FIRST USGS GLOBAL GEOLOGIC MAP OF TITAN: DRAFT FOR SUBMISSION. 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, AZ 85287-1404 (David.Williams@asu.edu), [2]NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA; [3]Department of Earth, Planetary, and Space Sciences, University of California, Los Angeles, Los Angeles, CA, USA; [4]Department of Geological Sciences, Brown University, Providence, RI.

Introduction: Geological maps are scientific products that enable understanding of the nature and timing of geologic processes that have shaped planetary surfaces, and are tools that are key to understanding a planet's surface evolution. We have been funded by NASA's *Cassini* Data Analysis program to produce a global geologic map of Saturn's moon Titan. This map will be published by the U.S. Geological Survey at a scale of 1:20,000,000. This abstract discusses the current status of the map as we prepare it for review by the USGS in Winter 2023.

Background: PI David Williams has been working with members of the *Cassini* Science Team for over a decade to establish the protocols for geologic mapping of Titan using various *Cassini* data sets. Co-Is Malaska, Lopes, Birch, and Schoenfeld have published geologic maps of different regions or quadrangles of Titan's surface, using SAR images as a primary basemap supplemented by ISS and VIMS mosaics, emissivity and SAR topography, and other data [e.g., 1-4]. Our first 6-unit basic global geomorphological map was published in 2020 [5].

During the *Cassini* Project, Malaska [1], Schoenfeld [4] and colleagues mapped Titan at 1:800,000 scale as a series of quadrangle maps consisting of 43 geologic units within 6 primary terrain types: plains, labyrinths, hummocky materials, dunes, craters, and (hydrocarbon) lakes. This mapping is too detailed for a USGS global map sheet, and our goal over the last year has been to simplify this map to a form that reflects Titan's geology and can fit on a single USGS map sheet.

USGS Map: The current version of the 1:20M map (**Fig. 1**) consists of 12 units: Labyrinth (polygonal), Labyrinth (valleyed), Plains (bright), Plains (dark), Craters (three degradation states), Mountains/Hummocky Terrain, Dunes, Broad Filled Depressions (hydrocarbon seas), Lakes (filled), and Lakes (empty). Production of this map required merging or deleting linear features ≤25 km and polygons ~<900 km^2. Titan's hydrocarbon fluvial channels and lakes (both filled and empty, ~<900 km^2) have been rendered as linear and point feature layers, respectively. Map units are described in our Description of Map Units based on their SAR backscatter and texture/features, microwave emissivity, and ISS albedo, with supplemental information from SAR topography. These data enable recognition of rare Titan's impact craters in three degradation states: c1 (most degraded/oldest – e.g., Guabonito), c2 (intermediate degradation/age – e.g., Menrva), and c3 (least degraded/youngest – e.g., Selk, Sinlap).

Geologic History: Global mapping clearly shows that Titan is a world dominated by gradational processes, i.e., processes related to the weathering, erosion, and deposition of material. Aeolian processes dominate the equatorial and mid-latitude regions with the movement of organic materials and the deposition of linear dune fields and sand seas, as first noted by [6]. Fluvial, lacustrine, and coastal processes dominate in the polar regions, particularly currently at the north pole, with contemporary transport and accumulation of liquid hydrocarbon, as first noted by [7]. While fluvial transport of fluids currently is dominant in the high latitudes, it may have had a greater role in the equatorial region in the past as part of Titan's climate cycles [8].

The relative lack of impact craters makes establishment of a crater-based age scheme for Titan impossible, but global mapping enables a relative chronology to be recognized. A Correlation of Map Units suggests three broad divisions of time in Titan's history, with unclear boundaries between them:

A) Oldest division: Formation and tectonic modification of Highland Units (Mountains-Hummocky Terrain, Polygonal and Valleyed Labyrinths) and c1 craters.
B) Intermediate division: Formation and ongoing modification of Bright Plains and Dark Plains, c2 and c3 craters.
C) Youngest division: Formation and modification of aeolian, fluvial, and lacustrine features as part of Titan's current climate cycle (Dunes, Filled Seas, Filled and Empty Lakes).

Acknowledgments: This project is supported by grant #80NSSC21K0865 with funding from the *Cassini* Data Analysis Program.

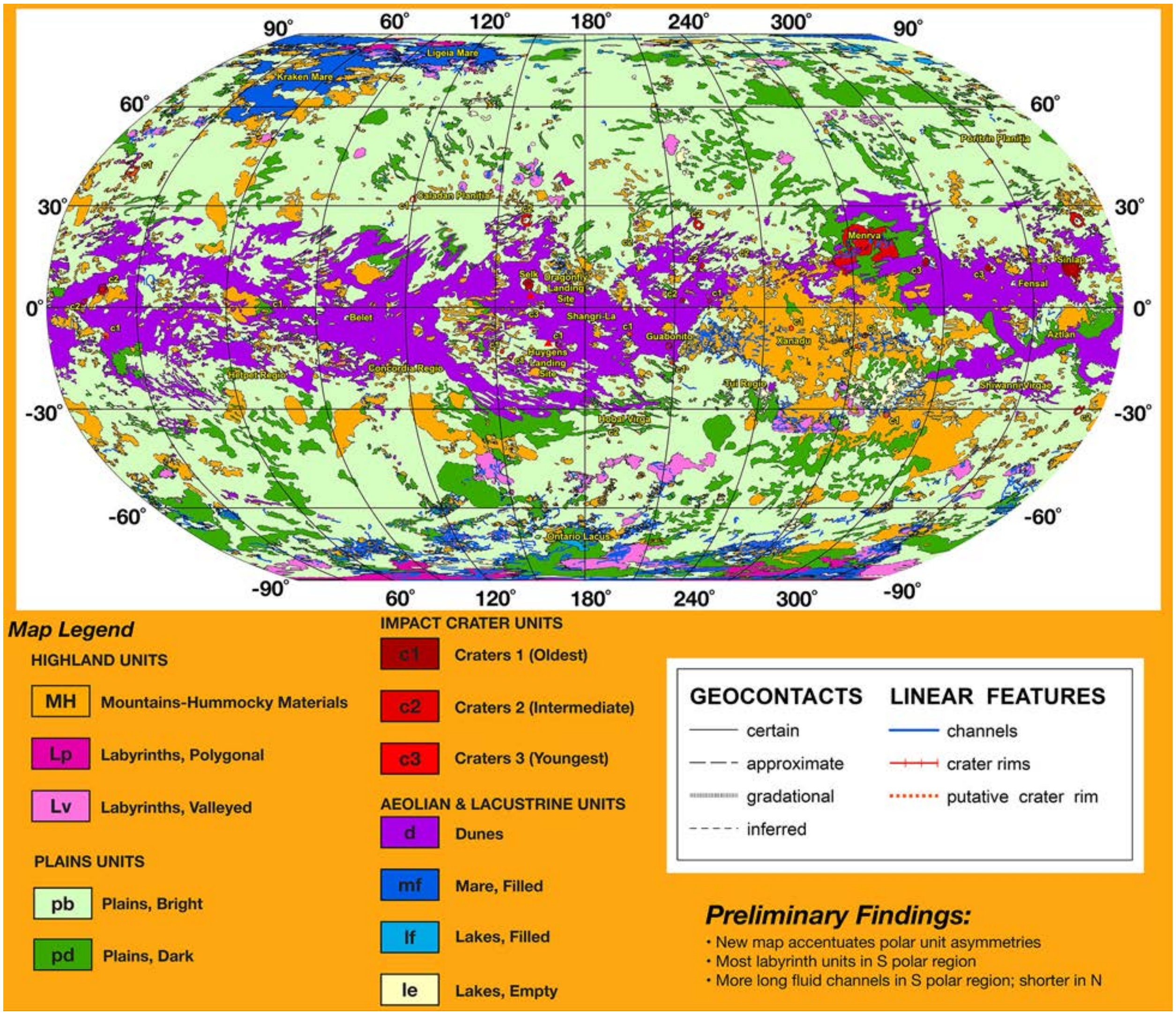

Figure 1. Global geologic map of Saturn's Moon Titan, scale 1:20,000,000, Robinson projection and centered on 0˚, 180˚. This version has been edited for submission to the USGS for review in Winter 2023.

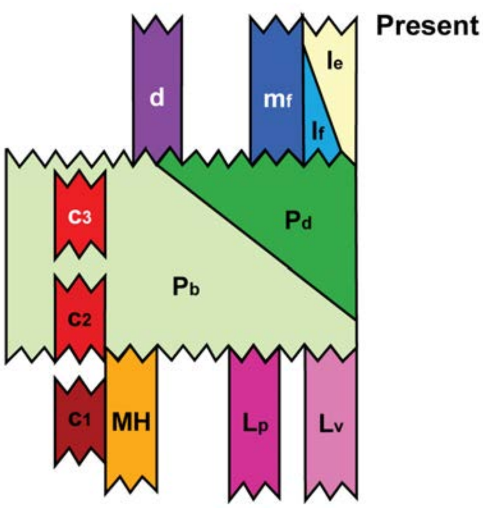

Figure 2. Correlation of Titan global map units. Three broad divisions of Titan's past are recognized.

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