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Extension joints: a tool to infer the active stress field orientation (case study from southern Italy)

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An intense tectonic activity in eastern Sicily and southern Calabria is well documented by the differential uplift of Late Quaternary coastlines and by the record of the strong historical earthquakes. The extensional belt that crosses this area is dominated by a well established WNW-ESE-oriented extensional direction. However, this area is largely lacking of any structural analysis able to define the tectonics at a more local scale. In the attempt to fill this gap of knowledge, we carried out a systematic analysis of extension joint sets. In fact, the systematic field collection of these extensional features, coupled with an appropriate inversion technique, allows to determine the characteristic of the causative tectonic stress field.

Joints are defined as outcrop-scale mechanical discontinuities showing no evidence of shear motion and being originated as purely extensional fractures. Such tectonic features are one of the most common deformational structures in every tectonic environment and particularly abundant in the study area. A particular arrangement of joints, called "fracture grid-lock system", and defined as an orthogonal joint system where mutual abutting and crosscutting relationships characterize two geologically coeval joint sets, allow to infer the direction and the magnitude of the tectonic stress field.

We performed the analyses of joints only on Pleistocene deposits of Eastern Sicily and Southern Calabria. Moreover we investigated only calcarenite sediments and cemented deposits, avoiding claysh and loose matrix-supported clastic sediments where the deformation is generally accomodated in a distributed way through the relative motion between the single particles. In the selection of the sites, we also took into account the possibility to clearly observe the geometric relationships among the joints. For this reason we chose curvilinear road cuts or cliffs, wide coastal erosional surfaces and quarries.

The numerical inversions show a similar stress tensors at all the investigated sites. Indeed, the maximum principal stress axis $\sigma 1$ is vertical or subvertical, while the intermediate and the least axes ($\sigma 2$ and $\sigma 3$) lie on the horizontal plane or show low plunging values. The main direction of extension ($\sigma 3$) at each site is in general agreement with the first-order regional stress field (WNW-ESE) even though some local perturbations have been recognized. These are interpreted as due to interferences between large active faults and their particular geometrical arrangement. In particular local stress deflections and stress swaps systematically occur in zones characterized by two overlapping fault segments or close to their tips.