Geophysical Research Abstracts
Vol. 18, EGU2016-4747, 2016
EGU General Assembly 2016

When mountain belts disrupt mantle flow: from natural evidences to numerical modelling

Philippe Yamato (1,2), Laurent Husson (3), and Benjamin Guillaume (1)

(1) Géosciences Rennes, University of Rennes1, UMR 6118 CNRS, Rennes, France (philippe.yamato@univ-rennes1.fr), (2) GFD group, Institute of Geophysics, Department of Geosciences, ETH-Zurich, CH-8093 Zurich, Switzerland, (3) ISTerre, UMR 5275 CNRS, Université Joseph Fourier, Grenoble, France

During the Cenozoic, the number of orogens on Earth increased. This observation readily indicates that in the same time, compression in the lithosphere became gradually more and more important.

Here, we show that such mountain belts, at plate boundaries, increasingly obstruct plate tectonics, slowing down and reorienting their motions. In turn, it changes the dynamic and kinematic surface conditions of the underlying flowing mantle, which ultimately modifies the pattern of mantle flow. Such forcing could explain many first order features of Cenozoic plate tectonics and mantle flow. Among others, at lithospheric scale, one can cite the compression of passive margins, the important variations in the rates of spreading at oceanic ridges, the initiation of subductions, or the onset of obductions. In the mantle, such changes in boundary conditions redesign the flow pattern and, consequently, disturb the oceanic lithosphere cooling.

In order to test this hypothesis we first present thermo-mechanical numerical models of mantle convection above which a lithosphere is resting on top. Our results show that when collision occurs, the mantle flow is strongly modified, which leads to (i) increasing shear stresses below the lithosphere and (ii) a modification of the convection style. In turn, the transition between a “free” convection (mobile lid) and a “disturbed” convection (stagnant - or sluggish - lid) highly impacts the dynamics of the lithosphere at the surface. Thereby, on the basis of these models and a variety of real examples, we show that on the other side of a lithosphere presenting a collision zone, passive margins become squeezed and can undergo compression, which may ultimately evolve into subduction initiation or obduction. We also show that much further, due to the blocking of the lithosphere, spreading rates decrease at the ridge, which may explain a variety of features such as the low magmatism of ultraslow spreading ridges or the departure of slow spreading ridges from the half-space cooling model.