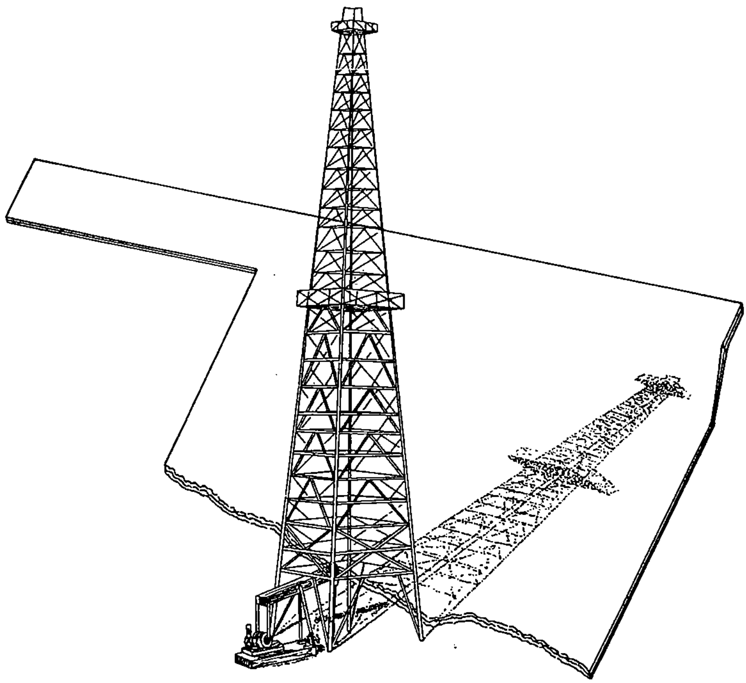
Oklahoma Geology Notes



OKLAHOMA GEOLOGICAL SURVEY
NORMAN, OKLAHOMA

Volume 16, Number 10 October, 1956

PREFACE

Oklahoma has not yet an operating proven commercial deposit of uranium. There are a few somewhat encouraging small discoveries. The guaranteed purchase price has been extended for an additional five years, and this fact is an incentive for further exploration. This pamphlet is issued to inform interested people of the State of the recent discoveries, the services available to them in searching for uranium, and the regulations affecting uranium search and development.

The information in this report is derived from several printed sources. The original reference is indicated by raised number, which refer to the list of references cited, given on the last page of this report.

Some Facts About Oklahoma Uranium

Compiled by Neville M. Curtis

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Introduction

In recent months the Oklahoma Geological Survey has received many inquiries regarding uranium exploration. The following types of questions are those usually asked: Where has uranium been found in Oklahoma? What is the price paid for one ton of uranium ore? Where can I have samples tested for uranium? What equipment is needed in order to prospect for uranium? Do I need a license in order to prospect for uranium? What are some of the limitations of Geiger and scintillation counters?

This report will attempt to answer briefly some of the above questions and to give sources of information for those desiring more details.

Recent Uranium Discoveries in Western Oklahoma*

by Ernest P. Beroni † (1)

There is, at the present time, considerable prospecting for uranium-bearing material throughout the State of Oklahoma. This paper primarily concerns the uranium-bearing deposits in the Permian Red Beds of south-central Oklahoma and the Panhandle region.

Uranium-bearing material has been known in the Permian Red Beds in Oklahoma since the latter part of the nineteen forties. Uranium was first found in the basal part of the undivided Permian Red Beds in Pawnee County. Figure 1 shows a typical sandstone in which uranium-bearing material was found associated with secondary copper and carbonized woody fragments and logs. Many of the woody fragments contain appreciable amounts of uranium and sulfide minerals, principally pyrite, chalco-pyrite, and chalcocite, which are associated with calcite or dolomite and with white and purple fluorite. Chalcocite is the most abundant sulfide and occurs in little veinlets and stringers cutting logs and woody fragments. Much uranium is associated with malachite and azurite, and in a few places the secondary uranium minerals, uranophane and carnotite, are visible. Analyses of selected samples from this area indicate a uranium content of 0.002 to over 1 percent U_3O_8.

One of the two most recent discoveries of uranium-bearing material in the Permian Red Beds is south of the Wichita Mountains in the Red River area; the other is north of the mountains in the Panhandle region.

The first of these comprises parts of Tillman, Comanche, Jefferson, and Cotton Counties. Here, secondary uranium minerals, principally carnotite and autunite, have been found in the Wichita formation of lower Permian age. In many cases, secondary copper minerals are associated with uranium minerals in sand-filled channels containing carbonized wood fragments. The localities where uranium-bearing material has been discovered are shown in figures 2 and 3. In one typical occurrence uranium minerals are present in a sandstone lens approximately 300 feet

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† Chief, Great Plains District of the Denver Exploration Branch, Atomic Energy Commission.

wide and 25 feet thick. The lower 10 feet of the sandstone lens contains most of the secondary uranium and copper minerals. The uranium minerals, identified as torbernite, autunite, uranophane, carnotite, and bayleyite, are associated with malachite, azurite and heavy iron and manganese staining. Small amount of uraninite were found with copper sulfide minerals, principally chalcocite, replacing the woody fragments. Within the sandstone lens is a uranium-bearing mudstone lens that is approximately 25 feet in length (see Figure 4). Analyses of selected samples from this area indicate a uranium content ranging from 0.04 to over 1 percent U_3O_8.

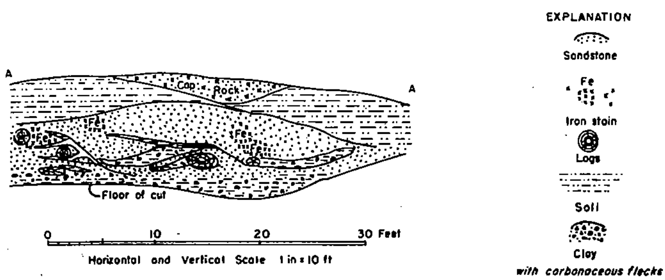


Figure 1. Geologic section of a portion of a bulldozer cut, showing area underlain by uranium-bearing material, Pawnee County, Oklahoma.

In Roger Mills, Custer and Washita Counties (see Figure 2) secondary uranium minerals, principally carnotite and tyuyamunite, occur in sandstone, siltstone, and mudstone lenses in the upper part of the Permian Red Beds in the Quartermaster formation. In this area, which differs somewhat from that to the south of the Wichita Mountains, there is a noticeable lack of secondary copper minerals and carbon trash and the uranium appears to be uniformly distributed throughout 1- to 5-foot sandstone and siltstone lenses. Most of these uranium deposits occur in areas of minor folding, especially along the flanks of small domal structures.

Asphaltic Pellets may be Related to Uranium Deposits

Uranium-bearing asphaltic pellets, occurring north of the Wichita Mountains along the flanks of the Anadarko Basin and the Wichita-Amarillo uplift, are distant from, but may be genetically related to the secondary uranium deposits in the Permian sediments to the north (see figure 2). It appears that the flanks of

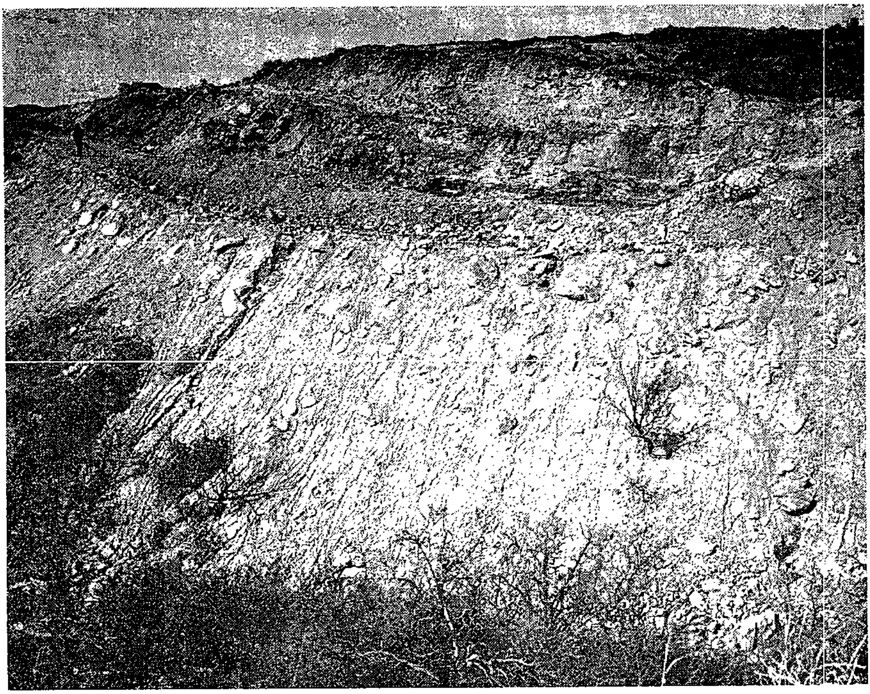


Figure 4—Photograph showing exploration cut in uranium-bearing sandstone bed, Cotton County, Oklahoma.

major structural features and areas with changes in lithology may be favorable locations for the occurrence of uraniferous asphaltic material and may be favorable for deposits containing secondary uranium minerals. According to Hill, most of the asphaltic pellets observed and collected in this area are combustible, hard, brittle, highly lustrous, and largely insoluble in carbon disulfide or benzene. In size, they range from about 1 millimeter to 5 centimeters in diameter. Their surfaces are ordinarily botryoidal, but the more weathered pellets have been altered to a soft pasty mass. A few of the larger pellets contain small nuclei of pyrite or limonite suggesting concretionary growth about centers. The asphaltic pellets are larger and more numerous in permeable zones and along fracture openings in shales and sandstones of the lower Permian Red Beds. X-ray patterns show that some of the pellets contain smaltite uraninite, and coffinite, and autoradiographs reveal that the uranium is uniformly distributed. Spectrographic analyses of the pellets reveal an assemblage of trace metals similar to that found in crude oils. The most abundant metals include uranium, vanadium, iron, nickel, cobalt, lead, and arsenic, and each ranges in content from 0.1 to 10 percent. It may be worth while to mention that the various contained metals also, to a certain degree, occur with the secondary uranium deposits to the north along the flanks of the Anadarko Basin.

Miscellaneous Occurrences

One of the more recent uranium prospects to come to the attention of the Oklahoma Geological Survey is located in Cement, Caddo County. In this area exploration has disclosed ore-grade secondary uranium minerals in the Rush Springs sandstone.

The basal Cretaceous Paluxy sandstone, in Johnston County, contains uranium-bearing coaly material and lignites.

The asphalt-bearing rock deposits of Oklahoma have been studied ([2]) with respect to the uranium content in the ash of the extracted oil. The average percent of uranium in ash ranges from 0.054-0.001. The averages are based on examination of 39 samples from 17 areas (Table 1). The ash of extracted oil from the Sulphur area contained significant amounts of uranium ([2]). The deposits in the Sulphur area contain large estimated reserves of asphalt-bearing rocks (15 million tons or more) ([2]). The possible value of these deposits as sources for low-grade uranium ore depends upon recovery methods in the utilization of the asphalt for other purposes ([2]).

Beds of the asphalt-bearing sandstone, in the Sulphur area, crop out in an area of about 1 square mile and range in thickness from about 6 to 90 feet ([2]).

A thin mineralized sandstone in the Cloud Chief formation has been located south of Clinton in northern Washita County.

Bulldozer trenches, north of Foss in Custer County, have exposed a 3- to 4-foot mineralized sandstone and claystone unit (top of Cloud Chief formation or bottom of Quartermaster formation).

Uraninite grains have been found in well cuttings from the basal Permian or upper Pennsylvanian sandstone in northern Pawnee County.

Research in the extraction of uranium and thorium from oil field flood waters is being conducted in the Nowata area of northeastern Oklahoma. American States Oil Company had invested $140,000, by May 1956 in a pilot plant southeast of the city of Nowata. ([3]) The pilot plant was erected on a 1,407-acre lease adjoining water-flood properties acquired by Climax Molybdenum Corporation. "Although optimistic of the ultimate outcome, operators concede it will take time and money to work out a commercial process. One operator said that "by 1962" the technique for extracting uranium from oil flood waters will be worked out to the point where he will be able to sell uranium ore to industry on a competitive basis." ([3])

Uranium Prices

The Atomic Energy Commission encourages uranium production by guaranteeing a fixed price through 1962. The price offered is a base price per pound of U_3O_8 per ton of ore beginning at 2 pounds per ton. At that minimum the seller receives $1.50 per pound plus 50 cents development allowance, or $4.00 per ton. On any deposit of 10,000 pounds (5,000 tons), there is a bonus of $3.00 per ton, or a total price of $7.00 per ton. There is also a pre-

Table 1. Summary of data from areas examined for uranium in asphalt-bearing rocks. (2)

Area	Formation	Age	Number of Samples	Average oil in sample %	Average ash in oil %	% Average U in ash
Parker	Wichita fm.	Permian	1	2.16	1.62	0.004
Elgin	Wichita fm.	Permian	1	1.76	1.98	.006
Velma	Wichita fm.	Permian	1	.94	1.68	.001
Baseline	Wichita fm.	Permian	2	.98	2.85	.005
Woodford	Springer fm.	Pennsylvanian	3	2.79	4.95	.010
Dougherty	Viola limestone	Ordovician	3	3.18	.07	.001
Ada	Ada fm.	Pennsylvanian	4	3.29	1.95	.014
Fitzhugh	Ada fm.	Pennsylvanian	2	1.35	2.00	.002
Sulphur	Oil Creek fm.	Ordovician	7	4.56	.70	.043
Bratcher	Deese fm.	Pennsylvanian	3	8.72	.59	.008
Morgan	Deese fm.	Pennsylvanian	1	5.71	.76	.005
Lone Cove	Wichita fm.	Permian	1	.87	3.31	.010
Oil City	Wichita fm.	Permian	1	12.28	4.49	.002
Asphaltum	Wichita fm.	Permian	5	6.15	1.60	.007
Frisco Creek	Wichita fm.	Permian	2	2.08	10.39	.004
Cameron	Wichita fm.	Permian	1	5.70	2.06	.054
Lawton Township	Wichita fm.	Permian	1	1.19	3.14	.020

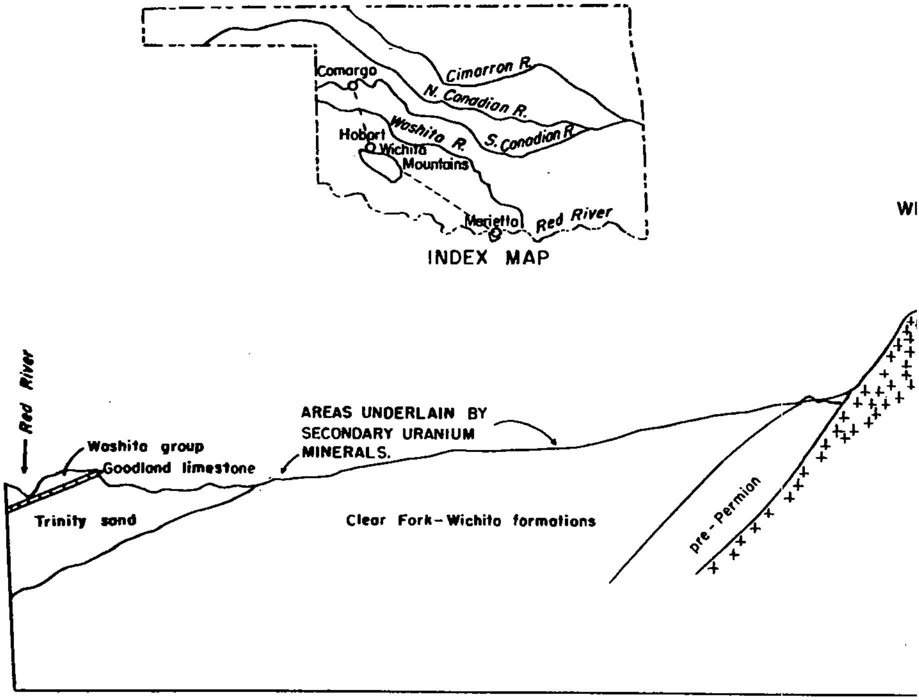


Figure 3. Structure section across Western Oklahoma,

mium for higher grade ores. An ore of 0.3% U_3O_8 receives the maximum ore price of $3.50 per pound, plus 75 cents per pound, plus $3.00 mine development allowance and $21.00 bonus on 10,000 pounds, or a total price of $46.50 per ton for ore three times as good as the 0.1% or $7.00 grade.

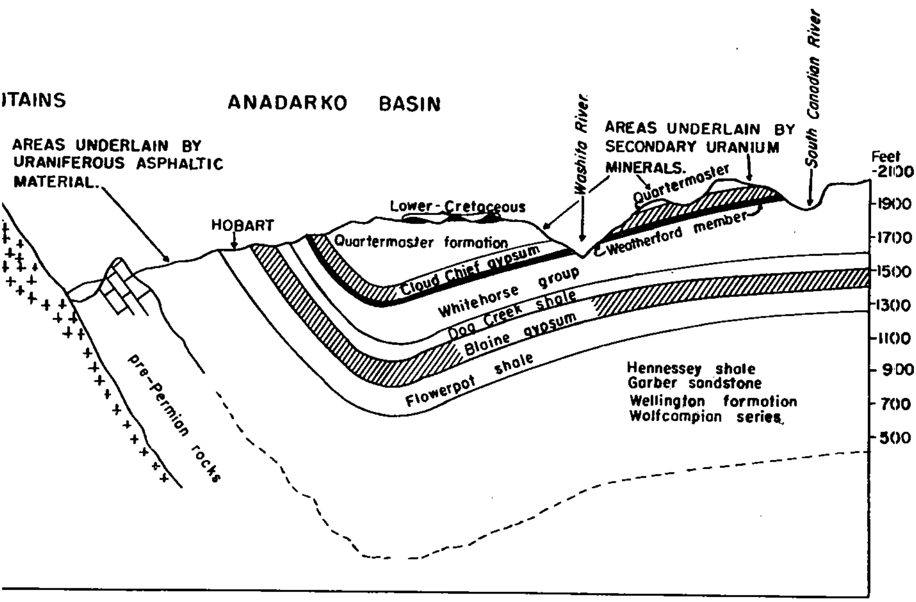
Few deposits are of commercial value below a concentration 0.6% U_3O_8. At that level the grade premium is $6.50 per pound, the total price $96.50 per ton. The official price list is given in the table.

New Uranium Procurement Program

The following public announcement was issued by the U. S. Atomic Energy Commission in Washington, D. C., for release on Thursday, May 24, 1956: ([5])

"The U. S. Atomic Energy Commission today announced establishment of a new domestic uranium procurement program for the period from April 1, 1962 through December 31, 1966, and an extension of the initial production bonus for uranium ore from February 28, 1957, its present expiration date, through March 31, 1960.

The new domestic procurement program provides a guaranteed market for all uranium concentrates produced by domestic mills from domestic ores, subject to a limitation, at the Commis-



areas underlain by uranium-bearing material.

sion's option, of 500 tons of U_3O_8 per year from any one mining property or mining operation and in compliance with Commission specifications. The price established is $8.00 per pound of U_3O_8 contained in normal mill concentrates or precipitates.

The present uranium ore procurement program will remain in effect until March 31, 1962. The new program establishes a base price for domestic uranium concentrates, rather than ores, for the period from April 1, 1962, through December 31, 1966. The base price will be $8.00 per pound of U_3O_8 contained in concentrates meeting specifications. This price will be applicable to the type of concentrate, i. e., high grade chemical precipitates, which is being purchased presently under negotiated unit price contracts with milling companies.

A gradual transition from a government-controlled uranium market to a commercial market is expected to take place as industrial demand for uranium develops. Commission regulations permit the private purchase, sale, and use of source materials under Commission license, with restriction only on certain uses such as utilization as a coloring agent in ceramics. Under the new procurement program, producers will be able to sell to licensed domestic commercial users in addition to the Commission.

TABLE 2

Schedule of Prices for Uranium Ore [3]

(As Specified in Circ. 5 Revised, and Circ. 6)

Grade of Ore Percent U_3O_8	Pounds U_3O_8 per ton of Ore	Base Price: Pound U_3O_8	Base Price: Ton of Ore	Price Per Ton of Ore: $0.75 a lb. over 4 lbs.	Premium $0.25 a lb. Over 10 lbs.	Mine Devel. Allowance .50/lb.	Price Before Initial Prod. Bonus and Haulage Allowance	Initial Prod. Bonus on 10,000 lbs.	Price before Haulage Allowance
0.10	2.00	$1.50	$ 3.00	$	$	$ 1.00	$ 4.00	$ 3.00	$ 7.00
0.21	4.20	3.50	14.70	0.15		2.10	16.95	14.70	31.65
0.31	6.20	3.50	21.70	1.65		3.10	26.45	21.70	48.15
0.41	8.20	3.50	28.70	3.15		4.10	39.95	28.70	64.65
0.60	12.00	3.50	42.00	6.00	0.50	6.00	54.50	42.00	96.50
1.00	20.00	3.50	70.00	12.00	2.50	10.00	94.50	70.00	164.50
2.00	40.00	3.50	140.00	27.00	7.50	20.00	194.50	140.00	334.50
5.00	100.00	3.50	350.00	72.00	22.50	50.00	494.50	350.00	844.50
10.00	200.00	3.50	700.00	147.00	47.50	100.00	994.50	700.00	1,694.50

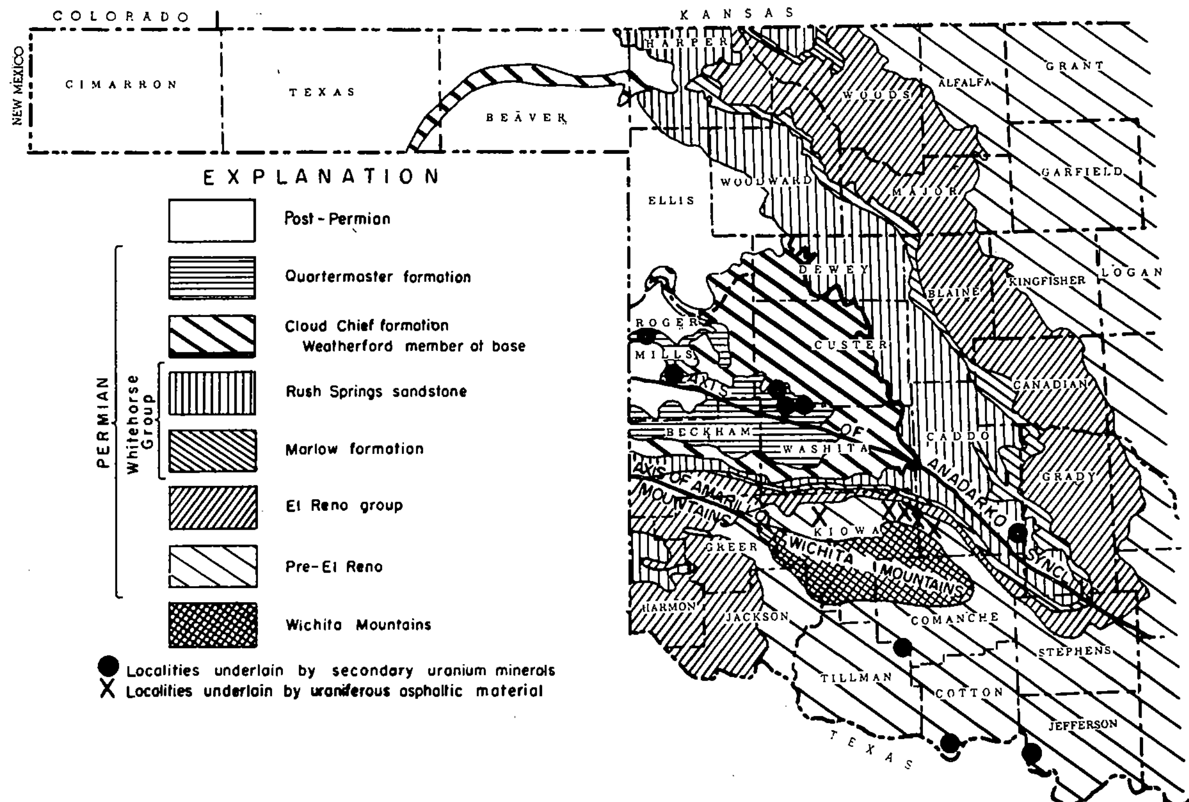


Figure 2. Geologic map of Western Oklahoma showing uranium-bearing localities. Modified from Geologic Map of Oklahoma, 1954.

Negotiated contracts executed prior to March 31, 1962, may provide for amortizing the cost of milling facilities over a period extending beyond March 31, 1962, with an amortization factor added to the $8.00 price established for the extended program. The amortization must be on not less than a five-year basis. If milling facilities are amortized or partially amortized under contracts executed with the Commission prior to March 31, 1962, the Commission may require that a reasonable percentage of mill capacity be made available for treatment of purchased or custom ores. There will be no commitment for the purchase of vanadium after March 31, 1962."

Prospecting for Uranium

"No license from the Atomic Energy Commission is required to own a radiation detection instrument or to prospect for radioactive ores. However, persons wishing to take such an instrument out of the country must obtain a license." (6)

It is necessary to obtain a license from the Atomic Energy Commission in order to sell, transfer, or receive certain quantities and grades of uranium and thorium ores which have been removed from the ground, no matter where or when they are mined.

Regarding licenses, write to the U. S. Atomic Energy Commission, Licensing Control Branch, Division of Construction and Supply, Washington 24, D. C.

It is not required to report the discovery of new deposits of radioactive ores. However, the U. S. Atomic Energy Commission and the Oklahoma Geological Survey do appreciate being informed of new discoveries in Oklahoma. The U. S. Atomic Energy Commission assists prospectors by making geological surveys and by furnishing free testing and assaying services in appropriate cases, as whenever there is strong preliminary evidence that radioactive minerals in quantities of interest to the Atomic Energy Commission do occur as reported.

Sample Testing Service

Samples will be tested, without charge, for radioactivity by the Denver Exploration Branch of the U. S. Atomic Energy Commission. Mail samples to U. S. Atomic Energy Commission, Denver Exploration Branch, DRM, P. O. Box 7647, Lakewood Branch, Denver 15, Colorado.

"One pound of material is needed and it will be tested for uranium only." (7) Samples will not be tested if the exact location of the material is not given. The material will not be tested if it does not exhibit three to four times the office background count. Surface material will not be tested unless definite uranium minerals are in evidence or radioactivity is in excess of three to four times the office background count. (7) "Samples not tested will be discarded within the week of receipt. If the prospector or operator desires return of the material submitted, sufficient postage must be included with the samples for remailing." (7) If sample is accepted for testing, a radiometric assay will be run to determine merit for chemical assay. Radiometric assay results of minimum ore grade, 0.10% e U_3O_8, or better may be considered for chemical assay by the Atomic Energy Commission. Pulp, resulting from grinding for radiometric assay will be held for thirty days. It will be sent to the prospector or operator upon receipt of sufficient postage to cover mailing one pound from assay office to their address. Only tentative mineral identification will be made by the Atomic Energy Commission.

Rock and mineral samples may also be tested, without charge, at one of the following agencies: U. S. Geological Survey, Geochemistry and Petrology Branch, Building 213, Naval Gun Factory, Washington 25, D. C.; Chief, Minerals Technology Division, Region VI, U. S. Bureau of Mines, Rolla, Missouri; Mr. John F. Shaw, Superintendent, Denver Experimental Station, U. S. Bureau of Mines, Building 20, Denver Federal Center, Denver 2, Colorado.

At least one month must be allowed for results to be obtained from analysis of samples.

Samples should fairly and accurately represent the entire deposit from which they were taken.

Regarding regulations for the mailing of radioactive materials, consult U. S. Post Office Department's Postal Manual, dated December 1, 1954, Part 125.24.

"The Oklahoma Geological Survey will determine radioactivity by Geiger counter of samples submitted from deposits within the state provided that an accurate locality is given. The determination is made without charge and the location is held confidential." (8)

"Nearly all land in Oklahoma is privately owned or is in Indian lands. Permission of the owner should be obtained before prospecting. Mineral rights must be purchased from the owner, or, in the case of Indian lands, obtained by bid at public auction." (8)

Detecting Radioactivity

(1) By Radiation Detection Instruments

(a) "Geiger counter: This instrument indicates the general amount of radioactivity in a rock sample or a deposit, by clicks in earphones, by a blinking light, by a dial reading, or by a combination of these methods. The instrument cannot distinguish between uranium and thorium; nor can it indicate the exact amount of radioactive material present (unless it has been calibrated by laboratory methods . . .)". (9)

"Although the Geiger counter is a simple instrument to operate it is not always easy for the prospector to interpret correctly the readings shown by the instrument . . . A rise in the reading may be caused not only by the presence of uranium but also by . . . (1) The background count; (2) The "mass effect"; and (3) The presence of thorium." (10)

"The **background count** is the count that is always registered by the instrument, even at a distance from radioactive ores, because of cosmic rays and random gamma radiation . . . The reading in any specific location, or for any sample, is not significant until the background count has been established and subtracted from the total count." (10) "Most rocks, even though they do not represent commercially valuable uranium deposits have some degree of radioactivity, and some more than others". (10)

The **"mass effect"** means that a large mass of weakly radioactive rock may have, as a whole, enough radioactivity to affect the counter strongly even though a small piece of the rock shows only a small radioactivity reading.

The radiations emitted by uranium and thorium register on most counters in the same way, therefore chemical tests may be necessary to determine whether the radioactivity is coming from uranium or thorium.

Overburden (covering layer of earth or rocks) above a radioactive deposit may cut off most or all of the radiation, depending upon the thickness of the covering layer. Only radioactive material at or within 2 feet of the land surface may be detected by the Geiger counter.

(b) Scintillation counter: This instrument, like the Geiger counter, is a gamma-ray detector. The scintillation counter is used in much the same manner as the Geiger counter, but it is more sensitive than the Geiger counter.

Airborne and carborne Geiger and scintillation counters are used in initial reconnaissance of large new areas. In making an airborne radiometric survey, a slow-flying plane and a counter with high sensitivity are necessary. The altitude of the plane during flight along traverse lines is about 50 feet and speed about 70 miles per hour.

An airborne radioactivity survey was run July-December 1954 in the Wichita Mountain area. ([11])

Geiger and scintillation counters are also used (with downhole probe) in measuring radioactivity in seismic shot holes, exploratory drill holes, and abandoned water well holes.

Fluorescence: The presence of uranium in a rock can be determined by fusing the material with lithium fluoride or sodium fluoride in a loop of wire (iron wire may be used). The bead that is formed will fluoresce under ultraviolet light, after it cools, even if it contains only a small amount of uranium. If the sample shows radioactivity but does not react to the above test, this usually indicates that the radioactivity is coming from thorium rather than uranium.

"Most uranium minerals—including pitchblende and carnotite—will not fluoresce simply by being placed under an ultraviolet light." ([9]) There are a few uranium minerals (autunite, for example) which will fluoresce under the ultraviolet light. Many non-uranium minerals fluoresce under the ultraviolet light.

Equilibrium: Geiger and scintillation counters will indicate the amount of radiation from a sample but they do not indicate the actual amount of uranium or thorium present unless the radioactive ore is in equilibrium. "When a radioactive ore is in equilibrium, a certain relative proportion of each daughter element is present, no matter what the grade of the ore, and there is a theoretical level of radiation for a given amount of uranium or thorium." ([12])

The major cause of lack of equilibrium is the solution effect of ground water, which dissolves primary minerals and redeposits secondary minerals. Because of this, the amount of radiation from uranium deposits containing a large percentage of secondary minerals is often misleading as to the actual uranium content.

Uranium Sample Sets (13)

The U. S. Atomic Energy Commission has for sale chemical analysis samples and counting samples.

Chemical Analysis Samples: These samples were prepared to test procedures for chemical analysis. The No. 3-A Pitchblende sample is in equilibrium and may be used for radioactivity comparison with a suitable counter. The Carnotite No. 4 and Carnotite No. 5 may be used for general comparison work.

Phosphate Rock	No. 1	0.029	percent U_3O_8
Pitchblende	No. 3-A	4.2	percent U_3O_8
Carnotite	No. 4	0.19	percent U_3O_8
Carnotite	No. 5	0.11	percent U_3O_8

Price of standard samples (postage free) $2.50/100 gram analysis samples and counting samples.

Counting Samples: These samples were prepared for use as a set in calibrating counting equipment and contain the following amounts of uranium: 4 percent, 2 percent, 1 percent, and 0.5 percent. Samples prepared from pitchblende and dunite and are in equilibrium. The sets will not be broken. Price of one set is $10.00 (postage free). Address orders for sample sets to the New Brunswick Laboratory, U. S. Atomic Energy Commission, P. O. Box 150, New Brunswick, New Jersey. Checks and money orders made payable to the Treasurer of the United States.

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