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The effect of biological cohesion on current ripple development

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SUMMARY
Results are presented from laboratory experiments examining the role of biological cohesion, associated with Extra Polymeric Substances, on the development of current ripples. The results demonstrate the importance of biological cohesion compared to the effect of physical cohesion associated with clays in an otherwise sandy bed.

FURTHER INFORMATION
In fluvial and marine environments sediment transport is mainly dependent on the nature of the bed surface (rippled or flat) and the nature of cohesion in the bed. Cohesion can be either physical, as a result of the presence of clays, or biological as a result of the presence of organisms. In the case of the latter, biological cohesion occurs as a result of the presence of Extra Polymeric Substances (EPS) secreted by microorganisms. While it is known that EPS can dramatically increase the threshold of motion (Grant and Gust, 1987), comparatively little is known about the effect of EPS on ripple formation and development. The experiments described here seek to fill this gap. They also allow the effect of biological cohesion to be compared with that of physical cohesion from previous experiments (Baas et al., 2013).

The experiments, which were conducted in a 10m flume at Bangor University, involved a current over a bed made of fine sand, with a median diameter of 0.148mm, and various amounts of xanthan gum, a proxy for naturally occurring EPS (Vardy et al., 2007). The hydrodynamic experimental conditions were matched very closely to those of Baas et al. (2013). The ripple dimensions were recorded through the glass side wall of the tank using time lapse photography.

In the physical cohesion experiments of Baas et al. (2013) for clay contents up to 12%, the clay was very quickly winnowed out of the bed, leaving essentially clay-free ripples that developed at more or less the same rate as clean sand ripples. The resulting equilibrium ripples were essentially the same length as the clean sand ripples but reduced in height. By contrast, the biological cohesion experiments resulted in a drastic slowing down in ripple development, for much smaller amounts of xanthan (< 1/8%), but resulted in equilibrium ripples with the same dimensions as abiotic sand.

This difference in effect for biological and physical cohesion is thought to be related to differences in the nature of the binding. In particular, sand grains with biological cohesion are inhibited from moving independently, which is crucial to ripple development. This work has profound implications for sediment transport studies and emphasises the importance of considering biology as well as clays in sediments.

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