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Assessing the suitability of infrared hyperspectral imaging to characterise organic-rich mudstones: an example from the Carboniferous Bowland-Hodder shales of the UK

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The formation-evaluation of organic-rich shales still remains a challenging prospect. Conventional methods of compositional core analysis, such as rock-eval pyrolysis and x-ray diffraction (XRD) are inherently destructive and costly to perform, typically limiting their use on difficult and expensive to obtain core. Hyperspectral imaging in the near to short-wave infrared spectrum (1.3-2.5μm) has the capability to non-destructively capture detailed, continuous mineralogical and geochemical data quickly at sub-millimetre resolution. In this study we assess the suitability of hyperspectral-IR as a technique to characterise organic rich shales using examples from the Bowland-Hodder of the UK.

The Carboniferous organic-rich shales of the UK are increasingly being explored as unconventional hydrocarbon resources. The Bowland-Hodder unit consists of several geographically extensive, organic rich marine shales of variable thickness that were deposited between the late Dinantian and early Namurian (c.347-318 Ma). With thicknesses of up to 5000m at basin depocentres, organic content of up to 8%, suitable kerogen-maturity and proven gas-shows, it appears that there is a potentially significant gas play present.

Several cored intervals of the Bowland-Hodder shales were selected from a commercial exploration well and scanned using the Spectra-Map SpecCam sensor with 0.5mm pixel resolution and 3mm along line resolution. Semi-quantitative mineral abundance curves and two-dimensional mineral abundance maps were estimated independently of any core data using a reference library of known IR-mineral spectra. This allowed a blind assessment of the technique and we find good correlations of IR-derived TOC and mineral-abundance estimates to those from XRD and rock-eval. We also demonstrate that when hyperspectral-IR is used alongside standard core analyses in a combined approach it has the potential to identify subtle bedding-scale variations in clay type, variable carbonate content and subtle structural fabrics. Such features would be otherwise difficult or impossible to identify from the core non-destructively and are significantly below the resolution of downhole geophysical logs. We find that in this manner hyperspectral imaging can be used as both a reconnaissance tool before further sampling, or alongside conventional core analyses in an enhanced analysis and assessment of the economic potential and brittleness of prospective unconventional shale gas deposits.

Andrews, I.J. 2013. The Carboniferous Bowland Shale gas study: geology and resource estimation. British Geological Survey for Department of Energy and Climate Change (DECC), London, UK