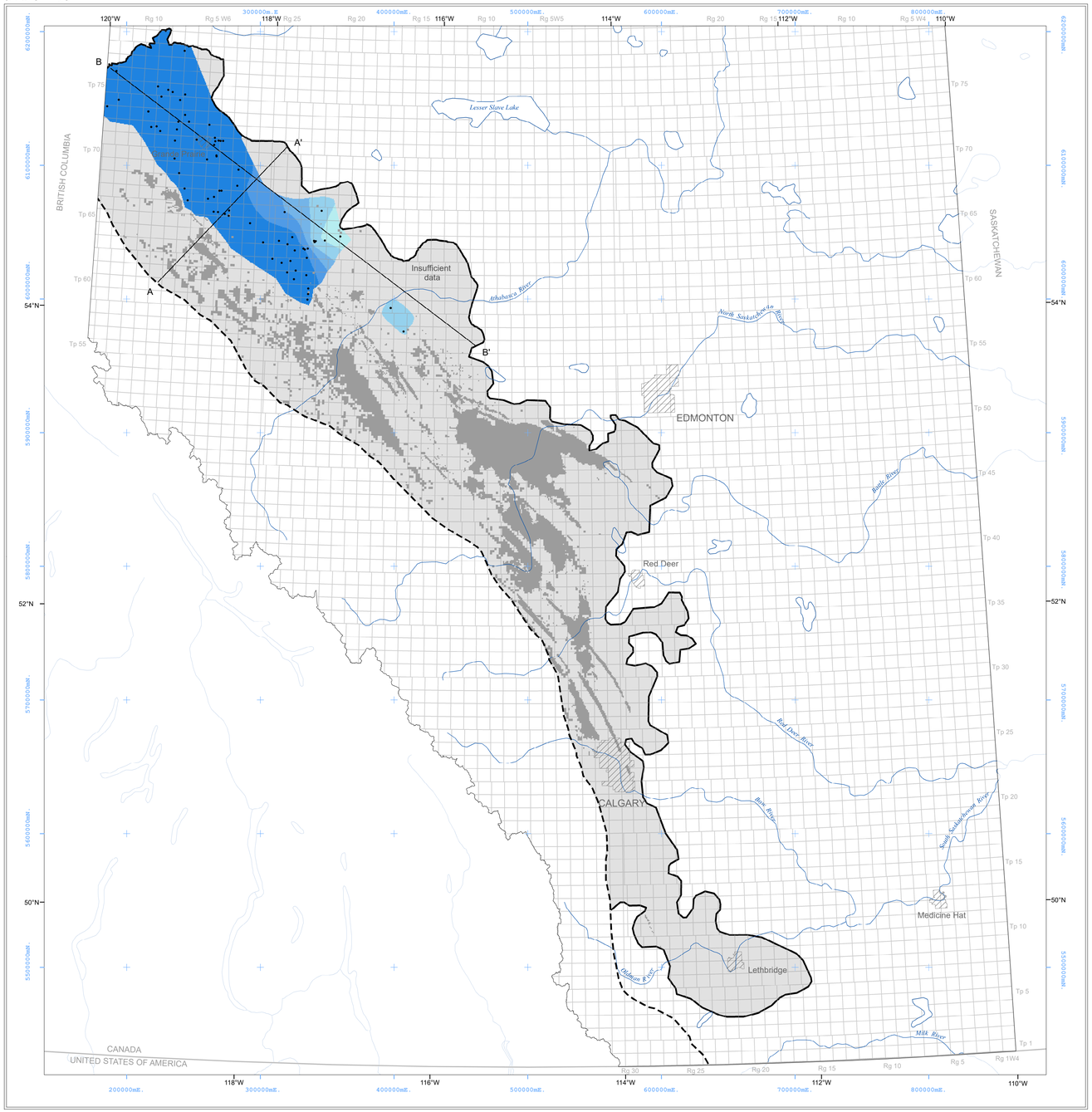
HYDRAULIC HEAD
CARDIUM HSU



Alberta Geological Survey
www.ags.aer.ca

Published 2021
ISBN 978-1-4601-4936-2

Map 545

Distribution of Hydraulic Head 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

Alberta Energy Regulator

AGS ALBERTA GEOLOGICAL SURVEY 100 YEARS

SYMBOL LEGEND

Hydraulic head (m asl)
- 300 - 400
- 401 - 500
- 501 - 600
- 601 - 700
- 701 - 800

- Well data point
- Hydrostratigraphic unit extent
- 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 hydraulic head in the Cardium hydrostratigraphic unit (HSU). The horizontal and vertical extent of the unit was adopted from the 3D Provincial Geological Framework Model, 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 hydraulic head distribution map is a result of an empirical Bayesian kriging technique using publicly available static water levels from 4 water wells and pressure data from 73 drillstem tests from oil and gas wells. A screening process modified from Jensen et al. (2013) was used to ensure that only representative pressures were used to calculate equivalent fresh water hydraulic heads.

Hydrogeological mapping was performed in the northern portion of the Cardium HSU, where drillstem tests with water recoveries, and water wells are present (Figure 3). Hydrocarbon production in the mapped northern portion of the Cardium HSU is infrequent and isolated. Using the methodology of Singh et al. (2017) the Cumulative Interference Index was determined, and no tests were identified as being influenced by production or injection activities. More extensive production from hydrocarbon pools is found throughout the remainder of the Cardium HSU (dark grey area on map), precluding the availability of data for hydraulic head 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 hydraulic head values.

Additional formation-scale hydrogeological maps for the Cardium HSU are presented in Figures 5 and 6. Figure 5 shows the distribution of total dissolved solids in the Cardium HSU. 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.

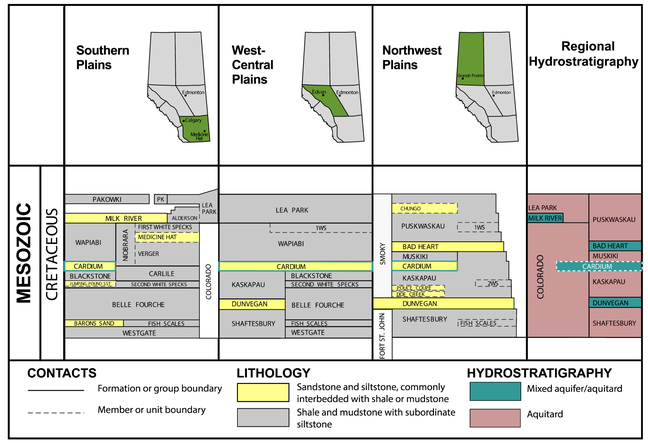

Figure 1. Regional lithostratigraphy and hydrostratigraphy (based on Alberta Geological Survey, 2019b). Solid teal lines highlight the Cardium Formation. Dashed white lines depict the Cardium HSU within the regional hydrostratigraphy. Strata above the Lea Park and Puskwaskau formations are not shown.

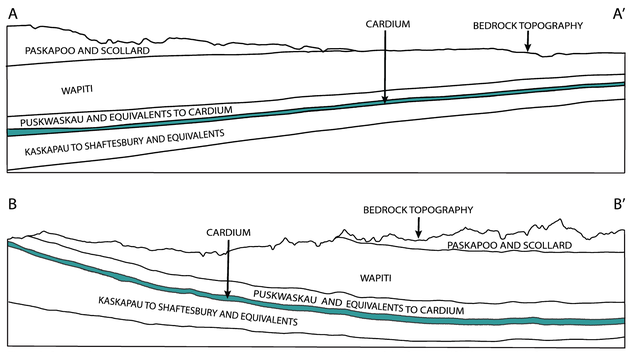

Figure 2. Schematic cross-sections identifying the geometry and variable thickness of the Cardium HSU (not to scale). Strata below the top of the Shaftesbury Formation (and equivalents) are not shown.

References

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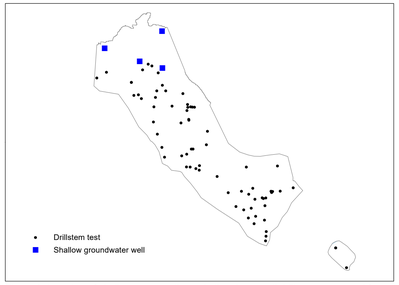

Figure 3. Location of shallow water wells, and oil and gas well drillstem tests used for mapping hydraulic head in the Cardium HSU.

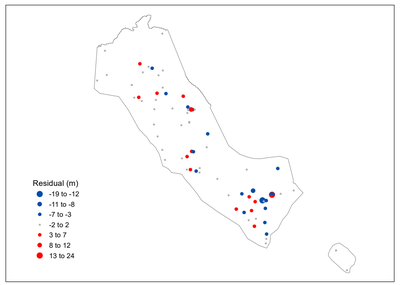

Figure 4. Calculated residuals between the modelled distribution of hydraulic head and measured values. Symbol classes are based on the standard deviation of the calculated residuals.

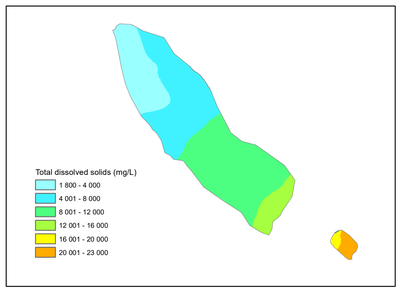

Figure 5. Distribution of total dissolved solids in the Cardium HSU (Brinsky, 2021). The map extent is based on the spatial distribution of TDS data and differs from the extent of the main map.

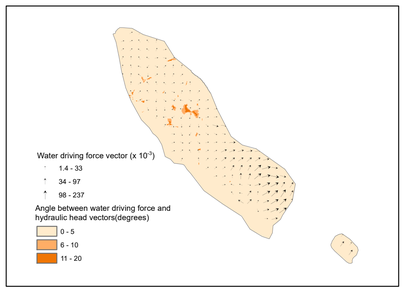

Figure 6. Water driving force vector map of the Cardium HSU. The map covers only the area where hydraulic head and TDS gridded surfaces overlap.

Acknowledgements

Data processing support by S. Stewart. Base data from the Atlas of Canada (Natural Resources Canada, 2012) and Spatial Data Warehouse, Ltd. Water driving force vector map created by A. Singh.

Recommended Reference Format

Brinsky, J. (2021): Distribution of hydraulic head in the Cardium hydrostratigraphic unit; Alberta Energy Regulator / Alberta Geological Survey, AER/AGS Map 545, scale 1:1 750 000.

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