Geophysical Research Abstracts
Vol. 19, EGU2017-11940, 2017
EGU General Assembly 2017

3D dynamics of crustal deformation driven by oblique subduction: Northern and Central Andes

Jorina M. Schütt (1) and David M. Whipp Jr. (2)

(1) Department of Physics, University of Helsinki, Helsinki, Finland, (2) Department of Geoscience and Geography, University of Helsinki, Helsinki, Finland

The geometry and relative motion of colliding plates will affect how and where they deform. In oblique subduction systems, factors such as the dip angle of the subducting plate and the convergence obliquity, as well as the presence of weak zones in the overriding plate, all influence how oblique convergence is partitioned onto various fault systems in the overriding plate. The partitioning of strain into margin-normal slip on the plate-bounding fault and horizontal shearing on a strike-slip system parallel to the margin is mainly controlled by the margin-parallel shear forces acting on the plate interface and the strength of the continental crust. While these plate interface forces are influenced by the dip angle of the subducting plate (i.e. the length of plate interface in the frictional domain) and the obliquity angle between the normal to the plate margin and the plate convergence vector, the strength of the continental crust in the upper plate is strongly affected by the presence or absence of weak zones such as regions of arc volcanism, pre-existing fault systems, or boundaries of stronger crustal blocks. In order to investigate which of these factors are most important in controlling how the overriding continental plate deforms, we compare results of lithospheric-scale 3D numerical geodynamic experiments from two regions in the north-central Andes: the Northern Volcanic Zone (NVZ; 5°N - 3°S) and adjacent Peruvian Flat Slab Segment (PFSS; 3°S -14°S). The NVZ is characterized by a $\sim$35° subduction dip angle with an obliquity angle of about 40°, extensive volcanism and significant strain partitioning in the continental crust. In contrast, the PFSS is characterized by flat subduction (the slab flattens beneath the continent at around 100 km depth for several hundred kilometers), an obliquity angle of about 20°, no volcanism and minimal strain partitioning. The plate geometry and convergence obliquity for these regions are incorporated in 3D (1600 x 1600 x 160 km) numerical experiments of oceanic subduction beneath a continent, focusing on the conditions under which strain partitioning occurs in the continental plate. In addition to different slab geometries and obliquity angles, we consider the effect of a continental crustal of uniform strength (friction angle Φ=15°) versus one including a weak zone in the continental crust (Φ=4°) that runs parallel to the margin.

Results of our experiments show that the obliquity angle has the largest effect on initiating strain partitioning, as expected based on strain partitioning theory, but strain partitioning is clearly enhanced by the presence of a continental weakness. Margin-parallel mass transport velocities in the continental sliver are similar to the values observed in the NVZ (about 1 cm/year) in models with a continental weakness and twice as high as those without. In addition, a shallower subduction angle results in formation of a wider continental sliver. Based upon our results, the lack of strain partitioning observed in the PFSS results from both a low convergence obliquity and lack of a weak zone in the continent, even though the shallow subduction should make strain partitioning more favorable.