

Preliminary study on the directional statistics of crush zones' strikes in the Kojaku Granite

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Introduction: Geological reports on crush zones in granitic basement rocks holding the FBR "Monju" by JAEA were submitted to the NRA, and they are under examination. In relation to the ensuring safety of important installations, there is a new horizon of open process of examination on practical geological problem between the NRA and electric power utilities. It is important to observe crush zones jointly and discuss objectively. In this preliminary study, more objective discrimination between orientations of small crush zones was carried out by means of directional statistics based on an awareness of field data should be discussed objectively. Then, a simple structural geologic interpretation was presented.

Problem: Intuitive discrimination that there were obvious two systems in crush zone (system alpha-3, strikes ca. 50 deg. ; system beta, strikes ca. 10 deg.) have been outlined from field observations. There should be an objective gauge.

Method: Prepare a sketch map of horizontal outcrop (1:200, ca. 15m squares) showing traces of high-angle crush zones and clay seams. Measure the strike and length of segments. The length is divided by unit length making a list of number of each strike. These strikes (0 - 180 deg.) are doubled for directional statistical approach. Mixture fitting method introduced by García-Portugués (2013) by means of the R version 3.1.2 (R Core Team, 2014) with "movMF" package (Hornik and Grun, 2014) is carried out. Resultant mean directions of each von Mises distribution are divided by two to convert direction to strike.

Result: Fitted number of mixture components of von Mises distribution is eight. Each of them has mean strike in deg., concentration parameter (κ) and fraction (total = 1) as follows 10/12.5/0.147 ($\hat{=}$ system beta), 14/3.79/0.117, 26/3.22/0.134, 44/15.3/0.145 ($\hat{=}$ system alpha-3), 47/3.55/0.116, 66/2.55/0.110, 132/4.14/0.066, 169/4.63/0.167. The two systems correspond to components with higher κ . A probability distribution function curve of eight components mixture shows two peaks (fig. 1). Estimations of κ via directional statistics give a basis of the description that there are principal two systems of crush zone.

Discussion: Crush zones principally depict dextral sense of shear along the system beta, and sinistral one along the system alpha-3. Plastically deformed biotite grains are observed in both crush zones. Deformation temperature of them seems to be higher. Statistically comparable development, nearly orthorhombic symmetry, and cross cutting relationship between the two systems suggest the development of crush zones in conjugate manner. Bisect orientation of acute angle, 30 deg., indicate a shortening axis and elongation normal to it during deformation. This movement picture is inconsistent with continuing E-W shortening during late Quaternary. These lines of evidence suggest that crush zones are old geologic structure which could not be formed near the surface.

References

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Fig.1 A probability distribution function curve. x: strike in 0-360 deg., y: relative probability (mean=1).

Keywords: directional statistics, crush zone, Kojaku Granite, Monju

HCG34-05

Room:101A

Time:May 26 10:00-10:15

