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Depositional and diagenetic processes involved in the development of mudstone successions: a multi proxy study of the Lower Jurassic Cleveland Basin (The North Yorkshire coast, England).

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Mud and mudstones are the most abundant (>60%) sediment and sedimentary rock type preserved at and close to the surface of the Earth. They have formed commonly throughout the Phanerozoic and are found in many environments including present-day soils, lake basins, continental shelves, and ocean basins. Mudstones deposited in ancient shelf seas are particularly important as they are very common and significant components of many petroleum systems as sources and seals. In spite of their importance the variability that they exhibit is usually not incorporated into basin-scale facies models as they are assumed to contain little information that is useful in predicting the distribution of reservoir facies. The fundamental mechanisms (physical, chemical and biological) that control the origin of fine-grained sediments in ancient shelf seas is less studied in comparison with other sediments types (e.g. limestones and sandstones). The Middle Jurassic aged succession from the Staithes Sandstone through to the Mulgrave Shale Member (Jet Rock), which is largely continuous and very well-exposed in two locations in the Cleveland Basin, North Yorkshire Coast, England is an ideal natural laboratory to investigate how marginal marine processes evolve into deep marine processes.

In the literature, the fundamental controls on lithofacies variability in mudstone-dominated successions preserved in distal shelf environments have been mainly interpreted in terms of varying bottom water oxygen concentrations, primary production and suspension settling. In proximal muddy environments researchers have broadly interpreted lithofacies variability in terms of storm events, tidal currents, etc. These are very different mechanisms. Moreover, these rocks are rarely studied as a whole system; the basinal mudstones are rarely connected up-dip to muddy sandstones and mudstones deposited in the offshore transition and offshore zones.

In order to determine the processes responsible for the formation of the individual beds samples were collected from both the proximal sandstone and more basinal mudstone lithofacies. The fabrics present and mineralogy of these materials were visualised by manufacturing unusually large thin sections and imaging the textures present using optical and electron optical methods.

A wide diversity of lithofacies present has been found in this section including (intensely bioturbated, silt-bearing, organic matter poor muddy sandstone; bioturbated, clay sized-bearing, silt-rich mudstone; relic, thin-bedded, silt-bearing clay sized-rich mudstone; bioturbated, silt-bearing carbonate cement-rich mudstone; and laminated, clay sized and silt bearing, organic matter rich mudstone). Facies variability in this succession was controlled by the complex interplay between clastic sediment input, physical sediment dispersal, primary production, bioturbation and rates of sedimentation.