RESEARCH NOTE

Malaysian Journal of Science **23** : 143 - 146 (2004)

Soil Radon Exhalation Rate as a Function of Rainfall and Soil Suction Pressure

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ABSTRACT It was been found that the contents of water in soil played a significant role in the rate of radon exhalation. Soil suction pressure, which is related to water content, is also related to radon exhalation rate. As the amount of rainfall increases, both the rate of radon emanation from soil and the soil suction pressure decreases. Usually, when the water content increases, landslides would occurs. In this paper, we describe our attempt at using radon emanation rate as a way of measuring slope stability.

ABSTRAK Ianya telah didapati bahawa kandungan air dalam tanah memain peranan dalam menentukan kadar keluaran radon. Tekanan sedutan tanah juga berhubungkait dengan kandungan air dalam tanah dan kadar keluaran radon. Apabila kadar hujan bertambah kadar keluaran radon dan tekanan sedutan mengurang. Kebiasaannya, apabila kandungan air bertambah, tanah runtuh mungkin berlaku. Makalah ini akan menerangkan cubaan mengunakan kadar keluaran radon untuk menentukan kestabilan cerun.

(soil radon, suction presure, slope stability)

INTRODUCTION

Radon gas constantly being exhaled from the earth to the atmosphere. The rate of radon exhalation from the soil depends on several factors such as soil structure, temperature, pressure and humidity. However in tropical countries such as Malaysia where rainfall occurs throughout the year, and is especially heavy during the monsoon season, it is expected that the moisture content of the soil will be the most important factor that influence the radon exhalation rate. The water content of the soil can be measured, indirectly by the amount of rainfall, and more directly by its suction pressure. Soil suction is the property of the soil which enables it to retain moisture above the water table at a pressure below the atmospheric pressure. It is inversely proportional to the amount of water in the soil. Landslides usually occurs during or after heavy rainfall, i.e. when the suction pressure decreases. As the radon exhalation rate is affected by soil water content and hence soil stability, it is therefore possible to use the change in radon concentration as a measurement of probability of landslides.

EXPERIMENTAL METHODS

The radon concentration in soil is measured by using track etched detector at about one meter depth [1]. It is a plastic (CR-39 and LR-115) based nuclear track detector in a weather-proof housing as shown in figure 1. The distance of ~27 cm from the soil surface gives enough time for the thoron gas to decay leaving only the radon gas to be detected by the plastic detector. Because of the high uranium and thorium content of the soil [2], a period of one week exposure is enough to get a reasonable track count. Track counting is done semi-automatically using a computer assisted image analyzer.

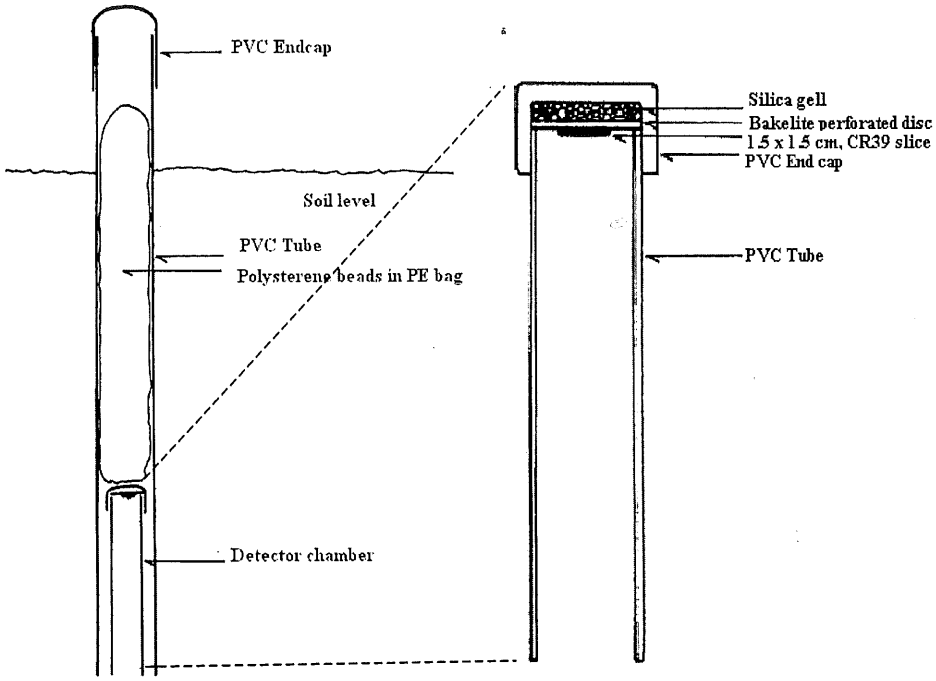


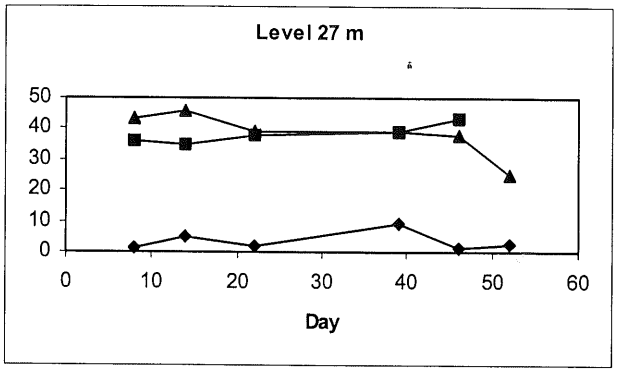
Figure1. Soil radon dosimeter consisting of an outer tube (8.9 x 99 cm) and a smaller detector chamber (5.6 x 27 cm)

The suction pressure measurement is carried out by the Civil Engineering Department; University of Malaya using a piezometer with its sensor buried 90 cm in the ground. The location of the experiment is a steep terraced slope situated at kilometer 31 Kuala Lumpur-Karak East coast highway. The track detectors and the suction meters were put on selected level of the terraced slope. A rain gauge is situated at the top of the slope. The suction pressure and rainfall are recorded everyday while the radon detectors are counted every week.

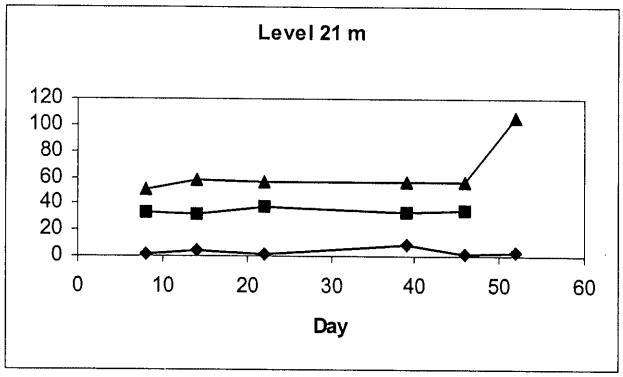
RESULTS AND DISCUSSION

The results obtained are shown in figure 2 (a-c). Each figure is for different location up the slope. Rain caused the suction pressure to fall. This corresponded to an increased in radon concentration if the pressure drop is slight i.e. little rainfall and decreases if the suction pressure drop is considerable i.e. heavy rainfall.

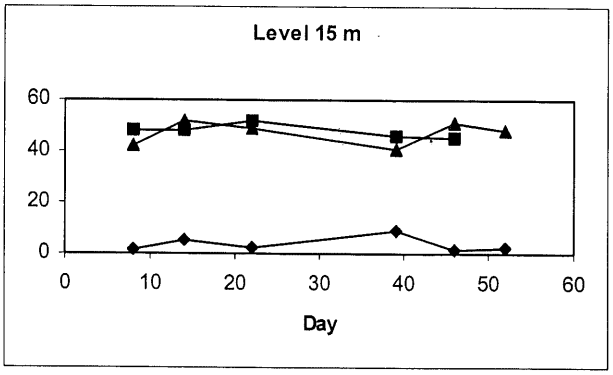
Radon transport in soil is due to diffusion through soil capillaries and pores. Our results tend to show that a slight rainfall would result in these capillaries and pores to be filled by water. As a result, the air as well as radon will be squeezed out resulting in the increase radon concentration. However after a prolonged and heavy rainfall, the soil is completely saturated with water, hence the suction pressure falls, the radon gas, which is quite soluble in water, will be trapped in water resulting in low radon detected. Our observations supported an earlier investigations carried out in an area of heavy rainfall in Thailand [3]. One of the reasons that landslides occur is when the weight of water that is being supported is beyond its structural strength of that type of soil; and this can occur after a heavy and prolonged downpour. And our result shows the radon concentration drop with an increase in soil water content. It is thus possible to use the change in radon concentration as a possible method for landslides prediction.



(a)



(b)



(c)

Figure 2. Average daily rainfall (▲) in mm, suction power (■) in cBar, and relative radon concentration (♦) measured at three different levels on a slope along the Karak Highway

CONCLUSION

Light and intermittent rainfall resulted in radon emanation rate from the soil to increase. On the other hand, if the rain is heavy and prolonged the radon emanation rate drops. The drop in radon emanation rate indicated the soil is saturated with water and is not stable.

Acknowledgments We would like to thank the Department of Civil Engineering, University of Malaya, for providing technical assistance. This

work is supported by IRPA research grant R&D 04-07-04-052-05.

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