Paleogeographic and Paleoclimatic Perspectives on the Distribution of Lower Jurassic Source Rocks in the North Sea

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ABSTRACT

Knowledge on Early Jurassic deposition in the North Sea area is limited, albeit considered remarkably homogeneous and fine-grained. In the Early Toarcian, substantial enrichment of organic-matter content occurred, as expressed by the source rocks of the Posidonia Shale Fm. in the Netherlands and Germany. In the UK, depositional patterns are better understood owing to extensive coastal exposures, where facies in range from hemipelagic mudstones to marginal marine oolite shoals. In the Norwegian North Sea, the earliest Jurassic Statfjord Group, consisting of parallic sandstones, is overlain by the Dunlin Group, consisting of mudstones from the Amundsen, Burton and Drake Formations and sandstones from the Johansen and Cook Formations. These patterns suggest that there is more variability in depositional facies distribution than often assumed. In addition, the climate was repeatedly perturbed by rapid carbon-cycle anomalies, such as i.e. the Early Toarcian Oceanic Anoxic Event (T-OAE), which is linked to the abovementioned Posidonia Shale. Because most studies focus on short-lived events, the knowledge deposition in northwest Europe remains relatively poorly understood. This study overcomes this gap by providing a stratigraphically sound analysis of the paleoclimatic, -environmental and -geographic evolution of the Early Jurassic in the North Sea. The first part of the study concerns the construction of an integrated bio- and isotope stratigraphic framework, based on outcrop samples from the Yorkshire and Dorset coastal sections. The resulting dataset was also used in an new integrated workflow aimed at deciphering environmental controls on organic carbon-enrichment. The second phase focused on subsurface records from the UK, Netherlands and Norway. Ten cored sections from key intervals throughout the study area were analyzed, while wireline logs from approximately 120 wells allowed for interpolation of the paleogeographic trends. The results reveal that climatic changes and hydrological feedbacks were important drivers for organic enrichment. Albeit other phases of anoxia are recorded, the T-OAE was the most prominent event. Even in the expanded and coarse-grained Dunlin Gp. (Norway), palynological indications for surface-water anoxia are recorded. Overall, the results illustrate that the actual accumulation of organic matter is influenced by the interplay between productivity, anoxia and equally important, the rate of dilution by detrital material.