FEATURE-LINKED ANNOTATION OF LUNAR AND MARTIAN NOMENCLATURE

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ABSTRACT
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New high-resolution data returns from spacecraft orbiting the Moon and Mars have led to an increase in localized topical science and geologic mapping studies of lunar and martian landforms. These studies have increased the demand on the International Astronomical Union (IAU) Working Group for Planetary System Nomenclature (WGPSN) to approve feature nomenclature [1]. To keep pace with the increase in IAU-approved nomenclature, we are utilizing a geographic information system (GIS), which provides a dynamic environment that supports feature-linked annotation for custom placement of nomenclature based on the feature's attributes. GIS has the added benefit of storing annotation as vectors with spatial reference and scale information [2]. The USGS Astrogeology Science Center's (ASC) Mapping, Remote-Sensing, Cartography, Technology, and Research (MRCTR, pronounced Mercator) GIS Lab has created, and made available, downloadable GIS nomenclature projects for the standard global (1:10M), regional (1:2M) and quadrangle (1:1M) scale maps for the Moon, and global (1:20M) and quadrangle (1:5M) scales for Mars [3].

METHODOLOGY

Landforms with direction, such as vallis and rupes features, required a basic bounding geometry to drive the angle of placement, and circular/point feature geometries were created through buffering points by their documented radius. Sizes of directional features were measured by the widest part of their minimum bounding envelopes. To facilitate data driven pages, polygon features were intersected with quadrangle boundaries so features are at the appropriate boundary. Within the annotation feature class, annotation subclasses were created for each feature type and size, each with its own font type, size, placement properties and rules for resolving conflicts that reflect IAU standards [4]. Simple Python or Visual Basic Script code was used to further customize placement. As examples, we used code to capitalize features over 85 kilometers, stack large feature nomenclature and insert line breaks.

The annotation placement rules described here produce results very similar to those performed manually with programs like Adobe Illustrator (AI). However, the flexibility of Esri's Maplex® label engine dictate that results are never as precise and the same parameters rarely produce identical results. Even without conflicting features in the area, placement of annotation can violate user defined rules so users must review all features. This methodology is meant to automate approximately 80% of annotation placement, but more importantly, to facilitate the editing and continued maintenance of nomenclature annotation.

GEODATABASE MANAGEMENT & EDITING

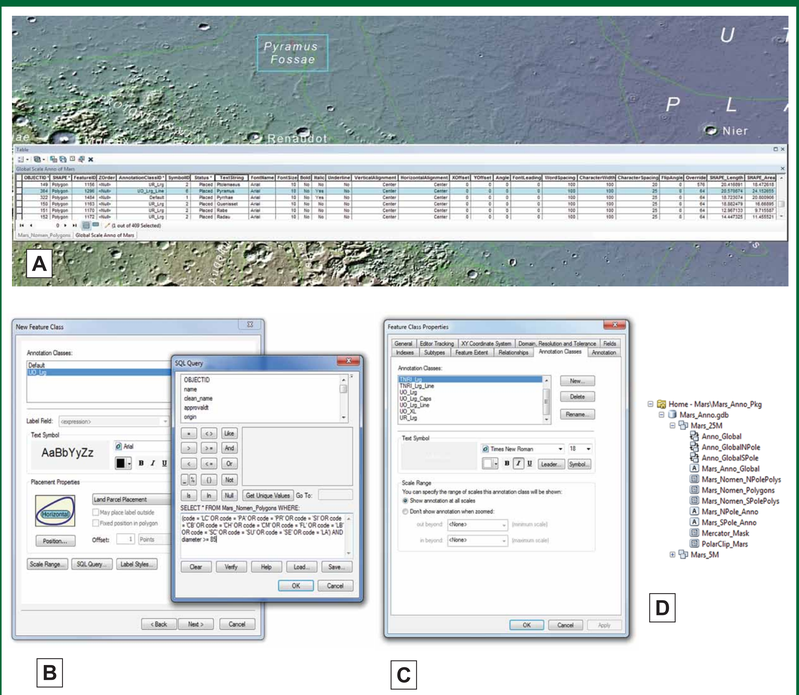

Figure 1. (A) Annotation feature class table stores placement properties as attributes, (B-C) user defined properties for each annotation class, and (D) geodatabase structure.

EXAMPLES

Figure 2. 1:5M Mars Chart quadrangle (MC-3) with Colorized MDIM 2.1 basemap and annotation layer.

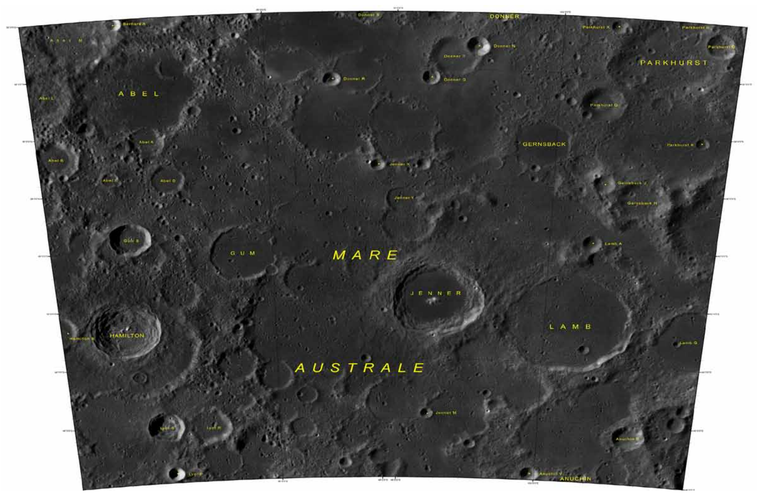

Figure 3. 1:1M Lunar Astronautical Chart quadrangle (LAC-116) with LRO WAC basemap and annotation layer.

REFERENCES

[1] IAU WGPSN. (2015). Gazetteer of Planetary Nomenclature, http://planetarynames.wr. usgs.gov/.
[2] ESRI. (2015). ArcGIS Help 10.1, About editing feature-linked annotation. http://resources.arcgis.com/EN/HELP/MAIN/10.1/index.html#/About_editing_feature_linked_annotation/01m70000004w 000000/.
[3] Fortezzo, C. M. (2010). Annotation & Nomenclature. http://astropedia.astrogeology.usgs.gov/download/Software/GISTutorials_ArcMap_Annotation_Nomenclature.pdf.
[4] IAU WGPSN (2015). 1:1 Million- Scale Maps of the Moon. http://planetarynames.wr.usgs.gov/Page/Moon1to1MAtlas.

MAPLEX® LABEL ENGINE

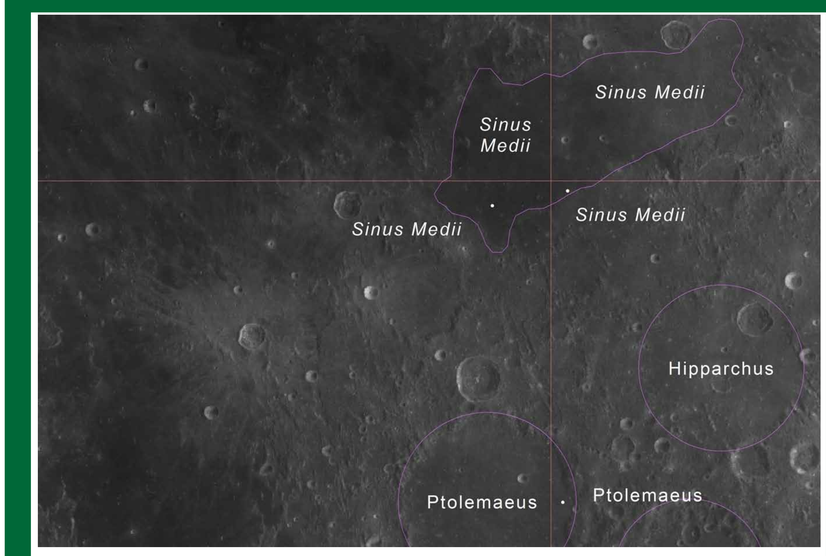

Figure 4. 1:2M Lunar Quadrangles with LRO WAC basemap and annnotation layer. Automatic placement of annotation differs based on space available; duplicates are created when features are within multiple quadrangles. All quadrangle-scale map projects were combined with the Data Driven Pages toolset to create map books with each page projected and extent clipped to the quadrangle boundary.

FUTURE WORK

Changes to IAU-approved nomenclature will have to be added in separately because each scale of annotation is kept in its own geodatabase along with the feature and relationship classes driving them. Recommendations for continuation of this work are to eliminate redundant workflows by supporting all scales and projections in a single geodatabase as well as to offer users custom annotation editing within web mapping interfaces for print-ready products. Because landform geometries have not been formally approved by IAU the feature polygons are not included in GIS downloads.

NOW AVAILABLE FOR DOWNLOAD AT:

http://planetarymapping.wr.usgs.gov/

Lunar Global with Poles (1:10,000,000)
Lunar Quadrangles (1:2,000,000)
Lunar Astronautical Charts (1:1,000,000)
Mars Global with Poles (1:20,000,000)
Mars Charts (1:5,000,000)

ACKNOWLEDGEMENTS

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