Plume- Lithosphere Interactions: Cases of Afar (Africa), and Pacific Hotspots

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The origin of hotspots is usually related to the surface manifestation of deep mantle plumes, which are originating in thermal boundary layers. Three boundary layers can be considered: asthenosphere, transition zone, D"-layer. And it can be shown that there are different kind of plumes.

The detection of plumes in the mantle from geophysical and geochemical data is still controversial and trigger vigorous debates. It remains unclear how plumes are formed, their origin at depth, and whether they act independently from plate tectonics. We may learn about the role of plumes in mantle dynamics by studying their interactions with lithosphere and crust below ridges and the way in which they perturb the flow pattern in the uppermost mantle.

Several regional tomographic studies of seismic velocity and anisotropy around several hotspots were obtained during the last 2 years. Their lateral resolution is smaller than 1000km and they enable to make qualitative intercomparison between Afar (Horn of Africa Program), Azores (COSEA project) in the Atlantic, La Reunion in the Indian Ocean and Pacific provinces hotspots. These models demonstrate that there is not only one family of plumes but several ones. Some plumes are confined in the uppermost 200km but a few can originate in the transition zone and may be at the Core-mantle Boundary for superplumes.

Seismic anisotropy which is a good marker of deformation processes and mantle flow pattern, shows that the interaction between a plume and a ridge below the lithosphere can occur over distances larger than 1000km, via sublithospheric channels. The existence of LACs (Low Anisotropy Channels) below the Pacific plate seems to be intimately related to the active hotspots in Central Pacific and indicate a future reorganization of plate boundaries. Another important consequence of the interaction between plume, lithosphere and ridge is the triggering of secondary convection in the asthenosphere, which can also give rise to babyplumes. In conclusion, the concept of plume is not univocal but might refer to different geological objects.