URANIUM RESOURCE POTENTIAL IN NEW MEXICO

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ABSTRACT

Mineral resources are the naturally occurring concentrations of materials (solids, gas, or liquid) in or on the earth's crust that can be extracted economically under current or future economic conditions. The *mineral-resource potential* of an area is the probability or likelihood that a mineral will occur in sufficient quantities so that it can be extracted economically under current or future conditions, including the occurrence of undiscovered concentrations of metals, nonmetals, industrial materials, and energy resources. The mineral-resource potential is not a measure of the quantities of the mineral resources, but is a measure of the *potential* of occurrence. Factors that could preclude development of the resource, such as the feasibility of extraction, land ownership, accessibility of the minerals, or the cost of exploration, development, production, processing, or marketing, are not considered in assessing the mineral-resource potential. Mineral-resource potential is a qualitative judgement of the probability of the existence of a commodity and is classified as very high, high, moderate, low, or no potential according to the availability of geologic data and relative probability of occurrence. Although no producing operations exist in New Mexico today, numerous companies have acquired uranium properties within the Grants, Hook Ranch-Riley, and Red Basin-Pietown districts and plan to explore and develop deposits in the future.

The mineral-resource potential for uranium is very high (VH) with a high level of certainty (D) in portions of the Morrison and Dakota Formations in the Grants uranium district and high (H) with a high level of certainty (D) in portions of the Morrison Formation elsewhere in the San Juan Basin and in the Todilto Formation in the Grants district. The mineral-resource potential for uranium is moderate (M) with a moderate level of certainty (C) in the Morrison Formation elsewhere in the San Juan Basin and in 19 districts in New Mexico and moderate (M) with a moderate to low level of certainty (B-C) in the Ogallala Formation in southeastern New Mexico. The mineral-resource potential for uranium is low (L) with a low level of certainty (B) in 20 districts throughout New Mexico and in the Morrison Formation in northeastern New Mexico. Exploration has occurred during the last decade in the Hook Ranch-Riley and Red Basin-Pietown districts, and at least one deposit has reported potential resources. Other basins in New Mexico, such as the Las Vegas, Sabinoso, Nacimiento, Chama, and Hagan-La Bajada basins and at Mesa Portales should be evaluated for sandstone uranium deposits. Although worldwide, other types of uranium deposits are higher in grade and larger in tonnage, the Grants district has been a significant source of uranium and has the potential to become an important future source, as low-cost technologies, such as in situ recovery and heap leach techniques improve, and as demand for uranium increases, thereby increasing the price of uranium. Molybdenum, selenium, and vanadium were produced as by-products at the mill and could be recovered by conventional milling in the future.

CLASSIFICATION OF MINERAL-RESOURCE POTENTIAL AND CERTAINTY OF ASSURANCE

Classification of mineral-resource potential differs from the classification of mineral resources. Quantities of mineral resources are classified according to the availability of geologic data (assurance), economic feasibility (identified or undiscovered), and as economic or uneconomic. Mineral-resource potential is a qualitative judgement of the probability of the existence of a commodity and is classified as very high, high, moderate, low, or no potential according to the availability of geologic data and relative probability of occurrence. Very high potential class was added by the senior author to emphasize producing mines, deposits in permitting, deposits undergoing active exploration, or deposits with defined reserves.

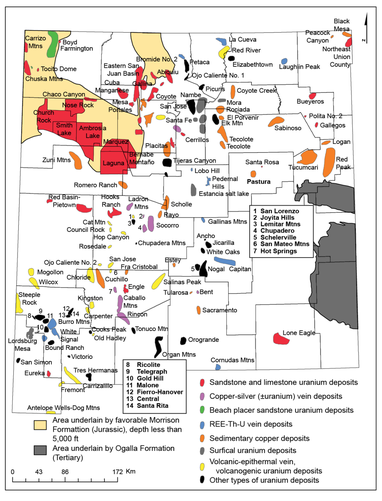
The evaluation of mineral-resource potential involves a complex process based on geologic analogy and probability of promising or favorable geologic environments with geologic settings (geologic models) that contain known economic deposits, as described in Goudarzi (1984) and McLemore (1985). Such subjective assessments or judgments depend upon available information concerning the area, as well as current knowledge and understanding of known deposits. The mineral resources were assessed by compilation and integration of all available published and unpublished geologic, geochemical, geophysical, and production data. Most commodities were evaluated at the mining district or prospect area scale (as defined by McLemore, 2017).

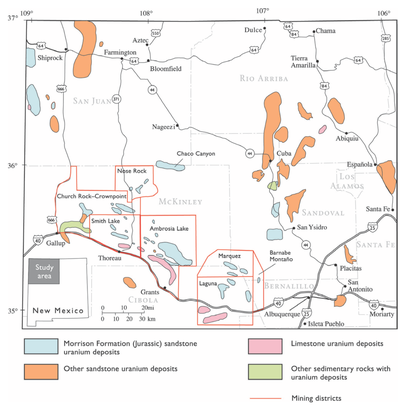
DEFINITIONS OF LEVEL OF RESOURCE POTENTIAL	
N	**No** mineral-resource potential is a category reserved for a specific type of resource/commodity in a well-defined area with no evidence of mineral resources. A high level of certainty is implied.
L	**Low mineral-resource potential** is assigned to areas where geologic, geochemical, and geophysical characteristics indicated geologic environment where the existence of economic mineral resources is unlikely and is assigned to areas of no or dispersed mineralized rocks.
M	**Moderate mineral-resource potential** is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for mineral-resource occurrence.
H	**High mineral-resource potential** is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence. Assignment of high mineral-resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area.
VH	**Very high mineral-resource potential** is assigned to areas where there is current mineral production and future economic production is reasonably certain. A high level of certainty is implied.
DEFINITIONS OF LEVEL OF CERTAINTY	
A	Available information is not adequate for the determination of the level of mineral-resource potential.
B	**Low**, available information suggests the level of mineral-resource potential.
C	**Moderate**, available information gives a good indication of the level of mineral-resource potential.
D	**High**, available information clearly defines the level of mineral-resource potential.

↑ INCREASING LEVEL OF RESOURCE POTENTIAL	U/A Unknown Potential	H/B High Potential	H/C High Potential	VH/D Very High Potential
				H/D High Potential
		M/B Moderate Potential	M/C Moderate Potential	M/D Moderate Potential
		L/B Low Potential	L/C Low Potential	L/D Low Potential
		L/B Low Potential	L/C Low Potential	N/D No Potential
				N/D No Potential
INCREASING LEVEL OF CERTAINTY →				

URANIUM DISTRICTS

Specific details on each mining district or prospect area, including names, are in McLemore (1983) and McLemore (2017).





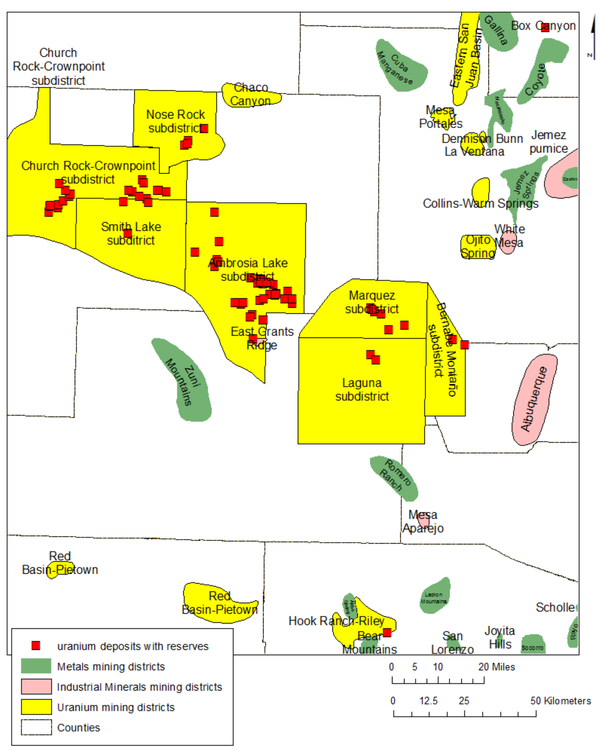
URANIUM PRODUCTION

Uranium production from 1947–2002 by type of deposit from New Mexico (McLemore and Chenoweth, 1989, 2003; production from 1988–2002 estimated by the authors). Type of deposits refers to Table 2 in McLemore and Chenoweth (in press). Total U.S. production from McLemore and Chenoweth (1989) and Energy Information Administration (2010). [1]Production rounded to the nearest 1,000 pounds. There has been no uranium production in New Mexico since 2002.

Type of Deposit	Production (lbs U_3O_8)	Period of Production (Years)	Production Total in New Mexico (Percent)
Primary, redistributed, remnant sandstone uranium deposits (Morrison Formation, Grants district)	330,453,000 [1]	1951-1988	95.4
Mine water recovery (Morrison Formation, Grants district)	9,635,869	1963-2002	2.4
Tabular sandstone uranium deposits (Morrison Formation, Shiprock district)	493,510	1948-1982	0.1
Other Morrison Formation Sandstone uranium deposits (San Juan Basin)	991	1955-1959	—
Other sandstone uranium deposits (San Juan Basin)	503,279	1952-1970	0.1
Limestone uranium deposits (Todilto Formation predominantly Grants district)	6,671,798	1950-1985	1.9
Other sedimentary rocks with uranium deposits (total NM)	34,889	1952-1970	—
Vein-type uranium deposits (total NM)	226,162	1953-1966	—
Igneous and metamorphic rocks with uranium deposits (total NM)	69	1954-1956	—
Total in New Mexico	348,019,000[1]	1948-2002	100
Total in United States	927,917,000[1]	1947-2002	NM is 37.5 of total US

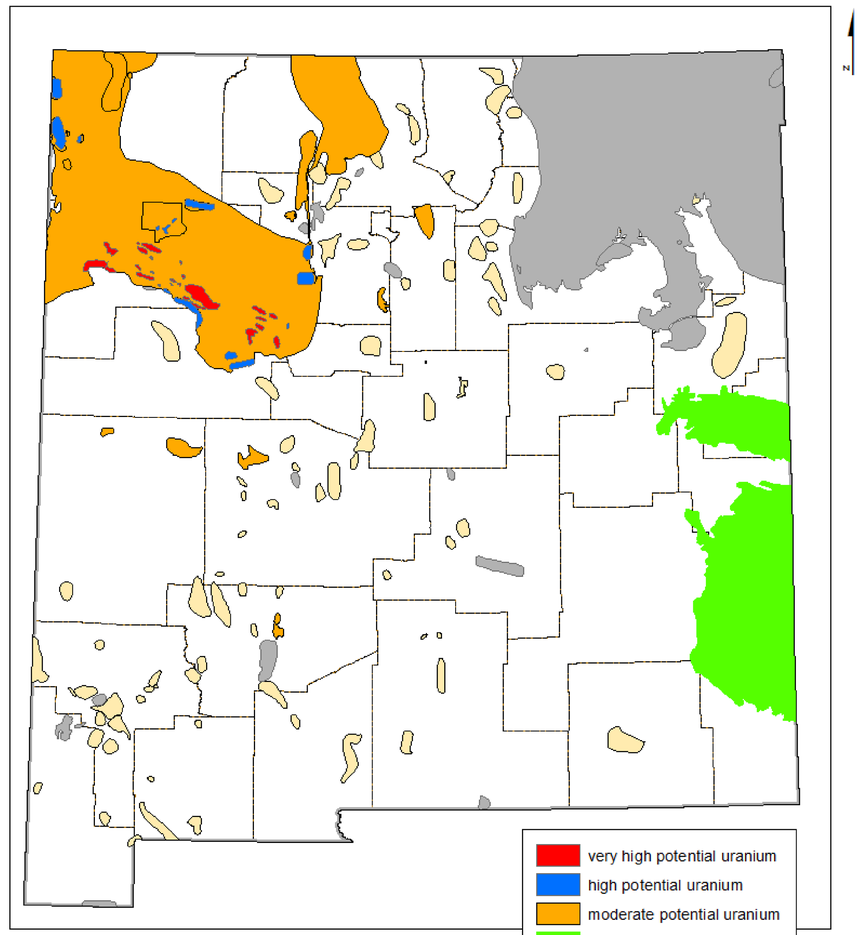
The most important deposits in the state are within the sandstones of the Jurassic Morrison Formation in the Grants district. More than 340 million pounds of U_3O_8 have been produced from Morrison Formation deposits from 1948–2002, accounting for 97% of the total production in New Mexico and more than 30% of the total production in the U.S. In addition known, unmined deposits contain an estimated 490 million pounds of U_3O_8 have been delineated in the Grants and Hook Ranch-Riley districts (McLemore and Chenoweth, in press). Other types of uranium deposits found in New Mexico include beach placer sandstone uranium deposits, Rio Grande Rift (RGR) Copper-silver (±uranium) veins, volcanic-epithermal veins , polymetallic veins, metasomatic or metasomatite deposits, pegmatites and potentially Iron Oxide-Cu-Au (IOCG) (Olympic Dam deposits, hematite breccia deposits).

URANIUM RESERVES



Deposits with uranium resources in New Mexico (McLemore and Chenoweth, in press). Only major mines and deposits are included here.

MINERAL-RESOURCE POTENTIAL FOR URANIUM DEPOSITS IN NEW MEXICO



SUMMARY

New Mexico has future resource potential for uranium. Sandstone and limestone uranium deposits in New Mexico have played a major role in historical uranium production, and likely will again in the future. Although worldwide, other types of uranium deposits are higher in grade and larger in tonnage, the Grants uranium district has been a significant source of uranium and has the potential to become an important future source, as low-cost technologies, such as in situ recovery and heap leaching techniques improve, and as demand for uranium increases, thereby increasing the price of uranium. However, several challenges need to be overcome by the companies before uranium could be produced once again from the Grants district and elsewhere from New Mexico, including:

- No conventional mills remain in New Mexico to process the ore, adding to the cost of producing uranium in the state. Currently, all conventional ore must be processed by the White Mesa Mill near Blanding, Utah, or heap leached on site.
- New infrastructure will need to be built before conventional mining can resume.
- Permitting for new in situ recovery and conventional mines and mills will take years to complete.
- Closure plans, including reclamation, must be developed before mining or in situ recovery begins. Modern regulatory costs will add to the cost of producing uranium in the U.S.
- Some communities, especially the Navajo Nation communities, do not view development of uranium properties as favorable. The Navajo Nation has declared that no uranium production will occur on tribal lands. Most of Mount Taylor and adjacent mesas have been designated as the Mount Taylor Traditional Cultural Property; the effect of this designation on uranium exploration and mining is uncertain.
- High-grade, low-cost uranium deposits in Canada and Australia and the large low-grade deposits in Kazakhstan are sufficient to meet current international demands; however additional resources will be required to meet long-term future requirements.

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