STRAIN ANALYSIS OF FABRIC EVOLUTION: A NUMERICAL MODELLING APPROACH

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Heterogeneous strain partitioning defines rock volumes characterized by different degree of fabric evolution related to successive stages of incremental strain (Lardeaux and Spalla, 1990). Recognising domains with homogeneous fabric evolution and associating the reconstruction of their tectono-metamorphic evolution is crucial to define the boundaries of crustal slice showing independent or same P-T-t evolutions.

The Lago della Vecchia metagranitoids are located within the Eclogitic Micaschists Complex of Sesia-Lanzo Zone, just to the north of the Oligocene Biella pluton, and they underwent high pressure (HP) – low temperature (LT) metamorphism during the Alpine subduction. Pre-Alpine magmatic features are well preserved in low-strain domains wrapped by a network of superposed tectonitic and mylonitic fabric domains. The multiscale structural analysis allows defining strain gradients, especially for the dominant D2 deformational stage (Fig.1A) that occurs at retrograde blueschist-facies condition (Corti et al., 2017). Intrusive granitoids bodies, initially characterized by isotropic textures are commonly taken as the best natural material for strain analysis and degree of fabric evolution analysis, though they show strong compositional, rheological, geometric and mechanical heterogeneities at closer scale (Pennacchioni and Mancktelow, 2007). Analysis of strain partitioning in metamorphic basements is crucial to identify rock volumes with homogeneous degree of fabric evolution (Fig. 1B) and constrain physical parameters controlling the tectono-metamorphic evolution of lithospheric slices involved in subduction-collision system.

In this contribution, we present the results of a 2D finite-element numerical modelling based on Duhamel-Hooke's law for elastic behaviour of solid material (Fig.1C). The formulation used for structural analysis of deformations is Lagrangian. This means that the computed stress and deformation state is always referred to the material configuration (elastic properties: Young's modulus and Poisson's ratio) and current spatial coordinates. The model setup consists of an ellipse of granodioritic material within micaschist matrix. We perform several simulations increasing the number of inclusions with different orientation respect the shear stress direction, increasing the shape ratio, and varying the inclusions composition from schist to gabbroic composition (Fig. 1C). The initial condition consists of lithostatic pressure of 2 GPa then we applied a differential stress (between lithostatic pressure and shear stress) at bottom and top boundaries increasing from 25 MPa to 250 MPa. Model results show that discrete high-strain domains nucleate from the inclusions and their compositional and mechanical heterogeneity controls the orientation, shape and pervasiveness of fabric evolution (Fig. 1C). Furthermore, the first principal strain direction corresponds to the directions along which the material accommodate the stress and it represent the foliations in natural deformed rocks (Fig. 1C). The results showing that the pattern of strain domains, the reconstructed foliation, and the relationships between them seem to be similar to real ones.

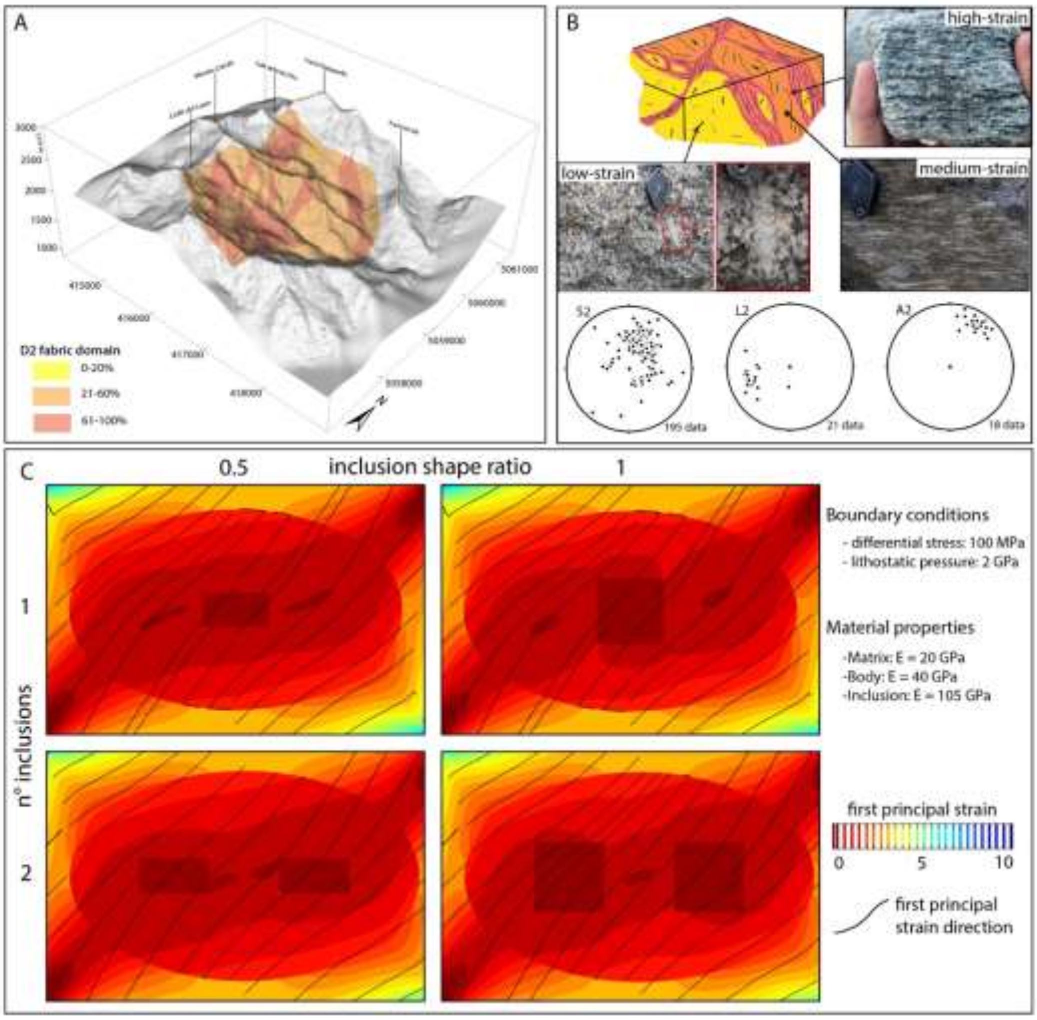

Figure 1 – Strain partitioning. A) 3D view of D2 fabric domains map. B) Idealized block diagram showing the coexistence of contrasted fabric domains due to the deformation partitioning and meso-scale structural features. C) Examples of numerical modelling obtained.

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