Regional Stratigraphy and Reservoir Units of the Grosmont Formation, Saleski and Burnt Lakes, Alberta, Canada*

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Introduction

The Grosmont Formation is comprised of shallow-water carbonates deposited in a platform to ramp succession during the Late Devonian. Early dolomitization pervasively replaced the limestone hosts. Erosion and truncation of the Grosmont Formation along its subcrop edge established a karst regime that resulted in leaching of the dolostones by meteoric waters, fracturing, and local clay infiltration. An extensive seal above the subcrop is provided by Lower Cretaceous shale. In the Early Tertiary, the Grosmont Formation was tilted to the west prior to bitumen charge.

Dolomitization and karst processes have significantly altered the fabric of Grosmont carbonates and several studies of reservoir properties emphasize reservoir heterogeneity. In this presentation we emphasize a regional stratigraphic framework to compare and contrast reservoir properties of two lease areas, Saleski Twp085 Rge19W4 and Burnt Lakes Twp095 Rge24W4 some100km to the northwest.

Regional Stratigraphy

The Grosmont Formation is divided into four members separated by three regionally distributed argillaceous carbonate horizons, variously referred to as shale or marl markers. Correlation of members in 5 wells spaced over 105 km is shown in Figure 1. The members have been interpreted as chronostratigraphic units by Cutler (1983) and are identified, from base to top, as the Lower Grosmont, Upper Grosmont 1, Upper Grosmont 2, Upper Grosmont 3; designated LG, UG1, UG2, UG3 or A,B,C,D in contemporary

terminologies. Harrison (1982) and Cutler (1983) interpreted this stratigraphy to represent depositional systems ranging from reef-rimmed platforms (Members A and B) through ramps (Members C and D).

Member A is limestone in the southeast, locally with anhydrite (Cutler 1983), to dolostone and shale in the northwest (Theriault 1987). The transition northwards into a local shale basin within the Grosmont platform is partly governed by subsidence thickening of the formation and hints at a complex of several depositional sequences within Member A.

Member B is comprised of stacked parasequences of shale to calcareous nodular dolostones that thicken and become highly fossiliferous towards the northwest before thinning into argillaceous carbonates.

Member C is represented by two upward shallowing parasequences of argillaceous dolomudstones, through nodular to laminated dolostones. The lower parasequence thins to the south. At the top of Member C is the *CD marl,* interpreted as a separate depositional sequence of argillaceous carbonate by Hopkins and Barrett (2008).

Member D includes at least two depositional sequences. The lower part is laminated peritidal dolostones and dolostone breccias with accessory detrital quartz. A regionally correlative surface marks a basin wide transgression into overlying fossiliferous to laminated dolostone parasequences.

Hydrocarbon Distribution

The bulk of heavy oil trapped within the Grosmont Formation is contained within Members C and D in a belt parallel to the subcrop and about 20 km wide (Dembicki and Machel 1996). The heavy oil column at Saleski reaches a maximum of 65 m thick (LEL 2007). At Burnt Lakes it is 45 m thick and occurs in the upper part of Member C and Member D.

Development

Laricina's Saleski lease is currently being developed for heavy oil production from a pilot project in section 26-085-19W4 (LEL 2007, 2009). Steam injection is planned to commence later in the year 2010. The Burnt Lakes lease is undergoing drilling/seismic evaluation for future pilot development.

Reservoir Units

Reservoir units (Figure 1) are recognised from log properties and comprise one or more dolostone lithologies that have similar petrophysical characteristics. Eight reservoir units in Members C and D have been correlated throughout 20 wells in Twp 085 Rge19W4 of Laricina's Saleski lease (Hopkins and Barrett 2008). Correlations of reservoir units from 1AA/07-26-085-19W4 (Saleski) and 1AA/06-17-095-24W4 (Burnt Lakes) 105 km to the northwest were made by Hopkins et al. (2010).

Stratigraphic continuity of reservoir units of Members C and D between the Saleski and Burnt Lakes leases underscores the broad uniformity of sedimentary and diagenetic processes across the Grosmont carbonate ramp. Within reservoir units, there is a general trend towards more open marine conditions to the northwest, from Saleski (restricted) to Burnt Lakes (less restricted). This is deduced from the increase in fossils, burrows, and broken shell material. Also laminites, indicative of greater hydrodynamic sorting of carbonate host sediment, are much more common at Burnt Lakes.

Manifestation of karst processes as fissures (vugs, channels, fractures, siliciclastic fills) and highly porous leached friable microdolomites are more prominent at Saleski than at Burnt Lakes. In contrast, calcitization of dolomite (dedolomitization) is much more common at Burnt Lakes than Saleski. Calcitization is a feature of fine-crystalline dolostones of the Grosmont Formation in the Liege Field (Theriault and Hutcheon 1987) adjacent to Burnt Lakes. According to these authors, calcitization of dolomite rhombs and leaching to form highly porous microdolomite are related but spatially variable processes.

Unit 6

Unit 6 at Saleski is laminated, massive and brecciated dolostone that varies between 8 and 12 metres thick (Hopkins and Barrett 2009). Core and FMI logs indicate that changes in thickness of Unit 6 occur where bedded, laminated or massive dolostones grade laterally into breccias: brecciated bed sets tend to be thinner.

HMI logs (Figure 2) for 1AA/06-17-94-25W4 (Burnt Lakes) and 1AA/08-27-85-19W4 (Saleski) emphasize that variations in degrees of brecciation at the Unit 6 horizon are regional over 100 km. Both areas exhibit decimetre-bedded carbonates, however, breccias and vuggy porosity are prominent at Saleski. Cavernous porosity at the top of Unit 6 in 1AA/06-17-94-25W4 is revealed by HMI logs, and marks an interval of lost core.

Dolostone breccias in Member D have been interpreted as evaporite dissolution collapse breccias (Cutler 1983; Theriault 1987). Regional and local transitions from bedded dolostones to breccias, suggest these breccias are not necessarily evaporite dissolution breccias.

Conclusions

Regional stratigraphy of the Grosmont along a section parallel to its eastern subcrop indicates deposition of carbonate platform to ramp successions with local subsidence and thickening.

Correlation of reservoir units within Members C and D at Saleski and Burnt Lakes, 105 km apart, underscores a basic sedimentary theme of marine to peritidal carbonates with subtle differences in the importance and distribution of facies.

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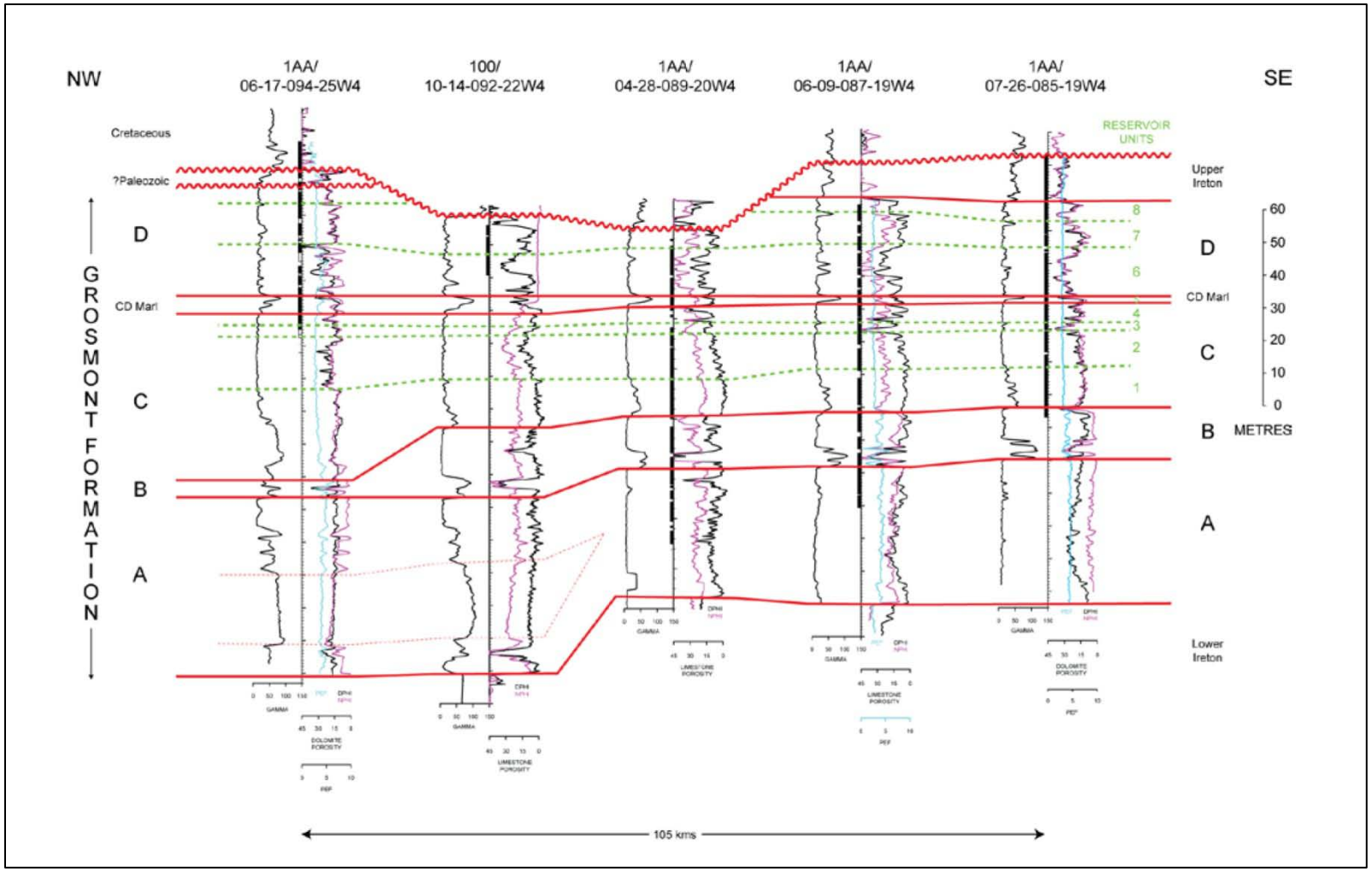

Figure 1. Regional northwest-southeast cross section oriented roughly parallel to strike of sub-Cretaceous subcrop. Wells 1AA/06-17-094-25W4 and 1AA/07-26-085-19W4, at each end of the line of section, are from the Burnt Lakes and Saleski leases respectively. From Hopkins et al. (2010).

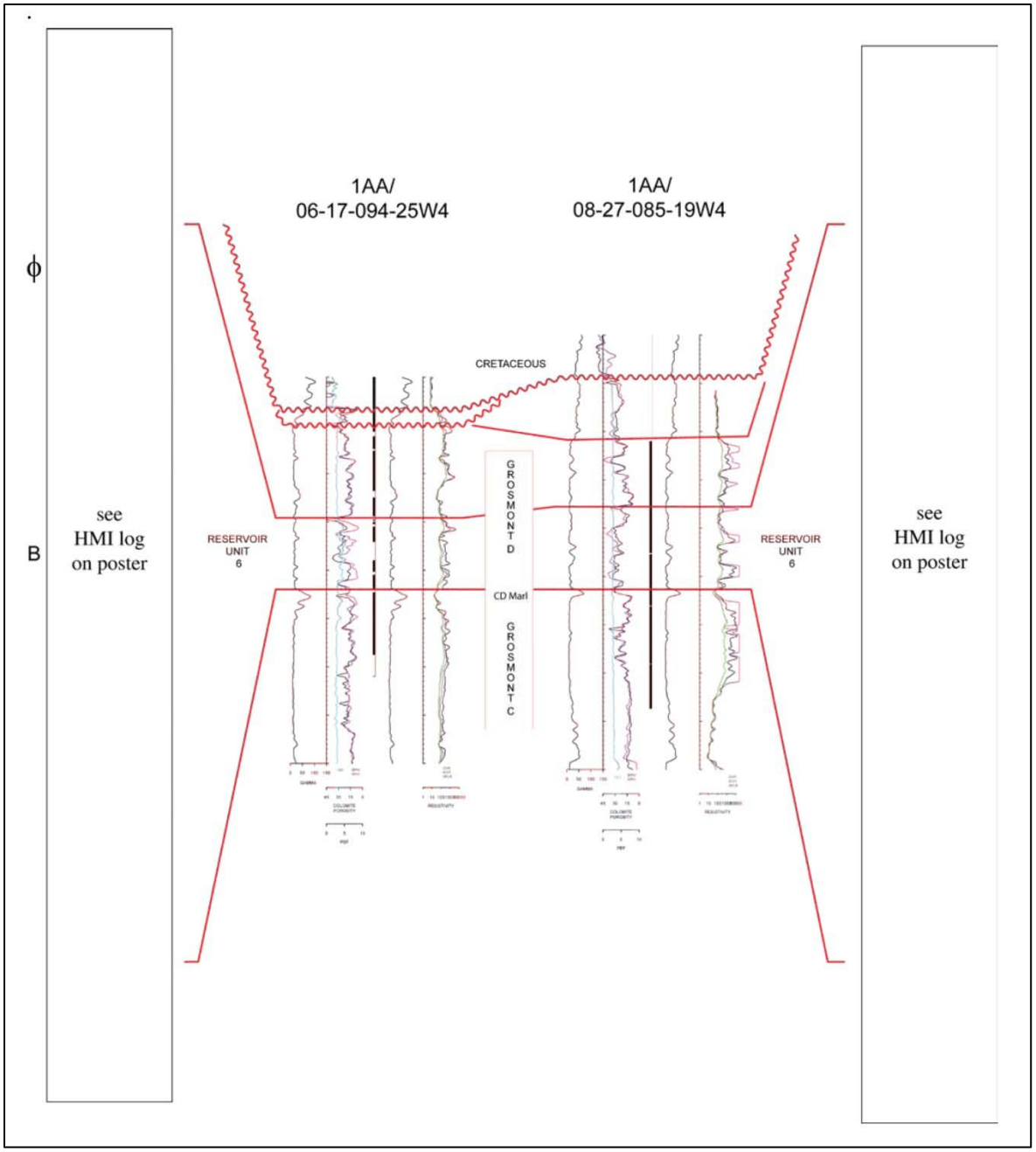

Figure 2. HMI logs for Reservoir Unit 6 of the Grosmont Formation contrasting the degree of brecciation of bedded dolostones in 1AA/06-17-094-25W4 (Burnt Lakes) and 1AA/08-27-085-19W4 (Saleski). Breccia (B) and cavernous porosity (ϕ) are present only locally in 1AA/06-17-094-25W4.