# Remnant iron oxide/sulfide mattes from a Hadean magma ocean at the core-mantle boundary: insights from a small scale post-Archean analog

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It has been suggested that a chemical boundary layer may reside at the Earth's core-mantle boundary and that it may have originated during Earth's first hundred million years (the Hadean) from Fe-rich liquids associated with a global magma ocean sinking to the core-mantle boundary. Estimates of the composition of this putative chemical boundary layer have been largely based on indirect mass balance approaches. Here, a post-Archean magnetite-sulfide magma formed from fractionation of a diabase intrusion is used as a small-scale analog of extreme magmatic differentiation during a Hadean magma ocean. It is characterized by ~65 wt. % total FeO and ~10 % Fe sulfides. Its trace-element signature is characterized by low Sm/Nd, high Lu/Hf, low U/Pb, high Re/Os and high U and Th (though even higher Pb). If such material can be taken as an analog for the last dregs of a differentiating magma ocean during Hadean times, it would have sank to the bottom of the mantle and remained their indefinitely due to its high density. Permanent sequestration would have led to a bulk silicate Earth (BSE) with anomalously high 142Nd/144Nd as well as early Archean mantle characterized by high 143Nd/144Nd and lower than expected 176Hf/177Hf. Sequestration of this Pb-rich magnetite-sulfide magma after most of the core formed would have also led to a BSE having a U-Pb age slightly older than that of the Hf-W age for core formation. Using the equation of state for magnetite in its high pressure form, we find that its physical properties (compressional and shear wave velocities) at core-mantle pressures are consistent with the seismic properties of the ultra-low velocity zone (ULVZ) at the base of the Earth's mantle. We estimate the thickness of this material to be on the order of ~ 10 kms, consistent with the seismically inferred thickness of the ULVZ. Although this primordial material is stable at the core-mantle boundary indefinitely, it might be occasionally sampled by plumes, and if so, might be characterized by radiogenic 187Os/188Os.