Employing magma ocean crystallization models to constrain the FeO content of the Moon

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The FeO content of the bulk silicate Moon (BSM) is still poorly constrained by petrological evidence or seismic data (9 –17 wt%, e.g. [1]). In this study we investigated how models of the lunar interior evolution can be employed to further constrain the BSM composition. We first used petrological modeling to study the effect of BSM FeO content on the properties of chemical reservoirs in the lunar mantle that were formed during lunar magma ocean solidification. In a second modeling step, we considered the effects of solid state convection on the distribution of these reservoirs in the lunar interior. The results are used to test the consistency of different BSM FeO contents and mantle convection scenarios with the bulk Moon density and BSM moment of inertia. Combining current estimates of the lunar core properties and today's selenotherm with our lunar interior models, we find that BSM FeO contents of 8 – 13.5 wt% are consistent with the observed bulk Moon properties. Further constraints on the lunar interior structure from seismic and selenodetic data (suggesting e.g. the presence of a dense, partially molten zone at the core mantle boundary [2]) indicate that BSM FeO contents of 9 – 11 wt% are most probable. This estimate could be further limited by tighter constraints on the size and density of the lunar core, e.g. by future seismic investigations.

References: [1] Jones and Delano (1988), Geochim. Cosmochim. Acta, 53, 513-527. [2] Matsumoto et al. (2015), GRL, 42 (18), 7351-7358.