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# Reconstruction of 3d grain boundaries from rock thin sections, using polarised light

Daniel Markus Hammes and Mark Peternell
Institute of Geoscience, University of Mainz, Mainz, Germany (danielhammesr@aol.com)

Grain boundaries affect the physical and chemical properties of polycrystalline materials significantly by initiating reactions and collecting impurities (Birchenall, 1959), and play an essential role in recrystallization (Doherty et al. 1997). In particular, the shape and crystallographic orientation of grain boundaries reveal the deformation and annealing history of rocks (Kruhl and Peternell 2002, Kuntcheva et al. 2006). However, there is a lack of non-destructive and easy-to-use computer supported methods to determine grain boundary geometries in 3D. The only available instrument using optical light to measure grain boundary angles is still the polarising microscope with attached universal stage; operated manually and time-consuming in use.

Here we present a new approach to determine 3d grain boundary orientations from 2D rock thin sections. The data is recorded by using an automatic fabric analyser microscope (Peternell et al., 2010). Due to its unique arrangement of 9 light directions the highest birefringence colour due to each light direction and crystal orientation (retardation) can be determined at each pixel in the field of view. Retardation profiles across grain boundaries enable the calculation of grain boundary angle and direction. The data for all positions separating the grains are combined and further processed. In combination with the lateral position of the grain boundary, acquired using the FAME software (Hammes and Peternell, in review), the data is used to reconstruct a 3d grain boundary model. The processing of data is almost fully automatic by using MATLAB®. Only minor manual input is required.

The applicability was demonstrated on quartzite samples, but the method is not solely restricted on quartz grains and other birefringent polycrystalline materials could be used instead.

References:

Birchenall, C.E., 1959: Physical Metallurgy. McGraw-Hill, New York.
Doherty, R.D., Hughes, D.A., Humphreys, F.J., Jonas, J.J., Juul Jensen, D., Kassner, M.E., King, W.E., McNelley, T.R., McQueen, H.J., Rollett, A.D., 1997: Current issues in recrystallization: a review. Materials Science and Engineering A 238, 219-274.

Hammes, D.M., Peternell, M., in review. FAME: Software for analysing rock microstructures. Computers & Geoscience.

Kruhl, J.H., Peternell, M., 2002. The equilibration of high-angle grain boundaries in dynamically recrystallized quartz: the effect of crystallography and temperature. Journal of Structural Geology 24, 1125-1137.

Kuntcheva, B., Kruhl, J.H. & Kunze, K., 2006. Crystallographic orientation of high-angle grain boundaries in dynamically recrystallized quartz: First results. Tectonophysics 421, 331-346.

Peternell, M., Hasalová, P., Wilson, J.L., Piaziolo, S., Schulmann, K., 2010. Evaluating quartz crystallographic preferred orientations and the role of deformation partitioning using EBSD and fabric analyser techniques. Journal of Structural Geology 32, 803-817.