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Can grain size, sorting and grading patterns be used to identify supercritical bedforms in cores?

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Reservoir characterisation is often based on integrated studies of few to several tools such as seismic profiles, wireline logs, borehole image, core observations and petrography. Typically these tools either provide information about the regional architecture of the reservoir or data source is restricted to a single point such as to core(s) or a well bore(s). This relatively large gap in scale of various data sources is likely to result in missing key information for reservoir characterisation, such as bedforms. Outcrop studies, where available, provide very valuable data; and upscaling/downscaling of the information obtained from outcrops are likely to fill the gap between the scales of core/well and seismic profile.

Recent flume experiments and submarine observations have increased our knowledge about flow dynamics and sediment deposition processes. One of the outcomes of these studies is the 'cyclic steps' which are recognised as a new bedform category, developing at maximum Froude numbers. Typically, they form aggredational packages composed of mainly structureless sandstones with undulating geometries. In one aggredational bedset, various bed-scale fabrics are likely to occur in different parts of the deposits due to the lateral change in flow characteristics and associated sediment transport processes. Cyclic steps are typically in a sub-seismic scale, yet they are very difficult to recognise in core. Better understanding of stacking pattern of bed-scale properties is the key for the recognition of cyclic steps in cores, however, this may be difficult due to the restricted core size.

In this study, we aimed to form a link from outcrop scale properties of cyclic steps to core and micro-scale features (typically grain size, sorting and grading) in order to be make an attempt to use petrography as a tool for recognition of the cyclic steps in core. For this case study, outcrops of Late Carboniferous sandstones of the Lower Kinderscout Grit, that were deposited in fluvio-deltaic to shallow-marine setting has been selected. The outcrop study was carried out in the Derby Delph Quarry (near the Booth Wood Reservoir, Rishworth, West Yorkshire) which comprises sets of large-scale (10s of meters in wavelength), undulating sandstone beds. These sandstones are typically massive, poorly to very poorly sorted and predominantly ungraded. In the main quarry wall, four aggredational bedsets, separated by distinct erosive surfaces are recognised. Preliminary petrographical studies on various transects throughout the bedsets of Derby Delph Quarry yielded promising result on possibility of using petrography as a tool for cyclic step recognition in cores.