



Uranium in the Socorro area, New Mexico

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URANIUM IN THE SOCORRO AREA, NEW MEXICO

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INTRODUCTION

Uranium occurrences in central and northern Socorro County are found as: (1) vein-type deposits, (2) early Paleozoic carbonatites in Precambrian terrains, (3) deposits in volcanic rocks, and (4) sandstone deposits in Permian, Triassic, Cretaceous, and Tertiary sedimentary rocks (fig. 1, Table 1). Additional uranium occurrences in Socorro County, but not described here, are found in Permian sandstones in the

Scholle and Rayo districts (McLemore, 1982), in volcanic rocks in the San Mateo Mountains (Berry and others, 1982; McLemore, 1983), and in scattered localities in eastern and southern Socorro County (McLemore, 1983).

In Socorro County, uranium production has been restricted to the Jeter mine in the Ladron Mountains (locality 2, Table 1), three vein-type deposits along the Rio Grande valley (localities 23, 24, and 26),

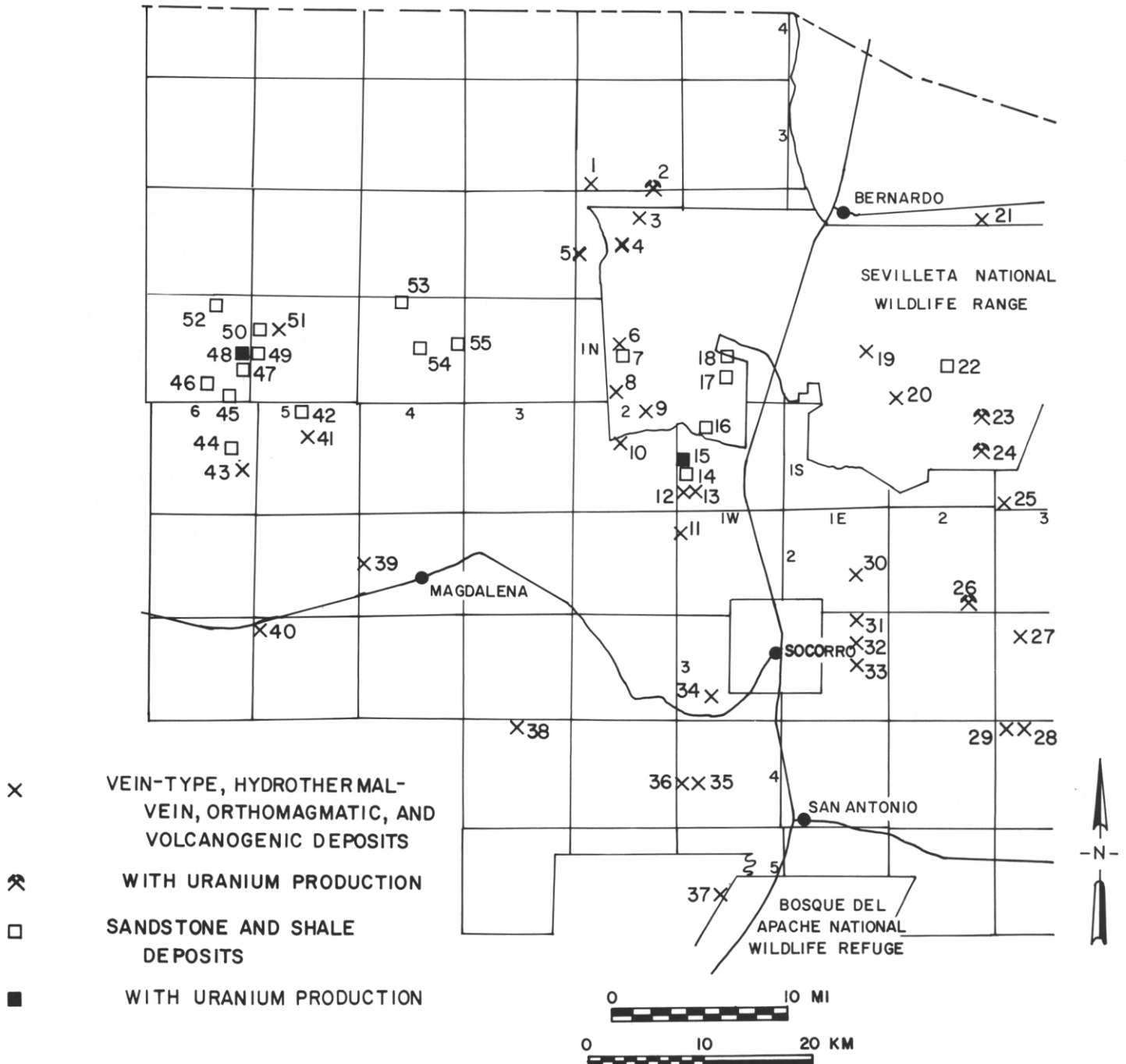


Figure 1. Map showing uranium occurrences in the Socorro area, New Mexico. Numbers represent localities given in Table 1.

Table 1. Uranium occurrences and mines in the Socorro area shown in Figure 1. (1) Host: pC = Precambrian rocks, O = Ordovician carbonatites, Pm = Madera Limestone, Pa = Abo Formation, Py = Yeso Formation, Ps = San Andres Limestone, Rc = Chinle Formation, Tv = Tertiary volcanic rocks, Tb = Baca Formation, Tp = Popotosa Formation, Ts = Santa Fe Group; (2) Status of deposit: 1 = occurrence of radioactive anomaly, 2 = producing mine (Table 2), 3 = 14 mt ore stockpiled but not shipped; (3) Chemical analyses by Lynn Brandvold and associates, New Mexico Bureau of Mines and Mineral Resources chemical laboratory; (4) Source of data: PRR = Preliminary Reconnaissance Reports of U.S. Atomic Energy Commission listed by number and year written, DEB-RRA = Denver Exploration Branch—Reconnaissance Report of Albuquerque, PC = personal communication, FN = field notes.

| Map No. on fig. 1 | Name | Location | Type of deposit | Host ¹ | Status of deposit ² | Chemical analyses ³ | Source of data ⁴ |
|------------------------------------|--|------------------------|---------------------|-------------------|--------------------------------------|--------------------------------|--|
| LADRON MOUNTAINS | | | | | | | |
| 1 | Alamito Canyon prospect | NW1/4 32 T3N R2W | Hydrothermal-vein | pC | 1 | 0.10% | Chamberlin and others (1982) |
| 2 | Jeter mine | NE1/4 35 T3N R2W | Vein-type | pC, Ts | 2 | 0.20% | FN 6/28/80; Hilpert (1969) |
| 3 | Granite Well group | 10 T2N R2W | Hydrothermal-vein | pC | 1 | — | PRR DEB-RRA-1440 (1954) |
| 4 | Rule prospect | 15 T2N R2W | Hydrothermal-vein | pC, Ts | 1 | — | FN 9/15/81 |
| 5 | Juan Torres | SE1/4 18 T2N R2W | Hydrothermal-vein | pC | 1 | — | FN 9/11/81 |
| 6 | Silver Creek area | NW1/4 15 T1N R2W | Sandstone | Tp | 1 | 0.021% | R.M. Chamberlin (PC, 10/6/80) |
| 7 | Silver Creek prospect | SW1/4 15 T1N R2W | Hydrothermal-vein | Tp | 1 | — | Hilpert (1969) |
| 8 | Copper prospect | 33 T1N R2W | Hydrothermal-vein | Ts or Tp | 1 | — | PRR DEB-RRA-462 (1954) |
| 9 | Unknown - San Acacia copper mine | 2 T1S R2W | Hydrothermal-vein | Tp | 1 | — | Gott and Erickson (1951) |
| 10 | Shaft | SE1/4 10 T1S R2W | Hydrothermal-vein | Tp | 1 | — | Gott and Erickson (1951) |
| RIO GRANDE VALLEY | | | | | | | |
| 11 | Carter-Tolliver-Cook and Vulcan claims (Lemitar carbonatites) | 6, 7 T2S R1W | Orthomagmatic | O | 1 | 0.001-0.25% | McLemore, this guidebook |
| 12 | Lemitar carbonatites | 30 T1S R1W | Orthomagmatic | O | 1 | 0.003% | McLemore, this guidebook |
| 13 | Lemitar carbonatites | 29 T1S R1W | Orthomagmatic | O | 1 | — | McLemore, this guidebook |
| 14 | Polvadera Mountain claim Four Jokers | Sl/2 19 T1S R1W | Sandstone | Tp | 1 | — | Collins and Smith (1956) |
| 15 | San Lorenzo #1 | NW1/4 18 T1S R1W | Sandstone | Tp | 2 | — | FN 5/13/82 |
| 16 | San Lorenzo Canyon | NW1/4 8 T1S R1W | Shale | Tp | 1 | — | S. Asher-Bolinder (PC, 5/20/81) |
| 17 | Unknown - San Acacia | 28 T1N R1W | Sandstone | Ts | 1 | — | Bachman and others (1957) |
| 18 | Unknown - San Acacia | 21 T1N R1W | Sandstone | Ts | 1 | — | Bachman and others (1957) |
| 19 | Unknown - La Joyita | 23 T1N R1E | Hydrothermal-vein | pC, Pm | 1 | — | Collins and Mallory (1954) |
| 20 | Unknown - La Joyita | 31 T1N R2E | Hydrothermal-vein | pC | 1 | — | Collins and Mallory (1954) |
| 21 | Black Butte | 12 T2N R2E | Volcanogenic | Tv | 1 | — | FN 3/2/82 |
| 22 | T.D. Campbell | W1/2 22 T1N R2E | Sandstone | O | 1 | — | Hilpert (1969) |
| 23 | Marie #1 | 1 T1S R2E | Vein-type | Pm, Pa | 2 | — | Hilpert (1969) |
| 24 | Agua Torres | 13 T1S R2E | Vein-type | Pm | 2 | — | Hilpert (1969) |
| 25 | Union #1 | SW1/4 31 T1S R3E | Sandstone/Vein-type | Pa | 1 | — | — |
| 26 | Lucky Don-Little Davie | 35 T2S R2E | Vein-type | Ps | 2 | 0.38, 1.4% | FN 8/31/80; Hilpert (1969) |
| 27 | Rheua #1 | 8 T3S R3E | Vein-type | Py | 1 | — | FN 11/11/82 |
| 28 | Unknown - Carthage | NE1/4 5 T4S R3E | Volcanogenic | Tv | 1 | — | Collins and Mallory (1954) |
| 29 | Unknown - Carthage | 6, 7 T4S R3E | Volcanogenic | Tv | 1 | — | Collins and Mallory (1954) |
| 30 | Minas del Chupadera | 26 T2S R1E | Vein-type | Pm | 1 | — | FN 7/3/80 |
| 31 | Gonzales | NE1/4 2 T3S R1E | Hydrothermal-vein | pC | 1 | — | FN 7/3/80, 12/28/81 |
| 32 | Unknown - Tajo granite | NW1/4 11 T3S R1E | Hydrothermal-vein | pC | 1 | 0.019% | FN 2/2/82 |
| 33 | Unknown - Tajo granite | 14 T3S R1E | Hydrothermal-vein | pC | 1 | 0.002, 0.005% | FN 1/6/82, 2/2/82 |
| 34 | Grefco perlite mine | NE1/4 28 T3S R1W | Volcanogenic | Tv | 1 | — | Collins and Mallory (1954) |
| 35 | Red Hills | NE1/4 19 T4S R1W | Hydrothermal-vein | Tv | 1 | — | FN 3/1/82 |
| 36 | Luis Lopez manganese mine | 16, 17, 20, 21 T4S R1W | Hydrothermal-vein | Tv | 1 | — | FN 3/1/82 |
| 37 | Chupadera carbonatites | 21, 28 T5S R1W | Orthomagmatic | O | 1 | 0.002% | McLemore (this guidebook), Kent (1982) |
| MAGDALENA MOUNTAINS | | | | | | | |
| 38 | Big Chief Group | SW1/4 3 T4S R3W | Hydrothermal-vein | Tv | 3 | — | Berry and others (1982), Ellis and Scott (1982) |
| GALLINAS MOUNTAINS | | | | | | | |
| 39 | Silver Hill prospect | 19 T2S R4W | Hydrothermal-vein | Tv | 1 | — | PRR DEB-RRA-1171 (1954) |
| 40 | Sixty prospect | 6 T3S R5W, 1 T3S R6W | Hydrothermal-vein | Tv | 1 | 0.002% | FN 4/7/81 |
| 41 | Council Rock | 9, 10 T1S R5W | Hydrothermal-vein | Tv | 1 | — | Pierson and others (1982) |
| 42 | Unknown | 3, 4 T1S R5W | Sandstone | Kc | 1 | — | PRR DEB-RRA-845 (1953) |
| 43 | Unknown (Hooks Ranch) | 23 T1S R6W | Volcanogenic | Tv | 1 | — | Pierson and others (1982) |
| 44 | Unknown (Hooks Ranch) | 14 T2S R6W | Sandstone | Kc | 1 | — | Pierson and others (1982) |
| 45 | Unknown (Hooks Ranch) | 35 T1N R6W | Sandstone | Tb | 1 | — | Bachman and others (1957) |
| 46 | Rusty Atom-Beall claims | 26 T1N R6W | Sandstone | Tb | 1 | — | Pierson and others (1982) |
| 47 | Hust-McDonald-Brown; Hogsett-Hust-Henderson | 24 T2N R6W | Sandstone | Tb | 1 | — | Hilpert (1969) |
| 48 | Hook Ranch | SW1/4 13 T1N R6W | Sandstone | Tb | 2 | 0.016% | FN 2/7/81; Hilpert (1969) |
| 49 | Hot Shot mine | 18 T1N R5W | Sandstone | Tb | 1 | — | Hilpert (1969) |
| 50 | Anomaly #5 (Hooks Ranch) | 7 T1N R5W | Sandstone | Kc | 1 | — | Hilpert (1969) |
| 51 | Alamosa Creek valley | 8 T1N R5W | Volcanogenic | Tv | 1 | — | Bachman and others (1957) |
| 52 | Nicolls-Higgins-Jones | SW1/4 2 T1N R6W | Sandstone | Tb | 1 | — | Pierson and others (1982) |
| BEAR MOUNTAINS (RILEY AREA) | | | | | | | |
| 53 | King-Fall Spring | 4, 5 T1N R4W | Sandstone | Tb | 1 | — | FN 11/12/82; Hilpert (1969) |
| 54 | Luciel claims | 15 T1N R4W | Sandstone | Tb | 1 | 0.004, 0.009% | FN 2/7/81; Potter (1970) |
| 55 | Disappointment #3 | NW1/4 13 T1N R4W | Sandstone | Tb | 1 | — | FN 11/12/82; Sargent (this guidebook) |

Table 2. Uranium production in Socorro County, New Mexico from the U.S. Atomic Energy Commission ore-production reports, government contracts only. This includes total ore that was received at the buying stations and mills, including "no-pay" ore (ore assaying less than 0.10% U₃O₈).¹ See Table 1 for definition of symbols.

| Map No. on fig. 1 | Name | Location | Metric tons ore | %U ₃ O ₈ | Kilograms U ₃ O ₈ | Host ¹ | Type of deposit | Periods of production |
|----------------------|--------------|------------|-----------------|--------------------------------|---|-------------------|-----------------|----------------------------|
| 2 | Jeter Mine | 35 T3N R2W | 8,007 | 0.33 | 26,563 | Ts, pE | vein-type | 1954-1958 |
| 15 | San Lorenzo | 18 T1S R1W | 13 | 0.02 | 3 | Tp | sandstone | 1955 |
| 22 | Marie #1 | 1 T1S R2E | 42 | 0.14 | 57 | Em | vein-type | 1956 |
| 23 | Agua Torres | 13 T1S R2E | 135 | 0.11 | 147 | Em | vein-type | 1955-1956 |
| 25 | Little Davie | 35 T2S R2E | 15 | 0.18 | 28 | Ps | vein-type | 1955 |
| 25 | Lucky Don | 35 T2S R2E | 875 | 0.22 | 1,891 | Ps | vein-type | 1955-1956, 1960, 1962-1963 |
| 47 | Hook Ranch | 13 T1N R6W | 79 | 0.18 | 139 | Tb | sandstone | 1954-1961 |
| TOTAL SOCORRO COUNTY | | | 9,165 | 0.31 | 28,828 | -- | -- | 1954-1961 |
| TOTAL NEW MEXICO | | | 144,335 | -- | 360,061,623 | -- | -- | 1948-1981 |

and two sandstone deposits in the Lemitar and Gallinas Mountains (localities 15 and 48; Table 2). Cumulative uranium production from Socorro County totals 28,828 kg of U₃O₈ (Table 2), which makes it the largest producing county outside the San Juan Basin area (northwestern New Mexico). Additional undiscovered uranium deposits may occur in the Gallinas-Bear Mountains, Ladron Mountains, and Rio Grande valley (Chapin and others, 1979; U.S. Department of Energy, 1980; Pierson and others, 1982; Chamberlin and others, 1982).

DESCRIPTION OF AREAS

Ladron Mountains

The Jeter mine (locality 2, fig. 1, Table 1) has been the largest uranium producer outside the San Juan Basin area (McLemore, 1983). Production from this mine, during the interval 1954 to 1958, totaled 26,563 kg of U₃O₈ at an average grade of 0.33% U₃O₈ (Table 2). In 1957, a 3,304 mt ore shipment averaged 0.46% U₃O₈. Other ore shipments averaged from 0.12% to 0.36% U₃O₈ (U.S. Atomic Energy Commission, ore production records, 1954-1958). Uranium, vanadium, and copper occurs within a mudstone that forms a fault gouge along the footwall of a gently dipping fault that places Tertiary upper Santa Fe Group fanglomerates against Precambrian granite (Chamberlin and others, 1982; Hilpert, 1969; Collins and Nye, 1957). The primary uranium mineral is coffinite and appears to be confined to the fault gouge (Collins and Nye, 1957). Two orebodies were mined in an open pit and in a 79-m, 25° decline (fig. 2). Additional orebodies are indicated (Collins and Nye, 1957; U.S. Atomic Energy Commission files, 1958). At least seven additional copper occurrences, some of which are associated with uranium (localities 3 and 4), are found along the Jeter fault zone (Chamberlin and others, 1982).

The origin of the Jeter deposit is controversial. It has been described as a hydrothermal deposit (Collins and Nye, 1957; U.S. Department of Energy, 1980) and as a vein-type deposit in sedimentary rocks (Hilpert, 1969; Pierson and others, 1982). However, the Jeter deposit lacks the intense silicification and symmetrical alteration of most hydrothermal-vein deposits (Chamberlin and others, 1982). The apparent late Tertiary age of mineralization, asymmetry of alteration and geochemical zonation of metals are consistent with an epigenetic origin (Chamberlin and others, 1982). Trace-element analyses of vertically oriented samples from the Jeter mine indicates that uranium and vanadium decreases from ton to bottom. whereas molybdenum is concentrated in the middle

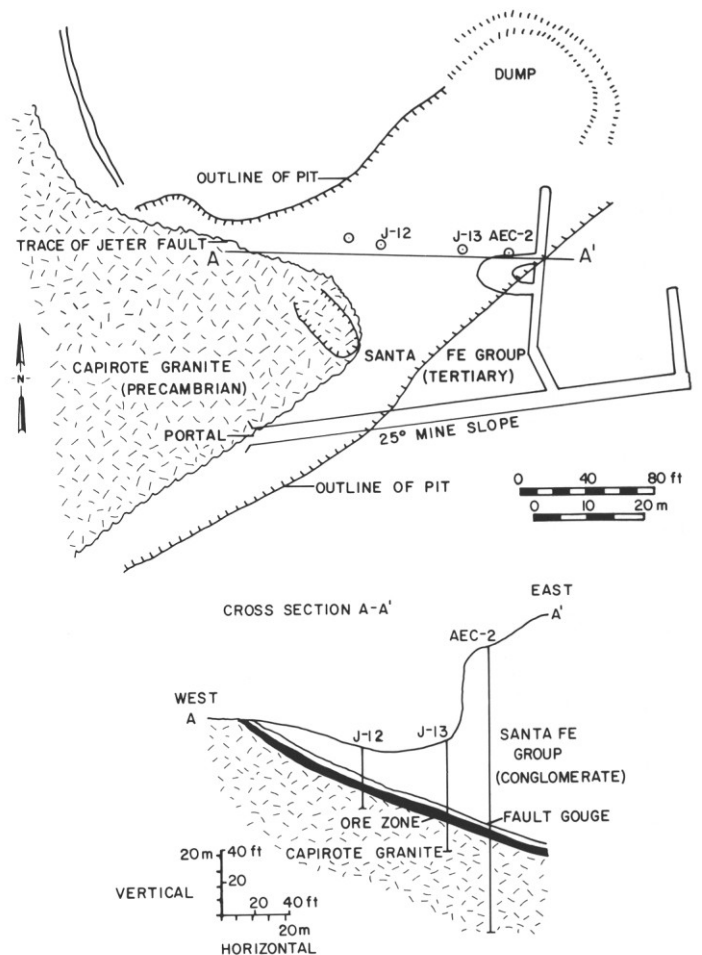


Figure 2. Map of the Jeter mine, sec. 35, T3N, R2W, Socorro County, New Mexico. Modified from U.S. Atomic Energy Commission unpublished map dated 11/1/57.

(Pierson and others, 1982). This zonation is similar to Wyoming-type sandstone deposits (Chamberlin and others, 1982). Additional geochemical studies are required to verify this geochemical signature.

Nine additional copper-uranium occurrences (localities 1, 3-10) are found along the eastern and southern margins of the Ladron Mountains (fig. 1). At the Juan Torres prospect (locality 5), fluorite, uranium, and copper occurs with siliceous veins in Precambrian granite. Copper and uranium minerals occur along foliation planes and fractures in Precambrian rocks at the Granite Well, Rule, and Alamito Canyon prospects (localities 1, 3, and 4). Copper and uranium minerals occur along fractures and joints in Tertiary volcanic rocks in the Silver Creek and San Acacia areas (localities 7-10). A sample of limonite gossan from the Alamito Canyon prospect contained 0.10% U₃O₈; but the lack of radioactivity suggests that the uranium was recently absorbed by iron oxides (Chamberlin and others, 1982). Silicification and hydrothermal-alteration is minor at these localities. In the Silver Creek area (locality 6); uranium, copper, and lithium occur in ash beds of the Popotosa Formation. A sample from this locality contained 0.021% U₃O₈ (Table 1).

The significance of these widely scattered occurrences is not clear. A pre-existing source for uranium in Precambrian rocks has not been verified; however, the high uranium content of well waters in the Jeter mine area (Pierson and others, 1982) may be indicative of on-going weathering of uranium-bearing rocks and/or uranium mineralization in the Precambrian terrain (Chamberlin and others, 1982).

Rio Grande Valley

Uranium occurs in the Rio Grande valley in: (1) vein-type deposits, (2) fractures in the Tajo granite, (3) sandstones and shales, and (4) early Paleozoic carbonatites. The only production is from four vein-type deposits in sedimentary rocks which amounted to 2,123 kg of U₃O₈ (Table 2). The Lucky Don—Little Davie mines (locality 26) alone yielded 1,919 kg of U₃O₈. Production from the Agua Tones and Marie mines (localities 23 and 24) amounted to 204 kg of U₃O₈.

Most of the vein-type uranium occurrences are found in silicified limestones and sandstones along the footwall of north-trending or northeast-trending faults. Uranium mineralization is sporadic and discontinuous along these faults. Secondary uranium minerals are common in mineralized areas. At the Marie and Agua Torres mines, north-trending faults juxtapose the Abo Formation (Permian) against the mineralized Madera Limestone (Pennsylvanian). Ore shipments as high as 0.23% U₃O₈ are reported from these deposits (U.S. Atomic Energy Commission, ore production reports, 1955-1956).

Secondary uranium minerals occur in silicified and recrystallized limestones of the San Andres Limestone (Permian) at the Lucky Don—Little Davie mines. A northeast-trending fault controls uranium mineralization and separates the San Andres Limestone from the Yeso Formation (Permian). Selected samples from these mines contain 0.38% and 1.40% U₃O₈ (Table 1). Average grade of ore shipments range from 0.16% to 0.30% U₃O₈ (U.S. Atomic Energy Commission, ore production reports, 1955-1963).

Uranium and copper minerals occur along faults and bedding planes at the Minas del Chupadera mine (locality 30). Although no uranium was produced from this copper mine, a sample collected by Pierson and others (1982) contained 0.30% U₃O₈. Copper and associated uranium mineralization occurs in the Madera Limestone (Pennsylvanian).

Uranium occurs along fractures and joints in weathered and altered Tajo granite (Precambrian), east of Socorro (localities 31-33; Table 1, fig. 1). Six outliers of granite are exposed along two northwest-trending fault zones (fig. 3). The Tajo granite is medium- to coarse-grained quartz monzonite (Condie and Budding, 1979). Metamorphic xenoliths are found in the exposures in sections 11 and 12 (fig. 3). Pegmatites and aplites are rare. Fluorite and barite veins occur along faults bounding

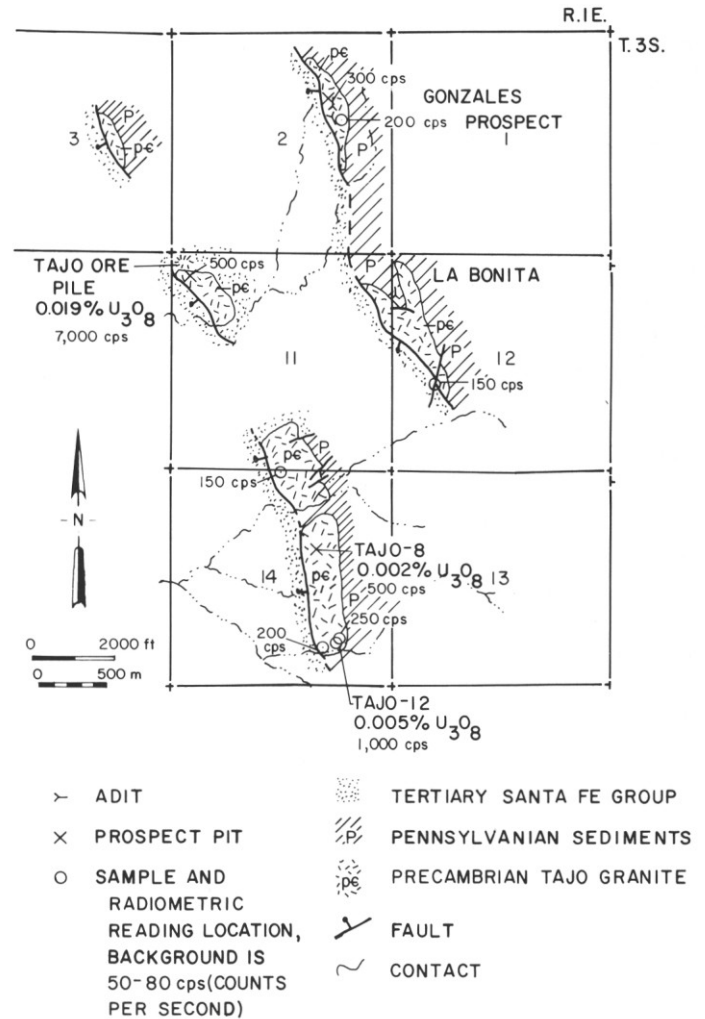


Figure 3. Geologic map of the Tajo granite (Precambrian) showing locations of high gamma radiation.

the outliers, but only the Gonzales fluorite-barite deposit is radioactive, indicating the presence of uranium or thorium. Several radiometric anomalies occur along northwest- to northeast-trending fractures or joints within five of the six outliers (fig. 3). Purple fluorite, hematitization, and silicification are associated with mineralized zones. Although no uranium minerals have been identified; uranium concentrations are as high as 0.019% U₃O₈ (Table 3). Higher uranium concentrations are expected to occur at depth, below the zone of oxidation. Thorium concentrations are only as high as 46 ppm and lead concentration in one sample is 0.13% (Table 3).

The chemical composition of the mineralized Tajo granite is unusual for Precambrian granites in New Mexico (Table 3). The Tajo granite is grossly similar in major-element chemistry to high-Si and high-K granites in the state (Condie and Budding, 1979); although trace-element analyses are required to adequately classify granites. The Tajo granite is enriched in Sig, Rb, U, and Th and depleted in CaO, Na₂O, Al₂O₃, and Sr, relative to most Precambrian granites (Table 3; Condie and Budding, 1979). This is due in part to silicification and hematitization related to the uranium mineralization. However, the chemical trends in the Tajo granite are different from chemical trends observed in altered Precambrian granites in New Mexico. Most Precambrian granites in New Mexico that are altered by albitization and epidotization are enriched in Na₂O, CaO, and Fe₂O₃ and depleted in K₂O, Rb, Sr, TiO₂,

Table 3. Chemical analyses of samples from the Tajo granite.¹ Average of high-Ca, high-Si, and high-K granites in New Mexico from Condie and Brookins (1980).

| Oxide (%) | Tajo-8 | Tajo-12 | Tajo ore pile | High-Ca granite ¹ | High-Si granite ¹ | High-K granite ¹ |
|--------------------------------|--------|---------|---------------|------------------------------|------------------------------|-----------------------------|
| SiO ₂ | 76.96 | 77.02 | 82.45 | 67.5 | 75.5 | 74.0 |
| TiO ₂ | 0.15 | 0.08 | 0.13 | 0.71 | 0.23 | 0.23 |
| Al ₂ O ₃ | 9.81 | 8.03 | 8.80 | 14.7 | 12.9 | 14.2 |
| Fe ₂ O ₃ | 5.62 | 6.28 | 1.64 | 4.93 | 1.74 | 1.35 |
| MgO | 0.13 | 0.09 | 0.31 | 1.42 | 0.07 | 0.43 |
| CaO | 0.62 | 0.41 | 0.26 | 3.00 | 0.65 | 0.91 |
| Na ₂ O | 1.59 | 1.02 | 0.19 | 3.40 | 4.00 | 3.40 |
| K ₂ O | 4.32 | 4.62 | 4.44 | 3.83 | 4.50 | 5.00 |
| P ₂ O ₅ | 0.05 | 0.04 | 0.05 | -- | -- | -- |
| LOI | 0.65 | 1.09 | 1.14 | -- | -- | -- |
| U ₃ O ₈ | 0.002 | 0.005 | 0.019 | 0.0007 | 0.0009 | 0.0007 |
| Trace Elements (ppm) | | | | | | |
| Th | 29 | 21 | 46 | 14 | 18 | 14 |
| Rb | 323 | 362 | 347 | 173 | 167 | 272 |
| Sr | 35 | 75 | 19 | 250 | 45 | 160 |

and Al₂O₃, relative to unaltered granites (Condie and Budding, 1979). However, with increase in U₂O₈ in the Tajo granite, SiO₂ increases and CaO and Na₂O decreases. Fe₂O₃ appears to decrease; whereas K₂O, TiO₂, Al₂O₃, Rb, and Sr do not change with increase in U₃O₈, or their concentrations are erratic with increase in U₃O₈ (Table 3).

The uranium potential of the Tajo granite is uncertain. This granite exhibits the mineralogy and chemistry typical of uraniferous granites (Mathews, 1978), which could provide a local source for uranium. However, the Tajo granite may also contain richer uranium concentrations at depth. The subsurface extent of the Tajo granite within the highly faulted Rio Grande graben is unknown.

The origin of the vein-type uranium deposits in Pennsylvanian and Permian sedimentary rocks and of the fracture-controlled deposits in the Tajo granite is unknown. The similarity in geometry, form, and associated alteration may suggest a similar process and a single source. Both a supergene (descending groundwaters) and a hypogene (ascending waters from a uraniferous basement) origin are possible. The potential for discovering additional small fracture- or fault-controlled deposits in the Rio Grande valley is moderate, especially in the vicinity of granitic plutons.

Minor uranium occurrences along the Rio Grande valley are also found in sandstones and shales of the Triassic Chinle Formation (locality 22), Tertiary Popotosa Formation (localities 14, 15, and 16), and upper Santa Fe Group (localities 17 and 18); hydrothermal-vein deposits in Precambrian rocks and the Pennsylvanian Madera Limestone (localities 19 and 20); volcanic rocks (localities 21, 28, 29, and 34); and in

manganese deposits in the Luis Lopez district (localities 35 and 36; see Eggleston and others, this guidebook). None of these occurrences are economically important, although uranium production from the San Lorenzo prospect (locality 15) amounted to 3 kg of U₃O₈ (Table 2).

Uranium also occurs within early Paleozoic carbonatite dikes in the Lemitar and Chupadera Mountains (localities 11, 12, 13, and 37; see McLemore, this guidebook). More than 100 dikes and veins are found in the Lemitar Mountains and more than a dozen dikes are found in the Chupadera Mountains. Uranium concentrations as high as 0.25% U₃O₈ are found in the Lemitar Mountains; however, uranium and thorium in most carbonatites are below economic grades (see McLemore, this guidebook).

Magdalena Mountains

Only one uranium occurrence has been reported in the Magdalena Mountains, the Big Chief Group (locality 38). The Big Chief Group (also known as C and K claims and Timber Peak mine) consists of two adits, trenches, and pits (Petty, 1979; Ellis and Scott, 1982). Gold, silver, lead, zinc, and uranium mineralization occurs in andesites of the Sawmill Canyon Formation (Osburn and Chapin, 1983) and the Hells Mesa Tuff along the margins of white rhyolite dikes (Petty, 1979). The mineralized area is structurally complex. An east-northeast-trending transverse shear zone cuts across the northern ring fracture zone of the Sawmill Canyon cauldron (see Osburn and Chapin, this guidebook).

The white rhyolite dikes have intruded the east-trending ring fracture zone and north-trending faults within the transverse shear zone (Petty, 1979). Although no ore shipments were received by the U.S. Atomic Energy Commission, 14 mt of 0.25% U308 were shipped to Socorro and stockpiled (U.S. Atomic Energy Commission files, 1960). Selected samples collected by Berry and others (1982) and Ellis and Scott (1982) from the upper adit contain 0.10% U308 and 0.007% U308. Economic uranium potential in this area remains to be proven.

Gallinas and Bear Mountains

Probably the most important uranium occurrences in Socorro County are in the Gallinas and Bear Mountains and are found in the sandstones of the lower and middle members of the Baca Formation (Eocene) and the upper Crevasse Canyon Formation (Cretaceous). Minor uranium occurrences are found in Tertiary volcanic rocks overlying the Baca Formation (Table 1, fig. 1). An unconformity separates the Crevasse Canyon Formation from the overlying Baca Formation. The unconformity is typically expressed by an abrupt change in grain size from medium-grained Cretaceous sandstones to conglomeratic sandstones of the Baca Formation (R. M. Chamberlin, 1983, personal commun.).

An altered or transition zone of bleached and oxidized sandstones and shales occurs at the top of the Crevasse Canyon Formation and is truncated by the unconformity (Chamberlin, 1981). This altered or transition zone was previously interpreted as: (1) reworked Cretaceous rocks and assigned to the Baca Formation (Anonymous, 1959), (2) an intertonguing Baca-Crevasse Canyon contact, (3) an altered zone formed by oxidizing groundwaters (Pierson and others, 1982), and (4) a paleosol or weathering profile (Chamberlin, 1981). This transitional zone contains lithologies typical of the Crevasse Canyon Formation—medium-grained sandstones compared to coarse conglomeratic sandstones of the Baca Formation. However, the basal contact of the Baca Formation is difficult to recognize because it contains reworked Cretaceous sediments. The interpretation of this altered or transition zone is important since all of the uranium occurrences in the Crevasse Canyon Formation in Socorro and Catron Counties are found within this zone. Uranium occurs only in trace amounts in the coal seams and carbonaceous shales below this transition zone (Bachman and Read, 1952, personal reconnaissance). In the Red Basin area of the Datil Mountains and in the Pie Town-Quemado area in Catron County, this transition zone is well developed and has been mapped by Chamberlin (1981). Small orebodies in the Red Basin area produced 542 kg of U308 from 1954 to 1957 (McLemore, 1983) and additional small orebodies were discovered by Gulf Minerals in the early 1970's (R. M. Chamberlin, 1983, personal commun.). Only small and isolated occurrences are found in the Crevasse Canyon Formation in the Gallinas and Bear Mountains (localities 42, 44, and 50; Table 1), although the transition zone is favorable for containing uranium deposits (Pierson and others, 1982).

Most of the major uranium occurrences in the Gallinas and Bear Mountains are found in the Baca Formation (localities 45-49, 52-55; Tables 1 and 2). One deposit in the Baca Formation at the Hook Ranch mine produced 139 kg of U308 from 1959 to 1961 (Table 2). In contrast, only small and isolated uranium occurrences are found in the Baca Formation in the Datil Mountains and Pie Town-Quemado area in Catron County (McLemore, 1983).

The Baca Formation unconformably overlies the Crevasse Canyon Formation and consists of mudstones, siltstones, sandstones, and conglomerates of braided-alluvial-plain, meander-belt, and lacustrine environments (Cather, 1982; Cather, this guidebook). Uranium mineralization is associated with carbonaceous material, shale lenses, and fossil logs in fluvial sandstones and conglomeratic sandstones in the lower and middle members of the Baca Formation. Chemical analyses as high as 3.27% U308 are reported from small mineralized lenses in the Baca Formation in the Hook Ranch area (Anonymous, 1959);

although samples collected by the author are less than 0.02% U308 (Table 1).

In the Riley area of the Bear Mountains (localities 53-55, Table 1), uranium mineralization is closely associated with organic material in reduced sandstones of the middle member of the Baca Formation. Detailed drilling by several companies has delineated orebodies in the area containing a few hundred thousand pounds of uranium at grades exceeding 0.10% U308 (see Sargent, this guidebook). Additional wide-spaced drilling has outlined an adjacent area of favorable reduced sandstones in the middle member. This area certainly warrants additional study.

Minor and isolated uranium occurrences are found in Tertiary volcanic rocks overlying the Baca Formation (localities 39-41, 43, and 51; Table 1). Although it is doubtful that economic deposits occur in these rocks, these occurrences indicate a possible uranium source terrain.

Future economic possibilities in the Gallinas and Bear Mountains are in the lower and middle members of the Baca Formation and possibly the upper Crevasse Canyon Formation (Chapin and others, 1979). Potentially commercial uranium orebodies have been delineated in the Riley area (see Sargent, this guidebook) and the outlook for discovering additional orebodies is good. Roll-type deposits are likely to occur in the uppermost Crevasse Canyon Formation (Chamberlin, 1981), although evidence demonstrating their presence is lacking. Few drill holes have penetrated the Crevasse Canyon Formation in this area to adequately assess the uranium potential in this unit.

URANIUM RESOURCES IN SOCORRO COUNTY

The U.S. Department of Energy (1980) has defined uranium resources as the sum of known uranium reserves and estimated potential uranium resources. Reserves are known quantities of uranium ore measured by drilling or direct sampling. Potential uranium resources are the quantities of uranium ore estimated or believed to occur in known uranium districts or favorable areas containing uranium deposits. Potential uranium resources are divided into three classes (in order of decreasing reliability): probable, possible, and speculative. They are further divided into selected maximum forwarded cost categories (\$30, \$50, and \$100 per pound of U308) to cover current economic conditions (U.S. Department of Energy, 1980).

Although there are no known uranium reserves in Socorro County at current prices, potential uranium resources have been calculated by the U.S. Department of Energy (1980) for three areas in Socorro and Catron Counties (Table 4). The majority of the estimated potential uranium resources are in sandstones of the lower and middle Baca Formation and upper Crevasse Canyon Formation in the Red Basin-Hook Ranch-Riley area and amounts to 312 mt of U308 at \$30 per pound of U308. Although the amount of potential uranium resources attributed only to the Hook Ranch and Riley area is unknown, the potential uranium resources in this area are greater than anywhere else in Socorro County. Two metric tons of U308 at \$30 per pound of U308 are estimated to occur in vein-type deposits similar to the Jeter deposit in the Ladron Mountains (Table 4). Only three metric tons of U308 at \$100 per pound of U308 are estimated to occur in vein-type deposits along faults in Permian limestone in the Rio Grande valley (Table 4). The future status of uranium mining in Socorro County, as elsewhere in New Mexico, is uncertain due to high production costs, lack of demand for uranium, taxation, and declining market conditions. In addition, the economic feasibility of these areas in the near future is limited by: (1) long haulage distances to existing mills, (2) remoteness of potential uranium deposits, and (3) land-use restrictions imposed by the Sevilleta Wildlife Refuge and the Ladron Wilderness Study Area.

Table 4. Potential uranium resources in the Socorro area from U.S. Department of Energy (1980) assessment reports and Pierson and others (1982).¹ Includes part of Red Basin area in Catron County.

| Locality | Host | Deposit class | Potential class | Unconditional Economic Potential | | | | | |
|---|---|---------------|-----------------|--|---------|----------|------------------------|---------|----------|
| | | | | Mean metric tons U ₃ O ₈ | | | Assigned average grade | | |
| | | | | \$30/lb | \$50/lb | \$100/lb | \$30/lb | \$50/lb | \$100/lb |
| Red Basin - Hook Ranch Riley area ¹ | Baca Formation and upper Crevasse Canyon Formation | sandstone | possible | 312 | 535 | 7,327 | 0.31 | 0.19 | 0.12 |
| Ladron Mountains | upper Santa Fe Group (confused with Popotosa Formation) | vein-type | possible | 2 | 3 | 34 | 0.37 | 0.24 | 0.16 |
| Rio Grande Valley (Chupadera Mesa) | Yeso and San Andres Formations (limestones) | vein-type | possible | -- | -- | 3 | 0.34 | 0.21 | 0.12 |
| Total Socorro County (including portion of Catron County) | | | | 314 | 538 | 7,364 | | | |
| Total New Mexico | | | | 26,716 | 54,964 | 880,770 | | | |

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Headframe of Waldo shaft in Kelly mining district with Magdalena Peak in background. Magdalena Peak is a dissected rhyolite dome of middle Miocene age (see Bobrow and others, this guidebook). Photo by Bob Osburn.