Geology and Mineralogy

This document consists of 57 pages,
plus 1 figure.
Series A

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

# INTERIM REPORT ON BOTANICAL PROSPECTING FOR URANIUM IN THE SHINARUMP CONGLOMERATE AT DEER FLAT, WHITE CANYON DISTRICT, SAN JUAN COUNTY, UTAH*

By

A. J. Froelich and F. J. Kleinhampl



September 1955

Trace Elements Investigations Report 564

This preliminary report is distributed without editorial and technical review for conformity with official standards and nomenclature. It is not for public inspection or quotation.

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

USGS - TEI-564

GEOLOGY AND MINERALOGY

| Distribution (Series A) | No. of copies |
| --- | --- |
| Atomic Energy Commission, Washington | 2 |
| Division of Raw Materials, Albuquerque | 1 |
| Division of Raw Materials, Austin | 1 |
| Division of Raw Materials, Butte | 1 |
| Division of Raw Materials, Casper | 1 |
| Division of Raw Materials, Denver | 1 |
| Division of Raw Materials, Hot Springs | 1 |
| Division of Raw Materials, Ishpeming | 1 |
| Division of Raw Materials, Phoenix | 1 |
| Division of Raw Materials, St. George | 1 |
| Division of Raw Materials, Salt Lake City | 1 |
| Division of Raw Materials, Washington | 3 |
| Exploration Division, Grand Junction Operations Office | 6 |
| Grand Junction Operations Office | 1 |
| Technical Information Service, Oak Ridge | 6 |
| U. S. Geological Survey: | |
| Fuels Branch, Washington | 1 |
| Geochemistry and Petrology Branch, Washington | 1 |
| Geophysics Branch, Washington | 1 |
| Mineral Deposits Branch, Washington | 2 |
| P. C. Bateman, Menlo Park | 1 |
| A. L. Brokaw, Grand Junction | 2 |
| N. M. Denson, Denver | 1 |
| V. L. Freeman, College | 1 |
| M. R. Klepper, Spokane | 1 |
| A. H. Koschmann, Denver | 1 |
| J. D. Love, Laramie | 1 |
| L. R. Page, Washington | 1 |
| R. L. Griggs, Albuquerque | 1 |
| Q. D. Singewald, Beltsville | 1 |
| A. E. Weissenborn, Spokane | 1 |
| TEPCO, Denver | 2 |
| TEPCO, RPS, Washington, (including master) | 2 |
| | 49 |

## CONTENTS



## ILLUSTRATIONS

# TABLES

# INTERIM REPORT ON BOTANICAL PROSPECTING FOR URANIUM IN THE SHINARUMP CONGLOMERATE AT DEER FLAT, WHITE CANYON DISTRICT, SAN JUAN COUNTY, UTAH

By A. J. Froelich and F. J. Kleinhampl

## ABSTRACT

The plant analysis method of botanical prospecting for concealed uranium deposits was employed from May to July 1953, in the Deer Flat area, White Canyon district, San Juan County, Utah. About 2,000 branch tip samples of junipers and pinyons were systematically collected along more than 27 miles of Triassic Shinarump conglomerate or laterally equivalent units and were analyzed in the laboratory for uranium content. Anomalously large amounts of uranium absorbed by trees imply a nearby source, which may be an ore deposit. The indicator plant method of prospecting did not prove very useful in the Deer Flat area and supplements the plant analysis method only rarely.

Botanically defined anomalies occur at all major known deposits at Deer Flat. Other botanically defined anomalies may reflect previously unknown mineralized parts of the Shinarump conglomerate. The distribution of botanical anomalies suggests that the southern half of the Deer Flat area is much more favorable for concealed uranium deposits than the northern half.

Further work by the U. S. Geological Survey is needed at the Deer Flat to test the validity of the plant analysis method of prospecting for uranium. The finding of mineralized ground at botanical anomalies would verify the anomalies, showing how reliable the botanical prospecting method is in defining mineralized areas.

# INTRODUCTION

The plant analysis method of uranium prospecting depends on the absorption by plants of abnormally large amounts of uranium if large concentrations of these elements are available.

The indicator plant method of prospecting relies on the close relationship between selenium- and sulfur-indicator plants and uraniferous ground on the Colorado Plateau, where selenium and sulfur are often associated with uranium. In the Deer Flat area, however, this prospecting method proved ineffective because the copper-uranium ores of the area are extremely low in selenium, and sulfur is an ubiquitous element.

The purpose of prospecting by the plant analysis method in the Deer Flat area was to indicate localities favorable for the occurrence of uranium deposits in advance of physical exploration, thereby reducing the cost of such exploration. This prospecting was done by the U. S. Geological Survey on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission. The field work on which this report is based was begun in May 1953, and completed in mid-July 1953.

Field work was done by Edward E. Clebsch, Warren R. Martin, Perry F. Narten, and Hal Hubbard.

Analyses for uranium in the plant ash were made by Claude Huffman, Jr., E. J. Fennelly, G. T. Burrow, I. C. Frost, and J. A. Patten of the Geological Survey Laboratory in Denver, Colorado.

## GEOGRAPHY

Deer Flat, a gently sloping bench on the southwest flank of Elk Ridge, is in the White Canyon mining district, San Juan County, Utah (fig. 1). As used in this report, the Deer Flat area includes the eastern portion of Pinyon Point, Hideout Canyon, Deer Flat, Deer Canyon, and Upper Lost Parks (fig. 2). The area under consideration is roughly 7 miles long by 6 miles wide and includes parts of Tps. 35 and 36 S., Rs. 17 and 18 E., Salt Lake meridian.

The climate is semiarid. Pinyon and juniper are the most abundant woody vegetation. Black sage, scrub oak, buffaloberry, serviceberry, and mountain mahogany, all woody plants, are common locally, as are legumes and other herbaceous plants.

Deer Flat is accessible by a graded dirt road, about 16 miles long, which joins Utah Highway 95 on Grand Flat about 35 miles west of Blanding, Utah (fig. 1). Another road, 13 miles long, connects with old Utah Highway 95 about 32 miles west of Blanding.

## GEOLOGY

Sedimentary rocks that crop out in the Deer Flat area range in age from Permian to Upper Triassic. They form part of the west flank of the Monument upwarp and strike N. 15° to 45° W. and dip 1° to 7° SW (Finnell and others, 1954, p. 7, unpublished structure contour map of the area). Rocks exposed include the Cedar Mesa sandstone, the Organ Rock, and the Hoskinnini tongues of the Permian Cutler formation; the Lower and Middle(?) Triassic Moenkopi formation; and the Upper Triassic Shinarump conglomerate and Chinle formation.

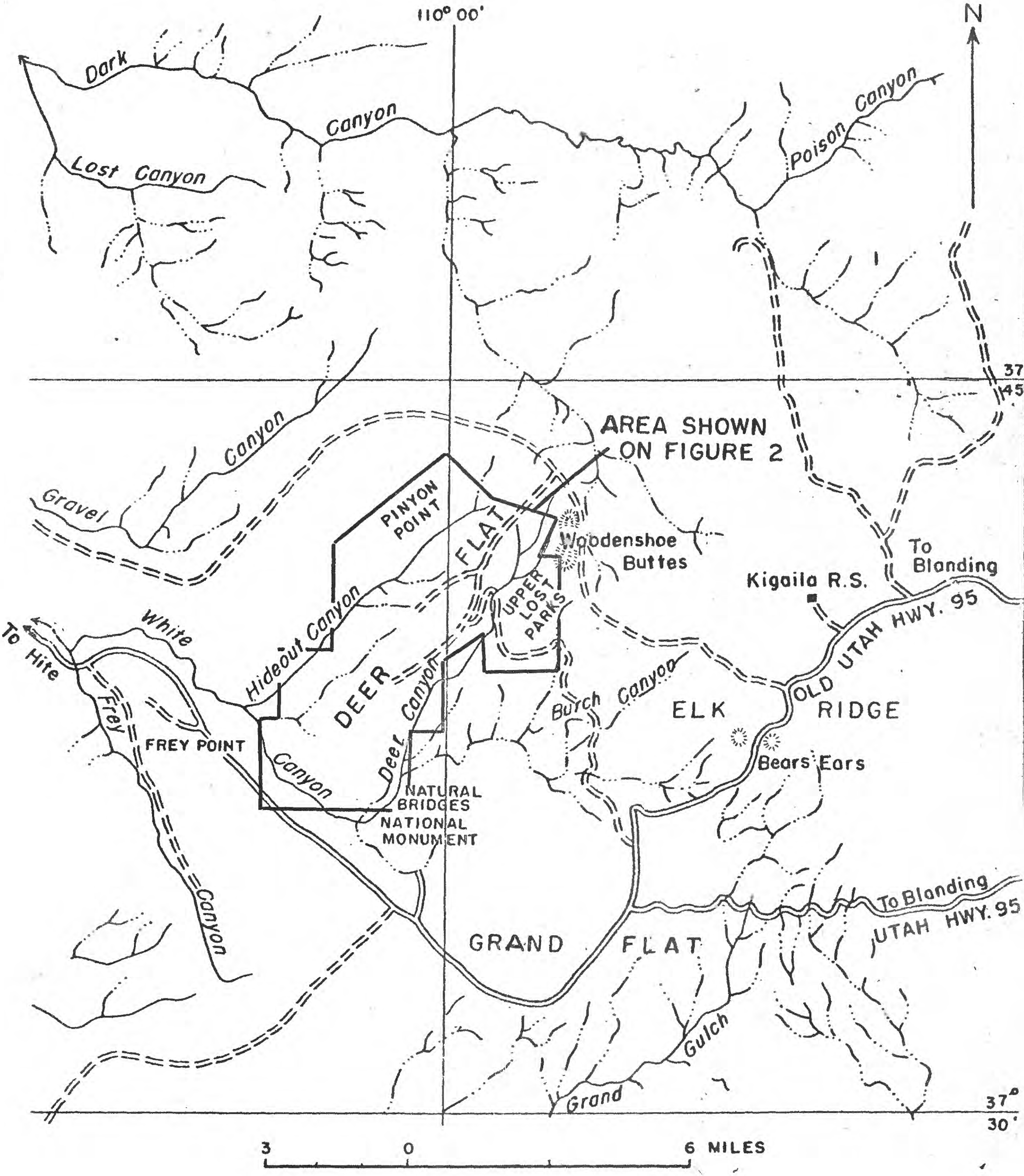



Figure 1. INDEX MAP SHOWING LOCATION OF DEER FLAT AREA, WHITE CANYON DISTRICT, SAN JUAN COUNTY, UTAH.

The Shinarump conglomerate, the principal ore-bearing formation in this district, rests unconformably on upper Moenkopi beds which commonly are bleached or altered at the contact. Figure 2 shows the approximate position of the top of the Moenkopi formation. The Shinarump of the Deer Flat area is generally a ledge-forming, cross-laminated coarse- to medium-grained sandstone with interbedded lenses of sandy conglomerate, sandy siltstone, and gray carbonaceous clay. Some lenses contain sandstone, chert, and limestone pebbles; silicified and carbonized wood fragments; clay balls; altered volcanic ash; and fragments of reworked Moenkopi siltstone (Granger and Beroni, 1950, p. 8; Benson and others, 1952, p. 4; Finnell and others, 1952, p. 8).

The lenticularity of the Shinarump in the Deer Flat area is its most striking characteristic. The Shinarump is absent at many places in the northern part of the area, and where present, beds 30 feet or more thick may thin to a feather edge within 1,000 feet. Thickening of the Shinarump has resulted from filling of channels at its irregular basal contact, and from thickening of sandstones above, with a resultant thinning of overlying Chinle shales. A maximum thickness of 75 feet is reported in White Canyon (Benson and others, 1952, p. 4), but the Shinarump rarely exceeds 40 feet in thickness at Deer Flat. The Shinarump ranges in altitude from 6,400 feet in the southwestern part of Deer Flat to 7,700 feet in the northern portion.

The Chinle formation rests conformably on the Shinarump conglomerate, and where the latter is absent rests directly on the Moenkopi formation. The upper part of the Chinle is missing, and the portion of the formation in the area ranges in thickness from about 220 to 245 feet. The Chinle in this area consists of two members-- a resistant cliff-forming sandstone and conglomerate sequence 10 to 100 feet thick, forming the cap rock of Deer Flat, and the underlying slope-forming member. The lower member consists of gray clay, variegated shale and siltstone, and lenticular beds of sandstone and conglomerate. A persistent bench-forming, thin-bedded sandstone occurs within the Monitor Butte member throughout the Deer Flat area, about 50 feet below the Moss Back member. Reddish jasper and chert fragments consistently occur in talus rubble at a horizon about 100 feet below the Moss Back.

The uranium-copper deposits of the Deer Flat area occur principally in the lower part of the Shinarump conglomerate where the Shinarump fills scour channels in the Moenkopi formation, but minor amounts of mineralized rock occur in the upper siltstones of the Moenkopi and the lower units of the Chinle formation. The uranium-copper deposits appear to be localized in porous scour channels where fractures offered access to these channels; ore minerals are concentrated near favorable lithologic or chemical constituents of the Shinarump. The Shinarump uranium deposits are irregular, lenticular or spotty, and low-grade, consisting of primary and secondary uranium minerals and iron and copper sulfides, sulfates, and carbonates. In order of abundance the uranium minerals occur chiefly as replacements of wood, as impregnations in sandstone and conglomerate, in clay stringers, at lighologic contacts, and at or near fractures.

The Hideout mine deposit and the Dead Buck claim deposit, two of the most promising deposits at Deer Flat, are closely associated with brecciated, highly porous and permeable Shinarump scour channel deposits.

Organic matter in the Shinarump has probably influenced mineralization in some places, as both copper and uranium minerals replace logs and other carbonaceous material.

## BOTANICAL PROSPECTING

Two principal methods of botanical prospecting have been applied to the search for uranium deposits in the Colorado Plateau region; the plant analysis method and the indicator plant method. These methods differ in application. By the former method, plants must be sampled and analyzed chemically before any abnormal concentrations of elements can be determined, whereas indicator plants themselves are a guide to abnormal concentrations of particular elements in the soil because large amounts of these elements are essential to continued life of the plants.

Inasmuch as selenium and sulfur are commonly associated with uranium and vanadium in the ore deposits, selenium- and sulfur-indicator plants have been used as indicators of mineralized ground in the Colorado Plateau region (Cannon, 1951a, p. 5-7; 1951b, p. 10; 1952, p. 737, 760-767; and 1954, p. 218). However, selenium-indicator plants are rare at Deer Flat probably because the copper-uranium ores of the area are extremely low in selenium (Appendix B, No. 1). Sulfur-indicator plants serve best as indicators of uranium deposits where the sulfur is associated only with ore minerals. An essential element to plants, sulfur in the form of a sulfate is absorbed into the root system. Ubiquitous gypsum in beds above and below the ore-bearing Shinarump makes sulfur-indicator plants useless in prospecting in the Deer Flat area.

Partial plant lists prepared by E. E. Clebsch during ecologic studies in several small areas on the upper Moenkopi formation, Shinarump conglomerate, and the lower part of the Chinle formation show the general types of plants growing on Deer Flat (Appendix A). Both selenium- and sulfur-indicators are much more common on the lower Chinle mudstones than on the Shinarump sandstones and the upper Moenkopi siltstones.

The plant analysis method of botanical prospecting is based on the absorption and accumulation of uranium by deep-rooted plants growing on shallow uraniferous deposits. Cannon (1951a, 1951b, 1952, and 1953) demonstrated that junipers and pinyons, where rooted in mineralized ground, absorb significant amounts of uranium, thereby indicating areas favorable for further investigations. The uranium is absorbed through the roots, and detectable amounts are transferred to the twigs and leaves by the life processes of the plants. The moisture content of the ore bed and of intervening beds is the prime controlling factor in the absorption of uranium from ore bodies by plants, but the amount absorbed varies with the species, part of plant sampled, time of year, availability of uranium in the soil, and the structural nature and chemical composition of the country rock. However, the usefulness of the plant analysis method is limited by the depth to which plant roots will penetrate. Cannon (1952, p. 747) stated that under favorable conditions juniper roots will penetrate 20 to 30 or more feet of sandstone to an ore-bearing bed, if that bed is also the only aquifer.

The plant analysis method for large-scale botanical prospecting has been made practical by the development of a sensitive method for detecting extremely small amounts of uranium in plant ash (Grimaldi and others, 1952 and 1954, parts 1 and 9). In this method plant samples are ground and mixed thoroughly, oven dried, quartered, ashed, predigested in nitric acid, quenchers extracted in ethyl acetate, and the evaporated residue fluorimetrically analyzed for uranium content. The results are reported as parts per million (ppm) uranium in the ash. This analytical method makes the plant analysis absorber method practical for large-scale botanical prospecting.

Cannon (1952, p. 748) has shown that contamination of trees, sampled in areas of active mining, introduces a source of error in comparative analysis. Contamination near mine entrances and along ore-haulage routes have made anomalous amounts of uranium available to nearby trees. The highest uranium content in ash is consistently obtained from trees growing on or near known deposits which were recently worked or were being mined at the time of sampling.

Washing of samples, though helpful in removing the effects of surface uranium contamination, generally does not alter the results significantly. Most analyses of washed samples fall within the limits of analytical error of the same samples unwashed. The assay values obtained from trees in areas of mining activity are unreliable for comparative purposes, as the uranium in wind-blown uranium-bearing material is apparently converted to a form readily available to plants. Indicator plant occurrences along access roads may reflect the increased availability of originally contained sulfur and selenium in newly disturbed ground, or the presence of contaminating material.

## Field methods at Deer Flat

Branch tip samples of the Utah juniper (Juniperus utahensis Engelm.) were collected over most of Deer Flat, but in areas of greatest altitude or high moisture content where the Utah juniper was absent, plants sampled were the Rocky Mountain juniper (J. scopulorum Sarg.), pinyon pine (Pinus edulis Engelm.), Douglas fir (Pseudotsuga taxifolia Britton), and buffaloberry (Shepherdia rotundifolia Parry). Most sampled plants are directly comparable in uranium content, but locally buffaloberry samples assayed much higher than nearby junipers. The significance of the buffaloberry assays is not yet known.

About 2,000 branch tip samples were collected along about 27 miles of Shinarump conglomerate or related rock units surrounding Deer Flat. Trees were selected at 200-foot intervals where the Shinarump is exposed, at 50-foot intervals were covered by rubble or vegetation, and at 100-foot intervals where the Shinarump is absent. The ore-bearing beds, where sampled, crop out only along walls of canyons, and sampling was therefore restricted to a single traverse line along the top of the Shinarump where the unit generally forms only a narrow bench or to a single traverse line along steep slopes where the Shinarump is absent.

A 1-quart container was filled with branch tips (twigs and needles) collected from around the entire periphery of a tree selected for sampling. Sampled trees were tagged, labeled, and located as accurately as possible on topographic base maps from aerial photographs.

A representative suite of rock samples was collected from barren layers of upper Moenkopi, Shinarump, and lower Chinle outcrops, as well as mineralized Shinarump samples from most known prospects. The rocks were analyzed for uranium, equivalent uranium, vanadium, and selenium in order to provide background information on the relative ability of plant species to absorb these elements (Appendix B).

The plants sampled in the Deer Flat area show a variation in uranium content that reflects the amount of subsurface uranium. The minimum uranium content in sampled plants for indicating mineralized ground was established in the field by comparing uranium assays from trees growing over mineralized ground in the Shinarump with assays from trees growing over apparently barren ground. Other test samples were collected up slope on the Chinle in an attempt to acquire information on the trend of the mineralized part of the Shinarump and on depth of root penetration.

Botanical anomalies are tentatively defined as those areas indicated by sampled trees whose branch tips contain 1.0 ppm or more uranium in the ash[/], and the anomalous areas are regarded as indicating

---

[/] All uranium contents of plants reported in this text are in ppm uranium in plant ash, but for simplicity the words "in plant ash" are omitted.

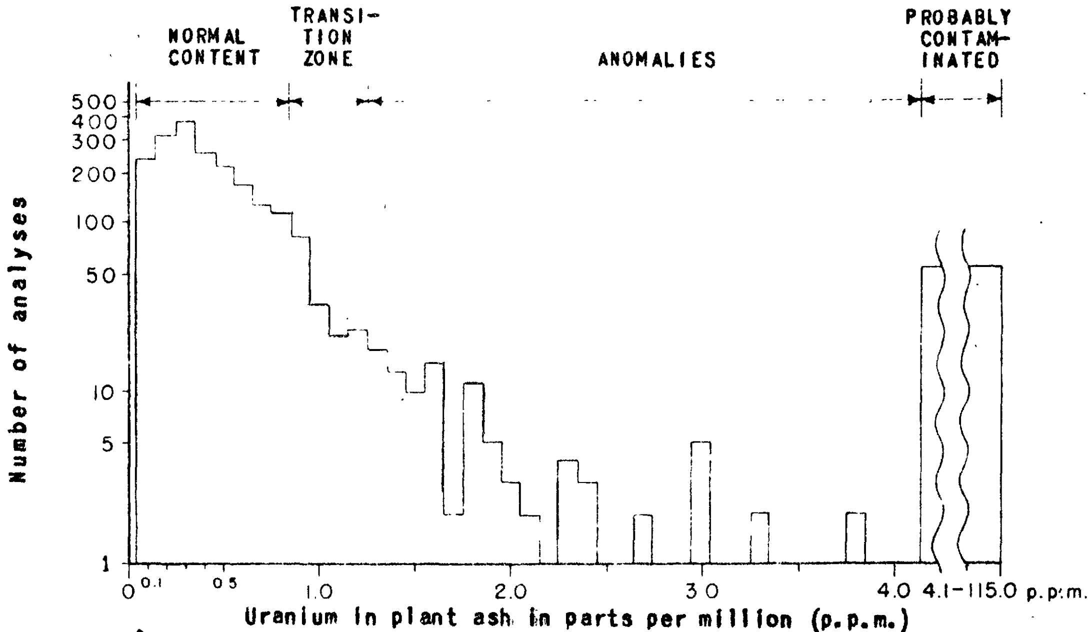
---

mineralized ground. This value is partly substantiated by values employed in previous plant studies (Narten, 1953, p. 10). A graph of assay results from Deer Flat plotted against the total number of assays shows that most samples assayed less than 1.0 ppm uranium (fig. 3A, B). Although the anomaly cutoff value has not been statistically picked in the Deer Flat area, the graph and empirical data from field tests suggest that 1.0 ppm uranium would be at or near a statistically derived value. For example, good positive correlation exists between botanical and geologic evaluations of Deer Flat localities with respect to their relative favorableness for the occurrence of uranium (table 1).

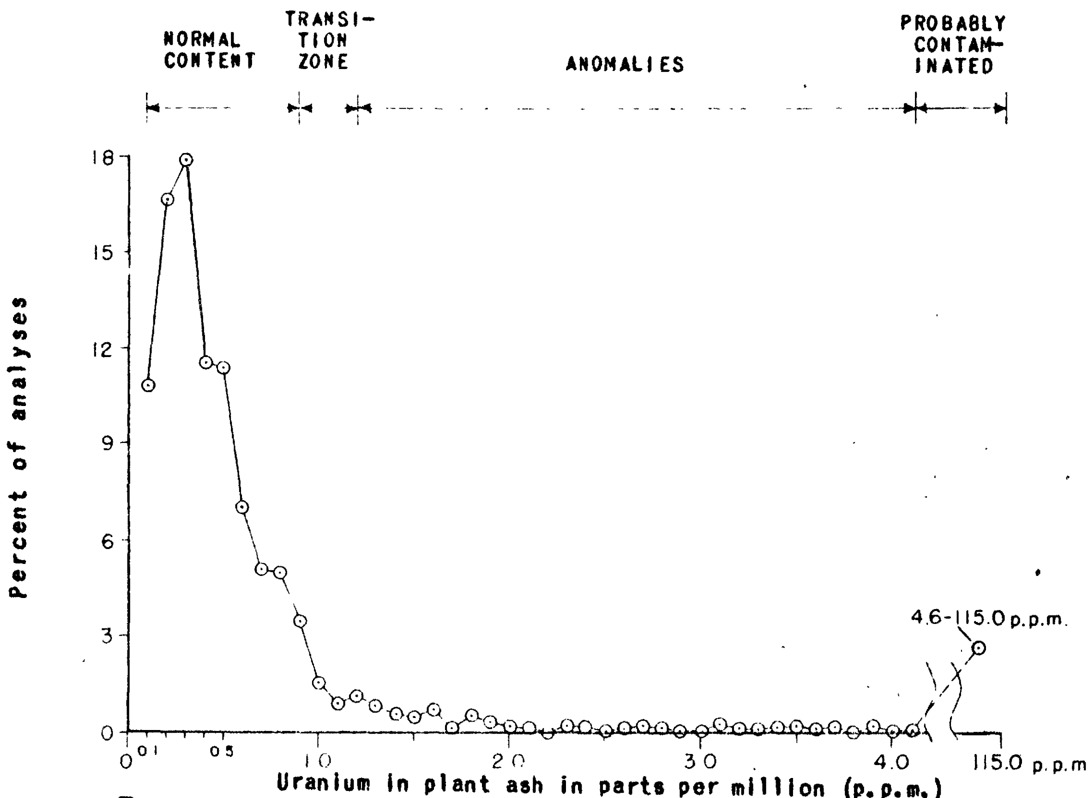
Table 1.--Botanical and geologic evaluation of relative favorableness for the occurrence of uranium in six localities in the Deer Flat area, White Canyon district, San Juan County, Utah

| Locality | Geological favorableness | Botanical favorableness |
|---|---|---|
| 1. Pinyon Point--Head of Hideout Canyon locality | Unfavorable | Semifavorable-unfavorable |
| 2. Head of Deer Canyon locality | Semifavorable | Semifavorable |
| 3. Upper Lost Parks locality | Very favorable | Very favorable |
| 4. Hideout locality | Very favorable | Very favorable |
| 5. Dead Buck locality | Very favorable | Very favorable |
| 6. Southern Deer Flat locality | Very favorable | Very favorable |

In areas remote from mines and prospects where windblown contamination is negligible, anomalous uranium contents of plants range from 1.0 to 5.4 ppm, whereas contents are less than 0.6 ppm. These anomalous values contrast markedly with concentrations of 8.0 to 115.0 ppm contained by plants in areas where windblown contamination is suspected. The lower values seem more reliable and appear to be a more valid guide in prospecting at Deer Flat than the extremely high but erratic values.




A. HISTOGRAM OF BRANCH TIP ANALYSES FROM DEER FLAT AREA (plotted on semilogarithmic scale and based on 2,046 analyses)




B. GRAPH OF PERCENT OF TOTAL ANALYSES VERSUS ANALYTICAL VALUES, DEER FLAT AREA (based on 2,046 analyses)

Figure 3. GRAPHICAL REPRESENTATION OF PLANT ANALYSIS, DEER FLAT AREA, WHITE CANYON DISTRICT, SAN JUAN COUNTY, UTAH.

Considerable caution must be exercised in the interpretation of botanical assay data, especially where anomalies are indicated by analyses of single, isolated trees. L. B. Riley of the U. S. Geological Survey Denver Laboratory (personal communication) stated that the expected precision for assay values of 0.3 to 5.0 ppm is a standard deviation of 0.5 ppm; however, field checks and preliminary statistical studies indicate that the precision is generally much better. In addition to the probable error in the analytical technique, uranium-bearing surface drainage or ground water may also result in botanical anomalies where no mineralized rock occurs. Narten (1953, p. 5) stated that under certain conditions anomalous amounts of uranium will be absorbed by trees growing above weakly mineralized ground; thus it is to be expected that some botanical anomalies will occur where there are no deposits of ore grade.

The descriptive term "significant," as applied to botanical anomalies in the section "Results of botanical prospecting at Deer Flat" serves to differentiate those botanical anomalies within one locality considered favorable for the occurrence of uranium ore deposits. A significant anomaly is not synonomous with a good anomaly; however, most significant anomalies are good anomalies. The best possible botanical anomaly doesn't necessarily contain minable quantities of uranium, but theoretically has, to an optimum degree of favorableness, the greatest number of the following features: tree samples with uranium contents above 1.0 ppm; consecutively or adjacently sampled trees with abnormally large uranium contents; abnormally high radioactivity; and geologic features, such as visible uranium or copper minerals, carbon, and channel-fill sandstones of the Shinarump conglomerate. Although abnormally high radioactivity and visible uranium or copper minerals are themselves guides to uranium deposits on Deer Flat, these guides could not always be discerned before they were emphasized by the broader guide of plants containing anomalously large amounts of uranium. Those botanical anomalies that on reinspection have no visible ore minerals or abnormally high radioactivity are considered poorer anomalies than ones with these guides.

## Results of botanical prospecting at Deer Flat

Results of botanical prospecting by the plant analysis method at Deer Flat are encouraging. Anomalies, defined by plants containing 1.0 or more ppm uranium, occurred above most known mineralized parts of the Shinarump conglomerate and in many other places. The anomalies not associated with known mineralized ground may indicate that the ground is underlain by uranium minerals, and they suggest new areas to be tested by drilling. Direct contamination of trees by dust in disturbed areas was negligible as most samples showed only slight variation after washing. The effects of contamination of the ground and subsequent absorption by trees could not be evaluated, but this type of contamination probably occurs.

For the purpose of reporting results of this study the Deer Flat area is divided into six contiguous localities (fig. 2). Specific botanical anomalies and the relative favorableness for the occurrence of uranium in each locality are discussed in the following portion of the text. Favorableness has been determined by both geological and botanical prospecting data.

Figure 2 and table 2 present information essential for locating ground defined by the plant analysis method as favorable for the occurrence of uranium. A few reference trees designated by their sample numbers appear on the map (fig. 2) to facilitate finding tagged and numbered trees in the field. Dashed circles and numbers on leaders refer to specific botanical anomalies discussed by locality in the report. Table 2 lists by locality, specific numbered anomaly, and sample numbers all trees containing significantly anomalous or near- anomalous amounts of uranium.

Table 2.--List of trees containing significantly anomalous or near-anomalous amounts of uranium arranged as they appear on the map (fig. 2) and in the text by locality, specific numbered anomaly and sample numbers.

Pinyon Point--Head of Hideout Canyon

| Anomaly No. | Sample No. | | | | Kind of tree[1] | Uranium assay value ppm in ash |
|---|---|---|---|---|---|---|
| 1 | WRM[2] | -53[3] | -409 | | J | 1.6 |
| | AJF | -53 | -999 | | J | 1.1 |
| | | | -1001 | | J | 0.9 |
| 2 | WRM | -53 | -414 | (AJF-53-994) | J | 1.8 |
| | AJF | -53 | -995 | | J | 1.0 |
| | | | -996 | | J | 1.1 |
| | | | -997 | | J | 1.3 |
| 3 | WRM | -53 | -488 | | J | 0.9 |
| 4 | WRM | -53 | -522 | | J | 1.5 |
| 5 | WRM | -53 | -551 | | J | 1.0 |
| 6 | WRM | -53 | -567 | | J | 0.8 |
| | | | -570 | | J | 0.9 |
| | | | -571 | | J | 0.9 |
| | | | -572 | | J | 0.8 |
| | | | -573 | | J | 0.9 |
| | | | -574 | | J | 0.9 |
| 7 | WRM | -53 | -584 | | J | 1.3 |
| | | | -585 | | J | 0.8 |
| | | | -586 | | J | 0.8 |
| | | | -588 | | J | 0.9 |
| | | | -589 | | J | 0.8 |
| 8 | WRM | -53 | -284 | | J | 1.0 |
| 9 | WRM | -53 | -213 | | J | 1.5 |
| 10 | WRM | -53 | -199 | | J | 1.4 |
| 11 | WRM | -53 | -192 | | J | 1.1 |
| 12 | WRM | -53 | -684 | | J | 1.0 |
| 13 | WRM | -53 | -168 | | J | 1.0 |

1/ J = Juniper; P = Pinyon; B = Buffaloberry
2/ Collector's initials
3/ Year sample collected

Table 2.--A list of trees containing significantly anomalous or near-anomalous amounts of uranium--Continued.

Head of Deer Canyon locality

| Anomaly No. | Sample No. | Kind of tree[1/] | Uranium assay value ppm in ash |
|---|---|---|---|
| 1 | AJF -53 -1015 | J | 1.3 |
| | -1016 | J | 1.0 |
| 2 | WRM -53 -903 | J | 1.1 |
| | -904 | J | 1.0 |
| 3 | WRM -53 -916 | J | 1.3 |
| 4 | WRM -53 -979 | J | 1.8 |
| | -981 | J | 0.8 |
| | -1113 | J | 1.0 |

Upper Lost Parks locality

| Anomaly No. | Sample No. | Kind of tree[1/] | Uranium assay value ppm in ash |
|---|---|---|---|
| 1 | WRM -53 -1071 | J | 0.8 |
| | -1072 | J | 0.9 |
| | -1075 | J | 0.8 |
| | -1077 | J | 0.9 |
| | -1078 | J | 0.9 |
| 2 | WRM -53 -1025 | J | 2.4 |
| | -1026 | J | 1.1 |
| | AJF -53 -959 | J | 1.9 |
| | -960 | P | 7.1 |
| | -961 | J | 2.4 |
| | -962 | P | 4.1 |
| | -963 | P | 2.2 |
| | -964 | P | 2.8 |
| | -965 | P | 8.8 |
| | -966 | J | 2.8 |
| | -967 | J | 2.0 |
| | -968 | J | 1.4 |
| | -969 | J | 1.7 |
| | -970 | J | 1.5 |
| | -971 | J | 1.2 |
| 3 | WRM -53 -1144 | J | 1.3 |
| 4 | WRM -53 -1158 | J | 6.7 |
| | -1159 | J | 3.2 |
| | -1160 | J | 4.8 |
| | -1161 | J | 1.2 |

Table 2.--A list of trees containing significantly anomalous or near-anomalous amounts of uranium--Continued.

Upper Lost Parks locality--Continued

| Anomaly No. | Sample No. | | | Kind of tree[1] | Uranium assay value ppm in ash |
|---|---|---|---|---|---|
| 5 | WRM | -53 | -1166 | J | 1.0 |
| | | | -1167 | J | 0.8 |
| | | | -1169 | J | 1.0 |
| 6 | WRM | -53 | -1191 | J | 1.2 |

Hideout locality

| Anomaly No. | Sample No. | | | Kind of tree[1] | Uranium assay value ppm in ash |
|---|---|---|---|---|---|
| 1 | EEC | -53 | -1 | J | 1.2 |
| | | | -2 | J | 1.6 |
| | | | -3 | J | 8.0 |
| | | | -4 | J | 56.0 |
| | | | -5 | J | 1.3 |
| | | | -7 | J | 1.3 |
| | | | -8 | J | 1.6 |
| | | | -9 | J | 2.3 |
| | | | -10 | J | 1.1 |
| | | | -11 | J | 0.9 |
| | | | -12 | J | 1.1 |
| | WRM | -53 | -232 | J | 10.0 |
| | | | -233 | J | 53.0 |
| | | | -234 | J | 77.0 |
| | | | -235 | J | 71.0 |
| | | | -236 | J | 38.0 |
| | | | -237 | J | 77.0 |
| | | | -238 | J | 45.0 |
| | | | -239 | J | 33.0 |
| | | | -240 | P | 54.0 |
| | | | -241 | J | 11.0 |
| | | | -242 | J | 11.0 |
| | | | -243 | J | 15.0 |
| | | | -244 | J | 6.0 |
| | | | -245 | J | 18.0 |
| | | | -246 | J | 19.0 |
| | WRM | -53 | -1116 | J | 1.5 |
| | | | -1117 | J | 0.8 |
| | | | -1123 | J | 0.8 |
| | | | -1124 | J | 2.0 |
| | | | -1125 | J | 2.4 |
| | | | -1126 | J | 9.2 |
| | | | -1127 | J | 11.0 |
| | | | -1128 | J | 1.4 |
| | | | -1129 | J | 1.0 |

Table 2.--A list of trees containing significantly anomalous or near-anomalous amounts of uranium--Continued.

Hideout locality--Continued

| Anomaly No. | Sample No. | | | Kind of tree1/ | Uranium assay value ppm in ash |
|---|---|---|---|---|---|
| 1--Continued | AJF | -53 | -955 | J | 15.3 |
| | | | -956 | J | 18.2 |
| | | | -957 | J | 18.0 |
| | | | -958 | J | 22.5 |
| 2 | EEC | -53 | -18 | J | 0.9 |
| | | | -19 | J | 1.5 |
| | | | -20 | J | 0.8 |
| 3 | EEC | -53 | -24 | J | 1.3 |
| | | | -25 | J | 0.8 |
| | AJF | -53 | -992 | J | 1.1 |
| | EEC | -53 | -27 | J | 1.3 |
| | | | -28 | J | 1.4 |
| | | | -30 | J | 1.5 |
| | | | -31 | J | 2.3 |
| 4 | EEC | -53 | -37 | J | 1.6 |
| 5 | EEC | -53 | -51 | J | 1.1 |
| | | | -52 | J | 2.7 |
| | | | -53 | J | 3.7 |
| | | | -54 | J | 1.4 |
| | | | -55 | J | 1.8 |
| | | | -176 | J | 0.9 |
| | | | -178 | J | 0.9 |
| | | | -179 | J | 1.2 |
| | | | -180 | J | 0.9 |
| | | | -181 | J | 0.9 |
| | | | -182 | J | 0.8 |
| | | | -183 | J | 0.8 |
| | | | -185 | J | 0.9 |
| | | | -186 | J | 1.2 |
| | | | -187 | J | 1.1 |
| | | | -188 | J | 0.8 |
| | | | -189 | J | 1.0 |
| | | | -190 | J | 0.8 |
| | | | -191 | J | 0.9 |
| | | | -192 | J | 1.2 |
| | | | -193 | J | 0.8 |
| | | | -194 | J | 1.1 |
| | | | -195 | J | 1.4 |
| | | | -196 | J | 0.8 |

Table 2.--A list of trees containing significantly anomalous or near-anomalous amounts of uranium--Continued.

Hideout locality--Continued

| Anomaly No. | Sample No. | Kind of tree[1] | Uranium assay value ppm in ash |
|---|---|---|---|
| 6 | EEC -53 -158 | J | 1.2 |
| 7 | EEC -53 -197 | J | 0.9 |
| | -198 | J | 2.7 |
| | -199 | J | 0.8 |
| | -200 | J | 0.8 |

Dead Buck locality

| Anomaly No. | Sample No. | Kind of tree[1] | Uranium assay value ppm in ash |
|---|---|---|---|
| 1 | WRM -53 -121 | J | 1.1 |
| 2 | WRM -53 -112 | J | 0.9 |
| | -114 | J | 1.5 |
| | -116 | J | 0.9 |
| 3 | WRM -53 -92 | J | 1.2 |
| | -93 | J | 1.2 |
| | -95 | J | 1.3 |
| | -96 | J | 1.3 |
| | -98 | J | 1.0 |
| | -99 | J | 3.1 |
| | -100 | J | 1.1 |
| | -102 | J | 1.0 |
| | -103 | J | 1.7 |
| 4 | WRM -53 -82 | J | 1.4 |
| | -83 | J | 0.9 |
| | -84 | J | 1.1 |
| | -85 | J | 0.9 |
| 5 | WRM -53 -72 (AJF-53-1025) | J | 1.8 |
| | AJF -53 -1026 | J | 0.9 |
| 6 | WRM -53 -39 (AJF-53-1022) | J | 1.6 |
| | AJF -53 -1023 | J | 4.4 |
| 7 | WRM -53 -10 | J | 1.0 |

Table 2.--A list of trees containing significantly anomalous or near-anomalous amounts of uranium--Continued.

Dead Buck locality--Continued.

| Anomaly No. | Sample No. | Kind of tree[1] | Uranium assay value ppm in ash |
|---|---|---|---|
| 8 | H -53 -330 | J | 0.8 |
| | -331 | J | 0.8 |
| | -332 | J | 1.1 |
| | -333 | J | 0.8 |
| | -334 | J | 1.7 |
| | -335 | J | 1.8 |
| | -336 | J | 1.8 |
| | -337 | J | 1.4 |
| | -338 | J | 5.4 |
| | -339 | J | 2.4 |
| | -340 | J | 0.8 |
| | -341 | J | 1.0 |
| | -343 | J | 0.8 |
| | -344 | J | 2.3 |
| | -346 | J | 3.5 |
| | -347 | J | 4.0 |
| | -348 | J | 1.3 |
| | -349 | J | 1.0 |
| 9 | H -53 -318 | J | 1.0 |
| | -321 | J | 7.5 |
| | -322 | J | 1.4 |
| | -325 | J | 1.6 |
| 10 | H -53 -5 (AJF-53-1002) | J | 1.5 |
| | AJF -53 -1003 | J | 1.7 |
| | -1004 | J | 1.9 |
| 11 | H -53 -24 | J | 0.8 |
| | -25 | J | 0.9 |
| 12 | H -53 -34 | J | 0.9 |
| | -35 | J | 0.9 |
| 13 | H -53 -39 | J | 0.9 |
| | -40 | J | 0.8 |

Table 2.--A list of tress containing significantly anomalous or nera-anomalous amounts of uranium--Continued.

Southern Deer Flat locality

| Anomaly No. | Sample No. | Kind of tree[1] | Uranium assay value ppm in ash |
|---|---|---|---|
| 1 | EEC -53 -210 | J | 1.8 |
| 2 | EEC -53 -227 | J | 2.6 |
| | -228 | J | 1.3 |
| | -230 | J | 1.6 |
| 3 | EEC -53 -267 | J | 0.8 |
| | -268 | J | 1.0 |
| 4 | EEC -53 -278 | B | 9.3 |
| | -279 | J | 1.3 |
| | -280 | J | 0.9 |
| 5 | EEC -53 -301 | J | 1.2 |
| | -302 | J | 1.0 |
| | -303 | J | 1.0 |
| | -304 | J | 1.2 |
| | -305 | J | 0.9 |
| | -306 | B | 1.8 |
| 6 | EEC -53 -322 | J | 1.0 |
| | -323 | J | 1.2 |
| 7 | EEC -53 -327 | J | 1.2 |
| | -328 | J | 1.2 |
| | -329 | J | 3.4 |
| | -330 | J | 1.8 |
| | -331 | J | 1.2 |
| 8 | EEC -53 -335 | J | 1.2 |
| | -336 | B(?) | 8.9 |
| | -337 | J | 1.0 |
| 9 | H -53 -309 | J | 1.5 |
| | -311 | J | 1.1 |
| | -312 | J | 0.8 |
| | -313 | J | 1.0 |
| | -315 | J | 1.0 |
| | -317 | J | 1.3 |
| 10 | H -53 -279 | J | 2.1 |
| | -280 | J | 0.8 |
| | -281 | J | 0.8 |
| 11 | H -53 -221 | J | 0.9 |
| | -222 | J | 0.8 |

Table 2.--A list of trees containing significantly anomalous or near-anomalous amounts of uranium--Continued.

Southern Deer Flat locality--Continued

| Anomaly No. | Sample No. | Kind of tree[1] | Uranium assay value ppm in ash |
|---|---|---|---|
| 12 | AJF -53 -1011 (H-53-116) | J | 1.6 |
| | -1012 | J | 0.8 |
| 13 | H -53 -105 | J | 0.8 |
| | -106 (AJF-53-1006) | J | 1.6 |
| | -107 (AJF-53-1005) | J | 1.0 |
| | AJF -53 -1007 | J | 1.1 |
| 14 | H -53 -80 | J | 0.8 |
| | -81 | J | 0.9 |
| 15 | H -53 -64 | J | 0.9 |
| | -65 | J | 1.0 |
| 16 | H -53 -43 | J | 0.9 |
| | -44 | J | 0.9 |
| | -45 | J | 0.9 |

Pinyon Point--Head of Hideout Canyon locality

The Pinyon Point--Head of Hideout Canyon locality--includes parts of secs. 25, 26, 35, and 36, T. 35 S., R. 17 E.; secs. 1, 2, 3, 10, 11, 12, and 15, T. 36 S., R. 17 E.; and the western part of secs. 30 and 31 (unsurveyed), T. 35 S., R. 18 E. (fig. 2). The eastern part of the area is accessible by a dirt road which parallels the southeast wall of Hideout Canyon, and the western part of the area may be reached by means of a dirt road which extends across the northern half of Pinyon Point. There are no working mines in this area.

The Shinarump conglomerate is mostly absent. Scattered purple and gray sandstone, which may represent thin lenses of Shinarump occur at wide intervals along the talus and vegetation covered rim; but, in the NE 1/4 SE 1/4 sec. 25, T. 35 S., R. 17 E., a small pit has exposed lower Chinle shale resting unconformably on upper Moenkopi siltstone.

The trees sampled were the Utah juniper, Rocky Mountain juniper, pinyon, and Douglas fir. No significant differences are apparent between the relative uranium absorption of these different species. About 500 samples were collected along 7-1/2 miles of the ore-bearing zone in this area, and only 15 samples had assay value of 1.0 or more ppm uranium. Rice grass, which requires only small amounts of selenium, was the only indicator plant recognized in this area. It occurs in widely scattered sparse clumps which do not correlate with absorber plant anomalies.

The 13 botanical anomalies in this locality are generally small, widely separated, and based on low assay values. The 2 anomalies in section 35 (nos. 1 and 2, fig. 2) are represented by 3 or more closely spaced trees which absorbed from about 1.0 to 2.0 ppm uranium. Both are in areas where green copper-stained jasper rubble is abundant, and where a thin lower Chinle sandstone is slightly radioactive at the outcrop. Two widely separated anomalies (nos. 8 and 9, fig. 2) based on single tree analyses are in sec. 36; 3 single tree anomalies (nos. 3, 4, and 5, fig. 2) are in sec. 25; 2 single tree anomalies (nos. 10 and 11, fig. 2) are in sec. 2; and 2 single tree anomalies (nos. 12 and 13, fig. 2) are in sec. 10. Two elongate anomalies (nos. 6 and 7, fig. 2) based on five or more samples are present in sec. 20 (unsurveyed). T. 35 S., R. 18 E.

## Head of Deer Canyon locality

The sampled portion of the head of Deer Canyon locality includes parts of secs. 12, and 13, T. 36 S., R. 17 E.; parts of secs. 5, 6, and 7, T. 36 S., R. 18 E.; and parts of secs. 31 and 32 (unsurveyed), T. 35 S., R. 18 E. (fig. 2). The area is accessible by foot from the west from dirt roads on Deer Flat, and from the east by road to the prospects on Upper Lost Parks. No mines or prospects are in this area; however, the Geological Survey has drilled in S 1/2 sec. 12 to define a channel (Finnell and others, 1954).

The Shinarump rim is heavily covered by talus, landslide debris, and vegetation, and outcrops of conglomerate and sandstone are sparse. The trees sampled were the Utah and Rocky Mountain juniper, Douglas fir, and Ponderosa pine. No significant differences were noted between the relative absorption of these different species. Few sulfur-indicator and no selenium-indicator plants grow on the Shinarump in this area. Approximately 350 samples were collected along 5 miles of Shinarump conglomerate, and only 7 had assay values of 1.0 or more ppm uranium.

Four widely separated botanical anomalies occur in this area (fig. 2). The most significant anomaly (no. 1, fig. 2) occurs in the SE 1/4 sec. 12 at a thick ledge of conglomeratic sandstone which appears to have been deposited in a Shinarump stream channel. The sandstone shows prominent green copper stains and hematite-stained joint surfaces.

A botanical anomaly (no. 2, fig. 2) in the western portion of sec. 5 is indicated by two adjacent trees growing on the east wall at the head of Deer Canyon. No Shinarump conglomerate is present in nearby areas where the Moenkopi-Chinle contact is exposed; however, a lenticular bed of mineralized Shinarump conglomerate may be present. An alternate explanation of the anomaly is that parts of the lower Chinle or upper Moenkopi are mineralized.

Two widely separated botanical anomalies occur on the east rim of Deer Canyon; one is the east portion of sec. 6 (no. 3, fig. 2), and the other in the SE 1/4 sec. 7 (no. 4, fig. 2). Both anomalies are on talus and vegetation-covered parts of the rim, and talus probably derived from the Shinarump was recognized only at the anomaly in sec. 7. Copper stains were noted in the overlying Chinle in sec. 7. Reanalyses of samples comprising both anomalies verified this higher than normal uranium content.

Upper Lost Parks locality

The Upper Lost Parks locality includes parts of secs. 5, 8, 17 and 18, T. 36 S., R. 18E., Salt Lake meridian (fig. 2). The area is accessible from the north by rough dirt roads which cross Upper Lost Parks and terminate at the Sandy No. 1 and No. 3 prospects along the southeast rim. Neither of the prospects was being worked at the time of sampling.

Thick Shinarump conglomerate is well exposed along the southern rim of Upper Lost Parks, but along the northern rim outcrops are partly or wholly covered by vegetation and talus. The Shinarump is generally 15 to 35 feet thick at the southern end of Upper Lost Parks and is composed of an upper and lower sandstone, both of which thin irregularly to the north. Locally the upper sandstone thickens and channels into the lower sandstone. Blue and green copper minerals stain the Shinarump locally along the south rim, and copper sulfides were tentatively identified at the Sandy No. 3 prospect in the NE 1/4 sec. 17 (Finnell, oral communication).

The trees sampled were pinyon and Utah and Rocky Mountain juniper. No significant differences were noted between the relative absorption of uranium by these different species. Few indicator plants are present in this area. About 190 plant samples were collected along about 2-1/3 miles of Shinarump rim, 23 of which had assay values of 1.0 or more ppm uranium.

Six separate botanical anomalies occur in the Upper Lost Parks locality, and two can be considered as significant anomalies (table 2).

Both significant anomalies (nos. 2 and 4, fig. 2) occur at the Sandy prospects in sec. 17 and are represented by very high assay values of 4 or more trees. All of these trees are listed in table 2, but all are not shown on the map (fig. 2). Both anomalous areas were sampled in detail, and rock specimens for chemical analysis were collected from the Sandy No. 1 prospect (Appendix B, No. 3). Uranium occurs at the base of the lowest of two sandstone units at the Sandy No. 3 prospect. Trees sampled along the top of the barren upper sandstone unit had normal uranium contents, whereas trees sampled along the uranium-bearing lower sandstone, 20 feet below, absorbed up to 10 times more uranium. The presence of a perched water table in the upper barren sandstone would support this explanation, as roots of the upper trees would in all likelihood only extend to water. Drilling by the Geological Survey has not proven the presence of perched water; drill core generally shows only that the upper sandstone is yellowish brown and underlain by gray, yellow, or red siltstone-mudstone. (Finnell, oral communication).

The significance of the yellowish-brown color of the upper sandstone with respect to the present water table is not known; however, much water occurs in steep fractures that cut the gray ore-bearing lower sandstone in the Sandy No. 3 adit. Where cut by the water-filled fractures, the sandstone is stained yellowish brown. In the area east of Upper Lost Parks, seeps occur locally at the base of sandstone ledges underlain by shale strata indicating perched water tables do exist in the area under circumstances similar to those at the Sandy No. 3 site.

The four other anomalies in Upper Lost Parks are represented either by single trees or by several trees with uranium content near the cutoff grade. One anomaly is in sec. 18, at the southwest tip of Upper Lost Parks (no. 1, fig. 2), represented by uranium contents near the anomaly cutoff (1.0 ppm U). Green copper stains were noted on the Shinarump conglomerate in this area. A second anomaly (no. 3, fig. 2), represented by the assay of one isolated tree, occurs at the southeast tip of Upper Lost Parks in sec. 17. It is above a well-exposed Shinarump-filled scour channel which is less than 45 feet wide. No mineralized rock was seen. The third anomaly (no. 5, fig. 2) is represented by several consecutive trees with assay values near the anomaly cutoff and is in sec. 8 a few hundred feet north of the Sandy No. 3 prospect. Where the Shinarump conglomerate is exposed, limonite stains are abundant. The fourth anomaly is in sec. 8 (no. 6, fig. 2) near the head of Deer Canyon, which forms the western boundary of Upper Lost Parks. This anomaly is indicated by the assay value of one tree growing above rubble- and vegetation-covered Shinarump conglomerate.

## Hideout locality

The sampled portion of the Hideout locality includes secs. 14 and 23, parts of secs. 15 and 22, T. 36 S., R. 17 E. (fig. 2). The area is accessible by dirt roads one of which parallels the eastern rim of Deer Flat in this area, and the other branching from it and extending to the Hideout mine. The Hideout mine, near the center of sec. 14, was the only active mine in the Deer Flat area during the prospecting.

The Shinarump is generally thick and well exposed along most of the rim in the Hideout area, but it thins locally and these places it is partly or completely covered by talus, landslide debris, and vegetation.

The principal tree sampled was the Utah juniper, but pinyon and buffaloberry were also sampled for comparative purposes. No significant differences were noted between the relative uranium absorption of the Utah juniper and pinyon; however, buffaloberry generally absorbed about twice as much uranium as nearby junipers. Excluding the detailed sampling above the Hideout mine, approximately 230 samples were collected along 2-1/4 miles of Shinarump conglomerate. Fifty-eight of these samples assayed 1.0 or more ppm uranium. Omission of some of these samples from the map (fig. 2) permitted clarity of presentation. Some of these can be seen in figure 4 and table 2 lists all samples considered to contain significantly large amounts of uranium.

The most significant botanical anomaly (no. 1, fig. 2) is at the Hideout mine. The ore deposit occurs near the base of a broad, highly fractured scour channel which trends about N. 70° W. Approximately half of the samples that assayed greater than 1.0 ppm uranium in the Hideout locality are at or near the Hideout mine. (See table 2.)

Close-spaced sampling on a landslide block of Chinle material (Finnell, oral communication) more than 100 feet above the ore bed was done at right angles to the supposed channel trend in an attempt to determine the direction of the mineralized part of the channel. A comparison of results of the sampling and diamond drilling shows only a fair correlation (fig. 4) between botanical anomalies and the trend at the Hideout ore deposit. Depth to the ore layer averages 120 feet, and it is unlikely that tree roots have penetrated so deeply. However, fractures may provide a passageway for rising uranium-bearing solutions which could account for a high uranium content in trees more than 100 feet above the ore bed.

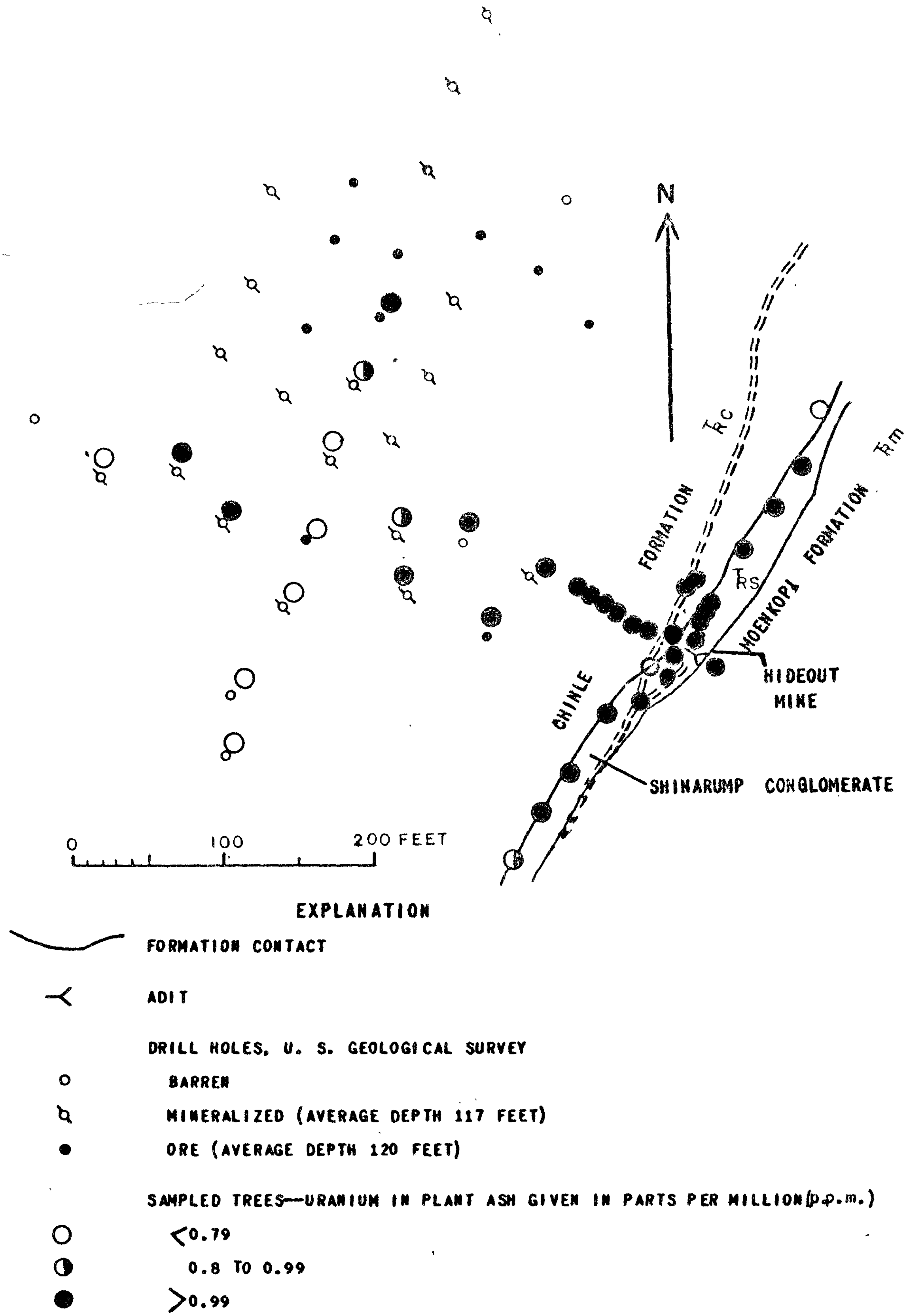



**Figure 4.** SKETCH MAP SHOWING THE LOCATION OF U.S. GEOLOGICAL SURVEY DRILL HOLES AND SAMPLED TREES IN THE VICINITY OF THE HIDEOUT MINE, DEER FLAT AREA, WHITE CANYON DISTRICT, SAN JUAN COUNTY, UTAH.

The results of chemical and spectrographic analysis of selected ore samples collected near the outcrop at the Hideout mine are summarized in Appendix B, No. 1.

Contamination of trees near the Hideout mine and along the access road is common, and many samples were washed in order to eliminate the effects of windblown contamination. Though washing decreased the analytical values in most cases, it resulted in no radical changes in interpretation.

Six other botanical anomalies, as defined by juniper samples, are along the Shinarump rim, all occurring southwest of the Hideout mine. Three are in sec. 14 where anomalies numbered 2 and 4 (fig. 2) are each represented by single samples containing over 1.0 ppm uranium. Anomaly no. 2, however, is supported by 2 samples containing almost 1.0 ppm uranium. The third anomaly is sec. 14 (no. 3, fig. 2) has six, almost consecutive, trees with values above 1.0 ppm uranium. All three anomalies are supported by surface manifestations such as copper and limonite stains, abnormal surface radioactivity, and very radioactive carbon pods and seams. A significant botanical anomaly (no. 5, fig. 2), the fourth of the six southwest of the Hideout mine, occurs in the NW 1/4 NW 1/4 sec. 23. It is indicated by analyses of samples of about 24 closely spaced trees. Twelve of the trees are above the anomaly cutoff grade and 12 are at or just below it. The thick conglomeratic lower sandstone unit of the Shinarump at this location is not mineralized along the outcrop. However, a thin coarse-grained upper sandstone from 2 to 10 feet above the lower conglomeratic sandstone is locally stained with copper and impregnated with limonitic material. All outcrops of this sandstone show abnormally high radioactivity, and mudstone above and below the sandstone is also locally radioactive. This sandstone probably supplies most of the uranium necessary to account for the anomaly; however, it is possible that the thick lower sandstone is mineralized behind the outcrop or where talus covered. The two remaining anomalies southwest of the Hideout mine, both small, are in the eastern half of sec. 22. One of these (no. 6, fig. 2) is indicated by a single juniper analysis, and the other (no. 7, fig. 2) is indicated by 3 analyses near the anomaly cutoff value and 1 analysis well above this value. The Shinarump at both places is thin and covered by talus and vegetation.

## Dead Buck locality

The Dead Buck locality includes parts of secs. 15, 16, 21, and 22, T. 36 S., R. 17 E. (fig. 2). The southern part of this area is accessible by mining roads which terminate at the principal prospects, but the northern part can be reached only by foot. Several prospects, the Dead Buck, Camel and W. N. are closely grouped in sec. 21.

The Shinarump conglomerate of the Dead Buck locality varies considerably in thickness and appears to thin irregularly to the north. It is poorly exposed at most places due to talus, landslide, and vegetative cover, but road cuts and rim stripping have exposed several lenses of Shinarump sandstone. The deposits at the prospects in the Dead Buck locality appear to be localized in fractured Shinarump scour channel fillings.

The Utah juniper was the only kind of tree sampled in this area. About 235 samples were collected along 3-3/4 miles of Shinarump conglomerate, and about 40 of these had assay values greater than 1.0 ppm uranium. Sulfur-and selenium-indicator plants Oryzopsis hymenoides, Senecio sp. and Cryptantha sp. are common locally on the Chinle and Shinarump slopes, and particularly common along roads or in areas of disturbed ground. Two large and 5 smaller anomalies are in sec. 21, and 6 separate anomalies are in adjoining sec. 16 (fig. 2). The 2 large, elongate anomalies (nos. 8 and 9, fig. 2) in the S 1/2 sec. 21 occur above the 3 prospects and along the roads which join them. The highest uranium content in the trees is at the Dead Buck and W. N. claims, with the next highest content in trees at the Camel claim. Three small possible botanical anomalies (nos. 11, 12, and 13, fig. 2), each represented by two analyses just below the cutoff value of 1.0 ppm, are in the SE 1/4 SE 1/4 sec. 21. The Shinarump rim is partly or completely covered in places by talus and vegetation in this area, and no surface indication of mineralized rock is present where it crops out. An anomaly (no. 10, fig. 2) originally represented by the analysis of 1 tree occurs about 200 feet east of the Camal claim in the SE 1/4 sec. 21. Reanalysis of this sample and sampling of two nearby trees verified this anomaly. The presence of Stanelya pinnata, Senecio uintahensis, Cryptantha sp., and Oryzopsis hymenoides on nearby undisturbed ground further supports this anomaly. The only botanical anomaly (no. 7, fig. 2) in the N 1/2 sec. 21 is represented by a single tree which absorbed 1.0 ppm uranium. No surface indications of mineralized rock occur at the poorly exposed Shinarump conglomerate below the sampled tree.

A good anomaly (no. 3, fig. 2) in an area not yet developed occurs in the NW 1/4 SE 1/4 sec. 16. Twelve consecutive trees were sampled along more than 600 feet of partly covered Shinarump conglomerate, and 9 absorbed 1.0 or more ppm uranium and 1 of these absorbed more than 3.0 ppm uranium. About 300 feet south of this large anomaly another good anomaly (no. 4, fig. 2) represented by 4 consecutive sampled trees occurs where the Shinarump conglomerate is covered by talus and vegetation. Four isolated anomalies (nos. 1, 2, 5, and 6, fig. 2) originally indicated by single tree analyses are in the E 1/2 sec. 16. Resampling, reanalysis, and in some cases sampling of nearby trees supported these anomalies, and the presence of Eriogonum corymbosum, Cryptantha sp., and Euphorbia sp. may be a further indication of mineralized Shinarump near the southernmost two anomalies. The anomaly in the SE 1/4 sec. 16 (no. 6, fig. 2) is supported by 2 trees, 1 of which absorbed more than 4.0 ppm uranium.

## Southern Deer Flat locality

The southern Deer Flat locality includes secs. 27, 28, and parts of secs. 29, 32, 33, and 34, T. 36 S., R. 17 E. (fig. 2). The eastern part of this area is accessible by a dirt road paralleling the rim and terminating at the southeastern tip of Deer Flat, but the western part can be reached only by foot.

The Shinarump conglomerate is generally thick and well exposed along most of the rim in the southern Deer Flat area, but locally it is partly or completely covered by talus, landslide debris, and vegetation. At places a thick upper sandstone channels into a lower sandstone. The base of the Shinarump has been exposed by rim stripping for about one-third of a mile along the southern rim.

Sparse patches of sulfur- and selenium-indicator plants are generally associated with areas of disturbed ground along roads, on the lower Chinle, in the Southern Deer Flat locality. Indicator plants in this area show no apparent relationship to mineralized ground.

About 430 branch tip samples were collected along 4-1/2 miles of Shinarump conglomerate in this area; 33 samples contained 1.0 ppm or more uranium. These 33 samples are distributed among 16 anomalies (fig. 2 and table 2). The principal tree sampled was the Utah juniper, but buffaloberry was sampled for comparative purposes at several places. Two buffaloberry samples contained about 6 times, and 5 samples contained about 2 times, as much uranium as nearby junipers. The broad, pubescent leaves of the buffaloberry make it very susceptible to windblown contamination, probably accounting for the large uranium contents of the two samples. Though samples are too few to be conclusive, the comparisons made indicate that buffaloberry could be sampled in a plant analysis prospecting program.

No significant anomalies are present along the southwestern tip of Deer Flat in secs. 29, 32, and the western one-third of sec. 28, but one small anomaly (no. 11, fig. 2) is indicated by the near cutoff uranium contents of two consecutively sampled trees.

The eastern two-thirds of sec. 28 contains five separate anomalies (nos. 12 through 16, fig. 2). None appears very good, but resampling, reanalysis, and sampling of nearby trees have verified these anomalies. Rim stripping in this area exposed weakly mineralized rock in the lower part of the Shinarump conglomerate. No botanical anomaly was indicated by samples of trees growing on upper Shinarump sandstone ledges 33 feet above the weakly mineralized lower Shinarump, but a small anomaly was indicated by a tree growing 8 feet above a prominent mineral-stained joint.

Two anomalies occur in sec. 27. The northernmost anomaly (no. 1, fig. 2) is indicated by a single tree analysis of nearly 2.0 ppm uranium. The second anomaly (no. 2, fig. 2) is located near the center of the section and is indicated by 3 trees, 1 of which contained 2.6 ppm uranium. Three anomalies are in sec. 34. The largest of these (no. 5, fig. 2) is indicated by six consecutively sampled trees in the SW 1/4 NW 1/4 sec. 34. The other two anomalies occur in the NE 1/4 NW 1/4 of the section. The northernmost one (no. 3, fig. 2) is based on samples of 2 trees which contained uranium near the cutoff amount, but the other (no. 4, fig. 2) is indicated by 2 juniper analyses and 1 buffaloberry analysis. The buffaloberry sample contained about 10.0 ppm uranium, which is about 7 times the amount of uranium contained in samples of neighboring junipers.

The N 1/2 sec. 33 contains five botanical anomalies. One (no. 10, fig. 2) is in the NW 1/4 NW 1/4 of the section and is indicated by 1 tree sample which contained 2.1 ppm uranium and 2 near the anomaly cutoff value. Another botanically favorable area (no. 9, fig. 2) is in the NE 1/4 NW 1/4 sec. 33 where 5 of 8 consecutively sampled trees absorbed over 1.0 ppm uranium. The other 3 favorable sites are along 1,500 feet of outcrop where the base of the Shinarump conglomerate is exposed by rim stripping in the NE 1/4 of the section. The easternmost (no. 6, fig 2) is represented by samples from two consecutive trees containing near-cutoff amounts of uranium and growing on well-exposed Shinarump ledges. No mineralized rock was seen at this anomaly, though radioactive carbonaceous seams and pods are common in the area. Two hundred feet west of this anomaly, near the Standard prospect, a much larger anomaly (no. 7, fig. 2) is represented by samples of five consecutive trees. At this anomaly the radiation background is from 6 to 15 times the normal background, and the samples contained more than 1.0 ppm uranium. The most radioactive material at the Standard claim is limonite-stained sandstone and the underlying sandy carbonaceous siltstone. Samples of mineralized rock taken from near the surface at both the Standard claim and the Hideout mine show similar disequilibrium conditions (Appendix B, nos. 1a and 5). Development work behind the outcrop at the Hideout mine has exposed unoxidized uranium minerals, copper sulfides, and pyrite. The ore appears to increase in grade behind the outcrop. These factors, together with the occurrence of limonite and secondary copper minerals near the surface of the deposit, and the disequilibrium of the uranium suggest that an oxidizing sulfuric acid environment removed uranium by selective leaching from rocks near the surface (Phair and Levine, 1953). If chemical conditions at both the Hideout mine and the Standard claim are analagous, the Standard ore deposits may increase in grade behind the outcrop. About 450 feet west of the Standard prospect a botanical anomaly (no. 8, fig. 2) is represented by two low juniper assay values (table 2) and a buffaloberry sample which contained about 9.0 ppm uranium. No mineralized rock was seen, but radiation is somewhat above the normal background amount.

# SUMMARY AND CONCLUSIONS

Botanical prospecting for uranium in the Shinarump conglomerate or related rocks extended over more than 27 miles of rim in the Deer Flat area, White Canyon district, San Juan County, Utah. Botanical anomalies occur at all major known deposits, which suggests that uranium deposits underlie some of the anomalies not known to be associated with mineralized rock. The distribution and quantity of significant botanical anomalies indicate that the southern half of the Deer Flat area is more favorable for concealed uranium deposits than the northern half. Many botanical anomalies are in areas where the ore zone is partly or completely obscured by rock debris and vegetation, but verification of these anomalies can be determined by rim stripping or shallow drilling. In addition, it is possible to check some anomalous areas by close inspection of outcrops of the Shinarump conglomerate and adjacent units. The presence of visible uranium minerals or abnormally high radioactivity would verify botanical anomalies.

Buffaloberry may prove useful in plant analysis prospecting programs as it generally absorbs about twice as much uranium as the Utah juniper, but additional research should be made before the plant is widely used.

Recommendations for exploration by localities are as follows:

## Pinyon Point--Head of Hideout Canyon locality

Large scale exploration of this area for ore deposits probably would not be justified on the basis of botanical data because all anomalies, except two, are indicated by single, isolated tree analyses or several analyses below the cutoff value of 1.0 ppm. Geological criteria are also unfavorable because the Shinarump conglomerate is absent throughout most of this area. The 13 widely separated botanical anomalies might be field checked to determine whether rocks of the lower Chinle or upper Moenkopi formation are mineralized.

## Head of Deer Canyon locality

Four botanical anomalies are present in the Head of Deer Canyon locality. Although the Shinarump is thin or absent in most of this area, thick channel deposits are locally present. The most favorable area for ore deposits (no. 1, fig. 2), as indicated by botanical prospecting, is in the SE 1/4 sec. 12, T. 36 S., R. 17 E., where sandstones in a thick Shinarump channel are stained by copper minerals. The other three anomalies are in areas where the Shinarump conglomerate or related beds are thickly covered by talus or vegetation.

## Upper Lost Parks locality

Three good anomalies and three poorer anomalies occur in this area. Two of the good anomalies (nos. 2 and 4, fig. 2) occur above the Sandy prospects; the third (no. 5, fig. 2) is a few hundred feet north of the Sandy No. 3 prospect. All anomalies in this area appear to justify checking for ore deposits because the Shinarump conglomerate is thick throughout most of the area, and copper minerals are commonly associated with the Shinarump in five anomalous areas.

## Hideout locality

Numerous good botanical anomalies are present; some are associated with the Hideout mine and vicinity, but some are in areas not known to contain uranium deposits. These anomalies may justify checking because thick Shinarump conglomerate crops out along the rim in most of this area.

## Dead Buck locality

Many good botanical anomalies are present, and most of these coincide with areas known to be mineralized. The two good elongate anomalies (nos. 3 and 4, fig. 2) occur along an exposure of a radioactive black fissile shale. Only very thin to no Shinarump conglomerate occurs at anomalies 3 and 4. Other anomalies in this locality warrant close inspection because thick Shinarump conglomerate is present over most of the area.

## Southern Deer Flat locality

Many good botanical anomalies are in this area, and some of these are supported by visible uranium minerals or high radioactivity. Anomalies are distributed completely around the Shinarump rim in this area, but those in the south and east appear most promising. The Shinarump conglomerate is thick at most places along the rim, justifying checking for concealed uranium deposits.

## LITERATURE CITED

Benson, W. E., Trites, A. F., Jr., Beroni, E. P., and Feeger, J. A., 1952, Preliminary report on the White Canyon area, San Juan County, Utah: U. S. Geol. Survey Circ. 217.

Cannon, H. L., 1952, The effect of uranium-vanadium deposits on the vegetation of the Colorado Plateua: Am. Jour. Sci., v. 250, p. 735-770.

___________1953, Geobotanical reconnaissance near Grants, New Mexico: U. S. Geol. Survey Circ. 264.

___________1954, Botanical methods of prospecting for uranium: Mining Engineering, v. 6, p. 217-220.

Grimaldi, F. S., May, Irving, and Fletcher, M. H., 1952, U. S. Geological Survey fluorimetric methods of uranium analysis: U. S. Geological Survey Circ. 199.

Grimaldi, F. S., Ward, F. N., and Kreher, R. F., 1954, A direct fluorimetric method for the determination of small amounts of uranium in the field and laboratory, in Grimaldi, F. S., May, Irving, Fletcher, M. H., and Titcomb, Jane; Collected papers on methods of analysis for uranium and thorium: U. S. Geol. Survey Bull. 1006, pt. 9, p. 69-75.

Phair, George, and Levine, Harry, 1953, Notes on the differential leaching of uranium, radium, and lead from pitchblende in $H_2SO_4$ solutions: Econ. Geology, v. 48, p. 358-369.

## UNPUBLISHED REPORTS

Cannon, H. L., 1951a, Preliminary report on geobotanical prospecting studies on the Colorado Plateau: U. S. Geol. Survey Trace Elements Memo. Rept. 199.

___________1951b, Preliminary report on geobotanical exploration in the Yellow Cat district, Grand County, Utah: U. S. Geol. Survey Trace Elements Memo. Rept. 273.

Finnell, T. L., Franks, P. C., Marsh, O. T., and Brew, D. A., 1954, Interim report on exploration in the Deer Flat area, White Canyon district, San Juan County, Utah: U. S. Geol. Survey Trace Elements Memo. Rept. 579.

Finnell, T. L., Renzetti, B. L., Trites, A. F., Jr., 1952, Preliminary report on the geology of the Tiger (Hideout) claim, White Canyon area, San Juan County, Utah, with recommendations for exploration for geologic information: U. S. Geol. Survey Trace Elements Memo. Rept. 479.

Granger, H. C., and Beroni, E. P., 1950, Uranium occurrences in the White Canyon area, San Juan County, Utah: U. S. Geol. Survey Trace Elements Memo. Rept. 7.

Narten, P. F., 1953, Preliminary report on the results of geobotanical prospecting on the south flank of Haystack Butte, McKinley County, New Mexico: U. S. Geol. Survey Trace Elements Memo. Rept. 670.

# APPENDIX A

Partial plant list, Deer Flat area, White Canyon district, San Juan County, Utah

| | Upper Moenkopi Elev. 6,750 ft. NW. slope (sec. 16, T. 36 S., R. 17 E.) | Shinarump Elev. 6,800 ft. NW. slope | Lower Chinle Elev. 7,000 ft. 1/ (sec. 14 & 28, T. 36 S., R. 17 E.) | Lower Chinle Elev. 7,100 ft. 2/ (sec. 14, T. 36 S. R. 17 E.) | Lower Chinle Elev. 7,000 ft. 2/ (sec. 21, T. 36 S. R. 17 E.) |
|---|---|---|---|---|---|
| Probable selenium-indicator plants | | | | | |
| Astragalus sp. (loco) | - 3/ | - | P 4/ | P | - |
| Stanleya pinnata (Pursh) Britt. (princesplume) | - | - | P | P | P |
| Aster xylorhiza T & G (woody aster) | - | - | - | - | P |
| Oryzopsis hymenoides (R. & S.) Rick. (Indian ricegrass) | P | - | P 5/ | P | P |

1/ Undisturbed ground
2/ Along roads or disturbed ground
3/ Not seen by authors
4/ Plant present
5/ Plant present at drill sites on lower Chinle

APPENDIX A--Continued

Partial plant list, Deer Flat area, White Canyon district, San Juan County, Utah--Continued

| | Upper Moenkopi Elev. 6,750 ft. NW. slope (sec. 16, T. 36 S., R. 17 E.) | Shinarump Elev. 6,800 ft. NW. slope | Lower Chinle Elev. 7,000 ft. 1/ (sec. 14 & 28 T. 36 S. R. 17 E.) | Elev. 7,100 ft. 2/ (sec. 14, T. 36 S., R. 17 E.) | Elev. 7,000 ft. 2/ (sec. 21, T. 36 S. R. 17 E.) |
|---|---|---|---|---|---|
| Probable sulfur-indicator plants | | | | | |
| Arabis holboelli Hornem (Holboell rockcress) | - | P | PC | P | P |
| Erysimum elotum Nutt. (hedgemustard) | - | - | P | - | P |
| Lesquerella gordoni (A. Gray) S. Wats. (bladderpod) | - | - | P | - | P |
| Physaria chambersii Rollins (double bladderpod) | - | - | P | P | P |
| Sisymbrium altissimum (L.) Britt. (tumglemustard) | - | - | P | P | P |
| Cryptantha ambigua (Gray) Greene (Cryptantha) | - | - | PC | - | P |
| Eriogonum corymbosum Benth. (Corymbed eriogonum) | - | - | - | - | P |
| E. deflexem Torr. (skeletonweed) | - | - | - | - | P |
| Euphorbia sp. (spurge) | - | - | - | - | P |

APPENDIX A--Continued

Partial plant list, Deer Flat area, White Canyon district, San Juan County, Utah--Continued

| | Upper Moenkopi Elev. 6,750 ft. NW. slope (sec. 16, T. 36, S., R. 17 E.) | Shinarump Elev. 6,800 ft. NW. slope | Lower Chinle Elev. 7,000 ft. 1/ (sec. 14 & 28, T. 36 S., R. 17 E.) | Elev. 7,100 ft. 2/ (sec. 14, T. 36 S. R. 17 E.) | Elev. 7,000 ft. 2/ (sec. 21, T. 36 S., R. 17 E.) |
|---|---|---|---|---|---|
| Probable sulfur-indicator plants--Continued | | | | | |
| Senecio uintahensis A. Nels (Uintah groundsel) | - | - | PC | - | P |
| Plants not dependent on selenium or sulfur | | | | | |
| Amelancher utahensis Koehne (serviceberry) | P | P | P | P | P |
| Artemisia tridentata Nutt. (black sage) | - | - | PC | P | P |
| Artemisia sp. (sagebrush) | - | - | - | - | P |
| Atriplex canescene (Pursh) Nutt. (fourwing saltbush) | - | - | P | - | P |
| A. confertifolia (Torr.) S. Wats. (shadscale) | - | - | P | - | P |
| Brickellia sp. (brickellbush) | P | - | P | - | P |
| Bouteloua sp. (grama grass) | - | - | P | - | P |
| Cercocarpus montanus Raf. (alderleaf mountain-mahogany | P | P | P | P | - |

APPENDIX A--Continued

Partial plant list, Deer Flat area, White Canyon district, San Juan County, Utah--Continued

| | Upper Moenkopi Elev. 6,750 ft. NW. slope (sec. 16, T. 36 S., R. 17 E.) | Shinarump Elev. 6,800 ft. NW. slope | Lower Chinle Elev. 7,000 ft.[1] (sec. 14 & 28, T. 36 S., R. 17 E.) | Lower Chinle Elev. 7,100 ft.[2] (sec. 14, T. 36 S., R. 17 E.) | Lower Chinle Elev. 7,000 ft.[2] (sec. 21, T. 36 S., R. 17 E.) |
|---|---|---|---|---|---|
| Plants not dependent on selenium or sulfur--Continued | | | | | |
| Chrysothemus linifollus Green (rabbitbrush) | - | - | - | - | P |
| Cirsium sp. (thistle) | - | - | - | - | P |
| Cowania stansburiana Torr. (Stansbury cliffrose) | - | - | P | - | P |
| Ephedra virdis Coville (Mormon-tea) | - | P | PC | P | P |
| Erigeron aphenactis Greene (fleabane) | - | - | - | - | P |
| Gilia leptortieria A. Gray (fairy trumpet) | - | - | P | P | P |
| Gutierrezia sarothra (Pursh) Britt. & Rusby (broom snakeweed) | - | P | PC | P | P |
| Aplopappus clementis (Nutt) Gray (goldenweed) | P | - | PC | P | P |
| Juniperus utahensis (Engelm.) Lemmon (Utah juniper) | P | P | PC | P | P |
| Lappula sp. (Sti[illegible]kseed) | - | - | PC | P | P |
| Berberis sp. (barberry) | - | P | - | P | - |

APPENDIX A--Continued

Partial plant list, Deer Flat area, White Canyon district, San Juan County, Utah--Continued

| | Upper Moenkopi Elev. 6,750 ft. NW. slope (sec. 16, T. 36 S., R. 17 E.) | Shinarump Elev. 6,800 ft. NW. slope | Lower Chinle Elev. 7,000 ft.[1] (sec. 14 & 28, T. 36 S., R. 17 E.) | Lower Chinle Elev. 7,100 ft.[2] (sec. 14, T. 36 S., R. 17 E.) | Lower Chinle Elev. 7,000 ft.[2] (sec. 21, T. 36 S., R. 17 E.) |
|---|---|---|---|---|---|
| Plants not dependent on selenium or sulfur--Continued | | | | | |
| Mirabilis multiflora (Torr.) A. Gray | - | - | P | - | - |
| (showy four o'clock) | | | | | |
| Opuntia sp. (pricklypear cactus) | - | - | PC | P | - |
| Penstemon sp. (beardtongue) | - | - | - | P | P |
| Phlox diffusa Benth. (phlox) | - | - | P | - | P |
| Pinus edulis Engelm. (pinyon) | P | P | P | P | P |
| Quercus gambelii Nutt. (Gembel oak) | - | - | P | - | - |
| Salsola pestifer A. Nels. (russian thistle) | - | - | P | P | - |
| Shepherdia rotundifolia Parry | P | P | PC | - | P |
| (roundleaf buffaloberry) | | | | | |
| Sitanion hystrix (Nutt.) J.C.Smith | - | - | P | P | - |
| (squirreltail) | | | | | |
| Solidago sp. (goldenrod) | - | - | P | P | - |

## APPENDIX A--Continued

Partial plant list, Deer Flat area, White Canyon district, San Juan County, Utah--Continued

| | Upper Moenkopi Elev. 6,750 ft. NW. slope (sec. 16, T. 36 S., R. 17 E.) | Shinarump Elev. 6,800 ft. NW slope | Elev. 7,000 ft.[1/] (sec. 14 & 28, T. 36 S., R. 17 E.) | Lower Chinle Elev. 7,100 ft.[2/] (sec. 14, T. 36 S., R. 17 E.) | Elev. 7,000 ft.[2/] (sec. 21, T. 36 S., R. 17 E.) |
|---|---|---|---|---|---|
| Plants not dependent on selenium or sulfur--Continued | | | | | |
| Streptanthus cordatus Nutt. ex Torr. & Gray | - | P | P | P | P |
| Symphoricarpos sp. (snowberry) | P | P | PC | P | - |
| Yucca sp. (Spanish bayonet) | - | P | - | P | - |

# APPENDIX B

Chemical and radiometric analyses (in percent) of representative soil and barren and mineralized rock samples, Deer Flat area, White Canyon district, San Juan County, Utah.

| Location and type of sample | Percent U | Percent eU | Percent V | Se(ppm) |
|---|---|---|---|---|
| Mineralized Shinarump conglomerate | | | | |
| 1a.1/ Hideout mine | 0.060 | 0.44 | <0.03 | <2.0 |
| 1b.4/ Hideout mine2/ | 0.050 | 0.072 | -- | <0.1 |
| 2.1/ Dead Buck claim | 1.49 | 1.4 | <0.03 | 5.0 |
| 3a.1/ Sandy No. 1 claim(sandstone) | 0.007 | 0.021 | <0.03 | <2.0 |
| 3b.1/ Sandy No. 1 claim (shale) | 0.022 | 0.084 | <0.03 | <2.0 |
| 4.1/ SW 1/4 SE 1/4 sec. 28, T. 36 S., R. 17 E. | 0.032 | 0.087 | <0.03 | <2.0 |
| 5.1/ Near Standard claim | 0.027 | 0.23 | <0.03 | <2.0 |

1/ Analysts: S. Furman, J. Siverly, and J. Wahlberg

2/ Spectrographic analysis shows the following percentages of elements:

| | | | |
|---|---|---|---|
| .0X | manganese | .0X | molybdenum |
| .000X | silver | .0X | nickel |
| .00X | cobalt | .0X | lead |
| .00X | chromium | .00X | vanadium |
| X. | copper | .0X | zinc |

3/ Analysts: E. Fennelly and S. Furman
4/ Analysts: S. Furman, J. Wahlberg, and Tripp
5/ Analysts: Unknown

APPENDIX B--Continued

Chemical and radiometric analyses (in percent) of representative soil and barren and mineralized rock samples, Deer Flat area, White Canyon district, San Juan County, Utah--Continued

| Location and type of sample | Percent | | | Se(ppm) |
|---|---|---|---|---|
| | U | eU | V | |
| Mineralized Shinarump conglomerate--Continued | | | | |
| 6.[3] Bridges claim | 0.030 | 0.089 | -- | -- |
| 7.[3] W. N. claim | 0.020 | 0.040 | -- | -- |
| Unmineralized Shinarump conglomerate | | | | |
| 8.[3] Near Hideout mine (sandstone) | 0.0002 | 0.001 | -- | -- |
| 9.[3] Siltstone lens at W. N. Claim | <0.0001 | 0.001 | -- | -- |
| 10.[5] NE 1/4 sec. 28, T. 36 S., R. 17 E. | 0.002 | 0.001 | -- | -- |

APPENDIX B--Continued

Chemical and radiometric analyses (in percent) of representative soil and barren and mineralized rock samples, Deer Flat area, White Canyon district, San Juan County, Utah--Continued

| Location and type of sample | Percent | | | Se(ppm) |
|---|---|---|---|---|
| | U | eU | V | |
| Upper Moenkopi formation | | | | |
| 11.3/ Bleached siltstone below W. N. claim | 0.007 | 0.011 | -- | -- |
| 12.3/ Red siltstone from NE 1/4 sec. 16, T. 36 S., R. 17 E. | 0.0005 | 0.006 | -- | -- |
| 13.3/ Red siltstone from SE 1/4 sec. 21, T. 36 S., R. 17 E. | < 0.0001 | 0.001 | -- | -- |
| Lower Chinle formation | | | | |
| 14.3/ Soil from road in sec. 34, T. 36 S., R. 17 E. | 0.0002 | 0.002 | -- | -- |
| 15.3/ Gray shale above Shinarump (3 samples) | < 0.0001- 0.0004 | < 0.001- 0.001 | -- | -- |
| 16.3/ Lower sandstones | < 0.001- 0.0001 | < 0.001 0.001 | -- | -- |