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Quantification of anisotropy and inhomogeneity of complex fabrics by modified fractal geometry methods

Jörn H. Kruhl (1), Mark Peternell (2), Axel Gerik (1,3)

(1) Technische Universität München, Tectonics and Material Fabrics Section, 80333 München, Germany (kruhl@tum.de, +498928925852), (2) University of Melbourne, School of Earth Sciences, Victoria 3010, Australia (petm@unimelb.edu.au, +61383447761), (3) Present address: Erdwärme Oberland GmbH, 81675 München, Germany (axel.gerik@erdwaerme-oberland.de, +49894576908109)

Anisotropy and inhomogeneity are typical for most material fabrics. Fabric anisotropy results from direction-related processes, leads to anisotropy of physical properties and, therefore, represents an important material characteristic. Fabric inhomogeneity is mainly related to inhomogeneous distribution of matter, for example, as a result of mingling-mixing in magma, of transport and deposition of sediment, or of fluid and material flow in metamorphic rocks. Fundamental investigation of fabric anisotropy and inhomogeneity needs quantification, mainly of the pattern component of a fabric, in order to allow comparison of natural fabrics with experimentally generated ones and to form a basis for simulations. However, rock-fabric patterns often show complexity and quantification of complex patterns is mainly, if not soley, possible by fractal geometry methods.

Since classical methods, such as box-counting or divider method, are not designed for quantifying anisotropy or inhomogeneity, these methods have been modified and automated. Based on the Spacing-Population Technique, a modified Cantor-Dust Method was developed and, by automation, made applicable to large data sets and refined analysis (Gerik & Kruhl 2009). This method quantifies the direction-related complexity of a pattern. The pattern is dismembered into segments that are statistically analysed. Although this is a straightforward method that proved its usefulness, part of the information about pattern complexity is lost because the method does not investigate the internal geometry of pattern fractions. This problem is partly overcome by a modified Divider Method that analyses complexity of curves along directions. Based on a defined procedure and in relation to a set of parallel scan-lines, curves are constructed from a line pattern. The complexities of these curves represent the direction-related complexity of the pattern (Kruhl et al. 2004).

In order to quantify pattern inhomogeneity, Box Counting is combined with the gliding window method. This leads to a contour map of fractal dimensions and, consequently, to visualization of the inhomogeneous distribution of pattern complexity (Peternell et al., 2003). Both types of techniques of anisotropy and inhomogeneity quantification can be combined. This leads to the quantification of the inhomogeneity of anisotropy and, consequently, to more sophisticated information about material fabrics. In general, different types of material fabrics and different scientific questions require a variety of quantification methods, in order to fully explore the wealth of information stored in these fabrics and to receive satisfying answers. Applications of the various methods on different types of rock fabrics, together with their advantages and disadvantages, will be presented.

References:

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