

ESR dating of barite in sea-floor hydrothermal sulfide deposits in comparison with disequilibrium dating

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The evolution of the hydrothermal fields is one of the important issues. Dating methods using disequilibrium between radioisotopes such as U-Th method (e.g. You and Bickle, 1998), ²²⁶Ra-²¹⁰Pb and ²²⁸Ra-²²⁸Th method (Noguchi et al., 2011) have been employed for such studies.

Okumura et al., (2010) made the first practical application of ESR (electron spin resonance) dating technique to a sample of submarine hydrothermal barite to obtain preliminary ages, while Kasuya et al., (1991) pointed out the possibility ESR dating. Toyoda et al., (2011) determined the optimum condition for ESR measurement while Sato et al., (2011) confirmed that the signal is thermally stable enough for an age range of several thousand years. Recently it was shown that this method is also practically applicable to barite, especially those in sea-floor hydrothermal sulfide deposits (Takamasa et al., 2013).

ESR, ²²⁶Ra-²¹⁰Pb, and ²²⁸Ra-²²⁸Th ages were determined for barite crystals extracted from hydrothermal sulfide deposits taken at hydrothermal fields taken from Okinawa Trough. The ESR ages range 4.1 to 16000 years where the ages obtained by the three methods coincide in the samples up to 15 years while, for the other older samples, the ²²⁸Ra-²²⁸Th ages are the youngest and ESR ages, the oldest and the ²²⁶Ra-²¹⁰Pb ages in between. The samples with younger ESR ages show younger ²²⁶Ra-²¹⁰Pb ages and those with older ESR ages show older ²²⁶Ra-²¹⁰Pb ages with no detection of ²²⁸Ra. This tendency of the ages is explained by more than two hydrothermal events that formed the sulfide deposits where barite crystals with different ages are mixed together in the examined portions of the samples. While ESR method gives the averaged ages, ²²⁶Ra-²¹⁰Pb and ²²⁸Ra-²²⁸Th ages are underestimated because of decay of the parent nuclides.

Based on the results of ESR measurements, for which the applicability of wide age range is shown in the present study, the order of ages of the 6 hydrothermal fields would be arranged, from young to old as follows; Yoron Hole field, Irabu Knoll field, Daiyon-Yonaguni Knoll field, Hatoma Knoll field, being nearly equal to Iheya North Knoll field. ESR is a practical dating method of hydrothermal barite, however, calibration for the absolute age determination would be still an issue.

Keywords: barite, hydrothermal activities, electron spin resonance, radioactive disequilibrium, dating