Diagenetic Evolution of Middle Devonian Carbonate Reservoirs of Stone and Dunedin Formations, Liard Basin, Northeastern British Columbia

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Summary

The carbonate rocks of the Middle Devonian Stone and Dunedin formations host Beaver River, Pointed Mountain and Kotaneelee gas fields in the Liard Basin, which were interpreted to represent a transgressive sequence of intertidal mudstones, subtidal bioclastic wackestones/packstones, platformal stromatoporoids floatstones/rudstones and reefal stromatoporoids boundstones (Fig. 1; Hersi et al. 2006). These strata have been extensively dolomitized and show features of both fabric retentive and destructive textures (Fig. 2). Secondary inter-crystalline and vuggy porosity occur up-section in the Dunedin platformal and reefal strata (Fig. 2A and E). These pores are connected by horizontal and sub-vertical fractures (Fig. 2C and D), which host potential hydrocarbons resource in northeastern British Columbia and adjacent subsurface.

Sixteen diagenetic phases have been identified from core and petrographical studies (Fig. 3). These include 2 major types of fabric retentive matrix dolomites, dissolution, saddle dolomite, brecciation, calcite cement, fractures and stylolites. Fabric retentive matrix dolomites consist an earlier grey finely-crystalline dolomite and a later grey medium-crystalline dolomite (Fig. 2B). Finely-crystalline dolomite forms in the carbonate mud matrix, where the primary sedimenatary structures are typically preserved. Medium-crystalline dolomite appears replacing fossil grains and syntaxial cement. These 2 types of matrix dolomites occurs mostly in the Stone and lower Dunedin formations. Only limited primary fenestral porosity and secondary moldic porosity were preserved in the strata.

Dissolution vugs and saddle dolomite cement are typically found in the Dunedin Formation and become abundant up in the section. Two types of saddle dolomites were found in some of the centimeter scale dissolution vugs (Fig. 2E). Further geochemical analysis will help to identify the fluid composition of these two petrographically different saddle dolomite cements. Late calcite cement is typically found in dissolution vugs and sub-vertical fractures that post-date saddle

dolomite (Fig. 2D); it is post-dated by the second generation of horizontal stylolites and further tectonic fractures.

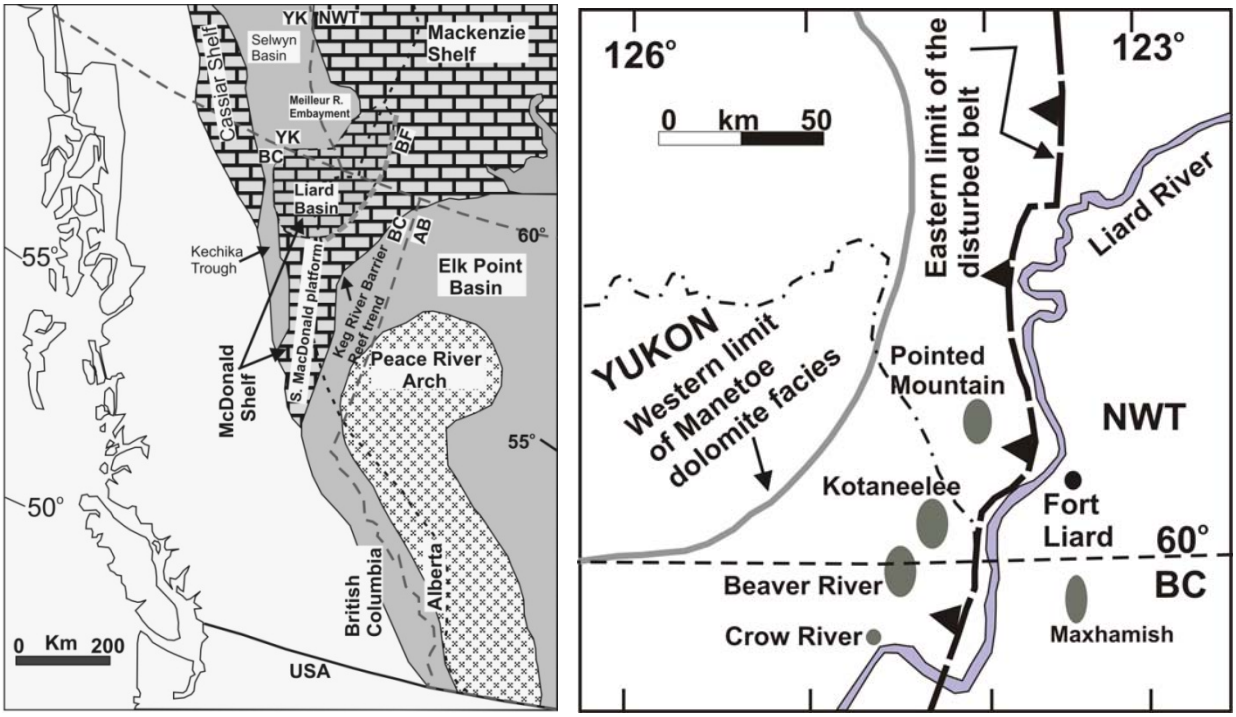

Figure 1: Geographic maps showing the location of the Liard Basin (left) and major gas fields in the region (right). Modified from Morrow and Geldsetzer (1988) and Morrow and Aulstead (1995).

Preliminary fluid inclusions studies from saddle dolomite samples within the Beaver River Gas Field show homogenization temperature from 151 to 190 ºC (average 170.3 ºC); and final melting temperature from -7.4 to -17.7 ºC (average -12.7 ºC). Homogenization temperature measured from calcite cement is between 130 and 190 ºC (average 164.3 ºC). Final melting temperature is from -5.5 to -10.5 ºC (average -8.1 ºC). These suggested that saddle dolomite cement was precipiated from hot, saline fluid. Later formed calcite cemented was precipiated from slightly cooler and less saline fluid.

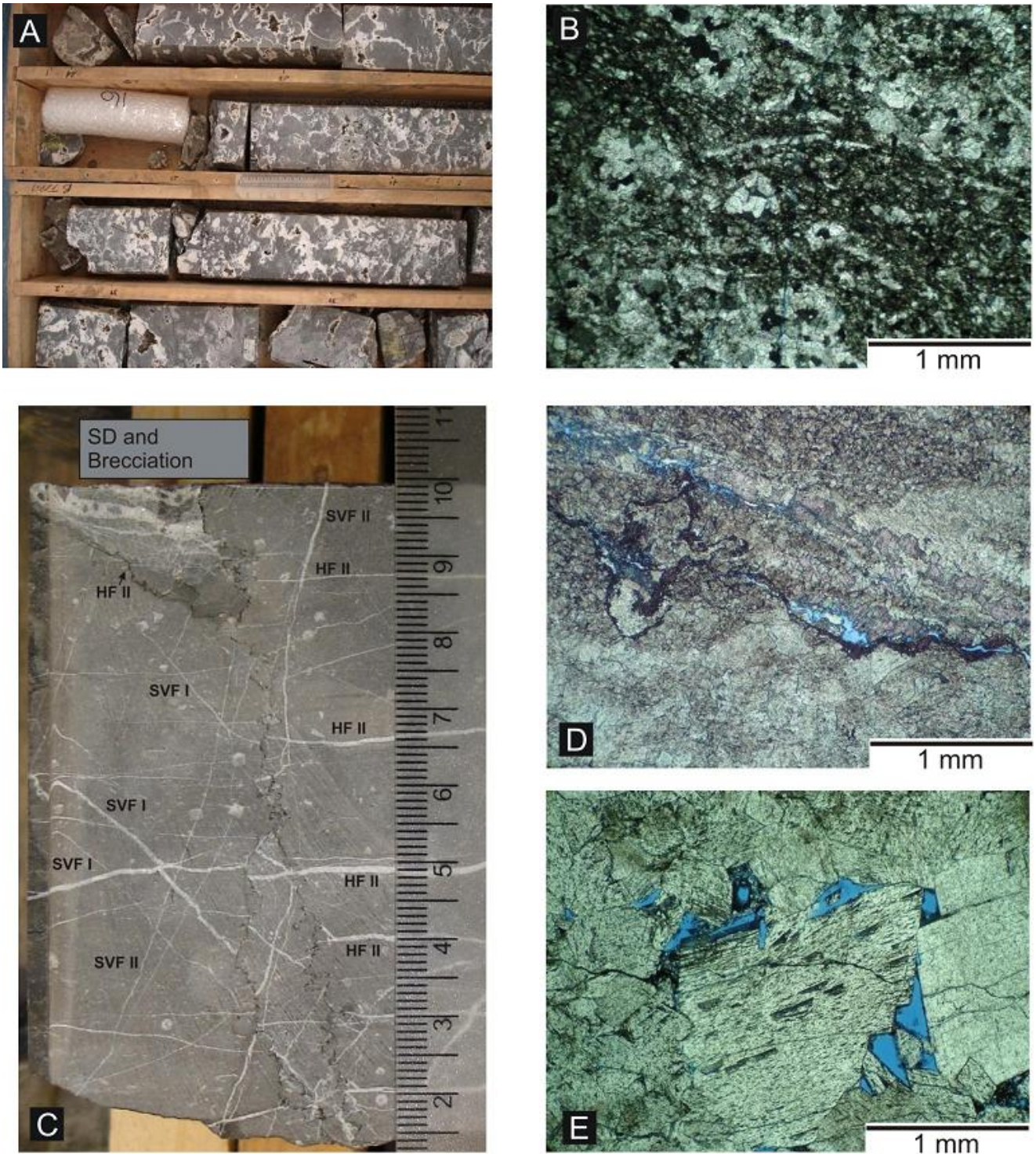

Figure 2: Photos taken from samples of the Beaver River Gas Field, Northeast British Columbia. A) Cores from the Upper Dunedin Formation showing abundant vuggy and moldic porosity, 12135 – 12145 ft, Amoco A-6 well. B) Grey finely-crystalline matrix dolomite and medium-crystalline matrix dolomite in wackestone facies of the Stone Formation, 13757'7'', Amoco B-2 well. C) Core slab showing two generations of subvertical fracture (SVF I and II), the second generation of horizontal fracture (HF II) and vertical stylolites. All of these features postdate saddle dolomite and brecciation. Stone Formation, 14716'6'', Pan Am A-3 well. D) Late calcite cement postdates saddle dolomite. Calcite cement is fractured and cut by a horizontal stylolite (stylolites II). Photo was taken with both transmitted and reflective lights on under a research microscope. Dunedin Formation, 12194', Pan Am A-3 well. E) Two types of petrographically different saddle dolomite cements. Non-planar S saddle dolomite cement is found around rims of vuggy pores; non-planar E saddle dolomite crystals are found in the middle of the vugs and appear post-dating the non-planar S counterpart. Dunedin Formation, 13276', Amoco B-2 well.

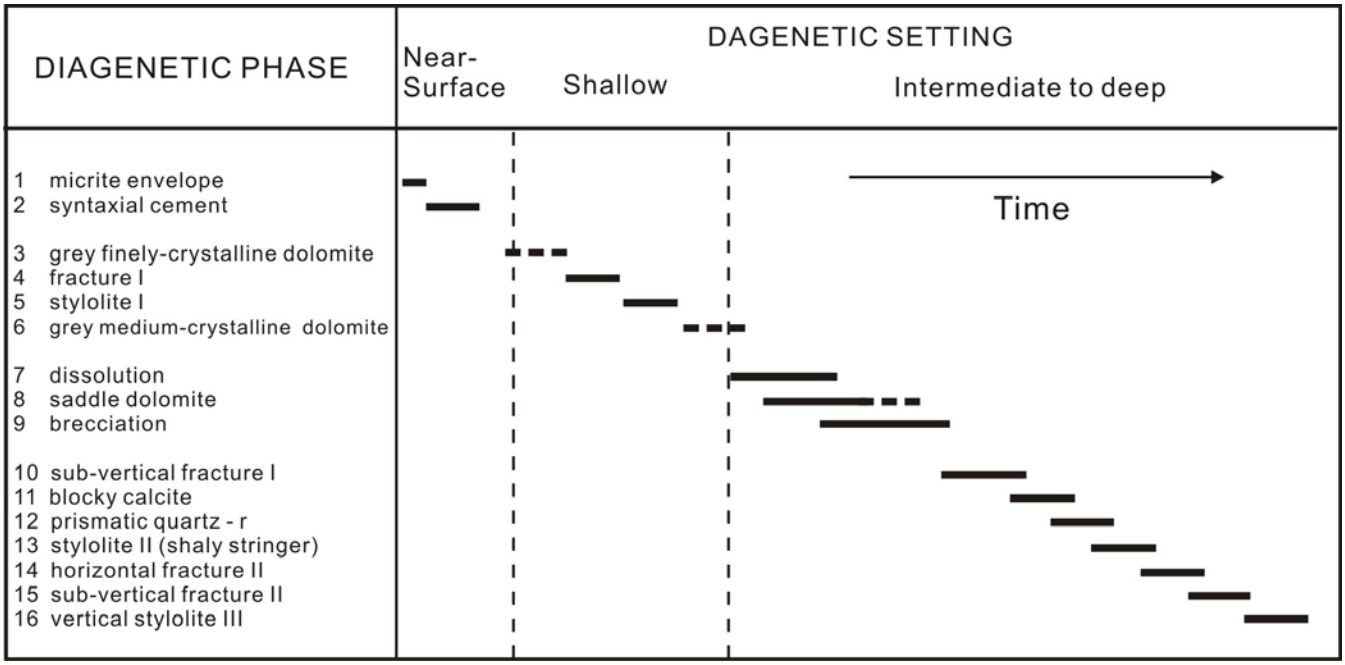

Figure 3: Preliminary summary of diagenetic paragenesis. Thin section samples were collected from the Beaver River and Crow River Gas Fields.

References

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