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**PRELIMINARY STUDY OF THE
URANIUM FAVORABILITY OF THE
JORNADA DEL MUERTO BASIN AND
ADJACENT AREAS,
SOUTH-CENTRAL NEW MEXICO**

Field Engineering Corporation
Grand Junction Operations
Grand Junction, Colorado 81501

June 1978

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CONTENTS

	<u>Page</u>
Summary	1
Introduction	2
Purpose	2
Project location	2
Previous work	2
Procedures	8
Literature study	8
Field investigation	8
Analytical procedures.	8
Geology	8
Stratigraphy	8
Geologic history	8
Structure	10
Favorable rock units under consideration	12
Precambrian rocks	12
Bat Cave Formation and Cable Canyon Sandstone	12
Abo Formation	12
Dakota Sandstone	13
Mesaverde Formation	13
McRae Formation	13
Evidence of uranium favorability	15
Precambrian	15
Bat Cave Formation and Cable Canyon Sandstone	15
Abo Formation.	15

CONTENTS (continued)

	<u>Page</u>
Evidence of uranium favorability (continued)	
Dakota Sandstone	15
Mesaverde Formation	16
McRae Formation	16
Results	16
Conclusions	19
Bibliography	21

ILLUSTRATIONS

	<u>Page</u>
Figure 1. Location maps of study area in Socorro, Sierra, and Dona Ana Counties, New Mexico	3
2. Location map of uranium occurrences, Jornada del Muerto area	5
3. General geology and oil test hole locations, Jornada del Muerto area	6
4. Columnar section of Jornada del Muerto area, New Mexico	9
5. Jornada del Muerto area showing possible pinch-out of pre-Pennsylvanian rocks and southern boundary of Triassic rocks	11
6. Diagrammatic cross section of lithofacies in the Jose Creek Member of the McRae Formation	14
7. Location map of rock samples, Jornada del Muerto area	17

TABLES

Table 1. Uranium occurrences in the Jornada del Muerto area	4
2. Data on oil test wells in the Jornada del Muerto Basin.	7
3. Mineralogy of rock samples taken in the Jornada del Muerto basin area	18

SUMMARY

The Jornada del Muerto Basin area, about 3,000 sq mi, is in Sierra, Socorro, and Dona Ana Counties, New Mexico. This preliminary study evaluates available surface and subsurface geologic data to assess uranium favorability of the area.

Data indicate that possible uranium host rocks include the Precambrian rocks, the Ordovician Bat Cave Formation and Cable Canyon Sandstone, the Permian Abo Formation, Lower Cretaceous Dakota Sandstone, and the Upper Cretaceous-lower Tertiary McRae Formation. The Cenozoic sequence contains possible host beds; little is known, however, about its stratigraphy. Secondary uranium mineralization is found associated with faults in the Jornada area. All fault zones there are possible sites for uranium deposition.

Possible sources for uranium in the Jornada del Muerto area include uraniferous Precambrian rocks, tuffaceous beds in the McRae Formation, and the Tertiary Datil and Thurman Formations. Hydrothermal solutions may have deposited the veinlike fluorite deposits, of which the purple varieties were found to be radioactive during this study.

INTRODUCTION

This report summarizes the general uranium favorability of rocks in the Jornada del Muerto Basin area, south-central New Mexico (Fig. 1). The study started December 1976 and ended March 1977. The investigation was conducted by Bendix Field Engineering Corporation (BFEC) on behalf of the U.S. Energy Research and Development Administration, which subsequently became the U.S. Department of Energy.

PURPOSE

The purpose of this study was to evaluate available surface and subsurface geologic data in order to assess the uranium favorability of rocks in and adjacent to the Jornada basin. The objective was to make appropriate recommendations for work needed to refine favorability assessment.

PROJECT LOCATION

The project area comprises about 3,000 sq mi in parts of Sierra, Socorro, and Dona Ana Counties, New Mexico (Fig. 1). The region is covered by parts of the Tularosa (NI 13-7) and the Las Cruces (NI 13-10) quadrangles. It extends between lats 32°30' and 34° N. and longs 106°30' and 107°15' W.

PREVIOUS WORK

Kern County Land Company conducted an air and ground radiometric survey of the Pedro Armendaris Land Grant (Reim, 1955). The survey located eight anomalous areas in Tertiary, Cretaceous, and Permian formations (Table 1; Fig. 2).

Atomic Energy Commission geologists described and sampled uranium occurrences in the Jornada area (Hudfield, 1952; Jedlicka, 1954; Stroud and Wilson, 1954; Wilson, 1954; Wolfe, 1954; Sharps and Allison, 1955). Oil-test holes have been drilled in the Jornada area (Fig. 3), which indicated above-normal radioactivity in the Cretaceous Dakota Sandstone and Permian Abo Formation (Table 2). Seismic surveys have also been conducted in the Jornada area.

The outcrops, especially those of Precambrian and Permian Abo rocks, have been prospected sporadically for uranium since the early 1950s by local prospectors and mining companies. Numerous claim posts and discovery and prospect pits are evident. Exploration was mainly confined to the red beds, where zones of alteration are exposed. There is evidence of recent exploration activity in an area of Precambrian rocks in Ts. 16 and 17 S., R. 4 W.

Known uranium production from the Jornada area and adjacent mountains is small. According to records at the Grand Junction Office of the U.S. Department of Energy, the U.S. Atomic Energy Commission purchased 1,022 tons of ore, averaging 0.22 percent U_3O_8 and containing 4,493 lb U_3O_8 , from the Lucky Don property (NE¼ sec. 35, T. 2 S., R. 2 E.) outside the study area. Ore was produced from a fault zone in the Permian San Andres Limestone at the property (Wolfe, 1954). Secondary uranium minerals coat shears and fill pore spaces.

Figure 1. Location maps of study area in Socorro, Sierra and Dona Ana Counties, New Mexico.

TABLE 1. URANIUM OCCURRENCES IN THE JORNADA DEL MUERTO AREA

Occurrence no. (Fig. 3)	Age/Formation	Geology	Reference
1	Permian/Abo	Radioactivity associated with secondary copper in a fault zone for 1,000 ft on strike.	Reim, 1955
2	Upper Cretaceous/ McSaverde	Radioactivity in coarse-grained sandstone and shale.	Reim, 1955
3	Upper Cretaceous/ McRae(Jose Creek Mbr.)	Siltstone associated with coarse-grained sandstone; 1-ft sample, 0.02% cU_3O_8 .	Reim, 1955
4	Upper Cretaceous/ Mesaverde	Radioactivity, 3X background on a lenticular channel sandstone.	Reim, 1955
5	Lower Tertiary/ McRae(Hall Lake Mbr.)	Radioactivity, 4X background in a fault zone between Jose Creek and Hall Lake. Assay, trace U_3O_8 .	Reim, 1955
6	Upper Cretaceous Lower Tertiary	Radioactivity, 7X background in a fault zone between Jose Creek and Hall Lake. Assay, trace U_3O_8 .	Reim, 1955
7	Lower Tertiary/ McRae(Hall Lake Mbr.)	Cross-bedded sandstone and siltstone, 39 ft thick. Assay, 5 ft of 0.02% cU_3O_8 .	Reim, 1955
8	Upper Cretaceous/ McRae(Jose Creek Mbr.)	Sandstone, siltstone, and mudstone associated with faulted anticline, small areas of carbonaceous plant remains. Radioactivity up to 2X background.	Reim, 1955
9	Precambrian	Shears in gneiss at contact with siliceous dike--selected samples. Assay, 0.02% cU_3O_8 .	Wilson, 1954
10	Precambrian	Fault zone between Precambrian and Cambrian. Fluorite vein, purple fluorite associated with yellow radioactive mineral and copper stains.	Jedlicka, 1954
11	Permian/Abo	Sparse secondary copper and uranium mineralization along joint surfaces in thin sandstones.	Stroud and Wilson, 1954
12	Precambrian	Faulted Precambrian granites and syenite dikes.	Stroud, 1954
13	Permian/Abo	Fault zone in sandstone. Secondary copper and yellow uranium minerals, estimated grade 0.10% U_3O_8 for 7 ft.	Sharps and Allison, 1955

Figure 2. Location map of uranium occurrences, Jornada del Muerto area.

Figure 3. General geology and oil test hole locations, Jornada del Muerto area (adapted from Dane and Bachman, 1965).

TABLE 2. DATA ON OIL TEST WELLS IN THE JORNADA DEL MUERTO BASIN

Ref. no. (Fig. 2)	Name of well	Location	Total depth (ft)	Surface formation	Deepest formation penetrated	Remarks
1.	Sun Oil Co. #1 Victoria L & C Co.	sec. 25, T. 10 S., R. 1 W. Sierra Co.	6,053	Mesaverde	Precambrian	Water in Dakota and San Andres 1000 ft, 1318 ft.
2.	Sun Oil Co. #2 Victoria L & C Co.	sec. 27, T. 10 S., R. 1 W. Sierra Co.	6,352	Mesaverde	Precambrian	Water in Dakota and San Andres
3.	Gulf Oil Co. #1 K State	sec. 27, T. 10 S., R. 1 W. Sierra Co.	7,860	Recent	Pennsylvanian	Tops: Mancos 1265 ft; Dakota 1678 ft; Abo 4020 ft; Bat Cave 7735 ft - Radioactivity 2X background in Mesaverde(?), Dakota, Abo, Lake Valley and Cable Canyon(?)
4.	Shell Oil #1 Lemon Fed.	sec. 16, T. 13 S., R. 1 E. Sierra Co.	7,346	Recent	Unknown	Tops: Mancos 835 ft; Dakota 1300 ft; Abo 3570 ft, Radioactivity in Abo 2X background.
5.	Coxton #1 Beard Federal	sec. 5, T. 14 S., R. 1 E. Sierra Co.	8,850	Recent	Pennsylvanian	Tops: San Andres 2040 ft; Abo 4140 ft; no logs available.
6.	Beard Oil Co. #1 Jornada del Muerto	sec. 17, T. 14 S., R. 1 W. Sierra Co.	9,800	Recent	Pennsylvanian	Tops: Dakota 2670 ft; Abo 7786 ft; no logs available.
7.	Clyde R. Wofford #1 Wofford	sec. 7, T. 14 S., R. 1 W. Sierra Co.	533	Mesaverde	Mesaverde	None.
8.	Clyde R. Wofford #1 Graham State	sec. 8, T. 14 S., R. 2 W. Sierra Co.	507	Mesaverde	Mesaverde	Water 90 ft - show gas and oil, coal 389-397 ft.
9.	Clyde R. Wofford #1 J. H. Winslow	sec. 18, T. 14 S., R. 2 W. Sierra Co.	587	Mesaverde	Mesaverde	Water 104-109 ft, 230- 275 ft.
10.	McCall Drilling Co. #1 State	sec. 19, T. 14 S., R. 12 E. Sierra Co.	2,900	Mesaverde	Permian	Show oil 513-531 ft, 1116-1620 ft; water 160- 180 ft, 470-500 ft, 750 ft, 944-1024 ft, 1290-1305 ft.
11.	Winslow & Wright #1 State	sec. 19, T. 14 S., R. 2 W. Sierra Co.	700	Mesaverde	Mesaverde	No shows sulfur, water, or oil.
12.	McCall Drilling #2 Park-Lowes	sec. 32, T. 14 S., R. 2 W. Sierra Co.	2,205	Mesaverde	Mesaverde	No logs available.
13.	Wright & Winslow #1 State	sec. 2, T. 15 S., R. 3 W. Sierra Co.	900	Cretaceous	Cretaceous	No logs available.
14.	F. William Carr #1 Gentry State	sec. 32, T. 15 S., R. 3 W. Sierra Co.	5,408	Pennsylvanian	Mississippian	No logs available.
15.	Sunray-Mid Cont. N.M. Federal M#1	sec. 23, T. 15 S., R. 2 W. Sierra Co.	9,765	McRae	Cambrian	Tops: Mesaverde 954 ft; Mancos 2606 ft; Dakota 3316 ft; Abo 5260 ft. Radioactivity 2X back- ground in Mancos, Dakota, and Abo.

Kelley and Silver (1952) studied the stratigraphy and structure of the Caballo Mountains. Bushnell (1953) studied the structure and the stratigraphy of the McRae Formation in the Elephant Butte area. Kottowski and others (1956) described the stratigraphy of the San Andres Mountains. Geologic maps of the area have been published by Kelley and Silver (1952), Kottowski and others (1956), and Bushnell (1953).

PROCEDURES

LITERATURE STUDY

Available geologic reports and maps, and oil-test-hole logs were obtained and reviewed. Information was also obtained from unpublished, private-company, and AEC reports and maps.

FIELD INVESTIGATION

Field investigation was limited mainly to the Caballo Mountains and the central Jornada area. Access to the White Sands Missile Range and the Pedro Armendaris Grant was not possible. Reported uranium occurrences were investigated. Anomalous radioactive areas were investigated with a hand-held Mt. Sopris SC-131 Scintillometer. Five rock samples were collected for analyses.

ANALYTICAL PROCEDURES

Rock samples were analyzed fluorometrically for uranium content. Petrographic descriptions were obtained by thin-section study. Uranium mineral identification was by means of x-ray and electron-microscope study.

GEOLOGY

STRATIGRAPHY

Rocks in the Jornada area range from Precambrian to Recent in age (Fig. 4). Total thickness of the sedimentary rocks is more than 17,000 ft (Kelley and Silver, 1952). Brief descriptions and distinguishing features are given in the stratigraphic columnar section (Fig. 4).

GEOLOGIC HISTORY

Early Precambrian rocks were intruded and metamorphosed by late Precambrian granites. During late Precambrian time, the Precambrian rocks were uplifted and peneplaned.

ERA	System	Group	Formation	Thickness (ft)	Lithology	Description
CENOZOIC	Quaternary			0-500		Valley fill and pediment gravels
	Tertiary		Intrusives	0-2000		Dikes, sills, and stocks of basalt and other intrusives
			Santa Fe	0-2000		Red clays to conglomerates
			Datil	0-2000		Purple volcanic flows, pyroclastics, and sediments
			Thurman	0-2500		White tuff, tuffaceous sandstones and clays
			Palm Park	0-1000		Tuffaceous silts to conglomerates
			Baca	0-2100		Red bouldery conglomerates, sandstone, and shale
MESOZOIC	Cretaceous		McRae	0-3000		Alternating red shales and sandstones, volcanic conglomerates at base
			Mesaverde	0-3000		Alternating light-gray shales and lenticular fine- to coarse-grained sandstone, locally carbonaceous coal seams near base
			Mancos	400-500		Gray shale with thin gray limestone, some thin bentonite beds
			Dakota	125-250		Light-gray, fine- to coarse-grained sandstones, gray shale, very fine grained sandstone and siltstone at base
	Jurassic					
	Triassic	Dockum		0-500		Red, purple, and light-gray shale, siltstone, and sandstone
PALEOZOIC	Permian	Manzano	San Andres	700-1000		Gray, medium-bedded limestone with thin beds of very fine grained sandstones and claystones
			Yeso	200-1200		Pale-red, thin- to thick-bedded, very fine grained sandstone and gypsum
			Abo	500-900		Thin- to medium-bedded, red and brown lenticular sandstone and siltstone, red to purple shale
	Pennsylvanian	Magdalena	Bar B	335 +		Alternating thin gray limestone and shale
			Nakaye	420 +		Thick- to massive-bedded limestone; occasional shale lenses; abundant beds, lenses, and nodules of cherts
			Red House	360 +		Thin-bedded gray limestone and shale
	Mississippian		Lake Valley	0-50		Nunn Mbr. (0-13 ft.): Massive crinoidal gray limestone Almagordo Mbr. (0-36 ft.): Massive gray limestone with chert lenses
	Devonian		Percha	0-105		Calcareous claystone, olive shale, and very fine grained sandstone and siltstone
	Silurian		Fusselman	0-50		Dark-gray, cherty dolomite
	Ordovician	Montoya	Cutter	0-160		Gray dolomite limestone with thin bands of chert
			Aleman	0-170		Dark-gray, alternating chert and dolomite
			Upham	0-80		Gray massive dolomite
			Cable Canyon	0-35		Medium-grained dolomitic sandstone
		El Paso	Bat Cave	0-305		Gray, massive limestone to dolomite with bioherm masses, collapse breccia
			Sierrite	0-170		Thin- to medium-bedded gray limestones with thin beds of chert
	Cambrian		Bliss	0-160		Fine- to coarse-grained, thin-bedded brown sandstone
PRECAMBRIAN						Granite, gneiss, schist, and pegmatite

Figure 4. Columnar section of Jornada del Muerto area, New Mexico (modified after Kelley and Silver, 1952).

The Bliss Sandstone (Cambrian) was deposited on the peneplaned Precambrian rocks by a sea slowly transgressing from west to east in the Sonoran seaway. During Ordovician and Silurian times, great thicknesses of carbonates were deposited on a foreland shelf as the epicontinental seas expanded eastward. During Devonian time, a recurrently rising upland to the north became a source of late Paleozoic sediments. Then, erosion, subsequent to regional southward tilting, beveled the underlying beds and completely removed them north of the Fra Cristobal Mountains (Fig. 5). Another sea advanced from the east to deposit the Percha Shale (Devonian).

In Mississippian time, after renewed epeirogenic uplift and erosion, the same sea deposited the Lake Valley Group. In Pennsylvanian time, after another pulse of uplift and erosion, the Red House shale, the Nakaye limestone, and the Bar B shale of the Magdalena Group were deposited by a sea transgressing from and regressing to the east. The transition from predominantly marine to predominantly continental sedimentation occurred during the Permian time. It is represented by the Manzano Group, which comprises the Abo, Yeso, and San Andres Formations.

Triassic rocks are not exposed except for small remnants of the Dockum Group north of lat $33^{\circ}45'$ N. Beds are absent because of nondeposition and erosion. Jurassic rocks are absent in the Jornada del Muerto Basin because of nondeposition during Jurassic time.

In Cretaceous time, another transgressing and regressing sea deposited the Dakota Sandstone, the Mancos Shale, and then the Mesaverde Formation. After uplift, erosion, and volcanism during the Laramide orogeny, the McRae shales were deposited.

In Tertiary time, continued volcanism provided the tuffaceous sediments of the Palm Park, Thurman, and Datil Formations. In late Tertiary time, the Santa Fe gravels filled the Rio Grande rift as alluvial fans. In Quaternary time, fluvial gravels covered great pediments and filled the river valleys.

STRUCTURE

The Jornada del Muerto Basin is a broad, northward-trending syncline bounded by the Caballo and Fra Cristobal uplifts to the west and the San Andres-Sierra Oscura uplifts to the east. The basin and uplifts are in the Mexican Highland section of the Basin and Range province.

Eastward-dipping Mesaverde and McRae beds crop out from the western margin of the Jornada basin almost to its center. Westward-dipping San Andres limestone beds are composed of bedrock on the Jornada's east side but are generally concealed by thin valley fill.

The uplifts are tilted fault blocks of Precambrian and Paleozoic rocks that rose along late Tertiary, high-angle faults. The San Andres uplift rose differentially along a bounding fault at its eastern base, and the Paleozoic beds now dip approximately 10° W. The Sierra Oscura dips to the East.

Figure 5. Map of Jornada del Muerto area showing possible pinch-out of pre-Pennsylvanian rocks and southern boundary of Triassic rocks (after Kelley and Silver, 1952; Bushnell, 1955).

The Caballo and Fra Cristobal uplifts rose differentially along the Caballo Hot Springs fault at their western bases, and the beds now dip to the east, approximately 15° in the Caballo Mountains and 6° in the Fra Cristobals. The Fra Cristobal uplift also rose differentially along a bounding fault at its eastern base; here, the beds now dip west and south. Both uplifts are crossed by three northwest-trending, overturned fold belts that are Laramide in age.

The Cutter sag is an embayment of the Jornada basin between the Caballo and Fra Cristobal uplifts. It is a broad northwest-trending trough filled with 2,000 to 3,000 ft of McRae Formation sediments.

FAVORABLE ROCK UNITS UNDER CONSIDERATION

Most of the reported uranium occurrences are associated with fault structures. Mineralization associated with faults can be expected from Precambrian through lower Tertiary.

The following formations are considered more likely to contain epigenetic uranium deposits in the Jornada subsurface: Precambrian rocks, Bat Cave Formation, Cable Canyon Sandstone, and Abo, Dakota, Mesaverde, and McRae Formations. The lower Tertiary, if present in the central Jornada, may comprise possible host rocks. The above assessment is supported by the favorable features noted in the following sections.

Precambrian Rocks

The Precambrian, well exposed on the west sides of the Caballo and Fra Cristobal ranges, consists mainly of coarse-grained red granites. Schists, granite gneisses, and aplite and pegmatite dikes enclosed by granite are also present.

Bat Cave Formation and Cable Canyon Sandstone

The Bat Cave Formation (Ordovician) is a dark-gray to medium-gray limestone and dolomite. Many bioherm and stromatolite reef structures are present. The upper part of the formation contains collapse breccia, consisting of carbonates, some chert, and sandstone. The formation is unconformably overlain by the Cable Canyon Sandstone. Some of the collapse structures contain stratified Cable Canyon Sandstone (Kelley and Silver, 1952).

The Cable Canyon is a well-sorted, medium-grained sandstone. The sand is highly dolomite-cemented, although locally it has excellent permeability and porosity and contains petroliferous residue (Kelley and Silver, 1952).

Abo Formation

The Abo Formation (Permian) is composed of thin- to medium-bedded, reddish-brown sandstones, siltstones, and red shales. The beds are continental in

origin and are typical wide flood-plain deposits (Kelley and Silver, 1952). Locally, in the upper Abo, light-gray to white, fine- to medium-grained, thick-bedded, lenticular sandstones are present. Individual beds are lenticular, mostly cross-bedded, with scour-and-fill structures. The sandstones are composed of angular to subrounded quartz, feldspar, and muscovite grains and various other minerals cemented by reddish clay and iron oxides.

Dakota Sandstone

The basal unit of the Dakota Sandstone (Lower Cretaceous) is medium-bedded, white siltstone up to 30 ft thick. This unit is well cemented, and resembles a novaculite or quartzite on outcrop. Above the basal siltstone, the formation is laminated, thick-bedded, pink to white, medium- to coarse-grained sandstone. This sandstone varies in thickness: its minimum thickness is unknown; its maximum is 220 ft. It contains some medium-gray shales in the lower part and a 10- to 30-ft-thick shale bed near the middle. The formation grades upward into a distinctive dark-brown, very coarse-grained, cross-bedded sandstone (Kelley and Silver, 1952).

Mesaverde Formation

The Mesaverde Formation (Upper Cretaceous) consists of alternating sandstone and shale beds. The sandstones are feldspathic, light gray to buff with some reddish or purplish hues on outcrop, fine to coarse grained, lenticular, locally carbonaceous, mainly massive, and cross bedded. The lenticular nature of the formation is evident in outcrop. No single sandstone unit is known to extend more than 1/2 mi (Bushnell, 1955). The shale beds are fairly continuous, light gray to medium gray in color, and locally carbonaceous. The lower part of the formation contains coal seams up to 6 ft thick, especially near Carthage.

McRae Formation

The McRae Formation is divided into the Jose Creek Member and the overlying Hall Lake Member (Bushnell, 1953). The geologic age of the formation is approximately Late Cretaceous to early Tertiary.

The Jose Creek grades from brown and greenish shales at the base to tan and dark-brown feldspathic sandstones with chloritic and ferruginous silt at the top (Kottlowski and others, 1963). Near Elephant Butte, the Jose Creek grades from vent agglomerates and volcanic conglomerates to olive shales and brown sandstones (Fig. 6). The conglomerates contain pebbles, cobbles, and boulders of intermediate volcanic rocks with some basalt.

The Hall Lake Member consists of purple shales with alternating sandstones up to 20 ft thick. A few distinctive conglomerate beds are present near the base. They consist of quartzite with small amounts of granite, schist, and scattered andesite cobbles in a matrix of light-gray, friable, arkosic, tuffaceous sandstone. Sandstone beds are medium to coarse grained, and contain mica and subangular quartz (Kelley and Silver, 1952).

Figure 6. Diagrammatic cross section of lithofacies in the Jose Creek Member of the McRae Formation (From Bushnell, 1955).

EVIDENCE OF URANIUM FAVORABILITY

Precambrian

The Precambrian granites are highly altered and contain uranium mineralization in Ts. 16 and 17 S., R. 4 W. A grab sample assayed 0.20 percent U_3O_8 (Hadfield, 1952). Altered and possibly mineralized areas are easily distinguished by color contrast because of abundant iron-oxide staining. In the area of secs. 4, 9, and 16, T. 16 S., R. 4 W., areas of iron staining similar to that of the mineralized area in T. 16 S. are evident.

Bat Cave Formation and Cable Canyon Sandstone

There are no known uranium occurrences in the Bat Cave and the Cable Canyon. However, the possibility of solution passage is provided by channels formed by karst-like solution and collapse brecciation of the upper part of the Bat Cave before and during deposition of the Cable Canyon.

The Cable Canyon Sandstone is well cemented but does contain areas of high permeability and porosity, and contains locally petroliferous residue. Such residue may serve as reductant and may precipitate uranium. Some faults in the mountain blocks that flank the Jornada area extend from known mineralized areas into favorable formations. The faults (and unconformities) may have channeled uraniferous solutions into the Bat Cave Formation and the Cable Canyon Sandstone.

Abo Formation

The Abo has been the most widely prospected formation in the Jornada area. Three known uranium occurrences are in faults in the Caballo and Fra Cristobal Mountains. Sparse, secondary uranium mineralization also is found in other faulted areas and lenticular sandstones. The known occurrences are generally associated with carbonaceous trash and secondary copper minerals (Table 2; Fig. 3). Oil-test-hole gamma-ray logs indicate radioactivity up to 2X background in scattered, thin zones within and at or near the top of the Abo.

Dakota Sandstone

Although there are no known uranium occurrences in the Dakota in the Jornada area, literature research and field examination indicates that the formation should not be discounted as a potential host rock. Near Carthage, a bleached zone in the Dakota is associated with radioactivity that is 2X background. In sec. 29, T. 14 S., R. 3 W., a light-gray, silty shale, approximately 10 ft thick, has radioactivity of 3X background. Some small spots of alteration in a medium-grained sandstone above this shale show radioactivity that is slightly above background. Gamma-ray logs indicate radioactivity up to 2X background (Table 1; Fig. 2). The radioactivity and

reported streaks of bituminous matter in the upper Dakota (Kelley and Silver, 1952) indicate that the Dakota is a possible uranium host rock in the Jornada area.

Mesaverde Formation

Two anomalous radioactive areas in the upper Mesaverde were found on the Pedro Armendaris Grant by airborne radiometric survey (Reim, 1955). Field work conducted during this study indicates that the carbonaceous shales near the base of the formation in T. 14 S., R. 3 W. have 2X background radioactivity. A gamma-ray log (Table 1; Fig. 2) indicates 2X background radioactivity in the Mesaverde. Permeability and porosity appear to be good on outcrop. The coloration, trash content, and radioactivity suggest that uranium mineralization can possibly be found downdip from surface outcrops.

McRae Formation

Four uraniferous areas are known in the McRae Formation (Reim, 1955). Uranium contents are 0.02 percent or less. Although lateral extent and thicknesses are limited, they do indicate that uranium mineralization is present in the McRae Formation.

McRae beds are folded and faulted where exposed at and near the Cutter sag. The folding and faulting probably continue into the covered areas of the basin. If present in the basin, the structures may have impeded solution flow or provided entry to host rocks for mineralizing solutions.

The Hall Lake Member has distinctive conglomerate beds and arkosic, feldspathic, tuffaceous, locally carbonaceous sandstone beds up to 20 ft thick. The sandstone beds are separated by chocolate-brown tuffs, tuffaceous siltstones, and purple shales (Kottowski and others, 1963). Possible source and host beds are therefore present within the McRae Formation.

RESULTS

Three rock samples were taken from the McRae Formation and one rock sample was taken from the Precambrian. A sample of radioactive fluorite was selected from a uranium occurrence in sec. 13, T. 24 S., R. 3 E., which is outside of the study area. Locations of samples are shown on Figure 7. Mineralogy of the McRae and the Precambrian is found in Table 3. No uranium minerals were found in the samples. Uranium-and-thorium-bearing zircons in the Precambrian sample were found by heavy-mineral analysis.

Field observations and analyses of samples 22545 through 22547 (Table 3) indicate that suitable source rocks and host rocks are present within the McRae Formation. Samples 22545 and 22546 (Table 3) of the Hall Lake Member of the McRae Formation contain only 2 ppm U_3O_8 , which probably indicates that considerable leaching of uranium has taken place since its deposition.

Figure 7. Location map of rock samples, Jornada del Muerto area.

TABLE 3. MINERALOGY OF ROCK SAMPLES TAKEN IN
THE JORNADA DEL MUERTO BASIN AREA.

<u>Mineral/Component</u>	<u>22545*</u>	<u>Percent in sample number</u>		
		<u>22546*</u>	<u>22547*</u>	<u>22548*</u>
Quartz	21	5	tr	25
Chert	4	-	-	-
K-feldspar	7	tr	tr	43
Plagioclase	25	4	17	10
Biotite	tr	tr	-	-
Muscovite	-	-	-	3
Chlorite	1	tr	-	tr
Plutonic RF	tr	-	-	-
Volcanic RF	20	-	58	-
Metamorphic RF	-	-	-	-
Sedimentary RF	tr	tr	-	-
Epidote	tr	-	tr	-
Apatite	tr	-	tr	tr
Zircon	tr	tr	tr	tr
Opakes	6	1	tr	6
Carbonate	tr	-	-	-
Barite	tr	-	-	-
Matrix	15	69	24	-
Ferruginous clay**	-	20	-	12

* 22545-Arkosic wacke, Hall Lake Member of McRae Formation.

* 22546-Siltstone, Hall Lake Member of McRae Formation.

* 22547-(Volcanic) Lithic wacke, Jose Creek Member of McRae Formation.

* 22548-Altered granite, Precambrian.

** Not included as matrix.

Sample 22547 of the Jose Creek Member of the McRae Formation contains 31 ppm U_3O_8 and 0.08 percent organic carbon, which indicates a concentration of uranium in a carbonaceous area.

The radioactive, purple fluorite, sample 22549, assayed 0.05 percent U_3O_8 . No uranium mineral could be identified, however. Although clear fluorite and barite were found in the vein structure, only the purple fluorite was radioactive. The same relationship was found in other fluorite occurrences in the Caballo Mountains. The radioactive purple fluorite probably represents different periods of mineralization.

Field observations and literature research indicate that the stratigraphy of Cenozoic formations is complex. The Baca Formation was seen in T. 4 S., R. 2 E. only and is probably not present except in the immediate vicinity of the outcrop area. The correlation between the Baca and the top of the Hall Lake Member of the McRae is unknown, although they are approximately the same age.

CONCLUSIONS

The Datil Formation is present to the north and west of the study area. The Thurman Formation was mapped (Dane and Bachman, 1965) as being present in T. 17 S., R. 1 W. It is probable that the Datil and (or) the Thurman Formations covered and were in contact with the entire stratigraphic section during Tertiary pre-Santa Fe Formation time. The presence and subsequent erosion of the Datil and Thurman Formations would provide a uranium source for surficial secondary uranium occurrences now seen in the Jornada area. The same source can be postulated for possible uranium occurrences in the Jornada del Muerto Basin subsurface.

Reported uranium mineralization in granites, granite gneisses, syenites, and veins that contain purple fluorite suggests that the Precambrian is the most favorable host rock in the Jornada area. The Precambrian can also be considered to be a source of uranium for other uranium occurrences in the Jornada del Muerto Basin.

Secondary uranium mineralization is associated with and can be expected at or near fault zones in any stratigraphic unit within the project area. Although known occurrences are small (100 tons or less of ore), little evaluation of the occurrences has been done down dip.

Although there are no known uranium occurrences in the Bat Cave Formation and Cable Canyon Sandstone, they are possible host rocks in the Jornada area. The unconformity and karst surface that developed during Ordovician time in the Bat Cave Formation and the subsequent deposition of the Cable Canyon Sandstone provide a means for uranium-bearing solution entry into an environment favorable for deposition. Petroliferous residues in the Cable Canyon Sandstone are suitable reductants for uranium deposition from uraniumiferous solutions.

The Abo Formation has been the most prospected formation. It is easily recognized in the field and weathers to more accessible terrain. Secondary mineralization occurs with fault structures and bleached sandstone zones that are easily recognized. The upper Abo contains light-gray to white, fine- to medium-grained, thick-bedded, lenticular sandstones. Unfortunately, the upper Abo beds are not well exposed at the surface and are covered in most places with alluvium eroded from the ridge-forming San Andres Limestone and with fine silt and sand from the Permian Yeso above the Abo Formation.

The Dakota Sandstone in the Jornada del Muerto Basin contains a bleached zone with an attendant increase in radioactivity. In the Caballo Mountains in sec. 29, T. 14 S., R. 3 W., a shale bed in the upper Dakota has above-background radioactivity. The formation contains petroliferous residues in the Caballo Mountains area, which may act as a reductant to uranium-bearing solutions. The possible sources of uraniferous solution are the Tertiary Datil and Thurman Formations.

The Mesaverde Formation is a potential host rock in the Jornada del Muerto Basin. The Mesaverde contains areas of anomalous radioactivity, located by an airborne radiometric survey and by field work conducted during this study. The formation was deposited in a fluvial and paludal environment. The sandstone beds are lenticular and locally contain carbonaceous trash. The Tertiary Datil and Thurman Formations are postulated as the sources for uranium.

The McRae Formation contains radiometric anomalies and low-grade uranium occurrences (0.02 percent or less U_3O_8 ; Reim, 1955) on the Pedro Armendaris Grant in the Cutter sag area. The occurrences are associated with faults and structural features. This faulting probably extends into the Jornada basin subsurface, where little geological information is available. The McRae Formation contains suitable host and source beds.

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