Geophysical Research Abstracts
Vol. 17, EGU2015-5687, 2015
EGU General Assembly 2015

Role of folded anisotropic fabric in the failure mode of gneiss: new insights from mechanical, microseismic and microstructural laboratory data

Federico Agliardi (1), Sergio Vinciguerra (2,3), Marcus R. Dobbs (3), and Stefano Zanchetta (1)

(1) Department of Earth and Environmental Sciences, University of Milano - Bicocca, Milano, Italy (federico.agliardi@unimib.it), (2) Department of Geology, University of Leicester, Leicester, UK, (3) British Geological Survey, Environmental Science Centre, Keyworth, Nottingham, UK

Fabric anisotropy is a key control of the mechanical behaviour of rocks in a variety of geological settings and on different timescales. However, the effects of inherited, tectonically folded anisotropic fabrics on the brittle strength and failure mode of foliated metamorphic rocks is yet to be fully understood. Data from laboratory uniaxial compression tests on folded gneiss (Agliardi et al., 2014, Tectonophysics) recently showed that the brittle failure mode of this rock type depends on the arrangement of two distinct anisotropies (i.e. foliation and fold axial plane anisotropy), and that rock strength correlates with failure mode. Here we investigate the effects of confining pressure on this behaviour by performing triaxial compression experiments with acoustic emission (AE) monitoring, and analyse resulting fracture mechanisms and their microfabric controls using high resolution microanalysis techniques.

We tested the Monte Canale Gneiss (Austroalpine Bernina nappe, Central Italian Alps), characterized by low phyllosilicate content, compositional layering folded at the cm-scale, and absence of a well-developed axial plane foliation. We used a servo-controlled hydraulic loading system to test 19 air-dry cylindrical specimens (diameter: 54 mm) that were characterized both in terms of fold geometry and orientation of foliation and fold axial planes to the axial load direction. We instrumented the specimens with direct contact axial and circumferential strain gauges. We performed tests at confining pressures of 40 MPa and constant axial strain rates of $5*10^{-6}$ s^{-1}, measuring acoustic emissions and P- and S-wave velocities by three wideband (350–1000 kHz) piezoelectric transceivers with 40 dB preamps, mounted in the compression platens. We carried out post-failure microscale observation of fracture mechanisms, microcrack patterns and related fabric controls on resin-impregnated samples, using X-ray MicroCT (resolution: 9 μm), optical microscopy and SEM.

Samples failed in three distinct brittle modes with different combinations of neat shear planes parallel to foliation, fractures parallel to fold axial planes, or less localized mm-scale brittle shear zones. The different failure modes, consistent with those previously described in uniaxial compression experiments, are associated with distinct stress-strain and acoustic emission signatures (i.e. overall activity, rate distribution, frequency and amplitude patterns). Failure modes involving the quartz-dominated axial plane anisotropy correspond to higher peak strength and axial strain, less brittle macroscopic behaviour with well-developed fracture process zones, and higher and more progressive acoustic emission activity than failure controlled by mica-dominated foliation anisotropy. Experimental and microstructural observations support a decisive control of folded microfabric on the overall behaviour of the same rock type, through the activation of Q-dominated vs. M-dominated crack nucleation / propagation mechanisms.