CHAPTER 3

MEASURING METHOD AND RESULTS

3.1 Field Measurement

Soil gas radon was determined by measuring the α-decay rate of radon with a cellulose nitrate film detector (Kodak LR-115 type 2). A small piece of the detector (1 cm x 2 cm) was attached to the bottom of a plastic cup. The diameter of this cup is about 7 cm and the cup height is 9 cm. A small bag of $CaSo_4$ was attached to the inner wall of the cup, for absorbing moisture, before the cup was covered by an anti-thoron membrane. This cup was inserted facing downward into the base of a PVC pipe in order to prevent the soil from caving. The pipe has an inner diameter of 7.1 cm and had been previously buried to a specific depth in the ground. After the cup was inserted, a plastic bag containing pieces of Styrofoam was pushed into the upper space of the pipe before the pipe was capped and plugged in order to avoid atmospheric air mixing downward. (Figure 3.1a)

The experiment was made in a 2-m x 2-m square configuration as shown in Figure 1.4.2. Within this square, five cups were placed at 1-m depths and five cups at 0.5-m depths. The shallow and deep cups were 0.5 m apart. The exposure time for all these cups was seven days. At the end of seven days, they were replaced by ten new cups. Measurements were made from 15 September 1996 until 5 July 1997.

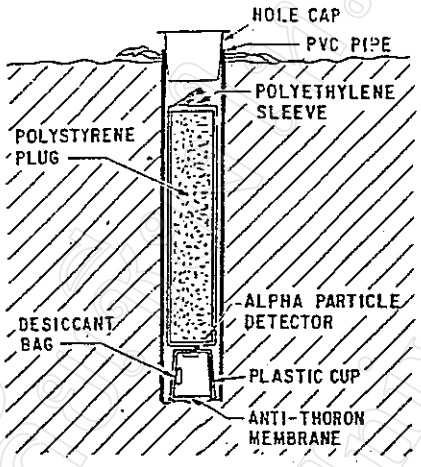

Figure 3.1a Schematic diagram of a soil gas radon detector.

After exposure, all detectors were chemically etched in 10 percent NaOH solution at 60 ^{0}C for 90 minutes. The equipment used to etch film is shown in Figure 3.1b. The enlarged α-tracks in the detectors then were counted on a 27-inch screen of a color video monitor that was connected to an optical microscope (50x) through a video camera (Figure 3.1c).

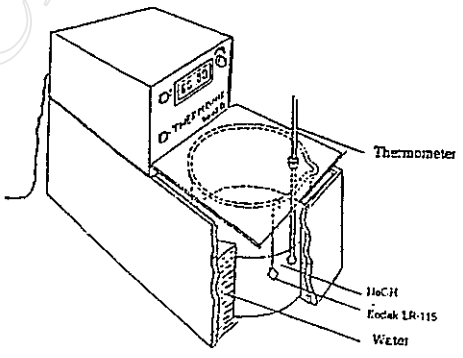

Figure 3.1b Equipment used to etch film.

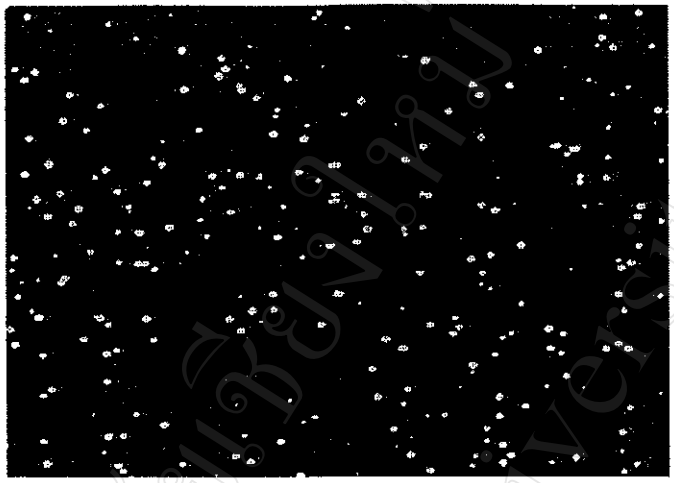

Figure 3.1c Illustrated picture on screen of color TV.

The results of radon concentration are displayed in Tables A1, A2 and Figures 3.1d, 3.1e.

Meteorological data, such as soil temperature at depths of 50 cm and 100 cm, and precipitation were measured every day at study site. Barometric pressure data were obtained from Northern Meteorological Center, Chiang Mai. The results of meteorological data are displayed in Table A3 and Figures 3.5f, 3.5g, 3.5h.

Earthquake data were obtained from the Chiang Mai seismological station. Since there were so many earthquakes during the period of radon monitoring, and many of them were either too small in magnitude or too far away from the radon monitoring site. These quakes may not affect radon concentration. In order to select only the appropriate earthquakes which are likely to affect radon concentration, the dislocation model of Fleischer

(1981) is therefore used as a guide line. However, in order to be sure that we do not miss any quake which may influence radon data, many more quakes than those obtained by the model are also selected during this study. This selections are based on the criteria given in Table 3.1. Information for 40 earthquakes selected from total occurrences during 29 September 1996 to 5 July 1997 is listed in Tables A4 and A5. Daily earthquake occurrences are also shown in Figure 3.1i. The distribution of these earthquakes in northern Thailand and the surrounding area are shown in Figure 3.6j.

Table 3.1 The criteria used for selecting earthquakes during this study.

Distance from monitoring site X (km)	Magnitude selected M (Richter)
$X \leq 10$	every magnitude
$10 < X \leq 100$	≥ 2
$100 < X \leq 200$	≥ 3
$X > 200$	≥ 4

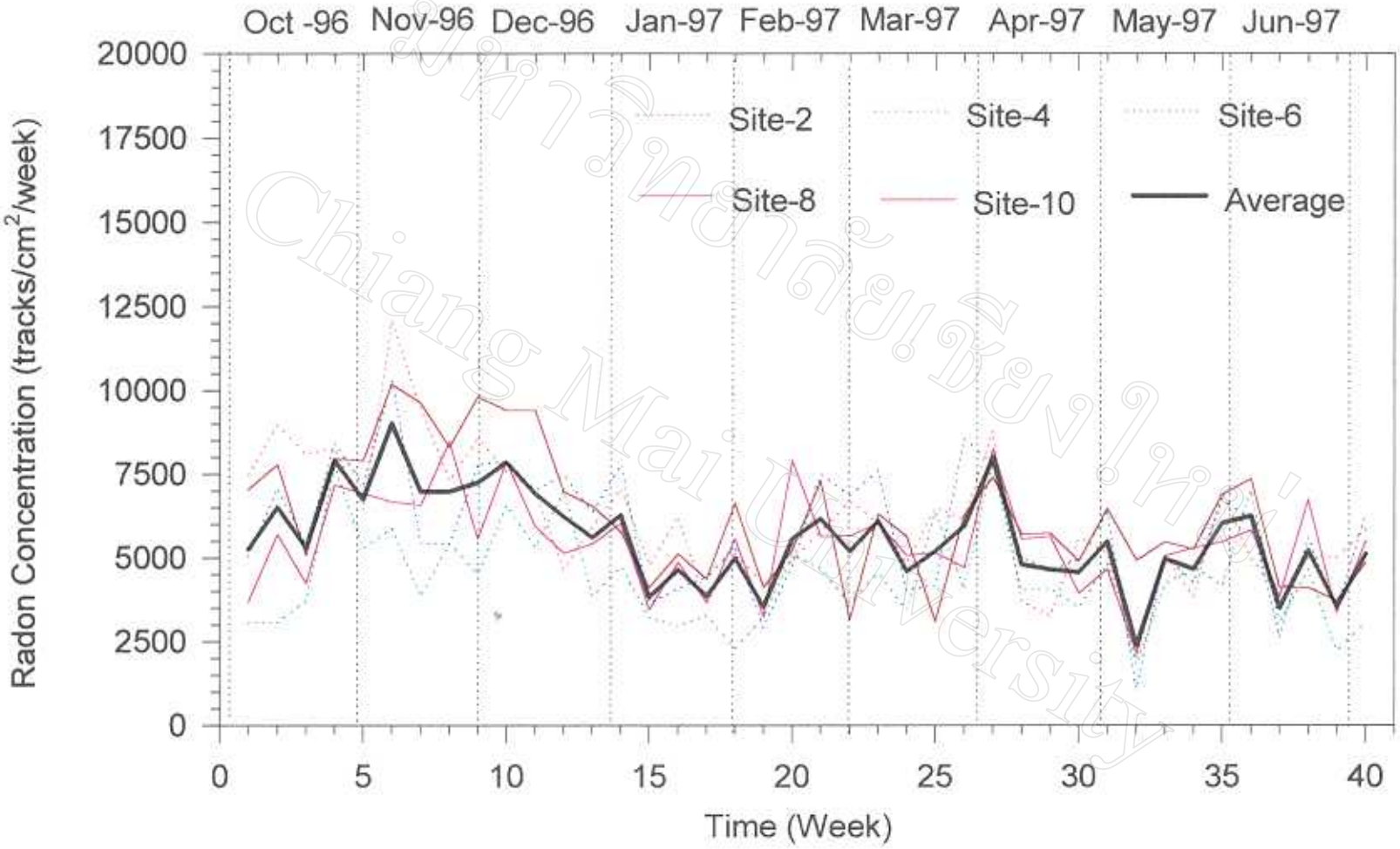

Figure 3.1d Times series of radon concentration at 50-cm depth.

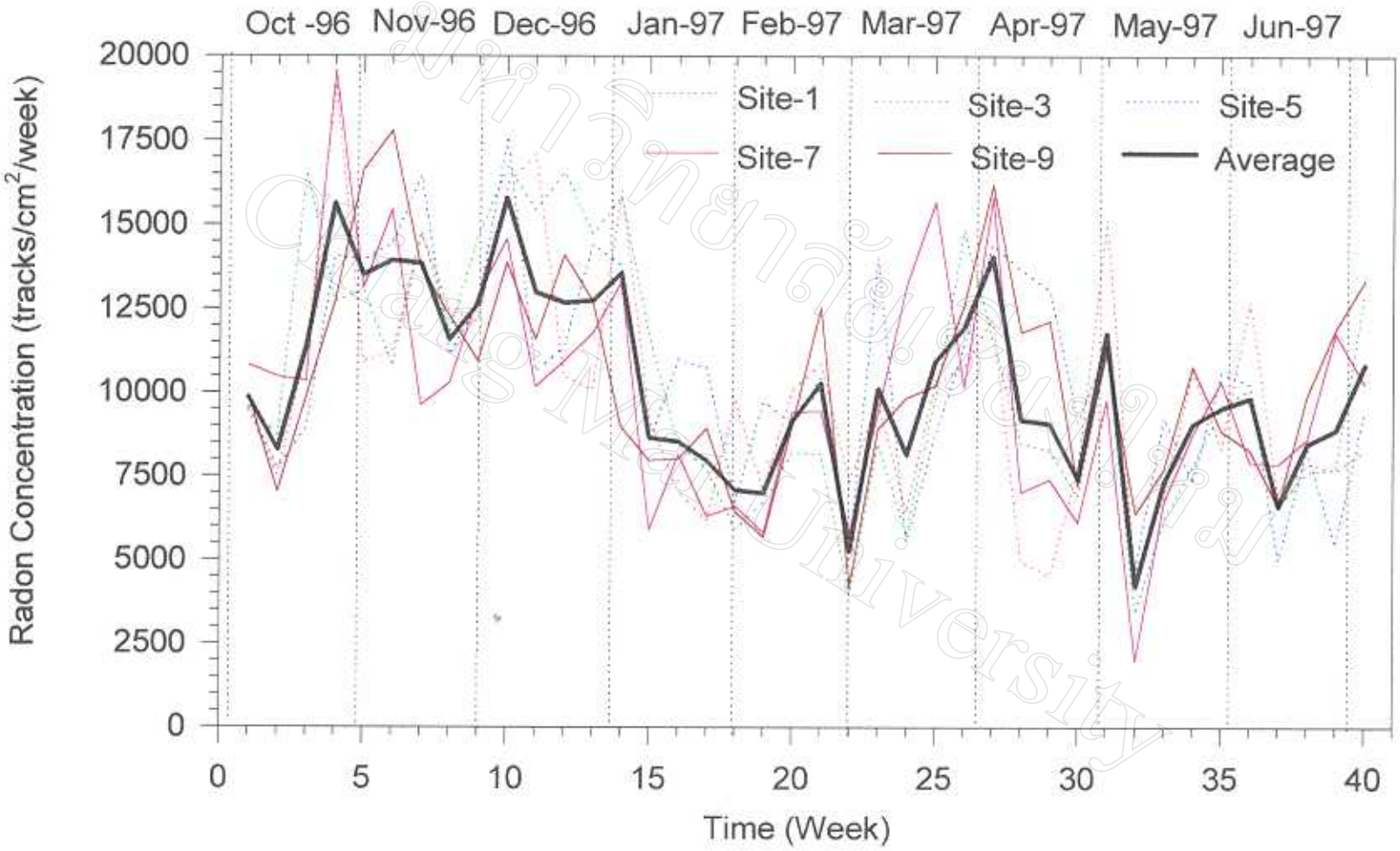

Figure 3.1e Times series of radon concentration at 100-cm depth.

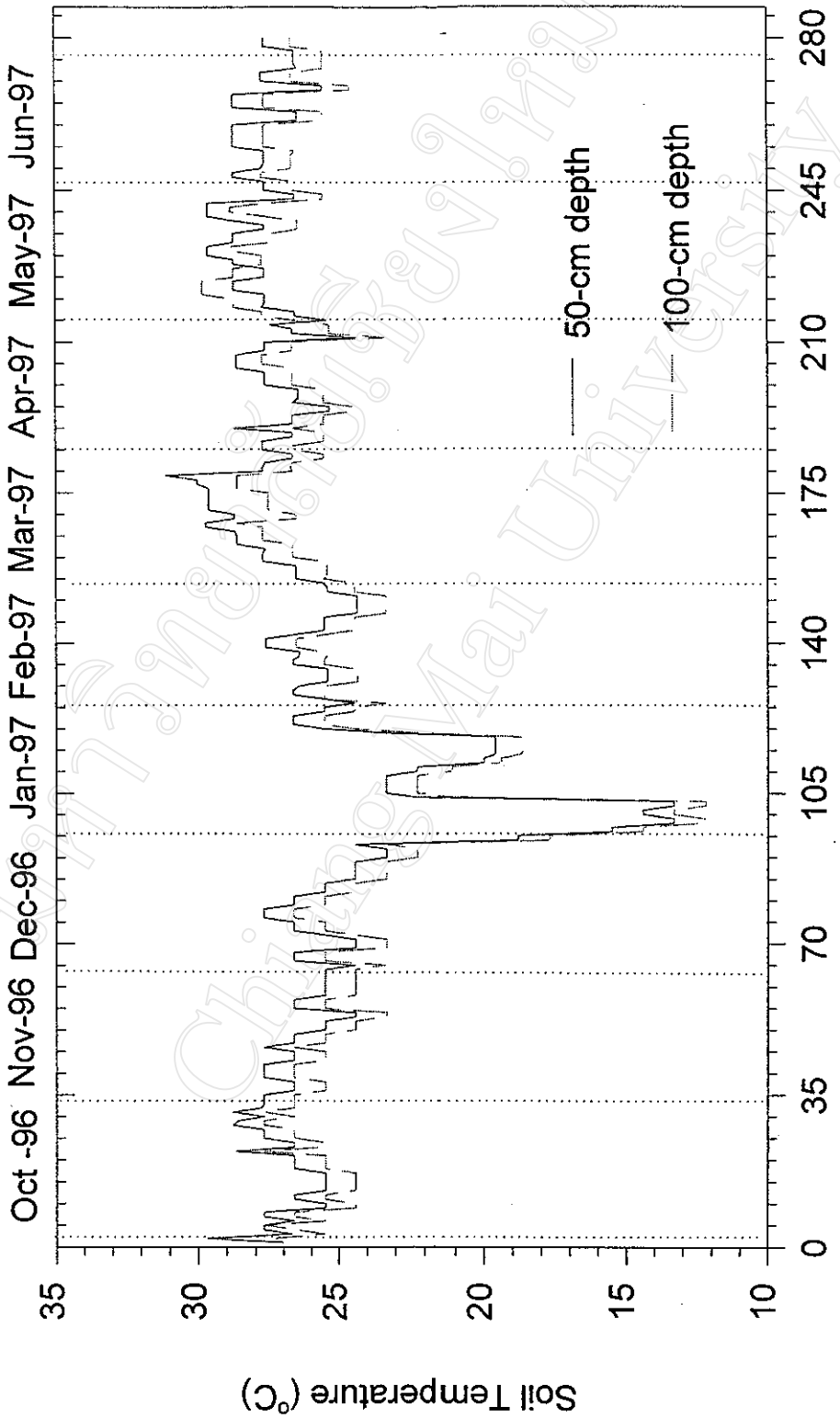

Figure 3.1f Times series of soil temperature.

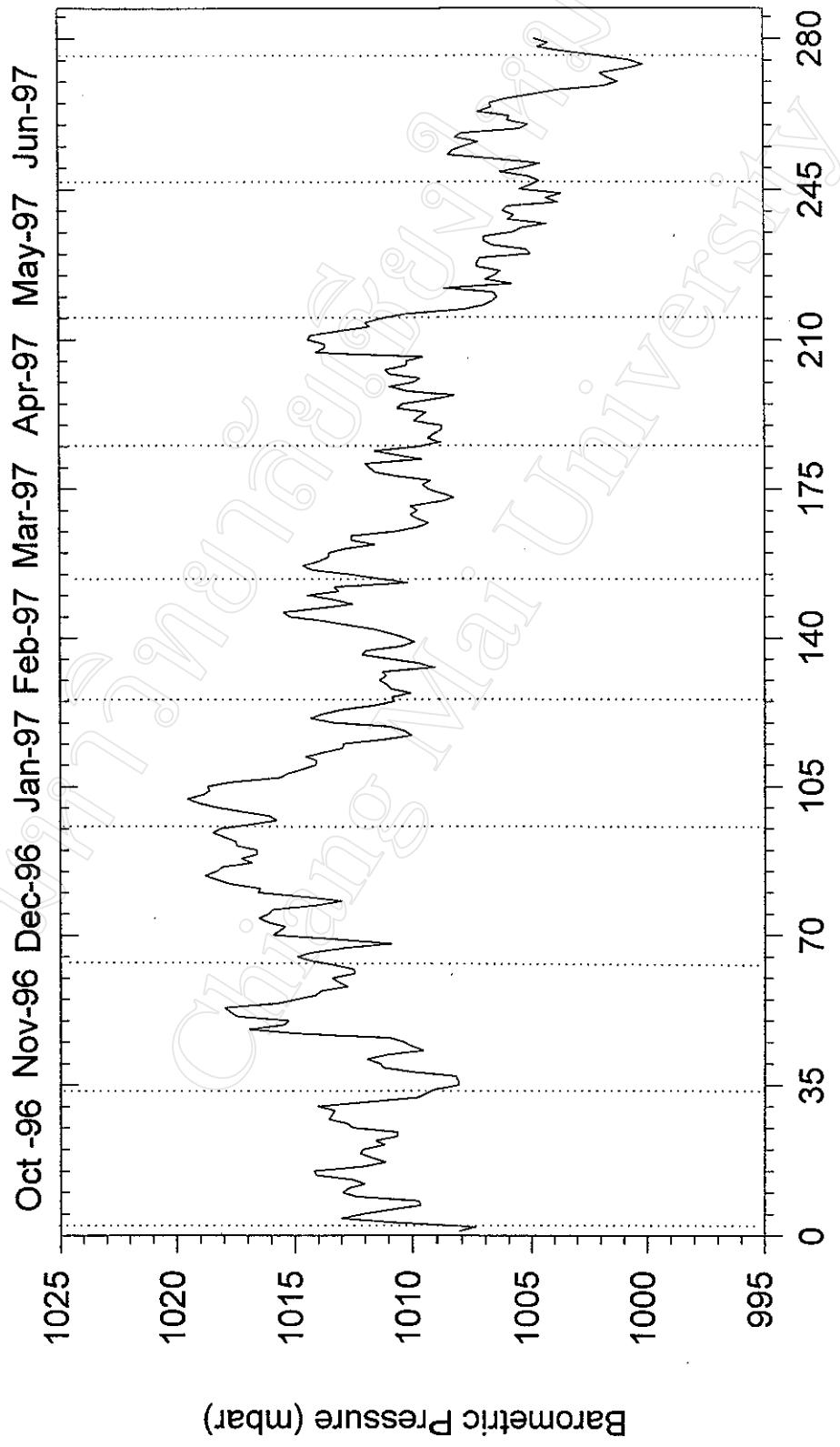

Figure 3.1g Times series of barometric pressure.

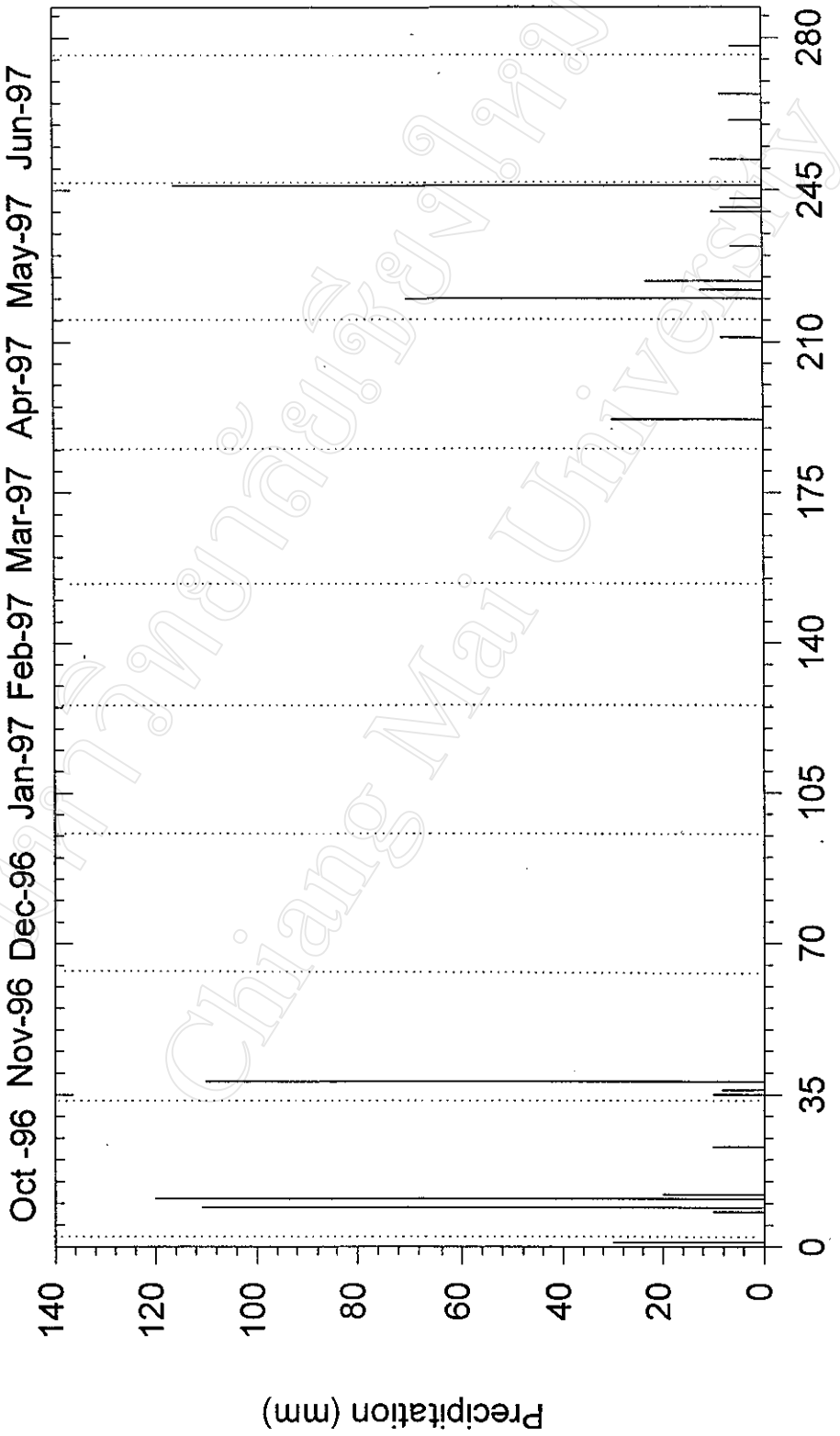

Figure 3.1h Times series of rainfall.

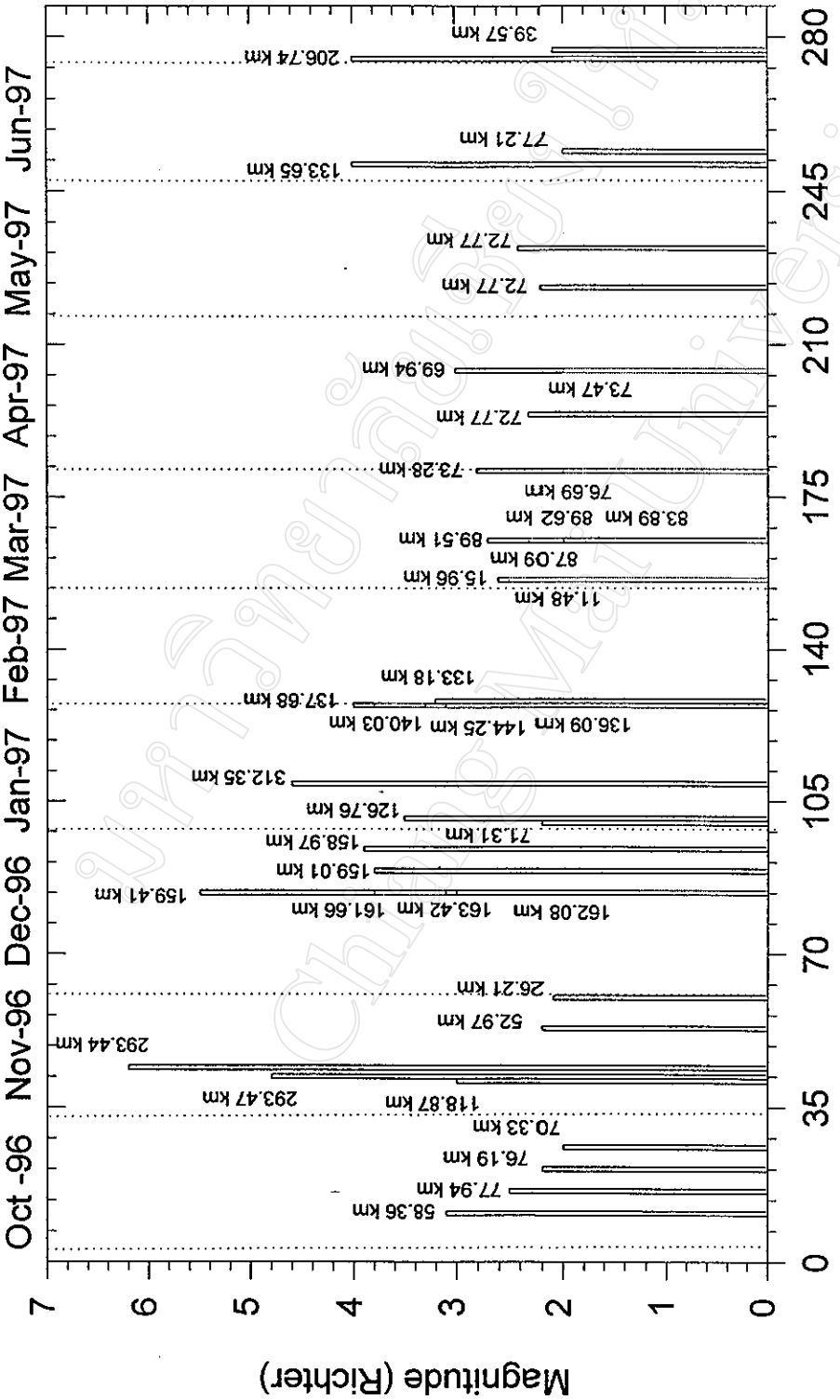

Figure 3.1i Daily earthquakes selected, from 29 September 1996 to 5 July 1997.

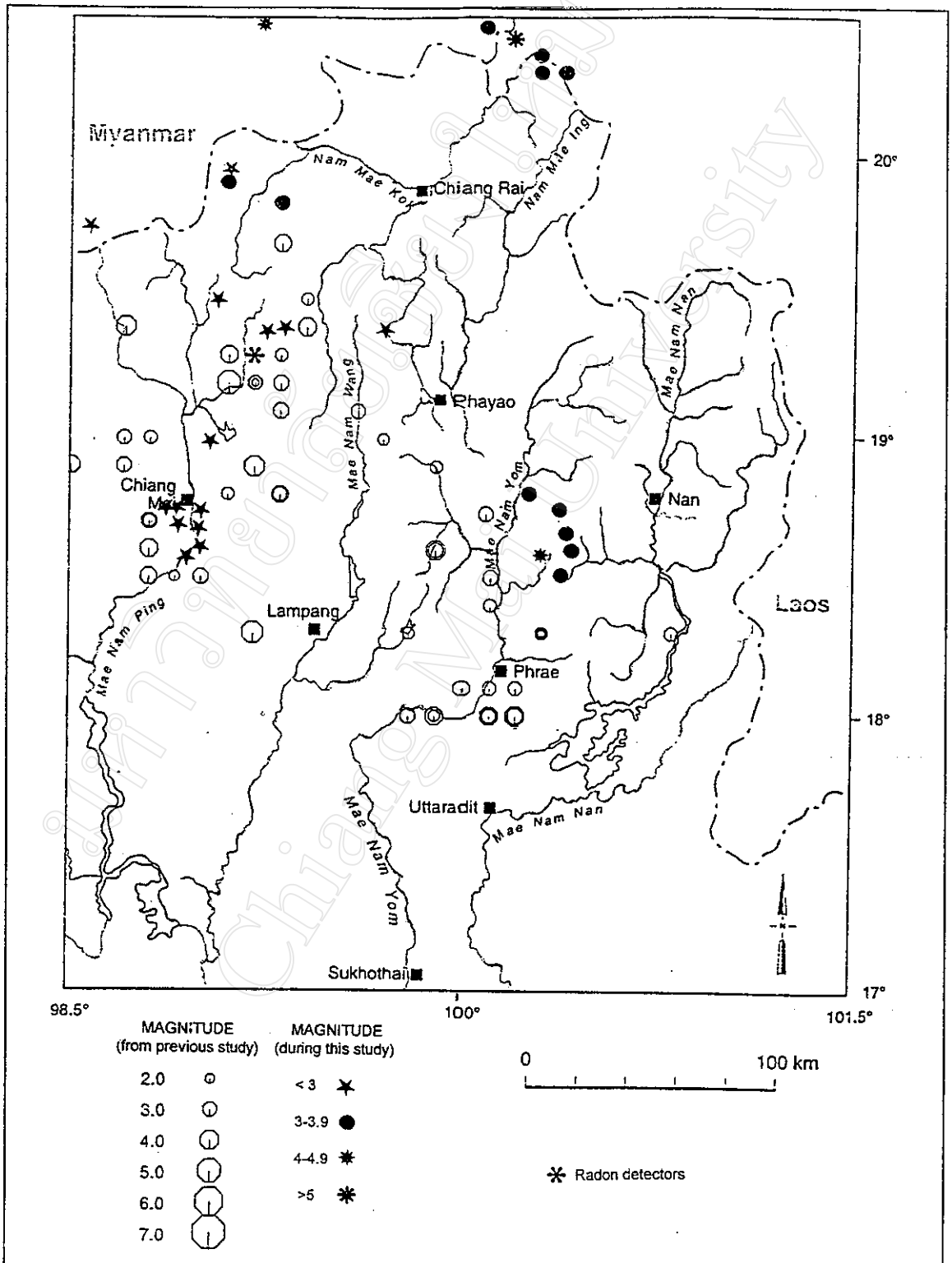

Figure 3.1j Historical seismicity during 1977-1996, and selected earthquakes during the period of 29 September 1996 to 5 July 1997. (modified from Department of Mineral Resources, 1996)

3.2 Laboratory Measurement

The soil samples at depths of 20, 40, 60, 80, and 100 cm were collected from each measuring station and then dried in an oven at a temperature of 100 ^{0}C for a period of 12 hours. Two hundred grams of each of these samples were put inside a plastic container, that has an inside diameter of 7 cm and is 4 cm deep. Each container was covered with an anti-thoron membrane and an inverted soft-drink cup that had a cellulose nitrate detector attached to its inner upper wall. Both the membrane and soft-drink cup were of the same type as those used during field measurements. Each system was left undisturbed for 28 days before the detector was remove, etched, and counted on a monitor screen. Equipment set up is shown in Figure 3.2.

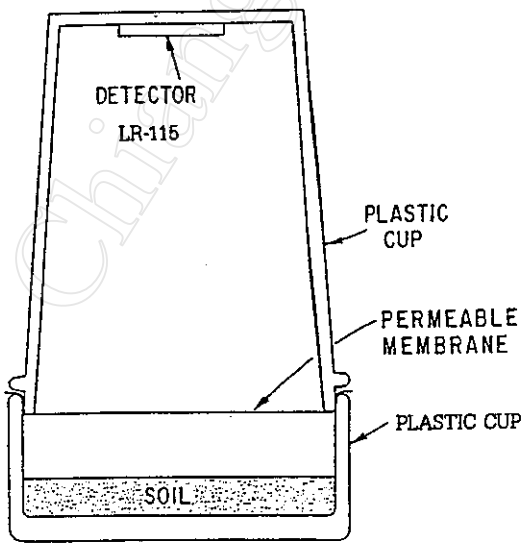

Figure 3.2 Equipment used to measure emanations from a soil sample.

The resulting track densities for all samples are shown in Table 3.2. From this result, it is clear that the soil does not contain significant amount of radon source.

Table 3.2 Radon concentration of soil samples.

Site (No.)	Radon concentration (tracks/cm^2/day)				
	20 cm	40 cm	60 cm	80 cm	100 cm
1	0	0	0	0	0
3	0	0	0	0	0
5	0	0	0	0	0
7	0	0	0	0	0
9	0	0	0	0	0
Average	0	0	0	0	0