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Esker-based computation of glacial load and new insights into glacio-fluvial depositional settings in southern Argyre Planitia, Mars

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1. Introduction
The southern rim of the Argyre basin on Mars between -52°S/-59°S and 310°E/322°E shows several landforms of likely glacio-fluvial origin [e.g., 1,2,3,4,5]. We compiled a new a detailed geomorphologic map of the study area, whose southern half consists of the heterogeneous Charitum Montes highland terrain representing the southern rim of the Argyre basin. The northern half represents the southern basin floor consisting mostly of rough, layered terrain, slowly changing to intermediate and smooth terrain within a ∼100 km wide zone circumferential to the Charitum Montes. Sinuous, layered and branching ridges, up to 300 km in length and 160 m in height can be seen on the basin floor with their apparent vertices being located close to the mouth of Surius Vallis.

2. Morphology and stratigraphy
Absolute model ages based on crater counts on the basin floor suggest a formation of the esker-like ridges along with a suite of layered sediments ∼3.7 – 3.5 Gyr ago. On the basis of the braided pattern and state of degradation of the sinuous ridges, we subdivided them into two populations (relatively pristine and braiding vs. degraded and solitary), which could in turn reflect changing conditions of glacial retreat: Based on the analysis of crest shapes of the more pristine ridges and their surrounding surface gradients, we used the transition method and the oblique path method [6,7] to compute four ice surface gradients of the glacier under which they might have formed. According to this reconstruction, the ice sheet reached a thickness of ∼2 km if a conservative glacial terminus near the end of the easternmost ridge is applied. This would imply at least ∼100,000-150,000 km^3 of ice on the southern floor of the Argyre basin during the time the relatively pristine ridges were deposited.

3. Discussion
In order to explain the transition of layers from the ridges into their surroundings, subglacial cavities in contact with subice channels have previously been proposed [3] as depositional environments. However, due to the vast extent of the more degraded ridges on terrain with visible layering (over 40.000 km^2), such a scenario seems problematic, as subglacial cavities are spatially limited features. A more suitable scenario can be observed at the Piedmont-style Malaspina Glacier, Alaska [9], and was also proposed for terraced landscapes around Pleistocene eskers in Canada [10]: A glacial retreat involving backwasting of stagnant ice lying beneath fresh outwash sediments, thereby creating a degraded and layered lag around the emerging eskers. If outwash sediments were fed by the same drainage source as an esker, sections of layers can extend from the ridge into the surrounding deposits. Therefore, we propose that the different orientations and surroundings of the two ridge-populations are a result of a change of the subglacial drainage direction coupled with diminished downwasting, possibly due to a decreased deposition of outwash sediments.
After sedimentation during this proposed glacial period had ceased, a distinct period of fluvial activity is indicated by a large alluvial fan, a channel-like trough and vast streamlined terrain overlying or being etched into possible glacial deposits.

4. Conclusions
Two morphologically distinct esker-like ridge populations in southern Argyre Planitia likely reflect the transition between two modi of glacial retreat in the Hesperian: Wet-based - involving down- and backwasting of ice and outwash sediments similar to Piedmont-style glaciers like Malaspina Glacier, Alaska; and stagnant (possibly later cold-based) - preserving more pristine ridges which enabled the computational reconstruction of a ∼2 km-thick ice sheet. During a distinct period of fluvial activity, streamlined landforms were then emplaced on top of the glacial deposits.

References

[1] J. Kargel and R. Strom (1992), Geology, 20, 2-7. [2] H. Hiesinger and J. Head (2002) PSS, 50, 939-981. [3] M. Banks et al. (2009) JGR, 114, doi:10.1029/2008JE003244. [4] A. Pacifici and M. Pondrelli (2010) Proc. 1st Int. Conf. Mars Sed. and Strat., 50, 6043. [5] D. Scott and K. Tanaka (1986) USGS, I-1802-A. [6] R. Shreve (1985) Geol. Soc. Am. Bull., 96, 27-37. [7] R. Shreve (1985), Quaternary Research, 23, 27-37. [8] T. Brennand (2000) Geomorphology, 32, 263-293. [9] T. Gustavson and J. Boothroyd (1987) Geol. Soc. Am. Bull., 99, 187-200. [10] W. Shilts et al. (1987). Geol. Soc. Am., Cent. Spec. 2, 119-161.