THE JURASSIC PAGE SANDSTONE: COUPLING AEOLIAN STRATIGRAPHIC ARCHITECTURE TO WATER TABLE AND SEA LEVEL FLUCTUATIONS.

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Introduction: Parameters defining aeolian dune field patterns, including dune height and dune spacing, are a function of dune field development time [1-2]. Over time, dune spacing and height increase. This change in pattern could be preserved in the rock record, and should display as a vertical increase in set and grainflow thickness [3] in systems preserving the complete development stages of the dune field.

Herein, we examine the stratigraphic architecture of the Page Sandstone along 1.5 km of outcrop in northern Arizona. Field measurements and maps are used to determine which developmental phases of the dune field are preserved. The spatial and topographic arrangement of these phases are then used to test hypotheses regarding paleo-environmental conditions, which can affect when and where deposits are preserved.

The Page Sandstone: The Page Sandstone (Fig. 1) is the deposit of the Page coastal dune field during the Jurassic. It overlies and in is separated from the Navajo Sandstone by the continental-scale J2 unconformity [4]. During the Jurassic, the adjacent Carmel Sea experienced several fluctuations in sea level, affecting the position of the water table in the Page Erg [5]. Highstands in the Carmel are associated with high water-table elevations in the Page dune field that are tied to development of polygonally-fractured sabkha surfaces [5-6], and the preservation of some portion of underlying aeolian cross-strata. The packages of lowstand aeolian strata, bounded by sabkha deposits and/or polygonally-fractured surfaces (Fig. 1) represent parasequences within the overall transgressive succession of the Page Sandstone.

The occurence of an extensive wet sabkha surface prohibited dune field development and this lack of wind-blown sand lead to surface deflation down to elevation of the water table [5]. As such, each parasequence bounding surface represents a reset of the dune field pattern, and provides an opportunity to correlate stratigraphic architecture to paleo-environmental conditions.

Results: The Page Sandstone is dominated by large sets of cross-strata composing 8 parasequences (Fig. 1). The uppermost parasequence represents a compound dune field and is ignored here. Parasequences range in thickness from 1-15 meters and are most commonly a single set thick (Figs. 1 & 2). Relief on parasequence surfaces ranges from 6-12 meters. There is no relationship between local parasequence thickness and the number of stacked cross-strata sets found at that location. There is however a relationship between basal relief along a parasequence surface and parasequence thickness (Fig. 2).

These results indicate there is almost no preservation of the early, developing dune field. Instead, the record is dominated by large, later-stage dunes which mined any potential deposits of the earlier dune field. Although topographic lows along parasequence surfaces do preserve a thicker section, it is still preserving cross-strata associated with later-stage dunes. The relief along the parasequence surfaces is hypothesized to be the result of these same erosional episodes. Relating local parasequence surface relief to local polygonal fracture dimensions is ongoing work testing this hypothesis.

The inferred cannibalization of the earlier dune field deposits is confirmed at two locations above the J2 surface. At both locations, a single parasequence preserves several meters of thin stacked sets of cross-strata composed of relatively thin grainflows, indicating deposition by smaller dunes [3]. In both locations, this architecture is laterally discontinuous due to the truncation of these deposits against a much thicker set of cross-strata with thicker grainflows (Fig. 3). In one example, this architecture is associated with a topographic depression 10 meters in depth on the J2 surface. The topography of the J2 surface is unknown at the second location. Their preservation is unusual at the studied outcrops and likely aided by their deposition in high-accommodation topographic depressions.

Conclusions: Parasequence architecture of the Page Sandstone preserves a record of intense erosion. Instead of stacks of climbing dunes and inter-dune sabkhas indicating a wet system [7-9], the architecture is dominated by single, large cross-strata sets associated with large erosional dunes. These dunes generally completely cannibalized earlier deposits within the parasequence, and potentially the upper parts of lower parasequences. Within parasequences, there is no evidence of a near-surface water table encouraging climb or even limiting erosion. Water table did rise episodically to create the ubiquitious parasequence surfaces [5], but significant erosion of the upper parts of parasequences is associated with the formation of these surfaces due to a wet, limited sediment supply. Erosion of that surface further continued via mining by later dunes associated with the following parasequence. Although the extensive erosion recorded in the Page Sandstone makes the parasequences an incomplete record of the dune field's development, the architecture of the parasequences is still extremely informative of the coupling of migrating dunes, the water table, and an adjacent large body of water. As such, similar methods applied to aeolian sandstones on Mars [10-11] could be extremely informative of the martian paleo-environment. The scale of observations made here is possible with rover data or potentially high-resolution orbital data.

References: [1] Kocurek G. and Ewing R.C. (2005) *Geomorphology*, *72*, 94-105. [2] Ewing R. C. et al. (2006) *ESPL*, *31*, 1176-1191. [3] Kocurek G. and Dott R.H. (1981) *JSR*, *51*, 579-595. [4] Pipiringos G.N. and O'Sullivan R.B. (1978) *U.S. Geol. Survey Prof. Paper 1035-A.* 29 pages. [5] Havholm K.G. et al. (1993) *Spec. Publs. Int. Ass. Sediment*, *16*, 87-107. [6] Kocurek G. and Hunter R.E. (1986) *JSR*, *56*, 895-904. [7] Kocurek G. and Havholm K. G. (1993) *AAPG Memoir*, *58*, 393-409. [8] Carr-Crabaugh M. and Kocurek G. (1998) *SEPM Spec. Pub.*, *59*, 213-228. [9] Mountney N.P. and Jagger A. (2004) *Sedimentology*, *51*, 713-743. [10] Watkins J. et al. (2016) *LPS XXXXVII*, Abstract #2939. [11] Milliken R.E. et al. (2014) *GRL*, *41*, 1149-1154.

Figure 1 – *Left:* Representative photo of the Page Sandstone. Person for scale. Note the thick sets and the capping Carmel Fm. *Right:* Polygonal fracture terminating at the top at a parasequence boundary (surface the person is on).

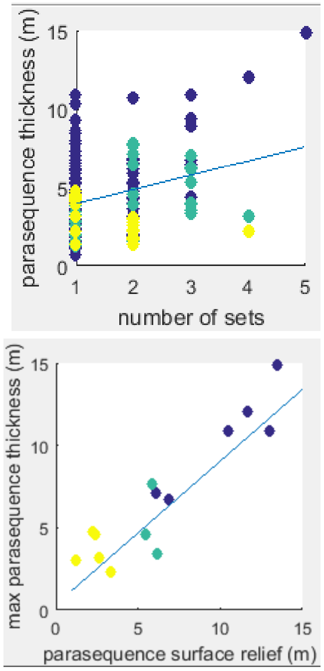

Figure 2 – Relationships described in text. *Top:* r^2 = .08. *Bottom:* r^2 = .84. Colors correspond to different outcrops.

Figure 3 – Thinner sets of cross-strata truncated by a typical large set of cross-strata (arrow points to erosional surface). Scene is ~3 m high.