Fluid Inclusion Study of Gas-Bearing Dolomites from Northeast British Columbia: Evidence for Dolomitization Mechanism and Condition of Hydrocarbon Migration

Mengwei Zhao, David W. Morrow*, GSC-Calgary

Fluid inclusion (FI) analysis has been carried out on gas-bearing dolomites from the Devonian Slave Point Formation of the Peggo and Helmet gas fields at the southern end of the Cordova Embayment within the Keg River, or Presqu'ile Barrier of northeast British Columbia.

FI assemblages (FIA) of one-phase aqueous inclusions and two-phase aqueous inclusions have been observed in the dolomites. The one-phase aqueous inclusions are primary, and mostly very small, <3 mm in size. They can be found to be paired with two-phase aqueous inclusions in some samples. Some of these two-phase aqueous inclusions have a variable vapor-liquid ratio. However, most two-phase aqueous inclusions show a consistent vapor-liquid ratio. They are primary and range from 3 to 40 mm in size, mostly between 4 and 10 mm. Their homogenization temperatures (Th) range from 108 to 192°C, mostly between 120-160°C with a peak at 130-150°C. The measurement of first melting or eutectic temperatures (Te) and final melting temperatures ™ indicates two different FIAs of the two-phase aqueous inclusions, although they have similar Th values. One FIA yields Te values between -57 to -53°C and Tm values between -30.9 to -19.6°C, which suggest a model composition of NaCl-CaCl2-MgCl2-H2O system (Te=-57°C) and a salinity of 22.1 to >23.2 wt% NaCl equivalent. The other FIA yields Te values between -36 to -34°C and Tm values between -12.0 to -10.3°C, indicating to a model composition of NaCl-MgCl2-H2O system (Te=-35°C) and a salinity of 14.3-16.0 wt% NaCl equivalent.

Clear late calcite cements contain large (up to 60 mm) two-phase primary aqueous inclusions with consistent vapor-liquid ratio that homogenize at 113 to 181°C with a peak at 150-170°C. They yield similar Te and Tm values to those of the second FIA in dolomites. Hydrocarbon inclusions occurring in the calcite cements are also primary and range from 10 to 35 mm in size. The oil inclusions are clear to dark under the transmitted light and exhibit dark yellow color under the ultraviolet microscope. The CH4 inclusions are dark under the transmitted light. They yield Th values between -87 to -88°C.

Two different dolomitization mechanisms can be inferred. The presence of the one-phase aqueous inclusions indicates that the host dolomites should have precipitated below temperature of <40-50°C. The coexistence of the two-phase aqueous inclusions together with them and their variable phase ratios might suggest entrapment of these inclusions in the vadose zone. The host dolomites of two-phase aqueous inclusions with consistent vapor-liquid ratio must have precipitated at high temperatures (120-160°C) form high saline (>13 wt% NaCl equivalent) brines of Na-Mg-(Ca)-Cl systems during burial. The late clear calcite cements must have occurred at higher temperatures (150-180°C) also from high saline brines of Na-Mg-Cl system during further burial. The high saline brines may have different chemical compositions and salinities in different locations. Maturation and migration of hydrocarbons postdated dolomitiztion but coincided with late calcite cementation.

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