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Soil-Gas Helium Concentrations in the Vicinity  
of a Uranium Deposit, Red Desert, Wyoming

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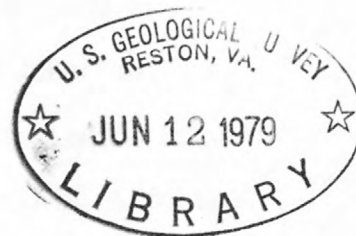
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This report is preliminary and has not  
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with U.S. Geological Survey standards  
and nomenclature



Soil-gas helium concentrations in the vicinity of  
a uranium deposit, Red Desert, Wyoming  
by G.M. Reimer and C.G. Bowles

Abstract

A survey of the helium concentration in soil-gas was conducted in the Red Desert Area, Sweetwater County, Wyoming. The area studied is directly over a low-grade uranium deposit that may be suitable for recovery by in-situ leaching techniques. The area was sampled twice, once in December, 1977, and again in July, 1978. Wind was a significant factor affecting the helium concentrations. Wind gusts exceeded 110 km/hr (70 mph) during the December, 1977, sampling; wind gusts did not exceed 30 km/hr (20 mph) during the July, 1978, sampling. The average helium concentration for all the July, 1978, soil-gas samples was about twice the average of the December, 1977, samples. In addition, a contour plot of the July, 1978, soil-gas samples showed an area of higher helium values that corresponds to the location of anomalies detected by other exploration techniques, and may be associated with the uranium deposit.

Introduction

A survey of the helium concentration in soil-gas was conducted in the Red Desert Area, Sweetwater County, Wyoming. The area studied is directly over a low-grade uranium deposit that may be suitable for recovery by in-situ leaching techniques. The area is described by Pacer and others (1978), and was the subject of geophysical and geochemical studies sponsored by Bendix Field Engineering Corporation, Grand Junction, Colorado. Soil-gas samples for helium analysis were collected in December, 1977, and July, 1978. The samples were analyzed in the field using the U.S. Geological Survey's mobile helium mass spectrometer (Reimer, 1976).

## Probe Description

The probes used in this study were slightly modified from the probes described previously (Reimer, 1976). The probes (fig. 1) were constructed of hollow stainless steel tubing, 0.8-cm outside diameter and 0.16-cm inside diameter. Carbon-steel, or any other alloy, could be used and the dimensions are not critical; the probe should have sufficient strength for its length to withstand pounding into the ground.

The probe tip is capped with a machine screw and five holes, 0.16 cm in diameter, holes were drilled into the base of the probe perpendicular to the axis thus creating 10 entry ports for the soil gas. The area of the entry ports was recessed slightly to assist in keeping soil from clogging the ports. A 0.10-cm diameter wire is inserted the length of the probe to prevent soil from clogging the probe, and to decrease the dead-volume to less than 2 cm<sup>3</sup>.

Two pounding collars, 3 cm in diameter and 6 cm in length, are silver-soldered onto the probe to enable the probe to be driven into the ground. The length of the probe under the bottom collar determines the sample depth; the distance between the collars is sufficient for hammer movement.

The hammer is a split barbell type, weighing about 2 kg. It is fitted between the two pounding collars and can be removed and used on other probes.

The top of the probe is threaded above the upper pounding collar and accepts a cap that protects the top of the probe and keeps the insert wire in place during the pounding of the probe into the ground.

The soil gas is collected by replacing the cap with a needle guide containing a rubber septum. The needle guide is attached to the top of the probe by a common O-ring tubing adaptor for vacuum systems.

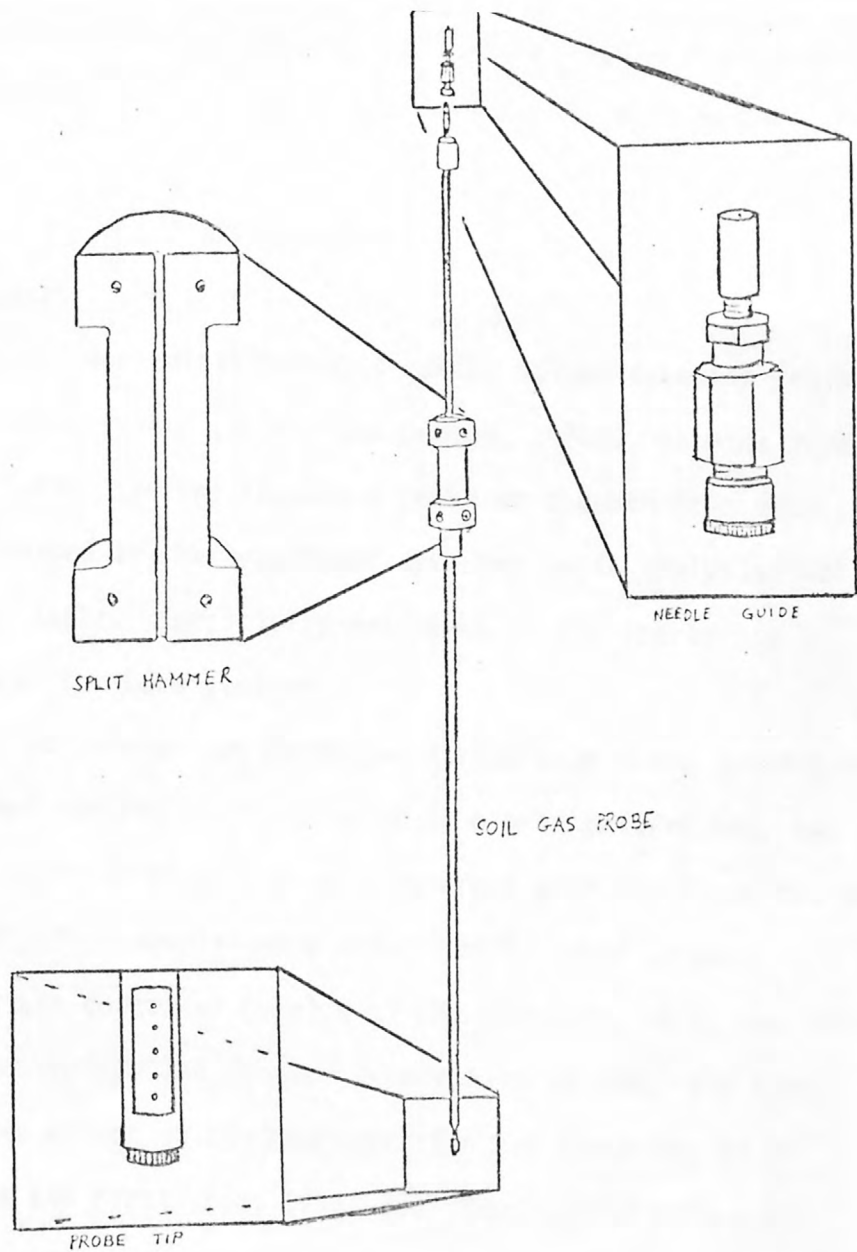


Figure 1.--Drawing of the soil-gas probe used for these studies. The drawing is not to scale.

The gas is extracted using a hypodermic syringe with a side-hole needle. The side-hole needle extends the life of the septum and can be easily capped to prevent gas loss until the analysis is performed.

### Analytical Results

For the Red Desert surveys, helium analyses were performed in duplicate with the U.S. Geological Survey's mobile helium detector (Reimer, 1976) and modified inlet system (Reimer and Denton, 1978). Samples were collected in a hypodermic syringe through a probe at a depth of 1 meter. The soil gas was retained in the hypodermic syringes until analysis, not more than four hours later. Sensitivity was about 10 ppb (parts per billion) helium-in-air for both studies.

The December, 1977, survey was conducted during high winds gusting to 110 km/hr; forty-seven samples were collected in a grid pattern over the 1.25-km<sup>2</sup> area. The July, 1978, survey was conducted when the Winds did not exceed 30 km/hr; fifty-four samples were collected for this survey. Figures 2 and 3 show the contoured results of the December, 1977, and July, 1978, surveys, respectively. The contour interval is 10 ppb. The high winds had a pronounced effect on the concentration and distribution of helium in soil-gas in the first study (fig. 2). The highest helium in soil-gas values are located in an area about 200 meters southeast of the subsurface outline of the economic uranium ore (fig. 3). This anomaly corresponds to the areas of higher radon values described in another study (Pacer and others, 1978).

The overall helium values are low for this area compared to soil-gas values for some other areas also associated with uranium deposits (Reimer and Adkisson, 1977; Brady and Rice, 1977). The average soil-gas helium

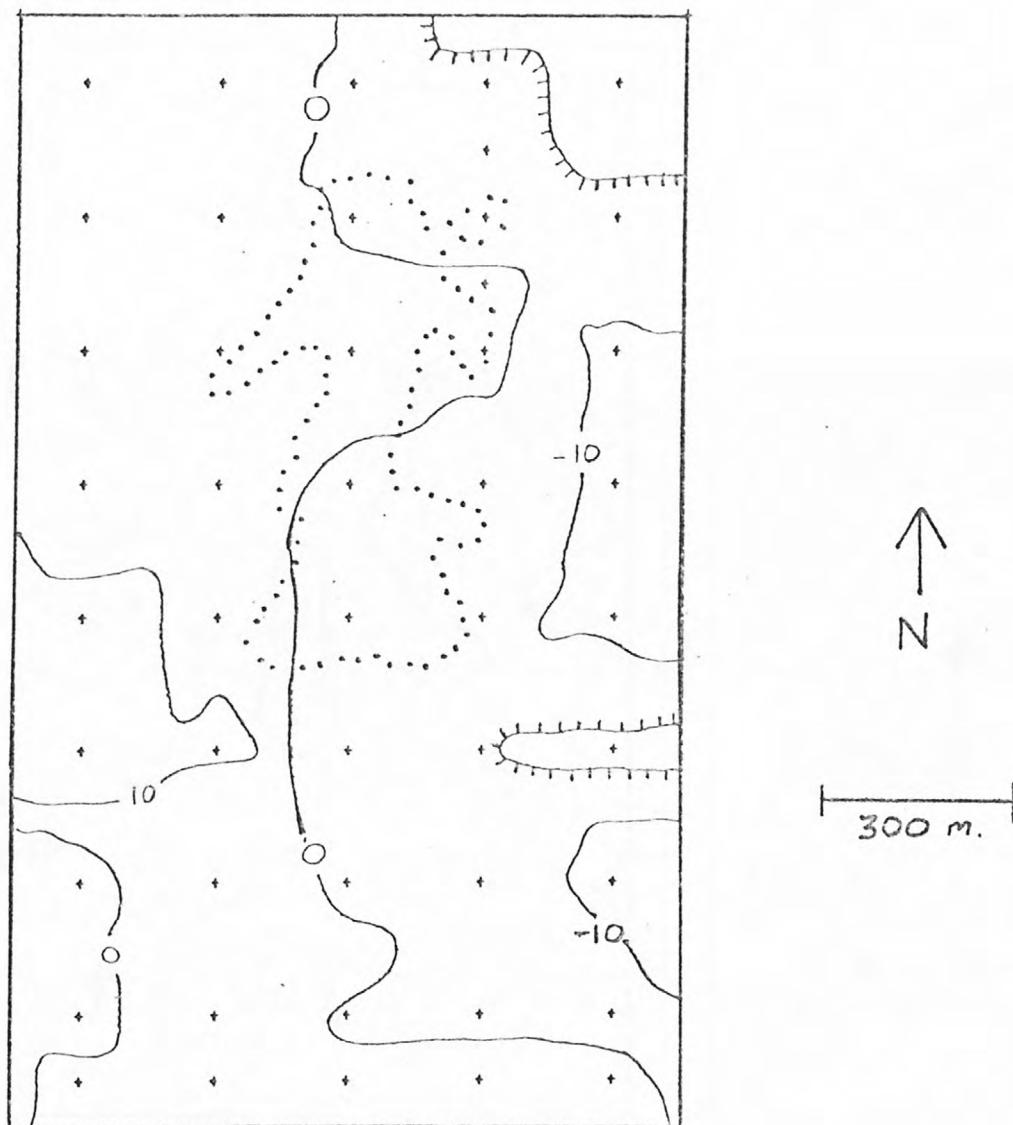


Figure 2.--Contour map of soil-gas helium concentrations for December, 1977, Red Desert area. The enclosed area is 0.9 by 1.7 km. Crosses indicate sample localities. The approximate location of the ore body is outlined by dots. The contour interval is 10 ppb. No distinct contour pattern is present.

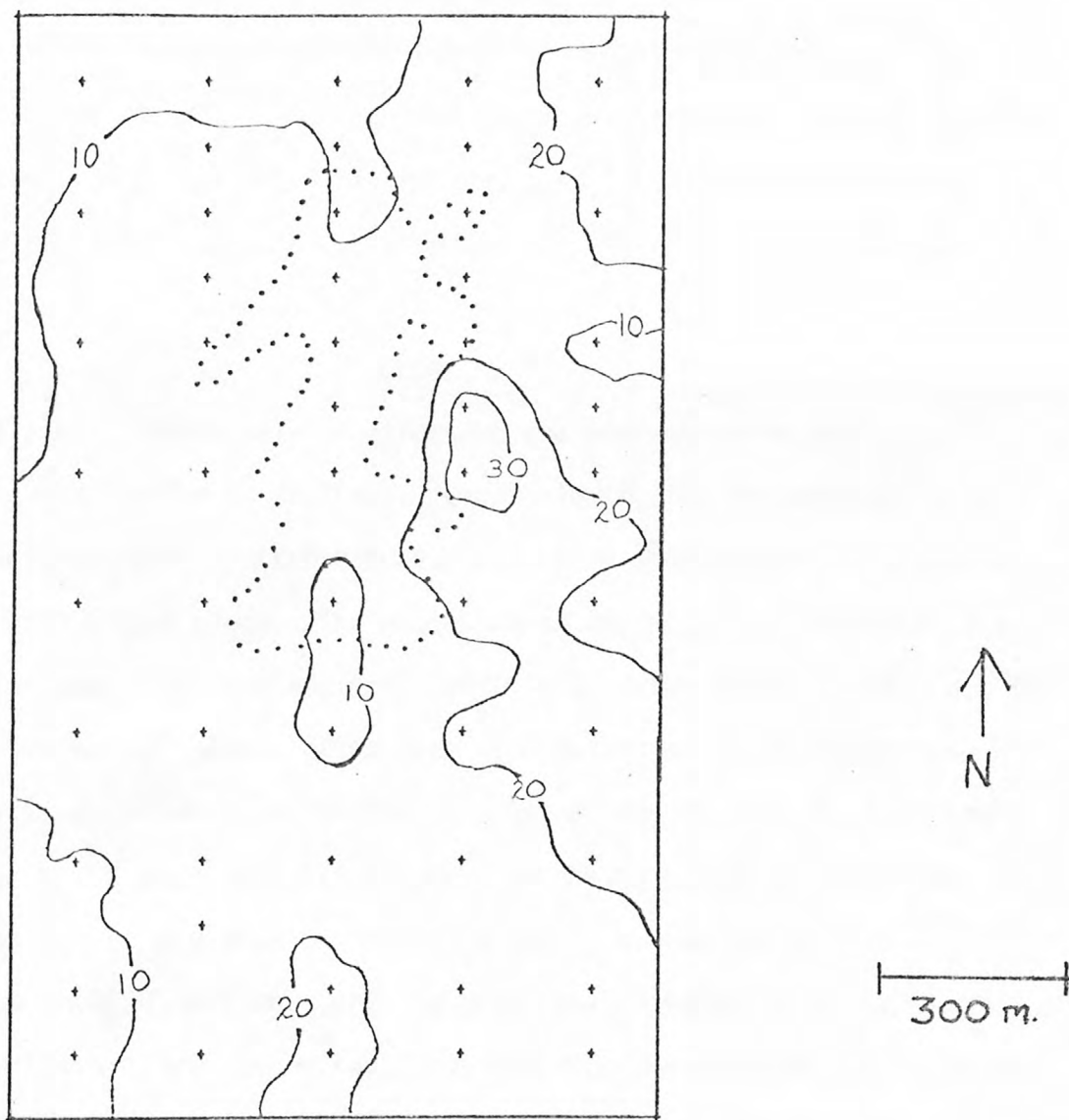


Figure 3.--Contour map of soil-gas helium concentrations for July, 1978, Red Desert area. The enclosed area is 0.9 x 1.7 km. Crosses indicate sample localities. The approximate location of the ore body is outlined by dots. The contour interval is 10 ppb. A distinct contour pattern is present with the highest anomaly southeast of the center of the ore body.



concentration with respect to air at 5240 ppb He, for the December, 1977, study is  $1 \pm 11$  ppb compared to  $15 \pm 9$  ppb for the July, 1978, study. The range of values was -20 to +20 ppb for the first study and 0 to +45 for the second study. Although the averages vary slightly, definite trends are absent in the first study, but present in the second.

### Discussion

Wind plays a major role in affecting the concentration and distribution of helium in soil gas. Even allowing for seasonal effects, such as soil moisture or temperature, the helium concentration, in general, is lower with higher winds. The magnitude of the effect is undoubtedly a function of sampling depth and soil conditions. High winds probably act to decrease the helium concentration by a combination of three mechanisms. The first is direct dilution of the soil gas by the atmosphere, the wind providing the force to push the atmosphere into the upper parts of the soil. The second is a drying effect, whereby the wind increases the evaporation rate of soil moisture, removing that moisture which can both contain helium and trap it in soil pore spaces. The third mechanism is a bernoulli effect where the wind creates a situation at the soil-air interface drawing the gas out of the soil. Although the degree of influence from the individual mechanisms is not known, recovery is fairly rapid (hours), perhaps soil moisture recovery requiring the longest time. In addition, the influence of these mechanisms may not be the same on every constituent of the total soil gas. The predominant effect of the high winds would be for the soil-gas composition to approach atmospheric composition. However, the soil-gas helium values, which are less than the atmosphere concentration, suggest a nonuniform influence by the wind.



The location of the soil-gas helium anomaly shows a slight 200 m displacement toward the southeast with respect to the location of the ore body (fig. 3). The topography suggests the near-surface ground water flow to be in a southerly direction and this may be controlling the location of the soil-gas anomaly. This observation is analogous to another area surveyed in Weld County, Colorado, where rapid ground-water movement caused a 2-km displacement from the subsurface location of the ore body (Reimer and Otton, 1976).

Some additional observations need to be considered as having a possible influence on the location of the soil-gas helium anomaly. The area of the anomaly is adjacent to a slight topographic depression. This feature can control the local direction of surface water flow. The soil in that area probably contains more moisture than the surrounding area and could therefore yield higher soil-gas helium values as was indicated by a previous study (Reimer and Adkisson, 1977).

A second consideration is that this area of the Red Desert contains many areas of uranium mineralization of noneconomic grade. These areas are capable of being detected by a helium survey and may be indicated by very localized (one or two samples) anomalies.

### Conclusion

A soil-gas helium anomaly has been located in association with a low-grade uranium deposit in the Red Desert Area, Wyoming. Wind is a factor in considering the interpretation of the helium data. Ideally, samples should be collected during a period of low, relatively constant winds.

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