LABORATORY NOTEBOOK

CNWRA/SwRI

NOTEBOOK NO. 482

ISSUED TO Bobby Pabalan

ON _____

DEPARTMENT 20 CNWRA

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INSTRUCTIONS

1. **The primary purpose of this notebook is to protect your and the Company's Patent-Rights by keeping records of all original work in a form acceptable as evidence if any legal conflict arises.**

2. • When starting a page, enter the title, project number, and book number.
   • Use ink for permanence -- avoid pencil.
   • Record your work as you progress, including any spur-of-the-moment ideas which may be developed later.
   • Avoid making notes on loose paper to be recopied.
   • Record your work in such a manner that a co-worker can continue from where you stop. You might be ill and to protect your priority it could be urgent that the work continue while you are absent.

3. • Give a complete account of your experiments and the results, both positive and negative, including your observations.
   • Record all diagrams, layouts, plans, procedures, new ideas, or anything pertinent to your work including the details of any discussions with suppliers, or other people outside the Company.
   • Do not try to erase any incorrect entries; draw lines deleting them, note the corrections, sign and date the changes. This extra care is worthwhile because of the necessity of original data to prove priority of new discoveries.

4. • After entering your data, sign and date the entries.
   • Explain your work to at least two witnesses who are not co-inventors, and have them sign and date the pages in the place provided.
   • Record the names of operators and witnesses present during any demonstration and have at least two witnesses sign the page. If no witnesses are present during an experiment of importance, repeat it in the presence of two witnesses.

5. Since computer programs can be patented these instructions apply to the development of computer software. In this case a description of the structure and operation of the program should be recorded in the notebook, together with a basic flow diagram which illustrates the essential features of the program. In the course of developing the code, the number of lines of code written each day should be recorded in the notebook, together with a statement of the portion of the flow diagram to which the section of code is directed.

6. This notebook and its contents are the exclusive property of the Company. It is confidential and the contents are not to be disclosed to anyone unless authorized by the Company. You must return it when completed, upon request, or upon termination of employment. It should be kept in a protected place. **If loss occurs, notify your supervisor immediately, and make a written report describing the circumstances of the loss.**

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This scientific notebook documents work performed to study the thermal effects on hydraulic conductivity for vitric tuff Project # 20.01402.561	
Initial entry on 10/3/01 by Alka Jain.	
AJ 10/3/01	

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TITLE Air porosity on vitric tuff

Project No.

Book No.

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wt. of BBI (AJ 10/3/01) before putting in oven = 50.0834 g.
@ 90°C overnight

wt. of BBI after removing from oven and cooling in dessicator = 49.7316 g.

Objective:- To determine the air porosity of vitric tuff BBI rock sample using multipycnometer.

Equipment and Supplies:-

1. Air multipycnometer
2. Dried BBI rock sample in form of cylinder (3x5 cm.)
3. Compressed N_2 tank
4. Reference calibration spheres

Procedure:- Per product manual as follows:-

Basic Pycnometer Operation

I. Theory

Working Equation:

$$V_P = V_C - V_R\left[\frac{P_1}{P_2} - 1\right]$$

II. Installation and Components

Tank pressure regulator: 20 psi

III. Calibration Values: Calibration

(all values in cm^3)	Large	Small	Micro
V_{cal}	56.559	----------	2.145
V_c	148.172	29.041	12.17
V_{Ref}	89.577	12.627	7.184

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V. CALIBRATION

The first page of this manual contains calibration information. This includes the sample cell volumes (V_c), the reference volumes (V_R), the volume of the large calibration sphere (V_{cal}large) and the volume of the micro calibration spheres (V_{cal}micro) provided with the MULTIPYCNOMETER. If, for any reason it is suspected that the value of V_c or V_a has been altered then recalibration should be performed. Powder blowing out of the sample cell into the tubing or operation at temperatures substantially different that room temperature will require recalibration.

To recalibrate the MULTIPYCNOMETER the following steps should be followed in order.

1. Place the large calibration sphere into the large cell. Insert the large cell into the cell holder and close the cover.
2. Open valves I and II.
3. Turn the selector valve to "CELL".
4. Open the "GAS OUT" toggle and "RATE" valves.
5. Open the "GAS IN" toggle valve and adjust the "RATE" valve until the display shows about 1 PSI.
6. Purge the MULTIPYCNOMETER" in this mode for about 5 minutes.
7. Close the "GAS IN" toggle valve.
8. When the display shows a stable reading, set it to zero using the zero control knob and turn the selector valve to "REF".
9. Close the "GAS OUT" toggle valve.
10. Open the "GAS IN" toggle valve until the pressure is approximately 17 PSI. Then close the "GAS IN" toggle valve.
11. When the display is stable, note the pressure reading (P_1).
12. Turn the selector valve to "CELL".
13. When the display is again stable, note the new pressure reading (P_2).
14. Vent the MULTIPYCNOMETER by opening the "GAS OUT" toggle valve.

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15. Remove the calibration sphere from the large cell and repeat steps 1-14 noting the pressures P_1', P_2' with the selector valve in "REF" and "CELL" positions.

16. Calculate the volume of the large reference Volume ($V_R$large) using equation.

$$V_R\,large = \frac{V_{cal}\,large}{\left[\left(P_1'large / P_2'large\right)-1\right]-\left[\left(P_1\,large / P_2 large\right)-1\right]} \qquad (9)$$

Where:

V_{cal} = volume of the large calibration sphere

P_1' large = pressure in V_R large with no sphere in the cell.

P_2' large = pressure in V_R large and the large cell with no sphere in the cell.

P_1 large = pressure in V_R large with the calibration sphere in the cell.

P_2 large = pressure in V_R large and the large cell with the sphere in the cell.

17. After solving equation (9) for V_R large use this value in equation(10) to calculate V_c large for the large sample cell.

$$V_C large = V_{cal} large + V_R large\left(\left(P_1\,large / P_2 large\right)-1\right) \qquad (10)$$

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MULTIPYCNOMETER DENSITY WORKSHEET

TRUE POWDER DENSITY

SAMPLE I.D BB1 DATE 10/3/01

SOURCE _____ OPERATOR AJ

OUTGASSING CONDITIONS N_2 @ 25 PSI

TOTAL WEIGHT 49.7316 g REFERENCE VOLUME (V_R) _____ cm^3

TARE WEIGHT _____ g CELL VOLUME (V_c) _____ cm^3

SAMPLE WEIGHT _____ g

OPERATIONAL EQUATION:

$$V_P = V_c - V_R\left((P_1/P_2)-1\right)$$

where

V_p = Volume of powder (cm^3)

V_c = Volume of sample cell (cm^3)

V_R = Reference Volume (cm^3)

P_1 = Pressure reading after pressurizing the Reference Volume

P_2 = Pressure reading after including V_c .

$$V_R = \frac{56.559}{\left[\left(\frac{P_1'}{P_2'}-1\right)-\left(\frac{P_1}{P_2}-1\right)\right]} \quad -(2)$$

$$V_C = 56.559 + V_R\left(\frac{P_1}{P_2}-1\right) \quad -(3)$$

DATA

	RUN 1	RUN 2	RUN 3
P_1	17.554	17.469	17.682
P_2	8.683	8.642	8.743
V_P			
DENSITY			
P_1'	17.592	17.616	17.778
P_2'	6.634	6.645	6.703

NO sphere

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use eqn (2) to calculate reference volume V_R.

RUN 1 :-

$$V_R(1) = \frac{56.559}{\left(\frac{17.592}{6.634}-1\right)-\left(\frac{17.554}{8.683}-1\right)}$$

$$= \frac{56.559}{1.6518-1.0217} = \frac{56.559}{0.6301}$$

$$\boxed{V_R(1) = 89.7619\ cm^3}$$

RUN 2 :-

$$V_R(2) = \frac{56.559}{\left(\frac{17.616}{6.645}-1\right)-\left(\frac{17.469}{8.642}-1\right)}$$

$$= \frac{56.559}{1.6510-1.0214} = \frac{56.559}{0.6296}$$

$$\boxed{V_R(2) = 89.8332\ cm^3}$$

RUN 3 :-

$$V_R(3) = \frac{56.559}{\left(\frac{17.778}{6.703}-1\right)-\left(\frac{17.682}{8.743}-1\right)}$$

$$= \frac{56.559}{1.6523-1.0224} = \frac{56.559}{0.6299}$$

$$\boxed{V_R(3) = 89.8004\ cm^3}$$

$$V_R = \frac{V_R(1)+V_R(2)+V_R(3)}{3}$$

$$= \frac{89.7619+89.8332+89.8004}{3}$$

~~$V_R = 89.8237\ cm^3$~~ AJ 10/3/01

$$\boxed{V_R = 89.7985\ cm^3}$$

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Use eq^n ③ to calculate volume of the sample chamber.

Run 1 :-

$$V_C(1) = 56.559 + \sout{89.8237}\ 89.7985 \left(\frac{17.554}{8.683} - 1\right)$$

AJ 10/3/01

$$= 56.559 + 91.\sout{7097}\ 74$$

AJ 10/3/01

$$\boxed{V_C(1) = 148.2687}$$

RUN 2 :-

$$V_C(2) = 56.559 + \sout{89.8237}\ 89.7985 \left(\frac{17.469}{8.642} - 1\right)$$

$$= 56.559 + 89.8237 (1.0214)$$

$$= 56.559 + 91.7556$$

$$\boxed{V_C(2) = 148.1463}$$

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RUN 3 :

$$V_C(3) = 56.559 + 89.8237 \left(\frac{17.682}{8.743} - 1\right)$$

$$= 56.559 + 89.8237 (1.0224)$$

$$= 56.559 + 91.8135$$

$$\boxed{V_C(3) = 148.3725\ cm^3}$$

Wrong Calculations AJ 10/3/01

$$V_C = \frac{V_C(1) + V_C(2) + V_C(3)}{3}$$

$$\boxed{V_C = 148.2025\ cm^3}$$

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Use eq^n ③ to calculate volume of the sample chamber:

Run 1 :

$$V_C(1) = 56.559 + 89.7985 \left(\frac{17.554}{8.683} - 1\right)$$

$$= 56.559 + 91.7428$$

$$\boxed{V_C(1) = 148.3018\ cm^3}$$

Run 2 :

$$V_C(2) = 56.559 + 89.7985 \left(\frac{17.469}{8.642} - 1\right)$$

$$= 56.559 + 89.7985 (1.0214)$$

$$= 56.559 + 91.7208$$

$$\boxed{V_C(2) = 148.2798\ cm^3}$$

Run 3 :

$$V_C(3) = 56.559 + 89.7985 \left(\frac{17.682}{8.743} - 1\right)$$

$$= 56.559 + 91.8116$$

$$\boxed{V_C(3) = 148.3706\ cm^3}$$

$$V_C = \frac{V_C(1) + V_C(2) + V_C(3)}{3}$$

$$= \frac{148.3018 + 148.2798 + 148.3706}{3}$$

$$\boxed{V_C = 148.3174\ cm^3}$$

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Book No.____ TITLE____

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MULTIPYCNOMETER DENSITY WORKSHEET

TRUE POWDER DENSITY

SAMPLE I.D BB1 DATE 10/3/01

SOURCE ____ OPERATOR AJ

OUTGASSING CONDITIONS Compressed N_2 @ ~ 25 PSI

TOTAL WEIGHT 49.7316 g REFERENCE VOLUME (V_R) 89.7985 cm^3

TARE WEIGHT ____ g CELL VOLUME (V_c) 148.3174 cm^3

SAMPLE WEIGHT ____ g

OPERATIONAL EQUATION:

$$V_P = V_c - V_R\left((P_1/P_2)-1\right) \quad -(1)$$

V_p = Volume of powder (cm^3)

V_c = Volume of sample cell (cm^3)

V_R = Reference Volume (cm^3)

P_1 = Pressure reading after pressurizing the Reference Volume

P_2 = Pressure reading after including V_c .

No mold
With sample only

DATA

	RUN 1	RUN 2	RUN 3
P_1	17.402	17.274	17.338
P_2	7.247	7.188	7.222
V_P			
DENSITY			

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Use eqn (1) to calculate Volume of sample V_P. Substitute average values of V_R and V_C calculated from equations (2) & (3)

Run 1: $V_c = 148.3174\ cm^3$, $V_R = 89.7985\ cm^3$

$$V_P(1) = 148.3174 - 89.7985\left(\frac{17.402}{7.247} - 1\right)$$

$$= 148.3174 - 125.8319$$

$$V_P(1) = 22.4855\ cm^3$$

Run 2:

$$V_P(2) = 148.3174 - 89.7985\left(\frac{17.274}{7.188} - 1\right)$$

$$= 148.3174 - 126.0027$$

$$V_P(2) = 22.3147\ cm^3$$

Run 3:

$$V_P(3) = 148.3174 - 89.7985\left(\frac{17.338}{7.222} - 1\right)$$

$$= 148.3174 - 125.7826$$

$$V_P(3) = 22.5348\ cm^3$$

$$V_P = \frac{V_P(1) + V_P(2) + V_P(3)}{3}$$

$$= \frac{22.4855 + 22.3147 + 22.5348}{3}$$

$V_P = 22.4450\ cm^3$ — Sample BB1

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MULTIPYCNOMETER DENSITY WORKSHEET

TRUE POWDER DENSITY

SAMPLE I.D BB1 & Mold DATE 10/3/01

SOURCE _____ OPERATOR AJ

OUTGASSING CONDITIONS Compressed N_2 @ ~ 25 PSI

TOTAL WEIGHT _____ g REFERENCE VOLUME (V_R) 89.7985 cm^3

TARE WEIGHT _____ g CELL VOLUME (V_c) 148.3174 cm^3

SAMPLE WEIGHT _____ g

OPERATIONAL EQUATION:

$$V_P = V_c - V_R\left((P_1/P_2)-1\right) \quad -①$$

V_p = Volume of powder (cm^3)

V_c = Volume of sample cell (cm^3)

V_R = Reference Volume (cm^3)

P_1 = Pressure reading after pressurizing the Reference Volume

P_2 = Pressure reading after including V_c .

DATA Mold and Sample

	RUN 1	RUN 2	RUN 3
P_1	17.581	17.252	17.584
P_2	12.146	11.923	12.165
V_P			
DENSITY			

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Use eqn ① to calculate the volume of the (mold + sample) Vp as follows:

Run 1:

$$V_p(1) = 148.3174 - 89.7985\left(\frac{17.581}{12.146} - 1\right)$$

(7985 → 7985 AJ 10/3/01)

$$= 148.3174 - 40.1824$$

$$\boxed{V_p(1) = 108.1350\ cm^3}$$

Run 2:

$$V_p(2) = 148.3174 - 89.7985\left(\frac{17.252}{11.923} - 1\right)$$

$$= 148.3174 - 40.1356$$

$$\boxed{V_p(2) = 108.1818\ cm^3}$$

Run 3:

$$V_p(3) = 148.3174 - 89.7985\left(\frac{17.584}{12.165} - 1\right)$$

$$= 148.3174 - 40.0015$$

$$\boxed{V_p(3) = 108.3159\ cm^3}$$

$$V_p = \frac{V_p(1) + V_p(2) + V_p(3)}{3}$$

$$= \frac{108.1350 + 108.1818 + 108.3159}{3}$$

$$\boxed{V_p = 108.2109\ cm^3}$$ (mold + sample)

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MULTIPYCNOMETER DENSITY WORKSHEET

TRUE POWDER DENSITY

SAMPLE I.D BB1 DATE 10/9/01

SOURCE _____ OPERATOR AJ

OUTGASSING CONDITIONS Compressed N_2 @ ~ 25 PSI

TOTAL WEIGHT _____ g REFERENCE VOLUME (V_R) _____ cm^3

TARE WEIGHT _____ g CELL VOLUME (V_c) _____ cm^3

SAMPLE WEIGHT _____ g

OPERATIONAL EQUATION:

$$V_P = V_c - V_R\left((P_1/P_2)-1\right) \quad -(1)$$

V_p = Volume of powder (cm^3)

V_c = Volume of sample cell (cm^3)

V_R = Reference Volume (cm^3)

P_1 = Pressure reading after pressurizing the Reference Volume

P_2 = Pressure reading after including V_c.

$$V_R = \frac{56.559}{\left[\left(\frac{P_1'}{P_2'}-1\right)-\left(\frac{P_1}{P_2}-1\right)\right]} \quad -(2)$$

$$V_C = 56.559 + V_R\left(\frac{P_1}{P_2}-1\right) \quad -(3)$$

DATA

	RUN 1	RUN 2	RUN 3	
P_1	17.467	17.617	17.325	w/large sphere
P_2	8.638	8.712	8.568	
V_P				
DENSITY				
P_1'	17.982	17.241	17.244	NO sphere
P_2'	6.781	6.501	6.503	

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Use eqn (2) to calculate reference volume V_R

Run 1: $V_R(1) = 89.8475\ cm^3$

Run 2: $V_R(2) = 89.7904\ cm^3$

Run 3: $V_R(3) = 89.8332\ cm^3$

$$V_R = \frac{V_R(1) + V_R(2) + V_R(3)}{3}$$

$$V_R = 89.8237\ cm^3$$

Use eqn (3) to calculate sample cell volume V_c, ~~(mold + sample in this case)~~ AJ 10/9/01

Run 1: $V_C(1) = 148.3678\ cm^3$

Run 2: $V_C(2) = 148.3768\ cm^3$

Run 3: $V_C(3) = 148.3678\ cm^3$

$$V_C = \frac{V_C(1) + V_C(2) + V_C(3)}{3}$$

$$V_C = 148.3708\ cm^3$$ ~~(Mold & Sample)~~ AJ 10/9/01

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MULTIPYCNOMETER DENSITY WORKSHEET

TRUE POWDER DENSITY

SAMPLE I.D BB1 DATE 10/9/01

SOURCE _____ OPERATOR AJ

OUTGASSING CONDITIONS compressed N_2 @ ~ 25 PSI

TOTAL WEIGHT _____ g REFERENCE VOLUME (V_R) 89.8237 cm^3

TARE WEIGHT _____ g CELL VOLUME (V_c) 148.3708 cm^3

SAMPLE WEIGHT _____ g

OPERATIONAL EQUATION:

$$V_P = V_c - V_R\left((P_1/P_2)-1\right) \quad -(1)$$

V_P = Volume of powder (cm^3)

V_c = Volume of sample cell (cm^3)

V_R = Reference Volume (cm^3)

P_1 = Pressure reading after pressurizing the Reference Volume

P_2 = Pressure reading after including V_c.

NO sample
Mold only

DATA

	RUN 1	RUN 2	RUN 3
P_1	17.487	17.527	10.468
P_2	10.324	10.347	10.318
V_P			
DENSITY			

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Use eqn (1) to calculate the volume of the mold only (V_P).

Run 1:

$V_P(1) = 86.0493\ cm^3$

Run 2:

$V_P(2) = 85.9772\ cm^3$

Run 3:

$V_P(3) = 86.0509\ cm^3$

$$V_P(mold) = \frac{V_P(1) + V_P(2) + V_P(3)}{3}$$

$$V_P(mold) = 86.0509\ cm^3$$

$V_P(sample) = V_P(mold + sample)$ from page 11 $- V_P(mold)$

$= 108.2109 - 86.0509$

$$V_P(sample) = 22.1600\ cm^3$$

$$Porosity = \frac{V_{voids}}{V_{Total}}$$

V_{Total} is Geometric volume calculated as follows:

Diameter = 3.1 cm
3.08 cm
3.00 cm
$\rightarrow$ Diameter average $= \frac{3.1 + 3.08 + 3.00}{3}$

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Diameter, D = 3.06 cm.

r, Radius = $\frac{3.06}{2}$ = 1.53 cm.

Height, H = 4.86 cm
4.90 cm
4.90 cm.

$H_{av} = \frac{4.86 + 4.9 + 4.9}{3} = 4.8867$ cm.

$V_{Total} = \pi r^2 H$ ~~$\frac{AJ}{10/3/01}$~~

$= 3.14 (1.53)^2 (4.8867)$

$V_{Total} = 35.9193\ cm^3$

V_{solid} (from pycnometer) = $22.4450\ cm^3$ (Calculated w/o mold from Page 9)

(1) $V_{Void} = V_{Total} - V_{solid}$

$= 35.9193 - 22.4450$

$= 13.4743\ cm^3$

Porosity = $\frac{13.4743}{35.9193}$

= 0.3751 or 37.51 %

(2) $V_{solid} = 22.1600\ cm^3$ (from pycnometer measurements with mold on page 15)

$V_{void} = 35.9193 - 22.1600 = 13.7593\ cm^3$

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Porosity = $\frac{13.7593}{35.9193}$

= 0.3831 or 38.31 %

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Project No._____
Book No._____ TITLE Design of Saturation Unit for Hydraulic Conductivity measurements

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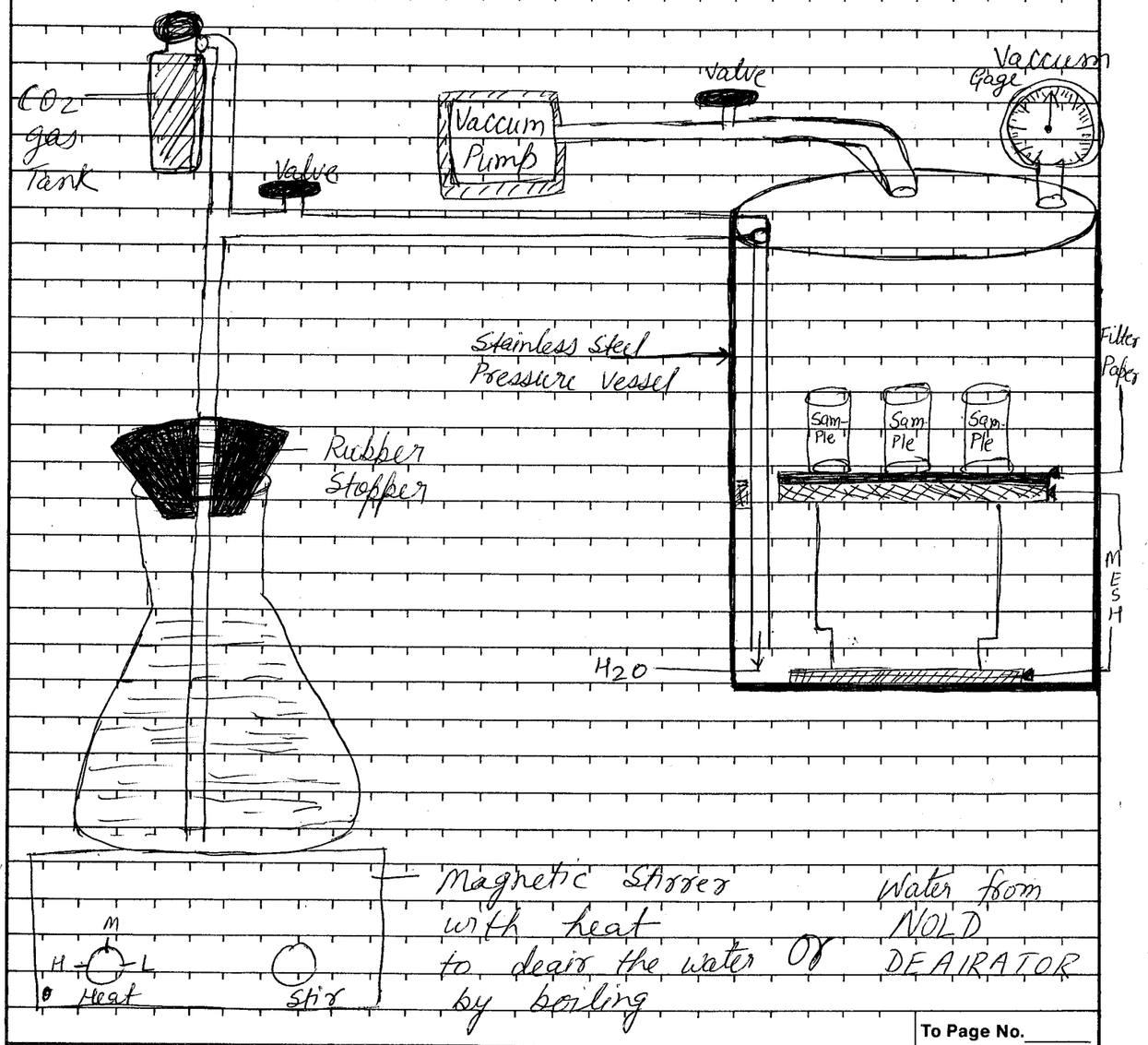

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Procedure :- (1) Place the samples in stainless steel pressure vessel as shown in figure.

(2) Turn the valve on and vaccum pump to deair the sample chamber. Close the valve and hold vaccum in the chamber for 15 minutes.

(3) Turn on the CO_2 gas cylinder to open and also the valve. Set the pressure to 1 PSI for the (O_2 gas. Pass the gas to (steel cylinder) sample chamber. Hold the flow of gas for 15 min.

(4) Repeat steps (2) & (3) ~~twice~~ twice. Finally, leave the chamber under vaccum until ready for water inflow. AJ 10/3/01

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Objective :- To measure the hydraulic conductivity of saturated BBI vitric tuff samples using constant head method. A Brainard Kilman, S-480 and a S-90 flex-wall permeameter in conjunction with a Brainard Kilman control panel ~~was~~ AJ 12/7/01 were used for measurements.

Supplies & Equipments :

① BBI vitric tuff samples in form of cylindrical cores (2.5cm x 5.0cm & 2.5cm x 2.5cm)

② Saturation unit (page 18 & 19) with vaccuum pump.

③ NOLD Deairator to supply deaired water

④ Stop watch

Procedure :- ① The basic methodology was taken from American Society for Testing materials (1997).

② It is assumed that the flow is ~~steady~~ AJ 12/7/01 steady, one-dimensional (1D) and that the core is completely saturated.

The specific method used to measure Ksat (Saturated ~~Hydraulic~~ AJ 12/7/01 hydraulic conductivity) is as follows:

③ A saturated sample was confined between two filter papers, which were positioned on the top and bottom of the sample as shown in Fig (3-2) to ensure adequate, hydraulic connection.

④ Lengths of the samples used in these tests varied from 2.3 cm to 5.0 cm.

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⑤ The sample and filter paper ~~were~~ AJ 12/7/01 were placed between end plates and encased in an impermeable latex membrane (two ~~balloons~~ AJ 12/7/01 layers of balloons were used in this case) and positioned inside the permeameter cell.

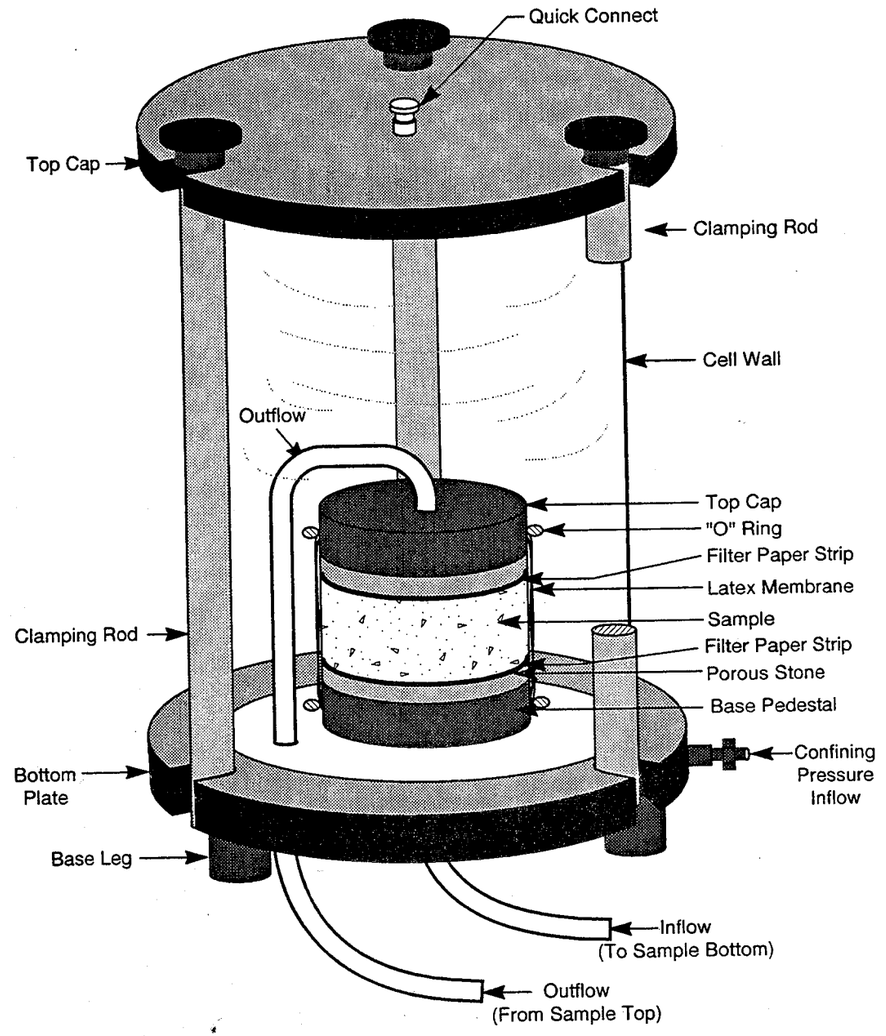

Figure 3-2. Schematic of a constant head permeameter used to measure saturated hydraulic conductivity

Note : No ~~porous~~ plates were used

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⑥ The cell was sealed, and the annulus was filled with water.

① The annulus water in the permeabreter cell was brought to and maintained at a pressure greater than the pressure to be imposed on the sample. As a result, the latex membrane (membrane AJ 12/7/01) was forced against the sidewalls of the sample to prevent flow of the permeant from the (the AJ 12/7/01) sides of the sample except through the sample.

⑧ A constant (head AJ 12/7/01) pressure head differential was then imposed across the sample.

⑨ The permeant was deaired & dionized water.

⑩ The quantity of permeant discharged through the sample was measured with respect to time using a stop watch. (hydraulic AJ 12/7/01) Saturated ~~hydraulic~~ conductivity was calculated using Darcy's law:

$$K_{sat} = \left(\frac{q}{t}\right)\left(\frac{L}{Ah}\right)$$

where

K_{sat} = hydraulic conductivity (m/s)
q = quantity of flow, taken as average of inflow & outflow volume change (m^3)
t = interval of test time (s)
L = length of sample along which flow occurs (m)
A = cross-sectional area of sample (m^2)
h = difference in hydraulic head across sample (mH_2O)

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Sample: BB1 Test=Ksat

Width(cm): 3	Area(cm^2): 7.065	Height(cm): 5

Time

Start time: 0	Stop time: 7:30 min.
Start date: 12/5/01	Stop date:
Elapsed Time	7:30 min.
Time(hrs):	Time(sec): 450

Pressure

Confining Pressure(psig):	13.2
Inflow Pressure(psig):	8.3
Outflow Pressure(psig):	6.2

Differential Pressure (dP)

dP(psig) = Inflow-Outflow	dP(cm H2O) = dP(psig)*27.68*2.54
2.1 [psig]	147.6451 [cm H2O]

Fluid Levels

	Initial (ml)	Final (ml)
Confining:	0.3	0.4
Inflow:	0.3	10.5
Outflow:	17.6	7.4

Fluid Level Changes

Confining (ml):	0.1 ml
Inflow (ml):	10.2 ml
Outflow (ml):	10.2 ml

Volume change

[Inflow (ml) + Outflow (ml)] / 2
10.2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	= (1)	0.02267 [ml/sec]
A = Area (cm^2)	= (2)	7.065 [cm^2]
dL = Sample Height (cm)	= (3)	5 [cm]
dH = Differential Pressure (cm H2O)	= (4)	147.6451 [cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		1.08X10-4 [cm/sec]

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Sample: Test=Ksat

Width(cm): 3	Area(cm^2): 7.07	Height(cm): 5

Time

Start time: 0	Stop time: 7:30
Start date: 12/5/01	Stop date:

Elapsed Time 7:30 m/h

Time(hrs):	Time(sec): ~~450~~ 450

AJ 2/15/02

Pressure

Confining Pressure(psig): 13.4
Inflow Pressure(psig): 8
Outflow Pressure(psig): 6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow	dP(cm H2O) = dP(psig)*27.68*2.54
2 [psig]	140.6144 [cm H2O]

Fluid Levels

Initial (ml)		Final (ml)	
Confining:	7.0	Confining:	7.0
Inflow:	0.5	Inflow:	10.5
Outflow:	17.3	Outflow:	7.3

Fluid Level Changes

Confining (ml): 0 ml
Inflow (ml): 10 ml
Outflow (ml): 10 ml

Volume change

[Inflow (ml) + Outflow (ml)] / 2
10 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	= (1) 0.0222	[ml/sec]
A = Area (cm^2)	= (2) 7.07	[cm^2]
dL = Sample Height (cm)	= (3) 5	[cm]
dH = Differential Pressure (cm H2O)	= (4) 140.6144	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)	1.11 X 10^-4	[cm/sec]

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Sample: BB1 Test=Ksat

Width(cm): 3	Area(cm^2): 7.07	Height(cm): 5

Time

Start time: 0	Stop time: 7:16 m/h.
Start date: 12/5/01	Stop date:

Elapsed Time 7:16 m/h.

Time(hrs):	Time(sec): 436

Pressure

Confining Pressure(psig): 13.2
Inflow Pressure(psig): 8.3
Outflow Pressure(psig): 6.2

Differential Pressure (dP)

dP(psig) = Inflow-Outflow	dP(cm H2O) = dP(psig)*27.68*2.54
2.1 [psig]	147.6451 [cm H2O]

Fluid Levels

Initial (ml)		Final (ml)	
Confining:	1.4	Confining:	1.4
Inflow:	0	Inflow:	10.1
Outflow:	17.2	Outflow:	7.1

Fluid Level Changes

Confining (ml): 0
Inflow (ml): 10.1
Outflow (ml): 10.1

Volume change

[Inflow (ml) + Outflow (ml)] / 2
10.1 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	= (1) 0.02317	[ml/sec]
A = Area (cm^2)	= (2) 7.07	[cm^2]
dL = Sample Height (cm)	= (3) 5	[cm]
dH = Differential Pressure (cm H2O)	= (4) 147.6451	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)	1.11 X 10^-4	[cm/sec]

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Sample: BB1 Test=Ksat

Width(cm): 3	Area(cm^2): 7.07	Height(cm): 2.5

Time

Start time:	Stop time:
Start date:	Stop date:

Elapsed Time 5:45 min

Time(hrs):	Time(sec): ~~345~~ 345 AJ 2/13/02

Pressure

Confining Pressure(psig):	13
Inflow Pressure(psig):	8
Outflow Pressure(psig):	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow	dP(cm H2O) = dP(psig)*27.68*2.54
2 [psig]	140.6144 [cm H2O]

Fluid Levels

	Initial (ml)	Final (ml)
Confining:	1.7	1.5
Inflow:	1.1	11.2
Outflow:	17.8	7.7

Fluid Level Changes

Confining (ml):	0.2
Inflow (ml):	10.1
Outflow (ml):	10.1

Volume change

[Inflow (ml) + Outflow (ml)] / 2
10.1 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	= (1) 0.02928	[ml/sec]
A = Area (cm^2)	= (2) 7.07	[cm^2]
dL = Sample Height (cm)	= (3) 2.5	[cm]
dH = Differential Pressure (cm H2O)	= (4) 140.6144	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)	0.74 X 10^{-4}	[cm/sec]

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Sample: BB1 Test=Ksat

Width(cm): 3	Area(cm^2): 7.07	Height(cm): 2.5

Time

Start time:	Stop time:
Start date: 12/7/01	Stop date:

Elapsed Time 5:45 min

Time(hrs):	Time(sec): 345

Pressure

Confining Pressure(psig):	13
Inflow Pressure(psig):	8
Outflow Pressure(psig):	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow	dP(cm H2O) = dP(psig)*27.68*2.54
2.0 [psig]	140.6144 [cm H2O]

Fluid Levels

	Initial (ml)	Final (ml)
Confining:	1.3	1.5
Inflow:	0	10
Outflow:	16.5	6.6

Fluid Level Changes

Confining (ml):	0.2
Inflow (ml):	10
Outflow (ml):	10.1

Volume change

[Inflow (ml) + Outflow (ml)] / 2
10.05 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	= (1) 0.0293	[ml/sec]
A = Area (cm^2)	= (2) 7.07	[cm^2]
dL = Sample Height (cm)	= (3) 2.5	[cm]
dH = Differential Pressure (cm H2O)	= (4) 140.6144	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)	0.73 X 10^{-4}	[cm/sec]

Witnessed & Understood by me,	Date 12/7/01	Invented by	Date
		Recorded by AJ	

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Sample: BB1 Test=Ksat

Width(cm): 3 cm	Area(cm^2): 7.065	Height(cm): 2.3

Time

Start time:	Stop time:
Start date: 12/07/01	Stop date:

Elapsed Time 5:42 min.

Time(hrs):	Time(sec): 342

Pressure

Confining Pressure(psig):	13
Inflow Pressure(psig):	8
Outflow Pressure(psig):	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow	dP(cm H2O) = dP(psig)*27.68*2.54
2 [psig]	140.6144 [cm H2O]

Fluid Levels

	Initial (ml)	Final (ml)
Confining:	8.5	9.0
Inflow:	1.0	11.0
Outflow:	20.3	10.7

Fluid Level Changes

Confining (ml):	0.5
Inflow (ml):	10
Outflow (ml):	9.6

Volume change

[Inflow (ml) + Outflow (ml)] / 2
9.8 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	= (1) 0.0295	[ml/sec]
A = Area (cm^2)	= (2) 7.065	[cm^2]
dL = Sample Height (cm)	= (3) 2.3	[cm]
dH = Differential Pressure (cm H2O)	= (4) 140.6144	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)	0.66 X 10^{-4}	[cm/sec]

Witnessed & Understood by me,	Date 12/7/01	Invented by	Date
		Recorded by AJ	

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Sample: BB1 Test=Ksat

Width(cm): 3 cm.	Area(cm^2): 7.07 cm^2	Height(cm): 2.3 cm.

Time

Start time:	Stop time:
Start date: 12/7/01	Stop date:

Elapsed Time 6:13 min.

Time(hrs):	Time(sec): 373

Pressure

Confining Pressure(psig):	13
Inflow Pressure(psig):	8
Outflow Pressure(psig):	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow	dP(cm H2O) = dP(psig)*27.68*2.54
2.0 [psig]	140.6144 [cm H2O]

Fluid Levels

	Initial (ml)	Final (ml)
Confining:	7.9	8.2
Inflow:	2.7	12.7
Outflow:	22.7	12.7

Fluid Level Changes

Confining (ml):	0.3 ml
Inflow (ml):	10
Outflow (ml):	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2
10 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	= (1) 0.0271	[ml/sec]
A = Area (cm^2)	= (2) 7.07	[cm^2]
dL = Sample Height (cm)	= (3) 2.3	[cm]
dH = Differential Pressure (cm H2O)	= (4) 140.6144	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)	0.62 X 10^{-4}	[cm/sec]

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		Recorded by AJ	

Sample: BB1 Test=Ksat

Width(cm): 3	Area(cm^2): 7.065	Height(cm): 2.3

Time

Start time: AJ 12/15/02	Stop time:
Start date: 12/7/01	Stop date:

Elapsed Time 6:28 min.

Time(hrs):	Time(sec): 388

Pressure

Confining Pressure(psig):	13
Inflow Pressure(psig):	8
Outflow Pressure(psig):	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow	dP(cm H2O) = dP(psig)*27.68*2.54
2.0 [psig]	140.6144 [cm H2O]

Fluid Levels

	Initial (ml)	Final (ml)
Confining:	9.2	9.2
Inflow:	4.0	14.1
Outflow:	20.2	10.1

Fluid Level Changes

Confining (ml):	0
Inflow (ml):	10.1
Outflow (ml):	10.1

Volume change

[Inflow (ml) + Outflow (ml)] / 2
10.1 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	= (1)	0.0260 [ml/sec]
A = Area (cm^2)	= (2)	7.065 [cm^2]
dL = Sample Height (cm)	= (3)	2.3 [cm]
dH = Differential Pressure (cm H2O)	= (4)	140.6144 [cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		6.03x10^-7 [cm/sec]

12/7/01

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Bulk density measurements

BB3(I)

① Volume of liquid displaced by BB3(I) = 540 ml (H2O)
- 400 ml
140 ml

② Volume of liquid displaced by BB3(I) = 640 ml (H2O)
- 500
140 ml

③ Volume of water displaced by BB3(I) = 500 ml
- 360
140 ml

BB3(2)

AJ
2/10/02

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Bulk Density Measurements for Rock samples BB1 & BB3

wt. of beaker containing BB1 (1) = 165.45 g

wt. of beaker containing BB1 (2) = 170.60 g

wt. of beaker containing BB1 (3) = 28.70 g

wt. of beaker containing BB3 (1) = 165.67 g

wt. of ~~weat~~ beaker containing BB3 (2) = 115.92 g
AJ 2/8/02

BB1(1), BB1(2), BB1(3), BB3(1) & BB3(2) were placed in beakers and kept in oven @ 105°C to obtain the dried weight.

Volume of BB1(3) :- Geometric height and diameter of BB1(3) were measured with vernier callipers.

$H = 3.93\,cm, 3.95\,cm, 3.92\,cm$

$Average\ H = \frac{3.93 + 3.95 + 3.92}{3} = 3.933\ cm$

$Diamter, D = \frac{3.12 + 3.12 + 3.12}{3} = 3.12\ cm$

$R = \frac{3.12}{2} = 1.56\ cm$

Geometric Volume BB1(3) $= \pi R^2 H$

$= 3.14 \times 1.56 \times 1.56 \times \overset{AJ\ 2/8/02}{\cancel{3.12}}\ 3.933\ cm$

$= 30.054\ cm^3$

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① wt. of BB1(1) + beaker = 352.78 g.

All the samples were removed from the oven and cooled in dessicator for few hours before measuring the weights.

② wt. of BB1(2) + beaker = 329.31 g

③ wt. of BB1(3) + beaker = 71.00 g

④ wt. of BB3(1) + beaker = 301.26 g

⑤ wt. of BB3(2) + beaker = 270.15 g.

Dried
① wt. of BB1(1) = 352.78 − 165.45

BB1(1) = 187.33 g

② Dried wt. of BB1(2) = 329.31 − 170.60

= 158.71 g

③ Dried wt. of BB1(3) = 71.00 − 28.70 g

= 42.30 g

④ Dried wt. of BB3(1) = 301.26 − 165.67

= ~~135.60~~ 135.59 g
AJ 2/12/02

⑤ Dried wt. of BB3(2) = 270.15 − 115.92 g

= 154.23 g

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All the samples were again placed in beakers and kept in oven @ 105°C. Next day the samples ~~were~~ AJ 2/13/02 were removed from oven and cooled in dessicator before weighing.

wt. of BB1(1) + beaker = 352.80 g

wt. of BB1(2) + beaker = 329.31 g

wt. of BB1(3) + beaker = 71.00 g

wt. of BB3(1) + beaker = 301.25 g

wt. of BB3(2) + beaker = 270.15 g

These weights are within ±0.02g of the previously measured weights.

(1) wt. of dried BB1(1) = 352.80 − 165.45 g
= 187.35 g

(2) wt. of dried ~~BB2~~ BB1 (2) = 329.31 − 170.60 AJ 2/13/02
= 158.71 g

(3) wt. of dried BB1(3) = 71.00 − 28.70
= 42.30 g

(4) wt. of dried BB3(1) = 301.25 − 165.67
= 135.58 g

(5) wt. of dried BB3(2) = 270.15 − 115.92
= 154.23 g

(6) Bulk density from BB1(3) = 42.30 g / 30.054 cm³ = ~~+.3~~ 2/13/02 AJ 1.41 g/cm³

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All the samples were again placed in beakers and kept in oven @ 105°C. The samples were removed from the oven after 48 hrs. and ~~dried~~ cooled AJ 2/15/02 in dessicator before weighing.

wt. of BB1(1) + beaker = 352.79 g

wt. of BB1(2) + beaker = 329.34 g

wt. of BB1(3) + beaker = 70.99 g

wt. of BB3(1) + beaker = 301.24

wt. of BB3(2) + beaker = 270.15 g

(1) Vol. of DI H_2O displaced by BB1(2) = 150 ml, 150 ml
Vol. of tape + plastic ~~wrap~~ AJ 2/19/02 wrap = 30ml., 30 ml
Vol. of DI H_2O displaced by BB1(2) = 150 − 30 ml
= 120 ml.

Bulk Density from BB1(2) = 158.72 g / 120 ml
= 1.323

(2) Vol. of DI H_2O displaced by BB3(2) wrapped in plastic wrap & tape = 150 ml, 150 ml.
~~Vol.~~ Vol. of DI H_2O displaced by tape + plastic wrap = 25 ml
AJ 2/19/02
Vol. of DI H_2O displaced by BB3(2) = 150 − 25 ml
= 125 ml.
Bulk density from BB3(2) = 154.23 g / 125 ml = 1.234

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① Vol. of DI H_2O displaced by BB1(1) wrapped in plastic and duck tape = 160ml

Vol. of DI H_2O displaced by plastic wrap & duck tape = 25 ml

Bulk density from BB1(1) = $\frac{187.35\ g}{(160-25)}$

$= \frac{187.35}{135}$

$= 1.388\ g/cm^3$

② Vol. of DI H_2O displaced by BB3(1) wrapped in plastic & duck tape = 135 ml

Vol. of DI H_2O displaced by plastic wrap + tape = 25ml

Vol. of DI H_2O displaced by BB3(1) = 135 - 25 = 110 ml

Bulk density from BB3(1) = $\frac{135.58\ g}{110\ ml}$

$= 1.23\ g/ml$

Average Bulk density from BB1 & BB3 samples

$= \frac{1.41 + 1.323 + 1.234 + 1.388 + 1.23}{5}$

$= 1.317\ g/cm^3$

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Sample: BB1(1) Test=Ksat

Width(cm):	Area(cm^2):	Height(cm):
3.0	7.065	2.45

Time

Start time:	0	0	0	0
Start date:	2/15/02			
Stop time:	9:13	3:35	2:08	7:02
Stop date:				
Elapsed Time	9:13	3:35	2:08	7:02
Time(hrs):				
Time(sec):	553	215	128	422

Pressure

Confining Pressure(psig):	13.1	16	18	13
Inflow Pressure(psig):	8.1	11	12	8
Outflow Pressure(psig):	6	7	6	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54
2.1	4	6	2	[psig] / [cm H2O]

Fluid Levels

Initial (ml)					Final (ml)				
Confining:	0.8		0.5	1.5	Confining:	1.0		0.5	1.5
Inflow:	5.7	3	3	2.9	Inflow:	15.7	11.5	13	12.9
Outflow:	15.8	13	15	15.4	Outflow:	6.2	1.4	4.9	5.4

Fluid Level Changes

Confining (ml):	0.2		0	0	
Inflow (ml):	10	8.5	10	10	
Outflow (ml):	9.6	11.6	10.1	10	

Volume change

[Inflow (ml) + Outflow (ml)] / 2				
9.8	10.05	10.05	10	[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2) 7.065	[cm^2]
dL = Sample Height (cm)	(3) 2.45	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)	4.16×10^{-7} * 5.76×10^{-7} / 6.45×10^{-7} / 5.84×10^{-7}	[cm/sec]

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Fro

Sample: BB1(2) Test=Ksat

Width(cm):	3.0 cm	Area(cm^2):	7.065	Height(cm):	2.22

Time

Start time:	0	0	0	0	Stop time:	6:04	2:48	1:54
Start date:	2/20/02				Stop date:			
					Elapsed Time	6:04	2:48	1:54
Time(hrs):					Time(sec):	364	168	114

Pressure

Confining Pressure(psig):	13	16	18	
Inflow Pressure(psig):	8	11	12	
Outflow Pressure(psig):	6	7	6	

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H20) = dP(psig)*27.68*2.54	
2	4	6	[psig]	140.6144	[cm H20]

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	0.3	0.3	1.1	Confining:	0.5	0.4	1.2
Inflow:	2	2	2	Inflow:	12	12	12
Outflow:	14	14	13.9	Outflow:	4	4	3.9

Fluid Level Changes

Confining (ml):	0.2	0.1	0.1	
Inflow (ml):	10	10	10	
Outflow (ml):	10	10	10	

Volume change

[Inflow (ml) + Outflow (ml)] / 2			
10	10	10	[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	=	(1) 10	[ml/sec]
A = Area (cm^2)	=	(2) 7.065	[cm^2]
dL = Sample Height (cm)	=	(3) 2.22	[cm]
dH = Differential Pressure (cm H20)	=	(4) 140.6144	[cm H20]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		6.14 x10^-5 / 6.65x10^-7 / 6.53x10^-7	[cm/sec]

Witnessed & Understood by me, Date 2/20/02 Invented by Recorded by AJ Date

Sample: BB1(3) Test=Ksat

Width(cm):	3.0	Area(cm^2):	7.065	Height(cm):	4.9

Time

Start time:	0,0,0,0	Stop time:	2:22	3:44	8:45	2:20
Start date:	2/20/02	Stop date:				
		Elapsed Time	2:22	3:44	8:45	2:20
Time(hrs):		Time(sec):	142	224	525	140

Pressure

Confining Pressure(psig):	18	16	13	18
Inflow Pressure(psig):	12	11	8	12
Outflow Pressure(psig):	6	7	6	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow					dP(cm H20) = dP(psig)*27.68*2.54			
6	4	2	6	[psig]	421.843	281.228	140.614	421.843 [cm H20]

Fluid Levels

Initial (ml)					Final (ml)				
Confining:	0.7	0	0.1	0.6	Confining:	0.7	0	0.1	0.6
Inflow:	0.1	0.2	0.2	0.5	Inflow:	10.1	10.3	10.2	10.7
Outflow:	12.9	14.2	15.2	13	Outflow:	2.9	4.1	5.2	3.3

Fluid Level Changes

Confining (ml):	0	0	0	0	
Inflow (ml):	10	10.1	10	10.2	
Outflow (ml):	10	10.1	10	9.7	

Volume change

[Inflow (ml) + Outflow (ml)] / 2				
10	10.1	10	9.95	[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	=	(1)	[ml/sec]
A = Area (cm^2)	=	(2) 7.065	[cm^2]
dL = Sample Height (cm)	=	(3) 4.9	[cm]
dH = Differential Pressure (cm H20)	=	(4)	[cm H20]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		1.16x10^-6 / 1.11x10^-6 / 9.39x10^-7 / 1.17x10^-6	[cm/sec]

Witnessed & Understood by me, Date 2/20/02 Invented by Recorded by AJ Date

Project No._____
Book No._____

Sample: BB1(4) Test=Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 3.75

Time

Start time: 0,0,0,0	Stop time: 19:44	9:55	11:34	9:04
Start date: 2/20/02	Stop date:			
	Elapsed Time 19:44 min.	9:55	11:34	9:04
Time(hrs):	Time(sec): 1184	595	694	544

Pressure

Confining Pressure(psig):	13	16	16	18	
Inflow Pressure(psig):	8	11	11	12	
Outflow Pressure(psig):	6	7	7	6	

Differential Pressure (dP)

dP(psig) = Inflow-Outflow					dP(cm H20) = dP(psig)*27.68*2.54				
2	4	4	6	[psig]	140.614	281.2288	281.2288	421.843	[cm H20]

Fluid Levels

Initial (ml)					Final (ml)				
Confining:	0	0	0.3	0.7	Confining:	0	0.1	0.3	0.7
Inflow:	2	1.3	3.1	1.0	Inflow:	12	11.4	13.2	11.0
Outflow:	15	14.1	14.9	14.9	Outflow:	5.1	4.0	5.0	4.9

Fluid Level Changes

Confining (ml):	0	0.1	0	0	
Inflow (ml):	10	10.1	10.1	10	
Outflow (ml):	9.9	10.1	9.9	10	

Volume change

[Inflow (ml) + Outflow (ml)] / 2				
9.95	10.1	10	10	[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	= (1)	[ml/sec]
A = Area (cm^2) 7.065	= (2)	[cm^2]
dL = Sample Height (cm) 3.75	= (3)	[cm]
dH = Differential Pressure (cm H20)	= (4) 3.11×10^{-7}	[cm H20]
Ksat = [1 / 2] * [3 / 4] (cm/sec)	3.20×10^{-7}	[cm/sec]

Witnessed & Understood by me,

Date 2/20/02

Invented by

Recorded by AJ

Date 2.72×10^{-7} 2.31×10^{-7}

Project No._____
TITLE_____ Book No._____

Sample: BB3(1) Packed Test=Ksat in clear tube

Width(cm): 3	Area(cm^2): 7.065	Height(cm): 4.45

Time

Start time:	Stop time:			
Start date: 2/27/02	Stop date:			
	Elapsed Time 2:34	3:03	3:17	1:29
Time(hrs):	Time(sec):			

Pressure

Confining Pressure(psig):	13	13	13	16.1	
Inflow Pressure(psig):	8	8	8	11.1	
Outflow Pressure(psig):	6	6	6	7.1	

Differential Pressure (dP)

dP(psig) = Inflow-Outflow	dP(cm H20) = dP(psig)*27.68*2.54
[psig]	[cm H20]

Fluid Levels

Initial (ml)					Final (ml)				
Confining:	5.5	1	1.1	1	Confining:	5.5	1.1	1.3	1
Inflow:	1	0	0	0	Inflow:	11.5	10	10	10
Outflow:	15.2	16	16.5	16	Outflow:	5.2	6.1	6.5	6

Fluid Level Changes

Confining (ml):	0	0.1	0.2	0	
Inflow (ml):	10.5	10	10	10	
Outflow (ml):	10	10.1	10	10	

Volume change

[Inflow (ml) + Outflow (ml)] / 2	
	[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	= (1)	[ml/sec]
A = Area (cm^2)	= (2) 7.065	[cm^2]
dL = Sample Height (cm)	= (3) 4.45	[cm]
dH = Differential Pressure (cm H20)	= (4) 1.29×10^{-6}	[cm H20]
Ksat = [1 / 2] * [3 / 4] (cm/sec)	2.44×10^{-6} 2.27×10^{-6} 2.52×10^{-6}	[cm/sec]

Notes

2/27/02 Recorded by AJ

Project No.

Sample: BB3(1) Packed in Test=Ksat clear tube

Width(cm): 3	Area(cm^2): 7.065	Height(cm): 4.45

Time

Start time:	Stop time:
Start date: 2/27/02	Stop date:

Elapsed Time 1:10 | 1:15 | 2:38 | 1:35

Time(hrs):	Time(sec):

Pressure

Confining Pressure(psig):	18	18	13	16
Inflow Pressure(psig):	12	12	8	11
Outflow Pressure(psig):	6	6	6	7

Differential Pressure (dP)

dP(psig) = Inflow-Outflow [psig]	dP(cm H2O) = dP(psig)*27.68*2.54 [cm H2O]

Fluid Levels

Initial (ml)				
Confining:	0	0.5	0.2	0.8
Inflow:	0	2	0	0
Outflow:	16.1	16	16	15.1

Final (ml)				
Confining:	0	0.5	0.2	0.8
Inflow:	10.2	12	9.9	10
Outflow:	5.9	6	6	5.1

Fluid Level Changes

Confining (ml):	0	0	0	0
Inflow (ml):	10.2	10	9.9	10
Outflow (ml):	10.2	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2				
10.2	10	9.95	10	[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2) 7.065	[cm^2]
dL = Sample Height (cm)	(3) 4.45	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)	2.18×10^{-6} 1.99×10^{-6} 2.82×10^{-6} 2.36×10^{-6}	[cm/sec]

Notes

2/27/02 Recorded by AJ

Project No.

Sample: BB3(2) Packed in Test=Ksat black tube

Width(cm): 3	Area(cm^2): 7.065	Height(cm): 5

Time

Start time:	Stop time:
Start date: 2/27/02	Stop date:

Elapsed Time 2:51 | 3:26 | 1:45 | 2:02 | 1:25 | 1:29

Time(hrs):	Time(sec):

Pressure

	(1)	(2)	(3)	(4)	(5)	(6)
Confining Pressure(psig):	13	13	16	16	18	18
Inflow Pressure(psig):	8	8	11	11	12	12
Outflow Pressure(psig):	6	6	7	7	6	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow [psig]	dP(cm H2O) = dP(psig)*27.68*2.54 [cm H2O]

Fluid Levels

Initial (ml)						
Confining:	0.4	0.6	1	0	0.4	0.4
Inflow:	0	0	0	0	0	0
Outflow:	15.1	14	14	14	15.1	14

Final (ml)						
Confining:	0.6	0.6	1	0	0.4	0.4
Inflow:	10	10	10	10	10	10
Outflow:	5.1	4	4	4	5.1	4

Fluid Level Changes

Confining (ml):	0.2	0	0	0	0	0
Inflow (ml):	10	10	10	10	10	10
Outflow (ml):	10	10	10	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2						
10	10	10	10	10	10	[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2) 7.065	[cm^2]
dL = Sample Height (cm)	(3) 5	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)	(1) 2.94×10^{-6} (2) 2.94×10^{-6}	[cm/sec]

③ 2.4×10^{-6} ④ 2.06×10^{-6} **Notes** ⑤ 1.97×10^{-6} ⑥ 1.89×10^{-6}

2/27/02 Recorded by AJ

Project No.

Sample: BB3(1) Test=Ksat

Width(cm):	Area(cm^2): 7.065	Height(cm): 2 cm

Time

Start time:	Stop time:
Start date: 3/5/02	Stop date:

Elapsed Time

Time(hrs):	Time(sec): 0:24	0:13	0:12

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54			
2	4	6	[psig]	140.61	281.23	421.84	[cm H2O]

Fluid Levels

Initial (ml)			
Confining:	0.3	0.8	2.5
Inflow:	0	0	0
Outflow:	15.5	15	15

Final (ml)			
Confining:	0.3	0.8	2.5
Inflow:	10.1	10	10
Outflow:	5.4	4.9	5.0

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10.1	10	10
Outflow (ml):	10.1	10.1	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2	
	[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	= (1)	[ml/sec]
A = Area (cm^2)	= (2)	[cm^2]
dL = Sample Height (cm)	= (3)	[cm]
dH = Differential Pressure (cm H2O)	= (4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)	9.68X10^-6 ~~7.78X10^-6~~ 5.59X10^-6	[cm/sec]

Notes

3/5/02 Recorded by AJ

Project No.

TITLE Thermal effects on Ksat. Book No.

From Page No.

Samples BB1(1), BB1(2), BB1(3), BB1(4) and BB3(1) packed were saturated with ~~J~~ AJ 3/19/02 UZ-14 perched water

AJ

3/19/02

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Witnessed & Understood by me,	Date 3/19/02	Invented by	Date
		Recorded by AJ	

From Page No.____

objective :- To prepare UZ-14 perched water to study the thermal effects on hydraulic conductivity of vitric tuff.

Supplies :-

$NaHCO_3$ (FS lot # 006275, ACS certified)
KNO_3 (FS lot # 017063, ACS certified)
$MgCl_2 \cdot 6H_2O$ (FS lot # 006854. ACS certified)
$CaSO_4 \cdot 2H_2O$ (EM science PR # 50559)
$Ca(NO_3)_2 \cdot 4H_2O$ (FS, lot # 006169, ACS certified)
$CaCO_3$ (FS lot # 986396, ACS certified)
Nanopure water
Magnetic stirrer & stir plate
400 ml beaker
2L measuring flask
20L Nalgene Plastic bottle to store water

Procedure :-

To prepare one liter of Simulated UZ-14 Perched Water, add reagent grade CaSO4.2H2O and CaCO3, in the amounts shown in the table, to 900 mL of high purity water at room temperature in a beaker and stir until dissolved. Then add the other reagents, in the amounts shown in the table, to the solution and stir until dissolved completely. Care should be taken to weigh/add MgCl2.6H2O amd Ca(NO3)2.4H2O quickly since those are hygroscopic and can cause inaccuracies in weight measurement. Transfer the solution into a 1-L volumetric flask and adjust the volume to 1-L with high purity water.

Ingredient	millimolar concentration	formula wt. of reagent	grams reagent per Liter solution
NaHCO3	1.522	84	0.127848
KNO3	0.105	101.11	0.010617
MgCl2.6H2O	0.103	203.31	0.020941
CaSO4.2H2O	0.252	172.17	0.043387
Ca(NO3)2.4H2O	0.0855	236.15	0.020191
CaCO3	0.2785	100.09	0.027875

A batch of 10L UZ-14 perched water was prepared as follows:

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Ingredient	millimolar concentration	grams reagent per Liter solution	grams reagent per 10L solution	grams reagent added
NaHCO3	1.522	0.127848	1.2785	1.2788
KNO3	0.105	0.010617	0.1062	0.1065
MgCl2.6H2O	0.103	0.020941	0.2094	0.2095
CaSO4.2H2O	0.252	0.043387	0.4339	0.4341
Ca(NO3)2.4H2O	0.0855	0.020191	0.2019	0.2020
CaCO3	0.2785	0.027875	0.2788	0.2789

$CaCO_3$ and $CaSO_4 \cdot 2H_2O$ were added to 3500 ml nanopure H_2O in 4L beaker and stirred continously to dissolve.

The solution was still cloudy next day. The other ingradients were added to the solution. The solution was stirred for next 6 days. The solution was still not clear. The mixture was then filtered using Fisherbrand P5 filter paper and vaccum pump. The total solution was diluted to 10L with nanopure water and stored in 20L Nalgene plastic container.

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Witnessed & Understood by me, | Date 3/10/02 3/12/02 | Invented by | Date | Recorded by AJ

Project No._____
Book No._____ TITLE Thermal effects on Ksat.

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① Samples BB1(1), BB1(2), BB1(3), BB1(4) and BB3(1) packed were saturated with UZ-14 perched water.

② These samples were then transferred to separate 5 pressure vessels (Parr Instrument).

③ Additional UZ-14 perched water was added to each pressure vessel. ~~to~~ AJ 3/19/02 The total volume of the sample and UZ-14 perched water in the vessel is 110 ml.

ⓐ Volume of BB1(1) = 17.31 ml
Volume of UZ-14 H_2O added = 92.7 ml

ⓑ Volume of BB1(2) = 15.7 ml
Volume of UZ-14 H_2O = 94.3 ml added

ⓒ Volume of BB1(3) = 34.6 ml
Volume of UZ-14 H_2O = 75.4 ml added

ⓓ Volume of BB1(4) = 26.5 ml
Volume of UZ-14 H_2O = 83.5 ml added

ⓔ Volume of BB3(1) packed = 31.4 ml
Volume of UZ-14 H_2O added = 60 ml
The total volume was less than 110 ml for packed sample. Sample BB3(1) packed seems to absorb more H_2O than core samples.

The samples were placed in oven @ 90°C on 3/26/02

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Witnessed & Understood by me,	Date 3/19/02	Invented by / Recorded by AJ	Date

Sample: BB3(2) Test=Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 4.15

Time

Start time:	Stop time:
Start date: 3/26/02	Stop date:

Elapsed Time 0:36 | 0:22 | 0:17 | 0:17

Time(hrs):	Time(sec): 36, 22, 17, 17

Pressure

Confining Pressure(psig):	13	16	18	18
Inflow Pressure(psig):	8	11	12	12
Outflow Pressure(psig):	6	7	6	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow					dP(cm H2O) = dP(psig)*27.68*2.54			
2	4	6	6	[psig]	140.61	281.23	421.84	[cm H2O]

Fluid Levels

Initial (ml)					Final (ml)				
Confining:	0.9	2.1	2.8	2.9	Confining:	0.9	2.1	2.8	2.9
Inflow:	1	1	1	1	Inflow:	11	11.1	11.2	11.1
Outflow:	16	16	16.2	16	Outflow:	6	5.9	6.0	5.9

Fluid Level Changes

Confining (ml):	0	0	0	0
Inflow (ml):	10	10.1	10.2	10.1
Outflow (ml):	10	10.1	10.2	10.1

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

Notes Ksat Values in cm/sec.
before thermal treatment

1.16×10^{-3} cm/sec.	9.59×10^{-4}	8.35×10^{-4}	8.35×10^{-4} cm/sec.

Witnessed & Understood by me,	Date	Invented by / Recorded by AJ	Date

Project No._____
Book No._____ TITLE _____

Sample: BB3(3) Test-Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 3.36

Time

Start time:	Stop time:
Start date: 3/27/02	Stop date:
Elapsed Time 1:35 | 0:54 | 0:40	
Time(hrs):	Time(sec): 95 | 54 | 40

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54			
2	4	6	[psig]	140.61	281.23	421.84	[cm H2O]

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	0.9	1.6	2.1	Confining:	0.9	1.6	2.1
Inflow:	1	1	1	Inflow:	11	11	11
Outflow:	16	16	16	Outflow:	6	6	6

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2	
	[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	=	(1)	[ml/sec]
A = Area (cm^2)	=	(2)	[cm^2]
dL = Sample Height (cm)	=	(3)	[cm]
dH = Differential Pressure (cm H2O)	=	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)			[cm/sec]

Notes Ksat Values in cm/sec. before thermal treatment

3.56×10^{-4} AJ 3/27/02 | 3.13×10^{-4} AJ 3/27/02 | 2.82×10^{-4} cm/sec.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

TITLE _____ Book No._____

Sample: BB3(4) Test-Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 3.2

Time

Start time:	Stop time:
Start date: 3/27/02	Stop date:
Elapsed Time 1:33 | 0:52 | 0:39	
Time(hrs):	Time(sec): 93 | 52 | 39

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54			
2	4	6	[psig]	140.61	281.23	421.84	[cm H2O]

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	0.6	0.6	2.2	Confining:	0.6	1.6	2.2
Inflow:	1.1	1.1	1	Inflow:	11.1	11.1	11
Outflow:	17	17	16	Outflow:	7	7	6

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2	
	[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	=	(1)	[ml/sec]
A = Area (cm^2)	=	(2)	[cm^2]
dL = Sample Height (cm)	=	(3)	[cm]
dH = Differential Pressure (cm H2O)	=	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)			[cm/sec]

Notes Ksat Values in cm/sec. before thermal treatment

3.46×10^{-4} | 3.10×10^{-4} | 2.75×10^{-4} cm/sec.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

Sample: BB3(5) Test-Ksat

Width(cm):	3.0	Area(cm^2):	7.065	Height(cm):	2.86

Time

Start time:		Stop time:	
Start date:	3/27/02	Stop date:	

Elapsed Time: 11 min | 5:16 min | 3:32 min

Time(hrs):	Time(sec):	660	316	212

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54		
2	4	6	[psig]	140.61	281.23	421.84 [cm H2O]

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	1.0	2.0	2.6	Confining:	1.0	2.0	2.6
Inflow:	1	1	1	Inflow:	11	11	11
Outflow:	19	16	16	Outflow:	9	6	6

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

Notes: Ksat Values in cm/sec. before thermal treatment

4.36×10^{-5} | 4.56×10^{-5} | 4.53×10^{-5} cm/sec.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

Sample: BB3(6) Test-Ksat

Width(cm):	3.0	Area(cm^2):	7.065	Height(cm):	2.55

Time

Start time:		Stop time:	
Start date:	3/29/02	Stop date:	

Elapsed Time: 0:33 | 0:23 | 0:21

Time(hrs):	Time(sec):	33	23	21

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54		
2	4	6	[psig]	140.61	281.23	421.84 [cm H2O]

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	0.4	0.9	2.0	Confining:	0.4	0.9	2.0
Inflow:	1.0	1	1	Inflow:	11	11	11
Outflow:	16	16	16	Outflow:	6	6	6

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

Notes: Ksat Values in cm/sec. before thermal treatment

7.78×10^{-4} | 5.58×10^{-4} | 4.67×10^{-4} cm/sec.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

Sample: BB1(5) Test=Ksat

Width(cm): 3	Area(cm^2): 7.065	Height(cm): 3.95

Time

Start time:	Stop time:
Start date: 3/29/02	Stop date:

Elapsed Time: 5:45 | 2:40 | 1:55 (min)

Time(hrs):	Time(sec): 345	160	115

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54			
2	4	6	[psig]	140.61	281.23	421.84	[cm H2O]

Fluid Levels

Initial (ml)			
Confining:	0.4	1.5	2.2
Inflow:	1	1	1
Outflow:	16	16	16

Final (ml)			
Confining:	0.4	1.5	2.2
Inflow:	11	11	11
Outflow:	6	6	6

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	=	(1)	[ml/sec]
A = Area (cm^2)	=	(2)	[cm^2]
dL = Sample Height (cm)	=	(3)	[cm]
dH = Differential Pressure (cm H2O)	=	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)			[cm/sec]

Notes: Ksat Values in cm/sec. before thermal treatment.

7.78 x 10^-4 | 5.58 x 10^-4 | 4.07 x 10^-4 cm/sec.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

Sample: BB1(2) Packed Test=Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm):

Time

Start time:	Stop time:
Start date: 4/19/02	Stop date:

Elapsed Time: 2:11, 1:42, 1:32, 1:26, 2:26, 5:36

Time(hrs):	Time(sec): 131, 102, 92, 86, 146, 336

Pressure

Confining Pressure(psig):	13	16	18	18	16	13
Inflow Pressure(psig):	8	11	12	12	11	8
Outflow Pressure(psig):	6	7	6	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow							dP(cm H2O) = dP(psig)*27.68*2.54			
2	4	6	6	4	2	[psig]	140.6	281.23	421.84	[cm H2O]

Fluid Levels

Initial (ml)						
Confining:	1.0	1.5	2.0	1.8	1.6	1.2
Inflow:	0.9	0.9	0.5	1.0	1.0	1.0
Outflow:	15	15	15	15	15	15

Final (ml)						
Confining:	1.0	1.5	2.0	1.8	1.6	1.2
Inflow:	11	11.2	10.7	11.2	11	11
Outflow:	5.2	4.8	4.8	4.8	5	5

Fluid Level Changes

Confining (ml):	
Inflow (ml):	
Outflow (ml):	

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	=	(1)	[ml/sec]
A = Area (cm^2)	=	(2)	[cm^2]
dL = Sample Height (cm)	=	(3)	[cm]
dH = Differential Pressure (cm H2O)	=	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)			[cm/sec]

Notes

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

From Page No. ___

Two aliquots of 150 ml each of UZ-14 Perched water were send to Div. 01 for chemical analysis. Cl, SO_4, NO_3 & F were requested to be analyzed by ion chromatography. Na, K, Ca, Mg, Si, Al & Fe were requested to be analyzed by ICP & HCO_3 by wet chemistry.

SAMPLE LIST/CHAIN OF CUSTODY

Southwest Research Institute
Chemistry and Chemical Engineering Division
6220 Culebra Road
San Antonio, Texas 78238-5166

Requested Turnaround:
☐ 1 Week
☐ 2 Weeks (Normal)
☐ 3 Weeks
☒ Other: 4 wks

SwRI Contact: Mike Dunnagan

REMARKS
NO Preservation during analysis
Preservation
a = HCl to pH <2
b = HNO_3 to pH <2
c = H_2SO_4 to pH <2
d = NaOH to pH >12
e = Other (Specify)

Nuclear Safety Related
Use appropriate QA procedures.

POC – Alka Jain
ext. 5651
fax 5184

SwRI Project No: 20.01402.561

Received by SwRI Lab (Signature): Alka Jain

Samples Disposed by:

Date/Time: 5/1/02 1035

Page 1 of 1

Client Name/Address: ALKA JAIN CNWRA - DIV. 20 BLD. 57

Client Purchase Order/Other ID:

Analyses Requested

Sample ID	Sample Collection Date (mm/dd/yy)	Sample Collection Time (mm/dd/yy)	Site/Zone ID	Matrix Type	Sample Type	# of Containers	Na, K, Ca, Mg, Si Al, Fe by ICP	Alkalinity as HCO_3	Cl, SO_4, NO_3, F by IC
UZ-14PW1	4/26/02			W	DM	1	✓	✓	✓
UZ-14PW2	〃			W	DM	1	✓	✓	✓

Matrix Types: **A** - Air; **P** - Product; **S** - Soil; **T** - Tissue; **W** - Water

Sample Types: **DM** - Dissolved Metals; **ER** - Equipment Rinsate; **FB** - Field Blank; **MSD** - Matrix Spike Duplicate; **MS** - Matrix Spike; **TB** - Trip Blank; **TM** - Total Metals; **ES** - Environmental Samples; **FD** - Field Duplicate

Relinquished by (Signature):

Received by (Signature)

Relinquished by (Signature)

Relinquished by Sampler (Signature): Alka Jain

Received by (Signature):

Comments: 482/46 UZ-14 Perched water

Div 01 COC Form 01-01-001, Rev 1/97

Witnessed & Understood by me,

Date 5/1/02

Invented by

Recorded by AJ

Date

Sample: BB1(1) after 6 weeks in the oven @ 90°C

Test=Ksat

Width(cm):	Area(cm^2):	Height(cm):
3.0	7.065	2.45

Time

Start time:	Stop time:
Start date: 5/7/02 & 5/8/02	Stop date:

Elapsed Time: 6:33 | 2:41 | 1:40 & 6:45 | 2:42 | 1:5

Time(hrs):	Time(sec): 393	161	100	405	162	111

Pressure

Confining Pressure(psig):	13	16	18	13	16	18
Inflow Pressure(psig):	8	11	12	8	11	12
Outflow Pressure(psig):	6	7	6	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow							
2	4	6	8	2	4	6	[psig]

dP(cm H2O) = dP(psig)*27.68*2.54			
140.61	281.23	421.84	[cm H2O]

Fluid Levels

Initial (ml)						
Confining:	1.5	2.6	3.2	1.3	2	2.5
Inflow:	1	2	2	2	2	2
Outflow:	16	15	16	15	14	14.2

Final (ml)						
Confining:	1.5	2.6	3.2	1.3	2	2.5
Inflow:	11	12.1	12	12	12	12.1
Outflow:	6	5.1	6	5	4	4.1

Fluid Level Changes

Confining (ml):	0	0	0	0	0	0
Inflow (ml):	10	10.1	10	10	10	10.1
Outflow (ml):	10	9.9	10	10	10	10.1

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

Notes: Ksat Values in cm/sec.

6.28×10^{-5}	7.66×10^{-5}	8.22×10^{-5}	6.09×10^{-5}	7.61×10^{-5}	7.48×10^{-5} cm/sec.

Sample BB1(1) was removed from the oven and air cooled for a few hours before Ksat measurements. UZ-14 Perched water in contact with sample in the oven was cooled & filtered through 0.45 um syringe filter & set aside for analysis by Div. 01.

Witnessed & Understood by me,

Date

Invented by

Recorded by AJ

Date

Project No._____
Book No._____ TITLE_____

From Page No.___

Sample BB1(1) was removed from oven after 4 weeks. UZ-14 perched water in contact with BB1(1) sample was filtered thru 0.45 um syringe filter (after cooling for ~ 4 hrs.). The filtrate was stored in plastic bottle to be sent to Div. 01 for chemical analysis. The sample was placed back in DI H_2O until 5/14/02 to keep it saturated with H_2O. Following measurements were taken on 5/14/02

Sample: BB1(1) after 6wks@90°C Test-Ksat

Width(cm):	Area(cm^2):	Height(cm):
3.0	7.065	2.45

Time

Start time:	Stop time:
Start date: 5/14/02	Stop date:
Time(hrs):	Time(sec):

Elapsed Time 8:21, 3:35, 2:10, 2:08, 3:24, 9:06
Time(sec): 501, 215, 130, 128, 204, 546

Pressure

Confining Pressure(psig):	13	16	18	18	16	13
Inflow Pressure(psig):	8	11	12	12	11	8
Outflow Pressure(psig):	6	7	6	6	17	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow							dP(cm H2O) = dP(psig)*27.68*2.54			
2	4	6	6	4	2	[psig]	140.61	28.23	421.84	[cm H2O]

Fluid Levels

Initial (ml)						Final (ml)					
Confining:	1.8	2.6	3.2	3.2	2.8	2.0	1.8	2.6	3.2	3.2	2.8	2.0
Inflow:	0	1.0	1.0	1.0	1.0	1.0	10	11	11	11	11	11
Outflow:	13	14	14	14	14	14	3	4	4	4	4	4

Fluid Level Changes

Confining (ml):	0	0	0	0	0	0
Inflow (ml):	10	10	10	10	10	10
Outflow (ml):	10	10	10	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec) 4.92×10^{-5}, 5.74×10^{-5}, 6.32×10^{-5}		[cm/sec]

Witnessed & Understood by me,
Date 5/7/02, 5/14/02
Invented by
Recorded by AJ
Date

TITLE_____
Project No._____
Book No._____

Sample: BB1(1) 6 wks@90°C Test-Ksat

Width(cm):	Area(cm^2):	Height(cm):
3	7.065	2.45

Time

Start time:	Stop time:
Start date: 5/17/02	Stop date:
Time(hrs):	Time(sec):

Elapsed Time 9:09, 4:02, 2:30, 2:27, 4:02, 11:21
Time(sec): 549, 242, 150, 147, 242, 681

Pressure

Confining Pressure(psig):	13	16	18	18	16	13
Inflow Pressure(psig):	8	11	12	12	11	8
Outflow Pressure(psig):	6	7	6	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow							dP(cm H2O) = dP(psig)*27.68*2.54			
2	4	6	6	4	2	[psig]	140.61	28.23	421.84	[cm H2O]

Fluid Levels

Initial (ml)						Final (ml)					
Confining:	3.5	4.3	4.8	4.8	4.5	3.8	3.5	4.3	4.8	4.8	4.5	3.8
Inflow:	1	1	1	1	1	1	11	11	11	11	11	11
Outflow:	14	14	14	14	14	14	4	4	4	4	4	4

Fluid Level Changes

Confining (ml):	0	0	0	0	0	0
Inflow (ml):	10	10	10	10	10	10
Outflow (ml):	10	10	10	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

cm/sec					
4.99×10^{-5}		5.1×10^{-5}		5.48×10^{-5}	

Notes Ksat Values in cm/sec.

The sample was placed back in DI H_2O to keep it saturated before taking the above measurements.

To Page No._____

Witnessed & Understood by me,
Date 5/17/02
Invented by
Recorded by AJ
Date

From Page No.

AJ
5/19/02

To Page No.

Witnessed & Understood by me,

Date 5/19/02

Invented by

Recorded by AJ

Date

Fro

Sample: BB1(1) 6 wks @ 90°C Test-Ksat

Width(cm): 3	Area(cm^2): 7.065	Height(cm): 2.45

Time

Start time: 5/28/02	Stop time:
Start date:	Stop date:

Elapsed Time 5:14, 2:22, 1:28, 4:32, 2:12, 1:29

Time(hrs):	Time(sec): 314, 142, 88, 272, 132, 89

Pressure

Confining Pressure(psig):	13	16	18	13	16	18
Inflow Pressure(psig):	8	11	12	8	11	12
Outflow Pressure(psig):	6	7	6	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow						
2	4	8 6	2	4	6	[psig]

AJ 5/28/02

dP(cm H2O) = dP(psig)*27.68*2.54			
140.61	281.23	421.84	[cm H2O]

Fluid Levels

Initial (ml)						
Confining:	2.7	3.5	3.9	2.9	3.5	3.9
Inflow:	1	1	1	1	1	1
Outflow:	14	14	14	14	14	14

Final (ml)						
Confining:	2.7	3.5	3.9	2.9	3.5	3.9
Inflow:	11	11	11	11	11	11
Outflow:	4	4	4	4	4	4

Fluid Level Changes

Confining (ml):	0	0	0	0	0	0
Inflow (ml):	10	10	10	10	10	10
Outflow (ml):	10	10	10	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2	
	[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	=	(1)	[ml/sec]
A = Area (cm^2)	=	(2)	[cm^2]
dL = Sample Height (cm)	=	(3)	[cm]
dH = Differential Pressure (cm H2O)	=	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)			[cm/sec]

Notes Ksat Values in cm/sec.

cm/sec -5	-5	-5			
7.85 X10	8.68 X10	9.34 X10	9.07 X10-5	9.34 X10-5	9.24 X10-5

The sample was removed from water & dried in oven for 8 AJ 5/28/02 days. The sample was cooled & resaturated with UZ-14 perched water before Ksat measurements.

To Page No.

Witnessed & Understood by me,

Date 5/28/02

Invented by

Recorded by AJ

Date

From Page No.

Sample: BB1(1) after 6wks @ 90°C Test-Ksat

Width(cm):	3	Area(cm^2):	7.065	Height(cm):	2.45

Time

Start time:		Stop time:	
Start date:	6/7 5/29/02 AJ 5/29/02	Stop date:	

Elapsed Time 5:29, 2:31, 1:38, 5:19, 2:28, 1:40

Time(hrs):		Time(sec):	329, 151, 98, 319, 148, 100

Pressure

Confining Pressure(psig):	13	16	18	13	16	18
Inflow Pressure(psig):	8	11	12	8	11	12
Outflow Pressure(psig):	6	7	6	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow							dP(cm H2O) = dP(psig)*27.68*2.54			
2	4	6	2	4	6	[psig]	140.61	281.23	421.84	[cm H2O]

Fluid Levels

Initial (ml)							Final (ml)						
Confining:	4.8	5.6	6.1	5	5.7	6.2	Confining:	4.8	5.6	6.1	5	5.7	6.2
Inflow:	1	1	1	1	1	1	Inflow:	11	11	11	11	11	11.1
Outflow:	14	14	14	14	14	14	Outflow:	4	4	4	4	4	3.9

Fluid Level Changes

Confining (ml):	0	0	0	0	0	0
Inflow (ml):	10	10	10	10	10	10.1
Outflow (ml):	10	10	10	10	10	10.1

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	= (1)	[ml/sec]
A = Area (cm^2)	= (2)	[cm^2]
dL = Sample Height (cm)	= (3)	[cm]
dH = Differential Pressure (cm H2O)	= (4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

Notes Ksat Values in cm/sec.

cm/sec:	-5	-5	-5	-5	-5
	7.5X10	8.17X10	8.39X10	7.73X10	8.33X10-5	8.22X10-5

The sample was placed back in U2-14 perched H2O to keep it saturated before taking these measurements.

Witnessed & Understood by me,	Date 5/29/02	Invented by	Date
		Recorded by AJ	

From Page No.

The filtrate from sample BB1(1) after 6 wks of thermal treatment @ 90°C was send to Div. 01 on 5/29/02. The filtrate was U2-14 perched H2O in contact with BB1(1) sample for 6 wks @ 90°C. The filtrate was filtered through 0.45 um syringe filter before sending to Div. 01 for chemical analyses.

Client Name/Address	ALKA JAIN CNWRA - DIV. 20 BLDG. 57	**SAMPLE LIST/CHAIN OF CUSTODY** **Southwest Research Institute** Chemistry and Chemical Engineering Division 6220 Culebra Road San Antonio, Texas 78238-5166	Requested Turnaround: ☐ 1 Week ☐ 2 Weeks (Normal) ☐ 3 Weeks ☒ Other: 4 wks.
Client Purchase Order/Other ID	Site/Zone ID	Analyses Requested	SwRI Contact: Mike Dunnington

Sample ID	Sample Collection Date (mm/dd/yy)	Sample Collection Time (mm/dd/yy)	Matrix Type	Sample Type	# of Containers	Na, K, Ca, Mg, Si, B, As by ICP	Alkalinity as HCO_3^-	Cl^-, SO_4^{2-}, NO_3^-, F by IC	970# 5 dd
U2-14PWBB1(1)	EALT 5-29-02		W	DM	1	✓	✓	✓	

REMARKS
No Preservation analysis
Preservation as per Table 1
a = HCl to pH <2
b = HNO_3 to pH <2
c = H_2SO_4 to pH <2
d = NaOH to pH >12
e = Other (Specify)

Nuclear Safety Related
Use appropriate QA procedures

POC - Alka Jain
Ext. 5051
Fax 5184

Matrix Types: **A** - Air; **P** - Product; **S** - Soil; **T** - Tissue; **W** - Water
Sample Types: **DM** - Dissolved Metals; **ER** - Equipment Rinsate; **FB** - Field Blank; **MSD** - Matrix Spike Duplicate; **MS** - Matrix Spike; **TB** - Trip Blank; **TM** - Total Metals; **ES** - Environmental Samples; **FD** - Field Duplicate

Relinquished by Sampler (Signature): Alka Jain	Relinquished by (Signature): Brad Werling
Received by (Signature): Brad Werling	Received by (Signature)
	Relinquished by (Signature)
	Comments: 482/58 U2-14 Perched water after 6 wks @ 90°C with BB1(1)

Div 01 COC Form 01-01-001, Rev 1/97

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To Page No.

Witnessed & Understood by me,	Date 5/29/02	Invented by	Date
		Recorded by AJ	

Project No.
Book No.
TITLE

From Page No.

Samples BB3(1), BB3(2), BB3(3), BB3(4) and BB3(5) were placed in oven @ 90°C for thermal treatment. Ksat was measured before placing in the oven.

The samples were prepared following the procedure as follows before thermal treatment.

(1) Samples BB3(1), BB3(2), BB3(3), BB3(4) and BB3(4) saturated with UZ-14 perched H_2O

(2) These samples were then transferred to separate 5 pressure vessels (Parr Instruments).

(3) Addition perched water (UZ-14) was added to each vessel. The total volume of sample and UZ-14 perched water is kept constant at 110 ml.

Additions of UZ-14 perched H_2O to different samples were as follows:

(a) BB3(1) sample volume = 14.13 ml
Volume of UZ-14 perched H_2O added = 95.7 ml

(b) BB3(2) sample volume = 29.32 ml
Volume of UZ-14 perched H_2O added = 80.68 ml

(c) BB3(3) sample volume = 23.74 ml
Volume of UZ-14 perched H_2O added = 86.3 ml

(d) BB3(4) sample volume = 22.6 ml
Volume of UZ-14 perched H_2O added = 87.4 ml

(e) BB3(5) sample volume = 20.2 ml
Volume of UZ-14 perched H_2O added = 89.8 ml

To Page No.

Witnessed & Understood by me,
Date 5/29/02
Invented by
Recorded by AJ
Date

Project No.
Book No.
TITLE

Fro

Sample: BB1(1) after 6wks @ 90°C Test=Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 2.45

Time

Start time:	Stop time:
Start date: 6/10/02	Stop date:
Time(hrs):	Time(sec): 462, 204, 129, 439

Elapsed Time 7:40, 3:24, 2:09, 7:17

Pressure

Confining Pressure(psig):	13	16	18	13
Inflow Pressure(psig):	8	11	12	8
Outflow Pressure(psig):	6	7	6	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow					dP(cm H2O) = dP(psig)*27.68*2.54			
2	4	6	2	[psig]	140.61	281.23	421.84	[cm H2O]

Fluid Levels

Initial (ml)					Final (ml)				
Confining:	0.5	2.6	3.8	1	Confining:	0.5	2.6	3.8	1
Inflow:	0	1	1	1	Inflow:	10	11	11	11
Outflow:	15	16	15	14	Outflow:	5	6	5	4

Fluid Level Changes

Confining (ml):	0	0	0	0
Inflow (ml):	10	10	10	10
Outflow (ml):	10	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	= (1)	[ml/sec]
A = Area (cm^2)	= (2)	[cm^2]
dL = Sample Height (cm)	= (3)	[cm]
dH = Differential Pressure (cm H2O)	= (4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

cm/sec. Notes Ksat in cm/sec.

-5	-5	-5	-5
5.34 x 10	6.04 x 10	6.44 x 10	5.62 x 10

5.34×10^{-5} | 6.04×10^{-5} | 6.44×10^{-5} | 5.62×10^{-5} cm/sec.

To Page No.

Witnessed & Understood by me,
Date
Invented by
Recorded by AJ
Date

Project No._____
Book No._____ TITLE _____

Sample: BB1(3) after 11WKS @ 90°C Test=Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 4.9

Time

Start time:	Stop time:
Start date: 6/11/02 & 6/14/02	Stop date:
Elapsed Time 6:22 | 2:53 | 1:56 | & 6:53 | 3:12 | 2:09	
Time(hrs):	Time(sec): 382 | 173 | 116 | & 413 | 192 | 129

Pressure

Confining Pressure(psig):	13	16	18		13	16	18
Inflow Pressure(psig):	8	11	12	&	8	11	12
Outflow Pressure(psig):	6	7	6		6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow	dP(cm H2O) = dP(psig)*27.68*2.54
2 | 4 | 6 & 2 | 4 | 6 [psig]	140.61 | 281.23 | ~~48~~ 421.83 [cm H2O]

AJ 6/11/02

Fluid Levels

Initial (ml)							Final (ml)						
Confining:	0.0	3	4.2		0.2	1	2	Confining:	1.0	3	4.2		0.2	1	2
Inflow:	1	1	1	&	1	1	1.0	Inflow:	11	11	11	&	11	11	11
Outflow:	14	14	14		14	14	14	Outflow:	4	4	4		4	4	4

Fluid Level Changes

Confining (ml):	0	0	0		0	0	0
Inflow (ml):	10	10	10	&	10	10	10
Outflow (ml):	10	10	10		10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2
[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)		
Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

1.29X10^-4 | 1.43X10^-4 | 1.42X10^-4 cm/sec. Notes ~~Ksat~~ 1.19X10^-4 | 1.28X10^-4 | 1.27X10^-4

The sample was removed from permeameter cell & placed back in U2-14 perched H2O after taking measurements on 6/11/02. Another set of measurements were taken on 6/14/02.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by AJ

Project No._____
TITLE _____ Book No._____

Sample: BB1(1) ~~BB1(3)~~ after 6WKS @ 90°C Test=Ksat — After placed back in DI H2O to keep it saturated

Width(cm): ~~3~~ 6/14/02	Area(cm^2): 7.065	Height(cm):

Time

Start time:	Stop time:
Start date: 6/14/02	Stop date:
Elapsed Time 7:43, 3:31, 2:15	
Time(hrs):	Time(sec): ~~6~~ 463, 211, 135

AJ 6/14/02

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow			dP(cm H2O) = dP(psig)*27.68*2.54		
2	4	6 [psig]	140.61	281.23	421.84 [cm H2O]

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	4.5	5.5	6	Confining:	4.5	5.5	6
Inflow:	1	1	1	Inflow:	11	11	11
Outflow:	14	14	14	Outflow:	4	4	4

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2
[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)		
Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

cm/sec. -5 | -5 | -5
5.33X10 | 5.84X10 | 6.04X10 Notes Ksat in cm/sec.

To Page No._____

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by AJ

Sample: BB1(1) after 6 wks @ 90°C Test=Ksat After Drying & Resaturating with DI H2O

Width(cm): 3	Area(cm^2): 7.065	Height(cm): 2.45

Time

Start time:	Stop time:
Start date: 6/19/02	Stop date:

Elapsed Time 5:56, 2:43, 1:51

Time(hrs):	Time(sec): 356, 163, 111

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54		
2	4	6	[psig]	140.61	281.23	421.84 [cm H2O]

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	2.5	0.7	3.5	Confining:	2.5	0.7	3.5
Inflow:	1	1	1	Inflow:	11	11	11
Outflow:	14	14	14	Outflow:	4	4	4

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

cm/sec			Notes Ksat in cm/sec.
6.93×10^{-5}	7.56×10^{-5}	7.41×10^{-5}	

To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

Sample: BB1(3) after 11 wks @ 90°C Test-Ksat

Width(cm): 3	Area(cm^2): 7.065	Height(cm): 4.9

Time

Start time:	Stop time:
Start date: 6/25/02	Stop date:

Elapsed Time 4:52 | 2:32 | 1:48

Time(hrs):	Time(sec): 292 | 152 | 108

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54		
2	4	6	[psig]	140.61	281.23	421.83 [cm H2O]

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	0.5	1.9	2.6	Confining:	0.5	1.9	2.6
Inflow:	1	1	1	Inflow:	11	11	11
Outflow:	14	14	14	Outflow:	4	4	4

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

			Notes cm/sec
1.69×10^{-4}	1.62×10^{-4}	1.52×10^{-4}	

The sample was removed from U2-14 perched water & dried in oven @ 90°C and resaturated with DI H2O (& deaired) before these measurements.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

Project No._____
Book No._____ TITLE _____

Sample: BB3(1) Packed after 13 WKS @ 90°C Test-Ksat

Width(cm): 3	Area(cm^2): 7.065	Height(cm): 4.45

Time

Start time:	Stop time:
Start date: 6/26/02	Stop date:

Elapsed Time 0:33, 0:23, 0:18,

Time(hrs):	Time(sec):

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow [psig]			dP(cm H2O) = dP(psig)*27.68*2.54 [cm H2O]		
2	4	6	140.61	281.23	421.84

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	0.8	1.5	2	Confining:	0.8	1.5	2
Inflow:	1	1	1	Inflow:	11	11	11
Outflow:	14	13	14	Outflow:	4	3	4

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

1.36 X 10^-3	9.74 X 10^-4	8.3 X 10^-4 cm/sec. Notes

BB3(1) packed sample was removed from the oven after 13 weeks and cooled for several hours before Ksat. measurements.

To Page No._____

Witnessed & Understood by me, Date | Invented by | Date | Recorded by AJ

TITLE _____ Project No._____
Book No._____

Sample: BB3(1) Packed after 13 weeks @ 90°C Test-Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 4.45

Time

Start time:	Stop time:
Start date: 6/28/02	Stop date:

Elapsed Time 0:33 | 0:18 | 0:14

Time(hrs):	Time(sec): 33 | 18 | 14

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow [psig]	dP(cm H2O) = dP(psig)*27.68*2.54 [cm H2O]

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	2.3	3.0	3.5	Confining:	2.3	3	3.5
Inflow:	1	1	1	Inflow:	11	11	11
Outflow:	14	14	14	Outflow:	4	4	4

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

1.36 X 10^-3	1.24 X 10^-3	1.07 X 10^-3 cm/sec. Notes

Sample was not removed from the permeameter cell after 1st set of Ksat measurements due to fragile nature of the sample. Sample stayed loadd in permeameter cell for 1 day before taking these measurements.

Witnessed & Understood by me, Date | Invented by | Date | Recorded by AJ

Sample: BB3(1) Packed after 13 wks @ 90°C Test-Ksat

Width(cm): 3	Area(cm^2): 7.065	Height(cm): 4.45

Time

Start time:	Stop time:
Start date: 7/2/02	Stop date:

Elapsed Time 0:34, 0:19, 0:17

Time(hrs):	Time(sec): 34 | 19 | 17

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow	dP(cm H2O) = dP(psig)*27.68*2.54
2 | 4 | 6 [psig]	140.61 | 281.23 | 421.84 [cm H2O]

Fluid Levels

Initial (ml)			
Confining:	5.2	5.6	6
Inflow:	1	1	1
Outflow:	14	14	14

Final (ml)			
Confining:	5.2	5.6	6
Inflow:	11	11	11
Outflow:	4	4	4

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

1.32×10^{-3} | 1.18×10^{-3} | 8.78×10^{-4} cm/sec Notes: Ksat values in cm/sec.

Sample stayed loaded in permeameter cell for another day before taking ksat measurements.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

Sample: BB1(3) after 11 wks @ 90°C Test-Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 4.9

Time

Start time:	Stop time:
Start date: 7/2/02	Stop date:

Elapsed Time 8:03, 4:22, 2:46

Time(hrs):	Time(sec): 483, 262, 166

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow	dP(cm H2O) = dP(psig)*27.68*2.54
2 | 4 | 6 [psig]	140.61 | 281.23 | 421.84 [cm H2O]

Fluid Levels

Initial (ml)			
Confining:	1	1.8	2.2
Inflow:	1	1	1
Outflow:	14	14	14

Final (ml)			
Confining:	1	1.8	2.2
Inflow:	11	11	11
Outflow:	4	4	4

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

1.02×10^{-4} | 9.41×10^{-5} | 9.90×10^{-5} cm/~~sec~~ Notes: Ksat values in cm/sec.

Sample was placed back in DI H_2O to keep it saturated before taking these Ksat measurements. Sample was in DI H_2O for ~ ~~12~~ 7 days. AJ 07/2/02

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

Project No._____
Book No. TITLE

Sample: BB1(2) after 14 wks @ 90°C Test=Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 2.22

Time

Start time:	Stop time:
Start date: 7/3/02	Stop date:

Elapsed Time 4:42, 2:05, 1:23

Time(hrs):	Time(sec): 282 | 125 | 83

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54		
2	4	6	[psig]	140.61	281.23	421.84 [cm H2O]

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	1.2	3.0	3.5	Confining:	1.2	3.0	3.5
Inflow:	1	1	1	Inflow:	11	11	11
Outflow:	14	14	14	Outflow:	4	4	4

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

7.92X10^-5 | 8.94X10^-5 | 8.97X10^-5 cm/sec. Notes Ksat measurements in cm/sec.

Sample BB1(2) was removed from the oven after 14 weeks and air cooled for few hours before taking these Ksat. measurements.

Witnessed & Understood by me,	Date	Invented by	Date	
		Recorded by AJ		

Project No._____
Book No.
TITLE

Sample: BB1(2) after 14 weeks @ 90°C Test=Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 2.22

Time

Start time:	Stop time:
Start date: 7/5/02	Stop date:

Elapsed Time 5:50, 2:29, 1:30

Time(hrs):	Time(sec): 350, 149, 90

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54		
2	4	6	[psig]	140.61	281.23	421.84 [cm H2O]

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	4	4.7	5.1	Confining:	4	4.7	5.1
Inflow:	1	1	1	Inflow:	11	11	11
Outflow:	14	14	14	Outflow:	4	4	4

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

6.38X10^-5 cm/sec | 7.50X10^-5 cm/sec Notes 8.28 X10^-5 cm/sec — Ksat. Value

Sample was placed back in U2-14 perched H2O to keep it saturated before taking these measurements.

Witnessed & Understood by me,	Date	Invented by	Date	
		Recorded by AJ		

From Page

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET

Chemical Analysis results on UZ-14 Perched H_2O from Div. 01

Sample ID: UZ-14PW1

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Water

Lab System ID: 205002

Client: Division 20

Date Received: 05/01/02

Project No.: 20.01402.561

Work Order: 22381

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.5	0.5
Calcium	2.45	0.5
Iron	<1	1
Magnesium	2.07	0.5
Potassium	3.98	1
Silicon	0.160	0.1
Sodium	31.4	0.5
Hydroxide as $CaCO_3$	<3	3
Bicarbonate as $CaCO_3$	46.7	3
Carbonate as $CaCO_3$	<3	3
Alkalinity as $CaCO_3$	46.7	3
Fluoride	<0.1	0.1
Chloride	7.00	0.1
Nitrate	3.51	0.1
Sulfate	23.1	0.2

SOUTHWEST RESEARCH INSTITUTE

DUPLICATE SUMMARY

Sample ID: UZ-14PW1

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Water

Lab System ID: 205002D

Client: Division 20

Date Received: 05/01/02

Project No.: 20.01402.561

Work Order: 22381

Analysis	Sample Result (mg/L)	Duplicate Result (mg/L)	RPD
Aluminum	<0.5	<0.5	0.00%
Calcium	2.45	2.47	0.50%
Iron	<1	<1	0.00%
Magnesium	2.07	2.19	5.77%
Potassium	3.98	3.27	19.5%
Silicon	0.160	0.196	20.7%
Sodium	31.4	31.4	0.10%
Hydroxide as $CaCO_3$	<3	<3	0.00%
Bicarbonate as $CaCO_3$	46.7	47.3	1.28%
Carbonate as $CaCO_3$	<3	<3	0.00%
Alkalinity as $CaCO_3$	46.7	47.3	1.28%
Fluoride	<0.1	<0.1	0.00%
Chloride	7.00	6.97	0.43%
Nitrate	3.51	3.52	0.28%
Sulfate	23.1	23.3	0.66%

Witnessed & Understood by me, | Date | Invented by | Date

Recorded by AJ

TITLE_

From Pa

SOUTHWEST RESEARCH INSTITUTE

MATRIX SPIKE SUMMARY

Sample ID: UZ-14PW1

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Water

Lab System ID: 205002S

Client: Division 20

Date Received: 05/01/02

Project No.: 20.01402.561

Work Order: 22381

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Aluminum	----	----	----	----
Calcium	----	----	----	----
Iron	----	----	----	----
Magnesium	----	----	----	----
Potassium	----	----	----	----
Silicon	----	----	----	----
Sodium	----	----	----	----
Hydroxide as $CaCO_3$	NA	NA	NA	NA
Bicarbonate as $CaCO_3$	NA	NA	NA	NA
Carbonate as $CaCO_3$	NA	NA	NA	NA
Alkalinity as $CaCO_3$	46.7	82.7	33.3	108.1%
Fluoride	<0.1	0.895	1.00	89.5%
Chloride	7.00	8.80	2.00	90.1%
Nitrate	3.51	4.34	1.00	83.2%
Sulfate	23.1	30.6	8.00	93.4%

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET

Sample ID: UZ-14PW2

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Water

Lab System ID: 205003

Client: Division 20

Date Received: 05/01/02

Project No.: 20.01402.561

Work Order: 22381

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.5	0.5
Calcium	2.45	0.5
Iron	<1	1
Magnesium	2.20	0.5
Potassium	2.79	1
Silicon	0.190	0.1
Sodium	31.3	0.5
Hydroxide as $CaCO_3$	<2	2
Bicarbonate as $CaCO_3$	48.4	2
Carbonate as $CaCO_3$	<2	2
Alkalinity as $CaCO_3$	48.4	2
Fluoride	<0.1	0.1
Chloride	7.00	0.1
Nitrate	3.51	0.1
Sulfate	23.1	0.2

Witnessed & Understood by me, | Date | Invented by | Date

Recorded by AJ

From Page

SOUTHWEST RESEARCH INSTITUTE
MATRIX SPIKE SUMMARY

Sample ID: UZ-14PW2

Lab Name: Southwest Research Institute
Client: Division 20

Lab Code: SwRI
Date Received: 05/01/02

Matrix: Water
Project No.: 20.01402.561

Lab System ID: 205003S
Work Order: 22381

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Aluminum	<0.5	19.4	20	96.8%
Calcium	2.45	210	200	104.0%
Iron	<1	9.83	10	98.3%
Magnesium	2.20	211	200	104.2%
Potassium	2.79	193	200	95.2%
Silicon	0.190	58.4	50	116.4%
Sodium	31.3	230	200	99.2%
Hydroxide as $CaCO_3$	----	----	----	----
Bicarbonate as $CaCO_3$	----	----	----	----
Carbonate as $CaCO_3$	----	----	----	----
Alkalinity as $CaCO_3$	----	----	----	----
Fluoride	----	----	----	----
Chloride	----	----	----	----
Nitrate	----	----	----	----
Sulfate	----	----	----	----

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

AJ 8/6/02 UZ Sample ID: ~~XZ~~-14PWBB1(1) FA6T

Lab Name: Southwest Research Institute
Client: Division 20

Lab Code: SwRI
Date Received: 05/29/02

Matrix: Water
Project No.: 20.01402.561

Lab System ID: 206903
Work Order: 22550

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.5	0.5
Calcium	10.7	0.5
Iron	<1	1
Magnesium	1.06	0.5
Potassium	5.70	1
Silicon	84.8	0.1
Sodium	37.6	0.5
Hydroxide as $CaCO_3$	<8	8
Bicarbonate as $CaCO_3$	79.2	8
Carbonate as $CaCO_3$	<8	8
Alkalinity as $CaCO_3$	79.2	8
Fluoride	0.820	0.1
Chloride	15.4	0.20
Nitrate	3.96	0.1
Sulfate	23.2	0.2

Witnessed & Understood by me, | Date | Invented by | Date

Recorded by AJ

From P.

SOUTHWEST RESEARCH INSTITUTE
DUPLICATE SUMMARY

chemical analysis results on filtrate from BB1(1) sample after 6 wks of thermal treatment @ 90°C.

8/6/02 AJ UZ Sample ID: ~~XZ~~-14PWBB1(1) FA6T

Lab Name: Southwest Research Institute
Client: Division 20

Lab Code: SwRI
Date Received: 05/29/02

Matrix: Water
Project No.: 20.01402.561

Lab System ID: 206903D
Work Order: 22550

Analysis	Sample Result (mg/L)	Duplicate Result (mg/L)	RPD
Aluminum	<0.5	<0.5	ERR
Calcium	10.7	10.6	1.83%
Iron	<1	<1	0.00%
Magnesium	1.06	1.03	3.30%
Potassium	5.70	5.64	1.04%
Silicon	84.8	85.4	0.75%
Sodium	37.6	38.1	1.28%
Hydroxide as $CaCO_3$	<8	<8	0.00%
Bicarbonate as $CaCO_3$	79.2	78.4	1.02%
Carbonate as $CaCO_3$	<8	<8	0.00%
Alkalinity as $CaCO_3$	79.2	78.4	1.02%
Fluoride	0.820	0.803	2.09%
Chloride	15.4	15.3	0.30%
Nitrate	3.96	3.95	0.25%
Sulfate	23.2	23.3	0.30%

SOUTHWEST RESEARCH INSTITUTE
MATRIX SPIKE SUMMARY

8/6/02 AJ UZ Sample ID: ~~XZ~~-14PWBB1(1) FA6T

Lab Name: Southwest Research Institute
Client: Division 20

Lab Code: SwRI
Date Received: 05/29/02

Matrix: Water
Project No.: 20.01402.561

Lab System ID: 206903S
Work Order: 22550

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Aluminum	<0.5	20.0	20	99.8%
Calcium	10.7	211	200	100.3%
Iron	<1	9.51	10	95.1%
Magnesium	1.06	207	200	103.1%
Potassium	5.70	198	200	96.2%
Silicon	84.8	142	50	114.7%
Sodium	37.6	239	200	100.5%
Hydroxide as $CaCO_3$	NA	NA	NA	NA
Bicarbonate as $CaCO_3$	NA	NA	NA	NA
Carbonate as $CaCO_3$	NA	NA	NA	NA
Alkalinity as $CaCO_3$	79.2	126	50	93.6%
Fluoride	0.820	1.593	1.00	77.3%
Chloride	15.4	19.3	4.00	97.0%
Nitrate	3.96	4.93	0.940	103.6%
Sulfate	23.2	30.7	8.00	93.9%

D.

Witnessed & Understood by me, | Date | Invented by | Date

Recorded by AJ

From F

SOUTHWEST RESEARCH INSTITUTE
LABORATORY CONTROL SAMPLE

Sample ID: LCSW

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Water
Lab System ID: NA

Client: Division 20
Date Received: NA
Project No.: 20.01402.561
Work Orders: 22381, 22550

Analysis	Sample Result (mg/L)	True Value (mg/L)	Recovery
Aluminum	1.99	2.00	99.5%
Calcium	20.0	20.0	100.0%
Iron	0.921	1.00	92.1%
Magnesium	20.6	20.0	102.9%
Potassium	19.2	20.0	96.2%
Silicon	5.82	5.00	116.4%
Sodium	20.0	20.0	99.8%
Hydroxide as $CaCO_3$	NA	NA	NA
Bicarbonate as $CaCO_3$	NA	NA	NA
Carbonate as $CaCO_3$	NA	NA	NA
Alkalinity as $CaCO_3$	64.6	66.6	97.0%
Fluoride	96.2	100	96.2%
Chloride	195	200	97.5%
Nitrate	88.8	90.4	98.3%
Sulfate	381	400	95.3%

SOUTHWEST RESEARCH INSTITUTE
BLANK SUMMARY

Sample ID: PBW

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Lab System ID: NA

Client: Division 20
Date Received: NA
Project No.: 20.01402.561
Work Orders: 22381, 22550

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.05	0.05
Calcium	<0.05	0.05
Iron	<0.1	0.1
Magnesium	<0.05	0.05
Potassium	<0.1	0.1
Silicon	<0.01	0.01
Sodium	<0.05	0.05
Hydroxide as $CaCO_3$	<2	2
Bicarbonate as $CaCO_3$	<2	2
Carbonate as $CaCO_3$	<2	2
Alkalinity as $CaCO_3$	<2	2
Fluoride	<0.1	0.1
Chloride	<0.1	0.1
Nitrate	<0.1	0.1
Sulfate	<0.1	0.1

NA- Not Applicable.

Witnes

Recorded by AJ

ITLE

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No.

Project No.

SOUTHWEST RESEARCH INSTITUTE
LABORATORY CONTROL SAMPLE

Sample ID: LCSW2

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Water
Lab System ID: NA

Client: Division 20
Date Received: NA
Project No.: 20.01402.561
Work Orders: 22381, 22550

Analysis	Sample Result (mg/L)	True Value (mg/L)	Recovery
Aluminum	----	----	----
Calcium	----	----	----
Iron	----	----	----
Magnesium	----	----	----
Potassium	----	----	----
Silicon	----	----	----
Sodium	----	----	----
Hydroxide as $CaCO_3$	NA	NA	NA
Bicarbonate as $CaCO_3$	NA	NA	NA
Carbonate as $CaCO_3$	NA	NA	NA
Alkalinity as $CaCO_3$	43.0	43.4	99.1%
Fluoride	105	100	105.3%
Chloride	202	200	101.2%
Nitrate	89.5	90.4	99.0%
Sulfate	387	400	96.7%

SOUTHWEST RESEARCH INSTITUTE
BLANK SUMMARY

Sample ID: PBW2

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Lab System ID: NA

Client: Division 20
Date Received: NA
Project No.: 20.01402.561
Work Orders: 22381, 22550

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	----	----
Calcium	----	----
Iron	----	----
Magnesium	----	----
Potassium	----	----
Silicon	----	----
Sodium	----	----
Hydroxide as $CaCO_3$	<2	2
Bicarbonate as $CaCO_3$	<2	2
Carbonate as $CaCO_3$	<2	2
Alkalinity as $CaCO_3$	<2	2
Fluoride	<0.1	0.1
Chloride	<0.1	0.1
Nitrate	<0.1	0.1
Sulfate	<0.1	0.1

NA- Not Applicable.

Witnessed

Recorded by AJ

Project No.
Book No. TITLE

From

Sample: BB1(4) after 20 wks & 4 days @ 90°C Test=Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 3.75

Time

Start time:	Stop time:
Start date: 8/13/02	Stop date:

Elapsed Time 20:27, 7:21, 4:45

Time(hrs):	Time(sec): 1227, 441, 285

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow [psig]			dP(cm H2O) = dP(psig)*27.68*2.54 [cm H2O]		
2	4	6	140.61	281.23	421.84

Fluid Levels

Initial (ml)			
Confining:	0.4	1.7	2.6
Inflow:	1.0	1.0	1.0
Outflow:	11	13	14

Final (ml)			
Confining:	0.4	1.7	2.6
Inflow:	11	11	11.0
Outflow:	1	3.0	4.0

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

Notes

3.08 X 10^-5 cm/sec. | 4.28 X 10^-5 | 4.41 X 10^-5 cm/sec. — Ksat values

The sample was removed from the oven and air cooled for few hours before taking these Ksat measurements.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

Project No.
TITLE Book No.

From

Sample: BB1(4) after 20 wks & 4 days @ 90°C Test=Ksat

Width(cm):	Area(cm^2):	Height(cm):

Time

Start time:	Stop time:
Start date: 8/16/02	Stop date:

Elapsed Time 16:22, 7:47, 5:17

Time(hrs):	Time(sec): 982, 467, 317

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow [psig]	dP(cm H2O) = dP(psig)*27.68*2.54		
	140.61	281.23	421.84 [cm H2O]

Fluid Levels

Initial (ml)			
Confining:	0.2	0.9	1.4
Inflow:	2	1	1
Outflow:	11	11	11

Final (ml)			
Confining:	0.2	0.9	1.4
Inflow:	12	11	11
Outflow:	1	1	1

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

3.84 X 10^-5 | 4.04 X 10^-5 | 3.97 X 10^-5 Notes cm/sec. — Ksat values

Sample stayed loaded in permeameter cell for 2 days to keep it saturated before taking these measurements again.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

Project No.
Book No. TITLE

From

Sample: BB3(2) after 13 wks @ 90°C Test-Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 4.15

Time

Start time:	Stop time:
Start date: 8/30/02	Stop date:

Elapsed Time 0:22 sec., 0:13, 0:10

Time(hrs):	Time(sec): 22, 13, 10

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54		
2	4	6	[psig]	140.6	281.23	421.84 [cm H2O]

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	0.8	1.8	2.4	Confining:	0.8	1.8	2.4
Inflow:	1	1	1	Inflow:	11	11	11
Outflow:	12	12	12	Outflow:	2	2	2

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2
[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

1.90×10^{-3} cm/sec | 1.61×10^{-3} | 1.39×10^{-3} Notes – Ksat values in cm/sec.

Sample was removed from the oven and air cooled to room temperature for few hours before taking these measurements.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

Project No.
TITLE Book No.

Fr

Sample: BB3(2) after 13 wks @ 90°C Test-Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 4.15

Time

Start time:	Stop time:
Start date: 9/3/02	Stop date:

Elapsed Time 0:20, 0:12, 0:10

Time(hrs):	Time(sec): 20, 12, 10

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54		
2	4	6	[psig]	140.61	281.23	421.84 [cm H2O]

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	1.1	1.9	2.5	Confining:	1.1	1.9	2.5
Inflow:	1	1	1	Inflow:	11	11	11
Outflow:	13	13	13	Outflow:	3	3	3

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2
[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

Notes

Sample stayed loaded in permeameter cell for 3 days before taking these measurements again.

Ksat values in cm/sec. 2.09×10^{-3} | 1.74×10^{-3} | 1.39×10^{-3}

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

Project No.
Book No. TITLE

From:

Sample: BB3(3) after 14 weeks @ 90°C Test-Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 3.36

Time

Start time:	Stop time:
Start date: 9/3/02	Stop date:

Elapsed Time 1:23 | 0:40 | 0:29

Time(hrs):	Time(sec): 83, 40, 29

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54			
2	4	6	[psig]	140.61	281.23	421.84	[cm H2O]

Fluid Levels

Initial (ml)			
Confining:	1.2	2.0	2.4
Inflow:	1.0	1.0	1.0
Outflow:	13	13	13

Final (ml)			
Confining:	1.2	2.0	2.4
Inflow:	11	11	11
Outflow:	3	3	3

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2	
	[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	=	(1)	[ml/sec]
A = Area (cm^2)	=	(2)	[cm^2]
dL = Sample Height (cm)	=	(3)	[cm]
dH = Differential Pressure (cm H2O)	=	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)			[cm/sec]

4.07X10^-4 | 4.23X10^-4 | 3.89X10^-4 Notes — Ksat Values in cm/sec.

Sample was removed from the oven and air cooled to room temperature for few hours before taking these measurements.

To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

Project No.
TITLE Book No.

Fr

Sample: BB3(3) after 14 weeks @ 90°C Test-Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 3.36

Time

Start time:	Stop time:
Start date: 9/4/02	Stop date:

Elapsed Time 1:19 | 0:41 | 0:29

Time(hrs):	Time(sec): 79 | 41 | 29

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54			
2	4	6	[psig]	140.61	281.23	421.84	[cm H2O]

Fluid Levels

Initial (ml)			
Confining:	2.8	3.3	3.7
Inflow:	1.0	1.0	1.0
Outflow:	13	13	13

Final (ml)			
Confining:	2.8	3.3	3.7
Inflow:	11	11	11
Outflow:	3	3	3

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2	
	[ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	=	(1)	[ml/sec]
A = Area (cm^2)	=	(2)	[cm^2]
dL = Sample Height (cm)	=	(3)	[cm]
dH = Differential Pressure (cm H2O)	=	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)			[cm/sec]

4.28 X 10^-4 | 4.12 X 10^-4 | 3.89 X 10^-4 Notes — Ksat Values in cm/sec.

Sample stayed loaded in permeameter cell for 1 day before taking these measurements again.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

Sample: BB3(4) after 15 wks @ 90°C Test=Ksat

Width(cm):	3.0	Area(cm^2):	7.065	Height(cm):	3.2

Time

Start time:		Stop time:	
Start date:	9/11/02	Stop date:	

Elapsed Time: 0:41 | 0:22 | 0:18 | 0:42 | 0:23 | 0:17

Time(hrs):		Time(sec):	

Pressure

Confining Pressure(psig):	13	16	18	13	16	18
Inflow Pressure(psig):	8	11	12	8	11	12
Outflow Pressure(psig):	6	7	6	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow				dP(cm H2O) = dP(psig)*27.68*2.54			
2	4	6	[psig]	140.61	281.23	421.84	[cm H2O]

Fluid Levels

Initial (ml)							Final (ml)						
Confining:	8.5	9.6	10.3	9.1	9.9	10.5	Confining:	8.5	9.6	10.3	9.1	9.9	10.5
Inflow:	1	1	1	1.0	1	1	Inflow:	11	11	11	11	11	11
Outflow:	13	13	13	13	13	13	Outflow:	3	3	3	3	3	3

Fluid Level Changes

Confining (ml):	0	0	0	0	0	0
Inflow (ml):	10	10	10	10	10	10
Outflow (ml):	10	10	10	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

7.86×10^{-4}	7.32×10^{-4}	5.97×10^{-4}	Notes Ksat Values in cm/sec.

The sample was removed from the oven and air cooled for few hours before taking these Ksat measurements.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by AJ	

From Page No. UZ-14 perched H_2O filtrate from samples BB1(3), BB1(4), BB3(1) Packed, BB3(2), BB3(3) & BB3(4) after thermal treatment was sent to Div. 01 for Chemical analysis.

Div 01 COC Form 01-01-001, Rev 4/02

Matrix Types: A – Air; B – Biota; D – Dust; E – Emission/Stack; P – Product; S – Soil; SED – Sediment; T – Tissue; W – Water; WP – Wipe

Sample Types: D – Duplicate; ER – Equipment Rinsate; FB – Field Blank; FD – Field Duplicate; MS – Matrix Spike; MSD – Matrix Spike Dup; TB – Trip Blank

Temp: 0.1.0c

Therm #: 026

Comments: 482/84, 482/74, 482/66, 482/82, 482/86, 482/88, UZ-14 #20 Filtrate after thermal treatment.

Sample ID	Sample Collection Date (mm/dd/yy)	Sample Collection Time	Matrix Type	Sample Type	# of Containers	Na, K, Ca, Mg & Si	Alkalinity as HCO_3^-	Cl, SO_4, NO_3 & F by IC
BB1(2)FA14T	9/2/02		W		1	✓	✓	✓
BB1(3)FA11T	7/3/02				1	✓	✓	✓
BB1(4)FA20T	8/20/02				1	✓	✓	✓
BB3(1)PFA13T	7/3/02				1	✓	✓	✓
BB3(2)FA13T	9/3/02				1	✓	✓	✓
BB3(3)FA15T	9/3/02				1	✓	✓	✓
BB3(4)FA16T	9/3/02		↓		1	✓	✓	✓

Client: ALKA JAIN

Shipper Name/Address: CNWRA - DIV. 20 BLDG - 57

SAMPLE LIST/CHAIN OF CUSTODY

Southwest Research Institute
Chemistry and Chemical Engineering Division
6220 Culebra Road
San Antonio, Texas 78238-5166

Client Purchase Order/Other ID:

Site/Zone ID:

Analyses Requested

Requested Turnaround: ☐ 2 Weeks ☐ 3 Weeks ☒ Other: 4 wks

SwRI Contact: Mike Dammann

REMARKS: Preservation ____ None; a = HCl to pH <2; b = HNO_3 to pH <2; c = H_2SO_4 to pH <2; d = NaOH to pH >12; e = Cool (4°C±2°C); f = Other (specify)

Nuclear Safety Related. Use appropriate QA procedures.

POC – Alka Jain
ext. – 5051
Fax – 5184
e-mail – ajain@cnwra.swri.edu

Relinquished by (Print/Signature): Alka Jain Date 9/17/02 Time 13:40

Received by (Print/Signature): Eric Gallmeier Date 9/17/02 Time 13:40

Relinquished by (Print/Signature) Date Time

Received by (Print/Signature) Date Time

Relinquished by (Print/Signature) Date Time

Samples Disposed: Date Time

Samples Disposed by:

SwRI Project: 20.01402.501

Received by SwRI Lab: (Signature)

Page 1 of 1

Witnessed & Understood by me,	Date 9/17/02	Invented by	Date
		Recorded by AJ	

No.

Project No._____
Book No._____ TITLE _____

From

Sample: BB3(5) after 19 weeks (23 AT 10/8/02) @ 90°C Test-Ksat

Width(cm): 3.0	Area(cm^2): 7.065	Height(cm): 2.86

Time

Start time:	Stop time:
Start date: 10/8/02	Stop date:

Elapsed Time 6:30, 3:02, 2:10

Time(hrs):	Time(sec):

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8	11	12
Outflow Pressure(psig):	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow			[psig]	dP(cm H2O) = dP(psig)*27.68*2.54			[cm H2O]
2	4	6		140.61	281.23	421.84	

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	6.0	7.1	7.9	Confining:	6.0	7.1	7.9
Inflow:	1	1	1	Inflow:	11	11	11
Outflow:	13	13	13	Outflow:	3	3	3

Fluid Level Changes

Confining (ml):	0	0	0
Inflow (ml):	10	10	10
Outflow (ml):	10	10	10

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

Notes

7.38 x 10^-5 cm/sec | 7.91 x 10^-5 cm/sec | 7.38 x 10^-5 cm/sec

To Page No._____

Witnessed & Understood by me,	Date 10/8/02	Invented by	Date
		Recorded by AJ	

TITLE _____ Project No._____
Book No._____

Sample: BB3(6) after 24 wks of thermal treatment @ 90°C Test-Ksat

Width(cm):	Area(cm^2):	Height(cm):

Time

Start time:	Stop time:
Start date: 10/16/02	Stop date:

Elapsed Time 0:14, 0:09, 0:07

Time(hrs):	Time(sec): 14, 9, 7

Pressure

Confining Pressure(psig):	13	16	18
Inflow Pressure(psig):	8.4	11	13.8
Outflow Pressure(psig):	6.4	7	7.8

Differential Pressure (dP)

dP(psig) = Inflow-Outflow [psig]	dP(cm H2O) = dP(psig)*27.68*2.54 [cm H2O]

Fluid Levels

Initial (ml)				Final (ml)			
Confining:	2.0	3.9	6	Confining:	2	3.9	6
Inflow:	1	1	1	Inflow:	11	11	11
Outflow:	13	14	14	Outflow:	3	4	4

Fluid Level Changes

Confining (ml):
Inflow (ml):
Outflow (ml):

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec)		[cm/sec]

Notes

Note: Problem with pressure regulator 3, leaking. Data no good ??

To Page No._____

Witnessed & Understood by me,	Date 10/16/02	Invented by	Date
		Recorded by AJ	

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SOUTHWEST RESEARCH INSTITUTE
MATRIX SPIKE SUMMARY

Sample ID: BB1(3) FA11T

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 09/17/02
Matrix: Water
Project No.: 20.06002.01.071
Lab System ID: 212945
Work Order: 23163

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Hydroxide	----	----	----	----
Bicarbonate	----	----	----	----
Carbonate	----	----	----	----
Alkalinity	----	----	----	----
Fluoride	----	----	----	----
Chloride	----	----	----	----
Nitrate-N	----	----	----	----
Sulfate	----	----	----	----
Aluminum	<0.05	2.07	2.00	104%
Calcium	31.8	52.8	20.0	105%
Iron	<0.025	1.03	1.00	103%
Magnesium	1.66	22.9	20.0	106%
Potassium	9.50	31.2	20.0	109%
Silicon	95.6	166	40.0	176%
Sodium	75.0	97.0	20.0	110%

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: BB3 (1) PFA13T

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 09/17/02
Matrix: Water
Project No.: 20.06002.01.071
Lab System ID: 212947
Work Order: 23163

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Hydroxide	<10	10
Bicarbonate	48.5	10
Carbonate	<10	10
Alkalinity	48.5	10
Fluoride	5.78	0.1
Chloride	12.6	0.1
Nitrate-N	3.21	0.1
Sulfate	26.5	0.2
Aluminum	0.164	0.05
Calcium	5.53	0.05
Iron	<0.025	0.025
Magnesium	0.448	0.05
Potassium	4.35	0.75
Silicon	98.9	0.2
Sodium	44.3	0.05

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: BB1(4) FA20T

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 09/17/02
Matrix: Water
Project No.: 20.06002.01.071
Lab System ID: 212946
Work Order: 23163

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Hydroxide	<10	10
Bicarbonate	102	10
Carbonate	<10	10
Alkalinity	102	10
Fluoride	0.943	0.1
Chloride	25.2	0.2
Nitrate-N	4.19	0.1
Sulfate	25.9	0.2
Aluminum	<0.05	0.05
Calcium	13.3	0.05
Iron	<0.025	0.025
Magnesium	0.670	0.05
Potassium	10.9	0.75
Silicon	105	0.2
Sodium	74.7	0.05

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: BB3 (2) FA13T

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 09/17/02
Matrix: Water
Project No.: 20.06002.01.071
Lab System ID: 212948
Work Order: 23163

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Hydroxide	<10	10
Bicarbonate	113	10
Carbonate	<10	10
Alkalinity	113	10
Fluoride	<0.1	0.1
Chloride	27.3	0.2
Nitrate-N	1.54	0.1
Sulfate	25.5	0.2
Aluminum	<0.05	0.05
Calcium	12.5	0.05
Iron	<0.025	0.025
Magnesium	2.35	0.05
Potassium	7.95	0.75
Silicon	79.2	0.2
Sodium	56.4	0.05

Project No.
TITLE
From Pa
Date
Invented by
Recorded by AJ
Date 10/29/02
Witnessed & Understood by me,

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

chemical Analysis results from Div. 01

Sample ID: BB1(2) FA14T

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 09/17/02
Matrix: Water
Project No.: 20.06002.01.071
Lab System ID: 212944
Work Order: 23163

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Hydroxide	<20	20
Bicarbonate	105	20
Carbonate	<20	20
Alkalinity	105	20
Fluoride	0.323	0.1
Chloride	16.8	0.1
Nitrate-N	3.42	0.1
Sulfate	23.4	0.2
Aluminum	<0.05	0.05
Calcium	12.9	0.05
Iron	<0.025	0.025
Magnesium	1.84	0.05
Potassium	5.90	0.75
Silicon	86.7	0.2
Sodium	49.3	0.05

SOUTHWEST RESEARCH INSTITUTE
MATRIX SPIKE SUMMARY

Sample BB1(2) filtrate after 14 WKS of Thermal treatment

Sample ID: BB1(2) FA14T

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 09/17/02
Matrix: Water
Project No.: 20.06002.01.071
Lab System ID: 212944
Work Order: 23163

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Hydroxide	----	----	----	----
Bicarbonate	----	----	----	----
Carbonate	----	----	----	----
Alkalinity	----	----	----	----
Fluoride	0.323	1.12	1.00	79.7%
Chloride	16.8	18.7	2.00	95.0%
Nitrate-N	3.42	4.26	0.904	92.9%
Sulfate	23.4	30.0	8.00	82.5%
Aluminum	----	----	----	----
Calcium	----	----	----	----
Iron	----	----	----	----
Magnesium	----	----	----	----
Potassium	----	----	----	----
Silicon	----	----	----	----
Sodium	----	----	----	----

SOUTHWEST RESEARCH INSTITUTE
DUPLICATE SUMMARY

Sample ID: BB1(2) FA14T

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 09/17/02
Matrix: Water
Project No.: 20.06002.01.071
Lab System ID: 212944
Work Order: 23163

Analysis	Sample Result (mg/L)	Duplicate Result (mg/L)	RPD
Hydroxide	<20	<20	0.00%
Bicarbonate	105	106	0.95%
Carbonate	<20	<20	0.00%
Alkalinity	105	106	0.95%
Fluoride	0.323	0.336	3.95%
Chloride	16.8	16.7	0.60%
Nitrate-N	3.42	3.40	0.59%
Sulfate	23.4	24.4	4.18%
Aluminum	<0.05	<0.05	0.00%
Calcium	12.9	13.1	1.54%
Iron	<0.025	<0.025	0.00%
Magnesium	1.84	1.89	2.68%
Potassium	5.90	6.18	4.64%
Silicon	86.7	88.1	1.60%
Sodium	49.3	49.9	1.21%

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: BB1(3) FA11T

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 09/17/02
Matrix: Water
Project No.: 20.06002.01.071
Lab System ID: 212945
Work Order: 23163

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Hydroxide	<10	10
Bicarbonate	196	10
Carbonate	14.0	10
Alkalinity	210	10
Fluoride	0.801	0.1
Chloride	32.5	0.2
Nitrate-N	0.125	0.1
Sulfate	24.2	0.2
Aluminum	<0.05	0.05
Calcium	31.8	0.05
Iron	<0.025	0.025
Magnesium	1.66	0.05
Potassium	9.50	0.75
Silicon	95.6	0.2
Sodium	75.0	0.05

Project No.
Book No.
TITLE
From Pa
Date
Invented by
Recorded by AJ
Date 10/29/02
Witnessed & Understood by me,

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SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Water
Lab System ID: 212949

Sample ID: BB3 (3) FA15T

Client: Division 20
Date Received: 09/17/02
Project No.: 20.06002.01.071
Work Order: 23163

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Hydroxide	<20	20
Bicarbonate	143	20
Carbonate	143	20
Alkalinity	1.04	0.1
Fluoride	35.1	0.2
Chloride-N	3.88	0.1
Sulfate	26.2	0.2
Aluminum	0.064	0.05
Calcium	22.5	0.05
Iron	<0.025	0.025
Magnesium	1.08	0.05
Potassium	8.75	0.75
Silicon	68.2	0.2
Sodium	58.5	0.05

SOUTHWEST RESEARCH INSTITUTE
MATRIX SPIKE SUMMARY

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Water
Lab System ID: 212949

Sample ID: BB3 (3) FA15T

Client: Division 20
Date Received: 09/17/02
Project No.: 20.06002.01.071
Work Order: 23163

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Hydroxide	----	----	----	----
Bicarbonate	----	----	----	----
Carbonate	----	----	----	----
Alkalinity	143	190	50.0	94.0%
Fluoride	----	----	----	----
Chloride	----	----	----	----
Nitrate-N	----	----	----	----
Sulfate	----	----	----	----
Aluminum	----	----	----	----
Calcium	----	----	----	----
Iron	----	----	----	----
Magnesium	----	----	----	----
Potassium	----	----	----	----
Silicon	----	----	----	----
Sodium	----	----	----	----

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Water
Lab System ID: 212950

Sample ID: BB3 (4) FA16T

Client: Division 20
Date Received: 09/17/02
Project No.: 20.06002.01.071
Work Order: 23163

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Hydroxide	<10	10
Bicarbonate	125	10
Carbonate	<10	10
Alkalinity	123	10
Fluoride	0.623	0.2
Chloride	4.38	0.1
Nitrate-N	26.5	0.2
Sulfate	<0.05	0.05
Aluminum	22.1	0.05
Calcium	<0.025	0.025
Iron	0.894	0.05
Magnesium	7.74	0.75
Potassium	82.5	0.2
Silicon	55.1	0.05
Sodium		

SOUTHWEST RESEARCH INSTITUTE
LABORATORY CONTROL SAMPLE

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Water
Lab System ID: NA

Sample ID: LCSW

Client: Division 20
Date Received: NA
Project No.: 20.06002.01.071
Work Order: 23163

Analysis	Sample Result (mg/L)	True Value (mg/L)	Recovery
Hydroxide	----	----	----
Bicarbonate	----	----	----
Carbonate	----	----	----
Alkalinity	50.0	51.8	96.5%
Fluoride	101	100	101%
Chloride	207	200	104%
Nitrate-N	90.1	90.40	99.7%
Sulfate	400	400	100%
Aluminum	2.06	2.00	103%
Calcium	20.9	20.0	105%
Iron	1.04	1.00	104%
Magnesium	21.1	20.0	106%
Potassium	20.5	20.0	103%
Silicon	4.18	4.00	105%
Sodium	20.1	20.0	101%

NA- Not Applicable.

SOUTHWEST RESEARCH INSTITUTE
BLANK SUMMARY

Sample ID: PBW

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Water
Lab System ID: NA

Client: Division 20
Date Received: NA
Project No.: 20.06002.01.071
Work Order: 23163

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Hydroxide	<4	4
Bicarbonate	<4	4
Carbonate	<4	4
Alkalinity	<4	4
Fluoride	<0.1	0.1
Chloride	<0.1	0.1
Nitrate-N	<0.1	0.1
Sulfate	<0.1	0.1
Aluminum	<0.05	0.05
Calcium	<0.05	0.05
Iron	<0.025	0.025
Magnesium	<0.05	0.05
Potassium	<0.750	0.75
Silicon	<0.02	0.02
Sodium	<0.05	0.05

NA- Not Applicable.

Project No._____
Book No._____ TITLE _____

From Page No.___

Pressure regulators # 2 & # 3 for Triaxial Permeability Panel were replaced with new one. These following tests were performed to test the equipment performance. The performance seemed to be good.

Sample: BB1 (1) Packed in Teflon Test-Ksat Sample holder & no thermal treatment

Width(cm):	Area(cm^2):	Height(cm):

Time

Start time:	Stop time:
Start date: 2/6/03 & 3/3/03	Stop date:

Elapsed Time 1:31, 0:48, 0:33, 1:35, 0:44, 0:28

Time(hrs):	Time(sec): 91, 48, 33, ~~95, 44, 28~~

	2/6/03 Pressure			3/3/03		
Confining Pressure(psig):	13	16	18	13	16	18
Inflow Pressure(psig):	8	11	12	8	11	12
Outflow Pressure(psig):	6	7	6	6	7	6

Differential Pressure (dP)

dP(psig) = Inflow-Outflow [psig]	dP(cm H2O) = dP(psig)*27.68*2.54 [cm H2O]

Fluid Levels

	2/6/03 Initial (ml)			3/3/03		
Confining:	1.3	2.7	3.5	5	6.8	7.5
Inflow:	1	1	1	1	1	1
Outflow:	14	14	14	13	13	13

	Final (ml)					
Confining:	1.3	2.7	3.5	5	6.8	7.5
Inflow:	11	11	11	11	11	11
Outflow:	4	4	4	3	3	3

Fluid Level Changes

Confining (ml):
Inflow (ml):
Outflow (ml):

Volume change

[Inflow (ml) + Outflow (ml)] / 2 [ml]

Ksat Calculation

Ksat = (Q / A) * (dL / dH)

Q = Volume change (ml) / Elapsed time (sec)	(1)	[ml/sec]
A = Area (cm^2)	(2)	[cm^2]
dL = Sample Height (cm)	(3)	[cm]
dH = Differential Pressure (cm H2O)	(4)	[cm H2O]
Ksat = [1 / 2] * [3 / 4] (cm/sec) 2.82×10^{-4}, 2.67 $\times 10^{-4}$, 2.59×10^{-4}		[cm/sec]

Notes 2.70×10^{-4}, 2.92×10^{-4}, 3.06×10^{-4}

Witnessed & Understood by me,	Date 2/6/03 3/3/03	Invented by	Date
		Recorded by AJ	

I have reviewed this scientific notebook and find it in agreement with QAP-001. There is sufficient information regarding methods used for conducting tests, acquiring and analyzing data so that another qualified individual could repeat the activity.

R.C. Pe 4/4/2003