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Identification of a chondritic mantle reservoir in Mars from the 1.27-billion-year-old olivine-phyric shergottite Northwest Africa 13441

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Here we report on the petrology, mineralogy, geochemistry, and isotope compositions (including O isotopes and ^{147}Sm-^{143}Nd isotope systematics) for Northwest Africa (NWA) 13441, an olivine-phyric shergottite rich in melt glass that was recovered from Algeria in 2019. The meteorite NWA 13441 is a basalt containing abundant oriented olivine megacrysts set in a groundmass of pigeonite, olivine, and maskelynite with accessory chromite and merrillite. The Fe/Mn ratios of olivine (56.1 ± 7.2; 2σ, n=15) and pyroxene (30.1 ± 2.1; 2σ, n=10), and bulk rock O isotope ratios of $\Delta^{17}O$ = +0.270 ± 0.014 ‰, confirm a martian origin. Pyroxene Ti/Al barometry indicates that crystallization began near the crust-mantle boundary of Mars. The meteorite contains ~7 vol% pyroxene-dominated melt glass that together with undulatory extinction and mosaicism in olivine, mechanical twinning in pyroxene, and amorphized plagioclase, suggests a high level of shock metamorphism at estimated peak conditions of ~42-45 GPa and ~900 °C. The bulk rock rare earth element (REE) pattern ($(La/Yb)_{CI}$ = 0.64) suggests an affinity to intermediate shergottites. Hand-picked mineral separates as well as leachates define a ^{147}Sm-^{143}Nd isochron age of 1273 ± 21 Ma (MSWD = 19; n = 9) that is distinct from other shergottites, which primarily cluster at <600 Ma. Notably, NWA 13441 also yields a chondritic εNd_i composition of +0.96 ± 1.04, indicating derivation from a long-term broadly chondritic reservoir. The relationship of the chondritic εNd_i and intermediate trace element composition requires at least two stages of melt extraction over a relatively short timescale. The ~1.27 Ga age and unique isotope-trace element composition provide the first direct evidence for a chondritic mantle source on early Amazonian Mars, likely representing a new ejection site and a previously unsampled martian mantle reservoir.