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Source to Sink Analysis of the Sarah Formation, Late Ordovician – Early Silurian, Northwest Saudi Arabia

Nikolas Michael[1], Yin Xu[1], Christopher Ayadiuno[1], Shaun Hayton[1], Christos Saragiotis[1], Eduardo Garzanti[2], Pieter Vermeesch[3]

[1]NEXPEC ARC, Saudi Aramco, Abqaiq, SAUDI ARABIA
[2]Università di Milano-Bicocca, Milan, ITALY
[3]UCL, London, UNITED KINGDOM

ABSTRACT

A key question that sedimentologists and stratigraphers face is, what controls sedimentary facies and grain-size trends in depositional basins? Crucial parameters that control grain-size trends are sediment discharge into the basin, characteristic grain size mix of the supply and spatial distribution of accommodation. In this paper, we present an outcrop case study of the late Ordovician to the early Silurian Sarah Formation, in Saudi Arabia, that represents the proximal part of a glacigenic sedimentary system or a pro-glacial outwash fan where these parameters are quantified.

The Sarah Formation is a glacigenic sedimentary unit deposited along the Palaeo-Gondwana Margin as part of an extensive, but discontinuous belt of outcrop deposits that extend from Saudi Arabia to westernmost North Africa. This is a 600 km long sedimentary system that stretches from the northern outcrop belt of Saudi Arabia to at least the borders with Iraq. This source to sink system spans a great range of depositional environments from proximal coarse sand to pebbly pro-glacial outwash fan deposits to distal diamictites and offshore fine grained deep marine deposits. The proximal part of this system is preserved along an elongated and complex network of Palaeo-valley fill deposits. It is represented by coarse to medium sand and pebbly deposits of around 250 m thick deposited in a short time span of around 1 Myr (mean sedimentation rate of 0.25 mm/yr). We attribute this high sand fraction at outcrop to the high sediment load and bypass during the interglacial periods. We apply a source to sink approach to calculate the volume of bypassed sediment from specific regions to deposit and preserve the high abundance of coarse grained sediment. We consider controls on the sedimentary architecture with respect to observed grain sizes and we compare these trends with other sedimentary units in the Palaeozoic of Saudi Arabia.

We present a model of the evolution of this sedimentary system based on sedimentological and provenance work that include petrography, heavy mineral analysis and zircon U/Pb geochronology both in outcrop and core from wells. In addition to provenance, we try to map out sedimentary fairways from regional seismic lines. In this study, we teleconnect, reconstruct and calculate sediment budgets for the sedimentary system from outcrop to the subsurface.