Towards Economic Production of Grosmont Formation Bitumen: Assessing the Relative Influence of Reservoir Porosity and Permeability, Versus Bitumen Quality, on Production Potential

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Summary

Economic production of the large carbonate-hosted bitumen deposits of Alberta not only requires new production technologies, but a paradigm shift in how we evaluate reservoirs. Successful strategies must go beyond traditional geological methods of characterizing porosity and permeability and incorporate biodegradation and viscosity gradients. In the Grosmont Formation, the most prospective reservoirs appear to be those located down-dip from the porous subcrop edge, where improved bitumen viscosities translate into significantly improved potential flow rates.

Introduction

Vast volumes of bitumen are hosted within carbonates of the Devonian Grosmont Formation of northeastern Alberta; however, only a very small portion of this bitumen is currently recoverable (Hein, 2006). Recovery of these deposits presents unique challenges, namely the heterogeneity of reservoir porosity, and extreme bitumen viscosity. Previous studies and production efforts focused on the eastern portion of the deposit, near the Grosmont Formation subcrop edge. Grosmont Formation reservoirs neighboring the subcrop are shallow, have thick pay columns and possess enhanced reservoir porosity due to karstification (Dembicki 1994; Huebscher 1996).

Grosmont-hosted bitumen is more biodegraded, and of lower quality, than that of the overlying Cretaceous tar sands (Brooks *et al.* 1988). Regional variations in bitumen quality are also apparent in northeastern Alberta, with westerly fields hosting less biodegraded oil (Adams *et al*., 2006). Recent advances in petroleum geochemistry relate such biodegradation gradients to quantifiable geological factors such as maximum burial temperature, charge history, presence of a bottom seal, and the nature of the oil-water contact (Larter *et al.* 2003, 2006). Most importantly for production purposes, these biodegradation gradients relate to large variations in viscosity and have significant impact on flow rates (Larter *et al.* 2006).

Objective

Westerly Grosmont reservoirs tend to have lower porosity and permeability than their up-dip stratigraphic equivalents at the subcrop edge. However, these reservoirs have the potential to host higher quality bitumen with significantly lower viscosity. This study assesses whether oil quality and viscosity outweigh reservoir porosity and permeability variations when evaluating production potential from the Grosmont Formation.

Methods

Subcrop-type Grosmont reservoirs are well described and characterized in the literature (Luo and Machel, 1995). Porosity and permeability data from these studies are mapped to geological facies and compared to wireline log responses. These log responses, and facies models are extrapolated in order to characterize the down-dip Grosmont Formation reservoirs.

Most of the detailed published studies of Grosmont Formation stratigraphy, sedimentology and diagenesis predate the widespread use of the PE log (photoelectric effect). PE log response is proven to be a useful and quick tool for mapping highly prospective dolomitized zones within the Grosmont. Other methods used include detailed core description, thin section, and acetate peel analysis.

Grosmont oil viscosities are estimated from published geochemical data as well as regional viscosity trends in the overlying Cretaceous strata. In combination with the detailed reservoir characterizations, these viscosities are used to compare potential flow rates and production from the subcrop and down-dip Grosmont reservoirs.

Core Examples

Representative examples of significant porosity and permeability types from the Grosmont Formation are presented in core. The highly heterogeneous nature of the core also highlights the complex nature of the reservoir. Examples of heterogeneity in both the scale and the nature of Grosmont porosity are represented in Figures 1 and 2.

Conclusions

Although Grosmont subcrop reservoirs are associated with higher porosity and permeability, down-dip Grosmont reservoirs have the potential for significantly decreased bitumen viscosities. In addition, down-dip Grosmont reservoirs possess a more predictable reservoir architecture and better seal / flow barrier integrity; these are essential components for enhanced recovery schemes, such as steam injection.

In conclusion, bitumen viscosity is a key variable for evaluating Grosmont Formation plays. The down-dip Grosmont Formation reservoirs are prospective and merit further work, such as the acquisition of additional geochemical data.

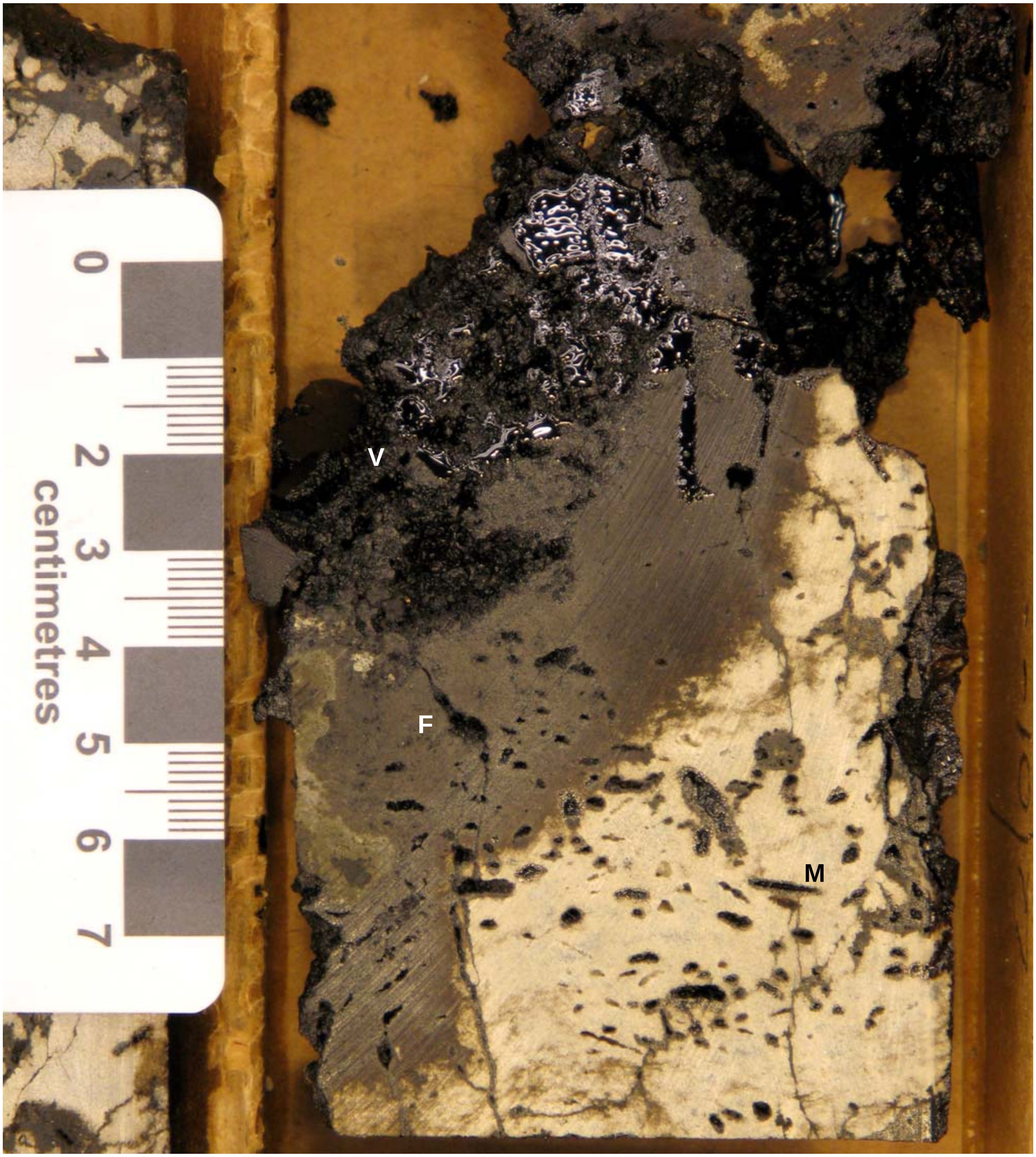

Figure 1: Core photograph of the Grosmont Formation displaying moldic, vuggy (V) and fracture (F) porosity types. Sample from 00/4-28-089-20W4 at 1077 feet depth.

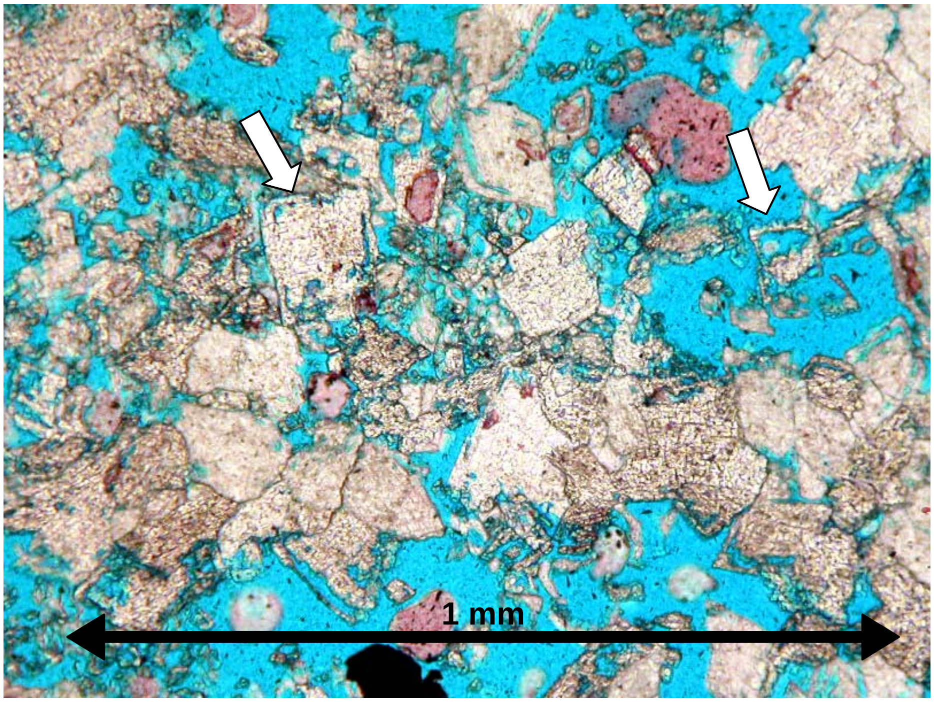

Figure 2: Plane polarized light thin section photomicrograph of Grosmont Formation dolomite. Note the intracrystal dissolution within dolomite rhombs (white arrows). The thin section has been impregnated with blue epoxy and stained with Alizarin Red S and Potassium Ferricyanide. Sample from 00/4-28-089-20W4 at 908.5 feet depth.

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