Towards an integrated vision of tectonic underplating in subduction zones.

Armel Menant

(menant@ipgp.fr)

Institut de Physique du Globe de Paris

Samuel Angiboust

Institut de Physique du Globe de Paris

Taras Gerya

ETH Zürich

Robin Lacassin

Institut de Physique du Globe de Paris

Martine Simoes

Institut de Physique du Globe de Paris

Raphael Grandin

Institut de Physique du Globe de Paris

Study of now-exhumed ancient subduction zones revealed km-scale tectonic units of marine sediments and oceanic crust, which have been underplated (i.e. basally accreted) to the overriding plate at more than 10-km depth. However, geophysical observations of this deep process in active subduction zones (e.g. SW-Japan, Cascadia, Chile) are unclear and the dynamics as well as the existence of tectonic underplating along most of active margins remain controversial. Using high-resolution visco-elasto-plastic thermo-mechanical models, we present with unprecedented details the dynamics of formation, preservation and destruction of underplated crustal nappes at 10-40-km depth in subductions zones. Thus, we are able to characterize tectonic underplating from the plate interface where tectonic slicing is triggered, to the surface where topographic variations may be expected in response to such huge mass transfers. Our results show that subduction segments exhibiting an increasing frictional behaviour control deep accretionary dynamics and that the long-term frictional zonation of the plate interface is stable due to a positive feedback between fluid distribution and effective stress. As a result, successive underplating events are maintained during tens of Myr, leading to the
formation of a high coastal relief. The rise of this relief is cadenced by an uplift-then-subsidence cycle, which characterizes each underplating event and the subsequent period of wedge re-equilibration. This periodical evolution is significantly modified by changing the rheological properties of the material entering the subduction zone, suggesting that tectonic underplating is likely a transient process active along most of active margins, depending on severe variations of the hydro-mechanical properties of the plate interface at Myr timescale.