Towards integrated models of the Earth's core and bulk volatile budget

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We examined evidences from seismology, thermal physics, paleomagnetic records, cosmochemistry and meteorite, metal-silicate partitioning experiments, phase diagrams and equations of state of iron and iron compounds to present briefly the state of art on the composition and evolution of the Earth's core and discuss some unresolved problems along with their relation to bulk Earth volatile budget. In this report we pay attention to the three particular subjects summarized below.

An existence of basal magma ocean (BMO) is required by recent models of the core thermal evolution with high thermal conductivity. BMO means extensive melting and core-mantle equilibration, which at those temperatures (above 4500 K) reveal extremely high content of light elements in the core, exceeding observed density deficit. The alternative to BMO is a significant contribution of radioactive elements to the core, which reduce initial temperature required for BMO. The problem of BMO is also related to existence of a hidden reservoirs, structure of the D" layer and volatile exchange at the core–mantle boundary.

We analysed Archean and Proterozoic paleointensity records and suggested that frequency of reversals and superchrons are consistent with the periods of intensive magmatism caused by generation of the mantle plumes from the core mantle boundary. The absolute values of paleointensities remain about the same from the Archaean to the present time, however, the peaks paleointensity correlate well with episodes of mantle plume activity (and episodes of continental crust formation). Significant decrease of paleointensity in Proterozoic near 1.4 Ga ago can be assigned as the age of the inner core.

We discuss problem of inner core composition and review recent models suggesting significant amount of carbon in the inner core. We calculated quasiharmonic PVT EOS for non-magnetic Fe-carbides and show their close proximity to the inner core density and seismic velocity. We also described Fe–C–O–H reactions at the core–mantle boundary conditions and suggested possible formation of hydrocarbon species by reaction of subducted fluid with metal from the core.

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