Geophysical Research Abstracts
Vol. 13, EGU2011-836, 2011
EGU General Assembly 2011

Strain gradient recorded in the Penedo Gordo granite during extensional movement of crustal-scale Vivero Fault (NW Spain)

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The Vivero Shear Zone (VSZ) is a large shear zone (>140Km) that follows the main Variscan structures with a N-S trend. It separates two major zones of the NW Iberian Variscan belt with different tectonostratigraphic features. The movement accumulated during its tectonic history affects the major lithostratigraphic sequence of Iberian rocks and the metamorphic contacts developed during Variscan orogenesis. The minimum vertical offset inferred from petrological thermobarometry data is 5.5 km and has an extensional character top-to-the-hinterland with the present-day geometry of the shear zone. A local heating event localized in the hanging wall of the VSZ is defined by the syn-tectonic growth, with respect to the development of VSZ, of staurolite and locally andalusite and biotite, based on porphyroblast-matrix relations. This event is superimposed on a regional Variscan greenschist facies metamorphism and a local kyanite metamorphism subsequently developed in Al-rich pelites.

In the hanging wall of the VSZ the microstructure of coarse-grained S-type granite, the Penedo Gordo (PG) granite, was studied. This granitic body shows an eastward increase in deformation, towards the shear zone.

In weakly deformed samples of PG granite, quartz shows very irregular and lobate boundaries at different scales, some new recrystallized fine grains located at the boundaries and chessboard subgrains. With increasing strain, dynamic recrystallization becomes widespread and chessboard subgrains become deformed and then completely erased. Recrystallized grains reduce its size more than one order of magnitude (mm to $\sim$96 μm), with an equigranular distribution, and show polygonal shapes usually free of deformation microstructures. In highly deformed samples, quartz sometimes has ribbon shapes.

In contrast to quartz, the behavior of the feldspars is completely different. In weakly deformed samples, K-feldspar shows deformation structures like patchy tartan twinning and perthites (in one or two dominant directions), sometimes with wavy geometries (flame-perthite). With the increase of deformation K-feldspar fractures along two dominant directions. New very fine-grained feldspar grains ($\sim$10 μm) crystallize along fractures and K-feldspar boundaries. The plagioclase (An_{00-20}) in the weakly deformed samples shows patchy undulose extinction and subgrains walls. With increasing deformation fracturing and crystallization of new very fine grains are common, similar to those shown in the K-feldspar, except that plagioclase shows a pervasive sericitic alteration.

The highly deformed samples consist of a matrix with feldspar, quartz and sericite with an average grain size of 10 μm, usually featuring some quartz pods and small feldspar porphyroclast. A further decrease in quartz grain size and the increase of mica content can only be inferred.

Based on pseudosections calculated for the hangingwall pelites that host the PG granite, the inferred temperature conditions during deformation fall in the 400-550°C range, while the pressure remained below 400 MPa. The observed microstructures for weak to moderately deformed samples indicate that the dominant deformation mechanisms are intracrystalline plasticity in quartz and cataclasis accompanied by syn-tectonic crystallization of albitic plagioclase in feldspars. In the case of quartz the dominant recrystallization mechanism is sub-grain rotation overprinting a previous chessboard subgrain microstructure.

Recrystallization features in quartz in the PG granite are consistent with SGR recrystallization. According to Stipp et al. (2002) this recrystallization is constrained to operate in the temperature-range of 400-500 ºC, which is in agreement with temperatures inferred in this study. The feldspar microstructures and neocrystallisation have been reported previously on rocks where the temperature was estimated between 250 to 400ºC (see Fizt-Gerald and Stünitz 1993; Ree et al. 2005). In our case, we have regional and local indirect evidence of temperatures during deformation reaching 400-550 ºC range. Furthermore, we suggest the involvement of fluids, reflected in an increase in mica content with the increasing of deformation.