MARS EXOBIOLOGY MISSION 2018 (MAX-C/EXOMARS) AND THE MARS ANALOGUE ROCK COLLECTION AT THE OSUC, ORLEANS. F. Westall[1], D. Pullan, N. Bost[1,2], C. Ramboz[2], F. Foucher[1], and the Mars-analogue rock collection team*.
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Introduction: ExoMars, the European exobiology mission to Mars in the new configuration is combined with the American Max-C rover in a joint, two rover mission to Mars in 2018 [1]. The science objectives of ExoMars are to search for traces of past or present life and to document the water/geochemical environment as a function of depth in the shallow subsurface. Max-C seeks to determine the habitability of the surface of Mars with the aim of selecting and caching rocks potentially containing traces of life for the future Mars Sample Return mission. The ExoMars rover will embark a number of scientific instruments to investigate rock outcrops and subsurface materials: cameras and a close up imager for observation, Raman, IR spectrometry and XRD for mineralogy, and GCMS and LDMS for chemical characterisation of the organics. A drill will provide subsurface access to (hopefully) preserved organics. Max-C will comprise a suite of arm-based tools for observation and mineralogical/elemental mapping of surface materials. These instruments suites on the two rovers will be complementary. In order to optimize the science return of the instruments, it will be necessary to test flight instrumentation with the same suite of Mars-analogue rocks and minerals. With this objective in mind, a collection of rocks that have been fully characterised by standard laboratory instrumentation is being prepared by the Observatoire de l'Univers de la region Centre (OSUC) in Orléans [2-4]. The ultimate goal is to offer the scientific community a suite of relevant Mars analogue rocks and minerals coupled to a an online database comprising the maximum information on materials that are analogues of Mars (and other planetary bodies), including relevant information on materials not present in the OSUC collection. The data base will contain both reference (lab) data and results from analyses using the planetary instruments or models. Here we present a preliminary selection of samples for testing instruments for the 2018 mission. Other samples will become ready as our lithotheque expands.

Materials : The preliminary group of samples available covers a range of lithologies found on Mars [5,6], especially those in Noachain/Hesperian terranes where the 2018 landing site will most likely be located. It includes (Table 1) a variety of basalts (plus cumulates) since rocks of basaltic lithology predominate on Mars; 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.

	Rocks/minerals	Provenance	Details
Volcanics	Basalt	Svarlbard	Ultramafic
	Basalt	Etna	Primitive
	Basalt	Barberton	Altered, silicified
	Komatiite	Barberton	Altered, silicified
	Dunite	Svarlbard	Cumulative-like
Sediments	Volcanic sands	Pilbara, Barberton	Silicified, carbonaceous traces of primitive life
	BIF	Pilbara	Chemical sediment
Minerals	Carbonates	Svarlbard	Hydrothermal
	Clay, nontronite	synthetic	Basalt weathering product

Table 1. List of preliminary Mars analogue materials available at the OSUC lithothèque in Orléans for testing flight instrumentation

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 [7,8]; 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 [9], 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 [4].

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 [10]. 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 water-littoral 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 organcs can be detected [10,11].

A banded iron formation (BIF) from the Pilbara (~3.4 Ga) is also included in the dataset, although such deposits have not yet been discovered on Mars. They were common sedimentary types on the early Earth and may have been formed in large bodies of water on Mars, especially given the higher Fe content of martian rocks.

Minerals in the collection include 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 [12].

Methods: The samples are analysed by standard field and laboratory techniques either as a whole rock sample, a thin section, or a powder. These data will be complimented by analyses made with the mission instruments. 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 laboratory instruments include a WITec Alpha 500R scanning confocal Raman spectrometer operating at 535.5 nm; a Nicollet IR spectrometer; a Mössbauer spectrometer (MIMOS II); and an INEL XRM3000/CPS120 X-Ray Diffractometer (Co source). The samples were also studied with a cathodoluminescence detector that can be developed for *in situ* space exploration. Elemental analyses were provided by ICP-OES of powdered sample.

All field, textural and compositional data are being collated in an online database that will be available to the scientists and instrumentalists associated with the mission.

Conclusions: The Orléans-OSUC collection of Mars analogue rocks and minerals 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 continuing to be added to the collection. All data are being collated into an online database that will be available by mid 2011 to scientists and instrumentalists working on the missions. The ongrowing database is planned to include a far broader range of data relating to Mars analogue materials than the range of materials present in the Orléans-OSUC rock collection.

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