Scientific Notebook 769E

Unconfined Compression Experiments

Borehole 14
Samples ID # 01026868, 01026869, 01026870, 01026871, and 01026872

Ahmed Elgamal and Jonathan Deck

January 31, 2006

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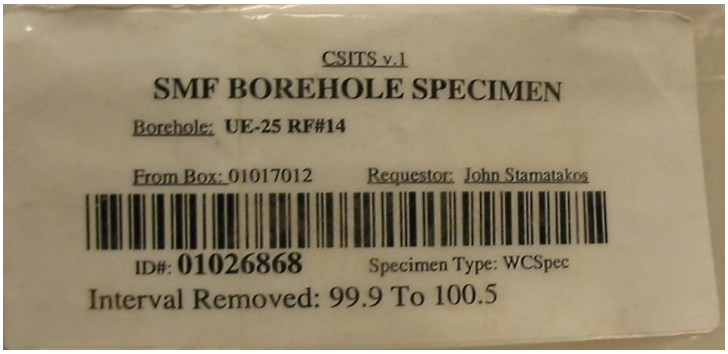
Opening and Inspection of Specimens: Today the five soil/rock specimens were opened and inspected. Observations are recorded below.

Specimen # 1:
Label: CSITS v.1
Borehole: UE-25 RF # 14
From Box: 01017012 Requestor: John Stamatakos
ID#: 01026868 Specimen Type: WCSpec
Interval Removed: 99.9 to 100.5 (depth in feet)
Observations: Sample is mostly loose soil and dust, largest pieces are approximately ¾" square. Solid pieces are whitish with some small aggregate, and are easily broken down into powder. The loose portion of the sample is a fine grayish brown soil. Approximate soil sample size is 3" diameter cylinder by 8" long. Soil sample cannot be tested.
Figure 1: Sample 1

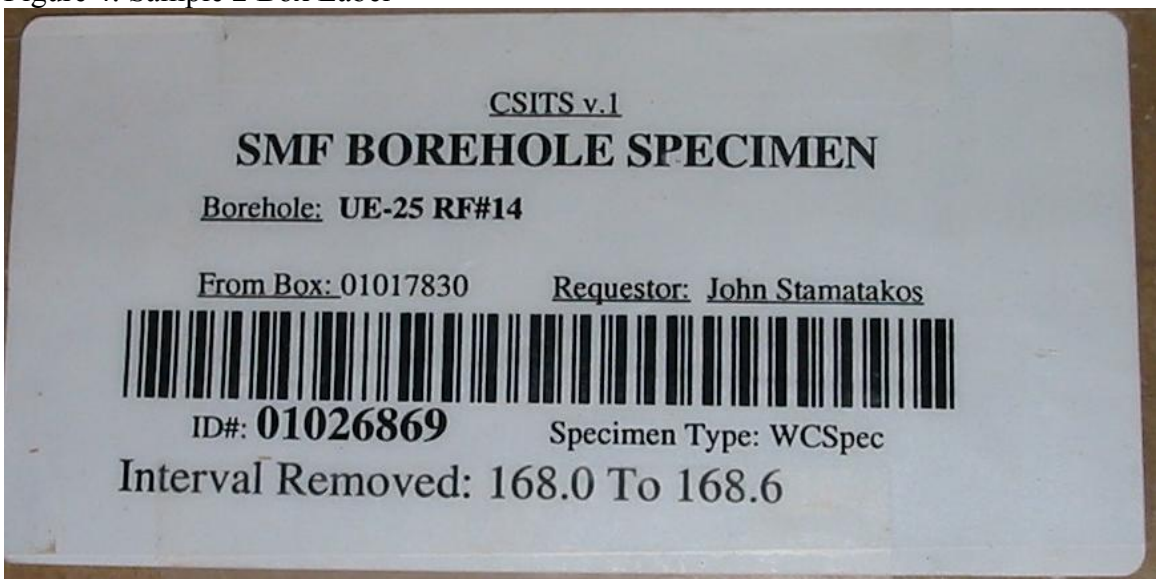
Figure 2: Sample 1 Box Label



Specimen # 2:
Label: CSITS v.1
Borehole: UE-25 RF # 14
From Box: 01017830 Requestor: John Stamatakos
ID#: 01026869 Specimen Type: WCSpec
Interval Removed: 168.0 to 168.6 (depth in feet)
Observations: Sample is mostly solid with some small (1/2" diameter by 1/8" deep) divots and chips missing. The specimen is white to off-white in color and is mostly composed of a fine cementitious material. Aggregate of varying size up to approximately ¼" in diameter and of varying color is present. The specimen has many small voids and is a noticeably porous material. The sample is rock-like and denser than previous sample. Approximate sample dimensions are 2 3/8" in diameter by 7 3/8" long. This sample will be testable.

Figure 3: Sample 2

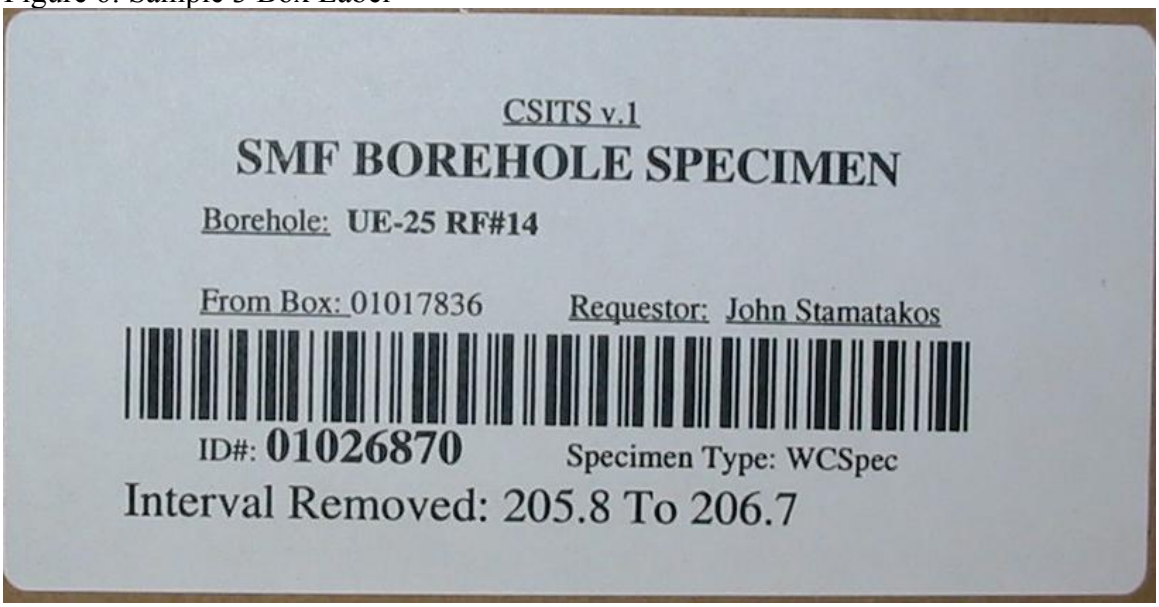
Figure 4: Sample 2 Box Label



Specimen # 3:
Label: CSITS v.1
Borehole: UE-25 RF # 14
From Box: 01017836 Requestor: John Stamatakos
ID#: 01026870 Specimen Type: WCSpec
Interval Removed: 205.8 to 206.7 (depth in feet)
Observations: Specimen is broken into 3 main pieces, the largest of which is 6 1/2" and contains 3" of undamaged sample. The sample is a reddish rock like material with some fine grain aggregate. This is the densest sample of the five. Cracks in the sample appear to have occurred along "veins" of a whitish material. The entire specimen is 2 3/8" in diameter and 12 ½" long. The specimen may be testable, but may not be long enough to produce an accurate failure plane.

Figure 5: Sample 3

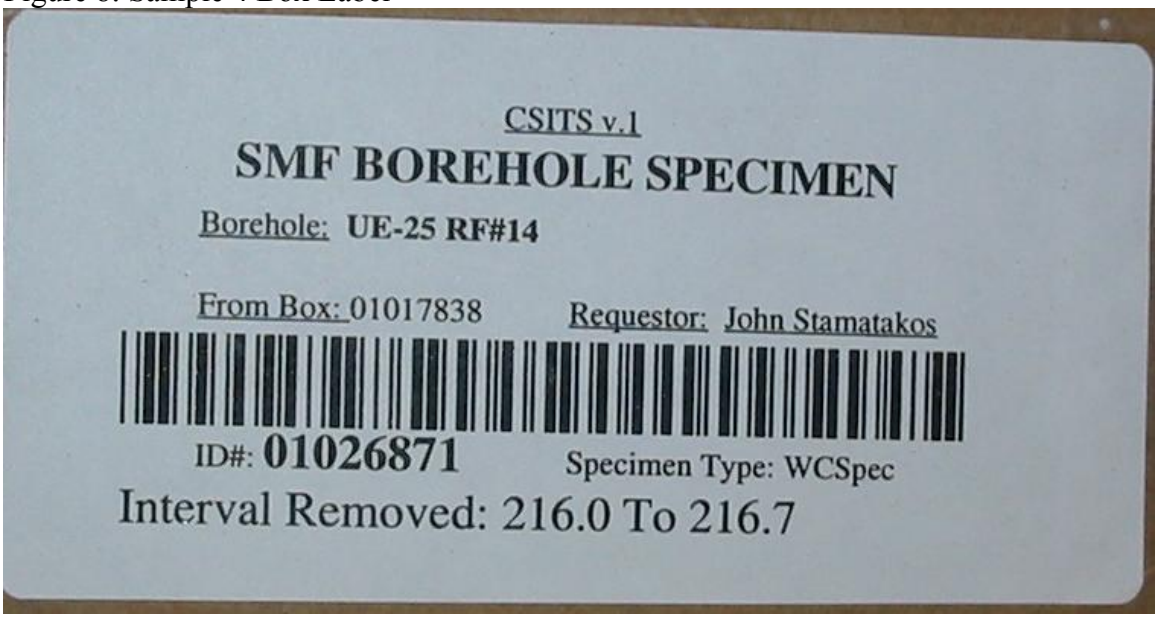
Figure 6: Sample 3 Box Label



Specimen # 4:
Label: CSITS v.1
Borehole: UE-25 RF # 14
From Box: 01017838 Requestor: John Stamatakos
ID#: 01026871 Specimen Type: WCSpec
Interval Removed: 216.0 to 216.7 (depth in feet)
Observations: Sample is composed of a red cementitious material that is chalk-like. The specimen is softer than the others and somewhat porous. The specimen is cracked, but about 5 ¼" of the cylinder remains intact. This material is very brittle and may crack or crumble when the cracked portion is cut off. The entire specimen is 2 3/8" in diameter and 8 ¼" long. The specimen may be testable, but should not develop a very high failure load.

Figure 7: Sample 4

Figure 8: Sample 4 Box Label



Specimen # 5:
Label: CSITS v.1
Borehole: UE-25 RF # 14
From Box: 01017841 Requestor: John Stamatakos
ID#: 01026872 Specimen Type: WCSpec
Interval Removed: 240.3 to 241.0 (depth in feet)
Observations: Sample is grayish rock-like material, less dense than sample 3. The sample is semi-porous with some small aggregate. The entire sample is intact, measuring 2 3/8" in diameter by 8 3/8" long. This specimen will be testable.

Figure 9: Sample 5

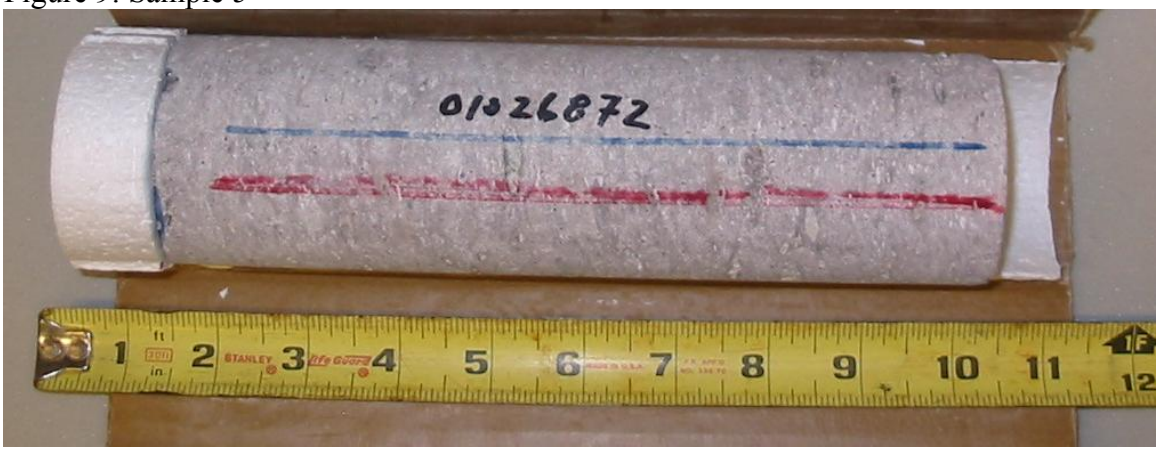
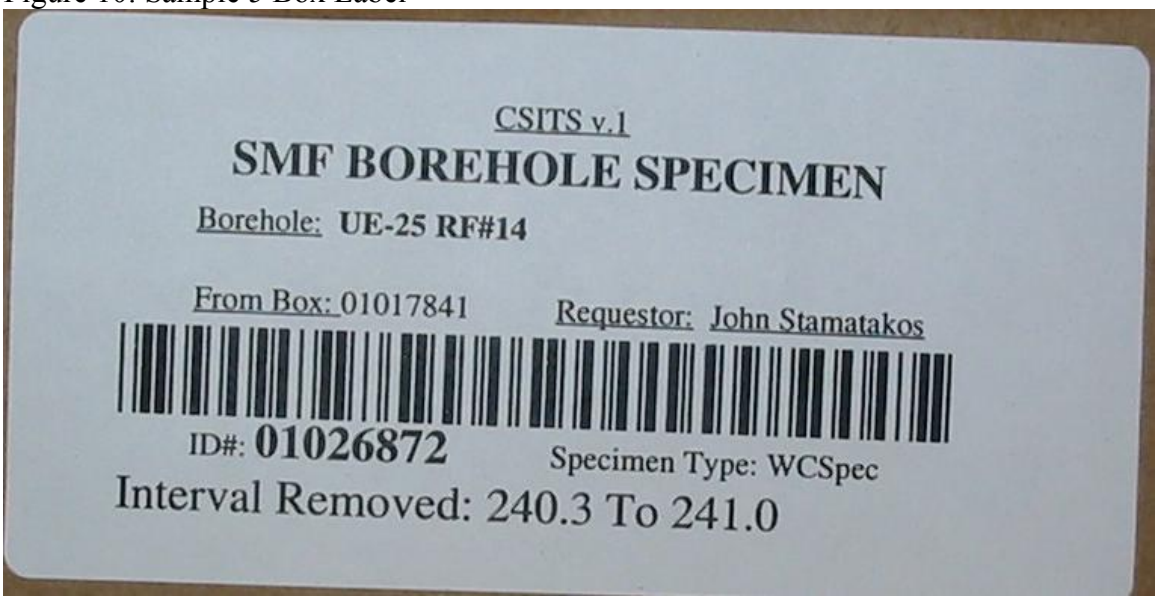


Figure 10: Sample 5 Box Label



Preparations for Testing

Cutting of Specimens

Specimen # 3, ID # 01026870 arrived in a number of pieces and needed to be trimmed in order to be testable. In compression testing of concrete cylinders, a typical minimum aspect ratio is 2:1, height to diameter. The largest undamaged portion of this cylinder was 2 7/8". The cylinder diameter was 2.387". In our opinion, this did not give a satisfactory aspect ratio to provide accurate results. It was determined that though the portion beyond 2 7/8" was damaged, the reduction in cross sectional area was minor until approximately 4". This would provide an aspect ratio of 1.68 which would provide more accurate results, even if not at the desired minimum ratio of 2:1. This was the most rock-like of all the specimens so it was determined that a special blade or saw would be necessary to cut it. Since it was not a cementitious material that might be degraded by contact with water, it was determined that a tile saw or other such wet cutting saw would provide the cleanest and most accurate cut. Unfortunately, no such saw was readily available for use. It was determined that a masonry blade for a cutoff saw would be able to cut the specimen cleanly enough for our purposes, even though not as well as a wet-cut saw. The saw used was a Makita 355 mm Portable Cutoff Saw (fig. 1) and the blade was a Flexovit 14" Heavy Duty Concrete/Masonry Blade (fig. 2).

Figure 1: Cutoff Saw

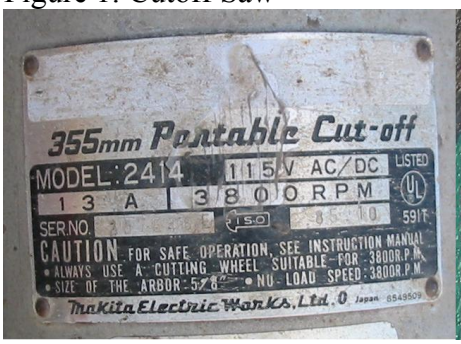
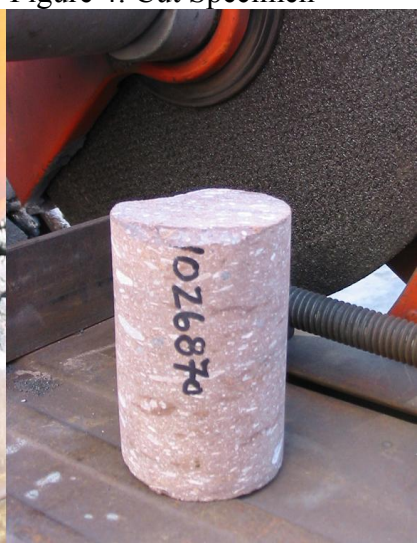


Figure 2: Saw Blade

Figure 3: Specimen being cut

Figure 4: Cut Specimen

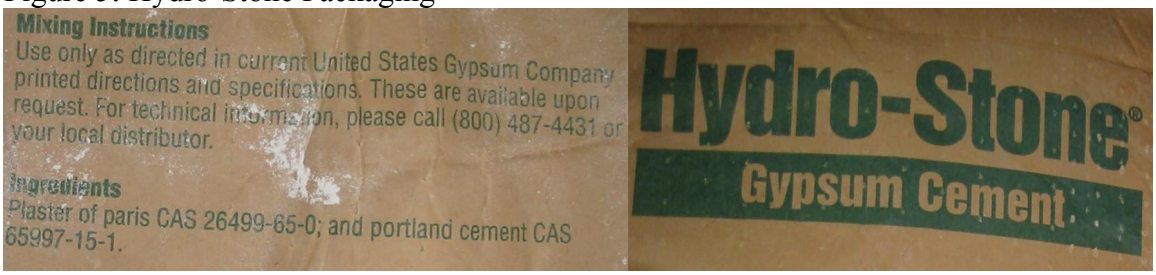


In Fig. 4, a small chip can be seen on the top of the specimen, which is common when cutting brittle materials, and will not be a problem when testing specimens.

Capping of Specimens:

Before testing a specimen, its end faces must be completely flat and parallel to prevent stress concentrations or other modes of failure. It is difficult to attain a perfectly flat surface or two completely parallel surfaces by means of cutting. The adopted technique for leveling specimens is capping them with Hydro-Stone. Hydro-Stone is gypsum cement made up of Plaster of Paris and Portland cement (fig. 5). This material has a strength of approximately 10 ksi if properly mixed, and will be sufficient for testing materials of similar or lesser strength.

Figure 5: Hydro-Stone Packaging



The Hydro-Stone is mixed to a very thick, putty like consistency (fig. 6) and then placed into 1" long sections of PVC pipe of slightly larger diameter than the specimens (3" pipe was used since specimens were roughly 2 3/8" in diameter). The PVC sections are filled with enough Hydro-Stone to have a ¼" layer beneath the specimen with some excess. These PVC sections are placed on a known flat surface that has been leveled in advance, in this case, a piece of thick glass (fig. 7).

Figure 6: Hydro-Stone consistency

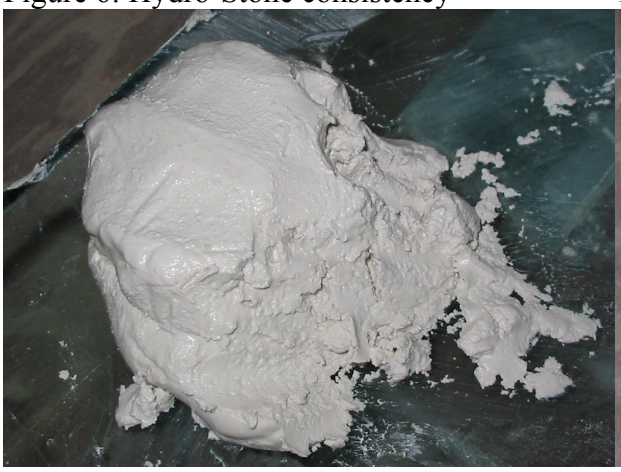


Figure 7: PVC and Glass Surface

Once the PVC sections have been filled with Hydro-Stone putty and placed on the level surface, the specimens may be placed inside of them. When the specimen is placed into the Hydro-Stone, it is important to maintain approximately a ¼" thick layer of Hydro-Stone beneath the specimen and allow for the Hydro-Stone to mold around the top of the specimen such that it encompasses approximately the top ¼" of the specimen. When the specimen is at proper location in the Hydro-Stone, a small level is used to ensure that the specimen is perfectly vertical (fig. 8). If the Hydro-Stone is not a thick enough

consistency, it will not maintain its position, and should be recast or constantly checked to ensure that it is level.

Figure 8: Specimens being leveled

Once the specimens have been leveled and the Hydro-Stone is thick enough to hold the specimens in place, they may be left to set completely for 30-40 minutes. After the Hydro-Stone has set completely, the PVC pipe pieces may be removed (a cut in the pipe section made beforehand makes this easier). Now the specimens have one completely flat surface which is perpendicular to their length (fig. 9). The specimens are now flipped over and the process is repeated. This time, in addition to the regular level, a circular level is used to ensure that the two surfaces being created at either end of the specimen are parallel. (figs. 10, 11)

Figure 9: One flat surface

Figure 10: 2 levels

Figure 11: Round level

The finished specimens have two level, flat surfaces which are parallel to each other (fig. 12)

Figure 12: Leveled Specimens

This technique of placing Hydro-Stone caps worked well in this situation because the materials were not weak or susceptible to water. Generally, the Hydro-Stone uses all water that it is mixed with. However, it is possible, though not likely, that a weak or cementitious material could deteriorate when it comes into contact with water or the Hydro-Stone putty. In the case that this type of material was being tested, it is possible another form of specimen leveling would have to be used. If the material is questionable, it is suggested that a small portion of the material be tested by contacting it with small amounts of Hydro-Stone or water and seeing if it is affected.

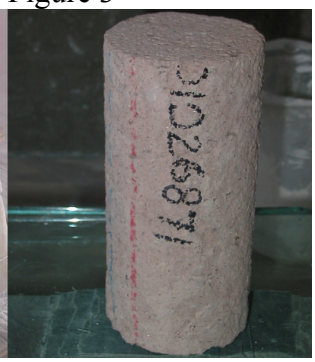
Cutting and Capping of Specimen # 01026871

Specimen 4, ID # 01026871 arrived in a few pieces and needed to be trimmed in order to be testable. The original damaged specimen was approximately 8.25 inches long and is shown in figure 1. In order to trim the specimen, the Makita 355 mm Portable Cutoff Saw and Flexovit 14" Heavy Duty Concrete/Masonry Blade used in the cutting of specimen # 01026870 were put to use again. The specimen is shown being cut in figure 2. The final specimen had a length of 4.975 inches, which is in excess of the 2:1 minimum aspect ratio and is shown in figure 3.

Figure 1

Figure 2

Figure 3



After the specimen was cut, it was capped with hydrostone following the same process previously used. The specimen is shown being capped and leveled in figure 4 below. The final capped specimen is shown in figure 5 prior to testing.

Figure 4

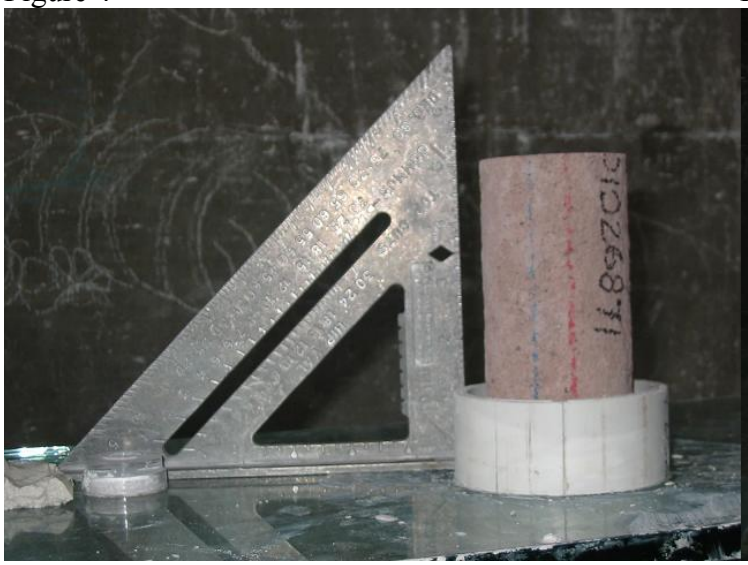
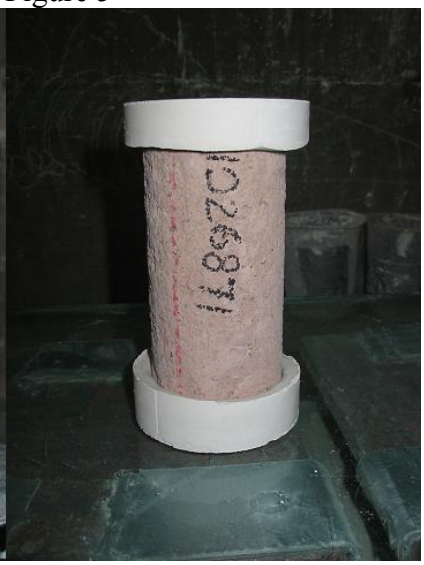


Figure 5



Testing of Specimens

The specimens were tested with the use of a MTS 810 Material Testing System (http://www.mts.com/menusystem.asp?DataSource=0&NodeID=1011) with 110 kip capacity and MTS 647 Hydraulic Wedge Grips (figure 1.) This machine has the capability to do tension and compression tests. Since this machine is usually used for tensile tests, it comes equipped with a number of different wedge grips, but no compression testing platforms. In order to create level surfaces to allow for compression testing, two aluminum plates were used. The 3" by ¾" aluminum plates were connected to plumb bolts which could be held by the wedge grips (figure 2.)

Figure 1: MTS 810

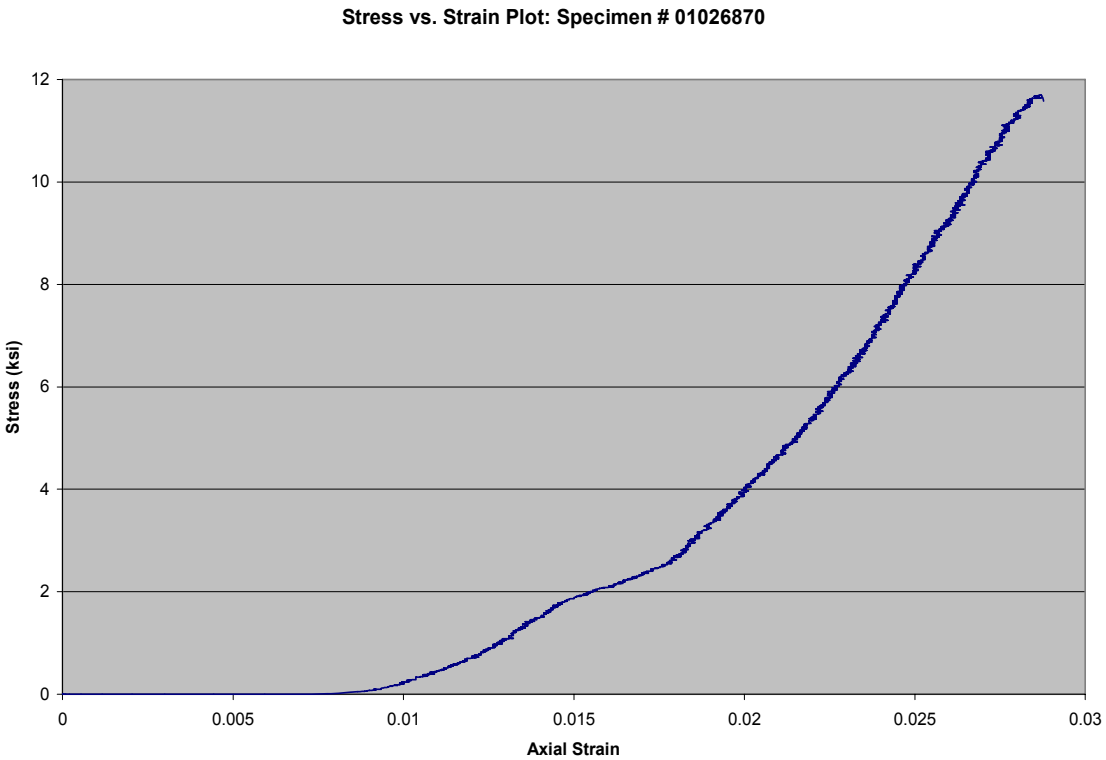
Figure 2: Wedge Grips and Aluminum Plate

The first specimen tested was Specimen # 01026870. Load was applied at a rate of 2.5 kips per minute with readings taken at a frequency of 2 Hz. The specimen is shown on the loading apparatus before and after testing (figures 3 and 4.) Since such a high load was achieved, the specimen exploded at failure and pieces had to be collected and placed on testing machine for the after testing picture. Due to its high strength, a shield was placed in front of the specimen during testing to contain any blast upon failure. As can be seen in figure 4, failure planes were very steep. The peak load achieved was 52.21 kips resulting in a stress of 11.69 ksi on the specimen. This axial stress translates to a shear strength of 5.845 ksi using the assumptions of the uni-axial compression test. This high load may have been affected by the aspect ratio of the specimen. The final aspect ratio of this specimen was 1.65, with a height of 3 15/16" and diameter of 2.387". A stress vs. strain plot for this specimen is shown in figure 5.

Figure 3: Before testing

Figure 4: After testing

Figure 5:

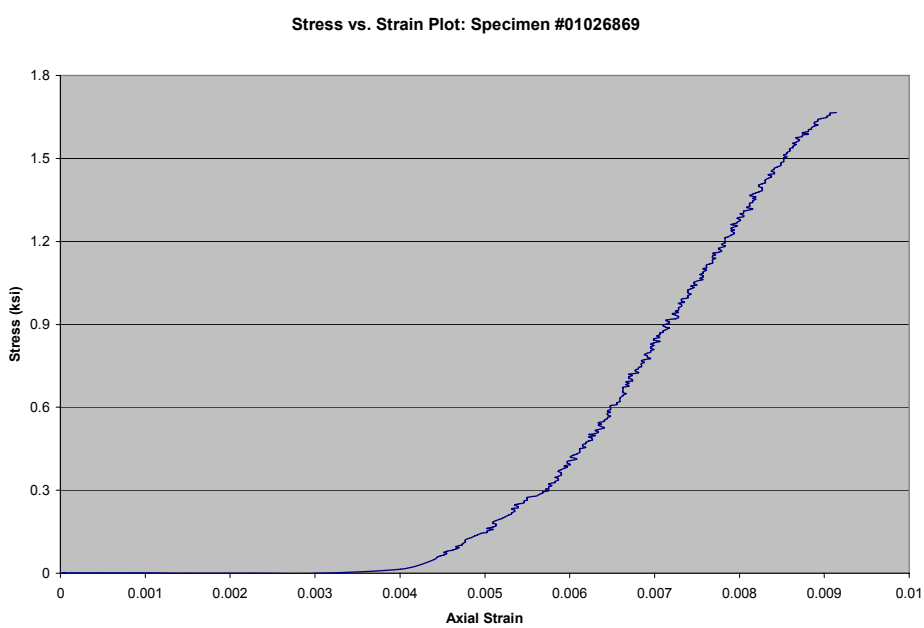


The second specimen tested was Specimen # 01026869. The same loading rate of 2.5 kips per minute was used. The peak load achieved was 7.319 kips resulting in an axial stress on the specimen of 1.67 ksi which translates to a shear strength of 0.833 ksi. Once again, the failure planes were very steep. In this test, since not nearly as high of a load was achieved, the specimen did not explode, but rather crumbled when it failed. The specimen is shown before and after testing in figures 6 and 7. The stress vs. strain behavior of this specimen is shown in figure 8.

Figure 6: Before testing

Figure 7: After testing

Figure 8:

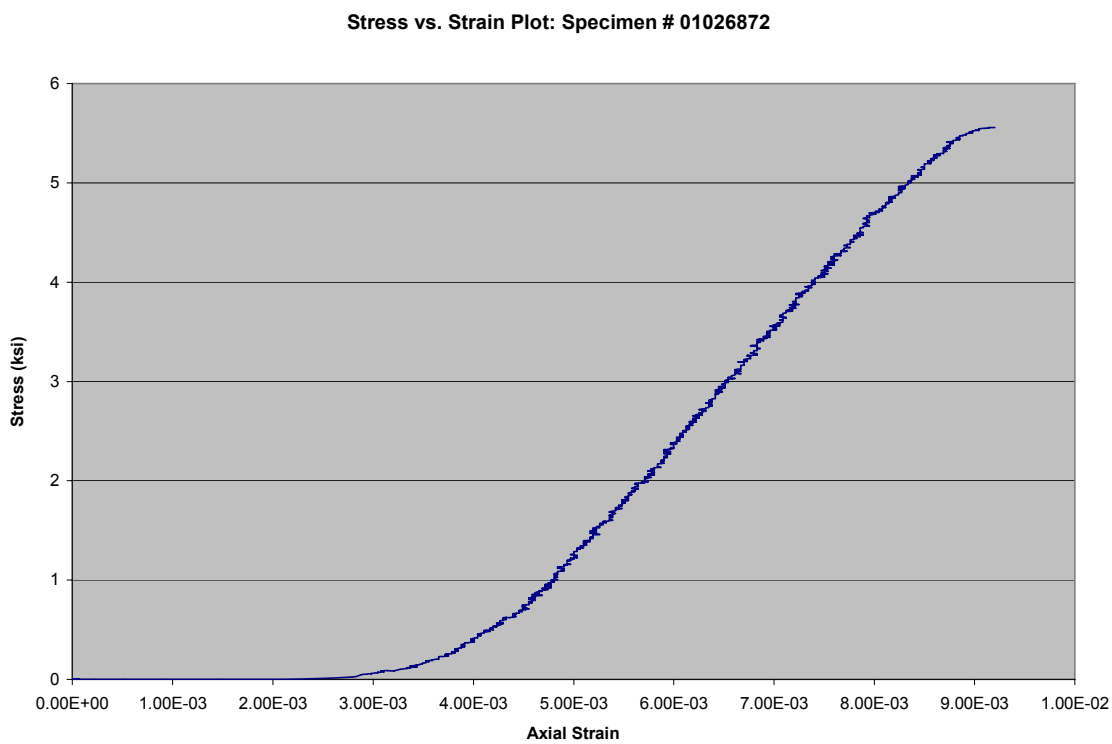


The final specimen tested was specimen # 01026872. The same loading rate of 2.5 kips per minute was used. The peak load achieved was 24.93 kips resulting in an axial stress on the specimen of 5.56 ksi which translates to a shear strength of 2.778 ksi. The main failure plane was nearly vertical. Since this material was of higher strength than specimen # 01026869, the failure was more brittle, though it did not explode as much as specimen # 01026870. The specimen is shown before and after testing in figures 9 and 10. The stress vs. strain behavior of this sample is shown in figure 11.

Figure 9: Before testing

Figure 10: After testing

Figure 11:



Testing of Specimen # 01026871

Specimen 4, ID # 01026871 was the final specimen to be tested. This specimen was not tested initially because it was very brittle and difficult to cut. Also, it was a very chalklike material and not expected to sustain very large loads. After testing the other three specimens, it was decided that an attempt should be made to test this final specimen before proceeding with computer analysis of the Yucca Mountain Site. The specimen was cut very slowly in order to prevent it from breaking again and then successfully capped with hydrostone.

The specimen was tested with the same MTS 810 Material Testing System with 110 kip capacity and MTS 647 Hydraulic Wedge Grips as used for the previous specimens. Load was applied at the same rate of 2.5 kips per minute with readings taken at a frequency of 2 Hz. The specimen is shown on the loading apparatus before and after testing (figures 1 and 2.) Since this specimen was very weak, it was crushed very quickly after failure. The center of the specimen smashed while outer portions broke off outwards. The pieces the split off the outside of the specimen during testing are shown in figure 3.

Figure 1: Before Testing

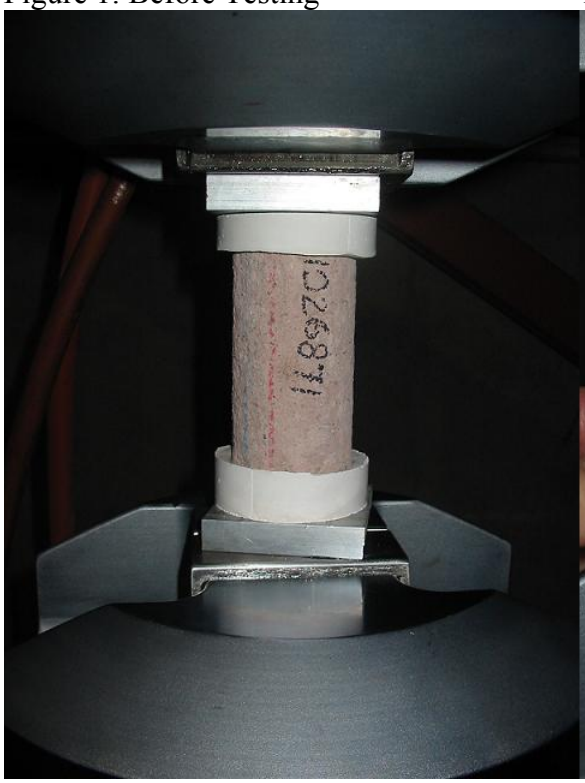
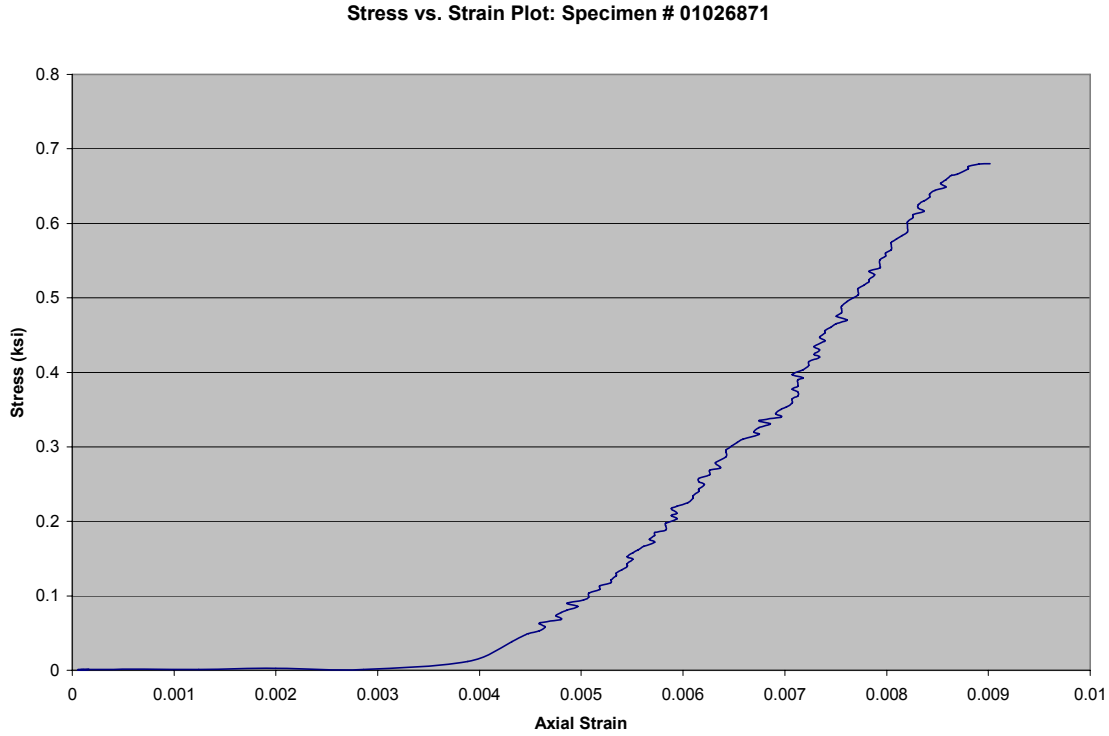


Figure 2: After Testing

Figure 3: Pieces Collected After Testing

The peak load achieved was 3.01 kips resulting in an axial stress on the specimen of 0.680 ksi which translates to a shear strength of 0.340 ksi. The main failure plane was very steep. Since this material was of very weak and quite brittle, it crushed upon failure. The stress strain plot for the unconfined compression test is shown in figure 4 below.

Figure 4:



Density Measurements of Specimen # 01026870

In order to use the Cyclic1D program, the approximate density of the soil in each layer must be known. Of the four specimens tested for shear strength with the unconfined compression test, specimen # 01026870 had the highest density and least voids by inspection. To measure the density of this specimen, several pieces from the broken sample were used. Several different trials were done such that the results could be checked for consistency.

First, each sample being tested was weighed using a Sartorius 2200.00 gram scale. The accuracy of this scale is stated to be +- 0.01 grams. Once the samples were weighed, they were submersed in water to determine their volume. The largest available graduated cylinder was 1,000 milliliters with markings for every 10 ml and accuracy to 5 ml. Since this cylinder had a diameter smaller than that of the sample, only small pieces could be used. In order to measure the volume of each sample, several 100 ml cylinders accurate to 0.5 ml were used. The samples were placed into the 1000 ml cylinder and then water was added from the 100 ml cylinders until the specimen was covered. Water was added until it reached a marked volume in the 1000 ml cylinder. The volume of each sample was determined by subtracting the amount of water added (from the 100 ml cylinders) from the volume read on the 1000 ml cylinder. Figure 1 depicts a sample on the scale and the graduated cylinders used are shown in figure 2. Using these methods, an average density was found to be 2.115 g/cc. The measurements taken are summarized in table 1.

Figure 1

Figure 2

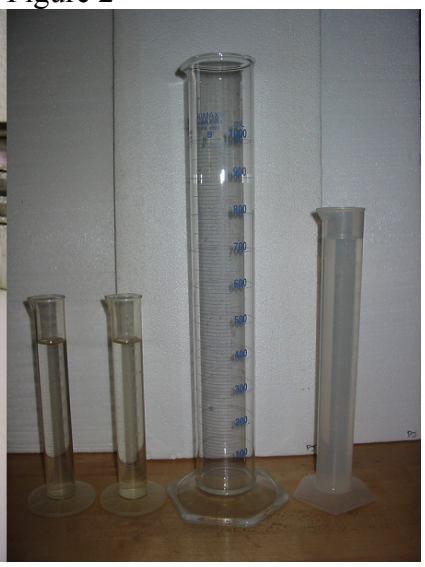


Table 1

Trial #	Mass (g)	Volume Added (ml)	Total Volume (ml)	Sample Volume (ml)	Sample Density (g/cc)
1	133.65	238	300	62	2.156
2	59.34	172.5	200	28.5	2.082
3	88.46	258	300	42	2.106

BSC

SMF Specimen Custody Receipt

QA:QA
CSITS v.1

Requestor:	Ship To:	
John Stamatakos (ID#503) **CNWRA** **Southwest Research Institute** **6220 Colebra Rd** **San Antonio, TX**	**John Stamatakos (ID#503)** ,	Date Received: _____ Shipment ID: 01000777 Shipping Date: 29-jun-2005 SMF Geotechnician [signature] Date 6-28-05

Container ID: 01006526 Specimens in this container: 5

Condition	Specimen ID	Type	Top	Bottom	Parent Borehole:
	01026868	WCSpec	99.9	100.5	UE-25 RF#14
	01026869	WCSpec	168.0	168.6	UE-25 RF#14
	01026870	WCSpec	205.8	206.7	UE-25 RF#14
	01026871	WCSpec	216.0	216.7	UE-25 RF#14
	01026872	WCSpec	240.3	241.0	UE-25 RF#14

Please Sign this form and return to:
Sample Management Facility
Yucca Mountain Site Characterization Project
P.O. Box 617
Mercury, NV 89023-0617

I hereby acknowledge the receipt of the Specimens listed above. I will return this form to the SMF within 10 business days of receipt.

Recipient [signature] Date 7/25/05

were subsequently infilled with detrital volcanic material consisting primarily of clay and fine-grained sediment (see borehole logs in Attachment I for detailed descriptions of fracture fill zones).

Best available copy

Best available copy

DTNS: GS020383114233.001, GS020383114233.003

Note: Borehole RF#13 completed in 1998. All other boreholes completed in 2000. Base photo is YMP Photo #BN8811_50.

Figure 2. Locations of Boreholes and Test Pits Completed in 1998 and 2000 in the WHB Area

Table 3. WHB Area Borehole Locations, Total Depth and Drilling Method

Designation	Northing	Easting	Elevation (ft.)	Total Depth (ft)	Drilling Method
RF#14	N765,309	E571,065	3651.5	550.0	Core
RF#15	N765,774	E570,225	3681.0	330.0	Core
RF#16	N765,056	E570,473	3672.0	452.8	Core
RF#17	N766,076	E571,042	3672.4	667.8	Core
RF#18	N764,522	E570,627	3640.3	493.6	Mud Rotary
RF#19	N765,880	E571,384	3661.8	645.2	Mud Rotary
RF#20	N765,637	E570,797	3671.3	160.0	Mud Rotary
RF#21	N765,899	E570,739	3673.0	192.2	Mud Rotary
RF#22	N766,206	E570,793	3679.2	540.6	Mud Rotary/core
RF#23	N765,311	E570,465	3674.0	159.1	Mud Rotary
RF#24	N766,344	E570,542	3684.5	268.0	Mud Rotary
RF#25	N765,968	E570,626	3676.5	159.0	Mud Rotary
RF#26	N765,248	E570,580	3670.8	264.9	Mud Rotary
RF#28	N765,510	E570,105	3680.6	99.8	Mud Rotary
RF#29	N766,018	E570,836	3672.7	430.0	Mud Rotary

DTN: GS020383114233.003

Note: DTN: GS020383114233.003 has some minor internal inconsistencies, as follows: RF#24: Log page 1 says at the top that total depth is 268.0 feet and at the bottom that total depth is 267.9 feet. RF#26: Log page 1 says at top that total depth is 264.9 feet and at bottom that total depth is 265.0 feet. RF#28: log page 1 says at the top that total depth is 100.0 feet and at the bottom that total depth is 99.8 feet. The values used herein are based on a review of the data.

Sample Custody/Control Log Entry Forms

GEOSCIENCES AND ENGINEERING DIVISION

SAMPLE CUSTODY/CONTROL LOG ENTRY FORM

SAMPLE IDENTIFICATION (Mandatory):

DESCRIPTION OF SAMPLE (Mandatory):

REFERENCE TO DOCUMENTATION OR SCIENTIFIC NOTEBOOK ENTRY:

AMOUNT OF SAMPLE: SIZE:

DATE OF SAMPLE RECEIPT, COLLECTION, OR SYNTHESIS (Mandatory):

PERSON(S) WHO COLLECTED SAMPLE:

DATE OF INITIAL LOG ENTRY (Mandatory): BY(Mandatory):

SAMPLE STORAGE LOCATION (Mandatory) Note: Update location when sample is moved.

COLLECTION SITE (Reference Maps or Field Notes As Required) or SUPPLIER:

OTHER:

FORM TOP-004 (8/2005)

GEOSCIENCES AND ENGINEERING DIVISION

SAMPLE CUSTODY/CONTROL LOG ENTRY FORM

SAMPLE IDENTIFICATION (Mandatory): Rock sample 01026868

DESCRIPTION OF SAMPLE (Mandatory): Sample is from borehole UE-25 RF#14 at a depth range of 99.9 to 100.5 ft and corresponds to the unit Qal. A sample description is provided in the geologic log from BSC, 2002 (refer to Attachment A).

REFERENCE TO DOCUMENTATION OR SCIENTIFIC NOTEBOOK ENTRY: Refer to Scientific Notebook 769E

AMOUNT OF SAMPLE: 1 sample SIZE: ~6" length, ~2.4 " diameter

DATE OF SAMPLE RECEIPT, COLLECTION, OR SYNTHESIS (Mandatory): 6/28/2005

PERSON(S) WHO COLLECTED SAMPLE: Sample was sent to CNWRA by the Sample Management Facility. Refer to the sample custody receipt provided in Attachment B.

DATE OF INITIAL LOG ENTRY (Mandatory):10/03/2005 BY(Mandatory): Sarah Gonzalez

SAMPLE STORAGE LOCATION (Mandatory) Note: Update location when sample is moved. Sample sent to Dr. Ahmed Elgamal at the Department of Structural Engineering, University of California, San Diego

COLLECTION SITE (Reference Maps or Field Notes As Required) or SUPPLIER: The borehole UE-25 RF#14 is located within the Waste Handling Building Site at Yucca Mountain, Nevada. Refer to the map and table provided in Attachments C and D, respectively.

OTHER: References

BSC (Bechtel SAIC Company) 2002. *Geotechnical Data for a Potential Waste Handling Building and for Ground Motion Analyses for the Yucca Mountain Site Characterization Project*. ANL-MGR-GE-000003 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20021004.0078.

GEOSCIENCES AND ENGINEERING DIVISION

SAMPLE CUSTODY/CONTROL LOG ENTRY FORM

SAMPLE IDENTIFICATION (Mandatory): Rock sample 01026869

DESCRIPTION OF SAMPLE (Mandatory): Sample is from borehole UE-25 RF#14 at a depth range of 168.0 to 168.6 ft and corresponds to the unit Tpki. A sample description is provided in the geologic log from BSC, 2002 (refer to Attachment A).

REFERENCE TO DOCUMENTATION OR SCIENTIFIC NOTEBOOK ENTRY: Refer to Scientific Notebook 769E

AMOUNT OF SAMPLE: 1 sample SIZE: ~6" length, ~2.4 " diameter

DATE OF SAMPLE RECEIPT, COLLECTION, OR SYNTHESIS (Mandatory): 6/28/2005

PERSON(S) WHO COLLECTED SAMPLE: Sample was sent to CNWRA by the Sample Management Facility. Refer to the sample custody receipt provided in Attachment B.

DATE OF INITIAL LOG ENTRY (Mandatory):10/03/2005 BY(Mandatory): Sarah Gonzalez

SAMPLE STORAGE LOCATION (Mandatory) Note: Update location when sample is moved. Sample sent to Dr. Ahmed Elgamal at the Department of Structural Engineering, University of California, San Diego

COLLECTION SITE (Reference Maps or Field Notes As Required) or SUPPLIER: The borehole UE-25 RF#14 is located within the Waste Handling Building Site at Yucca Mountain, Nevada. Refer to the map and table provided in Attachments C and D, respectively.

OTHER: References

BSC (Bechtel SAIC Company) 2002. *Geotechnical Data for a Potential Waste Handling Building and for Ground Motion Analyses for the Yucca Mountain Site Characterization Project*. ANL-MGR-GE-000003 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20021004.0078.

GEOSCIENCES AND ENGINEERING DIVISION

SAMPLE CUSTODY/CONTROL LOG ENTRY FORM

SAMPLE IDENTIFICATION (Mandatory): Rock sample 01026870

DESCRIPTION OF SAMPLE (Mandatory): Sample is from borehole UE-25 RF#14 at a depth range of 205.8 to 206.7 ft and corresponds to the unit Tpcrn. A sample description is provided in the geologic log from BSC, 2002 (refer to Attachment A).

REFERENCE TO DOCUMENTATION OR SCIENTIFIC NOTEBOOK ENTRY: Refer to Scientific Notebook 769E

AMOUNT OF SAMPLE: 1 sample SIZE: ~6" length, ~2.4 " diameter

DATE OF SAMPLE RECEIPT, COLLECTION, OR SYNTHESIS (Mandatory): 6/28/2005

PERSON(S) WHO COLLECTED SAMPLE: Sample was sent to CNWRA by the Sample Management Facility. Refer to the sample custody receipt provided in Attachment B.

DATE OF INITIAL LOG ENTRY (Mandatory):10/03/2005 BY(Mandatory): Sarah Gonzalez

SAMPLE STORAGE LOCATION (Mandatory) Note: Update location when sample is moved. Sample sent to Dr. Ahmed Elgamal at the Department of Structural Engineering, University of California, San Diego

COLLECTION SITE (Reference Maps or Field Notes As Required) or SUPPLIER: The borehole UE-25 RF#14 is located within the Waste Handling Building Site at Yucca Mountain, Nevada. Refer to the map and table provided in Attachments C and D, respectively.

OTHER: References

BSC (Bechtel SAIC Company) 2002. *Geotechnical Data for a Potential Waste Handling Building and for Ground Motion Analyses for the Yucca Mountain Site Characterization Project*. ANL-MGR-GE-000003 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20021004.0078.

GEOSCIENCES AND ENGINEERING DIVISION

SAMPLE CUSTODY/CONTROL LOG ENTRY FORM

SAMPLE IDENTIFICATION (Mandatory): Rock sample 01026871

DESCRIPTION OF SAMPLE (Mandatory): Sample is from borehole UE-25 RF#14 at a depth range of 216.0 to 216.7 ft and corresponds to the unit Tpcrn. A sample description is provided in the geologic log from BSC, 2002 (refer to Attachment A).

REFERENCE TO DOCUMENTATION OR SCIENTIFIC NOTEBOOK ENTRY: Refer to Scientific Notebook 769E

AMOUNT OF SAMPLE: 1 sample SIZE: ~6" length, ~2.4 " diameter

DATE OF SAMPLE RECEIPT, COLLECTION, OR SYNTHESIS (Mandatory): 6/28/2005

PERSON(S) WHO COLLECTED SAMPLE: Sample was sent to CNWRA by the Sample Management Facility. Refer to the sample custody receipt provided in Attachment B.

DATE OF INITIAL LOG ENTRY (Mandatory):10/03/2005 BY(Mandatory): Sarah Gonzalez

SAMPLE STORAGE LOCATION (Mandatory) Note: Update location when sample is moved. Sample sent to Dr. Ahmed Elgamal at the Department of Structural Engineering, University of California, San Diego

COLLECTION SITE (Reference Maps or Field Notes As Required) or SUPPLIER: The borehole UE-25 RF#14 is located within the Waste Handling Building Site at Yucca Mountain, Nevada. Refer to the map and table provided in Attachments C and D, respectively.

OTHER: References

BSC (Bechtel SAIC Company) 2002. *Geotechnical Data for a Potential Waste Handling Building and for Ground Motion Analyses for the Yucca Mountain Site Characterization Project*. ANL-MGR-GE-000003 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20021004.0078.

GEOSCIENCES AND ENGINEERING DIVISION

SAMPLE CUSTODY/CONTROL LOG ENTRY FORM

SAMPLE IDENTIFICATION (Mandatory): Rock sample 01026872

DESCRIPTION OF SAMPLE (Mandatory): Sample is from borehole UE-25 RF#14 at a depth range of 240.3 to 241.0 ft and corresponds to the unit Tpcrn. A sample description is provided in the geologic log from BSC, 2002 (refer to Attachment A).

REFERENCE TO DOCUMENTATION OR SCIENTIFIC NOTEBOOK ENTRY: Refer to Scientific Notebook 769E

AMOUNT OF SAMPLE: 1 sample SIZE: ~6" length, ~2.4 " diameter

DATE OF SAMPLE RECEIPT, COLLECTION, OR SYNTHESIS (Mandatory): 6/28/2005

PERSON(S) WHO COLLECTED SAMPLE: Sample was sent to CNWRA by the Sample Management Facility. Refer to the sample custody receipt provided in Attachment B.

DATE OF INITIAL LOG ENTRY (Mandatory):10/03/2005 BY(Mandatory): Sarah Gonzalez

SAMPLE STORAGE LOCATION (Mandatory) Note: Update location when sample is moved. Sample sent to Dr. Ahmed Elgamal at the Department of Structural Engineering, University of California, San Diego

COLLECTION SITE (Reference Maps or Field Notes As Required) or SUPPLIER: The borehole UE-25 RF#14 is located within the Waste Handling Building Site at Yucca Mountain, Nevada. Refer to the map and table provided in Attachments C and D, respectively.

OTHER: References

BSC (Bechtel SAIC Company) 2002. *Geotechnical Data for a Potential Waste Handling Building and for Ground Motion Analyses for the Yucca Mountain Site Characterization Project*. ANL-MGR-GE-000003 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20021004.0078.

Attachment (Geologic Logs)

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

SHEET 1 OF 11

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 9/13/2000 FINISHED: 9/27/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 765,308.73 E 571,065.44
TOTAL DEPTH: 550.0 ft.
DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
GROUND ELEVATION: 3651.52
ANGLE FROM HORIZONTAL: -90
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

NOTES

Purpose of Hole:
Develop geologic design data required for Waste Handling Building foundation parameters and seismic hazard analysis.

Drill Equipment:
Schramm T685 Drill Rig, UDR 1000 Drill Rig

Drillers:
D. Harrison, R. Mckay; Dynatec Drilling Inc.; Salt Lake City, Utah.

Drilling Method:
Used 12" hammer to 5.02. Cement 10.75 O.D. casing with 1.29 stickup. Re-enter hole on 9/13/2000 with PQ coring system. Cored with PQ to 116.06. Used PQ rods as casing and installed HQ coring system. Cored with HQ to the total depth of 549.99.

Drilling Conditions:
0.00 to 443.06: Replaced 2 bits.

Drilling Fluid:
0.00 to 5.02: Non-potable water. 5.02 to 290.09: Non-potable water, Quick Gel mud with EZ-Mud. 290.09 to 294.15: non-potable water, Quik Gel mud with EZ-Mud and LCM to re-establish circulation. 294.15 to 549.99: Non-potable water, Quick Gel mud with EZ-Mud.

Loss Intervals:
290.09 to 294.15

Casing Record:
0.00 to 4.72: 10.75 O.D. casing. 0.00 to 116.06: PQ casing 116.06 to 549.99: No casing

Hole Completion:
Ream hole from 5.00 to 550.15 with 8.5 Tricone Bit. Set and cement 512.22 of 4.5" PVC casing.

DEPTH	% CORE RECOVERY	% RQD	GEOLOGIC UNIT [USCS]
	0		Qal
5	100		Qal (GP-GM)s
	50		
10	100		Qal (GP)s
	59		Qal GW
15	100		
	63		Qal (GP)s
20	73		Qal (GP)sc
25	39		Qal GW
	77		Qal (SM)g
30	100		Qal (GP)s
35	23		
	100		
40	70		
45	91		Qal (SP)g
	0		NR

CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 101.8 ft. QUATERNARY ALLUVIUM (Qal)

0.0 to 5.0: No Recovery

5.0 - 9.1: POORLY GRADED GRAVEL WITH SAND AND SILT (GP-GM)s; About 50% fine to coarse, hard, subrounded to subangular gravel; about 40% predominately fine, hard, subrounded to subangular sand; about 10% nonplastic fines, no dry strength, rapid dilatancy, low toughness; maximum size 65mm, dry, light brown; strong reaction with HCl; firm, strongly cemented.

9.1 - 11.5: POORLY GRADED GRAVEL WITH SAND (GP)s; About 60% fine to coarse, hard subrounded to subangular gravel; about 35% fine to coarse, subrounded to subangular sand; about 5% nonplastic fines, no dry strength, rapid dilatancy, low toughness; maximum size 75mm, dry, light brown; strong reaction with HCl; firm, weak to strongly cemented.

11.5 - 14.9: WELL GRADED GRAVEL (GW); About 100% fine to coarse, hard, subrounded to angular gravel; maximum size 75mm, light brown; 10% of gravel is partially coated with up to 1mm white caliche.

14.9 - 18.1: POORLY GRADED GRAVEL WITH SAND (GP)s; About 70% fine to predominately coarse, hard, subrounded to subangular gravel; about 25% predominately fine sand; about 5% nonplastic fines, no dry strength, rapid dilatancy, low toughness; trace of cobbles; maximum size 95mm, dry, light brown; weak reaction with HCl; firm, weakly cemented.

18.1 - 23.2: POORLY GRADED GRAVEL WITH SAND AND COBBLES (GP)sc; About 65% fine to coarse, hard, subangular to angular gravel; about 30% predominately fine sand; about 5% nonplastic fines, no dry strength, rapid dilatancy, low toughness; trace of cobbles; maximum size 215mm, dry, light brown; weak to strong reaction with HCl; firm, weak to moderately cemented.

23.2 - 26.8: WELL GRADED GRAVEL (GW); About 100% fine to coarse, hard, subrounded to angular gravel; maximum size 75mm, light brown; 10% of gravel is partially coated with up to 1mm white caliche.

26.8 - 30.6: SILTY SAND WITH GRAVEL (SM)g; About 55% predominately fine sand; about 30% predominately fine to coarse, hard, subrounded to subangular gravel; about 15% nonplastic fines, no dry strength, rapid dilatancy, low toughness; maximum size 60mm, dry; weak reaction with HCl; firm, weakly cemented.

30.6 - 44.6: POORLY GRADED GRAVEL WITH SAND (GP)s; About 60% predominately fine to coarse, hard, subangular gravel; about 35% predominately fine to medium sand; about 5% nonplastic fines, no dry strength, rapid dilatancy, low toughness; maximum size 170mm, dry, light brown; weak reaction with HCl; firm, weakly cemented.

44.6 - 47.8: POORLY GRADED SAND WITH GRAVEL (SP)g; About 60% predominately fine to medium sand; about 35% fine to coarse, hard, subrounded to subangular gravel; about 5% nonplastic fines, no dry strength, rapid dilatancy, low toughness; maximum size 160mm, dry, light brown; weak reaction with HCl; firm, weakly cemented.

47.8 - 52.5: NO RECOVERY

52.5 - 55.6: WELL GRADED GRAVEL (GW); About 95% fine to coarse, hard, subrounded to subangular gravel; about 5% fine to coarse, subrounded to subangular sand; maximum size 190mm, moist; no reaction with HCl; approximately 30% of gravel is caliche coated.

COMMENTS:
1. All measurements are in feet unless noted otherwise.
2. LCM (Lost Circulation Material) consists of cellophane cuttings.
3. USCS classifications were determined in the field, with limited access to samples to keep samples intact for future tests.
4. Shear Wave Velocity data from GeoVision suspension logging. Data acquired from downhole survey conducted after PVC casing installed.
5. USCS soil classifications are based on USBR Earth Manual procedure 5005 - Determining Unified Soil Classification (Visual Method)

WHB_LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 9/13/2000 FINISHED: 9/27/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 765,308.73 E 571,065.44
TOTAL DEPTH: 550.0 ft.
DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
GROUND ELEVATION: 3651.52
ANGLE FROM HORIZONTAL: -90
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s (1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000, 9000)	ENGINEERING INDEXES: HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY	% RQD	GEOLOGIC UNIT [USCS]	GRAPHIC
	55					0		NR	
						71		Qal GW	
	60					43		Qal (GW)s	
						64		Qal (GP)s	
	65					58			
	70					35		Qal GP	
	75					47			
						0			
						82		Qal (GP)c	
	80					49		Qal (GP)c	
	85		H6		FD5	100	73	Qal	
					FD6	67	67		
						80	80		
						100	100		
	90				FD4	88	88		
			H7						
			H6			88	63		
	95		H7						
					NR	93	93		
	100		H6		FD2	93	83		
			H5			100	65	Tpki	
	105		H6		FD1	100	94		

55.6 - 60.5: WELL GRADED GRAVEL WITH SAND (GW)s; About 85% fine to coarse, hard, subrounded to subangular gravel; about 15% predominately fine sand; trace of fines; maximum size 120mm, dry, light brown; weak reaction with HCl; soft weakly cemented.

60.5 - 69.3: POORLY GRADED GRAVEL WITH SAND (GP)s; About 80% fine to coarse, hard, subrounded to subangular gravel; about 15% fine to coarse, subrounded to subangluar sand; about 5% nonplastic fines, no dry strength, rapid dilatancy, low toughness; maximum size 170mm, dry; weak reaction with HCl; soft, weakly cemented.

69.3 - 78.1: POORLY GRADED GRAVEL (GP); About 100% fine to coarse, hard, subrounded to subangular gravel; maximum size 120mm, moist; no to strong reaction with HCl.

78.1 - 80.3: POORLY GRADED GRAVEL WITH COBBLES (GP)c; About 50% coarse, hard, subangular gravel; about 50% cobbles; moist; cobbles have caliche coating.

80.3 - 84.8: POORLY GRADED GRAVEL WITH COBBLES (GP)c; About 80% coarse, subrounded to subangular gravel; about 20% cobbles; moist.

101.8 to 192.5 ft. COMB PEAK IGNIMBRITE - TUFF "X" (Tpki):
Pyroclastic flow, nonwelded, moderately indurated light to medium gray tuff with 10 to 15 percent, light greenish-gray, pumice clasts , up to 20 percent grayish-red volcanic lithic clasts and 2 to 3 percent phenocrysts of sanidine and plagioclase. Generally the tuff is slightly weathered (W4), moderately soft (H5) to soft (H6), and very slightly fractured (FD1). Both upper and lower contacts are unconformable.

Discontinuity Measurements:

Depth	Angle*	Roughness	Infilling
102.3	75	R2	5mm clay
115.8	05	R2	<1mm light brown stain
140.4	15	R2	clean
172.5	25	R2	trace clay
172.2	25	R2	trace clay
188.0	20	R3 to1	sand
189.9	30	R3	trace clay
190.2	35	R3	3mm altered tuff
190.9	30	R2	clean

192.5 to 203.4 ft. POST TIVA CANYON BEDDED TUFFS (Tpbt5):
Nonwelded, devitrified, reworked (?) fallout tephra and pyroclastic flows separated by distinct paleosols. Bedded tuffs are very pale orange with 20 to 30 percent pumice clasts and less than 1 percent, pale red, volcanic lithic clasts. The tuff has up to 1 percent quartz, sanidine and lesser plagioclase, with less than 1 percent biotite and manganese oxides. Generally the bedded tuffs are very soft (H7), moderately weathered (W6), and slightly to very slightly fractured (FD2). The lower contact is unconformable.

Discontinuity Measurements:

Depth	Angle*	Roughness	Infilling
197.3	20	R3	clean
201.8	45	R3	clean

203.4 to 275.0 ft. TIVA CANYON TUFF CRYSTAL RICH NON-LITHOPHYSAL ZONE (Tpcrn)
Pyroclastic flow, moderately to mostly densely welded, devitrified, pale red to grayish red, with up to 15 percent phenocryts. Phenocryts are mostly sanidine and plagioclase with some quartz and rare biotite. Rare pumice from 212.5 to 222.8 ft. and up to 15 percent pumice clasts from 222.8 to 269.0 ft. From 276.7 to 288.0 ft. the tuff has up to 2 percent pumice clasts and 5 to 8 percent phenocryts of sanidine and plagioclase with rare biotite. Generally the tuff is moderately soft (H5) to mostly moderately hard (H4), moderately to slightly weathered (W4), and intensely to moderately fracture (FD6). The lower contact is conformable.

Discontinuity Measurements:

Depth	Angle*	Roughness	Infilling
203.6	40	R3	clean
205.0	0	R3	8mm silica
205.4	30	R3	trace white mineral
206.2	35	R3	trace white mineral

WHB_LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 9/13/2000 FINISHED: 9/27/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 765,308.73 E 571,065.44
TOTAL DEPTH: 550.0 ft.
DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
GROUND ELEVATION: 3651.52
ANGLE FROM HORIZONTAL: -90
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s (1000 2000 3000 4000 5000 6000 7000 8000 9000)	ENGINEERING INDEXES: HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY	% RQD	GEOLOGIC UNIT [USCS]	GRAPHIC
	110					98	96		
	115					100	100		
	120					96	88		
	125								
						97	97		
	130								
	135					96	96		
	140		H6		FD1			Tpki	
	145					100	93		
	150								
	155					99	99		
	160								
	165					100	100		

CLASSIFICATION AND PHYSICAL CONDITION

206.5	40	R3	trace white mineral
206.9	20	R3	trace white mineral
208.0	10-20	R3	4mm white mineral
208.6	30	R2	0-5mm white mineral
213.6	35	R2	clean
214.7	10	R2	clean
215.8	10	R3	clean
218.1	30	R3	clean
223.5	25	R3	clean
223.7	50	R3	clean
224.7	40	R2	clean
225.3	20	R2	clean
227.8	15	R3	clean
228.4	25	R2	sand
230.0	05	R3	clean
234.7	40	R2	clean
238.4	30	R2	trace white mineral
240.1	55	R2	clean
243.3	65	R2	clean
250.1	05	R2	10mm tan clay; polished; slickensided
253.2	40	R2	sand; gravel
253.9	30	R3	clean
256.3	45	R2	sand
256.7	15 to 40	R2	sand
257.3	60		1mm white mineral
267.4	10	R3	clean
267.7	60	R2	2mm silica
268.0	0	R3	clean
268.4	0	R3	sand
268.8	20	R3	clean
268.9	25	R3	clean
269.3	30	R3	clean
270.5	10	R2	trace white mineral
270.7	20	R2	trace white mineral
273.4	15	R3	clean
274.3	15	R3	clean

275.0 to 395.0 ft. TIVA CANYON TUFF CRYSTAL POOR UPPER LITHOPHYSAL ZONE (Tpcpul)
Pyroclastic flow, densely welded, grayish orange to pale red, with 2 to 5 percent lithophysal cavities, up to 20 by 40 mm in size. Lithophysae increase to 15 percent at 310.0 ft and up to 25 percent at 320 ft., with up to 50 percent cavities partially filled with silica. Phenocryts compose less than 1 percent of the tuff mostly sanidine and plagioclase with minor biotite. Also up to 3 percent pumice clasts as large as 40 by 10 mm. Zones of nonwelded, fracture fill(?) from 334 to 359 ft., and 369 to 395 ft. composed of reworked and variously bedded clay/silt sized, tuffaceous material. Generally the tuff is moderately soft (H5) to mostly moderately hard (H4), slightly (W3) to moderately weathered (W5), and intensely to moderately fractured (FD6). Lower contact is conformable.

Discontinuity Measurements:

Depth	Angle°	Roughness	Infilling
275.9	20	R2	clean
276.0	25	R2	clean
278.7-279.4	30	R2	0.6' breccia; sand & gravel; cemented
279.6-280.0	60	R3	0.4' breccia; sand & gravel; cemented
280.1	35	R3	10mm breccia
282.0	30	R3	trace white mineral
280.9-281.2	50-80		rotated; breccia
281.4	55	R3	breccia
284.0	20	R2	1-2mm silica
283.1-284.9	0-20	R3	clean
285.0	10	R3	1mm silica
285.3	25	R2	clean
286.0	35	R3	trace silica
287.0	25	R2	3mm silica
287.6	25	R3	1mm silica
288.4	60	R3	clean
288.9	35	R3	clean
289.0	70	R3	clean
289.3	15	R2	clean
289.4	65	R3	clean
289.8	10	R3	2mm silica
290.7	25	R2	trace white mineral
291.4-291.6	35	R3	40mm clay, sand, gravel
292.2	35	R3	gravel
291.9	75	R3	2mm silica

WHB_LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 9/13/2000 FINISHED: 9/27/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 765,308.73 E 571,065.44
TOTAL DEPTH: 550.0 ft.
DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
GROUND ELEVATION: 3651.52
ANGLE FROM HORIZONTAL: -90
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s (1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000, 9000)	ENGINEERING INDEXES: HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY	% RQD	GEOLOGIC UNIT [USCS]	GRAPHIC
	170					100	100		
	175				FD1	100	90		
	180		H6					Tpki	
	185					100	80		
	190				FD2	81	74		
	195					78	59		
			H7					Tpbt5	
	200								
	205				FD6	94	46		
	210								
	215		H4			100	60	Tpcrn	
	220				FD5				
						92	25		
	225								
						91	56		

CLASSIFICATION AND PHYSICAL CONDITION

292.3	80	R3	clean
294.9	45	R3	clay, sand
295.1-295.5	30	R3	breccia, sand, gravel, tr. clay
295.8-296.0	50	R3	breccia, sand, gravel, tr. clay
298.6	30	R3	<1 mm silica
299.2	65	R3	clean
299.8	25	R3	clean
299.7	20	R3	clean
304.2-306.0	70	R2	clay, sand, gravel
306.8	30	R3	1mm silica
307.2	35	R3	1mm silica
308.9	60	R3	20mm silica
308.4	25	R3	2mm silica
310.4	35	R2	1mm quartz
310.6	30	R3	none
311.3	55	R3	none
311.8	55	R3	none
312.0	45	R3	sand, trace quartz
312.2-313.3	45	R2	breccia; sand & gravel
313.8	05	R3	1mm vapor phase minerals
314.5	35	R3	sand
315.2-316.1	45	R2	breccia; sand, gravel, clay
317.0-320.3	20	R2	sand, gravel, clay
322.5	65	R2	none
322.8	05	R2	trace white mineral
322.9	70	R2	none
323.4	50	R3	none
321.0	60	R3	8mm vapor phase alteration
326.3	10	R3	1.2' clay, sand, gravel
327.3	50	R3	clean
329.2	05 to 35	R2	15mm clay
344.8	5 to 15	R4	1mm clay
349.0	05	R3	<1mm white mineral & clay
351.7	35	R3	<1mm clay(?) & MnO(?)
358.0-358.9	85	R2	clay, sand, gravel breccia
359.2	40	R3	1mm clay
359.9	25	R2	3mm sand, gravel, clay
360.4	30	R2	clean
361.6	25	R3	clean
362.2-362.4	65	R2	sand, gravel, clay, MnO
363.4	70	R3	trace white mineral
364.0	35	R3	clean
364.6	55	R3	trace white mineral
364.8	20	R2	MnO coating
366.8-367.5	40	R3	clay, sand, gravel

395.0 to 443.7 ft. TIVA CANYON TUFF CRYSTAL POOR MIDDLE NON-LITHOPHYSAL ZONE (Tpcpmn)

Pyroclastic flow, densely welded, devitrified, pale red, tuff with less than 1 percent lithophysae up to 50 by 10 mm. Less than 1 percent phenocryts of sanidine, plagioclase, and biotite. The tuff has 1 to 2 percent very light gray pumice clasts and pink spherulites, and up to 10 percent volcanic lthic fragments. Zones of nonwelded, fracture fill(?) from 402.7 to 431.7 ft., 434.0 to 435.8 ft., and 442.4 to 443.7 ft. composed of reworked and variously bedded clay/silt sized, tuffaceous material. Generally the tuff is moderately soft (H5), moderately to slightly weathered (W4), with fracture densities ranging from slightly fractured (FD3) to very intensely fractured (FD8). Lower contact is conformable.

Discontinuity Measurements:

Depth	Angle°	Roughness	Infilling
367.9	60	R3	2mm clay
368.9	05	R2	clay, sand, gravel
370.0	30	R3	MnO stain & 5mm clay
373.7	15	R4	contact between clayey infilling material at Tpc
373.9	60	R2	2mm silica
374.3	35	R2	
374.3	55	R2	
374.8	60	R2	trace of clay
375.1			quartz filled lithophysal cav. 25mm thick
375.4	50	R3	trace of clay
375.6	60	R4	
378.6	45	R3	trace of clay
378.8	35	R3	
378.8	60	R3	
379.0	0	R4	1mm silica
379.6	15	R4	trace silica
379.8	20	R3	
380.0	75	R3	1mm silica
380.2	65	R3	trace silica
380.7	05	R3	

WHB_LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 9/13/2000 FINISHED: 9/27/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 765,308.73 E 571,065.44
TOTAL DEPTH: 550.0 ft.
DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
GROUND ELEVATION: 3651.52
ANGLE FROM HORIZONTAL: -90
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

NOTES

DEPTH

SHEAR WAVE VELOCITY ft/s (1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000, 9000)

ENGINEERING INDEXES

HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY	% RQD	GEOLOGIC UNIT [USCS]
		FD5			
		FD3	91	56	
H4		FD3	90	69	
		FD7	86	18	
H5		FD9	46	0	Tpcm
		FD6	77	38	
		FD9	34	0	
		FD9	81	0	
H4		FD9	97	23	
		FD4	99	32	
		FD9			Tpcpul
		FD4	100	54	
		FD8	98	0	

GRAPHIC

CLASSIFICATION AND PHYSICAL CONDITION

381.0	28	R3	
380.8	55	R3	
381.4	20	R4	
381.5	10	R4	
381.7	20	R4	
382.0	15	R3	trace of clay
382.2	15	R3	trace MnO, trace clay
382.1	45	R3	
382.3	20	R3	
382.8	70	R3	
382.9	35	R4	trace MnO
383.3	30	R4	
383.7	05	R4	trace silica, trace clay
384.5	10	R2	
384.7	60	R3	
384.7	35	R3	
384.9	20	R3	
384.9	25	R3	
385.0	35	R3	
386.1	10	R4	
386.4	40	R4	
386.7	80	R3	
387.8/387.9	75	R2	3 anastamosing vpps, vp coated
388.7	20	R4	
389.3	75	R5	
389.5	75	R3	trace MnO
389.8	80	R4	
390.4	80	R3	vapor phase (Vpp)
390.7	45	R4	
390.8	75	R3	vapor phase (Vpp)
391.5	80	R4	
392.1	75	R3	
392.2	40	R4	trace vapor phase
392.6	75	R2	vapor phase to 2mm (Vpp)
392.8	35	R4	
392.9	80	R2	vapor phase to 1mm (Vpp)
395.2	45	R3	
396.8	75	R2	vapor phase (Vpp)
398.8	80	R2	
399.5	5	R3	
400.3	15	R3	trace MnO
400.7	80	R2	vapor phase (Vpp)
401.7	0	R3	
401.4	80	R4	
403.8	20	R2	clay 0.5 2cm
408.6 &	45	R4	contact (?) between cobble
408.9/409.9	40	R4	pumiceous, lithic-rich infilling well cemented pumiceous lithic-rich infilling w/Tpc frags
409.9/413.4	40	R3	tuffaceous infilling w/<15% white/gray altered pumice
417.8	10	R5	clay 20mm
422.9 next run	10	R5	clay 30mm+ extends into
429.9	10	R4	bedding; f.grained
428.0	20	R4	bedding; f.grained
431.1	10	R3	2mm clay
432.2	20	R3	trace white mineral
432.4	15	R3	trace white mineral
432.6	25	R3	trace white mineral
433.0	20	R3	1-4mm tuff
434.0	15	R4	tuff
435.9	15	R3	1mm clay & white mineral
437.3	80	R2	vpp alteration
438.7	75	R3	trace white mineral; 5mm clay
440.3	15	R3	trace white mineral
441.3	75	R3	trace white mineral
441.4	65	R3	trace white mineral
441.8	85	R3	trace white mineral
442.0	85	R3	trace white mineral
442.1	15	R4	clay; tuff

443.7 to 455.6 ft. TIVA CANYON TUFF CRYSTAL POOR LOWER LITHOPHYSAL ZONE (Tpcpll)
Pyroclastic flow, densely welded, devitrified, moderate orange pink tuff with 1 percent very light gray pumice. Phenocryts of sanidine and rare biotite compose less than 1 percent of the rock by volume. Lithophysal cavities compose up to 15 percent of the rock by volume and are generally 20 by 30 mm in size. Lithophysae are filled and coated with vapor phase minerals to varying degrees. Generally the tuff is moderately hard (H4), slightly weathered (W3), and intensely fractured (FD6). Lower

WHB_LOG_WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 9/13/2000 FINISHED: 9/27/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 765,308.73 E 571,065.44
TOTAL DEPTH: 550.0 ft.
DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
GROUND ELEVATION: 3651.52
ANGLE FROM HORIZONTAL: -90
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s (1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000, 9000)	ENGINEERING INDEXES: HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY	% RQD	GEOLOGIC UNIT [USCS]	GRAPHIC
	290		H4		FD8	98	0	Tpcpul	
						66	0		
	295					100	0		
	300					91	0		
						89	13		
	305					78	0		
	310				FD6	99	32		
	315		H5		FD8	74	0		
	320		H4		FD6	83	38		
	325					91	41		
	330		H7		FD8	6	0		
	335				FD2	100	84	(Fracture Fill)	
						74	47		
	340					100	100		
	345					81	40		

CLASSIFICATION AND PHYSICAL CONDITION

contact is conformable.

Discontinuity Measurements:

Depth	Angle°	Roughness	Infilling
443.7	60	R3	1mm clay
444.2	75	R2	clean
444.9	60	R2	clean
445.1	35	R2	clean
446.3	15	R2	trace white mineral; sand
446.8	30	R2	sand
447.2	30	R2	sand
453.7	60	R2	1mm silica

455.6.0 to 550.0 ft. TIVA CANYON TUFF CRYSTAL POOR LOWER NON-LITHOPHYSAL ZONE (Tpcpln)
Pyroclastic flow, densely welded, devitrified, moderate orange pink tuff with less than 1 percent light gray pumice clasts. Phenocrysts of sanidine and plagioclase compose 1 to 2 percent of the rock by volume. Reddish brown lithic clasts compose less 1 percent of the rock by volume. Generally the tuff is moderately hard (H4), slightly weathered (W3), with fracture densities ranging from slightly fractured (FD3) to intensely fractured (FD6). Lower contact undetermined, bottom of borehole at 550.0 ft.

Discontinuity Measurements:

Depth	Angle°	Roughness	Infilling
455.7	40	R3	clean
456.4	20	R3	0 to 1mm silica
458.0	45	R3	clean
458.1	35	R3	3mm silica
460.2	60	R2	trace white mineral
460.0	30	R3	trace white mineral
460.4	70	R2	clean
460.9	65	R3	trace white mineral
461.1	85	R3	trace white mineral
461.3	35	R4	MnO & trace white mineral
461.8	60	R3	clean
462.1	60	R4	clean
462.7	30	R3	clean
463.1	25	R4	trace white mineral
463.9	75	R4	clean
464.1	55	R3	trace white mineral
464.8	35	R3	trace white mineral
465.0	55	R4	clean
465.5	65	R4	clean
465.9	70	R4	trace white mineral
466.3	65	R4	trace white mineral
467.0	20	R3	trace white mineral
467.1	75	R2	trace white mineral
467.3	50	R2	4mm sand & silica
467.7	50	R3	trace white mineral
468.0	80	R4	trace white mineral
468.2	55	R4	clean
468.4	80	R4	clean
468.5	35	R4	trace white mineral
468.7	60	R4	clean
469.0	70	R4	clean
469.4	45	R4	trace white mineral
470.0	60	R2	trace white mineral
471.2	80	R2	trace white mineral
472.4	80	R3	trace white mineral
472.8	80	R2	trace white mineral
473.1	75	R3	trace white mineral
474.5	10	R2	trace white mineral
476.8	80	R2	trace white mineral
476.2	80	R1	trace white mineral; trace silica
477.3	75	R1	trace white mineral
478.4	85	R1	vapor phase alteration-2mm
478.5	55	R3	trace white mineral
479.0	60	R1	trace white mineral
480.3 (healed)	70	R1	2mm vapor phase minerals
480.9 (healed)	75	R1	2mm vapor phase minerals
482.4 (healed)	55	R1	2mm vapor phase minerals
483.1	45	R4	trace white minerals
484.4	65	R4	clean
484.6	60	R4	clean
485.4	80	R2	trace white mineral
485.6	75	R4	clean
485.9	50	R4	trace white mineral

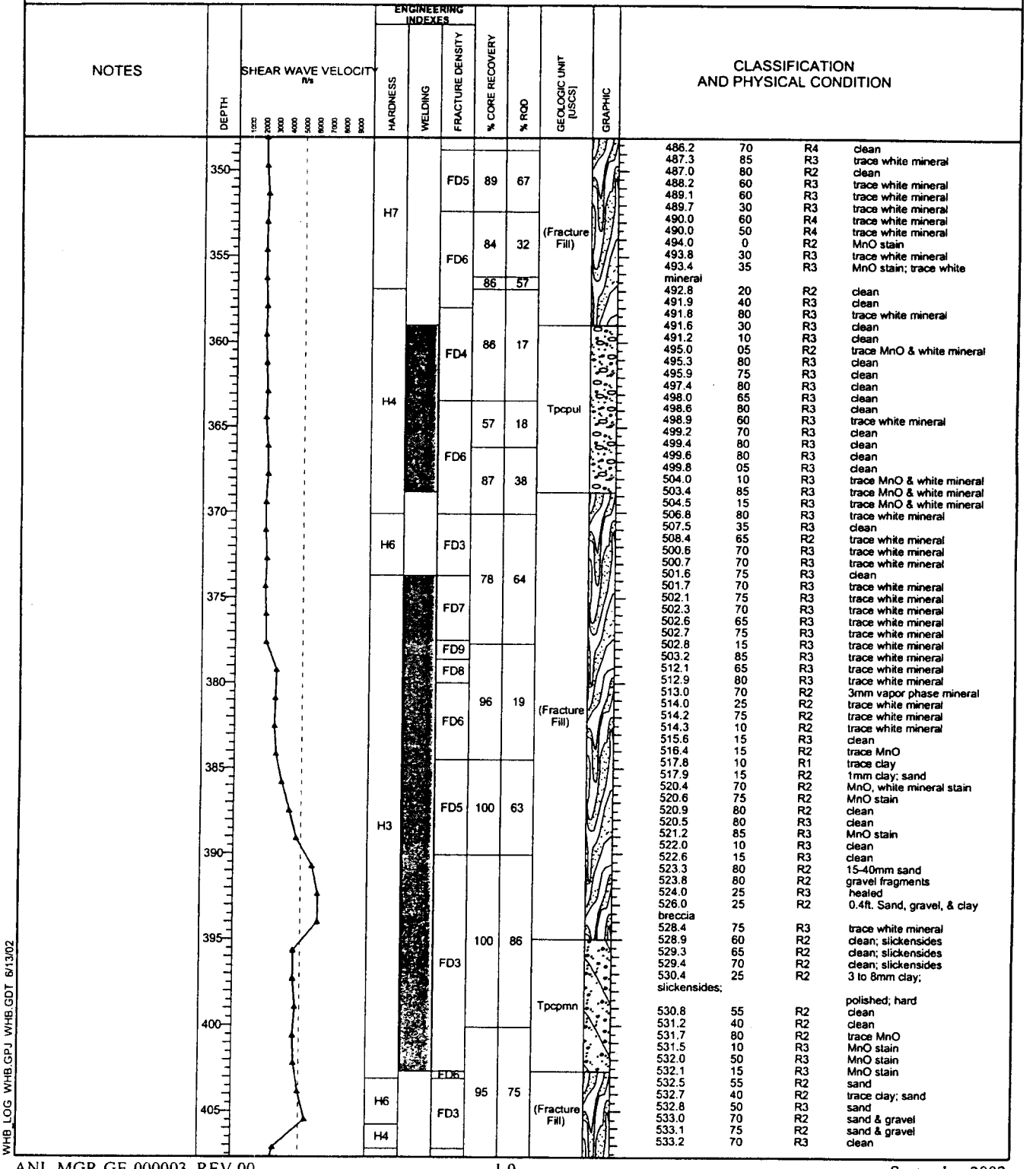
WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 9/13/2000 FINISHED: 9/27/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 765,308.73 E 571,065.44
TOTAL DEPTH: 550.0 ft.
DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
GROUND ELEVATION: 3651.52
ANGLE FROM HORIZONTAL: -90
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown



WHB_LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

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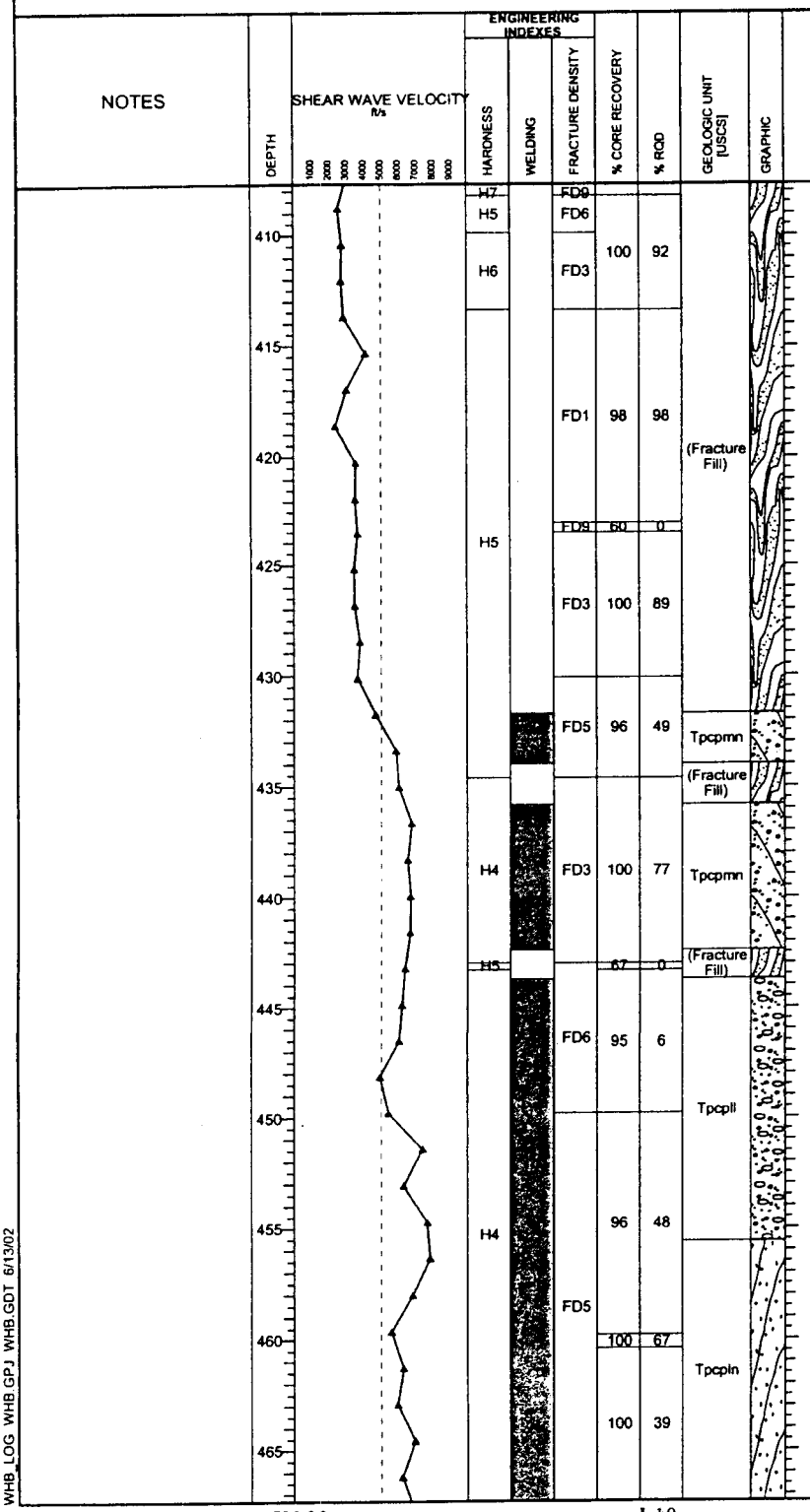

CLASSIFICATION AND PHYSICAL CONDITION			
533.3	65	R3	clean
533.5	65	R3	trace white mineral
536.0	70	R3	clean
534.1	45	R3	clean
534.1	45	R3	clean
534.4	50	R2	clean
534.5	15	R2	clean
534.6	80	R3	clean
534.7	70	R3	clean
534.8	30	R3	trace white mineral
535.4	60	R2	0-1 ft. Sand & gravel
535.6	70	R3	sand
536.1	80	R3	clean
536.3	80	R3	clean
536.6	80	R3	clean
536.9	80	R2	trace white mineral
537.5	60	R2	3mm clay
537.6	70	R2	clean
537.9	75	R2	clean
538.2	80	R2	clean
538.5	55	R2	clean
538.7	85	R2	clean
538.8	85	R2	clean
538.9	85	R2	clean
539.3	65	R3	trace white mineral
539.5	70	R3	clean
539.7	75	R3	clean
539.8	75	R3	clean
540.0	15	R3	trace white mineral
540.9	20	R3	trace white mineral
540.5	70	R2	clean
540.9	60	R2	trace white mineral
540.8	30	R3	clean
541.2	60	R2	trace white mineral
541.4	20	R2	trace white mineral
541.6	80	R3	trace white mineral
541.8	85	R3	trace white mineral
542.2	80	R3	trace white mineral
542.3	80	R3	trace white mineral
542.8	85	R3	trace white mineral
543.0	80	R2	trace white mineral
543.5	10	R2	clean
543.7	85	R3	trace white mineral
543.9	80	R2	clean
544.3	85	R2	1-2mm clay
544.4	85	R3	clean
545.0	85	R3	trace white mineral
545.3	50	R2	clean
545.7	10	R2	clean
545.5	10	R2	clean
546.8	80	R2	1mm clay
546.9	50	R2	1mm clay
547.0	75	R2	1mm clay
549.5	40	R3	clean

* Angles are measured from core axis and are plus or minus 5 degrees.

WHB_LOG_WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 9/13/2000 FINISHED: 9/27/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 765,308.73 E 571,065.44
TOTAL DEPTH: 550.0 ft.
DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
GROUND ELEVATION: 3651.52
ANGLE FROM HORIZONTAL: -90
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s (1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000, 9000)	ENGINEERING INDEXES: HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY	% RQD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
	470				FD5	100	39			
	475				FD4	100	69			
	480									
	485				FD3	98	76			
	490									
	495		H4			100	55	Tpcpln		
	500				FD4					
	505					100	45			
	510									
	515				FD3	100	88			
	520									
	525				FD4	99	54			

WHB_LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

FEATURE: Waste Handling Building
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BEGUN: 9/13/2000 FINISHED: 9/27/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
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REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s (1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000, 9000)	ENGINEERING INDEXES: HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY	% RQD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
	530		H4		FD4	99	54	Tpcpln		
	535		H6		FD6	100	18			
	540									
	545		H4		FD5	100	36			
	550									

BOTTOM OF HOLE

WHB_LOG_WHB.GPJ WHB.GDT 6/13/02

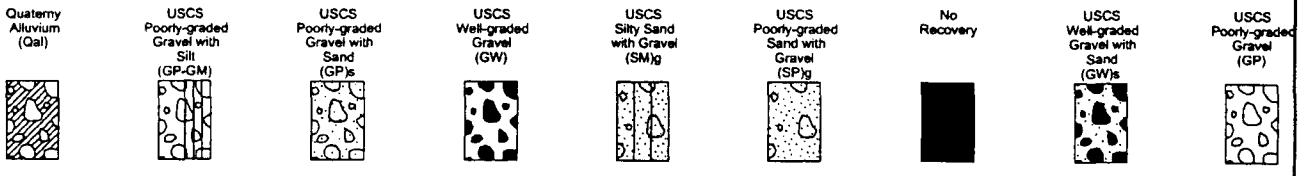
GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 9/13/2000 FINISHED: 9/27/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 765,308.73 E 571,065.44
TOTAL DEPTH: 550.0 ft.
DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
GROUND ELEVATION: 3651.52
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

SOIL



ROCK

WELDING

HARDNESS

Alpha-numeric descriptor	Descriptor	Criteria
H1	Extremely	Core, fragment, or exposure cannot be scratched with knife or sharp pick; can only be chipped with repeated heavy hammer blows.
H2	Very Hard	Cannot be scratched with knife or sharp pick. Core or fragment breaks with repeated heavy hammer blows.
H3	Hard	Can be scratched with knife or sharp pick with difficulty (heavy pressure). Heavy hammer blow required to break specimen.
H4	Moderately Hard	Can be scratched with knife or sharp pick with light pressure. Core or fragment breaks with moderate hammer blow.
H5	Moderately Soft	Can be grooved 1/16 inch (2mm) deep by sharp pick with moderate or heavy pressure. Core or fragment breaks with light hammer blow or heavy manual pressure.
H6	Soft	Can be grooved or gouged easily by knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.
H7	Very Soft	Can be readily indented, grooved or gouged with fingernail, or carved with a knife. Breaks with light manual pressure.

WEATHERING

Alpha-numeric descriptor	Descriptor	General characteristics (strength, excavation, etc.)
W1	Fresh	Hammer rings when crystalline rocks are struck. Almost always rock excavation except for naturally weak or weakly cemented rocks such as Siltstones or shales.
W2	Slightly weathered to fresh	
W3	Slightly weathered	Hammer rings when crystalline rocks are struck. Body of rock not weakened. With few exceptions, such as siltstones or shales, classified as rock excavation.
W4	Moderately to slightly weathered	
W5	Moderately weathered	Hammer does not ring when rock is struck. Body of rock is slightly weakened. Depending on fracturing, usually is rock excavation except in naturally weak rocks such as siltstones or shales.
W6	Intensely to moderately weathered	
W7	Intensely weathered	Dull sound when struck with hammer, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or veinlets. Rock is significantly weakened. Usually common excavation.
W8	Very intensely weathered	
W9	Decomposed	Can be granulated by hand. Always common excavation. Resistant minerals such as quartz may be present as "stringers" or "dikes".

FRACTURE DENSITY

Alpha-numeric descriptor	Descriptor	Criteria (Excludes mechanical breaks)
FD0	Unfractured	No observed fractures.
FD1	Very slightly fractured	Core recovered mostly in lengths greater than 3 feet (1 m).
FD2	Slightly to very slightly fractured	
FD3	Slightly fractured	Core recovered mostly in lengths from 1 to 3 feet (300 to 1,000 mm) with few scattered lengths less than 1 foot (300 mm) or greated than 3 feet (1,000 mm).
FD4	Moderately to slightly fractured	
FD5	Moderately fractured	Core recovered mostly in lengths from 0.33 to 1.0 foot (100 to 300 mm) with most lengths about 0.67 foot (200 mm).
FD6	Moderately to intensely fractured	
FD7	Intensely fractured	Lengths average from 0.1 to 0.33 foot (30 to 100 mm) with fragemented intervals. Core recovered mostly in lengths less than 0.33 foot (100 mm).
FD8	Very intensely to intensely fractured	
FD9	Very intenesely fractured	Core recovered mostly as chips and fragments with a few scattered short core lengths.

RF14_KEY_WHB.GPJ WHB.GDT 6/14/02

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