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Estimation of dose-rates for Mariana hydrothermal sites and comparisons with laboratory measurements

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The Mariana Trough is a present-day spreading backarc basin behind the Mariana Trench, where the Pacific Plate subducts under the Philippine Sea plate. The Mariana Trough is also characterized by active hydrothermal circulation with heat and chemical fluxes from the seafloor. Determination of the timescales of hydrothermal activity in the Southern Mariana trough has become important after the discovery of large hydrothermal plumes, with sudden changes in hydrothermal and volcanic activity in the sea floor. The long-term change of hydrothermal activities is also interesting in respect of ore formations. A systematic geochronological study of hydrothermal activities has not been possible due to the lack of methods which cover the age ranges of interest. In light of this, Electron Spin Resonance (ESR) dating of barites (BaSO₄) has been attempted in chimneys deposited from hydrothermal vents at the Archean site in the South Mariana spreading center and in the Okinawa Trough.

Estimation of ESR ages requires evaluation of onsite annual dose-rate estimation or laboratory measurements of radioactivity. Gamma spectroscopy of samples can be performed using scintillation or semiconductor detectors. Semiconductor detectors such as HPGe have high resolutions ($\sim 0.5\%$ at 662 keV), but require cooling at liquid Nitrogen temperatures, and have lower efficiencies in comparison to scintillation detectors. We used a NaI(Tl) scintillation detector for measurements of gamma spectra at the Archean, Urashima, Pika and Snail deep sea hydrothermal sites. The relative dose-rate values are nearly two orders of magnitude higher than background at the Archean sites, and at least an order of magnitude higher at the Urashima site. Furthermore, a correlation was observed between rock type and relative dose-rate at all hydrothermally active sites. At the Archean sites, dose-rates values for dead chimneys were two orders of magnitude higher than background values. However, dose-rates for basalts from Archean and Snail sites were around a factor of 10 higher than background values. At the Pika site, the basalt dose-rates were only a factor of two higher than background. Our presentation will also provide estimates of dose-rate for three samples based on laboratory measurements of U, Th and K using high resolution gamma spectrometry, and investigate the correlation between relative dose-rates estimates with laboratory estimates.

Keywords: radiation, Southern Mariana, ESR, dating, radon