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Preliminary scaling model for fracture lengths in a strike-slip tectonic setting: the Liquiñe-Ofqui Fault System and the Andean Transverse Faults, Southern Andes (39-40ºS)

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Geological fracture networks govern fluid flow in the upper crust. This implies that their geometry, size and spatial distribution directly influence the nature and development of shallow magmatic and hydrothermal systems, especially when fractures occur in impervious, crystalline rocks. However, fractures occur as complex meshes in a wide range of sizes and orientations, in which the scaling nature of their geometrical features (e.g. length, aperture) may follow different statistical distributions. One of the basic distributions defining the multi-scale properties of flow is the power-law length density distribution, expressed as $N(L,l)=\alpha L^D l^{-a}$. This expression relates the number of fractures $N(L,l)dl$ with lengths between l and $l+dl$ in a system of given size L. The distribution is defined by the fractal density term α, the mass dimension D, and the exponent a representing the balance between small and large fractures of the system. We chose a portion of the Southern Volcanic Zone of the Andes (SVZ) (39-40ºS) as a case study to test the consistency of the scaling model. In the SVZ, recent studies suggest that crustal flow is controlled by two groups of faults: the Liquiñe-Ofqui Fault System (LOFS) and the Andean Transverse Faults (ATF). Regionally, the LOFS is an active, intra-arc fault system composed of NNE-striking dextral and dextral-reverse master faults and NE to ENE-striking subsidiary faults with dextral and dextral-normal kinematics. The ATF are apparently older than the LOFS, and include a set of NW to WNW-striking faults and morphotectonic lineaments that show sinistral and sinistral-reverse kinematics. To define a preliminary scaling model for flow, we produced and measured different fracture trace maps at the regional-, outcrop- and thin section-scales. A total of 3347 fractures mainly hosted in grandioritic to tonalitic rocks were measured, with lengths ranging in eight orders of magnitude ($L \sim 10^4$-10^{-3} m). Assuming a representative mass dimension $D = 1.8$, the obtained best fit is a normalized power-law length density distribution $n(l)=N(L,l)/L^D$, as given by the expression $n(l)=3.5l^{-2.8}$. These preliminary results are in agreement with distributions reported in fractured systems, and indicate that fracture connectivity is dominated by both microscopic and macroscopic fractures, which excludes permeability within individual fractures or classical percolation theory as applicable models for the multi-scale flow structure of the study area.

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