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SAMPLING AN IMPACT MELT SHEET WITH UNUSUAL DIOGENITE NORTHWEST AFRICA 5480

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Introduction: The petrofabrics of meteorites can preserve information about melt flow and mechanical disruptions to the system among other things. Recent studies using electron backscatter diffraction (EBSD) have identified evidence – and distinguished between – magmatic flow and mineral settling in Martian nakhlites [1] and ungrouped achondrites [2], as well as the effects of shock [3]. Northwest Africa (NWA) 5480 is a harzburgitic diogenite with heterogeneous distribution of olivine and orthopyroxene that has been previously associated with the Vestan mantle [4] or an impact melt sheet [5]. Here, we utilize EBSD to explore the petrogenesis for this unusual meteorite.

Methods: Imaging of a polished thin section of NWA 5480 was carried out using a Zeiss Crossbeam 550 at 15 keV and 10 nA. EBSD analysis used an Oxford Instruments Symmetry detector and AZtec software, paird with an Oxford Instruments UltiMax 170 detector for phase identification. Post-processing was completed with AZtecCRYSTAL, and data plotted on upper hemisphere equal area projections, expressed as multiples of uniform density.

Results: NWA 5480 has a mean orthpyroxene (enstatite) composition of $En_{76.62}Fs_{21.34}Wo_{1.95}$ (n=28) and mean olivine composition $Fs_{25.84}Fo_{74.16}$ (n=23). Dunite clasts contain adcumulate textures with 120° triple junctions and sharp contacts to the enstatite matrix. Olivine also appears as pervasive chadacrysts which are restricted entirely to the enstatite matrix. No alignment in observed in the dunite clasts, olivine chadacrysts, nor enstatite matrix. An example of the data collected in this study, showing the before-mentioned features is presented in Figure 1.

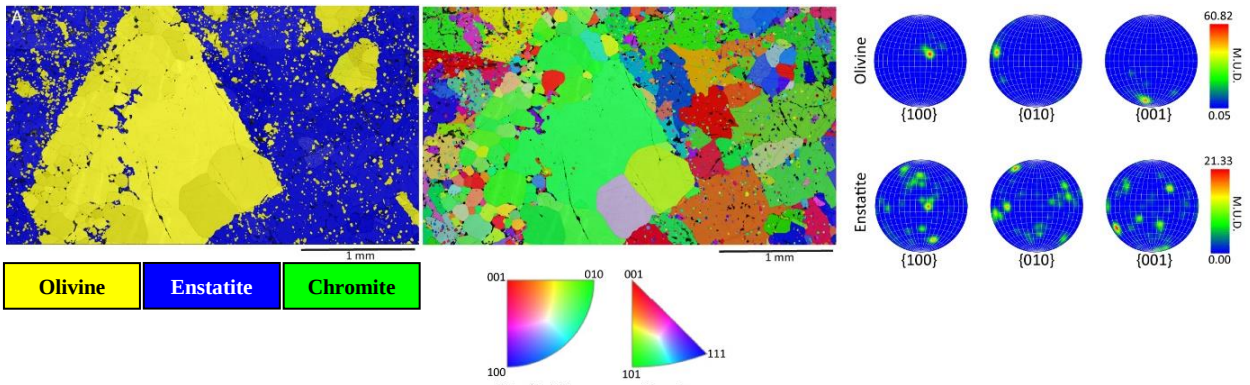

Figure 1. EBSD phase map overlaid on band contrast image to show grain boundaries (left) indexed for olivine, enstatite and chromite, IPF maps (right) of the same view and associated pole figures.

Discussion: The lack of preferred orientation in this sample suggests that NWA 5480 did not undergo shearing in a mantle setting as previously suggested [4]. Adcumulate textures identified in NWA 5480 further suggest that the dunite clasts represent a precurosor lithology that underwent mineral settling and compaction in a crustal magma chamber. This process is observed both terrestrially and in other HED samples [6,7]. Although poikilitic textures can often represent deep crustal processes on Earth [8], this texture combined with the finer-than-typical orthopyroxene grain size and previously reported minor element zoning [5] suggest that likley NWA 5480 cooled rapidly in a near-surface environment. Additionally, the compositions of pyroxene and olivine in NWA 5480 are not the most primitive recorded in the HED suite [9], contrary to what would be expected from a sample of the Vestan mantle [9,10]. As such, we propose that NWA 5480 represents a sampled melt sheet in which a pre-existing dunite-rich lithology was brecciated and entrained in the melt, surrounded by crystallising orthopyroxene, and the olivine chadacrysts are likely pre-existing crystals that were partially resorbed into the melt [8] following the impact event. NWA 5480 sheds new light on the complexities of impact processes in the early Solar System, and we conclude that the Vestan mantle most likely remains unsampled by the current global meteorite collection.

References: [1] Daly L. et al. (2020), *Earth and Planetary Science Letters*, 520:220-230; [2] Hasegawa, H. et al. (2019), *Meteoritics & Planetary Science*, 54:752-767; [3] Chen D.-L. et al. (2019), *Meteoritics & Planetary Science*, 286:14-22; [4] Tkalcec, B.J. & Brenker, F.E. (2015), *Journal of Structural Geology*, 77:138-150 [5] Yamaguchi, A. et al. (2015), *Meteoritics & Planetary Science*, 50:1260-1270; [6] Vukmanovic, Z. et al. (2018), *Contributions to Mineralogy and Petrology*, 173:73-85; [7] Barrat, J.-A. et al. (2006), *Meteoritics & Planetary Science*, 41:1045-1057, [8] Barnes, S.J. et al. (2016), *Journal of Petrology*, 57:1171-1196; [9] Lunning, N.G. et al. (2015), *Earth and Planetary Science Letters*, 418:126-135; [10] Mitchell J.T. & Tomkins, A.G. (2019), *Geochimica et Cosmochimica Acta*, 258:37-49