EPSC Abstracts
Vol. 13, EPSC-DPS2019-1744-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

NEWTON novel instrument for susceptibility on site characterisation

Marina Díaz-Michelena (1), Amanda Arlensiu (1), Claudio Aroca Hernández-Ros (3), Óscar Baeza (2), Veracruz González (1), Javier de Frutos (1), Rolf Kilian (2), Benoit Langlais (5), Cristina Lavín García (4), Marcos Maicas (3), Reinel Marante (4), José Luis Mesa (1), Marina Pérez Jiménez (3), Francisco Ríos (2), Miguel Ángel Rivero (1).

(1) Payloads and Space Sciences Department, National Institute for Aeroespace Technology, INTA Torrejón de Ardoz, Madrid. Spain, (2) Geology Department, University of Trier, Germany, (3) Physical Electronics Department, Technical Unversity Madrid, UPM Madrid. Spain, (4) TTI Norte, Santander, Spain, (5) Centre National de la Recherche Scientifique - Laboratoire de Planétologie et Géodynamique - (CNRS), France.

Abstract

Despite some advance in the exploration of rocky planets, many key questions concerning their detailed composition, geological history and present exogenic surface processes remain unanswered. Thus current endeavours are devoted to improve the geophysical, geochemical and mineralogical characterisation of surface rocks and regoliths [1], [2].

Compared with other measuring techniques, magnetic measurements have the uniqueness to provide information not only of the present state but also to give hints on the past processes through the records in the magnetic minerals [3].

This makes it very interesting to place magnetic instrumentation in rover payload suites.

Furthermore, apart from magnetometers, which have the capability to measure the environmental field sourced by the bodies, it is important to have instruments capable to quantify the capability of rocks to acquire magnetisation in the presence of a magnetic field. Thus it would be desirable to complement this information with other paleomagnetic measurements.

Magnetic instruments on board rovers have been generally limited in number and in complexity because rover platforms [4] and their motors produce a strong magnetic contamination, which make it difficult to reap the benefits from the inclusion of magnetometers. This has had a strong impact in the selection of the rover suites of instruments, where there have been very few magnetometers.

In this work the team describes a susceptometer developed in the frame of NEWTON EU funded project and some examples of its application on terrestrial analogues of rocky bodies, where the susceptibility measurements have greatly improved to unveil the structures origin.

1. NEWTON Instrument

NEWTON is a scientific instrument conceived and developed for future exploration missions based on a new technology that can perform the on-site measurement of the magnetic susceptibility (real and imaginary part). This will be combined with measurements from vector magnetometers. The final objective is to provide a first and unique technology capable of performing a complete characterisation of the rocks based on magnetic measurements. NEWTON instrument integrates three key building blocks: the sensor unit, the electronic control unit and the power distribution unit.

The sensor unit comprises a susceptometer and a vector magnetometer, as well as the proximity electronics. The vector magnetometer register the environmental magnetic field, the superposition of the global and the crustal fields, and the susceptometer measures the magnetic complex susceptibility in a sweep of 10 to 40 kHz within the range of 10 to 100 kHz. The magnetometer is based on a HMC6043 AMR device, COTS technology, while the susceptometer is based on a ferrite core with an H shape, conceived in the frame of the project. Additionally, the sensor unit includes temperature sensors: PT1000 platinum resistors fixed to the head for a proper thermal calibration of susceptometer and vector magnetometer data.

The power distribution and electronic units have been specifically designed for the instrument with radiation hardened components. Of special attention are the frequency generation and the acquisition systems with integrated lock-ins in order to improve the signal to noise ratios.

The magnetometer is calibrated in the Space Magnetism Laboratory singular facility. The susceptometer is calibrated by means of ad hoc manufactured samples and experimental set ups with well-known real and imaginary-equivalent susceptibilities.

2. On site measurements

Several field campaigns have been done at selected sites performing NEWTON susceptibility measurements together with a high resolution mapping of magnetic intensities in order to get a more complete characterization of the composition of exposed as well as underlying not exposed rocks and their geological history

A first case study concerns a 1.5 km wide crater within the ~150 m thick Barda Negra Plateau basalts in the province Neuquén (Argentina) for which an impact origin have been proposed [5]. However, our detailed magnetic studies and mapping of the crater and its surroundings with NEWTON instrument and a successive 3-D modelling were not consistent with an impact origin, but instead with a sinkhole formation. The results show that the crater floor still includes a not exposed thick basaltic layer below the sedimentary infill. Thus the basalts were not excavated by an impact, but instead slumped into preciously underlying dissoluble carbonate-bearing rocks below the plateau basalts. This scenario was also approved by geological, mineralogical and geomorphological implications and represents an example for an alternative origin of some crater-like features on rocky celestial bodies [6].

A second case study with NEWTON instrument was performed in the Spanish province Huelva within the Iberian Pyrite Belt along the Rio Odiel and next to the closed ancient mines of San Platón and Concepción. High resolution magnetic measurements (<50 cm spacings) were performed across a 12 km long transect which cross-cuts different perpendicular aligned Variscan lithological rock units. Along this transect five 10 to 50 m wide zones with pronounced positive magnetic anomalies (<500 nT) and relatively high magnetic susceptibilities have been detected. Additional mineralogical studies indicate that the magnetic signatures of zones are related to the minerals pyrrhotite and magnetite, both formed by hydrothermal mineralization processes.

Acknowledgements

This project has received funding from the European Union’s Horizon 2020 research and innovation program under grant agreement No 730041 and the Spanish National Plan project 2016 ESP2015-70184-R

References

[1] Bibring, J.P., et al., Global Mineralogical and Aqueous Mars History Derived from OMEGA/Mars Express Data, First Example Science, Vol. 312, pp. 400-404, 2015.

[2] Hemingway, D. J., and Tikoo, S. M., Lunar swirl morphology constrains the geometry, magnetization, and origins of lunar magnetic anomalies, Journal of Geophysical Research: Planets, 123, 2018.

[3] Tikoo et al.: A two-billion-year history for the lunar dynamo Sci. Adv. Vol. 3, pp. 1-9, 2017.

[4] https://mars.nasa.gov/mer/mission/instruments/

[5] Acevedo, R.D., Rocca, M.C.L., Ponce, J.F. & Stinco, S.G. Impact Craters in South America. Chapter 2, Argentina. 104 p., Springer, 2015.

[6] Adams, J.B., Gillespie, A.R., Jackson, M.P.A., Montgomery, D.R., Dooley, T.P., Combe J.-P.: Salt tectonics and collapse of Hebes Chasma, Valles Marineris, Mars. Geology, Vol. 37, pp. 691–694, 2009.