Characteristics of calcite thermoluminescence: Radiation and luminescence efficiency

Manabu Ogata[2], *Noriko Hasebe[1], Keisuke Fukushi[1], Naoki Fujii[3], Minoru Yamakawa[3]

1. Institute of Nature and Environmental Technology, Kanazawa University, 2. Graduate School of Natural Science and Technology, Kanazawa University, 3. Radioactive Waste Management Funding and Research Center

Thermoluminescence dating method as well as ^{14}C and U methods has been applied to calcite, but it is less popular partly because the difference in luminescence response for different kinds of radiation is not clear. To report more reliable thermoluminescence ages from for calcite, fundamental characteristics of its response to radiation exposure were investigated and related to chemical composition by analysing natural and systhetic calcites with controled impurity concentrations. Relative thermoluminescence efficiencies for calcite by beta or gamma irradiations for calcite against quartz are under 1.0, and it indicates that equivalent dose of calcites samples were underestimated when calibration curve was created with X-ray source calibrated using quartz. This may be caused by differences in common substitution elements in calcite versus quartz. Interaction between mediums and radiation is affected by radiation energies more sensitively for calcite than quartz. [NH1] Gamma efficiency is a function of total Mn, Mg, and Fe concentrations. Thermoluminescence efficiency by beta ray must be considered together with the cathodoluminescence emission. Fe, which works as quencher in cathodoluminescence, may keep prevent release of beta radiation energy from beta ray instead of transmitting to activatoras a form of cathodoluminesence and increase the thermoluminescence efficiency. The estimate of accumulated dose from alpha rays is affected by sample thickness because of the spatial energy density around the center of the alpha track and the luminescence detection range. Thus, for accurate alpha efficiency measurements, evaluation of the effective alpha ray range and luminescence detection thickness is important. The k-value (alpha efficiency against absorbed gamma ray dose rate) increases with Mn concentrations.

Keywords: calcite, thermoluminescence efficiency

