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Strength of the lithosphere from deformation data: the case of Italy

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Geodynamics relies on understanding the strength of the lithosphere. However, knowledge about the km-scale rheology usually stems from cm-sized laboratory samples or from microstructural studies of naturally deformed rocks.
Here, we present a method where the rheology can be constrained at a larger scale. By means of forward numerical modeling, we simulated the lithospheric deformation as a function of heat flow and rheology, and computed some testable predictions, such as GPS velocities, SHmax directions, and the tectonic regime. We compared the model predictions with the experimental data to select the best solutions.
We applied this method in Italy and found that the rheology shows significant variations at small distances. The strength ranged from 0.57+/-0.15 TN/m within the Apennines belt to 21+/-6 TN/m in the external Adriatic thrust; these strength values correspond to an aseismic mantle in the upper plate and to a strong mantle within the Adriatic lithosphere.
These changes in rheological behavior are greater than our estimated uncertainties and identify the Adriatic subduction margin. They can be also detected when information at depth is scarce, but sufficient surface data are available. Our approach complements both laboratory and field work in time, scale, and depth.