Iron isotopic composition of submarine hydrogenetic, diagenetic, and hydrothermal ferromanganese deposits

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In this study, we measured the iron isotopic compositions (δ^{56}Fe relative to IRMM-14) of hydrogenetic, diagenetic, and hydrothermal ferromanganese deposits from the Pacific Ocean (1400–6000 m water depth). The hydrogenetic nodules and crusts had a consistent average Fe isotopic composition of -0.34 ± 0.15‰ (2σ). Our study contrasts with previous reports that measured larger variations in the δ^{56}Fe of these crusts in the Pacific (-0.59 ± 0.36‰) and the Atlantic (-0.27 ± 0.36‰) [1]. The consistent δ^{56}Fe values imply homogenous Fe isotopic composition of modern deep seawater in the central to northeastern Pacific. Despite differences in mineralogy and chemistry, the average δ^{56}Fe of diagenetic nodules (-0.28 ± 0.13‰) was indistinguishable from the average δ^{56}Fe of nodules of hydrogenetic origin. These observations suggest that dissolution and re-precipitation of Fe in sediments resulted in no significant Fe isotope fractionation. In contrast, the recent and fossil hydrothermal manganese deposits from the Izu-Bonin arc showed large variations in δ^{56}Fe, from -3.43 to $+1.27$‰. The recent manganese deposits (~30 mm thick) generally consisted of Mn-cemented volcanic sand with high δ^{56}Fe values overlying dense gray to black layers of manganese oxides with low δ^{56}Fe values. The mixing of different Fe sources is unlikely for such large isotopic variation. Given the proposed formation models [2,3], the most plausible explanation is kinetic Fe isotope fractionation during rapid oxidation of Fe(II) and precipitation of ferric oxides at the seawater-sediment interface.

[1] Levasseur *et al*. (2004) *EPSL*, [2] Usui and Nishimura (1992) *Mar. Geol.*, [3] Hein *et al*. (2008) *JGR*

Intermethod Comparison for K-Ar Dating of Clay Gouge

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K-Ar dating of clay gouge has been reported as a suitable method for direct dating of shallow faults in recent decades. A new "unspiked" K-Ar dating system for clay samples has been set up at the Tono Geoscience Center (TGC), Japan Atomic Energy Agency. The unspiked K-Ar method is applied succesfully for age determination of young volcanic rocks, and the method could similar be useful to date young fault gouges. However, there is only one study reported that compares the age data for fault gouges by the conventional "spike" method and unspiked methods [1].

We conducted an intermethod comparison study for K-Ar dating of clay gouge in two laboratories. A unique gouge sample was collected at depth of 252.9 m from a fault on the wall of a shaft at the Mizunami Underground Research Laboratory, central Japan.

Three clay separates (<0.1, <0.4, <2 micron) were measured by the two different K-Ar methods. The conventional K-Ar method was applied at CSIRO and the unspiked method was applied at TGC.

The age data for each fraction with two method agree well in their analytical errors. Because the age calculation parameters are different, the errors of the unspiked method are larger than those of the conventional method. The ages of coarser <2 micron fractions spread slightly, suggesting sample heterogeneity. The obtained illite age range is consistent with the stability field of illite and the main temperature field of brittle deformation within the cooling history of the host granite body of the fault, which was evaluated by apatite and zircon fission-track and K-Ar biotite ages from the host rock.

The consistency of the data between two methods, and the consistency with constraints from other geochronology data, demonstrate the potential of gouge dating with the new analytical system.

[1] Zwingmann *et al*. (2010) *Chem. Geol.* **275**, 176-185

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