MINERAL RESOURCE ASSESSMENT, BIG BEND RANCH STATE NATURAL AREA, PRESIDIO AND BREWSTER COUNTIES, TEXAS

FINAL REPORT

Prepared by

Christopher D. Henry
Jay A. Raney
Jeffrey N. Rubin
Alan R. Standen

Bureau of Economic Geology
W. L. Fisher, Director
The University of Texas at Austin
Austin, Texas 78713

For
Texas Parks and Wildlife Department
Contract No. IAC (88-89)-1508

March 1989

CONTENTS

ILLUSTRATIONS

Figures

Tables

MINERAL RESOURCE ASSESSMENT, BIG BEND RANCH STATE NATURAL AREA, PRESIDIO AND BREWSTER COUNTIES, TEXAS

Christopher D. Henry
Jay A. Raney
Jeffrey N. Rubin
Alan R. Standen

Bureau of Economic Geology
The University of Texas at Austin
Austin, Texas 78713

SUMMARY

The Big Bend Ranch State Natural Area has a diverse geology reflecting nearly 600 million years of geologic evolution. Major geologic events include (1) deposition of clastic sedimentary rocks during the Paleozoic and their deformation (folding and faulting) at the end of the Paleozoic; (2) deposition of limestone and clastic rocks during the Cretaceous and their deformation during the early Tertiary; (3) intense extrusive and intrusive igneous activity during the middle Tertiary; and (4) major normal faulting during the late Tertiary.

Almost all mineral potential of the area is associated with mid-Tertiary igneous activity. The only significant mineral production within the Ranch area was from the Fresno Mine in the western part of the Terlingua mercury district, one of the largest mining districts in Texas. This mine produced approximately 3500 flasks of mercury, mostly during World War II. Other production was minor and included some additional mercury from localities near the Fresno Mine, as well as silver-lead ore containing minor gold from a small mine in the Solitario.

The eastern part of the Ranch has the greatest potential for economic mineral deposits. Areas along the Terlingua monocline, the site of the Fresno Mine, and within Contrabando Dome are prospective for mercury and possibly for precious metals (silver, gold). The Solitario, an igneous dome mantled by Cretaceous and Paleozoic sedimentary rocks, has numerous prospects and areas of

hydrothermal alteration. Both the extent of alteration and geochemical anomalies indicate significant potential for precious and base (molybdenum, lead, zinc, copper) metal deposits. However, none of the prospects are currently economic given existing prices of metals and available information on grades and tonnage of mineralization. Minor prospects and areas of hydrothermal alteration elsewhere on the Ranch indicate local potential for other metal deposits. Too little information is available for any of the prospects on the Ranch to permit us to estimate reserves or resources.

More speculative mineral potential includes (1) rare metals, particularly beryllium, associated with several peralkaline rhyolite intrusions and (2) zeolite (clinoptilolite) found in tuffaceous sediments. Potential for the former is based on the similarity of these intrusions to others in Trans-Pecos Texas that are hosts for significant concentrations of rare metals. However, no prospects exist within the Ranch, and considerable exploration would be necessary to determine whether any mineralization exists. Potential for zeolite is based on the known occurrence of clinoptilolite in the sediments, the existence of one prospect, and a history of exploration. However, development would require identification of a high-grade, large-volume deposit close to a major transportation line.

INTRODUCTION

Evaluation of the mineral potential of a region is a difficult task that requires a thorough knowledge of the area's geology and an understanding of how mineral deposits can form within the context of that geology. Site-specific information on mines or prospects is also essential. The information is never complete, because more can always be learned about the geology and about the extent and grade of a deposit.

Information to evaluate the proposed Big Bend Ranch State Natural Area (here referred to as the Ranch) is of variable scope and quality. The basic geology of the area is moderately well known. In contrast, little has been published about mineralization of the area, largely because mineral production has been small. In this study, we relied on published information, some unpublished data (including files of the General Land Office and of the Bureau of Economic Geology), and our own field investigation of the geology and prospects of the Ranch.

This report starts with a brief review of the geology of the Ranch, emphasizing the rocks and processes that are most likely to be associated with mineralization. Much of the basic data for the evaluation are in Appendix A, a compilation of all available information about mines, prospects, and areas of hydrothermal alteration on the Ranch. The geology and prospect data were used to evaluate each tract of land administered by the Texas General Land Office. A final section discusses the areas having the greatest potential for mineralization as well as some more speculative mineral possibilities.

GEOLOGY OF THE BIG BEND RANCH

The area now included within the Big Bend Ranch State Natural Area has undergone a long and complex geologic history. Rocks that crop out range in age from Cambrian to Recent. Major tectonic events near the end of the Paleozoic, in the early Cenozoic, and in the late Cenozoic have significantly deformed the rocks. The following discussion presents the rocks in chronological sequence from oldest to youngest. Tertiary igneous rocks are emphasized because much of the mineral potential of the Ranch is associated with these rocks. Additional information about the geology of the Ranch is cited in the references.

The Emory Peak-Presidio sheet (Brown and others, 1979) of the Geologic Atlas of Texas is an essential companion to a discussion of the geology and mineral potential of the Ranch area. Figure 1, an index map of areas, prospects, and selected geologic features of the Ranch, is also provided in a clear plastic version to lay over the published geologic map. Figures 2, 3, and 4 depict the geology of three areas of significant mineral prospects.

Previous Work

Geologic maps and reports by Erickson (1953), Herrin (1958), Dietrich (1966), McKnight (1970), and Hardisty (1982) cover most of the Ranch area; however, only the maps by Erickson and Hardisty are on a topographic base. A manuscript and geologic map of the Solitario quadrangle (Corry and others) have been submitted to the Bureau of Economic Geology for possible publication.

Other publications that specifically address geology of the Ranch include Lonsdale (1940) on the igneous geology of the Solitario, Yates and Thompson (1959) on the geology and ore deposits of the Terlingua mercury district, Robinson (1976) on sedimentary rocks in basins along the Rio Grande, and Price

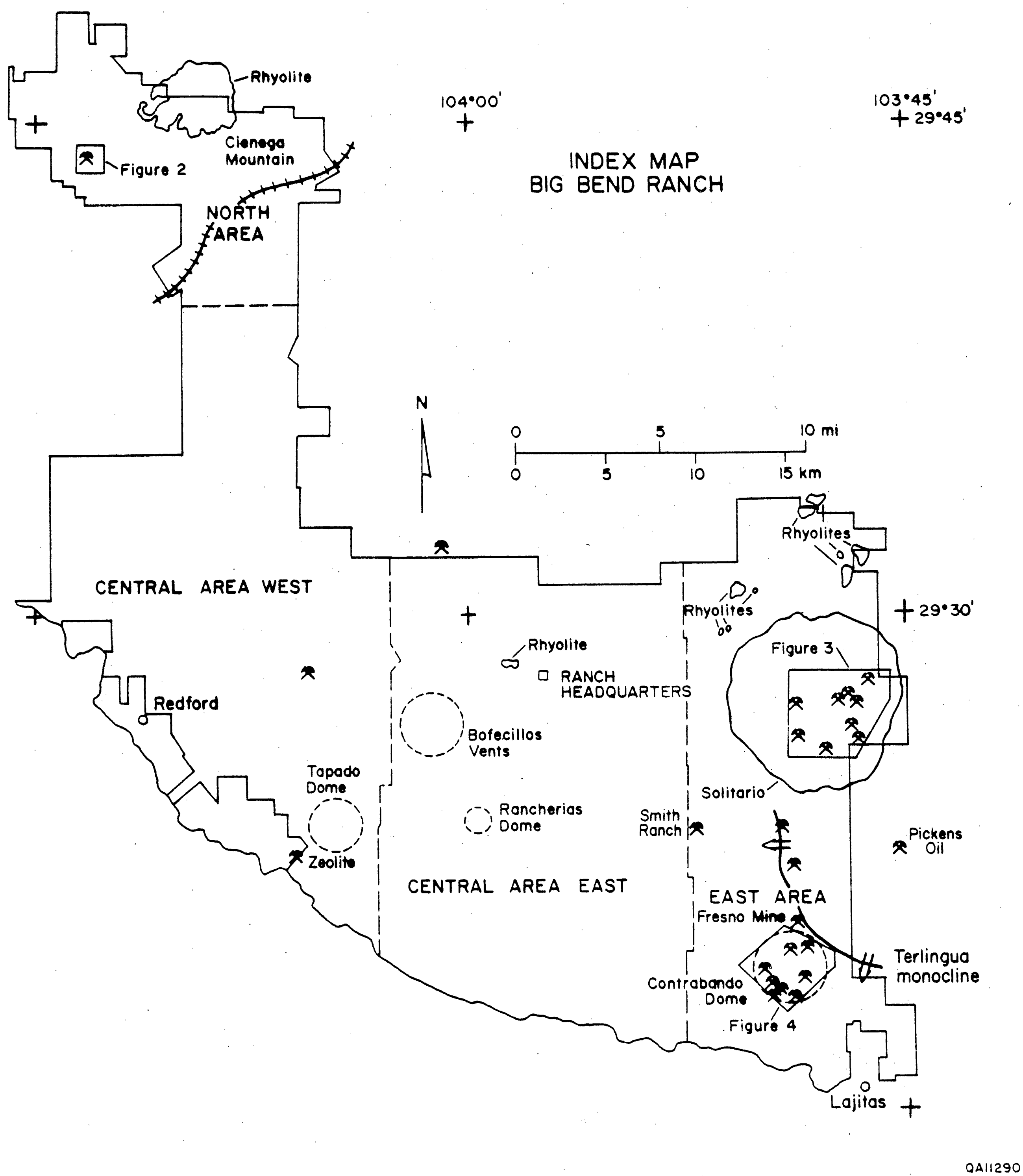
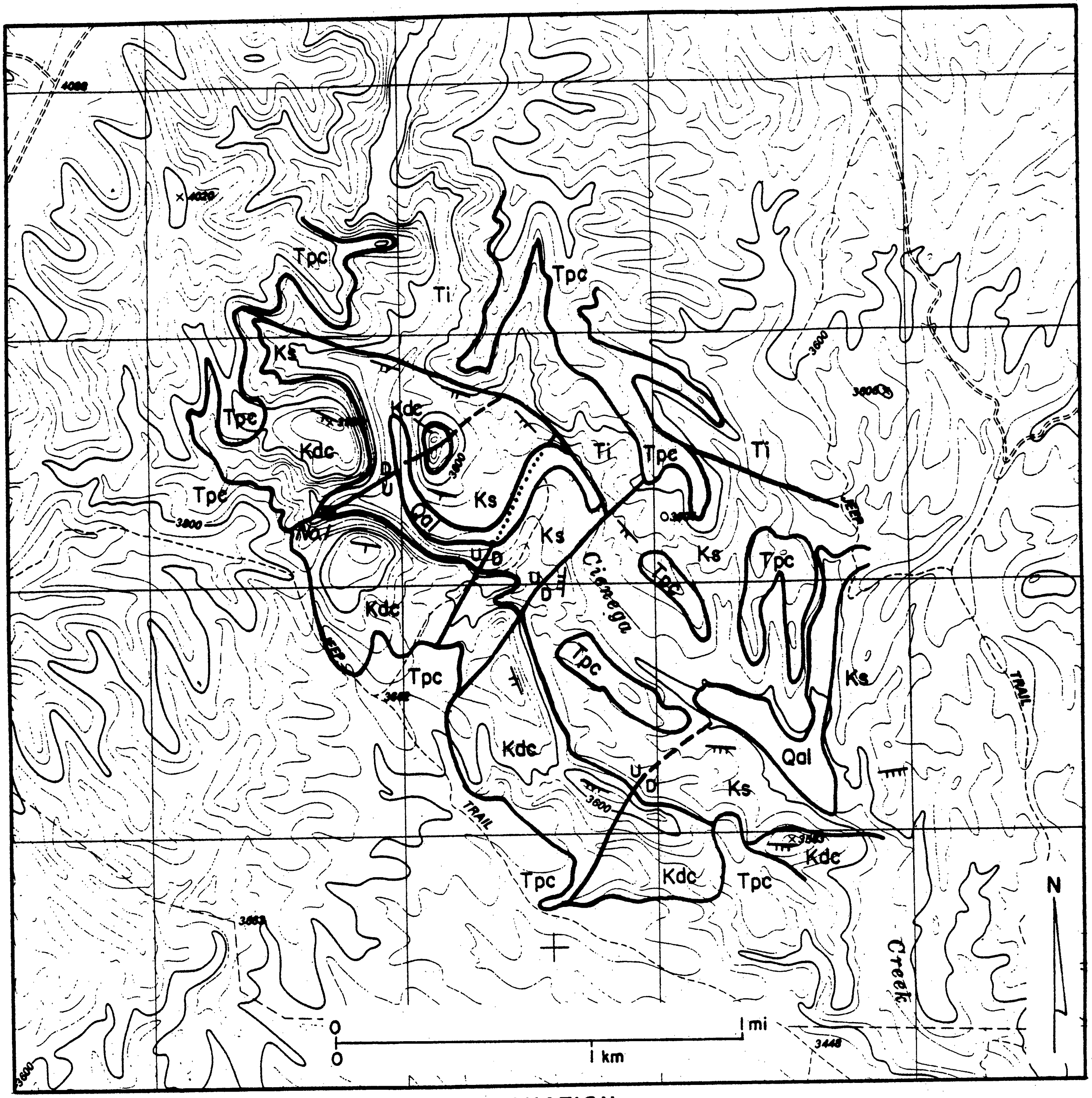


Figure 1. Index map of Big Bend Ranch State Natural Area showing divisions of the Ranch used in this report, mineral prospects and areas of hydrothermal alteration, geologic features discussed in the text, and the locations of Figures 2, 3, and 4.



EXPLANATION

Quaternary

Qal — Alluvium

Tertiary

Tpc — Perdiz Conglomerate; deposited after dome eroded

Ti — Rhyolite intrusion; created dome and radial faults; possible source of mineralization

Cretaceous

Kdc — Del Carmen Limestone; massive limestone

Ks — Shafter Formation; interbedded limestone, marl, shale, and sandstone

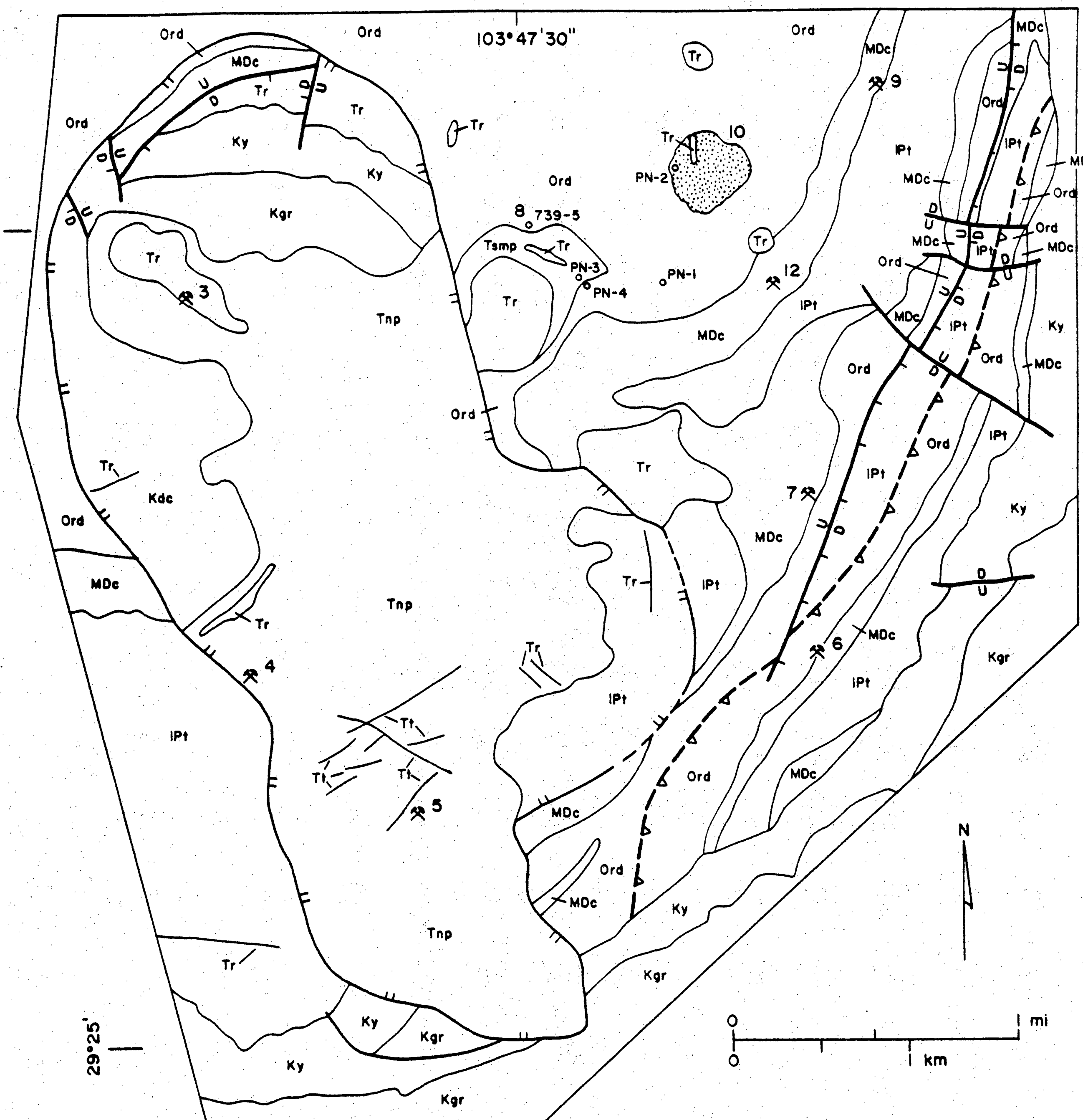
U/D — normal fault, showing relative motion; U = up, D = down

strike and dip determined from aerial photographs; number of tick marks increases with relative dip

■ collapsed mine shaft

QA 11293

Figure 2. Geologic map of prospect PR-PR-S21-1, Alamo Spring quadrangle, in north area of Ranch (see Figure 1 for location). Prospect, reportedly for manganese (Dietrich, 1966), is in Cretaceous rocks along northeast-trending fault on western flank of igneous dome.



EXPLANATION

Tertiary

- Tr — Rhyolite intrusions
- Tsmp — Syenite-monzonite intrusion
- Tnp — Needle Peak tuff; caldera-filling ash-flow tuff and debris-flow deposits
- Tt — Trachyte dikes

Cretaceous

- Kdc — Del Carmen Limestone; massive limestone
- Kgr — Glen Rose Formation; interbedded massive limestone and thin-bedded marly limestone
- Ky — Yucca Formation; conglomerate, sandstone, and sandy limestone

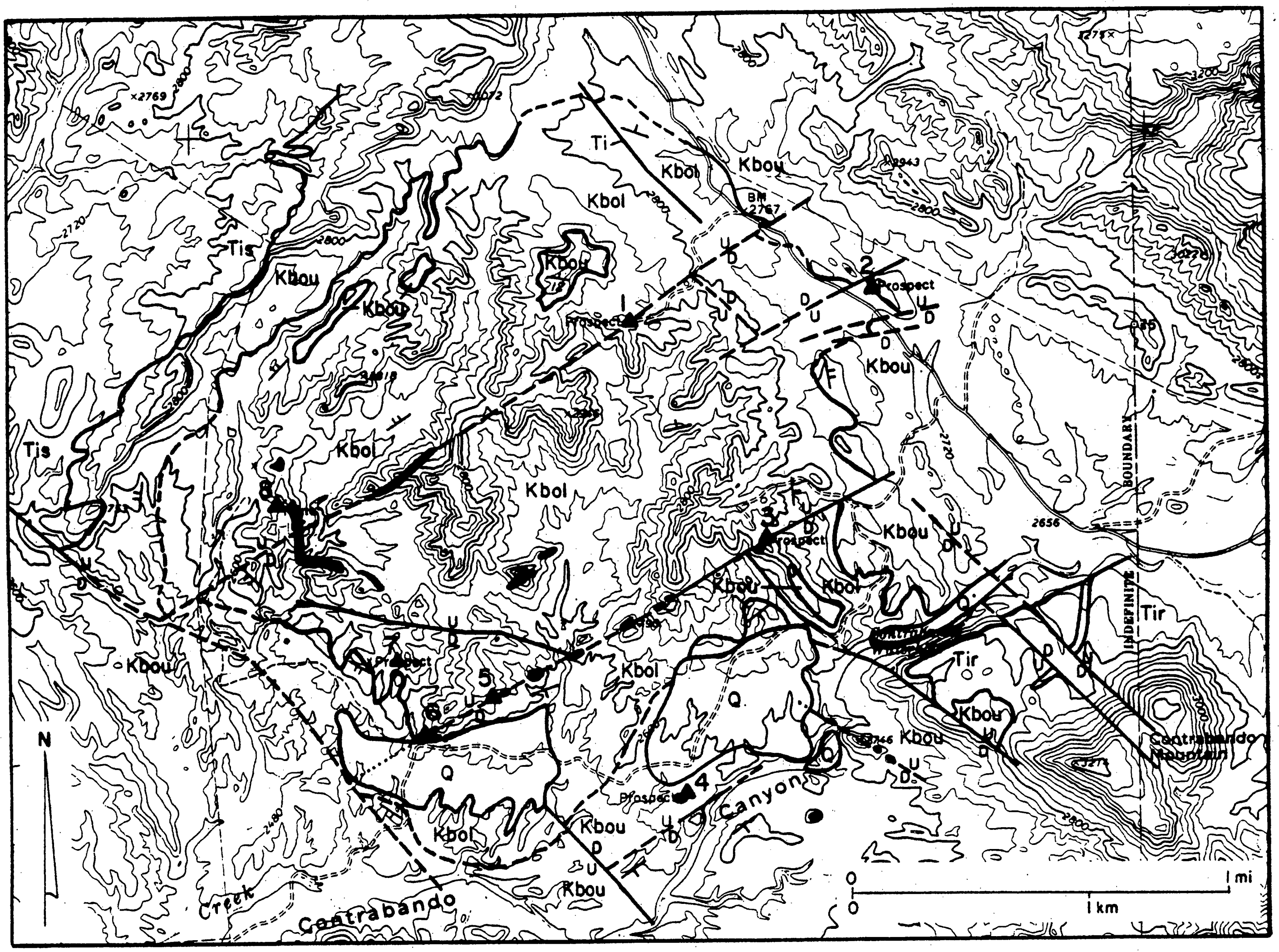
Paleozoic

- IPt — Tesnus Formation; interbedded shale, siltstone, and fine sandstone
- MDc — Caballos Novaculite; white chert and novaculite
- Ord — Ordovician rocks undivided; includes Maravillas Formation (black chert), Woods Hollow Shale (black shale), Fort Pena Formation (sandstone and limestone), and Marathon Formation (shale, sandstone, limestone, and chert)

- U/D — Normal fault, showing relative motion; U = up, D = down
- Thrust fault; teeth marks on upper plate
- Caldera boundary
- Prospects
- Exploration drill holes
- Area of intense limonitic alteration

QA11291

Figure 3. Geologic map of area of prospects and hydrothermal alteration within the Solitario, The Solitario quadrangle, east area of Ranch (see Figure 1 for location). Numbers on prospects are the last number on their listing in Appendix A: EM-PR-U24-3, EM-PR-U24-4, EM-PR-U24-5, EM-BR-U24-6, EM-BR-U24-7, EM-BR-U24-8, EM-BR-U24-9, EM-BR-U24-10, and EM-BR-U24-12.



EXPLANATION

Quaternary

Q — Alluvium, fan deposits, and gravel

Tertiary

Ti — Basalt dike

Tir — Rhyolite intrusions; one large sill or laccolith and abundant, small plugs, dikes, and sills; probably underlie Contrabando dome; (includes all small black dots)

Tis — Soda trachyte sill

Cretaceous

Kbo — Boquillas Formation; flaggy to marly limestone; Kbou = upper part, Kbol = lower part

normal fault, showing relative motion; U = up, D = down

strike and dip of beds; number of tick marks increases with increasing dip

▲ prospects

QA 11292

Figure 4. Geologic map of Contrabando dome, Lajitas quadrangle, east area of Ranch (see Figure 1 for location). Numbers on prospects are the last number on their listing in Appendix A: EM-PR-V24-3/1 through EM-PR-V24-3/8.

and others (1983) on mineral prospects within the Ranch. The tectonic setting of the Ranch is shown on a regional tectonic map of Trans-Pecos Texas (Henry and others, 1985). Additional references that are not specifically about the Ranch area but that provide useful information are cited where appropriate.

Paleozoic Rocks

Two distinctly different sequences of Paleozoic rocks occur within the Ranch area, but only one is exposed. Throughout most of the Ranch, Paleozoic rocks occur at depths greater than about 6000 feet (1800 m) below surface. What are generally termed Marathon-facies rocks crop out within the Solitario (Figs. 1 and 3) where they have been uplifted by intrusion of a granite laccolith (Lonsdale, 1940; Herrin, 1958; Corry and others, manuscript). Sedimentary rocks in the Solitario consist of a complex sequence of mostly clastic deposits, including sandstone, shale, chert, and novaculite, as well as minor limestone; total thickness of the deposits is about 9000 feet (2700 m) (Table 1).

The sequence in the Solitario is nearly identical to that in the Marathon basin approximately 50 miles (80 km) to the northeast (King, 1937; McBride, 1978). Marathon-facies rocks in both areas were actually deposited a considerable but unknown distance to the southeast, in what is now Mexico, and were transported northwestward during the late Paleozoic Ouachita-Marathon Orogeny. The Solitario is the southwesternmost exposure of Marathon-facies rocks and of the Ouachita-Marathon Orogeny.

A second sequence of Paleozoic rocks, generally termed foreland- or cratonic-facies, occurs only in the subsurface. These rocks underlie Cretaceous rocks in the northwestern part of the Ranch and lie below thrust sheets of Marathon-facies rocks in the southeastern part. Because they are not exposed, rock types in this second sequence are poorly known. However, they are probably more similar to the Paleozoic succession that occurs in the Delaware Basin to the north than to Marathon-facies rocks.

Table 1. Paleozoic Rocks of the Solitario[1]

System	Formation	Thickness (feet)	Lithology
Pennsylvanian-Mississippian	Tesnus Formation	> 4600	Interbedded dark green siliceous shale and massive brown fine sandstone and siltstone
Mississippian-Devonian	Caballos Novaculite	275	White banded chert and novaculite
Ordovician	Maravillas Formation	190	Black banded chert and minor limestone
	Woods Hollow Shale	385	Black shale and minor brown sandstone
	Fort Pena Formation	> 390	Massive brown sandstone, sandy limestone, shale, and minor chert
	Marathon Formation	up to 2250	Black siliceous shale, sandstone, sandy limestone, dark chert, and minor flaggy limestone
Ordovician-Cambrian	Dagger Flat Sandstone	600	Massive, light brown sandstone, and sandy limestone

[1] From Corry and others, manuscript.

Late Paleozoic Ouachita-Marathon Orogeny

A major, late Paleozoic deformation produced the Ouachita-Marathon fold and thrust belt along the southeastern margin of the North American continent (King, 1937; Muehlberger, 1980; Henry and Price, 1985). The deformation produced northeast-trending folds and thrust faults; transport direction was to the northwest. The basal thrust of the fold and thrust belt passes northeast-southwest through the middle of the Ranch. Paleozoic rocks exposed in the Solitario (Fig. 3) are complexly folded and thrust faulted as a result of the deformation. Marathon-facies rocks exhibiting similar structures must underlie the southeastern half of the Ranch. Foreland-facies rocks below the basal thrust and to the northwest are relatively little deformed.

Cretaceous Rocks

A sequence of Cretaceous sedimentary rocks (Table 2) more than 4000 feet (1250 m) thick overlies the Paleozoic rocks with angular unconformity. The Cretaceous rocks are exceptionally well exposed in the rim of the Solitario (Corry and others, manuscript) but also crop out irregularly in the southeastern and northwestern parts of the Ranch. They underlie Tertiary rocks throughout the Ranch area and are also exposed in the core of Rancherias Dome (Fig. 1). The Ranch lies approximately at the northeastern margin of the Chihuahua Trough, a deep sedimentary basin that formed in Jurassic time in Chihuahua and along the western edge of Trans-Pecos Texas (Muehlberger, 1980). The Cretaceous sequence thickens rapidly toward the southwest, into the Trough. Just 15 miles (24 km) to the south, in the Sierra Rica area of Chihuahua, Immitt (1981) measured more than 7000 feet (2150 m) of equivalent strata.

The Cretaceous rocks are divided into two series: a lower, Comanchean series and an upper, Gulfian series (Table 2). The Comanchean series, which makes up most of the section, has a basal conglomerate derived from the underlying

Table 2. Cretaceous Rocks of the Big Bend Ranch Area[1]

Series	Formation	Thickness (feet)	Lithology
Gulfian	Aguja Formation	up to 70	Interbedded gray to green to brown sandstone, shale, and minor lignite
	Pen Formation	200	Poorly indurated calcareous clay with minor chalk in lower part and sandstone in upper part
	Boquillas Formation	1000	Interbedded flaggy, argillaceous limestone, chalk, and calcareous clay; abundance of clay increases upward
Comanchean	Buda Limestone	100	Massive, blue limestone with marly partings
	Del Rio Clay	125	Black to green shale with minor marly limestone and sandstone
	Santa Elena Limestone	830	Massive, thick-bedded blue limestone with bedded chert
	Sue Peaks Formation	185	Interbedded marly shale and thin marly limestone
	Del Carmen Limestone	685	Massive, gray, cherty limestone
	Telephone Canyon Formation[2]	up to 75	Marly, gray limestone
	Glen Rose Formation[2]	1160	Interbedded massive gray limestone and thin-bedded marly limestone
	Yucca Formation	660	Conglomerate, sandstone, sandy limestone, dolomitic limestone, and minor marl at top

[1] From Dietrich, 1966; McKnight, 1970; Corry and others, manuscript.
[2] Shafter Formation is equivalent of Telephone Canyon and upper part of Glen Rose Formation in northwestern part of Ranch. See Figure 2 and prospect PR-PR-S21-1.

Paleozoic rocks. The section above the conglomerate is a repetitive sequence consisting of massive limestones interbedded with shale and marly limestone. The Gulfian series consists of flaggy, marly limestone, shale, and minor sandstone.

Early Cenozoic Laramide Orogeny

Cretaceous rocks along the eastern margin of the Chihuahua Trough were intensely deformed into northwest-trending thrust faults, folds, and monoclines during the Laramide Orogeny in the late Paleocene and early Eocene (Wilson, 1971; Muehlberger, 1980; Henry and Price, 1985); transport direction was to the northeast. Although major structures occur in Chihuahua immediately across the Rio Grande from the Ranch, Cretaceous rocks in the Ranch area were only slightly affected (Dietrich, 1966; McKnight, 1970; Corry and others, manuscript). The largest Laramide structure of the area is the Terlingua monocline, which extends into the eastern edge of the Ranch south of the Solitario (Fig. 1) (Erdlac, 1988). Cretaceous rocks in and adjacent to the northwestern part of the Ranch occur in broad, low-amplitude folds (Dietrich, 1966). Elsewhere, except where domed by Tertiary igneous bodies, the Cretaceous rocks are flatlying.

Tertiary Igneous Rocks

Igneous activity in Trans-Pecos Texas ranges in age from 47 to 17 Ma (Henry and McDowell, 1986; Henry and others, 1986); igneous rocks, including both volcanic and intrusive rocks, in and adjacent to the Ranch span almost this entire interval (Table 3). The oldest volcanic rocks were derived from source areas outside the Ranch. These include the Alamo Creek and Bee Mountain Basalts, the Mule Ear Springs Tuff, and the Tule Mountain Trachyandesite. All these are members of the Chisos Formation (Maxwell and others, 1967) and range in age from 47 to 34 Ma (Table 3). The Chisos Formation also includes thick sequences of tuffaceous sediments and air-fall tuffs, commonly altered to zeolites.

Table 3. Tertiary Rocks of the Big Bend Ranch Area[1]

Formation	Thickness[2]	Age (Ma)[3]	Lithology
Rawls Formation			
Member 9[4]	up to 100	18.0 to 23.6	Basalt lavas and dikes
Members 1 - 8[4]	up to 1200	26.8 to 28.3	Mafic to intermediate lavas and diorite intrusion
Santana Tuff	up to 550	26.9 to 28.3	Rhyolite ash-flow tuff
Rhyolite Intrusions		~28	Peralkaline rhyolite intrusions
Fresno[4] and Tascotal Formations	up to 1000	28 to 30	Tuffaceous sediments and mafic lavas
San Carlos Tuff	up to 600	30.2 and 30.6	Rhyolite ash-flow tuff
Mitchell Mesa Rhyolite	up to 50	32.3	Rhyolite ash-flow tuff
Cienega Mountain Intrusion[4]		32.7	Peralkaline rhyolite intrusion
Contrabando Dome Intrusion[4]		~34 ?	Porphyritic rhyolite intrusion
Solitario Igneous Suite[4]		~38	Granite to rhyolite intrusions; rhyolite ash-flow tuff and minor lavas
Chisos Formation[5]			
Tule Mountain Trachyandesite	up to 350	~34	Trachyandesite to quartz trachyte lava flows
Mule Ear Spring Tuff	up to 40	34.1	Rhyolite ash-flow tuff
Bee Mountain Basalt	up to 250	34.5	Basalt lavas
Alamo Creek Basalt	up to 95	46 to 47	Basalt lavas

1 From Dietrich, 1966; Maxwell and others, 1967; McKnight, 1970; Henry and Price, 1984; Henry and McDowell, 1986; Henry and others, 1986; Corry and others, manuscript.
2 Thicknesses are highly variable and not meaningful for intrusive rocks.
3 From Henry and McDowell, 1986; Henry and others, 1986.
4 Igneous rocks having sources within Big Bend Ranch.
5 Named formations are flows, which are interbedded with poorly indurated, zeolitized tuffaceous sediment and air-fall tuff.

The named members are lava flows and ash-flow tuffs derived from sources in Big Bend National Park to the east and possibly in the Sierra Rica area in Chihuahua to the south. They flowed into the eastern and southern parts of the Ranch area where they are exposed in the slopes along Fresno Canyon and near the Rio Grande northwest of Lajitas (Fig. 1). They also are exposed within a few domes in the interior of the Ranch. Flow rocks of the Chisos Formation probably underlie much of the southern part of the Ranch but probably do not extend much farther north. North of the Ranch, the equivalent volcanic section is termed the Devil's Graveyard Formation or the Pruett and Duff Tuffs.

The Solitario represents the first igneous activity with a source in the Ranch area and is one of the major areas of mineral prospects and hydrothermal alteration. The Solitario is an igneous dome or laccolith (Corry and others, manuscript) created by an underlying granitic intrusion approximately 38 Ma ago contemporaneous with deposition of the Chisos Formation (Table 3). Emplacement of the granite uplifted the Paleozoic and Cretaceous rocks that are now exposed in the interior and around the rim, respectively. This uplift created a topographic high that remains today. The granite is largely buried but has been cut by mineral exploration holes drilled by AMAX and Pioneer Nuclear in the 1970's (Fig. 3). Additionally, several small intrusions (such as Tr, Tsmp, and Tt on Figure 3) are probably offshoots of the main granite, and several volcanic rocks apparently erupted from it. The volcanic rocks include a rhyolitic ash-flow tuff that occurs in Fresno Canyon west and south of the Solitario. Eruption of this tuff created the caldera shown in Figure 3. A caldera is a collapse structure formed when eruption of a large volume of magma creates an underground cavity into which the overlying material collapses. This caldera was partly filled by the rhyolitic ash-flow tuff and by landslide material (both shown as Tnp, Needle Peak Tuff, Fig. 3) from the walls of the caldera.

The rhyolite intrusion that uplifted and probably underlies Contrabando Dome (Yates and Thompson, 1959; Figs. 1 and 4) was probably emplaced about 34 Ma ago. The rhyolite is exposed as numerous small dikes and plugs within the dome and as a larger, laccolithic body at Contrabando Mountain (Fig. 4). The age assignment is based on its similarity to a dated rhyolite intrusion at Black Mesa, which lies 5 miles (8 km) to the northwest. The age of the intrusion that produced the dome of Figure 2 is unknown.

Following these events, additional volcanic rocks flowed across the Ranch area from distant sources. The Mitchell Mesa Rhyolite, an ash-flow tuff, was erupted from the Chinati Mountains caldera to the northwest about 32 Ma ago (Henry and Price, 1984). It probably covered most of the Ranch area and lapped up against the high area of the Solitario. The San Carlos Tuff was erupted 30 Ma ago from a caldera in Chihuahua south of the Rio Grande (Chuchla, 1981; Henry and Price, 1984). It barely extends into Texas at Big Hill on the River Road. Following these two eruptions, tuffaceous sediments of the Fresno and Tascotal Formations covered all the Ranch area, except for the topographically high Solitario. The Fresno and Tascotal Formations are essentially the same rock bodies but were named differently because they occur in the southern and northern parts of the Bofecillos Mountains, respectively. They form steep cliffs in those areas overlain by lava flows of the Fresno and Rawls Formations. Alteration by groundwater converted volcanic glass in the sediments to clinoptilolite (Walton, 1979), a zeolite of potential commercial interest.

Mafic to intermediate lava flows in the Fresno Formation represent resumption of volcanic activity with sources within the Ranch area. These lavas were the initial eruptions of the Bofecillos volcano (McKnight, 1970), a large stratovolcano that formed approximately 28 Ma ago. Similar lava flows in members 1 through 8 of the Rawls Formation are the continuation of this activity. Many of the flows were erupted from the Bofecillos vents (Fig. 1), a central vent for the volcano. However, some flows were probably also erupted from satellite vents that occur throughout the Ranch area; one vent lies within the Solitario. Some of the many domes within the Ranch may be satellite vents. Together, the lava flows of the Fresno and Rawls Formations form a volcanic pile as much as 2500 feet (760 m) thick that is present in outcrops over most of the Ranch. The flows also form cliffs along Fresno Canyon and the Rio Grande in the eastern and southern parts of the Ranch.

Two other igneous events were contemporaneous with the Bofecillos volcano. Numerous peralkaline rhyolite intrusions were emplaced about 28 Ma ago into lava flows of the Rawls Formation. Peralkaline rhyolites are high in silica, sodium, and potassium, and are poor in aluminum. These intrusions are most abundant in the northeastern part of the Ranch (Erickson, 1953) (Fig. 1), where they form hills of moderate relief, but also occur just west of the Ranch headquarters. Similar intrusions may underlie some of the domes. Cienega Mountain in the northwestern panhandle of the Ranch is also a peralkaline rhyolite but was intruded about 33 Ma ago. It is mentioned here because it is geologically similar to the younger intrusions and has the same potential for rare-metal deposits, as will be discussed.

The Santana Tuff is a rhyolitic ash-flow erupted from a large caldera in Chihuahua south of the Ranch area and in approximately the same location as the caldera for the San Carlos Tuff (Chuchla, 1981; Henry and Price, 1984). The Santana Tuff is exposed in the southern part of the Ranch where it forms many of the large cliffs near the Rio Grande and in Fresno Canyon.

The youngest igneous activity in the Ranch area consists of basalt dikes and lava flows of member 9 of the Rawls Formation (Table 3). The lava flows form an extensive cover on the older parts of the Rawls Formation in the southern and western parts of the Ranch. These rocks formed about 23 to 18 Ma ago, contemporaneous with similar rocks throughout Trans-Pecos Texas (Henry and Price, 1986).

Late Tertiary Basin and Range Faulting

The southern part of the Ranch area was cut by northwest-striking, high-angle normal faults starting about 23 Ma ago (Henry and Price, 1986). The beginning of faulting was contemporaneous with eruption of the basalt lava flows of member 9 of the Rawls Formation; the flows may have used the faults as conduits to reach the surface. The normal faults created grabens, linear fault-bounded troughs, in which the central part of the graben has subsided relative to its flanks. The areas around Redford (Fig. 1) and farther southeast along the Rio Grande are two such grabens. Volcanic rocks in these grabens are hundreds to thousands of feet lower than the same rocks in the flanks. The grabens are partly filled by coarse sedimentary rocks derived from erosion of the volcanic rocks in the flanks.

The major east-striking fault that cuts through the western part of the Ranch and skirts its northern edge was active contemporaneously with the northwest-striking faults. However, it appears to have undergone some right-lateral strike-slip displacement. Also, it is probably reactivated from an older, possibly Paleozoic or Precambrian, structure (Muehlberger, 1980; Ammon, 1981; Ewing, 1985).

These faults are part of a regional tectonic event that created the Basin and Range province throughout Trans-Pecos Texas (Henry and Price, 1985, 1986) and much of western North America. The Basin and Range province is so named because faulting created a characteristic topography consisting of parallel basins and ranges.

Geology of the Four Ranch Areas

In this mineral resource assessment, the Ranch is divided into four areas: north, central west, central east, and east (Fig. 1). Although our geologic discussion applies to the entire Ranch, some specific comments about the four areas are warranted.

The two central areas make up most of the Ranch. Outcrop in both areas consists mostly of mafic lavas of the Rawls Formation that erupted from the Bofecillos volcano and related vents (Fig. 1). The central east area is distinguished by having most of the vents and domes of the volcano, including several that are not shown on Figure 1 but are depicted on geologic maps (McKnight, 1970; Brown and others, 1979). Older Tertiary and Cretaceous rocks are exposed only where uplifted within these domes. The southern parts of both areas are cut by numerous northwest-striking, Basin and Range faults.

The east area is the geologically most complex part of the Ranch and the most important in terms of mineral potential. The widest variety of rocks and most complex structures are exposed there. The Solitario exposes complexly deformed Paleozoic rocks, a nearly complete section of Cretaceous rocks, and a wide variety of igneous rocks (Fig. 3). Contrabando Dome is a much smaller analog of the Solitario (Fig. 4). The Terlingua monocline is the only significant expresion of Laramide deformation within the Ranch. Almost all of the peralkaline rhyolites occur in the northern part of the east area.

The north area contains the largest of the peralkaline rhyolites, Cienega Mountain (Fig. 1) and significant exposures of Cretaceous rocks. Otherwise, coarse gravels of late Tertiary age make up most of the outcrop. These gravels have no economic potential themselves, and they obscure older rocks that could contain significant mineralization.

EVALUATION OF MINERAL POTENTIAL

Appendix A summarizes the information available to us for all prospects or known areas of significant hydrothermal alteration on the Ranch. All prospects were evaluated to the extent that the study allowed, regardless of whether they were on State Fee, Mineral Classified, or other land. In evaluating the mineral potential of the Ranch, we relied on published accounts, unpublished reports or discussions by those who have expolored the area, files from the General Land Office, and unpublished material available at the Bureau of Economic Geology. Most prospects were examined in the field in December 1988, and, where appropriate, samples were collected for x-ray diffraction or geochemical analysis.

It is important to note the distinction between mineralization and ore. Mineralization is a geochemical or mineralogic anomaly with elevated concentrations of some useful element or mineral. Ore is an economic term that describes those anomalies that contain an element or mineral in sufficient concentrations and quantities and in appropriate geometries such that it can be mined and recovered at a profit.

Larger mining companies commonly require that deposits contain mineralization with a recoverable value in excess of several hundreds of millions of dollars before giving serious consideration to the possible exploitation of the resource. In contrast, an individual might be very well satisfied to produce ore from a deposit that will net only a few hundred dollars a day. Another economic factor that should be understood is that the smaller the total tonnage of a deposit the higher the recoverable value per ton that is required for the deposit to be economic.

The following discussions, conclusions, and the ranking of the various sections are based on our estimates of the apparent tonnage and grade potential and on comparison of the mineralization present in the area to other areas of similar types of mineralization in the western United States. We were influenced in our ranking of the sections by the probable attractiveness of the sections to potential lessees. A small area of strong alteration and sulfide mineralization may be attractive to a prospector even though economic mineralization is not known to be present. Areas previously explored by excavations or drilling may have renewed exploration interest in the future if the price for the commodity that is potentially present were to rise.

Ranking of Exploration Potential of Mineral Classified and State Fee Lands within Big Bend Ranch State Natural Area

The various tracts of land for which the mineral rights are administered by the General Land Office were categorized on the basis of our estimation of their hard mineral potential (Table 4). The ratings have five levels, 1 being most prospective and 5 being the least prospective:

Level 5. No obvious mineral potential: no known prospects or reported evidence of mineralization. These tracts commonly do not lie within 1 mile of known prospects or mineralization, or on trends of known mineralized structures. Any alteration known to be present is not thought to be related to mineralization.

Level 4. Speculative mineral potential: tract is not known to contain evidence of significant mineralization, but may have altered rocks present, or lies less than 1 mile from prospects or reported mineralization, or lies on projection of possible mineralized structure or host horizon.

Level 3. Low mineral potential: tract contains evidence of mineralization or includes attractive alteration. If prospects are present there may be some indication of the presence of economic metals or minerals, but economic potential may be small due to either the quantity or quality of the possible resource.

Level 2. Possible mineral potential: tract contains evidence suggesting that significant mineralization could be present using reasonable exploration models of ore deposits. Mineralization of probable economic grade over mineable widths may have been reported, or area is attractive due to size and intensity of alteration. Significant exploration activity may have occurred.

Level 1. Moderate mineral potential: tract contains extensive evidence of alteration or mineralization, or geology clearly is analogous to known deposits. Rock of near economic grade may have been reported or ore may have been produced. Significant exploration activity (excavations or drilling) may have occurred.

The mineral classified and state fee sections and tracts were listed and ranked in Table 4. For ease of presentation the ranch was divided into four areas: north, central west, central east, and east. Within each area the sections are listed from west to east beginning at the north and progressing to the south. This scheme is hampered by the irregular shape of some of the tracts. The maps available to us are not completely legible, and some discrepancies exist between the regional land map of the south part of Presidio County and the 1:24,000-(7.5-minute)-scale version of the maps. However, comparison of the tabulation with the land maps should make it obvious what section or tract is described.

Table 4. State Fee and Mineral Classified Sections,
Big Bend Ranch State Natural Area

NORTH AREA

Owner/ Block No.	Section No.	File No.	State Fee	Mineral Class.	Prospect	Comment	Rank
TTRR330	12	144482		X			5
AB & M	1	SF-10854	X				5
AB & M	2	SF-10855	X				5
TCRR WJG-2	34	137858		X			5
TTRR	?	132505	X				5
A. Hemphill	3	SF-10856	X				5
TTRR330	14	137860		X		1	5
V. Parks	6	146274		X		2	4
TTRR330	18	146268		X		R	4
TTRR330	18 1/2	SF-9910	X			R	4
TTRR330	19 1/2	SF-9909	X			R	4
TTRR330	20	146269		X		R	4
TTRR330	22	143738		X		R	4
GC & SFRR	40	143728		X		R	4
GC & SFRR	38	143727		X			5
TTRR330	28	146271		X			5
GC & SFRR	510	143735		X		3	4
GC & SFRR339	12	143731		X			5
GC & SFRR	508	143733		X			5
GC & SFRR	10	143730		X		Z	5
H & TCRR 9	6	141107		X		Z	5
TCRR	768	146272		X	X	4	3
J. K. Hindeman	24	146270		X		5	4
GC & SFRR	506	143734		X			5
GC & SFRR339	6	121373		X			5
GC & SFRR339	4	146273		X		Z	5
H & TCRR 9	4	141106	X				5
GC & SFRR	2	143729		X			5

Table 4 (continued)

CENTRAL AREA WEST

Owner/ Block No.	Section No.	File No.	State Fee	Mineral Class.	Prospect	Comment	Rank
TCRR313	10	124935	X				5
TCRR313	14	140770		X			5
TCRR313	16	140771		X			5
TCRR313	20	140773		X			5
TCRR313	18	140772		X			5
TCRR313	22	140774		X			5
TCRR313	26	140776		X			5
TCRR313	24	140775		X			5
TCRR313	28	141261		X			5
T & SLRR250	6	132606	X				5
T & SLRR250	8	128855	X				5
T & SLRR250	10	93902	X				5
GC & SFRR	640	140768		X			5
GC & SFRR	1320	140781		X			5
TCRR249	16	140779		X			5
TCRR249	14	140778		X			5
TCRR249	12	140777		X			5
J. Humphris	532	140478		X			5
J. D. English	1356	153237	X				5
C. H. Madrid	A-3	152337		X			5
PSL	3	SF-16275	X				5
TMRR349	36	128132	X				5
AC & SFRR	638	?	X				5
TMRR349	32	96095	X				5
TMRR349	28	?	X				5
TCRR	534	129134		X		6	4
TMRR349	26	129190	X				5
TMRR349	20	122509	X				5
TMRR349	22	122508	X				5

Table 4 (continued)

CENTRAL AREA WEST

Owner/ Block No.	Section No.	File No.	State Fee	Mineral Class.	Prospect	Comment	Rank
GC & SFRR	466	123128	X				5
TMRR349	18	122510	X				5
TMRR349	38	132601	X			Z	5
TMRR349	40	127947	X			Z	5
TMRR349	4	122514	X			Z	5
TMRR349	2	122513	X			Z	5
MK & TERR	2	152711	X			7	5
TCRR341	2	145008	X			7	5

Table 4 (continued)

CENTRAL AREA EAST

Owner/ Block No.	Section No.	File No.	State Fee	Mineral Class.	Prospect	Comment	Rank
GH & SARR14	5	144154		X			5
GH & SARR14	6	144155		X			5
GH & SARR14	2	140632	X			8	4
GH & SARR14	1	144152		X			5
GH & SARR14	3	144153		X		8	4
GH & SARR14	4	146286		X			5
GH & SARR14	18	144163		X			5
GH & SARR14	17	144157		X			5
GH & SARR14	19	144164		X			5
GH & SARR14	16	144162		X			5
GH & SARR14	21	144165		X			5
GH & SARR14	30	139810		X			5
GH & SARR14	36	139815		X			5
GH & SARR14	43	S25758		X			5
GH & SARR14	50	139819		X			5
GC & SFRR	462	?	X				5
DWG7	2	144150		X			5
DWG7	4	144151		X			5
GH & SARR14	8	144159		X			5
GH & SARR14	10	144160		X			5
DWG7	6	144158		X		9	5
GH & SARR14	9	144166		X		Z	5
GH & SARR14	12	146287		X			5
GH & SARR14	15	144161		X		Z	5
GH & SARR14	14	144168		X		R, Z	5
GH & SARR14	22	125734		X		Z	5
GH & SARR14	28	146289		X		Z	5
GH & SARR14	38	146290		X			5
GH & SARR14	42	146292		X			5
GH & SARR14	52	146293		X			5

Table 4 (continued)

CENTRAL AREA EAST

Owner/ Block No.	Section No.	File No.	State Fee	Mineral Class.	Prospect	Comment	Rank
GH & SARR14	40	146291		X			5
TCT	5	146305		X		Z	5
TCT	6	146306		X			5
TMRR 349	12	140374	X				5
D & W 67	8	138191		X			5
D & W 67	10	146301		X			5
J. J. Terrell	1	146303		X			5
GH & SARR14	26	146288		X			5
TCT	9	145779		X			5
TCT	8	146308		X			5
G5	84	144167		X			5
TCT	7	146307		X			5
G5	80	146295		X		Z	5
G5	82	146296		X			5
TMRR349	6	122512	X			Z	5
TCRR341	140	129598	X			Z	5
GC & SFRR	458	129127		X		Z	5
TCRR341	142	132605	X			10	5
HE & WTRR	512	146302		X			5
TMRR349	10	129216	X				5
GC & SFRR	480	129128	X				5
TCRR341	144	129085	X				5
HE & WTRR	514	S-32837	X				5
TCRR341	148	129166	X				5
G5	128	129589	X				5
G5	130	146300		X			5
G5	86	146297		X			5
G5	88	146298		X			5

Table 4 (continued)

CENTRAL AREA EAST

Owner/ Block No.	Section No.	File No.	State Fee	Mineral Class.	Prospect	Comment	Rank
J. F. Rawls	1	SF-11131?	X			11	4
G5	90	140641		X		11, Z	5
TCRR341	146	S-39901	X				5
TCRR	504	116794		X			5
TCRR341	126	125249	X				5
G5	122	124[B916	X				5
G5	126	146299		X			5
C. H. Madrid	460	125250		X		Z	5
G5	116	128794	X			Z	5
TTRR	118	152740	X			Z	5
TTRR	116	S-41206	X			Z	5
TCRR341	16	28815	X				5
TCRR341	122	142040	X			Z	5
TCRR341	120	142039		X		Z	5
TCRR341	18	142?	X				5
TCRR341	20	153434	X			Z	5
TCRR341	20	144829	X			Z	5
TCRR341	22	128814	X			Z	5
TCRR341	24	?	X			Z	5

Table 4 (continued)

EAST AREA
(SOLITARIO TO CONTRABANDO DOME)

Owner/ Block No.	Section No.	File No.	State Fee	Mineral Class.	Prospect	Comment	Rank
GH & SARR14	65	114313		X			5
GH & SARR14	66	115088		X			5
GH & SARR14	58	119263		X			5
GC & SFRR66	2	123390		X		R	4
GH & SARR14	60	139821		X			5
GH & SARR14	56	119262		X		Z	5
GH & SARR14	54	139820		X		R	4
TCT	4	146304		X		R	5
TCT	3	SF10257		X		R	5
TCT	2	SF10256		X		R	4
TCT	1	SF10255		X		R	4
G5	132	S50539		X			5
G5	52	122465		X		R	4
G5	36	123388		X		R	4
G5	78	146294		X		Z	5
G5	56	12878	X				5
G5	54	123387		X			5
G5	50	117623		X			4
G5	38	122275		X			5
G5	34	?		X	X	12	2
G5	76	140640		X			5
G5	66	140635		X			5
G5	58	122276		X			5
G5	48	122277		X	X	13	3
G5	40	117624		X	X	14	2
G5	32	?		X	X	15	3
G5	24	?		X			5

Table 4 (continued)

EAST AREA
(SOLITARIO TO CONTRABANDO DOME)

Owner/ Block No.	Section No.	File No.	State Fee	Mineral Class.	Prospect	Comment	Rank
G5	74	140639		X		Z	5
G5	68	140636		X			5
G5	64	117625		X			5
G5	46	117626		X		16	4
G5	42	78942	X		X	17	1
G5	72	140638		X		18, Z	4
G5	62	123527	X		X	19	4
G5	44	145508	X				5
G5	114	140645		X		Z	5
G5	70	140637	X				5
G5	110	140643	X		X	19	4
G5	60	128783	X				5
G5	106	128614	X				5
TCRR341	114	128801	X			Z	5
G5	112	140644		X		20	4
G5	108	128792		X	X	21	4
TCRR341	106	140647		X	X	22	1
TTRR	112	122127	X			23	4
TCRR341	108	126108	X		X	24	3
TCRR341	110	S39886	X			Z	4
TCRR341	104	140646		X	X	24	3
TCRR341	32	130200	X			Z	5

Table 4 (continued)

COMMENTS

R Section has outcrop of rhyolitic intrusion with possible rare metal potential; unproven; no prospects.

Z Section has outcrop of zeolite-bearing tuffaceous sediments or air-fall tuff of Fresno, Tascotal, or Chisos Formations; speculative zeolite potential; no prospects.

1. Section 14 contains two numerical designations: 137859 and 137860.

2. Section 6 lies within 1 mile of prospect PR-PR-S21-1 in section 768 (146272).

3. Section 510 contains two numerical designations: 143735 and 143736. This section lies within 1 mile of prospect PR-PR-S21-1 in section 768 (146272).

4. See prospect description PR-PR-S21-1.

5. Section 24 lies within 1 mile of prospect PR-PR-S21-1 in section 768 (146272).

6. Prospect indicated on Agua Adentro Mountain 7.5-minute quadrangle topographic map on Bofecillos Peak about 1500 ft east of section 534; possible shallow excavation seen on aerial photos of Bofecillos Peak, but no evidence of extensive workings; no written description in literature; not visited.

7. According to legal description, zeolite prospect PR-PR-U22-2 is in T. C. RR Blk 341, section 2. However, sections plotted on Agua Adentro Mountain and Redford SE 7.5-minute quadrangles show prospect to lie approximately 2 miles northwest of this section and closer to M.K. & T.E. RR Blk G-8, section 2.

8. Sections 2 and 3 are less than 1/2 mile from the Mills Uranium prospect; see prospect description PR-PR-T22-1.

9. Section 6 includes portions of the Bofecillos Vents volcanic center; this volcanic center, like others in the region, includes hydrothermally and deuterically altered rocks but has no known prospects, and field examination indicates no significant evidence of economic potential.

10. See discussion of silicification associated with Rancherias Dome.

11. Section is adjacent to area of probable shallow epithermal (hot spring) alteration (prospect EM-PR-U24-11); see discussion of prospect.

12. See prospect descriptions EM-BR-U24-9 and EM-BR-U24-10; latter is large area of alteration.

13. See prospect description EM-PR-U24-4; restricted area of alteration.

14. See prospect description EM-BR-U24-8; previously explored by major mining company.

15. See prospect descriptions EM-BR-U24-6 AND EM-BR-U24-7; small prospects, limited potential.

16. Section 46 is within 1/2 mile of prospect EM-PR-U24-5.

17. See prospect description EM-PR-U24-5; economic grades reported; limited tonnage potential.

18. Section is adjacent to area of alteration noted in prospect description EM-PR-U24-11.

19. See prospect description EM-PR-V24-6, reported fluorite occurrence of limited potential; not visited.

20. Lies on trend of Terlingua monocline; no known evidence of mineralization.

21. Only northern 1/3 of section is indicated to be mineral classified; southern part of section is adjacent to Fresno Mine (prospect EM-PR-V24-2).

22. Fresno mine (prospect EM-PR-V24-2) is privately held. Fresno Mine has been the most productive mineral property within the ranch, but data on remaining reserves are not available.

23. Section is adjacent to prospects EM-PR-V24-3/1 through 3/8 in Contrabando Dome.

24. Section contains prospects associated with altered rhyolite and locally abundant sulfides; see discussion of Contrabando Dome prospects EM-PR-V24-3/1 through 3/8.

DISCUSSION OF SPECIFIC AREAS

Precious and Base Metals in The Solitario

One of the two most favorable areas for mineral development in the Big Bend Ranch is within the Solitario (Figs. 1 and 3). The greatest potential exists for base (molybdenum, zinc, lead, and copper) and precious (silver, gold) metal deposits. This area has numerous major prospects and extensive areas of hydrothermal alteration associated with intense igneous activity. It is geologically similar to many other areas in the western United States that produce either precious or base metals.

Prospect EM-BR-U24-8 drilled by Pioneer Nuclear and Amax Exploration, Inc., constitutes a potential disseminated molybdenum deposit. Areas of extensive alteration, including EM-BR-U24-10, may be related to the hydrothermal system that generated the molybdenum prospect. Considerable drilling would be needed to evaluate the prospect and to establish resources. The fact that Amax and Pioneer Nuclear abandoned exploration reflects the current low price of molybdenum and the availability of production from several large deposits elsewhere in the United States. Further exploration would be justified only by a substantial and sustained price increase.

Prospects EM-PR-U24-5 and EM-PR-U24-4 indicate significant potential for precious metal deposits in epithermal veins containing lead and zinc. One of these localities was the source of a small amount of silver-lead ore containing minor gold reported by Baker (1934). Gold Capital Corporation, which did the most recent exploration, reported erratic but locally mineable concentrations of both silver and gold. Nevertheless, they terminated exploration because of insufficient metal values. Mining would require a sufficient combination of metal concentrations and total tonnage of ore.

Numerous manganese prospects occur within the Mississippian-Devonian Caballos Novaculite (EM-BR-U24-7, 9, and 12). Although some of the prospects are relatively high grade, the total resource is at most a few hundred thousand tons averaging 15 to 20% Mn. Mining of these deposits is unlikely.

Mercury in the western part of the Terlingua District

The greatest mineral production within the Ranch area was mercury from the Fresno Mine (EM-PR-V24-2), which produced approximately 3500 flasks. Additional production came from the adjacent Whit-Roy Mine (EM-PR-V24-1) and from several small deposits (EM-PR-V24-3/1 through 3/8) on Contrabando Dome (Fig. 4). These deposits are apparently exhausted, and the Fresno Mine is privately held. Nevertheless, Yates and Thompson (1959) considered the western part of the Terlingua district, which is the area within the Ranch, to be favorable for exploration for several reasons. The geology of this area is similar to areas to the east that hosted major mercury mineralization. The Fresno and Whit-Roy Mines are along the Terlingua monocline, a Laramide fold that appears to have localized much of the mercury deposition within the Terlingua district. A several mile length of this structure lies within the Ranch and joins the south end of the Solitario. This area has received relatively little exploration, in contrast to the eastern part of the district, which has been intensely explored. Thus, serious exploration could turn up additional deposits.

Mercury deposits of the Terlingua district display similarities to hot-spring gold deposits; therefore the area that is prospective for mercury is also prospective for precious metals. Hot-spring gold deposits typically are enriched in mercury; many were originally mined for mercury prior to the recognition of their gold potential. Hot-spring gold deposits commonly contain extensive silicification, which occurs only locally in the Terlingua district. Two highly silicified areas are the Pickens Oil prospect (EM-PR-U24-1), a mercury prospect 2 miles (3.2 km) southeast of the Solitario and outside the Ranch (Price and others, 1983), and the Smith Ranch Silicified Area (EM-PR-U24-11), to be discussed next. Hot-spring gold deposits are currently being actively explored for throughout the western United States. From discussions with mining geologists, we know that several companies have examined the Terlingua district for its gold potential.

Smith Ranch Silicified Area

An intensely silicified area within tuffaceous deposits and mafic lavas of Tertiary Fresno Formation (EM-PR-U24-11) is prospective for precious metals. The geology is generally similar to that of hot-spring gold deposits and was being investigated by Gold Capital Corporation for that reason. The hydrothermal system responsible for silicification probably deposited moderate amounts of sulfide, as shown by iron oxides replacing pyrite in the upper portion of the silicified section and localized silica veins that appear to contain sulfide minerals (probably pyrite). Abundant sulfate covering the lower part of the silicified area suggests the presence of additional sulfide. Semiquantitative analysis of two samples by the Bureau of Economic Geology shows slight enrichment in Ag, Au, As, and Hg, all characteristic of this kind of deposit. Known hot-spring gold deposits generally show repeated cycles of silicification, which was not observed at this prospect. Determination of the overall extent and intensity of silicification would better define the precious metal-bearing potential of the area.

Rare-Metal Deposits Associated With Peralkaline Rhyolites

Some potential exists for rare-metal deposits associated with the abundant intrusions of peralkaline rhyolite within the Ranch (Fig. 1). This potential is indicated by two factors: (1) the rhyolites are enriched in these elements, and (2) the rhyolites are similar to some other rhyolite intrusions in Texas that host known beryllium deposits.

(1) Peralkaline rhyolites in general are enriched in rare metals. Preliminary semiquantitative analyses of samples from several intrusions in the Ranch show anomalous concentrations of beryllium, fluorine, thorium, uranium, and rare earth elements. Although these concentrations are well below those needed for mining, they are high enough so that the rhyolites constitute potential sources if mechanisms exist to transport and concentrate the elements. The absence of ore-grade mineralization in the samples collected to date does not preclude the presence of economic mineralization associated with these rhyolites.

(2) A belt of similar alkalic rhyolites enriched in rare metals trends southeast through Trans-Pecos Texas from near El Paso into northern Mexico. The rhyolites at Sierra Blanca, approximately 90 miles (150 km) southeast of El Paso, were the source of beryllium and fluorine in beryllium-bearing fluorite deposits developed at the contacts of the rhyolites with Cretaceous limestone (Price and others, in press). Recent exploration by Cabot Corporation and currently by Cyprus Mining Company have delineated a major beryllium deposit containing at least 25 million pounds of the element. Most of this deposit is on land to which the State owns mineral rights, so mining would generate considerable income to the State. Similar mineral potential appears to exist in the Christmas Mountains area just east of the Ranch. Fluorite developed at contacts between peralkaline rhyolites and Cretaceous limestones in that area are enriched in beryllium, uranium, thorium, molybdenum, lead, and zinc (Duex and Henry, 1985; Henry and others, in press). The major fluorite district of Coahuila, Mexico, immediately across the Rio Grande from Texas is associated with alkalic rhyolites. At least one of the fluorite deposits contains ore-grade beryllium concentrations (McAnulty and others, 1963).

At this time, deposits associated with these intrusions are at most frontier exploration targets. Exploration for economically significant deposits could examine contacts between the rhyolites and Cretaceous limestone. Because limestone largely occurs beneath Tertiary volcanic rocks, this would require drilling. Nevertheless, the favorable geology and similarity to known deposits warrant considering these as potential resources.

Zeolite (Clinoptilolite)

Clinoptilolite-bearing tuffaceous sediments of the Tascotal, Fresno, and Chisos Formations constitute another relatively speculative mineral resource. Zeolites, particularly clinoptilolite, have abundant industrial uses, most of which are satisfied by varieties produced synthetically. Mining of natural zeolites, which occurs in several western states, requires a combination of high-grade deposits (approximately 90%) at or near the surface and favorable road or rail access. Published information, our field examination, and x-ray diffraction analysis indicate that most of the tuffaceous sediments on the Ranch contain between 20 and 40% total zeolite, essentially all clinoptilolite. These grades are probably not sufficient to be mineable. Thus, prospect EM-PR-U22-2 probably does not constitute a mineable deposit.

In contrast, some air-fall tuff beds within the formations, including one at the prospect, contain much higher clinoptilolite concentrations. X-ray data suggest that they are high enough to be mineable if sufficient volumes exist close to adequate transportation. Previous exploration in Texas by several major companies focused on finding similar tuff beds thick enough to be mineable and close to the rail line that runs across the North area of the Ranch (Fig. 1). In Table 4, we designate all sections in which any one of the three formations crops out as having potential for zeolite deposits. Nevertheless, only high-grade deposits close to the rail line are likely to be economic in the foreseeable future. The inaccessability of most other areas makes mining, even of a high-grade deposit, unlikely.

FUTURE CHANGES IN EXPLORATION ACTIVITY

If the mineral classified and State fee sections within Big Bend Ranch were to remain open to mineral entry, it is unrealistic to assume that the degree of private sector interest in the mineral potential of these sections would remain static. Predicting future leasing of state sections for exploration or exploitation of hard minerals is obviously difficult. Three influences on exploration are prices of the commodity sought, changes in infrastructure that change the economics of exploitation, and changes in ore deposit concepts that affect the perceived exploration potential of a given geologic setting.

Exploration activity is directly related to the current prices of commodities. Significant changes in those prices may be reflected in the degree to which explorationists seek to lease particular sections of the Ranch. For example, renewed interest in the exploration for molybdenum due to an increase in the value of this metal could generate additional exploration in the Solitario. This is probably unlikely in the near term because many major molybdenum deposits were discovered during the past decade that can readily supply the world's current demands. The precious metals, gold and silver, can undergo rapid price fluctuations, especially in periods of economic uncertainty or rising inflation. If major increases in the price of precious metals occurred, then prospects with even limited potential for small reserves could arouse the interest of small companies. The use of rare metals and zeolites could increase dramatically, which in turn could lead to substantial increases in their prices. Rare metals are used in a variety of electronic, space, and other high-technology applications, including super conductors. Zeolites already have significant uses, which are largely dominated by synthetic varieties. If the use of natural zeolites increases, their price and demand would increase apace.

Changes in available infrastructure can also cause significant changes in the economics of mineral deposits. This is especially true for those commodities with low unit value, such as zeolites and aggregate, that require ready access to an inexpensive means of transportation or proximity to consumers to reduce transportation costs. Zeolite deposits of sufficient thickness and purity to be mineable could occur on the Ranch. These would be economic, however, only if the deposit were mineable by open-pit methods and were close to a railroad or other economic means of transportation. Thus a zeolite deposit close to the rail line through the North Area (Fig. 1) is much more likely to be economic than one in Fresno Canyon in the East Area. Sources of aggregate were not considered in the current evaluation because potential markets are distant and because demand in or near the Ranch is unlikely to be significant.

The final factor that could alter the current degree of exploration activity is a change in present concepts of where and how ore deposits form. The association of major gold deposits with mercury mineralization was not appreciated by most explorationists until Homestake Mining Company discovered the McLaughlin deposit in the late 1970's. As a result of this change in concepts of gold deposits, exploration for precious metals in known mercury districts soared. Current interest in the Terlingua district is almost entirely a result of this concept change. Each decade produces advances in understanding that can redefine how attractive different geologic settings are to exploration groups.

The Bureau's rating of the state sections does not attempt to anticipate future changes in commodity prices, infrastructure, or ore deposit models. The rating is based on our perceptions of how attractive the sections are to explorationists based on current conditions.

ACKNOWLEDGMENTS

This study was supported by Interagency Cooperation Contract IAC(88-89)-1508 from the Texas Parks and Wildlife Department. Discussions with Bill Farr and Peter Boone of the Texas General Land Office about geology and mineral deposits of the Big Bend Ranch area were invaluable. The General Land Office also made available their extensive files related to exploration of lands administered by them.

References Cited

Ammon, W. L., 1981, Geology and plate tectonic history of the Marfa Basin, Presidio County, Texas, in Pearson, B. T., ed., Marathon-Marfa region of West Texas, Permian Basin Section, SEPM, symposium and guidebook, p. 75-102.

Baker, C. L., 1934, Metallic and non-metallic minerals and ores, in The Geology of Texas, v. II, structural and economic geology: University of Texas, Austin, Bureau of Economic Geology Bulletin 3401, p. 402-640.

Berkebile, C. A., 1983, Geology and mineralization in the southeast portion of the Solitario quadrangle, West Texas (abs.): Geological Society of America Abstracts with Programs, v. 15, p. 14.

Brown, J. B., Cepeda, J. C., and Daugherty, F. W., 1979, Emory Peak-Presidio sheet, Geologic Atlas of Texas: The University of Texas at Austin, Bureau of Economic Geology, scale 1:250,000.

Chester, J. W., 1965, Mercury potential in Texas: U. S. Bureau of Mines Information Circular 9252, p. 337-351.

Chuchla, R. J., 1981, Reconnaissance geology of the Sierra Rica area, Chihuahua, Mexico: The University of Texas at Austin, Master's thesis, 199 p.

Corry, C. E., Herrin, E., McDowell, F. W., and Phillips, K. A., manuscript, Geology of the Solitario, Trans-Pecos Texas.

Dietrich, J. W., 1966, Geology of Presidio area, Presidio County, Texas: The University of Texas at Austin, Bureau of Economic Geology, Geologic Quadrangle Map 28, scale 1:48,000.

Duex, T. W., and Henry, C. D., 1985, Uranium mobility in late magmatic and hydrothermal processes: evidence from fluorite deposits, Texas and Mexico, in Uranium deposits in volcanic rocks, International Atomic Energy Agency, Vienna, p. 365-377.

Erdlac, R. J., 1988, Structural development of the Terlingua Uplift, Brewster and Presidio Counties, Texas: The University of Texas at Austin, Ph. D. dissertation, 403 p.

Erickson, R. L., 1953, Stratigraphy and petrology of the Tascotal Mesa quadrangle, Texas: Geological Society of America Bulletin, v. 64, p. 1353-1386.

Ewing, T. E., 1985, Westward extension of the Devils River uplift-implications for the Paleozoic evolution of the southern margin of North America: Geology, v. 13, p. 433-436.

Hardisty, R., 1982, Geology of the Cienega Mountains area, Presidio County, Texas: Canyon, Texas, West Texas State University, Master's thesis, 121 p.

Henry, C. D., Gluck, J. K., and Bockoven, N. T., 1985, Tectonic map of the Basin and Range province of Texas and adjacent Mexico: The University of Texas at Austin, Bureau of Economic Geology Miscellaneous Map 36, scale 1:500,000.

Henry, C. D., and McDowell, F. W., 1986, Geochronology of the mid-Tertiary volcanic field, Trans-Pecos Texas; in Price, J. G., Henry, C. D., Parker, D. F., and Barker, D. S., eds., Igneous geology of Trans-Pecos Texas; The University of Texas at Austin, Bureau of Economic Geology Guidebook 23, p. 99-122.

Henry, C. D., McDowell, F. W., Price, J. G., and Smyth, R. C., 1986, Compilation of potassium-argon ages of Tertiary igneous rocks, Trans-Pecos Texas; The University of Texas at Austin, Bureau of Economic Geology Geological Circular 86-2, 34 p.

Henry, C. D., and Price, J. G., 1984, Variations in caldera development in the Tertiary volcanic field of Trans-Pecos Texas: Journal of Geophysical Research, v. 89, no. B10, p. 8765-8786.

Henry, C. D., and Price, J. G., 1985, Summary of the tectonic development of Trans-Pecos Texas: The University of Texas at Austin, Bureau of Economic Geology Notes to accompany Miscellaneous Map 36, 8 p.

Henry, C. D., and Price, J. G., 1986, Early Basin and Range development in Trans-Pecos Texas and adjacent Chihuahua: magmatism and orientation, timing, and style of extension: Journal of Geophysical Research, v. 91, no. B6, p. 6213-6224.

Henry, C. D., Price, J. G., and Miser, D., in press, Geology and Tertiary igneous activity of the Hen Egg Mountain and Christmas Mountains 7.5-minute quadrangles, Trans-Pecos Texas: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 183.

Herrin, E. T., 1958, Geology of the Solitario area: Cambridge, Harvard University, Ph. D. dissertation, 162 p.

Immitt, J. P., 1981, Skarn and epithermal vein mineralization in the San Carlos caldera region, northeastern Chihuahua, Mexico: The University of Texas at Austin, Master's thesis, 110 p.

King, P. B., 1937, Geology of the Marathon region, Texas: U. S. Geological Survey Professional Paper 187, 148 p.

Lonsdale, J. T., 1940, Igneous rocks of the Terlingua-Solitario region, Texas: Geological Society of America Bulletin, v. 51, p. 1539-1626.

Maxwell, R. A., Lonsdale, J. T., Hazzard, R. T., and Wilson, J. A., 1967, Geology of Big Bend National Park, Brewster County, Texas: The University of Texas at Austin, Bureau of Economic Geology Publication 6711, 320 p.

McAnulty, W. N., Sr., 1967, Fluorspar in Brewster County, Texas: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 67-2, 16 p.

McAnulty, W. N., Sr., 1974, Fluorspar in Texas: The University of Texas at Austin, Bureau of Economic Geology Handbook 3, 31 p.

McAnulty, W. N., Sr., 1975, Fluorspar deposits and the Rio Grande rift system: New Mexico Geological Society 26th Field Conference Guidebook, p. 167-168.

McAnulty, W. N., and McAnulty, Noel, 1976, Uranium in resurgent cauldron environments in Trans-Pecos Texas: El Paso, unpublished consultant's report, 49 p.

McAnulty, W. N., Sewell, C. R., Atkinson, D. R., and Rasberry, J. M., 1963, Aguachile beryllium-bearing fluorspar district, Coahuila, Mexico: Geological Society of America Bulletin, v. 74, p. 735-744.

McBride, E. F., 1978, The Ouachita Trough sequence: Marathon region and Ouachita Mountains: SEPM Permian Basin Section, Publication 78-17, p. 55-78.

McKnight, J. F., 1970, Geology of Bofecillos Mountains area, Trans-Pecos Texas: The University of Texas at Austin, Bureau of Economic Geology Geologic Quadrangle Map No. 37, scale 1:48,000, 36-p. text.

Mosconi, L. S., 1984, Tectonic history of the Black Mesa-Lowes Valley area, Brewster County, Texas: Stephen F. Austin State University, Master's thesis, 72 p.

Muehlberger, W. R., 1980, Texas Lineament revisited, in Dickerson, P. W., and Hoffer, J. M., eds., Trans-Pecos region, southwestern New Mexico and West Texas: New Mexico Geological Society 31st Field Conference Guidebook, p. 113-121.

Powers, S., 1921, Solitario uplift, Presidio-Brewster Counties, Texas: Geological Society of America Bulletin, v. 32, p. 417-428.

Price, J. G., Henry, C. D., and Standen, A. R., 1983, Annotated bibliography of mineral deposits in Trans-Pecos Texas: The University of Texas at Austin, Bureau of Economic Geology, Mineral Resource Circular No. 73, 108 p.

Price, J. G., Rubin, J. N., Henry, C. D., Pinkston, T. L., Tweedy, S. W., and Koppenaal, D. W., in press, Rare-metal enriched peraluminous rhyolites in a continental arc, Sierra Blanca area, Texas: chemical modification by vapor-phase crystallization: Geological Society of America Special Paper.

Robinson, B. R., 1976, Stratigraphy and environment of deposition of member 9 of the Rawls Formation, Presidio County, Texas: The University of Texas at Austin, Master's thesis, 151 p.

Rubin, J. N., Price, J. G., Henry, C. D., and Koppenaal, D. W., 1987, Cryolite-bearing and rare metal-enriched rhyolite, Sierra Blanca peaks, Hudspeth County, Texas: The American Mineralogist, v. 72, p. 1122-1130.

Sellards, E. H., Adkins, W. S., and Arick, M. B., 1933, Solitario of Texas (Brewster and Presidio Counties): University of Texas, Austin, Bureau of Economic Geology Miscellaneous Map 29, scale 1:31,680.

Sharpe, R. E., 1980, Development of the mercury mining industry, Trans-Pecos Texas: The University of Texas at Austin, Bureau of Economic Geology Mineral Resource Circular 64, 32 p.

Walton, A. W., 1979, Sedimentology and diagenesis of the Tascotal Formation: a brief summary, <u>in</u> Walton, A. W., and Henry, C. D., eds., Cenozoic geology of the Trans-Pecos volcanic field of Texas: The University of Texas at Austin, Bureau of Economic Geology Guidebook 19, p. 157-171.

Wilson, J. A., 1971, Vertebrate biostratigraphy of Trans-Pecos Texas and northern Mexico, <u>in</u> The geologic framework of the Chihuahua tectonic belt: West Texas Geological Society, p. 157-166.

Yates, R. G., and Thompson, G. A., 1959, Geology and quicksilver deposits of the Terlingua district, Texas: U.S. Geological Survey Professional Paper 312, 114 p.

APPENDIX A

Compilation of Mines, Prospects, and Areas of Hydrothermal Alteration in and around the Big Bend Ranch State Natural Area

Most of the localities listed herein are located on Figures 1, 2, 3, or 4 in the text. All are located on 7.5-minute quadrangles of the Ranch area. Each locality has an identification number (Price and others, 1983), which incorporates (1) the name of the 1 by 2° (1:250,000 scale) map (EM = Emory Peak, PR = Presidio), (2) the county name (PR = Presidio, BR = Brewster), (3) the 7.5-minute (1:24,000 scale) quadrangle map coded by a Cartesian grid, and (4) a number on the quadrangle map.

BIG BEND RANCH

IDENTIFICATION NO. PR-PR-R21-1

LOCATION: North area, south side of Cienega Mountain (Fig. 1)
7.5-minute quadrangle: Cienega Mountains and Alamo Spring
LATITUDE: No exact location, so not shown on Fig. 1
LONGITUDE:
BLOCK AND SECTION: T. T. RR. Blk 330, Sections 20 and 22
LAND CLASSIFICATION: Mineral classified

COMMODITY: Uranium, rare metals?

STATUS: Exploration area

EXTENT OF DEVELOPMENT: Sampling and limited geochemical analysis

GEOLOGY: Cienega Mountain intrusion is a peralkaline rhyolite containing high background concentrations of uranium and rare metals.

REFERENCES: Dietrich (1966) and Hardisty (1982) - regional geology

COMMENTS: Wold Nuclear ran an exploration program in West Texas in the late 1970's and early 1980's. Investigation of this "prospect" was part of that program. Probably no excavation or drilling occurred.

IDENTIFICATION NO. PR-PR-S21-1

LOCATION: North Area (Fig. 2)
7.5-minute quadrangle: Alamo Spring
LATITUDE: N29° 43'41"
LONGITUDE: W104° 12'53"
BLOCK AND SECTION: TC RR, Section 768
LAND CLASSIFICATION: Mineral classified

COMMODITY: Uncertain, reported to be manganese, but possibly silver

STATUS: Prospect

EXTENT OF DEVELOPMENT: Shaft and adit, both collapsed and of unknown dimensions

GEOLOGY:
Host rock: Calcite vein in limestone
Formation age and name: Upper part of Cretaceous Shafter Formation or base of Del Carmen Limestone
Other data: Shaft and adit are along a calcite vein as much as 3 ft (0.9 m) wide along a northeast-trending fault. Vein contains no obvious ore minerals but is locally iron-stained. Chemical analysis of vein sample shows negligible enrichment in precious or base metals, including manganese.

Fault is part of a radial system developed on the western flank of a dome related to a Tertiary rhyolite intrusion. The intrusion may be responsible for mineralization. Cretaceous rocks dip as much as 25° away from intrusion. Displacement on fault is down to north approximately 30 ft (9 m).

Dietrich (1966) described small veins containing manganese oxides in rhyolite of the Tertiary Morita Ranch Formation approximately 1.4 mi (2.2 km) north of this area.

REFERENCES: Dietrich (1966) - regional geology

COMMENTS: Other faults of radial system may have exploration potential, but absence of anomalous geochemistry is not encouraging.

BIG BEND RANCH
Mills Prospect

IDENTIFICATION NO. EM-PR-T22-1

LOCATION: Outside Ranch, northwest of Ranch Headquarters
7.5-minute quadrangle: Manzanillo Canyon
LATITUDE: N29°32'02"
LONGITUDE: W104°00'48"
BLOCK AND SECTION: T & St. L. Ry., Blk 204, Sec. 530
LAND CLASSIFICATION: ?

COMMODITY: Uranium

STATUS: Prospect

EXTENT OF DEVELOPMENT: Former owner of property opened an adit about 90 ft (27 m) long.

GEOLOGY: Prospect is on the flank of a dome centered on a trachyte intrusion. The adit is mostly in rhyolitic tuff (Tr2) of member 2 of the mid-Tertiary Rawls Formation; however, part of the end of the adit is in syenite intrusion. The tuff and syenite are reportedly yellow stained. Dietrich (1966) reported values up to 0.2% equivalent U_3O_8 from samples within the adit.

REFERENCES: Dietrich (1966) - deposit and regional geology

COMMENTS: This prospect is approximately 2000 ft (600 m) outside the Ranch boundary and was not visited.

BIG BEND RANCH
Tapado Dome

IDENTIFICATION NO. PR-PR-U22-1

LOCATION: Central area west, vicinity of Tapado Dome (Fig. 1)
7.5-minute quadrangle: Agua Adentro Mountain
LATITUDE: N29°23' (approximate)
LONGITUDE: W104°4' (approximate)
BLOCK AND SECTION: T.M. RR. Blk 349, Sections 2, 3, 4, and 40; M.K. & T. E. RR. Blk G-8, Sections 1, 2, and 3
LAND CLASSIFICATION: Blk 349, Sections 2, 4, and 40 and Blk G-8, Section 2 are State fee

COMMODITY: Uranium

STATUS: Exploration area

EXTENT OF DEVELOPMENT: Geological exploration and geochemical sampling

GEOLOGY: Wold Nuclear explored tuffaceous sediments and flow rocks in and around Tapado Dome (Fig. 1).

REFERENCES: McKnight (1970) and Walton (1979) - regional geology

COMMENTS: Wold Nuclear ran an exploration program in West Texas in the late 1970's and early 1980's. Investigation of this "prospect" was part of that program. Probably no excavation or drilling occurred.

BIG BEND RANCH
Zeolite prospect or mine

IDENTIFICATION NO. PR-PR-U22-2

LOCATION: Central area west, north of Highway 170
7.5-minute quadrangle: Agua Adentro Mountain
LATITUDE: N29°22'48"
LONGITUDE: W104°06'20"
BLOCK AND SECTION: Uncertain: According to legal information, prospect is in T. C. RR Blk 341, Sec. 2; according to sections plotted on quadrangle maps, it is in M.K. & T.E. RR. Co. Blk G-8, Sec. 1 or Tex. Mex. Ry. Co. Blk 349, Sec. 28
LAND CLASSIFICATION: Uncertain

COMMODITY: Zeolite (clinoptilolite)

STATUS: Prospect, some initial mine development and minor production.

EXTENT OF DEVELOPMENT: Various irregular bulldozer or scraper excavations

GEOLOGY: Deposit is diagenetically altered tuffaceous sediments of Fresno Formation. Sediments contain clinoptilolite replacement of volcanic glass, along with variable amounts of alkali feldspar, quartz, clay, calcite, and rock fragments. Sediments contain thin (1 ft [0.3 m] thick) interbeds of air-fall tuff that was initially more pure volcanic glass and now contains higher percentage of zeolite than the sedimentary beds. X-ray diffraction analysis of four samples indicates that the sedimentary beds have substantial amounts of non-zeolite impurities, whereas air-fall tuff beds are nearly pure clinoptilolite.

At the time of investigation, operations consisted of several irregular excavations of an unknown quantity of the sedimentary beds.

REFERENCES: McKnight (1970) and Walton (1979) - regional geology; Walton (1979) - sedimentology and diagenesis of Fresno and Tascotal Formations

COMMENTS: Viability of commercial operations depends on stripping ratios, mineable quantities of rock of high-purity clinoptilolite, market, and transportation.

BIG BEND RANCH
Bofecillos Vents

IDENTIFICATION NO. PR-PR-U-22-3

LOCATION: Central area east (Fig. 1)
7.5-minute quadrangle: Agua Adentro Mountain
LATITUDE: N29°27' (approximate)
LONGITUDE: W104°01' (approximate)
BLOCK AND SECTION: D. & W. RR. Blk G-7, Sections 3, 5, 6, and 7; W.R. Long, Sec. 1; T. M. RR. Blk 349, Sec. 12
LAND CLASSIFICATION: Section 6 is mineral classified; Section 12 is State fee; others are not State minerals

COMMODITY: None known

STATUS: Potential exploration area

EXTENT OF DEVELOPMENT: None known

GEOLOGY: Bofecillos Vents is the central volcanic source area for the volcanic rocks of the Fresno and Rawls Formations. It was examined because McKnight (1970) reported alteration and air inspection showed abundant iron staining (limonite). Weak argillic and silicic alteration is locally present. Most of the iron staining appears to be due to oxidation of mafic minerals; no evidence of sulfide mineralization was found. The most intense alteration we observed was an area of texture-destructive clay alteration near the west vent, south of Elephant triangulation station.

REFERENCES: McKnight (1970) - regional geology and alteration

COMMENTS: Absence of evidence for sulfides or multiphase silica veining and generally weak character of alteration suggest that this area has only minor exploration potential

BIG BEND RANCH
Rancherias Dome

IDENTIFICATION NO. EM-PR-U23-1

LOCATION: Central area east (Fig. 1)
7.5-minute quadrangle: Sauceda Ranch
LATITUDE: N29°23.5'
LONGITUDE: W103°59.5'
BLOCK AND SECTION: G.C. & S.F., Sec. 479; T.C. Ry. Co. Blk 341, Sections 142 and 143.
LAND CLASSIFICATION: Section 142 is mineral classified; others are not State minerals

COMMODITY: None known

STATUS: Unexplored area of hydrothermal alteration and silicification

EXTENT OF DEVELOPMENT: No development

GEOLOGY: Rancherias Dome is one of several igneous domes within the Ranch; a gabbro in the center of the dome is probably responsible for the uplift. The dome was examined briefly during this investigation because McKnight (1970) reported stratiform and cross-cutting masses of silica alteration. The silica is mostly white to pinkish-red cherty silica with late chalcedonic silica in vugs and crystalline quartz lining cavities. Some vugs appear to have been filled by stratified sediments that were later silicified. Alteration appears to be related to a shallow, low-temperature event, possibly controlled by fluid pathways along faults or bedding planes.

REFERENCES: McKnight (1970) - regional geology and silicification

COMMENTS: No obvious exploration potential

BIG BEND RANCH
Pickens Oil (La Escondida) Prospect

IDENTIFICATION NO. EM-BR-U24-1

LOCATION: East of Ranch, approximately 2 mi (3.2 km) southeast of the Solitario
7.5-minute quadrangle: The Solitario
LATITUDE: N29°22'50"
LONGITUDE: W103°45'22"
BLOCK AND SECTION: Outside Ranch
LAND CLASSIFICATION: ?

COMMODITY: Mercury

STATUS: Prospect

EXTENT OF DEVELOPMENT: Extensive exploration in late 1960's, based on an earlier prospect. One shaft 154 ft (47 m) deep with two drifts: one 75 ft (23 m) long at the 100 ft (30 m) level and another 50 ft (15 m) at the bottom. More than 50 trenches and abundant drill holes.

GEOLOGY: Cinnabar occurs in silicified rock along the margin of a solution-collapse sink in Cretaceous Santa Elena Limestone (F. W. Daugherty, personal communication, 1982). A large body of multicolored jasperoid (hydrothermal silicification) occurs adjacent to the prospect, possibly in another sink. Corry and others (manuscript) report several other jasperoidal veins in the prospect area. The silica ranges from cryptocrystalline to coarsely crystalline varities (quartz). These silica bodies are shown on the Geologic Atlas of Texas as intrusions.

REFERENCES: Yates and Thompson (1959), Corry and others (manuscript), and Berkebile (1983) - deposit; Mosconi (1984) - regional geology

COMMENTS: Pickens Oil reportedly found mercury mineralization but abandoned the prospect due to falling prices. This prospect is several miles outside the Ranch but is discussed here because it bears on the mercury and precious metal potential within the Ranch.

BIG BEND RANCH

IDENTIFICATION NO. EM-PR-U24-2

LOCATION: East area, immediately south of the Solitario
    7.5-minute quadrangle: The Solitario
    LATITUDE: N29° 23'26" approximate
    LONGITUDE: W103° 49'16" approximate
    BLOCK AND SECTION: Blk. G5, Sec. 62
LAND CLASSIFICATION: State fee

COMMODITY: Fluorite

STATUS: Occurrence

EXTENT OF DEVELOPMENT: None known

GEOLOGY:
Host rock: limestone (?)
Formation age and name: Cretaceous Santa Elena Limestone, Del Rio Clay, or Buda Limestone

REFERENCES: McAnulty, W.N., Sr. (1967, 1974, 1975) - deposits; Sellards and others (1933), Lonsdale (1940), Herrin (1958), Corry and others (manuscript) - regional geology

COMMENTS: Not visited.

IDENTIFICATION NO. EM-PR-U24-3

LOCATION: East area, Solitario (Fig. 3)
7.5-minute quadrangle: The Solitario
LATITUDE: N29° 27'16"
LONGITUDE: W103° 48'08"
BLOCK AND SECTION: Blk G5, Sec. 49
LAND CLASSIFICATION: Not State minerals

COMMODITY: Fluorite

STATUS: Occurrence

EXTENT OF DEVELOPMENT: None known

GEOLOGY:
Host rocks: rhyolite intrusion and breccia
Age: Tertiary
Ore mineralogy: fluorite, yellow cubes lining vugs
Gangue mineralogy: quartz and manganese oxides

REFERENCES: Corry and others (manuscript) - occurrence; Powers (1921), Sellards and others (1933), Lonsdale (1940), Herrin (1958), Corry and others (1977) - regional geology

COMMENTS: Corry and others (manuscript) state that this occurrence does not appear to be of commercial importance.

IDENTIFICATION NO. EM-PR-U24-4

LOCATION: East area, Solitario (Fig. 3)
7.5-minute quadrangle: The Solitario
LATITUDE: N29° 26'09"
LONGITUDE: W103° 48'27"
BLOCK AND SECTION: Blk G5, Sec. 48
LAND CLASSIFICATION: mineral classified

COMMODITY: Lead, zinc, manganese, silver

STATUS: Prospect

EXTENT OF DEVELOPMENT: One shaft and several trenches. Corry and others (manuscript) reported shaft measured to be 12 m (39 ft) deep but was previously reported to be 23 m (75 ft) deep. Initial exploration was pre-1942. Gold Capital Corporation examined and sampled around 1986.

GEOLOGY:
Host rock: Prospect is in caldera-fill debris-flow deposits (agglomerate) just east of western margin of caldera within the Solitario.
Formation age and name: Tertiary Needle Peak Tuff
Ore mineralogy: cerussite and smithsonite
Gangue mineralogy: manganite, limonite, quartz, calcite
Alteration: hematite haloes on vein; vein is highly oxidized.
Deposit type: vein; vertical, 1 ft (0.3 m) wide; reported to widen to 5 ft (1.5 m) at bottom of shaft
Other data: Corry and others (manuscript) report two assays: (1) 42% Mn across a 5 ft (1.5 m) width at bottom of shaft, (2) 38,000 ppm Zn, 4800 ppm Pb, 66 ppm Cu, 28,000 ppm Mn, 6.2 ppm Ag, and 0.16 ppm Au. Semiquantitative analysis of selected ore sample collected by BEG: 6000 ppm Zn, 1700 ppm Pb, 37,000 ppm Fe, 175 ppm Mo, 8.5 ppm Ag, and 0.06 ppm Au.

REFERENCES: Baker (1934), Corry and others (manuscript) - deposit; Powers (1921), Sellards and others (1933), Lonsdale (1940), Herrin (1958) - regional geology

COMMENTS: Baker (1934) reported that silver-lead ore with minor amounts of gold was shipped from a locality in Presidio County in the Solitario, which may have been this prospect but more likely was prospect U24-5.

BIG BEND RANCH
UNNAMED MINE - LEAD, SILVER, ZINC, GOLD, COPPER

IDENTIFICATION NO. EM-PR-U24-5

LOCATION: East area, Solitario (Fig. 3)
7.5-minute quadrangle: The Solitario
LATITUDE: N29° 25'43"
LONGITUDE: W103° 47'48"
BLOCK AND SECTION: Blk G5, Sec. 42
LAND CLASSIFICATION: State fee

COMMODITY: Lead, silver, zinc, gold, copper

STATUS: Abandoned mine

EXTENT OF DEVELOPMENT: Two shafts and one adit. Initial development 1934 or earlier. Sporadic activity until approximately 1985 or 1986, when Gold Capital Corporation began expansion of underground workings, extensive geochemical analysis, and some drilling. Main shaft is 85 ft (26 m) deep. Two drifts lead approximately 50 ft (15 m) off this shaft. Second shaft is approximately 49 ft (15 m) deep. Adit is approximately 25 ft (7.6 m) long. Gold Capital drilled six exploration holes around the prospect.

GEOLOGY:
Deposit type: vein, striking N70°E, dipping 90°, approximately 1.6 ft (0.5 m) wide. Vein reported to be 4 ft (1.2 m) wide at bottom of main shaft.
Host rocks: debris-flow deposits (agglomerate) on or near contact with rhyolite
Age: mid-Tertiary
Ore mineralogy: argentiferous galena, sphalerite, pyrite, chalcopyrite; malachite
Gangue mineralogy: quartz and jasperoid; barite (W. B. Bourbon, personal communication, 1982)
Alteration: oxidation along vein to a depth of about 75 ft (23 m); kaolinitization of rhyolite (W. B. Bourbon, personal communication, 1982); argillic alteration and minor chloritic alteration (Corry and others, manuscript).
Age of mineralization: mid-Tertiary
Other data: Corry and others (manuscript) noted gold in assays.

REFERENCES: Baker (1934), Corry and others (manuscript), General Land Office files - deposit; Powers (1921), Sellards and others (1933), Lonsdale (1940), Herrin (1958), Corry and others (manuscript) - regional geology

COMMENTS: Report (Baker, 1934) of a shipment of silver-lead ore with minor amounts of gold from a locality in Presidio County in the Solitario was probably from this locality.

IDENTIFICATION NO. EM-BR-U24-6

LOCATION: East area, Solitario (Fig. 3)
7.5-minute quadrangle: The Solitario
LATITUDE: N29° 26'11"
LONGITUDE: W103° 46'28"
BLOCK AND SECTION: Blk G5, Sec. 32
LAND CLASSIFICATION: Mineral classified

COMMODITY: Uranium and copper

STATUS: Prospect

EXTENT OF DEVELOPMENT: Shaft approximately 20 ft (6 m) deep; two shallow exploratory drill holes

GEOLOGY:
Host rocks: chert, phosphatic shale, and limestone
Formation age and name: at contact between Mississippian-Devonian Caballos Novaculite and Ordovician Maravillas Formation
Ore mineralogy: unidentified yellow uranium mineral (X-ray diffraction analysis of yellow mineral coating fractures by BEG); uranophane, autunite, copper oxides (W. B. Bourbon, personal communication, 1982) coating fractures; turquoise (Corry and others, manuscript).
Gangue mineralogy: quartz or chalcedony
Other data: Prospect area shows slight radiation anomaly. McAnulty and McAnulty (1976) suggested that the mineralization is structurally controlled. We observed minor faults striking N 60°E in access road downslope from shaft. Bedding of shale at shaft strikes N 25-30°E and dips approximately 50°E.

REFERENCES: McAnulty and McAnulty (1976), Corry and others (manuscript) - deposit; Powers (1921), Sellards and others (1933), Lonsdale (1940), Herrin (1958), Corry and others (manuscript) - regional geology

COMMENTS: Observed mineralization is limited to thin fracture coatings and appears of no commercial interest. Iron and manganese staining of novaculite appears widespread but has no obvious relationship to weak mineralization seen at prospect.

IDENTIFICATION NO. EM-BR-U24-7

LOCATION: East area, Solitario (Fig. 3)
7.5-minute quadrangle: The Solitario
LATITUDE: N29° 26'39"
LONGITUDE: W103° 46'34"
BLOCK AND SECTION: Blk G5, Sec. 32
LAND CLASSIFICATION: Mineral classified

COMMODITY: Manganese

STATUS: Prospect

EXTENT OF DEVELOPMENT: Adit, approximately 13 ft (4 m) long; several trenches up to 25 ft (8 m) long and 5 ft (1.5 m) deep; several bulldozer cuts.

GEOLOGY:
Host rock: novaculite
Formation age and name: Mississippian-Devonian Caballos Novaculite
Ore minerals: psilomelane and pyrolusite
Other data: Manganese minerals coat fractures, form irregular interbeds, and occur as massive bodies in small, brecciated folds within Caballos Novaculite. Maximum dimensions of surface area containing 15 to 20% manganese oxides are approximately 300 x 100 ft (91 x 30 m) McAnulty and McAnulty (1976) noted manganese oxides associated with several other silicified zones in Paleozoic clastic rocks in this vicinity.

RESOURCES: Prospect extends approximately 300 x 100 ft (91 x 30 m) along hillside and is 50 ft (15 m) thick = 61,000 tons containing 15 to 20% Mn.

REFERENCES: Baker (1934), McAnulty and McAnulty (1976), Corry and others (manuscript) - deposits; Powers (1921), Sellards and others (1933), Lonsdale (1940), Herrin (1958), Corry and others (manuscript) - regional geology

COMMENTS: Prospect symbol shown on topographic map at base of hill below these workings is dump containing material from above.

BIG BEND RANCH

IDENTIFICATION NO. EM-BR-U24-8

LOCATION: East area, Solitario (Fig. 3)
7.5-minute quadrangle: The Solitario
LATITUDE: N29° 27'17"
LONGITUDE: W103° 46'58"
BLOCK AND SECTION: Blk G5, Sections 40 and 33
LAND CLASSIFICATION: Section 40 is mineral classified, Section 33 is not State minerals

COMMODITY: Molybdenum and copper

STATUS: Prospect

EXTENT OF DEVELOPMENT: Five diamond drill holes (Fig. 3) were drilled by Pioneer Nuclear and Amax Exploration, Inc. in 1976 and 1977. Hole 739-5 trends due south at 52.5° for a distance of 2404 ft (733 m). Other holes are vertical. PN-1 is 1200 ft (365.8 m) deep; PN-2 is 454 ft (138.4 m) deep; PN-3 is 507 ft (154.5 m) deep; and PN-4 is 300 ft (91.4 m) deep. These companies also carried out an extensive geologic mapping and geochemical sampling program around the prospect.

GEOLOGY:
Host rock: brecciated intrusive rock, including syenite-monzonite porphyry and quartz porphyry grading into granite porphyry
Age: Tertiary
Alteration: silicification; margins of intrusion locally kaolinitized and iron-stained
Other data: The Bureau of Economic Geology has diamond-drill core from hole 739-5, donated by Pioneer Nuclear, from this prospect. Core has stockwork quartz veins containing molybdenite and pyrite, and pyrite is disseminated throughout the intrusion. Corry and others (manuscript) report anomalous molybdenum, zinc, lead, silver, fluorine, and sulfur in core from hole 739-5. McAnulty and McAnulty (1976) and Corry and others (manuscript) report molybdenite and ferrimolybdenite in outcrop. W. B. Bourbon (personal communication, 1982) recognized stockwork quartz molybdenite veinlets less than 0.08 inch (2 mm) wide in quartz latite clasts within vent (?) breccia or agglomerate.

Holes PN-1, PN-2, and PN-4 were drilled to check induced polarization anomalies (Corry and others, manuscript). These anomalies proved to be due to graphite, pyrite, and pyrrhotite in the Ordovician Woods Hollow Shale. No significant metal enrichment was found.

REFERENCES: Corry and others (manuscript) - exploration and deposit; McAnulty and McAnulty (1976) - molybdenite occurrences; Powers (1921), Sellards and others (1933), Lonsdale (1940), Herrin (1958), Corry and others (manuscript) - regional geology

COMMENTS: Previous exploration may not have exhausted the exploration potential of this area.

IDENTIFICATION NO. EM-BR-U24-9

LOCATION: East area, Solitario (Fig. 3)
7.5-minute quadrangle: The Solitario
LATITUDE: N29° 27'56"
LONGITUDE: W103° 46'14"
BLOCK AND SECTION: Blk. G-5, Sec. 34
LAND CLASSIFICATION: Mineral classified

COMMODITY: Manganese

STATUS: Prospect

EXTENT OF DEVELOPMENT: Shallow trench

GEOLOGY:
Host rock: novaculite
Formation age and name: Mississippian-Devonian Caballos Novaculite
Other data: Geology is similar to that of prospect U24-7, but development is less and apparent extent of mineralization is smaller.

REFERENCES: Baker (1934), McAnulty and McAnulty (1976), Corry and others (manuscript) - deposits; Powers (1921), Sellards and others (1933), Lonsdale (1940), Herrin (1958), Corry and others (manuscript) - regional geology

IDENTIFICATION NO. EM-BR-U24-10

LOCATION: East area, Solitario (Fig. 3)
7.5-minute quadrangle: The Solitario
LATITUDE: N29°27'43"
LONGITUDE: W103°46'49"
BLOCK AND SECTION: Blk. G-5, Secs. 33 and 34
LAND CLASSIFICATION: Section 34 is mineral classified; Section 33 is not State minerals

COMMODITY: Zinc, copper, silver?

STATUS: Prospect, area of alteration

EXTENT OF DEVELOPMENT: Geologic mapping and geochemical sampling by Amax Exploration, Inc., around 1976-1977.

GEOLOGY: Area consists of numerous, small rhyolite intrusions into shale and limestone of the Ordovician Marathon Formation. Rock, particularly the rhyolite, is intensely altered and contains limonite and hematite, probably from oxidation of pyrite. Iron oxides are especially common along fractures. Quartz veins are only locally present. Corry and others (manuscript) report an assay containing 31.2% Fe, 1700 ppm Zn, and 235 ppm Cu. Limonite-rich sample collected by BEG contained negligible base metals but showed 1.4 ppm Ag and 0.8 ppm Au (semiquantitative analysis).

REFERENCES: Corry and others (manuscript) - occurrence; Baker (1934), Herrin, 1958, McAnulty and McAnulty (1976), and Corry and others (manuscript) - regional geology

BIG BEND RANCH
Smith Ranch Silicified Area

IDENTIFICATION NO. EM-PR-U24-11

LOCATION: East area, southwest of Solitario
    7.5-minute quadrangle: The Solitario
    LATITUDE: N29°23'34"
    LONGITUDE: W103°22'18"
    BLOCK AND SECTION: Blk. G-5, Sec. 89
LAND CLASSIFICATION: Not State minerals

COMMODITY: Silver, gold

STATUS: Occurrence

EXTENT OF DEVELOPMENT: Geologic exploration and geochemical sampling in mid 1980's by Gold Capital Corporation.

GEOLOGY: Prospect consists of an area of clay and silica alteration within tuffaceous deposits and mafic lavas of Tertiary Fresno Formation. Silica is mostly in the form of chalcedony. Sulfide (probably pyrite) appears to be present in veinlets. Abundant sulfate suggests the former presence of additional sulfide. Alteration appears to be related to the upper levels of an epithermal system. This area was investigated by Gold Capital Corporation as a possible hot-spring gold deposit. Semiquantitative analysis of two samples by the Bureau of Economic Geology shows slight enrichment in Ag, Au, As, and Hg.

REFERENCES: McKnight (1970), Corry and others (manuscript) - regional geology

COMMENTS: Area of alteration may extend to the north beneath unaltered landslide deposit.

IDENTIFICATION NO. EM-BR-U24-12

LOCATION: East area, Solitario (Fig. 3)
7.5-minute quadrangle: The Solitario
LATITUDE: N29°27'17"
LONGITUDE: W103°46'34"
BLOCK AND SECTION: Blk. G-5, Sec. 33
LAND CLASSIFICATION: Not State minerals

COMMODITY: Manganese

STATUS: Occurrence

EXTENT OF DEVELOPMENT: None

GEOLOGY: Geology is similar to that of prospects U24-7 and U24-9

REFERENCES: Baker (1934), McAnulty and McAnulty (1976), Corry and others (manuscript) - deposits; Powers (1921), Sellards and others (1933), Lonsdale (1940), Herrin (1958), Corry and others (manuscript) - regional geology

BIG BEND RANCH
Whit-Roy (Anchor) Mine

IDENTIFICATION NO. EM-PR-V24-1

LOCATION: East area, 1 mi (1.6 km) north of Contrabando Dome
7.5-minute quadrangle: Lajitas
LATITUDE: N29°20'40"
LONGITUDE: W103°49'06"
BLOCK AND SECTION: T. C. RR Blk 341, Sec. 107
LAND CLASSIFICATION: Not State minerals

COMMODITY: Hg

STATUS: Abandoned mine

EXTENT OF DEVELOPMENT: Two major shafts with extensive underground workings; 1935 to 1973.

GEOLOGY: Similar to that at Fresno Mine.

REFERENCES: Yates and Thompson (1959), Chester (1965), and Sharpe (1980) - regional geology and deposit

COMMENTS: Whitroy Mine had some of the last mercury production, in 1973, in the Terlingua Mercury District.

BIG BEND RANCH
Fresno (Buena Suerte) Mine

IDENTIFICATION NO. EM-PR-V24-2

LOCATION: East area, 1 mi (1.6 km) north of Contrabando Dome
7.5-minute quadrangle: Lajitas
LATITUDE: N29°20'44'
LONGITUDE: W103°48'43"
BLOCK AND SECTION: T. C. RR Blk 341, Sec. 106
LAND CLASSIFICATION: Mineral classified

COMMODITY: Hg

STATUS: Abandoned mine; production more than 3500 flasks (120,000 kg)

EXTENT OF DEVELOPMENT: Discovered in 1930's. Extensive underground workings from two major shafts, each less than 100 ft (30 m) deep, and several open pits. Fresno Mine was the largest Texas producer during World War II, but almost all activity ceased after the end of the War. Dow Chemical Company did considerable exploration drilling in 1960 but had no production.

GEOLOGY: The Fresno and Whit-Roy mines are along the Terlingua moncoline, an east-west to northwest-trending fold produced by Laramide deformation. Ore was in lodes, mostly within solution collapse zones, along the Cretaceous Santa Elena Limestone - Del Rio Clay contact. Minor ore occurs in the overlying Buda Limestone. Deposits consist of cinnabar mixed with and replacing clay within the solution collapse zones. McAnulty (1974) noted fluorite associated with the cinnabar.

REFERENCES: Yates and Thompson (1959), Chester (1965), and Sharpe (1980) - regional geology and deposit; McAnulty (1974) - fluorite occurrence

COMMENTS: Although within mineral classified section, Fresno Mine is privately held. Yates and Thompson (1959) stated that the existence of ore at the Fresno Mine indicated potential for more deposits in the western part of the Terlingua district, which is within the Ranch.

BIG BEND RANCH
CONTRABANDO DOME PROSPECTS (V24-3/1 through 3/8)

IDENTIFICATION NO. EM-PR-V24-3/1

LOCATION: East area, Contrabando Dome (Fig. 4)
7.5-minute quadrangle: Lajitas
LATITUDE: N29°19'33"
LONGITUDE: W103°48'52"
BLOCK AND SECTION: TCRR Blk. 341, Sec. 105
LAND CLASSIFICATION: Not State minerals

COMMODITY: Mercury

STATUS: Prospect

EXTENT OF DEVELOPMENT: Small bulldozed area

GEOLOGY: Contrabando Dome is a gentle dome (radial outward dips up to about 15°) probably developed over a Tertiary rhyolite laccolith. The dome is cut by several northeast- and northwest-trending, small-displacement faults that are probably flexures over the dome. Flaggy limestone of the Cretaceous Boquillas Formation makes up most of the outcrop. Small plugs and dikes of rhyolite that occur throughout the dome, particularly along some of the faults, may be offshoots from the underlying intrusion. These rhyolites and the rhyolite exposed in a large laccolith on the east side of the dome are highly oxidized porphyries containing quartz and feldspar phenocrysts. Abundant iron-staining of the rhyolite indicates that it formerly contained considerable pyrite. Most of the prospects occur along the faults and within or adjacent to the small rhyolite intrusions. However, Yates and Thompson (1959) suggested that the association of cinnabar with the rhyolite is structural or hydrologic, rather than a direct igneous-hydrothermal relationship. The ore mineral at all prospects is probably cinnabar. Quartz, calcite, and pyrite are gangue minerals.

Host rock at this prospect is limestone; no porphyry or other igneous rock was seen in outcrop. Mineralization consists of minor white calcite veins with no iron oxides or other evidence of mineralization of economic interest.

REFERENCES: Yates and Thompson (1959) and Sharpe (1980) - deposits. Yates and Thompson (1959) - regional geology

COMMENTS: Diamond drilling in 1956 and 1957 at Contrabando Dome by the Big Bend Mining Company as a part of the Defense Minerals Exploration Administration encountered no significant mineralization. Known drill sites are at prospects 3/7 and 3/8.

IDENTIFICATION NO. EM-PR-V24-3/2

LOCATION: East area, Contrabando Dome (Fig. 4)
7.5-minute quadrangle: Lajitas
LATITUDE: N29°19'38"
LONGITUDE: W103°48'12"
BLOCK AND SECTION: TCRR Blk. 341, Sec. 105
LAND CLASSIFICATION: Not State minerals

COMMODITY: Mercury

STATUS: Prospect

EXTENT OF DEVELOPMENT: Vertical drill-hole (30 to 50 ft [9 to 15 m]?), bulldozed area

GEOLOGY: Geology is similar to that of prospect V24-3/1. Only limestone is present in outcrop. Calcite veins, 0.5 to 2 inches (1 to 5 cm) wide, strike northeasterly. No iron oxides or other evidence of economic mineralization was observed at this prospect.

REFERENCES: Yates and Thompson (1959) and Sharpe (1980) - deposits; Yates and Thompson (1959) - regional geology

IDENTIFICATION NO. EM-PR-V24-3/3

LOCATION: East area, Contrabando Dome (Fig. 4)
7.5-minute quadrangle: Lajitas
LATITUDE: N29°19'03"
LONGITUDE: W103°48'30"
BLOCK AND SECTION: TCRR Blk. 341, Sec. 105
LAND CLASSIFICATION: Not State minerals

COMMODITY: Mercury

STATUS: Prospect

EXTENT OF DEVELOPMENT: Two small trenches in rhyolite: one is 9 ft x 2 ft x 3 ft deep; the other is 7 ft x 2 ft x 3 ft (2 x 0.6 x 0.9 m) deep.

GEOLOGY: Host rock is a small plug of porphyritic rhyolite, approximately 100 ft by 30 ft, intruded into Boquillas Formation along a N64°E-trending normal fault along the southeast flank of the dome. On the southeast side of the fault, Boquillas Formation dips 12° southeast off the dome. On the northwest side, Boquillas is nearly flat-lying in the interior of the dome.

The trenches are within the rhyolite and aligned with the fault. Exploration apparently was investigating the combination of altered rhyolite, structural control, and brecciation of both rhyolite and limestone. The size of the workings suggest little economic mineralization was found. Our examination showed little if any cinnabar.

Other data: Semiquantitative analysis of a sample from the larger trench showed negligible Hg (1.8 ppm) but slight anomalies for Ag (0.8 ppm) and Au (0.07 ppm).

REFERENCES: Yates and Thompson (1959) and Sharpe (1980) - deposits; Yates and Thompson (1959) - regional geology

BIG BEND RANCH
CONTRABANDO DOME PROSPECTS

IDENTIFICATION NO. EM-PR-V24-3/4

LOCATION: East area, Contrabando Dome (Fig. 4)
7.5-minute quadrangle: Lajitas
LATITUDE: N29°18'28"
LONGITUDE: W103°48'44"
BLOCK AND SECTION: TCRR Blk. 341, Sec. 104
LAND CLASSIFICATION: Mineral classified

COMMODITY: Mercury

STATUS: Abandoned mine

EXTENT OF DEVELOPMENT: One shaft, approximately 50 ft (15 m) deep; one adit, approximately 15 ft (4.5 m) long; several trenches.

GEOLOGY: The mine area is on a small hill underlain by rhyolite that intrudes shaley limestone of the upper Boquillas Formation. Limestone and rhyolite in the wall of the shaft are highly sheared and brecciated; shearing and brecciation trend N72°E. The shaft and a shallow pit to the southwest are aligned along this east-northeast trend. Also, the adit and two trenches are aligned along a parallel trend. All these features suggest structural control by an east-northeast-trending, dome-related fault, although displacement is not apparent.

Exploration apparently investigated the combination of altered rhyolite, east-northeast-trending structure, and brecciation of rhyolite and limestone, as at prospect V24-3/3. The extent of the workings suggests that mineralization was better developed here. This deposit may have been the source of much of the approximately 10 flasks of mercury produced from Contrabando Dome deposits.

Other data: Semiquantitative analysis of sample from shaft shows negligible Hg (2.4 ppm) but slight enrichment in Ag (0.7 ppm) and Au (0.07 ppm).

REFERENCES: Yates and Thompson (1959) and Sharpe (1980) - deposits; Yates and Thompson (1959) - regional geology

BIG BEND RANCH
CONTRABANDO DOME PROSPECTS

IDENTIFICATION NO. EM-PR-V24-3/5

LOCATION: East area, Contrabando Dome (Fig. 4)
7.5-minute quadrangle: Lajitas
LATITUDE: N29°18'42"
LONGITUDE: W103°49'12"
BLOCK AND SECTION: TCRR Blk. 341, Sec. 109
LAND CLASSIFICATION: Not State minerals

COMMODITY: Mercury

STATUS: Prospect

EXTENT OF DEVELOPMENT: Small trench

GEOLOGY: Similar to that of prospect V24-3/3

REFERENCES: Yates and Thompson (1959) and Sharpe (1980) - deposits; Yates and Thompson (1959) - regional geology

BIG BEND RANCH
CONTRABANDO DOME PROSPECTS

IDENTIFICATION NO. EM-PR-V24-3/6

LOCATION: East area, Contrabando Dome (Fig. 4)
7.5-minute quadrangle: Lajitas
LATITUDE: N29°18'36"
LONGITUDE: W103°49'23"
BLOCK AND SECTION: TCRR Blk. 341, Sec. 109
LAND CLASSIFICATION: Not State minerals

COMMODITY: Mercury

STATUS: Prospect

EXTENT OF DEVELOPMENT: Small trench

GEOLOGY: Similar to that of prospects V24-3/3 and V24-3/5

REFERENCES: Yates and Thompson (1959) and Sharpe (1980) - deposits; Yates and Thompson (1959) - regional geology

BIG BEND RANCH
CONTRABANDO DOME PROSPECTS

IDENTIFICATION NO. EM-PR-V24-3/7

LOCATION: East area, Contrabando Dome (Fig. 4)
7.5-minute quadrangle: Lajitas
LATITUDE: N29°18'46"
LONGITUDE: W103°49'29"
BLOCK AND SECTION: TCRR Blk. 341, Sec. 109
LAND CLASSIFICATION: Not State minerals

COMMODITY: Mercury

STATUS: Abandoned mine?

EXTENT OF DEVELOPMENT: One adit, approximately 15 ft (4.5 m) long. Five trenches, each approximately 30 ft long by 2 ft wide (9 by 0.6 m) by 3 to 5 ft (0.9 to 1.5 m) deep. Collapsed area in arroyo bottom appears to have been shaft with drifts. Two dumps containing several tons of material each.

GEOLOGY: Three small, irregular rhyolite plugs intrude the upper part of the Boquillas Formation. The plugs are approximately 30 to 50 ft (9 to 15 m) in diameter. The adit is cut in brecciated, recrystallized limestone along a N68°E trend adjacent to one of the plugs, and the end of the adit may be in rhyolite. Four of the five trenches are in a second plug and one is in limestone. A shear zone in one of the trenches is N70°E. The shaft? in the arroyo is at least partly in rhyolite also. Two dumps contain highly oxidized, iron-stained rhyolite. Exploration apparently was examining the same features as at several other prospects, the combination of altered rhyolite, east-northeast-trending structure, and brecciated rhyolite and limestone.

The extent of workings, the size of the two dumps, and the remains of a small retort suggest that mineralization was relatively well developed here. Some of the mercury production from Contrabando Dome may have been from this locality. However, no significant cinnabar was found during this investigation.
Other data: Semiquantitative analysis of a sample from the dump showed a slight Hg (3 ppm) anomaly as well as Ag (0.6 ppm) and Au (0.07 ppm) anomalies.

REFERENCES: Yates and Thompson (1959) and Sharpe (1980) - deposits; Yates and Thompson (1959) - regional geology

BIG BEND RANCH
CONTRABANDO DOME PROSPECTS

IDENTIFICATION NO. EM-PR-V24-3/8

LOCATION: East area, Contrabando Dome (Fig. 4)
7.5-minute quadrangle: Lajitas
LATITUDE: N29°19'05"
LONGITUDE: W103°49'46"
BLOCK AND SECTION: TCRR Blk. 341, Sec. 108
LAND CLASSIFICATION: State fee

COMMODITY: Mercury

STATUS: Abandoned mine?

EXTENT OF DEVELOPMENT: Two adits (>100 ft [30 m]?) with sizeable dumps. USBM drill-hole nearby. One adit is in footwall of shear zone that trends N 80°E, dips 80° N. Shear zone is 3 ft (0.9 m) wide.

GEOLOGY:
Host rock: Fine-grained intrusive rhyolite containing quartz and feldspar phenocrysts. Geologic setting of this prospect is very similar to others in the Contrabando Dome.
Formation age and name: Tertiary rhyolite intrudes thin-bedded, platy limestone and black shale of the Boquillas Formation.
Ore mineralogy: Presumed to be cinnabar but none was identified during the field investigation.
Gangue mineralogy: Quartz and abundant pyrite.

REFERENCES: Yates and Thompson (1959) and Sharpe (1980) - deposits; Yates and Thompson (1959) - regional geology

BIG BEND RANCH

IDENTIFICATION NO. EM-BR-V24-6

LOCATION: East area, between Solitario and Contrabando Dome
7.5-minute quadrangle: Lajitas
LATITUDE: N29° 22'25" approximate
LONGITUDE: W103° 49'20" approximate
BLOCK AND SECTION: G.C. and S.F. RR Blk G-5, Sec. 110
LAND CLASSIFICATION: Mineral classified

COMMODITY: Fluorite

STATUS: Occurrence

EXTENT OF DEVELOPMENT: None known

GEOLOGY:
Host rock: limestone (?)
Formation age and name: presumed to be Cretaceous Santa Elena Limestone

REFERENCES: McAnulty, W.N., Sr. (1967, 1974, 1975) - deposits; Yates and Thompson (1959) and McKnight (1970) - regional geology

COMMENTS: Not visited.