Characterizing impactors on the HED parent body and the Moon using Mo and Ru isotopes

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The ambiguous nature of late impactors, which likely delivered siderophile elements and volatiles to the Earth during late accretion, can be investigated using genetic tracing of impactites from multiple parent bodies. To do this, we initiated a systematic study on impact melts from the howardite-eucrite-diogenite (HED) parent body (likely the asteroid 4 Vesta) and the Moon. In particular, we utilize the parent body-specific isotope anomalies observed at the bulk meteorite scale for Mo and Ru [e.g., 1-2]. Due to their siderophile behaviors, Mo and Ru are depleted in planetary crusts, so the isotopic compositions of Mo and Ru in impactites likely reflect those of the impactor. Further, Mo and Ru isotopes can differentiate between the two nebular reservoirs that existed in the early solar system, termed the non-carbonaceous (NC) and carbonaceous (CC) reservoirs, which likely represent inner and outer solar system regions, respectively [e.g., 3-4].

The Mo and Ru isotopic compositions for two eucrite impact melts indicate that the impactor components in them are distinct from one another, but both belong to the NC suite. The impactor signature in NWA 12340 is similar to ordinary chondrites. The impactor signature in NWA 1644 is most similar to enstatite chondrites, near the terrestrial isotopic composition. The NC compositions suggest that the impactors originated in the inner solar system and, for NWA 1644, may even have originated in the terrestrial planet-forming region. The different compositions of the eucrite impact melts show that impactors to Vesta were diverse, and cannot be the result of a single genetically related population of impactors. This work demonstrates that impactor signatures in lunar impactites may also be identified, which could elucidate the nature and origin of late accreted material to the Earth and may have implications for the putative late heavy bombardment on the Moon. To that end, data for lunar impactites will also be presented at the meeting.

[1] Worsham et al. 2017. GCA 467: 157-166 [2] Fischer-Gödde and Kleine 2017. Nature 541: 525-527 [3] Warren, 2011. EPSL 311:93-100. [4] Budde et al. 2016. EPSL 454: 293-303.