

Late Pennsylvanian–Early Permian Tectonically-Driven Stratigraphic Sequences and Carbonate Sedimentation Along Northern Margin of Sverdrup Basin (Otto Fiord Depression, Arctic Canada)

Benoit Beauchamp

Department of Geoscience, University of Calgary

Daniel Calvo Gonzalez

Department of Geoscience, University of Calgary

Charles Henderson

Department of Geoscience, University of Calgary

Summary

A thick succession of upper Paleozoic carbonate rocks and minor chert outcrops north of the head of Otto Fiord (NW Ellesmere Island, Nunavut) in the Canadian Arctic Archipelago. These rocks accumulated in a tectonic sub-basin—the Otto Fiord Depression (OFD)—of the Sverdrup Basin that likely originated through rifting in late Early Carboniferous (Serpukhovian) time. Following a long interval of passive subsidence that allowed a thick succession of Moscovian–Kasimovian carbonate rocks to fill the OFD, tectonic activity resumed in Gzhelian time (Late Pennsylvanian) resulting in rapid collapse of the depression along its axis and simultaneous uplifts of its margins, a style of tectonism in accord with the inferred basin-wide shift to a transpressional-transensional stress regime at that time. Late Pennsylvanian–Early Permian sedimentation in the OFD led to the development of four long-term transgressive-regressive sequences of early Gzhelian–middle Asselian (<1200 m), late Asselian–late Sakmarian (<380 m), latest Sakmarian–late Artinskian (<160 m) and latest Artinskian–late Kungurian (<60 m) age. The development of each sequence-bounding unconformity was associated with renewed tectonism in the OFD. Each sequence recorded the development of a depositional system characterized by high energy peripheral shoreface grainstones that pass basinward across a gently dipping ramp into deep-water basinal calcareous and siliceous mudrock. The ramp portion of the early Gzhelian–middle Asselian system comprise both cool-heterozoan to warm-photozoan carbonates (Nansen Formation) suggesting a relatively shallow thermocline at that time. These rocks are arranged in a series of high-order cyclothems of glacio-eustatic origin. Cyclothem sedimentation ended at the Asselian–Sakmarian boundary, simultaneous to a major depositional system shift to cool water heterozoan sedimentation (Raanes Formation), a change presumably brought on by the closure of the Uralian seaway linking NW Pangea with the Tethyan Ocean. This event led to the destruction of the permanent thermocline, and disappearance of photozoan carbonates by the early Sakmarian despite rising temperature globally. Cool water heterozoan sedimentation, associated with relatively shallow outer- to mid-ramp spiculitic chert resumed in the Artinskian and then again in the Kungurian (Great Bear Cape Formation) when the OFD was filled up. The depression ceased to exist as a separate

tectonic/subsidence entity with the widespread sub-Middle Permian unconformity that marks the onset of passive subsidence across most of the Sverdrup Basin. The Pennsylvanian–Lower Permian succession that accumulated in the OFD along the clastic-free northern margin of the Sverdrup Basin is essentially identical, both in terms of tectonic evolution and stratigraphic development, with the coeval succession of Raanes Peninsula, SW Ellesmere Island, the type area of the Raanes, Trappers Cove and Great Bear Cape formations along the clastic-influenced southern margin.

