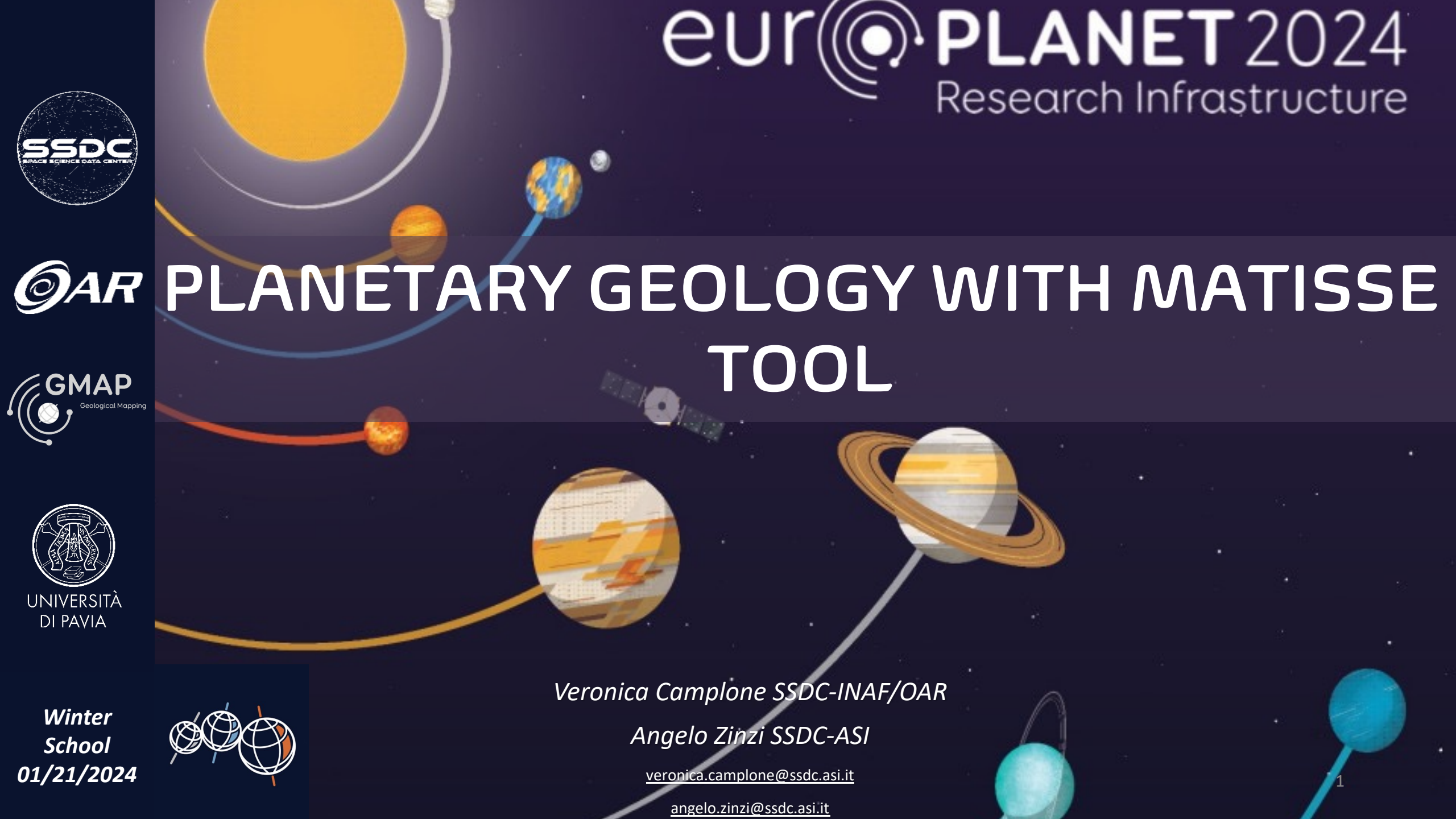

PLANETARY GEOLOGY WITH MATISSE TOOL

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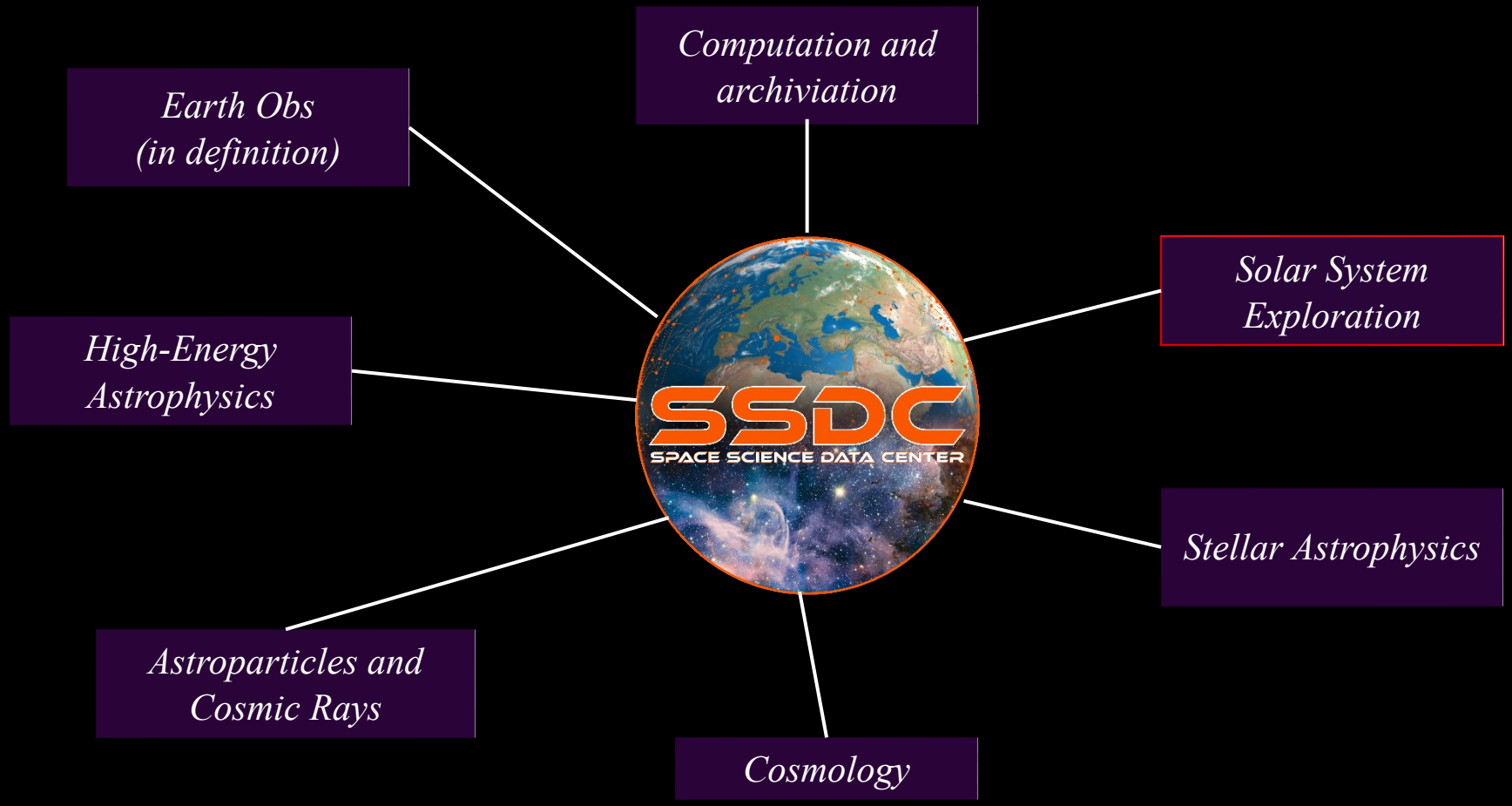
Winter School 01/21/2024

Space Science Data Center

Center for scientific operations, data processing, and data storage that provides support to various scientific space missions.
We are committed to acquiring, managing , processing and distributing space mission data following the FAIR principles (findable, accessible, interoperable and reusable), in order to guarantee the maximum quality and usability of the information collected.



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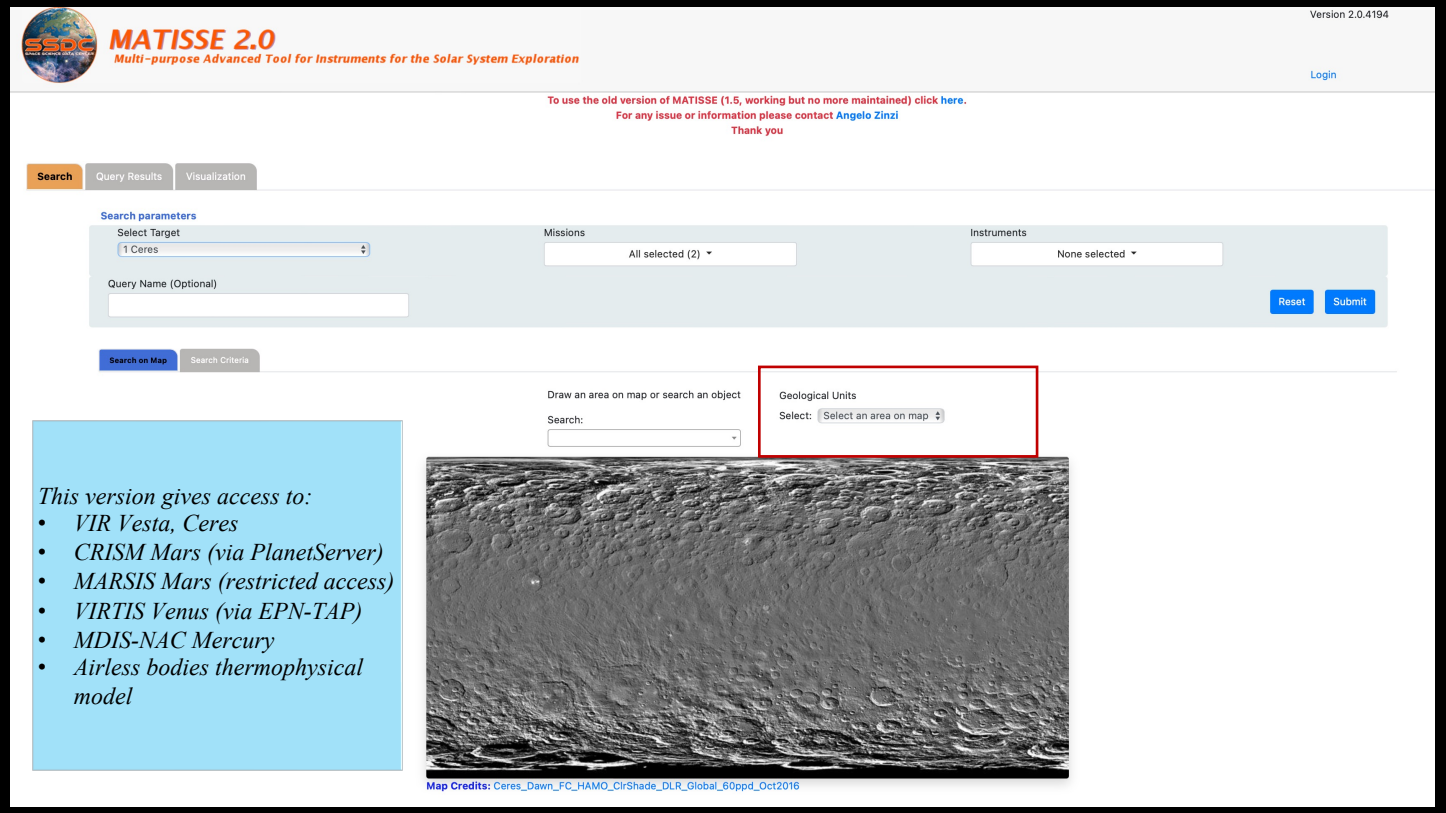
MATISSE (Multi Purpose Advanced tool for Instruments for the Solar System Exploration)

Completely written in **Python 3**, MATISSE 2 is now available at https://tools.ssdc.asi.it/Matisse

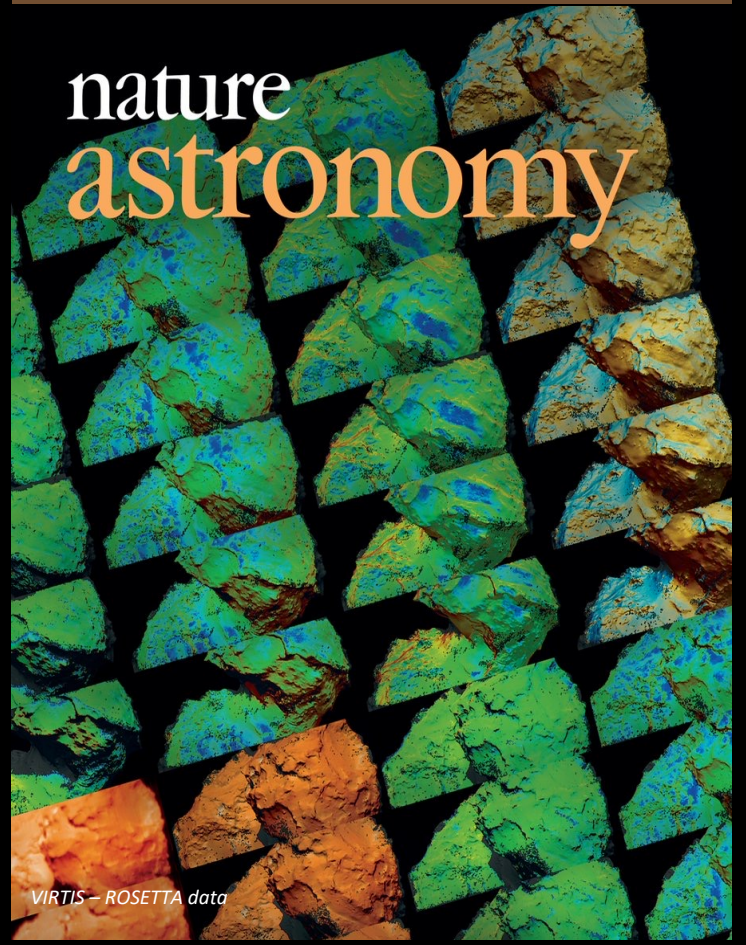


This version gives access to:

- *VIR Vesta, Ceres*
- *CRISM Mars (via PlanetServer)*
- *MARSIS Mars (restricted access)*
- *VIRTIS Venus (via EPN-TAP)*
- *MDIS-NAC Mercury*
- *Airless bodies thermophysical model*

- *Visualizzation of data direcly from the tool;*
- *Visualization 3D models for small bodies;*
- *Thermophysical model: it is available in MATISSE a thermophysical model for airless bodies (Ceres, Mercury), capable of predicting surface temperatures;*
- *Martian radar addition: together with MARSIS and Gmap teams we added subsurface radar data to the MATISSE DB*

July 2019 Nature Astronomy cover!



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MATISSE (Multi Purpose Advanced tool for Instruments for the Solar System Exploration)

Advanced queries based on models and geological maps

A new DBMS

The PostgreSQL + PostGIS allows you to define geological units in a specific reference system

A new version of the tool to overcome fundamental issues

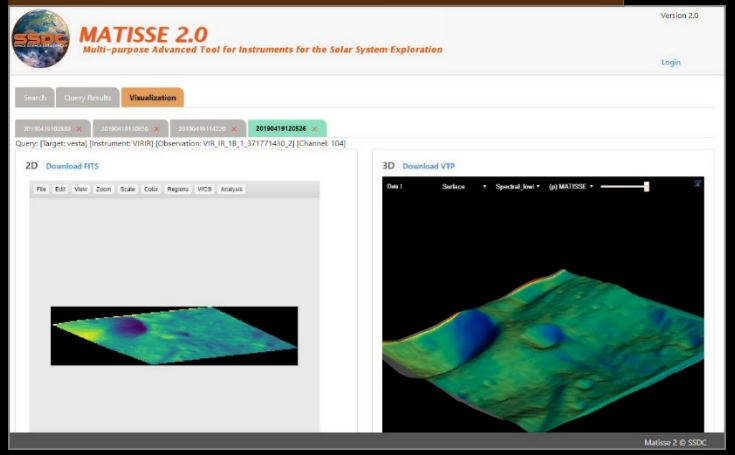
Models and Geology

User-friendly interface

Servlet based

It is possible to execute complex queries by command-line and not only by browser

You have a FITS file that already from the web page you can start editing and analyzing.



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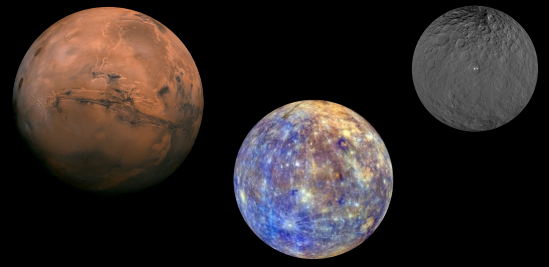
NEW FUNCTIONALITY IN MATISSE TOOL: Geological Maps

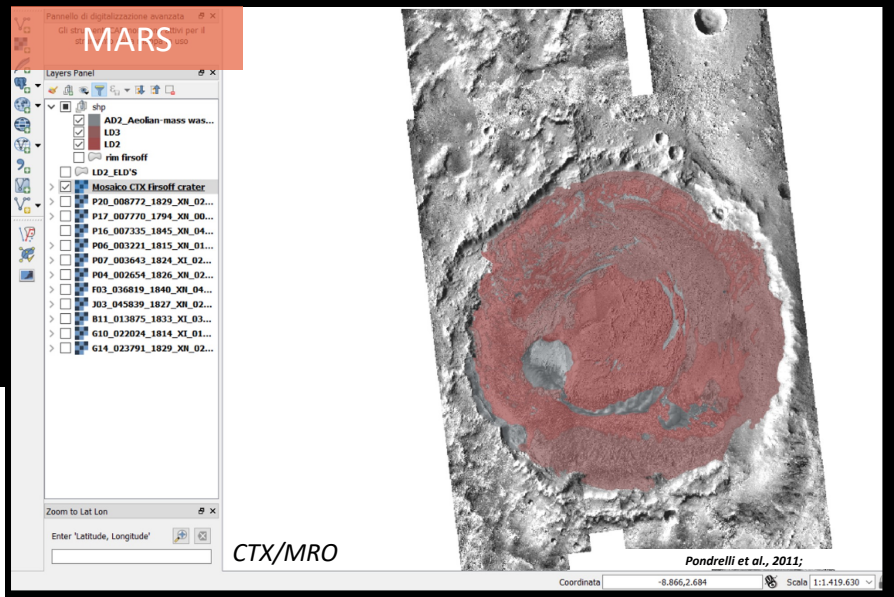
GMAP Geological Mapping

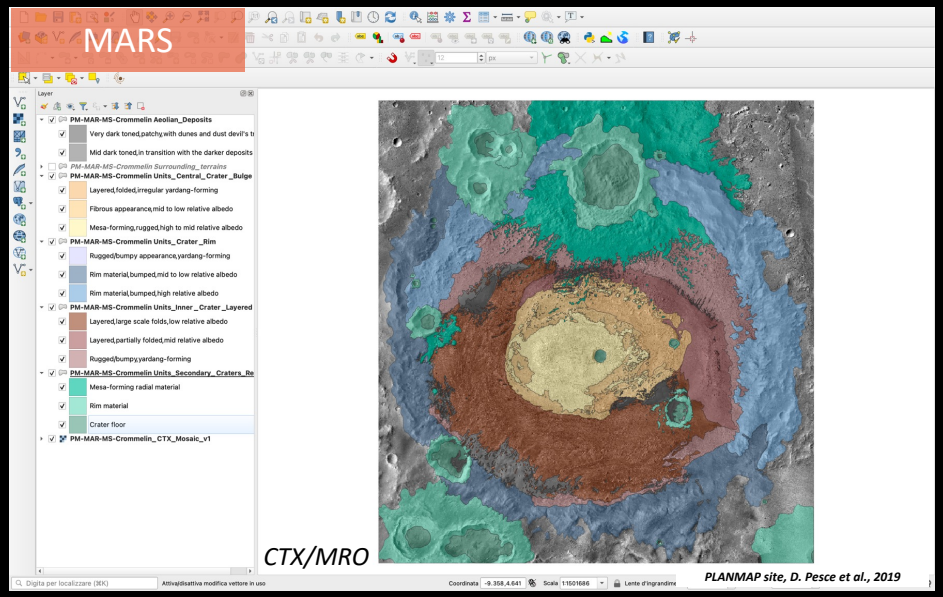
PLANMAP Geologic Mapping of our Solar System

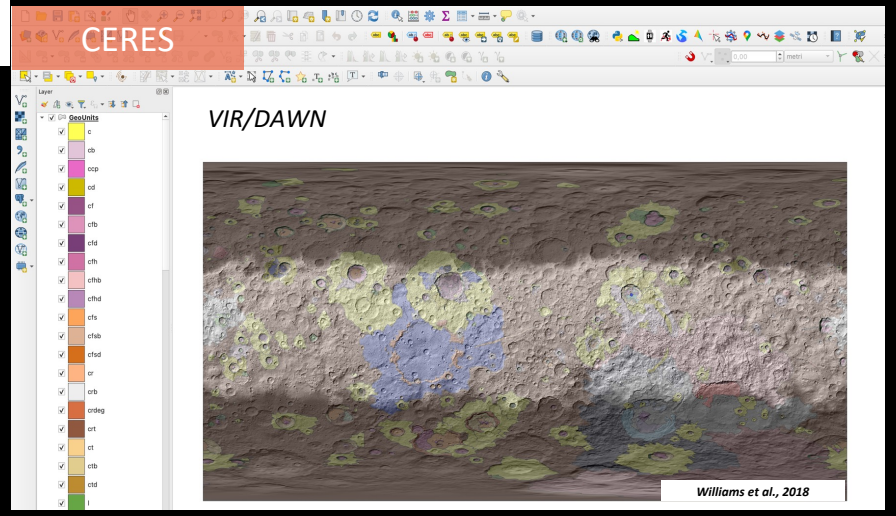


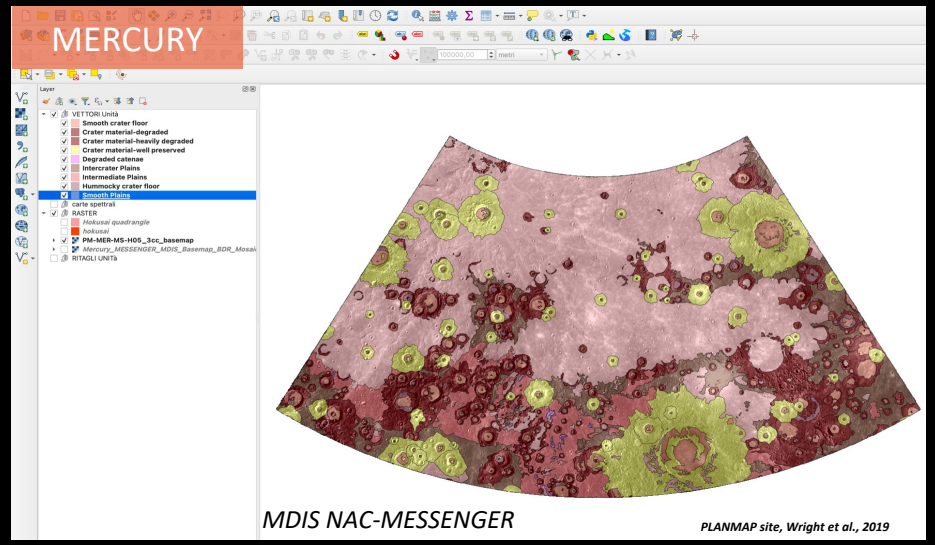
```
matisse_test=> select id,latlonsrid,ST_Srid(geometry), unit_name from geounits where id >=160 order by id;
 id  | latlonsrid | st_srid |                unit_name
-----+------------+---------+-----------------------------------------
 174 |      19910 |   19910 | Intermediate plains
 175 |      19910 |   19910 | Smooth plains
 176 |      19910 |   19910 | Crater materials-degraded
 177 |      19910 |   19910 | Intercrater plains
 178 |      19910 |   19910 | Hummocky crater floor
 179 |      19910 |   19910 | Degraded catenae
 180 |      19910 |   19910 | Crater materials-heavily degraded
 181 |      19910 |   19910 | Crater materials-well preserved
 194 |      19910 |   19910 | Smooth crater floor
 288 |      49900 |   49900 | Aeolian Deposits_Mid dark toned
 289 |      49900 |   49900 | Areas of mounds within ELDs
 290 |      49900 |   49900 | Equatorial Layered Deposits
 291 |      49905 |   49905 | Lobate material hummocky dark
 292 |      49905 |   49905 | Crater terrace material bright
 293 |      49905 |   49905 | Urvara crater peak material
 294 |      49905 |   49905 | Crater floor material hummocky bright
 295 |      49905 |   49905 | Urvara floor material smooth
 296 |      49905 |   49905 | Crater floor material hummocky
 297 |      49905 |   49905 | Crater floor material dark
 298 |      49905 |   49905 | Yalode ejecta
 299 |      49905 |   49905 | Lobate material smooth
```

We worked on creating tables in our database using codes written in Python.
These tables contain all the parameters necessary for the search and selection of units









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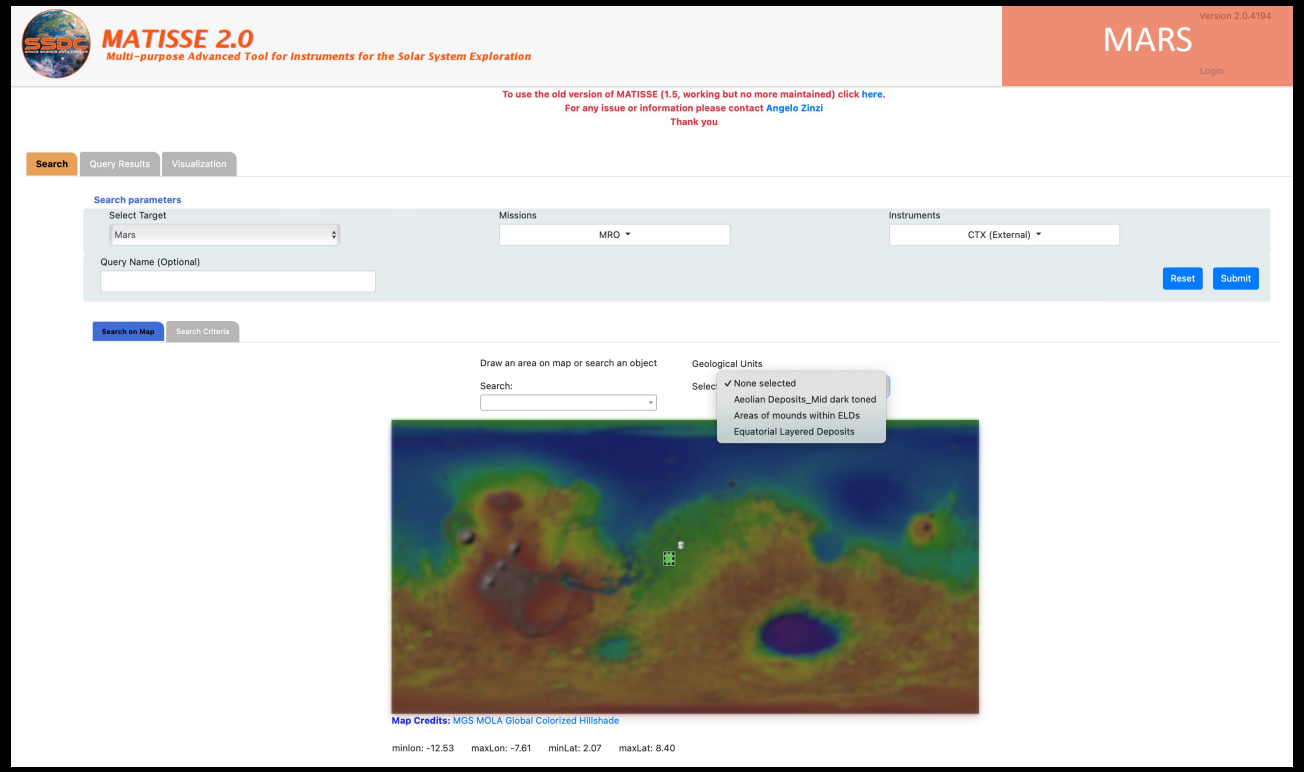
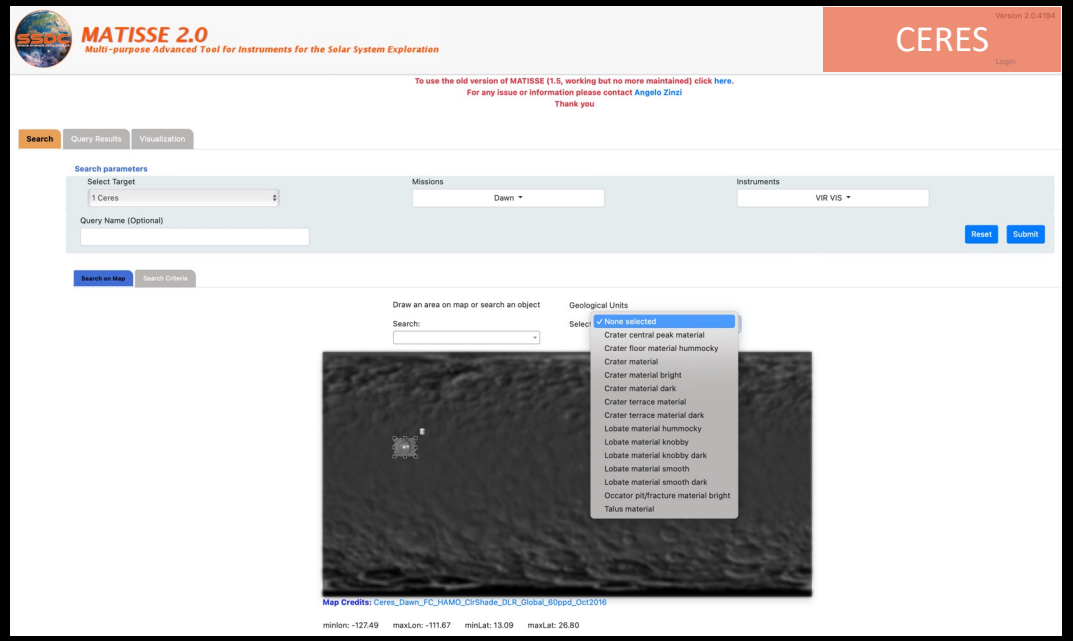
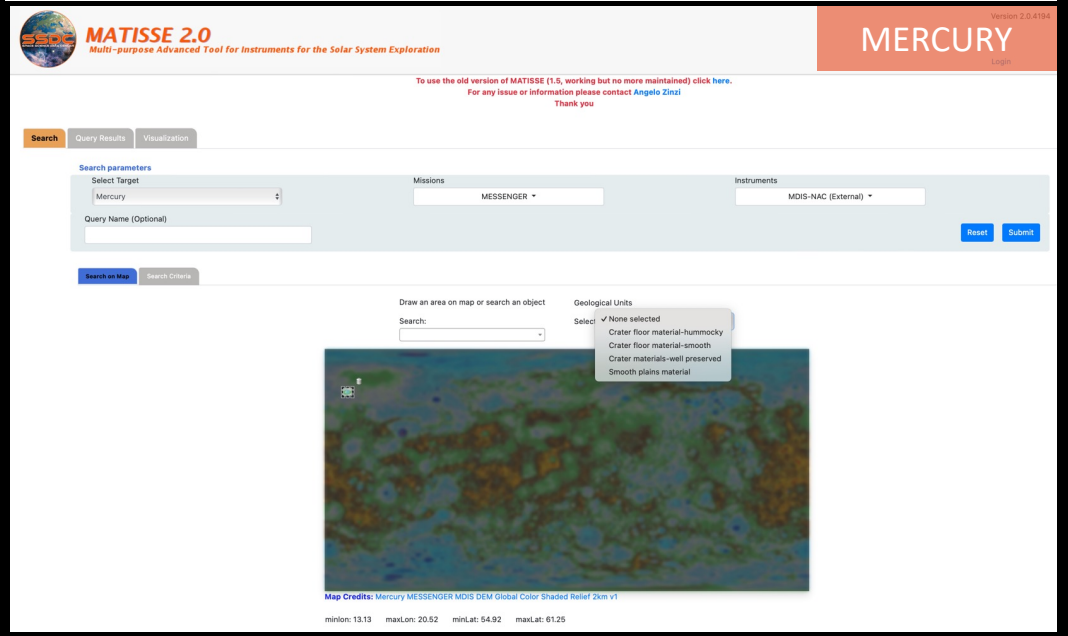
MATISSE tool







The approach is very flexible and we can use the geometries of the geological maps regardless of the dataset we want to analyze.

MATISSE automatically shows a detailed list of all geological units in that area, accessible through a dropdown menu.

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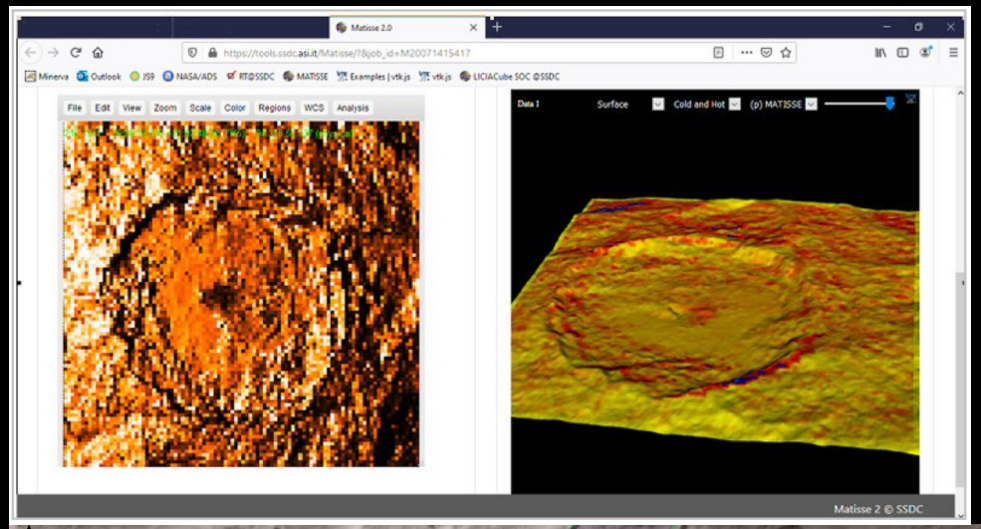
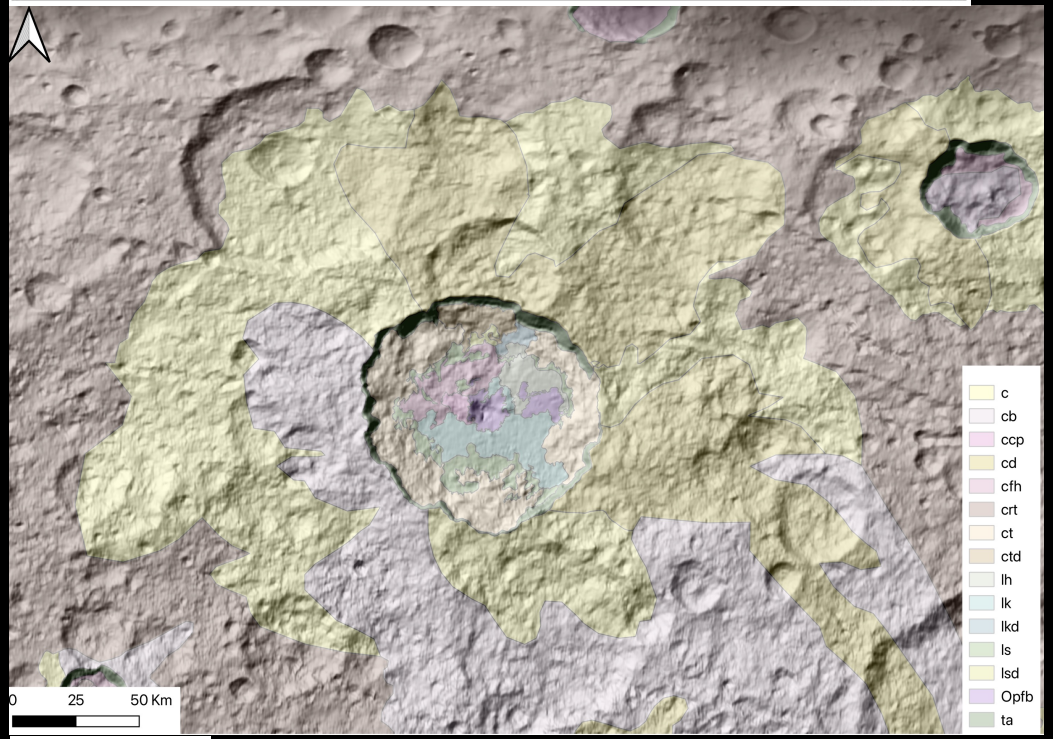
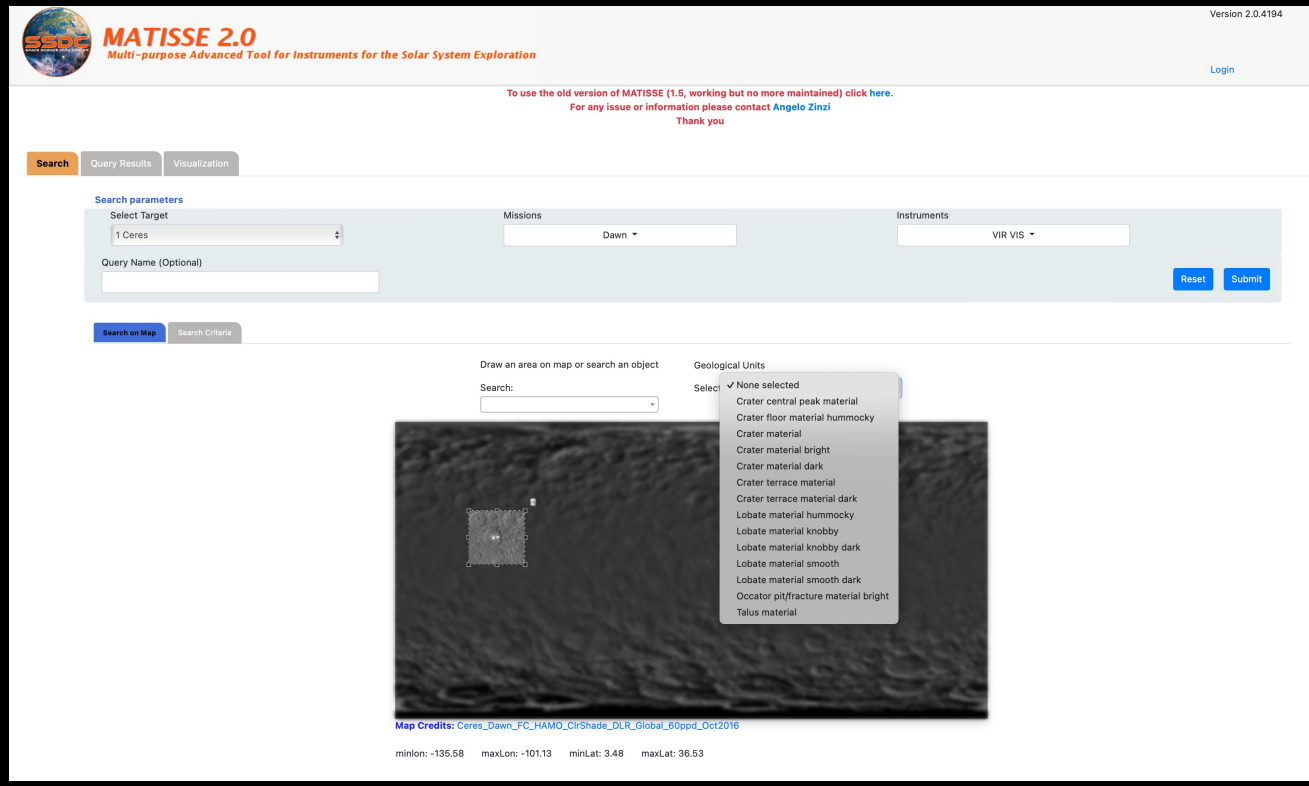
1. CERES: Occator crater





Nass, A. (2023)

Furthermore, in MATISSE it is possible to correlate geological maps with the thermophysical model. With this study it is possible to understand how the surface temperature changes based on the type of soil.



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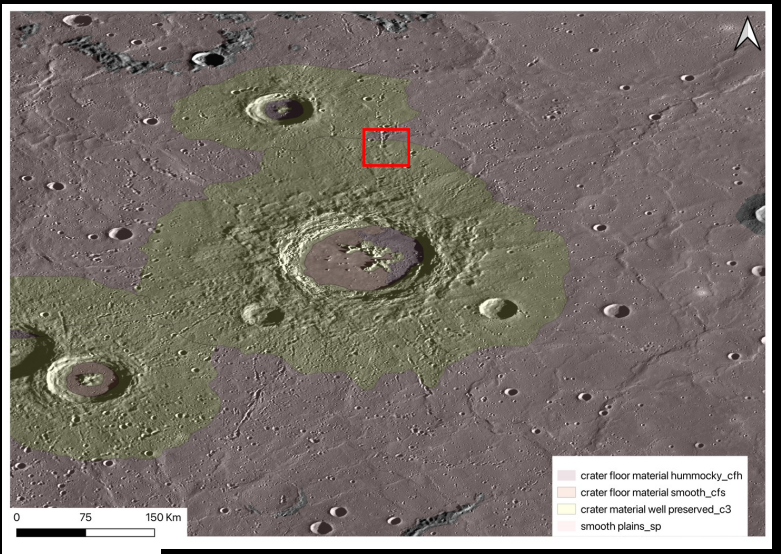
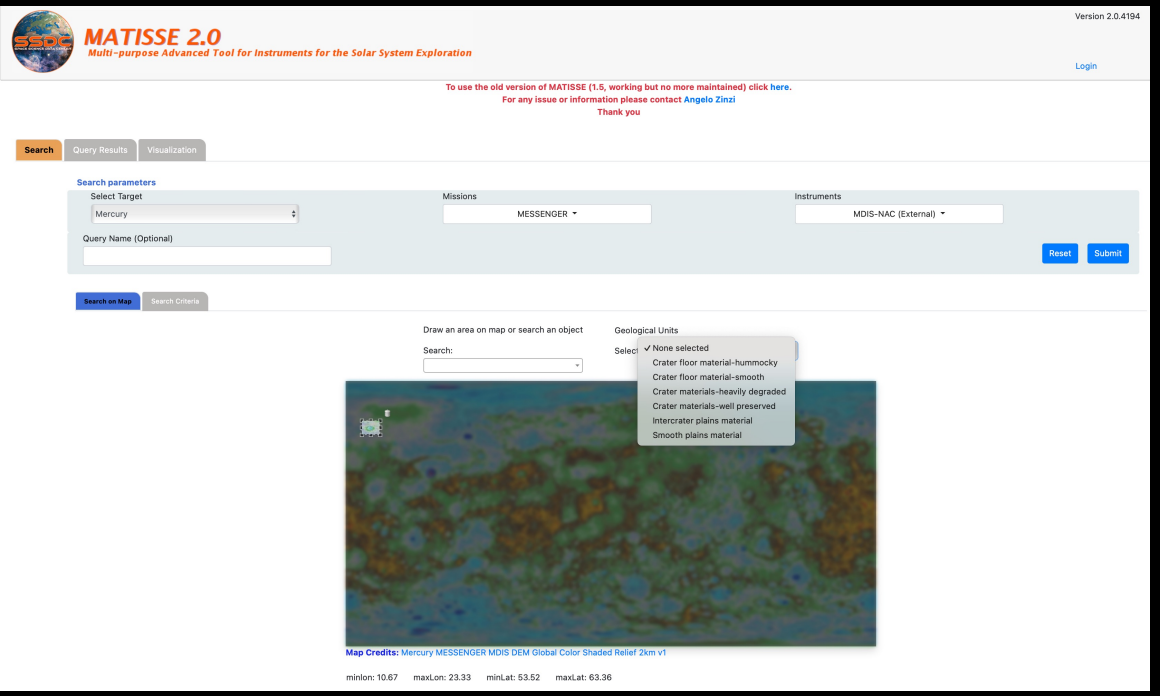
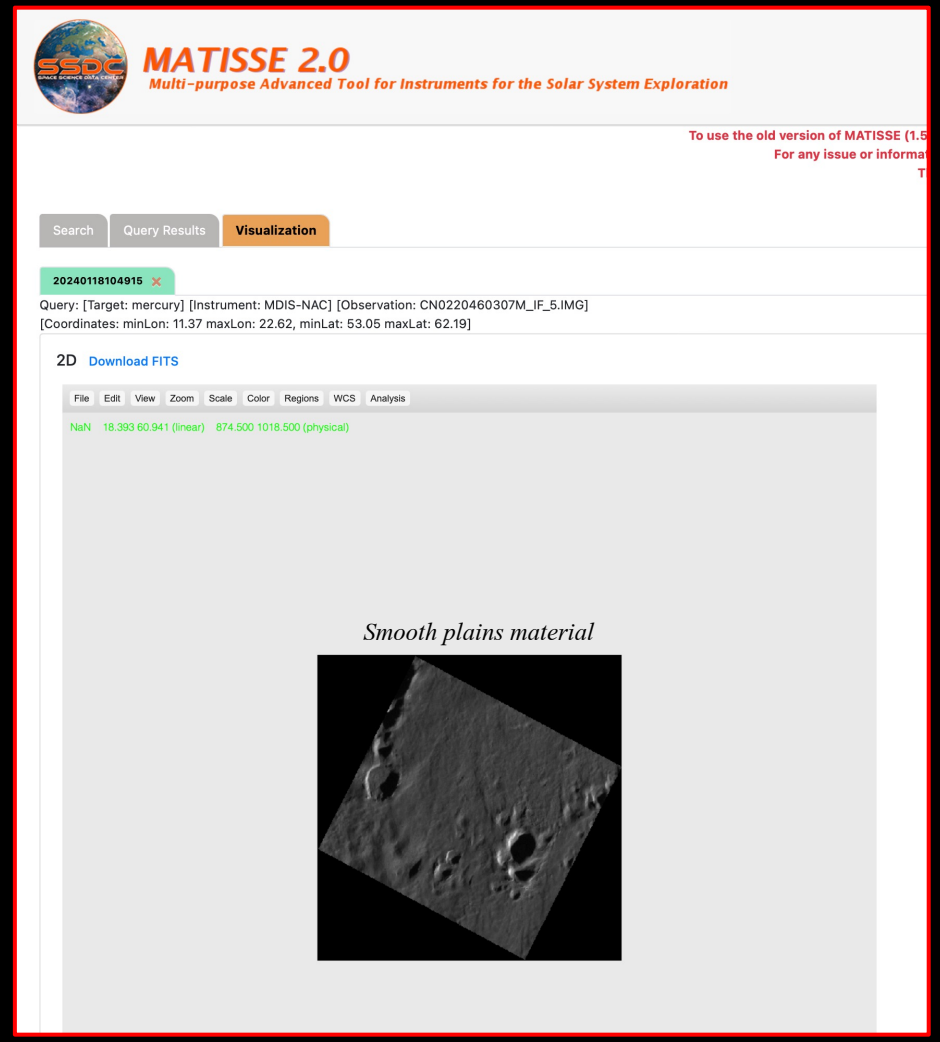
2. MERCURY: Hokusai crater



J.Wright et al.,

With MATISSE tool, we can quickly identify and correlate geological features with the presence of these particular craters, simplifying and speeding up field research





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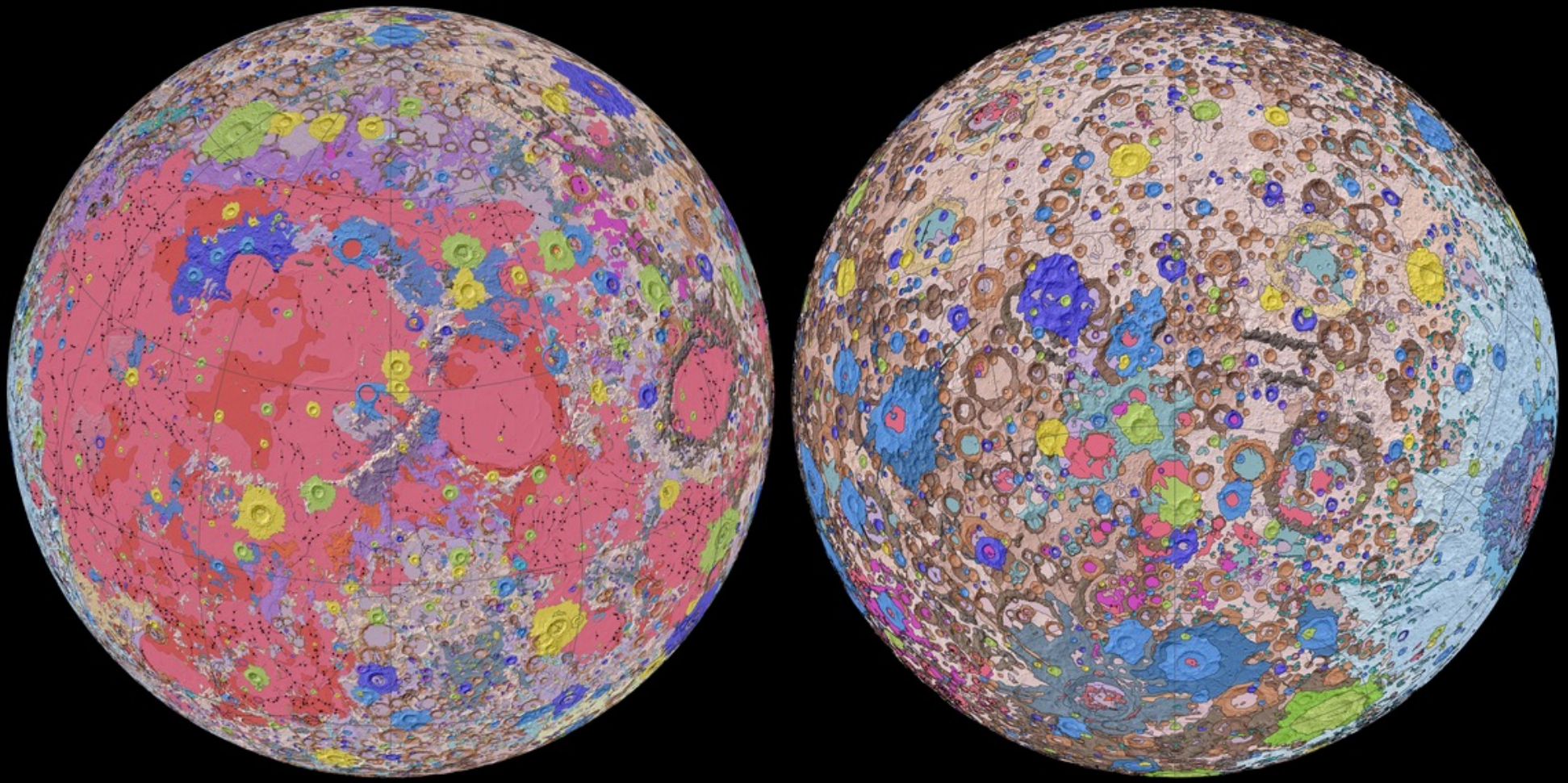
FUTURE TARGET INTO MATISSE TOOL



Nasa / Gsfc / Usgs

By integrating this unified geological map of the Moon, we aim to expand MATISSE into a more comprehensive tool for planetary scientists.

It allows us to set the stage for future scientific studies, making MATISSE not just a database for Mercury and Ceres, but a unified platform for planetary geology

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UPCOMING ENHANCEMENTS

CTX DATA

We are extending MATISSE's capabilities by incorporating new data sets for Mars. Specifically, we will soon be integrating CTX (Context Camera) images to provide an even more detailed view of the Martian surface, further enhancing our analytical precision. This update aims to meet the growing needs of the scientific community in Martian exploration.

ISIS_MATISSE

```
conda activate isisenv
python3
import subprocess
filein="/home/camplone/ISIS_MATISSE/P22_009816_1745_XI_05S073W.IMG"
fileout="/home/camplone/ISIS_MATISSE/P22_009816_1745_XI_05S073W.cub"
command=['mroctx2isis', 'from=',filein,'to=',fileout]
subprocess.call(command, stdout=subprocess.PIPE)
import subprocess
filein="/home/camplone/ISIS_MATISSE/P22_009816_1745_XI_05S073W.cub"
command=['spiceinit', 'from=',filein]
subprocess.call(command, stdout=subprocess.PIPE)
import subprocess
filein="/home/camplone/ISIS_MATISSE/P22_009816_1745_XI_05S073W.cub"
fileout="/home/camplone/ISIS_MATISSE/P22_009816_1745_XI_05S073W.cal.cub"
command=['ctxcal', 'from=',filein,'to=',fileout]
subprocess.call(command, stdout=subprocess.PIPE)
```

print

```
Object = mroctx2isis
  IsisVersion       = "6.0.0  | 2021-08-31"
  ProgramVersion    = 2016-06-10
  ProgramPath       = /home/camplone/.conda/envs/isisenv/bin
  ExecutionDateTime = 2022-07-13T12:07:57
  HostName          = Unknown
  UserName          = camplone
  Description       = "Import an MRO CTX image as an Isis cube"

  Group = UserParameters
    FROM    = P22_009816_1745_XI_05S073W.IMG
    TO      = P22_009816_1745_XI_05S073W.cub
    SUFFIX  = 18
    FILLGAP = true
  End_Group

  Group = Accounting
    ConnectTime = 00:00:07.4
    CpuTime     = 00:00:08.2
  End_Group
End_Object


Object = spiceinit
  IsisVersion       = "6.0.0  | 2021-08-31"
  ProgramVersion    = 2020-12-22
  ProgramPath       = /home/camplone/.conda/envs/isisenv/bin
  ExecutionDateTime = 2022-07-13T12:08:12
  HostName          = Unknown
  UserName          = camplone
  Description       = "Update SPICE data (kernels, pointing, and position) for
                       a camera cube"

  Group = UserParameters
    FROM          = P22_009816_1745_XI_05S073W.cub
```

TIFF

While we currently offer data in the FITS format, we are actively working to introduce downloads in the TIFF format. This addition will provide users with greater flexibility and ease in processing and analyzing the data.

ascii2geotif.py

```
from osgeo import gdal, osr, ogr
import numpy as np
import sys
import os

"""
python3 ascii2geotiff.py <outname> <target>
"""

f=open('body_radii.txt','r')
lines=f.readlines()
#result=[]
for x in lines:
    if sys.argv[2] == x.split(' ')[0]:
        a_radius=x.split(' ')[1]
        b_radius=x.split(' ')[2]
        c_radius=x.split(' ')[3]
f.close()

c_radius=c_radius.split('\n')[0]

"""
if (sys.argv[2] == 'moon'):
 radius='1737400'
if (sys.argv[2] == 'mercury'):
 radius='2439700'
if (sys.argv[2] == 'vesta_thomas'):
 radius='255000'
if (sys.argv[2] == 'ceres'):
 radius='473000'
if (sys.argv[2] == 'mars'):
 radius='3390000'
if (sys.argv[2] == 'venus'):
```


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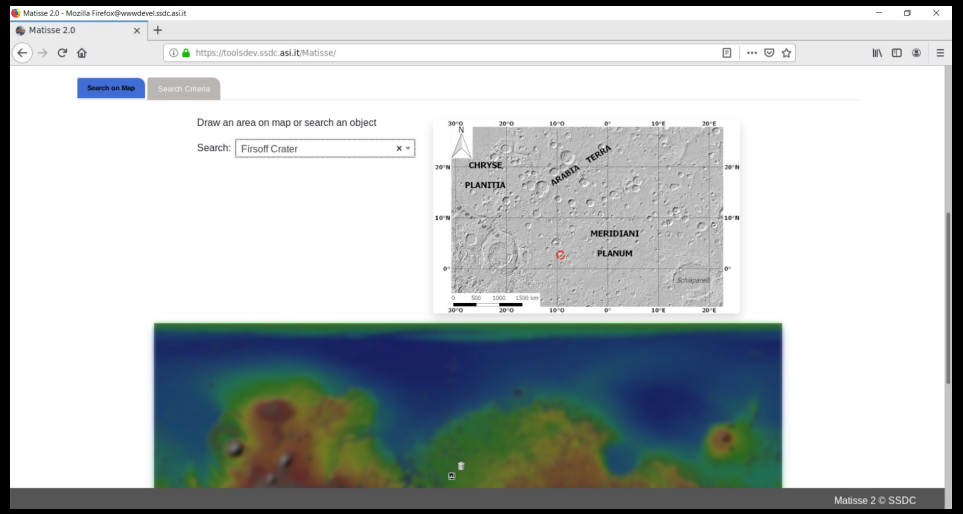
NEXT STEP

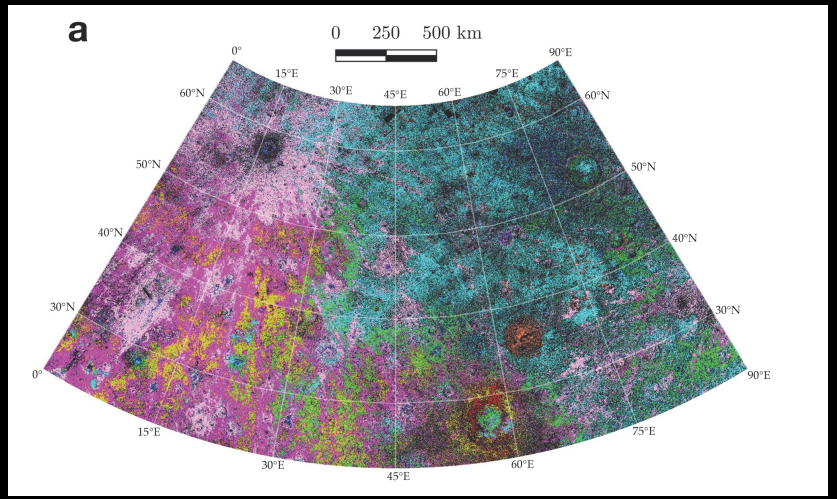
These changes will make MATISSE an even more powerful tool for the scientific community, facilitating access to valuable data and making the platform more versatile and user-friendly

POSSIBILITY OF SEARCHING FOR DATA BASED ON THE AREA YOU WANT TO ANALYZE (e.g. craters, valleys, etc.)

IMPLEMENTATION OF NEW FUNCTIONS FOR SURFACE ANALYSIS DIRECTLY FROM THE TOOL (e.g.topographic profile, spectral analysis, high resolution DTMs ...)

ADDITION OF OTHER DATASET (BepiColombo, CaSSIS; CTX, MARSIS, Moon Data)





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PLANETARY CARTOGRAPHY WITH MATISSE TOOL

Thank you for your attention

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