

Laboratory analyses on split core to assess the geothermal potential of the South Slave Region, Northwest Territories

Report for SR-2023-002 and SR-2023-004

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1. Introduction

The Energy Geosciences Group of the Northwest Territories Geological Survey (NTGS) is currently partnering with the Institut national de la recherche scientifique (INRS) to assess the geothermal potential of the South Slave Region (Northwest Territories, Canada). This project, initiated in summer 2022, aims to evaluate subsurface thermal properties and temperature to evaluate the performances of closed-loop geothermal systems for communities of Hay River, Fort Providence, Kakisa and Enterprise.

The South Slave Region is known for the potentially highest heat flow ($>100 \text{ mW/m}^2$) in the Western Canadian Sedimentary Basin (Rajaobelison et al., 2024; Thibault et al., 2024). Yet, no in-depth study has been conducted on the communities' deep geothermal resources.

This report objective is to improve our knowledge of the rock thermal properties in the South Slave region, building upon our prior research (Rajaobelison et al., In press).

2. Summary of the Sampling and Laboratory Analysis Procedures

Core sampling was authorized and approved by the Office of the Regulator of Oil and Gas Operations (OROGO) in July of 2023 for SR-2023-002 and sampling at the Geological Survey of Canada's Core Repository in Calgary was conducted August 2023 with a total of 22 samples from 7 wells (Table 1). For SR-2023-004, sampling was authorized in November 2023 and sampling was made in December 2025, with 8 samples from 4 wells (Table 2).

Thermal properties (thermal conductivity, thermal diffusivity and heat capacity) of rock samples were measured at the Laboratoire ouvert de géothermie (LOG) at INRS with an optical scanning instrument developed by Popov et al. (2023).

The parameters automatically computed from analysis with the optical scanning device are, λ the thermal conductivity [$\text{W m}^{-1} \text{K}^{-1}$], α the thermal diffusivity [$\text{m}^2 \text{s}^{-1}$], G the coefficient of variation (%), and IF the inhomogeneity factor. Rajaobelison et al. (In press) can be consulted for an exhaustive description of the laboratory analysis.

Table 1. Core samples collected from wells for SR-2023-002 request.

Well	Depth (m)	Formation	Lithology
A-66	538.7	Mirage Point	Red Beds
A-66	547.82	Mirage Point	Red Beds
A-66	549.43	La Loche	Sandstone
A-66	552.42	La Loche	Sandstone
A-70	642.63	Keg River	Limestone
A-70	646.85	Keg River	Limestone
A-70	689.82	Chinchaga	Anhydrite
A-70	690.65	Chinchaga	Anhydrite
C-19	393.5	Hay River	Shale
C-19	395.63	Hay River	Shale
I-57	508.6	Chinchaga	Anhydrite
I-57	509.3	Chinchaga	Anhydrite
B-75	443.63	Horn River	Limestone
B-75	446.83	Horn River	Limestone
I-08	416.51	Muskwa	Limestone
I-08	424.17	Muskwa	Shale
O-25	874.14	Chinchaga	Dolostone
O-25	879.55	Chinchaga	Anhydrite
O-25	881.7	La Loche	Unknown
O-25	882.19	La Loche	Unknown
O-25	885.93	Precambrian basement	Granitoid
O-25	886.51	Precambrian basement	Granitoid

Table 2. Core samples collected from wells for SR-2023-004 request.

Well	Depth (m)	Formation	Lithology
A-21	418	Precambrian basement	Granitoid
A-21	418,8	Precambrian basement	Granitoid
G-68	388,6	Precambrian basement	Granitoid
G-68	389	Precambrian basement	Granitoid
H-27	520,75	Precambrian basement	Granitoid
H-27	520,8	Precambrian basement	Granitoid
M-02	432,8	Precambrian basement	Granitoid
M-02	433,8	Precambrian basement	Granitoid

3. Summary and Interpreted Results

Two articles and a thesis were published including results from the analysis performed. A scientific article was published by [Rajaobelison et al. \(2024\)](#) in August 2024 and a conference paper was published by [Thibault et al. \(2024\)](#) in October 2024. An additional MSc thesis by Thibault (2025) was published in June 2025. These are included in the Appendix (1-3). The first paper focuses on a thermostратigraphic and heat flow assessment of the four South Slave communities, describing the development of 1D temperature models based on vintage oil and gas wells data to evaluate subsurface temperature within the sedimentary sequence below these communities (Rajaobelison et al., 2024). The second paper, presented at a Geothermal Rising Conference, assesses the temperature distribution in the Precambrian basement, underlying the sedimentary basin and providing insights into deep geothermal conditions below the communities (Thibault et al., 2024). The thesis covers these aspects in greater detail, providing more comprehensive interpretations of the results.

Appendix 4 present raw data associated to the thermal properties analysis from each sample.

Ongoing work includes numerical simulations of closed-loop geothermal systems, which requires as input subsurface thermal properties. Future work will focus on developing an open-access

geothermal database that will include detailed information on the thermal properties of rock samples.

4. Acknowledgement

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5. Reference

- Popov, Y., Lippmann, E., & Rauen, A. (2023). *TCS-Manual. Thermal conductivity (TC) and thermal diffusivity (TD) Scanner. Version 15.11.2023.*
https://www.schwartech.de/index_en.html#/tcs_en
- Rajaobelison, M., Thibault, M., Comeau, F.-A., Raymond, J., Smejkal, E. J., & Terlaky, V. (2024). Thermostratigraphic and Heat Flow Assessment of the South Slave Region in the Northwest Territories, Canada. *Energies*, 17(16), Article 16.
<https://doi.org/10.3390/en17164165>
- Rajaobelison, M., Thibault, M., Comeau, F.-A., Raymond, J., & Terlaky, V. (In press). *Laboratory analyses on split core samples from wells to assess the geothermal potential of the South Slave Region, Northwest Territories, Canada* (Open Report Nos. 2023–015; p. 71). Institut national de la recherche scientifique & Northwest Territories Geological Survey.
- Thibault, M. (2025). *Evaluation of the deep geothermal potential below four South Slave communities, Northwest Territories, Canada* [Thesis, Reykjavik University, Iceland School of Energy]. <https://skemman.is/handle/1946/50759>
- Thibault, M., Comeau, F.-A., Raymond, J., Rajaobelison, M., Terlaky, V., & Newson, J. (2024). Evaluation of the Precambrian Basement Temperature Below Four South Slave Communities, Northwest Territories, Canada. *GRC Transactions*, 48, 28.

6. Appendix

1. Rajaobelison et al., (2024) paper
2. Thibault et al. (2024) paper
3. Thibault (2025) thesis
4. Thermal properties raw data