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Strain localization in shear zones during exhumation: a graphical approach to facies interpretation

Giovanni Luca Cardello (1,2,3), Romain Augier (1,2,3), Valentin Laurent (1,2,3), Vincent Roche (1,2,3), Laurent Jolivet (1,2,3)

(1) Université d'Orléans, ISTO - Institute of Earth Sciences, Orléans, France (luca.cardello@univ-orleans.fr), (2) CNRS/INSU, ISTO, UMR 7327, 45071 Orléans, France, (3) BRGM, ISTO, UMR 7327, BP 36009, 45060 Orléans, France

Strain localization is a fundamental process determining plate tectonics. It is expressed in the ductile field by shear zones where strain concentrates. Despite their worldwide distribution in most metamorphic units, their detailed characterization and processes comprehension are far to be fully addressed. In this work, a graphic approach to tectono-metamorphic facies identification is applied to the Delfini Shear Zone in Syros (Cyclades, Greece), which is mostly characterized by metabasites displaying different degree of retrogression from fresh eclogite to prasinite. Several exhumation mechanisms brought them from the depths of the subduction zone to the surface, from syn-orogenic exhumation to post-orogenic backarc extension. Boudinage, grain-size reduction and metamorphic reactions determinate strain localization across well-deformed volumes of rocks organized in a hierarchic frame of smaller individual shear zones (10-25 meters thick). The most representative of them can be subdivided in 5 tectono-metamorphic (Tm) facies, TmA to E. TmA records HP witnesses and older folding stages preserved within large boudins as large as 1-2 m across. TmB is characterized by much smaller and progressively more asymmetric boudins and sigmoids. TmC is defined by well-transposed sub- to plane-parallel blueschist textures crossed by chlorite-shear bands bounding the newly formed boudins. When strain increases (facies TmD-E), the texture is progressively retrograded to LP-HT greenschist-facies conditions. Those observations allowed us to establish a sequence of stages of strain localization. The first stage (1) is determined by quite symmetric folding and boudinage. In a second stage (2), grain-size reduction is associated with dense shear bands formation along previously formed glaucophane and quartz-rich veins. With progressively more localized strain, mode-I veins may arrange as tension gashes that gradually evolve to blueschist shear bands. This process determinates the formation of smaller asymmetric syn-blueschist boudins and is associated with epidote grain-size reduction, synonym of more intense strain localization. In the latest stage (3), newly formed chlorite-rich shear bands bound new boudins of the previously produced terms having blueschist fine-grained heritage. Sense of shear is consistently top-to-the-ENE through the entire localization process. Greenschist-related boudinage is associated with quartz precipitation along the main shear bands and at the necks of boudins, places of strain localization. Metamorphic reactions and transpositions gradually obliterate the former texture, being progressively more active towards the top, where minor shear zones have been deforming at the expenses of similar folds and epidote-rich levels. The resulting qualitative analysis means to be a proxy for further numerical models and a comparison to similar field-study areas.