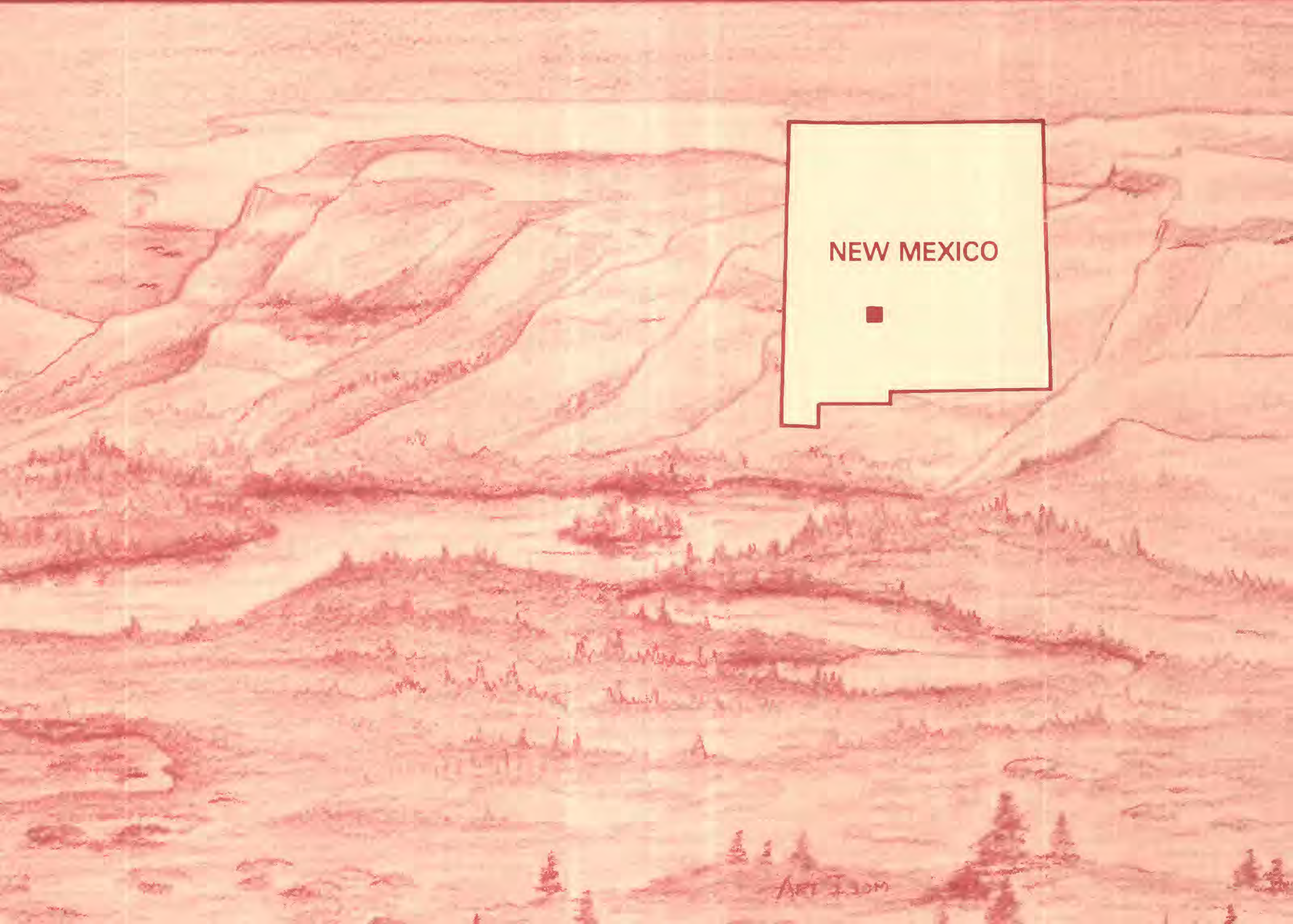
Mineral Resources of the Jornada del Muerto Wilderness Study Area, Socorro and Sierra Counties, New Mexico

U.S. GEOLOGICAL SURVEY BULLETIN 1734–A



Chapter A

Mineral Resources of the Jornada del Muerto Wilderness Study Area, Socorro and Sierra Counties, New Mexico

By DONALD H. RICHTER and RICHARD W. SALTUS
U.S. Geological Survey

GEORGE S. RYAN
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U.S. GEOLOGICAL SURVEY BULLETIN 1734

MINERAL RESOURCES OF WILDERNESS STUDY AREAS—
WEST-CENTRAL NEW MEXICO

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

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STUDIES RELATED TO WILDERNESS

Bureau of Land Management Wilderness Study Areas

The Federal Land Policy and Management Act (Public Law 94–579, October 21, 1976) requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine the mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the Jornada del Muerto (NM–020–055) Wilderness Study Area, Socorro and Sierra Counties, New Mexico.

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FIGURES

Mineral Resources of the Jornada del Muerto Wilderness Study Area, Socorro and Sierra Counties, New Mexico

By Donald H. Richter *and* Richard W. Saltus
U.S. Geological Survey

George S. Ryan
U.S. Bureau of Mines

SUMMARY

The Jornada del Muerto Wilderness Study Area (NM–020–055) includes 31,147 acres in Socorro and Sierra Counties in west-central New Mexico. It lies in remote country on the east side of the Rio Grande valley, approximately 35 mi (miles) south of the city of Socorro (fig. 1).

The wilderness study area includes most of the east half of a geologically young (760,000-year-old) basaltic lava field. The vent area for the lavas is marked by a cinder cone and lava domes about 1 mi west of the wilderness study area boundary. The lava field overlies a relatively flat surface of thin, unconsolidated basin and eolian sediments, which in turn overlie as much as 10,000 ft (feet) of older sedimentary rocks that filled the tectonically active Rio Grande rift valley during late Tertiary (see geologic time chart in Appendix) time (2–20 million years ago). Paleozoic limestones, which in southeast New Mexico are highly productive oil and gas reservoir rocks, probably underlie the wilderness study area at depth.

There has been no mineral production in the wilderness study area, and no leasable or locatable mineral deposits are known. The wilderness study area has low mineral resource potential for metals, including sedimentary uranium, geothermal energy, oil and gas, and magmatic segregates of gem-quality olivine (peridot); the mineral resource potential for coal is unknown (fig. 2). The northwest and southwest parts of the study area have moderate potential for undiscovered sand resources.

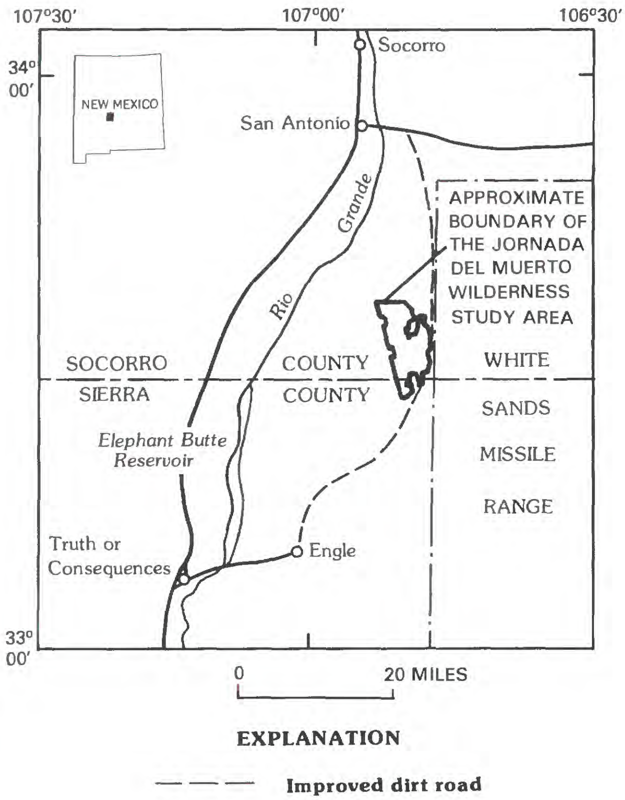


Figure 1. Map showing location of the Jornada del Muerto Wilderness Study Area, New Mexico.

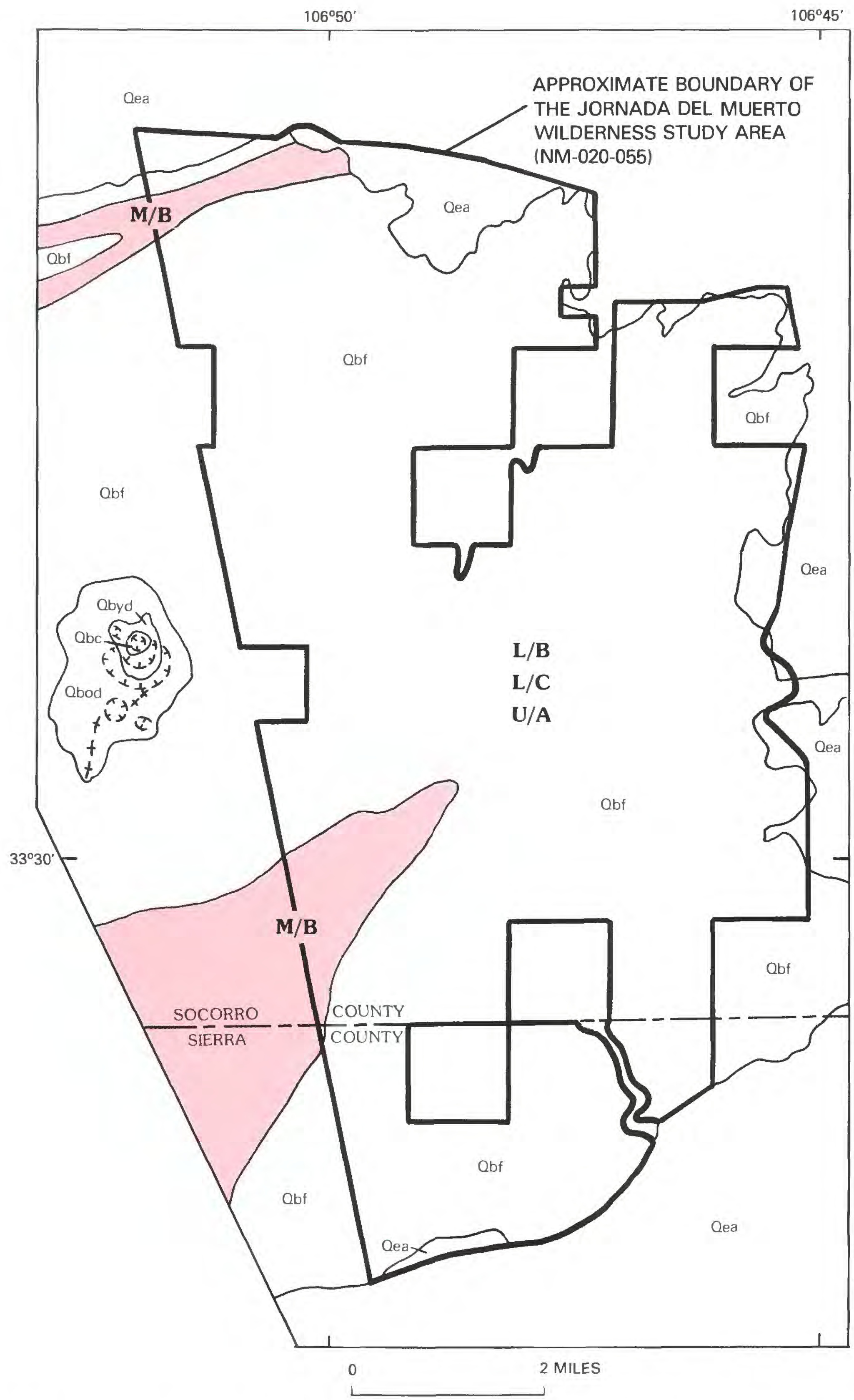


Figure 2 (above and facing page). Map showing mineral resource potential and geology of the Jornada del Muerto Wilderness Study Area, New Mexico.

EXPLANATION OF MINERAL RESOURCE POTENTIAL

M/B **Geologic terrane having high mineral resource potential for sand, with certainty level B**

L/B **Geologic terrane having low mineral resource potential for metals, including sedimentary uranium, oil and gas, and geothermal energy, with certainty level B**

L/C **Geologic terrane having low mineral resource potential for gem-quality olivine, with certainty level C**

U/A **Geologic terrane having unknown mineral resource potential for coal, with certainty level A**

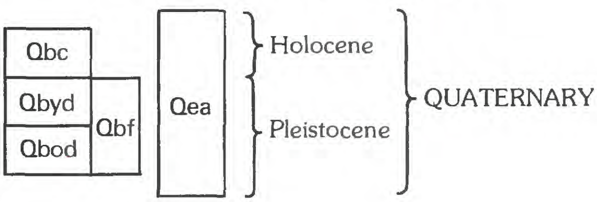
Certainty levels

A **Available information is not adequate for determination of the level of mineral resource potential**

B **Available information suggests level of mineral resource potential**

C **Available information gives a good indication of level of mineral resource potential**

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qea **Eolian and alluvial deposits, undivided (Holocene and Pleistocene)**—Chiefly stablized and active sheet sand and sand dunes intermixed with fine-grained alluvium in numerous small discontinuous drainages. Maximum thickness less than 10 ft

Lava of Jornada del Muerto (Pleistocene)—Medium-gray to black, porphyritic alkalic basalt containing phenocrysts of plagioclase (10-15 percent) and olivine (2-5 percent) in an intergranular to intersertal groundmass of feldspar, mafic minerals, and glass. Locally contains xenoliths of quartz and tridymite. Maximum thickness about 250 ft

Qbc **Cinder cone**—Scoriaceous lapilli, cinder, and blocks. Overlies vent for lava of Jornada del Muerto

Qbyd **Young lava dome**—Small, partly collapsed lava dome

Qbod **Old lava dome**—Broad lava dome containing an extensive collapsed lava tube and many pit craters. Dome is partly collapsed peripheral to vent area

Qbf **Lava flows**—Massive, extremely vesicular flows having a variety of collapse features

——— **Contact**—Both known and approximately located

┬┬┬┬ **Collapse scarp**—Hachures on collapsed side

++++ **Trace of collapsed lava tube**

INTRODUCTION

The Jornada del Muerto Wilderness Study Area (NM-020-055) includes 31,147 acres in Socorro and Sierra Counties in south-central New Mexico (fig. 1). It is about 35 mi south of the city of Socorro and is on the east side of the Rio Grande but within the Rio Grande rift valley. Access is by several improved dirt roads that service remote ranches in the area, and these roads can be difficult to traverse during periods of inclement weather. The best routes are south from U.S. Highway 380 just west of San Antonio, N. Mex., a distance of about 25 mi, and north from Truth or Consequences, N. Mex., a distance of about 48 mi. The wilderness study area includes most of the east half of a large Pleistocene lava field, roughly 15 mi in diameter; the lava flowed out on a relatively flat alluvial plain from a central vent area. The lava field has the form of a very broad shield with the central vent area about 250 ft higher than the distal edges of the flows. The surface of the field is extremely rough and consists largely of broken and disrupted lava, collapse pits, rifts, and pressure domes; no streams drain the lava field.

This report presents an evaluation of the mineral endowment (identified resources and mineral resource potential) of the study area and is the product of several separate studies by the U.S. Bureau of Mines and the U.S. Geological Survey. Identified resources are classified according to the system of the U.S. Bureau of Mines and U.S. Geological Survey (1980), which is shown in the Appendix of this report. Identified resources are studied by the Bureau of Mines. Mineral resource potential is the likelihood of occurrence of undiscovered metals and nonmetals, industrial rocks and minerals, and of undiscovered energy sources (coal, oil, gas, oil shale, and geothermal sources). It is classified according to the system of Goudarzi (1984) and is shown in the Appendix. Undiscovered resources are studied by the U.S. Geological Survey.

Investigations by the U.S. Bureau of Mines

The Bureau of Mines investigation included a search of literature relating to the mineral resources and mining activity in or near the study area. Claim status was checked in the U.S. Bureau of Land Management claim-recordation files, and it was determined that no claims exist within the study area.

Bureau of Mines personnel spent 10 employee-days in the study area. During the field investigation, five rock and soil samples were collected (Ryan, 1986). All samples were analyzed for gold and silver by fire assay and for 40 elements by semiquantitative optical-emission spectrographic methods at the Bureau of Mines Reno Research Center, Reno, Nev. Detailed information is available through the Intermountain Field Operations Center, Building 20, Denver Federal Center, Denver, Colorado 80225.

Investigations by the U.S. Geological Survey

A brief field investigation consisted of helicopter-supported geologic mapping and rock sampling. The absence of streams or any locally derived alluvial material in the wilderness study area ruled out the possibility of a stream-sediment geochemical investigation. Small-scale gravity and aeromagnetic maps of the wilderness study area and vicinity were prepared from gravity data used for regional gravity maps of New Mexico and a widely spaced aeromagnetic survey flown for the National Uranium Resource Evaluation program. No new geophysical data were acquired for this resource evaluation.

Acknowledgments.—Personnel of the Bureau of Land Management in Socorro, N. Mex., especially geologist Roy Dean, were extremely helpful in providing information on the wilderness study area and making available to us the Bureau of Land Management's aerial photographs. Special thanks are also due to G.R. Osburn of the New Mexico Bureau of Mines and Mineral Resources in Socorro for providing data on the Jornada del Muerto lava field. A report on the geology, energy, and mineral resources of the Armendaris area, New Mexico (Krason, Jan, Wodzicki, Antoni, and Cruver, S.K., unpub. data, 1982), prepared for the Bureau of Land Management, was a useful guide in the preparation of this report.

APPRAISAL OF IDENTIFIED RESOURCES

By George S. Ryan
U.S. Bureau of Mines

The Jornada del Muerto Wilderness Study Area does not contain any identified mineral resources. No known locatable or leasable mineral deposits are in the wilderness study area or within 2–5 mi of the study area, and the wilderness study area does not contain any existing mining claims. The lava flow of Jornada del Muerto constitutes a possible source of construction or decorative stone, but the area is so distant from any potential market that stone is not considered a resource.

ASSESSMENT OF POTENTIAL FOR UNDISCOVERED RESOURCES

By Donald H. Richter and Richard W. Saltus
U.S. Geological Survey

Geology

The Jornada del Muerto Wilderness Study Area consists of the east half of an extensive Pleistocene lava field, dated at 760,000 years (Bachman and Mehnert, 1978), in the Rio Grande valley of west-central New Mexico. The lava field forms a low broad shield about 15 mi in diameter and has a maximum thickness of about 250 ft. The vent area for the lava is 1 mi west of the wilderness study area boundary and consists of a young cinder cone constructed on a partly collapsed small lava dome, which in turn is superimposed on an older and considerably larger lava dome (fig. 2). A large, partly collapsed lava tube extends more than a mile through the older lava dome.

The lavas are porphyritic alkali olivine basalts containing phenocrysts of plagioclase (10–15 percent) and olivine (3–5 percent) in a fine-grained groundmass of feldspar, mafic minerals, and, locally, glass. Xenoliths of quartz, partly replaced by tridymite, as much as 4 inches in diameter, are locally abundant in some parts of the flow. Chemically, the lavas contain about 50 percent SiO_2 and 5 percent Na_2O+K_2O, and probably represent mantle-derived magma that ascended to the surface with minimum contamination by crustal rocks. The lavas are typical of the many lava fields that have been erupted throughout the length of the Rio Grande rift system in the last 6 million years.

The lavas were erupted onto a relatively flat surface of Quaternary basin sediments, piedmont alluvium, and eolian deposits probably less than 200 ft thick. These thin alluvial and eolian deposits overlie and in part are gradational downward into a great thickness of sedimentary rocks of the Santa Fe Group that filled the tectonically active Rio Grande rift during early Quaternary and late Tertiary time. The Santa Fe Group consists of moderately indurated conglomerate, sandstone, and siltstone and may be as much as 3,500 ft thick under the wilderness study area. Locally, the rocks are tuffaceous and intercalated with mafic lava flows. The Santa Fe Group was deposited unconformably on rocks ranging from Precambrian to early Tertiary in age. Pre-Santa Fe Group basement rocks are exposed at Little San Pascual Mountain, about 5 mi north of the wilderness study area, where upper Paleozoic sedimentary rocks, including Pennsylvanian and Permian limestones, dip to the southeast under basin-fill deposits of the Santa Fe Group (Geddes, 1963). The lava field is locally covered by a veneer of eolian deposits.

Geophysics

Gravity Data

A regional isostatic residual gravity map (fig. 3) of a 30-minute by 30-minute (27.5×35 mi) area containing the wilderness study area was compiled using data from about 600 gravity stations; none of these stations are in the wilderness study area. The data for the map were assembled and edited for regional gravity maps of New Mexico by Cordell and others (1982). The map (fig. 3) shows the gravity effect of density distributions in the upper crust (Simpson and others, 1986).

The wilderness study area is on an elongate north-trending gravity high. This high is flanked on the west by steep gravity gradients leading down into the Rio Grande rift zone. On the east side of the high, the gravity field drops to a very large closed gravity low (40 milligals below the high) centered near the Baber well about 16 mi northeast of the wilderness study area.

The regional anomalies on the gravity map are probably due primarily to the relief on the contact between the relatively low density Santa Fe Group sedimentary rocks at the surface and the underlying high density Paleozoic carbonate rocks. Thus, the central gravity ridge indicates rather thin Santa Fe Group rocks, a shallow depth to the Paleozoic rocks, and the large closed low to the east is caused by a relatively thick Santa Fe section. If the Paleozoic limestones are assumed to have a bulk density of 2.7 g/cm^3 (grams per cubic centimeter), the largest reasonable density contrast between the Paleozoic rocks and the Santa Fe Group rocks is probably 0.5 g/cm^3. If this maximum density contrast is assumed, the minimum depth to the Paleozoic basement can be modeled. Using the method of Cordell and Henderson (1968), a map showing minimum depth to Paleozoic basement rocks has been prepared (fig. 4). Because no gravity stations are within the wilderness study area boundary, the depth estimate there is based on data from outside of the area. The map shows that the Paleozoic basement may be within 3,500 ft of the surface near the wilderness study area and drops to at least 10,000 ft under the gravity low near Baber well to the east.

The steep gradient along the western edge of the gravity ridge (fig. 3), best defined by a line of closely spaced gravity stations at the north edge of the ridge, is probably associated with graben faulting along the Rio Grande rift to the west.

Aeromagnetic Data

Data for an aeromagnetic map (fig. 5) were obtained as part of the National Uranium Resource Evaluation (NURE) program in 1982 (Berry and others, 1982). The survey was flown at an altitude of 400 ft above the ground along flight lines 3 mi apart. Because the flight lines are so widely spaced, short-wavelength features cannot be contoured reliably from line to line. In order to avoid false correlation of these contours by computer contouring, a grid was produced from the original data using the method of minimum curvature (Briggs, 1974), and the grid was continued upward 1,600 ft to remove the short-wavelength features.

The aeromagnetic map (fig. 4) is dominated by a large crescent-shaped closed low northeast of the study area with a triangular-shaped high intersecting it from the west. These broad long-wavelength features are probably due to relief on the contact between the Precambrian basement rocks and the relatively nonmagnetic rocks above them. A two-dimensional structural model constructed from two flight lines crossing the broad low indicated a depth of about 23,000 ft to the Precambrian basement under the lowest part of the anomaly at the eastern edge of the wilderness study area. This model assumed a 0.001-electromagnetic unit per cubic centimeter intensity of magnetization for normally polarized basement rocks. The same model yielded depths of about 7,000 ft to Precambrian basement under the magnetic highs flanking the western and southern edges of the wilderness study area.

A small ridge of aeromagnetic lows coincides with the gravity high discussed in the previous section. This aeromagnetic anomaly probably reflects a small increase in the depth of the Paleozoic basement (fig. 4); this increase suggests the presence of a small arch in the basement rock.

Aerial Radiometric Survey

The Jornada del Muerto Wilderness Study Area has low overall radioactivity. The aerial radiometric survey

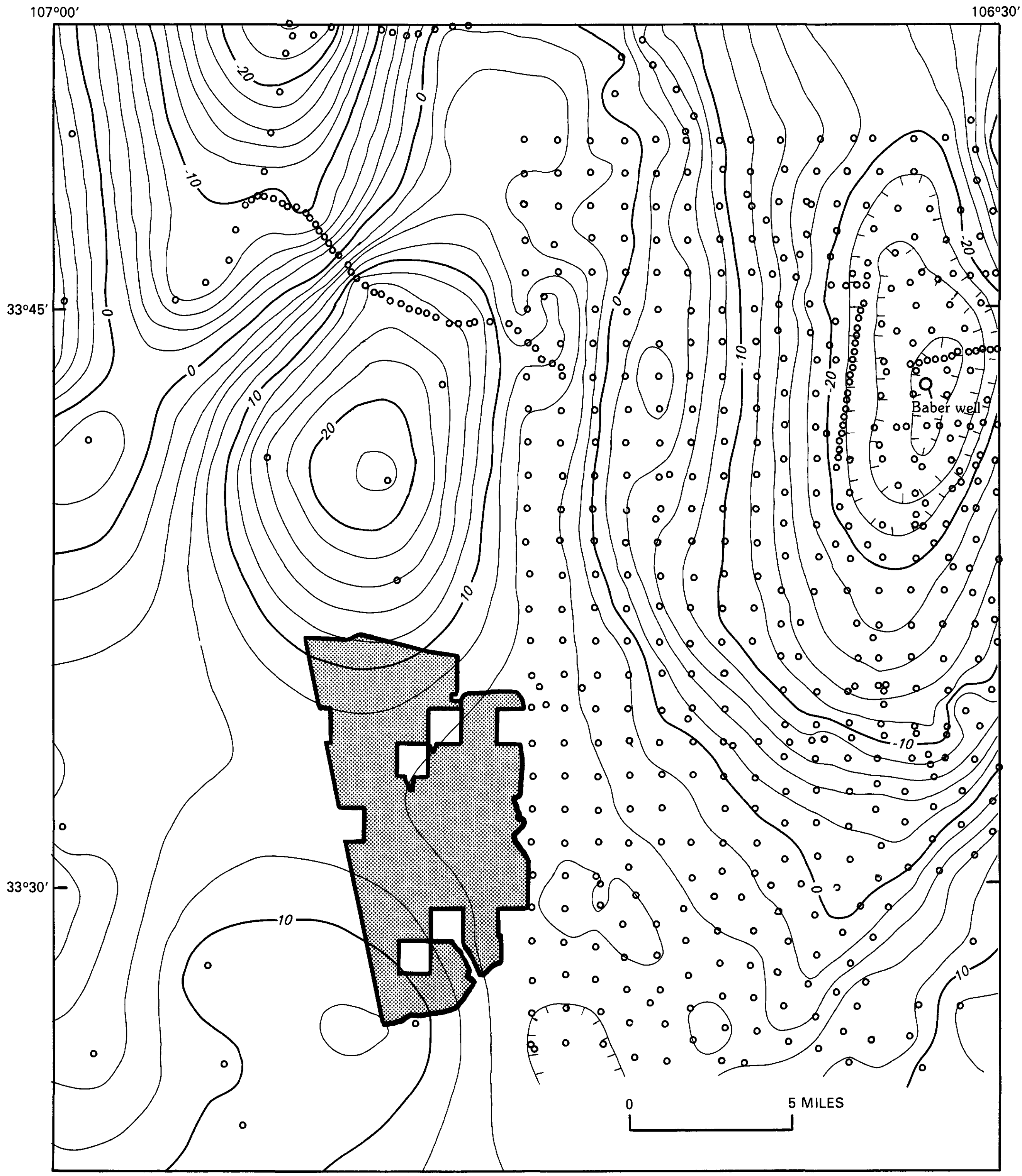


Figure 3. Isostatic residual gravity map of the Jornada del Muerto Wilderness Study Area and vicinity, New Mexico. Contour interval 2 milligals. Dots are gravity stations. Reduction density 2.67 grams per cubic centimeter. Hachures show areas of lower gravity values. Data are from Cordell and others (1982). Wilderness study area is shaded.

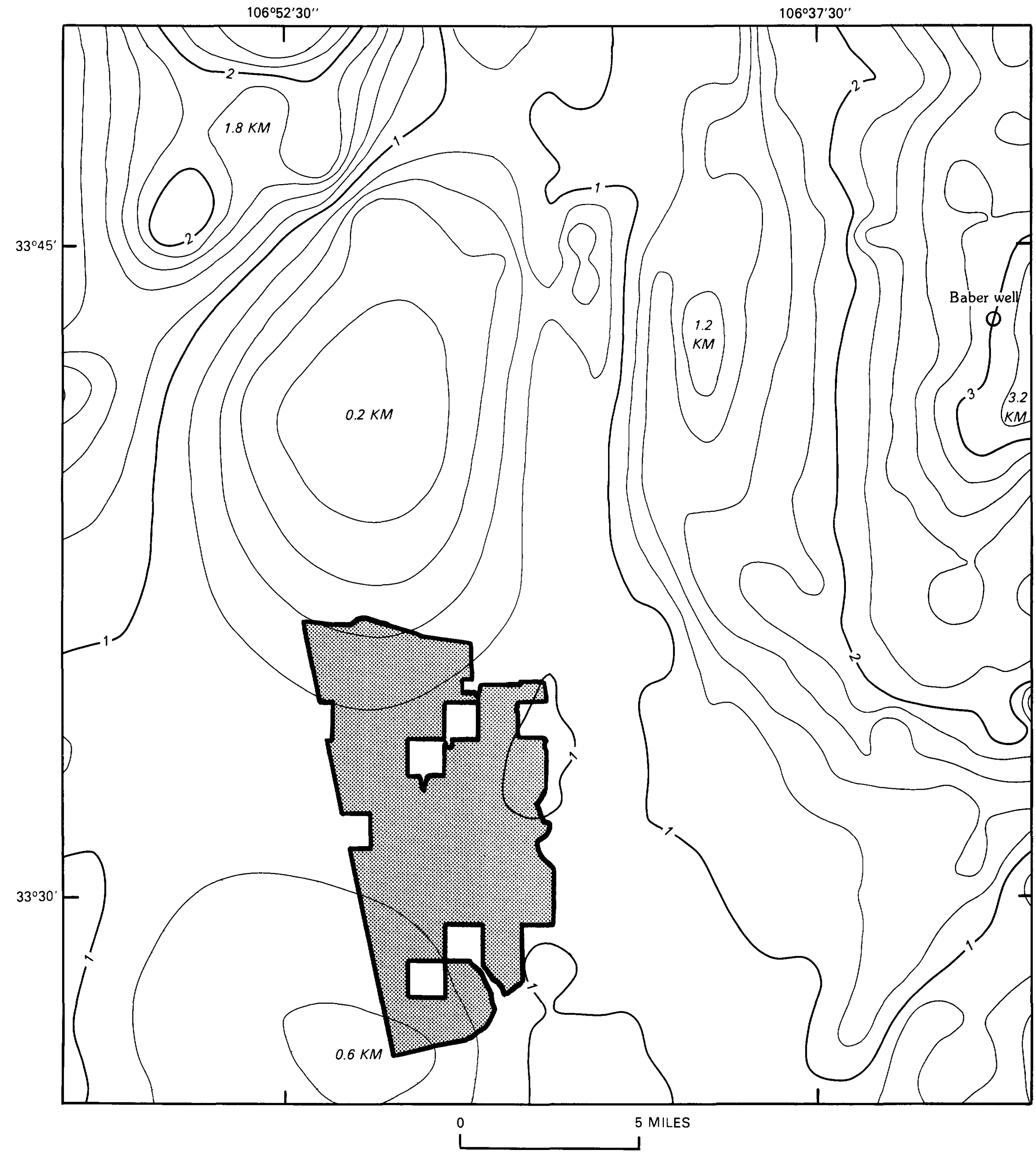


Figure 4. Map showing depth to Paleozoic basement rocks below Santa Fe Group rocks, Jornada del Muerto Wilderness Study Area and vicinity, New Mexico. Contour interval 0.2 kilometers (about 650 ft). Wilderness study area is shaded.

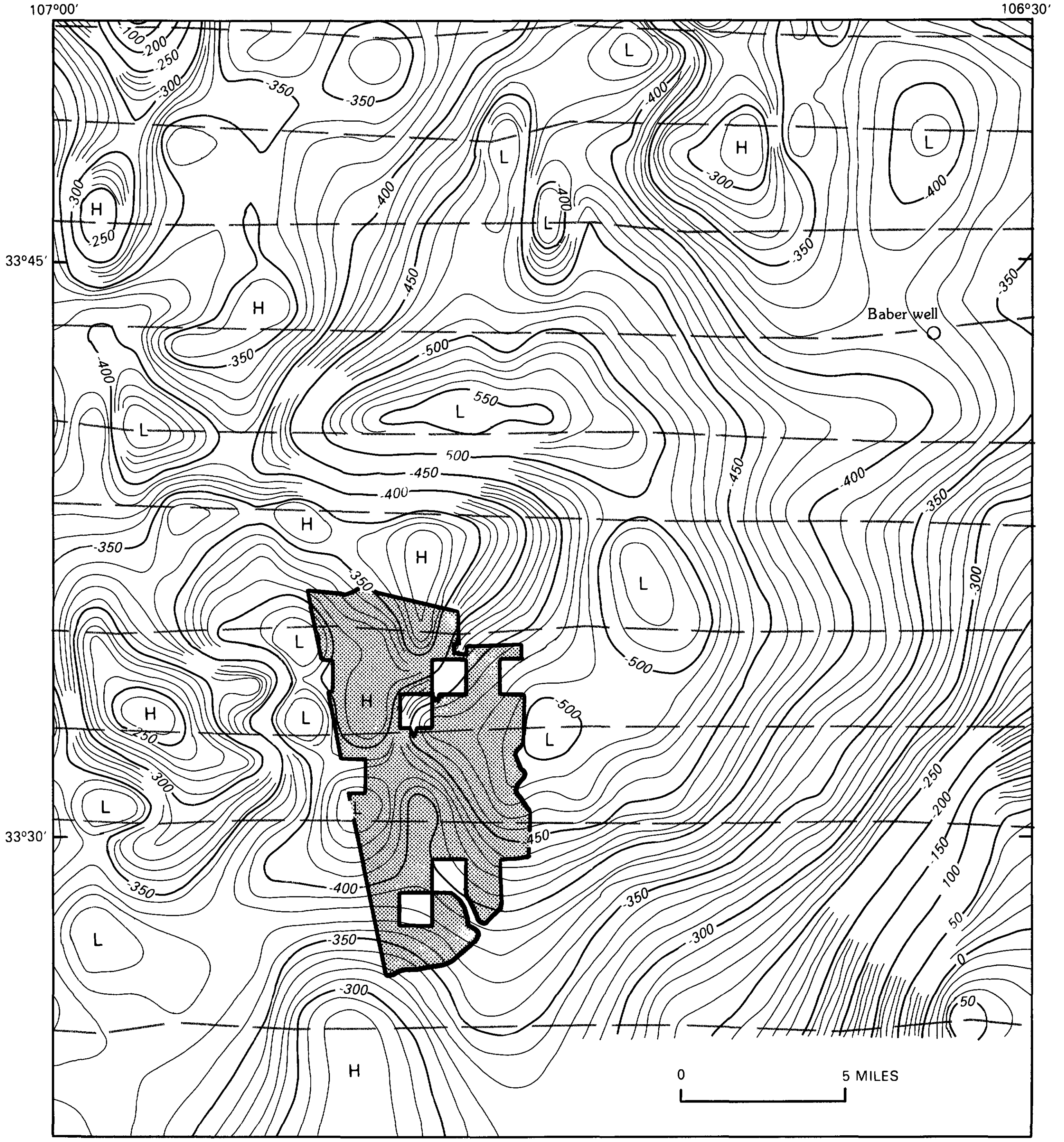


Figure 5. Aeromagnetic map of the Jornada del Muerto Wilderness Study Area and vicinity, New Mexico. Dashed lines are flight lines from the National Uranium Resource Evaluation survey. Contour interval 10 gammas. Wilderness study area is shaded.

indicated values of 1.6–2.0 ppm (parts per million) equivalent uranium, 6.0–7.5 ppm equivalent thorium, and 1.5–2.1 percent potassium (J.S. Duval, U.S. Geological Survey, written commun., 1986). No anomalies are within or near the study area.

Mineral Resource Potential

Metallic Deposits

The Jornada del Muerto Wilderness Study Area lacks the geologic environments favorable for metallic mineral deposits, with the exception of sedimentary uranium. Occurrences of uranium minerals have been found in sedimentary rocks of the Tertiary Santa Fe Group throughout New Mexico (Hilpert, 1965). These moderately indurated and generally permeable basin-fill sediments contain abundant silicic volcanic debris and some organic-rich material, features which suggest a favorable environment for sandstone-hosted uranium deposits. In addition, the wilderness study area subsurface may meet some of the criteria proposed by Carlisle and others (1978) for uranium-bearing nonpedogenic calcrete deposits, namely adequate source terrane (deeply eroded Tertiary volcanic rocks) and a large catchment area. On the other hand, Berry and others (1982) concluded that the Santa Fe Group (in the Tularosa 1°×2° quadrangle, New Mexico) is unfavorable for either uraniferous calcrete or sandstone uranium deposits because the unit is above ground-water table and is highly oxidized. A low potential for metals, including uranium in sedimentary-type deposits, is assigned to the wilderness study area, with certainty level B.

Geothermal Energy

Two thermal springs, with water temperatures of 24 °C and 34 °C, 5–7 mi southwest of the wilderness study area, and the presence of Pleistocene volcanic activity suggest that an anomalous heat source may underlie the general area. Geophysical data, however, do not indicate the presence of any plutonic bodies close to the surface of the study area. The wilderness study area is assessed as having a low potential, at certainty level B, for geothermal energy.

Oil and Gas

The wilderness study area is probably underlain at depths as shallow as 3,000 ft by upper Paleozoic rocks that in southeastern New Mexico are highly productive reservoir rocks. In the Rio Grande rift valley, however, these rocks have been structurally disturbed and intruded by igneous rocks, factors which do not enhance the rock's ability to hold significant quantities of oil and gas. Five exploratory holes testing the oil and gas potential of the Paleozoic rocks have been drilled near the wilderness study area, two about 6 mi to the southwest and three about 14 mi to the north; all were dry (U.S. Geological Survey, 1981). The wilderness study area is assessed as having a low potential, at certainty level B, for oil and gas.

Coal

The wilderness study area consists of recent volcanic rocks and therefore lacks the environment suitable for coal. Coal is present 25 mi north of the study area in rocks of the Mesaverde Group at the Carthage coal field. Because of the cover of Quaternary deposits, it is unknown how far south the Mesaverde Group extends, and whether coal-bearing units in the Mesaverde are present beneath the study area. Most of the coal in New Mexico occurs in the Mesaverde Group. However, minor amounts of coal occur in southern New Mexico in Paleozoic sedimentary rocks (U.S. Geological Survey, 1965). Paleozoic sedimentary rocks may underlie the wilderness study area at depths as shallow as 3,000 ft below the surface but whether they are coal-bearing is unknown. The mineral resource potential for coal in the wilderness study area is unknown, with certainty level A.

Sand

In the northwestern and southwestern parts of the study area, deposits of sand as much as 10 ft thick overlie the basalt. The mineral resource potential for undiscovered sand resources in these areas is moderate, with certainty level B.

Gem-Quality Olivine (Peridot)

Semiprecious gem-quality olivine occurs in several late Tertiary–Quaternary alkali olivine basalt flows in the southwestern United States. The olivine occurs both as phenocrysts disseminated throughout the lava and as xenocrystic clots carried up from depth by the lava. Most of the occurrences are only mineralogic curiosities; however, in the San Carlos Indian Reservation in southeastern Arizona gem olivine is mined from a young basalt flow (Vuich and Moore, 1977). The lavas of Jornada del Muerto contain only 3–5 percent small phenocrysts of olivine, and no olivine-bearing xenocrystic nodules have been observed; the potential for gem-quality olivine is low, with certainty level C.

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APPENDIX

DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

Definitions of Mineral Resource Potential

LOW mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics define a geologic environment in which the existence of resources is unlikely. This broad category embraces areas with dispersed but insignificantly mineralized rock as well as areas with few or no indications of having been mineralized.

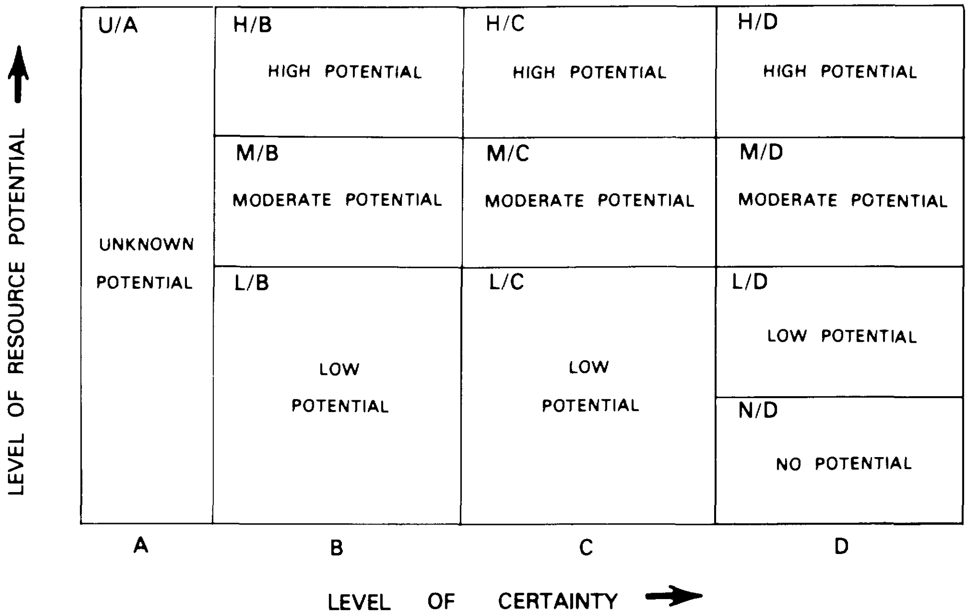
MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a reasonable likelihood of resource accumulation, and (or) where an application of mineral-deposit models indicates favorable ground for the specified type(s) of deposits.

HIGH mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a high degree of likelihood for resource accumulation, where data support mineral-deposit models indicating presence of resources, and where evidence indicates that mineral concentration has taken place. Assignment of high resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area.

UNKNOWN mineral resource potential is assigned to areas where information is inadequate to assign low, moderate, or high levels of resource potential.

NO mineral resource potential is a category reserved for a specific type of resource in a well-defined area.

Levels of Certainty



A. Available information is not adequate for determination of the level of mineral resource potential.
B. Available information suggests the level of mineral resource potential.
C. Available information gives a good indication of the level of mineral resource potential.
D. Available information clearly defines the level of mineral resource potential.

Abstracted with minor modifications from:

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RESOURCE / RESERVE CLASSIFICATION

	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability Range (or)	
	Measured	Indicated		Hypothetical	Speculative
ECONOMIC	Reserves		Inferred Reserves		
MARGINALLY ECONOMIC	Marginal Reserves		Inferred Marginal Reserves		
SUB-ECONOMIC	Demonstrated Subeconomic Resources		Inferred Subeconomic Resources		

Major elements of mineral resource classification, excluding reserve base and inferred reserve base. Modified from U. S. Bureau of Mines and U. S. Geological Survey, 1980, Principles of a resource/reserve classification for minerals: U. S. Geological Survey Circular 831, p. 5.

GEOLOGIC TIME CHART

Terms and boundary ages used in this report

EON	ERA	PERIOD		EPOCH	BOUNDARY AGE IN MILLION YEARS
Phanerozoic	Cenozoic	Quaternary		Holocene	0.010
				Pleistocene	1.7
		Tertiary	Neogene Subperiod	Pliocene	5
				Miocene	24
			Paleogene Subperiod	Oligocene	38
				Eocene	55
				Paleocene	66
	Mesozoic	Cretaceous		Late	96
				Early	138
		Jurassic		Late Middle Early	205
		Triassic		Late Middle Early	~ 240
	Paleozoic	Permian		Late Early	290
		Carboniferous Periods	Pennsylvanian	Late Middle Early	~ 330
			Mississippian	Late Early	360
		Devonian		Late Middle Early	410
		Silurian		Late Middle Early	435
		Ordovician		Late Middle Early	500
		Cambrian		Late Middle Early	~ 570[1]
Proterozoic	Late Proterozoic				900
	Middle Proterozoic				1600
	Early Proterozoic				2500
Archean	Late Archean				3000
	Middle Archean				3400
	Early Archean				3800?
pre-Archean[2]					4550

[1] Rocks older than 570 m.y. also called Precambrian, a time term without specific rank.

[2] Informal time term without specific rank.

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