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# Alberta Precambrian Basement: Implications for EGS Development

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## Summary

The Precambrian basement rocks underlying the province of Alberta have recently been of interest for the development of an enhanced geothermal system (EGS) for the purpose of processing oil sands to extract bitumen. Using batch reactor experiments and specific surface area measurements of reacted Precambrian basement rocks, the evolution of the brine and reservoir rocks are tracked over the course of ten days. It has been found that ion concentrations in the brine remain low and can be described by logarithmic functions with high fitting coefficients ($R^2 > 0.95$).

## Method

Due to recently proposed geothermal sites near the Fort McMurray area, the Alberta Precambrian basement has been proposed as a potential enhanced geothermal system reservoir (Bachu and Burwash 1991, Banks and Harris 2015). In order to alleviate the risk inherent in developing such a system, the geochemical characteristics of brine that would develop must be determined. Additionally, one must also take into account the evolution of the reservoir rocks within the basement as their level of reactivity will change throughout the system's lifespan.

Three Precambrian terranes are present near Fort McMurray, the Buffalo Head terrane, Rimbey terrane, and Talston Magmatic Zone (Ross 1991, Pană 2002). As these terranes are covered by the Phanerozoic cover of the Western Canadian Sedimentary Basin, information regarding lithologies comes from mineral exploration and industrial oil and gas drill cores (Pană 2002). In a study done by Banks and Harris, 2015 six mineral exploration wells were identified and sampled to determine their lithologies. Further research was done by Samuel Johnson to determine the specific surface areas and lithologies in detail of these six drill cores.

This study utilizes one of these six original wells to react in a batch reactor. Five grams of rock are reacted with 450 grams of deionized water over four different time periods: 0.5 hours, 4 hours, 48 hours, and 240 hours. After each experiment, the rock samples were removed and the specific surface area of the rocks measured via an Autosorb IQ BET machine. Three samples are taken during the course of each experiment and ion concentrations measured using an ICP-MS, for a total of 12 measurements at differing time steps per sample. These experiments were carried out at a temperature of 105°C and at a pressure of 10 bars. The well that was chosen was originally well number 4 from the study as it is the southernmost well and therefore more likely to represent the reservoir present at the proposed site.

## Results

The results for batch reactor brine experiments as measured by ICP-MS are summarized in table 1. Figure 1 displays graphs of the brine evolution over the course of batch reactor experiments. Table 2 displays the evolution of specific surface area of reservoir rock over the course of the experiment.

| Time (Hours) | Na | Mg | Al | K | S | Ca | Fe | Sr |
|---|---|---|---|---|---|---|---|---|
| **8** | 0.223208 | 0.1580408 | 0.1494987 | 0.5819355 | 0.0860454 | 0.1610601 | 0.0714728 | 0.003119 |
| **24** | 0.2562568 | 0.1849528 | 0.1107449 | 0.6929563 | 0.1066734 | 0.2108839 | 0.0184217 | 0.0044517 |
| **48** | 0.3337318 | 0.1953535 | 0.1181711 | 0.855994 | 0.1206248 | 0.2471406 | 0.0116595 | 0.0050558 |
| **72** | 0.4553331 | 0.1005285 | 0.0429425 | 0.8452838 | 0.1329427 | 0.1438876 | 0.0034898 | 0.0015295 |
| **120** | 0.5166283 | 0.1042835 | 0.0267455 | 0.9688859 | 0.1034354 | 0.1643675 | 0.0036424 | 0.0021296 |
| **240** | 0.6613297 | 0.1220808 | 0.0157186 | 1.1615035 | 0.1287703 | 0.2316453 | 0.0088555 | 0.0033692 |

*Table 1 - Concentrations of ions during batch reactor experiments. Concentrations in ppm.*

| Time step (hours) | Specific surface area ($m^2/g$) |
|---|---|
| **240** | 0.2155 |
| **48** | 0.1443 |
| **4** | 0.2594 |
| **0.5** | 0.1767 |

*Table 2 - Specific surface areas of sample 003.5 during batch reactor experiments.*

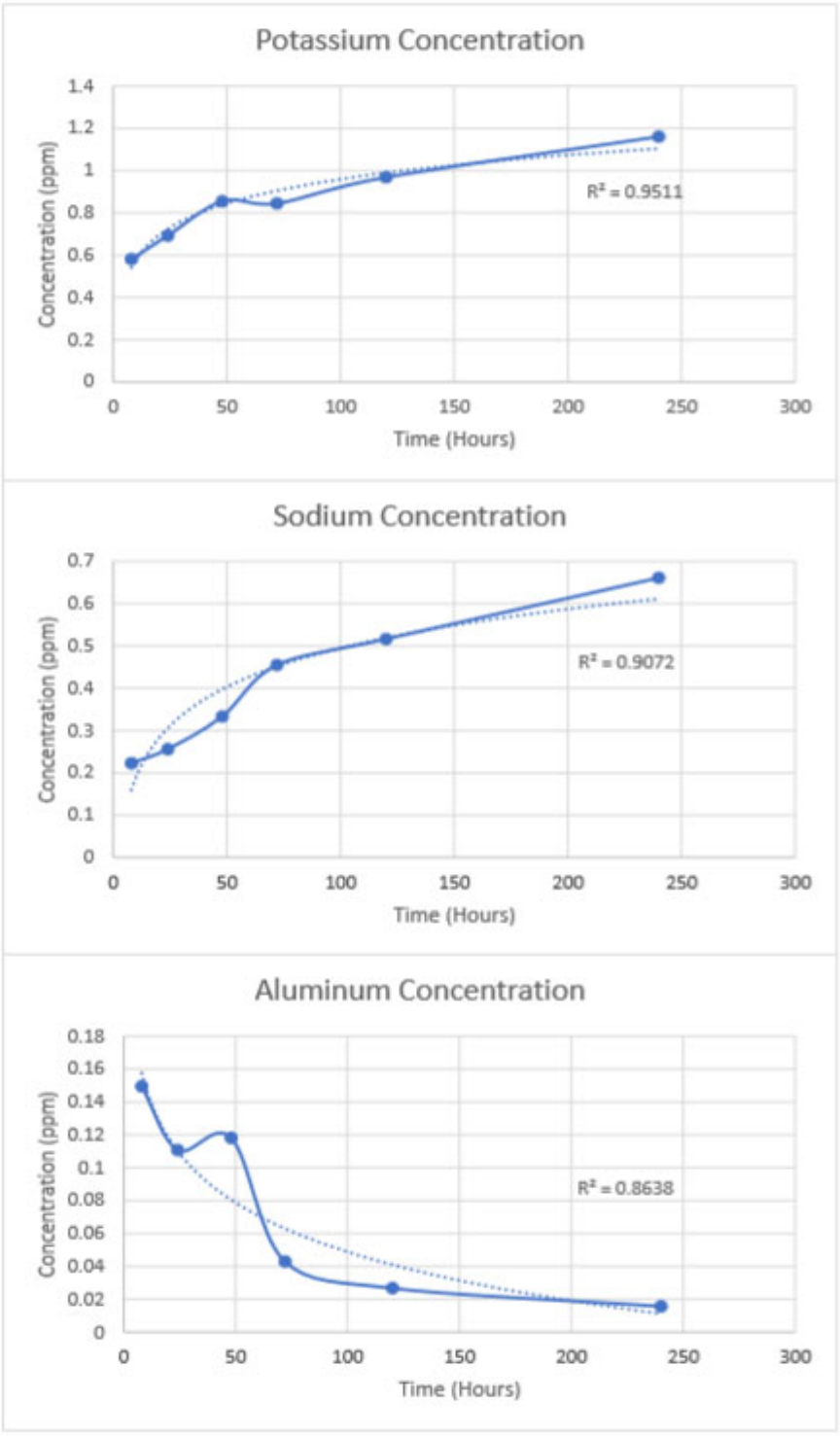


*Figure 1 - Graphs of ion concentrations with $R^2$ values of trendline on chart. Concentrations in ppm, time in hours.*

## Novel/Additive Information

This study displays the results of batch reactor experiments which seek to predict the evolution of brine chemistry throughout the lifespan of an enhanced geothermal system in the Fort McMurray area. Using pure water, the brine evolves to a predictable end point in terms of individual ion concentrations, Specific surface area, when used as a proxy for the reactivity of reservoir rocks, displays the evolution of the reservoir throughout the life of the experiments, and thus the enhanced geothermal system.

## Acknowledgements

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