geoconvention
Calgary • Canada • May 11-13 2026

Geothermal gradient mapping for documented producing and non-producing oil and gas wells in Canada

Flora Sun[1], Bianca Lamarche[1], Jade Boutot[1], Mohammad Zolfagharroshan[2], Agus Sasmito[2], Mary Kang[1] (*mary.kang@mcgill.ca*)

[1]*Department of Civil Engineering, McGill University*

[2]*Department of Mining and Materials Engineering, McGill University*

Summary

Canada has hundreds of thousands of documented producing and non-producing oil and gas wells, many of which are associated with environmental and public health risks, including greenhouse gas emissions, air and water quality degradation, and, in some cases, explosions. Repurposing existing wells for geothermal energy can provide a way to support energy transition efforts while reducing the high upfront costs of drilling new geothermal wells and creating incentives for the management of non-producing wells. A challenge in evaluating wells for geothermal potential is the uncertainty of geothermal gradient data, which is an important factor, among others, such as density, thermal conductivity, specific heat capacity, and well depth, in determining which wells meet the temperature thresholds required for heating and electricity generation. To address these limitations, we compiled a database of producing and non-producing oil and gas wells across Canada to assess data availability for geothermal potential. We estimate a total of 725,940 documented wells as of January 2026, with 29% (210,356) producing, 58% (421,528) non-producing, and 11% (79,985) unknown wells. We also compare maps of geothermal gradient estimates to characterize uncertainty in the spatial distribution of geothermal gradient data across Canada. We find that available heat flow and geothermal gradient datasets differ greatly in geographic coverage and data density. The choice of input data substantially influences the results of geothermal potential estimates. Our results provide a foundation for future assessments of geothermal potential at producing and non-producing wells in Canada.

Methods

We compiled oil and gas well data from public well databases maintained by regulatory oil and gas agencies in Canada to estimate the number of documented wells and evaluate key well attributes for geothermal potential, such as well location, status, depth, and bottom hole temperature. For provinces and territories without publicly available well data, we contacted the corresponding regulatory agencies to obtain the required information. When well depth information was unavailable from public databases, we obtained data from the proprietary geoSCOUT well database using corresponding unique well identifier (UWI) numbers. For the purposes of this study, geothermal gradient is defined as the rate of change of temperature with depth below the ground surface (°C/km) (Hasan & Kabir, 2010; Hu et al., 2014) To create geothermal gradient maps, we obtained temperature gradient data and heat flow from the Natural Resources Canada (NRCan), geoSCOUT, and BC Energy Regulator (BCER), and the International Heat Flow Commission's Global Heat Flow Database (IHFC) (British Columbia Oil and Gas Commission, 2025; geoLOGIC systems ltd., 2026; Global Heat Flow Data Assessment Group et al., 2024; Grasby et al., 2009). Geothermal gradient maps were generated in ArcGIS

using kriging. We assess how the choice of heat flow and geothermal temperature gradient data influences the spatial distribution of estimated geothermal gradients, and consequently, which wells are identified as candidates for geothermal conversion.

Results

We present a comprehensive database of oil and gas wells across all Canadian provinces and territories, including key well attributes for geothermal potential. We found that the total number of documented producing and non-producing wells in Canada is 725,940 (as of January 2026). Of the 725,940 wells, location information was available for 99% (725,814) of wells. We find that well type is reported for 98% (711,806) of documented wells; however, 34% (247,276) of these records are classified as “unknown” or blank, meaning that well type is effectively known for only 65% (478,664) of the 725,940 documented wells. Among wells with known well type, 28% (203,868) are producing wells, and 57% (416,920) are non-producing wells. Gas wells are concentrated primarily in Alberta, while oil wells are concentrated in Alberta and Saskatchewan. Furthermore, depth information is available for 97% (704,900) of documented wells, with an average depth of 1,311 m across Canada. Among the provinces with the largest numbers of wells, the average depth is 1,294 m in Alberta, 1,301 m in Saskatchewan, and 2,481 m in British Columbia. We evaluate the spatial variation of geothermal gradients across Canada using the heat flow and geothermal temperature gradient datasets, which differ in geographic coverage and data density. Interpolated geothermal gradients vary with each available dataset, with notable spatial discrepancies in the IHFC dataset, which has major gaps in heat flow data in Western Canada, where oil and gas wells are primarily located (Figure 1). These differences suggest that the choice of input data can substantially influence the results of geothermal potential estimates. Figure 2 shows the geothermal gradient map produced by combining the three available datasets to improve spatial coverage across Canada. The database and geothermal gradient maps presented here provide a basis for screening wells for geothermal conversion in Canada and establish a foundation for future work to incorporate additional screening criteria, such as proximity to electrical grid infrastructure and population centers.

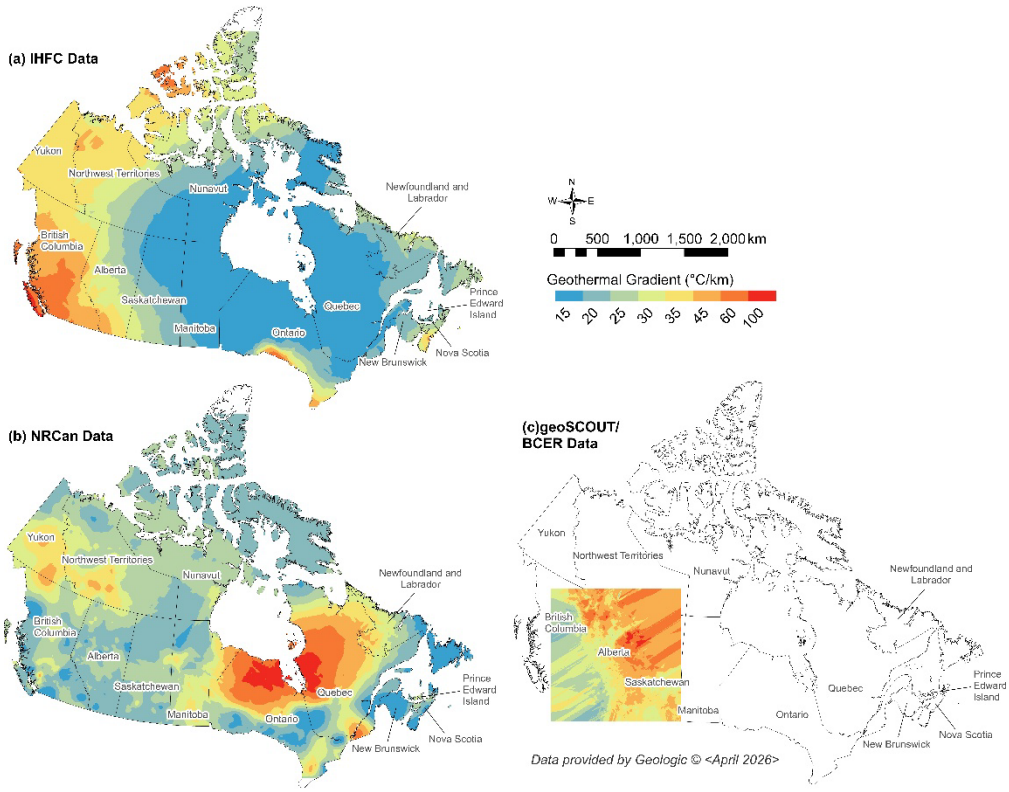


Figure 1: Geothermal gradient maps generated for Canada using (a) the International Heat Flow Commission, (b) the NRCan database, and (c) the GeoScout and BCER well databases.

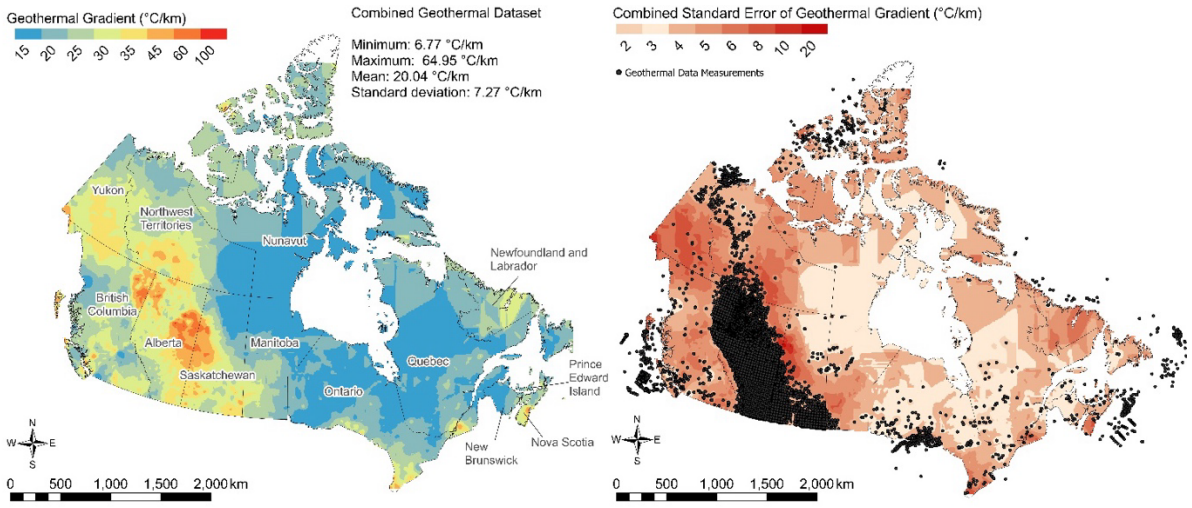


Figure 2: Geothermal gradient map generated using a combined dataset of the International Heat Flow Commission, the NRCan database, and the geoSCOUT and BCER well databases.

Acknowledgements

NSERC Alliance Grant ALLRP 577160-22

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