,000	50	20	20	<5	7,000	5,000	N
MZ442RI	1.0	1,000	50	5	N	>20,000	20	20	50	<5	5,000	10,000	N
MZ454RB	<1.0	>1,000	200	20	30	>20,000	20	10	N	15	10,000	5,000	<5
MZ476RI	<1.0	1,000	N	5	50	700	50	10	50	5	200	7,000	5

Hells Gate Roadless Area

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s
HG091RA	1.5	100	300	30	N	>20,000	N	20	N	7	1,000	10,000	<5
MZ491RA	5.0	150	N	N	N	70	100	15	70	15	>20,000	N	<5

Table 3 continued

McFarland Canyon-Story Mine

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
MZ554RA	33 57 43	111 30 20	5.0	.20	.15	.020	5,000	100.0	200	N	50	100
MZ554RB	33 57 43	111 30 20	15.0	.10	.10	.100	2,000	70.0	>10,000	15	1,500	500
MZ555R	33 57 41	111 30 22	2.0	.10	.07	.010	2,000	200.0	3,000	N	30	200
MZ556R	33 57 45	111 30 21	1.0	.20	.07	.100	100	N	<200	N	300	200
MZ557R	33 57 44	111 30 25	1.0	.10	.07	20	1,000	300.0	<200	N	200	200
MZ558R	33 57 47	111 30 27	3.0	.50	.05	.500	200	50.0	1,000	N	>2,000	200
MZ559R	33 57 35	111 30 33	.2	.02	<.05	<.002	200	N	N	N	20	<20
MZ560R	33 57 32	111 30 40	10.0	.20	.70	.050	100	70.0	>10,000	N	2,000	100
MZ561R	33 57 30	111 30 38	7.0	1.00	20.00	.500	>5,000	<.5	2,000	N	100	300
MZ562R	33 57 28	111 30 42	7.0	.10	.20	.005	>5,000	N	<200	N	50	50
MZ563R	33 56 58	111 30 28	1.0	.10	.05	.002	500	N	N	N	10	50
MZ564R	33 57 3	111 30 8	5.0	.10	.07	.300	700	N	700	N	500	300
MZ564RA	33 57 3	111 30 8	5.0	.15	1.50	.020	1,000	N	N	N	1,000	100
MZ564RB	33 57 5	111 30 8	10.0	.10	.10	.100	1,500	N	<200	N	100	200
MZ564RC	33 57 5	111 30 8	7.0	.05	.10	.200	100	N	1,000	N	50	200
MZ565R	33 56 18	111 30 24	2.0	.50	<.05	.015	100	1.0	N	N	>2,000	20

Mazatzal Wilderness Area

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
MZ442R	34 8 27	111 31 47	20.00	1.00	.07	<.002	<10	200.0	>10,000	N	70	200
MZ442RA	34 8 27	111 31 47	10.00	.30	<.05	.005	150	500.0	>10,000	N	30	3,000
MZ442RB	34 8 27	111 31 47	20.00	.70	.07	<.002	150	1,000.0	>10,000	N	50	2,000
MZ442RC	34 8 27	111 31 47	15.00	<.02	.05	<.002	<10	1,000.0	>10,000	N	50	200
MZ442RD	34 8 27	111 31 47	15.00	<.02	<.05	.015	200	500.0	>10,000	N	30	5,000
MZ442RI	34 8 27	111 31 47	20.00	<.02	.05	.005	50	1,000.0	>10,000	N	100	3,000
MZ454RB	34 12 41	111 33 19	20.00	.15	3.00	.070	100	300.0	>10,000	N	30	300
MZ476RI	34 12 41	111 33 13	20.00	<.02	.30	.200	<10	20.0	>10,000	N	200	<20

Hells Gate Roadless Area

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
HG091RA	34 3 18	111 12 16	2.0	3.00	10.00	.050	2,000	150.0	>10,000	10	10	300
MZ491RA	34 15 50	111 11 10	5.0	0.15	<0.05	.20	500	10.0	>10,000	N	30	150

Table 3 Continued

McFarland Canyon-Story Mine

Sample	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	Au-ppm aa	Hg-ppm inst	Te-ppm aa	Cu-ppm aa	Pb-ppm aa
MZ554RA	N	100	50	N	10	500	20	N	N	.12	.1	15.0	35
MZ554RB	N	500	50	N	20	500	100	N	13.00	1.20	24.0	470.0	>1
MZ555R	N	N	10	N	<10	500	N	N	.10	.15	.2	5.0	50
MZ556R	N	N	15	N	10	200	50	N	N	<.02	N	<5.0	<5
MZ557R	N	N	15	N	N	<200	20	N	.10	.18	.2	45.0	15
MZ558R	N	100	70	N	20	200	200	N	1.30	3.00	<.1	10.0	>1
MZ559R	N	N	N	N	N	<200	N	N	N	.10	N	<5.0	10
MZ560R	N	300	70	N	10	10,000	20	N	1.30	>10.00	.1	480.0	>1
MZ561R	N	700	200	N	50	<200	50	N	<.05	.24	N	50.0	10
MZ562R	N	200	10	N	N	<200	N	N	N	.12	<.1	<5.0	10
MZ563R	N	N	20	N	N	N	N	N	N	.60	<.1	5.0	5
MZ564R	N	200	200	N	20	<200	70	N	N	>10.00	<.1	85.0	5
MZ564RA	N	N	200	N	N	<200	20	N	N	1.00	N	20.0	<5
MZ564RB	N	N	200	N	10	300	<10	N	N	>10.00	N	25.0	30
MZ564RC	N	N	100	N	10	<200	30	N	N	>10.00	N	3.5.0	5
MZ565R	N	N	50	N	10	500	10	N	<.05	.22	1.0	60.0	5

Mazatzal Wilderness Area

Sample	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	Au-ppm aa	Hg-ppm inst	Te-ppm aa	Cu-ppm aa	Pb-ppm aa
MZ442R	50	N	<10	N	N	1,000	10	N	.05	38.00	(9.3)	69,000	3,000
MZ442RA	300	200	50	N	10	3,000	30	<100	.10	.20	1.3	5,400	8,300
MZ442RB	>1,000	<100	10	N	N	10,000	<10	N	.10	90.00	(5.5)	77,000	30,000
MZ442RC	200	<100	10	N	<10	1,000	30	N	.15	13.00	(9.4)	38,000	6,500
MZ442RD	300	150	15	<50	20	5,000	<10	200	.05	50.00	(7.5)	58,000	4,700
MZ442RI	150	N	15	N	<10	2,000	20	100	.10	24.00	(10.0)	27,000	4,900
MZ454RB	1,000	1,500	100	N	15	1,000	30	N	.25	.60	2.5	--	--
MZ476RI	70	N	50	N	15	200	70	N	.60	(2.00)	1.0	500	180

Hells Gate Roadless Area

Sample	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	Au-ppm aa	Hg-ppm inst	Te-ppm aa	Cu-ppm aa	Pb-ppm aa
HG091RA	N	200	30	N	15	>10,000	50	N	4.90	--	1.5	--	240
MZ491RA	100	150	10	N	50	700	500	N	N	.90	.3	65	17,000

Table 3 continued

McFarland Canyon-Story Mine

Sample	Zn-ppm aa	Ag-ppm aa	Cd-ppm aa	Bi-ppm aa	Sb-ppm aa	As ppm aa	Sn-ppm aa
MZ554RA	130	>1.00	.05	N	6	>1	
MZ554RB	140	>1.00	11.00	190	110	>1	
MZ555R	130	>1.00	.80	<2	3	>1	
MZ556R	40	.05	.10	N	2	120	
MZ557R	40	>1.00	.20	N	10	60	
MZ558R	40	>1.00	3.90	1	400	400	
MZ559R	5	.10	N	N	1	50	
MZ560R	>1	>1.00	>1.00	N	>1	>1	
MZ561R	85	.10	.30	N	5	1,100	
MZ562R	5	.10	.10	N	1	150	
MZ563R	N	.05	.10	N	N	140	
MZ564R	25	.05	N	N	10	400	
MZ564RA	15	.05	N	N	N	140	
MZ564RB	95	.10	N	N	N	180	
MZ564RC	<5	.10	N	N	5	200	
MZ565R	90	.15	N	N	7	50	

Mazatzal Wilderness Area

Sample	Zn-ppm aa	Ag-ppm aa	Cd-ppm aa	Bi-ppm aa	Sb-ppm aa	As ppm aa	Sn-ppm aa
MZ442R	2,400	435.00	90.00	1,600	--	--	450
MZ442RA	400	135.00	25.00	680	--	--	36
MZ442RB	7,800	575.00	170.00	4,300	--	--	--
MZ442RC	950	790.00	20.00	2,200	--	--	35
MZ442RD	2,100	450.00	60.00	1,300	--	--	53
MZ442RI	900	460.00	25.00	730	--	--	19
MZ454RB	320	--	--	--	--	--	800
MZ476RI	60	3.00	2.00	440	5,200	--	55

Hells Gate Roadless Area

Sample	Zn-ppm aa	Ag-ppm aa	Cd-ppm aa	Bi-ppm aa	Sb-ppm aa	As ppm aa	Sn-ppm aa
HG0913A	400	6.00	49.00	70	5,800	--	390
MZ491RA	300	12.80	2.35	140	48	--	8