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Mantle upwellings and their topographic signatures

Claudia Adam
Kansas State University, Geology, United States (cadam@ksu.edu)

Mantle upwellings occur at different scales, varying from a few hundred kilometers to thousands of kilometers, and they may be associated with topography anomalies or not. At some of the smallest scales, plume upwellings are often associated with hotpots swells. In some cases, there are excellent correlations between the buoyancy fluxes representative of the plume upwelling, computed through numerical models of mantle dynamics using as an input tomography models, and the buoyancy fluxes deduced from the swells morphology. In other cases, the hotspot swells do not seem to be correlated with any other geophysical or geochemical observations. At the oceanic lithospheric plates scale, the main topography variations are related to the subsidence of seafloor, which is generally considered as a passive phenomenon due to the conductive cooling of the lithosphere. However, recent studies point out that the variations of the subsidence parameters, derived from a statistical study based on bathymetry and seafloor age data, show a very good correlation with the dynamic topography modeled with the S40RTS tomography model. Indeed, the dynamic topography reproduces the subsidence pattern observed in the bathymetry of the major oceans. From the subsidence rate, we compute the effective thermal conductivity, keff, which ranges between 1 and 7 $Wm^{-1}K^{-1}$. We show that departures from the keff = 3 $Wm^{-1}K^{-1}$ standard value are systematically related to mantle processes and not to lithospheric structure. Regions characterized by keff > 3 W m^{-1} K^{-1} are associated with mantle uplifts (mantle plumes or other local anomalies). Regions characterized by keff < 3 W m^{-1} K^{-1} are related to large-scale mantle downwellings such as the Australia–Antarctic Discordance (AAD) or the return flow from the South Pacific Superswell to the East Pacific Rise. This demonstrates that mantle dynamics plays a major role in the shaping of the oceanic seafloor at several scales.