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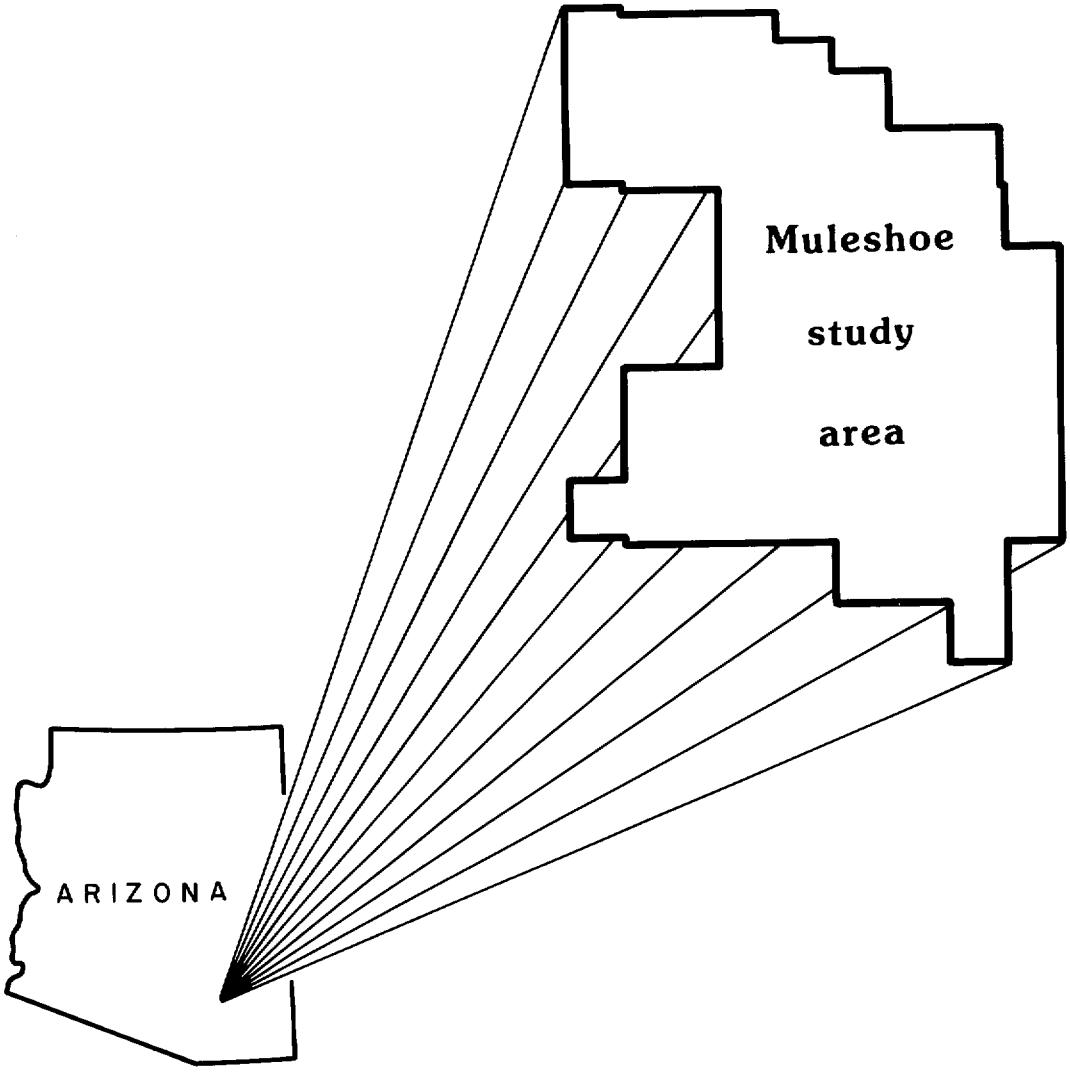
Mineral Investigation of the Muleshoe study area, Cochise and Graham Counties, Arizona



BUREAU OF MINES
UNITED STATES DEPARTMENT OF THE INTERIOR

MINERAL INVESTIGATION OF THE MULESHOE STUDY AREA, COCHISE AND GRAHAM COUNTIES, ARIZONA

by

Russell A. Schreiner

MLA 43-88
1988

Intermountain Field Operations Center
Denver, Colorado

UNITED STATES DEPARTMENT OF THE INTERIOR
Donald P. Hodel, Secretary

BUREAU OF MINES
T S Ary, Director

This open-file report summarizes the results of a Bureau of Mines mineral study requested by the Bureau of Land Management. The report is preliminary and has not been edited or reviewed for conformity with the Bureau of Mines editorial standards. This study was conducted by personnel from the Resource Evaluation Branch, Intermountain Field Operations Center, P.O. Box 25086, Denver Federal Center, Denver, CO 80225.

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

°C	degree celsius
ft	foot
in.	inch
mi	mile
ppb	part per billion
ppm	part per million
%	percent
lb	pound
oz	troy ounce
oz/st	troy ounce per short ton

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Russell A. Schreiner, Bureau of Mines

SUMMARY

In February and March 1988, at the request of the Bureau of Land Management, the Bureau of Mines conducted a mineral investigation of the Muleshoe study area comprising approximately 60,000 acres in Cochise and Graham Counties, Arizona. Bureau personnel mapped and sampled mines, prospects, and mineralized zones to appraise identified mineral resources and conducted a reconnaissance sediment survey to identify areas favorable for resources.

The study area lies at the southern end of the northwest-trending Galiuro Mountains and consists of Cretaceous- to Tertiary-age volcanic and sedimentary rock units. There has been no mineral production from the area and it is not in any organized mining district.

Occurrences of base and precious metals in vein/fault type deposits were identified at the Now prospects in the study area and within 1/4 mi of the southern and northern boundaries of the study area in Teran Basin and Jackson Cabin areas, respectively. Anomalous metal concentrations were present in stream-sediment samples from Redfield Canyon in the north-central part of the study area and Teran Basin within 1 mi of the southern boundary. Two areas, the Now prospects and part of Redfield Canyon, warrant additional exploration in the Muleshoe study area.

The Now prospects and vicinity is considered to be favorable for resources of copper and silver. Although no resources were identified, additional silver-bearing tetrahedrite mineralization is inferred at depth in

extensions of fault zones. Increases in size and grade of the mineralization at depth are conjectural, but the possibility exists. A detailed field examination of the area, including additional sampling and trenching, would be necessary to determine the extent and nature of the mineralization.

The geochemical anomaly in Redfield Canyon appears to be associated with a mineral occurrence or deposit, and the area around the anomaly is considered favorable for the occurrence of gold, arsenic, copper, and molybdenum. No occurrences or resources of these metals were identified in outcrop in the area. A detailed field examination, including additional sampling, would be necessary to identify possible mineralization in this area.

Sand and gravel occurs in the canyons in the study area but the inaccessibility of the area and the abundance of sand and gravel throughout the region would preclude anything but local use.

The U.S. Geological Survey has rated the petroleum potential of the study area as low.

The Arizona State Bureau of Geology and Mineral Technology has rated the area surrounding Warm Springs and Hookers Hot Springs in the southeastern part of the study area favorable for low temperature geothermal resources.

INTRODUCTION

The Muleshoe study area is one of two tracts of land in the Galiuro Mountains acquired in 1986 by the U.S. Bureau of Land Management (BLM) in a land exchange with the Arizona State Land Department. The Muleshoe study area comprises 60,000 acres in Cochise and Graham Counties, Arizona, administered by the BLM Safford district office. In February and March of 1988, the Bureau of Mines conducted a mineral investigation to provide current data on mines, prospects, and mineralized areas to appraise identified mineral resources and

areas favorable for resources in the study area to aid in developing a resource management plan for the Safford district.

Geographic setting

The Muleshoe study area is 25 mi west of Willcox and 28 mi north of Benson, Arizona, (fig. 1) at the southern end of the northwest trending Galiuro Mountains in the Basin and Range physiographic province. The topography consists of mountainous terrain dissected by east-west trending canyons. Elevation ranges from 3,400 ft in the bottom of the canyons along the western boundary to 6,200 ft along the ridgeline near the northeastern boundary. The study area lies along the southwestern boundary of the Coronado National Forest, within 1/4 mi of the Galiuro Wilderness Area. It includes private inholdings, the majority of which are owned by the Nature Conservancy and managed out of the Muleshoe Ranch at Hookers Hot Springs. Access to the study area is by unimproved roads from the San Pedro River Road and from the Muleshoe Ranch.

Method of investigation

Published and unpublished literature relating to the study area was reviewed to obtain pertinent information concerning mineral occurrences and mining activity. Mining claim locations and land status plats were acquired from the BLM state office in Phoenix, Arizona. Information on issued prospecting permits and oil and gas leases was provided by the Arizona State Land Department, Phoenix, Arizona.

Two geologists spent twelve days mapping and sampling prospects and mineralized areas by compass- and-tape method, and conducting a reconnaissance geochemical survey. Twelve rock chip, one grab, and forty-two stream-sediment samples were taken.

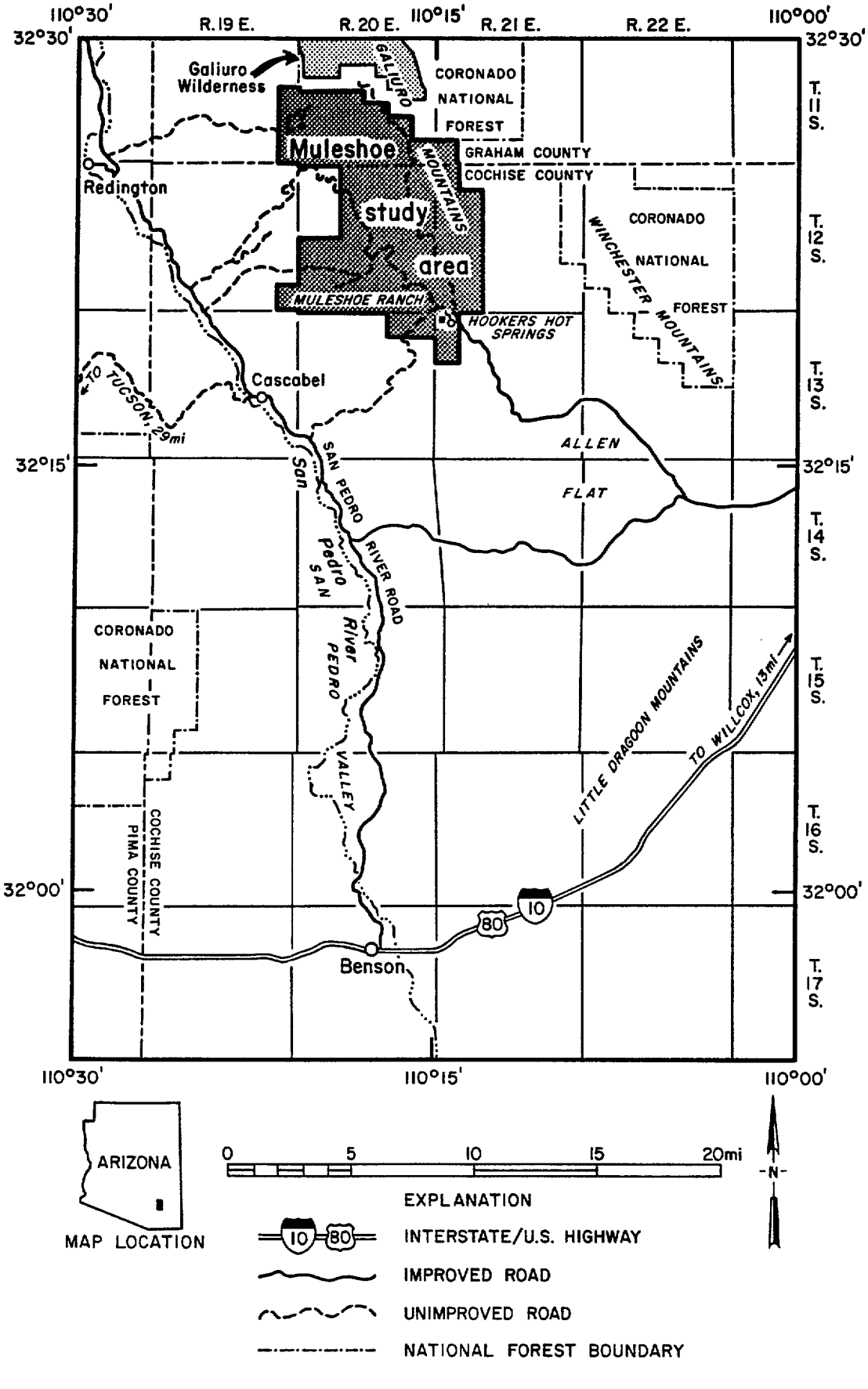

Figure 1.--Index map of the Muleshoe study area, Cochise and Graham Counties, Arizona.

Analytical determinations were made by Bondar-Clegg, Inc., Lakewood, Colorado. All samples were analyzed for gold by fire assay-atomic absorption spectroscopy and for an additional thirty-one elements by direct-coupled plasma emission spectroscopy, using a multiacid total digestion. Samples containing metal concentrations over the upper detection limits were then re-analyzed for silver by fire assay, for copper by atomic absorption spectroscopy, for barium by X-ray fluorescence and for arsenic and antimony by titrametric method.

In addition to the analytical determinations, a polished section and a polished thin section of vein material, and thin sections of altered host rocks at the Now prospects were examined under a petrographic microscope. Identification of metallic minerals was then verified by microprobe analysis by Peter Modreski, U.S. Geological Survey, Denver, CO.

Previous investigations

Reconnaissance geologic maps of the study area have been published by Creasey and others (1961) and Creasey and Krieger (1978). Creasey and others (1981) evaluated the mineral potential of the Galiuro Wilderness Area, and their evaluation and geologic mapping at a scale of 1:62,500 included the northern part of the Muleshoe study area. Detailed mapping at a scale of 1:24,000 of the Cretaceous sedimentary and volcanic rocks in the southern part of the study area was completed by Goodlin (1985) and Mark (1985). In the northern part of the study area, detailed mapping of the Tertiary Galiuro volcanics is currently in progress by John Quinby (unpublished Masters Thesis, California State University at Hayward, California).

GEOLOGIC SETTING

The study area consists of exposed Cretaceous- and Tertiary-age volcanic and sedimentary rock units of the Willow Canyon Formation, Muleshoe volcanics,

Cascabel Formation, Galiuro volcanics, and the Quiburis Formation (pl. 1). The geology and structure as described below is taken from Goodlin (1985), Mark (1985), and Creasey and others (1981).

Cretaceous rocks crop out in the southwestern part of the study area, where the overlying Galiuro volcanics have been eroded away. The Willow Canyon Formation of the Bisbee Group, is the oldest formation exposed in the study area, consists of interbedded green-gray to brown-red quartzose conglomerate, sandstone, and siltstone and red and green mudstone and shale. The Willow Canyon Formation is overlain unconformably by the Muleshoe volcanics, a heterogenous group of purple andesite breccias with less abundant rhyolite breccia, tuff, lahar deposits, mudstone, sandstone, and conglomerate. The Muleshoe volcanics are overlain conformably by the Cascabel Formation, consisting of red-brown to red-gray indurated conglomerate, sandstone, siltstone, and mudstone with clasts derived from the Muleshoe volcanics and the Bisbee Group.

The middle Tertiary Galiuro volcanics are made up of andesite, dacite, latite, and rhyolite flows, rhyolite and latite welded tuffs, and conglomerate. This series lies unconformably on the older Cretaceous formations, covering the northern half of the study area and extending in a narrow strip down to the southern boundary in the eastern part of the study area.

The upper Tertiary Quiburis Formation is the youngest rock unit and lies unconformably on all other units. It consists primarily of poorly consolidated conglomerate with clasts derived primarily from the Galiuro volcanics. The formation is exposed all along the southeastern boundary and on Soza Mesa in the southwestern part of the study area.

The area is structurally complex and has undergone four major deformational events; early Cretaceous rifting, late Cretaceous to early Tertiary Laramide compression, middle Tertiary extension, and late Tertiary basin and range faulting.

MINING HISTORY

The Muleshoe study area is not within any organized mining district and there has been no mineral production. Two claims, the Now #1 and #2 in the NE. 1/4 sec. 22, T. 12 S., R. 20 E., (referred to in this report as the Now prospects) abandoned in 1985, and an application for a state prospecting permit in 1968 in the same area (sec. 15 and 22, T. 12 S., R. 20 E.) are the only records of any activity in the study area. Most of the activity in the Galiuro Mountains has been in the Copper Creek (Bunker Hill) and Rattlesnake mining districts 20 mi and 6 mi north of the study area, respectively. These mining districts have no known relationship to the Muleshoe study area and are presented here to inform the reader of the general character of mineral deposits that have been exploited in the past in the Galiuro Mountain Range.

In the Copper Creek district, the first ore was shipped in 1863 but quantitative production records are available only from 1905 to 1975. During this time the district had production of 27,300,000 lb copper, 5,770,000 lb lead, 4,150,000 lb molybdenum, 190,000 oz silver and 1,000 oz gold (Keith and others, 1983, p. 20) from breccia pipes and veins associated with the Laramide-age Copper Creek porphyry copper system, which is 2,000 ft below the surface.

From 1908 to 1940 the Rattlesnake district had production of 12,203 lb copper, 2,310 oz silver and 163 oz gold (Creasey and others, 1981, p. 34).

The production came from Miocene-age or younger vein-type deposits principally from the Gold Mountain, Powers, and Long Tom Mines.

The Jackson Mine, 2 mi north of the study area, consists of a shaft reported to be 300 to 400 ft deep. No recorded production is known; if anything was produced, it was probably assigned to the Rattlesnake district. The Jackson Mine is on a silicified fault zone between andesite flows and ash flow tuffs. The fault zone strikes N. 20° W., dips 60° SW., and contains copper, gold, silver, and minor zinc, arsenic and antimony. (See Creasey and others, 1981.) Several small workings have been cut along this fault zone on shows of mineralized rock from the Jackson Mine toward the study area. A small pit containing chrysocolla, azurite, and malachite within 1/4 mi of the study area is the southernmost extension of visible mineralization along this fault.

GEOTHERMAL

Two thermal springs occur on and near the Muleshoe Ranch in the southeastern part of the study area (pl. 1). Hookers Hot Springs and Warm Springs have temperatures of 52°C and 33°C, respectively. Although no geothermal leases have been issued, the area surrounding these thermal springs was considered favorable for the development of low temperature (lower than 100°C) geothermal resources (Witcher and others, 1982).

OIL AND GAS

As of June 1988, no leases were present and no holes have been drilled for oil and gas in the study area. In the late 1970's, oil and gas leases issued to Anschutz Corporation covered all of the study area. The leasing of large tracts of land was related to Anschutz's overthrust concept, which was based on the idea that the Cordilleran Overthrust belt extends through Arizona

connecting the Idaho-Wyoming-Utah Fold/Thrust Belt and the Chihuahua Fold/Thrust Belt both of which have large petroleum reserves (Keith, 1979). Ryder (1983) rated the hydrocarbon potential as low to zero in this area due to rifting and volcanism.

APPRAISAL OF SITES EXAMINED

Occurrences of base and precious metals in vein/fault type deposits were identified at the Now prospects in the study area, and within 1/4 mi of the southern and northern boundaries in the Teran Basin and Jackson Cabin areas, respectively.

Now prospects

The Now prospects are in the central part of the study area, in sec. 22, T. 12 S., R. 20 E., (pl. 1). The majority of the workings, two 20-ft-deep shafts, two pits and a trench have been cut on or along four narrow silicified fault zones exposed over a distance of 250 ft in brown conglomerates and coarse grained sandstones of the Cascabel Formation (fig. 2). The fault zones are 0.5 to 2 ft wide, strike N. 50° to 80° W., dip 50° to 85° N., and could not be traced for more than 25 ft along strike due to alluvium and vegetation that covers much of the bedrock in the area. The faults contain veinlets and pods of primary tetrahedrite containing inclusions of chalcopyrite and galena, secondary chalcocite, covellite, malachite, azurite, and antimony oxide (stibiconite ?) in a gangue of quartz, barite, brecciated wallrock fragments, and minor calcite. The wallrock on the footwall side has been bleached white to light gray by quartz-sericite alteration to least 4 ft out from the fault zones. The wallrock on the hangingwall side of the fault zones has a brick red color due to hematite, from oxidation of iron-bearing minerals.

Four samples (22, 23, 24, 26) taken from the fault zones contained 1.0 to 19.71 oz/st silver (average of 7.1 oz/st), 0.28 to 10.15% copper (average of

3.93%), 0.02 to 2.47% barium, and 0.1 to 2.72% antimony (table 1). In addition, concentrations as high as 90 ppb gold, 0.18% arsenic, 0.37% zinc, 213 ppm cadmium, 141 ppm lead, and 63 ppm molybdenum were present. A select grab sample (25) from a small stockpile contained 19.74 oz/st silver, 7.60% copper, 2.54% antimony, 0.41% zinc, 0.19% arsenic, 214 ppm lead, 175 ppm cadmium, 55 ppm molybdenum, and 35 ppb gold. Microprobe analysis verified the presence of argentian (silver-bearing) tetrahedrite.

Two additional shallow shafts were sunk on vein/faults just to the north and northwest of the main group of workings. Sample 20 from a 1.5-ft-wide quartz and calcite vein, striking N. 37° W. and dipping 59° NE., contained low concentrations of lead (121 ppm) and antimony (21 ppm). Sample 21 from a 10-in.-wide silicified fault zone, striking N. 25° W. and dipping 50° SW., contained low concentrations of barium (0.26%), copper (282 ppm), and antimony (73 ppm).

No resources were identified at the Now prospects because of limited outcrop exposure due to alluvial cover but additional mineralized rock is inferred in extensions of the fault zones. The presence of tetrahedrite with high silver concentrations warrants additional, subsurface exploration to determine the extent and nature of these occurrences. The mineralogy and alteration of these occurrences fit the polymetallic vein model as described by Cox (1986, p. 125) that may be associated with a buried copper-molybdenum porphyry deposit.

Teran Basin area

At the north end of Teran Basin, in sec. 11, T. 13 S., R. 20 E., a few narrow quartz-barite-calcite veins occur between 1 and 1/4 mi outside of the study area. The veins trend toward the study area but appear to pinch

out 1/4 mi from the boundary. No evidence of extensions of this mineralization was observed in the study area and sediment samples taken in drainages that would cut the projection of the faults contained no anomalous concentrations. The veins are exposed in a folded and highly faulted section of conglomerate, sandstone, and mudstone of the Cascabel Formation and andesite breccia of the Muleshoe volcanics. Most of the bedrock is covered by alluvium, and the veins are exposed for distances of less than 80 ft along strike in small drainage cuts through this area. An 8-ft-wide shear zone (at sample site 53), striking N. 20° W. and dipping vertically, contained several 1/4-in.- to 6-in.-wide quartz-barite veins and was the largest mineralized structure in the area. The presence of barite and bleaching of wallrocks due to quartz-sericite alteration along the veins were the only visible evidence of hydrothermal activity.

Samples 50, 52, and 53 were taken from three veins, all contained concentrations of antimony (15 to 47 ppm). Sample 53, taken from the shear zone, contained 240 ppb gold.

Jackson Cabin area

The Jackson Cabin area in secs. 9, 16, and 22, T. 11 S., R. 20 E. (pl. 1), includes the Jackson Mine and numerous small workings along a fault zone between andesite flows and ash flow tuffs of the Galiuro volcanics. Occurrences of copper, gold, and silver and minor zinc, arsenic, and antimony are found in silicified zones along the fault from the Jackson Mine south to within 1/4 mi of the Muleshoe study area. This area has been sampled, mapped and described by Creasey and others (1981). The fault zone extends into the Muleshoe study area, where it is mostly covered by alluvium, and no surface evidence of mineralization was found during the field examination. Analyses

of sediment samples taken from drainages cutting through the fault zone showed no anomalous concentrations.

Industrial materials

No unique or valuable rock or rock materials that would be economical for industrial use were identified in the study area. Sand and gravel occurs in the canyons but the inaccessibility of the area and the abundance of sand and gravel throughout the region would preclude all but local use.

STREAM-SEDIMENT DATA

Forty-two stream-sediment samples, taken from drainages in and near the study area as an aid in identifying mineralized areas, were dried and sieved to -80 mesh fraction. Sample results were considered anomalous if concentrations exceeded the mean of the values (background) plus two times the standard deviation (Hawkes and Webb, 1962). Metals with concentrations mostly below the lower detection limits, such as gold, could not be treated statistically. Any gold concentrations at or above the lower detection limit were considered anomalous because its average abundance is below the limit of detection of the analytical method used. Only anomalous concentrations of gold, silver, arsenic, barium, copper, lead, molybdenum, and zinc are discussed in the report. Other metals with concentrations that would be considered anomalous using this simple statistical method are not discussed because their relationship to expected mineral deposit types in the area is unknown.

Two areas, Redfield Canyon in the north central part of the study area and Teran Basin within 1 mi of the south boundary, have a group of two or more sample sites that contained anomalous metal concentrations. In both areas visible mineralized rock fragments were found near the sample sites.

In Redfield Canyon, stream-sediment samples contained weakly anomalous concentrations of gold (sample 2, 5 ppb; sample 6, 5 ppb), arsenic (sample 5, 39 ppm), copper (sample 5, 101 ppm), and molybdenum (sample 4, 3 ppm; sample 5, 5 ppm) (table 2). A rounded fist-sized cobble of quartz and chrysocolla was found between sample sites 2 and 4. The closest known mineralized area and possible source for the metal concentrations is the Jackson Mine and associated workings 3-4 mi to the north. However, this distance and the lack of anomalous metal concentrations in samples 7, 8, and 9 farther up the canyon and closer to the mine workings, makes it unlikely that the Jackson Mine is the source. Redfield Canyon makes an abrupt turn from south to west in this area suggesting a major structural control that might provide a favorable conduit for hydrothermal fluids and mineral deposition.

In Teran Basin, stream-sediment sample 55 contained anomalous concentrations of gold (10 ppb), silver (6.1 ppm), barium (2,700 ppm), and molybdenum (3 ppm). Samples 54 and 55 had anomalous lead, 105 ppm and 73 ppm, respectively. Several fist-sized fragments of barite and quartz vein material were found near sample site 55. The source of the gold and barium can be traced to the shear zone at sample site 53 less than 1/4 mi up the drainage. Anomalous concentrations of silver, lead, and molybdenum were not detected in sample 53 or in the other samples of vein material in this area but these metals could be present in other unexposed sections of the shear zone.

In addition to the two areas mentioned above, six other scattered sample sites (17, 18, 31, 33, 39, and 43) contained anomalous metal concentrations the source of which is unknown.

Due to the nature of reconnaissance geochemical surveys, the wide spacing and small number of sample sites from an area, they can only indicate areas of

interest. Detailed surveys are required to determine if the metal concentrations are associated with a mineral occurrence or deposit.

CONCLUSIONS

Two areas, the Now prospects and the geochemical anomaly in Redfield Canyon, warrant additional investigation in the Muleshoe study area.

The Now prospects and vicinity is considered to be favorable for resources of copper and silver. Although no resources were identified, additional silver-bearing tetrahedrite mineralization is inferred at depth in extensions of fault zones. Increases in size and grade of the mineralization at depth are conjectural, but the possibility exists. A detailed field examination of the area, including additional sampling and trenching, would be necessary to determine the extent and nature of the mineralization.

The geochemical anomaly in Redfield Canyon appears to be associated with a mineral occurrence or deposit and the area around the anomaly is considered favorable for the occurrence of gold, arsenic, copper, and molybdenum. No occurrences or resources of these metals were identified in the area but the anomaly suggests they are present. A detailed field examination, including additional sampling, would be necessary, to identify possible mineralization in this area.

Sand and gravel occurs in the canyons in the study area but the inaccessibility of the area and the abundance of sand and gravel throughout the region would preclude all but local use.

The U.S. Geological Survey has rated the petroleum potential of the study area as low.

The Arizona State Bureau of Geology and Mineral Technology has rated the area surrounding Warm Springs and Hookers Hot Springs in the southeastern part of the study area favorable for low temperature geothermal resources.

REFERENCES

Cox, D. P., 1986, Descriptive model of polymetallic veins; in Cox, D. P., and Singer, D. A., ed., Mineral deposit models: U.S. Geological Survey Bulletin 1693, p. 125.

Creasey, S. D., Jackson, E. D., and Gulbrandsen, R. A., 1961, Reconnaissance geologic map of parts of the San Pedro and Aravaipa Valleys, south-central Arizona: U.S. Geological Survey Mineral Investigation Field Studies Map MF-238, scale 1:125,000.

Creasey, S. C., Jinks, J. E., Williams, F. E., and Meeves, H. C., 1981, Mineral resources of the Galiuro wilderness and contiguious further planning areas, Arizona: U.S. Geological Survey Bulletin 1490, 94 p.

Creasey, S. C., and Krieger, M. H., 1978, Galiuro volcanics, Pinal, Graham, and Cochise Counties, Arizona: U.S. Geological Survey Journal of Research, vol. 6, no. 1, p. 115-131.

Goodlin, T. C., 1985, Stratigraphic and structural relations of the area south of Hot Springs Canyon, Galiuro Mountains, Arizona: University of Arizona unpublished M.S. thesis, 101 p.

Goodlin, T. C., and Mark, R. A., 1985, Geologic map of the Hot Springs Canyon area, Cochise County, Arizona: Arizona Bureau of Geology and Mineral Technology Miscellaneous map MM-85-D, scale 1:24,000.

Hawkes, H. E., and Webb, J. S., 1962, Geochemistry in Mineral Exploration, Harper and Row.

Keith, S. B., 1979, The great southwestern Arizona overthrust oil and gas play: Arizona Bureau of Geology and Mineral Technology Field Notes, v. 9, no. 1, p. 10-14.

Keith, S. B., Gest, D. E., DeWitt, Ed, Toll, N. W., and Everson, B. A., 1983, Metallic mineral districts and production in Arizona: Arizona Bureau of Geology and Mineral Technology Bulletin 194, 58 p.

Mark, R. A., 1985, Structural and sedimentary geology of the area north of Hot Springs Canyon, southern Galiuro Mountains, Cochise County, Arizona: University of Arizona, unpublished M.S. thesis, 96 p.

Ryder, R. T., 1983, Petroleum potential of wilderness lands in Arizona, in Miller, B. M., ed., Petroleum potential of wilderness lands in the western United States: U.S. Geological Survey Circular 902-A-P, p. C1-C22.

Witcher, J. C., Stone, Claudia, and Holman, W. R., Sr., 1982, Geothermal resources of Arizona: State of Arizona Bureau of Geology and Mineral Technology, scale 1:500,000.

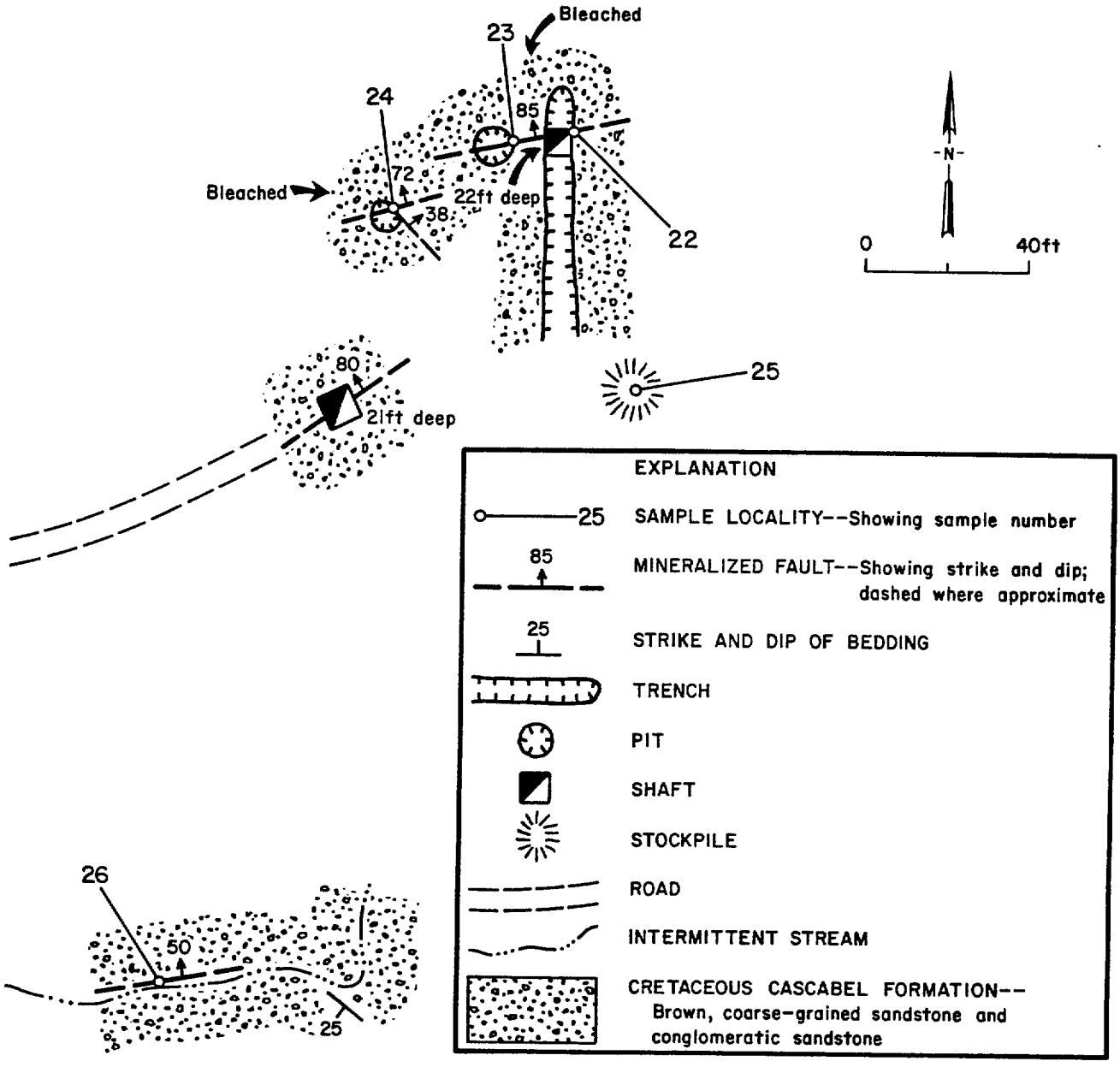

Figure 2.--Sketch map of workings on the Now claims showing sample localities 22-26.

Table 1.--Analytical results and sample descriptions for chip and grab samples from in and near the Muleshoe study area, Cochise and Graham Counties, Arizona.

[All analysis by direct coupled plasma-emission spectroscopy except for metal concentrations also listed in oz/st or %. Ag by fire assay atomic absorption spectroscopy, Cu by atomic absorption spectroscopy, As and Sb by titrametric method, and Ba by x-ray fluorescense spectroscopy. <, less than; oz/st, troy ounces per short ton; ppb, parts per billion; ppm, parts per million.]

Sample			Analytical data														
no.	type	length (ft)	Au ppb	Ag	As	B	Ba	Be	Bi	Cd	Ce	Co	Cr	Cu	Ga	La	Li
								ppm									
20	chip	1.3	<5	0.9	<5	<2	629	<0.5	3	2	51	3	13	3	<2	13	49
21	do.	.8	<5	2.1	<5	<2	2,600 (0.26%)	.7	5	2	29	15	1	282	14	14	51
22	do.	1.3	15	144.86 (4.23 oz/st)	571	<2	884	.9	<2	81	5	15	230	24,900 (2.49%)	6	8	180
23	do.	1.0	10	117.81 (3.44 oz/st)	640	<2	1,760	1.4	<2	74	<5	15	25	28,100 (2.81%)	9	13	217
24	do.	1.5	<5	34 (1.0 oz/st)	61	<2	7,200 (0.72%)	1.6	<2	7	<5	13	33	2,776	15	14	193
25	Grab	random	35	676.03 (19.74 oz/st)	1,900 (0.19%)	<2	229	<.5	<2	175	<5	21	37	76,000 (7.6%)	2	3	139
26	Chip	.5	90	675 (19.71 oz/st)	1,800 (0.18%)	<2	24,700 (2.47%)	.7	<2	213	<5	45	41	101,500 (10.15%)	6	11	169
34	do.	2.0	<5	<.2	21	<2	1,424	5.8	11	<1	74	1	29	85	24	25	117
35	do.	2.5	<5	1.5	23	<2	302	1.2	7	<1	<5	21	9	73	3	5	13
36	do.	3.0	<5	2.1	21	<2	393	1.8	<2	<1	<5	25	53	59	18	17	55
50	do.	.5	<5	<.2	<5	<2	18,700 (1.87%)	.5	<2	1	13	3	13	9	3	6	191
52	do.	.8	<5	.7	<5	<2	539	<.5	3	<1	13	7	11	37	7	11	173
53	do.	.5	240	<.2	<5	<2	8,300 (0.83%)	1.7	3	2	<5	3	27	15	9	4	86

Table 1.--Analytical results and sample descriptions for chip and grab samples from in and near the Muleshoe study area, Cochise and Graham Counties, Arizona--Continued

Sample no.	Analytical data (ppm)																Remarks
	Mo	Nb	Ni	Pb	Rb	Sb	Sc	Sn	Sr	Ta	Te	Tl	V	W	Y	Zn	Zr	
20	<1	<1	11	121	<20	21	1	<20	776	<10	<10	<10	6	<10	34	13	36	Shaft, 12-ft-deep; quartz-calcite vein striking N. 37° W. and dipping 59° NE. in conglomerate of Cascabel Formation; specular hematite, conglomerate, hematite stain.
21	1	7	43	27	<20	73	5	<20	608	<10	<10	<10	84	<10	10	101	73	Shaft inclined 50° to SW., 18 ft deep; silicified fault zone striking N. 25° W. dipping 50° SW. in andesite breccia of Muleshoe volcanics; barite, calcite, hematite stain.
22	63	<1	55	141	35	13,200 (1.32%)	2	<20	252	<10	<10	<10	33	<10	6	1,030	33	Silicified fault zone, striking N. 80° E. and dipping 85° N. in coarse-grained sandstone of Cascabel Formation; tetrahedrite, chalcocite, malachite, azurite, brecciated wall-rock, minor calcite, hematite-limonite stain.
23	29	3	23	97	54	10,500 (1.05%)	4	<20	268	<10	<10	<10	56	<10	9	1,020	43	Silicified fault zone, partially exposed, striking N. 80° E. and dipping 85° N. in coarse-grained sandstone of Cascabel Formation; tetrahedrite, chalcocite, malachite, azurite, brecciated wallrock, barite, minor calcite, hematite-limonite stain.
24	3	5	27	13	57	1,078	10	<20	83	<10	<10	<10	74	<10	9	380	60	Silicified fault zone, striking N. 76° E. and dipping 72° NW. in coarse-grained sandstone of Cascabel Formation; tetrahedrite, chalcocite, malachite, azurite, barite.
25	55	<1	33	214	26	25,400 (2.54%)	1	<20	167	<10	<10	<10	31	<10	4	4,067	26	Stockpile, pieces of silicified fault material, tetrahedrite, chalcopyrite, chalcocite, malachite, azurite, brecciated wallrock, barite, minor calcite, hematite-limonite stain, pyrolusite stain.

Table 1.--Analytical results and sample descriptions for chip and grab samples from in and near the Muleshoe study area, Cochise and Graham Counties, Arizona--Continued

Sample no.	Analytical data (ppm)																	Remarks
	Mo	Nb	Ni	Pb	Rb	Sb	Sc	Sn	Sr	Ta	Te	Tl	V	W	Y	Zn	Zr	
26	17	7	41	95	34	27,200 (2.72%)	7	<20	296	<10	<10	<10	90	<10	13	3,735	54	Silicified fault zone, partially exposed, striking N. 80° E. and dipping 50° NW.; tetrahedrite, chalcocite, malachite, azurite, brecciated wallrock, barite, minor calcite.
34	3	11	11	11	93	<5	1	<20	417	<10	<10	<10	21	<10	20	117	116	Fault zone, low angle fault striking N. 30° W. between andesite of Galiuro volcanics and sandstone and mudstone of Willow Canyon Formation, wallrock fragments and clay gouge.
35	1	<1	39	7	23	<5	<1	<20	195	<10	<10	<10	25	<10	2	55	44	Fault zone, striking N. 40° W. and dipping 18° SW. between andesite of Galiuro volcanics and conglomerate of Willow Canyon Formation; andesite and conglomerate fragments, clay gouge, calcite, hematite stain.
36	1	3	65	11	153	<5	5	<20	91	<10	<10	<10	29	<10	17	93	48	Fault zone, striking N. 40° and dipping 15° SW., clay gouge, andesite and sandstone fragments, calcite, hematite stain; ground mass of andesite altering to green caladonite.
50	<1	<1	17	47	22	47	1	<20	411	<10	<10	<10	10	<10	8	21	20	Quartz-barite vein striking N. 40° W. and dipping 70° N; in andesite breccia of Muleshoe volcanics.
52	<1	<1	15	27	57	43	3	<20	13	<10	<10	<10	23	<10	7	43	28	Quartz-calcite vein striking N. 20° E. and dipping vertically in andesite breccia of Muleshoe volcanics; brecciated andesite and quartz fragments, minor barite, andesite bleached white to light gray next to vein.

Table 1.--Analytical results and sample descriptions for chip and grab samples from in and near the Muleshoe study area, Cochise and Graham Counties, Arizona--Continued

Sample no.	Analytical data																Remarks
	Mo	Nb	Ni	Pb	Rb	Sb	Sc	Sn	Sr	Ta	Te	Tl	V	W	Y	Zn	Zr	
	ppm																	
53	<1	<1	13	31	28	15	1	<20	157	<10	<10	<10	9	<10	4	17	23	Quartz-barite vein in 8-ft-wide shear zone striking N. 20° W. and dipping vertically in interbedded sandstone and mudstone of the Cascabel Formation; several quartz-barite veins up to 0.5 ft wide in shear zone; brecciated wallrock, minor calcite; mudstone bleached white next to veins.

Table 2.--Analytical results for stream-sediment samples from in and near the Muleshoe study area, Cochise and Graham Counties, Arizona.

[Analysis by direct coupled plasma emission spectroscopy except for samples noted with an asterik* by atomic absorption spectroscopy; <, less than, na, not applicable.]

Sample no.	Analytical data																	
	Au	Ag	As	B	Ba	Be	Bi	Cd	Ce	Co	Cr	Cu	Ga	La	Li	Mo	Nb	Ni
	ppb	ppm																
1	<5	1.5	5	<2	675	2.7	5	<1	<5	29	115	59	26	44	51	1	22	79
2	5	1.5	7	<2	606	.9	3	<1	<5	27	105	61	22	36	39	1	14	67
3	<5	1.7	15	<2	642	1.6	<2	<1	<5	27	113	61	19	10	19	1	9	75
4	<5	2.5	9	<2	652	2.3	3	<1	<5	39	230	67	11	26	45	3	9	123
5	5	2.5	5	<2	566	1.6	7	<1	<5	25	79	51	22	22	30	1	5	63
6	<5	4.9	39	<2	623	2.2	5	2	<5	53	312	101	20	43	46	5	27	127
7	<5	2.1	13	<2	765	2.8	5	<1	21	25	69	63	23	35	43	1	18	59
8	<5	1.5	<5	<2	109	.9	<2	<1	15	29	167	65	9	33	37	<1	5	95
9	<5	2.5	21	<2	622	2	7	1	<5	29	87	49	8	12	24	1	7	67
10	<5	2.5	21	<2	618	1.5	3	<1	<5	37	222	77	14	11	16	1	3	111
11	<5	1.7	5	<2	591	1.8	<2	<1	<5	33	151	81	7	15	27	1	<1	95
12	<5	3.1	5	<2	650	2.4	5	<1	<5	37	202	71	11	61	61	1	22	119
13	<5	1.5	<5	<2	668	2.4	5	<1	<5	35	171	67	21	36	122	1	20	95
14	<5	2.5	11	<2	612	1.9	7	<1	<5	39	222	69	14	29	73	1	22	107
15	<5	1.1	11	<2	509	1.8	5	<1	<5	25	113	63	7	6	41	1	<1	67
16	<5	3.5	23	<2	780	1.1	7	<1	<5	47	284	75	16	19	46	1	4	137
17	<5	3.5	35	<2	788	1.1	7	<1	<5	43	179	67	17	25	53	3	10	101
18	<5	2.3	25	<2	445	2.4	5	<1	<5	31	79	63	25	39	81	1	25	79
19	<5	.7	5	<2	340	1.4	5	<1	<5	13	25	45	15	23	73	1	7	23
27	<5	.7	<5	<2	418	1.6	5	<1	<5	17	19	39	13	26	91	1	9	19
28	<5	2.3	25	<2	505	1.7	<2	<1	<5	33	43	47	25	30	67	1	34	47
29	<5	.7	<5	<2	189	<.5	7	<1	<5	9	19	33	8	16	46	1	3	17
30	<5	.9	<5	<2	304	.5	7	<1	<5	17	37	49	9	17	58	<1	11	25
31	<5	2.5	37	<2	326	1	5	1	<5	25	57	47	15	19	60	1	19	37
32	<5	1.5	<5	<2	318	1.2	7	<1	<5	17	35	47	11	18	60	<1	12	27
33	<5	2.1	11	<2	360	1.3	5	<1	<5	17	39	87	12	22	73	1	10	35
37	<5	2.1	7	<2	475	2.2	5	<1	<5	25	73	43	19	29	35	1	9	47
38	<5	2.1	7	<2	567	2.1	3	<1	<5	29	129	47	19	35	28	1	18	49
39	<5	3.3	17	<2	534	2.2	3	<1	<5	37	171	53	17	41	31	1	29	69
40	<5	3.5	21	<2	540	2.1	<2	<1	<5	41	208	67	21	53	25	1	34	67
41	<5	3.5	13	<2	556	2.7	3	<1	<5	35	173	37	17	47	36	1	26	59
42	<5	3.1	15	<2	790	2.3	5	<1	<5	37	173	53	25	46	65	1	21	103
43	<5	7.3	47	<2	523	2.4	<2	1	<5	67	429	63	29	77	34	1	76	111
44	<5	4.1	23	<2	808	2.4	5	1	21	37	141	61	24	45	36	1	22	79
45	<5	3.5	11	<2	578	1.8	5	2	<5	37	191	39	27	52	43	1	24	85
46	<5	2.9	<5	<2	695	3	5	1	<5	33	109	43	19	62	24	1	27	59
47	<5	3.3	13	<2	550	2.1	<2	<1	<5	33	41	45	24	34	74	1	36	41
48	<5	3.1	9	<2	523	2	3	1	<5	27	25	43	24	30	81	1	21	33

Table 2.--Analytical results for stream-sediment samples from in and near the Muleshoe study area, Cochise and Graham Counties, Arizona--Continued

Sample no.	Analytical data																	
	Au	Ag	As	B	Ba	Be	Bi	Cd	Ce	Co	Cr	Cu	Ga	La	Li	Mo	Nb	Ni
	ppb	ppm																
49	<5	2.3	7	<2	717	1.4	<2	2	<5	27	23	43	28	23	72	<1	30	35
51	<5	.7	<5	<2	559	1.7	<2	<1	<5	21	15	39	25	22	100	<1	13	25
54	<5	1.7	5	<2	642	2.3	<2	<1	<5	25	19	39	18	23	61	1	14	27
55	10	6.1	33	<2	2,700	2.3	<2	1	<5	57	115	69	23	38	46	3	64	91
Maximum value	10	7.3	47	<2	2,700	3	7	2	21	67	429	101	29	77	122	5	76	137
Minimum value	<5	0.7	5	<2	109	<0.5	<2	<1	<5	9	15	33	7	6	16	<1	<1	17
Average value (background)	na	2.5	14	na	606	1.8	4	na	na	32	124	57	18	32	52	1	19	68
Standard deviation	na	1.4	11	na	363	0.6	2	na	na	11	90	15	6	15	23	1	15	33
Threshold (average value + two times the standard deviation)	na	5.3	36	na	1,332	3.0	8	na	na	54	304	87	30	62	98	8	49	134

Table 2.--Analytical results for stream-sediment samples from in and near the Muleshoe study area, Cochise and Graham Counties, Arizona--Continued

Sample no.	Analytical data													
	Pb	Rb	Sb	Sc	Sn	Sr	Ta	Te	Tl	V	W	Y	Zn	Zr
	ppm													
1	13	89	<5	14	<20	286	<10	<10	<10	135	<10	29	109	202
2	17	83	<5	12	<20	238	<10	<10	<10	95	<10	8	95	50
3	17	71	<5	2	<20	248	<10	<.2*	<10	41	<10	11	175	28
4	27	62	<5	12	<20	340	<10	<10	<.2*	121	<10	16	117	123
5	35	68	<5	5	<20	216	<10	<10	<10	76	<10	24	83	61
6	39	52	<5	11	27	374	16	<10	<10	126	<10	30	143	144
7	23	72	<5	4	<20	276	<10	<10	<10	58	<10	26	157	95
8	27	<20	<5	8	<20	79	<10	<10	<10	120	<10	19	107	49
9	45	39	<5	2	<20	155	<10	<10	<10	85	<10	12	97	77
10	25	43	<5	3	<20	252	<10	<.2*	<10	58	<10	5	131	25
11	17	48	<5	6	<20	254	<10	<10	<10	61	<10	8	155	73
12	25	33	<5	27	<20	314	<10	<10	<10	168	<10	7	93	254
13	9	75	<5	18	<20	298	<10	<10	<10	138	<10	25	111	202
14	2	79	<5	17	<20	264	<10	<10	<10	146	<10	27	105	172
15	15	24	<5	3	<20	183	<10	<.2*	<.4*	33	<10	3	153	19
16	25	45	<5	10	<20	374	<10	<.2*	<10	99	<10	7	121	84
17	27	44	<5	13	<20	366	<10	<10	<10	124	<10	13	123	128
18	33	92	<5	14	<20	139	<10	<10	<10	154	<10	28	284	179
19	13	72	<5	8	<20	143	<10	<10	<10	62	<10	27	61	100
27	13	50	<5	9	<20	83	<10	<10	<10	89	<10	17	145	108
28	43	62	<5	9	<20	111	<10	<10	<10	265	<10	21	177	120
29	9	38	<5	8	<20	95	<10	<10	<10	41	<10	15	43	100
30	17	37	<5	9	<20	99	<10	<10	<10	97	<10	16	79	95
31	43	39	<5	10	20	83	<10	<10	<10	162	<10	16	93	135
32	33	40	<5	9	<20	87	<10	<10	<10	91	<10	16	77	109
33	23	51	7	12	<20	105	<10	<10	<10	92	<10	19	99	129
37	15	63	<5	9	<20	246	<10	<10	<10	92	<10	22	105	112
38	9	69	<5	10	<20	264	<10	<10	<10	118	<10	23	127	161
39	29	78	<5	12	20	202	<10	<10	<10	169	<10	22	332	154
40	33	72	<5	12	22	248	<10	<10	<10	180	<10	28	427	137
41	33	73	<5	11	<20	228	<10	<.2*	<10	154	<10	32	127	140
42	25	65	<5	19	<20	356	<10	<10	<10	130	<10	33	163	212
43	71	60	<5	18	39	199	<10	<10	<10	371	<10	55	230	194
44	39	64	<5	12	<20	248	<10	<10	<10	118	<10	32	113	222
45	35	60	<5	15	<20	342	<10	<10	<10	143	<10	33	109	151
46	31	75	<5	11	<20	258	<10	<10	<10	81	<10	37	105	97
47	29	93	<5	14	<20	147	<10	<10	<10	209	<10	27	121	178
48	35	111	<5	14	<20	183	<10	<10	<10	147	<10	23	97	154

Table 2.--Analytical results for stream-sediment samples from in and near the Muleshoe study area, Cochise and Graham Counties, Arizona--Continued

Sample no.	Analytical data													
	Pb	Rb	Sb	Sc	Sn	Sr	Ta	Te	Tl	V	W	Y	Zn	Zr
	ppm													
49	51	79	<5	17	<20	248	<10	<10	<10	187	<10	19	99	170
51	13	83	<5	12	<20	171	<10	<10	<10	120	<10	19	81	139
54	105	123	<5	10	<20	103	<10	<10	<10	131	<10	16	252	120
55	73	68	<5	16	36	137	<10	<10	<10	511	<10	25	181	216
Maximum value	105	123	7	27	39	374	16	25	14	511	<10	55	427	254
Minimum value	<2	20	<5	2	<20	79	<10	<0.2	<0.2	33	<10	3	43	19
Average value (background)	30	63	na	11	na	215	na	na	na	133	na	21	138	129
Standard deviation	19	22	na	5	na	88	na	na	na	85	na	10	72	56
Threshold (average value + two times the standard deviation	68	107	na	21	na	391	na	na	na	303	na	41	282	241

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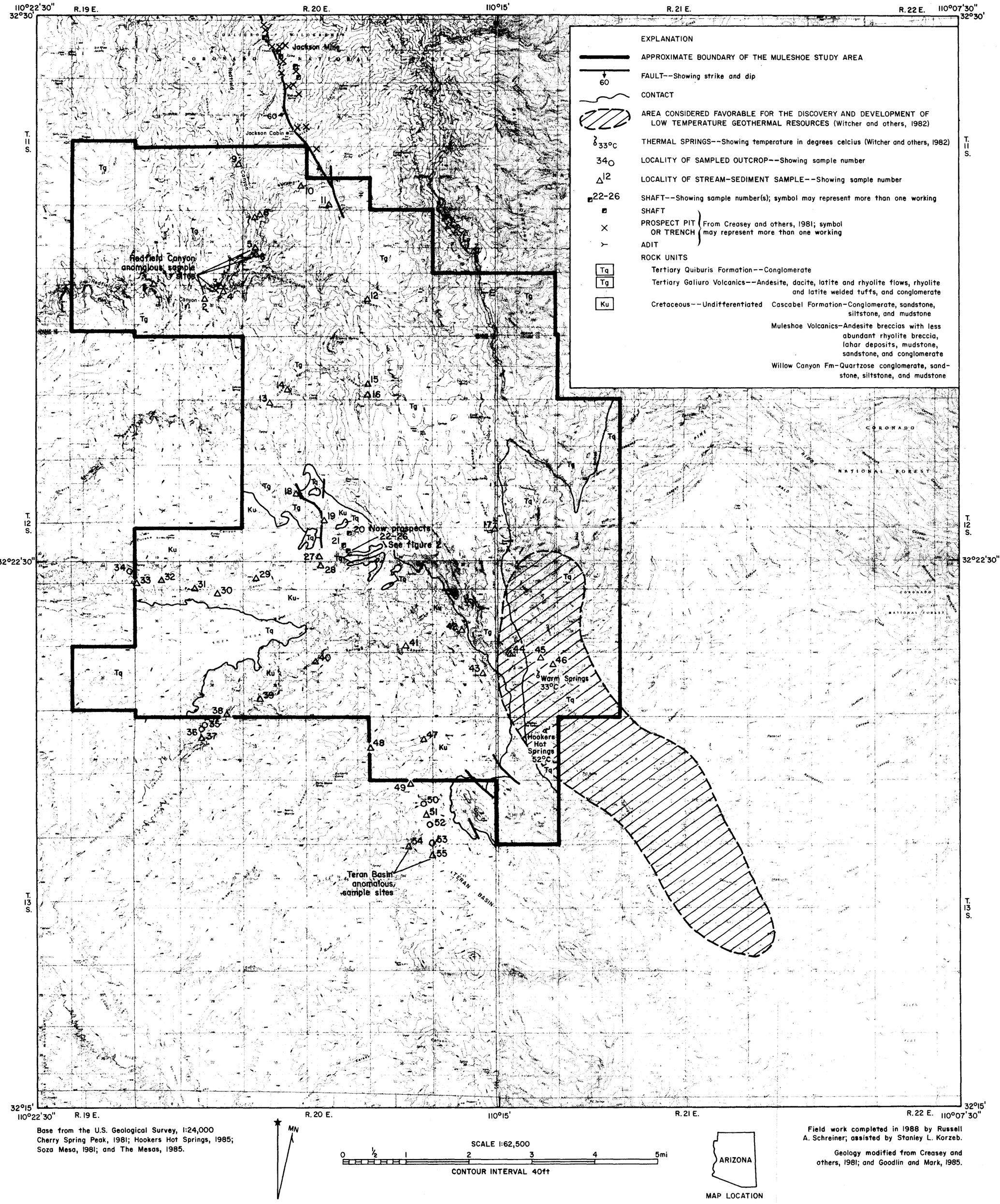
PLATE 1



Base from the U.S. Geological Survey, 1:24,000 Cherry Spring Peak, 1981; Hookers Hot Springs, 1985; Soza Mesa, 1981; and The Mesas, 1985.

Field work completed in 1988 by Russell A. Schreiner; assisted by Stanley L. Korzeb.

Geology modified from Creasey and others, 1981; and Goodlin and Mark, 1985.

MINE AND PROSPECT MAP OF THE MULESHOE STUDY AREA, COCHISE AND GRAHAM COUNTIES, ARIZONA

BY