Reconstructing sediment transport rates in the rivers of the Great Plains using cosmogenic nuclides

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**Background** – Quantifying sediment transport rates and the duration of depositional hiatuses from the stratigraphic record is a key challenge in earth history. Identification of key condensation surfaces is critical for the development of reservoir models for hydrocarbon extraction or water extraction from aquifers. The reconstruction of sediment transport rates relies on a number of proxies such as detrital thermochronology. Traditionally, stratigraphic correlations are based primarily on sequence interpretations supported by bio- and chemostratigraphy. However, a team at the University of Edinburgh and the Scottish Universities Environment Research Centre (SUERC) have developed a new technique that has the potential to revolutionise the quantification of transport rates and the identification of key surfaces. The isotope $^{21}$Ne measured in quartz records the duration of exposure of the quartz grain before being buried by further sediment accumulation (Libarkin et al., 2002; Codilean et al., 2010). The analysis of sandstones enables rates of sediment accumulation and stratigraphic condensation to be identified. This has major potential for identifying intraformational unconformities in continental successions such as fluvial and desert sand systems, and for quantifying the durations of sediment transport from source to sink.

**Aims of project** – This project will apply the $^{21}$Ne methodology to quantifying transport rates and condensation intervals in Tertiary successions of the Great Plains, western US where preliminary analysis by the supervisory team has already been done in a pilot grant (McCann et al., 2013; Duller et al., 2012). The analysis will determine where and for how long, sediment is stored in floodplains and small alluvial basins on its path from the Medicine Bow Mountains of Wyoming to the Great Plains of Nebraska.

**Methodology** – For each sample site, sands and quartzite pebbles will be collected. In the Ogallala Formation, samples are already available that were collected from the base of fluvial channels of Miocene, Pliocene, Pleistocene and modern channels. Initial analyses indicate that some of the quartzite pebbles have been exposed for approximately 7 Myrs, indicating very slow sedimentation rates and long surface residence times. Quartz rich material will be sampled from shielded localities, minimising modern exposure to cosmogenic rays. The quartz needs to be prepared by applying hydrofluoric acid to leach the outermost 40 $\mu$m, etching away any impacted nucleogenic Ne. The quartz grains are then crushed and heated in the furnace of the noble gas mass spectrometer at the SUERC facility in East Kilbride under the supervision of Prof. F. Stuart. Cosmogenic concentrations are derived from measuring $^{21}$Ne and $^{22}$Ne in the sample and in air, and applying a set of equations to derive the nucleogenic component (Libarkin et al., 2002). Alongside the sampling for cosmogenic nuclides, each locality will be analysed sedimentologically by generating detailed sedimentary logs, and analysing the regional stratigraphic context of each sample site.

**Student Training** The student will be integrated into a large research team at the University of Edinburgh analysing surface processes and sedimentology. They will also become a part of the School of GeoSciences Postgraduate School, which undertakes generic training in
transferable skills associated with research. A comprehensive training programme will be provided comprising both specialist scientific training and generic transferable and professional skills. A 12 month and 24 month progress report are required to be passed in order to proceed. In relation to the topic, the student will be trained in detail sedimentary logging and stratigraphic correlation. In the laboratory, they will be trained in the chemistry used to generate aliquots, and in running the noble gas spectrometer at SUERC. This training will provide them with an excellent skill set for a future career in research or applied geology, and with unique knowledge of a new technique which they will be responsible for advancing.

**Requirements:** A geologist/geographer with experience in sedimentology and a keen interest in applying isotopic techniques to quantifying transport processes. A willingness to consider the application of theoretical models to understanding processes is beneficial.

**References:**

