Taming the complexity: new developments in quantification of rock structures

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Rock structures are mainly represented by patterns with complex geometry that often is heterogeneous and anisotropic and not easily – if at all – analysable by standard methods. However, heterogeneity and anisotropy are fundamental properties of most rocks (as well as artificial crystalline material) and bear important information on processes which form and change rocks and their structures. Investigation of rock structures requires specific methods of quantification which are able to deal with complexity.

In general, such methods are offered by fractal geometry (Kaye 1989) but have to be modified for application on heterogeneous and anisotropic patterns. Recent investigations include (i) modification of the Cantor-dust method, which leads to a direction-related fractal dimension and, consequently, quantifies the intensity of pattern anisotropy; (ii) modification of the perimeter method, which allows determining the fractal dimension of complex curves in relation to their average orientations; (iii) a combination of box-counting method and kriging, which results in an contour map of the fractal box-counting dimension, revealing the local pattern heterogeneity ('map-counting method': Kruhl et al. 2004), and (iv) a combination of map counting and a modified Cantor-dust method, leading to mapping of rock-fabric anisotropy (Peternell et al. subm.). Application of these methods to a variety of structures on different scales from plutonic, volcanic and metamorphic rocks will be presented and discussed, including patterns of mingled magmatic rocks as well as fracture, grain-boundary and crystal-distribution patterns.

In addition, automated pattern recording (Peternell & Kruhl subm.) and automation of the modified fractal-geometry methods (Gerik & Kruhl subm.) not only allows fast recording and generation of large data sets. It leads to a precision of pattern analysis, not obtainable by manual method execution. Application of automated methods on different types of patterns will be presented and discussed. In general, combining different methods and their automation open the door to a wide field of useful investigations which do not only represent a quantitative improvement but a qualitative step forward. Data sets of such accuracy provide completely new types of information and will highly improve the analysis of rock structures and structure-forming processes.

REFERENCES
Gerik, A. & Kruhl, J.H.: Towards automated pattern quantification: time-efficient assessment of anisotropy of 2D pattern with AMOCADO. Computers & Geosciences (subm.).