Geophysical Research Abstracts
Vol. 20, EGU2018-13937, 2018
EGU General Assembly 2018

Refueling the mantle carbon by compression melting

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Petrological and geophysical evidence suggests the presence of a global carbonate-bearing layer in oceanic mantle. Petrological evidence comes from the first degree melts in spreading centers (1), from petit spot volcanism (2) and from metasomatism in the source of hot spots (3). Further evidence of melt presence at the lithosphere-asthenosphere boundary arises from seismic data (4). Furthermore, electrical conductivity in the mantle wedge at subduction zones reveals the presence of conductive anomalies at depths were hydrous-fluid presence is not expected (5). Here, we show that compression melting of oxidized carbon-enriched material at the slab-wedge interface may be responsible for the continuous refueling of this layer. Without this mechanism, and because of constant degassing of magmas at ocean ridges and volcanic arcs, carbon would have been long-time exhausted, preventing lubrication of the lithosphere-asthenosphere boundary. Therefore, compression melting may be a key mechanism of modern-style plate tectonics.

On the basis of thermodynamic modeling, high CO_2 content should be expected in fluids produced in hot subduction environment. Here, we suggest that highly mobile carbonatitic melts, originating from the encounter of released CO_2-rich fluids with the mantle wedge peridotites are the cause of the observed high conductivity of Cascadia subduction zone. At a larger scale, this mechanism could be responsible for delivering carbon-rich material at the base of the lithosphere, creating a shallow mantle carbon reservoir. If reheated, this metasomatized mantle region could be the source of kimberlite-carbonatite magmatism such as observed in North America along a line parallel to the western subduction margin of the North American plate (6). It may also be the source of recently reported carbonatites in paleo-subduction zones (7). After spreading at the base of the lithosphere, the CO_2-bearing melts may be involved in the source of petit spots, as recently discussed by (2).

Carbonate-based sediments are present in Archean terranes, and 3.7 Ga old stromatoliths have been reported from the Isua region in Greenland (8). Recycling of material of crustal origin in modern type subduction started at least about 3.2 billion years ago (9). Given that hot subduction regime was rather the rule for the young Earth, it can be anticipated that the process of sub-lithospheric impregnation by carbonate melts has been active very early in the planet history.

(1) Zhang G-L et al. (2017) Nat. Geoscience 10, 229. (2) Machida, S et al. (2017) Nature Comms. 8:14302. (3) Hauri, E. H et al. (1993) Nature, 365, 221. (4) Schmerr N. (2012) Science 335, 1380-1383. (5) Soyer, W., Unsworth, M. (2006) Geology 34, 53. (6) Duke et al. (2014) Earth Planet. Sci. Lett. 403, 1. (7) Chen et al. (2016) Geology 44, 1039. (8) Nutman et al. (2016) Nature 537, 535. (9) Næraa et al. (2012) Nature 485, 627.