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Controls on the Burial of Organic Carbon in the Late Mississippian Craven Basin, UK

Joseph Emmings (1), Sarah Davies (1), Mike Stephenson (2), Chris Vane (2), and Melanie Leng (3)

(1) Department of Geology, University of Leicester, University Road, Leicester, LE1 7RH, UK, (2) British Geological Survey, Keyworth, Nottingham, NG12 5GG, UK, (3) NERC Isotopes Geosciences Facilities, British Geological Survey, Keyworth, Nottingham, NG12 5GG, UK

A key question for understanding the long term geological carbon cycle is what controls the distribution, abundance and type of organic matter (OM) that is preserved in the deep-water basin sink? The Bowland Shale (Late Mississippian) was deposited in a relatively deep water setting as part of an epicontinental seaway that extended from western Europe to the Lublin Basin, Poland and may therefore present a significant sink for organic carbon. There are few legacy boreholes with core through the Bowland Shale Formation to address this question; however, exposures across Lancashire and Yorkshire provide excellent spatial coverage. Data from these sites will ultimately provide insights into the controls (sedimentological, biological, geochemical) on the spatial distribution of OM in approximately time-equivalent sample locations.

In an exposed (124 m thick) succession of the Bowland Shale, located in the Craven Basin, Lancashire, we identify variations in lithology, organic geochemistry (including total organic carbon (TOC), RockEval (RE) and carbon isotope data (δ13C)), palynology and inorganic geochemistry (e.g., major and trace elements). By comparing these data across a suite of outcrop drill cores, we have developed a strategy for sampling fresh material from outcrop to ensure our data are unaffected by modern weathering.

At the field-scale, the dominant mudstone lithology is interbedded with decimetre thick, carbonate-cemented silty to fine sandy turbidites that likely represent at least 40 events. Preliminary data indicate fresh (unweathered) mudstone TOC ranges between 4 to 6 wt. % and exhibits exceptionally low oxygen index (OI; typically < 10), low to moderate hydrogen index (HI; 150) and Tmax at 430°C. Palynological and δ13C results corroborate the RE data, which indicate a dominance of (marine) amorphous organic matter. A range of sedimentary and water column processes, identified through interpretation of sedimentological and inorganic geochemical data, enable the burial and preservation of large volumes of organic matter in these basinal settings.