

## Andrew Whitham CASP Fieldwork Award - 2021-22 Winner

**Applicant:** Deitrich Pierre

**Project title:** The onset of an icehouse: chasing the sedimentological signature and eustatic imprint of the onset of the Late Paleozoic Ice Age (LPIA) in Morocco

**Award:** £2,000

**Scientific question and rationale:** Most of Gondwana was covered in ice during the Late Paleozoic Ice Age (LPIA), the penultimate icehouse our planet experienced and the longest of the phanerozoic (~100 Ma, from 360 to 260 Ma). Although sparse sedimentological evidences suggest the ice sheets initiated in northern South America and in western parts of the Sahara (Niger) during the lower Carboniferous, the exact location and spatial extent of the waxing ice masses as well as the amplitude of associated relative sea level (RSL) changes remain largely unknown and have yet to be unraveled. These are nevertheless of prime importance for understanding climatic changes during the Paleozoic and more generally deciphering modes of icehouse's establishment, which correspond to dramatic climate transitions in Earth's history. The Moroccan Anti & High Atlas correspond to thick Paleozoic sediment piles accumulated on Gondwana's northern continental margin at ~60°S of palaeolatitude during the Viséan. Allegedly close to LPIA ice spreading centers, this Moroccan sedimentary record thus appears ideal to constrain the onset of this glacial epoch. Here indeed, coarse continental clastics Viséan in age directly resting upon the bedrock, could be coeval to the glaciogenics found in 'nearby' Niger and potentially record the expansion of the ice masses and the associated eustatic sea level fall. Such deposits have never been investigated under the light of up-to-date glacial sedimentology; they may however be crucial for the characterisation of the onset dynamic of this protracted icehouse.

**Specific objectives and deliverables:** The research proposed here aims at characterizing the sedimentary archives of the onset of the LPIA by conducting a fieldwork-based, multidisciplinary (sedimentology, stratigraphy, paleontology, provenance) study on both the Ourika (High Atlas) and Ouarkiz (southern Anti Atlas) regions where the Viséan clastics form seismic-scale cliff sections. I therefore plan to combine (1) a detailed sedimentological analysis to reconstruct depositional environments, and determine ice margin dynamics and their northward extent, (2) a sediment provenance analysis (detrital zircons), to locate source areas of glaciogenic supplies and thus ice flow directions, and (3) a sequence stratigraphy study to unravel associated eustatic sea level changes and sediment supply trends. Age control will be provided by the rich fossiliferous content (corals, foram., algae), and if ash layers are encountered, U-Pb dating of juvenile zircons will be performed.

**Proposed work plan:** Before fieldwork, a phase of data collection (geol. maps, literatures, satellite imagery) will be performed to target key sites. Using satellite images, mapping of marker beds will serve to foresee large-scale stratal architecture. The second phase will be a 25-days fieldwork (10 days on each site, plus transfer days) in fall 2021 or postponed to spring 2022 depending on sanitary conditions (winter/summer conditions must be avoided in the High/Anti Atlas). Composite sedimentological logs (scale 1/100) will be established and geological mapping performed. The stratigraphic correlation over long distances (tens of km) of these logs, based on their stacking patterns, allied with with airborne- (drone, already acquired) and satellite-imagery will permit to characterize the stratal architecture and regressive-transgressive patterns later used to infer RSL changes. Samples will be collected for dating, palaeontology and provenance studies. The applicant has fieldwork skills (many campaigns in northern and southern Africa; postdoc in South Africa) and an extensive knowledge of glaciogenic sediments. Fieldwork will be conducted in collaboration with Pr Lahcen Kabiri (Univ. Moulay Ismael, Morocco) and Dr Alexis Nutz (Aix-Marseille, France), who have extensive experience with Moroccan geology, but for whom no funding is demanded here (supported by own funds). The third phase is sample processing and analytical work (U-Pb on detrital and juvenile zircons, necessary equipment housed in Rennes Univ lab), leading to data compilation (sed log and map drawing) and article writing.

**Proposed expenditure, including details of any other sources of funding:** No other source of funding is available for the proposed project. The following expenditure encompasses (1) **flight and train tickets £346** (round trip Rennes-Paris-Marrakech, €150 & €240 with *Royal Air Maroc*), (2) **car rental: £1.325** (£53/day, 4-wheels drive necessary for desert condition with SIXT, cheapest option) and **petrol: £200**; (3) **accommodation: £825** (25 nights half-board, 400 dirhams (~£33)/night, cheapest hotels are avoided for sanitary and safety reasons); and (4) **subsistence: £300** (£12/day) for the applicant. **TOTAL: £2.996**