Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SIT38-P01 Room:Convention Hall Time:May 23 18:15-19:30

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

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Along the Median Tectonic Line (MTL) formed in the Cretaceous period, which separates the Ryoke belt from the Sanbagawa belt, localized deformation which resulted in the formation of mylonite to cataclasite occurred in the Ryoke belt with decreasing temperature. The borehole at the Iitaka Observatory, Mie Prefecture, southwest Japan, drilled through the upper cataclasite zone of Sanbagawa belt, penetrates the MTL at the depth of 473.9 m. In this study, for samples from the depths of c. 450-470 m that originated from tonalite, we investigated the major element migration based on the whole rock composition determined by X-ray fluorescence analysis. Further, we showed changes of the mineral assemblage resulting from element migration with a point counting method aided by image analyses. All analyzed rocks once became mylonite by plastic deformation, which were later fractured to various degree with decreasing temperature. 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. For the correct mode analyses of mineral composition in the deformed rock samples, we classified plagioclase into three groups based on the degree of muscovitization: non- , moderately and the strongly alterated plagioclase. Further, we estimated an area of mica fraction in a grain of feldspar by analyzing images of elements (i.e. K) obtained by EDS mapping. The mineral compositions of gauges of strongly deformed rocks were estimated by analyzing images of element mapping of EDS. From these analyses, we found that there are feldspar, quartz and hornblende as fragments, and are chlorite, calcite and titanite as precipitated minerals. 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 Al as an immovable element. We calculated the volume change of deformed rock samples as $V=[(1/S)-1] * 100$, assuming no density change during deformation, where S is the slope of the line connecting the origin of isocon plot and an immovable element. Further, we calculated the change of elements with the increasing degree of fracturing (coefficient of variation of element) from the following formula, $(El_f/Al_f)/(El_h/Al_h)$, where El is any element, Al is an immovable element. Subscripts f and h indicate a fault rock and an undeformed host rock. We analyzed these for the following three pairs, which showed the volume changes of +24 % for W vs UN, -26 % for M vs W, and -19 % for W vs S, respectively. In the cataclasite samples, since the change of SiO2 is the largest, the volume increase from UN to W rocks was perhaps caused by deposition of quartz. With the increasing degree of fracturing from UN to W rocks, Si and Na increased, because fluids, which included Si and Na as solutes released by feldspar-to-mica reaction, invaded into the pore spaces created by fracturing and deposited there. The volume decrease from W to M or S rocks was caused by dissolution of quartz and subsequent fluid moving out from the fault rocks by strong compression, accompanied by the decrease of Si and Na contained in the fluids. On the other hand, Fe, Mg, Ca and Ti increased during the further fracturing. In the gauge of M or S rocks, although it seems that those mineral phases consisting of Fe, Mg, Ca and Ti deposited from the fluids despite strong compression, the reason why the volume of these elements in fact increased from W to M or S rocks remains to be investigated.

Keywords: element migration, cataclasite, isocon diagram