GEOLOGICAL MAPPING AND REPRESENTATION OF MARTIAN SEDIMENTARY DEPOSITS: AN EXAMPLE FROM THE SOUTHEASTERN MARGIN OF HOLDEN CRATER. M. Pondrelli[1], A. Frigeri[2], L. Marinangeli[3], I. DI Pietro[3], A.C. Tangari[3], M. Pantaloni[4], E. Luzzi[5], R. Pozzobon[6], A. Nass[7], A.P. Rossi[5], [1]IRSPS, Università G. d'Annunzio, viale Pindaro 42, 65127, Pescara, Italy, [2]Istituto di Astrofisica e Planetologia Spaziali, Istituto Nazionale di Astrofisica, Roma, Italy, [3]Laboratorio di Telerilevamento e Planetologia, Dip. di Scienze Psicologiche, della Salute e del Territorio (DISPUTer), Università G. d'Annunzio, Via Vestini 31, 66013, Chieti, Italy, [4]Servizio Geologico d'Italia, ISPRA, via V. Brancati 48, 00144, Rome, Italy, [5]Department of Physics and Earth Sciences, Jacobs University Bremen, Campus Ring 1, 28759, Bremen, Germany, [6]Department of Geosciences, University of Padova, Via Gradenigo 6, 3131, Padova, Italy, [7]DLR, Institute of Planetary Research, Rutherfordstrasse 2, 12489 Berlin, Germany,

Introduction and context: Sedimentary rocks and associated morphologies are among the most appealing deposits present on Mars surface, because of their implication in the understanding of climatic conditions and of their variations through deep geological times. At the same time, their study is favored by the quantity, quality, and type of the datasets that are now available on Mars. These relatively recent datasets coupled with the older datasets and Geographical Information Systems (GIS) provide an impressive suite of tools to develop meaningful planetary geological maps.

These new data allow to prepare topical maps with an approach somewhat akin to the relatively 'objective' geological map approach well-known on Earth. In particular, data coverage is extremely dense and has high-resolution in correspondence of small areas (e.g., basins) by ensuring that the mapping process easier and more significant. This is generally true for most of the sedimentary systems on Mars. Such an approach would allow to distinguish the deposits characterized on the base of their objectively defined characters (i.e., tone, texture, absence/presence of sedimentary structure, compositional hints) from the genetic interpretation provided by the morphological characters. A clear distinction between descriptive and interpretative units is specifically envisaged when geomorphological interpretation is particularly controversial. Stratigraphy represents another concept that needs to be included within map information. Unlike on Earth, sedimentary (and not only) systems preserve their morphological assemblages down to the deep stratigraphic record, making the recognition of unconformities and stratigraphic relations a pre-requisite to a constrained interpretation on Mars.

In the framework of the GMAP (Geologic MApping of Planetary bodies) project, herein we present an attempt to include all these different but complementary information in a single cartographic product, taking advantage of GIS-based tools. Moreover, we aim at testing, where possible, the Earth-born symbols designed for the Geological Map of Italy [1,2] in order to try to make the 'language' of geological maps as uniform as possible.

In order to perform these analyses, we selected a series of putative fluvio-lacustrine landforms located in Holden crater, along the south-eastern inner rim (coordinates 26.9°S-33.5°W) (Fig. 1).

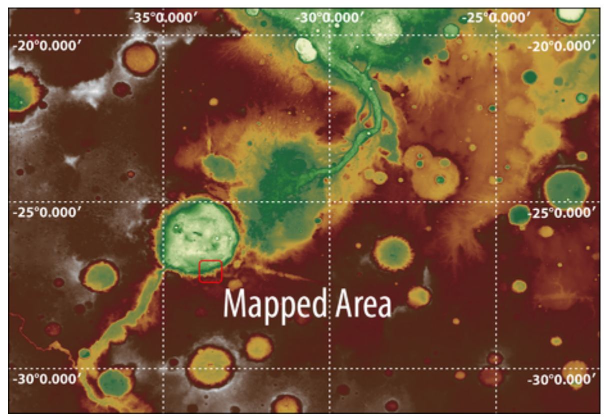

Figure 1 - Location map of the study area

Holden crater is well known because of its fluvio-lacustrine geological evolution, although the details of such evolution (i.e., water level fluctuations, timing) remain still unknown [3,4,5]. The area selected show the presence of superposed fan-shaped features reflecting a complex basin evolution (Fig. 2).

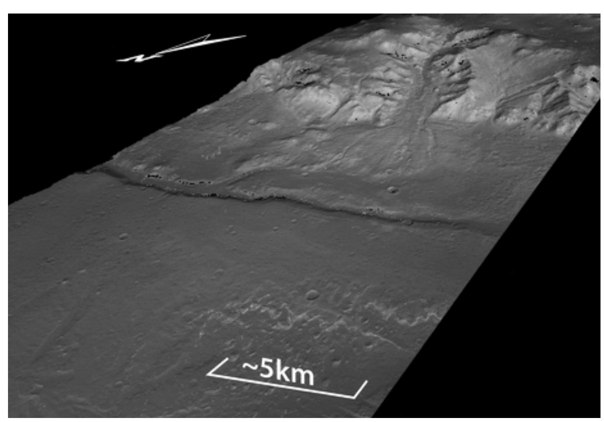

Figure 2 - CTX-based perspective view of the study area

Mapping approaches: We realized a geological map including i) a polygon shapefile with the units described using the as objective as possible characters, ii) a linear shapefile defining the nature of the stratigraphic boundaries, and iii) a linear shapefile with tectonic features and interpretative geomorphological structure. Although geology is an interpretative science and nothing is really free from interpretation, this organization allows to focus, simultaneously but separately, on the description, on the stratigraphic relations (emphasizing the missing time) with different hierarchy, and on the genetic interpretation, respectively. The genetic interpretation in turn is constrained by the reconstruction of the vertical and lateral relationships among the units that allow to interpret the genesis of a specific landform in the framework of a context of associated landforms (i.e., landscape).

Preliminary results and further steps: The preliminary results are shown in Fig. 3.

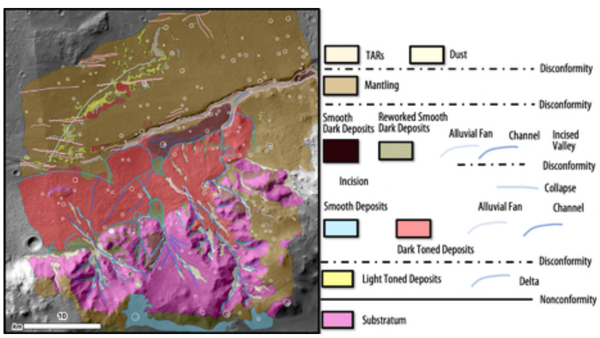

Figure 3 - Geological map of the studied area.

Each unit was described in correspondence of a ‘stratotype’. We are aware of the differences, not just of formal nature, with the classic stratotype definition on Earth. However, we want to introduce a concept that addresses the ‘objective’ description of the units with all the available dataset that in turn might favor the reproducibility of these observations in different areas/settings. As an example (Fig. 4), the Light Toned Deposits were described as light toned, moderately rough, layered and associated with flat or very low-dipping terrains at CTX scale. Whereas they show a bedsets thickness of few meters and they are disrupted in a post-depositional meter-scale polygonal pattern at the HiRISE scale. This unit onlaps the older ‘Substratum’ and is covered in disconformity by the Dark-toned layered deposits or by the mantling unit.

The stratigraphic reconstructions allowed to identify a succession of depositional events separated by unconformities which are expressed by space-space and space-time reconstructions.

Figure 4 - Stratotype (at HiRISE scale) of the LTD unit (ESP_011542_1530).

The genetic interpretations associated to such schemes allowed to reconstruct the geological evolution of the studied area, characterized by a first impact stage, correspondent to the emplacement of Holden crater, to a ‘water-related’ phase, including a sustained phase of fluvio-lacustrine activities followed by discontinuous ephemeral alluvial episodes. An aeolian phase made of several generations of mega-ripples and dunes represents the youngest part of the stratigraphic succession.

The next step will include the hyperspectral data in the unit definition. The problem of the different resolution among the images and the spectral data will be addressed in order to organize a consistent legend. Then, we will identify a possible set of graphical symbols describing the surface features, locating potential limits in current GIS symbology implementation. The aim is to develop a ‘language’ as uniform as possible between Earth and Planetary geological-geomorphological maps.

Acknowledgments: We are indebted with the GMAP (Geologic MApping of Planetary bodies) project participants for fruitful and lively discussions. Data were obtained from the PDS Geoscience Node and processes using ISIS and the NASA AMES tools.

References:

[1] ISPRA (2009) *Carta Geologica d’Italia. Guida alla rappresentazione cartografica. Modifiche e integrazioni ai Quaderni 2/1996 e 6/1997,* pp 166. [2] ISPRA (2018) *Carta Geomorfologica d’Italia. Guida alla rappresentazione cartografica. Modifiche e integrazioni al Quaderno 4/1994,* pp 95. [3] Pondrelli M. et al. (2005) *JGR*, 110, E04016. [4] Grant J.A. et al. (2008) *Geology*, *36*(3), 195–198. [5] Grant J.A. et al. (2011) *Icarus,* 212(1), 110–122.