**LAURA ANNE QUICK**
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## HIGHER EDUCATION AND RELEVANT EXPERIENCE

**Education:**

**Sep '2016 – Present:** University of Edinburgh, PhD (NERC funded E3 DTP)

**Sep '11 – Jun '14:** University of Liverpool, BSc Geology and Physical Geography (1st class honours)

**Dissertation:** Time scales of geomorphic change at Falljokull glacier (awarded 81%)

**Awards:** University of Liverpool school prize for overall BSc excellence

**Work experience:**

**Jul '14 – Aug'16:** Robertson CGG, Carbonate sedimentology/Geoscientist (Oil and Gas)

**Duties:** Reservoir quality analysis of Middle Eastern carbonate and clastic reservoirs. Included: thin section description, core logging, (CL, SEM, MICP, FI analysis), sequence stratigraphic interpretation, wire line log interpretation, report writing, formation of well correlations and depositional models

**Research Specific Training at the University of Edinburgh:**

During October 2016 I was a field assistant in Nepal for an ongoing project. During the field campaign I received sedimentological training in the form of outcrop description (grain size, contacts etc.) and lithology identification. I've also received training on how to use UAVs, and the Acoustic Doppler Current Profiler (ADCP). Ongoing training includes LSD TopoTools and various undergraduate degree modules (e.g. Earth modelling and predictions). I am also applying to attend the Summer Institute on Earth-Surface Dynamics (US) in 2017.

**Funding**

Home department: Research training support grant of £1150 per year for training and conference attendance.

NERC E3 DTP: £4050 for field work.

## PRESENT AND PROPOSED RESEARCH

**Title:** Sediment dynamics of the Himalayan foreland basin from the Neogene to present day

**Supervisors:** Prof Hugh Sinclair and Dr Mikael Attal

**Introduction of the PhD project and proposed work.** Present day fluvial systems, outcropping units, and subsurface data will be utilised with numerical modelling to explore and quantify the sediment dynamics of the Himalayan foreland basin from the Neogene to present day. The main themes are centred around the conglomerates of the Upper Siwaliks and the gravels trapped up stream of the gravel sand transition (GST) in the modern river systems across the Indo-Gangetic plain.

**Theme 1: Has the gravel-sand transition remained stable through geological time?** The GST is a geomorphic feature observed within the major Himalayan river systems and is observed in both foothill and mountain fed rivers (Dubille and Lave, 2015; Dingle et al., 2016). It is characterised by an abrupt change in grain size from gravel to sand (creating a 'grain size gap') and is often associated with a break in slope, suggesting that in recent times it has been a relatively stable feature (Dingle et al., 2016).

In Nepal the GST in western and central mountain-fed river systems progrades to approximately 30-45km downstream of the mountain front, whereas in the east the GST progrades to approximately 20km downstream of the mountain front; thought to be caused by differential subsidence across the foreland basin (Figure 2)(Dingle et al., 2016). However, new subsurface data (ground water well data & drill cores) from the Kosi mega fan (East Nepal) has discovered gravel existing at least 50km downstream from the current location of the GST, suggesting that it may have occupied a different location much further downstream during the Quaternary period (Figure 1) (Sinha et al., 2014). This new evidence suggests that the GST may not have been stable in recent geological time. Comparing the Quaternary data with older Siwalik successions would enable us to find out whether movement (progradation and retrogradation) of the GST is a frequent occurrence (Figure1 & 4). If so, what caused the movement and how likely is it to happen again? Will predicted climate change (intensification of the Indian summer monsoon, glacial outburst floods etc.) impact the movement of the GST, triggering progradation downstream? By comparing present day river systems, Quaternary deposits, and ancient outcrops, the stability of the GST will be better understood.

**Theme 2: Are modern river systems of the Indo-Gangetic Plain effective analogues for the ancient Siwalik deposits?** The modern Himalayan rivers are thought to be direct analogues for the ancient Siwalik deposits (Figure 3). Dubille and Lave (2015) suggest that the abrupt change in grain size (from Middle to Upper Siwaliks) emerged from a steady facies migration over millions of years in response to continuous orogen construction. This suggests that the GST observed within the modern Himalayan rivers is comparable to the Middle and Upper Siwaliks in terms of depositional regime. Szulc et al (2006) also identified a sustained southward flow in the ancient Siwalik successions, suggesting that the palaeorivers (like the present-day systems) dominantly flowed transverse to the mountain front.

However, there is little understanding of what type of event(s) is preserved in the Siwalik sedimentary succession. Through geological time the Himalayan foreland has been subjected to the annual Indian summer monsoon and frequent earthquakes, causing widespread flooding throughout the region. These events are likely to affect the preservation of other events in the geological record (e.g. large flood event vs. background sedimentation). Studying the Siwalik outcrops will reveal how sensitive these systems are to future climate change.

**Theme 3: Is it possible quantify sediment recycling within the Himalayan foreland basin?** Currently the Siwalik successions are eroded and incised by a dense fluvial network of foothill-fed rivers. These rivers recycle the Upper Siwalik conglomerates producing a more mineralogically mature gravel (i.e. increased quartz lithics) with increased fission-track thermochronology lag times (Dubille and Lave, 2015; Beek, et al., 2006). The amount of recycling, however, has not been quantified. We would expect that older thrusted Siwalik successions would have a smaller percentage of quartz pebbles compared to younger successions. This data will feed into the overall theme of the GST and how it has changed through geological time.

**Significance:** The GST is still a poorly understood geomorphic feature, yet surprisingly the location of the GST along a river's course can greatly influence flooding downstream. It is predicted that future climate change will impact Nepal's glaciers, causing down-wasting, retreat, and potential intensification of Indian summer monsoons. This will cause large amounts of fine-grained sediment to be released into the river systems, which will then be deposited in front of the GST, possibly causing aggradation within the river channels and therefore wide spread flooding. Knowing how stable the GST is throughout geological time and potentially in the future is therefore a research priority.

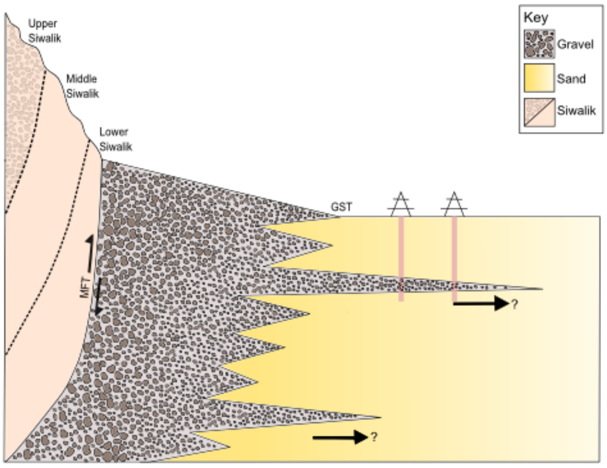


**Figure 1**

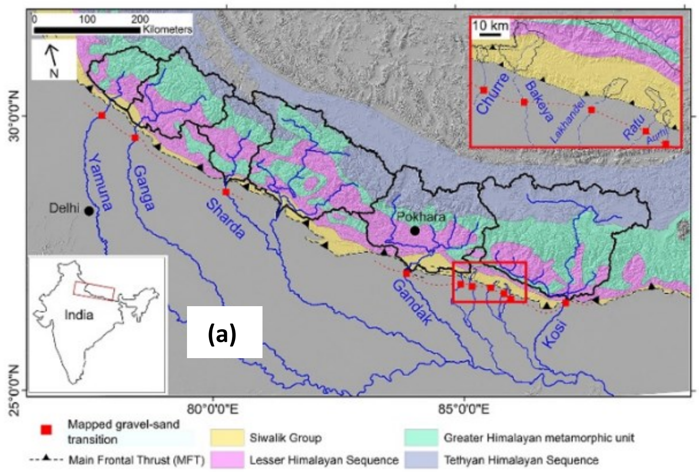


**Figure 2**

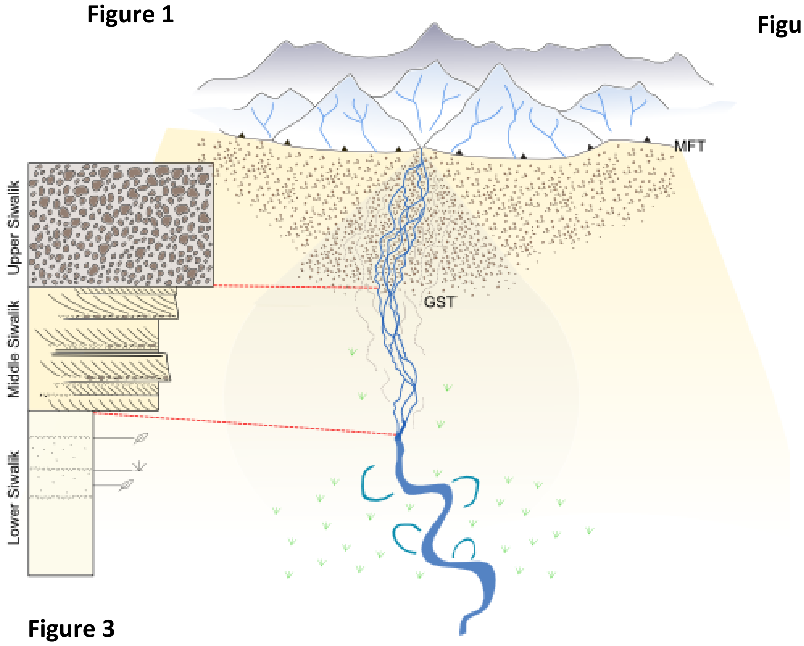


**Figure 3**

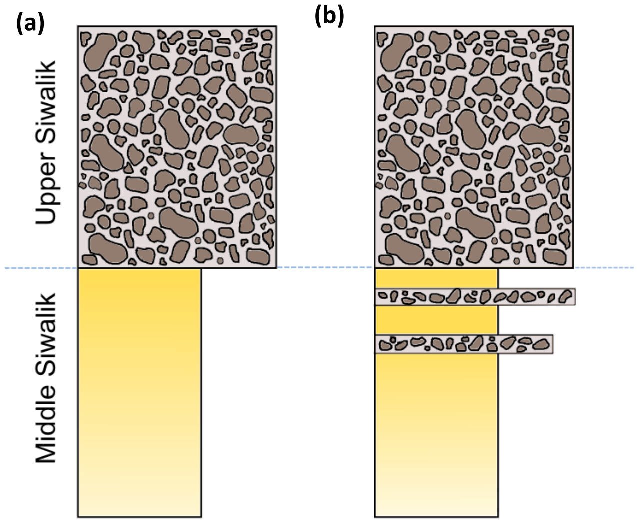


**Figure 4**

**Figure 1.** Theoretical cross section through quaternary sediments of the Indo-Gangetic plain. Illustrates the GST progradating into the basin, possibly after an extreme event (climatic or tectonic). **Figure 2.** Map displaying GST locations along strike of the Himalayan Mountain front (Dingle et al., In press). **Figure 3.** Diagram illustrating how the Siwalik sedimentary record relates to the modern fluvial systems of the Indo-Gangetic plain. **Figure 4.** Theoretical Siwalik sedimentary logs displaying GST contacts. Log (a) represents a sharp contact with no conglomerate facies in the middle Siwalik. Log (b) displays conglomerate facies beds within the middle Siwalik, perhaps suggesting that the GST was previously mobile enabling progradation in the basin.

## AMOUNT REQUESTED AND BREAKDOWN OF EXPENSES

I am requesting a grant of £900 from the Gill Harwood Memorial Fund to cover costs of a second field season in Nepal.

My first field season (March – April 2017) will cover the 'modern fluvial' system aspect of my project and will be based on the Karnali river in Western Nepal.

A second trip is needed to study the Siwalik outcrops in further detail. New localities in the Nepalese foothills have been identified by colleagues in Nepal which provide a new opportunity to document the GST as recorded by the Siwalik succession; this prospect underpins this application for field work.

Good Siwalik outcrops are typically located in isolated, rural areas, so a second trip will allow adequate time to travel to these areas to collect data and fully concentrate on the ancient aspect of the project. The money will go towards a return flight from Edinburgh to Kathmandu during October 2017. This will help spread the cost of the field trip, allowing a field assistant to come along for both safety and efficient data collection.

The field campaign will be ~21 days long.

a) Return flight from Edinburgh to Kathmandu October 2017: Average return flight cost per person is £900 (Qatar Airways)

Total: £900

## RELEVANT REFERENCES


- Beek, P., Robert, X., Mugnier, J., Bernet, M., Huyghe, P., and Labrin, E. (2006). Late Miocene - Recent exhumation of central Himalaya and recycling in the foreland basin assessed by apatite fission-track thermochronology of Siwalik sediments, Nepal. *Basin Research*. 18, 413-434.
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- Dingle, E.H., Sinclair, H.D., Attal, M., Milodowski, D.T., Singh, V. (2016). Subsidence control on river morphology and grain size in the Ganga Plain. *American journal of science*. 316, 778-812.
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