THE THICKNESS AND MORPHOLOGY OF A YOUNG PYROCLASITIC DEPOSIT IN CERBERUS PALUS, MARS: IMPLICATIONS FOR THE FORMATION SEQUENCE. D. G. Horvath[1] and J. C. Andrews-Hanna[1], [1]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, dhorvath@lpl.arizona.edu.

Introduction: The Cerberus Palus region south of Elysium Mons contains some of the youngest volcanism on Mars. Effusive lava flows emanating from long sub-parallel fissures and shield volcanoes in the region have crater retention ages younger than 250 Ma and possibly as young as 2 Ma [1]. Here we report on a potential recent pyroclastic eruption, first reported [2] as a low albedo, high thermal inertia deposit approximately symmetric around one of the Cerberus Fossae fissures near Zunil crater (7.9°N, 165.8°E). The high thermal inertia in both the day and night infrared is consistent with partial welding of an ash tuff and CRISM spectra of the unit indicates the presence of pyroxene proximal to the fissure. Furthermore, the deposit is smooth relative to the textures of the lava flows in the surrounding volcanic plains. The interpretation that the deposit buried and obscured these underlying flow textures, and also mantles Zunil secondary craters suggests that this deposit is younger than surrounding volcanic plains (<250 Ma) [1] and the Zunil impact (< 5 Ma) [3]. Here we expand on the geomorphology, age, and thickness of this deposit (here in referred to as the Cerberus mantling unit, CMU) using HiRISE imagery and suggest a formation sequence for the CMU.

Observations: In addition to the observed albedo differences between the main deposit and the surrounding volcanic plains, HiRISE imagery and CRISM spectra reveal albedo and spectral variations on the deposit itself. The most obvious internal albedo and spectral variation are noted between the deposit proximal to the fissure (here in referred to as CMUp) and the surrounding more distal deposit (here in referred to as CMUd, Fig. 1a).

CMUd is dark and smooth relative to the lava flow texture of the surrounding dusty volcanic plains (Fig. 1c). A band of low thermal inertia and bright albedo exposed at the edge of the deposit suggests that the CMU as a whole is mantling an underlying dust layer that was deposited across the region at an earlier time [4], also preserved in the bright ejecta blankets surrounding Zunil secondary craters outside of the CMU [3]. Bright ejecta primary craters observed on the CMUd suggest that these craters on the deposit excavated through the deposit into the underlying dust layer (Fig. 1d). The excavation depths of theses craters indicate that the CMUd deposit is substantially less than 1 m in thickness (Fig. 2), consistent with a distal ash fallout and minor welding.

In contrast, the CMUp is dark relative to the distal portions of the deposit, while CRISM spectra indicate a higher pyroxene content proximal to the fissure [2]. Texturally this deposit is characterized by sinuous troughs and ridges 10s of meters across and approximately perpendicular to the fissure (Figure 1b). A relative dearth of bright ejecta craters on the dark CMUp indicates that the deposit closer to the fissure is thicker and/or stronger than distal portions of the deposit (Fig. 2). Along with a higher pyroxene content observed on the CMUp, the apparent strength is consistent with welded tuff ring deposits observed around explosive volcanic centers on Earth.

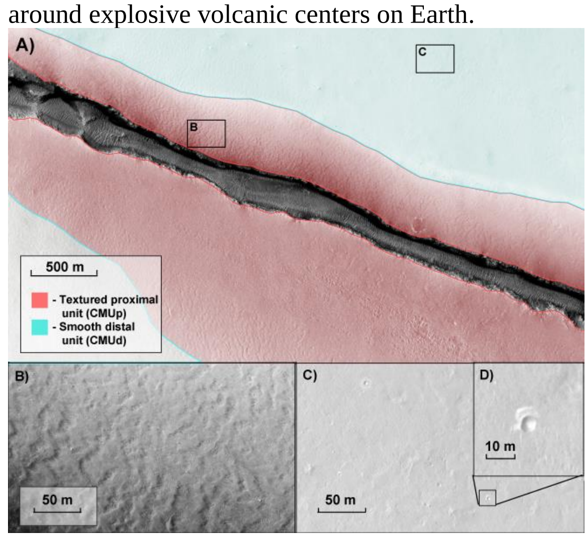

Fig. 1. A) HiRISE imagery of a portion of the Cerberus mantling unit delineating the proximal textured unit and smooth distal unit. The proximal unit **B)** contains the majority of the sinuous troughs and ridges observed on the deposit in contrast to the relatively smooth deposit **C)** further from the fissures where bright ejecta craters are observed **D)**.

Formation sequence: Based on HiRISE observations of the morphology and albedo variations on the deposit, a depositional scenario and formation sequence is proposed. Evidence for shallow ground-ice in this region [5] suggests that magma interaction with a layer of ground-ice or an underlying aquifer may have initiated the pyroclastic eruption that deposited the CMU. We propose that the initial interaction of intrusive magma with a ground-ice layer or aquifer resulted in a Strombolian to plinian style eruption, dispersing fine ash and pumice fallout to form the main CMUd unit (Fig. 3a). This is supported by the thinness of the CMUd and the slight asymmetry of the deposit, likely due to wind direction during eruption of the ash plume. Gas pressure buildup in the magma column close to the surface [6]

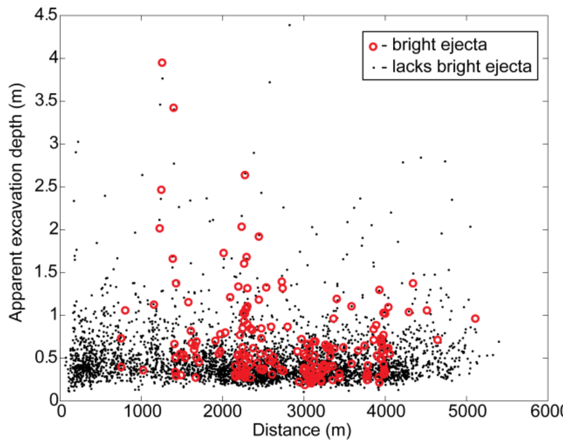

Fig. 2. The spatial distribution of bright ejecta and no ejecta craters relative to the eruptive source.

then initiated either a single or sporadic explosive eruptions and deposition of the CMUp containing lithics of the parent magma body as well as surge flow deposits from the continuing ash plume. The proposed sequence is consistent with Strombolian style eruptions on Earth [7]. We propose that the CMUp is a tuff ring proximal to the fissure and that the sinuous trough and ridge features are related to an explosive phase of the pyroclastic eruption. This is supported by the thickness, crystalline mineral spectra, and apparent strength of the CMUp relative to only minor welding distal to the eruptive source. Furthermore, inverse bedding is common in many pyroclastic flows on Earth [e.g., 8] and has been attributed to sorting during lateral flow or a temporal change in the eruptive style, both of which are consistent with the proposed formation scenario and observations. The size of the CMU deposit suggests a short lived eruption and/or a low eruptive mass flux, which is characteristic of most explosive basaltic eruptions on Earth.

Age: We performed a detailed survey of craters on the main deposit using HiRISE imagery and revised the previous age estimates from [2]. Age estimates are based on the Hartmann production function for small craters [9], as well as the present-day cratering rate [10]. Craters interpreted to be primary on the deposit suggest an age for the deposit of 200 Ka (Fig. 3) based on the Neukum steep branch extrapolation to small crater diameters [9]. A recent study [10] has suggested that the present-day cratering rate is less than estimates from previous production functions [9, 11], which would increase the age estimates for the crater population on the deposit compared to Hartmann [9] and Ivanov [11]. Comparing the crater size-frequency distribution on the deposit to the modern crater rate [10] suggests an age of 4 Ma (Fig. 3). Although the age based on the modern impact rate may be more accurate, comparison to other ages in the literature must be based on the earlier production function. The young age of the deposit is consistent with its stratigraphic age being younger than Zunil and the surrounding volcanic plains [1]. This age also makes this deposit the youngest eruption product and thus the most recent volcanic eruption yet documented on Mars.

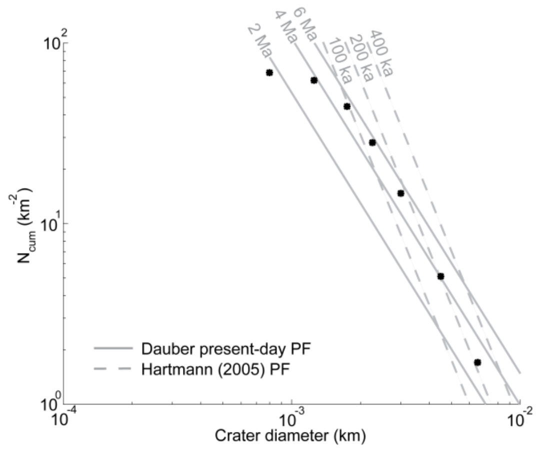

Fig. 3. Crater size frequency distribution on the entire CMU compared to the current Martian production function [10] and the Hartmann (2005) production function [9].

Conclusions: We have detailed the youngest known volcanic eruption on Mars and hypothesize an eruptive sequence in which a dike intrusion interacts with a subsurface volatile reservoir resulting in an initial ash plume eruption followed by explosive volcanism. Variations in spectra and albedo suggest that this deposit is two distinct units, one proximal to the eruptive source with a high pyroxene content and surge textures (CMUp) and a broadly distributed thin, smooth distal unit (CMUd), consistent with our proposed eruptive scenario. While young volcanism is observed in the Elysium region, the very young age of this deposit indicates that intrusive magmatism may be active today, which may be detectable with the upcoming InSight mission.

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