Airborne Radioactivity Survey in the Vicinity of Grants, McKinley and Valencia Counties, New Mexico

Trace Elements Memorandum Report 161

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
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Sincerely,

/S/ [signature]

for W. H. Bradley
Chief Geologist

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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

AIRBORNE RADIOACTIVITY SURVEY IN THE VICINITY OF GRANTS, McKINLEY AND VALENCIA COUNTIES, NEW MEXICO

by

Frank W. Stead

July 1951

Trace Elements Memorandum Report 161

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ILLUSTRATIONS
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Figure 1. Airborne radioactivity survey in Grants, McKinley and Valencia Counties, New Mexico

2. E-A records near Haystack area

A. Geiger-Mueller counters, T-C channel

B. Geiger-Mueller counters, automatic sensitivity

C. Radar altimeter

D. Magnetic airborne detector

3. Magnetic profile, flight line 7 E

4. Magnetic profile, flight line 8 W

5. Magnetic profile, flight line 9 E

AIRBORNE RADIOACTIVITY SURVEY IN THE VICINITY OF GRANTS, McKINLEY AND VALENCIA COUNTIES, NEW MEXICO

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Frank W. Stead

ABSTRACT

An airborne radioactivity survey in the vicinity of Grants, New Mexico, was made on May 28, 1951; aeromagnetic measurements were made concurrently with the radioactivity measurements. Several radioactivity anomalies were noted in conjunction with negative magnetic anomalies; this association is unusual and may reflect a genetic relationship between the uranium mineralization and the geologic structure causing the negative magnetic effect. Further investigation of the vicinity of the anomalies near the Haystack area, including a ground magnetometer survey, seems warranted.

INTRODUCTION

The airborne radioactivity survey in the vicinity of Grants, New Mexico, was made on May 28, 1951, as a part of a cooperative program with the U. S. Atomic Energy Commission. The accompanying map, figure 1, shows the location of the radioactivity and aeromagnetic anomalies over an area of about 45 square miles.

The survey was made by Geiger-counter and scintillation-counter equipment mounted in a Douglas DC-3A aircraft. Aeromagnetic measurements were made concurrently with the radioactivity measurements. All traverses were flown at a nominal 500-foot flight level at quarter-mile intervals. Aerial photographs were used for pilot guidance, and the flight path of the aircraft was recorded by a gyrostabilized continuous strip-film camera. The distance of the aircraft from the ground was measured with a continuously recording radar altimeter. A total of 2½ hours were spent in actual surveying. Approximately 300 miles of traverse were flown.

The flight lines in the area, shown on figure 1, were oriented to give the maximum coverage of the outcrop of the Todilto limestone of Jurassic age with the objectives of determining the response of the radiation detection equipment over known radioactive mineralization and of locating other radioactive deposits in the general vicinity. One flight line, the extension of line 7 westward along the outcrop of Todilto limestone to near Gallup, New Mexico, has not been plotted on a base map as no anomalies were found along that flight line.

RADIOACTIVITY MEASUREMENTS

All radioactivity measurements were made approximately 500 feet above the ground by: (1) a dual channel radiation detector employing

19 2 by 42-inch Geiger counters; and (2) a scintillation detector employing 4-inch diameter by 2-inch thick sodium iodide crystals.

The dual-channel radiation detector has two output channels, the C channel and the T-C channel. The C channel records the multiple or coincidence pulses originating from hard cosmic radiation striking the bundle of counters; the T-C channel records the anticoincidence pulses or the total counting rate minus the coincidence counting rate. A portion of the record for the T-C channel is shown in figure 2 A where the average counting rate is roughly 300 counts per second at 40 divisions on the E-A tape. The time constant of the T-C channel of the dual-channel radiation detector, with a standard counting-rate meter output, is one second.

The scintillation detector consists of the 4-inch sodium iodide crystals as the radiation detector proper, a pre-amplifier, a linear amplifier and discriminator, and a modified counting-rate meter. The only unusual feature is the modified counting-rate meter which records automatically alternate one-second measurements from two identical output stages; thus, each channel accumulates pulses for one second and records that measurement in the following second to complete the cycle. Thus, the output of the modified counting-rate meter is comparable to that of a scaler for a one-second period of measurement, an improvement over the slower and more complex response of a standard counting-rate meter with a one-second time constant.

The automatic correction of the radiation measurements for variation in distance of the aircraft from the ground, achieved by utilizing the radar altimeter output to modify the counting-rate meter output, was applied only to the modified counting-rate meter of the scintillation detection equipment; it was not applied to the dual-channel radiation detector. Using this correction, an anomaly will maintain the same apparent amplitude when measured between 250 and 1,000 feet above the source, although the statistical fluctuation of the measurements becomes larger with increase in distance from the source.

During the survey, the Geiger counters were connected through a pre-amplifier to: (1) the dual-channel radiation detector (T-C channel); and (2) one of the modified counting-rate meters of the scintillation detection equipment whose output was also corrected for distance from source. Comparison of figures 2 A and 2 B shows the gain in resolution of the modified counting-rate meter with a one-second period of measurement, where the standard deviation would be $\sqrt{N}$, over the typical counting-rate meter of the dual-channel radiation detector with a one-second time constant, where the standard deviation would be $\sqrt{2NXTC}$.

A Halross Model 939 Scintillometer was carried during the survey and by visual comparison with the records of the other equipment was found to be relatively sluggish and insensitive.

Measurements of total magnetic intensity were made simultaneously with the radioactivity measurements, using a Model ASQ-3A airborne magnetometer.

Extent of coverage

At a nominal 500-foot flight level, the width of the zone from which the radioactivity is measured is at least 1,400 feet. Thus, at quarter-mile spacing of flight lines or 1,320-foot intervals, the entire area should be covered adequately. During this particular survey, deviations from planned parallel flight lines were made on lines 6, 7, 8, and 9 to avoid topographic highs where the Todilto outcrop was lacking. It is possible that small areas of considerable activity midway between flight lines 6 and 7 may not have been noted.

Location of anomalies

The approximate location of each radioactivity and magnetic anomaly is shown on figure 1 by appropriate symbols. The compilation and plotting of data _/ require the assumption of straight-line flight

_/ Jensen, Homer, and Balsley, J. R., Jr., Controlling plane position in aerial magnetic surveying: Eng. & Min. Jour., vol. 147, no. 8, pp. 94-95, 153-154, August 1946.

and constant ground speed between recognizable positions plotted on the maps; thus, if the distance between such points is large, the error in estimated position midway between the points may be considerable. In this survey, the location of anomalies, as shown on figure 1, is correct within 300 feet; more precise plotting is not possible due to inaccuracies in the base map of that order of magnitude.

RADIOACTIVITY AND MAGNETIC ANOMALIES

The radioactivity and magnetic anomalies recorded during the survey are listed in table 1 and are shown on figure 1 by appropriate symbols. Small changes in radiation intensity occurring over a flight distance of more than 1 mile (24 seconds average flying time) probably reflect a characteristic of the soil mantle or formations exposed at the surface and have not been shown as anomalies.

The pertinent E-A records for the anomalies of greatest interest near the Haystack area in Sec. 19, T. 13 N., R. 10 W., are shown in figures 2 A, 2 B, 2 C, and 2 D. The records for the scintillation detector during this particular survey were essentially valueless due to excessive noise in the amplifier and were used solely as a confirmation of anomalies recorded by the dual-channel radiation detector.

Figure 2 A is the E-A record of the Geiger counters from the T-C channel of the dual-channel radiation detector and is uncorrected for variation in distance from ground. The counting rate at 40 divisions is approximately 300 counts per second with a one-second time constant;

Table 1

Radioactivity and Aeromagnetic Anomalies

Flight line	Location of radioactivity anomaly 1/	Location of aeromagnetic anomaly 1/
4	No. 1254.8S 2/	
5	No. 1301.5S	
	No. 1303.6S	
7	No. 1380.7S	
	No. 1389.4M	No. 1389.7
8	No. 1426.5L	No. 1426.0 3/
	No. 1430.2M	
	No. 1439S	
9	No. 1456S	
	No. 1466.3L	No. 1466.2 3/

1/ Location designated by serial number on strip photograph and by corresponding edge marks on other records; on figure 1 the first two numbers have been dropped to avoid 5 digit numbers.

2/ S, M, L after number denote respectively small, medium and large radioactivity anomalies.

3/ Magnetic anomalies on lines 8 and 9 occur so close together due to overlapping of flight paths that they are plotted as one anomaly on figure 1.

thus, the standard deviation of measurement is slightly less than 3 divisions on the E-A tape. The large anomaly at 1426.5 is roughly 8 times the standard deviation of the general background counting rate; the medium anomaly at 1430 is roughly 3 times the standard deviation.

Figure 2 B is the E-A record of the Geiger counters connected to the modified counting-rate meter including automatic correction for distance from the outcrop. The counting rate at 10 divisions on the E-A tape is roughly 300 counts per second, the same as for the dual-channel radiation detector, but the measurement reflects a one-second period in which the pulses are accumulated as in a standard scaler rather than a one-second time constant. The standard deviation for each one-second period is the square root of the total events in that second. Comparison of figures 2 A and 2 B shows the advantage of sharpening the resolution of measurement; the anomalies in 2 B are considerably easier to interpret than those in 2 A.

Figure 2 C is the radar altimeter record. The distance from the ground for the large anomaly at No. 1426.5 was 400 feet and for the anomaly at No. 1430 was also 400 feet.

Figure 2 D is the E-A tape for the magnetic airborne detector where the full-scale deflection was 200 gammas; thus, several scale shifts were made to obtain a complete record of the negative anomaly whose minimum was at No. 1426. It will be noted that the large radioactivity anomaly at No. 1426.5 is almost coincident with the sharp negative magnetic anomaly, in excess of 500 gammas, at No. 1426.

The significant portions of magnetic measurements have been rectified and are shown as magnetic profiles for flight lines 7, 8, and 9 in figures 3, 4, and 5 respectively. Rectification of measurement here includes changing to rectilinear coordinates and adjusting the horizontal scale to 1 inch to the mile and the vertical scale to 1 inch equals 160 gammas.

Interpretation of anomalies

The interpretation of the radioactivity anomalies is relatively straightforward as nearly all the anomalies can be directly related to ground areas where present exploration is underway. Exceptions are anomalies No. 1380.7 on line 7, No. 1439 on line 8, and No. 1456 on line 9 that, from examination of the strip photograph, do not appear to be related to any present exploration. However, these anomalies are all small and may represent no more than small local areas in which the general level of radioactivity is several times normal, a not unusual variation in background.

In the vicinity of the Haystack area, Sec. 19, T. 13 N., R. 10 W., the almost coincident occurrence of medium and large radioactivity anomalies with sharp negative magnetic anomalies is highly unusual.

Although the relationship may be one of chance, the two cases separated by 0.7 miles suggest a possible genetic relationship rather than an accidental relationship. The negative magnetic anomaly may reflect a diabase dike or plug with inverse remanent magnetization; thus, the uranium mineralization in the Todilto limestone may be hydrothermal (?) and genetically related to a buried diabase dike or plug which was the source, or channelway, for the mineralizing solutions. The nearby presence of a volcanic cone one mile to the south of the Haystack area lends credence to this possibility.

The negative magnetic anomaly, No. 1426 on line 8 and shown on the magnetic profile in figure 4, is in excess of 500 gammas and should be several thousand gammas if measured on the ground.

CONCLUSIONS

The occurrence of negative magnetic anomalies in close association with radioactivity anomalies known to represent uranium mineralization of commercial importance is sufficiently unusual to warrant further investigation. A ground magnetometer survey, properly coordinated with all available geologic data, is recommended in the Haystack area. Should such an investigation demonstrate any genetic relationship between uranium mineralization and the geologic structure causing the negative magnetic anomalies, further consideration might be given to a more comprehensive radioactivity-aeromagnetic survey of the surrounding region.