Paleoenvironmental controls on sweetspots in early toarcian black shales

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A key challenge for assessment of source-rock and shale gas potential is to determine and predict the vertical and lateral distribution of specific properties in organic-rich deposits. A number of these properties, such as mineralogy and amount and type of organic matter are linked to surface-water productivity, bottom-water oxygenation and sedimentology. Here, we apply a multidisciplinary analytical approach aimed at predicting prosperous zones and intervals by addressing surface water productivity patterns, bottom water redox conditions and the relationship of these parameters with the mineralogical and petrophysical properties in Lower Toarcian (Early Jurassic) organic-rich shales from NW-Europe.

Samples from subsurface cores of the Posidonia Shale Formation in the Netherlands and from outcrops of the Jet rock in Yorkshire, UK were analysed for major and trace element compositions, Fe-speciation, palynology, TOC and $\delta^{13}C$. Fe-speciation indicates remarkably stable anoxic bottom water conditions throughout the organic-rich shale units in the Netherlands and in Yorkshire, whereas bottom water euxinia varies episodically. Elevated biological productivity appears to be the main driver for organic matter accummulation. The mineralogical brittleness index indicates variations both vertically and laterally, due to detrital input and carbonate formation.

A high-detail stratigraphic framework was obtained via isotope- and chemostratigraphy, which enables the results to be compared in a paleogeographic context. Extrapolation of the results using wireline log-based properties will be used to achieve a better understanding of the heterogeneity of the Toarcian organic-rich shales on a regional scale. This may aid towards assessing prolific areas for shale-gas and conventional source-rock potential.