ESR dating of barite in sea-floor hydrothermal deposits, a new dating technique

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Dating of submarine hydrothermal activities is an important issue for the studies on the processes of ore formation and on the evolution of the biological systems sustained by the chemical species arising from hydrothermal activities. Conventionally, dating methods using radioactive disequilibrium, such as U-Th method for sulfide, ^{226}Ra-^{210}Pb and ^{228}Ra-^{228}Th methods for barite, have been employed.

The electron spin resonance (ESR) dating method applied to barite is a new technique, filling the gap of age determination between 150 years (upper limit of ^{226}Ra-^{210}Pb method) and about 1000 years (lower limit of U-Th method), possibly applicable from several years to several thousand years. ESR detects upaired electrons in materials. A radical, SO_3^-, is created in barite by natural radiation, which is from ^{226}Ra, ^{228}Ra, replacing Ba in barite, and their daugher nuclei. The amount of narural radiation dose is estimated from the signal intensity of the dating signal. The obtained natural dose is divided by the dose rate which is estimated from the concentration of radioactive nuclei in the sample, in order to deduce the ESR age.

Although Kasuya et al. (1991) pointed out that ESR dating with barite is possible, Okumura et al. (2010) first made a practical dating work on barite extracted from sea-floor hydrothermal sulfide deposits. Subsequently, several basic studies were made on the physical properties of the dating signal, which is SO_3^-, and on the dose rate estimation. The most complicated issue is the temporal change of the dose rate due to the disequilibrium of ^{226}Ra, ^{228}Ra, and their daugher nuclei. The presentation will summerize the established method for this issue.

On the other hand, using the radioactive disequilibirum, ^{226}Ra-^{210}Pb and ^{228}Ra-^{228}Th ages are also obtained for the same barite samples. The dating results with these three methods are not consitent in some of the samples. The two stage and continuous barite deposition models will be proposed based on those results.