Deformation of subducting plates in the mantle and implications for deep seismicity

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Processes within subduction zones have a major influence on the plate dynamics and mantle convection. Subduction is controlled by a combination of parameters and there is no simple global relationship between the resulting slab geometry and deformation and any specific subduction parameter. Deformation of the subducted lithosphere in the mantle reflects the thermo-compositional structure of individual subducting plates as well as the mineralogical properties and rheological stratification of mantle material. Constructing the geodynamic models of subduction thus critically depends on our knowledge of mantle composition, phase transitions, water content and rheology.

Most of the world seismicity is associated with the subducting lithosphere. While earthquakes occur on very short time scales, they reflect thermal conditions and stress state attained in the subducted slab during its long-term evolution. Analysis of deep seismicity in subduction zones thus provides invaluable information that helps to constrain geodynamic subduction models. Spatial distribution of deep-focus earthquakes may delineate slab geometry, seismogenic stresses indicate the directions of tectonic stress that developed in the subducting plate due to the thermal and petrological buoyancy and viscous resistance of the mantle. On the other hand, geodynamic models allow to illuminate a possible seismogenic mechanism – dehydrational embrittlement, transformational faulting or thermal runaway.

Here we will present subduction models tailored to several subduction zones including South America (Fig. 1), Japan Sea, Tonga and Aegean. The pressure-temperature conditions and stress orientations in the subducting plates will be used to interpret observed earthquake source mechanisms and shed some light on possible seismogenic mechanism of intermediate and deep-focus seismicity.

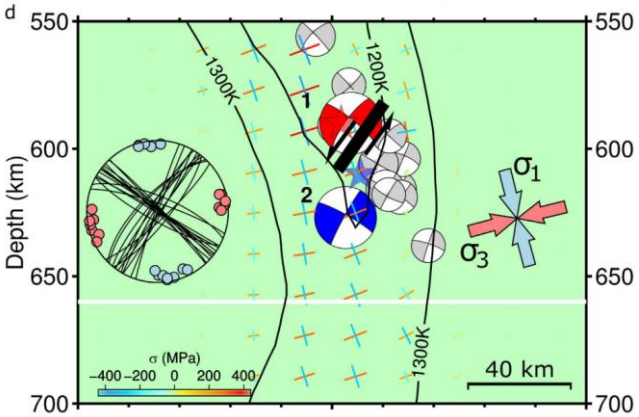

Figure 1: Seismogenic and tectonic stress in the subducted Nazca plate [1]. Seismic data are illustrated by beachballs, nodal planes, P-T axes and principal stress axes in the insets. Geodynamic model stresses are plotted by color-coded crosses.

References

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