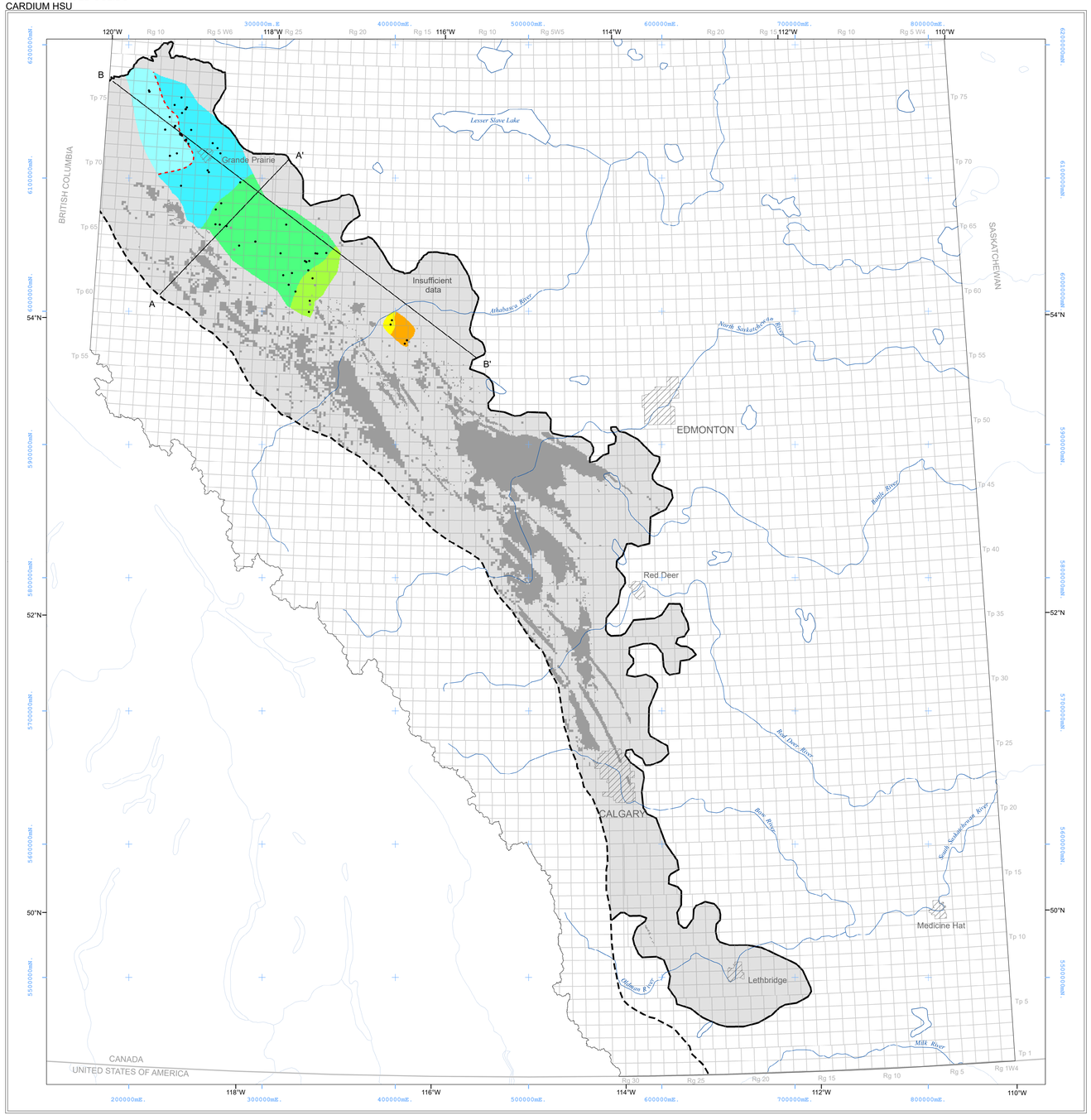
TOTAL DISSOLVED SOLIDS
CARDIUM HSU



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Map 544

Distribution of Total Dissolved Solids in the Cardium Hydrostratigraphic Unit

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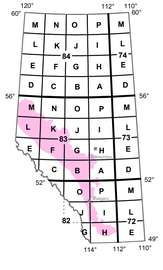
Scale 1:1 750 000

60 30 0 60 120 Kilometres
25 12.5 0 25 50 Miles

Projection: 10 Degree Transverse Mercator
Datum: North American Datum, 1983



SYMBOL LEGEND

Total dissolved solids (mg/L)
- 1 800 - 4 000
- 4 001 - 8 000
- 8 001 - 12 000
- 12 001 - 16 000
- 16 001 - 20 000
- 20 001 - 23 000

- Well data point
- Hydrostratigraphic unit extent
- Non-saline / saline boundary (4 000 mg/L)
- Eastern limit of main Cordilleran deformation
- Cross-section line A — A'
- Hydrocarbon pool within the Cardium HSU
- Insufficient data

This map depicts the distribution of total dissolved solids (TDS) in groundwater in the Cardium hydrostratigraphic unit (HSU). The horizontal and vertical extent of the unit was adopted from the 3D Provincial Geological Framework Model of Alberta, Version 2 (Alberta Geological Survey, 2019a). The relationship of the Cardium HSU with the units above and below as well as its geometry can be seen in Figures 1 and 2.

Methodology

The TDS distribution map is a result of an empirical Bayesian kriging technique using publicly available data from 55 water chemistry analyses from oil and gas wells and 11 water chemistry analyses submitted with Water Act license applications. A screening process modified from Jensen et al. (2013) was used to ensure that only representative formation water chemistries were used.

Hydrogeological mapping was performed in the northern portion of the Cardium HSU, where drillstem tests from oil and gas wells with water recoveries, and water wells are present (Figure 3). Measured TDS values range from 2 491 mg/L to 23 051 mg/L. Hydrocarbon production in the mapped northern portion of the Cardium HSU is infrequent and isolated, while extensive production from hydrocarbon pools is found throughout the remainder of the Cardium HSU (dark grey area on map), precluding the availability of water chemistry data for TDS mapping. The final gridded map surface was clipped based on the spatial distribution of representative data. Residual values are plotted at each location (Figure 4) to indicate where underprediction or overprediction occurs compared to the measured TDS values.

Additional formation-scale hydrogeological maps for the Cardium HSU are presented in Figures 5 and 6. Figure 5 shows the distribution of hydraulic head in the Cardium HSU, with hydraulic heads calculated using fresh water density. Figure 6 shows the water driving force (WDF) vector map for the Cardium HSU. The WDF vector map allows identification of areas where the buoyancy effect of formation water density has the potential to change the inferred magnitude and direction of groundwater flow (Singh et al., 2017). Buoyancy does not appear to have a significant effect on groundwater flow in the Cardium HSU.

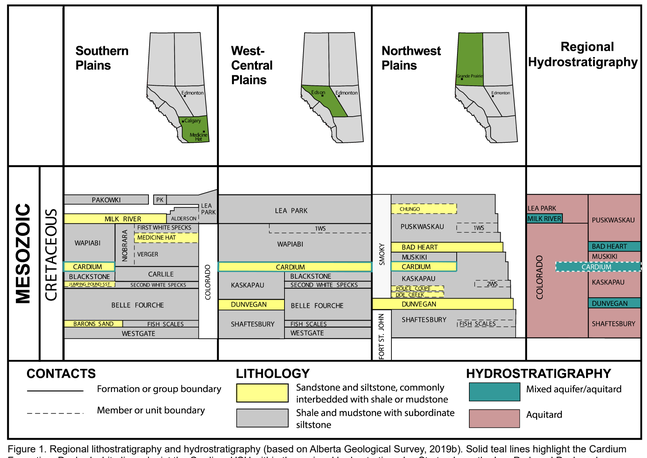


Figure 1. Regional lithostratigraphy and hydrostratigraphy (based on Alberta Geological Survey, 2019b). Solid teal lines highlight the Cardium Formation. Dashed white lines depict the Cardium HSU within the regional hydrostratigraphy. Strata above the Lea Park and Puskwaskau formations are not shown.

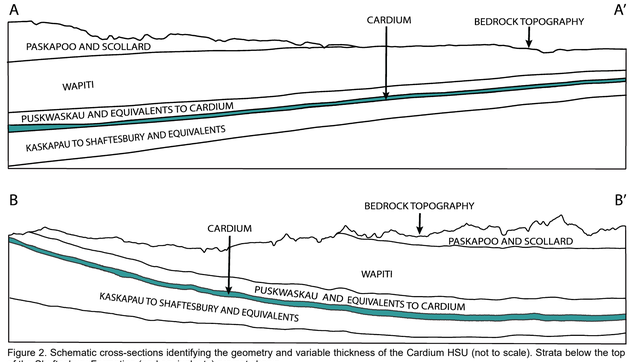


Figure 2. Schematic cross-sections identifying the geometry and variable thickness of the Cardium HSU (not to scale). Strata below the top of the Shaftesbury Formation (and equivalents) are not shown.

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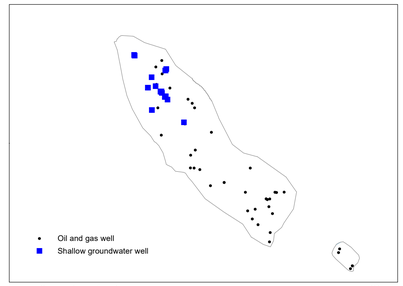

Figure 3. Location of water source wells, and oil and gas wells used in mapping TDS in the Cardium HSU.

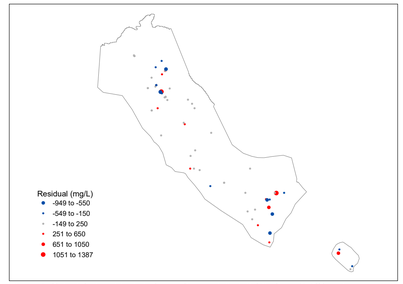

Figure 4. Calculated residuals between the modelled distribution of TDS and measured values. Symbol classes are based on the standard deviation of the calculated residuals.

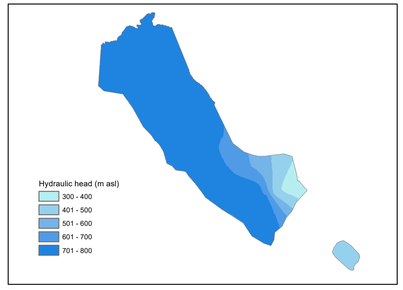

Figure 5. Distribution of hydraulic head in the mapped portion of the Cardium HSU (Brinsky, 2021). The map extent is based on the spatial distribution of hydraulic head data and differs from the extent of the main map.

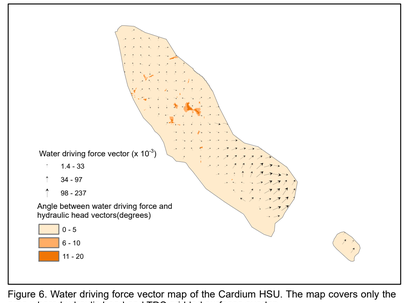

Figure 6. Water driving force vector map of the Cardium HSU. The map covers only the area where hydraulic head and TDS gridded surfaces overlap.

Acknowledgements

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Recommended Reference Format

Brinsky, J. (2021): Distribution of total dissolved solids in the Cardium hydrostratigraphic unit; Alberta Energy Regulator / Alberta Geological Survey, AER/AGS Map 544, scale 1:1 750 000.

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