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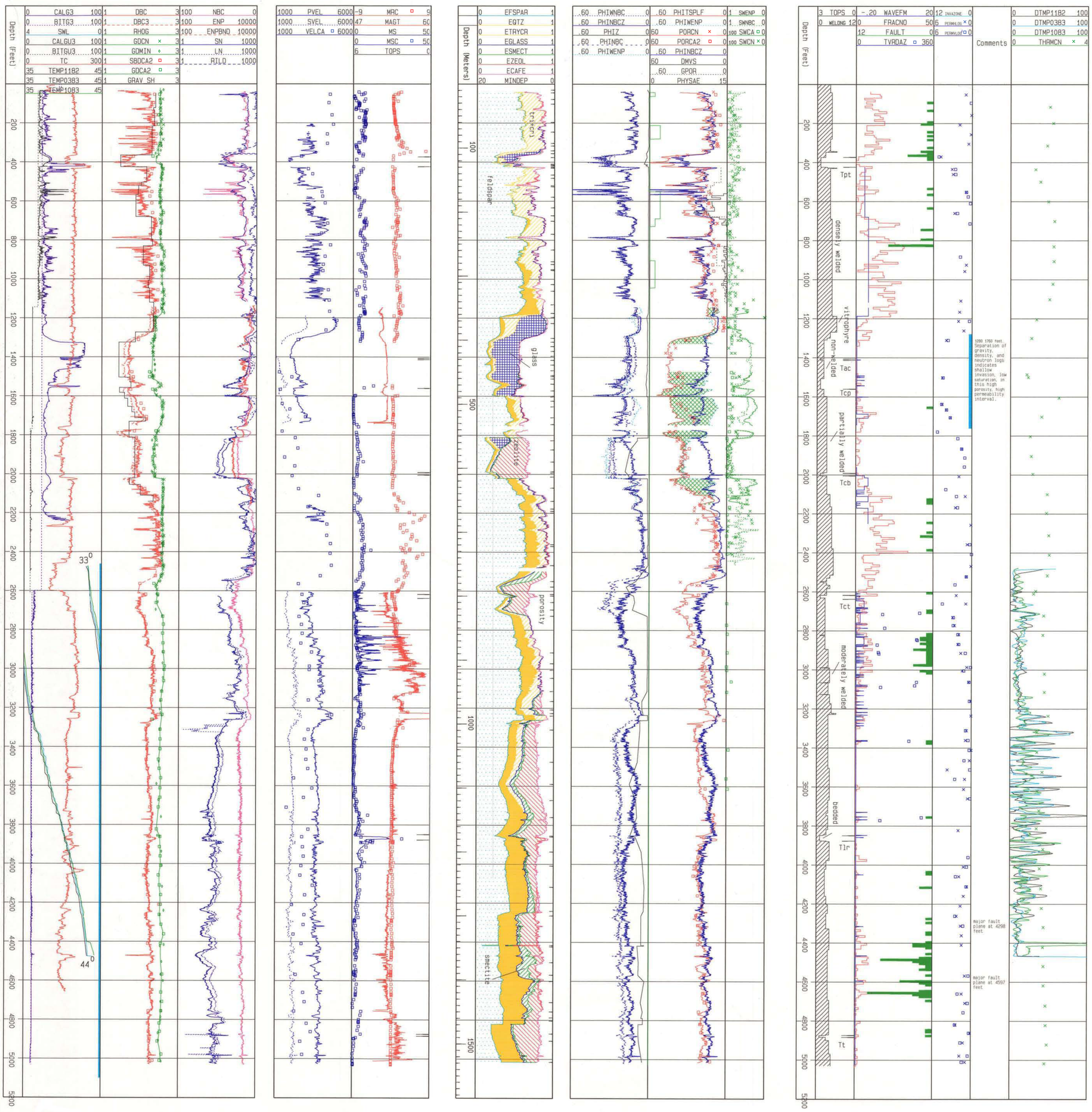
Plate 3 of 27

USW GU-3 / USW G-3

Original Logs and Core Data

Mineralogy, Porosity, Water Content

Stratigraphy and Fractures



BOREHOLE USW GU-3/G-3, YUCCA MOUNTAIN, NEVADA

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Data from a pair of boreholes located 100 feet apart, US GU-3 and USW G-3, have been combined in this plot. Scott and Castellanos (1986) summarized the drilling history: "USW GU-3 and USW G-3 were cored in two stages. USW GU-3 was cored in the unsaturated zone and USW G-3 was cored largely in the saturated zone. This two-stage coring program was designed to obtain maximum hole stability and to optimize conditions for wet-hole geophysical logging above the zone of saturation. Drill hole USW G-3 was spudded January 8, 1982, and completed March 21, 1982. GU-3 was spudded January 26, 1982, and competed June 12, 1982. USW GU-3 was continuously cored from 31 to 2644 feet, and USW G-3 was continuously cored from 2609 to 5031 feet." GU-3 was drilled with polymer and bentonite mud, whereas G-3 was drilled with air-foam mud from 38 to 2600 feet and with polymer mud from 2600 to 5031 feet.

Depth on the plot is measured along hole, and has not be corrected for deviation. Deviation from vertical in G-3 increases with depth below 2500 feet to a maximum angle of 25½ at 4990 feet. At a true vertical depth of 4887.9 feet, the measured depth is 4990 feet and horizontal offset is 674 feet (from Plate 4, Nelson and others, 1991).

Original logs in columns 1-5 were acquired between February 1982 and November 1983 and were described by Nelson and others (1991). Not all logs from GU-3 and G-3 have been retained here. All logs below 2600 feet originate from G-3. Most but not all logs from 0 to 2600 feet originate from GU-3. Exceptions are the rild and enp logs which were run in G-3 and are used here, after appropriate depth shifting to accomodate features which are not horizontal between the two holes. Caliper logs from both GU-3 and G-3 are shown. Temperature logs run in November 1982, March 1983, and October 1983 from Sass and others (1988) also appear in column 1.

Bulk density, grain density, and porosity from core measurements were presented by Nelson and others (1991). Anderson (1984) reported on measurements on large-volume core samples; Anderson (1994) later reported measurements on oriented plugs. Here the permeability data are from plugs, density and porosity data below 3940 feet are averaged from plugs, and all other core data by Anderson are from large-volume samples. Measurements by Anderson (gdca2, roca, sbdca2, etc.) are designated with an 'a' in the curve name. Nelson and Anderson (1992) discuss the measurements, give reasons for selecting from large samples or plugs, and examine the core data in terms of mineralogy. Magnetic property data, mrc and msc, are taken from Rosenbaum and Snyder (1984).

Mineralogy in column 6 is derived from x-ray diffraction data by Bish and Chipera (1989). Their data have been converted to volume percent, combined with the porosity curve phitsplf, and extrapolated to boundaries inserted in several places where marked changes in log response occur. Vaniman and others (1984) discuss the petrology and alteration mineralogy in detail.

Porosity (phitsplf) and water content (phiwenp, phinbc) are given in columns 6 and 7. Curve phitsplf is a filtered splice of phitenp, from air-filled hole, and phiden, from water-filled hole. Phitenp and phiwenp were computed from epithermal neutron and density logs (Nelson, 1994). Phiden is porosity computed from the density log, dbc3. From 1505 to 3862 feet, total water content is available from both phiwenp and phinbc. Phinbc is based upon the thermal neutron log, nbc, after correction for hole size. Structural water, phiz, was computed from mineralogical data. To create an estimate of pore space water, phinbcz = phinbc - phiz.

Muller and Spengler (1989) estimated lithophysal pore space, dmvs, from inspection of core, and computed a second estimate, gpor, from the gravimeter log.

Stratigraphic tops, degree of welding, lithophysal occurrences (physae) and faults given in columns 10 and 11 are taken from Scott and Castellanos (1984). Disruptions in the sonic waveform log (wavefm) are often due to fractures or faults.

Nelson and others (Fig. 19, 1991) identified a high porosity, high permeability zone between 1280 and 1760 feet on the basis of separation between the neutron, density, and gravimeter-based density logs (invazone, column 12). The separation is attributed to invasion of mud filtrate into the formation and occurs in a high permeability interal.

Stock and others (1986) report that the televiewer log obtained in G-3 from 2600 to 4480 feet does not show many through-going fractures, but remark that this may be due to the thick mud coating the walls of the hole. The dip azimuths (tvrdaz) of 14 individual fractures are plotted in column . See figure 7 of Stock and others (1986) for tracings of all fractures observed in the televiewer log, including those attributed to hydraulic fracturing by drilling mud pressure. No borehole breakouts were visible on the televiewer log.

Temperature gradients, dtmp, were computed by differenc the temperature logs over fourteen-foot intervals. Thermal conductivities, thrmcn, are from Sass and others (1988).

EXPLANATION OF CURVES AND SYMBOLS

Column 1
CALG3 Caliper in cm from G-3, blue curve.
BIT63 Bit size in cm from G-3, blue dash.
CALGU3 Caliper in cm from GU-3, black dash curve.
BITGU3 Bit size in cm from GU-3, black dash.
SWL Static water level, vertical cyan bar.
TEMP Temperature in deg C, three curves (month, year).
TC Gamma ray in API units, red curve.

Column 2
DBC Density in g/cc, red curve.
DBC3 Corrected density in g/cc, red dash curve.
SBDCA Density of saturated samples in g/cc, red squares.
RHOG Grain density in g/cc, green curve.
GDCN, GDCA Grain density from cores, green X, green squares.
GDMIN Grain density from mineralogy, green diamonds.
GRAV_SH Density from gravimeter in g/cc, black line.

Column 3
ENP Epithermal neutron in counts/sec, red curve.
ENPBND Epithermal bound, red dash curve.
NBC Thermal neutron log in porosity, magenta curve.
SN Short normal resistivity in ohm-m, blue curve.
LN Long normal resistivity in ohm-m, blue dot curve.
RILD Induction resistivity in ohm-m, blue dash curve.

Column 4
PVEL P-wave velocity, m/s, blue curve.
SVEL S-wave velocity, m/s, blue dot.
VELCA P-wave velocity from core, m/s, blue squares.

Column 5
MAGT Magnetic field, total, in microtesla, red curve.
MRC Magnetic remanence from core in amp/m, red squares.
MS Magnetic susceptibility in milliSI, blue curve.
MSC Magnetic susceptibility from core in milliSI, blue squares.
TOPS Stratigraphic boundaries, black ticks.

Column 6 [shaded areas represent volume fractions]
EFSPAR Feldspar, blue dotted area to left-hand edge.
EQTZ Quartz, dark yellow area.
ETRYCR Tridymite + cristobalite + opal, light yellow.
EGLASS Glass, blue gridded area.
ESMECT Smectite + kaolinite, green slanted area.
EZEOL Clinoptilolite + mordenite + analcime, red slant.
ECAFE Calcite + hornblende + hematite + chlorite, magenta hatc
Porosity Unshaded area to the right-hand edge.
MINDEP Depth of x-ray diffraction samples, ticks.

Column 7 [fractional volumes of whole rock, increasing to the left
PHIWENP Water content from ENPBND and DBC3 logs, dotted cyan curve.
PHINBC Water content from corrected NBC, dashed blue curve.
PHIWNBC Water content from NBC, corrected for partial saturation, dotted blue curve.
PHIZ Structural water from mineralogy, black curve.
PHINBCZ Water content with structural water removed, blue solid.

Column 8 [fractional volumes of whole rock, increasing to the left
PHITSPLF Porosity, computed in two segments using different methods, filtered, red curve.
PHINBCZ Water content with structural water removed, blue solid.
PORCA2 Porosity from core measurements, red squares.
PORCN Porosity from core measurements, red X.
DMVS Void space from core inspection, black line.
GPOR Void space from gravimeter log, black dotted curve.
PHYSAE Lithophysal zone, value of 1 where sparse (1 to 50f rock), value of 2 where common or abundant (greater than 50f rock), green bar.

Column 9
SWENP Water saturation from ENP, green curve.
SWNBC Water saturation from NBC, green dotted curve.
SWCA,N Water saturation from core, green squares, green X.

Column 10
WELDNG Degree of welding from core inspection, black slant.
TOPS Lithologic tops, black ticks.

Column 11
WAVEFM Disruptions in sonic waveform log, blue ticks and bars.
FRACNO Natural fractures, number per 10-foot interval, red bars
FAULT Fault occurrences, number per 10-foot interval, green bars.
TVRDAZ Dip azimuth of fractures from televiewer, in degrees, blue squares.

Column 12
PERMHLOG Permeability from horizontal plugs in microdarcy, logarithmic scale, blue X.
PERMVLOG Permeability from vertical plugs in microdarcy, logarithmic scale, blue squares.
INVAZONE Invasion of drilling mud filtrate, cyan bar.

Column 13
DTMP Temperature gradient, deg C/km, three curves (month, year).
THRMCN Thermal conductivity, W/m/degK, green X.

Stratigraphic Names

-Paintbrush Group-	
Tpc	Tiva Canyon Tuff
Tpb	Bedded Tuff (ash flow)
Tpt	Topopah Spring Tuff
Tac	Calico Hills Formation
-Crater Flat Group-	
Tcp	Prow Pass Tuff
Tcb	Bullfrog Tuff
Tct	Tram Tuff
Tlr	Lithic-rich tuff
Tt	Older ash flow and bedded tuff

NOTES

Last computation: August 1995 Plotted: August 1995
Scientific Notebook: SN-0092

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Petrophysical Properties, Mineralogy, Fractures, and Flow Tests in 25 Deep Boreholes at Yucca Mountain, Nevada

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