New insights into the lithospheric and deeper mantle

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Mantle samples from >250 km depth are few, small and torn from their context; to study the deeper mantle we have relied largely on geophysics, and petrologic interpretation of geophysical data. Interpretation of lithospheric seismic data has been hindered by ambiguity between T and non-unique effects of composition. However, recent development of multi-observable probabilistic tomography has minimized this problem, allowing more robust separation of T and lithology effects, resulting in radically new insights into lithospheric composition, evolution and dynamics [1]. At the same time, large bodies of peridotite in major collisional belts (Tethys, Urals) have been shown to contain not only diamonds but relics after majoritic garnet, and mineral assemblages requiring remarkable negative fO_2 anomalies. These super-reducing, ultra-high pressure (SuR-UHP) assemblages can tell us something new about the deeper mantle. Chromite chemistry indicates that these peridotite bodies were formed, or seriously modified, in shallow SSZ-type environments; they were then deeply subducted. The origins of the SuR-UHP mineral assemblages and the processes that have allowed their preservation are still unclear; they may be related to processes in the Transition Zone, or at shallower depths within the diamond stability field. After residing in the deep upper mantle or Transition Zone for 100-200 Ma [2], they were rapidly excavated from these depths (6-10 Ma), and emplaced at shallow levels, perhaps even to the sea floor. Dynamic modelling shows that this excavation was driven by the rollback of a slab stalled in the Transition Zone. However, this excavation process represents a previously unrecognized mechanism of mantle recycling. It has provided us very large samples of very deep mantle, well exposed for detailed study. Mike O'Hara would have loved this!

[1] Afonso *et al*. (2015) *EPSL* (under review); [2] McGowan *et al*. (2015) *Geology* **43**, 179-182.