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Tracing the origin and differentiation of the enstatite achondrite parent bodies using Cr isotopes

KE ZHU[1], FRÉDÉRIC MOYNIER[2], MARTIN SCHILLER[3], HARRY BECKER[1], JEAN-ALIX BARRAT[4] AND MARTIN BIZZARRO[2,3]

[1]Freie Universität Berlin
[2]Université de Paris, Institut de physique du globe de Paris
[3]University of Copenhagen
[4]UBO-IUEM

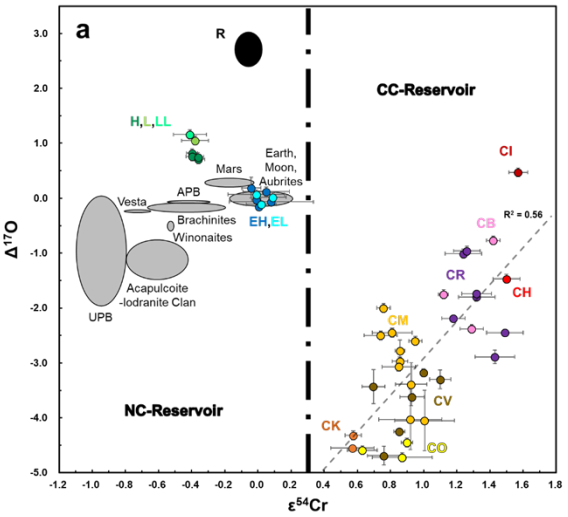
Presenting Author: zhu@ipgp.fr

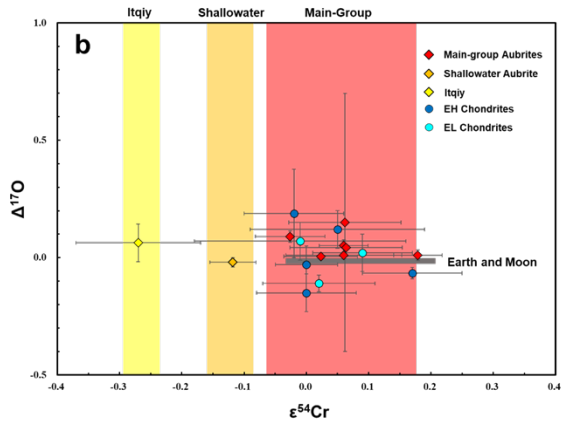
Enstatite achondrites (including aubrites) have similar isotope compositions to the Earth-Moon system for most of the elements (e.g. O). However, the origin and differentiation of enstatite achondrites and their parent bodies remain poorly understood. This work reported both the mass-independent (MC-ICP-MS [1] and TIMS [2]) and mass-dependent (MC-ICP-MS [3]) Cr isotope data for 10 enstatite achondrites, including 8 aubrites, Itqiy (EH7-an) and one enstatite-rich clast in Almahatta Sitta [4]. Combined with literature [5], our data provide insights into the origin (ε^{54}Cr) and the formation processes (δ^{53}Cr) and timing (ε^{53}Cr) of the enstatite achondrite parent bodies.

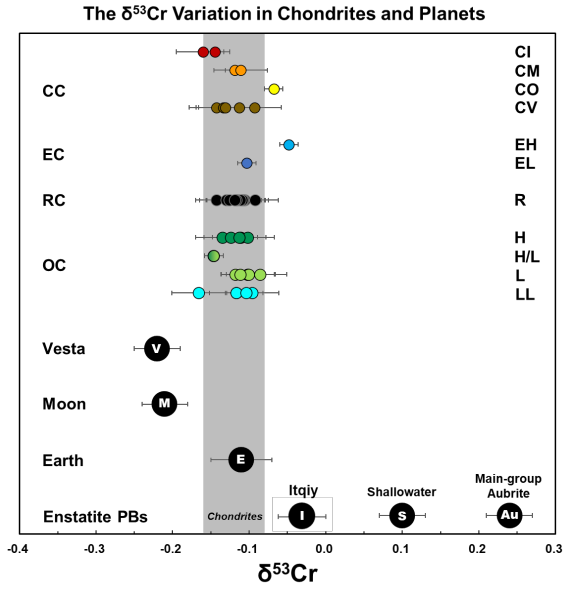
The ε^{54}Cr values define three groups of meteorites (**Figure 1**) that represent: the main-group aubrite parent body with ε^{54}Cr of 0.06 ± 0.12 (2SD, N = 7), Shallowater parent body with ε^{54}Cr = -0.12 ± 0.04 and Itqiy parent body with ε^{54}Cr = -0.26 ± 0.03 (2SD, N =2). This is consistent with their different δ^{53}Cr values: 0.24 ± 0.03 ‰, 0.10 ± 0.03 ‰ and -0.03± 0.03 ‰, respectively (**Figure 2**).

While variable, the δ^{53}Cr value are all higher in aubrites than in any group of chondrites (**Figure 2**). This most likely represents stable isotope fractionation of isotopically light Cr-sulphide during core formation, resulting in an isotopically heavy mantle.

The aubrite samples record heterogeneous distribution of Mn and Cr. The ^{53}Mn-^{53}Cr correlation for the main-group aubrites (except Bustee) is interpreted to reflect mixing of different proportions of sulfides and silicates, consistent with Cr stable isotope variation. The absence of internal ^{53}Mn-^{53}Cr isochrons for individual main-group aubrite samples implies that they underwent metamorphic redistribution of Mn and Cr after ^{53}Mn became extinct, possibly following a disruption event of the main-group aubrite parent body, which could reset the internal Mn-Cr isochrons.







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