DUNE FORMS AND AGES AND ASSOCIATED OBLATE DEPRESSIONS IN THE CHASMA BOREALE REGION OF PLANUM BOREUM, MARS. K.F. Mullins, R. Hayward, K.L. Tanaka, U.S. Geological Survey, Astrogeology Team, 2255 N. Gemini Dr. Flagstaff, AZ. 86001 (kmullins@usgs.gov)

Introduction: THEMIS and MOC images acquired over the Chasma Boreale contain key geologic and stratigraphic information relating to aeolian deposition and the Polar Layered Deposits (PLD). Preliminary analyses of THEMIS VIS and MOC images show a clear progression of morphologic change of dark albedo dune deposits along the chasma axis.

Geologic Relations: The source for the dunes appears to be moderately dark material, relatively high in sand-sized grains of the Olympia Undae unit as redefined by [1]. This unit overlies the thick layers of the Early Amozonian Rupes Tenuis unit and underlies the bright, finely layered PLD [1]. MOC images show the dark material being eroded from chasma wall layers that exhibit varying thickness. Here, small individual dunes with simple morphologies of domes and barchans are common. Farther down-chasma, where depositional processes have concentrated a larger volume of dark material, the dune morphology changes to reflect the effects of multiple wind directions and the availability of increased sediment [2]. Barchans with elongated horns and longitudinal dune forms begin to dominate. Even farther along the chasma axis, barchanoid- and transverse-ridge dunes are being exhumed from beneath the younger PLD, suggesting an pre-PLD age for the dune field. However, minor dune migration and emplacement and erosion of younger PLD's may have occurred multiple times in the chasma after initial emplacement of the dunes.Temperatures derived from THEMIS IR images suggest the presence of water-ice during the early spring in the chasma, surviving for several sols past the last sublimation period for CO_2 in the area [3]. Previous work [4], suggests that many Martian dunes exhibit over-steepened slip faces and cornices of aeolian material bound by subsurface water ice. Given the stratigraphic and geographic location of the older dune field in Chasma Boreale (Fig. 2d), it is likely the same process is at work on these dunes; i.e. paleo-dunes from a drier warmer climatic period have been frozen and buried beneath PLD and are now being exhumed.

Dune form: The dune forms seen in the four MOC images of the Chasma Boreale region (Fig. 2), progress from simple to more complex in form and smaller to larger in size as one travels down-chasma (Table 1). This change reflects the aeolian conditions under which the dunes were deposited. At the head of the chasma dark-albedo layers exposed in the canyon walls exhibit nonuniform thickness (Fig. 1). The wavy pattern could reflect the erosional cross-section of an ancient, buried dune field. If that is indeed the case, then the dunes presently exposed down-chasma are reworked deposits of these older dunes. In the walls of the chasma, below these wavy layers, domes and simple barchan dunes appear where dark albedo layers with relatively high sand content [1] are exposed and being eroded (Fig. 2a). This corresponds to an aeolian depositional environment of limited sediment and unidirectional winds. 135 kilometers down-chasma the domes disappear and barchans begin to show elongation of their horns (Fig. 2b). At 70km farther down-chasma these forms soon string out into classical longitudinal dunes and streaks (Fig. 2c); evidence that sediment availability has increased and that winds blowing off both sides of the polar cap and into the chasma are equalized in magnitude. Another 105 km down-chasma the dunes have coalesced into a larger contiguous dune field of barchanoid ridges and transverse dunes, an indication of plentiful sand and winds returning to a more unidirectional mode as the chasma widens out (Fig. 2d). Here the dune field appears to be undergoing exhumation from relatively younger, light albedo material. Remnants of this light-albedo layer can be seen preserved in low-topographic swales and inter-dune areas within the dune field proper. To the south, oblate depressions parallel the dune field and expose the darker dune material in their floors. Evidence of exhumation suggests the dune field is older than the dunes up-chasma and may have been formed by reworking of earlier dune deposits during several earlier episodes of deposition.

Oblate depressions: A series of elongated oval depressions can be seen among the dunes in MOC image s0100668 (Figure 2b). These depressions display several striking similarities to each other throughout the image. 1) All are of a similar size, 2) all are of the same shape and are oriented parallel to each other and the surrounding dunes, 3) all have flat, even floors that appear of consistent depth below a bright, rippled unit (BRU). We propose that these depressions are remnant "footprints" of pre-existing dunes that predated the deposition of the

BRU and that were subsequently reactivated leaving behind a "cast" of the dune base (Fig. 3).

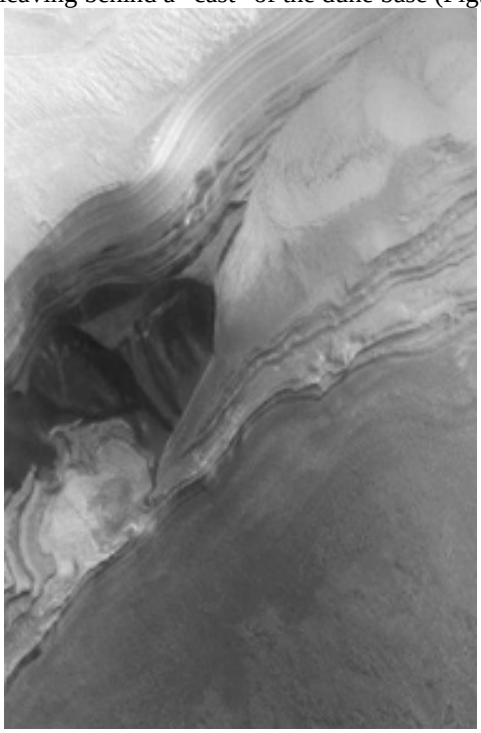

Figure 1. Sub-area of MOC image s0300184 showing a portion of the southern Chasma Boreale wall (north is toward the bottom of the image). Note the uneven thickness of the dark layers in the wall suggesting the exposed cross-section of dune deposits.

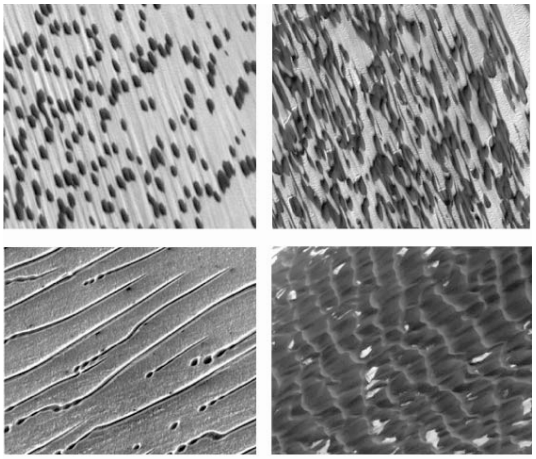

Figure 2. MOC images showing the morphologic change in dune form relative to location along the chasma axis. a) Domes and individual barchans, b) barchans with elongated horns and stringers, c) linear dunes with associated barchans, d) barchoid ridges with remnant overlying bright deposits.

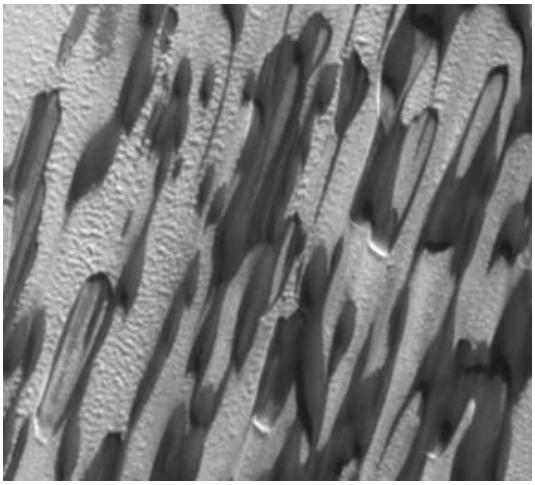

Figure 3. Sub-area of MOC image s0100668 showing oblate depressions interspersed with dunes. The relationship between the depressions and the dark dune material suggests the BRU unit was deposited around pre-existing dunes forming a cast of the dune base. Recent reactivation of the less resistant dune material removes the dunes exposing the depressions as "casts" of the pre-existing dune base.

MOC image #	Dune width	Dune Length
M0200317	90m	148m
S0100668	78m	192m
E1500940	68m	630m
R0200326	600m	345m

Table 1. Average dune width and length for the dunes in the four fields in Figure 2.

References: [1] Rodriguez, J.A.P. and Tanaka, K.L. (this volume). [2] McKee, E.D.,USGS Prof. Paper 1052, 1979. [3] Titus, T.N. pers. comm. [4] Bourke, M. AGU Fall Meeting, 2004. abs. #P21B-01.