Reconstructing ancient passive margin dynamics by relating geomorphic and stratigraphic surfaces: a combined laboratory and field study

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In the last year a student funded by this award has focused on work that is summarized in the abstract below, which we have in submission at Nature Geoscience (Fig. 1):

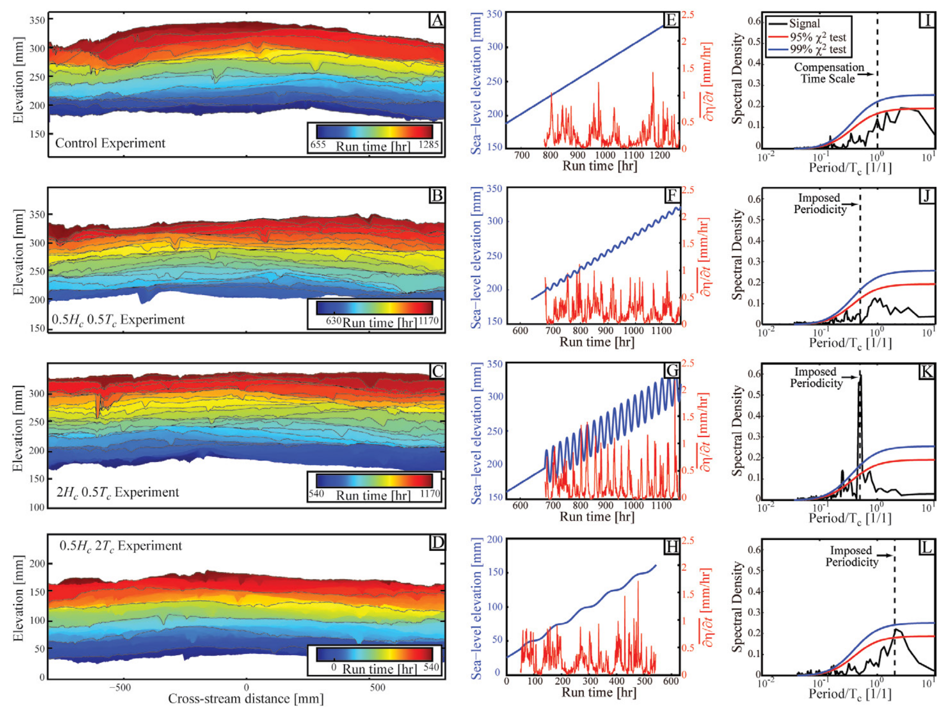

Figure 1. Time series analysis of mean deposition rate calculated from preserved stratigraphy for all experimental deltas with comparison to sea level time series. A-D) Synthetic stratigraphy along a proximal transect location illustrated in Fig. 1A. Solid black lines represent time horizons separated by 1 Tc (A) or demarcating the start of each RSL cycle (B-D). E-H) Sea level and mean deposition rate time series along proximal transects; I-L) Power spectra of mean deposition rate time series and χ_2 confidence limits

The tug of Relative Sea Level (RSL), set by climate and tectonics, is widely viewed as the most important boundary condition for the evolution of deltas. However, the range of amplitudes and periodicities of RSL cycles stored in deltaic stratigraphy remains unknown. Using experiments, we demonstrate that RSL cycles with magnitudes and periodicities less than the spatial and temporal scales of the internal (autogenic) dynamics of deltas cannot be extracted from the physical stratigraphic record. These results predict stratigraphic storage of information pertaining to RSL cycles during icehouse Earth conditions. However, these thresholds often overlap with the magnitudes and periodicities of RSL cycles for major river deltas during greenhouse Earth conditions, which suggest stratigraphic signal shredding. This theory defines quantitative limits on the range of paleo-RSL information that can be extracted from stratigraphy, which could aid the prediction of deltaic response to climate change.

Other publications that have come out in the last year in which my involvement or data was partially related to this award include:

Kim., W., Petter, A., Straub, K.M., Mohrig, D., 2014, Decoupling allogenic forcing from autogenic processes: Experimental geomorphology and stratigraphy, In: From Depositional Systems to Sedimentary Successions on the Norwegian Continental Shelf (Eds A.W. Martinius, R. Ravnås, J.A. Howell, R.J. Steel, and J.P. Wonham), IAS Spec. Publ., 46, 127-138.

Armstrong, C., Mohrig, D., Hess, T., George, T., Straub, K.M., 2014, Influence of growth faults on coastal fluvial systems: Examples from the late Miocene to Recent Mississippi River Delta, v. 301, p. 120-132, DOI: 10.1016/j.sedgeo.2013.06.010.

There will likely be two additional manuscripts submitted in the coming year that are primary products of this award. Unfortunately, the PhD student working on this has back-ended all of his publications and so a bunch will come out (hopefully) in a flurry as he gets ready to defend this year.

If I were try to summarize the key findings of the work, it's as follows: We have defined 2 nondimensional numbers important for storing environmental signals (here focused on sea-level) in stratigraphy. These numbers compare the amplitude (H*) and period (T*) of sea level cycles to the space and time scales of internal deltaic dynamics. In order for paleo-sea level information to be inverted from the stratigraphic record one of these numbers must be great than one. It turns out that in many systems important Milankovic scale cycles should not be expected to be stored in stratigraphy, if you scale our experiments up to the field through these non-dimensional numbers. This is a start (I hope a big one) towards placing quantitative limits on the fidelity of the stratigraphic record.