Episodic Tectonism and Depositional History of the Mid-Cretaceous (Aptian-Turonian) Succession of Sverdrup Basin, Canadian Arctic Archipelago

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The mid-Cretaceous (Aptian-Turonian) succession of Sverdrup Basin, Canadian Arctic Archipelago, is up to 1.8 km thick and comprises the upper portion of the Isachsen Formation (sandstone-dominant), the entire Christopher (shale/siltstone-dominant), Hassel (sandstone-dominant), Bastion Ridge (shale/siltstone-dominant) and Strand Fiord (volcanic-dominant) formations and the basal portion of the Kanguk Formation (shale/siltstone-dominant). The strata contain three, large magnitude sequence boundaries of mid-Aptian (2nd order), near base Cenomanian (1st order) and late Cenomanian (2nd order) age The sequence boundaries divide the succession into two second order sequences of mid-Aptian/Albian, and Cenomanian age with Turonian strata forming the basal portion of an overlying Turonian-Maestrichtian second order sequence.

The three sequence boundaries were generated by tectonics and significant depositional and tectonic changes occurred across each boundary. From Hauterivian to mid-Aptian the Sverdrup Basin was dominated by coarse-grained fluvial deposits derived from cratonic areas to the east and south. Substantial uplift occurred in mid-Aptian and was followed by high rates of subsidence. A major transgression pushed the shoreline beyond the basin margins. From late Aptian through early Albian, the basin was occupied by a marine shelf which received mainly mud and silt with shelf sandstone restricted to the basin margins. Marine shelf sandstones of storm origin prograded into the basin in mid Albian but renewed subsidence soon resulted in transgression and a return of widespread marine mud and silt deposition. In late Albian a deltaic complex prograded into the west-central portion of the basin and a delta plain with coal swamps was established in that area. Marine shelf sandstones accumulated in the east at this time.

Substantial uplift occurred near the Albian/Cenomanian boundary and an angular, subaerial unconformity formed on the basin flanks and over salt structures. The unconformity correlates with a maximum regressive surface in the central portion of the basin. Subsidence resumed in earliest Cenomanian but was much reduced from that experienced in the Albian. Transgression occurred with fluvial/estuarine sediments forming the basal transgressive portion of the Cenomanian sequence along the basin margin and the flanks of salt domes. A muddy marine shelf was widespread by early Cenomanian. Regression followed with a delta plain again prograding into the west-central portion of the basin.

Basaltic volcanism, which had begun in Hauterivian, became much more voluminous on the northern flank of the basin adjacent to Alpha Ridge during the Cenomanian. A major volcanic plateau formed and submarine to subaerial basalt flows prograded southward into the marine basin and intertongued with the delta plain sediments to the west. The volcanic strata are almost 1 km thick in the far north. Uplift occurred in late Cenomanian but was restricted to the basin flanks. In a few marginal sections the entire Cenomanian sequence is absent. A major transgression occurred in latest Cenomanian and by early Turonian the entire basin was a marine shelf receiving bituminous mud and volcanic ash. Subsidence and sedimentation rates were very low and continued to be so until the Santonian.

The three major sequence boundaries of the mid-Cretaceous succession are present throughout the Arctic region and occur in basins throughout the world. Given their tectonic origin, they were likely generated by plate-tectonic processes driven by changes in the mantle. Notably, the first order, near base Cenomanian boundary appears to mark the cessation of sea floor spreading in the Amerasia Basin.