

Facies Characteristics and Depositional Models for Highly Bioturbated Siliclastic Strata: an example from the Upper Jurassic Ula Formation, Norwegian North Sea

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Abstract

The Ula Formation is an Upper Jurassic offshore siliclastic sedimentary succession located along the faulted northeastern margin of the Norwegian Central Graben. Within the studied units, the Ula Formation is largely comprised of highly (cryptically) bioturbated shales, siltstones, and sandstones. Depositional environments have been broadly characterized as ranging from a bioturbated shelf to storm-influenced shoreface. However, due to factors that influenced sedimentation—i.e. late Jurassic structural extension, differential salt withdrawal, and the accumulation of strata on a steeply dipping depositional gradient—the Ula Formation does not correspond to this accepted depositional framework.

Through ichnological and sedimentological observations of subsurface cores, nine distinct facies are recognized, which occur in two recurring facies associations. Facies Association 1 (FA1) is represented by massive to finely laminated silt and silty shale, and moderately to highly bioturbated very fine to fine grained sandstone. Thirteen ichnogenera representing a proximal *Zoophycos* to distal *Cruziana* ichnofacies were observed in FA1. Facies Association 2 (FA2) is represented by highly bioturbated fine to medium grained sandstones, occasional high angle cross-bedded sands, discrete pebble lags, and bivalve-rich shell layers. Only four ichnogenera were observed in FA2, with *Ophiomorpha* being the most dominant. A major erosional surface, represented by a *Glossifungites*-demarcated discontinuity, is present at the base of the Ula Formation.

Sedimentological and ichnological evidence, combined with knowledge of the structural history, suggests that sedimentation during the Upper Jurassic occurred through the diachronous back stepping of sandy facies along the main graben axes. FA1 was deposited in an offshore to inner shelf setting (i.e. equivalent to distal graben), with the deposits reflecting transgression following the exposure of the Triassic or Lower Jurassic strata. FA2 is generally bioturbated and is dominated by either cryptic bioturbation or *Ophiomorpha*. FA2 is interpreted to have accumulated within a proximal graben setting, with the structure of the graben attenuating storm energy. The presence of tubular tidalites and tidal bundles demonstrates a tidal influence on sedimentation, attesting to tide amplification in the graben setting.