Detection of Hadean crustal material in the deep Earth and Moon

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Because of the tectonic erosion associated with plate subductions, the Hadean crustal material may have been brought down to the deep interior of the Earth (Kawai et al., 2009, 2013; Isozaki et al., 2010; Dohm and Maruyama, 2015; Maruyama and Ebisuzaki, 2017; Maruyama et al., 2017). The primordial material may have physical properties different from those of the surrounding mantle rocks, hence it could be detected using seismic tomography.

Significant lateral variations of S-wave velocity (Vs) are revealed in the lunar mantle by tomographic imaging (Zhao et al., 2008, 2012). A correlation between the Vs tomography and the thorium abundance distribution is found. The area with a high thorium abundance exhibits a distinct low Vs zone which extends down to a depth of ~300 km below the Procellarum KREEP Terrane (PKT), which may reflect a thermal and compositional anomaly beneath the PKT. The distribution of deep moonquakes shows a correlation with the tomography in the deep lunar mantle, similar to earthquakes which are affected by structural heterogeneities in the terrestrial crust and upper mantle. The occurrence of deep moonquakes and seismic-velocity heterogeneities implies that the lunar interior may contain a certain amount of fluids and so still be thermally and dynamically active at present. Because there is no plate tectonics in the Moon, the Hadean crustal material may have been preserved near the lunar surface till today. However, due to the mantle overturn that happened at the early stage of the Moon, part of the Hadean crustal KREEP material may have sunk to the deep mantle, which may have become heat sources for the lunar mantle activities and so caused the deep moonquakes around them.

The processes happened in the Moon may have also taken place in the deep Earth. Due to the plate subductions, the Hadean crustal KREEP material may have sunk to the deep mantle of the Earth, which may have become heat sources for mantle plumes and super-plumes. Prominent low seismic-velocity (low-V) anomalies are clearly revealed in the deep mantle beneath the surface hotspot regions such as south-central Pacific, East Africa, Hawaii and Iceland (Zhao et al., 2013; Zhao, 2015). Some of the low-V anomalies could be caused by the Hadean crustal KREEP material.

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