THE GEOLOGY AND PLANETARY MAPPING WINTER SCHOOL.

M. Massironi[1] A. P. Rossi[2], L. Penasa[1], R. Pozzobon[3], G. Tognon[3], J. Wright[4], C. Van Der Bogert[5], F. Zambon[6], V. Galluzzi[6], G. Caravaca[7], S. Le Mouélic[7], and the GMAP-PLANMAP winter school instructors team and technical committee.

[1] Department of Geosciences, University of Padova, matteo.massironi@unipd.it, [2]Jacobs University Bremen, [3]CISAS, University of Padova, [4] School of Physical Sciences Open University, UK, [5]Westfälische-Wilhelms Universität Münster, [6]INAF-IAPS, [7]CNRS UMR 6112 LPG, Univ. Nantes, Univ. Angers Nantes

Introduction: In 2021, between 1-5 February, the University of Padua coordinated the 1st edition of the Geology and Planetary mapping virtual school (https://www.planetarymapping.eu/), which involved more than 150 participants spread all over the world and more than 50 instructors from at least 9 European institutions.

In planetary exploration programs, geological maps are crucial for science investigation, safe landing and roving, exploration of in situ resources, astronauts' safety, planning of stable settlements, identification of sites which might suffer biological contamination. Hence, any planetary mission which does not foresee the production of geological maps is a mission whose aims are at serious risk. To be prepared for the exponential increase of planetary missions in the years to come it is indeed needed that geological maps start to be produced worldwide, being at the moment the United State Geological Survey the only institute able to produce such maps on a regular basis. For this reason, the European project PLANMAP and the GMAP action within the EUROPLANET infrastructure have been devoted to foster the production of innovative geological maps in support of future European missions to planetary bodies. Both these activities are led by the Department of Geoscience of the University of Padua around which different institutions are collecting to form a European network for planetary geological map production.

A pivotal aim of the network is to prepare the next generation of planetary scientists to face the challenges of future planetary missions and for sure geological mapping is one of the main tools to successfully overcome them. However, the results obtained in the last 20 years of science exploration are changing dramatically the technical and scientific procedures to perform geological mapping, so that the topic is continuously evolving, and the teaching strategy need to be continuously renewed and re-focused.

The geology and planetary mapping winter school wanted to address the most recent outcomes on the production of planetary geological mapping.

Structure of the school: The school is based into two main blocks made up of theoretical lessons and practical activities. The exercises were in general carried out in separate virtual rooms in order to guarantee one instructor every 5-10 students.

Basic course: dedicated to students with no experience on planetary geological mapping and was especially focused on the theoretical concepts of planetary geological mapping and on the practical activities aimed at creating geological maps of selected regions on the Moon, Mercury and Mars. The mapping of the different bodies were carried out in sequence with increasing geologic complexity. All these activities were based on open source GIS-environment taking into account the state-of-the-art conventions and standards for planetary geological mapping. The exercises were carried out in separate virtual rooms in order to guarantee one instructor every 5-10 students. At the end of the course, the last half a day was dedicated to a virtual field trip on Martian environment (available to people with their own headsets) and an experience of interaction with the virtual environment using virtual tools for geological measurements (limited to students hosted in the laboratories of the GMAP beneficiaries).

Advanced course: it was dedicated to more expert people and was subdivided into four sections. The first section was focused on crater chronology whereas the second on the composition of diverse planetary bodies. The third section aimed at producing spectral index maps of different planetary bodies and integrating the information derived by the spectral indexes into more traditional morpho-stratigraphic units. Finally some simple examples on how to handle 3D data-sets were also presented.

Future implementations: For the second edition of the Geology and Planetary Mapping Winter School we foresee the following objectives partly common to the 1st edition with some new implementations in italics:

- provide students with the processing techniques necessary to realize 2d base-maps with some common planetary data;
- provide students an education program on the planetary geological mapping protocols and associated information.
- lead the students to the production of their own geological maps of selected areas embedding traditional geological mapping with crater chronology.

- to let the students live the experience of interactive Planetary geological Virtual Environment using the tools for measuring geological features directly on Mars.
- provide the students the needed knowledge for understanding the diverse surface composition of different planetary *and small bodies*
- *provide information on laboratory retrieval of spectral data from analogue materials*
- *lead the students to carry out spectral analysis on a given target area of one or more planetary surfaces.*
- lead the students to perform a geological map derived from the integration between morpho-stratigraphic units and spectral units.

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