Mineral Resources of the Papa Keal and Zapata Creek Wilderness Study Areas, Alamosa County, Colorado

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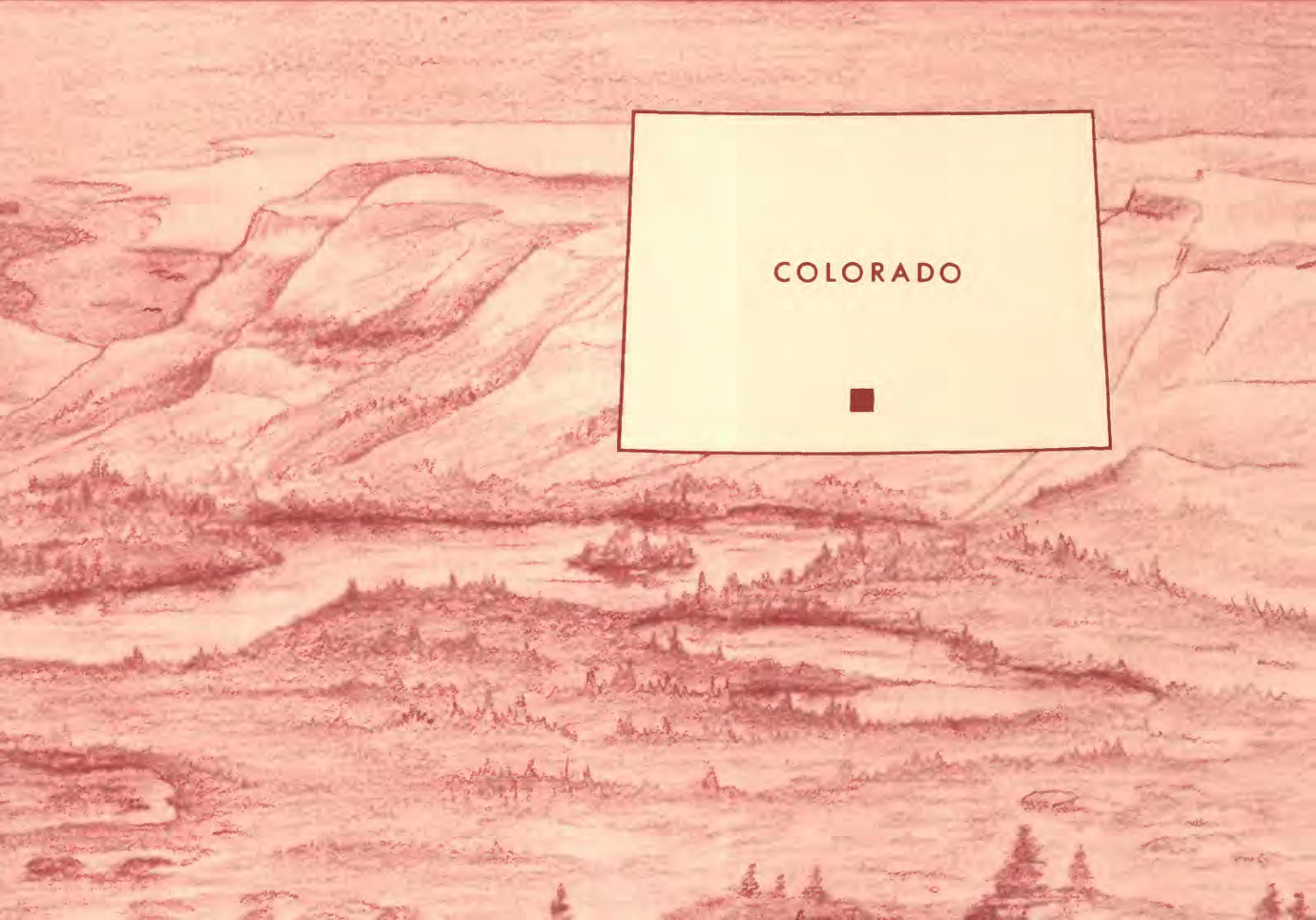


DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

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.

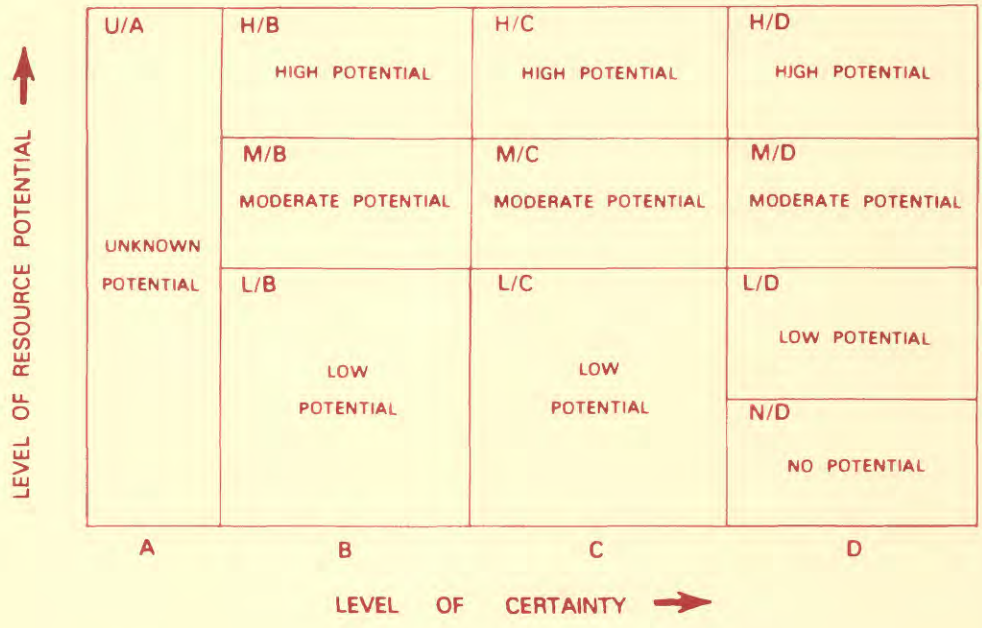
MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a reasonable likelihood of resource accumulation, and (or) where an application 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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Chapter D

MINERAL RESOURCES OF WILDERNESS STUDY AREAS—
SOUTH-CENTRAL COLORADO

Mineral Resources of the Papa Keal and Zapata Creek Wilderness Study Areas, Alamosa County, Colorado

By Bruce R. Johnson and Jerry R. Hassemer
U.S. Geological Survey, and
Brian J. Hannigan, U.S. Bureau of Mines

U.S. GEOLOGICAL SURVEY BULLETIN 1716–D

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, *Secretary*

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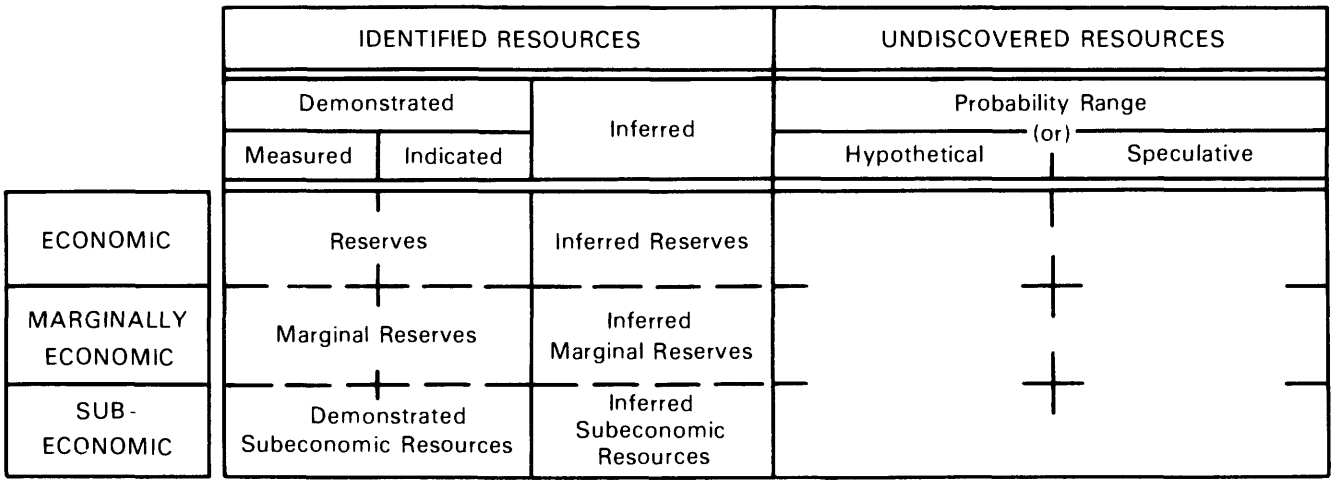
STUDIES RELATED TO WILDERNESS

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 Papa Keal (CO–50–137) and Zapata Creek (CO–50–139B) Wilderness Study Areas, Alamosa County, Colorado

RESOURCE/RESERVE CLASSIFICATION



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.

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(In pocket)

FIGURES

MINERAL RESOURCES OF WILDERNESS STUDY AREAS—
SOUTH-CENTRAL COLORADO

Mineral Resources of the Papa Keal and Zapata Creek Wilderness Study Areas, Alamosa County, Colorado

By Bruce R. Johnson *and* Jerry R. Hassemer
U.S. Geological Survey, *and*
Brian J. Hannigan
U.S. Bureau of Mines

SUMMARY

The Papa Keal (CO-50-137) and Zapata Creek (CO-50-139B) Wilderness Study Areas have no identified mineral resources and have low resource potential for mineral deposits including oil, gas, coal, and all metals. Factors considered in reaching this conclusion include: low values for all metals both in mine and prospect samples and in geochemical samples, limited distribution of visibly mineralized rock, and lack of host structures for mineral or energy deposits within the study areas. This conclusion is based on earlier surveys of the adjacent Sangre de Cristo Wilderness Study Area (Ellis and others, 1983; Johnson and others, 1984) and on field investigations conducted in 1983 and 1984.

The wilderness study areas are about 20 mi northeast of Alamosa along the western foothills of the Sangre de Cristo Range in Alamosa County, Colorado. The Papa Keal Wilderness Study Area (620 acres; fig. 1) is irregularly shaped and is about 1 mi (mile) south of the Great Sand Dunes National Monument. The Zapata Creek Wilderness Study Area (720 acres; fig. 1) is in two tracts extending south from the Papa Keal area. Both study areas are contiguous to the Sangre de Cristo Wilderness Study Area. The study of this acreage was requested by the U.S. Bureau of Land Management. In this report, the studied areas are called "wilderness study areas" or just "study areas."

Nearly all of the rocks exposed in the two study areas are Early Proterozoic (2,500–1,600 m.y. or million years; see the geologic time chart on the last page of this report) crystalline rocks. In the Papa Keal Wilderness Study Area and in the northern half of the Zapata Creek Wilderness Study Area, the crystalline rocks consist of

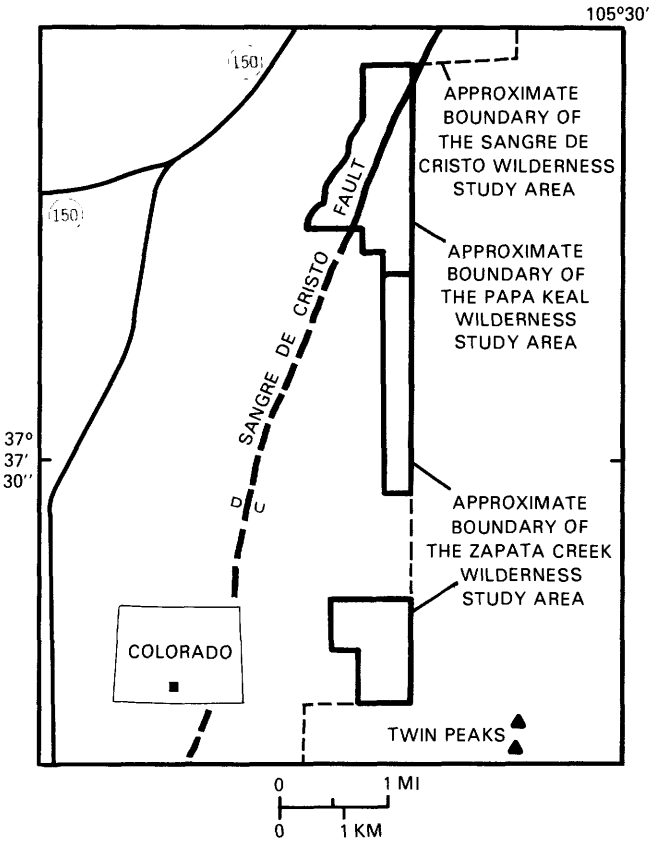

Figure 1. Map showing the mineral resource potential of the Papa Keal and Zapata Creek Wilderness Study Areas, Alamosa County, Colorado. Both study areas have low mineral resource potential for base and precious metals, oil, gas, and coal, and geothermal energy, with certainty level C. The Sangre de Cristo fault is dashed where approximately located. D, downthrown side; U, upthrown side.

a mixed gneiss unit composed of discontinuous layers of many rock types and a small part of a dioritic pluton. In addition, the northern part of the Zapata Creek study area contains a small thrust fault-bound slice of upper Paleozoic (360–240 m.y.) sedimentary rock and part of a small Tertiary (less than 63 m.y.) granitic stock. The southern half of the Zapata Creek study area is entirely underlain by a homogeneous tonalitic gneiss of Early Proterozoic age. The study areas straddle the topographic and structural boundary between the uplifted block of the Sangre de Cristo Range and the adjacent San Luis Valley. The boundary is marked by the Sangre de Cristo fault, a range-front normal fault zone with perhaps 20,000 ft (feet) of vertical offset since late Oligocene (about 30 m.y.) time.

Stream-sediment samples were collected from first- and second-order drainages in and near the study areas. At each site a panned concentrate was made of a sample of coarse-grained sediment, and a minus-80-mesh fraction was prepared from a separate sample of fine-grained sediment. No anomalous element values were found by analysis of panned-concentrate samples except for a few barely anomalous tungsten values. Tungsten occurrences along the crest of the range, east of the study areas, are the probable source of these anomalous values. No anomalous values were found by analysis of minus-80-mesh samples.

Although no mine workings were found within the wilderness study areas, several adits, shafts, and prospects are within 3 mi of the study-area boundaries. There are 15 patented claims within 2 mi of the study-area boundaries, but none of these claims extend within the study areas. The southern part of the Zapata Creek study area is in the West Blanca mining district. Although prospects are common within the mining district, there is no record of mineral production. The Papa Keal study area is not within a mining district. There is no record of production in or within 2 mi of either study area.

There are no identified resources within the study areas, and based upon geochemical analyses, geological surveys, and the absence of surface workings, the wilderness study areas are considered to have low mineral resource potential for both metallic mineral deposits and energy sources. Few stream-sediment samples showed values above background levels. No mineralized areas are within the study areas, and minor mineralized structures outside of the study areas do not trend toward or extend into the areas. The Sangre de Cristo fault passes through the Papa Keal study area. No evidence of mineralization was found along the fault within the study areas, but such evidence could be concealed by alluvial-fan deposits that cover the fault for part of its length. Surface bedrock within the study areas is not a suitable source or reservoir rock for oil or gas; favorable traps for petroleum are not likely even if suitable source rocks were present. No hot springs or hot-spring deposits have been found in the study areas.

INTRODUCTION

The Papa Keal (CO-50-137) and Zapata Creek (CO-50-139B) Wilderness Study Areas are about 20 mi northeast of Alamosa, in Alamosa County, Colorado (fig. 2). The U.S. Bureau of Land Management requested mineral surveys on 620 acres of the Papa Keal Wilderness Study Area and 720 acres of the Zapata Creek Wilderness Study Area. The Papa Keal study area is irregularly shaped and is about 1 mi south of the Great Sand Dunes National Monument along the western foothills of the Sangre de Cristo Range. The Zapata Creek study area consists of two separate tracts. The northern part (320 acres) adjoins the southern boundary of the Papa Keal study area and is a narrow rectangle 0.25 mi east to west and 2 mi north to south. The southern part of the Zapata Creek study area (400 acres) is an irregular block 1 mi south of the northern part. All three tracts of the two study areas adjoin the Rio Grande National Forest and the Sangre de Cristo Wilderness Study Area. The study areas are accessible from State Highway 150 via rough dirt roads near the northern and southern ends and via national forest trails. Elevations in the study areas range from 8,000 ft at the western edge of the Papa Keal area to 10,800 ft at the southeastern corner of the southern Zapata Creek area.

Investigations by the U.S. Bureau of Mines

The Papa Keal and Zapata Creek Wilderness Study Areas were examined by U.S. Bureau of Mines personnel in 1983 during an investigation of the Sangre de Cristo Wilderness Study Area in the Rio Grande and San Isabel National Forests (Ellis and others, 1983). Prior to the field investigations, a detailed literature search was made for pertinent geologic and mining information. In January 1984, Bureau of Land Management records were checked for the location of patented and unpatented claims, and for oil and gas, geothermal, and other mineral leases in or near the study areas.

Field studies by Bureau of Mines personnel included investigation of prospects and mineralized areas within 3 mi of the study areas. Although no workings were found within the study areas, assay samples were collected from 4 adits, 1 caved adit, 2 shafts, and 13 prospects within 3 mi of the study areas (Hannigan, 1984). Locations of adits, shafts, prospects, and claims within 1 mi of the study areas are shown on plate 1; for other locations, see Hannigan (1984). All samples were fire assayed for gold and silver and analyzed for 40 elements by semiquantitative spectrographic methods. Selected samples

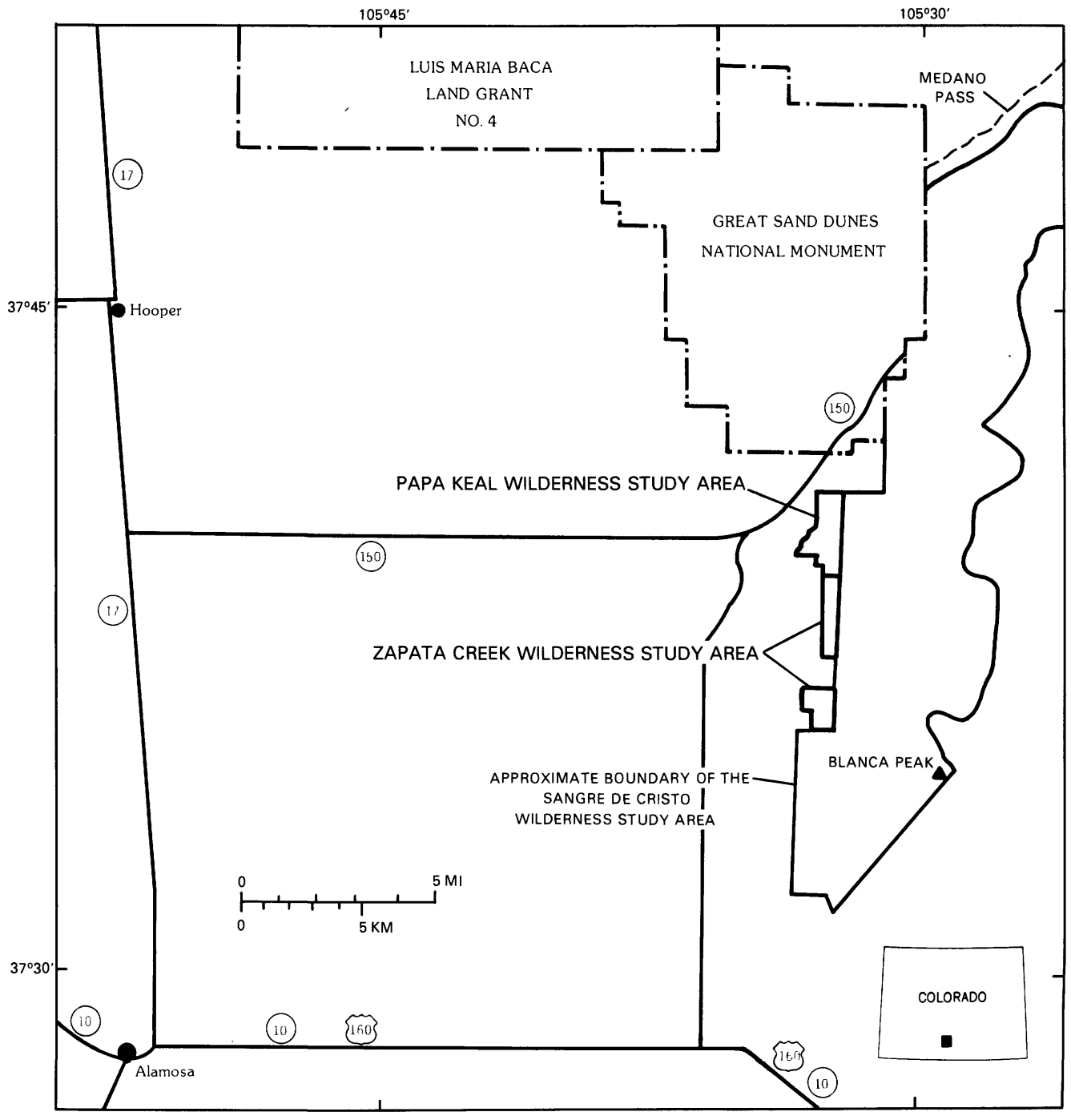

Figure 2. Index map showing the location of the Papa Keal and Zapata Creek Wilderness Study Areas, Alamosa County, Colorado.

were analyzed for base-metal content using atomic-absorption methods. Complete sample descriptions and analytical results are available for public inspection at the U.S. Bureau of Mines, Intermountain Field Operations Center, Building 20, Denver Federal Center, Denver CO 80225.

Investigations by the U.S. Geological Survey

From 1982 through 1984, U.S. Geological Survey personnel conducted investigations to assess the potential for undiscovered deposits in the Papa Keal and Zapata Creek Wilderness Study Areas. This assessment is based on the following: a published resource assessment of the Sangre de Cristo Wilderness Study Area (Johnson and others, 1984), geologic investigations of the Sangre de Cristo Wilderness Study Area (Johnson and others, in press) and of the Zapata Ranch and Twin Peaks quadrangles (Bruce and Johnson, in press; Johnson and Bruce, in press), geochemical sampling in the study areas (mostly in 1982) (see the section on "Geochemistry"), and other field

investigations in 1983. The study areas are included on an aeromagnetic map of the Sangre de Cristo Mountains (U.S. Geological Survey, 1983). The mineral resource potential classification of Goudarzi (1984) is used throughout this report (see inside front cover).

APPRAISAL OF IDENTIFIED RESOURCES

by Brian J. Hannigan, U.S. Bureau of Mines

Mining Districts and Mining Activity

The southern half of the Zapata Creek Wilderness Study Area is within the West Blanca mining district. Although prospects are common in the West Blanca mining district, there is no record of production. The Papa Keal Wilderness Study Area and the northern part of the Zapata Creek Wilderness Study Area are not in mining districts. There is no record of production in or within 2 mi of either of the study areas.

Although no patented claims exist within the study areas, 15 patented claims are within 2 mi of them (pl. 1). No unpatented claims are in or within 2 mi of the study areas. No mines or prospects were found within the study areas.

Mineralized Areas

Mineralized structures, scattered along the base of the Sangre de Cristo Range, occur along or near the Sangre de Cristo fault in rocks of all ages (Ellis and others, 1983). The Sangre de Cristo fault, the only major structure in the area, is present in the Papa Keal Wilderness Study Area and is within 1 mi of the western edge of the Zapata Creek Wilderness Study Area; it dips steeply to the west (pl. 1). No evidence of mineralization was found near the Sangre de Cristo fault in or within 1 mi of the study areas; however, the fault zone is covered by alluvial fans in much of the area. Minor faults near the Sangre de Cristo fault, 1–3 mi from the study areas, contain small, discontinuous occurrences of gold, silver, and copper.

About 1 mi north of the Papa Keal Wilderness Study Area, east-trending low-angle faults in granite gneiss (mixed gneiss, unit Xgn, pl. 1) dip shallowly to the north. The faults do not trend toward or extend into the study areas and are not shown on plate 1. The fault zones are 1 to 5 ft thick and are exposed in three adits, two shafts, and several prospects. Chip and grab samples were taken from sporadically mineralized fault zones and dumps at these workings. Gold values ranging from 0.02 to 0.26 oz/ton (ounce per ton) were determined in 7 of the 15 samples taken here. Two of the samples assayed 0.3 oz silver per ton. An average of 0.52 percent copper was detected in three of the samples. Three other samples contained traces of copper, and one sample contained a trace of molybdenum.

Two chip samples and one grab sample, taken from two prospects within 1 mi of the Zapata Creek Wilderness Study Area in an iron-stained granite containing epidote and chlorite, were barren. No structural features were observed in either of the prospects.

Small, discontinuous pods and veinlets of quartz in granodiorite, diorite, and gneiss are exposed in four prospect pits and an adit, 2–3 mi south of the Zapata Creek Wilderness Study Area (outside the area of pl. 1; see Hannigan (1984) for locations). Traces of silver, copper, bismuth, molybdenum, and cobalt were detected in chip and grab samples collected at these locations.

Energy Resources

There are no geothermal or oil and gas leases within 2 mi of the Papa Keal and Zapata Creek Wilderness Study Areas. No hot springs or remnants of hot springs were found in either of the study areas. No evidence of radioactive energy resources was observed in or near the study areas.

ASSESSMENT OF POTENTIAL FOR UNDISCOVERED RESOURCES

by Bruce R. Johnson and Jerry R. Hassemer U.S. Geological Survey

Geology

The Papa Keal and Zapata Creek Wilderness Study Areas lie in the western foothills of the Sangre de Cristo Range in south-central Colorado. The rocks of the Sangre de Cristo Range were extensively deformed by folding and thrust faulting during Laramide time (Late Cretaceous to Eocene; Lindsey and others, 1983). In the late Oligocene, the time of the opening of the Rio Grande rift, the Sangre de Cristo Range began to rise relative to the adjacent San Luis Valley. Uplift and erosion exposed the Laramide structures in the central part of the range. The study areas straddle the boundary between the uplifted Sangre de Cristo block and the down-dropped San Luis Valley.

Nearly all of the rocks exposed in the two study areas are Early Proterozoic crystalline rocks (pl. 1). The Papa Keal Wilderness Study Area and the northern part of the Zapata Creek Wilderness Study Area are almost entirely underlain by a mixed gneiss unit of Early Proterozoic age east of the Sangre de Cristo fault. West of

the fault, the areas are underlain by Quaternary alluvial-fan deposits. The mixed gneiss unit contains a wide variety of lithologies, both felsic and mafic gneisses and granitic intrusive bodies of various compositions. Layering in the gneisses is rarely continuous for more than a few hundred yards. The intrusive bodies are also discontinuous. All lithologies within the unit are extensively altered. In addition to the mixed gneiss unit, an Early Proterozoic diorite pluton crops out in the northern part of the Zapata Creek Wilderness Study Area. A small thrust-bound slice of upper Paleozoic clastic sedimentary rock (Minturn Formation) crops out at the southern edge of the northern part of the Zapata Creek Wilderness Study Area. Part of a small granitic stock of Tertiary age is also exposed in the northern part of this study area.

The southern part of the Zapata Creek Wilderness Study Area is entirely underlain by a tonalitic gneiss of Early Proterozoic age. The tonalitic gneiss is much more homogeneous than the mixed gneiss to the north. It is weakly foliated and moderately altered (to chlorite and sericite) throughout the study area. The alteration becomes more intense near faults and shear zones.

For most of its length, the Sangre de Cristo Range is bounded on the west by a large, normal, range-front fault (the Sangre de Cristo fault) that formed in response to extensional rifting. The extensional rifting and attendant uplift of the range probably began in late Oligocene time, proceeded rapidly at intervals beginning in early Miocene time, and continues today. The cumulative movement along the range-front fault is such that the floor of the Miocene and younger sedimentary and volcanic fill of the San Luis Valley is as much as 20,000 ft below the top of the range.

Geochemistry

Stream-sediment samples were collected from first- and second-order drainages in and near the Papa Keal and Zapata Creek Wilderness Study Areas (pl. 1). From each sample locality, a panned-concentrate sample and a minus-80-mesh fraction from a separate sample were analyzed for 31 elements, by semiquantitative spectrographic methods (Adrian and others, 1984). No anomalous values were found in the minus-80-mesh samples.

Each panned-concentrate sample represents a composite collection of stream sediment panned in the field to an approximate composition of half dark minerals and half light minerals. Samples were processed to obtain nonmagnetic, heavy-mineral (specific gravity greater than 2.80) concentrates for analysis. No anomalous values were found by the panned-concentrate analyses except for a few, barely anomalous tungsten values. These values are in samples from drainage basins predominantly above and east of the study areas. Known tungsten occurrences along the crest of the range, east of the study areas (Johnson and others, 1984), are the probable source of the anomalous tungsten in the samples from the study area. All of the samples from drainage basins essentially within the study areas are barren of anomalous metals.

Geophysics

No large-scale geophysical studies were carried out within the Papa Keal and Zapata Creek study areas. The study areas are included within the aeromagnetic map of the Sangre de Cristo Mountains (U.S. Geological Survey, 1983), where they do not appear to be associated with any significant anomalies.

Mineral and Energy Resources

No mineralized areas were identified within the Papa Keal and Zapata Creek Wilderness Study Areas. No geochemical anomalies could be defined within the study areas either from stream-sediment sampling or from rock assays. The bedrock, medium-grade Precambrian granitic gneisses of various compositions, is not known to be a source of significant mineral deposits in the vicinity of the study areas.

The only known occurrences of minerals of possible economic interest in rocks similar to those found in the study areas are small vein deposits containing gold, silver, and copper along the western margin of the Sangre de Cristo Range. These deposits occur discontinuously along the Sangre de Cristo fault zone and in smaller faults near the main fault. They consist of veins formed in fissures and fractures in siliceous host rocks. Although alluvial cover along parts of the main Sangre de Cristo fault zone precludes complete examination, no evidence was found to indicate the existence of base- or precious-metal vein deposits within the study areas.

Although biogenic gas occurs in water wells within the San Luis Valley west of the study areas (Gries, 1985), the exposed bedrock within the study areas is not a suitable source or reservoir rock for oil or gas. Due to the highly fractured nature of the Sangre de Cristo fault zone, favorable traps for petroleum are not likely even if suitable source and reservoir rocks were present. No hot springs or indications of geothermal activity have been found within the study areas. No occurrences of radioactive minerals above normal background levels are known within the study areas.

The Papa Keal and Zapata Creek Wilderness Study Areas are judged to have low mineral resource potential for both metallic-mineral deposits and energy sources. The low mineral resource potential designation for the study areas is assigned with a certainty level of C for all commodities because available information gives a good indication of the level of resource potential.

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GEOLOGIC TIME CHART

Terms and boundary ages used by the U. S. Geological Survey, 1986

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 Early	96 138
		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				
pre-Archean[2]					3800?
					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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Mineral Resources of Wilderness Study Areas—South-Central Colorado

This volume was published
as separate chapters A–D

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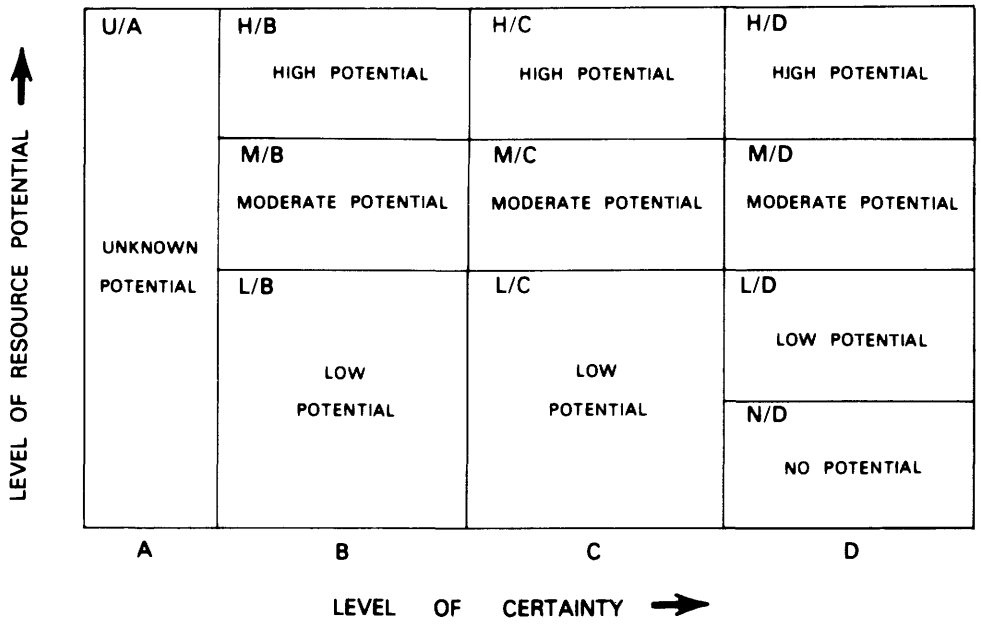
NO mineral resource potential is a category reserved for a specific type of resource in a well-defined area.

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:

Taylor, R. B., and Steven, T. A., 1983, Definition of mineral resource potential: Economic Geology, v. 78, no. 6, p. 1268–1270.

Taylor, R. B., Stoneman, R. J., and Marsh, S. P., 1984, An assessment of the mineral resource potential of the San Isabel National Forest, south-central Colorado: U.S. Geological Survey Bulletin 1638, p. 40–42.

Goudarzi, G. H., compiler, 1984, Guide to preparation of mineral survey reports on public lands: U.S. Geological Survey Open-File Report 84–0787, p. 7, 8.

CONTENTS

[Letters designate the chapters]