GEOCHRONOLOGIC IMPLICATIONS OF NON-RANDOM DISTRIBUTION OF PEDESTAL CRATERS IN THE CIRCUM-POLAR PLAINS SOUTH OF GEMINI SCOPULI, MARS , J. A. P. Rodriguez[1], K. L. Tanaka[2], D. C. Berman[1]; [1]Planetary Science Institute, Tucson, AZ 85719 (alexis@psi.edu).; [2]U.S. Geological Survey, Flagstaff, AZ 86001.

Background: Pedestal craters are impact craters situated on platforms that rise above the surrounding plains. They are thought to represent remnants of highly resurfaced Amazonian paleosufaces [1,2,3]. Rodriguez et al. [4] note that the circum-polar plains south of Gemini Scopuli comprise the only zone of the circum-polar plains in the north polar region of Mars that (1) forms part of an enclosed basin margin and does not include sub-basins, (2) is not directly below the mouths of outflow channel systems, and (3) is located on a broad slope at relatively higher elevations when compared to the other circum-polar plains regions. They suggest that it is possible that the plains within this region had (at least partly) an origin unrelated to the accumulation of outflow channel discharges in the northern plains of Mars. Instead, they suggest that the sediments that form the regional plains were, at least partly, produced by the *in situ* degradation of an ancient lowland cratered landscape during the Late Hesperian. In this abstract we examine various geologic scenarios concerning the collapse history of these plains materials to form the observed population of pedestal craters. Understanding the history of sedimentary emplacement and removal within the northern plains of Mars is relevant to most hydrologic models of the planet.

Observations: We have examined the platform heights and distribution of pedestal craters that range in rim diameter from 3000 m to 4600 m. These pedestal craters form a distinct cluster (dashed line in Fig. 1A) and the heights (thicknesses) of their pedestals range from 41 m to 184 m and have a mean height of 111 ± 54 m; the heights do not have any apparent and statistically significant systematic variation in relation to location (e.g., as in distance from Planum Boreum). Crater statistics performed within the region of interest, and at broader scale across the entire northern plains [e.g., 5] (Fig. 1B) suggest that fresh craters started to form from the beginning of the Amazonian [5] or near the end of the Hesperian (Tanaka et al., this vol.), and that the pedestal craters formed during the Late Amazonian.

Geochronologic implications: Our mapping shows that unlike ghost and fresh craters, pedestal craters are not distributed randomly throughout the whole of the study region (Fig. 1A). Next we discuss some potential geologic settings which could have resulted in the pedestal craters forming a distinct cluster within the study region.

Partial destruction of Hesperian sedimentary deposits: This scenario would have involved the collapse of the ancient plains materials to form the existing plains and the population of pedestal craters. A consequence of this scenario is that the pedestal crater population represents only a small part of the entire crater population that once existed on the paleosurfaces within the region of study, and thus their low areal density does not represent an actual paleosurface age. It appears that destruction of the paleosurface on which the pedestal crater formed and formation of the present plains surface could have happened before the emplacement of the fresh craters. In this scenario, pedestal craters would generally be older than fresh craters. An implication of this hypothesis is that collapse processes of vast plains-forming sedimentary deposits may have released significant amounts of volatiles into the Martian atmosphere, which could have potentially played a role in triggering, and/or enhancing, warmer and wetter climatic excursions. In addition, freed sediments and volatiles could have potentially contributed to the early construction of Planum Boreum, the northern polar plateau. Late Hesperian large-scale collapse of northern plains materials would have been contemporaneous with evidence for large-scale upper crustal disruption in highland materials to form chaotic terrains [6], suggesting that large-scale collapse processes during the Late Hesperian may have been more spreadout than previously considered. A weakness of this geologic scenario is that we have not been able to constrain wether the depth of collapse was limited to the thickness of the paleosurfaces, or alternatively, it was an indepent process that exended deeper than, or did not reach the plains materials base.

Partial destruction of Amazonian sedimentary deposits: The alternative is that the pedestal crater population (or a subset of the population) represents nearly the entire crater population that existed in the paleosurfaces within the region of study, and thus their Late Amazonian crater-count age determination is approximately correct. It is possible (yet unlikely) that random impacts may have resulted in the formation of a cluster of pedestal craters. This hypothesis relies on the assumption that the entire region of study was broadly mantled by sedimentary deposits. Given the absence of evidence of other large-scale deposition and erosion during the Amazonian, the polar layered deposits (PLD) form the most likely source of materials to account for pedestal craters formed in this

manner. From the Middle to Late Amazonian the Planum Boreum 1 unit was emplaced [7] as sequences of ice-rich layers following and progressively muting the topographic signature of the underlying plains. Remnants of the PLD as much as 300 m thick extend south to 74°N (e.g., Olympia Mensae) and likely extended farther south before being eroded, perhaps throughout the study region. However, we do not observe a southwards decrease in the thickness of pedestal craters as would be expected if they formed as remnants of a regional, cone-shaped polar deposit. Skinner and Tanaka (this vol.) document via a broader distribution of pedestal craters and other relict landforms a possible deposit throughout the northern plains that averaged about 35 m in thickness. They suggest that pedestal craters of Amazonian age may represent remants of a younger Vastitas Borealis Formation.

A consequence of the previous hypothesis (first geologic scenario) is that during the Late Hesperian large amount of sediments would have been liberated and become available to aeolian reworking and redistribution into regional mantles, which could have accumulated during the Amazonian. Cycles of sedimentary emplacement and removal could have been the result of volatile destabilization. However, an alternative is that variations in wind shear stress associated with atmospheric density fluctuations [8] would have led to periods of net erosion (e.g., widespread and frequent saltation of sand-sized particles) and periods of net deposition. This issue needs further investigation.

Variability in the thickness and degree of continuity of plains materials: Rodriguez et al. [4] observe that the PLD deposits form thinner sequences where they overlie local topographic highs in the plains materials. The mean value for the thickness of pedestal craters within the study region is 111 ± 54 m, which is similar to the relief of PLD, wrinkle ridges and impact crater rims in the region (Fig. 1). Thus, in this scenario the relief of pedestal craters would have been a function of the variability in the PLD thickness. Given the existence of pre-existing, widespread promontories observed in the study region, the deposits likely would have been uneven in thickness. Thus, the cluster may represent a zone of elevated sedimentary accumulation relative to other circum-polar plains regions. A similar scenario would result if the plains were accumulated into discrete "mounds". In this scenario, pedestal craters would have formed only on discontinouosly distributed plains materials. As a consequence, their age may be Hesperian and/or Amazonian. A shortcoming of this hypothesis is the assumption that the thickness of the PLD was equal, or lower, than the vertical irregularies of the underlying topography. Further investigation is required regarding the geologic factors that would have determined the range of PLD thickness within the circum-polar regions surrounding Planum Boreum.

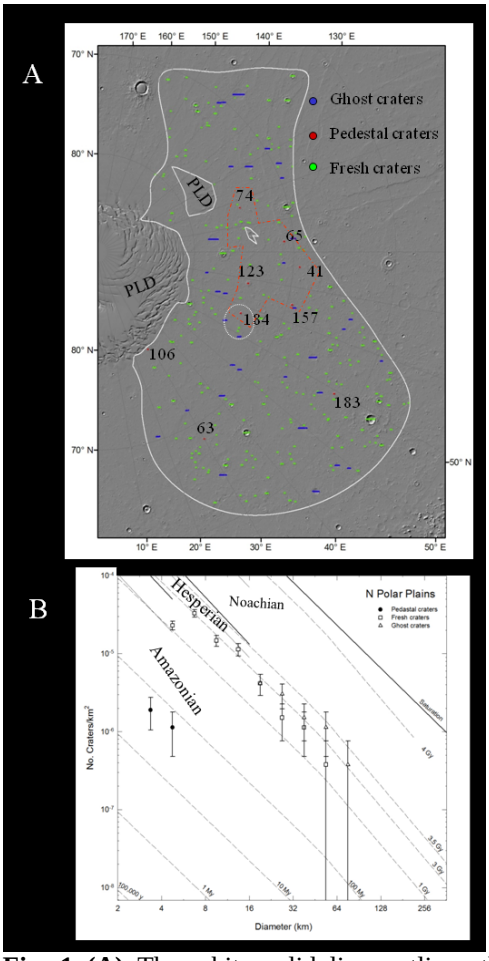

Fig. 1 (A) The white solid line outlines the region where the crater counts were performed down to a diameter of 3 km for ghost, pedestal, and fresh craters. The numbers are the heights of pedestal craters in meters. The dashed red line outlines a cluster of pedestal craters. **(B)** Graph showing incremental, binned craters densities vs. diameter for pedestal, fresh, and ghost craters in part of the study region (for location of sample area see panel A). Isochrones (dashed lines) from Hartmann [9] and Martian period boundaries (solid lines) from Tanaka [10] are shown.

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