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Raft River Geoscience Case Study Appendixes

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Technical Editor

November 1981

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**EG&G Idaho, Inc.
Idaho Falls, Idaho 83415**

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APPENDIX A
LITHOLOGY, X-RAY ANALYSIS, AND CORES

APPENDIX A

LITHOLOGY, X-RAY ANALYSIS, AND CORES

This appendix includes a description of cored intervals in the geothermal wells, the lithology of drill cuttings from the wells, and the results of x-ray analysis performed on selected intervals of the drill cuttings.

The core descriptions were taken from work accomplished by the United States Geological Survey (USGS). The lithology is a composite of work performed by the USGS and EG&G Idaho, Inc. The latter's work is based upon commercial mud logging performed on the seven deep wells and EG&G lithologic description of the shallow wells. At present, all cuttings and cores are stored at the University of Utah Earth Science Laboratory.

The x-ray analysis was performed by Boise State University on a contract from DOE-ID. An analysis of select thin sections was performed by the Idaho Bureau of Mines and Geology.

LITHOLOGY

Table A-1. Cored intervals in RRGE-1

Core Number	Cored Interval (m)	Amount Recovered (m)	Recovery (%)	Description
1	1364.5 to 1383.2	7	37	Salt Lake Formation. Green-speckled cellular silica, considerably fractured and slickensided. Probably a major fault zone. Parent material probably sandstone and siltstone. Dark gray, calcareous claystone, and light gray, probably tuffaceous sandstone, cut by vertical fractures; some fractures filled with calcite.
2	1423.2 to 1426.5	2.7	82	Upper Narrows Schist. Gray to dark gray quartzite and graphitic biotite schist, with minor amounts of dolomitic cement, scattered pyrite, and vugs with calcite and quartz crystals.
3	1520.4 to 1521.0	0.6	100	Quartz Monzanite. Gneissic, light to dark greenish-gray, 50% feldspar, 30% quartz, 20% chlorite, trace of pyrite and magnetite. Fractures with slickensides and calcite; iron staining.

Table A-2. Cored intervals in RRGE-2

Core Number	Cored Interval (m)	Amount Recovered (m)	Recovery (%)	Description
1	931 to 936	5.0	100	Salt Lake Formation. Siltstone: light and dark green banding, tuffaceous, calcareous cement, small pebbles of limestone, bedding dip at 30 degrees, becomes sandy downward to pure tuffaceous sand below 932 m. At 934 m there is a fault with 40 degrees dip, many 60 to 90 degrees dipping fractures below the fault. Another fault with 75-degree dip at 935 m. Abundant pyrite.
2	1128.5 to 1132.5	4	100	Salt Lake Formation. Sandstone at 1128.5 to 1129.5 m, fine- to medium-grained quartz, calcareous cement, finely disseminated pyrite, bedding dip 45 degree. Siltstone at 1129.5 to 1130.5 m, tuffaceous, light green to white, slightly calcareous, many small high angle faults, carbonaceous material on bedding surface. Sandstone at 1130.5 to 1132.5 m and siltstone interbedded, tuffaceous, calcareous, bedding dip 45 degree, scattered limestone pebbles up to 3 cm in diameter.
3	1280.2 to 1283.2	3	100	Salt Lake Formation. Interbedded calcareous fine-grained quartz sandstone and tuffaceous siltstone. Bedding dip 35 degree with carbonaceous material on some bedding surfaces.
4	1326.8 to 1328.6	1.8	100	Salt Lake Formation. Calcareous tuff, gray, highly fractured, core has crystalline appearance.
5	1459.5 to 1459.5	0	0	Elba Quartzite. Attempted core in Elba Quartzite; no recovery. Cuttings 95% white quartzite, 5% white mica probably from bedding surfaces, minor pyrite.

Table A-2. (continued)

Core Number	Cored Interval (m)	Amount Recovered (m)	Recovery (%)	Description
6	1990.8 to 1992.1	0	0	
7	1993.5 to 1994.5	0.3	30	Quartz Monzonite: gneissic quartz monzonite, 50% feldspar, 30% quartz, 20% chlorite, abundant magnetite. Core is dense with no sign of fractures.

Table A-3. Cored intervals in RRGE-3

Core Number	Cored Interval (m)	Amount Recovered (m)	Recovery (%)	Description
1	849.4 to 852.4	3.0	100	Salt Lake Formation. Alternating light gray sandstone and dark gray siltstone laminae; tuffaceous, calcareous, minor amounts of pyrite, and some soft sediment deformation. Bedding dip 15 degree.
2	1020.4 to 1025.3	1.07	22	Salt Lake Formation. Sandstone: light green, tuffaceous, noncalcareous cement. Quartz sand: well-rounded, frosted, fine- to coarse-grained. Many fractures with 60 degree dips, most containing gypsum and analcite crystals.

Table A-3. (continued)

Core Number	Cored Interval (m)	Amount Recovered (m)	Recovery (%)	Description
3	1203.4 to 1207.9	4.5	100	Salt Lake Formation. Alternating thin laminae of dark brown to gray siltstone, and light gray sandstone; calcareous, tuffaceous, abundant muscovite, minor amounts of biotite, and trace of sulfides, occasional quartz pebbles, soft sediment deformation throughout, bedding dip 60 degree at top of core, decreasing to 20 degree at bottom, many small fractures and faults all at high angle and generally dip opposite bedding.
RRGE-3C				
4	1511.6 to 1517.7	6.1	100	Salt Lake Formation. Alternating laminae of greenish-gray siltstone and green sandstone that is calcareous, tuffaceous; soft sediment deformation throughout, bedding dips 30 to 40 degrees, many fractures dipping 60 degree to vertical.
5	1600.3 to 1603.0	1.83	67	Salt Lake Formation. Alternating thin laminae of brown siltstone and light green sandstone; calcareous, tuffaceous, bedding dip 25 degrees, fractures vertical to 70 degrees throughout, open or filled with calcite.
6	1686.6 to 1686.9	0.3	100	Precambrian--Elba Quartzite. Quartzite: white to milky, clean, dense, micas on bedding surfaces, and rare magnetite grains. Some schist laminations.

Table A-4. Cored intervals in RRG1-4/RRGP-4

Core Number	Cored Interval (m)	Amount Recovered (m)	Recovery (%)	Description
1	577.4 to 579.57	1.07	51.7	Salt Lake Formation. Sandstone: gray-green, calcareous, tuffaceous, medium- to coarse-grained. Clasts of subangular to rounded quartz, feldspar, schist, and tuff.
2	859.8 to 865.9	6.1	65	Salt Lake Formation. Sandstone: gray-green, medium-grained, with thin interbeds of tan, calcareous siltstone. Sand: medium-grained, clean, angular to sub-rounded clasts of quartz, feldspar, schist, and biotite. Pyrite crystals scattered throughout. Silt: calcareous, micaceous, with scattered angular quartz and feldspar grains.
3	1414 to 1419	3	60	Salt Lake Formation. Alternating siltstone and fine sandstone from light green to light gray, tuffaceous, calcareous, with many small fractures filled with calcite. The siltstone and sandstone brecciated downward with calcite filling fractures and surrounding many angular clasts. Downward, abundant green mica forms schistose lenses with reddish-brown mica. These schistose lenses alternate with a dark green tuffaceous siltstone containing angular clasts of quartz, quartzite, schist, and quartz monzonite. Clasts are as large as 3 cm in diameter. The base of the core is gneissic, composed of gray quartz and green mica. The core is highly foliated with slickensides on many of the parting surfaces.
4	1419 to 1424	2	40	

Table A-5. Cored interval in RRGP-5

Core Number	Cored Interval (m)	Amount Recovered (m)	Recovery (%)	Description
1	1125 to 1130	5	100	Salt Lake Formation. Fine sandstone and siltstone in alternating light and dark gray laminae. The lighter sandstone laminae are very calcareous in the upper part of the core, becoming slightly calcareous in the lower part. The darker siltstone laminae are slightly calcareous in the upper part of the core, becoming noncalcareous in the lower part. The laminae dip 20 degrees at the top of the core and slowly increase downward to 30 degrees at the bottom. The entire core is fractured and faulted, the fractures being mostly healed with calcite. The faults offset no more than a few centimeters, but all display slickensides and some are healed with calcite. The fault and fracture dips range from 60 to 90 degrees.

Table A-6. Cored intervals in RRG1-6

Core Number	Cored Interval (m)	Amount Recovered (m)	Recovery (%)	Description
1	903.7 to 912.7	6	67	Salt Lake Formation. Siltstone and fine-grained sandstone in alternating light and dark grayish-green laminae. The lighter laminae are calcareous sandstone while the darker laminae are noncalcareous siltstones. The laminae maintain a 20-degree dip throughout the core; carbonaceous material occurs between the laminae near the middle of the core. The few fractures and faults are partly filled with calcite and dip 60 to 90 degrees.

Table A-6. (continued)

Core Number	Cored Interval (m)	Amount Recovered (m)	Recovery (%)	Description
2	1166.7 to 1175.7	3	33	Salt Lake Formation. Coarse-grained sandstone and gravel grading downward to fine-grained sandstone. Entire core is light gray-green in color with bedding dips from 30 to 40 degrees. A few fractures, dipping 70 to 90 degrees, and partly filled with calcite can be seen. The sandstone is calcareous and consists of subangular to rounded clasts of quartz and minor ryholite. The gravel is calcareous and contains rounded clasts of ryholite, quartzite and dolomite as much as 2 cm in diameter.

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Table A-7. Cored interval in RRG1-7

Core Number	Cored Interval (m)	Amount Recovered (m)	Recovery (%)	Description
1	1162.7 to 1171.7	6	66.7	Salt Lake Formation. Siltstone and medium-grained sandstone; calcareous, greenish-gray, bedding dips 5 to 10 degrees. Few fractures present with 60 to 90-degree dips and partly filled with calcite.

Table A-8. Lithology of RRGE-1

Depth (m)	Description ^a
0 to 7	Silt and sand: tan.
7 to 61	Tan silt: angular to subangular gravel composed of Tertiary Lava of the Salt Lake Formation (Tsj), minor amounts of green tuff; Paleozoic limestone; and Precambrian quartzite.
61 to 107	Sand and silt: green-gray, fine- to coarse-grained. Minor amounts of gravel: 50 to 70% quartz and quartzite, 15 to 30% Tsj, 5 to 20% green tuff; minor amounts of limestone.
107 to 137	Sand and fine gravel: gray, coarse-grained, 50% green tuff, 25% Tsj, 25% quartz and quartzite.
137 to 213	Sandstone and siltstone: gray to green gray, primarily quartz and Tsj with minor amounts of green tuff pebbles and glass shards.
213 to 274	Sandstone: greenish-gray, coarse-grained, tuffaceous, with minor amounts of conglomerate. Grains are altered Tsj, quartz and quartzite. Minor amounts of pyrite.
274 to 290	Sandstone and siltstone: gray, tuffaceous sandstone; tan, calcareous Siltstone.
290 to 427	Sandstone, siltstone, and gravel. Gray, fine- to medium-grained, tuffaceous sandstone. Tan siltstone. Gray gravel mostly Tsj and quartzite with minor amounts of limestone and fine-grained sandstone.
427 to 494	Interbedded tuff, sandstone, and siltstone. Tuff: light green. Sandstone: tuffaceous. Siltstone: tan, weakly calcareous.
494 to 595	Sandstone and conglomerate of Tsj and quartzite. Minor amounts of interbedded green and gray tuff, calcareous tan siltstone in the lower part. Crystalline calcite around 533 m.
495 to 649	Light green tuff and tuffaceous siltstone with minor amounts of sandstone and conglomerate of quartzite and Tsj.
649 to 683	Sandstone and conglomerate of quartzite and Tsj with interbedded tan calcareous siltstone and light green tuff. Small amount of muscovite flecks.
683 to 784	Light green tuff and tuffaceous siltstone and sandstone interbedded with minor amounts of weakly calcareous siltstone.

Table A-8. (continued)

Depth (m)	Description ^a
784 to 878	Tuffaceous sandstone with interbedded light green tuff and tan calcareous siltstone. Trace of loose, clear selenite, white earthy gypsum, and mica flakes.
878 to 1241	Light green and white partly silicified tuff, tuffaceous siltstone and fine-grained sandstone, interbedded with tan weakly calcareous siltstone. Rare quartz and quartzite pebbles. Trace of selenite and gypsum in upper part. Trace of selenite in lower part.
1241 to 1372	Light green and white tuff; tuffaceous siltstone with minor amounts of tan, weakly calcareous siltstone; and fine-grained sandstone. Trace of white light gray, soft, earthy gypsum, and silica veining.
1372 to 1381	Green-speckled, cellular silica, fractured, and slicken-sided. Parent material probably sandstone and siltstone.
1381 to 1396	Dark gray, calcareous claystone and light gray tuffaceous sandstone, cut by vertical fractures and high-angle faults which are displaced 1 to 2 in. and healed by calcite.
1396 to 1433	Schist of the Upper Narrows. Gray to dark gray quartzite with graphitic biotite schist. Minor amounts of dolomite cement and pyrite. Vugs filled with calcite and quartz crystals. Fractures containing quartz crystals and massive quartz. Iron staining.
1433 to 1512	Elba Quartzite. Clean, white to clear micaceous quartzite. Minor amounts of biotite, pyrite, and magnetite. Quartz crystals in open fractures.
1512 to 1521 (total depth)	Quartz Monzonite. Light greenish-gray, chlorite biotite gneiss. Trace of pyrite and magnetite.

a. Mud logging by Core Laboratories Inc. and by H. Covington of the United States Geological Survey.

Table A-9. Lithology of RRG-2

Depth (m)	Description ^a
0 to 6	Loess; tan silt and fine sand.
6 to 186	Raft Formation. Gravel composed of pebbles and cobbles of Tertiary Lava of the Salt Lake Formation. Tsj, tuff, and quartzite. Sand matrix of quartz and tuff grains.
186 to 259	Salt Lake Formation. Green, calcareous, tuffaceous clay with scattered pebbles of Tsj.
259 to 357	Siltstone grading downward to sandstone with silt interbeds. Silt is tan, tuffaceous, slightly to noncalcareous. Sand is gray green, tuffaceous, slightly calcareous. Scattered pebbles of Tsj, tuff, and quartzite. Minor amounts of pyrite and biotite flakes.
357 to 396	Sand and gravel of Tsj, tuff, and quartzite. Calcareous clayey matrix with minor amounts of calcite and biotite flakes.
396 to 518	Interbedded gray to gray-green, calcareous, tuffaceous clay, silt, and sand. Scattered pebbles of Tsj, tuff, and quartzite. Minor amounts of pyrite, biotite, and calcite.
518 to 558	Sand and gravel: primarily Tsj, quartzite, and tuff. Minor amounts of pyrite and biotite.
558 to 701	Silt and sand: gray, tuffaceous, calcareous. Scattered pebbles of Tsj, tuff, quartzite, and limestone. Minor amounts of pyrite, calcite, and green muscovite. Also minor amounts of magnetite below 646 m.
701 to 753	Siltstone: gray-green, tuffaceous, siliceous. Minor amounts of pyrite, calcite, biotite, and gypsum.
753 to 1049	Interbedded silt, sand, and gravel: green, calcareous, tuffaceous. Gravel is Tsj, tuff, quartzite, and limestone. Sand is mainly subangular and frosted. Minor amounts of pyrite and mica.
1049 to 1084	Siltstone: tan, calcareous. Tuff: tan, gray-green. Trace of pyrite.
1084 to 1112	Siltstone: green, tuffaceous. Tuff: tan, gray-green. Trace of pyrite, Tsj, and quartzite.
1112 to 1158	Sandstone: fine- to medium-grained, clear to frosted, sub- to well-rounded. Siltstone: dark gray-brown, slightly calcareous, tuffaceous. Minor amounts of pebbles of Tsj, tuff, quartzite, and pyrite.

Table A-9. (continued)

Depth (m)	Description ^a
1158 to 1229	Siltstone: alternating tan and light green, calcareous, tuffaceous. Tuff: light green. Pyrite and silica on a possible slickenside face from 1195 to 1213 m.
1229 to 1326	Sandstone: tan, calcareous. Thin tuffaceous, calcareous, tan to light brown siltstone beds. Abundant mica and pyrite, minor calcite flakes. Thin siliceous siltstone layer at 1323 m.
1326 to 1357	Tuff: calcareous, dark brown to gray, minor amounts of abundant calcite and quartz crystals. Fractures with calcareous fillings.
1357 to 1420	Sandstone: tuffaceous, siliceous zones. Tuff: light brown to gray. Abundant pyrite, calcite, and quartz crystals.
1420 to 1524	Schist of Upper Narrows. Dark gray quartzite and biotite schist, abundant magnetite. Biotite increases downward.
1524 to 1728	Quartz Monzonite: gneissic, light to greenish-gray. White to clear quartz and feldspar, black to green chloritic biotite, trace of pyrite and magnetite, occasional flakes of calcite. Fractured in places.
1728 to 1760	Chlorite Biotite Schist: dark green to black, fractured.
1760 to 1994 (total depth)	Gneissic: light greenish-gray. White to clear quartz and feldspar. Black to green chlorite biotite. Fractured.

a. Mud logging by the Rocky Mountain Geological Engineering Company and by H. Covington of the United States Geological Survey.

Table A-10. Lithology of RRGE-3

Depth (m)	Description ^a
427 to 440	Sand: light gray, slightly calcareous, subangular to well-rounded, milky to translucent, frosted. 75% quartz and feldspar, 15% rhyolite, 5% tuff, 2% biotite, 2% pyrite, and a trace of muscovite and magnetite.
440 to 448	Sandstone: light gray, tuffaceous, calcareous, fine- to coarse-grained. 50% tuff, 45% quartz and feldspar, 5% rhyolite, minor amounts of biotite, muscovite, and pyrite.

Table A-10. (continued)

Depth (m)	Description ^a
448 to 713	Conglomerate and sandstone. Conglomerate is mainly clasts of rhyolite in a quartz sand matrix. Sandstone is coarse grained, angular to sub-rounded, quartz and rhyolite grains. Quartz grains are frosted.
713 to 884	Sandstone: gray to grayish brown, alternating calcareous to noncalcareous, tuffaceous. Thin interbeds of rhyolite pebble conglomerate and light gray tuff. Trace of pyrite, magnetite, and volcanic glass.
884 to 927	Tuff: light and dark green laminae, noncalcareous. Minor amounts of quartz sand, silt, and rhyolite pebbles. Trace of biotite, muscovite, and pyrite.
927 to 997	Sandstone: quartz, brown to gray, tuffaceous, calcareous, medium- to coarse-grained. Interbedded with tuff: brown, calcareous, silty to sandy. Trace of quartzite and rhyolite pebbles, pyrite, and magnetite.
997 to 1168	Tuff: greenish-gray, slightly calcareous, silty to sandy. Scattered pebbles of quartzite and rhyolite. Minor amounts of pyrite and magnetite. Trace of gypsum in fractures.
1168 to 1244	Sandstone containing thin interbeds of tuff, silt, and conglomerate. Sandstone is quartz, light gray, medium-grained, calcareous, abundant muscovite, trace of pyrite and magnetite. Conglomerate is clasts of quartz, quartzite, and rhyolite with a fine-grained, light gray calcareous sand matrix.
1244 to 1268	Tuff: alternating light brown and light green laminae, calcareous, minor amounts of sand, and conglomerate interbeds. Trace of pyrite and calcite.
<u>Sidetrack A</u>	
1268 to 1372	Sandstone: quartz, sub-rounded, frosted, brown to gray, calcareous, trace of pyrite and gypsum. Thin interbeds of light green, calcareous tuff and tab calcareous siltstone with scattered quartzite pebbles.
1372 to 1454	Alternating layers of siltstone, sandstone, and tuff. Siltstone: tan to dark brown, calcareous. Sandstone: quartz, tan, calcareous. Tuff: light green to green, calcareous. All contain a trace of calcite flakes and pyrite.
1454 to 1475	Siltstone: tan to dark brown, calcareous, rare grains of tuff, rhyolite, and mica.

Table A-10. (continued)

Depth (m)	Description ^a
1475 to 1491	Tuff: light green, siliceous with abundant pyrite.
1491 to 1524	Siltstone: tan to dark brown, calcareous, scattered pyrite, thin tuff and quartz sand interbeds.
1524 to 1540	Sandstone and siltstone: brown to dark gray, calcareous, tuffaceous. Trace of calcite flakes and pyrite.
1540 to 1555	Tuff: light green, calcareous near the top, silicified near the bottom, abundant pyrite.
1555 to 1560	Siltstone: tan to brown, calcareous, pyrite and calcite flakes.
1560 to 1585	Sandstone: white to light gray-green, tuffaceous, slightly calcareous, with minor amounts of gypsum.
1585 to 1594	No sample.
1594 to 1646	Quartzite of Yost. Quartzite: white, minor amounts of chlorite and disseminated pyrite. Some schistose lenses of silvery to green micas.
1646 to 1670	Schist of the Upper Narrows. Schist: quartzose, biotite, muscovite, abundant pyrite and magnetite.
1670 to 1750	Elba Quartzite. Quartzite: white to green with muscovite on bedding surfaces. Trace of pyrite and magnetite.
1750 to 1780	Older Schist. Schist: biotite, chlorite, muscovite, quartzose, brown color, abundant magnetite.
1780 to 1784 (total depth)	Quartz Monzonite. 40% quartz, 40% feldspar, 20% biotite and chlorite, greenish-gray color, with minor amounts of pyrite and magnetite.
<u>Sidetrack B</u>	
1381 to 1393	Siltstone and sandstone: light green, slightly calcareous, tuffaceous.
1393 to 1426	Tuff: light green, silicified, with trace of pyrite and magnetite.
1426 to 1469	Siltstone: tan, calcareous, with abundant pyrite and calcite flakes.

Table A-10. (continued)

Depth (m)	Description ^a
<u>Sidetrack B (continued)</u>	
1469 to 1482	Tuff: light green, calcareous, silicified, and sandy at top.
1482 to 1539	Siltstone: tan to gray, calcareous, thin interbeds of light green tuff, scattered pyrite.
1539 to 1557	Sandstone: greenish-gray, tuffaceous, calcareous. Trace of pyrite.
1557 to 1631	Tuff: light green, slightly calcareous, with interbeds of tan to gray, calcareous siltstone. Pyrite and calcite flakes.
1631 to 1655	Quartzite of Yost.
1655 to 1682	Schist of the Upper Narrows.
1682 to 1687 (total depth)	Elba Quartzite.
<u>Sidetrack C</u>	
1337 to 1341	Siltstone: tan, calcareous, micaceous.
1341 to 1360	Quartz, muscovite, biotite schist.
1360 to 1387	Quartzite: white, with minor amounts of muscovite.
1387 to 1399	Tuff: light green calcareous, few thin interbeds of tan calcareous siltstone.
1399 to 1463	Siltstone: tan to brown, calcareous, micaceous.
1463 to 1518	Tuff: light green, silicified.
1518 to 1534	Siltstone: tan to gray, calcareous, micaceous, few interbeds of light green tuff.
1534 to 1549	Sandstone: quartz, light gray, calcareous, pyrite and calcite flakes.
1549 to 1567	Tuff: light green, silicified, pyrite and calcite flakes.
1567 to 1615	Siltstone: brown, calcareous, micaceous, thin interbeds of light green silicified tuff. Pyrite, magnetite, and calcite flakes.

Table A-10. (continued)

Depth (m)	Description ^a
<u>Sidetrack C (continued)</u>	
1615 to 1631	Tuff: light green to white, silicified, with abundant pyrite.
1631 to 1646	Quartzite of Yost.
1646 to 1676	Schist of the Upper Narrows.
1676 to 1747	Elba Quartzite. No sample from 1707 to 1729 m.
1747 to 1768	Older Schist.
1768 to 1803 (total depth)	Quartz Monzonite.

a. Mud logging by Rocky Mountain Geological Engineering Company and by H. Covington of the United States Geological Survey.

Table A-11. Lithology of RRG1-4/RRGP-4

Depth (m)	Description ^a
0 to 45	Raft Formation. Sand: light greenish-gray, fine- to medium-grained, quartzose, tuffaceous, slightly calcareous. Gravel: quartzite, dolomite, schist, Tertiary lava of the Jim Sage Mountain (Tsj), and tuff, angular to sub-rounded, 0.5 to 2 cm in diameter.
45 to 70	Gravel with a sand matrix. Gravel: clasts of quartzite, dolomite, schist, Tsj, and tuff, angular to sub-rounded, 0.5 to 2 cm in diameter. Sand matrix: quartzose, gray-green, slightly calcareous.
70 to 109	Sand and gravel. Sand: coarse-grained quartz, gray-green, clear and angular to frosted and rounded grains, tuffaceous, calcareous. Gravel: subangular to sub-rounded, 1 to 2 cm in diameter, quartzite, dolomite, schist, Tsj, and tuff.
109 to 118	Salt Lake Formation. Tuffaceous silt: light green, slightly calcareous, minor amounts of clear, angular quartz grains.

Table A-11. (continued)

Depth (m)	Description ^a
118 to 152	No samples.
152 to 192	Sand and gravel. Sand: coarse-grained, unconsolidated, quartz, feldspar and mica. Gravel: rounded, less than 1 cm in diameter, quartzite, dolomite, schist, Tsj, and tuff.
192 to 225	Silt: gray to gray-green, calcareous, tuffaceous. Minor amounts of free grains of quartz and mica.
225 to 304	Sand and gravel. Sand: coarse-grained, unconsolidated, angular to rounded, quartz, feldspar and Tsj. Thick sand bed from 225 to 237 m. Gravel: 1 to 2 cm in diameter, unconsolidated, angular to rounded, tuff, Tsj, quartzite, trace of biotite and schist. Thick bed of gravel with 30% tuff at 298 to 304 m.
304 to 362	Tuffaceous sand and gravel. Sand: light green, calcareous, tuffaceous, quartz, and feldspar. Gravel: 1 to 2 cm in diameter, rounded, Tsj, and quartzite. Trace of muscovite. No sample from 329-335 m.
362 to 381	Gravel: 1 to 2 cm in diameter, rounded, quartzite, dolomite, Tsj, tuff, and schist. Coarse-grained sand matrix cemented with calcite. Trace of pyrite.
381 to 432	Sand: tuffaceous, fine- to medium-grained, subangular to sub-rounded, calcareous matrix. Trace of pyrite, micas, and calcite flakes.
432 to 487	Sand: light green, coarse-grained, unconsolidated, angular to well-rounded, quartz, dolomite, tuff, and Tsj. Trace of muscovite, pyrite, and free calcite flakes.
487 to 500	Sand: tuffaceous, fine- to medium-grained, subangular to sub-rounded quartz, feldspar, and tuff.
500 to 532	Sand: medium- to coarse-grained quartz and feldspar, weak calcite cement. Trace of muscovite, biotite, and calcite flakes.
532 to 545	Tuffaceous silt and sand: green gray, calcareous. Abundant muscovite and calcite flakes.
545 to 554	Sand and gravel sand: unconsolidated, subangular to sub-rounded quartz, feldspar, biotite and muscovite flakes. Gravel: 1 to 2 cm in diameter, rounded, quartzite, Tsj, and tuff.

Table A-11. (continued)

Depth (m)	Description ^a
554 to 560	Tuffaceous silt: light green, slightly calcareous, few free grains of angular, clear quartz.
560 to 585	Sandstone: fine- to medium-grained, clear to frosted, angular to rounded quartz, and feldspar. Few thin tuffaceous, calcareous interbeds.
585 to 640	Sandstone: coarse-grained, unconsolidated, subangular to sub-rounded quartz, feldspar, schist, dolomite, tuff, and Tsj. No samples from 585 to 591 m, 634 to 640 m.
640 to 655	Siltstone: tuffaceous, light green, calcareous.
655 to 670	Sandstone: tuffaceous, light green, quartz, and tuff, calcareous matrix.
<u>Sidetrack A</u>	
670 to 1021	Sandstone and siltstone: interbedded, light green, tuffaceous, partly silicified, micaceous, noncalcareous. Trace of pyrite and analcite. Sandstone: tan to gray-green, medium- to coarse-grained, subangular to sub-rounded quartz, quartzite, feldspar, dolomite, and schist.
1021 to 1030	Siltstone: gray, micaceous, calcareous.
1030 to 1082	Siltstone: light green, tuffaceous, partly silicified. Trace of pyrite and selenite. No samples from 1050 to 1065 m.
1082 to 1103	Siltstone: gray to tan, micaceous, calcareous.
1103 to 1399	Siltstone: light gray-green to white, tuffaceous, slightly calcareous siltstone interbedded with tan to dark gray, calcareous, micaceous siltstone. Tuffaceous siltstone is partly silicified and contains pyrite and selenite.
1399 to 1419	Quartzite of Yost. Quartzite: clear to white quartz grains, 5% feldspar, 5% green, black and white mica. Trace of pyrite. Interbedded with gray quartzose schist below 1409 m.
1419 to 1451	Schist of the Upper Narrows. Quartz schist: gray to brown with abundant magnetite and pyrite. 60 to 80% schist of black, white and brown mica. 20 to 40% gray quartzite.
1451 to 1539	Elba Quartzite. Quartzite: white quartz and 5 to 10% feldspar grains with minor green and white mica. Trace of pyrite and magnetite.

Table A-11. (continued)

Depth (m)	Description ^a
<u>Sidetrack A (continued)</u>	
1539 to 1649 (total depth)	Quartz Monzonite. Quartz monzonite: white to gray-green, trace of pyrite and magnetite, 50% clean to white quartz, 30% clean to white feldspar, 20% black to green mica.
<u>Sidetrack B</u>	
1078 to 1115	Siltstone: gray, calcareous, micaceous. Trace of pyrite.
1115 to 1416	Siltstone: light gray-green to white, tuffaceous, slightly calcareous, interbedded with tan to dark-gray, calcareous and micaceous siltstone. Tuffaceous siltstones are partly silicified. Trace of green mica. Abundant pyrite and selenite.
1416 to 1468	Schist of the Upper Narrows. Quartz schist: dark gray to brown. Abundant magnetite. Trace of pyrite. 80 to 90% schist of black, white, and brown mica. 10 to 30% gray to greenish-gray quartzite.
1468 to 1548	Elba Quartzite. Quartzite: minor green and white mica on parting surfaces. Trace of magnetite and pyrite. Clear to white quartz grains with 5 to 10% white feldspar.
1548 to 1554 (total depth)	Quartz Monzonite. Quartz monzonite: white to gray-green. Trace of pyrite and magnetite. 70% clear to white quartz grains, 20% white feldspar, 10% dark green mica.

a. Mud logging by Rocky Mountain Geological Engineering Company and by H. Covington of the United States Geological Survey.

Table A-12. Lithology of RRGP-5

Depth (m)	Description ^a
0 to 271	Silt, sand, and gravel: poorly consolidated, light green, tuffaceous, slightly to noncalcareous matrix. Trace of mica and selenite. Silt: green, tuffaceous. Sand: coarse-grained, rounded, frosted clasts of quartz, feldspar and mica. Gravel: subangular to sub-rounded, quartzite, quartz monzonite, limestone, green tuff pebbles, Tertiary Lava of the Jim Sage Mountain (Ts) and schist.

Table A-12. (continued)

Depth (m)	Description ^a
271 to 423	Salt Lake Formation. Siltstone, sandstone, and minor gravel. Trace of micas and pyrite crystals. Siltstone: light gray-green, tuffaceous, calcareous. Sandstone: clean, poorly consolidated, light gray to gray, fine- to coarse-grained, subangular to sub-rounded, quartz, feldspar, Tsj, and micas. Gravel: subangular to sub-rounded, Tsj, quartzite, and quartz monzonite, >5 mm in diameter.
423 to 457	Sandstone: clean, light gray to white, poorly consolidated, calcareous cement, medium-grained, subangular to sub-rounded, quartz, quartzite, feldspar, and quartz monzonite. Trace of micas and pyrite.
457 to 471	No samples.
471 to 551	Sandstone: poorly consolidated, trace of calcareous cement, coarse-grained, angular to rounded, quartz, feldspar, quartz monzonite, limestone, and minor micas. Trace of magnetite and pyrite.
551 to 628	Sandy siltstone with well-rounded quartz grains up to 1 mm in diameter near the bottom. Siltstone: tan, light gray, gray-green, thinly laminated with tuffaceous interbeds, slightly calcareous to calcareous, micaceous. Trace of pyrite.
628 to 728	Sandstone with thin siltstone interbeds. Sandstone: fine-grained, calcareous, micaceous, tuffaceous in lower part, light greenish-gray, Tsj, quartz, feldspar, and quartzite. Siltstone: light gray, tan, gray-green, calcareous, tuffaceous.
728 to 844	Siltstone with interbeds of fine sandstone and claystone. Siltstone: light tan to gray, thinly laminated, tuffaceous to nontuffaceous, calcareous to noncalcareous, micaceous, partly silicified near the bottom. Trace of pyrite.
844 to 914	Siltstone: tan to gray, thinly laminated, silicified, abundant pyrite, mica, and calcite flakes.
914 to 986	Sandstone, siltstone, and tuff: slightly calcareous to silicified, micaceous, abundant pyrite and calcite flakes. Sandstone; light greenish-gray to gray, fine-grained, quartz and rhyolite. Siltstone: tan, light gray to gray. Tuff: light gray to gray, silty.
986 to 1006	Siltstone: tan, light gray to gray, thinly laminated, calcareous, micaceous, with trace of pyrite and feldspar.

Table A-12. (continued)

Depth (m)	Description ^a
1006 to 1137	Siltstone and sandstone: partly silicified. Siltstone: light green to light gray, tuffaceous, slightly calcareous to noncalcareous, abundant pyrite and gypsum. Sandstone: light green to light gray, fine- to medium-grained, tuffaceous, slightly calcareous, clear to frosted quartz and feldspar.
1137 to 1149	Siltstone: light to dark gray, light green, tuffaceous, thinly laminated, calcareous, micaceous, with abundant calcite flakes.
1149 to 1320	Siltstone and very fine sandstone: light green, calcareous, silicified in places, micaceous, trace of pyrite, gypsum, mica, and feldspar. No sample from 1298 to 1304 m.
1320 to 1335	Quartzite of Yost. Quartzite: clear to white, 10% feldspar, 5% biotite and chlorite. Trace of magnetite and some free quartz crystals.
1335 to 1387	Schist of the Upper Narrows. Quartz schist: gray to brown, white to greenish-gray quartzite from 25 to 75% of sample. Schist: gray, gray-green to brown, some magnetite, pyrite and garnet. No sample from 1371 to 1384 m.
1387 to 1475	Elba Quartzite. Quartzite: clear to milky white with 5% feldspar, minor muscovite schist on parting surfaces, trace of magnetite, pyrite, and chlorite, free quartz crystals, and calcite flakes. No sample from 1454 to 1460 m.
1475 to 1493	Older Schist. Quartz schist: 20 to 50% quartzite, clear to white with 5% feldspar. Schist: 50 to 80% white to dark green muscovite and chlorite with a trace of magnetite and pyrite.
1493 to 1497 (total depth)	Quartz Monzonite: 40% clear to white quartz, 30% white feldspar, 30% dark green and white mica, trace of magnetite and pyrite.

a. Mud logging by Rocky Mountain Geological Engineering Company and by H. Covington of the United States Geological Survey.

Table A-13. Lithology of RRG1-6

Depth (m)	Description ^a
0 to 45	No samples.
45 to 356	Sand and gravel: poorly consolidated with minor amounts of calcareous cement in places. Sand: light gray to tan, coarse-grained, subangular to well-rounded grains of quartz, rhyolite and schist. Gravel: subangular to well-rounded clasts of rhyolite, schist, dolomite, quartzite and quartz monzonite. Clasts mainly range up to 1 cm in diameter with two beds of clasts up to 5 cm in diameter at 183 to 192 m and 329 to 357 m.
356 to 378	Salt Lake Formation. Siltstone: light green, tuffaceous, partly silicified, slightly calcareous. Tuff: green, slightly calcareous. Trace of pyrite.
378 to 390	No samples.
390 to 475	Sandstone: poorly consolidated, light greenish-gray, medium- to coarse-grained, angular to sub-rounded quartz and rhyolite. Trace of pyrite, mica and green tuff.
475 to 621	Sand and gravel: 60 to 80% sand, 20 to 40% gravel, poorly consolidated, minor amounts of calcareous cement. Trace of pyrite. Sand: medium- to coarse-grained, angular to sub-rounded, quartz and rhyolite. Gravel: subangular to well-rounded, quartzite and rhyolite, clasts up to 1 cm in diameter. No samples from 487 to 493 m, 506 to 521 m, 532 to 539 m.
621 to 631	No samples.
631 to 682	Sand with minor amounts of siltstone interbeds. Sand: poorly consolidated with weak calcareous cement in places, light gray-green, coarse-grained, subangular to rounded quartz and rhyolite. Siltstone: light gray, slightly calcareous. Trace of pyrite.
682 to 707	Gravel: poorly consolidated with a quartz sand matrix and weak calcareous cement. Clasts are subangular to rounded, rhyolite, quartzite, minor schist and quartz monzonite up to 5 mm in diameter.
707 to 823	Sandstone and siltstone: alternating beds with a trace of pyrite throughout and calcite flakes between 811 to 817 m. Sand: poorly consolidated, medium- to coarse-grained, subangular to sub-rounded, quartz and rhyolite. Silt: white, light gray, light tan, calcareous, micaceous.

Table A-13. (continued)

Depth (m)	Description ^a
823 to 871	Siltstone: light tan to light green, tuffaceous, partly silicified. Trace of pyrite.
871 to 1180 (total depth)	Sandstone and siltstone: alternating beds, trace of pyrite and calcite flakes throughout. Sandstone: light gray to greenish-gray, fine- to coarse-grained, calcareous, angular to sub-rounded, quartz and rhyolite. Siltstone: light greenish-gray, calcareous, micaceous.

a. Mud logging by Rocky Mountain Geological Engineering Company and by H. Covington of the United States Geological Survey.

Table A-14. Lithology of RRG1-7

Depth (m)	Description ^a
167 to 175	Sandstone: quartz, white, clear, yellow, rose.
175 to 198	Siltstone: light brown to tan, calcareous. Trace of biotite. Scattered pebbles.
198 to 206	Sandstone: quartz, white, clear, rose. Siltstone: gray-green, noncalcareous. Decreased pebbles.
206 to 236	Sandstone: light gray, slightly calcareous. Siltstone: light gray to tan. Scattered pebbles, trace of mica and biotite.
236 to 297	Sandstone: quartz, white, clear, yellow, gray. Siltstone: gray to dark gray, noncalcareous. Scattered pebbles. Trace of biotite and gypsum towards the bottom.
297 to 304	Siltstone: light gray, very calcareous.
304 to 328	Sandstone: quartz, clear, white, light gray. Siltstone: green to dark green, noncalcareous. Trace of pyrite and biotite. Scattered pebbles.
328 to 358	Siltstone: light gray to dark gray, slightly calcareous, clayey. Sandstone: gray, coarse-grained, slightly calcareous.
358 to 373	Siltstone: dark gray, brown, dark green, noncalcareous. Trace of gypsum and pyrite.

Table A-14. (continued)

Depth (m)	Description ^a
373 to 381	Sandstone: fine-grained, light gray to gray, slight increase in pyrite.
381 to 411	Siltstone: dark gray to dark green, micaceous, decrease in pyrite, clayey, calcareous. Trace of biotite and selenite. A few thin layers of sandstone: quartz, yellow, rose, clear.
411 to 442	Siltstone: gray to dark gray, noncalcareous. Trace of pyrite.
442 to 510	Siltstone: green, tuffaceous, noncalcareous. Sandstone: quartz, white, clear. Trace of pyrite, mica and selenite near the bottom.
510 to 550	Sandstone: light gray to gray, slightly calcareous, fine- to medium-grained. Trace of biotite and pyrite. Siltstone: gray to dark gray, slightly calcareous to noncalcareous.
550 to 628	Salt Lake Formation. Sandstone: poorly consolidated with thin interbeds of siltstone and gravel. Minor calcareous cement. Trace of pyrite. Sandstone: light greenish-gray, medium- to coarse-grained, angular to well-rounded, white quartz and gray rhyolite. Siltstone; greenish-gray, calcareous. Gravel: rounded clasts of quartzite, rhyolite, dolomite and quartz monzonite up to 5 cm in diameter.
628 to 649	Claystone: sandy to silty, white to light green, slightly calcareous, micaceous, tuffaceous, partly silicified. Calcite flakes and trace pyrite.
649 to 722	Alternating siltstone and sandstone. Siltstone: tan to brown, micaceous, calcareous. Sandstone: medium- to coarse-grained, angular to sub-rounded grains of gray rhyolite and white quartz. Abundant pyrite.
722 to 847	Alternating siltstone and sandstone beds. Siltstone: light green to greenish-gray, slightly calcareous, micaceous and partly silicified. Sandstone: greenish-gray, subangular to rounded, medium- to coarse-grains of gray rhyolite and white quartz. Trace of pyrite.
847 to 942	Sandstone: poorly consolidated, micaceous, coarse-grained, angular to sub-rounded grains of quartz, feldspar, and rhyolite. Pyrite.

Table A-14. (continued)

Depth (m)	Description ^a
942 to 1054	Siltstone with minor sandstone interbeds. Siltstone: greenish-gray, calcareous, micaceous, minor pyrite. Sandstone: poorly consolidated, coarse-grained, angular to sub-rounded grains of quartz, feldspar, and rhyolite.
1054 to 1088	Siltstone: greenish-gray, calcareous, micaceous siltstone alternating with light green, partly silicified siltstone. Trace of biotite.
1088 to 1171 (total depth)	Sandstone with minor siltstone interbeds. Sandstone: medium- to coarse-grained, angular to sub-rounded grains of quartz, feldspar, and rhyolite. Siltstone: greenish-gray, calcareous, tuffaceous, micaceous. Trace of pyrite and selenite.

a. Mud logging by Rocky Mountain Geological Engineering Company and by H. Covington of the United States Geological Survey.

Table A-15. Lithology of MW-1

Depth (m)	Description
4.6	Sandy calcareous clay: silt to coarse-grained, rounded to subangular, clear to white quartz, gray quartzite sand ($\approx 10\%$). Few quartzite pebbles up to 10 mm (≈ 5 to 10%). Light gray calcareous clay ≈ 70 to 80% . Minor amounts of limonite staining.
4.6 to 9.1	Tuffaceous clay: silt to medium-grained, rounded to angular, clear to white to gray quartz and quartzite (≈ 15 to 20%). Quartzite grains ($< 2\%$) up to 5 mm. Lithic tuff grains ($\approx 10\%$) up to 15 mm. Light gray tuffaceous clay (≈ 70 to 75%).
9.1 to 18.3	Data missing.
18.3 to 27.4	Light gray tuff: clay to 10 mm in size.
27.4 to 36.6	Light gray tuff: clay to 10 mm in size, fine- to very coarse-grained, sub-rounded to angular, clear to gray quartz and quartzite grains (≈ 10 to 15%).

Table A-15. (continued)

Depth (m)	Description
36.6 to 45.7	Tuffaceous sand: slightly calcareous, fine- to very coarse-grained, angular to very angular, clear to white to orange quartz, light gray to brown quartzite and light gray, crystal rich tuffs (≈ 30 to 40%). Tuff grains reach 12 mm in size. Minor amounts of biotite ($<1\%$). Magnetite ($<2\%$).
45.7 to 54.9	Sandy gravel: fine- to very coarse-grained, sub-rounded to angular, clear to white quartz, light gray to green welded tuffs, dark gray quartzite and black chert sand (≈ 20 to 30%). Gravel reaches 15 mm in size.
54.9 to 64.0	Same as above. Sand content ≈ 35 to 45% .
64.0 to 91.4	Sand: silt to coarse-grained, sub-rounded to very angular, clear to yellow quartz, gray to brown quartzite, and light gray tuffs. Minor amounts of magnetite ($<2\%$). Silt $\approx 10\%$.
91.4 to 100.6	Sand: very fine- to medium-grained, subangular to very angular, clear to white quartz. Minor amounts of gray quartzite ($\approx 10\%$), biotite ($<1\%$), magnetite ($<1\%$).
100.6 to 118.9	Sand: fine- to very coarse-grained, sub-rounded to angular, clear to white quartz, light to dark gray quartzite, light gray tuff. Minor amounts of biotite ($<1\%$) and limonite staining.
118.9 to 128.0	Sand: fine- to coarse-grained, sub-rounded to angular, clear to white quartz, light to dark gray quartzite, light gray tuff. Minor amounts of biotite ($<1\%$). Limonite staining and pyrite ($<1\%$).
128.0 to 146.3	Sand: fine- to very coarse-grained, sub-rounded to angular, frosted clear to white quartz, light to dark gray quartzite, light gray tuff. Minor amounts of muscovite and biotite ($<1\%$) and limonite staining.
146.3 to 173.7	Calcareous tuffaceous sand: fine- to very coarse-grained, sub-rounded to angular, frosted clear to white quartz, gray quartzite and light gray tuff. Tuff ≈ 20 to 30% . Minor amounts of limonite staining.
173.7 to 198.1	Calcareous sand: fine- to very coarse-grained, sub-rounded to angular, frosted clear to white quartz, gray quartzite and gray tuff. Minor amounts of muscovite and biotite ($<1\%$) and limonite staining.

Table A-15. (continued)

Depth (m)	Description
198.1 to 222.5	Calcareous tuffaceous sand: same as above. Tuff content ≈25 to 35%.
222.5 to 307.8	Calcareous slightly tuffaceous sand: same as above. Tuff content ≈10 to 15%.
307.8 to 313.9	Calcareous tuffaceous sand: silt to coarse-grained, sub-rounded to angular, frosted clear to white quartz, light to dark gray quartzite, gray to light brown tuff (≈20 to 30%). Minor amounts of biotite (<1%). Limonite staining minor.
313.9 to 350.5	Calcareous tuffaceous sand: silt to very coarse-grained, sub-rounded to angular, frosted clear to white quartz, light to dark quartz and light gray tuff (≈20 to 30%). Minor amounts of biotite. Pebbles up to 5 mm..
350.5 to 356.6	Data missing.
356.6 to 362.7	Same as above. Tuff content ≈30 to 40%.
362.7 to 374.9	Calcareous sandy tuff: silt to coarse-grained, sub-rounded to angular, frosted clear to white quartz and light to dark gray quartzite (≈30 to 40%). Light gray tuff (60 to 70%).
374.9 to 387.1	Calcareous tuffaceous sand: silt to coarse-grained, sub-rounded to angular, frosted clear to white quartz, light to dark gray quartzite, and light gray tuff. Tuff ≈10 to 20%.
387.1 to 399.3	Calcareous sandy tuff: same as above. Sand content ≈30 to 40%. Tuff ≈60 to 70%.

Table A-15. Lithology of MW-2

Depth (m)	Description
0 to 23.5	Data not available.
23.5 to 50.0	Silty sand: fine- to very coarse-grained, sub-rounded to angular, clear to orange quartz, white to dark gray quartzite. Minor amounts of biotite and muscovite (<2%) and magnetite (<2%). Silt ≈5 to 20%. Pebbles up to 1 cm of quartz, quartzite, and granitic rock fragments (<5%).

Table A-16. (continued)

Depth (m)	Description
50.0 to 54.9	Silty to sandy, calcareous clay: sand is silty to very coarse-grained, rounded to angular, clear to white quartz, light gray quartzite and tuffaceous ($\approx$ 20 to 30%) sand. Minor amounts of biotite ($<$ 2%), feldspar ($<$ 2%). Pebbles of granitic rock fragments of quartz, quartzite, and tuff ($\approx$ 10 to 20%) up to 10 mm in size. Very light brown calcareous clay (50 to 70%).
54.9 to 61.0	Same as above.
61.0 to 67.1	Silty, calcareous clay with minor amounts of sand and gravel. Silt to very coarse-grained, sub-rounded to angular, clear to white quartz, quartzite and light gray to green tuff sand ($\approx$ 15 to 25%). Pebbles of quartz, quartzite, and tuff up to 10 mm in size ($\approx$ 10%). Gray, slightly calcareous clay (65 to 75%).
67.1 to 73.2	Gravely, noncalcareous clay: minor amounts of silt and sand. Silt to very coarse-grained, sub-rounded to angular, clear to white quartz, light gray quartzite and gray-green tuffaceous sand ($\approx$ 10 to 15%). Quartz, quartzite, and tuff pebbles up to 10 mm ($\approx$ 10%). White, noncalcareous clay (75 to 80%).
73.2 to 79.2	Gravely, slightly calcareous clay: minor amounts of silt and sand ($\approx$ 15 to 25%). Light gray calcareous clay ($\approx$ 65 to 75%).
79.2 to 91.4	Sandy calcareous clay: silt to coarse-grained, rounded to subangular, clear to white quartz, light to dark gray quartzite and light gray tuffaceous sand ($\approx$ 30 to 40%). Quartz, quartzite, and tuff pebbles up to 5 mm ($\approx$ 10%). Light gray calcareous clay $\approx$ 50 to 60%.
91.4 to 103.6	Argillaceous silt: silt to medium-grained, rounded to subangular, clear to white quartz and light to dark gray quartzite. Sand $\approx$ 60 to 70%. Pebbles of quartz and quartzite up to 5 mm ($\approx$ 10%). Dark gray calcareous clay $\approx$ 20 to 30%. Minor amounts of biotite ($<$ 1%).
103.6 to 109.7	Same as above.
109.7 to 115.8	Argillaceous silt, sand, and gravel: silt to coarse-grained, rounded to subangular, clear to white quartz, light gray tuff, gray to green quartzite sand $\approx$ 40 to 60%. Light green to gray to black quartz and quartzite pebbles up to 12 mm in size ($\approx$ 20 to 25%). Light gray calcareous clay ($\approx$ 20 to 30%). Minor amounts of biotite ($<$ 1%) and limonite staining.

Table A-16. (continued)

Depth (m)	Description
115.8 to 121.9	Same as above. Pebble size only 3 mm.
121.9 to 134.1	Argillaceous silty sand and gravel: silt to very coarse-grained, sub-rounded to angular, clear to white quartz, gray to black quartzite and light gray tuffaceous sand (≈ 65 to 75%). Quartzite pebbles up to 5 mm ($\approx 10\%$). Slightly calcareous light gray clay (≈ 15 to 25%). Minor amounts of biotite ($< 1\%$) and limonite staining.
134.1 to 152.4	Silty calcareous clay: silt to very fine-grained, sub-rounded to angular, clear to white quartz and quartzite sand (≈ 20 to 25%). Gray calcareous clay (70 to 80%). Minor amounts of biotite ($< 2\%$).
152.4 to 158.5	Tuffaceous silty clay: silt to very fine-grained, sub-rounded to angular, clear to white quartz, quartzite and tuffaceous silt and sand ($\approx 20\%$). Greenish-gray tuffaceous clay (75 to 80%). Minor amounts of biotite and pyrite ($< 3\%$).
158.5 to 164.6	Slightly calcareous silty sand: silt to coarse-grained, sub-rounded to angular, frosted clear to white quartz and gray quartzite. Silt ≈ 10 to 15%. Minor amounts of pyrite ≈ 2 to 3%. Gray tuff grains ≈ 5 to 10%.
164.6 to 170.7	Slightly calcareous silty tuffaceous clay: silty to fine-grained, sub-rounded to angular, frosted clear to grayish-white quartz, light gray quartzite and gray tuff (≈ 30 to 35%). Greenish-gray clay (≈ 60 to 65%). Minor amounts of biotite ($< 1\%$) and limonite staining.
170.7 to 173.7	Sand: fine- to coarse-grained, sub-rounded to angular, clear to orange quartz, light gray quartzite. Minor amounts of biotite, pyrite ($< 1\%$) and limonite staining.

Table A-17. Lithology of MW-3

Depth (m)	Description
0 to 61	Sandy silt: subangular to very angular, clear to orange quartzose silt. Fine- to coarse-grained, subangular to angular sand ($\approx 20\%$). Few pebbles of quartz and quartzite (5 mm). Minor amounts of biotite and muscovite ($< 2\%$).
6.1 to 12.7	Same as above.

Table A-17. (continued)

Depth (m)	Description
12.2 to 18.3	Same as above.
18.3 to 24.4	Same as above.
24.4 to 30.5	Same as above.
30.5 to 36.6	Same as above.
36.6 to 42.7	Same as above.
42.7 to 48.8	Sandy silt: subangular to very angular, clear to orange quartzose silt. Fine- to very coarse-grained, subangular to angular quartz and quartzite sand (≈ 30 to 35%). Pebbles of quartz and quartzite (up to 10 mm) more abundant ($\approx 10\%$). Minor amounts of biotite ($< 2\%$). Limonite staining present on biotite grains.
48.8 to 54.9	Sandy silt: subangular to very angular, clear to orange quartzose silt. Fine- to coarse-grained, sub-rounded to angular, white to red quartz and quartzite sand (≈ 5 to 10%). Few quartz and quartzite pebbles ($< 3\%$) (up to 5 mm). Minor amounts of biotite ($< 2\%$).
54.9 to 61.0	Same as above. Sand content ≈ 10 to 20%.
61.0 to 67.1	Same as above.
67.1 to 73.2	Sand: very fine- to coarse-grained, sub-rounded to very angular, clear to orange quartz, and light to dark gray quartzite. Minor biotite ($< 1\%$) and magnetite ($< 2\%$).
73.2 to 79.2	Silty sand: Same as above. Silt to very coarse-grained, content $\approx 20\%$.
79.2 to 85.3	Sandy silt: sub-rounded to very angular, clear to orange quartzose silt. Fine- to very coarse-grained, sub-rounded to angular quartz and quartzite sand. Sand content $< 20\%$. Minor amounts of biotite ($< 1\%$) and magnetite ($< 2\%$).
85.3 to 91.4	Calcareous sandy silt: silt to very coarse-grained (up to 8 mm), sub-rounded to angular, clear to yellow quartz, and light to dark gray quartzite sand (≈ 30 to 40%). Quartzose silt ≈ 60 to 70%. Minor amounts of biotite and magnetite ($< 1\%$).
91.4 to 97.5	Sand: silt to coarse-grained (up to 5 mm), sub-rounded to angular, clear to yellow quartz, light gray quartzite. Minor amounts of biotite ($< 1\%$) and limonite staining.

Table A-17. (continued)

Depth (m)	Description
97.5 to 103.6	Calcareous silty sand: silt to coarse-grained (up to 5 mm), sub-rounded to subangular, clear to white quartz, gray quartzite. Minor amounts of biotite (<1%) silt ≈15 to 20%.
103.6 to 115.8	Calcareous sandy silt: silt to medium-grained, sub-rounded to subangular, clear to white quartz, gray quartzite (≈10 to 20%). Minor amounts of magnetite and biotite (<1%). Quartzose silt ≈80 to 90%.
115.8 to 121.9	Silty sand: silt to coarse-grained (up to 5 mm), sub-rounded to angular, clear to white quartz, gray quartzite and gray tuffaceous sand. Quartzose and tuffaceous silt (≈10 to 15%).
121.9 to 128.0	Sandy silt: silt to coarse-grained (up to 3 mm), sub-rounded to subangular, clear to white quartz, gray quartzite sand (≈10 to 20%). Quartzose silt ≈80 to 90%.
128.0 to 134.1	Data missing.
134.1 to 140.2	Silty sand: silt to very coarse-grained (up to 10 mm), sub-rounded to angular, clear to white quartz, gray to black quartzite, gray to white welded tuffaceous sand (≈80 to 90%). Quartzose and tuffaceous silt (≈10 to 20%).
140.2 to 146.3	Silt: quartzose

Table A-18. Lithology of MW-4

Depth (m)	Description
0 to 18.3	Calcareous sandy silt: very fine- to coarse-grained (up to 10 mm), sub-rounded to angular, clear to white quartz, light to dark gray quartzite and light gray tuff sand (≈30 to 40%). Quartzose silt ≈60 to 70%. Minor amounts of magnetite (<1 to 2%) and muscovite (<1%).
18.3 to 30.5	Quartzose silt: fine-grained, sub-rounded to angular quartz and quartzite sand (≈10 to 15%). Quartzose silt ≈90%.

Table A-18. (continued)

Depth (m)	Description
30.5 to 85.3	Sandy silt: fine- to very coarse-grained (up to 10 mm), sub-rounded to angular, clear to white quartz and light gray quartzite sand (≈ 10 to 20%). Quartzose silt (≈ 80 to 90%). Minor amounts of muscovite ($< 1\%$).
83.3 to 103.6	Data missing.
103.6 to 109.7	Silty sand: silt to coarse-grained (up to 5 mm), sub-rounded to angular, clear to white quartz, yellow to gray quartzite sand ($\approx 90\%$). Quartzose silt ($\approx 10\%$). Minor amounts of biotite, magnetite ($< 1\%$), and limonite sand.
109.7 to 115.8	Same as above. Silt content ≈ 20 to 30%.
115.8 to 134.1	Calcareous silt: quartzose silt.
134.1 to 146.3	Calcareous sandy silt: very fine- to very coarse-grained (up to 10 mm), sub-rounded to angular, clear to white quartz and gray quartzite sand (≈ 25 to 35%). Quartzose silt 65 to 75%.
146.3 to 164.6	Silty sand: quartzose silt $\approx 20\%$. Very fine- to very coarse-grained (up to 5 mm), sub-rounded to angular, clear to white quartz, and gray quartzite sand ($\approx 80\%$). Minor amounts of magnetite and biotite ($< 1\%$).
164.6 to 170.7	Same as above: pebbles up to 10 mm.
170.7 to 189.0	Silt: quartzose.
189.0 to 195.1	Data missing.
195.1 to 201.2	Pebbly sandy silt: fine- to very coarse-grained, sub-rounded to angular, clear to white quartz, light gray to brown quartzite and gray to light green tuff sand and pebbles (≈ 25 to 35%). Quartzose silt ≈ 65 to 75%. Minor amounts of biotite ($< 1\%$).
201.2 to 219.5	Data missing.
219.5 to 225.6	Silt: quartzose.
225.6 to 243.8	Sandy silt: fine- to coarse-grained (up to 5 mm), sub-rounded to angular, clear to white quartz, light to dark gray quartzite (≈ 10 to 15%). Minor amounts of biotite ($< 1\%$).

Table A-18. (continued)

Depth (m)	Description
243.8 to 249.9	Calcareous silty sand: fine- to coarse-grained (up to 3 mm), sub-rounded to angular, clear to white quartz, light to dark gray quartzite, light gray tuff sand (≈ 60 to 70%). Quartzose silt (≈ 30 to 40%).
249.9 to 256.0	Calcareous sandy silt: fine- to very coarse-grained (up to 10 mm), sub-rounded to angular, clear to white quartz, gray quartzite and gray tuff sand (≈ 30 to 40%). Quartzose silt (≈ 60 to 70%). Minor amounts of biotite, magnetite ($< 1\%$), and limonite staining.
256.0 to 268.2	Calcareous silt: quartzose silt, minor gray quartzite sand (up to 3 mm) (≈ 5 to 7%). Minor amounts of biotite ($< 1\%$) and limonite staining.
268.2 to 304.8	Calcareous silty clay: quartzose silt (≈ 20 to 40%).

Table A-19. Lithology of MW-5

Depth (m)	Description
0 to 12.2	Calcareous sandy silt: fine- to coarse-grained, sub-rounded to angular, clear to white quartz and gray quartzite sand ≈ 10 to 20%. Quartzose silt. Minor amounts of magnetite.
12.2 to 97.5	Sandy silt: same as above (not calcareous).
97.5 to 146.3	Calcareous sandy silt: same as above.
146.3 to 152.4	Silty sand: silt to very coarse-grained (up to 12 mm), sub-rounded to angular, clear to white sand, light to dark gray quartzite, light gray tuffs. Minor amounts of biotite and magnetite ($< 2\%$). Quartzose silt ≈ 20 to 30%.

Table A-20. Lithology of MW-6

Depth (m)	Description
0 to 9.1	Silty sand: silt to coarse-grained, sub-rounded to very angular, clear to yellow quartz, light gray to reddish-brown quartzite. Silt $\approx$ 20 to 30%. Minor amounts of biotite ($<$ 2%). Quartzite pebbles ($\approx$ 5 to 10%) up to 25 mm.
9.1 to 18.3	Silt: sub-rounded to angular, clear to orange quartz. Minor amounts of biotite ($<$ 5%). Silt $\approx$ 20 to 30%.
18.3 to 27.4	Silty sand: silt to coarse-grained, sub-rounded to very angular, clear to yellow quartz. Light gray quartzite. Minor amounts of biotite ($<$ 5%). Silt $\approx$ 20 to 30%.
27.4 to 36.6	Tuffaceous sand: fine- to very coarse-grained, sub-rounded to angular, clear to yellow quartz, light gray to black quartzite, light gray tuffs. Tuffs $\approx$ 30 to 40%.
36.6 to 45.7	Gravelly sand: fine- to very coarse-grained sand to gravel, sub-rounded to angular, clear to yellow quartz, light gray to dark gray quartzite. Minor amounts of tuff, biotite, and muscovite. Gravel $\approx$ 20 to 25%.
45.7 to 54.9	Tuffaceous sand: fine- to very coarse-grained, sub-rounded to angular, clear to yellow quartz, light gray to brown quartzite, light gray tuffs. Minor amounts of biotite ($\approx$ 2%). Tuff grains $\approx$ 25 to 35%.
54.9 to 64.0	Slightly calcareous argillaceous sand: silt to very coarse-grained, sub-rounded to angular, clear to yellow quartz, light to dark gray quartzite, light gray tuff. Minor amounts of biotite ($<$ 2%). Silt $\approx$ 10 to 15%; clay 10 to 15%.
64.0 to 73.2	Same as above. Few pebbles ($<$ 10%) up to 10 mm.
73.2 to 146.3	Calcareous argillaceous sand: same as above.
146.3 to 173.7	Slightly argillaceous sand: fine- to very coarse-grained, sub-rounded to angular, clear to yellow quartz, light gray to brown quartzite, light gray tuff. Minor amounts of biotite ($<$ 2%). Clay content 10 to 15%.
173.7 to 192.0	Slightly argillaceous sand: fine- to very coarse-grained, sub-rounded to angular, clear to yellow quartz, light gray quartzite. Minor amounts of biotite (2 to 3%). Very slight limonite staining. Clay content $\approx$ 10 to 15%.
192.0 to 204.2	Argillaceous sand: same as above. Clay content 15 to 25%.

Table A-20. (continued)

Depth (m)	Description
204.2 to 216.4	Slightly argillaceous sand: fine- to coarse-grained, sub-rounded to angular, clear to white quartz, light gray to black quartzite, light gray tuff. Minor amounts of biotite (≈ 2 to 3%).
216.4 to 228.6	Same as above. Limonite staining throughout (≈ 5 to 7% of grains).
228.6 to 234.7	Sand: fine- to medium-grained, sub-rounded to very angular, clear to yellow quartz, red to gray to black quartzite. Minor amounts of biotite ≈ 2 to 3%.
234.7 to 253.0	Argillaceous sand: same as above. Clay content ≈ 10 to 20%.
253.0 to 259.1	Sand: fine- to coarse-grained, sub-rounded to very angular, clear to yellow quartz, light gray to black quartzite, white tuff. Minor amounts of biotite ($\approx < 2\%$).
259.1 to 265.2	Tuffaceous sand: fine- to coarse-grained, rounded to angular, clear to yellow quartz, light gray to black quartzite, light gray tuff (≈ 10 to 25%). Minor amounts of biotite ($< 2\%$).
265.2 to 277.4	Silty sand: silt to coarse-grained, sub-rounded to angular, clear to black quartz, white to brown quartzite, light gray tuff. Minor amounts of biotite ($< 2\%$). Silt ≈ 20 to 30%.
277.4 to 286.5	Very argillaceous sand: very fine-grained, rounded to subangular, clear to yellow to black quartz. Minor amounts of biotite and magnetite (< 2 to 3%). Light gray tuff ≈ 34 to 45%.
286.5 to 298.7	Argillaceous sand: fine-grained, sub-rounded to very angular, clear to yellow quartz. Minor amounts of biotite and magnetite (< 2 to 3%). Gray clay $\approx 20\%$.
298.7 to 304.8	Sand: medium- to coarse-grained, sub-rounded to very angular, clear to white quartz, white to green to black quartzite and gray tuff.

Table A-21. Lithology of MW-7

Depth (m)	Description
6.1	Sandy silt: coarse-grained (up to 4 mm in diameter), sub-rounded to angular, clear to yellow quartz, gray quartzite sand (20 to 30%). Quartzose silt: 70 to 80%. Minor amounts (<1%) of biotite and magnetite.
6.1 to 30.5	Silty sand: coarse-grained (up to 7 mm in diameter), sub-rounded to angular, clear to white quartz, gray quartzite sand (70 to 80%). Quartzose silt: 20 to 30%. Minor amounts of muscovite, biotite, and magnetite (<1%).
30.5 to 97.5	Sandy silt: coarse-grained (up to 5 mm in diameter), sub-rounded to angular, clear to white quartz, and gray quartzite sand (20 to 30%). Quartzose silt: 70 to 80%. Minor amounts of biotite and magnetite (<1%).
97.5 to 140.2	Silty sand: same as above. Silt: 20 to 30%.
140.2 to 152.4	Calcareous argillaceous sandy silt: same as above. Sand content: 20%. Clay: 10 to 20%. Silt: 60 to 70%.

Table A-22. Lithology of heat flow well

Depth (m)	Description
0 to 12.2	Gravel: fine- to very coarse-grained (up to 25 mm in diameter), subangular to angular, light gray parphyritic andesite (90 to 95%), dark gray to black vitrophyre (1 to 2%), white to gray-green welded tuff. Dedritic hematite staining in tuffs. Localizes deutification in ritrophyres and slight secondary calcite (calicle) coating on same andesite grains.
12.2 to 18.3	Gravel: fine- to very coarse-grained (up to 20 mm in diameter), subangular to angular, light gray parphyritic andesite (70% to 80%). Light gray quartz latite (5 to 10%). Dark gray to black dacite (2 to 5%). Dark gray to black ritrophyre (5 to 10%). Minor amounts of magnetite (<1%). Slight calcite (calicle) coating on some grains.
18.3 to 21.3	Silty sand: very coarse-grained (up to 4 mm in diameter), sub-rounded to angular, clear to yellow quartz (75 to 80%), light gray quartzite (10 to 20%), dark gray to black dacite (1 to 2%). Minor amounts of muscovite (<1%) pyrite (<1%), and magnetite (<1%). Silt ≈10 to 20%.

Table A-22. (continued)

Depth (m)	Description
21.3 to 24.4	Sand: fine- to very coarse-grained (up to 3 mm in diameter), subangular to very angular, clear to yellow quartz (80 to 90%), light gray quartzite (5 to 10%) light gray rhyolite (5 to 10%). Minor amounts of tuff (1 to 2%), magnetite (<1%) and pyrite (<1%).
24.4 to 36.6	Tuffaceous sand: fine- to very coarse-grained (up to 10 mm in diameter), sub-rounded to angular, clear to white quartz (60 to 70%) light gray quartzite (5 to 10%) light gray to white tuff (5 to 10%) light gray to red rhyolite (5 to 10%). Minor amounts of magnetite (<1%), muscovite (<1%).
36.6 to 42.7	Same as above: tuff content 15 to 25%.
42.7 to 51.8	Quartzose Silt.
51.8 to 73.2	Tuffaceous silty sand: Silt to coarse-grained, sub-rounded to subangular, clear to yellow quartz (70 to 80%), tuff (10 to 20%), light gray quartzite (5%), light gray rhyolite (5 to 10%), minor biotite (<1%) muscovite (<1%), and magnetite (<1%), silt =10 to 20%.
73.2 to 79.2	Sandy silt: very coarse-grained (up to 5 mm in diameter), sub-rounded to subangular, clear to yellow quartz (70 to 80%), light yellow to gray tuff (10 to 20%), light gray rhyolite (10 to 20%), minor amounts of biotite <1%, magnetite (<1%) and muscovite (<1%), silt =60 to 70%.
79.2 to 100.6	Tuffaceous sand: silt to very coarse-grained (up to 3 mm in diameter), sub-rounded to subangular, clear to white quartz (70 to 80%), light gray to white tuff (5 to 10%), gray rhyolite (5 to 10%), minor amounts of biotite (<1%) and magnetite (<1%).
100.6 to 109.7	Tuffaceous sand: Same as above. Tuff content: 75%.
109.7 to 115.8	Tuffaceous sand: Same as above; tuff content 40 to 50% and minor amounts of biotite (1 to 2%). Pyrite (<1%), graphite (1%), hydrothermally altered.
115.8 to 121.9	Tuffaceous sand: silt to coarse-grained (up to 3 mm in diameter), sub-rounded to very angular, clear to yellow quartz (10 to 20%), gray quartzite (30 to 40%), light gray tuff (30 to 40%) black vitrophyre (5 to 10%). Rhyolite (5 to 10%) minor amounts of limonite stained biotite (1%).

Table A-22. (continued)

Depth (m)	Description
121.9 to 146.3	Silty sand: silt to very coarse-grained (up to 8 mm in diameter), sub-rounded to very angular, clear to white quartz (50 to 70%), light gray rhyolite (10 to 20%), light gray tuff (5 to 10%), minor vitrophyres (2 to 3%), minor amounts of muscovite (<1%) and biotite (<1%).
146.3 to 152.4	Same as above, slightly calcareous.

X-RAY ANALYSIS

X-RAY ANALYSIS^a

X-Ray Analysis of Well RRG-3, Sample 1, at a Depth of 855 Meters

The sample taken is a siltstone with well-sorted grains floating in an ashy matrix. A few very thin beds have clay matrix. Compaction is indicated by the orientation of the elongated grains parallel to the bedding. Some very large opaques (possibly secondary) are concentrated in certain beds.

All grains appear to be detrital except for some small patches of carbonate cement and possibly a very large opaque.

The rock consists of 11% quartz, 11% plagioclase, 7% opaques, 7% muscovite, 4% carbonate cement, 35% ashy matrix, 25% clay matrix, and a trace of biotite.

Minerals

1. Muscovite: Subangular; detrital; 0.35 x 0.07 to 0.06 mm long.
2. Opaques: Detrital and secondary; subangular to subrounded; a few elongated opaques that parallel the bedding may be organic; 0.35 x 0.3 mm to 0.01 x 0.01 mm.
3. Plagioclase: Detrital; angular to subrounded; 0.15 x 0.09 mm to 0.03 x 0.01 mm.
4. Quartz: Detrital; angular to subangular; 0.2 x 0.17 mm to 0.03 x 0.01 mm.
5. Biotite: Detrital; subangular to subrounded; 0.14 x 0.04 to 0.08 mm long.

X-Ray Analysis of Well RRG-3, Sample 2, at a Depth of 1210 Meters

The sample taken is a feldspathic graywacke composed of well sorted grains floating in a clay matrix in contact with a shale consisting of well-sorted silt-sized grains also floating in a clay matrix. Many of the opaques appear to be organic. The shale unit is finely laminated. Compaction is indicated by the orientation of elongated minerals.

Minor portions of the matrix are altering to carbonate. All other grains present are detrital.

The rock consists of 13% quartz, 12% plagioclase, 4% muscovite, 3% opaques, 2% rock fragments, 1% biotite, 64% matrix, 1% carbonate, and a trace of microcline and augite.

Minerals

1. Quartz: Detrital; subangular to subrounded; 0.25 x 0.2 mm to 0.02 x 0.02 mm.
2. Plagioclase: Detrital; subangular to subrounded; 0.18 x 0.18 mm to 0.02 x 0.02 mm.
3. Microcline: Detrital; subangular to subrounded; 0.5 x 0.4 mm to 0.12 x 0.07 mm.
4. Carbonate: Detrital; subrounded; 0.14 x 0.08 mm to 0.07 x 0.07 mm.
5. Muscovite: Detrital; subangular and elongated; 0.18 x 0.04 to 0.04 mm long.

a. Adapted from work by the Geology Department of Boise State University.

6.	Biotite:	Detrital; subangular and elongated; 0.35 x 0.1 mm to 0.14 x 0.05 mm.
7.	Rock fragments:	Subangular to subrounded; volcanic; 0.2 x 0.18 mm to 0.09 x 0.07 mm.
8.	Opaques:	Detrital and secondary; subrounded; 0.7 x 0.7 mm to 0.02 x 0.02 mm.
9.	Augite:	Detrital; subangular; 0.18 x 0.18 mm.

X-Ray Analysis of Well RRG-3, Leg C, Sample 3, at a Depth of 1462 Meters

The sample taken is an angular-grained, well-sorted feldspathic quartz arenite with a small amount of ashy and clay matrix. The rock is laminated with some very fine-grained, clay-rich beds. Portions of the matrix are altering to carbonate. Some of the opaques follow grain boundaries and may be secondary.

Detrital grains are plagioclase, quartz, rock fragments, monazite, microcline, muscovite, biotite, opaques, and garnet. Carbonate cement is the only secondary mineral.

This rock consists of 39% quartz, 26% plagioclase, 7% rock fragments, 5% matrix, 5% biotite, 5% opaques, 6% carbonate, 4% microcline, 3% muscovite, and a trace of monazite and garnet.

Minerals

1.	Plagioclase:	Detrital; subangular to subrounded; 0.6 x 0.2 mm to 0.12 x 0.07 mm; some grains were poikilitic.
2.	Quartz:	Detrital; angular to subrounded; 0.5 x 0.2 mm to 0.07 x 0.07 mm.
3.	Rock fragments:	Subrounded; volcanic; 0.2 x 0.2 mm to 0.18 x 0.09 mm.
4.	Monazite:	Detrital; subangular; 0.09 x 0.09 mm to 0.07 x 0.05 mm.
5.	Microcline:	Detrital; subangular to subrounded; 0.35 x 0.14 mm to 0.2 x 0.1 mm.
6.	Muscovite:	Detrital; subangular and elongated; 0.35 x 0.1 mm to 0.04 x 0.02 mm.
7.	Biotite:	Detrital; subangular to elongated; 0.14 x 0.04 mm to 0.5 x 0.1 mm; some altering to chlorite.
8.	Opaques:	Detrital and secondary; 1.0 x 0.2 mm to 0.3 x 0.1 mm.
9.	Garnet:	Detrital; subangular; 0.35 x 0.2 mm.

X-Ray Analysis of Well RRG-3, Leg C, Sample 4, at a Depth of 1518 Meters

The sample taken is a tuff in which many of the grains and glass shards have altered to carbonate and all of the matrix has altered to carbonate and clay. Carbonate and zeolite veins are present and sometimes occur together.

The rock appears to have been a very fine-grained tuff interbedded with thin clay-rich beds. Carbonate alteration has masked most of the original texture. Extensive fracturing has brecciated the rock. The sediments were still soft during fracturing as the coarser grains and glass shards from an overlying bed appear to have flowed into the larger fractures. Carbonate appears to have precipitated in two stages. One stage fills fractures as veins and another stage replaces the matrix.

All grains are detrital with carbonate and zeolites being secondary. Some of the opaques follow grain boundaries and may also be secondary.

The rock consists of 2% quartz, 4% plagioclase, 5% opaques, 35% carbonate cement, and 54% matrix.

Minerals

1. Quartz: Detrital; angular to subangular; 0.25 x 0.18 mm to 0.03 to 0.03 mm.
2. Plagioclase: Detrital; angular to subangular; 0.2 x 0.1 mm to 0.08 x 0.07 mm; some have euhedral shapes.
3. Muscovite: Detrital; subangular and elongated; 0.09 x 0.04 mm to 0.07 x 0.03 mm.
4. Opaques: Detrital; subrounded; 0.18 x 0.12 mm to 0.07 x 0.04 mm.

X-Ray Analysis of Well RRG-3, Leg C, Sample 5, at a Depth of 1520 Meters

The sample taken is an angular-grained well-sorted tuffaceous sandstone with an ashy matrix altering to carbonate. Glass shards are present and have altered to carbonate. Broken fossil fragments are also present but are unidentifiable. A large carbonate vein fills a fracture running through the slide. Zeolites also occur in parts of this vein. The rock shows graded bedding with the finer-grained portion showing less carbonate cement and more ashy matrix. A few thin, clay-rich beds are present and show the offset caused by the fracture. Many of the grains are rimmed with carbonate.

All grains present are detrital. Secondary minerals are carbonate and zeolites in veins.

The rock consists of 22% quartz, 15% plagioclase, 5% opaques, 1% rock fragments, 1% muscovite, 32% matrix, 24% carbonate cement, and a trace of microcline.

Minerals

1. Quartz: Detrital; subangular; 0.2 x 0.15 mm to 0.07 x 0.06 mm.
2. Plagioclase: Detrital; subangular to subrounded; 0.2 x 0.15 mm to 0.07 x 0.05 mm.
3. Muscovite: Detrital; subangular and elongated; 0.12 x 0.04 to 0.04 mm long.
4. Opaques: Detrital and secondary; subrounded; 0.14 x 0.12 mm to 0.07 x 0.04 mm.
5. Rock fragments: Subrounded; volcanic; 0.3 x 0.3 mm to 0.14 x 0.1 mm.
6. Microcline: Detrital; subangular; 0.2 x 0.18 mm.

X-Ray Analysis of Well RRG-3, Leg C, Sample 6, at a Depth of 1606 Meters

The sample taken is a quartzite with some carbonate cement and crystalloblastic muscovite. Porphyroblasts of quartz and plagioclase are present with sutured boundaries and undulatory extinction. Veins are present and have carbonate lining the walls with silica crystallizing on the inside. Another type of silica is present flowing around the grains.

This rock consists of 78% quartz, 8% plagioclase, 4% sphene, 3% silica, 3% muscovite, 2% carbonate, 1% muscovite, 1% opaques, and a trace of epidote, microcline, and monazite.

Minerals

1. Epidote: Subhedral; 0.18 x 0.1 mm.
2. Microcline: Anhedral; 0.2 x 0.14 mm.
3. Monazite: Subhedral; 0.35 x 0.2 mm to 0.03 x 0.03 mm.
4. Quartz: Anhedral; 20.0 x 0.7 mm to 0.12 x 0.07 mm.
5. Plagioclase: Anhedral; 1.7 x 0.5 mm to 0.15 x 0.1 mm.
6. Opaque: Anhedral; 0.14 x 0.04 mm to 0.03 x 0.03 mm.
7. Sphene: Anhedral; 0.2 x 0.05 mm to 0.03 x 0.03 mm.

X-Ray Analysis of Well RRG-3, Leg C, Sample 7, at a Depth of 1606 Meters

The sample taken is a shale with a few silt-sized grains floating in a matrix of clay and ash. Much of the matrix is altering to carbonate cement. Many elongated opaques are present and may be organic. Several microfaults are present throughout the slide.

Detrital grains present are quartz, plagioclase, muscovite, and opaques. Carbonate occurs as secondary cement.

The rock consists of 3% quartz, 2% plagioclase, 1% muscovite, 10% opaques, 20% ashy matrix, 31% clay matrix, and 23% carbonate cement.

Minerals

1. Quartz: Detrital; angular to subangular; 0.14 x 0.06 mm to 0.03 x 0.03 mm.
2. Plagioclase: Detrital; subangular to subrounded; 0.07 x 0.07 mm to 0.05 x 0.04 mm.
3. Opaques: Detrital; subangular and elongated; 0.08 x 0.05 to 0.03 mm long.
4. Muscovite: Detrital; subangular; 0.4 x 0.12 to 0.14 mm long.

X-Ray Analysis of Well RRG-3, Leg C, Sample 8, at a Depth of 1692 Meters

The sample taken is a quartzite with porphyroblasts of quartz and feldspar. Sutured boundaries and undulose extinction exists throughout and a slight schistosity of muscovite grains is present.

This rock consists of 57% quartz, 38% plagioclase, 3% muscovite, 1% sphene, 1% opaques, and a trace of microcline and monazite.

Minerals

1. Plagioclase: Anhedral; 3.0 x 1.5 mm to 0.35 x 0.2 mm.
2. Monazite: Subhedral to anhedral; 0.1 x 0.1 mm to 0.9 x 0.05 mm.
3. Microcline: Subhedral; 0.14 x 0.07 mm to 0.3 x 0.15 mm.
4. Quartz: Subhedral; 3.5 x 1.0 mm to 0.14 x 0.07 mm.
5. Muscovite: Subhedral; 0.1 x 0.03 to 0.02 mm long.
6. Sphene: Subhedral; 0.07 x 0.07 mm to 0.02 x 0.01 mm.
7. Opaque: Euhedral to subhedral; 0.07 x 0.07 mm to 0.01 x 0.01 mm.

X-Ray Analysis of Well RRG-4, Leg B, Sample 1, at a Depth of 1415 Meters

This sample is a laminated rock with interbeds of shale, siltstone, and sandstone. The shale and siltstone beds are well sorted with the sandstone bed being very poorly sorted. All units have a clay matrix. Extensive microfaults exist throughout the slide. The rock appears to have been water saturated during deformation as the sediments have seeped down the fractures. Compaction during deposition is indicated by the orientation of elongated minerals parallel to the bedding. The matrix is altering to carbonate in places. All other grains present are detrital.

The sandstone unit consists of 25% quartz, 24% plagioclase, 7% muscovite, 3% biotite, 5% opaque, 2% microcline, 28% matrix, 6% carbonate, and a trace of rock fragments.

Minerals

1. Muscovite: Detrital; subangular and elongated; 1.2 x 0.3 mm to 0.07 x 0.03 mm.
2. Biotite: Detrital; subangular to subrounded and elongated; 0.35 x 0.35 mm to 0.12 x 0.04 mm.
3. Quartz: Detrital; subangular to subrounded; 1.0 x 0.75 mm to 0.04 x 0.04 mm; some polycrystalline.
4. Plagioclase: Detrital; subangular to subrounded; 1.0 x 0.7 mm to 0.04 x 0.03 mm.
5. Rock fragments: Subangular; 0.75 x 0.75 mm; quartzite.

6. Microcline: Detrital; subangular to subrounded; 0.5 x 0.4 mm to 0.14 x 0.14 mm.
7. Opaques: Detrital; subangular to subrounded; 0.5 x 0.15 mm to 0.05 x 0.05 mm.

X-Ray Analysis of Well RRG1-4, Leg B, Sample 2, at a Depth of 1415 Meters

This sample is a well sorted graywacke in contact with a sandstone unit whose matrix has completely altered to carbonate. The graywacke unit contains angular grains floating in a matrix of ash and clay. Portions of the matrix are altering to carbonate. A few glass shards are present and have also been altered to carbonate. Some of the matrix has altered to a clay mineral which appears to be saponite. Some opaques are detrital but most appear secondary growing around grain boundaries. All other grains present are detrital.

The rock consists of 18% quartz, 17% plagioclase, 6% muscovite, 3% microcline, 7% rock fragments, 5% opaques, 2% biotite, 36% matrix, 6% carbonate, and a trace of zircon, saponite, and monazite.

Minerals

1. Plagioclase: Detrital; subangular to subrounded; 0.5 x 0.4 mm to 0.04 x 0.02 mm; some poikilitic.
2. Quartz: Detrital; subangular to subrounded; 0.6 x 0.3 mm to 0.04 x 0.03 mm; some polycrystalline.
3. Microcline: Detrital; subangular to subrounded; 0.3 x 0.3 mm to 0.25 x 0.18 mm.
4. Muscovite: Detrital; subangular and elongated; 0.4 x 0.2 to 0.04 mm long.
5. Monazite: Detrital; subangular; 0.08 x 0.06 mm to 0.03 x 0.02 mm.
6. Rock fragments: Subrounded; volcanic; 0.35 x 0.35 mm to 0.25 x 0.2 mm.
7. Biotite: Detrital; subangular and elongated; 0.5 x 0.04 to 0.04 mm long.
8. Zircon: Detrital; prismatic and elongated; 0.15 x 0.09 mm.
9. Opaques: Detrital and secondary; 0.3 x 0.2 mm to 0.02 x 0.02 mm.
10. Saponite: Secondary; identification not certain; optical properties are parallel extinction, length slow, olive to brownish pleochroism.

X-Ray Analysis of Well RRG1-4, Leg B, Sample 3, at a Depth of 1416 Meters

This sample is a shale with poorly sorted silt- and sand-sized grains floating in a matrix of ash and clay. Some of the matrix is altering to carbonate. Microfaults and areas of brecciation occur throughout with fractures being filled with carbonate. All other grains present are detrital.

The rock consists of 7% quartz, 7% plagioclase, 2% muscovite, 4% opaques, 69% matrix, 11% carbonate, and a trace of biotite.

Minerals

1. Quartz: Detrital; subangular to subrounded; 0.75 x 0.75 mm to 0.02 x 0.02 mm.
2. Plagioclase: Detrital; subangular to subrounded; 0.18 x 0.09 mm to 0.04 x 0.03 mm.
3. Muscovite: Detrital; subangular and elongated; 0.18 x 0.06 mm to 0.07 x 0.04 mm.
4. Biotite: Detrital; subangular and elongated; 0.4 x 0.2 to 0.04 mm long.
5. Opaques: Detrital; subangular to subrounded; 0.4 x 0.2 mm to 0.05 x 0.05 mm.

X-Ray Analysis of Well RRG1-4, Sample 4, Leg B, at a Depth of 1416 Meters

The sample taken is a lithic wacke with very large rock fragments and very poorly sorted grains in a matrix of clay and ash. Rock fragments present are all quartzite schist. Some of the matrix is altering to carbonate. Secondary opaques are also present. All other grains are detrital.

The rock consists of 34% quartz, 14% plagioclase, 8% muscovite, 18% rock fragments, 13% opaques, 8% matrix, 5% carbonate, and a trace of monazite.

Minerals

1. Quartz: Detrital; subangular to subrounded; 1.0 x 0.6 mm to 0.07 x 0.07 mm.
2. Plagioclase: Detrital; subangular to subrounded; 1.0 x 0.7 mm to 0.07 x 0.07 mm.
3. Muscovite: Detrital; subangular and elongated; 0.5 x 0.4 to 0.04 mm long.
4. Monazite: Detrital; subangular to subrounded; 0.15 x 0.04 mm to 0.12 x 0.12 mm.
5. Rock fragments: Subrounded; quartzite schist; 15.0 x 5.0 mm to 1.25 x 0.5 mm.
6. Opaques: Detrital and secondary; detrital grains are subrounded; 0.25 x 0.25 mm to 0.04 x 0.04 mm; secondary opaques occur around grain boundaries.

X-Ray Analysis of RRG1-4, Leg B, Sample 5, at a Depth of 1419 Meters

This sample is a lithic wacke with very poorly sorted grains in a matrix of ash and clay. No alteration to carbonate is present. This unit is in contact with an igneous unit. Opaques and chlorite are secondary growing along grain boundary contacts. All other grains are detrital.

The rock consists of 23% quartz, 21% plagioclase, 15% rock fragments, 6% microcline, 3% muscovite, 3% opaques, 29% matrix, and a trace of chlorite.

Minerals

1. Plagioclase: Detrital; subangular to subrounded; 0.9 x 0.75 mm to 0.02 x 0.02 mm; most are poikilitic.

2. Quartz: Detrital; subangular to subrounded; 1.0 x 0.75 mm to 0.02 x 0.02 mm.
3. Microcline: Detrital; subangular to subrounded; 0.5 x 0.5 mm to 0.14 x 0.12 mm.
4. Muscovite: Detrital; subangular and elongated; 0.3 x 0.2 mm to 0.18 x 0.05 mm.
5. Rock fragments: Subrounded; igneous and quartzites; 4.0 x 3.0 mm to 6.5 x 5.5 mm.
6. Chlorite: Secondary; 0.5 x 0.4 mm to 0.2 x 0.07 mm; growing along grain contacts with opaques.
7. Opaques: Secondary; occur as streaks along grain boundaries with chlorite.

X-Ray Analysis of RRG1-4, Leg B, Sample 6, at a Depth of 1419 Meters

This sample is a quartzite schist with lepidoblastic biotite, chlorite, and muscovite. The parent rock was probably a quartz arenite, with minor muscovite and opaques, which was metamorphosed in the greenschist facies. Biotite, chlorite, sphene, epidote, and apatite grew during metamorphism. The schistose character suggests mechanical deformation. A few fractures are present and are filled with carbonate.

The rock consists of 80% quartz, 7% biotite, 1% muscovite, 4% chlorite, 6% apatite, 2% opaques, and a trace of epidote and sphene.

Minerals

1. Quartz: Anhedral; average size 0.18 x 0.2 mm; undulose.
2. Biotite: Schistose; occurs in streaks rather than in individual grains; some altering to chlorite.
3. Muscovite: Schistose; subhedral to anhedral; 0.35 x 0.2 mm to 0.12 x 0.06 mm.
4. Chlorite: Schistose; occurs in streaks rather than in individual grains; some are alteration products of biotite.
5. Sphene: Anhedral; 0.2 x 0.2 mm; associated with the biotite and chlorite.
6. Opaques: Anhedral; 0.5 x 0.2 mm to 0.18 x 0.12 mm.
7. Epidote: Anhedral; 0.04 x 0.04 mm to 0.04 x 0.02 mm; associated with the biotite and chlorite.
8. Apatite: Anhedral; 0.09 x 0.08 mm to 0.04 x 0.03 mm.

X-Ray Analysis of Well RRG1-4, Sample 7, Leg B, at a Depth of 1420 Meters

Sample 7 is a quartzite schist that has been extensively fractured. A quartz vein runs through the slide, but appears to be pre-kinematic as it has been fractured and metamorphosed with the schist. A trace of

secondary carbonate is present. Chlorite and some opaques are also secondary and occur around grain boundaries. Chlorite occurs as an alteration product of biotite.

The rock consists of 46% quartz, 30% plagioclase, 11% muscovite, 1% biotite, 1% opaques, and 11% chlorite.

Minerals

1. Quartz: Subangular to subrounded; 0.18 x 0.18 mm to 0.05 x 0.04 mm.
2. Plagioclase: Subangular to subrounded; 0.18 x 0.15 mm to 0.05 x 0.03 mm.
3. Muscovite: Subangular to elongated; 0.5 x 0.4 to 0.06 mm long.
4. Biotite: Subangular and elongated; 0.35 x 0.2 to 0.05 mm long; most grains are altering to chlorite.
5. Opaques: Angular to subrounded; 0.35 x 0.2 mm to 0.02 x 0.02 mm; secondary opaques are associated with chlorite occurring around grain boundaries.

X-Ray Analysis of Well RRG1-4, Leg B, Sample 8, at a Depth of 1420 Meters

The sample is a lithic arenite that has been extensively fractured throughout. All rock fragments present are quartzite schists. Secondary muscovite and opaques are present in the fractured areas. A small amount of secondary carbonate is also present. All other grains are detrital.

The rock consists of 12% quartz, 11% plagioclase, 17% muscovite, 1% biotite, 3% opaques, 55% rock fragments, a trace of matrix, and 1% carbonate.

Minerals

1. Quartz: Detrital; subrounded; 0.18 x 0.18 mm to 0.05 x 0.04 mm.
2. Plagioclase: Detrital; subrounded; 0.15 x 0.15 mm to 0.04 x 0.03 mm.
3. Muscovite: Detrital and secondary; detrital grains are subangular to elongated; 0.09 x 0.09 mm to 0.05 mm long; secondary muscovite occurs in streaks.
4. Biotite: Detrital; subrounded and elongated; 0.2 x 0.1 mm to 0.15 mm long.
5. Opaques: Detrital and secondary; detrital grains are subrounded; 0.2 x 0.18 mm to 0.02 x 0.02 mm; secondary opaques occur around grain boundaries in the fractured areas.
6. Rock fragments: Subrounded; quartzite schists; 9.0 x 6.0 mm to 1.0 x 0.75 mm.

X-Ray Analysis of Well RRG1-4, Leg B, Sample 9, at a Depth of 1423 Meters

The sample is a quartz monzonite with one very large fracture running through the slide. The fracture zone contains fragments of all sizes of quartz monzonite. This is the only igneous rock noted thus far in

thin section. No stained slab was available for modal analysis, so the feldspar grains are divided into microcline and feldspars.

The rock consists of 29% feldspar, 29% quartz, 8% microcline, 6% muscovite, 1% opaques, and a trace of chlorite.

Minerals

1. Quartz: Subhedral to anhedral; 4.5 x 2.25 mm to 0.14 x 0.1 mm; undulose.
2. Feldspar: (Untwinned plagioclase and orthoclase); equant to subhedral; 3.75 x 2.75 mm to 0.14 x 0.07 mm; poikilitic.
3. Microcline: Subhedral; 3.0 x 2.25 mm to 0.14 x 0.14 mm.
4. Chlorite: Subhedral; 1.0 x 0.3 mm to 0.2 x 0.1 mm.
5. Muscovite: Subhedral; 1.5 x 0.3 mm to 0.3 x 0.1 mm.
6. Opaques: Anhedral; 0.2 x 0.1 mm to 0.03 x 0.03 mm; some opaques surround chlorite grains and some occur around grain boundaries in the fracture zone.

X-Ray Analysis of Well RRG1-4, Leg B, Sample 10, at a Depth of 1423 Meters

This rock has been completely altered to carbonate. The only grains present are a few subrounded opaques. Streaks of silica are also present but occur only in traces. Mechanical deformation has occurred after the rock altered to carbonate. In places the rock appears to be sheared with the development of boudins.

The rock consists of 100% carbonate with a trace of opaques and silica.

X-Ray Analysis of Well RRG1-6, Sample 1, at a Depth of 916 Meters

This sample is a finely laminated siltstone and shale with well-sorted grains floating in a matrix of ash and clay. Some of the matrix is altering to carbonate. Compaction is indicated by the orientation of elongated grains. A few glass shards are present in the silty beds. An opaque horizon is present parallel to the bedding and appears to be secondary. All other grains present are detrital.

The rock consists of 10% plagioclase, 7% quartz, 11% muscovite, 1% biotite, 5% opaques, 61% matrix, 5% carbonate, and a trace of microcline.

Minerals

1. Microcline: Detrital; subangular to subrounded; 0.14 x 0.06 mm to 0.05 x 0.05 mm.
2. Plagioclase: Detrital; subangular to subrounded; 0.14 x 0.12 mm to 0.05 x 0.03 mm.
3. Quartz: Detrital; subangular to subrounded; 0.12 x 0.07 mm to 0.05 x 0.04 mm.
4. Muscovite: Detrital; subangular to elongated; 0.14 x 0.02 to 0.04 mm long.
5. Biotite: Detrital; subangular to elongated; 0.21 x 0.03 to 0.04 mm long.

6. Opaques: Detrital and secondary; subangular to subrounded; some elongated opaques may be organic; 0.3 x 0.2 mm to 0.07 x 0.03 mm.

X-Ray Analysis of Well RRG1-6, Sample 2, at a Depth of 917 Meters

This sample is a well sorted feldspathic graywacke with grains floating in a matrix of clay and ash. Parts of the matrix are altering to carbonate. Compaction is indicated by the orientation of elongated grains. Carbonate and some opaques are secondary. All other grains present are detrital.

The rock consists of 24% plagioclase, 16% quartz, 6% muscovite, 4% biotite, 3% opaques, 36% matrix, 11% carbonate, and a trace of zircon, epidote, and microcline.

Minerals

1. Biotite: Detrital; subangular and elongated; 0.35 x 0.1 mm to 0.07 x 0.03 mm.
2. Muscovite: Detrital; subangular and elongated; 0.36 x 0.12 to 0.04 mm long.
3. Microcline: Detrital; subangular to subrounded; 0.2 x 0.18 mm.
4. Quartz: Detrital; subangular to subrounded; 0.2 x 0.2 mm to 0.05 x 0.04 mm.
5. Plagioclase: Detrital; subangular to subrounded; 0.2 x 0.14 mm to 0.06 x 0.03 mm.
6. Epidote: Detrital; subangular; 0.06 x 0.03 mm.
7. Zircon: Detrital; subangular; 0.08 x 0.05 mm.
8. Opaques: Detrital and secondary; 0.5 x 0.3 mm to 0.09 x 0.08 mm; elongated opaques appear to be organic.

X-Ray Analysis of Well RRG1-6, Sample 3, at a Depth of 918 Meters

This sample is a fine-grained, well-sorted lithic wacke with angular grains floating in an ashy matrix. Much of the matrix is altering to carbonate. All rock fragments are volcanic. Carbonate cement is the only secondary mineral present.

The rock consists of 22% plagioclase, 15% quartz, 5% biotite, 8% rock fragments, 2% muscovite, 4% opaques, 35% matrix, 9% carbonate, and a trace of zircon and microcline.

Minerals

1. Quartz: Detrital; subangular to subrounded; 0.3 x 0.18 mm to 0.04 x 0.03 mm.
2. Plagioclase: Detrital; subangular to subrounded; 0.3 x 0.3 mm to 0.03 x 0.02 mm; some are poikilitic.
3. Microcline: Detrital; subangular to subrounded; 0.2 x 0.2 mm to 0.06 x 0.06 mm.
4. Biotite: Detrital; subangular to elongated; 0.3 x 0.2 mm to 0.15 x 0.12 mm.
5. Rock fragments: Subrounded; volcanic; 0.3 x 0.2 mm to 0.18 x 0.12 mm.

6. Zircon: Detrital; subrounded; 0.1 x 0.07 mm to 0.07 x 0.07 mm.
7. Muscovite: Detrital; subangular to elongated; 0.4 x 0.04 to 0.02 mm long.
8. Opaques: Detrital; subrounded; 0.35 x 0.2 mm to 0.08 x 0.07 mm.

X-Ray Analysis of Well RRG1-6, Sample 4, at a Depth of 919 Meters

This sample is a moderately well sorted lithic arenite with angular grains and a small amount of ashy matrix. Much of the matrix is altering to carbonate. Glass shards are present and completely altered to carbonate. Slight compaction is indicated by the orientation of elongated minerals. Carbonate is the only secondary mineral with all other grains being detrital.

The rock consists of 16% plagioclase, 23% quartz, 10% rock fragments, 6% biotite, 4% opaques, 4% muscovite, 3% microcline, 2% matrix, 32% carbonate, and a trace of monazite and augite.

Minerals

1. Opaques: Detrital; subangular to subrounded; 0.5 x 0.3 mm to 0.07 x 0.04 mm.
2. Muscovite: Detrital; subangular and elongated; 0.75 x 0.2 mm to 0.1 x 0.04 mm.
3. Microcline: Detrital; subangular to subrounded; 0.35 x 0.1 mm to 0.12 x 0.07 mm.
4. Monazite: Detrital; subrounded; 0.12 x 0.07 mm to 0.18 x 0.12 mm.
5. Augite: Detrital; subangular; 0.12 x 0.07 mm to 0.05 x 0.05 mm.
6. Biotite: Detrital; subangular and elongated; 1.2 x 0.2 to 0.1 mm long.
7. Quartz: Detrital; subangular to subrounded; 0.35 x 0.18 mm to 0.05 x 0.04 mm.
8. Plagioclase: Detrital; subangular to subrounded; 0.25 x 0.2 mm to 0.07 x 0.04 mm.
9. Rock fragments: Subangular to subrounded; 0.5 x 0.4 mm to 0.2 x 0.2 mm; all appear to be volcanic.

X-Ray Analysis of Well RRG1-6, Sample 5, at a Depth of 919 Meters

This sample is a laminated siltstone and shale with well-sorted grains floating in a matrix of ash and clay. Compaction is indicated by the orientation of elongated grains. Some of the matrix is altering to carbonate. All other grains present are detrital.

The rock consists of 15% quartz, 10% plagioclase, 6% opaques, 6% muscovite, 4% biotite, 41% matrix, 18% carbonate, and a trace of zircon and microcline.

Minerals

1. Quartz: Detrital; subangular to subrounded; 0.2 x 0.12 mm to 0.05 x 0.03 mm.
2. Plagioclase: Detrital; subangular to subrounded; 0.12 x 0.1 mm to 0.05 x 0.04 mm.

3. Opaques: Detrital; subangular to subrounded; 0.25 x 0.2 mm to 0.03 x 0.03 mm; elongated opaques appear organic.
4. Microcline: Detrital; subangular to subrounded; 0.15 x 0.12 mm.
5. Muscovite: Detrital; subangular and elongated; 0.14 x 0.07 to 0.02 mm long.
6. Biotite: Detrital; subangular and elongated; 0.1 x 0.05 to 0.04 mm long.
7. Zircon: Detrital; subangular; 0.04 x 0.03 mm.

X-Ray Analysis of Well RRG1-6, Sample 6, at a Depth of 920 Meters

This sample is a fine-grained shale with silt-sized grains floating in a matrix of clay and ash. Some of the matrix is altering to carbonate. Compaction is indicated by the orientation of elongated grains. A few glass shards are also present. Carbonate and a few of the opaques are secondary with all other grains present being detrital.

The rock consists of 4% quartz, 6% plagioclase, 9% muscovite, 4% biotite, 5% opaques, 58% matrix, 14% carbonate, and a trace of augite.

Minerals

1. Augite: Detrital; subrounded; 0.14 x 0.08 mm.
2. Muscovite: Detrital; subangular and elongated; 0.12 x 0.07 mm to 0.04 x 0.02 mm.
3. Quartz: Detrital; subangular to subrounded; 0.08 x 0.07 mm to 0.02 x 0.02 mm.
4. Plagioclase: Detrital; subangular to subrounded; 0.07 x 0.05 mm to 0.02 x 0.02 mm.
5. Biotite: Detrital; subangular and elongated; 0.12 x 0.05 to 0.04 mm long.
6. Opaques: Detrital and secondary; subangular to subrounded; elongated opaques appear to be organic; 0.2 x 0.18 mm to 0.07 x 0.05 mm.

X-Ray Analysis of Well RRG1-6, Sample 7, at a Depth of 921 Meters

This sample is a laminated siltstone with well-sorted grains floating in a matrix of clay and ash. The matrix in some beds is altering to carbonate. Some of the beds have very few grains and are almost entirely matrix. A few glass shards are present and have completely altered to carbonate. Compaction is indicated by the orientation of elongated minerals parallel to the bedding. In one very fine-grained bed, an opaque horizon is present parallel to the bedding and may be secondary. All other grains present are detrital.

The rock consists of 17% quartz, 17% plagioclase, 10% muscovite, 8% opaque, 5% biotite, 19% matrix, and 24% carbonate.

Minerals

1. Quartz: Detrital; subangular to subrounded; 0.2 x 0.09 mm to 0.02 x 0.02 mm.
2. Plagioclase: Detrital; subangular to subrounded; 0.18 x 0.12 mm to 0.02 x 0.02 mm.

3. Muscovite: Detrital; subangular and elongated; 0.18 x 0.04 to 0.03 mm long.
4. Biotite: Detrital; subangular and elongated; 0.18 x 0.12 to 0.02 mm long.
5. Opaques: Detrital and secondary; subrounded to elongated; 0.18 x 0.12 mm to 0.02 x 0.02 mm.

X-Ray Analysis of RRG1-6, Sample 8, at a Depth of 922 Meters

This sample is a lithic wacke with very poorly sorted grains in a matrix of clay and ash. Much of the matrix is altering to carbonate. Glass shards are present and have also altered to carbonate. Rock fragments are volcanic rocks and quartzites with at least one welded tuff. Most volcanic rock fragments are altering to carbonate. Opaques occurring around grain boundaries and carbonate are the secondary minerals, with all other grains being detrital.

The rock consists of 8% quartz, 6% plagioclase, 1% microcline, 6% muscovite, 18% rock fragments, 8% opaques, 25% matrix, 28% carbonate, and a trace of zircon and biotite.

Minerals

1. Quartz: Detrital; subangular to subrounded; some grains are polycrystalline; 1.5 x 0.75 mm to 0.02 x 0.02 mm.
2. Plagioclase: Detrital; subangular to subrounded; 1.0 x 0.75 mm to 0.03 x 0.02 mm.
3. Microcline: Detrital; subangular to subrounded; 1.5 x 1.0 mm to 0.3 x 0.2 mm.
4. Biotite: Detrital; subangular to subrounded and elongated; 0.75 x 0.3 mm to 0.14 x 0.06 mm.
5. Muscovite: Detrital; subangular and elongated; 0.35 x 0.2 to 0.02 mm long.
6. Rock fragments: Subrounded; volcanic rocks and quartzites; 10.0 x 9.5 mm to 0.5 x 0.4 mm.
7. Zircon: Detrital; subangular; 0.04 x 0.03 mm.
8. Opaques: Detrital and secondary; subrounded; 0.3 x 0.3 mm to 0.1 x 0.06 mm; secondary opaques occur around grain boundaries.

X-Ray Analysis of Well RRG1-6, Sample 9, at a Depth of 939 Meters

This sample is a poorly sorted lithic arenite with angular grains and a small amount of ashy matrix. Some of the matrix is altering to carbonate cement and a few of the grains are rimmed with carbonate. Rock fragments consist of volcanic rocks, tuffs, quartzites, and sandstone. Some have almost completely altered to carbonate. All grains present are detrital. Carbonate occurs in two stages. One stage is rimming the grains and the other stage is cement.

The rock consists of 16% quartz, 15% plagioclase, 2% microcline, 3% biotite, 2% muscovite, 24% rock fragments, 5% opaques, 9% matrix, 24% carbonate, and a trace of monazite.

Minerals

1. Biotite: Detrital; subangular to subrounded and elongated; 1.2 x 0.75 mm to 0.3 x 0.1 mm; some are altering to carbonate and an opaque mineral.
2. Quartz: Detrital; subangular to subrounded; 2.0 x 1.0 mm to 0.1 x 0.09 mm.
3. Plagioclase: Detrital; subangular to subrounded; 3.0 x 2.0 mm to 0.1 x 0.09 mm.
4. Microcline: Detrital; subangular to subrounded; 0.35 x 0.2 mm to 2.25 x 0.75 mm.
5. Muscovite: Detrital; subangular and elongated; 0.75 x 0.1 mm to 0.08 x 0.04 mm.
6. Rock fragments: Subrounded; 4.5 x 3.0 mm to 1.0 x 1.0 mm.
7. Monazite: Detrital; subrounded; 0.18 x 0.12 mm.
8. Opaques: Detrital; subangular to subrounded; 0.75 x 0.75 mm to 0.2 x 0.18 mm.

X-Ray Analysis of Well RRG1-6, Sample 10, at a Depth of 939 Meters

This sample is a very poorly sorted lithic arenite with minor ashy matrix altering to carbonate. The grains and rock fragments are rimmed with carbonate. Glass shards present have completely altered to carbonate. Rock fragments consists of volcanic rocks, tuffs, quartzites, and carbonates. Carbonate is the only secondary mineral present with all other grains being detrital.

The rock consists of 21% plagioclase, 13% quartz, 7% opaques, 2% microcline, 1% muscovite, 1% biotite, 37% rock fragments, 18% carbonate, and a trace of monazite.

Minerals

1. Microcline: Detrital; subangular to subrounded; 1.2 x 1.2 mm to 0.18 x 0.15 mm.
2. Plagioclase: Detrital; subangular to subrounded; 2.25 x 0.75 mm to 0.18 x 0.18 mm.
3. Muscovite: Detrital; subangular and elongated; 0.75 x 0.1 to 0.06 mm long.
4. Monazite: Detrital; subangular; 0.35 x 0.2 mm.
5. Biotite: Detrital; subangular and elongated; 0.75 x 0.3 mm to 0.5 x 0.2 mm.
6. Rock fragments: Subrounded; 5.5 x 4.5 mm to 0.6 x 0.5 mm; many have altered to carbonate before deposition.
7. Quartz: Detrital; angular to subangular; 1.5 x 0.75 mm to 0.25 x 0.18 mm.
8. Opaques: Detrital; subrounded; 0.35 x 0.2 mm to 0.03 x 0.03 mm.

X-Ray Analysis of RRG1-6, Sample 11, at a Depth of 939 Meters

This sample is a lithic wacke with the matrix completely altered to carbonate. Rock fragments are mostly quartzites and volcanic rocks. Some have altered to carbonate. Two stages of carbonate formation are

present. One stage rims the rock fragments and the other replaces the matrix. Some opaques are also secondary and occur around grain boundary contacts. All other grains are detrital.

The rock consists of 10% quartz, 7% plagioclase, 3% microcline, 31% rock fragments, 4% opaques, 2% muscovite, 49% carbonate, and a trace of biotite and monazite.

Minerals

1. Quartz: Detrital; subangular to subrounded; 1.5 x 0.75 mm to 0.35 x 0.2 mm.
2. Plagioclase: Detrital; subangular to subrounded; 0.9 x 0.4 mm to 0.3 x 0.2 mm; some are poikilitic.
3. Microcline: Detrital; subangular to subrounded; 0.6 x 0.5 mm to 0.35 x 0.35 mm.
4. Monazite: Detrital; subangular; 0.08 x 0.07 mm.
5. Rock fragments: Subrounded; volcanic rocks and quartzites; 7.0 x 6.0 mm to 0.5 x 0.3 mm.
6. Muscovite: Detrital; subangular and elongated; 0.08 x 0.02 mm to 0.2 x 0.1 mm.
7. Biotite: Detrital; subangular and elongated; 0.5 x 0.4 mm to 0.2 x 0.02 mm.
8. Opaques: Detrital and secondary; subrounded; 0.2 x 0.2 mm to 0.02 mm x 0.02 mm; secondary opaques forming around grain boundaries.

X-Ray Analysis of Well RRG1-6, Sample 12, at a Depth of 940 Meters

This sample is a well-sorted siltstone with grains floating in a matrix of clay and ash. The matrix is partly altered to carbonate. Compaction is indicated by the orientation of elongated minerals. Carbonate cement is the only secondary mineral with all grains being detrital.

The rock consists of 30% quartz, 25% plagioclase, 6% muscovite, 4% microcline, 5% biotite, 7% opaques, 15% matrix, and 8% carbonate.

Minerals

1. Quartz: Detrital; subangular; 0.12 x 0.14 mm to 0.04 x 0.04 mm.
2. Plagioclase: Detrital; subangular to subrounded; 0.12 x 0.12 mm to 0.04 x 0.04 mm.
3. Muscovite: Detrital; subangular and elongated; 0.14 x 0.06 to 0.02 mm long.
4. Microcline: Detrital; subangular to subrounded; 0.14 x 0.09 mm to 0.07 x 0.07 mm.
5. Biotite: Detrital; subrounded and elongated; 0.2 x 0.06 to 0.02 mm long.
6. Opaques: Detrital; subangular to subrounded; 0.2 x 0.15 mm to 0.07 x 0.07 mm.

X-Ray Analysis of Well RRG1-6, Sample 13, at a Depth of 940 Meters

This sample is a massive siltstone with well-sorted grains floating in an ashy matrix. Part of the matrix has altered to carbonate. No bedding and no signs of compaction are present.

Carbonate and some opaques are the only secondary minerals with all other grains being detrital.

The rock consists of 29% plagioclase, 19% quartz, 5% microcline, 6% muscovite, 8% opaques, 22% matrix, 11% carbonate, and a trace of biotite and zircon.

Minerals

1. Quartz: Detrital; subangular to subrounded; 0.12 x 0.07 mm to 0.05 x 0.05 mm
2. Plagioclase: Detrital; subangular to subrounded; 0.36 x 0.36 mm to 0.04 x 0.03 mm.
3. Microcline: Detrital; subrounded to subangular; 0.4 x 0.3 mm to 0.14 x 0.12 mm.
4. Muscovite: Detrital; subangular and elongated; 0.14 mm long to 0.2 x 0.05 mm.
5. Zircon: Detrital; subangular; 0.04 x 0.04 mm.
6. Biotite: Detrital; subangular and elongated; 0.14 mm long.
7. Opaques: Detrital and secondary; 0.3 x 0.2 mm to 0.07 x 0.05 mm.

X-Ray Analysis of Well RRG1-6, Sample 14, at a Depth of 941 Meters

This sample is a laminated siltstone with well-sorted grains floating in an ashy matrix. Some of the matrix is altering to carbonate. Slight compaction is indicated by the orientation of elongated minerals. All grains are detrital with carbonate cement and a few opaques are secondary.

The rock consists of 21% plagioclase, 20% quartz, 6% muscovite, 6% opaques, 3% biotite, 34% matrix, and 10% carbonate.

Minerals

1. Muscovite: Detrital; subangular and elongated; 0.15 x 0.05 to 0.04 mm long.
2. Biotite: Detrital; subangular and elongated; 0.18 x 0.05 to 0.05 mm long; some grains are altering to chlorite.
3. Plagioclase: Detrital; subangular to subrounded; 0.18 x 0.06 mm to 0.04 x 0.04 mm.
4. Quartz: Detrital; subangular to subrounded; 0.15 x 0.12 mm to 0.04 x 0.03 mm.
5. Opaques: Detrital and secondary; subrounded; 0.25 x 0.2 mm to 0.05 x 0.04 mm.

X-Ray Analysis of Well RRG1-6, Sample 15, at a Depth of 941 Meters

This sample is a laminated shale with well sorted very fine-sized grains floating in a matrix of clay and ash. Part of the matrix is altering to carbonate. Slight compaction is indicated by the orientation of elongated minerals. All grains present are detrital.

The rock is composed of 10% quartz, 9% plagioclase, 6% opaques, 5% muscovite, and 70% matrix.

Minerals

1. Quartz: Detrital; subrounded to subangular; 0.07 x 0.07 mm to 0.02 x 0.02 mm.
2. Plagioclase: Detrital; subrounded to subangular; 0.08 x 0.05 mm to 0.02 x 0.02 mm.
3. Muscovite: Detrital; subangular and elongated; 0.12 mm long to 0.02 mm long.
4. Opaques: Detrital; subangular to subrounded; 0.07 x 0.07 mm to 0.02 x 0.02 mm.

X-Ray Analysis of Well RRG1-6, Sample 16; at a Depth of 941 Meters

This sample is a very poorly-sorted lithic arenite with a small amount of ashy matrix altering to carbonate. Grains present are very angular. Rock fragments consist of volcanic rocks and quartzites. All grains present are detrital.

The rock consists of 20% quartz, 20% plagioclase, 4% microcline, 2% muscovite, 1% biotite, 40% rock fragments, 5% matrix, 5% carbonate, 3% opaques, and a trace of monazite.

Minerals

1. Quartz: Detrital; subangular to subrounded; 0.75 x 0.5 mm to 0.2 x 0.2 mm.
2. Opaques: Detrital; subrounded; 0.35 x 0.2 mm to 0.07 x 0.04 mm.
3. Microcline: Detrital; subangular to subrounded; 1.5 x 0.75 mm to 0.6 x 0.3 mm.
4. Rock fragments: Subrounded; 4.0 x 1.5 mm to 0.8 x 0.5 mm.
5. Plagioclase: Detrital; subangular to subrounded; 1.0 x 0.8 mm to 0.15 x 0.15 mm; some poikilitic.
6. Monazite: Detrital; subangular; 0.08 x 0.08 mm.
7. Biotite: Green and brown; detrital; subangular to subrounded; 0.5 x 0.4 mm to 0.18 x 0.12 mm.
8. Muscovite: Detrital; subangular to subrounded; 1.5 x 0.3 mm to 1.8 x 0.09 mm.

APPENDIX B
WELL CONSTRUCTION

APPENDIX B

WELL CONSTRUCTION

Detailed well data on the seven deep wells drilled in the Raft River Geothermal Site from 1975 through 1978 are presented in the following figures. The Well Location Survey lists the exact location of each well as well as a summary of well construction and location figure.

The figures that follow are well construction diagrams as well as two- and three-dimensional deviation diagrams. The data in these figures are taken from Well Completion Reports prepared on each well. A list of these reports is provided at the end of this Appendix.

Raft River Well System

INEL-A-19 487

Figure B-1. Well construction and location of Raft River Exploration, Production, and Injection Wells.

INEL-A-19 458

Figure B-2. Well construction of RRGE-1.

Exploratory Well RRGE-1

All depths referenced to ground level

INEL-A-19 442

Figure B-3. Two-dimensional drilling deviation plot of well RRGE-1.

Figure B-4. Three-dimensional drilling deviation plot of well RRGE-1.

Figure B-5. Well construction of RRGE-2.

Figure B-6. Two-dimensional drilling deviation plot of RRGE-2.

Total depth surveyed (GL) 1825 m

Total depth (GL) (additional drilling) 1994 m

All depths referenced to ground level

INEL-A-19 461

Figure B-7. Three-dimensional drilling deviation plot of RRGE-2.

Figure B-8. Well construction of RRGE-3.

All depths referenced to ground level.

INEL-A-19 441

Figure B-9. Two-dimensional drilling deviation plot of RRGE-3.

Figure B-10. Three-dimensional drilling deviation plot of RRGE-3.

Not drawn to scale
INEL-A-19 533

Figure B-11. Well construction of RRG-4.

Figure B-12. Well construction of RRGP-4 after fracture treatment.

Figure B-13. Two-dimensional drilling deviation plot of RRGP-4.

Figure B-14. Three-dimensional drilling deviation plot of RRGP-4.

INEL-A-19 455

Figure B-15. Well construction plot of RRGP-5.

INEL-A-19 454

Figure B-16. Well construction RRG-5 after fracture treatment.

Figure B-17. Two-dimensional drilling deviation of RRGP-5.

	Leg A	Leg B
Total depth (GL)	1497 m	1501 m

INEL-A-19 460

Figure B-18. Three-dimensional drilling deviation plot of RRG-5.

Not drawn to scale

INEL-A-19 456

Figure B-19. Well construction of RRG1-6.

INEL-A-19 453

Figure B-20. Well construction of RRG1-7.

RAFT RIVER WELL LOCATIONS

All wells are in Township 15 South, Range 26 East, Boise Meridian, Cassia County, State of Idaho.

- RRGE-1: 620 m from South Line, 735 m from West Line in Section 23 (T15S, R26E, sec. 23) caa.
- RRGE-2: 75 m from North Line, 120 m from East Line in Section 23 (T15S, R26E, sec. 23) aca.
- RRGE-3: 594 m from North Line, 6 m from West Line in Section 25 (T15S, R26E, sec. 25) bdb.
- RRGI-4: 5 m from South Line, 652 m from West Line in Section 23 (T15S, R26E, sec. 23) cdd.
- RRGP-5: 436 m from South Line, 14 m from East Line in Section 22 (T15S, R26E, sec. 22) dad.
- RRGI-6: 535 m from North Line, 75 m from East Line in Section 25 (T15S, R26E, sec. 25) ada.
- RRGI-7: 426 m from South Line, 538 m from East Line in Section 25 (T15S, R26E, sec. 25) dbd.

REFERENCES

- B-1. Reynolds Electrical Engineering Company, Inc., Las Vegas, Nevada, *Completion Report, Raft River Geothermal Exploratory Hole No. 1 (RRGE-1)*, IDO-10062 (NVO-410-31), 1975.
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- B-3. H. H. Shoopman, *Completion Report-Raft River Geothermal Exploration Hole No. 3 (RRGE-3)*, IDO-10069, (NVO-410-40), 1977.
- B-4. S. M. Prestwich, *Drilling and Completion Report, Raft River Geothermal, Injection No. 4 (RRGI-4)*, TREE-1761, 1977.
- B-5. L. G. Miller and S. M. Prestwich, *Completion Report: Raft River Geothermal Production Well Five (RRGP-5)*, IDO-10082, 1979.
- B-6. L. G. Miller and S. M. Prestwich, *Completion Report: Raft River Geothermal Injection Well Six (RRGI-6)*, IDO-10083, 1979.
- B-7. L. G. Miller and S. M. Prestwich, *Completion Report: Raft River Geothermal Injection Well Seven (RRGI-7)*, IDO-10084, 1979.
- B-8. L. G. Miller and S. M. Prestwich, *Completion Report: Raft River Geothermal Production Well Four (RRGP-4)*, IDO-10081, 1979.

APPENDIX C
BOREHOLE GEOPHYSICAL LOGS

APPENDIX C

BOREHOLE GEOPHYSICAL LOGS

During the drilling of the seven geothermal wells at Raft River, commercial, United States Geological Survey, and EG&G Idaho, Inc. borehole geophysical logging was performed. Tables C-1 through C-7 list the date, type, and depth of coverage of the commercial logging performed for each well. Since commercial logs are given in English units, depths are given by footage.

Table C-1. RRG-1

<u>Date</u>	<u>Type</u>	<u>Depth (ft)</u>
01/09/75	Caliper	18 to 898
	Borehole volume integration	30 to 900
	Dual induction	33 to 900
02/02/75	Compensated neutron	880 to 4620
02/03/75	Sonic	350 to 4620
	Temperature	500 to 4620
	Temperature	800 to 4610
	Dual induction	888 to 4618
02/09/75	Temperature	875 to 4610
	Dual induction	870 to 4620
	Caliper	900 to 4617
02/24/75	Cement bond	1200 to 2830
04/06/75	Sonic	3592 to 5000
	Caliper	3000 to 5002
	Cement bond	2700 to 3650
	Compensated neutron	
	Formation density	2692 to 4992
	Temperature	0 to 5000
	Coriband	900 to 4600

Table C-2. RRG-2

Date	Type	Depth (ft.)
04/30/75	Caliper	17 to 900
	Temperature	30 to 899
05/12/75	Compensated sonic	870 to 4228
	Compensated neutron formation density	870 to 4247
	Temperature	780 to 4228
05/19/75	Continuous dipmeter	926 to 4142
05/21/75	Caliper	850 to 4232
	3-D Velocity Log	30 to 4232
06/03/75	Cement bond	0 to 4200
06/04/75	Cement bond	0 to 4806
06/09/75	"	"
06/12/75	"	"
06/27/75	Compensated sonic	4219 to 5997
	Compensated neutron formation density	4220 to 6003
	Temperature	4220 to 6004
	Dual induction	4215 to 5998

Table C-3. RRG-3

Date	Type	Depth (ft.)
03/30/76	Caliper	54 to 1412
	Acoustilog	25 to 1412
	Dual induction	140 to 1410
04/17/76	Caliper	1382 to 4212
	Compensated neutron	1385 to 4208
	Dual induction (focused)	1400 to 4211
	Densilog	1384 to 4211
	Acoustilog	1385 to 4201
04/23/76	Cement bond	1150 to 4232
05/01/76 to 05/03/76	Temperature	0 to 5868
	Acoustilog	4247 to 5856
	Dual induction (focused)	4247 to 5856
	Compensated neutron	4200 to 5856
	Densilog	4247 to 5863
	Temperature	0 to 5865

Table C-4. RRG1-4/RRGP-4

Date	Type	Depth (ft)
04/15/77 to 04/17/77	Compensated neutron	401 to 1909
	Densilog	400 to 1908
	Dual induction	403 to 1886
	Acoustilog	401 to 1901
09/27/78 to 09/29/78	Dual induction (focused)	1824 to 3460
	Caliper	1815 to 3464
	Acoustilog	1820 to 3448
	Densilog-neutron	1820 to 3456
	Differential temperature	0 to 3463
10/02/78	Cement bond	1450 to 3247
10/19/78 to 10/20/78	Densilog	3471 to 5221
10/20/78	Caliper	3459 to 5200
10/20/78	Compensated neutron	3474 to 5220
10/20/78	Dual induction (focused)	3450 to 5218
10/19/78	Temperature	3420 to 5230
	Differential temperature	5220
10/20/78	*Diplog	3467 to 5186
10/20/78	Acoustilog	3467 to 5208
11/13/78	High resolution Temperature	32 to 5128
	Dual induction	3471 to 5120
	Compensated sonic	3421 to 5113
	Full bore spinner	3376 to 4200
	Fracture I.D. Log	3470 to 5124
	Compensated neutron	3470 to 5120
	Formation density	
	4-arm caliper	3470 to 5124
	Directional	3470 to 5124

Table C-5. RRG-5

Date	Type	Depth (ft)
05/13/78 to 05/15/78	Temperature	50 to 1453
	Temperature	40 to 1514
	Cement bond	50 to 1453
	Caliper	120 to 1514
05/28/78 to 05/29/78	Dual induction (focused)	1510 to 3743
06/27/78	Dual induction	3160 to 3320
06/22/78	Differential temperature	70 to 3370
	Densilog-neutron	1508 to 3744
	Caliper	1509 to 3742
	Densilog	1508 to 3742
	Acoustilog	1508 to 3744
05/28/78	Differential temperature	10 to 3370
06/02/78	Epilog	1500 to 3750
09/13/78 to 09/15/78	BGT caliper	3394 to 4924
	High resolution temperature	30 to 4934
11/14/78	High resolution temperature	3300 to 4936
07/06/78 to 07/08/78	X-Y caliper	1500 to 4936
	Full bore spinner	1330 to 4908
	Full bore spinner	3380 to 4936
07/30/78	High resolution temperature	80 to 4908
	Temperature	300 to 4916
	Dual induction	3360 to 4930
	Compensated sonic	3370 to 4934
	Compensated neutron/ formation density	3396 to 4934
	Dual induction	1513 to 4919
	Compensated neutron/ formation density	1513 to 4919
	Compensation sonic	2903 to 4919
	Temperature	1500 to 4908

Table C-6. RRG1-6

Date	Type	Depth (ft)
04/16/78 to 04/17/78	Compensated neutron	100 to 2017
	Dual induction (focused)	90 to 2020
	Acoustilog	100 to 2011
	Temperature	4 to 2016
	Caliper	38 to 2018
	Epilog	120 to 2020
04/30/78	Differential temperature	1660 to 3782
	Acoustilog	1700 to 3773
	Dual induction (focused)	1700 to 3784
	Densilog-neutron	1700 to 3789
05/08/78	Epilog	2000 to 3790

Table C-7. RRG1-7

Date	Type	Depth (ft)
07/31/78 to 08/03/78	Epilog	150 to 3800
07/23/78 to 07/25/78	Acoustilog	160 to 2055
	Differential temperature	100 to 2054
	Caliper	10 to 2016
	Compensated neutron	160 to 2050
	Dual induction focused	150 to 2052
	Densilog	2049 to 3798
	Acoustilog	2050 to 3800
	Compensated neutron	160 to 2050
	Compensated neutron	2050 to 3789
	Differential temperature	2050 to 3800
11/14/78	High resolution temperature	34 to 3808
08/01/78	Dual induction	2050 to 3789

APPENDIX D

**CHEMICAL ANALYSES FROM WELLS
AT THE RAFT RIVER GEOTHERMAL SITE**

APPENDIX D

CHEMICAL ANALYSES FROM WELLS AT THE RAFT RIVER GEOTHERMAL SITE

This appendix contains a listing of chemical analyses from the geothermal and monitor wells at the Raft River KGRA. Samples were collected using a number of different sampling methods by personnel whose training ranged from none to extensive. Earlier analyses were not covered by a quality control program, and many of the variations are due to collection and analytical problems rather than actual changes in ground-water chemistry. The following data have been reviewed, and values that showed marked departures from the general trends were deleted. Since October 1980, the analyses have been reviewed for internal consistency based on the charge balance between cations and anions, and the ratio of ionic charge to specific conductance (SPC). Additional discussion of the sampling program and evaluation of the analytical labs can be found in Reference D-1.

Each well is identified by well identification, location, latitude, longitude, well type, and well depth. The following units in the figures are used for presenting data: meters for depth; mg/L for concentrations of the indicated species except as follows; degrees centigrade for temperature, mg/L as CaCO_3 for alkalinity and hardness; μS for specific conductance; and units for pH.

The laboratory codes stand for the following analytical labs:

EI: Energy Incorporated, Idaho Falls, Idaho

IDWR: Idaho Department of Water Resources

INEL: Idaho National Engineering Laboratory

RR: Various generations of Raft River Laboratories at the KGRA Site

USGS: United States Geological Survey

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGE-1	B15S26E23CAA	0420609	1132301	GTHRML PROD	1521

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
USGS	02 06 76	43.00	140.00	56.00	40.00		52.00	7.30
		90.00	1800.00	.20		130.00		66.00
			8.20	550.00			920.00	
RR	05 01 78	45.68	110.00					5.69
		2800.00					800.00	
			8.37					
RR	05 08 78	20.70	120.00					7.75
		2800.00					705.00	
			7.80					
RR	05 15 78	40.92	110.00					7.55
		3000.00					750.00	
			6.95					
RR	05 22 78	44.60	112.00					9.05
		2900.00					750.00	
			7.67					
RR	05 30 78	35.60	115.00					8.96
		2800.00					725.00	
			8.46					
RR	06 05 78		115.00					8.37
		3000.00					855.00	
RR	06 12 78		120.00					8.21
		3000.00					755.00	
			8.40					
RR	06 19 78		110.00					7.80
		2600.00					800.00	
			8.40					

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGE-1	B15S26E23CAA	0420609	1132301	GTHRML PROD	1521

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
RR	06 26 78	20.00 2950.00	130.00 8.25				750.00	8.03
RR	07 03 78	22.08 3400.00	110.00 8.25				800.00	
RR	07 10 78	3250.00	117.00 8.20				800.00	7.32
RR	07 17 78	32.48 2900.00	110.00 8.40				800.00	7.71
RR	07 24 78	41.40 2900.00	100.00 8.46				775.00	9.31
RR	07 31 78	36.92 2800.00	125.00 8.65				750.00	7.83
RR	08 07 78	44.32 2800.00	150.00 8.48				760.00	8.62
RR	08 21 78	36.08 3550.00	144.50 8.47				892.00	
RR	08 28 78	39.92 3000.00 94.00	125.00 8.30				814.00	

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGE-1	B15S26E23CAA	0420609	1132301	GTHRML PROD	1521

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
RR	09 11 78	39.24 3000.00 90.00	130.00 7.90				885.00	7.84
RR	09 21 78	32.48 2800.00 91.00	150.00 8.50				740.00	8.28
RR	09 25 78	42.36 3000.00 91.00	144.00 8.74				843.00	8.08
RR	10 02 78	51.12 2900.00 95.00	148.00 8.87				848.00	7.98
RR	10 09 78	47.20 2800.00 87.50	119.00 8.10				743.00	5.98
USGS	10 13 78	42.00 3000.00 91.00	140.00 1740.00	54.00 .10 530.00	39.00 1.80	140.00	51.00 870.00	8.00 67.00
RR	10 16 78	38.80 3100.00 91.00	142.00 8.25				872.00	7.75
RR	10 23 78	39.80 3900.00 93.00	150.00 8.25				853.00	6.48
INEL	11 12 78	33.20 2980.00	1656.00	56.00 1.00 466.00	34.00 1.40 1.60	137.00	830.00	5.58 45.00

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGE-1	B15S26E23CAA	0420609	1132301	GTHRML PROD	1521

SAMPLE-LAB	DATA-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
INEL	11 12 78	34.60 3000.00	1658.00	50.00 .18 472.00	32.00 1.40 1.60	137.00	834.00	5.78 35.80
RR	11 27 78	41.84 2900.00 90.00	140.00 8.07				924.00	8.05
RR	12 04 78	45.20 2900.00	144.00 8.20	582.00			843.00	7.42
RR	12 11 78	48.80 2800.00	153.00 8.45	537.00			957.00	8.32
RR	12 18 78	44.20 2900.00	158.00 8.50	510.00			1000.00	8.41
RR	12 25 78	42.40 2700.00	136.00 8.30	615.00			1010.00	6.55
RR	01 22 79	42.20 2700.00	150.00 8.30	497.00			954.00	7.78
RR	01 29 79	37.92 2800.00	148.00 8.30	492.00			1070.00	7.78
RR	02 05 79	43.20 2900.00	152.00 8.20	518.00			1000.00	7.73

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGE-1	B15S26E23CAA	0420609	1132301	GTHRML PROD	1521

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
RR	02 12 79	38.00 3000.00	130.00 8.30	551.00			965.00	8.09
RR	02 19 79	37.12 3000.00	8.30	540.00			894.00	7.91
RR	04 09 79	38.20 2700.00	130.00 8.15	543.00			935.00	7.94
RR	04 16 79	59.00 2700.00	136.00 8.40	513.00			937.00	7.59
RR	04 23 79	36.80 2700.00	140.00 8.20	510.00			915.00	7.75
RR	04 30 79	40.40 3000.00	132.00 7.60	489.00			730.00	6.56
RR	05 07 79	49.60 2000.00	120.00 7.70	376.00			623.00	8.85
RR	05 14 79	44.20 2000.00	7.80	380.00			644.00	8.62

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGE-2	B15S26E23AAA	0420627	1132228	GTHRML PROD	1994

SAMPLE-LAB	DATA-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
USGS	10 23 75	52.00 1880.00 85.00	110.00 1380.00 8.10	43.00 1.00 400.00	37.00	140.00	63.00 680.00	9.10 40.00 .04
USGS	10 06 76	48.00 2300.00 62.00	88.00 1240.00 5.90	35.00 .10 370.00	32.00 .73 1.10	150.00	59.00 570.00	10.00 46.00 .13
INEL	03 21 77	41.40 2900.00 132.78		44.00 .20 412.00	34.00 .80 1.20	150.00	665.00	10.00
RR	05 30 78	46.40 2200.00	75.00 7.55				550.00	10.46
RR	06 05 78	2400.00	85.00				600.00	9.02
INEL	11 12 78	42.00 2160.00	1206.00	32.00 .46 336.00	32.00 .80 1.00	158.00	592.00	55.60
RR	11 27 78	37.16 2300.00 87.00	104.00 8.75				772.00	10.40
RR	12 04 78	43.40 1780.00 77.00	90.00 7.55	303.00			565.00	11.10
RR	12 11 78	46.80 1900.00 76.50	82.00 7.65	324.00			513.00	11.40

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGE-2	B15S26E23AAA	0420627	1132228	GTHRML PROD	1994

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	12 18 78	43.80 1800.00 74.00	88.00 7.60	314.00			567.00	11.50
INEL	01 15 79	41.60 2400.00	 7.55	36.00 .88 426.00	36.00 1.20 1.10	110.00	645.00	6.50 56.10 1.05
INEL	01 15 79	34.90 2400.00	 7.26	34.00 .57 449.00	36.00 1.20 1.10	120.00	659.00	6.80 52.80 .13
INEL	01 15 79	83.30 2390.00	 7.33	34.00 .43 428.00	36.00 1.20 1.20	120.00	654.00	6.80 47.60 3.09
INEL	01 20 79	45.20 2751.00	1234.00	30.00 .22 365.00	 1.10	158.00	629.00	9.50 47.40
INEL	01 20 79	51.20 2733.00	1299.00	29.50 .14 371.00	 1.10	173.00	574.00	10.10 49.30
RR	01 22 79	69.72 2300.00	122.00 8.90	420.00			746.00	9.52
RR	02 05 79	41.68 2200.00	88.00 8.50	384.00			725.00	10.20
RR	02 12 79	52.00 2500.00	100.00 8.40	419.00			889.00	9.47

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGE-2	B15S26E23AAA	0420627	1132228	GTHRML PROD	1994

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
RR	02 19 79	37.00 2800.00	100.00 8.80	392.00			718.00	9.19
RR	04 09 79	2400.00	102.00 7.15	438.00			729.00	8.73
INEL	04 12 79	23.90 2450.00	1322.00 7.52	49.00 .14 511.00	37.80 2.10 1.30	150.00	682.00	8.65 50.00 2.50
INEL	04 12 79	74.80 2520.00	1296.00	46.00 .10 416.00	38.40 1.40 1.20	163.00	680.00	8.48 56.00 2.50
INEL	04 12 79	72.80 2510.00	1288.00	46.00 .16 466.00	38.20 1.80 1.20	154.00	676.00	9.00 54.00 2.50
RR	05 14 79	42.40 2000.00	114.00 7.60	415.00			681.00	8.09
RR	05 28 79	40.76 2400.00	100.00 7.90	422.00			722.00	8.77

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGE-3	B15S26E25BDD	0420526	1132147	GTHRML PROD	1789

LAB	SAMPLE-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
INEL	02 01 77	33.20	4160.00	198.00	96.00	180.00		4.80
		137.78		1182.00	2.20		2168.00	64.20
INEL	02 01 77	30.40	4160.00	182.00	102.00	188.00		4.40
		137.78		1178.00	2.20		2124.00	65.00
INEL	06 10 77	25.60	4780.00	200.00	94.00	188.00		4.80
		8960.00		1254.00	5.40		2240.00	66.00
		141.11			3.40			
INEL	06 10 77	25.60	4740.00	186.00	102.00			4.60
		8960.00		1228.00	5.00		2220.00	66.00
		146.67			3.20			
INEL	07 21 77	26.00	4460.00	202.00	110.00	163.00		5.12
		137.78		1330.00	5.00		2280.00	67.20
					3.40			
INEL	07 21 77	26.00	4600.00	200.00	106.00	128.00		5.28
		143.33		1348.00	5.40		2280.00	68.60
					3.60			
INEL	07 21 77	23.60	4380.00	196.00	98.00	145.00		4.88
		143.33		1282.00	5.00		2300.00	56.20
					3.40			
INEL	07 21 77	26.80	4840.00	204.00	106.00	145.00		5.22
		143.33		1360.00	5.20		2340.00	67.00
					3.60			
INEL	07 21 77	7466.00	4520.00					
		143.33						

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGE-3	B15S26E25B00	0420526	1132147	GTHRML PRDD	1789

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
INEL	07 21 77	9740.00 143.33	4660.00					
INEL	07 21 77	9960.00 143.33	4480.00					
RR	05 01 78	8150.00	551.00 7.05				2260.00	5.59
RR	05 30 78	34.08 10900.00	595.00 7.95				3305.00	7.96
RR	06 05 78	8600.00	550.00				2775.00	6.92
RR	06 12 78	9000.00	565.00 7.30				2700.00	6.80
RR	06 19 78	8600.00	565.00 7.25				2700.00	6.55
RR	06 26 78	26.80 8500.00	525.00 8.10				2650.00	6.73
RR	10 09 78	26.40 8000.00	584.00 8.20				2560.00	5.12

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGE-3	B15S26E25BDD	0420526	1132147	GTHRML PROD	1789

LAB	SAMPLE-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
INEL	11 12 78	25.80 8000.00	4300.00	258.00 1.08 1240.00	102.00 5.20 2.40	163.00	2152.00	3.74 44.60
INEL	11 12 78	25.80 8000.00	4360.00	246.00 1.06 1250.00	104.00 5.20 2.40	167.00	2080.00	3.66 42.40
RR	11 27 78	27.16 6800.00 75.00	568.00 7.44				2280.00	5.24
RR	12 04 78	26.00 6800.00 72.00	568.00 6.70	1190.00			2500.00	5.17
RR	12 11 78	27.00 6700.00 77.00	472.00 7.00	1220.00			2190.00	5.10
RR	12 18 78	26.16 6800.00 77.00	560.00 6.85	1150.00			2740.00	5.08
RR	12 25 78	28.00 6900.00 70.00	566.00 6.90	1380.00			2720.00	4.28
INEL	01 20 79	39.40 8866.00	4123.00	175.00 .46 1194.00	105.00 3.20	173.00	2261.00	4.90 60.90
INEL	01 20 79	36.10 8866.00	4096.00	178.00 .51 1178.00	105.00 3.20	160.00	2266.00	4.90 60.10

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGE-3	B15S26E25BDD	0420526	1132147	GTHRML PROD	1789

SAMPLE-LAB	DATA-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	01 22 79	48.80 6900.00	564.00 7.10	1200.00			2540.00	4.92
RR	01 29 79	26.92	558.00 6.90	1100.00			2720.00	4.86
RR	02 05 79	26.76 6700.00	554.00 7.00	1150.00			3150.00	4.69
RR	02 12 79	26.40 7800.00	540.00 6.80	1160.00			3110.00	4.69
RR	02 19 79	26.84 7900.00	224.00 7.90	1100.00			3650.00	4.61

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGI-6	B15S26E25ADA	0420526	1132116	GTHRML INJ	1176

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	05 15 78	50.44 9800.00	410.00 7.45				3045.00	6.25
RR	05 30 78	60.32 10500.00	393.00 7.27				3150.00	8.46
RR	06 12 78	10900.00	427.00 7.30				3300.00	8.16
INEL	11 12 78	61.60 11600.00	6420.00	214.00 1.38 2020.00	32.00 8.00 5.00	94.00	3576.00	5.74 66.40
INEL	11 12 78	62.40 11600.00	6340.00	184.00 1.36 2020.00	32.00 8.00 5.20	94.00	3696.00	5.78 53.00
RR	11 27 78	60.08 10700.00 72.00	436.00 7.60				3970.00	7.54
RR	12 04 78	50.60 10200.00 70.00	438.00 7.10	2200.00			3810.00	7.11
RR	12 11 78	65.08 10200.00 77.00	420.00 7.10	2200.00			3930.00	7.56
RR	12 16 78	60.00 10300.00 77.00	442.00 7.35	2120.00			4200.00	7.58

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGI-7	B15S26E25DBD	0420506	1132129	GTHRML INJ	1185

SAMPLE-DATE		PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
LAB	DATE	ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
INEL	08 07 78	21.40 12000.00	7440.00	350.00 1.60 2200.00		79.00	4170.00	4.80 38.00
INEL	08 07 78	30.80 12000.00		280.00 1.50 2000.00		88.00	4000.00	5.10 89.00

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGP-4	B15S26E23CDD	0420558	1132310	GTHRML PROD	866

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
INEL	05 27 77	52.40 4150.00	2050.00 8.00				892.00	7.80
INEL	05 27 77	58.00 4760.00	2120.00				906.00	8.40
INEL	11 08 77	24.30 7220.00 111.11	4498.00 7.39	140.00 .23 1490.00	28.00 6.30 2.80	109.00 1.16	2640.00	4.51 61.20
INEL	11 08 77	23.90 7330.00 111.11	4448.00 7.39	160.00 .15 1560.00	28.00 6.40 3.40	96.00 1.01	2510.00	4.54 61.00
INEL	11 08 77	23.20 7620.00 111.11	4744.00	144.00 .15	6.60	103.00 .98		78.00
INEL	11 08 77	25.40 7620.00 111.11	4626.00	142.00 .16		107.00 .98		78.00
RR	09 25 78	26.40 7400.00	404.00 8.08				2590.00	5.96

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGP-4	B15S26E23CDD	0420558	1132310	GTHRML PROD	1654

LAB	SAMPLE-DATE DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
RR	10 16 78	63.72	238.00					6.87
			8.87				1490.00	
RR	10 23 78	65.20	254.00					7.03
		5000.00	8.80				1310.00	
RR	11 27 78	36.00	224.00					6.67
		4400.00	7.00				1670.00	
RR	12 04 78	34.48	230.00					6.23
		4300.00	7.30	805.00			1400.00	
RR	12 11 78	36.60	222.00					6.72
		4100.00	7.30	728.00			1400.00	
RR	12 18 78	32.50	204.00					6.98
		4000.00	7.40	710.00			1620.00	
RR	12 25 78	34.64	196.00					5.54
		4000.00	7.50	878.00			1560.00	
RR	01 22 79	32.36	220.00					6.27
		4000.00	7.20	741.00			1750.00	
RR	01 29 79	35.20	213.00					6.45
		3550.00	7.20	707.00			1780.00	

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGP-4	B15S26E23CDD	0420558	1132310	GTHRML PROD	1654

LAB	SAMPLE-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	02 05 79	33.24 4400.00	204.00 7.10	759.00			1820.00	6.30
RR	02 12 79	33.20 4200.00	224.00 7.20	756.00			1710.00	6.13
RR	02 19 79	39.04 4100.00	212.00 7.00	695.00			1670.00	6.32

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGP-5	B15S26E23CBD	0420552	1132331	GTHRML PROD	1497

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	06 05 78	3700.00	120.00				975.00	8.12
RR	06 12 78	2800.00	160.00				725.00	11.80
			8.25					
RR	06 19 78	2150.00	100.00				900.00	8.70
			8.10					
INEL	11 12 78	40.80		46.00	32.00			6.22
		2860.00	1416.00	.58	1.20	137.00	602.00	45.60
					1.60			
INEL	11 12 78	39.20		54.00	36.00			6.16
		2800.00	1598.00	.50	1.20	141.00	582.00	33.80
					1.60			
RR	12 04 78	45.12	139.00					8.15
		2800.00						
		67.50	7.50	439.00				
RR	12 11 78	54.40	132.00					8.38
		2500.00						
		57.00	7.50	454.00			734.00	
RR	12 18 78	44.88	142.00					8.64
		2550.00						
		67.50	7.50	442.00			926.00	
RR	12 25 78	46.00	136.00					8.72
		2400.00						
		69.00	7.65	419.00			817.00	

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGP-5	B15S26E23CBD	0420552	1132331	GTHRML PROD	1497

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	01 22 79	51.60 2600.00	156.00 7.50	414.00			850.00	7.72
RR	01 29 79	44.24 2500.00	102.00 7.30	418.00			987.00	8.20
RR	02 19 79	44.52 2600.00	114.00 7.35	431.00			853.00	7.94
RR	04 23 79	39.20 2400.00	120.00 6.95	423.00			740.00	7.56
RR	04 30 79	39.40 2400.00	130.00 8.00	425.00			754.00	7.72
RR	05 07 79	39.92 2400.00	130.00 8.60	450.00			802.00	7.50
RR	05 14 79	50.80 2400.00	110.00 7.45	478.00			839.00	7.71
RR	05 28 79	72.20 2400.00	114.00 7.20	472.00			820.00	7.08
INEL	05 31 79	28.90 2690.00	1660.00 6.90	41.00 .09 484.00	31.00 1.20 1.40	122.00	800.00	7.20

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
RRGP-5	B15S26E23CBD	0420552	1132331	GTHRML PROD	1497

SAMPLE-DATA LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SIO2	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	03 11 81	2550.00	110.00	42.00 1.90	51.00	185.00	92.00	7.00
RR	03 12 81	2600.00	108.00 7.05	43.00 1.00	49.00	190.00	65.00 840.00	8.80
RR	03 16 81	2200.00	109.00	43.00 1.20	48.00	165.00	65.00 900.00	9.00

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
BLM	B15S26E23BBC	0420628	1132327	UNUSED	126

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
USGS	02 18 70	39.00 3020.00 95.00	130.00 1650.00 7.90	51.00 .20 541.00	20.00 1.00	80.00 .24	47.00 869.00	7.80 56.00 1.50
USGS	05 18 72	45.00 3050.00 93.00	130.00 1720.00 7.40	53.00 .40 560.00	22.00	90.00	55.00 900.00	5.70 57.00
USGS	08 24 72	42.00 3030.00 95.00	130.00 1640.00 7.40	51.00 .20 510.00	20.00 1.00 1.00	81.00 .30	51.00 880.00	69.00
INEL	03 27 78	39.00	1810.00	50.00 .30 580.00	25.00 1.40 1.50	73.00	930.00	5.80 54.30
RR	05 01 78	43.60 3100.00	115.00 7.60				895.00	6.49
RR	05 08 78	8.58 3200.00	115.00 7.79				850.00	6.75
RR	05 15 78	38.00 3250.00	123.00 7.60				850.00	7.35
RR	05 30 78	36.40 3250.00	120.00 7.77				850.00	9.16
RR	06 12 78	3050.00	152.00 8.10				865.00	9.61

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
BLM	B15S26E23BBC	0420628	1132327	UNUSED	126

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	06 19 78	2600.00	125.00 7.70				810.00	7.75
RR	06 26 78	12.60 2900.00	120.00 7.45				800.00	8.03
RR	06 26 78	2900.00					800.00	
RR	06 28 78	3100.00					800.00	
RR	06 29 78	3000.00					875.00	
RR	06 30 78	3000.00					850.00	
RR	07 03 78	23.20 3100.00	135.00 7.70				850.00	
RR	07 07 78	3100.00					850.00	
RR	07 08 78						800.00	

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
BLM	B15S26E23B8C	10420628	1132327	UNUSED	126

SAMPLE-DATE LAB DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
	ALK	HARD	CA	K		HCO3	F
	SPC	TDS	MG	SR	SI02	CO3	SO4
	TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR 07 10 78	3450.00	120.00 7.50				855.00	7.07
RR 07 10 78	3450.00					855.00	
RR 07 12 78	3000.00					825.00	
RR 07 17 78	35.28 3000.00	120.00 7.17				800.00	8.21
RR 07 18 78	3000.00					800.00	
RR 07 24 78	37.60 3000.00	120.00 7.35				825.00	8.01
RR 07 26 78	36.04 2900.00	121.00 7.32				810.00	7.76
IDWR 07 27 78	45.52 3000.00 94.30	7.73	51.70 .85 552.45	21.11 .37	76.00	55.53 887.92	7.80 57.64
RR 07 31 78	38.72 3100.00	7.42				800.00	8.13

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
BLM	B15S26E238BC	10420628	11132327	UNUSED	126

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
RR	08 07 78	42.40 2900.00	170.00 7.10				810.00	7.91
RR	08 21 78	39.44 3300.00	135.00 7.34				898.00	8.20
RR	09 11 78	35.16 3000.00 90.00	130.00 7.35				560.00	7.65
RR	09 21 78	40.68 3200.00 89.50	160.00 7.72				872.00	7.68
RR	09 25 78	37.00 3100.00 91.00	140.00 7.75				941.00	7.54
RR	10 02 78	39.84 3300.00 91.00	146.00 8.00				915.00	7.63
RR	10 09 78	36.24 3500.00 93.00	154.00 7.82				881.00	6.68
RR	10 16 78	40.40 3400.00 93.00	154.00 8.05				976.00	7.10
RR	10 23 78	39.20 3400.00 93.11	142.00 8.00					6.87

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
BLM	B15526E238BC	0420628	1132327	UNUSED	126

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SIO2	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	11 27 78	38.60 3400.00 92.00	168.00 7.75				1040.00	7.86
RR	12 04 78	38.72 3300.00 88.00	172.00 7.80	500.00				7.53
RR	12 11 78	41.88 3000.00 91.00	162.00 7.80	646.00			920.00	7.59
RR	12 18 78	38.48 3200.00 91.00	140.00 8.05	586.00			942.00	7.76
RR	12 25 78	37.80 3500.00 92.50	156.00	536.00			1030.00	7.84
USGS	01 17 79	3230.00						
RR	01 29 79	40.88 2800.00	160.00 7.80	524.00			1160.00	7.35
INEL	02 06 79	40.20 3200.00	1830.00 7.76	44.00 .68 577.00	21.00 1.50 1.40	68.00	950.00	5.30 64.90 .07
RR	02 19 79	38.48 3100.00	156.00 7.70	541.00			1120.00	8.05

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
BLM	B15S26E2388C	0420626	1132327	UNUSED	126

SAMPLE-LAB	DATA-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
USGS	03 21 79	3050.00						
RR	04 09 79	45.20 2900.00	124.00 7.75	586.00			864.00	7.30
RR	04 16 79	37.52 2900.00	138.00 7.60	534.00			1000.00	7.21
USGS	04 18 79	2460.00 94.00						
RR	04 23 79	38.48 2800.00	132.00 7.70	635.00			946.00	7.17
RR	04 30 79	38.60 2800.00	130.00 7.60	520.00			912.00	6.70
RR	05 07 79	39.92 2800.00	164.00 7.50	548.00			970.00	7.02
RR	05 14 79	36.80 2600.00	142.00 8.00	590.00			974.00	7.75
RR	05 14 79	41.40 2600.00	7.30	590.00			959.00	8.45

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
BLM	B15S26E238BC	0420628	1132327	UNUSED	126

SAMPLE-LAB	DATA-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
USGS	05 17 79	2930.00 94.00						
RR	05 28 79	41.84 2900.00	146.00 7.60	548.00			991.00	7.04
USGS	06 18 79	3140.00 94.00						
USGS	08 28 79	3000.00 76.00						
USGS	09 26 79	2930.00 94.00						
USGS	10 24 79	2680.00 94.50						
USGS	11 17 79	2560.00 94.50						
USGS	12 19 79	3110.00 94.50						
USGS	01 18 80	2710.00 92.50						

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
BLM	B15S26E2388C	0420628	1132327	UNUSED	126

LAB	SAMPLE-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	12 09 80	40.00	130.00	53.00	21.00		49.00	6.70
		3500.00		.24		106.00		51.00
		94.00		464.00			893.00	
RR	03 31 81	40.00	130.00	71.00	27.00		50.00	3.40
		2950.00		.22		101.00		60.00
		93.00	8.10	495.00			880.00	
EI	06 10 81	43.00	125.00	58.00	19.00		52.00	6.80
		3200.00		.26		79.00		56.00
		92.00	7.40	560.00			950.00	

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
CRGOK	B15S26E23DDC	0420549	1132238	GTHRML PROD	165

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
USGS	05 18 72	30.00 6090.00 90.00	330.00 3360.00 7.70	130.00 .40 1100.00	35.00 2.00	97.00	36.00 1900.00	61.00 2.50
USGS	08 24 72	27.00 6080.00 93.00	300.00 3720.00 7.90	120.00 .30 1000.00	29.00 2.00	91.00 1.40	33.00 1900.00	60.00
INEL	03 27 78	42.00	2280.00	110.00 1.10 1039.00	35.00 2.80 2.50	86.00	1682.00	5.80 56.30
RR	05 01 78	34.40 5750.00	285.00 8.10				1755.00	5.59
RR	05 08 78	5.52 5700.00	302.00 8.10				1655.00	6.75
RR	05 15 78	30.88 5650.00	310.00 7.20				1795.00	6.65
RR	05 22 78	34.60 5800.00	295.00 7.45				1750.00	8.05
RR	05 30 78	27.60 5900.00	271.00 7.95				1755.00	8.76
RR	06 12 78	5800.00	320.00 8.20				1705.00	7.16

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
CROOK	B15S26E23DDC	0420549	1132238	GTHRML PROD	165

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SIO2	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
RR	06 19 78	5350.00	302.00					7.20
			8.20				1800.00	
RR	06 26 78	8.40 5700.00	305.00					7.93
			7.85				1750.00	
RR	06 26 78	5700.00					1750.00	
RR	06 28 78	5800.00					1750.00	
RR	06 29 78	5800.00					1750.00	
RR	06 30 78	5800.00					1750.00	
RR	07 03 78	18.72 6200.00	290.00					
			8.25				1750.00	
RR	07 07 78	6200.00						
RR	07 08 78	6100.00					1750.00	

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
CROOK	B15S26E23DDC	0420549	1132238	GTHPML PROD	165

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HC03	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	07 10 78	6200.00	285.00 7.90				1750.00	6.67
RR	07 10 78	6200.00					1750.00	
RR	07 12 78	5900.00					1800.00	
RR	07 17 78	26.24 5900.00	270.00 8.00				1800.00	7.51
RR	07 18 78	5900.00					1800.00	
RR	07 24 78	28.00 5650.00	305.00 7.75				1725.00	7.51
RR	07 26 78	26.08 5800.00	288.00 7.65				1700.00	7.06
IDWR	07 27 78	38.51 5800.00 96.50	8.06	127.65 .85 1016.60	32.06 2.60	70.00	46.98 1865.20	6.20 55.71
RR	07 31 78	26.92 5700.00	290.00 7.75				1700.00	7.75

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
CROOK	B15526E23DDC	0420549	1132238	GTHRML PROD	165

SAMPLE-LAB	DATA-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
RR	08 07 78	29.28 5750.00	305.00 7.88				1800.00	7.61
RR	08 21 78	20.00 6000.00	315.00 8.00				1922.00	7.40
RR	08 28 78	27.40 5500.00 28.00	310.00 7.84				1914.00	
RR	09 11 78	28.32 6000.00 92.00	310.00 7.50				2260.00	6.34
PR	09 21 78	30.48 5600.00 74.00	335.00 7.50				1650.00	6.21
RR	09 25 78	37.20 5700.00 88.00	310.00 8.00				1940.00	6.13
RR	10 02 78	34.40 5750.00 94.00	316.00 8.28				1740.00	6.05
RR	10 09 78	29.00 5700.00 95.00	318.00 8.25				1580.00	5.25
RR	11 27 78	52.20 5100.00 79.00	306.00 7.49				1770.00	5.81

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
CROOK	B15S26E23DDC	0420549	1132238	GTHRML PROD	165

SAMPLE-DATE		PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
LAB	DATE	ALK	HARD	CA	K	SI02	HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	12 04 78	53.16 4700.00 77.00	322.00 7.40	791.00			1760.00	5.64
RR	12 11 78	54.00 5600.00 77.00	296.00 7.75	879.00			1760.00	5.85
RR	12 18 78	51.64 4500.00 77.00	296.00 8.10	929.00			1540.00	6.05
RR	02 19 79	32.72 5500.00	318.00 7.80	943.00			2220.00	9.30
RR	04 09 79	33.80 4900.00	298.00 7.50	1050.00			1820.00	5.87
RR	04 16 79	29.44 5000.00	318.00 8.10	1020.00			2040.00	5.95
RR	04 23 79	31.72 5000.00	326.00 7.80	1020.00			1950.00	5.68
RR	04 30 79	34.00	318.00 7.50	1060.00			1920.00	5.26
RR	05 07 79	33.20 5000.00	320.00 8.00	1070.00			1990.00	5.68

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
CROOK	B15S26E23DDC	0420549	1132238	GTHRML PROD	165

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	05 14 79	31.92 4900.00	312.00 8.35	1040.00			1780.00	5.40
RR	05 14 79	28.40 4800.00	308.00 8.45	1130.00			2040.00	6.60
RR	05 28 79	35.36 5000.00	328.00 8.10	1080.00			2090.00	5.79
RR	12 09 80	34.00 6200.00 95.00	320.00	121.00 .42 1032.00	33.00	99.00	42.00 1823.00	5.40 48.00
RR	03 31 81	35.00 6000.00 95.00	330.00 8.15	150.00 .43 1032.00	33.00	109.00	44.00 1900.00	3.00 69.00
RR	05 20 81	5100.00 96.00	280.00 8.30	110.00 .50		97.00		
RR	05 20 81	5300.00 96.00	284.00 8.30	110.00 1.00		98.00	1860.00	
EI	06 10 81	30.00 6100.00 96.00	320.00 7.90	130.00 .36 1070.00	28.00	89.00	37.00 2010.00	5.60 66.00

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
MW-1	B15S26E23CDD	0420552	1132305	MONITOR	399

SAMPLE-DATE LAB DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
	ALK	HARD	CA	K		HCO3	F
	SPC	TDS	MG	SR	SI02	CO3	SO4
	TEMP(C)	PH	NA	LI	NH4	CL	NO3
EI 03 17 78	14.00 12250.00	6320.00 9.15	171.00 .42 2204.00	36.40 3.76		38.00 3544.00	72.00 .25
EI 03 30 78	22.00 12250.00	6360.00 8.31	166.00 .36 2140.00	30.40 3.74		2.00 3644.00	2.50 59.00 2.60
EI 03 30 78	23.00 12400.00	6379.00 7.72	167.00 .42 2233.00	30.50 3.76	32.00	3594.00	2.40 62.00 .80
RR 05 01 78	36.00 10900.00	490.00 8.50				3575.00	5.09
RR 05 08 78	5.00 11000.00	479.00 8.15				3600.00	5.55
RR 05 15 78	24.28 11000.00	495.00 7.10				3550.00	5.55
RR 05 22 78	22.40 11000.00	470.00 7.25				3500.00	6.55
RR 05 30 78	23.60 11150.00	482.00 7.95				3500.00	7.16
RR 06 26 78	10.93 10900.00	470.00 7.75				3560.00	

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
MW-1	B15S26E23CDD	0420552	1132305	MONITOR	399

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
EI	06 30 78	36.00 10000.00	6359.00 7.96	214.00 3.90 1839.00	31.00 3.90	38.00	3544.00	2.81 67.20 .52
EI	06 30 78	28.00 10250.00	6329.00 8.03	217.00 .29 1959.00	31.40 3.90	40.00	3544.00	2.77 73.20 .14
RR	07 03 78	13.28 11200.00	480.00 7.70				3500.00	
RR	07 10 78	11400.00	490.00 8.10				3500.00	5.82
RR	07 17 78	21.28 11200.00	460.00 7.25				3600.00	6.31
EI	07 20 78	25.00 10500.00	6288.00 8.16	181.00 .30 1720.00	30.00 3.45	53.00	3484.00	2.40 75.60 .18
RR	07 24 78	23.84 10450.00	490.00 7.74				3500.00	5.01
RR	07 26 78	21.20 11200.00	470.00 7.12			51.00	3475.00	5.76
IDWR	07 27 78	28.01 11000.00 70.00	7.71	207.81 3.04 2005.60	31.67 3.96	64.00	34.17 3709.10	3.09 74.93

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
MW-1	B15S26E23CDD	0420552	1132305	MONITOR	399

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
RR	07 31 78	26.36 10800.00	490.00 7.20				3500.00	6.03
RR	08 07 78	19.36 11000.00	590.00 7.19				3500.00	6.01
RR	08 21 78	28.08 10700.00	540.00 7.25				3800.00	
RR	09 11 78	13.36 11200.00 59.22	520.00 7.07				4040.00	3.08
RR	09 21 78	25.84 10400.00 64.00	505.00 7.30				3620.00	3.07
RR	09 25 78	21.40 10800.00 74.00	530.00 7.87				3740.00	2.87
RR	10 02 78	26.00 10500.00 69.00	530.00 8.06				3480.00	2.80
RR	10 09 78	23.20 10900.00 40.00	518.00 7.70				3450.00	3.03
RR	10 16 78	23.68 10700.00 61.00	526.00 7.77				3540.00	2.98

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
MW-1	B15S26E23CDD	0420552	1132305	MONITOR	399

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	10 23 78	23.76 11000.00 64.00	526.00 7.80				3500.00	3.01
RR	11 27 78	27.60 10500.00 74.00	524.00 7.53				3970.00	3.45
RR	12 04 78	22.80 10800.00 73.00	546.00 7.60	1900.00			4300.00	3.50
RR	12 11 78	27.52 10400.00 73.00	558.00 8.10	970.00 1970.00			4130.00	3.38
EI	12 12 78	25.00 10600.00	6270.00 7.88	215.00 .35 2220.00	29.90 3.72	80.00	3680.00	65.60 .08
INEL	12 13 78	24.50 11350.00	6590.00 7.78	210.00 .47 2270.00	28.00 7.00 4.10	79.00	3670.00	2.10 67.00 .50
RR	12 25 78	22.60 10600.00 72.00	526.00 7.80	1940.00			4160.00	3.50
EI	02 05 79	24.00 10700.00	6297.00 7.60	208.00 .38 1840.00	28.90 4.79	78.00	4078.00	4.50 69.00 .06
INEL	02 06 79	25.00 11300.00	6650.00 7.70	190.00 .90 2270.00	30.00 6.30 4.10	63.00	4110.00	6.74 84.00 .49

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
MW-1	B15S26E23CDD	0420552	1132305	MONITOR	399

LAB	SAMPLE-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	02 19 79	24.80 10200.00	548.00 7.70	1860.00			4450.00	3.03
RR	10 08 80	29.00 10500.00 71.30	533.00					
RR	12 09 80	30.00 10900.00 74.00	530.00	205.00 .35 2048.00	34.00	112.00	37.00 3645.00	2.50 70.00
RR	04 01 81	25.00 11200.00 80.00	520.00 7.60	235.00 .37 2088.00	42.00	96.00	28.00 3620.00	1.50 76.00
EI	06 10 81	24.00 11200.00 79.00	510.00 7.60	200.00 .29 2460.00	26.00	78.00	29.00 3970.00	2.90 77.00

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
MW-2	B15S26E23DDD	0420549	1132230	MONITOR	174

SAMPLE- LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SIO2	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
EI	02 15 78	31.00 6400.00	250.00 3204.00 7.60	99.00 .72 1190.00	26.10 2.53		1662.00	4.33 57.00 .02
RR	12 11 78	28.00 5400.00 87.00	344.00 7.60	920.00			2000.00	6.12
EI	12 12 78	26.00 4400.00	3190.00 7.61	125.00 .49 1000.00	24.60 2.52		1740.00	5.63 56.70
RR	12 25 78	26.00 5700.00 87.00	350.00 7.75	963.00			2040.00	6.14
EI	02 05 79	27.00 4500.00	3218.00 7.50	122.00 .48 1130.00	25.20 3.24		2087.00	8.00 57.00 .04
INEL	02 06 79	27.00 5700.00	3360.00 7.44	120.00 1.20 1030.00	26.00 3.50 2.70	148.00	1970.00	2.40 57.60 2.80
RR	02 12 79	25.80 5300.00	344.00 7.40	1010.00			1980.00	5.77
INEL	12 13 79	26.20 5700.00	3130.00 7.56	140.00 .70 1320.00	24.00 3.80 4.10	83.00	1700.00	5.70 67.50 .50
RR	10 08 80	27.00 5600.00 54.00	312.00					

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
MW-2	B15S26E23DDD	0420549	1132230	MONITOR	174

SAMPLE-DATE LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
RR	12 09 80	35.00 6000.00 56.00	300.00	130.00 .36 1008.00	31.00	95.00	43.00 1666.00	5.10 48.00
RR	03 31 81	30.00 6000.00 66.00	310.00 7.23	135.00 .40 929.00	34.00	88.00	34.00 1660.00	2.80 51.00
EI	06 10 81	31.00 5500.00 68.00	290.00 7.30	110.00 .36 960.00	23.00	83.00	38.00 1760.00	5.40 58.00

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
MW-3	B15S26E25B08	0420539	1132208	MONITOR	153

SAMPLE-LAB	DATA-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SIO2	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
INEL	02 07 78			165.00 4.20 1050.00	35.00 3.20	75.00	2194.00	1.99 67.00
INEL	02 07 78			165.00 4.20 1000.00	35.00 3.20	71.00	2133.00	3.33 65.00
RR	07 26 78	48.50 5600.00	572.00 7.07			122.00		5.56
RR	12 11 78	44.00 5200.00	456.00 7.50	1250.00			2730.00	5.68
EI	12 12 78	55.00 5500.00	4350.00 7.80	177.00 4.60 1280.00	53.60 2.76		2420.00	5.11 52.20 .09
INEL	12 13 78	45.80 7700.00	4920.00 7.52	170.00 3.40 1350.00	54.00 1.80 3.10	92.00	2400.00	5.60 67.50 .50
EI	02 06 79	36.00 5500.00	4334.00 7.60	150.00 4.94 1190.00	57.20 3.33		2837.00	7.60 53.00 .07
INEL	02 07 79	52.00 7600.00	4590.00 7.52	150.00 3.30 1370.00	58.00 1.90 3.10	133.00	2770.00	5.70 58.90 6.40
RR	05 07 79	32.80 6200.00	400.00 8.15	1390.00			2500.00	5.02

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
MW-3	B15S26E258DB	0420539	1132208	MONITOR	153

LAB	SAMPLE-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SiO2	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
EI	05 07 79	47.00 6200.00	4360.00 7.51	155.00 6.33 1400.00	65.30 3.01		2460.00	5.40 60.00
RR	12 16 80	40.00 7600.00 46.00	440.00	168.00 2.50 1246.00	33.00	115.00	49.00 2327.00	4.80 48.00
RR	04 02 81	45.00 7000.00	440.00 7.43	185.00 .45 1300.00	49.00	107.00	56.00 2400.00	2.60 45.00

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
MW-4	B15S26E25BAD	0420542	1132147	MONITOR	305

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
EI	08 03 78	50.00 8000.00	3614.00 7.69	174.00 7.10 1370.00	26.60 3.70		2290.00	7.70 62.00 .98
RR	12 11 78	28.84 7400.00	392.00 8.00	1350.00			2850.00	5.91
EI	12 12 78	41.00 5750.00	4370.00 8.06	217.00 3.19 1400.00	24.90 3.24		2420.00	4.85 51.10 .09
INEL	12 13 78	29.70 7800.00	4520.00 7.71	160.00 .50 1450.00	23.00 .80 3.30	81.00	2610.00	5.60 19.80 .50
EI	02 06 79	27.00 5750.00	4497.00 7.90	156.00 .64 1230.00	29.10 3.71		2986.00	7.20 57.00 .04
INEL	02 07 79	30.60 7800.00	4840.00 7.76	150.00 1.00 1520.00	31.00 1.40 3.30	67.00	2770.00	5.60 53.40 .50
RR	12 17 80	25.00 7600.00 37.00	380.00	152.00 2.70 1294.00	34.00	95.00	32.00 2452.00	4.70 47.00
RR	04 02 81	30.00 7350.00 34.00	390.00 7.83	172.00 .55 1429.00	43.00	94.00	38.00 2500.00	2.60 58.00
EI	06 09 81	37.00 7900.00 42.50	370.00 7.90	150.00 .43 1500.00	30.00	85.00	45.00 2580.00	4.90 55.00

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
MW-5	B15S27E30BBD	0420539	1132112	MONITOR	152

SAMPLE-LAB	DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
RR	12 11 78	102.40 1990.00	342.00 7.60	221.00			639.00	.66
EI	12 12 78	168.00 2000.00	1240.00 7.98	169.00 33.90 190.00	17.40 1.72		610.00	.47 40.00 .44
INEL	12 13 78	113.60 2000.00	1180.00 7.84	110.00 21.00 242.00	12.00 .80 .40	34.00	560.00	1.00 19.80 .50
EI	02 06 79	101.00 2000.00	1229.00 7.80	107.00 24.80 230.00	13.70 .06		717.00	.70 27.00 .41
INEL	02 07 79	102.00 2000.00	1520.00 7.64	98.00 22.00 279.00	13.00 1.10 .30		610.00	.53 22.00 3.50
RR	12 16 80	100.00 2200.00 25.00	370.00	125.00 1.80 229.00	25.00	48.00	120.00 604.00	.60 19.00
RR	04 01 81	100.00 2050.00 26.00	370.00 7.27	122.00 .31 234.00	17.00	47.00	122.00 600.00	.80 35.00

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
MW-6	B15S27E30BDA	0420529	1132050	MONITOR	305

SAMPLE-LAB	DATA-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SI02	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
EI	05 30 78	40.00 6450.00	5083.00 8.21	230.00 2.40 1250.00	58.00 2.70		2443.00	3.87 64.00 3.25
EI	12 12 78	5600.00	4240.00 10.68	180.00 .09 1280.00	53.40 2.42		2360.00	3.44 62.20 .02
INEL	12 13 78	7600.00	4270.00 10.61	170.00 .10 1170.00	62.00 1.40 2.80	30.00	2340.00	4.10 62.70 .50
EI	02 06 79	42.00 6500.00	4822.00 7.90	205.00 2.02 1280.00	57.60 3.30		3315.00	5.90 78.00 .12
INEL	02 07 79	44.30 8700.00	5430.00 7.70	230.00 2.40 1570.00	56.00 1.30 3.10	85.00	2930.00	4.90 73.10 .73
RR	05 07 79	39.00 7000.00	532.00 7.60	1560.00			2830.00	4.31
EI	05 07 79	44.00 6900.00	4970.00 7.29	207.00 2.83 1610.00	68.60 3.07		2770.00	4.70 74.00
RR	12 15 80	50.00 8600.00 27.00	550.00 8.20	208.00 1.60 1349.00	51.00	124.00	60.00 2672.00	4.20 71.00
RP	04 01 81	45.00 8200.00 34.00	560.00 7.45	235.00 .21 1586.00	82.00	122.00	55.00 2700.00	2.30 82.00

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
MW-6	B15S27E30BDA	0420529	1132050	MONITOR	305

LAB	SAMPLE-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SIO2	CO3	SO4
		TEMP (C)	PH	NA	LI	NH4	CL	NO3
EI	06 09 81	45.00	550.00	190.00	56.00		55.00	4.20
		8700.00		1.90		85.00		76.00
		34.00	7.70	1620.00			2960.00	

WELLID	LOCATION	LAT(N)	LONG(W)	W-TYPE	DEPTH
MW-7	B15S26E25DAA	0420506	1132103	MONITOR	152

SAMPLE-LAB	DATA-DATE	PROPERTIES		CATIONS (MG/L)			ANIONS (MG/L)	
		ALK	HARD	CA	K		HCO3	F
		SPC	TDS	MG	SR	SIO2	CO3	SO4
		TEMP(C)	PH	NA	LI	NH4	CL	NO3
RR	12 11 78	100.00 2200.00	322.00 7.60	287.00			707.00	1.26
EI	12 12 78	107.00 2250.00	1380.00 7.97	110.00 28.90 350.00	12.40 1.55		640.00	1.26 31.70 2.92
INEL	12 13 78	101.50 2300.00	1300.00 7.83	94.00 17.00 375.00	14.00 .80 .60	43.00	650.00	1.00 24.80 .50
EI	02 06 79	104.00 2250.00	1289.00 7.80	96.10 21.00 250.00	13.70 .37		781.00	1.20 34.00 .27
INEL	02 07 79	110.00 2310.00	1370.00 7.76	99.00 18.00 333.00	14.00 1.00 .60	36.00	690.00	.91 32.00 .50
RR	12 16 80	90.00 2500.00	360.00	96.00 3.50 260.00	27.00	50.00	110.00 616.00	.90 14.00
RR	04 01 81	105.00 2350.00 31.00	330.00 7.15	120.00 .27 281.00	22.00	49.00	129.00 680.00	.90 51.00
EI	06 10 81	105.00 2400.00 31.50	340.00 7.50	120.00 18.00 350.00	14.00	43.00	130.00 652.00	1.10 31.00

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APPENDIX E
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APPENDIX E

BIBLIOGRAPHY

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