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Below, I will justify my request for a financial contribution from the Steve Farrell Memorial Fund to attend the 11th International Conference on Cohesive Sediment Transport Processes (INTERCOH 2011) to be held in Shanghai (China) from October 18th to 21st 2011.

Introduction and research aims

My ongoing PhD project '*Fluid and sediment interaction in open channel flows and turbidity currents moving over soft muddy beds*' aims to shed light on the feedback processes that occur when open channel flows (e.g., rivers, tidal flows) and sediment gravity flows (e.g., turbidity currents) move over a muddy substrate, and to establish diagnostic criteria for identifying these processes in sedimentary deposits.

Many aquatic sedimentary basins have soft, muddy substrates, but this important property has largely been ignored in process-based models of Earth-surface flow. A soft, 'sticky' substrate is believed to interact differently with a passing flow than a sandy substrate. Their cohesive properties render muddy beds susceptible to plastic deformation. Also, muddy beds may be more or less prone to erosion than sandy beds, depending on their consolidation state. Different feedback relationships between flows and muddy beds, as compared to hard and/or sandy substrates, are likely to affect the textural and structural properties, spatial distribution and 3D geometry of the resulting sedimentary facies in a manner that is largely unknown at present.

The present phase of my PhD project focuses on turbidites. Turbidite successions are one of the most important hydrocarbon reservoirs and understanding their geometry is a key issue for hydrocarbon exploration. Therefore, <u>it is essential to establish the differences between turbidity current dynamics over hard (fixed or mobile sandy) and soft substrates, and to determine how the facies and architecture of the resulting sedimentary successions are affected.</u>

Methods

To achieve these aims, my research combines novel laboratory experiments and field-based research. In the Hydrodynamics Laboratory at Bangor University, I generated kaolin-clay laden turbidity currents with different concentrations (between 0.4 and 10 vol%) that moved over soft, fluid-mud like, kaolin-clay deposits (with concentrations between 6 and 13 vol%). Ultrasonic Doppler Velocity Profilers (UDVP) and an HD camcorder were used to observe and quantify the interaction of the turbidity currents with their substrate at various contrasts in clay concentration between flow and bed.

In order to determine how the interaction between flow and substrate might affect sedimentary deposits, boundaries between turbiditic sandstones and underlying mudstones were studied in the Grès de Peira Cava (Annot Sandstone, S. France).

Results

The experiments revealed multiple types of complex flow-bed interaction, and remarkably large and unexpected variations in bed deformation/erosion and turbidity-current properties. The most notable result of the flume experiments is that <u>turbidity currents can accelerate over a plastically deformable, cohesive substrate in the absence of a slope gradient</u> (Fig. 1). The boundary conditions at which this flow acceleration takes place are under investigation, but the data already suggest that <u>prominent changes in the geometry of turbidity currents, closely associated with plastic deformation in the substrate (i.e., shear waves) and bed erosion, are vital in explaining the changes in turbidity-current velocity</u> (Fig. 2).

Preliminary fieldwork results confirm that it is possible to identify the products of flow-muddy bed interaction in geological outcrop. It was found that sand- and mudstone pairs vary in thickness in a wavy manner, with the sandstone filling in the troughs of the waves and showing thinning above the crests. This could be explained as preserved shear waves, similar to those found below the experimental turbidity currents, but further support is needed for this explanation.

Implications

Changes in the velocity of turbidity currents and the properties of the substrate are closely related to changes in bed shear stress, which in turn controls flow turbulence properties, substrate erodibility, flow density, and rates of deposition. On a field scale, this could translate into changes in flow runout distance and deposit geometry, and diagnostic sedimentary facies for depositional and erosional turbidity currents that move over soft, muddy substrates. My laboratory data potentially explain the large continuity of some turbidite beds in modern environments (e.g., 1000s of km in the Atlantic Ocean off NW Africa; Talling et al., 2007), and in the geological record (e.g., 100s of km in the Marnoso Arenacea, Italian Apennines; Amy and Talling, 2006). In fact, flow-muddy bed interaction is not unique to deep-marine environments; the basic physical sedimentological concepts derived from the flume experiments will also be applicable to other mud-dominated environments, such as estuaries and muddy rivers (e.g., Yellow River, China).

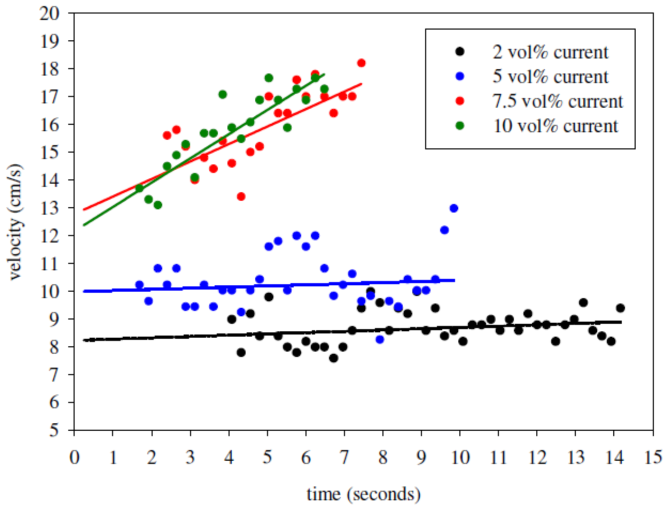

Figure 1 – Head velocities and best-fit curves of four turbidity currents with different clay concentrations, moving over a bed with 9.5 vol% clay. Note that: (a) each flow arrived at the kaolin substrate at t=0; (b) the lower-concentration flows maintained their initial head velocity; (c) the head of higher-concentration flows accelerated across the horizontal clay substrate.

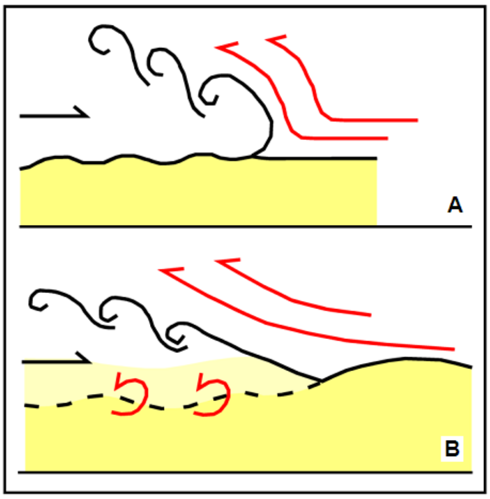

Figure 2 – Observed changes in turbidity current head geometry. When flow-bed interaction is absent or restricted to shear waves, a blunt nose prevails (A). If the interaction intensifies to mixing, erosion and the formation of a leading wave in the deformed substrate, the nose gets a streamlined shape (B) and the head velocity increases.

INTERCOH 2011

A large part of the success in identifying the products of flow-muddy bed interaction at field scale relies on a comprehensive understanding of the physical sedimentological processes that govern the flow-bed feedback processes. Hydraulic engineers generally have more expertise in the physics of cohesive flows and sediments than sedimentary geologists. Therefore, knowledge exchange with the engineering community would be highly beneficial to my project. This year, I have the unique opportunity to meet world-leading specialists at the 11th International Conference on Cohesive Sediment Transport Processes (INTERCOH 2011) in Shanghai (China). INTERCOH is an international conference usually attended by over 100 scientists and engineers who study the physical processes of cohesive sediment transport in the natural environment.

Two main topics of INTERCOH 2011 are 'Physical processes of fine and mixed sediments: erosion, transport, deposition, flocculation, liquefaction and consolidation' and 'Field and laboratory studies of these processes and instrument developments'. My research project fits in well with these topics, and I intend to submit an abstract for an oral presentation. Presenting and discussing my results will greatly benefit my academic progress, as I anticipate receiving direct input on the physics of cohesive sediments from experts who work in similar fields of research. These experts might also benefit from my work, as my observations are fundamental, novel, and potentially applicable to a range of engineering problems (e.g., fisheries, harbour management, dredging). I feel that attending INTERCOH 2011 can provide me with a fresh and original perspective to my research and it will allow me to greatly increase my network of contacts within the 'cohesive sediment community'. I will present the latest results of my project and share my scientific experiences of INTERCOH 2011 with the sedimentological community at BSRG2011, which will be my second presentation at BSRG annual meetings.

Budget

The estimated total cost for attending INTERCOH 2011 is 1800GBP, specified in Table 1.

I am applying for partial funding from the Steve Farrell Memorial Fund for the amount of 900GBP, to have the unique opportunity to interact with the leading international community of cohesive sediment specialists, which was not foreseen in the original description of my PhD project. I intend to use these funds for registration fees, the conference dinner, a visa needed to enter the People's Republic of China, and a return flight to Shanghai. The real costs are likely to be similar to the estimated costs in Table 1, since they are based on the costs of INTERCOH 2009 (Rio de Janeiro, Brazil), information from the Chinese embassy, and actual costs for flights in October 2011.

The remaining 900GBP will be paid from my PhD studentship funds, as agreed with my supervisors. These costs include accommodation, food and subsistence, conference proceedings booklet, and other travel in the UK and China (e.g., to and from the airport and hotel).

Table 1 – Specification of the conference costs

		Costs (estimated)	*Funding*
Conference	Registration Fee	£90	BSRG award
	Conference Dinner	£50	BSRG award
	Conference Proceedings booklet	£100	TRG PhD studentship
Travel	Visa	£110	BSRG award
	Flight UK-Shanghai v.v.	£650	BSRG award
	Other travel (UK and China)	£250	TRG PhD studentship
Other	Accommodation	£300	TRG PhD studentship
	Food and Subsistence	£250	TRG PhD studentship
Total		£1800 (of which £900 via BSRG award)	

References

Amy, L.A. and Talling, P.J. (2006) Anatomy of turbidites and linked debrites based on long distance (120 x 30 km) bed correlation, Marnoso Arenacea Formation, Northern Apennines, Italy. *Sedimentology*, **53,** 161-212.

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