BUILDING A GEOLOGIC MAP OF NEPTUNE’S MOON TRITON. E. S. Martin¹, D. A. Patthoff², M. T. Bland³, T. R. Watters⁴, G. C. Collins⁵, T. Becker⁶, ¹Smithsonian Institution, National Air and Space Museum, Center for Earth and Planetary Studies (martines@si.edu), ²Planetary Science Institute (appatthoff@psi.edu), ³U. S. Geological Survey, ⁴Wheaton College.

Introduction: In 1989, Voyager 2 encountered the Neptune system and returned images of its largest moon (~1350 km radius), Triton, and these images remain the primary data for our understanding of the satellite (Fig. 1). Triton was revealed to be a geologically active moon [1], and its activity has been linked to its dynamical history as a captured Kuiper Belt Object (KBO) [e.g., 2].

Until the New Horizons mission flew by Pluto in 2015, Triton was the only KBO visited by spacecraft; however, Triton’s role as our only close-up example of a probable KBO was always dogged by the question of whether its geology was representative of other KBOs, or resulted from its unique history. That question has not yet been rigorously reassessed in the post Pluto-encounter era.

Additionally, Triton bridges a gap between KBOs and icy satellites. As a likely KBO captured into Neptune’s orbit [e.g., 2] it contributes to the diverse population of icy satellites, but its origin is unique relative to those of the icy satellites and likely contributes to its young surface and exotic terrains (Fig. 1) [3]. The capture of Triton by Neptune likely resulted in a massive heating event that resulted in resurfacing [4, 5], possibly by cryovolcanism [6, 7]. Crater counts for both Triton [8] and portions of Pluto [9] suggest that both surfaces are exceptionally young, which may indicate that neither Triton nor Pluto retain their original surfaces.

The successful New Horizons flyby through the Pluto system opened the door to another part of the solar system revealing an extraordinary diversity of terrains, renewing interest in the origin, evolution, and diversity of KBOs [9], and by extension, Triton.

To-date, no peer-reviewed, broad-scale, detailed geologic map exists to characterize, classify, and identify geologic surface units and features on Triton. Mapping of Pluto and Charon is in progress [10, 11, 12], but no comparable geologic map of Triton exists, a direct comparison between these two KBOs cannot be performed at a fundamental level. Furthermore, as Triton serves as a bridge between KBOs and icy satellites, characterization of its terrains is important for advancing comparative planetological studies.

We aim to create an extensive accessible Triton data archive that will recover and restore original data products and provide context for future investigations by creating a geologic map across Triton’s Neptune-facing hemisphere.

Previous geologic mapping efforts on Triton include local geological maps of individual features (Fig. 2a) broad-scale terrain maps (Fig. 2b), or cursory maps that lack sufficient documentation (Fig. 2c). The most comprehensive of these maps was initially presented as a sketch map [1] and expanded into Fig. 3 [13]. However, Fig. 3 is not a Scientific Investigations Map (SIM) by the U. S. Geological Survey (USGS), and is not available in a digital format for distribution and use by the community. Detailed descriptions of geologic units are further illustrated with Voyager images of terrains and structures; however, poor printing quality makes it impossible to verify these geologic units. It is necessary for an accessible, digitized, USGS SIM be created to firmly establish the geology of Triton’s surface.

![Figure 1: Orthographic projection of Triton’s Neptune-facing hemisphere. Image No PIA00317](image1)

![Figure 2: Overview of Triton mapping efforts including a. A local-scale survey of the cantaloupe terrains (Fig. 2 from [3]) b. Crater locations and geologic units (modified from Fig 1 & 5 from [8]). c. Map of Triton’s tectonic structures [13].](image2)
Mapping Triton’s Geology: Understanding Triton’s geologic history is essential to unraveling its origin and evolution. The surface of Triton is estimated to be extraordinarily young [8], not unlike many regions of Pluto [9], which suggests the probability of being heavily modified from their original states. Geological mapping of Triton will allow for identification of geologic units and structures that are recently formed, and those that are ancient, revealing more about Triton’s evolution. The production of a geologic map builds a context for understanding the geologic history of a planetary body with a standardized set of criteria that conveys a geologic history in a way that is consistent across planetary bodies. Our mapping of Triton will build upon existing maps of Triton [e.g., 13] by using updated computer-aided digital mapping techniques that enable much finer details to be identified and shared with the community.

We will produce a SIM series geologic map of the Neptune-facing side of Triton at a scale of 1:5,000,000. The printed map product will be produced at 1:5M, however the digital product that will be published by the USGS will be 1:2.5M, higher than any Triton map product to date.

Mapping will occur on the USGS Voyager 2 orthographic color mosaic with a resolution of 600 m/pixel (Fig. 1), however for the purposes of mapping the color will be removed from the gray-scale color mosaic. This mosaic covers approximately 1/3 of Triton’s surface from 45° to -60°N latitude and -75° to 90°E longitude.

Our mapping effort will begin by identifying individual feature classes and cataloging characteristics. The first class of features to be mapped and described will be linear features. [13] produced a fracture map of Triton (Fig. 2c) including linear ridges, rugged ridges, sinuous ridges, graben, scarps, and lineaments. The map of these features exists only as a so-called sketch map [13] done at 1:5M. Furthermore, the description of the morphology and classification criteria defining different linear features is not documented.

Geologic mapping is one of the most fundamental practices necessary for understanding the geological history of a planetary body. The resurgence of interest in Triton and KBOs has been motivated in part by the success of the Pluto-system flyby by the New Horizons spacecraft and the approval for New Horizons to flyby a second targeted KBO. Triton is also a unique body because it bridges the gap between icy satellites as an icy KBO captured into Neptune’s orbit. This map will provide a framework for future Triton research, future KBO research, and preparation for future missions.