**METEORITES ON THE NULLARBOR PLAIN, INSIGHTS FROM SYNCHROTRON POWDER DIFFRACTION** H. E. A. Brand[1], A. D. Langendam[2], A. J. Whitworth[2], S. L. Alkemade[2], J. T. Mitchell[2], A. Davis[2], N. R. Stephen[3] and A. G. Tomkins[2]. [1]Australian Synchrotron, ANSTO, 800 Blackburn Rd., Clayton, VIC 3168 Australia. [2]School of Earth, Atmosphere and the Environment, Monash University, Melbourne, Victoria, 3800, Australia. [3] Plymouth Electron Microscopy Centre, Plymouth University, Drake Circus, Plymouth PL4 8AA, UK. helenb@ansto.gov.au

**Introduction:** The Australian deserts are an excellent place to search for meteorites, the dry warm climate limits changes on the surface allowing meteorites to remain in place for hundreds, if not thousands of years. Additionally, the Nullarbor plain – one of the largest limestone karst systems in the world provides an additional benefit in colour, the light limestone contrasting the black meteorites well. Over the past decade a group from Monash have been searching for these meteorites and with moderate success have collected over 200 new meteorites. This represents approximately 1/5 of Australia's meteorite collection. Although the Nullarbor provides a fairly stable environment, there are still variations in the weathering of these meteorites and it is important to establish if this is just a result of time on the surface or if there is also a location and local environment factors.

While these meteorites have been studied using optical and SEM techniques, synchrotron XRD (SXRD), represents a fast way to gain detailed bulk mineralogy of these samples to complement and add to the existing data. It can also be combined with geo-spatial data associated with the samples to model and determine weathering patterns for the meteorites on the Nullarbor. To this end we plan to study a wide selection of Australian Meteorites of various classes using SXRD to determine the phases present, with particular sensitivity to minor phases, both original and weathered mineral phases.

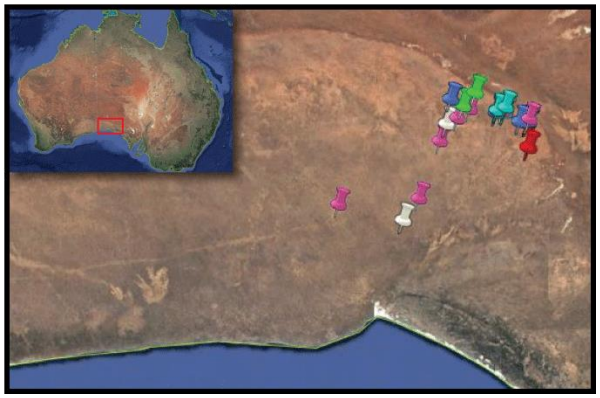

**Fig. 1. Context image to show meteorite collection sites.**

The meteorites described here are a mixture of officially described meteorites and new, as yet, unclassified meteorites from the Nullarbor as well as having a range of compositions. The samples were chosen as being a large enough sample, or multiple fragments, so that a representative sample (~0.5g) could be crushed while leaving enough for other analyses. Figure 1 shows the collection area for these meteorites. The meteorites which are not officially classified have been named for the date they were found (DDMMYY) and then alphabetically for the order they were found that day.

**Synchrotron X-ray powder diffraction:** Representative samples of each meteorite were crushed to a talc consistency and then hand ground with a mortar and pestle. These were then mixed to 90:10 by weight with NIST SRM 674b ZnO as an internal standard. These were then packed in 0.3 mm diameter quartz glass capillaries for SXRD data collections, which were conducted on the powder diffraction beamline at the Australian Synchrotron [1]. High energy, 16 keV, X-rays were used to reduce fluorescence due to Iron. The wavelength was 0.77697(1) Å, calibrated with NIST SRM LaB6 660b. The capillary was positioned in the diffractometer rotation centre and spun at ca. 1 Hz. The X-ray beam was aligned to coincide with the diffractometer centre. Data were collected using a Mythen position sensitive detector [2] covering 80° in 2θ with an inherent resolution of 0.004° in 2θ. Pairs of data sets were collected at two detector positions 0.5° apart for each meteorite in order to cover the gaps between the detector modules. Acquisition time at each position was 300 seconds. The data pairs were merged into single files using the in-house data processing software, PDViPeR, available at the beamline.

**Data analysis strategy and initial results:** The results shown here are preliminary reports of the SXRD only and further analysis in comparison with other techniques will be presented in the final contribution.

Initially, phase ID was carried out using Panalytical highscore with the ICDD PDF4 database. Rietveld analysis was then carried out using Topas academic V6

to determine the lattice parameters and semi-quantitative phase analysis. Despite the inclusion of an internal standard, no attempt is made in this contribution to determine the amount or composition of any amorphous phases present and the quantitative information reported here refers only to relative crystalline amounts – hence it is semi-quantitative only.

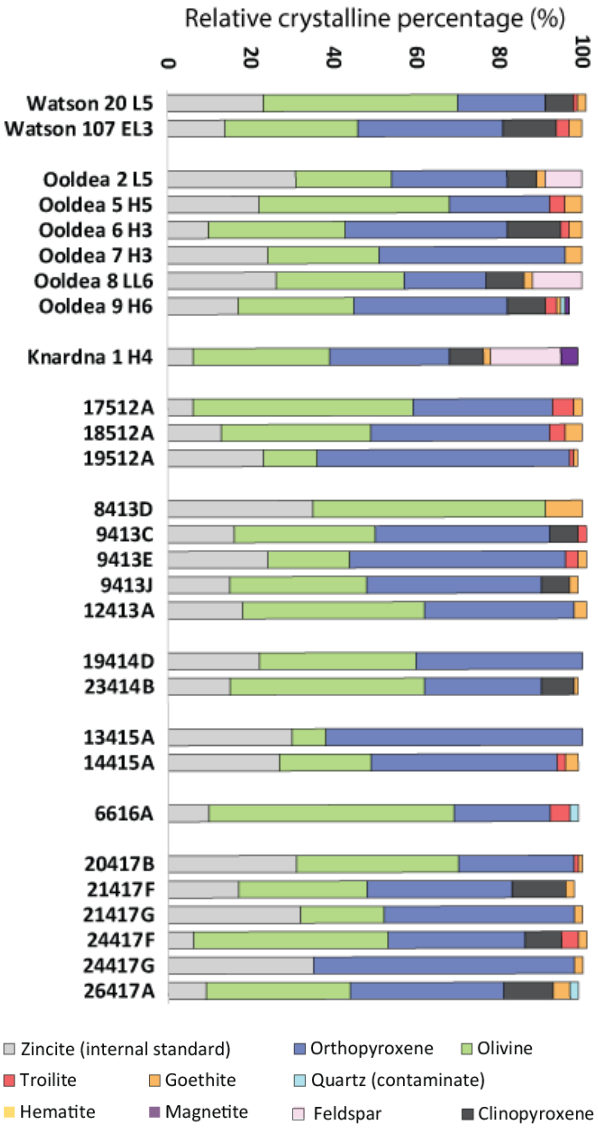


**Fig. 2 relative crystalline proportions of minerals present in the meteorites studied. Classifications of the officially named meteorites are included.**

Figure 2 shows the modal proportions of minerals within the meteorites investigated here. The sensitivity to minor phases of the SXRD is ~0.5 % in these samples thanks to the signal to noise afforded by the detector and the ability to tune out fluorescence by selecting wavelength.

The lattice parameters determined from these SXRD patterns can also be used as a proxy for elemental composition in some of the minerals present, as described in [3]. This is shown for Fe-Mg content in olivine in figure 3.

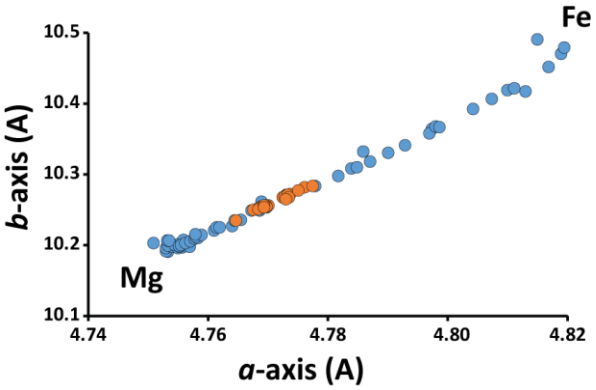


**Fig. 3 lattice parameters of meteorites studied (orange), compared to literature values (blue) from [3].**

This analysis can be expanded to other minerals present in the meteorites. The crystal structure and complexity of the phase relations of each mineral make some lattice parameters better than others as a proxy for elemental composition. The relative merits for each mineral in the context of meteorite analysis as well as wider planetary materials will be discussed in the final contribution as presented.

**References:** [1]Wallwork, K.S., Kennedy, B.J. and Wang, D. (2007) AIP Conference Proceedings, 879, 879–882. [2] Schmitt, B., C. Bronnimann, et al. (2003). Nuclear Instruments and Methods in Physics Research A 501: 267 - 272. [3] Morrison *et al*. (2018) American Mineralogist, **103**, 848–856