NEWTON – **NEW** portable multi-sensor scien**T**ific instrument for non-invasive **ON**-site characterisation of rock from planetary surface and sub-surfaces

M. Díaz-Michelena, J. de Frutos, A.A. Ordóñez, M.A. Rivero and J.L. Mesa (1), L. González and C. Lavín (2), C. Aroca, M. Sanz, M. Maicas, J.L. Prieto, P. Cobos and M. Pérez (3), R. Kilian and O. Baeza (4), B. Langlais and E. Thébault (5), J. Grösser and M. Pappusch (6)

(1) Instituto Nacional de Técnica Aerospacial (INTA), Madrid, Spain, (2) TTI, Santander, Spain, (3) Universidad Politécnica de Madrid (UPM), Madrid, Spain, (4) Universitat Trier (UT), Trier, Germany, (5) Laboratoire de Planétologie et Géodynamique (LPG), CNRS and University of Nantes, Nantes, France, (6) IGU Institut fur Industriellen Undgeotechnischen Umweltschutz GMBH (IGU GmbH), Wetzlar, Germany.

1. THE PROBLEM

Many of the celestial bodies, as for instance the Earth, the Moon and Mars, have an internal magnetic field. On the Moon and Mars, this magnetic field is now purely due to the remanent signature of the crust, magnetized by a past global magnetic field. However, the exact characteristics of this magnetization and how they relate to the ancient dynamo remain unexplored. To date **systematic magnetic surveys on Mars and Mercury have been only performed by satellites,** while on the Moon sparse surface measurements were just performed during the Apollo era and revealed an important variability over kilometre scales.

Worldwide experts [1] in planetary magnetism strongly recommend magnetic prospections on ground with rovers to obtain detailed magnetic signatures and rocks susceptibilities prior to sample-return missions. However, they have not been performed so far for the inadequacy of magnetic instrumentation with the magnetic noise of the landed platforms and the required light weight for space exploration.

Fig. 1 Solar System.

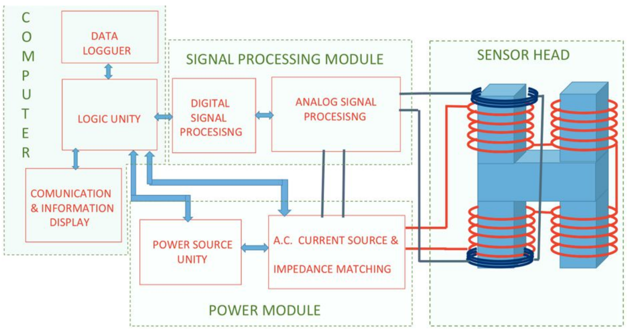

Fig. 2. Block diagram of the susceptometer.

2. THE SOLUTION

This work proposes a first and unique technology capable of performing a complete characterization of the rocks based on a **magnetic instrument suite**. This suite includes: a recurrent vector magnetometer, a highly innovative susceptometer with a power supply system and a very sophisticated frequency generation and shift detection.

The **sensor head** includes the susceptometer and the magnetometer. The susceptometer is a ferrite with H shape (to perform a differential measurement, increasing the sensitivity) and integrates a magnetic amplifier to have a significant frequency range. The device is capable to measure real and imaginary part of susceptibility.

3. INSTRUMENT REQUIREMENTS

An **exhaustive analysis** of available literature has been done to compile the **magnetic parameters of the rocks most representative of the Earth, Mars and the Moon**. Other parameters such as mass susceptibility and saturation remanence of the rocks has also been considered.

This study has allowed to define the instrument requirements to perform measurements of the magnetic susceptibility, environment magnetic field and paleomagnetic parameters on the Earth, Mars, Moon and other solid bodies.

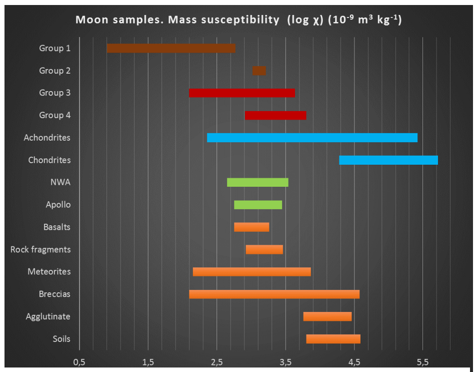

Fig. 3. Mass susceptibility of a number of Moon samples. Data are given as the log of the susceptibility in 10^{-9} m^3Kg^{-1}.

4. HOW THE SUSCEPTOMETER WORKS?

To measure the complex susceptibility of rocks with sufficient sensitivity, the instrument is designed with a **zero method based on temporal measurements**. This is an original an innovative system to both generate and retrieve the signals at different frequencies to cover the wide range of susceptibility of natural rocks.

The other challenge is the **use of magnetic amplifiers** to achieve the range of frequencies of work. This project intends to modernize a well known but poorly used technology opening new frontiers of applications like space exploration due to the recent progress in magnetic materials manufacturing.

References: [1] Dehant et al. 2012, Plan. Spa. Sci, 68.

www.h2020-newton.eu

NEWTON Consortium

Funded by

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730041.