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地球内部の東西半球構造とグローバルダイナミクス
East-west hemispherical structures in the Earth and their implications for global dynamics

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Hemispherical structures have been found in the inner core (Tanaka and Hamaguchi, 1997; Waszek et al., 2011; and the references therein), the outer core (Tanaka and Hamaguchi, 1993; Yu et al., 2005), and the mantle (Iwamori and Nakamura, 2012). While seismic velocities characterize the core hemispherical structures, the mantle east-west hemispheres have been proposed based on geochemistry, rather than south-north division as has been long argued for (Hart, 1984, known as “Dupal anomaly”). In order to better characterize and interpret the mantle geochemical hemispheres in both spatial and compositional domains, and to discuss whether the hemispherical structures in the core and mantle have any dynamical linkage or not, a total of 6854 young basalt data consisting of five isotopic ratios of Sr, Nd and Pb from almost all tectonic settings (mid-ocean ridge, ocean island, arc and continent) have been statistically analyzed (Iwamori and Nakamura, 2015).

As a result, it has been found that the continental basalts are mostly distributed only in the eastern hemisphere, while other basalts are distributed evenly. Using multivariate analysis (Independent Component Analysis, ICA), two independent compositional vectors have been extracted, which explain most of the sample variance (95%). Therefore, almost all young basalts from various tectonic settings plot on a single isotopic compositional plane, and can be explained solely by two elemental differentiation processes (e.g., melting and aqueous fluid-rock interaction, Iwamori and Albarede, 2008). One of the independent components (IC2) represents ‘anciently subducted aqueous fluid component’ stored for 300 to 900 million years in the mantle, and defines the fluid component-rich (=positive IC2) eastern hemisphere, while the western hemisphere shows the opposite polarity. We have also found a striking geometrical similarity between the IC2 and the inner core hemispheric structures (Iwamori and Nakamura, 2015): the eastern hemisphere shows positive IC2 in the mantle and high seismic velocities in the inner core. Combining these constraints, we propose ‘top-down hemispherical dynamics’: focused subduction within and around the supercontinent has created a fluid component-rich hemisphere with a lower temperature, compared to the oceanic mantle. The colder hemisphere seems to have been anchored to the asthenosphere during the continental dispersal, and may affect the temperature and growth rate of the inner core, resulting in the coupled hemispherical structures in the mantle and the core.

Keywords: mantle, core, supercontinent, hemispherical structure, isotope, independent component analysis