THE DISTINCT GENETICS OF CARBONACEOUS AND NON-CARBONACEOUS METEORITES INFERRED FROM MOLYBDENUM ISOTOPES.

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Introduction: The most direct and powerful approach for establishing genetic relationships between meteorites and meteorite components is through nucleosynthetic isotope anomalies, which result from the heterogeneous distribution of isotopically anomalous presolar matter. For instance, nucleosynthetic Cr and Ti isotope anomalies in bulk meteorites reveal a fundamental dichotomy in the genetic heritage of meteorites, distinguishing between 'non-carbonaceous' and 'carbonaceous' materials [1].

Recently, Budde et al. [2] not only demonstrated that this dichotomy is also evident in Mo isotope systematics, but also showed that carbonaceous meteorites (CC) and non-carbonaceous meteorites (NC) plot on distinct *s*-process mixing lines which are separated by a constant excess of *r*-process Mo in the CC reservoir. Moreover, as Mo isotopes can readily be measured for basically every meteorite type (in contrast to O, Ti, Cr), Mo isotope systematics provide a new and powerful means for assessing genetic links between meteoritic and planetary materials, making it a valuable addition to current meteorite classification schemes. Here, we discuss the implications of this dichotomy for meteorite genetics and reservoir formation in the early solar system in light of the most recent literature data as well as new isotope data for primitive achondrites that have not been investigated before.

Methods and Results: To date, we have obtained Mo isotope data for ten bulk ureilites. Molybdenum was separated from column washes collected during the separation of W in a previous study [3], following our established procedures [2]. All ureilites show well-resolved nucleosynthetic Mo isotope anomalies indicative of a deficit in *s*-process Mo relative to the terrestrial standard. Nine ureilites have indistinguishable Mo isotope signatures similar to those of MG pallasites, and plot on the *s*-mixing line defined by NC meteorites. By contrast, one ureilite (EET 87517) displays larger Mo isotope anomalies than the other ureilites, but also plots on the NC-line (Fig. 1).

Discussion: The Mo isotope signatures of ureilites demonstrate that they do not derive from carbonaceous precursors but are genetically linked to non-carbonaceous meteorites, as argued previously on the basis of Cr and Ti isotope systematics [1]. EET 87517 shows a much larger deficit in *s*-process Mo nuclides, and is also characterized by nucleosynthetic Os isotope anomalies that are absent from most other ureilites [4]. The anomalous isotopic composition of EET 87517 is difficult to reconcile with a simple admixture of carbonaceous material to typical ureilites (Fig. 1), but more likely reflects the selective destruction of presolar components during partial melting on the ureilite parent body [4] or, alternatively, derivation from a separate parent body. The new data for ureilites, in combination with recently published data for various other groups of meteorites (Fig. 1), further manifest the fundamental dichotomy between carbonaceous and non-carbonaceous materials. Given that the CC and NC reservoirs both contain chondrites, achondrites, and iron meteorites, indicates that both reservoirs must have remained separated for several million years, most likely as a result of the formation of Jupiter in between the two reservoirs [2, 5].

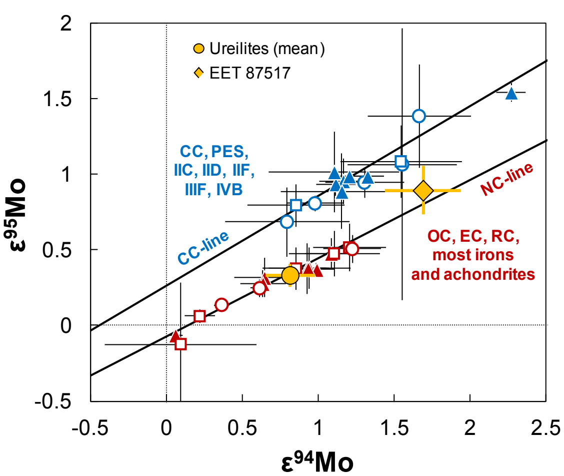

Fig. 1. Diagram of ε^{95}Mo versus ε^{94}Mo for bulk meteorites (open circles: chondrites, open squares: achondrites, triangles: iron meteorites). Carbonaceous (blue, CC-line) and non-carbonaceous (red, NC-line) meteorites plot on separate *s*-mixing lines, reflecting a different genetic heritage of these groups. Ureilites (orange symbols) plot on the NC-line, demonstrating their non-carbonaceous origin. The ε^{95}Mo and ε^{94}Mo values are parts per 10,000 deviations from terrestrial standard values (ε^{i}Mo ≡ 0), normalized to ^{98}Mo/^{96}Mo. Diagram modified after [2], with bulk meteorite data from [5–8] and references provided in [2]. Note that the NC-line has been re-defined based on recently published data (*e.g.*, OC, EC, IAB irons).

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