

## **Insights into Sedimentological and Diagenetic Processes within a Major Shale Gas Exploration Play: The Mississippian Bowland Shale, UK.**

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### **ABSTRACT**

The Carboniferous Bowland Shale Formation, a calcareous organic-rich mudstone of Mississippian (335Ma to 313Ma) age, is the major exploration target for shale gas in the UK, and is believed to share many characteristics with the proven Barnett and Utica Shales of North America. Sedimentological and diagenetic variability within the succession will likely play a major role in controlling reservoir quality but very limited knowledge of this is currently available, leading to significant uncertainty. Here we document the scale and nature of microfacies compositional and diagenetic variability within a marginal to basinal mudstone succession from the Bowland Basin (UK), and develop models to explain the variations observed.

Detailed sedimentary analysis undertaken from 125m of previously undescribed core and integrated with petrographic and organic geochemical data provides a clear insight into the deposition and subsequent burial evolution of this succession. A microfacies scheme was erected from scanned thin sections, optical microscopy and high resolution SEM images primarily based on texture and composition, and refined through consideration of physical sedimentary structures, biogenic sedimentary features and diagenetic products. Common diagenetic features within the microfacies are clay and carbonate cements including siderite, calcite, dolomite, kaolinite and illite as well as extensive pyrite framboid development often associated with organic matter. Organic geochemical analyses (TOC and RockEval) were integrated with microfacies observations to reveal key associations between organic matter type and richness with the depositional framework. The study shows a gradual transition from a detrital and biogenic carbonate dominated system with frequent mass transport from the surrounding carbonate shelves to a clay dominated system with periodic inputs from the surrounding shelves. The significant changes in the depositional setting through time have been attributed to variations in intra-basinal and extra-basinal inputs and sea level rise eventually resulting in the drowning of surrounding carbonate platforms. The sedimentology and diagenesis of the mudstone succession is substantially influenced by tectonostratigraphic setting and should be considered as linked variables. This has a significant impact on the generation of predictive geological models particularly for bulk rock properties within these unconventional reservoirs.