GL02975-7

COMPLETION REPORT:

RAFT RIVER

GEOTHERMAL INJECTION WELL SEVEN

(RRGI-7)

FEBRUARY 1979

L. G. Miller
EG&G Idaho, Inc.

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DOE-ID

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APPROVED:

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ABSTRACT

Raft River Geothermal Injection Well Seven (RRGI-7) is an intermediate-depth injection well designed to accept injected water in the 600 to 1000 m (2000 to 3500 ft) depth range.[a] It has one barefoot leg, and it was drilled so that additional legs could be added later; if there are problems with intermediate-depth injection, one or more additional legs could be directionally drilled from the current well bore.

This report describes the drilling and completion of RRGI-7 and provides a brief summary of preliminary testing. It includes daily drilling reports, as well as records of logging, coring, and containment techniques used during drilling operations.

[a] All depths are referenced from the Kelly Bushing, 420 cm (14 ft) above ground level, unless otherwise noted.

CONTENTS

FIGURES

TABLES

COMPLETION REPORT:
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I. INTRODUCTION

This report describes the drilling and completion of Raft River Geothermal Well Seven (RRGI-7). Previous Raft River wells established the feasibility of using the valley's resource for a 5-MW power plant, as well as for numerous nonelectrical applications. RRGI-7, planned as an injection well, will accept the spent geothermal fluid. This will prevent the pollution that surface disposal could cause.

Colorado Well Service performed the drilling and completion of RRGI-7 under the direction of EG&G Idaho, Inc., and DOE-ID. The drilling supervision, subcontracted by EG&G, was conducted by an independent company, Energy Drilling Specialists of Denver, Colorado. Technical direction was supplied to the drilling subcontractor through the drilling supervisor. DOE-ID provided funding for the drilling operation, and EG&G provided budgeting and procurement administration.

RRGI-7 is located about 1/2 mile southeast of the RRGE-3 well (see Figures 1 and 2). This area was selected by DOE-ID as the site for all injection wells.

II. DRILLING SUMMARY

RRGI-7 well design incorporates multiple factors. The design provides for injection into the intermediate zone, in order to minimize near-surface groundwater contamination, to avoid cooling production aquifers, and to reduce well costs. It also provides for completion options: deepening and casing with 24-cm (9-5/8-in.) casing, or deepening with directionally drilled legs.

The drill site was completed prior to rig move-on. Site preparation included excavation of a fluid reserve pit; leveling, grading, and gravelling of the site; and construction of a road. A temporary water line from RRGE-3 to the site provided drilling water. The site measured about 76 x 76 m (250 x 250 ft).

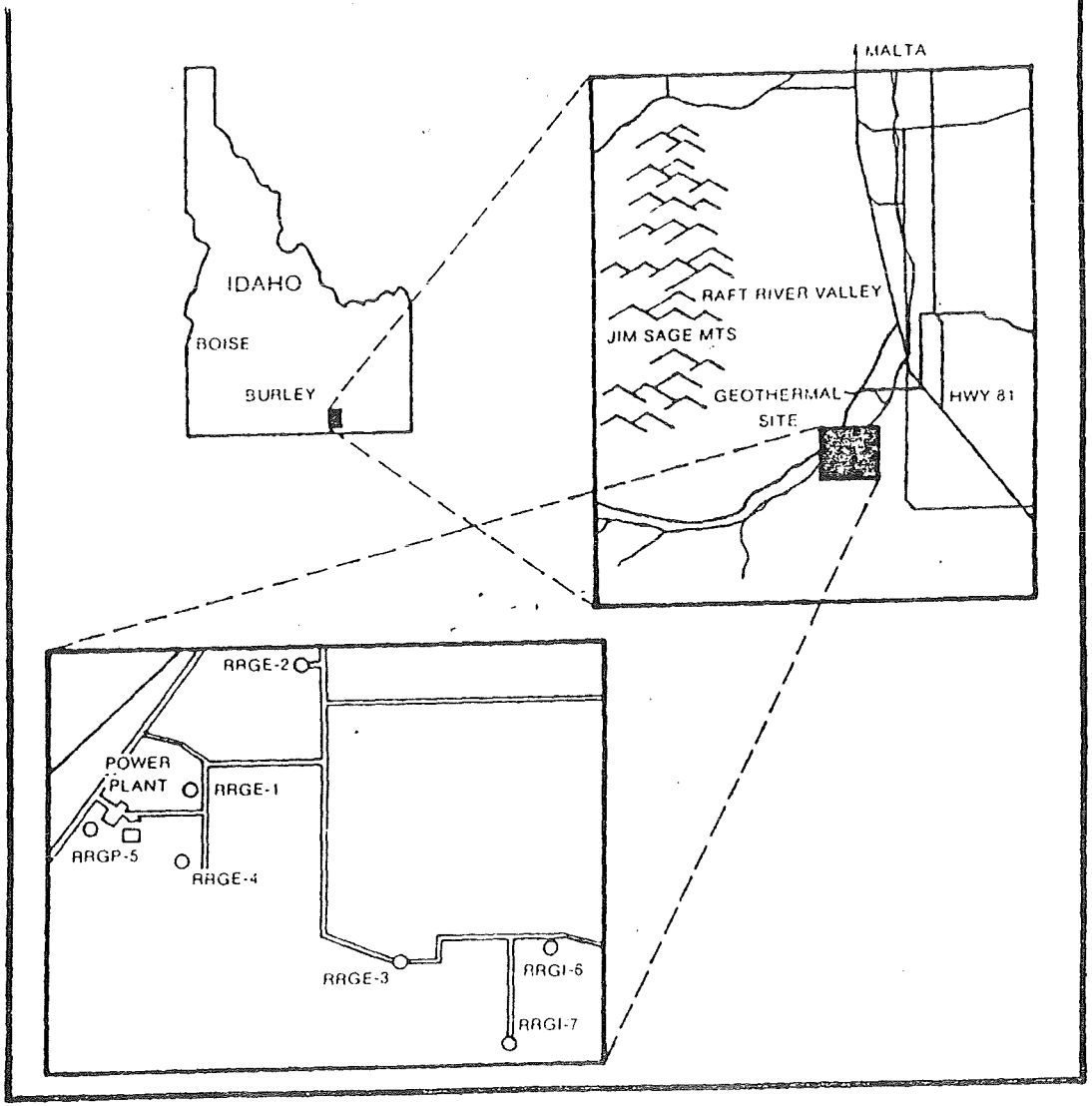

Fig. 1 Raft River Geothermal site and location of wells.

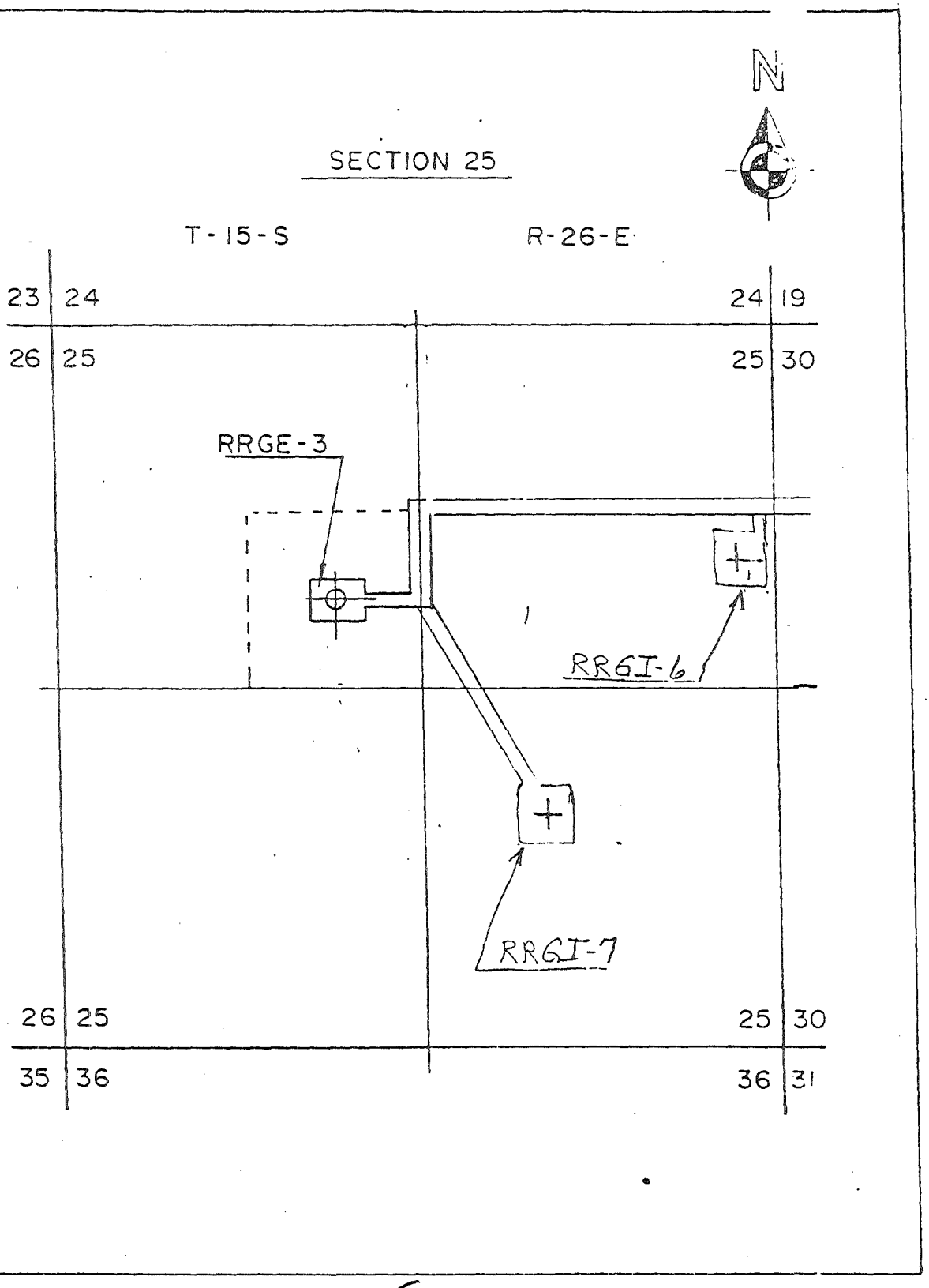

Figure 2 Location Survey.

Prior to rig move-on, the following work was performed. A dry-hole digger drilled a 66-cm (26-in.) diameter hole and set 46 m (150 ft) of 51-cm (20-in.) conductor pipe. This contractor cemented the pipe with plant-mix concrete. The dry-hole digger also drilled the rat and mouse holes. A subcontractor constructed a 2.4- x 2.4- x 3-m (8- x 8- x 10-ft) concrete-lined cellar around the conductor pipe.

Drilling began with a 44-cm (17-1/2-in.) diameter bit, using a low-solids mud. Minor problems with bit plugging developed upon encountering a gravel section. On July 19, 1978, at 7:00 P.M., drilling operations were shut down by the Idaho Department of Water Resources, because of environmental questions about RRGP-5 operations. Drilling resumed on July 21, 1978. At a depth of 610 m (2000 ft), the hole was logged. Fifty-one joints of 34-cm (13-3/8-in.), K-55, 81.1-kg/m (54-lb/ft) casing were run to a depth of 623 m (2044 ft). Cementing operations used 1600 sacks of Class-G cement with 11.5 kg/sack (25 lb/sack) kolite, 20% silica flour, and 8% D-53 with a slurry weight of 1.68 kg/L (12 lb/gal). While waiting on cement, the BOP was nippled up and pressure tested.

Drilling operations continued using a 31-cm (12-1/4-in.) bit, with water as the drilling fluid. After drilling to 1167 m (3828 ft), a 9-m (30-ft) core was cut with a 6-m (19-ft) recovery. Upon reentering the hole after coring, the hole had 18 m (60 ft) of fill. The hole was cleaned and logs were run.

A short-term airlift flow test was conducted. Flows measured 24 to 30 L/sec (400 to 500 gpm). Upon recovery, water level stabilized at 9 m (28 ft). An injection test was conducted at 54 L/sec (850 gpm) for a half hour, and 28 L/sec (463 gpm) for 4 hours. A second airlift flow test was conducted for 9-3/4 hours at 33 L/sec (540 gpm), to remove all injected water and clean out the formation. Rigging-down operations then began.

Figure 3 shows the status of the subsurface well. Figure 4 provides a drilling and operations summary.

III. SURFACE AND CONTAINMENT EQUIPMENT AND SERVICES

1. CONTAINMENT EQUIPMENT - SURFACE HOLE

A 51-cm (20-in.) single-gate Shaffer blowout preventor (BOP) was installed between the 51-cm (20-in.) casing head and the drilling nipple for drilling the 44-cm (17-1/2-in.) hole to 625 m (2050 ft).

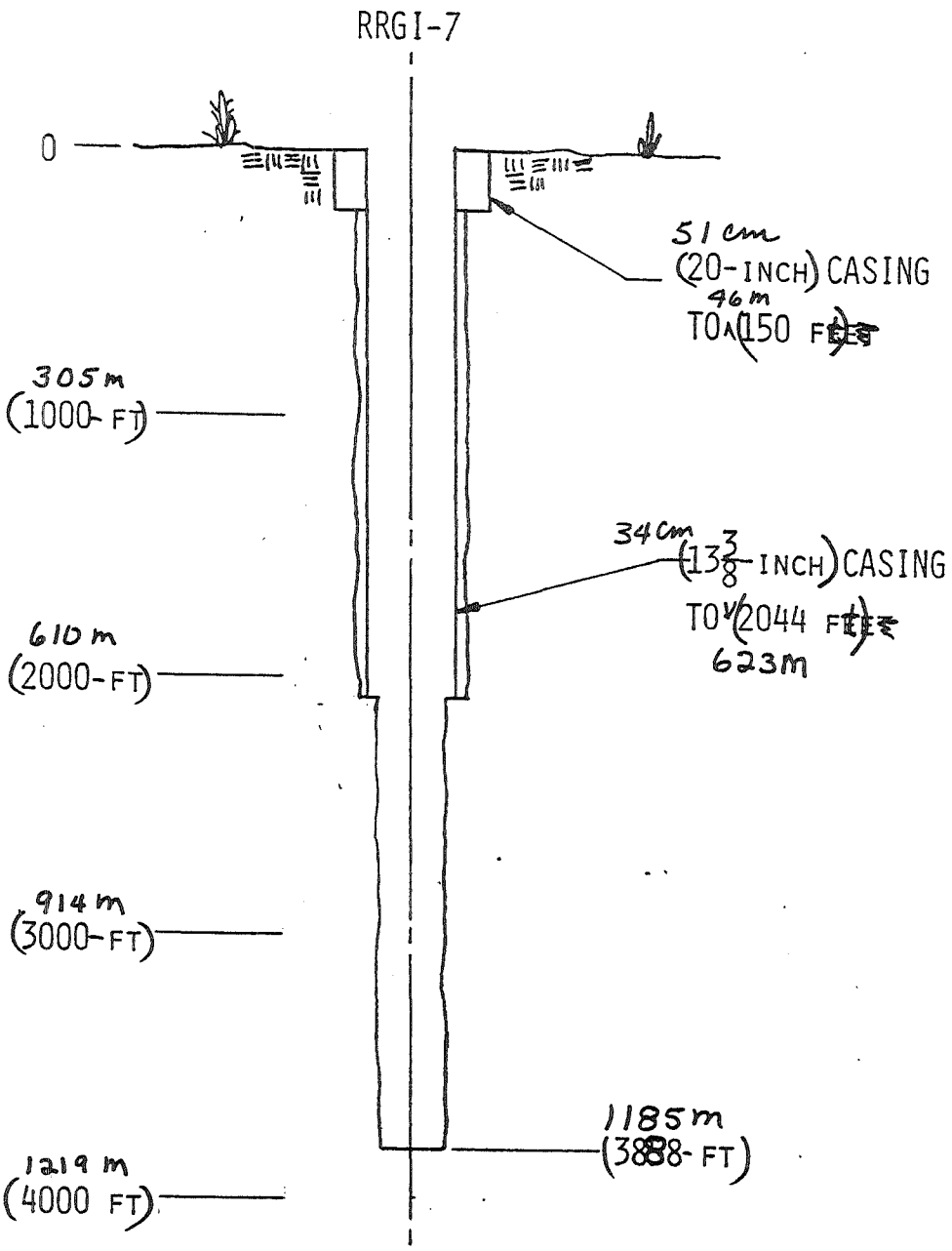

Figure 3 Subsurface Well Status

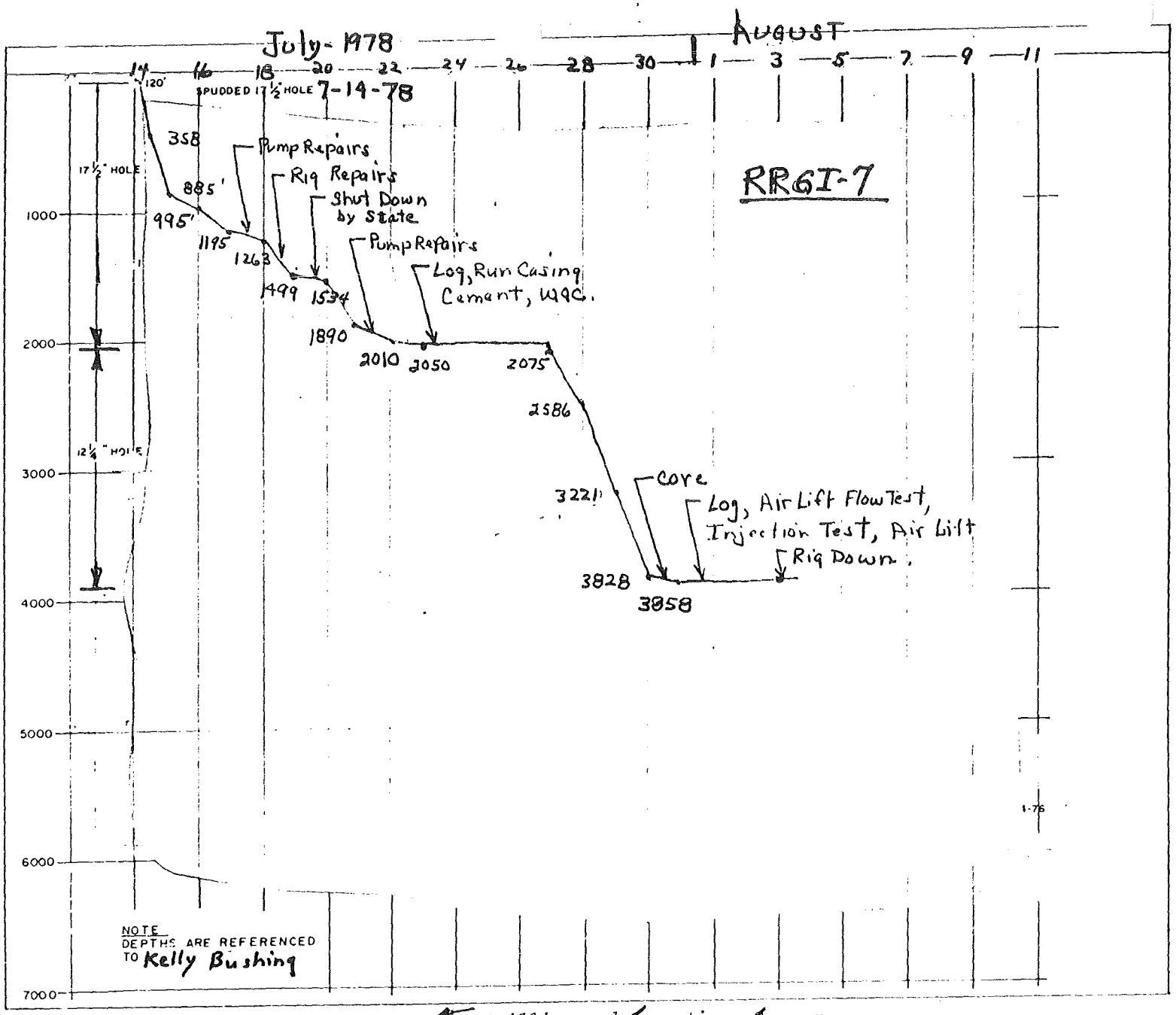

Figure 5. Drilling and Operations Summary.

2. CONTAINMENT EQUIPMENT - PRODUCTION HOLE

After setting the 34-cm (13-3/8-in.) casing at 623 m (2044 ft), the following containment stack, (listed from expansion spool up) was used (see Figure 6).

(1) WKM 51- x 30-cm (20- x 12-in.) expansion spool

(2) WKM 30-cm (12-in.) master valve

(3) Adaptor spool

(4) Shaffer double-gate 30-cm (12-in.) BOP

(5) Hydril Type-GK 30-cm (12-in.) BOP

(6) Grant 30-cm (12-in.) rotating head.

3. CELLAR

A subcontractor constructed a 2.4- x 3- x 2.4-m (8- x 10- x 8-ft) reinforced-concrete cellar to accommodate the BOP stack.

4. WELLHEAD

The permanent wellhead on this well consists of a standard WKM wellhead system. The casing head, with its 51-cm (20-in.) 14,000-kPa (2000-psi) API flange, is welded directly to the 51-cm (20-in.) well casing. The expansion spool mates to the 51-cm (20-in.) 14,000-kPa (2000-psi) API casing head flange on the bottom, and the 30-cm (12-in.) 2760-kPa (400-psi) ANSI flanged master gate valve on the top. Both sides of the expansion spool contain 7.5-cm (3-in.) valved outlets with 7.5-cm (3-in.) 14,000-kPa (2000-psi) API flanges.

A hanger spool mates with master valve on the bottom, and with a 20-cm (8-in.) 1860-kPa (600-psi) ANSI flanged power-seal gate valve on top. Above the power-seal gate valve is a 20-cm (8-in.) 1860-kPa (600-psi) ANSI tee (or cross).

For logging access into the well, a double-studded 20-cm (8-in.) 1860-kPa (600-psi) ANSI to 10-cm (4-in.) 930-kPa (300-psi) ANSI flanged gate valve is mounted above the double-studded flange. Figure 7 is a schematic view of the completed wellhead system, showing the expansion capabilities for the production casing and the packoff system. The packoff system is designed to be repacked under pressure.

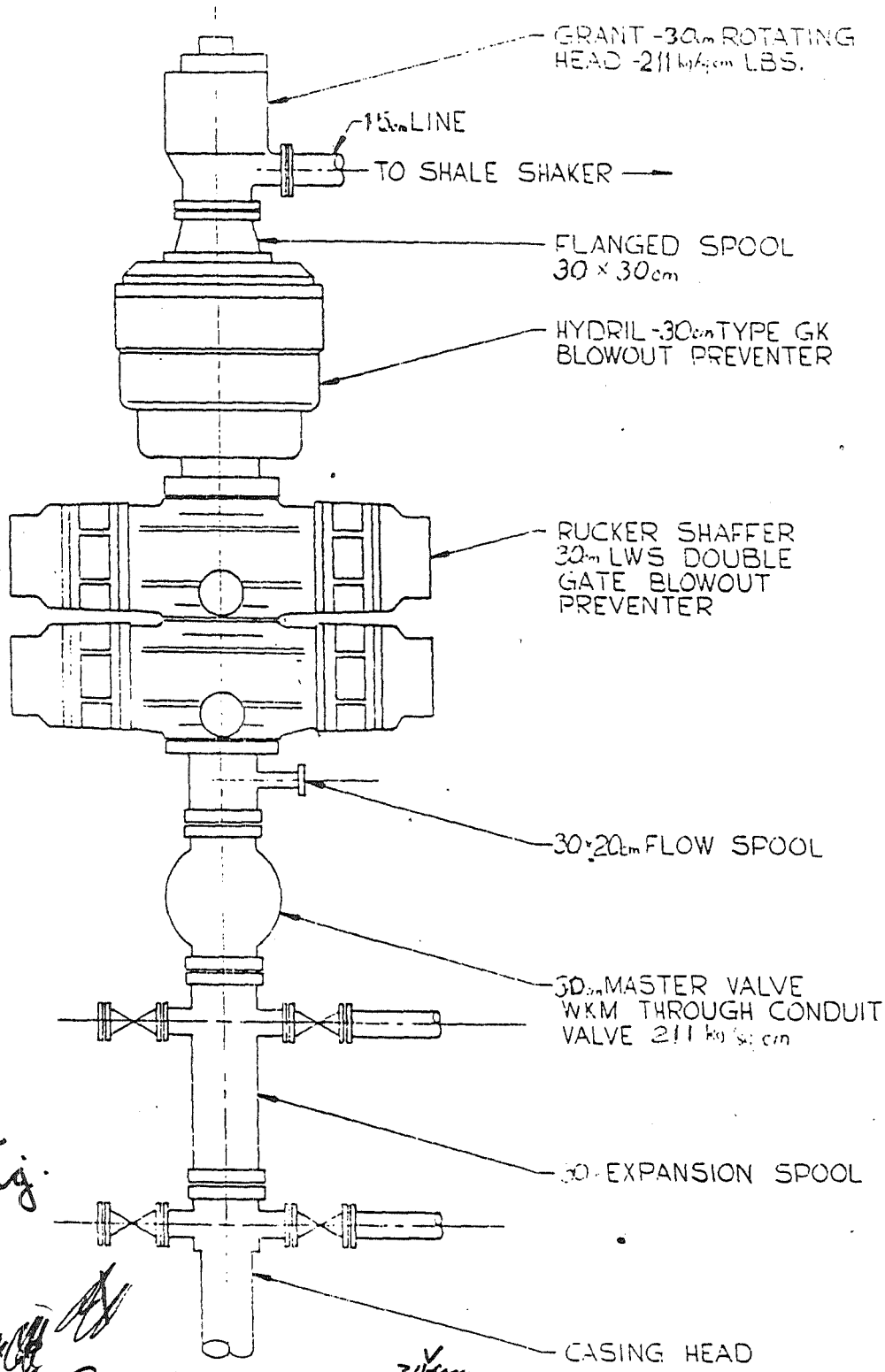

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Fig. ~~FIGURE~~ BOP for drilling below the 34cm (13-3/8-in) casing shoe.

[don't use]

Blowout preventer

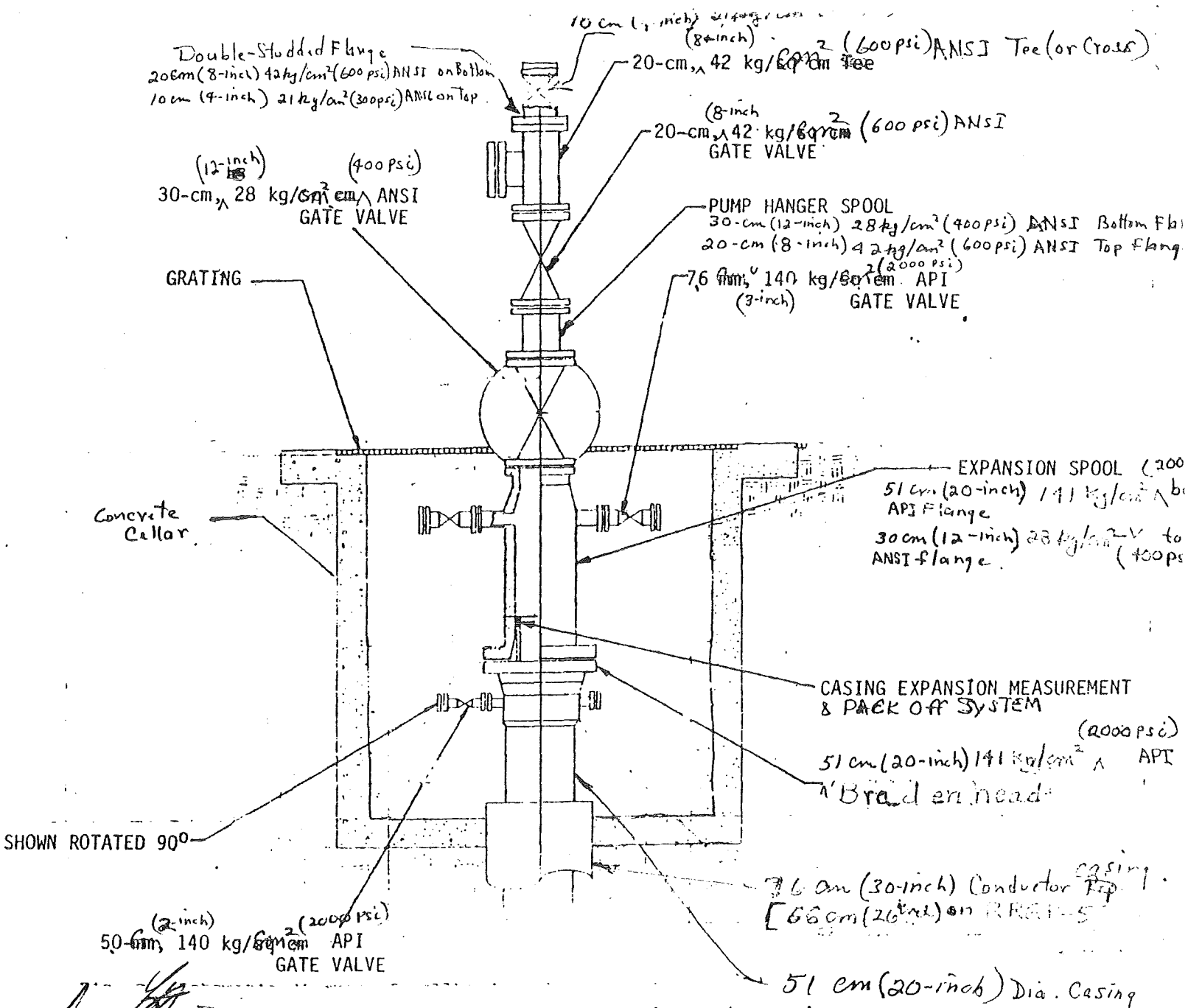


Fig. Schematic Diagram of Completed Wellhead.

[original in #5 spot]

5. DRILLING RECORDER

A six-pen recorder charted the weight on the derrick, the drilling rate, the rotary torque, the standpipe pressure, and the pump strokes on the number-one and number-two pumps during drilling.

IV. DOWNHOLE EQUIPMENT AND SERVICES

1. SURFACE CASING

Four joints of 51-cm (20-in.) H-40 casing were welded at each joint, set, and cemented to a 46-m (150-ft) depth.

2. INTERMEDIATE CASING

Fifty-one joints of 34-cm (13-3/8-in.), 81.1-kg/m (54.5-lb/ft), K-55 casing, guide shoe, and float collar were run and cemented.

3. DRILL BIT SUMMARY

A dry-hole driller drilled the 66-cm (26-in.) conductor hole to set the 46 m (150 ft) of 51-cm (20-in.) conductor pipe.

The intermediate hole was drilled with three 44-cm (17-1/2-in.) Hughes bits: Bit 1, an OSCIG-Jet, was used to drill from 46 to 312 m (150 to 1025 ft) in 34.75 hours. Bit 2, an OWV-Jet, was used to drill from 312 to 457 m (1025 to 1499 ft) in 22.5 hours. Bit 3, an OSCIG-Jet, went to 625 m (2050 ft) in 20.25 hours. The 44-cm (17-1/2-in.) hole was then cased and cemented.

The 31-cm (12-1/4-in.) hole was drilled with two Smith SVH-Jet bits. Bit 4 went to 916 m (3004 ft) in 23.5 hours, and Bit 5 to 1167 m (3828 ft) in 26.5 hours. A rerun bit, number 6, was used for reaming, drilling, and cleaning to 1176 m (3858 ft).

4. CORING

One 9-m (30-ft) core from 1167 to 1176 m (3828 to 3858 ft) was cut using a 20- x 8.9-cm (7-7/8- x 3-1/2-in.) diamond-core bit. The drilling fluid was water. Six meters (19 ft) of the core were recovered.

5. DRILLING FLUID

Drilling began with a dispersed polymer with a weight average of 1.06 kg/L (8.9 lb/gal) and viscosity of 34 to 44 sec/L. At approximately 290 m (950 ft), the drilling fluid was changed to a low-solids mud. Mud properties averaged as follows:

Weight	1.1 kg/L (9.2 lb/gal)
Viscosity	39 sec/L
Plastic Viscosity	10 cP (0.01 Pa's)
Sand Content	6%

After the 34-cm (13-3/8-in.) casing was set, drilling continued to a total depth of 1176 m (3858 ft) with water pumped from RRGE-3. Overall drilling-fluid circulation throughout the drilling operation was good.

6. SAMPLES AND MUD LOGGING SERVICE

A mud-logging service was employed to monitor drilling fluid and cutting returns. This service monitored fluid temperatures (in and out), and hydrogen sulfide and hydrocarbon concentrations. Samples were taken at 6-m (20-ft) intervals. Samples indicated the zone of penetration was mostly gravel near the surface, underlain by lacustrine siltstone and sandstone.

7. CEMENTING

The 51-cm (20-in.) surface casing was cemented from 46 m (150 ft) to ground level using plant-mix concrete, with 9 kg (20 lb) of fine sand per sack of cement.

The 34-cm (13-3/8-in.) intermediate casing was cemented to 623 m (2044 ft) in a 44-cm (17-1/2-in.) hole using RFC Thrixotropic cement. The drill crew established circulation to pretreat the hole. This was followed by 1600 sacks of Class-G cement, 11.5 kg (25 lb) of Kolite per sack of cement, 20% silica flour, and 8% D-53 with a slurry weight of 1.67 kg/L (14 lb/gal). Pumping started at 7:00 P.M. and was completed in 2 hours.

8. GEOPHYSICAL LOGGING PROGRAM

Various logs were run in the RRGI-7 well to determine the condition of the hole at different stages of the drilling operations. A listing of the logs, the intervals, and the lengths is shown in the following table.

TABLE I

LOGS RUN ON RRGI-7

Log	Type	Date	Shallowest Reading [m (ft)]		Deepest Reading [m (ft)]		Length [m (ft)]	
1	Compensated Neutron	7-23-78	49	(160)	625	(2050)	576	(1890)
2	Dual Induction Focused Log	7-23-78	49	(160)	625	(2052)	577	(1892)
3	Borehole Compensated Acoustilog	7-23-78	49	(160)	626	(2055)	578	(1895)
4	Differential Temperature Log	7-24-78	30	(100)	626	(2054)	596	(1954)
5	Four-Arm Caliper Log	7-25-78	30	(100)	614	(2016)	584	(1916)
6	Epilog - Computer Log Analysis	8-3-78	46	(150)	625	(2050)	579	(1900)
7	Dual Induction Focused Log	8-1-78	622	(2040)	1155	(3788)	533	(1749)
8	Borehole Compensated Acoustilog	7-31-78	625	(2050)	1156	(3793)	531	(1743)
9	Differential Temperature Log	7-31-78	625	(2050)	1158	(3800)	533	(1750)
10	Compensated Densilog - Compensated Neutron	8-1-78	625	(2050)	1155	(3789)	530	(1739)
11	Compensated Densilog	8-1-78	625	(2049)	1157	(3796)	532	(1747)
12	Epilog - Computer Log Analysis	8-17-78	625	(2050)	1158	(3800)	533	(1750)

APPENDIX A

DAILY DRILLING REPORTS

APPENDIX A

DAILY DRILLING REPORTS[a]

The following table contains excerpts from the notes recorded in the driller's IADC "Daily Drilling Report."

TABLE A-I

DAILY DRILLING REPORTS

Date	Report
June 24, 1978	Conductor was set. Rat and mouse holes drilled.
July 6, 1978	Cellar construction completed.
July 11 to 13, 1978	Rigging up Colorado Well Service Rig 75, a Cabot 750 with 34-m (112-ft) derrick [substructure 4.3 m (14 ft) above ground level].
July 14, 1978	Spudded. Drilled 44-cm (17-1/2-in.) hole from 37 to 109 m (120 to 358 ft), with a Hughes OSCIG-Jet bit. Pulled out of hole to unplug bit. Worked on pump. Ran back in hole. Mud - dispersed polymer. Bottom hole assembly - 6-point reamer Shock sub 9-m (30-ft) drill collar Stabilizer 9-m (30 ft) drill collar Stabilizer.
July 15, 1978	Drilled from 109 to 270 m (358 to 885 ft). Washed to bottom, worked pipe in hole. Serviced rig and worked on pumps. Reached gravel formation. Mud - dispersed polymer wt. - 1.05 kg/L (8.8 ppg) vis. - 20 sec/1000 cm^3. Bottom hole assembly - 6-point reamer Shock sub 9-m (30-ft) drill collar Stabilizer 9-m (30-ft) drill collar Stabilizer.

[a] All depths are referenced from the Kelly Bushing, 4.3 m (14 ft) above ground level, unless otherwise noted.

TABLE A-I (cont.)

Date	Report
July 16, 1978	Drilled from 270 to 303 m (885 to 995 ft). Repaired pump. Tripped out with a plugged bit, caused by gravelly formation. Tripped in hole and encountered 9 m (30 ft) of fill. Repaired mud line. Mud - low solids wt. - 109 kg/L (9.1 ppg) vis. - 42 sec/1000 cm^3. Bottom hole assembly - 6-point reamer Shock sub 9-m (30-ft) drill collar Stabilizer 9-m (30-ft) drill collar Stabilizer.
July 17, 1978	Drilled from 303 to 364 m (995 to 1195 ft). Tripped for new bit. Pump broken, waited for parts. Mud - low solids wt. - 1.1 kg/L (9.2 ppg) vis. - 44 sec/1000 cm^3. Bottom hole assembly - 6-point reamer Shock sub 9-m (30-ft) drill collar Stabilizer 9-m (30-ft) drill collar Stabilizer.
July 18, 1978	Drilled from 364 to 385 m (1195 to 1263 ft). Waited on pump parts. Repaired pump. Repaired shale shaker. Mud - low solids wt. - 1.2 kg/L (9.4 ppg) vis. - 39 sec/1000 cm^3. Bottom hole assembly - 6-point reamer Shock sub 9-m (30-ft) drill collar Stabilizer 9-m (30-ft) drill collar Stabilizer.
July 19, 1978	Drilled from 385 to 457 m (1263 to 1499 ft). Repaired pump. Serviced rig. Tripped for new bit. At 7:00 P.M., the Idaho Department of Water Resources issued a cease and desist order to all drilling operations, due to environmental concerns for RRGP-5 operations.

TABLE A-I (cont.)

Date	Report
July 19, 1978 (cont.)	Mud - low solids wt. - 1.1 kg/L (9.2 ppg) vis. - 38 sec/1000 cm^3. Bottom hole assembly - 6-point reamer Shock sub 9-m (30-ft) drill collar Stabilizer 9-m (30-ft) drill collar Stabilizer.
July 20, 1978	State gave okay to drill ahead at 7:00 P.M. Drilled from 457 to 468 m (1499 to 1534 ft). Mud - low solids wt. - 1.09 kg/L (9.1 ppg) vis. - 35 sec/1000 cm^3. Bottom hole assembly - 6-point reamer Shock sub 9-m (30-ft) drill collar Stabilizer 9-m (30-ft) drill collar Stabilizer.
July 21, 1978	Drilled from 468 to 576 m (1534 to 1890 ft). Worked on pump. Cleaned mud pits. Mud - low solids wt. - 1.1 kg/L (9.2 ppg) vis. - 35 sec/1000 cm^3. Bottom hole assembly - 6-point reamer Shock sub 9-m (30-ft) drill collar Stabilizer 9-m (30-ft) drill collar Stabilizer.
July 22, 1978	Drilled from 576 to 613 m (1890 to 2010 ft). Waited on parts for pump,and repaired pump. Changed shale shaker screen. Mud - low solids wt. - 1.09 kg/L (9.1 ppg) vis. - 39 sec/1000 cm^3. Bottom hole assembly - 6-point reamer Shock sub 9-m (30-ft) drill collar Stabilizer 9-m (30-ft) drill collar Stabilizer.

TABLE A-I (cont.)

Date	Report
July 23, 1978	Drilled from 613 to 625 m (2010 to 2050 ft). Circulated and conditioned hole. A directional survey to 619 m (2000 ft) showed a 2% deviation. Tripped out and laid down bottom hole assembly. Rigged up and began running logs. Mud - low solids wt. - 1.09 kg/L (9.1 ppg) vis. - 39 sec/1000 cm^3. Bottom hole assembly - 6-point reamer Shock sub 9-m (30-ft) drill collar Stabilizer 9-m (30-ft) drill collar Stabilizer.
July 24, 1978	Logged hole. Tripped in with bottom hole assembly and circulated. Mud - low solids wt. - 1.09 kg/L (9.1 ppg) vis. - 39 sec/1000 cm^3. Bottom hole assembly - 6-point reamer Shock sub
July 25, 1978	Circulated to run casing. Tripped out of hole and laid down bottom hole assembly. Rigged up and ran 51 joints of 34-cm (13-3/8-in.), K-55, 81.1-kg/M (54.5-lb/ft), casing to 623 m (2044 ft). Rigged up cementers. Cemented with 1600 sacks of Class G cement with 11.5 kg/sack (25 lb/sack) kolite, 20% silica and 8% D-53. Started cementing at 7:00 P.M. Cement in place at 9:00 P.M. Cleaned out lines and started removing BOP.
July 26, 1978	WOC - Nippling up BOP.
July 27, 1978	Completed nippling up BOP. Pressure tested casing at 2100 kPa (300 psi). Ran in the hole, drilled out cement, and began drilling new hole with 31-cm (12-1/4-in.) bit to 632 m (2075 ft). Drilling fluid - Water. Bottom hole assembly - Shock sub.

TABLE A-I (cont.)

Date	Report
July 28, 1978	Drilled to 788 m (2586 ft). At 667 m (2189 ft), pulled out of hole, and picked up bottom hole assembly. Cleaned pits. Reamed from 655 to 674 m (2150 to 2210 ft). Drilling fluid - Water. Bottom hole assembly - 6-point reamer Shock sub 9-m (30-ft) drill collar 3-point stabilizer 9-m (30-ft) drill collar Blade stabilizer.
July 29, 1978	Drilled to 982 m (3221 ft). Serviced rig and pumps. Ran deviation survey which showed a 3-1/2 degree deviation at 902 m (2960 ft). Tripped out for new bit. Washed and reamed to bottom. Drilling fluid - Water. Bottom hole assembly - 6-point reamer Shock sub 9-m (30-ft) drill collar 3-point stabilizer 9-m (30-ft) drill collar Blade stabilizer.
July 30, 1978	Drilled to 1167 m (3828 ft). Serviced rig. Cleaned mud pits. Circulated, in preparation to core. Drilling fluid - Water Bottom hole assembly - 6-point reamer Shock sub 9-m (30-ft) drill collar 3-point reamer 9-m (30-ft) drill collar Blade stabilizer.
July 31, 1978	Circulated and pulled out of hole. Picked up core-barrell and ran in hole. Cored 9 m (30 ft) and recovered 6 m (19 ft). Ran in hole with bit, reamer, and shock sub. Washed and reamed to total depth of 1176 m (3858 ft). Circulated. Ran a deviation survey which showed 5-1/2 degrees at 1176 m (3858 ft). Pulled out of hole and rigged up loggers. Started running logs.

TABLE A-I (cont.)

Date	Report
August 1, 1978	Ran logs. Prepared and started air lift from 55 m (180 ft) down hole.
August 2, 1978	Conducted air lift, recovering 24 to 30 L/sec (400 to 500 gpm). Shut in well. Water level at 9 m (28 ft). Injected at 34 L/sec (850 gpm) with 1380 kPa (200 psi) for 1/2 hour, 28 L/sec (463 gpm) for 4 hours. Shut in well. Restarted air lift from 55 m (180 ft) downhole and recovered 33 L/sec (540 gpm) for 1-3/4 hours.
August 3, 1978	Continued air lifting for 8 more hours for a total of 9-3/4 hours. Laid down drill pipe and bottom hole assembly. Began rigging down operations at 2:00 P.M.

APPENDIX B

BIT RECORD

The following table provides a performance record for each of the bits used to drill RRGI-7. This information was obtained from the IADC "Daily Drilling Report."

TABLE B-I

BIT RECORD

Bit	Make	Size [cm (in.)]	Type	Serial Number	Jets	Depth Out [m (ft)]	Footage [m (ft)]	Hours	Weight [1000 kg (1000 lb)]	RPM	Pump Pressure [kPa (psi)]	SPM	Bit Condition T/B/G	Formation Remarks
1	Hughes	44 (17-1/2)	OSCIG-Jet	JLN67	Open	312 (1025)	267 (875)	34.75	7 (15)	60	2069 (300)	65	5/4/1/8	Drilled with low solids mud to 625 m (2050 ft)
2	Hughes	44 (17-1/2)	OWV-Jet	AA421	Open	457 (1499)	144 (474)	22.5	7 (15)	60	3448-5516 (500-800)	65	3/4/0	
3	Hughes	44 (17-1/2)	OSCIG-Jet	HV649	Open	625 (2050)	168 (551)	20.25	7 (15)	60	2758-5516 (400-800)	69	5/3/0	From 625 m (2050 ft) to TD with water
4	Smith	31 (12-1/4)	SUH-Jet	598DN	Open	916 (3004)	248 (814)	23.5	7 (15)	65	4138 (600)	50	7/3/1/8	
5	Smith	31 (12-1/4)	SUH-Jet	635CA	Open	1167 (3828)	251 (824)	26.5	7 (15)	65	5516 (800)	50	8/3/1/8	
6	Hycalog	20x9 (7-7/8 x 3-1/2)	CMHIP	17479		1176 (3858)	9 (30)	--	--	--	--	--	--	Cored 9 m (30 ft), recovered 6 m (19 ft)

APPENDIX C

CASING RECORD

APPENDIX C

CASING RECORD

The following table contains excerpts from notes recorded in the drilling superintendent's casing record notebook.

TABLE C-1

CASING RECORD [a]

Joint	Measured Length [m (ft)]	Cumulative Length [m (ft)]
1	12.4 (40.72)	12.4 (40.72)
2	11.1 (36.42)	23.5 (77.14)
3	12.4 (40.55)	35.9 (117.69)
4	12.5 (41.12)	48.4 (158.81)
5	12.3 (40.51)	60.8 (199.32)
6	12.7 (41.56)	73.4 (240.88)
7	12.1 (39.82)	85.6 (280.70)
8	12.3 (40.27)	97.8 (320.97)
9	12.4 (40.60)	110.2 (361.57)
10	12.1 (39.68)	122.6 (402.25)
11	12.2 (40.11)	134.5 (441.36)
12	12.6 (41.19)	147.1 (482.55)
13	12.4 (40.66)	159.5 (523.21)
14	12.3 (40.42)	171.8 (563.63)
15	12.5 (41.00)	184.3 (604.63)
16	12.1 (39.69)	196.4 (644.32)
17	12.5 (40.95)	208.9 (685.27)
18	12.4 (40.63)	221.3 (725.90)
19	12.5 (40.89)	233.7 (766.79)
20	12.6 (41.50)	246.4 (808.29)
21	12.5 (40.91)	258.8 (849.20)
22	12.6 (41.27)	271.4 (890.47)
23	12.5 (41.01)	283.9 (931.48)
24	12.8 (42.01)	296.7 (973.49)
25	11.7 (38.46)	308.4 (1011.95)
26	12.3 (40.46)	320.8 (1052.41)
27	12.3 (40.39)	333.1 (1092.80)
28	12.0 (39.37)	345.1 (1132.17)
29	12.3 (40.20)	357.3 (1172.37)
30	11.9 (39.06)	369.2 (1211.43)
31	12.5 (40.92)	381.7 (1252.35)
32	12.3 (40.41)	394.0 (1292.76)
33	12.2 (40.06)	406.3 (1332.82)
34	12.6 (41.22)	418.8 (1374.04)
35	12.6 (41.30)	431.4 (1415.34)
36	12.1 (39.85)	443.5 (1455.19)
37	12.6 (41.34)	456.1 (1496.53)
38	12.3 (40.38)	468.5 (1536.91)
39	12.1 (39.59)	480.5 (1576.50)
40	12.1 (39.62)	492.6 (1616.12)
41	12.2 (40.01)	504.8 (1656.13)
42	12.3 (40.45)	517.1 (1696.58)
43	12.6 (41.42)	529.7 (1738.00)
44	12.4 (40.68)	542.1 (1778.68)
45	11.7 (38.50)	553.9 (1817.18)
46	11.8 (38.60)	565.6 (1855.78)
47	12.1 (39.85)	577.8 (1895.63)
48	12.7 (41.78)	590.5 (1937.41)
49	12.2 (39.89)	602.7 (1977.30)
50	12.5 (41.09)	615.2 (2018.39)
51	12.4 (40.55)	627.6 (2058.94)

[a] All intermediate casing was 34 cm (13-3/8 in.) OD, 81.3 kg/m (54.5 lb/ft), ST&C, K-55, Range 3.

ROCKY MOUNTAIN GEO-ENGINEERING COMPANY

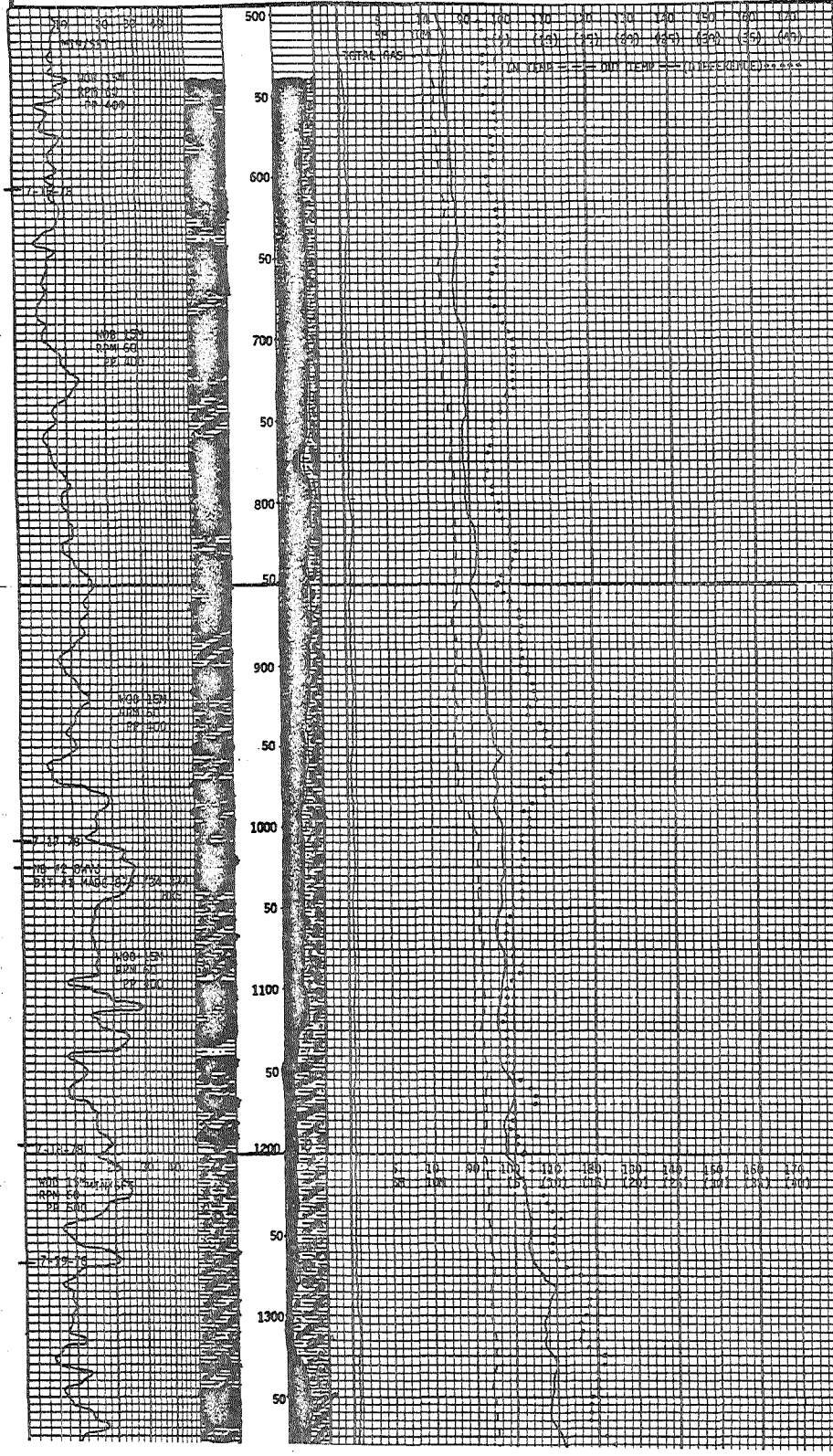
Grand Junction, Colorado

				FROM	TO
COMPANY	EG&G IDAHO INC.	LOCATION	NE SW SE SEC. 23 T15S R26E	DEPTH LOGGED	7/15/78	7/31/78
WELL	RRGI #7	COUNTY	CASSIA	DATE LOGGED	540'	3958'
FIELD	RAFT RIVER GEOTHERMAL	STATE	IDAHO			
ELEVATION	G.L. 4855 K.B. 4871	DRILLING FLUID	MUD & WATER	ENGINEERS	BLAIK COPELAND	

SHALE · SANDSTONE · SILTSTONE · TUFF · SCHIST · QUARTZ · QUARTZ MONZONITE · CONGLOMERATE · RHYOLITE

CORE NO. · DST NO. · DEVIATION

NB - NEW BIT
NR - NO RETURNS
CO - CIRCULATE OUT
NS - NO SAMPLE
TG - TRIP GAS



ONE MAN LOGGING UNIT ON LOCATION 7/15/78 @ 500'

SS LSE QTZ GRNS WH CLR YELL ROSE

SLTST LTBRN-TAN GY CALC
SLI INCR YELL ROSE QTZ
SLTST AA W/WH NON CALC

DECR CALC SLTST
SLTST GRN HD
TR BIOTITE

SS & SLTST PEBBLES W/SLI CALC

SS LSE QTZ WH CLR ROSE
SLTST GY GRN HD -SFT NON CALC
DECR PEBBLES

SS LTGY HD SLI CALC
SLTST LTGY TAN HD-SFT

SS PEBBLES
SLTST GY GRN HD CALC

SS UNCON QTZ GRNS CLR WH
TR MICA & BIOTITE
SS & SLTST PEBBLES

DECR UNCONS SS QTZ GRNS
DECR PEBBLES

SS QTZ GRNS WH CLR YELL GY
SLTST GY-DKGY W/CALC
SLTST GY-DKGY WH HD NON CALC

SS QTZ GRNS PEBBLES

INCR WHITE QTZ GRNS

SS & SLTST PEBBLES AA
UNCON QTZ GRNS
DECR PEBBLES

INCR LSE QTZ GRNS
SLTST GY-DKGY HD W/CALC
TR MICA & BIOTITE

INCR SS & SLTST PEBBLES

TR BIOTITE

DECR PEBBLES
SS WH CLR YELL LSE QTZ GRNS
SLTST GY-DKGY LTGY NON CALC

SLTST AA

TR GYP

SLTST GRN V HD NON CALC
SS CLR LSE QTZ GRNS

SLTST LTGY FRM V CALC

SS QTZ GRNS LSE CLR WH
W/SS & SLTST PEBBLES

SS LTGY W/BIOTITE INCLU
SLTST GRN-DKGRN HD NON CALC
TR CONG DKGY FRM

SS & SLTST PEBBLES
SS LSE QTZ YELL WH CLR
TR PYR INCLU

SLTST LTGY-GY-DKGY HD SLI CALC

SLTST LTGY FRM CLYEY CALC

SS LSE QTZ WH CLR

SLTST CLYEY CALC

SLTST FRM LTGY CLYEY V CALC
SS GY CG FRM MOEM SLI CALC

SLTST AA
SLTST DKGY BRN HD NON CALC
SS LSE QTZ GRNS

SLTST DKGY DKGRN HD NON CALC
TR GYP PYR INCLU

SS FG LTGY-GY S&P FRM-HD
LSE QTZ GRNS SLI INCR PYR

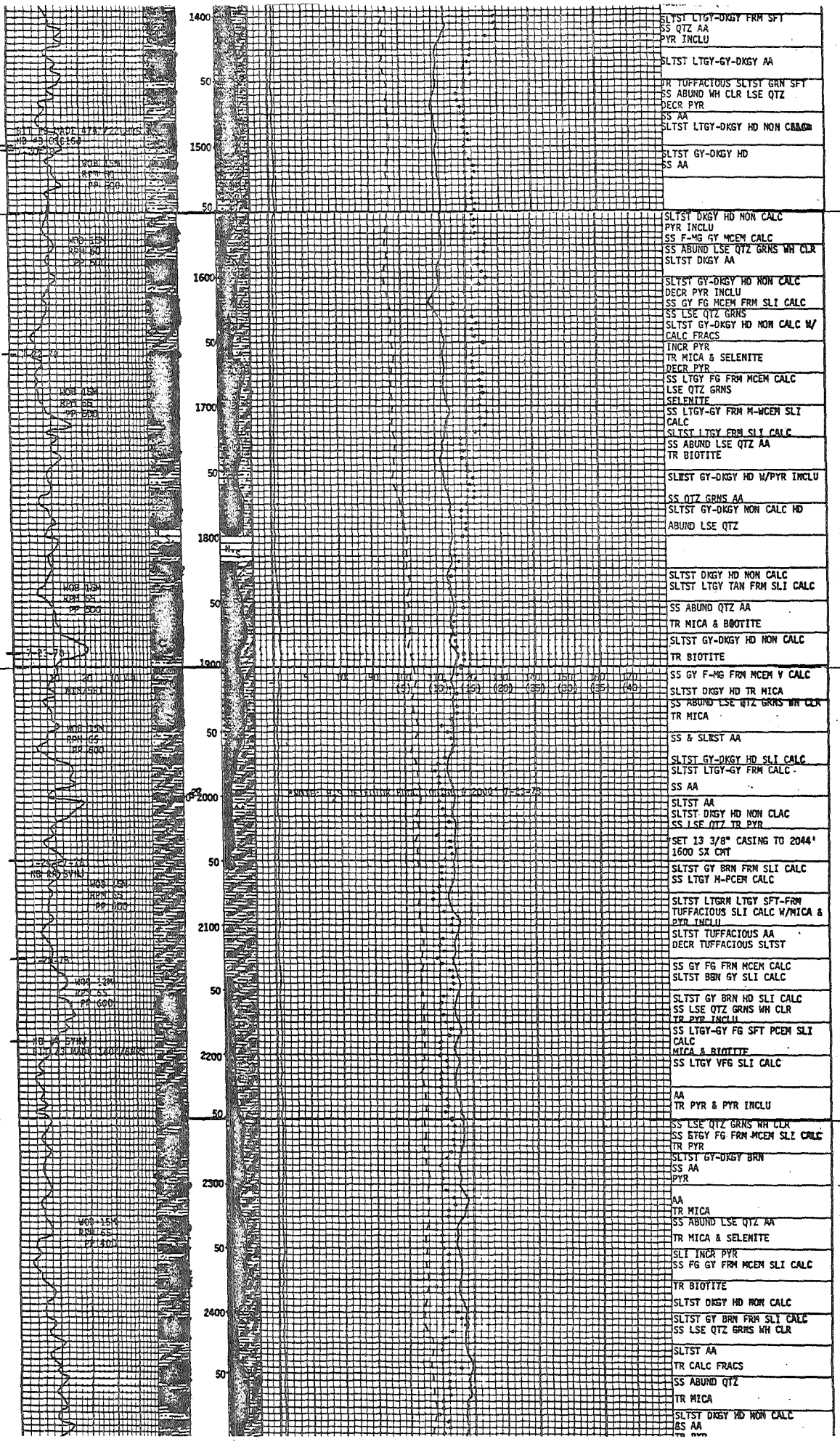
SLTST DKGY DKGRN HD MICACIOUS
DECR PYR
SS LSE QTZ GRNS CLR WH

TR BIOTITE & SELENITE
SLTST GY CLYEY SFT-FRM CALC

SLTST GY LTBRN CLYEY AA
SS LSE QTZ GRNS
W/CALC FRACS

SS LSE QTZ ROSE YELL
SLTST DKGY DKGRN HD
TR PYR INCLU

SLTST GY-DKGY HD NON CLAC
SS LSE QTZ
SS VFG LTGY SLI CALC
SLI INCR PYR INCLU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SS QTZ AA
PYR INCLU
SLTST LTGY-GY-DKGY AA
TR TUFFACIOUS SLTST GRN SFT
SS ABUND WH CLR LSE QTZ
DECR PYR
SS AA
SLTST LTGY-DKGY HD NON CALC
SLTST GY-DKGY HD
SS AA
SLTST DKGY HD NON CALC
PYR INCLU
SS F-MG GY MCEM CALC
SS ABUND LSE QTZ GRNS WH CLR
SLTST DKGY AA
SLTST GY-DKGY HD NON CALC
DECR PYR INCLU
SS GY FG MCEM FRM SLI CALC
SS LSE QTZ GRNS
SLTST GY-DKGY HD NON CALC W/
CALC FRACS
INCR PYR
TR MICA & SELENITE
DECR PYR
SS LTGY FG FRM MCEM CALC
LSE QTZ GRNS
SELENITE
SS LTGY-GY FRM M-MCEM SLI
CALC
SLTST LTGY FRM SLY CALC
SS ABUND LSE QTZ AA
TR BIOTITE
SLTST GY-DKGY HD W/PYR INCLU
SS QTZ GRNS AA
SLTST GY-DKGY NON CALC HD
ABUND LSE QTZ
SLTST DKGY HD NON CALC
SLTST LTGY TAN FRM SLI CALC
SS ABUND QTZ AA
TR MICA & BIOTITE
SLTST GY-DKGY HD NON CALC
TR BIOTITE
SS GY F-MG FRM MCEM V CALC
SLTST DKGY HD TR MICA
SS ABUND LSE QTZ GRNS WH CLR
TR MICA
SS & SLTST AA
SLTST GY-DKGY HD SLI CALC
SLTST LTGY-GY FRM CALC
SS AA
SLTST AA
SLTST DKGY HD NON CLAC
SS LSE QTZ TR PYR
*SET 13 3/8" CASING TO 2044'
1600 SX CMT
SLTST GY BRN FRM SLI CALC
SS LTGY M-FCEM CALC
SLTST LTGRN LTGY SFT-FRM
TUFFACIOUS SLI CALC W/MICA &
PYR INCLU
SLTST TUFFACIOUS AA
DECR TUFFACIOUS SLTST
SS GY FG FRM MCEM CALC
SLTST BRN GY SLI CALC
SLTST GY BRN HD SLI CALC
SS LSE QTZ GRNS WH CLR
TR PYR INCLU
SS LTGY-GY FG SFT FCEM SLI
CALC
MICA & BIOTITE
SS LTGY VFG SLI CALC
AA
TR PYR & PYR INCLU
SS LSE QTZ GRNS WH CLR
SS LTGY FG FRM MCEM SLI CALC
TR PYR
SLTST GY-DKGY BRN
SS AA
PYR
AA
TR MICA
SS ABUND LSE QTZ AA
TR MICA & SELENITE
SLI INCR PYR
SS FG GY FRM MCEM SLI CALC
TR BIOTITE
SLTST DKGY HD NON CALC
SLTST GY BRN FRM SLI CALC
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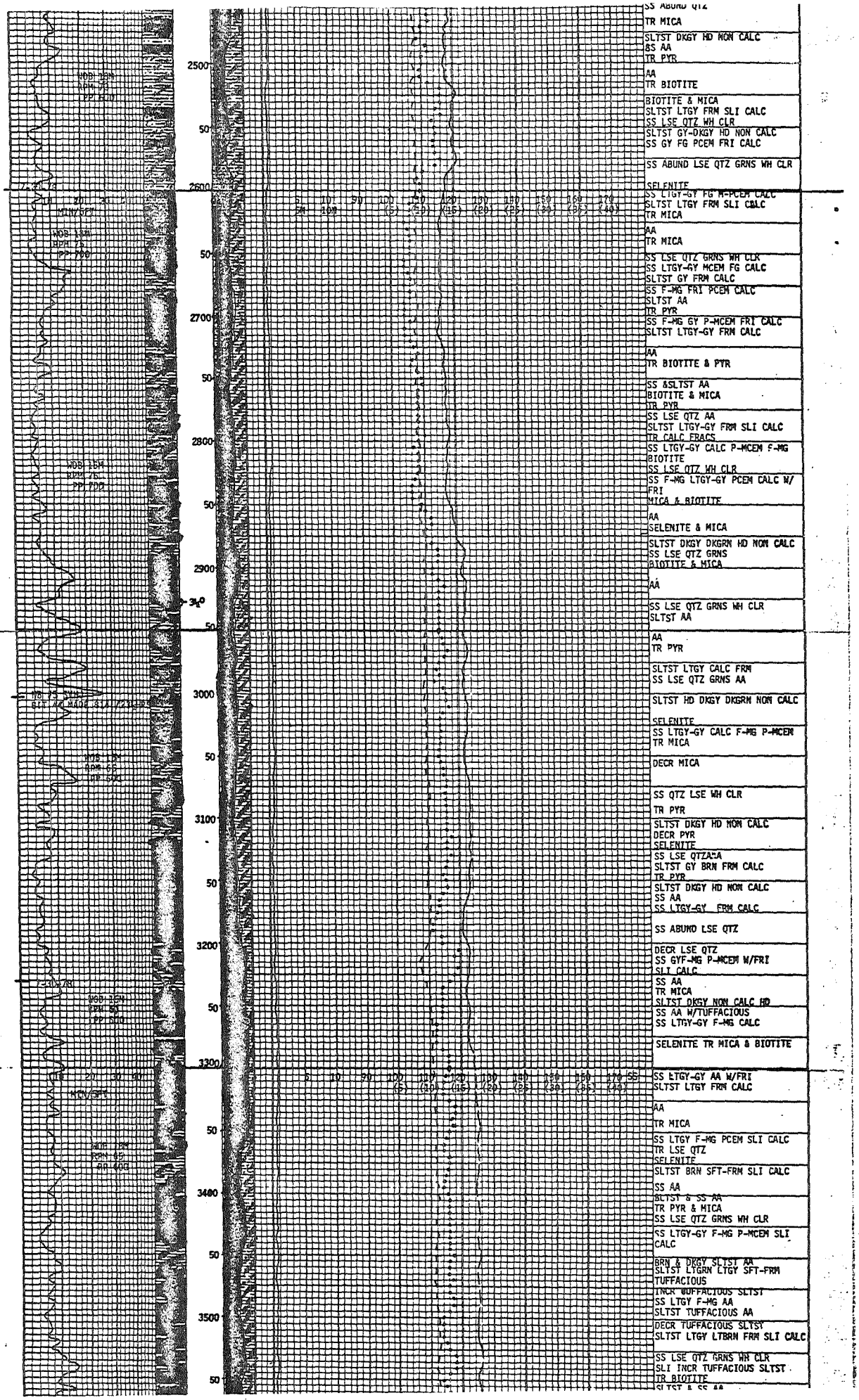
SLTST AA
TR CALC FRACS
SS ABUND QTZ
TR MICA
SLTST DKGY HD NON CALC
&S AA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3500
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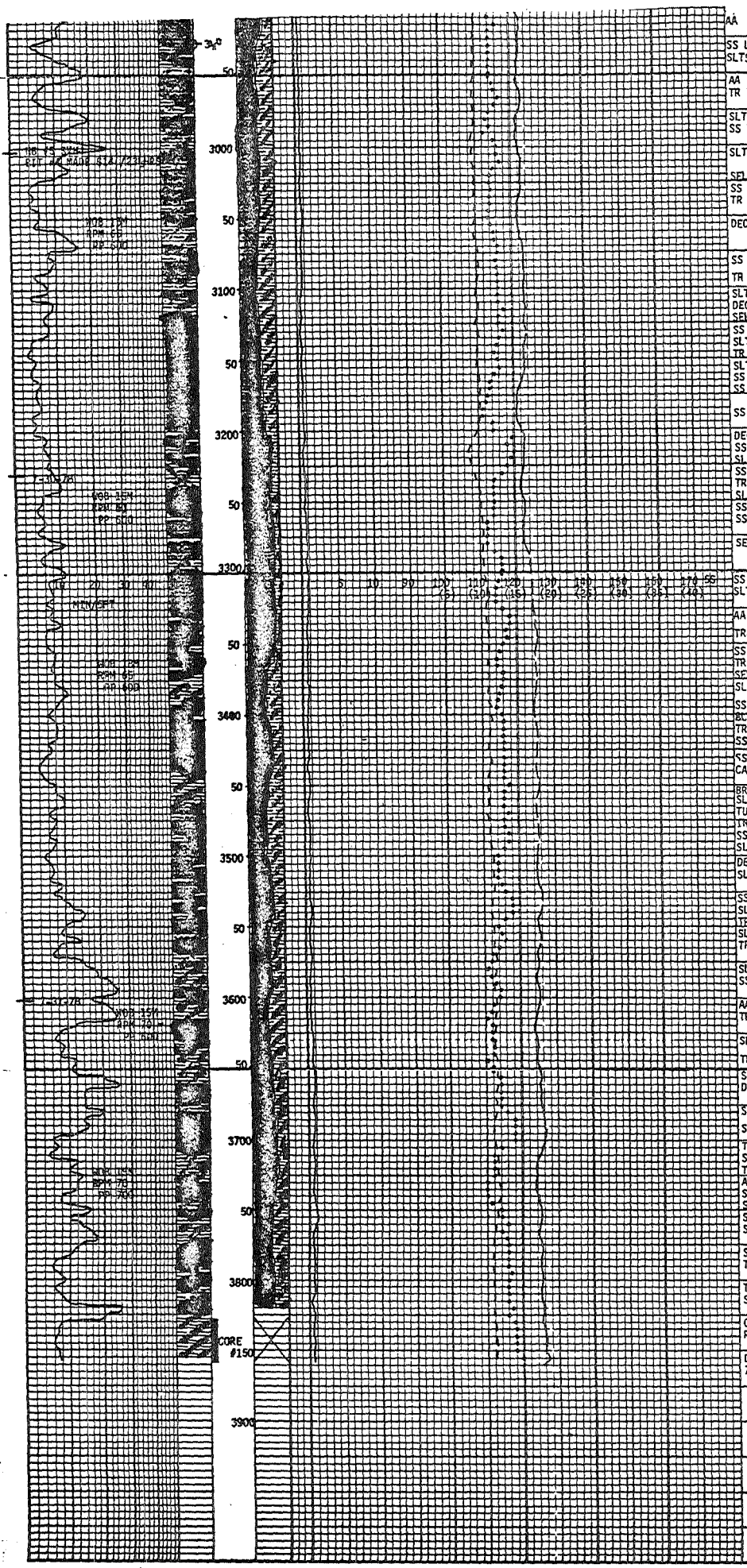
SS ABUND QTZ
TR MICA
SLTST DKGY HD NON CALC
BS AA
TR PYR
AA
TR BIOTITE
BIOTITE & MICA
SLTST LTGY FRM SLI CALC
SS LSE QTZ WH CLR
SLTST GY-DKGY HD NON CALC
SS GY FG PCEM FRI CALC
SS ABUND LSE QTZ GRNS WH CLR
SELENITE
SS LTGY-GY FG M-PCEM CALC
SLTST LTGY FRM SLI CALC
TR MICA
AA
TR MICA
SS LSE QTZ GRNS WH CLR
SS LTGY-GY MCEM FG CALC
SLTST GY FRM CALC
SS F-MG FRI PCEM CALC
SLTST AA
TR PYR
SS F-MG GY P-MCEM FRI CALC
SLTST LTGY-GY FRM CALC
AA
TR BIOTITE & PYR
SS &SLTST AA
BIOTITE & MICA
TR PYR
SS LSE QTZ AA
SLTST LTGY-GY FRM SLI CALC
TR CALC FRACS
SS LTGY-GY CALC P-MCEM F-MG
BIOTITE
SS LSE QTZ WH CLR
SS F-MG LTGY-GY PCEM CALC W/
FRI
MICA & BIOTITE
AA
SELENITE & MICA
SLTST DKGY DKGRN HD NON CALC
SS LSE QTZ GRNS
BIOTITE & MICA
AA
SS LSE QTZ GRNS WH CLR
SLTST AA
AA
TR PYR
SLTST LTGY CALC FRM
SS LSE QTZ GRNS AA
SLTST HD DKGY DKGRN NON CALC
SELENITE
SS LTGY-GY CALC F-MG P-MCEM
TR MICA
DECR MICA
SS QTZ LSE WH CLR
TR PYR
SLTST DKGY HD NON CALC
DECR PYR
SELENITE
SS LSE QTZ AA
SLTST GY BRN FRM CALC
TR PYR
SLTST DKGY HD NON CALC
SS AA
SS LTGY-GY FRM CALC
SS ABUND LSE QTZ
DECR LSE QTZ
SS GYF-MG P-MCEM W/FRI
SLT CALC
SS AA
TR MICA
SLTST DKGY NON CALC HD
SS AA W/TUFFACIOUS
SS LTGY-GY F-MG CALC
SELENITE TR MICA & BIOTITE
SS LTGY-GY AA W/FRI
SLTST LTGY FRM CALC
AA
TR MICA
SS LTGY F-MG PCEM SLI CALC
TR LSE QTZ
SELENITE
SLTST BRN SFT-FRM SLI CALC
SS AA
SLTST & SS AA
TR PYR & MICA
SS LSE QTZ GRNS WH CLR
SS LTGY-GY F-MG P-MCEM SLI
CALC
BRN & DKGY SLTST AA
SLTST LTGRN LTGY SFT-FRM
TUFFACIOUS
INCR TUFFACIOUS SLTST
SS LTGY F-MG AA
SLTST TUFFACIOUS AA
DECR TUFFACIOUS SLTST
SLTST LTGY LTBRN FRM SLI CALC
SS LSE QTZ GRNS WH CLR
SLI INCR TUFFACIOUS SLTST
TR BIOTITE
SLTST & SS AA



AA

SS LSE QTZ GRNS WH CLR
SLTST AA

AA
TR PYR

SLTST LTGY CALC FRM
SS LSE QTZ GRNS AA

SLTST MD DKGY DKGRN NOM CALC

SELENITE

SS LTGY-GY CALC F-MG P-MCEM
TR MICA

DECR MICA

SS QTZ LSE WH CLR

TR PYR

SLTST DKGY MD NOM CALC
DECR PYR
SELENITE

SS LSE QTZ AA
SLTST GY BRN FRM CALC
TR PYR

SLTST DKGY MD NOM CALC
SS AA
SS LTGY-GY FRM CALC

SS ABUND LSE QTZ

DECR LSE QTZ
SS GYF-MG P-MCEM W/FRI
SLI CALC

SS AA
TR MICA
SLTST DKGY NOM CALC MD

SS AA W/TUFFACIOUS
SS LTGY-GY F-MG CALC

SELENITE TR MICA & BIOTITE

SS LTGY-GY AA W/FRI
SLTST LTGY FRM CALC

AA

TR MICA

SS LTGY F-MG PCEM SLI CALC
TR LSE QTZ
SELENITE

SLTST BRN SFT-FRM SLI CALC

SS AA

SLTST & SS AA
TR PYR & MICA
SS LSE QTZ GRNS WH CLR

SS LTGY-GY F-MG P-MCEM SLI CALC

BRN & DKGY SLTST AA
SLTST LTGRN LTGY SFT-FRM
TUFFACIOUS

INCR TUFFACIOUS SLTST
SS LTGY F-MG AA
SLTST TUFFACIOUS AA

DECR TUFFACIOUS SLTST
SLTST LTGY LTBRN FRM SLI CALC

SS LSE QTZ GRNS WH CLR
SLI INCR TUFFACIOUS SLTST
TR BIOTITE

SLTST & SS AA
TR PYR

SLTST LTBRN FRM CALC
SS LTGY-GY F-MG P-MCEM CALC

AA
TR MICA & SELENITE

SLTST DKGY MD NOM CALC

TR PYR

SLTST LTGY-GY FRM CALC
DECR TUFFACIOUS SLTST

SS F-MG GY PCEM CALC

SS LSE QTZ AA

TR CALC FRACS
SLTST & SS AA
TR PYR

ABUND LSE QTZ GRNS WH CLR
SLTST LTGY-GY AA
SLTST LTGRN TUFFACIOUS

SS LSE QTZ
SLTST DKGY NOM CALC MD

SS LTGY-GY F-MG P-MCEM CALC
TR TUFFACIOUS SLTST

TR MICA +
SLTST & SS AA

CORE #1 FROM 3828' TO 3858'
RECV'D 18' SLTST & SS W/FRACS

DRILLERS & LOGGERS T.D. 3858'
7-31-78