Tectonic stress patterns along the Vrancea subcrustal zone from the inversion of focal mechanisms data

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The Vrancea zone is an unique area with both crustal and intermediate-depth seismic activity and constitutes one of the most active seismic area in Europe. An intense and persistent seismicity is generated between 60 and 180 km depth, within a relic slab sinking nearly vertical in the Earth's mantle due to the increasing of the stress state within this volume. At intermediate-depths, large magnitude events are frequent, i.e. four earthquakes with moment magnitudes (Mw) >7 occurred in the last century. An unique slab geometry, likely preserved until the present, causes stress localization due to the slab bending and subsequent stress release resulting in large mantle earthquakes in the region.

In this study, we evaluate the current stress field along the Vrancea subcrustal region by computing the fault plane solutions of 422 seismic events since January 2005. The continuous development of the National Seismic Network allows us to constrain the fault plane solutions and subsequently to evaluate the current stress field.

The main style of faulting for Vrancea subcrustal events presents a predominant reverse one, with two main earthquakes categories: the first one with the nodal planes oriented NE-SW parallel with the Carpathian Arc and the second one with the nodal planes oriented NW-SE perpendicular on the Carpathian Arc. The main axis of the moment tensor may indicate a predominant compressional stress field (T_{pl}>45^\circ \ P_{pl}<45^\circ). Another characteristic of the Vrancea subcrustal zone is the tendency of the extension axis T to be almost vertical and the compression axis P being almost horizontal.

The results of stress inversion indicate a dominant reverse faulting style, with an average stress regime index of 2.9. Other tectonic regimes were observed in the present dataset as normal and strike-slip but they are retrieved for a restrained number of events.

The stress patterns obtained from formal stress inversion of focal mechanism solutions reveal many features of the current stress field that were not captured by large-scale numerical models.