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The Influence of Meteorological Parameters on Soil Gas Radon

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ABSTRACT

The radon emission is continuously monitored for one year period at a non-mineralized site to study the time variation in soil gas radon. These variations are related to the simultaneous measurements of meteorological parameters viz.temperature, barometric pressure, rain fall, humidity and wind velocity which might influence the gas emission process. A correlation matrix analysis is computed for entire data set, in order to quantify the relationship between radon emission and secondary influences. The radon emission is positively correlated with temperature and wind velocity. It also shows the weak inverse relation with barometric pressure, humidity and rainfall. The integrated radon data shows better correlation with various meteorological variables.

INTRODUCTION

Radon is constantly emanating from the earth into the atmosphere, normally in minute amount by the omnipresent radium in the crustal materials. The emission of gas from the earth's crust is a complex process influenced by meteorological and seasonal processes which must be understood for effective application of gas emission to geochemical exploration. The use of gaseous species in exploration geochemistry potentially offers a significant advantage over the techniques involving solid media.

Measurement of gas in the open air is complicated by wind dispersion. Soil gas measurements are not as strongly affected by secondary dispersion processes as are atmospheric measurements. Kraner (1964) found precipitation and wind influences on radon concentration in soil gas. Fleischer et al (1979) has reported preliminary results of time variation of soil gas radon over a uranium deposit. The objective of the present study is to determine the time variation in radon emission for one year at a single unmineralized site and to relate these variations to simultaneous measurements of meteorological variables which might influence the gas emission process. The variables are summarized in Table 1.

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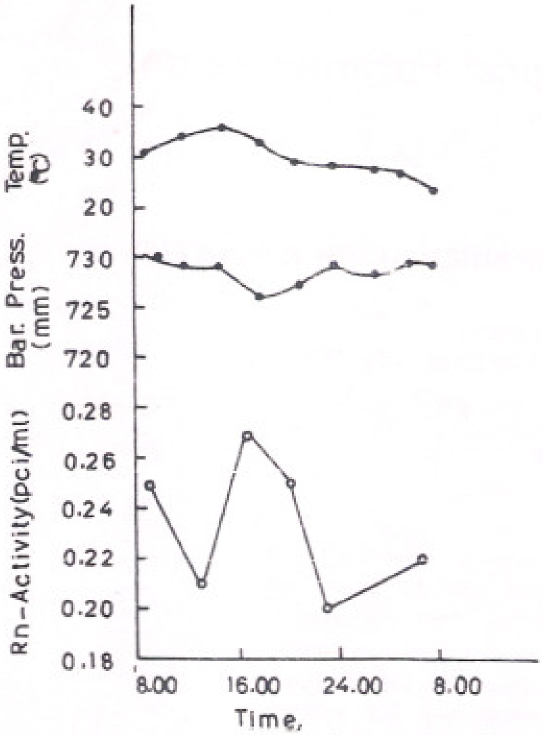

Fig. 1: Plot of radon emission, temperature and barometric pressure for the period of 24 hrs.

EXPERIMENTAL METHOD

The short term integrated technique using Alphameter-400 is employed for soil-gas radon measurement. Alphameter-400 (Alpha Nuclear Company, Canada) contains a 400 mm^2 diffused junction (DJ) detector for the detection of alpha particles striking the active surface of the detector which are counted and stored until a read mode is initiated. It's sensitivity is such that a 24 hrs exposure gives sufficient counts in most of the soils (Gaucher 1976 and Warren 1977). The detector unit is placed in the auger hole about 50 cm in depth for one day and the accumulated alpha activity read the next days. The meteorological variables viz. the temperature, wind velocity, humidity barometric pressure and rainfall are continuously measured using maximum minimum thermometer,annemometer, hygrometer, Fortin barometer and rain gauge respectivaly.

RESULTS AND DISCUSSIONS

Fig.1 is a plot of 24 hrs data for radon emission, the barometric pressure and the air temperature. The radon data recorded on sunny day (23.6.1984) shows clear diurnal variation and is usually peaked in the afternoon (4 or 5 p.m. local time) when the barometric pressure is at its daily minimum. Similar variations are recorded by some other authors (Tanner 1980, Ball et al. 1983 and King 1985) and may be due to the diurnal behaviour of temperature and barometric pressure. The results for the variation of soil gas radon with barometric pressure, air temperature, rainfall, wind velocity and humidity against the dates of measurements from April to September, 1984 and October, 84 to March 1985 are illustrated in Fig. 2 and 3 respectively.

The radon concentration is found to decrease with increase of barometric pressure from September, 84 to mid January, 1985 (Fig. 2 and Fig. 3). Thereafter the radon concentration increases with decrease in pressure. This shows a weak inverse relation (correlation coefficient is -0.29 for 30 days) of radon release with barometric pressure. A varying barometric pressure may exert a pumping effect on the soil gas. These investigations corroborate the findings by other authors (Gableman 1972, Clements and Wilkening 1974, Tanner 1978 and Dyck et al. 1983).

Both the radon concentration and temperature values are relatively high from April to August 1985 and drop to significantly lower values, thereafter. However the decrease in temperature is followed by several weeks. The radon emanation experience a resurgence in early January and is not accompanied by corresponding temperature rise. The prominent annual cycle in temperature data is not shared by the radon data. An increase in surface temperature

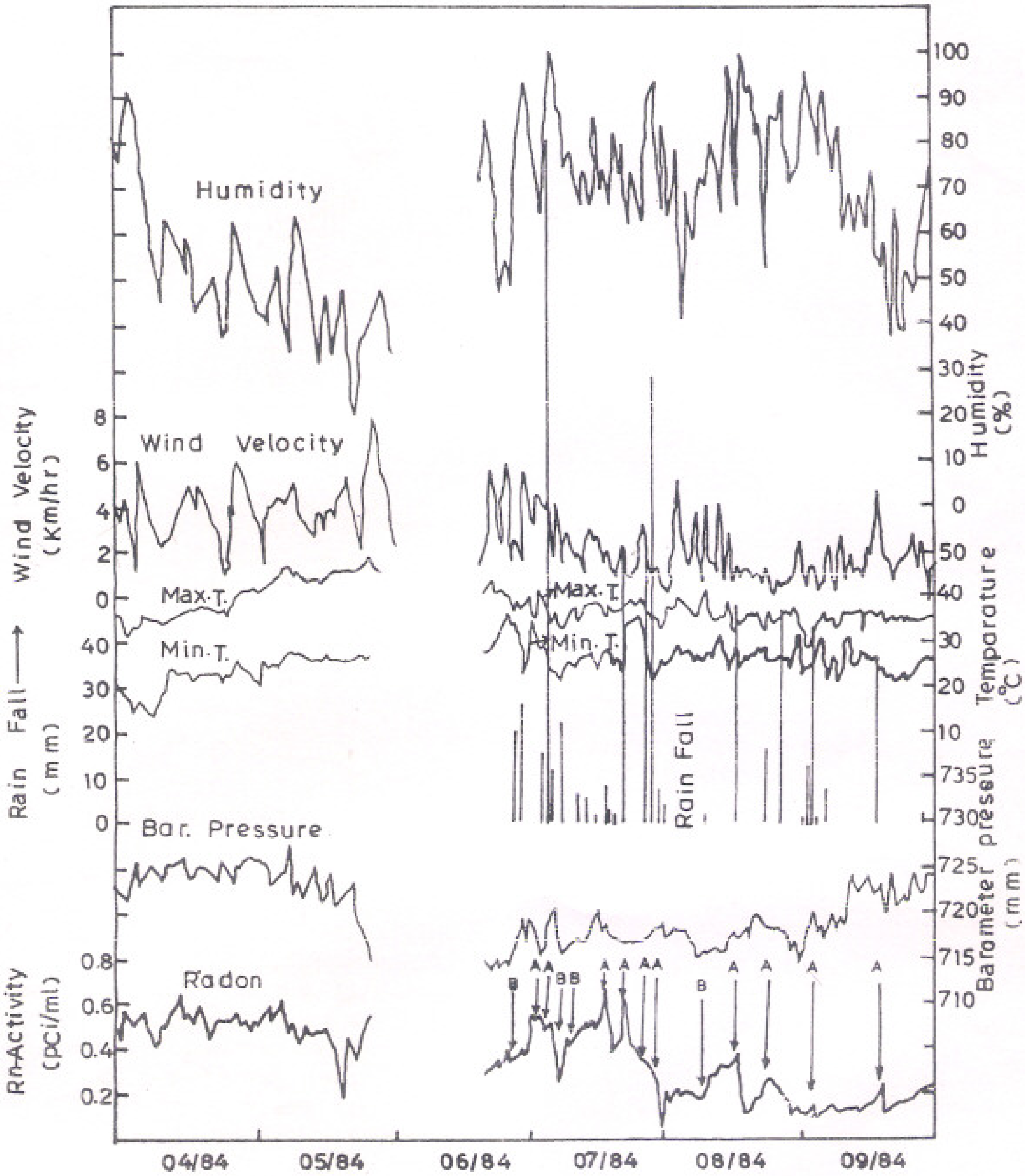

Fig. 2. Daily variation of soil gas radon, barometric pressure, maximum and minimum temperature, wind velocity, rainfall and humidity from April, 1984 to September 1984.

not only causes soil air to expand and escape but also tends torelease vapour species absorbed to the surface soil particles. Apositive correlation is observed between radon emission and temperature (Table 2).

The radon activity falls drastically after heavy rainfall and starts increasing (events A) considerably thereafter (Fig.2). This reduction in soil gas radon may be due to the presence of high humidity and moisture in the soil which dissolves

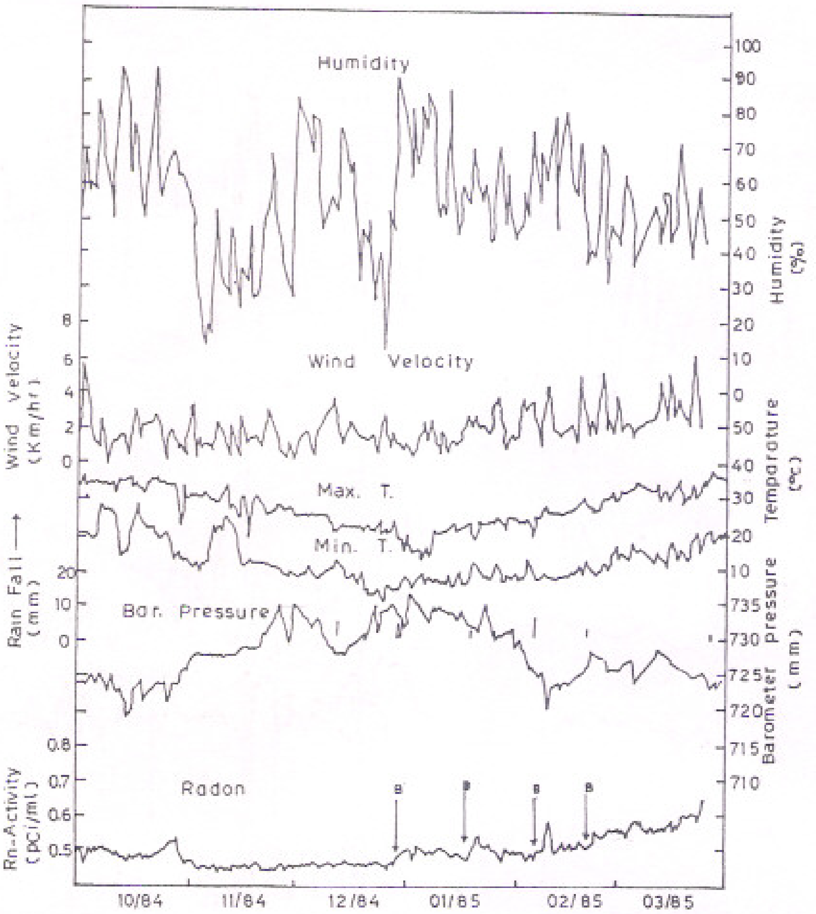

Fig. 3. Daily variation of soil gas radon, barometric pressure maximum and minimum temperature wind velocity, rainfall and humidity from October, 1984 to March 1985.

the diffusing radon and the deep percolation of rain water removes the radon by transport mechanism. Gableman (1972) and Ghosh and Bhalla (1981) also found an inverse relationship between heavy rainfall and radon activity. In case of light rain or drizzle (Fig. 2 and 3) the radon values show an increase (event B). This may be due to the closure of capillary pores on the upper surface of soil by light shower. The emanation from the top layer of the soil is stopped resulting in the accumulation of radon below the impervious layer and is available in excess at the bottom of the auger hole.

The radon content increases with the increase of wind velocity (April to June, Fig.2) and decreases thereafter due to fall in wind velocity (Fig.3). This shows that the radon release is directly related with the wind velocity. The strong winds are another possible cause for the flow of soil air in summer seasons.

In order to quantify the relationship between radon emission and secondary influences, a correlation matrix is computed for entire data set. In addition to the daily interval data, an average radon concentration is calculated for one, two and four weeks periods (Table 2). The radon emission is positively correlated with maximum temperature and the wind velocity. However it shows a weak positive relation with the minimum temperature. It also shows weak inverse relation with the barometric pressure, humidity and rainfall. The integrated radon data shows the better correlation with various meteorological variables.

CONCLUSIONS

The radon release is related directly with the air temperature and wind velocity and inversly with the barometric pressure, humidity and rainfall. The radon shows diurnal behaviour due to the diurnal variations in temperature and barometric pressure.

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Table 1 : Variables measured in the study

Measurement	Frequency	Instrument used
Radon	Daily	Alphameter-400
Maximum temperature	Continuos	Thermometer
Minimum temperature	Continuos	Thermometer
Relative humidity	Continuos	Hygrometer
Barometric pressure	Continuos	Fortin's Barometer
Wind velocity	Continuos	Annemometer
Rainfall	As it occurs	Rain guage

Table 2 : Correlation of radon emission with meteorological variables.

Variables	Correlation Coefficients			
	Daily	7 days	15 days	30 days
Maximum temperature	0.36	0.40	0.44	0.52
Minimum temperature	0.11	0.20	0.24	0.30
Barometric pressure	-0.21	-0.23	-0.26	-0.29
Wind Velocity	0.42	0.64	0.63	0.85
Humidity	0.02	-0.04	-0.05	-0.12
Rainfall	-0.09	-0.11	-0.08	0.05