Utah FORGE Deep Well Water and Gas Sampling with Analyses by ThermoChem

Clay Jones,

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This document is a description of the effort to collect and analyze water and gas samples from deep Utah FORGE wells 16A(78)-32, 58-32, 56-32 and 78B-32. Summary tables of the water and gas analyses are provided in this document with additional pdf files showing ThermoChem’s analyses attached as an appendix.

**Sampling**

The water and gas samples were collected on two trips to the Utah FORGE site. Durring the first trip from the 15th to the 17th of June 2022 water samples were collected (including water produced from 16A(78)-32 collected in an evacuated gas flask for analyses of dissolved gasses). Durring the second trip on September 8th 2022 dry gas samples were collected from 16A(78)-32 and 78B-32.

Samples from 16A(78)-32 were sampled with positive pressure at the wellhead after the April 2022 stimulation. During the first sampling trip water discharged from the wellhead, producing water that had been injected during the stimulation. At the time of the second acquisition only gas was produced at the wellhead. It’s unclear how far the water level had dropped between sampling trips.

Water samples from wells 58-32, 56-32 and 78B-32 were retrieved by collecting the water in a pipe lowered into the wellbore. Samples from these three wells were contaminated by an oily sludge that accumulated near the top of the water in each well. This material was introduced post drilling to winterize the wells.

A gas sample was collected from 78B-32 despite the lack of positive pressure by suctioning the gas from within the wellhead into evacuated gas sampling flasks that were under vacuum. Only the second of the two samples were analyzed to minimize atmospheric contamination.

**Water Analyses**

In all water analyses pHs were observed to be generally benign ranging from 6.41 to 8.53 (**Table 1**). For reference, rain water has a pH of ~6.5, and seawater ~8.2. In addition, the samples were found to be low in total dissolved solids and hydrogen sulfide.

**Table 1:** Water chemistry data. Columns shaded in gray are pervious measurements shown here for comparison. Milford City water was used during well drilling, completion and stimulation activities. The water sample from 78-32 was produce from the shallow groundwater aquifer within the alluvium that overlies the FORGE EGS reservoir. Recent samples with analyses by ThermoChem are shown in white.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|   | **MilfordCity** | **MilfordCity** | **78-32** | **56-32** | **78B-32** | **58-32** | **56-32** | **78B-32** | **16A(78)-32** |
| **Analyte** | **mg/kg** | **mg/kg** | **mg/kg** | **mg/kg** | **mg/kg** | **mg/kg** | **mg/kg** | **mg/kg** | **mg/kg** |
| *Sodium* | 59 | 61 | 1028 | 723 | 363 |   |   |   |   |
| *Potassium* | 1.9 | 1.7 | 153 | 1280 | 46.3 |   |   |   |   |
| *Calcium* | 12 | 13 | 151 | 47.8 | 31.7 |   |   |   |   |
| *Magnesium* | 4.6 | 4 | 17 | 1.81 | 6.87 |   |   |   |   |
| *Lithium* | 0.05 | 0.1 | 11.2 | <0.1 | 0.547 |   |   |   |   |
| *Boron* | 0.1 | 0.1 | 22 | 1.04 | 1.64 |   |   |   |   |
| *Silica (SiO2)* | 28 | 23 | 84 | 62.2 | 4.39 |   |   |   |   |
| *Chloride* | 67 | 17 | 1825 | 112 | 425 | 509 | 112 | 425 | 5230 |
| *Fluoride* | 3.2 | 1 | 0.8 |   |   |   |   |   |   |
| *Sulfate (SO4)* | 93 | 36 | 52 | 1.33 | 4.4 |   |   |   |   |
| *Bicarbonate (HCO3)* | 140 | 159 | 294 | 2600 | 421 |   |   |   |   |
| *Ammonia* |   |   |   | 0.111 | 3.78 |   |   |   |   |
| *Hydrogen Sulfide* |   |   |   | 3.1 | 1.54 | 0.811 | 3.1 | 1.54 | 1.46 |
| *TDS (Calculated)* |   |   |   | 4830 | 1300 |   |   |   |   |
| *Lab pH (units)* | 8.32 | 7.9 | 7.24 | 8.53 | 6.66 | 6.49 | 8.5 | 6.66 | 6.41 |
| *Oil and Grease (mg/L)* |   |   |   | 9690 | 175 | 1960 | 9690 | 175 | 9.73 |

**Gas Analyses**

The first gas analyses sample listed from well 16A(78)-32 in Table 2 comes from dissolved gasses in produced water, the second consists of dry gas sampled at the wellhead. The percent air in each sample is estimated based on oxygen determination.

**Table 2:** Gas analyses by ThermoChem.

|  |  |  |  |
| --- | --- | --- | --- |
|   | **78B-32** | **16A(78)-32** | **16A(78)-32** |
| *Percent air in Sample:* | 42% | 2.4% | 75% |
|  | *Dry Gas% by Volume* | *Dry Gas% by Volume* | *Dry Gas% by Volume* |
| *Carbon Dioxide*  | 2.79% | 73.30% | 68% |
| *Hydrogen Sulfide*  | 0.11% | 0.925% | 2.63% |
| *Ammonia*  | <0.002% | 13.60% | <0.351% |
| *Argon*  | 1.02% | 0.28% | <0.155% |
| *Nitrogen*  | 94.60% | 1.20% | 5.71% |
| *Methane*  | 1.46% | 0.01% | <2.08% |
| *Hydrogen*  | 0.07% | <.007% | <4.42% |