IMPROVING THE ACCESSIBILITY AND FUNCTIONALITY OF PLANETARY MAPS THROUGH WEB-BASED RESOURCES. S. R. Black and J. A. Skinner, Jr., USGS Astrogeology Science Center, 2255 N. Gemini Drive, Flagstaff, Arizona 86001 (sblack@usgs.gov).

Introduction: Since the creation of the United States Geological Survey Astrogeology Program in 1960, standardized planetary map products published through the USGS have been available to the science community as printed paper maps and, in more recent decades, as digital Geographic Information Systems (GIS) files. These formats require map users to either acquire a hard copy of the map or, if the map is to be used for additional analyses, possess the necessary GIS software and skills to interact with the data. Both methods create barriers to those who wish to view and use planetary maps.

Interactive map initiative: In June 2020, the USGS Astrogeology Planetary Geologic Mapping Program began an initiative to make all published standardized USGS planetary maps available through interactive web services (**Fig. 1A**). Creation of interactive maps is ongoing; we plan to create these products for all existing and future USGS standardized planetary maps. Currently, maps are available through direct links [1,2]. However, interactive maps will soon be discoverable through a search interface on the USGS Planetary Mapping website [3].

Methods: Interactive maps are created using published GIS files for each map, which are available through the USGS Publications Warehouse [4]. Interactive web map components are published and hosted in ArcGIS Online (AGOL) using tile services for basemaps and annotation layers, and feature services for map components such as the geologic units, contacts, and linear features. Web maps are assembled in AGOL using the published map components (basemaps, annotation layers, and feature services). Web maps are then incorporated into an AGOL custom web application, which is embedded and shared through the USGS Planetary Mapping website [3].

Before the feature services are published for each map, unit descriptions and interpretations are added to the geologic unit attributes. Unit descriptions and interpretations are then viewable through pop-ups in the interactive map, eliminating the need for users to access the Description of Map Units PDF separately from the map itself (**Fig. 1B**).

Improving accessibility: The goals of the interactive map initiative are to reduce the technical and computational requirements for working with planetary maps and to make them widely accessible to both the scientific community and the public. Interactive maps are publicly available through the USGS Planetary Mapping website [3]. Therefore, the only requirement for map users is to have an internet connection. The interactive web map interface removes the need for map users to have both GIS software and the technical GIS skills to import, view, and work with map files. Original GIS files remain available through the USGS Publications Warehouse [4] for those who wish to access them directly and are accessible via the Map Documentation and Download section of the interactive map (**Fig. 1C**). In addition to the basic GIS functions described below, interactive maps also function as a data search and discovery tool for planetary scientists who would like to explore a map or region before acquiring a hard copy or downloading the GIS files for further in-depth analyses.

Web-based GIS functions: In addition to search and discovery, these interactive maps also contain basic GIS functions such as bookmarking, querying, and measurement capabilities. Maps that contain figures and cross sections have bookmarks to allow users to easily view those locations. Users may also add their own custom bookmarks to any map. The querying tool (**Fig. 1D**) allows map users to search features such as the geologic units and contacts by name, location, or intersecting with another feature or user-defined area. Query results may also be exported for further analysis. The included measurement tool (**Fig. 1E**) calculates both area and distance using user-defined inputs.

Upcoming capabilities: The interactive maps as described above are products and capabilities that are afforded by GIS files prepared either as required for submission and review of a planetary geologic map through the USGS or as those digitized from a previously published hard copy map. However, there are additional improvements and capabilities that the USGS Planetary Geologic Map Coordination Group plans for future iterations. These efforts will focus more specifically on analyzing the GIS data rather than simple visualization and querying. Planned evaluations include the role of zonal statistics (such as calculating elevation statistics per geologic unit), comparisons between maps (for example, identifying Noachian units that intersect across multiple maps on Mars), and advanced queries such as crater size-frequency statistics. Furthermore, we are exploring methods for authors to share non-standardized maps (for example, maps published in journal articles). Inputs for community-sourced maps may initially involve a simplified entry of coordinates, map title, authors, a

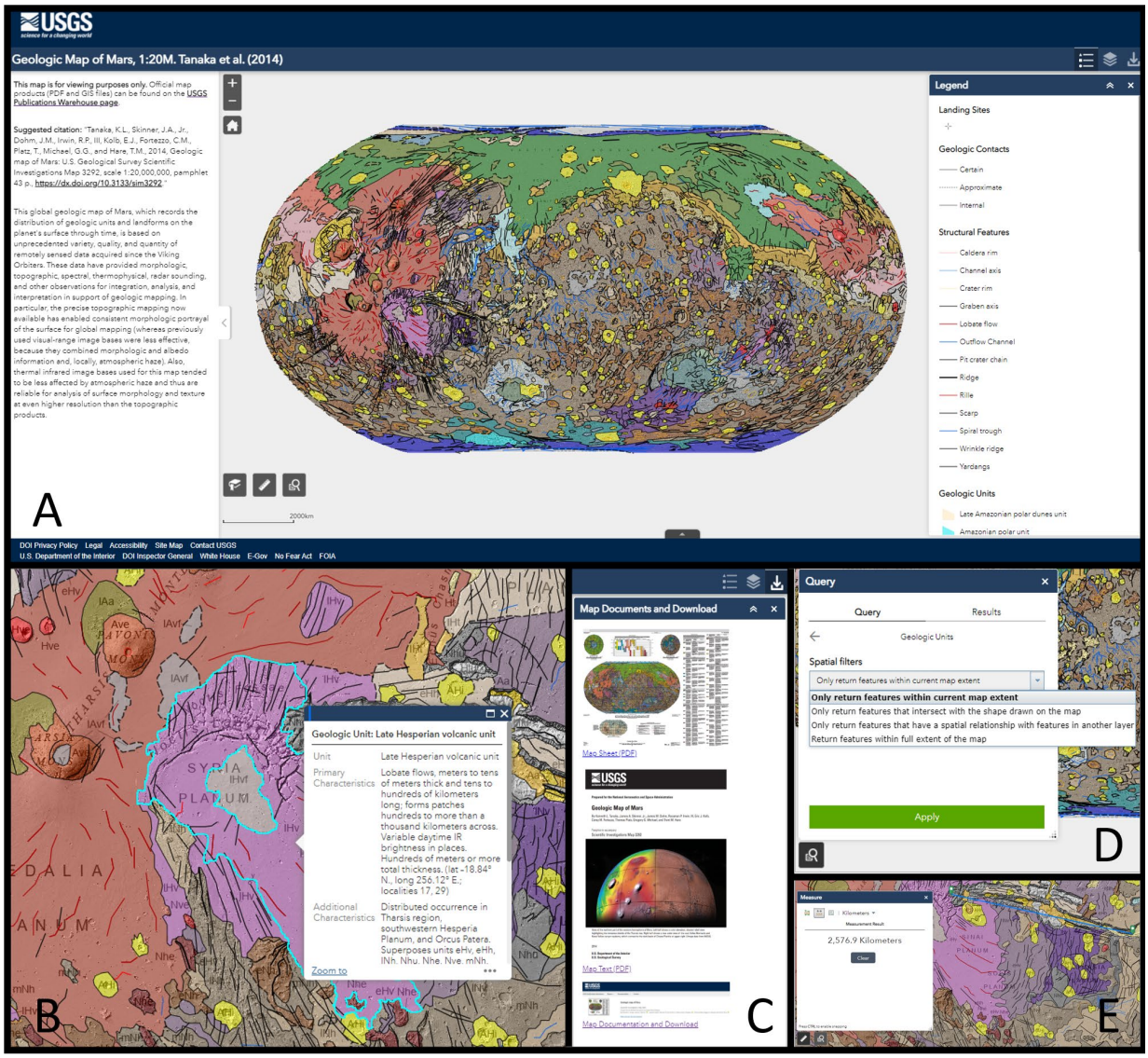

Figure 1: Example interactive map interface and functionality. A) Example interactive map using the 1:20M Tanaka et al., 2014 [2] Geologic Map of Mars. The interactive map is hosted and available through the USGS Planetary Mapping website [3] and contains the map description and links to the map on the USGS Publications Warehouse [4] website; B) An example of Description of Map Units information available in the interactive pop up menu; C) The Map Documentation and Download icon contains direct links to PDFs of the map sheet and map text, and the USGS Publications Warehouse [4]. D) Querying capabilities include the ability to search for geologic units and other features which fall within the map area, the current display extent, a user-defined region, or intersecting with other user-defined layers; E) Mensuration capabilities include both area and distance.

brief map description, and a link to the publication. These author-provided entries will be discoverable using USGS search tools and will direct users to the published resources. Community input and suggestions are encouraged for these upcoming projects. Initial exploration and development will occur during FY22 and continue into the following years.

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References: [1] Sun, V. Z., and Stack, K. M., (2020) Geologic map of Jezero crater and the Nili Planum region, Mars: USGS SIM 3464, scale 1:75K. [2] Tanaka, K. L. et al., (2014) Geologic map of Mars: USGS SIM 3292, scale 1:20M. [3] USGS Planetary Mapping: https://planetarymapping.wr.usgs.gov/. [4] USGS Publications Warehouse: https://pubs.er.usgs.gov/.