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SAND87–2380 • UC–814
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Yucca Mountain Site Characterization Project

Statistical Analysis of Hydrologic Data for Yucca Mountain

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Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550
for the United States Department of Energy
under Contract DE-AC04-76DP00789

HYDROLOGY DOCUMENT NUMBER 676

"Prepared by Yucca Mountain Site Characterization Project (YMSCP) participants as part of the Civilian Radioactive Waste Management Program (CRWM). The YMSCP is managed by the Yucca Mountain Project Office of the U.S. Department of Energy, DOE Field Office, Nevada (DOE/NV). YMSCP work is sponsored by the Office of Geologic Repositories (OGR) of the DOE Office of Civilian Radioactive Waste Management (OCRWM)."

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SAND87-2380
Unlimited Release
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STATISTICAL ANALYSIS OF HYDROLOGIC DATA FOR YUCCA MOUNTAIN

by

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ABSTRACT

The geologic formations in the unsaturated zone at Yucca Mountain are currently being studied as the host rock for a potential radioactive waste repository. Data from several drill holes have been collected to provide the preliminary information needed for planning site characterization for the Yucca Mountain Project. Hydrologic properties have been measured on the core samples and the variables analyzed here are thought to be important in the determination of groundwater travel times.

This report presents a statistical analysis of four hydrologic variables: saturated-matrix hydraulic conductivity, maximum moisture content, suction head, and calculated groundwater travel time. It is important to modelers to have as much information about the distribution of values of these variables as can be obtained from the data. The approach taken in this investigation is to 1) identify regions at the Yucca Mountain site that, according to the data, are distinctly different; 2) estimate the means and variances within these regions; 3) examine the relationships among the variables; and 4) investigate alternative statistical methods that might be applicable when more data become available.

The five different functional stratigraphic units at three different locations are compared and grouped into relatively homogeneous regions. Within these regions, the expected values and variances associated with core samples of different sizes are estimated. The results provide a rough estimate of the distribution of hydrologic variables for small core sections within each region. One conclusion of this analysis is that the present data do not, in general, indicate a significant difference among the holes. The data in a given functional stratigraphic unit, with one exception, are statistically similar among the three drill holes considered.

The data were gathered under
WBS number 1.2.1.4.4; however, the
report was completed under
WBS number 1.2.1.4.4.1.

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1. INTRODUCTION

1.1 Project Description

The unsaturated tuffs (i.e., the tuffs above the water table) at Yucca Mountain, Nye County, Nevada (Figure 1.1), are being investigated as a host for a potential radioactive waste repository. The U.S. Department of Energy (DOE) is carrying out studies through the Yucca Mountain Project (YMP), formerly called the Nevada Nuclear Waste Storage Investigations (NNWSI) Project. Licensing the repository will require that performance-assessment calculations show that a repository at Yucca Mountain will meet or exceed the requirements set forth by the Environmental Protection Agency in 40 CFR 191 (EPA, 1986). Meeting the requirements of 40 CFR 191 will require a probabilistic assessment of the movement of radionuclides from the repository to the accessible environment. The Nuclear Regulatory Commission in 10 CFR 60 (NRC, 1986) has prescribed additional requirements concerning the life of the waste canister, the transport rate of the radionuclides into the rock surrounding the waste canister, and preemplacement groundwater travel time; these requirements demand a thorough understanding of the hydrologic system.

1.2 Site Description

Yucca Mountain is a prominent group of north-trending, fault-block ridges. The northern end of Yucca Mountain is approximately 1,500 m above sea level, and the ridge of the mountain is about 300 m above the surrounding valley floors. Yucca Mountain is made up predominantly of ash-flow and air-fall tuffs. These tuffs may be subdivided into functional stratigraphic units that minimize the variability in thermal and mechanical properties within each unit (Ortiz et al., 1985). It appears that this same subdivision may also be used to define a first estimate of the hydrologic units at Yucca Mountain (Figure 1.2). In this report, we concentrate on the data from samples from the Topopah Spring welded (TSw) and Calico Hills nonwelded (CHn) functional stratigraphic units because these functional stratigraphic units are of primary importance to system performance if the repository is located in the TSw unit. (Data for other units are available.) The Topopah Spring welded unit is subdivided into three subunits--TSw1, TSw2, and TSw3, while the Calico

Hills nonwelded unit is subdivided into two subunits--CHnv and CHnz ("v" indicating tuffs that are primarily vitric and "z" indicating tuffs that are primarily zeolitic). In subsequent sections, we will refer to the subunits (e.g., TSwl or CHnv) as units. Each of the functional stratigraphic units above the water table (e.g., TSwl) can be placed into one of three basic groups according to their properties.

(1) Densely welded tuffs that are highly fractured. These units have low saturated-matrix conductivities (10^{-11} m/s or less for all but one unit) and high saturated-fracture conductivities. (For a unit volume of rock, the total saturated conductivity of the fracture system is probably several orders of magnitude higher than the total saturated conductivity of the matrix.) The matrix porosity ranges from about 0.03 to 0.30 with the fracture porosity or void space probably in the range of 10^{-3} to 10^{-5}. The units included in this group are designated as TSwl, TSw2, and TSw3 (Figure 1.2).

(2) Nonwelded, vitric tuffs that have few fractures. These units have high saturated-matrix conductivities (approximately 10^{-6} to 10^{-8} m/s) and relatively low saturated-fracture conductivities. The matrix porosity ranges from about 0.30 to 0.65. The unit included in this group is CHnv.

(3) Nonwelded, zeolitized tuffs that have few fractures. These units have low saturated-matrix conductivities (10^{-11} m/s or less) and low saturated-fracture conductivities. The matrix porosity ranges from about 0.20 to 0.40, with the fracture porosity probably in the range of 10^{-4} to 10^{-6}. The unit included in this group is CHnz.

Information listed above regarding hydrologic properties was drawn from a variety of different documents: DOE, 1986; Peters et al., 1984; and Peters and Klavetter, 1987.

Conceptual models of the hydrologic system at Yucca Mountain have been developed (e.g., DOE, 1986; Montazer and Wilson, 1984; Peters and Klavetter, 1988) (Figure 1.2). Mathematical models for predicting the movement of water

in fractured, unsaturated tuff have also been developed (Peters and Klavetter, 1988; Wang and Narasimhan, 1985). The evaluation of mathematical models and conceptual models of the hydrologic system will require hydrologic information concerning the site. This report presents an analysis of the available hydrologic data on tuffs at Yucca Mountain.

A conceptual model of the hydrologic system at Yucca Mountain is shown in Figure 1.2. A small fraction of the annual precipitation infiltrates the surface of the mountain. It then moves down through the various units. At present, it is thought that most of the flux moves vertically through the units as it travels down to the water table. It is possible, however, that some portion of the total flux may be diverted at interfaces between the functional units because of the extreme contrast in the hydrologic properties of two units, e.g., PTn (the unit directly above TSwl) and TSwl. If the saturated conductivity of the lower unit is less than the average downward flux, perched groundwater could form above the interface, and water might be diverted laterally. Water diverted laterally may eventually reach the water table by flowing eastward along the interface and then down a structural feature such as a fault zone.

1.3 Drilling and Sampling

The data analyzed in this report consist of measurements made on tuff samples obtained from cylindrical cores taken from three drill holes at Yucca Mountain. The drill holes, designated as USW G-1, USW GU-3, and USW G-4, are shown in Figure 1.1. In the remainder of this document, the drill holes will be identified as G-1, GU-3, and G-4, respectively.

The cores were about 6 cm in diameter and 6 to 20 cm long. The core sections are referred to as samples and the separate pieces of rock cut from the core sections, on which the tests are conducted, as specimens. The volume of the specimens ranged from approximately 2 to 40 cm^3.

Samples were taken from each of the functional units within each drill hole. The sampling procedure was determined by NNWSI Project hydrologic data needs for scoping analyses and experiments subject to the limited available core.

More samples and data will become available as characterization of the site proceeds. Samples have been taken at various depths within each unit, usually 10 m or more apart. A listing of the sample depths for each drill hole is given in Appendix A. As the tables show, the sampling was not uniform across depths. Some hydrologic units were sampled only a few times. At each depth, one, two, or three rock specimens were cut from the sample drill core, and various measurements were made on each specimen. Figure 1.3 shows a diagram giving the sample breakdown from the three drill holes and five units. Table 1.1 gives the thickness of each unit for each of the three drill holes. This table can be used with the tables in later chapters showing the number of samples and specimens for each variable to determine the sampling density.

Values for four variables were calculated from the measurements on the specimens. These variables were saturated-matrix hydraulic conductivity; maximum moisture content; suction head; and groundwater travel time. The methods of computation and sources of data for each variable are given with the analysis in Chapters 3 through 6.

Table 1.1

Unit Thickness in Feet for the Three Holes.*

(Depths at the top of each unit are given in parenthesis.)

	Hole		
Unit	USW G-1	USW GU-3	USW G-4
TSw1	717 (280)	260 (430)	427 (243)
TSw2	290 (997)	497 (690)	623 (670)
TSw3	55 (1287)	82 (1187)	52 (1293)
CHnv	51 (1342)	332 (1269)	18 (1345)
CHnz	475 (1393)	Not present	429 (1363)

* Source: Ortiz, et al., 1985

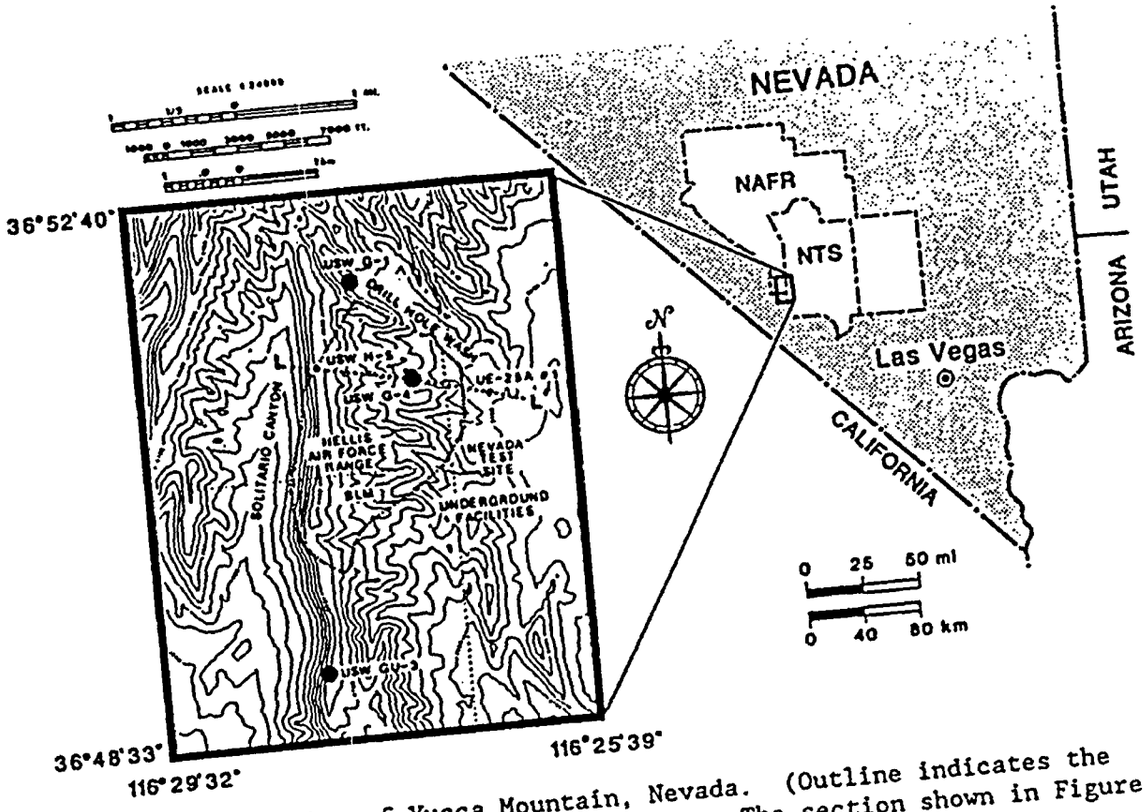

Figure 1.1. Location of Yucca Mountain, Nevada. (Outline indicates the preliminary repository boundary. The section shown in Figure 1.2 is along line L-L'.

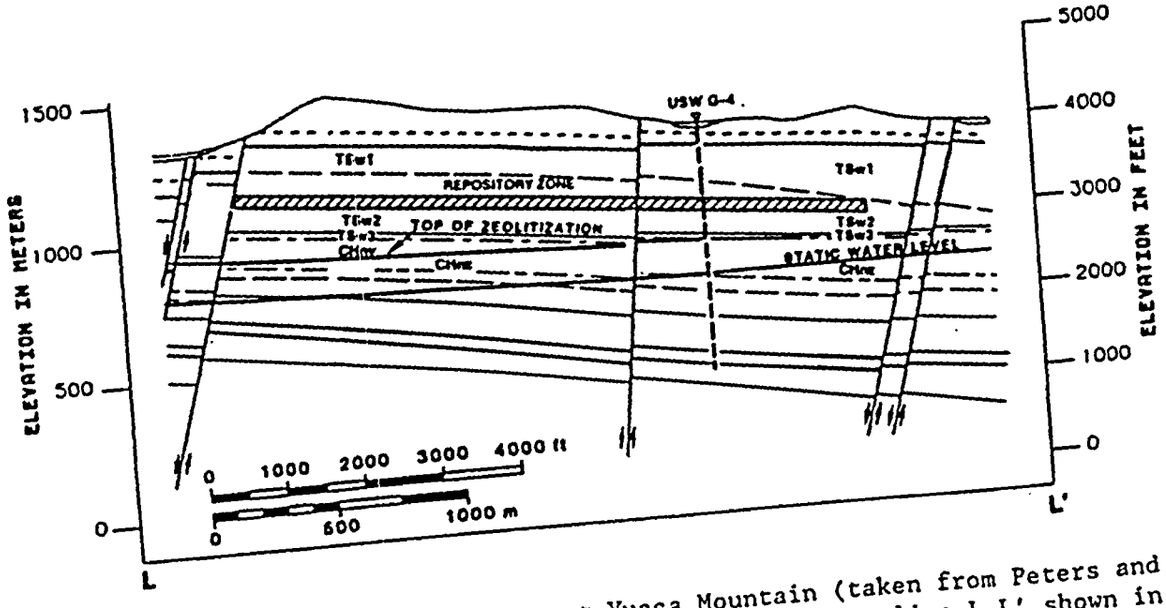

Figure 1.2. Hydrogeologic Units at Yucca Mountain (taken from Peters and Klavetter, 1988). (This section is along line L-L' shown in Figure 1.1.)

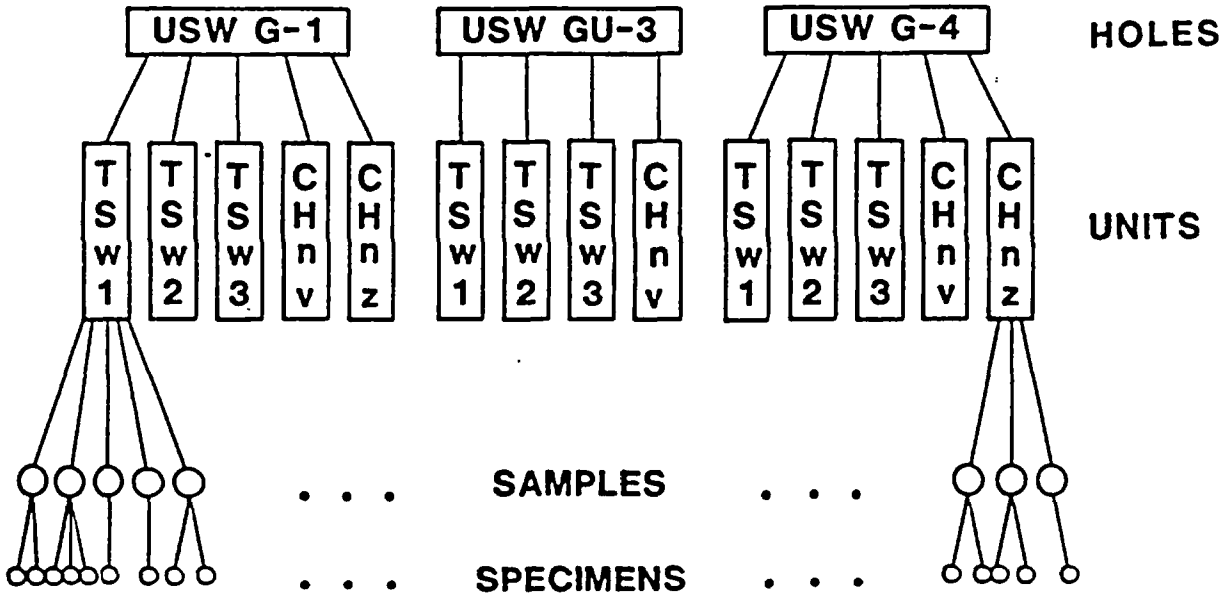

Figure 1.3. Sampling Pattern.

2. STATISTICAL MODELS, ASSUMPTIONS, AND PROCEDURES

2.1 Steps in the Analysis

A two-step analysis has been performed for each of the variables under consideration. First, the combinations of units and holes that can be grouped are determined on the basis of evidence presented by the data. These grouped hole-unit combinations are referred to as "regions" in the remainder of this report. Once these regions have been established, the components of variability within each region are examined. These components of variability include the variability of specimens within the same core sample, referred to as specimen variability, and the variability between the core samples, referred to as sample variability. The model and assumptions of the analysis of variance are given in Section 2.2. The procedure for computing the components of variability (variance components) is described in Section 2.3. Section 2.4 discusses an alternative method of analysis that relates variability to spatial separation. Appendix B gives further details on how these analyses were performed.

2.2 Analysis of Variance

The purpose of this analysis is to identify the units, holes, and hole-unit combinations in the area under study that have greater differences than can be attributed to the inherent variability within the area. It should be emphasized that the homogeneous regions established in this analysis have been determined using available data; we have assumed that all the hole-unit combinations can be combined unless statistically significant evidence is provided by the data to group them in separate regions. Because available data are very limited, one might expect a different and very probably finer breakdown into regions when more data become available.

The statistical model, suggested by the data structure in Figure 1.3 and, therefore, used for the analysis, is given as follows:

$$Z = \mu + H_i + U_j + HU_{ij} + S_{(ij)k} + \epsilon_{(ijk)l}$$

where:

Z	represents the variable being measured;
μ	is the overall mean;
H_i	is the effect of the ith hole $i = 1, 2, 3$ (G-1, GU-3, G-4);
U_j	is the effect of the jth unit $j = 1, 2, 3, 4, 5$ (TSw1, TSw2, TSw3, CHnv, CHnz);
HU_{ij}	is the hole-unit interaction effect for the ith hole and jth unit;
$S_{(ij)k}$	is the effect of the kth sample in unit i and hole j; and
$\epsilon_{(ijk)l}$	is the effect of the lth specimen in the kth sample.

The hole effects (H_i, $i = 1, 2, 3$) represent differences from the overall mean value associated with measurements in a particular hole. Down a given hole, an additional change in mean value could occur from one unit to the next. This change might depend upon which hole is being considered, as could be the case, for example, when one hole is much closer to the source of an ashflow when the unit was being formed. To reflect this dependence, we include both an overall unit effect U_j, where $j = 1,\ldots,5$, and the interaction term HU_{ij}, where $i = 1, 2, 3$ and $j = 1,\ldots,5$, to account for the possible differences as described above. As part of the analysis for each of the hydrologic variables, these terms H, U, and HU will be tested statistically for nonzero values. Associated with each statistical test is a level of significance. This level gives the probability under the assumptions of the test that a significant effect is calculated when in fact no such effect is real. For the analysis of variance tests performed here, this level will be 0.1. On the other hand, these tests may fail to show a significant difference because not enough data are available to statistically establish a real difference when one exists.

Separation of the effects labeled sample and specimen reflects the fact that we might expect values of hydrologic properties within a single 20-cm piece of core to be closer together than values from core samples separated in most cases by 10 or more meters. The term for the sample effect, $S_{(ij)k}$, then gives the deviation from the hole-unit average for a given sample k in hole-unit i,j. The actual deviation of specimen value from the sample mean within this kth sample is the term $\epsilon_{(ijk)l}$. In addition to the random variation of

the variables at short range, this term will include errors in measurements during testing. During our analysis for each variable, we will estimate the variability of these sample and specimen terms.

Following are the assumptions for this analysis:

- H_i are independent and normally distributed with mean 0 and variance σ_H^2 ;
- $\sum_{j=1}^{5} U_j = 0$;
- HU_{ij} are independent and normally distributed with mean 0 and variance σ_{HU}^2;
- $S_{(ij)k}$ are independent and normally distributed with mean 0 and variance σ_S^2; and
- $\epsilon_{(ijk)l}$ are independent and normally distributed with mean 0 and variance σ^2.

The intent here is to provide a reasonable first approximation to determining which hole-unit combinations are similar in mean value. When the results of the analysis of variance indicated significant effects or interactions, hole-unit means were compared statistically to determine how more homogeneous regions could be formed. In the next section, procedures are given where the regions determined to be more homogeneous are further analyzed to obtain estimates of the variance components contributing to the variability within a region.

2.3 Components of Variance

The model for the components of variance analysis within regions selected in the analysis of variance is

$$Z = \mu_r + S_k + \epsilon_{(k)l} \tag{2.1}$$

where:

Z again represents the variable being measured;

μ_r is the mean within the region;

S_k is the effect of the kth sample within the region; and

$\epsilon_{(k)l}$ is the contribution of the lth specimen in the kth sample.

The assumptions of this model are that

S_k are independent with mean 0 and variance σ_S^2 and
$\epsilon_{(k)l}$ are independent with mean 0 and variance σ^2.

The purpose of this analysis is to provide estimates of σ_S^2 and σ^2 within each of the regions determined in the analysis of variance. These are the estimates of variability referred to in the previous section. It is possible that the variance σ_S^2 is also a function of separation distance. Examination of this possibility requires more data than are generally available in the selected homogeneous regions. This is the topic of the next section.

2.4 Spatial Analysis

For core samples such as those considered here, it might be expected that the correlation or similarity of measurements taken within a homogeneous region depends on the separation distance. Thus, an analysis of spatial variability is appropriate. Ideally, one would perform this analysis by identifying a spatial covariance structure for each of the random variables within stationary regions of the overall area (i.e., regions where we are willing to assume that the mean value of the random variable is constant and the covariance as a function of distance and direction is also fixed).

For regions assumed to be stationary, we can define the expected value,

$$E[Z(X)] = M \quad , \tag{2.2}$$

and, as a measure of spatial variability, the variogram (or what is referred to in much of the literature as the semi-variogram),

$$\gamma(h) = (1/2)E\{[Z(X) - Z(X + h)]^2\} \tag{2.3}$$

In this formulation, Z is a random function of spatial location; X is a vector of dimension equal to the dimension of the region (generally, one-, two-, or three-dimensional); and h is distance (and possibly direction in more than one dimension). Additional details about stationary regions appear in Journel and Huijbregts (1978). Two points regarding spatial analysis are to be made here.

First, the problem with performing a spatial analysis of the Yucca Mountain data is the extreme paucity of these data. One problem for this type of analysis is that the covariance structure or variogram must be inferred from the data. Current data on the horizontal direction are too sparse to make a reliable estimate. In the vertical direction, however, a substantial amount of data can be used, but only if most of the area of interest is considered a stationary region. Vertical stationarity is part of what is being tested in the analysis of variance when testing for a significant unit difference.

Second, the assumptions associated with the analysis of variance in the previous section represent a special case for the spatial covariance structure. If the assumptions of that analysis hold, the form of the variogram is

$$\gamma(h) = \begin{cases} \sigma^2 & h < 20 \text{ cm} \quad \text{(within a sample)} \\ \sigma^2 + \sigma_S^2 & h > 10 \text{ m} \quad \text{(between samples)} \\ \text{unknown} & 20 \text{ cm} < h < 10 \text{ m} \quad . \end{cases} \tag{2.4}$$

This form of the variogram is the result largely of the independence assumptions associated with the analysis of variance. The unknown interval (20 cm < h < 10 m) is a result of the fact that most samples are 10 m or more apart. The variation of the points between 20 cm and 10 m cannot be analyzed with the current data.

A spatial analysis includes computation of the sample variogram, an estimate of the unknown function, $\gamma(h)$. To compute the sample variogram, the range is partitioned into distance intervals containing approximately equal numbers of pairs. Within the interval where h falls, the sample variogram is computed as

$$\gamma^*(h') = [1/N(h')] \sum_{(i,j)\epsilon S(h')} [Z_i - Z_j]^2 \quad , \tag{2.5}$$

where $S(h')$ is the set of pairs in the distance interval where h' falls, and $N(h')$ is the number of pairs in $S(h')$. In order to see how close the sample variogram comes to this hypothesized variogram, the variograms are compared using the sample averages in the next chapter. In the regional breakdown for hydraulic conductivity, one region is almost the entire area of study, and hence, a good approximation is possible. The sample variograms are compared to the hypothesized variograms to see if there are major violations of the assumptions of the analysis of variance due to the spatial correlation of the data. This same comparison is omitted for the remaining variables because the regions determined in the analysis of variance are smaller, and less information is available.

3. ANALYSIS OF SATURATED HYDRAULIC CONDUCTIVITY

The methods used to measure saturated-matrix hydraulic conductivity are described in Peters et al. (1984), and the data used in this analysis are taken from Klavetter and Peters (1987). A list of the data and their natural logarithms is given in Table A.1 of Appendix A. The analysis is performed using the natural log values because saturated hydraulic conductivity is thought to have a distribution that is approximately lognormal (Freeze, 1975). We will refer to this as log saturated hydraulic conductivity in the remainder of this section.

One further point concerning the saturated hydraulic conductivity data is that although the sample depth is always recorded correctly, some of the test results have not been recorded as belonging to Specimen A, B, or C. Specifically, the saturated hydraulic conductivity values reported in Peters et al. (1984) from hole GU-3 were made on large pieces of core that were not the same as any specimen. In those cases, the values have been randomly assigned to a specimen. In that same report, the saturated hydraulic conductivity measurements from hole G-4 were made on the individual specimens, however, laboratory procedures used to obtain these measurements could not guarantee that measurements within a sample were assigned to the right specimen. Thus, for example, the saturated hydraulic conductivity measurement labeled Specimen A may not correspond to Specimen A of the other variables, but the core depth will be correct. These uncertainties in data identification do not affect the analysis of this chapter, but they have a potential effect when saturated hydraulic conductivity measurements are paired with measurements of other variables. More will be said on this later in Chapters 6 and 7 when the analysis is affected.

Table 3.1 gives the means and variance estimates of the various hole-unit combinations (the CHnz unit is not present at the GU-3 hole location). Figure 3.1 shows the data plotted against hole depth for each hole. Figure 3.2 plots the unit means by hole. It is clear from both the table and the figures that the GU-3, CHnv hole-unit is an outlier in the sense that the values in that region are distinctly different from the rest of the data and appear to be the result of a different phenomenon. Because an objective of this study is to break down the area into relatively homogeneous regions for further analysis, the GU-3, CHnv hole-unit has been removed for independent analysis.

An analysis of variance (ANOVA) performed on the remaining hole-unit combinations reveals no significant effects at the 0.1 level of significance. The analysis was performed using the Statistical Analysis System (SAS, 1985) software, General Linear Models Procedure. This software package has been commercially available for over 10 years. The ANOVA table is given in Table B.1 of Appendix B. We may conclude that the data do not provide enough evidence to identify further regions of nonhomogeneity. The two regions that we will now deal with separately are the region containing only the hole-unit GU-3, CHnv, and the region encompassing all other hole-unit combinations as indicated by the partitioning of Table 3.2.

The second part of the log saturated hydraulic conductivity analysis is to estimate the mean values and components of variance within these two regions. These estimated variances are computed for specimen-to-specimen variability within a sample and for sample-to-sample variability within the region. Table 3.2 gives these estimates for the regions specified above. The mean values and variance components in Table 3.2 apply to all hole-units not separated by line segments. Figures 3.3 and 3.4 show histograms of the sample means for each region with a normal distribution superimposed. Tests of hypotheses concerning the distribution of the data are typically not conclusive for samples with so few data.

Within the larger region (GU-3, CHnv excluded) indicated by the ANOVA, a variogram as discussed in the previous chapter can be constructed and compared to the variogram assumed by the ANOVA model. A similar analysis for the smaller region (five sample values) would be meaningless. Figure 3.5 shows the hypothesized and empirical variograms. In constructing this empirical variogram, only vertical separation is considered. The values from the three holes have been combined based on the ANOVA finding of no significant differences among the drill holes. The data used to construct the empirical variogram were the sample averages. The fine horizontal lines represent approximate 90% confidence intervals under the assumptions of the ANOVA. It is difficult to say that the empirical variogram shows a clear pattern of spatial variability. One could conclude looking at the variogram plot that it does not provide strong evidence of spatial correlation between the sample means; that is, the ANOVA assumption that the variance of the sample means is independent of separation distance is not contradicted by the available data.

Table 3.1

Statistics by Hole-Unit for Log Saturated Hydraulic Conductivity

Each entry includes the average of sample means;
(the number of samples, estimated sample variance);
and [the number of specimens, estimated specimen variance].

Unit \ Hole	USW G-1	USW GU-3	USW G-4
TSw1	-25.42 (3, 2.57) [5, 0.87]	-26.24 (2, 3.07) [4, 0.02]	-26.57 (3, 1.81) [3, --]
TSw2	-26.31 (2, 0) [4, 3.59]	-24.49 (4, 6.12) [4, --]	-25.34 (8, 0.21) [14, 0.62]
TSw3	-24.02 (1, --) [1, --]	-26.08 (2, 2.56) [2, --]	-24.94 (3, 8.72) [3, --]
CHnv	-23.71 (3, 5.36) [5, 1.07]	-16.72 (5, 3.54) [5, --]	-26.41 (2, 11.22) [4, 0.50]
CHnz	-24.90 (7, 1.89) [14, 0.07]		-25.43 (15, 0.90) [27, 1.20]

Table 3.2

Statistics for the Regions for Log
Saturated Hydraulic Conductivity

Each entry includes the average of sample means;
(the number of samples, estimated sample variance);
and [the number of specimens, estimated specimen variance].

Unit \ Hole	USW G-1	USW GU-3	USW G-4
TSw1			
TSw2		-25.32 (55, 1.82) [90, 0.87]	
TSw3			
CHnv		-16.72 (5, 3.54) [5, --]	
CHnz			

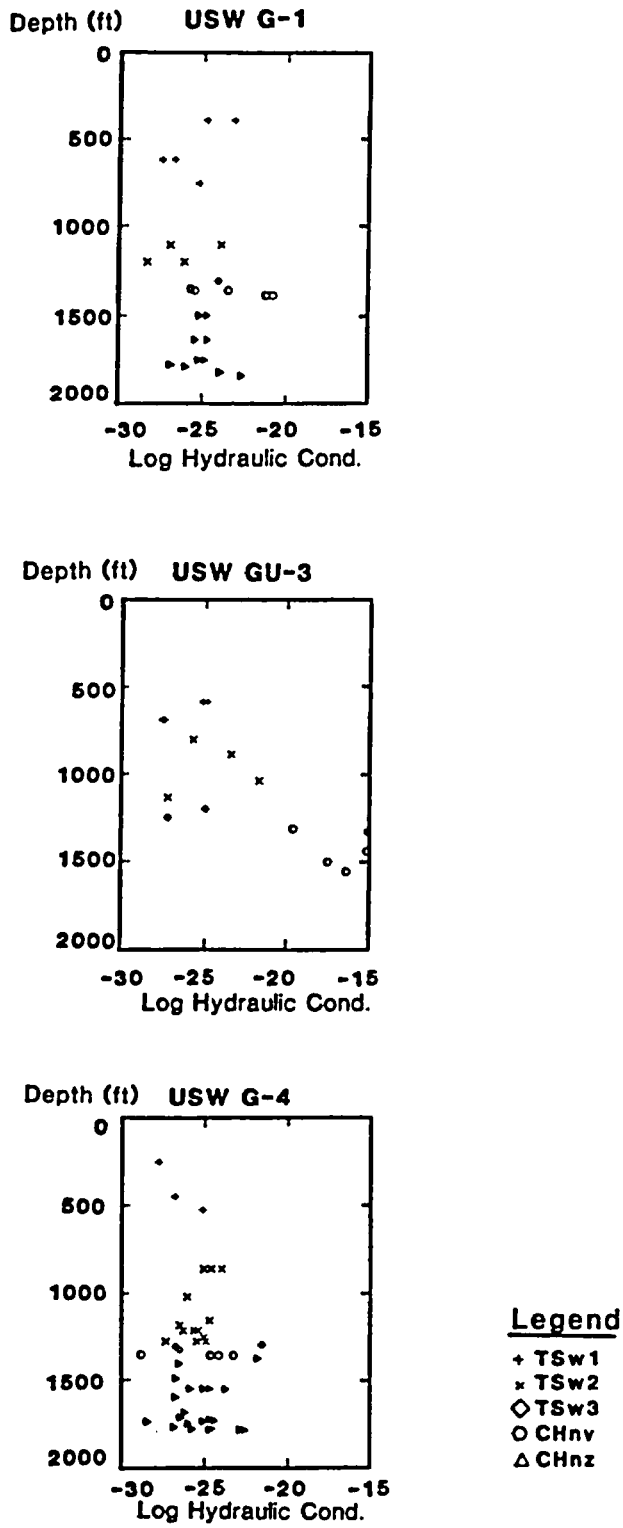

Figure 3.1. Specimen Values by Hole for Natural Log of Saturated Hydraulic Conductivity.

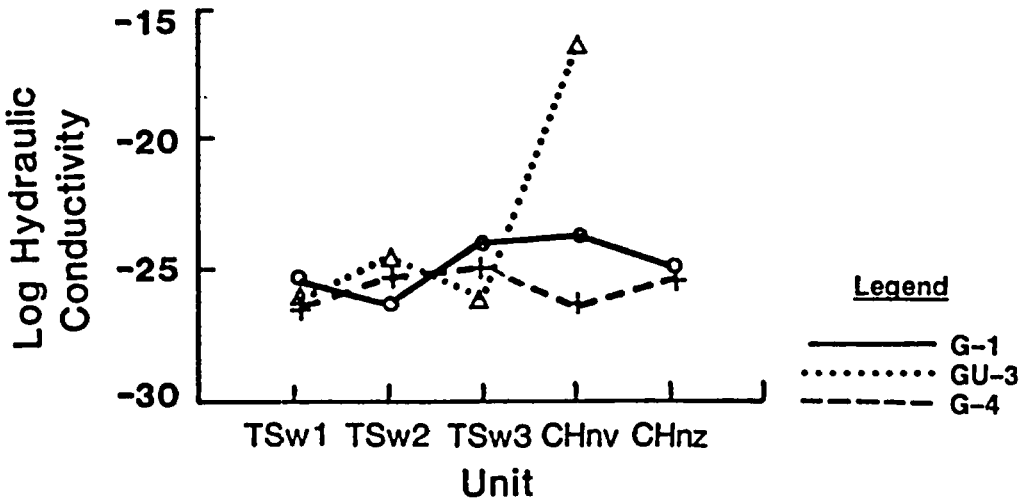

Figure 3.2. Unit Means by Hole for Natural Log Saturated Hydraulic Conductivity.

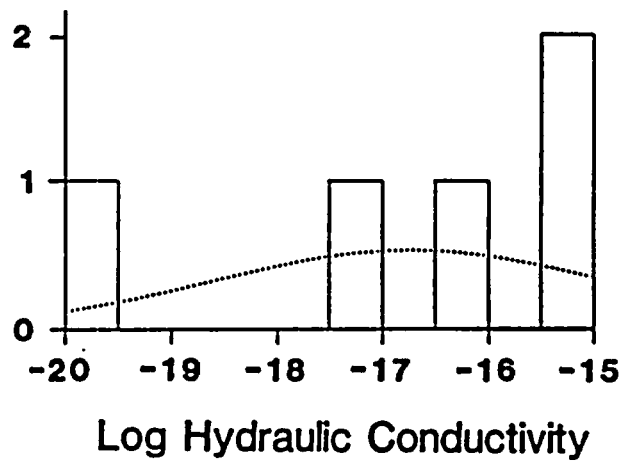

Figure 3.3. Histogram for Data from USW GU-3, Unit CHnv (Five Data Points).

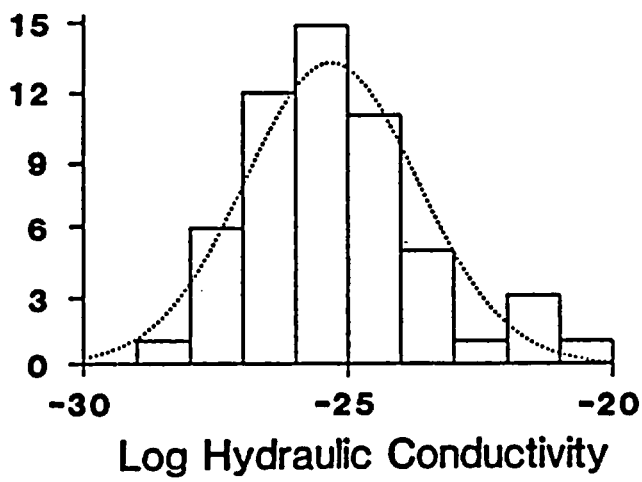

Figure 3.4. Histogram for Data from All Other Holes and Units.

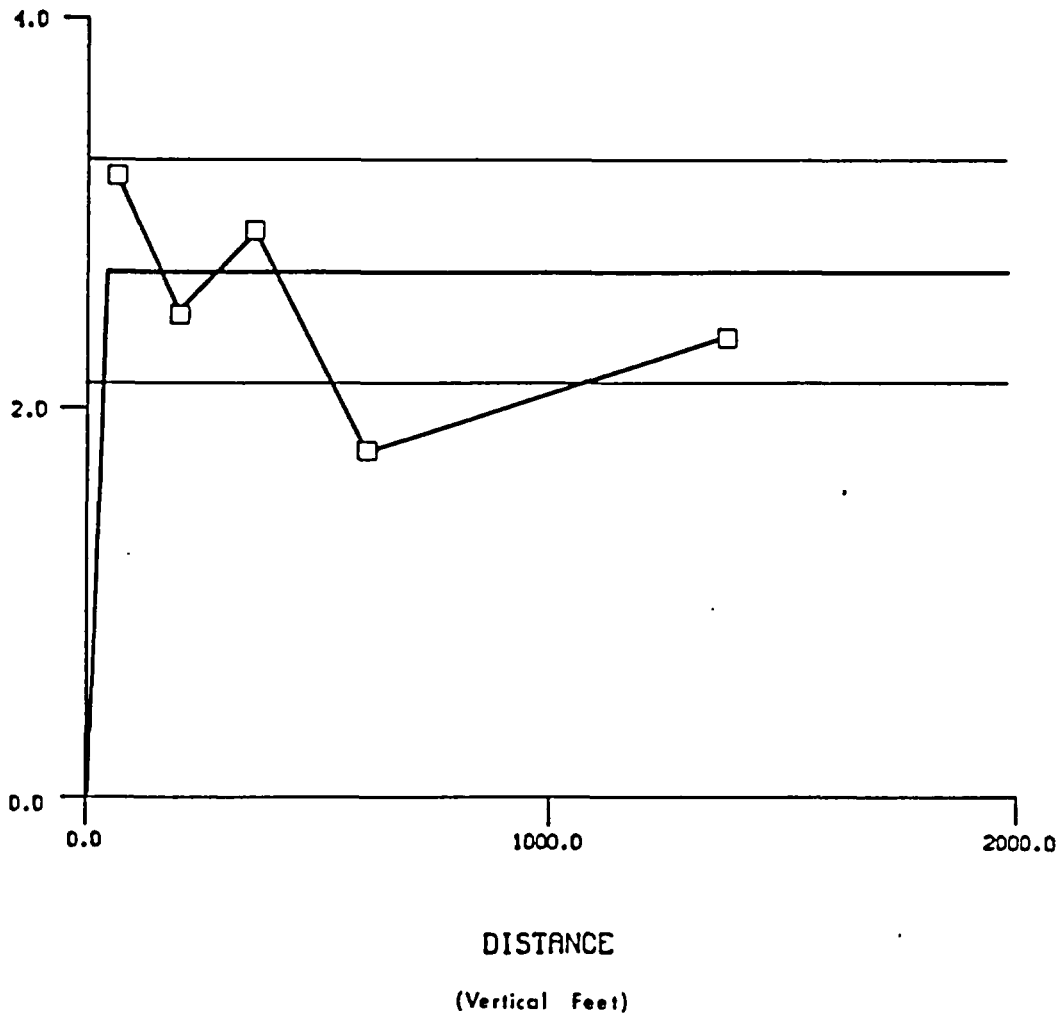

Figure 3.5 Variogram (dark line) Assumed by the ANOVA and the Empirical Variogram. (Fine horizontal lines represent approximate 90% confidence intervals under the assumption of the analysis of variance performed on the sample means. The square symbols are plated at the distance class centers; each distance class contains approximately 110 pairs.)

4. ANALYSIS OF MAXIMUM MOISTURE CONTENT

The methods used to measure maximum moisture content are described in Peters et al. (1984). Maximum moisture content is the volume of water in the "saturated" specimen divided by the total specimen volume. This represents an estimate of specimen porosity. The source of data for this analysis is Klavetter and Peters (1987). A list of the data is given in Table A.2 of Appendix A.

Table 4.1 gives the means and estimated variances of the various hole-unit combinations, and Figure 4.1 shows these data plotted against depth for each hole. From the table it appears that the Units TSwl, TSw2, and TSw3 have a considerably different sample-to-sample variability from that in CHnv and CHnz. As a result, CHnv and CHnz will be analyzed separately. This decision followed a visual examination of the variances in Table 4.1. Formal statistical tests for equality of variances are available, but generally assume that there are more data (and an equal number of data) for each hole-unit.

An analysis of variance was performed first on data from Units TSwl, TSw2, and TSw3; testing for significant hole differences, unit differences, and interactions. The ANOVA table is given in Table B.2 of Appendix B. The analysis reveals a significant unit effect at level of significance 0.1. To determine which units are significantly different, a multiple-comparison test of treatment means was performed using Scheffe's method (Bickel and Doksum, 1977) (applied here as an option in the SAS, 1985, General Linear Models Procedure). This test grouped Units TSwl and TSw2, leaving TSw3 as a separate region.

Figure 4.2 shows the average of the maximum moisture content sample means by unit for each hole. Looking specfically at the CHnv, CHnz portion of that plot, it appears that the GU-3, CHnv hole-unit is again an outlier. Testing the remaining two holes over Units CHnv and CHnz still reveals a significant unit effect. The ANOVA table is included in Table B.3 of Appendix B.

The above analysis has determined five regions that will now be analyzed separately: Tswl and TSw2; TSw3; GU-3, CHnv; the remainder of CHnv; and CHnz.

Table 4.2 gives the results of an analysis of the components of variance within the regions. Again, the estimated variances are given for specimen-to-specimen variance within samples and for sample-to-sample variance within the region. Figures 4.3 through 4.7 show histograms of the sample means for each of the regions determined above. Again, no formal tests of distributional assumptions have been performed on the data from the various regions because of the limited data in each region.

As was the case with log saturated hydraulic conductivity, the hole-unit GU-3, CHnv seems to contain relatively extreme values. With maximum moisture content, our analysis points to significant unit effects also. Maximum moisture content and saturated hydraulic conductivity are computed directly from measurements performed on the specimens. The suction head information discussed in the next section is computed from a curve fit to the saturation versus suction head data.

Table 4.1

Statistics by Hole-Unit for Maximum Moisture Content

Each entry includes the average of sample means;
(the number of samples, estimated sample variance);
and [the number of specimens, estimated specimen variance].

Unit \ Hole	USW G-1	USW GU-3	USW G-4
TSw1	0.099 (3, 0.0005) [6, 0.0002]	0.100 (2, 0.0007) [4, 0.0001]	0.031 (1, --) [3, 0.0000]
TSw2	0.096 (2, 0.0002) [4, 0.0001]	0.091 (2, 0.0007) [4, 0.0002]	0.093 (6, 0.0003) [18, 0.0001]
TSw3	0.025 (1, --) [2, 0.0002]	0.030 (2, 0.0000) [4, 0.0001]	0.041 (2, 0.0017) [6, 0.0001]
CHnv	0.230 (2, 0.0080) [4, 0.0000]	0.352 (5, 0.0034) [10, 0.0036]	0.180 (1, --) [3, 0.0021]
CHnz	0.309 (7, 0.0026) [14, 0.0003]		0.290 (10, 0.0010) [30, 0.0005]

Table 4.2

Statistics for the Regions of
Maximum Moisture Content

Each entry includes the average of sample means;
(the number of samples, estimated sample variance);
and [the number of specimens, estimated specimen variance].

Unit \ Hole	USW G-1	USW GU-3	USW G-4
TSw1 TSw2	0.092 (16, 0.0006) [39, 0.0001]		
TSw3	0.033 (5, 0.0006) [12, 0.0001]		
CHnv	0.213 (3, 0.0040) [7, 0.0011]	0.352 (5, 0.0034) [10, 0.0036]	Combined with G-1, CHnv
CHnz	0.298 (17, 0.0015) [44, 0.0004]		Combined with G-1, CHnz

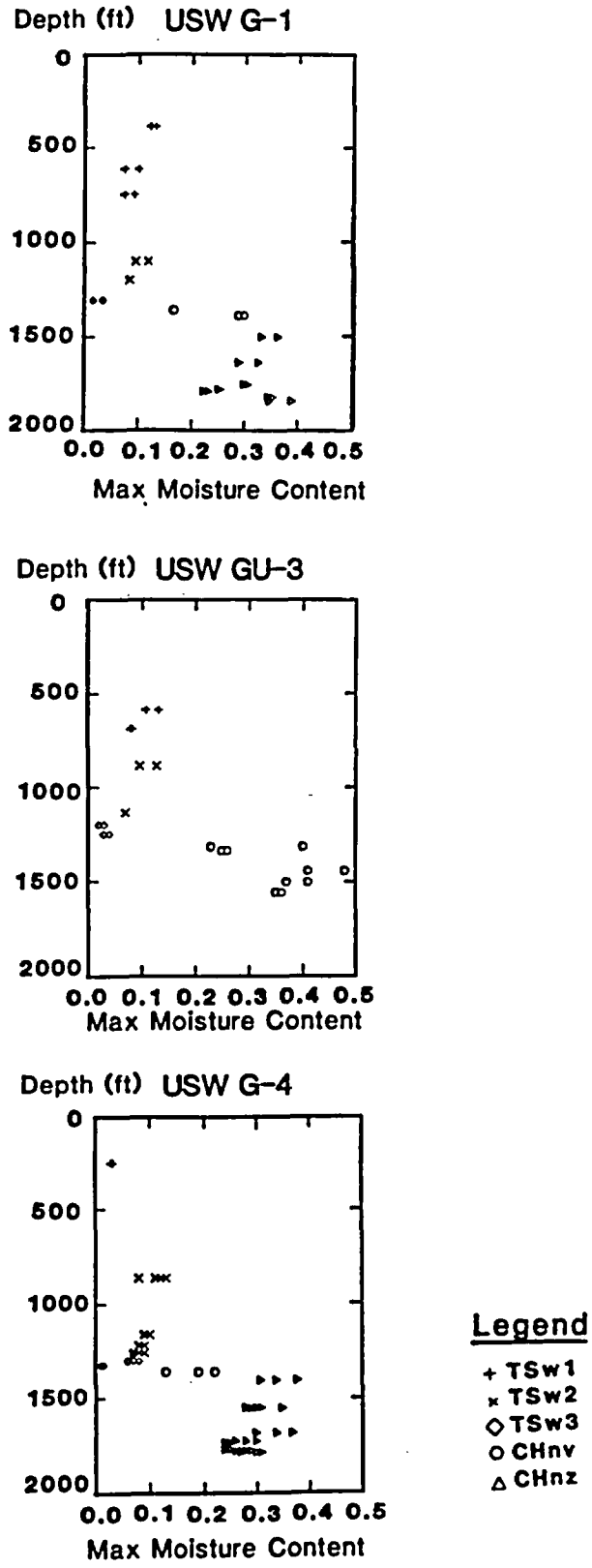

Figure 4.1. Specimen Values by Hole for Maximum Content.

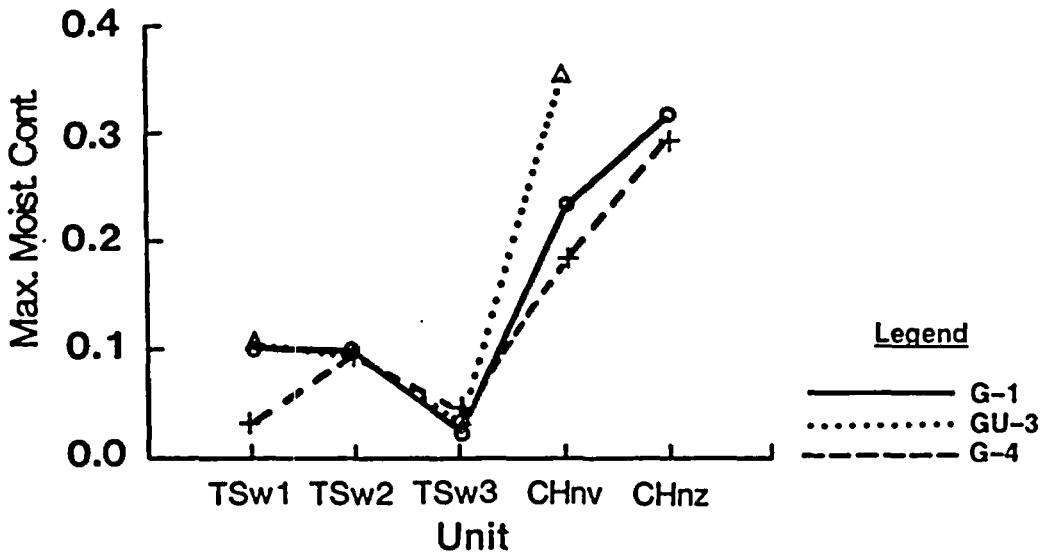

Figure 4.2. Unit Means by Hole for Maximum Moisture Content.

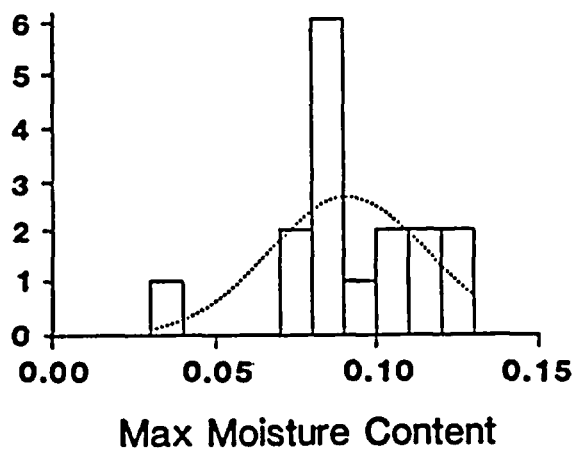

Figure 4.3. Histogram for Data from Units TSw1 and TSw2.

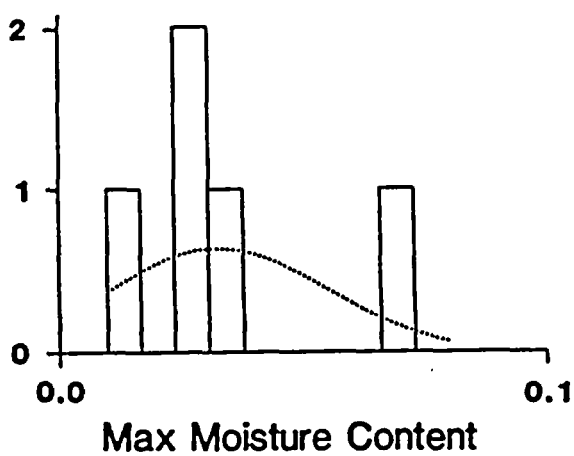

Figure 4.4. Histogram for Data from Unit TSw3.

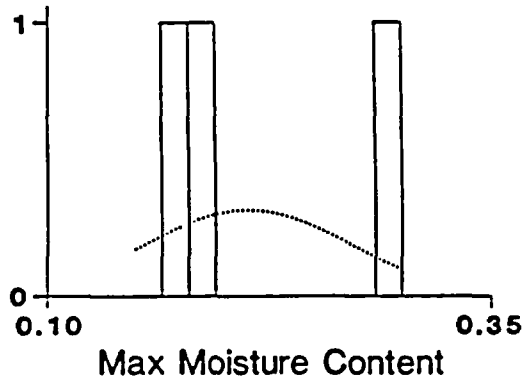

Figure 4.5. Histogram for Data from Unit CHnv, Holes G-1 and G-4.

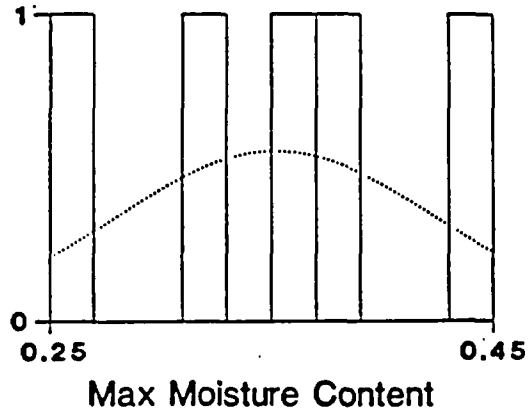

Figure 4.6. Histogram for Data from Unit CHnv, Hole GU-3.

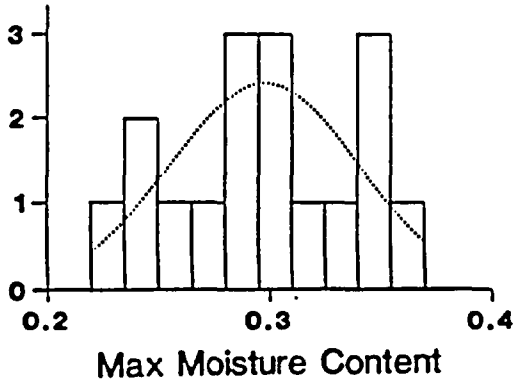

Figure 4.7. Histogram for Data from CHnz.

5. ANALYSIS OF SUCTION HEAD

The data for this variable have been obtained from the measurements of saturation (S) versus suction head (ψ) (or negative pressure head) curves, which are described in Peters et al. (1984) and Klavetter and Peters (1987). The S-versus-ψ data for each specimen were fitted to the van Genuchten equation

$$S(\psi) = (1 - S_r)(1 + |\alpha\psi|^{\beta})^{-\lambda} + S_r \quad ,$$

where

$\lambda = 1 - (1/\beta)$;

α is a scale parameter;

β is a shape parameter; and

S_r is an asymptote parameter (for many of the samples the estimate for S_r was zero).

Figure 5.1 is an example of a plot in which the van Genuchten equation is fitted to the data. The fitted parameters used for this analysis are listed in Appendix C.

The variables analyzed in this section are the suction head values taken from curves as in Figure 5.1 corresponding to S values of 0.6 and 0.8. These saturation values are considered to represent in situ conditions for many of the units at Yucca Mountain. We will discuss the analysis of the data taken for S = 0.8 and then comment on the analysis for S = 0.6. Conclusions for the separate analyses of the two S values are similar, as one would expect.

Because the original data appear to be substantially skewed, this variable has been analyzed using the natural logarithm of suction head (referred to as log suction head) rather than suction head. The log suction head values for S = 0.8 and S = 0.6 for the three drill holes are listed in Table A.3 of Appendix A. The means and variance estimates for the various hole-unit combinations are given in Table 5.1; Figure 5.2 shows log suction head plotted against depth for the three holes; and Figure 5.3 is a plot of unit means by hole. Again, the unit means are calculated as the average of sample means within that unit.

The analysis of variance shown in Table B.4 (Appendix B), indicates that there is a significant unit effect at almost any reasonable level of significance, as one might expect from Figures 5.2 and 5.3. Using Scheffe's method of multiple comparisons, several groupings are possible. Table 5.2 gives the mean values for each unit, and the letters A, B, and C indicate the possible groupings of the units for both S = 0.8 and S = 0.6. Units with the same capital letters cannot be shown to be significantly different with the data at hand; hence, it is possible that some units can be grouped with one region or another. Alternatively, units that can be grouped together will have the same capital letter. The breakdown into three regions CHnz; CHnv; and TSw1, TSw2, and TSw3 has been chosen because it is acceptable for both S = 0.6 and S = 0.8 in Table 5.2. We now proceed to examine the components of variability within these regions.

Table 5.3 gives the components of variance for the three regions determined above. Figures 5.4 through 5.6 show histograms of the sample means for the three regions. The histograms seem to indicate that a normal distribution is a reasonable choice for the log suction head values. As mentioned above, the regional breakdown of hole-units was the same for S = 0.6. The components of variance for that analysis are given in Table 5.4.

Suction head, like the previous two variables, was computed from measurements on the rock specimens. Here again, no specific hole differences have been noted. With the exception of Hole-Unit GU-3, CHnv, holes have not been a significant influence on the values of these variables. The next variable, groundwater travel time, will be computed from the values of the three variables already analyzed; so again, we do not expect to find significant hole differences.

Table 5.1

Statistics by Hole-Unit for a Suction Head of S = 0.8

Each entry includes the average of sample means;
(the number of samples, estimated sample variance);
and [the number of specimens, estimated specimen variance].

Unit \ Hole	USW G-1	USW GU-3	USW G-4
TSw1	4.63 (3, 1.41) [6, 0.043]	4.37 (2, 0.315) [4, 0.122]	4.43 (1, --) [3, 0.194]
TSw2	5.25 (2, 0.133) [4, 0.024]	4.56 (2, 0) [4, 0.213]	4.95 (6, 0.327) [18, 0.043]
TSw3	5.40 (1, --) [2, 0.260]	5.42 (2, 0.064) [4, 0.076]	5.73 (2, 0.192) [6, 0.128]
CHnv	3.84 (2, 0.001) [2, --]	3.87 (5, 0.261) [9, 0.046]	3.34 (1, --) [2, 0.140]
CHnz	5.52 (7, 0.439) [14, 0.125]		5.84 (10, 0.263) [28, 0.226]

Table 5.2

Groupings of Unit Means Computed Using the SAS
Scheffe's Option of the General Linear Model Procedure

(S = 0.8)

Means with the Same Letter Are Not Significantly Different

Scheffe's Grouping		Mean	N	Unit
	A	5.7102	17	CHnz
	A			
B	A	5.5383	5	TSw3
B	A			
B	A	4.9350	10	TSw2
B				
B	C	4.5132	6	TSw1
	C			
	C	3.7953	8	CHnv

(S = 0.6)

Means with the Same Letter Are Not Significantly Different

Scheffe's Grouping		Mean	N	Unit
	A	6.5925	17	CHnz
	A			
B	A	6.2494	5	TSw3
B	A			
B	A	5.6835	10	TSw2
B				
B		5.3854	6	TSw1
	C	4.2360	8	CHnv

Table 5.3

Statistics for the Region with a Suction Head of S = 0.8

Each entry includes the average of sample means;
(the number of samples, estimated sample variance);
and [the number of specimens, estimated specimen variance].

Unit \ Hole	USW G-1	USW GU-3	USW G-4
TSw1			
TSw2		4.96 (21, 0.406) [51, 0.089]	
TSw3			
CHnv		3.79 (8, 0.180) [13, 0.064]	
CHnz	5.71 (17, 0.305) [42, 0.198]		Combined with G-1, CHnz

Table 5.4

Statistics for the Regions with a Suction Head of S = 0.6

Each entry includes the average of sample means;
(the number of samples, estimated sample variance);
and [the number of specimens, estimated specimen variance].

Unit \ Hole	USW G-1	USW GU-3	USW G-4
TSw1			
TSw2		5.73 (21, 0.373) [51, 0.073]	
TSw3			
CHnv		4.24 (8, 0.084) [13, 0.038]	
CHnz	6.59 (17, 0.184) [42, 0.169]		Combined with G-1, CHnz

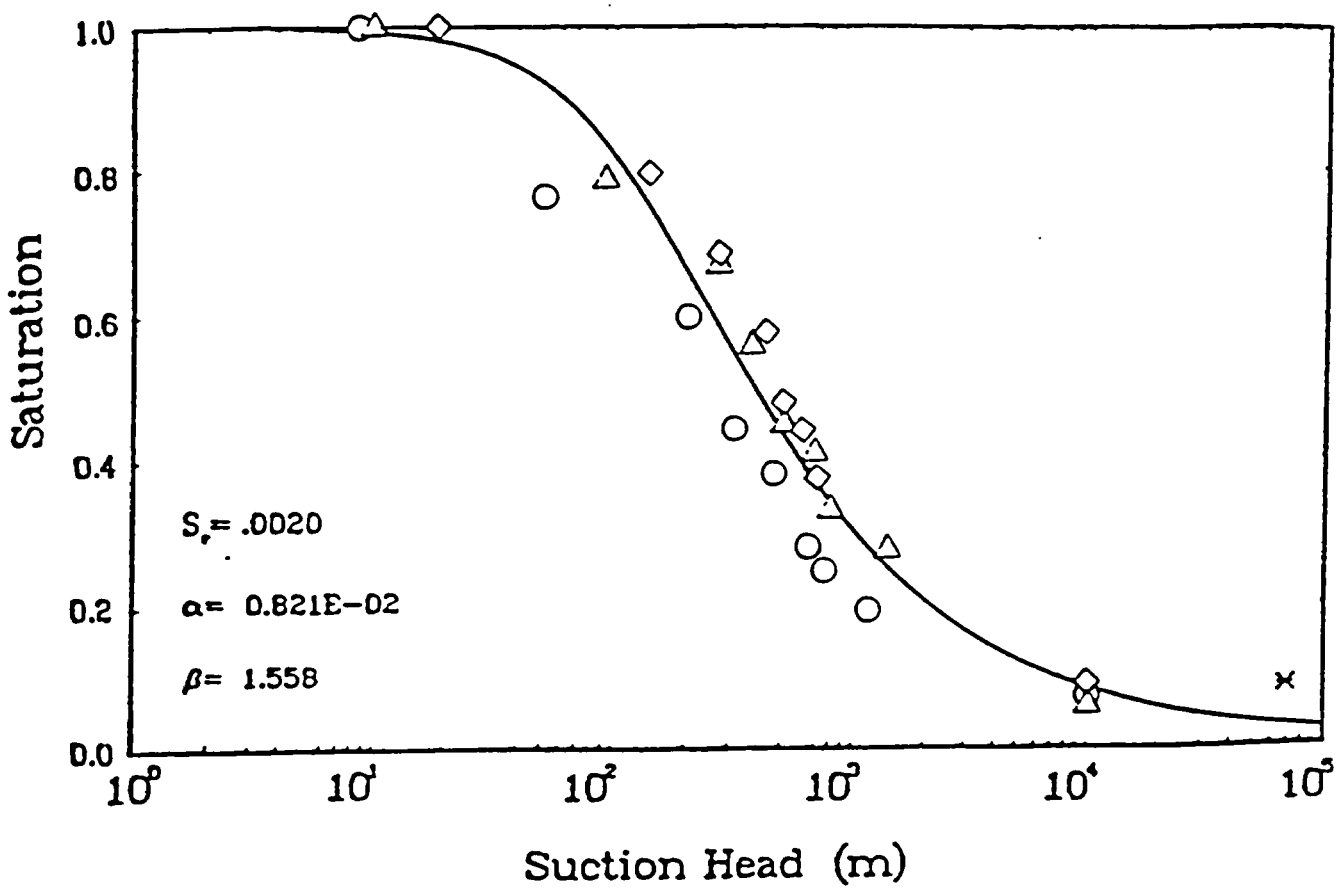

Figure 5.1. Example of fitting van Genuchten Equation to Data for Saturation as a Function of Suction Head. Symbols represent recorded data on three different specimens from one sample. This particular sample was from G-4, TSwl at depth 1158 ft.

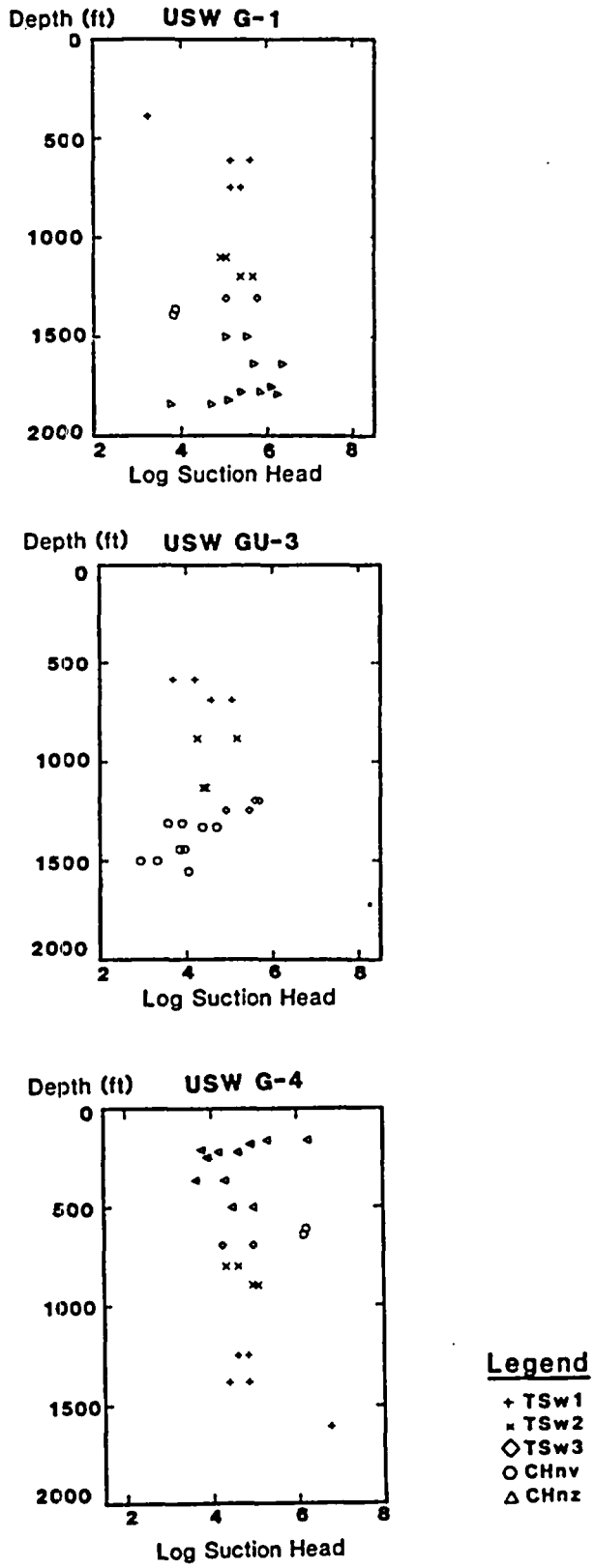

Figure 5.2. Specimen Values by Hole for a Log Suction Head of S = 0.8.

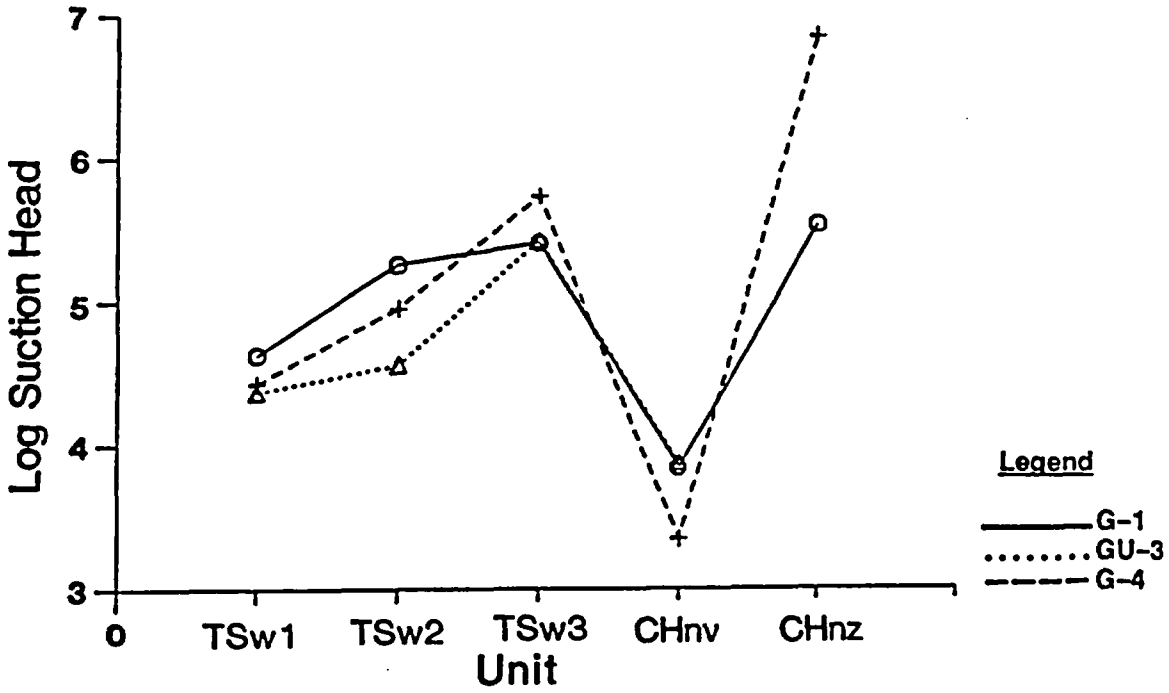

Figure 5.3. Unit Means by Hole for a Log Suction Head of S = 0.8.

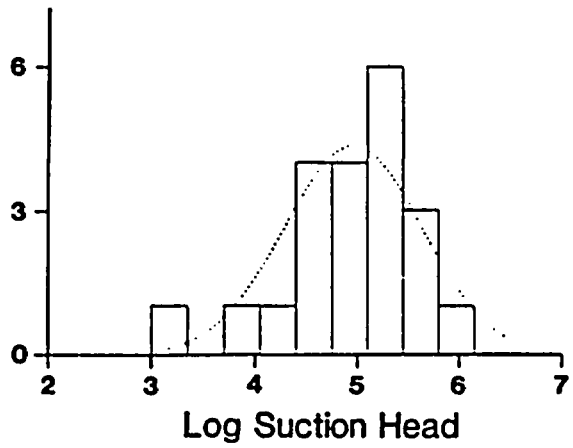

Figure 5.4. Histogram for Data from Units TSw1, TSw2, and TSw3.

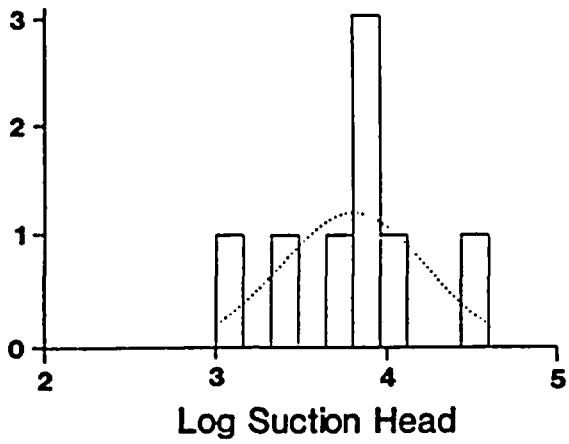

Figure 5.5. Histogram for Data from Unit CHnv.

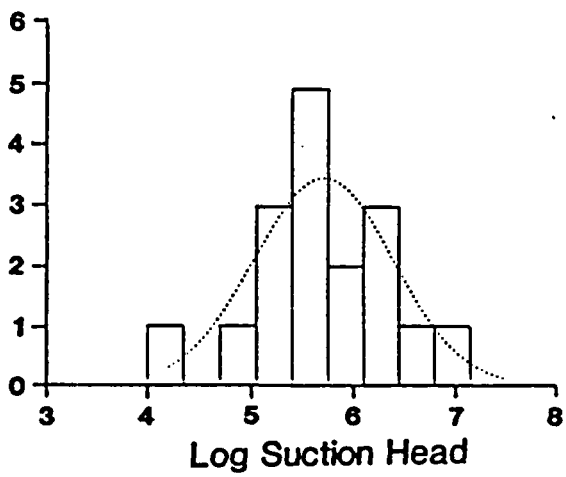

Figure 5.6. Histogram for Data from Unit CHnz.

6. ANALYSIS OF GROUNDWATER TRAVEL TIME

Risk assessment of the Yucca Mountain site requires an estimate of the travel time of water from the repository site to the groundwater level. One approach to obtaining such an estimate is to mathematically model flow through a hydrologic unit as a function of various properties of the unit such as conductivity and moisture content. Then, estimates of these properties, obtained from data such as considered here, can be substituted into the model to provide an estimated travel time.

A possible source of inaccuracy in this approach is that the complexity of the model generally requires treating the hydrologic properties as being constant throughout large (relative to specimen size) vertical sections of a unit, when in fact, as has been seen, there can be considerable variation, even within a sample. It has not been determined how, or whether, specimen properties can be scaled to these larger sections.

An alternative approach to estimating total travel time that avoids the scaling problem is to estimate flow time through a specimen-sized amount of material, the amount of material on which the hydrologic properties are measured, then estimate total travel time as the sum of the flow times through an appropriate number of specimens. For example, suppose that specimen flow time data lead to a model in which flow time through a 1.2 cm specimen is estimated to have a mean of 10 years and a standard deviation of 6 years. Then, by modeling the flow through 120 meters, say, of such material as the sum of 10,000 such independent specimen flow times, the total travel time distribution would have a mean of 100,000 years and a standard devation of 600 years. Statistical prediction analysis could be used to account for the uncertainty in this result due to the amount of data underlying the specimen flow time estimates.

This approach has the advantage that it addresses variability at the level it is measured; there is no need to scale or to try to adjust an analysis that treats a variable property as a constant so that it will account in some way for that variability. A disadvantage is that travel time through a unit may not be well modeled as the sum of independent specimen flow times. More sophisticated

modeling, however, such as the inclusion of a spatial correlation function, and perhaps a two-dimensional flow model based on the above approach, may overcome this disadvantage. Another problem with this approach is that the estimates of travel time require the hydraulic-head gradient in the sample to be assumed; usually, it is set to "1". However, it is unlikely that its value is "1" in a heterogeneous unit. The paper by Dudley et al. (1988) shows that near the contact between two different materials the hydraulic-head gradient (the sum of the pressure-head gradient and "1" for the case of vertical flow) is not "1". Thus, there is a variability in travel time resulting from the properties of the neighboring specimens; this variability is not accounted for in the following analysis. It is possible, however, that an iterative method of adjusting travel times to account for neighboring specimen properties could provide a reasonable approach to the estimation of a travel time distribution.

Thus, to illustrate this alternative approach to estimating groundwater travel time, the variable analyzed in this chapter is the estimated travel time required (in years) for water to pass through the specimen. The simplified procedure for calculating values for this variable is outlined in the next two paragraphs. It is expected that further experimentation and research on flow through unsaturated tuffs will lead to more sophisticated flow calculations. The values of the other variables discussed in this report were used in these calculations.

In these simplified calculations, two types of flow are considered--matrix and fracture flow. If the flux rate, q, is greater than the value for the saturated-matrix hydraulic conductivity, then fracture flow is assumed, and a travel time of zero is assigned to this specimen. If the flux rate is less than the sample value of the saturated hydraulic conductivity, then Equations 6.1 through 6.4 below are solved in order.

First, to determine suction head, ψ, we use Darcy's law with the assumption that the vertical head gradient is 1. We solve for ψ in Equation 6.1

$$q = K(\psi) = K_S\left[1 + |\alpha\psi|^{\beta}\right]^{-\lambda/2}\left\{1 - \left(\frac{|\alpha\psi|^{\beta}}{1 + |\alpha\psi|^{\beta}}\right)^{\lambda}\right\}^2 \quad , \tag{6.1}$$

where the flux rate, q, is assumed to be 0.1 mm/yr; K_s is the saturated hydraulic conductivity; and the van Genuchten parameters α, β, and λ have been described in the previous chapter. Next, we evaluate van Genuchten's equation at the value of ψ determined in Equation 6.1 to obtain a value for saturation:

$$S(\psi) = (1 - S_r)(1 + |\alpha\psi|^{\beta})^{-\lambda} + S_r \quad , \tag{6.2}$$

where S_r has been defined in Chapter 5. Velocity, v, is then given by

$$v = q/(n[S(\psi) - S_r]) \quad , \tag{6.3}$$

where, for this calculation, n was the sampled value of maximum moisture content. Finally, the travel time in years was computed as

$$STT = L/v \quad , \tag{6.4}$$

where L is the length of the specimen equal to 1.2 cm.

This calculation requires measurements of each variable involved to be available for each specimen included in the analysis. As noted in Chapter 3, however, in some cases there is uncertainty in associating a K_s measurement with a specimen. Other assignments could result in different results. The effect of this uncertainty on the analysis in this chapter would be small, though, because the specimen-to-specimen variability of K_s is relatively small compared to the variability among samples.

Table 6.1 gives the means and estimated variances for the various hole-units. Figure 6.1 plots the average of the sample means by unit for the three holes, and Figure 6.2 plots the unit means by hole. The data values are listed in Table A.4 of Appendix A.

The analysis performed for the estimated travel time deviates slightly from that used with the previous three variables. Here, largely because of the clear lack of normality of the data, we will first examine the fracture flow versus matrix flow ratio for the various units. Once we have determined regions where this ratio can be treated as similar, on the basis of our tests, we will perform an analysis within each of these regions similar to the analyses used for the preceding variables.

The statistical test performed first will test the hypothesis that the relative proportions of fracture flow and matrix flow are not dependent on the unit from which the sample is taken. The distribution of the statistic used to test this hypothesis can be approximated by a chi-squared distribution. Because this approximation is more accurate for large sample sizes and because most of the variables used to compute groundwater travel time have significant unit differences but not significant hole differences, the test is only performed for unit effects (and hence, there are more data in each category). Table 6.2 shows the frequencies by unit of the computed fracture and matrix flows. The test also assumes that the specimen values are independent. We know this assumption not to be the case, however, because values within a single sample are more likely to be similar than values between samples. In spite of this, the test is thought to be a reasonable first step for the data at hand. More details about chi-squared tests of homogeneity can be found in Freund and Walpole (1987), for example.

The units have been compared pairwise at a lower than usual significance level (.05) because the probability of some statistically significant differences appearing by chance increases with the number of tests. Here, 10 separate tests were performed. Table 6.3 gives the pairwise p-values from these tests. These p-values may be interpreted as the lowest significance level at which the hypothesis of homogeneity would be rejected. They are given here because even though few of the pairwise hypotheses have been rejected, we need a rational criterion for grouping all the units into regions. By using Table 6.3, TSw1 and TSw3 are grouped together, CHnv and CHnz are grouped together, and because it is midway between the others, TSw2 is left in a group of its own. There is no unique way to group the data based on a given set of p-values and this breakdown represents only one possible grouping.

Continuing with the second part of the analysis as proposed within these three regions, Tables B.5 through B.7 give the ANOVA tables. The data used for these tests were just the travel-time values for matrix flow. None of these tests indicate a significant difference at Level 0.1. One final subdivision, however, is suggested by the two tests combined. Both the chi-squared tests of homogeneity and the analysis of variance provided substantial evidence of differences between Units CHnv and CHnz. In both cases, the lack of data in CHnv limited the power of the test to detect differences that appear to be present. Because both tests were used to test different aspects of the data and both indicated that differences are likely (though not significant), the units

have been treated as separate regions. Table 6.4 gives the means and components of variance for the four regions, and Figures 6.3 through 6.6 show histograms of the sample means for each region. The fracture flow data have been included in the plots of Figures 6.3 through 6.6.

For a number of reasons, this variable appears to be the one where more data would have a large effect on the breakdown into regions. First, not as many data were included in this analysis because if any individual measurements were missing for a specimen, then travel time was not computed. Second, high sample-to-sample variability of groundwater travel time within hole-units has made the data requirements more stringent for this variable in order to find statistically significant effects. Finally, as we mentioned in Chapter 3, some of the saturated hydraulic conductivity values were randomly assigned a specimen designation within a sample because that information was lost during testing. More data would reduce the effect of that problem as well.

To provide the specimen flow-time estimated distributions discussed at the beginning of this chapter for flow that is assumed to be one dimensional; two alternatives exist. Random travel times could be generated by first generating a Bernoulli random variable with probability of fracture flow computed using Table 6.2 to determine between matrix and fracture flow and then generating correlated normally distributed variables to get the travel times for the matrix flow specimens. The variances would be taken from Table 6.4, and the correlations would come from a variogram approximation similar to (2.4) but computed for each unit. The total travel time would then be computed as the sum of the matrix specimen travel times. By repeating the above procedure a large number of times, one could construct an approximation to the distribution of travel time.

For the second alternative, which could also be adjusted to take into account the spatial correlation, it is necessary to recombine the matrix and fracture flow results. Let the proportion of specimens that have fracture flow, and hence a zero flow time, be p and let the mean and variance of matrix flow time be μ and σ^2. The combined flow-time distribution has a mean of $(1 - p)\mu$ and a variance of $(1 - p)\sigma^2 + \mu^2 p(1 - p) = (1 - p)[\sigma^2 + \mu^2 p]$. Table 6.2 provides estimates of p for the different units, and Table 6.4 provides estimates from which σ^2 could be estimated (by the sum of the sample and

specimen variances). Though the specimen flow-time distribution will be decidedly non-normal--it has a spike of probability at zero--the sum of hundreds of values from this distribution should be well approximated by a normal distribution.

Either of these alternatives with the present data would provide very rough approximations to the distribution of travel times. However, refinements of these approaches might eventually give a more realistic distribution of travel times than might be provided using those alternatives that rely on scaling.

Table 6.1

Statistics by Hole-Unit for Travel Time in Years Per Specimen

Each entry includes the average of sample means;
(the number of samples, estimated sample variance);
and [the number of specimens, estimated specimen variance].

Unit \ Hole	USW G-1	USW GU-3	USW G-4
TSw1	8.9 (3, 80.77) [5, 1.33]	8.3 (2, 137.29) [4, 1.13]	0 (1, --) [1, --]
TSw2	7.0 (2, 0) [4, 99.4]	6.5 (2, 84.11) [2, --]	11.4 (6, 5.58) [12, 14.90]
TSw3	4.1 (1, --) [1, --]	.8 (2, 1.43) [2, --]	3.5 (2, 24.43) [2, --]
CHnv	6.8 (2, 3.98) [2, --]	5.9 (5, 46.78) [5, --]	21.1 (1, --) [2, 0.15]
CHnz	35.7 (7, 289.05) [14, 4.78]		28.8 (10, 145.82) [22, 73.0]

Table 6.2

Number of Specimens Computed to Have
Fracture Flow and Matrix Flow

(These data were used for the Chi-Squared Analysis.)

Unit	Fracture Flow	Matrix Flow
TSw1	5	5
TSw2	4	14
TSw3	2	3
CHnv	0	9
CHnz	5	31

Table 6.3

P-Values for Pairwise Chi-Squared Tests of
Homogeneity for Within-Unit Distributions
of Fracture Versus Matrix Flow

(Significant differences are considered to
be those with P-values of .05 or below.)

	TSw1	TSw2	TSw3	CHnv	CHnz
TSw1	--	.13	.71	.01	.01
TSw2		--	.42	.13	.44
TSw3			--	.04	.15
CHnv				--	.24
CHnz					--

Table 6.4

Statistics for the Regions for Travel Time in Years Per Specimen

Each entry includes the average of sample means;
(the number of samples, estimated sample variance);
and [the number of specimens, estimated specimen variance].

Unit \ Hole	USW G-1	USW GU-3	USW G-4
TSw1	5.1 (11, 52.7) [15, 1.2]		
TSw2	9.6 (10, 0.0) [18, 36.0]		
TSw3	Combined with TSw1		
CHnv	8.0 (8, 69.0) [9, 0.15]		
CHnz	31.6 (17, 191.29) [36, 47.86]		Combined with G1, CHnz

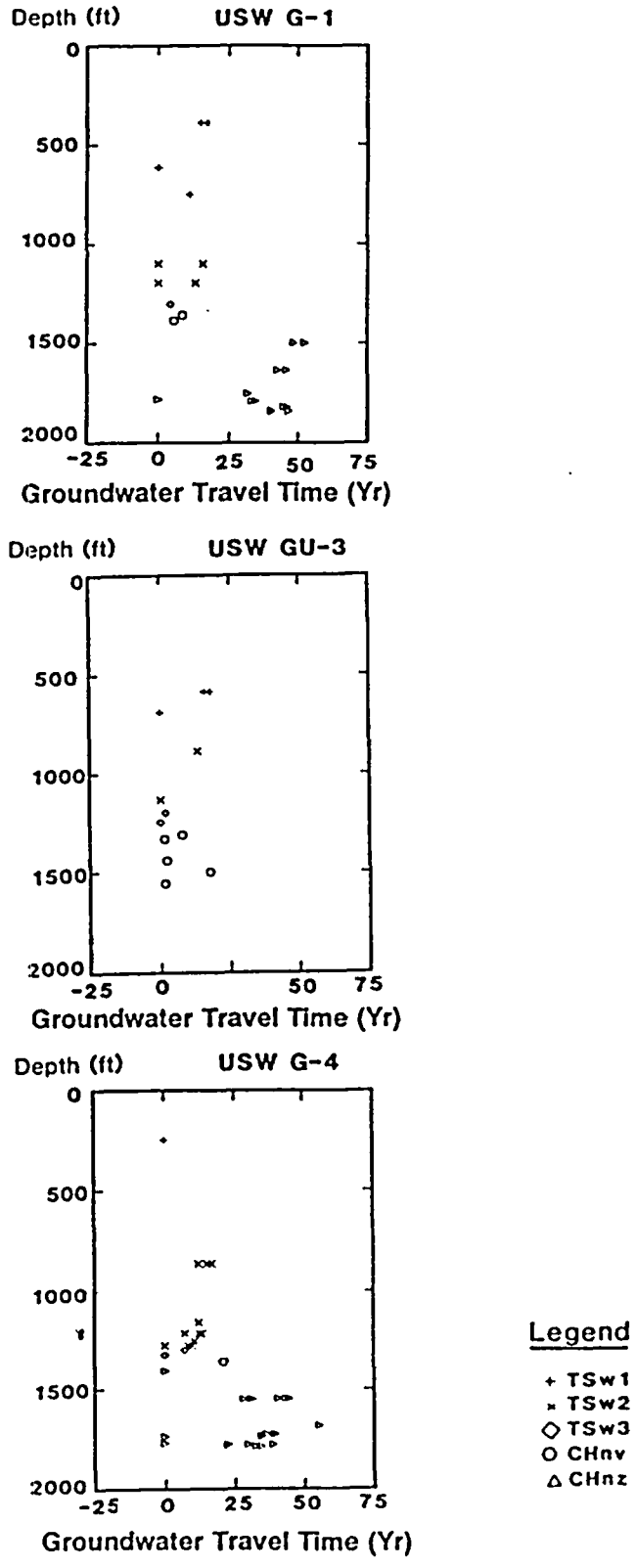

Figure 6.1. Specimen Values by Hole for Travel Time in Years Per Specimen.

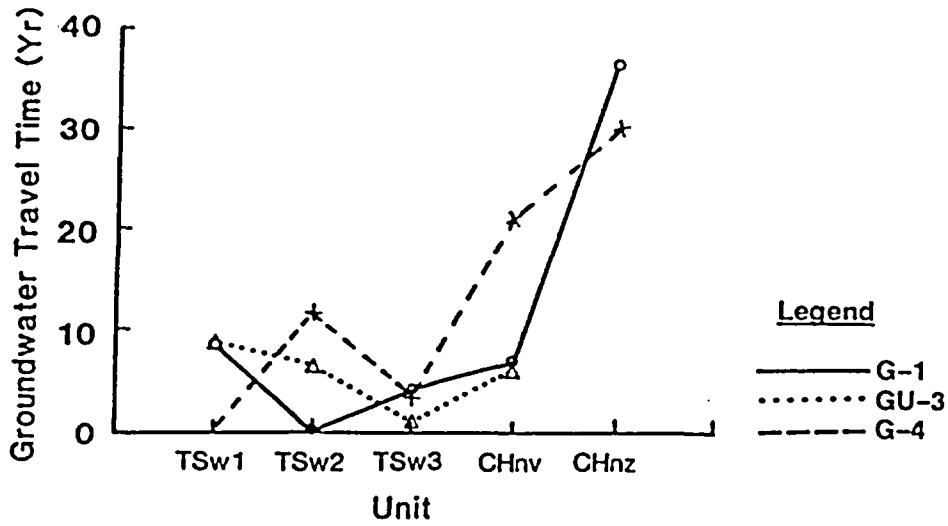

Figure 6.2. Unit Means by Hole for Travel Time. (Travel time is in years per specimen.)

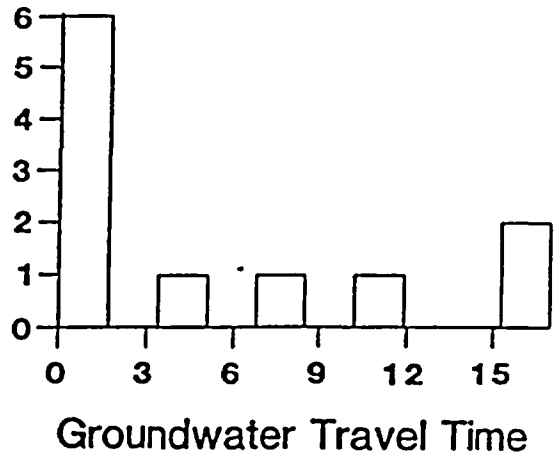

Figure 6.3. Histogram for Data from Units TSw1 and TSw3. (Travel time is in years per specimen.)

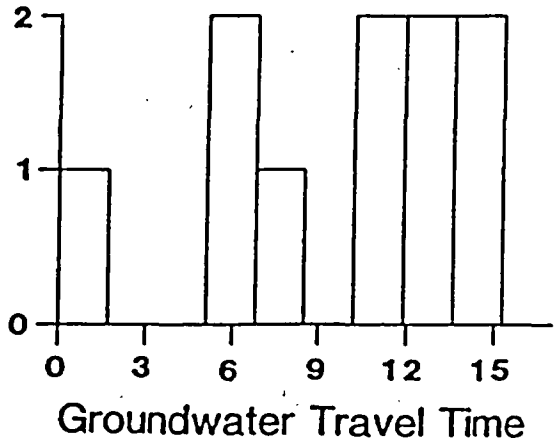

Figure 6.4. Histogram for Data from Unit TSw2. (Travel time is in years per specimen.)

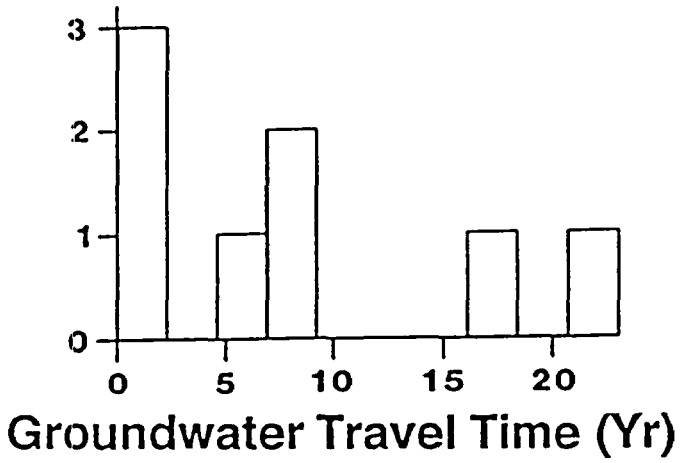

Figure 6.5. Histogram for Data from Unit CHnv. (Travel time is in years per specimen.)

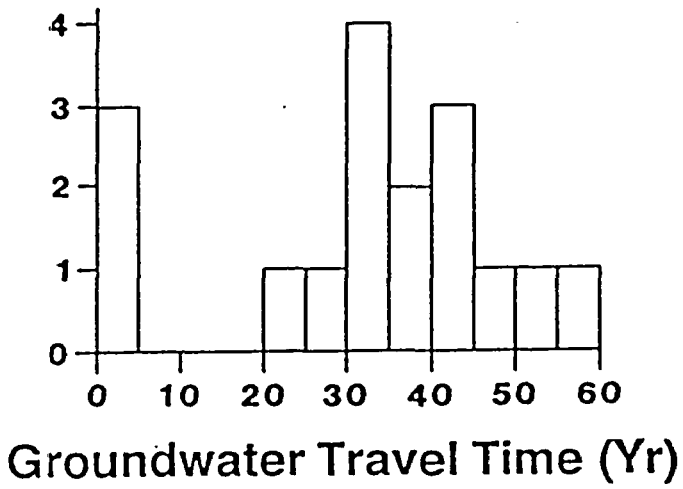

Figure 6.6. Histogram for Data from Unit CHnz. (Travel time is in years per specimen.)

7. FURTHER ANALYSIS AND SUMMARY

This chapter has two objectives: first, to present statistical results not specific to one of the four variables reported in earlier chapters and second, to summarize all the results. The regions used in the tables in this section for representative specimen values and mean calculations have been chosen to include all the partitioning used in each of the individual variables. The regional breakdown in this chapter, therefore, is finer than any of the individual tables.

7.1 Correlation Results

Table 7.1 gives the sample correlation matrix for the four variables. Groundwater travel time, which is a function of the three other variables, has been included to indicate what correlations might be expected. Because of the problems relating the value of hydraulic conductivity to a specific specimen within a sample, as mentioned in Chapter 3, the correlation coefficients between log hydraulic conductivity and both maximum moisture content and log suction head represent the correlation between sample means. The remainder of the entries are computed using the specimen values. In each case, the value presented in Table 7.1 shows the pooled correlation coefficient where the pooling is over regions. Details concerning the computation of the pooled correlation coefficients are given in Appendix B.5. Two plots showing specific relationships are described in the following paragraph.

Saturated hydraulic conductivity and maximum moisture content are the only variables that are determined directly from experimental measurements of the specimens. These two variables are plotted in Figure 7.1, where the plotted values represent sample averages. One can see that within a unit there is a generally positive association between these two variables. The second plot, Figure 7.2, shows the relationship between groundwater travel time and log saturated hydraulic conductivity. Zero values represent the points where flux exceeds the saturated hydraulic conductivity values and fracture flow has been assumed. This plot shows the relationship between the matrix flow values of groundwater travel time and log saturated hydraulic conductivity. While one might expect travel time to be negatively correlated

with log saturated hydraulic conductivity for just the matrix flow values, this association is barely evident in Figure 7.2.

7.2 "Representative" Samples

One additional set of values that may be of interest to modelers is a "representative sample," or in this case, "representative specimen." One such specimen has been selected for each region for any of the measured hydrologic variables (saturated hydraulic conductivity, maximum moisture content, or suction head). The measurements on this specimen can be regarded as representative of the region, in a sense to be described. This set of values has the feature that it is known that the measurements of the different variables are compatible with one another (since these values are from a single specimen). The averages within a region, which also can be regarded as representative of the region, may or may not be values likely to be computed for a single piece of core. The lack of correlation among some measurements, noted in the previous subsection, suggests, though, that the averages might be compatible values. In either case, we would advise readers not to use "representative" values as constants throughout the entire region. A major purpose of this analysis has been to characterize the variability of hydrologic variables within a region, so it would be inappropriate to perform an analysis that assumes no such variability.

To compute the regional representative specimen, all specimens are ranked according to each variable. These ranks represent the order number of the ascending values of the absolute differences between the variable and the average for the region. The ranks are then summed for each specimen. (The average rank of suction head, computed at saturation levels of 0.6 and 0.8, is used for that variable.) These sums are then ordered. The specimen with the smallest sum is selected as the representative specimen. Table 7.2 gives these representative specimens for each of the region as discussed. Appendix D gives, in order, a list by region of the representative samples. Table 7.3 gives the regional sample means and standard deviations for this same regional breakdown.

7.3 Summary

We have analyzed available data from three Yucca Mountain drill holes on four hydrologic variables: log saturated matrix hydraulic conductivity; maximum moisture content; log suction head; and groundwater travel time. In each case, analysis of variance and multiple comparisons of sample means have been used to suggest regions in which the data appear to have relatively homogeneous values. Within these regions, estimates were made for both the variability within sample specimens and the variability between samples. Regional mean values were computed. The data available for this analysis were very limited in number, leaving a great deal of uncertainty concerning which holes and units really constitute homogeneous regions with respect to these hydrologic variables. When more data become available, another statistical analysis should be performed and this regional structure updated. This will allow modelers to better understand the distribution of these variables in different parts of the site.

The specific homogeneous regions identified are somewhat different for each variable, but one general finding is that the data in a given unit are relatively close in value across the three holes considered in the analysis. An exception is unit CHnv in hole GU-3 which has values that deviate substantially from those in the same unit from the other two holes. From geologic considerations, one might expect consistency from hole to hole in a given unit, so it is encouraging that the data generally support this assumption.

Several points should be made with regard to our analysis. With the exception of the computed travel times, the variables or tranformed variables appear to be approximately normally distributed. The assumption of equality of variance within hole-unit combinations appears questionable in a few cases, but no statistical test has been performed because of the limited amount of data. The assumption of uncorrelated sample means within hole-units is also to be questioned. The assumption of no correlation between sample means of log saturated hydraulic conductivity appears reasonable, as discussed in Chapter 3, but this may not be the case for other variables. Figure 7.3 gives the variogram for log suction head in its largest region. Here, spatial

correlation appears more likely than it did for saturated hydraulic conductivity. This empirical variogram has been constructed using less than 20 pairs in most of its distance classes and hence provides a very rough approximation.

Another point which must be mentioned is that the estimates of variability in this analysis have been treated as physical variability for each of the variables. The actual measurements probably have two sources contributing to their variance, physical variability and errors in measurement. If the latter are large, then estimates of the physical variability are biased on the high side.

Because of these possible violations to the assumptions of the analysis, we can only consider the findings of this report to be a reasonable first approximation to analyzing these variables. Additional data should provide a considerably finer breakdown in the regional structure as well as more accurate estimates of the mean values, variances, and correlations.

The data, broken down into regions, can be used to approximate the distribution of hydrologic properties of specimen size pieces of core in those regions. The approximate distributions do not extend to rock masses of an arbitrary size. Even at a sample level, one cannot, in general, average the specimen values and then suggest that the result is an appropriate value for the entire sample. Averaging may be appropriate for maximum moisture content or travel time (after multiplying by the sample-to-specimen length ratio), but it would not be appropriate for such nonadditive variables as hydraulic conductivity. In the latter case, some other measure such as minimum or maximum specimen value may be more useful.

To meet the EPA requirements of probabilistic assessment of radionuclide travel, one might be tempted to randomly generate hydrologic variables according to the estimated specimen distributions provided here. These generated variables could then be used as input to computer codes that estimate travel time. However, unless the codes treat specimen-sized elements, such an exercise is inappropriate. To generate specimen-sized realizations, one would first generate a sample average realization within the

appropriate region using the region mean and sample variance. Added to this would be a specimen term taken from an appropriate distribution with mean zero and specimen variance. In most cases in this study, it appeared that a normal distribution would provide a reasonable approximation.

Table 7.1

Correlations for the Four Variables

(Numbers in parenthesis indicate the number of observations used in the computations. The correlations are pooled correlation coefficients where the pooling is over regions.)

	LHC	MMC	LSH	TT
LHC		.78	-.65	.46
		(25)	(22)	(78)
MMC			-.38	.38
			(106)	(78)
LSH				-.19
				(78)

Table 7.2

Representative Specimen Values by Region

Values are given for
log saturated hydraulic conductivity,
maximum moisture content,
log suction head (S = 0.8),
travel time (yr),
α, β, S_r and
hole, depth, specimen.

Unit \ Hole	USW G-1	USW GU-3	USW G-4
TSw1 TSw2	-26.10 0.085 5.38 12.74 .005, 1.476, 0.0 G-1, 1198, A		
TSw3	-24.02 0.034 5:04 4.11 .008, 1.39, 0.0 G-1, 1306, A		
CHnv	-24.15 0.19 3.08 21.36 0.043, 1.65, 1.01 G-4, 1359, A	-16.35 0.350 4.04 1.41 .016, 10.137, 0.189 GU-3, 1555, A	Combined with CHnv, G-1
CHnz	-24.83 0.30 6.13 31.7 0.002, 2.07, 0.19 G-1, 1753, B		Combined with CHnz, G-1

Table 7.3

Sample Means and Standard Deviations by Region

Values are given for
log saturated hydraulic conductivity,
maximum moisture content,
log suction head (S = 0.8), and
travel time (yr).
Standard deviations are in parentheses.

Unit \ Hole	USW G-1	USW GU-3	USW G-4
TSw1 TSw2	-25.6, (1.48) 0.09, (0.026) 4.8, (0.659) 8.86, (6.66)		
TSw3	-25.2, (2.15) 0.035, (0.024) 5.57, (0.441) 2.59, (3.0)		
CHnv	-24.15, (2.45) 0.208, (0.064) 3.59, (0.359) 13.95, (8.33)	-16.72, (1.88) 0.352, (0.081) 3.85, (0.528) 5.94, (6.84)	Combined with CHnv, G-1
CHnz	-25.05, (1.39) 0.296, (0.043) 5.68, (0.7) 32.63, (15.22)		Combined with CHnz, G-1

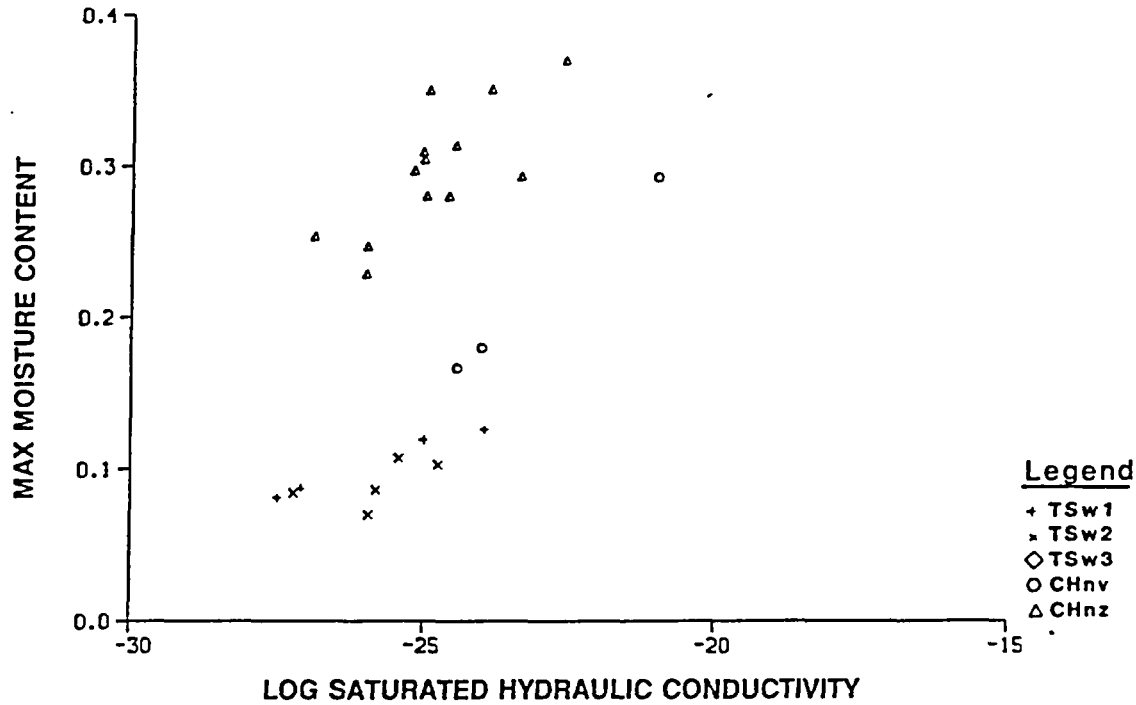

Figure 7.1. Plot of Maximum Moisture Content with Log Saturated Hydraulic conductivity. (Plotted values are sample means.)

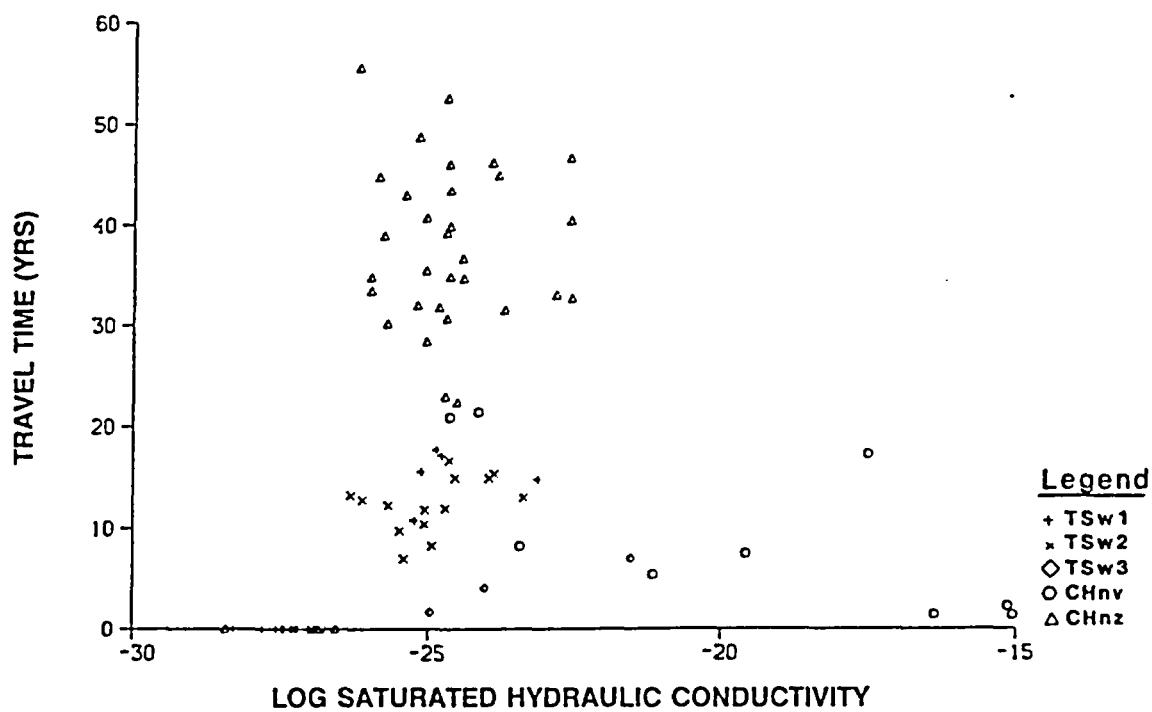

Figure 7.2. Plot of Travel Time with Log Saturated Hydraulic Conductivity. (Plotted values are specimen values.)

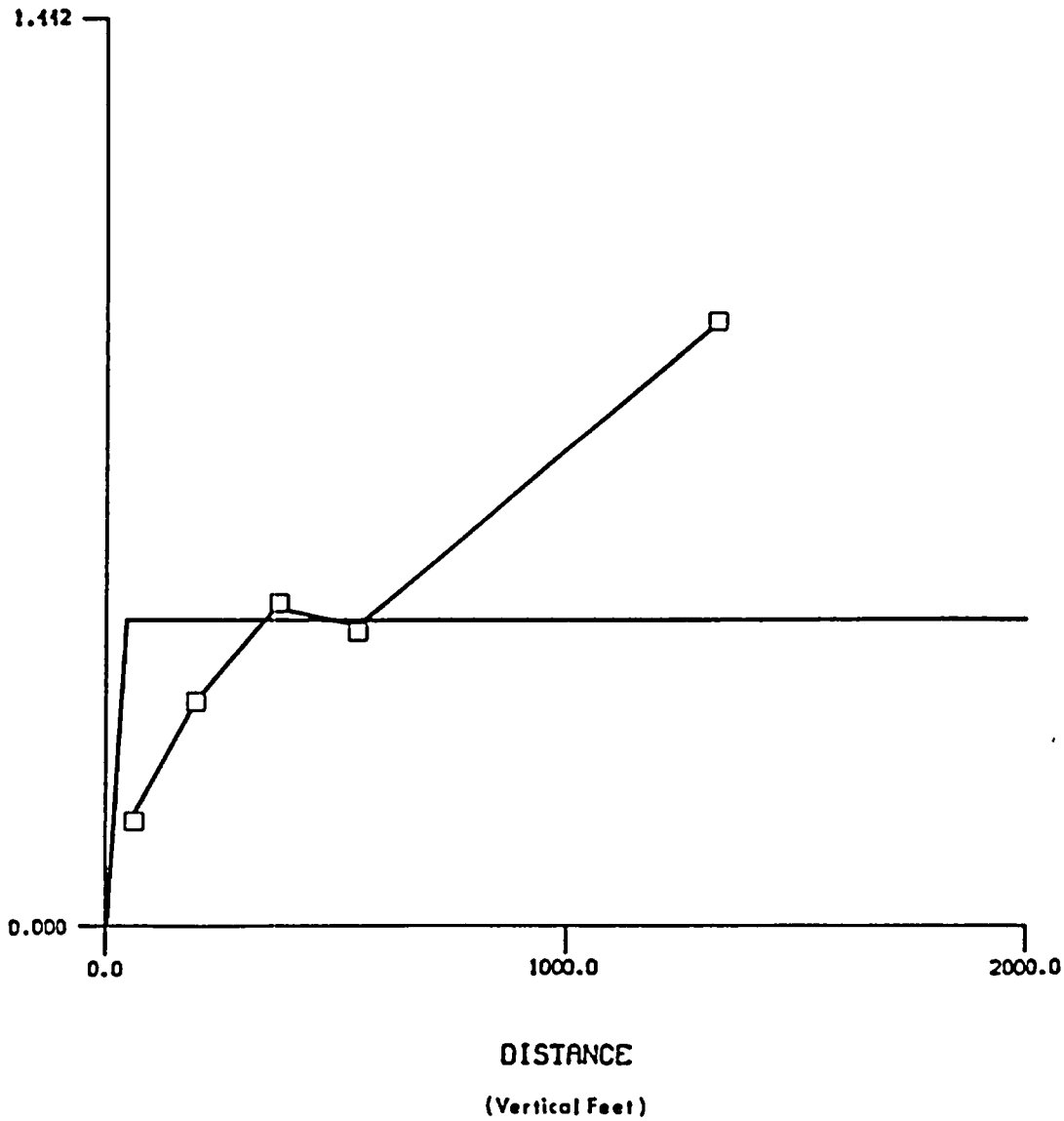

Figure 7.3. Empirical and Hypothesized Vertical Variograms for the Analysis of Variance for Log Suction Head for Units TSw1, TSw2, and TSw3. (Horizontal line shows the variogram assumed by the ANOVA.)

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APPENDIX A

DATA LISTINGS

This appendix gives listings of the data for each variable: Table A.1 lists hydraulic conductivity data; Table A.2 lists the maximum moisture content data; Table A.3 lists the suction head data for saturations 0.6 and 0.8; and Table A.4 gives the data used for the groundwater travel time analysis.

Table A.1 Log Saturated Hydraulic Conductivity

OBS	HOLE	UNIT	SAMPLE	SAMP	HYD_COND	LOG_HYC
1	G1	CHNV	1350.0	A	6.82000E-12	-25.711
2	G1	CHNV	1359.1	A	6.72000E-11	-23.423
3	G1	CHNV	1359.1	B	8.78000E-12	-25.459
4	G1	CHNV	1387.0	A	6.44000E-10	-21.163
5	G1	CHNV	1387.0	B	9.56000E-10	-20.768
6	G1	CHNZ	1500.0	A	1.16000E-11	-25.180
7	G1	CHNZ	1500.0	B	1.86000E-11	-24.708
8	G1	CHNZ	1637.0	A	1.94000E-11	-24.666
9	G1	CHNZ	1637.0	B	9.23000E-12	-25.409
10	G1	CHNZ	1753.0	A	1.13000E-11	-25.206
11	G1	CHNZ	1753.0	B	1.64000E-11	-24.834
12	G1	CHNZ	1780.0	A	2.21000E-12	-26.838
13	G1	CHNZ	1780.0	B	2.08000E-12	-26.899
14	G1	CHNZ	1790.0	A	5.22000E-12	-25.979
15	G1	CHNZ	1790.0	B	5.22000E-12	-25.979
16	G1	CHNZ	1821.0	A	4.07000E-11	-23.925
17	G1	CHNZ	1821.0	B	4.52000E-11	-23.820
18	G1	CHNZ	1841.0	A	1.59000E-10	-22.562
19	G1	CHNZ	1841.0	B	1.57000E-10	-22.575
20	G1	TSW1	388.8	A	1.73000E-11	-24.780
21	G1	TSW1	388.8	B	9.13000E-11	-23.117
22	G1	TSW1	615.5	A	2.50000E-12	-26.715
23	G1	TSW1	615.5	B	1.20000E-12	-27.449
24	G1	TSW1	752.0	A	1.09000E-11	-25.242
25	G1	TSW2	1102.0	A	4.28000E-11	-23.874
26	G1	TSW2	1102.0	B	1.98000E-12	-26.948
27	G1	TSW2	1198.0	A	4.61000E-12	-26.103
28	G1	TSW2	1198.0	B	5.04000E-13	-28.316
29	G1	TSW3	1306.0	A	3.70000E-11	-24.020
30	G4	CHNV	1353.8	A	3.05000E-13	-28.818
31	G4	CHNV	1359.0	A	3.25000E-11	-24.150
32	G4	CHNV	1359.0	B	1.99000E-11	-24.640
33	G4	CHNV	1359.0	C	8.03000E-11	-23.245
34	G4	CHNZ	1375.8	A	3.49000E-10	-21.776
35	G4	CHNZ	1405.0	A	2.99000E-12	-26.536
36	G4	CHNZ	1489.8	A	2.50000E-12	-26.715
37	G4	CHNZ	1548.0	A	1.31000E-11	-25.058
38	G4	CHNZ	1548.0	B	5.90000E-12	-25.856
39	G4	CHNZ	1548.0	C	1.97000E-11	-24.650
40	G4	CHNZ	1551.0	A	5.06000E-11	-23.707

Table A.1 Log Saturated Hydraulic Conductivity

OBS	HOLE	UNIT	SAMPLE	SAMP	HYD_COND	LOG_HYC
41	G4	CHNZ	1551.0	B	1.88000E-11	-24.697
42	G4	CHNZ	1551.0	C	1.33000E-11	-25.043
43	G4	CHNZ	1596.8	A	2.43000E-12	-26.743
44	G4	CHNZ	1686.0	A	4.24000E-12	-26.186
45	G4	CHNZ	1714.5	A	3.31000E-12	-26.434
46	G4	CHNZ	1728.0	A	1.86000E-11	-24.708
47	G4	CHNZ	1728.0	B	2.45000E-11	-24.432
48	G4	CHNZ	1728.0	C	1.97000E-11	-24.650
49	G4	CHNZ	1737.0	A	1.31000E-11	-25.058
50	G4	CHNZ	1737.0	B	4.59000E-13	-28.410
51	G4	CHNZ	1737.0	C	2.48000E-11	-24.420
52	G4	CHNZ	1746.8	A	5.19000E-12	-25.984
53	G4	CHNZ	1769.0	A	2.30000E-12	-26.798
54	G4	CHNZ	1778.0	A	6.47000E-12	-25.764
55	G4	CHNZ	1778.1	A	6.89000E-12	-25.701
56	G4	CHNZ	1778.1	B	1.83000E-11	-24.724
57	G4	CHNZ	1778.1	C	2.25000E-11	-24.518
58	G4	CHNZ	1787.0	A	1.61000E-10	-22.550
59	G4	CHNZ	1787.0	B	1.97000E-11	-24.650
60	G4	CHNZ	1787.0	C	1.24000E-10	-22.811
61	G4	TSW1	247.0	A	8.60000E-13	-27.782
62	G4	TSW1	445.0	A	2.28000E-12	-26.807
63	G4	TSW1	521.8	A	1.23000E-11	-25.121
64	G4	TSW2	1020.7	A	4.80000E-12	-26.062
65	G4	TSW2	1158.0	A	1.86000E-11	-24.708
66	G4	TSW2	1184.3	A	3.07000E-12	-26.509
67	G4	TSW2	1215.0	A	3.77000E-12	-26.304
68	G4	TSW2	1215.0	B	7.11000E-12	-25.670
69	G4	TSW2	1215.0	C	9.19000E-12	-25.413
70	G4	TSW2	1256.0	A	1.30000E-11	-25.066
71	G4	TSW2	1278.0	A	8.58000E-12	-25.482
72	G4	TSW2	1278.0	B	1.34000E-12	-27.338
73	G4	TSW2	1278.0	C	1.48000E-11	-24.936
74	G4	TSW2	864.0	A	2.17000E-11	-24.554
75	G4	TSW2	864.0	B	1.31000E-11	-25.058
76	G4	TSW2	864.0	C	1.97000E-11	-24.650
77	G4	TSW2	864.1	A	3.90000E-11	-23.967
78	G4	TSW3	1299.0	A	4.47000E-10	-21.528
79	G4	TSW3	1306.9	A	2.41000E-12	-26.751
80	G4	TSW3	1324.0	A	3.02000E-12	-26.526

Table A.1 Log Saturated Hydraulic Conductivity

OBS	HOLE	UNIT	SAMPLE	SAMP	HYD_COND	LOG_HYC
81	GU3	CHNV	1311.0	A	3.15000E-09	-19.576
82	GU3	CHNV	1331.0	A	2.92000E-07	-15.047
83	GU3	CHNV	1440.0	A	2.68000E-07	-15.132
84	GU3	CHNV	1499.0	A	2.57000E-08	-17.477
85	GU3	CHNV	1555.0	A	7.90000E-08	-16.354
86	GU3	TSW1	585.1	A	1.22000E-11	-25.130
87	GU3	TSW1	585.1	B	1.59000E-11	-24.865
88	GU3	TSW1	686.6	A	1.24000E-12	-27.416
89	GU3	TSW1	686.6	B	1.09000E-12	-27.545
90	GU3	TSW2	1036.5	A	3.98000E-10	-21.645
91	GU3	TSW2	1132.0	A	1.50000E-12	-27.226
92	GU3	TSW2	801.0	A	6.80000E-12	-25.714
93	GU3	TSW2	884.4	A	7.17000E-11	-23.359
94	GU3	TSW3	1197.0	A	1.46000E-11	-24.950
95	GU3	TSW3	1246.0	A	1.52000E-12	-27.212

Table A.2 Maximum Moisture Content

OBS	HOLE	UNIT	SAMPLE	SAMP	MMC
1	G1	CHNV	1359.1	A	0.167
2	G1	CHNV	1359.1	B	0.166
3	G1	CHNV	1387.0	A	0.288
4	G1	CHNV	1387.0	B	0.298
5	G1	CHNZ	1500.0	A	0.334
6	G1	CHNZ	1500.0	B	0.364
7	G1	CHNZ	1637.0	A	0.328
8	G1	CHNZ	1637.0	B	0.290
9	G1	CHNZ	1753.0	A	0.308
10	G1	CHNZ	1753.0	B	0.300
11	G1	CHNZ	1780.0	A	0.255
12	G1	CHNZ	1780.0	B	0.251
13	G1	CHNZ	1790.0	A	0.224
14	G1	CHNZ	1790.0	B	0.233
15	G1	CHNZ	1821.0	A	0.354
16	G1	CHNZ	1821.0	B	0.346
17	G1	CHNZ	1841.0	A	0.349
18	G1	CHNZ	1841.0	B	0.390
19	G1	TSW1	388.8	A	0.122
20	G1	TSW1	388.8	B	0.131
21	G1	TSW1	615.5	A	0.100
22	G1	TSW1	615.5	B	0.074
23	G1	TSW1	752.0	A	0.074
24	G1	TSW1	752.0	B	0.092
25	G1	TSW2	1102.0	A	0.119
26	G1	TSW2	1102.0	B	0.096
27	G1	TSW2	1198.0	A	0.085
28	G1	TSW2	1198.0	B	0.083
29	G1	TSW3	1306.0	A	0.034
30	G1	TSW3	1306.0	B	0.016
31	G4	CHNV	1359.0	A	0.190
32	G4	CHNV	1359.0	B	0.220
33	G4	CHNV	1359.0	C	0.130
34	G4	CHNZ	1405.0	A	0.380
35	G4	CHNZ	1405.0	B	0.310
36	G4	CHNZ	1405.0	C	0.340
37	G4	CHNZ	1548.0	A	0.280
38	G4	CHNZ	1548.0	B	0.300
39	G4	CHNZ	1548.0	C	0.310
40	G4	CHNZ	1551.0	A	0.350

Table A.2 Maximum Moisture Content

OBS	HOLE	UNIT	SAMPLE	SAMP	MMC
41	G4	CHNZ	1551.0	B	0.300
42	G4	CHNZ	1551.0	C	0.290
43	G4	CHNZ	1686.0	A	0.370
44	G4	CHNZ	1686.0	B	0.340
45	G4	CHNZ	1686.0	C	0.300
46	G4	CHNZ	1728.0	A	0.300
47	G4	CHNZ	1728.0	B	0.260
48	G4	CHNZ	1728.0	C	0.280
49	G4	CHNZ	1737.0	A	0.250
50	G4	CHNZ	1737.0	B	0.240
51	G4	CHNZ	1737.0	C	0.250
52	G4	CHNZ	1769.0	A	0.250
53	G4	CHNZ	1769.0	B	0.240
54	G4	CHNZ	1769.0	C	0.240
55	G4	CHNZ	1778.0	A	0.260
56	G4	CHNZ	1778.0	B	0.280
57	G4	CHNZ	1778.0	C	0.270
58	G4	CHNZ	1778.1	A	0.290
59	G4	CHNZ	1778.1	B	0.270
60	G4	CHNZ	1778.1	C	0.280
61	G4	CHNZ	1787.0	A	0.300
62	G4	CHNZ	1787.0	B	0.270
63	G4	CHNZ	1787.0	C	0.310
64	G4	TSW1	247.0	A	0.033
65	G4	TSW1	247.0	B	0.029
66	G4	TSW1	247.0	C	0.031
67	G4	TSW2	1158.0	A	0.090
68	G4	TSW2	1158.0	B	0.090
69	G4	TSW2	1158.0	C	0.100
70	G4	TSW2	1215.0	A	0.090
71	G4	TSW2	1215.0	B	0.090
72	G4	TSW2	1215.0	C	0.080
73	G4	TSW2	1256.0	A	0.080
74	G4	TSW2	1256.0	B	0.070
75	G4	TSW2	1256.0	C	0.090
76	G4	TSW2	1278.0	A	0.070
77	G4	TSW2	1278.0	B	0.070
78	G4	TSW2	1278.0	C	0.070
79	G4	TSW2	864.0	A	0.110
80	G4	TSW2	864.0	B	0.080

Table A.2 Maximum Moisture Content

OBS	HOLE	UNIT	SAMPLE	SAMP	MMC
81	G4	TSW2	864.0	C	0.120
82	G4	TSW2	864.1	A	0.130
83	G4	TSW2	864.1	B	0.120
84	G4	TSW2	864.1	C	0.120
85	G4	TSW3	1299.0	A	0.080
86	G4	TSW3	1299.0	B	0.060
87	G4	TSW3	1299.0	C	0.070
88	G4	TSW3	1324.0	A	0.009
89	G4	TSW3	1324.0	B	0.010
90	G4	TSW3	1324.0	C	0.015
91	GU3	CHNV	1311.0	A	0.230
92	GU3	CHNV	1311.0	B	0.400
93	GU3	CHNV	1331.0	A	0.250
94	GU3	CHNV	1331.0	B	0.260
95	GU3	CHNV	1440.0	A	0.410
96	GU3	CHNV	1440.0	B	0.480
97	GU3	CHNV	1499.0	A	0.370
98	GU3	CHNV	1499.0	B	0.410
99	GU3	CHNV	1555.0	A	0.360
100	GU3	CHNV	1555.0	B	0.350
101	GU3	TSW1	585.1	A	0.108
102	GU3	TSW1	585.1	B	0.131
103	GU3	TSW1	686.6	A	0.083
104	GU3	TSW1	686.6	B	0.079
105	GU3	TSW2	1132.0	A	0.070
106	GU3	TSW2	1132.0	B	0.070
107	GU3	TSW2	884.4	A	0.127
108	GU3	TSW2	884.4	B	0.096
109	GU3	TSW3	1197.0	A	0.030
110	GU3	TSW3	1197.0	B	0.020
111	GU3	TSW3	1246.0	A	0.030
112	GU3	TSW3	1246.0	B	0.040

Table A.3 Suction Head

OBS	HOLE	UNIT	SAMPLE	SAMP	HD6	HD8
1	G1	CHNV	1359.1	A	4.39673	3.86494
2	G1	CHNV	1387.0	A	4.08593	3.81592
3	G1	CHNZ	1500.0	A	6.61287	5.52881
4	G1	CHNZ	1500.0	B	6.22106	5.04509
5	G1	CHNZ	1637.0	A	6.77450	5.69985
6	G1	CHNZ	1637.0	B	7.36264	6.36204
7	G1	CHNZ	1753.0	A	6.74116	6.08675
8	G1	CHNZ	1753.0	B	6.87960	6.13017
9	G1	CHNZ	1780.0	A	6.50176	5.39814
10	G1	CHNZ	1780.0	B	6.84939	5.84264
11	G1	CHNZ	1790.0	A	7.00501	6.22922
12	G1	CHNZ	1790.0	B	7.05830	6.25501
13	G1	CHNZ	1821.0	A	6.00448	5.09122
14	G1	CHNZ	1821.0	B	6.04039	5.11009
15	G1	CHNZ	1841.0	A	5.69169	4.70748
16	G1	CHNZ	1841.0	B	4.82090	3.77145
17	G1	TSW1	388.8	A	4.14709	3.26008
18	G1	TSW1	388.8	B	4.06791	3.24723
19	G1	TSW1	615.5	A	5.94338	5.14844
20	G1	TSW1	615.5	B	6.49791	5.60087
21	G1	TSW1	752.0	A	6.30736	5.39052
22	G1	TSW1	752.0	B	6.00627	5.15658
23	G1	TSW2	1102.0	A	5.81405	4.91927
24	G1	TSW2	1102.0	B	6.00165	5.04543
25	G1	TSW2	1198.0	A	6.29930	5.38005
26	G1	TSW2	1198.0	B	6.50462	5.66171
27	G1	TSW3	1306.0	A	6.08686	5.03915
28	G1	TSW3	1306.0	B	6.63490	5.75975
29	G4	CHNV	1359.0	A	3.90020	3.08009
30	G4	CHNV	1359.0	B	4.05299	3.60854
31	G4	CHNZ	1405.0	A	5.87151	4.48353
32	G4	CHNZ	1405.0	B	5.59179	4.18422
33	G4	CHNZ	1405.0	C	6.69955	5.56681
34	G4	CHNZ	1548.0	A	6.74523	5.77249
35	G4	CHNZ	1548.0	B	6.64094	5.70306
36	G4	CHNZ	1548.0	C	6.58027	5.65738
37	G4	CHNZ	1551.0	A	5.97698	5.23977
38	G4	CHNZ	1551.0	B	6.21288	5.39944
39	G4	CHNZ	1551.0	C	6.14515	5.52065
40	G4	CHNZ	1686.0	A	8.18991	7.10202

Table A.3 Suction Head

OBS	HOLE	UNIT	SAMPLE	SAMP	HD6	HD8
41	G4	CHNZ	1686.0	B	6.23973	5.29801
42	G4	CHNZ	1686.0	C	6.52608	5.62904
43	G4	CHNZ	1728.0	A	7.72577	7.04119
44	G4	CHNZ	1728.0	B	7.10567	6.07655
45	G4	CHNZ	1728.0	C	6.93781	5.93569
46	G4	CHNZ	1737.0	A	6.30963	5.49161
47	G4	CHNZ	1737.0	B	6.48025	5.74964
48	G4	CHNZ	1737.0	C	6.44802	5.49046
49	G4	CHNZ	1769.0	A	7.54113	7.05492
50	G4	CHNZ	1778.0	A	6.54077	5.48957
51	G4	CHNZ	1778.0	B	6.30029	5.24204
52	G4	CHNZ	1778.0	C	6.48659	5.54487
53	G4	CHNZ	1778.1	A	6.88901	6.52617
54	G4	CHNZ	1778.1	B	6.95294	6.58180
55	G4	CHNZ	1778.1	C	6.82029	6.45695
56	G4	CHNZ	1787.0	A	6.43618	5.55570
57	G4	CHNZ	1787.0	B	6.75763	6.08688
58	G4	CHNZ	1787.0	C	6.13914	5.34337
59	G4	TSW1	247.0	A	5.36681	4.17866
60	G4	TSW1	247.0	B	5.95355	4.93738
61	G4	TSW1	247.0	C	5.19273	4.17176
62	G4	TSW2	1158.0	A	5.47573	4.74578
63	G4	TSW2	1158.0	B	6.00378	5.38765
64	G4	TSW2	1158.0	C	5.82448	5.02456
65	G4	TSW2	1215.0	A	5.64619	4.90173
66	G4	TSW2	1215.0	B	5.66348	4.97568
67	G4	TSW2	1215.0	C	5.45719	5.05034
68	G4	TSW2	1256.0	A	6.38720	5.82576
69	G4	TSW2	1256.0	B	6.61112	5.86126
70	G4	TSW2	1256.0	C	6.18094	5.59519
71	G4	TSW2	1278.0	A	5.92675	5.34296
72	G4	TSW2	1278.0	B	5.74059	5.19669
73	G4	TSW2	1278.0	C	5.82304	5.39500
74	G4	TSW2	864.0	A	5.30306	4.46206
75	G4	TSW2	864.0	B	5.61503	4.50126
76	G4	TSW2	864.0	C	5.47335	4.58744
77	G4	TSW2	864.1	A	4.82826	4.17680
78	G4	TSW2	864.1	B	4.51599	3.73473
79	G4	TSW2	864.1	C	5.04187	4.38990
80	G4	TSW3	1299.0	A	5.96479	5.16902

Table A.3 Suction Head

OBS	HOLE	UNIT	SAMPLE	SAMP	HD6	HD8
81	G4	TSW3	1299.0	B	6.43396	5.55455
82	G4	TSW3	1299.0	C	6.21122	5.43542
83	G4	TSW3	1324.0	A	6.63654	5.57109
84	G4	TSW3	1324.0	B	7.23102	6.49435
85	G4	TSW3	1324.0	C	6.72598	6.15024
86	GU3	CHNV	1311.0	A	4.02031	3.57822
87	GU3	CHNV	1311.0	B	4.19528	3.90321
88	GU3	CHNV	1331.0	A	4.64844	4.36958
89	GU3	CHNV	1331.0	B	5.18919	4.69265
90	GU3	CHNV	1440.0	A	4.12353	3.84833
91	GU3	CHNV	1440.0	B	4.26086	3.94753
92	GU3	CHNV	1499.0	A	4.13895	3.31826
93	GU3	CHNV	1499.0	B	3.99989	2.93262
94	GU3	CHNV	1555.0	A	4.14017	4.04169
95	GU3	TSW1	585.1	A	4.57092	3.68828
96	GU3	TSW1	585.1	B	4.91201	4.19313
97	GU3	TSW1	686.6	A	5.41185	4.56605
98	GU3	TSW1	686.6	B	5.75111	5.04899
99	GU3	TSW2	1132.0	A	5.33820	4.44454
100	GU3	TSW2	1132.0	B	5.28840	4.38219
101	GU3	TSW2	884.4	A	4.88979	4.25398
102	GU3	TSW2	884.4	B	5.85440	5.17599
103	GU3	TSW3	1197.0	A	6.10364	5.69500
104	GU3	TSW3	1197.0	B	5.89018	5.59128
105	GU3	TSW3	1246.0	A	5.59496	4.91986
106	GU3	TSW3	1246.0	B	6.04798	5.46184

Table A.4 Groundwater Travel Time

OBS	HOLE	UNIT	SAMPLE	SAMP	TRV_TIME
1	G1	CHNV	1359.1	A	8.22
2	G1	CHNV	1387.0	A	5.40
3	G1	CHNZ	1500.0	A	48.67
4	G1	CHNZ	1500.0	B	52.48
5	G1	CHNZ	1637.0	A	46.03
6	G1	CHNZ	1637.0	B	42.88
7	G1	CHNZ	1753.0	A	31.93
8	G1	CHNZ	1753.0	B	31.70
9	G1	CHNZ	1780.0	A	0.00
10	G1	CHNZ	1780.0	B	0.00
11	G1	CHNZ	1790.0	A	33.36
12	G1	CHNZ	1790.0	B	34.74
13	G1	CHNZ	1821.0	A	46.18
14	G1	CHNZ	1821.0	B	44.93
15	G1	CHNZ	1841.0	A	40.41
16	G1	CHNZ	1841.0	B	46.65
17	G1	TSW1	388.8	A	17.12
18	G1	TSW1	388.8	B	14.81
19	G1	TSW1	615.5	A	0.00
20	G1	TSW1	615.5	B	0.00
21	G1	TSW1	752.0	A	10.78
22	G1	TSW2	1102.0	A	15.34
23	G1	TSW2	1102.0	B	0.00
24	G1	TSW2	1198.0	A	12.74
25	G1	TSW2	1198.0	B	0.00
26	G1	TSW3	1306.0	A	4.11
27	G4	CHNV	1359.0	A	21.36
28	G4	CHNV	1359.0	B	20.82
29	G4	CHNZ	1405.0	A	0.00
30	G4	CHNZ	1548.0	A	40.63
31	G4	CHNZ	1548.0	B	44.80
32	G4	CHNZ	1548.0	C	43.38
33	G4	CHNZ	1551.0	A	31.46
34	G4	CHNZ	1551.0	B	30.59
35	G4	CHNZ	1551.0	C	28.34
36	G4	CHNZ	1686.0	A	55.51
37	G4	CHNZ	1728.0	A	39.15
38	G4	CHNZ	1728.0	B	36.58
39	G4	CHNZ	1728.0	C	39.80
40	G4	CHNZ	1737.0	A	35.35

Table A.4 Groundwater Travel Time

OBS	HOLE	UNIT	SAMPLE	SAMP	TRV_TIME
41	G4	CHNZ	1737.0	B	0.00
42	G4	CHNZ	1737.0	C	34.61
43	G4	CHNZ	1769.0	A	0.00
44	G4	CHNZ	1778.0	A	38.87
45	G4	CHNZ	1778.1	A	30.09
46	G4	CHNZ	1778.1	B	22.88
47	G4	CHNZ	1778.1	C	22.34
48	G4	CHNZ	1787.0	A	32.65
49	G4	CHNZ	1787.0	B	34.75
50	G4	CHNZ	1787.0	C	32.98
51	G4	TSW1	247.0	A	0.00
52	G4	TSW2	1158.0	A	11.96
53	G4	TSW2	1215.0	A	13.18
54	G4	TSW2	1215.0	B	12.23
55	G4	TSW2	1215.0	C	7.01
56	G4	TSW2	1256.0	A	10.40
57	G4	TSW2	1278.0	A	9.74
58	G4	TSW2	1278.0	B	0.00
59	G4	TSW2	1278.0	C	8.25
60	G4	TSW2	864.0	A	14.93
61	G4	TSW2	864.0	B	11.77
62	G4	TSW2	864.0	C	16.65
63	G4	TSW2	864.1	A	14.92
64	G4	TSW3	1299.0	A	6.99
65	G4	TSW3	1324.0	A	0.00
66	GU3	CHNV	1311.0	A	7.48
67	GU3	CHNV	1331.0	A	1.32
68	GU3	CHNV	1440.0	A	2.19
69	GU3	CHNV	1499.0	A	17.29
70	GU3	CHNV	1555.0	A	1.41
71	GU3	TSW1	585.1	A	15.54
72	GU3	TSW1	585.1	B	17.67
73	GU3	TSW1	686.6	A	0.00
74	GU3	TSW1	686.6	B	0.00
75	GU3	TSW2	1132.0	A	0.00
76	GU3	TSW2	884.4	A	12.97
77	GU3	TSW3	1197.0	A	1.69
78	GU3	TSW3	1246.0	A	0.00

APPENDIX B

DETAILS OF THE STATISTICAL ANALYSIS

B.1 Organization of Appendix B

The purpose of this appendix is to give the details of the analysis of variance computations summarized in the main chapters of this report. Section B.2 gives the procedures for testing for significant effects; Section B.3 discusses briefly the multiple comparison procedures; and Section B.4 describes the variance component analysis.

B.2 Significance Tests

The tests for significant main effects and interactions have been performed using information obtained from SAS's General Linear Models (GLM) Procedure. This procedure gives the sum of squares (SS), degrees of freedom (df) and expected mean squares (EMS) for the ANOVA Tables B.1 through B.5. For an analysis of the unbalanced data, the appropriate denominator for computing the F statistic and its associated degrees of freedom must be approximated. The procedure used here is that of Satterthwaite (Bennett and Franklin, 1954), where a linear combination of mean squares is computed as determined by the EMS column provided by SAS.

In Table B.1, for example, to test the hypothesis of no unit-hole interaction, we compute the denominator of the F statistic to be the mean square

$$MS = \frac{1.36}{1.63}MS_S + (1 - \frac{1.36}{1.63})MS_E \qquad (B.1)$$

$$= (0.83)(3.97) + (0.17)(0.87) = 3.44$$

where the subscripts S and E represent respectively the sample and specimen. The associated degrees of freedom are approximated according to

$$\upsilon^* = (MS)^2/[(\frac{1.36}{1.63})^2 MS_S^2/df_S + (1 - \frac{1.36}{1.63})^2 MS_E^2/df_E] \qquad (B.2)$$

$$= 47 \quad .$$

Finally, the approximated F statistic is computed as

$$F = \frac{22.14/6}{3.44} = 1.07 \qquad (B.3)$$

which is compared to the tabled critical value for the F distribution with 6 and 47 degrees of freedom. In this case, the table value $f_{.1,6,47}$ is 1.92 and because $F < 1.92$, we conclude that the data have not provided enough evidence to reject the hypothesis of no interaction. Other tests have been performed following this same procedure.

Table B.1

ANOVA Table for Log Saturated Hydraulic Conductivity

(Data from Unit CHnv, GU-3 excluded.)

Source	df	SS	MS	EMS	F	Sig.
Hole	2	6.85	3.43	$\sigma^2+1.27\sigma_S^2+3.72\sigma_{UH}^2+15.16\sigma_H^2$	0.98	
Unit	4	7.24	1.81	$\sigma^2+1.37\sigma_S^2+5.14\sigma_{UH}^2+\phi(U)$	0.51	
Unit-Hole	6	22.14	3.69	$\sigma^2+1.36\sigma_S^2+4.55\sigma_{UH}^2$	1.07	
Sample	42	166.85	3.97	$\sigma^2+1.63\sigma_S^2$		
Specimen	35	30.58	0.87	σ^2		

* indicates significance at Level 0.1.

$\phi(U)$ is a quadratic function of unit means.

Table B.2

ANOVA Table for Maximum Moisture Content

for Units TSw1, TSw2, and TSw3

Source	df	SS	MS	EMS	F	Sig.
Hole	2	0.0024	0.0012	$\sigma^2+2.27\sigma_S^2+4.52\sigma_{UH}^2+13.3\sigma_H^2$	0.48	
Unit	2	0.0256	0.0128	$\sigma^2+2.24\sigma_S^2+4.39\sigma_{UH}^2+\phi(U)$	5.12	*
Unit-Hole	4	0.0098	0.0025	$\sigma^2+2.28\sigma_S^2+4.38\sigma_{UH}^2$	1.67	
Sample	12	0.0166	0.0014	$\sigma^2+2.5\sigma_S^2$		
Specimen	30	0.0033	0.0001	σ^2		

* indicates significance at Level 0.1.
$\phi(U)$ is a quadratic function of unit means.

Table B.3

ANOVA Table for Maximum Moisture Content

for Units CHnv and CHnz in Holes G-1 and G-4

Source	df	SS	MS	EMS	F	Sig.
Hole	1	0.0074	0.0074	$\sigma^2+2.49\sigma_S^2+8.19\sigma_{UH}^2+15.6\sigma_H^2$	4.9**	
Unit	1	0.0510	0.0510	$\sigma^2+2.45\sigma_S^2+5.87\sigma_{UH}^2+\phi(U)$	34.0	*
Unit-Hole	1	0.0014	0.0014	$\sigma^2+2.53\sigma_S^2+5.81\sigma_{UH}^2$	0.28	
Sample	16	0.0800	0.0050	$\sigma^2+2.56\sigma_S^2$		
Specimen	31	0.0160	0.0005	σ^2		

* indicates significance at Level 0.1.
$\phi(U)$ is a quadratic function of unit means.
** Satterthwaite's procedure yielded a negative sum of squares for the denominator of the F statistic. The test was rerun without the interaction term in the model to obtain the F statistic shown.

Table B.4
ANOVA Table for Log Suction Head S = 0.8

Source	df	SS	MS	EMS	F	Sig.
Hole	2	0.25	0.13	$\sigma^2+2.01\sigma_S^2+4.63\sigma_{UH}^2+20.47\sigma_H^2$	0.16	
Unit	4	28.21	7.05	$\sigma^2+2.06\sigma_S^2+5.90\sigma_{UH}^2+\phi(U)$	30.0	*
Unit-Hole	7	2.33	0.33	$\sigma^2+2.09\sigma_S^2+5.06\sigma_{UH}^2$	0.37	
Sample	32	29.59	0.92	$\sigma^2+2.35\sigma_S^2$		
Specimen	60	7.94	0.13	σ^2		

* indicates significance at Level 0.1.

$\phi(U)$ is a quadratic function of unit means.

Table B.5
ANOVA Table for Sample Travel Time
in Units TSw1 and TSw3

Source	df	SS	MS	EMS	F	Sig.
Hole	2	31.0	15.5	$\sigma^2+1.15\sigma_S^2+1.95\sigma_{UH}^2+3.9\sigma_H^2$	0.65	
Unit	1	27.2	27.2	$\sigma^2+1.12\sigma_S^2+1.79\sigma_{UH}^2+\phi(U)$	1.01	
Unit-Hole	2	53.9	27.0	$\sigma^2+1.12\sigma_S^2+1.79\sigma_{UH}^2$	0.31	
Sample	5	562.7	112.5	$\sigma^2+1.44\sigma_S^2$		
Specimen	4	4.9	1.2	σ^2		

* indicates significance at Level 0.1.

$\phi(U)$ is a quadratic function of unit means.

Table B.6

ANOVA Table for Sample Travel Time

in Unit TSw2

Source	df	SS	MS	EMS	F	Sig.
Hole	2	75.9	38.0	$\sigma^2+1.46\sigma_S^2+4.13\sigma_{UH}^2+4.13\sigma_H^2$	1.06	
Sample	7	213.3	30.4	$\sigma^2+1.78\sigma_S^2$		
Specimen	8	288.2	36.0	σ^2		

* indicates significance at Level 0.1.

Table B.7

ANOVA Table for Sample Travel Time

in Units CHnv and CHnz

Source	df	SS	MS	EMS	F	Sig.
Hole	2	123.4	61.7	$\sigma^2+1.42\sigma_S^2+4.28\sigma_{UH}^2+6.6\sigma_H^2$	0.16	
Unit	1	1285.2	1285.2	$\sigma^2+1.47\sigma_S^2+3.53\sigma_{UH}^2+\phi(U)$	3.23	
Unit-Hole	1	397.5	397.5	$\sigma^2+1.54\sigma_S^2+3.53\sigma_{UH}^2$	1.28	
Sample	20	7169.0	358.5	$\sigma^2+1.81\sigma_S^2$		
Specimen	20	909.6	45.5	σ^2		

* indicates significance at Level 0.1.

$\phi(U)$ is a quadratic function of unit means.

B.3 Multiple Comparisons

Hole means and unit means have been compared using the SAS (1985) GLM Procedure with the option MEANS/SCHEFFE. This procedure has been applied to the sample means rather than the specimen values because the multiple-comparison procedure compares hole or unit mean values, and these values are affected by the differing number of specimens per sample. A description of Scheffe's method can be found in Bickel and Doksum (1977).

B.4 Variance Component Analysis

To determine the components of variance, we are using the simplified model

$$Z = \mu + S_k + \epsilon_{(k)l} \tag{B.4}$$

as discussed in Chapter 3. An abbreviated ANOVA table for this model is

Source	MS	EMS
Sample	MS_S	$\sigma^2 + C\sigma_S^2$
Specimen	MS_E	σ^2

for some constant C. The estimates for σ^2 and σ_S^2 are then

$$\hat{\sigma}^2 = MS_E \quad \text{and} \tag{B.5}$$

$$\hat{\sigma}_S^2 = (MS_S - MS_E)/k \quad . \tag{B.6}$$

These calculations were made using the SAS procedure VARCOMP.

B.5 Pooled Correlation Coefficient

The estimation of a pooled correlation coefficient or pooled covariance estimate is common in the analysis of multivariate data (Morrison, 1967). The

procedure assumes that a common correlation exists between variables within each of several groups that may differ in mean. In the case presented here, the groups were the regions. To compute the pooled correlation coefficient estimate for X and Y, the within-group sums of squares and crossproducts

$$S_{XX} = \Sigma(X_i - \bar{X})^2 \quad ; \tag{B.7}$$

$$S_{YY} = \Sigma(Y_i - \bar{Y})^2 \quad ; \text{ and} \tag{B.8}$$

$$S_{XY} = \Sigma(X_i - \bar{X})(Y_i - \bar{Y}) \tag{B.9}$$

are computed. These are then summed over the regions to get

$$SS_{XX} = \sum_{\text{regions}} S_{XX} \quad ; \tag{B.10}$$

$$SS_{YY} = \sum_{\text{regions}} S_{YY} \quad , \text{ and} \tag{B.11}$$

$$SS_{XY} = \sum_{\text{regions}} S_{XY} \quad . \tag{B.12}$$

The pooled correlation coefficient estimate is then computed as

$$r_{XY} = SS_{XY}/[(SS_{XX})(SS_{YY})]^{1/2} \tag{B.13}$$

APPENDIX C

PARAMETERS DERIVED FROM FITTING CURVES OF SATURATION AS A FUNCTION OF SUCTION HEAD

This appendix lists the results of the curve fitting procedure that was used to calculate the parameters of the van Genuchten equation, α, β, and S_r. The van Genuchten equation is written below for reference.

$$S(\psi) = (1 - S_r)(1 + |\alpha\psi|^{\beta})^{-\lambda} + S_r \quad .$$

Definition of these parameters is given in Chapter 5.

The calculations listed here differ slightly from those reported in Klavetter and Peters (1987). One difference is that small fitted values of residual saturation (S_r) were tested statistically for values different from zero. Those values that were not different from zero were forced to zero, and the other parameters were fit again. A second difference from Klavetter and Peters (1987) is that a few additional samples were included here.

Entries in Appendix C give the fitted values of α, β, and S_r, where S_r is not taken to be zero. Included with each entry are the parameter estimates, an asymptotically valid estimate of the standard error (SE) of the parameter estimate, and the number of data points included in the calculations. The standard error estimate is discussed briefly in the SAS (1985) Statistics Manual and further in Ralston and Jennrich (1978).

The first entry for a given depth is the combined entry for the sample where specimen readings have been combined before the fit. The remaining entries at the same depth are given for individual specimens. The specimen entries have been used in the analysis except in two cases where the nonlinear procedure failed to converge. In those cases (Hole USW GU-3, depth 1,555 ft and Hole

SAS procedure NLIN, SAS (1985), was used to make the estimates of the parameters necessary to fit the data. The objective of the fitting procedure was to select values of the parameters α, β (and S_r where applicable) that minimize the sum of squared residual values.

In NLIN, the default method DUD, the method of false position, was used, which is a multivariate secant method where the derivatives are estimated from the history of iterations. One set of inputs required for the use of this procedure is the selection of starting values. Potential starting values are input to Procedure NLIN, and the functional values at those points are compared in search of a minimum. This minimum is used as a starting value. Potential starting values are given below for both cases (the case where S_r is calculated in the model and the case where it is set to zero). In a few of the fits, these values had to be altered to avoid convergence problems:

With S_r . α ranged from .001 to .01 by .0035,
β ranged from 1.6 to 2.15 by .25, and
S_r ranged from 0. to .13 by .05.

Without S_r α ranged from .001 to .035 by .005 and
β ranged from 1.2 to 1.85 by .15.

These starting values have been chosen using old data and results of some experimentation.

Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-4	247.0	comb	G4-247	0.167	1.344		26
				0.0056	0.046		
USW G-4	247.0	a	G4-247a	0.021	1.319		9
				0.0107	0.0587		
USW G-4	247.0	b	G4-247b	0.008	1.406		9
				0.0032	0.0771		
USW G-4	247.0	c	G4-247c	0.0173	1.403		8
				0.0104	0.1192		
USW G-1	388.8	comb	G1-389	0.036	1.538		28
				0.0059	0.0464		
USW G-1	388.8	a	G1-389a	0.037	1.504		13
				0.0098	0.0703		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

SNL Data Report No.: SAND87-2380 QA Level of Calculational Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) Specimens (or subsamples) were taken from a core sample and tests were made on each specimen. The individual specimens are denoted by "a", "b", and "c". In most cases, the data from specimens taken from a core sample were combined and a curve-fit through all these data points was obtained; this curve fit for the combined data set is denoted by "comb".

2) No entry in this column indicates that statistical tests determined the value should be set to zero.

Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-1	388.8	b	G1-389b	0.035	1.571		15
				0.0074	0.0614		
USW G-1	615.5	comb	G1-616	0.0049	1.514		29
				0.00086	0.0509		
USW G-1	615.5	a	G1-616a	0.0051	1.601		15
				0.00051	0.0376		
USW G-1	615.5	b	G1-616b	0.0036	1.495		14
				0.00052	0.0401		
USW G-1	752.0	comb	G1-752	0.005	1.507		19
				0.0008	0.0481		
USW G-1	752.0	a	G1-752a	0.0045	1.478		9
				0.0011	0.0693		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

SNL Data Report No.: SAND87-2380 QA Level of Calculational Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) Specimens (or subsamples) were taken from a core sample and tests were made on each specimen. The individual specimens are denoted by "a", "b", and "c". In most cases, the data from specimens taken from a core sample were combined and a curve-fit through all these data points was obtained; this curve fit for the combined data set is denoted by "comb".

2) No entry in this column indicates that statistical tests determined the value should be set to zero.

Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-1	752.0	b	G1-752b	0.0053	1.54		10
				0.00057	0.0353		
USW GU-3	585.1	comb	GU3-585	0.0171	1.6		25
				0.0021	0.0425		
USW GU-3	585.1	a	GU3-585a	0.024	1.51		12
				0.0048	0.0513		
USW GU-3	585.1	b	GU3-585b	0.0124	1.706		13
				0.0014	0.0484		
USW GU-3	686.6	comb	GU3-687	0.007	1.644		25
				0.00083	0.0425		
USW GU-3	686.6	a	GU3-687a	0.0096	1.544		12
				0.0017	0.0545		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

SNL Data Report No.: SAND87-2380 QA Level of Calculational Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) Specimens (or subsamples) were taken from a core sample and tests were made on each specimen. The individual specimens are denoted by "a", "b", and "c". In most cases, the data from specimens taken from a core sample were combined and a curve-fit through all these data points was obtained; this curve fit for the combined data set is denoted by "comb".

2) No entry in this column indicates that statistical tests determined the value should be set to zero.

Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW GU-3	686.6	b	GU3-687b	0.0052	1.733		13
				0.00045	0.0445		
USW G-4	1278.0	comb	G4-1278	0.0037	2.122	0.1205	34
				0.0002	0.1227	0.026	
USW G-4	1278.0	a	G4-1278a	0.0036	1.978	0.108	10
				0.0046	0.2112	0.054	
USW G-4	1278.0	b	G4-1278b	0.0041	2.089	0.1121	13
				0.00027	0.1499	0.033	
USW G-4	1278.0	c	G4-1278c	0.0033	2.544	0.1635	11
				0.00021	0.2598	0.0345	
USW G-4	1215.0	comb	G4-1215	0.006	1.919	0.1205	31
				0.00058	0.1413	0.0367	

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

SNL Data Report No.: SAND87-2380 QA Level of Calculational Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) Specimens (or subsamples) were taken from a core sample and tests were made on each specimen. The individual specimens are denoted by "a", "b", and "c". In most cases, the data from specimens taken from a core sample were combined and a curve-fit through all these data points was obtained; this curve fit for the combined data set is denoted by "comb".

2) No entry in this column indicates that statistical tests determined the value should be set to zero.

Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-4	1215.0	a	G4-1215a	0.0063	1.685	0.023	12
				0.00058	0.099	0.0461	
USW G-4	1215.0	b	G4-1215b	0.0057	1.808	0.0593	11
				0.00094	0.1934	0.0656	
USW G-4	1215.0	c	G4-1215c	0.0055	3.25	0.2866	8
				0.0006	0.786	0.0427	
USW G-4	1102.0	comb	G4-1102	0.0068	1.474		31
				0.00074	0.0248		
USW G-1	1102.0	a	G1-1102a	0.0071	1.497		15
				0.0009	0.03		
USW G-1	1102.0	b	G1-1102b	0.0067	1.447		16
				0.0008	0.228		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

SNL Data Report No.: SAND87-2380 QA Level of Calculational Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) Specimens (or subsamples) were taken from a core sample and tests were made on each specimen. The individual specimens are denoted by "a", "b", and "c". In most cases, the data from specimens taken from a core sample were combined and a curve-fit through all these data points was obtained; this curve fit for the combined data set is denoted by "comb".

2) No entry in this column indicates that statistical tests determined the value should be set to zero.

Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-1	1198.0	comb	G1-1198	0.0039	1.501		27
				0.00047	0.0351		
USW G-1	1198.0	a	G1-1198a	0.0046	1.476		13
				0.00062	0.0363		
USW G-1	1198.0	b	G1-1198b	0.0032	1.547		14
				0.0005	0.06		
USW GU-3	884.4	comb	GU3-884	0.0089	1.858		26
				0.0014	0.0975		
USW GU-3	884.4	a	GU3-884a	0.011	1.857		14
				0.001	0.0568		
USW GU-3	884.4	b	GU3-884b	0.0045	2.27		12
				0.0007	0.222		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

SNL Data Report No.: SAND87-2380 QA Level of Calculational Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) Specimens (or subsamples) were taken from a core sample and tests were made on each specimen. The individual specimens are denoted by "a", "b", and "c". In most cases, the data from specimens taken from a core sample were combined and a curve-fit through all these data points was obtained; this curve fit for the combined data set is denoted by "comb".

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Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW GU-3	1132.0	comb	GU3-1132	0.0117	1.495		20
				0.0027	0.0605		
USW GU-3	1132.0	a	GU3-1132a	0.0114	1.498		11
				0.0033	0.0794		
USW GU-3	1132.0	b	GU3-1132b	0.0123	1.487		9
				0.0051	0.1033		
USW G-1	864.0	comb	G1-864	0.011	1.461		26
				0.0017	0.0414		
USW G-4	864.0	a	G4-864a	0.0106	1.549		8
				0.0013	0.0439		
USW G-4	864.0	b	G4-864b	0.0139	1.352		9
				0.0044	0.0539		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

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Data Compilation Form for Saturation Curve-Fit Parameters
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PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-4	864.0	c	G4-864c	0.0098	1.505		9
				0.0016	0.0533		
USW G-4	864.1	comb	G4-864	0.0132	1.753		33
				0.0012	0.0474		
USW G-4	864.1	a	G4-864a	0.012	1.825		12
				0.0014	0.0727		
USW G-4	864.1	b	G4-864b	0.0207	1.618		12
				0.0025	0.0414		
USW G-4	864.1	c	G4-864c	0.0097	1.824		9
				0.0009	0.0615		
USW G-4	1158.0	comb	G4-1158	0.0063	1.626		34
				0.001	0.071		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

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for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-4	1158.0	a	G4-1158a	0.0072	1.689		12
				0.0008	0.0612		
USW G-4	1158.0	b	G4-1158b	0.0035	1.9		11
				0.0006	0.1589		
USW G-4	1158.0	c	G4-1158c	0.0058	1.595		11
				0.0014	0.098		
USW G-4	1256.0	comb	G4-1256	0.0027	1.732		25
				0.0003	0.0922		
USW G-4	1256.0	a	G4-1256a	0.0022	2.038		8
				0.00026	0.2027		
USW G-4	1256.0	b	G4-1256b	0.0024	1.66		9
				0.00045	0.1087		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

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Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-4	1256.0	c	G4-1256c	0.0028	1.973		8
				0.0003	0.1795		
USW G-4	1215.0	comb	G4-1215	0.00601	1.919	0.1205	31
				0.00058	0.1413	0.0367	
USW G-4	1215.0	a	G4-1215a	0.0063	1.685	0.023	12
				0.00058	0.099	0.0461	
USW G-4	1215.0	b	G4-1215b	0.0057	1.808	0.0593	11
				0.0009	0.1934	0.0656	
USW G-4	1215.0	c	G4-1215c	0.0055	3.249	0.2866	8
				0.00057	0.786	0.0427	
USW G-4	1278.0	comb	G4-1278	0.0037	2.122	0.1205	34
				0.0002	0.123	0.0258	

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

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PART 4 Reference and Supporting Information

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Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-4	1278.0	a	G4-1278a	0.0036	1.978	0.108	10
				0.00043	0.2111	0.054	
USW G-4	1278.0	b	G4-1278b	0.0041	2.089	0.1121	13
				0.00027	0.15	0.0327	
USW G-4	1278.0	c	G4-1278c	0.0033	2.544	0.1634	11
				0.0002	0.26	0.0345	
USW G-1	1306.0	comb	G4-1306	0.0038	1.484		24
				0.00097	0.0654		
USW G-1	1306.0	a	G1-1306a	0.0075	1.387		12
				0.0034	0.0733		
USW G-1	1306.0	b	G1-1306b	0.003	1.515		12
				0.0007	0.0757		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

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PART 4 Reference and Supporting Information

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Data Compilation Form for Saturation Curve-Fit Parameters
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PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW GU-3	1197.0	comb	GU3-1197	0.0033	4.118	0.3757	17
				0.00016	0.724	0.0303	
USW GU-3	1197.0	a	GU3-1197a	0.0032	4.209	0.4506	8
				0.00016	0.835	0.031	
USW GU-3	1197.0	b	GU3-1197b	0.0033	4.495	0.3289	9
				0.00006	0.3379	0.013	
USW GU-3	1246.0	comb	GU3-1246	0.0049	1.78		18
				0.001	0.1487		
USW GU-3	1246.0	a	GU3-1246a	0.0058	1.78		10
				0.0016	0.1873		
USW GU-3	1246.0	b	GU3-1246b	0.0032	1.972		8
				0.00063	0.2159		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

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Data Compilation Form for Saturation Curve-Fit Parameters
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PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-4	1299.0	comb	G4-1299	0.0044	1.549		31
				0.00065	0.0591		
USW G-4	1299.0	a	G4-1299a	0.005	1.6		11
				0.001	0.0881		
USW G-4	1299.0	b	G4-1299b	0.0037	1.511		11
				0.0005	0.0478		
USW G-4	1299.0	c	G4-1299c	0.00376	1.625		9
				0.0005	0.0729		
USW G-4	1324.0	comb	G4-1324	0.0017	1.706		24
				0.0003	0.1376		
USW G-4	1324.0	a	G4-1324a	0.0045	1.377		8
				0.0021	0.0974		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

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Data Compilation Form for Saturation Curve-Fit Parameters
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PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r^2 SE(S_r)	No. of Points
USW G-4	1324.0	b	G4-1324b	0.0012	1.679		8
				0.00024	0.1406		
USW G-4	1324.0	c	G4-1324c	0.0016	2.001		8
				0.00035	0.285		
USW GU-3	1311.0	comb	GU3-1311	0.0175	2.827		15
				0.0017	0.3117		
USW GU-3	1311	a	GU3-1311a	0.0203	2.475		7
				0.0037	0.346		
USW GU-3	1311.0	b	GU3-1311b	0.0152	3.577		8
				0.0012	0.558		
USW GU-3	1331.0	comb	G1-1331	0.011	3.26		8
				0.0056	1.181		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

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PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW GU-3	1331.0	a	GU3-1331a	0.0096	3.733		4
				0.016	5.408		
USW GU-3	1331.0	b	GU3-1331b	0.0067	2.247		4
				0.0033	0.3285		
USW GU-3	1440.0	comb	GU3-1440	0.0161	3.372		16
				0.0011	0.3941		
USW GU-3	1440.0	a	GU3-1440a	0.0162	3.779		9
				0.0012	0.6318		
USW GU-3	1440.0	b	GU3-1440b	0.0144	3.354		7
				0.0009	0.3586		
USW GU-3	1499.0	comb	GU3-1499	0.0458	1.463		15
				0.017	0.0761		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

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PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW GU-3	1499.0	a	GU3-1499a	0.0326	1.571		8
				0.0154	0.117		
USW GU-3	1499.0	b	GU3-1499b	0.0631	1.376		7
				0.0434	0.1069		
USW GU-3	1555.0	comb	GU3-1555	0.0155	10.137	0.1893	9
				0.0004	3.071	0.0369	
USW G-4	1359.0	comb	G4-1359	0.0265	2.221	0.1636	31
				0.0044	0.303	0.0202	
USW G-4	1359.0	a	G4-1359a	0.043	1.651	0.1027	10
				0.0148	0.272	0.0664	
USW G-4	1359.0	b	G4-1359b	0.0212	2.648	0.1315	11
				0.003	0.3835	0.0176	

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

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Data Compilation Form for Saturation Curve-Fit Parameters
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PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-1	1500.0	comb	G1-1500	0.0071	1.333		32
				0.001	0.0197		
USW G-1	1500.0	a	G1-1500a	0.0048	1.367		15
				0.0008	0.0267		
USW G-1	1500.0	b	G1-1500b	0.0087	1.324		17
				0.0015	0.023		
USW G-4	1551.0	comb	G4-1551	0.0042	1.9037	0.2077	34
				0.00028	0.1045	0.0259	
USW G-4	1551.0	a	G4-1551a	0.0048	1.848	0.1756	11
				0.00055	0.1635	0.0453	
USW G-4	1551.0	b	G4-1551b	0.0044	1.782	0.2145	12
				0.00023	0.0653	0.0201	

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

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Data Compilation Form for Saturation Curve-Fit Parameters
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PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-4	1551.0	c	G4-1551c	0.0035	2.169	0.23	11
				0.00021	0.1493	0.025	
USW G-1	1637.0	comb	G1-1637	0.0028	1.386		31
				0.00043	0.03		
USW G-1	1637.0	a	G1-1637a	0.004	1.372		16
				0.0004	0.0169		
USW G-1	1637.0	b	G1-1637b	0.00189	1.416		15
				0.00008	0.0107		
USW G-1	1753.0	comb	G1-1753	0.002	1.961	0.2055	27
				0.00011	0.0864	0.018	
USW G-1	1753.0	a	G1-1753a	0.002	2.071	0.2157	14
				0.00011	0.1	0.0179	

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

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Data Compilation Form for Saturation Curve-Fit Parameters
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PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-1	1753.0	b	G1-1753b	0.002	1.845	0.189	13
				0.0002	0.1225	0.0313	
USW G-1	1780.0	comb	G1-1780	0.0044	1.376		28
				0.0005	0.02		
USW G-1	1780.0	a	G1-1780a	0.0056	1.357		14
				0.0007	0.0203		
USW G-1	1780.0	b	G1-1780b	0.0032	1.412		14
				0.0004	0.0276		
USW G-1	1790.0	comb	G1-1790	0.00171	1.606		24
				0.00009	0.0254		
USW G-1	1790.0	a	G1-1790a	0.0017	1.625		12
				0.00012	0.335		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

SNL Data Report No.: SAND87-2380 QA Level of Calculational Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) Specimens (or subsamples) were taken from a core sample and tests were made on each specimen. The individual specimens are denoted by "a", "b", and "c". In most cases, the data from specimens taken from a core sample were combined and a curve-fit through all these data points was obtained; this curve fit for the combined data set is denoted by "comb".

2) No entry in this column indicates that statistical tests determined the value should be set to zero.

Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-1	1790.0	b	G1-1790b	0.0017	1.591		12
				0.00015	0.0388		
USW G-1	1821.0	comb	G1-1821	0.0061	1.473		29
				0.00067	0.0256		
USW G-1	1821.0	a	G1-1821a	0.0061	1.481		14
				0.00098	0.039		
USW G-1	1821.0	b	G1-1821b	0.0061	1.467		15
				0.00097	0.036		
USW G-1	1841.0	comb	G1-1841	0.0174	1.391		26
				0.0046	0.04		
USW G-1	1841.0	a	G1-1841a	0.0097	1.427		13
				0.0019	0.0368		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

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PART 4 Reference and Supporting Information

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Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-1	1841.0	b	G1-1841b	0.0267	1.386		13
				0.0072	0.0389		
USW G-4	1405.0	comb	G4-1405	0.0193	1.243		27
				0.0061	0.0287		
USW G-4	1405.0	a	G4-1405a	0.0197	1.254		10
				0.0062	0.031		
USW G-4	1405.0	b	G4-1405b	0.0273	1.249		9
				0.0122	0.0405		
USW G-4	1405.0	c	G4-1405c	0.0049	1.343		8
				0.002	0.0772		
USW G-4	1548.0	comb	G4-1548	0.0035	1.45		27
				0.00033	0.0268		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

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Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-4	1548.0	a	G4-1548a	0.0033	1.435		9
				0.0006	0.0482		
USW G-4	1548.0	b	G4-1548b	0.0034	1.461		9
				0.00052	0.0427		
USW G-4	1548.0	c	G4-1548c	0.0035	1.473		9
				0.00053	0.048		
USW G-4	1551.0	comb	G4-1551	0.0042	1.904	0.2077	4
				0.00028	0.1045	0.026	
USW G-4	1551.0	a	G4-1551a	0.0047	1.848	0.1756	11
				0.00055	0.1635	0.0453	
USW G-4	1551.0	b	G4-1551b	0.0044	1.782	0.2145	12
				0.0002	0.0653	0.0201	

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

SNL Data Report No.: SAND87-2380 QA Level of Calculational Activity: TBD

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2) No entry in this column indicates that statistical tests determined the value should be set to zero.

Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-4	1551.0	c	G4-1551c	0.0035	2.169	0.23	11
				0.0002	0.1493	0.0249	
USW G-4	1686.0	comb	G4-1686	0.0063	1.41		35
				0.00072	0.0249		
USW G-4	1686.0	a	G4-1686a	0.01	1.365		12
				0.001	0.0189		
USW G-4	1686.0	b	G4-1686b	0.00512	1.458		12
				0.00046	0.025		
USW G-4	1686.0	c	G4-1686c	0.0035	1.495		11
				0.00031	0.0271		
USW G-4	1728.0	comb	G4-1728	0.00165	1.499		26
				0.00033	0.0843		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

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Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-4	1728.0	a	G4-1728a	0.0007	1.763		8
				0.00004	0.0619		
USW G-4	1728.0	b	G4-1728b	0.0026	1.398		9
				0.0006	0.0581		
USW G-4	1728.0	c	G4-1728c	0.0029	1.415		9
				0.00035	0.0335		
USW G-4	1737.0	comb	G4-1737	0.0037	1.515	0.1196	25
				0.00048	0.0973	0.06	
USW G-4	1737.0	a	G4-1737a	0.0037	1.574	0.188	8
				0.00025	0.0529	0.024	
USW G-4	1737.0	b	G4-1737b	0.00264	1.688	0.169	8
				0.0003	0.1183	0.044	

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

SNL Data Report No.: SAND87-2380 QA Level of Calculational Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

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Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-4	1737.0	c	G4-1737a	0.0043	1.446	0.0565	9
				0.0011	0.1717	0.1459	
USW G-4	1769.0	comb	G4-1769	0.0006	2.484		19
				0.00003	0.1463		
USW G-4	1769.0	a	G4-1769a	0.00064	2.381		9
				0.00005	0.268		
USW G-4	1769.0	b	G4-1769b	0.00059	2.406		5
				0.000034	0.1243		
USW G-4	1769.0	c	G4-1769c	0.00052	2.671		5
				0.00002	0.1026		
USW G-4	1778.0	comb	G4-1778	0.0049	1.404		36
				0.00055	0.025		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

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Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-4	1778.0	a	G4-1778a	0.0048	1.385		12
				0.0012	0.0531		
USW G-4	1778.0	b	G4-1778b	0.0062	1.381		11
				0.001	0.0332		
USW G-4	1778.0	c	G4-1778c	0.004	1.458		13
				0.004	0.0301		
USW G-4	1778.1F	comb	G4-1778F	0.0012	3.322	0.1938	36
				0.00002	0.1754	0.0182	
USW G-4	1778.1	a	G4-1778Fa	0.0012	3.335	0.2073	14
				0.00003	0.1885	0.0189	
USW G-4	1778.1	b	G4-1778Fb	0.00112	3.213	0.1855	11
				0.00004	0.3247	0.0371	

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

SNL Data Report No.: SAND87-2380 QA Level of Calculational Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) Specimens (or subsamples) were taken from a core sample and tests were made on each specimen. The individual specimens are denoted by "a", "b", and "c". In most cases, the data from specimens taken from a core sample were combined and a curve-fit through all these data points was obtained; this curve fit for the combined data set is denoted by "comb".

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Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-4	1778.1	c	G4-1778Fc	0.00127	3.274	0.1854	11
				0.00005	0.287	0.0302	
USW G-4	1787.0	comb	G4-1787	0.003	1.603		26
				0.0005	0.0802		
USW G-4	1787.0	a	G4-1787a	0.0037	1.51		8
				0.0007	0.07		
USW G-4	1787.0	b	G4-1787b	0.0018	1.788		9
				0.00025	0.1213		
USW G-4	1787.0	c	G4-1787c	0.0042	1.6		9
				0.0008	0.0827		

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

SNL Data Report No.: SAND87-2380 QA Level of Calculational Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) Specimens (or subsamples) were taken from a core sample and tests were made on each specimen. The individual specimens are denoted by "a", "b", and "c". In most cases, the data from specimens taken from a core sample were combined and a curve-fit through all these data points was obtained; this curve fit for the combined data set is denoted by "comb".

2) No entry in this column indicates that statistical tests determined the value should be set to zero.

Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-1	1359.1	comb	G1-1359[3]	0.191	2.796	0.349	28
				---	---	---	(top)
				0.0002	3.212	0.0459	
				---	---	---	(bottom)
USW G-1	1387.0	comb	G1-1387[3]	0.0197	5.020	0.3418	26
				---	---	---	(top)
				0.0002	3.721	0.0477	
				---	---	---	(bottom)

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

SNL Data Report No.: SAND87-2380 QA Level of Calculational Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) Specimens (or subsamples) were taken from a core sample and tests were made on each specimen. The individual specimens are denoted by "a", "b", and "c". In most cases, the data from specimens taken from a core sample were combined and a curve-fit through all these data points was obtained; this curve fit for the combined data set is denoted by "comb".

2) No entry in this column indicates that statistical tests determined the value should be set to zero.

3) The curve fit for these two samples is the sum of two van Genuchten curves.

Data Compilation Form for Saturation Curve-Fit Parameters
for Input to the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Values

Drill Hole	Depth (ft)	Specimen[1]	ID	α SE(α)	β SE(β)	S_r[2] SE(S_r)	No. of Points
USW G-1	1359.1	comb	G1-1359[3]	0.191	2.796	0.349	28
				---	---	---	(top)
				0.0002	3.212	0.0459	
				---	---	---	(bottom)
USW G-1	1387.0	comb	G1-1387[3]	0.0197	5.020	0.3418	26
				---	---	---	(top)
				0.0002	3.721	0.0477	
				---	---	---	(bottom)

Uncertainty: The uncertainty in the calculated curve-fit parameters is listed explicitly as the standard error of the parameter (e.g., SE(α) is the standard error of α).

PART 3 Calculations

Saturation data were fit using the equation suggested by van Genuchten. Discussion of fitting procedure may be found in SAND87-2380.

PART 4 Reference and Supporting Information

SNL Data Report No.: SAND87-2380 QA Level of Calculational Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) Specimens (or subsamples) were taken from a core sample and tests were made on each specimen. The individual specimens are denoted by "a", "b", and "c". In most cases, the data from specimens taken from a core sample were combined and a curve-fit through all these data points was obtained; this curve fit for the combined data set is denoted by "comb".

2) No entry in this column indicates that statistical tests determined the value should be set to zero.

3) The curve fit for these two samples is the sum of two van Genuchten curves.

APPENDIX D

LISTING OF REPRESENTATIVE SPECIMENS

This appendix lists the candidates for the representative specimen from each of the regions. The first value on the list in each region represents the "most representative specimen," the second represents the second "most representative specimen," etc. The regions are separated by a blank line and can be identified by hole and unit. The abbreviated headings are the same as those used in Appendix A, but these tables give the rankings by variable as discussed in Chapter 7. These rankings are then weighted and summed to get the overall ranking. For the one tie-in overall ranking, which occurred in CHnv Holes USW G-1 and USW G-4, the representative specimen was taken from Hole USW G-4.

YUCCA MOUNTAIN DATA

HOLE	UNIT	DEPTH	SPECIMEN	HD6	HD8	MMC	LOG_HYC	SUM
G1	TSW2	1198.0	A	4	2	6	4	13.0
G1	TSW1	615.5	A	2	1	5	15	21.5
G1	TSW2	1102.0	B	1	5	4	17	24.0
G4	TSW2	1215.0	B	22	19	3	1	24.5
G1	TSW1	752.0	A	5	3	16	5	25.0
G4	TSW2	1158.0	A	12	10	1	13	25.0
G4	TSW2	1256.0	A	8	11	11	7	27.5
G4	TSW2	864.0	B	9	14	9	8	28.5
G4	TSW2	1215.0	A	23	22	2	9	33.5
G4	TSW2	1215.0	C	21	26	10	3	36.5
GU3	TSW1	585.1	A	20	21	13	6	39.5
GU3	TSW1	686.6	B	6	4	12	24	41.0
GU3	TSW1	686.6	A	14	13	7	21	41.5
G1	TSW1	615.5	B	10	7	15	22	45.5
G1	TSW2	1198.0	B	11	8	8	28	45.5
G4	TSW2	864.0	A	16	15	14	16	45.5
G4	TSW2	1278.0	A	28	25	18	2	46.5
G1	TSW2	1102.0	A	3	6	21	23	48.5
G4	TSW2	864.0	C	13	12	22	14	48.5
GU3	TSW2	1132.0	A	15	16	17	18	50.5
GU3	TSW1	585.1	B	17	18	27	11	55.5
G4	TSW2	1278.0	C	27	28	20	10	57.5
G1	TSW1	388.8	A	24	23	23	12	58.5
G4	TSW1	247.0	A	7	9	28	25	61.0
G4	TSW2	864.1	A	19	20	25	20	64.5
G4	TSW2	1278.0	B	26	27	19	19	64.5
GU3	TSW2	884.4	A	18	17	24	26	67.5
G1	TSW1	388.8	B	25	24	26	27	77.5
G1	TSW3	1306.0	A	2	2	1	2	5.0
GU3	TSW3	1197.0	A	1	4	2	1	5.5
GU3	TSW3	1246.0	A	4	3	3	4	10.5
G4	TSW3	1299.0	A	3	1	5	5	12.0
G4	TSW3	1324.0	A	5	5	4	3	12.0

YUCCA MOUNTAIN DATA

HOLE	UNIT	DEPTH	SPECIMEN	HD6	HD8	MMC	LOG_HYC	SUM
G1	CHNV	1359.1	A	2	1	3	1	5.5
G4	CHNV	1359.0	A	1	2	2	2	5.5
G4	CHNV	1359.0	B	4	3	1	3	7.5
G1	CHNV	1387.0	A	3	4	4	4	11.5
GU3	CHNV	1555.0	A	1	2	1	1	3.5
GU3	CHNV	1499.0	A	2	4	2	2	7.0
GU3	CHNV	1440.0	A	3	1	4	3	9.0
GU3	CHNV	1331.0	A	5	5	3	4	12.0
GU3	CHNV	1311.0	A	4	3	5	5	13.5
G1	CHNZ	1753.0	B	10	11	1	4	15.5
G4	CHNZ	1548.0	A	2	3	12	2	16.5
G1	CHNZ	1753.0	A	1	9	9	6	20.0
G4	CHNZ	1548.0	B	5	5	2	21	28.0
G4	CHNZ	1548.0	C	8	7	10	12	29.5
G1	CHNZ	1500.0	A	6	13	18	5	32.5
G1	CHNZ	1637.0	A	4	6	17	11	33.0
G4	CHNZ	1728.0	C	14	2	13	13	34.0
G4	CHNZ	1787.0	B	3	10	16	14	36.5
G4	CHNZ	1778.1	B	16	24	15	7	42.0
G4	CHNZ	1551.0	C	35	34	7	1	42.5
G1	CHNZ	1637.0	B	25	20	6	15	43.5
G4	CHNZ	1728.0	A	31	30	4	9	43.5
G4	CHNZ	1737.0	A	22	15	23	3	44.5
G4	CHNZ	1778.1	A	12	23	8	19	44.5
G4	CHNZ	1778.1	C	7	22	14	16	44.5
G4	CHNZ	1551.0	B	34	33	3	10	46.5
G4	CHNZ	1728.0	B	21	8	19	17	50.5
G4	CHNZ	1778.0	A	11	17	20	20	54.0
G4	CHNZ	1787.0	A	18	12	5	35	55.0
G1	CHNZ	1780.0	B	9	1	22	31	58.0
G4	CHNZ	1737.0	C	17	16	24	18	58.5
G1	CHNZ	1500.0	B	23	27	32	8	65.0

YUCCA MOUNTAIN DATA

HOLE	UNIT	DEPTH	SPECIMEN	HD6	HD8	MMC	LOG_HYC	SUM
G4	CHNZ	1787	C	24	21	11	32	65.5
G1	CHNZ	1780	A	13	19	21	30	67.0
G1	CHNZ	1790	A	19	14	34	22	72.5
G1	CHNZ	1790	B	20	18	31	23	73.0
G4	CHNZ	1737	B	15	4	30	36	75.5
G1	CHNZ	1821	B	26	25	26	25	76.5
G1	CHNZ	1821	A	27	26	29	24	79.5
G4	CHNZ	1769	A	29	31	25	29	84.0
G4	CHNZ	1686	A	28	28	33	26	87.0
G4	CHNZ	1551	A	33	35	28	27	89.0
G1	CHNZ	1841	A	32	29	27	34	91.5
G4	CHNZ	1405	A	30	32	35	28	94.0
G1	CHNZ	1841	B	36	36	36	33	105.0

APPENDIX E

KEYSTONE DOCUMENT 6310-85-10 HYDROLOGIC DATA

This appendix contains the contents of Keystone Document 6310-85-10 as published on November 20, 1985. This appendix is included in this report in order to provide the data in the Keystone Document in a form that may be referenced.

Sandia National Laboratories

Albuquerque, New Mexico 87185

date: November 20, 1985

to: Distribution

from: Ralph Peters, 6312 R.R. Peters
Elmer Klavetter, 6313 E. A. Klavetter

subject: Recently Acquired Data on Saturated Hydraulic Conductivity and Saturation as a Function of Pressure Head for Tuff Samples from USW G-1, USW GU-3, and USW G-4

Pacific Northwest Laboratories (PNL) has served as a contractor to measure hydrologic properties for SNL. Previous hydrologic data have been published jointly by SNL and PNL in the Sandia technical report SAND84-1471, "Fracture and Matrix Hydrologic Characteristics of Tuffaceous Materials from Yucca Mountain, Nye County, Nevada." Glendon Gee, Paula Heller, and Steve Blair were responsible for the hydrologic testing at PNL for the data in that report. The data included saturated fracture hydraulic conductivities, saturated matrix hydraulic conductivities, and matrix saturation as a function of pressure head for samples from drill holes USW GU-3 and USW G-4, on and adjacent to the Nevada Test Site.

Attached to this memo are (1) a PNL letter report containing data on saturated matrix hydraulic conductivity for 40 tuff samples from drill holes USW G-1, USW GU-3, and USW G-4 and data on matrix saturations as a function of pressure head (referred to as water-retention data and desaturation data in the PNL letter report) for 20 samples from USW G-1, USW GU-3, and USW G-4, and (2) an appendix containing plots of data on saturation as a function of pressure head and a curve fit of those data. The PNL letter report has had only one minor change; a new column indicating the current unit name ("Current Unit Designator") has been added. The two unit designator columns show the unit names used in the past (e.g., in SAND84-1471) and those used currently. The majority of the samples are from depths above the water table. In the PNL letter report, the term "sample" refers to a piece of core from a specified depth. The term "subsample" then refers to a small piece (approximately three to four grams) taken from the "sample." A brief discussion on the testing methods is provided in the PNL letter report; for more detailed information, refer to the previously mentioned Sandia report, SAND84-1471. The functional form of the saturation curve is provided in the appendix with the curve-fitting parameter values listed on the plot for each sample. Again, for more information, refer to SAND84-1471.

The data in this document appear to be consistent with the data provided in SAND84-1471, but are being examined in more detail to determine the variation of the results for samples within a particular hydrogeologic unit and between drill holes. This document was written to present acquired hydrologic data as quickly as possible to interested NNWSI participants. A comprehensive report will be written in the future; it will contain all the data, statistical analysis of the data, comparisons of testing methods, etc. If there are any questions concerning the data, please refer them to Ralph Peters (844-4001) or Elmer Klavetter (846-9647).

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Letter Report

WATER RETENTION CHARACTERISTICS AND HYDRAULIC CONDUCTIVITIES FOR TUFFACEOUS MATERIAL FROM THE NEVADA TEST SITE - 1985 SAMPLE TESTS

Paula R. Heller
Pacific Northwest Laboratory
September, 1985

Forty tuff samples taken from the USWG-4, USWG-1 and USWGU-3 wells at the Nevada Test Site were evaluated in this study. Twenty designated samples were evaluated for water retention characteristics and saturated hydraulic conductivity. The other twenty samples were analyzed for saturated hydraulic conductivity only. The bulk density of each individual subsample was measured to determine the volumetric water content. The desaturation values and hydraulic conductivities were determined after vacuum saturation.

The following samples were tested for both saturated hydraulic conductivity and water retention characteristics.

Drill Hole	PNL No.	Core Depth (feet)	Former Unit Designator	Current Unit Designator
USWG-1	G1-1	388.8	II-L	TSw1
	G1-2	515.5	II-L	TSw1
	G1-3	1101.8	II-NL	TSw2
	G1-4	1198.3	II-NL	TSw2
	G1-5	1306.3	III	TSw3
	G1-6	1359.3	IV-A-v	CHn1v
	G1-7	1386.7	IV-A-v	CHn1v
	G1-8	1499.8	IV-A-z	CHn1z
	G1-9	1637.0	IV-A-z	CHn1z
	G1-10	1752.7	IV-B-z	CHn2z
	G1-11	1779.5	IV-B-z	CHn2z
	G1-12	1789.6	IV-B-z	CHn2z
	G1-13	1820.7	IV-C-z	CHn3z
	G1-14	1841.1	IV-C-z	CHn3z
	G1-15	1917.4	V	PPw
USWGU-3	GU3-101	585.1	II-L	TSw1
	GU3-102	686.6	II-L	TSw1
	GU3-103	684.4	II-NL	TSw2
USWG-4	G4-101	136.0	I-B	PTn
	G4-102	172.0	I-B	PTn

The following samples were tested for saturated hydraulic conductivity only:

Drill Hole	PNL No.	Depth (feet)	Former Unit Designator	Current Unit Designator
USWG-1	G1-16	1349.9	IV-A-v	CHnlv
	G1-17	1979.3	V	PPw
USWGU-3	GU3-104	801.0	II-NL	TSw2
	GU3-105	1036.5	II-NL	TSw2
USWG-4	G4-103	105.3	I-A	TCw
	G4-104	145.0	I-B	PTn
	G4-105	240.0	I-B	PTn
	G4-106	445.0	II-L	TSwl
	G4-107	521.8	II-L	TSwl
	G4-108	1020.7	II-NL	TSw2
	G4-109	1184.3	II-NL	TSw2
	G4-110	1306.9	III	TSw3
	G4-111	1344.8	III	TSw3
	G4-112	1353.5	IV-A-v	CHnlv
	G4-113	1375.8	IV-A-z	CHnlz
	G4-114	1489.8	IV-A-z	CHnlz
	G4-115	1596.8	IV-A-z	CHn2z
	G4-116	1714.5	IV-B-z	CHn2z
	G4-117	1746.8	IV-B-z	CHn2z
	G4-118	1849.0	V	PPw

Methods

The samples were received as large cores. Subsamples 1.5 cm x 1.2 cm (dia x height) were cut from the large core samples. As per instructions, two subsamples from each of the samples to be evaluated for desaturation values and hydraulic conductivity were tested and one subsample from each sample to be evaluated for hydraulic conductivity only was tested. The subsamples were then saturated with J-13 well water from the Nevada Test Site. The samples were placed in a vacuum desiccator, and enough water was added to cover the samples. The desiccator was evacuated for two hours and the samples were allowed to equilibrate in the water under vacuum for 48 hr. The samples were wiped clean of free water and weighed. Over a period of several days, water retention characteristics were determined using a commercial sample changing psychrometer (Decagon, Inc., Pullman, WA). The samples were placed in small cups that fit into vapor-tight chambers in the sample changer. After approximately one hour, the relative humidity was measured with a miniature thermocouple psychrometer. The samples were removed, dried slightly in a microwave oven, weighed, placed in the psychrometer sample changer, and the process repeated.

The hydraulic conductivity was determined using a Ruska Liquid Permeameter (Ruska Instr. Corp., Houston, Texas). This method measures conductivity by determining the time necessary for a given amount of liquid to pass through the subsample under a fixed pressure gradient. A saturated sample, 1.5 cm x 1.2 cm (dia x height) was inserted into a coreholder. The coreholder and buret above the sample were filled with J-13 well water to a level slightly

above an upper index mark. A 2214 cm pressure gradient was applied to the liquid from the top of the buret. The time necessary for the water to drop from the upper index mark to the lower index mark was recorded and the hydraulic conductivity calculated using the following equation:

$$K = (Q/A\Delta t)(L/\Delta H)$$

where Q = volume of water passing through the samples (cm^3)
A = cross-sectional area of the sample (cm^2)
Δt = time (sec)
L = length of sample (cm)
ΔH = hydraulic head difference (cm).

(Details of the above procedures are given in Peters, R. R., et al., 1985). After completion of all the tests, the samples were thoroughly dried in a convection oven at 110°C for 24 hr.

To determine the water retention characteristics at high suction head, vapor pressure equilibrium techniques were used (ASTM E 104-51). Approximately 500 ml of a saturated salt solution, having the desired relative humidity, was placed in the bottom of an airtight vessel. A shelf was placed in the vessel well above the solution and the core samples placed on the shelf. The samples were weighed every few days and as the weight began to reach equilibrium the samples were weighed every day. When each sample weight differed by less than ± 0.0005 g over the 24 hr period the samples were oven dried and the water content calculated.

Results and Discussion

Table 1 presents the desaturation and suction head values for the twenty designated samples. Table 2 presents the hydraulic conductivities for all 40 samples. Because of either brittleness or softness several samples were broken when being loaded into the coreholder of the permeameter. Sample G4-102 could not be cut into a regular shape to be put into the coreholder. For these reasons no hydraulic conductivities were obtained on samples G4-102 a and b, G1-5b, GU3-103b, or G4-111.

The desaturation values for each sample at 30773 m head (Table 1) were obtained using vapor pressure equilibrium techniques. A saturated salt solution of 11% relative humidity was put in the bottom of a desiccator. The saturated samples were placed on a plate a few cm above the solution and the desiccator sealed to maintain a constant humdity. The samples were weighed once or twice during the first week and then everyday until they reached equilibrium. The samples were oven dried (24 hrs at 110°C) and the water content calculated. The 9631 head values and corresponding desaturation values were obtained by air drying the samples in the lab (uncontrolled atmosphere) and measuring the relative humidity of the room air just before the samples were oven dried. Because of changes in room temperature and humidity during the drying process, these values are not as reliable as the controlled atmosphere values at 30773 m.

Table 1. Density and water retention data for designated samples samples from Drill Holes USWG-4, USUG-1, and USWGU-3

SAMPLE	CORE DEPTH ft	DENSITY (g/cm^3)	SUCTION HEAD meters	WATER CONTENT (g/g)	WATER CONTENT (vol/vol)
G1-1a	388.8	2.14	0	0.0570	0.122
			16	0.0570	0.122
			28	0.0505	0.108
			53	0.0295	0.063
			105	0.0224	0.048
			231	0.0194	0.042
			542	0.0153	0.033
			664	0.0147	0.031
			1007	0.0110	0.024
			1248	0.0093	0.020
			1675	0.0085	0.018
			2406	0.0044	0.009
			9631	0.0013	0.003
			30773	0.0008	0.002
G1-1b	385.8	2.21	0	0.0593	0.131
			20	0.0593	0.131
			43	0.0353	0.078
			103	0.0225	0.050
			217	0.0189	0.042
			401	0.0143	0.032
			598	0.0124	0.027
			751	0.0108	0.024
			1161	0.0087	0.019
			1378	0.0078	0.017
			1560	0.0069	0.015
			2175	0.0042	0.009
			2475	0.0036	0.008
			3358	0.0025	0.006
			9631	0.0015	0.003
			30773	0.0007	0.002
G1-2a	615.5	2.18	0	0.0457	0.100
			22	0.0457	0.100
			91	0.0412	0.090
			143	0.0358	0.078
			384	0.0277	0.060
			489	0.0258	0.056
			703	0.0212	0.046
			874	0.0201	0.044
			996	0.0156	0.034
			1221	0.0143	0.031
			1548	0.0127	0.028
			1780	0.0106	0.023

SAMPLE	DEPTH ft	CORE DENSITY (g/cm^3)	SUCTION HEAD meters	WATER CONTENT (g/g)	(vol/vol)
G1-2a	615.5	2.18	3061	0.0092	0.020
			4192	0.0069	0.015
			9531	0.0048	0.010
			30773	0.0002	0.001
G1-2b	615.5	2.28	0	0.0324	0.074
			28	0.0324	0.074
			114	0.0285	0.065
			316	0.0258	0.059
			550	0.0203	0.046
			890	0.0179	0.041
			999	0.0152	0.035
			1558	0.0144	0.033
			1693	0.0126	0.029
			1958	0.0116	0.026
			2881	0.0097	0.022
			5022	0.0093	0.021
			5782	0.0056	0.020
			9531	0.0038	0.009
			30773	0.0017	0.004
G1-3a	1101.8	2.20	0	0.0541	0.119
			20	0.0541	0.119
			75	0.0490	0.108
			200	0.0371	0.082
			352	0.0306	0.067
			888	0.0256	0.056
			1136	0.0186	0.041
			1383	0.0177	0.039
			1884	0.0151	0.033
			2193	0.0145	0.032
			2744	0.0130	0.029
			3430	0.0105	0.023
			4089	0.0083	0.018
			4948	0.0068	0.015
			9631	0.0062	0.014
			30773	0.0034	0.007
G1-3b	1101.8	2.26	0	0.0423	0.096
			20	0.0423	0.096
			39	0.0355	0.082
			168	0.0332	0.075
			371	0.0261	0.059
			510	0.0225	0.051
			715	0.0214	0.048
			1072	0.0178	0.040
			1251	0.0165	0.037
			1463	0.0154	0.035
			1805	0.0146	0.033
			2069	0.0132	0.030

SAMPLE	DEPTH ft	DENSITY (g/cm^3)	SUCTION HEAD meters	WATER CONTENT (g/g)	(vol/vol)
			2454	0.0126	0.028
			3514	0.0097	0.022
			4211	0.0084	0.019
			9631	0.0049	0.011
			30773	0.0028	0.006
G1-4a	1198.3	2.31	0	0.0369	0.085
			30	0.0369	0.085
			188	0.0325	0.075
			323	0.0263	0.061
			508	0.0204	0.047
			669	0.0193	0.045
			827	0.0186	0.043
			1286	0.0162	0.037
			1867	0.0147	0.034
			2136	0.0130	0.030
			3676	0.0104	0.024
			4379	0.0075	0.017
			9631	0.0054	0.012
			30773	0.0033	0.008
G1-4b	1198.3	2.31	0	0.0360	0.083
			30	0.0360	0.083
			380	0.0313	0.072
			526	0.0218	0.050
			703	0.0190	0.044
			852	0.0181	0.042
			1099	0.0174	0.040
			1585	0.0148	0.034
			1758	0.0143	0.033
			2223	0.0129	0.030
			2637	0.0114	0.026
			3569	0.0096	0.022
			4001	0.0082	0.019
			9631	0.0062	0.014
			30773	0.0034	0.008
G1-5a	1306.3	2.30	0	0.0149	0.034
			30	0.0149	0.034
			114	0.0118	0.027
			137	0.0105	0.024
			899	0.0094	0.022
			1234	0.0074	0.017
			1566	0.0061	0.014
			1779	0.0056	0.013
			2153	0.0049	0.011

SAMPLE	DEPTH ft	DENSITY (g/cm^3)	SUCTION HEAD meters	WATER CONTENT (g/g)	(vol/vol)
G1-5a	1306.3	2.30	2751	0.0044	0.010
			3432	0.0036	0.005
			9631	0.0012	0.003
			30773	0.0006	0.001
G1-5b	1306.3	2.15	0	0.0073	0.016
			18	0.0073	0.016
			218	0.0059	0.013
			432	0.0053	0.011
			853	0.0040	0.009
			1109	0.0037	0.008
			1477	0.0035	0.008
			1884	0.0032	0.007
			2592	0.0029	0.006
			3145	0.0023	0.005
			4135	0.0021	0.005
			9631	0.0001	0.001
			30773	0.0008	0.002
G1-6a	1359.3	1.95	0	0.0856	0.167
			16	0.0856	0.167
			31	0.0759	0.148
			123	0.0439	0.086
			472	0.0320	0.062
			1067	0.0293	0.057
			1968	0.0278	0.054
			2809	0.0264	0.051
			3040	0.0225	0.044
			3211	0.0213	0.042
			4925	0.0171	0.033
			9631	0.0069	0.013
			30773	0.0045	0.009
G1-6b	1359.3	1.95	0	0.0853	0.166
			16	0.0853	0.166
			39	0.0764	0.149
			81	0.0503	0.098
			114	0.0399	0.078
			196	0.0358	0.070
			885	0.0320	0.062
			2211	0.0294	0.057
			2925	0.0281	0.055
			3569	0.0254	0.050
			3718	0.0225	0.044
			4604	0.0213	0.042
			5694	0.0168	0.033
			9631	0.0074	0.014
			30773	0.0051	0.010

SAMPLE	DEPTH ft	DENSITY (g/cm^3)	SUCTION HEAD meters	WATER CONTENT (g/g)	(vol/vol)
G1-7a	1386.7	1.50	0	0.1917	0.288
			16	0.1917	0.288
			39	0.1911	0.287
			71	0.1079	0.162
			420	0.0755	0.113
			1283	0.0588	0.103
			2641	0.0643	0.096
			3251	0.0614	0.092
			3461	0.0584	0.088
			3860	0.0550	0.083
			4147	0.0508	0.076
			4485	0.0459	0.069
			9631	0.0192	0.029
			30773	0.0114	0.017
G1-7b	1386.7	1.57	0	0.1897	0.298
			14	0.1897	0.298
			41	0.1422	0.223
			67	0.0983	0.154
			79	0.0717	0.113
			558	0.0586	0.092
			1023	0.0544	0.085
			2334	0.0497	0.078
			3113	0.0460	0.072
			6337	0.0222	0.035
			9631	0.0140	0.022
			30773	0.0087	0.014
G1-8a	1499.8	1.55	0	0.2153	0.334
			12	0.2153	0.334
			35	0.2020	0.313
			74	0.1837	0.285
			372	0.1643	0.255
			607	0.1379	0.214
			805	0.1270	0.197
			1054	0.1180	0.183
			1635	0.0958	0.148
			2036	0.0913	0.142
			2486	0.0871	0.135
			3271	0.0816	0.126
			3881	0.0768	0.119
			8903	0.0498	0.077
			9631	0.0496	0.077
			30773	0.0299	0.046
G1-8b	1499.8	1.50	0	0.2428	0.364
			16	0.2428	0.364
			39	0.2308	0.346
			60	0.1965	0.295
			220	0.1781	0.267

SAMPLE	DEPTH ft	DENSITY (g/cm^3)	SUCTION HEAD meters	WATER CONTENT (g/g)	(vol/vol)
G1-8b	1499.8	1.50	394	0.1655	0.248
			515	0.1499	0.225
			654	0.1352	0.204
			889	0.1238	0.185
			1092	0.1150	0.173
			1217	0.1087	0.163
			1747	0.1036	0.155
			2124	0.0941	0.141
			2881	0.0888	0.133
			4274	0.0776	0.116
			9356	0.0545	0.082
			9631	0.0503	0.075
			30773	0.0305	0.046
G1-9a	1637.0	1.55	0	0.2119	0.328
			14	0.2119	0.328
			43	0.2000	0.310
			446	0.1581	0.245
			605	0.1415	0.219
			710	0.1315	0.204
			1059	0.1193	0.185
			1452	0.1101	0.171
			1942	0.1021	0.158
			2305	0.0918	0.142
			2727	0.0832	0.129
			3040	0.0791	0.123
			3906	0.0751	0.116
			4368	0.0713	0.111
			7858	0.0530	0.082
			9631	0.0522	0.081
			30773	0.0441	0.068
G1-9b	1637.0	1.66	0	0.1749	0.290
			6	0.1749	0.290
			244	0.1628	0.270
			662	0.1384	0.230
			858	0.1246	0.207
			1058	0.1172	0.195
			1383	0.1094	0.182
			1768	0.1021	0.169
			2105	0.0973	0.162
			2630	0.0843	0.140
			3375	0.0785	0.130
			4012	0.0749	0.124
			4344	0.0717	0.119
			7494	0.0574	0.095
			9631	0.0508	0.084
			30773	0.0345	0.057

SAMPLE	DEPTH ft	DENSITY (g/cm^3)	SUCTION HEAD meters	WATER CONTENT (g/g)	(vol/vol)
G1-10a	1752.7	1.66	0	0.1854	0.308
			20	0.1854	0.308
			74	0.1737	0.288
			279	0.1662	0.276
			395	0.1556	0.250
			675	0.1243	0.206
			817	0.1095	0.182
			1100	0.0989	0.164
			1362	0.0904	0.150
			1725	0.0752	0.125
			2188	0.0676	0.112
			3067	0.0599	0.099
			4316	0.0539	0.089
			9631	0.0485	0.081
			30773	0.0409	0.068
G1-10b	1752.7	1.62	0	0.1854	0.300
			20	0.1854	0.300
			95	0.1741	0.282
			358	0.1637	0.265
			508	0.1418	0.230
			737	0.1186	0.192
			1024	0.1064	0.172
			1369	0.0970	0.157
			1747	0.0901	0.145
			2031	0.0743	0.120
			3553	0.0666	0.108
			5281	0.0483	0.078
			9631	0.0480	0.078
			30773	0.0408	0.066
G1-11a	1779.5	1.83	0	0.1391	0.255
			28	0.1391	0.255
			97	0.1242	0.227
			153	0.1147	0.210
			292	0.1031	0.189
			473	0.0923	0.169
			666	0.0827	0.151
			1423	0.0725	0.133
			1974	0.0609	0.111
			2864	0.0551	0.101
			3493	0.0497	0.091
			4052	0.0444	0.081
			6975	0.0349	0.064
			9531	0.0255	0.047
			30773	0.0199	0.036

SAMPLE	DEPTH ft	DENSITY (g/cm^3)	SUCTION HEAD meters	WATER CONTENT (g/g)	(vol/vol)
G1-11b	1779.5	1.83	0	0.1371	0.251
			28	0.1371	0.251
			153	0.1215	0.222
			429	0.1014	0.186
			625	0.0913	0.167
			968	0.0817	0.150
			1357	0.0739	0.135
			1972	0.0650	0.119
			2967	0.0582	0.107
			3549	0.0524	0.096
			4290	0.0466	0.085
			5426	0.0462	0.085
			6818	0.0384	0.070
			9631	0.0236	0.043
			30773	0.0144	0.026
G1-12a	1789.6	1.95	0	0.1149	0.224
			59	0.1149	0.224
			390	0.1004	0.196
			461	0.0936	0.183
			761	0.0829	0.162
			921	0.0732	0.143
			1428	0.0598	0.117
			1812	0.0501	0.098
			2846	0.0440	0.086
			3804	0.0386	0.075
			4470	0.0281	0.055
			9631	0.0197	0.038
			30773	0.0126	0.025
G1-12b	1789.6	1.96	0	0.1189	0.233
			59	0.1189	0.233
			400	0.1051	0.206
			606	0.0873	0.171
			981	0.0766	0.150
			1174	0.0707	0.139
			1390	0.0624	0.122
			1985	0.0534	0.105
			2925	0.0478	0.094
			4147	0.0412	0.081
			6148	0.0318	0.062
			9631	0.0185	0.036
			30773	0.0078	0.015
G1-13a	1820.7	1.46	0	0.2423	0.354
			18	0.2423	0.354
			48	0.2265	0.331
			192	0.1668	0.244
			482	0.1470	0.215
			610	0.1289	0.188

SAMPLE	DEPTH ft	DENSITY (g/cm^3)	SUCTION HEAD meters	WATER CONTENT (g/g)	(vol/vol)
G1-13a	1820.7	1.46	958	0.1141	0.163
			1249	0.0960	0.140
			1431	0.0852	0.124
			1787	0.0709	0.104
			2948	0.0584	0.085
			3607	0.0470	0.069
			6754	0.0318	0.046
			9631	0.0308	0.045
			30773	0.0198	0.029
G1-13b	1820.7	1.50	0	0.2308	0.346
			19	0.2308	0.346
			64	0.1894	0.284
			217	0.1749	0.262
			464	0.1409	0.211
			661	0.1213	0.182
			1025	0.1036	0.155
			1167	0.0902	0.135
			1423	0.0786	0.118
			1862	0.0665	0.100
			3009	0.0566	0.085
			3589	0.0507	0.076
			4634	0.0455	0.068
			6369	0.0397	0.060
			9631	0.0384	0.058
			30773	0.0200	0.030
G1-14a	1841.1	1.52	0	0.2296	0.349
			14	0.2296	0.349
			130	0.1603	0.244
			341	0.1428	0.217
			414	0.1250	0.190
			727	0.1064	0.162
			1223	0.0906	0.138
			1442	0.0663	0.101
			2198	0.0544	0.083
			3079	0.0481	0.073
			3881	0.0419	0.064
			4611	0.0403	0.061
			9631	0.0336	0.051
			30773	0.0277	0.042
G1-14b	1841.1	1.39	0	0.2808	0.390
			21	0.2808	0.390
			43	0.1938	0.369
			231	3.1503	0.209
			358	0.1243	0.173
			634	0.0978	0.136
			813	0.0839	0.117
			1119	0.0741	0.103

SAMPLE	DEPTH ft	DENSITY (g/cm^3)	SUCTION HEAD meters	WATER CONTENT (g/g)	(vol/vol)
G1-14b	1841.1	1.39	1337	0.0635	0.088
			1633	0.0560	0.078
			2716	0.0506	0.070
			3472	0.0471	0.065
			9631	0.0345	0.048
			30773	0.0265	0.037
G1-15a	1917.4	1.77	0	0.1695	0.300
			19	0.1695	0.300
			62	0.1425	0.252
			100	0.0392	0.069
			194	0.0299	0.053
			324	0.0234	0.041
			490	0.0179	0.032
			779	0.0143	0.025
			1614	0.0093	0.016
			2374	0.0063	0.011
			4627	0.0048	0.008
			6085	0.0047	0.008
			9631	0.0028	0.005
			30773	0.0008	0.001
G1-15b	1917.4	1.79	0	0.1623	0.291
			19	0.1623	0.291
			64	0.1378	0.246
			94	0.0438	0.078
			151	0.0369	0.066
			214	0.0287	0.051
			414	0.0234	0.042
			611	0.0184	0.033
			929	0.0148	0.026
			1331	0.0110	0.020
			1849	0.0095	0.017
			2112	0.0061	0.011
			2735	0.0045	0.008
			4141	0.0020	0.004
			9631	0.0019	0.003
			30773	0.0010	0.002
GU3-101a	585.1	2.20	0	0.0492	0.108
			23	0.0492	0.108
			62	0.0323	0.071
			149	0.0251	0.055
			234	0.0176	0.039
			570	0.0128	0.028
			773	0.0120	0.026
			871	0.0095	0.021
			3619	0.0069	0.015
			4391	0.0066	0.015

SAMPLE	DEPTH ft	DENSITY (g/cm^3)	SUCTION HEAD meters	WATER CONTENT (g/g)	(vol/vol)
GU3-101a	585.1	2.20	6212	0.0054	0.012
			9631	0.0025	0.006
			30773	0.0010	0.002
GU3-101b	585.1	2.15	0	0.0510	0.131
			27	0.0610	0.131
			64	0.0497	0.107
			178	0.0292	0.063
			294	0.0221	0.048
			544	0.0168	0.036
			696	0.0139	0.030
			980	0.0126	0.027
			1215	0.0113	0.024
			1979	0.0052	0.011
			2569	0.0041	0.009
			2985	0.0028	0.006
			9631	0.0020	0.004
			30773	0.0013	0.003
GU3-102a	686.6	2.25	0	0.0370	0.083
			19	0.0370	0.083
			109	0.0281	0.063
			235	0.0239	0.054
			343	0.0160	0.036
			560	0.0135	0.030
			815	0.0120	0.027
			1179	0.0112	0.025
			2197	0.0100	0.023
			2472	0.0057	0.013
			2815	0.0049	0.011
			9631	0.0024	0.005
			30773	0.0011	0.002
GU3-102b	686.6	2.28	0	0.0347	0.079
			29	0.0347	0.079
			198	0.0270	0.062
			346	0.0195	0.044
			476	0.0151	0.034
			677	0.0136	0.031
			952	0.0121	0.028
			1157	0.0108	0.025
			1751	0.0082	0.019
			2256	0.0062	0.014
			3094	0.0050	0.011
			3288	0.0044	0.010
			9631	0.0029	0.007
			30773	0.0016	0.004

SAMPLE	DEPTH ft	DENSITY (g/cm^3)	SUCTION HEAD meters	WATER CONTENT (g/g)	(vol/vol)
GU3-103a	884.4	2.17	0	0.0585	0.127
			25	0.0585	0.127
			64	0.0447	0.097
			139	0.0365	0.079
			286	0.0222	0.048
			422	0.0144	0.031
			695	0.0090	0.020
			777	0.0070	0.015
			1408	0.0060	0.013
			2057	0.0041	0.009
			2267	0.0039	0.008
			3508	0.0029	0.006
			5695	0.0028	0.006
			9631	0.0020	0.004
			30773	0.0013	0.002
GU3-103b	884.4	2.27	0	0.0423	0.096
			29	0.0423	0.096
			263	0.0295	0.067
			434	0.0113	0.026
			589	0.0091	0.021
			872	0.0075	0.017
			1199	0.0063	0.014
			1711	0.0057	0.013
			2032	0.0038	0.009
			2203	0.0031	0.007
			3565	0.0027	0.006
			9631	0.0023	0.005
			30773	0.0011	0.003
G4-101a	136.0	1.34	0	0.2659	0.359
			29	0.2659	0.359
			177	0.0831	0.111
			360	0.0509	0.068
			694	0.0202	0.027
			1725	0.0132	0.018
			2514	0.0110	0.015
			4295	0.0071	0.010
			9631	0.0046	0.006
			30773	0.0023	0.003
G4-101b	136.0	1.34	0	0.2673	0.358
			29	0.2673	0.358
			45	0.2449	0.328
			224	0.0870	0.117
			518	0.0538	0.072
			885	0.0269	0.036
			1664	0.0198	0.027
			4387	0.0133	0.018

SAMPLE	DEPTH ft	DENSITY (g/cm^3)	SUCTION HEAD meters	WATER CONTENT (g/g)	(vol/vol)
G4-101b	136.0	1.34	5598	0.0108	0.014
			9631	0.0055	0.007
			30773	0.0024	0.003
G4-102a	172.0	0.89	0	0.7101	0.685
			27	0.7101	0.685
			166	0.1736	0.155
			304	0.1016	0.090
			2568	0.0303	0.027
			3461	0.0061	0.005
			8112	0.0049	0.004
			9631	0.0002	0.001
			30773	0.0008	0.001
G4-102b	172.0	0.89	0	0.6040	0.538
			29	0.6040	0.538
			98	0.2166	0.193
			174	0.0822	0.073
			1041	0.0491	0.044
			2023	0.0285	0.025
			9631	0.0057	0.005

Table 2. Hydraulic conductivities for samples from Drill Holes USWG-1, USWG-4, USWGU-3

SAMPLE	HYDRAULIC CONDUCTIVITY (m/sec)
G1-1a	1.73e-11
b	9.13e-11
G1-2a	2.50e-12
b	1.20e-12
G1-3a	4.28e-11
b	1.98e-12
G1-4a	4.61e-12
b	5.04e-13
G1-5a	3.70e-11
b	broken
G1-6a	6.72e-11
b	8.78e-12
G1-7a	6.44e-10
b	9.56e-10
G1-8a	1.16e-11
b	1.86e-11
G1-9a	1.94e-11
b	9.23e-12
G-10a	1.13e-11
b	1.64e-11
G1-11a	2.21e-12
b	2.08e-12
G1-12a	5.22e-12
b	5.22e-12
G1-13a	4.07e-11
b	4.52e-11
G1-14a	1.59e-10
b	1.57e-10
G1-15a	1.63e-09
b	1.63e-09
GU3-101a	1.22e-11
b	1.59e-11
GU3-103a	7.17e-11
b	broken

SAMPLE	HYDRAULIC CONDUCTIVITY (m/sec)
G4-101a	4.68e-08
b	1.65e-07
G4-102a	no sample
b	no sample
GU3-104	6.80e-12
GU3-105	3.98e-10
G1-16	6.82e-12
G1-17	1.11e-08
G4-103	1.94e-12
G4-104	3.00e-12
G4-105	1.82e-12
G4-106	2.28e-12
G4-107	1.23e-11
G4-108	4.80e-12
G4-109	3.07e-12
G4-110	2.41e-12
G4-111	broken
G4-112	3.05e-13
G4-113	3.49e-10
G4-114	2.50e-12
G4-115	2.43e-12
G4-116	3.31e-12
G4-117	5.19e-12
G4-118	5.13e-12
GU3-102a	1.24e-12
b	1.09e-12

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R. R. Peters, E. A. Klavetter, I. J. Hall, S. C. Blair, P. R. Heller, G. W. Gee. 1985. Fracture and Matrix Hydrologic Characteristics of Tuffaceous Materials from Yucca Mountain, Nye County, Nevada, SAND84-1471. (NNA.870407.0036)

*Presently, the American Society for Testing snd Materials

Appendix: Saturation-Curve Fits

PNL has recently supplied data on saturation as a function of pressure head for twenty samples taken from drill holes USW G-1, USW GU-3, and USW G-4. The specific locations, data, and other relevant information are contained in the letter report from PNL dated September 1985. The saturation data in the PNL report were fit using the van Genuchten (1978) formula, which is the same one used in the report by Peters et al. (1984) The van Genuchten formula fits the saturation (S) as a function of the pressure head (ψ) using three fitting parameters which are listed below. A discussion of the curve fits available, fitting techniques used, etc. is included in Peters, et al. (1984) The formula, which relates pressure head and saturation, follows:

$$S = (S_s - S_r)\left[\frac{1}{1 + |\alpha\psi|^{\beta}}\right]^{\lambda} + S_r$$

The variables in this equation are defined as follows.

S - the saturation as a function of ψ, the pressure head. The saturation is equal to 1 for all pressure heads greater than zero.

S_s - the saturation at the fully saturated state (~1).

S_r - the residual saturation.

α - the curve-fitting parameter that primarily affects the pressure head at which desaturation occurs.

β - the curve-fitting parameter that primarily affects the slope of desaturation portion of the curve.

λ = $1 - 1/\beta$.

The results are seen in the attached figures. The stratigraphy and unit names are those suggested by Ortiz et al. (1985) The stratigraphy is the same as that used in the report by Peters et al. (1984); the only change is the name applied to each of the units. Pages 1 and 2 of the PNL letter report contain a table showing the previously used unit names and those suggested by Ortiz et al.

The values of the curve-fit parameters are listed in the figures. The type of symbol used in the figures indicates the source of the data. The circle and triangle symbols indicate data values from two different subsamples taken from the sample. The star character (see the right margin of the plot for G1-11) indicates a value added to the data set to force the curve-fit solution to have a residual saturation (S_r) larger than or equal to zero. The added

points were chosen to conform to the trends exhibited in the plots and to keep S_r larger than or equal to zero. In most cases the added points had the same saturation as the lowest measured saturation but a more negative pressure head.

The results, with two exceptions, appear to be comparable to those in the report by Peters et al. (1984). The two exceptions are samples G1-6 and G1-7 which are taken from the vitric portion of the Calico Hills nonwelded unit. The data for these samples show two regions of rapid change in saturation, whereas the other samples show a simple, monotonically decreasing saturation. Examination of these samples indicates that they are made up of several visually distinct materials that include partially zeolitized pumice fragments, welded tuff fragments, and glassy to partially zeolitized particles. These materials are partially welded together to make a relatively competent material. Thus, it appears reasonable that these two samples may have two relatively distinct porosity distributions. The vitric material has been shown (see Peters et al., 1984) to be made up of relatively large pores that drain at small negative pressure heads. The welded tuffs and the zeolitized tuffs have been shown to have pore-size distributions that are broad with many small pores. These last two tuff types drain over a wide range of negative pressure heads. A material made up of these materials would have a saturation curve made up of two distinct regions of rapid change in saturation, which is what is seen in the G1-6 and G1-7 figures. Some of the other samples (e.g., G1-15) may also be made up of two distinct porosity distributions. The evidence for this hypotheses was not as strong as for samples G1-6 and G1-7 and therefore, the data from the other samples were fit in the standard manner.

The data for G1-6 and G1-7 were fit with two curves with the upper (or top curve) curve fitting the saturation region from a value of one to $S_{r,t}$ and the second (or bottom) curve fitting from $S_{r,t}$ to $S_{r,b}$. In the plots for G1-6 and G1-7, the values for first three parameters having a subscript of "t" are for the top curve while those for the bottom curve have a "b" subscript. The top and bottom curves are added together to obtain the lines shown in the plots for G1-6 and G1-7.

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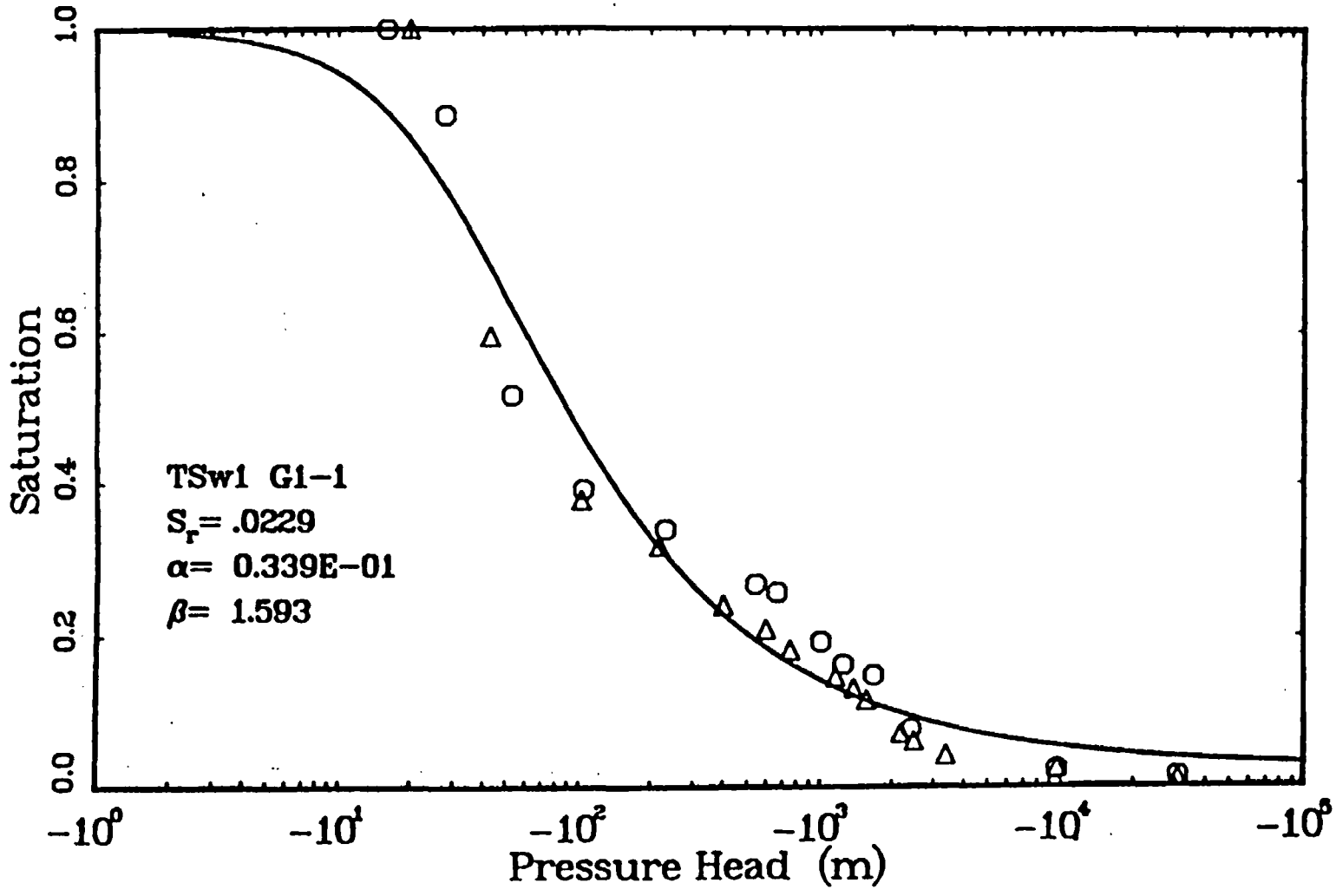
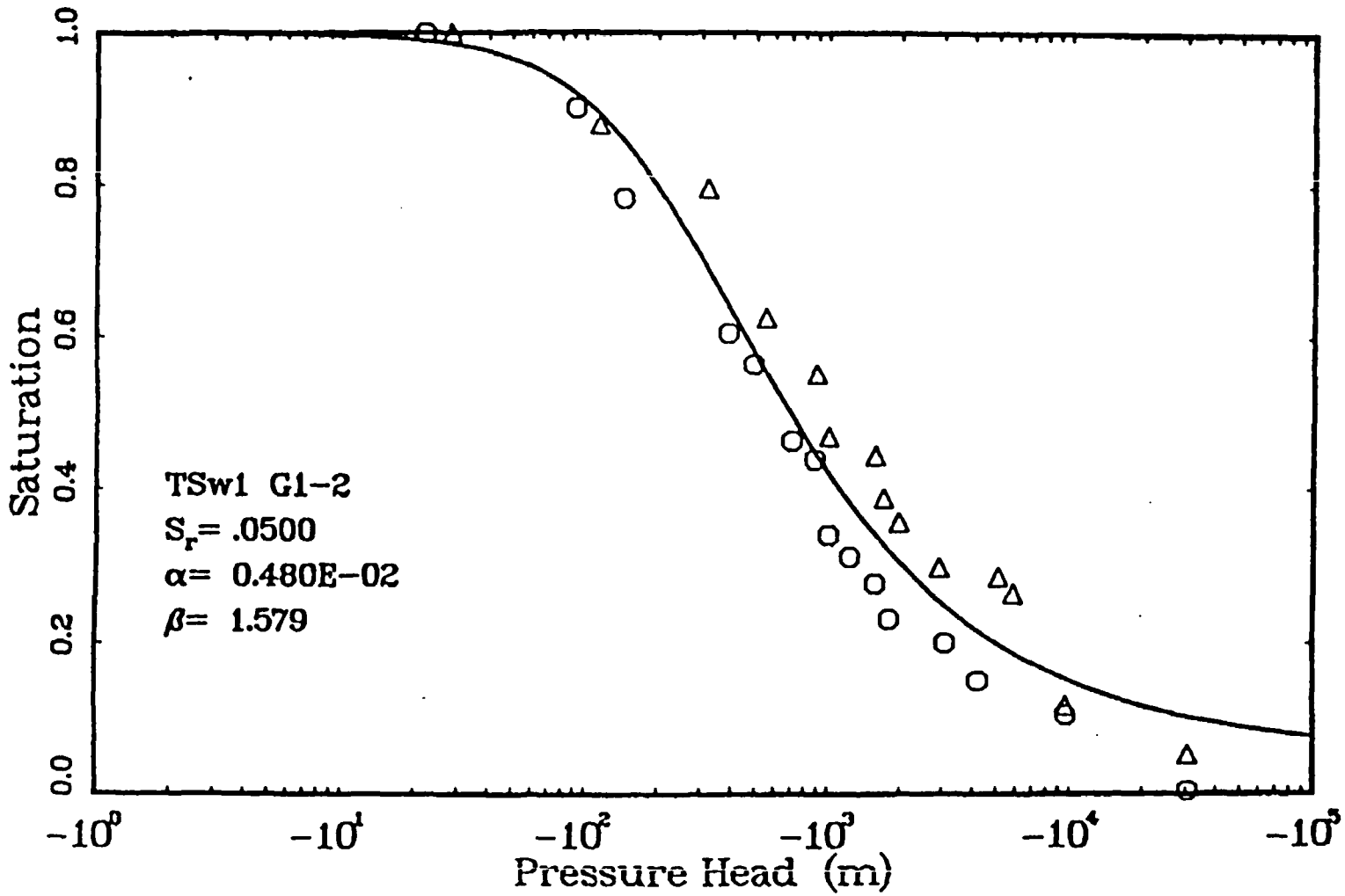
Peters, R. R., E. A. Klavetter, I. J. Hall, S. C. Blair, P. R. Heller, and G. W. Gee. 1984. "Fracture and Matrix Hydrologic Characteristics of Tuffaceous Materials from Yucca Mountain, Nye County, Nevada," SAND84-1471, Sandia National Laboratories, Albuquerque, NM. (NNA.870407.0036)

van Genuchten, R. 1978. "Calculating the Unsaturated Hydraulic Conductivity with a New Closed Form Analytical Model," Water Resources Bulletin, Princeton University Press, Princeton University, Princeton, NJ. (HQS.880517.1859)


TSw1 G1-1
S_r= .0229
α= 0.339E-01
β= 1.593
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)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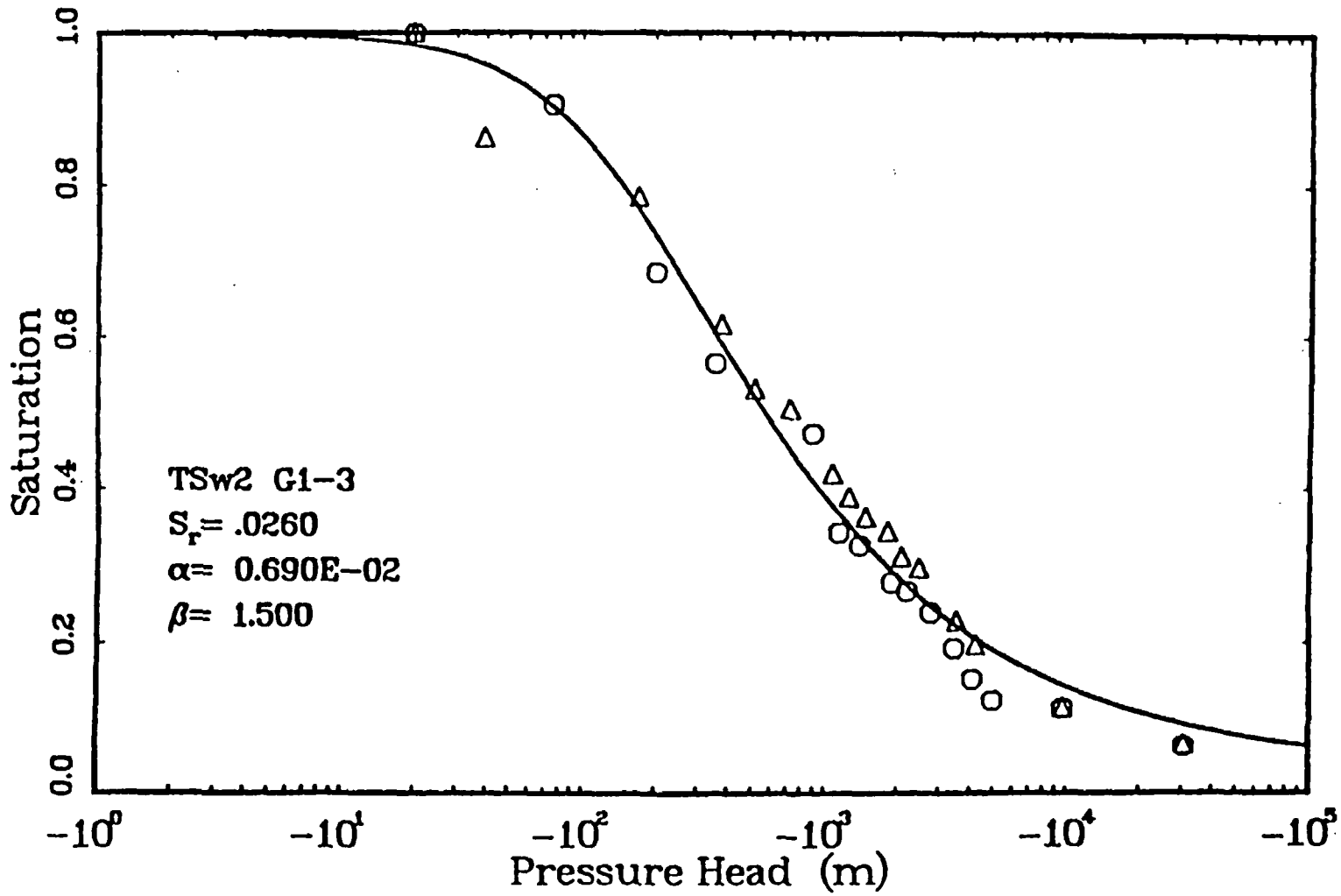
S_r= .0500
α= 0.480E-02
β= 1.579
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)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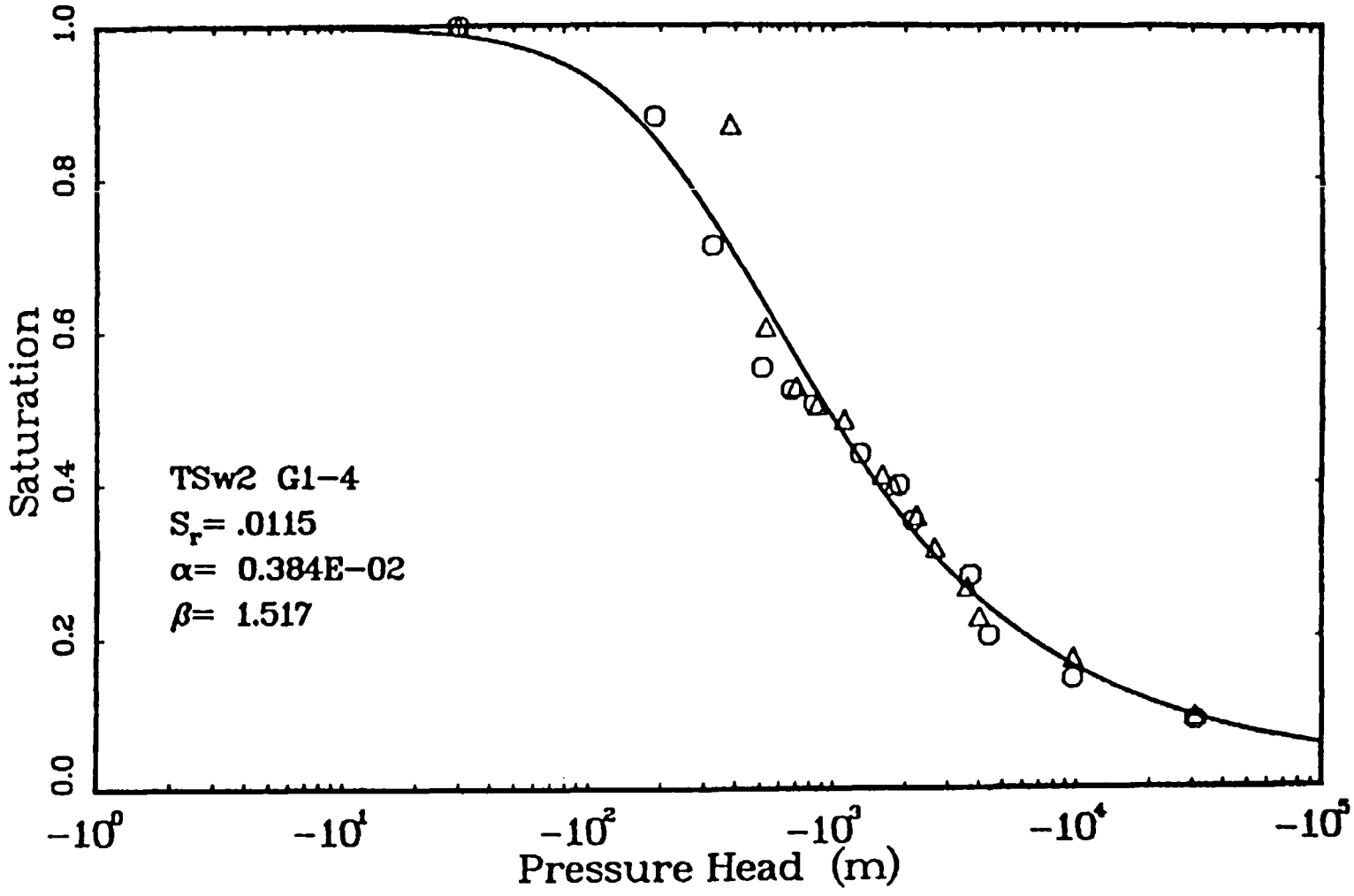
S_r= .0260
α= 0.690E-02
β= 1.500
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)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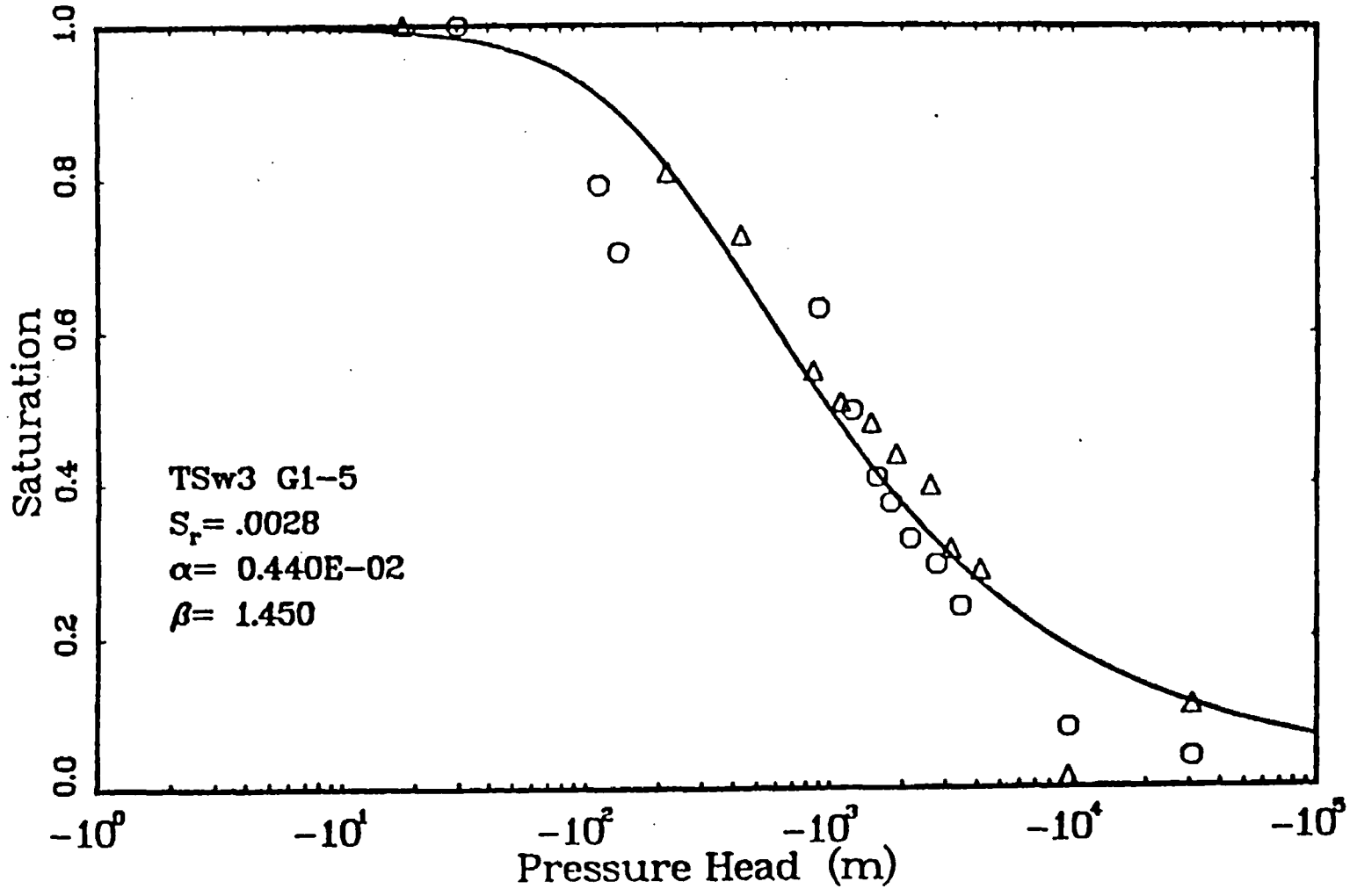
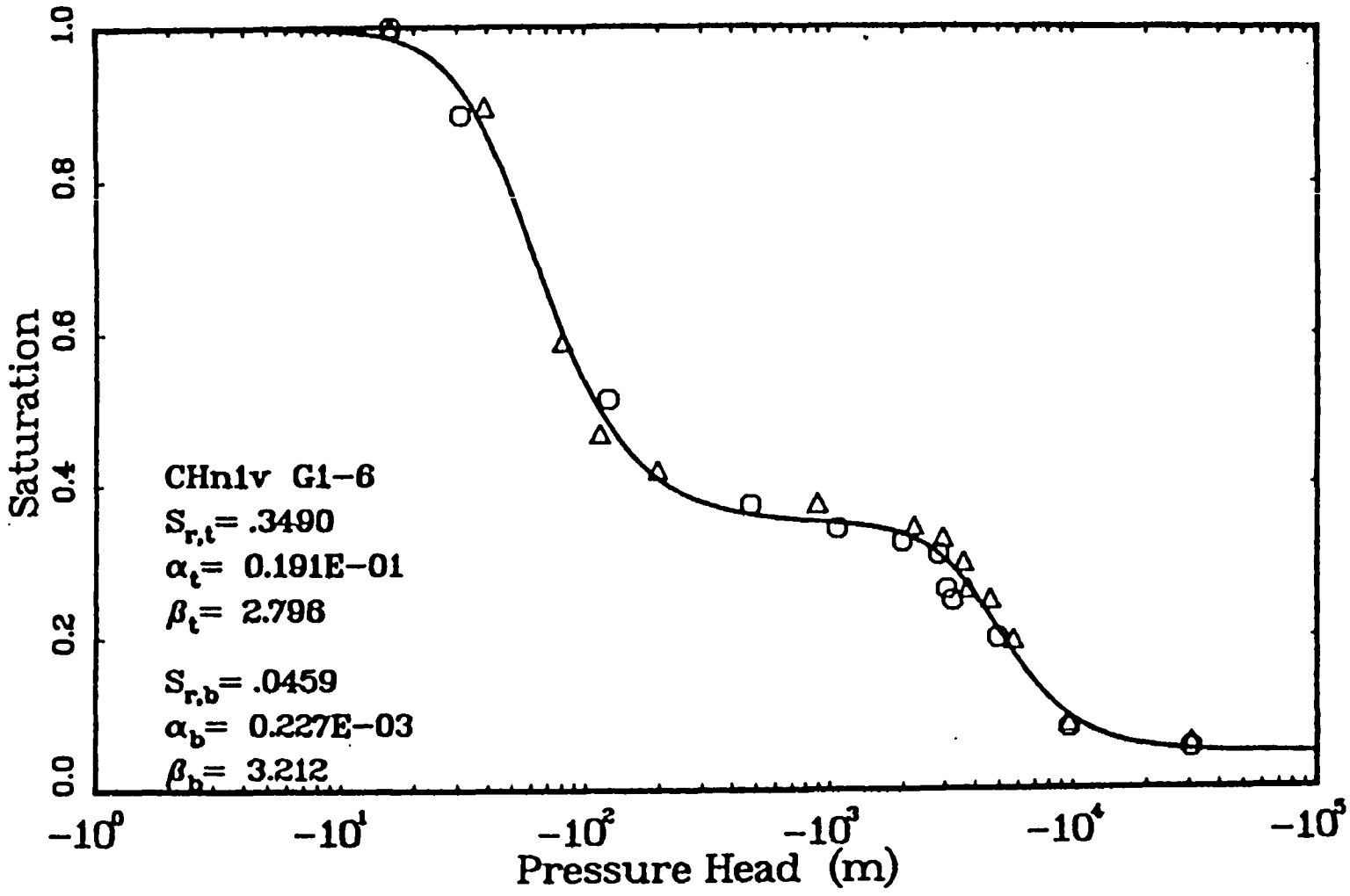
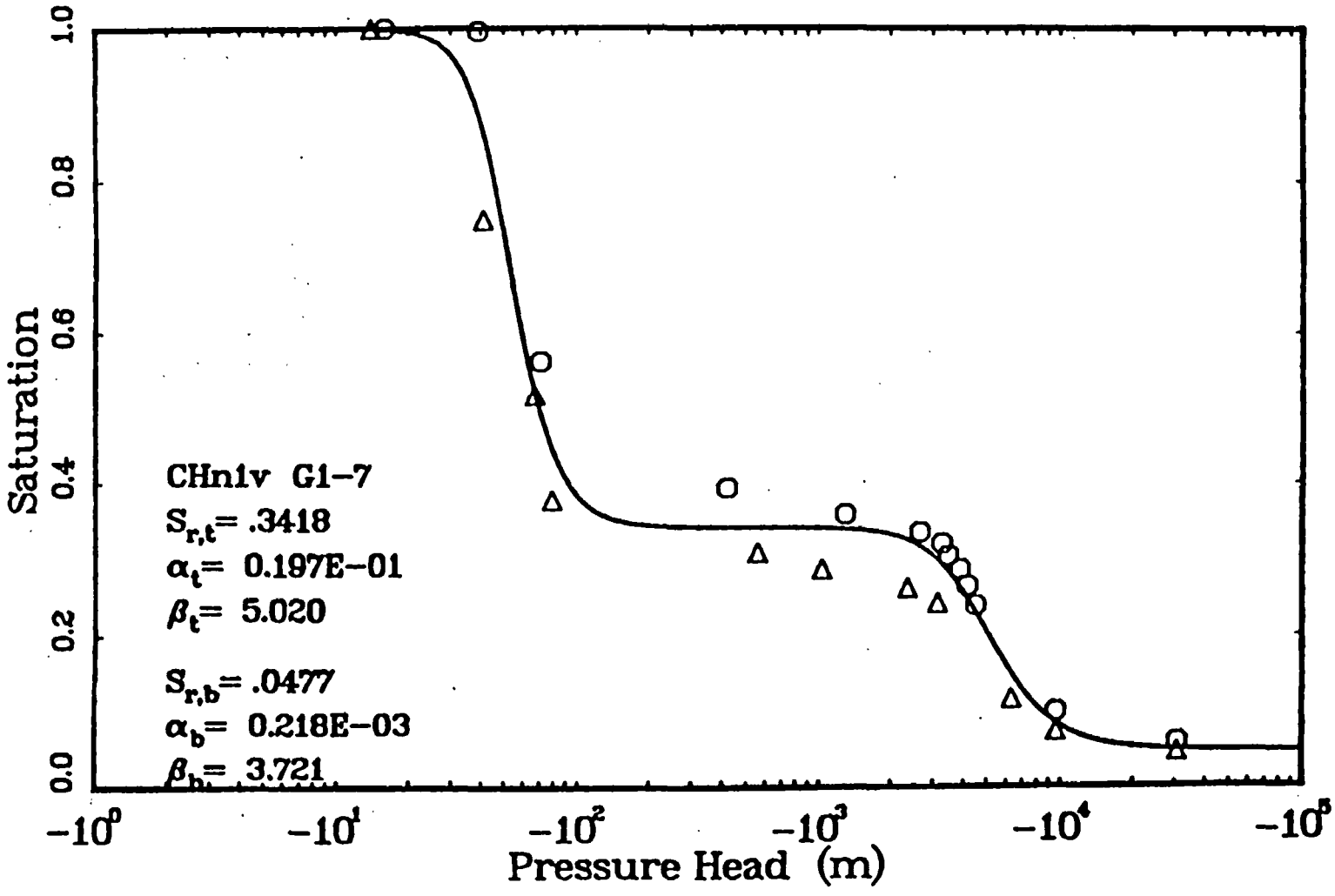
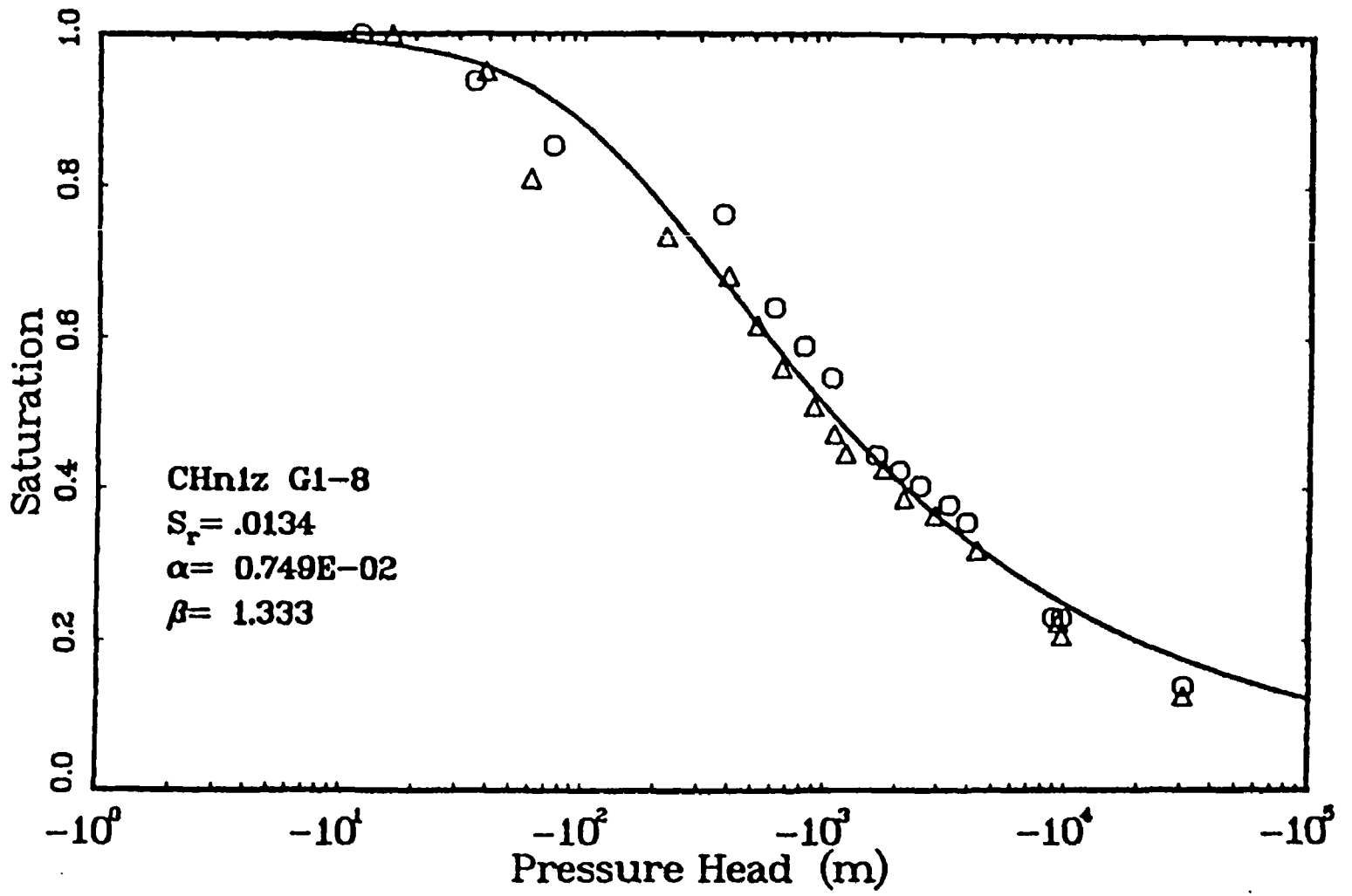
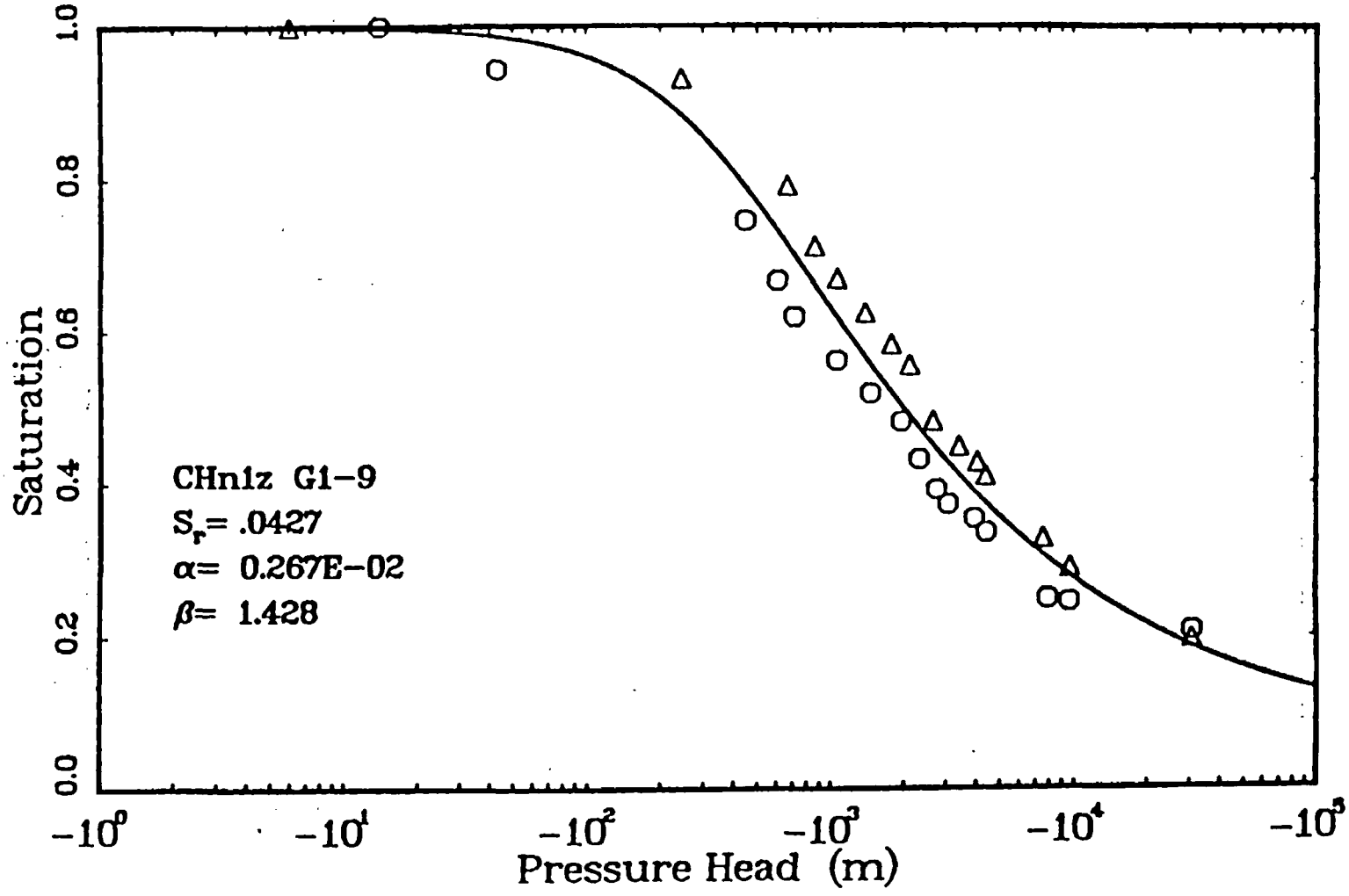
S_r= .0115
α= 0.384E-02
β= 1.517
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)

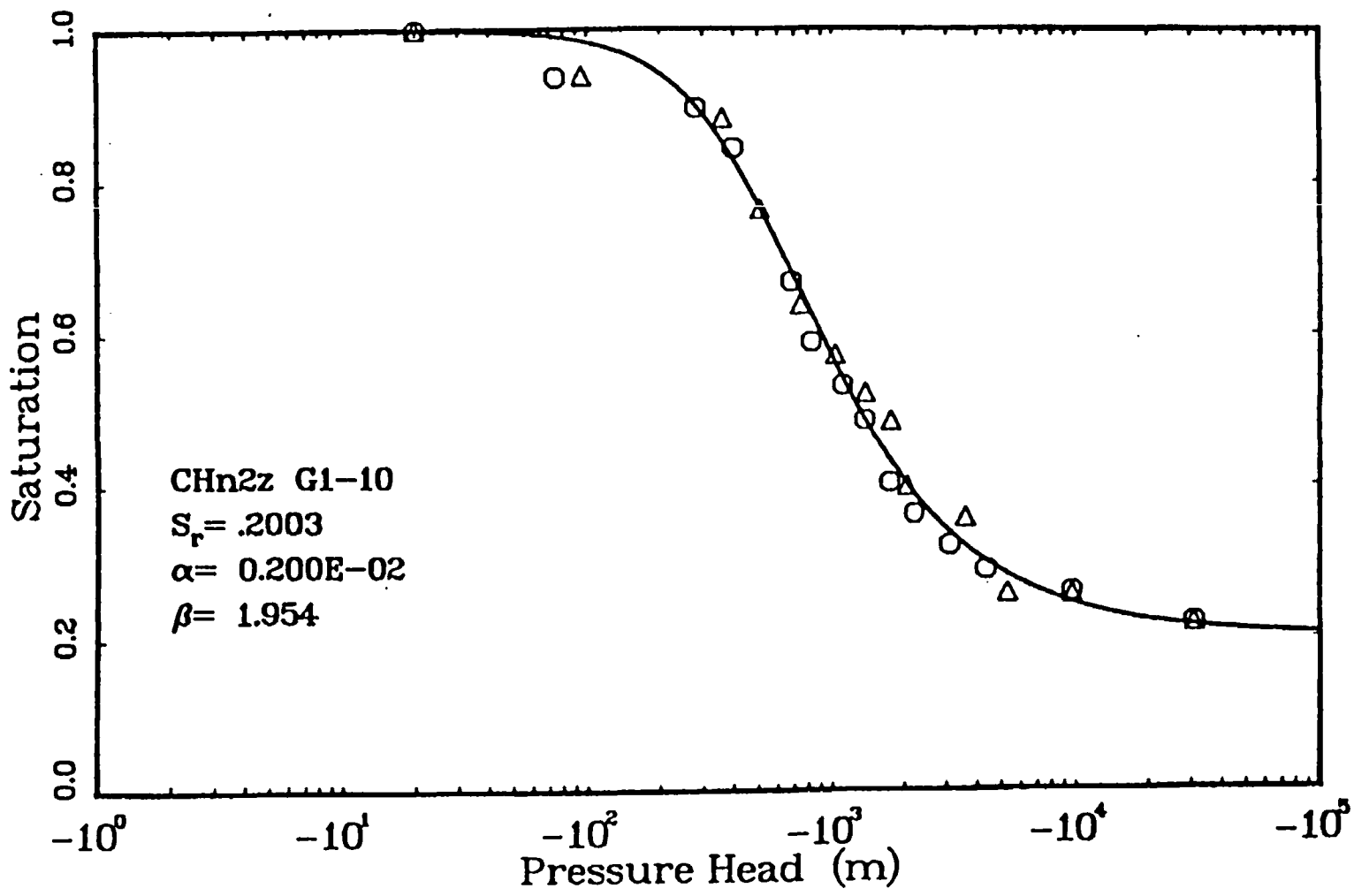

TSw3 G1-5
S_r= .0028
α= 0.440E-02
β= 1.450
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)

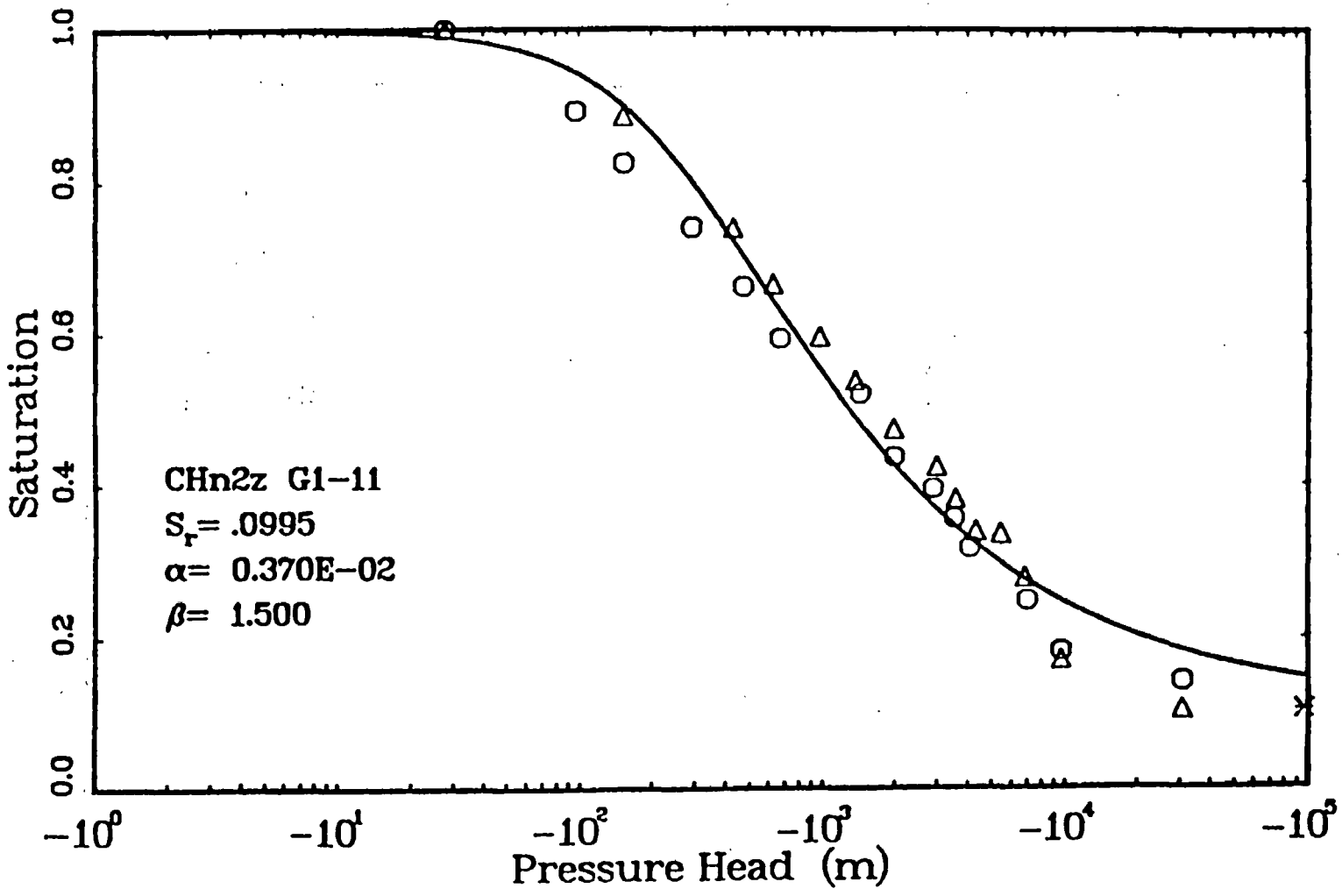

CHn1v G1-6
$S_{r,t}$= .3490
α_t= 0.191E-01
β_t= 2.796
$S_{r,b}$= .0459
α_b= 0.227E-03
β_b= 3.212
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)

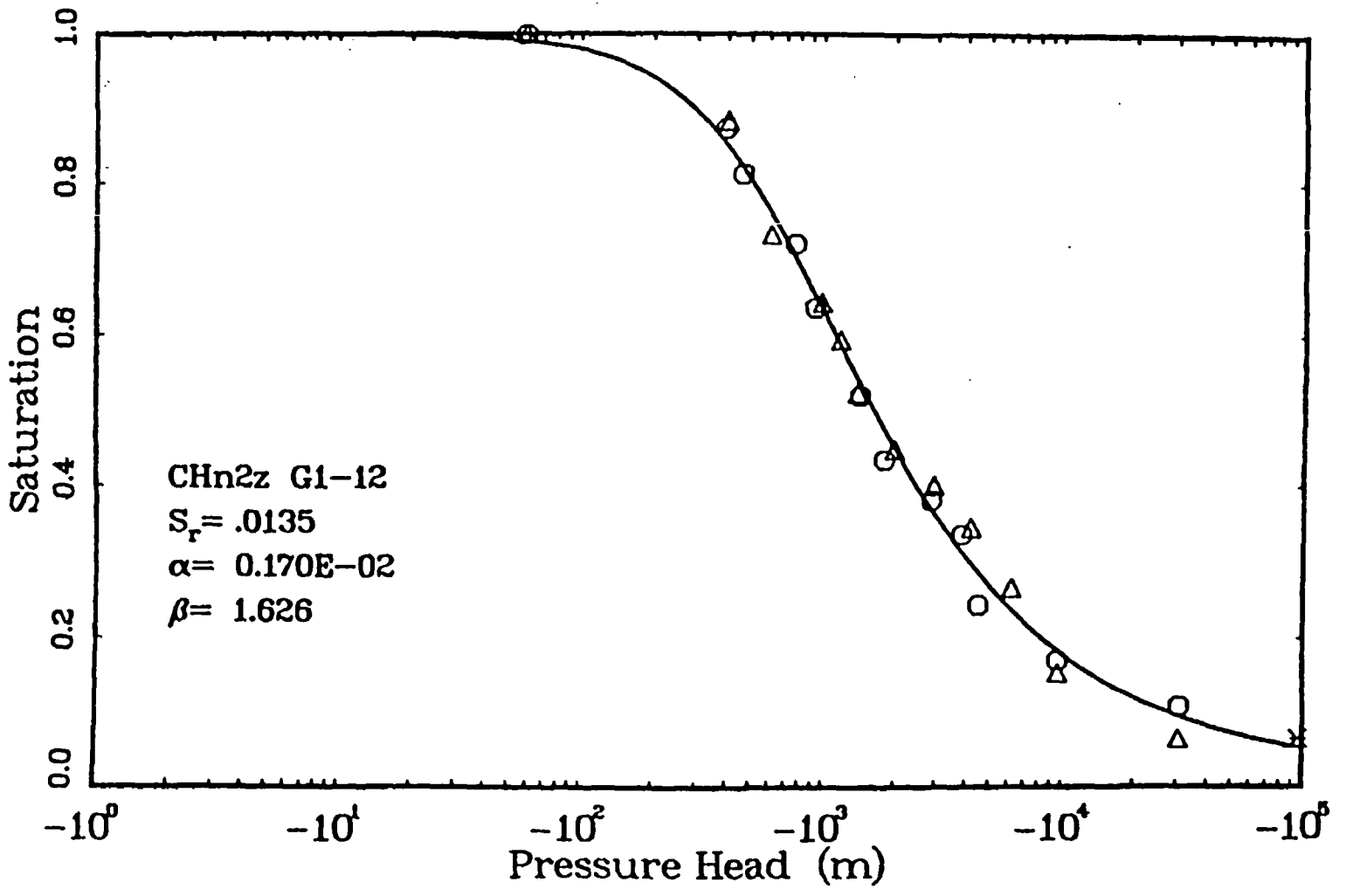

CHn1v G1-7
$S_{r,t}$= .3418
α_t= 0.197E-01
β_t= 5.020
$S_{r,b}$= .0477
α_b= 0.218E-03
β_b= 3.721
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)

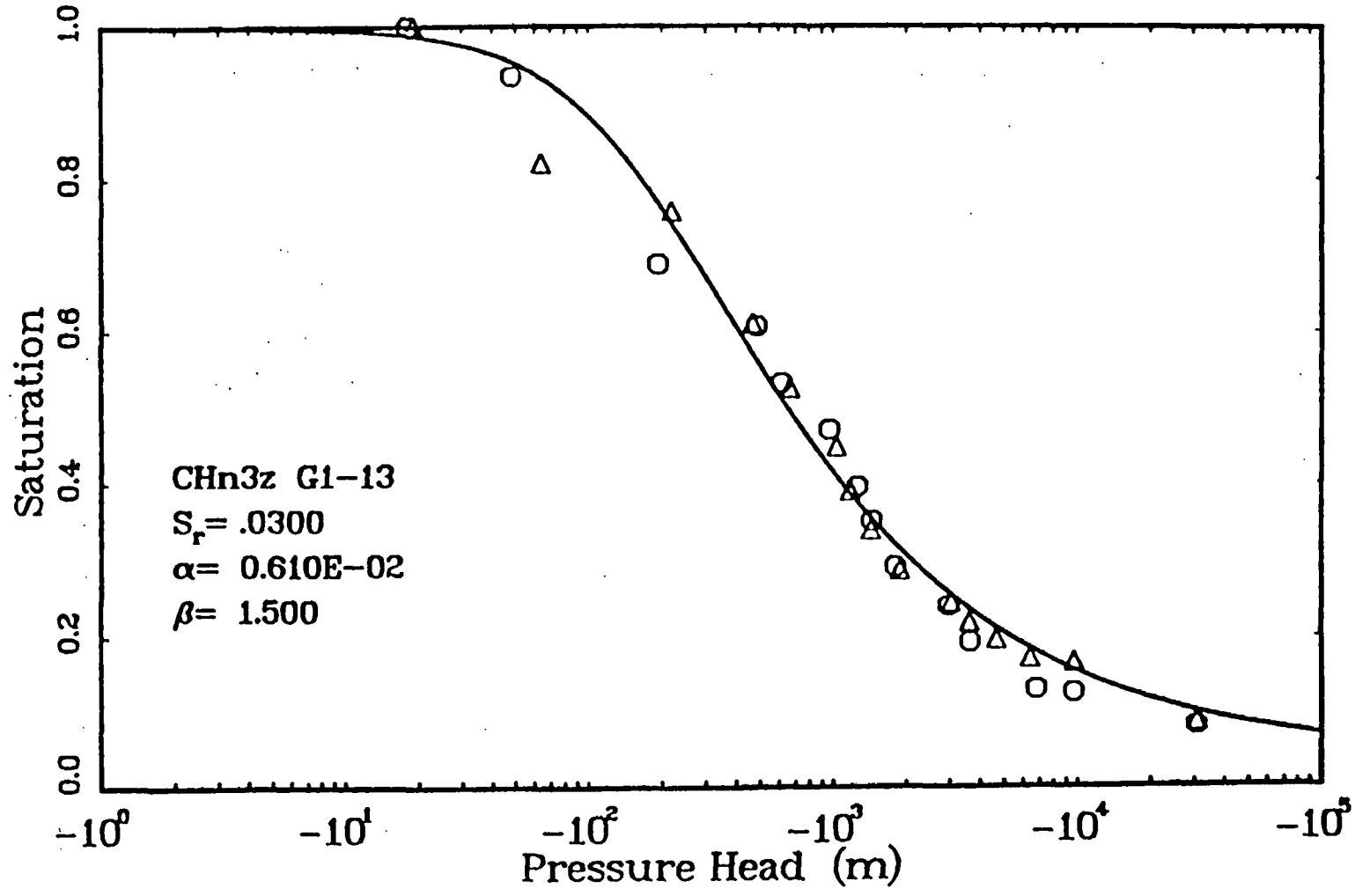

CHn1z G1-8
S_r= .0134
α= 0.749E-02
β= 1.333
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)

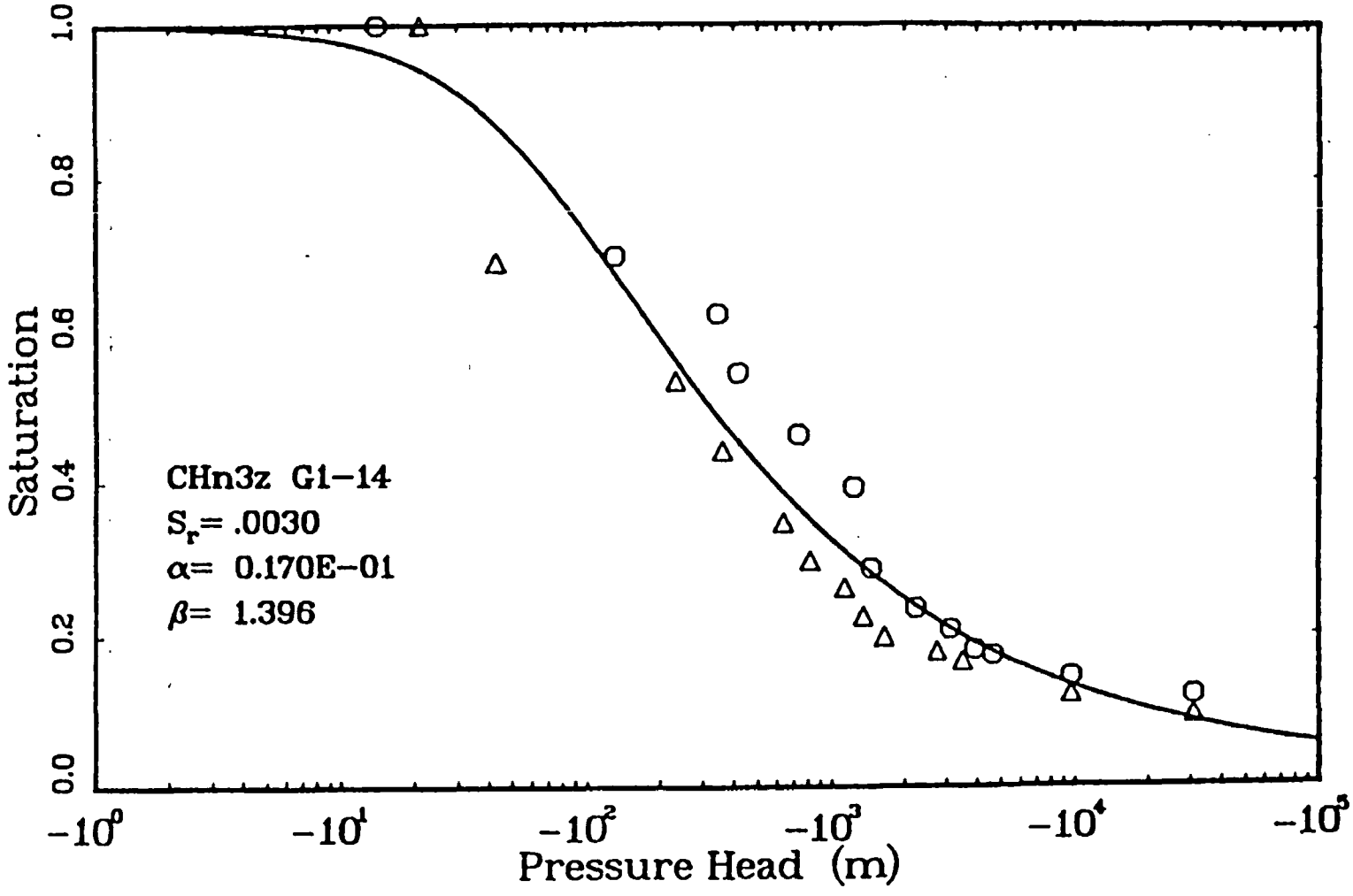

CHn1z G1-9
S_r= .0427
α= 0.267E-02
β= 1.428
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)

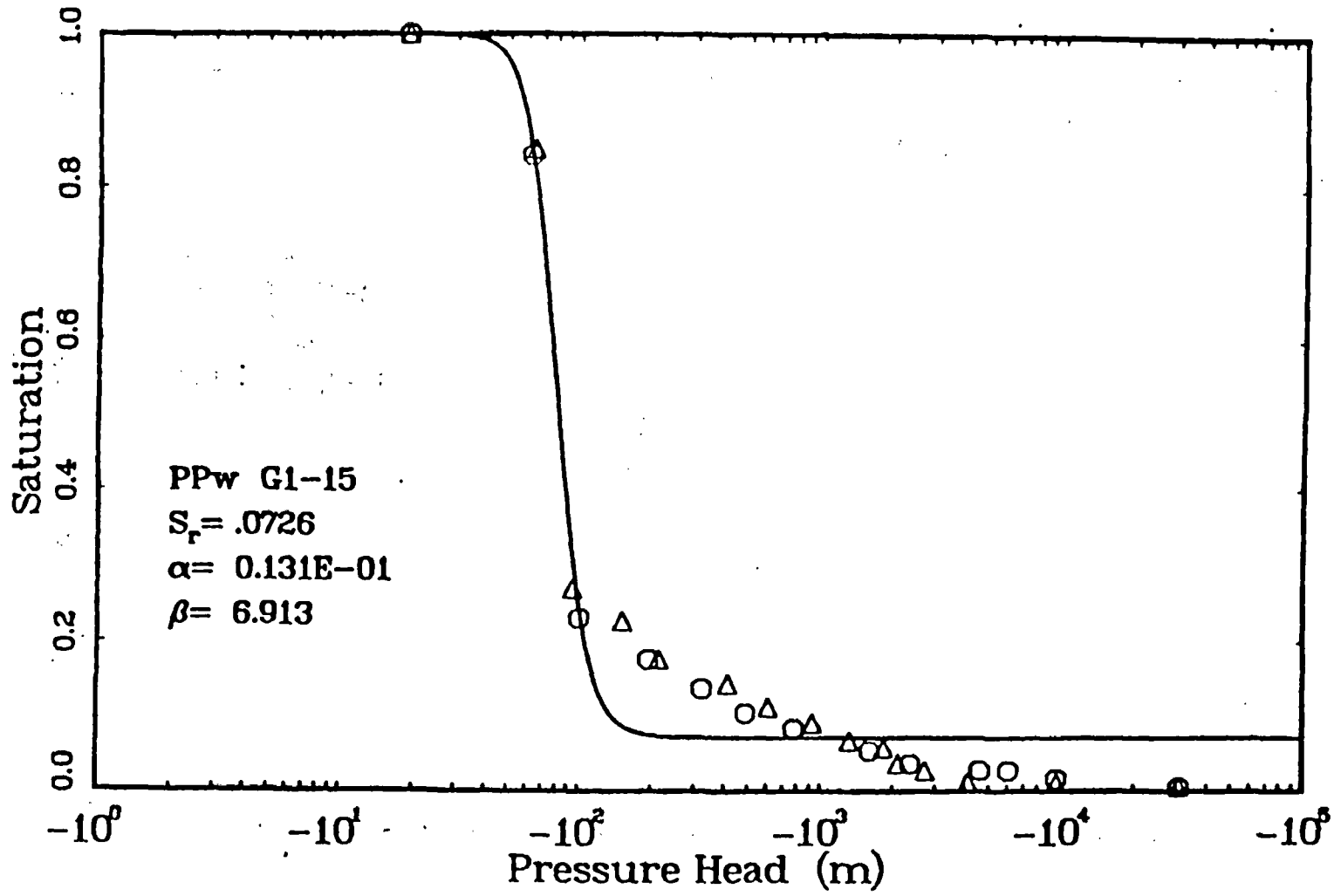

CHn2z G1-10
S_r= .2003
α= 0.200E-02
β= 1.954
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)

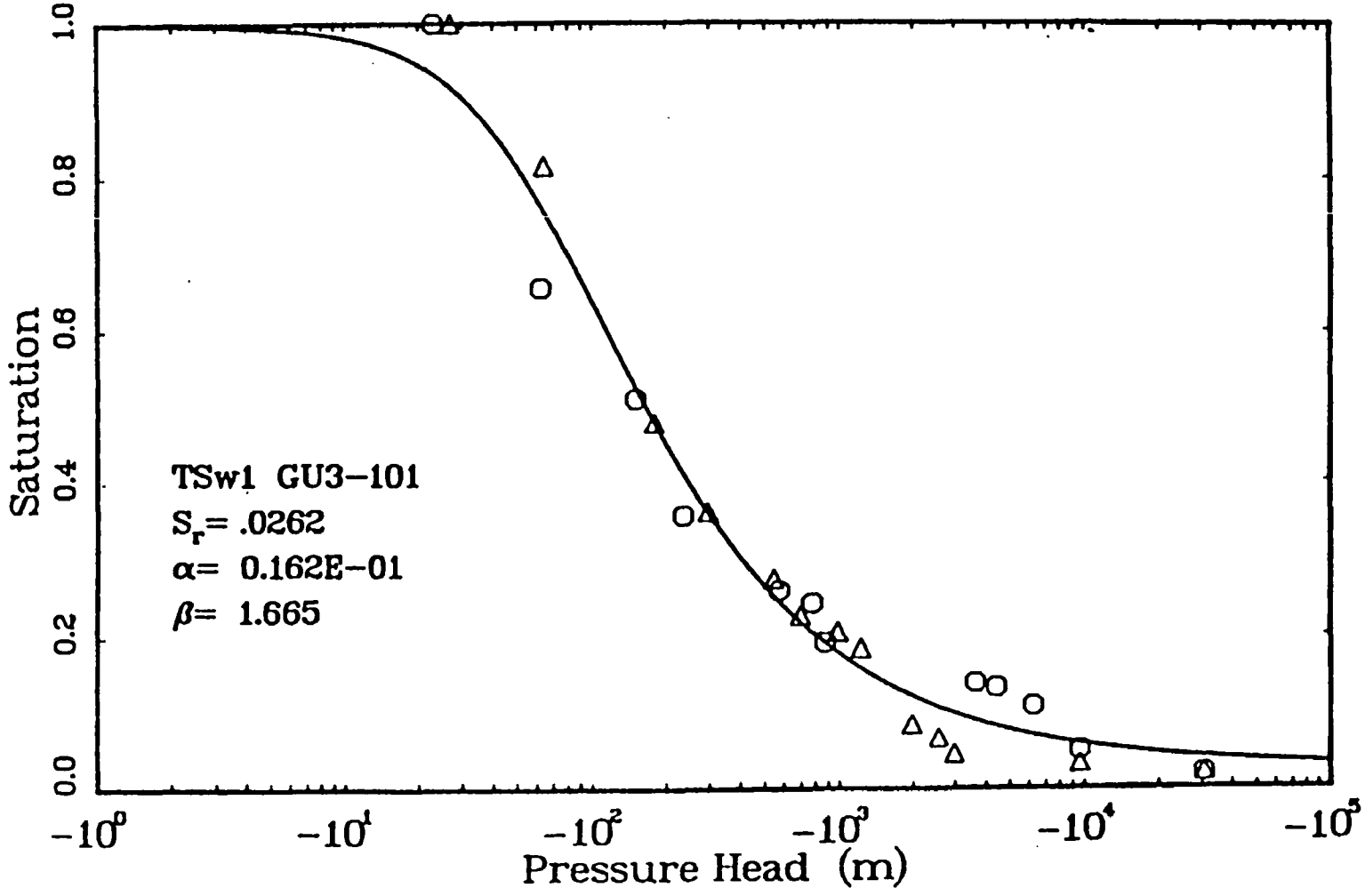

CHn2z G1-11
S_r= .0995
α= 0.370E-02
β= 1.500
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)

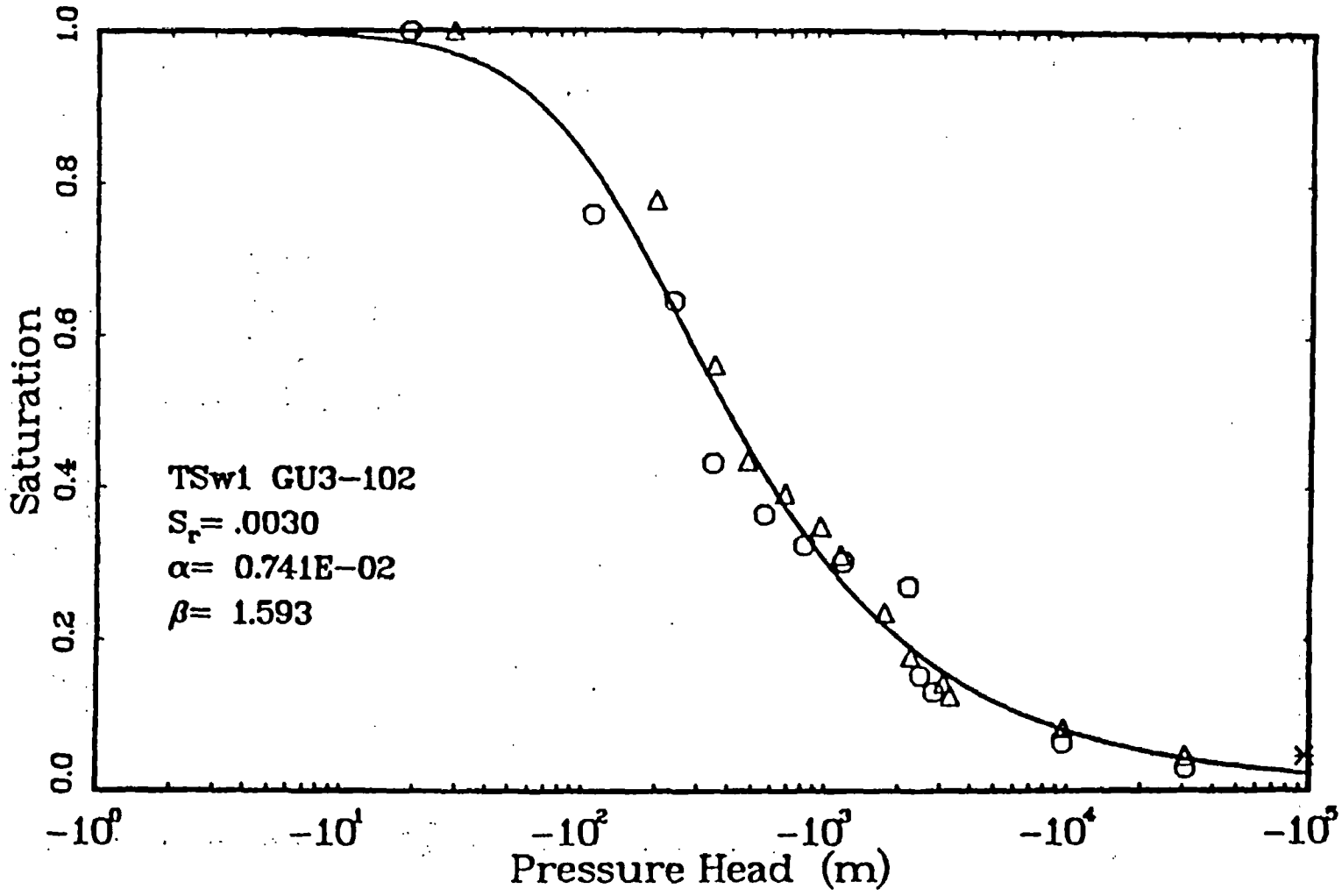

CHn2z G1-12
S_r= .0135
α= 0.170E-02
β= 1.626
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)

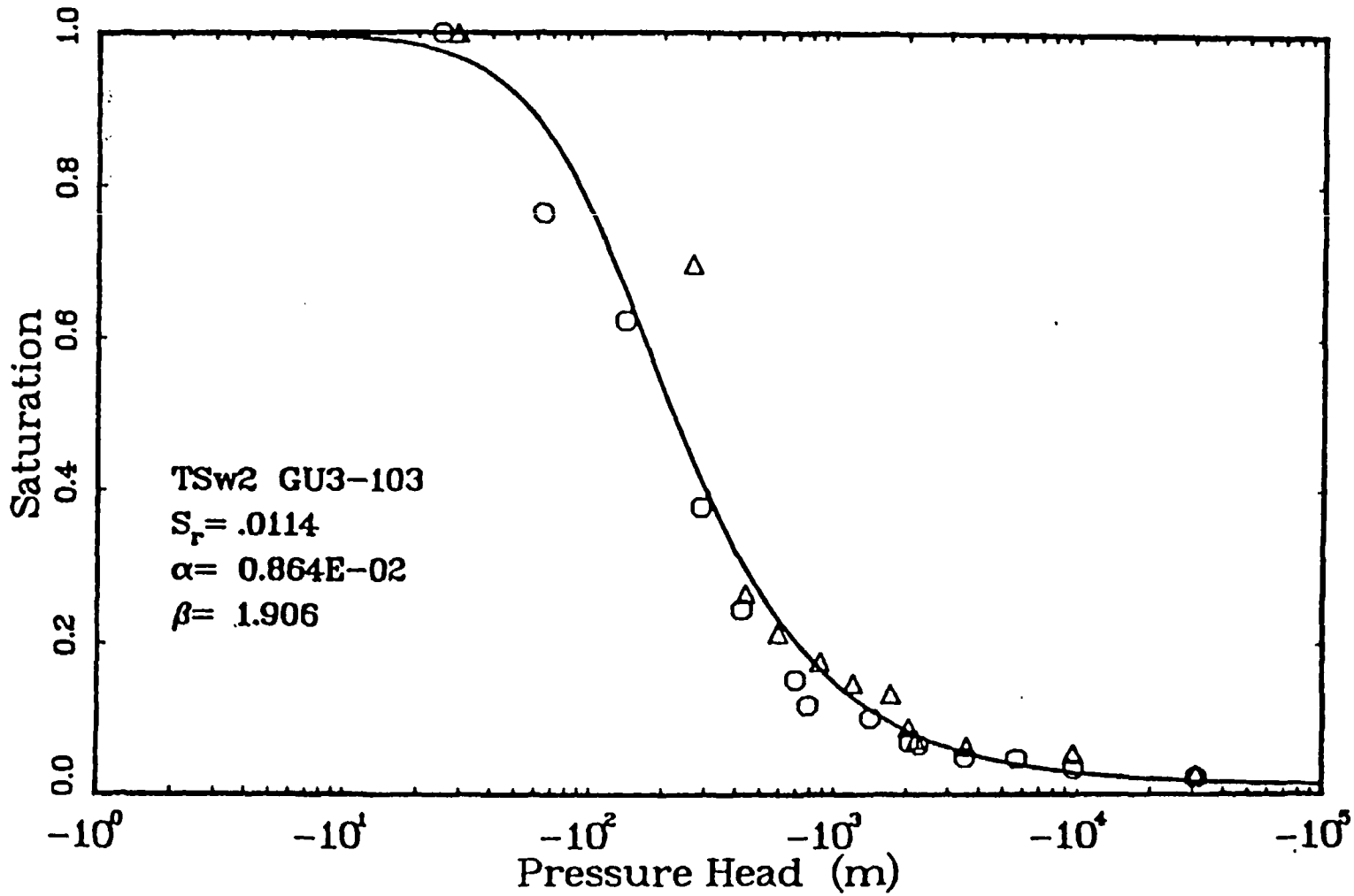

CHn3z G1-13
S_r= .0300
α= 0.610E-02
β= 1.500
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)

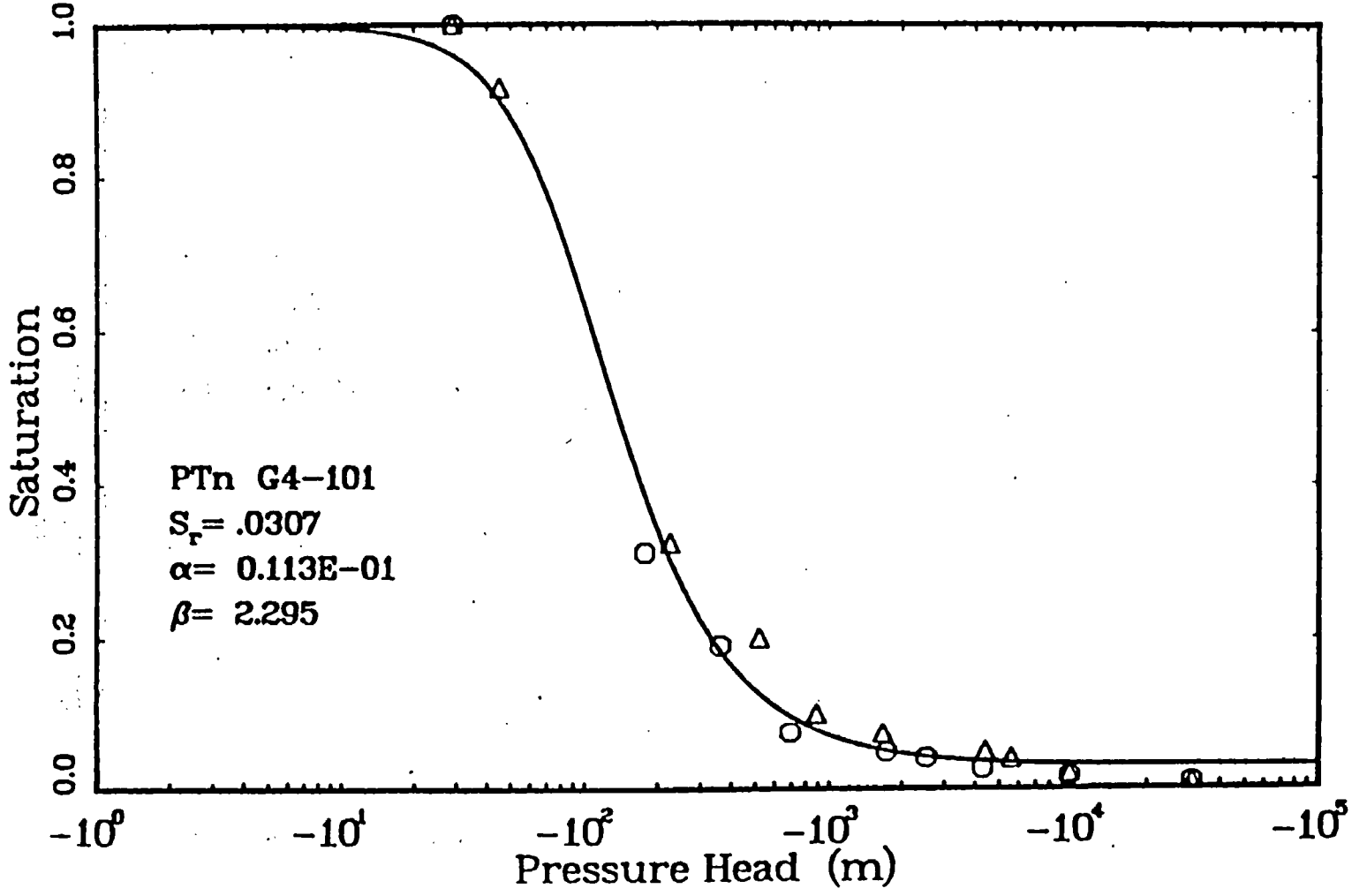

CHn3z G1-14
S_r= .0030
α= 0.170E-01
β= 1.396
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)

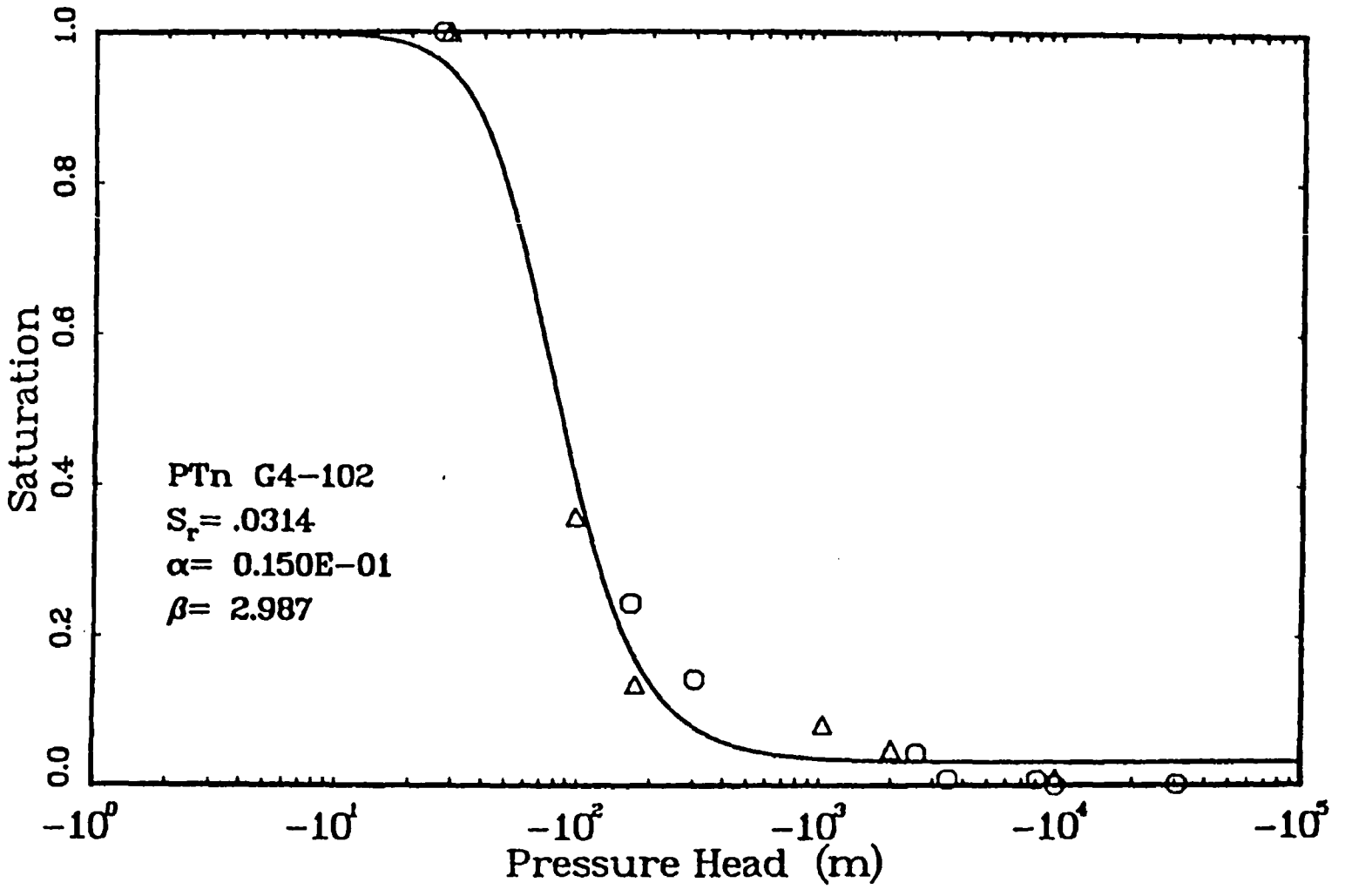

PPw G1-15
S_r= .0726
α= 0.131E-01
β= 6.913
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)


TSw1 GU3-101
S_r= .0262
α= 0.162E-01
β= 1.665
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)


TSw1 GU3-102
S_r= .0030
α= 0.741E-02
β= 1.593
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)


TSw2 GU3-103
S_r= .0114
α= 0.864E-02
β= 1.906
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)


PTn G4-101
S_r= .0307
α= 0.113E-01
β= 2.295
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)


PTn G4-102
S_r= .0314
α= 0.150E-01
β= 2.987
Saturation
0.0
0.2
0.4
0.6
0.8
1.0
-10^0
-10^1
-10^2
-10^3
-10^4
-10^5
Pressure Head (m)

APPENDIX F

SATURATED BULK DENSITY DATA FROM KEYSTONE DOCUMENT 6310-85-10

This appendix contains the forms required to submit the saturated bulk density data contained in Keystone Document 6310-85-10 to the YMP Site and Engineering Properties Data Base (SEPDB).

Saturated Bulk Density Data Compilation Form
for the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Value

Drill Hole	Depth (ft)	Sub-sample	ID	Previous ID[1]	Saturated Bulk Density (g/cm^3)
USW G-1	388.8	a	G1-389a	G1-1a	2.14
USW G-1	388.8	b	G1-389b	G1-1b	2.21
USW G-1	615.5	a	G1-616a	G1-2a	2.18
USW G-1	615.5	b	G-1 616b	G1-2b	2.28
USW G-1	1101.8	a	G1-1102a	G1-3a	2.20
USW G-1	1101.8	b	G1-1102b	G1-3b	2.26
USW G-1	1198.3	a	G1-1198a	G1-4a	2.31
USW G-1	1198.3	b	G1-1198b	G1-4b	2.31
USW G-1	1306.3	a	G1-1306a	G1-5a	2.30
USW G-1	1306.3	b	G1-1306b	G1-5b	2.15
USW G-1	1359.3	a	G1-1359a	G1-6a	1.95
USW G-1	1359.3	b	G1-1359b	G1-6b	1.95
USW G-1	1386.7	a	G1-1387a	G1-7a	1.50
USW G-1	1386.7	b	G1-1387b	G1-7b	1.57
USW G-1	1499.8	a	G1-1500a	G1-8a	1.55
USW G-1	1499.8	b	G1-1500b	G1-8b	1.50
USW G-1	1637.0	a	G1-1637a	G1-9a	1.55

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

This experiment measured sample volume (by water displacement) and sample mass (by weighing). A value for sample volume may be estimated using the nominal sample length and diameter. A value for sample mass may be estimated using the nominal sample volume and the saturated bulk density listed above. The sample was saturated by a vacuum saturation technique.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Saturated Bulk Density Data Compilation Form
for the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Value

Drill Hole	Depth (ft)	Sub-sample	ID	Previous ID[1]	Saturated Bulk Density (g/cm^3)
USW GU-3	884.4	a	GU3-884a	GU3-103a	2.17
USW GU-3	884.4	b	GU3-884b	GU3-103b	2.27
USW G-4	136.0	a	G4-136a	G4-101a	1.34
USW G-4	136.0	b	G4-136b	G4-101b	1.34
USW G-4	172.0	a	G4-172a	G4-102a	0.89
USW G-4	172.0	b	G4-172b	G4-102b	0.89

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

This experiment measured sample volume (by water displacement) and sample mass (by weighing). A value for sample volume may be estimated using the nominal sample length and diameter. A value for sample mass may be estimated using the nominal sample volume and the saturated bulk density listed above. The sample was saturated by a vacuum saturation technique.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Saturated Bulk Density Data Compilation Form
for the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Value

Drill Hole	Depth (ft)	Sub-sample	ID	Previous ID[1]	Saturated Bulk Density (g/cm^3)
USW G-1	1637.0	b	G1-1637b	G1-9b	1.66
USW G-1	1752.7	a	G1-1753a	G1-10a	1.66
USW G-1	1752.7	b	G-1 1753b	G1-10b	1.62
USW G-1	1779.5	a	G1-1780a	G1-11a	1.83
USW G-1	1779.5	b	G1-1780b	G1-11b	1.83
USW G-1	1789.6	a	G1-1790a	G1-12a	1.95
USW G-1	1789.6	b	G1-1790b	G1-12b	1.96
USW G-1	1820.7	a	G-1 1821a	G1-13a	1.46
USW G-1	1820.7	b	G1-1821b	G1-13b	1.50
USW G-1	1841.1	a	G1-1841a	G1-14a	1.52
USW G-1	1841.1	b	G1-1841b	G1-14b	1.39
USW G-1	1917.4	a	G1-1917a	G1-15a	1.77
USW G-1	1917.4	b	G1-1917b	G1-15b	1.79
USW GU-3	585.1	a	GU3-585a	GU3-101a	2.20
USW GU-3	585.1	b	GU3-585b	GU3-101b	2.15
USW GU-3	686.6	a	GU3-687a	GU3-102a	2.25
USW GU-3	686.6	b	GU3-687b	GU3-102b	2.28

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

This experiment measured sample volume (by water displacement) and sample mass (by weighing). A value for sample volume may be estimated using the nominal sample length and diameter. A value for sample mass may be estimated using the nominal sample volume and the saturated bulk density listed above. The sample was saturated by a vacuum saturation technique.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. *DO NOT* INCLUDE THIS INFORMATION IN THE SEPDB.

APPENDIX G

SATURATED HYDRAULIC CONDUCTIVITY DATA FROM KEYSTONE DOCUMENT 6310-85-10

This appendix contains the forms required to submit the saturated hydraulic conductivity data contained in Keystone Document 6310-85-10 to the YMP Site and Engineering Properties Data Base (SEPDB).

Saturated Hydraulic Conductivity Data Compilation Form
for the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Value

Drill Hole	Depth (ft)	Sub-sample	ID	Previous ID[1]	Saturated Hydraulic Conductivity (m/s)
USW G-1	388.8	a	G1-389a	G1-1a	1.73e-11
USW G-1	388.8	b	G1-389b	G1-1b	9.13e-11
USW G-1	615.5	a	G1-616a	G1-2a	2.50e-12
USW G-1	615.5	b	G1-616b	G1-2b	1.20e-12
USW G-1	1101.8	a	G1-1102a	G1-3a	4.28e-11
USW G-1	1101.8	b	G1-1102b	G1-3b	1.98e-12
USW G-1	1198.3	a	G1-1198a	G1-4a	4.61e-12
USW G-1	1198.3	b	G1-1198b	G1-4b	5.04e-13
USW G-1	1306.3	a	G1-1306a	G1-5a	3.70e-11
USW G-1	1306.3	b	G1-1306b	G1-5b	broken
USW G-1	1359.3	a	G1-1359a	G1-6a	6.72e-11
USW G-1	1359.3	b	G1-1359b	G1-6b	8.78e-12
USW G-1	1386.7	a	G1-1387a	G1-7a	6.44e-10
USW G-1	1386.7	b	G1-1387b	G1-7b	9.56e-10
USW G-1	1499.8	a	G1-1500a	G1-8a	1.16e-11
USW G-1	1499.8	b	G1-1500b	G1-8b	1.86e-11
USW G-1	1637.0	a	G1-1637a	G1-9a	1.94e-11

Estimated Uncertainty: The data available is insufficient to make rigorous quantitative statements concerning experimental uncertainty. See text for discussion.

PART 3 Experiment Conditions

Experiment Type: Liquid Permeameter (Ruska) Fluid: J-13 well water

Inlet Pressure Head (m): 22.14 (gauge) Outlet Pressure Head (m): 0 (gauge)

Confining Pressure (MPa): zero (gauge) Temperature (C): ambient

Nominal Sample Length (cm): 1.2 Nominal Sample Diameter (cm): 1.5

Sample Orientation (degrees from vertical): No data

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L05-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Saturated Hydraulic Conductivity Data Compilation Form
for the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Value

Drill Hole	Depth (ft)	Sub-sample	ID	Previous ID[1]	Saturated Hydraulic Conductivity (m/s)
USW G-1	1637.0	b	G1-1637b	G1-9b	9.23e-12
USW G-1	1752.7	a	G1-1753a	G1-10a	1.13e-11
USW G-1	1752.7	b	G1-1753b	G1-10b	1.64e-11
USW G-1	1779.5	a	G1-1780a	G1-11a	2.21e-12
USW G-1	1779.5	b	G1-1780b	G1-11b	2.08e-12
USW G-1	1789.6	a	G1-1790a	G1-12a	5.22e-12
USW G-1	1789.6	b	G1-1790b	G1-12b	5.22e-12
USW G-1	1820.7	a	G1-1821a	G1-13a	4.07e-11
USW G-1	1820.7	b	G1-1821b	G1-13b	4.52e-11
USW G-1	1841.1	a	G1-1841a	G1-14a	1.59e-10
USW G-1	1841.1	b	G1-1841b	G1-14b	1.57e-10
USW G-1	1917.4	a	G1-1917a	G1-15a	1.63e-09
USW G-1	1917.4	b	G1-1917b	G1-15b	1.63e-09
USW GU-3	585.1	a	GU3-585a	GU3-101a	1.22e-11
USW GU-3	585.1	b	GU3-585b	GU3-101b	1.59e-11
USW GU-3	884.4	a	GU3-884a	GU3-103a	7.17e-11
USW GU-3	884.4	b	GU3-884b	GU3-103b	broken

Estimated Uncertainty: The data available is insufficient to make rigorous quantitative statements concerning experimental uncertainty. See text for discussion.

PART 3 Experiment Conditions

Experiment Type: Liquid Permeameter (Ruska) Fluid: J-13 well water

Inlet Pressure Head (m): 22.14 (gauge) Outlet Pressure Head (m): 0 (gauge)

Confining Pressure (MPa): zero (gauge) Temperature (C): ambient

Nominal Sample Length (cm): 1.2 Nominal Sample Diameter (cm): 1.5

Sample Orientation (degrees from vertical): No data

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L05-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Saturated Hydraulic Conductivity Data Compilation Form
for the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Value

Drill Hole	Depth (ft)	Sub-sample	ID	Previous ID[1]	Saturated Hydraulic Conductivity (m/s)
USW G-4	136.0	a	G4-136a	G4-101a	4.68e-08
USW G-4	136.0	b	G4-136b	G4-101b	1.65e-07
USW G-4	172.0	a	G4-172a	G4-102a	no sample
USW G-4	172.0	b	G4-172b	G4-102b	no sample
USW GU-3	801.0		GU3-801	GU3-104	6.80e-12
USW GU-3	1036.5		GU3-1037	GU3-105	3.98e-10
USW G-1	1349.9		G1-1350	G1-16	6.82e-12
USW G-1	1979.3		G1-1979	G1-17	1.11e-08
USW G-4	105.3		G4-105	G4-103	1.94e-12
USW G-4	145.0		G4-145	G4-104	3.00e-12
USW G-4	240.0		G4-240	G4-105	1.82e-12
USW G-4	445.0		G4-445	G4-106	2.28e-12
USW G-4	521.8		G4-522	G4-107	1.23e-11
USW G-4	1020.7		G4-1021	G4-108	4.80e-12
USW G-4	1184.3		G4-1184	G4-109	3.07e-12
USW G-4	1306.9		G4-1307	G4-110	2.41e-12
USW G-4	1344.8		G4-1345	G4-111	broken

Estimated Uncertainty: The data available is insufficient to make rigorous quantitative statements concerning experimental uncertainty. See text for discussion.

PART 3 Experiment Conditions

Experiment Type: Liquid Permeameter (Ruska) Fluid: J-13 well water

Inlet Pressure Head (m): 22.14 (gauge) Outlet Pressure Head (m): 0 (gauge)

Confining Pressure (MPa): zero (gauge) Temperature (C): ambient

Nominal Sample Length (cm): 1.2 Nominal Sample Diameter (cm): 1.5

Sample Orientation (degrees from vertical): No data

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L05-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Saturated Hydraulic Conductivity Data Compilation Form
for the YMP SEPDB

PARTS 1 and 2 Sample Location, Identification, and Parameter Value

Drill Hole	Depth (ft)	Sub-sample	ID	Previous ID[1]	Saturated Hydraulic Conductivity (m/s)
USW G-4	1353.5		G4-1354	G4-112	3.05e-13
USW G-4	1375.8		G4-1376	G4-113	3.49e-10
USW G-4	1489.8		G4-1490	G4-114	2.50e-12
USW G-4	1596.8		G4-1597	G4-115	2.43e-12
USW G-4	1714.5		G4-1715	G4-116	3.31e-12
USW G-4	1746.8		G4-1747	G4-117	5.19e-12
USW G-4	1849.0		G4-1849	G4-118	5.13e-12
USW GU-3	686.6	a	GU3-687a	GU3-102a	1.24e-12
USW GU-3	686.6	b	GU3-687b	GU3-102b	1.09e-12

Estimated Uncertainty: The data available is insufficient to make rigorous quantitative statements concerning experimental uncertainty. See text for discussion.

PART 3 Experiment Conditions

Experiment Type: Liquid Permeameter (Ruska) Fluid: J-13 well water

Inlet Pressure Head (m): 22.14 (gauge) Outlet Pressure Head (m): 0 (gauge)

Confining Pressure (MPa): zero (gauge) Temperature (C): ambient

Nominal Sample Length (cm): 1.2 Nominal Sample Diameter (cm): 1.5

Sample Orientation (degrees from vertical): No data

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L05-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

APPENDIX H

MOISTURE RETENTION DATA FROM KEYSTONE DOCUMENT 6310-85-10

This appendix contains the forms required to submit the moisture retention data contained in Keystone Document 6310-85-10 to the YMP Site and Engineering Properties Data Base (SEPDB).

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-389a

Sample Depth (ft): 388.8 Previous ID[1] (If Applicable): G1-1a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0570	0.122
16	Psychrometer	0.0570	0.122
28	Psychrometer	0.0505	0.108
53	Psychrometer	0.0295	0.063
105	Psychrometer	0.0224	0.048
231	Psychrometer	0.0194	0.042
542	Psychrometer	0.0153	0.033
664	Psychrometer	0.0147	0.031
1007	Psychrometer	0.0110	0.024
1248	Psychrometer	0.0093	0.020
1675	Psychrometer	0.0085	0.018
2406	Psychrometer	0.0044	0.009
9631	Room Dry	0.0013	0.003
30773	Salt Solution	0.0008	0.002

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.14

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-389b

Sample Depth (ft): 388.8 Previous ID[1] (If Applicable): G1-1b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0593	0.131
20	Psychrometer	0.0593	0.131
43	Psychrometer	0.0353	0.078
103	Psychrometer	0.0225	0.050
217	Psychrometer	0.0189	0.042
401	Psychrometer	0.0143	0.032
598	Psychrometer	0.0124	0.027
751	Psychrometer	0.0108	0.024
1161	Psychrometer	0.0087	0.019
1378	Psychrometer	0.0078	0.017
1560	Psychrometer	0.0069	0.015
2175	Psychrometer	0.0042	0.009
2475	Psychrometer	0.0036	0.008
3358	Psychrometer	0.0025	0.006
9631	Room Dry	0.0015	0.003
30773	Salt Solution	0.0007	0.002

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.21

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-616a

Sample Depth (ft): 615.5 Previous ID[1] (If Applicable): G1-2a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0457	0.100
22	Psychrometer	0.0457	0.100
91	Psychrometer	0.412	0.090
143	Psychrometer	0.0358	0.078
384	Psychrometer	0.0277	0.060
489	Psychrometer	0.0258	0.056
703	Psychrometer	0.0212	0.046
874	Psychrometer	0.0201	0.044
996	Psychrometer	0.0156	0.034
1221	Psychrometer	0.0143	0.031
1548	Psychrometer	0.0127	0.028
1780	Psychrometer	0.0106	0.023
3061	Psychrometer	0.0092	0.020
4192	Psychrometer	0.0069	0.015
9631	Room Dry	0.0048	0.010
30773	Salt Solution	0.0002	0.001

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.18

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-616b

Sample Depth (ft): 615.5 Previous ID[1] (If Applicable): G1-2b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0324	0.074
28	Psychrometer	0.0324	0.074
114	Psychrometer	0.0285	0.065
316	Psychrometer	0.0258	0.059
550	Psychrometer	0.0203	0.046
890	Psychrometer	0.0179	0.041
999	Psychrometer	0.0152	0.035
1558	Psychrometer	0.0144	0.033
1693	Psychrometer	0.0126	0.029
1958	Psychrometer	0.0116	0.026
2881	Psychrometer	0.0097	0.022
5022	Psychrometer	0.0093	0.021
5782	Psychrometer	0.0086	0.020
9631	Room Dry	0.0038	0.009
30773	Salt Solution	0.0017	0.004

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.28

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1102a

Sample Depth (ft): 1101.8 Previous ID[1] (If Applicable): G1-3a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0541	0.119
20	Psychrometer	0.0541	0.119
75	Psychrometer	0.0490	0.108
200	Psychrometer	0.0371	0.082
352	Psychrometer	0.0306	0.067
888	Psychrometer	0.0256	0.056
1136	Psychrometer	0.0186	0.041
1383	Psychrometer	0.0177	0.039
1884	Psychrometer	0.0151	0.033
2193	Psychrometer	0.0145	0.032
2744	Psychrometer	0.0130	0.029
3430	Psychrometer	0.0105	0.023
4089	Psychrometer	0.0083	0.018
4948	Psychrometer	0.0068	0.015
9631	Room Dry	0.0062	0.014
30773	Salt Solution	0.0034	0.007

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.20

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

Moisture Retention Data Compilation Form
for the YMP SEPDB (concluded)

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1102b

Sample Depth (ft): 1101.8 Previous ID[1] (If Applicable): G1-3b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0423	0.096
20	Psychrometer	0.0423	0.096
39	Psychrometer	0.0365	0.082
168	Psychrometer	0.0332	0.075
371	Psychrometer	0.0261	0.059
510	Psychrometer	0.0225	0.051
715	Psychrometer	0.0214	0.048
1072	Psychrometer	0.0178	0.040
1251	Psychrometer	0.0165	0.037
1463	Psychrometer	0.0154	0.035
1805	Psychrometer	0.0146	0.033
2069	Psychrometer	0.0132	0.030
2454	Psychrometer	0.0126	0.028
3514	Psychrometer	0.0097	0.022
4211	Psychrometer	0.0084	0.019
9631	Room Dry	0.0049	0.011
30773	Salt Solution	0.0028	0.006

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.26

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

Moisture Retention Data Compilation Form
for the YMP SEPDB (concluded)

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1198a

Sample Depth (ft): 1198.3 Previous ID[1] (If Applicable): G1-4a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0369	0.085
30	Psychrometer	0.0369	0.085
188	Psychrometer	0.0325	0.075
323	Psychrometer	0.0263	0.061
508	Psychrometer	0.0204	0.047
669	Psychrometer	0.0193	0.045
827	Psychrometer	0.0186	0.043
1286	Psychrometer	0.0162	0.037
1867	Psychrometer	0.0147	0.034
2136	Psychrometer	0.0130	0.030
3676	Psychrometer	0.0104	0.024
4379	Psychrometer	0.0075	0.017
9631	Room Dry	0.0054	0.012
30773	Salt Solution	0.0033	0.008

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.31

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions
The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1198b

Sample Depth (ft): 1198.3 Previous ID[1] (If Applicable): G1-4b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0360	0.083
30	Psychrometer	0.0360	0.083
380	Psychrometer	0.0313	0.072
526	Psychrometer	0.0218	0.050
703	Psychrometer	0.0190	0.044
852	Psychrometer	0.0181	0.042
1099	Psychrometer	0.0174	0.040
1585	Psychrometer	0.0148	0.034
1758	Psychrometer	0.0143	0.033
2223	Psychrometer	0.0129	0.030
2637	Psychrometer	0.0114	0.026
3569	Psychrometer	0.0096	0.022
4001	Psychrometer	0.0082	0.019
9631	Room Dry	0.0062	0.014
30773	Salt Solution	0.0034	0.008

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.31

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1306a

Sample Depth (ft): 1306.3 Previous ID[1] (If Applicable): G1-5a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0149	0.034
30	Psychrometer	0.0149	0.034
114	Psychrometer	0.0118	0.027
137	Psychrometer	0.0105	0.024
899	Psychrometer	0.0094	0.022
1234	Psychrometer	0.0074	0.017
1566	Psychrometer	0.0061	0.014
1779	Psychrometer	0.0056	0.013
2153	Psychrometer	0.0049	0.011
2751	Psychrometer	0.0044	0.010
3432	Psychrometer	0.0036	0.008
9631	Room Dry	0.0012	0.003
30773	Salt Solution	0.0006	0.001

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.30

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1306b

Sample Depth (ft): 1306.3 Previous ID[1] (If Applicable): G1-5b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0073	0.016
18	Psychrometer	0.0073	0.016
218	Psychrometer	0.0059	0.013
432	Psychrometer	0.0053	0.011
853	Psychrometer	0.0040	0.009
1109	Psychrometer	0.0037	0.008
1477	Psychrometer	0.0035	0.008
1884	Psychrometer	0.0032	0.007
2592	Psychrometer	0.0029	0.006
3145	Psychrometer	0.0023	0.005
4135	Psychrometer	0.0021	0.005
9631	Room Dry	0.0001	0.001
30773	Salt Solution	0.0008	0.002

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.15

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1359a

Sample Depth (ft): 1359.3 Previous ID[1] (If Applicable): G1-6a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0856	0.167
16	Psychrometer	0.0856	0.167
31	Psychrometer	0.0758	0.148
123	Psychrometer	0.0439	0.086
472	Psychrometer	0.0320	0.062
1067	Psychrometer	0.0293	0.057
1968	Psychrometer	0.0278	0.054
2809	Psychrometer	0.0264	0.051
3040	Psychrometer	0.0225	0.044
3211	Psychrometer	0.0213	0.042
4925	Psychrometer	0.0171	0.033
9631	Room Dry	0.0069	0.013
30773	Salt Solution	0.0045	0.009

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.95

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1359b

Sample Depth (ft): 1359.3 Previous ID[1] (If Applicable): G1-6b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0853	0.166
16	Psychrometer	0.0853	0.166
39	Psychrometer	0.0764	0.146
81	Psychrometer	0.0503	0.098
114	Psychrometer	0.0399	0.078
196	Psychrometer	0.0358	0.070
885	Psychrometer	0.0320	0.062
2211	Psychrometer	0.0294	0.057
2925	Psychrometer	0.0281	0.055
3569	Psychrometer	0.0254	0.050
3718	Psychrometer	0.0225	0.044
4604	Psychrometer	0.0213	0.042
5694	Psychrometer	0.0168	0.033
9631	Room Dry	0.0074	0.014
30773	Salt Solution	0.0051	0.010

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.95

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1387a

Sample Depth (ft): 1386.7 Previous ID[1] (If Applicable): G1-7a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.1917	0.288
16	Psychrometer	0.1917	0.288
39	Psychrometer	0.1911	0.287
71	Psychrometer	0.1079	0.162
420	Psychrometer	0.0755	0.113
1283	Psychrometer	0.0688	0.103
2641	Psychrometer	0.0643	0.096
3251	Psychrometer	0.0614	0.092
3461	Psychrometer	0.0584	0.088
3860	Psychrometer	0.0550	0.083
4147	Psychrometer	0.0508	0.076
4485	Psychrometer	0.0459	0.069
9631	Room Dry	0.0192	0.029
30773	Salt Solution	0.0114	0.017

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.50

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions
The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1387b

Sample Depth (ft): 1386.7 Previous ID[1] (If Applicable): G1-7b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.1897	0.298
14	Psychrometer	0.1897	0.298
41	Psychrometer	0.1422	0.223
67	Psychrometer	0.0983	0.154
79	Psychrometer	0.0717	0.113
558	Psychrometer	0.0586	0.092
1023	Psychrometer	0.0544	0.085
2334	Psychrometer	0.0497	0.078
3113	Psychrometer	0.0460	0.072
6337	Psychrometer	0.0222	0.035
9631	Room Dry	0.0140	0.022
30773	Salt Solution	0.0087	0.014

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.57

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

Moisture Retention Data Compilation Form
for the YMP SEPDB (concluded)

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1500a

Sample Depth (ft): 1499.8 Previous ID[1] (If Applicable): G1-8a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.2153	0.334
12	Psychrometer	0.2153	0.334
35	Psychrometer	0.2020	0.313
74	Psychrometer	0.1837	0.285
372	Psychrometer	0.1643	0.255
607	Psychrometer	0.1379	0.214
805	Psychrometer	0.1270	0.197
1054	Psychrometer	0.1180	0.183
1635	Psychrometer	0.0958	0.148
2036	Psychrometer	0.0913	0.142
2486	Psychrometer	0.0871	0.135
3271	Psychrometer	0.0816	0.126
3881	Psychrometer	0.0768	0.119
8903	Psychrometer	0.0498	0.077
9631	Room Dry	0.0496	0.077
30773	Salt Solution	0.0299	0.046

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.55

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1500b

Sample Depth (ft): 1499.8 Previous ID[1] (If Applicable): G1-8b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.2428	0.354
16	Psychrometer	0.2428	0.364
39	Psychrometer	0.2308	0.346
60	Psychrometer	0.1965	0.295
220	Psychrometer	0.1781	0.267
394	Psychrometer	0.1655	0.248
515	Psychrometer	0.1499	0.225
654	Psychrometer	0.1362	0.204
889	Psychrometer	0.1238	0.186
1092	Psychrometer	0.1150	0.173
1217	Psychrometer	0.1087	0.163
1747	Psychrometer	0.1036	0.155
2124	Psychrometer	0.0941	0.141
2881	Psychrometer	0.0888	0.133
4247	Psychrometer	0.0776	0.116
9356	Psychrometer	0.0545	0.082
9631	Room Dry	0.0503	0.075
30773	Salt Solution	0.0305	0.046

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.50

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions
The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1637a

Sample Depth (ft): 1637.0 Previous ID[1] (If Applicable): G1-9a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.2119	0.328
14	Psychrometer	0.2119	0.328
43	Psychrometer	0.2000	0.310
446	Psychrometer	0.1581	0.245
605	Psychrometer	0.1415	0.219
710	Psychrometer	0.1315	0.204
1059	Psychrometer	0.1193	0.185
1452	Psychrometer	0.1101	0.171
1942	Psychrometer	0.1021	0.158
2305	Psychrometer	0.0916	0.142
2727	Psychrometer	0.0832	0.129
3040	Psychrometer	0.0791	0.123
3906	Psychrometer	0.0751	0.116
4368	Psychrometer	0.0713	0.111
7858	Psychrometer	0.0530	0.082
9631	Room Dry	0.0522	0.081
30773	Salt Solution	0.0441	0.068

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.55

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions
The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1637b

Sample Depth (ft): 1637.0 Previous ID[1] (If Applicable): G1-9b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.1749	0.290
6	Psychrometer	0.1749	0.290
244	Psychrometer	0.1628	0.270
662	Psychrometer	0.1384	0.230
858	Psychrometer	0.1246	0.207
1058	Psychrometer	0.1172	0.195
1383	Psychrometer	0.1094	0.182
1768	Psychrometer	0.1021	0.169
2106	Psychrometer	0.0973	0.162
2630	Psychrometer	0.0843	0.140
3375	Psychrometer	0.0785	0.130
4012	Psychrometer	0.0749	0.124
4344	Psychrometer	0.0717	0.119
7494	Psychrometer	0.0574	0.095
9631	Room Dry	0.0508	0.084
30773	Salt Solution	0.0345	0.057

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.66

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

Moisture Retention Data Compilation Form
for the YMP SEPDB (concluded)

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1753a

Sample Depth (ft): 1752.7 Previous ID[1] (If Applicable): G1-10a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.1854	0.308
20	Psychrometer	0.1854	0.308
74	Psychrometer	0.1737	0.288
279	Psychrometer	0.1662	0.276
395	Psychrometer	0.1566	0.260
675	Psychrometer	0.1243	0.206
817	Psychrometer	0.1095	0.182
1100	Psychrometer	0.0989	0.164
1362	Psychrometer	0.0904	0.150
1725	Psychrometer	0.0752	0.125
2188	Psychrometer	0.0676	0.112
3067	Psychrometer	0.0599	0.099
4316	Psychrometer	0.0539	0.089
9631	Room Dry	0.0485	0.081
30773	Salt Solution	0.0409	0.068

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.66

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

Moisture Retention Data Compilation Form
for the YMP SEPDB (concluded)

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1753b

Sample Depth (ft): 1752.7 Previous ID[1] (If Applicable): G1-10b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.1854	0.300
20	Psychrometer	0.1854	0.300
95	Psychrometer	0.1741	0.282
358	Psychrometer	0.1637	0.265
508	Psychrometer	0.1418	0.230
737	Psychrometer	0.1186	0.192
1024	Psychrometer	0.1064	0.172
1369	Psychrometer	0.0970	0.157
1747	Psychrometer	0.0901	0.146
2031	Psychrometer	0.0743	0.120
3553	Psychrometer	0.0666	0.108
5281	Psychrometer	0.0483	0.078
9631	Room Dry	0.0480	0.078
30773	Salt Solution	0.0408	0.066

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.62

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1780a

Sample Depth (ft): 1779.5 Previous ID[1] (If Applicable): G1-11a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.1391	0.255
28	Psychrometer	0.1391	0.255
97	Psychrometer	0.1242	0.227
153	Psychrometer	0.1147	0.210
292	Psychrometer	0.1031	0.189
473	Psychrometer	0.0923	0.169
666	Psychrometer	0.0827	0.151
1423	Psychrometer	0.0725	0.133
1974	Psychrometer	0.0609	0.111
2864	Psychrometer	0.0551	0.101
3493	Psychrometer	0.0497	0.091
4052	Psychrometer	0.0444	0.081
6976	Psychrometer	0.0349	0.064
9631	Room Dry	0.0255	0.047
30773	Salt Solution	0.0199	0.036

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.83

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation-Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1780b

Sample Depth (ft): 1779.5 Previous ID[1] (If Applicable): G1-11b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.1371	0.251
28	Psychrometer	0.1371	0.251
153	Psychrometer	0.1215	0.222
429	Psychrometer	0.1014	0.186
625	Psychrometer	0.0913	0.167
968	Psychrometer	0.0817	0.150
1357	Psychrometer	0.0738	0.135
1972	Psychrometer	0.0650	0.119
2967	Psychrometer	0.0582	0.107
3549	Psychrometer	0.0524	0.096
4290	Psychrometer	0.0466	0.085
5426	Psychrometer	0.0462	0.085
6818	Psychrometer	0.0384	0.070
9631	Room Dry	0.0236	0.043
30773	Salt Solution	0.0144	0.026

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.83

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

Moisture Retention Data Compilation Form
for the YMP SEPDB (concluded)

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1790a

Sample Depth (ft): 1789.6 Previous ID[1] (If Applicable): G1-12a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.1149	0.224
59	Psychrometer	0.1149	0.224
390	Psychrometer	0.1004	0.196
461	Psychrometer	0.0936	0.183
761	Psychrometer	0.0829	0.162
921	Psychrometer	0.0732	0.143
1428	Psychrometer	0.0598	0.117
1812	Psychrometer	0.0501	0.098
2846	Psychrometer	0.0440	0.086
3804	Psychrometer	0.0388	0.076
4470	Psychrometer	0.0281	0.055
9631	Room Dry	0.0197	0.038
30773	Salt Solution	0.0126	0.025

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.95

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

Moisture Retention Data Compilation Form
for the YMP SEPDB (concluded)

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1790b

Sample Depth (ft): 1789.6 Previous ID[1] (If Applicable): G1-12b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.1189	0.233
59	Psychrometer	0.1189	0.233
400	Psychrometer	0.1051	0.206
606	Psychrometer	0.0873	0.171
981	Psychrometer	0.0766	0.150
1174	Psychrometer	0.0707	0.139
1390	Psychrometer	0.0624	0.122
1985	Psychrometer	0.0534	0.105
2925	Psychrometer	0.0478	0.094
4147	Psychrometer	0.0412	0.081
6148	Psychrometer	0.0318	0.062
9631	Room Dry	0.0185	0.036
30773	Salt Solution	0.0078	0.015

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.96

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions
The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

Moisture Retention Data Compilation Form
for the YMP SEPDB (concluded)

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1821a

Sample Depth (ft): 1820.7 Previous ID[1] (If Applicable): G1-13a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.2423	0.354
18	Psychrometer	0.2423	0.354
48	Psychrometer	0.2265	0.331
192	Psychrometer	0.1668	0.244
482	Psychrometer	0.1470	0.215
610	Psychrometer	0.1289	0.188
958	Psychrometer	0.1141	0.163
1249	Psychrometer	0.0960	0.140
1431	Psychrometer	0.0852	0.124
1787	Psychrometer	0.0709	0.104
2948	Psychrometer	0.0584	0.085
3607	Psychrometer	0.0470	0.069
6754	Psychrometer	0.0318	0.046
9631	Room Dry	0.0308	0.045
30773	Salt Solution	0.0198	0.029

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.46

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1821b

Sample Depth (ft): 1820.7 Previous ID[1] (If Applicable): G1-13b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.2308	0.346
19	Psychrometer	0.2308	0.346
64	Psychrometer	0.1894	0.284
217	Psychrometer	0.1749	0.262
464	Psychrometer	0.1409	0.211
661	Psychrometer	0.1213	0.182
1025	Psychrometer	0.1036	0.155
1167	Psychrometer	0.0902	0.135
1423	Psychrometer	0.0786	0.118
1862	Psychrometer	0.0665	0.100
3009	Psychrometer	0.0566	0.085
3589	Psychrometer	0.0507	0.076
4634	Psychrometer	0.0455	0.068
6369	Psychrometer	0.0397	0.060
9631	Room Dry	0.0384	0.058
30773	Salt Solution	0.0200	0.030

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.50

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1841a

Sample Depth (ft): 1841.1 Previous ID[1] (If Applicable): G1-14a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.2296	0.349
14	Psychrometer	0.2296	0.349
130	Psychrometer	0.1603	0.244
341	Psychrometer	0.1428	0.217
414	Psychrometer	0.1250	0.190
727	Psychrometer	0.1064	0.162
1223	Psychrometer	0.0906	0.138
1442	Psychrometer	0.0663	0.101
2198	Psychrometer	0.0544	0.083
3079	Psychrometer	0.0481	0.073
3881	Psychrometer	0.0419	0.064
4611	Psychrometer	0.0403	0.061
9631	Room Dry	0.0336	0.051
30773	Salt Solution	0.0277	0.042

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.52

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions
The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1841b

Sample Depth (ft): 1841.1 Previous ID[1] (If Applicable): G1-14b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.2808	0.390
21	Psychrometer	0.2808	0.390
43	Psychrometer	0.1938	0.369
231	Psychrometer	3.1503	0.209
358	Psychrometer	0.1243	0.173
634	Psychrometer	0.0978	0.136
813	Psychrometer	0.0839	0.117
1119	Psychrometer	0.0741	0.103
1337	Psychrometer	0.0635	0.088
1633	Psychrometer	0.0560	0.078
2716	Psychrometer	0.0506	0.070
3472	Psychrometer	0.0471	0.065
9631	Room Dry	0.0346	0.048
30773	Salt Solution	0.0255	0.037

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.39

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1917a

Sample Depth (ft): 1917.4 Previous ID[1] (If Applicable): G1-15a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.1695	0.300
19	Psychrometer	0.1695	0.300
62	Psychrometer	0.1425	0.252
100	Psychrometer	0.0392	0.069
194	Psychrometer	0.0299	0.053
324	Psychrometer	0.0234	0.041
490	Psychrometer	0.0179	0.032
779	Psychrometer	0.0143	0.025
1614	Psychrometer	0.0093	0.016
2374	Psychrometer	0.0063	0.011
4627	Psychrometer	0.0048	0.008
6085	Psychrometer	0.0047	0.008
9631	Room Dry	0.0028	0.005
30773	Salt Solution	0.0008	0.001

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.77

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

Moisture Retention Data Compilation Form
for the YMP SEPDB (concluded)

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-1 Sample ID: G1-1917b

Sample Depth (ft): 1917.4 Previous ID[1] (If Applicable): G1-15b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.1623	0.291
19	Psychrometer	0.1623	0.291
64	Psychrometer	0.1378	0.246
94	Psychrometer	0.0438	0.078
151	Psychrometer	0.0369	0.066
214	Psychrometer	0.0287	0.051
414	Psychrometer	0.0234	0.042
611	Psychrometer	0.0184	0.033
929	Psychrometer	0.0148	0.026
1331	Psychrometer	0.0110	0.020
1849	Psychrometer	0.0095	0.017
2112	Psychrometer	0.0061	0.011
2735	Psychrometer	0.0045	0.008
4141	Psychrometer	0.0020	0.004
9631	Room Dry	0.0019	0.003
30773	Salt Solution	0.0010	0.002

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.79

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW GU-3 Sample ID: GU3-585a

Sample Depth (ft): 585.1 Previous ID[1] (If Applicable): GU3-101a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0492	0.108
23	Psychrometer	0.0492	0.108
62	Psychrometer	0.0323	0.071
149	Psychrometer	0.0251	0.055
234	Psychrometer	0.0176	0.039
570	Psychrometer	0.0128	0.028
773	Psychrometer	0.0120	0.026
871	Psychrometer	0.0095	0.021
3619	Psychrometer	0.0069	0.015
4391	Psychrometer	0.0066	0.015
6212	Psychrometer	0.0054	0.012
9631	Room Dry	0.0025	0.006
30773	Salt Solution	0.0010	0.002

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.20

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions
The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

1) The "Previous ID" column refers to the sample ID used in the accompanying KEYSTONE DOCUMENT 6310-85-10. It is listed to aid in cross-referencing the data from this form and other documents published after the Keystone document (e.g., SAND86-0286) to the data in the Keystone document. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

2) The "Water Volume/Sample Volume" (also called moisture content) is calculated by multiplying the "Water Weight/Initial Sample Weight" times the "Saturated Bulk Density". The moisture content data are included as a convenience to the user. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW GU-3 Sample ID: GU3-585b

Sample Depth (ft): 585.1 Previous ID[1] (If Applicable): GU3-101b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0610	0.131
27	Psychrometer	0.0610	0.131
64	Psychrometer	0.0497	0.107
178	Psychrometer	0.0292	0.063
294	Psychrometer	0.0221	0.048
544	Psychrometer	0.0168	0.036
696	Psychrometer	0.0139	0.030
980	Psychrometer	0.0126	0.027
1215	Psychrometer	0.0113	0.024
1979	Psychrometer	0.0052	0.011
2569	Psychrometer	0.0041	0.009
2985	Psychrometer	0.0028	0.006
9631	Room Dry	0.0020	0.004
30773	Salt Solution	0.0013	0.003

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.15

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

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3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW GU-3 Sample ID: GU3-687a

Sample Depth (ft): 686.6 Previous ID[1] (If Applicable): GU3-102a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0370	0.083
19	Psychrometer	0.0370	0.083
109	Psychrometer	0.0281	0.063
235	Psychrometer	0.0239	0.054
343	Psychrometer	0.0160	0.036
560	Psychrometer	0.0135	0.030
815	Psychrometer	0.0120	0.027
1179	Psychrometer	0.0112	0.025
2197	Psychrometer	0.0100	0.023
2472	Psychrometer	0.0057	0.013
2815	Psychrometer	0.0049	0.011
9631	Room Dry	0.0024	0.005
30773	Salt Solution	0.0011	0.002

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.25

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

Moisture Retention Data Compilation Form
for the YMP SEPDB (concluded)

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

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Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW GU-3 Sample ID: GU3-687b

Sample Depth (ft): 686.6 Previous ID[1] (If Applicable): GU3-102b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0347	0.079
29	Psychrometer	0.0347	0.079
198	Psychrometer	0.0270	0.062
346	Psychrometer	0.0195	0.044
476	Psychrometer	0.0151	0.034
677	Psychrometer	0.0136	0.031
952	Psychrometer	0.0121	0.028
1157	Psychrometer	0.0108	0.025
1751	Psychrometer	0.0082	0.019
2256	Psychrometer	0.0062	0.014
3094	Psychrometer	0.0050	0.011
3288	Psychrometer	0.0044	0.010
9631	Room Dry	0.0029	0.007
30773	Salt Solution	0.0016	0.004

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.28

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

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Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW GU-3 Sample ID: GU3-884a

Sample Depth (ft): 884.4 Previous ID[1] (If Applicable): GU3-103a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0585	0.127
25	Psychrometer	0.0585	0.127
64	Psychrometer	0.0447	0.097
139	Psychrometer	0.0365	0.079
286	Psychrometer	0.0222	0.048
422	Psychrometer	0.0144	0.031
695	Psychrometer	0.0090	0.020
777	Psychrometer	0.0070	0.015
1408	Psychrometer	0.0060	0.013
2057	Psychrometer	0.0041	0.009
2267	Psychrometer	0.0039	0.008
3508	Psychrometer	0.0029	0.006
5695	Psychrometer	0.0028	0.006
9631	Room Dry	0.0020	0.004
30773	Salt Solution	0.0013	0.002

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.17

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

COMMENTS

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3) This saturated bulk density data are included on the "Moisture Retention Data Compilation Form" for information purposes only. The data are being submitted to the SEPDB by a separate form. DO NOT INCLUDE THIS INFORMATION IN THE SEPDB.

Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW GU-3 Sample ID: GU3-884b

Sample Depth (ft): 884.4 Previous ID[1] (If Applicable): GU3-103b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.0423	0.096
29	Psychrometer	0.0423	0.096
263	Psychrometer	0.0295	0.067
434	Psychrometer	0.0113	0.026
589	Psychrometer	0.0091	0.021
872	Psychrometer	0.0075	0.017
1199	Psychrometer	0.0063	0.014
1711	Psychrometer	0.0057	0.013
2032	Psychrometer	0.0038	0.009
2203	Psychrometer	0.0031	0.007
3565	Psychrometer	0.0027	0.006
9631	Room Dry	0.0023	0.005
30773	Salt Solution	0.0011	0.003

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 2.27

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

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Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-4 Sample ID: G4-136a

Sample Depth (ft): 136.0 Previous ID[1] (If Applicable): G4-101a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.2659	0.359
29	Psychrometer	0.2659	0.359
177	Psychrometer	0.0831	0.111
360	Psychrometer	0.0509	0.068
694	Psychrometer	0.0202	0.027
1725	Psychrometer	0.0132	0.018
2514	Psychrometer	0.0110	0.015
4295	Psychrometer	0.0071	0.010
9631	Room Dry	0.0046	0.006
30773	Salt Solution	0.0023	0.003

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.34

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
Name	SNL Division	Date

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Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-4 Sample ID: G4-136b

Sample Depth (ft): 136.0 Previous ID[1] (If Applicable): G4-101b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.2673	0.358
29	Psychrometer	0.2673	0.358
45	Psychrometer	0.2449	0.328
224	Psychrometer	0.0870	0.117
518	Psychrometer	0.0538	0.072
885	Psychrometer	0.0269	0.036
1664	Psychrometer	0.0198	0.027
4387	Psychrometer	0.0133	0.018
5598	Psychrometer	0.0108	0.014
9631	Room Dry	0.0055	0.007
30773	Salt Solution	0.0024	0.003

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): 1.34

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

Ralph R. Peters	6312	3/1/89
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Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-4 Sample ID: G4-172a

Sample Depth (ft): 172.0 Previous ID[1] (If Applicable): G4-102a

Subsample: a

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.7101	0.685
27	Psychrometer	0.7101	0.685
166	Psychrometer	0.1736	0.155
304	Psychrometer	0.1016	0.090
2568	Psychrometer	0.0303	0.027
3461	Psychrometer	0.0061	0.005
8112	Psychrometer	0.0049	0.004
9631	Room Dry	0.0002	0.001
30773	Salt Solution	0.0008	0.001

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): .89

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

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Name	SNL Division	Date

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Moisture Retention Data Compilation Form
for the YMP SEPDB

PART 1 Sample Location and Identification

Sample Origin: Drill Hole USW G-4 Sample ID: G4-172b

Sample Depth (ft): 172.0 Previous ID[1] (If Applicable): G4-102b

Subsample: b

PART 2 Parameters

Pressure Head (m)	Experimental Conditions	Water Content (Water Weight) / (Initial Sample Weight)	Water Volume[2] / Sample Volume
0	Psychrometer	0.6040	0.538
29	Psychrometer	0.6040	0.538
98	Psychrometer	0.2166	0.193
174	Psychrometer	0.0822	0.073
1041	Psychrometer	0.0491	0.044
2023	Psychrometer	0.0285	0.025
9631	Room Dry	0.0057	0.005

Estimated Experiment Uncertainty: Because of questions regarding the experimental procedures used, no statement regarding uncertainty can be made.

Saturated Bulk Density[3] (g/cm^3): .89

Estimated Uncertainty: No data; see SAND88-0811 for discussion of uncertainty of this type of data.

PART 3 Experiment Conditions

The experiment measured sample water weight at different pressure heads. Three different methods were used to obtain a wide range of pressure head versus sample water content.

Psychrometer - Data in the pressure-head range of 0 to -9631 m (not including the -9631 m data) were obtained by repeated drying of the sample in an oven, weighing the sample and then using a Decagon thermocouple psychrometer to measure equilibrium relative humidity which was used to calculate the pressure head.

PART 3 Experiment Conditions (continued)

Room Dry - The sample was allowed to dry under room conditions and weighed. Room humidity corresponded to a pressure head of -9631 m.

Salt Solution - The sample was allowed to equilibrate with a salt solution (11% relative humidity) which correspond to a pressure head of -30,773 m and weighed.

Sample Length (cm): 1.2 Sample Diameter (cm): 1.5

Fluid: J-13 well water Temperature (C): ambient

PART 4 Reference and Supporting Information

SNL YMP Data Set ID: 51/L07-11/5/84

SNL Data Report No.: SAND87-2380 QA Level of Data-Gathering Activity: TBD

This Data Compilation Form completed by

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APPENDIX I

SEPDB AND RIB APPENDIX

The following portions of this document are candidate information for the YMP Site and Engineering Properties Data Base (SEPDB):

Appendices C, F, G, and H

The candidate information in Appendix C is composed of values for the van Genuchten curve-fitting parameters, α, β, and S_r that determine the relationship between saturation and pressure head. The candidate information in Appendices F, G, and H is composed, respectively, of saturated bulk density data, saturated conductivity data, and moisture retention data for the core samples taken from drill holes USW G-1, USW GU-3, and USW G-4.

The following portions of this document are candidate information for the YMP Reference Information Base (RIB):

Table 7.2
Table 7.3

The candidate information is composed of values for the following parameters: saturated hydraulic conductivity, maximum moisture content, and the van Genuchten curve-fit parameters α, β, and S_r.

DISTRIBUTION LIST

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