Microporosity Evolution in the Lower Carboniferous (Visean) Bowland Basin Mudstone, UK

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ABSTRACT

Mineral matrix-related pores and organic matter-hosted pores control the total porosity of fine-grained rocks. Organic matter-hosted pores develop during sediment burial and are controlled by the type and thermal maturation of the organic matter while pores in and around mineral matrix are modified by diagenesis. The understanding of mineral and organic matter properties play a major role in characterising mudstone porosity. This study presents a characterisation of organic and inorganic mineral-hosted pores and evaluation of the effects of mineral diagenesis and thermal maturation on pore-size distribution across a carbonate- and organic-rich mudstone. The study focuses on the Visean age Hodder Mudstone which forms the lower section of Bowland-Hodder Shale, a potential UK shale-gas play.

Core lithofacies analysis has been undertaken on 132 core samples from 11 boreholes utilising optical and scanning electron microscopy. For mineral and diagenetic studies, whole rock mineralogy using X-ray diffraction and major and trace elements geochemistry utilising X-ray fluorescence spectroscopy were employed. RockEval pyrolysis and total organic carbon measurements enabled geochemical characterization and maturity analysis. Two-dimensional image-based pore analysis and nitrogen adsorption data were employed to characterize pore types and distributions.

Current analysis reveals significant pore modification through (1) spatial alteration of the mineral fraction from mechanical compaction, (2) mass exchange from dissolution and precipitation of carbonates, sulphides and silica during burial, and (3) late diagenetic fracturing and mineralization of veins. The reorientation, fracturing and bending phyllosilicate grains and clay minerals around rigid grains during mechanical compaction apparently resulted in differential preservation of interparticle pores. Conversely, a negative correlation exist between interparticle pores sizes and degree of carbonate mineral cementation. Hence, relative porosity variation in studied mudstone samples is not a direct correlation to fine-grained sediment compaction but a strong factor of authigenic processes that resulted in mineral precipitation in intra- and inter-particle pore spaces. Geochemical data reveals a mature (oil-window) organic-rich mudstone, and remains for further analysis the evaluation of organic matter pores in relation to variation in organic matter richness and maturity.

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