

Effects of light elements on metal-silicate partitioning of siderophile elements

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The most important constraints on processes and conditions of core formation in the early history of the Earth are provided by the chemistry of the Earth's mantle combined with experimental data on the partitioning of a wide range of elements between metal and silicate. Up to data, the element partitioning has been insensibly studied under variety conditions of pressure, temperature, oxygen fugacity. In addition to these physical parameters, the light elements in the present Earth's core are also expected to have an influence on element partitioning behaviors during core formation. In this study, we investigate the effects of Si, O and S on the element partitioning for Ni, Co, W, V, and Cr between liquid metal and silicate melt.

The partitioning experiments were performed at 15-25 GPa and at 2700-3000 K using a Kawai-type multianvil apparatus. The partitioning coefficients between liquid metal and silicate melt were obtained from chemical analyses using an electron microprobe. We evaluate the results with the Wager's activity model for metal alloys which takes into account mutual interactions between Fe, Si, S, O and the siderophile elements of interest. The distribution coefficients for Ni and Co decrease by ~ 0.2 log units by adding 8 wt% Si to metal, whereas O has negligible influence for both elements at the present experimental conditions (< 1.2 wt% O). The addition of 3 wt% S decreases coefficients for Co by ~ 0.3 log units whereas its effect on Ni is relatively small. The Si content has less and negligible effect on V and Cr partitioning, respectively. In contrast, both S and O can make V and Cr more siderophile. The influence of Si is significantly emphasized in the W partitioning and the partitioning coefficient for W decreases by 2 order magnitude with the addition of 8 wt% Si.

The recently prevailing view of core formation is that the core forming metal segregated continuously from silicate magma ocean through the Earth's accretion history (e.g. Rubie et al., 2011 EPSL). In addition, the accreting materials on proto-Earth could have changed with a time from highly-reducing to oxidizing and finally volatile-rich, which may result in the progressive change of dominant light elements of core forming metals from Si-rich to O and/or S-rich. As shown in this study, the change of dominant light elements could affect the element distributions in relevant phases during core formation.

Keywords: element partitioning, light elements, core formation