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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Knowledge for Tomorrow
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 HOLLOW**
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.
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 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 1

**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**

Waters Crater *, Mercury

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

[Image descriptions and visualizations related to the application example]
Example of application I

Area of interest and polygon definition

Available Spectra
9740 spectra, in 4442.51 ms

Polygons and measurement intersection

Spectra extraction

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