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Improved understanding of observed 2D and 3D geological structures using geomechanically-based approaches

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Recent advances in geologic mapping techniques, reflection seismology, aftershock location and GPS measurements allow geoscientists to image surface and subsurface structures with greater precision. We present 2 numerical approaches that help improving the understanding of these imaged structures by bringing rational physical principles to the geological interpretations.

Poly3Dinv is a 3D slip-inversion method based on the analytical solution of an angular dislocation in a linear-elastic, homogeneous, isotropic, half-space. The approach uses the boundary element method (BEM) that employs planar triangular elements to model complex fault surfaces. Slip inversion techniques are used by geophysicists to invert for coseismic slip associated with earthquakes. We used this first technique to investigate the 3D geometry of normal faults by integrating high-precision aftershock locations and published geological and geodetic data sets from the 1995 Kozani-Grevena earthquake in Greece.

Dynel is a new generation restoration tool based on the finite element method (FEM), which allows unfolding and unfaulting of complex 2D and 3D structures using the physical behavior of rock mass and taking into account rock heterogeneous mechanical properties as well as physical boundary conditions. The technique has been used to understand the development and the geometry of a decameter-scale fold, which crops out in the Coulazou gully located near the Montpellier thrust fault, Southern France.

Through these two examples we show that the geometric flexibility of the geomechanical techniques and the ability to integrate available data sets can lead to improved understanding of observed 2D and 3D geological structures.