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Redox controls on tungsten and uranium crystal/silicate melt partitioning and implications for the W/U ratio of the lunar mantle

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We report partitioning data for W, U, HFSE, and Th between cpx, opx, olivine and silicate melt. In agreement with previous studies, we show that these elements behave as homovalent elements at fO_2 higher than QFM. However, both W and U become more compatible at fO_2 lower than QFM, indicating a change in their redox state. This result is particularly unexpected, because W is thought to be hexavalent even at very low fO_2. However, the much higher compatiblity of W^{4+} as compared to W^{6+}, means that even a small fraction of W^{4+} will increase the overall compatibility of W. Our results imply that under the reducing conditions in which lunar differentiation is thought to have taken place (i.e. ~IW-1), W is likely to become fractionated from U. These newly obtained partitioning data carry with them the potential implication that the W-to-U ratio of lunar basalts does not directly represent their mantle source. More high-precision measurements of W and U abundances in lunar rocks are needed to more precisely estimate the Hf/W of the Moon and thus, the age of the Moon itself.

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