Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.31786

Discovery of a primitive Mg-rich clast within a proto-breccia fragment in NWA 7533

NINNA KORSGAARD JENSEN[1], ALEXANDER NEMCHIN[2], TAKASHI MIKOUCHI[3] AND PROF. MARTIN BIZZARRO, PHD[1]

[1]Centre for Star and Planet Formation, Globe Institute, University of Copenhagen
[2]School of Earth and Planetary Sciences, Curtin University
[3]The University Museum, The University of Tokyo

The martian meteorite Northwest Africa (NWA) 7034 and paired stones (incl. NWA 7533) are regolith breccia samples that contain a diversity of igneous clasts with pre-Noachian ages of ~4.44 Ga [1,2,3]. In addition to various igneous clast types, a large proto-breccia fragment has been observed within NWA 7034 [1]. The investigation of proto-breccia clasts, i.e. breccia clasts that predate the lithification of the host breccia, has the potential to bring insights into the history of the martian crust at a greater spatial and/or temporal extent than that recorded in the host breccia.

We report the discovery of another large (>1.4 cm^3) proto-breccia clast with a distinctly different matrix texture and geochemistry relative to the bulk matrix domain (BMD) of NWA 7533. In detail, the proto-breccia matrix has a crystalline texture with larger crystal sizes than the BMD, and it exhibits enrichments in Al, Ca, and Na and depletions in Fe, Mg, and Mn. This points to a history of prolonged heating for the proto-breccia (classified as a granulitic breccia) and possibly an origin of its components from a different crustal terrain than that sampled by the NWA 7533 regolith breccia. The sampling of a different source terrain is supported by the entrainment of fragments of a newly discovered Mg-rich rock type (MgO~30 wt%) which has not been observed within the host breccia. Investigations of a larger clast of this Mg-rich rock reveals a complex texture with a “melt-like” interior, a crystalline rim containing abundant olivine, large fractures, and signs of alteration. Based on geochemical data for the bulk clast and olivine crystals, we find that it is distinct from any other clast type (including NWA 7533 impact melt spherules containing olivine) observed within the host breccia. Typical forsterite contents of 73-82% are among the highest observed for martian olivine and may reflect a primitive precursor melt composition for this Mg-rich clast.

[1] McCubbin, F. M. *et al.* (2016) *J. Geophys. Res. Planets* **121**, 2120–2149. [2] Costa, M. M. *et al.* (2020) *PNAS* **117**, 30973-30979. [3] Jensen, N. K. *et al.* (2025) *Geochim. Cosmochim. Acta* **390**, 70-85.