BASALTIC BRECCIA NWA 7034: UNIQUE 2.1 GA SAMPLE OF ENRICHED MARTIAN CRUST

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Introduction: NWA 7034 is a porphyritic basaltic breccia with phenocrysts of dominant andesine, low-Ca pyroxene, pigeonite, and augite set in a very fine-grained, clastic to plumose, groundmass with abundant magnetite and accessory sanidine, anorthoclase, Cl-rich apatite, chromite, ilmenite, and pyrite (EPMA at UNM). Macromolecular carbon, similar to that found in martian meteorites and carbonaceous chondrites, was identified in the groundmass of NWA 7034 (confocal laser Raman spectroscopy at GL). Clast varieties in NWA 7034 include gabbros, apatite-ilmenite-Kspar clusters, quenched melts, and magnetite-rich reaction spherules. The major and minor element composition of NWA 7034 is a remarkably good match with the geochemistry of the rocks and soil at Gusev Crater measured by the Spirit rover and the average martian crust composition from the Odyssey Orbiter gamma ray spectrometer.

REE and Radiometic Age: (Neptune MC-ICPMS at UNM) NWA 7034 is REE enriched (La x58 CI) and strongly light REE over heavy REE enriched $(La/Yb)_N=2.3$, with negative-Eu anomaly ($Eu/Eu^*=0.67$). A five-point isochon gives an Rb-Sr age of 2.089±0.081 Ga (2σ) (MSWD=6.6) and an initial 87Sr/86Sr ratio of 0.71359±54. The Sm-Nd data for the same samples show more scatter, with an isochron of 2.19±1.4 Ga (2σ). The combined REE and isotopic data show that NWA 7034 is an enriched martian crustal rock. The whole rock has 143Nd/144Nd=0.511756 and 147Sm/144Nd=0.1664, giving a calculated initial (source value) 143Nd/144Nd=0.509467 (initial εNd=-9.1) which requires that it be derived from an enriched martian reservoir, with an inferred time-integrated 147Sm/144Nd=0.1689, assuming separation from a chondrite-like martian mantle 4.5 Ga. An age of ~2.1 Ga for NWA 7034 would make it the first meteorite sample from the early Amazonian or late Hesperian epoch in Mars geologic history.

Oxygen Isotopes: Oxygen isotope analyses of NWA 7034 were performed by laser fluorination at UNM on acid-washed bulk sample and at UCSD on vacuum pre-heated (1000°C) bulk sample and give mean values $\Delta^{17}O=0.57\pm0.05‰$ n=10 and $\Delta^{17}O=0.50\pm0.03‰$ n=2, respectively. These interlab values are in good agreement, but are significantly higher than literature values for SNC meteorites ($\Delta^{17}O$ range 0.15-0.45‰).

Indigenous Water: NWA 7034 has an order of magnitude more indigenous water than most SNC meteorites, with at least ~3000 ppm extraterrestrial H_2O released during stepwise heating. Six whole-rock pyrolysis measurements yielded a bulk water content for NWA 7034 of 6190±620 ppm with $\delta D=+46.3\pm8.6‰$. Approximately half of the released water is low temperature (<320°C) water from terrestrial weathering. The maximum δD value in three separate stepwise heating experiments was +276, +327, and +319‰ reached at 1050°C, 1014°C, and 804°C respectively. The comparatively high water content of NWA 7034 may be giving a glimpse of conditions in its source on Mars 2.1 billion years ago.