

## On the turn determination of crush zone activity, a lesson from granitic basement rock holding the fast breeder reactor

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Activity evaluation of crush zones encountered in basement rock is an issue of the seismic safety assessment of nuclear plant and geological isolation of radioactive wastes. The selection of crush zone of which has been evaluated should be defined as the latest one by means of turn determination of crush zone activity based on stratigraphic or structural geological method. A lesson from granitic basement rock (Kojaku granite) holding the fast breeder reactor "Monju" is presented. The Kojaku Granite form the oval Tsuruga peninsula (ca. 8km in width) on the southeastern coast of the Sea of Japan and the age is  $68.5 \pm 0.7$ Ma (Zircon U-Pb age).

### 1. Stratigraphy-oriented turn determination of crush zone activity.

#### (1.1) Turn determination using cover sediments

The age determination of undeformed cover sediments indicates the activity of crush zone older than the sediments. In the case of crush zones observed at separate outcrop, deformation of the same strata can be utilized for the turn determination.

Trenching evidence (with tephra chronological analyses) of the active Shiraki-Nyu fault near the Monju site indicate repeated activity after ca. 30ky strata (including AT-tephra). On the other hand, crush zones in the Monju site affect no deformation on the strata of identical age observed during the site construction. These data indicate the last movement of the latter is older than the active fault, and no movement in sympathy with the active faulting repeatedly during, at least, ca. 30ky.

#### (1.2) Turn determination using dyke, mineral and clay vein ("Dyke", hear after)

Undeformed dykes intersecting crush zones indicate that the movements of crush zones are older than the dyke formation. Age determination of the dyke constrain the latest age of the crush zone activity.

Excavation survey of basement rocks at the Monju site shows a basaltic dyke (ca. 19Ma, Plagioclase K-Ar age) cut by the crush zone (crush zone alpha-3 and alpha-4) indicate that the movements of these crush zones are later than the dyke formation.

### 2. Structural-oriented turn determination of crush zone activity

Intersecting relationship between crush zones indicate which of them is the latest one at least locally. This rule can be hold in the case of conjugate set, although they suggest the contemporaneous development in one tectonic stage. Conjugate relations should be judged from traditional Griffith-Coulomb failure criterion as well as the Maximum effective moment criterion<sup>(1)</sup>. Despite of the development of remarkable clay rich zone, cross cutting crush zone with meso- and microstructures developed under the higher temperature and pressure indicate the movement of the clay rich zone is older.

Excavation survey of basement rocks at the Monju site shows conjugate like development of the crush zone beta and younger alpha-3 with 50-55 degrees between them. The crush zone beta is composed of clay rich vein. Along the crush zone alpha-3, dragged sigmoidal quartz veins, dragged biotite along shear layers and preferred orientation of quartzo-felspathic lenses composed of foliated cataclasite with P-Y-R<sub>1</sub> fabric are observed. These ductile features suggest that relatively higher temperature and pressure during the development of crush zone alpha-3. Hence, the crush zone beta is old structure.

These stratigraphic and structural evidences for the turn determination indicate that the activity of crush zone alpha-3 is the object of the evaluation.

(1)Zheng et al., 2004, Journal of Structural Geology, 26, 271-285.

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