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Soil gas radon spectra and earthquake prediction

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Continuous soil gas radon monitoring with improved solid-state detector is carried out in south-central and southern Taiwan; designated as Taiwan 1 and Taiwan 3 (Fig. 1). The detector system, including a radon detector and an interface allowing data logging on a computer, is housed in a PVC pipe and buried in a ditch lined with aggregates and covered with plastic sheeting. Taiwan 1 is buried in a brecciated area of an active fault zone with four faults intersecting at Chunglun, and Taiwan 3 is buried on top of a fractured anticline near locked Chisan fault at Yentsao. Maximum stress is found within an active fault zone but outside a locked one (Scholz, 2002). Gas and groundwater seepages are widespread in the vicinity of both sites. The spectra recorded at Taiwan 1 and 3 are similar but offset by 39 hours. The nature and distribution of faults in Taiwan are described by (Lin et al., 2000). Detector, housing and ditch configuration is duplicated in Akron over North America craton, designated as Akron 1. The spectra recorded at Taiwan 1 and 3 show drastic variation of radon counts with precursors indicating the coming of earthquakes as the terrain is stressed continuously. In contrast, the spectrum recorded at Akron 1 shows no significant radon variations.

To actually prove that the variation of spectrum is related to stress, a sand column is prepared inside a 55-gallon drum with exactly the same type of radon detector system. It is designated as Akron 2 (Fig. 2). The detector system is placed in the middle of that sand column to record radon while the column is stressed from the top. The entire setup is placed in a laboratory with essentially constant temperature and relative humidity. The spectrum recorded in this manner shows increases in radon counts when it is stressed. The situation is probably related to the reduction of porosity in the sand column. Bruno (1983) described how porosity and nature of porosity fluid is related to radon emanation. Schubert et al. (2002) showed further how soil gas radon concentration is related to the nature and saturation of fluid in soil pores. The experiment indicates that change of porosity due to stress could increase radon release rate. Digital hygrometer and thermometer are placed next to radon detector inside the PVC pipe of Akron 1 and 2.

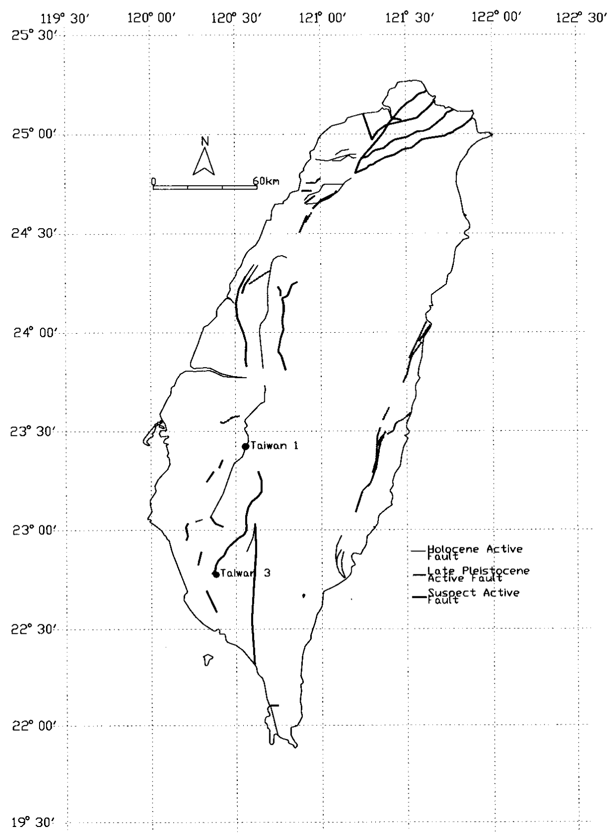

Fig. 1. Distribution of active and inactive faults in Taiwan. The island has a core of metamorphic and igneous area with high geothermal gradient. Major faulting is confined to the wider plain in the west and the narrower coastal valley in the east. (modified after Lin et al., 2000)

At 0.5 m below the ground surface as observed at Akron

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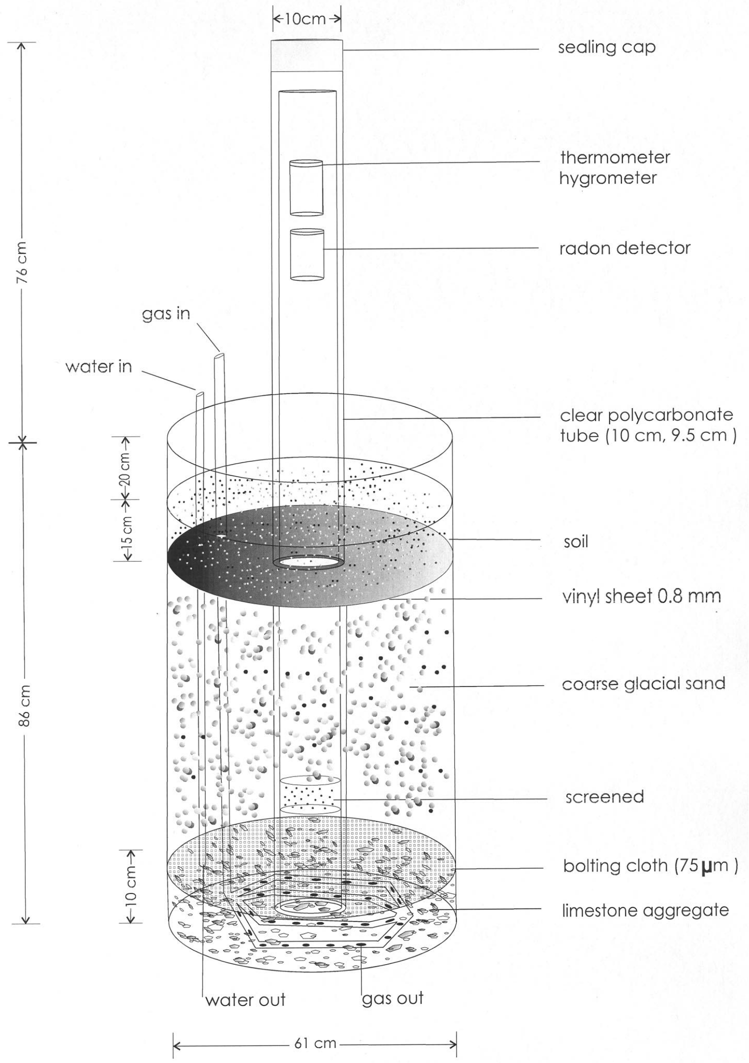

Fig. 2. The construction and essential dimensions of Akron 2. At present time, water and gas inlets are sealed. The radon level of the glacial sands used in the experiment is higher than normal soil gas.

1, with the PVC housing protection, soil-gas radon variation as measured is essentially unaffected by the ambient temperature and humidity. Furthermore, it can be demonstrated that subzero temperature could not generate significant downward soil gas flux to affect radon counts. The PVC housing is an adequate construction in recording radon spectrum with minimal environmental factor influence to register the nature of the stress state of the terrain. Recognizing that the terrain is in a stressed state is essential for short-term earthquake prediction.

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