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Element migration via fluids with progress of fracturing along the Median Tectonic Line, Mie Prefecture, southwest Japan

KANEKO, Yumi[1*] ; TAKESHITA, Toru[1] ; SHIGEMATSU, Norio[2] ; FUJIMOTO, Koichiro[3]

[1]Hokkaido University Graduate school of science, [2]Active Fault and Earthquake Research Center, Geological Survey of Japan, National Institute of Advan, [3]Tokyo Gakugei University

Dissolution and precipitation (i.e. chemical reaction) pervasively occur via fluids in brittle fault rocks (cataclasite) resulting in either softening or hardening of rocks. In this study, we used the core samples obtained at the Matsusaka-Iitaka observatory of AIST, which penetrate the MTL at depth 473.9 m, and revealed element migration via fluids with progress of fracturing.

Along the MTL mylonite and cataclasite are distributed in the Ryoke belt. We used the cataclasite samples (depth 439-473 m) immediately above the MTL that originated from tonalite and relatively undeformed tonalite samples (depth 87 m, 88 m, 317 m and 358m).

Based on optical thin section observations, we classified the cataclasite samples into four groups: relatively undeformed (UN), weakly (W), moderately (M) and strongly (S) deformed rocks based on the degree of cataclasis. We investigated the major element migration based on the whole rock composition determined by X-ray fluorescence analysis. We applied principal component analysis to the data of XRF to reveal the causes of the major element migration. Further, we analyzed changes of the mineral assemblage with increasing cataclasis based on X-ray diffraction. We also analyzed changes of the mineral assemblage resulting from element migration with a point counting method under optical microscope aided by image analyses.

To analyze element migration with the increasing degree of fracturing, we determined the changes in the whole rock major elements in deformed samples using isocon plots. In this study, we treated Zr as an immobile element. We calculated the volume change of deformed rock samples as $V = [(1/S)-1] \times 100$, assuming no density change during deformation, where S is the slope of the line connecting the origin of isocon plot and an immobile element.

We analyzed these for the following three pairs, which showed the volume changes of +21 % for W vs UN, +33 % for M vs W, and +52 % for S vs W, respectively. With the increasing degree of fracturing from UN to W rocks, Si, Na and K increased, because K was settled in muscovite, and Si and Na were released in fluids as solutes, by feldspar-to-mica reaction. The fluids invaded into the pore spaces created by fracturing and deposited quartz there, and Na was used for albitization of oligoclase. On the other hand, TiO2, FeO$*$, MnO, MgO, CaO decreased from UN to W rocks and increased from W to M or S. LOI (loss on iginition) and Al2O3 increased during throughout the fracturing. The increase of CaO was caused by forming of laumontite and prehnite, while that of FeO$*$was caused by forming of iron sulfide and chlorite. The increase of MgO and MnO was caused by forming of chlorite, and that of TiO2 was caused by forming of sphene. Further, the increase of Al2O3 was caused by forming of chlorite, muscovite and laumontite, and that of LOI was caused by forming of chlorite and muscovite. Since not only muscovite and chlorite with lower coefficients of internal friction, but also calcite with less viscosity increased a lot from W to M or S rocks, it can be inferred that the strength of cataclasites become lower from W to M or S rocks.

Keywords: Median Tectonic Line, mass transfer, cataclasite, isocon diagram, resolution precipitation reaction, reaction softening