DEVELOPMENT OF A MONITORING METHOD IN THE RADIATION FIELD UNDER THE GROUND

Yoshiyuki NAKASHIMA, Hiroyuki OHTA, Takashi AKAZAWA, Kazuko MEGUMI*, Masahiro DOI* and Toshio ISHIYAMA*
Radiation Safety Engin.Labo.,Nuclear Engin.,Nagoya Univ.,
*Radiation Center of Osaka Prefecture

I. INTRODUCTION

Environmental effects from a radioactive waste depository would ,if they could be occurred, be arisen extremely very slowly through water and soil. In the case, although detrimental effects on man and his environment from the depository would be negligible, it will be necessary to prove it by some measure to assure safety of the public substancially or psychologically. And it is also important to develop monitoring techniques around the facility from the view point of radiological protection.

As the first step toward the above purposes,the authors have discussed the informations on the radiation field in the soil through the measurements using TLD-set at several depth under the ground.

II. CONSTRUCTION OF DETECTOR AND MEASURING LOCATION

It is desirable for the detectors of evaluating the radiation field in the soil to fulfill the following requirements:

- i) to be able to detect variations in the radiation field in the natural soil,
- ii) to be able to set the detectors in the soil without a disturbance of their surrounding if possible,
- iii) to keep stability of the detectors during the measurements in the soil,
- iv) to be free from their maintenance during the measurements if possible,
- v) to be inexpensive in cost of the detector for being distributed to many points, and so on.

To be taken these requriments into consideration, TLDs fulfill those comparatively, though they can only meausre integral dose. The detectors to be set in the soil were composed of (1)a brass tube (D_{outer}=15mmϕ, D_{inner}=12mmϕ, 1 or 2m in length)for making energy dependence of the detectors flat, a methacrylate resin tube (D_{outer}=10mm, D_{inner}=5mmϕ), methacrylate resin rod as spacer and TLD-chips (denote Type A detector, hereafter) and (2)the detectors without brass tube (Type B) (see Fig.1). TLD-chips are CaSO Tm (UD110S,National Elect. Co.). The energy dependences for both types of detectors are given in Fig.2.

Both types of the detectors were buried vertically in the soil. For the detectors with 1m length, two pieces of

TLD-chips were set at 2.5,10,25,45,55,75 and 90 cm from the soil surface, respectively. And for that with 2m length, three pieces of TLD-chip were set at 5,40,80,120,160,and 195cm, respectively.

Four points, where detectors were buried, were chosen; 2 for 1m length and 1 for 2m length on the campus of the Nagoya University (denote Pts I,II and III,hereafter), and 1 point for 2m length in the field attached to the Faculty of Agriculture, Nagoya University (Pt.IV).
TLD-chips were exchanged almost every month, and monthly averaged exposure rates were measured.

A,B and C horizons were clearly found pedologically for Pts.I,II and III. For Pt.IV,however, A and B horizons were artificially removed and only C horizon was for our experimental depth.

III.RESULTS AND DISCUSSION

1)Monthly Variations in Exposure Rate

One of the examples for monthly variations in exposure rate for various depth in the soil (for Pt.I) is given in Fig.3. The general feature for each depth showed that monthly averaged exposure rates were decreased as the liquid water content in the soil increased. As seen in the Figure, the range of variations in exposure rate was 3μR/h and maximum at 2.5 cm depth. And that at 55 cm depth was almost constant. The exposure rates in the soil were generally varied in time.

From the present interval of the exchange of TLD-chips,one of the sources of variations in exposure rate was supposed to be largely related to the content of liquid water easily movable in the soil, that is, the changes in the bulk density of the soil due to the liquid water originated from precipitations.

2)Index of Liquid Water Content in the Soil

As previouly described, the authors have buried two types of the detectors (Types Aand B). For the exposure rates from both types of the detectors, the authors denoted exposure rates for type A by D_c ,and those for type B by D_N . Since the exposure rate of interest are considered to be proportional to the averaged photon flux density, the authors defined Apparent Flux Ratio (AFR)as a following equation,

$$AFR = (D_N - D_c)/D_c \times 100 \quad (\%). \qquad (1)$$

The AFR were related clearly to the amount of photon flux scattered by the liquid water in the soil. Then, there couldbe seen a negative correlation between the exposure rates in the soil D_c and the quantity AFR. This quantity was related to the amount of liquid water in the soil.

For Pt.I, the spread of the averaged values of exposure rates for each depth have been observed almost 0.7 to 1μR/h as yet. Considering the spread originated from the change in the liquid water content, the authors estimated the spread expected by the change of liquid water content from 0 to 25% for dried soil of interest. The comparison of the above results with the observed ones is given in Fig.4. Since both results were comparatively coincided, the main source of variations in exposure rates was probably arisen from the changes in liquid water content in the soil.

The change in exposure rates due to wter in the soil could be estimated through the present study.
For fallout case, the TLD-chips set at shallow depth would first detect the change in exposure rate. On the contrary, those set deeply would show higher dose, if they would be originated from the deep sources.

The averaged exposure rates of 8 to 10μR/h were observed in the natural background soil within our experiments. Some 20 or 25 % of seasonal variations were additional to these values. If further changes in exposure rate of 1μR/h were assumed to be detectable, the changes originated only from ^{137}Cs would be corresponded to about 2 pCi/g of soil at present, assuming 1.25 g/cm^3 of dry soil density and 15% of liquid water content. Improveing the detector configuration, the detectable changes could be reduced.

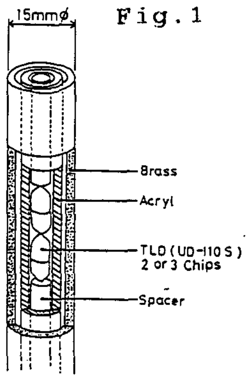


Fig.1

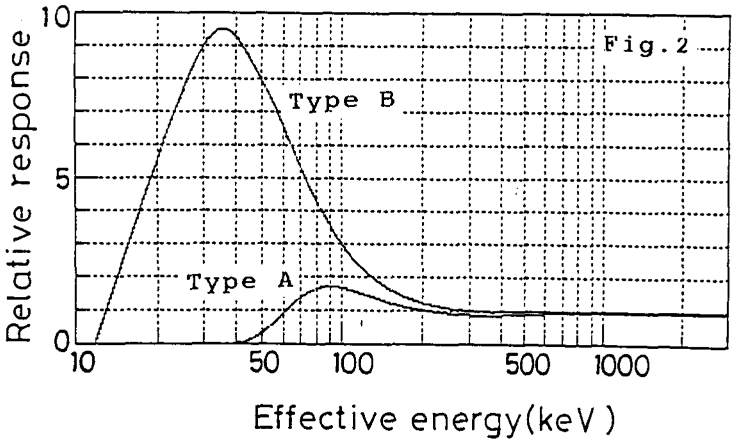
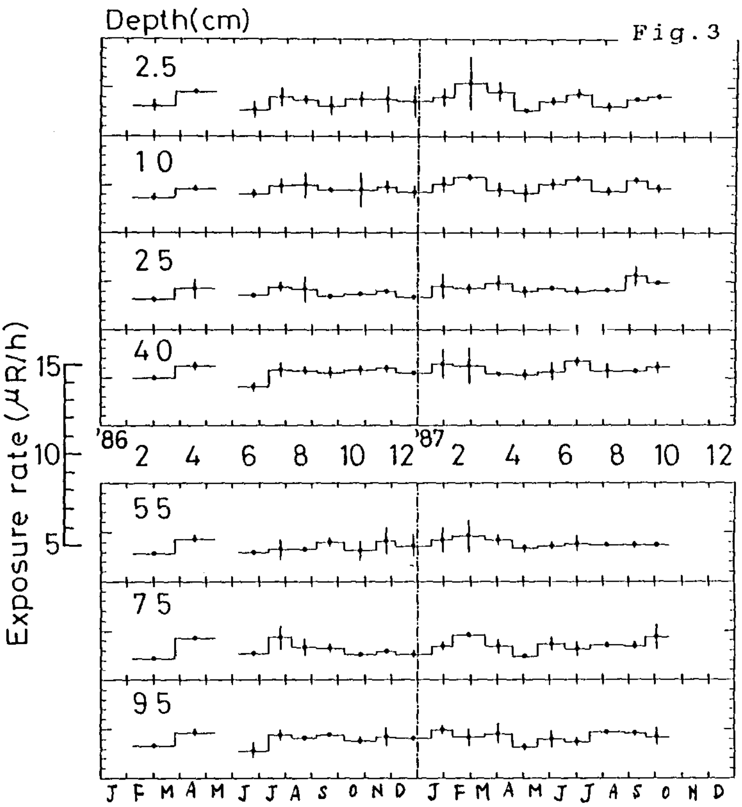


Fig.2


Depth(cm)
Fig.3
2.5
10
25
40
55
75
95
Exposure rate (μR/h)
15
10
5
'86
'87
2 4 6 8 10 12 2 4 6 8 10 12
J F M A M J J A S O N D J F M A M J J A S O N D

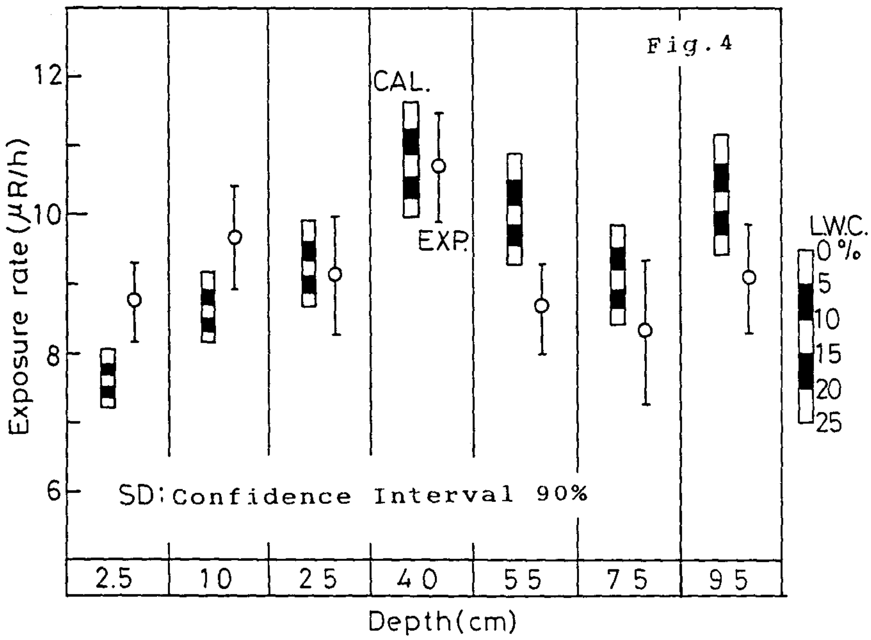


Fig.4
CAL.
EXP.
Exposure rate (μR/h)
12
10
8
6
L.W.C.
0 %
5
10
15
20
25
SD: Confidence Interval 90%
2.5
10
25
40
55
75
95
Depth(cm)