METEORITES OF THE NULLARBOR PLAIN; RECENT RECOVERY & CLASSIFICATION EFFORTS

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Introduction: The Nullarbor Plain in Southern Australia provides opportune conditions for meteorite preservation; largely arid, the Nullarbor has been known to preserve meteorites for thousands of years. These meteorites are located either through use of 'fireball' cameras such as the *desert fireball network*, which has found four meteorites to date [1], or by manual search & recovery expeditions. Each year, a team from Monash University and the University of Plymouth manually explore a previously uncovered region of the Nullarbor in order to retrieve new meteorite specimens. Since 2008, this team have recovered more than 200 new meteorites, with 78 officially classified so far.

A recent study provided insight into a small sample of the more recent Nullarbor recoveries using synchrotron powder X-ray diffraction (XRD), aiming to inform a full classification of each specimen [2], upon which this study will build prior to submission to the Meteoritical Bulletin.

Samples & Analytical Techniques: Nine chondrite meteorites were used in this study, as polished thin sections or homogenized powders. The meteorites are not yet officially classified and have therefore been named for the date they were found (DDMMYY), then alphabetically for the order. *Scanning Electron Microscopy (SEM):* Large area, whole section backscattered electron (BSE) images and energy dispersive spectroscopy (EDS) maps were generated for each thin-section, using a JEOL 7001F FEG-SEM with an accelerating voltage of 15 kV, unless otherwise indicated. Layered X-ray element maps combined with spot analyses to determine mineral composition were generated using an Oxford Instruments X-Max 80 mm^2 EDS detector with AZtec software, and calibrated using a cobalt reference standard and MAC rock-forming minerals block. *X-Ray Diffraction:* Samples were crushed, hand ground and mixed with a ZnO internal standard before being loaded into capillaries on the PD beamline at the Australian synchrotron. Data were analysed using Topas V6 (Bruker).

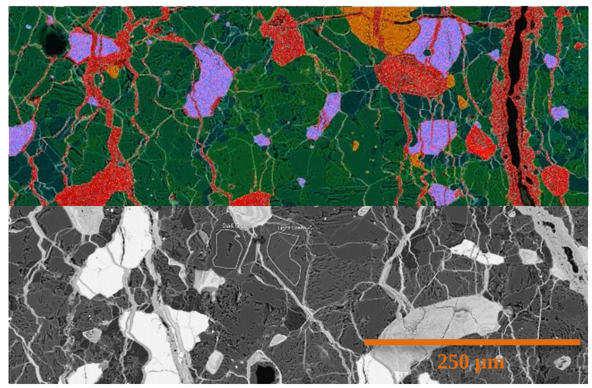

Figure 1: Layered EDS (top) and BSE (bottom) image showing the typical weathered texture observed in Nullarbor chondrites (sample 24417G), with Fe-oxide phases identified within pervasive veining. Red - Fe-oxide weathering products; orange - chromite; purple - sulfides; green - pyroxene; dark green - feldspar.

Results: Modal analyses by XRD and SEM-EDS were generated for each of the samples, allowing for a direct comparison between the two methods. However, the SEM-EDS also allowed comparisons to be made across the suite of chondrites with respect to chondrule size, type, degree of weathering and amount of metal. Most of the samples have chondrules between 100 µm and 1.2 mm diameter of varied composition, with 24417G indicating the most severe weathering. Major phases within chondrules and matrix included pyroxene, olivine and feldspar, whilst goethite, pyrrhotite and troilite were all observed as veins or within matrix (see figure 1). Minor phases across all samples analysed included chromite, apatite and chlor-apatite (<6.5 wt% Cl).

Discrepancies were observed within the initial modal data obtained via XRD vs SEM-EDS owing to several minor phases (i.e. apatite) sitting below the detection limit of the XRD technique. In addition, a lower proportion of some phases (i.e. goethite) were observed within XRD analyses, and others (i.e. sulfides & feldspar) were missing from XRD datasets (table 1) entirely. However, we are confident that the phases are correct owing to SEM-EDS analyses, and the varied compositions observed as a result (figure 1). Several of the phases determined using SEM-EDS are not represented in the XRD data due to sample preparation bias; this is being addressed through a separate study. It is hoped that this combination of SEM-EDS & XRD will enable the backlog of Nullarbor meteorites to now be classified.

	Goethite & Fe-oxides	Chromite	Sulfides	Apatite	Pyroxene	Feldspar
XRD	8.00	3.00	Not seen	Below limit	89.00	Not seen
SEM-EDS	19.57	1.04	4.35	0.92	65.10	9.03

Table 1: Modal mineralogy for sample 24417G, determined via XRD [3] or SEM-EDS.

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References: [1] Benedix, G. K. et al. (2017) *Met. Soc.* Abstract #6229. [2] Brand, H.E. et al. (2019) *LPS L*, Abstract #1361.