The Analysis of Water Chemistry for Geothermal Exploration: A Case Study of Deadwood Formation

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Abstract

Geothermal energy is a promising and clean source of renewable energy that utilizes the earth's core heat to generate electricity. However, it's crucial to understand the chemistry of the brine that carries geothermal fluid to explore, drill, and monitor geothermal resources. Collecting water chemistry data helps predict the behavior of reservoirs and prevent scaling and corrosion, which can reduce efficiency and cause equipment failure. Chemical analysis, such as measuring total dissolved solids and pH levels, can measure water quality indicators. In this study, we used the PHREEQC geochemical modeling software developed by the U.S. Geological Survey to investigate the geochemistry of geothermal wells in North Dakota's Deadwood Formation. Our chemical analysis revealed that sodium and potassium were the most abundant cations, and the presence of stronger acids was higher than weaker ones. These findings are crucial for electricity generation using geothermal resources in the sedimentary basin. Furthermore, measuring the saturation (SI) index helps determine the potential for scaling or corrosion in water, and parameters like alkalinity, temperature, and pH contribute to the SI calculation. Our study also investigated undersaturated and supersaturated phases in the Deadwood Formation. The results showed that $CaSO_4$ and KCl were the most undersaturated minerals, while Fe (II) and Fe (III) were the most supersaturated. Using the PHREEQC modeling software, we obtained valuable insights into the geochemistry of geothermal brine in the Deadwood Formation, highlighting the need for appropriate materials and infrastructure to prevent scaling and corrosion. In conclusion, the results of our study provide a foundation for developing and implementing geothermal energy in the Deadwood Formation, guiding further research into the chemistry of geothermal brine in other regions. The high concentrations of sodium and potassium and the presence of stronger acids underline the need for careful selection of materials and infrastructure to ensure efficient geothermal energy production. The saturation index calculations also demonstrate the potential for undersaturation and supersaturation of various minerals, emphasizing the importance of monitoring water quality in geothermal energy production.