Rare Earth Elements Partitioning Between Sulphides and Melt: Evidence for Yb^{2+} and Sm^{2+} in EH Chondrites

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Oldhamite (CaS) is a key mineral in rare earth element (REE) budget of enstatite chondrite (EC). REE are important for tracing and dating cosmochemical processes, and a precise knowledge of their behavior in the EC formation conditions is essential. We present REE sulphide/silicate partitioning values (D), obtained at 1300 and 1400°C from experiments performed in evacuated silica tubes for different oxygen fugacity conditions (from IW-6.9 to IW-4.1).

Analyses were done on sulphides and silicates by electron microprobe for major elements and with Laser Ablation ICPMS for trace elements. Obtained D values are between 0.5 and 5 for oldhamites and between 0.001 and 1 for FeS. These results are in agreement with literature data [1,2] but provide a more complete dataset. We note positive anomalies for Eu and Yb partition coefficients in both sulphides.

Here positive anomalies appear to be caused by Eu and Yb reduction to Eu^{2+} and Yb^{2+}. This is confirmed by X-ray Absorption Near Edge Spectroscopy (XANES) analysis on Yb. XANES on Sm also shows evidence of some Sm^{2+} in the system. An extensive study of the partitioning data highlights the relation between the intensity of the anomaly and the oxygen fugacity of the experiment.

The obtained partition coefficients cannot explain the observed high (100 to 1000 x CI) REE abundances in natural CaS from reduced meteorites [3,4]. Hence, the natural REE patterns cannot be explained by CaS crystallization on the liquidus. In primitive EH, positive Eu and Yb anomalies may reflect the presence of Eu^{2+} and Yb^{2+} in CaS.

[1] Lodders et al. (1996) *MAPS*, **31**, 749-766. [2] Dickinson et al. (1997) *MAPS*, **32**, 395-412. [3] Floss et al. (1993) *GCA*, **57**, 4039-4057; [4] Gannoun et al. (2011) *GCA*, **75**, 3269-3289