Interpretative model of shearband boudins internal evolution in HT ductile shear zones

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The internal structure of a shearband boudin resulting from an original igneous, hydrothermal or metamorphic segregation tabular rigid body is a subject of scientific interest. It allows understanding the deformation mechanisms acting on homogeneous quartz aggregate activated during simple shear progressive deformation.

This work is focused on the characterization of the internal evolution of shearband boudins, using microtextural analysis, fluid inclusions studies, fractal and OCP analysis. The proposed interpretative model shows the several structural stages that can be well established during the process of the internal evolution of shearband boudin.

In the first stage a quartz-rich layered body was submitted to the boudinage process. This layer has most likely a segregation or igneous and hydrothermal texture, in equilibrium with Lcw or Lwc fluids, catched in isolated fluid inclusions (FI). The quartz fabric is supposed to be random or controlled by a nucleation/growth process. In continuity, with major or minor time gap, were preserved vapor-carbonic fluids (Vc) in intracrystaline trails.

The boudinage process starts when the original layer achieved enough viscosity contrast relatively to the surrounding matrix, caused by a differential stress field. Two main transformations occur simultaneously: i) a change in the external shape with continuous evolution from tabular rigid body to sigmoidal assymetric morphology (shearband boudin) and, ii) localized dynamic recrystallization in the sharp-tips (parameter defined by Pamplona and Rodrigues, 2011) and, along the boudin's margin and grain boundaries. The smaller recrystallized grains, particularly in the sharp-tip domains (StD) accommodate most of the external strain and preserve the larger, relict grains in the centre.

The dynamic recrystallization was one single process, indicated by grain boundary fractal dimension analysis that results in a single mean fractal dimension $D_{EDM} = 1.13$. Most strain is accommodated in the StD and the c´type structures. As a consequence of this strain partitioning the small recristallized quartz grains in the StD define c-axis patterns indicating an inferred anthithetical shear sense. Nevertheless, the recrystallization process is very complex, implying two internal rotations around kinematics axis Z and Y in amphibolitic facies conditions.

Two sub-stages inside the deformation stage are only recorded by textural analysis and fluid inclusion studies. The first of these sub-stages is characterized by the formation of the heterogeneous domain (HtD). The external envelope of the boudin is locally permeable to the penetration of external aluminous fluids with crystallization of a paragenesis dominated by andalusite. This episode is recorded by a new set of transgranular and intracrystaline trails of fluid inclusions within andalusite grains and quartz grains in the whole body of the boudin.

The last deformation episode shows the final formation of blunt-tip domain and secondary shear planes (c' type-I and c'type-II structures – shearband boudin parameters defined by Pamplona and Rodrigues, 2011), sometimes marked by sillimanite crystallization.

References

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