MORPHOLOGIC OBSERVATIONS OF CHASMA BOREALE, MARS USING MOC, THEMIS, AND MOLA: ORIGINS REVISTED. N. H. Warner[1] and J. D. Farmer[1], [1]Department of Geological Sciences, Arizona State University, Tempe AZ, 85287, Nicholas.Warner@asu.edu

Introduction: Chasma Boreale, a large reentrant in the martian North Pole, is distinct from other polar troughs by its large size and counterclockwise orientation [5]. The ~ 1300 m deep chasma extends for ~ 500 km from its proposed origin at 85° N, 2º E and is on average ~ 60 km wide. The head of the feature is marked by two major steep, arcuate scarps. Extending from the mouth of Chasma Boreale is a large lobate feature [11]. This Amazonian age deposit is ~ 250 m thick and appears to overlay polygonal terrain of the Vastitas Borealis Formation (Hvg) [10].

There have been several proposed formation mechanisms for Chasma Boreale, including katabatic wind erosion [8,9], accumulation/ablation [6], and catastrophic outflooding [1,3,5].

Here we examine the latest image data from the Mars Orbiting Camera (MOC) and Thermal Emssion Imaging System (THEMIS) to describe the overall morphology of the Chasma Boreale system and to attmept to reconcile its mechanism of formation. THEMIS VIS images provide complete coverage for the chasma at an ideal 18 – 40 m/pixel resolution. Mars Orbiting Laser Altimeter (MOLA) topographic profiles were also constructed across observed features.

General Morphology: The floor of the chasma has an overall negative slope of ~0.1°, measured from the center of the source arcuate scarp (85° N, 2° E) to the furthest margin of the lobate deposit (79° N, 53° W). The lowest elevations are found within the depressions at the base of the arcuate scarps [5].

The steep-walled, arcuate scarps appear as single continuous arcs in lower resolution Viking Orbiter images. These arcs cut through the polar layered material (PLD) and perennial cap. However, higher resolution THEMIS images reveal that each major scarp actually consists of a series of smaller, adjacent scarps. Depressions at the base of each scarp expose an older unit with a cratered, low albedo surface, and wrinkle ridge-like features that suggest similarities to ridged lava plains [10].

Extending from the mouth of Chasma Boreale is a distinctive lobate scarp. This scarp is approximately ~250 m in height and has a slope of ~ 5° [5]. The lobate material exhibits meter scale layering at MOC and THEMIS resolutions. Although it may have a different origin, this layering is similar in scale to the layering of the PLD displayed in the chasma walls.

The lobate material overlies polygonal terrain of the Upper Hesperian Vastitas Borealis Formation (grooved member, Hvg) [10]. Based on crater counts, the lobate material itself is likely Amazonian in age. THEMIS images reveal, however, that the polygonal pattern, although subdued, is also present on the younger lobate material (Figure 1). Several troughs, forming orthogonal intersection patterns, are visible in the western exposures of this deposit. These troughs are not as obvious along the southern and eastern margins, where they appear to be mantled by a surface deposit. In many cases, troughs extend outward from the base of the lobate deposit at small reentrants. These troughs join with other troughs to form the pologynol terrain of Hvg.

Aeolian Features: Aeolian features, including sand dunes and seasonal frost streaks, dominate the floor of Chasma Boreale. For this research, aoelian dunes were mapped, described, and orientations determined. Three dune forms are abundant within the chasma. These include transeverse, barchan, and linear dunes. Slip face orientations of the transverse and

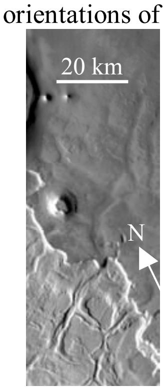

Figure 1: Network of straight to curvilinear troughs developed in the lobate deposit that extend from the margin of Chasma Boreale. THEMIS image V11474001 [2]

barchan dunes suggest a down chasma wind component, consistent with seasonal frost streak observations [8]. Linear dune orientations suggest a bi-directional southeast and northwest wind regime across the chasma. The overall preservation suggests these dune forms may have been recently active.

Fluvial Features: The polygonal terrain mapped by [10] at the margin of the lobate deposit has also been suggested to resemble pro-glacial braided stream networks [1] (Figure 1). Most troughs appear to have a low to moderate sinuosity, are often curvilinear, and intersect each other at angles of 50 - 90° forming, in most cases, a polygonal pattern. The margins of some of the troughs lie above the surrounding terrain giving them a leveed appearance (Figure 1). Lengthwise, the slope of individual trough floors is highly variable. The troughs atop the lobate deposit, described here from higher resolution imagery, are more subdued and appear to share a similar polygonal pattern.

Volcanic Features: Several small cones with cratered summits have been identified from MOC images near the mouth of Chasma Boreale [7]. For the present study, we examined later release MOC and THEMIS images for other possible volcanic features within and surrounding Chasma Boreale. Several cone like features were identified near the western margin of the lobate deposit, including a cratered cone found within the chasma itself (Figure 2). Using conservative polar resurfacing rates, a maximum age of ~ 20 Ma has been suggested for the near polar cratered cones [7].

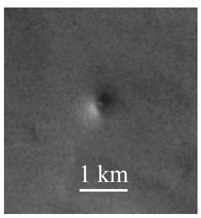

Figure 2: A cone with cratered summit superimposed on the lobate deposit within Chasma Boreale. THEMIS image V10725002 [2].

Preliminary Interpretations: The current models of formation for Chasma Boreale involve wind or catastrophic fluvial erosion [1,3,5,6,8,9]. Wind erosion models are inconsistent with the presence of aeolian depositional features (dunes) and dust mantling over the majority of the Chasma floor. In addition, the large lobate deposit, although it shares bedding characteristics of the PLD, is unlikely to be a remnant of the PLD. Its extension from the mouth of the chasma, beyond the margin of the present day cap, suggests transport and deposition [5]. Observed layering may represent pulses of depositional events. Difficulties with the fluvial model arise from the lack of obvious catastrophic flood features (i.e. streamlined erosional remnants, cataracts, depositional bars) and the previous lack of an obvious mechanism for melting. However, the discovery of several younger (possibly volcanic) coniform features, near the margin of the lobate deposit and within the Chasma, suggests the possibility of a higher heat flow in the area.

Consistent with proposed models by [1,3,5,7], we provide new evidence from THEMIS and MOC data for basal water ice melting, possibly induced by shallow igneous intrusions or direct magma-ice contact, in this region of the north polar cap. The formation and flow of basal melt water beneath the polar cap may have caused several localized areas of collapse within the PLD. Continual melting and flow may have caused progressive headward eroswion and collapse along the arcuate scarp system of the Chasma, forming this large re-entrant. In agreement with [1,5] we suggest that the apperent linearity of the feature is consistent with a structural control for this melting activity. Geologically recent (~ 20 Ma) basal melting and rapid recession of the glacial margin along the western edge of the Chasma site may have led to fluvial deposition of the lobate deposit. This region harbors many young coniform features with cratered summits, interpreted to be volcanic in origin. Dust mantling of the western portion of the lobate deposit appears to be minimal, based on the presence of sharply-defined polygonal troughs. While these troughs may have served to focus outflows of subglacial meltwater, their actual origin is likely to have been by earlier polygonal terrain formation processes [10].

Strong katabatic slope winds generated down the arcuate scarps may have assisted to deflate the surface of the arcuate scarp depressions exposing older Hesperian lava flood plain units. Low albedo sand dunes present on the Chasma floor were likely derived from materials removed from these upwind low albedo lava plain units.

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