

Dolomitization of the Boat Harbour Carbonates of St. George Group in Western Newfoundland, Canada: Implications for Porosity Controls

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Summary

The lower part of the St. George Group of western Newfoundland consists of the Boat Harbour (~180m thick) and the underlying Watts Bight (~60m thick) formations, which are Early Ordovician (Tremadocian) shallow marine platform carbonate. In the Boat Harbour Formation, dolomitization is more pervasive at the top of most shallowing-upward, meter-scale, peritidal hemicycles. Petrographic examination of the Boat Harbour carbonates suggests that the succession has been affected by at least three phases of burial dolomitization, which influenced the final rock porosity. These phases have crystal-size ranges of ~4 to 40 μm (earliest dolomite D1), 50 to 150 μm (D2), and 300 μm to 20mm (saddle dolomite D3), respectively. They occur as both replacements and cements and exhibit dull (D1 and D3) to zoned (D2) luminescence under the cold cathodoluminoscope. The occurrence of near-micritic size dolomites (~4 - 40 μm) may suggest that dolomitization started at low temperatures during early stages of diagenesis. The lack of evaporite interbeds in the formation and the depleted $\delta^{18}\text{O}$ values (~-6.2‰ VPDB) as well as the low Sr contents (~168ppm) of the earliest dolomites likely exclude a brine origin from evaporated seawater. The Sr/Ca molar ratios (0.0069 to 0.0017), calculated for the earliest dolomitizing fluid, suggest a mixture of marine and meteoric waters possibly in a mixing zone environment. The petrographic features and geochemical attributes of D2 and D3 phases, such as their depleted $\delta^{18}\text{O}$ values (~-6.9‰ and -8.3‰ VPDB, respectively) and Sr contents (~177 and 117ppm, respectively), suggest that they were formed under relatively deeper burial conditions and possibly from hydrothermal fluids which is supported by homogenization temperatures (up to 127°C) and estimates of salinities (up to 22 wt% NaCl) in the latest dolomites (D3). Based on visual estimates

from thin sections, the porosity varies from < 1 % in most of the formation to ~10 % in a dolomitized algal lime mudstone bed in the lower part of the formation, few meters below the Boat Harbour Disconformity. Except for some vugs, the majority of pores are intercrystalline and associated with D2 which is interpreted to be formed under relative closed conditions.