Automating pattern quantification: new tools for analysing anisotropy and inhomogeneity of 2d patterns

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The quantitative analysis of patterns as a geometric arrangement of material domains with specific geometric or crystallographic properties such as shape, size or crystallographic orientation has been shown to be a valuable tool with a wide field of applications in geo- and material sciences.

Pattern quantification allows an unbiased comparison of experimentally generated or theoretical patterns with patterns of natural origin. In addition to this, the application of different methods can also provide information about different pattern forming processes. This information includes the distribution of crystals in a matrix – to analyze i.e. the nature and orientation of flow within a melt – or the governing shear strain regime at the point of time the pattern was formed as well as nature of fracture patterns of different scales, all of which are of great interest not only in structural and engineering geology, but also in material sciences.

Different approaches to this problem have been discussed over the past fifteen years, yet only few of the methods were applied successfully at least to single examples (Velde et al. 1990, 1991; Harris et al. 1991; Peternell et al. 2003; Volland & Kruhl 2004). One of the reasons for this has been the high expenditure of time that was necessary to prepare and analyse the samples. To overcome this problem, a first selection of promising methods have been implemented into a growing collection of software tools: (1) The modifications that Harris et al. (1991) have suggested for the Cantor's dust method (Velde et al. 1990) and which have been applied by Volland & Kruhl (2004) to show the anisotropy in a breccia sample. (2) A map-counting method that uses local box-counting dimensions to map the inhomogeneity of a crystal distribution pattern. Peternell et al. (2003) have used this method to analyze the distribution of phenocrysts in a porphyric granite. (3) A modified perimeter method that relates the directional dependence of the perimeter of grain boundaries to the anisotropy of the pattern (Peternell et al. 2003).

We have used the resulting new possibilities to analyze numerous patterns of natural, experimental and mathematical origin in order to determine the scope of applicability of the different methods and present these results along with an evaluation of their individual sensitivities and limitations.

REFERENCES

Harris, C., Franssen, R. & Loosveld, R. (1991): Fractal analysis of fractures in rocks: the Cantor's Dust method – comment. Tectonophysics 198: 107-111.

Peternell, M., Andries, F. & Kruhl, J.H. (2003): Magmatic flow-pattern anisotropies – analyzed on the basis of a new 'map-mounting' fractal geometry method. DRT Tectonics conference, St. Malo, Book of Abstracts.

Velde, B., Dubois, J., Touchard, G. & Badri, A. (1990): Fractal analysis of fractures in rocks: the Cantor's Dust method. Tectonophysics (179): 345-352.
Velde, B., Dubois, J., Moore, D. & Touchard, G. (1991): Fractal patterns of fractures in granites. Earth & Planetary Science Letters 104: 25-35.
Volland, S. & Kruhl, J.H. (2004): Anisotropy quantification: the application of fractal geometry methods on tectonic fracture patterns of a Hercynian fault zone in NW-Sardinia. Journal of Structural Geology 26: 1499-1510.