A comparison of the post-seismic deformation of Maule and Illapel earthquakes: Highlights on the presence of a low viscosity channel over the deep subduction interface

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Global Navigation Satellite Systems (GNSS) allow to measure the motions of the earth's crust. After the Maule, Tohoku and Aceh megathrust earthquakes, uplift has been observed in vertical GNSS time series over the seaward side of the volcanic arc. Concerning the Maule earthquake (Mw 8.8) in 2010 in south-central Chile, the vertical uplift reached 3 cm/year during the first years after the earthquake and induced more than 15 cm of cumulative displacement in 10 years.

Numerical experiments based on 3D spherical finite element models (FEM) are used to model the subduction process. They allow, in particular, to explore geometries and rheologies that reproduce best the surface deformations observed by GPS. Models built for the Maule earthquake have highlighted that a a low viscosity channel (LVC) at depths larger than 50 km is requested to match the vertical motion observed in GNSS data. A LVC is a thin layer between the subducting plate (slab) and the overriding plate with a viscosity of a few 10^{17} Pa.s, lower than in the asthenosphere. This LVC area can be related to the dehydration of the slab which generates serpentinization of the olivine present in the asthenosphere.

In September 2015, the Illapel earthquake (Mw 8.3) occurred in north-central Chile. Contrary to the Maule area, the slab is here flattened under the Andes Mountains. Simple observations on GNSS time series in the Illapel area show that no post-seismic uplift occurred after the Illapel earthquake. The hypothesis is that the presence of the flat slab in this region inhibits the action of the LVC. In order to explore this hypothesis, we follow the same methodology as previous studies made in Maule, to model the post-seismic deformation. We present here 3D FEM models exploring the effect on surface deformation of the slab geometry and of the presence or absence of the LVC.

Key words: GNSS ; Finite Element Model ; Subduction ; Chile ; Post-seismic

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