THE AGE AND COMPOSITION OF THE MARTIAN CRUST FROM NWA 7533.

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Introduction: The ancient cratered terrain of the southern highlands of Mars holds most of the clues to its early differentiation, but until now no meteoritic regolith breccias have been recovered from this important region. New chronological and compositional data show that NWA 7533 (paired with NWA 7034 [1] and NWA 7475) is a pre-Noachian regolith breccia, and that provide new insights in the origin of the Martian crust.

Composition of the interclast matrix in NWA 7533: The matrix in NWA 7533 is uniform in composition, rich in siderophile elements (Ni-Ge-Ru-Rh-Re-Os-Ir-Pt) that are present in chondritic relative abundances, implying ~5% CI impactor contribution [2]. The matrix composition closely resembles Martian rock and soil analyses returned by the rover missions [3] with the exception of its lower S, Cl and Zn abundances [2]. The REE pattern is smooth with $(La/Yb)_{CI}$~2.5 and $(Gd/Yb)_{CI}$~1.6 consistent with a 4% partial melt of a primitive garnet peridotite source. Similar enrichments of highly incompatible elements (Cs-Rb-Ba-Th-U-Nb-Ta-La) imply the matrix composition represents a low degree partial melt of a fertile mantle. If the matrix is representative of the crust and the mantle was uniformly melted throughout to the same degree, then our geochemical estimate of the melt thickness (~50 km) is identical to the geophysical estimate for the thickness of the crust [4]. This corroborates that NWA 7533 matrix is representative of the Mars global surface composition.

Zircon U-Pb dating: NWA 7533 contains igneous-textured clasts some of which include alkali feldspar, Cl-apatite, zircon, baddeleyite and other accessory phases [5]. SHRIMP U-Pb dating of 10 zircon grains yields a discordia line with an upper intercept age of 4428±25 Ma and a lower intercept age of 1712±85 Ma. Eight analyses of 3 grains are concordant at the upper intercept with a weighted average $^{207}Pb/^{206}Pb$ age of 4443±22 Ma. Several grains plot concordantly on the lower intercept indicating a major resetting of the U-Pb system at ~1.7 Ga, perhaps related to impact melting that compacted the breccia. This interpretation is supported by the excellent correlation between $^{206}Pb/^{238}U$ age and U+Th concentration. These first zircon ages from a Martian meteorite are also the oldest ages from Martian crust, yet. The evolved chemistry of the clasts implies that they are products of reprocessing of the earliest alkali basalt crust and so the zircon ages are minimum ages of formation of the crust. Thus, by 4.44 Ga Mars already had a differentiated crust consistent with ^{146}Sm-^{142}Nd constraints from SNCs for silicate differentiation ~100 Ma after solar system formation [6].

References: [1] Agee C.B. et al. 2013. *Science* 339:780. [2] Humayun M. et al. 2013. Abstract #1429. 44th LPSC. [3] McSween H.Y. et al. 2009. *Science* 324:736. [4] Zuber M.T. et al. 2000. *Science* 287:1788. [5] Hewins R.H. et al. 2013. *MAPS,* this volume. [6] Debaille V. et al. 2007. *Nature* 450:525.