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Radon–Thoron Discrimination Using a Polythene Foil: an Application in Uranium Exploration

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Abstract—Integrated measurements of radon concentrations in subsurface soil are being used extensively for uranium exploration and earthquake prediction. For uranium exploration only the radon signals are needed, however a part of the α-activity may derive from thoron. To exclude thoron, a polythene foil has been used as an anti-thoron membrane to delay the entry of thoron into the detector system so that only the longer lived isotope ^{222}Rn survives to be measured. A long term integrated measurement has been carried out using LR-115 and CR-39 plastic track detectors. The observed track density has been determined as a function of foil thickness. It is found that a polythene foil of appropriate thickness could be successfully employed for the separation of radon and thoron in soil.

1. INTRODUCTION

Plastic track detectors are widely used for radon measurements in air and in soil under different environmental conditions. The measurement of radon in soil gas is recognized as a useful technique for uranium exploration and earthquake prediction.[1–9] In field observations, the general intention is to measure only radon (^{222}Rn) for uranium exploration, however a part of the α-activity may be due to thoron (^{220}Rn) derived from thorium. In order to separate radon from thoron, several workers have proposed to cover the open end of the radon measuring vessel with a permeation foil.[10,11] The use of an air column as a diffusion barrier has also been reported.[7,12] Data related to the permeability of plastics to radon are hardly available in the literature. However, some results have been reported recently by Pohl-Ruling *et al.*[13] and Jha *et al.*[14] by using ionization chamber and scintillation detection methods, respectively.

The aim of the present work was to separate radon from thoron signals by using polythene foil as a permeation barrier. Polythene (polymer) is easily available and has the ability to permit the entry of radon and thoron. However, due to the large difference in half-lives of radon and thoron the permeability factor for radon is different from that of thoron which makes it useful for separating these two isotopes.

2. METHODS OF MEASUREMENT

Measurements of radon have been carried out using LR-115 type II and CR-39 plastic track detectors with uranium-rich ore (Pitch-Blende) as a radon source. In this laboratory experiment, an aluminium cylinder 20 cm in height and 4.5 cm dia with a screw cap on one end was deployed vertically (Fig. 1). The radon source is placed at the bottom of the cylinder in the cavity of the screw cap. A cord carrying detector films at different heights in the cylinder was fixed at the upper end and was stretched by applying a heavy load on the lower end. The lower detectors were kept at a distance of 10 cm from the source in order to protect them from the alpha particles emitted directly from the source. The entire system is sealed and the plastic detectors are left exposed for a period of one week. The experiment is repeated for varying thicknesses of polythene foil.

Similar observations were taken using monazite sand as a thoron source. The detector films were then retrieved, etched and scanned for track density measurements.

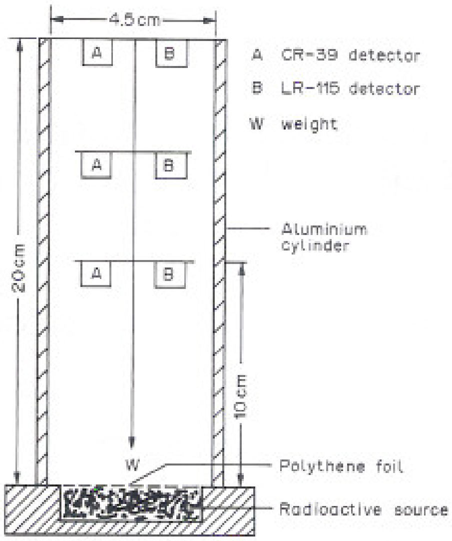

Fig. 1. LR-115 and CR-39 detector films exposed to radon and thoron atmosphere in cylinder.

3. RESULTS AND DISCUSSION

The results for the variation of track density as a function of foil thickness at three different heights, viz. 10, 15 and 20 cm from the source point are plotted in Figs 2(a), (b) and (c), respectively. From these figures it is evident that the track density due to thoron reduces to almost a negligible value for a foil thickness of 30 μm, while in the case of radon there appears to be no appreciable change. Because of the large difference in half-lives of radon and thoron, most of the thoron and almost none of the radon decays in transit through the barrier, and thus only the longer lived isotope, ^{222}Rn, survives to be measured. Both the radon and thoron concentrations are found to decrease with height. The radon value is found to be a maximum at a column height of 10 cm, hence a soil gas probe with a height of 10 cm and covered at the lower end with a polythene foil 30 μm thick is suggested for radon measurements in the field. The plastic track detectors may be fixed at the upper end of the cylinder in order to record tracks due to radon alone. The foil thickness is found to be less than that reported by Ward *et al.*[9] using a copolymer of dimethyl siloxane and polycarbonate as the permeable barrier.

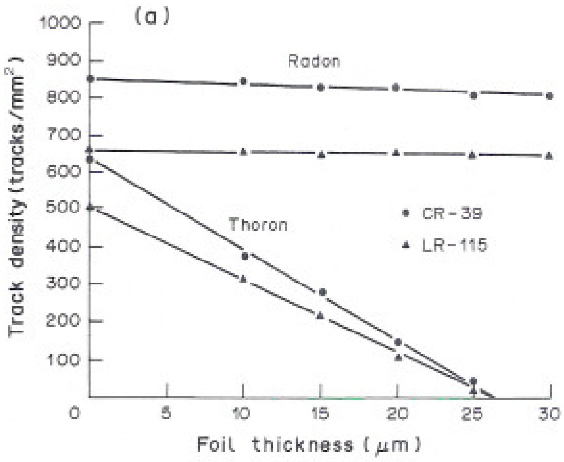

Fig. 2 (*continued opposite*)

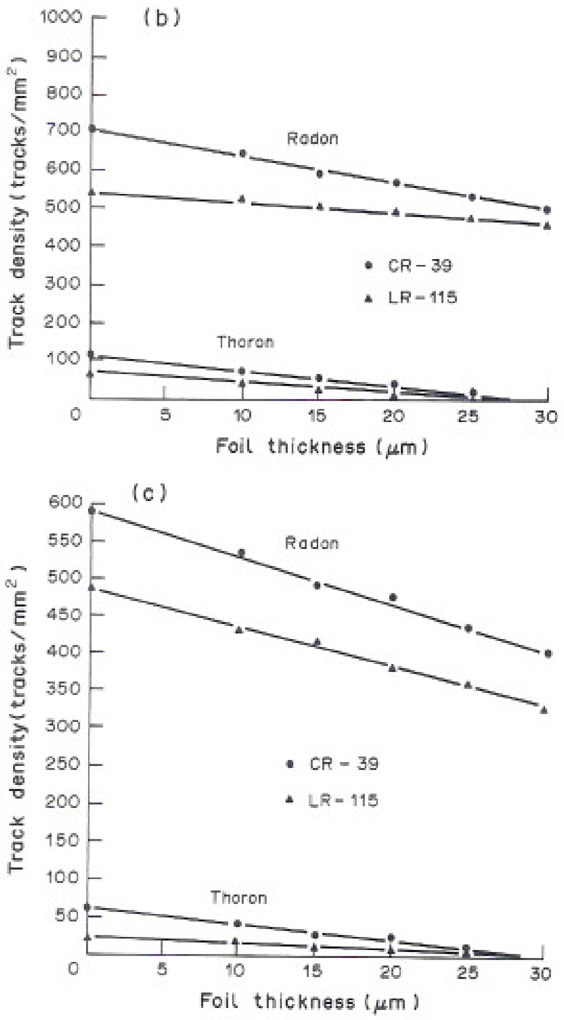

Fig. 2. Variation of track density with varying thickness of polythene foil at (a) 10 cm (b) 15 cm and (c) 20 cm column heights, respectively.

4. CONCLUSIONS

A polythene foil 30 μm in thickness is suitable for separating radon from thoron signals. This new soil gas probe may be useful for field measurements during uranium exploration.

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