
**Reconstructing restricted to open marine settings
using trace fossils in the Jurassic through Tertiary of
Orphan Basin and the northern Grand Banks, offshore
Newfoundland**

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North of the well explored Jeanne d'Arc Basin and the emerging Flemish Pass area is a frontier region that is slowly gaining recognition as a petroleum prospect, the Orphan Basin. With its highly attenuated continental crust, deep basin infill, and situation north of highly productive offshore wells, the depositional history of the Orphan Basin is of significant interest and is the focus of this study. Ichnological and sedimentological analysis of available core within Orphan Basin was integrated with materials from the northern Jeanne d'Arc, Outer Ridge, and Flemish Pass areas by extrapolating similarities between log signatures.

In the Late Jurassic, a significant shift in basin dynamics was observed from brackish, anoxic, restricted embayment deposition to open-marine conditions. The latter persisted through the latest Jurassic and Cretaceous and into the Tertiary. The restricted embayment deposits are dominated by laminated muddy bay, lagoonal, deltaic, and tidal flat sediments reflecting hundreds of metres of nearshore deposition in the ?Middle to Late Jurassic. Trace fossils are sparse and tend to be isolated along specific horizons, have low diversity, and are represented by highly stressed suites of the distal to proximal *Cruziana* ichnofacies. Although no core has been collected from the Late Jurassic in Orphan Basin, the ragged gamma ray signature associated with core materials in the Jeanne d'Arc area possibly correlates with ?Jurassic strata in the more recent Great Barasway well in central Orphan Basin. The restricted embayment environment resulted in dysoxic to anoxic conditions that limited colonization. The lack of oxygen allowed organic-rich material supplied by rivers to escape decomposition, contributing to a significant source rock potential.

In the Late Jurassic, relative sea level rose and flooding took place in conjunction with opening of the area to normal marine conditions. In contrast to the restricted embayment, open marine deposits are characterized by homogenized sediment with diverse and abundant suites of trace fossils, reflecting offshore to shoreface strata. Trace fossil suites are often dominated by *Phycosiphon* and *Chondrites* of the archetypal *Cruziana* ichnofacies. Subsequently, Tertiary deposition is marked by significant deepening to bathyal conditions and deposition of shale with a distal *Cruziana* to? Zoophycos ichnofacies, in which trace fossils are visible within siltier or sideritized intervals.

Identification of trace fossils has been pivotal in understanding the variation and fluctuation between

depositional environments in Orphan Basin and the northern Grand Banks. Future correlation in conjunction with seismic interpretation and refined biostratigraphy will provide a better understanding of the depositional history within this frontier basin.