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Quantification of rock fabric anisotropy and inhomogeneity

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Rock fabrics are often anisotropic and/or inhomogeneous. However, common fractal geometry methods are not able to investigate such fabric properties and have to be modified in order to allow the quantification of pattern inhomogeneity and anisotropy. First promising steps show that modified Cantor-dust, perimeter and box-counting methods are useful in quantifying anisotropies as well as inhomogeneities. (1) A modified Cantor-dust method, applied on fracture patterns, leads to a direction-related fractal dimension and, consequently, quantifies the intensity of fracture-pattern anisotropy (Velde et al., 1990; Volland & Kruhl, 2004). Such a quantification allows the characterization of anisotropy-forming processes and their parameters, e.g. the shear stresses applied on rocks. (2) A modification of the perimeter method allows to determine the fractal dimension of complex curves in relation to their average orientations (Kruhl et al., 2004). The application on e.g. grain boundary curves may provide information about the interaction between the development of crystallographic preferred orientations and the migration of grain boundaries. (3) The application of the box-counting method, combined with kriging, results in an isoline map of the fractal box-counting dimension, which reveals the local inhomogenieties of a pattern ('map-counting method': Peternell et al., 2003; Kruhl et al., 2004). This method is easily automated and already proved useful in studying crystal distribution patterns in magmatic rocks but may be also applied to any type of material fabric on any scale.

Directions of future investigations will be discussed. (1) The combination of the fractal and non-fractal properties of fabrics: Fractal dimension isolines, based on the map-counting method, can be combined with chemical and/or mineralogical data (grain types, shapes, sizes; rock chemistry). Since both data sets provide information on pattern- as well as rock-forming processes their combination can reveal more detailed

information about these processes. In a similar way, the combination of the fractal dimensions of grain boundaries with crystallographic orientations potentially provides information on grain boundary migration and stabilization. (2) Investigation of distribution patterns of fractal dimension: For example, isoline maps of fractal dimensions themselves (based on crystal distributions, grain boundaries, fractures, or any other type of fabric) are patterns that are potentially fractal and can be studied with fractal geometry methods. (3) Analysis of fractal dimension data sets: The arrangement of data points in a log-log-diagram may contain interesting information about the analyzed pattern, which is not provided by the fractal dimension value (Suteanu & Kruhl, 2002).

In general, the information about pattern-forming processes will be more detailed and more profound with increased precision and completeness of pattern analysis. Since fractal rock fabrics are the result of non-linear geological processes the fabrics are our basic source of information on these processes and, therefore, worth to be studied.

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