Magmatic flow-pattern anisotropies – analyzed on the basis of a new 'map-counting' fractal geometry method

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Flow patterns represent a useful data basis for analyzing the structure and development of syntectonic melts and the effects of melt injection into a deforming and reorganizing continental crust. New analytical methods, based on fractal geometry, are applied to syntectonic granitoids of the Dom Feliciano Belt (Proterozoic basement of southern Brazil).

In the Itapema region, ~80 km north of Florianopolis, two syntectonic granitoids subsequently intruded a low-strain region – Neoproterozoic volcanosedimentary schists and Paleoproterozoic granites and gneisses – bounded by two major, NE-trending, strike-slip zones, both considered as part of the Neoproterozoic III Southern Brazilian Shear Belt. The younger Rio Pequeno granite is porphyritic and, therefore, suitable for the analysis of synmagmatic structures. The general absence of significant solid-state deformation enables magmatic flow structures to be preserved, such as: (i) a weak, S-C type flow foliation, (ii) synmagmatic shear zones, both structures marked by the distribution and alignment of K-feldspars, (iii) elongated mafic microgranular enclaves. In addition the lack of corresponding solid-state deformation structures in the wall rocks argue for a low differential regional stress during melt intrusion. A system of two synmagmatic conjugate shear zones is observed. The more strongly developed set occurs as up to 5 m long and 10 cm wide, subvertical and E-W to ENE-WSW trending zones with dextral shear sense. The zones of the second set are shorter, NE-SW to NNE-SSW oriented, with a sinistral shear sense. In addition to magmatic microfractures in feldspars, chessboard subgrain patterns in quartz and plagioclase recrystallized grains with 0.5–1 mm diameters indicate high-T deformation. These features, together with the lack of lower-temperature deformation, argue for melt crystallization in a regional low differential stress field. Flow patterns and crystal distributions have been studied on the basis of modern methods of fractal geometry, specifically designed for unraveling local pattern inhomogeneity and anisotropy. The distribution behavior of the feldspars was analyzed on two approx. 3–6 m large rock sections with the box-counting method. The resulting two fractal dimensions are interpreted to reflect two different processes of flow and shearing. To overcome the limitation of the box-counting method with respect to anisotropic patterns, a new 'map-counting' method was developed that is able to analyze pattern inhomogeneity and anisotropy. The fractalities of sub-regions of the total rock section are determined, combined with a specific type of kriging process. On the basis of the resulting fractal dimensions, isoline maps are constructed. First results of map counting show an inhomogeneous distribution of the fractal dimensions that reflect shear zone patterns remarkably well and are interpreted as a quantification of the shear pattern, which might be potentially useful for more detailed analyses of the magmatic shear processes. In addition, future work is intended to increase the structural data basis and reveal more details of the relationship between the melt injections, the regional stress field and the large-scale shear zone pattern of the Dom Feliciano Fold Belt and, consequently, provide a better understanding of its late Proterozoic development.