EPSC Abstracts
Vol. 10, EPSC2015-780-2, 2015
European Planetary Science Congress 2015

Mars analogue activities: the Ibn Battuta Centre and the Sahara desert

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Abstract

The Ibn Battuta Centre for Exploration and Field Activity is a facility of the Europlanet Research Infrastructure. It was established in 2006 by the International Research School of Planetary Sciences (IRSPS) at Pescara, Italy to prepare and execute analogue science and tests of rovers, landing systems, instruments and operations related to the exploration of Mars and Moon.

1. Introduction

The analysis of Mars analogue environments on Earth is important for the interpretation of the data from past, present and future orbital and lander missions, as well as mission planning. Whereas testing single instruments dealing with collection and analysis of single specimens can be performed in restricted environment, the testing of instrument suites, rovers, landers and operations must be conducted in large-scale analogue environments. Therefore, analogue terrains are also of paramount importance for the robotic and human exploration of Space. Human planetary missions will face tremendous challenges that can be mitigated by a careful planning based on testing of human mission on planetary analogues. However, test for robotic and, chiefly, human missions requires environmental characteristic of the analogues different from the environments used for scientific analogues studies. Human mission testing needs broad, arid and vast landscapes. Relief must be smooth and scattered over a large area. Landmarks must be negligible or absent. Surface water must be absent as well as vegetation. The Ibn Battuta Centre (www.ibnbattutacentre.org) deals with both scientific and operational analogues. In both case it take advantage of the long geological history of Morocco and the remarkable geological and geomorphological diversity. Quaternary environments are a host of morphologies and geological settings similar to Mars from reg surfaces to dry lakes, from aeolian dunes to bio-induced carbonates. Besides these quaternary environments, several sites of the Centre consist of ancient deposits such as the Devonian Mud Mounds of the Kess Kess or the Precambrian stromatolites.

2. The activities

Under the frame of the Europlanet RI, in the last 4 years, about 15 scientists have been able to obtain grants to carry on field work in Ibn Battuta field sites In addition, other activities deal with space missions or future exploration scenarios, such as the test of Dreams, the atmosphere and dust instrument onboard ExoMars 2016. Human exploration is an important issue that take Human exploration simulations have

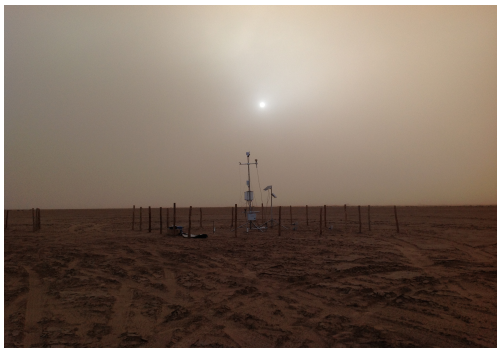

Figure 1: Test of the Dreams instruments in a Moroccan Martian-like environment.

been already executed. In particular, the Centre participated to the control, organized in ESTEC by ESA, of the NASA simulation experiment Desert RATS in Utah. Moreover, with the Austrian Space Forum, a month-long simulation test was performed in two desert sites near Erfoud. The Ibn Battuta Centre deals with both scientific and operational analogues. In both case it take advantage of the long geological history of Morocco and the remarkable geological and geomorphological diversity. The Centre is both using the remarkable diversity of the Moroccan desert and also is investigating other areas such as Patagonia, the Arctic, the Mediterranean volcanic edifices, and other desert areas in Africa. of Morocco. The Sahara in South Morocco exhibits a large-scale scenario that can be similar to the broad Martian landscape. This allows the creation of large test range that can mimic the Martian surface over 100s of km. This characteristic allows the test of aerial operations like spacecraft descent, test of touch down and also of launching to mimic a sample return missions.

3. Why Sahara

Sahara is a continent-wide desert that replicates several large-scale processes occurring on Mars. Sahara has experienced during its long geological history a large number of climatic changes from humid conditions (with savanna-type environments) to dry conditions (with hot desert enviroments). Therefore since the late Miocene Sahara alternated periods with rivers, lakes, deltas swamps with periods with a strong aeolian activity and the formation of deflation surface and sand seas. The Sahara is also dominated by a cratonic landscape with a marginal mountain chain (the Atlas) and volcanic centres (Hoggar, Tibesti). The landscape is therefore broad with swells and domes resembling the Martian topography. Wind processes have reworked, during dry periods, the fluvial deposits that formed during humid period. The aeolian erosion has been extremely efficient leaving some remains of the fluvial deposits as meander belts or exhumed (inverted) channels. Deltaic deposits are strongly eroded and large inland lakes and swamp eroded and a few remains are mostly buried below dunes and sand seas. The leftover of the fluvial deposits is basically the coarse-grained component because the finer sediment has been removed by the wind. Sand to silt material accumulated (mostly by saltation) in the sand sheets and seas. The finer portion (able to enter the wind as suspended material) can be trapped in the large- scale atmospheric circulation. The consequence is that it enter the large-scale atmospheric circulation and has been redistributed in Sahara and in other adjacent continents (mostly Europe and South America) and oceans. The results of these climatic changes are fluvial systems and lacustrine deposits interrelated with deflation surfaces and sand accumulations. This situation is similar to Mars where fluvial deposits and morphologies abound but are largely eroded. When deposits are present are basically coarse-grained (e.g. the meandering channels of the Eberswalde deltaic plain) because the long lasting aeolian. This has removed the finer portion of the sediment and accumulated the sand to silt grade portion in sand seas and sheets and the fines in a sort of draping dust. Therefore Sahara harbour a large number of sedimentary environments that dominated Mars in the mid- and low-latitude. These deposits underwent a number of climatic changes from wet to dry condition in a similar way than the climatic changes on Mars. Aeolian erosion and deposition has been similar in both Sahara and Mars in term of duration of the events, extension and efficiency. Extensive fluvial deposits have been deflated by strong wind activity.

4. Future work

Science is the first item of the Ibn Battuta Centre mission. In order to increase the impact in this field it is planned to increase the number of fieldwork grants to work in Morocco. Moreover, a couple of expeditions will be organised in the next 4 years in the Danakil depression or other remote Martian analogues. It would be also interesting to create science team operating a rover in Martian conditions. This experiment would allow scientists to be exposed to the planning and execution of an analogue rover missions with the identification and analysis of geological settings. Finally the Ibn Battuta Centre/IRSPS would like to increase the link with the industry under the Europlanet RI programme.