The European Space Analogue Rock Collection (ESAR) at the OSUC-Orleans for in situ planetary missions

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Abstract

The ESAR is a collection of well-characterised planetary analogue rocks and minerals that can be used for testing *in situ* instrumentation for planetary exploration. An online database of all relevant structural, compositional and geotechnics information is also available to the instrument teams and to aid data interpretation during missions.

1. Introduction

A number of *in situ* space missions are being planned and implemented in the near to medium term future. Mars is the immediate goal for MSL-2011 and the new international mission ExoMars-C-2018. The mission Phobos-Grunt-2011 will land on Mars' moon Phobos. For this reason the initial rock and mineral analogues in the ESAR collection are those of direct relevance for Mars missions. The lithothéque will be enlargened in the future to include other types of materials (e.g. lunar, asteroids). For maximum science return, all instruments on a single mission should ideally be tested with the same suite of relevant analogue materials. The ESAR lithothéque in Orléans aims to fulfil this role by providing suitable materials to instrument teams [1, 2, 3]. The lithothéque is accompanied by an online database of all relevant structural, textural, geochemical and geotechnics data (www.esar.cnrs-orleans.fr; at present under construction). The data base will also be available during missions to aid interpretation of data obtained *in situ*.

2. Materials and methods

The preliminary group of samples covers a range of lithologies found on Mars [4, 5], especially those in Noachain/Hesperian terrains where the 2018 landing site will most likely be located. It includes a variety of basalts (plus cumulates) since rocks of basaltic lithology predominate on Mars; artificially-synthesised martian basalts; volcanic sands deposited in shallow-water environments similar to what could be expected from aqueously eroded volcanic materials on Mars; a banded iron formation (not yet discovered on Mars but may be present in Noachain age basinal deposits); carbonates associated with volcanic lithologies and hydrothermalism; and the clay, nontronite as an example of aqueous alteration of basalts. The basalts include an ultramafic tephritic basalt from Svalbard (Norway) containing dunite xenoliths and hydrothermal carbonate deposits and exhalites, the latter similar to those observed in the Martian meteorite ALH84001 [6, 7]; a primitive basalt from Etna (Italy), an altered, silicified basalt from Barberton (N.B. purported traces of microbial borings have been found on the surfaces of pillow basalts from Barberton [8]), and an altered, silicified komatiite (∼18% Mg) from Barberton. The Barberton volcanics were aqueously-altered and silicified by hydrothermal processes/Si-rich seawater. Although the terrestrial basalts have lower Fe contents than martian volcanics, in terms of total alkalis-silica they are compositionally similar to rocks analysed by the MERs [2]. However, because of the compositional difference between terrestrial and martian basalts, we have also prepared synthetic martian basalts with a generalised composition based on data from Gusev Crater [2, 5]. The shallow water volcanic sands are of particular relevance to astrobiology on Mars because they were deposited in an environment similar to that of Noachian Mars, and in a time period overlapping with the period in which life could have existed at the surface of Mars [9]. The samples include a ∼3.5 Ga-old volcanic sand from the Pilbara, Australia, deposited in a mudflat environment, and ∼3.3 Ga-old volcanic sands from Barberton, South Africa, deposited in a shallow waterlittoral environment. Contemporaneous hydrothermal activity strongly influenced the environment and the silicification of the sediments, including the associated microorganisms. The carbonaceous remains of chemolithotrophic colonies of microorganisms (and some photosynthetic microbial mats) are present in these sediments. The fossil microorganisms are too small to be observed *in situ* on Mars but the associated organics could be detected [9, 10]. Minerals in the collection include siderite, antigorite, carbonates associated with the Svarlbard basalt as hydrothermal exhalations,and the clay nontronite, as a typical weathering product of basalt. We use laboratory-synthesised nontronite [11]. The samples were analysed by standard field and laboratory techniques either as a whole rock sample, a thin section, or a powder. In the database, this information will be complimented by analyses made with the mission instruments, as received. Structural and textural information was provided by visual field and hand specimen observation to simulate Pancam, HR camera, and close up imager observations. Optical and electron microscopy of thin sections and etched rock surfaces was also undertaken. Mineralogical analyses (spot and mapping) were made on rock surfaces, thin sections and powdered sample, depending on instrument type to simulate XRD, IR, Raman, and Mössbauer analyses. The samples were also studied with a cathodoluminescence detector that can be developed for *in situ* space exploration. Elemental analyses of powdered samples was made by ICP-OES. All field, textural and compositional data are being collated in an online database (www.esar.cnrs-orleans.fr) that will be available to the scientists and instrumentalists associated with the mission.

3. Summary and Conclusions

A preliminary range of Mars analogue rocks and minerals, the Orléans-OSUC ESAR collection, is now available to the scientific community for instrument testing. Organics analyses of some of the samples still need to be completed and more rocks and minerals are being added continually to the collection. All data on the ESAR database will be available to scientists and instrumentalists working on the missions. The database will be linked to other databases and will thus provide access to a broad range of data relating to Mars analogue materials.

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