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UNIVERSITÀ
DEGLI STUDI
DI PADOVA



Geological mapping and structural analysis of fault networks on Mars and Mercury: Implications for regional tectonics and geodynamics

Supervisor: Prof. Matteo Massironi (Dipartimento di Geoscienze, Università di Padova)

PhD student: El Yazidi Mayssa

11th September 2020, at 9:50 AM

34° Cycle

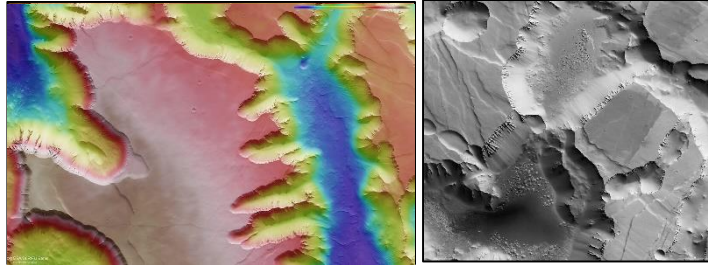
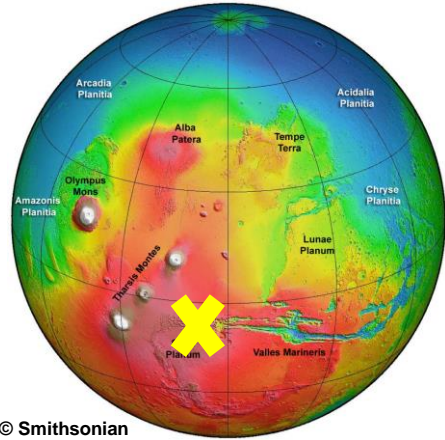
Corso di SCIENZE TECNOLOGIE E MISURE SPAZIALI

Curricoli: Misure meccaniche per l'ingegneria e lo spazio,

Centro di Ateneo di Studi e Attività Spaziali "Giuseppe Colombo" - CISAS

Mars

Noctis Labyrinthus: A particular target in Mars



© ESA

Data



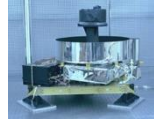
Base map :
h3212_0000 and h3221_0000 orthoimages (HRSC_Mars Express)

DEM : MOLA (~460 m/pixel)

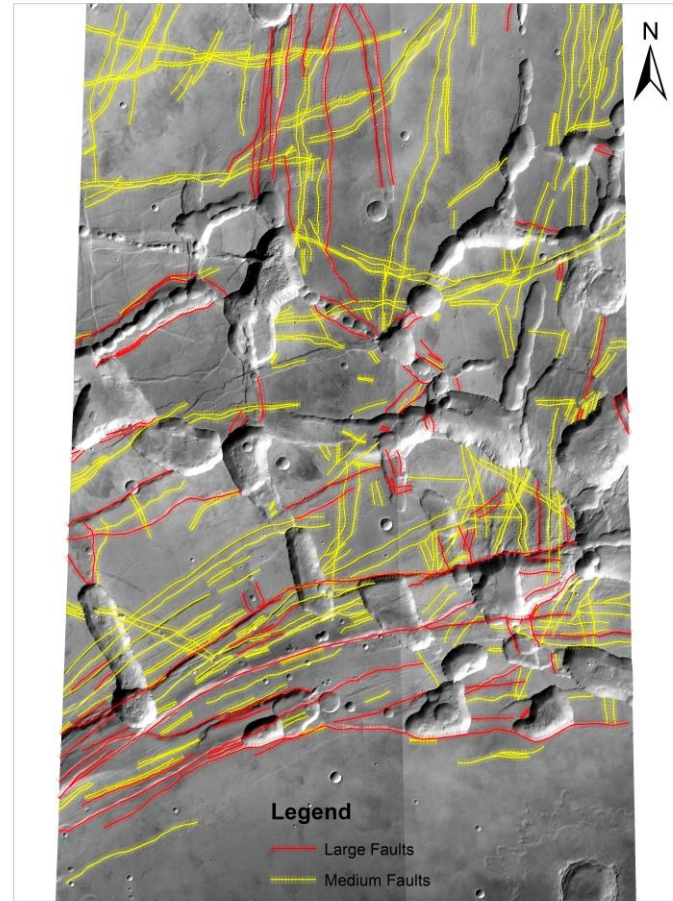
CTX Mosaic : For regional analysis (Mars Reconnaissance Orbiter)

Mapping Scale: 1:37.000

© Smithsonian Institution
Quadrangle:
Phoenicis Lacus (MC-17)

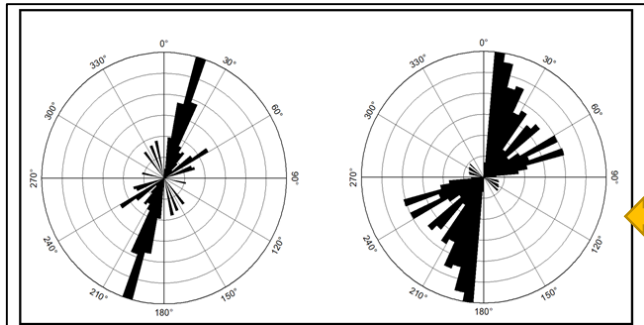
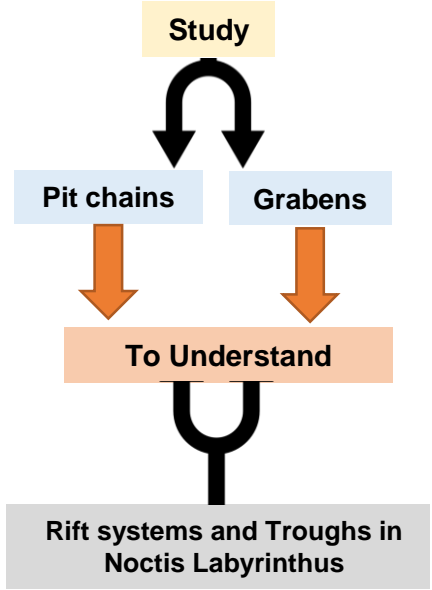
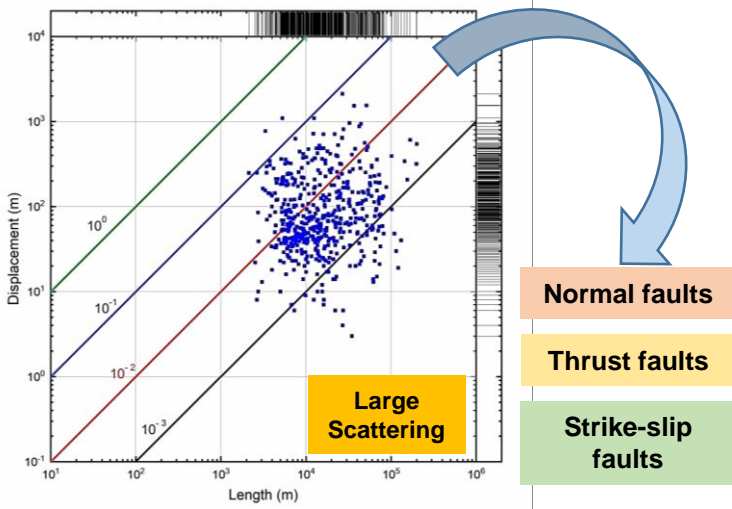
| HRSC | CTX | MOLA |
|--|---|---|
| 19.5 m/pixel | 5.2 m/pixel | 460 m/pixel |
|  |  |  |
| © ESA | © JPL | © JPL |

$2.130 \text{ km} \leq \text{Length} \leq 269 \text{ km}$
 $8\text{m} \leq \text{Maximum vertical offset} \leq 773\text{m}$

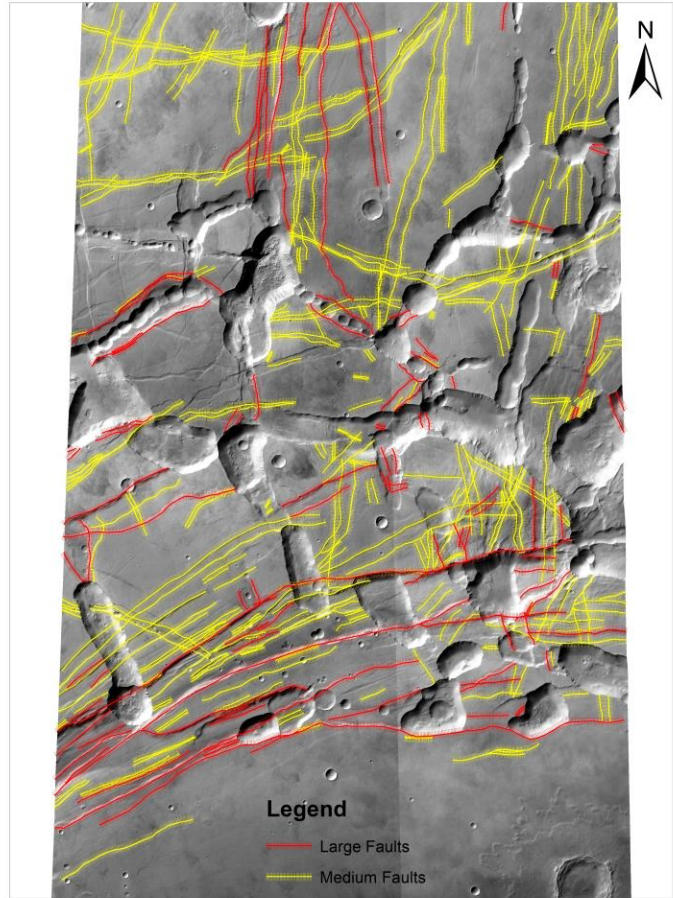


Legend
— Large Faults
— Medium Faults

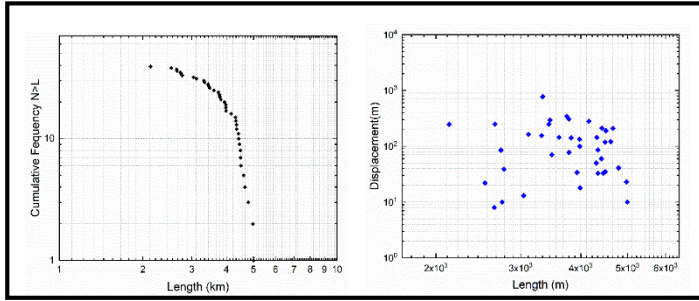
Noctis Labyrinthus: A particular target in Mars



The directions attributes of faults population through the rose diagrams show two different trends of the faults system: ENE-WSW and NS.

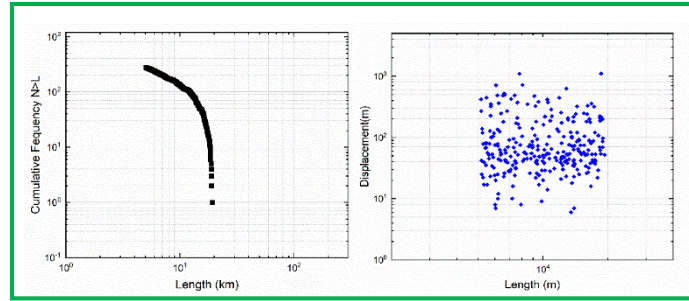


Noctis Labyrinthus: A particular target in Mars



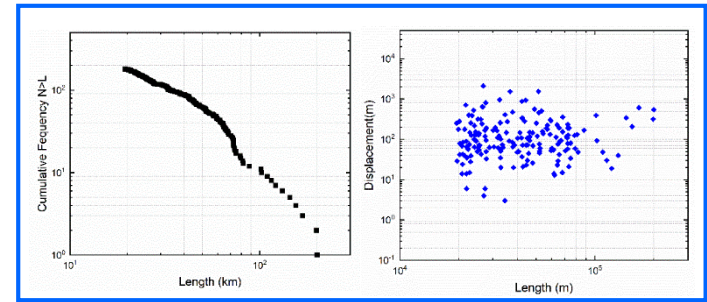
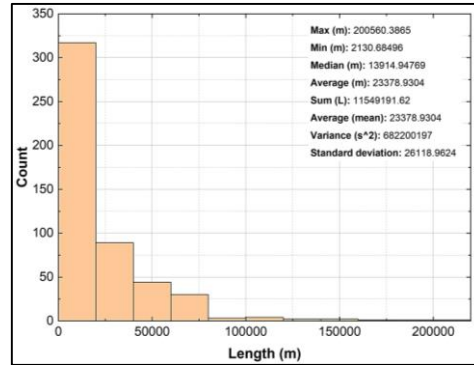
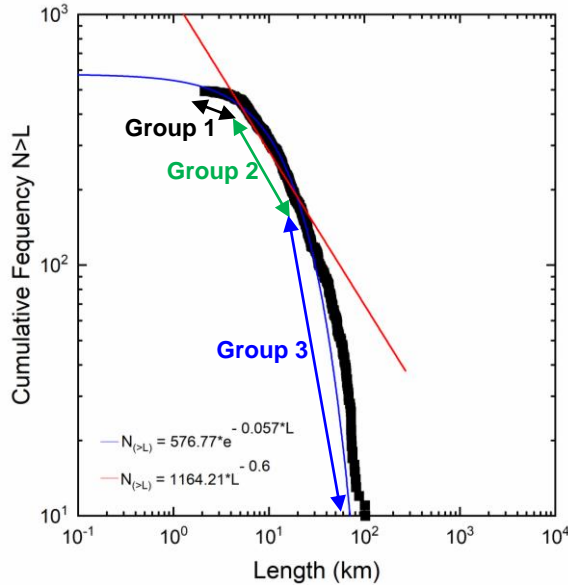
Group 1

2.130 km < L < 4.998 km and 8m < D < 773m



Group 2

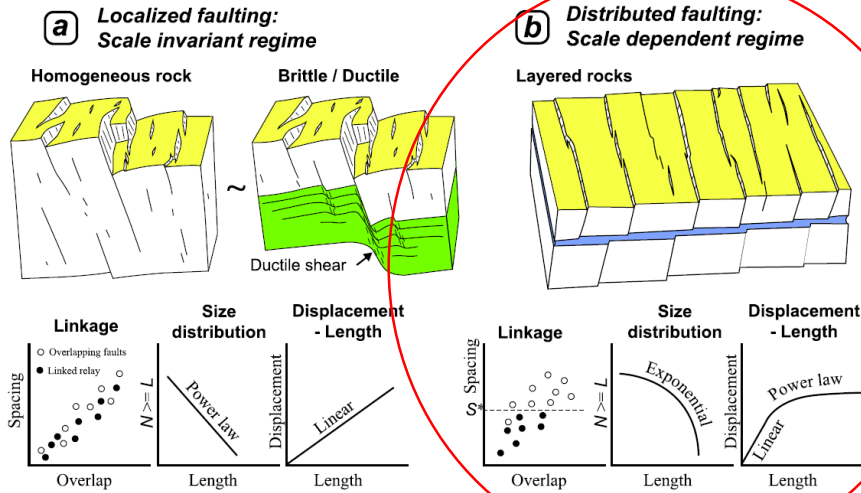
5.060 km < L < 19.303 km and 6m < D < 1095m



Group 3

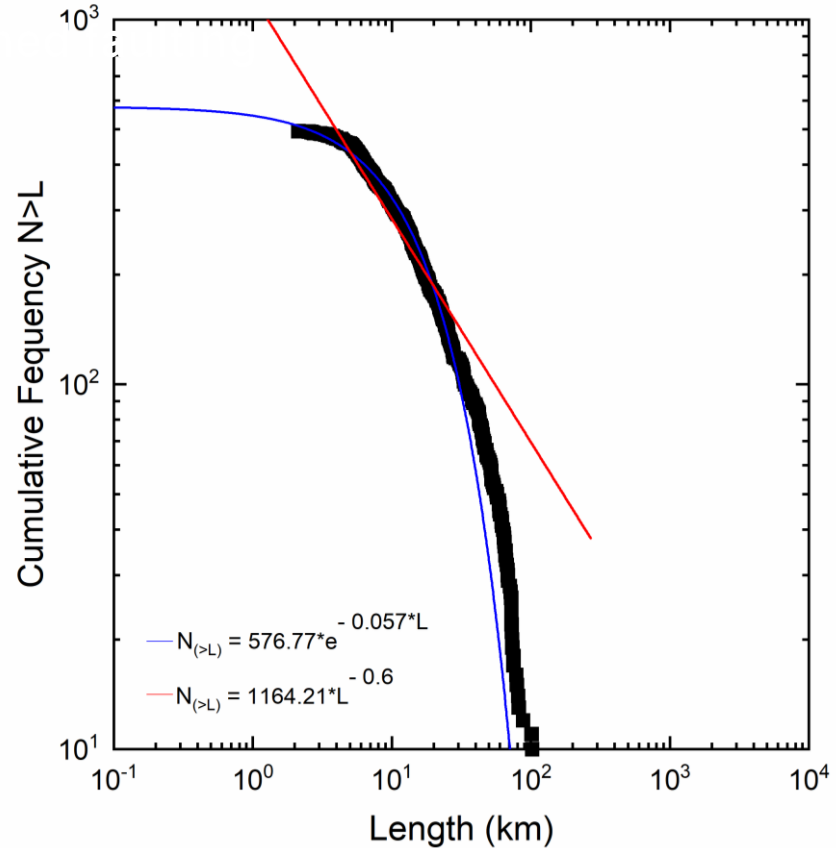
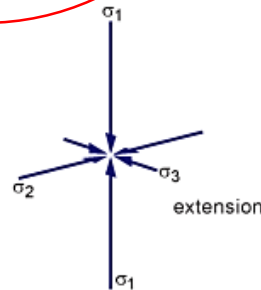
19.545 km < L < 200.560 km and 3m < D < 2119m

Noctis Labyrinthus: A particular target in Mars

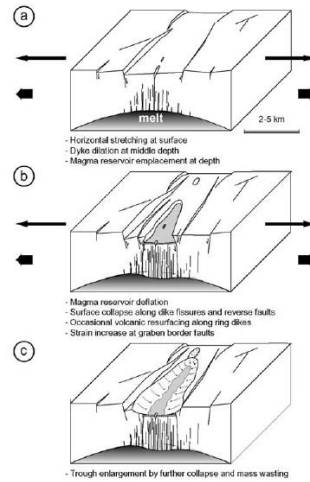
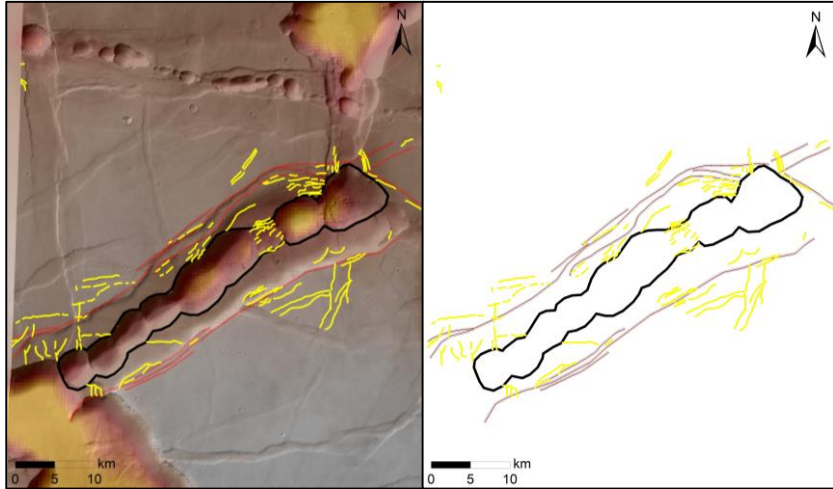


(Soliva, R & Scultz, R.A., 2008)

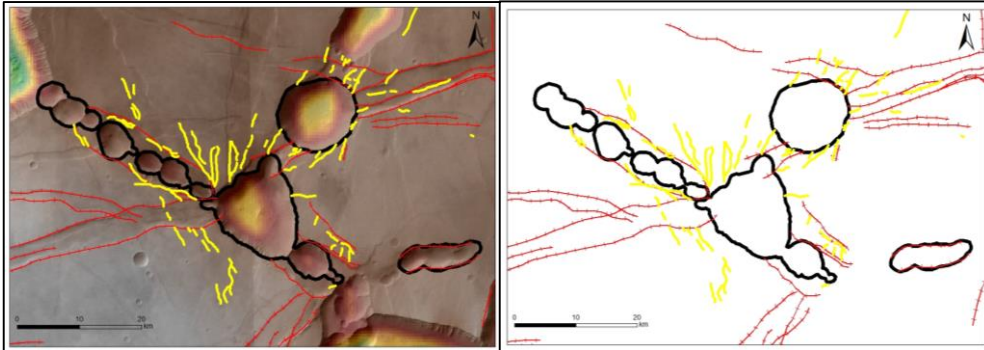
Invariant early extensional stress field



Noctis Labyrinthus: A particular target in Mars



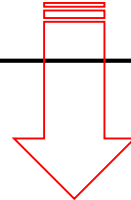
(Mège et al, 2003)



**Rift System
+
Scalloped troughs and Pit
chains**



**Earlier extensional stress
field
+
Magmatic processes**



Main driving processes

Mercury

Eminescu quadrangle (H9) of Mercury

Mapping scale: 1:3M

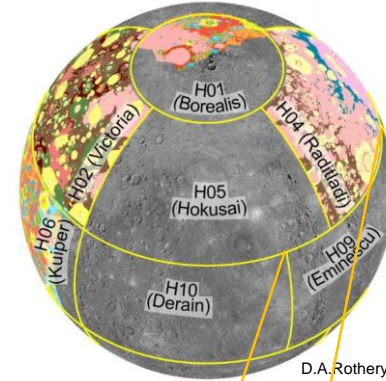
Symbology: Following the same symbology used by V.Galluzzi et al.,2016.

Objectives:

1- Mapping: Morpho-stratigraphic and Chrono-stratigraphic Maps.

2- Selection of the targets for the SIMBIO-SYS on-board BepiColombo space mission.

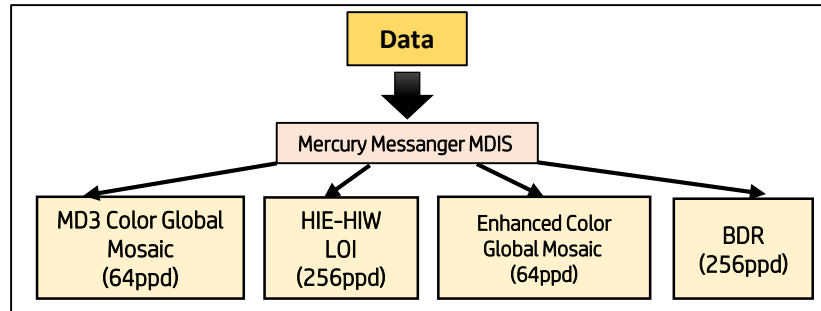
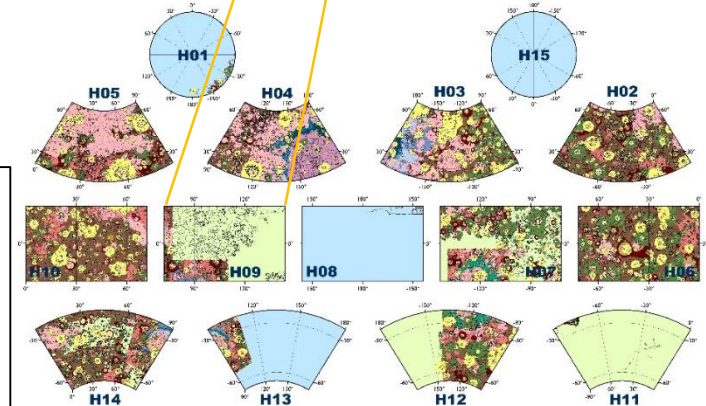
3- Study the main geological features.



Coordinates:
72°E - 144°E
22,5°N - 22,5°S

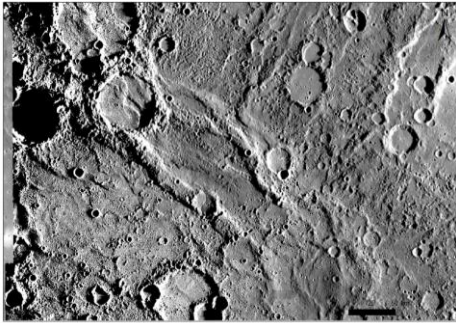
Projection System:
Equirectangular projection

D.A.Rothery et al., 2020

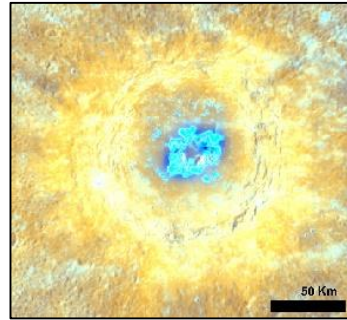


[1] Mapping : Morpho-stratigraphic Map

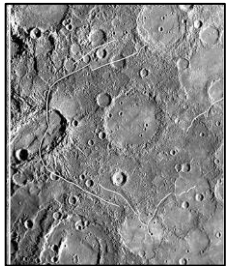
- ❖ 45% have been mapped.
- ❖ Selection of some interesting targets to study the regional tectonic and the geomorphology.



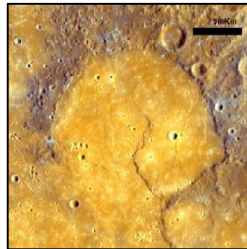
Broad valleys



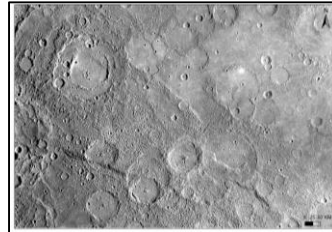
Hollows



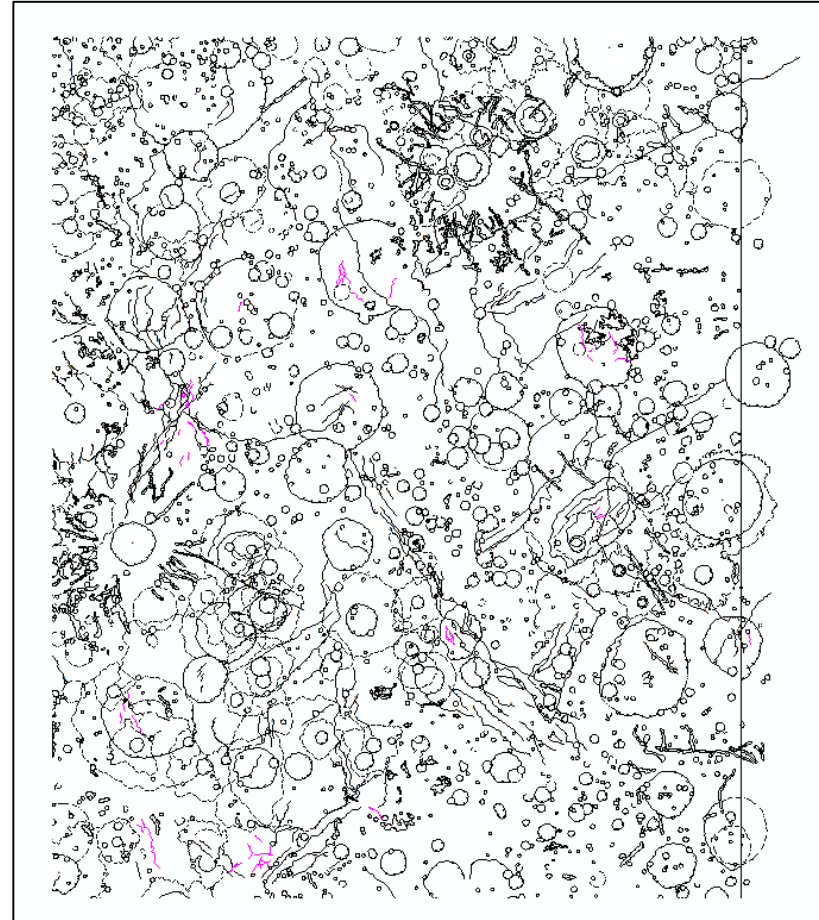
Beagle
Rupes






Faulted Crater floor






Densely cratered terrains

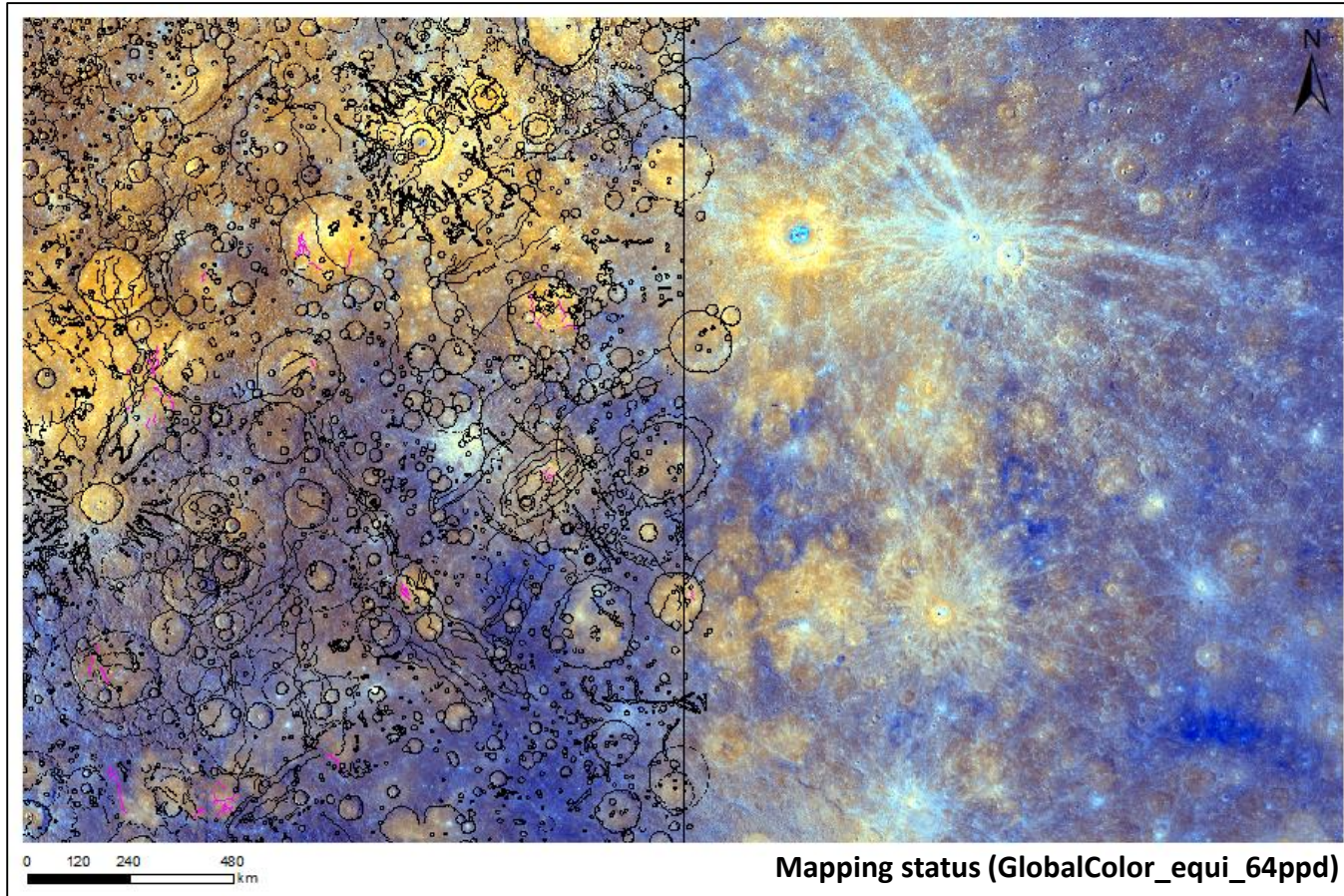


[1] Mapping : Morpho-stratigraphic Map

- H09_PointFeatures
 - Undefined point feature
 - TYPE
 - isolated bright spots
 - isolated dark spots
 - isolated hollowsNot yet 
- H09_LinearFeatures_Morphology
 - undefined morphology
 - crest of crater rim $D > 20$ km
 - crest of crater rimp $5 < D < 20$ km
 - crest of degraded or buried crater
 - volcanic ventDone 
- H09_LinearFeatures_Structures
 - Undefined Structures
 - TYPE
 - certain fault
 - certain graben axis
 - certain thrust
 - uncertain fault
 - uncertain graben axis
 - uncertain thrust
 - wrinkle ridgeDone 

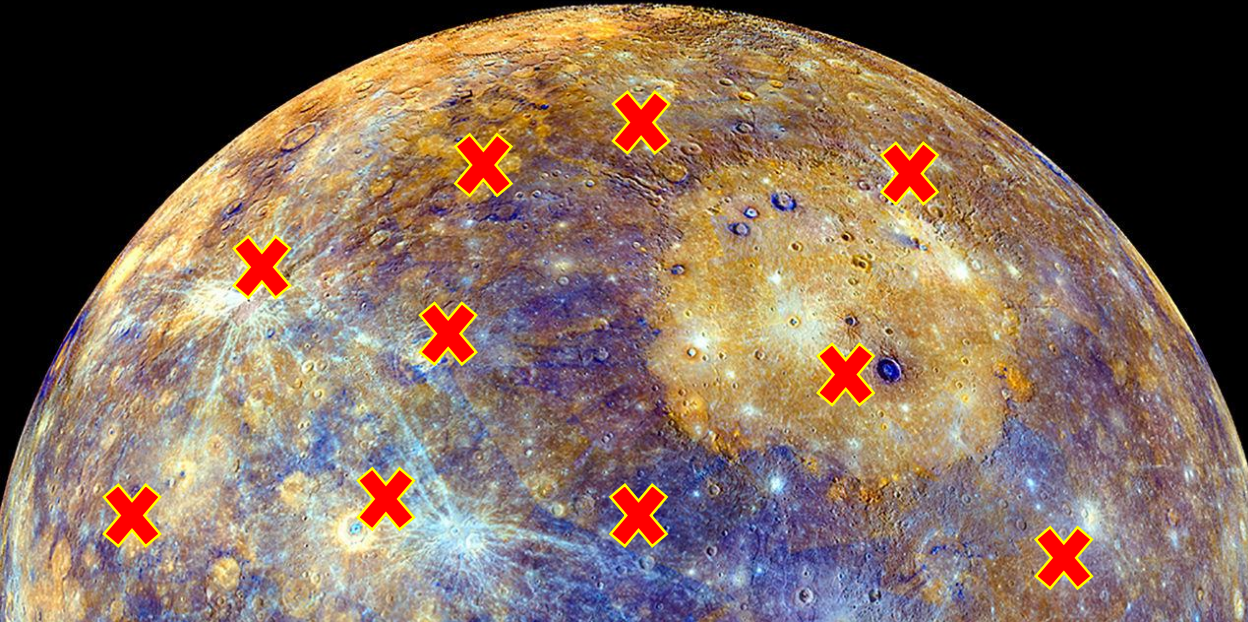
- H09_GeologicalContact
 - Undefined contact
 - Geological contact
 - contact, approximate
 - contact, certain45% 
In progress
- H09_SurfaceFeatures
 - uncertain surface features
 - Surface Features
 - bright material
 - cluster of hollows
 - dark material
 - rough ejecta
 - secondary crater chain or clusterNot yet 
- H09_GeologicalUnits
 - No Unit
 - UNIT
 - c1, heavily degraded crater
 - c2, degraded crater
 - c3, well preserved crater
 - dark material
 - hummocky crater floor
 - intercrater plains
 - intermediate plains
 - smooth crater floor
 - smooth plainsNot yet 

Mercury: Eminescu quadrangle



Mercury: Eminescu quadrangle

[2] Selection of the targets for the SIMBIO-SYS on-board BepiColombo space mission



bepicolombo

→ INVESTIGATING
MERCURY'S MYSTERIES

Mercury Planetary Orbiter (MPO)



Study the planet's surface and interior

Mercury Planetary Orbiter (MPO): 2,540 pounds (1,150 kilograms)

1. BELA–BepiColombo Laser Altimeter
2. ISA–Italian Spring Accelerometer
3. MPO-MAG–Magnetic Field Investigatio.
4. MERTIS–Mercury Radiometer and Thermal Imaging Spectrometer
5. MGNS–Mercury Gamma-Ray and Neutron Spectrometer
6. MIXS–Mercury Imaging X-ray Spectrometer
7. MORE–Mercury Orbiter Radio Science Experiment
8. PHEBUS–Probing of Hermean Exosphere by Ultraviolet Spectroscopy
9. SERENA–Search for Exosphere Refilling and Emitted Neutral Abundances (neutral and ionized particle analyzer)
10. SIMBIO-SYS–Spectrometers and Imagers for MPC BepiColombo Integrated Observatory
11. SIXS–Solar Intensity X-ray and Particle Spectrometer

Mercury Magnetospheric Orbiter (MMO)



Study the planet's magnetic field

Mercury Magnetospheric Orbiter (MMO): 606 pounds (275 kilograms):

1. MMO-MGF–Mercury Magnetometer
2. MPPE–Mercury Plasma Particle Experiment
3. PWI–Mercury Plasma Wave Instrument
4. MSASI–Mercury Sodium Atmospheric Spectral Imager
5. MDM–Mercury Dust Monitor

Mercury: Eminescu quadrangle

[2] Selection of the targets for the SIMBIO-SYS on-board BepiColombo space mission

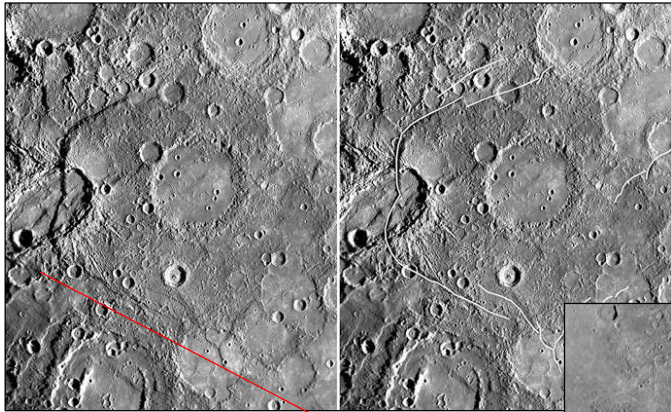
25 Target have been selected

| | | | |
|-----------------------|---|---|--|
| bright deposits | 2 | Scattered bright deposits around a very small crater | The BM cluster around the crater's floor, rim and the surrounding area. Th |
| bright deposits | 2 | Scattered bright deposits around a very small crater | The BM cluster around the crater's floor, rim and the surrounding area. Th |
| Landslide in Crater | 4 | ed a landslide, depth differentiated sampling peak of the crater. Target useful for | o understand how the cliff recession occurred. This target is interesting to |
| Young Crater | 2 | Young Crater with large and thin ejecta of blue color overlies a yellow terrains | n and ejecta present different color variation. This target it can help by giv |
| Young Crater | 4 | ng crater with Surrounding bright and dark materials, useful to study the composi | t color variation with bright and dark materials. This target it can help by g |
| Dark spot | 3 | Dark spot in low reflectance materials | crater's rim, with a low reflectance material. This target is useful for the su |
| Bagryana crater | 2 | Bagryana crater with fresh,clear central peak (Good sample for age marker) | The crater rim and the central peak show the presence of a bright materi |
| Complex crater | 4 | Fresh and clear peak of complex crater | ng HRM. The ejects present various color variation. The selected target is ci |
| Complex crater | 3 | Complex crater with gravitational landslide, useful for stratigraphy study | posits in the crater's floor is very useful to understand how the cliff recessi |
| Small crater | 2 | Fresh small impact crater over yellow terrains | atch. The crater is surrounded by a BM. This target is interesting to study ti |
| Small crater | 2 | Young crater with dark materials | nd the ejecta present some bright spots. This target is interesting to study f |
| crater floor | 4 | teresting floor color of the crater (It could be interesting to study the compositi | cta do no present higher albedo or HRM. The crater's floor can be consid |
| Crater with landslide | 4 | Impact generated a landslide,Target useful for the stratigraphy | o understand how the cliff recession occurred. This target is interesting to |
| hollows field | 4 | Possible hollows target, useful for gravitational landslide studies | ow the cliff recession occurred. This target is interesting to study how Lan |
| Crater with landslide | 3 | Impact generated landslide, useful for the stratigraphy | o understand how the cliff recession occurred. This target is interesting to |
| central peak | 5 | Interesting morphology for the crater's central peak | a particular shape of the central peak. This target is interesting to study th |
| Unclassified features | 3 | Unclassified features within a crater | with high albedo and BM. This target is interesting to study the crater char |
| Crater with landslide | 3 | Impact generated landslide, useful for the stratigraphy | o understand how the cliff recession occurred. This target is interesting to |
| Elliptical irregular | 3 | Elliptical and irregular crater with Hummocky morphology in the floor | n the crater's floor. The floor display and high albedo. This target it's intere |
| hollows field | 4 | Possible hollows target | v clusters. It is an important target to study the volatiles and the sublimati |
| hollows field | 4 | Possible hollows target | ogy of the surface. Hollows can be an age marker since they are considere |
| hollows field | 4 | Possible hollows target | v clusters. It is an important target to study the volatiles and the sublimati |
| hollows field | 4 | Possible hollows target | ogy of the surface. Hollows can be an age marker since they are considere |
| hollows field | 4 | Possible hollows target | v clusters. It is an important target to study the volatiles and the sublimati |
| hollows field | 4 | Possible hollows target | ogy of the surface. Hollows can be an age marker since they are considere |

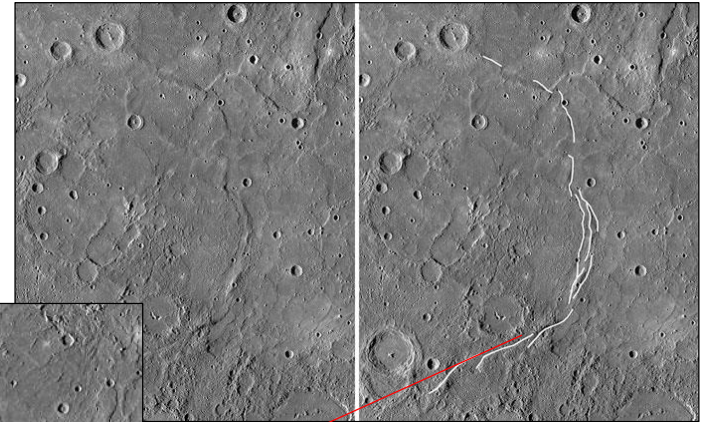


Mercury: Eminescu quadrangle

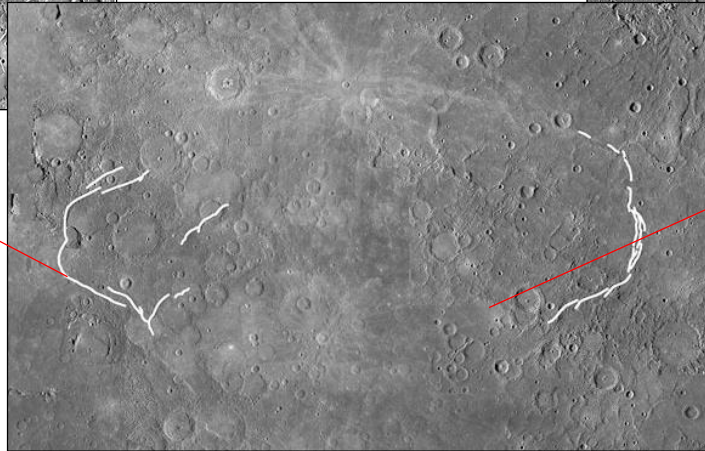
[3] To study the tectonic and geomorphological features:



Beagle Rupes

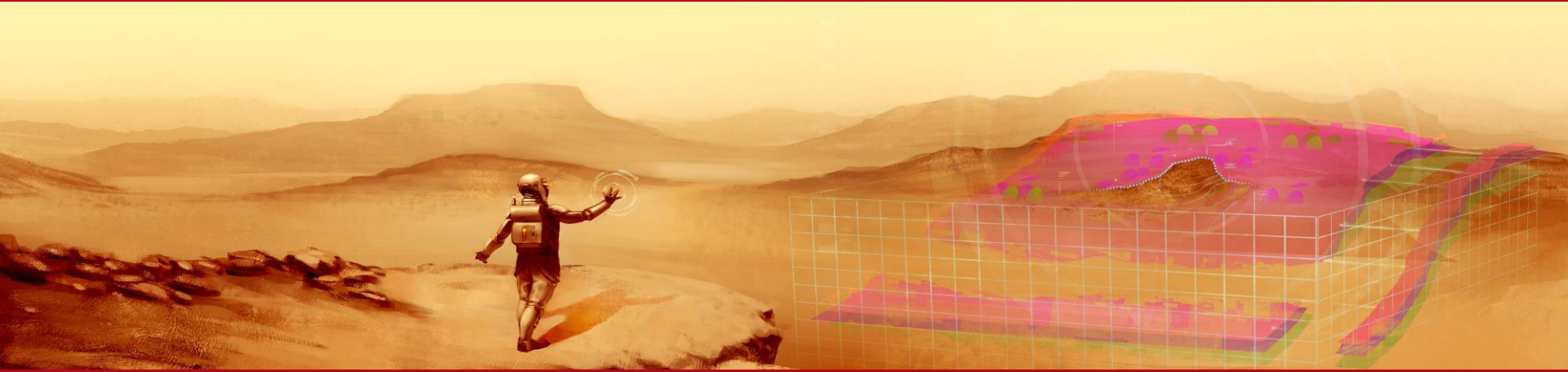


Paramour Rupes



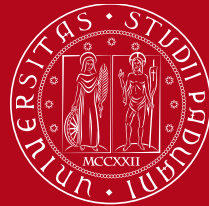
The area is 2500 km wide,
centered at 130°E, 5°N

Thank you for your attention



PLANMAP
Geologic Mapping of our Solar System

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