A COMPARISON OF PLANTS AND SOILS AS PROSPECTING GUIDES FOR URANIUM IN FALL RIVER COUNTY, SOUTH DAKOTA

By Robert S. Jones, Irving C. Frost, and Lewis F. Rader, Jr.

Trace Elements Investigations Report 686

UNITED STATES DEPARTMENT OF THE INTERIOR

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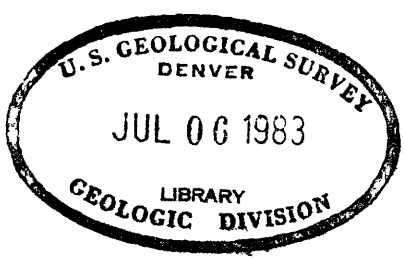

*This report concerns work done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

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A COMPARISON OF PLANTS AND SOILS AS PROSPECTING GUIDES FOR URANIUM IN FALL RIVER COUNTY, SOUTH DAKOTA

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Robert S. Jones, Irving C. Frost, and Lewis F. Rader, Jr.

ABSTRACT

A comparison of the uranium content of plants and soils as prospecting guides for uranium was made for areas of known mineralization in Fall River County, South Dakota. Results of radioactivity measurements are presented. The uranium content of either plants or soils may indicate anomalous areas. The more general availability of soils, and their greater ease of collection, preparation, and analysis recommends them over plants as prospecting guides for the area studied. The data also show that the same anomalous areas are delineated by the uranium content of the soil and the observed radioactivities. The minus 100-mesh sieve fraction of soil was found to contain the most uranium.

INTRODUCTION

Uranium in carnotite was first reported in Fall River County, South Dakota in 1951 (Page and Redden, 1952). Since this discovery numerous economic deposits have been found and uranium ore has been shipped from more than 50 locations in Fall River County alone. Most of the ore is in small deposits but a few claims have yielded as much as a thousand tons or more. The ore deposits are confined to the Fall River and Lakota formations in the Inyan Kara group of Early Cretaceous age (Bell and Bales, 1955).

Studies of prospecting guides which might be useful in delineating additional areas containing uranium were undertaken soon after the original discovery. As geobotanical methods had been successfully used to detect uranium anomalies in other areas by Cannon (1953) and Gilbert (1956), it seemed advisable to investigate geobotanical and other methods as prospecting guides in the southern Black Hills area.

Some preliminary work showed that significant amounts of uranium were present in the soil and warranted more detailed study of both plants and soils as prospecting guides.

Areas of known mineralization, figure 1, were chosen and soil and plant samples were collected and analyzed for their uranium content. Radioactivity measurements were also made. Of prime importance, however, was the investigation of the relative merits of plants as contrasted with soils for detecting uranium anomalies.

This study is part of a program being conducted by the U. S. Geological Survey on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

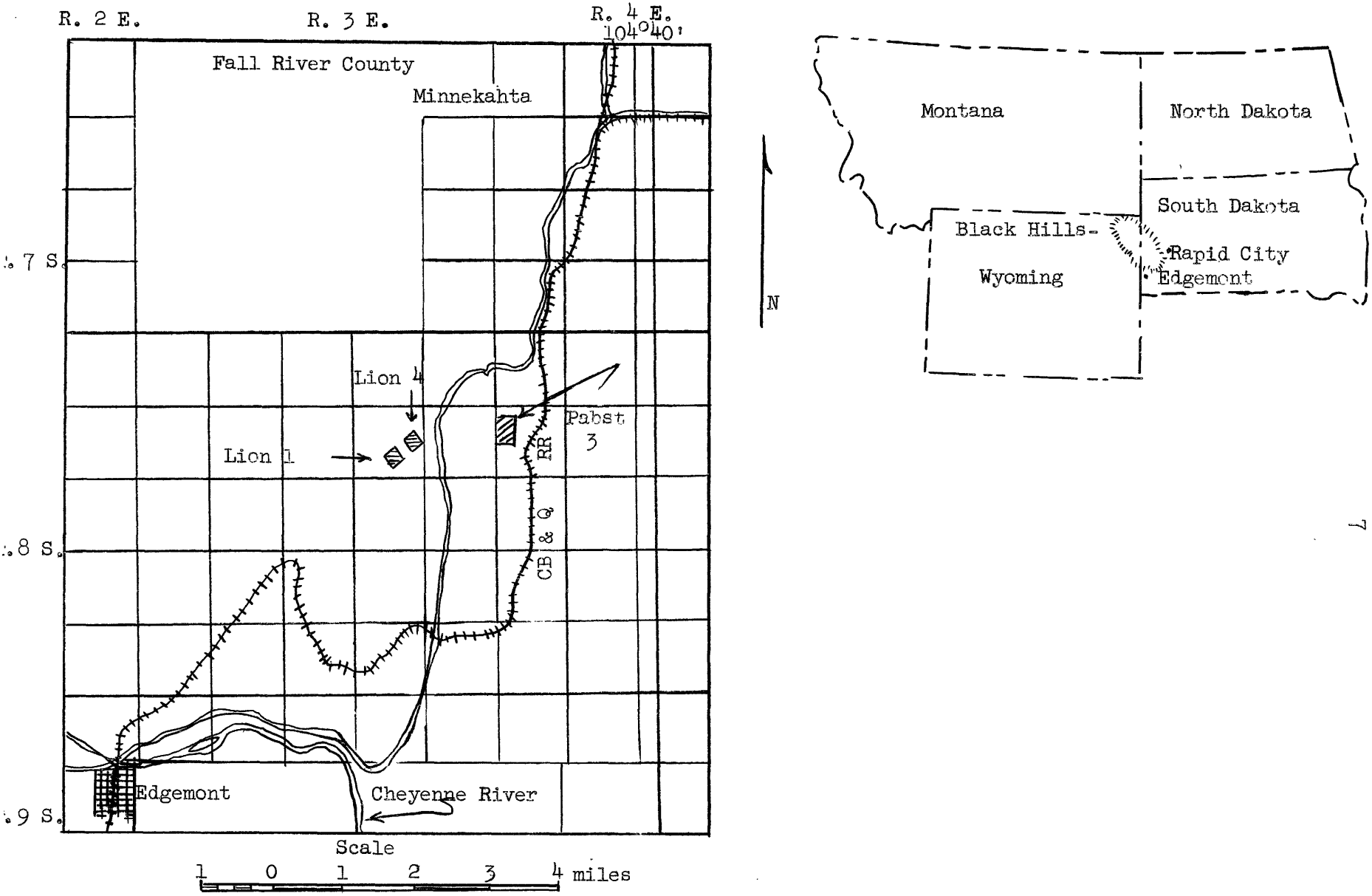

Figure 1.--Map showing location of Lion 1 and 4 and Pabst 3 areas, Fall River County, South Dakota.

GEOLOGY AND SAMPLING LOCALITIES

The presently known formations yielding uraniferous and vanadiferous ore overlie the Morrison formation where it is present. These formations are in the Inyan Kara group; they are separated into the Lakota sandstone at the base, the Fuson shale, and the Fall River sandstone at the top. This Inyan Kara group has been described by Rubey (1931) as " ... an extremely variable group consisting of discontinuous beds of sandstone, sandy shales, conglomerate, lignite, and variegated siltstone." Because of this variability it is difficult to distinguish these three formations everywhere from each other. These rocks form a broadly exposed belt about 5 miles wide in the southern part of the area.

The Lakota sandstone is described as being from 70 to 485 feet thick, composed of coarse-grained, hard crossbedded sandstone with conglomerate at the base, and colored mostly buff to gray.

The Fuson shale is a finer clastic "phase" in the Inyan Kara group between the Fall River and Lakota sandstones. It is reportedly from 30 to 188 feet thick and consists of massive gray to purple shale or clay.

The uppermost formation of the Inyan Kara group is the Fall River sandstone. This formation is from 25 to 200 feet thick and consists of massive sandstone near the base and thin-bedded sandstone near the top of the formation. The Inyan Kara group directly underlies the investigated areas.

Carnotite and tyuyamunite have been the most conspicuous and important minerals in the area. Other minerals found include uraninite, corvusite, rauvite, hewettite, and autunite. Corvusite is an important mineral of the larger and richer deposits where the Fall River and Lakota formations are thinly bedded sandstones and mudstones.

Sampling localities for plants and soils were all in Fall River County, S. Dak. at the Lion 1 and Lion 4 claims in sec. 10, T. 8 S., R. 3 E., and Pabst 3 claim in sec. 12, T. 8 S., R. 3 E., as shown on figure 1. The locations of plant samples are shown by letters and the locations of soil samples and radioactivity stations are shown by numbers in figures 2 and 3.

OCCURRENCE OF PLANTS AND SOILS

Plants

The vegetation in the areas chosen for this study can be placed in two main groups. Conifer trees (Pinus ponderosa and Juniperus virginiana) dominate the sloping areas and are believed to be the best source of geobotanical samples on sloping terrain. Their roots may penetrate mineralized ground not detected by surface observations or physical measurements. They were found on only part of the areas studied. The other group consists of herbs and shrubs which grow mainly on relatively flat areas. Their stalks and leaves grow closer to the ground and are probably more subject to wind-blown contamination than are tree samples.

No one plant was common enough for sampling on a grid pattern.

Soils

The soils in the southern Black Hills are brown with a slight darkening of the upper part corresponding to the A zone. They are without a B zone but have indistinct A and C zones. This thin soil cover is found over most of the area and can be sampled on a grid system. Although the pH of the soils analyzed ranged from 4.9 to 8.5, the median pH was 6.7. Over 80 percent of these soils ranged in pH from 6.0 to 7.5. These soils contrast with the sediments in the area that are more alkaline and have a measured pH ranging from 6.9 to 9.4 with a median pH of 7.9.

These soils have two natural sources of uranium: (1) subjacent rock and (2) the decomposition of plants whose roots have brought up uranium from slightly greater depths than the adjacent underlying rocks; however, most of the uranium in plants is probably derived from soil and less from sources beneath the soil.

Soils were not only present wherever plants grew but were also where many species did not grow.

PREPARATION AND ANALYSES OF PLANTS AND SOILS

Plants

Trees were sampled by taking needles at intervals at about shoulder height from 8 to 10 different places around the tree. Low growing plants were sampled by taking the aboveground portion as a sample. Where the plants were too small to provide sufficient material for analysis, several of the same plant species growing close together were gathered and composited.

All plant samples were washed with distilled water as soon as possible after arrival at the laboratory. They were then dried at 80° C in an oven, ground to about 20 mesh, redried and a portion ashed at 550° to 600° C. The ash was thoroughly mixed, placed in a stoppered vial, and reserved for analysis.

Weighed portions of the plant ashes were transferred to a volumetric flask and digested with dilute nitric acid. The acidity and volume of this solution were finally adjusted to 7 percent nitric acid and portions taken for uranium determination by the ethyl acetate extraction and fluorimetric method described by Grimaldi, May, and Fletcher (1952).

Soils

Soil samples were collected chiefly from the base of the A zone of the soil and consisted of 100 to 150 grams of soil freed of all +20 mesh material. Samples were collected on a 100-foot grid pattern from approximately 300,000 square feet at the Lion 4 area (fig. 2) and approximately 1,000,000 square feet at the Pabst 3 area (fig. 3). Other soil samples were collected from the base of selected pine trees.

Soil samples were dried upon receipt in the laboratory. Most were then ground in a disk pulverizer to pass an 80-mesh sieve. The sample passing the 80-mesh sieve was thoroughly mixed and reserved for analysis. Some of the soil samples were selected for a special study and were not ground but were disaggregated and sieved into fractions for a special part of this study.

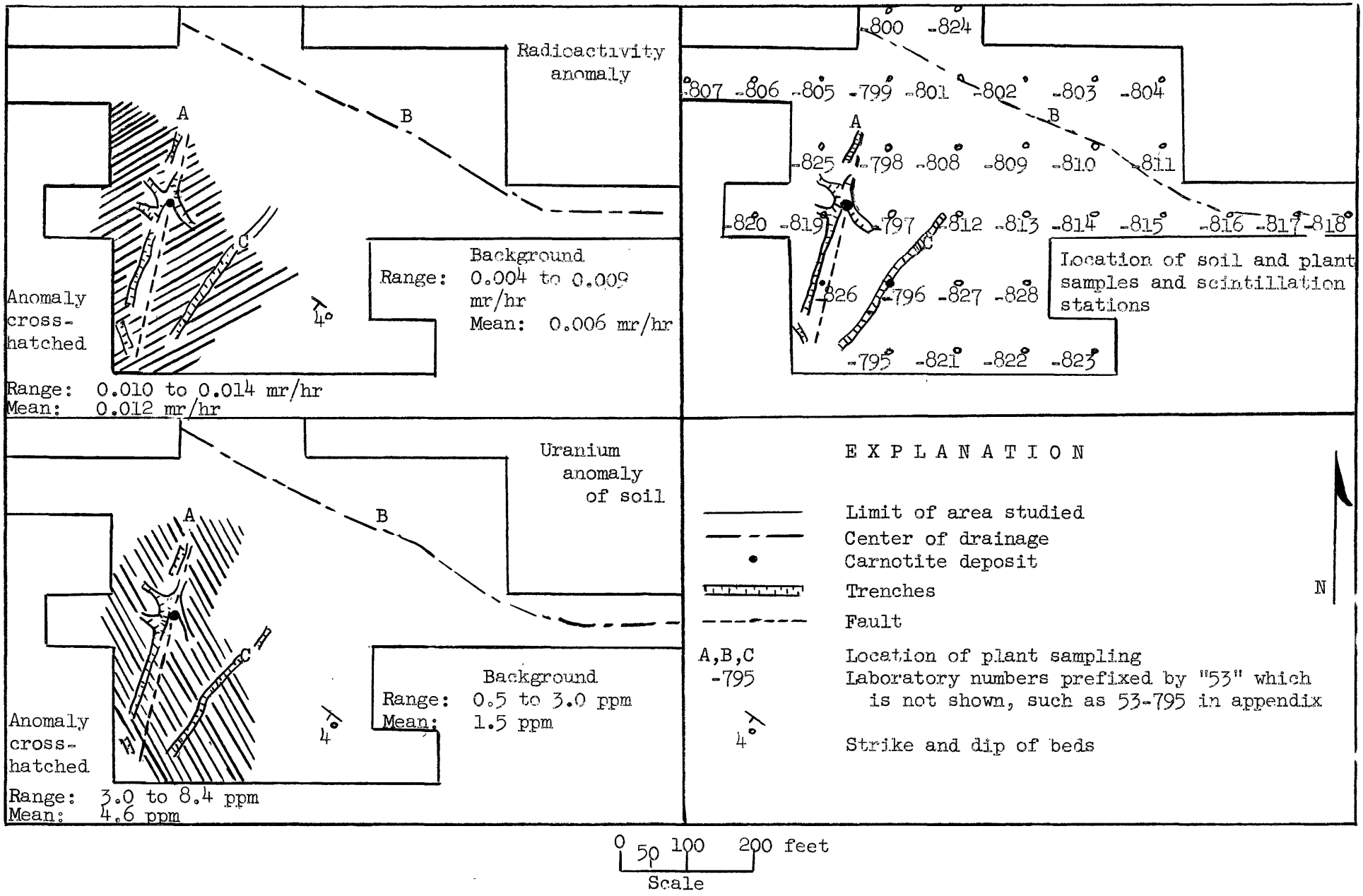

Figure 2.--Sampling and scintillation stations showing radioactivity and uranium anomalies in Lion 4 area, Fall River County, South Dakota.

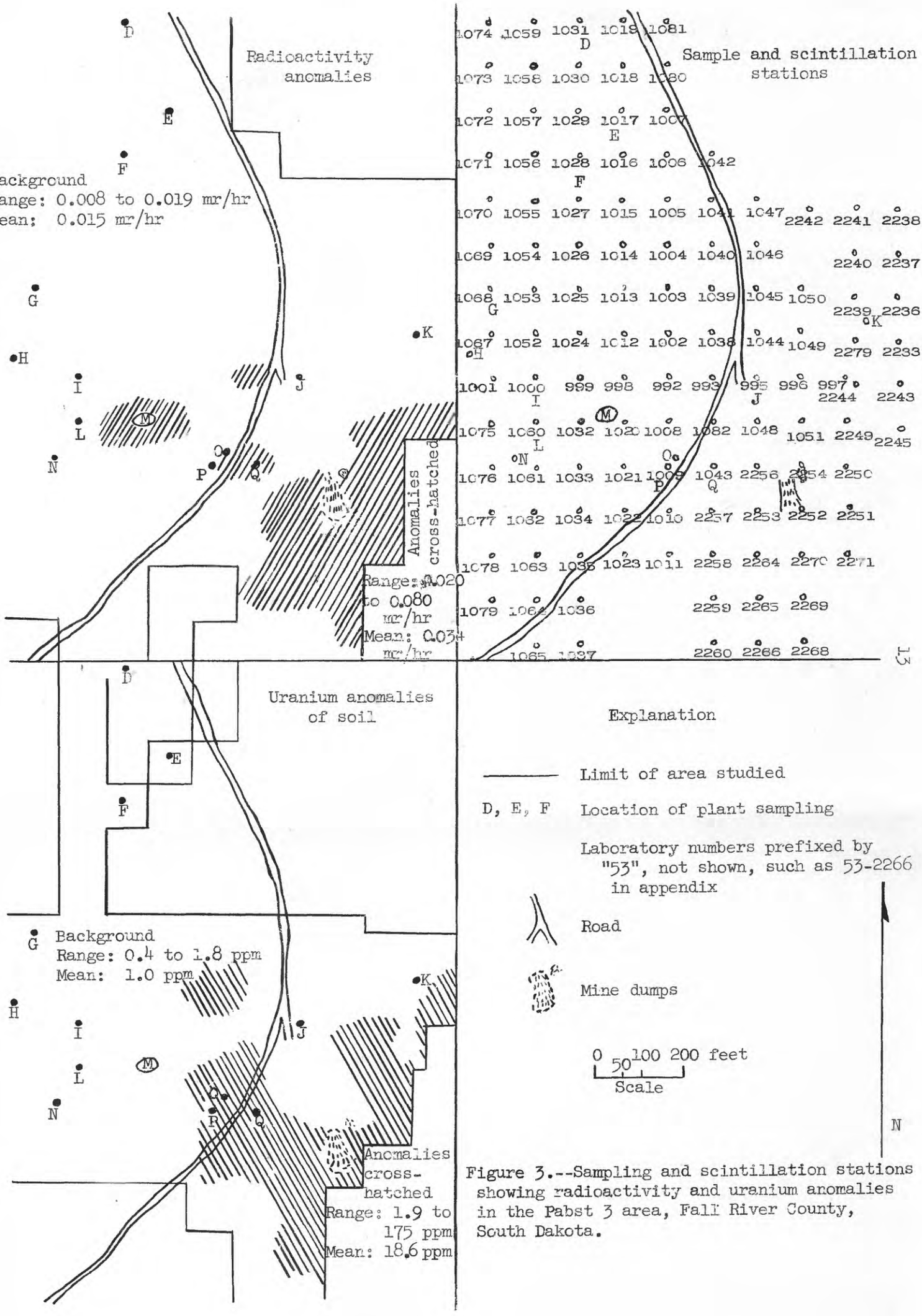

Figure 3.--Sampling and scintillation stations showing radioactivity and uranium anomalies in the Pabst 3 area, Fall River County, South Dakota.

Generally uranium analyses of soil are made by weighing the sample and roasting it in an iron crucible to remove all organic matter and to decompose partially the metal sulfides. The sample is then fused with sodium hydroxide which breaks up the silicates. This fused mass is digested in water and transferred to a volumetric flask. Its acidity, by volume, is adjusted to 7 percent nitric acid at the determined volume. An aliquot of this solution is analyzed for uranium by the method described by Grimaldi, May, and Fletcher (1952). This method gives total uranium in the samples because the silicates are completely decomposed.

A more rapid procedure has been used extensively in the analyses of phosphate rocks (Grimaldi, May, and Fletcher, 1952). This procedure is as follows: a weighed sample of 1.0 to 2.0 grams of soil is transferred to a volumetric flask of 100 ml capacity, 20 ml of 1 + 1 nitric acid is added, and the contents are then cooled. The solution is diluted to volume and shaken to insure uniformity. After complete settling a 5.0 ml aliquot is pipetted from the solution and analyzed for uranium by the ethyl acetate extraction method.

Ten soil samples were selected and their uranium contents determined by the standard sodium hydroxide fusion and nitric acid digestion methods. The results are compared in table 1. The sodium hydroxide fusion method gave higher uranium contents for all but one of the samples. The uranium contents ranged from 2 to 14 parts per million with the average obtained by the rapid method being about 35 percent (1.7 ppm) less than the average by the sodium hydroxide fusion method. Nevertheless, nitric acid digestion of the soil extracts uranium in sufficient amounts to define anomalous areas and also has the advantage that samples can be analyzed in less time than is possible by the sodium hydroxide fusion method. All uranium analyses of soils used in this comparative study were determined by the rapid nitric acid digestion method. They are given in the appendix.

Table 1.--Comparison of sodium hydroxide fusion and nitric acid digestion in the determination of uranium in soils.

Sample no.	Uranium in ppm		
	NaOH fusion	HNO_3 digestion	Difference
53796	14.	8.4	5.6
53795	7.3	6.1	1.2
53797	5.0	3.0	2.0
53798	4.5	3.6	0.9
53799	4.4	2.5	1.9
53812	3.0	1.3	1.7
53815	2.2	1.6	0.6
53824	1.9	0.6	1.3
53800	1.9	0.5	1.4
53822	1.8	1.8	0.0
Arithmetic mean	4.60	2.94	1.66

ANOMALIES

The chemical analyses for uranium and the radiometric observations show that areas can be divided into anomalous and background areas. Because the radioactivity near the surface of the ground, uranium in the soil, and uranium in plant ash have their values differently skewed, it is not always possible to compare the same upper percentiles with one another. However, a limited number of comparisons may be made of radioactivity and uranium anomalies which cover equal areas. Such comparisons might represent the upper 30 percent of the radioactivity values, but only 20 percent of the uranium values would be considered as anomalous. An area is therefore considered as anomalous only after evaluation and consideration of local factors.

RADIOACTIVITY MEASUREMENTS

Radioactivity measurements were made with a scintillation counter. Readings were observed on a 100-foot grid interval in the Lion 4 and Pabst 3 areas, figures 1, 2, and 3. The counter was held approximately 2 feet above the surface of the ground. The measurements, as milliroentgens per hour are given in the appendix, and the anomalous areas as outlined by these measurements are compared with other data for the Lion 4 and Pabst 3 areas. The anomalies represent the highest radioactivity in each area and are shown by diagonal lines in figures 2 and 3. Their mean is about twice that of the adjacent areas.

The field radioactivity shown should not be construed as entirely representing the uranium content of the soil, because cosmic radiation, variation in atmospheric radon due to weather, variation in instruments, and radiation from nuclides other than uranium affect the instrument.

COMPARATIVE STUDIES

Lion 1 and 4 areas

At the Lion 1 area a single pine tree was sampled as well as the underlying soil. Two limbs, one bearing S. 85 E., and the other N. 85 E., and their needles were sampled as well as the soil beneath the limbs on the east side of the tree. The ash from the two limbs contained 3.9 and 7 ppm uranium and their respective needles 5 and 8 ppm. The underlying soil was sampled due east from the trunk of the tree at 1 foot intervals and showed the following uranium contents:

1 foot from tree	2.6 ppm uranium
2 feet from tree	1.1 ppm uranium
3 feet from tree	17.0 ppm uranium
4 feet from tree	27.0 ppm uranium
5 feet from tree	24.0 ppm uranium
6 feet from tree	1.5 ppm uranium

The average uranium content of the plant ash analyzed was 6 ppm and of the soil, 12 ppm.

In the Lion 4 area, figure 2, the radioactivity readings adjacent to the trenches were highest and ranged from 0.010 to 0.014 milliroentgens per hour. Those away from the trenches, by comparison, ranged from 0.004 to 0.010 milliroentgens per hour. The uranium content of soils, analyzed after nitric acid digestion treatment, ranged from 3.0 to 8.4 ppm with a mean of 4.6 ppm within the area of the anomaly. Outside the anomaly the uranium content of soils ranged from 0.5 to 3.0 ppm with a mean of 1.5 ppm. The anomalous area outlined by either radioactivity measurements or by the uranium content of the soils corresponds closely.

The uranium content of the plant ashes indicated a similar anomalous high area, but no one plant species was sufficiently distributed throughout the area to outline the anomaly. It was observed that the ash of Pinus ponderosa needles at A, figure 2, contained 2.3 ppm of uranium, in comparison to four adjacent soils whose uranium content averaged 2.9 ppm. The average of the four corresponding radiometric readings was 0.014 mr/hr. At B, located approximately 300 feet east of A, the uranium content of the ash of some Pinus ponderosa needles was 0.8 ppm, in comparison to four adjacent soils averaging 1.1 ppm uranium. The radioactivity averaged 0.007 mr/hr. At C, near the anomalous areas, the ash of Cleome serrulata contained 1.3 ppm of uranium in comparison to four adjacent soil samples averaging 3.6 ppm uranium. The radioactivity averaged 0.011 mr/hr.

The soils at the Lion 1 and 4 areas contained more uranium than the ash of the nearby plants.

Pabst 3 area

In the Pabst 3 area, figure 3, the radioactivity ranged from 0.008 to 0.080 milliroentgens per hour. (See appendix.) The radioactivity of the greater part of the area ranged from 0.008 to 0.019 milliroentgens per hour and was considered background. The range from 0.020 to 0.080 milliroentgens per hour was considered anomalous and was used to delineate the indicated anomalous area.

The uranium content of 77 soil samples was determined. It ranged from 0.4 to 175 ppm. Those samples containing less than 1.8 ppm were considered background while those greater than 1.8 ppm were considered anomalous. The anomalous areas delineated accordingly correspond well with that determined from the radioactivity. (See figure 3.) The two soil samples with the highest uranium contents (sample 53-2252 containing 170 ppm and sample 53-2253 containing 175 ppm) were from locations near the Pabst 3 mine.

The uranium content of the ashes of 14 plants ranged from 0.7 to 11. ppm. The data are given in table 2 together with the uranium contents and radioactivity of nearby soil. The uranium content of plant ashes from localities E, K, M, O, and Q was greater than 2.0 ppm and may be considered anomalous for this area.

Table 2.--Uranium in plant ash and soil, and radioactivity in the Pabst 3 area, Fall River County, South Dakota.

Plant	Location	Ash percent	U in plant ash (ppm)	U in soil (ppm)	Radioactivity mr/hr
Psoralea tenuiflora	D	8.69	1.0	1/	0.019
Do.	E	9.47	3.2	1.1	0.016
Pinus ponderosa	F	2.46	1.1	0.7	0.013
Psoralea tenuiflora	G	9.67	1.3	0.8	0.015
Pinus ponderosa	H	2.18	1.9	0.8 2/	0.016 2/
Psoralea tenuiflora	I	9.83	1.2	1.6	0.018
Pinus ponderosa	J	2.35	1.4	1.0	0.014
Do.	K	2.52	2.1	2.1 3/	0.018 3/
Do.	L 4/	1.51 4/	1.8 4/	1.0	0.017
Psoralea tenuiflora	M	1.84	3.6	1.6 2/	0.020 2/
Do.	N	11.67	1.2	0.8 3/	0.018 3/
Pinus ponderosa	O	1.57 5/	9.2 5/	6.2 6/	0.024 6/
Psoralea tenuiflora	P	7.79	0.7	1.8	0.019
Pinus ponderosa	Q	2.24	11.	2.8	0.017
Arithmetic mean			2.9	1.7	

1/ No analysis.

2/ Arithmetic mean of 2 soil samples near plants.

3/ Arithmetic mean of 4 soil samples around tree.

4/ Arithmetic mean of 13 samples.

5/ Arithmetic mean of 14 samples.

6/ Arithmetic mean of 8 soil samples around tree.

Both plant samples, O and Q, were collected from the indicated anomalous areas as defined by the soil uranium content and radioactivity. Plant K (2.1 ppm U) lies on the border of the defined uranium anomaly, while plant E (3.2 ppm U) lies entirely outside the indicated anomalies. Plant P (0.7 ppm U), although from within the areas considered anomalous, does not indicate an anomalous condition. On the other hand, plant Q, which showed the highest (11.0 ppm uranium content, was the nearest plant sample to the two high (170 and 175 ppm U) soil samples. The average uranium content of the five anomalous plant ashes was 5.8 ppm while that of their nearby soils was 2.8 ppm uranium. The remaining plants (with the exception of plant D having no corresponding soil) averaged 1.3 ppm of uranium and that of their nearby soils was 1.1 ppm.

These data show that the uranium content of any single plant ash may not be representative of the general conditions. Therefore, delineations of anomalous areas from the uranium content of plant ashes can only be reliable when adequate numbers of plant samples are available. In the areas of this study adequate plant samples were not available.

It should also be noted that, although the ash from plants in the Pabst 3 area contained more uranium than the nearby soils, these plants commonly grew in and near soils containing the most uranium.

Discussion

The data from the Lion and Pabst areas show that analyses of soils and plants, and radiometric surveys indicate anomalous areas. In general, the same anomalous areas are well delineated from the uranium contents of soils and from the field radioactivity measurements. The data also show plant ashes and soils to contain similar amounts of uranium. Plants, however, are not so uniformly distributed as soils.

Therefore, soils are preferred to plants in the area studied, because soils are generally available; they can be sampled on a grid pattern and can be prepared and analyzed more readily than plant samples. A similar conclusion was reported by Debnam (1955) after an extensive investigation of the relative merits of plants and soils as prospecting guides for uranium in Australia. He stated "... that biogeochemical methods were found to compare unfavorably with geochemical methods."

STUDIES OF PARTICLE SIZE

Because most of the uranium in soils of the area was known to be of secondary origin, the finer soil materials such as clays and organic matter might contain more uranium than the coarser fraction. Therefore, tests were made to determine the extent of "upgrading" to be gained by analyzing only the finer fractions.

Ten samples were disaggregated and sieved into the following fractions: +20 mesh, -20+100, -100+200, -200+325, and -325 mesh. The +20 mesh fraction was discarded because it was chiefly very coarse sand. The -20+100 fraction was divided equally into two parts, one part was ground in an agate mortar until it all passed through a 325 mesh sieve, and the other part was analyzed without grinding. All the soil fractions from each of the ten samples were analyzed for uranium.

The percentage composition by weight (sieve analysis) and the uranium content of each fraction are given in tables 3 and 4. Table 3 shows that the ten samples averaged 69.2, 14.5, 9.7, and 6.6 percent in the following particle sizes; -20+100, -100+200, -200+325, and -325 mesh, respectively, although the differences between samples with regard to particle size was large. Table 4 gives the uranium content for each sieve fraction for the ten soils. In general the finer fractions contained more uranium than the coarser fraction, particularly for the samples containing uranium in the range 1 to 14 ppm. However, when calculated to a weighted average basis, these samples containing the least uranium, show that 30.2, 39.9, 17.3, and 12.6 percent of the uranium was distributed to the -20+100, -100+200, -200+325, and -325 mesh fractions, respectively. Fine grinding and analysis of a portion of the -20+100 mesh material show that the weighted average of

Table 3.--Sieve analysis of soils, in weight percent. (Samples disaggregated in laboratory without crushing or grinding.)

Laboratory no.	-20+100 mesh	-100+200 mesh	-200+325 mesh	-325 mesh
203473	89.0	7.4	1.5	2.1
203474	67.2	15.1	9.4	8.3
203475	68.6	18.2	18.6	4.6
203476	48.2	18.5	22.7	10.6
203477	42.4	19.9	19.3	18.4
203478	71.1	12.0	7.4	9.5
203479	81.2	12.3	3.8	2.7
203480	64.6	22.0	8.6	4.8
203481	91.0	4.7	2.0	2.3
203482	78.3	14.7	3.3	3.7
Arithmetic mean	69.2	14.5	9.7	6.6

Table 4.--Uranium content, in ppm, of sieve fractions of soils.1/

Laboratory no.	-20+100 mesh ground to pass -325 mesh	-20+100 mesh	-100+200 mesh	-200+325 mesh	-325 mesh	Weighted average -20 mesh	Weighted average -100 mesh	Weighted average -100 mesh / Weighted average -20 mesh
		(Weight percent)						
203473	1.8	0.05	2.0	3.0	3.6	0.3	--	--
203474	1.5	0.06	1.1	2.8	2.7	0.7	2.0	2.9
203475	1.0	0.08	0.6	0.8	1.4	0.4	0.8	2.0
203476	1.9	0.8	0.7	1.2	1.1	0.9	1.0	1.1
203477	2.6	1.5	1.6	1.8	2.5	1.8	2.0	1.1
203478	2.1	1.3	1.2	1.6	2.4	1.4	1.7	1.2
203479	150.	150.	240.	290.	300.	170.	260.	1.6
203480	14.	15.	52.	90.	110.	84.	70.	2.1
203481	94.	105.	180.	140.	150.	110.	160.	1.5
203482	5.9	5.0	5.6	2.5	2.8	4.9	4.7	1.0
Arithmetic mean								1.6

1/ Uranium determined on nitric acid extract of samples.

these low samples contained more uranium than the equivalent samples of coarser material. This probably is due to more efficient extraction of the uranium from the fine material with nitric acid. The data of table 4 indicate that it would be advantageous in prospecting work to sieve soil samples, discarding the portion coarser than 100 mesh, and to analyze the part finer than 100 mesh. The samples were beneficiated by a factor of from 1 to 2.9 times as shown in the last column of table 4.

Such a method of sampling soils for prospecting work in connection with metals, other than uranium, is widely employed. For example, Kennedy (1952), working with lead, zinc, and copper, showed that the percentages of these metals found increased as the particle size decreased until the particle size ranged from 0.061 to 0.117 mm (about -150+250 mesh).

CONCLUSIONS

Plant zoning is based chiefly on difference in the slope of the ground; conifer trees grow mostly on the steeper slopes, and grasses and herbs grow on more flat-lying ground. Consequently, no one plant species was common enough for widespread sampling.

The rapid nitric acid digestion method for determination of the uranium in soils generally gives low values compared to the sodium hydroxide fusion treatment. The values are adequate, however, for delineation of anomalous areas.

The minus 100-mesh fraction of soil was found to contain more uranium than the coarser fraction and might be a means of up-grading the uranium content of soils for reconnaissance investigations.

The use of soil instead of plants is recommended for detecting uranium anomalies in the area studied because of wider coverage by soils, lower cost of analyses and greater speed in collecting and analyzing soil samples.

However, the field radioactivity measurements and the uranium content of the soil and plant samples indicate anomalies in about the same areas and the use of radioactivity measurements seems most desirable.

ACKNOWLEDGMENTS

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APPENDIX

Uranium analyses of soils and field radioactivity measurements in the Lion 4 and Pabst 3 areas.

Lion 4 area [1]

Lab. no.	U (ppm) [2]	Counting rate mr/hr [3]	Lab. no.	U (ppm) [2]	Counting rate mr/hr [3]
53-795	6.1	0.011	53-815	1.6	0.005
53-796	8.4	0.011	53-816	1.3	0.005
53-797	3.0	0.012	53-817	1.6	0.004
53-798	3.6	0.010	53-818	1.3	0.004
53-799	2.5	0.008	53-819	4.2	0.012
53-800	0.5	0.005	53-820	2.8	0.010
53-801	2.2	0.009	53-821	1.8	0.006
53-802	1.1	0.007	53-822	1.8	0.005
53-803	1.4	0.006	53-823	1.8	0.006
53-804	1.2	0.005	53-824	0.6	0.009
53-805	2.0	0.009	53-825	3.4	0.014
53-806	1.3	0.008	53-826	3.8	0.013
53-807	0.7	0.006	53-827	1.6	0.012
53-808	2.3	0.007	53-828	1.3	0.007
53-809	1.0	0.006			
53-810	1.0	0.007			
53-811	0.8	0.004			
53-812	1.3	0.007			
53-813	1.6	0.007			
53-814	1.5	0.005			

1/ Sec. 10, T. 8 S., R. 3 E. (See figures 1 and 2 for location.)

2/ Uranium, in parts per million, air-dried sample, crushed to pass 80-mesh sieve, determined from a nitric acid extract of samples.

3/ Readings obtained with scintillation counter held 2 feet above ground at sample point, indicated on map figures 2 and 3.

Uranium analysis of soils and field radioactivity measurements in the Lion 4 and Pabst 3 areas--Continued.

Pabst 3 area 4/

Lab. no.	U (ppm) 2/	Counting rate mr/hr 3/	Remarks
92710	7	0.024	NW 2 ft from tree at 0
92711	5	0.024	NW 7 ft from tree at 0
92712	5	0.024	NE 2 ft from tree at 0
92713	7	0.024	NE 7 ft from tree at 0
92714	7	0.023	SE 2 ft from tree at 0
92715	6	0.023	SE 7 ft from tree at 0
92716	5	0.027	SW 2 ft from tree at 0
92717	8	0.027	SW 7 ft from tree at 0

Lab. no.	U (ppm) 2/	Counting rate mr/hr 3/	Lab. no.	U (ppm) 2/	Counting rate mr/hr 3/
53-992	0.7	0.017	53-1013	0.8	0.015
53-993	1.9	0.020	53-1014	No analysis	0.012
53-995	1.0	0.014	53-1015	No analysis	0.012
53-996	2.1	0.015	53-1016	No analysis	0.015
53-997	2.6	0.013	53-1017	1.1	0.016
53-998	1.0	0.017	53-1018	No analysis	0.018
53-999	No analysis	0.017	53-1019	No analysis	0.019
53-1000	1.6	0.018	53-1020	1.5	0.020
53-1001	1.0	0.017	53-1021	1.2	0.017
53-1002	4.1	0.016	53-1022	1.1	0.014
53-1003	1.3	0.017	53-1023	No analysis	0.013
53-1004	No analysis	0.014	53-1024	0.6	0.016
53-1005	No analysis	0.013	53-1025	0.7	0.014
53-1006	No analysis	0.016	53-1026	No analysis	0.013
53-1007	No analysis	0.014	53-1027	No analysis	0.012
53-1008	1.4	0.016	53-1028	0.7	0.013
53-1009	1.8	0.019	53-1029	No analysis	0.018
53-1010	2.2	0.018	53-1030	No analysis	0.016
53-1011	1.4	0.017	53-1031	No analysis	0.019
53-1012	0.9	0.013	53-1032	1.6	0.020

4/ Sec. 12, T. 8 S., R. 3 E. (See figures 1 and 3 for location.)

Uranium analysis of soils and field radioactivity measurements in the Lion 4 and Pabst 3 areas--Continued.

Pabst 3 area 4/

Lab. no.	U (ppm) 2/	Counting rate mr/hr 3/	Lab. no.	U (ppm) 2/	Counting rate mr/hr 3/
53-1033	1.6	0.018	53-1069	No analysis	0.014
53-1034	1.0	0.012	53-1070	No analysis	0.013
53-1035	No analysis	0.014	53-1071	No analysis	0.018
53-1036	No analysis	0.012	53-1072	No analysis	0.018
53-1037	No analysis	0.013	53-1073	No analysis	0.019
53-1038	0.8	0.017	53-1074	No analysis	0.019
53-1039	0.8	0.015	53-1075	0.8	0.018
53-1040	No analysis	0.015	53-1076	0.8	0.018
53-1041	No analysis	0.017	53-1077	0.4	0.013
53-1042	No analysis	0.018	53-1078	No analysis	0.011
53-1043	2.8	0.017	53-1079	No analysis	0.014
53-1044	1.1	0.014	53-1080	No analysis	0.017
53-1045	0.9	0.017	53-1081	No analysis	0.014
53-1046	No analysis	0.018			
53-1047	No analysis	0.017	53-2233	5.3	0.015
			53-2236	1.2	0.008
53-1048	1.0	0.018	53-2237	No analysis	0.008
53-1049	1.0	0.015	53-2238	No analysis	0.008
53-1050	0.6	0.013	53-2239	1.2	0.011
53-1051	1.8	No datum			
53-1052	0.7	0.015	53-2240	No analysis	0.012
			53-2241	No analysis	0.010
53-1053	0.7	0.015	53-2242	No analysis	0.010
53-1054	1.5	0.014	53-2243	No analysis	0.015
53-1055	0.6	0.013	53-2244	1.5	0.008
53-1056	0.8	0.019			
53-1057	1.2	0.018	53-2245	No analysis	0.026
			53-2249	2.7	0.027
53-1058	0.8	0.018	53-2250	2.1	0.038
53-1059	1.0	0.019	53-2251	No analysis	0.046
53-1060	1.0	0.017	53-2252	170.0	0.055
53-1061	0.7	0.018			
53-1062	0.5	0.014	53-2253	175.0	0.046
			53-2254	1.3	0.018
53-1063	No analysis	0.012	53-2256	1.9	0.017
53-1064	No analysis	0.013	53-2257	2.0	0.019
53-1065	No analysis	0.012	53-2258	1.4	0.015
53-1067	0.6	0.015			
53-1068	0.8	0.015			

Uranium analysis of soils and field radioactivity measurements in the Lion 4 and Pabst 3 areas--Continued.

Pabst 3 area 4/

Lab. no.	U (ppm) 2/	Counting rate mr/hr 3/	Lab. no.	U (ppm) 2/	Counting rate mr/hr 3/
53-2259	1.4	0.020	53-2268	No analysis	0.021
53-2260	1.4	0.018	53-2269	No analysis	0.035
53-2264	2.0	0.080	53-2270	No analysis	0.030
53-2265	2.0	0.022	53-2271	No analysis	0.038
53-2266	1.4	0.018	53-2272	0.8	0.038