Daily Drilling Reports – 2018 Drilling Campaign

Snake River Plain – Geothermal Play Fairway Analysis Project
Geothermal Technology Office,
Department of Energy Project: EE0006733

Camas Prairie Test Well
Camas Prairie, Idaho: 43.2994º N, -114.9088º W

Sept. 15, 2018 Daily report - Camas-1 drill site

Project personnel on site this morning included Dennis Newell (USU), Kenny Kehoe (USU), Jesse Schoppe (USU), and the USGS drilling crew (Jack Hennagan, and Derek). Tait Earney and William Schermerhorn from USGS Menlo Park were off site today collecting geophysical data. At the end of the day, Kenny K. and Jesse S. returned to Logan, UT. Jim Evans (USU) will be arriving this evening for site geological support and supervision over the next several days.

Today's drill-site activities included final drilling equipment preparation and breaking ground on borehole Camas-1. Drilling officially started a 12:10 PM and progressed smoothly to 40 ft below ground surface (bgs). The drilling plan and permit call for setting surface conductor casing to 40 ft. Dennis Newell and the USU crew collected and logged chips on 10 ft intervals during this time. Geological materials encountered included near-surface soils and loess, sand and gravels, and clay-rich intervals near 40 ft. Encountering clay at 40 ft was ideal for setting the surface casing so the drillers tripped out and replaced the bit with a reaming bit to enlarge the hole for the 14-inch diameter surface casing. Casing with a length of 43 ft was lowered into the reamed hole and set into the clay horizon. The final top of casing was at ground surface, so the bottom of casing is at 43 ft bgs.

Portland cement grouting of the surface casing will be done tomorrow morning. The delivery of the cement mixing equipment and supply truck was delayed until this evening, preventing casing grouting during this shift. Drilling will resume once the cement grout has been allowed to set.

Dennis L. Newell
Assistant Professor of Geology
Department of Geology
Utah State University
4505 Old Main Hill
Logan, UT 84322
435-797-0479

Camas Prairie Drill Camas-1 Drill Hole
September 16 Daily Report

0-42 feet

Project personnel on site this morning included Dennis Newell and Jim Evans(USU), the USGS drilling crew (Jack Hennagan, Derek, Joe), and Tait Earney and William Schermerhorn from the USGS Menlo Park (Geophysics support). The main activity was cementing the conductor casing, which is set to a depth of 42' into a clay horizon. This took 42 bags of cement, and was completed mid-day. The rest of the day was spent repairing and replacing some drilling equipment, staging drill pipe, and site maintenance. Cement curing will continue and drilling is scheduled to start the morning of Sept 17.

Geology at the drill site included logging of cuttings from the first 40' of hole – unconsolidated deposits. Dennis Newell returned to Logan, and Jim Evans replaced him. Evans spent the rest of the day examining the geology of the area and collecting rock samples to guide any onsite geologists on the possible lithologies to be encountered in the drill hole. USGS personnel collected more geophysical data in the hills to the south of the drill site.

Camas Prairie Drill hole
September 17 Daily Report

42 – 400 feet

Project personnel on site this morning included Jim Evans (senior geologist, USU), Natalie Tanski (jr. geologist, USU) the USGS drilling crew (Jack Hennagan, Derek, Joe), and Tait Earney and William Schermerhorn from the USGS Menlo Park (Geophysics support; helped with geology logging).

Operations Summary Drilling started at ~ 0850 with 7 7/8" dia. core bit at a depth of 42', mud wt. of 9 lbs/gal, and mud viscosity of ~ 40 Marsh units. On site geologists collected drilling cuttings every 10' off the shaker table. A lightly washed sample was bagged, and a smaller sample was washed and put into chip trays. Drilling ROP was 0.5 -2 ft/min, and drilling ended at 1810 at a depth of 400' below KB. Drilling went smoothly with two small interruptions – a clay boot developed at ~ 160' md and lost circulation occurred at 255'-260'. The clay boot occurred at the base of a thick clay layer, and slower drilling into the underlying sand resolved this. Loss of circulation was managed by increasing the mud viscosity to 65 Marsh units; the drillers also ordered more drilling mud and went to Boise to pick up more drilling mud in case more is needed.

Geology Summary The geology in the drill hole consists of ~ 120' grey to grey blue clay from 40'-160', with small amounts of fine sands. From 160' to 400' the lithologies are a range of fine, medium, and coarse sands to fine pebble sands. The upper ~ 80 ft of this sand section consist basalt dominated sand grains, and from 260 to 400', the medium grey sand is dominated by quartz, feldspar, lithic fragments, minor basalt, and ± 1-2 % blue – green grains.

The high drilling rates, nature and condition of cuttings, and the minor loss of circulation all indicate that we drilled into unconsolidated clay deposits (lacustrine?) common in the logs of water wells drilled in the area and according to a local driller (Lee Barron), with older variable Q-F sand deposits below. The large percentage of quartz and feldspars is notable when compared to the nearby bedrock, dominated by basalt flows and Challis (?) volcanics.

Camas Prairie Drill hole
September 18 Daily Report

400-527 feet

Project personnel on site this morning included Jim Evans (senior geologist, USU) and Natalie Tanski jr. geologist, USU) the USGS drilling crew (Jack Hennagan, Derek, Joe), and Tait Earney and William Schermerhorn from the USGS Menlo Park (Geophysics support; helped with geology logging).

Operations Summary Drilling started at ~ 0830 with 7 7/8" dia. core bit to re-enter the hole; drill string slid easily in the hole and drilling started at 400' at ~ 0945. The drilling advanced through the day, and at 430' the returned mud fluids were recorded at 100°F. The drilling was steady throughout the day with one short operational delay of 15 minutes for a minor repair on the shaker table. Drilling ended at 1750 pm at a depth of 527', and a mud return temperature of 110°F. The ROP declined after ~450' depth, through the day, and the head driller ordered new bits to be delivered 19 September for the rocks encountered. Several small lost circulation events were reported by the driller. The driller decided to continue to advance slowly for the rest of the day, and use the end of day trip to replace the bit, rather than use up drilling time during the day. Cuttings were collected at 10' intervals and lightly washed and logged by site geologists.

Geology Summary The geology in the drill hole consists of ~ 127' of granitic sandstone. The very fine sand fraction is 10-20% of most samples, and contains some micaceous grains. The rest of the samples consist of coarse sand to medium pebble granite sand grains. An occasional cm-long angular chip of fine-to medium grained granitic composition, or dark fine-grained chip were encountered. The lower drilling rates, nature and condition of cuttings, and the minor loss of circulation all indicate that we drilled into a well cemented sandstone comprised of granitoid grains- quartz, feldspars, amphiboles, and some biotite. We infer from cuttings and ROP that this unit is cemented.

Camas Prairie Drill hole
September 19 Daily Report

527-640 feet

Project personnel on site included and Natalie Tanski (geologist, USU) the USGS drilling crew (Jack Hennagan, Derek, Joe, switched at midday), and Tait Earney and William Schermerhorn from the USGS Menlo Park (Geophysics support; helped with geology logging).

Operations. Started at 10:16, after removal and replacement of drill bit. Started at 527' depth. Drill bit was still the same type as 9/18 - one we used yesterday's bearing was damaged. New bits ordered should have come to the hotel today - will arrive tomorrow? Drillers took delivery of new water tank so that drillers don't have to make trips to get water. New driller + second hand man came up at 2:15 (Greg and Jonathon?). Water hit 120°F @ 590 ft. Drillers installed temperature probe in water just near the drill hole In the afternoon. Drilling ended at 525 @640 ft. ROP .25 ft/ min.

Geology: Cuttings are very much the same as yesterday. Fine sand to fine pebble sand composed of fine granitic grains, quartz, feldspar, amphiboles, and mica. At 600 ft we encountered a very pebbly sand with more pink feldspar and light yellow granitic grains. Fined back up in next sample. In some samples today we noticed light clay cementation in the sand - not drilling clay the pieces were dry inside when broken. Not many larger angular chips that look like have been cut by the drill today - we saw some yesterday.

Camas Prairie Drill hole
September 20 Daily Report

640-720 feet

Project personnel on site included and Natalie Tanski and Tom Lachmar (USU) the USGS drilling crew, Greg (driller) and two helpers, and Tait Earney and William Schermerhorn from the USGS Menlo Park (geophysics support).

Operations. Everyone arrived at drill site at 0700. USGS geophysicists left shortly thereafter, and returned briefly later in the afternoon. Drillers switched from a tooth bit to one with tungsten-carbide teeth to try and increase penetration rate, and made some minor repairs to the drill rig. They began tripping back into hole at approximately 0900. Encountered blockage at 420 feet, probably due to swelling clays, and proceeded to clean out the hole. Landed on bottom at 640 feet at approximately 1100. Drilled steadily until about 1830 when drillers began tripping out of hole, with a brief break at 660 feet at about 1215 to switch from centrifugal mud pump to piston pump to increase pressure and improve circulation with increasing depth of hole. Initial penetration rate was around 75 minutes for one 20-foot length of drill rod, which slowed to 100 minutes by the end of the day. Mud temperature increased from 41 degrees C to 41.8, then steadily decreased to 39.7 at the end of the day. Chad Hersley from the Idaho Department of Water Resources visited the site briefly near the end of the shift. John Shervais arrived at the Prairie Inn at 2130.

Geology: Cuttings remained the same as they were yesterday and the day before. Coarse sand to pebbly sand composed of fine granitic grains; quartz, feldspar, amphiboles and mica, along with a few dark, rounded lithic pebbles. Pebbles appeared to increase towards the end of the shift. Also noticed a few rather bright green mineral grains, possibly epidote. There were a few angular granitic pebbles, too. Relatively slow drilling rate implies that rock probably is more well cemented than at shallower depths.

Camas Prairie Drillhole
September 21 Daily Report

720-846 feet

Project personnel on site included and Natalie Tanski, Tom Lachmar and John Shervais (USU), and the USGS drilling crew consisting of Greg (driller) and two helpers.

Operations. N. Tanski and drillers arrived at site at 0700. T. Lachmar and J. Shervais arrived at 0815. Drillers switched from a used tungsten-carbide to a new one to try and increase penetration rate. They tripped back into hole and proceeded to clean it out. Landed on bottom at 720 feet at 1030. Drilled steadily until about 1745, when drillers encountered a high-pressure, water-bearing zone at about 840 feet. Initially, they tried to increase mud density to hold back the water, but after drilling for six feet they decided to mix a fresh batch of mud and circulate it before tripping out of hole for the day. They will check tomorrow morning to see if the fresh mud has been successful in holding back the high-pressure zone. The penetration rate was faster today, with time to drill one 20-foot length of drill rod varying from about 30 to 60 minutes. Mud temperature rose from 40.6 degrees C to 42.2, then decreased to 38.3 at approximately 770 feet due to addition of make-up water and mud to overcome some loss of drilling fluid into formation. Then temperature rose again, with the last two measurements at 43.9 and 43.8 degrees C. John Shervais left at about 1545 when drillers decided to mix new mud. T. Lachmar and N. Tanski left shortly thereafter when drillers expressed decision to wait until tomorrow to resume drilling.

Geology: Cuttings changed in color from gray to reddish-brown due to a change in color of the feldspar grains. J. Shervais posited that this may be due to alteration. Otherwise, the cuttings were the same as they were for the past three days. Coarse sand to pebbly sand composed of granitic grains; quartz, feldspar, amphiboles and mica, along with a few dark, rounded lithic pebbles. There seemed to be fewer pebbles today, though. J. Shervais identified green mineral grains from yesterday as altered plagioclase. There were a few angular granitic pebbles again today, too. Faster drilling rate implies that rock probably is not as well cemented as yesterday, possibly due to alteration as reflected by color change.

Camas Prairie Drillhole
September 22 Daily Report

846-846 feet

Project personnel on site included and Natalie Tanski, Tom Lachmar and John Shervais (USU), and the USGS drilling crew consisting of Greg (driller), Derek and Jonathan.

Operations. Everyone arrived at site at 0700. Drillers tripped back into hole and reached 840 feet at 0910. Circulated drilling mud and then prepared a fresh batch. Temperature of mud left in hole overnight was 52 degrees C. Well was not flowing, indicating that mud had successfully held back the high-pressure, water-bearing zone encountered at about 840 feet yesterday. Unfortunately, when drillers began pumping fresh mud into hole, piston pump stopped working due to hydraulic fluid leak. Jonathan was sent to purchase necessary supplies to repair hydraulic leak. In the meantime, drillers attempted to switch back to centrifugal pump by blocking flow of hydraulic fluid to piston pump. However, when they tried to engage centrifugal pump, the hydraulic fluid pressure was too high, and the control valve for the lift pump began gushing hydraulic fluid. Once Jonathan returned from Twin Falls with necessary parts several hours later, drillers were able to block flow of hydraulic fluid to lift-pump control valve, repair leaky hydraulic line to piston pump, and trip out of hole. Drillers hope to purchase necessary parts to repair or replace lift-pump control valve Monday morning, allowing them to resume drilling that same afternoon. T. Lachmar and N. Tanski returned to Logan after end of shift, since no drilling will take place tomorrow.

Geology: Nothing to report, since no drilling was done today.

Camas Prairie Drillhole Camas-1
Daily Drilling Report for Sunday and Monday, September 23-24

No Footage

No project personnel on site Sunday - rig down for repairs, parts not available until Monday.
On Saturday, project personnel were Eric Sonnenthal (LBNL), Will Kersey (USU), and John Shervais (USU). The USGS drilling crew was off obtaining parts.

Operations. Project personnel arrived on site at 2 PM. Shervais reviewed logging procedures and site safety materials with Sonnenthal and Kersey. A call to Steve Crawford indicated that the crew were off obtaining parts, in particular an electric mud motor to circumvent the hydraulic systems. Sonnenthal and Kersey will return to site on Tuesday and report back on progress.

Geology: Nothing to report, no new cuttings.

Camas Prairie Drill hole
September 25 Daily Report

840 – 940 feet

Project personnel on site this morning included Eric Sonnenthal (senior geologist, LBNL), Will Kersey (jr. geologist, USU), the USGS drilling crew (Greg, Derek, Joe?).

Operations Summary: After rig repairs, drilling started at ~ 0950. On site geologists collected drilling cuttings every 10' off the shaker table. A lightly washed sample was bagged, and a smaller sample from the same batch was put into chip trays. Drilling ROP was 0.13 – 0.29 ft/min, and drilling ended at 1845 at a depth of 940' below KB. Drilling went smoothly until a significant slowdown took place from 860 – 890', corresponding first to an increase in rock chips, and then transitioning to a clay-rich zone. At 1845 drill strings were removed. Mud temperatures were generally increased slightly with depth, but inconsistently and only varied between about 41 and 47 C.

Geology Summary: From 840 to 870' the geology in the drill hole consists of a mixture of fine to coarse angular granitic grains and small lithic fragments, similar in mineralogy to samples in the 800-840' depth range. The rock fragments consisted of pinkish granodiorite with quartz, whitish plagioclase and pink K-feldspar,
abundant hornblende, and biotite. Some rock fragments have green altered plagioclase, snd greenish quartz possibly from disseminated chlorite with slightly less abundant pink K-feldspar. Smaller grains consisted of a mixture of single crystals and smaller multigrain angular rock fragments. All grains appeared to be from the same rocks as the lithic fragments. Samples had a larger proportion of rock chips and a fairly fresh angular unweathered appearance, suggesting that granodioritic rock might have been encountered at between 860 and 870', also accompanied by a sharp drop in the ROP by about 50%. However, between 870 – 880', a small amount of whitish-grey-green sticky clay was observed, with large amounts between 890 - 940'. Rock fragments also consisted of sugary-textured (aplitic?) altered rock with a green-grey-white color, possibly the result of hydrothermal alteration. These rock fragments look like a very fine-grained equigranular intrusive rock, but a fine sandstone cannot be ruled out without closer examination.

Camas Prairie Drill hole
September 26 Daily Report

940 – 1100 feet

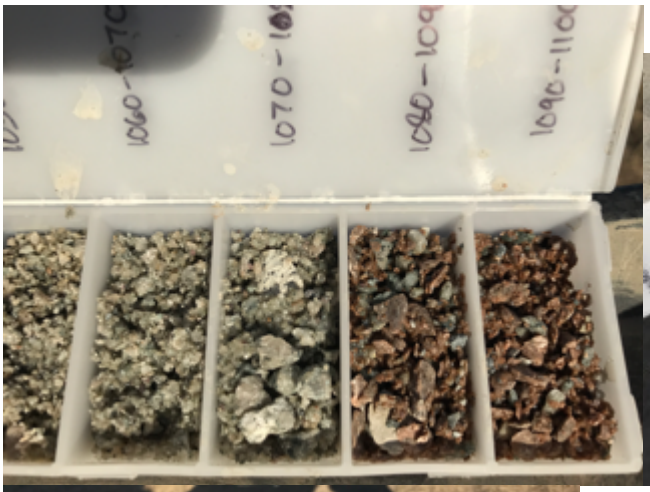
Project personnel on site this morning included Eric Sonnenthal (senior geologist, LBNL), Will Kersey (jr. geologist, USU), the USGS drilling crew (Greg, Derek, John).

Operations Summary: Switched to 7 7/8" PDC (diamond) bit to increase ROP. Drilling just started at 1025, and ROP was initially much faster - 1 foot/min, with 9.2 -9.3 mud weight.

Drilling ROP started at about 1 ft/min, but dropped to 0.18 ft/min in the last 20' string in the hard rock that was encountered. Drilling ended at 1755 at a depth of 1100' below KB. Added polymer at 990'to contain clay lumps. Drilling went smoothly until a significant slowdown took place 1085', corresponding to an increase in angular rock chips. Immediately prior to encountering this very hard rock, at about 1082', a large mud loss occurred (about 1 tank). Drilling continued 1100' in the same increasing hard silicified rock. Mud temperatures were generally increased slightly with depth, but inconsistently and only varied between about 45 and 49 C. On-site geologists collected drilling cuttings every 10' off the shaker table. A lightly washed sample was bagged, and a smaller sample from the same batch was put into chip trays. Conference call at 13:00 with Steve Crawford (USGS) and DOE to discuss current status. Decided to keep drilling to bedrock was encountered.

Geology Summary: From 940 to 950', similar clayey sticky mud as encountered starting at 880'. From 950 to 990' in an increasingly sulfide-rich hydrothermally-altered microgranite. Looks like chalcopyrite with rings of cuprite? Lots of disaggregated beige blocky tiny feldspar grains. From 990' to 100' saw appearance of reddish purple clay lumps and green very fine-grained chlorite rich fragments loaded with dissseminated sulfides. Chlorite-rich sulfide-bearing hydrothermally altered rock. Rock fragment that has prismatic hornblende, that may be hydrothermally altered dacite (Challis volcanic?). The grain size is almost identical, and the color is similar to the less altered chips we saw earlier. From 1070-1080', a mix of fine-grained felsic igneous rock (dacite or fine grained intrusive). From 1080 to 1085 in very hard silicified mix of quartz-chlorite vein, silicified volcanic rock(?) Increasing amounts of nice crystalline calcite. Samples fizz in HCl from ~1040-1090'. Chlorite is very bright intense green. Continuous increase in the proportion of sharp chips of reddish brown quartzitic (silicified?) rock to 1100'. Likely in bedrock, but will keep drilling. Very obvious change from gray-white clay-rich hydrothermally-altered to silicified rock on the tailings pile (photo).

Camas Prairie Drill hole - September 26 Daily Report
940 – 1100 feet PHOTOS:



Quartz-chlorite-calcite sulfide-bearing veins in hydrothermally-altered dacite (?) transitioning to increasing amounts of hard reddish-brown silicified “dacite” with original quartz micro-phenocrysts.

Camas Prairie Drill hole

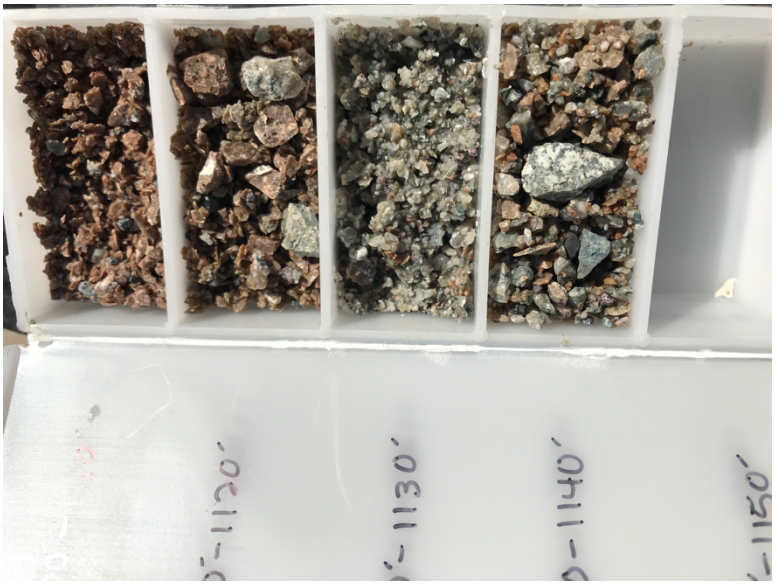
RE: September 27 Daily Report

1100 – 1140 feet

Project personnel on site this morning included Eric Sonnenthal (senior geologist, LBNL), Will Kersey (jr. geologist, USU), the USGS drilling crew (Greg, Derek, John).

Operations Summary Replaced PDC (diamond) 7/7/8" bit. Drilling just started at 1050. ROP was slow in hard rock, with first 20' string at 0.1 ft/min, with 9.2 -9.3 mud weight. Second string went a little faster partway at an overall rate of 0.17 ft/min. Drilling ended at 1615 at a depth of 1140' below KB. Mud temperatures generally decreased with depth, but inconsistently and only varied between about 45 and 41 C. On-site geologists collected drilling cuttings every 10' off of the shaker table, and checked samples more frequently to look for changes in lithology. A lightly washed sample was bagged, and a smaller sample from the same batch was put into chip trays. Drilling was planned to finish at around 16:00, hoping to finish out the second 20' string, which was achieved. Ended day, waiting for geophysical logging to be performed at night. Geophysical loggers arrived in Fairfield at approximately 2100.

Geology Summary From 1100-1120', mostly very hard chips of orangish-brown silicified volcanic rock(?), almost like a quartzite with about 20% chlorite-rich disseminated sulfide-bearing hydrothermally altered rock fragments some with primary prismatic hornblende. Looks like hydrothermally altered dacite (Challis volcanic?). From 1120-1130' mostly quartz-chlorite altered dacite, and lesser amounts of orange-brown silicified volcanic rock(?). Possible fine-grained yellowish epidote in a few chips. Increasing amounts of nice crystalline calcite and thin fracture-filling calcite. Chlorite is darker green than in samples shallower than 1100'. From 1130-1140' mostly a mix of very hard chips of orangish-brown silicified volcanic rock(?), and greenish chlorite-bearing altered volcanic rock with abundant calcite. Apparently alternating layers of two distinct rock types, as no chips contain both types of rock. A few very fine-grained greenish rounded lumps of chlorite-oxide were also present.



LAG METHOD: Driller

Depth	Time (min)	Rig noise etc.	Color (Munsell-soil)	Cones / EC	Graphic	Description and other observations (cc=calcite)	Bit size, &Rice time
000 010	1:03PM	49.2°C				Purple mud + fine to coarse sand, sand composed of altered granitic grains, sulfide bearing dark grains. →very little material to sample from shaker table	
010 020	1:16PM	47.5°C				purple mud + fine to coarse sand, sand composed of altered granitic grains, sulfide rich dark grains + green. mud looks a little lighter in color, almost off-white	
020 030	1:46	48.0°C				purple-gray mud + medium to coarse sand, qz, FS, dark grains which are gray-green with light and dark xtls visible (FS and amph) +sulfides	
030 040	2:00	48.2°C				purple-gray mud + medium to coarse sand, qz grains, blocky salmon-colored FS, dark grains appear to be dark gray-green matrix w/ light (FS) and dark xtls (amphibole) + sulfides + cc	
040 050	2:40	48.1°C				fine to coarse sand, very angular, qz, fs, bt, + some dark gray grains →chlorite + abundant sulfides altered almost entirely	dark grains from 1__ + __ are probably ex[…] igneou[…]
050 060	3:05	48.0°C				fine to coarse sand, v angular, qz, fs, gray hb + plag bearing extrusive ig rx + sulfides minor cc	
060 070	3:50	46.3°C				fine to course v angular sand, abundant qz, fs, some amphibole, + dark grains + chlorite minor cc hydrothermal vein material?	
070 080	4:04	46.8°C				qz, plag, hb, chlorite - fine to course sand + rock chips, v angular altered fs present minor cc	
080 090	5:01	46.0°C				m sand + v angular flat rock chips, orange porphyritic rock (silicified) with qz xtl inclusions drusy qz vein material PROBABLY BEDROCK	1085' - dr[…] slowed, […] porphyri[…] rock chi[…] became abundan[…] on sha[…] table
090 100	5:57	44.9°C				angular chips and sand, mostly of orange silicified porphyry as above minimal sulfides minor cc	
100 110	1:07	45.1°C				fine to coarse v angular sand, mostly (>80%) some orange material as above + cc, qz, and dark igneous grains epidote observed in some light-colored ~granitic lithic fragments	
110 120	2:17	42.9°C				fine to coarse v angular sand + rock chips, mostly same orange material as above (rhyolite porphyry?) loose qz chips (vein material?), some gray-green chips w/ amph, qz xtl phenocrys[…] + minor cc + epidote?	
120 130	3:28	43.5°C	Drilling much faster	+ vitreous yellow grains		fine to coarse v angular sand + rock chips - orange porphyry now makes up <20% of sample, qz, amph-bearing gray igneous rock, FS, + abundant cc xtls (up to .5cm) make up the remainder of the ma[…]	
130 140	4:17	41.0°C	Drilling slowed significantly @ 1139'			fine to v coarse v angular sand, ~30% orange rhyolite, 50% other consisting of cc, amph-bearing gray ext. ig rock, black grains, qz + chlorite + epidote	
140 150							
150 60							
60 70							
70 80							

Camas Prairie Drillhole

September 28 Daily Report

0-380’

Project personnel on site included Eric Sonnenthal (LBL), Will Kersey and Tom Lachmar (USU), and the USGS drilling crew consisting of Greg (driller), Jon(athan) and Joseph.

Operations. T. Lachmar arrived at site at 1545. E. Sonnenthal had left site, but W. Kersey was still there. He left shortly thereafter. Drillers were in the process of opening hole with 12-inch reaming bit attached behind 7-7/8 pilot bit. Reached 380 feet before tripping out of hole. Finished tripping at 1900. Drillers anticipate that reaming will be completed by end of day on Sunday. Then casing will be installed, which will take another two or three days. After that, the annular space between casing and borehole wall will be grouted with neat cement, which should take another day plus at least one more day to allow cement to cure. Drillers think that coring probably will commence in approximately one week. However, drillers have been informed that core rig should arrive at drill site tomorrow. Some of the auxiliary equipment for core rig is already on site.

Geology: Nothing to report, since hole was not deepened today. However, Greg (driller) thinks hole reached hard rock late on Wednesday at 1,086 feet. Was only able to drill 40 feet yesterday, indicating rock is harder than anything penetrated so far. W. Kersey thinks cuttings for final 54 feet are volcanic, based on apparent porphyritic texture, and silica rich, based on phenocrysts that appear to be quartz; probably Challis.

Camas Prairie Drillhole

September 29 Daily Report

380-540’

Project personnel on site included USGS drilling crew consisting of Greg (driller), Jon(athan), Joseph and Jeff Eman, and Tom Lachmar (USU).

Operations. T. Lachmar and drillers arrived at site at 0715. Drillers performed brief maintenance and/or minor repairs to rig and/or equipment, then continued opening hole with 12-inch reaming bit attached behind 7-7/8 pilot bit. Reached 540 feet before tripping out of hole. Finished tripping at 1900. Drilling was much slower today, presumably due to harder materials. Drillers will pull reamer bit out of hole first thing tomorrow morning and inspect it for wear. J. Eman arrived with core rig at 1515 and left shortly thereafter.

Geology: Nothing to report, since hole was not deepened today.

Camas Prairie Drillhole

September 30 Daily Report

540-680’

Project personnel on site included USGS drilling crew consisting of Greg (driller), Jon(athan), Joseph and Jeff Eman, and Tom Lachmar (USU).

Operations. T. Lachmar arrived at site at 0715. Drillers had already arrived and were preparing to remove reamer bit from hole. Bit was cleaned with high-pressure water and inspected. It looked to be in fine shape. Drillers tripped back into hole, and then continued opening it with 12-inch reaming bit attached behind 7-7/8 pilot bit. Reached 680 feet before tripping out of hole. T. Lachmar left site at 1830 while drillers were tripping out of hole. Drilling was slow again today, presumably because materials continued to be hard. Drillers report that casing should be delivered to site tomorrow.

Geology: Nothing to report, since hole was not deepened today.

Camas Prairie Drillhole

October 1 Daily Report

680-820'

Project personnel on site included USGS drilling crew (Greg (driller), Jonathan, and Joseph), and Pat Dobson (LBNL)

Operations: P. Dobson arrived onsite at 0815 from Boise. Drillers had already arrived and were cleaning the reaming bit with high-pressure water – the bit was then inspected and approved for use. Drillers tripped into the hole, and then continued opening up the hole using a 12" reaming bit attached behind a 7-7/8" pilot bit. Drilling was slow, as predicted by the drillers at the start of the day (based upon prior experience drilling through this section). Note that the actual depth of reaming is 6 feet deeper than the reported depth, due to the 6' long stabilizer that was added to the bottom hole assembly. Reaming was completed around 1815, and the string was tripped to a depth of 40' – this was completed around 1910.

Joseph made a trip to Boise for supplies once drilling had started. The big news was that 1160' of 6" casing was delivered to the site. The crew will perform routine maintenance to the rig in the morning before resuming drilling.

Geology: Nothing to report – hole was not deepened today.

(Left) Inspecting the reaming bit assembly after cleaning. (Right) New casing.

Reaming at ~780'.

Tripping out at the end of the day.

Camas Prairie Drillhole

October 3 2018 – Daily Report

935-1060 feet

Project personnel on site included USGS drilling crew (Greg (driller), Jonathan, and Joseph – several other crew members arrived later in the day), John Shervais (USU), Lee Liberty (BSU), James St. Clair (BSU), and Pat Dobson (LBNL). Visitors included Eric Hass and Alex Prisjatschew (DOE), Roy Mink, Lee Barron, and several other people from Fairfield.

Operations: P. Dobson arrived onsite at 800 from Fairfield. Drillers had tripped out of the hole and were pressure cleaning the bit and stabilizer, and inspected it for use. The bit was deemed good to continue, so the crew tripped in to 935' and continued opening up the hole using a 12" reaming bit attached behind a 7-7/8" pilot bit. Drilling was fairly slow – this was expected based on previous drilling through this interval. Note that the actual depth of reaming is 6 feet deeper than the reported depth, due to the 6' long stabilizer that is part of the bottom hole assembly. Reaming was completed for the day at around 1810, and the string was tripped to a depth of 40' – this was completed around 1910.

A new crew with another rig arrived today, and the drilling crew will switch out tomorrow. Robert will complete reaming out the remainder of the hole tomorrow, and will oversee the welding of the casing. Jack will then take over as head driller at the site.

Geology: Nothing to report – hole was not deepened today.

(Left) Washing of stabilizer (Right) Alex and Eric visiting the site.

Arrival of new drill rig.

Camas Prairie Drillhole

October 4 Daily Report

1060-1092'

Project personnel on site included USGS drilling crew (Robert (driller) and Eddie, with Jack arriving around 1530), and Pat Dobson (LBNL).

Operations: P. Dobson arrived onsite at 830 from Fairfield. The new drilling crew was still getting adjusted to the rig. They started tripping out of the hole at around 0900 and removed the 6' stabilizer and the 12" reaming bit attached behind a 7-7/8" pilot bit. They then installed a 9-7/8" tricone bit with a collar to ream out the last portion of the hole (no stabilizer was added to the BHA). The crew then tripped back into the hole starting around 1115 and continued opening up the hole beginning about 1250 (starting nominally at a depth of 1060', but really ~1066') using the new bit. Drilling was painfully slow throughout the day – this section was known to be hard rock that would be slow to drill. The switch to the smaller diameter bit was made with the hope that this would lead to slightly faster drilling rates – this doesn't seem to have really sped things up much. During the afternoon, I noticed that the drilling display screen was displaying all zeros, so Jack reset the device and it now registers almost everything correctly – the depth needs to be reset manually (it registered zero). Reaming was completed for the day at around 1820, and the string was tripped to a depth of 700' – this was completed around 1850.

Jack arrived onsite at 1530 with 11 bundles (each with 19 sticks) of 10' NQ drill rod – this equates to 2090 feet. After the reaming has been completed (hopefully tomorrow), Robert will oversee the welding of the casing, and Jack will take over as head driller at the site. The weather was rainy, windy, and cold.

Geology: Nothing to report – hole was not deepened today.

(Left) Removing stabilizer (Right) New drill bit and collar.

Arrival of new NQ coring drill rod.

Drilling in the rain!

Camas Prairie Drillhole

October 5 Daily Report

1092-1139'

Project personnel on site included USGS drilling crew (Jack (driller), Robert and Eddie), and Pat Dobson (LBNL).

Operations: P. Dobson arrived onsite at 0830 from Fairfield. The drilling crew was tripping back into the hole then, and reached drilling depth around 0840. The crew made a trip to refill the water truck and got the mud system up and running. Reaming started at 0934 at a depth of 1092' using the 9-7/8" bit. Drilling was still slow throughout the day – this section was known to be hard rock that would be slow to drill. Reaming was completed for the day at the final depth of 1139'. On Saturday morning, the crew will do a wiper run and then begin to install and weld 6" casing.

Around midday, two USGS trucks with drilling gear from the Washington State job showed up at the site (Joseph and Tom) – Joseph left soon afterwards with one of the trucks. Robert began preparations for welding the casing. The weather was sunny but cold. P. Dobson left at 1320. At that time, the reaming was at ~1110'.

Geology: Nothing to report – hole was not deepened today.

(Left) Starting up in the morning (Right) Eddie mixing up mud.

Reaming away.

Drilling conditions at ~1317 hours

Camas Prairie Drillhole

October 6 Daily Report

Staff on site included USU Site Geologist Will Kersey and the USGS drill crew (Jack, Robert, and Derek).

Operations: Drillers tripped out 500' on the evening of 4 October 2018 and tripped back in 500' this morning. Mud was circulated on the bottom of the hole for about an hour and a half to ensure that it was clear of any debris. Following this, the drillers tripped out and removed the drill bit. Finally, 400' of 2" tremie pipe was tripped in.

The rest of the day was devoted to welding and setting of casing. Setting casing in the hole began around 14:30 hours. By 18:15, 260' of casing had been set. At 18:15, what had started as a light drizzle turned into a chilly downpour, and work was halted due to unsafe conditions presented by the weather. At 18:35, with no break in the rain, the call was made to halt operations for the day.

Geology: Nothing to report

Camas Prairie Drillhole

October 7 Daily Report

260'-1029'

Staff on site included USU Site Geologist Will Kersey and the USGS drill crew (Jack, Robert, and Derek).

Operations: The entirety of the day was devoted to welding and setting casing. Operations started around 7:30 and ended around 19:15 at 1029' of casing. A total of 769' of casing was installed today.

Geology: Nothing to report

Camas Prairie Drillhole Camas-1

October 8 Tuesday - Daily Report

Staff on site included USU Site Geologist Will Kersey and the USGS drill crew (Jeff, Jack, Robert, and Derek).

Operations: The drillers made the call to delay cement delivery until tomorrow. It's been raining/sleeting/snowing and is projected to for the rest of the day. They're worried that the cement truck will get stuck in the mud in the field here.

Drillers circulated mud till afternoon. Cement is scheduled for noon tomorrow, weather permitting. Drilling will not likely resume till Friday 12 Oct.

Geology: Nothing to report

Camas Prairie Drillhole

October 9 Daily Report

Staff on site included USU Site Geologist Will Kersey and the USGS drill crew (Jeff, Jack, Robert, and Derek).

Operations: Operations started at 7:30. The drill crew made the call to delay cement delivery until tomorrow due to rough weather. Mud was circulated periodically until operations were halted around 14:00. Cement delivery was rescheduled for noon tomorrow.

Geology: Nothing to report

Photo: Snow on the mountains, Wednesday morning.

Camas Prairie Drillhole Camas-1

October 10 Daily Report
1029'-1138'

Staff on site included USU Site Geologist Will Kersey and the USGS drill crew (Jeff, Jack, Robert, and Derek). Chad Hersley from Idaho Department of Water Resources made an appearance during cementing.

Operations: Operations started at 7:30. Mud was circulated in the well until about 10:30. This was followed by preparations for cement delivery and injection. Cement trucks arrived at 12:15, and cement pumping began around 12:50. Both of the two cement trucks were emptied by 13:10. The first batch of cement was low quality, containing chunks of unmixed cement. The second batch was smoother. The cement truck drivers were directed by Jeff to dump their remaining cement in a borrow pit down the road specified by Lee Barron.

Water was pumped into the casing to force a plug down through it. This forced the cement inside of the casing out through the bottom and subsequently up around the outside of the casing. During this process, some of the cement was channeled up to the top of the hole. Due to this unexpected occurrence, the tremie was removed from the hole for fear of it getting stuck, as the drillers did not know what depth the cement had stopped at. Once the tremie had been removed, the site was cleaned and prepped for tomorrow. Operations halted at 16:20.

Tomorrow, once the cement has hardened, the drillers plan to trip the tremie back in to assess the depth the cement reached today. They anticipate finishing cementing tomorrow and potentially to start installation of the BOP (blow-out preventor) in the afternoon.

Geology: Nothing to report

Camas Prairie Drillhole Camas-1

October 11 Daily Report

Staff on site included USU Site Geologist Will Kersey and the USGS drill crew (Jeff, Jack, Robert, John, and Derek). Jonathan Keith, an archeologist from Cannon Heritage Consultants, was on site for the latter half of the day to look for cultural artifacts during some digging.

Operations: Operations started at 7:30. The depth that concrete had reached yesterday was assessed by tripping tremie into the hole. Cement was prepared on site and pumped into the hole to finish the cement job. Pumping of cement started at 10:15 and ended at 10:40. A backhoe was delivered at 11:00, and preparation began for digging out the area around the well. The backhoe was used to dig out the mud pit (no new ground broken, digging through well cuttings and drill mud) until Jonathan arrived at 14:35. Once there was an archeologist on site, digging around the well began. The area excavated around the well was roughly 2mx2mx1.2m. The upper ~1.5m of casing was removed to make room for the BOP. The BOP was nearly completely installed, with some minor work left to finish in the morning. Continued digging of the mud pit occurred during the work on the BOP. Operations halted at 19:00.

Geology: Nothing to report

Camas Prairie Drillhole

October 12 Daily Report

Staff on site included USU Site Geologist Will Kersey and the USGS drill crew (Jeff, Jack, John, and Derek).

Operations: Operations started at 7:30. The morning was devoted to completing the installation of the BOP and preparing to trip in with the rotary drill. The backhoe was used to refill part of the hole dug yesterday around the well (no new ground broken). The drill rig was securely re-situated, and preparation was made to pump the remaining water out of the well. Tripping in began at 13:00, with a minor delay to wait for parts Jeff was retrieving from out of town. Around 17:00 a hose on the air compressor ruptured and began gushing oil. The drill crew performed cleanup of the spill and set up their backup compressor to continue pumping water from the hole as they tripped in. The crew continued tripping in, finishing the day at 19:00 having made 1000'.

Geology: Nothing to report

Camas Prairie Drillhole

October 13 Daily Report

Staff on site included USU Site Geologist Will Kersey, USU Senior Geologist John Shervais, and the USGS drill crew (Jeff, Jack, John, and Derek).

Operations: Operations started at 7:30. Drillers encountered resistance when attempting to pump water up through the casing in the morning, and tripped out part of the way thinking that water had flowed into the casing from the ground. They later concluded that the cause of the problem had been cement or mud getting caked onto the drill bit and tripped back in. Water was injected to clear out the bottom of the hole, which led to a release of what appeared to be liquid cement from the cuttings hose.

Drilling through the plug at the bottom of the casing occurred around 11:15. While some of the rubber from the plug came out of the hole, the drillers remarked that it should have been significantly more. Following drilling through the plug, the well stopped producing any fluids or gasses for more than 30 minutes despite the air pump being active with pressures above 250psi. The drillers decided to trip out to see if they could improve suction that way.

At 12:20, the seal broke and water began coming out of the well. This was unexpected and undesirable, as the drill string was only at 400'. The drillers believed that this was groundwater that had been able to get into the casing because the cement job had not created a good seal. The drillers devised a plan to rotary drill for another 5 feet at the bottom of the well, trip out, trip in tremie, and inject more cement to attempt to create a good seal at the bottom of the casing. Water was circulated at the bottom of the hole to ensure that any debris had been removed.

At 14:45, the drill crew started rotary drilling into the rock at the bottom of the well using water as their drill fluid. A sample taken at 1145' was composed nearly entirely of the orange silicified rock seen in the previous 50+ feet. The drillers made the 5' from 1140-1145 in less than 10 minutes. 1146' was the final depth reached. By 16:45, the drillers had tripped the drill string out. Tremie began to be tripped in at 17:20 and had finished at 18:50 with 1120' of tremie in the hole and 20' attached and ready to enter in the morning.

Operations halted at 18:50.

Geology: Nothing to report

Camas Prairie Drillhole

October 14 Daily Report

Staff on site included USU Site Geologist Will Kersey, USU Senior Geologist John Shervais, and the USGS drill crew (Jeff, Jack, John, and Derek).

Operations: Operations started at 8:00. The crew prepared to mix and pump cement through the tremie until Jeff arrived at 10:00 with a pallet of Portland cement. Pumping cement began at 10:15 and was finished at 10:55. A total of 50x 42kg bags of cement were used. The tremie was tripped out by noon, and the hole was flushed with water. The rest of the day was devoted to cleaning up the site and preparing to rotary drill Monday. Operations halted at 16:00.

Drillers notes that the cement they mixed on site was 16lb/gal while the delivered cement was 14lb/gal. They believe that low quality cement may have been responsible for the poor cement job.

Geology: Nothing to report

Camas Prairie Drillhole, 1144-1160 feet
October 15 Daily Report

Staff on site included USU Site Geologist Will Kersey, USU Senior Geologist John Shervais (morning) and USU Site Geologist Natalie Tanski (afternoon) and the USGS drill crew (Jeff, Jack, John, and Derek).

Operations: Operations started at 7:30. The crew began tripping in at 9:15 and hit cement at 965' while we were at lunch. Drilling into rock started at 1144' at 16:15 with 5.5" bit. Water temperature was 35.2ºC at 1144' and continued to get hotter until we hit 71.4ºC at 1160' at 17:05. Funnel where rock chips and water were coming out was shaking voliently and gushing from the top at this time. Drilling ended here at 1160' due to high water pressure in the well (can't pump water out, drillers guess 800 to 850ft of head) and saftey concerns. Jack, head driller, mentioned he thinks he hit fracture zones between 1150' and 1160'. Operations halted at 17:25, drillers prepare for tomorrow and plan to continue to drill Tuesday but with mud.

Geology: Samples taken at 1150' and 1160' both contain coarse sand to coarse pebble sized angular rock chips of orange rhyolite, crystals <1mm. We appear to be in fractured Challis Volcanics rhyolite with an artesian hot water aquifer. A water sample was obtained from the pressurized water stream.

Camas Prairie Drillhole, 1160-1380 feet

October 16 Daily Report
Staff on site included USU Site Geologist Natalie Tanski, USU Senior Geologist Jim Evans and the USGS drill crew (Jeff, Jack, John, and Derek).

Operations: Operations started at 7:30. The crew tripped out to 700ft, at 8:15 they blew air and we took a water sample and a water temp of 67.9•C. Tripped back in and drilling into rock started at 1160' at 10:45 with a 5.5" bit. On average the ROP was 0.5 ft/min. Drilling ended at 1380 ft at 17:40. Drill crew tripped out until the bit was within the casing.

Geology: From 1160' to 1180' the geology consisted of coarse sand to coarse pebble sized angular rock chips of orange rhyolite, crystals <1mm, with quartz inclusions, and few flakes of calcium carbonate were seen. We appeared to be in fractured Challis Volcanics rhyolite with an artesian hot water aquifer. From 1180' to 1345' the geology consisted of medium sand to fine pebbles of subangular granitic grains ranging from light grey to pink, quartz, feldspar, mica, dark green mineral (altered plagioclase?) and calcium carbonate. From 1345' to 1360' the geology consisted of angular, medium sand to fine pebbles of the orange rhyolite we saw earlier. Then 1360' to 1380' the geology consisted of medium sand to fine pebbles of subangular light and dark grey granitic grains, quartz, feldspars, few smaller grains of amphibole.

Camas Prairie Drillhole, 1380- 1520'feet

October 17 Daily Report
Staff on site included USU Site Geologist Natalie Tanski, USU Senior Geologist Jim Evans and the USGS drill crew (Jack, John, and Derek).

Operations: Operations started at 7:30. Crew trips in, initial mud temp coming out of hole was 47.1 deg C. Drilling into rock started at 1380' at 8:52 with a 5.5" bit. On average the ROP was 0.3 ft/min. Drilling ended at 1520' at 17:15 with a mud temp at 46.1 deg C. Generator for shaker table stopped. Drill crew tripped out until the bit was within the casing.

Geology: From 1380' to 1520' the geology consisted of medium sand to fine pebble-sized grains of subangular light grey, dark grey, and light pink granitic grains, quartz, feldspars, a dark green mineral (altered plagioclase?) few amphibole, mica, and calcium carbonate. Between 1450' to 1460' the geology consisted angular fine sand to fine pebble-sized grains of orangish reddish brown porphyry and few calcium carbonate flakes.

Camas Prairie Drillhole

October 18 Daily Report

1,520'-1,608’

Project personnel on site included Steve Crawford (supervisor), Jack Hennagan (driller), Derek and Jonathan (helpers) from the USGS, and Natalie Tanski and Tom Lachmar from USU.

Operations: T. Lachmar arrived at 1140. Drillers had reached 1,560'. Drilled steadily until 1830 before pulling bit up off bottom at end of day. Mud temperature decreased steadily from 55.3 degrees C at 1,570', to 53.8 at 1,580, to 52.3 at 1,590, to 44.8 and 45.7 at 1,600' and 1,608', respectively. Penetration rate slowed dramatically from 85 minutes for 20' interval from 1,560' to 1,580', to approximately 3-1/2 hours from 1,580' to 1,600', with the last 4' taking 80 minutes. Final 8' from 1,600' to 1,608' took about 2 hours to drill, but penetration rate appeared to increase for the last 3'.

Geology: Cuttings consisted mostly of coarse sand to fine pebble-sized, sub-rounded to sub-angular light gray granitic grains; quartz, feldspar, amphibole and mica, with some calcite, presumably a secondary mineral filling fractures. Encountered a very hard zone from 1,596’ to 1605’ consisting of coarse sand to fine pebble-sized, sub-angular to angular chips of pinkish rhyolite, also with some calcite.

Camas Prairie Drillhole

October 19 Daily Report

Project personnel on site included Jack Hennagan (driller), Derek and Jonathan (helpers), and Tony Brown (logger) from the USGS, Ghanashyam (Hari) Neupane from the University of Idaho, Idaho Falls, Tom Lachmar from USU, and Colin Goranson (consultant).

Operations: C. Goranson and T. Lachmar arrived at drill site at 0710. Drillers arrived shortly thereafter and began circulating mud. Initial temperature was 45.1 degrees C. Drillers tripped out of hole, and T. Brown arrived shortly before they finished. T. Brown spent afternoon running borehole geophysical logs. Hari arrived around midday to sample, but fluid level in well was at 46’ below ground surface. So he took a sample of water that will be introduced into well tomorrow, both to replace the mud and to conduct an injection test, and then he left the drill site. He hopes to return Sunday to collect water samples. Temperature log showed warmer water from approximately 1,160’ to 1,300’, and caliper log showed a slight increase in hole diameter at about 1,300’, too. C. Goranson thinks this likely is the location of the geothermal reservoir. Another temperature log will be run first thing tomorrow morning, prior to replacing mud with water and conducting injection test.

Geology: Nothing to report, as drilling has been completed.

Camas Prairie Drillhole

October 20 Daily Report

Project personnel on site included Jack Hennagan (driller), Derek and Jonathan (helpers), and Tony Brown (logger) from the USGS, Ghanashyam (Hari) Neupane from the University of Idaho, Idaho Falls, Tom Lachmar from USU, and Colin Goranson (consultant).

Operations: T. Brown, C. Goranson and T. Lachmar left for drill site at 0710. Drillers had already arrived. Mud temperature was 45 degrees C. T. Brown began running temperature log, but tool malfunctioned. It was decided that water samples would be collected today. Drillers tripped into hole until bottom of string was 735' below ground surface. Air-lifting started at 1030, and water reached ground surface at 1038. Initial air pressure applied was 300 psi, but soon stabilized at around 150 psi. Initial water temperature approximately 60 degrees C. Discharge estimated at 50 to 75 gpm. Hari was notified of intention to sample today and he drove to drill site from Idaho Falls with sampling equipment. Water was turbid at first, so he waited until it had cleared up before sampling. Temperature had increased to 65.0 degrees C at time when sampling commenced, and reached 66.7 when sampling was completed at 1430. Drillers shut off air at 1433 and tripped out of hole. T. Brown ran temperature log afterwards. Another temperature log will be run tomorrow morning, and injection test will be conducted afterward.

Geology: Nothing to report, as drilling has been completed.

Camas Prairie Drillhole

October 21 Daily Report

Project personnel on site included Jack Hennagan (driller), Derek and Jonathan (helpers), and Tony Brown (logger) from the USGS, Tom Lachmar from USU, and Colin Goranson (consultant).

Operations: T. Brown, C. Goranson and T. Lachmar arrived drill site at 0720. Drillers arrived shortly thereafter. T. Brown began setting up to run temperature-pressure log, but decision was made to dispense with log and begin injection test. Temperature-pressure tool was lowered to 1,225', roughly in the middle of suspected production zone. It was programmed to record measurements every 10 seconds. Injection commenced at 1119 by pumping water with piston pump used for mud. Stroke rate was adjusted to one stroke every 12 to 13 seconds. Based on driller's estimate, this correlated with an injection rate of between 30 and 35 gpm. Also measured temperature of injection water at 5.0 degrees C, and measured approximate volume of water injected from supply tank at 10,900 gallons. Injection was halted at 1810, so test duration was 411 minutes. Thus, injection rate estimated by water usage was only about 26 gpm. T. Brown will leave tool in hole overnight to record recovery pressures, remove it and download data tomorrow morning, and then run a final temperature log.

Geology: Nothing to report, as drilling has been completed.