See Packet 1 PDR encl

FEB 27 1984

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WMEG r/f
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LPDR

MEMORANDUM FOR: Robert J. Wright
Repository Projects Branch
Division of Waste Management

FROM: Mysore S. Nataraja
Engineering Branch
Division of Waste Management

John T. Buckley
Engineering Branch
Division of Waste Management

SUBJECT: INFORMATION COLLECTED DURING DATA REVIEW VISIT AT BWIP (JANAURY 23-26, 1984)

During January 23-26, 1984, M. Nataraja and J. Buckley performed a data review at the BWIP site. This memo describes the events which took place and lists the attendees that took part in the data review and presents the details on data either gathered or requested during the visit.

On Monday, (January 23, 1984) we (Mysore Nataraja, John Buckley, Jaak Daemen and Ernie Corp) met in the BWIP library to review colored photographs of the rock cores from various boreholes. By examining the core photographs and a borehole information handout (attachment 1), we determined which core boxes should be examined on Wednesday the 25th, in the core library.

Tuesday morning, (January 24, 1984) Rockwell, DOE, NRC, and their Consultants (EI, GAI, and BOM) gathered at the Visitors Center-Gable Mountain for presentations on current in situ testing. Prior to a general introduction by P. Boileau of DOE and N. Steger of Rockwell, the meeting attendees (attachment 2) received a copy of the program (attachment 3). Following the general introduction, E. C. Gregory, M. L. Cramer, T. A. Rundle and D. L. South (all from Rockwell) gave brief presentations on the Full-Scale Heater Test, Block Test, Hydrofracture Test and Rock Mechanics Laboratory tests respectively. These presentations concentrated on collection and analyses of current in situ test data. Each presentation was supplemented by handouts (attachments 4-9).

WM Record File 101
WM Project 10
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OFC	WMEG	WMEG					
NAME	JTBuckley:jet	MSNataraja					
DATE	02/ /84	02/ /84					00689

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Following the Rockwell presentations, the NRC representatives and their Contractors divided into three groups. Each group was responsible for reviewing the data from one of the following three tests;

1. Full-Scale Heater Test,
2. Block Test,
3. Hydrofracture Test.

Prior to the BWIP visit we (NRC and Contractors) developed a standard data review checklist. Each person in each group was responsible for completing the data review checklist for that particular test. Copies of the checklists are enclosed with this memo (attachments 10-16). The purpose of the visit was to review in situ test procedures and to obtain existing data for our evaluation. For the Block Test, a request was made for data from one complete loading and unloading cycle. The data was not given to us during the visit, however, we were assured that the said data would be sent to us after going through Rockwell's clearance. Some data has been collected for the Full-Scale Heater Test and the Hydrofracture Test. Attachment 17 is a copy of the data collected while at BWIP and attachment 18 is a list of data requested from Rockwell. Rockwell has agreed to send this data after clearance.

On Wednseday morning, the 25th, R. Wilde of Rockwell presented handouts (attachments 19-20) along with a short introduction. J. T. Baxter of Rockewell gave a brief presentation on the "Overview of Application of Geomechanics Numerical Modeling to Repository Design and Performance Assessment" (attachment 21). Based on information presented during Baxter's presentation, review checklists were prepared on computer codes being used at BWIP. (see attachment 22). In the afternoon we toured the rock mechanics laboratory (see attachment 23) and examined rock cores of interest at the core library. A demonstration triaxial test was performed on a rock specimen in an MTS machine along with a demonstration of analyzing and plotting the stress-strain data on the computer screen. Larry Hulstrom of Rockwell gave us an overview of the laboratory instrumentation and briefly presented the procedures for determining the dynamic modulus, coefficient of thermal expansion, joint shear strength. He also showed us the filing and record keeping system for all tests performed in the laboratory.

Thursday morning, January 26, 1984 was spent at the Visitors Center-Gable Mountain. We completed our data review checklists and viewed videotapes of the boreholes. On the way back to Richland, we stopped at the exploratory shaft site and toured the drill rig and vicinity.

OFC	WMEG	WMEG					
NAME	JTBuckley	MSNataraja					
DATE	02/ /84	02/ /84					

SUMMARY AND FUTURE PLANS

The data review visit was productive because we could visit the test location, visually observe the test set-up and instrumentation, and collect raw data for further review. BWIP has agreed to provide additional test data for the Block Test, Hydrofracture Test and Heater Test as soon as they are cleared through Rockwell clearance procedures.

The proposed data review process will consist of four (4) steps:

1. Convey our preliminary observations to DOE;
2. Review and analyze the data;
3. Convey NRC concerns, if any, to DOE; and
4. Perform sensitivity analyses and analyze test data in detail.

Original Signed By:

Mysore S. Nataraja
Engineering Branch
Division of Waste Management

Original Signed By:

John T. Buckley
Engineering Branch
Division of Waste Management

OFC	WMEG	WMEG					
NAME	JTBuckley	MSNataraja					
DATE	02/24/84	02/24/84					

see folder for memo to Wright frm. Nazaroja 2/27/84

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NUCLEAR REGULATORY COMMISSION
GEOMECHANICS WORKSHOP

Attached are the following items:

1. BWIP Borehole Catalogue
2. Borehole location maps
3. Stratigraphic column
4. List of boreholes with video tape data
5. List of boreholes with acoustic logging data
6. List of boreholes with geophysical logging data
7. List of boreholes with laboratory data. Also includes list of areas within the Near-Surface Test Facility for which data is available
8. List of boreholes with hydrofracture data
9. List of tests performed in the Near-Surface Test Facility
10. Appendix A - lists specific geophysical and acoustic data available for selected boreholes in the reference repository location
11. Appendix B - lists references in which laboratory test results are presented

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Appendix A

BWIP Borehole Catalog

March, 1982

BOREHOLE NUMBER	DRILLING COMPLETE	DEPTH (FEET)	COORDINATE LOCATION*	PURPOSE FOR DRILLING	STATUS AS OF MARCH, 1982	PLANNED BWIP ACTIVITY
EARLY BOREHOLES						
Enyeart	1922	1,092	699-59-112	Ranch water well	Cased to 915 feet, open below	Limited testing
O'Brian	1922	700	699-52-115	Ranch water well	Cased to 600 feet, open below	Limited testing
Ford	1925	777	699-52-111	Ranch water well	Cased to 625 feet, open below	Limited testing
McGee	1927	960	699-53-103	Ranch water well	Cased to 600 feet, open below	Extend to 3,500 feet, drill & test
Benson	1929	1,000	699-20-82	Ranch water well	Plugged at about 600 feet	Cleanout & test selected sections
RH #6	1931	3,660	699-51-67	Gas well	Cased to 776 feet, plugged at 300 feet	Cleanout & test selected sections
92-14	1951	1,396	699-92-14	Army water well	Cased to about 945 feet, plugged	Cleanout & test selected sections
113-38	1953	1,140	699-113-38	Army water well	Cased to about 1,115 feet, plugged	Cleanout & test selected sections
114-60	1953	887	699-114-60	Army water well	Plugged	Cleanout & test selected sections
RSH-1	1958	10,660	699-52-116	Resource exploration	Plugged at 3,300 feet, open below	Cleanout & test selected sections
BH-17	1971	1,456	699-82-60	SPPSS siting	Cased to 1,011 feet	Extend to 1,500 feet & selected tests
PRIOR HANFORD DRILLING PROGRAMS						
399-5-2	1954	426	699-S26-E10	Groundwater monitoring	Cased to basalt, open below	Geophysical logging standard hole
S11-E12A	1960	282	699-S11-E12A	Groundwater monitoring	Piezometer installed to 225 feet	Limited testing
ARH-DC-1	1969	5,661	699-48-48	Site feasibility	Reentered in 1973 & piezometers installed	Sample and/or test piezometers
DDH-1	1969	1,165	699-49-48	Site feasibility	Rods in hole, partially plugged	Limited testing or sampling
DH-2	1969	690	699-52-118	Site feasibility	Open, next to RSH-1	None
DDH-3	1970	3,540	699-S30-E15	Site feasibility	Piezometer installed, 1,973-2,053 feet	Limited testing or sampling
DH-4	1971	4,773	699-115-11	Site feasibility	Piezometer installed, 4,500-4,710 feet	Cleanout plugged piezometer, test
DH-5	1972	5,002	699-115-122	Site feasibility	Piezometer installed, 4,854-5,002 feet	Cleanout plugged piezometer, test
DH-6	1976	515	699-43-74	200 Area waste mgmt.	NX cased to total depth	None
DH-7	1976	573	699-37-75	200 Area waste mgmt.	NX cased to 406 feet, open below	None
DH-8	1976	266	699-51-55	Radionuclide migration	Open	Limited testing
DH-8A	1976	327	699-51-55	Radionuclide migration	Open	Limited testing & sampling
DH-9	1976	429	699-49-100	Groundwater monitoring	Cased entry hole for DB-11	See DB-11
DH-9A	1976	222	699-41-42	Groundwater monitoring	Cased to 154 feet, grouted back to casing	None
DH-10	1976	145	699-59-55	Groundwater monitoring	Drilling stopped by caving sand	None
DH-11	1977	501	699-40-78	200 Area waste mgmt.	NX cased to total depth	None
DH-12	1977	531	699-41-75	200 Area waste mgmt.	Open	None
DH-13	1977	244	699-40-72	200 Area waste mgmt.	NX cased to 473 feet, open below	None
DH-14	1977	262	699-42-56	200 Area waste mgmt.	Hole deviated and was stopped	None
DH-15	1977	381	699-42-52	200 Area waste mgmt.	NX cased to total depth	None
DH-16	1977	353	699-42-48	200 Area waste mgmt.	Cemented to top	None
DH-17	1977	536	699-38-56	200 Area waste mgmt.	Cased to 411 feet, open below	None
DB-1	1973	1,139	699-2-E14	Radionuclide migration	Cased to 1,030 feet, open below	Test and/or deepen to 1,500 feet
DB-2	1974	1,273	699-15-E13	Radionuclide migration	Cased to 957 feet, open below	Test and/or deepen to 1,500 feet
DB-3	1973	190	699-15-E17	Radionuclide migration	Entry hole only, not cored	None
DB-4	1978	3,998	699-49-85	Radionuclide migration	Cased to 1,278 feet, open below	Limited testing
DB-5	1973	803	699-52-57	Radionuclide migration	Cased to 288 feet, open below	Limited testing
DB-6	1974	350	699-1-18	Radionuclide migration	Coring cancelled, entry hole not to basalt	None
DB-7	1974	812	699-S16-24	Radionuclide migration	Cased to 597 feet, open below	Limited testing
DB-8	1977	1,092	699-42-42	Radionuclide migration	Cased to 937 feet, cemented to 902 feet	None
DB-9	1977	589	699-63-57	Radionuclide migration	Cased to 461 feet, screen 490-589 feet	Limited testing
DB-10	1977	893	699-51-36	Radionuclide migration	Cased to 744 feet, screen 843-893 feet	Limited testing
DB-11	1977-82	1,199	699-49-100	Radionuclide migration	Cased to 709 feet, open below	Limited testing
DB-12	1978	707	699-63-35	Radionuclide migration	Cased to 524 feet, open below	Limited testing, deepen to 1,000 feet
DB-13	1974	1,292	699-17-47	Radionuclide migration	Cased to 353 feet, screened below	Limited testing
DB-14	1978	1,212	699-25-80	Radionuclide migration	Cased to 1,038 feet, open below	Limited testing, deepen to 1,500 feet
DB-15	1979	1,971	699-47-42	Radionuclide migration**	Cased to 854 feet, open below	Limited testing
BASALT WASTE ISOLATION PROJECT BOREHOLES						
DC-2	1977	3,300	699-48-49	Site characterization	Plugged back to 2,370 feet	None
DC-2-A1	1978	3,348	699-48-49	Site characterization	Plugged back to 2,786 feet	None
DC-2-A2	1978	3,374	699-48-49	Site characterization	Cased to 2,253 feet, open below	Test selected sections
DC-3	1977	3,635	699-44-70	Site characterization	Cased to 3,575 feet, open below	Limited testing, install geophone
DC-4	1978	3,998	699-49-85	Site characterization	Cased to 2,639 feet, open below	Test selected sections
DC-5	1978	3,990	699-49-85	Site characterization	Cased to 2,615 feet, open below	Test selected sections-deepen to 5,800'
DC-6	1978	4,336	699-54-17	Site characterization	Cased to 2,260.5 feet, open below	Test selected sections
DC-7	1977(80)	5,008	699-35-15	Site characterization	Cased to 2,780 feet, open below	Test selected sections
DC-8	1978	4,100.5	699-35-15	Site characterization	Cased to 2,734 feet, open below	Test selected sections
DC-9			699-54-17		Drilling cancelled by budget constraints	None
DC-10	1977	456	699-62-53	NSTF construction	Uncased 26° slant hole	None, evaluate for limited testing
DC-11	1978	385	699-61-53	NSTF construction	Uncased vertical hole	None, evaluate for limited testing
DC-12	1981	4,455	699-10-54	Site characterization	Cased to 2,260 feet, open below	Test selected sections
DC-13			699-72-85		Drilling cancelled, replaced by BH-17 data	None
DC-14	1981	3,355	699-84-34	Site characterization	Cased to 1,085 feet, open below	Test selected sections
DC-15	1981	4,243	699-S15-E14	Site characterization	Cased to 2,198 feet, open below	Test selected sections
DC-16A		Coring	699-31-84	Site characterization	Cased to 1,369 feet, open below	Drill & test to 4,000 feet
DC-16B				Site characterization	Near DC-16A, south of RRL	Rotary drill to 3,670 feet
DC-16C				Site characterization	Near DC-16A, south of RRL	Rotary drill to 3,670 feet
DC-17				Site characterization	Planned W/ of RRL, location not staked	Drill and test to 4,200 feet
DC-18				Site characterization	Planned Gable Mt. Gap, location not staked	Drill and test to 3,500 feet
DH-18	1980	630	699-28-15	Site characterization	NX cased to total depth	None
DH-19	1980	776	699-71-14	Site characterization	NX cased to total depth	None
DH-20	1981	569	699-24-83	Site characterization	NX cased to total depth	None
DH-21	1982	828	699-37-85	Site characterization	NX cased to total depth	None
DH-22	1981	688	699-37-91	Site characterization	NX cased to total depth	None
DH-23	1982	177	699-47-84	Site characterization	Drilling stopped, replaced by RRL-7 data	None
DH-24		85	699-41-84	Site characterization	Entry hole cased to 85 feet	Complete to top of basalt
DH-25		138	699-39-84	Site characterization	On standby until DH-17 is complete	Complete to top of basalt
DH-26	1982	363	699-26-84	Site characterization	NX cased to total depth	None
RRL-1	1980	282	699-33-94	Site characterization	Bit lost in hole, replaced by DC-16 data	None
RRL-2***	1980	213	699-39-84	Site characterization	Bit lost in hole, replaced by RRL-2B	None
RRL-2(B)		Coring	699-39-84	Site characterization*	Cased to 1,544 feet* (CS-1 PRINCIPAL BOREHOLE)	Extend to 3,900 feet
RRL-3	1981	710	699-46-79	Site characterization	PVC cased to 700 feet	None
RRL-4	1981	638	699-35-78	Site characterization	PVC cased to 638 feet	None
RRL-5	1981	703	699-42-88	Site characterization	PVC cased to 201 feet	None
RRL-6A	1981	441	699-34-89	Site characterization	Completed as temporary water supply well	Periodic groundwater sampling
RRL-6B	1981	1,613	699-34-89	Site characterization	PVC cased to 1,611 feet	Limited sampling and testing
RRL-7	1982	724	699-37-84	Site characterization	PVC cased to 724 feet	None
RRL-8	1981	733	699-47-93	Site characterization	PVC cased to 713 feet	None
RRL-9	1982	559	699-39-79	Site characterization	PVC cased to 559 feet	None
RRL-10	1982	148	699-36-89	Baseline data	Cancelled, not required	None
RRL-11	1982	142	699-36-93	Baseline data	Cancelled, not required	None
RRL-12	1982	150	699-32-84	Baseline data	Cancelled, not required	None
RRL-13	1982	150	699-25-70	Baseline data	Cancelled, not required	None
CH-1	1980	150	699-61-54	Borehole sealing test	Cased to 5 feet, 3.937 inch open below	Possible borehole sealing tests
CH-2	1980	160	699-61-54	Borehole sealing test	Cased to 4 feet, 3.937 inch open below	Possible borehole sealing tests
CH-3	1980	150	699-61-54	Borehole sealing test	Cased to 4 feet, 3.937 inch open below	Possible borehole sealing tests
CH-4	1980	160	699-61-54	Borehole sealing test	Cased to 4 feet, 3.937 inch open below	Possible borehole sealing tests
CH-5	1980	150	699-61-54	Borehole sealing test	Cased to 4 feet, 3.937 inch open below	Possible borehole sealing tests
CH-6	1980	200	699-61-54	Borehole sealing test	Cased to 4 feet, 3.937 inch open below	Possible borehole sealing tests
RC-1	1981	96.5	699-62-101	Rock mechanics core	Cased to 5 feet, 8 inch open below	None
FH-1	1982	151	699-38-85	CS-1 foundation studies	Drilled as hole B-1	None
FH-2	1982	30	699-38-85	CS-1 foundation studies	Drilled as hole B-2	None
FH-3	1982	31	699-35-85	CS-1 foundation studies	Drilled as hole B-3	None
FH-4	1982	21	699-38-85	CS-1 foundation studies	Drilled as hole B-4	None

NOTES: *Coordinate locations are based on the Hanford Coordinate System.
**Borehole DB-15 was completed as a Basalt Waste Isolation Project borehole from below the Mabton Interbed at 1,[illegible] feet to a total depth of 1,971 feet.
***Borehole RRL-2 was terminated at 213 feet due to drilling problems. A new hole, RRL-2B, was then drilled 25 feet south of the RRL-2 site. RRL-2B will henceforth, for convenience, be referred to as RRL-2.

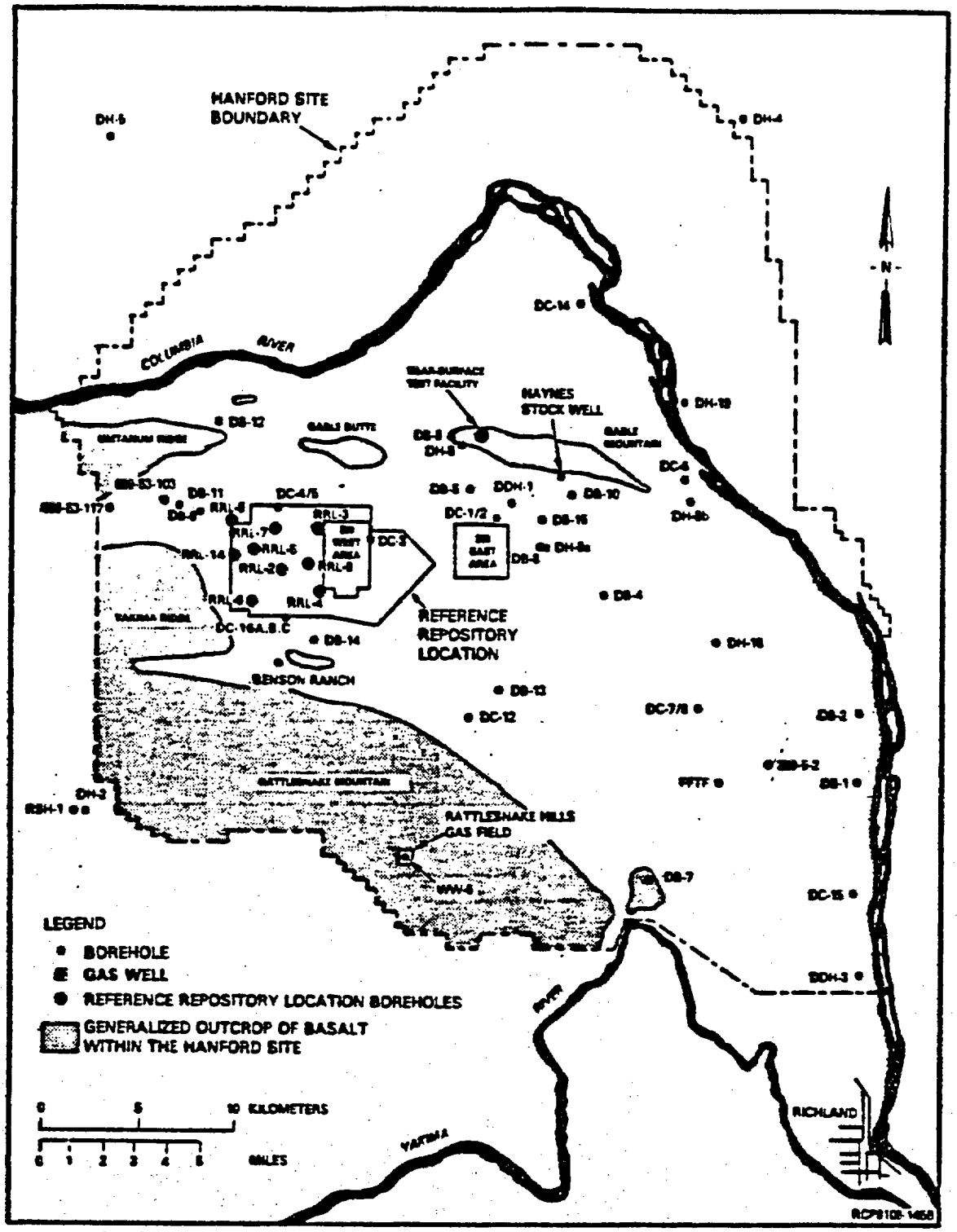
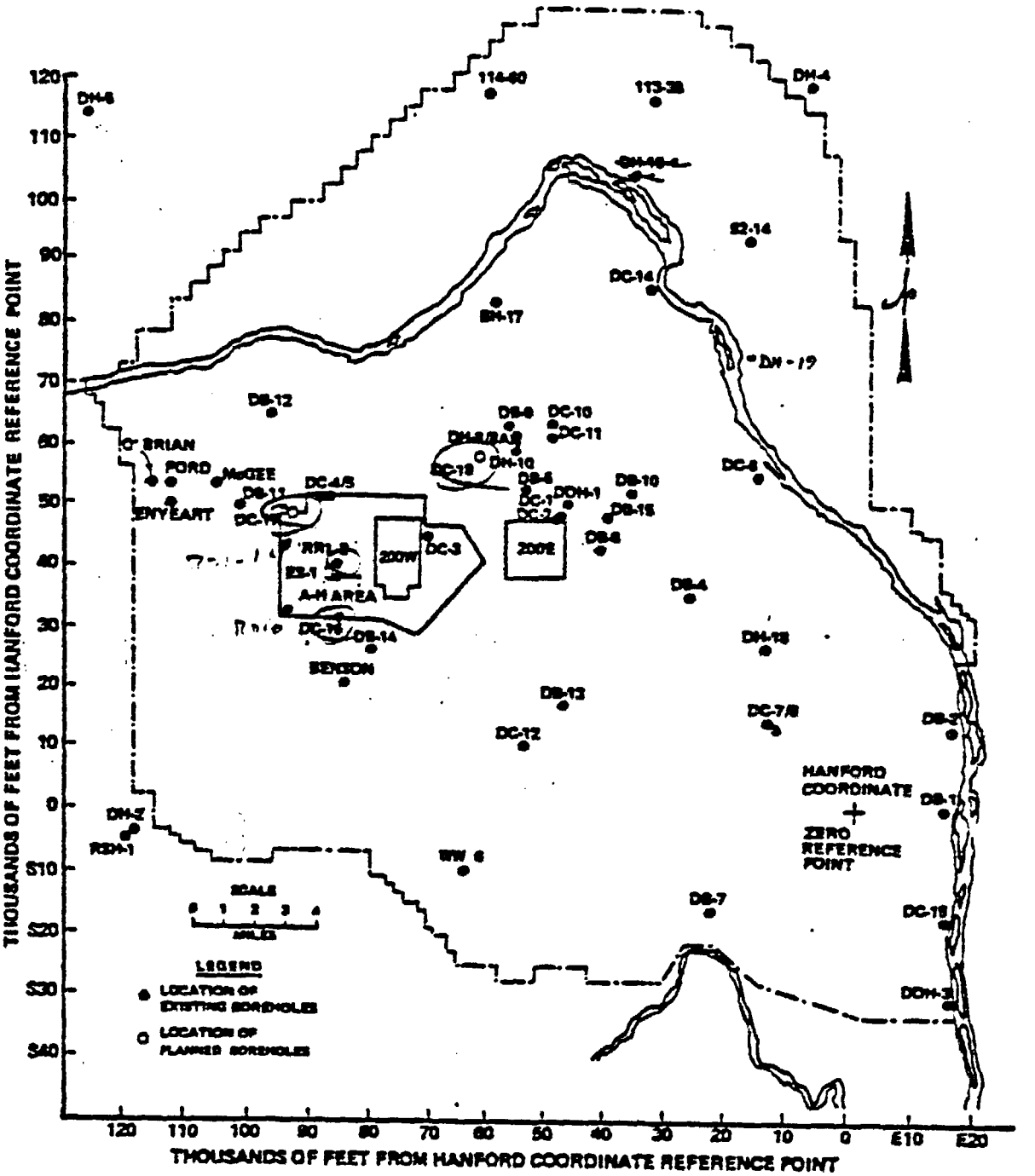


FIGURE 3-3. Location Map for Key Boreholes Used in Basalt Waste Isolation Project Studies.

from: DOE/RL 82-3, Site Characterization Report for BWIP


THOUSANDS OF FEET FROM HANFORD COORDINATE REFERENCE POINT
THOUSANDS OF FEET FROM HANFORD COORDINATE REFERENCE POINT
HANFORD COORDINATE
ZERO REFERENCE POINT
200W
200E
A-H AREA
BRIAN
FORD
McGEE
BENYEART
BENSON
SCALE
MILES
LEGEND
LOCATION OF EXISTING BOREHOLES
LOCATION OF PLANNED BOREHOLES

PERIOD	EPOCH	GROUP	SUBGROUP	FORMATION	K-Ar AGE YEARS X 10^6	MEMBER OR SEQUENCE	GEOLOGIC MAPPING SYMBOL	SEDIMENT STRATIGRAPHY OR BASALT FLOWS	
QUATERNARY	Pleistocene/ Holocene					SURFICIAL UNITS	Ql	LOESS	
							Qd	SAND DUNES	
							Qa, Qaf	ALLUVIUM AND ALLUVIAL FANS	
							Qld	LANDSLIDES	
							Qt	TALUS	
							Qco	COLLUVIUM	
	Pleistocene			Hanford		TOUCHET BEDS/ PASCO GRAVELS	Qht/Qhp		
								PLIO-PLEISTOCENE UNIT	
TERTIARY	Pliocene			Ringold			Tre	UPPER RINGOLD	FANGLOMERATE
							Trc	MIDDLE RINGOLD	
							Trls	LOWER RINGOLD	
							Trg	BASAL RINGOLD	
	Miocene	Columbia River Basalt Group	Yakima Basalt Subgroup	Saddle Mountains Basalt	6.5	ICE HARBOR MEMBER	Ti: Tig	GOOSE ISLAND FLOW	ELLENSBURG FORMATION Tel
							Tim	MARTINDALE FLOW	
							Tib	BASIN CITY FLOW	
								LEVEY INTERBED	
					10.5	ELEPHANT MOUNTAIN MEMBER	Tem: Tem_2	UPPER ELEPHANT MOUNTAIN FLOW	
							Tem_1	LOWER ELEPHANT MOUNTAIN FLOW	
								RATTLESNAKE RIDGE INTERBED	
					12.0	POMONA MEMBER	Tp: Tp_2	UPPER POMONA FLOW	
							Tp_1	LOWER POMONA FLOW	
								SELAH INTERBED	
						ESQUATZEL MEMBER	Te: Te_2	UPPER GABLE MOUNTAIN FLOW	
								GABLE MOUNTAIN INTERBED	
							Te_1	LOWER GABLE MOUNTAIN FLOW	
								COLD CREEK INTERBED	
						ASOTIN MEMBER	Ta	HUNTZINGER FLOW	
						WILBUR CREEK MEMBER	Tw	WAHLUKE FLOW	
						UMATILLA MEMBER	Tu: Tu_s	SILLUSI FLOW	
							Tu_u	UMATILLA FLOW	
					13.6			MASTON INTERBED	
				Wanapum Basalt		PRIEST RAPIDS MEMBER	Tpr: Tpr_l	LOLO FLOW	
							Tpr_r	ROSALIA FLOWS	
								QUINCY INTERBED	
						ROZA MEMBER	Tr: Tr_2	UPPER ROZA FLOW	
							Tr_1	LOWER ROZA FLOW	
								SQUAW CREEK INTERBED	
						FRENCHMAN SPRINGS MEMBER	Tf: Tf_a	APHYRIC FLOWS	
							Tf_p	PHYRIC FLOWS	
					15.6			VANTAGE INTERBED	
				Grande Ronde Basalt		SENTINEL BLUFFS SEQUENCE	Tsb	UNDIFFERENTIATED FLOWS	
								ROCKY COULEE FLOW	
								UNNAMED FLOW	
								COHASSETT FLOW	
								UNDIFFERENTIATED FLOWS	
								McCOY CANYON FLOW	
								INTERMEDIATE-Mg FLOW	
						SCHWANA SEQUENCE	Ts	LOW-Mg FLOW ABOVE UMTANUM	
								UMTANUM FLOW	
								HIGH-Mg FLOWS BELOW UMTANUM	
								VERY HIGH-Mg FLOW	
					16.1			AT LEAST 30 LOW-Mg FLOWS	

RCP8108-1G

1/20/84

VIDEO TAPES

DC-6		
0 - 691'	6-10-83	#1
DC-8		
0 - 3703.7'	6-10-83	#1
3703.7 - 3800'	6-10-83	
DC-12		
0 - 3000'	6-9-83	
DC-16C		
0 - 2051'	6-6-83	#1
2051 - 3235'	6-6-83	#2
3235 - 3839'	6-6-83	#3
DC-19C		
1578 - 2366'	10-21-83	#1
2366 - 3232'	10-21-83	#2
3232 - 3980'	10-21-83	#3
1580 - 2587'	12-19-83	#1
2587 - 3544'	12-19-83	#2
3544 - 3955'	12-19-83	#3
DC-20A		
3 - 526'		
DC-20C		
320 - 2225'	12-6-83	#1
2225 - 2761'	12-6-83	#2
2700 - 3731'	12-7-83	#3
3731 - 3781'	12-7-83	#4
1690 - 3176'	1-19-84	#1
3175 - 3786'	1-19-84	#2

VIDEO TAPES

RRL-2		
0 - 2674'	6-8-83	#1 (plus copy)
0 - 2696'	6-6-83	#1A (plus copy)
2674 - 3634'	6-8-83	#2
2696 - 3530'	6-6-83	#2A (plus copy)
RRL-14		
0 - 2541'	6-9-83	#1 (plus copy)
2541 - 3668	6-9-83	#2 (plus copy)
3668 - 3949.5'	6-9-83	#3 (plus copy)
DB-2		
950 - 1225'	6-7-83	#1
RATTLESNAKE HILLS #1	6-20-83	
O'BRIAN	3-18-83	

Boreholes for which acoustic logging data are available:

RRL-6

DC-4

DC-19C

DC-20C

DC-22C

Boreholes for which geophysical logging data are available:

RRL-2

RRL-6

RRL-14

DC-4

DC-16A

DC-19C

DC-20C

DC-22C

In general, all DC holes have been logged by Pacific Northwest Laboratories (PNL) and logs for their suite of geophysical tests are available.

ROCK MECHANICS LABORATORY DATA

Location	Reports
DC-10	C-11
DC-11	C-38
DH-4	C-38
DH-5	C-38, LBL-7038
DDH-3	C-38
DC-2	C-38, C-92
DC-4	C-55
DC-6	C-50
DC-8	C-54
DB-5	C-76, LBL-7038
DB-15	C-76
NSTF	LBL Letter Report
FS#1	C-77
FS#2	C-85
Area 3	C-100
RRL-2	SD-BWI-TD-002 LBL Letter Report
RRL-6	SD-BWI-TD-003
RRL-14	SD-BWI-TD-00r

Summary Reports: SD-BWI-DP-041
RHO-BWI-C-90

NOTES: 1. References for the reports are presented in Appendix B. All reports listed will be available at the workshop.

2. FS#1 and FS#2 indicate the two full-scale heater tests. Area 3 is the block test area. NSTF indicates the Near-Surface Test Facility. All other designations are boreholes.

HYDROFRACTURING TESTS CONDUCTED TO DATE

Borehole #	Test #	Depth to center of fracture interval *	Basalt flow
DC-12	1	3417	Umtanum
	2	3400	
	3	3382	
	4	3350	
	5	3323	
	6	3288	
RRL-2	1B	3831	Umtanum
	1A	3827	
	2B	3805.5	
	2A	3801	
	3B	3786	
	3A	3782	
	4B	3768	
	4A	3762	
	5B	3471	Grande Ronde #7
	11A	3466	
	6B	3457.5	
	7B	3251.5	Cohassett
	10A	3247.5	
	5A	3244	
	8B	3234	
	6A	3231	
	9B	3181	
	7A	3174	
	10B	3106	
	8A	3102	
	11B	3053	
	9A	3043.5	
	12A	3030	
RRL-6	9	3919	Umtanum
	8	3900.5	
	7	3709	McCoy Canyon
	6	3637	
	5	3624	
	4	3340.5	Cohassett
	3	3336	
	2	3306	
	1	3084	Rocky Coulee
DC-4	2	3202	Cohassett
	1	3170.5	
	3	3021	

* Fracture interval is two feet in length for all tests

Rock Mechanics Tests Performed at the Near-Surface Test Facility

- Laboratory Tests (see lab test data sheet)

- Full-Scale Heater Tests Nos. 1 and 2

- Borehole Jacking
  - Goodman Jack (Foundation Sciences, Inc.)
  - Modified Borehole Jack (De la Cruz and Voss)
  - Sleeve Fracturing (Stephansson)

- Overcoring
  - Borehole Deformation Gauge (Foundation Sciences, Inc.)
  - Borehole Deformation Gauge, CSIRO Hollow Inclusion Stress Cell, cast epoxy inclusion, Luleå triaxial strain cell, and the CSIR doorstopper (Rockwell)

- Block Test
  - Step 1
  - Step 2

- Hydraulic Fracturing
  - pre-NSTF construction (Haimson)
  - post-NSTF construction (Rockwell)

- Crosshole Seismic (LBL)

APPENDIX A

GEOPHYSICAL AND ACOUSTIC DATA AVAILABLE FOR SELECTED BOREHOLES IN THE REFERENCE REPOSITORY LOCATION

TABLE 4. Borehole RRL-2--Geophysical Logging Intervals.

Performed by Pacific Northwest Laboratory

DATE	NEUTRON-NEUTRON (ft)	GAMMA GAMMA (ft)	NATURAL GAMMA (ft)	SONIC (ft)	FLUID TEMPERATURE (ft)	CALIPER (ft)	SPONTANEOUS POTENTIAL/ RESISTIVITY (ft)	DENSITY (ft)	MAGNETOMETER (ft)
03-06-81	2-592		0-591	9-597	13-587			4-597	
06-09-81	3-1450		3-1450	569-1454	3-1450	3-1450	569-1454	3-1450	569-1454
10-21-81					160-1443				
12-31-81					50-552				
02-05-82				1400-1714	450-1714	1530-1712			1545-1712
02-18-82	1400-1772			1600-1772	1200-1772	1650-1771	1545-1770		
03-18-82	1740-2222				1700-2222	1740-2222			
04-07-82	2150-2642				2000-2642	2150-2642			
04-20-82	1400-2713	1400-2713	1400-2713		230-2713	2590-2713	1542-2713	1400-2713	1542-2713
04-26-82				1530-2712		1520-2712			
04-29-82					240-2713				
05-06-82	2650-2913				236-2913	2698-2913			
05-20-82	2850-3020				2600-3020	2850-3020			
06-21-82	2970-3851				220-3851				
06-25-82			2660-3972		2714-3972	3746-3972			2713-3972
06-30-82				2660-3972			2713-3972		
10-06-82		2650-3927							
10-07-82	3550-3951					2700-3951			

Performed by Birdwell

DATE	DENSITY	GAMMA RAY	NEUTRON	ELASTIC PROPERTIES	3-D VELOCITY	ELECTRIC	TEMPERATURE	CALIPER	
04-27-82	1500-2712	0-2705	0-2705	1500-2700	1500-2695	1530-2713	0-2713	1500-2712	
10-05-82	2650-3924	2700-3924	2700-3924	2700-3920	2700-3922	2710-3920		2650-3924	

NOTE: To convert feet to meters, multiply by 0.3048.

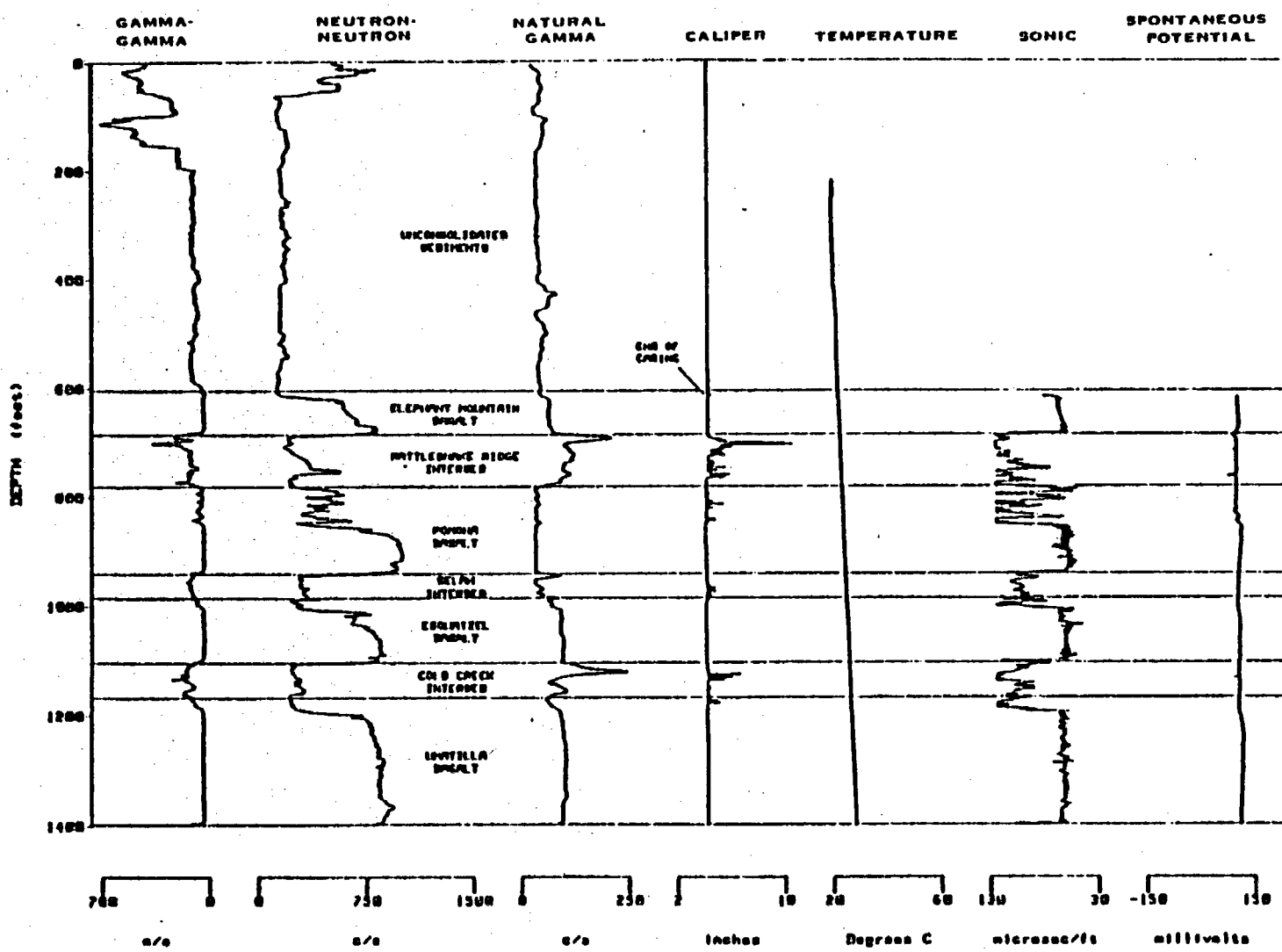


FIGURE 10. Borehole RRL-2--Summary Geophysical Log, 0-1,400 Feet

BEST AVAILABLE COPY

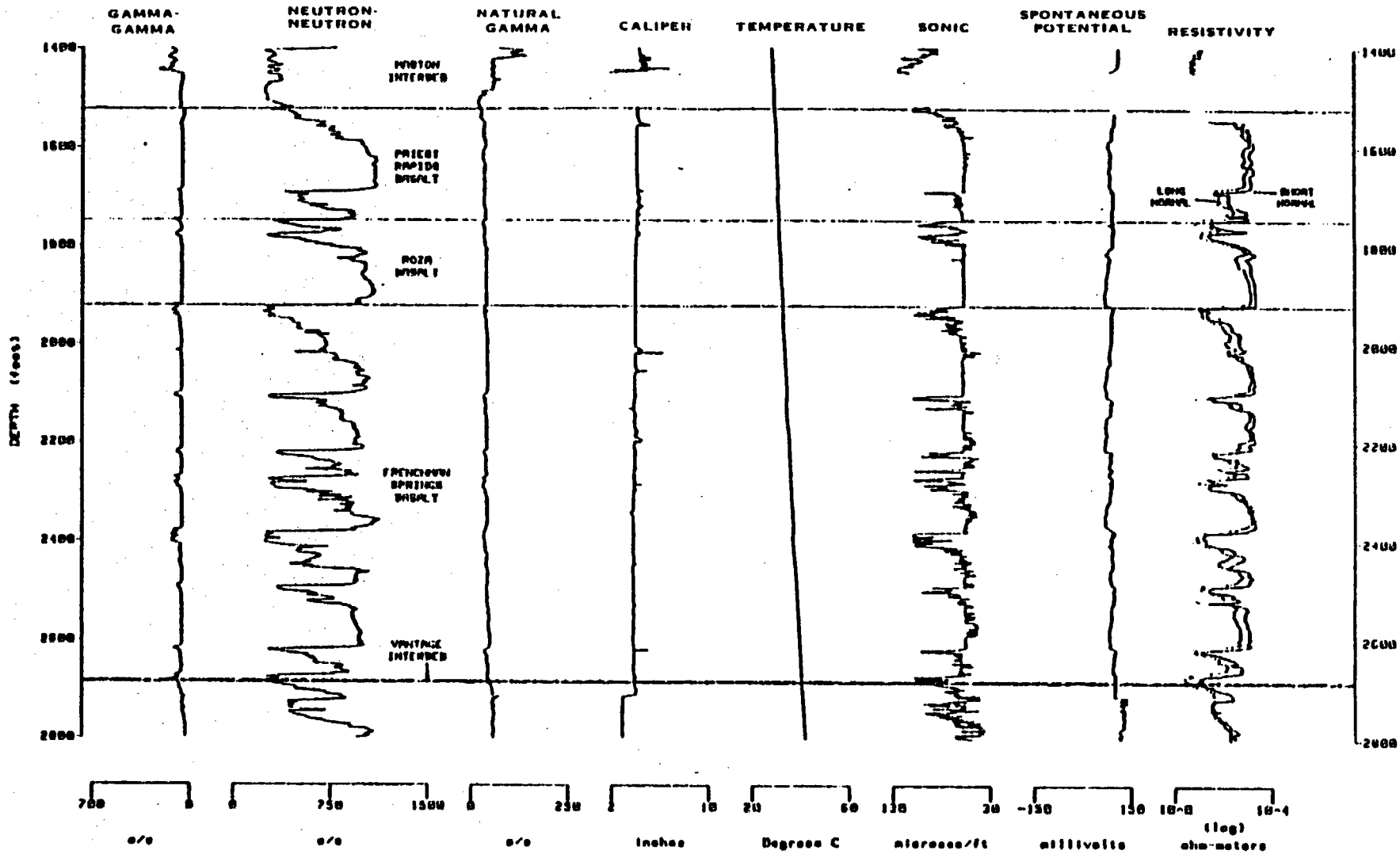


FIGURE 11. Borehole RRL-2--Summary Geophysical Log, 1,400-2,800 Feet.

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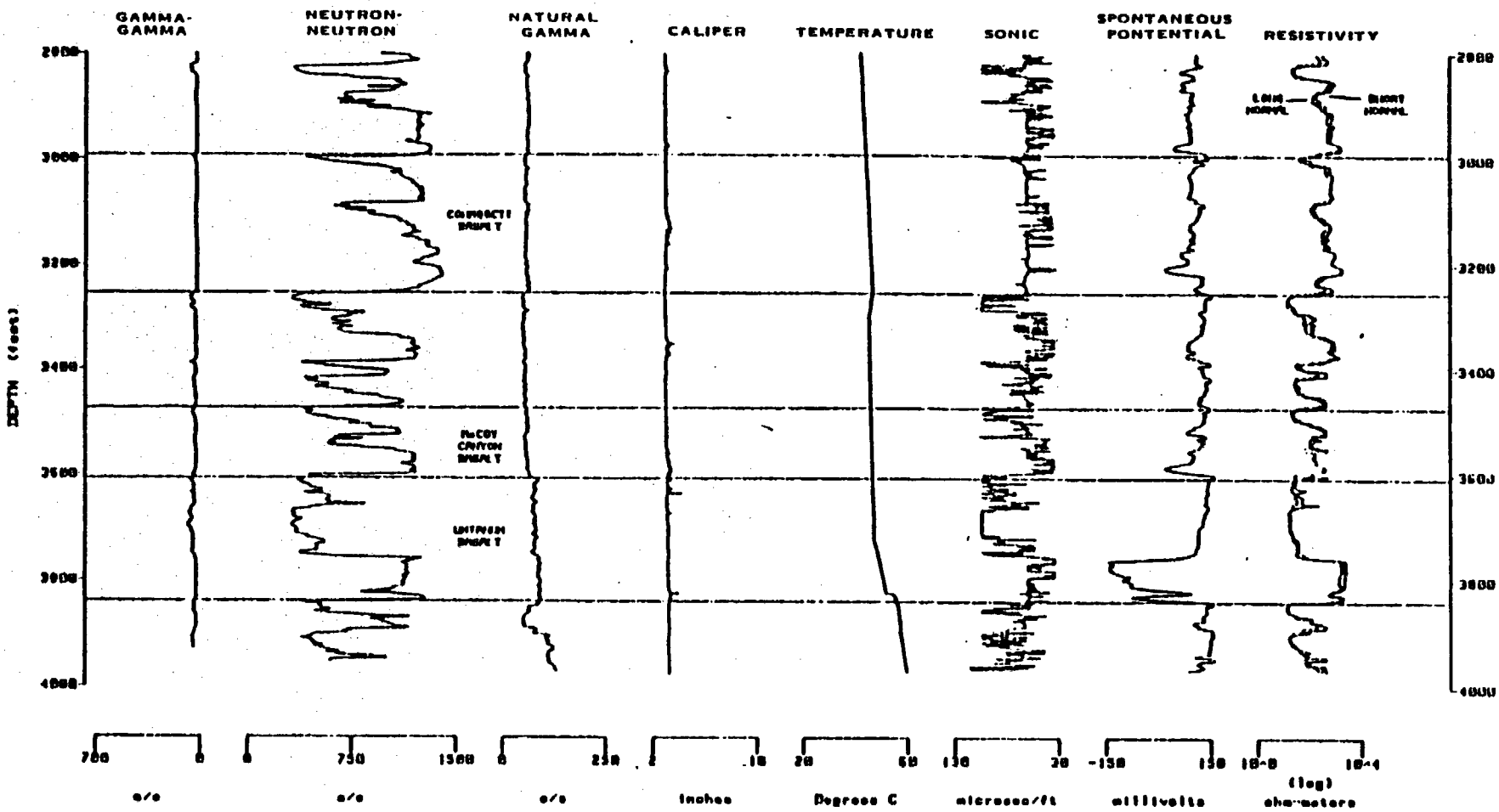


FIGURE 12. Borehole RRL-2--Summary Geophysical Log, 2,800-3,973 Feet.

BEST AVAILABLE COPY

TABLE 3. Borehole RRL-6--Geophysical Logs.

Performed by Pacific Northwest Laboratory								
DATE	NEUTRON-NEUTRON FT	GAMMA GAMMA FT	NATURAL GAMMA FT	SONIC FT	FLUID TEMPERATURE FT	CALIPER FT	SPONTANEOUS POTENTIAL RESISTIVITY	MAGNE-TOMETER FT
9/15/81	7-1538	4-1538	4-1538	10-1538	160-1538	600-1538	640-1538	---
8/21/82	1400-2843	1400-2843	1400-2843	1400-2843	1400-2843	1580-2843	1611-2843	1608-2843
9/16/82	2700-4031	---	---	2970-4030	2700-4031	---	---	---
2/14/83	---	2292-4027	2790-4027	---	190-4030	2820-4027	2840-4027	2840-4027

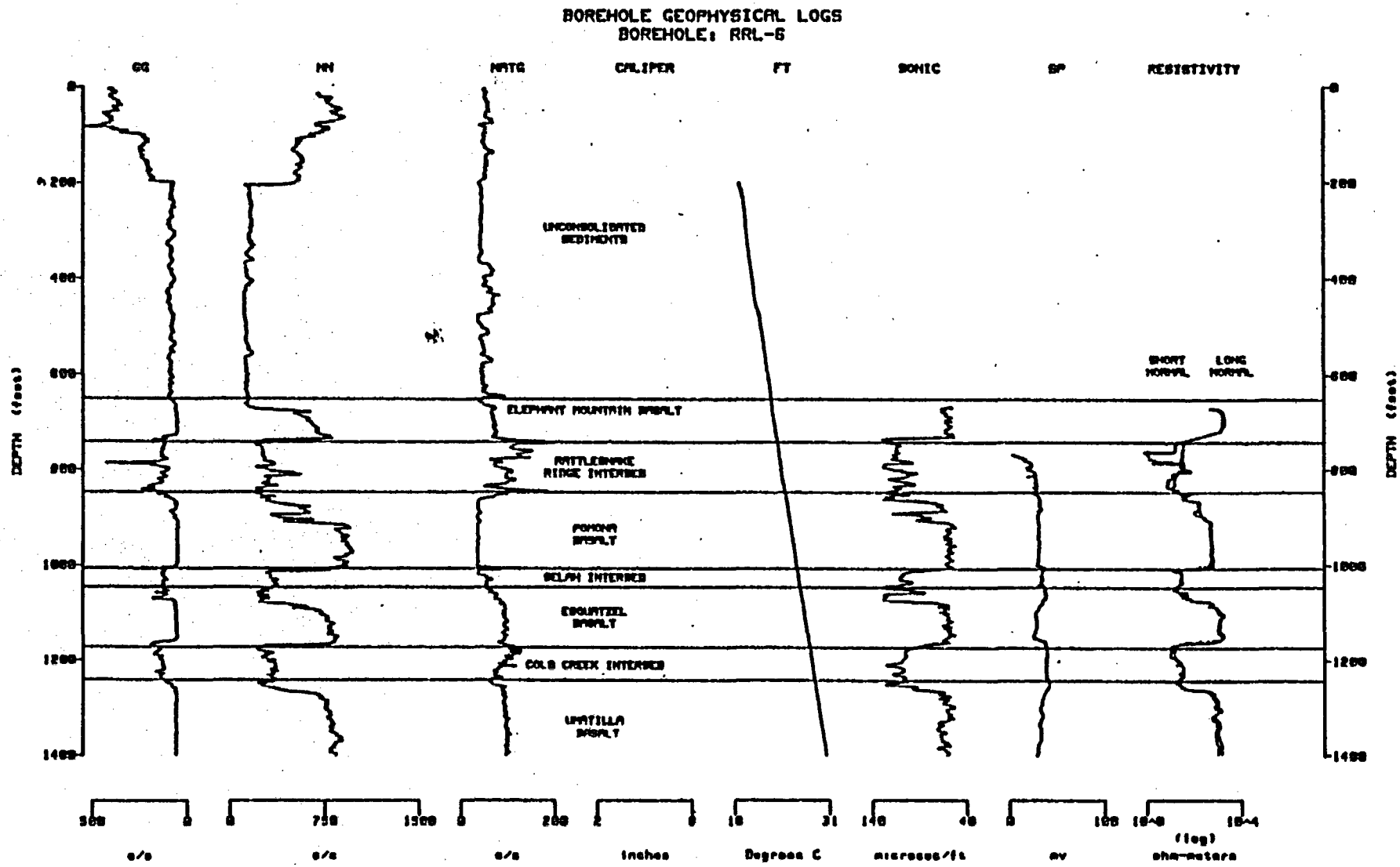


FIGURE 8. Borehole RRL-6 Geophysical Logs
(1 of 3)

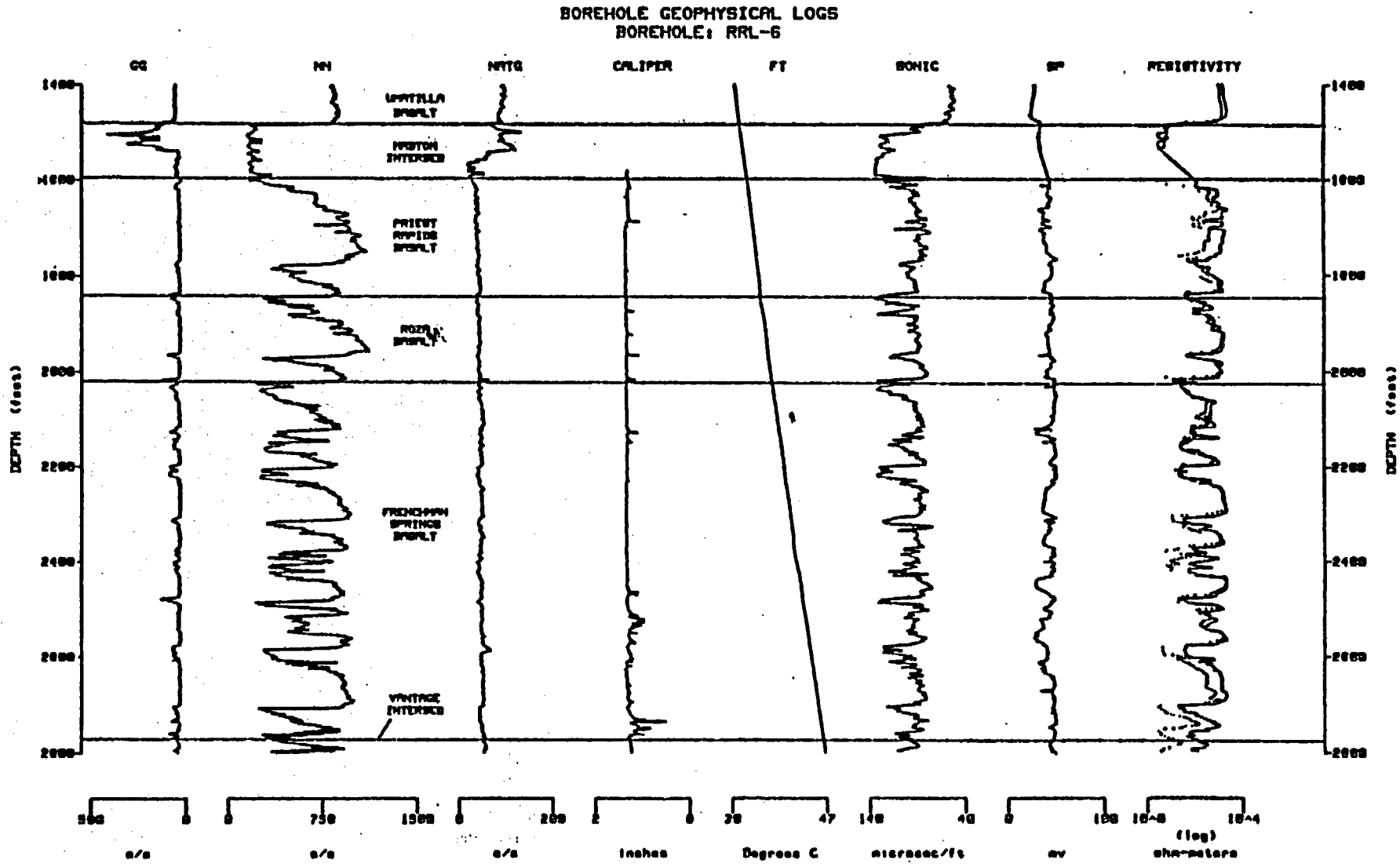


FIGURE 8. Borehole RRL-6 Geophysical Logs
(2 of 3)

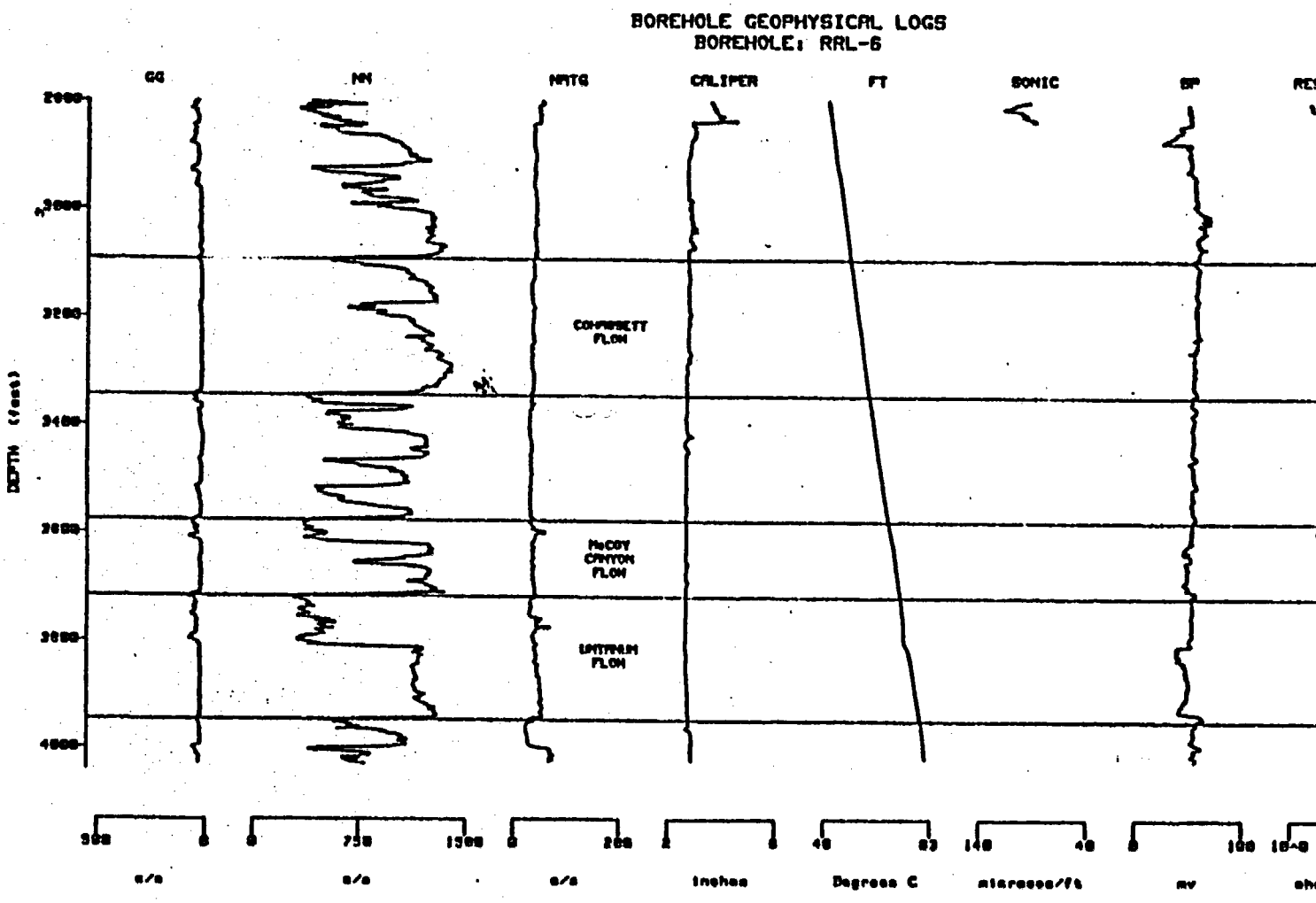


FIGURE 8. Borehole RRL-6 Geophysical Logs
(3 of 3)

RRL-6

USGS

Full Wave Train Acoustic	(GR)
Acoustic Televiewer	(GR)

TABLE 2. Borehole RRL-14 - Geophysical Log

GEOPHYSICAL LOG	Interval Logged (Feet)			
	8/14/82	8/29/82	10/18-19/82	10/20-21/82
Neutron-epithermal neutron	4 - 1,690	1,650 - 2,870	1,640 - 3,997	-----
Gamma gamma	4 - 1,690	1,650 - 2,870	1,640 - 3,997	-----
Natural gamma	4 - 1,690	1,650 - 2,870	2,340 - 3,997	2,800 - 3,997
Sonic	4 - 1,690	1,650 - 2,870	-----	2,800 - 3,997
Fluid temperature	4 - 1,690	-----	150 - 3,999	2,800 - 3,997
Caliper	4 - 1,690	1,680 - 2,870	1,640 - 3,997	-----
Spontaneous potential resistivity	4 - 1,690	1,696 - 2,870	2,870 - 3,997	-----
Magnetometer	4 - 1,690	1,696 - 2,870	-----	-----

DC-4

PNL

Full suite, see DC-20C

USGS

Full-Wave-Train Acoustic	(GR)
Acoustic Televiewer	(GR)

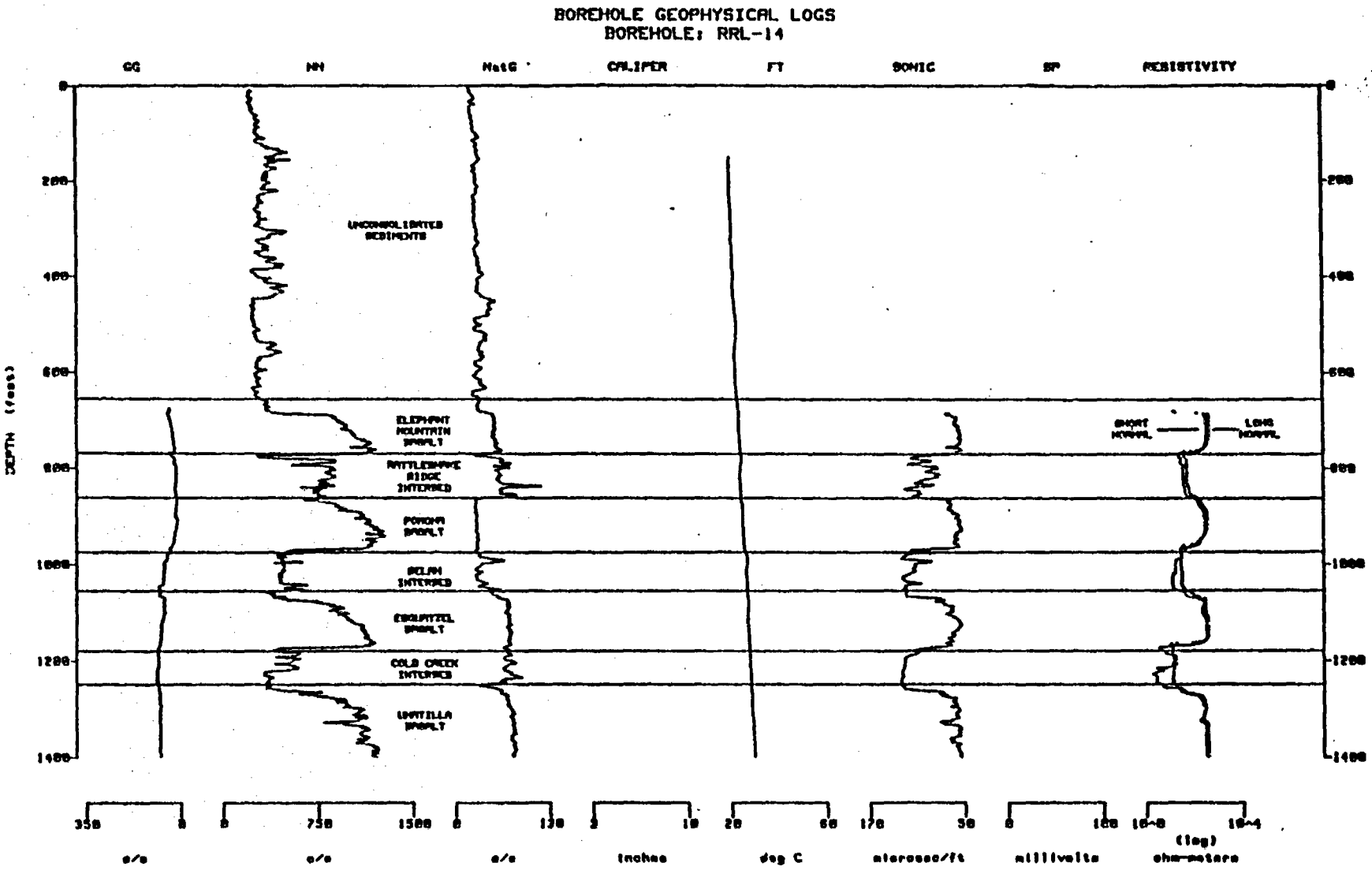


FIGURE 6, Borehole RRL-14 Geophysical Logs
(1 of 3)

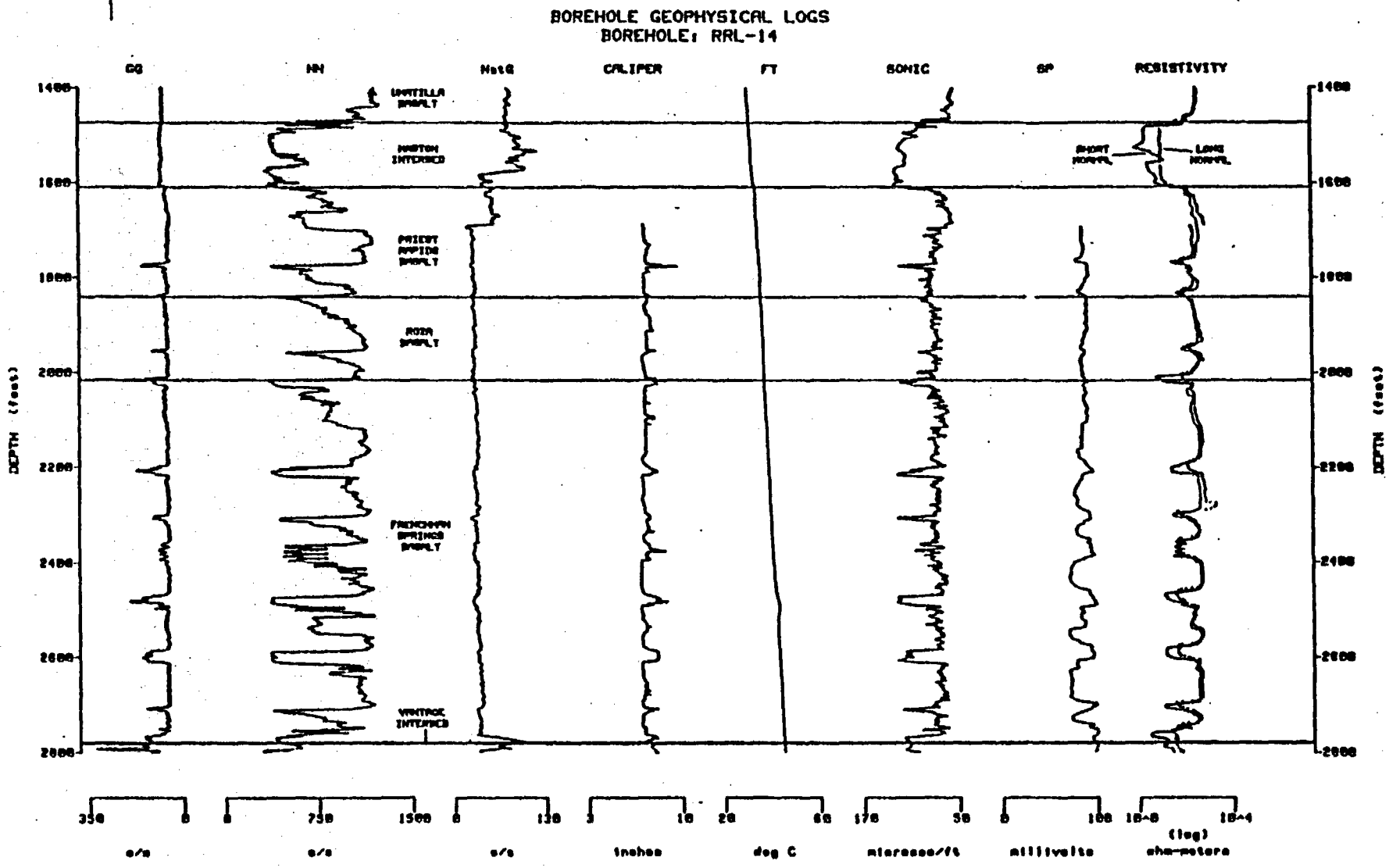


FIGURE 6. Borehole RRL-14 Geophysical Logs
(2 of 3)

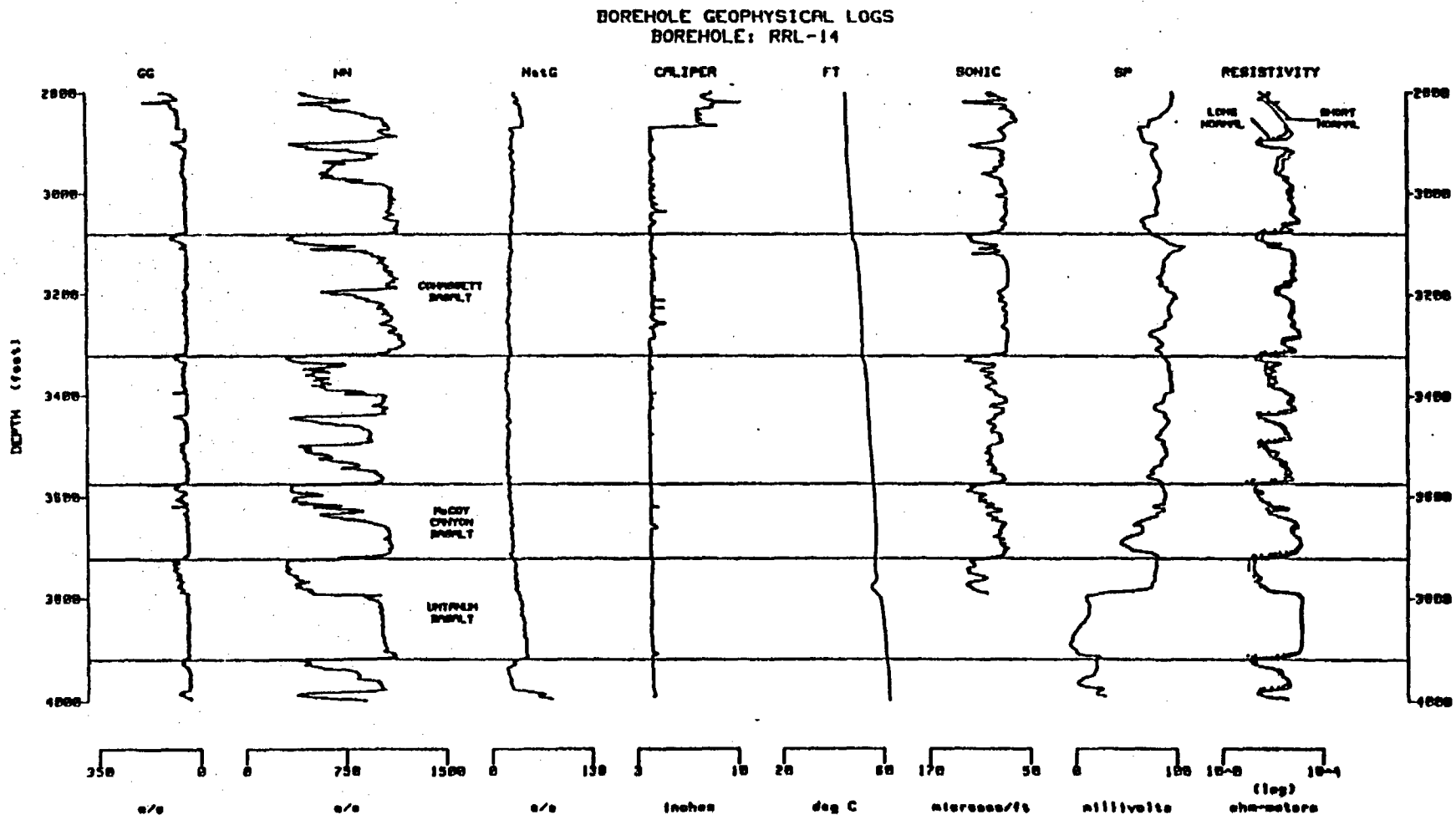


FIGURE 6. Borehole RRL-14 Geophysical Logs
(3 of 3)

TABLE 2. Borehole DC-16A Geophysical Logs

DATE	NEUTRON-EPITHERMAL NEUTRON	GAMMA-GAMMA	NATURAL GAMMA	SONIC	FLUID TEMPERATURE	CALIPER	SPONTANEOUS POTENTIAL	RESISTIVITY
06/25/81	7-617	4-617	7-618	n/a	160-611	n/a	n/a	n/a
09/03/81	550-834	550-834	550-834	550-725	0-834	550-834	n/a	n/a
09/22/81	n/a	n/a	n/a	550-725	n/a	n/a	550-725	550-725
09/25/81	n/a	n/a	n/a	550-834	n/a	n/a	550-834	550-834
10/01/81	750-1021	750-1021	750-1021	602-1021	180-1021	750-1021	602-1021	602-1021
11/5-6/81	950-1212	n/a	950-1212	950-1212	200-1212	930-1212	950-1212	950-1212
01/15/81	1150-1515	975-1515	1150-1515	1150-1515		1150-1515	1150-1515	1150-1515
03/02/82	1400-1728	n/a	1518-1728	1530-1728	200-1728	1546-1728	1567-1828	1567-1828
03/15/83	1650-1828	1300-1828	1650-1828	1650-1828	240-1828	1650-1828	1650-1828	1650-1828
4/8-9/82	1750-1998	1750-1999	1750-1998	n/a	220-1999	1750-1999	1560-1998	1560-1998
5/3-4/82	1950-2156	1950-2156	n/a	n/a	1800-2156	1950-2156	n/a	n/a
05/21/82	2100-2261	2100-2261	2100-2261	n/a	1500-2261	2100-2261	2100-2261	2100-2261
06/10/82	2200-2371	2200-2371	1920-2371	1750-2371	2200-2371	2200-2371	1569-2371	1569-2371
07/15/82	2320-2557	2320-2557	2320-2556	2556-2250		2320-2556	2556-2320	2556-2350
08/12/82	2632-2500	2632-2500	2632-2500	2632-2500	2500-2632	2632-2500	2632-2500	2632-2500
08/26/82	2720-2550		2720-2550	2720-2550	2550-2717	2720-2550		
09/28/82	2822-2620							
10/11/82		1995-2777	1560-2777				1569-2777	1569-2777
10/12/82					1500-2777	1545-2777		
10/13/82				1540-2777				
10/21/82	2700-2944			2700-2944		2700-2944		
10/22/82					2700-2044			
10/24/82	2900-3083							
12/27/82	3000-3358	3000-3358	3000-3358	3000-3358	3000-3358	3000-3358	3000-3358	3000-3358
02/03/83				3493-3300	3495-2700	3494-3300		
02/24/82	3547-3450	3020-2950	3020-2950		3546-3000	3020-2950	3020-2950	3020-2950
		3547-3450	3547-3450			3547-3450	3547-3450	3547-3450
06/02/83	4398-2700	4398-2700	4398-2700	4394-2700	4398-220	4398-2800	4398-2827	4398-2827
07/19/83	3800-3550	3800-3550		3800-3550		3800-3550		

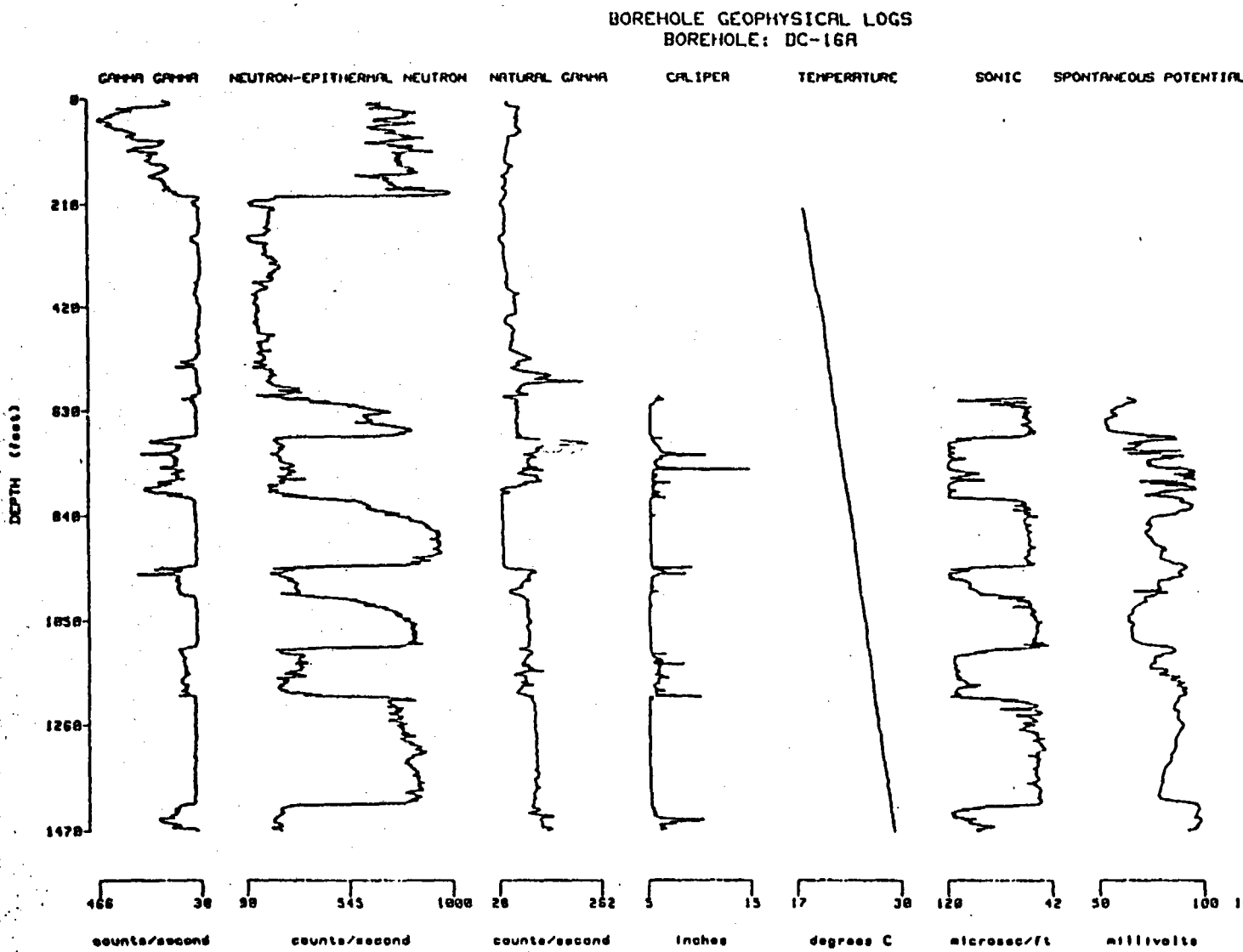


FIGURE 8A. Geophysical Logs for Borehole DC-16A.

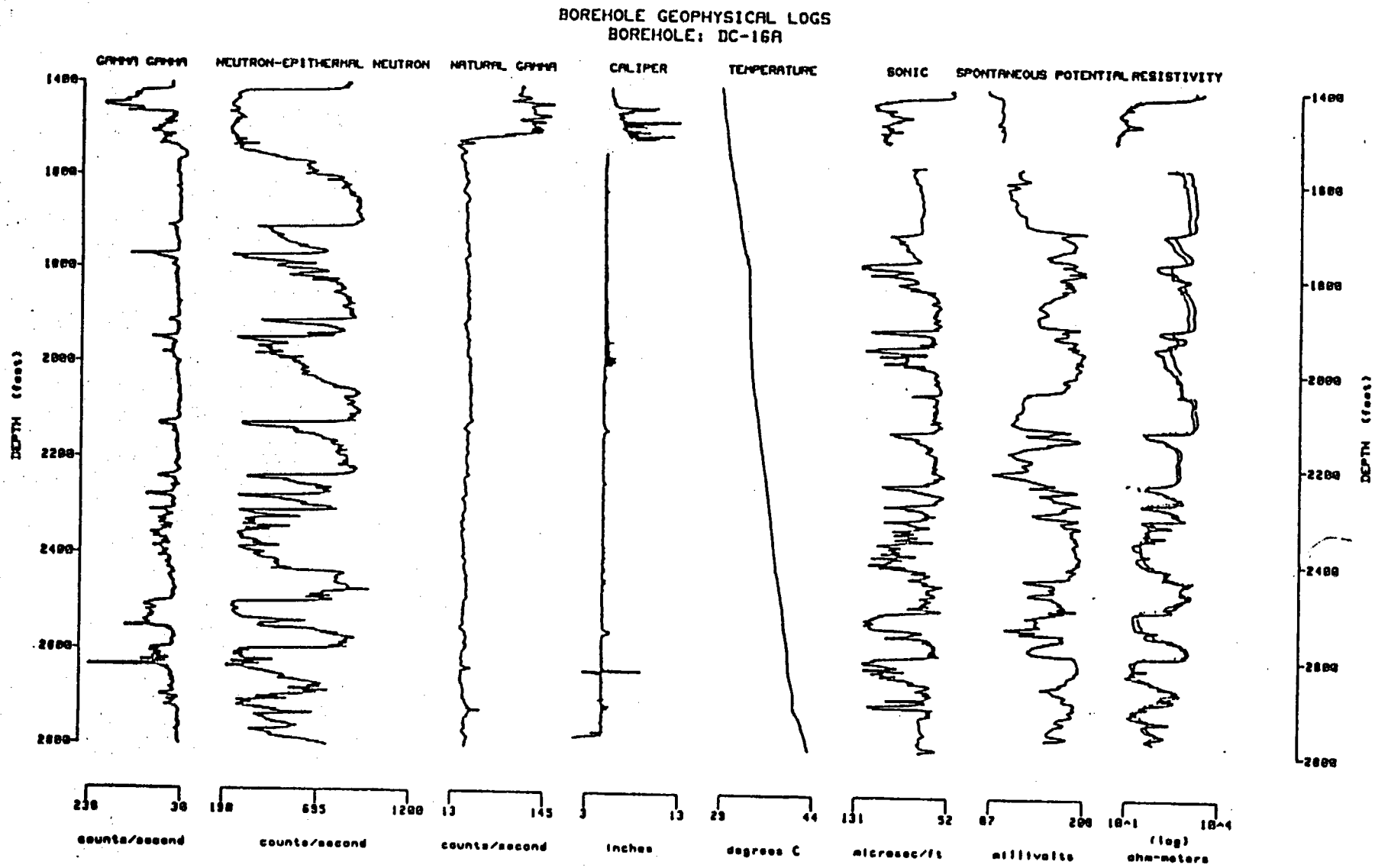


FIGURE 8B. Geophysical Logs for Borehole DC-16A.

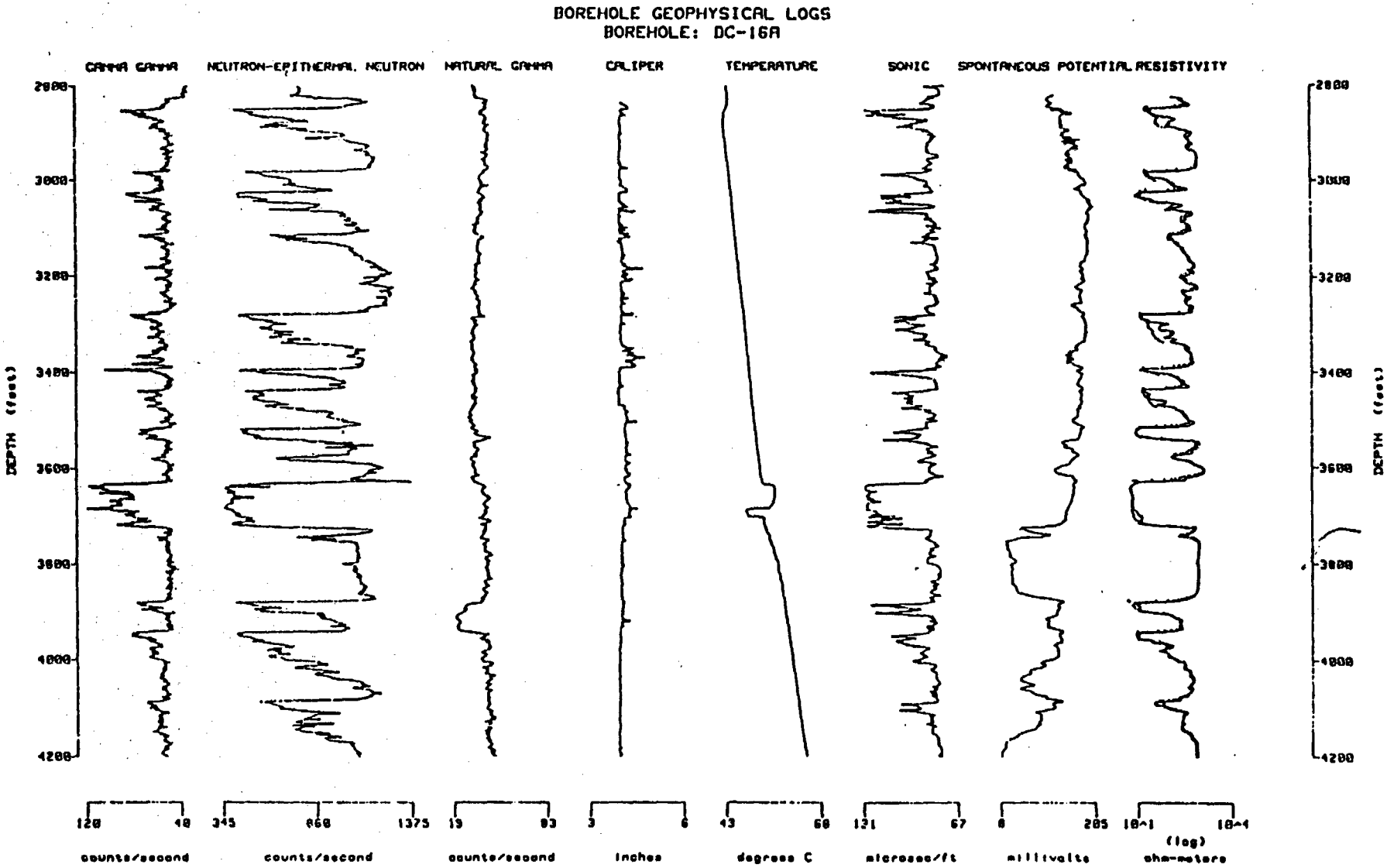


FIGURE 8C. Geophysical Logs for Borehole DC-16A.

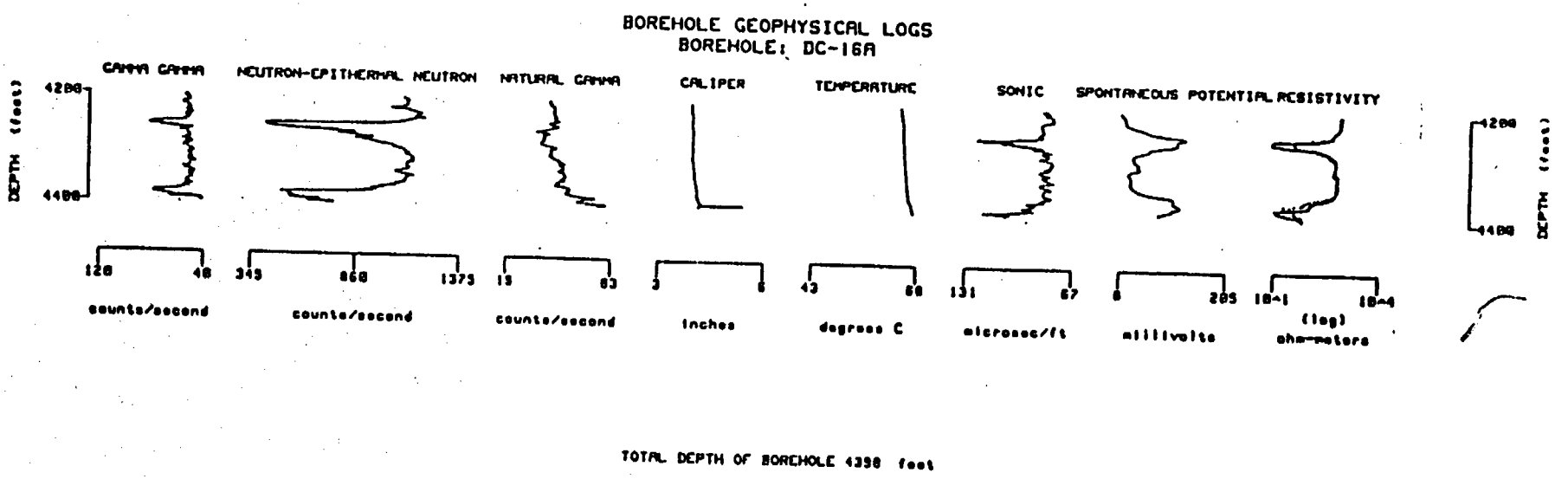


FIGURE 8D. Geophysical Logs for Borehole DC-16A.

DC-19C

PNL

Neutron-Epithermal-Neutron	(SM-W-GR)
Natural Gamma	(SM-W-GR)
Gamma-Gamma	(SM-W-GR)
Fluid Temperature	(SM-W-GR)
Sonic	(SM-W-GR)
Spontaneous Potential	(SM)
Long & Short Normal Resistivity	(SM-W-GR)
3 Arm Caliper	(W-GR)
X-Y (4 arm) Caliper	(W-GR)
Magnetometer	(SM-W-GR)

Washington State University

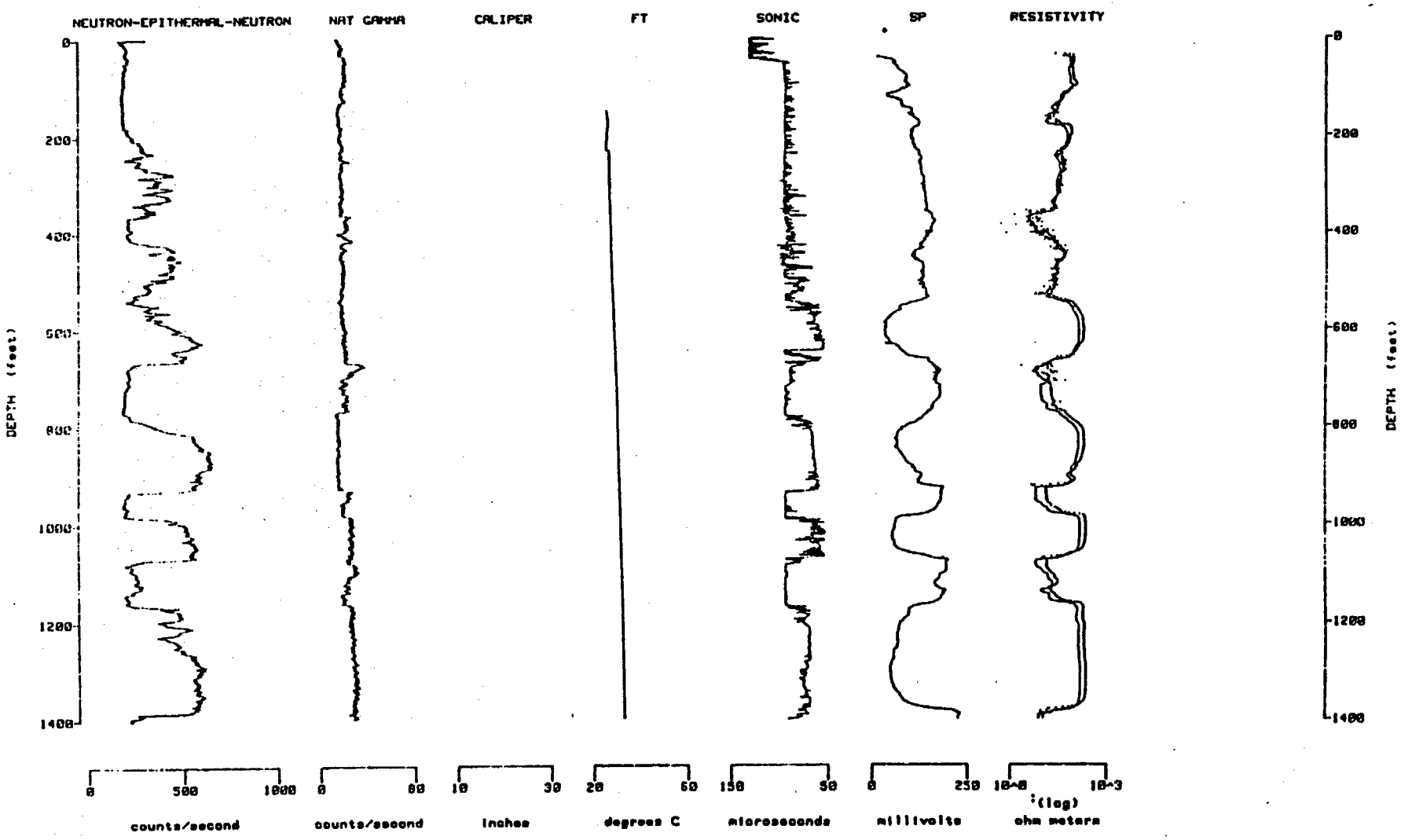
Full Wave Train Acoustic	(W-GR)

Birdwell

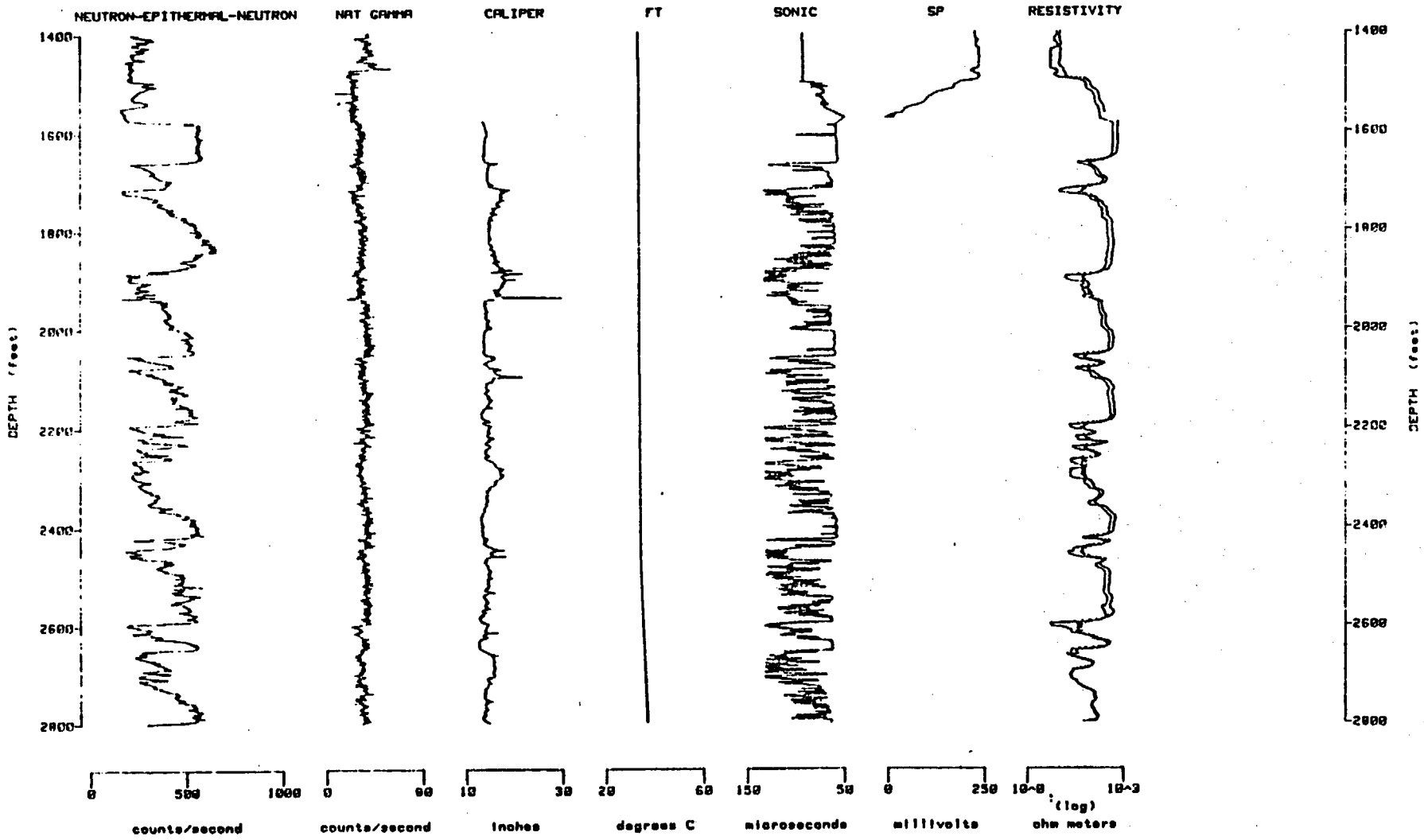
Induction Electric Log	(W-GR)
6 Arm Caliper	(W-GR)
Neutron Borehole Compensated	(W-GR)
3-D Velocity	(W-GR)
Density	(W-GR)

SM - Saddle Mtns.
W - Wanapum
GR - Grande Ronde

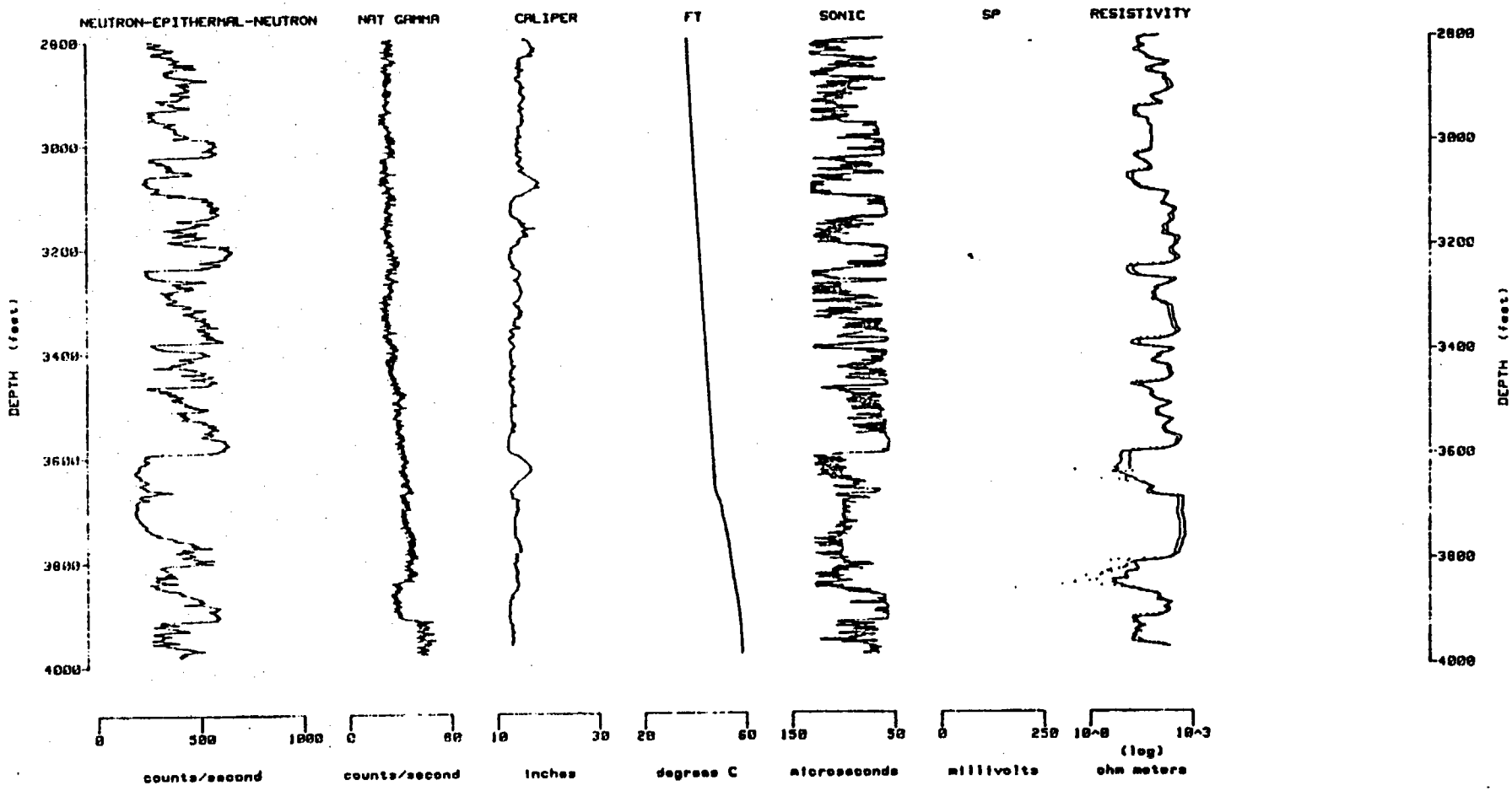
BOREHOLE GEOPHYSICAL LOGS
BOREHOLE: DC-19C



BOREHOLE GEOPHYSICAL LOGS
BOREHOLE: DC-19C



BOREHOLE GEOPHYSICAL LOGS
BOREHOLE: DC-19C



DC-20C

PNL

Neutron-Epithermal-Neutron	(SM-W-GR)
Natural Gamma	(SM-W-GR)
Gamma-Gamma	(SM-W-GR)
Fluid Temperature	(SM-W-GR)
Sonic	(SM-W-GR)
Spontaneous Potential	(SM-W-GR)
Long & Short Normal Resistivity	(SM-W-GR)
3 Arm Caliper	(W-GR)
X-Y (4 arm) Caliper	(W-GR)
Magnetometer	(SM)

Washington State University

Full Wave Train Acoustic	(W-GR)

Birdwell

Induction Electric Log	(W-GR)
6 Arm Caliper	(W-GR)
Neutron Borehole Compensated	(W-GR)
3-D Velocity	(W-GR)
Density	(W-GR)

SM- Saddle Mtn.
W - Wanapum
GR- Grande Ronde

DC-22C

PNL

Neutron-Epithermal-Neutron	(SM-W-GR)
Natural Gamma	(SM-W-GR)
Gamma-Gamma	(SM-W-GR)
Fluid Temperature	(SM-W-GR)
Spontaneous Potential	(SM-W-GR)
Long & Short Normal Resistivity	(SM-W-GR)
3 Arm Caliper	(W-GR)
X-Y (4 arm) Caliper	(W-GR)
Magnetometer	(SM)

Washington State University

Full-Wave Train Acoustic	(W-GR)

SM - Saddle Mtns.
W - Wanapum
GR - Grande Ronde

APPENDIX B

REFERENCES CONTAINING LABORATORY TEST RESULTS

Craig, P. A., 1983, Tabulation of Young's Moduli and Poisson's Ratio Determinations from Uniaxial and Triaxial Compressive Strength Tests from Boreholes RRI-2, RRL-6, and RRL-14, SD-BWI-TI-132, Rev. 0-0, Rockwell Hanford Operations, Richland, Washington. Official Release Date September 29, 1983.

Hulstrom, L. C., and D. J. Hanson, 1982, Tabulation of Physical and Mechanical Property Data from Borehole RRL-2, SD-BWI-TD-002, Rev. 0-1, Rockwell Hanford Operations, Richland, Washington. Official Release Date November 2, 1982.

Hulstrom, L. C. and D. J. Hanson, 1983, Tabulation of Physical and Mechanical Property Data from Borehole RRL-6, SD-BWI-TD-003, Rev. 0-0, Rockwell Hanford Operations, Richland, Washington. Official Release Date January 31, 1983.

Hulstrom, L. C., and D. J. Hanson, 1983, Tabulation of Physical and Mechanical Property Data from Borehole RRL-14, SD-BWI-TD-004, Rev. 0-1, Rockwell Hanford Operations, Richland, Washington. Official Release Date March 9, 1983.

Landon, R. D., 1983, Geologic Thickness Data - Candidate Repository Horizons, SD-BWI-DP-011, Rev. A-0, Rockwell Hanford Operations, Richland, Washington. Official Release Date August 6, 1983.

Sublette, W. R., 1983, Rock Mechanics Data Package, SD-BWI-DP-041, Rev. 0-0, Rockwell Hanford Operations, Richland, Washington. Official Release Date Sept. 20, 1983.

Duvall, W. I., R. J. Miller, and F. D. Wang, 1978, Preliminary Report on Physical and Thermal Properties of Basalt, Drill Hole DC-10, Pomona Flow, Gable Mountain, RHO-BWI-C-11, Rockwell Hanford Operations, Richland, Washington.

Excavation Engineering and Earth Mechanics Institute, 1978, Final Report for Fiscal Year 1978 on the Physical and Thermal Properties of Basalt Cores, RHO-BWI-C-38, Rockwell Hanford Operations, Richland, Washington.

Martinez-Baez, L. F. and C. Hal Amick, 1978, Thermal Properties of Gable Mountain Basalt Cores, Hanford Nuclear Reservation, LBL-7038, Lawrence Berkeley Laboratory, Berkeley, California.

Excavation Engineering and Earth Mechanics Institute, 1979, Determination of Basalt Physical and Thermal Properties at Varying Temperatures, Pressures, and Moisture Contents, First Progress Report, Fiscal Year 1979, RHO-BWI-C-50, Rockwell Hanford Operations, Richland, Washington.

Excavation Engineering and Earth Mechanics Institute, 1979, Determination of Basalt Physical and Thermal Properties at Varying Temperatures, Pressures, and Moisture Contents, Second Progress Report, Fiscal year 1979, RHO-BWI-C-54, Rockwell Hanford Operations, Richland, Washington.

Excavation Engineering and Earth Mechanics Institute, 1979, Determination of Basalt Physical and Thermal Properties at Varying Temperatures, Pressures, and Moisture Contents, Third Progress Report, Fiscal Year 1979, RHO-BWI-C-55, Rockwell Hanford Operations Richland, Washington.

Foundation Sciences, Inc., 1980, Thermal/Mechanical Properties of Pomona Member Basalt - Full-Scale Heater Test #1 (Area 1), RHO-BWI-C-77, Rockwell Hanford Operations, Richland Washington.

Foundation Sciences, Inc., 1980, Thermal/Mechanical Properties of Pomona Member Basalt - Full-Scale Heater Test #2 (Area 2), RHO-BWI-C-85, Rockwell Hanford Operations, Richland, Washington.

Schmidt, B., W. F. Daly, S. W. Bradley, P. R. Squire, and L. C. Hulstrom, 1980, Thermal and Mechanical Properties of Hanford Basalts, Compilation and Analyses, RHO-BWI-C-90, Rockwell Hanford Operations, Richland, Washington.

Shuri, F. S., D. J. Dodds, and K. Kim, 1980, Measurement of Rock-Mass Deformation Properties by the Borehole Jacking Method at the Near-Surface Test Facility, RHO-BWI-C-89, Rockwell Hanford Operations, Richland, Washington.

Foundation Sciences, Inc., 1981, Thermal/Mechanical Properties of Pomona Member Basalt - Area 3 and Summary, RHO-BWI-C-100, Rockwell Hanford Operations, Richland, Washington.

Foundation Sciences, Inc., 1981, Thermal/Mechanical Properties of Umtanum Basalt -- Borehole DC-2, RHO-BWI-C-92, Rockwell Hanford Operations, Richland, Washington.

Erikson, R. L. and K. M. Krupka, undated, Thermal Property Measurements of Pomona Member Basalt from Core Holes DB-5 and DB-15, Hanford Site, Southeastern Washington, RHO-BWI-C-76, Rockwell Hanford Operations, Richland, Washington.

Myer, Larry, 1982, Results of Thermomechanical Tests on Specimens of Hanford Basalts, Letter Report, September 30, 1982, Lawrence Berkeley Laboratory, Berkeley, California.

Craig, P. A., 1983, Tabulation of Young's Moduli and Poisson's Ratio Determinations from Uniaxial and Triaxial Compressive Strength Tests from Boreholes RRL-2, RRL-6, and RRL-14, SD-BWI-TI-132, Rev. 0-0, Rockwell Hanford Operations, Richland, Washington. Official Release Date September 29, 1983.

Hulstrom, L. C., and D. J. Hanson, 1982, Tabulation of Physical and Mechanical Property Data from Borehole RRL-2, SD-BWI-TD-002, Rev. 0-1, Rockwell Hanford Operations, Richland, Washington. Official Release Date November 2, 1982.

Hulstrom, L. C. and D. J. Hanson, 1983, Tabulation of Physical and Mechanical Property Data from Borehole RRL-6, SD-BWI-TD-003, Rev. 0-0, Rockwell Hanford Operations, Richland, Washington. Official Release Date January 31, 1983.

Hulstrom, L. C., and D. J. Hanson, 1983, Tabulation of Physical and Mechanical Property Data from Borehole RRL-14, SD-BWI-TD-004, Rev. 0-1, Rockwell Hanford Operations, Richland, Washington. Official Release Date March 9, 1983.

Landon, R. D., 1983, Geologic Thickness Data - Candidate Repository Horizons, SD-BWI-DP-011, Rev. A-0, Rockwell Hanford Operations, Richland, Washington. Official Release Date August 6, 1983.

Sublette, W. R., 1983, Rock Mechanics Data Package, SD-BWI-DP-041, Rev. 0-0, Rockwell Hanford Operations, Richland, Washington. Official Release Date Sept. 20, 1983.

Duvall, W. I., R. J. Miller, and F. D. Wang, 1978, Preliminary Report on Physical and Thermal Properties of Basalt, Drill Hole DC-10, Pomona Flow, Gable Mountain, RHO-BWI-C-11, Rockwell Hanford Operations, Richland, Washington.

Excavation Engineering and Earth Mechanics Institute, 1978, Final Report for Fiscal Year 1978 on the Physical and Thermal Properties of Basalt Cores, RHO-BWI-C-38, Rockwell Hanford Operations, Richland, Washington.

Martinez-Baez, L. F. and C. Hal Amick, 1978, Thermal Properties of Gable Mountain Basalt Cores, Hanford Nuclear Reservation, LBL-7038, Lawrence Berkeley Laboratory, Berkeley, California.

Excavation Engineering and Earth Mechanics Institute, 1979, Determination of Basalt Physical and Thermal Properties at Varying Temperatures, Pressures, and Moisture Contents, First Progress Report, Fiscal Year 1979, RHO-BWI-C-50, Rockwell Hanford Operations, Richland, Washington.

Excavation Engineering and Earth Mechanics Institute, 1979, Determination of Basalt Physical and Thermal Properties at Varying Temperatures, Pressures, and Moisture Contents, Second Progress Report, Fiscal year 1979, RHO-BWI-C-54, Rockwell Hanford Operations, Richland, Washington.

Excavation Engineering and Earth Mechanics Institute, 1979, Determination of Basalt Physical and Thermal Properties at Varying Temperatures, Pressures, and Moisture Contents, Third Progress Report, Fiscal Year 1979, RHO-BWI-C-55, Rockwell Hanford Operations Richland, Washington.

Foundation Sciences, Inc., 1980, Thermal/Mechanical Properties of Pomona Member Basalt - Full-Scale Heater Test #1 (Area 1), RHO-BWI-C-77, Rockwell Hanford Operations, Richland Washington.

Foundation Sciences, Inc., 1980, Thermal/Mechanical Properties of Pomona Member Basalt - Full-Scale Heater Test #2 (Area 2), RHO-BWI-C-85, Rockwell Hanford Operations, Richland, Washington.

Schmidt, B., W. F. Daly, S. W. Bradley, P. R. Squire, and L. C. Hulstrom, 1980, Thermal and Mechanical Properties of Hanford Basalts, Compilation and Analyses, RHO-BWI-C-90, Rockwell Hanford Operations, Richland, Washington.

Shuri, F. S., D. J. Dodds, and K. Kim, 1980, Measurement of Rock-Mass Deformation Properties by the Borehole Jacking Method at the Near-Surface Test Facility, RHO-BWI-C-89, Rockwell Hanford Operations, Richland, Washington.

Foundation Sciences, Inc., 1981, Thermal/Mechanical Properties of Pomona Member Basalt - Area 3 and Summary, RHO-BWI-C-100, Rockwell Hanford Operations, Richland, Washington.

Foundation Sciences, Inc., 1981, Thermal/Mechanical Properties of Umtanum Basalt -- Borehole DC-2, RHO-BWI-C-92, Rockwell Hanford Operations, Richland, Washington.

Erikson, R. L. and K. M. Krupka, undated, Thermal Property Measurements of Pomona Member Basalt from Core Holes DB-5 and DB-15, Hanford Site, Southeastern Washington, RHO-BWI-C-76, Rockwell Hanford Operations, Richland, Washington.

Myer, Larry, 1982, Results of Thermomechanical Tests on Specimens of Hanford Basalts, Letter Report, September 30, 1982, Lawrence Berkeley Laboratory, Berkeley, California.

LIST OF GEOMECHANICS MODELS AND CODES USED AND/OR BEING DEVELOPED

ADINA

UDEC

ANSYS

DAMSWEL

NONSAP

These models and codes will be discussed and statused in the Wednesday morning session

AGENDA

NUCLEAR REGULATORY COMMISSION WORKSHOP

GEOMECHANICS REPOSITORY

Tuesday, January 24, 1984	Visitor's Center, Gable Mountain	
9:00 - 9:05 a.m.	INTRODUCTION	P. L. Boileau
9:00 - 9:15 a.m.		N. A. Steger
9:15 - 9:45 a.m.	FULL-SCALE HEATER TESTS • Test Layout • Analysis	 E. C. Gregory R. R. Ames
9:45 - 10:15 a.m.	BLOCK TEST • Test Layout and Analysis	 M. L. Cramer
10:15 - 10:30 a.m.	BREAK	
10:30 - 11:00 a.m.	HYDROFRACTURE TESTING • Measurement of In Situ Stress in Rock	 T. A. Rundle
11:00 - 11:30 a.m.	ROCK MECHANICS LABORATORY • Test Activities	 D. L. South
11:30 - 12:00 noon	BOX LUNCH	K. A. Hadley
12:00 - 4:15 p.m.	DISCUSSION	ALL
Wednesday, January 25, 1984	Peoples Bank Building/3rd Floor Conference Room	
8:00 - 10:00 a.m.	OVERVIEW OF APPLICATION OF GEOMECHANICS NUMERICAL MODELING TO REPOSITORY DESIGN & PA	J. T. Baxter R. T. Wilde
10:00 - 10:15 a.m.	BREAK	
10:15 - 12:00 noon	DISCUSSION	
12:00 - 1:00 p.m.	LUNCH	
1:00 - 4:00 p.m.	ROCK MECHANICS LABORATORY TOUR 200 East Area/2101M Building	L. C. Hulstrom
Thursday, January 26, 1984		
	Some of the NRC people may elect to stay over for further discussion.	

1-19-84/jcs

NUCLEAR REGULATORY COMMISSION — 13 ATTACHMENT 1

GEOMECHANICS DATA REVIEW VISIT — 16

JANUARY 1984 — 12

③

ATTENDEES — 4

M. S. Nataraja	(NRC)	(301) 427-4678
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Ernie Corp	USBM -- Spokane (NRC Consult.)	FTS 439-6880
John Buckley	NRC	301-427-4544
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David L. South	Rockwell - Modeling & Analysis Group	(509) 373 9206
Norm STEGER	ROCKWELL - TEST GROUP MGR	(509) 373 2889
P. L. Boileau	DOE BWIP	—
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Kunsoo Kim	BWIP (Rock Mechanics)	(509) 373-4181
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Z. T. (Dick) Bieniawski	Penn State Univ. / DOE consultant	(814) 863-1645
L. C. Hulstrom	Rockwell - Engineered Barrier Dept	(509) 373-2639
A. J. BELL	DOE - RL (BWIP) Running Team	(509) - 376-1821

1

ROCK MECHANICS TESTS PERFORMED AT THE NEAR-SURFACE TEST FACILITY

(JANUARY 24, 1984)

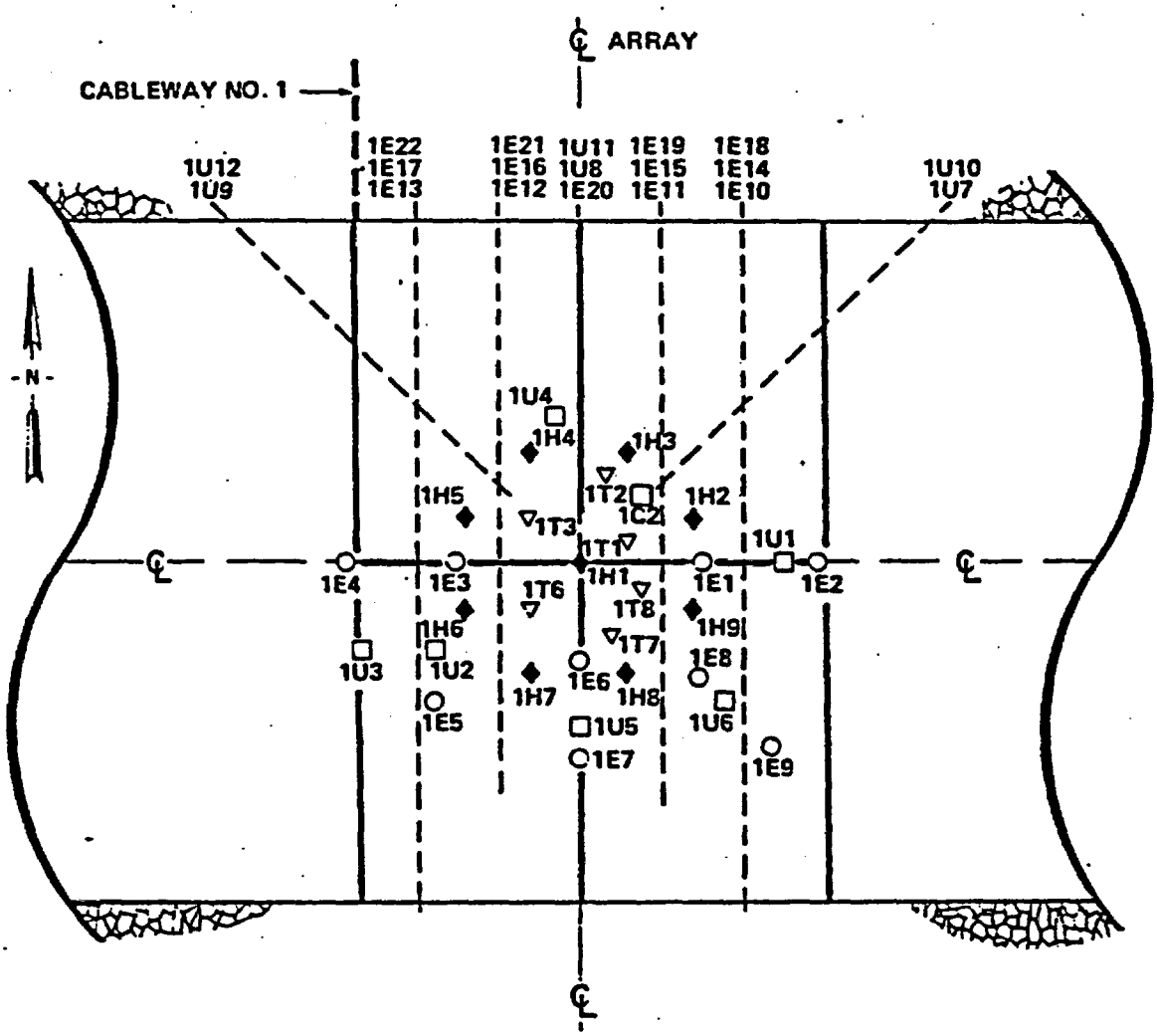
- o LABORATORY TESTS (SEE LAB TEST DATA SHEET)
- o FULL-SCALE HEATER TESTS NOS. 1 AND 2
- o BOREHOLE JACKING
  - GOODMAN JACK (FOUNDATION SCIENCES, INC.)
  - MODIFIED BOREHOLE JACK (DE LA CRUZ AND VOSS)
  - SLEEVE FRACTURING (STEPHANSSON)
- o OVERCORING
  - BOREHOLE DEFORMATION GAUGE (FOUNDATION SCIENCES INC.)
  - BOREHOLE DEFORMATION GAUGE, CSIRO HOLLOW INCLUSION STRESS CELL, CAST EXPOXY INCLUSION, LULEÅ TRIAXIAL STRAIN CELL, AND THE CSIR DOORSTOPPER (ROCKWELL)
- o BLOCK TEST
  - STEP 1
  - STEP 2
- o HYDRAULIC FRACTURING
  - PRE-NSTF CONSTRUCTION (HAIMSON)
  - POST-NSTF CONSTRUCTION (ROCKWELL)
- o CROSSHOLE SEISMIC (LBL)

APPLICABILIY OF FULL-SCALE HEATER TESTS TO REPOSTIORY DESIGN

- DETERMINATION OF IN SITU ROCK MASS THERMAL CONDUCTIVITY, HEAT CAPACITY, AND THERMAL EXPANSION FOR COMPARISON TO PRE-TEST LABORATORY VALUES

- EVALUATION OF HIGH TEMPERATURE EFFECTS ON INTACT BASALT AT CANISTER SCALE

- POTENTIAL DATA SOURCE FOR MODEL VERIFICATION



0 4 8 FEET

0 1 2 METERS

VWS = VIBRATING WIRE STRESSMETER
BDG = BOREHOLE DEFORMATION GAUGE
MPBX = MULTIPLE-POSITION BOREHOLE EXTENSOMETER

– – – – DOTTED LINE INDICATES A HORIZONTAL BOREHOLE DRILLED FROM THE EXTENSOMETER ROOM

HOLE SYMBOLS	HOLE SIZE	INSTRUMENTS
♦	EX 1.485	HEATER (H)
□	AX 1.890	BDG/VWS (U&C)
▽	EX 1.485	THERMOCOUPLE (T)
○	NX 2.980	MPBX (E)

♦ EXCEPT 1H1 AND 2H1 ARE 18-in.-(45.7-cm) DIA. HOLES

RCP8007-102B

FIGURE 3-4. Plan-Instrumentation Layout and Borehole Designation for Full-Scale Heater Test 1.

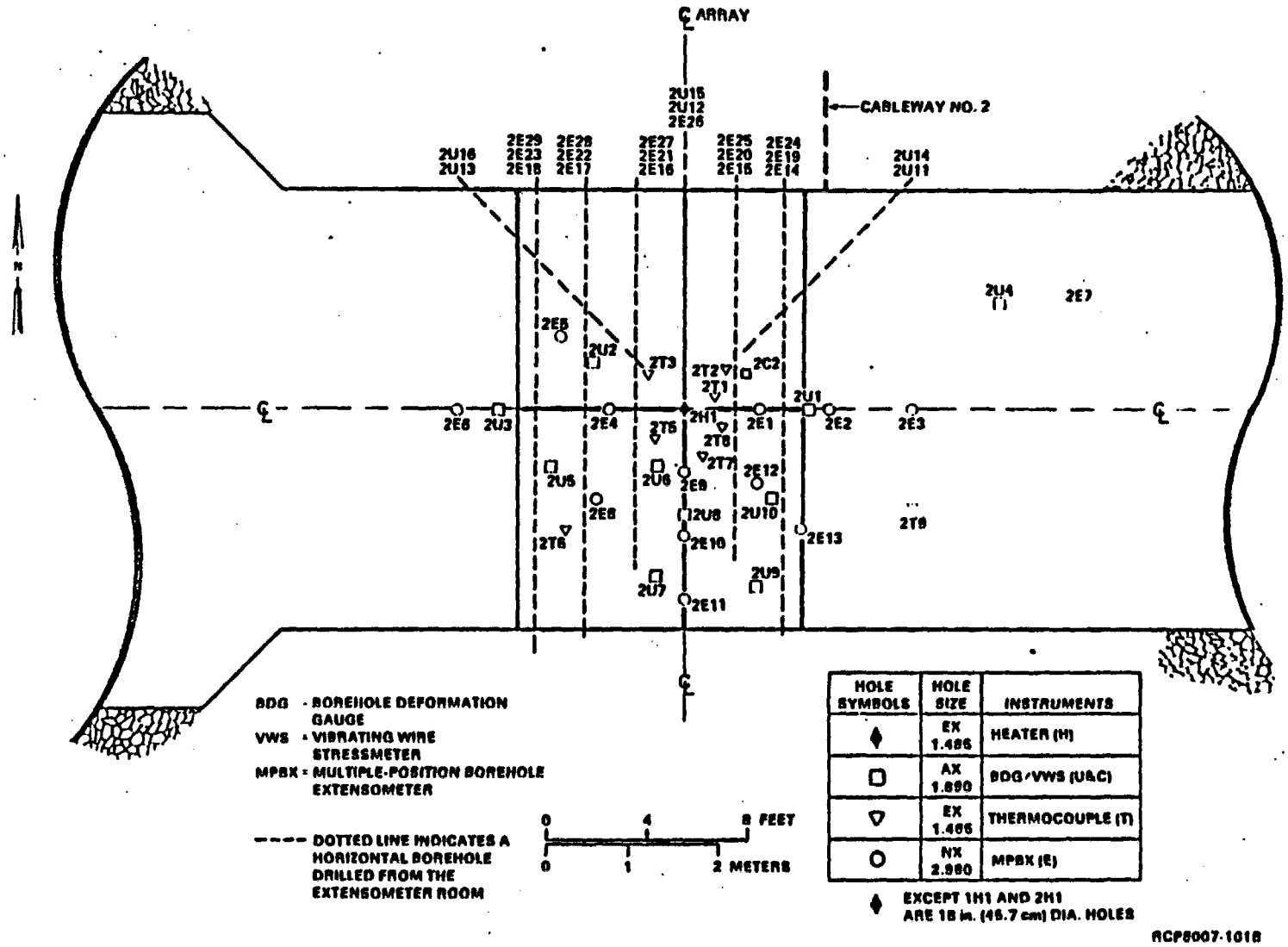
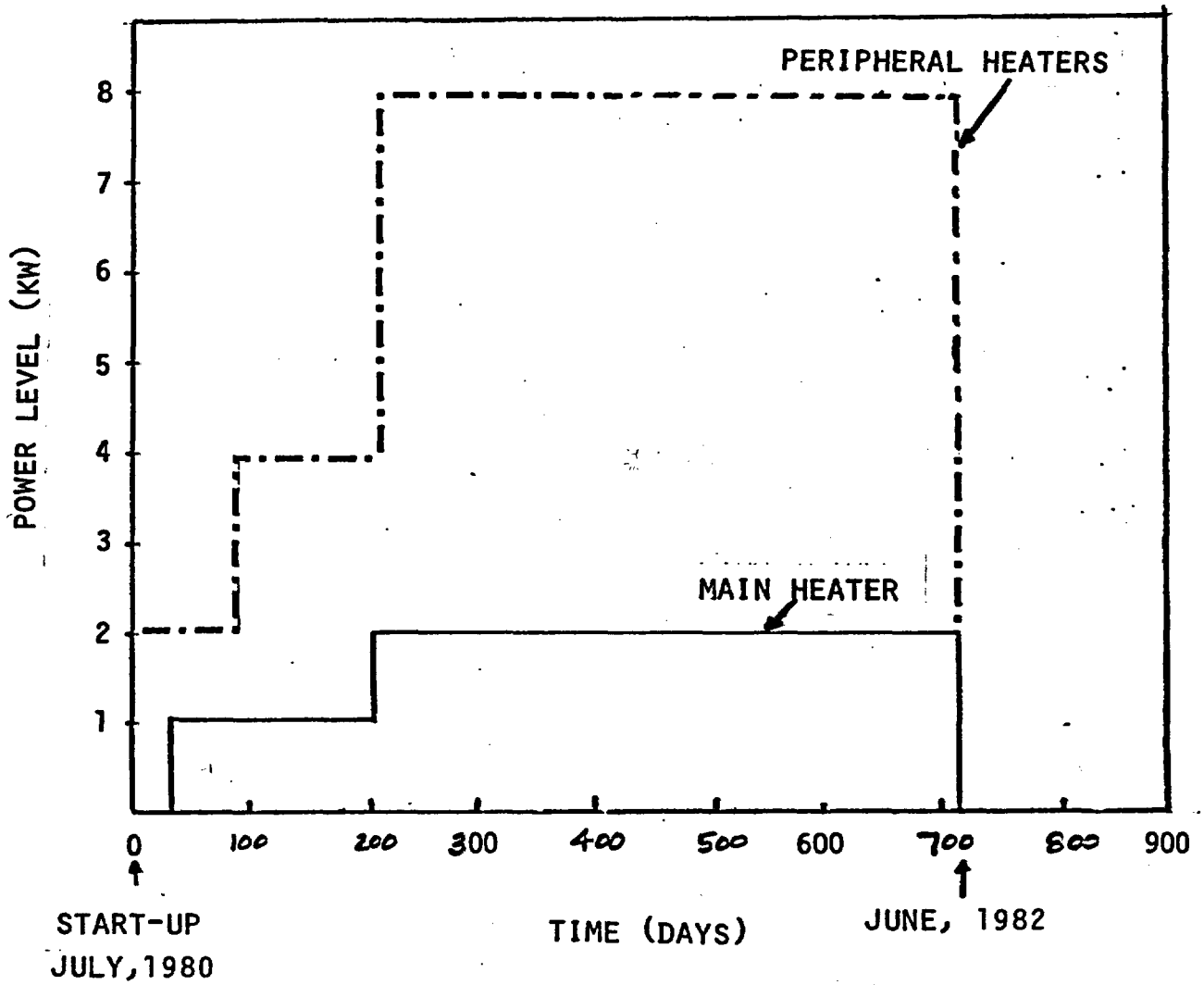
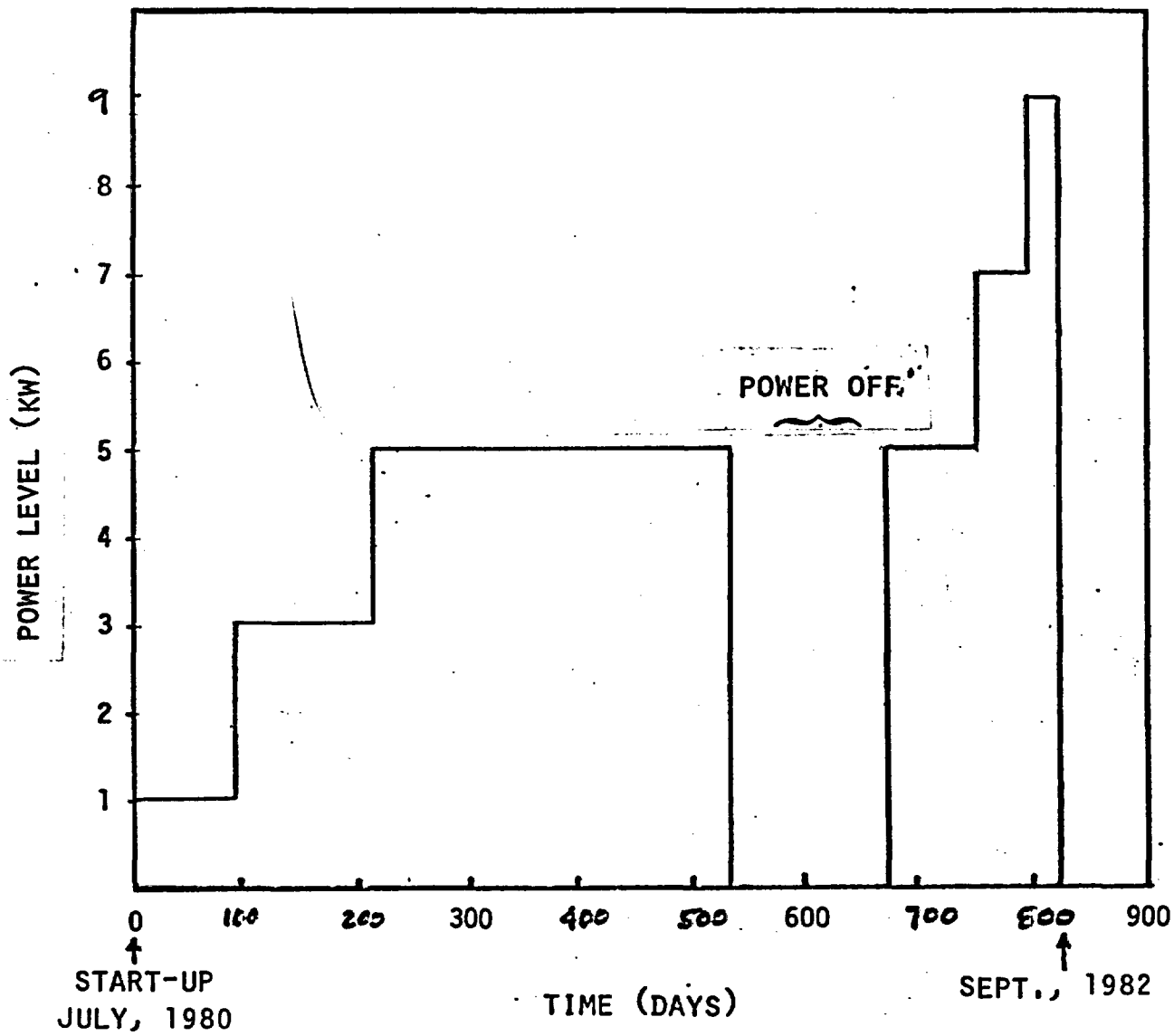


FIGURE 3-5. Plan-Instrumentation Layout and Borehole Designation for Full-Scale Heater Test 2.

POWER LEVELS FOR FULL-SCALE HEATER TEST NO. 1



POWER LEVELS FOR FULL-SCALE HEATER TEST NO. 2



FULL-SCALE HEATER TESTS

MAXIMUM TEMPERATURES RECORDED

TEST	AT HEATER CANISTER	BASALT ~ 0.2 M FROM HEATER
FS#1	429° C	370° C
FS#2 (INITIAL)	450° C	320° C
FS#2 (OVERPOWER)	679° C	465° C

FULL-SCALE HEATER TEST-MODELING

- LBL - PRE-TEST SCOPING ANALYSIS FOR TEST PLANNING. BASALT PROPERTIES FOR ROCK MASS PARAMETERS WERE BASED ONLY ON LABORATORY TESTS.

- PRE-TEST SITE CHARACTERIZATION (MOAK AND WINTCZAK)
  BASED ON THIS CHARACTERIZATION A REVISED PREDICTIVE ANALYSIS WAS CONDUCTED USING A NEW BASALT DEFORMATIONAL MODEL TO ACCOUNT FOR ANTICIPATED ROCK MASS BEHAVIOR.

- BLOCK TEST (PRELIMINARY RESULTS)
  REVISED DEFORMATION CHARACTERISTICS INDICATE SIGNIFICANTLY REDUCED STRESSES

CANISTER BOREHOLE STRESSES AT BOREHOLE WALL

SOURCE	S_θ (MPA)	S_R[1] (MPA)	
LAWRENCE BERKELEY LABORATORY	244.8	85.1	1A @ 365 DAYS
DAMES & MOORE	51.0	18.3	FS#2 @ 500 DAYS
APPLIED MECHANICS INC.	15.0	5.8	FS#2 @ 500 DAYS

S_R - MAXIMUM RADIAL STRESS IN THE TEST AREA AT HEATER CENTERLINE

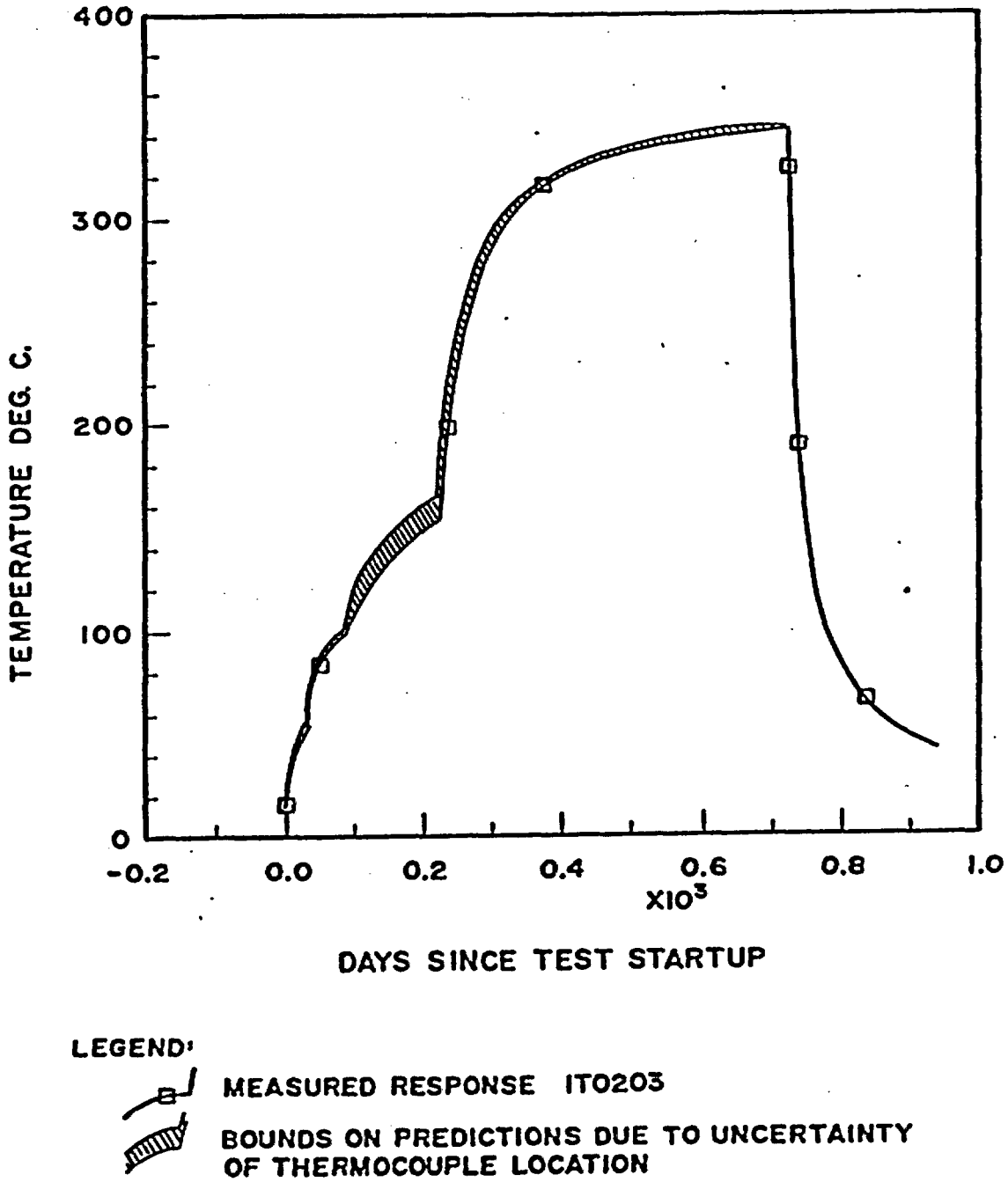


FIGURE 7.7 FS #1 MEASURED AND PREDICTED TEMPERATURE BAND TO TAKE INTO ACCOUNT UNCERTAINTY IN THERMOCOUPLE LOCATION 1T02T03

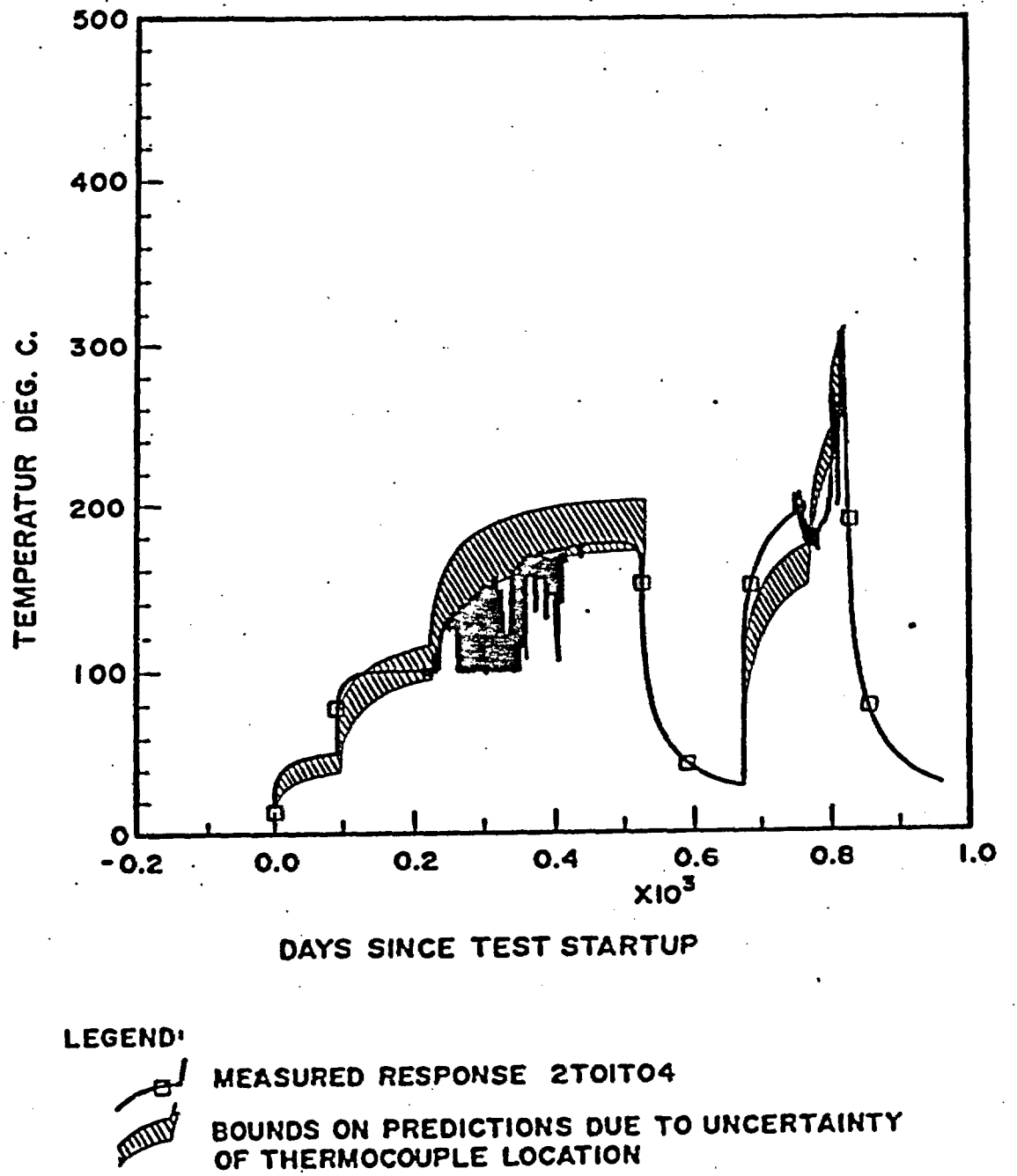


FIGURE 7.9 FS #2 MEASURED AND PREDICTED TEMPERATURE BAND TO TAKE INTO ACCOUNT UNCERTAINTY IN THERMOCOUPLE LOCATION 2T01T04.

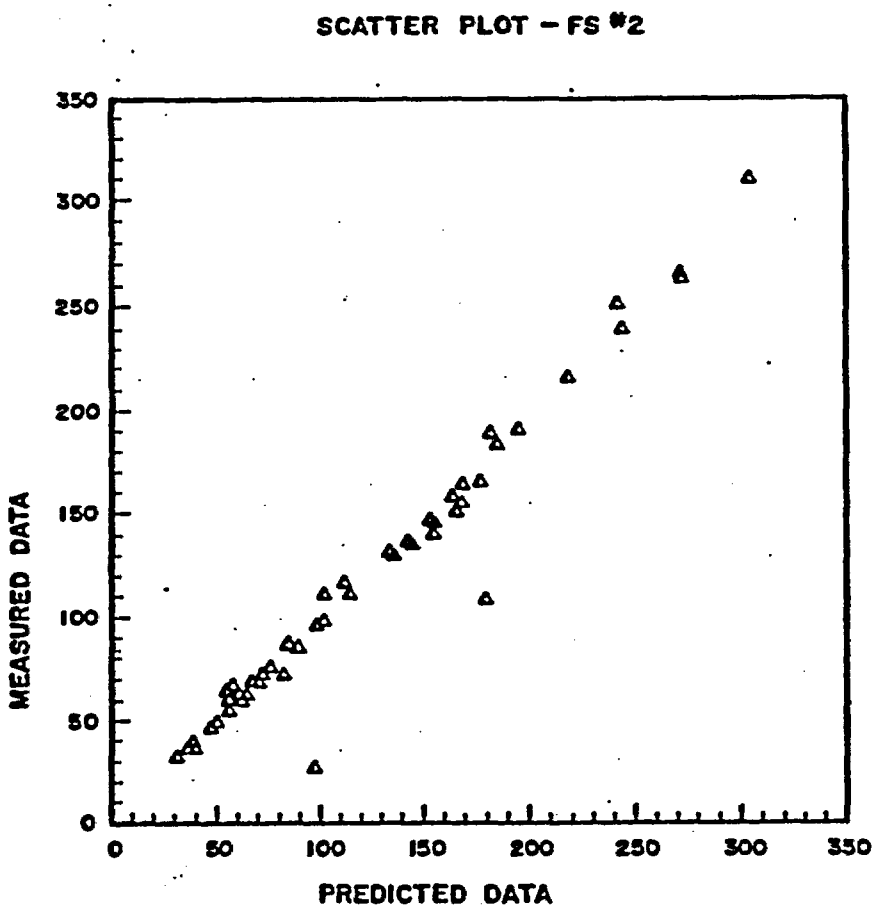
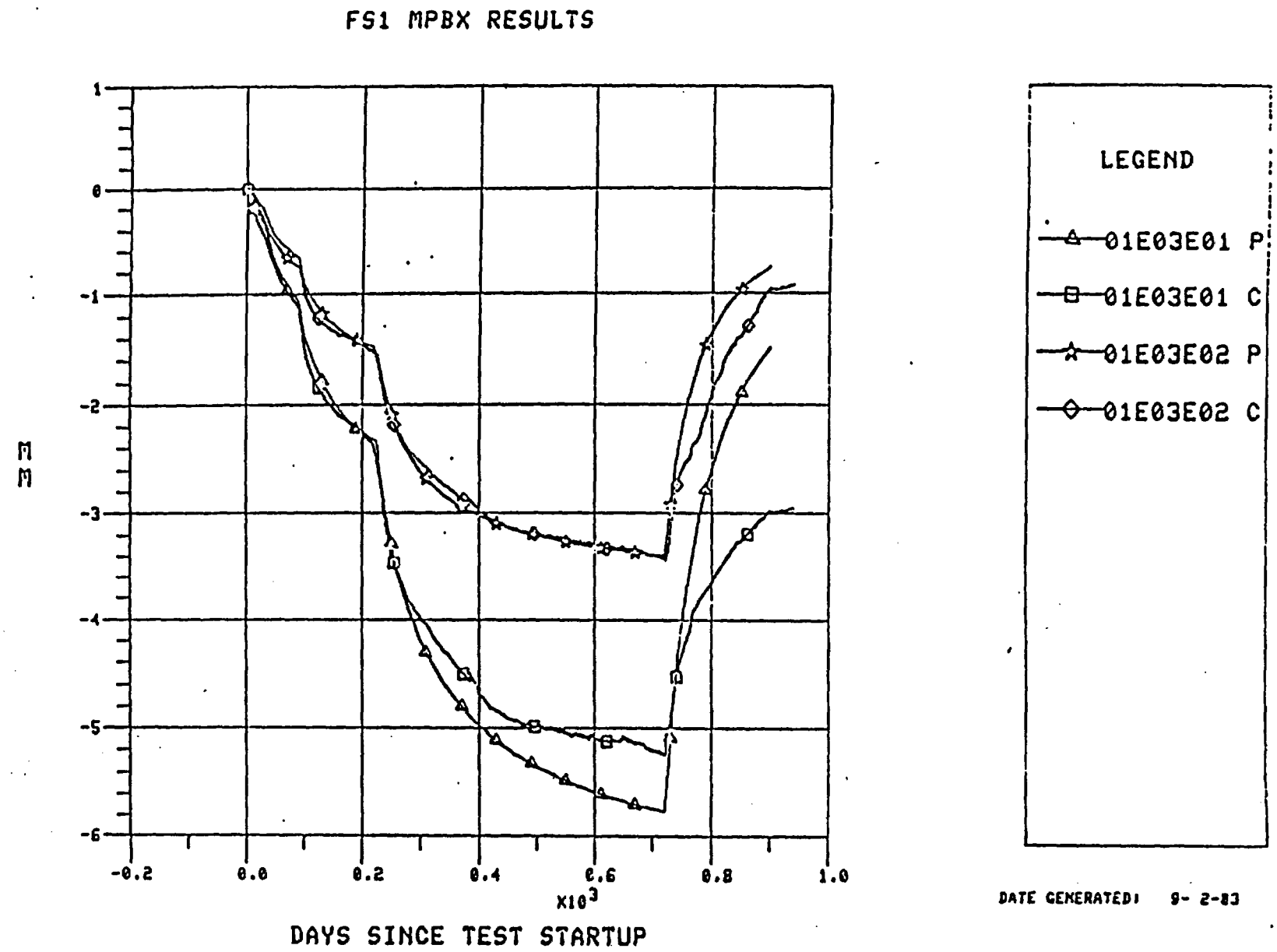


FIGURE 7.1 SCATTER PLOT OF MEASURED AGAINST PREDICTED DATA AT DAY 365 FOR 69 LOCATIONS THROUGHOUT THE ROCK MASS



DAS REV 7 NON-CONTROLLED DEVELOPMENTAL SOFTWARE

FIGURE 6.5 MEASURED (C) AND PREDICTED (P) DISPLACEMENTS FOR VERTICAL MPBX 1E03 AT RADIUS 0.95 M

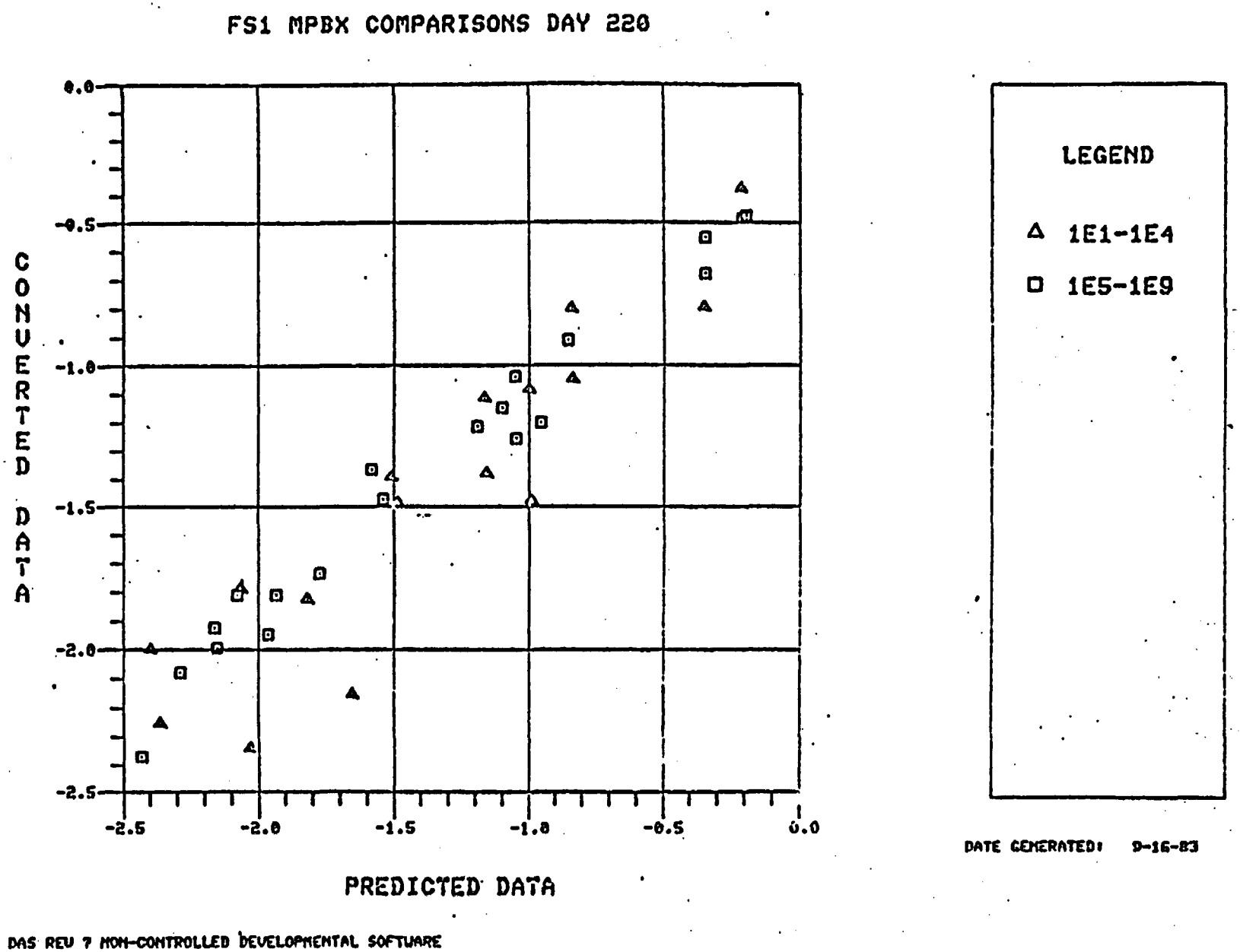


FIGURE 6.1 SCATTER PLOT OF PREDICTED AGAINST MEASURED DATA FOR VERTICAL MPBX'S AT DAY 220

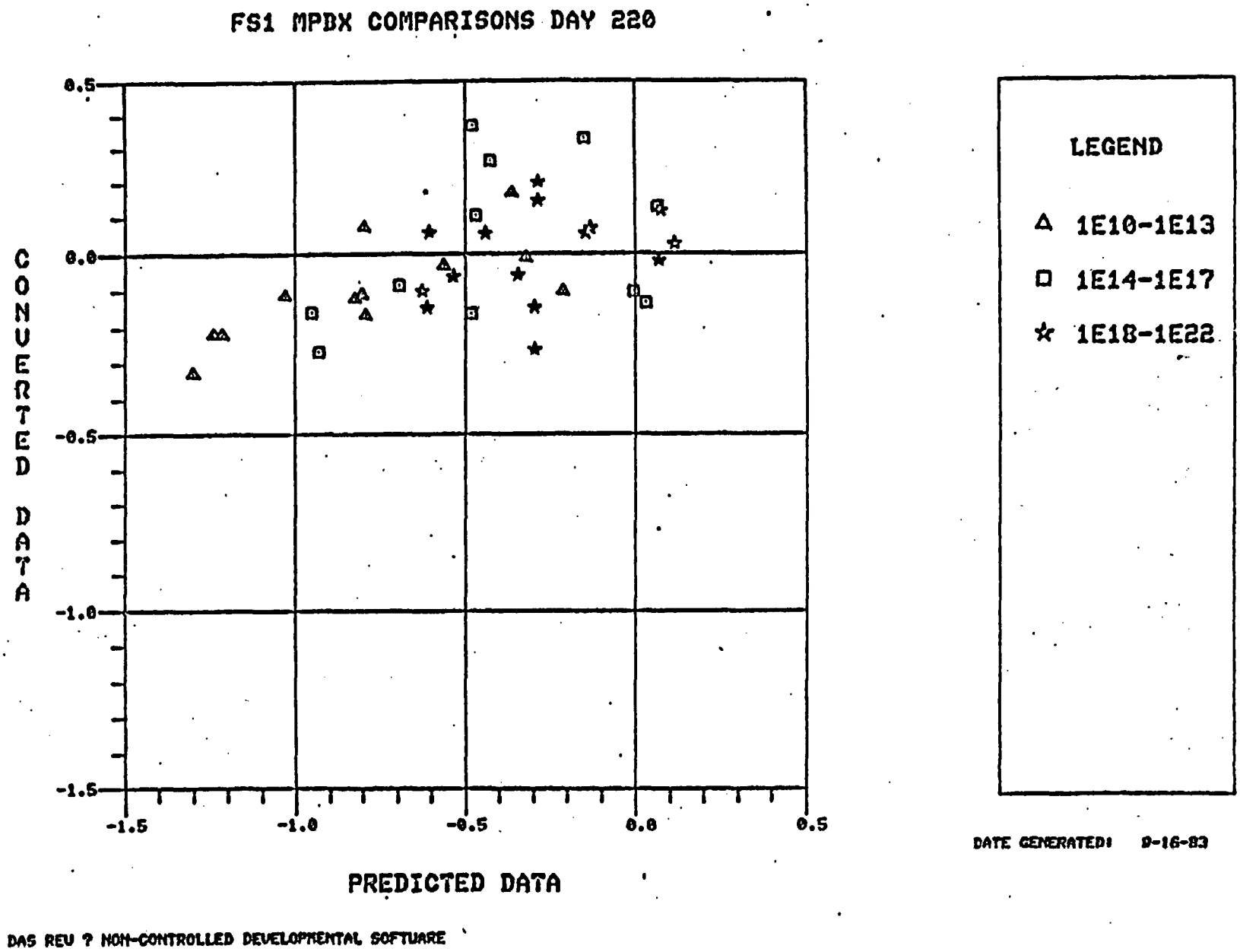
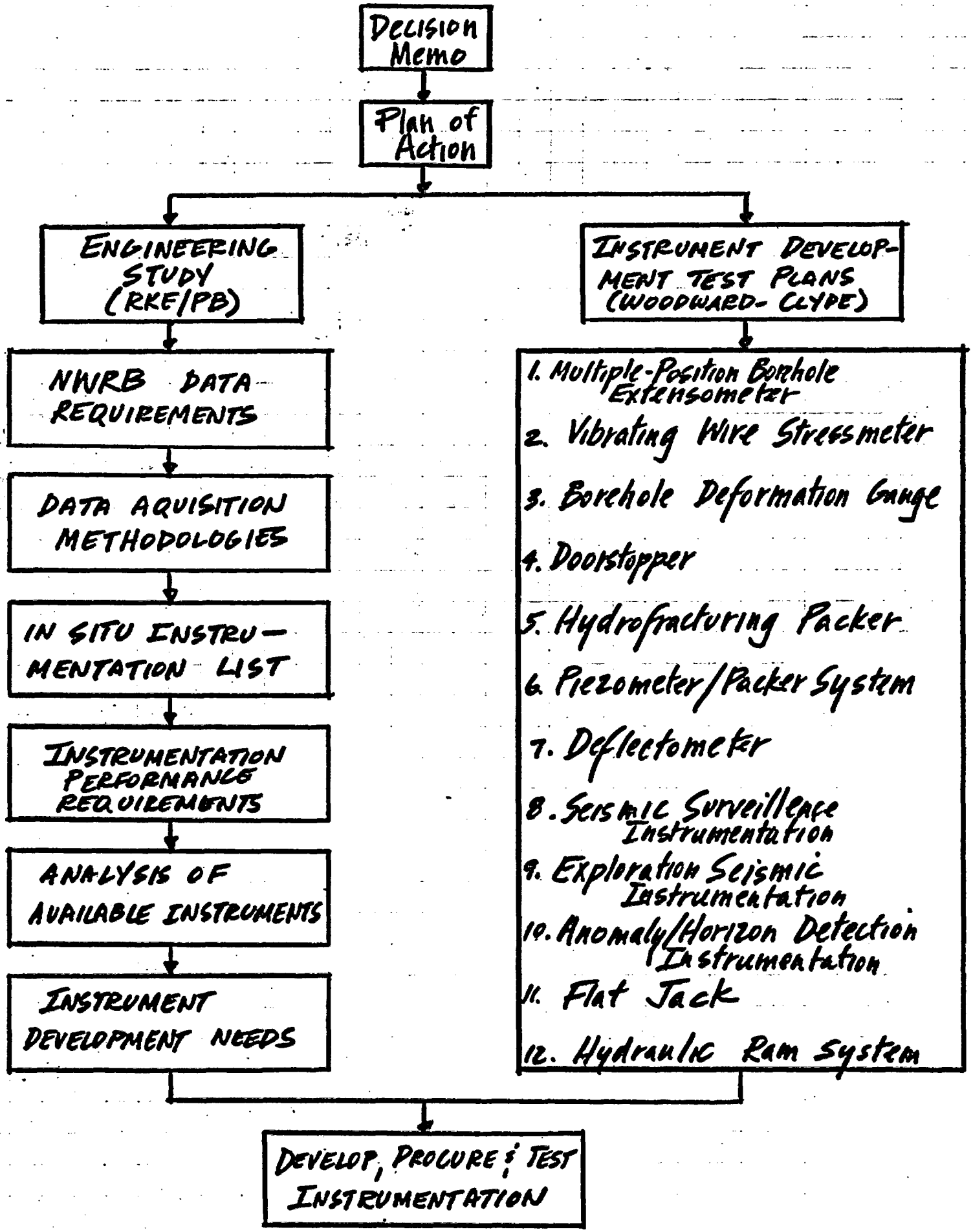


FIGURE 6.9 SCATTER PLOT OF PREDICTED AGAINST MEASURED DATA FOR FS#1 HORIZONTAL MPBX AT 220 DAYS

BWIP INSTRUMENTATION DEVELOPMENT



APPLICATION OF BLOCK TEST RESULTS TO REPOSITORY DESIGN

I. DEVELOPMENT AND VALIDATION OF NUMERICAL MODELING TECHNIQUES

A. PROVIDES MATERIAL PROPERTIES FOR INPUT INTO MODELS:

- O COEFFICIENT OF THERMAL EXPANSION
- O DEFORMATION RESPONSE
- O THERMAL CONDUCTIVITY

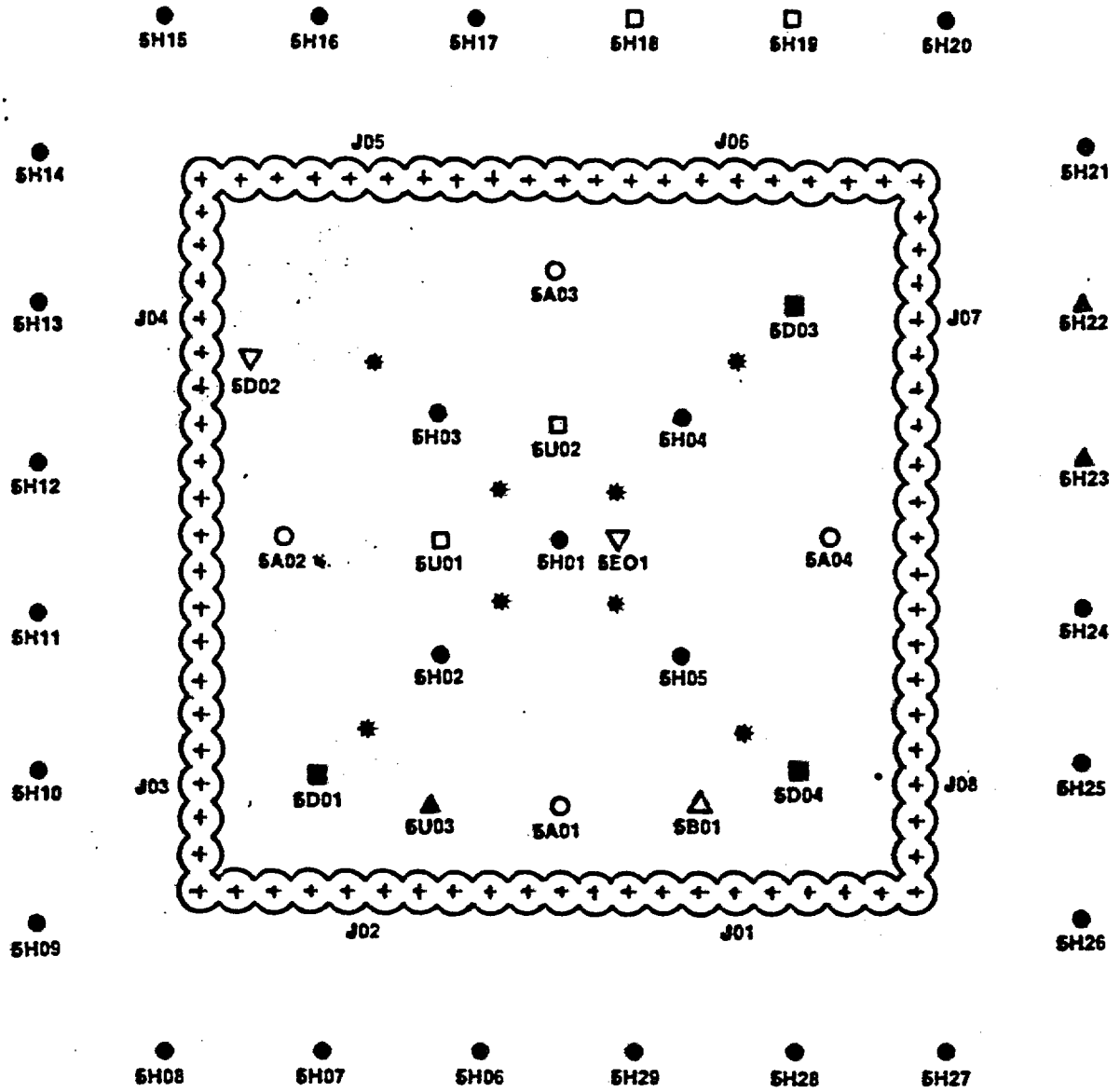
B. ALLOWS COMPARISON BETWEEN MODELING RESULTS AND ACTUAL ROCK MASS DATA

II. DEVELOPMENT OF INSTRUMENTATION AND TEST TECHNIQUES PRIOR TO APPLICATION AT DEPTH

Answer to Q. 1.a

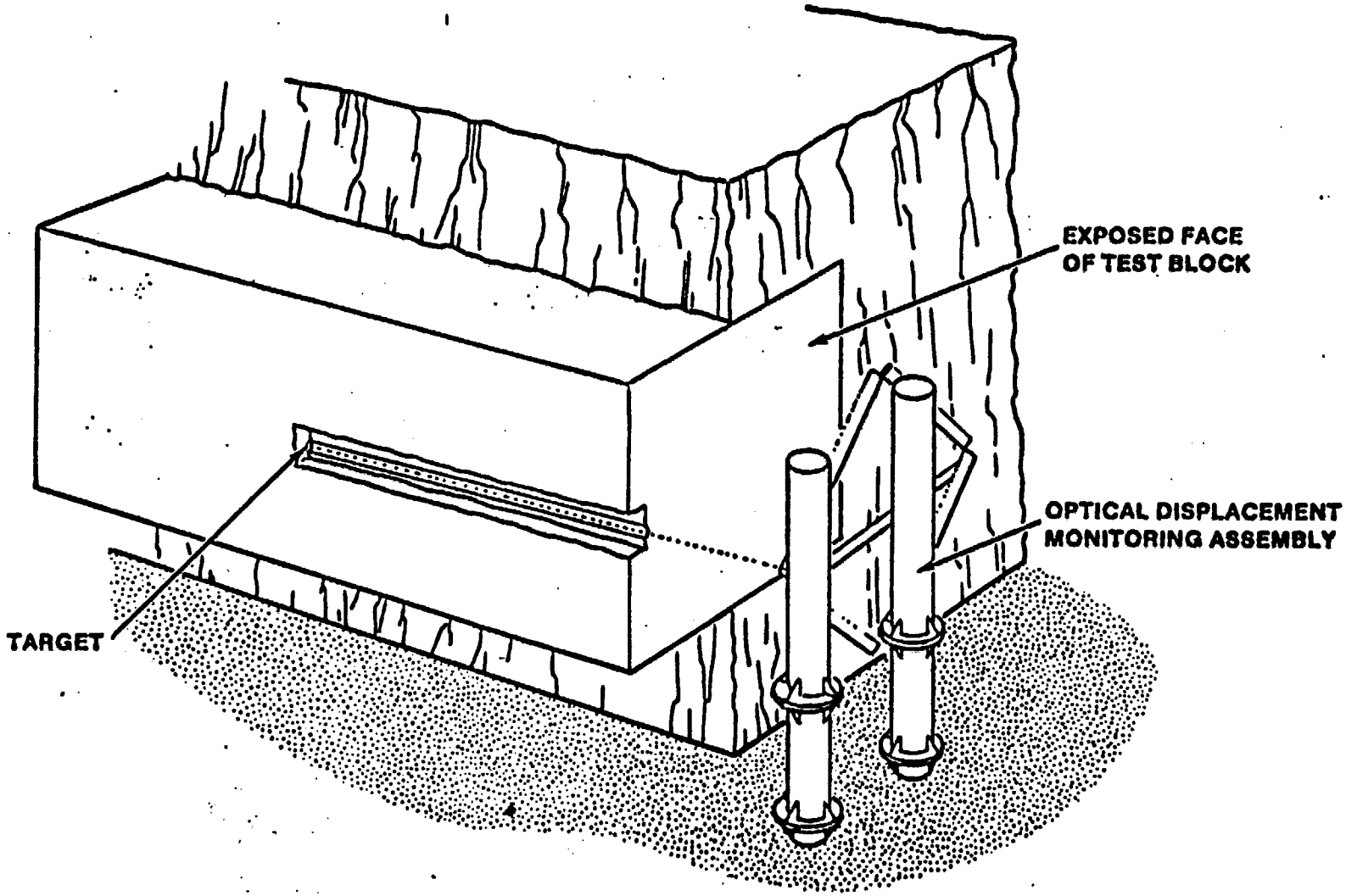
CRONOLOGY OF BLOCK TEST #1

- o JANUARY 14, 1981 - DRILLING OF STEP 1 SLOT BEGUN
- o JUNE 22, 1981 - STEP 1 TESTING BEGUN
- o AUGUST 18, 1983 - STEP 1 TESTING COMPLETED
- o JANUARY 15, 1982 - STEP 2 CONSTRUCTION BEGUN
- o JANUARY 28, 1982 - STEP 1 REPORT COMPLETED
- o JULY 15, 1982 - STEP 2 TESTING BEGUN (PHASE I)
- o MAY 15, 1983 - PHASE II OF THE STEP 2 TESTING SEQUENCE BEGUN

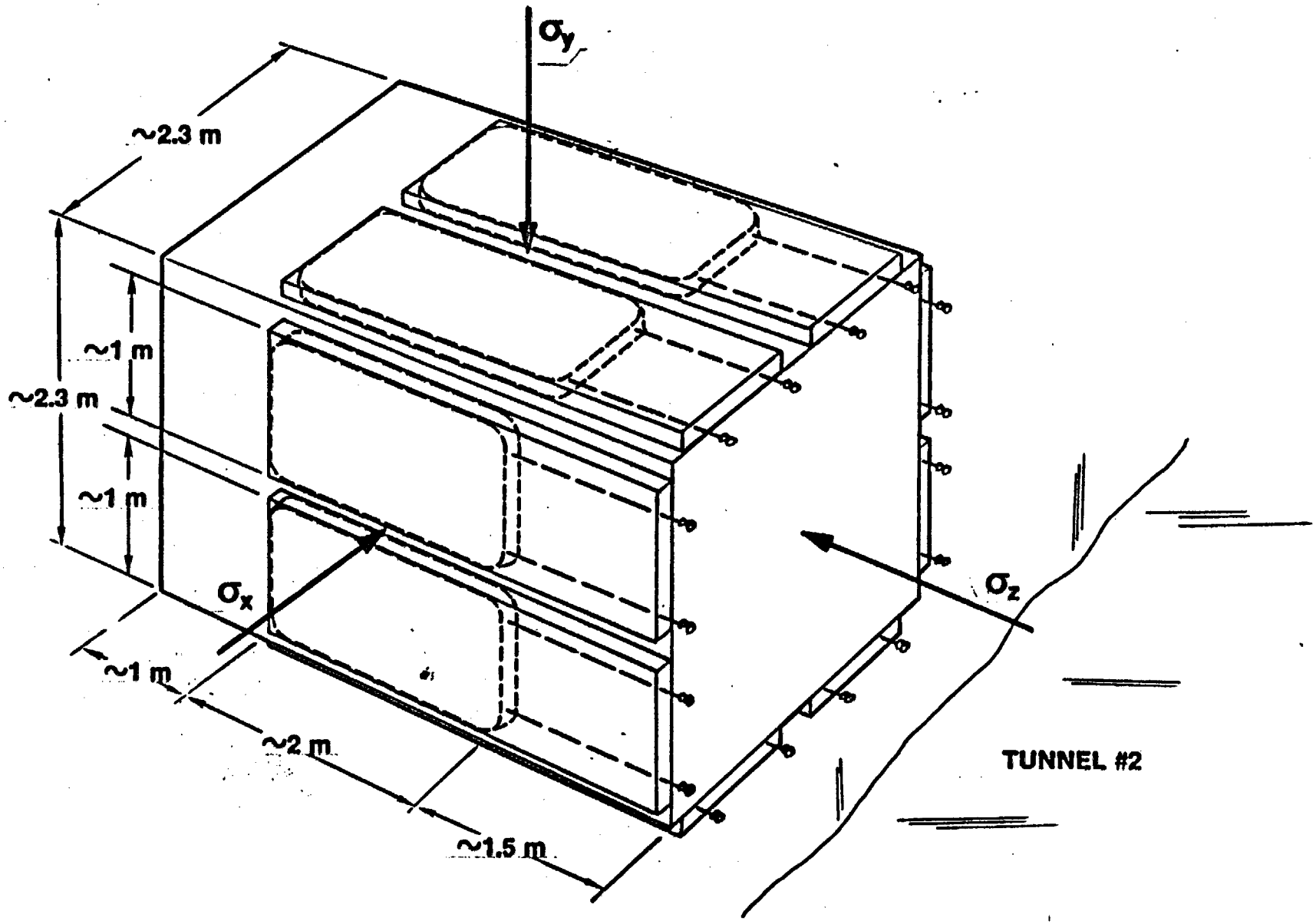


- ✸ CABLE TENDON HOLE
- ▽ EXTENSOMETER
- ● HEATER
- OPTICAL TARGET
- ■ MONITORING HOLE
- □ BOREHOLE DEFORMATION GAUGE
- ▲ BOREHOLE DEFORMATION GAUGE AND VIBRATING WIRE STRESSMETER
- △ VIBRATING WIRE STRESSMETER

NOTE: EACH INSTRUMENT AND HEATER SHOWN CONTAINS A THERMOCOUPLE



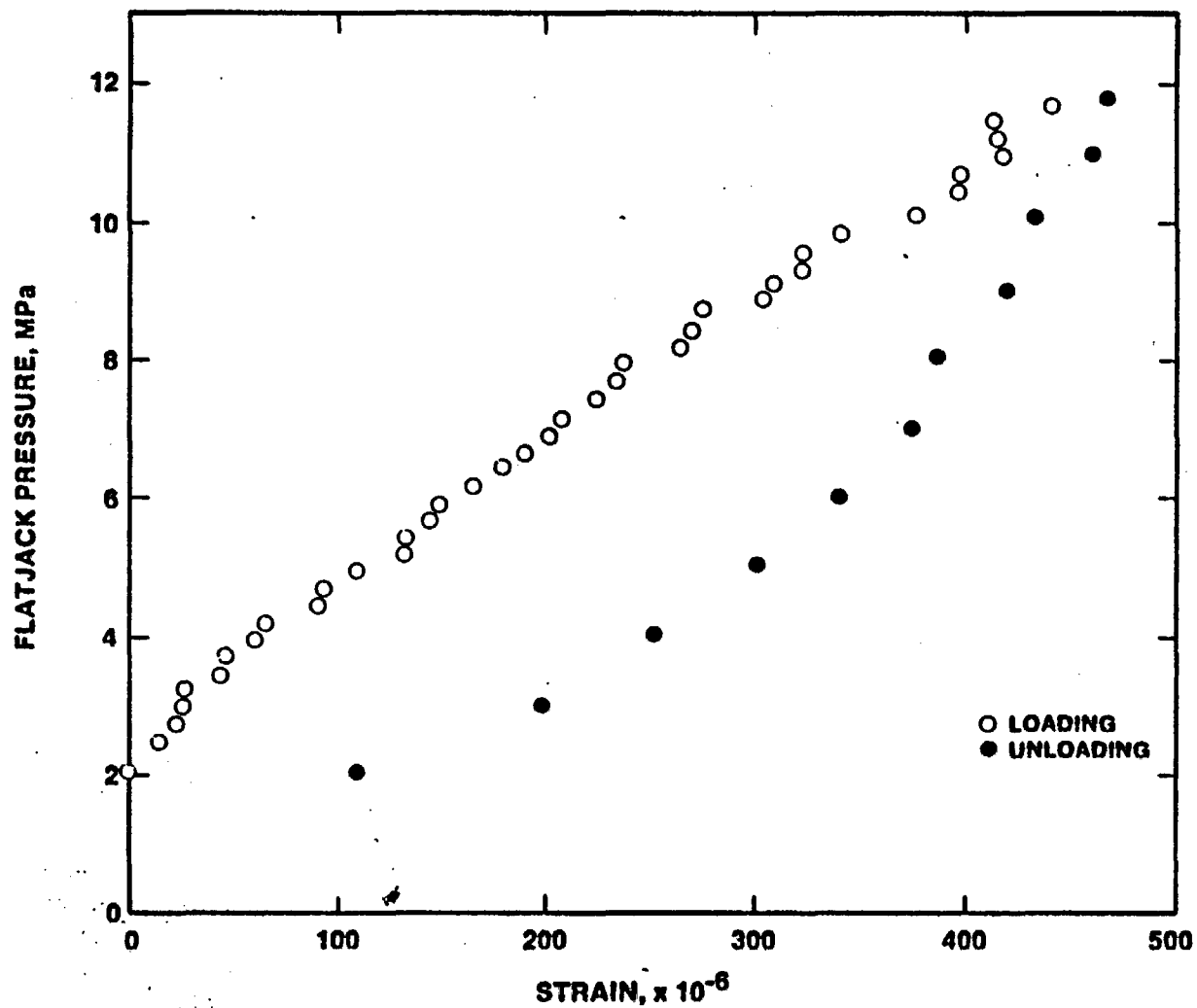
Basalt Deformation Measurement System



BLOCK TEST ISOMETRIC VIEW

SUMMARY OF BLOCK TEST AMBIENT TEMPERATURE LOADING CYCLES

CYCLE	DEVIATORIC STRESS (MPA)	CONFINING STRESS (MPA)	
1	σ_{xx} 1.00 - 3.75	σ_{yy} 1.50	σ_{zz} 1.50
2	σ_{xx} 1.00 - 6.50	σ_{yy} 2.50	σ_{zz} 2.50
3	σ_{xx} 2.00 - 12.0	σ_{yy} 5.00	σ_{zz} 5.00
3R	σ_{xx} 2.00 - 12.5	σ_{yy} 5.00	σ_{zz} 5.00
4	σ_{yy} 1.00 - 3.75	σ_{xx} 1.50	σ_{zz} 1.50
5	σ_{yy} 1.00 - 6.50	σ_{xx} 2.50	σ_{zz} 2.50
6	σ_{yy} 2.00 - 12.50	σ_{xx} 5.00	σ_{zz} 5.00
7	σ_{yy} 2.00 - 9.00	σ_{xx} 5.00	σ_{zz} 5.00
8	σ_{xx} 2.00 - 9.00	σ_{yy} 5.00	σ_{zz} 5.00
9	σ_{yy} 2.00 - 9.00	σ_{xx} 5.00	σ_{zz} 5.00
10	σ_{yy} 2.00 - 9.00	σ_{xx} 5.00	σ_{zz} 5.00
11	σ_{zz} 1.00 - 5.00	σ_{xx} 2.50	σ_{yy} 2.50
12	σ_{zz} 2.00 - 5.00	σ_{xx} 5.00	σ_{yy} 5.00
13	σ_{zz} 2.00 - 5.00	σ_{xx} 9.00	σ_{yy} 9.00
14	$\sigma_{xx}, \sigma_{yy}, \sigma_{zz}$ (hydrostatic test) 1.00 - 5.00	-- --	-- --
15	σ_{zz} 1.00 - 5.00	σ_{xx} 2.50	σ_{yy} 2.50
16	$\sigma_{xx}, \sigma_{yy}, \sigma_{zz}$ (hydrostatic test) 1.00 - 5.00	-- --	-- --



BLOCK TEST BDMS DISPLACEMENTS

TARGET NUMBER A02A04
TESTING PERFORMED 8/17/82
AMEIENT CYCLE NUMBER 3

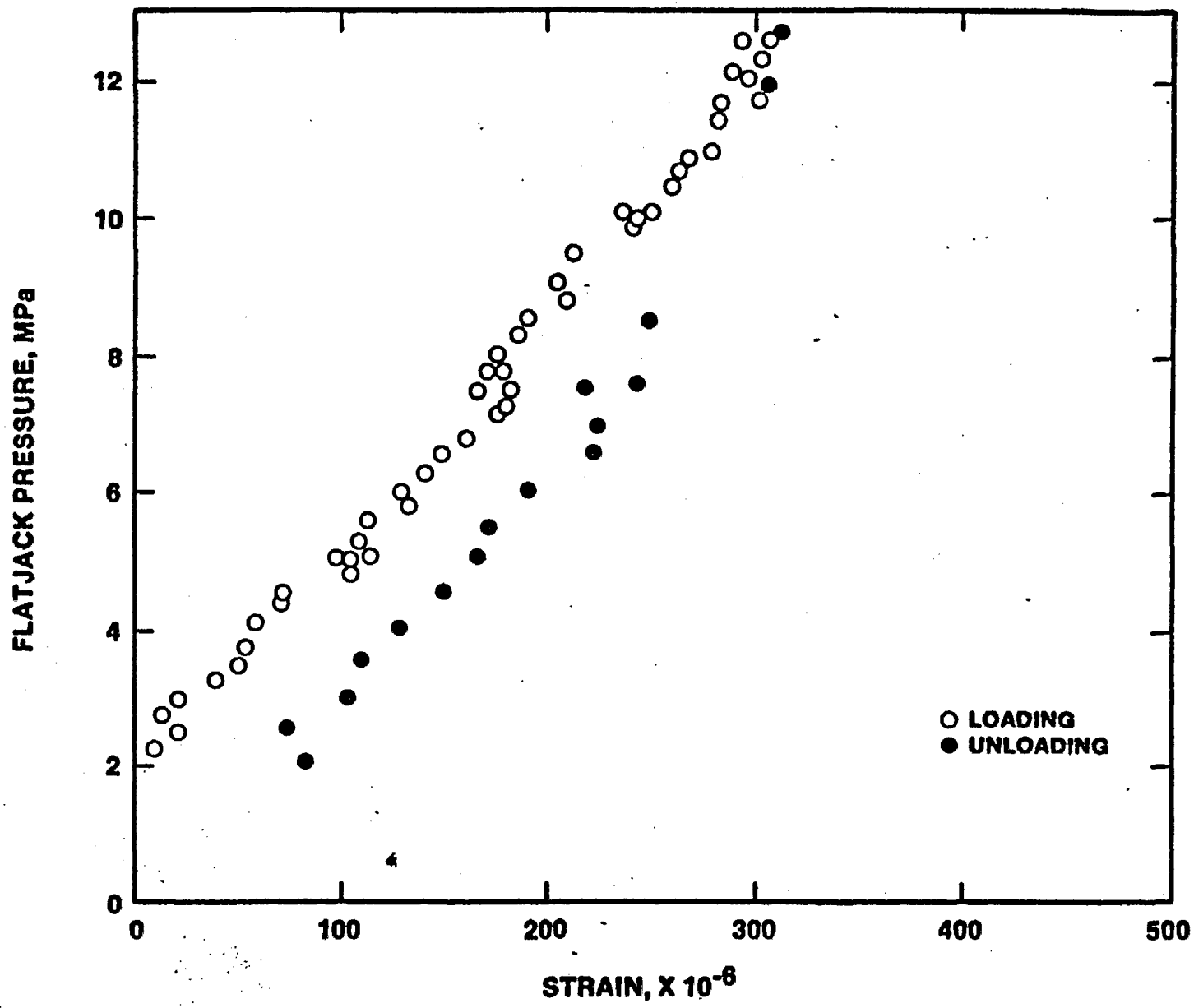


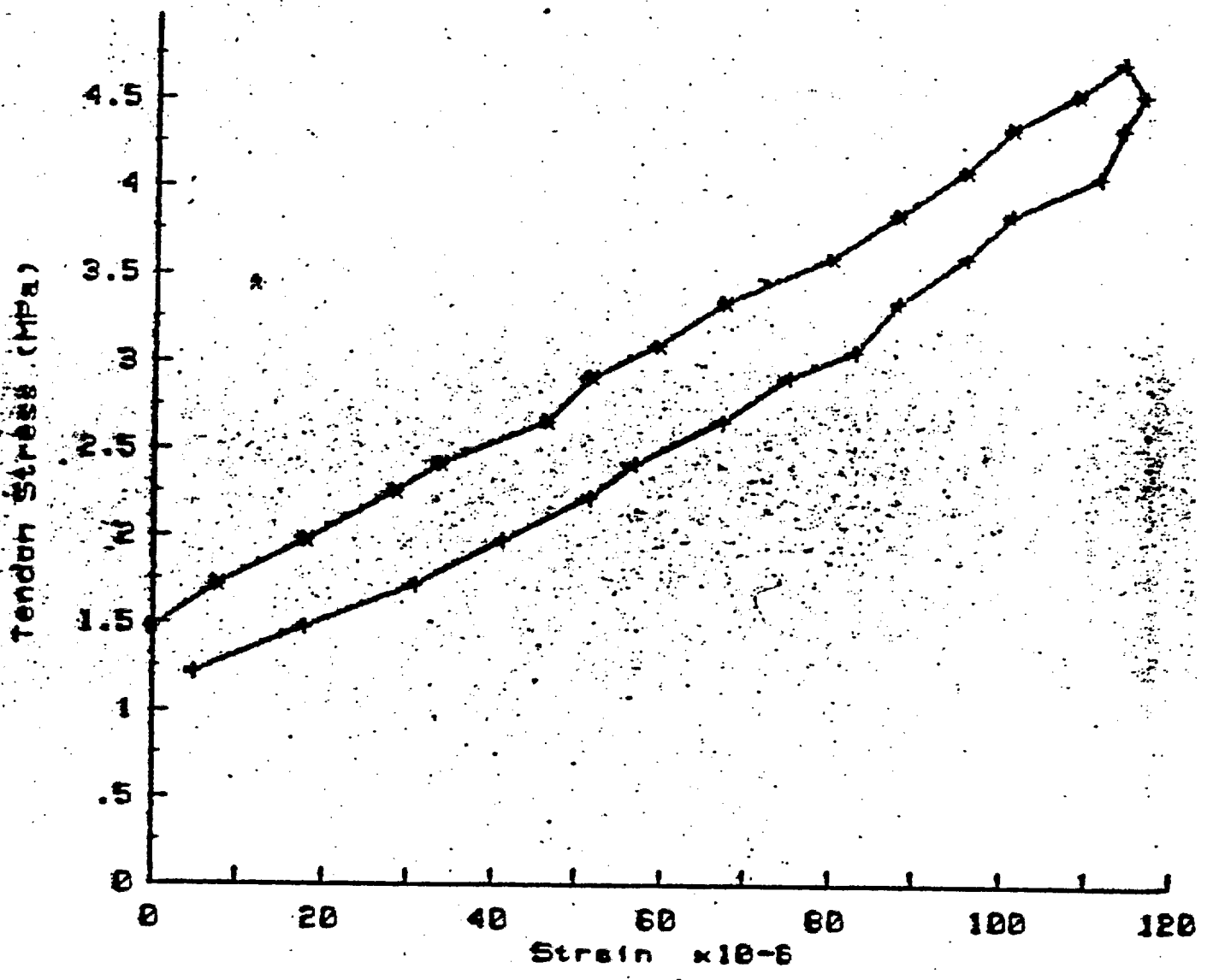
FIGURE 3.2

BLOCK TEST BDMS DISPLACEMENTS

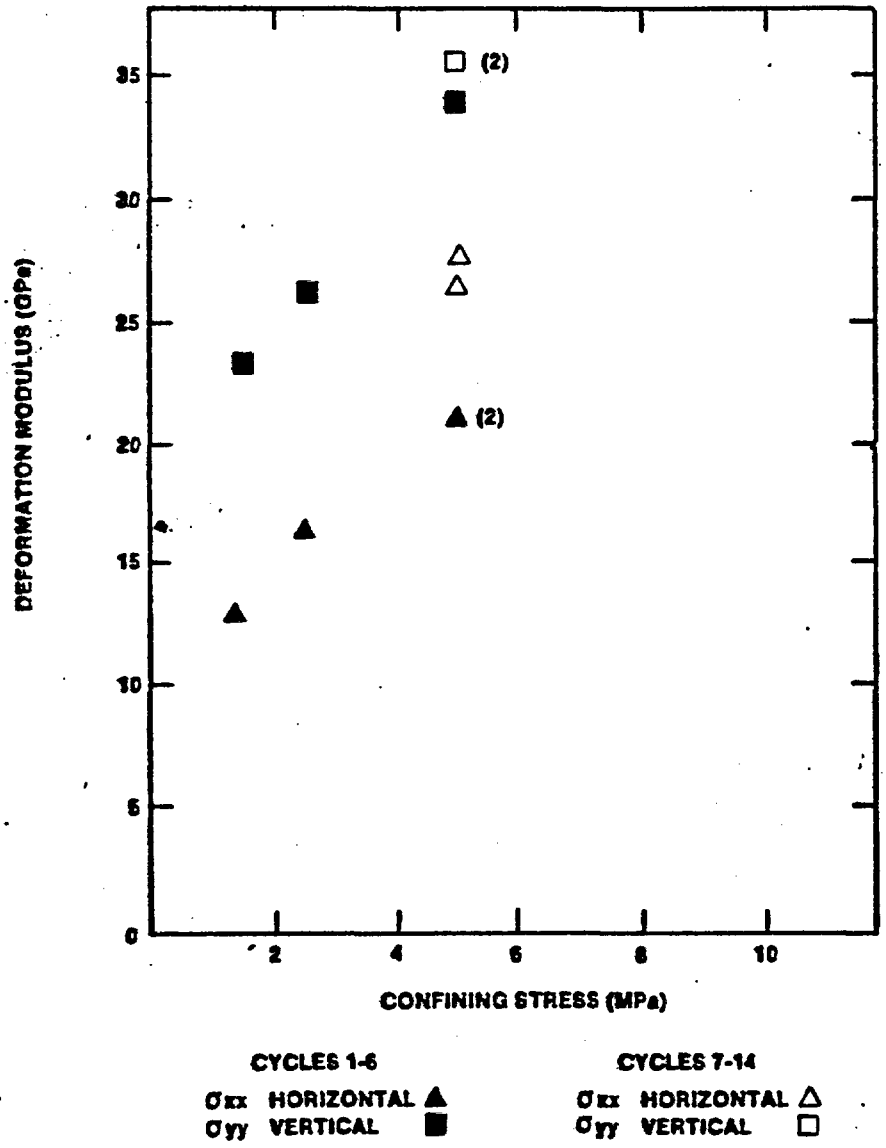
TARGET NUMBER A01A03
TESTING PERFORMED 8/30/82
AMEIENT CYCLE NUMBER 6

TESTING FOR TENDON CYCLE 11
BLOCK TEST MPBX DISPLACEMENTS
(MPBX 7E01)

ANCHOR STRAIN (E04-E03)



* = loading of flatjacks.
* = unloading of flatjacks.



NOTE: (2) INDICATES TWO DATA POINTS AT THIS LOCATION

DEFORMATION MODULI RESULTS VERSUS CONFINING STRESS

I. Development of Basalt Consitutive Model

- Implementation on DAMSWEL
- Assumes three major response characteristics from initial Block Test data

  1) Moduli dependence on confining stress
  2) Minimal non-linearity of stress-strain response
  3) Loading and unloading path dependence

II. ANALYSIS OF TEST BOUNDARY CONDITIONS

- IMPLEMENTATION ON ANSYS
- EXPLICIT MODELING OF FLAT JACKS
- ASSUME HOMOGENEOUS, ISOTROPIC, LINEAR ELASTIC MATERIAL RESPONSE

III. DISCRETE BLOCK MODELING TECHNIQUE

- o DISTINCT ELEMENT CODE - UDEC
- o INVESTIGATE INFLUENCE OF VARIOUS JOINTING CONDITIONS
  1) PATTERN
  2) SPACING
  3) ELASTIC AND FRICTIONAL PROPERTIES
- o ATTEMPT TO DETERMINE DOMINATE MECHANISM WHICH PRODUCES INELASTIC BEHAVIOR
  1) SLIP ON SUBVERTICAL AND/OR SUBHORIZONTAL JOINTS
  2) OPENING AND CLOSING OF JOINTS
- o INVESTIGATE UNIFORMITY OF STRESS DISTRIBUTION IN BLOCK

SUMMARY OF STEP 2 RESULTS

- ROCK MASS EXHIBITS AN ANISOTROPIC AND NON-HOMOGENEOUS DEFORMATIONAL RESPONSE.
- THE DEFORMATION RESPONSE IS SENSITIVE TO CHANGES IN THE CONFINING STRESS LEVEL.
- THE BOUNDARY CONDITIONS OF THE TEST CONFIGURATION CAN INFLUENCE THE MATERIAL RESPONSE.
- FLAT-JACK LOADING SYSTEM REQUIRES FURTHER DEVELOPMENT.
- THE BDMS AND EXTENSOMETERS HAVE PERFORMED SATISFACTORILY WHILE THE BOREHOLE DEFORMATION GAUGE, THE VIBRATING WIRE STRESSMETER AND FLAT-JACK DEFORMETERS REQUIRE FURTHER DEVELOPMENT.

SUMMARY OF BLOCK TEST
FUTURE ACTIVITIES

- COMPLETE AMBIENT TEMPERATURE TESTING PHASE
  - COMPLETE ALL ITEMS INCLUDED IN CURRENT PLAN-OF-ACTION
  - CONDUCT ADDITIONAL TESTING CYCLES AS NECESSARY
  - PREPARE COMPLETE REPORT ON AMBIENT TEMPERATURE TESTING

- CONDUCT ELEVATED TEMPERATURE TESTING
  - EVALUATE DEFORMATIONAL RESPONSE AT 100°C, 150°C, AND 200°C
  - EVALUATE COEFFICIENT OF THERMAL EXPANSION AND THERMAL CONDUCTIVITY AS A FUNCTION OF TEMPERATURE AND CONFINING STRESS

- PREPARE COMPREHENSIVE BLOCK TEST REPORT

1-8

AVAILABLE BLOCK TEST DOCUMENTS

TEST PLANS

SD-BWI-TP-001 A-0, "Test Plan for Jointed Block Test #1"

SD-BWI-TI-042 0-2, "Operational Test Guidelines and Support Data for Jointed Block Test #1"

REPORTS

RSD-BWI-TI-059, "Pre-Test Analysis of Step 2 of the Jointed Block Test"

SD-BWI-TP-001, "Block Test Step 1 Report"

Cramer, M. L., Cunningham, J. P., Kim, K., "Rock Mass Deformation Properties from a Large-Scale Block Test," 24th U.S. Symposium on Rock Mechanics, Texas A&M University, College Station, Texas, June, 1983. Also to be published in the Bulletin of the Association of Engineering Geologists. (RHO-BW-SA-284P)

Cramer, M.L., Black, M. T., "The Design and Construction of a Block Test in Closely Jointed Rock," 24th Symposium on Rock Mechanics, Texas A&M University, College Station, Texas, June, 1983. Also to be published in the Bulletin of the Association of Engineering Geologists. (RHO-BW-SA-286P)

Gregory, E. C., Cramer, M. L., Ames, R. R., McHenry, J. M., "Applicability of Borehole Stress Measurement Instrumentation to Closely Jointed Rock," 24th U.S. Symposium on Rock Mechanics, Texas A&M University, College Station Texas, June 1983. Also to be published in the Bulletin of the Association of Engineering Geologists. (RHO-BW-SA-285P)

Cramer, M. L., Kim, K., "Rock Mass Deformation Properties of Closely Jointed Basalt," American Geophysical Union Fall Meeting, San Francisco, December 1982. (RHO-BW-SA-267P)

Gregory, E. C., Cramer, M. L., McCabe, W. M., Kim, K., "Summary of Near-Surface Test Facility Results and Their Application to Repository Design," 1982 NWTS Information Meeting, Las Vegas, December 1982. (RHO-BW-SA-256P)

Lanigan, D. C., Cramer, M. L., Kim, K., "Determination of Rock Mass Deformation Modulus in Closely Jointed Columbia River Basalt," 29th Pacific Northwest Meeting - American Geophysical Union, Fairbanks, September 1982. (RHO-BW-SA-229P)

Kim, K., Cramer, M. L., Jimenez, R. F., Christenson, J. E., "Thermo-mechanical Jointed Block Test in Basalt - Preliminary Results," 23rd U.S. Symposium on Rock Mechanics, Berkeley, August 1982. (RHO-BW-SA-230P)

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OTHER DOCUMENTS

STP-M-991-00002 B-0, NSTF Operating Procedures - Block Test No. 1

SD-BWI-ATR-002, Acceptance Test Report for the Rock Instrumentation System for the Rock Instrumentation System Block Test #1, Step 2

SD-BWI-VP-002, Verification Plan for Equipment Installation, Block #1

HWS-10287, Specification for the Basalt Deformation Measurement System