

The Andrew Whitham CASP Fieldwork Award - 2020-21 Winner

Applicant: Warren, Reybi

Project title: Rift Initiation, Structurally Controlled Topography, and Long-Term Slip Rates during Basement Extension: A Case Study from Windhoek Graben, Namibia

Scientific question and rationale:

How rapidly faults propagate and establish major rift segments, and how that strain rate is reflected in deformation styles, rift topography and drainage basin evolution during the early stages of continental rifting are unclear. Yet it is in the early stage of rifting that the keys to rift propagation and continental break-up lie. To better articulate these early rift processes, their geomorphological impact and their implications for the process of continental break-up, I am investigating the rift geology at the propagating tip of Africa's South-western Rift in Namibia. This investigation will comprise field based basin analysis of the Windhoek Graben complimented by lab based studies to constrain deformation rates and uplift. The results will then be compared with more quaternary rifts to develop a model of early stage rift propagation and associated topographic and drainage evolution.

Specific objectives and deliverables:

This research aims to investigate how structural deformation and topography are inter-related during early stages of continental rifting, and how the topography can be used to measure total slip on the major faults, and from knowledge of rift onset timing, the slip rates. To address these questions, the project will be divided into two sections.

First, the study will be focused on Windhoek Graben (WG) in Namibia to understand its deformation styles, slip rates, and mechanisms driving its formation. Second, I will produce a global database of Cenozoic continental rifts which are found in different tectonic habitats (i.e., East African Rift System (EARS), Gulf of Corinth, Great Basin, Dead Sea, and Rhine Graben). This database will compile information on the contrasting deformation rates and styles from published literature and open subsurface data in these different continental rift types. The global database will be used to provide a framework comparison for the analysis made on the Windhoek Graben. Ultimately, the outcomes of the research are expected to provide a comprehensive model of early stage rift basin evolution, which are important to assist in hydrocarbon exploration and production strategy in rift basins.

Proposed work plan:

Windhoek Graben (WG), an N-S Cenozoic rift, is located in the centre of Namibia, in the Windhoek Highlands. Regional elevation is c.1700 m here but has been locally perturbed by the rifting. The WG may be the southwestern limit of the EARS, which is known to extend from Zambia into Botswana. I will initially analyse the rift-related topography using satellite mapping techniques, prior to undertaking the field campaign.

Fieldwork plan, a 14 days long (excluding UK – Namibia travel days), is divided into two parts:

- ▣ First, 11 days are spent to describe the rift-related topography, erosion patterns, fault zones topology, and kinematic indicators (slickensides, veins, etc.) in both rift margin and graben areas. First 5 days spend at East border faults of WG (from Avis to Von Bach dams). Following 3 days spend at the northern part of the graben where Okahandja lineament can be found. Last 3 days spend at the West border faults of WG (from Krumhuk to Gross Barmen)
- ▣ Second, 3 days are spent on describing the young intrusion and pre-fabric structures of the WG. First 1 day spend at Aris region to the south of WG (young intrusions). Following 2 days spend at the southwestern part of Auas Mountain to observe the structural styles of the early Damara sequences and its relationship with Cenozoic rift.

During the trip, produce outcrop sketches, take high-resolution photos, and collect samples for further analysis.

Groundwater boreholes, earthquake distribution patterns, gravity, and fault zones dating will then be integrated with field data to synthesis the whole observation, using GIS platform.

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

| Items | Volume | Price per unit | Total Price |
|--------------------------------|---------|----------------|-------------|
| Return flight | 1 unit | £763 / unit | : £763 |
| Per diem (accommodation, food) | 14 days | £100 / day | : £1400 |
| Car rental + fuel | 14 days | £75 / day | : £1050 |
| Drone rental | 14 days | £19 / day | : £266 |

Grand Total : **£3479**

(Shortfall of £479 and the cost of lab analysis will be covered by my Ph.D. RTSG)