

TIMESCALES OF EROSION AND DEPOSITION RECORDED IN THE RESIDUAL SOUTH POLAR CAP OF MARS.

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Introduction The residual south polar cap (RSPC) of Mars has been subject to competing processes during recent Mars years that have been observed with high resolution imaging: continuing erosion of scarps while the maximum extent grows as well as shrinks [1, 2]. Additionally, the cap has a variety of morphologies and erosion (scarp retreat) rates that vary with morphology [3]. Do these different forms and competing processes indicate an aging and possibly disappearing cap, a growing cap, or a fluctuating cap, and is it possible to infer the timescales of the processes acting on the RSPC? We use the latest imaging data from Mars' southern summer in Mars Year 30 (Calendar year 2011) to evaluate erosion rates of forms in the RSPC over six Mars years, and to map more fully features whose sizes can be used to predict deposit ages.

Results Data through Mars Year 30 show that scarp retreat rates in the RSPC have remained approximately the same for at least six Mars years. Scarp retreat rates in the thicker units remain higher (~4.4 m/Mars y) than that of the thinnest (~2.4 m/Mars y). Mariner 9 observations provide a low-resolution fiducial mark at Mars year 9 that shows the thicker unit has eroded at approximately the recent rates for the last 21 Mars years. Thus, extrapolation of recent rates is a reasonable technique albeit progressively uncertain over longer past intervals. The thicker units appear to have undergone changes in erosion about 30-50 Mars years ago (Fig. 1). The thinner units have some areas possibly 80 Mars years old, and younger materials over a meter thick have accumulated since Mars Year 9 (Fig. 2). Formation of the thicker units probably required over 100 Mars years given likely thermal balance variations [3]. HiRISE images show that the upper surfaces of most areas, especially the thicker units, show little change at the few-cm level over the last two Mars years. This observation suggests that current conditions are substantially different from those in effect when the thicker units were deposited. The thicker units may have resulted from climate variations on centuries time scale (consistent with early estimates [4]). The thinner units show events largely on time scales of tens of Mars years.

Addendum While the scarp retreat rates (= pit size expansion) have been approximately consistent through several Mars years of close observation, our ignorance of the causes of the different units and the reason for different scarp retreat rates encourages great caution in the assignment of specific dates. However, it is becoming clearer every Mars year that parts of this cap that formed well in excess of several Mars decades ago (probably a Mars century) represent depositional environments not observed during the period of spacecraft observation. Non astronomically-driven time scales may be the most applicable for these changes.

References: [1] Piqueux, S., Christensen, P.R., (2008) *J. Geophys. Res. (Planets)* 113, 2006. [2] James, P.B., Thomas, P.C., Malin, M.C. (2010) *Icarus* 208, 82-85. [3] Thomas, P.C., James, P.B., Calvin, W.M., Haberle, R., Malin, M.C. (2009) *Icarus* 203, 352-375. [4] Byrne, S., Ingersoll, A.P. (2003) *Geophys. Res. Lett.* 30, 130000-1.

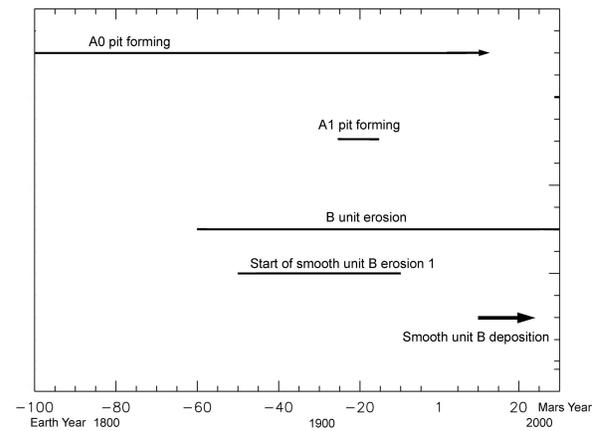


Fig. 1. Estimates of timescales recorded in the RSPC from pit sizes and erosion rates. A0 and A1 are two thickest units. B is thinner (generally <3 m) unit. B unit covers many regions (most of the RSPC). Smooth B units are a subset specifically identified in Mariner 9 images or later.

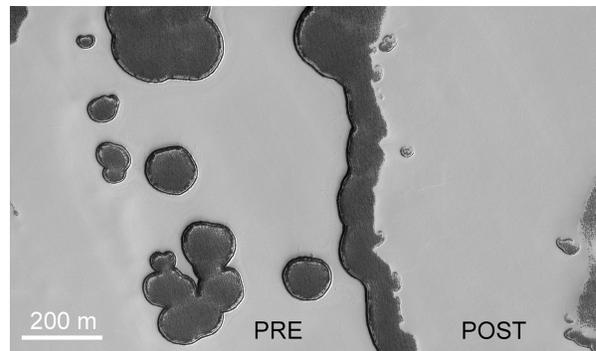


Fig. 2. Pre- (left) and post-Mariner 9 deposits. Much of this later material was deposited after the Viking observations in MY 12. Darker area separating these materials is typical of boundaries of post-Mariner 9 deposits throughout the RSPC. HiRISE image ESP_023792-0940, $L_s = 349.7^\circ$, MY 30. Strongly contrast enhanced