NON-DESTRUCTIVE STRUCTURAL CHARACTERIZATION OF TWO DIFFERENT UREILITES BY MEANS OF NEUTRON TECHNIQUES F. Salvemini, V. Luzin, S. Caporali, M. Morelli, D. Faggi, V. Moggi-Cecchi, R. Serra, G. Pratesi. 1Australian Centre for Neutron Scattering, Australian Nuclear Science and Technology Organisation (ANSTO), Lucas Height, NSW 2234, Australia, e-mail: filomens@ansto.gov.au 2Dipartimento Ingegneria Industriale, Università degli Studi di Firenze, Via S. Marta 3, 50139 Firenze, Italy, 3Fondazione Parsec - Museo di Scienze Planetarie, Via Galcianese, 20H, 59100 Prato Italy, 4Museo di Storia Naturale-SMA, Università degli Studi di Firenze, Via G. La Pira 4, I-50121, Firenze, Italy, 5Museo del Cielo e della Terra, Vicolo Baciadonne, 1, 40017 San Giovanni in Persiceto, Italy. 6 IAPS-INAF, Via del Fosso del Cavaliere, 100, 00133 Roma, Italy

Introduction: Ureilites are ultramafic achondrite meteorites consisting almost entirely of olivine and pyroxene that have experienced significant igneous processing whilst retaining heterogeneity in mg# and oxygen isotope ratios [1,2,3]. However, despite having residual mantle mineralogy, they have other characteristics such as distinctive lithologies, that are difficult to reconcile with any simple igneous model, and the petrogenesis of ureilites remains highly controversial [4,5]. Even if it is not universally accepted, several authors suggest ureilites derive from a single parent asteroid [6,7]. To provide further insight into ureilites structures and genesis, we have begun a structural study based on neutron computed tomography (NCT) and neutron diffraction texture analysis (NDT). NCT and NDT are powerful analytical tools to qualitatively and quantitatively characterize textural and structural properties of the bulk in meteorite samples in a non-destructive way [8, 9]. For such reasons their application to planetary science materials is observing a growing interest [10-12].

Method and samples: NCT and NDT were performed at the Australian Nuclear Science and Technology Organisation (ANSTO, Lucas Heights Australia) with their Neutron Imaging Facility (DINGO beamline [13]) and Neutron Diffractometer (KOWARI beamline [14]), respectively. The system uses thermal neutrons (wavelength distribution centered on 1.8 Å) and the projection images are acquired using a combination of a 30 µm thick Gadox scintillation screen to convert the neutrons to visible light and a 15 Megapixel (5056 x 2968) IRIS CMOS sensor camera. The pole figure measurement routine includes measurements of the main pole figures of major phases (i.e. olivine).

The two investigated samples consist of fragments of the Watson018 meteorite, which is described as an olivine-pigeonite ureilite fund in South Australia [15] and the NWA 3140, an olivine dominated ureilite fund in Morocco [16].

Results and discussion: Figure 1 displays the volume rendered NCT image of Watson018 meteorite and a reconstructed slice through the sample (bottom). The structure of the sample is evidenced by the reconstructed slice in figure 1. It is constituted by coarse pyroxene and olivine grains (light gray) embedded in melted material (dark gray). The pyroxene and olivine crystals are oriented (north-south direction in figure 1). It is also worth to note the presence of macroscopic voids (black spots).

Figure 1. Volume rendered NCT image (top) and a CT slice through the Watson018 meteorite sample (bottom).
On the other side, NWA 3140 meteorite (figure 2) results a much dense object, petrologically constituted by mostly rounded olivine and pyroxene crystals, randomly oriented, with almost neglectable interstitial melt. There also no evidence of macro voids in this sample (figure 2, bottom).

The neutron diffraction texture analysis is still under progress and some preliminary results will be showcased.

Figure 2. Volume rendered NCT image (top) and a CT slice through the NWA 3140 meteorite sample (bottom).

**Conclusions:** NCT investigation carried out on these two ureilites successful evidenced significative differences regarding their lithology. Watson018 is very porous and constituted by large (3-5 mm) olivine and pyroxene crystals, while the NWA 3140 meteorite is characterized by a compact lithology constituted by randomly oriented nearly equigranular crystals.

The rather different lithologies displayed by these two ureilites were unequivocally determined via a nondestructive approach. Exploiting the different neutron attenuation capability (sum of neutron absorption and neutron scattering) of the elements constituting the samples, allowed us to discern among different phases, and voids, present within the sample interior from its computationally reconstructed 3D structure.

Complementarily, NDT determined crystallographic relationship between major phases and other minerals in the meteorite body.

These preliminary results evidenced the suitability of the neutron methods to get some valuable information on the complex petrogenetic history of the ureilite parent asteroid, including asteroidal igneous crystallization, impact disruption, reheating and partial melting, and possibly re-agglomeration.

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