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P-T Path of a Variscan Shear Zone recorded on Quartz-Aluminous Shearband Boudins

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The work is focused on the P-T path recorded on internal shearband boudin microstructures, developed during simple shear progressive deformation (Malpica-Lamego Ductile Shear Zone – MLDSZ, NW Portugal). In the studied area, MLDSZ is a NW-SE striking Variscan crustal shear zone with a sub-vertical and west-dipping foliation and a sub-horizontal stretching lineation; it is recorded as a heterogeneous simple shear zone with bulk left-lateral kinematics (Pamplona and Rodrigues, 2011). The deformation zone is marked by a generalized foliation (Sn) defined by Bt+Ms±Sil and a stretching mineral lineation marked by sillimanite fibres.
Microstructural analysis, fluid inclusions studies, Raman spectroscopy, crystallographic preferred orientation on quartz grains and fractal geometry based analysis were applied to the boudins (Rodrigues et al., submitted).
In several microstructural domains, the sharp-tip domain, formed by recrystallized coarse quartz grains, and internal secondary shear zones with sillimanite recrystallization are the most remarkable ones; these features indicate to conditions of T≥560ºC and P≈360 MPa. Quartz crystallographic preferred orientation diagrams are complex and quartz opening angle on cross girdle like structures indicate a recrystallization temperature of T= 625ºC ± 50ºC that is in good coincidence to microstructural observations.
Fluid inclusions record the complete deformation path with primary hydrothermal quartz grains, including primary "isolated" fluid inclusions (LCW and LWC, T≥340ºC and P≥100 MPa), quartz grains with intracrystalline trails of fluid inclusions (VC, T≈400ºC and P≈130 MPa), recrystallized quartz and andalusite grains with intercrystalline trails of fluid inclusions (LC, T=380-560ºC and P=250-360 MPa), and transgranular trails of fluid inclusions (LW, T>210ºC and P>100 MPa).
The fractal dimension maps for all studied shearband boudins are similar, with constant mean Euclidian-distance-mapping fractal dimension that corresponds to a maximum deformation temperature of 600-640ºC ± 50ºC at regional strain rate.
The integration of this multiple approaches supports a model of a regional metamorphic P-T path during the internal evolution of shearband boudins. Thus, we established three main stages for the MLDSZ development. In a first stage quartz-aluminous veins generate and the shear zone core has undergone a clockwise P-T path metamorphic evolution. The stage 2a shows grain reduction by partial dynamic recrystallization and the stage 2b begins with the crystallization of anadalusite after an internal shearband boudin dilatation event and end with quartz dynamic recrystallization on boudin tips. The main deformation stage (final 2b stage and 3th stage; Variscan D2, 310/315 M.a.) led to reactivation of internal secondary shear zones with sillimanite crystallization. These data have major regional tectonic-stratigraphic implications.

Pamplona J, Rodrigues BC (2011). Kinematic interpretation of shearband boudins: New parameters and ratios useful in HT simple shear zones. Journal of Structural Geology, 33: 38-50.

Rodrigues BC, Peternell MP, Moura A, Schwindinger M, Pamplona, J. Microstructures of Shearband Boudins in HT simple shear zones. Submitted to Journal of Metamorphic Geology.