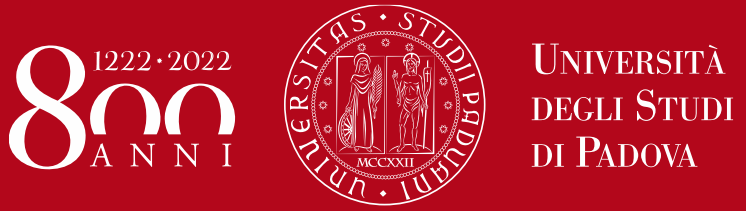


Telerilevamento e mappatura di superfici planetarie

Silvia Bertoli - 36th Cycle

Supervisor: Gabriele Cremonese Co-supervisor: Maurizio Pajola

Admission to the second year - 08/09/2021

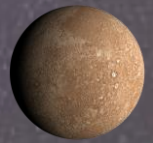
Introduction

Project focused on

MARS

CaSSIS

MERCURY

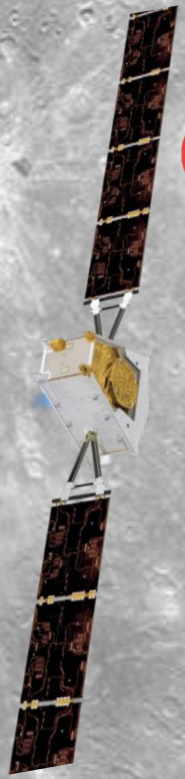


SIMBIO-SYS

MERCURY: SIMBIO-SYS

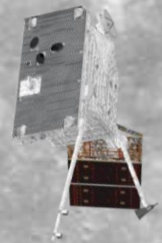
SIMBIO-SYS-Spectrometers and Imagers for MPO BepiColombo Integrated Observatory SYStem

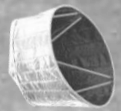
bepicolombo

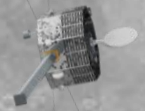


MPO - Bepi
Mercury Planetary Orbiter

MTM
Mercury Transfer Module







MMO - MIO
Mercury Magnetospheric Orbiter

MOSIF
Magnetospheric Orbiter Sunshield and Interface Structure

SIMBIO-SYS-Spectrometers and Imagers for MPO BepiColombo Integrated Observatory SYStem

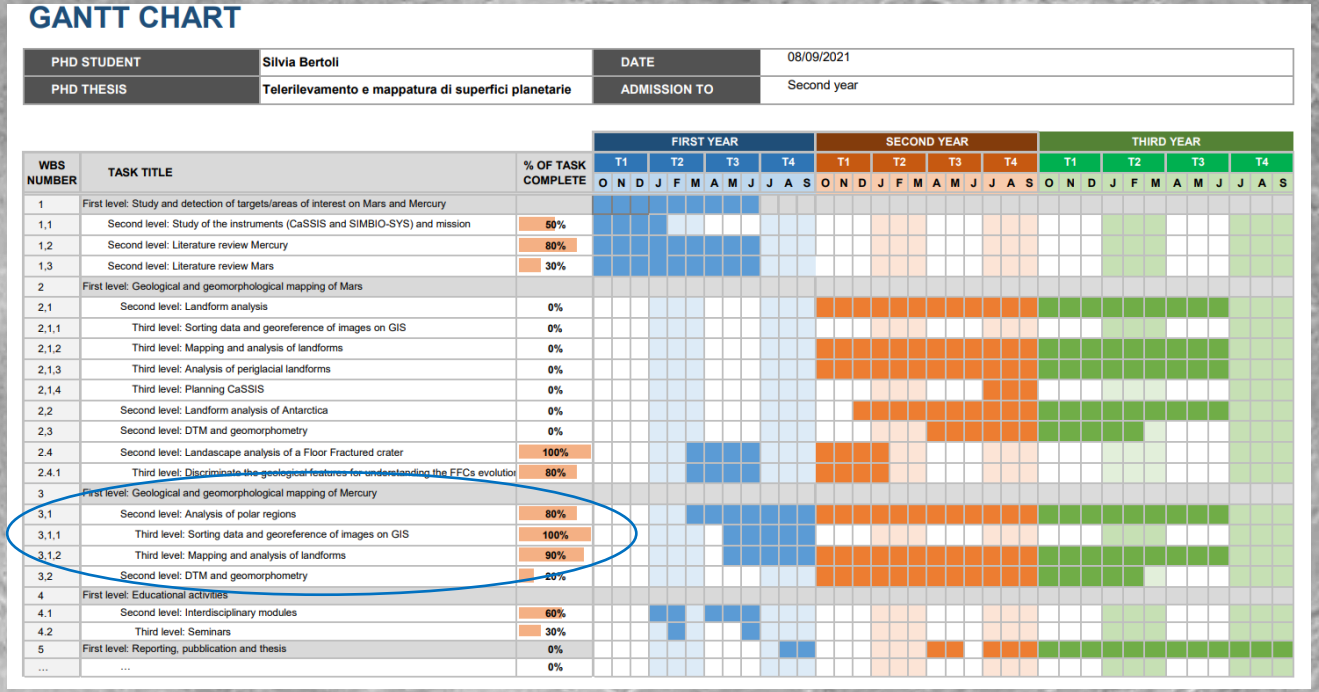
PI: Gabriele Cremonese

Main scientific objectives:

- Global stereo-mapping of the planet for the first 6 months of nominal mission
- Global spectroscopic mapping for the first 6 months
- High resolution images of about 20% of the surface

GANTT CHART

PHD STUDENT	Silvia Bertoli	DATE	08/09/2021
PHD THESIS	Telerilevamento e mappatura di superfici planetarie	ADMISSION TO	Second year



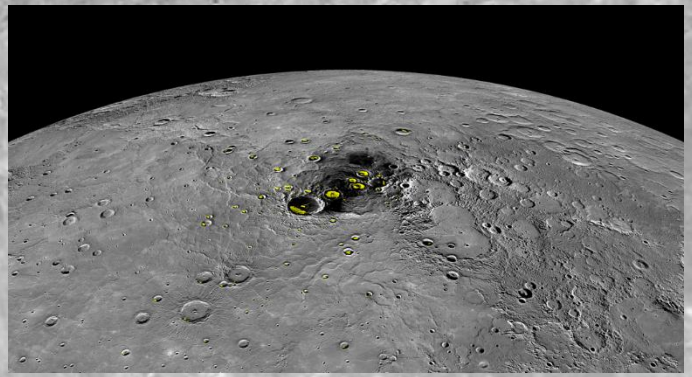
WBS NUMBER	TASK TITLE	% OF TASK COMPLETE
1	First level: Study and detection of targets/areas of interest on Mars and Mercury	
1,1	Second level: Study of the instruments (CaSSIS and SIMBIO-SYS) and mission	50%
1,2	Second level: Literature review Mercury	80%
1,3	Second level: Literature review Mars	30%
2	First level: Geological and geomorphological mapping of Mars	
2,1	Second level: Landform analysis	0%
2,1,1	Third level: Sorting data and georeference of images on GIS	0%
2,1,2	Third level: Mapping and analysis of landforms	0%
2,1,3	Third level: Analysis of periglacial landforms	0%
2,1,4	Third level: Planning CaSSIS	0%
2,2	Second level: Landform analysis of Antarctica	0%
2,3	Second level: DTM and geomorphometry	0%
2.4	Second level: Landascape analysis of a Floor Fractured crater	100%
2.4.1	Third level: Discriminate the geological features for understanding the FFCs evolution	80%
3	First level: Geological and geomorphological mapping of Mercury	
3,1	Second level: Analysis of polar regions	80%
3,1,1	Third level: Sorting data and georeference of images on GIS	100%
3,1,2	Third level: Mapping and analysis of landforms	90%
3,2	Second level: DTM and geomorphometry	20%
4	First level: Educational activities	
4.1	Second level: Interdisciplinary modules	60%
4.2	Third level: Seminars	30%
5	First level: Reporting, pubblication and thesis	0%
...	...	0%

MERCURY: Aim of the project

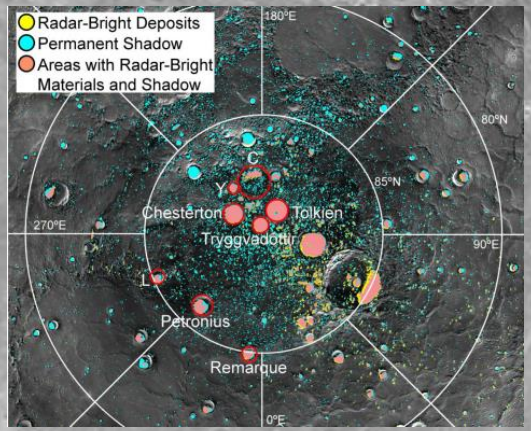
- Study polar regions to understand better the processes and the morphologies on the shadowed areas
- Understand the role of the water ice and its possible source
- Landforms analysis to prepare the studies of specific target for Bepi Colombo Mission

MERCURY: Introduction

Water ice on polar regions



Instrument: Mercury Dual Imaging System (MDIS)
Arecibo Radar Image: In yellow (Harmon et al., 2011, Icarus 211, 37-50)

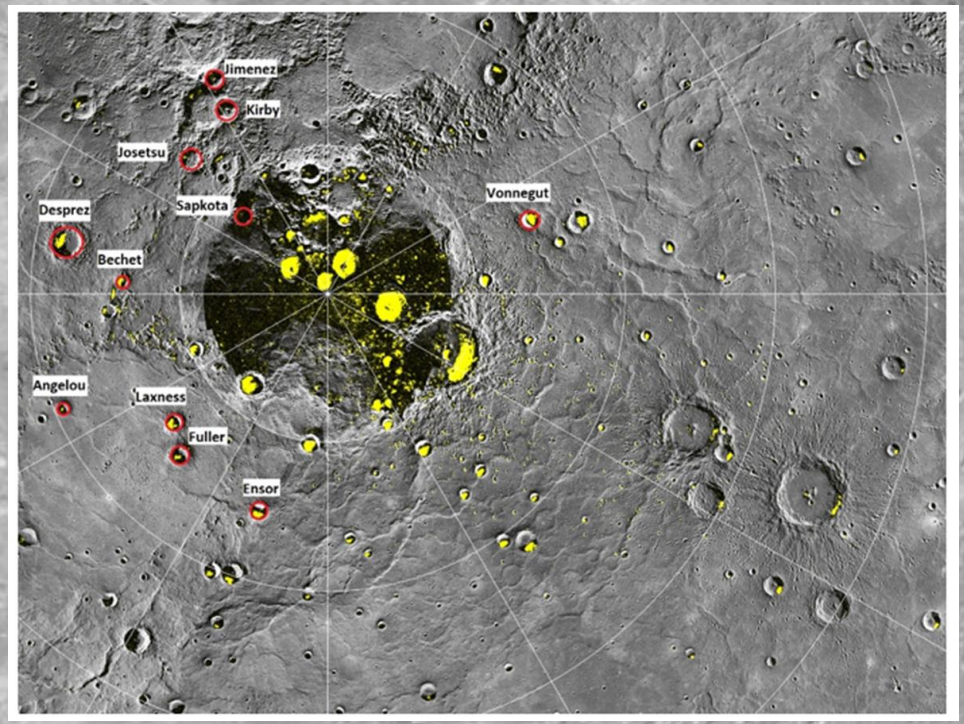


J.L. Fastook et al., 2019

MERCURY:Landforms analysis

Analysis of craters in PSR

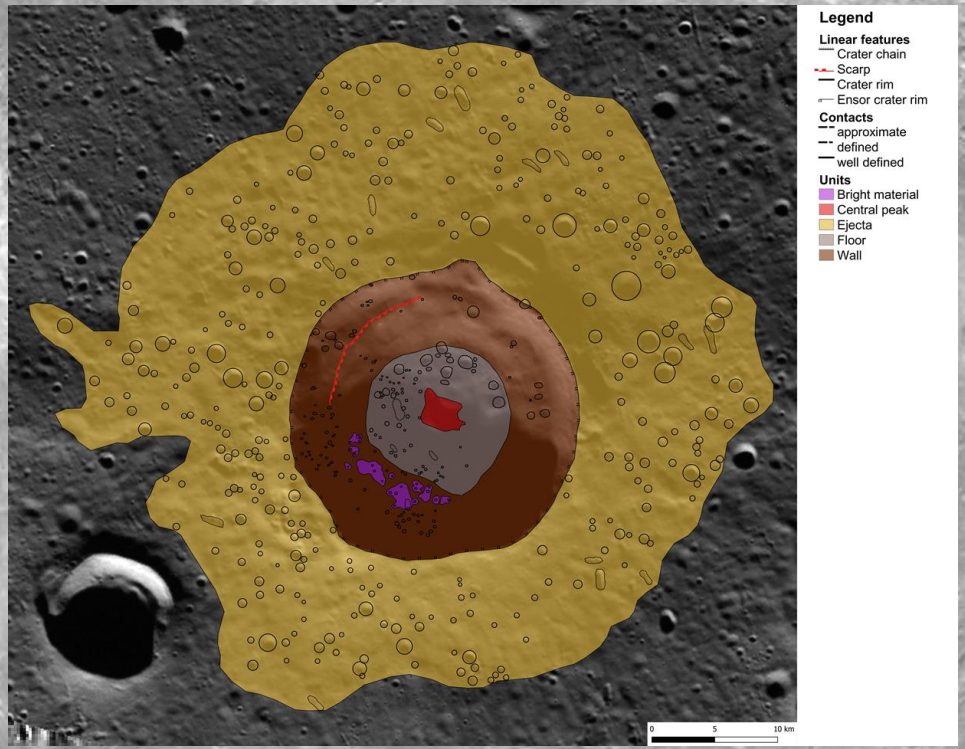
- Provide new insights into the behavior of water ice deposits
- Study of landscape evolution



[NASA/Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington]

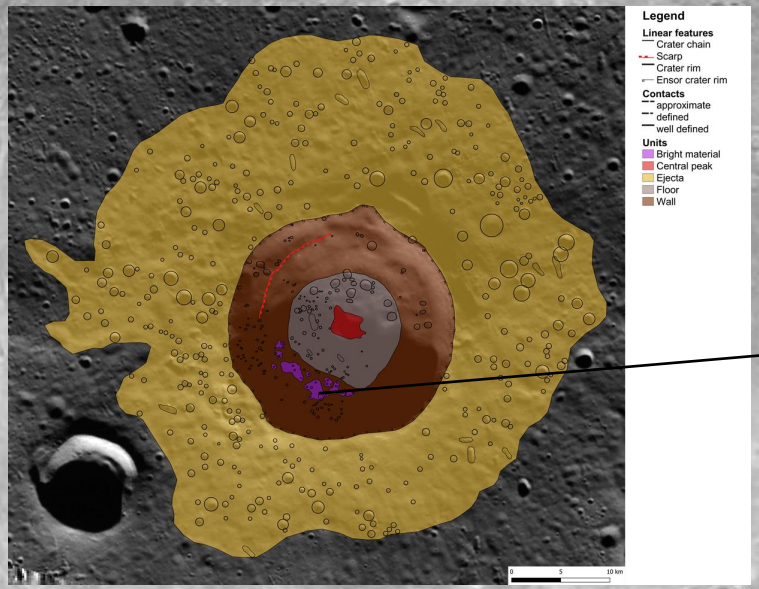
MERCURY: Investigation methods

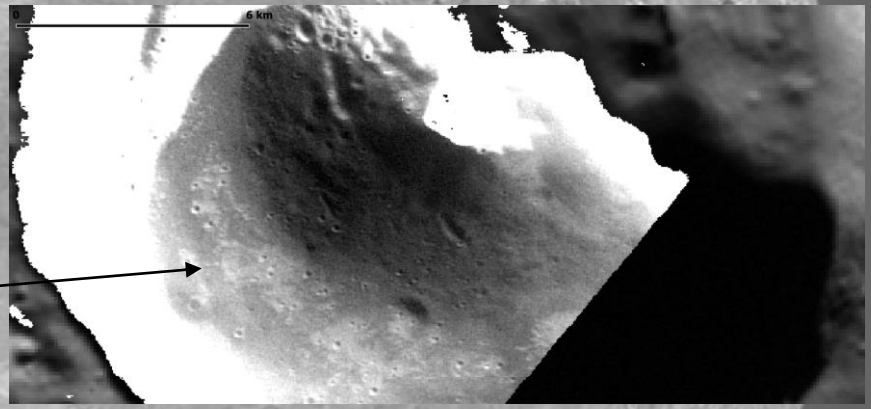
ENSOR



MERCURY: Investigation methods

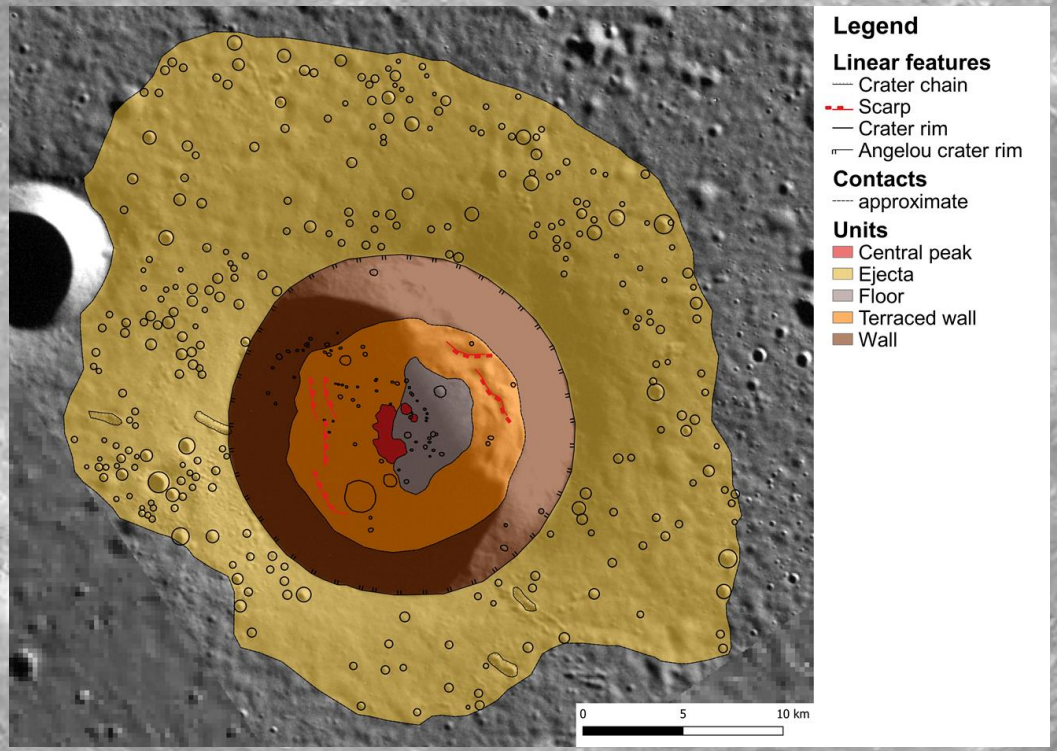
ENSOR



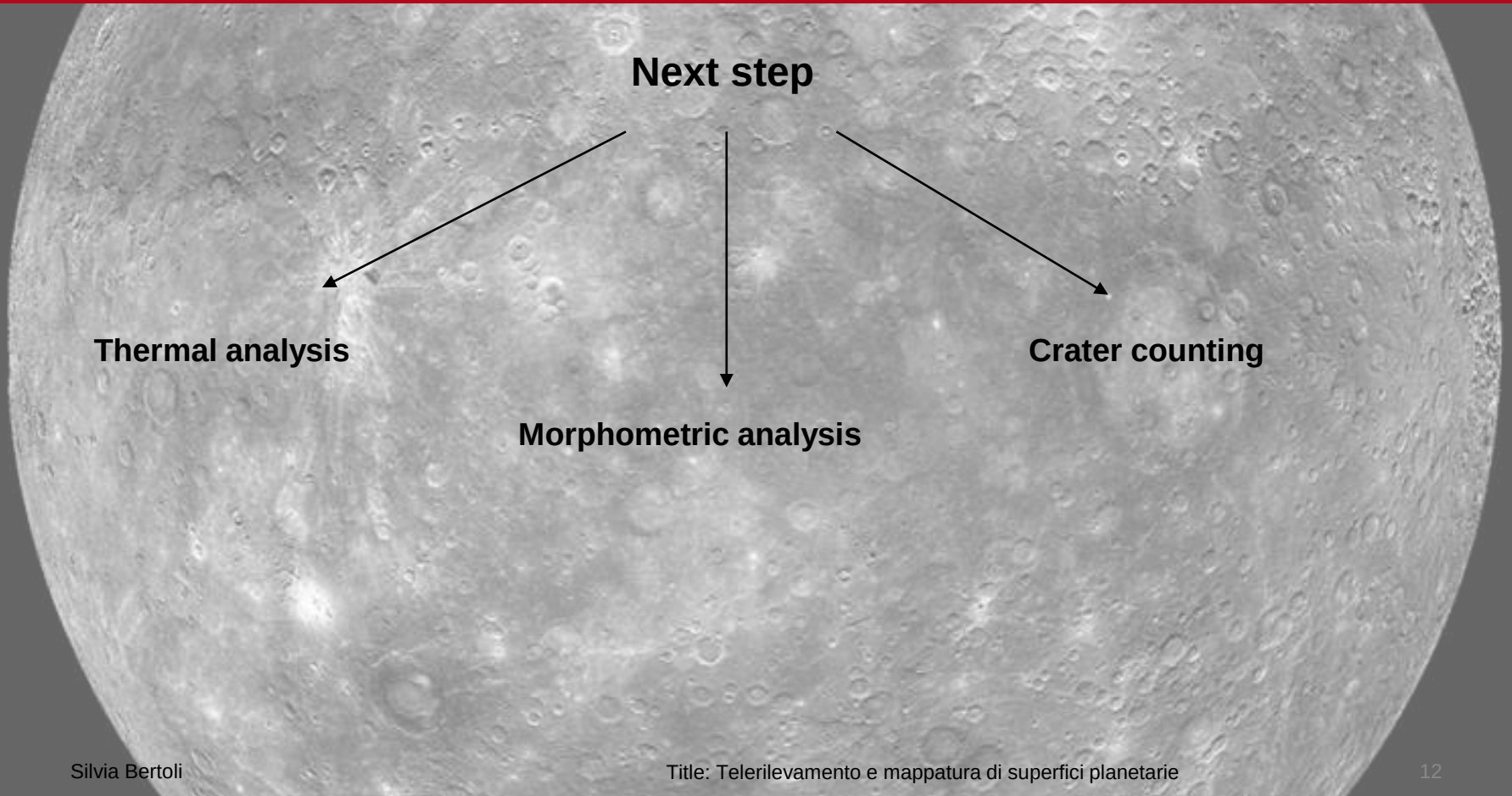


MERCURY: Investigation methods

ANGELOU



MERCURY: Investigation methods



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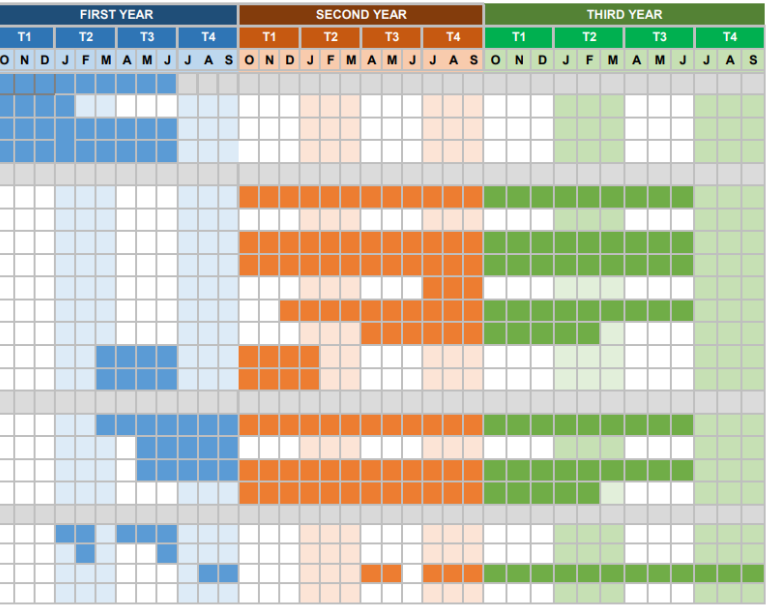


MARS: Introduction

PLANET MARS

ANTARCTICA CONTINENT

COLD AND HYPER-ARID DESERTS

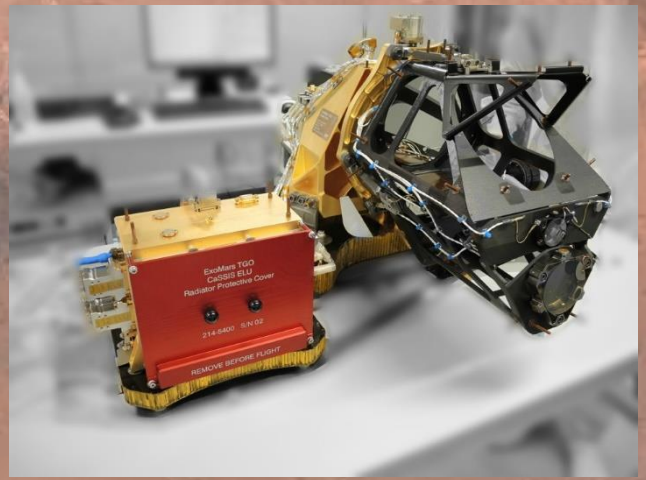
CaSSIS

Colour and Stereo Surface Imaging System

Color and Stereo Surface Imaging System

(PI: N.Thomas

CoPI: G.Cremonese)

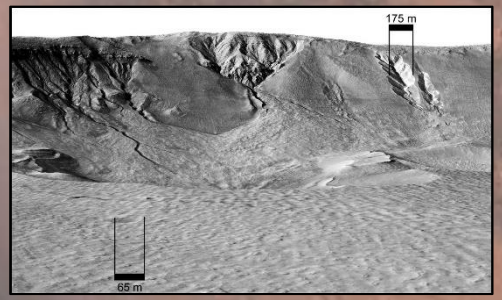


CaSSIS: Top Level Requirements

- **Imaging at ~5 m/px (≤ 10 m resolution)** requires major optical design modification; 2.5x inferior to HiSCI (SNR)
- **Individual image size of ~>8km x >8km** dictated by sensor dimension
- **Stereo coverage in a pan-chromatic channel** to provide ≤ 15 m vertical resolution
- **Colour in 3 bands** (in addition to pan)

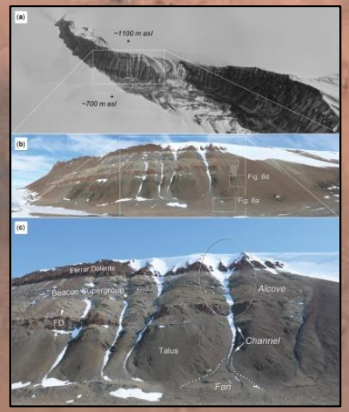
MARS: Scientific interest

The red planet keeps the traces of a similar terrestrial past.
On its surface there are clear morphological evidences of wind erosion and water action



Conway et al. (2018a)

Antarctica landforms represent the best analogues to understand the Martian dynamics. Despite being a remote continent, it is possible verify multiple Martian studies with a field camp.



Hauber et al. (2019)

MARS: Aim of the project

- The study of periglacial forms and deposit (periglacial-like in the Martian context) as main indicator of potential ice and liquid water on the Martian terrains.
- The study of Antarctic and Martian periglacial morphologies also through the definition of morphodynamics and morphometry, will allow to implement the knowledge on Martian permafrost
- Understanding the evolution of the permafrost also in relation to the climatic changes that have affected and still affect Mars and Antarctica.

MARS: Investigation methods

Landscape analysis on the **Antarctica context**:

- **Remote sensing part:** analysis of the aerial images Trimetrogon Antarctica by USGS (taken on 1957) and of the data from satellites (Word View)
- The data would be reworked in **GIS** (Geographic Information System) and **SNAP** (Sentinel Application Platform)
- A possible **geomorphological survey in situ**

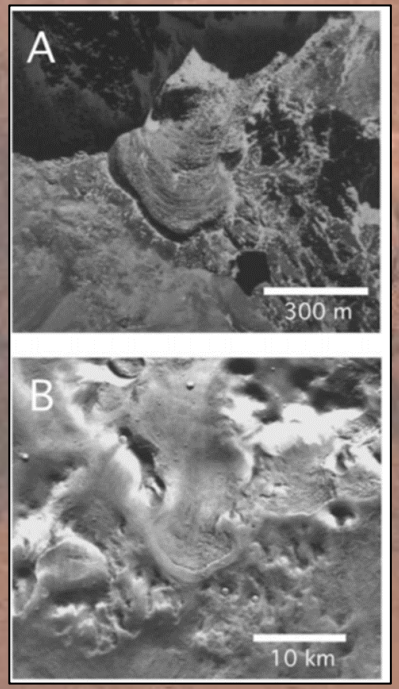
Landscape analysis on the **Martian context**:

- **Remote sensing** (image processing and photointerpretation) with data from:
  - **CaSSIS (**the main part**)**
  - **HiRISE**
  - **CTX**
  - **HRSC and MOLA**
  - **CRISM**
- All analysis, 3D characterization and data processing would take place in the **GIS** environment

MARS: Rock glacier

Rock glacier

Jones et al., 2019



Degenhardt and Giardino, 2003

Rock glaciers are lobate or tongue-shaped bodies composed of mixtures of poorly sorted angular, blocky rock debris and ice. These landforms, whose wide distribution, occurrence, and significance often go unnoticed, **move by slip, flow and/or creep deformation**

MARS: Rock glacier

Why Rock glacier?

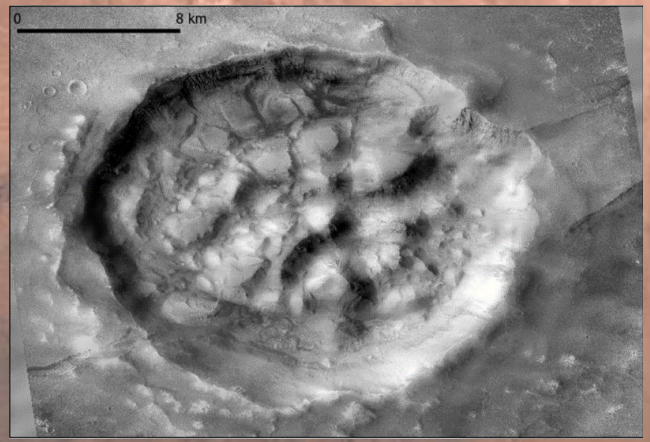
- The discovery of **rock glacier-like** features on Mars suggests the presence of flowing, or once-flowing, ice-rock mixtures.
- These landforms as **reservoirs of stored water ice** and provide a frozen record of the climatic history of the planet
- Rock glaciers, which are common not only to the Dry Valleys but throughout the Antarctic, are **important archives of glaciological and climatological data**, as well as important landforms to monitor with future potential warming.

MARS:Floor Fractured Craters

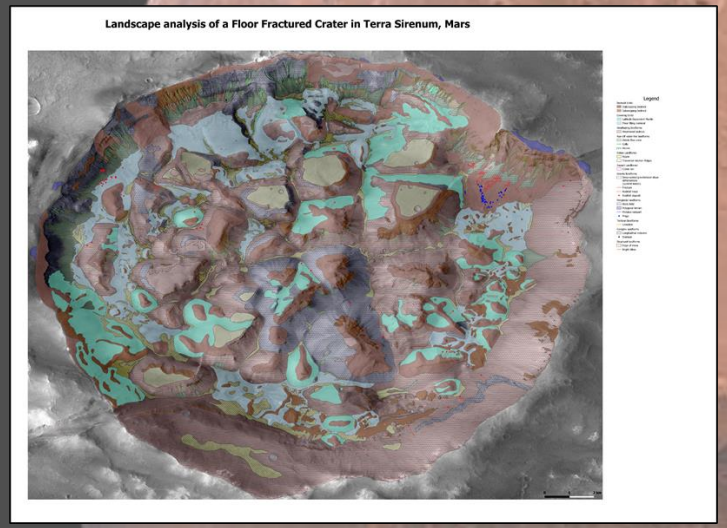
Features

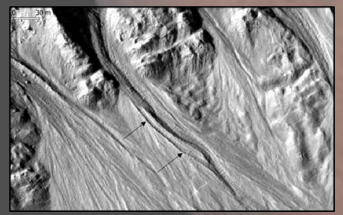
- diverse FFCs have different genetic origins
- discriminate the geological features for understanding their diverse evolutions
- Water or not?

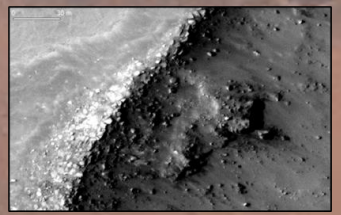
Study area



MARS:Floor Fractured Craters







- Action of at least **three main morphogenetic agents**: subsurface ice, gravity and wind, plus the interaction with fractures and faults
- In our case (a crater of about 18 km in diameter), the filling material could have led only a partial melting of the ice layer. Then the melting of ice stored in the pre-existing fractures, would have caused an underground runoff and the erosion of the fine materials within the fractured floor

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Hauber E., Sassenroth C., De Vera J. P., Schmitz N., Jaumann R., Reiss D., Hiesinger H. and Johnsson A. (2019) – *Debris flows and water tracks in northern Victoria Land, continental East Antarctica: a new terrestrial analogue site for gullies and recurrent slope lineae on Mars*. In: Conway S. J., Carrivick J. L., Carling J. L., De Hass P. A. and Harrison T. N. (2019) - Martian Gullies and their Earth Analogues, V. 467, pp. 267-28

Thanks for the attention