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RADON SURVEY FOR URANIUM PROSPECTION USING ALPHA DETECTORS

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ABSTRACT

The results of radon survey for uranium prospection using alpha track detector and radon emanometer in some geological area are reported. The Rn-Th discriminator with plastic track detectors in which air column acts as diffusion barrier is employed for separating Rn from Th.

KEY WORDS

Radon; thoron; tracks; uranium; plastic detector.

INTRODUCTION

The measurement of radon (Rn-222) in soil gas aids in uranium exploration by indicating the presence of burried ore deposits. The radon measurement technique involves the detection of alpha emission from the gas fraction of radon and its decay products. Emanometers were the earliest devices used to measure the radon and are still widely used for U exploration (Tewari et al, 1968; Ghosh and Bhalla, 1981). Another technique involves soil gas migration into inverted cups having alpha sensitive plastic track detectors which record their time integrated exposure (Fleischer et al, 1975; Gingrich and Fisher, 1976; Ghosh and Soudararajan, 1984).

The radon measurements were carried out in Chhinjra Valley, Kasol near Kulu and Andretta in Kangra Valley (Himachal Pradesh), Paritibba and Maldeota on Mussorie Syncline (Uttar Pradesh) for uranium prospection using the radon emanometer and the track etch method. The geological overlain by Chlorite schists and gneisses. The phosphorite horizon of Mussorie syncline in the lesser Himalayan region of Uttar Pradesh occurs at the transition zone between the underlying krol limestones and the overlying tal shales and sandstones and has intercalations of chert and black shales.

EXPERIMENTAL TECHNIQUE

An auger hole about 50 cms in depth and 6 cm in diameter is made in the soil and is left closed for 24 hrs so that the amount of radon and thoron becomes stable. The gas from the auger hole is pumped into the scintillation cell with the help of a hand operated rubber pump connected in a closed circuit (Tewari et al., 1968; Ghosh and Bhalla, 1981). After a period of 4 hrs when radon has come in equilibrium with its alpha emitting daughters (RaA and RaC), the count rate is recorded.

In radioactive surveys there used to be difficulties in interpretation of anomalies in thoriferrous areas. In order to separate thoron signal from radon, some methods for their discrimination using SSTD have been reported (Fisher, 1976; Gingrich and Fisher, 1976). In the present investigations this has been achieved by using Rn-Th discriminator which is an aluminium cylinder (25 cm length and 4.5 cm diameter) consisting of a film holder (Fig.1). The air column in the cylinder act as a diffusion barrier. Due to the large difference in half lives of Rn-222 and Rn-220 (3.82 days and 54.5 sec respectively) the lengths they can travel before decay also differ by a large factor.

Consider the migration of Rn-222 in any particular direction. In the steady state, if N_o is the concentration at the source, then the concentration N at a distance x from the source is given by:

$$N = N_o \exp\left(-\sqrt{\lambda/D}\, x\right) \qquad \ldots \qquad (1)$$

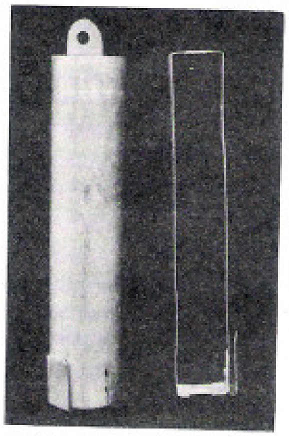

Fig.1. Radon - thoron Discriminators

where λ is the decay constant of Rn-222 or Rn-220 and D is the diffusion constant of the gas in the medium. The samples of U and Th rich ores assaying 1.54% U_3O_8 with 0.56% Th and 2.11% Th with 0.30% U_3O_8 respectively were placed at the bottom of the hollow cylinder (100 cm in length and 4.5 cm in diameter). The detector films were suspended at different heights in the cylinder. The variation of alpha track density as a function of distance from the source is plotted on a semilog graph paper (Fig.2). The track density due to Rn-220 is very much reduced within 25 cm of height of the air column, while in the case of Rn-222 there seems to be no appreciable change. Thus the air column of this length can discriminate Rn-222 from Rn-220. The percentage transmission as calculated theoretically from eq(1) with D = 0.37 cm^2 sec^{-1} for air column of 25 cm lengths are 94 and 0.7% respectively (Fig.3). The lower detector in the discriminator given the track due to Rn-222 and Rn-220 both where as the upper detector records the tracks due to Rn-222 alone. These discriminators were burried in an auger holes each of 50 cm depth in the area surveyed for a period of 1-3 weeks. The retrieved films were etched and scanned for the track density measurements.

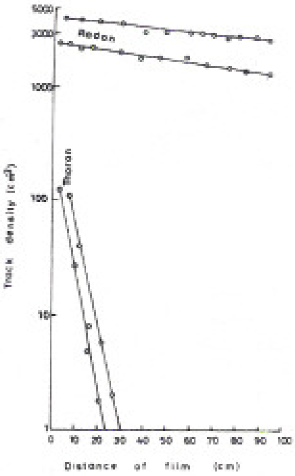

Fig.2. Change of track density with distance from the source.

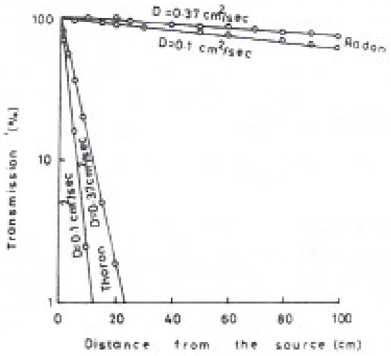

Fig.3. Theoretical plot of eq(1) for radon and thoron.

RESULTS AND DISCUSSION

All the areas surveyed have registered higher value of Rn-222 than the Rn-220 (Table 1) which proves the uraniferrous nature of these areas. The radon values recorded with the SSTD films are higher than those obtained with the radon emanometer (Table 2). This shows that SSTD is more sensitive because its placement in the soil for longer period records the weak signals from greater depths.

Table 1: Radon-Thoron Content at different sites.

Location	Mean Track Density* (Track/mm^2/hr) due to		
	Rn + Tn	Rn	Tn
Himachal Pradesh			
Chhinjra	1.345	1.106	0.239
Andretta	0.141	0.099	0.042
Kasol	10.710	10.034	0.676
Uttar Pradesh			
Paritibba	0.393	0.321	0.072
Punjab			
Amritsar	0.172	0.125	0.047

*Exposure period 1-3 weeks

The statistical treatment of the data include the determination of the mean ($\bar{x}$), the standard deviation (1σ) and signal-to-background contrast. The signal-to-background contrast was determined by taking the ratio of the mean of the values greater than one standard deviation above the overall mean of the population to the overall mean of the population.

$$\text{Signal/Background} = \frac{\text{Mean of Measurements} + 1\sigma}{\text{Mean of population}}$$

This quantity indicates the relative magnitude of an anomalous radon signal. In the same geological area this ratio for radon measurements recorded with radon emanometer is stronger than obtained with track etch method. The lower signal-to-background ratio produced by track etch method may be due to an inherent background with these measurements. This ratio is maximum in the Chhinjra and Kasol area. These zones are known for uranium mineralization (Udas and Mahadevan, 1974).

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Table 2: Statistical parameters of soil gas Rn-222 at different sites

Research Site	Radon Emanometer					Track Etch Method				
	Mean ($\bar{x}$)	Std. Dev.*	Min. Value	Max. Value	Sig./ B.G.	Mean ($\bar{x}$)	Std. Dev.*	Min. Value	Max. Value	Sig./ B.G.
Himachal Pradesh										
Chhinjra	1.60	3.39	0.12	15.34	9.96	2.47	4.47	0.26	20.18	8.17
Kasol	12.24	27.54	0.21	27.54	7.65	21.72	37.47	0.64	118.53	5.46
Andretta	-	-	-	-	-	0.22	0.06	0.17	0.36	1.63
Uttar Pradesh										
Paritibba	0.40	0.47	0.06	1.90	4.36	0.72	0.67	0.02	2.44	2.67
Maldeota	0.93	0.86	0.05	2.85	2.79	-	-	-	-	-
Punjab										
Amritsar	0.15	0.06	0.06	0.26	1.73	0.27	0.07	0.16	0.34	1.39

*Standard Deviation (1σ)

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