Andrew Whitham CASP Fieldwork Award 2023 - Winner

Applicant: Yorick Veenma
Project title: The dawn of the diggers: Did non-uniformitarian Sedimentation rates control the rock record of Cambrian bioturbation?
Award: £3,410

Scientific question and rationale: The sedimentary rock record encapsulates several orders of magnitude of sedimentation rates, which complicates the literal interpretation of signatures that it hosts (e.g., geochemical, palaeontological, etc.). There is increasing recognition that the interplay between erosion, deposition, and stasis controls how time is reflected in the rock record and that this may affect reconstructions of Earth's history. A key aspect is that sedimentation rates not only vary spatially, but also throughout deep time: In the Cambrian, before the evolution of land plants started stabilizing substrates, sedimentation rates for fluvially derived clastics may have been much higher than they are today. Potentially, such non-uniformitarian sedimentation rates may have variably diluted or condensed evidence for time-dependent biological processes such as bioturbation. Recent studies have remarked that Cambrian evidence for bioturbation is surprisingly sparse and as a result, controversy surrounds the evolutionary timeframe of the origins of this process: Did widespread bioturbation start when animals and their behaviour diversified during the Cambrian (i.e., the Cambrian Explosion), or did it only become widespread in the later Palaeozoic? Using Cambrian bioturbation as a case study, this proposal seeks funding to address overlooked aspects of this discussion: Do non-uniformitarian sedimentation rates affect our understanding of the onset of bioturbation? And can bioturbation be used as a proxy to refine our understanding of how time is archived in the sedimentary record?

Specific objectives and deliverables: The objective of this project is to compare the bioturbation signatures of slowly and rapidly accrued strata through a field-based sedimentological and ichnological analysis of selected Cambrian units in eastern Canada, which (based on their age, depositional environments, and trace fossil content) are highly likely to yield important new insights into the interplay between bioturbation and sedimentation state (deposition, erosion, stasis). The results of this project will be presented at a relevant academic conference and submitted to a peer-reviewed journal.

Proposed work plan: Over 24 field days, I will work on two work packages that reflect different sedimentation rates and which were selected on the basis that they contain both trace fossil-rich and trace fossil-poor facies. I will systematically log these successions and undertake architectural analyses to assess how much time is reflected in the beds and the bedding planes that separate them. Concurrently, I will record bioturbation indices as well as the diversity and the architectural complexity of trace fossils. This way, new data will be closely tied to original sedimentological observations to assess whether trace fossils reflect a non-uniformitarian distribution of time in the Cambrian rock record and how bioturbation informs on local sedimentation rates.
WP1: Rapid sedimentation on a shallow shelf (Labrador): The Labrador Group represents Early Cambrian deposition in fluvial to shallow marine environments characterised by rapid sedimentation. Its marine deposits are often thoroughly bioturbated by vertical burrows to create classical 'pipe rock' fabrics (Bradore Formation). This unit can be compared to less trace fossil-rich deposits from the same setting.
WP2: Slow and episodic sedimentation in deeper waters (Newfoundland and Nova Scotia): The Curling Group (NL) and Goldenville Group (NS) represent Early to Middle Cambrian turbiditic deepwater environments. Both units contain trace fossil-bearing successions that have never been studied in detail (the Woods Island Section (NL) and the Mahone Bay section (NS)). The ichnology and sedimentology of these successions will be contrasted with trace fossil-poor deposits from the same groups.

Proposed expenditure, including details of any other sources of funding: Costs for 24 days.

Travel:	Round trip flights: London->Halifax (Nova Scotia)->Deer Lake (Newfoundland)->London, plus ferry trips to and from Newfoundland.	£1250
Car rental:	@ £40/day	£960
Accommodation and food:	@ £50/day	£1200
	Total requested	**£3410**