Plastic Deformation on the Ureilite Parent Body revealed by Structural Analysis of Dunitic Ureilite NWA 7630

B. J. Tkalcec and F. E. Brenker. Goethe University, Frankfurt, Germany. tkalcec@em.uni-frankfurt.de

Introduction: Ureilites are ultramafic achondrites [1] thought to have formed as partial melt residues in the mantle of a large, differentiated carbon-rich asteroid that has since been disrupted [2]. Related core samples, however, have not yet been found. The wide variety in $\Delta^{17}O$ values indicates that the parent body never totally melted [3]. However it underwent sufficient heating to generate magmas [4] and a small S-rich core [5]. Investigations of the core forming processes of the ureilite parent body are as yet inconclusive, with geochemical data indicating an efficient segregation of S-rich metallic Fe-FeS melts yet with insufficient percolation to form the core [2]. It has been suggested that other factors, such as shear deformation, may enhance segregation rates of liquid metal from silicate matrix [6], contributing to core formation. Following the recent discovery of solid-state plastic deformation in several olivine-rich diogenites [7] we now examine olivine-rich ureilites for any evidence for plastic deformation, which would support the suggestion of shear deformation on the ureilite parent body.

Sample and Methods: Structural analysis was performed on the dunitic ureilite, NWA 7630, an unbrecciated, low-shocked, low-weathered, monomict ureilite composed of >90 wt% olivine ($Fa_{12.3\text{-}21.3}$) [8]. A foliation identified by the pyroxene veins as well as a lineation and preferred orientation of the olivine crystals is visible in both hand specimen and thin section. Electron Backscatter Diffraction (EBSD) was performed both manually and with automatically scanning on a 30 µm thin section cut perpendicular to the lineation. An accelerating voltage of 15 kV and a working distance of 20 mm were maintained. Only measurements with a mean angular deviation <1.0 (manual) and <1.3 (automatic scanning) were accepted and recorded.

Results: Both manually acquired data and automatic scanning data yielded the same results. The olivine crystals of NWA 7630 display a clear lattice-preferred orientation (LPO) that bears a certain similarity to that formed by activation of the pencil-glide slip systems {0kl}[100] [9].

Discussion: The identification of a clear LPO in the dunitic ureilite NWA 7630 confirms the occurrence of solid-state plastic deformation, likely shear deformation, on the ureilite parent body. This reveals that enhancement of segregation rates of liquid metal from silicate matrix by shear deformation [6] could be a plausible contributing factor to core formation on the ureilite parent body and warrants further consideration.

References: [1] Mittlefehldt D. W. et al. 1998. In: Papike J.J. (Ed.), Planetary Materials: 195. [2] Barrat J. A. et al. 2015. *Earth and Planetary Science Letters* 419:93–100. [3] Claydon R. N. & Mayeda T. K. 1996. *Geochimica et Cosmochimica Acta* 60:1999-2017. [4] Bischoff A. et al. 2014. Proc. of the Natl. Academy of Sciences 111(35):12689-12692. [5] Warren P. H. et al. 2006. *Geochimica et Cosmochimica Acta* 70:2104-2126. [6] Rushmer T. & Petford N. 2010. *Geochemisry Geophysics Geosystems* 12: Q03014, doi:10.1029/2010GC003413. [7] Tkalcec B. J. & Brenker F. E. 2014. *Meteoritics & Planetary Sciences 49*(7): 1202-1213. [8] Irving A. and Kuehner S. 2013. Meteoritical Bulletin 102. [9] Carter N. L. & Ave'Lallement H. G. 1970. *Geological Society of America Bulletin* 81:2181-2202.