Low core-mantle boundary temperature inferred from the solidus of pyrolite

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The solidus of a pyrolite-like composition plays a fundamental role for understanding structure and evolution of the deep Earth, such as temperature profile in the lowermost mantle and melting in the early Earth. Fiquet *et al.* [1] determined the solidus of a pyrolitic composition up to 120 GPa with X-ray diffraction (XRD) measurements using laser-heated diamond anvil cell techniques (LH-DAC). They identified melting by the disappearance of Debye rings of $CaSiO_3$-rich perovskite and/or ferropericlase, however, this melting criteria has a potential to overestimate the solidus temperature due to high temperature gradient along X-ray transmitted axis in LH-DAC.

Solidus temperatures of pyrolitic mantle material were determined by discerning a melting texture from synchrotron dual-energy three-dimensional micro-tomographic images measured at BL47XU of SPring8 [2]. The melting was identified by the existence of (a) round-shaped and (b) iron-enrichd region at the hottest part of the sample. The measured solidus temperature of the pyrolitic material was 3700 K at 135 GPa, which is extensively lower than that of 4200 K at 135 GPa measured by XRD [1]. Since seismic observations suggest that melting of the current lowermost mantle is very localized [3], the solidus of pyrolite set an upper limit to the present temperature at core-mantle boundary below 3700 K.

The subsolidus phase assemblage and the phase transition boundary between $MgSiO_3$-rich perovskite and post-perovskite were also determined near the solidus temperature on the basis of high *P-T* XRD measurements in LH-DAC.

These results have great significance for understanding temperature profile in the lowermost mantle and melting in the early Earth such as volume of basal magma [4] remnants, since these remnants should have lower solidus temperature than that of pyrolite.

[1] Fiquet *et al.* (2010) *Science* **329**, 1516-1518. [2] Tsuchiyama *et al. GCA in press*. [3] Williams & Garnero (1996) *Science* **273**, 1528-1530. [4] Labrosse *et al.* (2007) *Nature* **450**, 866-869.

A practical constraint on entrainment and condensate evaporation and from aircraft and satellite observations of isotope ratios of water

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Convective clouds play a significant role in the moisture and heat balance of the tropics. The dynamics of organized and isolated convection are a function of the background thermodynamic profile and wind shear, buoyancy sources near the surface and the latent heating inside convective updrafts. The stable oxygen and hydrogen isotope ratios in water vapour and condensate can be used to identify dominant moisture exchanges and aspects of the cloud microphysics that are otherwise difficult to observe. Aircraft observations show that there is significant disequilibrium between the cloud core and the ambient environment, which allows an estimate of exchange at cloud boundaries that lead to condensate evaporation. Indeed, the mechanisms for condensate evaporation gives a basis for using satellite profiles of D/H isotope ratios to yield estimates of the rate of moistening of the troposphere above the boundary layer. In the western tropical Pacific and over tropical continents in excess of 60% of condensate evaporates into the environment, and is the principal moisture source for tropospheric water. The success of the calculation relies on both an adequate parameterization of the mechanisms driving the water budget, and the use of isotope ratio data to satisfactorily constrain the parameters. The unique information on moisture history provided by the isotope ratio measurements allows assessment of moisture transport that is not otherwise easily observed.

DOI:10.1180/minmag.2013.077.5.14