geologica

Innovative Strategies for Environmental and
Natural Resource Management

18 October 2008

Al Waibel
Newberry Geothermal Company
225 NW Franklin Ave #1
Bend, Oregon 97701
Via E-mail:awaibel@hevanet.com

RE: Letter Report
Geochemical Analysis from Flow Testing of Well 55-29
Newberry, Oregon

This report presents the results and preliminary interpretation of geochemical analysis performed on fluid samples collected during the flow testing of the geothermal exploration well 55-29 by Newberry Geothermal Company (Newberry Geothermal). This report is submitted to Newberry Geothermal in accordance with our proposal dated October 30, 2007 and includes the results of our discussion of preliminary results in Reno on October 7, 2008.

The objective of the sampling and analysis was primarily to determine if the fluids produced from the 55-29 flow line or weir box have a geothermal source. Low flow levels during sampling and the high levels of mud in the liquid produced from the well suggest that little if any geothermal fluid was flowing out of the well. Despite these conditions, sufficient sample was collected to obtain repeatable noncondensible gas analysis of the gas in the blooie line and samples of the liquid in the weir box. The results are discussed below.

1 BACKGROUND

Well 55-29 was drilled on the east flank of Newberry Volcano in the spring of 2008 by Newberry Geothermal. With the drill rig on-site, Newberry Geothermal set up a flow line, silencer and weir box for flow testing July 16, 2008. A sampling separator was attached to the flow line upstream of the James tube. After cleaning out the well by circulating water, several attempts were made to flow the well by pumping air at various depths to unload the wellbore fluids. Fluids produced to the weir box during these periods of air pumping were steam and brown to grey-brown liquid.

Late on July 18, 2008, the well was cleaned out to the bottom and unloaded with air. The well produced some fluid as described above. Approximately 2 hours after the

564 Howard Street
San Francisco, CA 94105
info@geologica.net
www.geologica.net
Phone (415) 597-7881 ♦ Fax (415) 597-7880

air was turned off and early on July 19th the produced fluids produced were sampled. There was insufficient pressure in the line to draw the sample through the sample line and no significant liquid or steam condensate, so the sampling separator was not used. Noncondensible gases were sampled directly from the flow line at the sampling separator location using a vacuum pump to pull the sample from the line into the evaluated sampling gas bottles. As no steam condensate was visible in the bottles to estimate sample quantity, five samples were collected over increasing sampling times in order to be sure that the sample bottles were sufficiently full for analysis. Liquid samples were collected from the weir box and from a nearby water well used for drilling fluids. The liquid in the weir box was dark grey to brown and it was not clear that any liquid was flowing into the weir box although a very slight puff of steam was exiting the top of the silencer. Gas samples were analyzed for comprehensive geothermal gases and liquid samples were analyzed for typical suite of geothermal brine constituents and the stable isotopes of water by Thermochem.

2 ANALYTICAL RESULTS

Noncondensible Gases

Carbon Dioxide (CO_2) made up 99% of dry gas by volume. Hydrogen sulfide (H_2S) was 0.06% by volume, nitrogen (N_2) gas was 0.6% by volume, methane (CH_4) was 0.04% by volume, and hydrogen (H_2) gas was roughly 0.1%. Results are presented in Table 1 and Figure 1.

Stable Isotopes

Deuterium (^2H (as δD ‰ vs SMOW, ‰)) in WW1 was measured at -118.4‰. Oxygen-18 (^{18}O (as $\delta^{18}O$ ‰ vs SMOW, ‰)) levels were -15.02‰. These levels are comparable to other groundwater data in the area, with Deuterium levels around -109 to -122‰ and Oxygen levels of -14 to -16‰ (USGS, 1997). Measured Deuterium in weir box water from 55-29 was -61.1‰, while Oxygen-18 was -6.73‰. Surface water samples taken by the USGS from nearby East and Paulina Lakes as well as just outside the Newberry Caldera fell in between WW1 and 55-29. Deuterium levels ranged from -77 to -92‰ and ^{18}O levels were -7 to -11‰ (USGS, 1997). Newberry 2, a USGS exploratory well in the Newberry Caldera produced fluids at approsimately 230°C and D -100‰ and ^{18}O -9.2‰ respectively. Results are presented in Table 2 and Figure 2.

Water Chemistry

Compared water from the nearby cold water well which was used for drilling fluids, WW1, and other nearby waters, concentrations of nearly all general mineral constituents tested including, sodium (Na), potassium (K), barium (Ba), iron (Fe), boron (B), sulfate (SO_4), ammonia (NH_3), alkalinity, bicarbonate (CO_3) and total dissolved solids (TDS) are elevated in the 55-29 weir box. However, calcium (Ca), and magnesium (Mg) levels are both lower than measured levels in the utility groundwater well,

suggesting that these constituents are being buffered by carbonate precipitation (seeTable 3 and Figure 3).

3 DISSCUSION

Noncondensible gas (NCG) samples collected from well 55-29 display geothermal reservoir characteristics (Figure 1) in comparison with air. The relative concentrations of individual gases (in % dry gas by volume) are typical of geothermal fluids and readily distinguishable form average atmospheric composition (nitrogen (N_2) gas 78.08%, oxygen (O_2) 20.95%, and argon (Ar) and carbon dioxide (CO_2) the remaining 0.97%). Insignificant amounts of water (steam) was present in the NCG. Therefore these gases may be magmatic and may or may not be related to hydrothermal fluids. Additional analyses of the noncondensible gases such as helium (He), helium isotopes ($^3He/^4He$), and carbon monoxide would allow additional interpretation of the magmatic versus hydrothermal source of these gases.

Stable isotope results are evaluated by comparison with local meteoric and surface waters in a standard $\delta^{18}O$ ‰ versus δD ‰ (Figure 2). All groundwaters including water from the cold water well used for drilling fluids, WW1, are isotopically similar, suggesting a common origin of groundwater in the region. The isotopic signature of local lake waters can be produced by low temperature evaporation of groundwater. Similarly, the water from the 55-29 weir box appears to be low temperature ($\leq 100^oC$) evaporation of groundwater (probably drilling fluid). Moreover, isotopic measurements for Newberry 2, a known local geothermal source, are distinct from the water from 55-29 weir box. Newberry 2 fluids show the positive $\delta^{18}O$ shift which is indicative of high temperature water/rock interaction and typical of geothermal fluids.

Fluid chemistry of 55-29 weir box does not indicate a geothermal origin. Constituent concentrations appear to concentrated but in the same proportions as cold groundwaters with a few exceptions (Figure 3). This would suggest that the fluid is not groundwater that has equilibrated with rocks at high temperatures but rather groundwater concentrated by evaporation with some possible carbonate equilibration.

4 CONCLUSIONS

Preliminary data suggest the following conclusions regarding sampling at well 55-29

- Aqueous fluids retrieved from the weir box at 55-29 primarily do not originate from a geothermal reservoir.
- The water appears to be local groundwater either entering the well from near surface fractures, or injected during the drilling process which is subsequently evaporated at low temperatures.

- Noncondensible gas appear to be coming from a geothermal source (hydrothermal or magmatic).
- Limited permeability allows these gases to enter the well but apparently not an aqueous phase (steam or water).
- Additional analyses of the noncondensible gases such as helium (He), helium isotopes ($^{3}He/^{4}He$), and carbon monoxide to allow additional interpretation of the magmatic versus hydrothermal source of these gases.
- A more thorough evaluation of the geothermal fluid chemistry and the implications for the Newberry geothermal reservoir will be performed after the next well is test, sampled and analyzed.

Table 1 Noncondensible Gas

Well	55-29	55-29
Sample	#2	#3
Sampled	7.19.08 0:00	7.19.08 0:36
Analyte	Dry Gas % (by vol)	Dry Gas % (by vol)
H2O vapor		
CO2	99.2	99.2
H2S	0.0589	0.0601
NH3	<.0274	<.0144
Ar	0.00138	0.00151
N2	0.622	0.562
CH4	0.042	0.0408
H2	0.113	0.106
% air	0.117	0.014

Table 2 Stable Isotopes

Sample	D	^{18}O
WW1	-118.4	-15.02
55-29 Weirbox	-61.1	-6.73
Newberry 2 (USGS)	-100	-9.2

Table 3 Water Analysis

Sample	WW1	55-29 Weirbox
Analyte	mg/kg	
Na	45.7	1360
K	4.72	120
Ca	20	15.3
Mg	24.9	3.36
Li	<0.1	
Sr	<0.1	
Ba	0.064	2.62
Fe	<0.05	7.98
B	0.57	247
Si	54.7	99.4
Ar	0.034	3.96
Mn	0.0089	1.14
Cl	13.8	646
F	0.582	7.75
SO4	2.58	233
Tot Alk (HCO3-)	296	1930
CO3=	<2.00	235
Bicarb Alk (HCO3-)	296	1350
NH3	<0.255	12
TDS	464	4330
pH (lab)	7.85	8.3

Figure 1 Noncondensible Gas with Air and "Typical" Geothermal Fluid

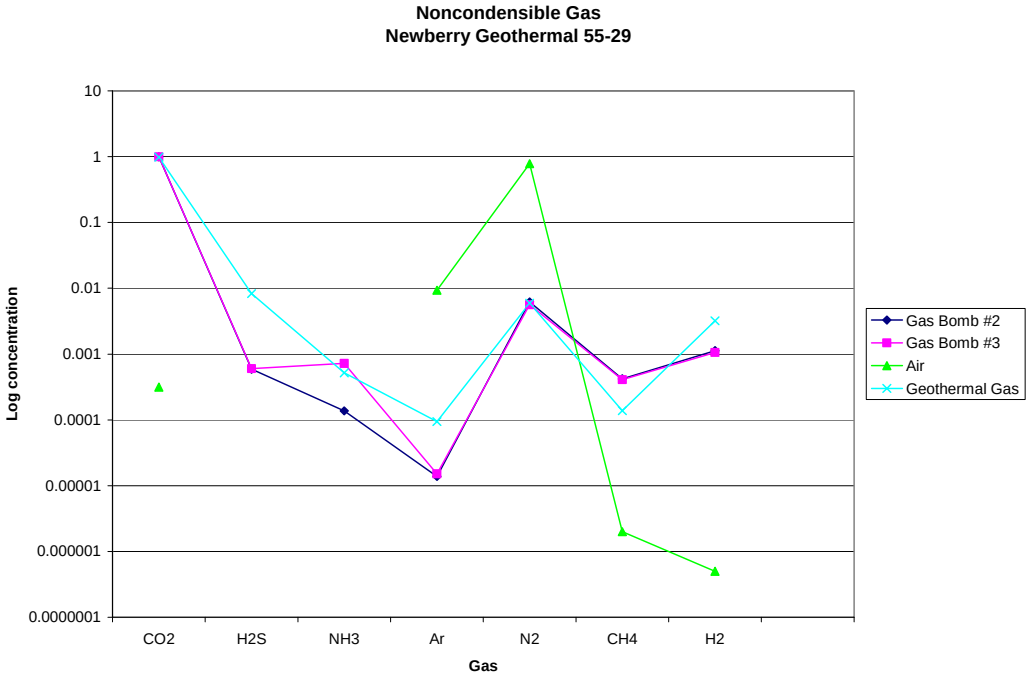

Figure 2 Stable Isotopes of Water Newberry Caldera and 55-29

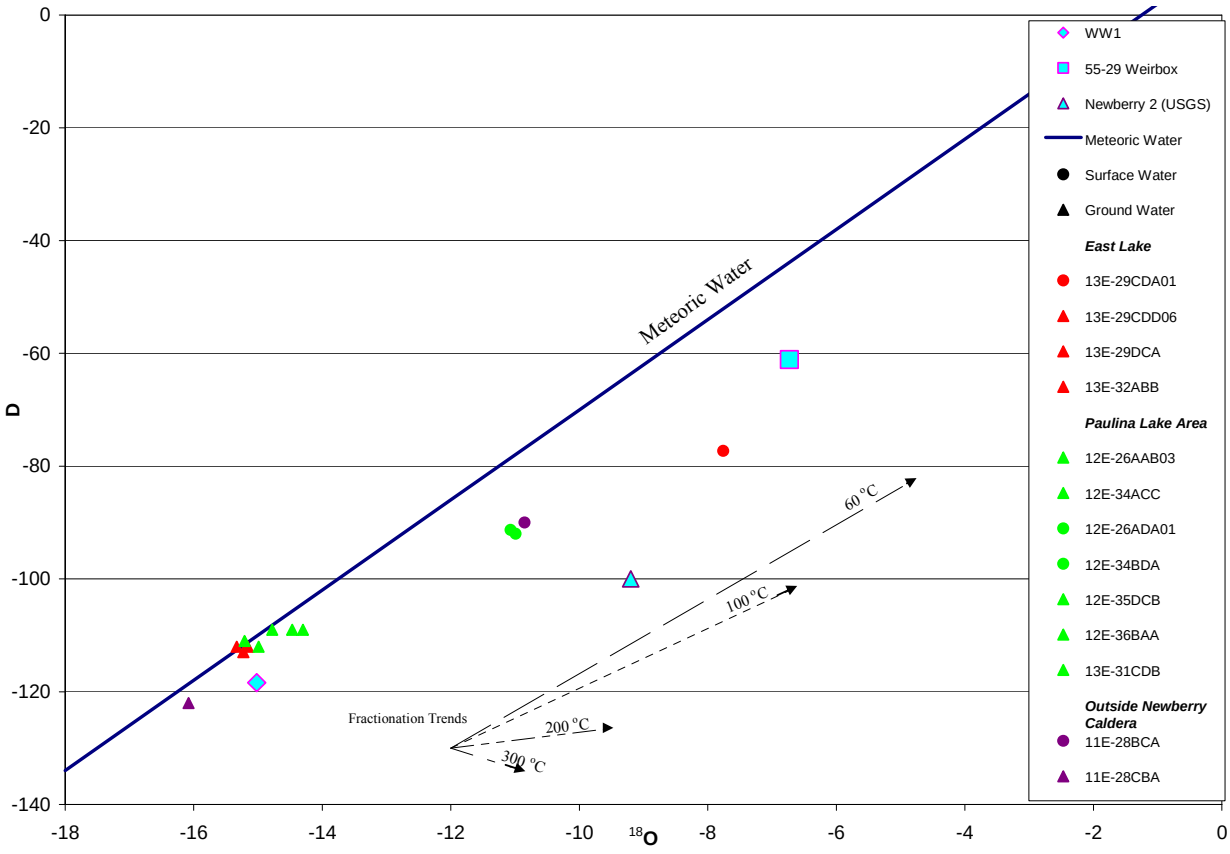

Figure 3 Newberry Geothermal 55-29 and Newberry Caldera Waters