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URANIUM IN TEXAS

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Contents

Illustrations

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1. Uranium in Texas, by D. Hoye Eargle. 13 p., 3 figs. 602 Thomas Bldg., Dallas, Texas 75202; 1012 Federal Bldg., Denver, Colo. 80202; 8102 Federal Office Bldg., Salt Lake City, Utah 84111.

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3. Preliminary report of geochemical sampling at the Brewer Gold Mine, Chesterfield Co., South Carolina, by Arthur R. Kinkel, Jr. 6 p., 1 fig.

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Uranium in Texas[1/]

By D. Hoye Eargle

Introduction

Producers of fossil fuels in the United States have been charged with the responsibility of providing the Nation with energy materials, the demand for which is constantly increasing and the sources for which are nonrenewable. Lately, however, the development of nuclear reactors that use fissionable uranium for the generation of electric power has made uranium competitive in several respects with fossil fuels. Consequently petroleum and uranium-mining companies have in some instances joined forces in exploration for uranium and in the development and mining of uranium deposits. In other instances they are competing. A familiar pattern has been the organization of branches for exploration for uranium or other minerals within the structure of the petroleum company. Today, therefore, some companies are in both the mining and the petroleum business and are meeting with varied success.

Texas, at first considered a petroleum State almost exclusively, came into the uranium picture rather late, but now ranks high among other States in the Nation in its uranium potential. In spite of the great activity carried on in the Coastal Plain in recent years in land acquisition and in exploration, much of the State remains relatively poorly explored, and the State's potential for uranium production only can be guessed.

Let us look at the five geographic areas of Texas where at least some uranium has been found (Butler, Finch, and Twenhofel, 1962), summarize the nature of the uranium mineralization in the areas, and consider briefly their potential for uranium production (fig. 1):

1. The Trans-Pecos
2. The Panhandle
3. The Red River region
4. The Llano uplift
5. The South Texas Coastal Plain

1/Publication authorized by the Director, U.S. Geological Survey. Paper presented at International Mining Days, El Paso, Texas, November 18, 1969; the information contained herein applied at that time.

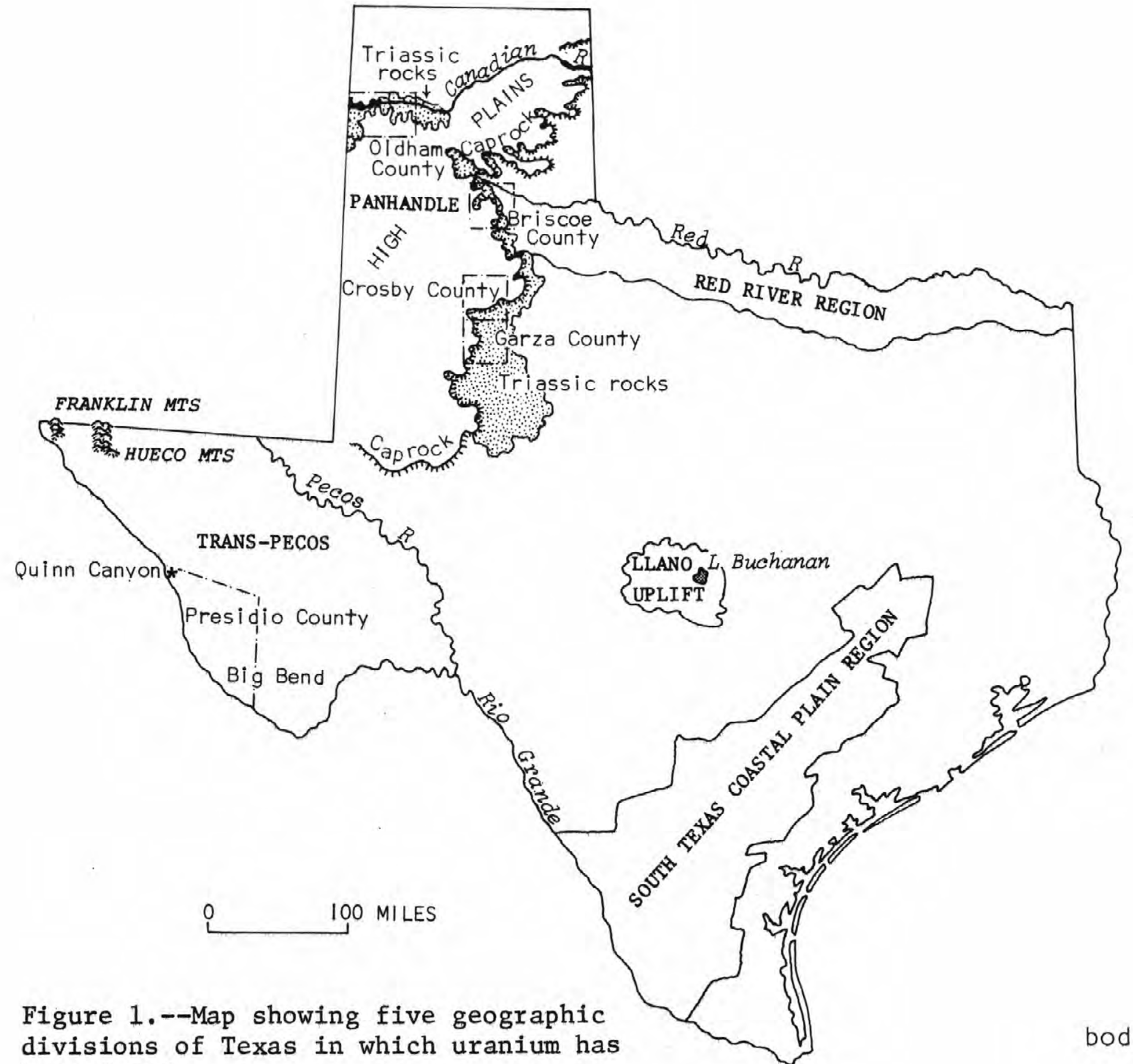

Figure 1.--Map showing five geographic divisions of Texas in which uranium has been found.

The Trans-Pecos

Because most of the uranium discovered prior to the middle 1950's was in the arid western United States, much of the earliest exploration for uranium was in that part of Texas that lies west of the Pecos River (fig. 1). The igneous rocks and tuffs of the Big Bend and the complicated faults and structures of the entire Trans-Pecos were considered most favorable for uranium, and they were at least superficially explored. For several reasons, however, very little drilling was done in the region, and to this date very little ore has been found there. In the Trans-Pecos the following geologic occurrences of uranium have been found:

1. Yellow efflorescent secondary uranium mineral and vesicle-filling hydrous uranium oxide in a welded tuff or flow in outcrops in the walls of Quinn Canyon in the Van Horn Creek valley, a few miles north of the Rio Grande in Presidio County (fig. 1) (Eargle, 1956). Subsequent drilling of this site and some underground work reportedly have not revealed further concentrations of uranium, and the prospect is now inactive. Some radioactivity has been found along faults in the region, but exploration has been scant.
2. In the western part of the Hueco Mountains (fig. 1), spectacular but thin films of yellow uranium oxide occur in caliche-cemented talus on the slopes of hills of dense, shaly Permian limestone and in Permian and lower Paleozoic shales containing some organic matter; also in caliche-cemented sinkhole-filling rubbly debris in Permian limestones.
3. Several occurrences of radioactivity associated with intrusive rocks, such as in the Franklin Mountains and the Big Bend (fig. 1) (Hadfield, 1953; Stroud and Nye, 1957).
4. Moderately radioactive Paleozoic black shales that contained some organic matter, in the Hueco Mountains and outlying hills; shown by analysis to have little uranium content.
5. Some tuffaceous Tertiary sandstone and a fresh-water limestone in Tertiary tuffs are radioactive.

What more drilling and subsurface work on some of these prospects will bring to light is certainly a matter of conjecture.

The Panhandle

Lying below the base of the caprock south and east of the scarp at the edge of the High Plains and in the Canadian River valley (fig. 1) are channel-filled sandstones and conglomerates of Triassic age that contain some yellow uranium oxide minerals along with spectacularly radioactive logs and other organic debris.

According to W. I. Finch (written commun., 1970), nearly 800 tons of uranium ore has been mined from the Triassic in Crosby and Garza Counties, where several prospects are considered significant. Other localities have been prospected in the Canadian River valley in Oldham and Briscoe Counties. The Triassic, dipping beneath the Tertiary Ogallala Formation of the High Plains, contains anomalously radioactive beds (Grimes, 1961). The Triassic beneath the plains is about 1200 feet thick, and the overlying sediments are about 500 feet thick (Flawn, 1967). Some exploration of the subsurface Triassic has been done recently by drilling.

The Red River Region

Several localities showing radioactivity anomalies and uranium-bearing rock, a little of it of ore grade, have been found in the Red River region (fig. 1). The occurrences are similar to the early discovered sites on the Colorado Plateau and are in beds of the same general age (Eargle and McKay, 1956). These are generally in sand- and conglomerate-filled channels and in carbonaceous sandstone in outcrops of Permian redbeds. No one has yet succeeded in tracing mineralized rock underground from the rather meager surface occurrences. The potential for production from this region seems to be low, and if a Lisbon Valley or a Lucky Strike or Happy Jack mine is there, it has not been found.

The Llano Uplift

The Baringer Hill deposit, now about 75 feet beneath the surface of Lake Buchanan (fig. 1), has produced considerable quantities of rare minerals, including some uraniferous ones (Hess, 1908). Not far away, but on dry land, at least one other occurrence has been found in gneissic granite closely injected with pegmatites. Limited exploration of this prospect has not developed a mine.

In the same region are some moderately radioactive Paleozoic black shales containing some thin phosphatic limestone beds, but analyses of these indicate no worthwhile concentrations of uranium.

The potential of this area appears to be low, but here again relatively little prospecting has been done.

The South Texas Coastal Plain

Uranium discoveries in the Coastal Plain (fig. 2) followed most other Texas uranium discoveries, but the Coastal Plain is the only part of the State in which economic deposits have been exploited to a great extent. Many admitted, after uranium was found here, that this region was the last place on earth where they would have looked for uranium, but it has been found here, in the shadow of and even within oil and gas fields (fig. 3). The early deposits were found in tuffaceous sandstone of the upper Eocene Whitsett Formation, which consists of beds of almost pure tuffs and some thin lignitic beds; but later deposits have been found in Oligocene(?), Miocene, and Pliocene formations.

The story of the discovery of uranium in the Coastal Plain bears repeating. While making an airborne scintillation traverse for oil in the fall of 1954, a pilot discovered several anomalies near Tordilla Hill (fig. 3), a prominent cuesta that points northward in the western tip of Karnes County. At about the time of this discovery or shortly after, an amateur rockhound found the deposit at the foot of Tordilla Hill that became the Boso-Hackney mine (fig. 3).

Following the discovery the region was combed with all types of exploration equipment--not only hand-carried counters, but also sophisticated types such as scintillator-equipped airplanes, helicopters, and cars.

The search was so thorough that nearly all if not all the surface anomalies now known in the region were located during this period. About a dozen of these were economic. The localities where significant deposits have been found extend from the northern part of Fayette County in east-central Texas to the southern part of Starr County, which borders on the Rio Grande (Eargle and Snider, 1956; Maxwell, 1962), but the principal deposits of near-surface ores, in beds of late Eocene age, were in Karnes County, 9 to 12 miles southwest of Falls City, about 50 miles southeast of San Antonio, near the abandoned community center Deweesville. Mines

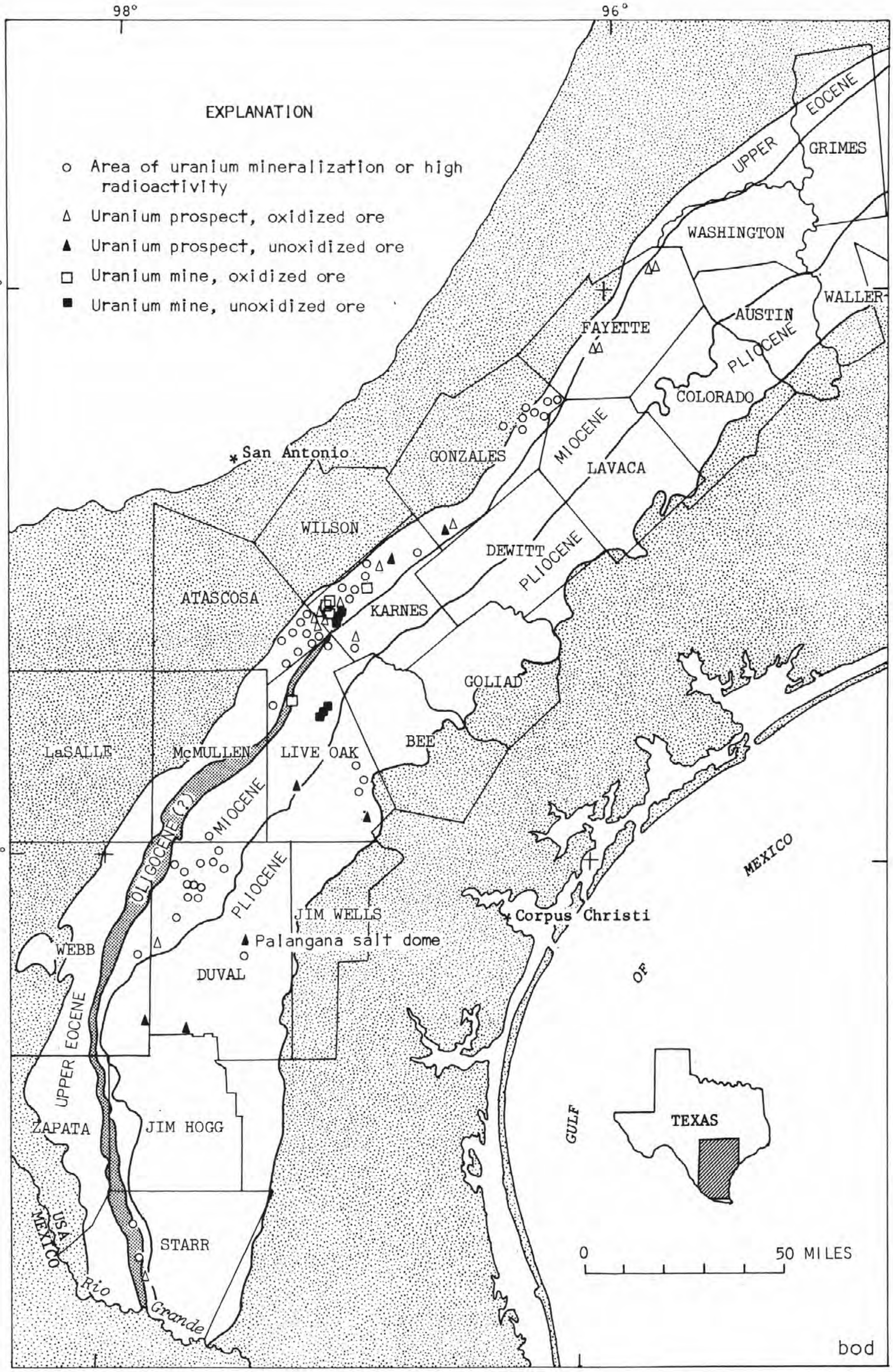

Figure 2.--Map showing areas of mineralization, prospects, and uranium mines in the South Texas Coastal Plain.

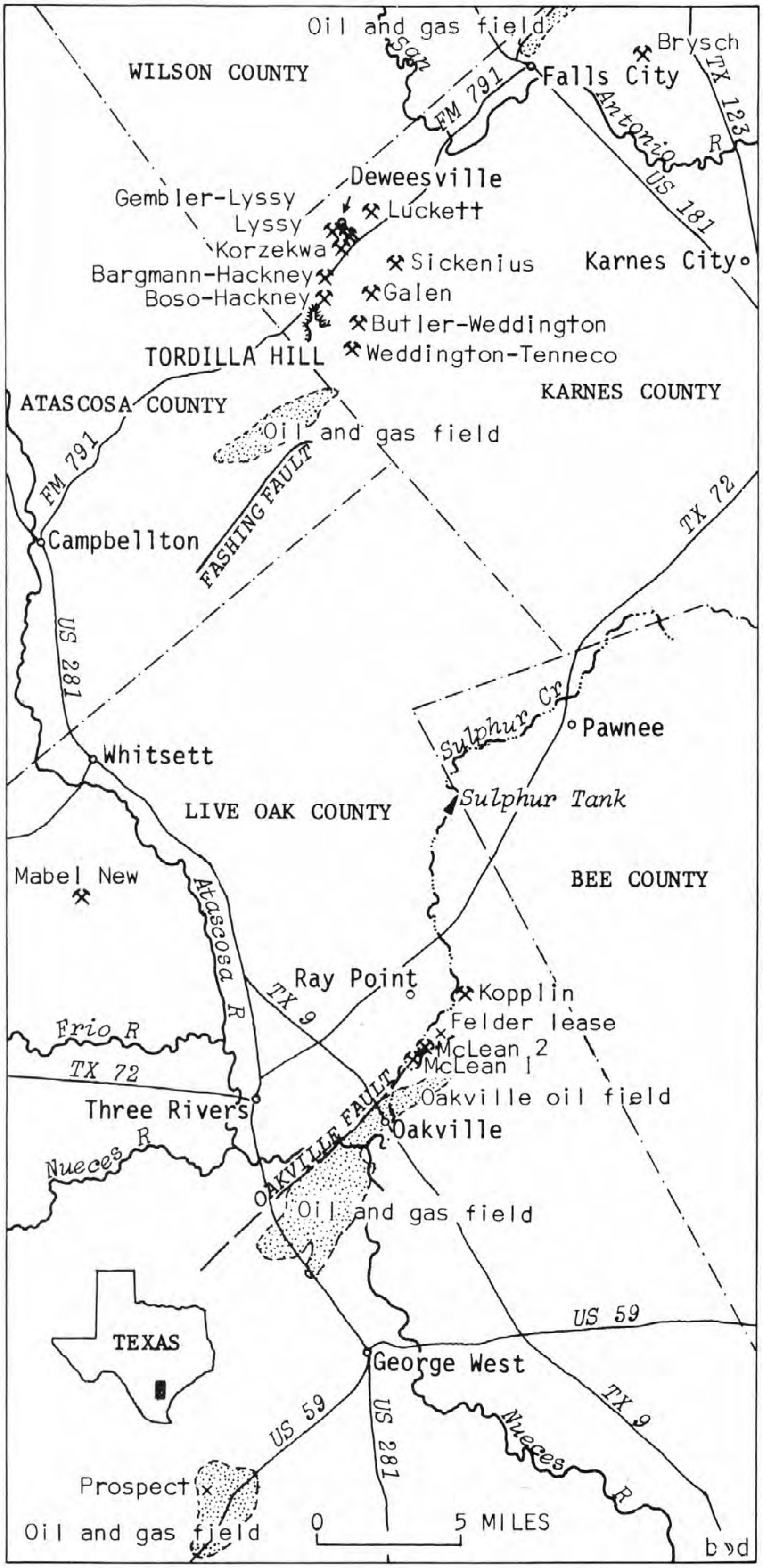

Figure 3.--Map showing the Karnes and Live Oak uranium districts.

in the oxidized ore deposits of Karnes County extend from 3 miles east of Falls City to Tordilla Hill. One deposit in northwestern Live Oak County was mined from beds of Oligocene(?) age.

In 1958, Climax Molybdenum Co., operating through its subsidiary the San Antonio Mining Co., began the stripping and mining of three ore bodies on their lease near Deweesville. The pits ranged from 20 to 40 feet in depth, and some were more than 1,000 feet long. long. A total of 100,000 tons of ore averaging about 0.20 percent U_3O_8 was mined and stockpiled to fulfill a contract with the Atomic Energy Commission.

In April 1959, Susquehanna-Western, Inc., of Denver, contracted with the Atomic Energy Commission to build a mill and to supply more than 1 1/4 million pounds of refined U_3O_8 from this stockpiled ore and from ore to be mined from other localities in the region. While building the mill and afterward, this company opened and exploited mines in Karnes and Live Oak Counties and prospected many other properties.

Before the shallow deposits of oxidized ore had been mined out, Susquehanna-Western, Inc., in a program of downdip exploration, discovered a downdip body of unoxidized ore in the sandstone that forms the crest of Tordilla Hill. This bed lies about 100 feet above the sandstone in which most of the shallow oxidized deposits had been found. Several anomalies indicating ore-grade radioactivity had been logged previously in holes drilled downdip by the U.S. Geological Srrvey in the vicinity of Tordilla Hill, but subsequent closely spaced boring by Susquehanna-Western showed the ore body to be a roll front extending a long distance laterally, parallel to the surface outcrop of the bed.

The discovery of this unoxidized ore gave a tremendous boost to the uranium industry in South Texas. Since the beginning of the mine's development a pit more than 2 miles long and as much as 130 feet deep has been excavated along the trend of the roll ore body. The pit contains the Galen, Butler-Weddington, and Weddington-Tenneco mines (fig. 3).

Mining of the downdip ore, in progress since early 1964, is continuing, following the trend to the southwest toward the surface expression of the economically important Fashing fault that has formed a trap for oil and gas accumulation. In addition to Susquehanna-Western's mining, Tenneco is now mining on their lease of the southwestern part of the Weddington ore body (fig. 3). Since the discovery of the downdip, easily milled, amenable ore, Susquehanna-Western has more than doubled the capacity of the mill at Deweesville.

In 1966, Susquehanna-Western, In., explored an unoxidized deposit in calcareous sands of the Oakville Sandstone (middle Miocene) in Live Oak County, 3 miles northeast of Oakville, about 30 miles south of the Karnes deposits. The deposit lies near a strong surface radioactivity anomaly, reportedly found in the middle 1950's by aerial surveying, along the well known Oakville fault, where the fault forms the valley wall of Sulphur Creek. The same fault forms the trap for the oil of the shallow Oakville oil field half a mile to the south of the ore body of the McLean mines (fig. 3). Removal of overburden from the McLean mines began in 1967, and one mine came into production late that year. The mines are now inactive, but extensions are being explored. At the northeast end the McLean 2 mine abuts the property line of Humble's Felder lease, an extensively explored but still unmined deposit, and discoveries of other deposits have been announced along this trend. A new mill, equal in capacity to the one in Karnes County, is being built to process the calcareous ores of the Live Oak district.

Southward from the Live Oak district to the Rio Grande, exploration has been active, expecially in the Miocene Soledad Volcanic Conglomerate Member of the Catahoula Tuff, the Oakville Sandstone, and the Pliocene Goliad Sand.

The Soledad, which crops out in Duval and McMullen Counties (fig. 2), is a sandstone and conglomerate enclosed by hundreds of feet of tuff and composed of volcanic debris that geologists believe was derived from the intense volcanic activity in western Texas and northern Mexico in Miocene time. In fact, Frank Woodward, Jr., and R. A. Maxwell (oral commun., 1969), geologists who are familiar with the volcanic rocks of West Texas, say they can identify the specific stocks or flows from which these pebbles came. The rocks were transported to this region, perhaps during the intense volcanic eruptions, by a stream whose valley lay generally 100 miles or more to the north of the present Rio Grande.

The Goliad Sand has a high percentage of volcanic materials believed to be derived by erosion of the tuffs and related rocks of the upper Rio Grande valley and deposited in a climate considerably more arid than the present. In addition to the arid climate of deposition, a more recent (Pleistocene) period of aridity has produced a thick surficial caliche accumulation that obscures the character of the bedrock and inhibits surface mapping. The arid climate, however, associated with alkaline ground water, is believed to have caused the release of uranium and other trace elements from the tuffs and transported tham in solution to subsurface reducing environments where precipitation of the uranium took place.

One of the principal occurrences of uranium in South Texas is the still unmined body of ore in the sand of the Goliad that overlies sulfur-bearing caprock of Palangana salt dome in central Duval County (fig. 2) (Weeks and Eargle, 1960). This ore is 300 feet below the land surface and about 100 feet above the caprock.

Hydrogen sulfide permeates the sand and is believed to be the precipitant for the uranium that is weakly disseminated in the ground water circulating through the permeable sand.

Current Exploration

Current exploration in Texas is chiefly by boring, core-sampling, and logging of bore holes. The logging has been mainly by induction-electrical and gamma-ray methods, but some other methods--indicating eH, pH, and salinity or chlorinity--have also been experimented with if not extensively used. Because many anomalies have been found along faults, one method of exploration has been to locate faults by geophoto methods in which air photographs in color as well as in black and white have been used. Some geochemical methods have also been tried, such as water and soil analyses, and analyses for trace elements, such as molybdenum and selenium, which are known to be closely associated with uranium.

The present activity in the search for uranium in Texas is comparable to the activity initiated by the discovery of a new petroleum province. Texas has had several such oil discoveries. Although the value of uranium located may not compare with the value of petroleum produced in even one of the larger oil fields, and the economic impact of the uranium industry may be only a small fraction of the impact of the oil industry in the same region (G. C. Hardin, Jr., written commun., 1968), nevertheless the recent surge of activity gave new life to the region when it was experiencing a definite slump in petroleum production. The uranium industry has made good use of the technical help and knowledge of geologists and geophysicists, as well as that of the experienced land men and scouts formerly concerned solely with petroleum production, and it has contributed to the Country's supply of energy resources.

Uranium scouts report that in Texas at the present time 25 to 30 companies are leasing for uranium, about 60 geologists are employed, and at least 40 drill rigs and 32 logging units are in operation (Helmuth Schuenemann, Jr., written commun., 1968). Rumors of several new deposits not yet reported are extant. About a million acres are under lease, specifically for uranium, and about another million are under old leases for "oil, gas, or other minerals," where "other minerals" is considered applicable to uranium.

Susquehanna-Western, Inc. reported that production for 1968 from their mill at Deweesville, 9 miles southwest of Falls City (fig. 3), was about 1.2 million pounds of U_3O_8, near the design capacity of the mill, and that their operating costs per pound were among the Nation's lowest. Presumably their 1969 production will reach a similar figure, since the mill has been operating continuously.

The Atomic Energy Commission reported that 3,300,000 feet of hole was drilled in exploration for uranium in Texas in 1968 and 6,440,000 feet in 1969 (Press release 538, February 6, 1970). Texas now ranks second in the Nation in exploration footage drilled: 21.6 percent of the Nation's footage was drilled in Texas. The Commission also reported that Texas contains 3,800,000 tons of ore averaging 0.18 percent U_3O_8, or about 7,000 contained tons of U_3O_8. Texas is fifth in the Nation in reserves, almost tying Colorado for fourth place.

References

Butler, A. P., Jr.; Finch, W. I.; and Twenhofel, W. S. (compilers), 1962, Epigenetic uranium in the United States, exclusive of Alaska and Hawaii: U.S. Geol. Survey Mineral Inv. Resource Map MR-21.

Eargle, D. H., 1956, Some uranium occurrences in west Texas: Texas Univ. Bur. Econ. Geology Rept. Inv. no. 27, 23 p.

Eargle, D. H., and McKay, E. J., 1956, Stratigraphic distribution of the uranium in northern Texas and southern Oklahoma: U.S. Geol. Survey Rept. TEI-620, p. 261-265. (Report prepared for U.S. Atomic Energy Commission.)

Eargle, D. H., and Snider, J. L., 1956, A preliminary report on the stratigraphy of the uranium-bearing rocks of the Karnes County area, south-central Texas: Texas Univ. Bur. Econ. Geology Rept. Inv. no. 30, 30 p.

Flawn, P. T., 1967, Uranium in Texas--1967: Texas Univ. Bur. Econ. Geology Geol. Circ. 67-1, 16 p.

Grimes, D. N., 1961, West-east cross section showing aquifers of Garza County, Texas. Cross section 6 *in* Shallow formations and aquifers of the West Texas area: West Tex. Geol. Soc. Pub. 61-45, [20] p.

Hadfield, J. P., Jr., 1953, Reconnaissance in the western part of the Trans-Pecos region of Texas: U.S. Atomic Energy Comm. Rept. RME-4021, 16 p.

Hess, F. L., 1908, Minerals of the rare-earth metals at Baringer Hill, Llano County, Tex.: U.S. Geol. Survey Bull. 340-D, p. 286-294.

Maxwell, R. A., 1962, Mineral resources of south Texas--Region served through the Port of Corpus Christi: Texas Univ. Bur. Econ. Geology Rept. Inv. 43, 140 p.

Stroud, R. B., and Nye, T. S., 1957, Some occurrences of uranium in southwest Brewster County, Big Bend area, Texas: Natl. Western Min. Conf., 60th, Denver, Colo., Feb. 7-9, 1957, Trans., v. 1, p. 155-159.

Weeks, A. D., and Eargle, D. H., 1960, Uranium at Palangana salt dome, Duval County, Texas: Art. 24 *in* U.S. Geol. Survey Prof. Paper 400, Chap. B, p. B48-B52.

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