

Plate tectonics and mantle flow patterns constrained by seismic anisotropy: integrated numerical modeling of 3D subduction, mineral physics and seismic wave propagation

The flow patterns of the Earth's convecting mantle associated with recent tectonic plate motions can be constrained mainly by studying the seismic anisotropy generated by strain-induced lattice preferred orientation (LPO) of anisotropic mantle minerals. As the formation of the mantle anisotropy during flow occurs at timescales and depths such that it is not directly observable, numerical modeling provides a useful tool to reproduce the development of mantle anisotropy induced by plate motions and the resulting seismic anisotropy patterns that can be compared with those measured in analogous tectonic settings. Such workflow has been recently developed to study subduction systems using purely mechanical 3D models where the deformation in the upper mantle is accommodated exclusively by strain-rate dependent dislocation creep and single crystal elastic tensors valid at ambient P-T conditions (Faccenda & Capitanio 2012, 2013; Faccenda, 2014)).

Nowadays, a large amount of seismological data (mainly shear wave splitting observations) are available to constrain the patterns of mantle flow at convergent margins, whose interpretation, however, still remains elusive.

The aim of this project is to explore with 3D petrological-thermo-mechanical models the dynamics of plate deformation, patterns of mantle flow and associated fabric evolution (Fig. 1) of different convergent settings, with particular attention to some specific subduction and collision zones where the measured seismic anisotropy can be compared with the synthetics, constraining the recent regional dynamics (e.g., Tonga, Japan, Calabria, Alps, Himalaya, Aegean).

The main project expectations are: 1) reproduce seismic anisotropy due to complex mantle circulation patterns typical of subduction and collision zones from which we can 2) indirectly reconstruct the kinematic and dynamic evolution of a given convergent margin.

It is strongly encouraged the attendance at the course: "Numerical modelling in Geoscience" by Dr. Manuele Faccenda held during the next semester (October 2014-January 2015).

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Computational resources: FERMI supercomputer at CINECA, Bologna, Italy

References

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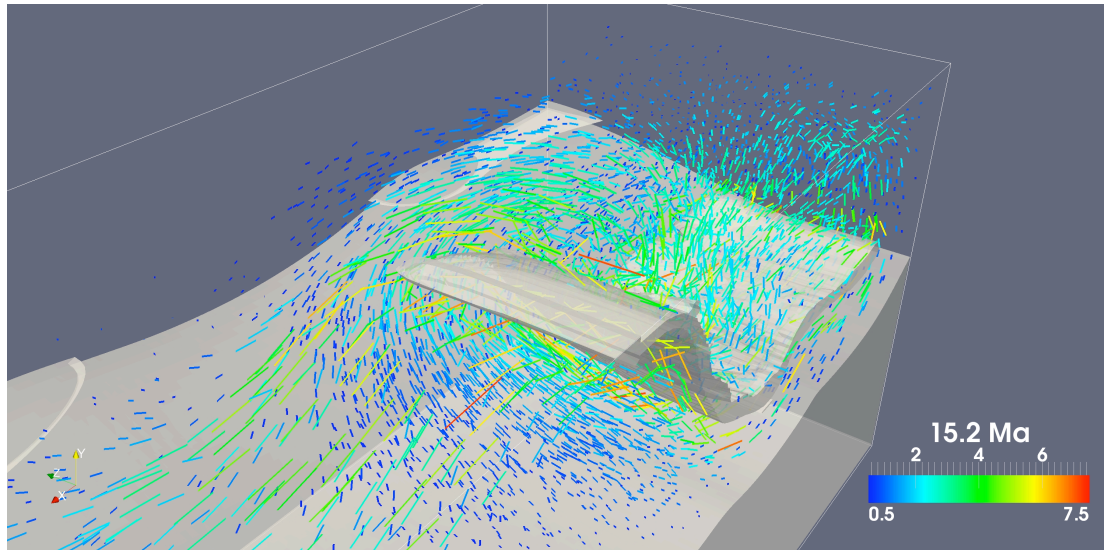


Fig. 1 – 3D numerical model of rigid plate subduction and viscous mantle deformation after 15.2 Ma. The model is symmetric with respect to the right wall. The slab is stagnating over the 660 km discontinuity. The bars indicate the direction of maximum extension and coloured proportionally to the amount of deformation. Mantle fabric and seismic anisotropy (not shown here) is proportional to the amount of deformation.