Geophysical Research Abstracts
Vol. 12, EGU2010-4952, 2010
EGU General Assembly 2010

Experiments on internal hydraulic jumps in stratified turbidity currents and their relation to structureless sands.

Matthieu Cartigny and George Postma
Department of Earth Sciences, University of Utrecht, The Netherlands (m.cartigny@geo.uu.nl)

Turbidity currents are subaqueous, turbulent sediment suspensions that flow down the slope solely by the pull of gravity. These suspension flows can freely exchange sediment with the seabed. On decelerating, turbidity currents start to form deposits. These deposits typically consist of a structureless basal unit followed by plane bed lamination, small-scale ripple sets and silt lamina formed under low shear stresses and suspension fall-out. The unit is covered by a hemi-pelagic graded mud unit. The exact mechanism which enables turbidity current to form a structureless, basal Bouma A-unit is still under debate. Such a structureless deposit is characterized by a complete lack of internal structure. Recent experimental work has shown that the formation of the structureless unit is only possible if the shear stress is reduced to about nil in the basal portion of the flow. The complete lack of shear stress is prohibiting grain sorting and thereby preventing the formation of any sedimentary structures. Our experimental work also showed that the required strong reduction of the shear stress occurs in the case of an internally stratified turbidity current that passes a break of slope. At the break of slope internal waves in the stratified turbidity current start to break and form a hydraulic jump. While the bottom layer passes through a hydraulic jump the high-velocity core abruptly detaches upwards form the bed, which enables shear free settling of grains in between the detached high-velocity core and the bed.

Hence, a structureless sand deposit forms by a turbidity current if: 1) the suspension flow is internally stratified, while 2) the bottom layer of the stratified flow passes through a hydraulic jump. Our research tries to quantify these necessary conditions. Internal stratification is related to the sediment concentration. If a flow has a sediment concentration of over 9%, it will establish an internally stratified turbidity current, with a low-concentrated, turbulence-supported, upper-layer and a high-concentrated grain-to-grain contact supported bottom-layer. After establishing an internally stratified turbidity current, the second condition states that the bottom layer should be initially super critical, so the bottom layer should have a velocity above that of propagation velocity of the interval waves. Calculating this from our experimental images is not a straight forward matter, due to the vertical velocity and concentration gradients in the flow. These gradients make it difficult to determine where a layer starts and ends. As a result, the determination of layer velocities and wave propagation velocities are troublesome and is the determination of the densimetric Froude number a matter of discussion.

Yet, establishing quantification of necessary conditions for a stratified turbidity current to pass through an internal jump would give insight into the formation of structureless sands and opens possibilities of deducing paleodynamics of turbidity currents form just their deposits.