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Quantitative analysis on hydrothermal alteration on fault rocks in the borehole core penetrating the MTL

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We will more precisely reconstruct the history of the condition of deformation and alteration in the hangingwall by especially advancing quantitative analysis on alteration mineral by principle component analysis (PCA). We studied hydrothermal alteration along the Median Tectonic Line (MTL) which has a long history of displacement and the fault rocks deformed under variable conditions.

AIST drilled a borehole penetrating the MTL for predicting Tonaikai-Nankai Earthquake at Iitaka, Matsusaka, Mie prefecture. The drilling length is 600m. It crosses MTL at the depth of 473.9m. Hangingwall of the MTL consists of Ryoke-derived tonalitic mylonite and footwall of the MTL consists of fractured rocks derived from Sanbagawa metamorphic rocks.

The rocks in the hangingwall experienced the four kinds of stress pattern after the mylonitization. These are stresses which caused normal faultings (vertical compressive stress and North-South tensional stress, order of the two is unknown), North-South compressive stress and East-West compressive stress (present stress pattern) in turn with time (Shigematsu et al., oral presentation in the 117th Annual Meeting of the Geological Society of Japan, 2010).

In addition, based on the analysis of deformation structure and alteration minerals, prehnite generated before the stresses which caused normal faultings, laumontite had produced since the stresses which caused normal faultings until the present stress pattern and then has decomposed later on in the hangingwall (Fujimoto et al., oral presentation in the 117th Annual Meeting of the Geological Society of Japan, 2010).

We sampled the 124 bulk samples and fault material on the 129 slip surfaces of the small brittle faults in the borehole core the depth from 138m to 473.9m, analyzed mineral composition of those samples by X-ray diffraction and the bulk and the fault material mineral composition data sets are analyzed by PCA respectively. We obtained these principle components (PC).

1) First principle component of the bulk samples: explained variance is 0.536.
It explains how much degree the wall rock is altered.
2) Second principle component of the bulk samples: explained variance is 0.203.
It explains which hydrothermal alteration mineral is mainly distributed, carbonate or chlorite.
3) Third principle component of the bulk sample: explained variance is 0.127.
It reflects the alteration zones (K-feldspar zone, chlorite zone and laumontite zone).
4) First principle component of the fault materials: explained variance is 0.798.
It explains carbonate filling fractures.
5) First principle component of the fault materials: explained variance is 0.101.
It explains chlorite and laumontite replacing rock-forming minerals.

We inferred these points from the five PCs.

1) The alteration of the bulk samples is more variable than the fault materials.
2) Laumontite and carbonate occur together in the bulk samples, but not together in the fault materials resulting from different mode of occurrences.
3) Quartz is similar to carbonate in the second PC of the two.

Keywords: Median Tectonic Line, Fault, Borehole core, Hydrothermal alteration, Mineral composition, Principle component analysis