

DATA INFRASTRUCTURE REQUIREMENTS AND CONCEPTUAL DATABASE MODEL FOR CONDUCTING AND ORGANIZING GEOLOGICAL AND GEOMORPHOLOGICAL MAPPING. S. van Gasselt¹, A. Nass², G. Neukum¹, ¹Freie Universitaet Berlin, Insitute of Geological Sciences, Planetary Sciences and Remote Sensing, Malteserstr. 74-100, D-12249 Berlin, ²German Aerospace Center, Institute for Planetary Research, Rutherfordstr. 2, D-12489 Berlin (stephan.vangasselt@fu-berlin.de).

Abstract: We report on the conceptual design of a geodatabase model as part of a larger-scaled GIS-based system composed of several applications, templates and database backend which supports conducting geological as well as geomorphological mapping of planetary surfaces and which simplifies the process of maintaining data and map products.

Motivation and Background: Performing geological and/or geomorphological stand-alone or systematic mapping of planetary surfaces supported by modern GIS environments involves some *a priori* tasks to be performed before the actual mapping process can be carried out. Such tasks deal with setting up a working environment by querying and defining raster data from a variety of planetary missions to be used and processed, importing auxiliary data (e.g., scanned maps and other digitized non-georeferenced products), defining projection parameters for one or more map layer(s) and each raster/vector dataset, importing processed data, and defining a variety of vector shape geometries and attributes for mapping in terms of geometry type, representation symbology and attribute domains in a consistent way.

As each mapper uses different techniques to perform one or the other tasks, subsequent work dealing with combining and integrating such heterogeneous map data for further studies and exploitation becomes time-consuming and is often limited due to ambiguities (on the attribute level) and data inconsistencies (on the level of domains and missing topologic constraints). However, integration and homogenisation of map data (including geometries, symbologies, representations, metadata) becomes important to allow future continuation of work. In contrast to storing information on each geometry's physical level, data stored within a geodatabase context allows not only to wire attribute data and meta information across individual features (allowing complex querying tasks) but it also allows to, e.g., link spatial information to domains and pre-defined representations providing a framework for consistency and transportability.

Data models are commonly designed, developed and utilized for focussed analysis tasks with integrated applications dealing with special topics. Such models often consist of a basic database schema and are adapted and modified according to specific needs.

Requirement Catalog and Use Cases: In order to allow consistent mapping approaches and subsequent homogenisation success, a mapper can either stick to a certain definition, i.e., guidelines, that have to be implemented individually, or the mapper makes use of pre-defined model schemas (templates) and definitions allowing to import mapping representation and styles as well as a backbone geo-database to immediately start working and making use of the provided infrastructure. In contrast to the first approach, the latter makes full use of the data infrastructure potential modern GIS provide today.

An additional need to provide such an environment is the wealth and variety of different-resolution and different-type data for the terrestrial planets in the course of recent missions which has led to reconsidering mapping approaches in terms of map-unit definitions and data to be utilized and integrated into a mapping project. In order to be applicable in a wide context and to allow, e.g., geologic as well as geomorphologic mapping in a combined form, any system must cope with such requirements and must be expandable by the user. Many maps frequently on display deal with a hybrid approach of mapping geological as well as geomorphological units in order to depict not only lithologies and time-stratigraphic relationships but also highlight geomorphological characteristics related to a unit's shape and its general appearance. Such needs are challenging for the definition of a map and are also a challenge for the software system in which such requirements need to be addressed, handled and managed in a consistent way. Consistency is therefore a driving requirement in order to be able to allow comparability of map products provided by different mappers and generated at [a] different scales, [b] at different locations of a planetary surface with [c] different mapping foci.

A data model and the related infrastructure must therefore support the mapper in his/her task to conduct mapping and to be able to expand a system but it also needs to support the administrator in homogenizing/combining different mapping efforts. In order to support the mapper in his work, the database model should, e.g., contain as much information about prior mapping efforts and data coverages, i.e., extent and meta information, in order to query, relate and efficiently analyse data. It should furthermore

provide a high-level of standardized representations and mapping symbologies as defined by, e.g., FGDC or any other local authority/organization in order to facilitate the mapping process and avoid inconsistencies. Selections of appropriate symbologies should be based upon pre-selecting genetic terrain types (volcanic, tectonic, eolian, ...) and provide subsets (i.e., subtypes and domains) of appropriate unit representations. Such a system should furthermore support the selection of stratigraphic schemes and definitions by providing planet-specific and domain-driven attributes. It should also provide a high-level of topological constraints in order to avoid errors which become visible during an homogenisation process.

Such basic requirements are mainly database-driven while other requirements and add-on tools are defined on the overall data model level which are discussed, e.g., in [1], and which deal with handling and maintainance of metadata information.

Conceptual Design: The conceptual geo-database design thus far involves the design of the main object and data layers and consists of objects, object types, their relationships and additionally the formulation of integrity conditions on a level which is in principle independent of the exact implementation and its environment. Furthermore, the data layer containing attribute domains has been implemented. The conceptual design has been crafted using ESRI's ArcGIS File Geodatabase environment but it can be exported to any other GDBMS.

The overall layout consists of several main elements or entity groups composed of relations concerning, e.g., map products (product and cartographic representation), sensor-data products, stratigraphy definitions for each planet (facies, formation, ...) , and mapping units. Domains and subtypes as well as a set of two dozens relationships define their interaction and allow a high level of constraints that aid to limit

errors by domain- and topologic boundary conditions without limiting the ability of the mapper to perform his/her task.

Framework and Outlook: The geodatabase model is part of a data model currently under development and design in the context of providing tools and definitions for mapping, cartographic representations and data exploitation. The database model as an integral part is designed for portability with respect to geoscientific mapping tasks in general and can be applied to every GIS project dealing with solid-surface planets. It will be accompanied by definitions and representations on the cartographic level as well as tools and utilities for providing easy accessible workflows focussing on query, organization, maintainance, integration of planetary data and meta information [1].

The data model's layout is modularized with individual components dealing with symbol representations (geology and geomorphology), metadata accessibility and modification, definition of stratigraphic entities and their relationships as well as attribute domains, extensions for planetary mapping and analysis tasks as well as integration of data information on the level of vector representations for easy accessible querying, data processing in connection with ISIS/GDAL [3,4] and data integration.

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References: [1] A. Nass, Lun. Planet. Sci. Conf. this volume; [2] ESRI Data Models, <http://support.esri.com/index.cfm?fa=downloads.dataModels.matrix>; [3] <http://isis.astrogeology.usgs.gov/>; [4] <http://www.gdal.org/>