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Shape analysis of experimental and natural fault rocks

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Fault rocks display a variety of microstructures which can be used to distinguish fresh from healed faults, to determine the amount of deformation accommodated by the gouge, and and to derive the degree of healing. The most important features are: the fractal dimension of the grain size distributions and the shape of the cracked grain fragments and of the grains of the fault gouge.

A number of natural and experimental fault rocks were analyzed and compared. Fresh natural samples are from the Nojima fault zone (Kobe Earth quake 1995), healed natural samples from Tertiary Alpine faults. Experimental samples have been produced in a Griggs apparatus, using a fine grained granite at a confining pressure of 500 MPa, temperature of 300 to 500˚C, strain rates of 10-4 to 10-7 s-1 and healing times up to 14 days under hydrostatic or slow axial straining conditions.

Grain size analysis was performed over several orders of magnification; for results see Keulen et al. (2005). For a better distinction and quantification of the grain shapes the fabric analysis program iSHAPES (used to calculate the PARIS factor, see Panozzo & Hürlimann, 1983) was extended to allow for improved measurements of angularity and surface corrugation.

Apart from the classical shape factors, a number of new measures are derived. The difference between the convex envelope and the actual surface of grains is determined. In essences, this is same as the PARIS factor which describes the convexity-concavity of grains. In contrast, the difference between the area included by the convex envelope and the actual sectional area of the grain defines a different measure which is useful to describe the degree of fragmentation. iSHAPES also derives angles at vertices, and from a weighted histogram of angles, the angularity. The input can be manually digitized data or raw pixel coordinates from image analysis programs such as NIH Image (http://rsb.info.nih.gov/nih-image/Default.html),

Scion Image (http://www.scioncorp.com/frames/fr_download_now.htm), imageJ (http://rsb.info.nih.gov/ij/) or image SXM (http://reg.ssci.liv.ac.uk/).

The poster demonstrates the quality of these new shape factors and compares them to classical shape factors. A number of test images are evaluated and examples of fault rock microstructures are analyzed. The iSHAPES program (Fortran source code) runs on Linux/Unix, i.e., on MacOSX, and is available from http://www.unibas.ch/earth/micro/.

Keulen, N., Stünitz, H. and Heilbronner, R. (2005). Deformation and healing processes in granitoid fault rocks in experiments and nature. (This conference, section TS17).

Panozzo, R. and H. Hürlimann (1983). "A simple method for the quantitative discrimination of convex and convex-concave lines." Microscopica Acta 87: 169-176.