EURO-CARES (EUROPEAN CURATION OF ASTROMATERIALS RETURNED FROM EXPLORATION OF SPACE): AN UPDATE. S. S. Russell[1], C. L. Smith[1], A. Hutzler[2], A. Meneghin[3], J. R. Brucato[3], P. Rettberg[4], L. Ferrière[2], A. Bennett[5], Aléon[6], M. Gounelle[6], I. A. Franchi[7], F. Westall[8], F. Foucher[8], J. Zipfel[9], L. Berthoud[10], J. Vrublevskis[10], M. Grady[7], and the EURO-CARES Consortium. [1]Department of Earth Sciences, The Natural History Museum, Cromwell Road, London, SW7 5BD, UK, [2]Natural History Museum, Burgring 7, A-1010 Vienna, Austria, [3]INAF Astrophysical Observatory of Arcetri, Firenze, Italy, [4]DLR, Deutsches Zentrum für Luft - und Raumfahrt, Cologne, Germany, [5] Public Health England, Soulsbury, UK, [6]Museum National d'Histoire Naturelle, 57 rue Cuvier, 75005 Paris, France, [7]The Open University, Milton Keynes, MK7 6AA, UK, [8]CNRS-CBM, rue C. Sadron, 45071 Orléans, France, [9]Senckenberg Gesellschaft für Naturforschung, Frankfurt, Germany, [10]TAS UK, Coldharbour Lane, Bristol, BS16 1EJ, UK
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Introduction: EURO-CARES is a project to roadmap a European Sample Curation Facility (ESCF) for sample return mission material from Mars, Moon, and asteroids. It was funded by the EC H2020 COMPET program and runs from January 2015 to December 2017. While there have already been projects to investigate the curation of extraterrestrial sample return material in Europe, EURO-CARES is unique in being neither country-specific or mission-specific. While there have already been sample returns from asteroids and the Moon which we can learn from, a sample return mission to Mars requires new curation protocols, especially since such samples will have a planetary protection constraints.

This is an update from the report of last year [1] of the EURO-CARES project. During 2016 we held a series of workshops to engage the community and stakeholders from research and industry. We have invited key participants from NASA and JAXA and also a number of experts from the industry to share their experience. Here is a summary of the current status of the project, organised by the workpackages of the project: Planetary Protection, Facilities and Infrastructure, Instruments and Methods, Analogue Samples, Portable Receiving Technologies and Maximising Impact.

Planetary Protection:

For restricted samples that are a potential biohazard – e.g. Mars sample return, the protection of people and the environment is paramount. Lessons can be learnt from biohazard laboratories used for containment and analysis of terrestrial pathogens (BSL-4 labs). These facilities can be operated safely, and operator error is the main cause of contamination. The operations to take place in the facility will need to feed in to the planetary protection team in order to design a facility that meets both the sample curation requirements and the planetary protection requirements.

Facilities and Infrastructure:

This workpackage considers all the aspects of the building design, storage of the samples, and curation. A list of the different identified units and subunits of the facility was established and then several different possible scenarios for the building of the ESCF were envisioned to test the modularity of the facility. Importantly is that it is not mandatory to build all units at the same time, knowing that they should be designed to be structurally independent. This non exhaustive list of scenarios, includes, an "integrated approach" (with all units built on the same site, but not necessarily at the same time), a "restricted vs. unrestricted" scenario (with potentially biohazardous samples and non-biohazardous samples treated separately, i.e., with SRF/SCF built on different sites), a "distributed approach" (with all functions, receiving and curation, scattered in different locations), etc.

In 2016 we also continued our visits of divers facilities and meetings with experts from different fields. An architecture *Design Studio*, in collaboration with the Vienna University of Technology, took place during teh first semester of 2016. Eighteen students attended the studio and produced whole concepts of the ESCF. The results of this exercise were published in a booklet [2].

Instruments and Methods: The instrumentation required is the minimum necessary in order to:

(a) properly characterise a sample. This covers a wide range of measurements; from photo- documentation of the samples primarily for identification purposes and detailed records of the samples sent out, to preliminary determination of the structure, mineralogy and organic inventory of the samples. More detailed characterization would be expected to be an activity undertaken by the scientific experts on allocated samples. All characterization activities in the curation facility should be conducted with little, or no, impact on the physical and chemical nature of the sample in order to preserve it for scientific research and storage.

(b) Sample selection and quality control on sample preparation. This task involves the identification and verification of the most appropriate samples to meet the requirements of approved sample requests, and if necessary, specific sample preparation (e.g. polished sections) for use by external scientists.

(c) Monitoring of clean room operations. This will include analyzing witness plates and test samples regularly in order to measure contamination, and to ensure and that cleaning and handling procedures are meeting specification.

We have discussed the relative models of roles of for the preliminary examination teams. A model involving many external teams seems likely to be the most appropriate for the ESCF.

Analogue Samples:

Analogue materials will be required in the ESCF for several tasks:

- To test transport protocols for movement of the returned samples within the facility and for shipment out of it. It will be necessary to practice with empty containers and appropriate analogue samples (cores, fragments, dust) (sample size and nature are important). In this case, analogue samples exhibiting different physico-chemical-technical etc. properties will be necessary.

- To establish sample preparation protocols, for example, sectioning, powdering, splitting, chemical/heat extraction, and imaging (optical-SEM EDS). Analogue types exhibiting appropriate physical/chemical properties will be appropriate.

- To train science and curation teams and perform science lab quality assessment, i.e. making sure that the external laboratory facility can handle/analyse the returned samples. ISAS/JAXA made a blind test of laboratories interested in analysing the Hyabusa 1 samples (Kushiro et al., 2003). Such activities would use reference analogue materials.

- Long-term storage needs to be tested using witness plates, hardware samples, voucher specimen and reference materials (including frozen materials).

We anticipate the ESCF will require approximately 40kg of terrestrial rocks, ~40 kg of terrestrial analogues (rocks), ~1 kg separated minerals and ~1 kg meteorites.

Portable Receiving Technologies:

We have considered the design of the Earth Return Capsule (ERC). It will be designed to survive in the case of a hard landing, and therefore will withstand considerable force without breakage. To minimise the risk of sample loss, this will be a multi-layered structure. This is especially important for restricted samples with a planetary protection requirement. We are considering the actions to be taken in the case of non-nominal landing of a restricted sample, and the protocols to be followed will depend on whether particles of returned sample are released in the atmosphere or on the ground.

Maximising Impact: Public engagement is essential to allow us to communicate with the various scientists engineers and decision makers who will contribute to the curation facility, as well as engaging children and adults to inspire and reassure them about the importance of sample return science. Public engagement will inevitably an essential part of the curatorial facility once it is built. We have produced educational materials and a MOOC (massive online course) associated with the project.

Future Plans:

We will assimilate the information we have gathered into a final document of our findings and conclusions. Our work over the next months will culminate in a workshop in July 2017, to be held in Florence, Italy. More details of our project can be found on our website:

www.euro-cares.eu

At the end of the project, members of the team will work together to engage stakeholders in such a way as to ensure the curation facility to be built in preparation for sample return missions with European involvement.

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