

## **Devonian Reef-Builders and the Development of the Fairholme Carbonate Reef Complex, Banff-Kananaskis Country, Alberta, Canada**

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### **Abstract**

The Fairholme Carbonate Complex is the southernmost and largest in an extensive stromatoporoid-dominated reef domain that developed in Alberta during Frasnian time. Its western margin in the Kananaskis-Banff region is defined, and exhibits a major re-entrant 25 km wide named the Shark Embayment. A Devonian paleoclimatic model suggests that the western margin was subjected to seasonal oceanic upwelling of nutrient-rich and oxygen-poor waters that influenced the development of the carbonate buildups.

Three buildup margins exposed within the Kananaskis - southern Banff area define the western margin of the Fairholme Carbonate Complex: Turbulent Creek headwaters, Fatigue Mountain, and Copper Mountain. Overlying the Flume (Swan Hills equivalent) carbonate platform at these margins, the Cairn (Lower Leduc/Cooking Lake) platform ramp extends, and gradually thins in a basinward direction; it was a distally-steepened carbonate ramp, comprised of three transitional facies: (i) a shallow, upper ramp stromatoporoid platform interior; (ii) a mid-ramp coralline facies; and (iii) a black, organic-rich Perdrix/Duvernay basin. The subsequent Peechee (Upper Leduc) buildup developed into a more steeply sloping, rimmed carbonate margin, which periodically shed reefal blocks and debris flows downslope and into the (uppermost) Perdrix and Mount Hawk (Ireton) basin. The western Peechee margin trends roughly northwest - southeast, but forms a major re-entrant in the Spray Lakes Reservoir/Mount Shark area approximately 25 km wide, called the *Shark Embayment*. The northern margin of the Shark Embayment is well-defined at Turbulent Creek headwaters and Fatigue Mountain.

Only the northern extent of the western margin of the Fairholme Complex within the study area shows the presence of Arcs (Nisku) strata prograding over Mount Hawk (Ireton) basin fill. Mount Hawk sediments did not completely infill the late Frasnian basin adjacent to buildup margins in the Shark Embayment and to the south, preventing the progradation of the Arcs Member. Consequently, a large depression developed by the end of Frasnian time, subsequently infilled by westerly(?) - derived siliciclastics of the Sassenach Formation (Graminia equivalent).

Stromatoporoids were widespread and abundant calcareous benthos living in shallow, tropical, oligotrophic, and agitated marine environments. Five stromatoporoid assemblages are defined in the Flume and Upper Cairn succession, and are correlated with RM conodont zones. Stromatoporoids exhibit mostly domical, but also bulbous, laminar, and dendroid growth forms that were genetically prescribed and only slightly modified by environmental factors. Evidence suggest that Paleozoic stromatoporoids eventually developed into mixotrophic organisms (containing symbiotic algae) enabling them to construct large carbonate buildups, but they were also vulnerable to the devastating effects of paleoceanic upwelling of nutrient-rich waters.