

CASP Research Award for Geological Fieldwork – 2018 Award Winner

Applicant: Bébhinn Anders, University of Galway

Project title: Mixed Signals: Understanding Cryptic Provenance of Carboniferous Deltas.

Award: £2,253

Scientific Question and rationale: This proposal seeks funds to support fieldwork for an ongoing PhD project which focusses on provenance studies and sediment tracking. Provenance techniques have direct application to industry, as they can be used as correlation tools and to help understand and predict reservoir quality and distribution. They also provide information on the source of sediment, the paleogeography and evolving sand supply through time in modern and ancient drainage systems. However, there are uncertainties about the behaviour of some provenance signals in the sedimentary environment. While some grains used to track sediment are prone to weathering (e.g. feldspar) others are extremely robust and should survive multiple recycling. Added to this is the complication of source mixing, with certain environments (and, therefore, facies – e.g. shoreface) more likely to record a signal mixed from all possible sediment input points, which makes palaeodrainage reconstruction more difficult. These phenomena, unless better understood, can also reduce the utility of provenance techniques as correlation tools. The Mullaghmore Sandstone Formation (MSF) in North West Ireland is the ideal location to test these ideas as detailed below.

Specific objectives and deliverables: Deltas are ideal environments to investigate these concepts, as they can comprise of variable input points from distinct source terranes, with a range of sedimentological processes (e.g. direct fluvial input versus longshore drift) which can impact the amount of mixing. Understanding these relationships is important because they will control the extent that sedimentary processes, like shelf mixing and point sourcing, effect the provenance signal. The MSF is a Carboniferous [Mississippian] fluvial/deltaic system outcropping onshore west Ireland in the North West Carboniferous Basin (NWCB) and is a perfect site for testing these ideas. Not only are cycles of various facies packages present, but there are also spatial variations such that the provenance signal can be investigated through a number of sections from different parts of the basin. These results will also give a better insight into the palaeogeographic reconstruction of this part of Ireland during the Carboniferous.

During a six-month pilot study, I logged, sampled, and carried out facies analysis on the MSF in Carrowmorán, Co. Sligo. This section represents a delta, with input and progradation from the northeast. Provenance analysis of the samples (U-Pb zircon dating and Pb-in-K-feldspar) revealed intriguing results suggesting that supply to the basin appears to fluctuate through time with some correspondence between facies packages and provenance signal – for example “shoreface” facies display a mixed provenance signal while “channelised sandstones” have unimodal provenance and are possibly from a point source. This suggests that the detrital signal could be linked to facies – potentially indicating point sourcing versus shelf mixing. This could have wide implications for how provenance techniques are applied by geologists worldwide, and especially in their utility as a correlation tool. The initial results have already been presented at four conferences (detailed in CV below). However, at the moment, the dataset is sparse and more information from the entire basin needs to be gathered. With aid of this grant I hope to gather enough data during fieldwork to 1) write a paper which will ultimately become a chapter of my PhD thesis; 2) present at upcoming international conferences (e.g. Conjugate Margins Conference in Nova Scotia, Canada; BSRG 2018).

As part of my fieldwork of my PhD research, I will investigate, log, sample and analyse a much broader area, including targeting the MSF equivalents in Co. Donegal, Co. Mayo and the MSF itself in Co. Sligo. Along with my previous data from Carrowmorán, these will build into a dataset with enough sampling, stratigraphic and geographic coverage to provide a clear indication if the detrital signal is definitively linked to specific facies packages.

Proposed work plan: Funds are specifically being sought to support a full season (6 weeks) of fieldwork, targeting the MSF in Co. Sligo first, then the MSF in Co. Donegal and Co. Mayo. During three two week blocks of fieldwork, I plan to accurately log the MSF sequence at these locations, identify any sedimentary features, record fossils and trace fossils found, and create a digitised graphic logs of the sequences. I will then categorise each bed into facies packages and link them to their depositional environment. Samples will then be taken from carefully selected areas for processing and analysis. Future work will include U-Pb zircon analysis, Pb-in-K-feldspar analysis and also heavy mineral assemblages. This will give a good understanding of paleogeography and also sediment source by applying a multi proxy provenance approach. The nature, evolution and architecture of the sedimentological fill of the basin are important to understand, especially in the context of other large ancient fluvial-deltaic systems in the Carboniferous (Tyrrell et al., 2006).

Proposed expenditure, including details of any other source of funding:

Item	Details	Cost GBP£
Travel	Petrol	270
Accommodation	Total 36 nights B&B	1368
Meals	Total 36 days breakfast, lunch, dinner	540
Field consumables	Notebooks, pencils, tape measure, printing	75
Total		2253

I have been awarded the NUIG Hardiman Scholarship in 2017, which covers university fees and a stipend of €16,000 p.a. for four years. This scholarship does not however provide funding for any fieldwork, labwork, analytical costs, travel costs or any other expenses incurred during the PhD.