Dolomitization of the Presqu'ile Barrier: An Alternative Paleohydrological Model

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Abstract

Regional geographic trends of dolomite stable oxygen isotope values, radiogenic strontium ratios and fluid inclusion homogenization temperatures were interpreted in earlier studies of the Presqu'ile barrier to reflect a basin-scale, eastward up-dip migration of hot, radiogenic fluids driven by tectonic compression, sedimentary loading and uplift of the western part of the Western Canada Sedimentary Basin. These dolomitizing fluids were thought to have been derived by a combination of topographic recharge and tectonic compaction during either the Cretaceous-Tertiary Laramide Orogeny (probably the main phase) or possibly the earlier Antler Orogeny (Devonian-Carboniferous). Recent reexamination of the petrography and geochemistry of the hydrothermal, fabric-destructive dolomites from 4 diamond drill cores from the Pine Point Mines property and 31 petroleum cores from the subsurface of the NWT to the west of Pine Point (Fig. 1), and reconsideration of the previously derived data, provide a basis for challenging this model. Overall, newly obtained geochemical and fluid inclusion data are remarkably variable, and also show inconsistent relationships with both petrographic and cathodoluminescence characteristics.

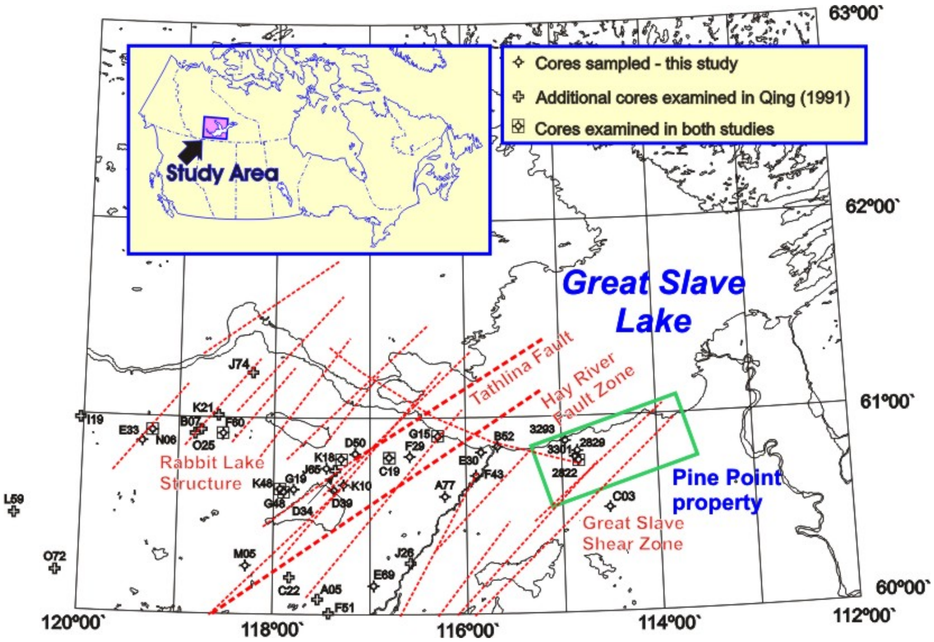

Figure 1. Locations of wells sampled and from previous studies (Qing and Mountjoy 1994) and locations of major faults in the study area.

Figure 2 illustrates the non-correspondence between oxygen isotopes from samples of Presqu'ile Dolomite and their geographic location.

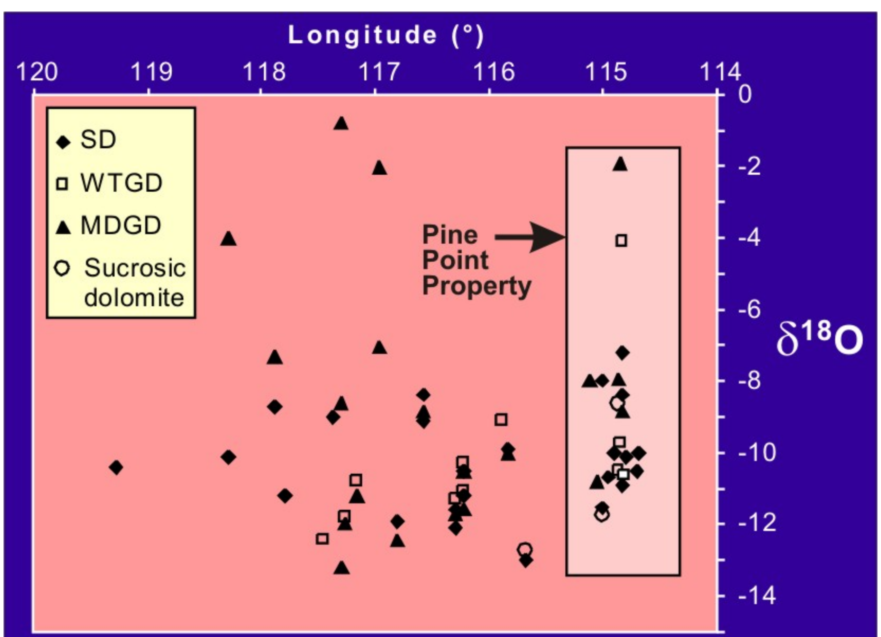

Figure 2. Plot of per mil O^{18} versus longitude for all dolomites (SD=saddle dolomite cement [200µm to 6mm], WTGD=white to tan-grey replacive dolomite [30µm to 4000 µm], MTGD=medium to dark grey replacive dolomite [5µm to 2000µm], sucrosic dolomite=sucrosic replacement dolomite [10µm to 2000µm]) in this study.

The lack of correlation between geographic location and oxygen isotope values indicate that extensive dolomitization may instead have been facilitated by the development of convection cells that formed in response to spatial variations in relatively high basal heat flow. Cross-formational fluid flow would have been encouraged by the prominent NE-trending, mostly extensional faults in the study area and the karstic pore-system that developed in the Presqu'ile barrier. Previous work has shown, for example, that within the regionally stratiform Presqu’ile Dolomite along the Presqu’ile Barrier, a particularly large mass Presqu’ile Dolomite is bounded by the “Tathlina” and “Hay River” faults (Fig. 1; Janicki, 2004). Such large, fault controlled dolomite thickness variations are more consistent with focusing of subsurface dolomitizing fluid flow along sub-vertical permeable fault zones during regional convective overturn than by unidirectional updip fluid flow driven by basin-wide deep topographic recharge or by “Tectonic” compaction-driven fluid flow. Variability in the isotopic data, particularly stable oxygen isotope values, even at a borehole scale, can be explained by temporal or spatial variations in heat flow and/or depth to basement, or to the degree of recrystallization as a function of fluid-rock interaction.

References

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