Petrologic model of Pacific superplume, and its implication to the mechanism for the formation of superplume

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[Problems] Superplume is critically important to control the dynamics of the Earth, as a main engine to drive the Earth, yet not well-known the entity either thermal, compositional or both. Moreover, what is the fuel to drive the engine, core heat or light elements from the core? What is the mechanism of its birth and demise?

[Method employed] (1) Seismic tomography by P-wave, thickness of MBL (410-660 km depth range), and topographic relief of top of D" layer, (2) Phase diagrams of MORB and pyrolite from surface to CMB, (3) thermal structure of the Earth, estimated by the combination of (1) and (2), and (4) Subduction history back to 1.0 Ga..

[Results] Thermal structure of the solid Earth, from surface, through MBL to the CMB, combined with the regional distribution of ULVZ (melt), all indicate the presence of superplume under Pacific Ocean and Africa. A large temperature gradient occurs at D" layer which ranges from 350 km in thickness (coldest) to zero (hottest), if assuming the top of D" layer corresponds to perovskite(PV)/post-perovskite(pPV) transformation with a Clapeyron slope of 9.0 MPa/K. The Pacific superplume is defined by the concentric large-scale structure with a core of low-V region (3000-5000 km across), surrounded by a donut-shaped high-V anomaly with a steep velocity gradient. This surrounding high-P wave velocity mantle is presumably the slab graveyard in origin when Rodinia was formed extending over the present whole Pacific region before 750Ma. Low-V anomaly representing rising plumes is detected three or more from only the peripheral region in the lower mantle, suggesting the recycled MORB is depleted in the center of superplume at CMB, and is present as a fuel of superplume in the peripheral parts, because MORB solidus is ca.200 K lower T than that of peridotite. Large velocity gradient on the margin of superplume may suggest the penetration of light elements passing through from the core, as a fate of oversatulation by consolidation of solid inner core.

[Mechanism to form superplume] Reconstructing paleogeography back to 1.0 Ga, indicates that supercontinent Rodinia covered the Pacific Ocean by extensive collision and amalgamation of continents to provide low-T slabs into deeper mantle preferentially to the bottom of Pacific Ocean, where a thick D" layer enriched in pPV was formed. Starting from the lowest-T CMB at 1.0 Ga, Pacific superplume was born at 750 Ma, spending pPVe, yielding PV and heat by an exothermic phase change. By the help of phase transfer, D" layer was heated to male it possible to partially melt recycled MORB to yield dense and heavy melt (sinking) and andesitic residue. The melt moved downwards forming a ULVZ pool on the bottom of CMB, whereas restite migrated upwards by chemical buoyancy to form a cluster of plumes. With time, birth place of plume moved from center to the peripheral part, and changed composition, remaining the anti-crust on the bottom of mantle.