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The method and issues of ESR dating of hydrothermal barite

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At an initial stage of studies of sea floor hydrothermal activities, their changes with time was not an issue. However, it has become important since it was found that such sea floor hydrothermal activities support the biological communities. We have been making progress in developing dating method using ESR (electron spin resonance) signals in barite contained in hydrothermal sulfides.

Kasuya et al. (1991) first pointed out that barite is possibly suitable mineral for ESR dating. Okumura et al. (2010) first practically applied this method to barite in sulfide made by sea floor hydrothermal activities, however, the work investigated neither if the properties of the signals are appropriate for dating nor the method for appropriate dose rate estimation. Subsequently, Toyoda et al. (2011) and Sato et al. (2011) studied these topics but they are still insufficient. Currently, most critical issue of ESR dating of sea floor hydrothermal barite is appropriate dose rate estimation.

The dose rate estimation for barite is quite different from that for other minerals, which are

(1) Ra and its daughter elements are the source of natural radiation, but not U or Th.

(2) Radiation from other minerals is negligible.

(3) Internal alpha particles give significant contribution to dose rate (40-60 %)

(4) Shape of the sulfide deposits (chimneys) have to be considered in estimating gamma ray dose.

The first two items are easy to be taken into account. For the third, Toyoda et al. (submitted) determined the alpha effectiveness, which is the ratio of formation efficiency of the signal by a unit dose of alpha particles to that of gamma rays. However, the variation of dose response is so large that re-examination is necessary. For the last item, this shape correction is necessary when the radius of the chimney is less than 20 cm or when the sample is taken from the position other than its center. We will report how we can make this correction in the presentation. Results of actual gamma ray measurements revealed that the contribution of dose to barite from the radioactive nuclei in sea water with hydrothermal activities is negligible. White and Rood (2001) found that Rn escapes from barite but we found that it is not the case.

The ESR ages of barite are roughly consistent with U-Th ages but much older than 226Ra-210Pb ages. Results of our ^{226}Ra-^{210}Pb age estimates will also be presented.

Keywords: ESR, dating, barite, sea floor hydrothermal activity, natural radiation