LATE ACCRETION TO THE MOON AND VESTA

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Introduction: We present new highly-siderophile element (HSE: Os, Ir, Ru, Pt, Pd, and Re) abundance and $^{187}Os/^{188}Os$ data for low-Ti mare basalt meteorites, Apollo 12 samples, and diogenite meteorites to explore the late accretion histories of the Moon and asteroid (4) Vesta, the probable diogenite parent body. Moon/Vesta comparisons are potentially useful because both bodies are considered to have witnessed magma ocean differentiation, are relatively volatile depleted (e.g., low $^{87}Sr/^{86}Sr$), and because recent work has identified the possibility of massive (D = 100's to 1000's km, respectively) impactors striking the Moon and Earth subsequent to the major phases of core formation [1]. Thus, interpretation of HSE signatures for differentiated asteroids like Vesta may provide complementary information on the timing, size distribution and distribution within the Solar System of potential late accretion impactors to bodies such as the Moon [2-4], Earth [5], Mars [6], and the angrite parent body [7].

Results and Discussion: Apollo 12, 15, 17 mare basalts, and mare basalt meteorites have HSE abundances (~1×10^{-3} to 1×10^{-7} $\times$ CI-chondrite) that extend the abundance range measured for lunar picritic glass bead interiors (~1×10^{-3} to 1×10^{-5} $\times$ CI [2]), and exhibit relatively flat chondrite-relative HSE patterns. Current HSE abundance data for lunar derivative melts and pristine crustal rocks support their derivation from a relatively homogenised lunar mantle with HSE abundances <20 × lower than for the terrestrial or martian mantles, consistent with stochastic late accretion [1]. Diogenite meteorites have chondritic relative abundances of the HSE and close-to-chondritic $^{187}Os/^{188}Os$ [8], and span a range of HSE concentrations from close to terrestrial upper mantle values, to HSE concentrations observed in lunar mare basalts. If it is assumed that the HSE characteristics of most diogenites are reflections of processes internal to Vesta, then their generally chondritic natures, suggests chondritic additions following core formation, but prior to completion of mantle crystallization [8]. If interpretations of stochastic late accretion are valid [1], Vesta, and other asteroids, are smaller targets than Earth, the Moon, or Mars, so the largest early impactors to strike them may have been D < 100 km. Consequently, perhaps only a portion of the Vesta was affected by late accretion, such that some HSE signatures are more consistent with regional rather than global effects. Planetesimals like Vesta, therefore, may be expected to retain compositional heterogeneity that records their magnitude and frequency of late accretion and provides a complementary record to that retained in terrestrial, lunar and martian rocks and achondritic meteorites. **Acknowledgements:** This research was partially supported by NASA LASER grant (NNX11AG34G).

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