DATA REPOSITORY ITEM 2009102

BACKGROUND TO SEDIMENT TRANSPORT ANALYSIS

The hypothesis that chevrons are bed forms requires that they are deposited and developed under conditions of the fluid that allow bed load transport. In this appendix, we test this hypothesis more elaborately and more formally than in the text.

The Rouse parameter, $\boldsymbol{p} = w_s/\kappa u_*$, is used to characterize the sediment transport regime. When $\boldsymbol{p} > 2.5$ grains are transported as bed load; if $\boldsymbol{p} < 0.8$ as suspended load. For the grain settling velocity, w_s, we apply the following equation from Ferguson and Church (2004):

$$w_s = \frac{RgD^2}{C_1\upsilon + \sqrt{0.75C_2RgD^3}} \tag{1}$$

where C_1 and C_2 are coefficients with values of 18 and 0.4. Parameter R is the submerged specific gravity (R=1.65 for quartz), υ is the kinematic viscosity of water, g is gravity, and D is the grain size.

In order to work out a formalism to describe the flow, it is necessary to find simplifying approximations. One of them is, for example, that the flow can be scaled by Froude number:

$$Fr = \frac{u}{\sqrt{gh}} \tag{2}$$

where u is the velocity of the flow, g is gravity, and h is the water depth. Because we consider overland flow of the tsunami, h is also flow depth. Equation (2) rearranged to isolate u gives:

$$u = Fr\sqrt{gh} \tag{3}$$

The velocity u is depth-averaged. Another assumption is that the law of the wall holds for hydraulically rough flow conditions:

$$\frac{u(z)}{u_*} = \frac{1}{\kappa}\log\left[\frac{30z}{k_s}\right] \tag{4}$$

in which κ is von Karman's constant, u_* is the shear velocity ($\sqrt{\tau_b/\rho}$), and $k_s/30$ is Nikuradse's roughness length. The roughness k_s is varied over several orders of magnitude. Equation (4) is rearranged to isolate u_*:

$$u_* = \frac{u(z)\kappa}{\log[30h/k_s]} \tag{5}$$

It can furthermore be assumed that for z=h: $u \approx Fr\sqrt{gh}$, which changes Equation (5) to

$$u_* = \frac{Fr\sqrt{gh}\kappa}{\log[30h/k_s]} \tag{6}$$

DATA REPOSITORY REFERENCES CITED

Ferguson, R.I. and Church, M., 2004. A simple, universal equation for grain settling velocity: J. Sedimentary Research, v. 74, p. 933-937.

Hearty, P.J., Neumann, A.C., and Kaufman, D.S., 1998. Chevron ridges and runup deposits in the Bahamas from storms late in oxygen isotope substage 5e: Quaternary Research, v. 50, p. 309-322.

Scheffers, A., Kelletat, D., Scheffers, S. R., Abbott, D. H., and Bryant, E. A., 2008, Chevrons enigmatic sedimentary coastal features: Z. Geomorph. N. F., v. 52, p. 375-402.

Data Repository Figure captions

Figure DR1. Large bed forms in the Bahamas. A,B,C are all shown at the same scale and are images extracted from Google Earth. From each, a single bed form is outlined and compared in the sketch below A. A: This chevron near Staniel Cay was used by Hearty et al. (1998) to illustrate chevron ridges. B: Left—satellite image and right—sketch from Hearty et al., 1998 of south Eleuthera Island showing inactive chevrons. C: Satellite image of active large oolitic bed forms in the northern Bahamas. White areas are actively moving oolitic sand, dark areas are vegetated (grasses and algae). D: Oblique air photo (by Bourgeois) of similar bed forms in the middle Bahamas, east of Andros Island.

Figure DR2. Images of chevron-like bed form [from Google Earth], clockwise, from upper left: White Sands, New Mexico [not on a coast]; near Kozirevsk, Kamchatka [not on the coast]; south coast of North Island, New Zealand; southwest coast of Australia; Mediterranean coast of Israel. See also Scheffers et al., 2008, for more images [coastal cases only].

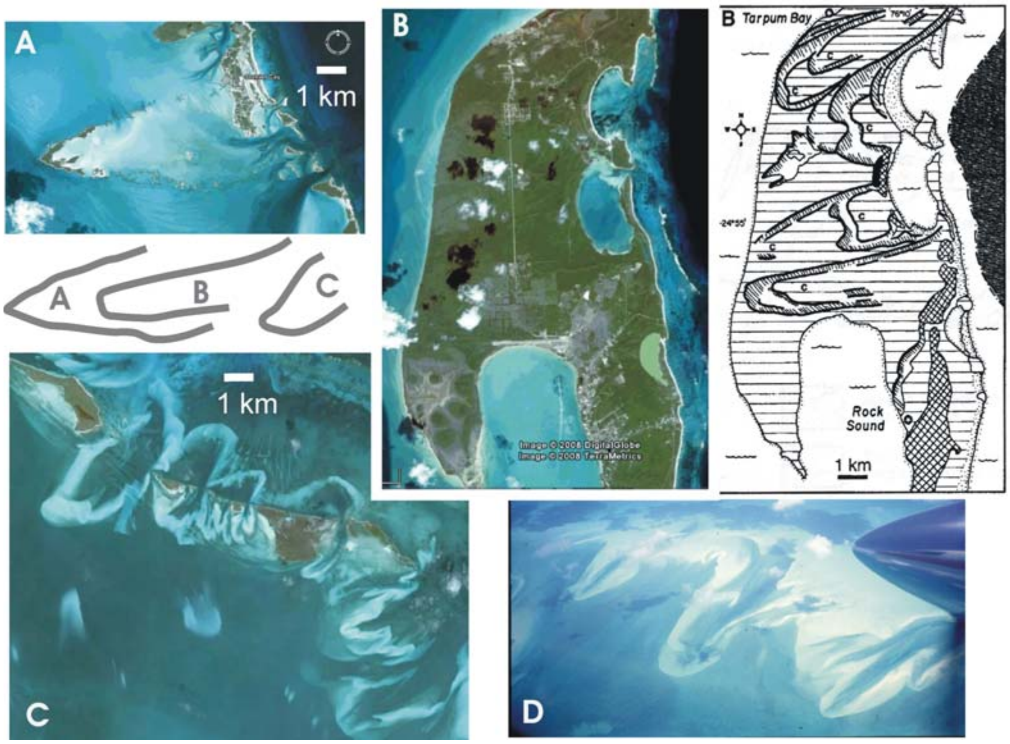

FIGURE DR1

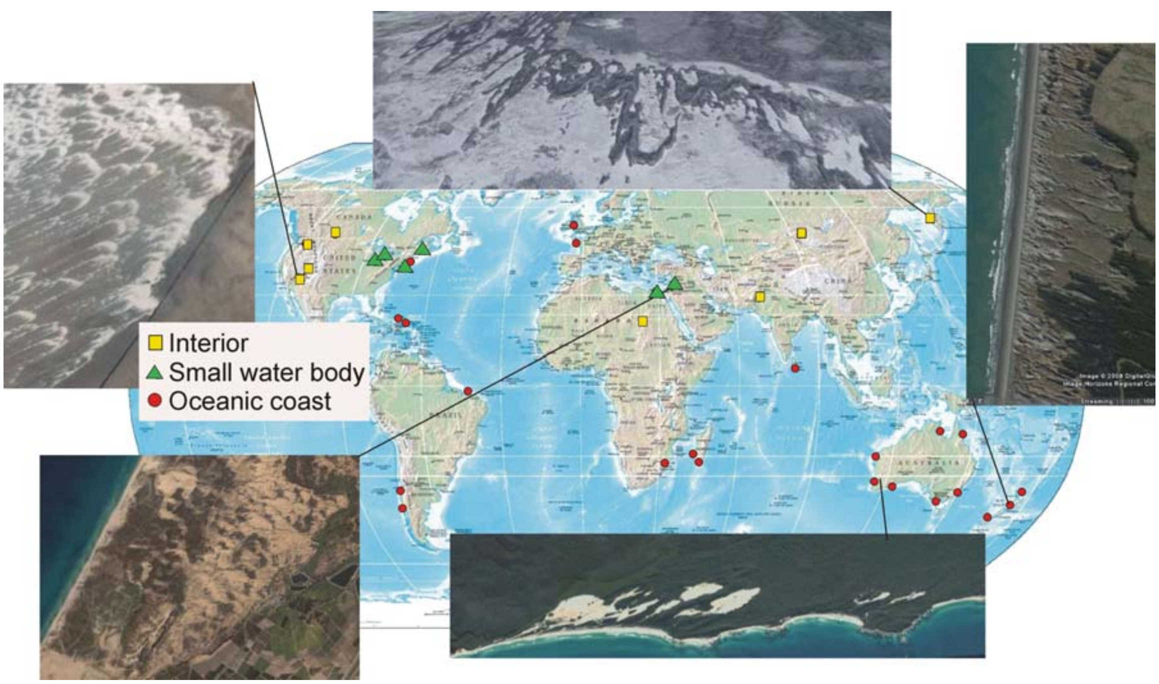

FIGURE DR2