Dolomitization By Halite-Saturated Brine And Subsequent Hydrothermal Alteration In The Devonian Slave Point Formation, Clarke Lake Gas Field, British Columbia

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ABSTRACT

The Clarke Lake gas field, one of the largest gas fields in western Canada, is hosted in pervasively dolomitized Middle Devonian carbonates of the Slave Point Formation. The bulk of the dolomite in the reservoir consists of replacive grey matrix dolomite (~ 80 vol-%) and saddle dolomite cement (< 20 vol-%). A rigorous petrographic and geochemical examination of the reservoir indicates that dolomitization was not accomplished simply through the advection of seawater, as in most other parts of the Western Canada Sedimentary Basin, but rather, by a mixture of fluids with distinct origin. As a result of the proper characterization and interpretation of dolomitization, we are able to provide a valuable tool that should improve exploration success.

Matrix and saddle dolomite exhibit similar stable isotope values, with $\delta^{18}O$ ranging between –16 and –12‰ VPDB. These values are significantly depleted with respect to Devonian seawater, and suggest formation as well as recrystallization at elevated temperatures. The $^{87}Sr/^{86}Sr$ ratios of both dolomite types range from 0.7168 and 0.7088, which are also enriched with respect to Devonian seawater. The lower values may represent modified Devonian seawater or extra-formational fluids expelled from Paleozoic shales in the area, while the higher values suggest fluid interaction with underlying sandstone or Proterozoic meta-sedimentary rocks. Homogenization temperatures were measured in grey matrix dolomite both in the cloudy brown cores and the clear overgrowth rims, under the assumption that the temperatures from the cores represent the original temperature of crystallization. Homogenization temperatures range from 130 to 160°C in the cores and from 180 to 200°C in the rims. Fluid inclusion homogenization temperatures in the saddle dolomite range from 115 to 220°C. The corresponding salinity values range from 24 to 17 wt% NaCl equivalent for matrix dolomite, and from 19 to 12 wt% NaCl equivalent for saddle dolomite. These values suggest precipitation from hot, highly saline fluids during burial. Furthermore, the differences in salinity between the two dolomite phases indicates that matrix and saddle dolomite were not co-genetic. Crush-leach analysis was conducted to further characterize the composition of the fluid inclusions. Both cation and anion results from all inclusions differ from seawater, and indicate the contribution from 3 distinct fluids. Dolomitization of the matrix was accomplished through reflux or convection of halite-saturated brine. The precipitation of saddle dolomite cement, and the recrystallization of matrix dolomite, was for the most part, accomplished by either evaporated seawater

that was variably diluted by meteoric water, or fluid derived from the dissolution of halite. Where dolomite contains highly radiogenic strontium, basement-rooted faults provided the conduit for the dolomitizing fluid.