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Thermal stability of the ESR signal in hydrothermal barite

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At the initial stage of studies on the seafloor hydrothermal activities, their temporal changes were not argued. However, their temporal changes, which are most probably controlled by geothermal conditions, is now an important issue in order to discuss its influence to the biosphere. For this purpose, new dating techniques are necessary, which are applied to hydrothermal minerals, in addition to conventional dating techniques. Toyoda et al (2009) pointed out that the ESR (Electron spin resonance) dating method may be useful for hydrothermal barite. It is necessary to evaluate the thermal stability of the dating signal in order for us practically to apply this method, as the thermal stability limits the oldest age to be obtained. In the present study, heating experiment was done to examine the thermal stability of SO_3^- signal in barite.
Barites ($BaSO_4$) was extracted from chimney samples (220-E, 1354-R1, 903R-7-2) taken from 2 sites at a Okinawa trough and one at the southern Mariana trough. Samples were crushed after cutting. About 2.0g of the crushed sample was soaked in 12M hydrochloric acid. Where the beaker was covered with a watch glass and left for approximately 24 hours. Then, 13M nitric acid was added. Finally, after rinsing in distilled water, the sample was filtered and dried. Impurities were removed by handpicking. The extracted sample was confirmed to be barite by X-ray diffraction.
Isothermal and isochronal annealing experiments were performed for these purified barite samples. In the isothermal annealing experiment, the sample was heated at 280°C with 6 steps up to 130 min before ESR measurements at room temperature. In the isochronal annealing experiment, the sample was heated for 15 min from 100°C to 490 °C with every 30°C step, before ESR measurements.
It was found from the results of isothermal annealing experiments that the signal decays with the mixture of first and second decay kinetics. The decay parameters were plotted in the Arrhenius diagram to obtain the activation energies to be 0.87-1.18 eV. By extrapolating the lines in the Arrhenius diagram, the half life of the signal at the temperature of the seafloor, 3°C, was obtained to be 5.56×10^4-2.57×10^8 years. The SO_3^- signal was found to be stable enough to discuss the events in the age range obtained for the present samples.

Keywords: ESR, Hydrothermal Barite, Thermal stability