

Fe, Zn and Mg stable isotope records of early differentiation and core formation of the ureilite parent body

STEPAN M. CHERNONOZHKIN^{1,2}, STEVEN GODERIS³,
GENEVIÈVE CLAIRE HUBLET⁴, STEFAN WEYER⁵, INGO
HORN⁶, LIDIA PITTARELLO⁷, PHILIPPE CLAEYS⁸,
VINCIANE DEBAILLE⁹ AND FRANK VANHAECKE²

¹Montanuniversität Leoben

²Ghent University

³AMGC, Vrije Universiteit Brussel

⁴Université Libre de Bruxelles (ULB)

⁵Leibniz University Hannover, Germany

⁶Leibniz Universität Hannover

⁷Naturhistorisches Museum Wien – NHMW

⁸Analytical, Environmental & Geo-Chemistry, Vrije Universiteit Brussel

⁹Université Libre de Bruxelles

Presenting Author: stepan.chernonozhkin@unileoben.ac.at

Ureilites are achondrites formed as ultramafic mantle restites on a planetesimal that did not reach a magma ocean stage. As such they represent an appealing target to study early planetary differentiation, formation of early cores and mantle processes, which have a direct bearing onto formation of terrestrial planets. Here, we use Fe, Zn and Mg isotope ratio variations of bulk ureilites, their separated silicate and metal fractions, as well as handpicked single mineral fractions to explore the evolution of the ureilite parent body.

None of the measured isotope ratio patterns correlate with proxies of nebular processes, such as oxygen isotopic composition or composition of the olivine cores. Within the attained uncertainty, the isotope ratios of Mg indicate no radiogenic ingrowth from ²⁶Al decay. The mass-dependent Mg isotopic signatures are slightly heavier than chondritic, hinting towards evaporation-related fractionation. The slightly heavier than chondritic Fe and Zn isotopic signatures of bulk ureilites are fully consistent with earlier observations. However, where earlier studies suggested evaporative Zn isotope fractionation on a ureilite parent body, the isotopic signatures of ureilite metal separates presented here indicate that the Zn systematics in ureilites are largely controlled by differentiation between liquid and solid metallic phases and metal melt extraction. In addition, the Fe isotopic compositions of ureilite metal and silicate separates imply isotopic disequilibrium between these reservoirs.

Finally, lateral profiles of Fe and Mg isotope ratios were measured *in situ* in several olivine grains selected by their heavily reduced appearance. Such zoned olivine grains in ureilites are traditionally interpreted to form in the process of reduction of the olivine rims by carbon. The complex lateral Fe and Mg isotope ratio profiles likely reflect a multi-stage evolution of fast cooling followed by overgrowth from fractionated magma and/or metal-olivine reaction at the rims.

Combined, the Fe, Mg and Zn isotope ratio systematics of