

ABERRANT DUPEROW CYCLES AND STRATIGRAPHIC TRAPPING IN THE NORTHERN WILLISTON BASIN

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The Upper Devonian Duperow Formation in the northern Williston Basin displays roughly 17 carbonate-evaporite cycles. Each cycle, in ascending order, comprises marine shelf, biostrome, restricted shelf and salina facies, any of which may be missing or repeated. Duperow cycles are commonly predictable both regionally and vertically, presumably reflecting effects of allocyclic glacio-eustasy and distant shelf-margin barriers. However, three aberrant cycles in the upper Duperow responded to two local events: the subsidence of the Flat Lake subbasin in southeastern Saskatchewan and the concurrent growth of unusually thick biostromes to the south.

The biostromes, lacking intervening anhydrites, are formed of stromatoporoid-coral floatstone, boundstone and grainstone, and extend as a quasi-barrier from southeastern-most Saskatchewan, across northwestern North Dakota and northeastern Montana, to the Little Rocky Mountains. To the north an equally extensive arcuate belt of exceptionally thick nodular-mosaic anhydrite, forming most of cycles 12 and 13, replaces the biostromes. Underlying marine shelf deposits double in thickness northward, perhaps marking initial subsidence of the Flat Lake subbasin. The Flat Lake halite, in the upper part of cycle 14, occupies the subbasin as a contiguous body up to 25 m thick in southeastern

Saskatchewan and as remnant bodies to the west and south. The nodular-mosaic fabric of cycles 12 and 13 anhydrite, which immediately overlies planar stromatolites, and exceptional features attributed to vadose-zone leaching in cycles 12 and 13 biostromes suggest shallow hypersaline conditions and subaerial exposure. Ubiquitous columnar stromatolites beneath cycle 14 halite indicate more uniformly submergent salinas.

This unique Duperow paleogeography set the stage for productive stratigraphic traps in northern Divide County, North Dakota, downdip of the sinuous southern apex of the Flat Lake halite. Ambrose, Gooseneck and lesser oil pools along this trend are developed as relatively thin pay zones in dolomitized cycle 14 restricted shelf facies and overlying cycle 15 marine shelf facies. Although these pools occupy subdued structural noses, the principal trapping component is location within updip embayments of the Flat Lake halite with updip loss of porosity and permeability in salt-plugged dolomite and limestone. A broad belt of dolomitized rock south of the Flat Lake halite enhances potential for additional discoveries. Similar stratigraphic traps may exist downdip of the far more extensive Flat Lake halite in southeastern Saskatchewan.