Redox control on Nb/Ta fractionation: new constraints on the Earth-Moon system

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Nb and Ta have long been considered as refractory lithophile elements, and should then have been accreted in the Earth in chondritic proportions. However, the Nb/Ta ratio of the bulk silicate Earth (BSE) is subchondritic[1]. To solve this paradox, Wade and Wood[2] suggested that at the high pressure of Earth's core formation Nb becomes siderophile, thus being depleted from the silicate Earth. Yet, the impact of the evolution of fO_2 during Earth's core formation from reducing to more oxidizing conditions on Nb/Ta in silicate melts has not been investigated.

Here we present Nb-Ta ratios measured in chondritic melts equilibrated with Fe-Ni-Si metallic alloys, under variable oxygen fugacities (IW to IW-8). Experiments have been conducted in the multianvil apparatus between 1580 and 1850°C, using doped material. Trace elements were analyzed using laser ablation ICP-MS on metal and silicate quenched liquid phases. We show that the behavior of Nb and Ta during planetary magmatic processes is mainly controlled by the oxygen fugacity, while pressure, temperature and composition have only a negligible impact on Nb-Ta ratio. By applying our new metal-silicate partitioning data to a 24 steps heterogeneous accretion scenario[3] we reproduce the Nb/Ta values of the BSE. The Nb/Ta of the Moon is estimated at 17.0±0.8[1] and then is different from the Earth's value. In order to reconcile this difference with the isotopic similarity measured in terrestrial and lunar samples, different scenarios can be evoked. For example the Moon may have inherited the chemical signature of the Earth's upper mantle at the time of impact, whose Nb/Ta was higher than the modern value due to the crystallization of perovskite. This signature would have been erased due to the homogeneisation of the whole Earth's mantle.

[1] Münker *et al* (2003), *Science* **301** [2] Wade and Wood (2001), *Nature* **409** [3] Rubie *et al* (2011) *Earth Planet. Sci. Lett.* **301**