Geophysical Research Abstracts
Vol. 17, EGU2015-2971, 2015
EGU General Assembly 2015

Two-way interaction between plume and slab: The Hainan-Manila example

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Three-dimensional upper-mantle laboratory models consisting of a compositional plume that is initiated underneath an entirely dynamically driven dense plate fixed at the surface along its trailing edge exhibit a two-way interaction between plume and slab. The slab influence on the plume is driven by the induced mantle flow generated by the plate motion, which includes a sinking and a retreating phase. Slab/Plume buoyancy flux ratios ranged between 7 and 18. In all models, the plume is being swept away from the slab during its rise, and once it has reached the surface, its head spreads towards the trench as a gravity current while its conduit keeps being deflected away. The plume influence on the slab is seen later, when the slab in its retreat gets closer to the plume. The plume buoyancy spreading under the slab then weakens the subduction rate. The degree to which the subduction rate is lessened is conditioned by the level of asymmetry, which the slab may develop along its free edge during its impact at the bottom surface. A lasting symmetric plate causes maximum disturbance of the plume to the slab retreat rate, while plate asymmetry alleviates the plume influence as the plume buoyancy is no longer trapped underneath the plate in its centreline but can escape sideways. Our laboratory model configuration applies to the Hainan plume and Manila subduction system. The geophysical and seismic observations showing the existence of a NW-SE tilting plume-like mantle low-velocity structure in the crust and in the mantle beneath the north Hainan Island-Leizhou Peninsula basalt province are explained by slab rollback induced toroidal mantle flow from the Manila subduction zone. On the basis of our models, it can be foreseen that the Hainan plume is to spread out under the Manila slab towards the mantle wedge in the future, which could lessen the Manila subduction rate.