Precipitation of deep carbon from mantle transition zone -derived reduced fluids (C-H ± H_2): Evidence from Indus ophiolite and Alpe Arami peridotites

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Knowledge of fluid speciation in deep Earth is mainly based on speculative models because samples are rare from the mantle transition zone (MTZ ~ 410 – 660 km deep). However, our discovery of MTZ peridotites [1] with 'microstructural memories' of pre-existing wadsleyite (β – Mg_2SiO_4) and ultra-high-pressure (UHP) clinoenstatite from Indus ophiolite (SE Ladakh, India) provide a unique opportunity to study deep mantle fluids. Within that peridotite, we found discrete primary hydrocarbon (C-H) + hydrogen (H_2) fluid inclusions with graphite pseudomorph after diamond crystals and an *in situ* octahedral diamond associated with retrogressed MTZ minerals (wadsleyite → Cr-spinel exsolution needles in olivine) indicating precipitation of diamond from C-H ± H_2 followed by diamond → graphite transition because of progressive rise in oxygen fugacity (f_{o2}) during mantle upwelling beneath a spreading center [2]. Similar process of carbon formation is observed in Alpe Arami garnet peridotite (Bellinzona, Swiss Alps), another MTZ -derived orogenic peridotite [3] from entirely different tectonic setting. Recently, we observed TiO_2 needles along with pyroxenes in the core of Mg-rich Alpe Arami garnet suggesting a precursor majoritic garnet (> 5 – 15 GPa). In places, we have also noticed that the majoritic garnets are replaced by retogressed wadsleyite, only possible in upper part of MTZ depth [4]. Within the core of the retrogessed majoritic garnet, C-H found as primary fluid inclusion. Further, in that C-H fluid inclusion graphitic carbon was detected with the aid of Raman spectroscopy. Based on these obsevations from two MTZ -derived peridotites, we propose that dehydrogenation/oxidation of reduced fluids can produce carbon in upper mantle, a process other than subduction.

[1] Das *et al.* (2015) *Geol Soc London,* **sp 412,** 271–286. [2] Das *et al.* (2017) *Geology,* **45(8),** 755–758. [3] Dobrzhinetskaya *et al.* (1996) *Science,* **271,** 1841–1845. [4] Dobrzhinetskaya *et al.* (2004) *Terra Nova,* **16(6),** 325–330.