Geophysical Research Abstracts
Vol. 20, EGU2018-10364, 2018
EGU General Assembly 2018

Sedimentological evidence for large, low-sloping Precambrian rivers and implications for continental-scale drainage of Rodinia

Alex Whittaker (1) and Vamsi Ganti (2,1)

(1) Imperial College London, Department of Earth Science and Engineering, London, United Kingdom (a.whittaker@imperial.ac.uk), (2) University of California Santa Barbara, Department of Earth Science, USA

The extent to which depositional stratigraphy records environmental boundary conditions is a major research challenge, particularly so for ancient deposits where palaeo-environmental circumstances were completely unlike today, and where rare sedimentary exposures provide our only snapshot of mass transfer across the Earth's surface in deep time. The Torridonian super-group of NW Scotland comprises an exceptionally complete middle to upper Proterozoic succession of clastic fluvial deposits, largely unmetamorphosed and undeformed, which rests uncomformably on Archaean to Lower Proterozoic gneissic basement. The $>$ 6 km succession, dominated by the spectacular ubiquity of trough-cross bedded sands in its upper to middle parts, provides a highly significant window into the dynamics of large-scale, pre-vegetation sediment routing systems in the Precambrian world. Here we exploit this archive to quantify and refine the palaeo-hydrology and likely dynamics of this system using field observations, theory and empirical constraints.

In the field, we measured the thicknesses, palaeo-flow direction and grain size of 1724 individual cross-sets in stratigraphically well-constrained sections of the Applecross and Aultbea Formations of the Torridon Group. We show that median and 95th percentile thicknesses increase in a statistically significant way from the lower Applecross to the upper Applecross and the overlying Aultbea Formation, where maximum cross-set thicknesses are $>$1 m. Using this data, we reconstruct bedform heights for the dunes that existed at the bottom of this Proterozoic fluvial system, and thus quantify palaeo-flow depths for our sample sites. Our data show that flow depths increased from 2-5 m in the lower part of the Applecross formation to 8-16 m in the Aultbea formation, consistent with large river systems. We combine these values with our grain size data to estimate channel palaeoslopes, channel widths and flow discharges, and we estimate unit sediment discharges based on known constraints on dune migration rates. Out data are consistent with reach slopes of ca. 10^{-4}, and bankfull discharges which are ca. 2-5 x 10^4 m^3s^{-1} in the upper part of the succession. These values are the same order of magnitude as the largest river systems today (e.g., Mississippi, Amazon), and suggest that the upper part of the sequence records fluvial deposition from a continental-scale drainage that tapped the supercontinent of Rodinia. Our analyses paints a morphodynamic picture of these Precambrian river systems that is not very distinct from the modern river systems, and sheds new light into the inner workings of fluvial systems that evolved in the absence of vegetative cover.