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NERC SCIENCE OF THE ENVIRONMENT

Landscape evolution across climate gradients in tectonically active settings (Ref IAP-17-20)

University of Glasgow, School of Geographical and Earth Sciences

In partnership with Durham University, Earth Sciences

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Key Words	1. **Geomorphology** 2. **Landscape Evolution** 3. **Climate** 4. **Tectonics**

Overview

The Earth's topography reflects competition between tectonic processes we act to generate relief and surface processes redistributing mass and tending to reduce relief. Regional geomorphology and the landscape's response to tectonic forcing are sensitive tracers of the processes involved (Hurst et al., 2013) with the potential to aid understanding of long-term continental tectonics. However surface processes are modulated by climate, with temperature and precipitation controlling the efficacy and distribution of erosion processes (Perron, 2017). Study of the interaction between tectonic and climatic processes in dictating the style and pace of landscape evolution are vital if topography is to continue to be used as a reliable indicator of tectonic history (Allen et al., 2017).

The margins of continental-scale mountain belts are settings with substantial gradients in rates of tectonic processes but are also often subjected to significant climate gradients, given changes in surface elevations and interactions between topography and atmospheric circulation (e.g. declining temperature with altitude, orographic rainfall). This project will combine topographic analysis and geochronological techniques to analyse climatic controls on surface processes across an actively uplifting mountain belt (the Qilian Shan, NW China) in order to tease apart the relative importance of climatic and tectonic processes in governing landscape form.

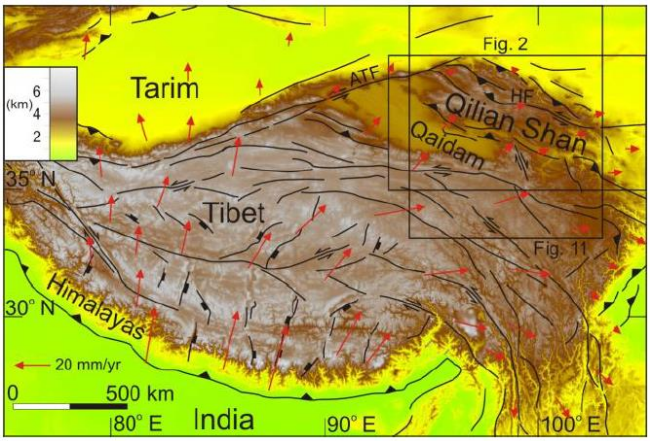

Figure 1: Topography of the tectonically-active Qilian Shan on the NE margin of the Tibetan Plateau. Red arrows show GPS surface velocities (Allen et al., 2017).

Methodology

The acquisition of high-resolution digital elevation models (DEMs) now provides topographic data

globally at resolutions suitable for quantitative interrogation of surface form (30 m SRTM/ASTER GDAEM; 12 m TanDEM-X). Coupled with modern satellite-derived climate data, GPS data revealing modern rates of tectonic processes, and cosmogenic isotope analyses to reveal landscape-wide erosion rates, this PhD will investigate the climatic control on landscape morphology.

The student will focus on the Qilian Shan mountain range on the NE margin of the Tibetan Plateau (Figure 1). Landscape scale erosion rates will be quantified using cosmogenic isotopes, which can be correlated to topographic metrics such as channel steepness and hillslope gradients (Figure 2) across the climate zones. These can then be assessed in relation to tectonic forcing.

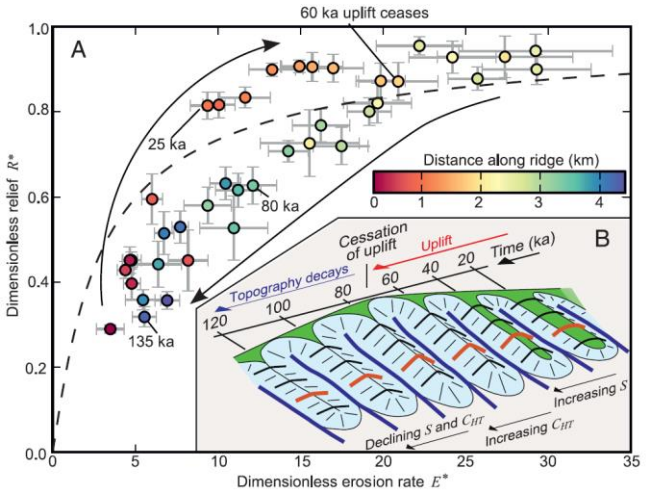

Figure 2: Relief and erosion rate relationships adjacent to a segment of the San Andreas Fault, California. From Hurst et al. (2013).

The student will emerge from the PhD process with skills making them highly suited to a career in the Environmental Sciences, including the ability to manipulate and interpret large datasets, and conduct numerical modelling. There are obvious career paths in natural hazards and land management, for example, as well as research.

Timeline

Year 1 (October 2018 start): Initial training in techniques, processes and research methods. Development and selection of initial scientific problem informed by reviewing existing literature in tectonic and climatic geomorphology as training in the preparation of a research paper. Fieldwork to collect landscape data and sampling for cosmogenic isotope analysis.

Years 2 and 3: Student trained to conduct sample preparation for cosmogenic isotope analysis. Data analysis and comparison between topographic, tectonic and climatic datasets. Development of numerical modelling of landscape evolution. Presentation of findings at national and international conferences.

Year 4 (six months): Final interpretation of research findings; write-up of thesis and research papers.

Training & Skills

The student will be trained by leading experts in tectonics and geomorphology, and in particular novel approaches to quantifying and interpreting regional patterns in topographic data. The student will receive training in customising and automating GIS and appropriate computer programming languages (e.g. Python, C++) required to develop and deploy algorithms to perform topographic analyses and interpret results. The student will receive training in the application of cosmogenic isotopes to quantify landscape scale erosion rates (Mudd et al., 2016) in partnership with the UK's leading facility for cosmogenic isotope geochronology, SUERC.

References & Further Reading

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Further Information

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