EURO-CARES: PROJECT ROADMAP OF A EUROPEAN SAMPLE CURATION FACILITY. A. Hutzler[1], L. Ferrière[1], C. L. Smith[2], S. Russell[2], J. Aléon[3], L. Berthoud[4], J. R. Brucato[5], M. Gounelle[3], M. Grady[6], A. Meneghin[5], F. Westall[7], and the EURO-CARES Consortium, [1]Natural History Museum, Burgring 7, A-1010 Vienna, Austria (aurore.hutzler@nhm-wien.ac.at), [2]The Natural History Museum, Cromwell Road, London, SW7 5BD, UK, [3]Museum National d'Histoire Naturelle, 57 rue Cuvier, 75005 Paris, France, [4]TAS UK, Coldharbour Lane, Bristol, BS16 1EJ, UK, [5]INAF – Astrophysical Observatory of Arcetri, Firenze, Italy, [6]The Open University, Milton Keynes, MK7 6AA, UK, [7]CNRS-CBM, rue C. Sadron, 45071 Orléans, France.

Introduction: EURO-CARES (European Curation of Astromaterials Returned from Exploration of Space) is a three year, multinational project, funded under the European Commission's Horizon2020 research programme to create a roadmap for the implementation of a European Extra-terrestrial Sample Curation Facility (ESCF). Such an ESCF would be designed to receive and curate samples returned from Solar System exploration missions to asteroids, Mars, the Moon, and comets. So far, there are only two facilities of this type: the NASA Johnson Space Centre in Houston (USA) and the JAXA Hayabusa curation facility in Sagamihara (Japan). However, these two facilities do not meet all requirements for sample return missions from Mars. Previous studies of an ESCF have either been country-specific (e.g., [1]) or mission/target specific (e.g., for Marco Polo-R [2]).

With the EURO-CARES project we propose to move onwards from these specific studies, using experience accumulated at NASA, JAXA, and in various laboratories and museums curating meteorites, in combination with expertise from biosafety laboratories, cleanroom manufacturers, electronics and pharmaceutical companies, nuclear industry, etc. Study and long-term curation of extra-terrestrial samples requires that the samples are kept as clean as possible to minimize the risk of detrimental contaminants, at the same time ensuring that Martian samples 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 specialized and unique facility that will require the development of novel scientific and engineering techniques. We report here on a description of the organization of the project and summarize what we have learnt so far from an extensive literature review and visits to facilities and laboratories.

The project: EURO-CARES team work is organized around five technical Work Packages (WP), led by scientists and engineers from competitive institutions from all over Europe. Along with the scientific and technical requirements, the EURO-CARES project is also focused on a high impact public engagement plan [3].

WP2* – *Planetary Protection: Planetary protection requirements and implementation approaches are determined by the best multidisciplinary scientific advice according to international policy [4] and recent recommendations from the European Science Foundation [5]. A plan for terrestrial planetary protection will be devised: it has to be effective, legally compliant, and realistic, at the same time as minimizing risk to current scientific study and optimizing access to researchers for future studies.

The first step of a biohazard assessment protocol is to select a representative portion of the returned samples for life and biohazard detection. Prior to such a time as samples being deemed safe for release, samples leaving the facility will almost certainly require sterilization. The existing sterilization methods and techniques will be reviewed under the new discoveries of phenomena associated with terrestrial microbial extremophiles, which could survive in a Martian environment.

WP3* – *Facilities and Infrastructure: The objective of this work package is to define the state of the art facilities required to receive, contain, and curate extra-terrestrial samples and guarantee terrestrial planetary protection. All the aspects, from the building design to the storage of the samples as well as curation are covered by this work package. The facility should be composed of at least: a receiving laboratory, a cleaning and opening laboratory, a bio-assessment laboratory, a curation laboratory, and a storage room. The facility will have to be easily adaptable.

Storage of the samples: Long-term curation of samples is challenging, especially because their pristine nature should be preserved as far as possible knowing that, in case of potentially biohazardous samples, specific planetary protection analyses will have to be undertaken. The facility will have to operate at controlled pressure, temperature, and atmospheric environment, depending on the samples requirements. Contamination should also be monitored with specific witness materials to be already placed inside the sample container on the spacecraft.

Curation: It mainly consists in the handling, documentation, preparation, preservation, and allocation of samples for research. Different documentation, handling, and preparation technologies have been designed, developed, and tested in the last decades but some issues still remain to be further investigated; a specific challenge being the manipulation and documentation of small samples (micrometer-sized).

Example of the lunar sample curation laboratory at the JSC (Houston, Texas, USA).

WP4** – **Instruments and Methods: The objective of this work package is to determine the methodology of characterization of returned samples and the instrument base required at the ESCF. The analyses should provide an appropriate level of characterization while ensuring minimal contamination and minimal alteration of the sample. Instrumentation will also be required to monitor contamination levels within the facility. The space limitation inside the facility, the cost of some instruments, and the specificity of some techniques of investigations will have to be considered and necessary measures taken to ensure rapid dissemination of samples to selected researchers. This WP needs the input of various fields of research to ensure that the major science questions can be addressed. Importantly, it will be necessary to follow and anticipate technical developments since samples will not be returned for years to come.

WP5** – **Analogue Samples: Analogue proxies are necessary in a curatorial facility for testing sample handling, preparation techniques, storage conditions, planetary protection measures as well as to validate new analytical methods. For practical reasons, it may be necessary for the curation and analytical facility to have its own collection of analogue samples. The selection of analogues will be constantly evolving to take into account the rapid changes in the understanding of different Solar System bodies that result from current and future space missions e.g., Curiosity, Hayabusa 2 and OSIRIS-REx.

WP6** – **Portable Receiving Technologies: The objective of this work package is to propose methods for the recovery and transport of samples from the landing site to the ESCF. The Earth re-entry capsule from a sample return mission is targeted at a specific landing ellipse on Earth, possibly at considerable distance from the ESCF. Once the capsule has landed, an assessment of the state of the spacecraft will lead to a recommended recovery procedure. A portable receiving facility may be used to inspect, document, and package the sample container(s). It will then be transported to the ESCF using a safe and secure method. In addition, methods for the transport of samples from the facility to the outside institutions will be studied, to ensure security and non-contamination of the samples.

Plans and pending issues: Each WP will be hosting an international meeting in 2016, with experts from all over the world, in respect to gather additional information and to discuss issues; More information is available on the project website: www.euro-cares.eu.

Some major issues identified during our literature review are still pending and will be addressed in the next steps of the project, such as: should the samples be manipulated by humans and/or robots? Should it be an independent structure, or be part of an existing facility (such as a Biosafety Level 4 (BSL-4) facility, a University, etc.)? What administrative protocols will be required given that several (space) agencies and countries will have to collaborate to build and to maintain it? What storage environment should be chosen (P, T, and specific atmosphere composition)? Which experiments should be conducted inside the facility, and in which order? What sterilization protocol should be used, if any? What kind of database system will allow the team and the scientific community to record everything happening to the samples?

Concluding remarks: The experience from past sample return missions and existing facilities is invaluable in addressing the future challenges of planning and building such an ESCF, but scientific and political developments should also be taken into account.

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