

Processes of and controls on erosion in bedrock rivers

Project reference IAP/13/35. Please quote this when applying.

Durham University, Department of Geography; In partnership with University of Glasgow, Geographical & Earth Sciences, British Geological Survey

Supervisory Team

- **Dr Rebecca Hodge, Durham University**
<https://www.dur.ac.uk/geography/staff/geogstaffhidden/?id=9857>
- **Prof Trevor Hoey, University of Glasgow**
<http://www.gla.ac.uk/schools/ges/staff/trevorhoey/>
- **Dr Nick Rosser**
<https://www.dur.ac.uk/geography/staff/geogstaffhidden/?id=976>
- **Dr Katie Whitbread**
<http://www.bgs.ac.uk/staff/profiles/6621.html>

Key Words

1. **Bedrock river**
2. **Erosion**
3. **Field and laboratory experiments**

Overview

Bedrock rivers erode through the action of multiple processes (abrasion, plucking, solution, cavitation), shaping the channel morphology and ultimately affecting long-term landscape evolution. However, current understanding of the controls on and relative importance of the different processes is limited. Recent research has demonstrated that erosion is often controlled by sediment transport and in some cases is contingent upon transport, suggesting that understanding incision also requires consideration of sediment dynamics. The role of sediment is complicated by the contrasting roles that it can play in protecting and eroding bedrock. Furthermore, although incision rates broadly scale with rock strength, it is unclear as to which components of rock strength are the dominant controls.

This project aims to quantify the controls on and relative importance of bedrock incision processes in semi-alluvial rivers. This will be achieved through a focus on both the driving forces of the flow and sediment transport, and the strength and integrity of the bedrock. The main component of the research will be a field investigation into channel properties and

erosive processes, which will be complemented by numerical modelling and laboratory experiments.



Figure 1: A range of erosive morphologies present in Trout Beck, North Pennines.

Methodology

A number of field sites will be selected to cover a range of geology, channel morphology, flow conditions and sediment fluxes. These sites will include Trout Beck in the North Pennines, where monitoring is already on-going. At each field location, rock properties (strength, structure, degree of weathering) will be quantified using a suite of field and laboratory tests, uniquely available at Durham University. Channel and bedrock morphology and the extent of sediment cover will be recorded using Terrestrial Laser Scanning (TLS). A selection of the field sites will

be monitored for flow, sediment flux, micro-seismics and bedrock incision over the course of the project.

Analysis of the data will include 1) identifying topographic signatures of different erosion processes, their spatial distribution and bedrock structure; 2) correlations between bedrock properties and extent of erosion; 3) analysis of seismic data to quantify the magnitude and temporal signal of sediment transport and erosion processes. These analyses will be integrated to produce a model of the processes and controls on bedrock incision. Further analytical approaches could include 1) the use of flow modelling to predict spatial distributions of flow properties and sediment transport, and 2) laboratory experiments designed to aid interpretation of the seismic data.

Timeline

Year 1: Identification of field localities, set-up and maintenance of field monitoring. On-going analysis of field data. Laboratory analysis to quantify rock properties.

Year 2: Continuation of field monitoring and on-going data analysis. Laboratory experiments to quantify seismic components of bedrock erosion processes.

Year 3: Complete field monitoring and laboratory experiments. Analysis of combined dataset, and production of integrated model.

Year 4: Finalise papers for publication and prepare thesis.

Training & Skills

The student will be based in the Department of Geography and will receive training within the departmental post-graduate programme. Specialist training in the use of field and laboratory techniques (including Terrestrial Laser Scanning, field monitoring, and rock strength laboratory tests) will be provided by the supervisors and will be supported by specialist technical staff. Training in statistics and numerical modelling will also be available if appropriate. Training in all of these areas will primarily be provided by Durham University, although there is the potential for additional training to be taken at the University of Glasgow. In Durham, the student will be a member of the Catchments and Rivers research cluster and will have the opportunity to engage with the wide range of Physical Geography research activities.

References & Further Reading

Hodge, RA, Hoey, TB and Sklar, LS 2011 Bed load transport in bedrock rivers: The role of sediment cover in grain entrainment, translation, and deposition, *Journal of Geophysical Research-Earth Surface*, 116, F04028, doi:10.1029/2011JF002032.

Norman, EC, Rosser, NJ, Brain, MJ, Petley, DN and Lim, M 2014 Coastal cliff-top ground motions as proxies for environmental processes, *Journal of Geophysical Research-Oceans*.

Sklar, LS and Dietrich, WE 2004 A mechanistic model for river incision into bedrock by saltating bed load, *Water Resources Research*, 40, W06301, doi:10.1029/2003WR002496.

Whipple KX 2004 Bedrock rivers and the geomorphology of active orogens, *Annual Review of Earth and Planetary Sciences*, doi:10.1146/annurev.earth.32.101802.120356.

Further Information

Enquiries can be addressed to any of the supervisors:
Rebecca.Hodge@durham.ac.uk
Trevor.Hoey@glasgow.ac.uk
N.J.Rosser@durham.ac.uk
kwhi@bgs.ac.uk