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Exploring Geothermal Resources in the North: Investigations near the Tintina Trench by the Kaska Dena

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Summary

Many communities in northern Canada are dependent on costly trucked-in diesel for electricity and heating, contributing to energy insecurity, a high carbon footprint, and limited economic growth opportunities. The communities of Lower Post, Watson Lake, and Upper Liard are located along the Alaska Highway and rely on an isolated 5 MW diesel-powered electricity grid. With favourable geological conditions and limited renewable energy resources as alternatives, geothermal development could provide a new source of clean energy with additional socioeconomic benefits, such as improved food security and tourism opportunities. However, the subsurface in the region has seen limited exploration, and the uncertainty surrounding the availability of resources presents a major hinderance to the evaluation of geothermal development potential. The Indigenous inhabitants of the region, the Kaska Dena, are advancing geothermal investigations and building capacity to embrace and have a leading role in potential geothermal development in the region.

Geological Background

The Upper Liard-Lower Post region lies in a subsided area surrounded by mountains, at the intersection between the Northern Rocky Mountain Trench Fault and the Tintina Fault. This crustal-scale fault system accumulates 400 km of displacement, and has been active from Eocene to Holocene and possibly Present (Gabrielse et al., 2006; Finley et al., 2022).

Paleocene to Eocene terrestrial sediments accumulated over the Tintina and other faults in the area along narrow intermontane basins developed during the extension period that followed the Laramide Orogeny, and appear highly deformed over the general area of the Tintina Fault (Jenkins, 1980; Klassen, 1987). In the Coal River region to the East, coal-bearing sediments assigned to the Sifton Formation outcrop along a narrow north-striking fault-bounded sliver, and along strike with the Portage Brûlé Hot Springs. North-south extensional faulting near Lower Post juxtaposes lightly metamorphosed clastic Neoproterozoic to Cambrian strata and predominantly shale and carbonate-rich Ordovician to Devonian units, while the geometry and locations of these faults near the community remain unknown due to sedimentary cover and lack of detailed mapping.

Quaternary alkalic volcanism produced lava flows during glacial times across the region (Klassen, 1987; Hasik, 1994), and comprise the furthest inland exposure of magmatism associated with the Northern Cordillera Volcanic Province, a hypothesized incipient rift active from Miocene to present (Edwards and Russell, 2000, 2021). Surficial geology is dominated by glacial deposits and post-glacial fluvial incision, with cut-and-fill paired terraces developing over glaciolacustrine sediments in a subsided area east of Lower Post. This location corresponds, within current mapping resolution, to the location of a major north-striking extensional fault, and correlates with a marked change in magnetic and electromagnetic properties of the bedrock, anomalous springs at surface, and Quaternary volcanic centres along strike 14 km to the south (Ferri et al., 1999).

Geothermal manifestations are scattered across the region as warm, hot, and mineral springs, and occur within close proximity to volcanic centres and faults. However, while there are no documented geothermal anomalies in the Watson Lake-Lower Post area, the combination of large extensional crustal faults, Cenozoic basins, and Quaternary volcanism supports the potential for blind or hidden geothermal systems with no evident surface expression. Where they are active, these kinds of geothermal systems can create higher-quality resources (i.e., hotter and shallower) that may present attractive attributes for development.

Geothermal Resources in the Region

Geothermal resources in the Watson Lake-Lower Post region remain largely unknown, as they have not been a historical target for exploration, and geological information in the area is primarily derived from other industries and research activities. To address the resulting data gaps and improve our understanding of the subsurface opportunities in the region, a targeted exploration and test drilling program was completed, including geological, geophysical, remote sensing, and geochemical surveys.

The bedrock in the Lower Post area consists of variably fractured carbonaceous shales without aquifer potential, and fractured siliceous conglomerates and sandstones that form bedrock aquifers, which appear to be particularly productive where localized north-striking, west-dipping faulting is prevalent. Volcanic deposits and associated magmatic intrusions as dykes have a strong effect on the magnetic data, while electromagnetic data reveals broad areas covered by Cenozoic sedimentary units, as well as both mapped and hidden north-striking faults, and shallow horizontal conductors beneath mildly thermal acidic springs.

The results from these studies reveal that the Watson Lake-Lower Post region hosts geothermal resources in the form of conductively heated ground and aquifers, in both fractured bedrock units and Cenozoic sediments. Initial geoscientific investigations suggest that convection-driven, hidden or blind geothermal systems in the same units are possibly present, and may be associated with circulation along faults and proximity to young magmatic intrusions. Additional work will be required to locate and test locations where geothermal activity may exist near infrastructure, and to evaluate potential development opportunities of both conductive and convective geothermal resources.

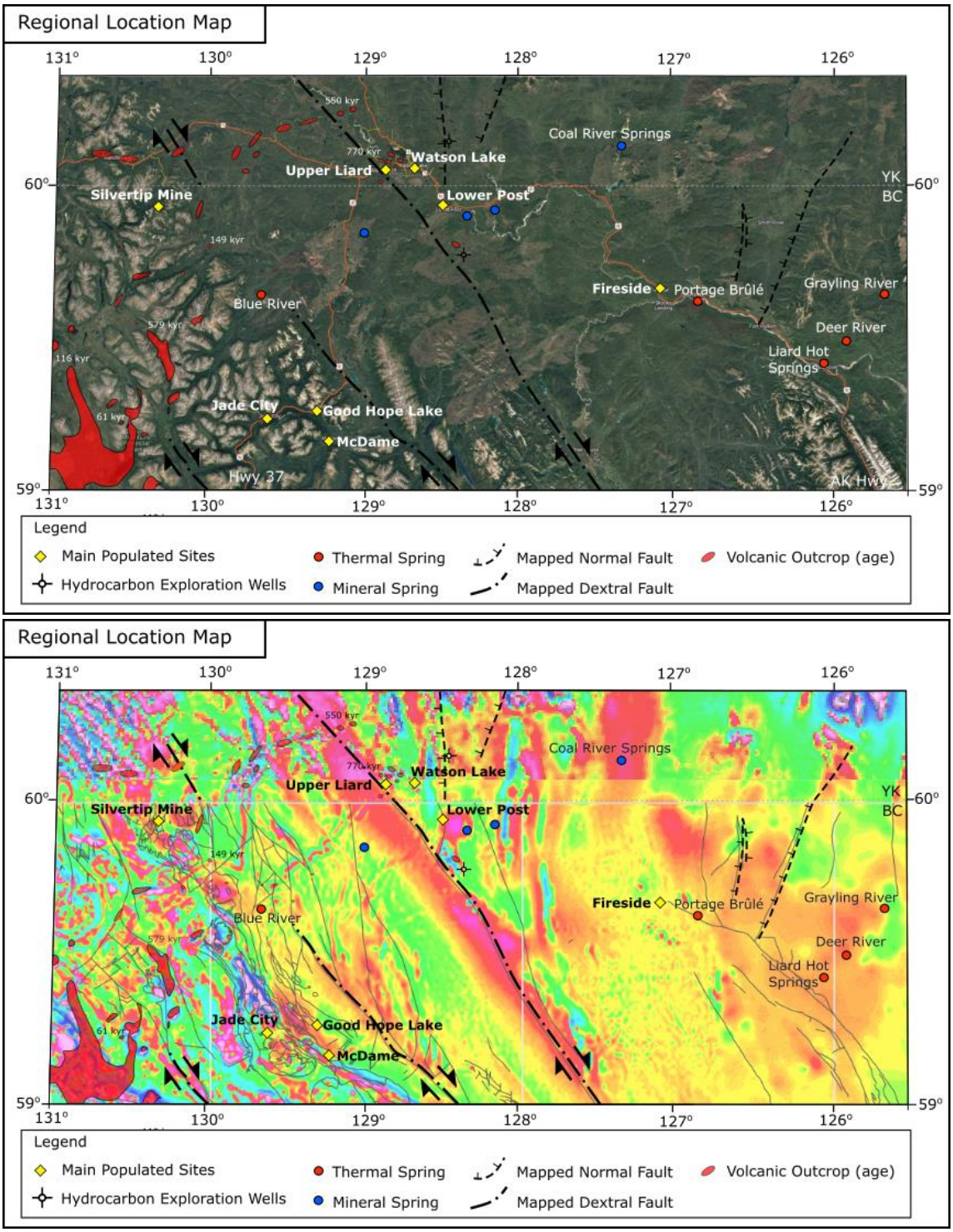

Figure 1. Regional Location Maps with selected geological annotations. Top: Satellite imagery. Bottom: Magnetic First Vertical Derivative maps for Yukon (GeoYukon from Oneschuk et al. (2019)) and British Columbia (including fault data, from MapPlaceBC, Cui et al., 2017).

Acknowledgements

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References

Cui, Y., Zhao, S., Fortin, G., Meredith-Jones, S. and Jones, L.D., 2017. Development of MapPlace 2 geospatial web service to disseminate geoscience in British Columbia. Geological Fieldwork, pp.2018-1.

Edwards, B.R. and Russell, J.K., 2000. Distribution, nature, and origin of Neogene–Quaternary magmatism in the northern Cordilleran volcanic province, Canada. Geological Society of America Bulletin, 112(8), pp.1280-1295. https://doi.org/10.1130/0016-7606(2000)112%3C1280:DNAOON%3E2.0.CO;2

Edwards, B.R., Russell, J.K., Jicha, B., Singer, B.S., Dunnington, G. and Jansen, R., 2021. A 3 my record of volcanism and glaciation in northern British Columbia, Canada. https://doi.org/10.1130/2020.2548(12)

Ferri, F., Rees, C., Nelson, J., Legun, A., Orchard, M.J., Norford, B.S., Fritz, W.H., Mortensen, J.K. and Gabites, J.E., 1999. Geology and mineral deposits of the northern Kechika Trough between Gataga River and the 60th parallel. Bulletin-British Columbia Ministry of Energy and Mines, Energy and Minerals Division, Geological Survey Branch, 107(122), p.2. https://www.bcprospectors.ca/Bulletins/Bull%201999-107%20Cover.pdf

Finley, T., Salomon, G., Nissen, E., Stephen, R., Cassidy, J., Menounos, B. 2022. Mapping Tectonically Active Faults for Geothermal Energy Exploration in the Yukon, Canada. AGU Fall Meeting Abstracts, 2022, T32C-01. https://ui.adsabs.harvard.edu/abs/2022AGUFM.T32C..01F/abstract

Gabrielse, Hubert, Murphy, D.C., and Mortensen, J.K., 2006, Cretaceous and Cenozoic dextral orogen-parallel displacements, magmatism, and paleogeography, north-central Canadian Cordillera, in Haggart, J.W., Enkin, R.J., and Monger, J.W.H., eds., Paleogeography of the North American Cordillera; Evidence for and against large-scale displacements: Geological Association of Canada Special Paper 46, p. 255–276.

Hasik, V., 1994. Volcanic evidence for a compositional contrast in the lithospheric upper mantle across the Tintina Trench, southeastern Yukon, Canada. M.Sc. Thesis. McGill University. https://escholarship.mcgill.ca/concern/theses/hq37vp83f

Jenkins, D. M., 1980. A Report on the Exploration of Liard Coal Basin, Watson Lake, M.D., Yukon Territory. Placer Development Limited, Liard Coal Basin Area, Yukon. Yukon Mining Assessment Report 062121. https://data.geology.gov.yk.ca/AssessmentReport/062121#InfoTab

Klassen, R.W., 1987. The Tertiary Pleistocene stratigraphy of the Liard Plain, southeastern Yukon Territory. Geological Survey of Canada. Paper 86-17. Open File Report. https://emrlibrary.gov.yk.ca/gsc/papers/86-17.pdf

Oneschuk, D., Miles, W.F., Saltus, R.W. and Hayward, N., 2019. Alaska and Yukon magnetic compilation. Geological Survey of Canada, Open File 7862, scale 1:1 125 000.