

Trace fossils as indicators of fully marine and restricted marine settings in conventional core, offshore Labrador, Canada

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Offshore Labrador, the Labrador Sea formed during Cretaceous rifting and Paleogene seafloor spreading. The 26 wells drilled in this area are located on the shelf in the Hopedale and southern Saglek basins and intersected Lower Cretaceous through Cenozoic sediments. In this study, sedimentary conventional core intervals of Cretaceous to early Eocene age from 13 wells were analyzed in terms of lithology, sedimentary structures, degree of bioturbation, trace fossil suites and presence of fossil material, which is extremely rare. Trace fossils combined with the sedimentology allowed for interpretation of depositional settings in the Bjarni (Barremian-Cenomanian in age), Markland (Santonian-Maastrichtian in age), and Gudrid (Paleocene-early Eocene in age) formations. In the Bjarni Formation of the northern Hopedale Basin, dark grey shales are characterized by a low abundance and low diversity, highly stressed expression of the *Cruziana* ichnofacies comprised of: *Phycosiphon*, *Helminthopsis*, *Chondrites* and *Schaubcylindrichnus*. The trace fossil suite and sedimentological characteristics suggest deposition within a restricted bay setting with limited oxygenation. Heterolithic sandstones and shales encountered across the Labrador margin are also characterized by trace fossil suites with a low diversity and low abundance of forms representing a stressed *Cruziana* ichnofacies primarily including: *Helminthopsis*, *Chondrites*, *Planolites*, *Rhizocorallium*, *Palaeophycus*, *Asterosoma*, *Phycosiphon*, *Thalassinoides*, and *Skolithos*. These sandier facies are cross-bedded with unbioturbated mudstone intervals and coal fragments suggesting delta front to prodelta settings under river-dominated and waveinfluenced conditions. The Markland Formation in both the Hopedale and Saglek basins is characterized by fully marine trace fossil suites of the *Cruziana* ichnofacies (*Helminthopsis*, *Chondrites*, *Phycosiphon*, *Planolites*, *Rhizocorallium*, *Asterosoma*, *Thalassinoides*, *Schaubcylindrichnus*, and *Skolithos*) reflecting intense bioturbation in inner to outer shelf settings. Conversely, the Freydis Member of the Markland Formation (cored in the southern Saglek Basin) is sandstone-dominated with rare trace fossils suggestive of a stressed *Cruziana* Ichnofacies reflecting river-dominated deltaic deposition. The Gudrid Formation in the southern Saglek Basin is characterized by heterolithic facies with trace fossil suites consistent with weakly-stressed expressions of the *Cruziana* ichnofacies. In one core, crossbedded sandstones with intensive bioturbation by *Helminthopsis*, *Macaronichnus*, and *Spirophyton* trace-makers represent a wave/storm-dominated delta front succession. In another core, wave-rippled sandy mudstones are predominated by *Phycosiphon* and *Helminthopsis* trace-makers in a prodeltaic setting. In some core intervals, localized trace fossil occurrences provide the only evidence of shallow marine deposition in what is otherwise considered to be non-marine in origin, and in other cases, trace fossils aid in delimiting more specific marine depositional settings or paleoenvironmental conditions.