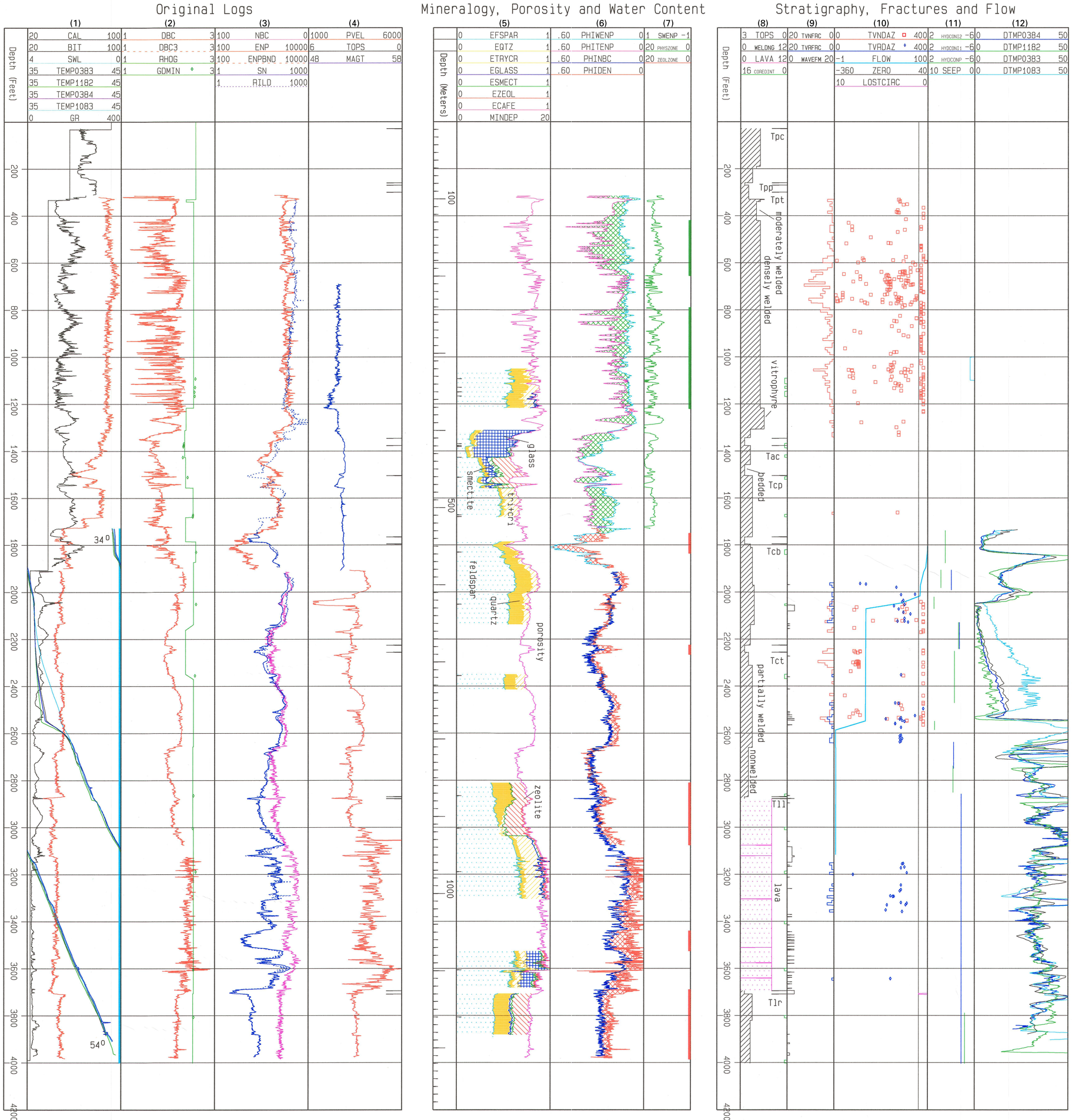
U.S. Department of the Interior
U.S. Geological Survey

USW H-6

Original Logs

Mineralogy, Porosity and Water Content

Stratigraphy, Fractures and Flow



BOREHOLE USW H-6, YUCCA MOUNTAIN, NEVADA

Compiled by Philip H. Nelson and Joyce E. Kibler
U.S. Geological Survey, Denver, Colorado

Borehole H-6 was completed in September, 1982 to a total depth of 4002 feet. The hole was rotary drilled using air foam consisting of air, detergent, and water (Craig et al., 1983). Rotary drilling was interrupted to core the intervals indicated in column 8 (coredint). Depth on the plot is measured along hole, and has not been corrected for deviation. Hole deviation is slight, (Plate 13 in Nelson and others, 1991): at a true vertical depth of 3949.5 feet, the measured depth is 3950 feet and the horizontal offset is 52.5 feet.

Original logs in columns 1-4, acquired during July-October 1982, were described and presented by Nelson and others, 1991. Four temperature logs (Sass and others, 1988) obtained in November 1982, March 1983, October 1983, March 1984 also appear in column 1.

Mineralogy in column 5 is derived from X-ray diffraction data by Bish and Chipera (1989). Their data have been converted to volume percent, combined with porosity, and in several places extrapolated to boundaries inserted where marked changes in log response occur.

Porosity (phitenp) and water content (phiwenp) in column 6 were computed from epithermal neutron and density logs (Nelson, 1994). Within the water-filled borehole below 1904 feet, water content has been estimated from the thermal neutron log (phinbc). The epithermal and thermal neutron logs do not overlap in this hole. Porosity phiden was computed in the saturated zone from the density log. The general agreement among phiden, phinbc, and phiwenp indicates that these estimates are sound. Green hatching between the porosity and water content curves denotes air-filled porosity. Red hatching appears where water content exceeds porosity, often indicating the presence of zeolitic minerals.

Saturation (column 7) is computed as the ratio of phiwenp to phitenp from 310 to 1726 feet. The flag physzone (red bars in column 7) denotes the presence of extensive alteration. Their depth extent is taken from inspection of red hatch areas in column 6 and from consideration of other logs, especially resistivity (rild and sn).

Stratigraphic tops and degree of welding, given in column 8, are taken from Craig and others, 1983.

Disruptions in the sonic waveform log (wavefm, column 9) are often due to fractures or faults. Plots of individual fractures, column 10, observed on televiewer (tvrdaz) and television (tvndaz) logs are plotted to show the azimuth of the dip of each fracture. The same data are plotted as fracture density (tvrfrc, tvnfrc) in column 9. The televiewer log extends from 1900 to 3949 feet. The television log extends from 310 to 1724 and from 1992 to 2565 feet.

A flow log (Craig and others, 1991) shown in column 10 was derived from tracer tests carried out during a pumping test over the interval 1739 mto 4002 feet. Hydraulic conductivity values (hydconp) from pumping tests were prorated along the tested interval on the basis of the flow log using data given by Craig and others, 1991. Hydraulic conductivity values (hydconi) from packer-injection tests were given by Craig and others, 1991. Temperature gradient logs, dtmp in column 12, were computed from the temperature logs in column 1 by differencing over a 14-foot interval.

EXPLANATION OF CURVES AND SYMBOLS

Column 1
CAL Caliper in cm, black curve.
BIT Bit size in cm, black line.
SWL Static water level, vertical cyan bar.
TEMP Temperature in degrees C, four colors dated by month, year.
GR Gamma ray in API units, red curve.

Column 2
DBC Density in g/cc, red curve.
DBC3 Density bound in g/cc, red dash curve.
RHOG Grain density in g/cc, green curve.
GDMIN Grain density from mineralogy, green diamonds.

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

Column 4
PVEL Compressional-wave velocity in m/s, red curve.
MAGT Total magnetic field in microTesla, blue curve.
TOPS Stratigraphic boundaries, black ticks.

Column 5 [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 hatch.
Porosity Unshaded area to the right-hand edge.
MINDEP Depth of x-ray diffraction samples, ticks.

Column 6 [fractional volume of whole rock, increasing to left]
PHIWENP Water-filled porosity, from ENPBND and DBC3 logs, cyan curve.
PHITENP Porosity, from ENPBND and DBC3 logs, magenta curve.
(green hatch where PHITENP > PHIWENP, red where PHITENP < PHIWENP).
PHIDEN Porosity, computed from DBC3 log, red curve.
(red hatch where PHIDEN < PHINBC).
PHINBC Water content from NBC, blue curve.

Column 7
SWENP Water saturation, ratio of PHIWENP to PHITENP, green curve.
ZEOLZONE Zeolitic zone, picked from logs, red bar.
PHYSZONE Lithopysal zone, picked from logs, green bar.

Column 8
TOPS Stratigraphic boundaries, black ticks.
WELDNG Degree of welding from core inspection, black slant.
COREDINT Location of cored samples, green intervals.

Column 9
WAVEFM Disruptions in sonic waveform log, blue ticks and bars.
TVRFRC Number of fractures per 10 feet, from televiewer, blue.
TVNFRC Number of fractures per 10 feet, from television, red.

Column 10
FLOW Flow log from tracer tests while pumping, percent of total, cyan.
TVRDAZ Dip azimuth of fractures in degrees, from televiewer, blue diamonds.
TVNDAZ Dip azimuth of fractures in degrees, from television, red squares.
Undetermined azimuth is coded as 380 or 390 degrees.
LOSTCIRC Loss of fluid circulation during drilling.

Column 11
SEEP Water seep observed with television, magenta.
PUMPINT Intervals of pumping tests, red.
HYDCONP Hydraulic conductivity, in m/day, logarithmic scale, blue segments.
HYDCONI Hydraulic conductivity, in m/day, logarithmic scale, green segments.

Column 12
DTMP Temperature gradient, degC/km, three colors by month, year.

Stratigraphic Names
[Unmarked ticks are bedded units]

-Paintbrush Group-
Tpc Tiva Canyon Tuff
Tpp Pah Canyon Tuff
Tpt Topopah Spring Tuff

Tac Calico Hills Formation

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

Tll Lava
Tlr Lithic Ridge Tuff

NOTES

Date of last computation: January 1996
Plot Generation Date: January 1996
Scientific Notebook: SN-0092

REFERENCES

Bish, D. L., and Chipera, S.J., 1989, Revised mineralogic summary of Yucca Mountain, Nevada: Los Alamos National Laboratory Report LA-11497-MS, 68 p.

Nelson, P.H., Muller, D.C., Schimschal, U., Kibler, J.E., 1991, Geophysical logs and core measurements from forty boreholes at Yucca Mountain, Nevada: Geophysical Investigations Map GP-1001, 64 p., 40 plates.

Nelson, P.H., 1994, Saturation levels and trends in the unsaturated zone, Yucca Mountain, Nevada, Proceedings of the Fifth Annual International Conf. on High Level Radioactive Waste Management, Las Vegas, v. 4, p. 2774-2781.

Sass, J. H., Lachenbruch, A. H., Dudley, W.W., Jr., Priest, S.S., and Munroe, R.J., 1988, Temperature, thermal conductivity, and heat flow near Yucca Mountain, Nevada: Some tectonic and hydrologic implications: U.S. Geological Survey Open-file Report 87-649, 118 p.

Craig, R. W., Reed, R. L., and Spengler, R. W., 1983, Geohydrologic data for well USW H-6, Yucca Mountain Area, Nye County, Nevada: U.S. Geological Open-File Report 83-856, 35 p.

Craig, R. W., and Reed, R. L., 1991, Geohydrology of rocks penetrated by test well USW H-6, Yucca Mountain Area, Nye County, Nevada: U.S. Geological Open-File Report 89-4025, 40 p.

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

By Philip H. Nelson and Joyce E. Kibler

ISSN 2331-1258 (online)
http://dx.doi.org/10.3133/ofr20141023