What is Mars made of? NEANIAS to help interactive exploration of Mars composition via spectral data access

Planetary science is very broad, with subjects of study ranging from the interiors of planets and moons to the space environment in between them, and a wide range of bodies, from dust to giant planets. Even just within terrestrial planets, there is a lot of **geologic diversity**. Different Solar System bodies are characterized by a variable complexity, which is reflected by their surface geology and **composition**.

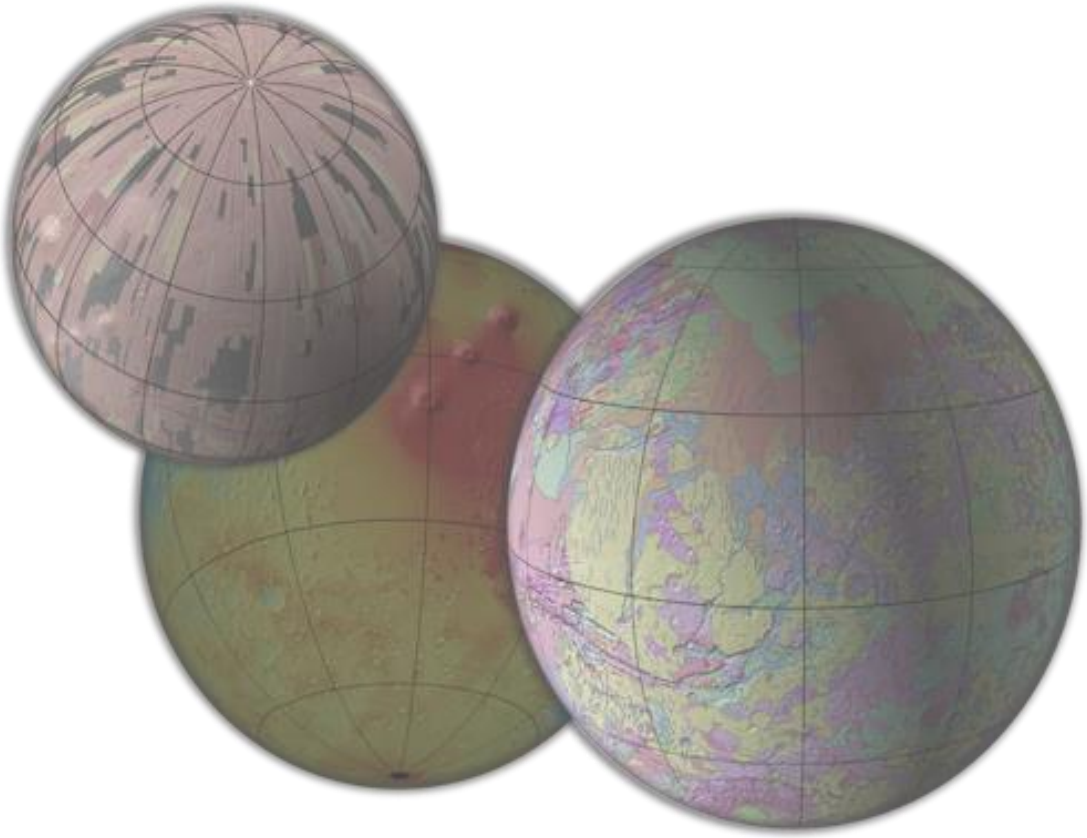

Figure 1: Mars, from left to right an exemplary data image coverage, its topography and the global geology (Source: Tanaka et al., 2014 – Geologic map of Mars, USGS Scientific Investigations Map 3292).

Data availability and **coverage** used to be the limiting factor for several decades. Lately, although available spatial and spectral resolution vary across the surface, data are increasingly available and their actual exploitation (human-based or algorithm-aided) can be the bottleneck. Data availability through **open standards** is the key to access data regardless their volume.

Services providing access to basemap data were established through the years, mostly by USGS[1] and NASA PDS[2]. Meanwhile, **data access and exploitation** services developed in Europe[3], so its planetary science data efforts[4] .

Traditional file-based access can be prohibitive for the growing sheer amount of planetary data, thus the establishment of OGC **web services** and **efficient data discovery** providing access to higher-level data helps the community. Also, the **capability of running on the cloud** (and on **EOSC**) some of the custom mosaicking and map-making tasks can provide benefits the **planetary community** and foster its **inclusivity**, particularly because it is not tied to the processing resources available to individual researchers or institutions.
Planetary science and data experience the progressive evolution from repeated efforts of individual researchers towards the use of accessible higher-level datasets via **web services**, providing **FAIR** data access and fostering **reproducibility**.
NEANIAS space research services through its planetary science-focused services will enable the European and community to ease planetary **data access and visualization**, in particular of **image** and **hyperspectral data**.

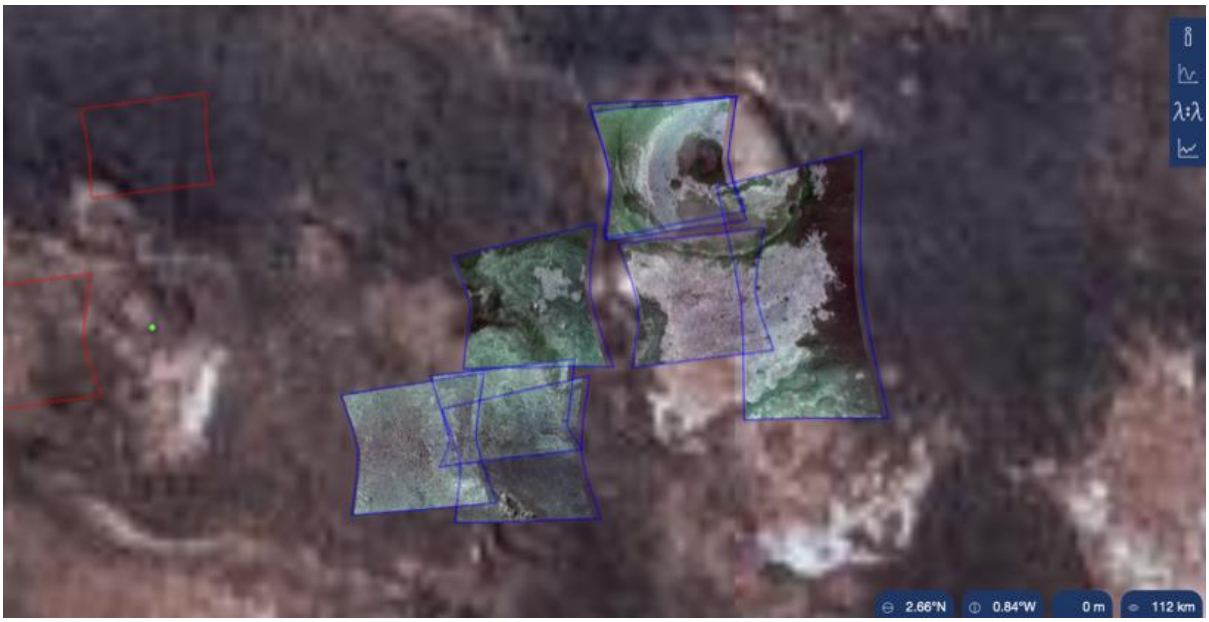

Figure 2: Exemplary Red-Green-Blue visualisaiton of multiple hyperspectral cubes over Nili Fossae (Mars), as visible from the web client of PlanetServer, being ported to EOSC via NEANIAS. Surface variability is highlighted.

Image data collected by spacecraft exist for most solid bodies of our **Solar System**, but the ones where orbital data of resolutions and amount comparable to the Terrestrial case, are essentially **Mars** and the **Moon** and, to a lesser extent, **Mercury**.

[1] https://www.usgs.gov/centers/astrogeology-science-center
[2] E.g. https://pds-geosciences.wustl.edu
[3] E.g. http://access.planetserver.eu – becoming part of NEANIAS
[4] http://www.europlanet-vespa.eu

Mars In particular combines a large amount and variety of data with a comparably rich and varied surface geology: the most **accessible** part of Mars' **geologic record** is its **surface.** Some light can be shed over the nature and evolution of surface material by the morphology, when the link to certain processes can be uniquely made. Nevertheless, there are often large **uncertainties**, which can be reduced trying to **address the composition**, through the spectral characteristics of materials cropping out. This, in combination with medium to high-resolution imaging and mapping can be powerful to explore surface diversity and unravel the geologic history of a certain area.

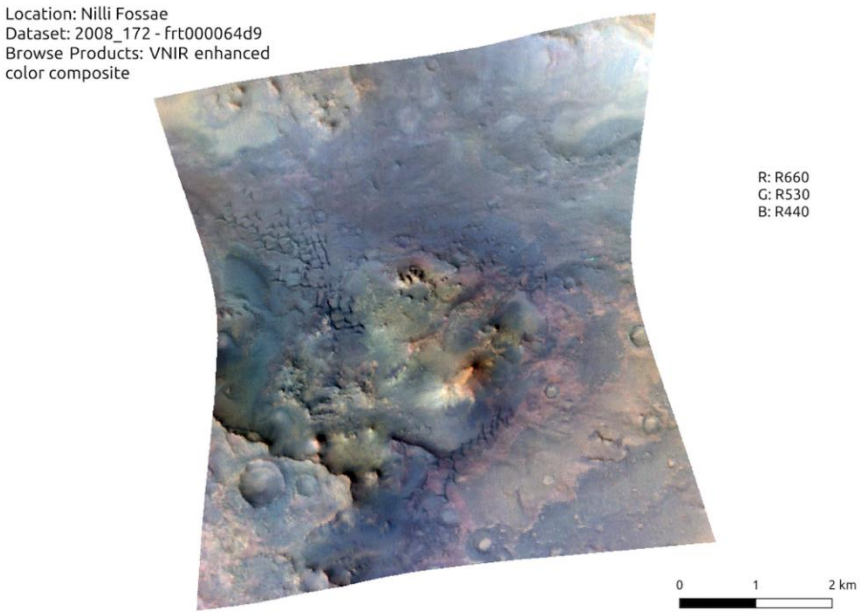

Figure 3: Exemplary Red-Green-Blue color-composite view of an area of Mars displaying surface compositional variability.

In this respect, planetary data within NEANIAS will be part of visualization services (NEANIAS S1) as well as **mosaicking** and **map-making** (NEANIAS S2), using Open Source software commonly used by the planetary community. Augmenting manual mapping, the use of **machine learning** (NEANIAS S3) will help the process of compositional information extraction over large areas and large data volumes.
NEANIAS planetary services will enable science and community support via the Europlanet Planetary Science Research Infrastructure[5] (RI) and its **geologic mapping** activities[6].

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[5] https://www.europlanet-society.org/europlanet-2024-ri/
[6] https://www.europlanet-society.org/europlanet-2024-ri/gmap/