

A review of Cartographic Symbol for Geologic and Geomorphologic Maps in Planetary Science

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Abstract

A critical review of existing standard for geological features in planetary sciences is important to ensure uniform and understandable maps in the future. This contribution presents current efforts to handle this within a joint USGS/ASC - DLR project.

1. Introduction

Maps are one of the most powerful communication tools for spatial data. Maps of planetary surfaces, in particular those of the Moon, Mars, and Venus, are standardized products and often prepared as a part of hypothesis-driven science investigations. The Planetary Geologic Mapping program, funded by NASA and coordinated by the USGS/ASC [1], produces high-quality, standardized, refereed geologic maps and digital databases of planetary bodies. In this context, 242 geologic/geomorphologic, and thematic map sheets and map series have been published since 1962. However, outside of this program, numerous non-USGS published maps are created as result of scientific investigations and published within peer-reviewed journal articles.

The mapping basis is mostly limited to remotely sensed satellite data, with a few exceptions from rover data. Furthermore, due to the complexity of planetary surfaces, diversity between different planet surfaces, and the varied resolution of the data, geomorphologic/geologic mapping is a challenging task and highly interpretative work.

Uniform and unambiguous data are fundamental to make quality observations that lead to unbiased and supported interpretations, especially when there is no current groundtruthing [2]. To allow for correlation between different map products (digital or analogue), the spatial objects are visualized by predefined and standardized cartographic symbols. [3] defines the most commonly used symbols, colours, and hatch patterns. Chapter 25 of this document defines the

Planetary Geology Features based on the symbols defined in [4].

The focus of this contribution is on changing the symbology with respect to time and how it effects communication within and between the maps. Two key questions are

Q1 Does [3] provides enough variability within the chapter 25 and the other subcategories (e.g., faults) to represent the data within currently needed maps?

Q2 What recommendations can the mapping community and its steering committees make to convey information succinctly and thoroughly in planetary themed maps to enhance a map's communicability?

2. Approach for

To determine the most representative symbol collection supporting future map results, we defined the task list as follows, we are currently working on:

M1 Statistical review of existing symbol sets and collections: The symbol sets within the USGS products of the geologic mapping program (available here [1]) would be documented and analysed.

M2 Establish a representative symbol set for planetary mapping: The results of M1 will be compared with the symbols in [3] to determine how they overlap. Finally, members of the mapping community and staff at USGS/ASC will review the symbols to identify where deficiencies and excesses exist within the current [3].

M3 Update cartographic symbols: The symbol set resulting from M2 will be used to create a new set of symbols. This will respect symbols used in past maps, but will focus on retiring low-use and outmoded symbols and replacing them with the appropriate terrestrial symbols, when they exist.

M4 Implementation into GIS-based mapping software: every particular (carto-)graphically formulated symbol will be implemented into the GIS software to increase the usability for the mappers.

This implementation will mimic the 2010 application of the planetary symbol set into ArcGIS ([5]), but also implementations into other GIS, e.g., QGIS.

M5 Distribute the symbol set: to reach as many planetary users as possible, it is necessary to draw attention to the symbol recommendations (e.g. within workshop and conference contributions) and provide the updated symbol set at different locations (e.g., institute websites, cross link to international organizations like IAU, ICA, ISPRS, and initiatives like openplanetary [6], MAPSIT, FGDC, and academic institutes).

3. Current Status

We considered 154 of the 242 on [1] available geological maps sheets. Within these 154 maps the mappers used 531 different symbol descriptions (map legends have mean. = 12, max. = 30, and min. = 1 listed symbol). The symbol description often shows different phrasing for the same feature, so that the used description does often not link distinctively to one symbol graphic. Based on this fact, it isn't easily possible to find the most needed symbols. We generated an overview of the most described objects in a map by querying keywords in the statistic (see figure 1). This gives the first realistic hint to the most used objects which were described in the available maps and will serve as basis for the next decisions.

4. Summary and Outlook

Following the formulated task list, the next steps are:

- (1) Increase the statistical population by including representative maps in- and outside USGS maps.
- (2) Establish a digital collection of most used symbols for geological planetary maps.
- (3) Discuss colour recommendation for geological units of different planetary bodies and chronological epochs following, e.g. shown in [3] or www.stratigraphy.org/.

After the first symbol collection a few more task are essential to enable a user-friendly and software independent usage of the symbols in GIS environment

A1 merge symbols with predefined attribute values characterize planetary objects in geological data model – already ongoing approach see also [7].

A2 convert and save symbols in open formats, e.g. *.svg (already discussed in [5]).

A critical review of the existing standard for geological features in planetary sciences is important to ensure uniform and understandable maps in the future. Therefore we established the joint and ongoing project between USGS ASC and DLR and are working on an updated symbol collection for geologic and geomorphologic maps.

If you as experienced mapper in planetary science like to volunteer, please contact us!

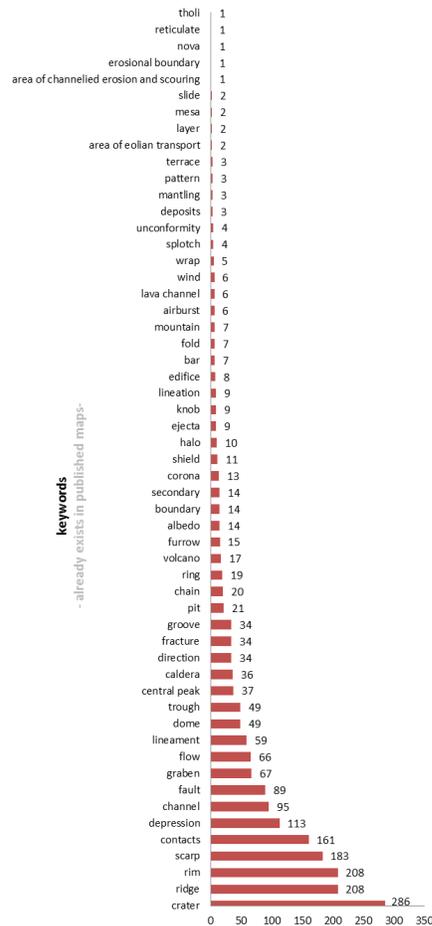


Figure 1 Statistical overview of already used symbol.

References

[1] United States Geological Survey, *Planetary Geologic Mapping Program Website*, <https://planetarymapping.wr.usgs.gov/>, 2016 [2] Archinal et al., *LPSC*, #2286, 2017 [3] FGDC, *Digital Cartographic Standard for Geologic Map Symbolization*, 2006 [4] Tanaka, K. et al. *The Venus geologic mappers' handbook*, Open-File Report 94-438, U.S. Geological Survey, 1994 [5] Naß, A. et al. *PSS*, Vol. 59(11-12), 2011 [6] Manaud, N. et al., *DPS-EPSC*, #2587836, 2016, [7] Naß, A, *LPSC*, #1892, 2017.