

Oxygen isotope ratios of authigenic smectites at Site 808 in the Nankai Trough: implication to fluid flow in accretionary prisms

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Distribution pattern and flow system of the fluid are important factors controlling the physical and chemical properties, which affect to the various geological processes, such as deformation and geochemical and thermal transport in accretionary prisms. Since the diagenetic products record the history of fluid, we observed the diagenetic altered volcanic glasses in the volcanic ash layers recovered from the Nankai Trough subduction zone. Oxygen isotope compositions of authigenic smectites, which was produced as the dissolution product of the glass, separated from the altered ash layers were analyzed to estimating the origin of the porewater. Based on the results, we discussed fluid flows in the sediment column.

A 1300 m thick sediment column, through the frontal thrust and the decollement zones, and down to the basement basalt, obtained at Site 808, Leg. 131, in the Nankai Trough in 1989 was used for this study. The proceeding dissolution of the volcanic glass and the precipitation of authigenic smectite, clinoptilolite and analcime have been reported in the studies of the recovered ash layers (Masuda et al., 1993); high amount of smectite precipitated below 550mbsf, clinoptilolite were observed abundantly between 760 and 820mbsf, and analcime was one of the dominant minerals below 1254 mbsf. Volcanic glass dissolution extensively proceeded below ca 600 mbsf and the glass was dissolved completely below 807 mbsf. However, the dissolution rate of volcanic glasses is not concordant with the depth, and corresponds to the SiO₂ content; the glass with low SiO₂ content (63 %) taken from 585.5mbsf was more dissolved than those with high SiO₂ contents (72 to 74%) from the upper and lower layers (505.2, 598.8, 611.4, 634.3 and 739.1 mbsf).

The oxygen isotope ratios of authigenic smectite (smaller than 0.1micron meter) was obtained for the ten ash layers. Those range within +17.0 and +21.9 permil (SMOW). In general, the authigenic mineral crystallization takes place in isotopically equilibrium with the coexisting porewater (Nahl et al., 1999). Assuming that the authigenic smectites are in isotopically equilibrium with the coexisting porewater, the calculated oxygen isotope ratios of the porewater in the ash layers range from -0.1 to 5.4 permil. Those values are higher than those of the pore waters already reported by Kastner et al. (1993) for the surrounding shales (from -3.5 to 0 permil). Assuming the dissolution-precipitation processes in a closed system, the oxygen isotope ratio of porewater react with the glass and authigenic minerals was calculated using a simple material balance calculation. The obtained oxygen isotope ratios of the pore waters are comparable with the above estimated ones, supporting that the oxygen isotope ratios of the pore waters in the volcanic ash layers are strongly controlled by the water-rock interaction in the closed system. The difference of the isotope ratios of porewaters in the volcanic ash layers from those in the surrounding shales suggests that the vertical fluid migration is negligible to change the oxygen isotope ratios of pore water in the sediment column.