# A petrologic investigation into ureilite NWA 7059

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Ureilites are achondritic meteorites that are mineralogically similar to terrestrial peridotites, though both their origin and petrogenesis are poorly constrained. NWA 7059 is the second largest ureilite in the world (11.73 kg), and is housed at the Royal Ontario Museum, Toronto, Canada. Here we conduct a comprehensive petrologic and geochemical analysis of the meteorite using a range of techniques including optical petrography, Raman, EPMA, and SEM.

NWA 7059 is composed chiefly of olivine and low-Ca pyroxene (≤ 5 mm and ≤ 4 mm in length, respectively), which is typical of olivine-pigeonite ureilites. The slab macroscopically shows crystallographic preferred orientations (CPO) parallel to the cut face, and electron backscatter diffraction (EBSD) was used to quantitatively investigate the existence and nature of this apparent fabric. In total, 210 individual point analyses were conducted on 145 olivine grains within a polished thin section of NWA 7059. The Matlab toolbox MTEX [1] was used to plot all individual orientation data, which showed no apparent CPO. Olivine grains feature reverse zoning and are decreasingly forsteritic toward their cores ($Fo_{77.8\pm0.1}$ at core to $Fo_{89.7\pm1.2}$ at rim), which are compositionally homogeneous. Poikilitically enclosed olivine chadocrysts (≤ 0.35 mm in size) within pyroxenes are also present throughout the sample—chemically, they match the olivine cores (e.g. $Fo_{78.1\pm0.4}$, $Fo_{78.7}$). Low-Ca pyroxenes appear as pigeonite ($En_{75.1\pm0.1}Wo_{7.2\pm0.1}Fs_{17.7\pm0.1}$), do not exhibit any sort of zoning, and are also chemically homogeneous.

The preliminary results of this study raise further questions about the formation and history of the urelite parent body, which is already widely debated [2]. For example, the homogenous Fo content of olivine chadocrysts and cores offers support for a cumulate origin for NWA 7059. Simultaneously, the macroscopic observation of a foliation within the meteorite would bolster this cumulate model—however, quantitative EBSD data contradicts this by lacking a CPO on any axis. This study demonstrates the currently under-explored potential of EBSD when examining these early solar system fabrics, which in turn aids in understanding the model of petrogenesis for NWA 7059 and the urelite parent body as a whole.

[1] Bachmann, Hieschler & Schaeben (2010) *Sol. St. Phen.* **160**, 63-68. [2] Goodrich (1992) *MAPS* **27**, 327-352.