

**ANALOGUE SAMPLES IN AN EUROPEAN SAMPLE CURATION FACILITY - THE EURO-CARES PROJECT.** J. Zipfel<sup>1</sup>, F. Westall<sup>2</sup>, F. Foucher<sup>2</sup> and the EURO-CARES Consortium, <sup>1</sup>Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganlage 25, 60325 Frankfurt am Main, Germany, jzipfel@senckenberg.de, <sup>2</sup>CNRS Orleans (CNRS-Centre de Biophysique Moléculaire, Rue Charles Sadron, 45071 Orléans Cedex 1, France).

**Introduction:** The return of extraterrestrial samples brought to Earth from different bodies in the Solar System (Mars, planetary satellites, asteroids, the Moon), either by unmanned and/or by manned missions will require specific storage conditions and handling procedures. An important aspect of a storage and curation facility will be analogue samples. For practical reasons and sterility concerns it might be necessary for such a facility to have its own collection of analogue samples. Within the EURO-CARES project [1] that is aimed at creating a curation and analytical facility dedicated to extraterrestrial samples, we address objectives related to analogue samples in WP5. The major objectives of this study are 1) to evaluate specific storage conditions and handling procedures during curation and analysis of extraterrestrial materials, 2) to identify analogue samples crucial for evaluating and defining the protocols necessary to accomplish safe and sustainable handling of extra-terrestrial materials; 3) to create a list of different types of samples that would be required for a sample curation facility.

**Aspects and requirements for analogue samples:** In order to evaluate the objectives listed above, it is important to define the basic functions of a curation facility. We expect the facility to be used for receiving and opening of the returned sample canisters, as well as for handling and preparation of the returned samples. Furthermore it will provide some basic analysis of the returned samples, i.e. initial sample characterisation, and is expected to provide long-term storage of the returned samples. Each of these basic functions requires special equipment, e.g. for sample handling, manipulation, storage and analysis. Equipment, handling protocols and long-term storage conditions will strongly depend on the characteristics of the materials that may be returned. Therefore we need to consider what are the different types of relevant analogue samples, what is the nature of the materials, what analogues are needed for what purpose, what mass is needed, and how analogue samples will be stored within the facility.

*Types of analogue samples:* We distinguish five different types of analogue samples. Analogues are materials that have one or more physical or chemical properties similar to Earth-retured extraterrestrial samples. Reference samples are well characterised materials with known physical/chemical properties used for testing of the whole process or part of it. They

may not necessarily be the same materials as the analogues defined above. Standards are internationally recognised, homogeneous materials with known physical/chemical properties that are used for calibration. They can also be used as reference samples in certain circumstances. They may be made of natural materials but are often produced artificially. A voucher specimen is a duplicate of materials used at any stage during sample acquisition, storage, transport, treatment etc., e.g. space craft materials (including solar panels), lubricants, glues, gloves, saws, drills, and other, and stored for when needed. In addition, Earth landing site samples (from the touch down site) would be necessary in case of doubtful analysis even if normally this type of contamination is not expected (cf. Stardust). A witness plate is defined material left in an area where work is being done or assessed for e.g. biological, particulate, chemical, and/or organic contamination. It is a spatial and temporal document of what happens in the work area.

*The nature of analogue materials:* Analogue materials could be solids, including ices, liquids or gases. These could contain biological (extant and/or extinct) and/or organic components. They could be natural materials, e.g. rocks or minerals, or manufactured, such as mixtures of different components, that may be biologically and/or organically doped.

*What analogue samples for what purpose?* Analogues with appropriate sample size and nature, as well as physical/chemical properties will be suited best for testing and training of sample handling procedures, and transport protocols. Training of science and curation teams also requires reference samples and standards. Long-term storage needs special witness plates and voucher specimens. Developing and testing sample preparation protocols need all analogue sample types.

*Storage considerations:* How and where analogue samples are stored within the facility differs for restricted or unrestricted sample return. Furthermore contamination assessment, and control plans during all curation activities must be considered. We assume that analogues, reference, standard and voucher samples need to be kept temporally and/or spatially isolated from the extraterrestrial samples but easily accessible. Witness plates need to be close to returned extraterrestrial samples. All past plates should be stored separated from returned extraterrestrial samples.

**Natural and manufactured analogues necessary:**  
Based on this study a list of natural analogues considered a minimum to be available within the curation facility was put together. This list includes rocks and minerals but also gases and liquids. The latter two should be provided on demand if considered necessary.

Among the rocks listed are terrestrial igneous rocks (e.g., basalts, tuff), sedimentary rocks (e.g., carbonates), impact melt breccias, and meteorites, such as chondrites and achondrites. Minerals identified as necessary include major rock-forming minerals such as olivine and pyroxenes, metal (Fe-Ni alloys), magnetite, hematite, calcite, dolomite, gypsum, anhydrite, perchlorates, sulphides, smectites, serpentine, silica polymorphs and ices. Masses should be on the order of 1 kg for minerals and meteorites, and about 40 kg for terrestrial rocks.

Manufactured analogues are needed to simulate regolith and soil materials, various mixtures of soils (e.g.

with perchlorate, ice), icy/dusty mixtures, biological and organic doped samples.

**Spreadsheet:** Each proposed analogue contains specific information which will be provided in the form of an spreadsheet that was especially developed for this purpose (see fig. 1). It lists for the analogue: nature and provenance, a EURO-CARES code number, the target extraterrestrial body for which it is an analogue (specific mission, if relevant), the target body geological context, the curation facility storage, the analogue's state of matter, a general geological description of the target including petrography, mineralogy, chemistry, etc.; physical properties, including density, hardness/compressive strength, porosity, tenacity; cleavage, fracture, electrical properties, magnetic properties, thermal behaviour; health risks; location of the sample, if relevant; other information; associated data; history of the sample.

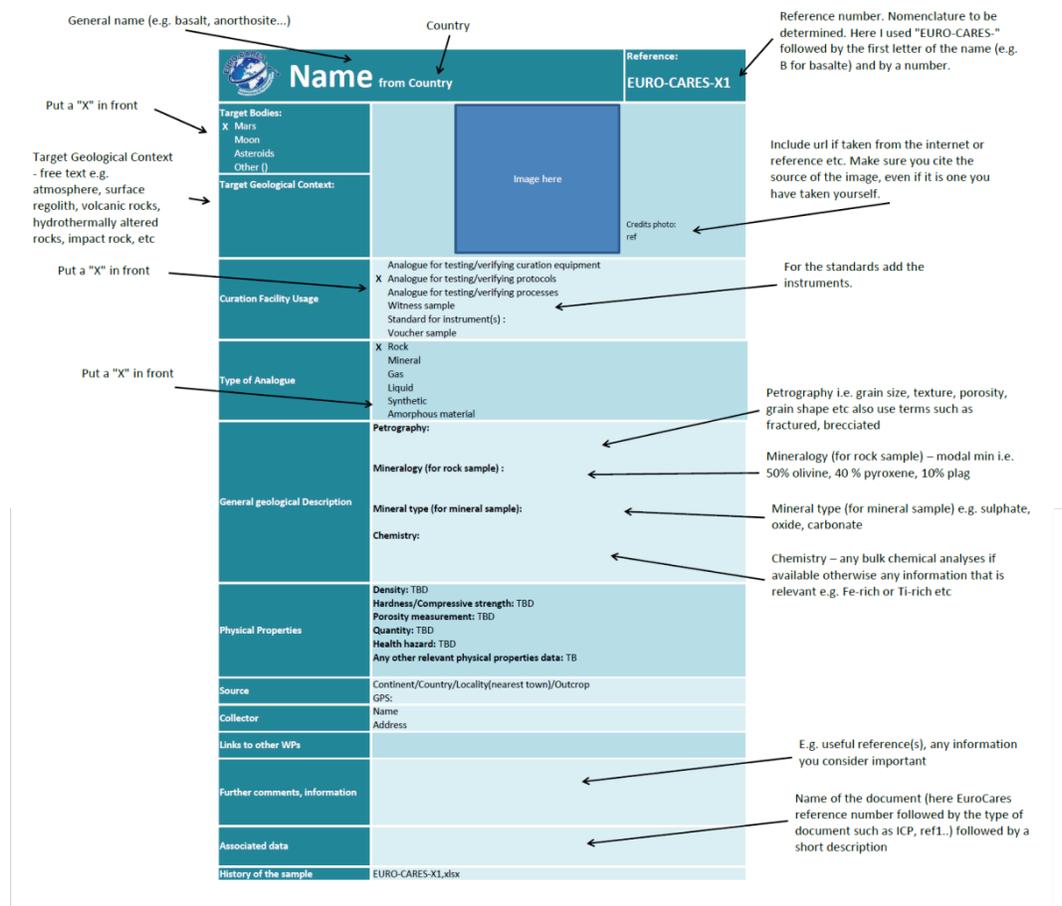


Fig. 1: Schematic of the spreadsheet providing detailed information for analogue samples proposed for a curation facility as developed in the EURO-CARES project.

**References**

[1] Hutzler A. et al. (2016) *LPS XLVII* #1937.