EURO-CARES

A PLAN FOR EUROPEAN CURATION OF RETURNED EXTRATERRESTRIAL MATERIALS

WORK PACKAGE 5

INTERIM REPORT ON ANALOGUE CHARACTERISTICS

NECESSARY FOR THE CURATORIAL FACILITY

(DELIVERABLE D5.1)

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D 5.3 Interim Report on list of abstracts of presentations at interternational conferences for WP5

Introduction

The aim of the EURO-CARES project is to create a curation and analytical facility dedicated to extra-terrestrial 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. These samples will require specific storage conditions and handling procedures. For practical reasons and sterility concerns it might be necessary for the curation and analytical facility to have its own collection of analogue samples.

Objectives

- to evaluate specific storage conditions and handling procedures during curation and analysis of extraterrestrial materials
- to identify analogue samples crucial for evaluating and defining the protocols necessary to accomplish safe and sustainable handling of extra-terrestrial materials.
- to create a list of different types of samples that would be required for a sample curation facility (analogues and standards)
- to create a preliminary list of analogue materials already available
- to complete these lists over the course of this project in response to the requirements established by the other work packages
- to include recommendations for the fabrication of new artificial analogues

WP5 Team Members:

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DELIVERABLE 5.3

List of abstracts for oral and poster presentations at international conferences, seminars

Seminars and conference presentations (copies of abstracts in Annex 1)

[1] Missions to Habitable Worlds, Budapest, Hongrie, 28-29 octobre 2015.
Analogues for Planetary Missions, F. Foucher, F. Westall, J. Zipfel & N. Bost,

[2] EURO-CARES WP3 workshop, Designing a European extraterrestrial sample curation facility. NHM Vienna, Austria, 14-15 April 2016
Storage and usage of analogue samples in an extraterrestrial sample curation facility, J. Zipfel[1], F. Westall[2], F. Foucher[2] and the EURO-CARES Consortium.

[3] EURO-CARES WP5 workshop, Francfort, Allemagne, 1 juin 2016.
Analogues for planetary missions: the engineer point of view, F. Foucher, F. Westall, J. Zipfel, N. Bost & the ISAR and Euro Cares team.

[4] European Astrobiology Network Association (EANA) Conference, Athens, Greece 27-29 September, 2016.
EURO-CARES: European Curation of Astromaterials Returned from Exploration of Space
Caroline Smith, Sara Russell, Frances Westall and the EURO-CARES team. Oral presentation given by F. Westall

[5] European Astrobiology Network Association (EANA) Conference, Athens, Greece 27-29 September, 2016.
Reflections on the definition of analogues and consequences for the EURO-CARES project, F. Westall, J. Zipfel, F. Foucher, J. Bridges, V. Debaille, L. Folco, J. Michalski, P. Woznikiewicz, J. Martines-Frias, K. Joy, M. Lee, J. R. Brucato, M. Viso, N. Bost, A. Hutzler, G. Kminek, H. Schroeven-Deceuninck, M. E. Zolensky, C. Smith, O. Bacon, M. Van Ginneken & L. Ferrière (ORAL)

[6] European Commission Earth Analogue Workshop, REA, Brussels, Belgium, **12/10/2016** Talk by Jutta Zipfel about analogues in EURO-CARES; presentations were distributed among attendees.

[7] EURO-CARES WP4 workshop, Paris, France, 13 octobre 2016
EURO-CARES WP5: Analogues and instrumentation, F. Westall, J. Zipfel, F. Foucher, J. Bridges, V. Debaille, L. Folco, J. Michalski, P. Woznikiewicz, J. Martines-Frias, K. Joy, M. Lee, J.R. Brucato, M. Viso, N. Bost, A. Hutzler, G. Kminek, H. Schroeven-Deceuninck, M. E. Zolensky, C. Smith, O. Bacon, M. Van Ginneken & L. Ferrière.

[8] Journées de la SFE, Lyon, France, 22-24 novembre 2016.
EURO-CARES: EUROpean Curation of Astromaterials Returned from Exploration of Space, The EUROCARES consortium, (Poster)

[9] 48th Lunar and Planetary Science Conf. The Woodlands, Tx, USA, p. 2674. submitted poster.2017.

Analogue samples in an European sample curation facility - the Euro-Cares project.
Zipfel J., Westall F. and Foucher F. and the EURO-CARES Consortium.

[10] AbSciCon, Phoenix, 24-28 April 2017
General reflections on the definition of analogues and consequences for the EURO-CARES project.
F. Foucher, F. Westall, J. Zipfel N. Bost and the EURO-CARES Team
Submitted abstract for oral presentation

[11] AbSciCon, Phoenix, 24-28 April 2017
Analogue samples in a European sample curation facility - the EURO-CARES project.
F. Westall1, J. Zipfel2, F. Foucher1 and the EURO-CARES Team
Submitted abstract for oral presentation

Annex 1. Copies of presentation abstracts

Abstract 1. Missions to Habitable Worlds, Budapest, Hungry, 2015.

Analogues for planetary missions

Frédéric Foucher, Frances Westall, Jutta Zipfel, Nicolas Bost et al.

Analogue sites and samples are used in space exploration for many purposes: to test space craft landing and rovers mobility, to test and calibrate instruments and sample preparation systems for *in situ* missions before launch, to help interpretation of data acquired during missions, and to carry out laboratory experiments. Analogue samples are complementary to the calibration samples used during instrument development, which are not necessarily relevant to the extra-terrestrial body being studied (such as a colour target used to calibrate a camera or a piece of silicon used to calibrate a Raman spectrometer, for example).

Most of the *in situ* investigations dedicated to astrobiology were, are and will be focused on solid materials, including rocks, soil, and ices. However, natural rocks can be very complex in composition and the potential traces of life they could contain may be very subtle and challenging to detect using *in situ* instrumentation. It is therefore crucial to cross-calibrate the payload of a mission before launch using analogue samples. Thus, we have developed a collection of analogue rocks, the International Space Analogues Rockstore (ISAR, www.isar.cnrs-orleans.fr) in Orléans (France) that can be used to test and calibrate space instruments. This collection was used to make a "Blind Test" consisting of analysis of two unknown samples using a part of the ExoMars payload, including the RLS instrument. Each instrumental analysis was presented to geologists having no prior knowledge of the rocks, who then proceeded to a geological interpretation. The geologists were able to make relatively detailed interpretations, demonstrating thus that the use of the complementary payload can compensate for the technical limitations of the instruments (compared to laboratory instruments).

Analogue samples will also be crucial to test and calibrate instruments for a future European curation facility under consideration in the framework of the EuroCares project. These samples will include minerals and rocks as well as chemical, biological and material samples.

Abstract 2. Designing a European extraterrestrial sample curation facility. Vienna, Austria, 2016

Storage and usage of analogue samples in an extraterrestrial sample curation facility

J. Zipfel[1], F. Westall[2], F. Foucher[2] and the EURO-CARES Consortium, [1]Senckenberg Forschungsinstitut und Naturmuseum, Senckenberganlage 25, 60325 Frankfurt am Main, Germany (jutta.zipfel@senckenberg.de), [2]CNRS - Centre de Biophysique Moléculaire, Rue Charles Sadron, 45071 Orléans Cedex 1,FRANCE.

One particular challenge concerns the handling of extraterrestrial materials returned to Earth in a curation facility. The facility needs to serve at least three major purposes: (1) initial inspection and characterisation of extraterrestrial materials, (2) preparation and allocation of samples for analysis in internal and external laboratories, and (3) long-term storage of such materials. Each of these points needs special equipment for sample handling, manipulation, analysis and storage. In addition, samples from planets or asteroids will need different kinds of treatment. Analogue samples are important for testing handling protocols and may be crucial in monitoring effects from long-term storage.

We are presently expanding the list of existing analogue samples, based on a review of the literature. The criteria for determining analogue rocks and minerals include characteristics, such as the kinds of physical and chemical properties expected for returned samples from potential target materials. The major focus here clearly lies on non-biological analogue samples.

While, so far, analogue samples are kept outside existing curation facilites, we follow the approach to keep them inside a curation facility for immediate accessibility and for long-term storage. In order to accommodate different returned sample materials, we are considering two distinct handling and storage areas within a curation facility. One "normal" non-sterile area for returned samples without restrictions for planetary protection, and a sterile area for samples returned from Mars that are restricted. Analogue sample collections would ideally be kept separately in both areas. The collection in the non-sterile area could be larger and a small collection of the most essential analogue types could be stored in the sterile area. In addition to the analogues used for testing handling procedures, we recommend keeping a pure, clean sample for monitoring purposes in these areas in order to evaluate any potential forward or cross contamination, e.g., of biological signatures.

The physical requirements on the curation facility for storage conditions of analogue samples are expected to be minimal. In the event of returned samples from Mars, a mirror sterile area that would allow testing protocols with biological analogues without compromising the returned samples should be considered.

Keywords: Sample analogues, planetary materials, storage and curation, handling protocols.

Abstract 3. EANA, Greece, 2016

EURO-CARES: European Curation of Astromaterials Returned from Exploration of Space

Caroline Smith[1], Sara Russell[1], Frances Westall[2] and the EURO-CARES team
[1]Natural History Museum, London, UK; [2]CNRS-Centre de Biophysique Moléculaire, Orléans, France

The objective of the H2020-funded EURO-CARES project is to create a roadmap for the implementation of a European Extra-terrestrial Sample Curation Facility (ESCF) that would be suitable for the curation of samples from all possible return missions likely over the next few decades, to the Moon, asteroids and Mars.

Study and long-term curation of extra-terrestrial samples imply keeping the samples as clean as possible from any possible contaminants, while ensuring they remain contained in case of biohazards. The requirements for a combined high containment and ultraclean facility will naturally lead to the development of a highly specialised and unique facility that will require the development of novel scientific and engineering techniques.

EURO-CARES team work is organized around five distinct technical Work Packages (WP), led by institutions and scientists and engineers from all over Europe. These cover aspects including:

- Planetary Protection to devise an effective, legally compliant and realistic, programme while minimising risk to current scientific study and optimising access to researchers for future studies;
- Facilities and Infrastructure to define the state of the art facilities required to receive, contain and curate extra-terrestrial samples and guarantee terrestrial planetary protection;
- Instruments and Methods to determine which analyses should be performed within the ESCF while ensuring minimal contamination and minimal damage to the sample;
- Analogue Samples to determine which analogue proxies are necessary in a curatorial facility for testing sample handling, storage and preparation techniques;
- Portable Receiving Technologies to propose methods for the recovery and transport of samples from the landing site to the permanent curatorial facility.

Along with the scientific and technical requirements, the EURO-CARES project is also focussed on a high impact public engagement plan that engages children, university students, the general public and policy makers, as well as our academic and industrial peers. A significant risk to the development of an ESCF is the public perception of extra-terrestrial samples, potentially containing biological entities, being deliberately returned to Earth without going through the "sterilising" process of exposure to cosmic-rays and space environment. This could be of great concern to many people and could lead to major delays in the establishment of an ESCF. Hence, open communication is of great importance.

The planning of the facility design needs to start as early as possible (i.e., several years before the planned return sample date), ideally to finish the construction and interior design of the building at least one or two years before any sample return, to have enough time to properly test the facility on analogue samples and to train a dedicated team. Such a facility will have to preserve (and protect) samples for decades of research to be carried out on them, so its lifespan must be sufficient enough.

Abstract 4. EANA, Greece, 2016

Reflections on the definition of analogues and consequences for the EURO-CARES project

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Most astrobiological investigations have been, and will be focused on solid materials, including rocks, soil, and ices. However, natural materials can be very complex in composition and the potential traces of life and/or molecules of astrobiological interest they could contain may be very subtle and challenging to detect. Hence, the importance of prior preparation of the missions using analogues. Analogues are terrestrial sites or samples having properties more or less similar than those expected on a given extraterrestrial body. There is a huge variety of analogues on Earth that can be used for many purposes: to test space craft landing and rover mobility, to test and calibrate instruments and sample preparation systems for *in situ* missions before launch, to help interpretation of data acquired during missions, and to carry out laboratory experiments. Analogue samples include minerals and rocks, as well as chemical, biological and material samples.

Analogue samples will also be crucial to test and calibrate instruments for a future European curation facility under consideration in the framework of the EURO-CARES project (Fig. 1), funded under the European Commission's Horizon2020 research programme. More information about the project can be found on the website: www.euro-cares.eu. The EURO-CARES WP5 lead by Frances Westall and Jutta Zipfel is dedicated to analogues, in particular the different kinds of samples needed in such a facility, including rock, mineral, iceanalogues, analogues for calibration and reference, as well as witness and voucher samples.

Fig. 1. Logo of the EURO-CARES project.

Here, we will present the different types of samples and their use. The relevance of the different types of analogues will also be discussed.

Abstract 5. LPCE, The Woodlands, 2017

ANALOGUE SAMPLES IN AN EUROPEAN SAMPLE CURATION FACILITY - THE EURO-CARES PROJECT. J. Zipfel[1], F. Westall[2], F. Foucher[2] and the EURO-CARES Consortium, [1]Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganalage 25, 60325 Frankfurt am Main, Germany, jzipfel@senckenberg.de, [2]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 an 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 anologue samples. Analogues are materials that have one or more physical or chemical properties similar to Earth-returened 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 exinct) and/or organic componends. 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 specimes. 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 returened 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.

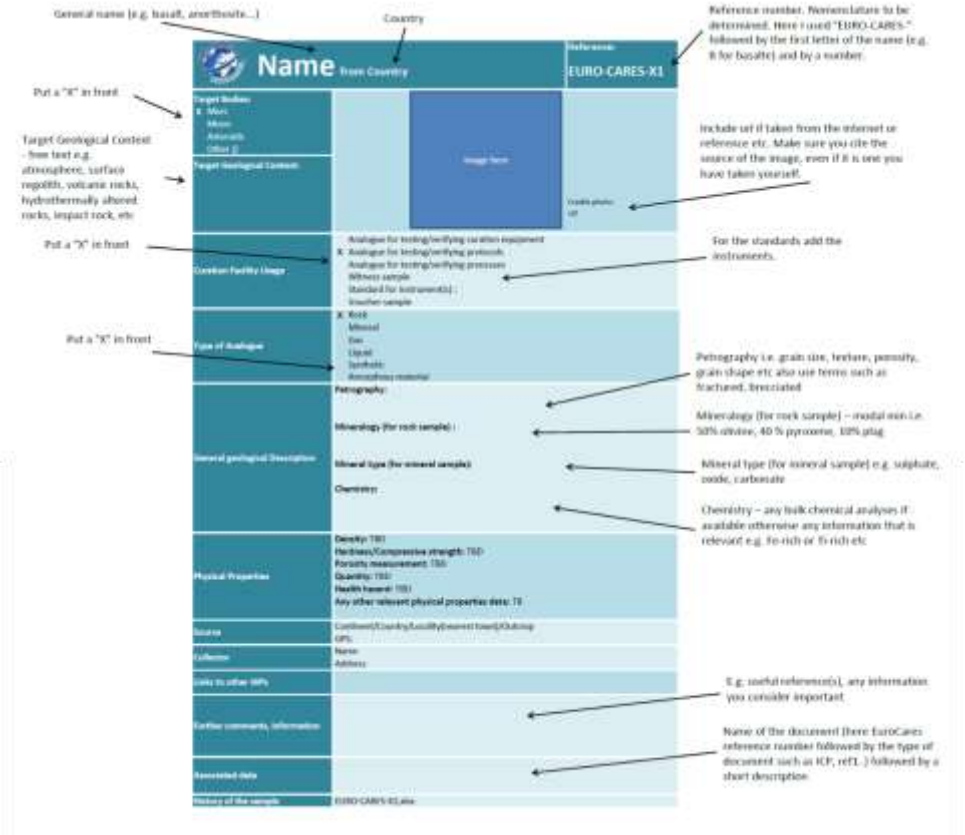

Fig. 1: Schematic of the spreadsheet providing detailed information for analogue samples proposed for a curation facility as developed in the EURO-CARES project.

References

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

Abstract 6. Journées de la SFE, Lyon, France, 2016

EURO-CARES

SMITH Caroline[1] et le Consortium EURO-CARES
(projet présenté aux journées de la SFE par FOUCHER Frédéric[2])

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Les contraintes inhérentes à l'exploration spatiale *in situ* limitent énormément les instruments en termes de masse, de consommation électrique ou de volume de données. Pour réaliser des analyses fines, il est donc souhaitable de rapporter des échantillons sur Terre comme ce fut le cas avec les missions Apollo, Luna, Stardust et Hayabusa. Excepté pour les roches lunaires, les quantités transportées sont généralement petites. Ainsi, le projet commun à la NASA et à l'ESA de Mars Sample Return ne prévoit le retour que d'un peu plus de 500 g d'échantillons martien à l'horizon 2025-2030. Cette rareté rend les roches spatiales particulièrement précieuses. De plus, elles nécessitent des conditions de stockage particulières afin d'éviter toute contamination, dans un sens comme dans l'autre. De telles infrastructures de curation, c'est-à-dire de stockage et d'analyse, ont ainsi été créées aux États-Unis pour les missions Stardust et Apollo, et au Japon pour la mission Hayabusa. L'Europe ne disposant pas encore de ce type d'infrastructures, le projet EURO-CARES, pour *European Curation of Astromaterials Returned from Exploration of Space*, a pour objectif de réfléchir à la création d'un centre européen de curation d'échantillons extraterrestres.

Le projet EURO-CARES est financé par le programme de recherche et d'innovation Horizon 2020 de l'Union Européenne. Il est coordonné par Sara Russell et Caroline Smith du Muséum d'Histoire Naturelle de Londres et implique des chercheurs et ingénieurs européens issus de 14 institutions différentes et de formations différentes (géologues, biologistes, physiciens, chimistes, etc).

Si Mars est certainement le corps du système solaire dont le retour d'échantillon est le plus pertinent, c'est aussi celui qui nécessite un centre de curation le plus exigeant en terme de conditions de stockage et de techniques d'analyse. A l'heure actuelle, il n'existe pas dans le monde de centre de curation répondant au cahier des charges imposé par des échantillons qui seraient rapportés de Mars. EURO-CARES s'intéresse donc particulièrement à cette éventualité.

EURO-CARES est scindé en groupes de travail, ou *work packages* (WP), chacun dédié à un aspect particulier de l'étude : protection planétaire, architecture du bâtiment et des infrastructures, méthodes et instruments, analogues utiles pour les tests, technologies de stockage et de transport des échantillons, préparation et gestion du projet, et communication (auprès du grand public notamment).

Pour plus d'information et pour suivre les avancés des travaux, le projet dispose d'un site internet (http://www.euro-cares.eu/), d'une page Facebook (EuroCares) et d'un compte Tweeter (@EuroCares).

Abstract 7. AbSciCon, Phoenix 2017

ANALOGUE SAMPLES IN A EUROPEAN SAMPLE CURATION FACILITY - THE EURO-CARES PROJECT. F. Westall[1], J. Zipfel[2], F. Foucher[1] and the EURO-CARES Team, [1]Centre de Biophysique Moléculaire, CNRS, rue Charles Sadron, 45071 Orleans, France, frances.westall@cnrs.fr, [2]Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganalage 25, 60325 Frankfurt am Main, Germany.

Introduction: The objective of the H2020-funded EURO-CARES project is to create a roadmap for the implementation of a European Extra-terrestrial Sample Curation Facility (ESCF) that would be suitable for the curation of samples from all possible return missions likely over the next few decades, *i.e.* from the Moon, asteroids and Mars.

www.euro-cares.eu

The return of extraterrestrial samples brought to Earth will require specific storage conditions and handling procedures, in particular for those coming from Mars. For practical reasons and sterility concerns it might be necessary for such a facility to have its own collection of analogue samples permitting the testing of storage conditions, and to develop protocols for sample prepartion and analyses. Within the framework of the EURO-CARES project, we have created a list of the different types of samples that would be relevant for such a curation facility.

Function of the curation facility and requirements for analogue samples: The facility will 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 analyses 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. Equipment, handling protocols and long-term storage conditions will strongly depend on the characteristics of the materials, and on whether returned samples are from the Moon, Mars or an asteroidal body. For this reason, different types of analogue samples need to be considered, *i.e.* the nature of the materials, which analogues are needed for what purpose, what mass is needed, and how the analogue samples are to be stored within the facility.

Types of analogue samples: We distinguish five different types of anologue samples, namely analogue, witness plate, voucher specimen, reference sample, and standard. Analogues are materials that have one or more physical or chemical properties similar to the Earth-returned extraterrestrial samples. Reference samples are well-characterised materials with known physical and chemical properties used for testing and may not necessarily be the same materials as the analogues defined above. Standards are internationally recognised, homogeneous materials with known physical and 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. spacecraft materials (including solar panels), lubricants, glues, gloves, saws, drills, and others. 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. Finally, a witness plate is defined as material left in an area where work is being done to detect any 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 exinct) and/or organic components. They could be natural materials, e.g. rocks or minerals, or could be manufactured, such as mixtures of different components, which may be biologically and/or organically doped. Analogues of appropriate sample size and nature will be well-suited for testing and training of sample handling procedures, and for transport protocols. The training of science and curation teams also requires reference samples and standards. Long-term storage needs special witness plates and voucher specimes. Developing and testing sample preparation protocols needs all sample types.

Ackowledgements: EuroCares is funded by H2020 grant number 640190.

Abstract 8. AbSciCon, Phoenix 2017

GENERAL REFLECTIONS ON THE DEFINITION OF ANALOGUES AND CONSEQUENCES FOR THE EURO-CARES PROJECT. F. Foucher[1], F. Westall[1], J. Zipfel[2], N. Bost[1] and the EURO-CARES Team, [1]Centre de Biophysique Moléculaire, CNRS, rue Charles Sadron, 45071 Orleans, France, frederic.foucher@cnrs.fr, [2]Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganalage 25, 60325 Frankfurt am Main, Germany.

Introduction: Most astrobiological investigations have been, are, and will be, focussed on solid materials including rocks, soil, and ices. However, natural materials can be very complex in composition, and the potential traces of life and/or molecules of astrobiological interest that they could contain may be very subtle and challenging to detect; hence, the importance of prior preparation for the missions using analogues. Analogues are terrestrial sites or samples having properties more or less similar than those expected on a given extraterrestrial body. There is a huge variety of analogues on Earth that can be used for many purposes: to test spacecraft landing and rover mobility, to test and calibrate instruments and sample preparation systems for *in situ* missions before launch, to help interpretation of data acquired during missions, and to carry out laboratory experiments. Analogue samples include minerals and rocks, as well as chemical, biological and material samples.

On the use of analogues: It is crucial to cross-calibrate the payload of a mission before launch using analogue samples. Thus, we have developed a collection of analogue rocks, the *International Space Analogues Rockstore* (ISAR, www.isar.cnrs-orleans.fr) in Orléans (France) that can be used to test and calibrate space instruments[1]. This collection was used to make a "blind test" consisting of analyses of two unknown samples using a part of the ExoMars 2020 payload[2]. Each instrumental analysis was presented to geologists having no prior knowledge of the rocks, who then proceeded to develop a geological interpretation. The geologists were able to make relatively detailed interpretations, thus demonstrating that the use of the complementary payload can compensate for the technical limitations of the instruments (when compared with laboratory instruments).

On the limit of analogues: The term analogue may be confusing when applied to astrobiology. Indeed, if a basalt can be considered as an analogue of Martian rocks (since basalts have been found on Mars), considering terrestrial extremophiles as analogues of Martian life is less obvious, simply because life has never been found on Mars. These analogues may thus be deemed putative analogues to be used for scientific purposes more than for instrument testing.

Moreover, depending on the precision needed and on their specific use, the degree of analogy of sites or samples may be more or less important. For instance, if the aim is to test rover mobility, the composition of the soil is not relevant and only its mechanical properties are pertinent. It is thus possible to classify the analogues into different categories.

Analogues and other samples for the EURO-CARES project: Analogue samples are complementary to other samples used during instrument development, which are not necessarily relevant to the extraterrestrial body being studied (such as a colour target used to calibrate a camera or a piece of silicon used to calibrate a Raman spectrometer, for example).

The objective of the H2020-funded EURO-CARES project is to create a roadmap for the implementation of a European Extraterrestrial Sample Curation Facility (ESCF) that would be suitable for the curation of samples from all possible return missions likely over the next few decades, *i.e.* from the Moon, asteroids and Mars. The EURO-CARES Work Package n°5, led by Frances Westall and Jutta Zipfel, is dedicated to the different kinds of samples needed in such a facility, including analogues *sensu stricto* as well as calibration, reference, witness and voucher samples and standards. More information about the project can be found on the website: www.euro-cares.eu.

References: [1] Bost *et al.*, (2013) *Planetary and Space Science* **82-83**, 113-127 [2] Bost *et al.*, (2015) *Planetary and Space Science* **108**, 87-97.