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# Uranium Potential of the Texas Coastal Plain

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# URANIUM POTENTIAL OF THE TEXAS COASTAL PLAIN

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The highest potential for large new uranium deposits in the Texas coastal plain is in the subsurface in south Texas, below a depth of about 400 feet (122 m), the average depth of present exploratory drilling. The outlook in east Texas is not as good. This conclusion is based on the hypothesis that the uranium in south Texas came from volcanic material in the Catahoula Tuff and that in east Texas the Catahoula does not contain as much volcanic material. Also, the paleoclimate, like the present climate there, was more humid in east Texas; and geochemical conditions were less favorable for the formation or preservation of epigenetic uranium deposits. Very few radioactive anomalies or other prospects have been found in east Texas (fig. 1).

The purpose of this report is to evaluate the uranium potential of the Tertiary rocks of late Eocene and younger ages in the Texas coastal plain. Studies of the uranium areas in south Texas are the primary basis for this evaluation. As no uranium has been reported in rocks older than late Eocene in the Texas coastal plain, the potential in those rocks is considered to be nil. This evaluation of uranium potential in east Texas is based entirely on the literature. No fieldwork was done in east Texas or on rocks older than late Eocene.

The processeses of formation of epigenetic uranium deposits, the areas of uranium production in south Texas, and the U.S. Energy Research and Development Agency's reserve and resource data are discussed. As used in this report, south Texas includes the area from the eastern edge of Gonzales County to the Mexican border; the remainder of the coastal plain is termed east Texas.

Figure 1 shows the rock units that are of interest to the uranium geologist in the Texas coastal plain. They are Tertiary, mostly nonmarine sedimentary units that grade downdip to the southeast into marine rocks. The rocks consist mostly of sandstone, mudstone, and claystone; and they gently dip into the Gulf Coast geosyncline. Large growth faults, which are generally low displacement near the surface, together with numerous smaller faults and joints are important in controlling the ore emplacement. The stratigraphic units of the uranium areas in south Texas are shown on figure 2. They are the Whitsett Formation (upper Eocene) of the Jackson Group, the Frio Clay (Oligocene?), which crops out only in the southern one-third of the coastal plain area; the Catahoula Tuff (Miocene); the Oakville Sandstone (Miocene), which crops out only in the central part of the coastal plain; the Fleming Formation (Miocene), which is mapped with the Oakville Sandstone

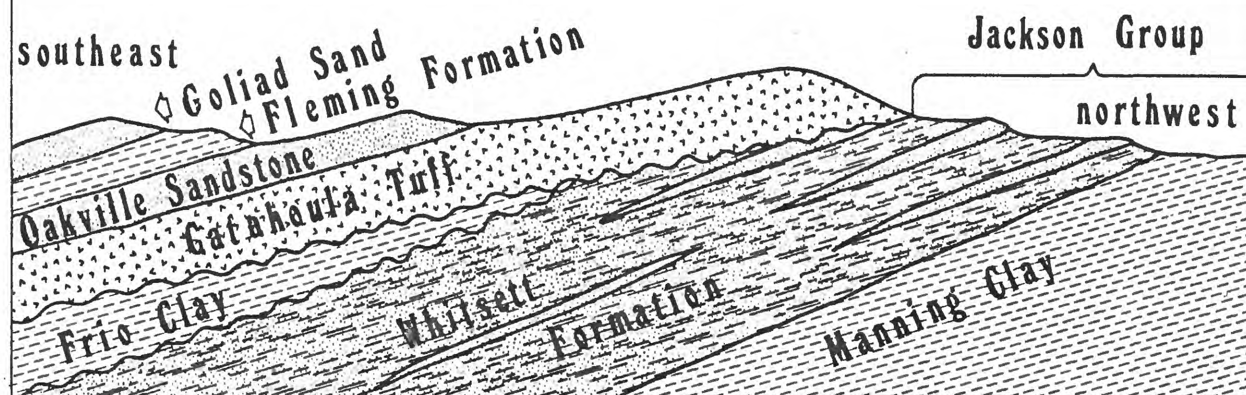


Figure 2.-- Diagrammatic Cross Section, South Texas

in east Texas on figure 1; and the Goliad Sand (Pliocene). Figure 2 is a diagrammatic cross section oriented parallel to dip. This cross section is made for an area such as Karnes County (fig. 1), where the Frio Clay does not crop out and the Catahoula Tuff lies directly on the Whitsett Formation. All the units in this section are uranium host rocks in south Texas except the Manning Clay and the Fleming Formation. The Whitsett Formation contains six members, three of which are continental or lagoonal units cut in places by sandstone bodies deposited in fluvial channels. Both the beach and the fluvial units are uranium host rocks in Karnes County.

There are three uranium areas in south Texas (Eargle and others, 1975). These are named for the counties of their principal occurrence: Karnes, Live Oak, and Duval. In the Karnes area the host rock is the Whitsett Formation, in the Live Oak area the host rock is the Oakville Sandstone, and in the Duval area the chief host rock is the Catahoula Tuff.

The potential resources of the various parts of the south Texas coastal plain are discussed from the standpoint of the factors affecting deposition of epigenetic uranium deposits (Dickinson, 1976). These factors are (1) source rock, (2) leaching, (3) movement, (4) host rock, (5) chemical reductant, and (6) preservation.

Evidence presently at hand suggests that the Catahoula Tuff was the principal source for the uranium in the uranium deposits of south Texas. The present low uranium content, 3 ppm, and the high thorium-to-uranium ratio, 5.6, suggest that uranium has been leached from the Catahoula (Dickinson, 1976; Duex, 1971; Moxham, 1964). Field relations, such as the lack of uranium deposits in the Whitsett Formation south of Atascosa County, where outcropping Frio Clay separates the Whitsett from the Catahoula, suggest that the Catahoula is the source. No other potentially good uranium source rocks are found in south Texas, except possibly the Whitsett, which also contains large amounts of volcanic material. The Whitsett, however, has a large present content of uranium, about 13 ppm average, and a low thorium-to-uranium ratio, 2.4, suggesting that it has not lost substantial quantities of uranium.

Dry-climate weathering that prevailed in south Texas during post-Eocene time was apparently an important factor in the formation of the south Texas uranium deposits. The uranium apparently became mobilized as di- or tri-carbonate ions under oxygenated, mildly alkaline conditions related to the dry climate (Weeks and Eargle, 1963; Hostetler and Garrels, 1962). Katayama (1960) reported that of 19 major uranium deposits in sedimentary rocks around the world, 16, including all of those in rocks of Triassic age or younger, could be related to past or present arid environments.

Uranium-bearing water in south Texas moved as surface drainage of meteoric water and as ground-water flow through porous rock units and along joints and faults. Fluvial channel deposits are especially important in directing uranium-bearing water into host rocks in the Whitsett Formation, Frio Clay, Catahoula Tuff, and Oakville Sandstone. Porous marine beach deposits were also important in the Whitsett. In all three uranium areas, faults were important in localizing uranium mineralization (Eargle and others, 1975; McKnight, 1972; and Dickinson, 1976).

Uranium host rocks in south Texas are generally well-sorted permeable sandstone units enclosed in less permeable mudstone and claystone units. The host rocks, like the conduit rocks mentioned above, were deposited mainly in fluvial channels, although beach sandstone bodies are very important in the Whitsett Formation. Alteration of volcanic glass grains to cristobalite, zeolite, and montmorillonite in sandstone of the Whitsett also affects permeability within these rocks and to some degree controls the ore deposition.

Chemical reductants can be generated from within the host rocks (autogenic reductants) or from outside the host rock (allogenic reductants). Both kinds appear to be important in south Texas. Carbonized plant material is a common autogenic reductant in host rocks of both beach and fluvial origin. Petrolic gases and dissolved organic matter may be important as allogenic reductants in some of the deposits.

Weeks and Eargle (1963) suggested that a dry climate aided in preserving the south Texas uranium deposits and that a caliche cap present in most of the south Texas uranium area protected the deposits by restricting leaching. The caliche cap is about 18,000 years old (Valastro and Davis, 1970), and much of the uranium is more than a quarter of a million years in age (Rosholt, 1963). The present caliche cap may have aided preservation for only a relatively short period. The deposits are destroyed during surface erosion. The oxidized deposits at the surface near the abandoned community of Deweesville in Karnes County (Bunker and MacKallor, 1973) are being destroyed by surface alteration and apparently have contributed uranium in some of the reduced deposits downdip. A large influx of oxidizing meteoric water for a long period would tend to remove uranium from the host rocks.

What is the geologic potential for large new uranium areas in the Tertiary of the Texas coastal plain? Two large areas have yet to yield a uranium orebody. They are east Texas and the deeper subsurface in south Texas.

A promising source of uranium for deposits in the east Texas Tertiary coastal plain is not known. Tuffaceous material has been reported from both the Catahoula Tuff and Jackson Group rocks in east Texas (Renick, 1936), but there is much less there than in south Texas. Fragments of volcanic rock, common in the Catahoula in the uranium areas of south Texas, are lacking in east Texas. According to Thomas (1960), these fragments are not present in the Catahoula east of Karnes County (fig. 1). Thomas (1960) has also determined that the Catahoula sediments in east Texas had a different source than those in south Texas. Neither of the possible sources for the south Texas volcanic rock fragments--a local source (Bailey, 1926) or a west Texas and northern Mexico source (McBride and others, 1968; Eargle and Weeks, 1973)--could have contributed much sediment to east Texas, because transport directions were to the southeast. On the geologic map of Texas (Darton and others, 1937), the Catahoula is mapped as a tuff in south Texas and as a sandstone in east Texas. Bailey (1926) gave the Catahoula of south Texas a separate name, the Gueydan Formation, on the basis of its content of volcanic rock fragments.

Geochemical conditions resulting from a more humid climate in east Texas may have prevented uranium leaching or, once the uranium was dissolved, may have completely flushed it out of potential host rocks. Thomas (1960) cited several lines of evidence that the climate was more humid in east Texas during deposition of the Catahoula than it was in south Texas: The feldspar is more weathered and less abundant in east Texas. Calcite is present in the Catahoula only in south Texas. Kaolinite is found only in the Catahoula of east Texas, and it suggests acid depositional conditions. On the other hand, alkaline conditions are suggested in south Texas by the calcite and abundant montmorillonite found there. The greater amounts of meteoric water accompanying the more humid climate tend to carry dissolved uranium through the potential host rocks, not allowing time for precipitation.

The lack of uranium deposits in east Texas cannot be explained by a lack of conduits, chemical reductants, or host rocks. There are ample streams, faults, and permeable rock bodies to serve as conduits, there are many porous sandstone bodies for host rocks, and there is an abundance of potential chemical reductant in the form of lignite beds or other carbonaceous material and petroleum deposits.

Large amounts of percolating meteoric water associated with the more humid climate in east Texas may also have destroyed uranium deposits if they formed. No well-developed caliche cap rock exists there.

For the deeper subsurface in south Texas, much greater potential exists for large new uranium deposits. The conditions for the formation of uranium deposits in the subsurface are nearly the same as for the present uranium-producing areas in south Texas, except for the depth of burial. The depth of burial at the time of formation of the deposits is not known, but it may have been much less than now. The Catahoula appears to be a potential source rock about as far downdip to the southeast as the present coastline, where it grades into a marine facies. Some doubt about the potential for this deeper uranium results from the lack of knowledge about the extent to which the formation of epigenetic uranium deposits depends on surface weathering.

ERDA's present estimates of reserves and potential resources generally agrees with the geological potential presented above. A little more than 7,000 tons of $U_3O_8$ have been produced from the south Texas uranium areas as of January 1, 1975 (Carl Applin, ERDA, oral commun.). The ore reserves for south Texas, as of October 1, 1975, are 50,250 tons $U_3O_8$ with a price of $30 per pound (Eugene Grutt, ERDA, written commun.). The potential resources figures, also based on a price of $30 per pound, were prepared by Donald Hetland (written commun., 1976) as a part of ERDA's National Uranium Resource Evaluation (NURE) program. Hetland reports 100,000 tons of probable resources, 128,000 tons of possible resources, and 31,000 tons of speculative resources. Definitions of these categories (U.S. Energy Research and Development Administration, 1976) are as follows: "Probable" potential resources are those estimated to occur in known uranium districts and are further postulated to be (1) in extensions of known deposits, (2) in new deposits within trends or areas of mineralization that have been identified by exploration. "Possible" potential resources are those estimated to occur in new deposits in formations or geologic settings productive elsewhere (1) within the same geologic province or subprovince under different geologic conditions, (2) within the same geologic province or subprovince under similar geologic conditions. "Speculative" potential resources are those estimated to occur in new deposits (1) in formations or geologic settings not previously productive within a productive geologic province or subprovince, (2) within a geologic province or subprovince not previously productive. Figure 3 shows the distribution of potential resources in the Texas coastal plain. Karnes County (Central Coast) and Duval County contain most of the "probable" resources; Duval and Starr Counties contain most of the "possible" resources; and east Texas contains most of the "speculative" resources.

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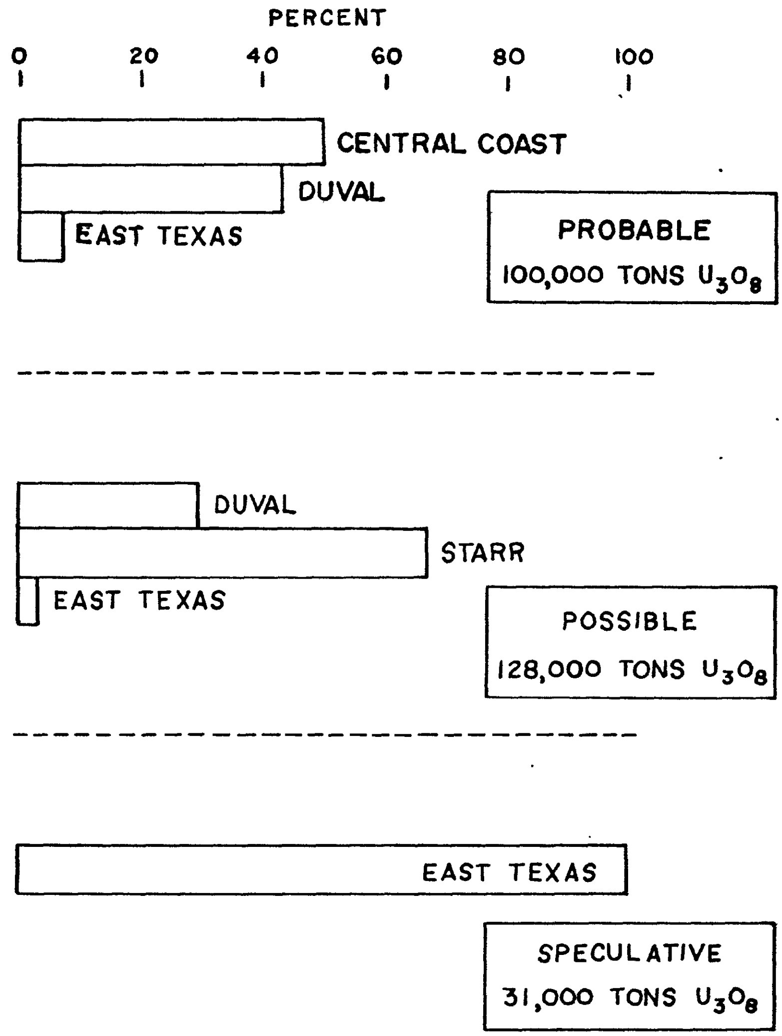


FIGURE 3.--DISTRIBUTION OF $30 POTENTIAL URANIUM RESOURCES BY SUBPROVINCE FOR THE TEXAS COASTAL PLAINS