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Structural Geology of Graciosa Island – a contribution for the geodynamics of the Azores triple junction

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The Azores geodynamic setting, its geological, geochemical and geophysical characteristics, and the frequent seismic and volcanic activity, motivated the development of multidisciplinary studies aiming at the creation of a coherent model explaining the geodynamic and kinematic particularities that characterize the Azores triple junction – the contact between the North American, Eurasian and Nubian lithospheric plates.

The tectonic regime determination at any given region, through the identification and characterisation of active faults, is a major contribution to the development of geodynamic models. In this domain the geometric and kinematic characterisation of Graciosa Island active faults was performed and a structural map was produced. The stress fields responsible for the development of the identified tectonic structures were also deduced. Two main fault systems were identified at Graciosa. One system (A) is composed of two sets of conjugated faults, one trending NW-SE and dipping to SW, presenting normal-dextral or dextral-normal oblique slip, and another striking NNE-SSW and dipping to ESE, with oblique normal-left lateral or left lateral-normal slip. The second fault system (B) includes NNE-SSW to NE-SW trending faults, dipping to WNW or NW, presenting normal-dextral or dextral-normal oblique slip. A family of conjugated faults with these structures was not found.

The structural data indicate two distinct stress fields acting in Graciosa region that could be separated in time and/or in space. A stress field I, responsible for the occurrence of fault system A, with 1 (maximum horizontal compressive stress axis) NNW-SSE to N-S, 3 (maximum horizontal tensile stress axis) trending ENE-WSW to E-W, and an intermediate vertical compressive stress axis (2); permutations between 1 and 2 may occur according to the alternation between transtensile and tensile tectonic regimes. A second stress field, II, is characterised by horizontal 1, trending E-W to WSW-ENE, horizontal 3, trending NNW-SSE to N-S, and vertical 2. Permutation may also occur between 2 and 1 after events of stress drop during transtensile phases. Fault system B is associated to stress field II.

The kinematic solutions shown in recent geodetic works and the stress fields determined from neotectonic analysis seem to point out to the presence of two distinct stress fields on the islands located near the margins of the shear zone where the Azorean islands of the central and eastern groups stand.

Stress field I agrees with the local stress regime proposed by several authors for the shear zone that constitutes the western segment of the Eurasia – Nubia plate boundary. To explain the existence of stress field II, two hypothesis are proposed: (1) an intermediate region, with a transtensile regime, making the transition between the area subjected to the Mid-Atlantic Ridge tensile stress field and the more distal region with a compressive stress field; or (2) an intermediate region (established when the interplate shear stress is weaker), with a transtensile regime, defining a narrow band between the region of dextral transtension (resulting from the differential motion between the Eurasian and the Nubian plates) and the external compressive stress field established as the sea-floor moves away from the Ridge.

Narrowing or widening of the area under influence of local stress field (I) may justify that the margins of the sheared region will become temporarily under the influence of the external stress field (II).