Mesozoic 1st Order Sequences of Svalbard, Canadian Arctic Islands and Northern Alaska

Ashton Embry*
Geological Survey of Canada, Calgary, AB
aembry@nrcan.gc.ca

Summary

The Mesozoic successions of Svalbard (Barents Sea), the Sverdrup Basin (Canadian Arctic) and Arctic Alaska are divisible into the same three 1st order sequences based on the occurrence of four, large magnitude, 1st order sequence boundaries which are present in these widely separated areas. These boundaries are of late Changhsingian (latest Permian), earliest Rhaetian (latest Triassic), early Barremian (Early Cretaceous) and early Paleocene (earliest Tertiary) age. Thus the three 1st order sequences grossly approximate the three Mesozoic systems. Each of the 1st order boundaries is characterized by a major shift in depositional and tectonic regime and by major, marginal uplift.

In general, sandstone units are most common in the lower portion of each sequence with thick shale and siltstone units dominating the middle portion. Sandstone content increases in the upper portion and sandstone again becomes dominant in the uppermost portion of each sequence. The Sverdrup Basin had the highest influx of sediment and thick units of braided stream deposits occur low in each sequence. Sediment supply to northern Alaskan basins was much less and sandstone units tend to be much thinner and of smaller areal extent than equivalent units in the Sverdrup Basin. On Svalbard, similar sand-dominant units are present in each sequence, but like Alaska, they are relatively thin and localized indicating a relatively low rate of sediment supply.

Source rocks are well developed in the middle portion of the Triassic 1st order sequence in all three areas and are richest, thickest and have the greatest stratigraphic range in the Alaskan basins where sediment influx was least. In the Jurassic 1st order sequence, notable source rocks are found only in Alaska. Organic rich shales occur in the Cretaceous 1st order sequence in both Alaska and Sverdrup Basin. In Alaska they occur in Lower Cretaceous and Upper Cretaceous strata whereas in the Sverdrup Basin they occur only in Upper Cretaceous strata. On Svalbard, the entire Upper Cretaceous succession was eroded in earliest Paleocene.

The occurrence of the same major sequences with the same general lithological and facies development in three areas of the Arctic suggests a fundamental tectonic control for such sequences. The tectonic episode which resulted in the creation of each 1st order sequence boundary must have generated substantial uplift in the hinterland of each basin and this in turn led to a marked increase in sediment influx rate and sand supply. Sediment supply gradually declined as elevations in source regions decreased and tectonic episodes disrupted sediment supply systems. This sediment reduction culminated in a time of very low sediment input, often characterized by organic-rich sediments (1st order MFS). The increased sand supply in the upper

portion of the sequences likely reflects renewed tectonic uplift which preceded the major event which generated the next 1st order boundary

Given that these major tectonic cycles affected a very large area of the Arctic, they are interpreted to be driven by mantle-crust interactions on a 50 -100 MA time scale. The initiating tectonic episode for each sequence occurred over a short time period and completely transformed the paleogeographic and tectonic setting of each area. These sequence-defining “times of terror” likely reflect major plate tectonic reorganizations.

Major petroleum fields have been discovered in the Mesozoic succession in northern Alaska, Sverdrup Basin and the Barents Shelf. Most of the largest fields are closely related to the first order boundaries. For example the Prudhoe Bay (Alaskan North Slope, 10 BBls) main reservoir unit is in the major sandstone above the latest Permian 1st order sequence boundary, the Drake Point/Hecla (Sverdrup Basin, 9 TCF) reservoir unit and that of the Snohvit field of the Barents Sea (6 TCF) is the sandstone unit directly above the earliest Rhaetian 1st order sequence boundary and the Burger (Chukchi Sea, 14 TCF 1 BBl) reservoir unit is a sandstone associated with the earliest Barremian 1st order sequence boundary.