PLANETARY GEOLOGIC MAPPING PYTHON TOOLBOX: A SUITE OF TOOLS TO SUPPORT MAPPING WORKFLOWS. M. A. Hunter, J. A. Skinner, Jr., T. M. Hare, and C. M. Fortezzo. U.S. Geological Survey, Astrogeology Science Center, 2255 N. Gemini Drive, Flagstaff, AZ, 86001 (mahunter@usgs.gov).

Introduction: The decentralized nature of the planetary science community, including those conducting geologic mapping investigations, has resulted in a wide variety of data management and analytical tools that have been developed on an ad-hoc basis to support common ArcGIS workflows. Though these tools are useful for particular individuals, groups, or projects, different computing environments make sharing and maintenance difficult. These tools often lack flexibility to handle different data formats and workspaces. To meet this community demand, USGS is releasing a Python Toolbox designed to aide planetary scientists in general, and planetary mappers specifically, by providing easily accessible tools that streamline typical mapping workflows.

Background: Most of the tools included in the PGM Python Toolbox were first developed with ArcGIS ModelBuilder, but lacked the flexibility necessary to be useful to a broader community. Such models are ideal for very specific use cases and data types. Additionally, supplemental Python scripts called in models were subject to problems with imported modules based on custom operating system configurations mandated by different institutions. Python Toolboxes function much like other geoprocessing tools in ArcGIS, including the familiar graphical user interface (GUI) as well as Tool Help dialog, in a self-contained *.pyt script that contains all parameter, validation and execution code [1]. The most notable limitation of this tool type is that they do not support interacting with the map (i.e., reading coordinates of the cursor location), but they do honor selections within a feature layer as with standard tools.

The first version of the PGM Python Toolbox contains four different tools: Shapefile Merge, Topology Check, Build Polygons, and Slope & Aspect Test [2]. The collective focus of this toolbox is to provide researchers with additional means to migrate legacy data, assess the quality of data and analysis results, and simplify common mapping tasks; it is not meant to solve for problematic data or substitute for fundamental GIS knowledge.

Toolset Summary:

Shapefile Merge Tool. The first tool in the PGM Python Toolbox is the Shapefile Merge tool, based on a model created by Trent Hare, which solves for the common issue of like data saved as separate shapefiles (Figure 1) [2]. For example, scientists often save land cover units separately for processing purposes, and they must be merged back together to check for gaps and overlaps between units. The recursive option in the tool searches subfolders in the workspace in sub-directories and filter by name or file extension, the output feature class contains a new attribute with the names of each input.

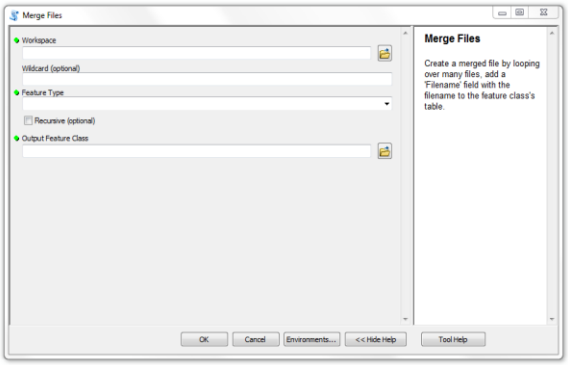

Figure 1. Merge Files tool GUI.

Topology Check Tool. The Topology Check tool tests either polyline or polygon-type features against the spatial relationships required to produce clean geologic maps (Figure 2). It does this by creating a topology class, adding rules based on the input feature geometry, validating the topology, and exporting the results for action by the user. Despite the improved ease of use, though, users must understand the requirements and limitations related to (re-)creating topologies in a geodatabase.

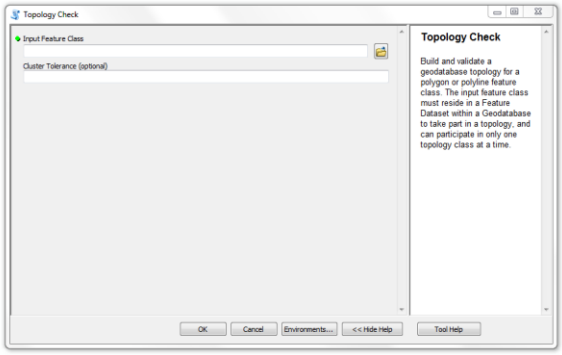

Figure 2. Topology Check tool GUI.

Build Polygon Tool. The most highly demanded tool from the 2016 Planetary Geologic Mappers' Meeting was to create geologic unit polygons from contact polylines, with the option to carry forward unit name attributes. By building polygons from contacts mappers can better ensure topological integrity without the redundancy of re-attributing units with each iteration (Figure 3) [3]. It is important that out-

puts follow a naming convention that keeps versions in order; the polyline feature class is continually edited, but previous versions polygons may be converted back to contacts with the Feature To Polyline tool.

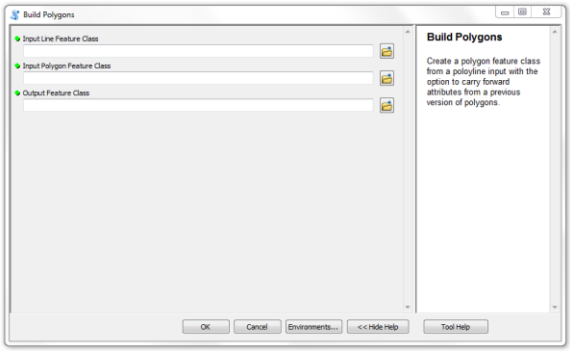

Figure 3. Build Polygons tool GUI.

Slope/Aspect Tool. Recently developed tools to measure strike and dip allow for more precise calculations; however, validation of such results have remained a time-consuming process [3]. The Slope & Aspect Test tool uses the point results of a strike and dip analysis to extract the values of derived slope and aspect rasters from an input Digital Elevation Model (DEM). These values are then evaluated against the user-specified tolerance (in degrees) to identify potentially errant results (Figure 4). As with the other tools, this is meant to identify possible errors for further investigation, not substitute for strike and dip calculations.

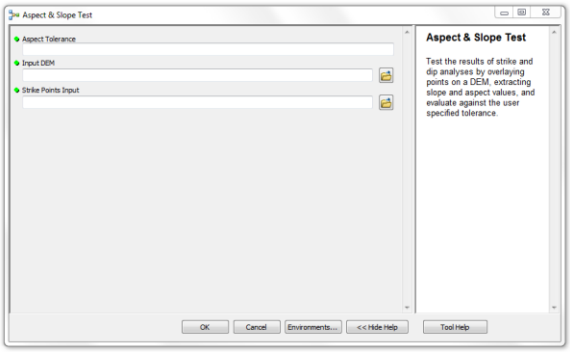

Figure 4. Slope & Aspect Test tool GUI.

Future Work: The PGM Python Toolbox will be posted to the PGM website for download, and be included with GIS templates for newly approved mapping projects. It is meant to be dynamic, and will grow to meet the changing needs of scientists as data and methodologies continue to evolve. New ideas for geoprocessing tools are encouraged, and community guidance will be solicited at the annual PGM Metting and Data Workshop. Recommendations may also be submitted directly to the author or PGM Coordinator for consideration. Additionally, researchers who have developed their own workflows or models may submit them for inclusion in the toolset.

References: [1] Esri. 2017. What is a Python Toolbox? http://desktop.arcgis.com/en/arcmap/10.3/analyze/creating-tools/a-quick-tour-of-python-toolboxes.htm. [2] T. M. Hare. 2016. AddMerge Tool. ArcGIS ModelBuilder v10.3.1. [3] USGS ASC. 2008. GIS for Planetary Geologic Mapping. 2008 Planetary Geologic Mappers Meeting. ftp://pdsimage2.wr.usgs.gov/pub/pigpen/mars/tutorials/USGS_PGM2008_ GIS-wkshp.pdf.