

GEOLOGICAL SURVEY CIRCULAR 264



GEOBOTANICAL RECONNAISSANCE
NEAR GRANTS, NEW MEXICO

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**GEOBOTANICAL RECONNAISSANCE NEAR
GRANTS, NEW MEXICO**

By Helen L. Cannon

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ABSTRACT

The application of geobotanical methods of prospecting in uranium-bearing areas in McKinley County, near Grants, N. Mex., has been investigated briefly. The uranium deposits occur in the Todilto limestone member of the Wanakah formation and in the overlying Morrison formation, both of Jurassic age. Carbonaceous uranium ore in the Morrison formation contains a high percentage of selenium, and selenium-indicator plants are commonly associated with these deposits. Such plants have not been observed on the Todilto deposits.

The average uranium content in the ash of trees rooted in ore deposits of the Todilto limestone member is more than 20 parts per million, and trees rooted in barren limestone average about 10 ppm. The uranium content of the plant ash is detectable by fluorimetric methods. Uranium analysis of trees growing on the Todilto bench and mapping of selenium-indicator plants on the sandstones of the Morrison formation are recommended as a method of prospecting.

INTRODUCTION

Geobotanical techniques show considerable promise as tools in the search for uranium in the Wanakah and Morrison formations of Jurassic age near Grants,

McKinley County, N. Mex. Large amounts of uranium are absorbed by plants growing near uranium deposits in the Todilto limestone member of the Wanakah formation (area 1, fig. 1). Selenium-indicator plants are present on the ore-bearing sandstones of the Morrison formation (area 2, fig. 1).

The outcrop of the Todilto limestone member chosen for study is 18 miles by road northwest of Grants, in the northwest corner of sec. 19, T. 13 N., R. 10 W., New Mexico principal meridian (fig. 1). The area lies near the south end of Haystack Mountain, McKinley County, N. Mex., and about 80 miles west of Albuquerque. The outcrop of uranium-bearing sandstone in the Morrison formation is 14 miles north of Grants in sec. 18, T. 13 N., R. 9 W. Both localities are reached by a dirt road leading north and east from U. S. Highway 66 just east of the town of Prewitt. The main line of the Atchison, Topeka, and Santa Fe Railway parallels U. S. Highway 66. Mineral rights to the property are controlled by the railroad.

The altitude of the deposits is about 6,500 feet. The average annual rainfall is 10 to 15 inches. The vegetation consists of xerophytes, or drought-resistant plants, such as saltbush, sagebrush, and grasses; junipers and pinyons grow on the sandstone and limestone benches.

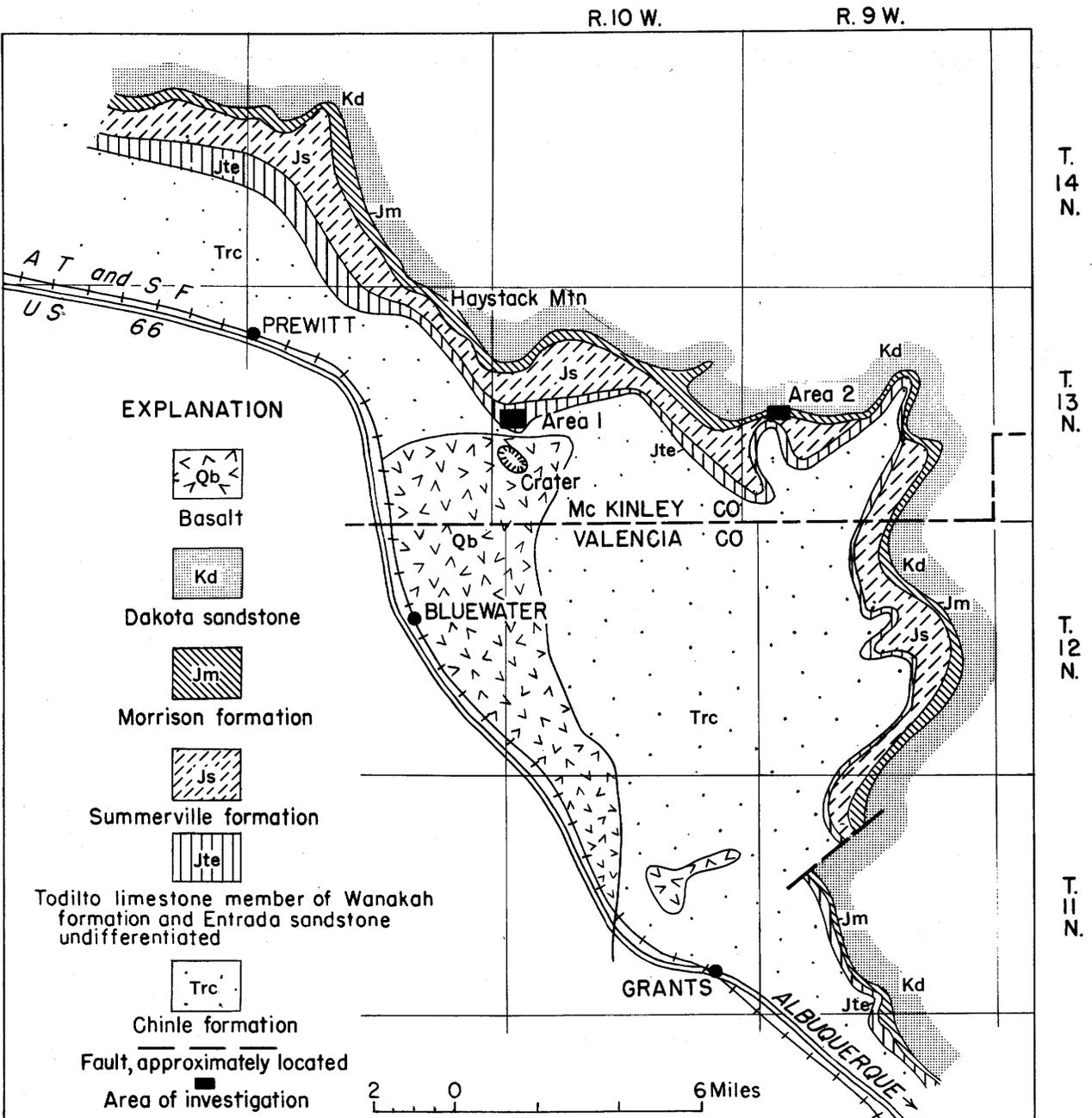


Figure 1.—Geologic map of Grants district, New Mexico, showing areas investigated.

The field work was done in May 1951. The author wishes to acknowledge the able assistance of Barbara Knapp and to express her appreciation to Irving Rapaport of the Atomic Energy Commission for help in field orientation and to Abraham Rosensweig of the Atomic Energy Commission for furnishing background information used in this report. Special acknowledgment is made to the Atchison, Topeka, and Santa Fe Railway for permission to study the deposits on the railroad property. The work was sponsored by the U. S. Atomic Energy Commission.

GEOLOGY

The area studied is on the northeast flank of the Zuni Mountains and within the Colorado Plateau province. The geology has been described by Gregory (1917), by Darton (1928), by Baker, Dane, and Reeside (1947), by Reyner and Sheridan (1950), and by Evans (1950). Sedimentary beds of Mesozoic age dip gently to the northeast and the resistant sandstones and limestones form inclined benches. A broad valley has been formed by the erosion of the Chinle formation of Triassic age.

Jurassic rocks—Entrada sandstone, Wanakah, Summerville and Morrison formations—crop out on the north-east side of the valley. The 4- to 18-foot thick Todilto limestone member of the Wanakah formation caps the Entrada sandstone and forms a broad shelf or bench along the edge of the valley. The Summerville formation is represented by a sandstone bed called the Red Mesa sandstone by Hoover (1950). This sandstone and the Westwater Canyon sandstone and Brushy Basin shale members of the Morrison formation form a south-facing slope along the north side of the Todilto bench. The slope is capped by the 'Dakota sandstone' of Cretaceous age.

Uranium deposits occur along the outcrops of these beds in McKinley and Valencia Counties for a distance of 18 miles, and also on the Laguna Indian Reservation 30 miles east of Grants. In the section studied, shown as area 1 on figure 1, the Todilto limestone member has a maximum thickness of 15 feet and forms a bench 1,000 feet wide; the overburden is less than 4 feet thick and the average depth to the top of the ore, which is exposed in numerous test pits, is only 5 feet. The ore minerals in this locality, according to Gruner and Gardiner (1951), are mainly secondary tyuyamunite, carnotite, and uranophane, associated with small amounts of pitchblende. Vanadium and uranium occur in nearly equal amounts. The content of selenium is very low. A specimen of ore, collected in conjunction with the geobotanical studies, contained 0.31 percent equivalent U, 0.22 percent U, 0.39 percent V_2O_5 , and less than 0.000001 percent Se. A specimen of ore of the Todilto interbedded with volcanic flows collected from the Laguna Reservation contained 0.0038 percent selenium.

Carnotite and carbonaceous uranium ores occur at several localities in the sandstone beds of the Morrison formation in the Grants area. The deposit studied is in Poison Canyon, 14 miles northeast of Grants, shown as area 2 on figure 1. The ore is in the conglomeratic Westwater Canyon sandstone member of the Morrison formation. A selected sample of black carbonaceous ore contained 2.02 percent equivalent U, 2.88 percent U, 0.99 percent V_2O_5 , and 0.234 percent Se. As far as the writer knows, this is the largest amount of selenium reported from a sedimentary rock. A highly vanadiferous ore specimen collected from the Laguna Reservation contained only 0.0001 percent selenium.

THE EFFECT OF ORE DEPOSITS ON NATIVE VEGETATION

Plants are affected by uranium ore deposits in two ways. First, due to the usual association of selenium with uranium ores, plants that require selenium may grow near uranium deposits. Second, plants that are rooted in ore deposits absorb uranium and vanadium in detectable quantities.

Selenium-indicator plants apparently do not grow on the Todilto limestone member, although in some areas the ore contains sufficient selenium to support selenium-indicator plants. These plants of the *preussii* group of *Astragalus* (milkvetch) and *Oryzopsis hymenoides* (Indian ricegrass) grow profusely along the base of the outcrop of the carbonaceous ore in the Westwater Canyon sandstone member of the Morrison formation in Poison Canyon. The vegetation

on the alluvium of the valley floor consists mainly of xerophytic plants such as *Atriplex confertifolia* (shadscale), which is a selenium absorber.

Juniper and pinyon trees that grow on the Todilto limestone member absorb unusual quantities of uranium but very little vanadium. Samples of unwashed and washed needles, peeled branches, and peeled roots of five selected trees were collected to provide data on distribution of uranium in plants in a lime environment, and also to check the amount of contamination. The analyses of these samples for uranium are given in table 1.

Analyses of washed and unwashed samples of the foliage indicate contamination. Washing does not remove all surface contamination from the vegetation; the chemical analyses of washed samples, therefore, do not represent uncontaminated material. Roots and branches were carefully peeled to eliminate all possibilities of contamination. The analyses, compared in dry weight figures, indicate only slightly less uranium in roots and branches than in washed needles. Results shown on figures 3 and 4 indicate that trunkwood also contains a quantity of uranium similar to that of needles. The average uranium content of tree samples from area 1 on the Todilto limestone member is about 10 times greater than the content of similar samples collected from sandstones elsewhere on the Colorado Plateau (Cannon, 1952). This is probably the result of the deposits having been exposed to weathering by extensive erosion and the uranium in the minerals becoming water soluble and available for plant absorption.

Eight samples were analyzed for vanadium. Samples of peeled branches and washed needles contained less than 10 ppm V_2O_5 in the ash and samples of unwashed needles contained from 18 to 27 ppm. The absorption of vanadium is surprisingly low and is in direct contrast to the higher absorption of uranium from the same deposits. The average content of V_2O_5 in vegetation of the Colorado Plateau as determined by previous work (Cannon, 1952) is 40 ppm in the ash. The plants sampled at Grants, N. Mex., were thus below normal background. The reasons for this are not clearly understood although presumably closely related to the physiologic means of absorption of these two elements and their availability in an oxidized limestone environment. A possible explanation is that in a calcium carbonate environment, the weathering process fixes the vanadium and frees the uranium.

APPLICATION OF GEOBOTANICAL METHODS OF PROSPECTING FOR URANIUM

Prospecting for uranium by analysis of vegetation is a feasible method of exploration in the Todilto limestone member.

Prospecting by chemical analysis was tested in sec. 19, T. 13 N., R. 10 W. The location of sample stations is shown on figure 2 and the results are shown graphically in figures 3 and 4. Test pits expose ore at an average depth of 5 feet. To test the amount of contamination by dust, as well as the usefulness of the sampling methods in prospecting, collections of both needles and trunkwood were made of juniper and pinyon at intervals of 100 feet along east-west and

Table 1.--Uranium content of samples from trees rooted in shallow ore bodies of the Todilto limestone member, sec. 19, T. 13 N., R. 10 W.¹

Plant station no. (shown on fig. 2)	Unwashed needles		Washed needles		Peeled branches		Peeled roots	
	U in ash (ppm)	U in dry wt. (ppm)	U in ash (ppm)	U in dry wt. (ppm)	U in ash (ppm)	U in dry wt. (ppm)	U in ash (ppm)	U in dry wt. (ppm)
Pinyon 3-----	112.0	2.9	106.0	2.0	44.0	0.57	97.0	1.3
Juniper 13-----	27.0	1.1	24.0	0.78	11.0	2.7	49.0	.49
Pinyon 13-----	53.0	1.2	30.0	0.69	26.0	.47	74.0	1.55 ²
Juniper 17-----	49.0	1.8	40.0	1.4	7.0	.29	---	---
Pinyon 17-----	46.0	1.0	33.0	0.76	13.0	.20	14.0	.20
Average-----	57.0	1.6	47.0	1.1	20.0	.85	60.0	.87

¹Claude Huffman, analyst.

²Unpeeled.

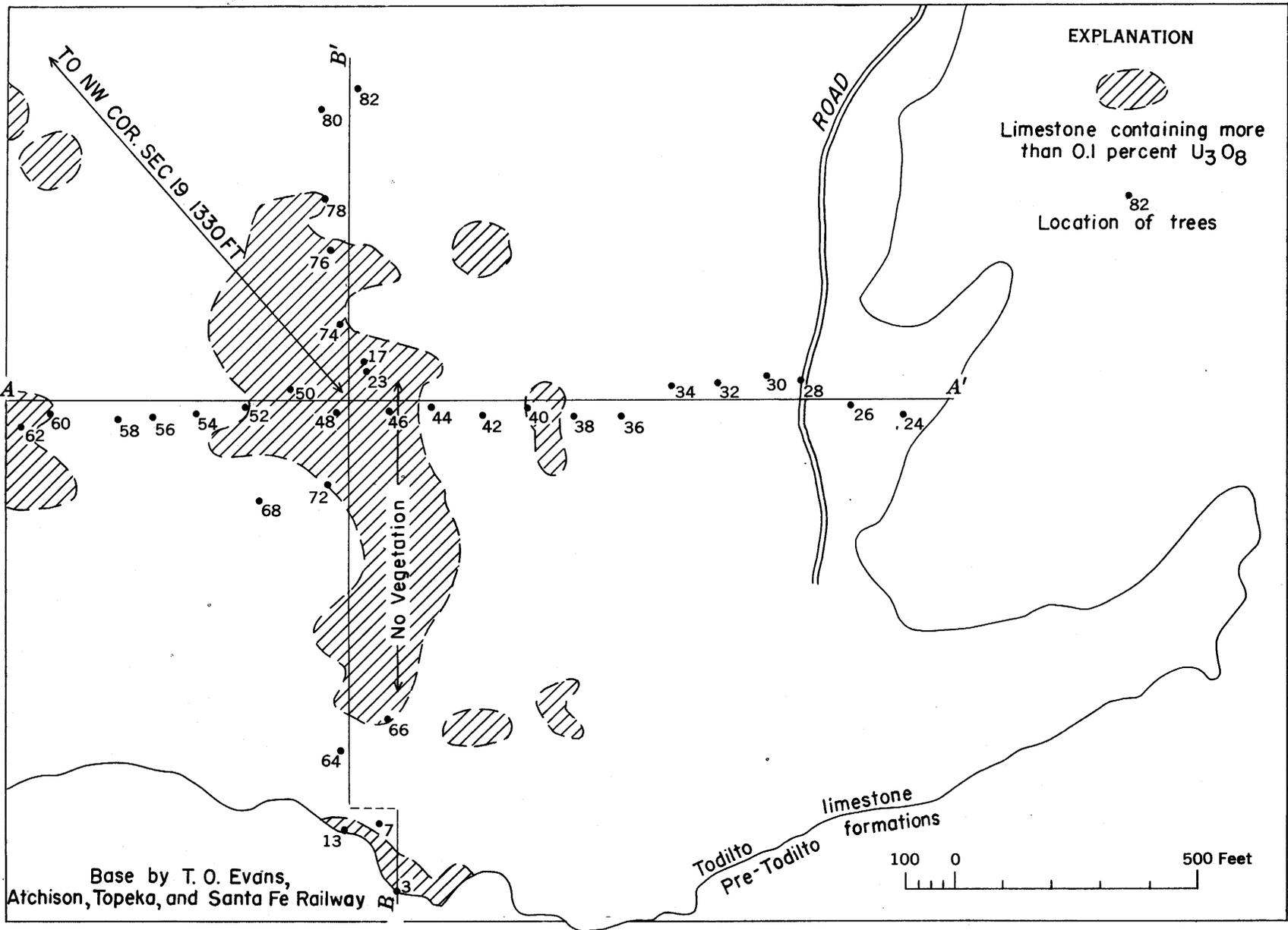


Figure 2. --Sketch map of area 1, NW $\frac{1}{4}$ sec. 19, T. 13 N., R. 10 W., showing geobotanical traverses across uranium deposits in the Todilto limestone member

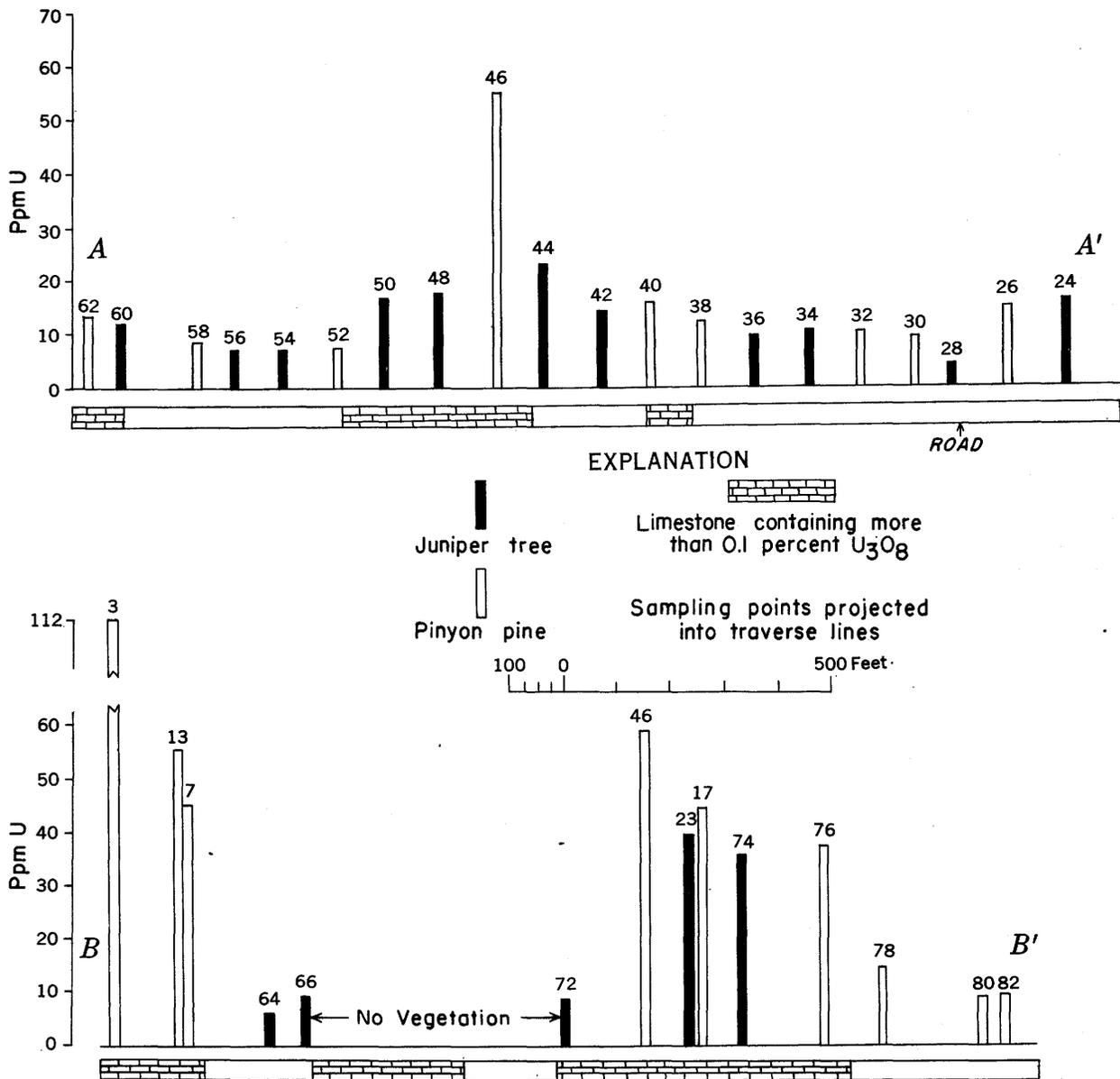


Figure 3. —Diagram showing uranium content of unwashed tree needles collected along traverses A-A' and B-B' in sec. 19, T. 13 N., R. 10 W.

north-south traverses across the ore body. Wood from the trunk and needles from all sides of the tree trunk were sampled at the same time. The samples were air-dried, ashed, and analyzed by the fluorimetric method, in the Trace Elements Section, Denver Laboratory of the Geological Survey (Grimaldi and others, 1950).

The absorption of uranium by trees rooted in weathered ore-bearing limestone is very high. Along section A-A' the increment due to contamination from dust was much less than expected, and in many places the trunkwood of the trees contained more uranium than the unwashed needles. The trunkwood of several trees over ore contained more than 30 ppm U in the ash.

The trunkwood samples average 10 ppm U in the ash on limestone containing less than 0.1 percent U_3O_8 , and more than 20 ppm on limestone containing 0.1 percent or more U_3O_8 . The results of this cursory examination are much more uniform than were expected for crude sampling in a disturbed area, and suggest that results may be contoured from an organized sampling program in unexplored outcrop.

Prospecting for uranium by analysis of vegetation on the favorable areas of the Todilto limestone member is recommended. Needles of deep-rooted pinyons or junipers may be sampled by collecting needles from all sides of a tree at certain specified intervals along

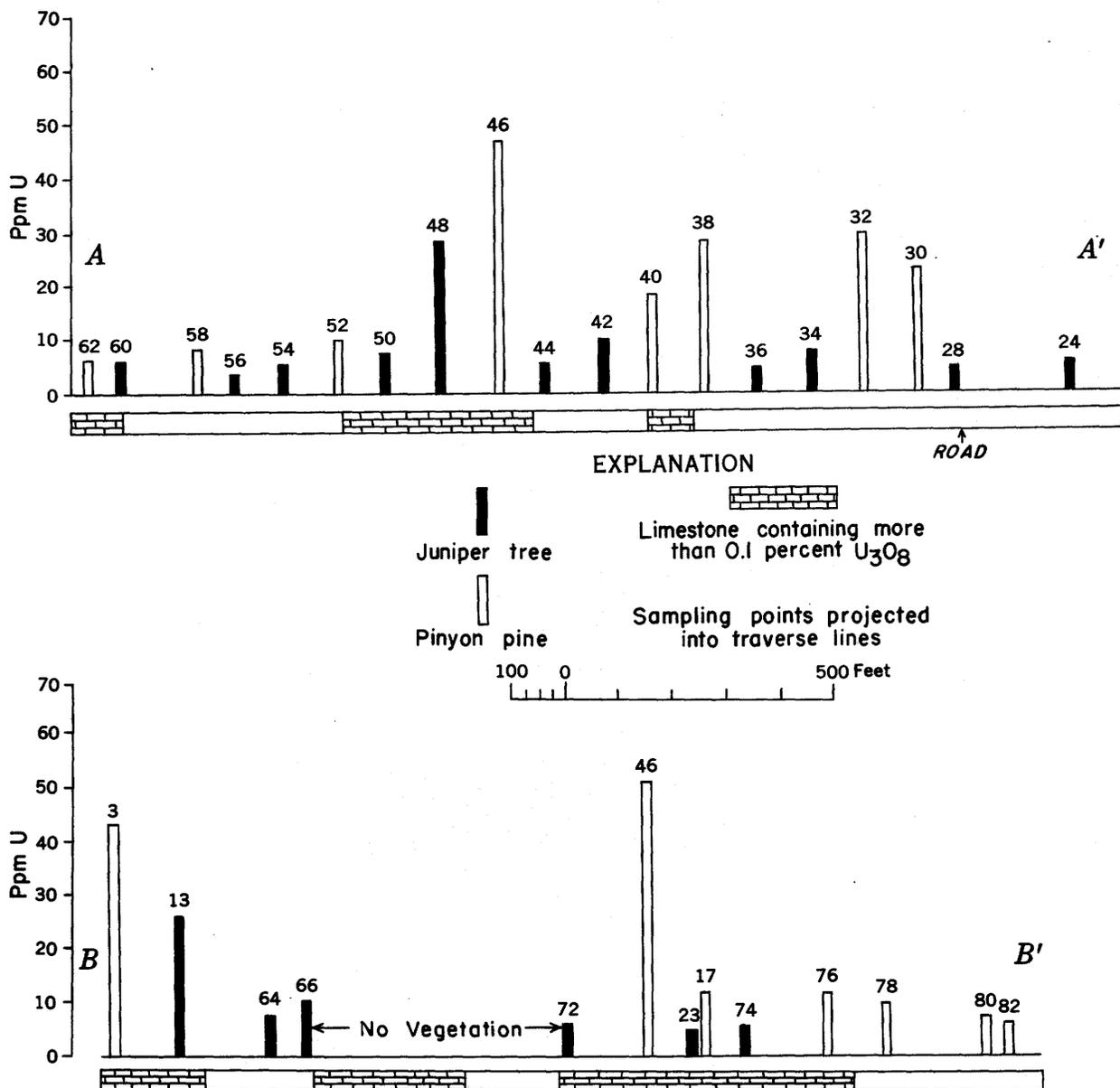


Figure 4.—Diagram showing uranium content of trunkwood collected along traverses A-A' and B-B' in sec. 19, T. 13 N., R. 10 W.

traverses or on a grid pattern. Wood from the branches or trunk of the trees is a favorable sampling medium. One hundred milligrams of dried wood or needles are needed for an analysis by the fluorimetric method. Thirty samples per day can be collected and charted by a two-man party, and a similar number can be analyzed by a chemist in a centrally located laboratory.

The occurrence of selenium-indicating *Astragalus* plants on the Westwater Canyon sandstone member of the Morrison formation at Poison Canyon and also in the Laguna Indian Reservation suggests that the mapping of the occurrence of these plants on the beds of the Morrison is a feasible method of prospecting for uranium.

Areas of plants occurring on colluvium and along appropriate stream drainage as well as areas of plants closely associated with the outcrop of the ore-bearing beds should be investigated.

LITERATURE CITED

Baker, A. A., Dane, C. H., and Reeside, J. B., Jr., 1947, Revised correlation of Jurassic formations of parts of Utah, Arizona, New Mexico, and Colorado: Am. Assoc. Petroleum Geol. Bull., v. 31, p. 1664-1668.

- Cannon, H. L., 1952, The effect of uranium-vanadium deposits on the vegetation of the Colorado Plateau: Am. Jour. of Science, v. 250, p. 735-770.
- Darton, N. H., 1928, "Red Beds" and associated formations in New Mexico: U. S. Geol. Survey Bull. 794, 356 p.
- Gregory, H. E., 1917, Geology of the Navajo country: U. S. Geol. Survey Prof. Paper 93, 161 p.
- Hoover, W. B., 1950, New Mexico Geol. Soc. Guidebook of the San Juan Basin, New Mexico and Colorado, p.77.
- Grimaldi, Frank, Ward, F. N., and Kreher, Ruth, 1950, A direct quantitative fluorimetric method for determining small amounts of uranium in the field and laboratory: U. S. Geol. Survey Trace Elements Investigations Rept. 98.
- Gruner, J. W., and Gardiner, Lynn, 1951, The mineralogy of the uranium deposits of the Grants area, New Mexico: Progress report, Contract AT-(30-1) 610, Atomic Energy Commission.
- Reyner, M. L., and Sheridan, M. J., 1950, Preliminary report on uranium deposits in McKinley and Valencia Counties, near Grants, New Mexico: Spokane Ext. Activity Rept., Atomic Energy Commission.

UNPUBLISHED REPORTS

- Evans, T. O., Exploration of uranium deposits sec. 19, T. 13 N., R. 10 W., N. M. B. & P. M. near Grants, New Mexico: Company report, Atchison, Topeka, and Santa Fe Ry., 1950.