

Nature and Origin of Dolomitization of the Boat Harbour Formation Carbonates in Northern Peninsula, Western Newfoundland, Canada: Implications for Porosity Controls

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The Boat Harbour Formation of the lower Ordovician (Tremadocian/Arenigian) St George Group Carbonate on Northern Peninsula is about 140m thick and conformably overlain by the porous Catoche Formation.

In addition to petrographic investigations (transmitted light microscope, cathodoluminescence and fluid inclusion microthermometry), data from geochemical analyses (major and trace elements-Ca, Mg, Fe, Mn, and Sr-, O-, and C- and Sr-isotopes) were utilized to investigate the origin of dolomites and the results were also compared with their counterparts of the equivalent section in Isthmus Bay at Port au Port Peninsula (about 300km to South).

At least three phases of dolomites were identified from petrographic examination. The earliest phase D1 is dolomicrite with crystals ranging from ~3 to 35 μm . The following phase D2 consists of planar sub-to euhedral crystals ranging from 30 to 120 μm . The latest phase, D3, is the coarsest and consists of curved, dominantly non-planar crystals ranging from 300 μm to 9mm, exhibit undulose extinction. The dolomite phases generally exhibit dull luminescence except for D3 which exhibits concentric zoning. Microthermometric measurements of the primary two-phase fluid inclusions in D2 (homogenization temperatures up to ~170°C and salinity up to ~13% eq. wt% NaCl) and D3 (homogenization temperatures up to ~181°C and salinity estimates up to 20.22 eq. wt% NaCl) suggest that they formed under relatively deep burial conditions and from hot saline brine. This is supported by the petrographic evidence and geochemical composition, especially the depleted $\delta^{18}\text{O}$ values ($-11.1 \pm 1.2\%$ VPDB) and low Sr contents (72 \pm 8 ppm).

Sr composition of the dolomites shows a decreasing trend from oldest (~228 ppm-D1) to youngest (72 ppm-D3). Also, the low Sr (228 \pm 28 ppm) and $\delta^{18}\text{O}$ ($-6.0 \pm 0.8\%$ VPDB) of D1 suggest that it was likely deposited from a relatively Sr-poor fluid such as a mixture of seawater and meteoric water while D2 and D3 were precipitated from diagenetic fluids that were circulated into the heated basin and refluxed back through faults.

In general, the Formation is not pervasively dolomitized compared to its counterpart section on the Port au Port Peninsula and dolomitization is more concentrated in the zones around the chemostratigraphically and petrographically delineated lower Boat Harbour disconformity.

Petrographic exams suggest that the dominant porosity type is intercrystalline and associated with D2 while vuggy porosity is associated with D3. Visual estimates of porosity imply that it varies from <1 to ~8% in an interval of ~3m-thick immediately below the lower Boat Harbour disconformity. Chemostratigraphic correlations with the equivalent Boat Harbour Formation

section in the Isthmus Bay (300 km to South) indicate that porous interval is associated with fluctuations in sea-level marked by a negative $\delta^{13}\text{C}$ profile of both sections.