COMPARATIVE GEOMORPHOLOGY OF SEASONALLY ACTIVE CRESCENTIC DUNES: NILI PATERA, MARS AND STRZELECKI DESERT, EARTH. M. A. Bishop[1], [1]Applied Geology, School of Engineering, University of South Australia, Mawson Lakes, S.A. 5095, Australia (mark.bishop@unisa.edu.au).

Introduction: Images from Mars Global Surveyor (MGS) have shown evidence for recent-to-current aeolian activity and bedform change. Previous studies of dune morphology and activity [1 and others] were limited by the lower resolution of Viking Orbiter (VO) images, and could not conclusively discern landscape age. In comparison, the resolution of the Mars Orbiter Camera (MOC) shows details equivalent to terrestrial aerial photos. Such detail allows the identification of local wind flow directions as shown by changes in dune form, as well as, features and properties of the interdune. Early MGS MOC results have shown that sand dunes in the low latitudes have been recently active [2], while dunes in the North Polar Region are considered currently active [3]. High-resolution MOC images of small dune concentrations such, as those within Nili Patera, also appear currently active.

Dune Settings. Nili Patera (lat. 9° N., long. 293°) located within the Syrtis Major Formation is attributed to volcanism during the Hesperian [4]. VO images show Syrtis Major Planum to have many light and dark windstreaks aligned W-to-SW. MOC image 2-88 has offered further insight into the aeolian activity of this region by showing highly resolved (3m pixel^{-1}) crescentic dunes (Fig. 1). A striking similarity in meso-form is offered between these dunes and those in the Strzelecki Desert, Australia (Fig. 2). Both localities show an array of analogous crescentic morphologies (barchan, barchanoid and transverse), albeit composed of different lithologies (*i.e.* terrestrial quartz sand *cf*. basaltic sand on Mars).

Nili Patera Dunes: MOC image 2-88 identifies an aeolian veneer that characterises regions of low albedo. Terrain of higher albedo appears planated or stripped and primarily consists of lava flows. Where the sediment pile is thickest, duneform is typically transverse (Fig. 1 - Dune B), in contrast, the existence of barchans (Dune A) occurs where the sedimentary pile is thinnest and overlies an indurated substrate or bedrock. The lack of superimposed features and an absence of morphological degradation is typical of this dune cluster, and suggests a recently if not currently active environment in which the dunes exist. For example, Dune (A) shows a 'sharp' perimeter traversing closely spaced lava flows, small impact craters, other topographic irregularities, and horn mergence with another sand barrier. A similarly sharp crestline and elongated horn further suggest morphological equilibrium with the current aeolian regime. In like manner, Dune (B) is a transverse form straddling a sediment infilled craterform of probable impact origin. The area surrounding this crater shows a thin concentric mantle of aeolian transported sediment. Overlying this translucent veneer, well-defined 'sand-sheets' are clearly visible. The lucid definition and superposition of these bedforms offers evidence for very recent stages of aeolian activity. Desert bedforms that are relic in terrestrial settings do not portray such distinct morphologies, but instead, show subdued and often 'ragged' appearance and outline.

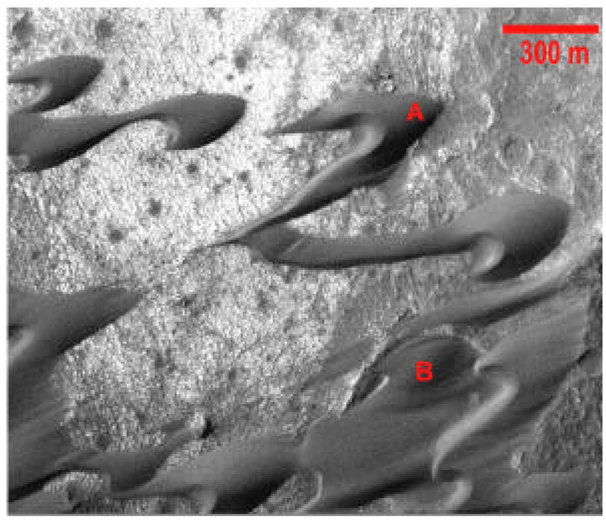

Figure 1. Crescentic dunes of Nili Patera, Syrtis Major Planum (MOC 2-88). Terrain of relative high albedo is characterised by basalt flows that assist the development of 'classical' barchan morphology (A). Areas of lower albedo are mantled by thick aeolian deposits (B) and show the development of more closely spaced transverse duneforms. A secondary wind has influenced horn and linguoid elongation on the barchans and transverse dunes, respectively.

Furthermore, elongated horns and linguoids each show definitive crestlines, as well as, what appears to be secondary slipfaces orthogonal to the primary leeface. The maintenance and 'freshness' of these features formed from bi-directional winds, also infers recent seasonal and/or diurnal activity rather than relic geomorphic traits.

Terrestrial Analogues of Process and Form: Thomas et al. [2] cited that aeolian mantles, several metres or more thick, cover large areas of Mars, yet they are free of obvious bedforms. Assuming that sufficient winds exist for particle entrainment, evidence from the Strzelecki Desert suggests that the lack of dunes in sediment mantled zones, is due to the nature of the surface upon which the bedforms are built. Crescentic dunes of the Strzelecki Desert showed that amorphous form correlated with an unconsolidated interdune, whereas, transverse morphologies were associated with interdune consolidation. The degree of consolidation was related to the presence of montmorillinite in the surface sands. The relatively 'smooth' clay-enriched surface developed during the wetter conditions of winter and spring. As seasonal conditions changed from cool and moist into dry and warm, induration of the sands took place during late spring and early summer. However, higher temperatures in mid- and late summer caused the clay surface to desiccate, and erode into micro-yardang fields (Fig. 2). The early summer interdune was analogous to a bedrock surface, almost totally lacking any unconsolidated surficial cover. This was found to be the time when all dunes were most mobile in primary unidirectional winds, while individual dunes became most barchan-like (morphologically equilibrated). Similarly, near identical morphology-surface relationships are expressed for the dunes of Nili Patera.

Figure 2. 'Classic' barchan morphology in summer, Strzelecki Desert. A surface veneer of montmorillinite and fine sands characterises a relatively 'smooth' and indurated interdune. Desiccation polygons and relic micro-yardangs lie within the lee-court of these 1.5-m high barchans. The morphogenetic pathway of desiccation polygon-to-yardang-to-sediment-to-dune depicts the intimate relationship of the seasonal aeolian cycle. MOC images suggest similar aeolian processes may currently occur on Mars.

Conclusions: Comparing the terrestrial aeolian environment of the Strzelecki Desert with that of Nili Patera on Mars, gives insight into a probable relationship between soil structure and mineralogy, and crescentic dune morphology. Assuming that moisture is available on Mars, it is possible that the general mafic mineralogy of aeolian mantles and soils permits widespread cementation by montmorillinitic clays, and for seasonally controlled desiccation to occur. In regions of thick aeolian mantles, the existence of bedforms, and their morphological character may be related to these surface-textural changes, as found in the Strzelecki Desert. Thick aeolian mantles seem to require surface induration (as achieved through the adhesion of sand grains or the property of bedrock) for meso-scale bedforms to develop. The degree of surface binding, hence interdune 'firmness' prescribes whether nondescript zibar sand-sheets or well-structured barchan-to-transverse dunes develop. Clay content of aeolian sands can be considered an important parameter in the development of meso-scale bedforms. The possibility of seasonal textural contrasts of the interdune, as well as, duneform definition supports the occurrence of a dynamic desert environment for Mars.

References: [1] Breed, C.S. et al. (1979) *JGR, 84*, 8183-8204. [2] Thomas, P.C. et al. (1999) *Nature*, *397*, 592-594. [3] Edgett, K. and Malin, M. (1998), *News Release #98-108*, JPL. [4] Greeley, R. and Guest, J.E. (1987) 1:15M Geologic Map of the Eastern Equatorial Region of Mars, I-1802-B.