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Merged data models for multi-parameterized querying: Spectral data base meets GIS-based map archive

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Abstract

Current and upcoming planetary missions deliver a huge amount of different data (remote sensing data, in-situ data, and derived products). Within this contribution present how different data (bases) can be managed and merged, to enable multi-parameterized querying based on the constant spatial context.

1. Introduction

Since the 1990s, Europe has become highly active in planetary exploration with spacecraft contributions (e.g., Mars Express, Venus Express, Huygens probe, ExoMars, Rosetta), and employment of dedicated mapping instruments. Along with recent and upcoming missions also to Mercury (BepiColombo), the Outer Solar System moons (JUICE), and asteroids (NASA`s Dawn mission), systematic mapping of surfaces has received new impulses. This systematic surface analysis based on comparison and combination of different remote sensing data sets, such as image data, spectral-/hyperspectral sensor data, radar images, and/or derived products like digital terrain model. Conditioned by spatial component the derived information of such analysis mainly resulted in map figure, data, and project. Since the late 1990s the scientific mapping community has started to use Geographic Information Systems (GIS) for planetary mapping. GIS frameworks are usually based on databases which represent an ideal tool for generating, but also for archiving and storing spatial data - raster- as well as vector based data.

Within this contribution we discuss two questions: *Q1* How also planetary (vector-based) mapping data could be archived, thus they could finally be used as additional base data for further investigations? *Q2* How different mission data (base data and derived products listed above) could be merged, to generate combined querying for the most efficient data and information handling?

2. Current Framework

On the way to handle these two questions, we build upon two already existing developments, which are established within the Institute of Planetary Science, DLR.

Part I: The Planetary Spectroscopy Laboratory (PSL) group at 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 have mapped Mercury surface in the 400–1145 nm wavelength range during orbital observations by the MESSENGER spacecraft. To overcome the dataset bulk size and fully exploit the information present in it, we developed a PostgreSQL/PostGIS distributed database. The DB contains the whole MASCS spectral dataset, around 4 Millions single measurements as vector data, and user defined polygons. To explore possible relations between composition and spectral behaviour, we have imported other dataset, like the elemental abundance maps derived from MESSENGER's X-Ray Spectrometer (XRS).

Part II: In the last years the Department of Planetary Geology, DLR established a GIS-based mapping archive storing all different kind of derived vector-based mapping projects, which are conducting within different investigations. This data base driven archive has to cover the requirement, it is (1) applicable for all known planetary bodies, (2) usable in the proprietary environment ArcGIS™ (ESRI), but also usable and accessible within independent and open GIS systems, like e.g. QGIS, (3) developed, or at least transferable, into a PostgreSQL/PostGIS driven data base structure, and last but not least (4) the archived data should be available and replicable for future investigations. To accomplish these requirements, every dataset, has to be generated and described uniformly. Therefore, different recommendations are developed, and are used as reference, e.g. [1, 2]. One first implementation was conducted for the systematic mapping of Ceres (Dawn mission), is useable also outside the DLR, and will be present on this conference [3].

3. Application

The current spatial intersection within Part I is a computation-heavy operation that is executed in the backend in period of low activity, typically at night. The current resulting features–measurements polygons intersection is stored in caching tables, allowing a quasi-live retrieve in GIS system from user perspective. The overhead in complexity is justified by the circumstance that the spatial query is executed only once, whereas the retrieving of the data could happen multiple times. Overall, despite the additional complexity and overhead to join different table, this approach optimizes the access time for spatial intersection. We are currently working on merging the GIS-based map archive to the PSL database to enable the data query for spectral data by the polygons, done within geologic/geomorphologic mapping projects.

4. Conclusion

The idea behind this contribution is to ingest the product of surface mapping done by experts (e.g., geomorphological or geological mapping), and intersect those features with the actual data, to extract spectral information in well know geological regions (Figure 1). The ingestion architecture expects a minimum set of feature to be defined by the user. Three examples of this approach are: 1. the comparison spectral behaviour with radial distance in more than 100 craters on the surface of Mercury [4], 2. the identification of Olivine outcrops on the surface of Vesta via DAWN data analysis [5], 3. a general automated multi instrument mapping framework [6].

The current approach shows that databases described as *Part I* and *Part II* are (1) theoretically transferable to any planetary body, e.g. from Moon, Mars, (2) through the spatial context all these data hold by nature, the two parts are combinable, this (3) enables an overarching and comparative research and analysis basis by multi-parameterized querying, and would (4) benefits the knowledge management and data/product usability for future missions and data.

References

[1] Naß, A. et al., AutoCarto, 2010, [2] van Gasselt, S. & Naß, A., *PSS 59(11-12),* 2011, [3] Naß, A., this issue, EPSC, 2017, [4] P. D'Incecco et al., *PSS 132(32-56)*, 2016, [5] D'Amore, M. et al, 48th LPSC, 2017, [6] D'Amore, M. et al. , EPSC 2017 (this conference), #497, 2017.

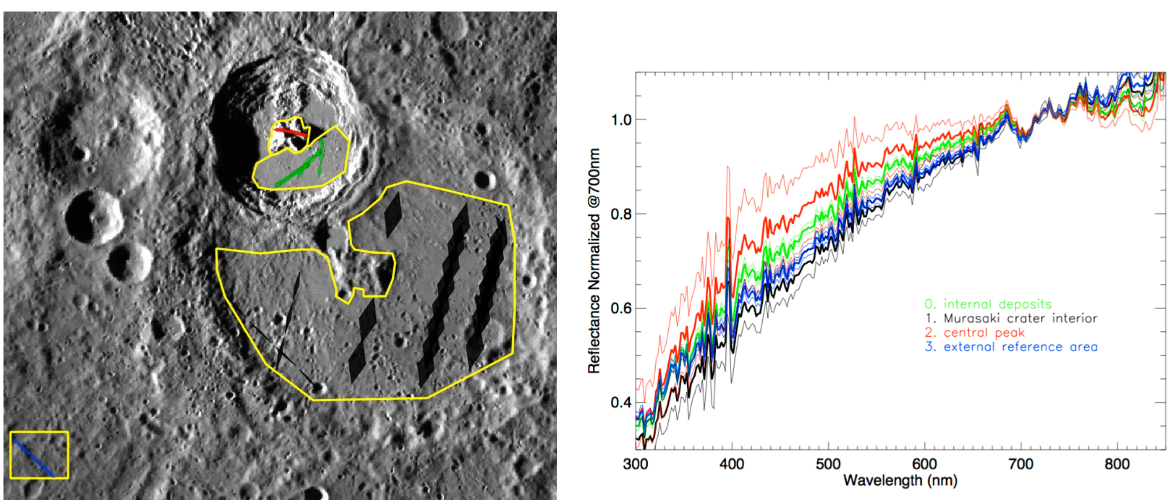

Figure 1: MASCS data coverage, incl. user defined area (right) and available spectral data (left) at Kuiper Crater (centered at 11.3 °S, 31.5°3), Mercury.