GS2024-21

Compilation of saline water analysis data from oil and gas wells, southwestern Manitoba (NTS 62F, G, J, K, N)

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Summary

In 2023, the Manitoba Geological Survey initiated the compilation of water analysis data from subsurface saline aquifers in the Williston Basin of southwestern Manitoba. This report focuses on the compilation of saline water analysis data extracted from technical well files for 298 oil and gas wells in southwestern Manitoba. Derived directly from water analysis reports, the compilation includes many fields of information, including location information, stratigraphy, salinity, pH, specific gravity, water resistivity, total dissolved solids, composition and much more. Each water analysis data entry was carefully assessed for quality and accuracy. Once completed, this dataset will inform future hydrogeological studies and the resultant mapping will inform regulatory decisions, land-use planning and future pore space resource exploration, including critical minerals, geothermal energy and carbon capture and storage.

In Brief:

- Saline water analysis data from oil and gas wells spanning 75 years has been compiled into a user-friendly digital format
- This data will inform hydrogeological evaluation of saline water aquifers

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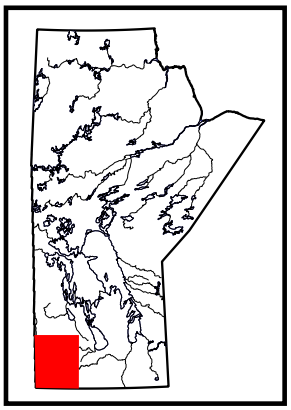
Introduction

Data compilation for saline aquifers is key to understanding their prospect, uses and limitations and industrial applications. Recently, there has been an increased demand for the compilation and evaluation of data on brines within saline aquifers, due to the potential for their use as storage sites for carbon dioxide (CO_2), geothermal energy, sources of lithium and in the secondary recovery of hydrocarbons. As a result of this demand, in 2023, the Manitoba Geological Survey (MGS) initiated a project to compile water analysis data from oil and gas well operations. Within the deep subsurface sedimentary formations of the Williston Basin in southwestern Manitoba, there are many saline aquifers that occur at varying depths and with salinity concentrations that vary by formation and location (Grasby and Betcher, 2002; Nicolas, 2017; Nicolas and Grasby, 2018).

Companies exploring for or producing oil and gas in Manitoba are required to submit all the technical well information to the provincial regulator for official filing and the information is made available to the public after a confidentiality period has ended. When a company collects and analyzes water samples from their well, the laboratory results are submitted and then added to the petroleum technical well file for that well (Manitoba Economic Development, Investment, Trade and Natural Resources, 2024). These water samples are collected from drillstem tests (DST), wellheads and battery sites. The water analysis reports ensuing are a good public source of information from which to begin a compilation.

These water analyses provide valuable information that can be used to help evaluate the hydrogeology and reservoir parameters of the aquifers. These reports are of variable digital quality and only available in Adobe Acrobat® portable document format (PDF), most of which were created by scanning paper documents up to 75 years old. The poor quality of the older reports and the variability in the information contained within each report prevented the use of automated digital scanning for data extraction. Therefore, in order to compile the water chemistry information, a manual extraction of information and entry into a database was required.



The objective of this project is to extract and compile all the information from water analysis reports into a new publicly accessible database. The outcome will be in a user-friendly digital format that will be updated regularly.

Geology and hydrogeology

The Williston Basin consists of stratigraphic sequences from the Paleozoic to Cenozoic eras. The Paleozoic formations in the subsurface in southwestern Manitoba consist dominantly of limestone, dolostone and evaporites (Nicolas and Barchyn, 2008). The Mesozoic formations consist of shale, red siltstone and sandstone whereas the Cenozoic section comprises silty and fine sandy shale (Corkery, 1996).

Hydrostratigraphic flow analysis models were developed by Palombi (2008) for the northeastern portion of the Williston Basin. Palombi (2008) observed large differences in the type of formation waters in the saline aquifers and identified four different water compositions based on their ion chemistry. These four water compositions are 1) calcium, 2) sodium chloride brines, 3) calcium sulphate freshwaters and 4) sodium sulphate brackish waters. Palombi and Rostron (2006) indicated that there are significant differences in the density and composition of waters in these saline aquifers.

The flow direction of these saline waters differs across formations, with a flow direction from east to northeast for Mesozoic aquifers, west to east for Mississippian aquifers, updip to the northeast for lower Paleozoic aquifers, and upward movement for Jurassic saline aquifers. At the margins of the basin, the flow is vertical, whereas in the centre of the basin it is horizontal (Palombi, 2008). A major hydrological divide occurs in Manitoba, extending roughly in a northwest–southeast trend along and through Lake Winnipegosis and Lake Manitoba. This divide separates the subsurface freshwaters to the east from the subsurface saline aquifer waters to the west (Grasby and Betcher, 2002).

Methodology

A four-phase approach was adopted to perform this data compilation (Figure GS2024-21-1). The first phase consisted of obtaining the well information and licence numbers of the oil and gas wells in the Williston Basin, searching for the well files using the licence number, and downloading the well files in PDF. The second phase consisted of searching for the saline water analysis data within the PDF documents, splitting the saline water analysis data from the other well data using Adobe® Acrobat Pro software and extracting the data from the PDF document and entering it into a Microsoft® Excel® spreadsheet. The third phase consisted of storing the extracted data securely in a Microsoft Excel spreadsheet, checking the spreadsheet to ensure that it is robust enough to accommodate variants of the data and quality checking the data for any errors introduced during the extraction process. The fourth phase will consist of the final compilation process and the preparation of a MGS GeoFile digital publication.

All water analysis reports found for these wells were extracted to individual PDF files. Data from each file was then entered into a spreadsheet, one row per analysis. The following information from each analysis was captured: oil and gas well licence number, unique well identifier (UWI), location, well name, DST number, sample identification, oil field name, depth intervals tested, subsurface formation assigned at the time of sampling, geological age, nature of liquid, total solids in parts per million (ppm), primary salinity, secondary salinity, primary alkalinity, secondary alkalinity, chloride salinity, sulphate salinity, pH, specific gravity (sg), density, water resistivity (R_w), total dissolved solids (TDS), resistivity index, hardness, turbidity and total concentration (in ppm).

Results

The search through the well files returned 298 oil and gas well licences with water analysis reports. Each of these reports was extracted from the well files and their chemistry information recorded in a Microsoft Excel spreadsheet. Figure GS2024-21-2 shows the locations of these 298 oil and gas wells.

Phases one, two and three of this saline water compilation project are now complete, and phase four is estimated to be completed in the winter of 2024–2025.

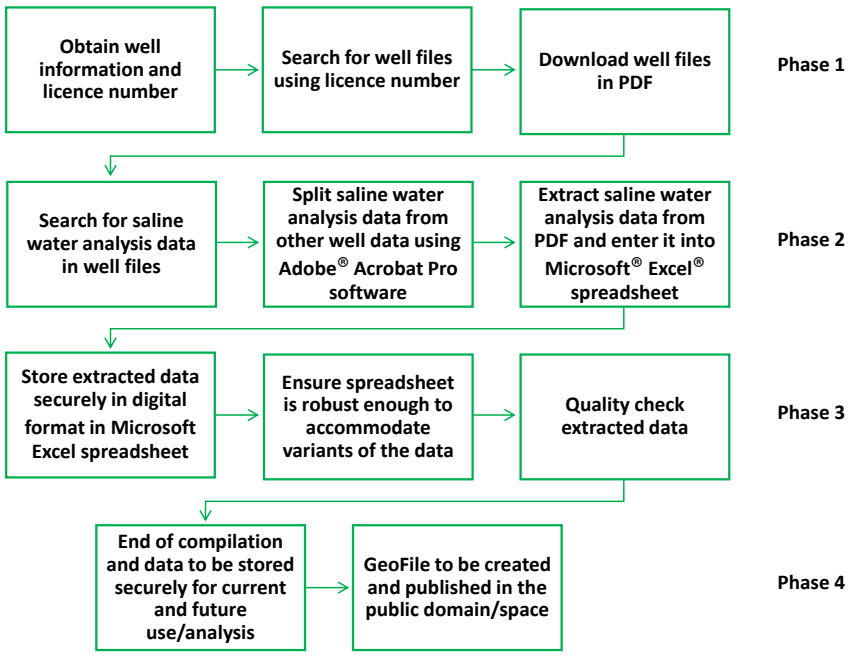


Figure GS2024-21-1: *Steps and workflow method used in the saline water analysis data compilation.*

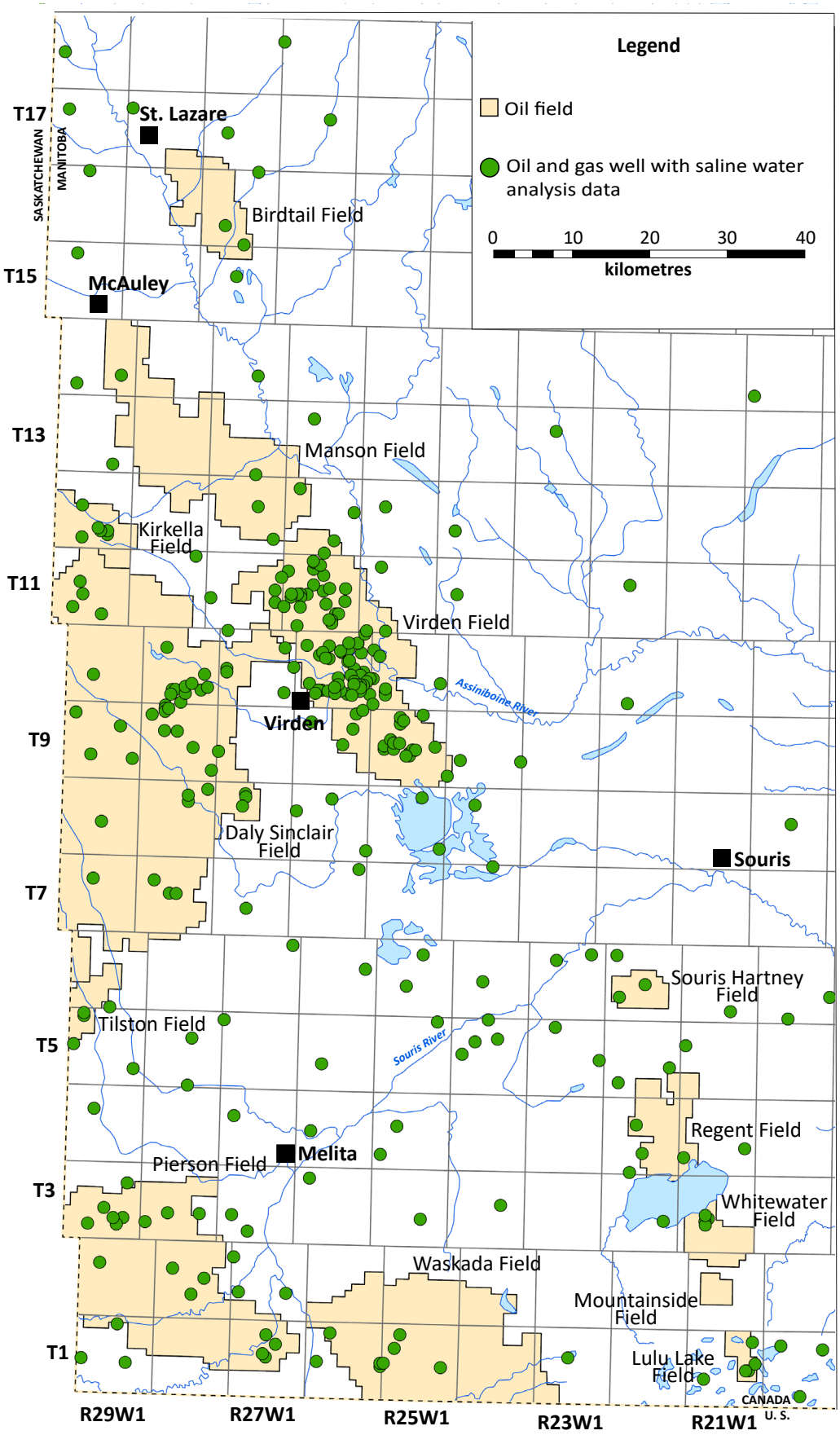


Figure GS2024-21-2: *Locations of oil fields and oil and gas wells with saline water analysis data in southwestern Manitoba. Oil field locations from Nicolas (2023) and well locations from Manitoba Economic Development, Industry, Trade and Natural Resources (2024).*

Future work

The fourth and final phase of this project is to finalize the compilation of the dataset and prepare it for publication. As new water analyses are submitted, the database will be updated and released to the public annually, or as needed. This compilation will have the following characteristics:

- uniquely structured to accommodate different formats of water analysis data
- robust, user-friendly and flexible enough to accommodate the integration of additional datasets
- each well point can be plotted according to location (DLS), geological period, stratigraphic formations, UWI, oil and gas licence number, etc.
- can be easily updated and converted into multiple formats
- can easily be imported into various software for further analysis

Products and maps derived from this saline water database will be produced by the MGS in the years to come and will further inform the hydrogeological framework of Manitoba's deep subsurface waters.

Economic considerations

As the green economy expands, more resources are required to fill the gap. Pore space resources are poised to fill that space and have become increasingly more important in the energy and mineral industry. One of those resources is the saline aquifers within the sedimentary basins in Manitoba. These saline aquifers include metal-rich brines. These brines are potential sources of dissolved metals and nonmetals, including lithium, magnesium, calcium, bromine and iodine, for use in a variety of industrial applications such as battery production, metallurgy, agriculture and medicine. Additionally, these brines can also be a source of geothermal heat and key targets for carbon capture and storage (CCS). The documentation and evaluation of the hydrogeology and saline aquifer characteristics of the subsurface brines in Manitoba is required to inform regulatory and exploration decisions and resource and land-use planning.

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