SOLUBLE ORGANICS WITHIN THE NEWLY FALLEN WINCHCOMBE CM CHONDRITE

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Introduction: The Winchcombe meteorite, a CM2 chondrite, fell on in Gloucestershire, UK at 21:54 UTC on 28th February 2021. Multiple pieces were collected over the subsequent days and weeks as part of a fireball search [1,2]. They include the main mass found on the driveway of the Wilcocks' family house in the village of Winchcombe on 1st March 2021, and a sample recovered in a field at Rushbury House Farm on 6th March. Environmental soil samples from each fall site were also collected.

This metabolomics study sought to characterise the soluble organic profile of the meteorite within one month of the fall to minimise the effects of exposure to the terrestrial environment. This research is focused on liquid chromatography mass spectrometry (LC-MS) analyses.

Methods: All glassware and equipment were wrapped in foil and heated in an oven at ~500 °C for six hours. They were then washed with 2 % DECON clean solution and de-ionised water and left to dry in a positive pressure fume hood. Two ~ 0.5 g chips of Winchcombe (one from the Wilcocks' driveway, and one from the Rushbury House farm, representing the two distinct lithologies in the stone) and corresponding environmental control samples were crushed using an agate mortar and pestle. Each powdered sample was then divided into six ~45 mg replicates for solvent extraction. Solvent extractions were carried out using hexane, dichloromethane, and methanol at room temperature as per [3]. Procedural blanks were introduced at each stage of analysis. Samples were then frozen at -80 °C until analysis with HILIC LC-MS. Three replicates of each sample, environmental control, and procedural blank were analysed with HILIC LC-MS at Polyomics for initial untargeted metabolomics (for further details see [3]). These data were processed as outlined in [4] and analysed initially to rule out laboratory contaminants from the procedural blanks, then principal component analysis (PCA) was carried out using Metaboanalyst - open source metabolomics software (Figure 1).

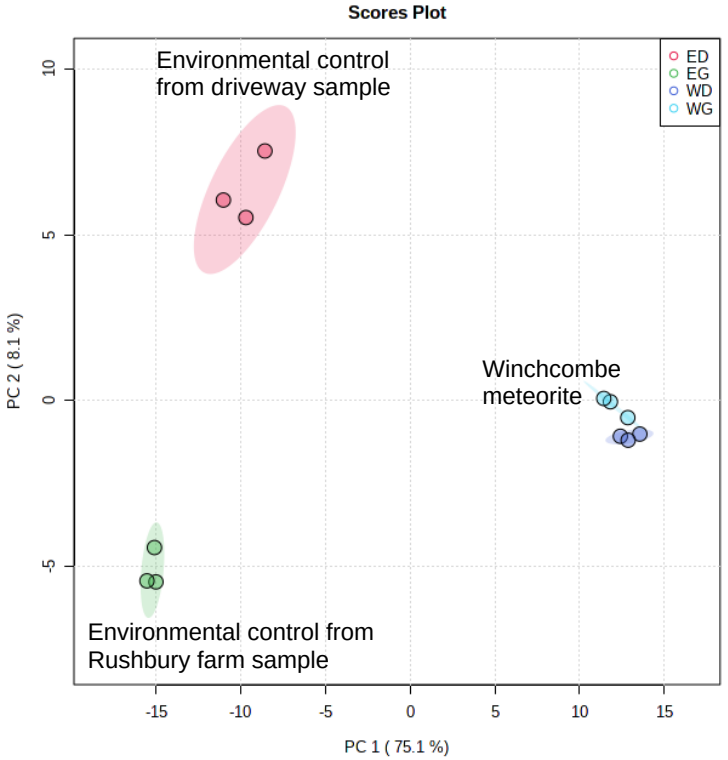

Figure 1 2D PCA from untargeted LC-MS analysis of the Winchcombe meteorite & corresponding environmental controls. The first principal component accounts for 75.1 % of the variance in the dataset and distinguishes the meteorite samples from their controls. The second principal component accounts for an additional 8.1 % of the variance and distinguishes the two environmental controls from each other (as well as from Winchcombe).

Results & Future Work: Principal component analysis (PCA- Figure 1) indicates that the meteorite extracts cluster together, and separate from their corresponding environmental controls primarily along the PC1 (first principal component) axis. PC1 accounts for 75.1% of the variance in the dataset, demonstrating how distinct the meteorite extracts are from the soil samples. The two soil samples are distinct from one another, as evidenced by their separation along the PC2 axis, consistent with the contrasting environments where the two meteorite fragments fell.

Examples of classes of metabolites we putatively detected in Winchcombe include a number of organic sulfonates (whose presence was further strengthened by the presence of sulfonate fragment ions, and ^{34}S isotope peaks in the MS spectra), and fatty acids and fatty amines. Subsequent targeted analyses with standards to confirm the exact molecular structure of the sulfonates are planned and will be presented at the meeting.

References:

[1] L. Daly et al. 2021. *Elements* 17:5 [2] A. C. O'Brien et al. 2022. *Astron. & Geophys.* 63:1. [3] A. C. O'Brien et al. 2021. LPSC LII. Abstr# 2069 [4] Creek et al. 2012. *Bioinformatics.* 28:7