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Depositional processes and environments of the Belle Fourche Formation, southern Alberta, Canada

Emma L. Percy
Department of Geoscience, University of Calgary

Per K. Pedersen
Department of Geoscience, University of Calgary

Summary

The purpose of this study is to determine the processes that deposited the mudstone dominated Cenomanian Belle Fourche Formation. The hypothesis for this study is that during the Cenomanian there was an east-west trending depocentre of unfilled accommodation space that existed between the Dunvegan Formation and the sandstones that make up the Belle Fourche Formation biogenic gas reservoirs in south-eastern Alberta (Figure 1). These Belle Fourche Formation sandstones are proposed to be shoreface deposits that underwent subsequent transgressive erosion that removed the shallower water deposits. This research will have implications for potential areas of unfilled accommodation space that would be conducive for the deposition of organic-rich mudstones.

Introduction

The Kaskapau Formation in north-western Alberta has been interpreted as being storm-influenced shelfal deposits on a low-angle ramp (Varban and Plint, 2008; Plint et al., 2012a). These studies are focussed in northern Alberta, and only address the Kaskapau Formation that is equivalent to the Second White Specks Formation to the middle Belle Fourche Formation. Therefore, these studies failed to explain the origin of the sandstones in south-eastern Alberta from which biogenic gas is being produced. Yang and Miall (2008; 2009; 2010) and Yang (2011) proposed that the Belle Fourche Formation was deposited in the backbulge of the foreland basin and that the biogenic gas sandstone reservoirs represented eroded material off of the forebulge. This model proposes a north-south trending forebulge that was uplifted in Alberta during the Cenomanian (Figure 1); however, this does not explain the linear, NW-SE oriented pools in south-eastern Alberta. An alternative explanation for the origin of these sandstones is that these deposits are distal shoreface deposits that have undergone subsequent transgressive erosion. This model requires very limited accommodation space, which is consistent with correlations completed by Yang (2011). This proposed model also explains the long distance transport of mud across a low-gradient basin.

Other studies have used isopach maps to determine thickness variations of allomembers within the Fish Scales, Belle Fourche and Second White Specks formations (Yang and Miall 2008; Yang and Miall 2009; Yang and Miall 2010; Plint et al., 2012b; Yang, 2011). These papers claim that isopach maps reveal the location of depocentres created through the migration of a forebulge in the central part of Alberta. These papers make the assumption that water depth is uniform and sediment has filled in all accommodation space below the storm-wave base in the basin, with no significant support of this assumption. The allomembers of the Belle Fourche Formation are wedge shaped and thicken westwards, indicating that there was tectonic induced subsidence at this time. An organic-rich unit occurs in the lower Belle Fourche Formation in the study area that correlates to allomember C of the Dunvegan Formation defined by Plint and Tyagi (2009). This supports that there was unfilled accommodation space in the middle of Alberta at this time.

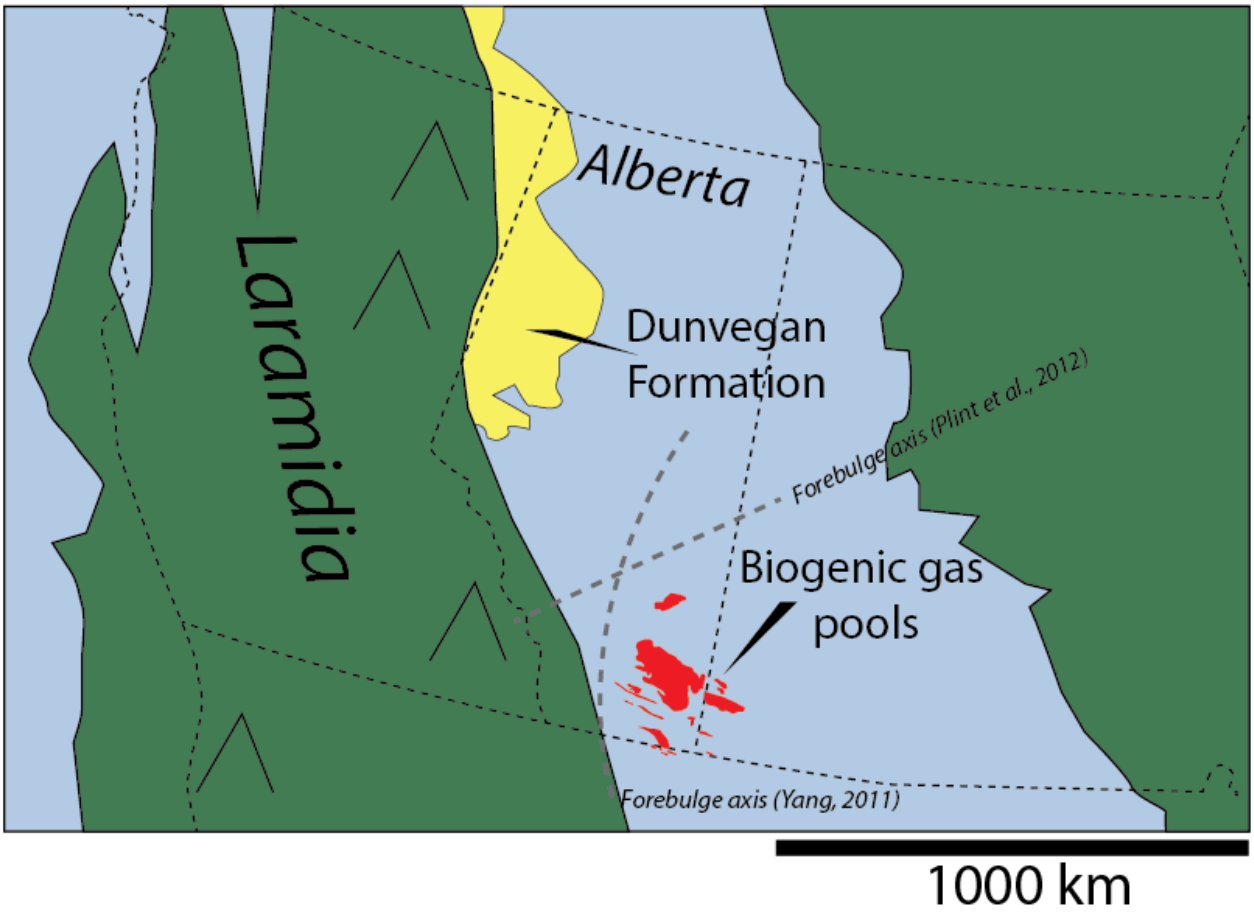

Figure 1: Paleogeography of the Western Interior Seaway during the Cenomanian. The Dunvegan Formation is shown in yellow, and the biogenic gas pools of the Belle Fourche Formation are shown in red. These pools do not match the trends of Cenomanian forebulges proposed by Yang (2011) and Plint et al. (2012).

Theory and/or Method

Described core and outcrop are correalted to subsurface well logs. An allostratigraphic framework has been correlated using flooding surfaces, bentonites and unconformities for southern Alberta using close (<5km) well spacing in order to resolve subtle stratal geometry changes. Facies identified from core and outrop are compared in order to asses how they vary regionally. Detailed cross-sections using well and core data can be made in the biogenic gas fields because of the abundance of well data. These correlations will be used to resolve the geometry and relationships between stratigraphci surfaces and facies in order to determine the depositional environment of these deposits.

Conclusions

The orientation of biogenic gas pools in the Belle Fourche Formation do not coincide with forebulge orientations proposed by Yang (2011) and Plint et al. (2012b). Instead, this research proposes that unfilled accommodation space existed between these biogenic gas pools and the Dunvegan Formation; an area of organic-rich mudstone deposition. These findings have implications for the paleogeography and depositional environments of the Western Interior Seaway during the Cenomanian.

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