ARCHIVE, ACCESS, AND SUPPLY OF SCIENTIFICALLY DERIVED DATA:

A DATA MODEL FOR MULTI-PARAMETERIZED QUERYING WHERE SPECTRAL DATA MEETS GIS-BASED MAPPING ARCHIVE

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DLR

Background

QUESTION

how **two separate** and **independent** databases can be merge via spatial attributes,
in the way that the stored data could be **managed sustainably** and **querying centrally**.

AREA of APPLICATION

Query **spectral data** via **spatial extension** of geological and geomorphological **interpreted objects** (polygons).

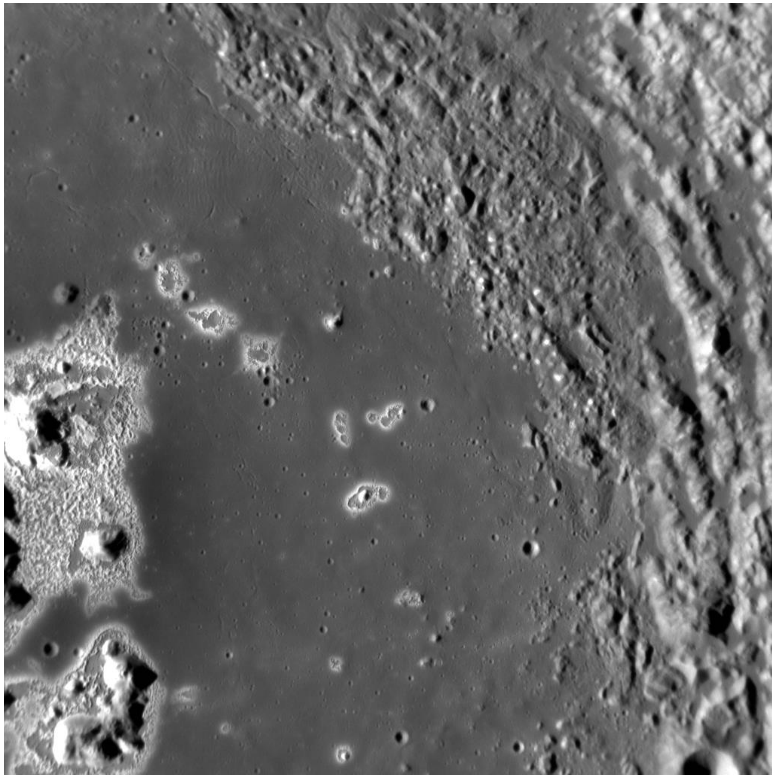
APPROACH build upon

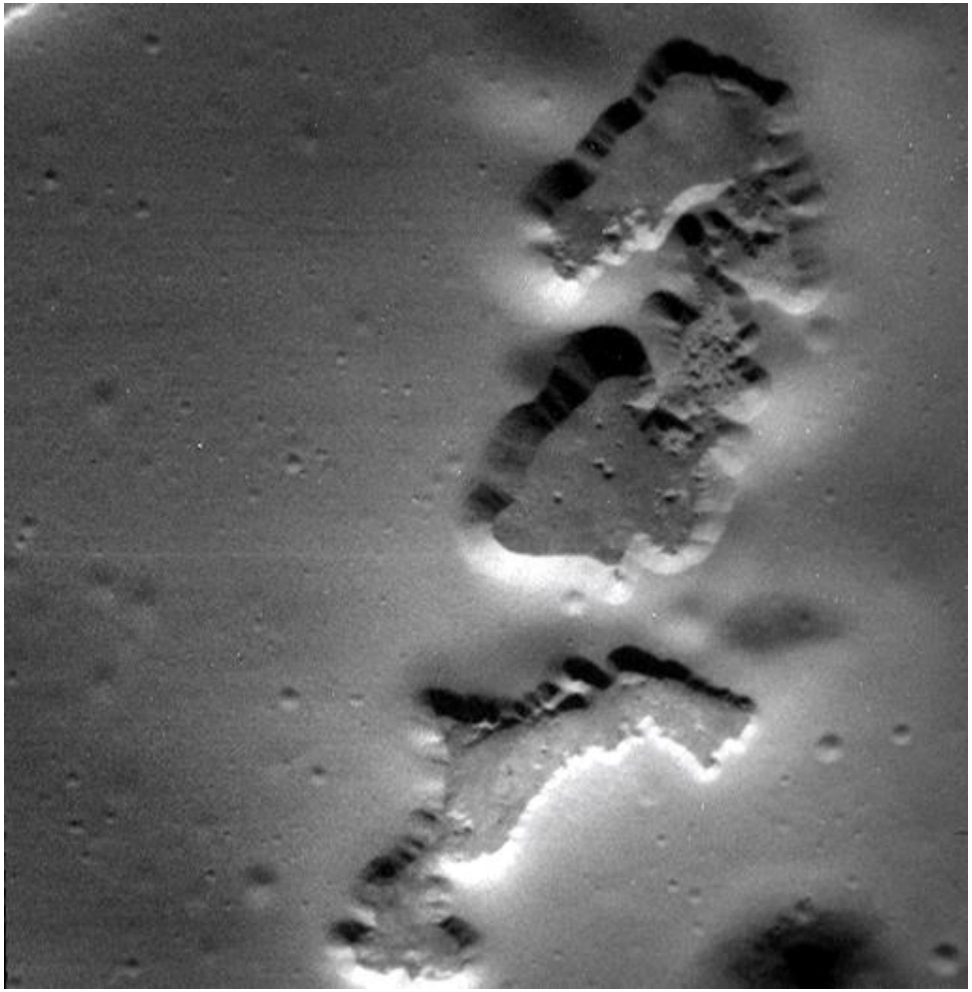
existing developments within the Institute for Planetary Research, DLR:

Part I: Spectral data within planetary missions investigating e.g. Mercury, or Vesta supplied by the *Planetary Spectroscopy Laboratory (PSL)* group, at DLR.

Part II: derived scientific information, conducted by GIS-based geological and geomorphological interpretations within the *Department of Planetary Geology (PF-GEO)* at DLR.

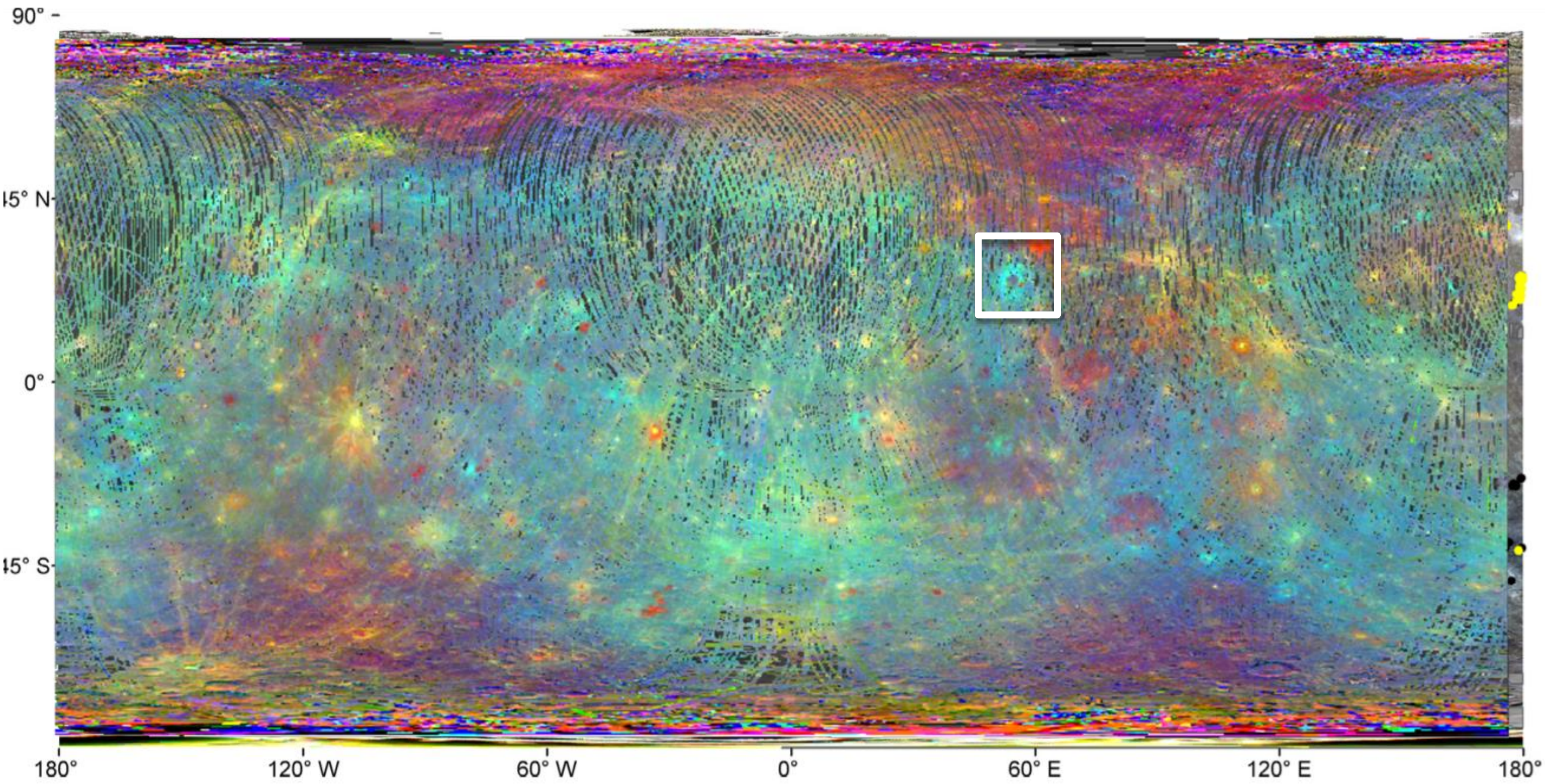
Quick Walkthrough - Hollows on Mercury





Example – Planet Mercury

Part II: Geospatial Database | GLOBAL DISTRIBUTION OF HOLLOWS



Part I ⟷ **Part II**

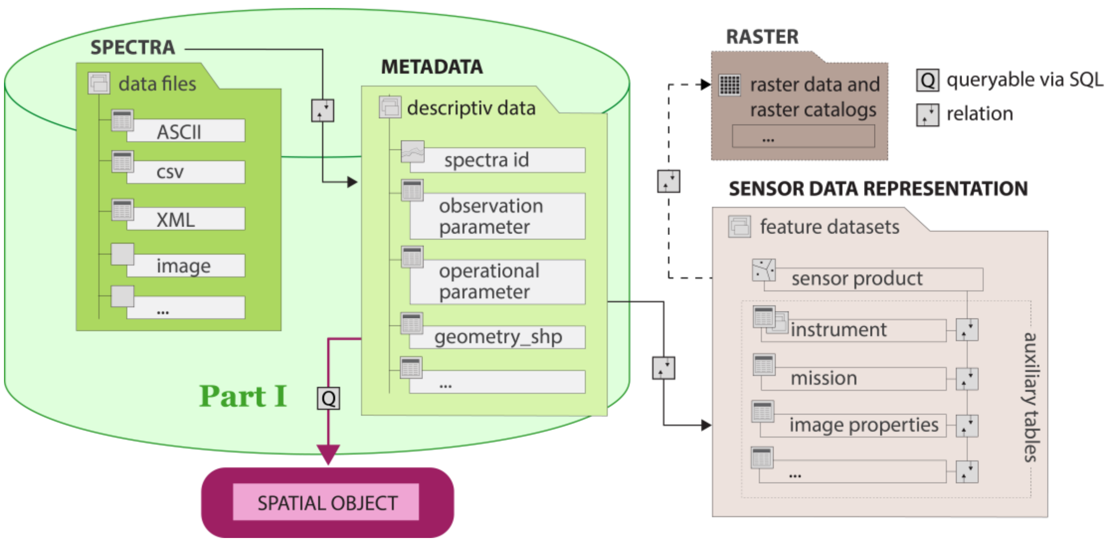
Part I – Spectral database

The Planetary Spectroscopy Laboratory (PSL-DLR)

joins the Participating Scientists for MESSENGER program for the *Mercury Atmospheric and Surface Composition Spectrometer* (MASCS) instrument, **allowing access** to the team data **before** the **official release** to PDS.
MASCS VIS channel have mapped Mercury surface in the 400–1145 nm wavelength range during orbital observations by the MESSENGER spacecraft.

Handling

the **dataset** bulk **size** and **exploit information** present in it,
we developed a **PostgreSQL/PostGIS** distributed **database.**



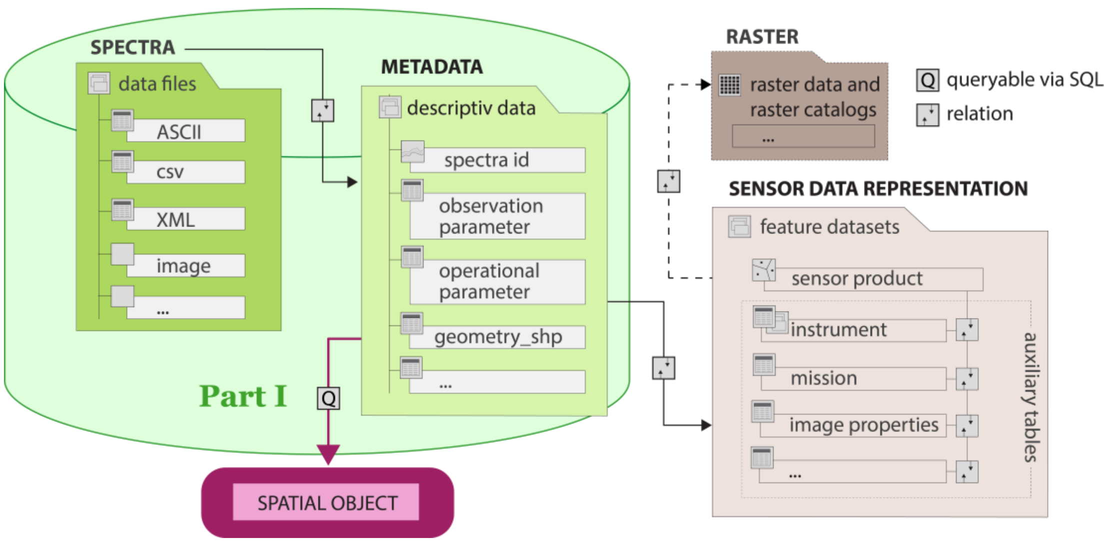
Part I – Spectral database

The database contains

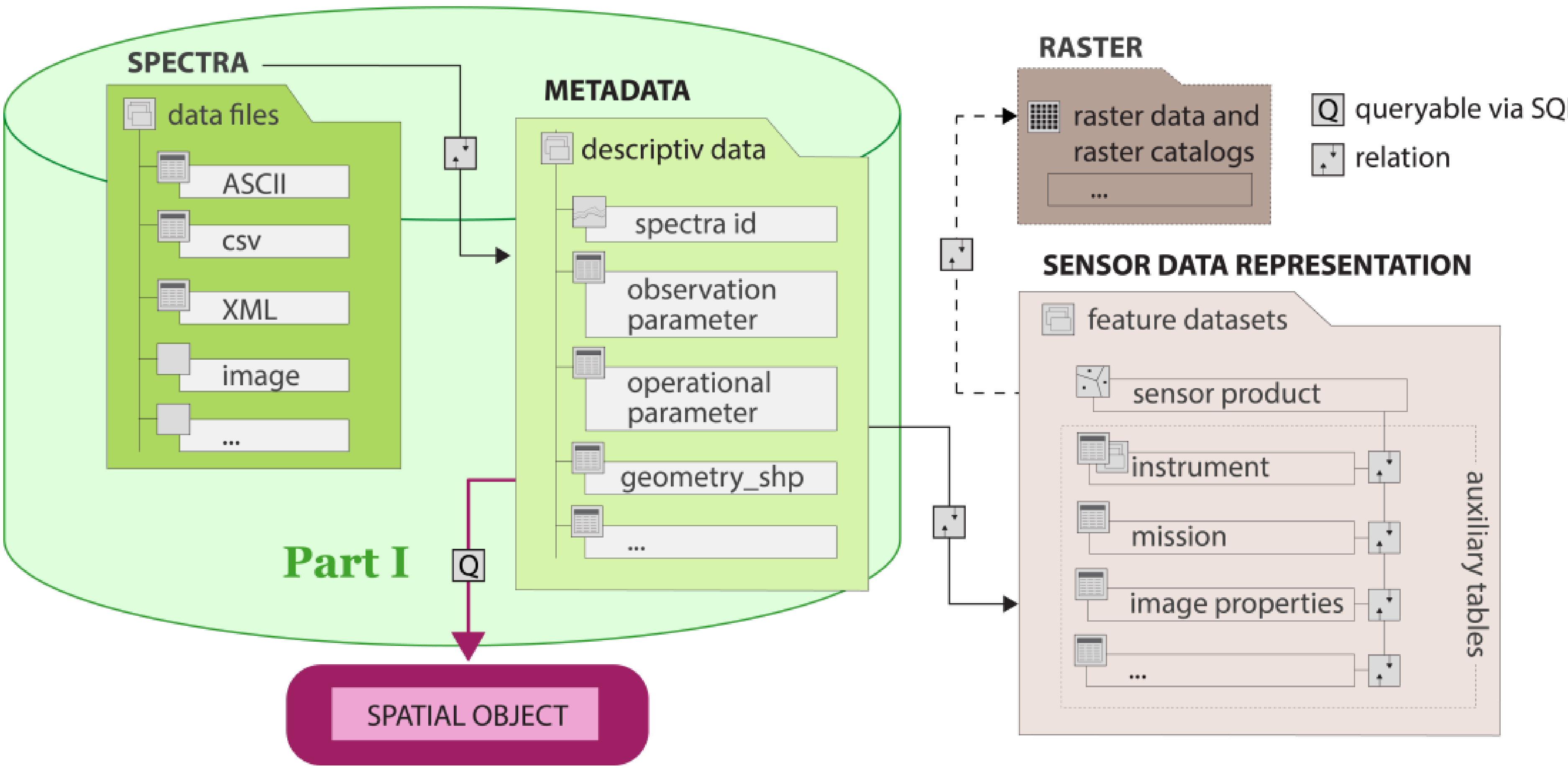
the whole **MASCS spectral dataset**,
around 4 Millions single **measurements** as vector data,
and **user defined polygons**.

Explore

possible **relations** between **composition** and **spectral behavior**,
we have **imported** other **dataset**,
like elemental abundance maps derived from MESSENGER's *X-Ray Spectrometer* (XRS).



Part I – Spectral database



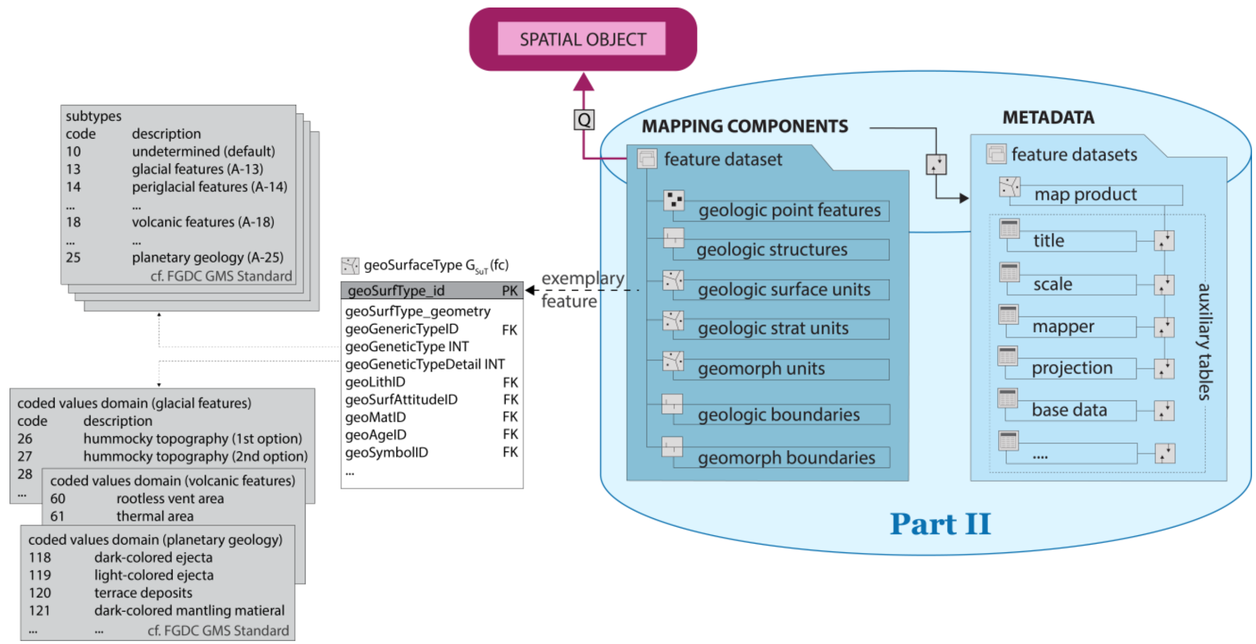
Part II – GIS-based archive of scientific analyses and interpretation

Developing and Implementation of a

GIS-based archive **for** vector-based mapping data, representing the **results of scientific analyses and interpretation**,
and make these results **queryable** and **available for future investigations**.

Focus is on **geological** and **geomorphological information**,

(1) compiled at the department Planetary Geology (PF-GEO), DLR and
(2) within Planetary Missions, where the Institute for Planetary Research is participating.



Part II – GIS-based archive of scientific analyses and interpretation

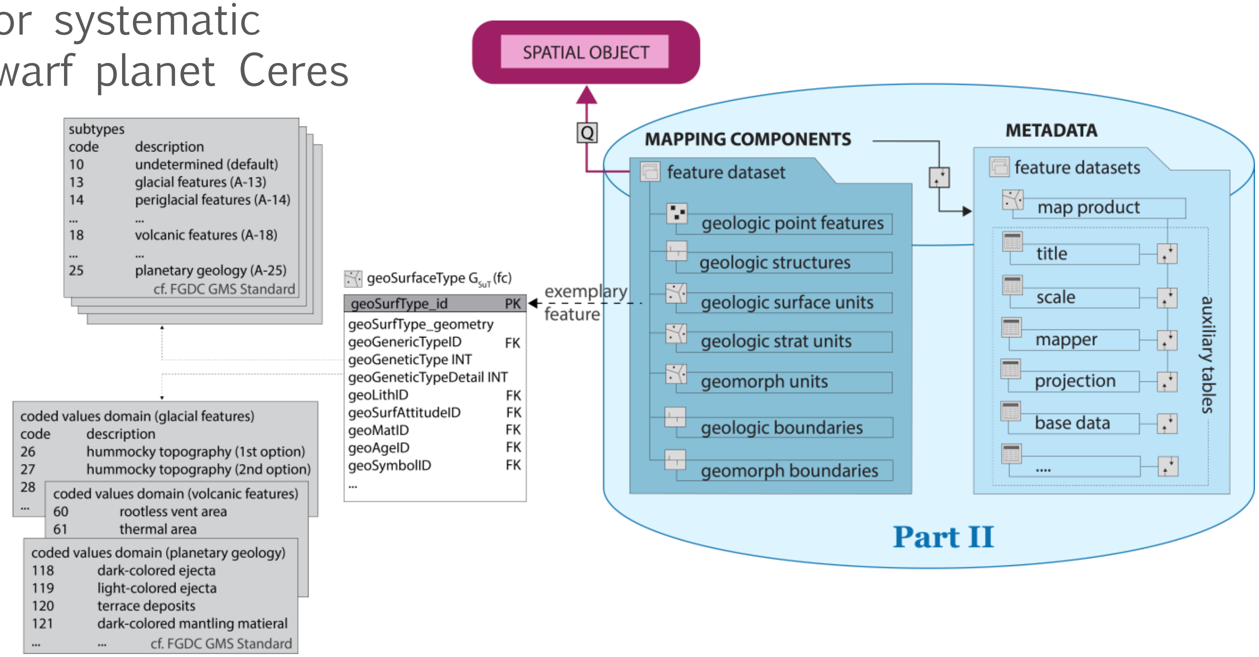
Requirements to the archive

(1) adaptable, and applicable to all planetary bodies,
(2) useable open source GIS (e.g. QGIS), but also in proprietary (e.g. ArcGIS™),
(3) developed in spatial database structure PostgreSQL/PostGIS.

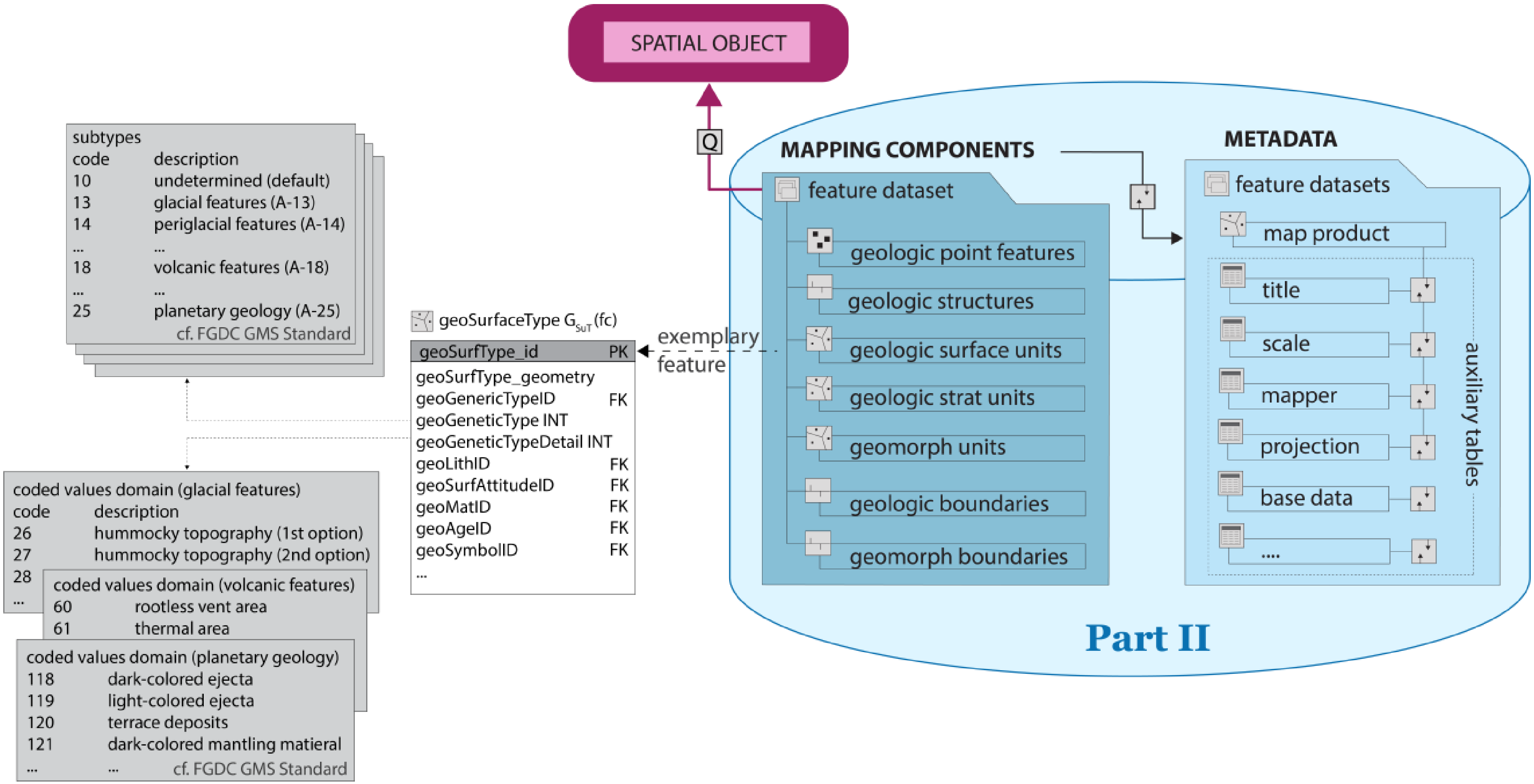
Requirements to the data sets

(1) uniform, and complete metadata description,
(2) homogeneous, and comparable data structure.

First implementation for systematic geological mapping of dwarf planet Ceres within the Dawn Mission.



Part II – GIS-based archive of scientific analyses and interpretation



Merging – Part I + Part II

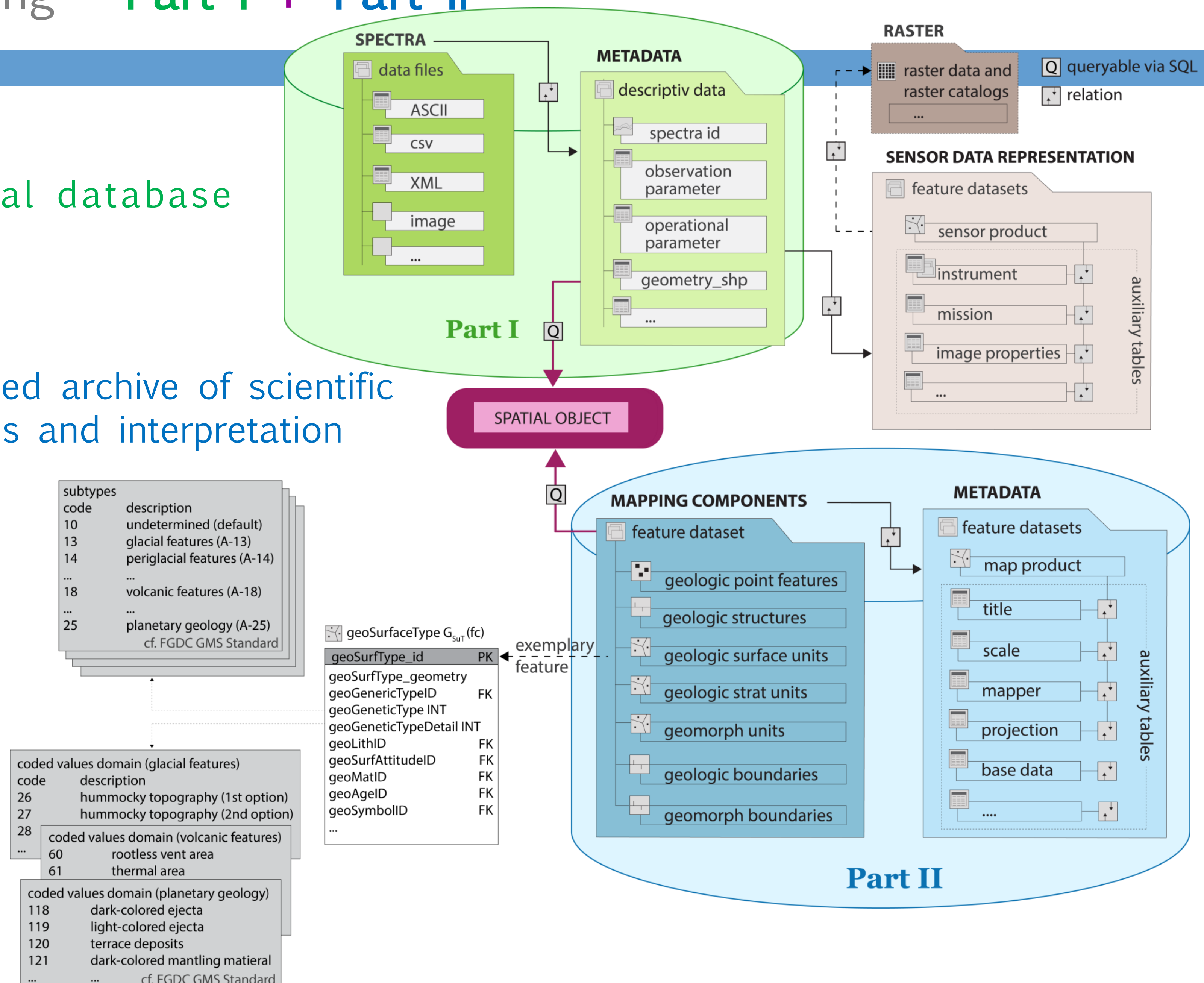
Part I

Spectral database

+

Part II

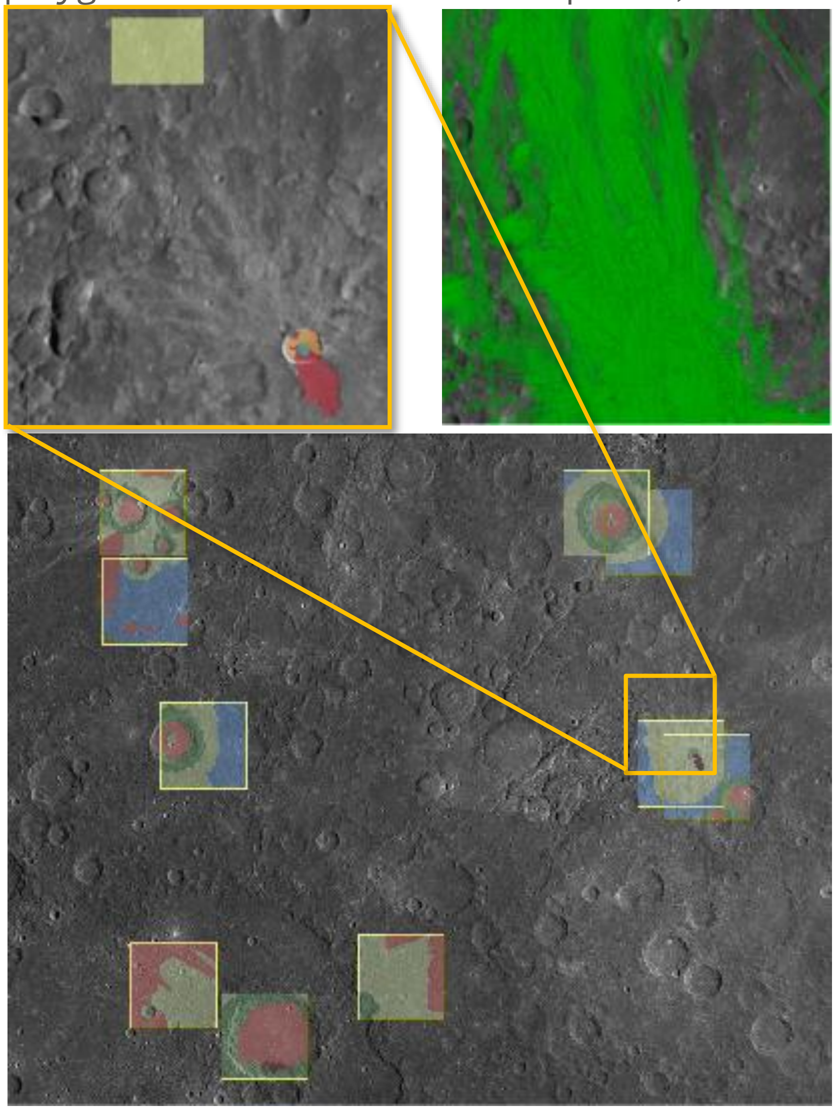
GIS-based archive of scientific analyses and interpretation



Example of application I

Area of interest and polygon definition

Available Spectra
9740 spectra, in 4442.51ms

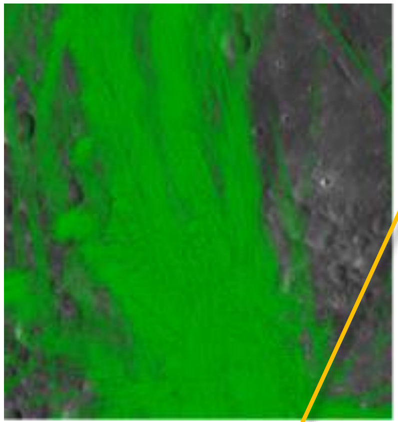


The example shows the intersection of the spectral FOV with user defined features to extract the spectral features of the geomorphological unit.

Example of application I

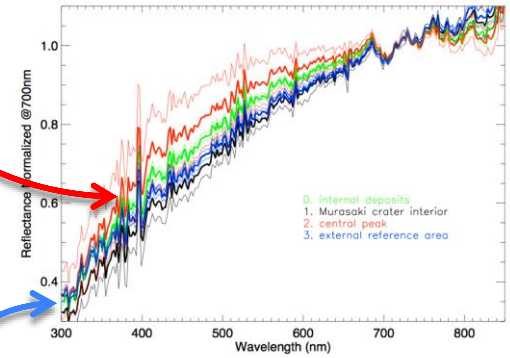
Area of interest and polygon definition

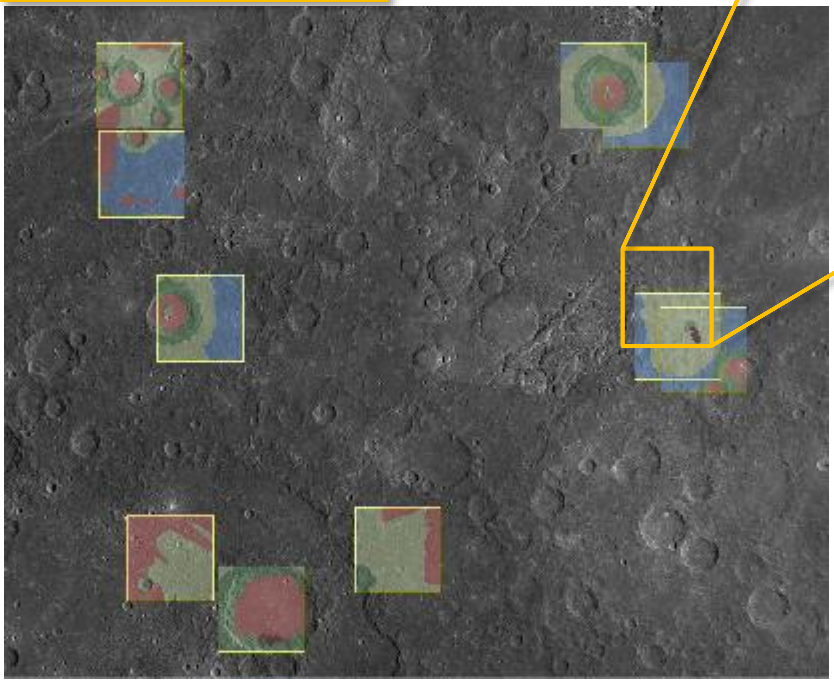
Available Spectra
9740 spectra, in 4442.51ms



Polygons and **measurement intersection**

Spectra





Waters Crater *, Mercury

[*] lat,lon = -8.96,105.45, IAU : https://planetarynames.wr.usgs.gov/Feature/15086

Example of application I

Area of interest and polygon definition

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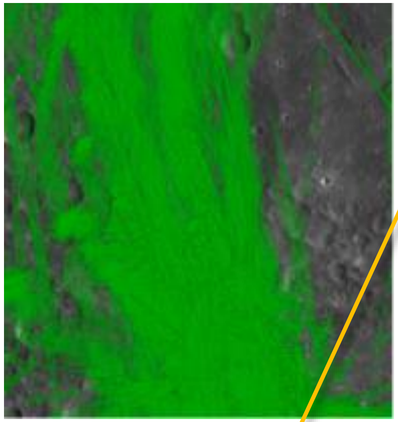
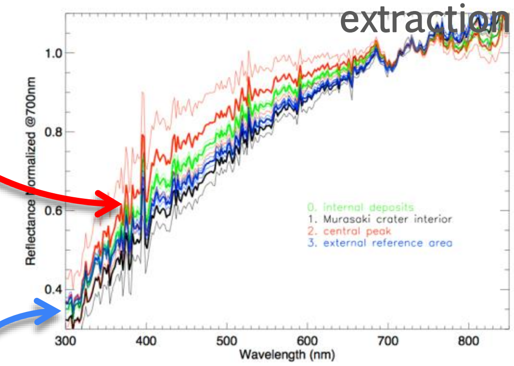
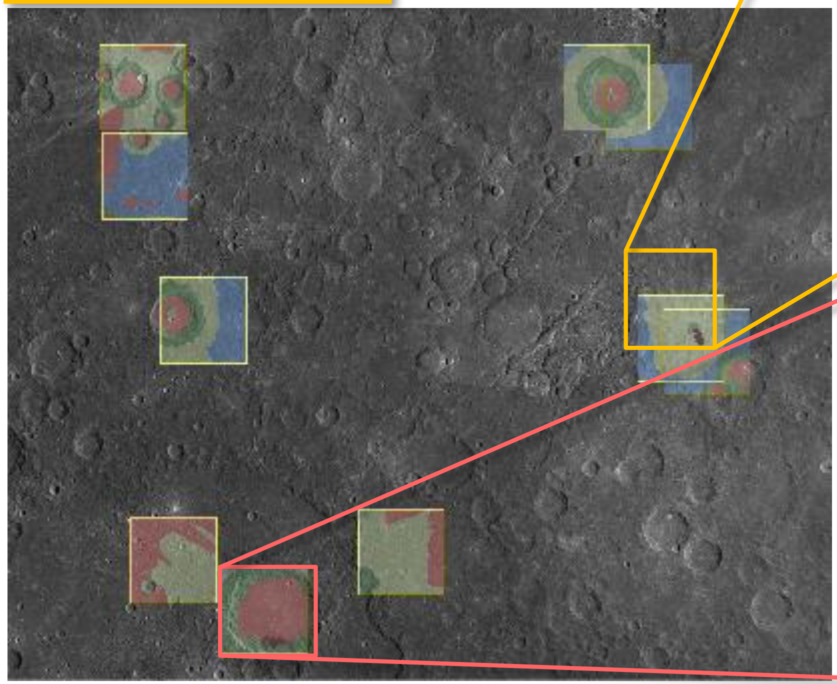
9740 spectra, in 4442.51ms



Polygons and **measurement intersection**

Spectra extraction





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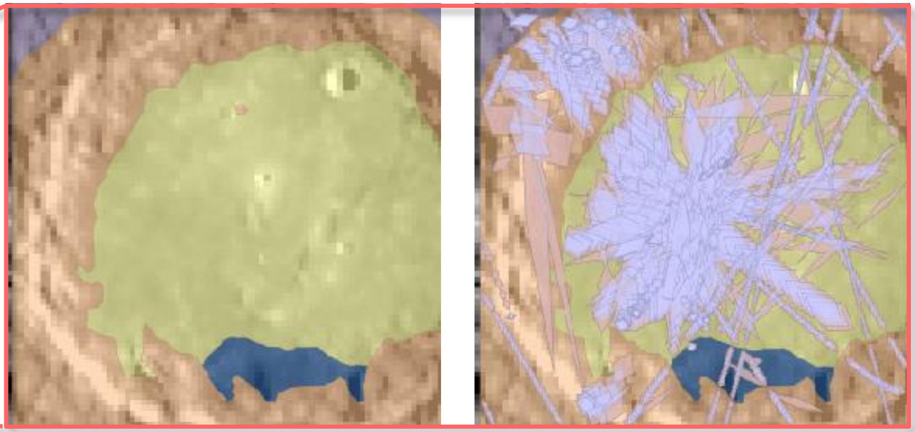
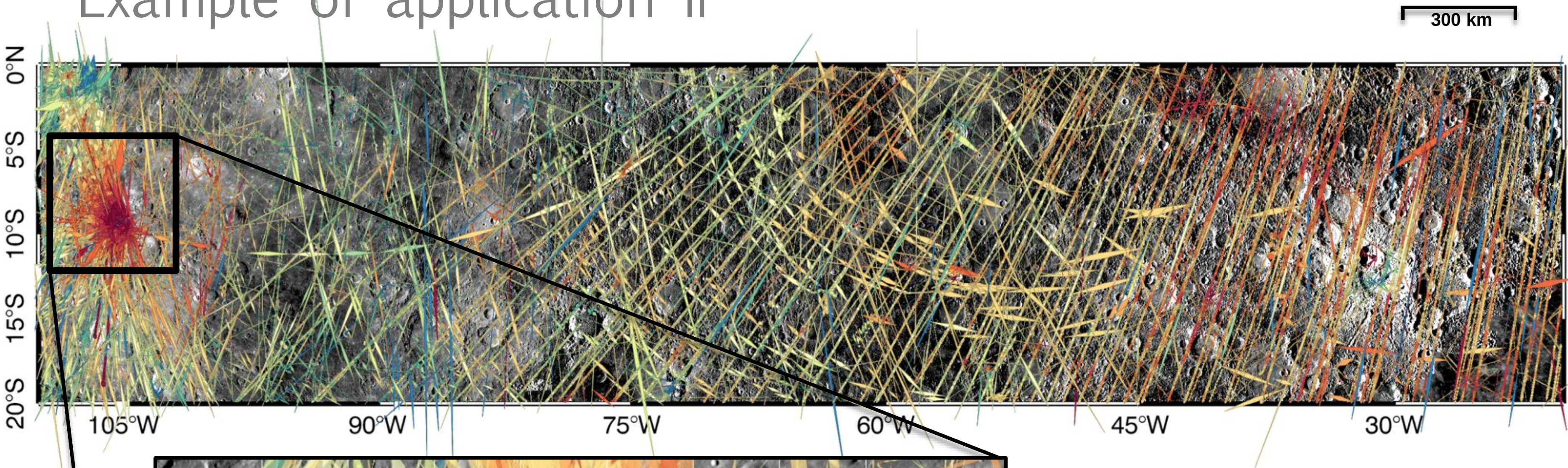
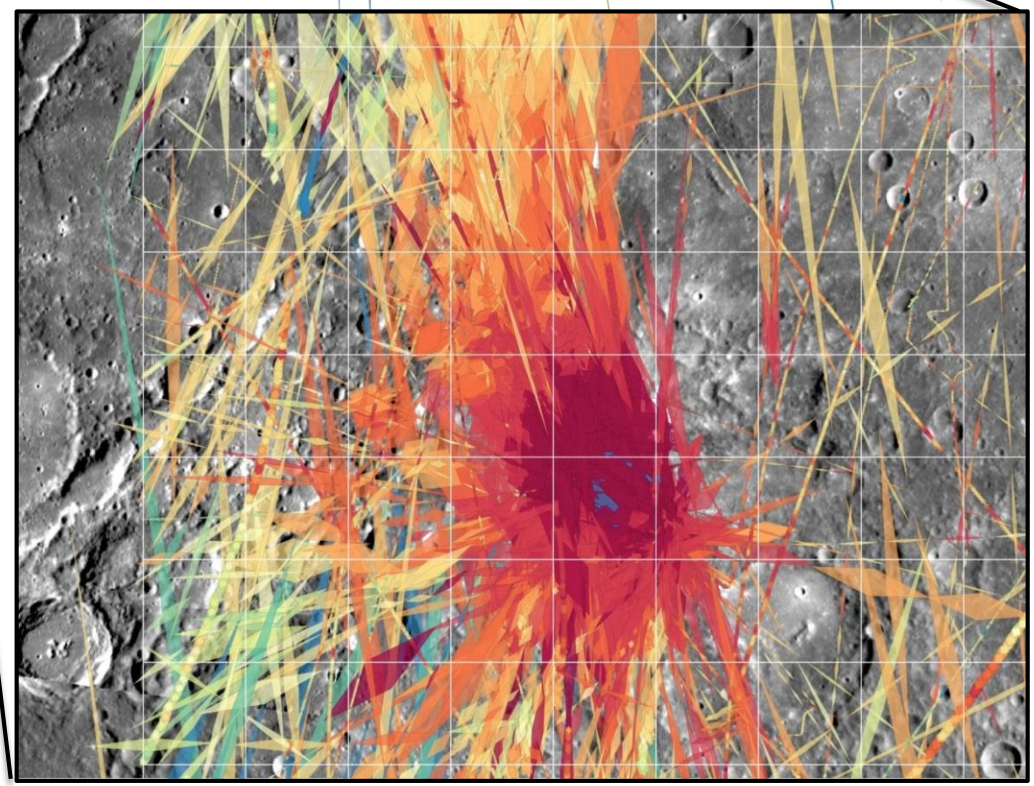
D'Incecco, P., et al., PSS, Volume 119, p. 250-263, 2015.



Example of application II





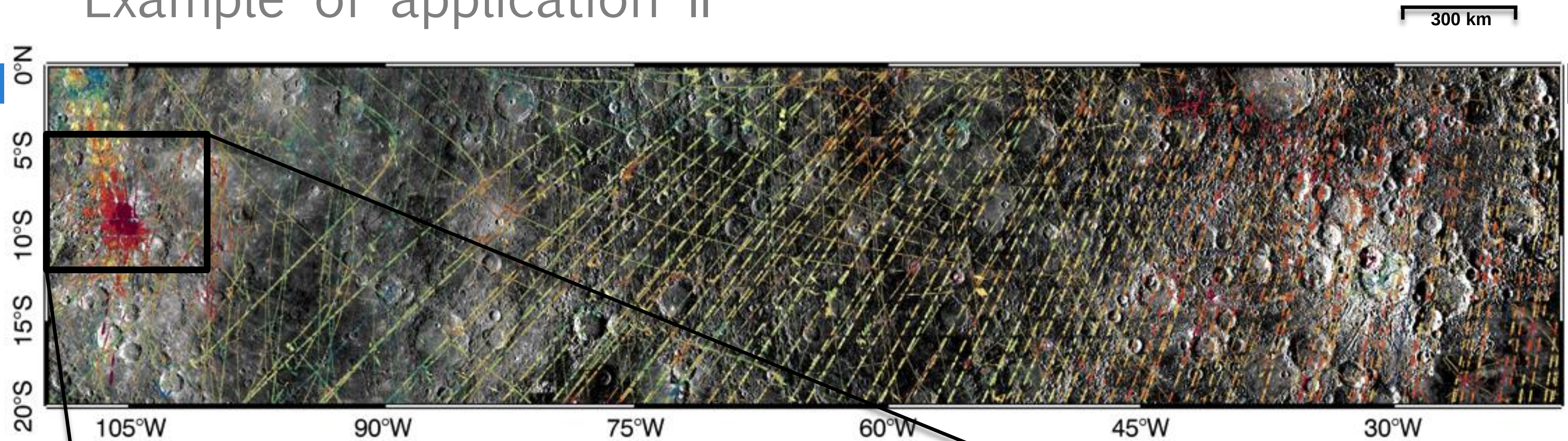
MASCS DLR database – regridding

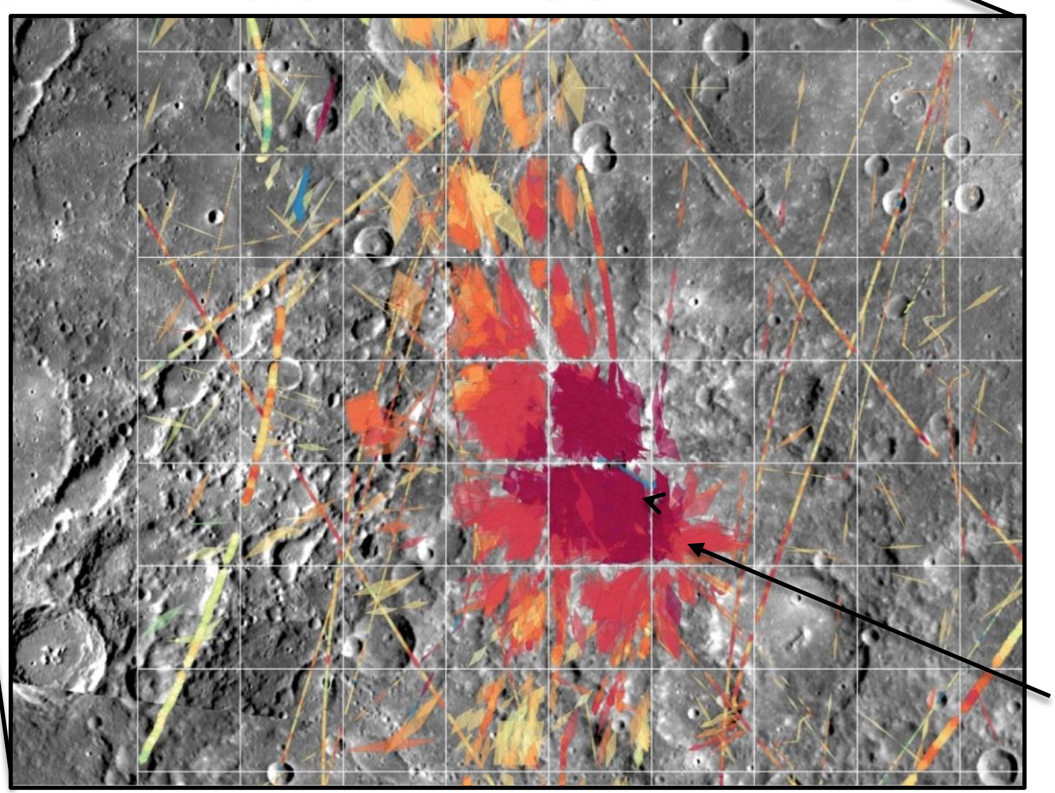
>134k Observations.

Color code: Reflectance at 450nm normalized to 700nm

Red : 0.72
Violet : 0.54

Example of application II





MASCS DLR database – regridding

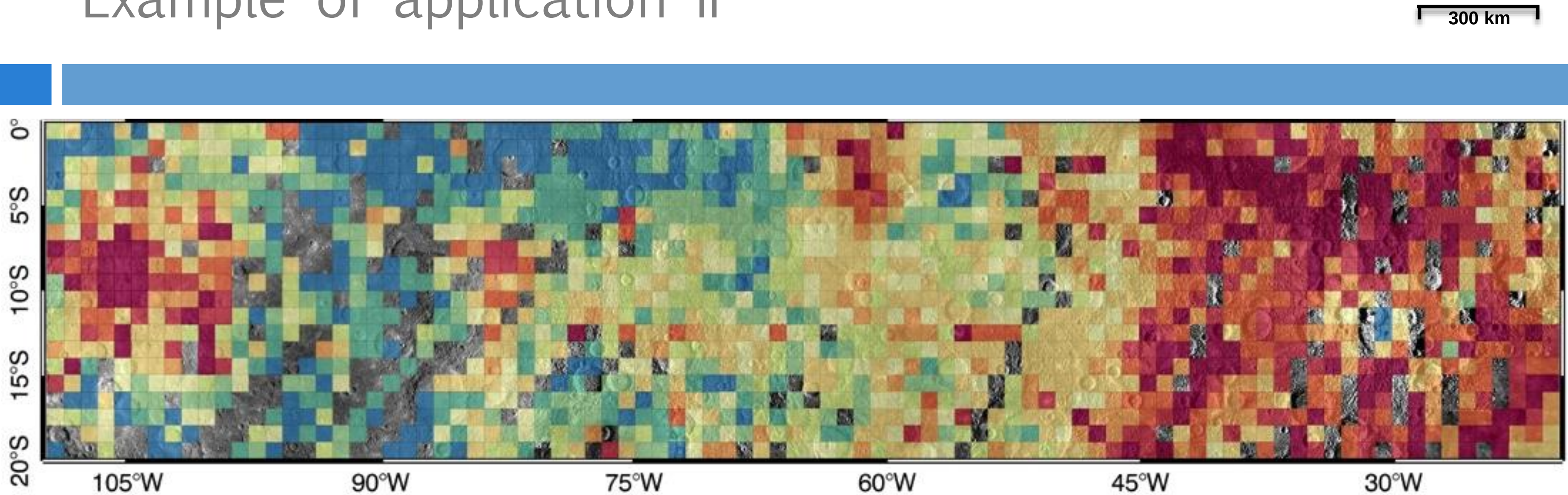
~109k Observations.

Color code: Reflectance at 450nm normalized to 700nm

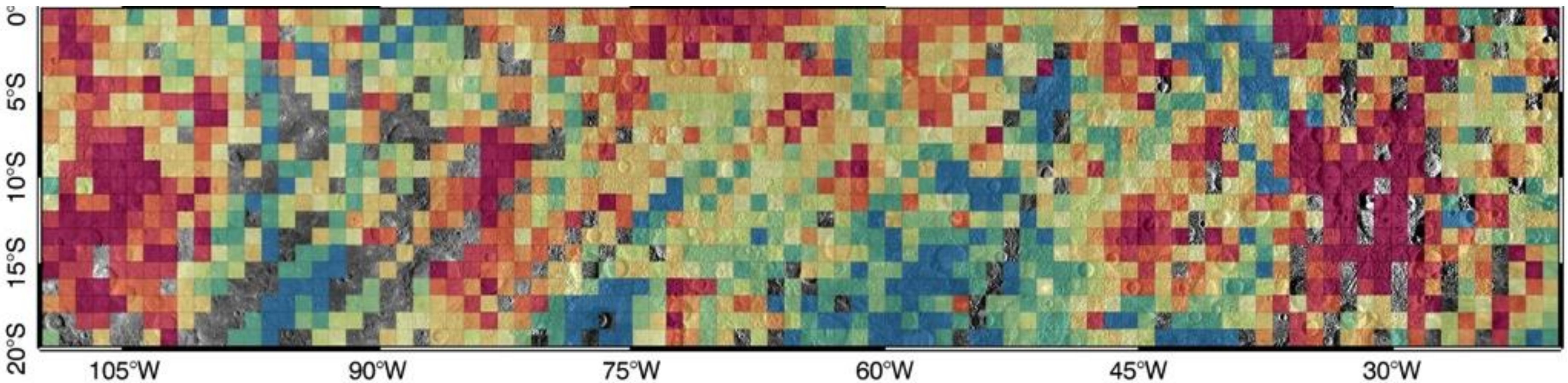
Red : 0.72
Violet : 0.54

Pixel-crossing measurements
Filtered out

Example of application II



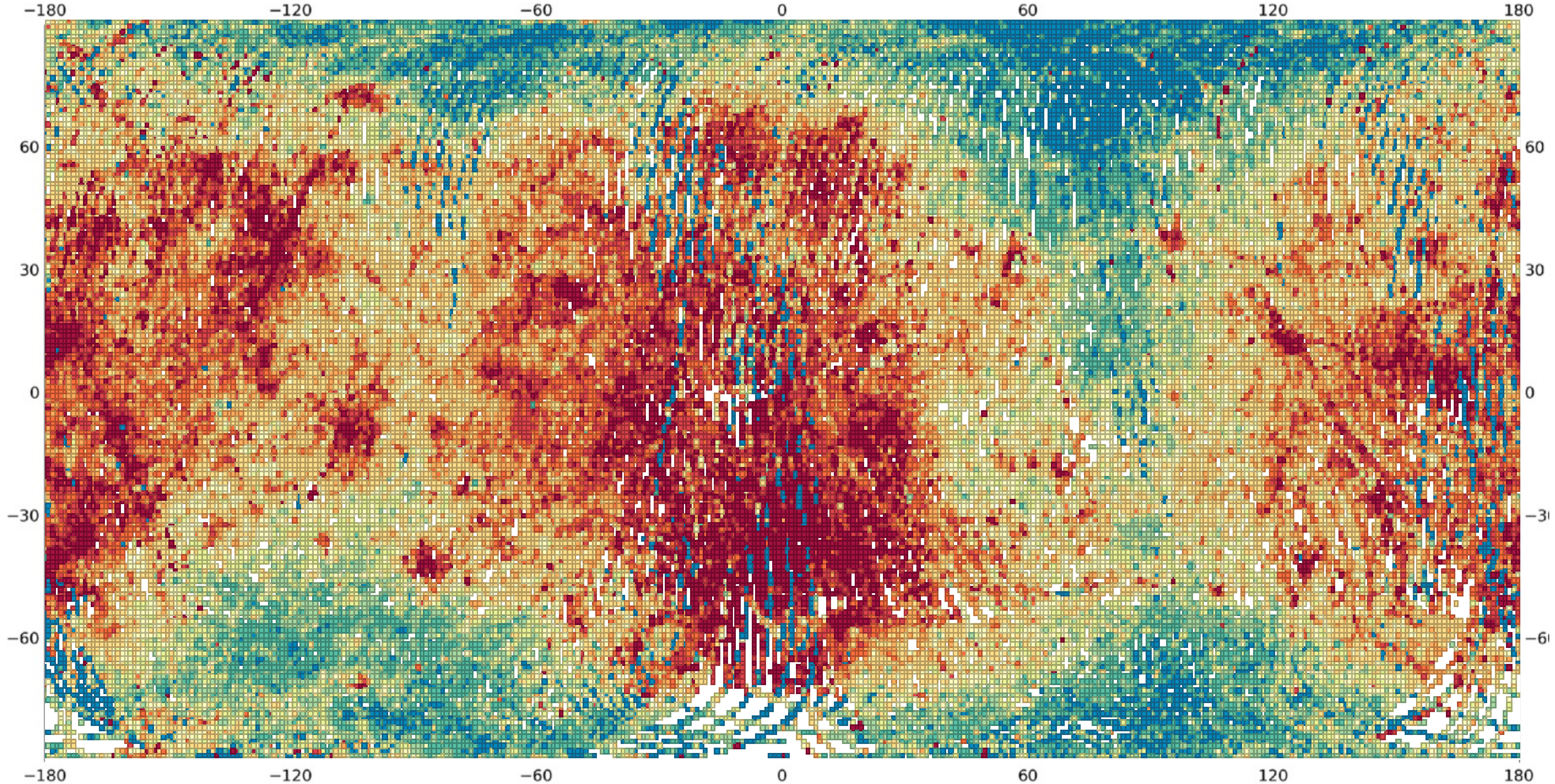
Reflectance at 450nm / 700nm – Blue : 0.54 / Red : 0.72



Reflectance at 700nm – Blue : 0.04 / Red : 0.09

MASCS DLR database – regridding

Example of application III



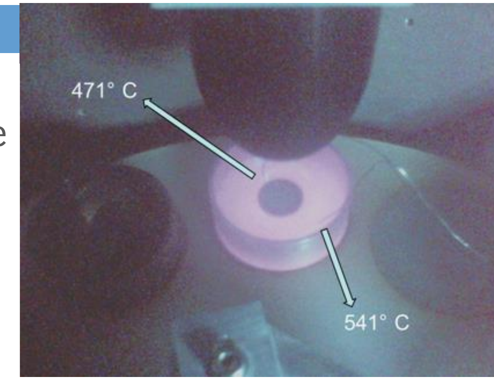
Global Grid (reflectance@500nm normalized @700nm)

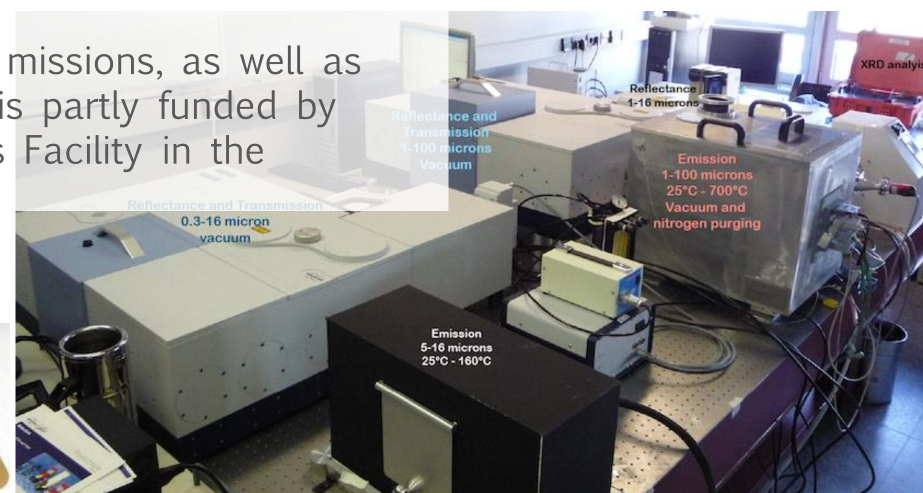
MASCS database example – regular grid

The Planetary Spectroscopy Laboratory (PSL)

http://s.dlr.de/2siu

- The state-of-the art PSL facility can provide emissivity, reflectance and transmission measurements of solid and fine-grained samples from the ultra-violet to the thermal infrared spectral range.
- The combination of extended wavelength coverage as well as the high sensitivity for fine grained sample is not offered by any of the international competitors.
- The capability to obtain emissivity measurements from 0.2 to 300µm at sample temperatures up to 1000°C is worldwide unique.
- Measurements at PSL allow studying mineralogy, water content, signatures of organic chemistry as well as structural changes and phase transitions due to temperature effects.
- **We are in the process to open the Spectral Database to any user via web interface for queries, data visualization/download using open source framework (python/Django).**
- PSL is working in support of several planetary missions, as well as terrestrial studies and industry contracts, and is partly funded by the European Union as a Transnational Access Facility in the EuroPlanet Research Infrastructure.





Status Quo – Challenges

Part I

(1) **Resulting** features–measurements polygons intersection is **stored in caching tables**, allowing a quasi-live retrieve in GIS system from user perspective.

(2) **Overhead in complexity** is justified **by** circumstance that **spatial query** is **executed** only **once**, whereas **retrieving data** could happen **multiple** times.

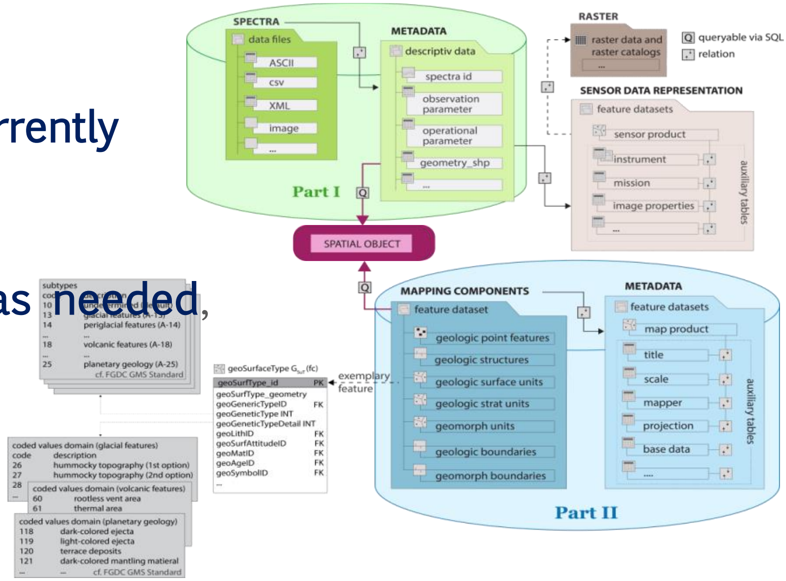
(3) Additional **complexity** and **overhead** to join different tables, this approach **optimizes** the **access time** for **spatial intersection**.

Part II

(1) Built a **representative data base**, because the GIS-based mapping data **currently** stored **locally** and in **different formats**.

(2) Develop a **joint basis model**, with predefined **attributes** and **relations as needed**, and **flexibility as possible**.

(3) Introduce and teach **user groups** about benefit of the centrally and jointly managed archive.



Summary

APPROACH

Merging of a GIS-based data archive (**part I**) and the PSL database (**part II**), to allow querying of spectral data via the spatial extension of predefined geological and geomorphological objects by scientific analysis and interpretation.

STATUS QUO

Current developments

(1) are **theoretically adaptable** to any other planetary body!

(2) are **easily combinable** by the common attribute of spatial context!

(3) enable **multidimensional query** of comparable scientific analyses!

(4) benefit and enable the **usability and sustainability** of already gained and existing information for future investigations and missions!

→ **Improved and enhanced MANAGEMENT of DATA, INFORMATION, and KNOWLEDGE!!**

THANK YOU FOR YOUR ATTENTION!

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Knowledge for Tomorrow

DLR