

Examination of dose dependence for quartz-TL using automated reader with four optical paths

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From minerals such as quartz, thermoluminescence (TL) is emitted from electrons in the electron traps as they recombine with holes in the recombination center. When a mineral crystal has recombination centers of several types, TL of several wavelengths with different cross-sections might be emitted. Consequently, the dose-dependence of a particular TL might differ from other TL of a different wavelength. When applying TL to dating, linear dose dependence is preferred along with strong TL sensitivity (Nagatomo *et al.*, 1999).

We designed and constructed a TL/OSL (NUE-05-OSLTL) reader that has four light paths with four condensing lenses and four PMTs for choosing the suitable luminescence wave range for dating (Shitaoka, 2015). The wave ranges of the four lens and optical filter assemblages are usually 300-390 nm, 390-590 nm, 570-700 nm, and 350-700 nm.

This study used an NUE-05-OSLTL reader to measure mafic lavas in the Oninomi monogenetic volcano in northern Kyushu, Japan, which include small amounts of quartz xenocrysts (Ohta *et al.*, 1992).

The TL-dose dependences from four wave ranges will be presented during the poster session.

Keywords: Thermoluminescence, dose dependence, linearity, quartz, Oninomi lava

Measurement of thermoluminescence efficiencies induced by alpha, beta, gamma and X-ray using synthetic calcite

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In comparison to quartz thermoluminescence, characteristics of calcite thermoluminescence is less understood, thus, thermoluminescence dating was not often applied to calcite in recent years. Earlier studies suggested that characteristics of calcite thermoluminescence depend on impurity concentrations, however, it is not quantitatively understood and the difference in characteristics of luminescence response against different kinds of radiation is not clear.

By analyzing chemical composition and luminescence efficiencies induced by alpha, beta, gamma and X-ray of natural calcites, it is suggested that luminescence efficiency factors are a function of Mg, Mn and Fe concentrations. In this study, synthetic calcites with controlled impurity concentrations were analyzed to evaluate relationship between multiple impurity concentration and thermoluminescence efficiencies by each radiation (alpha-ray, beta-ray, gamma-ray and X-ray) quantitatively.

In Kanazawa University, X-ray is used as artificial radiation source to prepare calibration curve. A known dose was given by each radiation source (alpha-ray; ²⁴¹Am, beta-ray; ⁹⁰Sr and gamma-ray; ⁶⁰Co) and then estimated by the SAR method using X-ray. The luminescence efficiencies by each radiation normalized to X-ray (a-x-value, b-x-value and c-x-value) were calculated with given dose and measured dose.

The c-x-values of Mn doped calcites are lower than that of non-doped and Mg doped calcites, and the c-x-values are negatively related with Mn concentration. The c-x-value of Mn-Mg and Mn-Fe doped calcites are slightly lower than that of Mn doped calcite, however, are independent of Mg or Fe concentration. As a result, Mn works to decrease c-x-value, and contributions of Mg and Fe to c-x-value are negligibly small.

Results of a-x-value and b-x-value also will be presented on our poster.

Keywords: Thermoluminescence, Calcite

Characteristics of ESR and TL signals of quartz in the present river bed sediments and in possible source rocks around Kizu River

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ESR, TL and OSL signals have been used for the dating of samples in Quaternary [1], [2], [3]. Recently another direction has been tried, using the ESR and TL signals as indicators of sediment provenance. The ESR signal intensity of quartz is shown to be a useful parameter to investigate the provenance of aeolian dust [4], [5]. The ESR signal intensities of quartz have been shown to be useful to distinguish the sediment provenance [6]. Quartz has been reported to show red and blue TL by the differences in origin [7].

Sediment provenance gives important information on the erosion processes, river contention, and crustal movement and so on, suggesting the environments at the time of sediment transportation. By examining the quartz crystals found in sediment and related bedrock, it may be possible to estimate the provenance of sediment.

In this study, we report the characteristics of ESR / TL signals of quartz in the present river bed sediments and in the possible source rocks, to discuss the possibilities of identifying sediment provenance.

All quartz samples were irradiated by gamma ray to a dose of 2.5kGy. ESR signals were observed by ESR spectrometers (JES-X320; X-band JEOL RESONANCE Inc.). TL signals were observed by selecting the wavelength region by using the Time-Resolving Spectroscopy System.

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Keywords: thermoluminescence, Electron Spin Resonance, sediments provenance, quartz, river bed sediments

OSL dating and tephra analysis of fluvial terrace sediments

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Estimating the geological environments associated with uplift and erosion is important for the safety assessment of the geological disposal of high-level radioactive waste in Japan. The uplift rate during the past hundred thousand years is estimated from the elevation and emergence ages of terrace surfaces which are used as geomorphologic standard. Optically stimulated luminescence (OSL) dating is effective method to determine the emergence ages because it can be applied to common mineral grains (quartz and feldspar) present in sediments. In recent years, OSL dating is generally used in the continental regions such as Europe and Australia, but the application in Japan is far behind. In particular, the application of OSL dating to fluvial sediments is still limited in Japan. We therefore report a case study of quartz OSL dating of fluvial terrace sediments, and its adequacy is considered in the correlation with intercalated marker tephra. All samples were collected from fluvial terrace sediments along Kiso River and Tsukechi River which is a tributary of the Kiso. The investigated fluvial terrace sediments are composed of laminated sand layer and pumice layer which is likely to be reworked. The pumice was identified as On-Pm1 tephra (100ka; Kobayashi et al., 1967; Takemoto et al., 1987) by mineral composition, refractive indices of volcanic glass and phenocryst minerals, and the major element composition of volcanic glass. This indicated that the fluvial terrace sediments were deposited after 100ka. The extracted quartz grains from terrace sediments were measured by conventional SAR protocol (Murray and Wintle, 2000). The obtained OSL ages are about 40~50 ka, as far as we can foresee, being underestimated because the OSL decay curves from all samples were dominant by medium component which is unsuitable for OSL dating. We thus address to isolate a fast-component which is suitable for OSL dating, and the equivalent dose derived from the fast-component OSL is discussed in the presentation. This study was conducted under a contract with METI (Ministry of Economy, Trade and Industry) as part of its R&D supporting program for developing geological disposal technology.

Keywords: OSL dating, Fluvial terrace sediments, On-Pm1

Luminescence dating of lacustrine lowland sediments around Lake Kasumigaura

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Lake Kasumigaura is a coastal lake in southeast Ibaraki Prefecture, and has lacustrine lowland formed in response to sea-level changes around its lake shoreline. While several studies have been conducted to explore the formative processes of the lowland which is critical for understanding of the paleoenvironment, little is known about absolute age of the lowland sediment. In this study, we applied luminescence dating to the lowland sediments of Lake Kasumigaura.

Nine sediment cores were obtained using a 2-m-long geoslicer in lacustrine lowland at Gochoda, Namegata. Six sediment samples were then taken from selected cores for the luminescence dating and processed in subdued red light. The samples were sieved and treated with chemicals to extract the 120-250 μm quartz and K-feldspar fraction. In preliminary measurement, we found that the quartz OSL signal is dominated by component unsuitable for dating, and thus decided to carry out K-feldspar IRSL and post-IR IRSL (pIRIR) protocols for equivalent dose (D_e) estimation. As a result of several test, the preheat and cut heat temperature of 200°C, hot IR breach of 205°C were suitable to measurements. As the lowland sediment is expected to have Holocene age according to previous studies, we used a relatively low pIRIR stimulation temperature, 170°C, which is known to be suitable for young samples. The bleaching and fading tests of pIRIR showed that the residual dose was about 1 Gy, and that the g-value was about 0-1 %/decade, respectively. Thus, for the age estimate of pIRIR, the residual dose should be subtracted from the D_e estimate while no fading correction is required. The IRSL in contrast showed considerable anomalous fading; its g-value was around 10%.

It was revealed the both of pIRIR and IRSL result that D_e tend to be higher with increasing depth at a single core site. The largest D_e of pIRIR was about 50 Gy from the deepest sample of the core nearby the Pleistocene terrace. Other samples showed D_e s ranging from 1 to 15 Gy. We will consider radionuclide concentration quantified by inductively coupled plasma mass spectrometry for the determination of the environmental dose rate and then calculate the pIRIR and IRSL ages. We will also compare the age estimate with ¹⁴C age.

Keywords: OSL dating, pIRIR dating, Kasumigaura, lacustrine lowland