Introduction: Noctis Labyrinthus consists of a network of intersecting linear troughs and pits along the eastern Tharsis rise that connect eastward to the continuous chasmata of Valles Marineris. The pits and troughs may have formed due to withdrawal of magmatic reservoirs at depth [1], or by collapse over conduits developed by tectonically controlled groundwater flow [2]. The age of Noctis Labyrinthus is thought to be Late Hesperian to Early Amazonian based upon disruption of the lava plains along the plateaus [3-5]. Consequently, sediments deposited within the depressions represent this age or younger materials.

Mapping Investigation: For this study, we are mapping the western portion of Noctis Labyrinthus (-6 to -14°N, -99.5 to -95.0°W; Fig. 1), which includes some of the most diverse mineralogies identified on Mars using CRISM data [6-9]. We are using THEMIS daytime IR as a basemap, with a 1:500,000 publication scale. Thus far across the Noctis Labyrinthus region, the following minerals have been identified in association with light-toned deposits (LTDs): several kinds of sulfates (monohydrated {kieserite, szomolnokite} and polyhydrated sulfates, jarosite, and Ca-sulfates {gypsum, basanite}), clays {Fe/Mg-phyllosilicates and Al-phyllosilicates}, a doublet absorption between 2.2-2.3 µm, and hydrated silica/opal. The role of water, both in the formation of the Noctis depressions and the hydrated deposits found within them, is a focus of this investigation. The diverse range of sulfates and phyllosilicates within the depressions of Noctis Labyrinthus likely resulted from localized aqueous activity [8,9], and may have been part of a broader synoptically driven period of late activity during the Late Hesperian to Amazonian [e.g., 10-12].

Constraints from geologic mapping and morphologic and stratigraphic analyses will be key contributions toward deciphering the geologic diversity and history of this portion of Noctis Labyrinthus, with specific implications regarding the role and history of water. In particular, the timing, duration, nature, and spatial extent of the influence of water-related processes in the region is a focus on this study. An understanding of the history of deformation and collapse within this region will also be key to deciphering the timing of sedimentary deposition and aqueous alteration.

Mapping Progress: We have completed mapping of all geologic units and linear features (Fig. 1). Numerous structural features, including grabens and fault scarps, are found throughout the mapping region. Mapping of normal faults and grabens indicates multiple episodes of collapse.

Eolian debris and dust cover much of the plateau, trough floors, and wallrock, obscuring geologic contacts between different units at these locations. The dust mantle thins to the east and south, where individual lava flows are evident along the plateau. Two volcanic shields have been mapped in the southwestern plateau and both are embayed by younger lava flows. Beneath the plateau plains unit is the gullied and layered wallrock unit, which is similar in morphology to the layered gullied upper wallrock observed throughout Valles Marineris. Light-toned deposits occur in only one location along the plateau and they are only visible as small patches because a dark mantle and eolian ripples cover much of the plateau, including the light-toned deposits, in this region. CRISM spectra show the presence of opal in association with these plateau deposits.

Floor units within the troughs and pits include light-toned deposits, many of which also exhibit spectral hydration features, and mass wasting deposits, including landslides. Lava flows with Amazonian ages [13] have been mapped on two trough floors. Floor morphology can either be smooth or rough, with the rough morphology from collapsed materials and the smooth morphology typically the result of eolian fill. No fluvial channels have yet been identified either along the plateau or within the depressions, but a possible volcanic channel sourced by a collapsed rounded depression within one of the troughs indicates younger volcanism occurring after formation of the trough. Dark dunes have been mapped in two troughs.

The light-toned deposits observed within the pits and troughs can be one homogeneous bed or numerous layers with variable lithologies (e.g., brightness, fracturing, and lithification differences). Where CRISM data is available, the layered deposits display a wide range of mineralogies, indicating a complex aqueous history within this region. Topographic profiles reveal that the light-toned deposits within the pits and troughs all occur below 4 km in elevation, consistent with hydrologic resurfacing by water sourced from aquifers beneath the Tharsis rise [2].

Figure 1. THEMIS daytime IR basemap with geologic units and linework overlain for our geologic mapping region in Noctis Labyrinthus.