Spilling into confinement: submarine slope valleys as pollutant and carbon sinks

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Highlights

- An opportunity to investigate the distribution of organic carbon and pollutants in deep-marine channels, with societal and economic implications
- Fieldwork possibilities in Mexico, South Africa, and Spain
- Novel experiments in the national environmental fluid dynamics laboratory, Leeds
- Vibrant research community in the sedimentology / Earth surface processes group
- Internationally leading supervisorial team with strong industry links

Submarine slope valleys are the main conduits for the transfer of particulates from the continents to the deep oceans, including huge volumes of clastic sediment, organic carbon, and pollutants (e.g. microplastics). Submarine channels are dominated by sediment bypass for much of their lifespan, although buried systems show that internal levee and terrace deposits are a major volumetric component of ancient slope valley-fills (Hansen et al., 2015; Fig. 1). These confined overbank settings act as a major store for fine-grained sediment, and are thought to comprise low-density turbidites. However, the role of submarine slope valleys as sinks for pollutants, such as microplastics, and their importance in global carbon budgets, is poorly constrained.

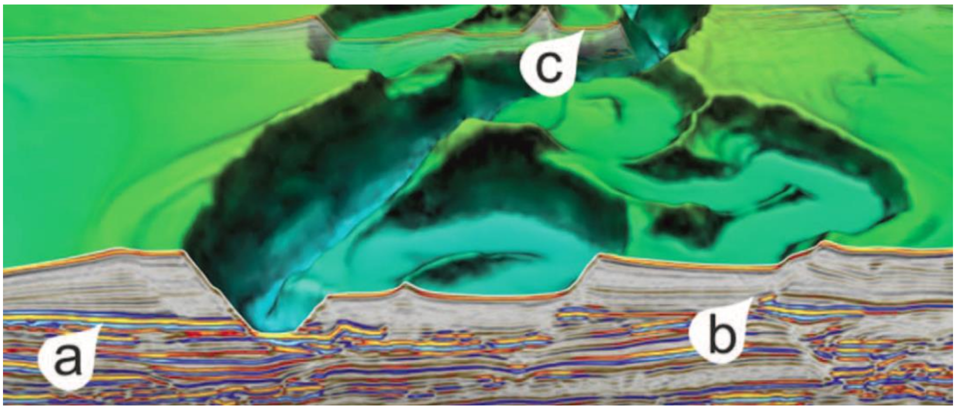

Figure 1: Seismic geomorphology of a slope valley system with abandoned bends and terrace deposits (from Hodgson et al. 2016).

Very little is known about the processes and grain-size distributions of internal levee and terrace deposits, and their role as carbon and pollutant sinks, because they are barely monitored in modern systems. Our understanding of their sedimentology and stratigraphy deposits is limited to a few exhumed systems (Kane and Hodgson 2011), and several cores in modern systems (Babonneau et al., 2010). Therefore, fieldwork is an essential component of this PhD studentship to examine exhumed slope valley systems and to document the grain-size distributions, sedimentary facies and depositional architecture in these ancient systems.

Examples of exhumed internal levee and terrace deposits include the Karoo Basin, South Africa, the Rosario Formation, Mexico, and the Ainsa Formation, NE Spain.

The sedimentary processes, and dynamic morphology, which internal levees and terraces form within the conduits has never been captured experimentally. Therefore, a series of novel physical experiments will be designed to investigate flow processes and products in confined settings. A larger surface will represent the slope valley confinement, with smaller sinuous channel forms, both leveed and terraced sitting inside the larger container. Initially, the 'inset' channel forms will be simple, in order to compare results to previous experiments run in the Sorby Sedimentology Laboratory (Fig. 2) that did not have a larger scale confining surface. This will form a baseline, and to identify process differences with the new experimental set-up, with scope to employ morphologies from modern systems in later experiments.

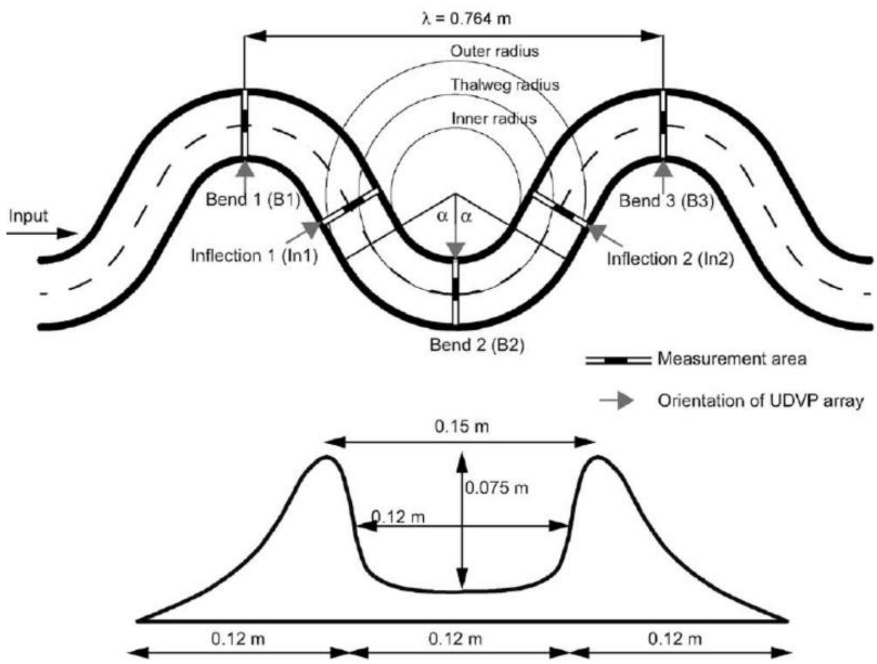

Figure 2: From Keevil et al. (2006) to illustrate previous simple sinuous channel experimental set up, with unconfined overbank area.

Aims and objectives:

The principal aim of the proposed PhD project is to investigate the processes sedimentology, and stratigraphic architecture, of internal levee and terrace deposits, and to assess their role as sinks for particulates during transport from continents to deep oceans. The results from the fieldwork and experimental components will be integrated in order to address the following objectives:

- To assess where particulates (e.g. organic carbon, pesticides, microplastics) with different hydrodynamic properties will be concentrated within submarine canyon systems
- To investigate the process differences between internal levee and 'depositional' terraces
- To examine whether turbidity currents start to decouple to form a higher density thalweg confined current, and lower density weakly confined current?

PhD Schedule, Outputs and Training

This PhD will commence before the end of 2019 and run for 3.5 years. During this period, the student will be eligible for all the postgraduate training typically provided to students attending the University as part of the PANORAMA DTP. This interdisciplinary project will provide the successful PhD candidate with highly valued and sought-after skills in modelling, and a deep understanding of particulate gravity flow. The student will receive training in relevant software packages, field based description, experimental techniques and data analysis, technical/scientific writing, and presentation of research to both scientific and public audiences. There will be opportunities to present results at major, international conferences, and the student willb e encouraged to publish their research during their studentship. The student will be based in the School of Earth and Environment at the University of Leeds, and will join the sedimentology / Earth surface processes group at Leeds that is one of the largest and most vibrant in the UK, with a very active group of doctoral and postdoctoral researchers, with close collaboration with researchers in the University of Manchester.

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