GEOHYDROLOGIC DATA FROM TEST HOLES UE-25 UZ #4 AND UE-25 UZ #5, YUCCA MOUNTAIN AREA, NYE COUNTY, NEVADA

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CONTENTS

FIGURES

TABLES

CONVERSION TABLE

Multiply	*By*	*To obtain*
centimeter cubed (cm^3)	0.06102	inch cubed
centimeter squared (cm^2)	0.1550	inch squared
gram (gm)	0.03527	ounce
gram per cubic centimeter (gm/cm^3)	0.03613	pounds per cubic inch
kilometer (km)	0.6214	mile
kilopascal (kPa)	0.1450	pounds per square inch
kilopascal (kPa)	0.01	bars
liter (L)	1.057	quart
meter (m)	3.281	foot
milliliter (mL)	0.06102	inch cubed
millimeter (mm)	0.03937	inch

Temperatures are given in degree Celsius. To convert degree Celsius (°C) to degree Fahrenheit (°F) use the following formula:

$$°F = 1.8 \times °C + 32.$$

GEOHYDROLOGIC DATA FROM TEST HOLES UE-25 UZ #4 AND UE-25 UZ #5, YUCCA MOUNTAIN AREA, NYE COUNTY, NEVADA

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ABSTRACT

Data collected to determine the hydraulic characteristics of rocks penetrated by test holes UE-25 UZ #4 and UE-25 UZ #5 are presented. These test holes are part of a series of test holes drilled in and near the southwestern part of the Nevada Test Site in an investigation conducted by the U.S. Geological Survey in cooperation with the U.S. Department of Energy. This investigation is part of the Yucca Mountain Project Branch, Hydrologic Investigations Program (formerly Nevada Nuclear Waste Storage Investigations) to determine the suitability of this site for storage of high-level radioactive wastes in an underground mined repository. Data on drilling operations, lithology, coring, and laboratory analyses of hydrologic characteristics of core and cuttings samples are included in this report.

The density, water content, and water potential of the samples collected from UE-25 UZ #4 and UE-25 UZ #5 are related to the degree of welding of the rock units. Water content, and water potential decrease with an increase in the degree of welding; density increases with the degree of welding. The partially welded, nonwelded, and bedded tuffs penetrated by UE-25 UZ #4 and UE-25 UZ #5 comprise a thicker section than the combined moderately welded and densely welded tuffs. The bulk density of core samples of nonwelded and bedded tuffs ranged from 0.97 to 1.54 and averaged 1.26 grams per cubic centimeter for UE-25 UZ #4 and ranged from 0.95 to 1.74 and averaged 1.25 grams per cubic centimeter for UE-25 UZ #5; grain density ranged from 2.30 to 2.61 and averaged 2.41 grams per cubic centimeter for UE-25 UZ #4 and ranged from 2.32 to 2.62 and averaged 2.40 grams per cubic centimeter for UE-25 UZ #5. Gravimetric water contents of partially welded, nonwelded, and bedded tuffs from cores from UE-25 UZ #4 and UE-25 UZ #5 averaged 0.168 and 0.146 grams per gram, respectively, and water potentials averaged 350 and 320 negative kilopascals, respectively. For UE-25 UZ #4, tritium concentrations of alluvial-colluvial drive core were higher than background levels (5-10 units) from 0.91 to 4.88 meters below ground surface.

INTRODUCTION

The U.S. Geological Survey has been conducting investigations at Yucca Mountain in Nevada to provide information about the hydrologic and geologic suitability of this site for storing high-level nuclear wastes in an underground mined repository. These investigations are a part of the Yucca Mountain Project Branch, Hydrologic Investigations Program (formerly Nevada Nuclear Waste Storage Investigations) conducted in cooperation with the U.S. Department of Energy, Nevada Field Office, under Interagency Agreement DE-AI08-78ET44802. Test drilling has been a principal method of investigation. This report presents hydrologic and geologic data collected during the drilling and coring of test holes UE-25 UZ #4 and UE-25 UZ #5, and the results of the first of a series of laboratory tests on drill cuttings and core. Methods used to obtain this data, including sample collection, handling, and testing methods also are presented. Work on UE-25 UZ #4 and UE-25 UZ #5 was done in accordance with the NNWSI Quality Assurance Program.

Purpose and Scope

Test holes UE-25 UZ #4 and UE-25 UZ #5 (hereinafter called UZ #4 and UZ #5) are the first in a series of relatively shallow unsaturated-zone test holes, with total depths of less than 160 m to be drilled at Yucca Mountain in rocks of volcanic and volcanic-clastic origin. The main objectives of the shallow unsaturated-zone test-hole program are: (1) to determine the flux of water moving through the nonwelded and bedded tuff rock units in the upper 160 m of unsaturated rock; (2) to determine the vertical distribution of moisture content, water potential, and other important geohydrologic characteristics in the rock units penetrated; and (3) to monitor changes in relevant in situ bore-hole hydrologic characteristics with time.

This report presents geohydrologic data collected to satisfy the second objective. Work currently is in progress to satisfy the first and third objectives. Hydrologic characteristics currently are being measured on minimally disturbed core taken from these holes; these measurements will permit the calculation of flux in the nonwelded and bedded rock units penetrated. Work will begin in the near future to instrument these test holes to monitor changes in hydrologic characteristics over time. Data from core testing and in situ test-hole instruments will be published in separate reports as they become available.

Location and Geohydrologic Setting

Test holes UZ #4 and UZ #5 are located in Nye County, Nevada, approximately 145 km northwest of Las Vegas on the Nevada Test Site (fig. 1). Coordinates of the well sites are based on the Nevada Coordinate System, Nevada Central Zone. Coordinates of UZ #4 are N 234,293.1 m and E 172,550.8 m; elevation of land surface at the hole is 1,200.40 m. Coordinates of UZ #5 are N 234,255.1 m and E 172,549.6 m; elevation is 1,204.39 m. UZ #4 is situated mid-channel in Pagany Wash, approximately 38.0 m north of UZ #5 in alluvial-colluvial material. Pagany Wash is a northwest-trending wash on the east flank of Yucca Mountain. UZ #5 is located on the southern margin of the wash, drilled directly in bedrock. Drilling and coring of UZ #4 started on September 6, 1984, and was completed on October 10, 1984. Drilling and coring of UZ #5 began October 11, 1984, and was completed November 19, 1984.

Test holes UZ #4 and UZ #5 were drilled into volcanic and volcanic-clastic rocks. Only UZ #4 penetrates alluvial-colluvial material of Quaternary age at the surface. Both test holes were drilled into the Paintbrush Tuff of Miocene age. The members of the Paintbrush Tuff penetrated are, in descending order, the Tiva Canyon Member, Yucca Mountain Member, Pah Canyon Member, and Topopah Spring Member. These members are interbedded with unnamed bedded tuffs.

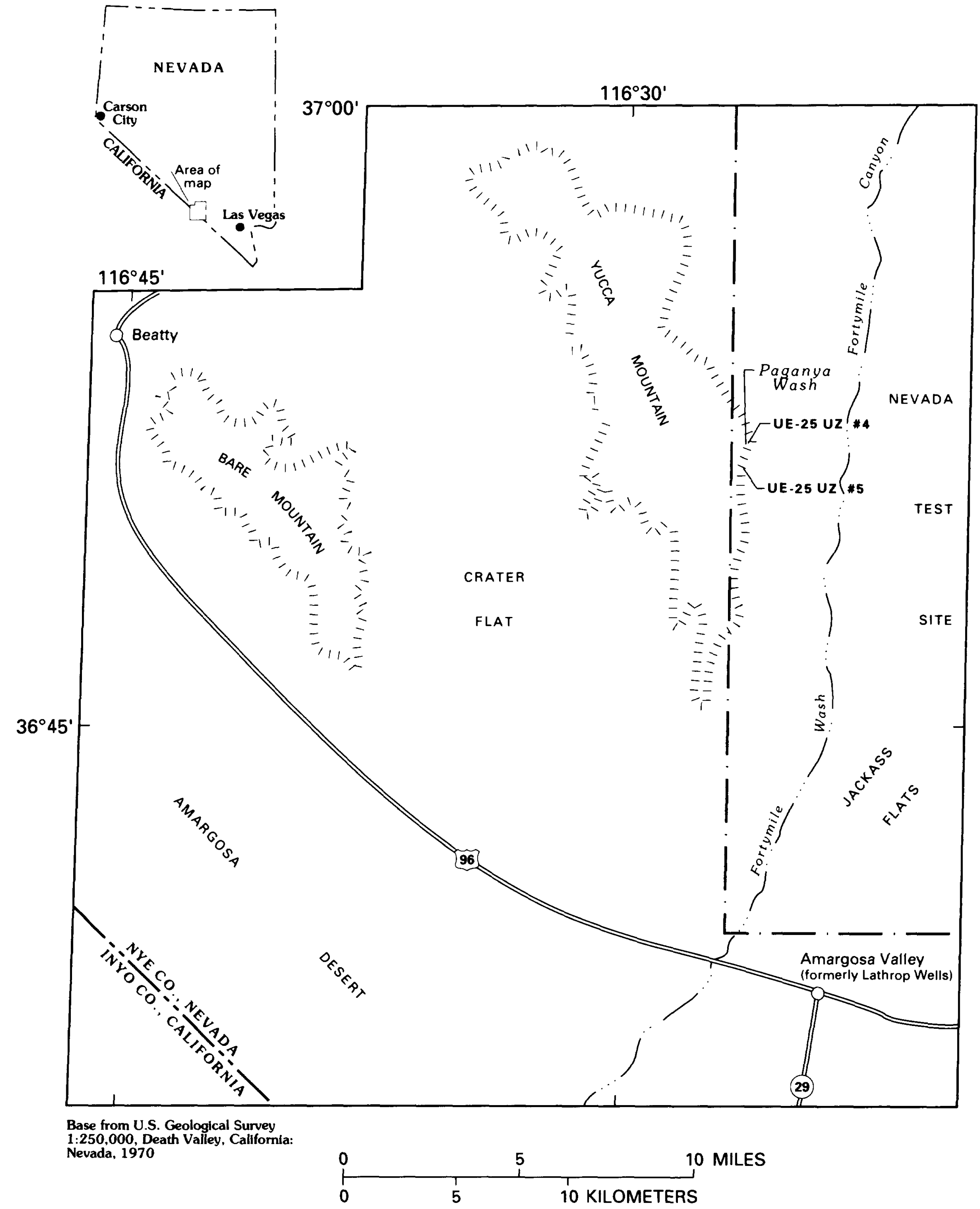

Figure 1.--Location of test holes UE-25 UZ #4 and UE-25 UZ #5, Pagany Wash, Nye County, Nevada.

DRILLING AND CASING METHODS

Drilling, casing, and coring methods used in these holes have been described in detail by Hammermeister and others (1985); therefore, these methods are only described briefly in this report. These authors also have shown that these methods minimally disturb the water content of the formation rock, core, and, in some cases, drill cuttings.

Drilling and casing of UZ #4 and UZ #5 were carried out using the Odex[1] 115 drilling system, which uses air as the drilling fluid. The method involves simultaneous downhole percussion-hammer drilling and casing driving. A pilot bit, in conjunction with an eccentric reamer, drills a hole slightly larger than the casing outside diameter (O.D.). The percussion hammer impacts on the casing through a shoe attached to the bottom joint of the casing (fig. 2). Thus, the casing moves downward as the hole is drilled. Drill cuttings are returned to the surface through the inside of the casing, thereby minimizing the disturbance of the bore-hole walls. Compressed air is injected into the casing through the drill pipe to aid in removal of drill cuttings.

The casing for UZ #4 and UZ #5 had 140-mm O.D. and 128-mm inside diameter (I.D.); casing sections were 1.52 m long. The drill holes for both UZ #4 and UZ #5 were 152 mm in diameter. UZ #4 was cored, drilled, and cased to a depth of 72.2 m, where the shoe separated from the casing. Drilling ceased at this point, but coring continued to a total depth of 112.01 m with a 108-mm-diameter hole. The casing then was pulled back to a depth of 18.3 m. The shoe presently (1990) is between about 70 to 73 m below land surface. UZ #5 was cored to a depth of 109.88 m, then drilled and cased to a total depth of 110.64 m. The casing was pulled back to a depth of 5.5 m.

CORING METHODS

Drive Core

Core samples were collected from alluvial-colluvial deposits at UZ #4 by drive-core methods, using a 102-mm-I.D., 0.61-m-long split-tube sampler attached directly to a percussion hammer. The hammer was used to drive the split-tube sampler into the alluvial-colluvial deposits. This drive-core method proved successful; there was 87.8 percent core recovery from 7.46 m cored. The split-tube samplers were fitted with two 152-mm long and four 76-mm long brass liners to contain the unconsolidated samples.

The use of brand, trade, or firm names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

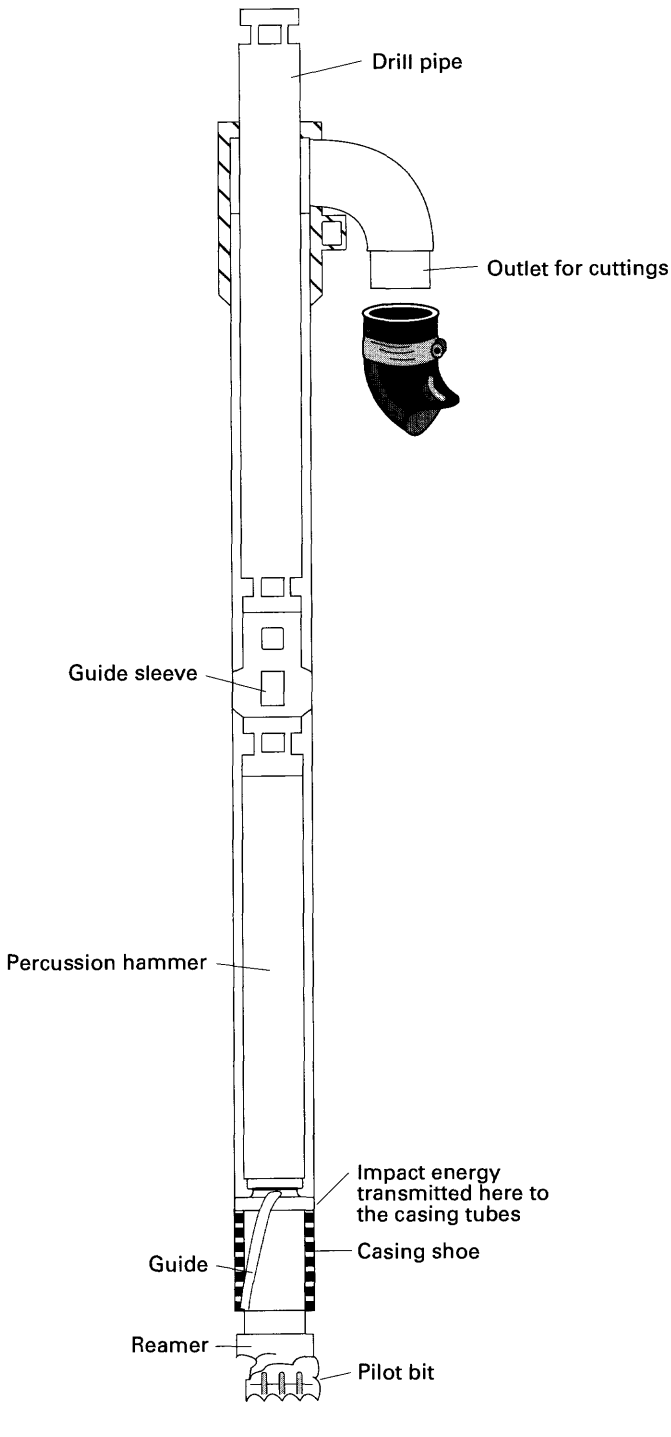

Figure 2.--Drilling system used for test holes.
[From Hammermeister and others, 1985, p. 512]

Rotary Core

A wire line, split-tube core barrel was used to obtain rotary cores in hard, densely welded tuffs. The core barrel was 1.52-m long. It was a triple-tube, HWD4-size barrel that was modified by Norten Christensen, Inc., Salt Lake City, Utah, for air coring. Surface-set diamond bits were used. In relatively soft, poorly consolidated, nonwelded and bedded tuffs, a tungsten-carbide, face-discharge bit was used. These bits were a pilot type with staggered teeth. The diameter of the core was 63.5 mm. A total of 85.02 m was cored from UZ #4 with 94.2 percent recovery; 82.12 m was cored from UZ #5 with 94.7 percent recovery.

SAMPLE COLLECTION AND HANDLING

Sample collection and handling followed approved NNWSI quality-assurance procedures. All procedures were designed to minimize the disturbance of the water content of the samples, from the time the samples left the borehole until water-content and water-content-dependent measurements were made.

Drill Cuttings

Drill cuttings were collected for the determination of hydrologic characteristics as well as for a lithologic record. Cuttings brought to the surface through the casing during drilling were diverted through a flexible hose to a dry cyclone separator located nearby. After a prescribed interval of the test hole had been drilled, the gate valve on the bottom of the separator was opened, and the cuttings fell into the collection containers. The cyclone separator was emptied at each collection interval in preparation for the next interval to avoid any mixing of samples. If the cuttings were moist, a hammer was used to knock the cuttings off the inside walls of the separator. Drilling generally did not stop during sample collection.

One or two liters of cuttings usually were collected at each sampling interval for laboratory measurements of water content and water potential. If the cuttings consisted mainly of fines, two liters were collected. The cuttings were placed in approximately 1-L glass mason jars. These jars were capped immediately with air-tight lids, taken into the onsite laboratory as soon as possible, and placed inside a humidified glove box. About 0.5 liter of cuttings was collected at the same time and placed in a paper carton for use later to describe the lithology and to be archived in the U.S. Geological Survey Core Library, Mercury, Nev.

Drill cuttings from UZ #4 were collected at 0.15-m intervals from a depth of 0.61 m to 12.50 m; at 0.61-m intervals from a depth of 12.50 m to 69.19 m, and at 1.52-m intervals from a depth of 69.19 m to 74.68 m. Drill cuttings from UZ #5 were collected at 0.61-m intervals from a depth of 0.91 m to 28.04 m and at 1.52-m intervals from 28.04 m to 110.64 m.

The drill cuttings were processed inside a humidified glove box. Drill cuttings from UZ #4 were divided into composite-, coarse-, and fine-particle-size fractions for water-content measurements, and into coarse- and fine-size fractions for water-potential measurements. Samples taken directly from the jars were designated as composite samples. Coarse samples were defined as those cuttings that would not pass through a screen with about 1.6-mm openings. Fines were defined as those cuttings that would pass through the screen. Samples for gravimetric water content were placed in pre-weighed 420-mL moisture tins, covered, and immediately weighed. Samples for water-potential measurements were placed in small glass jars (approximately 120 mL or less), capped, taped, labeled, sealed in wax, and stored in a cool environment (about 20 °C to 25 °C) until the measurements could be made.

Drill cuttings from UZ #5 were divided into coarse- and composite-size fractions only, based on results of UZ #4. Coarse cuttings were separated for water-potential and water-content measurements from reamed parts of nonwelded and bedded tuff-rock units. Water-content measurements only were made on composite cuttings from welded-tuff units.

Samples of drill cuttings were sieved into particle-size fractions for the following reasons: (1) Alluvial-colluvial deposits from UZ #4 were sieved to determine the degree of drying of different-size drill cuttings when air was used as the drilling fluid; and (2) cuttings samples were sieved to determine which particle-size fraction of drill cuttings would yield water-content and water-potential measurements most representative of the formation rock.

Drive Core

Drive core was collected from alluvial-colluvial deposits only at UZ #4 at intervals of as much as 0.61-m to a depth of 11.89 m using a 102-mm-I.D., 0.61-m-long, split-tube sampler. Each split-tube sampler contained two 152-mm-long and four 76-mm-long brass liners. Division of the drive core for testing purposes was carried out in a humidified glove box. The 152-mm segment in the uppermost part of the split-tube sampler usually contained some rubble from the bottom of the hole from the previous core run or drilling segment, in addition to a sample of alluvial-colluvial material. The rubble was discarded, and the sample was used to supplement samples for tritium analyses, gravimetric water-content measurements, or both. Generally, the other 152-mm segment was selected for tritium measurements, one 76-mm segment was selected for gravimetric water-content and water-potential measurements, two 76-mm segments were selected for matric-potential and permeability-related measurements, and the remaining 76-mm segment was selected for volumetric water-content measurements. A summary of tests, test priorities, and criteria for assigning segments of core is listed in table 1. Division of drive core was modified depending on the amount of core recovered; segments were assigned to the higher priority tests first.

Drive-core samples designated for gravimetric water-content and water-potential measurements were divided into composite-, coarse-, and fine-particle-size fractions to permit a comparison with similar-sized fractions from alluvial-colluvial drill cuttings. Unsieved samples were designated as composite samples. Coarse samples were defined as those cuttings that would not pass through a screen with about 1.6-mm openings. Fines were defined as those cuttings that would pass through the screen. The major part of each particle-size fraction was placed in a pre-weighed moisture can for gravimetric water-content measurements. The remaining part was placed in an approximately 120-mL glass bottle, capped, taped, labeled, sealed in wax, and stored at about 20 °C to 25 °C until water-potential measurements could be made. The remaining parts of the brass liners, which contained composite samples, were capped, taped, labeled, waxed, and stored at about 20 °C to 25 °C until the appropriate laboratory measurements could be made. All drive-core intervals and recovered core from test hole UZ #4 are listed in table 2.

Table 1.--*Division of drive core for testing*

Core label	Test	Test priority	Remarks
A	Tritium analysis	1	
B	Gravimetric water-content and water-potential measurements	1	
C	Matric-potential measurements[1]	1	One or both end surfaces flat
D	Matric-potential measurements[1]	1	Neither end surface flat
E	Matric-potential measurements[1]	2	Neither end surface flat
F	Permeability-related measurements	2	One or both end surfaces flat
G	Volumetric water-content measurements	1	One or both end surfaces flat

[1]Two samples generally were collected from each core for C, D, or E, preferably one with at least one flat surface.

Table 2.--*Drive-core test record for test hole UE-25 UZ #4*

[Tests performed: A, tritium analysis; B, gravimetric water-content and water-potential measurements; C, D, and E, matric-potential measurements; F, permeability-related tests; and G, volumetric water-content measurements]

Core run number	Cored interval (meters)	Cored (meters)	Core recovered (meters)	Core test record[1]
1	0.61-1.22	0.61	0.61	A B C D G
2	1.22-1.83	0.61	0.61	A B D E F
3	1.83-2.44	0.61	0.61	A B C D G
4	2.44-3.05	0.61	0.61	A B C D G
5	3.05-3.66	0.61	0.38	A D
6	3.66-3.81	0.15	0.15	B
7	4.27-4.88	0.61	0.61	A B C D F G
8	5.49-5.79	0.30	0.30	A B D
9	6.10-6.71	0.61	0.61	A B C D G
10	7.32-7.93	0.61	0.23	A G
11	8.53-9.14	0.61	0.46	A B C D F
12	9.75-10.36	0.61	0.53	A B D
13	10.97-11.58	0.61	0.61	A B C D F G
14	11.58-11.89	0.31	0.23	A D

[1]Indicates present and future testing.

Rotary Core

Cores from the formation rock were obtained using a HWD4 core barrel with a split inner tube. The top half of the split inner tube was removed in a humidified glove box. The natural fractures of the core were described, and a preliminary lithologic description was compiled. For each 1.52-m core, a 91-mm-long segment of core from near the bottom and another from near the midsection of the core generally were removed for water-potential and water-content measurements. Whenever possible, one approximately 152-mm-long unfragmented segment was taken from each half of the core for permeability-related tests, and one additional approximately 91-mm-long relatively unfragmented core segment was taken for matric-potential measurements. Finally, several approximately 91-mm-long sections of core were selected from most cores for as yet undefined hydrologic and geologic uses. All core segments, with the exception of those designated for water-content and water-potential measurements, were placed in split PVC liners, capped, taped, labeled, waxed, and stored at about 20 °C to 25 °C until further hydrologic testing could be conducted.

Rotary core samples designated for gravimetric water-content and water-potential measurements were divided into composite-, coarse-, and fine-particle-size fractions for UZ #4 to permit a comparison with similar-sized fractions from drill cuttings. For UZ #5, drilled after UZ #4, only composite-particle size fractions of rotary core were collected. Core samples were broken into smaller fragments inside a humidified glove box. Unsieved samples for both UZ #4 and UZ #5 were designated as composite samples. Coarse samples for UZ #4 were defined as those fragments that would not pass through a screen with about 1.6-mm openings. Fines for UZ #4 were defined as those core fragments that would pass through the screen.

Core designated for gravimetric water-content measurements was placed in pre-weighed moisture cans, covered, and immediately weighed. Core for water-potential measurements was placed in an approximately 120-mL or smaller container, capped, taped, labeled, and waxed for later measurements. All cored intervals and recovered core for UZ #4 and UZ #5 are listed in tables 3 and 4. Core depths are reported to the nearest 0.01 m to correspond to measured core depths.

For some intervals on tables 3 and 4, the length of core recovered is reported as being longer than the cored interval. This may be due, in part, to core breaking off above the bit and being recovered in the next interval. Also, the length of the measured core may exceed the interval length if the core is highly fractured and spreads out in the core barrel, or if the core ends are fractured at an angle and the length measured at its maximum.

Table 3.--*Rotary-core test record for test hole UE-25 UZ #4*

[Tests performed: A, gravimentric water-content, water-potential, bulk-density, and grain-density measurements; B, matric-potential tests; C, permeability-related tests; E, future undefined geologic and hydrologic uses]

Core run number	Cored interval (meters)	Cored (meters)	Core recovered (meters)	Core test record
1	14.33-14.94	0.61	0.61	A E
2	17.38-17.68	0.30	0.24	A E
3	20.42-20.72	0.30	0.30	A E
4	22.86-23.16	0.30	0.24	A E
5	23.16-24.69	1.53	1.52	A E
6	24.69-26.21	1.52	1.43	A E
7	29.57-30.94	1.37	1.37	A E
8	32.00-32.61	0.61	0.67	A E
9	33.53-35.05	1.52	1.46	A E
10	35.05-36.12	1.07	1.07	A E
11	36.12-37.19	1.07	1.07	A E
12	37.19-38.71	1.52	1.68	A E
13	38.71-40.23	1.52	1.37	A E
14	40.23-41.76	1.53	1.62	A E
15	41.76-43.28	1.52	1.55	A E
16	43.28-44.80	1.52	1.52	A E
17	44.80-46.33	1.53	1.58	A E
18	46.33-47.85	1.52	1.58	A E
19	47.85-49.38	1.53	0.67	A E
20	49.38-50.90	1.52	1.52	A E
21	50.90-52.12	1.22	0.24	E
22	52.12-52.73	0.61	0.61	A B C E
23	52.73-53.95	1.22	0.82	A B C E
24	53.95-55.47	1.52	1.25	A B C E
25	55.47-57.00	1.53	0.82	A B C E
26	57.00-57.61	0.61	0.24	E
27	57.61-58.52	0.91	0.67	A B C E
28	58.52-59.43	0.91	0.85	A B C E
29	59.43-60.96	1.53	1.31	A B C E
30	60.96-61.57	0.61	0.55	A B C E
30a	61.57-62.18	0.61	0.30	A B C
31	62.18-63.09	0.91	0.82	A B C E
32	63.09-64.22	1.13	1.13	A B C E
33	64.22-64.92	0.70	0.70	A B C E
34	64.92-65.83	0.91	0.85	A B C E

Table 3.--*Rotary-core test record for test hole UE-25 UZ #4*--Continued

Core run number	Cored interval (meters)	Cored (meters)	Core recovered (meters)	Core test record
35	65.83-66.90	1.07	1.07	A B C E
36	66.90-67.97	1.07	1.07	A B C E
37	67.97-69.49	1.52	1.52	A B C E
38	69.49-71.02	1.53	1.55	A B C E
39	71.02-72.24	1.22	1.22	A B C E
40	72.24-73.61	1.37	1.42	A B C E
41	73.61-74.98	1.37	1.38	A B C E
42	74.98-76.50	1.52	1.57	A B C E
43	76.50-78.03	1.53	1.55	A B C E
44	78.03-79.55	1.52	1.40	A B C E
45	79.55-81.07	1.52	1.55	A B C E
46	81.07-82.30	1.23	1.31	A B C E
47	82.30-83.82	1.52	1.43	A B C E
48	83.82-85.34	1.52	1.57	A B C E
49	85.34-86.56	1.22	1.34	A B C E
50	86.56-88.09	1.53	1.57	A B C E
51	88.09-89.61	1.52	1.52	A B C E
52	89.61-91.13	1.52	1.52	A B C E
53	91.13-92.66	1.53	1.49	A B C E
54	92.66-93.57	0.91	0.91	A B C E
55	93.57-94.49	0.92	0.79	A B C E
56	94.49-96.01	1.52	1.49	A B C E
57	96.01-97.53	1.52	1.46	A B C E
58	97.54-99.06	1.52	1.58	A B C E
59	99.06-100.58	1.52	1.28	A B C E
60	100.58-102.11	1.53	1.40	A B C E
61	102.11-103.63	1.52	1.40	A B C E
62	103.63-104.24	0.61	0.76	A B C E
63	104.24-104.55	0.31	0.40	A E
64	104.55-105.77	1.22	1.22	A B C E
65	105.77-106.38	0.61	0.70	A B C E
66	106.38-106.60	0.22	0.23	A E
67	106.60-108.13	1.53	1.49	A B C E
68	108.13-109.65	1.52	1.40	A B C E
69	109.65-111.17	1.52	1.58	A B C E
70	111.17-111.79	0.62	0.70	A C E
71	111.79-112.01	0.23	0.0	

Table 4.--*Rotary-core test record for test hole UE-25 UZ #5*

[Tests performed: A, gravimetric water-content, water-potential, bulk-density, and grain-density measurements; B, matric-potential tests; C, permeability-related tests; E, future undefined geologic and hydrologic uses; and F, geochemical testing]

Core run number	Cored interval (meters)	Cored (meters)	Core recovered (meters)	Core test record
1	2.13-2.43	0.30	0.27	A B C
2	5.18-5.49	0.31	0.30	A E
3	8.23-8.53	0.30	0.0	
4	14.02-14.32	0.30	0.34	A E
5	28.04-29.56	1.52	1.52	A B C F
6	29.56-31.09	1.53	1.40	A B C E F
7	31.09-32.61	1.52	1.52	A B C F
8	32.61-34.14	1.53	1.52	A B C F
9	34.14-35.66	1.52	1.58	A B C F
10	35.66-37.18	1.52	1.46	A B C E F
11	37.18-38.71	1.53	1.52	A B C E F
12	38.71-40.23	1.52	1.52	A B C E
13	40.24-41.76	1.52	1.55	A B C E
14	41.76-43.28	1.52	1.43	A B C E
15	43.28-44.80	1.52	1.49	A B C E
16	44.80-46.33	1.53	1.43	A B C E
17	46.33-47.24	0.91	0.91	A B C E
18	47.24-48.77	1.53	1.52	A B C E
19	48.77-50.29	1.52	1.49	A B C E F
20	50.29-51.81	1.52	0.52	A B E
21	51.81-53.34	1.53	0.85	A B E
22	53.34-54.86	1.52	1.16	A B C E
23	54.86-56.39	1.53	1.34	A B C E
24	56.39-57.91	1.52	1.25	A B C E
25	57.91-59.43	1.52	0.91	A B C E
26	59.43-60.96	1.53	1.40	A B C E
27	60.96-62.48	1.52	1.31	A B C E
28	62.48-63.70	1.22	0.91	A B E
29	64.62-66.14	1.52	1.43	A B C E
30	66.14-67.66	1.52	1.55	A B C E F
31	67.66-69.19	1.53	1.57	A B C E F
32	69.19-70.71	1.52	1.60	A B C E F
33	70.71-72.24	1.53	1.55	A B C E F
34	72.24-73.76	1.52	1.54	A B C E F
35	73.76-75.28	1.52	1.52	A B C E
36	75.28-76.81	1.53	1.55	A B C E F
37	76.81-78.33	1.52	1.52	A B C E F
38	78.33-79.86	1.53	1.55	A B C E F
39	79.86-81.38	1.52	1.54	A B C E F
40	81.38-82.90	1.52	1.58	A B C E F

Table 4.--*Rotary-core test record for test hole UE-25 UZ #5*--Continued

Core run number	Cored interval (meters)	Cored (meters)	Core recovered (meters)	Core test record
41	82.90-84.43	1.53	1.37	A B C E
42	84.43-85.95	1.52	1.58	A B C E
43	85.95-87.48	1.53	1.58	A B C E F
44	87.48-89.00	1.52	1.37	A B C E F
45	89.00-90.52	1.52	1.58	A B C E F
46	90.52-92.05	1.53	1.52	A B C E F
47	92.05-93.57	1.52	1.55	A B C E F
48	93.57-95.10	1.53	1.46	A B C E F
49	95.10-96.62	1.52	1.46	A B C E F
50	96.62-98.14	1.52	1.54	A B C E F
51	98.14-99.67	1.53	1.52	A B C E F
52	99.67-101.19	1.52	1.52	A B C E F
53	101.19-102.72	1.53	1.52	A B C E F
54	102.72-104.24	1.52	1.52	A B C E F
55	104.24-105.76	1.52	1.55	A B C E F
56	105.76-107.29	1.53	1.58	A B C E
57	107.29-107.89	0.60	0.67	A E
58	107.89-109.12	1.23	1.10	A B C E
59	109.12-109.73	0.61	0.73	A B E
60	109.73-109.88	0.15	0.09	A

LITHOLOGY

The rocks penetrated by UZ #4 and UZ #5 are of volcanic and volcanic-clastic origin. Lithologic descriptions from drill cuttings and cores are given in tables 5 and 6. The members of the Paintbrush Tuff of Miocene age are composed of ash-flow and ash-fall tuffs, which are the predominant rock types in this section. The tuffs exhibit various degrees of welding, ranging from nonwelded to densely welded; a thick section of bedded and nonwelded tuffs is present between the densely welded tuffs in both test holes. The upper 11.89 m of UZ #4 is alluvial-colluvial material of Quaternary age.

Samples of drill cuttings or unwaxed core were not available for a detailed lithologic description for UZ #4 from the surface to a depth of 13.11 m and from a depth of 86.26 m to 105.70 m. As indicated on table 5, the descriptions for these intervals are from test holes UE-25 UZN #6 and UE-25 UZN #7 (0 to 13.11 m) and UZ #5 (86.26 to 105.70 m). When waxed core from these intervals undergoes hydrologic testing, a lithologic description will be made.

Table 5.--*Lithologic log of test hole UE-25 UZ #4*

[Modified from R.W. Spengler, U.S. Geological Survey, written commun., 1985]

Geologic unit and lithologic description	Thickness of interval (meters)	Depth to bottom of interval (meters)
Alluvium and colluvium (Quaternary)		
silt to pebble-sized gravel; poorly sorted, subangular to subrounded, light gray to medium light gray, moderately to densely welded tuffs of the Tiva Canyon Member. The silt to fine-sand portion is grayish-orange pink to light brown[1]	[2]11.89	11.89
Paintbrush Tuff (Miocene)		
Tiva Canyon Member		
Tuff, ash-flow, moderately to densely welded[1]	[2]1.22	13.11
Tuff, ash-flow, densely welded, devitrified	1.83	14.94
Tuff, ash-flow, moderately welded, devitrified	6.70	21.64
Tuff, ash-flow, partially to nonwelded, slightly argillic	2.19	23.83
Tuff, ash-flow, nonwelded, vitric, slightly argillic	2.29	26.12
Bedded tuff (unnamed)		
Tuff, ash-fall, vitric, poorly consolidated	0.40	26.52
Tuff, ash-fall, vitric, poorly to moderately consolidated	4.17	30.69
Tuff, ash-fall, vitric, unconsolidated	1.62	32.31
Yucca Mountain Member		
Tuff, ash-flow, nonwelded, vitric	2.74	35.05
Tuff, ash-flow, partially welded, vitric	5.79	40.84
Tuff, ash-flow, nonwelded, vitric	5.79	46.83
Bedded tuff (unnamed)		
Tuff, ash-fall, unconsolidated, vitric	1.65	48.28
Tuff, ash-fall, poorly consolidated, vitric	1.65	49.93
Tuff, ash-fall, unconsolidated, vitric	0.97	50.90
Tuff, ash-fall, poorly consolidated, vitric	2.10	53.00
Pah Canyon Member		
Tuff, ash-flow, nonwelded, vitric	15.28	68.28
Tuff, ash-flow, partially to nonwelded, vitric	17.98	86.26
Tuff[3]	[2]3.64	89.90
Bedded tuff (unnamed)[3]	[2]11.60	101.50
Topopah Spring Member		
Tuff[3]	[2]4.20	105.70
Tuff, ash-flow, densely welded, glassy	0.07	105.77
Tuff, ash-flow, densely welded, devitrified (caprock)	3.63	109.40
Tuff, ash-flow, moderately welded, vapor phase crystallization	2.46	111.86

[1]Lithology based on samples collected from UE-25 UZN #6 and UE-25 UZN #7, which are located approximately 25 to 30 m north-northwest from UZ #4.

[2]Estimated contact based on geohydrologic data from UZ #4 and UZ #5 and driller's log from UZ #4.

[3]Generalized lithology based on samples collected from UZ #5.

Table 6.--*Lithologic log of test hole UE-25 UZ #5*

[Modified from R.W. Spengler, U.S. Geological Survey, written commun., 1985]

Geologic unit and lithologic description	Thickness of interval (meters)	Depth to bottom of interval (meters)
Paintbrush Tuff (Miocene)		
Tiva Canyon Member		
Tuff, ash-flow, densely welded, devitrified----------	20.12	20.12
Tuff, ash-flow, moderately welded, devitrifed--------	7.31	27.43
Tuff, ash-flow, partially to nonwelded, vitric-------	3.05	30.48
Tuff, ash-flow, nonwelded, vitric--------------------	5.49	35.97
Bedded tuff (unnamed)		
Tuff, ash-fall, unconsolidated, moderately to poorly sorted, vitric------------------------------	1.22	37.19
Yucca Mountain Member		
Tuff, ash-flow, nonwelded, vitric (partially welded from 42.06 to 43.89 m)----------------------------	7.62	44.81
Tuff, ash-flow, nonwelded, vitric--------------------	5.79	50.60
Bedded tuff (unnamed)		
Tuff, ash-fall, poorly consolidated, poorly sorted, vitric--	0.30	50.90
Tuff, ash-fall, unconsolidated, poorly sorted, vitric	1.52(?)	52.42(?)
Tuff, ash-fall, unconsolidated, poorly to moderately sorted, vitric------------------------------------	1.22	53.64
Tuff, ash-fall, poorly consolidated, poorly sorted, vitric--	3.05	56.69
Tuff, ash-fall, poorly consolidated, vitric----------	1.22	57.91
Pah Canyon Member		
Tuff, ash-flow, nonwelded, vitric, slightly argillic(?)---------------------------------------	12.80	70.71
Tuff, ash-flow, partially welded, vitric-------------	10.36	81.07
Tuff, ash-flow, nonwelded, vitric--------------------	13.72	94.79
Bedded tuff (unnamed)		
Tuff, ash-fall, moderately to highly indurated, poorly to moderately sorted, zeolitic(?), slightly silicified---	1.53	96.32
Tuff, ash-fall, moderately consolidated, poorly sorted, zeolitic(?)-------------------------------	0.91	97.23
Tuff, ash-fall, moderately consolidated, poorly sorted, vitric, partially zeolitic(?)--------------	0.89	98.12
Tuff, ash-fall, moderately consolidated, poorly to moderately sorted, vitric, partially zeolitic(?)---	0.94	99.06
Tuff, ash-fall, moderately to highly indurated, poorly sorted, vitric-----------------------------	2.44	101.50
Topopah Spring Member		
Tuff, ash-flow, nonwelded, zeolitic(?), argillic(?)--	3.35	104.85
Tuff, ash-fall(?), moderately to highly indurated, vitric, slightly argillic(?)----------------------	3.05	107.90
Tuff, ash-flow, densely welded, vitrophyre-----------	1.22	109.12
Tuff, ash-flow, densely welded, devitrified----------	1.52	110.64

GEOPHYSICAL LOGS

At present, only television logs have been run in UZ #4 and UZ #5. Geophysical logs to be run at a later date in UZ #4 and UZ #5 include neutron-moisture, neutron-porosity, density, and caliper logs. The data obtained from these logs will be presented in another report at a later date. Additional logs that may be run include dielectric and induction logs.

SAMPLE TESTING PROCEDURES AND RESULTS

Water-Content Measurements

Gravimetric water-content measurements were carried out onsite at the U.S. Geological Survey field laboratory using standard gravimetric oven-drying methods (Gardner, 1965) and following approved NNWSI Quality Assurance procedures. Moisture cans of known weight were filled with drill cuttings or core, covered, and immediately weighed. These moisture cans were weighed again after baking in an oven at 105°C for a minimum of 18 hours. The gravimetric water-content values, in grams per gram, equal the water lost through drying, divided by the weight of the dried sample. Results of laboratory analyses for gravimetric water-content for UZ #4 and UZ #5 cuttings and core are tabulated in tables 7, 8, 9, and 10. These tables also include the results of laboratory analyses for water-potential measurements that are discussed later in this report, beginning on page 39. When two samples from the same depth were analyzed, both values are listed. If three or more samples were analyzed, an averaged value is reported. The depths of cuttings in tables 7 and 9 represent the midpoints, or average depths, of the sample-collection intervals of the drill cuttings.

Comparisons of gravimetric water-content measurements of core samples and drilling cuttings for selected particle sizes from UZ #4 and UZ #5 are shown in figures 3 and 4. For multiple values per interval, the average value was plotted. Cuttings generally have a smaller moisture content than core samples. Nonwelded and bedded tuffs generally are more moist than the welded tuffs.

The relation of gravimetric water-content measurements of composite core samples from test holes UZ #4 and UZ #5 to geologic unit and degree of welding are summarized in table 11. Only the core data are tabulated because the cores were less disturbed than the drill cuttings and, therefore, are more representative samples of in-situ hydrologic conditions. Data from samples that included different geologic units are not included in the summarized data.

These water-content values indicate that, except for the bedded tuffs, the units of UZ #4, which is centrally located in Pagany Wash, are wetter than those of UZ #5, located in bedrock on the margin of the same wash. The densely welded units have the smallest moisture-content values. The densely welded part of the Tiva Canyon Member averages 0.039 gm/gm for UZ #4; the moderately welded section is moister, averaging 0.062 gm/gm. The densely welded part of the Tiva Canyon Member averages 0.030 gm/gm for UZ #5; no data are available for the moderately welded part.

Table 7.--*Results of laboratory analyses for gravimetric water content and water potential of drill cuttings from test hole UE-25 UZ #4*

[--, no data; > greater than]

Depth of midpoint of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
0.7	0.056	0.052	0.057	--	-240	-260
0.8	0.055	0.052	0.059	--	-96	>-50
1.0	0.055	0.052	0.057	--	-170	-110
1.1	0.058	0.053	0.062	--	-250	-290
1.3	0.054	0.055	0.051	--	-260	-270
1.4	0.044	0.045	0.042	--	-290	-440
1.6	0.057	0.057	0.053	--	-75	-250
1.8	0.060	0.062	0.061	--	-190	-280
1.9	0.061	0.057	0.066	--	-170	-280
2.1	0.068	0.065	0.073	--	-160	-340
2.2	0.069	0.065	0.070	--	-260	-270
2.4	0.064	0.060	0.069	--	-260	-190
2.5	0.037	0.027	0.043	--	-290	-510
2.5	--	0.028	--	--	--	--
2.7	0.052	0.041	0.063	--	-130	-280
2.8	0.045	0.045	0.057	--	-250	-150
2.8	--	0.046	--	--	--	--
3.0	0.055	0.054	0.066	--	-67	>-50
3.0	--	0.055	--	--	--	--
3.1	0.045	0.043	0.047	--	-370	-420
3.3	0.051	0.049	0.050	--	-120	-260
3.3	--	0.048	--	--	--	--
3.4	0.059	0.059	0.076	--	-83	-110
3.4	0.062	0.057	0.072	--	--	--
3.6	0.058	0.056	0.062	--	-240	-260
3.6	0.060	0.059	0.066	--	--	--
3.7	0.052	0.049	0.054	--	-160	-290
3.9	0.064	0.055	0.073	--	-93	-210
4.0	0.074	0.069	0.083	--	-200	-140
4.2	0.066	0.063	0.078	--	-140	-57
4.4	--	--	--	--	--	--
4.6	0.062	0.060	0.088	--	-110	-230
4.8	0.070	0.067	0.091	--	-230	-340
5.0	0.055	0.048	0.062	--	-500	-870
5.1	0.049	0.045	0.054	--	--	--

Table 7.--*Results of laboratory analyses for gravimetric water content and water potential of drill cuttings from test hole UE-25 UZ #4*--Continued

Depth of midpoint of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
5.3	0.048	0.045	0.051	--	-330	-270
5.6	0.073	0.066	0.078	--	--	-290
5.7	0.062	0.053	0.072	--	--	--
5.9	0.053	0.047	0.064	--	-240	-420
6.0	0.047	0.044	0.062	--	--	--
6.2	0.057	0.045	0.074	--	-240	-450
6.3	0.054	0.051	0.063	--	--	--
6.5	0.057	0.111	0.061	--	-350	-680
6.6	0.048	0.045	0.052	--	--	--
6.8	0.053	0.054	0.056	--	-260	-410
6.9	0.048	0.049	0.047	--	--	--
7.1	0.050	0.042	0.058	--	-200	-140
7.2	0.046	0.048	0.044	--	--	--
7.4	0.052	0.052	0.054	--	-290	-170
7.5	0.052	0.055	0.046	--	--	--
7.7	0.048	0.052	0.047	--	-170	-200
7.8	0.048	0.047	0.042	--	--	--
8.0	0.046	0.048	0.045	--	-310	-260
8.2	0.046	0.045	0.040	--	--	--
8.3	0.044	0.043	0.041	--	-270	-420
8.5	0.040	0.044	0.034	--	--	--
8.6	0.044	0.042	0.037	--	-230	-370
8.8	0.041	0.042	0.039	--	--	--
8.9	0.035	0.035	0.029	--	-540	-730
9.1	0.032	0.031	0.029	--	--	--
9.2	0.029	0.028	0.034	--	-580	-700
9.5	0.042	0.039	0.041	--	-240	-280
9.7	0.040	0.039	0.047	--	--	--
9.8	0.043	0.037	0.044	--	-530	-740
10.0	0.048	0.042	0.049	--	--	--
10.1	0.040	0.040	0.039	--	-500	-580
10.3	0.039	0.040	0.038	--	--	--
10.4	0.038	0.037	0.036	--	-310	-430
10.6	0.040	0.035	0.052	--	--	--
10.7	0.036	0.034	0.047	--	-430	-450
10.9	0.043	0.043	0.052	--	--	--
11.0	0.045	0.044	0.044	--	-340	-450
11.2	0.031	0.031	0.032	--	--	--
11.4	0.030	0.030	0.031	--	-770	-810
11.5	0.025	0.025	0.026	--	--	--

Table 7.--*Results of laboratory analyses for gravimetric water content and water potential of drill cuttings from test hole UE-25 UZ #4*--Continued

Depth of midpoint of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
11.7	0.014	0.013	0.022	--	-6,100	-7,600
11.8	0.032	0.026	0.029	--	--	--
12.0	0.026	0.025	0.025	--	-2,200	-2,600
12.1	0.021	0.013	0.015	--	--	--
12.3	0.013	0.012	0.013	--	-7,200	-9,600
12.4	--	--	--	--	-19,000	-22,000
12.8	0.014	0.009	0.010	--	-22,000	-15,000
12.8	0.013	--	--	--	--	--
13.4	0.022	0.023	0.016	--	-6,100	-7,000
13.4	0.021	--	--	--	--	--
14.0	0.024	0.028	0.021	--	-4,000	-4,600
14.0	0.023	--	--	--	--	--
14.6	0.026	0.029	0.019	--	-4,400	-4,900
14.6	0.029	--	--	--	--	--
15.1	0.029	0.032	0.023	--	-3,700	-3,900
15.4	--	--	--	--	--	--
15.8	0.027	0.032	0.025	--	-2,500	-2,600
15.8	0.028	--	--	--	--	--
16.5	0.037	0.040	0.036	--	-1,400	-1,400
16.5	0.037	--	--	--	--	--
17.1	0.046	0.047	0.040	--	-1,100	-1,000
17.1	0.046	--	--	--	--	--
17.7	0.047	0.048	0.041	--	-1,800	-1,200
17.7	0.045	--	--	--	--	--
18.3	0.056	0.050	0.041	--	-1,300	-1,100
18.3	0.054	--	--	--	--	--
18.9	0.054	0.052	0.041	--	-1,300	-1,800
18.9	0.056	--	--	--	--	--
19.5	0.071	0.066	0.054	--	-1,400	-1,600
19.5	0.073	--	--	--	--	--
20.1	0.055	0.063	0.066	--	-840	-1,100
20.1	0.065	--	--	--	--	--
20.7	0.054	0.048	0.042	--	-2,700	-3,200
20.7	0.055	--	--	--	--	--
21.3	[1]0.052	0.066	0.044	--	-1,100	-1,400

Table 7.--*Results of laboratory analyses for gravimetric water content and water potential of drill cuttings from test hole UE-25 UZ #4*--Continued

Depth of midpoint of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
21.9	[1]0.106	0.098	0.071	--	-550	-760
22.6	[1]0.183	0.148	0.105	--	-900	-1,100
23.2	0.116	0.155	0.107	--	-8,600	-9,600
23.2	0.105	--	--	--	--	--
23.8	[1]0.130	0.223	0.149	--	-5,100	-8,500
24.4	[1]0.156	0.170	0.134	--	-7,600	-8,600
25.0	0.193	0.272	0.195	--	-2,700	-3,700
25.0	0.254	--	--	--	--	--
25.6	[1]0.199	0.274	0.214	--	-1,100	-700
26.2	[1]0.212	0.236	0.197	--	-590	-1,000
26.8	[1]0.210	0.235	0.203	--	-780	-1,000
27.4	[1]0.200	0.288	0.207	--	-380	-650
28.0	[1]0.228	0.323	0.218	--	-500	-640
28.7	0.344	0.368	0.377	--	-290	-520
28.7	0.322	--	--	--	--	--
29.3	0.072	0.223	0.181	--	-560	-740
29.9	0.071	0.147	0.069	--	-25,000	--
29.9	0.080	--	--	--	--	--
30.5	0.090	0.131	0.086	--	-22,000	--
30.5	0.103	--	--	--	--	--
31.1	0.128	0.206	0.128	--	-2,700	--
31.1	0.145	--	--	--	--	--
31.7	0.154	0.210	0.148	--	-1,900	--
31.7	0.150	--	--	--	--	--
32.3	0.212	0.277	0.191	--	-490	--
32.3	0.189	--	--	--	--	--
32.9	0.158	0.204	0.127	--	-22,000	--
32.9	0.144	--	--	--	--	--
33.5	0.133	0.177	0.134	--	-3,100	--
33.5	0.128	--	--	--	--	--
34.1	0.036	0.098	0.034	--	-34,000	--
34.1	0.034	--	--	--	--	--
34.7	0.066	0.110	0.069	--	-17,000	--
34.7	0.070	--	--	--	--	--
35.4	--	--	--	--	--	--

Table 7.--*Results of laboratory analyses for gravimetric water content and water potential of drill cuttings from test hole UE-25 UZ #4*--Continued

Depth of midpoint of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
36.0	0.072	0.094	0.065	--	-12,000	--
36.0	0.072	--	--	--	--	--
36.6	0.092	0.118	0.075	--	-4,400	--
36.6	0.101	--	--	--	--	--
37.2	0.101	0.114	0.080	--	-2,400	--
37.2	0.102	--	--	--	--	--
37.8	0.104	0.110	0.090	--	-1,800	--
37.8	0.090	--	--	--	--	--
38.4	0.059	0.090	0.058	--	-9,700	--
38.4	0.095	--	--	--	--	--
39.0	0.075	0.120	0.074	--	-2,500	--
39.0	0.084	--	--	--	--	--
39.6	0.082	0.109	0.076	--	-2,400	--
39.6	0.099	--	--	--	--	--
40.2	0.114	0.128	0.100	--	-900	--
40.8	0.088	0.101	0.063	--	-4,000	--
40.8	0.085	--	--	--	--	--
41.5	0.053	0.082	0.053	--	-6,400	--
41.5	0.067	--	--	--	--	--
42.1	0.048	0.100	0.041	--	-8,100	--
42.1	0.054	--	--	--	--	--
42.7	0.050	0.076	0.040	--	-7,900	--
42.7	0.047	--	--	--	--	--
43.3	0.050	0.065	0.041	--	-8,100	--
43.3	0.047	--	--	--	--	--
43.9	0.052	0.062	0.041	--	-650	--
43.9	0.104	--	--	--	--	--
44.5	0.092	0.091	0.059	--	-390	--
44.5	0.079	--	--	--	--	--
45.1	0.020	0.050	0.018	--	-31,000	--
45.1	0.021	--	--	--	--	--
45.7	0.026	0.047	0.027	--	-24,000	--
46.3	0.021	0.050	0.025	--	-20,000	--
46.3	0.017	--	--	--	--	--
46.9	0.036	0.060	0.027	--	-2,500	--

Table 7.--*Results of laboratory analyses for gravimetric water content and water potential of drill cuttings from test hole UE-25 UZ #4*--Continued

Depth of midpoint of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
47.5	0.030	0.092	0.049	--	-12,000	--
47.5	0.027	--	--	--	--	--
48.2	0.018	0.036	0.018	--	-13,000	--
48.2	0.017	--	--	--	--	--
48.8	0.025	0.042	0.033	--	-5,900	--
48.8	0.028	--	--	--	--	--
49.4	0.041	0.067	0.049	--	-1,400	--
49.4	0.036	--	--	--	--	--
50.0	0.070	0.104	0.061	--	-670	--
50.6	0.032	0.075	0.038	--	-8,000	--
51.2	0.036	0.068	0.057	--	-3,600	--
51.2	0.041	--	--	--	--	--
51.8	0.052	0.085	0.045	--	-2,000	--
51.8	0.043	--	--	--	--	--
52.4	0.084	0.104	0.067	--	-1,300	--
53.0	0.070	0.104	0.063	--	-670	--
53.0	0.075	--	--	--	--	--
53.6	0.048	0.045	0.068	--	--	--
53.6	0.059	--	--	--	--	--
54.2	0.043	0.073	0.049	--	-860	--
54.2	0.042	--	--	--	--	--
54.9	0.044	0.087	0.049	--	-2,000	--
55.5	0.044	0.093	0.039	--	-900	--
56.1	0.047	0.075	0.027	--	-3,500	--
56.1	0.051	--	--	--	--	--
56.7	0.040	0.075	0.029	--	-1,600	--
56.7	0.054	--	--	--	--	--
57.3	0.036	0.067	0.033	--	-2,100	--
57.3	0.050	--	--	--	--	--
57.9	0.039	0.057	0.025	--	-4,100	--
57.9	0.035	--	--	--	--	--
58.5	0.040	0.061	0.029	--	-3,600	--
58.5	0.041	--	--	--	--	--
59.1	0.038	0.059	0.032	--	-2,600	--
59.1	0.035	--	--	--	--	--

Table 7.--*Results of laboratory analyses for gravimetric water content and water potential of drill cuttings from test hole UE-25 UZ #4*--Continued

Depth of midpoint of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
59.7	0.036	0.056	0.025	--	--	--
59.7	0.024	--	--	--	--	--
60.4	0.032	0.052	0.028	--	-3,500	--
60.4	0.045	--	--	--	--	--
61.0	0.033	0.048	0.026	--	--	--
61.0	0.033	--	--	--	--	--
61.6	0.028	0.031	0.019	--	--	--
61.6	0.035	--	--	--	--	--
62.2	0.022	0.045	0.023	--	--	--
62.2	0.030	--	--	--	--	--
62.8	0.027	0.058	0.038	--	--	--
62.8	0.034	--	--	--	--	--
63.4	0.025	0.025	0.007	--	--	--
63.4	0.029	--	--	--	--	--
64.0	0.009	0.027	0.011	--	--	--
64.0	0.010	--	--	--	--	--
64.6	0.017	0.030	0.015	--	--	--
65.2	0.017	0.036	0.017	--	--	--
65.8	0.026	0.043	0.021	--	--	--
65.8	0.017	--	--	--	--	--
66.4	0.022	0.044	0.019	--	--	--
66.4	0.025	--	--	--	--	--
67.1	0.032	0.056	0.027	--	--	--
67.1	0.043	0.036	--	--	--	--
67.7	0.029	0.058	0.027	--	--	--
67.7	0.046	0.035	--	--	--	--
68.3	0.028	0.053	0.026	--	--	--
68.3	0.026	0.054	--	--	--	--
68.9	0.031	0.074	0.028	--	--	--
68.9	0.026	0.053	--	--	--	--
69.6	--	0.045	--	--	--	--
70.9	--	0.071	--	--	--	--
72.4	--	0.075	--	--	--	--
73.9	--	0.050	--	--	--	--

[1]Average of four values.

Table 8.--*Results of laboratory analyses for gravimetric water content and water potential of core samples from test hole UE-25 UZ #4*

[--, no data; >, greater than]

Depth interval of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
0.69-0.84	0.058	0.065	0.097	--	-100	-170
0.69-0.84	--	0.064	0.094	--	--	--
0.84-0.91	--	--	--	-200	--	--
1.30-1.45	0.082	0.070	0.104	--	-100	-180
1.30-1.45	--	0.087	0.108	--	--	--
1.45-1.52	--	--	--	-230	--	--
1.90-2.06	0.119	0.123	0.146	--	>-50	-170
1.90-2.06	--	0.114	0.146	--	--	--
2.06-2.13	--	--	--	-220	--	--
2.82-2.97	0.093	0.111	0.159	--	-160	-270
2.82-2.97	--	0.106	0.169	--	--	--
3.35-3.43	--	--	--	-220	--	--
3.66-3.81	--	0.058	0.085	--	-290	-190
3.66-3.81	--	0.054	0.086	--	--	--
4.65-4.80	--	0.077	0.130	--	-610	-330
4.65-4.80	--	0.075	0.117	--	--	--
4.80-4.88	--	--	--	-280	--	--
5.49-5.72	--	0.111	0.163	--	-250	-110
5.49-5.72	--	0.077	0.142	--	--	--
5.72-5.79	--	--	--	-280	--	--
6.48-6.63	--	0.099	0.179	--	-110	-290
6.48-6.63	--	0.105	0.178	--	--	--
6.63-6.71	--	--	--	-150	--	--
7.54-7.62	--	--	--	-150	--	--
7.70-7.85	--	0.073	0.104	--	-150	-200
7.70-7.85	--	0.073	0.099	--	--	--
8.76-8.92	--	0.062	0.070	--	-170	-360
8.76-8.92	--	0.063	0.070	--	--	--
10.06-10.13	--	--	--	-200	--	--
10.13-10.29	--	0.056	0.136	--	-60	-97
10.13-10.29	--	0.061	0.131	--	--	--
11.35-11.51	--	0.058	0.088	--	-590	-250
11.35-11.51	--	0.059	0.093	--	--	--
14.48-14.57	0.036	--	--	-1,800	--	--
14.63-14.72	--	--	--	-2,200	--	--

Table 8.--*Results of laboratory analyses for gravimetric water content and water potential of core samples from test hole UE-25 UZ #4*--Continued

Depth interval of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
14.84-14.94	0.042	--	--	-1,600	--	--
17.62-17.68	0.061	--	--	-590	--	--
20.42-20.51	0.063	--	--	-1,400	--	--
23.04-23.13	0.300	--	--	-330	--	--
23.77-23.84	0.253	--	--	-210	--	--
24.63-24.69	0.334	--	--	-110	--	--
25.30-25.39	0.521	--	--	-120	--	--
26.03-26.12	0.408	--	--	-310	--	--
26.03-26.12	--	--	--	-170	--	--
29.84-29.90	0.206	--	--	-240	--	--
30.63-30.69	0.218	--	--	-250	--	--
32.00-32.06	0.391	--	--	-270	--	--
[1]32.58-32.67	0.210	--	--	-260	--	--
34.38-34.44	0.172	--	--	-240	--	--
34.84-34.90	0.209	--	--	-220	--	--
35.66-35.75	0.174	--	--	-300	--	--
36.33-36.39	0.178	--	--	-210	--	--
37.12-37.19	0.183	--	--	-290	--	--
37.67-37.76	0.177	--	--	-450	--	--
38.37-38.50	0.162	--	--	-210	--	--
38.86-38.95	0.158	--	--	-360	--	--
39.96-40.02	0.186	--	--	-300	--	--
40.39-40.45	0.161	--	--	-330	--	--
40.39-40.45	--	--	--	-320	--	--
41.65-41.71	0.141	--	--	-430	--	--
42.31-42.37	0.141	--	--	-390	--	--
[1]43.25-43.31	0.107	--	--	-390	--	--
43.69-43.75	0.101	--	--	-150	--	--
44.58-44.65	0.102	--	--	-680	--	--
45.57-45.63	0.104	--	--	-390	--	--
46.33-46.39	0.168	--	--	-300	--	--
46.94-47.02	0.126	--	--	-670	--	--
47.55-47.64	0.085	--	--	-370	--	--
48.19-48.28	0.069	--	--	-380	--	--
49.83-49.93	0.110	--	--	-420	--	--
49.83-49.93	0.106	--	--	--	--	--
50.72-50.90	0.205	--	--	-390	--	--
52.67-52.73	0.178	--	--	-440	--	--
52.94-53.00	0.148	--	--	-430	--	--
54.50-54.56	0.156	--	--	-390	--	--

Table 8.--*Results of laboratory analyses for gravimetric water content and water potential of core samples from test hole UE-25 UZ #4*--Continued

Depth interval of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
55.99-56.08	0.110	--	--	-300	--	--
58.23-58.29	0.114	--	--	-410	--	--
59.31-59.38	0.115	--	--	-430	--	--
60.69-60.75	0.099	--	--	-460	--	--
61.26-61.33	0.094	--	--	-340	--	--
61.75-61.87	0.095	--	--	-500	--	--
62.88-63.00	0.106	--	--	-290	--	--
64.19-64.22	0.101	--	--	-440	--	--
64.86-64.92	0.102	--	--	-540	--	--
65.78-65.83	0.091	--	--	-490	--	--
66.17-66.23	--	--	--	-530	--	--
66.51-66.60	0.092	--	--	--	--	--
67.91-67.97	0.104	--	--	-640	--	--
68.67-68.73	0.123	--	--	-490	--	--
69.43-69.49	0.139	--	--	-540	--	--
70.13-70.23	0.143	--	--	-470	--	--
[1]70.99-71.05	0.164	--	--	-380	--	--
71.26-71.37	0.150	--	--	-430	--	--
72.18-72.24	0.174	--	--	-420	--	--
72.80-72.88	0.152	--	--	-470	--	--
73.61-73.65	0.173	--	--	-530	--	--
73.94-74.01	0.182	--	--	-530	--	--
[1]74.95-74.99	--	--	--	-500	--	--
75.54-75.59	0.156	--	--	-550	--	--
76.03-76.08	0.171	--	--	-460	--	--
76.95-77.01	0.137	--	--	-440	--	--
77.82-77.88	0.143	--	--	-450	--	--
78.59-78.65	0.117	--	--	-320	--	--
79.17-79.22	0.173	--	--	-610	--	--
80.13-80.22	0.154	--	--	-680	--	--
80.80-80.86	0.149	--	--	-360	--	--
81.65-81.71	0.158	--	--	-340	--	--
82.14-82.20	0.152	--	--	-260	--	--
83.21-83.27	--	--	--	-180	--	--
84.41-84.49	0.126	--	--	-290	--	--
84.73-84.80	0.132	--	--	--	--	--
85.19-85.27	0.129	--	--	-180	--	--
86.20-86.26	--	--	--	-170	--	--
87.75-87.81	0.177	--	--	-280	--	--
88.64-88.70	0.180	--	--	-200	--	--

Table 8.--*Results of laboratory analyses for gravimetric water content and water potential of core samples from test hole UE-25 UZ #4*--Continued

Depth interval of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
89.31-89.37	0.194	--	--	-460	--	--
90.07-90.18	0.293	--	--	-280	--	--
90.83-90.92	0.182	--	--	-300	--	--
91.70-91.76	0.327	--	--	-230	--	--
92.28-92.37	0.157	--	--	-86	--	--
93.21-93.30	0.150	--	--	-170	--	--
94.06-94.12	0.186	--	--	-310	--	--
95.65-95.77	0.159	--	--	-150	--	--
96.01-96.10	0.234	--	--	-130	--	--
97.81-97.89	0.190	--	--	-160	--	--
[1]99.03-99.12	0.127	--	--	-300	--	--
99.55-99.70	0.150	--	--	-240	--	--
100.25-100.34	0.205	--	--	-510	--	--
101.13-101.22	0.166	--	--	-180	--	--
101.93-101.99	0.202	--	--	-500	--	--
102.41-102.47	0.166	--	--	-460	--	--
103.14-103.24	0.152	--	--	-230	--	--
104.18-104.24	0.140	--	--	-73	--	--
104.55-104.64	0.088	--	--	-270	--	--
105.70-105.77	0.035	--	--	-480	--	--
106.19-106.25	0.011	--	--	-540	--	--
106.51-106.60	0.007	--	--	-2,900	--	--
106.51-106.60	--	--	--	-2,000	--	--
107.35-107.45	0.009	--	--	-710	--	--
107.94-108.06	0.014	--	--	-240	--	--
107.94-108.06	0.020	--	--	--	--	--
108.78-108.87	0.031	--	--	-190	--	--
109.31-109.39	0.029	--	--	-320	--	--
109.97-110.16	0.038	--	--	-210	--	--
110.96-111.05	0.044	--	--	-210	--	--
111.59-111.69	0.045	--	--	--	--	--

[1]Recovered core interval exceeds the drilled interval; further discussed in the rotary core section under sample collection and handling.

Table 9.--*Results of laboratory analyses for gravimetric water content and water potential of drill cuttings from test hole UE-25 UZ #5*

[--, no data]

Depth of midpoint of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
1.2	0.023	0.021	--	--	-4,500	--
1.8	0.024	0.024	--	--	-3,200	--
2.4	0.028	0.028	--	--	-2,500	--
3.0	0.029	0.028	--	--	-1,700	--
3.7	0.028	0.028	--	--	-2,300	--
4.3	0.033	0.034	--	--	-1,500	--
4.9	0.028	0.031	--	--	-3,300	--
5.3	0.025	--	--	--	-2,400	--
5.6	0.019	--	--	--	-6,600	--
6.1	0.022	--	--	--	-4,200	--
6.7	0.026	--	--	--	-1,700	--
7.3	0.025	--	--	--	-2,100	--
7.9	0.026	--	--	--	-2,400	--
8.4	0.021	--	--	--	-4,400	--
8.7	0.028	--	--	--	-1,600	--
9.1	0.028	--	--	--	-1,900	--
9.8	0.027	--	--	--	-2,000	--
10.4	0.023	--	--	--	-2,600	--
11.0	0.024	--	--	--	-2,800	--
11.6	0.022	--	--	--	-5,800	--
12.2	0.022	--	--	--	-5,800	--
12.6	0.025	--	--	--	-4,300	--
13.1	0.024	--	--	--	-2,100	--
13.7	0.018	--	--	--	-8,000	--
14.2	0.023	--	--	--	-4,200	--
14.5	0.019	--	--	--	-7,400	--
14.9	0.021	--	--	--	-5,800	--
15.5	0.019	--	--	--	-6,600	--
16.2	0.017	--	--	--	-8,500	--
16.8	0.017	--	--	--	-10,000	--
17.4	0.019	--	--	--	-9,600	--
18.0	0.020	--	--	--	-8,800	--
18.6	0.020	--	--	--	-8,500	--
19.2	0.018	--	--	--	-10,000	--
19.8	0.018	--	--	--	-12,000	--

Table 9.--*Results of laboratory analyses for gravimetric water content and water potential of drill cuttings from test hole UE-25 UZ #5*--Continued

Depth of midpoint of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
20.4	0.026	--	--	--	-7,300	--
21.0	0.042	--	--	--	-3,000	--
21.6	0.051	--	--	--	-2,700	--
22.3	0.051	--	--	--	-1,800	--
22.9	0.060	--	--	--	-860	--
23.5	0.061	--	--	--	-870	--
24.1	0.087	--	--	--	-440	--
24.7	0.092	--	--	--	-400	--
25.1	0.106	--	--	--	-560	--
25.5	0.096	--	--	--	--	--
25.8	0.082	--	--	--	-980	--
26.1	0.069	--	--	--	-1,200	--
26.4	0.081	--	--	--	-700	--
26.7	0.077	--	--	--	-840	--
27.0	0.106	--	--	--	-430	--
27.3	0.107	--	--	--	-370	--
27.5	0.105	--	--	--	-3,800	--
27.5	--	--	--	--	-3,100	--
27.7	0.191	--	--	--	-380	--
27.8	0.222	--	--	--	-530	--
28.0	0.209	--	--	--	-480	--
29.6	--	0.223	--	--	-390	--
29.6	--	--	--	--	-500	--
30.2	--	0.215	--	--	-350	--
[1]30.3	--	0.039	--	--	-3,000	--
[1]31.9	--	0.032	--	--	-2,300	--
[1]33.4	--	0.041	--	--	-1,400	--
[1]34.9	--	0.027	--	--	-7,800	--
[1]36.4	--	0.044	--	--	-2,200	--
37.9	--	0.127	--	--	-560	--
39.5	--	--	--	--	--	--
41.0	--	0.074	--	--	-1,100	--
42.5	--	0.086	--	--	-1,700	--
44.0	--	0.090	--	--	-580	--
45.6	--	0.098	--	--	-140	--
47.1	--	0.091	--	--	-1,000	--
48.6	--	0.089	--	--	-530	--
50.1	--	--	0.087	--	-540	--
51.7	--	0.115	--	--	-390	--
53.2	--	0.063	--	--	-1,500	--

Table 9.--*Results of laboratory analyses for gravimetric water content and water potential of drill cuttings from test hole UE-25 UZ #5*--Continued

Depth of midpoint of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
54.7	--	0.135	--	--	-410	--
56.2	--	0.092	--	--	-350	--
57.8	--	0.097	--	--	-810	--
59.3	--	0.170	--	--	-190	--
60.8	--	0.110	--	--	-170	--
62.3	--	0.106	--	--	-360	--
63.9	--	0.089	--	--	-320	--
65.4	--	0.028	--	--	-4,900	--
66.9	--	0.044	--	--	-8,500	--
68.4	--	0.037	--	--	-8,500	--
70.0	--	0.037	--	--	-4,000	--
71.5	--	0.054	--	--	-1,700	--
73.0	--	0.077	--	--	-950	--
74.5	--	0.093	--	--	-800	--
76.0	--	0.095	--	--	-830	--
77.6	--	0.105	--	--	-540	--
79.1	--	0.089	--	--	-1,800	--
80.6	--	0.088	--	--	-2,900	--
82.1	--	0.068	--	--	-5,400	--
83.7	--	0.058	--	--	-6,400	--
85.2	--	0.071	--	--	-1,400	--
86.7	--	0.080	--	--	-820	--
88.2	--	--	--	--	--	--
89.8	--	0.081	--	--	-560	--
91.3	--	0.072	--	--	-650	--
92.8	--	0.070	--	--	-990	--
94.3	--	0.090	--	--	-840	--
95.9	--	0.146	--	--	-540	--
97.4	--	0.213	--	--	-420	--
98.9	--	0.115	--	--	-810	--
100.4	--	0.092	--	--	-3,500	--
102.0	--	0.088	--	--	-2,200	--
103.5	--	0.100	--	--	-970	--
105.0	--	0.129	--	--	-750	--
106.5	--	--	--	--	--	--
108.1	--	0.033	--	--	-8,600	--
109.6	--	0.048	--	--	-6,000	--
110.5	--	0.020	--	--	-12,000	--

[1]Sample contaminated by overlying material.

Table 10.--*Results of laboratory analyses for gravimetric water content and water potential of core samples from test hole UE-25 UZ #5*

[--, no data]

Depth interval of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
2.35-2.41	0.036	--	--	-370	--	--
5.39-5.48	0.033	--	--	-1,000	--	--
8.23-8.53	0.024	--	--	-3,300	--	--
[1]14.26-14.36	0.025	--	--	-2,300	--	--
28.71-28.79	0.264	--	--	-110	--	--
29.49-29.56	0.290	--	--	-140	--	--
30.11-30.28	0.198	--	--	-190	--	--
30.75-30.80	0.199	--	--	-160	--	--
31.55-31.70	0.192	--	--	-110	--	--
32.52-32.61	0.184	--	--	-180	--	--
33.01-33.10	0.172	--	--	-350	--	--
33.74-33.80	0.181	--	--	-400	--	--
34.53-34.63	0.241	--	--	-330	--	--
35.45-35.51	0.145	--	--	-370	--	--
35.91-35.97	0.158	--	--	-470	--	--
37.12-37.18	0.342	--	--	-330	--	--
38.02-38.13	0.106	--	--	-460	--	--
38.63-38.71	0.115	--	--	-250	--	--
39.52-39.59	0.102	--	--	-510	--	--
40.00-40.13	0.102	--	--	-350	--	--
40.81-40.95	0.107	--	--	-390	--	--
[1]41.74-41.79	0.114	--	--	-440	--	--
42.31-42.43	0.110	--	--	-340	--	--
43.07-43.19	0.059	--	--	-300	--	--
43.75-43.83	0.112	--	--	-620	--	--
44.53-44.61	0.137	--	--	-540	--	--
45.23-45.32	0.128	--	--	-510	--	--
46.15-46.24	0.123	--	--	-510	--	--
46.91-46.97	0.143	--	--	-270	--	--
47.85-48.04	0.103	--	--	-390	--	--
48.54-48.69	0.128	--	--	-270	--	--
49.21-49.35	0.099	--	--	-370	--	--
49.80-49.94	0.103	--	--	-370	--	--
50.41-50.49	0.098	--	--	-260	--	--
50.75-50.83	0.162	--	--	-240	--	--

Table 10.--*Results of laboratory analyses for gravimetric water content and water potential of core samples from test hole UE-25 UZ-5*--Continued

Depth interval of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
52.00-52.12	0.078	--	--	-230	--	--
53.52-53.61	0.152	--	--	-230	--	--
53.98-54.10	0.115	--	--	-340	--	--
54.86-54.99	0.104	--	--	-220	--	--
55.78-55.87	0.171	--	--	-420	--	--
56.39-56.48	0.178	--	--	-260	--	--
57.55-57.64	0.162	--	--	-160	--	--
58.52-58.60	0.120	--	--	-240	--	--
59.82-59.92	0.127	--	--	-420	--	--
60.41-60.53	0.117	--	--	-540	--	--
61.14-61.26	0.110	--	--	-460	--	--
62.18-62.27	0.103	--	--	-490	--	--
62.58-62.67	0.102	--	--	-450	--	--
64.95-65.04	0.093	--	--	-270	--	--
65.73-65.84	0.105	--	--	-390	--	--
66.68-66.77	0.104	--	--	-520	--	--
67.51-67.62	0.097	--	--	-540	--	--
68.14-68.24	0.088	--	--	-490	--	--
68.85-68.95	0.084	--	--	-490	--	--
69.77-69.86	0.086	--	--	-550	--	--
70.55-70.64	0.092	--	--	-540	--	--
71.38-71.45	0.099	--	--	-250	--	--
71.95-72.05	0.137	--	--	-290	--	--
72.65-72.74	0.107	--	--	-320	--	--
73.52-73.61	0.123	--	--	-300	--	--
74.19-74.28	0.098	--	--	-380	--	--
74.83-74.95	0.126	--	--	-230	--	--
75.64-75.77	0.117	--	--	-340	--	--
76.64-76.73	0.136	--	--	-460	--	--
77.65-77.72	0.132	--	--	-280	--	--
78.06-78.12	0.123	--	--	-99	--	--
79.10-79.19	0.125	--	--	-270	--	--
79.61-79.74	0.130	--	--	-260	--	--
80.33-80.45	0.121	--	--	-300	--	--
80.94-81.05	0.137	--	--	-320	--	--
81.75-81.87	0.113	--	--	-440	--	--
[1]82.81-82.96	0.129	--	--	-330	--	--
83.33-83.50	0.122	--	--	-350	--	--
84.00-84.12	0.134	--	--	-270	--	--
84.90-85.01	0.141	--	--	-320	--	--

Table 10.--*Results of laboratory analyses for gravimetric water content and water potential of core samples from test hole UE-25 UZ-5*--Continued

Depth interval of sample (meters)	Gravimetric water content (gram per gram)			Water potential (kilopascals)		
	Composite	Coarse	Fines	Composite	Coarse	Fines
85.66-85.77	0.146	--	--	-200	--	--
86.33-86.56	0.119	--	--	-410	--	--
[1]87.45-87.53	0.115	--	--	-250	--	--
88.09-88.18	0.117	--	--	-220	--	--
88.45-88.61	0.120	--	--	-360	--	--
89.55-89.66	0.119	--	--	-100	--	--
[1]90.48-90.58	0.132	--	--	-270	--	--
91.23-91.32	0.135	--	--	-240	--	--
91.71-91.81	0.142	--	--	-260	--	--
92.69-92.80	0.170	--	--	-200	--	--
93.30-93.39	0.198	--	--	-330	--	--
94.00-94.11	0.221	--	--	-360	--	--
94.76-94.88	0.263	--	--	-360	--	--
95.49-95.61	0.365	--	--	-350	--	--
96.01-96.15	0.131	--	--	-390	--	--
96.71-96.77	--	--	--	-300	--	--
96.93-97.00	0.259	--	--	-150	--	--
97.78-97.84	--	--	--	-340	--	--
[1]98.11-98.16	0.210	--	--	-290	--	--
98.62-98.72	0.147	--	--	-270	--	--
99.55-99.67	0.133	--	--	-330	--	--
100.08-100.17	0.117	--	--	-330	--	--
101.10-101.19	0.166	--	--	-180	--	--
101.42-101.50	0.185	--	--	-200	--	--
102.57-102.72	0.221	--	--	-280	--	--
103.25-103.36	0.254	--	--	-250	--	--
104.15-104.24	0.236	--	--	-160	--	--
104.75-104.83	0.279	--	--	-100	--	--
105.64-105.72	0.136	--	--	-360	--	--
106.34-106.48	0.097	--	--	-360	--	--
[1]107.24-107.35	0.109	--	--	-350	--	--
107.62-107.70	0.098	--	--	-810	--	--
107.95-108.07	0.015	--	--	-4,900	--	--
107.95-108.07	0.014	--	--	-5,800	--	--
108.87-109.00	0.013	--	--	-2,500	--	--
109.55-109.67	0.011	--	--	-1,500	--	--

[1]Recovered core interval exceeds drilled interval; further discussed in the rotary core section under sample collection and handling.

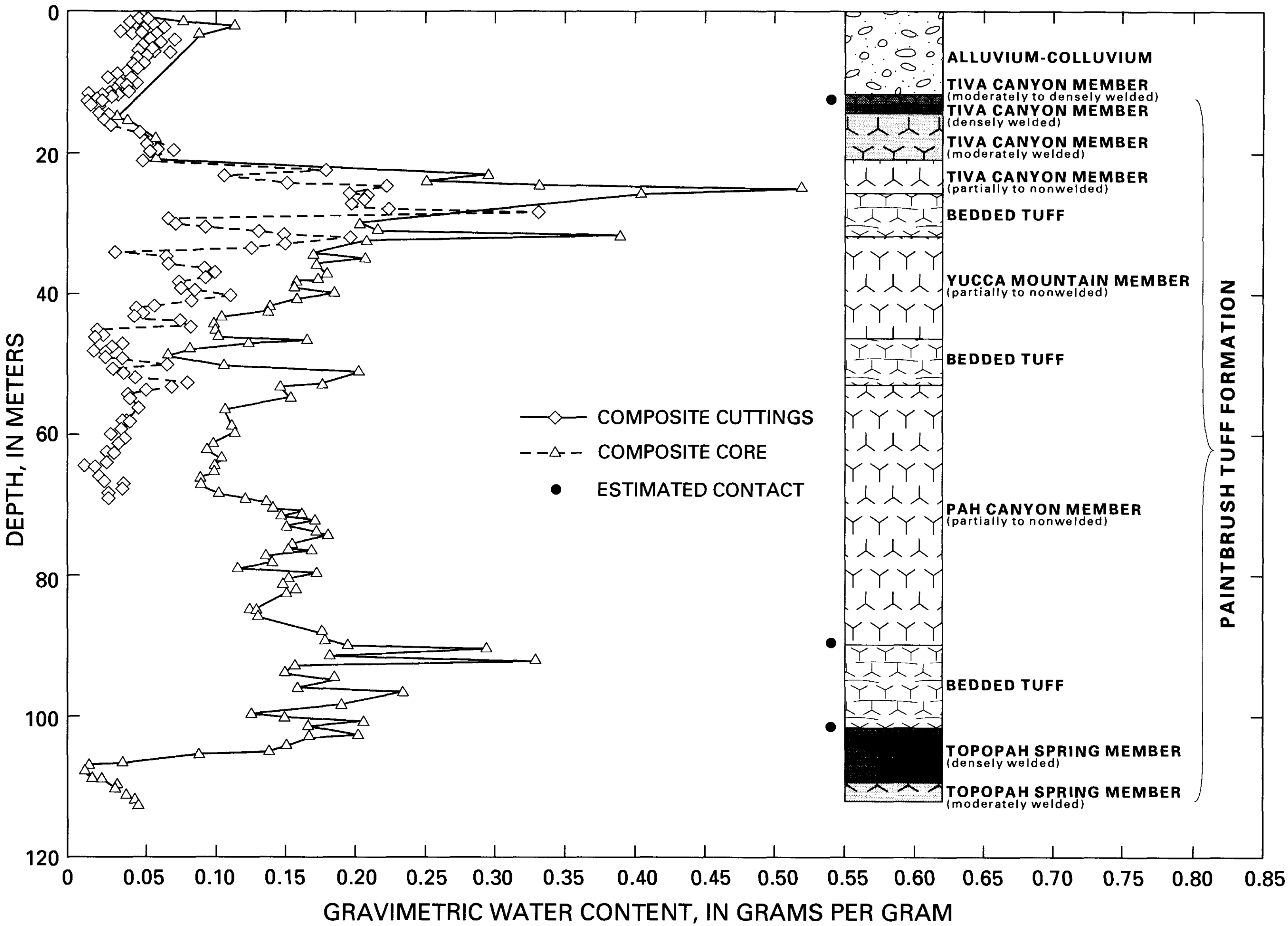

Figure 3.--Gravimetric water-content measurements of core and cuttings from test hole UE-25 UZ #4.

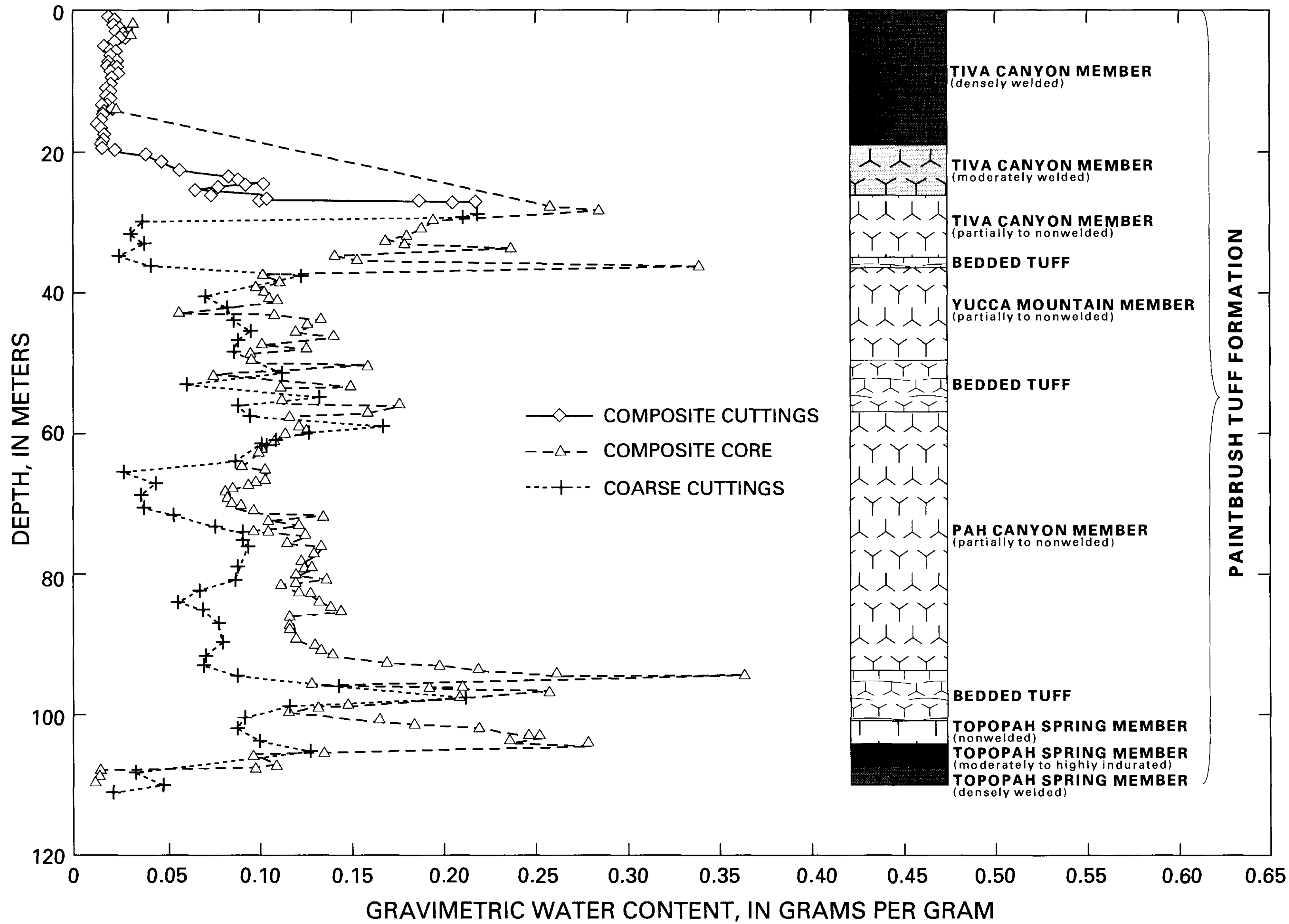

Figure 4.--Gravimetric water-content measurements of core and cuttings from test hole UE-25 UZ #5.

Table 11.--*Summary of relation of gravimetric water-content measurements of composite core for test holes UE-25 UZ #4 and UE-25 UZ #5 to geologic unit and degree of welding*

[All values in grams per gram; --, no data]

Geologic unit	Degree of welding	Test hole UE-25 UZ #4			Test hole UE-25 UZ #5		
		Range of values	Average	Median	Range of values	Average	Median
Tiva Canyon Member	Densely welded	0.036 and 0.042	0.039	0.039	0.024 to 0.036	0.030	0.029
	Moderately welded	0.061 and 0.063	0.062	0.062	--	--	--
	Partially welded to nonwelded	0.253 to 0.521	0.363	0.334	0.145 to 0.290	0.202	0.192
Yucca Mountain Member	Partially welded to nonwelded	0.101 to 0.210	0.157	0.165	0.059 to 0.143	0.110	0.108
Pah Canyon Member	Partially welded to nonwelded	0.092 to [1]0.182	[1]0.134	[1]0.137	0.084 to 0.221	0.122	0.120
Bedded tuffs		0.069 to 0.391	[1]0.167	[1]0.148	0.078 to 0.365	[2]0.176	[2]0.162
Topopah Spring Member	Nonwelded	--	--	--	0.221 to 0.279	0.248	0.245
	Moderately to highly indurated	--	--	--	0.097 0.136	0.110	0.104
	Moderately welded	0.038 to 0.045	0.042	0.044	--	--	--
	Densely welded	0.007 to [1]0.035	[1]0.020	[1]0.017	0.011 to 0.015	0.013	0.014

[1]The values obtained from the core samples from 86.26 to 105.70 m are not included because no lithologic description is available for this interval.

[2]The value obtained from the core sample at 94.76 to 94.88 m is not included because it contains part of the overlying Pah Canyon Member.

Nonwelded units exhibit much larger gravimetric water-content values than densely welded units. The partially to nonwelded part of the Tiva Canyon Member is the wettest of the partially to nonwelded units, averaging 0.363 gm/gm for UZ #4 and 0.202 gm/gm for UZ #5. The Yucca Mountain Member averages 0.157 gm/gm for UZ #4 and 0.110 gm/gm for UZ #5. The Pah Canyon Member averages 0.134 gm/gm for UZ #4 and 0.122 gm/gm for UZ #5. The unnamed bedded tuff units are combined in table 11 and have an average moisture content of 0.167 gm/gm for UZ #4 and 0.176 gm/gm for UZ #5.

The Topopah Spring Member is the deepest member penetrated. The moisture content of the nonwelded part averages 0.248 gm/gm for UZ #5; no data are available for UZ #4. In samples from UZ #4, the moderately welded part of the Topopah Spring Member averages 0.042 gm/gm and the densely welded part averages 0.020 gm/gm. UZ #5 samples average 0.110 gm/gm in the moderately to highly indurated part and 0.013 gm/gm in the densely welded part.

Linear regression analyses were calculated for water-content data from composite-, coarse-, and fine-sized particle fractions of cuttings and core from UZ #4 and UZ #5 to determine which particle-size fraction of drill cutings would yield water-content measurements most representative of the formation rock. The results of these linear regression analyses are presented in table 12. For nonwelded and bedded tuffs of test hole UZ #4, the best correlation based on 36 pairs of data was between the water-content measure-ents of coarse cuttings and composite core with a coefficient of determination (r^2) of 0.750. The coefficient of determination between a limited number of data points for composite cuttings and composite-core samples from both UZ #4 and UZ #5 was 0.964. The coefficient found between the water-content measurements of composite cuttings and composite core was 0.721. A poorer correlation was found between the water-content measurements of coarse cutings and composite core in UZ #5 (r^2 = 0.095, table 12). Additional data from several other core holes, comparing the water content of drill cuttings with that of core, were presented by Hammermeister and others (1985). Those results were for a larger data set than described here and indicate that for all lithologic units, including alluvium-colluvium, welded tuff, and nonwelded and bedded tuff, the water content of composite core samples generally is more highly correlated with coarse drill cuttings than fine- or composite-size fractions.

UZ #5 was cored continuously for greater intervals than UZ #4 before reaming and driving the casing down to the bottom of the hole. UZ #4 had intervals of approximately 9.14-m cored. UZ #5 had a 25.91-m interval cored from a depth of 38.71 m to 63.70 m; this coring was followed by continuous coring from a depth of 64.62 m to 109.88 m.

Results of statistical correlations of gravimetric water-content values of alluvial-colluvial drill cuttings with similar particle-size-fractions in core generally indicate that fine cuttings dried more than coarse cuttings (r^2 = 0.259 and 0.422, respectively, table 12). Because only 12 data pairs were available, more particle-size fraction data need to be collected from alluvial-colluvial deposits to define these relations more clearly. Additional data were presented by Hammermeister and others (1985).

After determining the gravimetric water content, the dried core samples were placed in paper cartons and labeled. These were later tested by Holmes & Narver Materials Testing Laboratory, Inc., Mercury, Nev., for bulk and grain density.

Table 12.--*Summary of linear-regression analysis of gravimetric water content of cuttings and core*

Test hole number	Rock units	Independent variable	Dependent variable	Coefficient of determination (r^2)	Intercept	Slope	Number of data pairs
UE-25 UZ #4	Alluvium-colluvium	Gravimetric water content of coarse cuttings	Gravimetric water content of coarse core	0.422	0.024	1.071	12
		Gravimetric water content of fine cuttings	Gravimetric water content of fine core	0.259	0.068	0.966	12
UE-25 UZ #4	Partially welded, nonwelded, and bedded tuffs	Gravimetric water content of coarse cuttings	Gravimetric water content of composite core	0.750	0.036	1.301	36
		Gravimetric water content of composite cuttings	Gravimetric water content of composite core	0.721	0.062	1.449	36
UE-25 UZ #4 and UE-25 UZ #5	Welded tuff	Gravimetric water content of composite cuttings	Gravimetric water content of composite core	0.964	0.000	1.238	7
UE-25 UZ #5	Partially welded, nonwelded, and bedded tuffs	Gravimetric water content of coarse cuttings	Gravimetric water content of composite core	0.095	0.106	0.356	41

Water-Potential Measurements

Water potential is defined as the sum of matric and osmotic potentials. Water potentials were measured using a Richards SC-10 thermocouple psychrometer in conjunction with an NT-3 nanovoltmeter (Decagon Devices, Pullman, Wash.). The SC-10 psychrometer is a stationary device with 10 rotating sample chambers. The Richards method (Richards and Ogata, 1958) is based on dipping a ceramic bead, attached at the thermocouple junction, into distilled water. The rate of evaporation of water on the ceramic bead is measured as voltage output readings throughout a period of as long as 10 minutes on the nanovoltmeter while vapor equilibrium occurs. Voltage outputs are recorded every minute.

Sample-chamber cups were placed within the 10 rotating sample chambers of the SC-10 psychrometer. Three sample-chamber cups were lined with filter paper and wetted with three of six calibration standards of known molality; six sample-chamber cups were filled with cuttings or core samples; the last sample-chamber cup was filled with distilled water. The calibration solutions were measured concurrently with the cuttings or core samples to compensate for the zero drift of the nanovoltmeter amplifier due to changes in temperature. The calibration solution molalities used with their approximate water potentials in kPa equivalents were: 0.02, -100 kPa; 0.05, -230 kPa; 0.1, -460 kPa; 0.4, -1,800 kPa; 0.8, -3,700 kPa; and 1.5, -7,100 kPa.

The same calibration solutions were not used for all cuttings and core samples. As much as possible, samples with similar moisture contents, based on gravimetric water-content measurements, were run together. Three of the six calibration solutions were then selected within a range that spanned the possible water-potential range of the six samples in the SC-10 psychrometer.

The SC-10 psychrometer sample-chamber cups were loaded with calibration solutions and rock samples in a humidified glove box to minimize evaporation. The SC-10 psychrometer was allowed to equilibrate for a minimum of 30 minutes before any measurements were made. All measurements were made inside the humidified box, with room temperatures maintained relatively constant, generally at 20 °C to 25 °C.

The procedure for taking water-potential readings was begun by first taking a temperature reading. The sample chambers were rotated and the ceramic bead of the thermocouple junction was wetted in distilled water. The sample chambers were then rotated back to the appropriate chamber, and as much as 10 minutes was allowed for vapor equilibrium to occur, with voltage outputs recorded every minute. Another temperature reading was then taken. The ceramic bead was wetted again in distilled water before taking readings at the next sample chamber. Thermocouple-voltage outputs were first measured on the calibration solutions from lowest to highest molality, followed by the rock samples, then repeated on the calibration solutions from lowest to highest molality. The two voltage readings for each calibration solution were averaged to compensate for any drift in temperature (Brown, 1970). The sample cups containing the cuttings or core were carefully cleaned and dried after each set of measurements.

At the end of 10 minutes of recording voltage outputs, an averaged representative voltage reading was selected based on the evidence of a "plateau." This plateau in voltage readings occurs when the system is in equilibrium and there is little change in the voltage readings. Once sufficient evaporation has occurred, the meniscus on the ceramic bead loses its cohesiveness, evaporation proceeds more quickly, and the voltage readings begin falling off rapidly. For relatively moister samples of more than -2,000 kPa, the plateaus tended to be more evident during the last 5 minutes of voltage readings and tended to last longer; the fall-off from the plateau usually was not noted within the 10 minutes of voltage readings. For relatively drier samples of less than -5,000 kPa, the plateaus tended to occur during the first 5 minutes of voltage readings and only lasted for a few minutes before the readings began falling off rapidly. Samples with readings of less than -10,000 kPa generally leveled off sufficiently fast that the voltage reading taken at 1 minute was considered to be the plateau.

The two voltage outputs were averaged for each calibration solution as well as the four recorded temperature values. The water potential was then calculated for each calibration solution based on the four averaged temperature values. A linear regression equation was determined for the calculated water potentials and the averaged voltage readings of the calibration solutions. The results of the linear regression equation were used to construct the calibration curve and include intercept, slope, and coefficient of determination. The coefficient of determination (r^2) is the square of the sample correlation coefficient (r) between y, the water-potential values of the calibration standards calculated from the averaged temperature values, and the independent variable or averaged voltage readings of the calibration solutions. The stronger the relation between the calibration solutions and temperature, the closer the value of r^2 is to 1.000. Using this calibration curve, the voltage reading from each core or cuttings sample is entered into the linear regression equation, and the resulting value is the water potential of the sample.

Generally, measurements of rock samples were rerun if the coefficient of determination (r^2) was less than 0.990 or if the voltage readings did not stabilize at a plateau. For moister samples with readings of less than 20 microvolts on the nanovoltmeter, a difference of 0.10 microvolts or less between two consecutive readings generally was considered a stable plateau. The calibration curves for core and cuttings from UZ #5 and core samples from UZ #4 were nearly linear with r^2 values ranging from 0.991 to 1.000. For UZ #4 cuttings, r^2 values ranged from 0.947 to 1.000. Most r^2 values were equal to 1.000.

A check on the linearity of the calibration data obtained from calibration solutions with water potentials of -7,100 kPa or less was done after all sample testing was completed. Calibration solutions with molalities of 0.05, 0.1, 0.4, 0.8, 1.5, 2.0 (approximately -9,800 kPa), saturated KCl (approximately 4.7 molal or -22,000 kPa), and saturated NaCl (approximately 8.2 molal or -39,000 kPa) were run several times in both SC-10 psychrometers. The calibration solution molalities from 0.05 (approximately -230 kPa) through saturated KCl (approximately -22,00 kPa) generally resulted in an r^2 value of 1.000. Calibration solutions from 2.0 molal (approximately -9,8000 kPa) through saturated NaCl (approximately -39,000 kPa) generally resulted in an r^2 value of 0.998. UZ #4 has only three samples having readings more negative than -22,000 kPa; UZ #5 has no samples having readings more negative than -12,000 kPa.

Results of water-potential measurements for UZ #4 and UZ #5 are summarized in tables 7, 8, 9, and 10 and are presented graphically in figures 5 and 6. For intervals with multiple measurements, an average value was plotted for figures 5 and 6. The differences in water-potential measurements between coarse cuttings and composite core for both UZ #4 and UZ #5 (figs. 5 and 6) are more pronounced than gravimetric water-content differences for the same sample types shown in figures 3 and 4. Linear-regression analyses (table 12) also indicate no correlation between the water-potential values of various particle-size fractions of alluvium-colluvium cuttings and similar particle-size fractions of core, even though this is not apparent in figure 5. The relation between water-potential and water-content measurements is nonlinear; small changes in water-content measurements due to drying can cause large changes in water-potential measurements (Hammermeister and others, 1985). These authors also list other factors that may be responsible for observable differences in water potentials of core and cuttings.

Water-potential data of composite core from UZ #4 and UZ #5 are summarized in table 13. Data from samples which overlapped geologic units are not included in the summarized data. In general, core from densely welded tuffs have the most negative water-potential values, moderately welded tuffs have intermediate water-potential values, and partially welded, nonwelded and bedded tuffs have less negative water-potential values.

Water-potential data for alluvial-colluvial material from UZ #4 for coarse- and fine-sized particle fractions of cutting and core were analyzed using linear regression. Statistical correlations of water-potential values for fine- and coarse-sized fractions had low r^2 values, calculated at 0.071 and 0.090, respectively (table 14), indicating a lack of correlation. These correlations are based on only 11 data pairs; more particle-size fraction data need to be collected from alluvial-colluvial deposits to define these relations more clearly. Some additional data were presented by Hammermeister and others (1985).

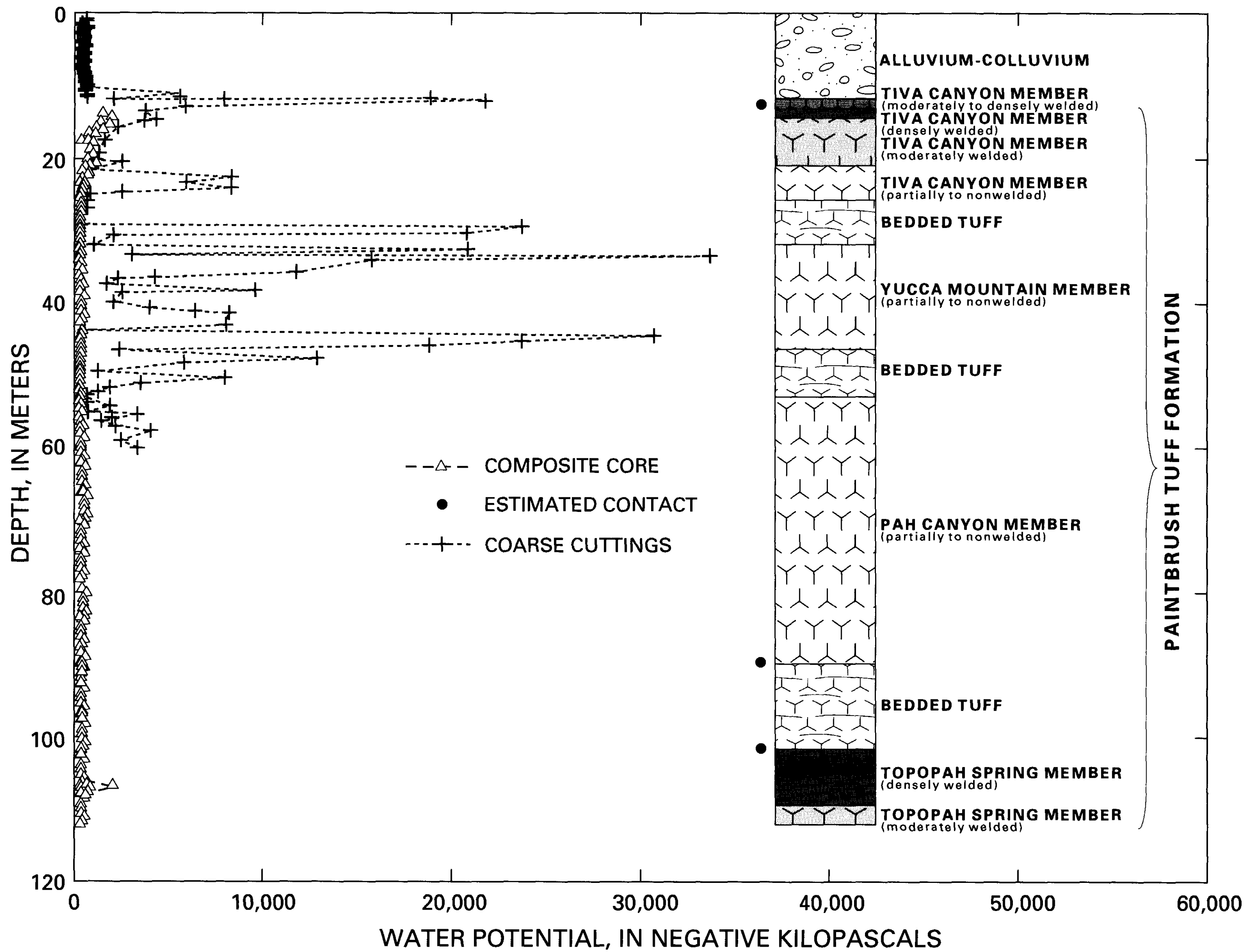

Figure 5.--Water-potential measurements of core and cuttings from test hole UE-25 UZ #4.

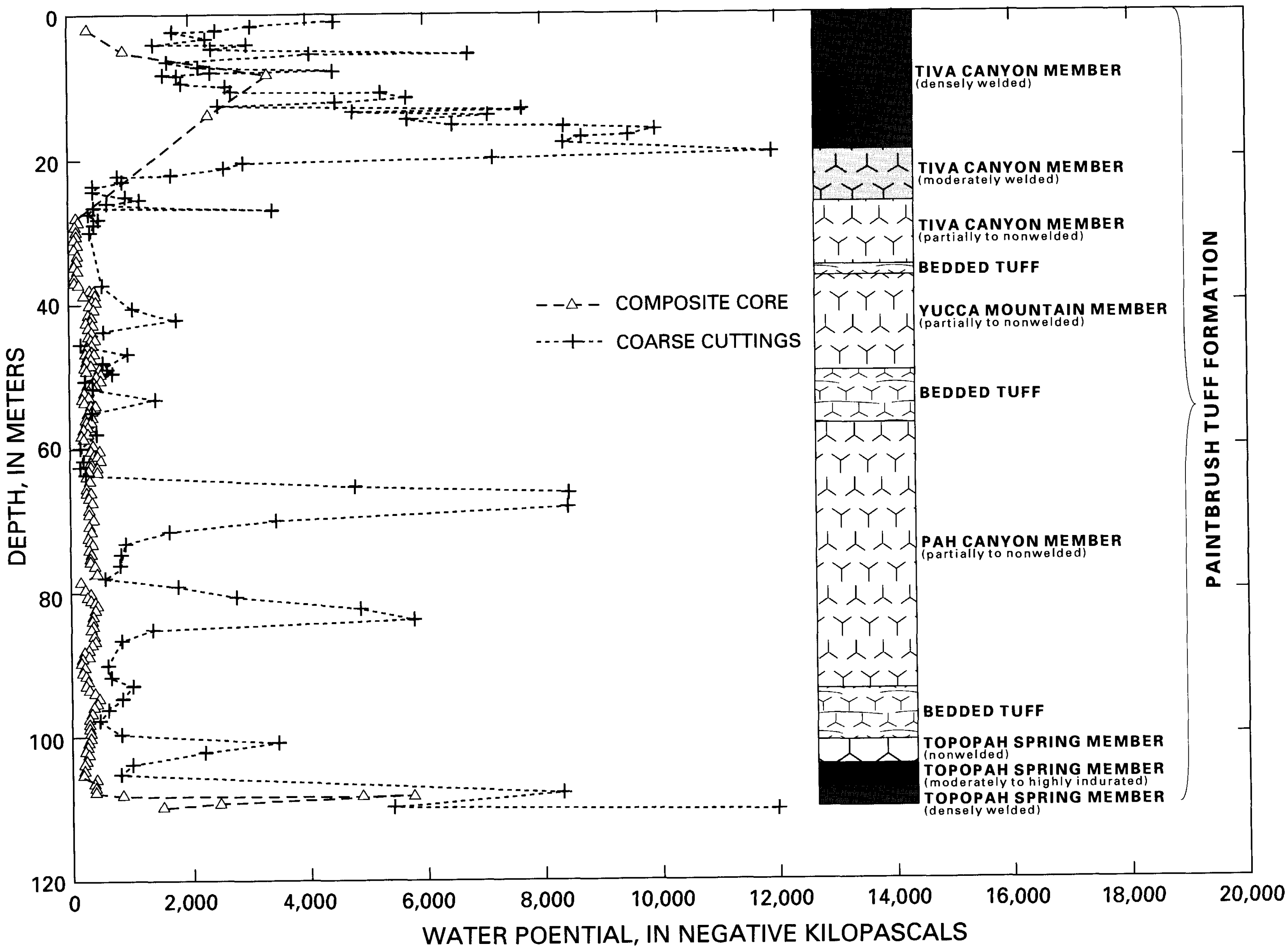

Figure 6.--Water-potential measurements of core and cuttings from test hole UE-25 UZ #5.

Table 13.--*Summary of relation of water-potential measurements of composite core for test holes UE-25 UZ #4 and UE-25 UZ #5 to geologic unit and degree of welding*

[All values in kilopascals; --, no data]

Geologic unit	Degree of welding	Test hole UE-25 UZ #4			Test hole UE-25 UZ #5		
		Range of values	Average	Median	Range of values	Average	Median
Tiva Canyon Member	Densely welded	-1,600 to -2,200	-1,900	-1,800	-370 to -3,300	-1,700	-1,600
	Moderately welded	-590 and -1,400	-1,000	-1,000	--	--	--
	Partially welded to nonwelded	-110 to -330	-210	-190	-110 to -470	-260	-190
Yucca Mountain Member	Partially welded to nonwelded	-150 to -680	-330	-300	-250 to -620	-400	-380
Pah Canyon Member	Partially welded to nonwelded	-170 to [1]-680	[1]-430	[1]-440	-99 to -550	-340	-320
Bedded tuffs		-240 to -670	[1]-390	[1]-380	-150 to [2]-420	[2]-280	[2]-280
Topopah Spring Member	Nonwelded	--	--	--	-100 to -280	-200	-200
	Moderately to highly indurated	--	--	--	-350 to -810	-470	-360
	Moderately welded	-210	-210	-210	--	--	--
	Densely welded	-190 to [1]-2,900	[1]-920	[1]-510	-1,500 to -5,800	-3,700	-3,700

[1]The values obtained from the core samples from 86.26 to 105.70 m are not included because no lithologic description is available for this interval.

[2]The value obtained from the core sample at 94.76 to 94.88 m is not included because it contains part of the overlying Pah Canyon Member.

Table 14.--*Summary of linear-regression analysis of water potential of cuttings and core for test hole UE-25 UZ #4*

Rock units	Independent variable	Dependent variable	Coefficient of determination (r^2)	Intercept	Slope	Number of data pairs
Alluvium-colluvium	Water potential of coarse cuttings	Water potential of coarse core	0.090	-1.268	0.289	11
	Water potential of fine cuttings	Water potential of fine core	0.071	-1.938	0.084	11

Bulk- and Grain-Density Measurements

The bulk- and grain-density measurements of core samples from UZ #4 and UZ #5 were determined by Holmes & Narver Materials Testing Laboratory, Inc., Mercury, Nev., in accordance with ASTM Procedure D-1188 (1980a), "Bulk Specific-Gravity of Compacted Bituminuous Mixtures Using Paraffin-Coated Specimens." Bulk density is the weight of an object or material divided by its material volume minus the volume of its open pores. Bulk density was calculated from bulk specific gravity.

After the bulk-density measurement was determined, each sample was pulverized to pass through a 200-mesh sieve, oven-dried, and tested in accordance with ASTM Procedure D-854 (1980b), "Specific Gravity of Soils," from which grain density was calculated. Grain density refers to the weight of a substance compared with the weight of an equal volume of pure water at 4 °C. Results of laboratory analyses for bulk- and grain-density measurements for UZ #4 and UZ #5 are listed in tables 15 and 16 and are summarized in tables 17 and 18 for UZ #4 and UZ #5, respectively, as these measurements relate to a degree of welding. The bulk- and grain-density profiles of UZ #4 and UZ #5 are shown in figures 7 and 8; the bulk densities increase with increasing welding. The grain densities of UZ #4 and UZ #5 (figs. 7 and 8) appear to be relatively constant with depth.

Bulk-density measurements were not made for drive core from alluvial-colluvial material in UZ #4. According to Hammermeister and others (1985), bulk-density values would be skewed due to compaction or expansion of the unconsolidated material during coring.

Table 15.--*Bulk- and grain-density measurements of rotary-core samples from test hole UE-25 UZ #4*

[Analyses by Holmes & Narver Materials Testing Laboratory, Inc., Mercury, Nev.]

Depth interval of sample (meters)	Density (grams per cubic centimeter)	
	Bulk	Grain
14.48-14.57	2.21	2.51
14.84-14.94	2.19	2.50
17.62-17.68	2.07	2.51
20.42-20.51	2.07	2.46
23.04-23.13	1.41	2.59
23.77-23.84	1.49	2.49
25.30-25.39	1.09	2.61
26.03-26.12	1.22	2.57
30.63-30.69	1.26	2.37
32.00-32.06	0.97	2.57
[1]32.58-32.67	1.23	2.44
34.38-34.44	1.23	2.38
34.84-34.90	1.28	2.36
36.33-36.39	1.34	2.39
37.12-37.19	1.42	2.43
37.67-37.76	1.47	2.40
38.37-38.50	1.49	2.41
38.86-38.95	1.52	2.41
39.96-40.02	1.54	2.39
41.65-41.71	1.54	2.38
42.31-42.37	1.50	2.38
[1]43.25-43.31	1.42	2.35
43.69-43.75	1.40	2.36
44.58-44.65	1.34	2.39
45.57-45.63	1.31	2.37
46.33-46.39	1.30	2.34
47.55-47.64	1.47	2.34
48.19-48.28	1.44	2.33
49.83-49.93	1.49	2.39
50.72-50.90	1.11	2.41
52.67-52.73	1.03	2.38
52.94-53.00	1.22	2.43
54.50-54.56	1.12	2.39
55.99-56.08	1.01	2.49
58.23-58.29	1.14	2.37
59.31-59.38	1.11	2.36

Table 15.--*Bulk- and grain-density measurements of rotary-core samples from test hole UE-25 UZ #4*--Continued

Depth interval of sample (meters)	Density (grams per cubic centimeter)	
	Bulk	Grain
60.69-60.75	1.16	2.38
61.26-61.33	1.16	2.39
61.75-61.87	1.07	2.38
64.19-64.22	1.08	2.38
65.78-65.83	1.14	2.39
66.51-66.60	1.20	2.30
68.67-68.73	1.27	2.38
69.43-69.49	1.21	2.35
70.13-70.23	1.29	2.43
[1]70.98-71.05	1.36	2.41
71.26-71.37	1.35	2.42
72.18-72.24	1.36	2.41
72.80-72.88	1.37	2.38
73.61-73.65	1.36	2.42
73.94-74.01	1.33	2.44
76.03-76.08	1.28	2.43
76.95-77.01	1.20	2.41
77.82-77.88	1.17	2.42
78.59-78.65	1.09	2.41
79.17-79.22	1.14	2.43
80.13-80.22	1.10	2.39
80.80-80.86	1.06	2.43
81.65-81.71	1.14	2.40
82.14-82.20	1.07	2.41
84.41-84.49	1.22	2.42
85.19-85.27	1.10	2.39
86.20-86.26	1.16	2.41
106.19-106.25	2.39	2.53
106.51-106.60	2.41	2.54
107.35-107.45	2.39	2.57
107.94-108.01	2.15	2.58
108.01-108.06	2.33	2.55
108.78-108.87	2.29	2.56
109.31-109.39	2.30	2.57
109.97-110.16	2.09	2.57
110.96-111.05	2.13	2.54
111.59-111.69	2.19	2.52

[1]Recovered core interval exceeds drilled interval; discussed in the rotary core section of "Sample Collection and Handling."

Table 16.--*Bulk- and grain-density measurements of rotary-core samples from test hole UE-25 UZ #5*

[Analyses by Holmes & Narver Materials Testing Laboratory, Inc., Mercury, Nev.]

Depth interval of sample (meters)	Density (grams per cubic centimeter)	
	Bulk	Grain
2.35-2.41	2.19	2.43
5.39-5.49	2.24	2.43
[1]14.26-14.36	2.31	2.48
29.49-29.56	1.38	2.51
30.75-30.80	1.49	2.42
31.55-31.70	1.28	2.45
32.52-32.61	1.35	2.41
34.53-34.63	1.26	2.42
35.45-35.51	1.28	2.38
35.91-35.97	1.29	2.40
38.02-38.13	1.26	2.37
38.63-38.71	1.31	2.36
40.00-40.13	1.37	2.36
40.81-40.95	1.43	2.35
42.31-42.43	1.52	2.36
43.07-43.19	1.53	2.39
43.75-43.83	1.52	2.37
44.53-44.61	1.54	2.39
45.23-45.32	1.51	2.38
46.15-46.24	1.46	2.38
46.91-46.97	1.43	2.37
47.85-48.04	1.37	2.36
48.54-48.69	1.39	2.39
49.21-49.35	1.31	2.38
49.80-49.94	1.31	2.38
50.41-50.49	1.35	2.35
[2]50.49-50.67	1.48	2.38
50.75-50.83	1.36	2.38
53.52-53.61	1.34	2.37
53.98-54.10	1.48	2.42
54.86-54.99	1.53	2.41
55.78-55.87	1.16	2.44
56.39-56.48	0.95	2.37
57.55-57.64	1.05	2.42
58.52-58.60	1.15	2.39

Table 16.--*Bulk- and grain-density measurements of rotary-core samples from test hole UE-25 UZ #5*--Continued

Depth interval of sample (meters)	Density (grams per cubic centimeter)	
	Bulk	Grain
59.82-59.92	1.02	2.38
60.41-60.53	1.10	2.35
61.14-61.26	1.14	2.36
62.18-62.27	0.99	2.34
62.58-62.67	1.03	2.36
64.95-65.04	1.15	2.37
65.73-65.84	1.15	2.37
66.68-66.77	1.09	2.39
67.51-67.62	1.06	2.38
68.14-68.24	1.15	2.36
68.85-68.95	1.13	2.40
69.77-69.86	1.18	2.40
70.55-70.64	1.24	2.41
71.38-71.45	1.19	2.41
71.95-72.05	1.27	2.41
72.65-72.74	1.29	2.39
73.52-73.61	1.25	2.37
74.19-74.28	1.30	2.36
74.83-74.95	1.36	2.42
75.64-75.77	1.40	2.43
76.64-76.73	1.37	2.41
77.65-77.72	1.37	2.40
78.06-78.12	1.26	2.41
79.10-79.19	1.25	2.62
79.61-79.74	1.23	2.43
80.33-80.45	1.21	2.40
80.94-81.05	1.12	2.45
81.75-81.87	1.09	2.40
[1]82.81-82.96	1.14	2.44
83.33-83.50	1.20	2.42
84.00-84.12	1.04	2.37
84.90-85.01	1.09	2.37
85.66-85.77	1.05	2.39
86.33-86.56	1.11	2.38
[1]87.45-87.53	1.15	2.40
88.09-88.18	1.09	2.41
88.45-88.61	1.07	2.40
88.75-88.84	1.13	2.41
89.55-89.66	1.12	2.44
[1]90.48-90.58	1.14	2.36

Table 16.--*Bulk- and grain-density measurements of rotary-core samples from test hole UE-25 UZ #5*--Continued

Depth interval of sample (meters)	Density (grams per cubic centimeter)	
	Bulk	Grain
91.71-91.81	1.15	2.39
92.69-92.80	1.16	2.42
93.30-93.39	1.14	2.36
93.57-93.63	1.12	2.42
94.00-94.11	1.17	2.46
94.76-94.88	1.19	2.32
95.61-95.67	1.33	2.32
96.01-96.15	1.74	2.32
96.71-96.77	1.29	2.37
97.78-97.84	1.24	2.48
[1]98.11-98.16	1.26	2.38
98.62-98.72	1.28	2.46
99.55-99.67	1.11	2.45
100.08-100.17	1.12	2.45
101.42-101.50	1.36	2.40
102.57-102.72	1.27	2.46
103.25-103.36	1.32	2.38
104.15-104.24	1.39	2.40
104.66-104.75	1.36	2.41
104.75-104.83	1.25	2.39
105.53-105.64	1.42	2.34
105.64-105.72	1.36	2.30
106.34-106.48	1.36	2.32
[1]107.24-107.35	1.58	2.21
107.62-107.70	1.61	2.24
107.89-107.95	2.28	2.41
107.95-108.07	2.30	2.34
108.87-109.00	2.33	2.46
109.55-109.67	2.39	2.54
109.73-109.82	2.47	2.45

[1]Recovered core interval exceeds drilled interval; discussed in the rotary core section of "Sample Collection and Handling."

[2]Contact between Yucca Mountain Member and an unnamed bedded tuff of the Paintbrush Tuff.

Table 17.--*Summary of bulk- and grain-density measurements of core for test hole UE-25 UZ #4 as related to degree of welding*[1]

[All values in grams per gram; --, no data]

Degree of welding	Bulk density		Grain density	
	Range of values	Average	Range of values	Average
Densely welded	2.14 to 2.41	2.32	2.50 to 2.58	2.55
Moderately welded	2.07 to 2.19	2.11	2.46 to 2.57	2.52
Nonwelded and bedded tuffs	0.97 to 1.54	1.26	2.30 to 2.61	2.41
Moderately to highly indurated	--	--	--	--

[1]Data from samples which overlapped geologic units are not included in these ranges and averages.

Table 18.--*Summary of bulk- and grain-density measurements of core for test hole UE-25 UZ #5 as related to degree of welding*[1]

[All values in grams per gram; --, no data]

Degree of welding	Bulk density		Grain density	
	Range of values	Average	Range of values	Average
Densely welded	2.19 to 2.47	2.32	2.34 to 2.48	2.45
Moderately welded	--	--	--	--
Nonwelded and bedded tuffs	0.95 to 1.74	1.25	2.32 to 2.62	2.40
Moderately to highly indurated	1.36 to 1.61	1.47	2.21 to 2.34	2.28

[1]Data from samples which overlapped geologic units are not included in these ranges and averages.

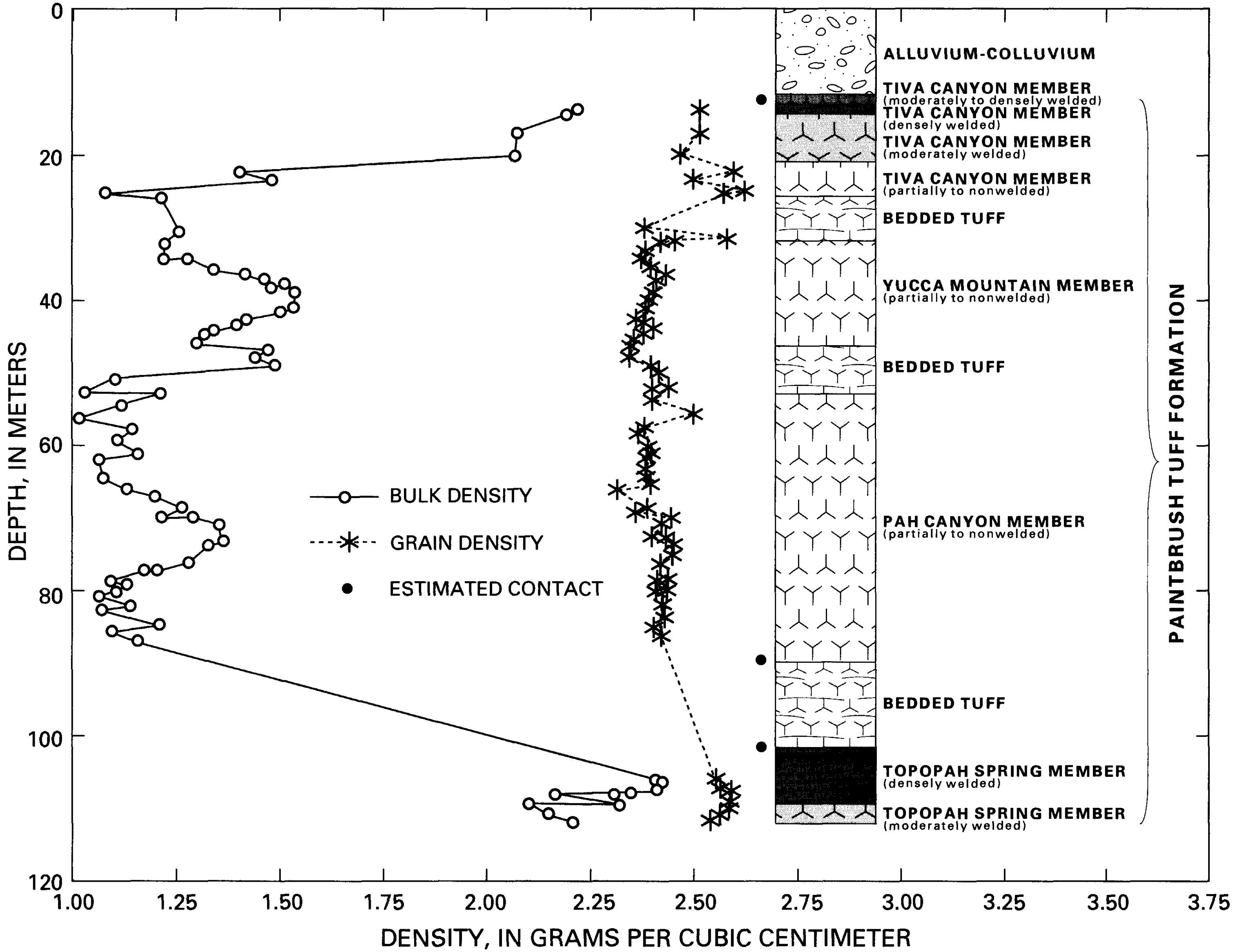

Figure 7.--Bulk- and grain-density measurements of core from test hole UE-25 UZ #4.

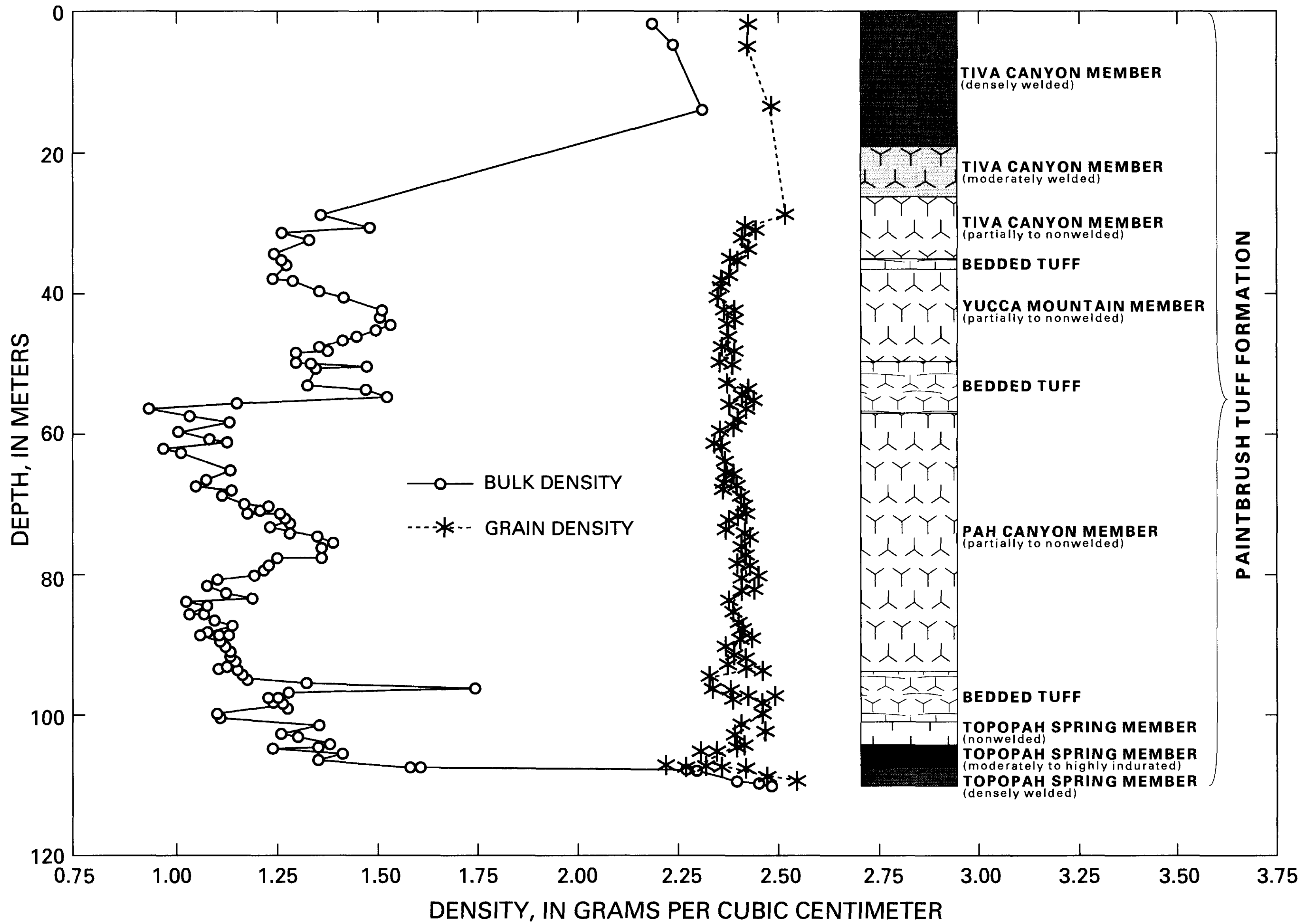

Figure 8.--Bulk- and grain-density measurements of core from test hole UE-25 UZ #5.

Tritium Analyses

Drive-core samples from UZ #4 were analyzed for tritium. Errors are equivalent to one standard deviation. The activity of tritium in pCi/L (picocuries per liter) can be obtained by multiplying the nonrounded tritium units by 3.22 (Thatcher and others, 1977, p. 77). The tritium data from UZ #4 alluvial-colluvial material is listed in table 19 and illustrated in figure 9.

The tritium concentration in samples can be used to distinguish between water that entered a ground-water system before and after the initial tests of thermonuclear devices in the atmosphere in 1952. According to Freeze and Cherry (1979, p. 136), water having less than 5-10 tritium units must have entered the ground-water system prior to 1953. Samples from UZ #4 had tritium concentrations less than 10 units from 5.49 to 11.89 m below land surface. Samples from 0.91 to 4.88 m had concentrations greater than 10 tritium units (table 19).

Table 19.--*Tritium concentrations in alluvial-colluvial material from test hole UE-25 UZ #4*

[Analyses by U.S. Geological Survey Tritium Laboratory, Reston, Va.]

Depth interval (meters)	Tritium (concentration units)
0.91-1.07	19.1 ± 0.8
1.52-1.68	17.9 ± 0.7
2.13-2.29	17.8 ± 0.7
2.44-2.59	21.3 ± 0.9
3.20-3.58	21.6 ± 0.8
4.27-4.88	21.9 ± 0.8
5.49-5.79	8.3 ± 0.5
6.10-6.71	4.6 ± 0.5
8.53-8.99	2.4 ± 0.7
9.75-10.36	1.7 ± 0.4
10.97-11.13	2.7 ± 0.5
11.58-11.89	1.5 ± 0.5

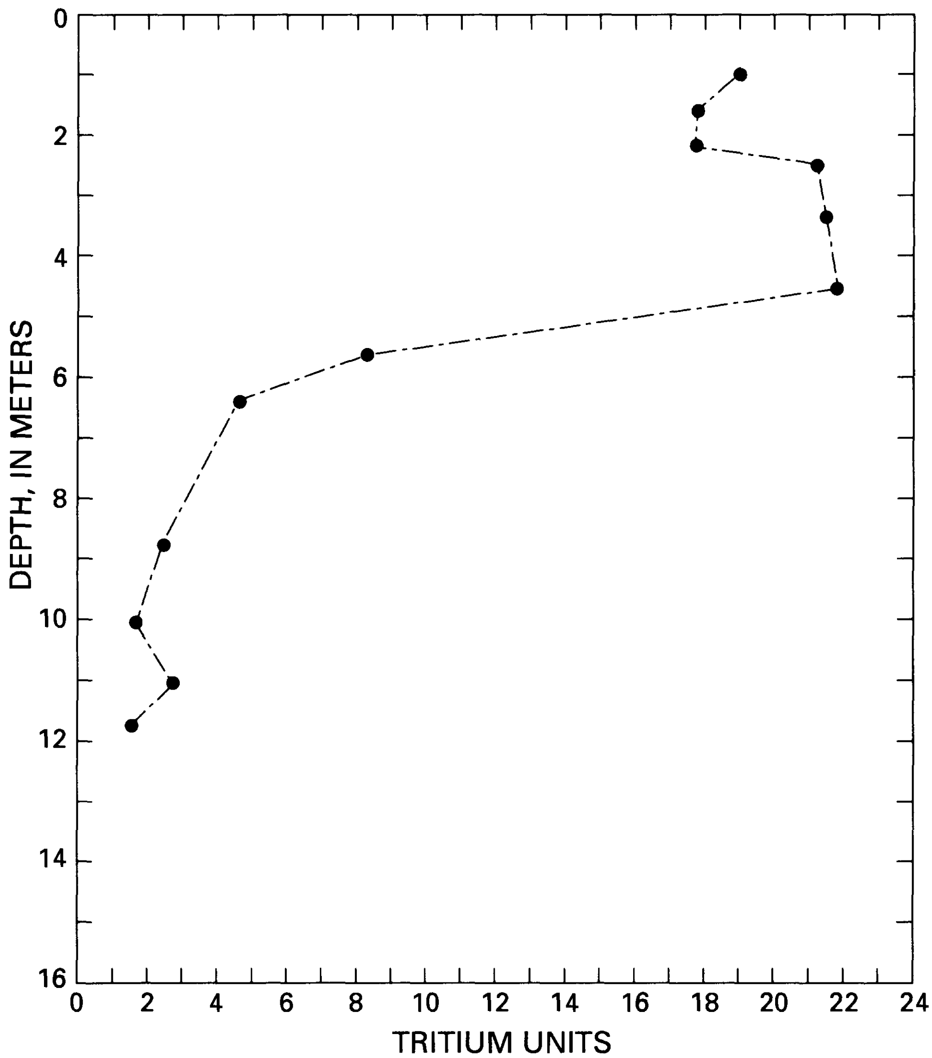

Figure 9.--Variation of tritium with depth in alluvial-colluvial material from test hole UE-25 UZ #4.

SUMMARY

Test hole UZ #4 is located in the middle of an alluvial-colluvial filled channel (Pagany Wash) approximately 38 m north of test hole UZ #5, which is located directly on bedrock on the margin of the same channel. The density, water content, and water potential of the samples collected from UZ #4 and UZ #5 are related to the degree of welding of the rock units from which the samples were obtained. Water content, and water potential decrease with increasing welding, whereas density increases with the degree of welding. The average water contents of nearly all tuffaceous units in UZ #4 are higher than corresponding units in UZ #5. No trends in the water potentials of samples are noticeable between test holes. Tritium concentrations were above background levels (5-10 units) to a maximum depth of approximately 5 m in UZ #4.

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