FIRST USGS GLOBAL GEOLOGIC MAP OF TITAN. D. A. Williams[1], M. J. Malaska[2], R. M. C. Lopes[2], A. M. Schoenfeld[3], S. P. D. Birch[4]. [1]School of Earth and Space Exploration, Arizona State University, Tempe, Arizona, 85287-1404 USA (David.Williams@asu.edu), [2]NASA Jet Propulsion Laboratory / California Institute of Technology, Pasadena, California, USA, [3]Department of Earth, Planetary, and Space Sciences, University of California, Los Angeles, Los Angeles, California, USA, [4]Department of Astronomy, Cornell University, Ithaca, New York, USA.

Introduction: Radar and visible image data from NASA's *Cassini* mission have enabled visualization of the surface of Saturn's moon Titan. Since early in the mission, members of the *Cassini* Science Team, and others, have been applying geologic mapping techniques to these data to better understand Titan's surface evolution [1-5]. This work culminated in the first 6-unit global geomorphological map published last year [6]. A more detailed geologic map was produced (**Fig. 1**), which we think should serve as the basis of the first U.S. Geological Survey (USGS) Special Investigations Map (SIM) global map of Titan. We received notification in April 2021 that our PDART (Planetary Data Archiving, Restoration, and Tools) proposal was selected to make a 1:20M SIM Titan map.

Mapping Approach: Our existing mapping was done in ArcGIS™ at a scale of 1:800,000, taking advantage of the resolution of *Cassini* RADAR data. To make a visually compelling map that will fit on a single USGS map sheet, this map will be adjusted to 1:20M scale. As such, all mapped features ≤30 km in length, or polygons 30 km x 30 km or smaller, will be reduced to point features. Additionally, the 1:800K map has 43 units in regions of SAR coverage, that were extrapolated to 7 undivided units in areas lacking SAR coverage. These are all subunits of Titan's 6 primary terrain types: plains, labyrinths, hummocky materials, dunes, craters, and (hydrocarbon) lakes. We recognize that 50 units is probably too detailed for the 1:20M map, and significant simplification will need to be done, including merging of units of limited areal extent.

Mapping Base: The USGS will create a new ArcGIS™ project with our ISS and RADAR basemap, on which we will overlay the existing mapping layers. We will create a Description of Map Units (DOMU) in the tabular style consistent with USGS maps. In addition to RADAR and ISS, our map units are additionally defined and characterized with HiSAR, SAR-derived topography, microwabe radiometry-derived emissivity, and VIMS data, where available.

Map Text and Supporting Documents: Using the USGS global geologic map of Mars [7] as a guide, we will include the following components in the map text: Introduction, physiographic setting, data used as basemap and ancillary supporting materials, mapping methods, map components (unit delineation, unit groups, unit names and labels, contact types, linear feature types, point and surface feature types), age determinations, and a concise geologic history of Titan's surface derived from all the geologic mapping that has been done. Explanation of map symbols (EOMS), figures, captions, and any required tables will be produced following submission guidelines for USGS planetary geologic maps in the most recent Planetary Mapping Protocols document [8].

We will create a Description of Map Units (DOMU) using data from SAR, HiSAR (including notes on incidence angle effects), radiometry, ISS, VIMS, and topographic relations to describe the characteristics of the terrain units. The units would be described in terms of plan, edges, and internal morphologies. We will provide an interpretation (or multiple, as necessary) of each unit. We will use the Afekan regional area work as a starting point to build a global DOMU and Correlation of Map Units (COMU) that is in accordance with USGS standards. We will create a COMU based on stratigraphic principles. We will use cross-cutting, embayment, and superposition relations to determine a relative stratigraphy, although the dearth of impact craters on Titan means age determination by crater statistics is not viable. A preliminary stratigraphy for mid-latitude and equatorial terrain units was published in [4].

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References: [1] Stofan E.R. et al. (2006) *Icarus, 185,* 443-456. [2] Lopes R.M.C. et al. (2010) *Icarus, 205,* 540-558. [3] Williams D.A. et al. (2011) *Icarus, 212*, 744-750. [4] Malaska M.J. et al. (2016) *Icarus, 270,* 130-161. [5] Birch, S.P.D. et al. (2017) *Icarus, 282,* 1-23. [6] Lopes R.M.C. et al. (2020) *Nat. Astron., 4*, 228-233. [7] Tanaka, K.L. et al. (2014), USGS SIM 3292, 1:20M. [8] Skinner, J.A. et al. (2018). https://planetarymapping.wr.usgs.gov/Page/view/Guidelines

Abbreviations:

ISS	Imaging Science Subsystem
SAR	Synthetic Aperture Radar
HiSAR	High altitude SAR (resolution >1 km)
VIMS	Visible & Infrared Mapping Spectrometer

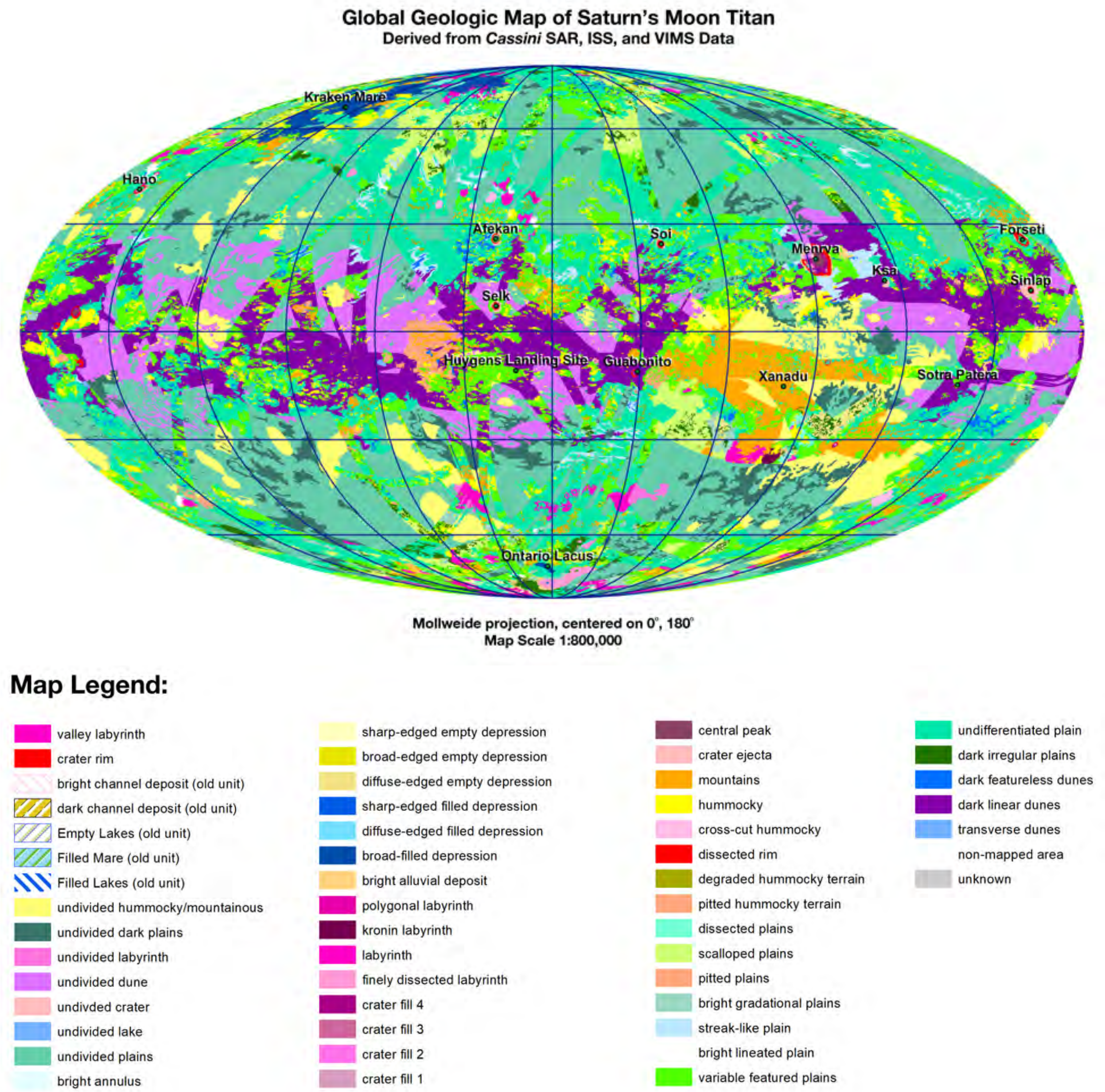

Figure 1. Our 1:800K-scale global geologic map of Titan, derived from NASA *Cassini* SAR, ISS, and VIMS data, as rendered in ArcGIS™ software. This map will be edited to USGS standards to become a published USGS SIM at 1:20M scale. Map is in Mollweide projection, centered on 0˚, 180˚. Mapping by M.J. Malaska, A.M. Schoenfeld, and S.P.D. Birch.