EPN2020-RI

EUROPLANET2020 Research Infrastructure

H2020-INFRAIA-2014-2015

Grant agreement no: 654208

Deliverable D9.1
Road map on preparation protocols

Due date of deliverable: 28/02/2017
Actual submission date: 17/03/2017

Start date of project: 01 September 2015 Duration: 48 months

Responsible WP Leader: VUA, Gareth Davies

Project funded by the European Union's Horizon 2020 research and innovation programme		
Dissemination level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Service)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (excluding the Commission Services)	

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Project Title	EPN2020 - RI
Project Duration	48 months: 01 September 2015 – 30 August 2019

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Contractual Delivery date	28/02/2017
Actual delivery date	17/03/2017
Title of Deliverable	Road map on preparation protocols
Contributing Work package (s)	WP9
Dissemination level	Public
Author (s)	Gareth Davies, Sara Russell

Abstract: This is a guide to protocols for meteorite collection and characterisation. It is aimed at geoscientists who may be unfamiliar with meteoritics research and the current protocols for the initial analysis of meteorites, and who may look to the EURO-PLANET team for advice. It is intended for analysis of serendipitous finding of meteorites or observations of meteorite falls, rather than for systematic field campaigns of meteorite searches.

Extraterrestrial samples are rare and precious, and are popular targets of research. Without a specific roadmap, there is potential for duplication of effort leading to the consumption of more sample than is necessary. http://www.lpi.usra.edu/meteor/metbull.php

Depending on sample size, it is recommended that at least 50% of the sample is preserved in an entirely pristine form, for future generations to study.

Sample retrieval

On retrieving the sample it is advantageous to consider the following:

1. The position that the sample is found/ fell should be recorded as accurately as possible.
2. If it is a meteorite fall, details of the fall should be recorded (for example, was a fireball observed? If so from which direction? What noises were heard, and how soon before the fall occurred?) Such observations can help later to calculate the orbital parameters of the object.
3. The sample should be collected as cleanly as possible. Avoid using bare hands if possible. The sample should be placed in a clean bag along with a unique identifying tag.
4. It should be stored in dry, cool conditions and away from potential sources of contamination such as petrol fumes.
5. While many sources recommend testing a meteorite by determining if it is attracted to a magnet, this is not currently considered best practise as it may compromise future magnetic studies.
6. Many meteorites fall as a shower, so the local area should be carefully searched for paired meteorites.
7. It is helpful to also sample the local soil/rock. This can enable the effects of any contamination to be determined more easily.
8. Local conditions such as the weather/climate and exact siting of the meteorite (e.g. in depression, next to a boulder, in a muddy puddle etc.) should be recorded. This is especially important for meteorite finds that may have been in this position on Earth for some time. Ideally the sample should be photographed *in situ* prior to being picked up.

Macroscopic Sample Description

On arrival at a geological facility the sample should be accurately weighed and photographed. A macroscopic description can be recorded at this stage, to include the sample's shape, colour, presence of fusion crust, visible presence of chondrules, metal, etc. Density can be estimated at this stage. Quantitative density determination is not advised as methods for determining volume (e.g. submersion in water or glass beads, or gas pycnometry) have a potential for contamination and so are best undertaken on a sub-sample only.

Sub-sampling

At this stage, sub-sampling is recommended. Even nominally non-destructive techniques, such as computed tomography, X-ray diffraction, etc, have the potential to alter the sample in subtle ways (e.g. Sears et al. 2016). Therefore, best practise is to preserve a pristine sub-sample of the meteorite. The meteorite can be sub-sampled by various techniques. Sawing can potentially introduce metal contamination (e.g. Ti, Cr, etc). Use of a rock splitter or hammer is usually preferable for this reason, although the sampling is then less well controlled.
After splitting the meteorite, each of the fragments should be separately weighed and curated. Dust produced from sawing can also be preserved separately.

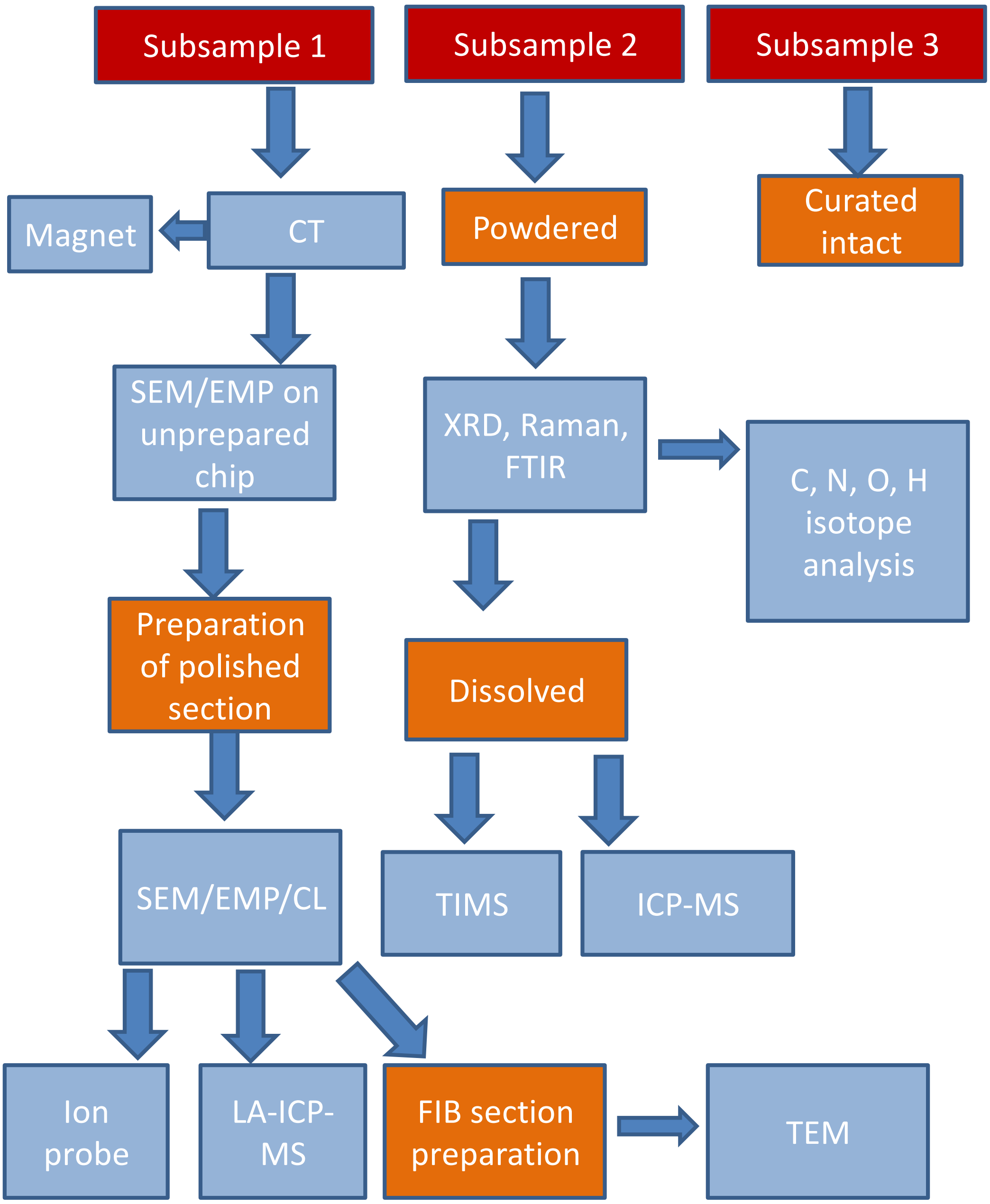
Sample Characterisation

We recommend a protocol similar to that outlined in the figure. This will ensure the maximum amount of information can be acquired on the bulk sample and will enable the sample to be formally classified according to established criteria (e.g. Van

Schmus 1979; Weisberg et al 2005). Targeted sampling- for example of individual chondrules- may be required from the subsample 3.

In the figure, the following abbreviations for instrumentation are used:
CT: Computed Tomography scans
Magnet: Magnetometer
SEM: Scanning Electron Microscopy
EMP: Electron microprobe
Raman: Raman spectroscopy
FTIR: Fourier Transform Infra-red spectroscopy
XRD: X-ray diffraction
CL: Cathodoluminescence
ICP-MS: Inductively coupled plasma mass spectrometry (often using multiple collectors for high precision work)
LA-ICP-MS: Laser ablation Inductively coupled plasma mass spectrometry
TIMS: Thermal ionisation mass spectrometry
TEM: Transmission electron microscopy
FIB: Focused ion beam

Roadmap for characterisation of a new meteorite sample



Not all the above analyses will be necessary in all cases, and for the most common meteorites, classifications are obvious from hand specimen and can be formally made from SEM or EMP analyses from polished sections. For rarer meteorite specimens, a critical measurement will be oxygen isotope analysis, which provides a framework for meteorite classification (e.g. Clayton and Mayeda 1996; 1999). This analysis should therefore be prioritised.
The above roadmap is designed for the more common rocky meteorite samples. Exact protocols will depend on the nature of the sample and the particular challenges

it presents. For example, organic -rich samples will require additional analyses to characterise the abundance and nature of this material.

Long term curation

The curation of the pristine sample will depend on its exact composition- iron, carbonaceous, etc. However all meteorites benefit from curation in dry conditions and a desiccant may be required. A clean storage room and controlled atmospheric conditions are essential. The sample should be kept in a secure environment, especially if it is a rare and valuable meteorite type, for example lunar or martian. Details of all new meteorites should be submitted to the Nomenclature Committee of the Meteoritical Society so that it can be added to their database of known meteorites:
http://www.lpi.usra.edu/meteor/metbull.php

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