重晶石を用いたESR年代測定におけるSO_3^-ラジカルのα線による生成効率
The alpha effectiveness of the dating ESR signal in barite: a revision

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The temporal change of submarine hydrothermal activities has been an important issue in the aspect of the evolution of hydrothermal systems which is related with ore formation Urabe (1995) and biological systems sustained by the chemical species arising from hydrothermal activities (Macdonald et al., 1980). Takamasa et al. (2013) and Fujiwara et al. (2015) showed that ESR (Electron Spin Resonance) dating of barite ($BaSO_4$) is useful for investigation of history of hydrothermal activities.

Barite crystals formed by sea-floor hydrothermal activities contains large amount of Ra which replaces Ba in the crystal lattice where the internal alpha dose rate in barite contributes 40 to 60 % of total dose rate (Okumura et al., 2010). As the LET of alpha particles is much larger than beta and gamma rays, causing high-density ionization, the probability of recombination which do not contribute to the generation of the signal is larger, therefore, generating smaller amount of signals. Determination of alpha effectiveness is thus the one of the essential factors for improving the precision of dating of barite by ESR.

Toyoda et al. (2012) investigated the alpha effectiveness for the ESR signal due to SO_3^- in barite by comparing the dose responses of the signal for gamma irradiation and for He^+ ion implantation with an energy of 4 MeV, to obtain a value 0.043 ±0.018. However, the dose response was far from “good”, where the number of points is not sufficient. The experiments of He^+ ion implantation was repeated in the present study for several samples to determine the precise alpha effectiveness.

A sample of hydrothermal barite, taken by the NT12-06 research cruise operated by Japan Agency for Marine-Earth Science and Technology (JAMSTEC) was used for the present study. The values were obtained to be 0.025±0.002 for synthetic barite, and to be 0.102(+0.014/-0.013) for barite extracted from a sea-floor hydrothermal sulfide deposit, being four times larger than the former. For the latter sample, it is possible that the slopes of the dose responses of the signal intensities around the zero dose value may not be estimated appropriately due to the extrapolation of the dose response curve. Tentatively, the value for the synthetic sample should be adopted.

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