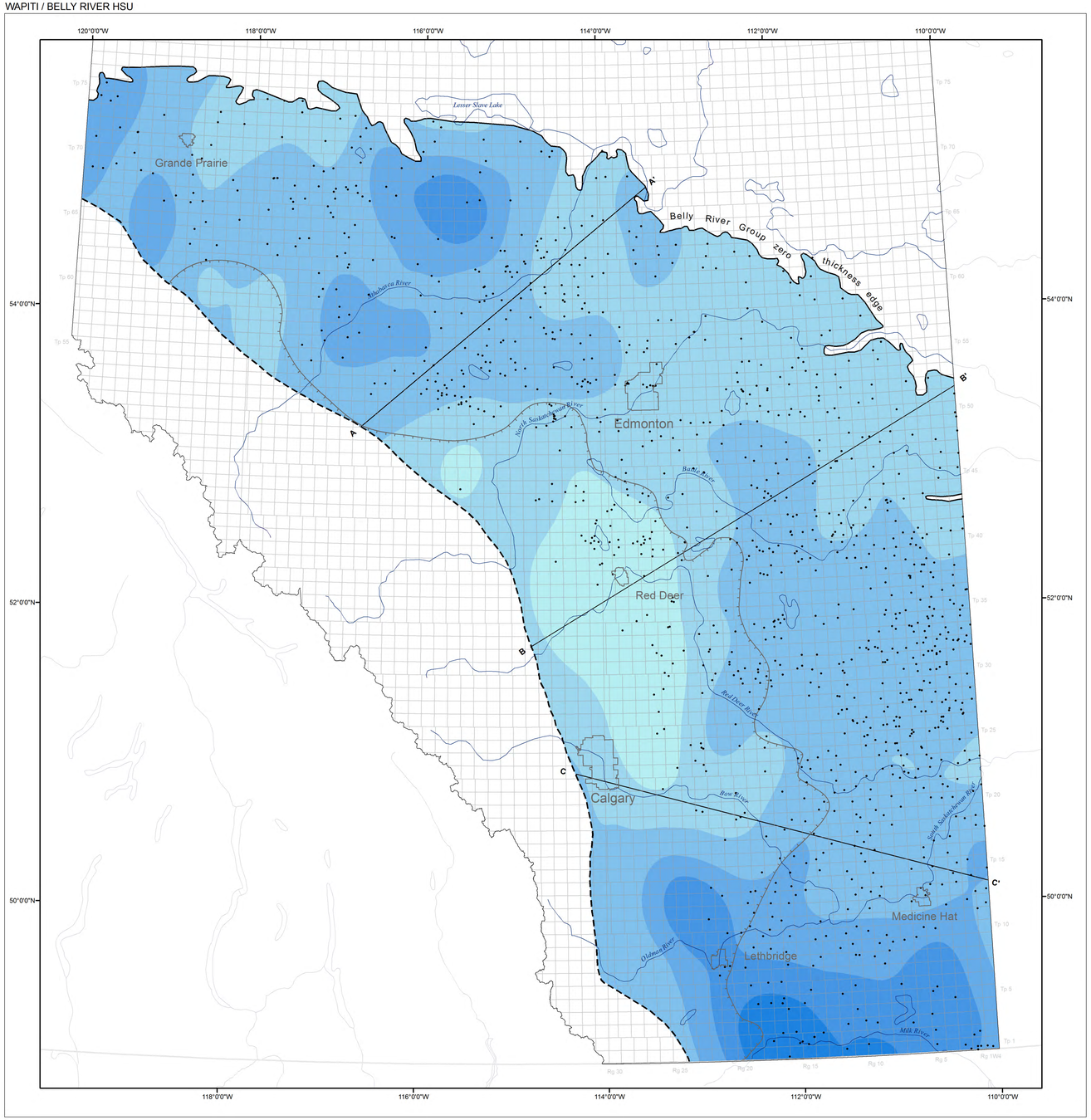
HYDRAULIC HEAD
WAPITI / BELLY RIVER HSU



SYMBOL LEGEND

Hydraulic head (masl)
- 440 - 550
- 551 - 650
- 651 - 750
- 751 - 850
- 851 - 950
- 951 - 1 050

Well data point

Hydrocarbon dominated flow zone; hachure points into flow zone

Eastern limit of main Cordilleran deformation

Cross-section line A ——— A'

This map depicts the groundwater hydraulic head distribution in the Wapiti / Belly River hydrostratigraphic unit (HSU). The horizontal and vertical extent of mapping was determined from the lithostratigraphy and hydraulic properties of the undivided Wapiti Formation in the west-central plains, and the Belly River Group in the east-central and southern plains (Figure 1). These two regional units were considered as a single HSU and the hydrogeological data were combined to develop this map. The thickness of the formations varies between the undivided Wapiti Formation and the Belly River Group, as shown in Figure 2, but they are interpreted to be in hydraulic communication and consequently are mapped as one HSU.

Methodology

The hydraulic head distribution map is a result of a simple kriging technique using publicly available data from 603 oil and gas wells (Figure 3, left) and 463 water wells (Figure 3, right), including wells from the Government of Alberta Groundwater Observation Network that were averaged for the available period. Residual values (predicted value minus measured value) are plotted at each location (Figure 3) to indicate where underprediction and overprediction occurs compared to the calculated hydraulic head values.

The hydrocarbon-dominated zone is denoted by a hachured grey line on the map. It delineates an area where most of the hydrocarbon production from the lowermost basal Belly River Group and Wapiti Formation occurs and where precaution was taken to eliminate pressures and formation water samples that might be affected by production activities. Delineation of this hydrocarbon zone was based on an assessment of the production wells and pressure regime, in addition to a previous assessment of the underpressured region in the Belly River aquifer by Bachu and Underschultz (1995). Using the methodology in Singh et al. (2017) the cumulative Inference Index (CII) technique is implemented to illustrate the difference in hydraulic head between the pre-development and production-affected groundwater head conditions.

Figure 4 illustrates the production-affected hydraulic head distribution for the Wapiti / Belly River HSU. The CII identified dataset, in combination with the original dataset, was used to map the production-affected head distribution using a simple kriging technique. Figure 5 presents the difference between the production-affected and pre-development hydraulic head distributions, highlighting the influence of hydrocarbon production in the central region of the Wapiti / Belly River HSU (red and orange colours) along the deformation belt. The distribution of total dissolved solids from water well and oil and gas well data is illustrated in Figure 6 (Nakevska and Singh, 2018).

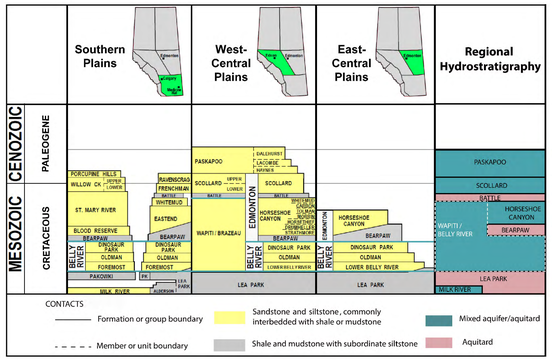


Figure 1. Alberta Table of Formations with regional hydrostratigraphy (modified after Alberta Geological Survey, 2015). Solid teal lines depict the top and base of stratigraphic units combined for the mapping of the Wapiti / Belly River HSU. Dashed white lines depict the Wapiti / Belly River HSU within the regional hydrostratigraphy.

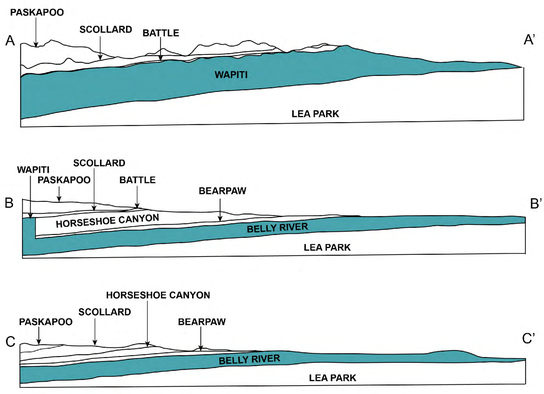


Figure 2. Schematic cross-sections identifying the geometry and variable thickness of the Wapiti / Belly River HSU (not to scale).

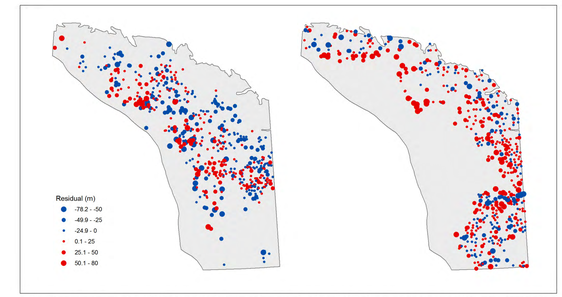


Figure 3. Calculated residuals between the modelled distribution of hydraulic head and measured values for oil and gas well locations (left) and water well locations (right).

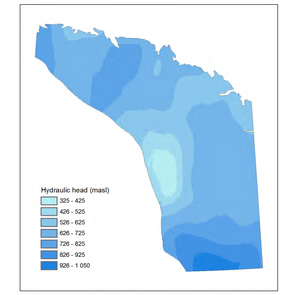


Figure 4. Distribution of hydraulic head in the Wapiti / Belly River HSU considering the influence of hydrocarbon production.

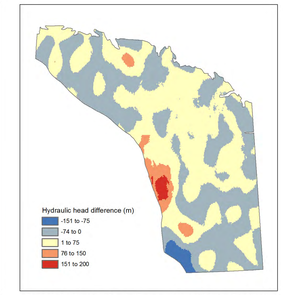


Figure 5. Production-influence map illustrating the difference between the distributions of production-affected and pre-development hydraulic heads.

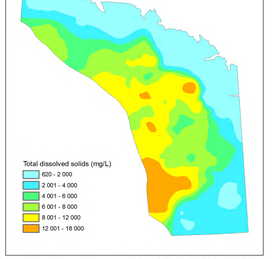


Figure 6. Distribution of total dissolved solids (TDS) in the Wapiti / Belly River HSU.

Acknowledgements

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Singh, A., Palombi, D., Nakevska, N., Jensen, G. and Rostron, B. (2017): An efficient approach for characterizing basin-scale hydrodynamics; Marine and Petroleum Geology, p. 332-340, URL <http://dx.doi.org/10.1016/j.marpetgeo.2017.02.015>.

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Map 543

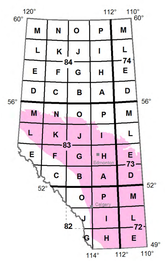
Distribution of Hydraulic Head in the Wapiti / Belly River Hydrostratigraphic Unit

Hydrogeology by: A. Singh and N. Nakevska

Scale 1:1 750 000

50 25 0 50 100 kilometres
25 12.5 0 25 50 miles

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



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