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§3. Sensitivity of TLD and RPLD to Cosmic Ray Hard Component Measured in Ogoya Tunnel

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Thermo-luminescence dosimeter (TLD) and radiophoto-luminescence glass dosimeter (RPLD) are used for environmental radiation monitoring. When these are applied to highly precise measurement, it is important to have evaluated the self dose and the sensitivity to cosmic rays. For the purpose of making clear these basic characteristics of TLD and RPLD, these dosimeters were set in several points in a tunnel, and were exposed for long period.

The measurement was done in the Ogoya tunnel which is located in Komatsu-shi, Ishikawa-prefecture. The overburden is 135 m at the point 300 m from the entrance of the tunnel, which corresponds to 270 m depth in water equivalent. Five sets of TLD and RPLD were set at the five points where were 20 m, 100 m, 200 m and 300m from the entrance of the tunnel, and the entrance of the tunnel. The dosimeters were installed in the lead box of 10 cm thickness because environmental gamma rays were shielded. The exposures were conducted as three series for 160 days, 266 days and 302 days. Since the dose due to cosmic rays is very small, the measurements were required high precision. In this study, lot control of the dosimeters, calibration of the readers, fading correction of TLD were paid attention to. The dose rates due to cosmic ray ionizing component at the measurement points were measured with NaI(Tl) scintillation detector. The relationship between the relative dose rate, X/X_0, and the count rate integrated in a pulse height region greater than 10 MeV, C/C_0, is empirically expressed by

$$X/X_0 = C/C_0 \qquad (1)$$

where X_0 and C_0 are, respectively, the dose rate and the count rate measured in an outdoor environment at sea level where there is no influence from buildings. Values of 29.4 nGy/h and 1.18 cps were used as X_0 and C_0, respectively. A discrimination level of 10 MeV was chosen to distinguish the cosmic-ray contribution of gamma rays from natural radionuclides. The energy calibration was conducted for each measurement using three points of 1.461 MeV from ^{40}K, 2.614 MeV from ^{208}Tl and 33 MeV from the interaction between muons and the detector.

Figure 1 and Fig. 2 show the relationship between measured dose rate by TLD or RPLD and intensity of cosmic ray hard component. The intensity of cosmic ray hard component in the horizontal axis was derived with consideration of the reduction effect by the 10 cm thick lead. From the tunnel entrance to the center of the tunnel, the dose rate measured by TLD or RPLD was decreased continually in correspondence with the decrease of the dose rate due to cosmic rays. The intensity of cosmic ray at the center of the tunnel is about one 100th at the outside of the tunnel. The measured value of the dosimeters at the center of the tunnel corresponds to the self dose of the dosimeters. The self doses of the dosimeters were evaluated as 2 – 5 nGy/h as shown in Fig. 1 and Fig. 2. The sensitivity to cosmic ray hard component of TLD and RPLD is concluded to be 0.78-0.88 by the gradient of the regression line.

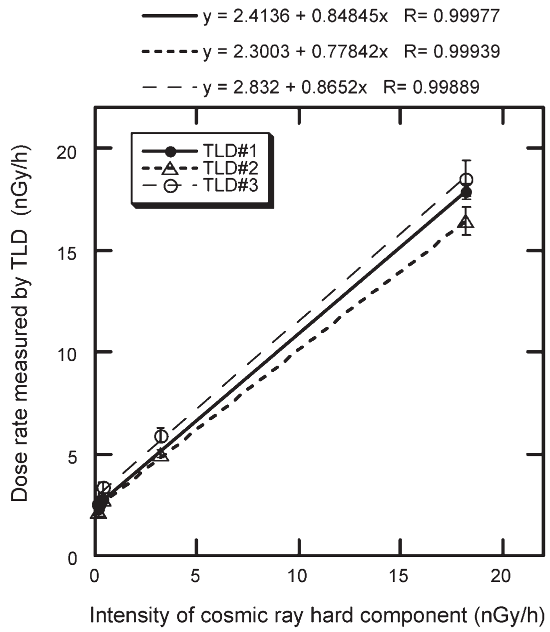

Fig. 1 Relationship between measured dose rate by TLD and intensity of cosmic ray hard component.

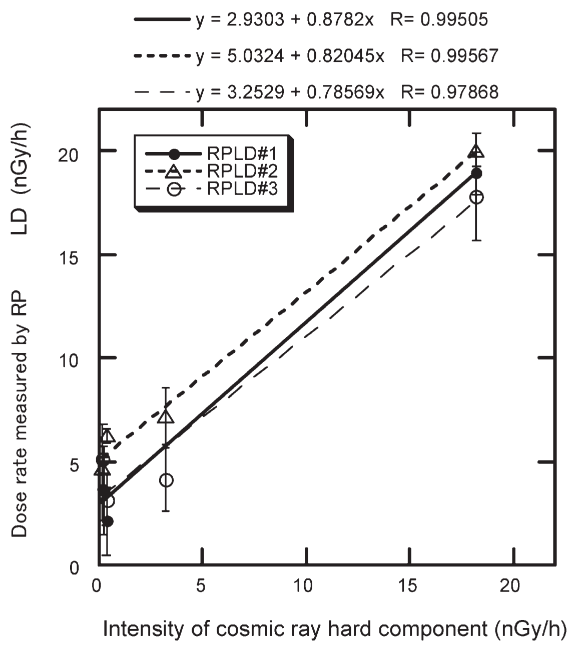

Fig. 2 Relationship between measured dose rate by RPLD and intensity of cosmic ray hard component.