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Reservoir modelling to support the proposed geothermally heated indoor aquatic facility in the City of Regina in Saskatchewan, Canada

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INTRODUCTION

The City of Regina proposed indoor aquatic facility in Saskatchewan, Canada is designed to utilize a deep geothermal heating system. The system will comprise two geothermal wells, one producer and one injector. The geothermal water supply will be sourced from the Winnipeg and Deadwood aquifers from 2,030 m to 2,200 m depth with an anticipated reservoir temperature of about 59°C and a high salt-mass-fraction of 12.5%. The geothermally heated water will be circulated through a heat exchanger and the heat-depleted water will be injected with no net loss to the aquifer at 20°C. Design draws on the team's experience with similar projects in Europe and the legacy UoR well drilled in the 1980's (Vigrass et al, 1989).



Figure 1. Members of the design team visited analog geothermal sites in Europe (VeliGeo, France)

METHODS

A local geological model was built using Leapfrog Energy to capture the geometry of the target reservoir as well as overlying low permeability rocks directly above it and the Precambrian basement underlying it.

The model incorporates the legacy University of Regina well drilled in 1979 as well as nearby oil and gas exploration and disposal wells and some seismic data. The various units within the geological model were evaluated onto a reservoir model grid and model-calibration was completed against pressure and temperature data within the model domain with a P50 calibration error of +/-0.5 bar +/-0.5°C. This was achieved by adopting a Darcy velocity of 0.05-0.25 m/year and a heat flux of 50-52 mW/m2.

The calibrated Waiwera (Croucher et al, 2020) geothermal reservoir model was used to simulate 100 years of operation and estimate temperature and pressure changes in the reservoir and to size the electrical submersible and injection pumps. The nearest operating wells targeting the reservoir are disposal wells to the north of Regina.

CALIBRATION

The objective of the modelling assessment was to:

- Provide an estimation of the likely recirculation between REG-GT-01p (producer) and REG-GT-02i (injector) and the impact on the long-term pumping temperatures.
- Provide an estimation of the extent of the thermal plume in the reservoir after 30 and 70 years of operation and discuss potential impact on other users (Co-op wells to the NE).

The study uses various inputs provided by Rockwater including but not limited to the stratigraphy, and anticipated flowrate and injection temperatures to meet CoR's heating requirements.

The model was developed using geothermal modelling best practices and a modelling workflow developed by the Geothermal Institute at the University of Auckland.

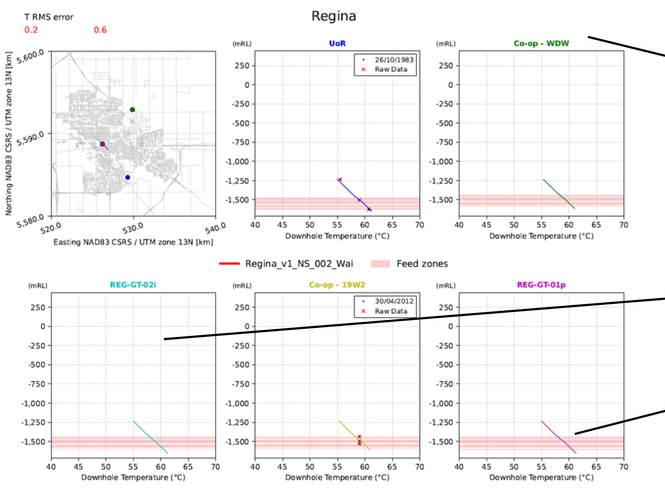


Figure 2. Natural State Temperature Calibration for key wells

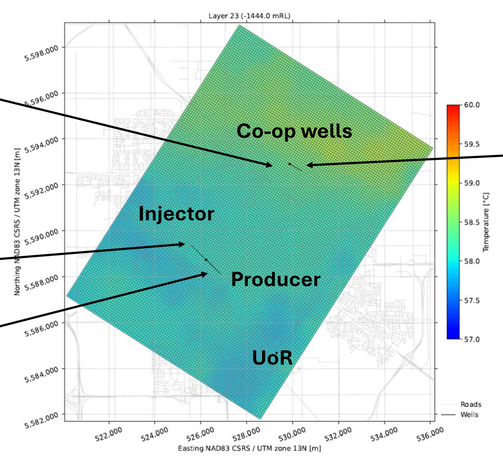


Figure 3. Natural State Temperature Calibration at reservoir level

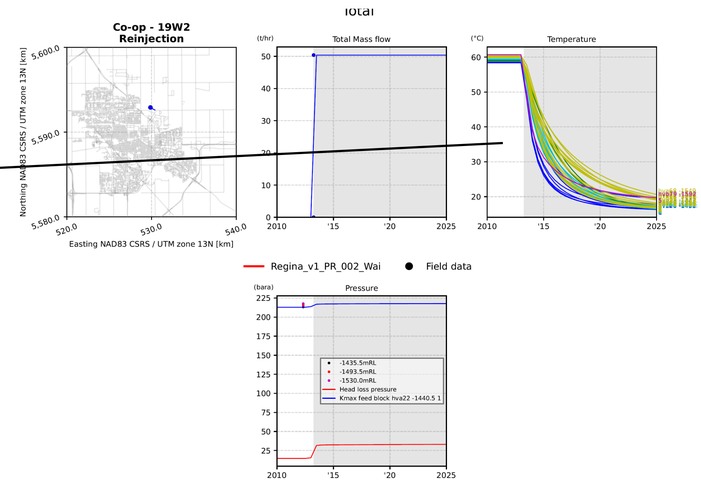


Figure 4 . 2010-2025 Production History showing injection at offset well

The results of the Production History show that injection at Co-Op wells has created a plume of lower salinity and lower tempoerature fluid in the aquifer restricted to the vicinity of those wells.

FUTURE SCENARIOS

Model-calculated temperature impact from the operation of REG-GT-01p and REG-GT-02i in the Winnipeg is shown below. The the temperature impact along the section A-G clearly showing the injection will have no temperature impact on the Co-Op wells. Model-calculated pressure changes at Co-Op wells are acceptable and less than 1 bar.

Figure 5. Temperature after 70 years

Figure 6. Temperature after 15, 30, 45 and 70 years

CONCLUSION

The results of the modelling undertaken for this project suggests:

- There is about 1 bar pressure change at the closest operating wells (Co-Op). This is anticipated to have negligible impact on their operation.
- Temperature changes are restricted to the vicinity of the proposed wells.
- The model-calculated surface pumping temperature is circa 58°C and no significant thermal breakthrough is predicted to occur with the adopted well separation at reservoir level.
- The model-calculated pumping water level is deep and will require an ESP to be set at a minimum of 350 m depth and perhaps deeper.
- The model-calculated injection pressure is predicted to increase from circa 25 bar at commissioning to 30 bar after 70 years of operation based on permeability and skin assumptions provided by the design team.

While the impact of these results on the business case of the project will need to be verified, no obvious red flags from a reservoir modelling point of view were identified from this study.

Drilling is anticipated to occur in late 2026. The model will be updated following well testing.

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