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UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PRELIMINARY ANALYSIS OF GEOPHYSICAL LOGS FROM DRILL HOLE UE-25p#1, YUCCA MOUNTAIN, NYE COUNTY, NEVADA

BY

D. C. Muller and J. E. Kibler

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ABSTRACT

Geophysical logs from drill hole UE-25p#1 correlate well with logs through the same geologic units from other drill holes at Yucca Mountain, Nevada. The in-situ physical properties of the rocks as determined from well logs are consistent with laboratory-measured physical properties of core from other drill holes. The density, neutron and caliper logs are very "spiky" through most of the Topopah Spring Member. This spikiness occurs on the same logs in cored holes where the Topopah Spring Member is highly fractured and lithophysal. The uranium channel of the spectral gamma-ray log through the Topopah Spring Member correlates with uranium logs from cored holes where most of the fractures have not been healed or filled with materials that concentrate uranium. Therefore, fracture porosity and permeability of the Topopah Spring Member are expected to be high and consistent with fracture analysis from other drill holes on Yucca Mountain, and hydrologic tests from well J-13. The Paleozoic dolomites which underlie the Tertiary tuffs are intensely brecciated, and the uranium count rate is much higher than normal for dolomites because uranium has been concentrated in the recementing material.

INTRODUCTION

Drill hole UE-25p#1 (fig. 1) was drilled in 1983 as part of the continuing exploration program for the U.S. Department of Energy (DOE) in the Nevada Nuclear Waste Storage Investigations (NNWSI). The purpose of the drill hole is to obtain geologic, hydrologic, and geophysical insight into the Tertiary tuffs of Yucca Mountain, Nevada, and the underlying Paleozoic rocks. Table 1 is a preliminary summary of the lithostratigraphy encountered at UE-25p#1 (written commun., M. D. Carr, 1984). A comparison of the geophysical logs with the lithostratigraphy is shown on Plate 1 (sheets 1 and 2 in the pocket). This report presents a preliminary analysis of the geophysical log data, and documents the data for Quality Assurance required by the Nuclear Regulatory Commission (NRC) and for use by other investigators. Detailed analysis of the data is not contained in this report.

GEOPHYSICAL LOGS

This section briefly describes each log plotted on Plate 1 and describes the logging method and tool response characteristics. For more detailed discussion of logging tools and response characteristics the reader is referred to Asquith and Gibson (1982), Freedman and Vogiatzis (1979), Pirson (1963), Poley and others (1978), Rau and Wharton (1980), Schlumberger (1972), and Schlumberger (1974). Additional log data from Yucca Mountain have been described by Daniels and Scott (1981), and Hagstrum and others (1980).

Drilling and logging operations can affect logging data -- such operational influences are discussed later in this report. Logging operations are monitored and actual procedures documented in an effort to attain high-quality geophysical log data. Accuracy and precision of tools and data are defined in logging contract specifications by Fenix & Scisson, the primary DOE contractor for logging. Specific information regarding the contracts and contracted standards are available from Fenix & Scisson. On-site contract monitoring during logging operations is performed by a Fennix & Scisson logging engineer. A representative of the USGS inspects all logs prior to installation of casing or any other operation that renders the drill hole unloggable, and recommends additional logging which may be needed to confirm anomalies and to repeat any inconsistent or unusable log data.

All depths from log data are presented as received from the logging companies in feet. To convert feet to meters multiply by 0.3048.

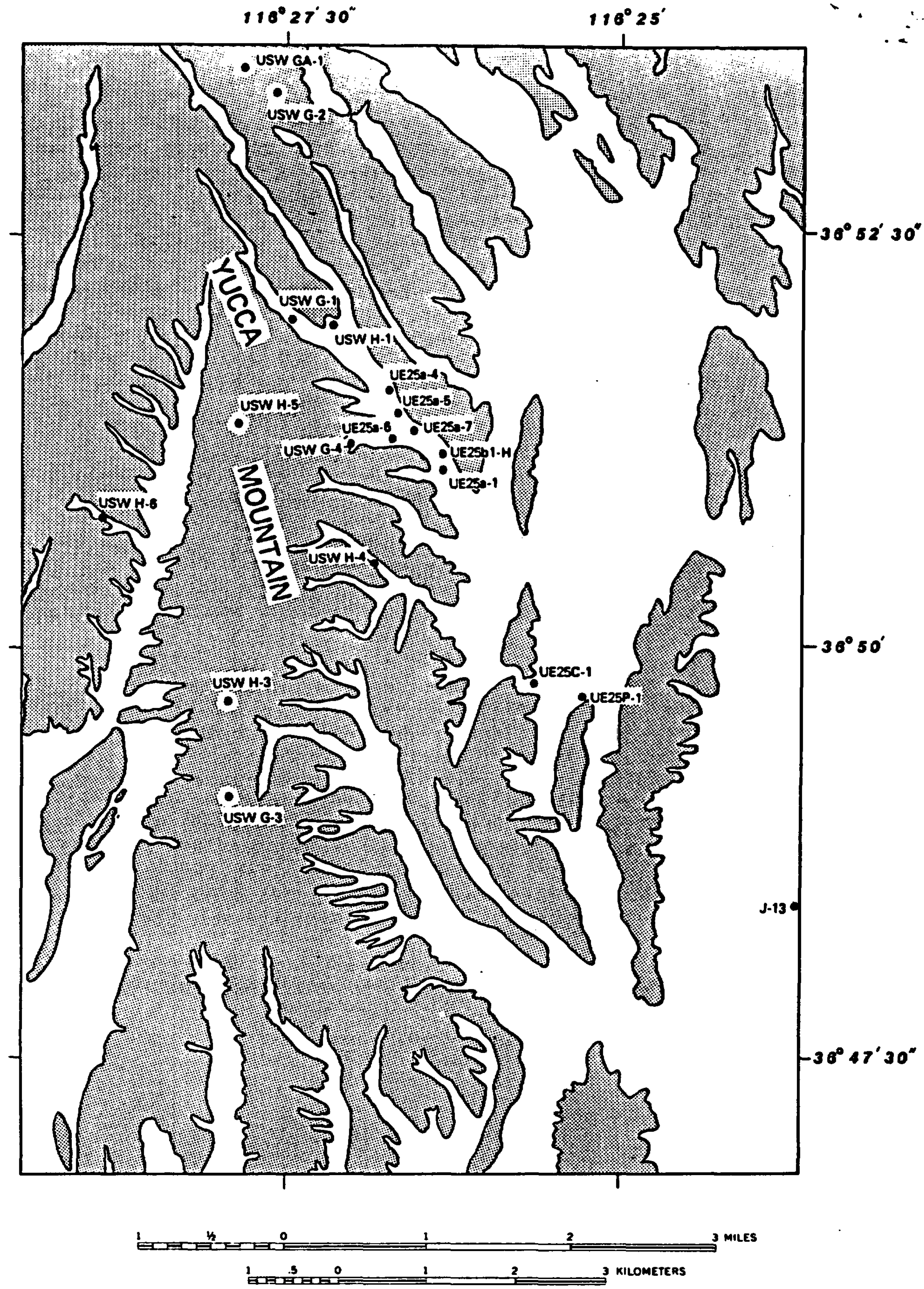

Figure 1. Map of Yucca Mountain showing the location of drill hole UE-25p#1.

Table 1--Preliminary summary of major lithostratigraphic units and contacts in drill hole UE-25p#1[1]

	Depth of Interval meters	(feet)	Thickness of Interval meters	(feet)
Alluvium......................	0-39	(0-128)	39	(128)
---------- unconformity ----------				
Timber Mountain Tuff				
Rainier Mesa Member..........	39-52	(128-170)	13	(42)
---------- unconformity ----------				
Bedded tuff....................	52-55	(170-180)	3	(10)
Paintbrush Tuff				
Tiva Canyon Member...........	55-81	(180-267)	26	(87)
------------- fault -------------				
Topopah Spring Member........	81-381	(267-1250)	300	(983)
Tuffaceous beds of Calico Hills	381-422	(1250-1385)	41	(135)
Bedded tuff....................	422-436	(1385-1430)	14	(45)
Crater Flat Tuff				
Prow Pass Member.............	436-546	(1430-1792)	110	(362)
Bedded tuff....................	546-558	(1792-1830)	12	(38)
Crater Flat Tuff--Cont.				
Bullfrog Member..............	558-683	(1830-2240)	125	(410)
Bedded tuff....................	683-690	(2240-2265)	7	(25)
Crater Flat Tuff--Cont.				
Tram Member.................	690-873	(2265-2863)	183	(598)
------------- fault -------------				
Lithic Ridge Tuff..............	873-1063	(2865-3488)	190	(623)
Bedded tuff....................	1063-1067	(3488-3502)	4	(14)
Older tuff				
Unit A.......................	1067-1100	(3502-3610)	33	(108)
Unit C.......................	1100-1138	(3610-3733)	38	(123)
Conglomerate..................	1138-1172	(3733-3844)	34	(111)
Older tuff				
Calcified tuff...............	1172-1204	(3844-3950)	32	(106)
Tuff of Yucca Flat (?).......	1204 1244	(3950-4080)	40	(130)
------------- fault -------------				
Lone Mountain Dolomite.........	1244-1667	(4080-5470)	423	(1390)
Roberts Mountain Formation.....	1667-1805	(5470-5923)	138	(453)

[1]Written communication M. D. Carr, 1984.

Caliper

Caliper tools are used to measure the diameter of drill holes. Three types of caliper tools are used at Yucca Mountain: a three-arm tool which measures average diameter, a four-arm tool which measures two diameters at right angles as well as the average diameter, and a six-arm tool which measures three equiangular diameters and the average diameter. The six-arm tool is used in holes greater than 10 centimeters in diameter; the four- and three-arm tools in holes 10 centimeters and less in diameter.

Data from caliper tools are used to calculate hole volumes for cementing casing, to identify unstable zones where the hole is washed out or caved, to indicate rugosity or roughness of the borehole wall, and to correct for borehole effects on data measured with other logging tools. Multi-diameter caliper data are used to determine borehole ellipticity, which indicates that the rocks are subject to unequal horizontal stresses or are horizontally anisotropic.

Neutron

Neutron tools have a source of high energy neutrons and one or two neutron detectors. The detectors count low-energy neutrons, which are the result of back-scattering (from the formation) of the high-energy neutrons. Two types of neutron logs are commonly used: one counts thermal neutrons which are in thermal equilibrium with the rock, and the other counts epithermal neutrons which have a higher kinetic energy than the thermal neutrons. Thermal neutrons are easily captured by many elements so that formation effects are greater on thermal than on epithermal neutrons, which are harder to capture due to higher kinetic energy. Newer, borehole-compensated tools count thermal neutrons with two detectors at different distances from the source. The ratio of the count rates from the two detectors is the formation response, compensated for borehole effects. Borehole-compensated neutron tools (and some single detector neutron tools) are sidewall tools designed to maintain contact with the side of the drill hole in order to minimize borehole effects and enhance formation response.

The primary mechanism for neutron scatter and loss of energy is collision with hydrogen nuclei. For most rocks, essentially all of the hydrogen is bound in water molecules which makes the neutron log a good indicator of the formation water content. In general, high neutron count rates correspond to low water content and low count rates to high water content. Below the static water level, where the assumption of total saturation is valid, borehole compensated neutron logs are calibrated to directly obtain reliable porosity for many rock types. Porosity from calibrated, single-detector neutron logs is generally not as reliable as compensated neutron porosity unless core data exist which either confirm the single detector neutron porosity, or can be used to develop corrected calibration curves for the specific rocks encountered in the drill hole.

Above the static water level, in the unsaturated zone, the neutron log count rate can be used as an indicator of relative variations in formation water content. For many rock types calibrations exist to convert the count rate to volume fraction of water in the rock. If the value of either porosity or saturation can be determined by some means, the other value can then be determined from the volume fraction of water from the neutron log. In air-filled boreholes, the neutron log is very sensitive to the borehole diameter and rugosity. Air-filled boreholes with diameters larger than the separation between the neutron source and detector do not provide a valid relationship between count rate and water content, and in extreme cases, the relationship can be reversed. This situation is minimized by the use of sidewall tools.

Anomalous neutron-log responses can be attributed to changes in mineralogy, water of hydration, crystallization in altered zones, and the presence of neutron moderators such as boron. Anomalies are detected and interpreted by comparing the neutron log to other logs that respond to formation water or porosity, such as the density, velocity, and resistivity logs.

Density

Density logs are obtained with borehole-compensated gamma-gamma tools, which beam gamma rays into the formation and detect the gamma rays that are scattered back from collisions with electrons. The compensated density tool has two gamma-ray detectors, one near the gamma-ray source and another farther away from the source. The response from the closer detector is dominated by gamma rays scattered from the borehole and from the formation near the borehole, where it may have been altered by the drilling. The response from the more remote detector, which is dominated by gamma rays scattered from rock about 15 cm from the borehole wall, is corrected for secondary borehole effects using the near detector response. Although the compensated density tool responds to the density of electrons in the formation, which depends on the formation's elemental distribution, it is calibrated to determine the bulk density of most earth materials including the tuffs of Yucca Mountain.

The density tool is a sidewall tool designed to maintain contact with the borehole wall to minimize borehole effects and enhance formation response. The tool often cannot compensate for borehole effects in very rough-walled boreholes or through badly caved or washed out intervals. This is particularly true in air or gas filled holes where the greatest borehole effects usually occur. Comparison with the caliper log can identify anomalies which are due to borehole effects beyond the limits of compensation.

Changes in density are due primarily to changes in porosity and water content. Alteration that changes the grain density has a significant secondary effect on formation density. Anomalies are detected and interpreted by comparisons with neutron, velocity, and resistivity logs.

Porosity

The porosity log plot has two traces. One is porosity computed from the density log assuming the grain density is that of sandstone (2.65 g/cc) and that the formation is totally saturated, which is a valid assumption below the static water level. The other trace is porosity from a borehole compensated sidewall neutron log, which is also based on the assumption of total saturation and calibrated for a sandstone rock matrix. The unaltered tuffs of Yucca Mountain are rhyolitic, highly silicic, and have the same matrix properties as some sandstones and granites. The borehole-compensated neutron tool is calibrated to determine porosity in fluid filled holes, and normally is not run above the fluid level in the air filled section of the hole. Logs made with borehole compensated neutron tools in air filled holes are recorded and reported as two single-detector neutron logs.

Values reported for porosities in fluid filled holes above the static water level are lower than true porosity unless drilling fluid has invaded the rock and has artificially created the condition of total saturation to at least the depth of investigation of the logging tool. Borehole-compensated density and neutron tools have different depths of investigation, on the order of 15 cm and 25 cm or more, respectively. Porosities from compensated density and neutron tools are expected to agree for saturated silicic rocks, such as the unaltered tuffs of Yucca Mountain, and disagreement between them indicates conditions such as less-than-total saturation, artificial saturation by borehole/drilling-fluid invasion (which affects the density log more than the neutron log), non-silicic mineralogy, alteration, or the presence of neutron moderators such as boron or chlorine.

Velocity

The velocity of sound waves is determined by measuring the time interval for waves to travel a known distance along the borehole wall parallel to the borehole axis. This distance is divided by the elapsed time to obtain the velocity of the formation. The log (Plate 1) has three traces: seismic compressional velocity, sonic compressional velocity (Vp), and sonic shear velocity (Vs).

Sonic compressional velocities are continuously measured with a sonic logging tool which has a relatively high frequency transmitter (typically 20 kHz) at the bottom of the tool, and two detectors (typically 1.2 m and 1.8 m from the source). Newer borehole-compensated sonic velocity tools use a second transmitter above the two receivers so that travel times of signals generated by both transmitters can be averaged to obtain improved measurement accuracy.

The compressional wave is the fastest wave traveling through the formation, and is detected automatically by the sonic tool as the first signal to arrive at each receiver. The shear wave arrives later, and is interpreted by examining displays of the full wave train. Sonic velocities are small-volume measurements which are affected by small irregularities such as fractures, joints, and lithophysal cavities. Anomalies are detected and interpreted by comparison with density, neutron, and resistivity logs.

Seismic velocity is determined by using a wall-locking geophone in the borehole to detect the arrival time of a seismic signal at known discrete depths. The seismic signal is generated near the borehole on the ground surface with a mechanical vibrator or other source of seismic energy. Seismic frequencies are relatively low, typically lower than 100 Hz. The resulting plot of velocity versus depth has a square, step-like appearance and indicates the average velocity of the formation through the interval between discrete geophone depths. Seismic velocity determined by this method is a large-volume measurement that includes average effects of fracturing, jointing, lithophysae, inhomogeneities, and in some cases refraction effects due to stratigraphy and structure.

Calculated

Calculated logs are logs which have been calculated from two or more measured logs. Acoustic impedance is calculated from the product of density and sonic velocity. Elastic moduli are calculated from density, compressional velocity, and shear velocity. Poisson's ratio is calculated from the ratio of compressional and shear velocity. Acoustic impedance logs are used to identify horizons where a large change in impedance occurs, indicating a good seismic reflecting horizon. The elastic moduli and Poisson's ratio are measures of the elastic properties of rock. The formulas for computing these values can be found in any geophysics text which contains discussions on seismology, such as Dobrin (1960). For specific application to sonic logs see Geyer and Myung (1970).

Dielectric

The dielectric log measures dielectric permittivity inductively at a frequency of 47 megahertz. Induction resistivity at this frequency is an incidental measurement made simultaneously with the dielectric permittivity. The dielectric permittivity of water (78-81) is much greater than most dry rocks (4-15), so changes in formation dielectric permittivity are due primarily to changes in water content, with secondary effects due to changes in rock type. Above the water table, the dielectric log can be used in conjunction with the density and neutron log to estimate formation water content. Because this tool is relatively new, interpretation parameters and calibration curves have not been developed for all rock types. Laboratory measurements of dielectric permittivity on core samples of the tuffs of Yucca Mountain are needed to accurately relate dielectric permittivity to porosity and water content. Core data from tuffs from Yucca Flat, Nevada (Eberle and Bigelow, 1973) are expected to be representative of the tuffs of Yucca Mountain.

Resistivity

Resistivity is a measure of the resistance of the rock around the borehole to the transmission of an electric current through the rock. Borehole resistivity measurements are made with two types of probes. One type uses contacting electrodes to pass a known current through the rock, and detect the resulting potential using a specified electrode arrangement to determine apparent resistivity. The other type uses a probe containing a transmitting coil to induce current in the rock, and one or more receiving coils to detect the resulting electromagnetic field from which apparent resistivity is determined. Standard induction tools measure resistivity at frequencies in the 20 kHz range.

Standard induction resistivities are reliable below 200 ohm-meters, but are unreliable for higher resistivities. Dielectric tools respond well to higher resistivities, but are unreliable for resistivities lower than about 10 ohm-meters. Because resistivity is dispersive and varies with measurement frequency, comparisons among direct current or low frequency resistivities, induction resistivities and dielectric resistivities may show considerable disagreement.

The minerals in most rocks are insulators, so electric current is transmitted by ions in the fluid in the pore spaces, causing measured resistivity to respond to changes in formation porosity and water content. However, borehole geometry, borehole fluid resistivity, changes in formation water salinity, presence of alteration products such as zeolites and clays (which have cation exchange capacity and double layer electrochemical properties), presence of metallic minerals, and changes in rock type all have significant secondary effects on the measured resistivity. Anomalies are identified and interpreted by comparison with density, neutron, and velocity logs.

Spontaneous potential

Spontaneous potential (SP) is the electric potential resulting from electrochemical and electrokinetic effects between the borehole and the formation referenced to a buried surface potential electrode. Due to combinations of such conditions as fresh water or drilling mud in the borehole, fresh formation water, high porosities, very low formation rock permeabilities, and variations in rock alteration products, spontaneous potential does not behave predictably at Yucca Mountain and does not correlate well with geology or from drill hole to drill hole. It is presented in this report as an incidental measurement which is made simultaneously with resistivity, but is not usually useful.

Gamma Ray

The gamma ray log is obtained from two tools, one containing a standard gamma ray detector, and the other containing a spectral detector. Standard gamma ray logs measure the total count rate of gamma rays of all energies emitted by the formation in API units, an industry standard. The total count rate is recorded as one of four traces of the spectral gamma log. The potassium, uranium, and thorium channels of the spectral log are made by detecting gamma rays of distinctive energy levels which are emitted by radioactive potassium and by radioactive daughter elements of uranium and thorium. Daughter elements result from radioactive decay of a mother element, and the number of gamma rays emitted by a radioactive daughter can be related to the volume percent of mother element present in the rock.

The tuffs at Yucca Mountain characteristically exhibit high total gamma radiation levels compared with sedimentary rocks. Relatively high uranium radiation levels mask the radiation from uranium which is usually concentrated in cement and filling in fractures so that individual fracture identification with the uranium trace has not been feasible. However, by comparison with logs from cored holes an overall increase or decrease in uranium level through a highly fractured interval would be reason to suspect increased or decreased cementing and filling of the fractures, and conversely lack of significant change in uranium level indicates lack of change in cementing or filling of fractures. Spectral gamma ray logs (particularly in the potassium channel) exhibit similar character from drill hole to drill hole in some lithostratigraphic units, making spectral gamma logs useful for lithologic identification and stratigraphic correlation. The gamma ray log is often run simultaneously with other logs, and is used to accurately correlate depths between logs in the same drill hole.

DISCUSSION

Geophysical logs were obtained in drill hole UE-25p#1 during six episodes of logging. Table 2 gives logging dates and other drill hole information useful for evaluating the log data. The shallowest fluid level shown on Table 2 for open hole (below casing) logging is 1262 feet. Porosity, sonic velocity, resistivity from the electric log, spontaneous potential, and calculated logs are missing above this depth on Plate 1 because these logs require a fluid filled hole and thus were not run. Log data are also missing for most logs between 3920 and 4000 feet because an unstable fault zone had to be cased in this interval, making it impossible to obtain open-hole geophysical logs. Density, neutron porosity, and spectral gamma ray logs were made through the casing in this interval, but only the gamma ray data is shown on Plate 1; the other logs were inaccurate because they could not be compensated for the effects of the casing. However, the character of these logs was used for defining the lithostratigraphy of the fault zone. All other intervals with missing data on Plate 1 represent zones of unreliable data or zones where data was not obtained for operational reasons.

The spectral gamma ray log was made through casing above 1581 feet and in the interval 3930 - 4257 feet. A standard gamma ray log was also run above 1581 feet before casing was set and is plotted with the total count rate from the spectral gamma ray log on Plate 1. The effect of casing on the spectral gamma ray total count rate trace is seen as a decreased count rate level due to attenuation. Through the Topopah Spring Member of Paintbrush Tuff, where the gamma ray count rate is high, the additional attenuation of a greater thickness of steel at casing collars is seen as low count rate spikes every 40 feet on Plate 1.

Comparing the total count and standard gamma ray traces with the potassium, uranium, and thorium traces leads to some useful observations. The total count through the Tertiary section is a result of potassium and thorium with very little contribution from uranium, while uranium is the major contributor in the Paleozoic section with little contribution from potassium and thorium. Sedimentary rocks, with a few exceptions (such as shale), have low gamma ray levels, so uranium count rates can then usually be interpreted as resulting from uranium concentrated in fracture fillings, making the uranium trace a useful fracture indicator. The Paleozoic dolomites encountered in this drill hole are described as fragmented and recemented (brecciated) by M. D. Carr (written communication, 1984). Concentration of uranium in the recementing material is considered to be the reason for the high count rate of the uranium trace.

Porosity is slightly higher and density is slightly lower than normal for Paleozoic dolomites, but the measured values are consistent with the effects of brecciation. Lower than normal resistivities were also observed. The electric log of June 23, 1983 (Table 2), was run to confirm the low resistivities obtained in the dolomite with an induction tool on May 3, 1983. Resistivities measured on core samples (Lennart A. Anderson, unpublished) are generally higher than the values on the resistivity logs, but they are still much lower than expected for dolomite. The difference between the resistivity log data and core data is thought to be the result of using fresh tapwater to resaturate the core in preparation for making laboratory measurements.

Table 2.--Summary of geophysical logs from UE-25p#1

Date	Drilled depth (feet)	Casing depth (feet)	Bit size (inches)	Fluid[1] level (feet)	Top of log (feet)	Bottom of log (feet)	Log[2]	Comments[3]
11/16/82	341	36	17.5	>317	6	309	CAL BW	NP
11/16/82	341	36	17.5	>317	20	315	DBC BW	
11/17/82	341	36	17.5	>317	29	311	IES BW	MAX T=66° F
11/17/82	341	36	17.5	>317	100	300	GS BW	
11/18/82	341	36	22.0	>317	5	319	CAL BW	Reamed hole for casing
11/30/82	1598	325	14.8	1263	272	1578	CAL BW	
11/30/82	1598	325	14.8	1263	290	1581	DBC BW	
12/01/82	1598	325	14.8	1262	300	1583	ENP BW	
12/01/82	1598	325	14.8	1262	326	1577	IES BW	RM >10
12/01/82	1598	325	14.8	1262	1247	1580	VDS BW	
12/01/82	1598	325	14.8	1262	300	1580	GAM BW	
12/01/82	1598	325	14.8	1262	0	1582	TEM BW	MAX T=98° F
12/01/82	1598	325	14.8	1262	278	1570	GS BW	
12/03/82	1598	325	14.8	1262	275	1569	CAL BW	NP
01/16/83	4279	1581	9.9	1254	1575	3938	GS BW	
01/16/83	4279	1581	9.9	1254	1498	3930	CAL BW	NP
01/17/83	4279	1581	9.9	1254	1550	3927	GAM BW	
01/17/83	4279	1581	9.9	1254	1540	3924	ENP BW	
01/17/83	4279	1581	9.9	1254	50	3930	TEM BW	MAX T=149° F
01/18/83	4279	1581	9.9	1254	1582	3922	ABC DA	
01/18/83	4279	1581	9.9	1254	1582	3930	DIF DA	MAX T=135° F
01/18/83	4279	1581	9.9	1254	1582	3930	DBC DA	
01/18/83	4279	1581	9.9	1254	1582	3920	NBC DA	
01/18/83	4279	1581	9.9	1254	0	3930	SPC DA	
01/22/83	4279	1581	9.9	U	3850	3966	CAL BW	NP, DRILL RODS AT 3930
01/22/83	4279	1581	9.9	U	3688	3953	CAL BW	DRILL RODS AT 3741
01/24/83	4279	1266	9.9	U	1200	1584	CAL BW	NP
01/25/83	4279	1266	9.9	U	1206	3921	CAL BW	
03/05/83	4279	1564	9.9	U	1562	3932	CAL DA	NP
03/07/83	4279	3950	9.9	U	3927	4246	CAL BW	NP
03/07/83	4279	4214	9.9	U	2900	4212	NBC DA	NP, LOG RUN IN CASING
03/08/83	4279	4214	9.9	1260	2900	4212	SPC DA	NP. LOG RUN IN CASING
03/08/83	4279	4214	9.9	1261	2879	4213	DBC DA	NP, LOG RUN IN CASING
03/09/83	4279	3991	9.9	1261	3927	4246	CAL BW	
03/09/83	4279	3991	9.9	1261	4000	4262	DIF DA	MAX T=140° F
03/09/83	4279	3991	9.9	1261	4000	4261	ABC DA	
03/09/83	4279	3991	9.9	1261	4000	4260	NBC DA	NP, UNRELIABLE DATA
03/09/83	4279	3991	9.9	1261	3950	4253	DBC BW	
03/09/83	4279	3991	9.9	1261	3950	4254	TEM BW	MAX T=158° F
03/09/83	4279	3991	9.9	1261	3990	4252	GS BW	

Table 2.--Summary of geophysical logs from UE-25p#1--Cont.

Date	Drilled depth (feet)	Casing depth (feet)	Bit size (inches)	Fluid[1] level (feet)	Top of log (feet)	Bottom of log (feet)	Log[2]	Comments[3]
05/02/83	5923	4257	6.8	U	4180	5912	CAL BW	
05/03/83	5923	4257	6.8	U	4190	5917	DBC BW	
05/03/83	5923	4257	6.8	U	4182	5918	ENP BW	
05/03/83	5923	4257	6.8	U	4257	5917	DIF DA	MAX T=130° F
05/03/83	5923	4257	6.8	1260	4000	5918	NBC DA	
05/04/83	5923	4257	6.8	U	4256	5914	DEL DA	
05/04/83	5923	4257	6.8	1212	3500	5917	SPC DA	
05/04/83	5923	4257	6.8	U	4257	5902	ABC DA	NG
05/04/83	5923	4257	6.8	U	5	5913	TEM BW	MAX T=132° F
05/04/83	5923	4257	6.8	U	4275	5913	GS BW	
06/02/83	5923	4257	6.8	U	4256	5902	ABC DA	
06/23/83	5923	4257	6.8	1187	4	5912	TEM BW	MAX T=130° F
06/23/83	5923	4257	6.8	1187	4226	5908	ES BW	RM=10 @77° F

[1]U=Unknown

[2]TEM = Temperature
CAL = Caliper
GAM = Gamma Ray
DBC = Borehole Compensated Density
ABC = Borehole Compensated Acoustic
NBC = Borehole Compensated Neutron
VDS = Variable Density Sonic
DIF = Dual Induction Focus
IES = Induction Electric Survey
SPC = Spectral Gamma Ray
GS = Geophone Survey
ENP = Epithermal Neutron
DEL = Dielectric Constant
BW = Birdwell Inc
DA = Dresser Atlas
ES = Electric Survey

[3]MAX T = Maximum Temperature
NG = No Good
RM = Mud Resistivity
NP = Not Plotted

The dielectric log was not made until after the hole was cased to the top of the Paleozoic section. The dielectric constant of the Paleozoic dolomite shown on Plate 1 is reasonable and correlates well with the porosity, as expected. Further studies of dielectric constant of the Tertiary tuffs in other drill holes are expected to result in reliable estimates of water content above the static water level in the unsaturated zone.

The caliper log indicates that the upper section of the drill hole is very rough and enlarged, particularly where the epithermal neutron and density logs are very noisy or "spiky" through the Topopah Spring Member of the Paintbrush Tuff. This spikiness also occurs in cored holes where the Topopah Spring Member contains lithophysal and is highly fractured. The cause of the spikiness is from the inability of the tools to correctly compensate for the combined effect of the enlarged rough drill hole, fracturing, and lithophysae (Spengler and others, 1979; and Spengler and others, 1981). In similarly rough and enlarged drill hole just below the Topopah Spring Member, the intensity of the spikiness is much lower because lithophysae are absent and the rock is less fractured. The uranium level is not significantly different through the Topopah Spring Member than in cored hole USW G-4 where fracture studies show the majority of the fractures are open and unfilled (R. W. Spengler, written communication), so we can infer that most of the fractures in this hole are open and have not been cemented or filled with materials that concentrate uranium. Fracture analysis of core from other drill holes (Spengler and others, 1979; Spengler and others, 1981) also show that most of the fractures in the Topopah Spring Member are open. The matrix permeability of tuffs is generally low, so the lack of return circulation and loss of large amounts of drilling fluid during drilling of some holes at Yucca Mountain indicates high fracture permeability (Ellis and Swolfs, 1983). Hydrologic testing in drill hole J-13, east of Yucca Mountain on the east side of Forty Mile Wash, confirm that the fracture permeability in the Topopah Spring Member is very high (Thordarson, 1983).

The geophysical logs in the Tertiary Tuffs encountered at drill hole UE-25p#1 correlate well with logs from other drill holes in the Yucca Mountain area reported by Daniels and Scott (1981), Hagstrum and others (1980), Muller and Kibler (1983), and Spengler and others (1979). Physical properties measured in laboratories on core from other drill holes and reported by Anderson (1981), Eberle and Bigelow (1973), and Thordarson (1983), are consistent with the in-situ properties from geophysical logs in this drill hole.

ACKNOWLEDGMENTS

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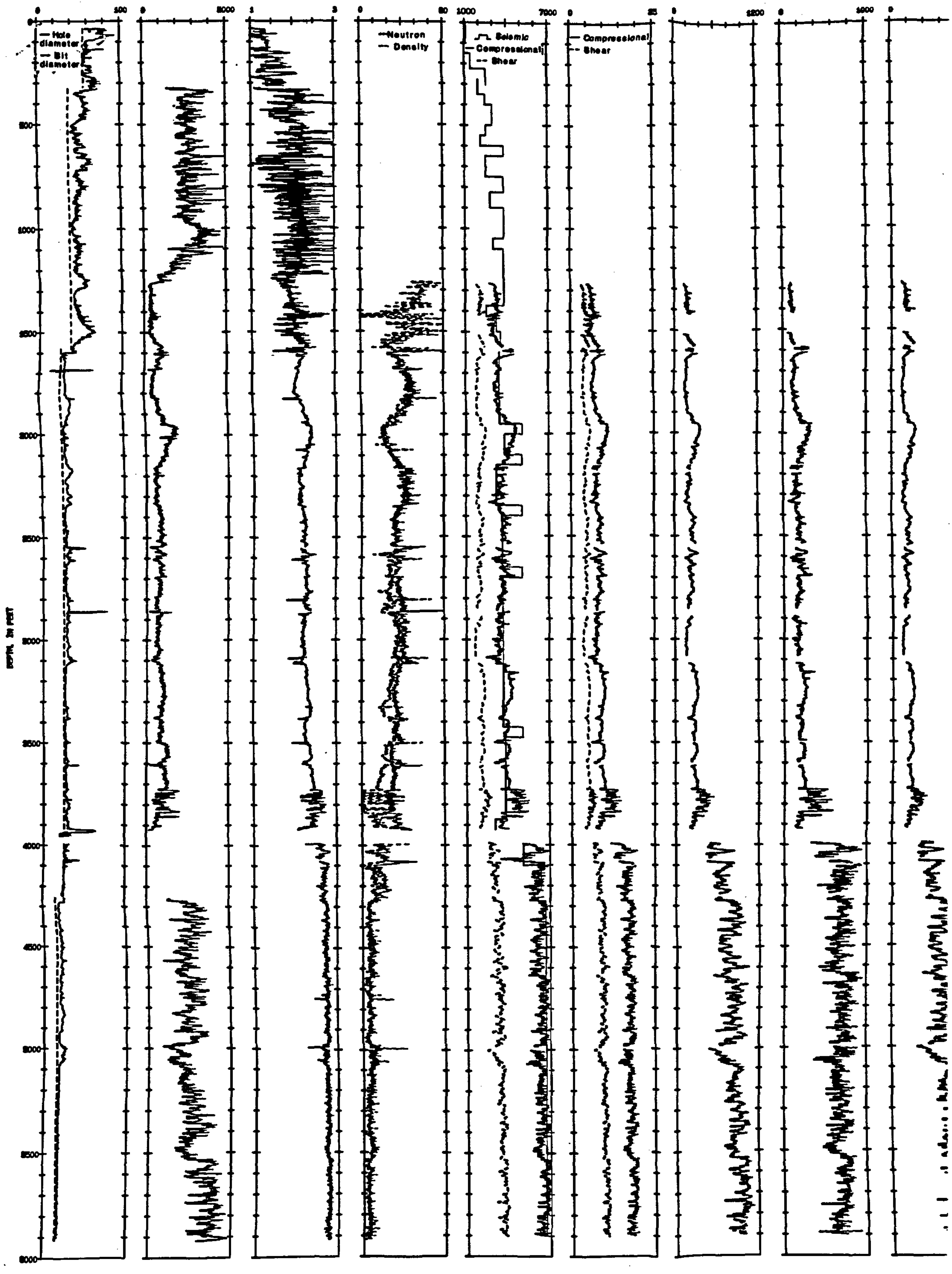
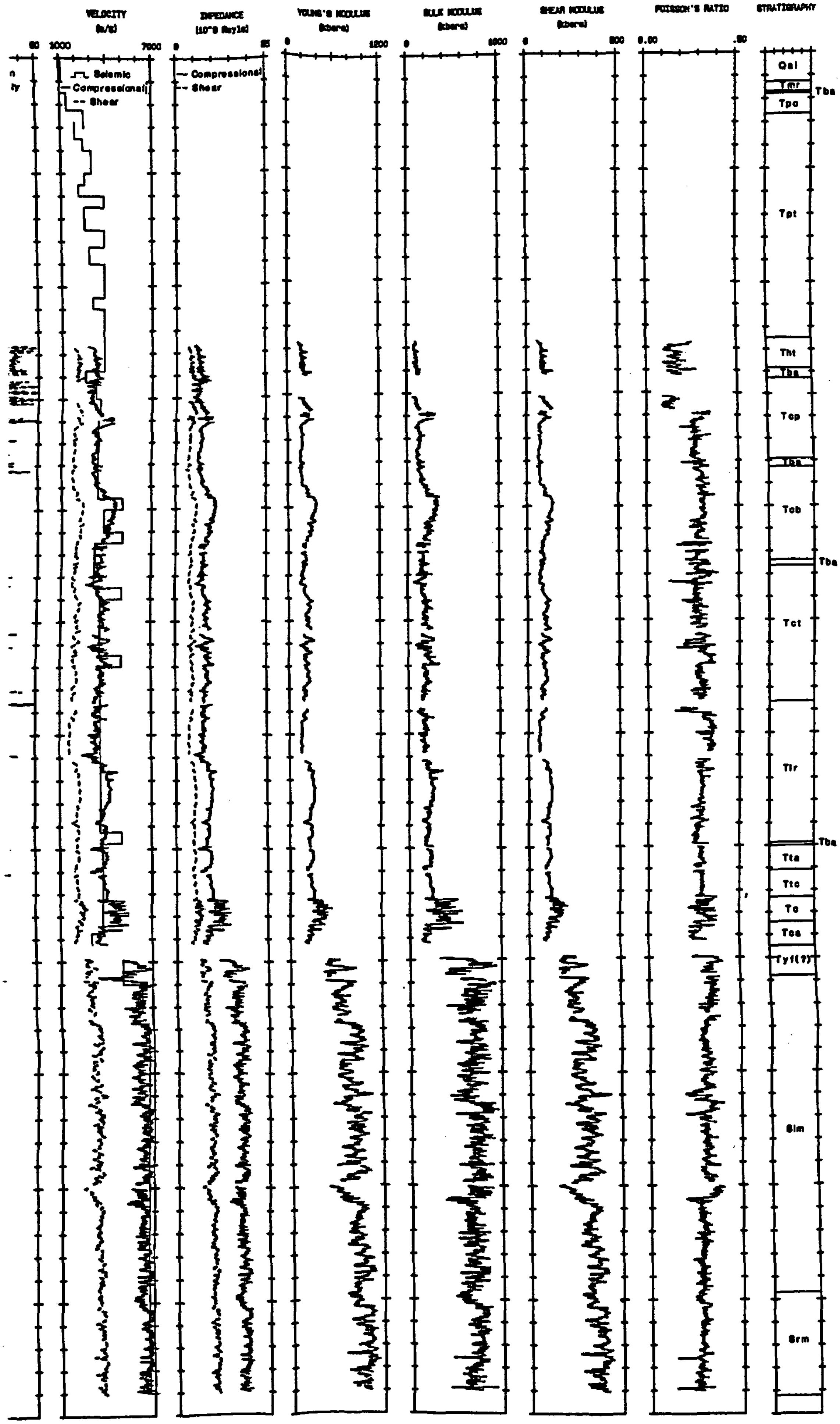


GEOPHYSICAL LOGS AND STRATIGRAPHIC UNITS FROM DRILL HOLE UE25p#1, NEVADA TEST SITE, NEVA

OPEN FILE REPORT
PLATE 1
SHEET 1 OF 2



Stratigraphic units[1]

Alluvium------Qal

Timber Mountain Tuff
Rainier Mesa Member------Tmr

Bedded tuff------Tba

Paintbrush Tuff
Pah Canyon Member------Tpc
Topopah Spring Member------Tpt

Tuffaceous beds of Calico Hills------Tht

Crater Flat Tuff
Prow Pass Member------Tcp
Bullfrog Member------Tcb
Tram Member------Tct

Lithic Ridge Tuff------Tlr

Older Tuff
Unit A------Tta
Unit C------Ttc

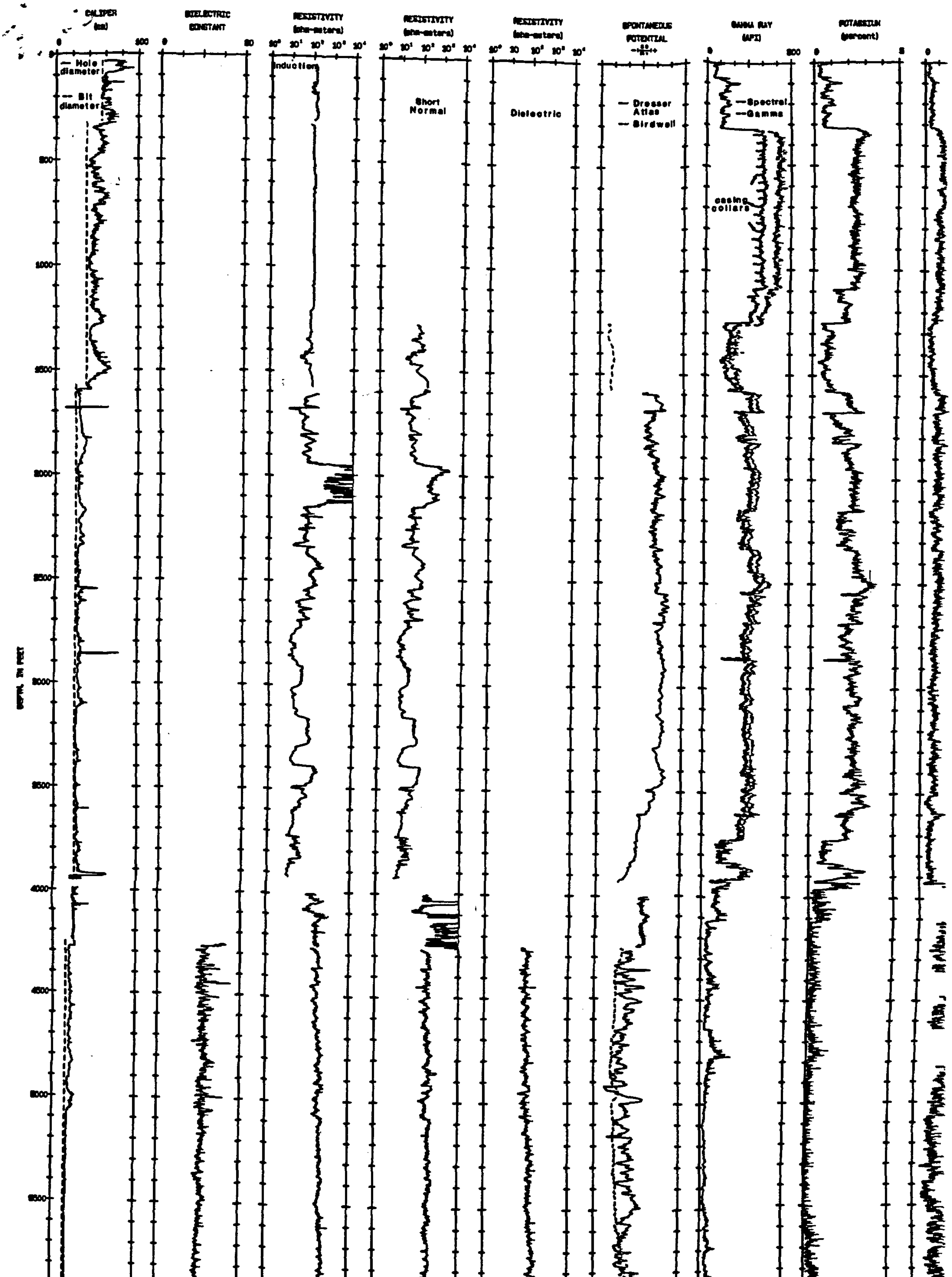
Conglomerate------Tc

Older Tuff
Calcified tuff------Tca
Tuff of Yucca Flat (?)------Tyf

Lone Mountain Dolomite------Slm

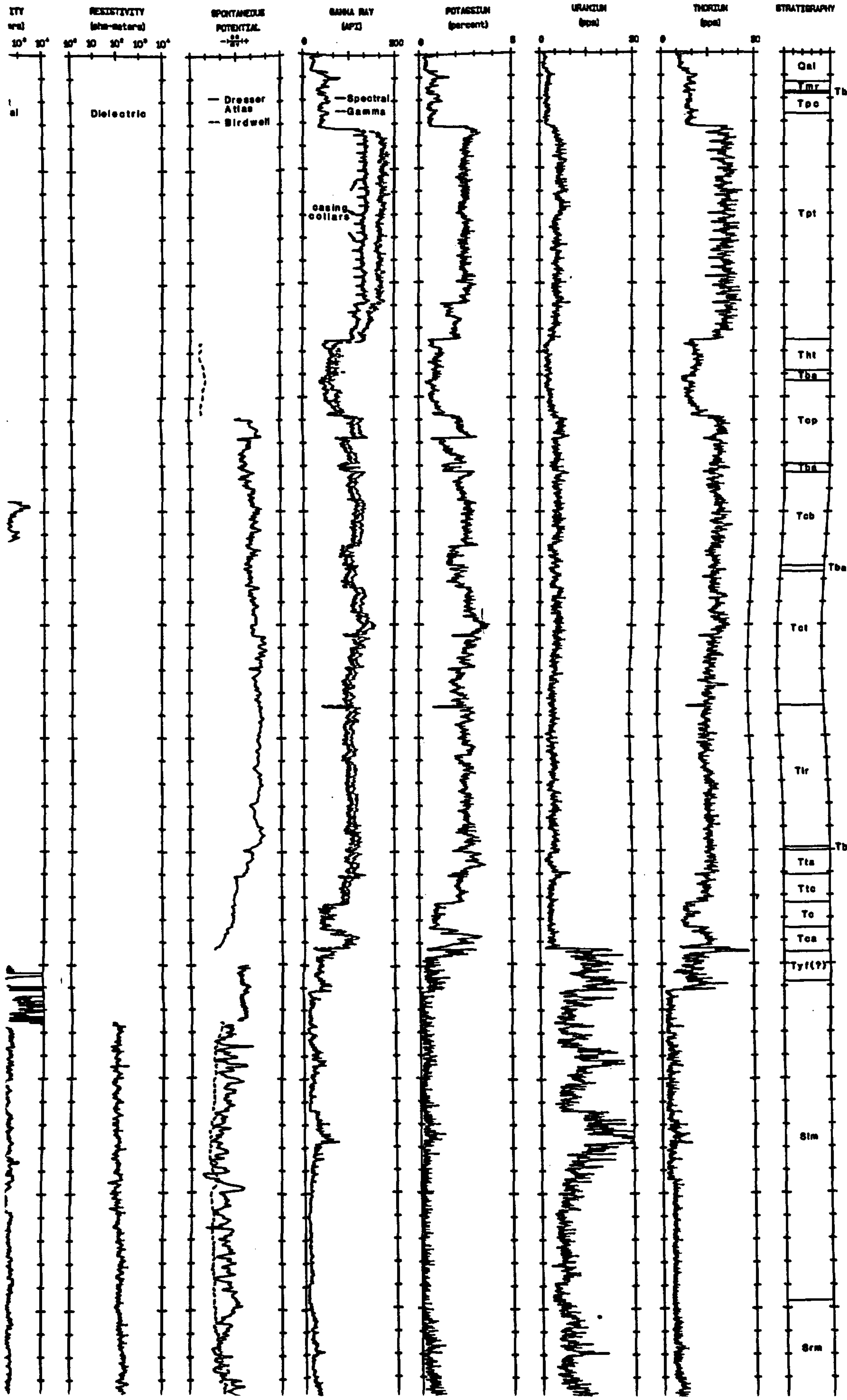
Roberts Mountain Formation------Srm

[1] Preliminary written communication from M. D. Carr, 1984.



GEOPHYSICAL LOGS AND STRATIGRAPHIC UNITS FROM DRILL HOLE UE25p#1, NEVADA TEST SIT

OPEN FILE REPORT
PLATE 1
SHEET 2 OF 2



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Older Tuff
Unit A—Tta
Unit C—Ttc

Conglomerate—Tc

Older Tuff
Silicified tuff—Tca
Tuff of Yucca Flat (?)—Tyf

Lone Mountain Dolomite—Slm

Roberts Mountain Formation—Srm

[1]Preliminary written communication from W. B. Carr, 1984.