DISRUPTED HYDRATED DEPOSITS IN SOUTHEASTERN NOCTIS LABYRINTHUS: POSSIBLE DISPLACED SUBSURFACE MATERIALS FROM OUDEMANS CRATER?  C. M. Weitz1, J. L. Bishop2, L. Tornabene3, S.C. Mest4, J.A. Grant4, C. Gross5, and J.A.P. Rodriguez1, 1Planetary Science Institute, 1700 E Fort Lowell, Suite 106, Tucson, AZ 85719 (weitz@psi.edu); 2SETI Institute, 189 Bernardo Ave., Mountain View, CA 94043. 3University of Western Ontario, Centre for Planetary Science and Exploration (CPSX), 1151 Richmond Street, London, ON, Canada N6A 5B7. 4Center for Earth and Planetary Studies, Smithsonian Institution, PO Box 37012, National Air and Space Museum, MRC 315, Washington, D.C. 20013-7012. 5Planetary Science and Remote Sensing Group, Institute of Geosciences, Freie Universität Berlin, 12249 Berlin, Germany.

Introduction: We have identified several hydrated materials, including Fe/Mg-smectites, Al-clays, Ca-sulfates, polyhydrated sulfates (PHS), and hydrated silica, in ~2 km high hills to the north of Oudemans crater in southeastern Noctis Labyrinthus (NL) (Figure 1). The hydrated deposits, especially the smectites, display numerous faults disrupting layered beds (Fig. 2a). The morphology of these disrupted layered materials is very similar to those observed within the central peak of Oudemans crater (Fig. 2b), where we also identified some Fe/Mg-smectites. We explore the possibility that the disrupted light-toned layered and hydrated materials within southeastern NL could represent strata at depth that was displaced to the north during the impact event that created Oudemans crater.

Oudemans Crater: Oudemans crater (268.2°E, 9.84°S) is ~123 km in diameter, 3-4 km deep, and is estimated to be Late Hesperian to Early Amazonian in age [1]. Although the bulk of the crater displays a well-preserved crater rim, there is a large gap in the northern section where the crater intersects a ~6 km deep portion of the Noctis Labyrinthus canyon (Fig. 1, red circle). The floor of Oudemans lies between 2-2.5 km in elevation compared to 0-0.5 km elevation along the NL floor to the north of Oudemans.

The ~2 km high central peak of Oudemans displays alternating light- and dark-toned layers cut by fractures and tilted near vertical (Fig. 2b). If these layered deposits represent materials originating at depths up to 7-11 km [2,3], then they provide insight into the stratigraphy occurring in the target rocks and at a depth that lies below that which is exposed along the southeastern floor of NL, which is ~6 km lower than the adjacent plateau. The rugged massifs and chaotic terrain on the floor of NL just to the north of Oudemans [2] appear unique to this region of NL and their appearance could relate to accumulations of impact-derived melt, im-

Figure 1. CTX mosaic showing Oudemans crater (red circle) and the depressions in southeastern Noctis Labyrinthus (NL). Yellow outlines mark locations where we have identified light-toned deposits, including hydrated materials, on hills in NL. The blue line represents an estimation of the southern edge of a NL depression before the impact of Oudemans crater. The green arrow shows the location of a light-toned layered jarosite-bearing deposit exposed at depth within a pit depression along the NL floor.
pact-displaced bedrock, and ejecta. In this study, we focus on hydrated and disrupted deposits located within 1 radius (60 km) to the northwest of Oudemans to understand if they could represent materials at depth that were displaced northward when the transient northern wall of Oudemans failed into NL.

**Observations:** The light-toned hydrated deposits we identify in southeastern NL are distinct from other hydrated deposits throughout NL [4,5] in that they are; 1) located on the upper portions of hills, rather than along the floors of troughs and pits, and 2) most appear disrupted, jumbled together, and/or faulted.

CRISM spectra extracted from these deposits are consistent with Fe/Mg-smectites, Al-clays, PHS, Ca-sulfates, and hydrated silica. Figure 2a-f shows HiRISE images of each of these materials. We also extracted a spectrum from a nearby NL pit depression to the northwest which exhibits light-toned layered deposits at depth (Fig. 1, green arrow). A spectrum from these light-toned layered deposits is consistent with jarosite. HiRISE and CRISM images show that the jarosite is only observed along the northwestern side of the pit, indicating that jarosite may not be at depth throughout this location but rather a localized or heterogeneous deposit.

We have utilized three HiRISE-derived Digital Terrain Models (DTMs) to observe the stratigraphic relationships of the hydrated deposits. The hydrated materials appear embedded within the hills and have variable bedding slopes that do not correspond to surface slopes along the hills. However, most of the terrain in this region, including the hydrated deposits, are covered by a ~5 m thick dark-toned layered mantle, which obscures many of the geologic contacts between the different materials.

The lack of grabens and collapse structures along northern Oudemans crater suggests that the northern crater wall has not been destroyed by continued expansion within NL. Instead, the continuous smooth floor of Oudemans continues to the north outside of the expected northern wall edge, which is consistent with the crater forming after the NL depression already existed here. A blue line in Figure 1 illustrates one possible edge of the NL depression before the Oudemans impact event. If the difference in elevation between the floor of NL and the plateau here was ~6 km, then the crater wall on the northern side of Oudemans would be expected to have collapsed outward and further north due to this large gap in elevation that existed prior to the impact. Thus, the faulted and heterogeneous mixtures of hydrated materials in these NL hills most likely represent subsurface strata in the target rocks that was displaced northward by the formation of Oudemans crater.

**Results:** Our results indicate that the stratigraphy at depth in eastern NL may be more complex than the layered smectite-bearing materials exposed within the Oudemans central peak, and the jarosite-bearing materials observed along the floor of eastern NL. Additional spectral signatures are consistent with materials bearing Al-clays, hydrated silica, PHS, and Ca-sulfates which may also exist at depth, buried in the subsurface.


---

**Figure 2.** HiRISE images showing different hydrated materials. (a) Faulted Fe/Mg-smectites in NL hills. (b) Faulted Fe/Mg-smectites in the central peak of Oudemans crater. (c) Al-clays (medium-toned) mixed with brighter deposits (possibly sulfates) in NL hills. (d) Ca-sulfates in NL hills. (e) PHS in NL hills. (f) Hydrated silica in NL hills.