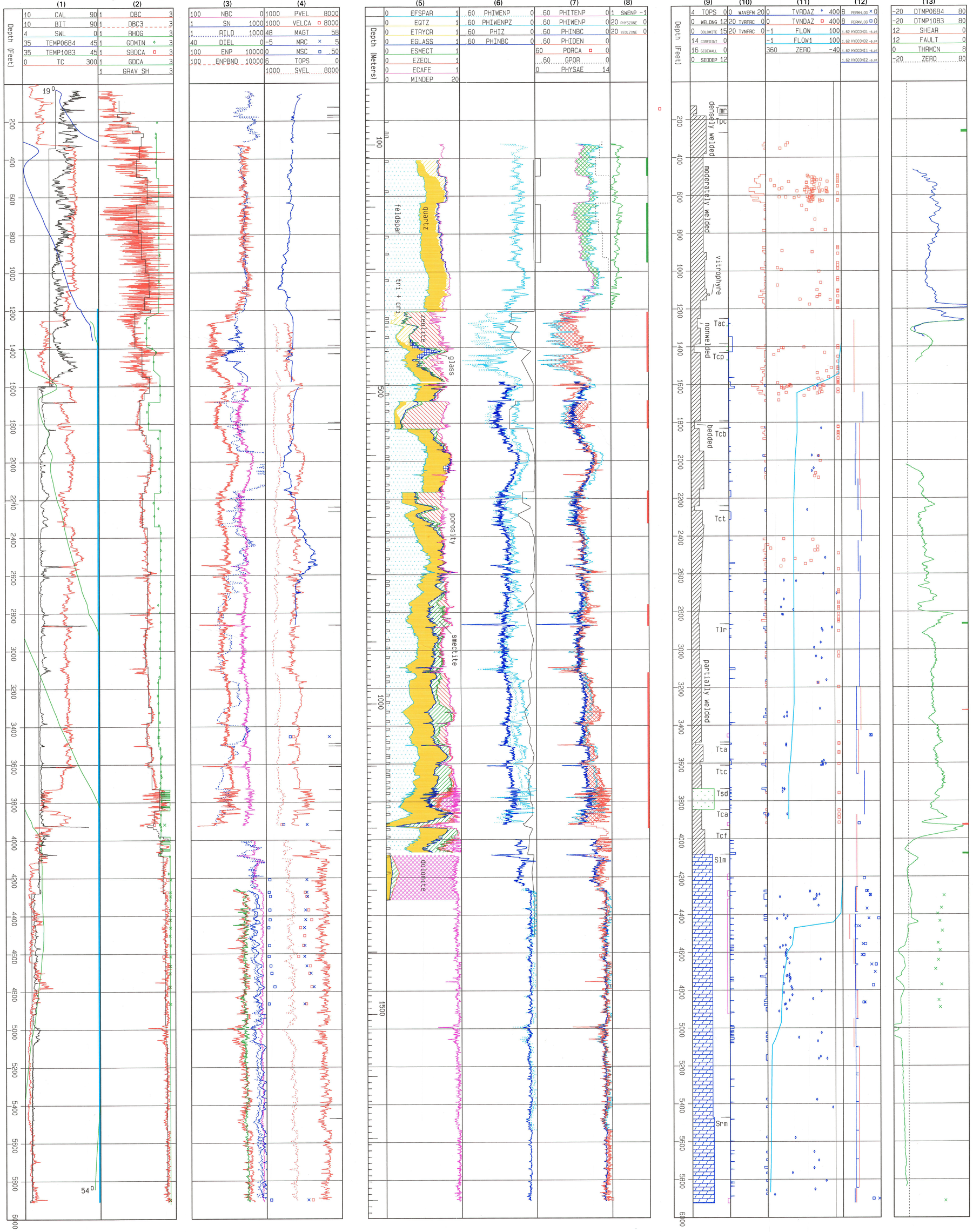
U.S. Department of the Interior
U.S. Geological Survey

UE-25p#1

Original Logs and Core Data

Mineralogy, Porosity, and Water Content

Stratigraphy, Fractures, and Flow



BOREHOLE UE-25p#1, YUCCA MOUNTAIN, NEVADA

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Drilling of UE-25p#1 commenced on November 14, 1982 and continued until reaching total depth of 5,923 feet on May 1, 1983 (Carr and others, 1986). It passes through the Tertiary volcanics and into Paleozoic dolomites at a depth of 4060 feet. Most of the hole was rotary drilled, except for the cored intervals (coredint) and a few sidewall cores (sidewall) designated in column 9. Depth on the plot is measured along hole, and has not been corrected for deviation. Deviation from vertical in UE-25p#1 is 1.25 degrees at 4000 feet, 2.25 degrees at 5000 feet and 8.75 degrees at 5923 feet. At a true vertical depth of 5916.7 feet, the measured depth is 5923 feet and horizontal offset is 137 feet from the surface location (from Plate 8, Nelson and others, 1991).

Most of the original logs in columns 1-4 were acquired between November, 1982 and May, 1983 (Nelson and others, 1991). The gravimeter log was acquired in November, 1983. The density log, dbc, is of poor quality in air-filled borehole. Consequently, for computational purposes, the corrected gravimeter, grav_sh, was spliced into the density log dbc3 from 85 to 1210 feet, and from 3922 to 3991 feet where the density log was not obtained. Two temperature logs obtained in October 1983 and June 1984, from Sass and others (1988), also appear in column 1.

Core measurements are taken from Anderson (1991): 2 samples from tuff, 13 from Lone Mountain Dolomite, and 1 from Roberts Mountain Formation (dolomite). The permeability data (permwlog, permhlog in col. 12) are from plugs, and all other core data by Anderson are from large-volume samples: saturated bulk density (sbdca, col. 2), grain density (gdca, col. 2), porosity (porca, col. 7), and magnetic properties (msc and mrc, col. 4). Sonic velocity (velca, col. 4) measurements on unconfined samples are substantially lower than the velocity log values (pvel). Nelson and Anderson (1992) discuss the measurements and examine the core data in terms of mineralogy.

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 the porosity curves phitenp and phiden, and extrapolated to boundaries inserted in several places where marked changes in log response occur.

Estimates of total water content in column 6 are derived from the epithermal neutron log (phiwenp) and thermal neutron log (phinbc). Between 1582 feet and total depth, phinbc can be compared with phiwenp. Structural water phiz is estimated from mineralogy and subtracted from phiwenp to form an estimate of water in pore space, phiwenpz.

Porosity (phitenp, phiden) and water content (phiwenp, phinbc) are given in column 7. Phitenp and phiwenp were computed from epithermal neutron and density logs (Nelson, 1994). Phiden was computed from density log dbc3. The grain density estimate, rhog, is constrained by grain density values from mineralogy, gdmin, and from core measurements, gdca. 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 and clay minerals. Muller and Spengler (1989) computed an estimate of lithophysal pore space, gpor, from the gravimeter log; it can be compared with green hatched areas. Carr et al. (1986) determined the depth intervals of the upper and lower lithophysal zones from television and density logs (physae), noting that the upper and lower contacts of the upper lithophysal zone are gradational.

Saturation (column 8) is computed as the ratio of phiwenp to phitenp from 310 to 1210 feet.

The flag physzone (green bars in column 8) denotes the presence of abundant lithophysae. Its boundaries are based primarily upon the green hatch areas in column 7, with consideration of caliper, gpor, and physae. The flag zeolzone (red bars in column 8) denotes extensive alteration to smectite and zeolite. Zeolzone boundaries are determined by inspection of red hatch areas and from consideration of other logs and data. In UE-25p#1, smectite is common and correlates with decreases in resistivity, rild.

Stratigraphic tops, degree of welding, and lithologies are taken from Carr et al. (1986). An interpretive section (Fig. 12 in Carr et al., 1986) shows that faulting and tilting cause have probably caused borehole UE-25p#1 to penetrate less than full section in Tac, Tcp, Tct, and Tlr.

Disruptions in the sonic waveform log (wavefm, column 10) are often due to fractures or faults. Fractures picked from television and televiewer logs are shown on a dip azimuth plot (tvndaz, tvrdaz) and in bar graph format (tvnfrc, tvrfrc). A televiewer log presented by Stock et al. (1986) was obtained in the course of in-situ stress determinations. The televiewer log extends from 1625 to 3945 and from 4260 to 5900 feet.

Hydraulic conductivity from pump tests and tracer tests (hydcond) and from injection tests (hydconi) are taken from Craig and Robison (1984). Permeability data from core measurements (permhlog, permvlog) are taken from Anderson (1994). The logarithmic scales in column 12 are arranged so that permeability and hydraulic conductivity can be compared, using a conversion of 1.196 darcy = 1 m/day.

Five fault and shear zones (fault, shear in column 13) were noted by Carr et al. (1986). The shear zone at 3921-3929 feet is coincident with a 10 degree cooling anomaly (Fig. 20 of Carr et al.) attributed to infiltration of drilling fluid.

Temperature gradients, dtmp, were computed by differencing the temperature logs over fourteen-foot intervals. Negative temperature gradients occure between 4000 and 6000 feet. Thermal conductivities, thrmcn, are from Sass and others (1988).

EXPLANATION OF CURVES AND SYMBOLS

Column 1
CAL — Caliper in cm, black curve.
BIT — Bit size in cm, black curve.
SWL — Static water level, vertical cyan bar.
TEMP — Temperature in deg C, two curves (month, year).
TC — Gamma ray in API units, red curve.

Column 2
DBC — Density in g/cm3, red curve.
DBC3 — Density bound in g/cm3, red dot curve.
SBDCA — Density of saturated samples in g/cm3, red squares.
RHOG — Grain density in g/cm3, green curve.
GDCA — Grain density from cores, green squares, green X.
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 neutron bound in counts/sec, red dash curve.
NBC — Thermal neutron log in porosity, magenta curve.
SN — Short normal resistivity in ohm-m, blue curve.
RILD — Induction resistivity in ohm-m, blue dot curve.

Column 4
PVEL — P-wave velocity in m/s, red curve.
SVEL — S-wave velocity in m/s, red dot.
VELCA — P-wave velocity from core in m/s, red squares.
MAGT — Total magnetic field in microtesla, blue curve.
MSC — Magnetic susceptibility in mSI, blue squares.
MRC — Magnetic remanence in mA/m, blue X.
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 — Dolomite + calcite + hornblende + 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 content from ENPBND and DBC3 logs, cyan dot.
PHINBC — Water content from corrected NBC, blue curve.
PHIZ — Structural water from mineralogy, black curve.
PHIWENPZ — Water content, structural water removed, cyan solid.

Column 7 [fractional volume of whole rock, increasing to left]
PHITENP — Porosity, from ENPBND and DBC3 logs, magenta curve.
PHIWENP — Water-filled porosity, from ENPBND and DBC3 logs, cyan curve. (green hatch where PHITENP > PHIWENP, red where PHITENP < PHIWENP).
PHIDEN — Porosity, computed from DBC3 log, red curve.
PHINBC — Water content from NBC, blue curve. (red hatch where PHIDEN < PHINBC).
PORCA — Porosity from core measurements, red squares.
GPOR — Void space from gravimeter log, black dotted curve.
PHYSAE — Lithophysal intervals, black curve.

Column 8
SWENP — Water saturation, ratio of PHIWENP to PHITENP, green curve.
PHYSZONE — Lithophysal zone, picked from logs, green bar.
ZEOLZONE — Zeolitic zone, picked from logs, red bar.

Column 9
WELDNG — Degree of welding from core inspection, black slant.
DOLOMITE — Intervals of Paleozoic dolomite, blue bricks.
SEDDEP — Interval of sedimentary deposits, green dots.
COREDINT — Cored intervals, magenta.
SIDEWALL — Location of sidewall samples, green tick.
TOPS — Lithologic tops, black ticks.

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

Column 11
TVNDAZ — Dip azimuth of fractures from television, in degrees, red squares.
TVRDAZ — Dip azimuth of fractures from televiewer, in degrees, blue diamonds.
FLOW, FLOW1 — Flow from tracer, percent of total, cyan curve.

Column 12
PERMHLOG — Permeability from horizontal plugs in microdarcy, logarithmic scale, blue X.
PERMVLOG — Permeability from vertical plugs in microdarcy, logarithmic scale, blue squares.
HYDCONI — Hydraulic conductivity in m/day, logarithmic scale, interpreted from injection tests, blue lines.
HYDCOND — Hydraulic conductivity in m/day, logarithmic scale, interpreted from pump tests and flow log, red line.

Column 13
SHEAR — Shear zones, red bars.
FAULT — Fault zones, green bars.
DTMP — Temperature gradient, deg C/km, two curves (month, year).
THRMCN — Thermal conductivity, W/m/degK, green X.

Stratigraphic Names

-Timber Mountain Group-
Tmr — Rainier Mountain Tuff

-Paintbrush Group-
Tpc — Tiva Canyon Tuff
Tpy — Yucca Mountain 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

Tlr — Lithic Ridge Tuff
Tta, Ttc — Older Tuffs of USW G-1, Units A and C (informal)
Tsd — Sedimentary deposits
Tca — Calcified ash-flow tuff
Tcf — Tuff of Yucca Flat (?) (informal)

Slm — Lone Mountain Dolomite
Srm — Roberts Mountain Formation

NOTES

Last computation: January 1996 Plotted: January 1996
Scientific Notebook: SN-0092

REFERENCES

Anderson, L. A., 1991, Results of rock property measurements made on core samples from Yucca Mountain boreholes, Nevada Test Site, Nevada, Part I, Boreholes Ue25A-4, -5, -6, and -7. Part 2. Borehole Ue25P#1: U.S. Geological Survey Open-File Report 90-474, 43 p.

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.

Carr, M. D., Waddell, S. J., Wick, G. S., Stock, J. M., Monsen, S. A., Harris, A. G., Cork, B. W., Byers, F. M., Jr., 1986, Geology of drill hole UE25p#1: A test hole into pre-Tertiary rocks near Yucca Mountain, southern Nevada: U.S. Geological Survey Open-File Report 86-175, 87 p.

Craig, R. W., and Johnson K. A., 1984, Geohydrologic data for test well UE25p#1, Yucca Mountain area, Nye County, Nevada: U.S. Geological Survey Open-File Report 84-450, 63 p.

Craig, R. W., and Robison, J. H., 1984, Geohydrology of rocks penetrated by test well UE-25p#1: U.S. Geological Survey Water-Resources Investigations Report 84-4248, 57 p.

Muller, D.C. and Spengler, R.W., 1989, Bulk porosity in lithophysal zones above the static water level calculated from borehole gravity and gamma-gamma density logs at Yucca Mountain, Nevada, in Proc. of 3rd Intl. Symp. on Borehole Geophysics for Minerals, Geotechnical, and Groundwater Applications, Las Vegas: Soc. of Prof. Well Log Analysts, p. 29-52.

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., and Anderson, L.A., 1992, Physical properties of ash-flow tuff from Yucca Mountain, Nevada, J. of Geophysical Research, v 97, no. B5, p 6823-6841.

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.

Stock, J. M., Healy, J. H., Svitek, J., and Mastin, L., 1986, Report on televiewer log and stress measurements in holes USW G-3 and UE-25p#1 Yucca Mountain, Nye County, Nevada: U.S. Geological Survey Survey Open-File Report 86-369, 91 p.

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

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