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Helium in soil-gas and helium/radon in ground water in the vicinity of a south Texas uranium roll-type deposit

by

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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards.

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Abstract

A survey was run in the vicinity of a south Texas uranium roll-type deposit to determine the general concentration of helium in the soil gas and helium/radon ratios in the ground water for deposits of this nature. The helium in soil-gas concentrations are typical of the concentrations found associated with other low-grade uranium deposits in other areas. The distribution of the values probably reflects local structure and is influenced by surface activities such as farming and mining. The helium/radon ratios in water strikingly reveal the known orebody, and some samples taken for background information may indicate the presence of nearby mineralized areas.

Introduction

A limited helium and radon survey was performed at the Lamprecht mine, Live Oak County, Texas, to establish a general idea of what helium soil-gas concentrations and helium/radon ratios in ground water might be expected for similar types of deposits in the area.

The host rocks for the orebody are the basal sands of the Oakville Sandstone (Miocene). These sands are overlain by about 70-90 m of clays and cemented sandstones. The strata dip to the southeast and the Oakville outcrops 2.5 km to the northwest. A normal fault is known to occur toward the southern end of the orebody and may continue along the roll front. The ore is below the water table and ground water movement in the vicinity of the orebody is generally towards the northeast.

One hundred and four soil-gas samples were collected in a 4 km^2 area (fig. 1) and eight ground-water samples were collected, four of which were from wells at the ore deposit and the remaining four as much as several kilometers from the deposit (fig. 2).

Sampling and analysis

The sampling procedure for collecting soil gas was to drive hollow 1-m probes into the ground, purge the probe by withdrawing 10 cm^3 of gas in a hypodermic syringe, and collecting another 10 cm^3 for analysis. Water samples were collected in 1-liter plastic bottles, which were filled three-fourths full. The bottles were capped and shaken for 30 seconds to degas the water; after the bottles stood for 2 minutes, they were overpressurized by injecting air through a septum attached to each bottle cap and the sample was withdrawn into the hypodermic syringe. A 10-cm^3 sample was for helium analysis and a 50-cm^3 sample was drawn for radon analysis.

Analysis for helium was performed using the U.S. Geological Survey's mobile helium analyzer (Reimer, 1976). Analysis for radon was performed using a fixed-volume alpha scintillometer (Reimer, 1977). Analytical sensitivity for helium was about 10 ppb with about equal precision. The analyses for soil gas are reported as parts per billion (ppb) with respect to air which contains 5,240 ppb helium; for water, helium is reported as 10^{-8}cc He/cc H_2O where 4.5 x 10^{-8} cc He/cc H_2O is the equilibrium helium concentration of water with the atmosphere at standard temperature and pressure (STP).

Radon analyses are reported as relative values using counts per minute (cpm) as the reporting unit. The radon analyzer was not calibrated before this study; therefore, the relative values were used.

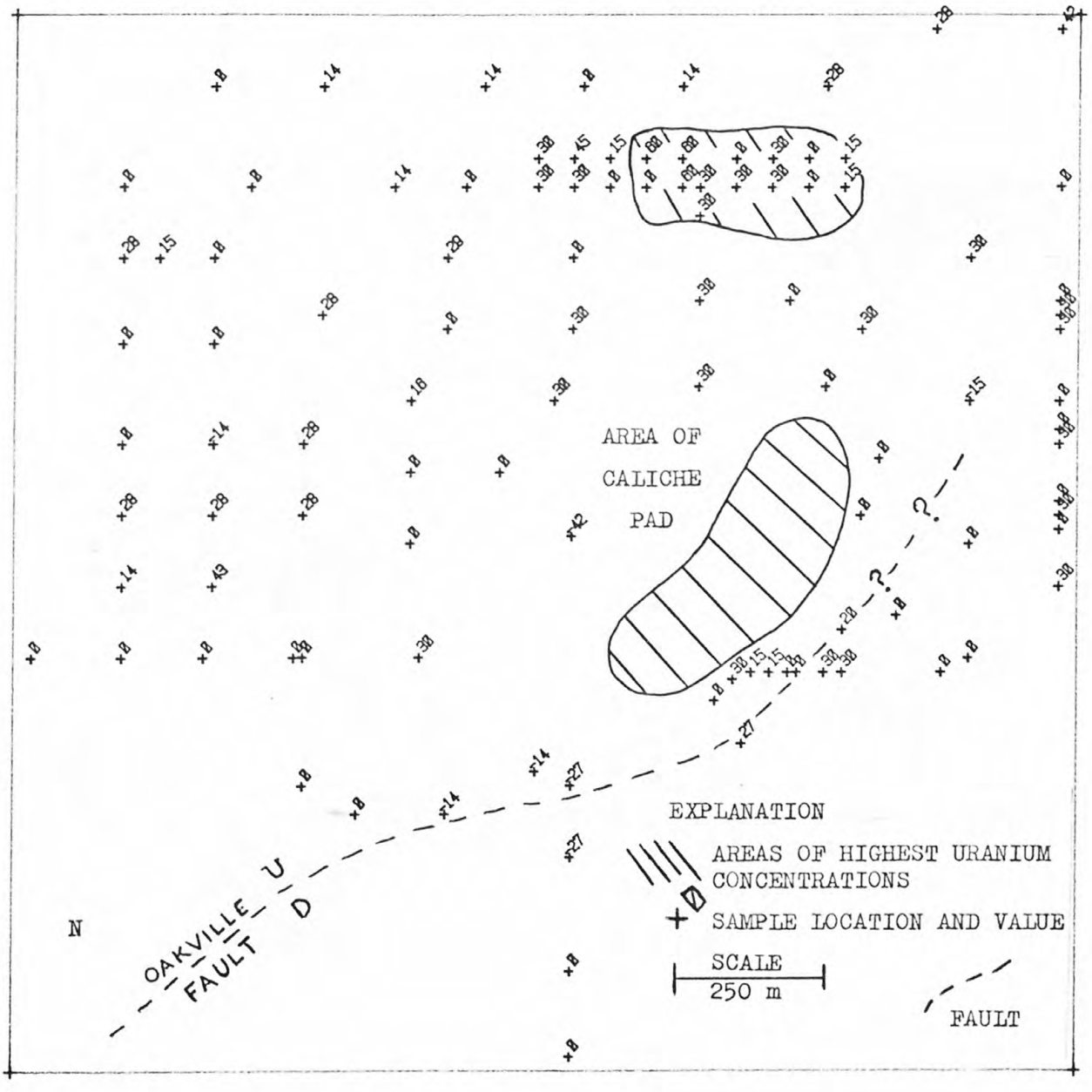

Figure 1.--Helium concentration and relative location of soil-gas samples collected in the vicinity of the Lamprecht orebody, Texas. The crosshatched area is the approximate outline of the areas of highest uranium concentration. The crosses mark the soil-gas sampling locations and give the concentration in ppb with respect to air at 5,240 ppb helium. The exact position of the northeast extension of the fault is not known.

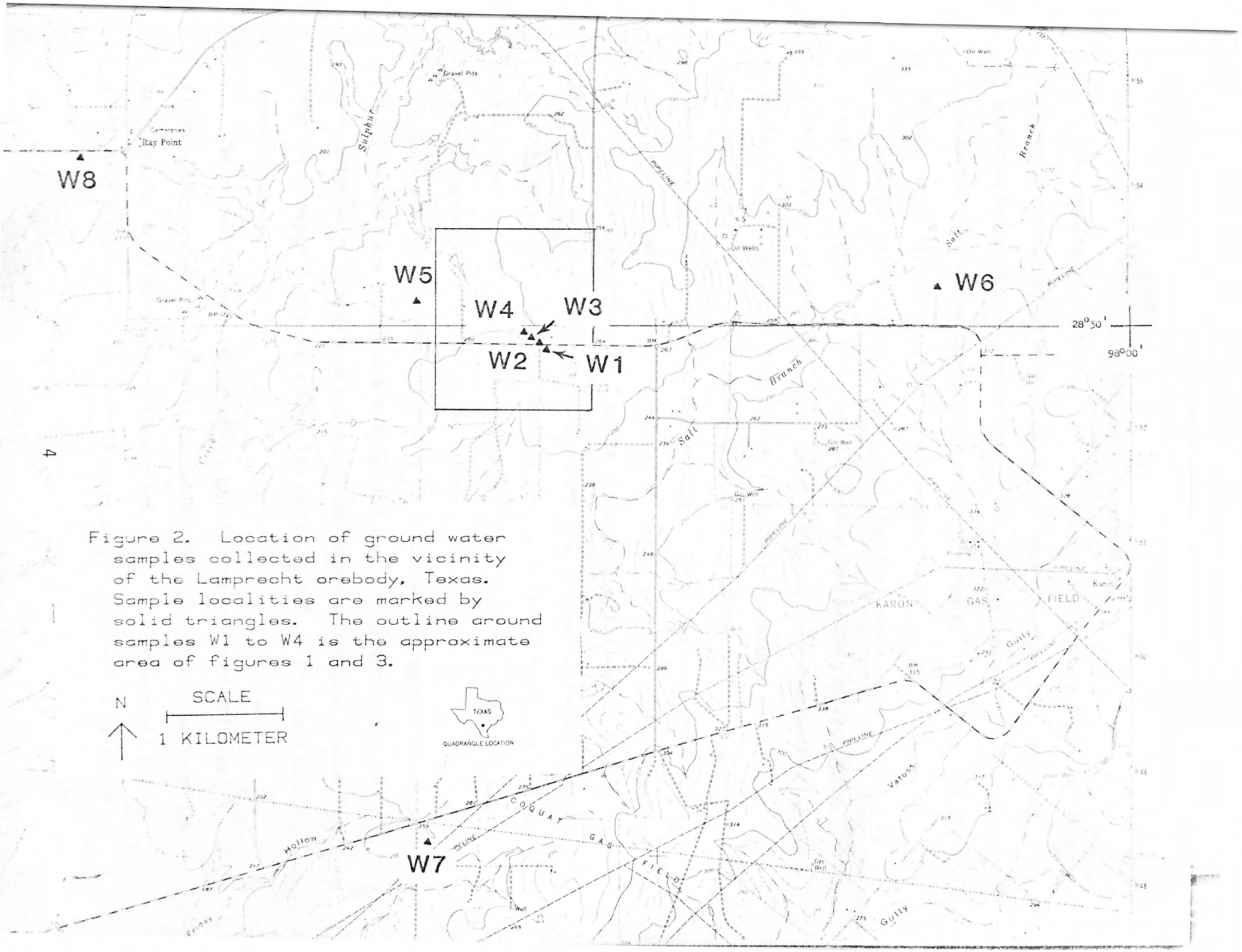

Figure 2. Location of ground water samples collected in the vicinity of the Lamprecht orebody, Texas. Sample localities are marked by solid triangles. The outline around samples W1 to W4 is the approximate area of figures 1 and 3.

Data and Interpretation

The results of the helium soil-gas analyses are shown in figure 3. This figure, a contour map using a 20 ppb helium interval, shows two areas that appear to be anomalous. The one area is dominated by low helium values near the southern end of the sample area and near the fault. The second area of higher values is over a portion of the orebody.

Soil-gas helium values that are less than the concentration of helium in the atmosphere gas, like those seen in the southern section of the sample collection area, indicate the presence of other gases effectively diluting the helium or, alternatively, helium being preferentially removed or redistributed. Diluting gases in the study could be from: (1) leakage of gases from deeper origin along the fault; (2) production of gases by plant metabolism or decay from the more abundant vegetation in the southern section of the sample area. The supply of the diluting gases can in turn be distributed by ground water recharge moving down the fault, thereby further altering helium concentrations measured just below the surface. The helium data do not provide direct information to explain what mechanism might be controlling the distribution of low values.

Soil-gas helium values higher than the atmospheric concentration, as seen in the northern end of the sample collecting area, are interpreted as being representative of an area that can supply and retain helium to a greater level than the atmospheric concentration. The obvious supply in this case is the uranium orebody.

The overall soil-gas helium values in this area are relatively low. Although they are not unlike those concentrations seen in the vicinity of low-grade uranium deposits elsewhere (Reimer and Otton, 1976; Reimer and Bowles, 1979), they are substantially lower than the several hundred ppb helium noted

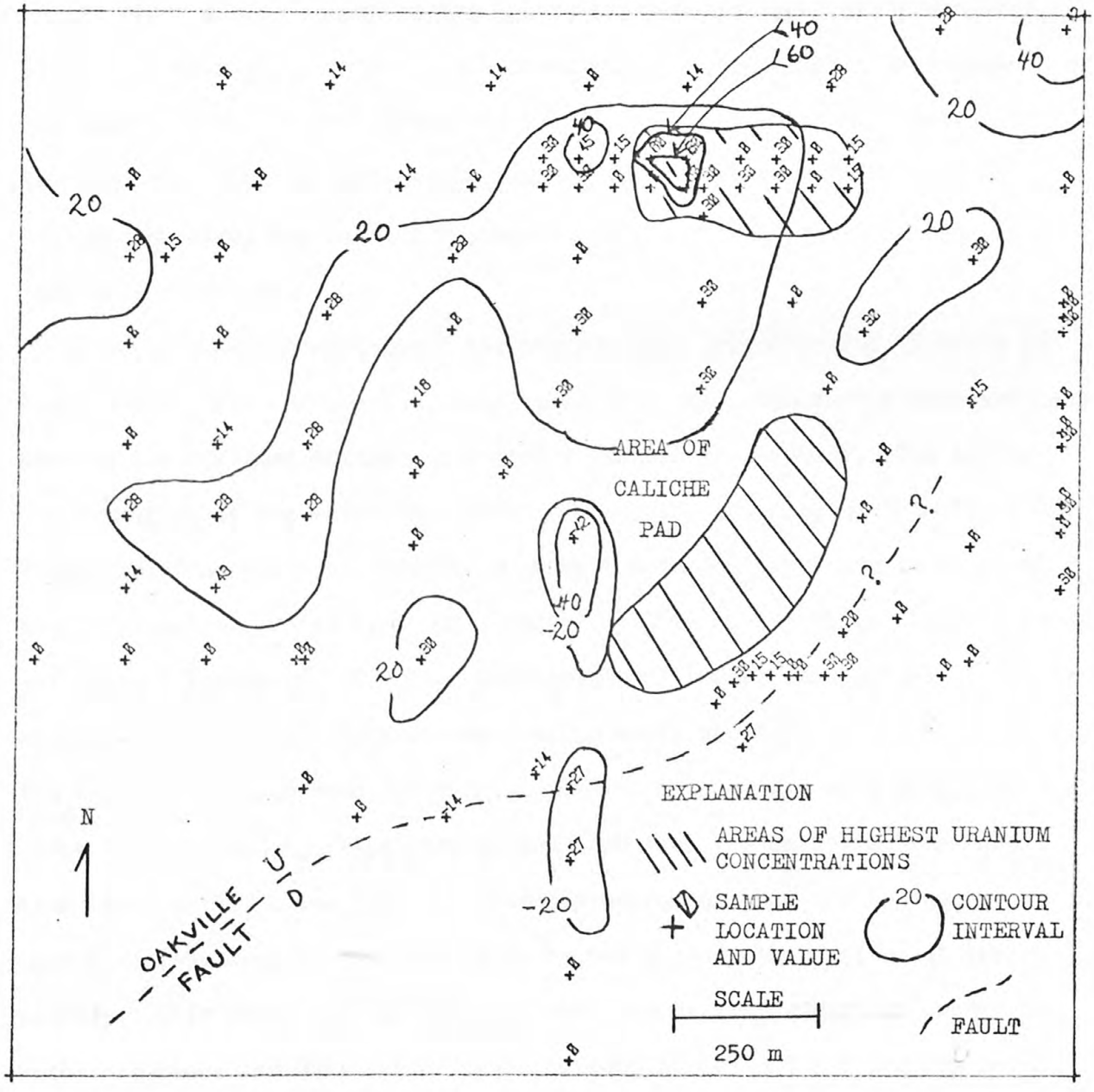

Figure 3.--Contour map of the helium soil-gas concentrations for samples collected in the vicinity of the Lamprecht orebody, Texas. The contour interval is 20 ppb with respect to a base line regarded as the helium concentration in air. Only contours of helium greater or less than the air concentration are shown. The region of the highest soil-gas helium concentrations is located in the northern part of the sampling area over an area of high uranium concentration.

around other deposits such as the Grants uranium district (Brady and Rice, 1977). In this study, the surface where the soil-gas samples were collected has been modified by the mining and farming, both of which may contribute to lowering the relative soil-gas helium contents. Therefore, the soil gas helium concentrations may not be representative of what might be seen at a less disturbed area.

The helium/radon ratios of the ground water are presented in table 1. Four samples, W-1 through W-4, were taken from wells about 90-m deep and cased down to the ore-sand horizon in a profile across the orebody. The helium concentration of the water from these wells was high, ranging from 15 to 40 times the atmospheric concentration of helium in equilibrium with water at STP. The helium varied by about a factor of 3 in this profile, but the radon varied by a factor of 100. Four additional wells were sampled away from the orebody. Samples W-6 and W-8 were shallow wells about 20-m deep and both had low helium and radon concentrations. Samples W-5 and W-7 were deeper wells about 70 m and 160 m, respectively, and both from the Oakville Sandstone. From these wells, water had low radon concentrations but the helium concentrations were in the same range as the ground-water helium at the orebody. This relationship indicates that the helium concentration may be high throughout the Oakville or that the samples W-5 and W-7 are representative of areas that are close to other uranium occurrences but yet not close enough for the radon concentrations to be high. Ground-water samples collected closer to a mineralized zone would presumably show a decreased He/Rn ratio as the Rn component increased. The observation of similar helium concentrations throughout the Oakville suggests that the helium distribution in the ground water may not have been significantly affected by the recent mining activity.

Conclusion

Ground-water analysis for helium and radon in the vicinity of a known uranium orebody in south Texas showed both high helium and radon concentrations. A helium soil-gas survey over the orebody showed only minor anomalies which were probably controlled by local structure.

Ground-water samples taken for background information in the host-rock formation showed high helium and low radon concentration. It is possible that a reconnaissance ground-water sampling program that incorporated helium and radon analysis along with other geochemical analyses would be very useful as an exploration tool in the south Texas area.

Table 1.--Helium and relative radon concentration and ratios of ground-water samples collected in the vicinity of the Lamprecht uranium deposit, Live Oak County, Texas

[See figure 2 for location of the samples]

Sample Number	Helium $cm^3He/cm^3H_2O \times 10^8$	Radon (counts/minute)	He/Rn (relative)	Well depth (in meters)
W1	95	1,600	0.059	90
W2	172	15,100	.011	90
W3	63	120,000	.0005	90
W4	81	1000	.081	90
W5	71	30	2.36	70
W6	5.5	320	.017	20
W7	105	80	1.62	160
W8	5	80	.063	20

References

Brady, B. T., and Rice, R. S., 1977, Helium determinations as an exploration technique at the Ambrosia Lake uranium district, McKinley County, New Mexico: U.S. Geological Survey Open-File Report 77-669, 8 p.

Reimer, G. M., 1976, Design and assembly of a portable helium detector for evaluation as a uranium exploration instrument: U.S. Geol. Survey Open-File Report 76-398, 18 p.

_____1977, Fixed-volume gas inlet system for an alpha-sensitive cell adapted for radon measurement: U.S. Geological Survey Open-File Report 77-409, 3 p.

Reimer, G. M., and Bowles, C. G., 1979, Soil gas helium concentrations in the vicinity of a uranium deposit, Red Desert, Wyoming: U.S. Geological Survey Open-File Report, 79-975, 9 p.

Reimer, G. M., and Dean, V. C., 1979, Computer program for the Hewlett-Packard-9825A to contour and plot data collected from helium surveys: U.S. Geological Survey Open-File Report 79-865.

Reimer, G. M., and Otton, J. K., 1976, Helium in soil gas and well water in the vicinity of a uranium deposit, Weld County, Colorado: U.S. Geological Survey Open-File Report. 76-699, 10 p.