Geophysical Research Abstracts
Vol. 21, EGU2019-6790, 2019
EGU General Assembly 2019

3D rock fabric analysis with X-ray computed microtomography and application to the Ivrea mafic complex (N Italy)

Benoît Petri (1,2), Bjarne S.G. Almqvist (3), Mattia Pistone (2), and Othmar Müntener (2)

(1) University of Strasbourg, IPGS - UMR 7516, Strasbourg, France (bpetri@unistra.fr), (2) University of Lausanne, ISTE, Lausanne, Switzerland, (3) Uppsala University, Department of Earth Sciences, Uppsala, Sweden

The rock fabric can be expressed by both shape preferred orientation (SPO) and crystallographic preferred orientation (CPO) of rock-forming elements (minerals, grain aggregates, pores, inclusions). The study of fabric properties (orientation, planar vs. linear fabric, anisotropy) is key to unravel the geological processes that forged it. State-of-the-art methods either assess the CPO by electron backscatter diffraction (EBSD), or a combination of CPO and SPO by anisotropy of magnetic susceptibility (AMS), whereas the documentation of solely SPO requires serial sectioning of rock samples. With advancements in data acquisition and treatment, X-ray computed microtomography (μXCT) represents a powerful alternative to analyse SPO in rocks.

Here, we propose and showcase the use of μXCT for rock fabric analysis. After reconstruction and segmentation of μXCT images (using Blob3D), we developed an approach based on the analysis of the fabric tensor, a 2nd rank symmetric tensor constructed using the orientation tensor and the length of the three characteristic axes of each grain (simplified to best fit ellipsoids). The analysis of the fabric tensor permits to calculate mean principal directions and associated confidence ellipses, but also to quantify the degree of anisotropy (P') and the "shape" (T) of the fabric ellipsoid by eigenvalue and eigenvector analysis.

We implemented this method in an open-source MATLAB package and designed the μTomoFab analysis tool. The code integrates a graphical user interface that allows the visualization of the full set of ellipsoid orientation, shape and size. Density plots and contouring can be utilised to graphically identify fabrics and sub-fabrics, and a full set of fabric parameters can be calculated based on the analysis of the fabric tensor (P', T) as well as the analysis of each principal direction orientation tensor (PGR values, K-index, LS-index).

We demonstrate the strength of μTomoFab analysis tool with synthetic dataset and a field- and laboratory-based investigation of the mechanism of emplacement of the Ivrea Mafic Complex within the lower crustal section of the Ivrea-Verbano Zone (N Italy). The new dataset provides crucial insights into the micro- and macro-scale evolution of the Mafic Complex during its emplacement, construction and deformation history: (1) at micro-scale, we have discriminated the magmatic fabric from the fabric recording sub-solidus static recrystallization ("metamorphic overprint"); (2) at macro-scale, we have revealed the internal architecture of the pluton made by magma sills.

In the light of these developments, we stress that μXCT represents a pertinent tool for rock fabric analysis to characterize the SPO of rock components. This approach can be performed parallel to other rock fabric quantification methods (e.g. AMS, EBSD) and applied to various rock types.