GIS-based Template for Geological Mapping –Ceres Use Case

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1. INTRODUCTION

One aim of the NASA Dawn space mission is to generate global geologic maps of the asteroid Vesta and the dwarf planet Ceres. To accomplish this, the Dawn Science team followed the technical recommendations for geological mapping, as outlined by [1]. The tiling schema for geological mapping is divided into two parts: 4 overview (survey) quadrangles and 15 more detailed (HAMO, high altitude mapping orbit) quadrangles [2]. Each quadrangle will be assigned to individual investigators.

To accommodate the map requirements regarding rules for data storage and database management (e.g., [3]), the computer-based environment used for the interpretative mapping process must be designed in a way that it can be adjusted to the unique features of the individual investigation areas. At present, the geological mapping of Vesta is completed as far as Dawn Science Team involvement [4, 5] and mapping of Ceres is just at the beginning. Therefore, for Ceres mapping we present a template that will set and use standards for digitizing, visualization, data merging and synchronizing in the processes of interpretative mapping. Following the new technological innovations within used software systems and the individual requirements for mapping Ceres, our template is based on the symbology and framework as described in [6] and [7].

2. ENVIRONMENT AND DATA

The entire interpretative mapping process will be conducted within geographic information systems (GIS). The GIS environment is organized in a structure that allows acquisition/preparation, analysis, storage, management, and visualization of spatial data. Once the final mapping products of Ceres have been produced by the individual researchers, the datasets must be in a format that can be combined in ESRI's ArcGIS [8]. To ensure standardized cartographic visualization of mapping data, the *Digital Cartographic Standard for Geologic Map Symbolization* [9] was used (as established by the US Federal Geographic Data Committee (FGDC)).

3. MAPPING TEMPLATE

The mapping template is based on the ArcGIS format called a file-geodatabase (FGDB). In our initial FGDB, map objects and features to be managed are based on the objects discovered on Vesta. As new feature-types are identified and classified on Ceres, additional object summaries will be added to the FGDB. These summaries contain thematic/genetic object descriptions (e.g., graben trace, accurate) as well as a (carto-)graphic object descriptions (based on the standardized FGDC catalogue).

In the ArcMap environment of ArcGIS, the FGDB is visualized and can be edited in three main layers (as *FeatureDatasets* (*FD*) or *MosaicDataset* (*MD*)): the *geologic mapping layer* (*gml, FD*), the *map sheet layer* (*msl, FD*), and the *basis data layer* (*bdl, MD*). The *bdl* serves as bottom-most layer which holds the map-projected images (raster format), upon which the geologic mapping is based. Within the *msl*, the map graticules (10x10° and 30x30° grid) and the different quadrangle boundaries are included. The *gml,* or geologic mapping layer, contains the layers (as *FeatureClasses* (*FC*)) into which the geologic features of the surface of Ceres will be digitized. Aspects of the Ceres *FGDB* include:

- 5 *FC*s that represent specific types of geologic features as vectors (point, line, polygon). The five FC are: point objects (PointFeature), linear objects (LineFeature), geological contact lines (GeoContact), thin deposits or surficial geomorphological objects (SurfaceFeature), and basic geological units (GeolUnits).
- *Subtypes and Domains* are the hierarchical, or domain-controlled, attributes that are coordinated within each *FC*. The attribute names are based on those that are used in the FGDC standard.
- *Cartographic symbols* follow the FGDC recommendation. For our implementation into ArcGIS, we used a predefined symbol set [6] that will be modified and expanded for the individual quadrangle mapping of Ceres.

In addition to the *FGDB* standards, mappers will also be supported by an instruction document. This document contains all necessary information about how to use, update and modify the *FGDB*. In order to ensure a uniform description across each of the individual map quadrangles, we are also providing a metadata template that is to be filled out by the mappers. This template uses standardized metadata keywords (e.g. [10], [11]) like `TARGET_NAME, MAP_PROJECTION_TYPE` and `TITLE`.

4. CONCLUSION AND FUTURE WORK

Development of the GIS template is still in progress and will be further improved throughout the mapping process. This development will be shaped by unique characteristics of the as-yet-unknown regions of Ceres and how these areas are

interpreted by individual mappers. Through a direct link between the domain-based object attributes and the predefined and standardized symbology, a unique mapping process can be implemented, and, as a result, be better controlled. By doing so, merging and synchronization of different map quadrangles will be far more practical because all maps will be based on the same predefined data (map) structure. One potential future benefit in using the *FGDB* model is that a software-independent use of mapping data and the structure of the template is made possible by transferring *FGDB* schema to open-source database systems (e.g., PostgreSQL).

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