

# TRIASSIC POROSITY TRENDS IN NORTHEASTERN BRITISH COLUMBIA UPDATE FEBRUARY 2009

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## ABSTRACT

*This report updates Triassic porosity-trend mapping from 2008 to identify possible sites for carbon storage and sequestration (CCS). Wireline logs from an additional 200 wells were added to the initial study of 600 wells to improve data density and extend the study area. A strong southeast Halfway Formation porosity trend, roughly adjacent to the edge of the deformed belt, was reaffirmed. The best prospects for CCS are likely to be found in thick, porous sections of the Halfway and Baldonnel formations near the southern end of the map area. Secure locations for CCS might also be located in several more isolated, lightly drilled areas around the edge of existing Triassic oil and gas production.*

Janicki, E. (2010): Triassic porosity trends in northeastern British Columbia — update February 2009; in Geoscience Reports 2010, BC Ministry of Energy, Mines and Petroleum Resources, pages 93–97.

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**Key Words:** Triassic, porosity, Halfway Formation, Baldonnel Formation, Carbon Capture and Storage (CCS), water disposal

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## INTRODUCTION

After reviewing an initial set of Triassic porosity-trend maps published in 2008 (Janicki, 2008), additional data was collected from the central portion and around the edges of the map (Figure 1). In this subsequent phase of mapping, 213 well locations were added to the 600 wells selected in 2008 to enhance the overall result. Approximately one extra location per township or NTS block was added, employing the same set of well-log quality criteria used for the initial phase (e.g., newer wells and Compensated Neutron/Formation Density (CNFD) preferred). Attention was paid to finding suitable locations around the map edges to the north and west while the southern edge was extended by roughly one township. The same log criteria for porosity cut-offs (10% porosity for the Halfway Formation and 6% for the Baldonnel Formation) were used as in 2008.

Only the Halfway and Baldonnel formation maps were revised because they seem to hold the greatest promise for CCS among Triassic formations in this area. Both of these formations have long been used for the analogous activity of water disposal, and more recently for limited disposal of acid gas. Good Doig Formation porosity is scattered and of limited areal extent. Porosity in the various Charlie Lake Formation members tends to be thin and inconsistent.

## FINDINGS

### *Halfway Formation porosity*

The updated porosity mapping (Figure 1) of the Halfway Formation shows essentially the same southeast trend displayed in the previous version. Several thick accumulations are centred along the edge of the deformed belt, which may suggest that deep-seated structures played a role in influencing porosity distribution (the Laramide orogeny having occurred after the deposition of the Halfway Formation). A separate northeast data trend, which has been made a little more apparent with additional data, also appears to be related to deep-seated structural influences — in this case, the Great Slave Shear Zone.

Thick and wet (water-saturated) Halfway Formation porosity (Figure 1) might represent the best possible situation for CCS because good reservoir capacity can be inferred and there is no offsetting hydrocarbon production. The best area displaying these characteristics occurs at the southern edge of the map area, and to a lesser degree scattered throughout the central portion of the map, north of Fort St John.

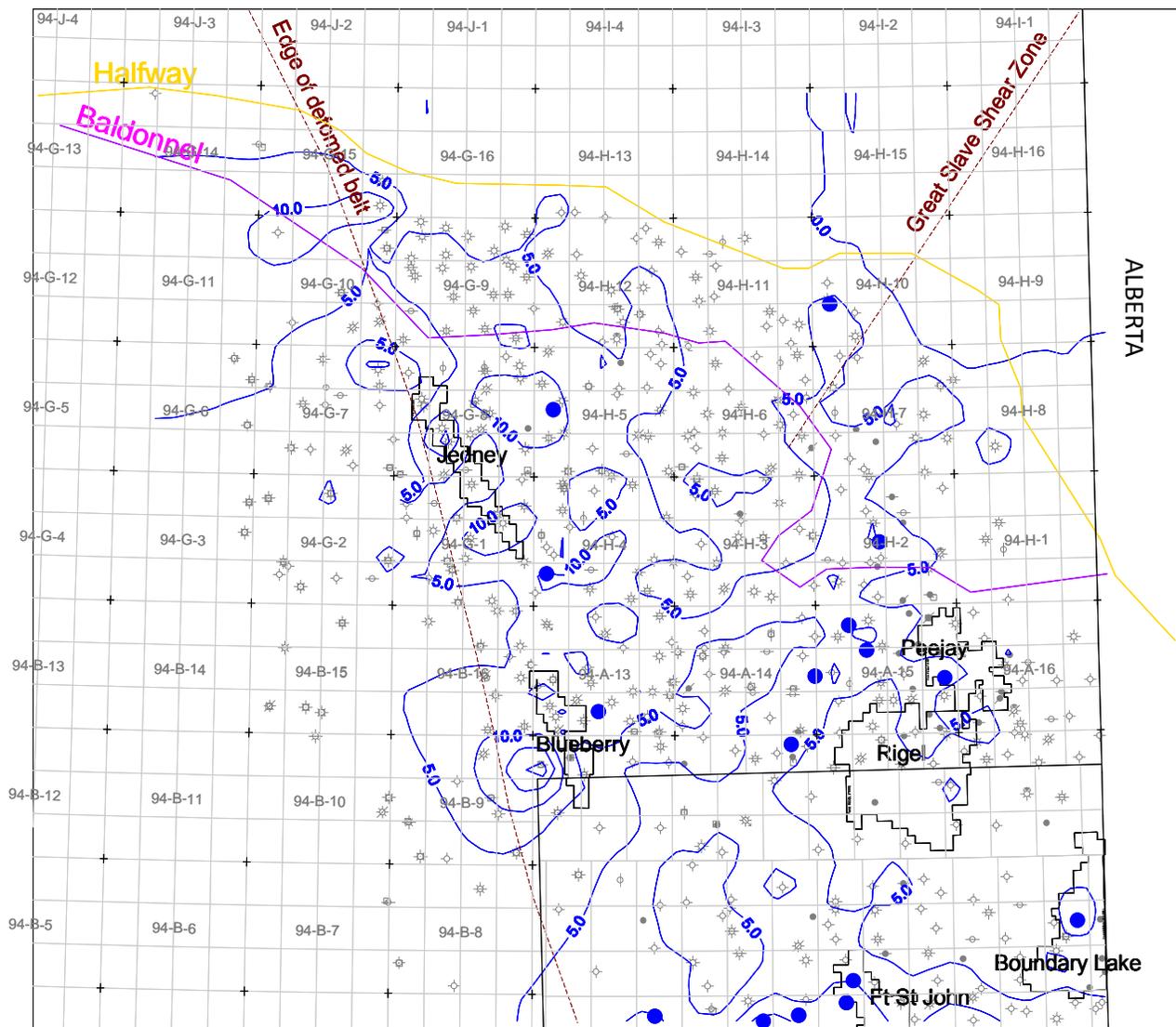


Figure 1. Halfway Formation porosity; contour interval 5 m. Blue dots represent wells where porosity in the Halfway Formation is thick, wet and possibly well suited for CCS. Selected oil and gas fields with production in the Halfway Formation are outlined in black. The Baldonnel Formation subcrop edge is indicated by magenta; the Halfway Formation depositional edge is in yellow. Wells included in this study are shown in grey. Petroleum and Natural Gas grid groups are indicated by 94-B-6, 94-B-7, etc. (Petroleum and Natural Gas Act, 1996). The Peace River Block is outlined in the southeast corner.

### ***Baldonnel Formation porosity***

Porosity trends are more difficult to distinguish for the Baldonnel Formation (Figure 2) than for the Halfway Formation because they are segregated into a few relatively thick areas isolated by intervening areas of low porosity. The single region of wet Baldonnel Formation porosity identified presents an interesting prospect for CCS because it is discretely concentrated into one small area at the southern end of the map (Figure 2), surrounded by relatively nonporous rock.

### **CARBON CAPTURE AND STORAGE**

Figure 3 shows some possible prospects for CCS in the map area. These are locations with greater than 10 m in the Halfway Formation, where the injection of carbon dioxide would likely occur sufficiently far from the existing boreholes to minimize the possibility of upward migration.

For the purpose of carbon capture and storage (CCS) and/or deep waste disposal, an ideal location should meet the following criteria, at least in part (Texas World Operations, 2008):

- It should have a thick and continuous porous section.
- It should have good matrix permeability.
- It should not be highly fractured.

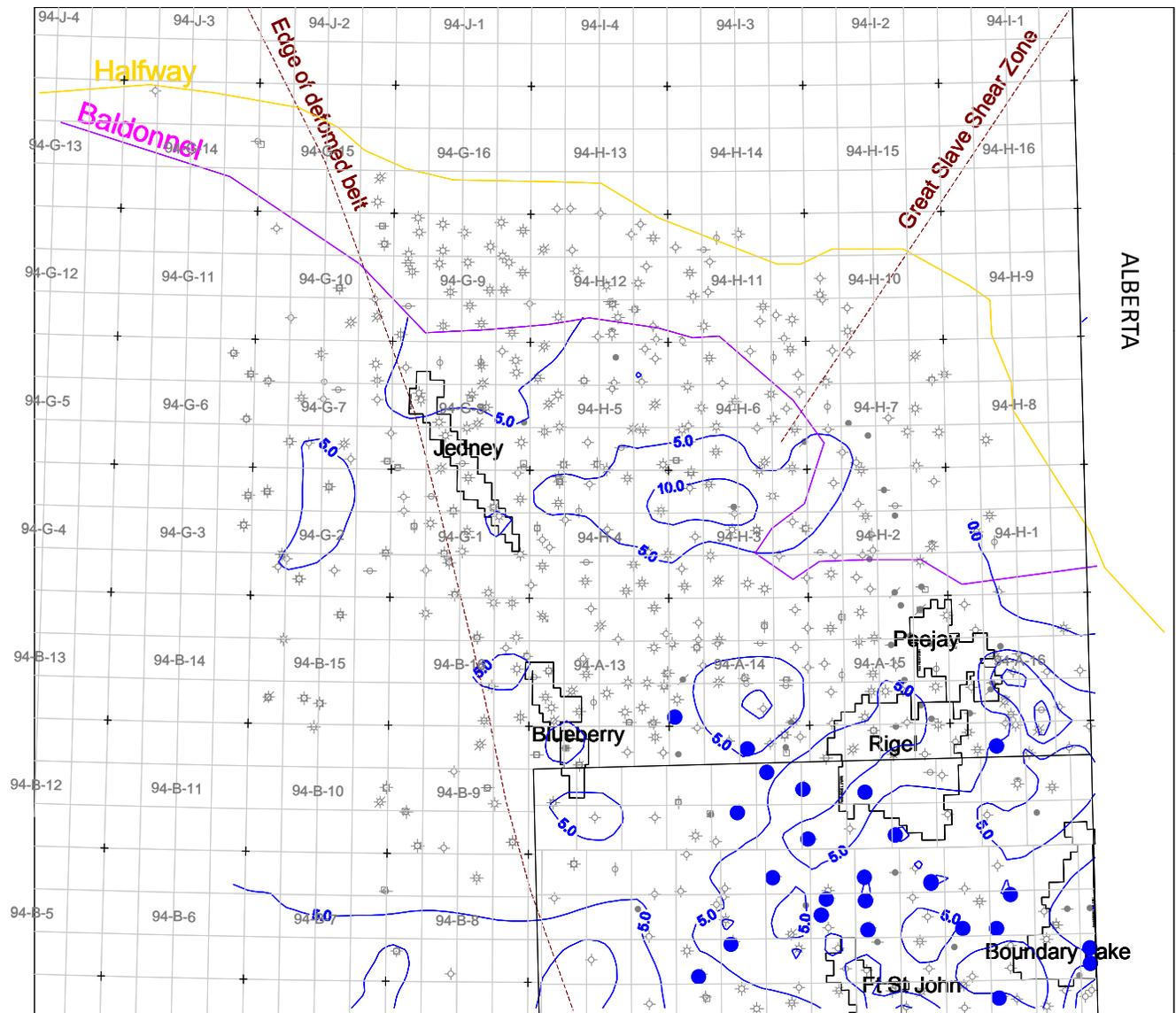


Figure 2. Baldonnell Formation porosity; contour interval 5 m. Trends may not be apparent, but the central part of the map area appears to be relatively less favourable for Baldonnell Formation porosity. Locations with wet Baldonnell Formation porosity are shown with blue dots.

- It should be isolated from other wells, producing or abandoned.
- It should have a good seal; the trap should be secure.
- It should be within a reservoir with readily defined boundaries, or within a large, slow-moving aquifer.
- It should be in a stable, unfaulted structure.
- It should preferably not be offset by hydrocarbon producers from the same reservoir to avoid potential conflicts.

Based on these criteria, the Halfway Formation appears to be more favourable than the Baldonnell Formation for CCS. Porosity in the Halfway Formation is usually in one thick, continuous zone, whereas Baldonnell Formation porosity is often divided into thin irregular streaks. Perme-

ability in the Halfway Formation is usually intergranular, whereas the Baldonnell Formation depends to a greater extent on natural fracturing to provide pathways for fluids or gas to flow. Porosity is also generally higher in the Halfway Formation, which would provide more storage capacity for CCS. The Halfway Formation has served as a water disposal zone at a number of wells in northeastern British Columbia (Janicki, unpublished work, 2008), so that gives reason to expect it to be appropriate for CCS as well. The Baldonnell Formation could also be acceptable for CCS because it is also used for water disposal with no reported incidents, but its tendency to fracture and the shallower depth are cause for further investigation.

A difficult, but important, criterion to satisfy in this study area is the preference for isolation from other wells.

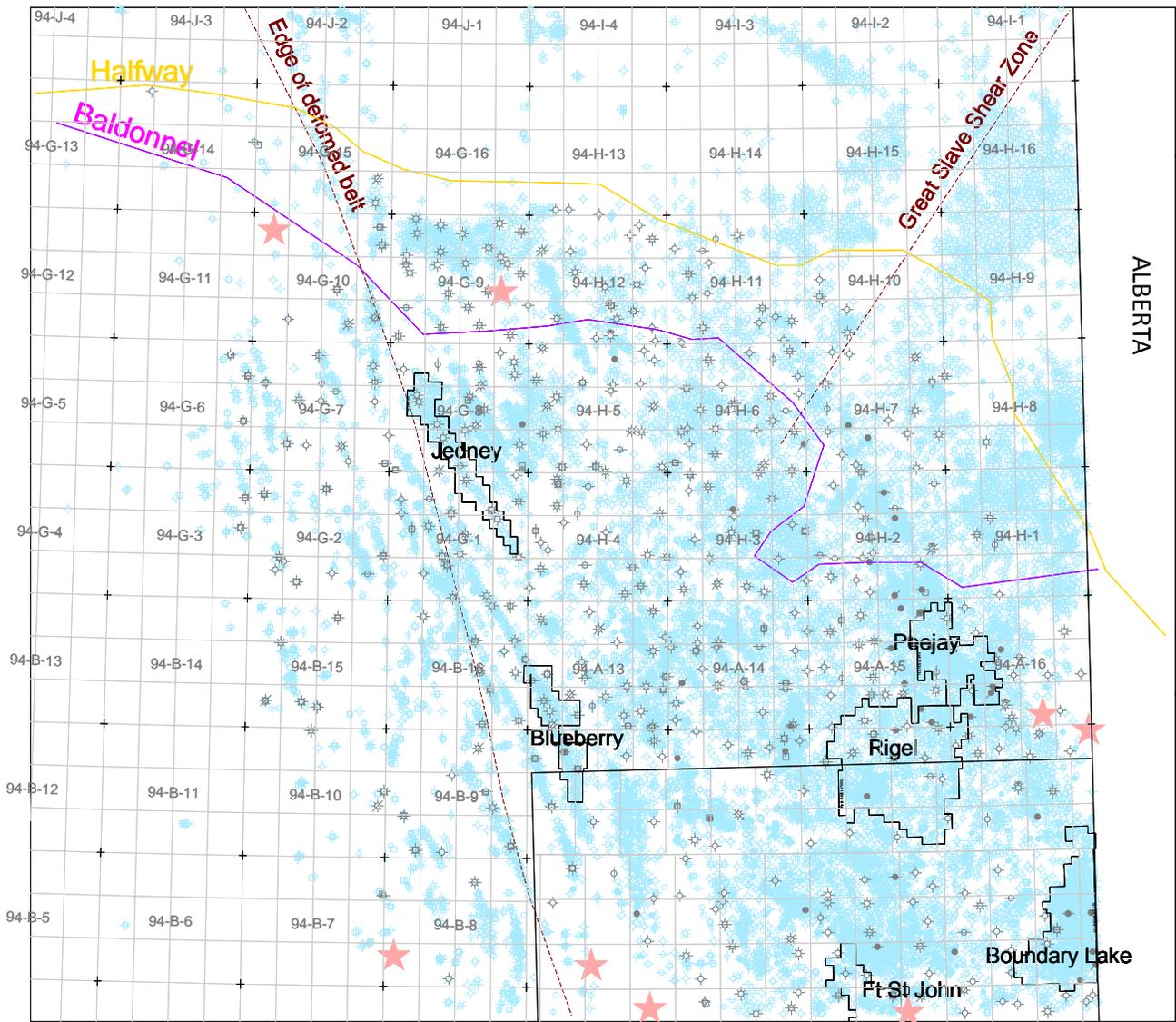


Figure 3. Suggested CCS locations in the Halfway Formation. Favourable locations for CCS are identified with pink stars. They may be sufficiently isolated from other boreholes to avoid uphole migration, and they have at least 10 m of rock with porosity greater than 10%. Wells selected for inclusion in this study are indicated by black well symbols; the balance of wells in the study area is indicated in light blue.

At the scale of mapping presented here, the density of drilling illustrates the difficulty of placing a CCS facility. Most of the areas mapped with thick Halfway or Baldonnell formation porosity rocks are surrounded by many existing wells. The use of these locations for CCS would require a stringent review of the integrity of the surrounding boreholes to ensure no leakage up improperly completed or abandoned boreholes. The locations suggested in Figure 3 could be drilled far enough from existing wells that it would likely take many years for CO<sub>2</sub> to reach the closest well. Further work would be required to ensure the suitability of site-specific CCS locations.

## CONCLUSIONS

Two hundred additional well data points were added to the Triassic porosity mapping originally done in 2008. Greater data density in the central regions of the map area was achieved along with greater control along the edges.

The Halfway Formation appears to be the most promising Triassic strata within the map area for the purpose of CCS, due to the more continuous nature of the porosity, deeper burial within the subsurface and proven storage capacity for water disposal. To avoid possible leakage up other boreholes, isolated areas with thick Halfway Formation porosity should initially be considered.

The Baldonnel Formation has generally less favourable characteristics for CCS due to its shallower depth of burial, lower porosity and the greater degree of fracturing. However, of note, the Baldonnel Formation has a long history of use for water disposal with no reported leakage or contamination issues.

The data used for this mapping have been compiled and are available upon request.

## REFERENCES

- Janicki, E.P. (2008): Triassic porosity trends in northeastern British Columbia; in Geoscience Reports 2008, *BC Ministry of Energy, Mines and Petroleum Resources*, pages 59–66.
- Petroleum and Natural Gas Act (1996): Chapter 361: petroleum and natural gas grid regulation, Regulation 536/2004; *BC Oil and Gas Commission, Queen's Printer*, Victoria, British Columbia, Revised Statutes British Columbia (RSBC), 79 p.
- Texas World Operations (2008): Class I UIC operator training; *Ground Water Protection Council* – January 2008, New Orleans, Louisiana.

