308 --- Q200002080004
Scientific Notebook # 062

308 --- Q200002080004
Scientific Notebook # 062

21
300
R

Ronald T. Green
CNWRA/SwRI
210-522-5305

Note: Old output from /home/sneezy/rgreen/noniso is stored as a compressed file in ~/noniso/old-output/* or ~/noniso/old-outputa/*

CNWRA
CONTROLLED
COPY 062

Contents — Page

RTG or RTG = Ronald T Green

Contents

Page

This Notebook contains daily entries on computer simulations and analyses for several different projects. Each task will be individually identified. RH 11/3/94

Initial entry for the Numerical Simulations of the Thermohydrology Research Project experiments is on pg 200. RH 3/5/97

1

3/5/93 RH Files from VTOUGH runs, performed on LANL Cray & stored on IRIS in /usr1/rgreen/one-d

One-d analogs of Test 5 & 6

4/1/93 RH Set up 1-d w/ 150 elements $\frac{.1551}{150} = 1.034E-3m$

x-sectional area = 1.0692E-6 m²
Vol = 1.1055 E-9 m³
½ distance = 5.1700 E-4

put into 1d-z16i

150 elements ~~148~~ 150 internal → 152 total

1 bound
75 bead1
50 bead2
25 bead3
1 bound

run z16-log

1d-z16.plt

9	0.5
11	1.0
13	2.0
15	5.0
19	20.0
21	50.0
24	120.0
29	1157.4

effect of 90 C boundary limited to elements near edge, increased time steps by 10X & resubmitted
(1E3 . . . 1E5)

no convergence after 25 iterations

set initial time step to ~~2E5~~ 5E2 RF & let automatic time stepping take it from there

24	0.5
26	1.0
28	2.0
30	5.0
34	20.0
36	50.0
39	120.0
44	1157.4

results were bad, no temp or pressure difference beyond 1 element

set Δt_i to 1E2 & resubmitted

4/2/93 RF

run z16.log results appear same as w/ Δt_i = 5E2, try again w/ smaller Δt

Δt_i = 1E1 same results

Δt_i = 1E0 same results

Decided to rerun 100 element mesh using a smaller Δt_i to compare w/ other one.
set Δt_i = 1E2 in 1d-x16i

times for this run are

25	0.5
27	1.0
30	2.0
33	5.0
39	20.0
44	50.0
47	120.0
53	1157.4

no change in output from old run x16.log

Set ϵ_1 to 1E-6 in 1d-z16i (150 elements) and re ran → no change

Set ϵ_1 to 1E-6, ϵ_2 = 0.5 & resubmit → no change

{ Put a copy of VTOUGH into IPX4/Bashful/rgreen/tough
this is the one Peter got to run on the IPX

set U = 0.5 in ~~run~~ 1d-z16i
this makes printing criteria more stringent resulting in better numerical stability but increased CPU
⇒ same result

ran 1d-z16i on Bashful & got same results

Renamed elements so that no # > 100 i.e.
B 74, D 25, E 25 etc → ran

27	0.5
29	1.0
31	2.0
34	5.0
38	20.0
40	50.0
43	120.0
48	1157.4

4/5/93 RA Output for 1d-z16i is better but there is discontinuity at the boundry between types of media. Made all media the same (BEAD1) reran → test.out

29	0.5
31	1.0
33	2.0
36	5.0
40	20.0
43	50.0
45	120.0
50	1157.4

Missing connection between domain types reran → 1d-z16.out

34	0.5
36	1.0
38	2.0
41	5.0
45	20.0
48	50.0
50	120.0
55	1157.4

removed flow connection to BOUND reran → 1d-z16.out

looks good
1d-z16.plt

27	0.5
29	1.0
32	2.0
35	5.0
41	20.0
46	50.0
49	120.0
55	1157.4

Will run TOUGH w/ 200 elements to compare w/ 150 elements

element size: 7.755E-4
distance from middle to edge: 3.878E-4
x-section area: 6.014E-7
volume: 4.664E-10

put into 1d-2ci (200) in /IPx4/rgreen/tough/1d-2ci

~~1d~~ RA
16-2c.plt

28	0.5
30	1.0
32	2.0
35	5.0
41	20.0
46	50.0
49	120.0
55	1157.4

4/6/93 results match 150 elements very closely when overlaid.

4/7/93 Will rerun tests for 60 & 90 at e-14, e-15, e-16

	90	60 (cool)
-16	~~1d~~-2ci 16 RA	~~1d~~c-2ci 16
-15	15-2ci	15c-2ci
-14	14-2ci	14c-2ci

16c-2c.out

iteration #	time (days)
22	0.5
24	1.0
26	2.0
29	5.0
33	20.0
36	50.0
40	120.0
45	1157.4

15 -2C.plt
15 -2C.out
15 -2C.sty
15 -2C.ps

28	0.5 ✓
30	1.0
32	2.0 ✓
35	5.0 ✓
39	20.0
42	50.0
45	120.0 ✓
50	1154.7

14-2C.plt
14-2C.out

28	0.5
30	1.0
32	2.0
34	5.0
38	20.0
40	50.0
43	120.0
48	1157.4

15c-2c.out
15c-2c.plt

22	0.5
24	1.0
26	2.0
28	5.0
32	20.0
34	50.0
37	120.0
42	1157.4

14c-2c.out

22	0.5
24	1.0
26	2.0
28	5.0
32	20.0
34	50.0
37	120.0
42	1157.4

4/8/93 RH Plotted liquid saturation for k_{sat} = e-14, e-15 & e-16 m². Both test 6 (60C) and test 12 (90 C) are on the same graph.

14-2C-LS.sty &.ps
15-2C-LS.sty &.ps
16-2C-LS.sty &.ps

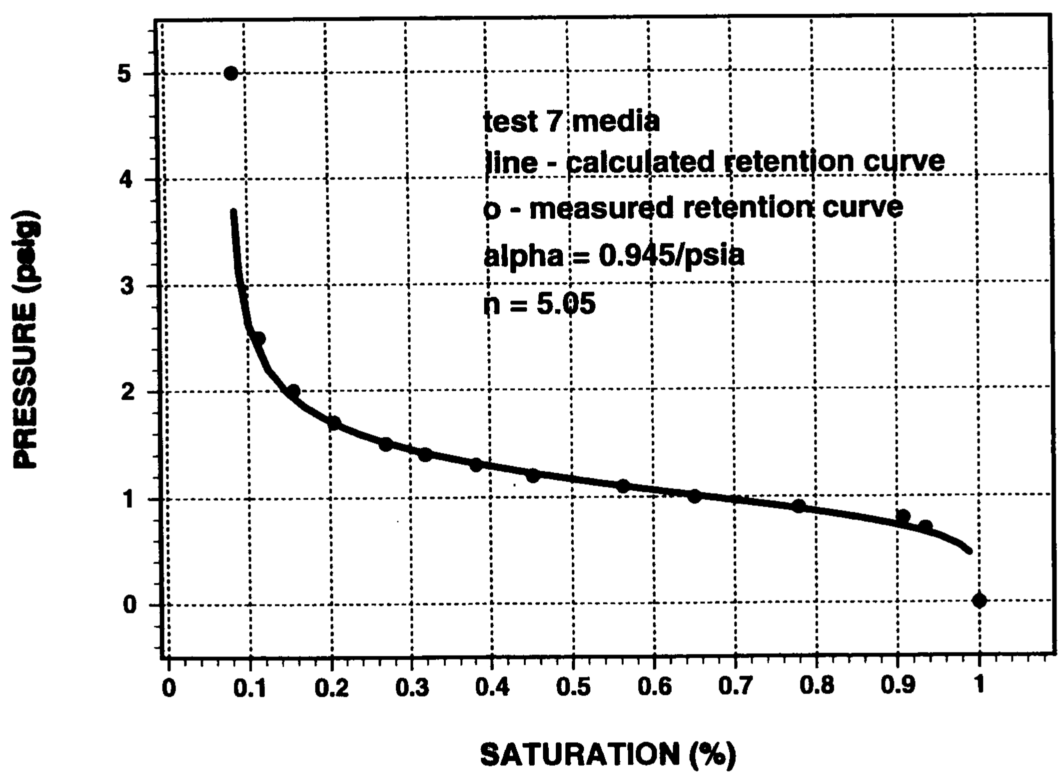
in usr1/rgreen/asme

5/3/93 RH — Ran VTOUGH to simulate Test 7.

Used hydraulic property values determined using RETC - sent by van Genuchten in late April/93

Retc results for test 7 are included below

MOISTURE RETENTION CURVE



$n \Rightarrow \quad m = 1 - \frac{1}{n} \qquad m = \lambda$

for $n = 5$; $\lambda = 0.8$

RH

for $\alpha = 0.945$/psia

$\alpha^{-1} = 1.058$ psia
$= 7.298e-2$ bar
$= 7.298e3$ Pa

$\alpha = 1.37e-4$

used $\lambda = 0.8$; $1/P_0 = 1.4e-4\ Pa^{-1}$ in VTOUGH

Ran on Bashful ~ 2 Hrs CPU Clocktime

21	0.5
23	1.0
25	2.0
27	5.0
31	20.0
33	50.0
36	120.0
41	1157.4

data looks interesting put into t7-nu-a.plt

5/4/93 RH — Compared results w/ previous results:

earlier results were same except for α, n
α was $1.1e-5\ Pa^{-1}$
n was 1.25 ($\lambda = .2$)

liquid sat at 120 days sty in t7c15n125.sty

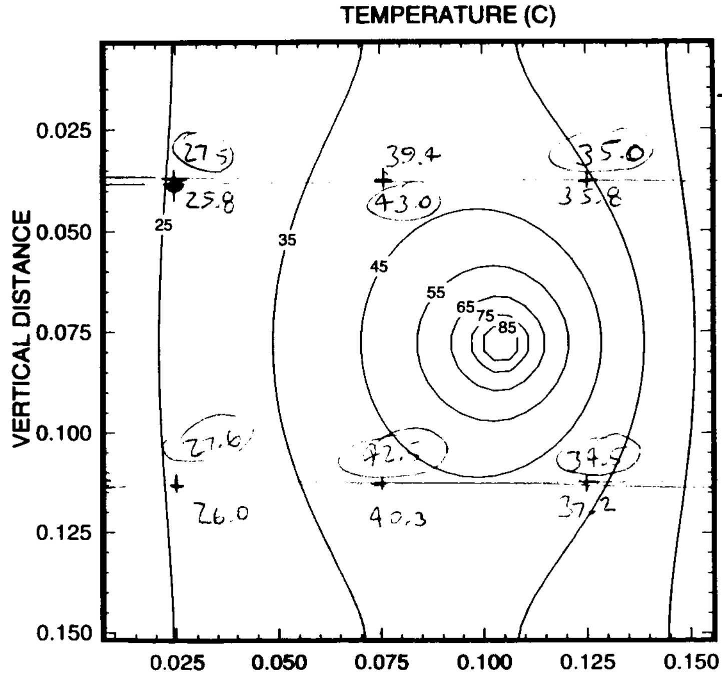
/lpx4
/bashful/rgreen
/test7/t7i

```
shful% more t7i
-t7,icp11,alf1.4e-4,ks-11,ll.2,b5.,q2.25,5/3/3,thermcon=19.7W/m,GENE=32
ROCKS
matr2    22500.     .35          1.0E-11                    19.7         800.
      0.0      0.0      19.7       0.5
    7          .800      0.0       1.0
   11          .800      0.0     1.4E-4     1.0E5      1.0      0.1
matr1    22500.     .0001        4.0E-90                     1.0        1.0E35
      0.0      0.0       1.0       0.0
    7          .800      0.0       0.5
   11          .800      0.0       1.0      1.0E5      1.0      0.1
matr3    22500.     .0001        4.0E-90                     1.0        1.0E35
      0.0      0.0       1.0       0.0
    7          .800      0.0       0.5
   11          .800      0.0       1.0      1.0E5      1.0      0.1

PARAM
   2 9902000   5000000000000000 41          2.00e-5      1.8
      0.0  1.000E+8       -1.           B  10      +9.80665
     1.E0
    1.E-5      1.0                                  1.E-8
               1.E5                 .20 20.
START
RPCAP
    7          .200      0.0       1.0
   11          .200      0.0     1.1E-5     1.0E5      1.0      0.35
TIMES
    7    7     1.E10 3.15576E8
   4.320e4   8.640e4   1.728e5   4.320e5   1.728e6   4.320e6   1.037e7
OPTN
    0    1    0    1    1    0
DTSTP
          0         0         0         0
ELEME
```

results are in:
t7-c.plt

Input for t7, used to get the following results
α, n are described on pages 8-9

TEST 7 - 120 DAYS
TEMPERATURE (C)

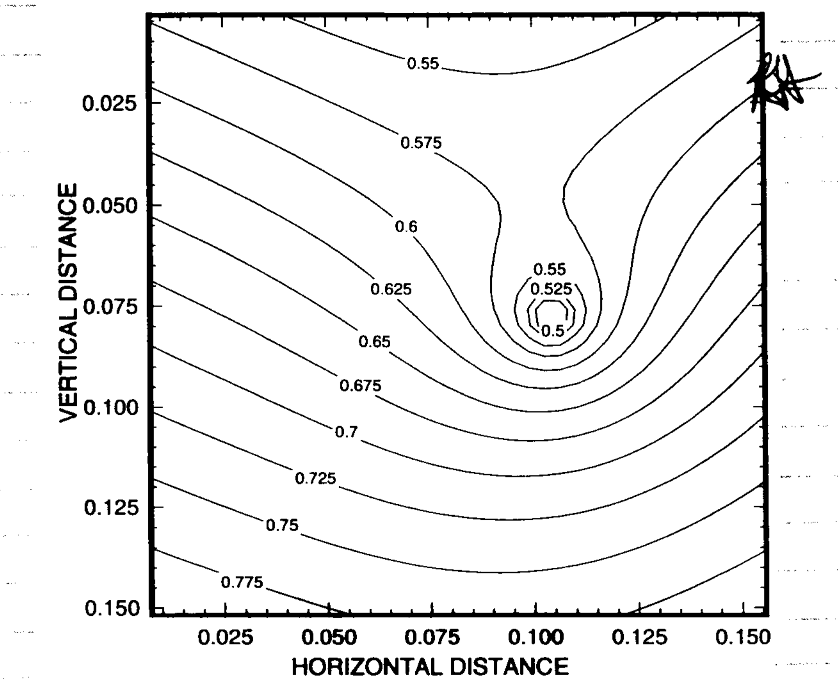


t7-c-t.sty
t7-c-t.ps

(35.0) Measured during Test 7

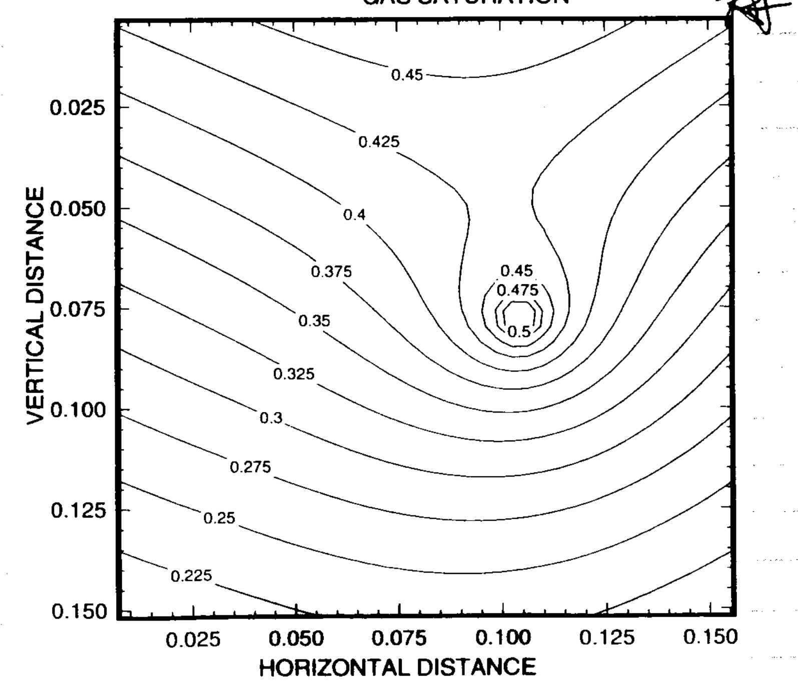
37.2 calculated using V[illegible]

TEST 7 - 120 DAYS
LIQUID SATURATION



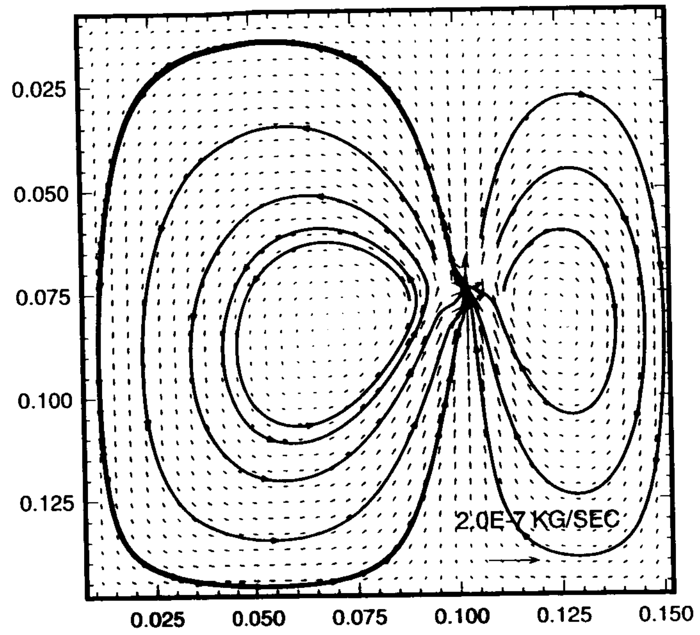
t7-c-ls.sty
t7-c-ls.ps

TEST 7 - 120 DAYS
GAS SATURATION



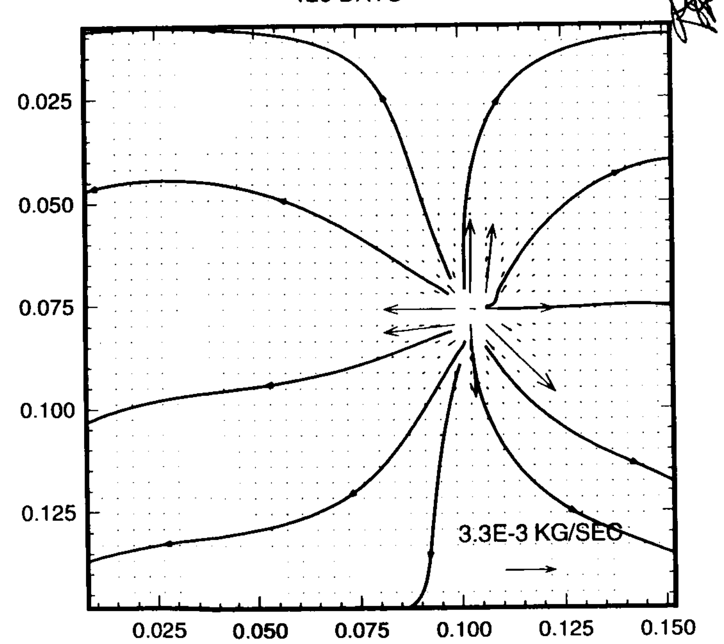
t7-c-gs.sty
t7-c-gs.sty

TEST 7
LIQUID FLOW RATE
120 DAYS



t7-lv.plt
t7-lv.sty
t7-lv.ps

TEST 7
GAS FLOW RATE
120 DAYS



t7-gv.ptl
t7-gv.sty
t7-gv.ps

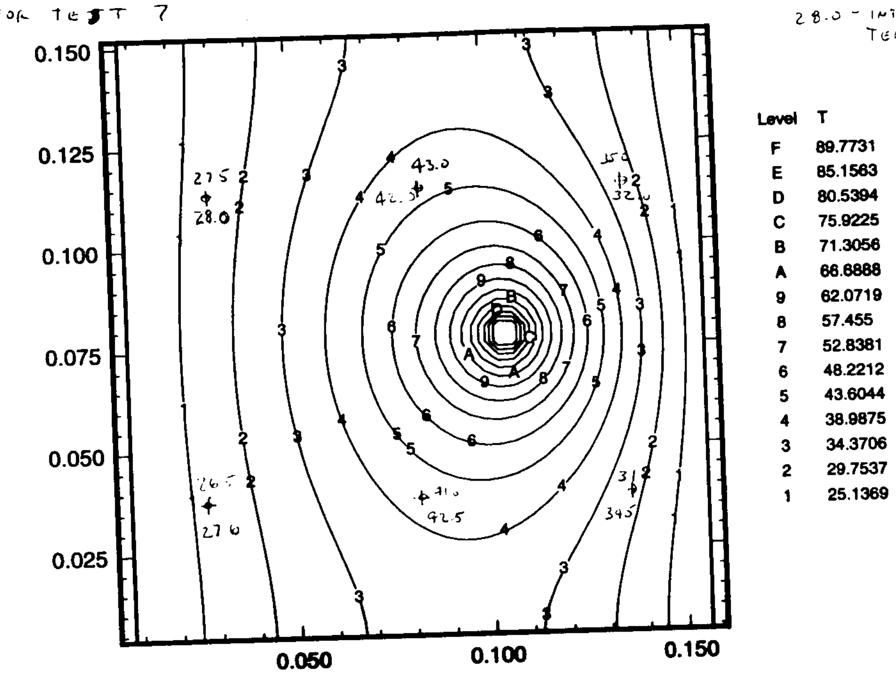
For comparison results of VFOUGH w/
$\alpha = 1.1e{-}5\ Pa^{-1}$ & $n = 1.25$ are below

t7-32.plt

COMPARISON OF MEASURED & SIMULATED TEMPERATURES FOR TEST 7

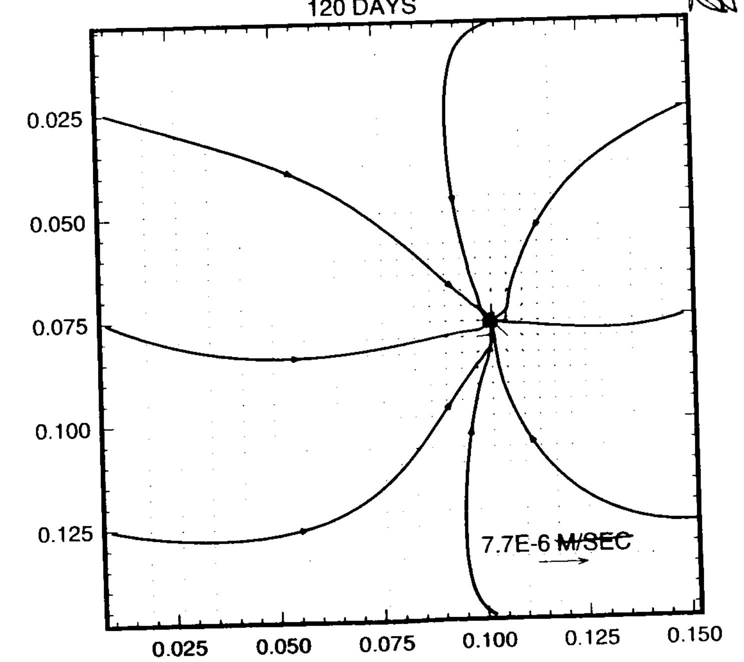
27.5 — Test 7 measured temperatures
28.0 — INTERPOLATED TEMPERATURES

t7-32-tps



TEST 7
~~LIQUID VELOCITY~~
120 DAYS

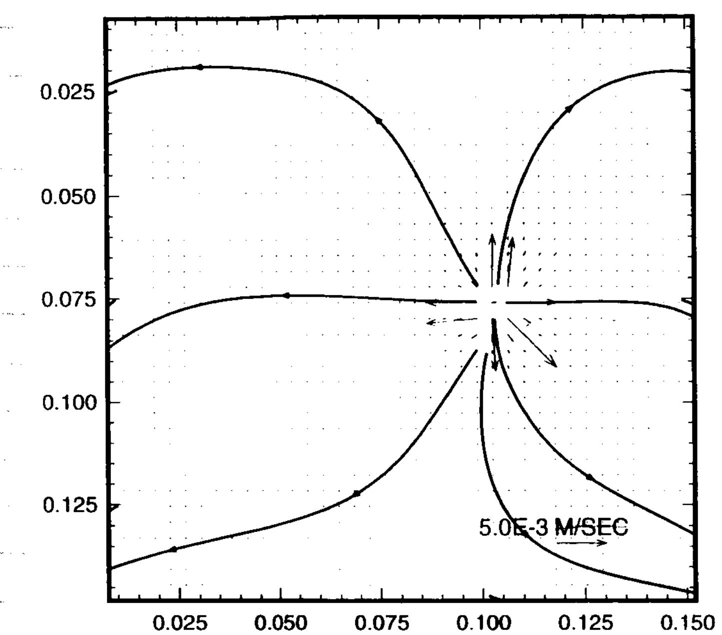
This is actually liquid flow rate Kg/s



t7v-l ps
t7-vect.sty

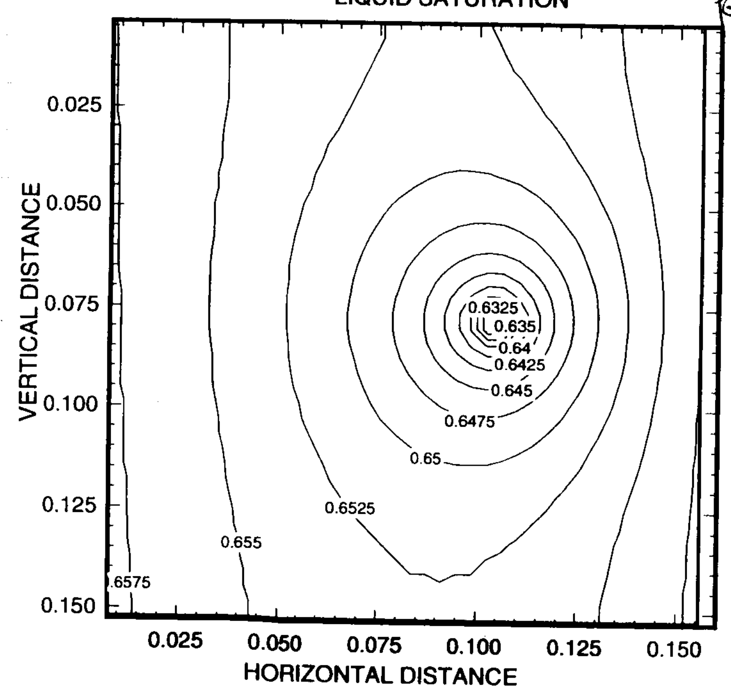
This is actually gas flow rate Kg/s

TEST 7
GAS VELOCITY
120 DAYS



t7v-g.ps
t7v-gv.sty

TEST 7 - 120 DAYS
LIQUID SATURATION



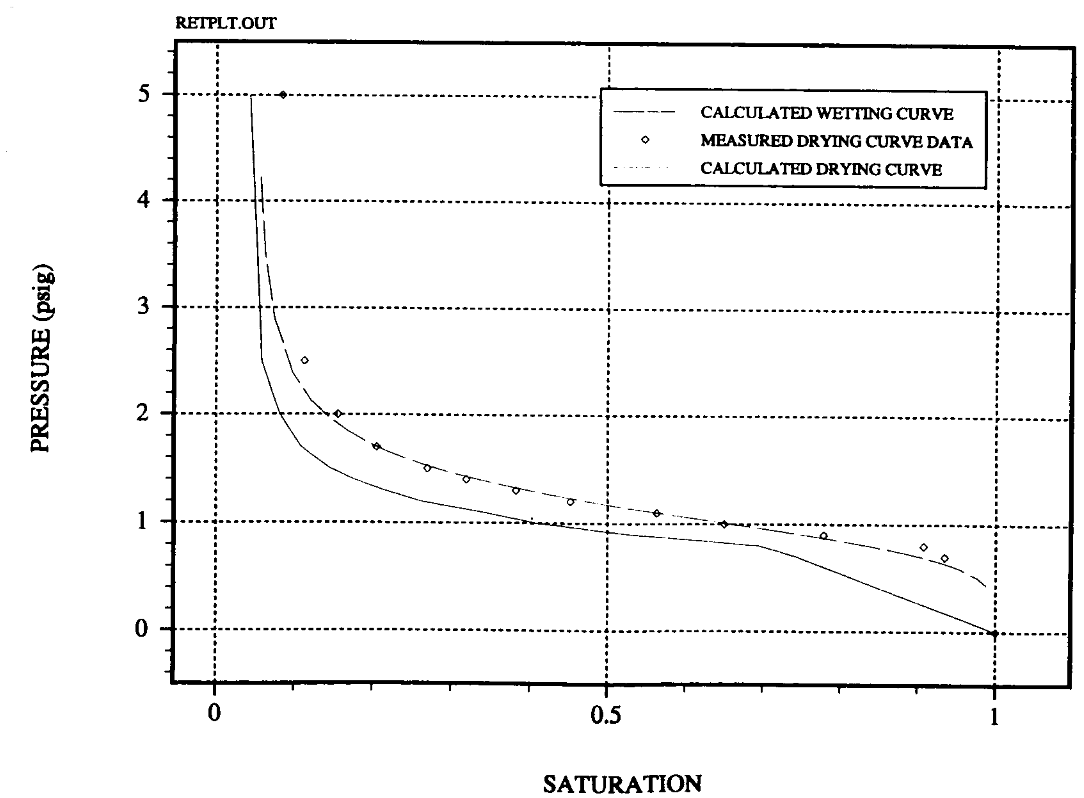
t7-old-t.sty
t7-old-t.ps

5/5/93 RH — To check if difference in results is due to dry end of the retention curve model, S* was set from 0.1 to 0.3 and re run. The ICP = 11 model by LLNL is being used.

5/6/93 RH — Absolutely no change. Diffed output files, they were identical

5/10/93 RH — Used Mualem (1977) independent domain theory to predict a wetting curve from measured (or calculated) drying curve. Plotted using XPLOT. ~~Test7.dat~~ RH 11/3/94 RETPLT.OUT on Bashful (from RETC) to get van Genuchten curve. Used exclaim to determine wetting curve (see next page)

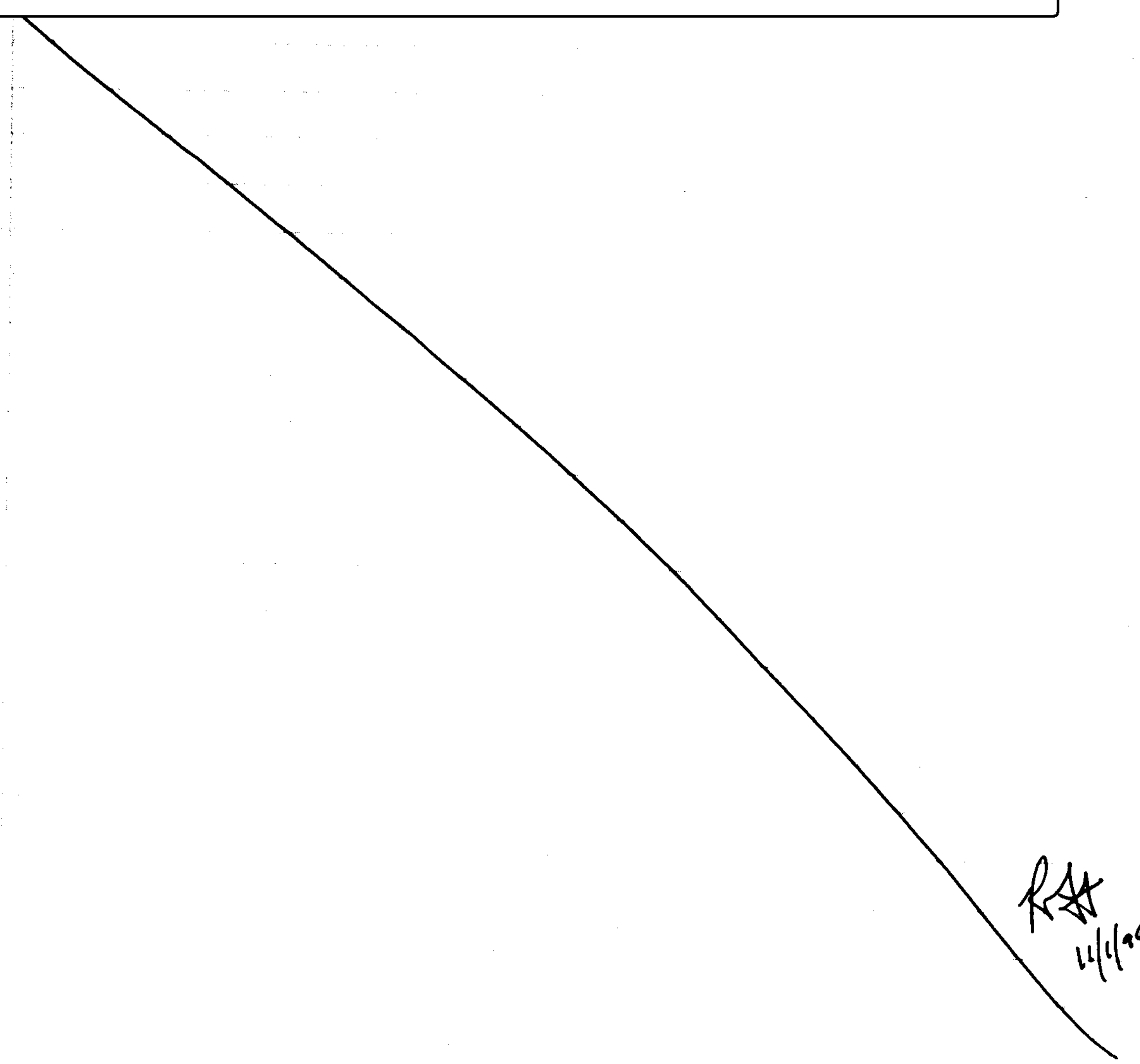
TEST 7 RETENTION CURVE



From pg 776 WRR 1977

Information potentially subject to copyright protection was redacted from this location. The redacted material (equation) is from the following reference: Water Resources Research. p. 776. 1977.

$)^{\frac{1}{2}}$



RH 11/1/94

6/1/93 RH

Test 11 is to be same as Test 7 but w/ source temperature @ 105°C. Set GENE = 36 to see what temp would be

22	0.5
24	1.0
26	2.0
29	5.0
32	20.0
35	50.0
37	120.0
42	1157.4

Note: test 11 was eventually called test 7B – RH 12/27/94

CPU = 5592.8 sec

test11 goes A–PP, 1 – 40

⇛ t11.out

BB 21 was 100.3°C w/ GENE = 36 W/m

set GENE = 38 ; AA 20 = 101.1°C
BB 21 = 101.0°C

set GENE = 46, resubmitted

6/2/93 RH

GENE = 46, time = 6648.7 sec

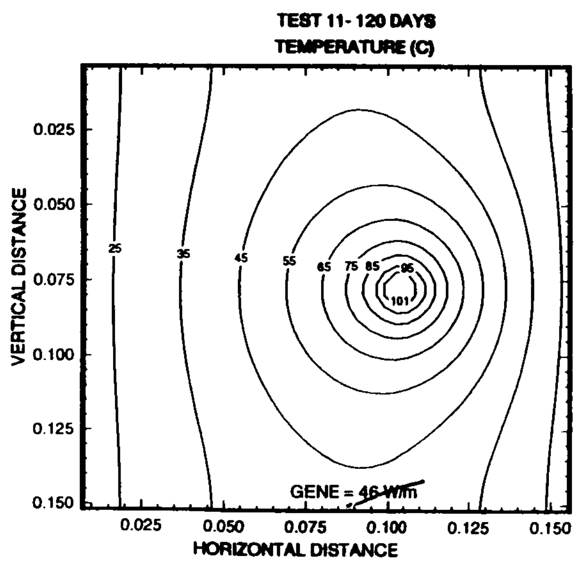
BB 21 101.7°C

25	0.5
27	1.0
29	2.0
31	5.0
35	20.0
37	50.0
40	120.0
45	1157.4

6/2/93 RH — Set GENE = 60   time = 9

29	0.5
31	1.0
33	2.0
36	5.0
39	20.0
42	50.0
46	120.0
49	1157.4

10/3/93 RH — Results for GENE = 46, 60 W/m are plotted below



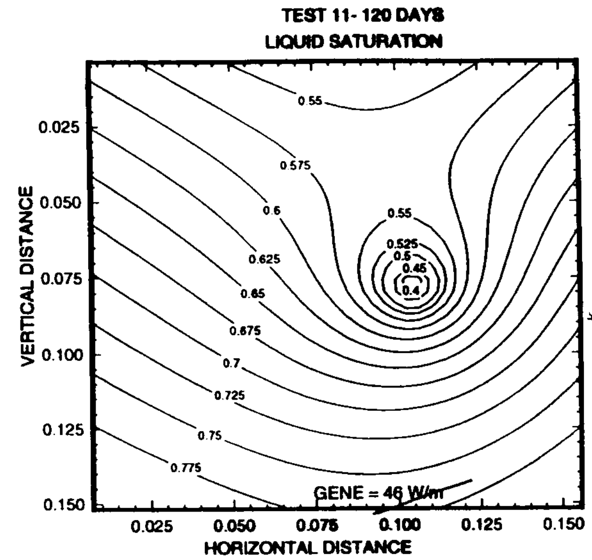
RH High temp < 102

t11-46.plt

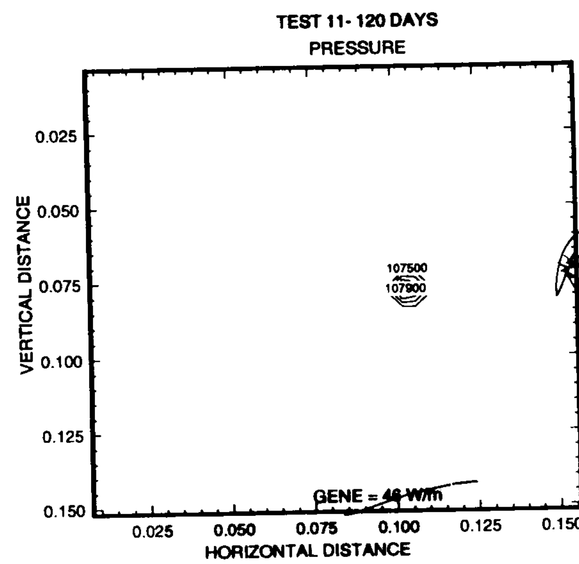
This is 46W/0.05m
RH 10/12/93

Same input as Test 7 on pg 10 except for heat source

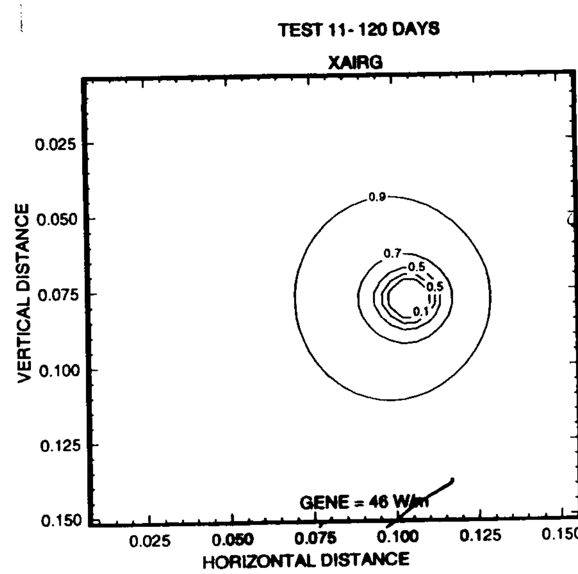
starting saturation = 0.65
RH 10/12/93



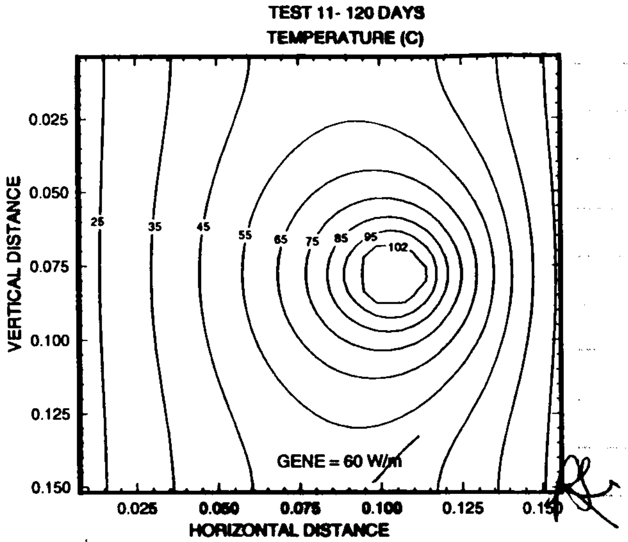
RH



RH

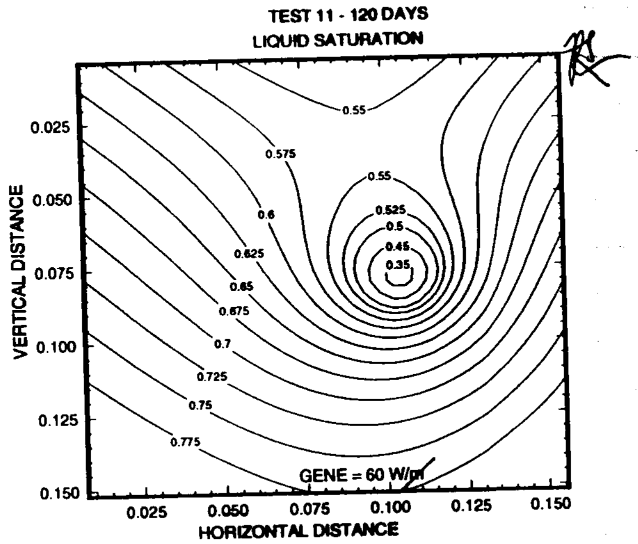


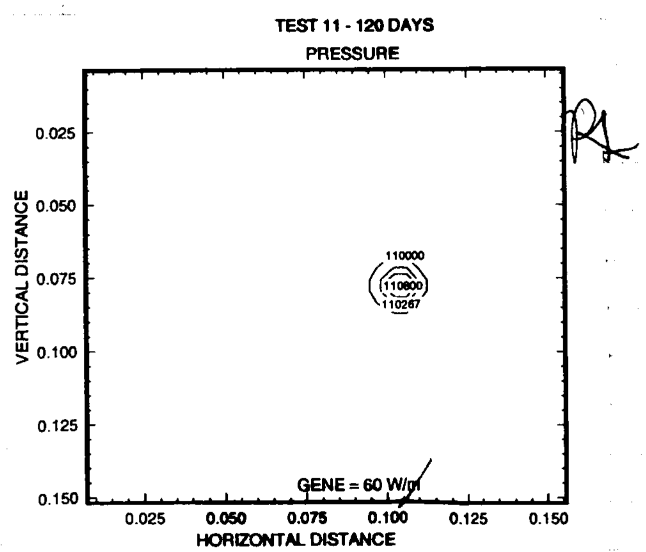
RH

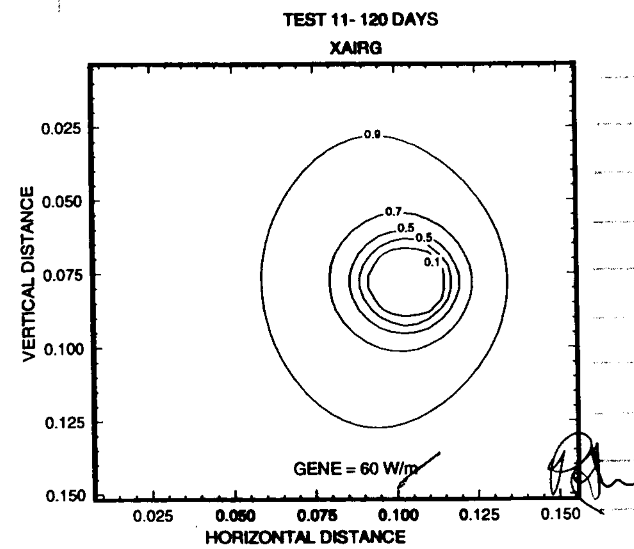


highest temp < 103 °C

t11-60.plt
t11-60.out







This is 60W/0.05m

6/4/93 Set up grids for canister scale simulations

multi - size of model 22m wide 10T tall
canisters are 2 elements wide (2 x 0.5m) & 5m tall
⇒ a total of 7 canisters @ C/D; I/J; O/P; U/V; AA/BB; GG/HH; MM/NN
gridspacing is as follows

←Z direction (48) 1-48

0.	56.5
5.	57.
10.	57.5
15.	58.
20.	58.5
25.	59.
29.	59.5
33.	60.
37.	61.
40.	62.
43.	63.5
45.	65.
47.	67.
48.5	69.
50.	72.
51.	75.
52.	79.
52.5	83.
53.	87.
53.5	92.
54.	97.
54.5	102.
55.	107.
55.5	
56.	

6/7/93 X-direction (~~45~~) 42 A - PP

0.	11.5
.5	12.
1.	12.5
1.5	13.
2.	13.5
2.5	14.
3.	14.5
3.5	15.
4.	15.5
4.5	16.
5.	16.5
5.5	17.
6.	17.5
6.5	18.
7.	18.5
7.5	19.
8.	19.5
8.5	20.
9.	20.5
9.5	~~21.~~
10.	~~21.5~~
10.5	~~22.~~
11.	

6/7/93

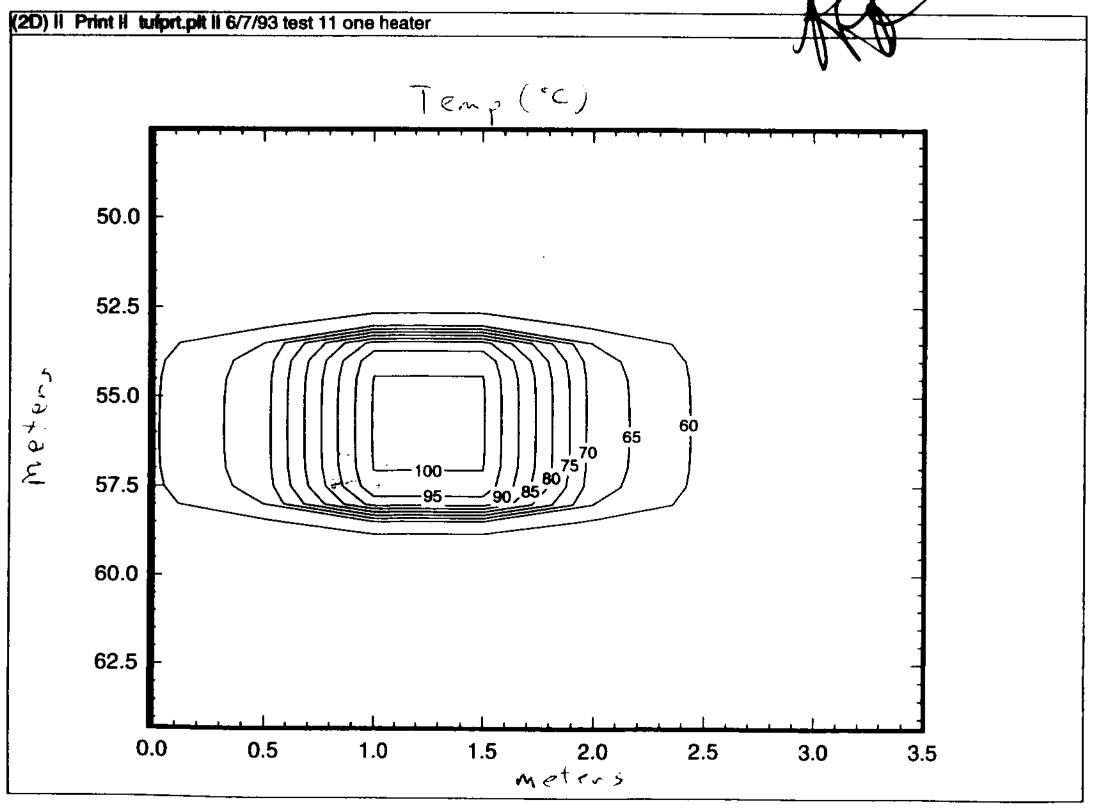
6/2/93 RF Set times to: 200 ; 500 ; 1000 ; 10,000

Tried to adjust heat source

T. Brandshaug (1989, NUREG 5429)
says SF = 3200 W (or J/s)
DHLW = 420 W (or J/s)

but for one canister at 10 J/s per element
(for a total of 200 J/s) get for
1.9 days:

RF



These temps seem high for such a short time.

Put in a decaying heat source using
T. Brandshaug, 1991 (SAND 85-7161)
up to 10,000 yrs

Start heat at 3200 J/s / 20 elements = 160 J/s per element

6/9/93 RF Can't get convergent solution for GENE = 160 J/s
at 20 elements per canister

Will try 16 J/s, could also try
ramping heat load up

Heat load of 1.6 J/s per element is tried some
16 J/s is still too large

1.6 J/s converges somewhat but w/ CPU ≈ 15 hrs, there
is still no sol^n for first time step (5 order @ ~200 days)

6/10/93 RF Will adjust first heat steps to make initial ramp smooth

RF

This is in GENE for heat source @ C 20

```
C  20HT1 1    9    1    1   10      HEAT
TIME   [0.000E+00    0.315E+09    0.631E+09    0.158E+10
(sec)  [0.315E+10    0.631E+10    0.158E+11    0.315E+11
       [0.631E+11    0.158E+12
HEAT   [0.160E+01    0.160E+01    0.124E+01    0.762E+00
(J/s)  [0.419E+00    0.238E+00    0.141E+00    0.824E-01
       [0.442E-01    0.283E-01
D  20HT2 1    9    1    1   10      HEAT
```

These results suggest heat per element should be < 1.0 J/s

put in new grid w/ constant temps upper boundary & lower boundary — NO, simply put in temps at 24°C at top and 27.5 at base & let it go

7/23/93 RH — Rerun g57i & g114i w/ $K_{sat} = 10^{-15}\ m^2$ for vector plots for Randy. Put results in Bashful ~/gutt/g57-15-vect.out
~/gutt/g114-15-vect.out

See initial entry on pg 199 RH 3/5/97

Grid size is 24 x 43

g57-15-vect.out

22	200 yrs
26	500 yrs
30	1000 yrs

7/26/93 RH — g114-15-vect.out

28	200 yrs
33	500 yrs
36	1000 yrs

for input into tutvector use

>max x coord:	41	(43 - 2)
>max y coord:	22	(24 - 2)
> x-axis start:	B	A - 1
> x-axis stop:	PP	QQ - 1
> y-axis start:	2	1 - 1
> y-axis stop:	23	24 - 1

7/27/93 RH — Ran on Sneezy w/ output every 20 iterations ⇒ 5 megabytes

107	200 yrs
139	500 yrs
168	1000 yrs

put gas velocity into: g114-v-gv.dat

7/28/93 RH — Ran for k_{sat} = e-12 m² put into ~~g114-v-12.out~~ g114-12-v.out RH
7.33 hrs CPU on Sneezy

152	200 yrs
178	500 yrs
206	1000 yrs

g114-12vg.plt
g114-12vg.sty

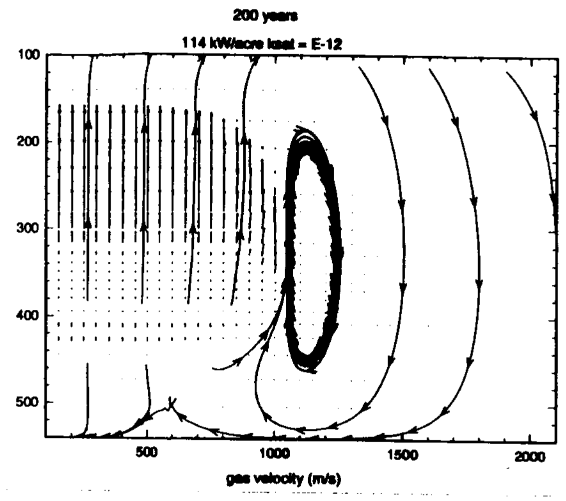
Figures on next page

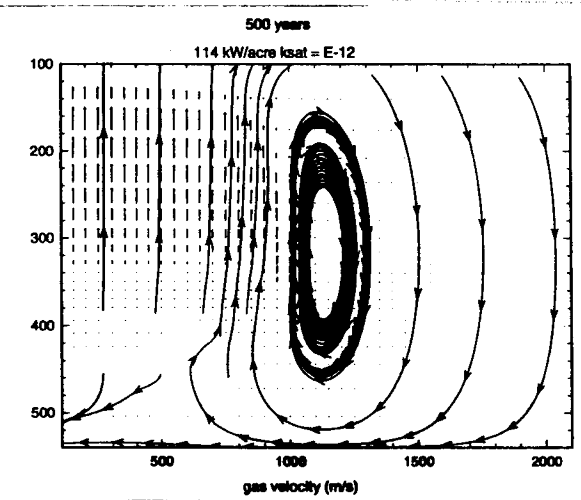
```
cp=9,7/27/93,h=114,Yucca Mt val,sat bet,hi sat,ksat=e-12,vectors, bound=e-22
ROCKS
BEADS    22580.      .11              1.9E-12   1.9E-12   1.9E-122.3          840.
       0.0       0.0       1.74       0.5
   9         1.9e-18 5.8004e-7       1.798      0.11      1.e-3
   9         1.0e-11 1.3147e-4        4.23     1.8e-3     1.e-3
BOUND    22580.      .11              1.9E-22   1.9E-22   1.9E-222.3          1.0E+9
       0.0       0.0       1.74       0.0
   9         1.9e-18 5.8004e-7       1.798      0.11      1.e-3
   9         1.0e-11 1.3147e-4        4.23     1.8e-3     1.e-3

PARAM
  2 9002000 1000000000000000 41               2.13e-5      1.8
     0.0  3.150E11       -1.            A  10      +9.80665
    1.E3      9.E3      2.E4      1.E5      1.E6      1.E7      1.E8
   1.E-5       1.                                   1.E-8
             1.E5                 .20 20.
START
RPCAP
   9         1.9e-18 5.8004e-7       1.798      0.11      1.e-3
   9         1.0e-11 1.3147e-4        4.23     1.8e-3     1.e-3
TIMES
   3    5     1.E11
 6.3072E09 1.5768E10 3.1557E10
OPTN
   0    1    0    1    1    0
DTSTP
        0         0         0         0
ELEME
A   1            BOUND0.1300E+10
A   2            BEADS0.1200E+04
```

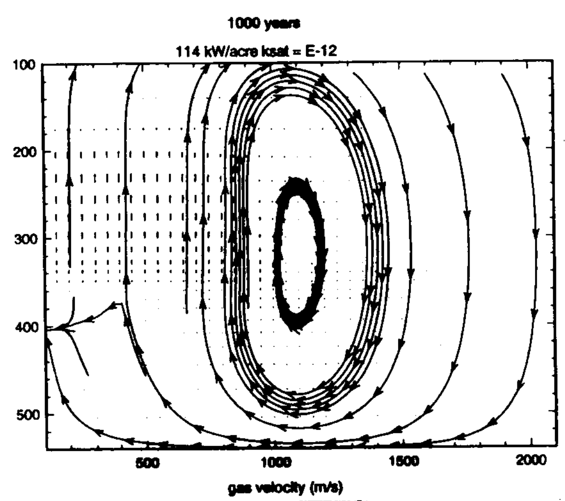
bulk K not correct, RH 11/3/94

Repository-scale model, high-heat load, 2-D vertical model.

RH 11/3/94







8/20/93 Ran RETCX on Pena Blanca samples

put NRG1 A&B into nrg1-cmp.dat for chilled mirror and
NRG1 A&B into nrg1-ppe.dat for
pressure plate extraction.

Initial entry on pg 199 RJ 3/5/97

Van Genuchten w/ α = ~~0.6~~ 0.0637
N = 2.0487
m = 0.8429

8/24/93 ran retcx w/ $m = 1 - \frac{1}{n}$

α = 0.1063
n = 2.0902
wcs ~~wcR~~ = 0.97
wcR = 0.05

changed to (input) α = 0.1
n = 3.0
wcs = 0.97
wcR = 0.025

held α constant @ 0.12 $m = 1 - \frac{1}{n}$
n = 2.0
wcs = 0.97
wcR = 0.015 $r^2 = 10.3$

plot file in ~/retc/nrg-mda.plt (model a)

regressed values are: n = 1.9137
α = 1.2000
wcs = 0.970
wcr = 0.015

These are the results used in the HLWM abstract

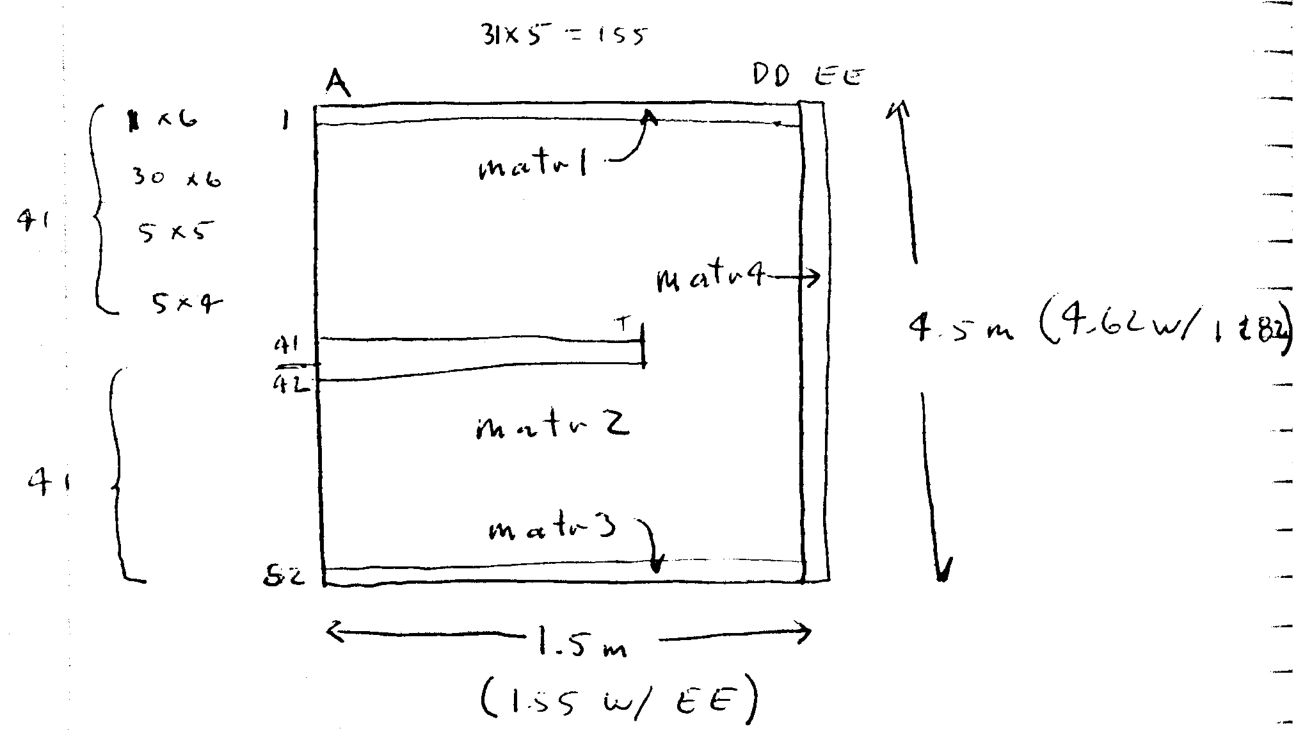
3/29/93 RH — Wait to do VTOUGH runs for LBT at Fran Ridge

10/12/93 RH — constructed grid for Fran Ridge heater block

Range of properties for these simulations will be

Initial entry on pg 200 RH 3/5/91

A) K_{sat} 10^{-12}, 10^{-14}, 10^{-16}
B) Q 1500 W, 150 W, 15 W
C) Sat .80, .50, .20
D) Guard Heaters (B.C) High temp & low



matr 1: $K_{sat} = 10^{-90}$

matr 2 K_{sat} = 1.9 E-15 9,9 model

matr 3 $K_{sat} = 10^{-90}$

matr 4 $K_{sat} = 10^{-90}$ SPHT = 1E+10

Recompiled VTOUGH on GOLIATH under /vtough-src

> changed dim.h to 2600 elements, >5000 connections & 1/2 band width of 90

> ~~tough~~ RH
> make tough

/bin has tough@ which allows tough to be executed from all directories under rgreen. Used ln -s (symbolic link) ____ /tough to put this in. All recompiled versions are automatically put into shared access.

Trouble getting model to run, changed I&P & ICP to 9,9 which is composite model.

Removed GENER section for now to get basic model running.

10/14/93 RH — Have adjusted B.C. & properties but still get underflows that cause simulation to stop after 9 time steps.

Changed 9-9 model to 7-11 but no luck, this time it only went 6 time steps (2254 CPU seconds)

10/15/93 RH — Got Frami to run. VTOUGH seems to be able to take only 34 HEAT sources. When CPU time was left blank, it ran to 50 days in ≈ 10^4 secon (~2.8 hrs).

Changed times to 1, 5, 20, ~~100~~ 50 RH, 120 days ran for infinite time. Put results into F10-15.out

10/17/93 Run Sat/Temp plots ok F10-15_out

Fram1.sat ps	19	1
fram2.sat ps	23	5
Fram 3.ps	26	20
	28	50
	31	120
Fram 5/6 ps	40	1157 (3.17 yrs)

34 heat elements @ 0.36 W

since each element is 0.05 m deep, each is 7.2 W/m

7.2 × 34 = 244.8 W per 1 m deep box

if 3m deep ⇒ 734.4 W per 3 m deep box

Put in new run

since each element is 0.05 m deep, 34 heaters

1500W/34 = 44.12 W/element

44.12W/3m ⇒ 14.71 W/m ⇒ 0.74 W/0.05m of element depth

7 times 1, 5, 20, 50, 120 days 1, 3 yrs

put into F10-17.out

10/18/93 F10-17.out ran for 16.8 hrs of CPU then I stopped it. It had 3 time steps

Sat/Temp	F1-t1.ps	20	1 day
	F1-t2.ps	26	5
F1-S3.ps	F1-t3.ps	30	7.86

This is part of Fram: used for run of F10-17.out

F10-15.out had GENER= 0.36W

10/19/93

```
m,10/17/3,9-9,gen0.74,34 ht elements,time=infin,7 times
ROCKS
matr2    22580.     .10          1.9E-15   1.9E-15   1.9E-152.3          840.
         0.0        0.0     1.74       0.5
    9         1.9e-18 5.8004e-7    1.798      0.11      1.e-3
    9         1.0e-11 1.3147e-4    4.23       1.8e-3    1.e-3
matr1    22500.     .0001        4.0E-90                   2.3          840.
         0.0        0.0     1.0        0.0
    7               .800    0.0        0.5
   11               .800    0.0        1.0       1.0E5     1.0    0.3
matr3    22500.     .0001        4.0E-90                   2.3          840.
         0.0        0.0     1.0        0.0
    7               .800    0.0        0.5
   11               .800    0.0        1.0       1.0E5     1.0    0.3
matr4    22500.     .0001        4.0E-90                   2.3          1e+10
         0.0        0.0     1.0        0.0
    7               .800    0.0        0.5
   11               .800    0.0        1.0       1.0E5     1.0    0.3

PARAM
   1 990      5000000000000000 41          2.13e-5     1.8
        0.0 1.000E+8       -1.          B  10      +9.80665
       1.E0
      1.E-5         1.0                                1.E-8
                    1.E5                 .20 20.
START
RPCAP
    7               .200    0.0      1.0
   11               .200    0.0      1.1E-5    1.0E5     1.0    0.35
TIMES
    7    7     1.E10 3.15576E8
   8.640e4   4.320e5   1.728e6   4.320e6   1.037e7   3.154e7   9.451e7
OPTN
    0    1    0    1    1    0
DTSTP
         0         0         0         0
ELEME
A    1          matr10.1500E-03
A
GENER
A  41HOT 2                          HEAT      0.74
A  42HOT 2                          HEAT      0.74
B  41HOT 3                          HEAT      0.74
B  42HOT 4                          HEAT      0.74
C  41HOT 5                          HEAT      0.74
```

← measured bulk K RH 11/3/94

Fran block model, described on pg 30

These are double what they should be for Heat = 1500W

RH

put output on hardcopy for F10-15.out & F10-17.out

Submitted new run: F10-19.out
Same as F10-17.out but w/ $K_{sat} = 1.0e{-12}\,m^2$
Sat = 0.8 $Q_H = 0.74$ W/element

$0.74\,(20\ \text{elements}/m)\,(3m)\ 34\ \text{elements} = 1509.6\ W$

but remember, this is only 1/2 block!!

⇒ should be 0.37 per element

Killed job, set GENER = 0.37 & resubmitted as F10-19.out

10/20/93 RH F10-19.out ran to completion (0.37 W)

Sat	Temp			
F2-s1.ps	F2-t1.ps	19	1	
F2-s2.ps	F2-t2.ps	23	5	
F2-s3.ps	F2-t3.ps	26	20	
F2-s4.ps	F2-t4.ps	28	50	
F2-s5.ps	F2-t5.ps	31	120	
Same	—	34	365	1YR
Same	—	37	1093	3YR
		38	1157	

Submitted next run same as F10-19.out but w/ $K_{sat} = 1e{-14}\,m^2$ (GENER = 0.37, Sat = 0.80) ⇒ F10-20.out

10/21/93 RH Reduced size of heaters to 4 elements for each heater, each heater is 8 × 8 cm and are located at

- A 41, A 42 } midplane
- K 41, K 42, L 41, L 42 } 2nd heater
- U 41, U 42, V 41, V 42 } 3rd heater

} all at 1.25 W

$\frac{1500}{2 \times 30} = 25$ W total for full slice of block

⇒ 12.5 W for 1/2 block

⇒ 1.25 W per element

Resubmitted for $K_{sat} = 1e{-14}\,m^2$, Sat @ 0.8

⇒ F10-21.out

10/26/93 RH output from F10-21.out

Sat	Temp	iter.	days	Gas Pressure
—	F3-t1.ps	19	1	—
F3-s2.ps	F3-t2.ps	23	5	—
F3-s3.ps	F3-t3.ps	27	20	F3-g3.ps
F3-s4.ps	F3-t4.ps	29	50	↑
F3-s5.ps	Same	32	120	
F3-s6.ps		35	365	Same
F3-s7.ps	↓	38	1094	F3-g7.ps
		39	1157	

10/27/93 RJF Changed K_{sat} = 10-16 m^2 and submitted as F10-27.out

10/28/93 RJF F10-27.out K_{sat}=e-16 1500 w

sat	temp	iter	Days	gas pressure
-	F4-t1.ps	19	1	F4-g1.ps
F4-s2.ps	F4-t2.ps	23	5	F4-g2.ps
F4-s3.ps	F4-t3.ps	27	20	F4-g3.ps
F4-s4.ps	F4-t4.ps	30	50	F4-g4.ps
F4-s5.ps	same ↓	33	120	F4-g5.ps
F4-s6.ps		38	365	F4-g6.ps
F4-s7.ps		44	1094	F4-g7.ps
		45	1157	

11/2/93 RJF Set K_{sat} to 10^{-12} m^2 in Frami and submitted → F11-2.out on goliath

11/5/93 RJF F11-2.out ksat = e-12 1500 w

sat	temp	iter		days	gas pressure
		19	①	1	
F5-s2.ps		23	②	5	
F5-s3.ps		27	③	20	
F5-s4.ps		29	④	50	
F5-s5.ps		32	⑤	120	
F5-s6.ps		35	⑥	365	
		38	⑦	1094	
		39		1157	

11/8/93 RJF F11-5.out K_{sat} = e-12, sat = 0.5, 1500 w

sat	temp	iter	days	gas pressure
		19	1	
		23	5	
		27	20	
F6-s4.ps		29	50	
		32	120	
		35	365	
F6-s7.ps		38	1094	
		39	1157	

Submitted new job to test out NSPCG routines & get vector plots using tough_ms

Fvect12.out

K_{sat} = e-12, Q = 1500W, Sat = 0.8

11/9/93 RJF Goliath ran out of room, abort job

Will set tolerances up some to make running easier

DPGMAX = 4e5
DSGMAX = 0.2
DTEMPMAX = 15
DXMAX = 0.2

FVC12.out

11/11/93 RK

Fvect12.out w/ vector info

K_{sat} = e-12   sat = 0.8 Q_H = 1500 W

tolerances as listed on pg 35   CPU = 13112

used NSPCG package

Preconditioner : LJAC3
Accelerator : BCGS

~~gas sat~~ flow RK	liq flow	iter	day
F7V-g1.ps	~~F7V-1 RK~~	19	1
	F7V-l2.ps	22	5
F7V-g3.ps	F7V-l3.ps	25	20
	F7V-l4.ps	27	50
	F7V-l5.ps	30	120
	F7V-l6.ps	33	365
F7V-g7.ps	F7V-l7.ps	~~1094~~ RK 36	1094
		37	1137

Fran

> max x coord	29	(31 − 2)
> max y coord	80	(82 − 2)
> X-axis start	B	(A + 1)
> X-axis stop	DD	(EE − 1)
> Y-axis start	2	(1 + 1)
> Y-axis stop	~~30~~ 81 RK	(~~31~~ − 1) RK 82

Set Ksat = 1e−16 m²

submitted as Fvect16.out

submitted same as Fvect16.out but with no heat source to see what initial moisture redistribution would be Fbase16.out

(9063 sec) Fbase16.out → tufprt → Fbase16.dat ; → tufvect → fbase16.vect.dat

iter	day
19	1
23	5
26	20
29	50
31	120
34	365
37	1094

Fvect16.out (24,870 sec)

iter	day
19	1
22	5
25	20
28	50
32	120
38	365
44	1094

11/23/93 RG — Based on discussion w/ Jim Blink (LLNL) at Fran Ridge, Fran set up will be changed.

Fnew.i : make column EE same as internal block, thus it is no longer a constant temperature boundary

Make heat row five feet from bottom instead of in the middle, put at rows 56 & 57

⇒ F11-23.out

11/24/93 RG — new input file Fn16.i, same as Fnew.i but w/ K_{sat} = 1e-16

⇒ F11-24.out

RG

12/4/93 RG — Modified r2grid.F → r2grid-new.F to more accurately calculate the volume & cross-sectional areas of r-z elements. Now use

$\rho \, d\theta \, d\rho \, dz$

checked several volumes and areas with hand calculations. These calculations are one 5 pages & filed w/ VTOUGH/Thermo files of RGreen

new routine is on Bashful

ipx4/bashful/rgreen/grid

started analysis of cylindrical experiment on goliath

/user2/goliath/rgreen/cyl

grid is .15 m radius (30 elements at 0.005m) and .12 m high (24 elements at 0.005m)

can run w/ TOUGH - original VTOUGH or w/ ~~TOUGH~~ toughx, a modified version of VTOUGH residing in cyl

two input files

cyl.i has heat load of 150W

cyl-a.i has heat load of 15W

heater in cylinder is 1½" long (3.8 cm)
and 1" in diameter (1.27 cm)

this will be rounded off to $r = 0.01$ m
$l = 0.04$ m

put heater at 15 W total

set vertical boundary at constant temp = 25°C
all four sides are no flow

12 W
e-16

cyl-a12-4.out also cyl-12.out (vectors)
⇒ ~~cyla-12-4.out~~ RF 1577 sec cpu

15W (actually 12 w)

sat	temp	gas press.	iter	day	liq vect	gas vector
~~c15s~~ RF		c15p-1.ps	60	1	c12lv-1.ps	c12gv-1.ps
c15s-5.ps			75	5	c12lv-5.ps	same ↑
			86	20	c12lv-20.ps	same ↑
c15s-50.ps			91	50	c12lv-50.ps	↑
			96	120	c12lv-120.ps	
			99	180		
c15s-365.ps	c15t-365.ps	c15p-365.ps	104	365		c12gv-365.ps

cyl-a12-4.plt output in /user2/goliath/rgreen/cyl/output

results look reasonable, will crank up heat

for 15 w A 10 … 3.75e-3 J/s m³
A 17
B 10 … 1.125e-2 J/s m³
B 17

for 30 W A 10 … 7.5e-~~3~~ 3 RF
A 17
B 10 … 2.25e-2
B 17

submitted 30w as cyl-30w.out 6143 cpu sec

30W (actually 24W)

sat	temp	gas pressure	iter	day	liq vect.	gas vect
		similar to 5 day	449	1	c30lv-1.ps	
c30s-5.ps	c30t-5.ps	c30p-5.ps	486	5	c30lv-5.ps	
			498	20	~~c~~ RF	
c30s-50.ps		c30p-50.ps	507	50	c30lv-50.ps	
			~~RF 120~~ 514	120		
			517	180		
c30s-365.ps	c30t-365.ps	c30p-365.ps	521	365	c30lv-365.ps	

12/5/93 RF

Heat source per element for 150w

not needed { for 10 rows @ 150 ⇒ each row is 15 W
for a (0.01)(π)(2) radian slice, each element is 0.9425

the volume of each disk is $\pi r^2 h = \pi (0.01)^2 (.005)$
$= 1.5708e-6$

vol of A cell = 0.3927e-8
vol of B cell = 0.1178e-7

Watts for A $= \frac{0.3927e-8}{1.5708e-6} (15\ J/s) = 2.5e-3(15) = 3.75e-2$ J/s

Watts for B $= \frac{0.1178e-7}{1.5708e-6} (15\ J/s) = 7.5e-3(15) = 1.125e-1$ J/s

since two rows were removed → 4 1 thru A 8
heat rates have been 0.8(15) = 12W 0.8(30) = 24W

24w gas pressure diff was 3100 Pa at 50 days
[102800, 105900]

24 w gas press diff was 8300 Pa at 5 days
[102600, 110900]

24 w gas press diff was 4800 at 20 days
[102700, 107500]

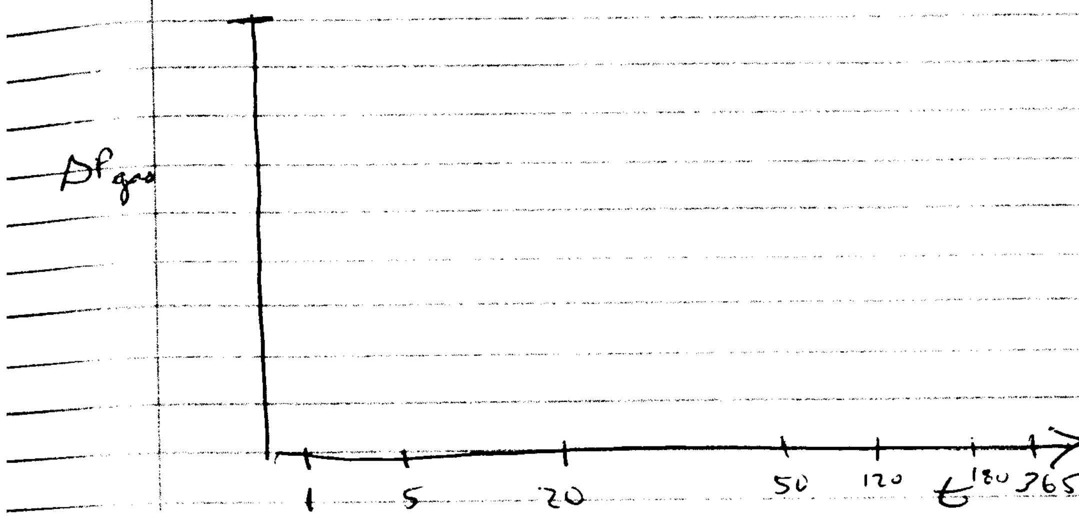
Resubmitted 12W w/ PARTI = 2, to get vector output ⇒ cyl-12.out → results reported on pg 40
liquid flow → cyl-12lv.plt & *.dat
gas flow → cyl-12gv.plt & *.dat

cyl

vector plots

max X	28	30-2
max Y	22	24-2
X start	B	A-1
X stop	CC	DD-1
Y start	2	1-1
Y stop	23	24-1

liq flow for 30 (24w) is in cyl-30wa.plt
gas flow for 30 (24 w) is in c30gv.dat
*.plt



24W fall off of maximum gas pressure difference w/ time

day	gas press diff (Pa)	max	min
1	~~22100~~ 25,000 RH	127600	102500
5	8300	RH 110900	102600
20	4800	107500	102700
50	3100	105900	102800
120	1800	104200	102200
180	1400	109400	103000
365	1100	104200	103100

This has been plotted & stored (XPLOT) on sneezy
/usr2/rgreen/tough/cyl/C24-graph-plt

12/6/93 RH
For heat load of 12w
This is stored as column 3 in C24-out_grf

day	gas press diff (Pa)	max	min
1	11100	111800	100200
5	5400 ~~10610~~ RH	106100	100700
20	2500	103200	100700
50	1600	102400	100800
120	1300	102200	100900
180	1000	101900	100900
365	700	101700	101000

12/7/93 RH

changed cyl-ai to Ksat = e-12
& heat load of 12 w ⇒ cyl-12-12.out

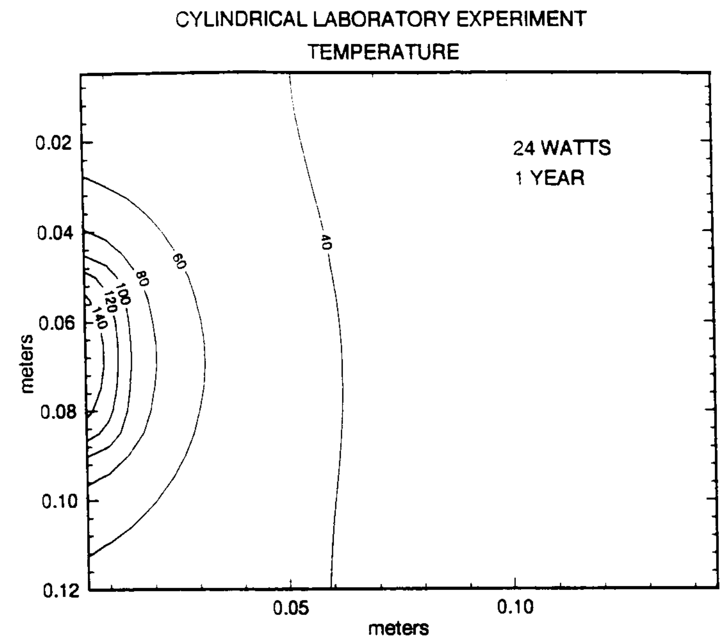
changed cyl-bi to Ksat = e-12
& heat load of 24 w ⇒ cyl-12-24.out

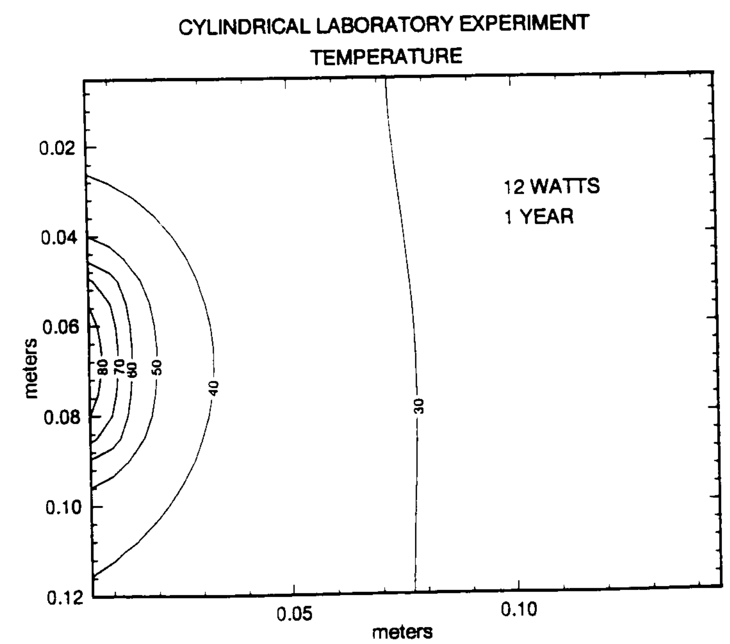
RH

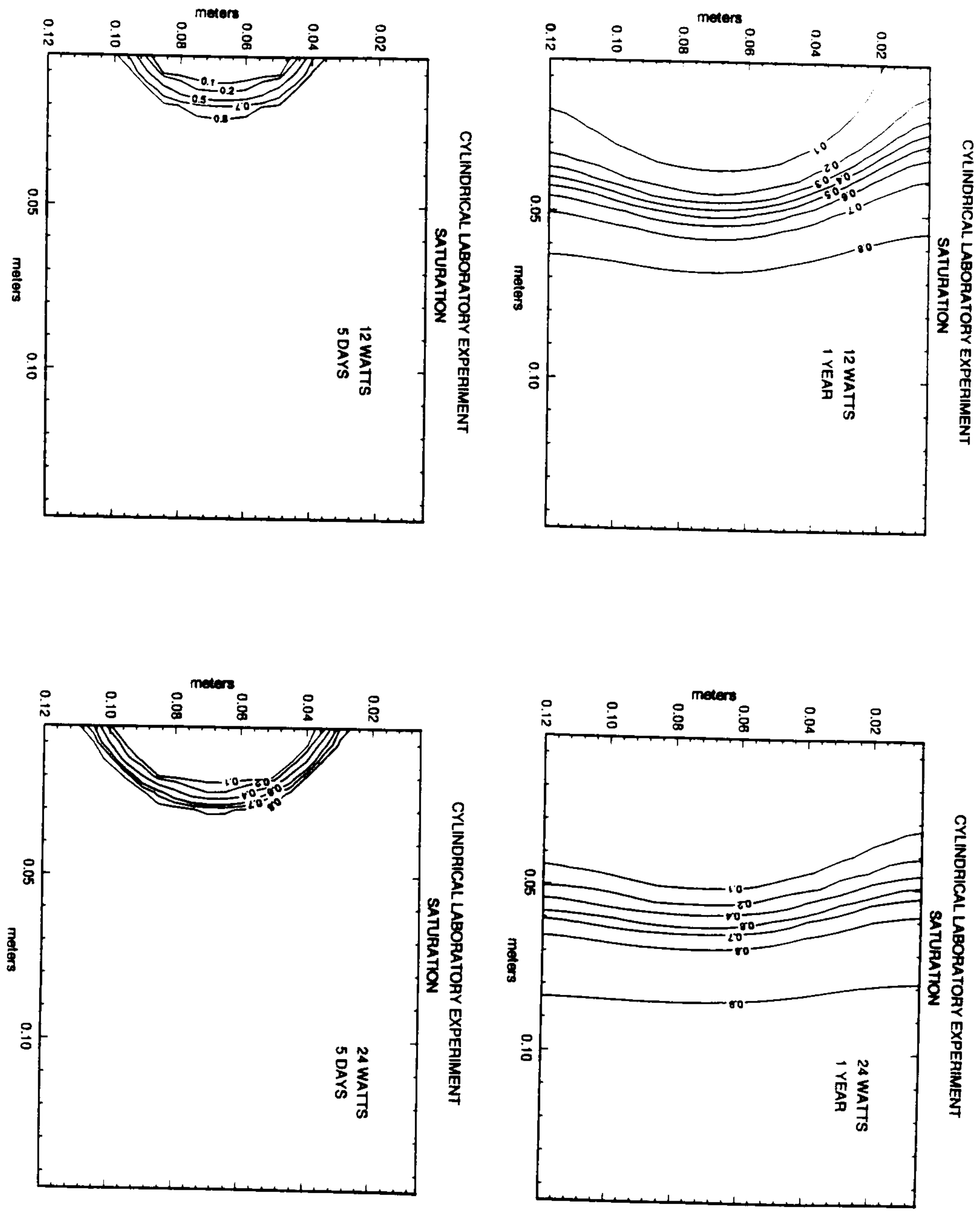
12/8/93 RH

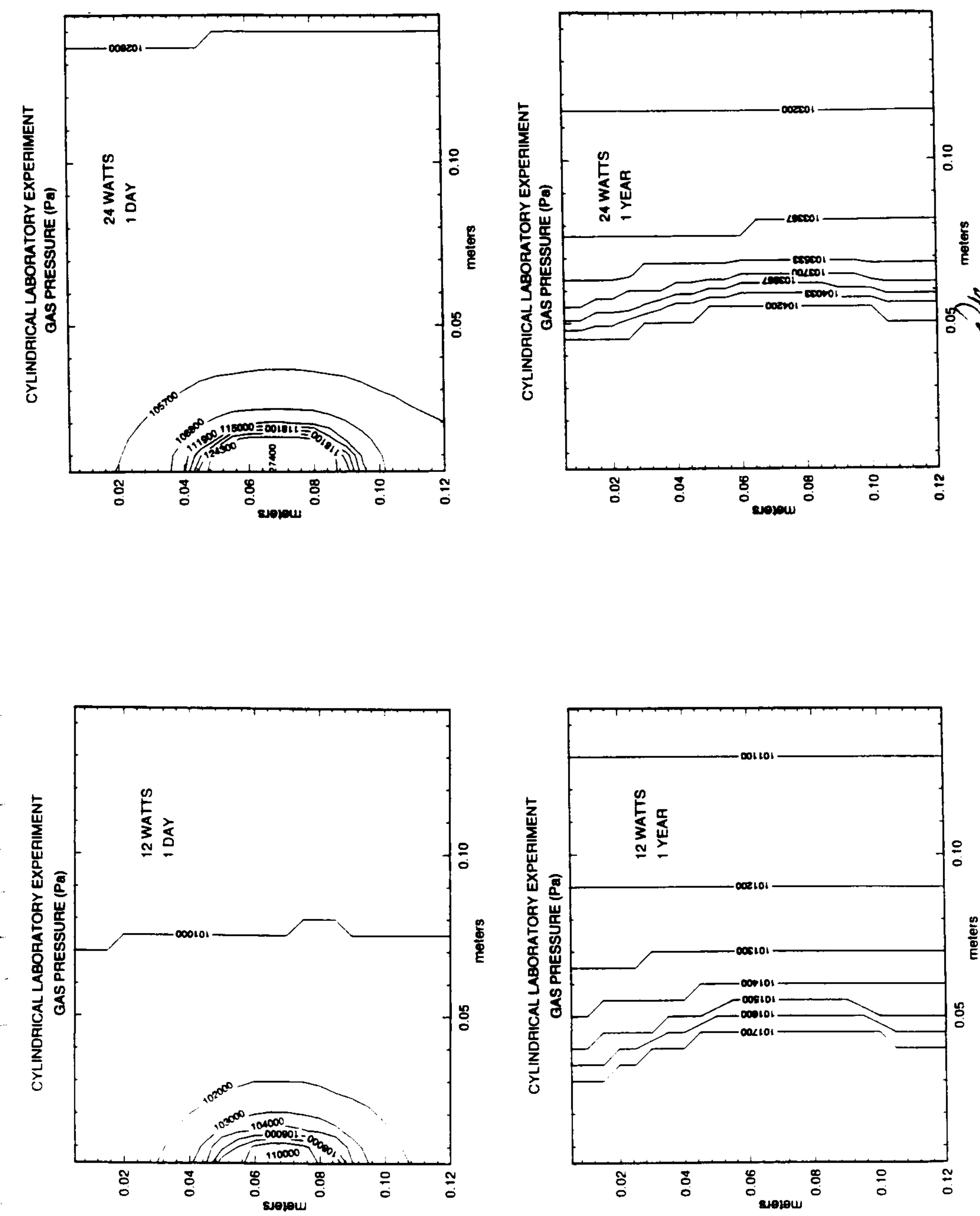
Results of 12 w, 24 w @ 0.8 saturation & Ksat = 1e-16 are on these pages. Results discussed on pg 40-43. These are to be used for mid-year presentation

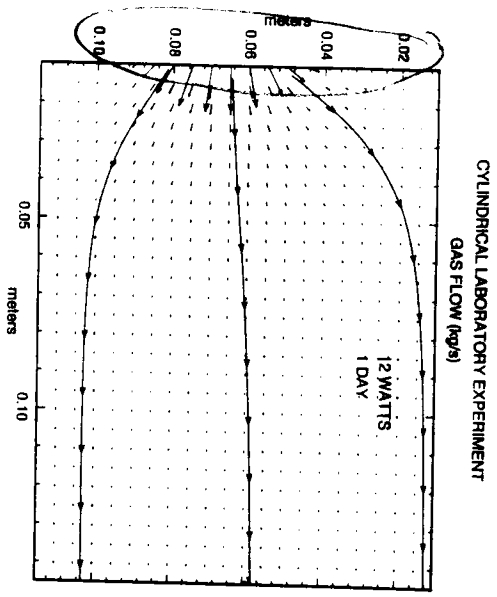
RH

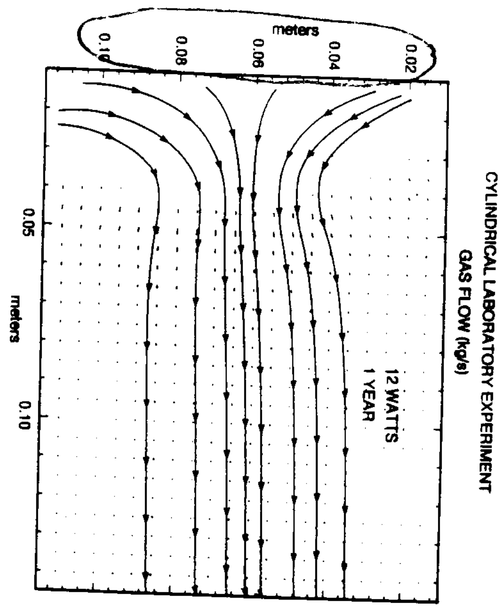


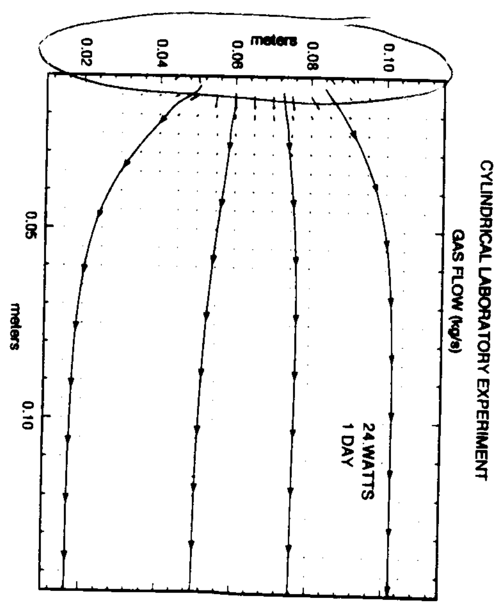


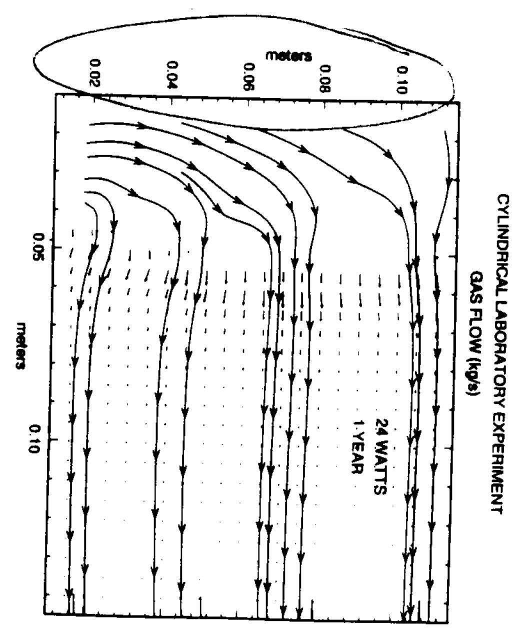

CYLINDRICAL LABORATORY EXPERIMENT
SATURATION
12 WATTS
5 DAYS
CYLINDRICAL LABORATORY EXPERIMENT
SATURATION
12 WATTS
1 YEAR
CYLINDRICAL LABORATORY EXPERIMENT
SATURATION
24 WATTS
5 DAYS
CYLINDRICAL LABORATORY EXPERIMENT
SATURATION
24 WATTS
1 YEAR
meters

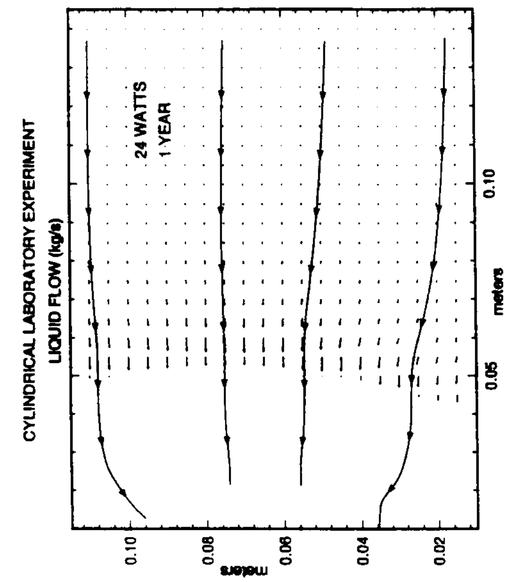

CYLINDRICAL LABORATORY EXPERIMENT
GAS PRESSURE (Pa)
24 WATTS
1 DAY
CYLINDRICAL LABORATORY EXPERIMENT
GAS PRESSURE (Pa)
24 WATTS
1 YEAR
CYLINDRICAL LABORATORY EXPERIMENT
GAS PRESSURE (Pa)
12 WATTS
1 DAY
CYLINDRICAL LABORATORY EXPERIMENT
GAS PRESSURE (Pa)
12 WATTS
1 YEAR
meters

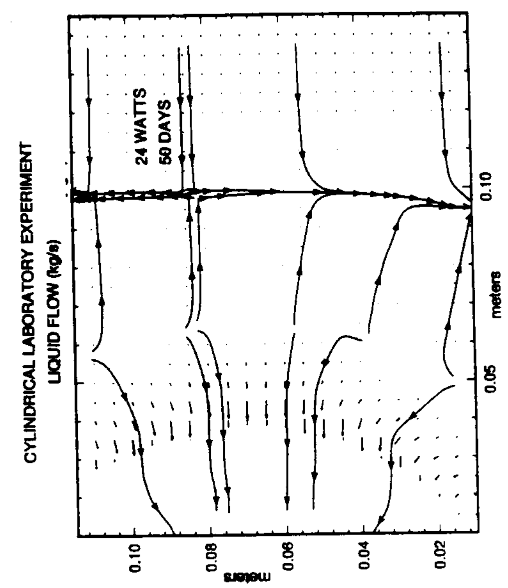

CYLINDRICAL LABORATORY EXPERIMENT
GAS FLOW (kg/s)
12 WATTS
1 DAY
meters

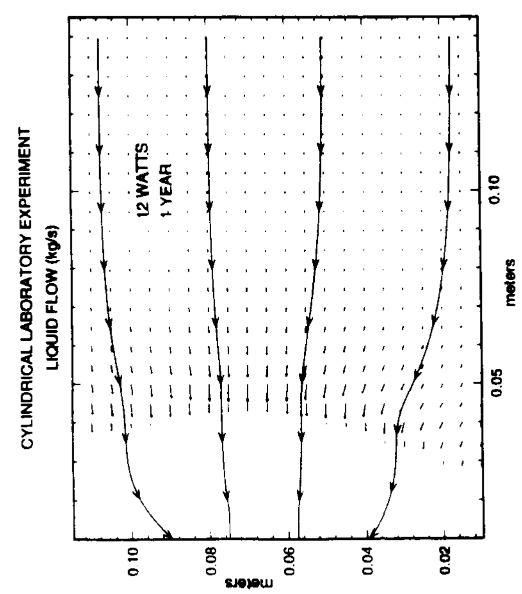

CYLINDRICAL LABORATORY EXPERIMENT
GAS FLOW (kg/s)
12 WATTS
1 YEAR
meters

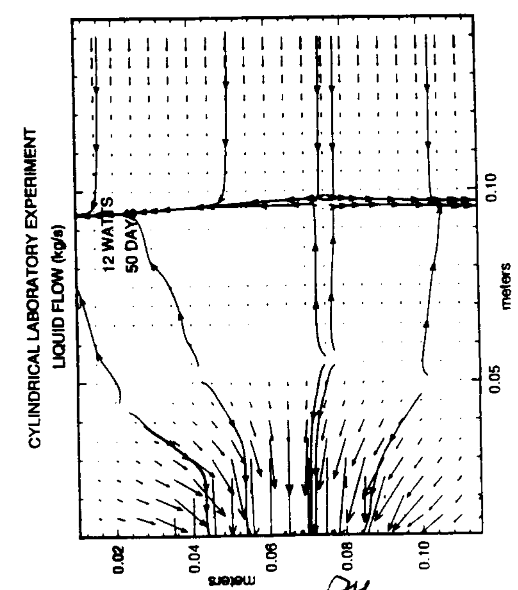

CYLINDRICAL LABORATORY EXPERIMENT
GAS FLOW (kg/s)
24 WATTS
1 DAY
meters


CYLINDRICAL LABORATORY EXPERIMENT
GAS FLOW (kg/s)
24 WATTS
1 YEAR
meters


CYLINDRICAL LABORATORY EXPERIMENT
LIQUID FLOW (kg/s)
24 WATTS
1 YEAR
meters


CYLINDRICAL LABORATORY EXPERIMENT
LIQUID FLOW (kg/s)
24 WATTS
50 DAYS
meters


CYLINDRICAL LABORATORY EXPERIMENT
LIQUID FLOW (kg/s)
12 WATTS
1 YEAR
meters


CYLINDRICAL LABORATORY EXPERIMENT
LIQUID FLOW (kg/s)
12 WATTS
50 DAYS
meters

12/8/93
cont [initials]

Results of cyl-12-12.out
Ksat = e-12 , Heat source = 12 W
sat = 0.8

sat	Temp	gas pressure	iter	day
c12-12s-a.ps		100700 Pa everywhere at all times	20	1
			24	5
			27	20
			29	50
			32	120
			33	180
	C12-12t-365.ps		35	365

C12-12s-a.ps has saturation which is unchanged for all times with range of 0.7707 – 0.803

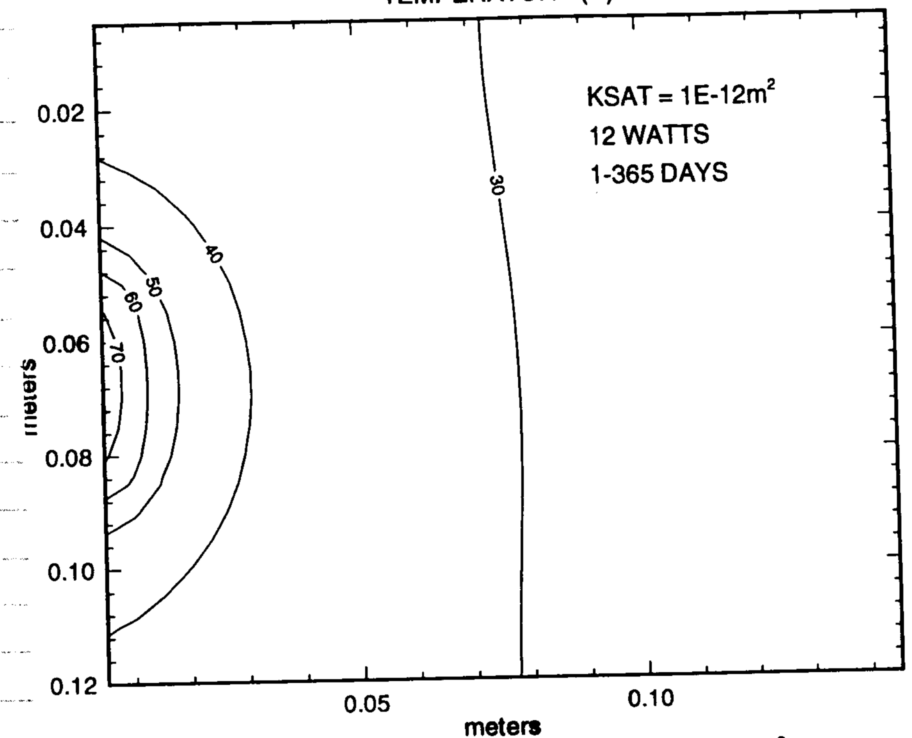
Results of cyl-12-24.out
Ksat = e-12, heat source = 24w
sat = 0.8

sat	temp	gas pressure	iter	day	liq vel	gas vel
C12-24s-1.ps	C12-24t-1.ps	C12-24p-1.ps	26	1		C12-24gv-1.ps
			30	5		
			33	20		
same	same	same (varies from 102300 to 102350)	36	50	same	same
			38	120		
			40	180		
			42	365	C12-24lv-365.ps	C12-24gv-365.ps

c12-24lv.plt
c12-24gv.plt

These are the results of cyl-12-12.out

CYLINDRICAL LABORATORY EXPERIMENT
TEMPERATURE (C)



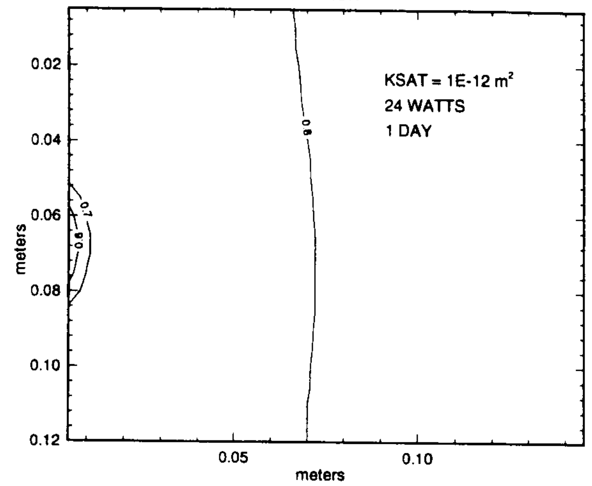
[initials]

Gas pressure was everywhere at 100700 Pa
Saturation varied from 0.7707 to 0.803 at all times

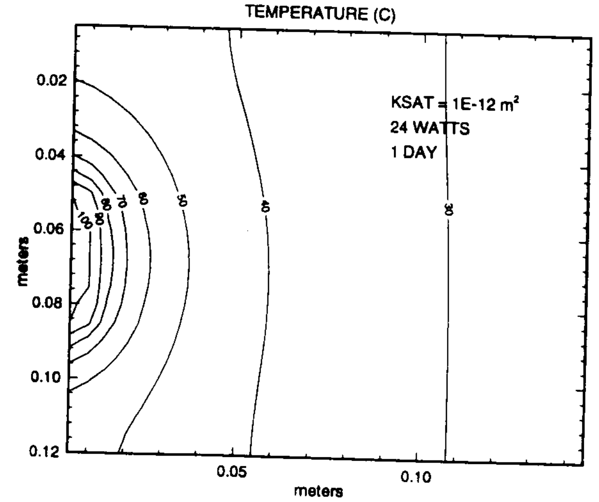
Ksat = 1e-12 m²
Sat = 0.8
heat = 12 w

These are results from:
Cyl12-24.out

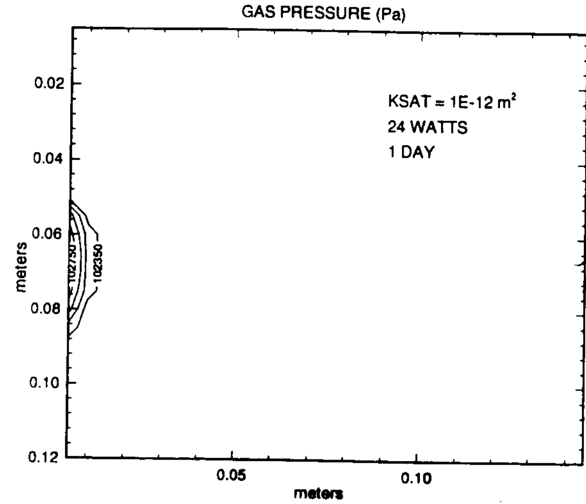
CYLINDRICAL LABORATORY EXPERIMENT
SATURATION



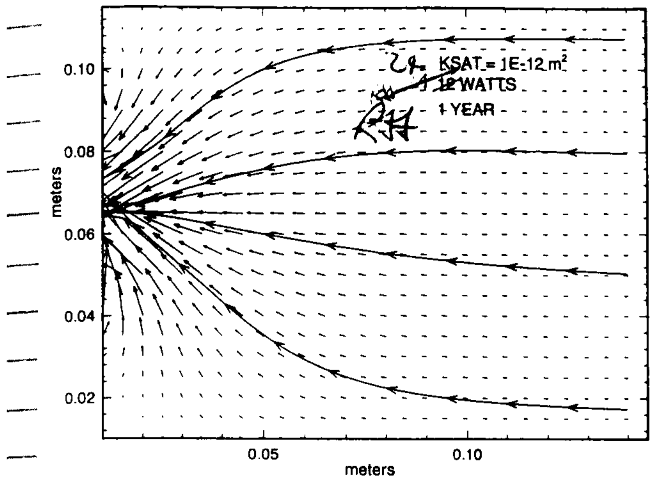
CYLINDRICAL LABORATORY EXPERIMENT
TEMPERATURE (C)



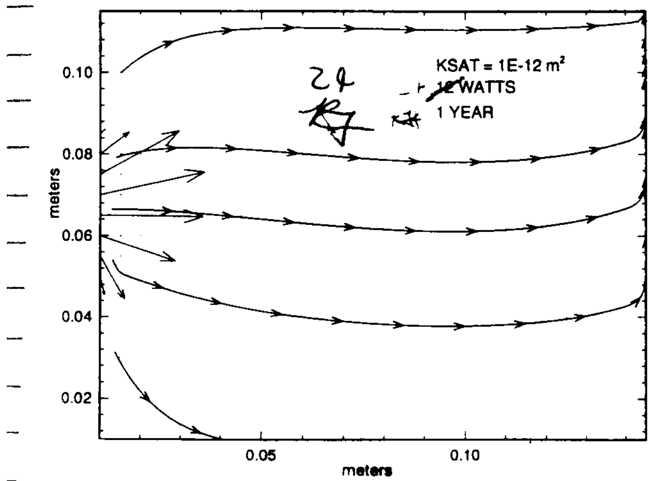
CYLINDRICAL LABORATORY EXPERIMENT
GAS PRESSURE (Pa)



CYLINDRICAL LABORATORY EXPERIMENT
LIQUID FLOW (kg/s)



CYLINDRICAL LABORATORY EXPERIMENT
GAS FLOW (kg/s)



12/8/93 RF Plots from F11-23.out
from block w/ heaters in bottom 1/3 of block
K sat = 1e-12 m²

iter	day
19	1
22	5
26	20
36	50
102	120

temps too high

not correct: note from pg 33 1.25 W/element, but need to average over 3m depth of block

$\frac{.05}{3.00}(1.25) = 0.021$ (0.0208) W/element that is 0.05m deep

correct:
1500 W for block
750 W for 1/2 block
750W/10 = 75 W/element
$\frac{.05}{3.00}(75) = 1.25$ W

Temps high because boundary conditions not appropriate

Will first adjust vertical boundary

set rt b.c. (col EE) to specific heat of 1e10 & Thermal cond. to 0.23 w/ K sat = e-90
⇒ F12-8.out

12/9/93 RF Results from F12-8.out 13,486 CPU sec

temp sat

iter	day
19	1
22	5
26	20
29	50
31	120
34	365
37	1094

F12-8t-365.ps F12-8s-365.ps

Max temp held to ~90°C & saturation variation .78-.815. Boundary temp lateral from heaters ~32.68°C

Will ~~not~~ decrease thermal conductivity of vertical boundary by another order of magnitude to 0.023

⇒ F12-9.out

Created 2nd File

Track Dodge's estimate of what the boundary temperature should be is 15-20°C higher (or about 40-45°C)

12/14/93 RF Could not get a convergent solution with top boundary set at high K sat, high specific heat & low thermal conductivity. Set heat to 4e-12 & specific heat to 840 but keep volume at e+13 & resubmitted

⇒ F12-14.out

No convergence, changed properties of matr 1 (top layer) to be same as interior (matr 2) → 9-9 & resubmitted as F12-14.out

12/16/93 RJJ

F12-14.out went thru several time steps then stalled

iter	day
20	1
24	5
28	20

~~Left~~ right boundary temperatures are too high (~65°) instead of 40-45, will increase T_K

Set mat-4 to 0.023 & resubmitted as F12-16.out

12/17/93 RJJ

output from F12-16.out stopped after 4 time steps, same as F12-14.out

iter	day
20	1
24	5
28	20
47	50 (not completed)

temperature on right boundary decreased by 5-10 C but simulation still hung up during 4th time segment (from ~65 C to about 58) still have to reduce it to about 40-45. Will increase thermal conductivity again

Set thermal conductivity of col EE to 0.1 (from 0.023) & increased value to 1E+03 from E-03

submitted as F12-17.out

12/20/93 RJJ

results for F12-17.out

iter	day
20	1
24	5
28	20
31	50
34	120
38	365
41	1094

column EE stays at 25, DD-57 had temp of 49.75

Set thermal conductivity of EE column from 0.1 to 0.2 resubmitted as F12-20.out

12/21/93 RJJ

Output from F12-20.out

iter	day
20	1
24	5
28	20
31	50
34	120
37	365
40	1094

DD 57 was 39.58 C - good value

Changed thermal conductivity of top layer to 0.2 ~~and~~ RJJ (from 0.012) and Ksat to 4e-02 from 4e-12

resubmitted as F12-21.out

F12-21.out finished after 16,223 CPU seconds
$K_{sat} = 10^{-12} m^2$

sat	temp	gas pressure	air fraction	iter	day	liquid vector	gas vector
F9-51.ps		no plots		20	1	F9-lv-1.ps	
F9-55.ps				24	5	F9-lv-5.ps	
F9-520.ps			F9-a20.ps	28	20	F9-lv-20.ps	
				31	50	F9 lv 50 ps	
				33	120	same as 50	same as 120 F9-gv-120.ps
F9-s365	F9-t365.ps		F9-a365.ps	36	365		same as 1094 F9-gv-1094.ps
				39	1094		

looks good

gas vector plot → F12-28 g.plt
liquid vector plot → F12-28 l.plt

Set Ksat to 1e-16m² resubmitted as
F16-21.out

12/22/93 F16-21.out $K_{sat} = 10^{-16} m^2$ 20,487 CPU seconds

sat	temp	gas press	air fraction	iter	day	liquid vector	gas vector
	added 5/19/94			19	1	F8-lv-1.ps	F8-gv-1.ps
				22	5	" " 5 "	" " -5 "
F8-s50.ps		F16cool-p50.ps	F8-a20.ps	26	20	" " 20 "	" " -20 "
		F8-p50.ps		29	50	" " 50 "	" " -50 "
		F8-p365.ps		33	120	" " 120 "	" " -120 "
F8-s365.ps	F8-t365.ps		F8-a365.ps	39	365	" " 365 "	" " -365 "
				45	1094	" " 1094 "	" " -1094 "

gas vector file → F16-27 g.plt
liquid vector file → F16-27 l.plt

/user2/goliath/rgreen/fran/output

max gas pressure difference ~ F16-21.out (e-16 1500w)

1 day	100000	103100	3100
5 "	"	110600	10600
20 "	"	127000	27000
50 "	"	137000	37000
120 "	"	137000	37000
365 "	"	133800	33800
1094 "	"	132700	32700

Output from F12-21.out e-12 m²

See pg 58 for file names

maximum gas pressure difference ~ F12-21.out

1 day	100000	100900	900
5 "	"	100900	900
20 "	"	100800	800
50 "	"	100800	800
120 "	"	101000	1000
365 "	"	101600	1600
→ 1094 "	"	102800	2800

note this buildup is at the bottom boundary.

Submitted F16-27.out to get vector plots.
everything else same as F16-21.out

file names are on pg 58 F8*

12/28/93 RH — Changed Ftopi to Ksat = e-12 & submitted as F12-28.out

12/30/93 RH — recalculated what boundary temp should be

⇒ 21.6 + 25 = 46.6°C (average)

will decrease boundary (vertical & top) thermal conductivity to get higher temps

set top & vertical boundary wet & dry thermal conductivity to 0.05 & submitted as F12-30.out

1/3/94 RH — F12-30.out

iter day

F12-3.out was killed

resubmitted e-12 as F1-2.out and e-16 as F16-2.out on 1/2/93

F1-2.out (close to 79 hrs cpu)

iter	day
20	1
24	5
28	20
33	50
38	120
42	365
51	1094

Calculated estimated heat loss thru top & side walls of Fran block.

ΔT should be 8.65°C average.

This is close to results of F12-21.out & F16-21.out where vertical & top layers have thermal conductivities of 0.2

Set Ksat = 10^{-10} in Ftopi & submitted as F10-3.out

1/6/94 RH — for Ksat = e-12, doubled heat load in GENER to 2.5 & submitted as F12hot.out

1/9/94 RH — F12hot.out finished, required more than 36 hrs CPU to complete

Changed Ksat to 10^{-16} & submitted as F16hot.out

1/10/94 RH — Output from F12hot.out 133,000 CPU ≈ 36 hrs

sat	temp	gas pressure	air fraction	iter	day	liquid vector	gas vectors
		none		20	1	f10-lv-1.ps	f10-gv-1.ps
F10-s5.ps				25	5	f10-lv-5.ps	f10-gv-5.ps
f10-s20.ps			F10-a20.ps	42	20	f10-lv-20.ps	f10-gv-20.ps
F10-s50.ps				60	50	f10-lv-50.ps	f10-gv-50.ps
F10-s120.ps				85	120	f10-lv-120.ps	same as at 20
F10-s365.ps	F10-t365.ps		F10-a365.ps	116	365	f10-lv-365.ps	
				124	1094		

F12hotg.plt gas vectors

F12hot.plt contours

* note: at 20 days, gas vectors take off (presumably that's when temps > 100°C)

max gas pressure difference F12hot.out

1 day	100,000	100,900	900
5 "	100,000	100,900	900
20 "	100,000	100,700	700
50 "	100,000	100,800	800
120 "	100,000	100,900	900
365 "	100,000	101,600	1600
1094 "	100,000	103,700	3700

all of difference in gas pressure is across the loose w/no significant gas difference within the block

1/12/94 RJf F16hot.out 145,587 CPU Sec ≈ 40.44 hrs
~~F16hot.dat~~

s.t

Fll-s20.ps
Fll-s50.ps
Fll-s120.ps
Fll-s365.ps

gas pressure	mass fraction	iter	day
F11		20	1
		25	5
	5/14/94 F11-a20.ps	32	20
added RJf	F16hot-p50.ps	59	50
		136	120
	F11-a365.ps	156	365
		170	1094

max gas pressure difference F16hot.out

1 day	100,000	109500	9500
5	100,000	141,000	41,000
20	100,000	209,600	109600
50	100,000	236,700	136,700
120	100,000	210,800	110,800
365	100,000	183,800	83,800
1094			

1/25/94 RJf Summary of output files from fran & cyl

cyl 12 & 24 w 10^{-12} & 10^{-16} m^2

contours:

✓ cyl-12-12.out; dat, plr 12 w Ksat = e-12
✓ cyl-12-24.out; dat, pH 24 w Ksat = e-12

✓ cyl-30 w.out, 24 w Ksat = e-16
✓ cyl-a12-4.out, 12 w Ksat = e-16

vectors ~~cyl-12 lv.dat 12 w Ksat = e-16 liq flow~~
~~cyl-12gv.dat 12 w " " gas flow~~

cyl-3wa 24 w Ksat = e-16 liq flow
c30gv-dat 24 w Ksat = e-16 gas flow

c12-24 lv 24 w Ksat e-12 liq flow
c12-24 gv 24 w Ksat e-12 liq flow

cyl-12.out vectors at 12 w Ksat = e-16

no vectors yet for cyl 12 w e-12

RJf 11/1/94

All these ps files are in /users2/goliath/rgreen/cyl/output2

files for gas & liq velocities

cyl-12-12.out 12w 10^{-12}
" .dat & plt

gas vel cyl-12-12gvel.dat & plt
liq vel cyl-12-12lvel.dat & plt

gas vel ~~cyl-12~~ c12-12gvel1.ps ...
put into /users2/goliath/rgreen/cyl/output2
liq vel c12-12lvel1.ps ...

cyl-12-24.out 24w 10^{-12}
" .dat & plt

gas vel cyl-12-24gvel.dat & plt
liq vel cyl-12-24lvel.dat & plt

liq vel c12-24lvel1.ps
gas vel c12-24gvel1.ps ...

cyl-a12-4 out 12w 10^{-16} → cyl-16-12 .dat & plt
(vectors are in cyl-12.out)
gas vel cyl-16-12gvel.dat & plt
liq vel cyl-16-12lvel.dat & plt

gas vel c16-12gvel1.ps
liq vel c16-12lvel1.ps

cyl-30w.out 24w 10^{-16} → cyl-16-24.dat & plt
(vectors are in cyl30wa.out)
gas vel cyl-16-24gvel.dat & plt
liq vel cyl-16-24lvel.dat & plt

All these ps files are in /users2/goliath/rgreen/fram/output2

1/28/94 RG files for fran block

F12-21.out	e^{-12}	1500w
F16-21.out	e^{-16}	1500w
F12hot.out	e^{-12}	3000w
F16hot.out	e^{-16}	3000w

F12-21.out (vectors in F12-28.out)

✓ gas vel F12-1500gvel.dat & plt
✓ liq vel F12-1500lvel.dat & plt

F16-21.out (vectors in F16-27.out)

✓ gas vel F16-1500gvel.dat & plt
✓ liq vel F16-1500lvel.dat & plt

F12hot.out
✓ gas vel F12-3000gvel.dat & plt
✓ liq vel F12-3000lvel.dat & plt

F16hot.out
✓ gas vel F16-3000gvel.dat & plt
✓ liq vel F16-3000lvel.dat & plt

2/1/94 RG

Max gas pressure difference in F16hot.plt

day	max press	min press	diff (Pa)
1	109500	100,000	9500
5	191000	"	91000
20	209600	"	109600
50	236700	"	136700
120	210800	"	110800
365	183800	"	83800
1094	169900	"	69900

put into /~~usrs~~ usr2 RG/rgreen/tough/cyl/F16hot-press.dat

Max gas press. diff in F16-21.plt (1500w; e^{-16})

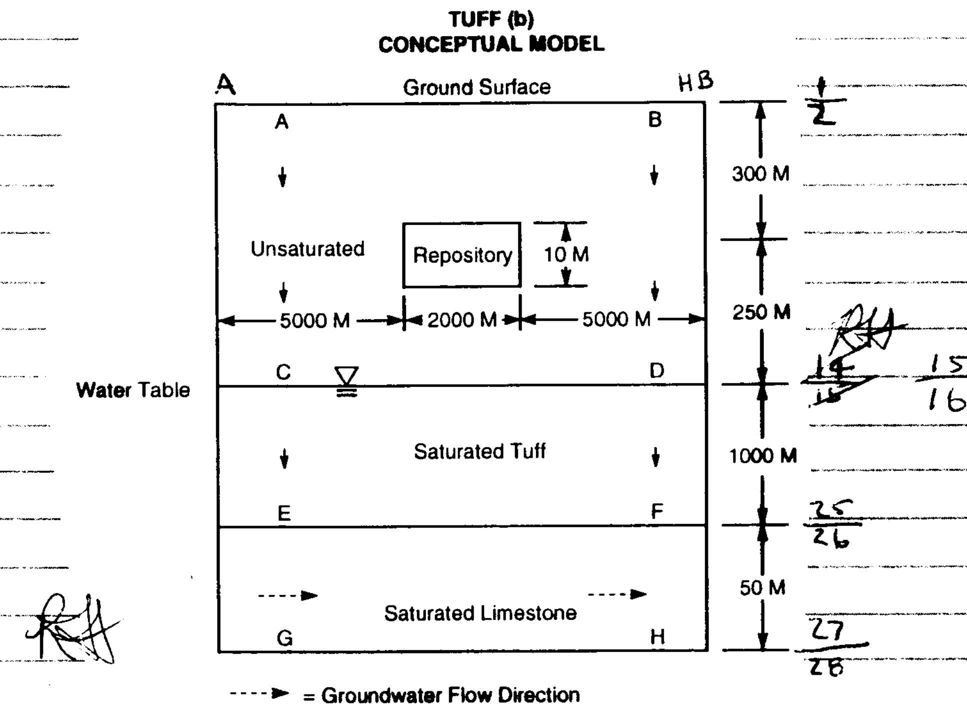
day	max press	min press	diff (Pa)
1	103100	100,000	3100
5	110600	"	10600
20	127000	100,000	27,000
50	137000	"	37,000
120	137000	"	37,000
365	133800	"	33,800
1094	132700	"	32700 RG

put into /usr2/rgreen/tough/cyl/Fcool-press.dat

RG 11/1/94

2/8/94 RG

Set up new grid for GWTT - tuff case w/ both saturated and unsaturated zones. Conceptual Model same as ~~that~~ described in CNWRA report by Rice & Green, Sept 1993.



Model has 3 layers: unsat tuff, sat tuff; sat. limestone w/ above dimensions except repository was made 20 m thick to avoid aspect ratio problem.

Element dimensions are on coord.dat file which is printed on next page. The working directory for this is:

/user2/goliath/rgreen/gwtt/gnew

coord.dat for gnew:

```
60,28       6000.      12000.
200.        6200.      50.
400.        6400.      100.
600.        6600.      150.
800.        6800.      200.
1000.       7000.      250.
1200.       7200.      290.
1400.       7400.      320.
1600.       7600.      340.
1800.       7800.      360.
2000.       8000.      380.
2200.       8200.      410.
2400.       8400.      450.
2600.       8600.      500.
2800.       8800.      550.
3000.       9000.      600.
3200.       9200.      700.
3400.       9400.      800.
3600.       9600.      900.
3800.       9800.      1000.
4000.       10000.     1100.
4200.       10200.     1200.
4400.       10400.     1300.
4600.       10600.     1400.
4800.       10800.     1500.
5000.       11000.     1600.
5200.       11200.     1625.
5400.       11400.     1650.
5600.       11600.     1675.
5800.       11800.
```

vertical grid

RH 2/8/94

grid is 60 wide (up to ~~BH~~ HB RH) and 28 deep. Horizontal spacing is uniform at 200m, vertical is variable as indicated above.

Initial gnew file is on next pg. This input file will run but it needs modification before it is appropriate - i.e. limestone properties need to be input.

Repository is at level 9 ~~Z~~ to AI
(Z, AA, AB, AC, AD, AE, AF, AG, AH, AI

RH 2/8/94

Repository scale model for gnew - no heat load - used to determine initial conditions

```
gnew,cp=9,2/7/94,YcMt val,hi sat,ks-12,bd=e-22,redcd toler,inc time,vectors
ROCKS
matr1    22580.      .11             1.9E-22   1.9E-22   1.9E-222.3        1.0E+9
       0.0       0.0       1.74       0.0
   9         1.9e-18 5.8004e-7      1.798       0.11      1.e-3
   9         1.0e-11 1.3147e-4       4.23     1.8e-3      1.e-3
matr2    22580.      .11             1.9E-12   1.9E-12   1.9E-122.3          840.
       0.0       0.0       1.74       0.5
   9         1.9e-18 5.8004e-7      1.798       0.11      1.e-3
   9         1.0e-11 1.3147e-4       4.23     1.8e-3      1.e-3
matr3    22580.      .11             1.9E-12   1.9E-12   1.9E-122.3          840.
       0.0       0.0       1.74       0.5
   9         1.9e-18 5.8004e-7      1.798       0.11      1.e-3
   9         1.0e-11 1.3147e-4       4.23     1.8e-3      1.e-3
matr4    22580.      .11             1.9E-12   1.9E-12   1.9E-122.3          840.
       0.0       0.0       1.74       0.5
   9         1.9e-18 5.8004e-7      1.798       0.11      1.e-3
   9         1.0e-11 1.3147e-4       4.23     1.8e-3      1.e-3
matr5    22580.      .11             1.9E-22   1.9E-22   1.9E-222.3        1.0E+9
       0.0       0.0       1.74       0.0
   9         1.9e-18 5.8004e-7      1.798       0.11      1.e-3
   9         1.0e-11 1.3147e-4       4.23     1.8e-3      1.e-3

PARAM
  2 900      10000000000000000 41          2.13e-5       1.8
       0.0  3.150E11        -1.          A  10      +9.80665
     1.E3       9.E3       2.E4       1.E5       1.E6       1.E7       1.E8
    1.E-5        1.                                         1.E-8
                1.E5                  .20 20.
START
RPCAP
   9         1.9e-18 5.8004e-7      1.798       0.11      1.e-3
   9         1.0e-11 1.3147e-4       4.23     1.8e-3      1.e-3
TIMES
   3    5      1.E11
 6.3072E09 1.5768E10 3.1557E10
OPTN
   0    1    0    1    1    0
DTSTP
      8.e4       0.02        10.       0.02

ELEME
A    1          matr10.5000E+03
A    2          matr20.5000E+03
A
```

RH 2/8/94

A uniform temperature gradient has been input
surface temp: 11.16C at A 1
base temp: 48.8C at A 28

Gas Sat was set at:

				(liq. sat)
surface sat:	48.5	at	A1	51.5%
water table:	33.58	at	A14	66.42%
	0	below		100%

RH

After running for 1000 yrs, the liq. sat gradient smoothed out to be linear from surface to 100% at water table.

Added heat source at repository
- spatially uniform
- temporally variable (exponential decay)

repository in model is 20m high & 2000 long w/ depth of 0.05 m ⇒ volume of each element is 200 m³

located in row 9 ~~Z~~ thru IA

57 Kw/acre = 5700 J/s /acre

since 1 acre = 4046.8564 m2
57 Kw/acre = 14.09 J s⁻¹ m⁻²

Each repository element has a surfical area of 200 m × 0.05 m = 10 m²
⇒ each element has a heat load of 140.9 J/s

Assume waste decays exponentially according to T. Brandshang (March 1991 SAND85-7101)

RA

Table 4-2. Thermal Power Decay of Combined 60 Percent PWR and 40 Percent BWR Spent Fuel

(J/s)

Time(sec)		Time (Years)[a]		NP[b]	57 Kw/acre	114 Kw/acre	28 Kw/acre
0	0	10	1	1.0000	140.85	281.70	70.42
3.1536e8	10	20	2	0.7786	109.67	219.34	54.835
1.2614e9 ~~5.7680e9~~ RA	40	50	3	0.4763	67.09	134.18	33.545
2.838e9 ~~3.1536e9~~ RA	90	100	4	0.2618	36.87	73.74	18.435
5.9918e9	190	200	5	0.1488	20.96	41.92	10.48
1.5453e10	490	500	6	0.0880	12.39	24.78	6.195
3.1221e10	990	1,000	7	0.0515	7.25	14.50	3.615
6.2757e10	1990	2,000	8	0.0276	3.89	7.77	1.945
1.5736e11	4990	5,000	9	0.0178	2.51	5.01	~~0.4~~ 1.255
3.1504e11	9990	10,000	10	0.0128	1.80	3.61	~~0.58~~ 0.9
6.3041e11	19990	20,000		0.0075	1.056	2.11	0.528
1.57648e12	49,990	50,000		0.0027	0.3803	0.76059	0.190
~~3.15328e12~~	~~99,990~~				(3.803e-1)	(7.6059e-1)	0.001
	99,990			0.2001	1.4085e-2	2.817e-2	7.093e-3

added 7/20/94 RA

[a]Years after discharge from the reactor.

[b]NP denotes normalised thermal power.

↑ arbitrary

2/11/94 RA Base run w/ no heat load to 10,000 yrs is ~ gn6.out   CPU ≈ ~~8~~ RA 9.5 hr

step	day
269	.73e5 (200 y)
312	.1825e6 (500 y)
351	.365e6 (1000 y)
535	.365e7 (10,000 y)

Difficulties w/ tufprt routine, Alfred to fix it

2/15/94 RA Modified rzgrid-new x to accumulate tilt in beds.

Put in 6% slope into gnew4i, also set A & BH columns volume up 10 orders of magnitude to insure constant head at model lateral (vertical) boundary.

2/21/94 RA Difficulty w/ getting hydrology to equilibrate but input w/ no slope into gnew6i

gnew5i has slope

gnew7i has slope but constant temp @ 25°C. Used stripxt in ~/gwtt/gnew to strip out temp gradient and replace w/ constant temp.

2/23/94 RA created gnew8i - constant temp, no tilt

added 50 m to column A from row 15 to 28 (saturated zone) to simulate regional flow

$\frac{P_a}{\rho g} = m \Rightarrow \rho = 992.24\ kg/m^2$ at ~~29~~ RA 40°C
$g = 9.80665\ m/sec^2$

$(50\ m_{H_2O})(992.24)(9.80665) = 4.8653e5\ Pa$

This number of Pa was added to A 15 thru A 28

3/8/94 KH
gnew8i was submitted w/ no tilt & no geothermal gradient. There was a 50 m head added to the left boundary. It ran to at least 1000 yrs in gn5.out

rzgrid-new.F was modified to include a new x-z grid routine. The resulting code is in
gridder.F
gridder.x

gn5.out

19	7.3 days
30	730 "
251	73000 "
570	182,500 " (500 yrs)
1097	1000 yrs

The columns A & BH were not made large, increased them by 10^{10} and set max time step too resubmitted as gn6.out

24	7.3 days	
33	730 days	2 yrs
72	200 YRS	
76	500 YRS	
79	1000 YRS	
99	10,000 YRS	

incorporated a geothermal gradient onto INCON that was at end of 10,000 yrs that was 10°C at base of upper boundary layer (50 down) and 50°C at top of lower boundary layer.
Submitted gnew8i > gn7.out nada

Configured gnew9i which was gnew8i w/ new INCON. INCON from stripx which put in geothermal gradient (same as in gnew8i) but with only head increase (+50 m) ~~of~~ on left boundary

File was put into gnew1i & submitted
> gn9.out

3/9/94 KH
gn9.out ran to 10,000 yrs in ~ 481K sec (~ 13½ hrs)

26	7.3 days
37	2 yrs
248	200 yrs
282	500 yrs
320	1000 yrs
628	10,000 yrs

right & left boundaries are not in equilibrium with unsat interior. Set right & left boundary elements to same size as interior in gnew1i & resubmitted as gn1.out, but kept elements at row 15 and below (sat zone) an order of magnitude larger

gn1.out 2695 sec (~45 min)

22	73 days
33	2 yrs
42	200 yrs
45	500 yrs
47	1000 yrs
53	10,000 yrs

rt boundary still strange. Set right boundary to same size as interior elements, this should let it float. Upped time to ~~100,000~~ 10,000 yrs. Resubmitted as gn2.out. 17101 cpusec = 4.75 hrs.

44	2 yrs	P contours all look the same
67	200 yrs	
74	500 yrs	
122	1000 yrs	
190	10,000 yrs	

Took results for 10,000 yrs put it as INCON in gnew2i & added heat source > ghot1.out

3/10/94 RJ Output for ghot.out

27	2 yrs
38	200 yrs
41	500 yrs
43	1000 yrs

Created gn57i with corrected heat generation tables to go to 10,000 yrs. for output times of 2, 200, 500, 1000, 5000, 10,000 yrs > gn57.out heat ~~source~~ of 57 J/s (see pg 70)

gn57.out

27	2 ~~days~~ yrs RJ
38	~~2 yrs~~ 200 yrs
41	500 yrs
43	1000 yrs
58	5000 yrs
69	10000 yrs

3/11/94 RJ Started gn57ai which will have a 2% tilt 2% = 3.4907e-2 radians and no heat submitted into gn57a.out

3/13/94 RJ gn57a.out 95411 sec CPU

552	2 yrs
596	200 yrs
635	500 yrs
690	1000 yrs
901	5000 yrs
1035	10,000 yrs

gn57a.dat, *plt

water table gradient was too high, reset gradient (tilt) to $\frac{50}{12,000}$ = 0.004666667 (cos q = 7.27226-5 & 0.999999997) & ~~also~~ submitted into gn57b.out

3/14/94 RJ gn57b.out required 25080 CPU sec (~7 hrs)

gn57b-out

32	2 yrs
53	200
77	500
136	1000
264	5000
280	10,000

Only 11 m of head difference from A 22 to BH 22 at 10,000 yrs. Angle was not correct. $\frac{50}{12000} = \tan\alpha \Rightarrow \alpha = 0.238731033°$
set $\cos\alpha$ = 0.004166630 for 1723, 3374
and 0.999991320 for 3375, 4994
Submitted as gn57c.out

3/15/94
RH

gn57c.out 20782 sec

51	2 yrs
83	200
97	500
138	1000
197	5000
235	10,000

at 10,000 yrs { A22 .6907e7 ; BH22 .7262e7 } 3.55e5 Pa

$$\frac{3.55e5}{(992.24)(9.80665)} = 36.48 \text{ m of water different}$$

at 5,000 yrs { A 22 .6909e7 ; BH 22 .7191e7 } 2.820e5 = 28.98 m_{H_2O}

Thus, it is still evolving

Put final conditions from gn57c-out into gn57ai & called it gn57ti to run it out 10,000 more years
Submitted to gn57d-out

at 10,000 more years (20,000 total)

20,000 yrs [A 22 .7240E7 ; BH22 .7567E7] 3.270E5 = 33.6 m

58	2 yrs
67	200 yrs
69	500 yrs
72	1000
106	5000
127	10,000

3/17/94
RH

Improper ~~incon~~ INCON file was loaded into gn57ti. Went back to gn57av and retrieved better final conditions (e.g. A 22 stayed @ .6909 or .6911e7 through out simulation, put into gn57ti & submitted as gn57e-out

gn57e.out 12,137 sec 3.37 hrs
(+10K yrs)

27	2 yrs
36	200 yrs
41	500 yrs
48	1000 yrs
72	5000 yrs
157	10,000 yrs

BH 22 wet up to 0.7314e7 (total head diff from A 22 is now 42.03 m) w/ an increase of 1.75 m over the last 5000 yrs compared w/ 3.8 m over previous 5000 yrs.

Put 57 Kw/acre heat (from gn57i) into gener.dat & into gn57fi
Submitted as gn 57f.out

3/18/94 RH

gn57f.out 13,550 3.76 hrs

66	2 yrs
81	200 yrs
84	500 yrs
93	1000 yrs
143	5000 yrs
158	10,000 yrs

Still an error in input deck, corrected & resubmitted as gn57g.out → note input for this was only w/ 10K run

3/19/94 RH

gn57g.out

27	2 yrs
40	200 yrs
43	500 yrs
49	1000 yrs
62	5000 yrs
108	10,000 yrs

3/23/94 RH Inserted two production wells into the carbonate layer A 26, A 27 at a rate of 0.05 Kg/s per element. This may correct the inconsistency in the carbonate layer in terms of flow direction. Submitted as gn 57h.out

3/24/94 RH

gn57h.out 16,536 CPU (4.6 hrs)

22	2 yrs
39	200 yrs
43	500
51	1000
136	5000
213	10,000

Put sinks at downgradient end of carbonate ⇒ BH 26, BH 27. gn57i.out
Killed job.

Added sinks at BH 26, 27 (−0.05 Kg/s) and sources at A 26, 27 (+0.05 Kg/s) and submitted as gn 57j.out

gn57j.out 4,071 (1.13 hrs)

22	2 yrs
40	200
43	500
47	1000
63	5000
72	10,000

Results look good, base flow appears to be consistently down gradient

3/25/94 RAA Set sat tuff at right & left (A 16 to A 25 & BH 16 to BH 25) to large vol (E+44) to maintain constant head. Kept A 26, 27 & BH 26, 27 at constant flux.

> gn57K.out

Made new file gn-ss: for steady state, to be run out 110 Kyrs. no heat load, constant flux in carbonate, left side sat boundary large (E+10 bigger) to get even (flat & tilted) water table surface

submitted into gn57m.out

3/28/94 RAA

gn57m.out

41	2 yrs
75	200
78	500
103	1000
409	5000
441	10,000
2229	100,000

Started new input file w/ 65 x 28 elements to put slope outside of area of interest

gn57bi big

⇒ gn57n.out

used stripx (in ~/grid or gohatt) to adjust initial conditions). grid now goes to BM 28

3/29/94 RAA

gn57n.out 15358 (4.27 hrs)

36	2 yrs
56	200
64	500
79	1000
137	5000
167	10,000

50 m head on left was not included, added it into gn57bi & resubmitted to gn57o.out

gn57o.out

72	2 yrs
90	200
97	500
116	1000
141	5000
164	10,000

need to check results in gn57o.dat

4/3/94 RAA gn57bi did not have A26 & 27, BM26 & 27 set to sources & sinks. Also set BM 16-25 to constant head (i.e. large volumes) in gn57bi

submitted to gn57p.out 38,868 (10.8 hrs)

4/4/94 RAA

85	2 yrs
139	200
144	500
156	1000
335	5000
377	10,000

⇒ gn57p.dat

4/6/94 RH — created gn572i 2 sides expanded. This is a new grid 70 x 28 that extends 1000m (5 elements) to both the right and the left. Let A 26,27 BR 26,27 to be sources/sinks in carbonate

4/7/94 RH

gn57q.out

83	2 yrs
142	200
147	500
155	1000
169	5000
176	10,000

Difference between F 16 & B 16 (12 Km apart) is 137,000 Pa (or 14.079 m_{H_2O}) this is a gradient of 0.0012 (or 0.12%)

increased head to 150m in A 16-25 resulted in gn57r.out, still has sources/sinks at A & BR 26,27.

4/8/94 RH

gn57r.out 49,991 CPU sec. 13.9 hrs

151	2 yrs
370	200
405	500
438	1000
472	5000
486	10,000

F 16 .2013 e7 } 4.1 e5 Pa = 42.13 m_{H_2O} difference
BR 16 .1603 e7 } at 10,000 yrs

This is a gradient of $\frac{42.13}{12,000}$ = 3.51 e-3 %

Resubmitted gn572i w/o sinks or sources in carbonate layer for comparison ⇒ gn57s.out

use SCP GW contour map for indication of gradient ⇒ highly variable

RH

Information potentially subject to copyright protection was redacted from this location. The redacted material (figure) was from Waddell, et al. (1984), which is all the information that could be found on this reference.

Figure 3-10. Regional ground-water flow paths Modified from Waddell et al (1984)

3-75

gn 57pi will have sources in it (ie at A 26,27 ; BR 26,27)

resubmitted as gn57t.out to get proper new incon if I decide to put heat source into case w/ sinks & sources

4/11/94
RJL

gn 57s.out

147	2 yrs
164	200 yrs
170	500 yrs
179	1000 yrs
283	5000 yrs
313	10,000 yrs

	F			
	A 16	.1984e7	3.91e5	= 40.18 m
at 10,000 yr	BR 16	.1593e7		

Vertical temperatures were weird, set heat capacity high on columns A & BR to maintain constant temp profile at boundaries - No sources or sinks in carbonate - New input file gn57ssi

4/12/94
RJL

gn 57u.out

139	2 yrs
168	200
174	500
181	1000
280	5000
303	10,000

Temperature contours are bizarre, too much circulation. Set thermal conductivity to be constant w/ saturation & ~~increase~~ decreased permeability of interior nodes from ~~10~~ 1-9e-12 m² to 1-9e-~~13~~ resubmitted as gn 57v-out.

4/13/94
RJL

gn 57V.out 15398 (4.3 hrs)

53	2 yrs
153	200
158	500
160	1000
166	5000
170	10,000

Temp contours look good, not sure if it is because of constant thermal conductivity or lower permeability, set $K_{T\,dry}$ to 1.70 and rerun to gn 57w-out

gn57w out

54	2 yrs
149	200
154	500
156	1000
164	5000
167	10,000

Results look good, similar to gn57v.out, thus it is the high K (ie high Rayleigh #) & not variable thermal conductivity that caused the formation of convection cells

use incon from gn57ssv → gn57ss.inc

new input file gn57Ahi for heated case. ⇒ gn57x out

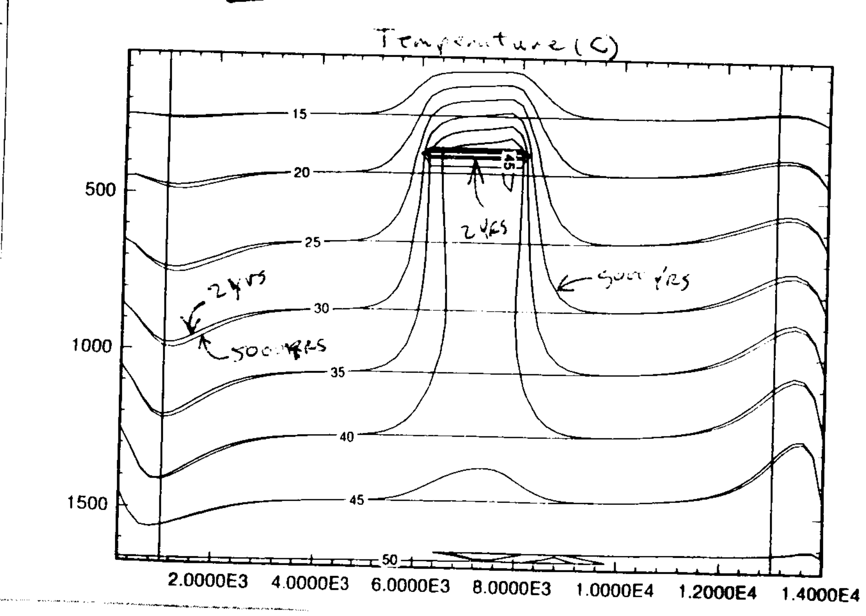
4/19/94 RF Put in wrong heat source. will put in heat at these elements Row 9 AE to AN

Heat source in gn57hi still not correct — times of most elements are off

gn57y.out

46	2 yrs
58	200
61	500
64	1000
68	5000

(2D) II Print II 14 Apr 1994 II gn57y.plt II 5k yr w/57kw



RF 4/19/94

The heat source is a little off here but pretty close

GENER

AE	**9HOT 1**	10	HEAT	
	0.000E+00	3.154E+08	1.261E+09	2.838E+09
	5.992E+09	1.545E+10	3.122E+10	6.276E+10
	1.574E+11	3.150E+11		
	1.4085E+02	1.0967E+02	6.709E+01	3.687E+01
	2.096E+01	1.239E+01	7.250E+00	3.890E+00
	2.510E+00	1.800E+00		
AF	9HOT 2	10	HEAT	
	0.000E+00	3.154E+08	1.261E+09	2.838E+09
	5.992E+09	1.545E+10	3.122E+10	6.276E+10
	1.574E+11	3.150E+11		
	1.4085E+02	1.0967E+02	6.709E+01	3.687E+01
	2.096E+01	1.239E+01	7.250E+00	3.890E+00
	2.510E+00	1.800E+00		
AG	9HOT 3	10	HEAT	
	0.000E+00	3.154E+08	1.261E+09	2.838E+09
	5.992E+09	1.545E+10	3.122E+10	6.276E+10
	1.574E+11	3.150E+11		
	1.4085E+02	1.0967E+02	6.709E+01	3.687E+01
	2.096E+01	1.239E+01	7.250E+00	3.890E+00
	2.510E+00	1.800E+00		
AH	9HOT 4	10	HEAT	
	0.000E+00	3.154E+08	1.261E+09	2.838E+09
	5.992E+09	1.545E+10	3.122E+10	6.276E+10
	1.574E+11	3.150E+11		
	1.4085E+02	1.0967E+02	6.709E+01	3.687E+01
	2.096E+01	1.239E+01	7.250E+00	3.890E+00
	2.510E+00	1.800E+00		
AI	9HOT 5	10	HEAT	
	0.000E+00	3.154E+08	1.261E+09	2.838E+09
	5.992E+09	1.545E+10	3.122E+10	6.276E+10
	1.574E+11	3.150E+11		
	1.4085E+02	1.0967E+02	6.709E+01	3.687E+01
	2.096E+01	1.239E+01	7.250E+00	3.890E+00
	2.510E+00	1.800E+00		
AJ	9HOT 6	10	HEAT	
	0.000E+00	3.154E+08	1.261E+09	2.838E+09
	5.992E+09	1.545E+10	3.122E+10	6.276E+10
	1.574E+11	3.150E+11		
	1.4085E+02	1.0967E+02	6.709E+01	3.687E+01
	2.096E+01	1.239E+01	7.250E+00	3.890E+00
	2.510E+00	1.800E+00		
AK	9HOT 7	10	HEAT	
	0.000E+00	3.154E+08	1.261E+09	2.838E+09
	5.992E+09	1.545E+10	3.122E+10	6.276E+10
	1.574E+11	3.150E+11		
	1.4085E+02	1.0967E+02	6.709E+01	3.687E+01
	2.096E+01	1.239E+01	7.250E+00	3.890E+00
	2.510E+00	1.800E+00		
AL	9HOT 8	10	HEAT	
	0.000E+00	3.154E+08	1.261E+09	2.838E+09
	5.992E+09	1.545E+10	3.122E+10	6.276E+10
	1.574E+11	3.150E+11		
	1.4085E+02	1.0967E+02	6.709E+01	3.687E+01
	2.096E+01	1.239E+01	7.250E+00	3.890E+00
	2.510E+00	1.800E+00		
AM	9HOT 9	10	HEAT	
	0.000E+00	3.154E+08	1.261E+09	2.838E+09
	5.992E+09	1.545E+10	3.122E+10	6.276E+10
	1.574E+11	3.150E+11		
	1.4085E+02	1.0967E+02	6.709E+01	3.687E+01
	2.096E+01	1.239E+01	7.250E+00	3.890E+00
	2.510E+00	1.800E+00		
AN	9HOT10	10	HEAT	
	0.000E+00	3.154E+08	1.261E+09	2.838E+09
	5.992E+09	1.545E+10	3.122E+10	6.276E+10
	1.574E+11	3.150E+11		
	1.4085E+02	1.0967E+02	6.709E+01	3.687E+01
	2.096E+01	1.239E+01	7.250E+00	3.890E+00
	2.510E+00	1.800E+00		

GENER.57heat

heat source for 70x28 grid @ 57KW/acre

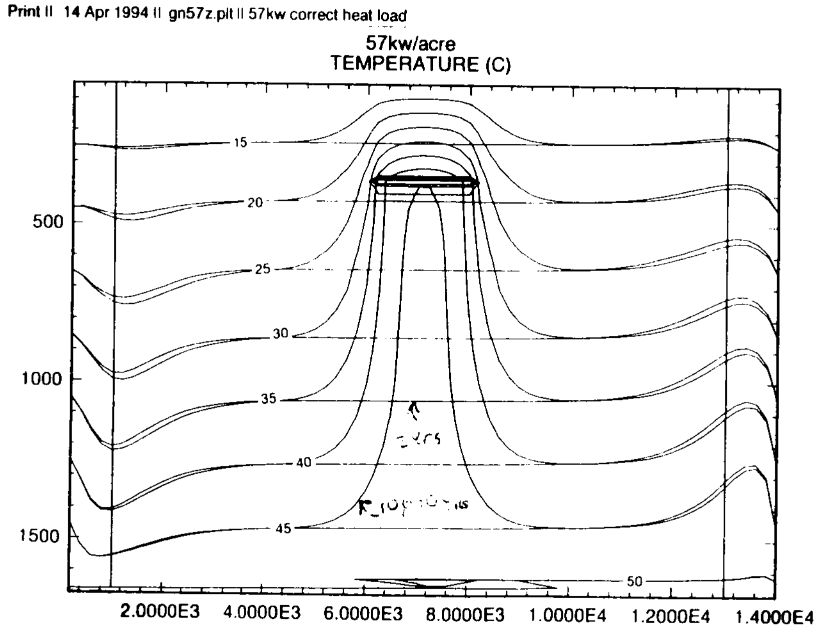
RF 4/19/94

Corrected gn57hi w/ heat source listed on pg 87 rerun as gn57z.out

gn 57

46	2
58	200
61	500
64	1000
68	5000
70	10,000

(2D) || Print || 14 Apr 1994 || gn57z.plt || 57kw correct heat load



RSA 4/14/94

4/15/94 RR Created GENER.114heat which has heat generation for 10,000 yrs. Put this into gn57hi and submitted ⇒ gn57a.out

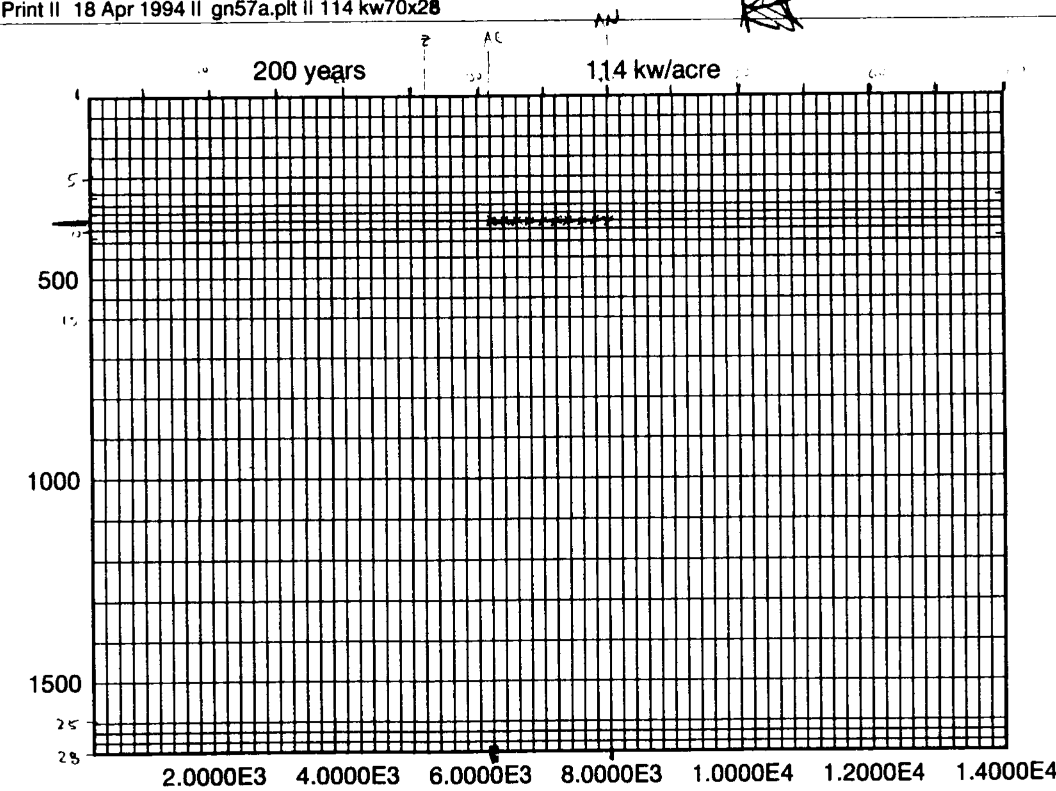
gn57a.out 12,704

47	2	yrs
103	200	
124	500	
136	1000	
174	5000	
178	10,000	

4/17/94 RR Locations of heat sources :

node-centered RR 4/17/94

(2D) || Print || 18 Apr 1994 || gn57a.plt || 114 kw70x28



Note: 10 node centered heat sources row 9 column 31-40 AE-AN

5/10/94 RH Copied Ftop.i into Fbot.i (goliath/rgreen/gutt/gnew) and set bottom boundary (matv 3) to large vol (E+13) w/ composite 9-9 model & permeability of 4e-16 m² submitted as Fbot.out to check effect of bottom boundary being open to mountain.

5/11/94 RH Fbot.out cpu = 41,737 11.6hrs

20	1 day
25	5
32	20
41	50
48	120
59	365
73	1093
75	1157

results look different than those w/ adiabatic no flow, normal-sized elements. Original look ok for now

5/17/94 RH Added A 26,27 BM 26,27 source & sink to gn114.i & submitted ⇒ gn114a.out

5/16/94 RH gn114a.out 16,276 4.5 hrs.

RH 5/16/94

48	~~1 day~~ 2 yrs	gn114-2.ps
126	200 yrs	gn114-200.ps
146	500	
155	1000	gn114-1k.ps
198	5000	gn114 5K.ps
209	10,000	gn114 10K.ps

plots look ok ps files in /users2/goliath/rgreen/gutt/gnew/output

gn114a.out, *.dat, *.plt
gn114av.dat, *.plt

5/19/94 RH Added additional times to gn114.i 15730 sec 4.37 hrs.

1)	35	1 day	11)	88	50 yr	yellow
2)	37	2 day	12)	104	100 yr	purple
3)	40	5 day	13)	148	500 yr	red
4)	42	10 day	14)	160	1000 yr	green
5)	44	20 day	15)	198	5000 yr	
6)	47	50 day	16	204	10,000 yr	
7)	49	100 day				
8)	51	200 day				
9)	54	500 day				
10)	56	1000 day				

submitted into gn114b.out, this will be the output for Ross to run his particle tracker. Put into gn114b.dat & gn114b.plt 7/11/94 RH

6/7/94 RETC analysis of Nopal tuff samples
RF

nrg5tot2.dat file is modeled w/ RETCX to estimate van Genuchten parameters

Use measured retention curve in (sneezy)

/home/sneezy/rgreen/analog/meyer/nrg5tot2.dat

Put input into test of infiltration @ Pena Blanca on goliath /user2/goliath/rgreen/pena/penai

matrix
adit

```
i,6/7/94,40x40,e-14,aditA-E27-36,const h A-E,1,nrg5 props
ROCKS
matr1    22580.      .10              1.0E-14   1.0E-14   1.0E-142.3          840.
      0.0         0.0        1.70       0.5
   7              0.44       0.02       0.97
  11              0.44       0.02     5.1e-7       0.0       0.97       0.1
matr2     2    1.      .99              1.0E-02   1.0E-02   1.0E-020.1          10.
      0.0         0.0        1.70       0.5
   7              0.44       0.02       0.97
  11              0.44       0.02     2.e-0        0.0       0.97       0.1

PARAM++++1++++|++++2++++|++++3++++|++++4++++|++++5++++|++++6++++|++++7
   19900     500000000000000000 41             2.13e-5       1.8
      0.0   8.640E06         1e-1            B  15      +9.80665
    1.E-5          1.                                      1.E-8
                 1.E5                    35. 00.
START
RPCAP
    9          1.9e-18 5.8004e-7     1.798      0.11       1.e-3
    9          1.0e-11 1.3147e-4      4.23     1.8e-3      1.e-3
TIMES
    8    8      1.E12
 4.3200E04 8.6400E04 1.7280E05 4.3200E05 8.6400E05 1.7280E06 4.3200E06 8.6400E06
OPTN
    0    1    0    1    1    0
DTSTP
      8.e5         0.1
ELEME
A    1             matr10.4500E+12
A    2             matr10.4500E-02
A    3             matr10.4500E-02
```

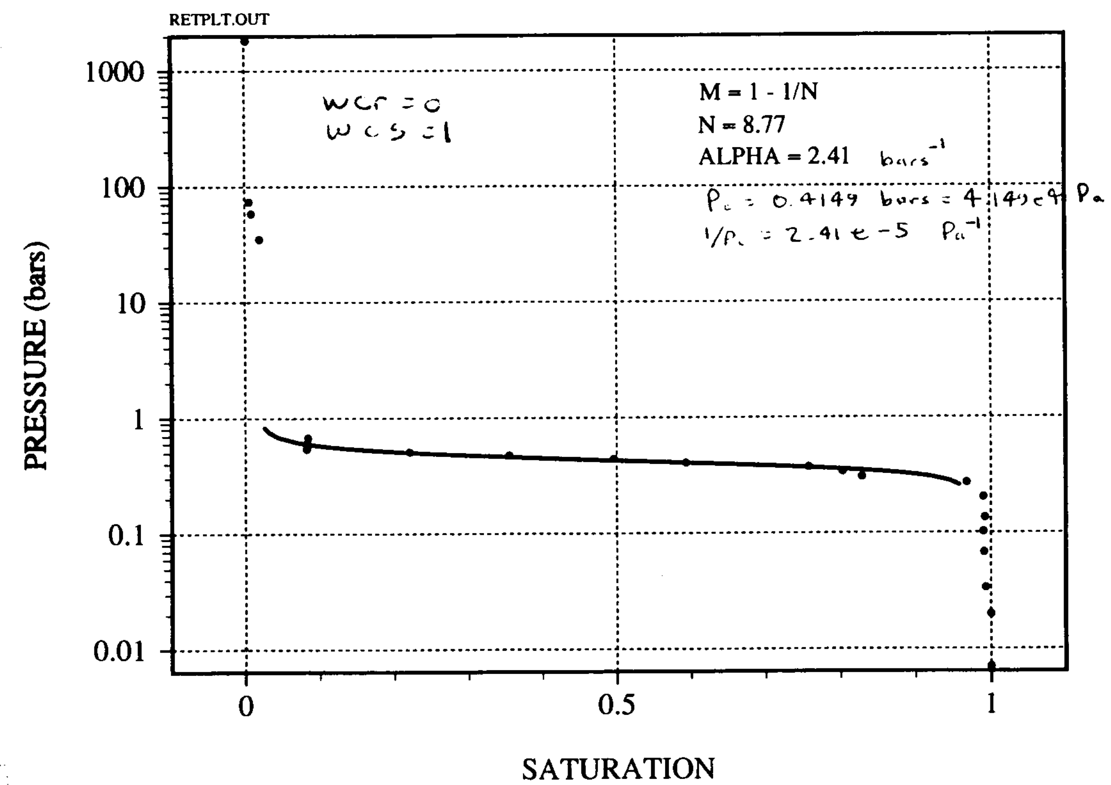
RF

Penai is a 40x40 element (12m x 12m) X-Z 2D grid w/ uniform nodal spacing, @ 30 cm w/ an adit at ~8 m depth A-E, 27-36

6/8/94 Started Test 7 runs again 40x42 grid
RF
original is located in goliath under /user2/goliath/rgreen/test7 moved input t7i to rory under /home2/rory/rgreen/test7

Retention Curve used for van Genuchten parameters: located in /home/sneezy/rgreen/test7/ceramic

CERAMIC



RF

$m = 1 - \frac{1}{8.77} = 0.886$

Input deck for t7i for ceramics

```
cp11,alf2.4e-5,ks-11,11.2,b5.,q2.25,6/7/3,thermcon=19.7W/m,GENE=60,s*=.3
ROCKS
matr2     22500.      .35              1.0E-11                             19.7          800.
     0.0        0.0       19.7         0.5
   7           .886        0.0         1.0
  11           .886        0.0     2.41e-5        0.0         1.0       0.3
matr1     22500.      .0001            4.0E-90                              1.0         1.0E35
     0.0        0.0        1.0         0.0
   7           .800        0.0         0.5
  11           .800        0.0         1.0        0.0         1.0       0.3
matr3     22500.      .0001            4.0E-90                              1.0         1.0E35
     0.0        0.0        1.0         0.0
   7           .800        0.0         0.5
  11           .800        0.0         1.0        0.0         1.0       0.3

PARAM
   1 990      2500000000000000 41            2.00e-5       1.8
     0.0  1.000E+8        -1.           B  10      +9.80665
    1.E0
    1.E-5       1.0                                        1.E-8
                1.E5                   .20 20.
START
RPCAP
   7            .200       0.0         1.0
  11            .200       0.0     1.1E-5      1.0E5        1.0       0.35
TIMES
   7     7     1.E10 3.15576E8
  4.320e4    8.640e4    1.728e5   4.320e5    1.728e6    4.320e6    1.037e7
OPTN
   0     1     0     1     1     0
DTSTP
         0          0          0          0
ELEM
```

RH

t7a.out

28	.5 days
30	1
32	2
35	5
38	20
41	50
43	120
98	1157

elements were mis-labeled (old A,...,Z, AA, BB...) style which is not compatable to tufprt. Re-constructed grid to new format A,...,Z, AA, AB, AC,... and submitted as t7b.out on rory

6/9/94 RH Results for Pena (pena5.out) are interesting. W/ 7-11 model, moisture front is much more diffuse. Results are in /users2/goliath/rgreen/pena

.5 day	47
1	51
2	55
5	61
10	66
20	155
50	382

time steps have bogged down. Will kill job & re-run w/ adit modeled as impermeable and k set to 1.0e-13 m^2 (from e-14) submitted as pena6.out
also set porosity of adit to 0.01 (K = 1.0e-94 m^2)

RH

6/9/94 t76.out results look variable
RH moved from ro-y to /usr2/goliath/rguson/test7

31	.5 days
33	1 (64 hr)
35	2
38	5
41	20
44	50
46	120
51	1157

6/10/94 RH — Original t7i data set was moved from bashful to goliath & put into t7i.orig. This was originally run w/ variable heat loads up to 60 Watts.

```
cp11,alf1.4e-4,ks-11,11.2,b5.,q2.25,6/2/3,thermcon=19.7W/m,GENE=60,s*=.3
ROCKS
matr2    22500.      .35             1.0E-11                      19.7        800.
    0.0         0.0       19.7        0.5
     7         .800        0.0        1.0
    11         .800        0.0     1.4E-4     1.0E5      1.0      0.3
matr1    22500.      .0001           4.0E-90                        1.0      1.0E35
    0.0         0.0        1.0        0.0
     7         .800        0.0        0.5
    11         .800        0.0        1.0     1.0E5      1.0      0.3
matr3    22500.      .0001           4.0E-90                        1.0      1.0E35
    0.0         0.0        1.0        0.0
     7         .800        0.0        0.5
    11         .800        0.0        1.0     1.0E5      1.0      0.3

PARAM
   2 9902000   5000000000000000 41          2.00e-5      1.8
     0.0  1.000E+8        -1.           B  10      +9.80665
    1.E0
   1.E-5        1.0                                    1.E-8
               1.E5                   .20 20.
START
RPCAP
```

t7i.orig on goliath/test7/t7i.orig

Pena

pena6.out flooded in ~2 days, killed job & set lower boundary to constant head and resubmitted as pena7.out 6/12/94 RH 6/12/94

pena6.out

52	.5	day
56	1	
309	2	
564	5	

6/12/94 RH — pena7.out ran through in 3758 seconds (62 min)

pena7.out

52	.5	days
56	1.0	
59	2	
63	5	
65	10	
67	20	
70	50	
72	100	

Results look good but goofed up saturation (initial) of adit cells A-E, 32-36. Corrected and resubmitted as pena8.out

Created pcompi which is penai but with composite 9-9 model for matrix instead of 7-11 model that is in penai.

Single medium model:

input for pena8.out

penai

```
i,6/12/94,40x40,e-13,imperm aditA-E27-36,const h A-E,1,A-AN,40,nrg5 props
ROCKS
matr1     22580.      .10            1.0E-13   1.0E-13   1.0E-132.3          840.
        0.0       0.0       1.70       0.5
     7            0.44      0.02       0.97
    11            0.44      0.02     5.1e-7       0.0       0.97      0.1
matr2     22580.      .01            1.0E-94   1.0E-94   1.0E-942.3          840.
        0.0       0.0       1.70       0.5
     7            0.44      0.02       0.97
    11            0.44      0.02     5.1e-7       0.0       0.97      0.1
matr3      2     1.   .99            1.0E-02   1.0E-02   1.0E-020.1           10.
        0.0       0.0       1.70       0.5
     7            0.44      0.02       0.97
    11            0.44      0.02      2.e-0       0.0       0.97      0.1
```

not used [(matr3)

changed m to 0.433 (n=1.764) } in pena?.out

changed α to 8.5e-7 Pa^{-1}

RF

composite medium model:

pcompi

```
,6/12/94,40x40,e-13,imperm aditA-E27-36,const h A-E,1,A-AN,40,nrg5 props
ROCKS
matr1     22580.      .10            1.0E-13   1.0E-13   1.0E-132.3          840.
        0.0       0.0       1.74       0.5
     9       1.9e-18 5.8004e-7      1.798      0.10       0.97
     9       1.0e-11 1.3147e-4       4.23     1.8e-3      1.e-3
matr2     22580.      .01            1.0E-94   1.0E-94   1.0E-942.3          840.
        0.0       0.0       1.70       0.5
     7            0.44      0.02       0.97
    11            0.44      0.02     5.1e-7       0.0       0.97      0.1
matr3      2     1.   .99            1.0E-02   1.0E-02   1.0E-020.1           10.
        0.0       0.0       1.70       0.5
     7            0.44      0.02       0.97
    11            0.44      0.02      2.e-0       0.0       0.97      0.1
11           0.44      0.02      2.e-0       0.0       0.97      0.1
```

not used [(matr3)

RF

both use ~ properties measured from nrg5

submitted pcompi as pcomp1.out

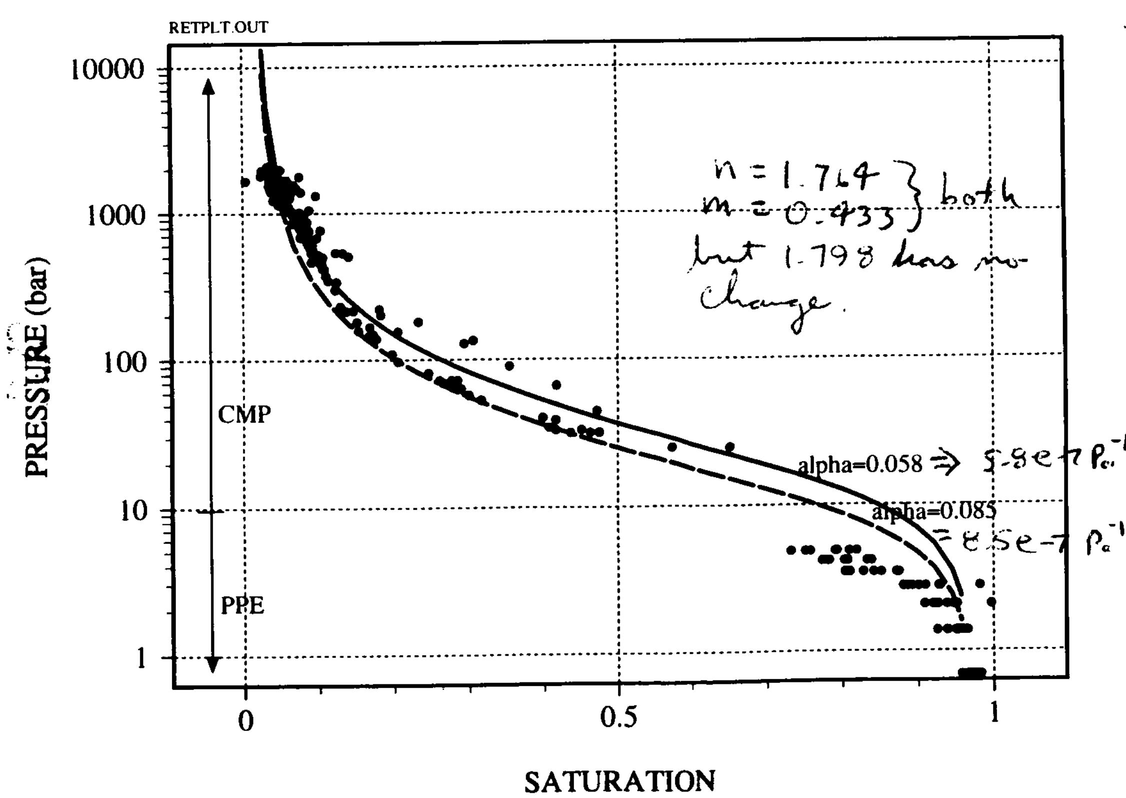
pena8.out   7-11 model w/ corrected adit initial saturation

52	.5 days
56	1
59	2
63	~~3~~ 5 RF 6/12/94
65	10
67	20
70	50
72	100

results for saturated plotted & put into /user/goliath/rgreen/pena/output

RF

RETENTION CURVE - nrg5



put updated m (0.433), α (8.5e-7) into penai & pcompi

→ pena9.out
→ pcomp1.out

6/13/94 RH — Output from pena9.out 3855 = 64 min CPU

51	.5 days
55	1
59	2
63	5
65	10
67	20
70	50
72	100

output files are in /usr2/goliath/rgreen/pena/output
Steady state saturation after 5 days

6/14/94 RH — pcomp2.out

83	0.5 days
116	1
172	2
307	5
531	10
604	20
621	50
629	100

6/21/94 RH — All goliath files moved to sneezy onto /usr2

Following are the values for nrg5 conductivities located on sneezy in /home/rgreen/exclam/nrg5.tbl

6/29/94 These data are incorrect (at least column F?)

A	B		D	E	F
pressure	rel frac	rel nrg5	frac cond	nrg5 cond	composite
2.6000e-03	1.1033e-13	1.0030e-14	1.1033e-19	1.0030e-18	1.1194e-19
5.1000e-03	4.1290e-08	3.4820e-13	4.1290e-14	3.4820e-17	4.1216e-14
1.0200e-02	3.5890e-07	1.2090e-11	3.5890e-13	1.2090e-15	3.5826e-13
2.0400e-02	3.1210e-06	4.1980e-10	3.1210e-12	4.1980e-14	3.1155e-12
3.0600e-02	1.1070e-05	3.3440e-09	1.1070e-11	3.3440e-13	1.1051e-11
4.0800e-02	2.7180e-05	1.4580e-08	2.7180e-11	1.4580e-12	2.7134e-11
5.1000e-02	5.4580e-05	4.5700e-08	5.4580e-11	4.5700e-12	5.4490e-11
6.1200e-02	9.6510e-05	1.1620e-07	9.6510e-11	1.1620e-11	9.6357e-11
7.1400e-02	1.5630e-04	2.5590e-07	1.5630e-10	2.5590e-11	1.5606e-10
8.1600e-02	2.3740e-04	5.0700e-07	2.3740e-10	5.0700e-11	2.3706e-10
9.1800e-02	3.4340e-04	9.2700e-07	3.4340e-10	9.2700e-11	3.4295e-10
1.0200e-01	4.7770e-04	1.5900e-06	4.7770e-10	1.5900e-10	4.7713e-10
1.1220e-01	6.4420e-04	2.5920e-06	6.4420e-10	2.5920e-10	6.4351e-10
1.2240e-01	8.4640e-04	4.0500e-06	8.4640e-10	4.0500e-10	8.4561e-10
1.3270e-01	1.0880e-03	6.1060e-06	1.0880e-09	6.1060e-10	1.0871e-09
1.4290e-01	1.3740e-03	8.9310e-06	1.3740e-09	8.9310e-10	1.3731e-09
1.5310e-01	1.7070e-03	1.2730e-05	1.7070e-09	1.2730e-09	1.7062e-09
1.6330e-01	2.0920e-03	1.7730e-05	2.0920e-09	1.7730e-09	2.0914e-09
1.7350e-01	2.5320e-03	2.4210e-05	2.5320e-09	2.4210e-09	2.5318e-09
1.8370e-01	3.0320e-03	3.2480e-05	3.0320e-09	3.2480e-09	3.0324e-09
1.9390e-01	3.5970e-03	4.2900e-05	3.5970e-09	4.2900e-09	3.5982e-09
2.0410e-01	4.2290e-03	5.5870e-05	4.2290e-09	5.5870e-09	4.2314e-09
2.1430e-01	4.9350e-03	7.1850e-05	4.9350e-09	7.1850e-09	4.9391e-09
2.2450e-01	5.7180e-03	9.1330e-05	5.7180e-09	9.1330e-09	5.7241e-09
2.3470e-01	6.5840e-03	1.1490e-04	6.5840e-09	1.1490e-08	6.5928e-09
2.4490e-01	7.5350e-03	1.4320e-04	7.5350e-09	1.4320e-08	7.5472e-09
2.5510e-01	8.5790e-03	1.7680e-04	8.5790e-09	1.7680e-08	8.5954e-09
2.6530e-01	9.7180e-03	2.1660e-04	9.7180e-09	2.1660e-08	9.7395e-09
2.7550e-01	1.0960e-02	2.6350e-04	1.0960e-08	2.6350e-08	1.0988e-08
2.8570e-01	1.2310e-02	3.1820e-04	1.2310e-08	3.1820e-08	1.2345e-08
2.9590e-01	1.3760e-02	3.8180e-04	1.3760e-08	3.8180e-08	1.3804e-08
3.0610e-01	1.5340e-02	4.5550e-04	1.5340e-08	4.5550e-08	1.5394e-08
3.1630e-01	1.7030e-02	5.4040e-04	1.7030e-08	5.4040e-08	1.7097e-08
3.2650e-01	1.8860e-02	6.3780e-04	1.8860e-08	6.3780e-08	1.8941e-08
3.3670e-01	2.0810e-02	7.4910e-04	2.0810e-08	7.4910e-08	2.0907e-08
3.4690e-01	2.2910e-02	8.7580e-04	2.2910e-08	8.7580e-08	2.3026e-08
3.5710e-01	2.5150e-02	1.0200e-03	2.5150e-08	1.0200e-07	2.5288e-08
3.6730e-01	2.7530e-02	1.1820e-03	2.7530e-08	1.1820e-07	2.7693e-08
3.7760e-01	3.0080e-02	1.3660e-03	3.0080e-08	1.3660e-07	3.0272e-08
3.8780e-01	3.2780e-02	1.5720e-03	3.2780e-08	1.5720e-07	3.3004e-08
3.9800e-01	3.5660e-02	1.8030e-03	3.5660e-08	1.8030e-07	3.5920e-08
4.0820e-01	3.8710e-02	2.0620e-03	3.8710e-08	2.0620e-07	3.9011e-08
4.1840e-01	4.1930e-02	2.3500e-03	4.1930e-08	2.3500e-07	4.2278e-08
4.2860e-01	4.5350e-02	2.6720e-03	4.5350e-08	2.6720e-07	4.5749e-08
4.3880e-01	4.8960e-02	3.0290e-03	4.8960e-08	3.0290e-07	4.9417e-08
4.4900e-01	5.2780e-02	3.4250e-03	5.2780e-08	3.4250e-07	5.3301e-08
4.5920e-01	5.6800e-02	3.8630e-03	5.6800e-08	3.8630e-07	5.7393e-08
4.6940e-01	6.1040e-02	4.3480e-03	6.1040e-08	4.3480e-07	6.1713e-08
4.7960e-01	6.5500e-02	4.8820e-03	6.5500e-08	4.8820e-07	6.6261e-08
4.8980e-01	7.0190e-02	5.4700e-03	7.0190e-08	5.4700e-07	7.1048e-08
5.0000e-01	7.5120e-02	6.1170e-03	7.5120e-08	6.1170e-07	7.6086e-08
5.1020e-01	8.0300e-02	6.8280e-03	8.0300e-08	6.8280e-07	8.1385e-08
5.2040e-01	8.5740e-02	7.6070e-03	8.5740e-08	7.6070e-07	8.6955e-08
5.3060e-01	9.1440e-02	8.4610e-03	9.1440e-08	8.4610e-07	9.2798e-08
5.4080e-01	9.7410e-02	9.3950e-03	9.7410e-08	9.3950e-07	9.8926e-08
5.5100e-01	1.0370e-01	1.0420e-02	1.0370e-07	1.0420e-06	1.0539e-07
5.6120e-01	1.1020e-01	1.1530e-02	1.1020e-07	1.1530e-06	1.1208e-07
5.7140e-01	1.1710e-01	1.2750e-02	1.1710e-07	1.2750e-06	1.1918e-07
5.8160e-01	1.2420e-01	1.4070e-02	1.2420e-07	1.4070e-06	1.2651e-07

These numbers are not correct for a composite medium 7/11/94 RH

nrg5-t61 cont

5.9180e-01	1.3170e-01	1.5510e-02	1.3170e-07	1.5510e-06	1.3425e-07
6.0200e-01	1.3950e-01	1.7090e-02	1.3950e-07	1.7090e-06	1.4233e-07
6.1220e-01	1.4770e-01	1.8790e-02	1.4770e-07	1.8790e-06	1.5082e-07
6.2240e-01	1.5620e-01	2.0650e-02	1.5620e-07	2.0650e-06	1.5964e-07
6.3270e-01	1.6510e-01	2.2660e-02	1.6510e-07	2.2660e-06	1.6888e-07
6.4290e-01	1.7440e-01	2.4850e-02	1.7440e-07	2.4850e-06	1.7856e-07
6.5310e-01	1.8410e-01	2.7230e-02	1.8410e-07	2.7230e-06	1.8867e-07
6.6330e-01	1.9410e-01	2.9800e-02	1.9410e-07	2.9800e-06	1.9911e-07
6.7350e-01	2.0460e-01	3.2600e-02	2.0460e-07	3.2600e-06	2.1010e-07
6.8370e-01	2.1560e-01	3.5630e-02	2.1560e-07	3.5630e-06	2.2163e-07
6.9390e-01	2.2700e-01	3.8910e-02	2.2700e-07	3.8910e-06	2.3360e-07
7.0410e-01	2.3880e-01	4.2470e-02	2.3880e-07	4.2470e-06	2.4601e-07
7.1430e-01	2.5120e-01	4.6330e-02	2.5120e-07	4.6330e-06	2.5909e-07
7.2450e-01	2.6410e-01	5.0510e-02	2.6410e-07	5.0510e-06	2.7272e-07
7.3470e-01	2.7750e-01	5.5050e-02	2.7750e-07	5.5050e-06	2.8691e-07
7.4490e-01	2.9140e-01	5.9970e-02	2.9140e-07	5.9970e-06	3.0167e-07
7.5510e-01	3.0590e-01	6.5310e-02	3.0590e-07	6.5310e-06	3.1711e-07
7.6530e-01	3.2100e-01	7.1110e-02	3.2100e-07	7.1110e-06	3.3322e-07
7.7550e-01	3.3680e-01	7.7400e-02	3.3680e-07	7.7400e-06	3.5013e-07
7.8570e-01	3.5320e-01	8.4250e-02	3.5320e-07	8.4250e-06	3.6773e-07
7.9590e-01	3.7020e-01	9.1690e-02	3.7020e-07	9.1690e-06	3.8604e-07
8.0610e-01	3.8800e-01	9.9800e-02	3.8800e-07	9.9800e-06	4.0527e-07
8.1630e-01	4.0650e-01	1.0870e-01	4.0650e-07	1.0870e-05	4.2533e-07
8.2650e-01	4.2590e-01	1.1830e-01	4.2590e-07	1.1830e-05	4.4643e-07
8.3670e-01	4.4600e-01	1.2890e-01	4.4600e-07	1.2890e-05	4.6840e-07
8.4690e-01	4.6710e-01	1.4050e-01	4.6710e-07	1.4050e-05	4.9155e-07
8.5710e-01	4.8910e-01	1.5320e-01	4.8910e-07	1.5320e-05	5.1580e-07
8.6730e-01	5.1210e-01	1.6720e-01	5.1210e-07	1.6720e-05	5.4127e-07
8.7760e-01	5.3610e-01	1.8270e-01	5.3610e-07	1.8270e-05	5.6802e-07
8.8780e-01	5.6130e-01	2.0000e-01	5.6130e-07	2.0000e-05	5.9629e-07
8.9800e-01	5.8780e-01	2.1920e-01	5.8780e-07	2.1920e-05	6.2620e-07
9.0820e-01	6.1570e-01	2.4070e-01	6.1570e-07	2.4070e-05	6.5792e-07
9.1840e-01	6.4500e-01	2.6500e-01	6.4500e-07	2.6500e-05	6.9154e-07
9.2860e-01	6.7610e-01	2.9280e-01	6.7610e-07	2.9280e-05	7.2759e-07
9.3880e-01	7.0910e-01	3.2470e-01	7.0910e-07	3.2470e-05	7.6627e-07
9.4900e-01	7.4430e-01	3.6220e-01	7.4430e-07	3.6220e-05	8.0816e-07
9.5920e-01	7.8220e-01	4.0700e-01	7.8220e-07	4.0700e-05	8.5405e-07
9.6940e-01	8.2350e-01	4.6250e-01	8.2350e-07	4.6250e-05	9.0527e-07
9.7960e-01	8.6940e-01	5.3500e-01	8.6940e-07	5.3500e-05	9.6414e-07
9.8980e-01	9.2260e-01	6.4200e-01	9.2260e-07	6.4200e-05	1.0365e-06
9.9490e-01	9.5440e-01	7.2770e-01	9.5440e-07	7.2770e-05	1.0837e-06

RJ

note: based on $K_{sat}^{frac} = 1e-4$ & $K_{sat}^{nrg5\ matrix} = 1e-6$
⇒ multiply rel. permeabilities by these number to get saturated conductivities

RJ 6/21/94

6/28/94 RJ — t7i test → t7c.out

59	.5 days
61	1.0
63	2.0
66	5.0
70	20.0
72	50.0
74	120
80	1157.4

6/29/94 RJ — ran pcompi w/ new property values
composite model of PEÑA Blanca (→ pcompi)

incorrect bulk K RJ 11/3/94

```
pcompi,6/28/94,40x40,e-13,imperm adit,cnsth A-E,1,A-AN,40,nrg5prpsmatrx,nit frac
ROCKS
matr1    22580.      .10              1.0E-13   1.0E-13   1.0E-132.3             840.
        0.0       0.0      1.74        0.5
   9          1.0e-13 8.5004e-7      1.764      0.11      0.02
   9          1.0e-11 1.3147e-4       4.23     1.8e-3     1.e-3
matr2    22580.      .01              1.0E-94   1.0E-94   1.0E-942.3             840.
        0.0       0.0      1.70        0.5
   7           0.433       0.02       0.97
  11           0.433       0.02      8.5e-7      0.0       0.97       0.1
matr3     2   1.     .99              1.0E-02   1.0E-02   1.0E-020.1              10.
        0.0       0.0      1.70        0.5
   7           0.433       0.02       0.97
  11           0.433       0.02      2.e-0       0.0       0.97       0.1

PARAM++++1++++|++++2++++|++++3++++|++++4++++|++++5++++|++++6++++|++++7
   19900     500000000000000000 41              2.13e-5      1.8
      0.0   8.640E06         1e-1          B  15      +9.80665
    1.E-5          1.                                  1.E-8
                 1.E5                  35. 00.

START
RPCAP
    9          1.0e-13 5.8004e-7     1.798      0.11      1.e-3
    9          1.0e-11 1.3147e-4      4.23     1.8e-3     1.e-3
TIMES
    8     8      1.E12
 4.3200E04 8.6400E04 1.7280E05 4.3200E05 8.6400E05 1.7280E06 4.3200E06 8.6400E06
OPTN
    0     1     0     1     1     0
DTSTP
      8.e5         0.1
ELEME
A    1           matr10.4500E+12
A    2           matr10.4500E-02
```

Not correct K_{sat}^{bulk} see bottom of page 104 RJ 6/30/94

* Note: K_{sat} for the matrix was decreased to $1e-13\ m^2$

this was run in pcompa.out

52	0.5 days
56	1
60	2
65	5
68	10
70	20
73	50
75	100

results plotted for saturation at 0.5, 2.0, 5.0 days & put into /home2/rory/rgreen/pena/output pcomp-13-505.ps, *52.ps; *55 ps

set pcompi to e-09 m² for fractures and resubmitted as pcompb.out

pcompb.out 6243 sec

50	0.5
54	1
59	2
64	5
69	10
74	20
80	50
83	100

6/30/94 RH Discovered inconsistency in documentation of Composite model in VTOUGH (9-9 model). The K_{sat} (m^2) required on media definition line has to be bulk permeability. This was done

for ~~matrix~~ Fracture RH 6/30/94 of 1.0e-9 m² and matrix of 1.0e-13 m² the k_{bulk} = 1.89982 e-12 and ρ_{bulk} = 0.10162 into pcompi

submitted as pcompc.out

59	.5 days
63	1
69	2
73	5
75	10
77	20
80	50
82	100

Changed fracture to 1e-11 m² & bulk k_{sat} to 1.1782 e-13 and resubmitted as pcompd.out

7/1/94 RH

pcompd.out 5651 sec

52	.5 days
56	1
61	2
66	5
68	10
70	20
73	50
75	100

7/25/94 Prepared heat loads out to 100,000 yrs for
RH 28 kW/acre, 57 kW/acre and 114 kW/acre
Set normalized thermal power to 0.0001 (see pg 70)

```
GENER heat rate for 28kw/acre for 100,000 yrs
AE  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
      7.042E+01    5.484E+02    3.354E+01    1.843E+01
      1.048E+01    6.195E+00    3.625E+00    1.945E+00
      1.255E+00    9.000E-01    5.280E-01    1.900E-01
      7.043E-03
AF  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
      7.042E+01    5.484E+02    3.354E+01    1.843E+01
      1.048E+01    6.195E+00    3.625E+00    1.945E+00
      1.255E+00    9.000E-01    5.280E-01    1.900E-01
      7.043E-03
AG  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
      7.042E+01    5.484E+02    3.354E+01    1.843E+01
      1.048E+01    6.195E+00    3.625E+00    1.945E+00
      1.255E+00    9.000E-01    5.280E-01    1.900E-01
      7.043E-03
AH  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
      7.042E+01    5.484E+02    3.354E+01    1.843E+01
      1.048E+01    6.195E+00    3.625E+00    1.945E+00
      1.255E+00    9.000E-01    5.280E-01    1.900E-01
      7.043E-03
AI  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
      7.042E+01    5.484E+02    3.354E+01    1.843E+01
      1.048E+01    6.195E+00    3.625E+00    1.945E+00
      1.255E+00    9.000E-01    5.280E-01    1.900E-01
      7.043E-03
AJ  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
      7.042E+01    5.484E+02    3.354E+01    1.843E+01
      1.048E+01    6.195E+00    3.625E+00    1.945E+00
      1.255E+00    9.000E-01    5.280E-01    1.900E-01
      7.043E-03
AK  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
      7.042E+01    5.484E+02    3.354E+01    1.843E+01
      1.048E+01    6.195E+00    3.625E+00    1.945E+00
      1.255E+00    9.000E-01    5.280E-01    1.900E-01
      7.043E-03
AL  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
      7.042E+01    5.484E+02    3.354E+01    1.843E+01
      1.048E+01    6.195E+00    3.625E+00    1.945E+00
      1.255E+00    9.000E-01    5.280E-01    1.900E-01
      7.043E-03
AM  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
      7.042E+01    5.484E+02    3.354E+01    1.843E+01
      1.048E+01    6.195E+00    3.625E+00    1.945E+00
      1.255E+00    9.000E-01    5.280E-01    1.900E-01
      7.043E-03
AN  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
      7.042E+01    5.484E+02    3.354E+01    1.843E+01
      1.048E+01    6.195E+00    3.625E+00    1.945E+00
      1.255E+00    9.000E-01    5.280E-01    1.900E-01
      7.043E-03
```

RH 7/25/94

RH 7/25/94

These files are located on sisyphus

/home2/sisyphus/rgreen/gutt/gnew


```
GENER   57 kW/acre out to 100,000 yrs
AE  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
    1.4085E+02   1.0967E+02    6.709E+01    3.687E+01
      2.096E+01    1.239E+01    7.250E+00    3.890E+00
      2.510E+00    1.800E+00    1.056E+00    7.604E-01
      1.408E-02
AF  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
    1.4085E+02   1.0967E+02    6.709E+01    3.687E+01
      2.096E+01    1.239E+01    7.250E+00    3.890E+00
      2.510E+00    1.800E+00    1.056E+00    7.604E-01
      1.408E-02
AG  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
    1.4085E+02   1.0967E+02    6.709E+01    3.687E+01
      2.096E+01    1.239E+01    7.250E+00    3.890E+00
      2.510E+00    1.800E+00    1.056E+00    7.604E-01
      1.408E-02
AH  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
    1.4085E+02   1.0967E+02    6.709E+01    3.687E+01
      2.096E+01    1.239E+01    7.250E+00    3.890E+00
      2.510E+00    1.800E+00    1.056E+00    7.604E-01
      1.408E-02
AI  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
    1.4085E+02   1.0967E+02    6.709E+01    3.687E+01
      2.096E+01    1.239E+01    7.250E+00    3.890E+00
      2.510E+00    1.800E+00    1.056E+00    7.604E-01
      1.408E-02
AJ  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
    1.4085E+02   1.0967E+02    6.709E+01    3.687E+01
      2.096E+01    1.239E+01    7.250E+00    3.890E+00
      2.510E+00    1.800E+00    1.056E+00    7.604E-01
      1.408E-02
AK  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
    1.4085E+02   1.0967E+02    6.709E+01    3.687E+01
      2.096E+01    1.239E+01    7.250E+00    3.890E+00
      2.510E+00    1.800E+00    1.056E+00    7.604E-01
      1.408E-02
AL  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
    1.4085E+02   1.0967E+02    6.709E+01    3.687E+01
      2.096E+01    1.239E+01    7.250E+00    3.890E+00
      2.510E+00    1.800E+00    1.056E+00    7.604E-01
      1.408E-02
AM  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
    1.4085E+02   1.0967E+02    6.709E+01    3.687E+01
      2.096E+01    1.239E+01    7.250E+00    3.890E+00
      2.510E+00    1.800E+00    1.056E+00    7.604E-01
      1.408E-02
AN  9HOT 1                     13           HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
    1.4085E+02   1.0967E+02    6.709E+01    3.687E+01
      2.096E+01    1.239E+01    7.250E+00    3.890E+00
      2.510E+00    1.800E+00    1.056E+00    7.604E-01
      1.408E-02
```

RH 7/25/94

```
GENER heat rate for 114kw/acre for 100,000 yrs
AE   9HOT 1                13      HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
     2.8170E+02   2.1934E+02   1.3418E+02    7.374E+01
      4.142E+01    2.478E+01    1.450E+01    7.770E+00
      5.010E+00    3.610E+00    2.110E+00    7.606E-01
      2.817E-02
AF   9HOT 1                13      HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
     2.8170E+02   2.1934E+02   1.3418E+02    7.374E+01
      4.142E+01    2.478E+01    1.450E+01    7.770E+00
      5.010E+00    3.610E+00    2.110E+00    7.606E-01
      2.817E-02
AG   9HOT 1                13      HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
     2.8170E+02   2.1934E+02   1.3418E+02    7.374E+01
      4.142E+01    2.478E+01    1.450E+01    7.770E+00
      5.010E+00    3.610E+00    2.110E+00    7.606E-01
      2.817E-02
AH   9HOT 1                13      HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
     2.8170E+02   2.1934E+02   1.3418E+02    7.374E+01
      4.142E+01    2.478E+01    1.450E+01    7.770E+00
      5.010E+00    3.610E+00    2.110E+00    7.606E-01
      2.817E-02
AI   9HOT 1                13      HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
     2.8170E+02   2.1934E+02   1.3418E+02    7.374E+01
      4.142E+01    2.478E+01    1.450E+01    7.770E+00
      5.010E+00    3.610E+00    2.110E+00    7.606E-01
      2.817E-02
AJ   9HOT 1                13      HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
     2.8170E+02   2.1934E+02   1.3418E+02    7.374E+01
      4.142E+01    2.478E+01    1.450E+01    7.770E+00
      5.010E+00    3.610E+00    2.110E+00    7.606E-01
      2.817E-02
AK   9HOT 1                13      HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
     2.8170E+02   2.1934E+02   1.3418E+02    7.374E+01
      4.142E+01    2.478E+01    1.450E+01    7.770E+00
      5.010E+00    3.610E+00    2.110E+00    7.606E-01
      2.817E-02
AL   9HOT 1                13      HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
     2.8170E+02   2.1934E+02   1.3418E+02    7.374E+01
      4.142E+01    2.478E+01    1.450E+01    7.770E+00
      5.010E+00    3.610E+00    2.110E+00    7.606E-01
      2.817E-02
AM   9HOT 1                13      HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
     2.8170E+02   2.1934E+02   1.3418E+02    7.374E+01
      4.142E+01    2.478E+01    1.450E+01    7.770E+00
      5.010E+00    3.610E+00    2.110E+00    7.606E-01
      2.817E-02
AN   9HOT 1                13      HEAT
      0.000E+00    3.154E+08    1.261E+09    2.838E+09
      5.992E+09    1.545E+10    3.122E+10    6.276E+10
      1.574E+11    3.150E+11    6.304E+11    1.576E+12
      3.153E+12
     2.8170E+02   2.1934E+02   1.3418E+02    7.374E+01
      4.142E+01    2.478E+01    1.450E+01    7.770E+00
      5.010E+00    3.610E+00    2.110E+00    7.606E-01
      2.817E-02
```

RH 7/25/94

Input files for VTOUGH are also created in this same directory for these heat loads. Everything is the same except for the heat loads: gn57i, gn114i, gn28i. Repository scale model for grout analyses w/ high heat load

```
gn114,cp=9,7/20/4,ks-15,70x28,A,BR16-25setT&P,varykt,ss@10k,A&BM26,27,18times
ROCKS
matr1     22580.      .11          1.8E-14   1.8E-14   1.8E-142.3       1.E+19
     0.0       0.0       1.70      0.0
    9         1.9e-18 5.8004e-7    1.798      0.11      1.e-3
    9         1.0e-11 1.3147e-4    4.23      1.8e-3     1.e-3
matr2     22580.      .11          1.8E-14   1.8E-14   1.8E-142.3         840.
     0.0       0.0       1.70      0.5
    9         1.9e-18 5.8004e-7    1.798      0.11      1.e-3
    9         1.0e-11 1.3147e-4    4.23      1.8e-3     1.e-3
matr3     22580.      .11          1.8E-14   1.8E-14   1.8E-142.3         840.
     0.0       0.0       1.70      0.5
    9         1.9e-18 5.8004e-7    1.798      0.11      1.e-3
    9         1.0e-11 1.3147e-4    4.23      1.8e-3     1.e-3
matr4     22580.      .11          1.8E-06   1.8E-06   1.8E-062.3         840.
     0.0       0.0       1.70      0.5
    9         1.9e-10 5.8004e-7    1.798      0.11      1.e-3
    9         1.0e-03 1.3147e-4    4.23      1.8e-3     1.e-3
matr5     22580.      .11          1.8E-42   1.8E-42   1.8E-422.3       1.E+19
     0.0       0.0       1.70      0.0
    9         1.9e-43 5.8004e-7    1.798      0.11      1.e-3
    9         1.0e-36 1.3147e-4    4.23      1.8e-3     1.e-3

PARAM++++1++++|++++2++++|++++3++++|++++4++++|++++5++++|++++6++++|++++7
   29900     500000000000000000 41          2.13e-5         1.8
     0.0    3.154E12       1e-1          B  15      +9.80665
   1.E-5         1.                                        1.E-8
              1.E5                      35. 00.

START
RPCAP
    9         1.9e-18 5.8004e-7    1.798      0.11      1.e-3
    9         1.0e-11 1.3147e-4    4.23      1.8e-3     1.e-3
TIMES
   18     18   3.154E12
  8.6400E04 1.7280E05 4.3200E05 8.6400E05 1.7280E06 4.3200E06 8.6400E06 1.7280E07
  4.3200E07 8.6400E07 1.5768E09 3.1536E09 1.5768E10 3.1536E10 1.5768E11 3.1536E11
OPTN
    0    1    0    1    1    0
DTSTP
       8.e5         0.1
ELEME                                  BQ 26          matr40.2500E+03
A    1         matr10.5000E+03         BQ 27          matr40.2500E+03
A    2         matr10.5000E+03         BQ 28          matr50.2500E+03
A    3         matr10.5000E+03         BR  1          matr10.5000E+03
A    4         matr10.5000E+03         BR  2          matr10.5000E+03
A    5         matr10.5000E+03         BR  3          matr10.5000E+03
A    6         matr10.4000E+03         BR  4          matr10.5000E+03
A    7         matr10.3000E+03         BR  5          matr10.5000E+03
A    8         matr10.2000E+03         BR  6          matr10.4000E+03
A    9         matr10.2000E+03         BR  7          matr10.3000E+03
A   10         matr10.2000E+03         BR  8          matr10.2000E+03
A   11         matr10.3000E+03         BR  9          matr10.2000E+03
A   12         matr10.4000E+03         BR 10          matr10.2000E+03
A   13         matr10.5000E+03         BR 11          matr10.3000E+03
A   14         matr10.5000E+03         BR 12          matr10.4000E+03
A   15         matr10.5000E+03         BR 13          matr10.5000E+03
A   16         matr10.1000E+14         BR 14          matr10.5000E+03
A   17         matr10.1000E+14         BR 15          matr10.5000E+03
A   18         matr10.1000E+14         BR 16          matr10.1000E+14
A   19         matr10.1000E+14         BR 17          matr10.1000E+14
                                       BR 18          matr10.1000E+14
A   20         matr10.1000E+14         BR 19          matr10.1000E+14
A   21         matr10.1000E+14         BR 20          matr10.1000E+14
A   22         matr10.1000E+14         BR 21          matr10.1000E+14
A   23         matr10.1000E+14         BR 22          matr10.1000E+14
A   24         matr10.1000E+14         BR 23          matr10.1000E+14
A   25         matr10.1000E+14         BR 24          matr10.1000E+14
A   26         matr40.2500E+13         BR 25          matr10.1000E+14
A   27         matr40.2500E+13         BR 26          matr40.2500E+13
A   28         matr50.2500E+13         BR 27          matr40.2500E+13
B    1         matr10.5000E+03         BR 28          matr50.2500E+13
```

← 1.5769E12 3.1533E12 These #'s were inadvertently omitted. RH 7/25/94

RH 7/25/94

bulk properties in gn 114i, gn 57i & gn 28.1 are as follows:

$$\phi_b = \phi_f + (1-\phi_f)\,\phi_m$$
$$= 1.8e{-3} + (1-1.8e{-3})(.11)$$
$$\phi_b = 0.1116$$

$$k_b = k_f\,\phi_f + (1-\phi_f)\,k_m$$
$$= 1.0e{-11}(1.8e{-3}) + (1-1.8e{-3})(1.9e{-18})$$
$$k_b = 1.8e{-14}$$

k_b for carbonate (rows 26 & 27) were made in similar fashion (just scaled by e+9)

Peter converted gn 114i to input into CTOUGH & ran on rory. Output was copied into sneezy → /usr2/sneezy/rgreen/gutt/gnew/output4

there are individual (by time) vector files
i.e. rz114VEL1.dat
↑ denotes time step.

There are 18 time steps up to 100,000 yrs.

7/28/94 RH

	#	sec			#	sec		
①	1	8.64e4	1 day	④	12	3.15e9	100 yrs	m
⑪	2	1.728e5	2 days	⑤	13	1.57e10	500 yrs	m
⑫	3	4.32e5	5 days	⑥	14	3.15e10	1000 yrs	m
⑬	4	8.64e5	10 days	⑦	15	1.57e11	5000 yrs	
⑭	5	1.728e6	20 days	⑧	16	3.15e11	10,000 yrs	L
⑮	6	4.32e6	50 days	⑨	17	1.57e12	50,000 yrs	L
⑯	7	8.64e6	100 days	⑩	18	3.15e12	100,000 yrs	L
⑰	8	1.728e7	200 days					
⑱	9	4.32e7	500 days					
②	10	8.64e7	1000 days					
③	11	1.57e9	50 yrs					

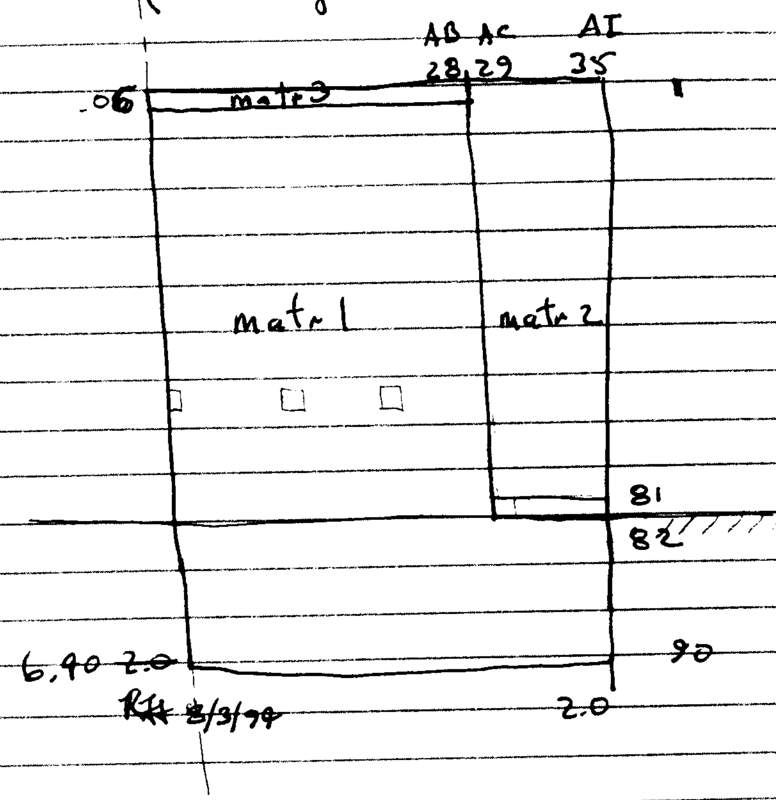
8/13/94 RH New Fran block model, to be run on pemrac

files kept on pemrac we/rgreen/fran and
sisyphus home2/sisyphus/rgreen/fran

model is 35 x 90 (AC by 90)

35,90	1.50	4.96
.05	1.56	5.20
.10	1.62	5.50
.15	1.68	5.80
.20	1.74	6.10
.25	1.80	6.40
.30	1.86	
.35	1.91	
.40	1.96	
.45	2.01	
.50	2.06	
.55	2.11	
.60	2.15	
.65	2.19	
.70	2.23	
.75	2.27	
.80	2.31	
.85	2.35	
.90	2.39	
.95	2.43	
1.00	2.47	
1.05	2.51	
1.10	2.56	
1.15	2.61	
1.20	2.66	
1.25	2.71	
1.30	2.76	
1.35	2.82	
1.40	2.88	
1.45	2.94	
1.50	3.00	
1.55	3.06	
1.60	3.12	
1.70	3.18	
1.80	3.24	
2.0	3.30	
.06	3.36	
.12	3.42	
.18	3.48	
.24	3.54	
.30	3.60	
.36	3.66	
.42	3.72	
.48	3.78	
.54	3.84	
.60	3.90	
.66	3.96	
.72	4.02	
.78	4.08	
.84	4.14	
.90	4.20	
.96	4.26	
1.02	4.32	
1.08	4.38	
1.14	4.44	
1.20	4.50	
1.26	4.56	
1.32	4.62	
1.38	4.70	
1.44	4.80	

RH 8/13/94



heat load is 5 x 300 Watts
⇒ 1.25

See properties in input file on next pg.

Fbigi

Fran block simulation, described on pg 111

```
fbig,8/13/4vect,9-9,gen1.25,ks-14,top9-9,T(.2)ks(e-02)
ROCKS
matr1     22580.      .10               1.8E-14   1.8E-14   1.8E-142.3            840.
    0.0       0.0       1.74        0.5
   9         1.9e-18 5.8004e-7      1.798      0.11      1.e-3
   9         1.0e-11 1.3147e-4       4.23     1.8e-3     1.e-3
matr3     22500.      .50               4.0E-02                        .200        840.
    0.0       0.0       .200        0.5
   9         1.9e-18 5.8004e-7      1.798      0.11      1.e-3
   9         1.0e-11 1.3147e-4       4.23     1.8e-3     1.e-3
matr4     22500.      .0001             4.0E-90                        2.3         840.
    0.0       0.0       1.0         0.0
   7            .800       0.0      0.5
  11            .800       0.0      1.0       1.0E5      1.0       0.3
matr2     22500.      .0001             1.8E-90                        .001        1e-10
    0.0       0.0       .001        0.0
   9         1.9e-94 5.8004e-7      1.798      0.11      1.e-3
   9         1.0e-87 1.3147e-4       4.23     1.8e-3     1.e-3

PARAM
  2 250      25000000000000000 41            2.13e-5      1.8
    0.0  1.000E+8        -1.           B  10      +9.80665
   1.E0
  1.E-5       1.0                                  1.E-8
              1.E5                   .20 20.
DTSTP----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
    4.e5      0.2       15.       0.2
START
RPCAP
   7          .200      0.0       1.0
  11          .200      0.0     1.1E-5    1.0E5      1.0       0.35
TIMES
   7    7     1.E10 3.15576E8
  8.640e4   4.320e5   1.728e6   4.320e6   1.037e7   3.154e7   9.451e7
OPTN
   0    1    0    1    1    0
ELEME
A    1          matr30.1500E+13
A    2          matr10.1500E-03
A    3          matr10.1500E-03

A   87          matr10.7500E-03
A   88          matr10.7500E-03
A   89          matr10.7500E-03
A   90          matr10.7500E-03
B    1          matr30.1500E+13
B    2          matr10.1500E-03
B    3          matr10.1500E-03

AB  88          matr10.7500E-03
AB  89          matr10.7500E-03
AB  90          matr10.7500E-03
AC   1          matr20.1500E-03
AC   2          matr20.1500E-03
AC   3          matr20.1500E-03
AC   4          matr20.1500E-03
AC   5          matr20.1500E-03

AC  80          matr20.1500E-03
AC  81          matr20.1500E-03

AC  82          matr10.1500E-03
AC  83          matr10.2000E-03
AC  84          matr10.2500E-03
AC  85          matr10.4000E-03
AC  86          matr10.6000E-03
AC  87          matr10.7500E-03
AC  88          matr10.7500E-03
AC  89          matr10.7500E-03
AC  90          matr10.7500E-03
AD   1          matr20.1500E-03

AI  88AI  89                   10.1500E+000.1500E+000.1000E-010.1000E+01
AI  89AI  90                   10.1500E+000.1500E+000.1000E-010.1000E+01

GENER
A   56HOT  1                   HEAT      1.25
A   57HOT  2                   HEAT      1.25
K   56HOT  3                   HEAT      1.25
K   57HOT  4                   HEAT      1.25
L   56HOT  5                   HEAT      1.25
L   57HOT  6                   HEAT      1.25
U   56HOT  7                   HEAT      1.25
U   57HOT  8                   HEAT      1.25
V   56HOT  9                   HEAT      1.25
V   57HOT10                    HEAT      1.25
```

RJ 8/13/94

submitted on pemrac → Fbiga.out

8/15/94 RJ — fbigi.out is hung up part way through 50 days. Will remove dead space AD-AI / 1-80 also remove AC 1-80 put this into Fmidi

also set K_T to 0.200 from 0.001 in matr2 only AC-AT row 81 is matr2

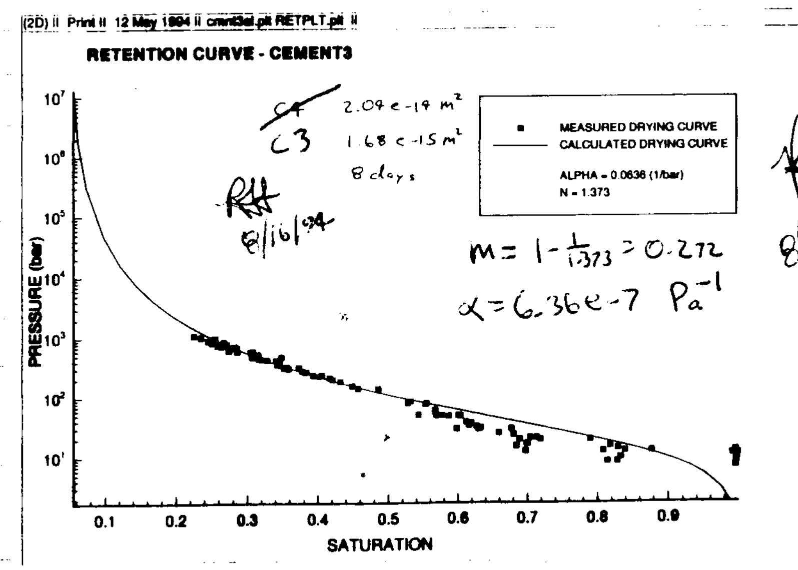
submitted into Fmida.out

8/16/94 RJ — Fmida.out is stalled in 50 day time step.

removed rest of matr2 (AC 81 – AI 81) and resubmitted, new input file is Fmid2i and output is Fmid2a.out, ran on pemrac

Fmid2i is on sisyphus & pemrac

Reded cyl-ai from /home2/sisyphus/rgress/cyl



These data are from aqualab for C3

RJ 8/16/94

cylinder test simulation w/ 12 in of heat.

```
cyl,8/15/93,GEN=12W,16 heat elements,ksat=7e-15,c4 values
ROCKS
matr1    22580.      .10              7.0E-15   7.0E-15   7.0E-152.3            840.
      0.0        0.0       1.74        0.5
   7            .272       0.0         1.0
  11            .272       0.0      6.36E-7     1.0E5       1.0       0.1
matr2    22580.      .10              7.0E-15   7.0E-15   7.0E-152.3            840.
      0.0        0.0       1.74        0.5
   7            .272       0.0         1.0
  11            .272       0.0      6.36E-7     1.0E5       1.0       0.1
matr3    22580.      .10              7.0E-15   7.0E-15   7.0E-152.3            840.
      0.0        0.0       1.74        0.5
   7            .272       0.0         1.0
  11            .272       0.0      6.36E-7     1.0E5       1.0       0.1
matr4    22500.      .0001            4.0E-90
      0.0        0.0       1.0         0.0                       2.3            1e+10
   7            .272       0.0         1.0
  11            .272       0.0      6.36E-7     1.0E5       1.0       0.1

PARAM
  2 990      5500000000000000 41            2.13e-5      1.8
      0.0  1.000E+8        -1.          B  10        +9.80665
     1.E0
    1.E-5        1.0                                  1.E-8
                1.E5                     .20 20.
START
RPCAP
    7           .200       0.0         1.0
   11           .200       0.0      1.1E-5      1.0E5       1.0       0.35
TIMES
    7    7     1.E08 6.30720E7
  8.640e4   4.320e5   1.728e6   4.320e6   1.037e7   1.555e7   3.154e7
OPTN
    0    1    0    1    1    0
DTSTP
      8e5         .25        20.        .25
ELEME
A    1          matr10.3927E-08
A    2          matr20.3927E-08
A    3          matr20.3927E-08

DD 21           matr40.2317E+06
DD 22           matr40.2317E+06
DD 23           matr40.2317E+06
DD 24           matr40.2317E+06

GENER
A  10HOT 1                          HEAT   3.75e-3
A  11HOT 2                          HEAT   3.75e-3
A  12HOT 3                          HEAT   3.75e-3
A  13HOT 4                          HEAT   3.75e-3
A  14HOT 5                          HEAT   3.75e-3
A  15HOT 6                          HEAT   3.75e-3
A  16HOT 7                          HEAT   3.75e-3
A  17HOT 8                          HEAT   3.75e-3
B  10HOT 9                          HEAT 1.125e-2
B  11HOT10                          HEAT 1.125e-2
B  12HOT11                          HEAT 1.125e-2
B  13HOT12                          HEAT 1.125e-2
B  14HOT13                          HEAT 1.125e-2

B  15HOT14                          HEAT 1.125e-2
B  16HOT15                          HEAT 1.125e-2
B  17HOT16                          HEAT 1.125e-2

INCON
A    1              0.100000E+00
      0.100000E+06           0.200000E+00           0.250000E+02
B    1              0.100000E+00
      0.100000E+06           0.200000E+00           0.250000E+02
```

RA 8/16/94

This file has values from C3 cement

9/6/94 Will use results of 1-D Yucca Mt model by P. Lichtner to get ΔP for repository case. Copied from Peter into /home2/rccy/rgrees/z114press/z114i on rccy

RA 9/6/94

1-D model of Yucca Mt

```
rz114, icp=9, 7/3/94,h=114 ,Yucca Mt
:
:
ROCKS
:
: mat nad   drock    por  permx   permy   permz     cwet   spht
TUFF  2  2.580E+03  0.10162  1.8E-14 1.8E-14 1.8E-14   2.3    840.0
:
: comp      expan     cdry        tortx
  0.0       0.0       1.74         0.5
: irp  rp(1)   rp(2)       rp(3)  rp(4)   rp(5)   rp(6)   rp(7)
  9    1.9E-18 5.8E-7     1.798  0.1      0.001   0.0     0.0
: icp  cp(1)   cp(2)       cp(3)  cp(4)   cp(5)   cp(6)   cp(7)
  9    1.0E-11 1.315E-4   4.23   1.8E-3  0.001   0.0     0.0
:
: mat  nad  drock    por  permx   permy   permz   cwet    spht
BOUND  2  2.580E+03  0.10162  1.8E-14 1.8E-14 1.8E-14  2.3    1.0E+9
:
: comp        expan       cdry        tortx
  0.0         0.0         1.740        0.0
: irp  rp(1)   rp(2)       rp(3)       rp(4)     rp(5)   rp(6)  rp(7)
  9    1.9E-18 5.8E-7     1.798       0.1       0.001   0.0    0.0
: icp  cp(1)   cp(2)       cp(3)       cp(4)     cp(5)   cp(6)  cp(7)
  9    1.E-11  1.315E-4   4.23        1.8E-3    0.001   0.0    0.0
                                               :reqd blank line
:
PARAM
:noit kdt cyc sec cypr  diffo   texp      (mop(i),i   =1,17)
:                                   1 2 3 4 5 6 7 8 9 1011121314151617
 8    2   999 0  1000   2.130E-5 1.8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 1
:   tstart timax      deltn  deltmx  elst      gf        redlt scale
 0.0      3.156E+12  -1.     0.0     A  1  9.807        0.0 0.0
:      dlt(i)..
 1.E+3 9.E+3 2.E+4 1.E+5 1.E+6 1.E+7 1.E+8 1.E+10
:
:  rel     re2    u        wup     wnr    dfac
 1.E-5    1.0    0.0      0.0     0.0    1.E-8
:
:      dep(1)  dep(2)   dep(3)
       1.E+5    0.2      25.
:
START
:
RPCAP
: irp   rp(1)   rp(2)      rp(3)   rp(4)     rp(5)    rp(6)   rp(7)
  9    1.E-15   5.8E-7     1.798   0.1       0.001    0.0     0.0
: icp   cp(1)   cp(2)      cp(3)   cp(4)     cp(5)    cp(6)   cp(7)
  9    1.E-11   1.315E-4   4.23    1.8E-3    0.001    0.0     0.0
:
TIMES
:
:  iti   ite   delaf tinter
   12    12  1.E+11  0.0
:
:  tis(1)     tis(2)    tis(3) ......
3.156E+8 1.578E+9 3.156E+9 1.578E+10 3.156E+10 6.312e10 9.468e10 12.624e10
1.578E+11 3.156E+11 1.578E+12 3.156E+12
:
OPTN
:
```

```
: ilimsl idsolc knudsn ipctem ivplow ilopt
     0      1      0      1      1     0
DTSTP
:
:   dpgmx   dsgmax dtmax  dxmax
:
 1.000E+4   0.05   10.0   0.05
:
EVAP
A 10
A 12
A 14
A 16
A 18
A 20
                    :added blank line
:
ELEME
: el ne   nsq  nad ma1 ma2    volx
:
A    1  0  0  BOUND  7.8540E+07
A    2  0  0  TUFF   7.8540E+01
A    3  0  0  TUFF   7.8540E+01
```

RH 9/6/94

pressure files in P1.xyp P12.xyp

	times	file	min P	max P	ΔP
10 yr	3.156 e8	P1.xyp	9.9755e4	1.2059e5	0.2084e5
50 yr	1.578 e9	P2.	"	1.4169e5	0.4194e5
100 yr	3.156 e9	P3.	"	1.3859e5	0.3884e5
500 yr	1.578 e10	P4.	9.9756e4	1.2221e5	0.2275e5
1000 yr	3.156 e10	P5.	"	1.0852e5	0.0876e5
	6.312 e10	P6.	9.9759e4	no ΔP, only gradient to depth	
	9.468 e10	P7.			
	12.624 e10	P8.			
	1.578 e11	P9.			
	3.156 e11	P10			
	1.578 e12	P11.			
	3.156 e12	P12.			

max occurred at 2.2810e2 & 2.2785e2 m above base in P1, moved up to 2.4350e2 in P2, 2.555e2 in P3, 2.9100e2 in P4, 3.0250e2 in P5

9/7/94 RH Reran Z114i w/ additional times from 1-100 yrs. put into /home2/rory/rgreen/114press/zearly.

yrs	times	file	min P	max P	ΔP
1	3.156e7	p1.xyp	9.9755e4	—	—
5	1.578e8	p2.	"	—	
10	3.156e8	p3.	"	1.2055e5	
20	6.312e8	p4.	"	1.3335e5	
30	9.461e8	p5.	"	1.3924e5	
40	1.261e9	p6.	"	1.4112e5	
50	1.578e9	p7.	"	1.4168e5	
60	1.8922e9	p8.	"	1.4189e5	
70	2.207e9	p9.	"	1.4146e5	
80	2.523e9	p10.	"	1.4230e5	
90	2.838e9	p11.	"	1.3959e5	

Z114i has about 238 vertical elements, that decrease to 0.05 m at the repository horizon

9/29/94 RH Excel spread sheets with densitometer data and VTOUGH data together are located in /ipx4/berkeful/rgreen/lab.cyl/pressd.wkx and */pressla.wkx

Put K_{sat} & van Genuchten parameters for Nopal are in /home/sneezy/rgreen/analog/nopal/rock-k.dat

Canvas for α vs ln K_{sat} xplot in .../nopal/np-k.cnv

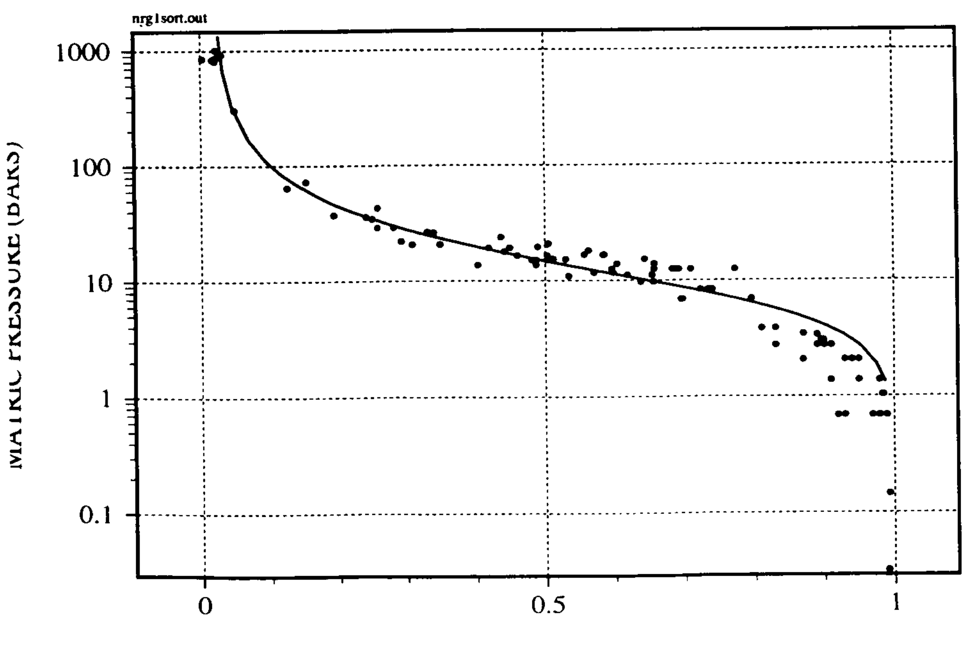
10/17/94 RA Cleaned up nrg– files from Kristi's report.
Created file space /home/saccey/rgreen/pa/ RA 10/26/94 meyer-final/*

nrg1sort.out measured retention data
retplt1.out fit retention line
retc1.out statistics for fit

included encapsulated postscript files as
*/ Fig 3-2 thru fig 3-8.eps

Fig 3-8.eps = np-k-n.ps RA 10/17/94 enu
fig 3-7.eps = compilation of 5 retention curves

Kristi has Figures 3-1 & 3-9



RA 10/17/94

replotted Fig 4-2 to Fig 4-8

→ Fig 4-*.eps
Fig 4-*.eps
in outer
~/pa/meyer-final/* for 4-2 to 4-7
or ~/analog/map../ Fig 4-8.eps
RA 12/16/94

Fig 4-2.eps

10/26/94 wrote into meyer-final to get RA /pa/ wcr

NRG1 - 0.02 NRG2 - 0.00 NRG3 - 0.02 NRG4 - 0.02 NRG5 - 0.04

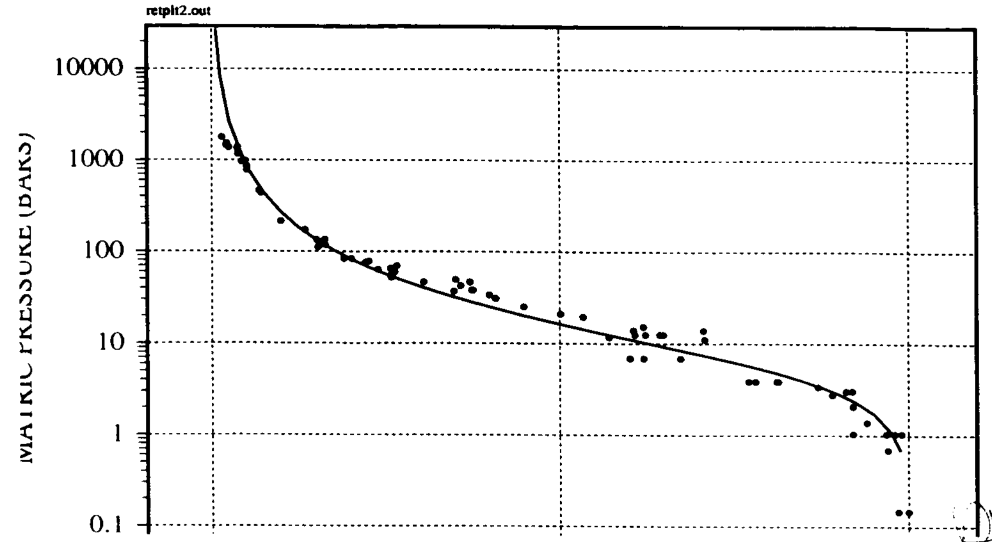


Fig 4-3.eps

RA 10/17/94

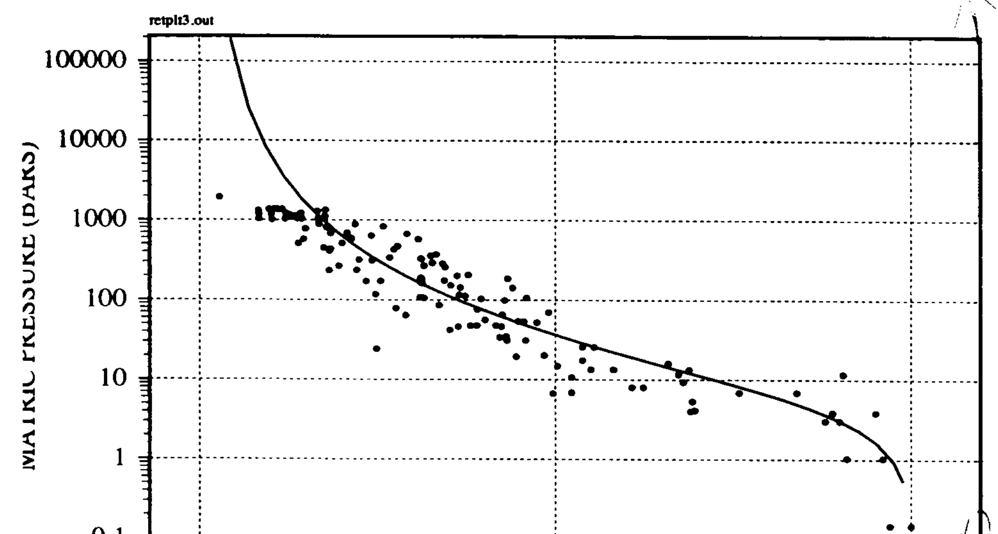


Fig 4-4.eps

RA 10/17/94

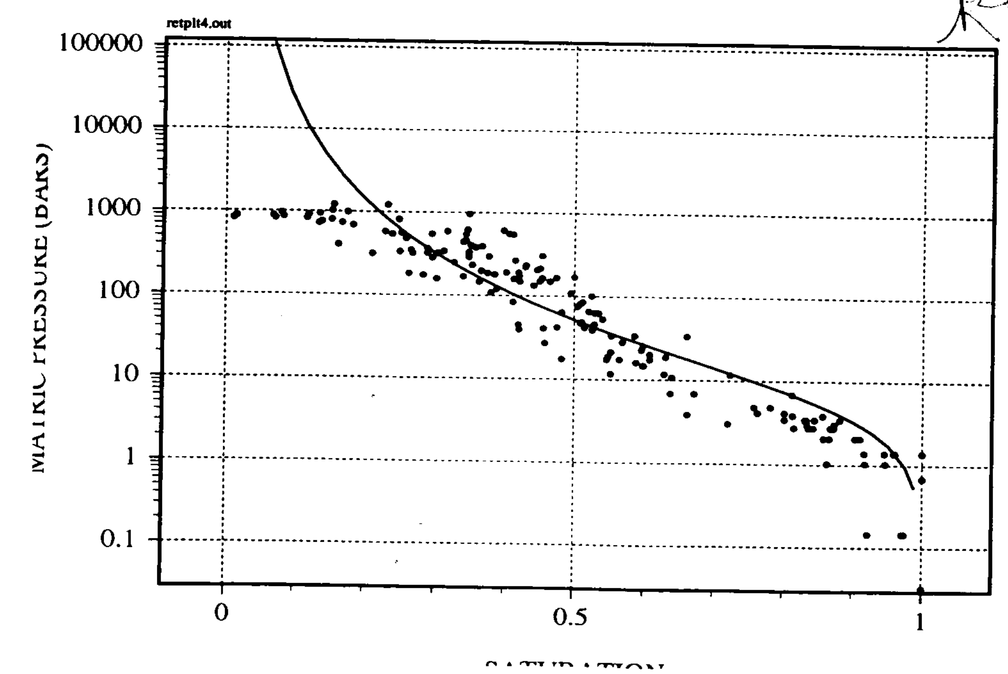
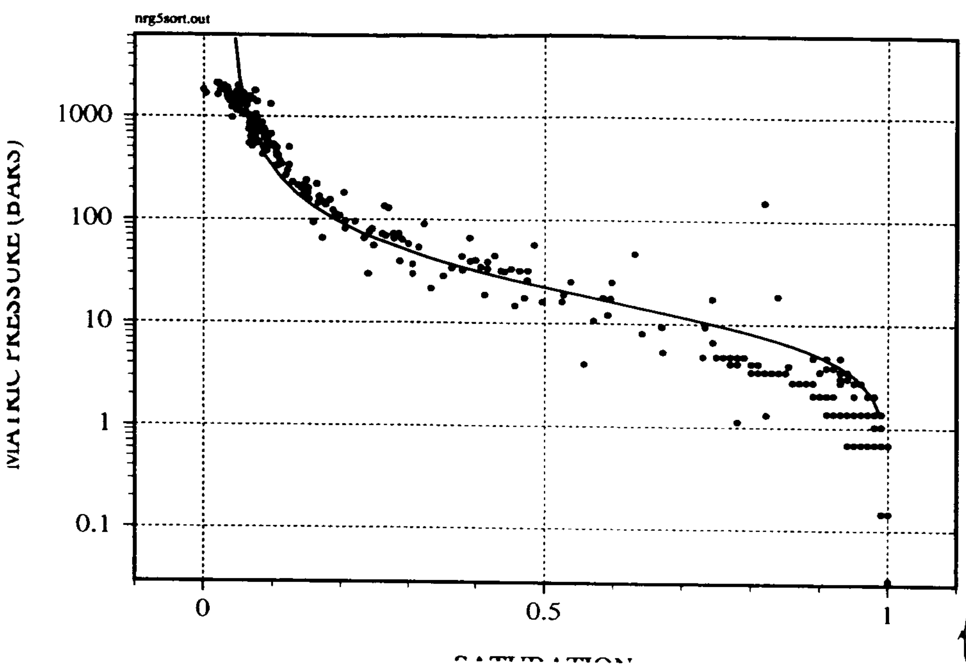


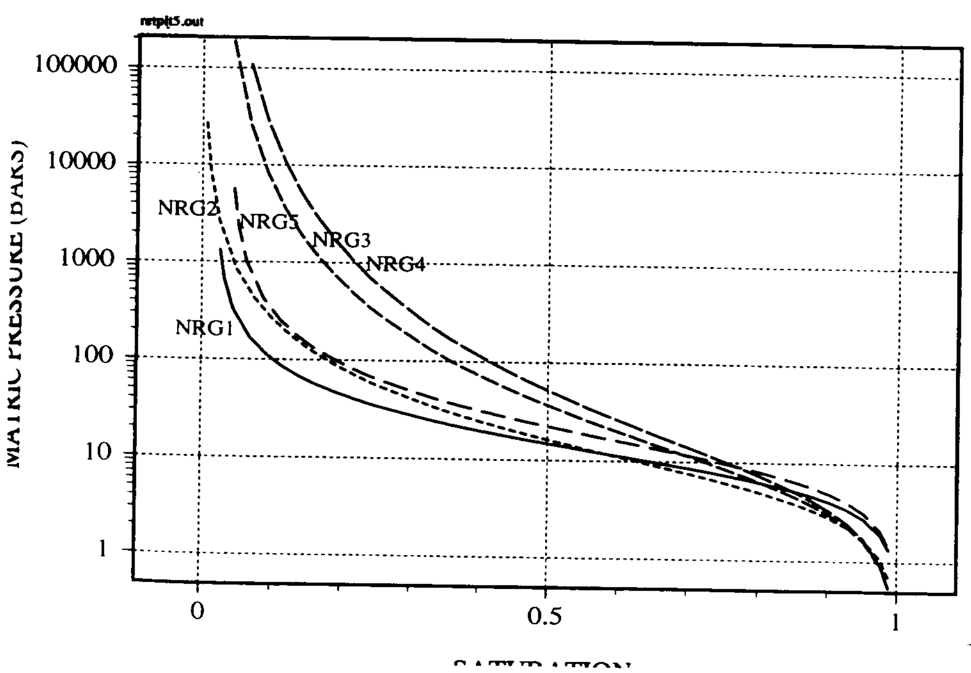
Fig 4-5.eps

Fig 4-6.eps



RAF 10/17/94

Fig 4-7.eps

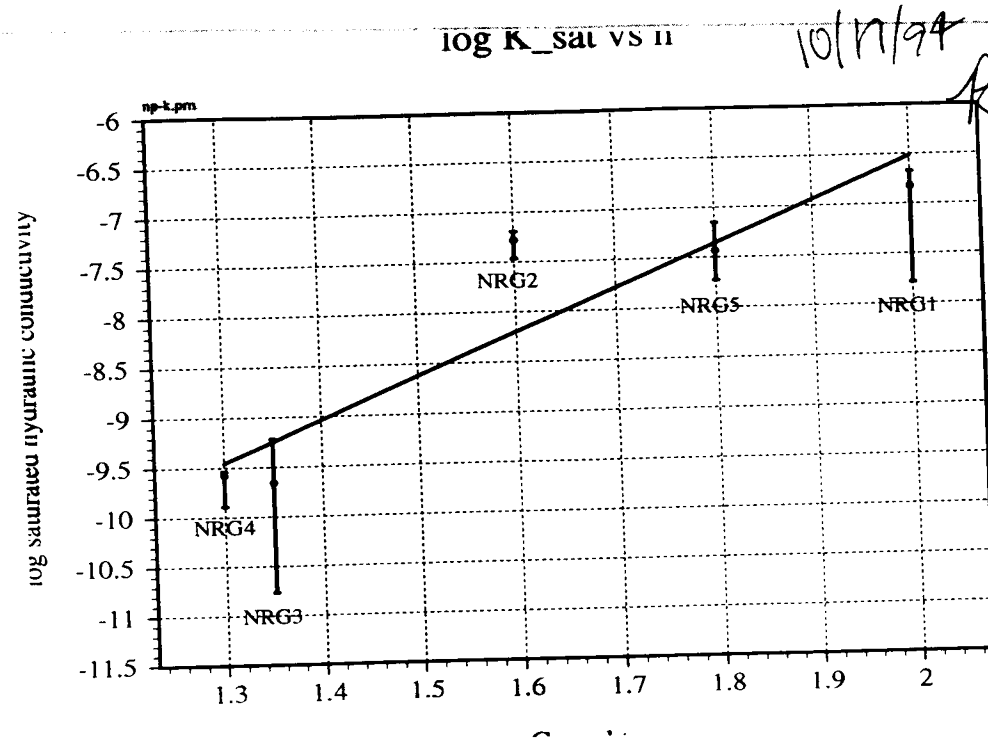


RAF 10/17/94

/home/sneezy/rgreen/analog/nopal/np-k-n.cnv

Fig 4-8.eps

10/17/94 RAF



10/25/94 RAF Need to redo & expand VTOUGH runs of percolation at Peña Blanca. Found old files w/ correct composite model in /usr2/sneezy/rgreen/rory-files/pena in pcompi

Moved back to /rory/ /home2/rory/rgreen/pena-nu

on next page is original pcompi from June 30, 1994

Need to run pcompi w/ values of K_{sat}, α, n for all 5 NRG samples.

```
pcompi,6/30/94,40x40,e-13,bulk perm&por,cnsth A-E,1,A-AN,40,nrg5,frac e-11
ROCKS
matr1    22580.      .10162    1.1782E-131.1782E-131.1782E-132.3           840.
     0.0         0.0        1.74       0.5
   9         1.0e-13 8.5004e-7     1.764      0.11       0.02
   9         1.0e-11 1.3147e-4      4.23    1.8e-3      1.e-3
matr2    22580.      .01             1.0E-94   1.0E-94   1.0E-942.3          840.
     0.0         0.0        1.70       0.5
   7           0.433       0.02       0.97
  11           0.433       0.02     8.5e-7       0.0       0.97       0.1
matr3    2   1.      .99             1.0E-02   1.0E-02   1.0E-020.1           10.
     0.0         0.0        1.70       0.5
   7           0.433       0.02       0.97
  11           0.433       0.02     2.e-0        0.0       0.97       0.1

PARAM++++1++++|++++2++++|++++3++++|++++4++++|++++5++++|++++6++++|++++7
   19900     5000000000000000000 41            2.13e-5       1.8
     0.0  8.640E06        1e-1            B  15      +9.80665
    1.E-5         1.                                    1.E-8
                 1.E5                     35. 00.
START
RPCAP
    9         1.0e-13 5.8004e-7      1.798      0.11      1.e-3
    9         1.0e-11 1.3147e-4       4.23    1.8e-3      1.e-3
TIMES
    8    8      1.E12
 4.3200E04 8.6400E04 1.7280E05 4.3200E05 8.6400E05 1.7280E06 4.3200E06 8.6400E06
OPTN
    0    1    0    1    1    0
DTSTP
     8.e5        0.1
ELEME
A   1           matr10.4500E+12
```

RH 10/25/94

Saturated Hydraulic Conductivity (cm/s)					
Sample	NRG1	NRG2	NRG3	NRG4	NRG5
Mean	9.49E−8	4.09E−8	1.09E−10	2.17E−10	1.95E−8
Coefficient Variation	0.556	0.191	0.995	0.312	0.509
Minimum	1.15E−8	2.78−8	6.22E−12	1.17E−10	9.67E−9
Median	1.06E−7	4.23E−8	7.97E−11	2.42E−10	1.91E−8
Maximum	1.5E−7	5.19E−8	2.20E−10	2.65E−8	3.67E−8

RH 10/25/94

Sample	NRG1	NRG2	NRG3	NRG4	NRG5
α (m^{-1})	0.12	0.175	0.20	0.20	0.10
n	2.00	1.60	1.35	1.30	1.80

Will use median values for K_{sat} (cm/s): converted to permeability (m^2), multiply by 10^{-9}

	k (m^2)	ϕ_b (10/25/94 RH)	K_b
NRG1	1.06 e−16	~~2.6~~ 2.91e-1	
NRG2	4.23 e−17	2.51e-1	
NRG3	7.97 e−20	6.17e-2	
NRG4	2.42 e−19	1.22e-1	
NRG5	1.91 e−17	2.01e-1	

Composite porosity is $\phi_b = \phi_F + (1 - \phi_F)\phi_m$ (or bulk). Will use gas pycnometer values (median)
Use 1.8 e-3 for ϕ_F (from Klavetter & Peters 198?, Nature 1988)

For composite permeability use $k_{rl}^{b} = \dfrac{K_F k_{rl}^{F} \phi_F + K_m k_{rl}^{m}(1-\phi_F)}{K_b}$

where $K_b = K_F \phi_F + K_m (1 - \phi_F)$

use $k^F = 1e{-11}\,m^2 \Rightarrow K^F =$ ~~1e-2 cm/s = 1e-7 m/s~~ $= 1e{-4}$ m/s (RH 10/25/94)

RH 10/25/94

Porosity (Gravimetric)					
Sample	NRG1	NRG2	NRG3	NRG4	NRG5
Mean	0.255	0.210	0.083	0.078	0.183
Coefficient Variation	0.029	0.061	0.229	0.149	0.060
Minimum	0.235	0.169	0.036	0.053	0.154
Median	0.256	0.213	0.089	0.074	0.188
Maximum	0.270	0.226	0.126	0.113	0.021

Table 3-6. Pycnometric porosity of NRG1, NRG2, NRG3, NRG4, and NRG5 Nopal tuff subsamples

Porosity (Gas Pycnometric)					
Sample	NRG1	NRG2	NRG3	NRG4	NRG5
Mean	0.295	0.264	0.083	0.128	0.211
Coefficient Variation	0.041	0.124	0.706	0.551	0.115
Minimum	0.28	0.23	0.02	0.04	0.18
Median ✗	0.29	0.25	0.06	0.12	0.20
Maximum	0.32	0.34	0.18	0.31	0.26

11/2/94

Bulk properties for Nopal are needed in percolation calculations. Fracture properties are determined as follows.

Use fracture density from Pearcy (1994) of 2 m/m² and 3 estimated average fracture aperture of 1, 10, 100, 1000 microns

$\phi_F = 2 \frac{m}{m^2} (1 \times 10^{-6} m) = 2 \times 10^{-6}$ — 1 micron
$= 2 \times 10^{-5}$ — 10 microns
$= 2 \times 10^{-4}$ — 100 microns
$= 2 \times 10^{-3}$ — 1000 microns

Use cubic law for k, where $k = \frac{N b^3}{12}$ where N = 2 m/m², b = 1, 10, 100 microns.

1 micron $k = 2\frac{m}{m^2}(1 \times 10^{-6} m)^3 \frac{1}{12} = 1.67 \times 10^{-19} m^2$
10 microns $k = 2\frac{m}{m^2}(1 \times 10^{-5})^3 \frac{1}{12} = 1.67 \times 10^{-16} m^2$
100 microns $k = 2\frac{m}{m^2}(1 \times 10^{-4})^3 \frac{1}{12} = 1.67 \times 10^{-13} m^2$
1000 microns $k = 2\frac{m}{m^2}(1 \times 10^{-3})^3 \frac{1}{12} = 1.67 \times 10^{-10} m^2$

For bulk properties use $K_b = K_F \phi_F + K_m (1 - \phi_F)$

K_m is taken from each rock measurement

K_F for the 1, 10, 100, 1000 micron cases are: (using a rough conversion of 10^{-7} to go from m² → m/s)

1 micron $K_F = 1.67 \times 10^{-12}$ m/s $K_F \phi_F = 3.33 \times 10^{-18}$ m/s
10 micron $K_F = 1.67 \times 10^{-9}$ m/s $K_F \phi_F = 3.33 \times 10^{-14}$ m/s
100 micron $K_F = 1.67 \times 10^{-6}$ m/s $K_F \phi_F = 3.33 \times 10^{-10}$ m/s
1000 micron $K_F = 1.67 \times 10^{-3}$ m/s $K_F \phi_F = 3.33 \times 10^{-6}$ m/s

Better to use:
K_F for cubic law (Snow 1968; Schwartz + Domenico, 1990)

$$K = \frac{\rho_w g N b^3}{12 \mu}$$

where $\rho_w = 1$ g/cm³ ; g = 9.80 m/s² = 980 cm/s ;
$\mu = 1 \times 10^{-2}$ g/s-cm

$$\frac{\rho_w g}{12 \mu} = \frac{1 \frac{g}{cm^3} \, 980 \frac{cm}{s^2}}{12 (1e{-2} \frac{g}{s \cdot cm})} = 8.17 \times 10^{+3} \frac{1}{cm \cdot s}$$

$$K = \left(8.17 \times 10^{+3} \frac{1}{cm \cdot s}\right) b^3 (cm^3) \; \frac{2 m}{m^2} \left(\frac{m}{100 cm}\right)\left(\frac{m}{10^{-2}}\right)$$

1 micron $K_F = 8.17 \times 10^{-13}$ m/s $K_F \phi_F = 1.63 \times 10^{-18}$ m/s
10 micron $K_F = 8.17 \times 10^{-10}$ m/s $K_F \phi_F = 1.63 \times 10^{-14}$ m/s
100 micron $K_F = 8.17 \times 10^{-7}$ m/s $K_F \phi_F = 1.63 \times 10^{-10}$ m/s
1000 micron $K_F = 8.17 \times 10^{-4}$ m/s $K_F \phi_F = 1.63 \times 10^{-6}$ m/s

Pages 1 through 125 of this Scientific Notebook were reviewed for compliance with QAP-001 in response to Corrective Action Request 94-02. Corrections and clarifications were made as appropriate. In some cases, the date of a change will reflect the date of this review rather than the date of the original Scientific Notebook entry.

Randy Folck
SwRI-QA
12/7/94

Objective of the Akrotiri analyses is to determine the van Genuchten parameters for samples collected at Akrotiri - RETC will be used in all analyses. RH 3/5/97

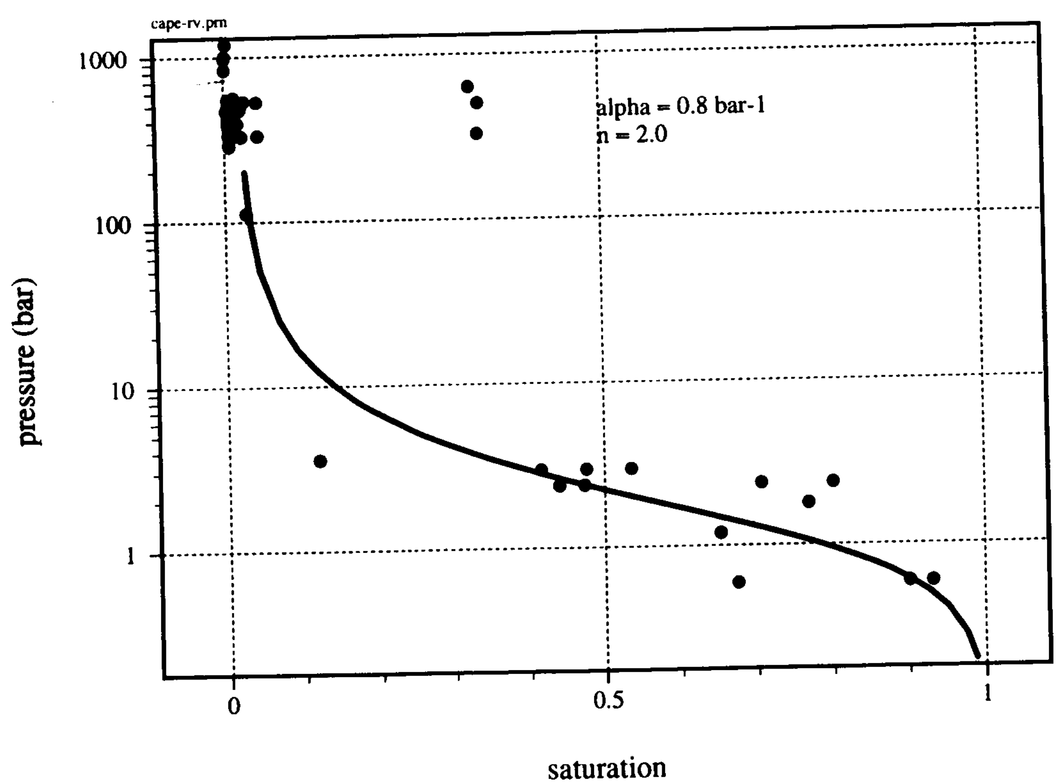
12/16/94 RH Data from Aqua Lab for Cape Riva are plotted & fitted w/ RETC. Data are in

/home/sneezy/rgreen/retc/cape-rv.prn

These data are preliminary & used only to get estimate for retention curve

RH 12/16/94

CAPE RIVA RETENTION CURVE



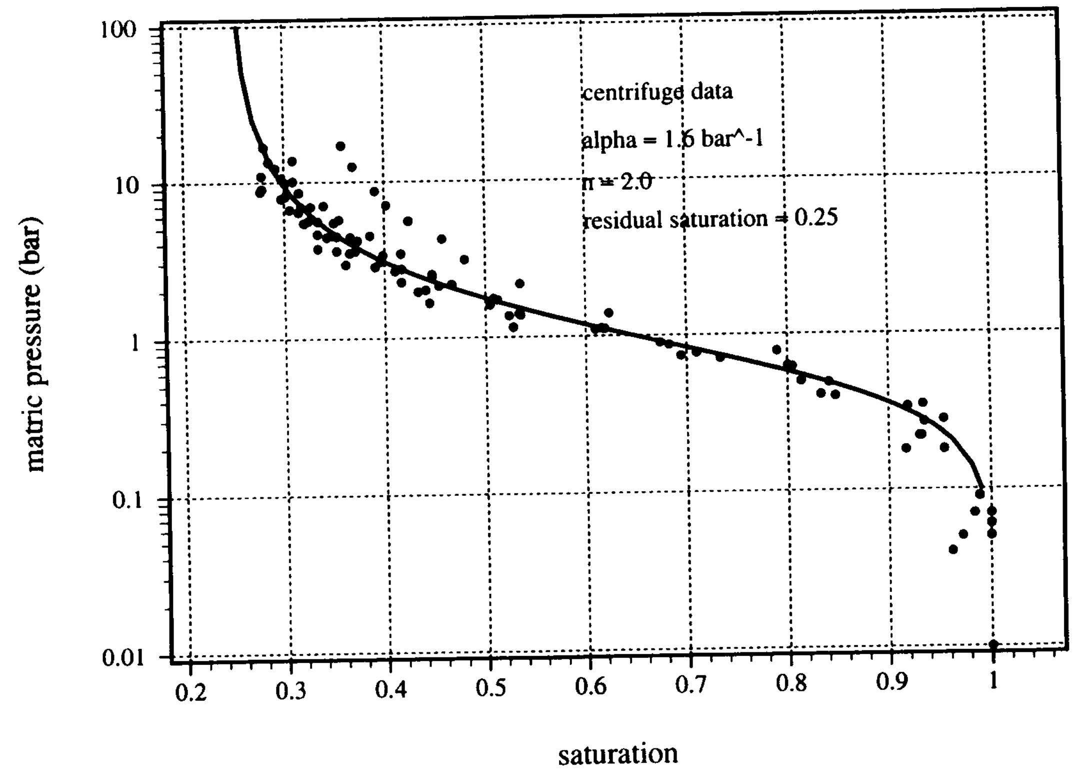
Retention curve by forward solution, data by aqualab only at this pt.

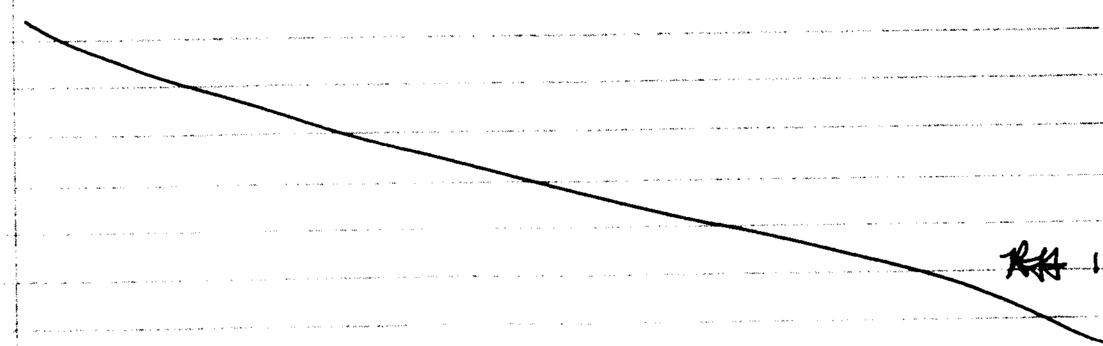
Minoan measurements from centrifuge
/home/sneezy/rgreen/analog/thira/mincan.dat
& minoan.prn (cleaned up file) & mincan.crv

Forward solution

RH 12/16/94

Minoan Retention Curve





RH 12/16/94

12/28/94 RKH

Analysis of test 12 (Final report test 2)

Want to do 1-D analysis, similar to that done in March & April 1993, original files are in /home/sneezy/rgreen/one-d

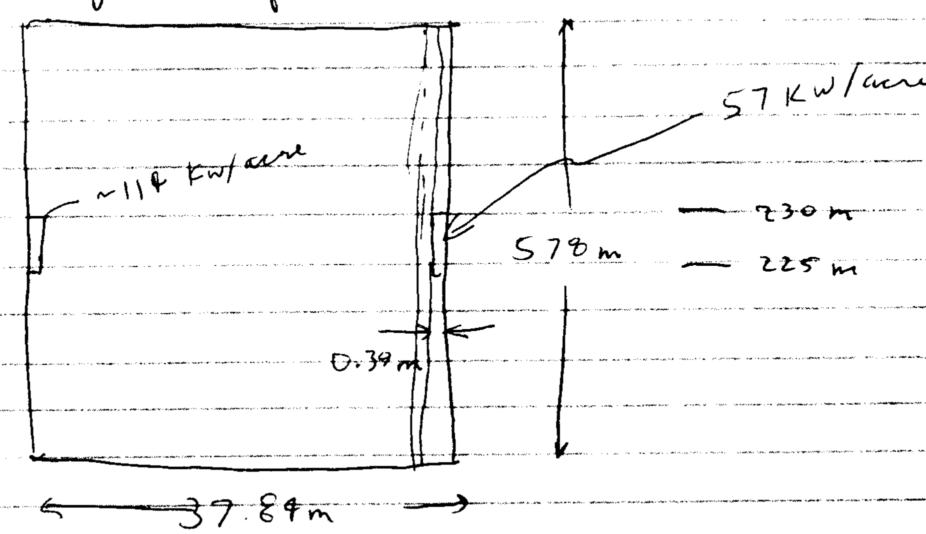
varied K_T & k in 1-D model

Test 12 media was alumina

12/28/94

The objective of these analyses is to determine the temperature and redistribution of moisture near a drift. All initial runs made with CTOUGH. This phase of testing completed & ended on pg 149 - RKH 3/5/97

10/18/95 RKH Started runs w/ CTOUGH. Base model is a 2 canister (centers) from ground surface to the watertable. Started w/ a file compiled by G. Rice on pg 103 of Notebook 150.



There is a fracture running down the side of the right, cooler canister. Grid is 30 elements tall and 15 wide. Decreased fracture from 10 cm as in 2heat-F-30x15-99-01.i to 1 cm as in 2h-01Frac10-24.i. The new runs are in
/home/sneezy/rgreen/noniso/

Input file is contained on following pages

→2h-01frac10-24.i

heater elements at: A 15; A 16; A 17; A 18; A 19
O 15; O 16; O 17; O 18; O 19

2h-01fract10-24i

RA 10-25-95

10/25/95 RA

```
GWTT, 10/18/95, Fracture Zone, Two Heaters, Equivalent Continuum (9,9)
: Using values (for equiv contin) from NITAO, 1988
: Added source of water above right fracture (col n), made n  1 huge
: 57 kW/Ac, Grid=30X15, 37.84m Wide, Top Row NOT Huge, Bottom Row Remains Huge.
: Permeability of Rock-Matrix Matrix = 1.9E-17m^2, Bulk Permeability of
: Rock Matrix=
:
ROCKS----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
: Rock Matrix
:
: mat  nad   drock      por      permx      permy      permz      cwet       spht
matr1  2  2.480E+03 1.100E-01 1.800E-14 1.800E-14 1.800E-14 2.340E-00 8.400E+02
:
:   comp        expan        cdry        tortx
  0.0000E+00  0.0000E-00  1.9000E-00  5.0000E-01
: irp   rp(1)       rp(2)       rp(3)       rp(4)       rp(5)       rp(6)       rp(7)
  9 1.9000E-17 5.7880E-07 1.7980E+00 1.1000E-01 0.0000E+00 0.0000E+00 0.0000E+00
: icp   cp(1)       cp(2)       cp(3)       cp(4)       cp(5)       cp(6)       cp(7)
  9 1.0000E-11 1.3120E-04 4.2300E-00 1.8000E-03 1.0000E+00 0.0000E-02 0.0000E+00
:
: Fracture Zone
:
: mat  nad   drock      por      permx      permy      permz      cwet       spht
matr2  2  2.480E+03 1.000E-01 1.000E-10 1.000E-10 1.000E-10 2.340E-00 8.400E+02
:
:   comp        expan        cdry        tortx
  0.0000E+00  0.0000E-00  1.9000E-00  5.0000E-01
: irp   rp(1)       rp(2)       rp(3)       rp(4)       rp(5)       rp(6)       rp(7)
  7 5.0000E-01 0.0000E-09 1.0000E+00 0.0000E-01 0.0000E+00 0.0000E+00 0.0000E+00
: icp   cp(1)       cp(2)       cp(3)       cp(4)       cp(5)       cp(6)       cp(7)
 11 5.0000E-01 0.0000E-09 1.0210E-04 1.0000E-00 1.0000E+00 2.0000E-02 0.0000E+00
:
: Heater
:
: mat  nad   drock      por      permx      permy      permz      cwet       spht
matr3  2  2.480E+03 1.000E-06 3.330E-99 3.330E-99 3.330E-99 2.340E-00 8.400E+02
:
:   comp        expan        cdry        tortx
  0.0000E+00  0.0000E-00  1.9000E-00  5.0000E-01
: irp   rp(1)       rp(2)       rp(3)       rp(4)       rp(5)       rp(6)       rp(7)
  7 8.0000E-01 0.0000E-09 1.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
: icp   cp(1)       cp(2)       cp(3)       cp(4)       cp(5)       cp(6)       cp(7)
 11 8.0000E-01 0.0000E-09 1.0210E-04 1.0000E+00 1.0000E+00 2.0000E-02 0.0000E+00
:
                                          :reqd blank line
:
PARAM----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:noit kdt cyc sec  cypr  diffo      texp       (mop(i),i   =1,17)
:                                              1 2 3 4 5 6 7 8 9 1011121314151617
  0  2  99999   0  550  2.1300E-05 1.8000E+00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 1
:   tstart       timax      deltn       deltmx      elst       gf        redlt      scale
 0.000E+00  1.000E+05 -1.000E+00  0.000E+00  A 35  1.000E+01 0.000E+00 0.000E+00
:      dlt(i)..
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
:
:   re1       re2        u         wup        wnr       dfac
 1.000E-05 1.000E+00 0.000E+00 0.000E+00 0.000E+00 1.000E-08
:
:        dep(1)               dep(2)                dep(3)

     1.00000000E+05       2.00000000E-01        2.00000000E+01
:
START----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
RPCAP----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
: irp   rp(1)       rp(2)       rp(3)       rp(4)       rp(5)       rp(6)       rp(7)
  7 2.0000E-01 0.0000E+00 1.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
: icp   cp(1)       cp(2)       cp(3)       cp(4)       cp(5)       cp(6)       cp(7)
 11 2.0000E-01 0.0000E+00 1.1000E-05 1.0000E+05 1.0000E+00 3.5000E-01 0.0000E+00
:
TIMES----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
:  iti  ite   delaf       tinter
   12   12  3.1700E+00  2.0000E+00
:
:  tis(1)     tis(2)     tis(3) .....
 1.000E-03 1.000E-01 1.000E-00 1.000E+01 2.000E+01 4.000E+01 6.000E+01 8.000E+01
 1.000E+02 5.000E+02 1.000E+03 1.000E+04
```

Time in years when VAR reported (handwritten numbering of tis values: 1 … 4, 5, 6, 7, 8, 9, 10, 11, 12)

RA


```
:
EVAP
 A   15
 A   17
 A   19
 B   17
 N   10
 N   14
 N   15
 N   17
 N   19
 N   20
 N   25
:
                                     :req blank line?
:
OPTN ----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
:  ilimsl idsolc  knudsn ipctem ivplow ilopt
     0      1      0      1      1      0
:
DTSTP----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
:   dpgmx      dsgmax     dtmax      dxmax
:
 8.000E+02 2.500E-01 2.000E+01 2.500E-01
:
:
ELEME
: el ne    nsq  nad ma1 ma2     volx
:
A    1  0  0  matr1  1.6282E+00
A    2  0  0  matr1  4.0704E+00
A    3  0  0  matr1  8.1409E+00
A    4  0  0  matr1  8.1409E+00
A    5  0  0  matr1  8.1409E+00
A    6  0  0  matr1  8.1409E+00
A    7  0  0  matr1  8.1409E+00

M   28  0  0  matr1  1.0208E+01
M   29  0  0  matr1  4.3384E+00
M   30  0  0  matr1  2.0416E+10

N    1  0  0  matr2  5.1039E+11
N    2  0  0  matr2  1.2760E+00
N    3  0  0  matr2  2.5520E+00

: el n1 e2   n2 nsq nd1 nd2 isot d1        d2          areax     betax
:
A     1 B     1 0 0 0  1  1.595E-01  2.500E-01  5.104E+00  0.000E+00 0
A     2 B     2 0 0 0  1  1.595E-01  2.500E-01  1.276E+01  0.000E+00 0
A     3 B     3 0 0 0  1  1.595E-01  2.500E-01  2.552E+01  0.000E+00 0

O    28 O    29 0 0 0  1  2.000E+01  8.500E+00  2.035E-01  1.000E+00 0
O    29 O    30 0 0 0  1  8.500E+00  4.000E+00  2.035E-01  1.000E+00 0
                    :reqd blank line
:
GENER----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
: el ne sl ns nsq nad nads ltb  itp   itb   gx         ex         hg
:
A  15 FLX  1    0    0    0  11 HEAT     b  0.0000E+00 0.00E+00 0.000E+00
   0.0000E+00 3.1536E+08 6.3072E+08 1.2614E+09
   1.8922E+09 3.1536E+09 6.3072E+09 1.8922E+10
   3.1536E+10 3.1536E+11 3.1536E+12
   4.53E+01 3.32E+01 2.73E+01 1.97E+01
   1.49E+01 9.84E+00 5.73E+00 3.07E+00
   2.00E+00 4.99E-01 2.52E-02
O  19 FLX  1    0    0    0  11 HEAT     b  0.0000E+00 0.00E+00 0.000E+00
   0.0000E+00 3.1536E+08 6.3072E+08 1.2614E+09
   1.8922E+09 3.1536E+09 6.3072E+09 1.8922E+10
   3.1536E+10 3.1536E+11 3.1536E+12
   2.27E+01 1.66E+01 1.36E+01 9.85E+00
   7.45E+00 4.92E+00 2.86E+00 1.54E+00
   1.00E+00 2.50E-01 1.26E-02
                                        :reqd blank line
:
:
INCON
:
: el ne   nsq nadd        porx
A     1  0  0     0.000000E+00
:
:          x1                  x2                  x3
       1.000000E+05        3.000000E-01        2.500000E+01
B     1  0  0     0.000000E+00
```

Sat, T etc are reported for these elements

A 16 has vol of 0.32219 m^3

RA 10-25-95

117 kW/acre

57 kW/acre

RA

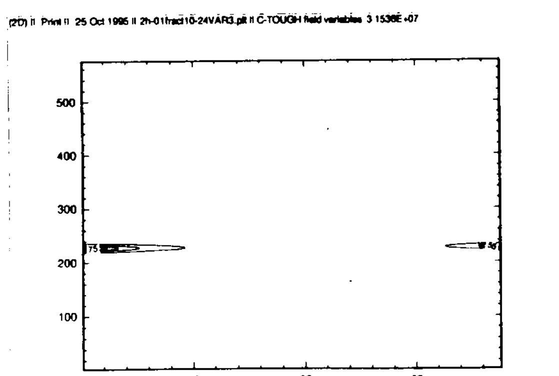
RJ 10/25/95

```
                1.000000E+05          3.000000E-01          2.500000E+01
N      1  0  0        0.000000E+00
                1.000000E+05          1.000000E-09          2.500000E+01
O      1  0  0        0.000000E+00
                1.000000E+05          3.000000E-01          2.500000E+01
A      2  0  0        0.000000E+00
                1.000000E+05          3.000000E-01          2.500000E+01

:reqd blank line
:
SOLVE
:precond accel  nz    nx    ibug
  BAND    NONE   30    15
:
ENDCY
```

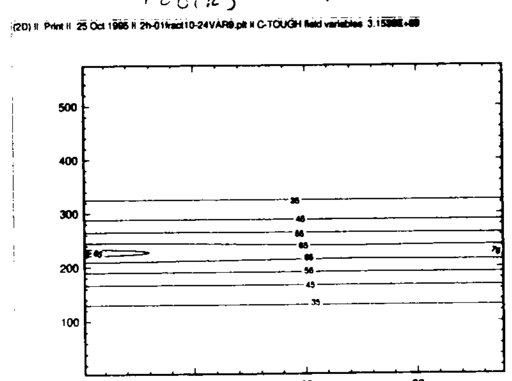
These are the temperature results for the 2 heater runs.

Note: Temps did not get high. RJ 10/25/95

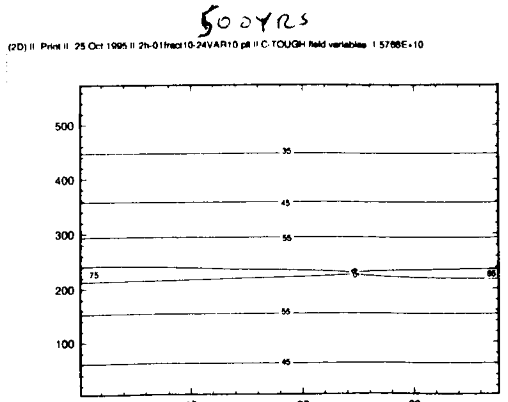
1 YR



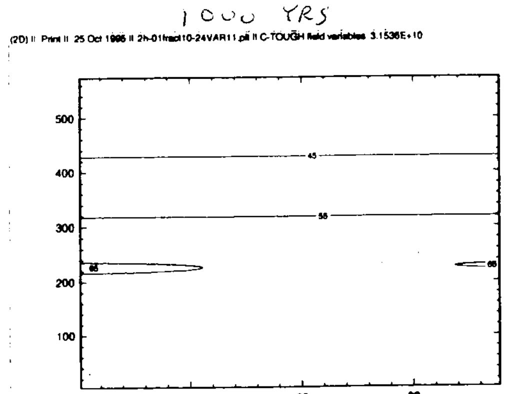
100YRS



500YRS



1000 YRS



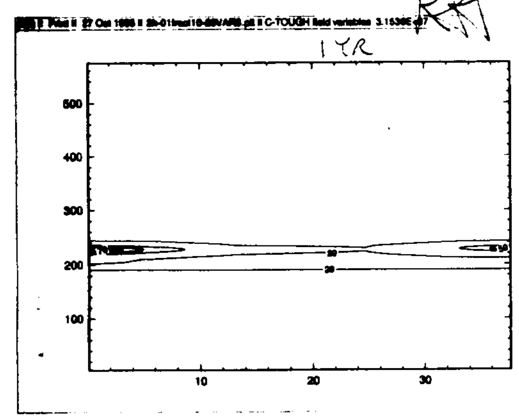
Need to incorporate a geothermal gradient into INCON the rerun. Also, temperature seem low.

10/26/95 RJ Put in a geothermal gradient of 0.025 K/m using strapn.f (~/noniso/.). New file is 2h-01Fract10-26i. All else is the same.

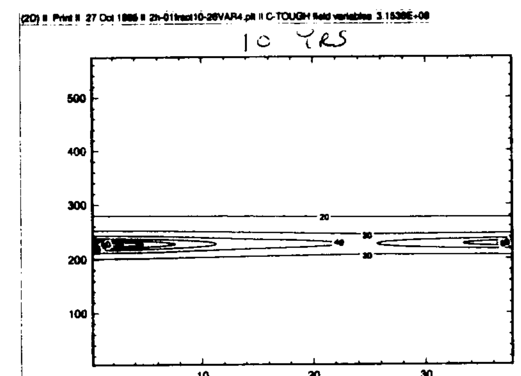
10/27/95 Results from 2h-01Fract10-26i

RJ 10/27/95

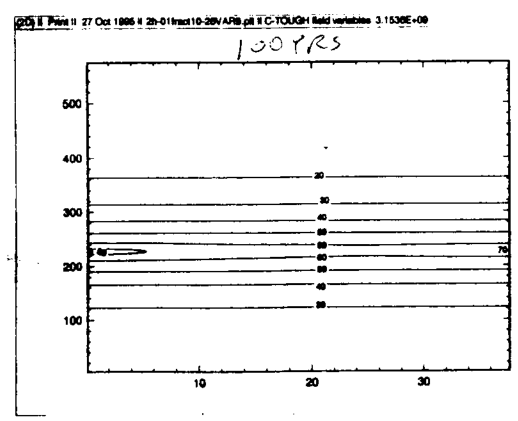
1 YR



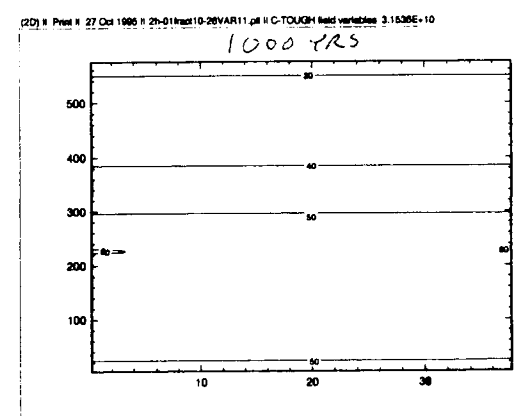
10 YRS



100YRS



1000 YRS



Not all Boundary conditions were set properly in 2h-01Fract10-26i

10/27/95 Put together 2h-01F10-27i with modified
RJ Boundary & matrix properties.

RJ 10-27/95

```
GWTT, 10/27/95, Fracture Zone, Two Heaters, Equivalent Continuum (9,9)
: Right heater has a 1 cm fracture from the surface
: Using values (for equiv contin) from NITAO, 1988
: Added source of water above right fracture (col n), made n   1 huge
: two heaters, left is hot at ~114 kW/ac, cool heater is on right at
: 57 kW/Ac, Grid=30X15, 37.84m Wide, Top Row NOT Huge, Bottom Row Remains Huge.
: Heaters in col A & O elem 15-19
: Permeability of Rock-Matrix Matrix = 1.9E-17m^2, Bulk Permeability of
: Rock Matrix=
: A geothermal gradient of 0.025 K/m is included
:
ROCKS----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
: Rock Matrix
:
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr1  2  2.480E+03 1.100E-01 1.800E-14 1.800E-14 1.800E-14 2.340E-00 8.400E+02
:
:   comp          expan         cdry         tortx
  0.0000E+00  0.0000E-00  1.9000E-00  5.0000E-01
: irp   rp(1)        rp(2)        rp(3)        rp(4)        rp(5)        rp(6)        rp(7)
  9 1.9000E-17 5.7880E-07 1.7980E+00 1.1000E-01 0.0000E+00 0.0000E+00 0.0000E+00
: icp   cp(1)        cp(2)        cp(3)        cp(4)        cp(5)        cp(6)        cp(7)
  9 1.0000E-11 1.3120E-04 4.2300E-00 1.8000E-03 1.0000E+00 0.0000E-02 0.0000E+00
:
: Rock Matrix horizontal boundary, high heat capacity
:
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr2  2  2.480E+03 1.100E-01 1.800E-14 1.800E-14 1.800E-14 2.340E-00 8.400E+22
:
:   comp          expan         cdry         tortx
  0.0000E+00  0.0000E-00  1.9000E-00  5.0000E-01
: irp   rp(1)        rp(2)        rp(3)        rp(4)        rp(5)        rp(6)        rp(7)
  9 1.9000E-17 5.7880E-07 1.7980E+00 1.1000E-01 0.0000E+00 0.0000E+00 0.0000E+00
: icp   cp(1)        cp(2)        cp(3)        cp(4)        cp(5)        cp(6)        cp(7)
  9 1.0000E-11 1.3120E-04 4.2300E-00 1.8000E-03 1.0000E+00 0.0000E-02 0.0000E+00
:
: Fracture Zone
:
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr3  2  2.480E+03 1.000E-01 1.000E-10 1.000E-10 1.000E-10 2.340E-00 8.400E+02
:
:   comp          expan         cdry         tortx
  0.0000E+00  0.0000E-00  1.9000E-00  5.0000E-01
: irp   rp(1)        rp(2)        rp(3)        rp(4)        rp(5)        rp(6)        rp(7)
  7 5.0000E-01 0.0000E-09 1.0000E+00 0.0000E-01 0.0000E+00 0.0000E+00 0.0000E+00
: icp   cp(1)        cp(2)        cp(3)        cp(4)        cp(5)        cp(6)        cp(7)
 11 5.0000E-01 0.0000E-09 1.0210E-04 1.0000E-00 1.0000E+00 2.0000E-02 0.0000E+00
:
: Heater
:
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr4  2  2.480E+03 1.000E-06 3.330E-99 3.330E-99 3.330E-99 2.340E-00 8.400E+02
:
:   comp          expan         cdry         tortx
  0.0000E+00  0.0000E-00  1.9000E-00  5.0000E-01
: irp   rp(1)        rp(2)        rp(3)        rp(4)        rp(5)        rp(6)        rp(7)
  7 8.0000E-01 0.0000E-09 1.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
: icp   cp(1)        cp(2)        cp(3)        cp(4)        cp(5)        cp(6)        cp(7)
 11 8.0000E-01 0.0000E-09 1.0210E-04 1.0000E+00 1.0000E+00 2.0000E-02 0.0000E+00
```



```
:
                                        :reqd blank line
:
PARAM----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:noit kdt cyc sec  cypr  diffo     texp       (mop(i),i   =1,17)
:                                              1 2 3 4 5 6 7 8 9 1011121314151617
  0  2  99999   0  550  2.1300E-05 1.8000E+00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 1
:   tstart        timax      deltn      deltmx     elst      gf        redlt      scale
 0.000E+00  1.000E+05 -1.000E+00  0.000E+00  A 35  1.000E+01 0.000E+00 0.000E+00
:     dlt(i)..
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
:
:   rel        re2        u          wup        wnr       dfac
 1.000E-05 1.000E+00 0.000E+00 0.000E+00 0.000E+00 1.000E-08
:
:        dep(1)                 dep(2)                 dep(3)
     1.00000000E+05       2.00000000E-01       2.00000000E+01
:
START----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
RPCAP----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
: irp   rp(1)        rp(2)        rp(3)        rp(4)        rp(5)        rp(6)        rp(7)
  7 2.0000E-01 0.0000E+00 1.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
: icp   cp(1)        cp(2)        cp(3)        cp(4)        cp(5)        cp(6)        cp(7)
 11 2.0000E-01 0.0000E+00 1.1000E-05 1.0000E+05 1.0000E+00 3.5000E-01 0.0000E+00
:
TIMES----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
:  iti  ite   delaf        tinter
   12   12  3.1700E+00  2.0000E+00
:
:  tis(1)      tis(2)     tis(3) ......
 1.000E-03 1.000E-01 1.000E-00 1.000E+01 2.000E+01 4.000E+01 6.000E+01 8.000E+01
 1.000E+02 5.000E+02 1.000E+03 1.000E+04
:
EVAP
 A   15
 A   17
 A   19
 B   17
 N   10
 N   14
 N   15
 N   17
 N   19
 N   20
 N   25
:
                                          :req blank line?
:
OPTN ----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
:  ilimsl idsolc  knudsn ipctem ivplow ilopt
     0      1       0      1      1     0
:
DTSTP----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
:   dpgmx      dsgmax     dtmax      dxmax
:
 8.000E+02 2.500E-01 2.000E+01 2.500E-01
```

RJ 10-27-95

Fracture in col n has water at upper boundary.
Rows 1 & 30 have high heat capacity to keep
them at a constant temp.

```
:
:
ELEME
: el ne   nsq  nad mal ma2     volx
:
A    1  0  0   matr2  2.5520E+00
A    2  0  0   matr1  6.3800E+00

A   29  0  0   matr1  5.4230E+00
A   30  0  0   matr2  2.5520E+00
B    1  0  0   matr2  4.0000E+00
B    2  0  0   matr1  1.0000E+01

M   29  0  0   matr1  8.3300E+00
M   30  0  0   matr2  3.9200E+00
N    1  0  0   matr3  7.9987E+12
N    2  0  0   matr3  1.9997E-01

N   30  0  0   matr3  7.9987E-02
O    1  0  0   matr2  2.5520E+00

O   14  0  0   matr1  6.3800E-01
O   15  0  0   matr4  3.2219E-01
O   16  0  0   matr4  3.2218E-01
O   17  0  0   matr4  3.2219E-01
O   18  0  0   matr4  3.2219E-01
O   19  0  0   matr4  3.2218E-01
O   20  0  0   matr1  6.2205E-01

O   30  0  0   matr2  2.5520E+00
                 :reqd blank line

:
CONNE
: el nl e2   n2 nsq nd1 nd2 isot d1        d2          areax     betax
:
A     1 B     1 0 0 0  1  1.595E-01  2.500E-01  8.000E+00  0.000E+00 0

O    29 O    30 0 0 0  1  8.500E+00  4.000E+00  3.190E-01  1.000E+00 0
              :reqd blank line

:
GENER----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
: el ne sl ns nsq nad nads ltb  itp   itb   gx        ex        hg
:
A  15 FLX  1     0    0    0  11 HEAT    b  0.0000E+00 0.00E+00 0.000E+00
  0.0000E+00 3.1536E+08 6.3072E+08 1.2614E+09
  1.8922E+09 3.1536E+09 6.3072E+09 1.8922E+10
  3.1536E+10 3.1536E+11 3.1536E+12
  4.53E+01 3.32E+01 2.73E+01 1.97E+01
  1.49E+01 9.84E+00 5.73E+00 3.07E+00
  2.00E+00 4.99E-01 2.52E-02

O  19 FLX  1     0    0    0  11 HEAT    b  0.0000E+00 0.00E+00 0.000E+00
  0.0000E+00 3.1536E+08 6.3072E+08 1.2614E+09
  1.8922E+09 3.1536E+09 6.3072E+09 1.8922E+10
  3.1536E+10 3.1536E+11 3.1536E+12
  2.27E+01 1.66E+01 1.36E+01 9.85E+00
  7.45E+00 4.92E+00 2.86E+00 1.54E+00
  1.00E+00 2.50E-01 1.26E-02
                                       :reqd blank line

:

INCON
:
: el ne   nsq nadd        porx
A    1  0  0      0.000000E+00
:
             x1                      x2                    x3
0.100000000000E+06  0.300000011921E+00  0.101999998093E+02

N    1  0  0  0.000000000E+00
0.100000000000E+06  0.100000011921E-09  0.101999998093E+02

O   30  0  0  0.000000000E+00
0.100000000000E+06  0.300000011921E+00  0.244500007629E+02
                         :reqd blank line
:
SOLVE
:precond accel  nz   nx    ibug
  BAND   NONE   30   15
:
ENDCY
```

RJ 10/27/95

11/27/95 Reviewed results from 2h-01F10-27i. Saturation in system approached 1.0 everywhere. Checked input. Bottom row was not large. Changed it to have elements w/ volume > e+30. Resubmitted as 2h-11-27i.

11/30/95 Corrected this by changing constant head at n 1 to constant flux of 9 e-5 Kg/s. Rock mass did not flood with this infiltration rate.

12/21/95 2 heater model with backfill is in ~/noniso/2h-bFi

Backfill in A 14, A 20 $k = 1 \times 10^{-10}$ m^2
B 14, ..., 20
C 14, ..., 20
D, 14, ..., 20
O, 14, ..0 20
M 14, ..., 20
N 14, ..., 20
L 14, ..., 20

Input for 2h-bFi on pages 138, 139, 140

```
: Thermal KTI, 12/11/95, Fracture Zone, 2 Heaters, Equivalent Continuum (9,9)
: This analysis is to assess localized drying model (LD) of Buscheck
: zone of low conductivity backfill around heaters
: zone= A&O 14,20 B,C,D,L,M,N 14-20 .305&.4425 W/m-C k=40 Darcy
: Right heater has a 1 cm fracture from the surface
: Using values (for equiv contin) from NITAO, 1988
: Added source of water above right fracture (col n), kept n   1 small
: two heaters, left is hot at ~114 kW/ac, cool heater is on right at
: 114 kW/Ac, Grid=30X15, 18.92m Wide, Top Row NOT Huge, Bottom Row Remains Huge.
: changed element n   1 to constant flux at 1e-6 kg/s and not constant head
: Heaters in col A & O elem 15-19
: Permeability of Rock-Matrix Matrix = 1.9E-17m^2, Bulk Permeability of
: Rock Matrix=
: A geothermal gradient of 0.025 K/m is included
:
ROCKS----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
: Rock Matrix
:
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr1  2  2.480E+03 1.100E-01 1.800E-14 1.800E-14 1.800E-14 2.340E-00 8.400E+02
:
:   comp         expan          cdry         tortx
  0.0000E+00  0.0000E-00  1.9000E-00  5.0000E-01
: irp   rp(1)        rp(2)        rp(3)        rp(4)        rp(5)       rp(6)       rp(7)
  9 1.9000E-17 5.7880E-07 1.7980E+00 1.1000E-01 0.0000E+00 0.0000E+00 0.0000E+00
: icp   cp(1)        cp(2)        cp(3)        cp(4)        cp(5)       cp(6)       cp(7)
  9 1.0000E-11 1.3120E-04 4.2300E-00 1.8000E-03 1.0000E+00 0.0000E-02 0.0000E+00
:
: Rock Matrix horizontal boundary, high heat capacity
:
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr2  2  2.480E+03 1.100E-01 1.800E-14 1.800E-14 1.800E-14 2.340E-00 8.400E+22
:
:   comp         expan          cdry         tortx
  0.0000E+00  0.0000E-00  1.9000E-00  5.0000E-01
: irp   rp(1)        rp(2)        rp(3)        rp(4)        rp(5)       rp(6)       rp(7)
  9 1.9000E-17 5.7880E-07 1.7980E+00 1.1000E-01 0.0000E+00 0.0000E+00 0.0000E+00
: icp   cp(1)        cp(2)        cp(3)        cp(4)        cp(5)       cp(6)       cp(7)
  9 1.0000E-11 1.3120E-04 4.2300E-00 1.8000E-03 1.0000E+00 0.0000E-02 0.0000E+00
:
: Fracture Zone
:
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr3  2  2.480E+03 1.000E-01 1.000E-10 1.000E-10 1.000E-10 2.340E-00 8.400E+02
:
:   comp         expan          cdry         tortx
  0.0000E+00  0.0000E-00  1.9000E-00  5.0000E-01
: irp   rp(1)        rp(2)        rp(3)        rp(4)        rp(5)       rp(6)       rp(7)
  7 5.0000E-01 0.0000E-09 1.0000E+00 0.0000E-01 0.0000E+00 0.0000E+00 0.0000E+00
: icp   cp(1)        cp(2)        cp(3)        cp(4)        cp(5)       cp(6)       cp(7)
 11 5.0000E-01 0.0000E-09 1.0210E-04 1.0000E-00 1.0000E+00 2.0000E-02 0.0000E+00
:
: Heater
:
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr4  2  2.480E+03 1.000E-06 3.330E-99 3.330E-99 3.330E-99 2.340E-00 8.400E+02
:
:   comp         expan          cdry         tortx

  0.0000E+00  0.0000E-00  1.9000E-00  5.0000E-01
: irp   rp(1)        rp(2)        rp(3)        rp(4)        rp(5)       rp(6)       rp(7)
  7 8.0000E-01 0.0000E-09 1.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
: icp   cp(1)        cp(2)        cp(3)        cp(4)        cp(5)       cp(6)       cp(7)
 11 8.0000E-01 0.0000E-09 1.0210E-04 1.0000E-00 1.0000E+00 2.0000E-02 0.0000E+00
:
: Backfill
:
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr5  2  2.480E+03 1.100E-01 4.000E-11 4.000E-11 4.000E-11 0.425E-00 8.400E+02
:
:   comp         expan          cdry         tortx
  0.0000E+00  0.0000E-00  0.3050E-00  5.0000E-01
: irp   rp(1)        rp(2)        rp(3)        rp(4)        rp(5)       rp(6)       rp(7)
  9 1.9000E-17 5.7880E-07 1.7980E+00 1.1000E-01 0.0000E+00 0.0000E+00 0.0000E+00
: icp   cp(1)        cp(2)        cp(3)        cp(4)        cp(5)       cp(6)       cp(7)
  9 1.0000E-11 1.3120E-04 4.2300E-00 1.8000E-03 1.0000E+00 0.0000E-02 0.0000E+00
:
                                              :reqd blank line
```



```
:
PARAM----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:noit kdt cyc sec  cypr  diffo      texp       (mop(i),i   =1,17)
                                               1 2 3 4 5 6 7 8 9 1011121314151617
:
  0  2  99999   0  550  2.1300E-05 1.8000E+00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 1
:   tstart         timax       deltn        deltmx     elst       gf        redlt       scale
 0.000E+00  1.000E+05 -1.000E+00  0.000E+00  A 35  1.000E+01 0.000E+00 0.000E+00
:     dlt(i)..
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
:
:   rel        re2        u          wup        wnr        dfac
 1.000E-05 1.000E+00 0.000E+00 0.000E+00 0.000E+00 1.000E-08
:
:       dep(1)                dep(2)                dep(3)
     1.00000000E+05        2.00000000E-01        2.00000000E+01
:
START----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
RPCAP----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
: irp   rp(1)        rp(2)        rp(3)        rp(4)        rp(5)       rp(6)       rp(7)
  7 2.0000E-01 0.0000E+00 1.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
: icp   cp(1)        cp(2)        cp(3)        cp(4)        cp(5)       cp(6)       cp(7)
 11 2.0000E-01 0.0000E+00 1.1000E-05 1.0000E+05 1.0000E+00 3.5000E-01 0.0000E+00
:
TIMES----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
:  iti  ite   delaf       tinter
   12   12  3.1700E+00  2.0000E+00
:
:  tis(1)     tis(2)    tis(3) ......
 1.000E-03 1.000E-01 1.000E-00 1.000E+01 2.000E+01 4.000E+01 6.000E+01 8.000E+01
 1.000E+02 5.000E+02 1.000E+03 1.000E+04
:
EVAP
 A   15
 A   17
 A   19
 B   17
 N   10
 N   14
 N   15
 N   17
 N   19
 N   20
 N   25
:
                                                    :req blank line?
:
OPTN ----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
:  ilimsl idsolc  knudsn ipctem ivplow ilopt
     0      1       0      1      1     0
:
DTSTP----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
:   dpgmx      dsgmax     dtmax      dxmax
:
 8.000E+02 2.500E-01 2.000E+01 2.500E-01
:
:
ELEME
: el ne    nsq   nad mal ma2     volx
:
A     1  0   0   matr2  1.2800E+00
A     2  0   0   matr1  3.2000E+00
A     3  0   0   matr1  6.4000E+00
A     4  0   0   matr1  6.4000E+00
A     5  0   0   matr1  6.4000E+00
A     6  0   0   matr1  6.4000E+00
A     7  0   0   matr1  6.4000E+00
A     8  0   0   matr1  6.4000E+00
A     9  0   0   matr1  6.4000E+00
A    10  0   0   matr1  3.2000E+00
A    11  0   0   matr1  1.6000E+00
A    12  0   0   matr1  8.0000E-01
A    13  0   0   matr1  4.8000E-01
A    14  0   0   matr5  3.2000E-01
A    15  0   0   matr4  1.6160E-01
A    16  0   0   matr4  1.6160E-01
A    17  0   0   matr4  1.6160E-01
A    18  0   0   matr4  1.6160E-01
A    19  0   0   matr4  1.6160E-01
A    20  0   0   matr5  3.1200E-01
A    21  0   0   matr1  4.8000E-01
A    22  0   0   matr1  8.0000E-01
A    23  0   0   matr1  1.6000E+00
```

```
A   24  0  0  matr1  3.2000E+00
A   25  0  0  matr1  6.4000E+00
A   26  0  0  matr1  6.4000E+00
A   27  0  0  matr1  6.4000E+00
A   28  0  0  matr1  6.4000E+00
A   29  0  0  matr1  2.7200E+00
A   30  0  0  matr2  1.2800E+30
B    1  0  0  matr2  2.0480E+00
B    2  0  0  matr1  5.1200E+00

N    1  0  0  matr3  3.9993E-02
N    2  0  0  matr3  9.9983E-02
N    3  0  0  matr3  1.9997E-01
N    4  0  0  matr3  1.9997E-01
N    5  0  0  matr3  1.9997E-01
N    6  0  0  matr3  1.9997E-01
N    7  0  0  matr3  1.9997E-01
N    8  0  0  matr3  1.9997E-01
N    9  0  0  matr3  1.9997E-01
N   10  0  0  matr3  9.9983E-02
N   11  0  0  matr3  4.9992E-02
N   12  0  0  matr3  2.4996E-02
N   13  0  0  matr3  1.4997E-02
N   14  0  0  matr5  9.9983E-03
N   15  0  0  matr5  5.0492E-03
N   16  0  0  matr5  5.0490E-03
N   17  0  0  matr5  5.0492E-03
N   18  0  0  matr5  5.0492E-03
N   19  0  0  matr5  5.0490E-03
N   20  0  0  matr5  9.7484E-03
N   21  0  0  matr3  1.4997E-02
N   22  0  0  matr3  2.4996E-02
N   23  0  0  matr3  4.9992E-02
N   24  0  0  matr3  9.9983E-02
N   25  0  0  matr3  1.9997E-01
N   26  0  0  matr3  1.9997E-01
N   27  0  0  matr3  1.9997E-01
N   28  0  0  matr3  1.9997E-01
N   29  0  0  matr3  8.4986E-02
N   30  0  0  matr3  3.9993E+32
O    1  0  0  matr2  1.2720E+00
O    2  0  0  matr1  3.1800E+00
O    3  0  0  matr1  6.3600E+00
O    4  0  0  matr1  6.3600E+00
O    5  0  0  matr1  6.3600E+00
O    6  0  0  matr1  6.3600E+00
O    7  0  0  matr1  6.3600E+00
O    8  0  0  matr1  6.3600E+00
O    9  0  0  matr1  6.3600E+00
O   10  0  0  matr1  3.1800E+00
O   11  0  0  matr1  1.5900E+00
O   12  0  0  matr1  7.9500E-01
O   13  0  0  matr1  4.7700E-01
O   14  0  0  matr5  3.1800E-01
O   15  0  0  matr4  1.6059E-01
O   16  0  0  matr4  1.6059E-01
O   17  0  0  matr4  1.6059E-01
O   18  0  0  matr4  1.6059E-01
O   19  0  0  matr4  1.6059E-01
O   20  0  0  matr5  3.1005E-01
O   21  0  0  matr1  4.7700E-01
O   22  0  0  matr1  7.9500E-01
O   23  0  0  matr1  1.5900E+00
O   24  0  0  matr1  3.1800E+00
O   25  0  0  matr1  6.3600E+00
O   26  0  0  matr1  6.3600E+00
O   27  0  0  matr1  6.3600E+00
O   28  0  0  matr1  6.3600E+00
O   29  0  0  matr1  2.7030E+00
O   30  0  0  matr2  1.2720E+30
                    ::reqd blank line
A  15 FLX  1    0   0   0  11 HEAT    b  0.0000E+00 0.00E+00 0.000E+00
  0.0000E+00 3.1536E+08 6.3072E+08 1.2614E+09
  1.8922E+09 3.1536E+09 6.3072E+09 1.8922E+10
  3.1536E+10 3.1536E+11 3.1536E+12
  4.53E+01 3.32E+01 2.73E+01 1.97E+01
  1.49E+01 9.84E+00 5.73E+00 3.07E+00
  2.00E+00 4.99E-01 2.52E-02
:
:          x1                   x2                   x3
        1.000000E+05          6.903128E-01          1.267301E+01
B     1  0  0      0.000000E+00
        1.000000E+05          6.903128E-01          1.267301E+01
```

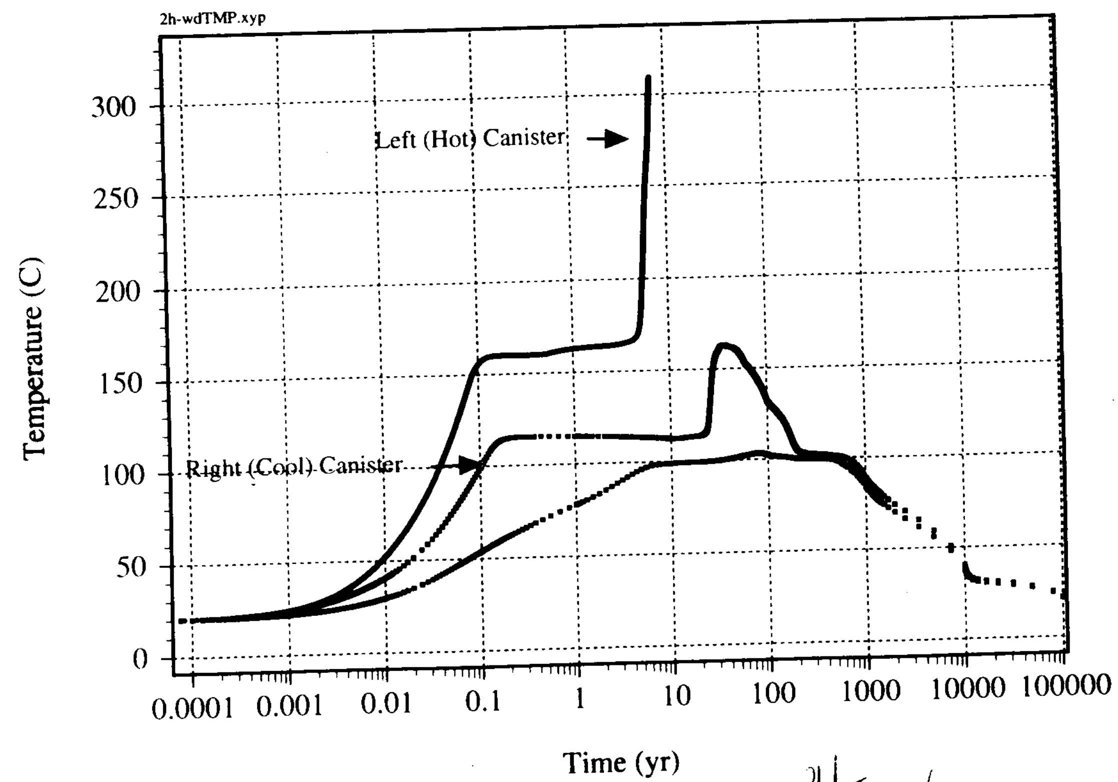
also L14 - L20 matrs: backfill

also B, C, D

RH
12/21/95

1/4/96 Heat (at about 145 KW/acre) was apparently too great. Thermal load resulted in the left canister temperature going above 310°C at about 7.1 yrs. Computational effort was apparently too much as the time step became very small (~ e-17 yrs). Stopped simulation after about 6 days. Below is xplot of right & left temps for lower heat load and left temp for 145 KW/acre heat load.

Two Heaters with Fracture at Right



RH 1/4/96

Ran base case w/ no canister heat but with uniform infiltration of 0.3 mm/yr.

Cross-sectional area (m²) of each column is (& infiltration)

	(m²)	(m/s)
A	0.319	3.03 e-12
B	0.5	4.76 e-12
C	0.5	4.76 e-12
D	1.0	9.51 e-12
E	2.0	1.90 e-11
F	3.0	2.85 e-11
G	11.6	1.10 e-10
H	11.6	1.10 e-10
I	3.0	2.85 e-11
J	2.0	1.90 e-11
K	1.0	9.51 e-12
L	0.5	4.76 e-12
M	0.49	4.66 e-12
N	0.00998	9.49 e-14
O	0.319	3.03 e12

infiltration @ 0.3 mm/yr $= 3 \times 10^{-4}$ m/yr $= 9.51 \times 10^{-12}$ m/s

input called 2h-wdbi w/ GENER of

```
GENER----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
 : el ne sl ns nsq nad nads ltb  itp    itb   gx          ex          hg
 :
 A    1 FLX  1     0    0    0    0 WATE    b  3.0300E-12 0.00E+00 0.000E+00
 B    1 FLX  1     0    0    0    0 WATE    b  4.7600E-12 0.00E+00 0.000E+00
 C    1 FLX  1     0    0    0    0 WATE    b  4.7600E-12 0.00E+00 0.000E+00
 D    1 FLX  1     0    0    0    0 WATE    b  9.5100E-12 0.00E+00 0.000E+00
 E    1 FLX  1     0    0    0    0 WATE    b  1.9000E-11 0.00E+00 0.000E+00
 F    1 FLX  1     0    0    0    0 WATE    b  2.8500E-11 0.00E+00 0.000E+00
 G    1 FLX  1     0    0    0    0 WATE    b  1.1000E-10 0.00E+00 0.000E+00
 H    1 FLX  1     0    0    0    0 WATE    b  1.1000E-10 0.00E+00 0.000E+00
 I    1 FLX  1     0    0    0    0 WATE    b  2.8500E-11 0.00E+00 0.000E+00
 J    1 FLX  1     0    0    0    0 WATE    b  1.9000E-11 0.00E+00 0.000E+00
 K    1 FLX  1     0    0    0    0 WATE    b  9.5100E-12 0.00E+00 0.000E+00
 L    1 FLX  1     0    0    0    0 WATE    b  4.7600E-12 0.00E+00 0.000E+00
 M    1 FLX  1     0    0    0    0 WATE    b  4.6600E-12 0.00E+00 0.000E+00
 N    1 FLX  1     0    0    0    0 WATE    b  9.4900E-14 0.00E+00 0.000E+00
 O    1 FLX  1     0    0    0    0 WATE    b  3.0300E-12 0.00E+00 0.000E+00
```

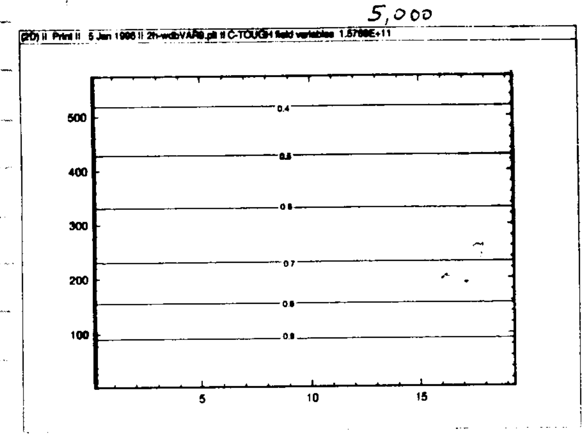
1/4/96

The rest of input is same as 2h-wdi

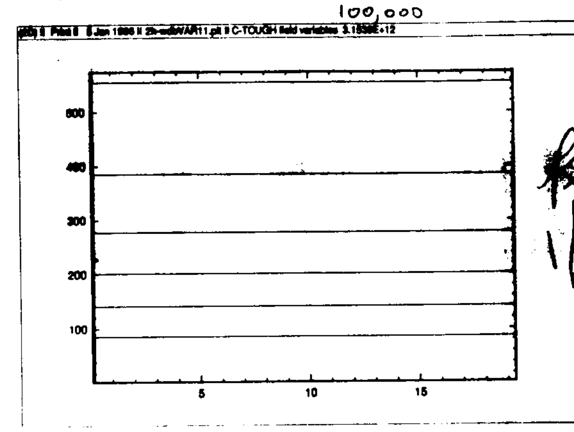
Submitted 2h-wdbi as basecase w/ infiltration of 0.3 mm/yr

1/5/96 Ran simulation out to 1,000,000 yrs. Saturation (liq) results for 2h-wdbi (no heat 0.3 mm/yr infiltration) are illustrated below.

5,000

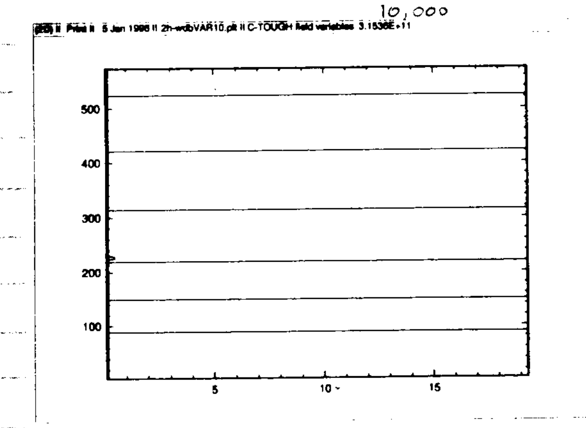


100,000

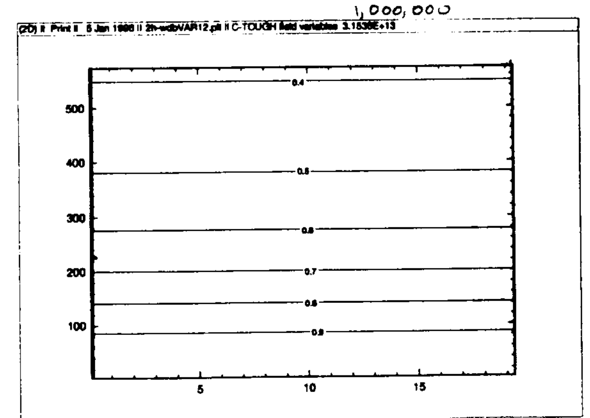


1/5/96

10,000



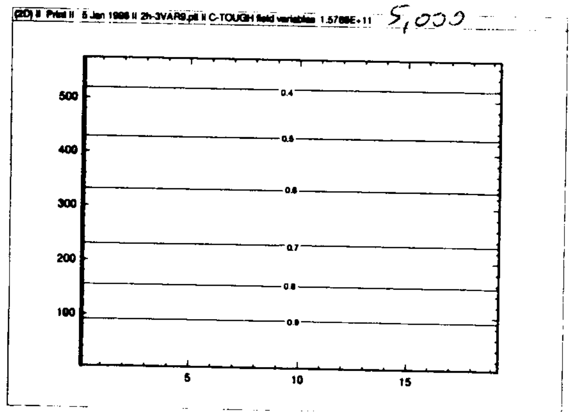
1,000,000



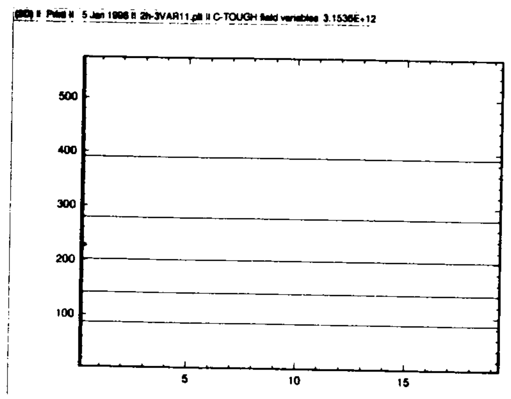
It appears steady state was attained. Output compressed into /home/sheezy/rgreen/nonisa/old-output/. Increased infiltration by 10x to 3.0 mm/yr, put input into 2h-3i & resubmitted (i.e. all gx on pg. 142 were increased by 10x)

Saturation (liq) for infiltration of 3.0 mm/yr
appear for 2h-3i

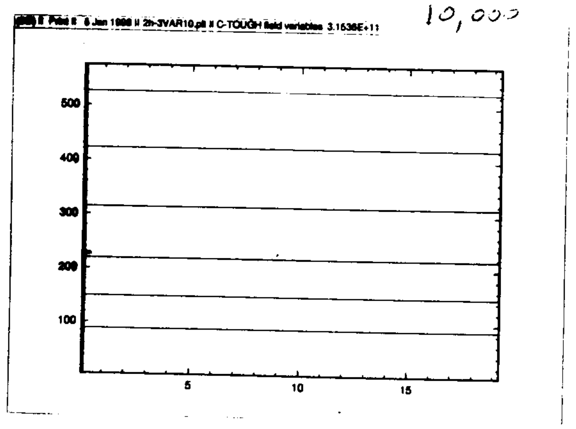
5,000 yrs



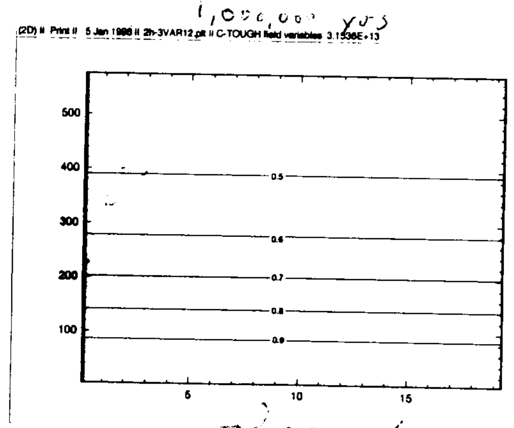
100,000 yrs



10,000



1,000,000 yrs



RH 1/5/96

Used output from this steady state infiltration as input to heater test.

```
A  19 FLX  1    0    0    0  11 HEAT    b  0.0000E+00 0.00E+00 0.000E+00
  0.0000E+00 3.1536E+08 6.3072E+08 1.2614E+09
  1.8922E+09 3.1536E+09 6.3072E+09 1.8922E+10
  3.1536E+10 3.1536E+11 3.1536E+12
  7.10E+01 5.21E+01 4.28E+01 3.09E+01
  2.34E+01 1.54E+01 9.02E+00 4.81E+00
  3.14E+00 7.83E-01 3.95E-02
O  15 FLX  1    0    0    0  11 HEAT    b  0.0000E+00 0.00E+00 0.000E+00
  0.0000E+00 3.1536E+08 6.3072E+08 1.2614E+09
  1.8922E+09 3.1536E+09 6.3072E+09 1.8922E+10
  3.1536E+10 3.1536E+11 3.1536E+12
  3.55E+01 2.60E+01 2.14E+01 1.55E+01
  1.17E+01 7.72E+00 4.49E+00 2.41E+00
  1.57E+00 3.91E-01 1.98E-02
```

RH 1/5/96

with heat load of 114 kW/acre

Determination of heat load in 2h-3-114i

Elements have depth of 1.0 m
i.e. A 1 has volume of 1.28
0.16 (x) × 8.0 (z) × 1.0 (y) ⇒ y = 1.0

total area of 2-D slice is 18.92 m²

~~Total heat (J/s) in A is 71 + 52.1 + 42.8 + 30.9 + 23.4 + 15.4 + 9.02 + 4.81 + 3.14 + 0.783 + 0.0395 = 253.39~~ wrong RH 1/5/96

1 acre has 4046 m² ⇒ $\frac{18.92}{4046}$ = 4.676 e-3

Since 114 kW/acre is averaged over slice need total heat load of 114(4.676e-3) = 0.5331 kW or 533.1 J/s. Since only ½ of heaters are modeled still need 533.1 because I am including 2 halves.

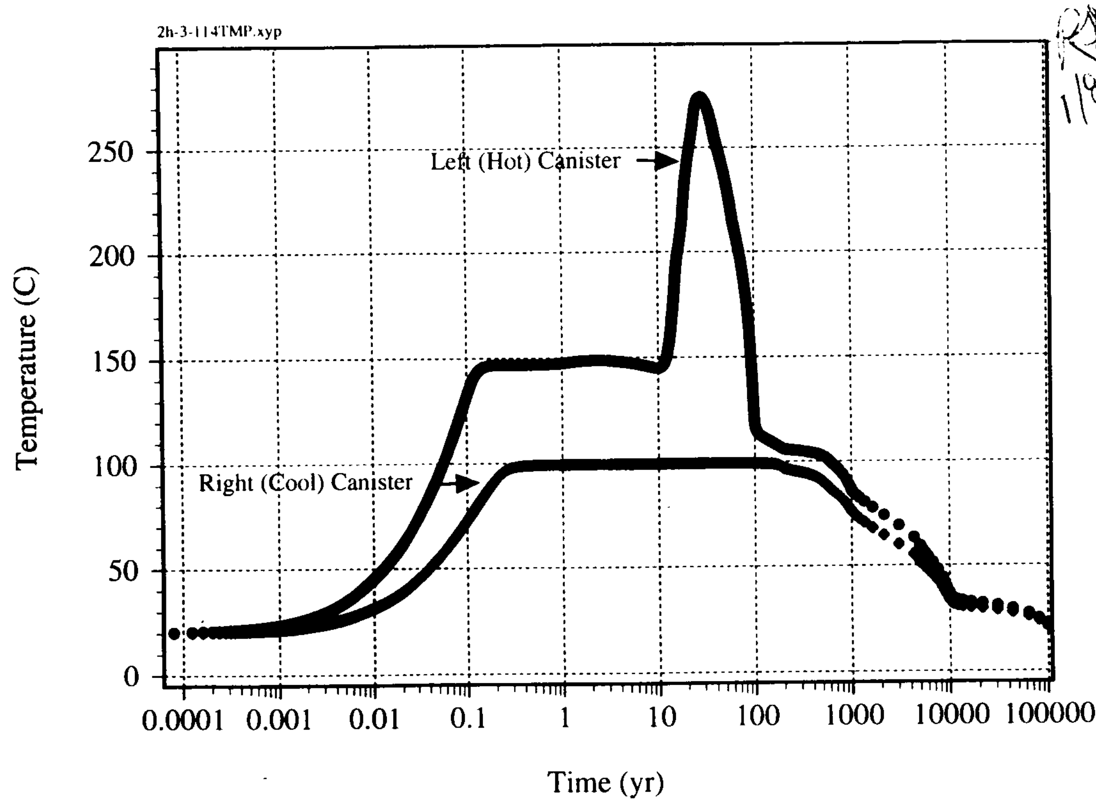
In 2h-3-114i, there is 5 × 71.0 + 5 × 35.5 or 532.5 J/s or about 114 kW/acre

But loaded w/ twice as much heat load on left as on right.

RH 1/5/96

1/8/96 2h-3-114i completed after ~ 18 hrs CPU

Two Heaters with Fracture at Right



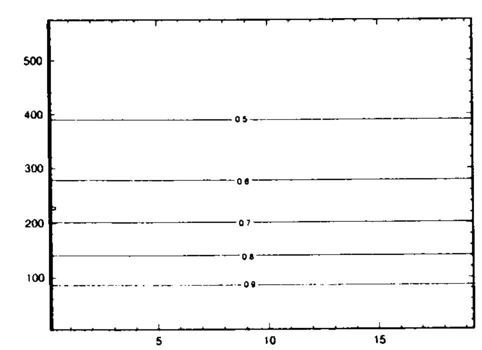
RA 1/8/96

1/9/96 Saturation (liquid) contours for 2h-3-114 on pg 147

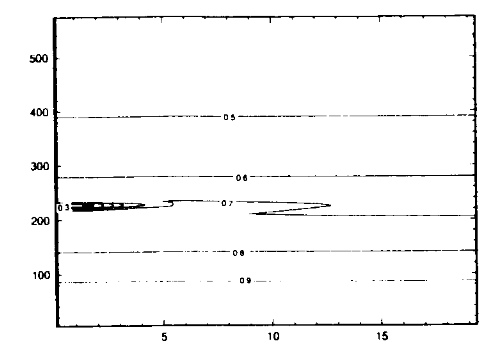
Expanded liq. saturation is on pg 148

Expanded (zoom) temperature contours are on pg 149

(2D) || Print || 8 Jan 1996 || 2h-3-114VAR1.plt || C-TOUGH field variables 3.1536E+08

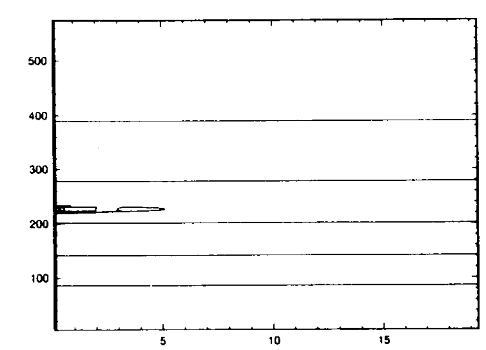


(2D) || Print || 8 Jan 1996 || 2h-3-114VAR3.plt || C-TOUGH field variables 3.1536E+08

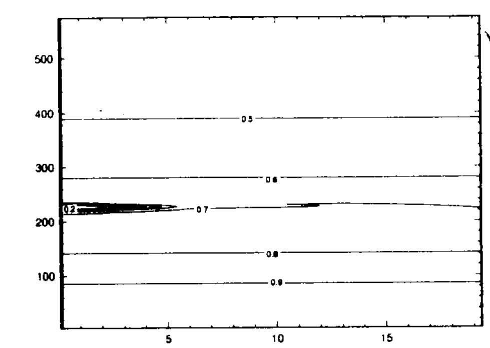


RA 1/9/96

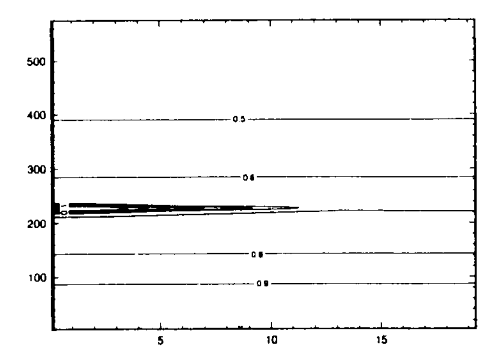
(2D) || Print || 8 Jan 1996 || 2h-3-114VAR2.plt || C-TOUGH field variables 3.1536E+07



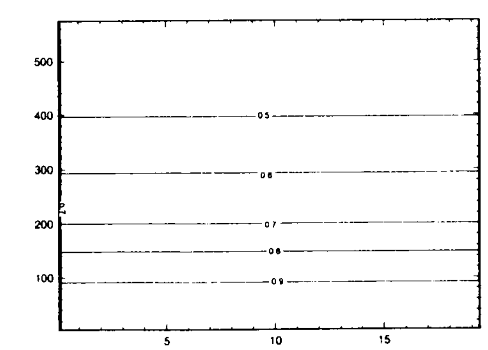
(2D) || Print || 8 Jan 1996 || 2h-3-114VAR4.plt || C-TOUGH field variables 6.3072E+08



(2D) || Print || 8 Jan 1996 || 2h-3-114VAR5.plt || C-TOUGH field variables 1.5768E+09

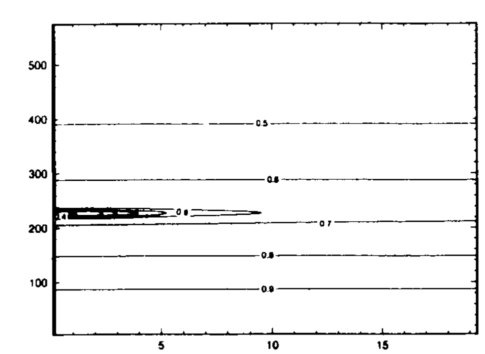


(2D) || Print || 8 Jan 1996 || 2h-3-114VAR7.plt || C-TOUGH field variables 1.5768E+10

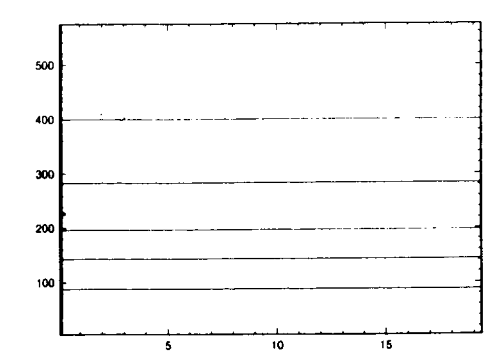


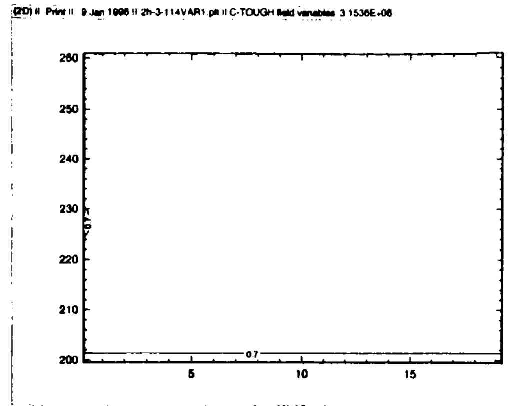
RA 1/9/96

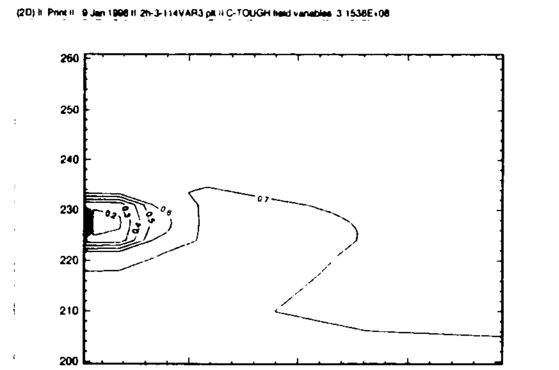
(2D) || Print || 8 Jan 1996 || 2h-3-114VAR6.plt || C-TOUGH field variables 3.1536E+09

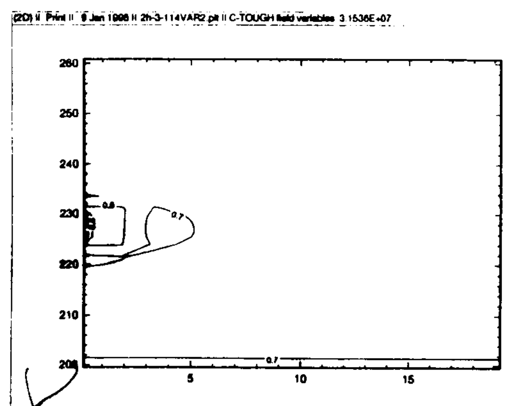


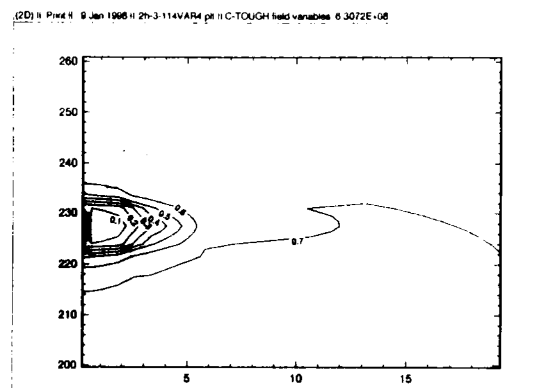
(2D) || Print || 8 Jan 1996 || 2h-3-114VAR8.plt || C-TOUGH field variables 3.1536E+10



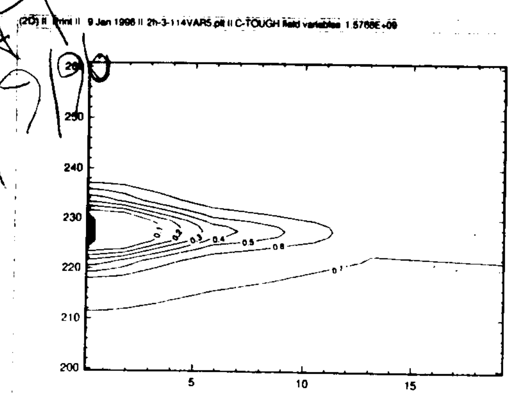


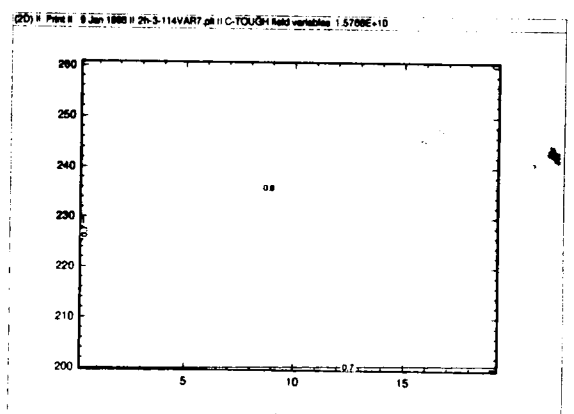


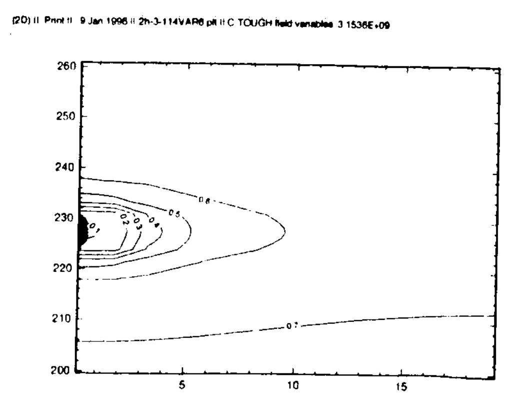


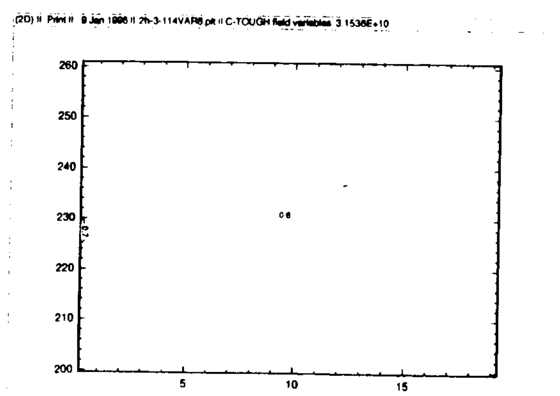


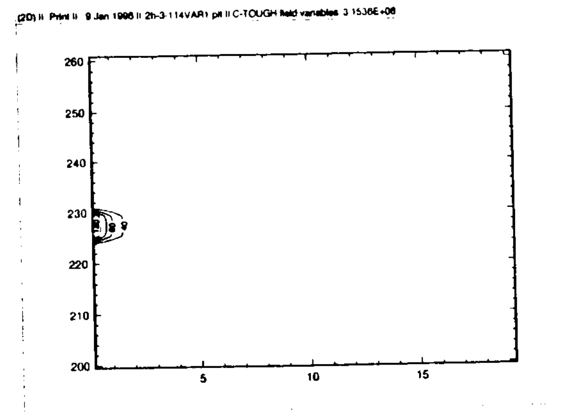
RA
1/9/96

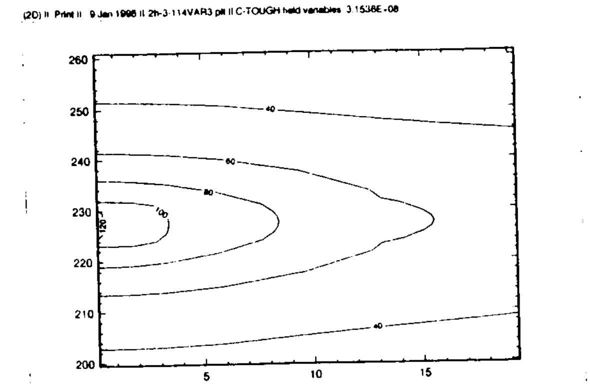


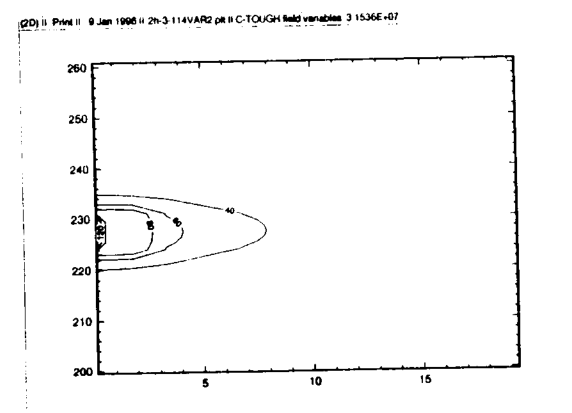


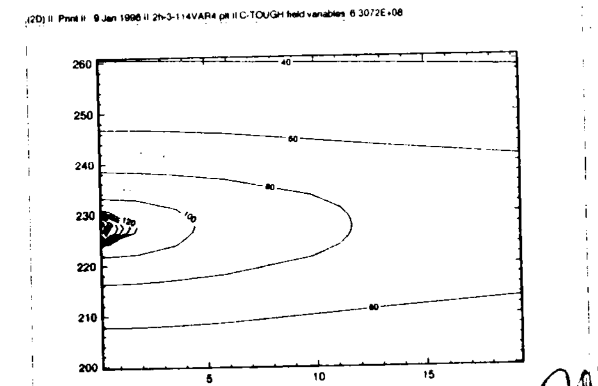




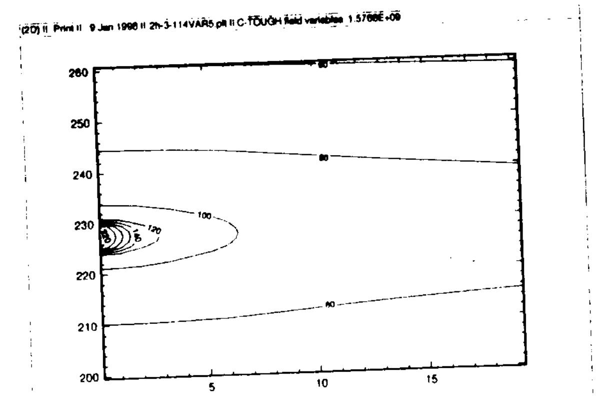


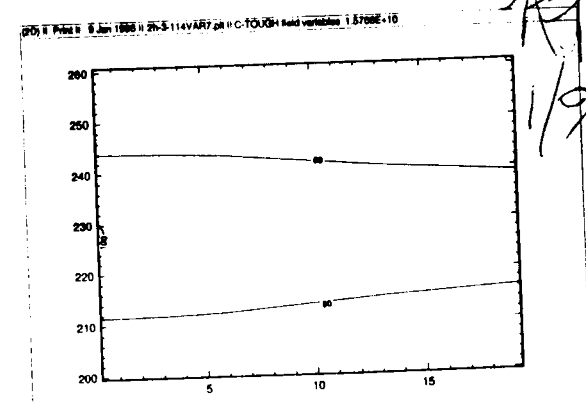


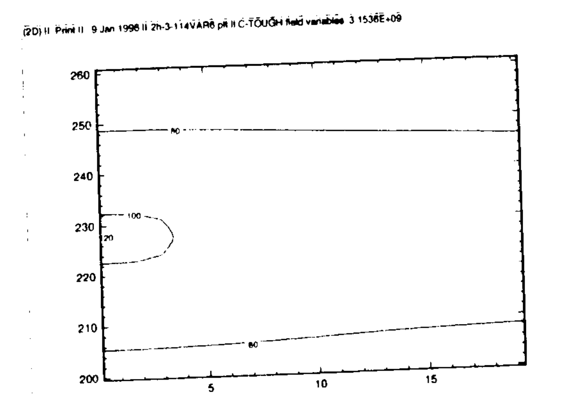


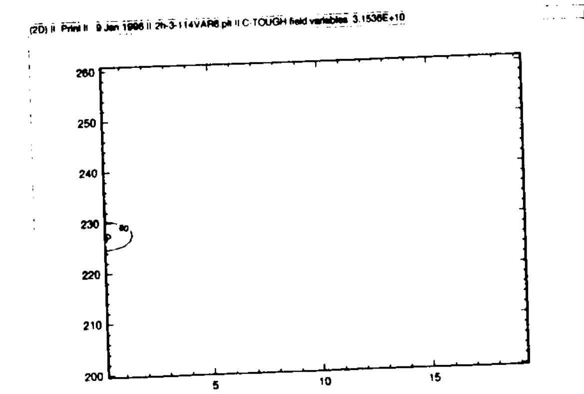


RA
1/9/96









Objectives of these analyses is to recreate TSPA-95 2-phase flow analyses. CTOUGH used in this phase of drift-scale analyses. Last CTOUGH entry on pg 159. Subsequent analyses made with MULTIFLO. RH 3/5/97

1/29/96 Put in a six layer model similar to that in the SNL 96 TSPA report. Initial model is 684m x 22m. All units are treated as equivalent porous media, including backfill.
Tried simulating w/ 3mm/yr of infiltration but program wouldn't go past 675 yrs. Removed infiltration & it ran for 1.33×10^5 yrs then died. It should have reached near steady state by then. Will remove backfill & try again. Backfill caused large saturation variations near waste package even though there is no heat.

```
0.
30.     TCw
68.
95.
122.    PTn
148.
163.
183.
217.
247.
277.
307.
324.
334.
339.
341.5
342.25
343     Tsw
343.5
344.
344.5
345.
345.75
346.5
349.
354.
364.
384.
414.
444.
474.
482.    TSV
502.
532     CHnv
563.
593.
623     CHnz
653.
684     CHnz
```

RH 1/29/96

```
0.
.5
1.
1.75
2.5
3.5
4.75
6.
8.
10.
12.
14.
16.
17.25
18.5
19.5
20.25
21.
21.5
22.
```

RH 1/29/96

bulk (equivalent continuum model) Backfill

```
kf = 3.9 10^-12; km = 3.9 10^-14;
pf = 0.0018; pm =0.5000;
pb = pf + (1-pf) pm;
kb = kf pf + km (1-pf);
sbmax = pm (1-pf)/pb;
{pb,kb}

{0.5009, 4.59498 10^-14}

kf pf

7.02 10^-15
```

RH 1/29/96

bulk (equivalent continuum model) TCw

```
kf = 3.9 10^-12; km = 9.7 10^-19;
pf = 0.0018; pm =0.0807;
pb = pf + (1-pf) pm;
kb = kf pf + km (1-pf);
sbmax = pm (1-pf)/pb;
{pb,kb}

{0.0823547, 7.02097 10^-15}
```

bulk (equivalent continuum model) PTn

```
kf = 3.9 10^-13; km = 3.9 10^-14;
pf = 0.0018; pm =0.4210;
pb = pf + (1-pf) pm;
kb = kf pf + km (1-pf);
sbmax = pm (1-pf)/pb;
{pb,kb}

{0.422042, 3.96318 10^-14}
```

RH 1/29/96

bulk (equivalent continuum model) TSw

```
kf = 3.9 10^-12; km = 1.9 10^-18;
pf = 0.0018; pm =0.1390;
pb = pf + (1-pf) pm;
kb = kf pf + km (1-pf);
sbmax = pm (1-pf)/pb;
{pb,kb}

{0.14055, 7.0219 10^-15}
```

bulk (equivalent continuum model) TSv

```
kf = 3.9 10^-12; km = 1.9 10^-18;
pf = 0.0018; pm =0.0650;
pb = pf + (1-pf) pm;
kb = kf pf + km (1-pf);
sbmax = pm (1-pf)/pb;
{pb,kb}

{0.066683, 7.0219 10^-15}
```

RH 1/29/96

bulk (equivalent continuum model) CHnv

```
kf = 3.9 10^-13; km = 2.7 10^-14;
pf = 0.0018; pm =0.3310;
pb = pf + (1-pf) pm;
kb = kf pf + km (1-pf);
sbmax = pm (1-pf)/pb;
{pb,kb}

{0.332204, 2.76534 10^-14}
```

bulk (equivalent continuum model) CHnz

```
kf = 3.9 10^-12; km = 2.0 10^-18;
pf = 0.0018; pm =0.3060;
pb = pf + (1-pf) pm;
kb = kf pf + km (1-pf);
sbmax = pm (1-pf)/pb;
{pb,kb}

{0.307249, 7.022 10^-15}
```

```
GENER----1----*----2----*----3----*----4----*----5----*----6----*----7--
: el ne sl ns nsq nad nads ltb  itp   itb   gx         ex       hg
:
A   1 FLX  1   0   0   0    0 WATE    b  9.0400E-07 0.00E+00 0.000E+00
B   1 FLX  1   0   0   0    0 WATE    b  9.0400E-07 0.00E+00 0.000E+00
C   1 FLX  1   0   0   0    0 WATE    b  1.3600E-06 0.00E+00 0.000E+00
D   1 FLX  1   0   0   0    0 WATE    b  1.3600E-06 0.00E+00 0.000E+00
E   1 FLX  1   0   0   0    0 WATE    b  1.8100E-06 0.00E+00 0.000E+00
F   1 FLX  1   0   0   0    0 WATE    b  2.2600E-06 0.00E+00 0.000E+00
G   1 FLX  1   0   0   0    0 WATE    b  2.2600E-06 0.00E+00 0.000E+00
H   1 FLX  1   0   0   0    0 WATE    b  3.6100E-06 0.00E+00 0.000E+00
I   1 FLX  1   0   0   0    0 WATE    b  3.6100E-06 0.00E+00 0.000E+00
J   1 FLX  1   0   0   0    0 WATE    b  3.6100E-06 0.00E+00 0.000E+00
K   1 FLX  1   0   0   0    0 WATE    b  3.6100E-06 0.00E+00 0.000E+00
L   1 FLX  1   0   0   0    0 WATE    b  3.6100E-06 0.00E+00 0.000E+00
M   1 FLX  1   0   0   0    0 WATE    b  2.2600E-06 0.00E+00 0.000E+00
N   1 FLX  1   0   0   0    0 WATE    b  2.2600E-06 0.00E+00 0.000E+00
O   1 FLX  1   0   0   0    0 WATE    b  1.8100E-06 0.00E+00 0.000E+00
P   1 FLX  1   0   0   0    0 WATE    b  1.3600E-06 0.00E+00 0.000E+00
Q   1 FLX  1   0   0   0    0 WATE    b  1.3600E-06 0.00E+00 0.000E+00
R   1 FLX  1   0   0   0    0 WATE    b  9.0400E-07 0.00E+00 0.000E+00
S   1 FLX  1   0   0   0    0 WATE    b  9.0400E-07 0.00E+00 0.000E+00
```

RA 1/29/96

This is the flux rate for 3mm/yr for the 694 x 22 model

Infiltration in input as kg/s

3mm/yr = 9.51e-11 m/s = 9.51e-8 Kg/s

(for ρ_{H_2O} = 1000 Kg/m³)

	~~area (m²)~~	Kg/s for area
A	2.5	9.04e-7
B	9.5	"
C	14.25	1.36e-6
D	14.25	"
E	19.00	1.81e-6
F	23.75	2.26e-6
G	23.75	"
H	38.0	3.61e-6
I	38.0	
J	38.0	
K	38.0	
L	38.0	
M	23.75	
N	23.75	
O	19.00	
P	14.25	
Q	14.25	
R	9.5	
S	9.5	

New file (input) 2h-1mmi has no heat or backfill and 1mm/yr to get background steady state /home/sneezy/rgreen/noniso/2h-1mmi

Infiltration for 1mm/yr used in 2h-1mmi

```
GENER----1----*----2----*----3----*----4----*----5----*----6----*----7----
: el ne sl ns nsq nad nads ltb  itp   itb   gx         ex       hg
:
A   1 FLX  1   0   0   0    0 WATE    b  3.0100E-07 0.00E+00 0.000E+00
B   1 FLX  1   0   0   0    0 WATE    b  3.0100E-07 0.00E+00 0.000E+00
C   1 FLX  1   0   0   0    0 WATE    b  4.5300E-07 0.00E+00 0.000E+00
D   1 FLX  1   0   0   0    0 WATE    b  4.5300E-07 0.00E+00 0.000E+00
E   1 FLX  1   0   0   0    0 WATE    b  6.0300E-07 0.00E+00 0.000E+00
F   1 FLX  1   0   0   0    0 WATE    b  7.5300E-07 0.00E+00 0.000E+00
G   1 FLX  1   0   0   0    0 WATE    b  7.5300E-07 0.00E+00 0.000E+00
H   1 FLX  1   0   0   0    0 WATE    b  1.2000E-06 0.00E+00 0.000E+00
I   1 FLX  1   0   0   0    0 WATE    b  1.2000E-06 0.00E+00 0.000E+00
J   1 FLX  1   0   0   0    0 WATE    b  1.2000E-06 0.00E+00 0.000E+00
K   1 FLX  1   0   0   0    0 WATE    b  1.2000E-06 0.00E+00 0.000E+00
L   1 FLX  1   0   0   0    0 WATE    b  1.2000E-06 0.00E+00 0.000E+00
M   1 FLX  1   0   0   0    0 WATE    b  7.5300E-07 0.00E+00 0.000E+00
N   1 FLX  1   0   0   0    0 WATE    b  7.5300E-07 0.00E+00 0.000E+00
O   1 FLX  1   0   0   0    0 WATE    b  6.0300E-07 0.00E+00 0.000E+00
P   1 FLX  1   0   0   0    0 WATE    b  4.5300E-07 0.00E+00 0.000E+00
Q   1 FLX  1   0   0   0    0 WATE    b  4.5300E-07 0.00E+00 0.000E+00
R   1 FLX  1   0   0   0    0 WATE    b  3.0100E-07 0.00E+00 0.000E+00
S   1 FLX  1   0   0   0    0 WATE    b  3.0100E-07 0.00E+00 0.000E+00
```

RA 1/29/96

→ output from 2h-1mmi died after about 2700 yrs. Checked saturation which appeared to have reached the PTn. I changed the porosity of the PTn from 0.4 to 0.04 & resubmitted.

→ This did not change output. Set porosity back to 0.4 and decreased α (or rp(2)) by a factor of 10 from E-06 to E-07 in PTn resubmitted

1/31/96 Change in α in the PTn did not change the difficulty in the simulation. Reset PTn α to E-06 and changed n from 6.872 to 1.558 (same as the TCw. Can't submit yet, server is down.

→ 2h-1mmi in ~/noniso

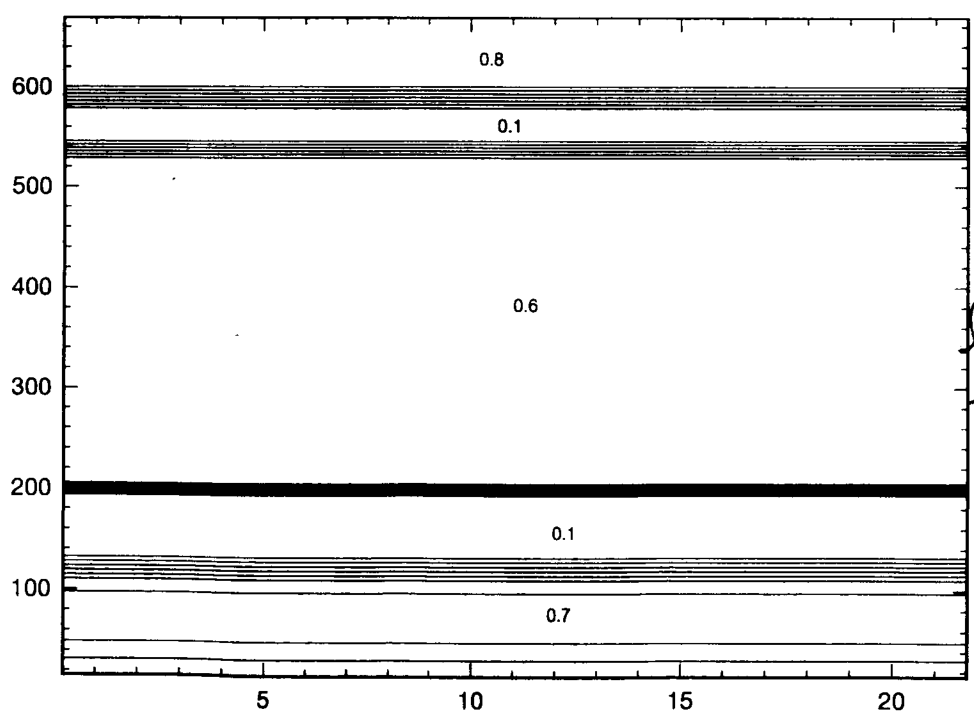
2/8/96 Used G. Wittmeyer's ODE solver to get a first guess of initial saturations.
Original code is in /home/sneezy/vgreen/noniso/ode/evaluate.F

Modified code to accommodate a specified vertical section. This is in eval-ctough.F
Used /noniso/ode/strip.F to ~~get~~ RA 2/8/96 create new initial conditions.

Put into 2h-odei and ran for 10^6 years. Saturation contours varied. See following plots.

10^4 yrs

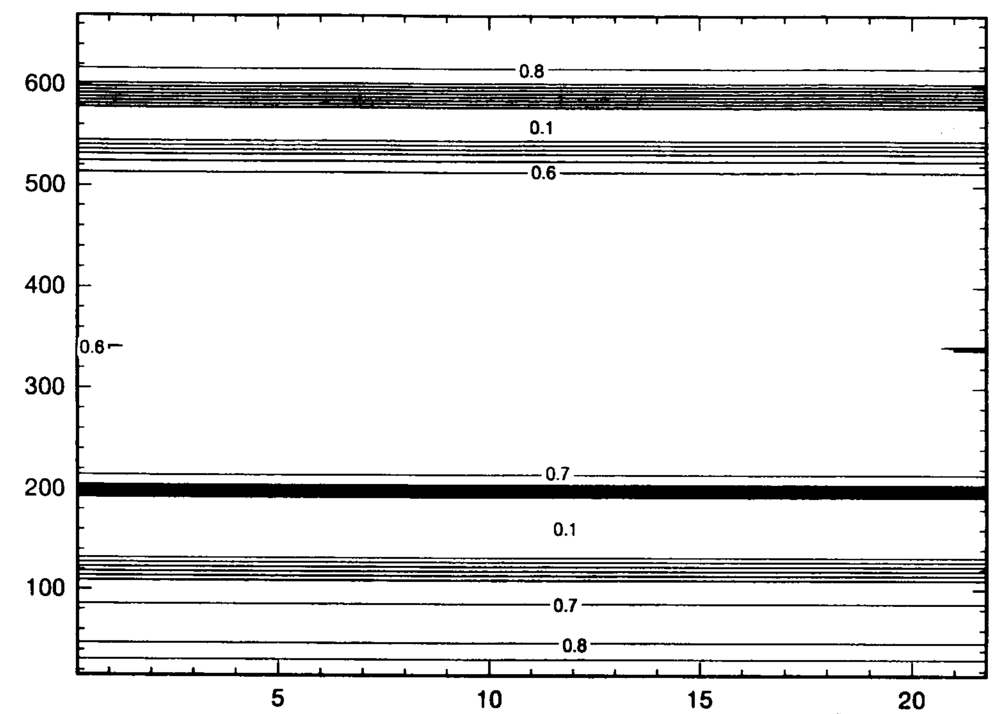
Print II 5 Feb 1996 II 2h-odeVAR1.plt II C-TOUGH field variables 3.1558E+11



RA 2/8/96

Print II 5 Feb 1996 II 2h-odeVAR2.plt II C-TOUGH field variables 3.1558E+12

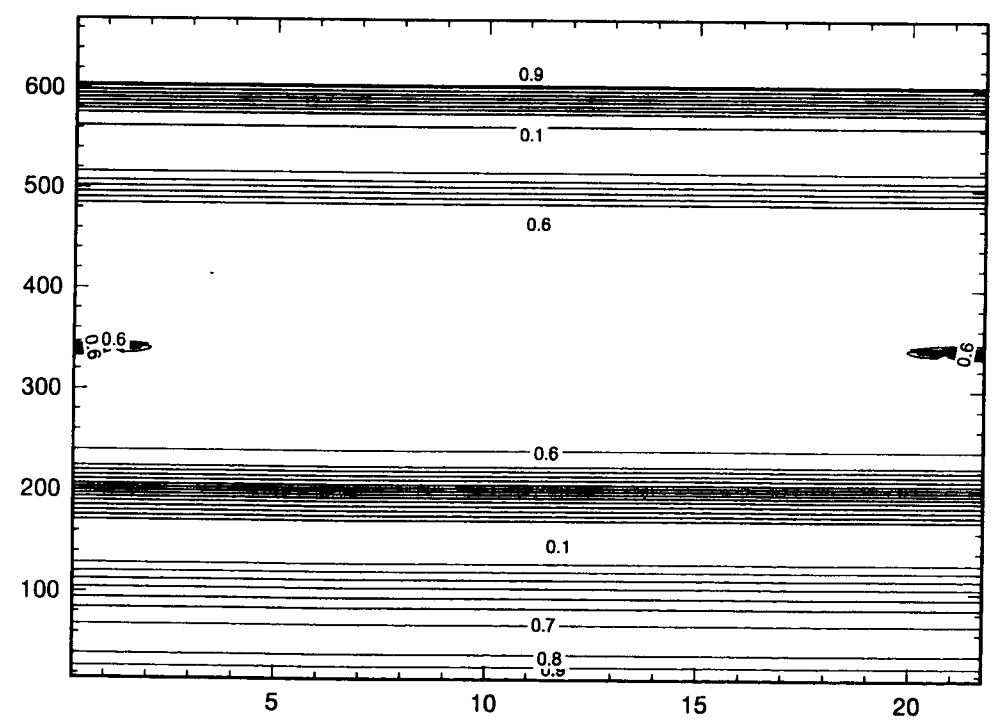
10^5 yrs



RA 2/8/96

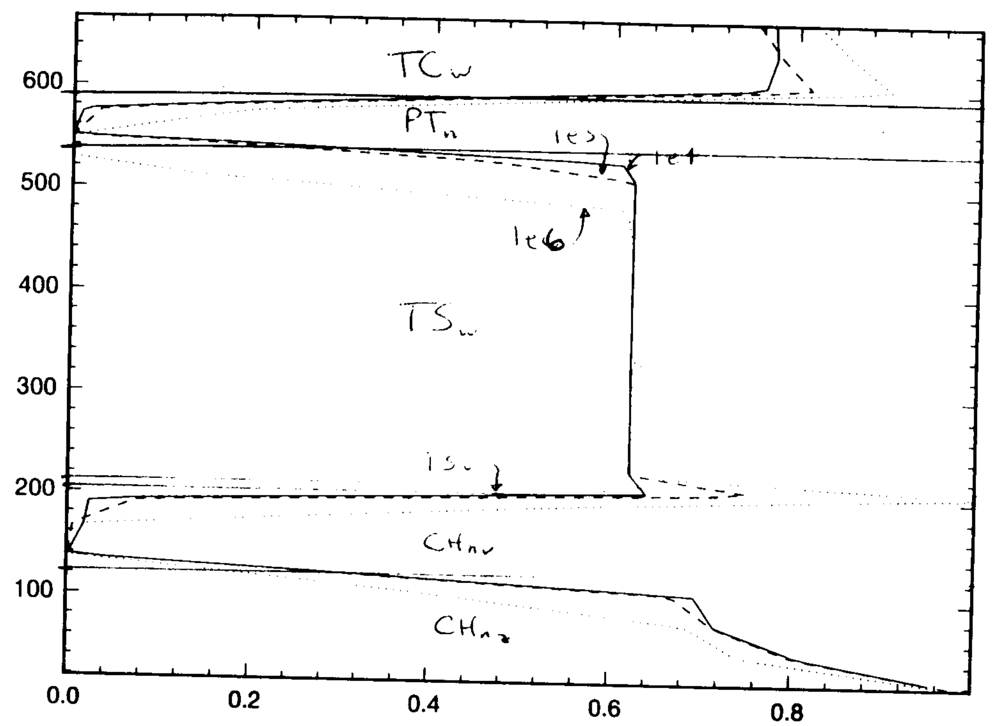
Print II 5 Feb 1996 II 2h-odeVAR3.plt II C-TOUGH field variables 3.1558E+13

10^6 yrs



Print 5 Feb 1996 line-1.plt lin-2.plt line-3.plt temp 1e4

RF 2/8/96



This shows evolution of saturation profile starting from initial guess provided by ODE in eval-ctough.F. Note PTn & CHnv both dry out

Used ODE guess as initial condition for 2h-85i, a simulation using 2 evenly input heaters at 85 kW/acre - same as in the TSPA95. 16 evenly sized heat sources in A, B, R, S 18-21

```
A  18 FLX  1    0    0    0  11 HEAT'    b  0.0000E+00 0.00E+00 0.000E+00
  0.0000E+00 3.1536E+08 6.3072E+08 1.2614E+09
  1.8922E+09 3.1536E+09 6.3072E+09 1.8922E+10
  3.1536E+10 3.1536E+11 3.1536E+12
  5.25E+02 3.85E+02 3.16E+02 2.28E+02
  1.73E+02 1.14E+02 6.67E+01 3.56E+01
  2.52E+01 5.79E+00 2.92E+00
A  19 FLX  1    0    0    0  11 HEAT     b  0.0000E+00 0.00E+00 0.000E+00
```

RF 2/8/96

* No infiltration: Even w/ 1mm/yr, 2h-ODEi will not run past 610 yrs with no heat

Calculations for heat source in 2h-85i

	cross-section (m²)
heaters in A, B, R, S 18-21	9.5

depth of elements is 19 m

⇒ total cross-section area 19 × 22 = 418 m²

$\frac{418\ m^2}{4046\ m^2/acre}$ = 0.103 acres

83 MTU/acre @ 0.98 kW/MTU = 81.3 kW/acre

⇒ (0.103 acres)(81.3 kW/acre) = 8.403 kW/slice

⇒ per column = $\frac{8.403}{4}$ = 2.101 kW/col

⇒ per element = $\frac{2.101}{4}$ = 0.525 kW/element = 525 J/s

for time varying heat source

1	525
2	385.2
3	316.4
4	228.4
5	173.0
6	113.9
7	66.69
8	35.57
9	25.21
10	5.790
11	0.292

4/16/96 ran 2h-85i for 8 days. It got to 12.1 yrs within a few hours then stalled. Time step stayed at 5e-7 yrs for remainder. Don't know the cause. Changed heater material to TSw & resubmitted as 2h-85ai. If this doesn't affect output, will remove PTn. Backfill has already been replaced by TSw

2/19/96 RFF — Adjusting of convergence criteria in DTSTP did not help. Simulation died after about 6.12 yrs

2/20/96 RFF — Changed heater material to single phase (all air) did not help. Simulation only made it to 12.1 yrs before time steps → 1e-7 yrs.

in DTSTP

dpg 8e5
dsg 0.5e-1
dt 1.0
dx 0.5e-1

heater had k_{sat} = 3.33 e-10 in x, y, z

2/26/96 RFF — Abandoned CTOUGH to try MULTIFLO & see what it might do with the same problem. Input file starts on pg 159

3/1/96 RFF — Ran tspa9.dat:
(home/sneezy/rgreen/multi/tspa/tspa9.dat)

first ont to 2,000,000 yrs w/ no heat source but w/ 0.3 mm/yr infiltration source. Would not run through w/ Bcon of 0.3 mm/yr.

Run quit after 1000 yrs of heating. Used cut & paste of results of 2,000,000 yr as initial conditions & reran. Went through to 2,000,000 yrs

tspa8.dat is the same but w/ different initial conditions and w/o SKIP/NOSKIP

tspa9.dat

```
Test  Data for Multiflo simulator (initial data : 2D, Yucca Mt.)
                   March 1, 1996
: added 0.3 mm/yr infiltration using source terms, not bcon
: heat added to 8 elements
: set upper element to large heat capacity
: tspa9 uses results from 2M yrs of tspa8
RSTART  0
:
:      XYZ                          = 1 table look-up,; pref = ref. press.
:      RADIAL                       = 0 correlations;   tref = ref temp.
:      OTHER                           ^
:                                      |
:grid  geometry  nx ny   nz ivplwr ipvtab  idir    pref tref  href
Grid   XYZ       19  1   43   1       1      1     0    0
:
Monitor
 135
debug 1
0                                :relative perm and pc keyword
Pckr
:   i  type-curv swir   rpm(lamda)  alpha    pcwmx  sgc  iecm
:                swirm  rpm(lamda)  alpham  phim     phif   permm    permf
                                   1.315e-5  50.       0.  1
    1  Van-Gen   0.040  .7635
                 0.002  0.3600     8.4e-7  .087     1.8e-3 9.7e-19 3.9e-12
                                   1.315e-5  50.       0.  1
    2  Van-Gen   0.040  .7635
                 0.100  0.8500    1.53e-7  .421     1.8e-3 3.9e-14 3.9e-13
                                   1.315e-5  50.       0.  1
    3  Van-Gen   0.040  .7635
                 0.080  0.4400     5.8e-7  .139     1.8e-3 1.9e-18 3.9e-12
                                   1.315e-5  50.       0.  1
    4  Van-Gen   0.040  .7635
                 0.080  0.4438     5.8e-7  .065     1.8e-3 1.9e-18 3.9e-12
                                   1.315e-5  50.       0.  1
    5  Van-Gen   0.040  .7635
                 0.041  0.7400    1.63e-6  .331     1.8e-3 2.7e-14 3.9e-13
                                   1.315e-5  50.       0.  1
    6  Van-Gen   0.040  .7635
                 0.110  0.3800    3.13e-7  .306     1.8e-3 2.0e-18 3.9e-12
                                   1.315e-5  50.       0.  1
:     7  Van-Gen   0.040  .7635                     phif   permm    permf
:                swirm  rpm(lamda)  alpham  phim    1.8e-3 3.9e-14 3.9e-12
:                0.010  0.7000     1.11e-5  0.50
0          :blank line
:
Debug  1
0
Thermal-prop
: no rho        cpr     ckdry  cksat   crp  crt   tau  cdiff    cexp  enbd
  1  2.580e+03 728.0    1.69   2.23    0    0     .5   2.13e-5  1.8   1.
  2  2.580e+03 422.     0.61   0.81    0    0     .5   2.13e-5  1.8   1.
  3  2.580e+03 840.0    2.10   2.78    0    0     .5   2.13e-5  1.8   1.
  4  2.580e+03 948.     1.28   1.69    0    0     .5   2.13e-5  1.8   1.
  5  2.580e+03 488.0    0.84   1.11    0    0     .5   2.13e-5  1.8   1.
  6  2.580e+03 526.     0.42   1.88    0    0     .5   2.13e-5  1.8   1.
  7  2.580e+03 9e+50    1.69   2.23    0    0     .5   2.13e-5  1.8   1.
: 8  2.580e+03 840.0    0.60   0.79    0    0     .5   2.13e-5  1.8   1.
0
:     igrid   rw       re
DXYZ   2
: (dx(i),i=1,nx)
.5 .5 .75 .75 1. 1.25 1.25 2. 2. 2.
2. 2. 1.25 1.25 1. .75 .75 .5 .5
: (dy(j),j=1,ny)
1.
: (dz(k),k=1,nz)


16. 16. 16. 16. 16. 15. 14. 13. 13. 13.
15. 20. 34. 30. 30. 30. 17. 10. 5. 2.5
.75 .75 .5 .5 .5 .5 .75 .75 2.5 5.
10. 20. 30. 30. 30. 8. 20. 30. 31. 30.
30. 30. 31.
PhiK
: i1 i2 j1 j2 k1 k2 iist ithrm vb   por permx permy  permz  pormm permm
   1 19  1  1  1  1   1    7   0.
   1 19  1  1  2  6   1    1   0.
   1 19  1  1  7 10   2    2   0.
   1 19  1  1 11 35   3    3   0.
   1 19  1  1 36 36   4    4   0.
   1 19  1  1 37 39   5    5   0.
   1 19  1  1 40 42   6    6   0.
   1 19  1  1 43 43   6    6   6.2832e7
 :
```

RF 3/1/96

```
 0
Init
:  i1   i2  j1   j2   k1   k2    p               t       sg       x2   sgm
   1    1   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   2    2   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   3    3   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   4    4   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   5    5   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   6    6   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   7    7   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   8    8   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   9    9   1    1    1    1 9.99999E+04    13.0480 2.3764E-01 0.0000E+00 2.3764E-01
  10   10   1    1    1    1 9.99999E+04    13.0480 2.3764E-01 0.0000E+00 2.3764E-01
  11   11   1    1    1    1 9.99999E+04    13.0480 2.3764E-01 0.0000E+00 2.3764E-01
  12   12   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
  13   13   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
  14   14   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
  15   15   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
  16   16   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
  17   17   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
  18   18   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
  19   19   1    1    1    1 9.99999E+04    13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   1    1   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
   2    2   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
   3    3   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
   4    4   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
   5    5   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
   6    6   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
   7    7   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
   8    8   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
   9    9   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
  10   10   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
  11   11   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
  12   12   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
  13   13   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
  14   14   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
  15   15   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
  16   16   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
  17   17   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
  18   18   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
  19   19   1    1    2    2 1.00190E+05    13.2832 2.5186E-01 0.0000E+00 2.5186E-01
   1    1   1    1    3    3 1.00380E+05    13.5189 2.7121E-01 0.0000E+00 2.7121E-01
   2    2   1    1    3    3 1.00380E+05    13.5189 2.7121E-01 0.0000E+00 2.7121E-01
   3    3   1    1    3    3 1.00380E+05    13.5189 2.7121E-01 0.0000E+00 2.7121E-01

  10   10   1    1   42   42 1.07610E+05    24.4662 1.2149E-02 0.0000E+00 1.2149E-02
  11   11   1    1   42   42 1.07610E+05    24.4662 1.2149E-02 0.0000E+00 1.2149E-02
  12   12   1    1   42   42 1.07610E+05    24.4662 1.2149E-02 0.0000E+00 1.2149E-02
  13   13   1    1   42   42 1.07610E+05    24.4663 1.2149E-02 0.0000E+00 1.2149E-02
  14   14   1    1   42   42 1.07610E+05    24.4663 1.2149E-02 0.0000E+00 1.2149E-02
  15   15   1    1   42   42 1.07610E+05    24.4663 1.2149E-02 0.0000E+00 1.2149E-02
  16   16   1    1   42   42 1.07610E+05    24.4663 1.2149E-02 0.0000E+00 1.2149E-02
  17   17   1    1   42   42 1.07610E+05    24.4663 1.2149E-02 0.0000E+00 1.2149E-02
  18   18   1    1   42   42 1.07610E+05    24.4663 1.2149E-02 0.0000E+00 1.2149E-02
  19   19   1    1   42   42 1.07610E+05    24.4663 1.2149E-02 0.0000E+00 1.2149E-02
   1    1   1    1   43   43 1.07983E+05    24.9873 1.2282E-05 0.0000E+00 1.2282E-05
   2    2   1    1   43   43 1.07983E+05    24.9871 1.2282E-05 0.0000E+00 1.2282E-05
   3    3   1    1   43   43 1.07983E+05    24.9867 1.2282E-05 0.0000E+00 1.2282E-05
   4    4   1    1   43   43 1.07983E+05    24.9861 1.2282E-05 0.0000E+00 1.2282E-05
   5    5   1    1   43   43 1.07983E+05    24.9852 1.2282E-05 0.0000E+00 1.2282E-05
   6    6   1    1   43   43 1.07983E+05    24.9839 1.2282E-05 0.0000E+00 1.2282E-05
   7    7   1    1   43   43 1.07983E+05    24.9825 1.2282E-05 0.0000E+00 1.2282E-05
   8    8   1    1   43   43 1.07983E+05    24.9808 1.2282E-05 0.0000E+00 1.2282E-05
   9    9   1    1   43   43 1.07983E+05    24.9795 1.2282E-05 0.0000E+00 1.2282E-05
  10   10   1    1   43   43 1.07983E+05    24.9791 1.2282E-05 0.0000E+00 1.2282E-05
  11   11   1    1   43   43 1.07983E+05    24.9795 1.2282E-05 0.0000E+00 1.2282E-05
  12   12   1    1   43   43 1.07983E+05    24.9808 1.2282E-05 0.0000E+00 1.2282E-05
  13   13   1    1   43   43 1.07983E+05    24.9825 1.2282E-05 0.0000E+00 1.2282E-05
  14   14   1    1   43   43 1.07983E+05    24.9839 1.2282E-05 0.0000E+00 1.2282E-05
  15   15   1    1   43   43 1.07983E+05    24.9852 1.2282E-05 0.0000E+00 1.2282E-05
  16   16   1    1   43   43 1.07983E+05    24.9861 1.2282E-05 0.0000E+00 1.2282E-05
  17   17   1    1   43   43 1.07983E+05    24.9867 1.2282E-05 0.0000E+00 1.2282E-05
  18   18   1    1   43   43 1.07983E+05    24.9871 1.2282E-05 0.0000E+00 1.2282E-05
  19   19   1    1   43   43 1.07983E+05    24.9873 1.2282E-05 0.0000E+00 1.2282E-05
    0
Recurrent-data
Output    A=1    C=1
:
```

RK 3/1/96


```
:  isolv  newtnmn  newtnmx
Solve 2     2        8        4  0  4
Bcon  1
: itype iface i1   i2 j1 j2  qbc    pbc     tbc  sgbc xabc
: 3         TOP   1   19  1  1 .0003 1.e5  13.05  0.48   0.
1        TOP   1   19  1  1 .0000 1.e5  13.05  0.48   0.
: 1   BOTTOM  1   19  1  1   0.  1.e5  25.0   .00945 0.
:
:AUTO-step  DPMXE    DSMXE  DTMPMXE   DP2MXe
AUTO-step   1.0E+4   0.03    5.0       1.e4
:
:TOLR TOLP  TOLS  TOLT  TOLP2  TOLM  TOLA  TOLE
Tolr   10. 1.e-4  1.e-3  1.e+1 1.e-5 1.e-3 1.e-3 1.e-25 1.e-25 1.e-25
:
:Limit dpmx    dsmx dtmpmx dp2mx dtmn dtmx icutmx
LIMIT  1.e5    .08    10.   1.e5  1.e-5 1.e5
:
Source  19   1.   1.
:  is  js  ks  istyp
    1   1   1   1
0. 13.05 4.756e-9
0
    2   1   1   1
0. 13.05 4.756e-9
0
    3   1   1   1
0. 13.05 7.135e-9
0
    4   1   1   1
0. 13.05 7.135e-9
0
    5   1   1   1
0. 13.05 9.513e-9
0
    6   1   1   1
0. 13.05 1.189e-8
0
    7   1   1   1
0. 13.05 1.189e-8
0
    8   1   1   1
0. 13.05 1.903e-8
0
    9   1   1   1
0. 13.05 1.903e-8
0
   10   1   1   1
0. 13.05 1.903e-8
0
   11   1   1   1
0. 13.05 1.903e-8
0
   12   1   1   1
0. 13.05 1.903e-8
0
   13   1   1   1
0. 13.05 1.189e-8
0
   14   1   1   1
0. 13.05 1.189e-8


0
   15   1   1   1
0. 13.05 9.513e-9
0
   16   1   1   1
0. 13.05 7.135e-9
0
   17   1   1   1
0. 13.05 7.135e-9
0
   18   1   1   1
0. 13.05 4.756e-9
0
   19   1   1   1
0. 13.05 4.756e-9
0
```

x-sectional area: 0.5 m², 0.5 m², 0.75 m², 0.75 m², 1.0 m²

RK 5/3/96

0.3 mm/yr = 9.51e-12 m/s

for ρ_{H_2O} = 1000 kg/m3

⇒ 9.51e-9 kg/m²s

RK 5/3/96

→ 0.3 mm/yr ⇒ 9.51e-9 Kg/m²s per m²

RK 5/3/96

RK 3/1/96

```
SKIP
PLOTS 1
Time[y]  10.
Time[y]  100.
Time[y]  1000.
Time[y]  10000.
Time[y]  20000.
Time[y]  50000.
Time[y]  100000.
Time[y]  200000.
Time[y]  500000.
Time[y]  1000000.
Time[y]  2000000.
rstart 1 0
Steady[y]  1.e+1 1.e-1 1.e-4
NOSKIP
:
Source   8   1.00   1.
: timeq(sec)    T/qht (C/(J/s))     qmt (kg/s) 80APD
:  is  js  ks  istyp
    1   1 .23   3
0.00000E+00       6.21022E+01
6.31152E+07       5.79882E+01
1.26230E+08       5.47233E+01
1.89346E+08       5.20440E+01
2.52461E+08       4.98523E+01
3.15576E+08       4.78501E+01
4.73364E+08       4.35616E+01
6.31152E+08       3.98890E+01
9.46728E+08       3.38588E+01
1.26230E+09       2.90845E+01
1.57788E+09       2.52460E+01
2.36682E+09       1.85840E+01
3.15576E+09       1.47704E+01
4.73364E+09       1.08665E+01
6.31152E+09       8.80230E+00
9.46728E+09       7.05269E+00
1.26230E+10       6.04817E+00
1.57788E+10       5.26637E+00
1.89346E+10       4.58451E+00
2.52461E+10       3.68061E+00
3.15576E+10       3.09849E+00
3.94470E+10       2.53799E+00
4.73364E+10       2.15559E+00

4.73364E+10       2.15559E+00
6.31152E+10       1.66775E+00
7.88940E+10       1.45740E+00
9.46728E+10       1.30629E+00
1.26230E+11       1.17340E+00
1.57788E+11       1.07943E+00
1.89346E+11       9.90374E-01
2.20903E+11       9.20813E-01
2.52461E+11       8.64512E-01
2.84018E+11       8.17705E-01
3.15576E+11       7.77674E-01
3.47134E+11       7.16013E-01
3.78691E+11       6.63996E-01
4.10249E+11       6.19488E-01
4.41806E+11       5.80940E-01
4.73364E+11       5.47211E-01
5.52258E+11       4.78752E-01
6.31152E+11       4.26408E-01
7.88940E+11       3.51390E-01
9.46728E+11       2.99969E-01
1.26230E+12       2.14482E-01
1.57788E+12       1.61784E-01
1.89346E+12       1.24442E-01
2.20903E+12       9.96789E-02
2.52461E+12       8.22487E-02
2.84018E+12       6.94221E-02
3.15576E+12       5.96569E-02
4.73364E+12       4.33199E-02
0
: NOSKIP
:
:        print all at every target time
:Skip
PLOTS 1 6 7 20 47 70 87 135
:      target  dt    dpmx   dsmx   dp2mx   dtmpmx
Time[y]  10.
Time[y]  100.
Time[y]  1000.
Time[y]  10000.
Time[y]  50000.
Time[y]  100000.
Time[y]  2000000.
rstart 1 0
```

4/18/96

22 m² / 4046 m²/acre = 5.44e-3 acres

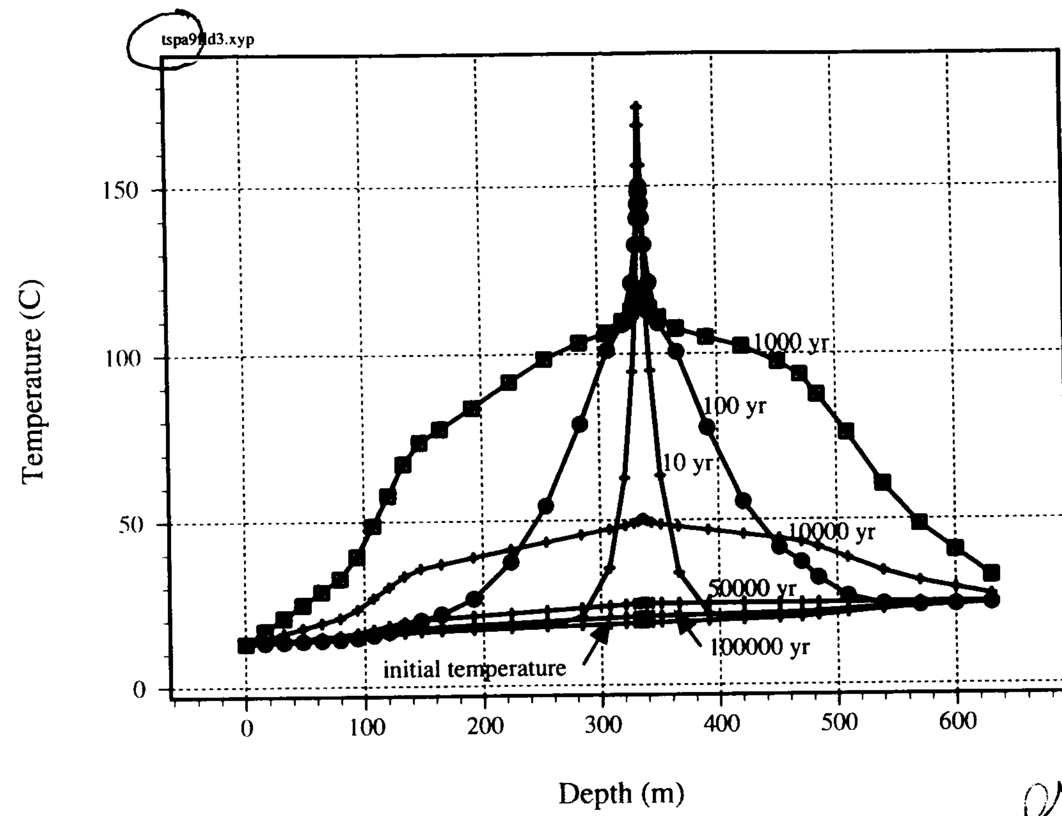
62.1 W / 5.44e-3 = 1.142e4 W/acre

= 11.42 kW/acre per element

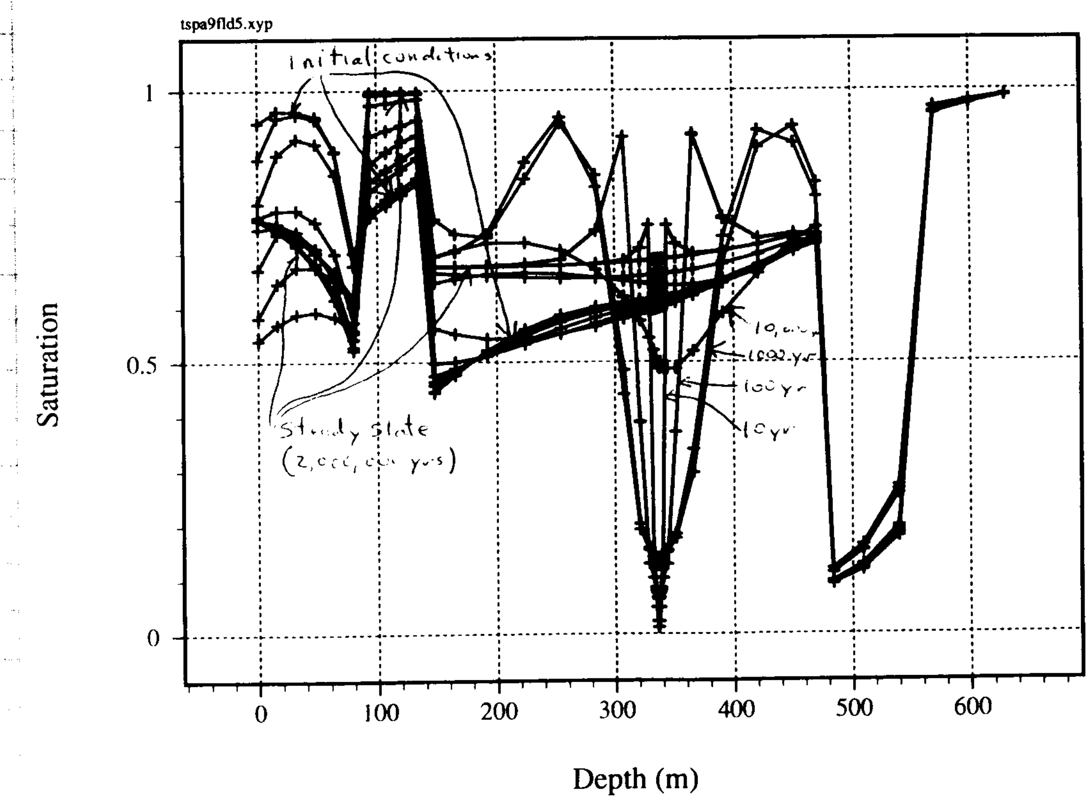
8 elements ⇒ 91.4 kW/acre total

← Ends

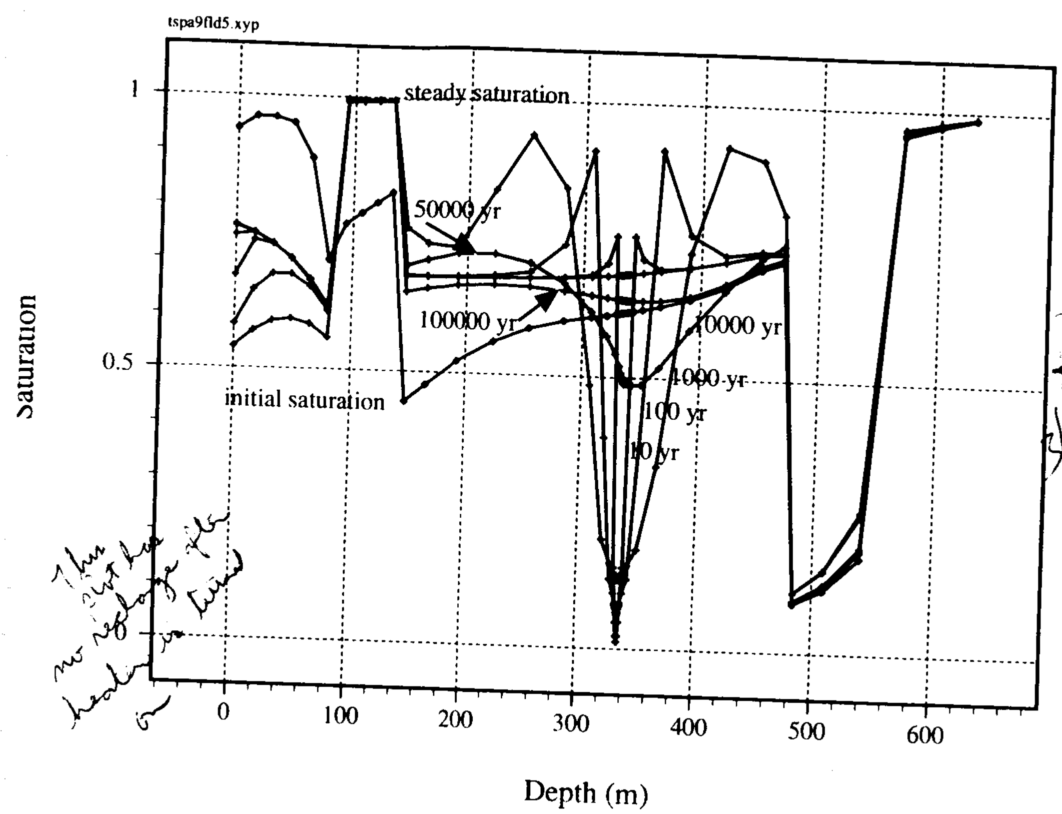
Vertical Temperature Profile-Rock



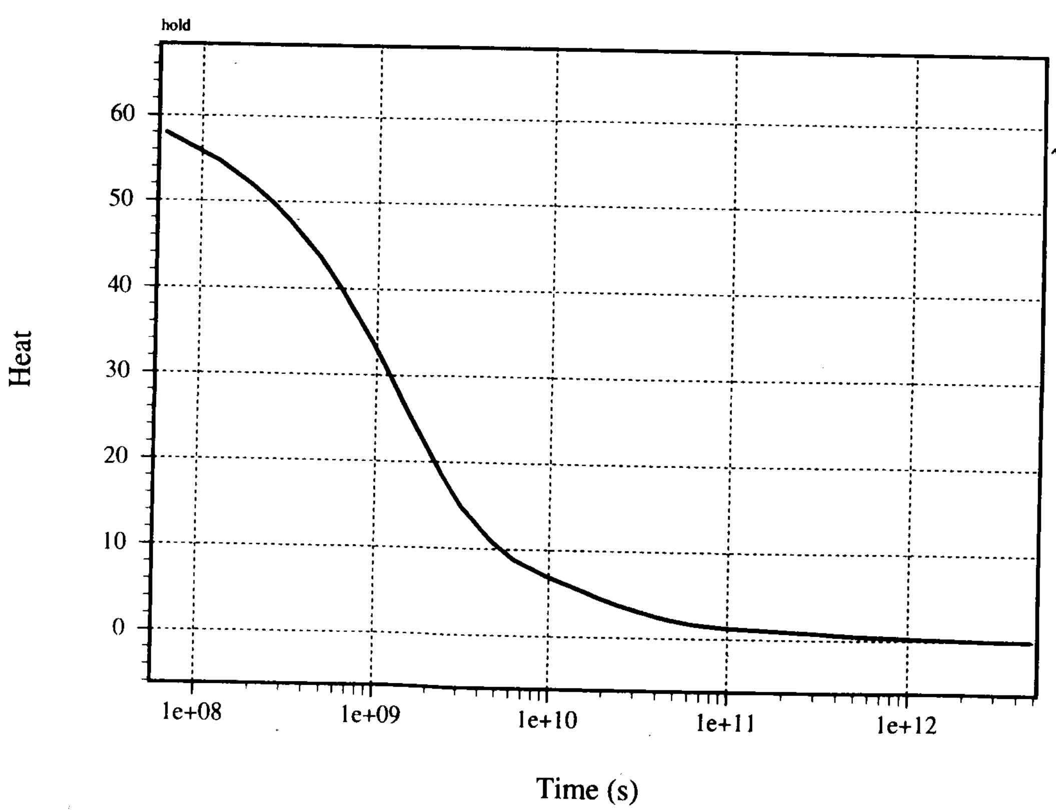
Vertical Saturation Profile-Rock - 0.3 mm/yr



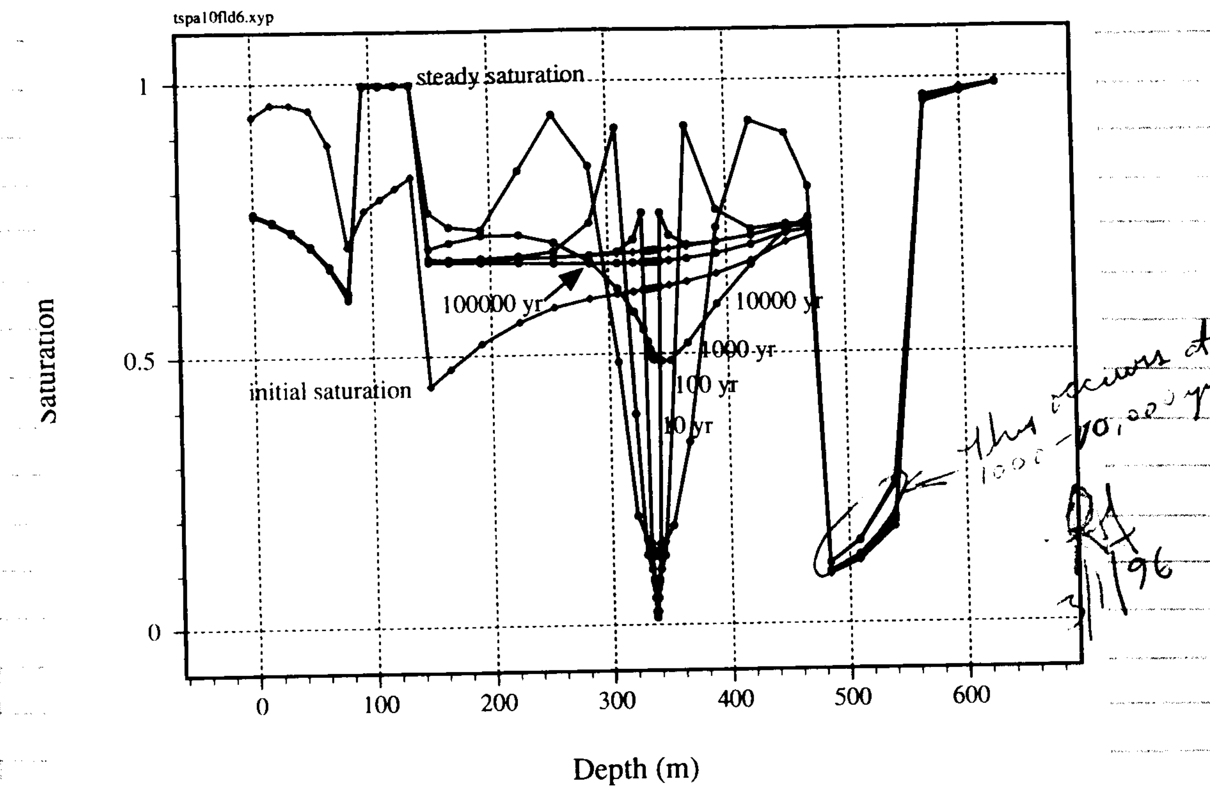
Vertical Saturation Profile-Rock



Heat Load



Vertical Saturation Profile-Rock



3/20/96 Found some input errors in tspa9.dat, particularly the α of the PTn corrected & resubmitted

/home/sneezy/rgreen/multi/tspa/tspa13.dat

→ 2,000,000 yr of infiltration at 0.3mm/yr & 92.5 KW/acre, no heat

input is on following pgs

```
Test  Data for Multiflo simulator (initial data : 2D, Yucca Mt.)
                    March 19, 1996
: tspa13
: added 0.3 mm/yr infiltration using source terms, not bcon
: heat not added to 8 elements
: set upper element to large heat capacity
: moved water infiltration into heat source area
RSTART  0
:
:      XYZ                          = 1 table look-up,; pref = ref. press.
:      RADIAL                       = 0 correlations;   tref = ref temp.
:      OTHER
:
:grid  geometry  nx ny   nz ivplwr ipvtab  idir    pref tref  href
Grid   XYZ       19  1   43   1       1      1      0    0
:
Monitor
 135
debug 1
0
Pckr                              :relative perm and pc keyword
:   i  type-curv swir   rpm(lamda)  alpha     pcwmx  sgc  iecm
:                swirm  rpm(lamda)  alpham  phim      phif   permm    permf
    1  Van-Gen   0.040  .7636        1.305e-5  50.       0.  1
                 0.002  0.3600      8.4e-7  .087     1.8e-3 9.7e-19 3.9e-12
    2  Van-Gen   0.040  .7636        1.315e-5  50.       0.  1
                 0.100  0.8500     1.53e-6  .421     1.8e-3 3.9e-14 3.9e-13
    3  Van-Gen   0.040  .7636        1.315e-5  50.       0.  1
                 0.080  0.4400      5.8e-7  .139     1.8e-3 1.9e-18 3.9e-12
    4  Van-Gen   0.040  .7636        1.315e-5  50.       0.  1
                 0.080  0.4438      5.8e-7  .065     1.8e-3 1.9e-18 3.9e-12
    5  Van-Gen   0.040  .7636        1.315e-5  50.       0.  1
                 0.041  0.7400     1.63e-6  .331     1.8e-3 2.7e-14 3.9e-13
    6  Van-Gen   0.040  .7636        1.315e-5  50.       0.  1
                 0.110  0.3800     3.13e-7  .306     1.8e-3 2.0e-18 3.9e-12
    7  Van-Gen   0.040  .7636        1.315e-5  50.       0.  1
                 0.010  0.7000     1.11e-5  0.50     1.8e-3 3.9e-14 3.9e-12
0           :blank line
:
Debug  1
0
Thermal-prop
: no rho        cpr     ckdry  cksat    crp  crt    tau  cdiff    cexp  enbd
   1  2.580e+03 728.0   1.69   2.23     0    0     .5   2.13e-5  1.8   1.
   2  2.580e+03 422.    0.61   0.81     0    0     .5   2.13e-5  1.8   1.
   3  2.580e+03 840.0   2.10   2.78     0    0     .5   2.13e-5  1.8   1.
   4  2.580e+03 948.    1.28   1.69     0    0     .5   2.13e-5  1.8   1.
   5  2.580e+03 488.0   0.84   1.11     0    0     .5   2.13e-5  1.8   1.
   6  2.580e+03 526.    0.42   1.88     0    0     .5   2.13e-5  1.8   1.
   7  2.580e+03 9e+50   1.69   2.23     0    0     .5   2.13e-5  1.8   1.
   8  2.580e+03 840.0   0.60   0.79     0    0     .5   2.13e-5  1.8   1.
0
:      igrid   rw       re
DXYZ    2
: (dx(i),i=1,nx)
.5 .5 .75 .75 1. 1.25 1.25 2. 2. 2.
2. 2. 1.25 1.25 1. .75 .75 .5 .5
: (dy(j),j=1,ny)
1.
: (dz(k),k=1,nz)
```

3/20/96


```
16. 16. 16. 16. 16. 15. 14. 13. 13. 13.
15. 20. 34. 30. 30. 30. 17. 10. 5. 2.5
.75 .75 .5 .5 .5 .5 .75 .75 2.5 5.
10. 20. 30. 30. 30. 8. 20. 30. 31. 30.
30. 30. 31.
PhiK
: i1 i2 j1 j2 k1 k2 iist ithrm vb  por permx permy  permz  pormm permm
   1 19  1  1  1  1   1    7   0.
   1 19  1  1  2  6   1    1   0.
   1 19  1  1  7 10   2    2   0.
   1 19  1  1 11 35   3    3   0.
   1 19  1  1 36 36   4    4   0.
   1 19  1  1 37 39   5    5   0.
   1 19  1  1 40 42   6    6   0.
   1 19  1  1 43 43   6    6   6.2832e7
:
   0
Init
:  i1   i2   j1   j2   k1   k2    p          t      sg      x2   sgm
   1    1    1    1    1    1 9.99999E+04   13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   2    2    1    1    1    1 9.99999E+04   13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   3    3    1    1    1    1 9.99999E+04   13.0480 2.3765E-01 0.0000E+00 2.3765E-01
>>>>>>>>>>>lines removed here<<<<<<<<<<<<<<
  16   16    1    1   43   43 1.07983E+05   24.9861 1.2282E-05 0.0000E+00 1.2282E-05
  17   17    1    1   43   43 1.07983E+05   24.9867 1.2282E-05 0.0000E+00 1.2282E-05
  18   18    1    1   43   43 1.07983E+05   24.9871 1.2282E-05 0.0000E+00 1.2282E-05
  19   19    1    1   43   43 1.07983E+05   24.9873 1.2282E-05 0.0000E+00 1.2282E-05
    0
Recurrent-data
Output   A=1   C=1
:
:  isolv  newtnmn  newtnmx
Solve 2     2        8          4  0  4
Bcon        1
:ityp fac   i1 i2 k1 k2
:  3  TOP   1 1   1 1
:time qflx   p       T     sg
: 0.   1.0e-4  100000.  25. 0.
: 0
:ityp fac    i1 i2  k1 k2
  1     TOP 1  1   1  1
:time qflx   p       T     sg
 0.    0.   100000.  13.05 0.65
0
:AUTO-step  DPMXE    DSMXE  DTMPMXE    DP2MXe
AUTO-step   1.0E+4   0.03    5.0        1.e4
:
:TOLR TOLP  TOLS  TOLT  TOLP2  TOLM  TOLA  TOLE
Tolr   10. 1.e-4  1.e-3  1.e+1 1.e-5 1.e-3 1.e-3 1.e-25 1.e-25 1.e-25
:
:Limit dpmx    dsmx dtmpmx dp2mx dtmn dtmx icutmx
LIMIT  1.e5    .08    10.   1.e5  1.e-5 1.e5
:
: SKIP
Source  19   1.   1.000
:  is  js  ks  istyp
    1   1   1   1
0. 13.05 4.756e-9
0
    2   1   1   1

0. 13.05 4.756e-9
0
    3   1   1   1
0. 13.05 7.135e-9
0
    4   1   1   1
0. 13.05 7.135e-9
0
    5   1   1   1
0. 13.05 9.513e-9
0
    6   1   1   1
0. 13.05 1.189e-8
0
    7   1   1   1
0. 13.05 1.189e-8
0
    8   1   1   1
0. 13.05 1.903e-8
0
    9   1   1   1
0. 13.05 1.903e-8
0
   10   1   1   1
0. 13.05 1.903e-8
0
   11   1   1   1
0. 13.05 1.903e-8
0
   12   1   1   1
0. 13.05 1.903e-8
0
   13   1   1   1
0. 13.05 1.189e-8
0
   14   1   1   1
0. 13.05 1.189e-8
0
   15   1   1   1
0. 13.05 9.513e-9
0
   16   1   1   1
0. 13.05 7.135e-9
0
   17   1   1   1
0. 13.05 7.135e-9
0
   18   1   1   1
0. 13.05 4.756e-9
0
   19   1   1   1
0. 13.05 4.756e-9
0
PLOTS 1
Time[y]  10.
Time[y]  100.
Time[y]  1000.
Time[y]  10000.
Time[y]  20000.
Time[y]  50000.
```

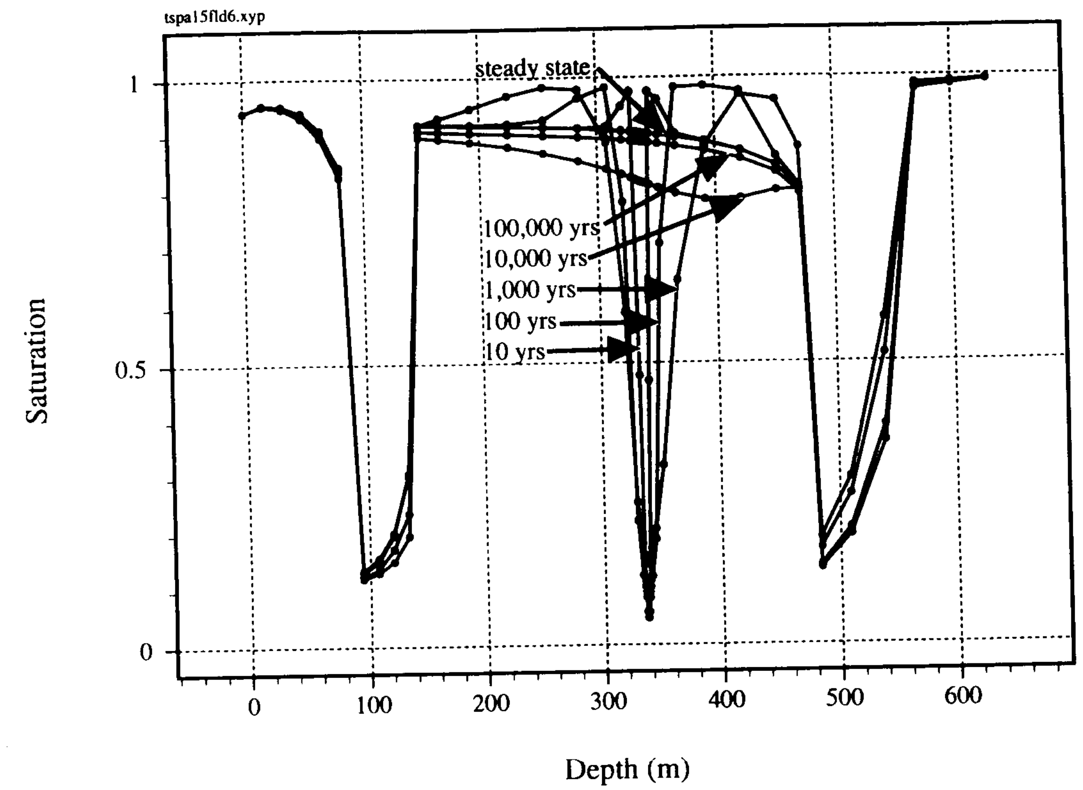
3/20/96

3/20/96

```
Time[y]  100000.
Time[y]  200000.
Time[y]  500000.
Time[y]  1000000.
Time[y]  2000000.
rstart 1 0
Steady[y]  1.e+1 1.e-1 1.e-4
: NOSKIP
SKIP
:
Source  27   1.00   1.000
: timeq(sec)   T/qht (C/(J/s))    qmt (kg/s) 80APD
:  is  js  ks  istyp
    1   1   1   1
0. 13.05 4.756e-9
0
    2   1   1   1
0. 13.05 4.756e-9
0
    3   1   1   1
0. 13.05 7.135e-9
0
    4   1   1   1
0. 13.05 7.135e-9
0
    5   1   1   1
0. 13.05 9.513e-9
0
    6   1   1   1
0. 13.05 1.189e-8
0
    7   1   1   1
0. 13.05 1.189e-8
0
    8   1   1   1
0. 13.05 1.903e-8
0
    9   1   1   1
0. 13.05 1.903e-8
0
   10   1   1   1
0. 13.05 1.903e-8
0
   11   1   1   1
0. 13.05 1.903e-8
0
   12   1   1   1
0. 13.05 1.903e-8
0
   13   1   1   1
0. 13.05 1.189e-8
0
   14   1   1   1
0. 13.05 1.189e-8
0
   15   1   1   1
0. 13.05 9.513e-9
0
   16   1   1   1
0. 13.05 7.135e-9
0
   17   1   1   1
0. 13.05 7.135e-9
0
   18   1   1   1
0. 13.05 4.756e-9
0
   19   1   1   1
0. 13.05 4.756e-9
0
    1   1  23   3
0.00000E+00      6.21022E+01
>>>>>>>>>>>>>>>>>>>lines removed here<<<<<<<<<<<<<<<
1.57788E+12      1.61784E-01
1.89346E+12      1.24442E-01
2.20903E+12      9.96789E-02
2.52461E+12      8.22487E-02
2.84018E+12      6.94221E-02
3.15576E+12      5.96569E-02
4.73364E+12      4.33199E-02
0
: NOSKIP
:
:        print all at every target time
:Skip
PLOTS 1 6 7 20 47 70 87 135
:      target  dt    dpmx   dsmx   dp2mx   dtmpmx
Time[y]  10.
Time[y]  100.
Time[y]  1000.
Time[y]  10000.
Time[y]  50000.
Time[y]  100000.
: Time[y]  2000000.
rstart 1 0
NOSKIP
Ends
```

RK 3/20/96

Yucca Mt - 0.3 mm/yr

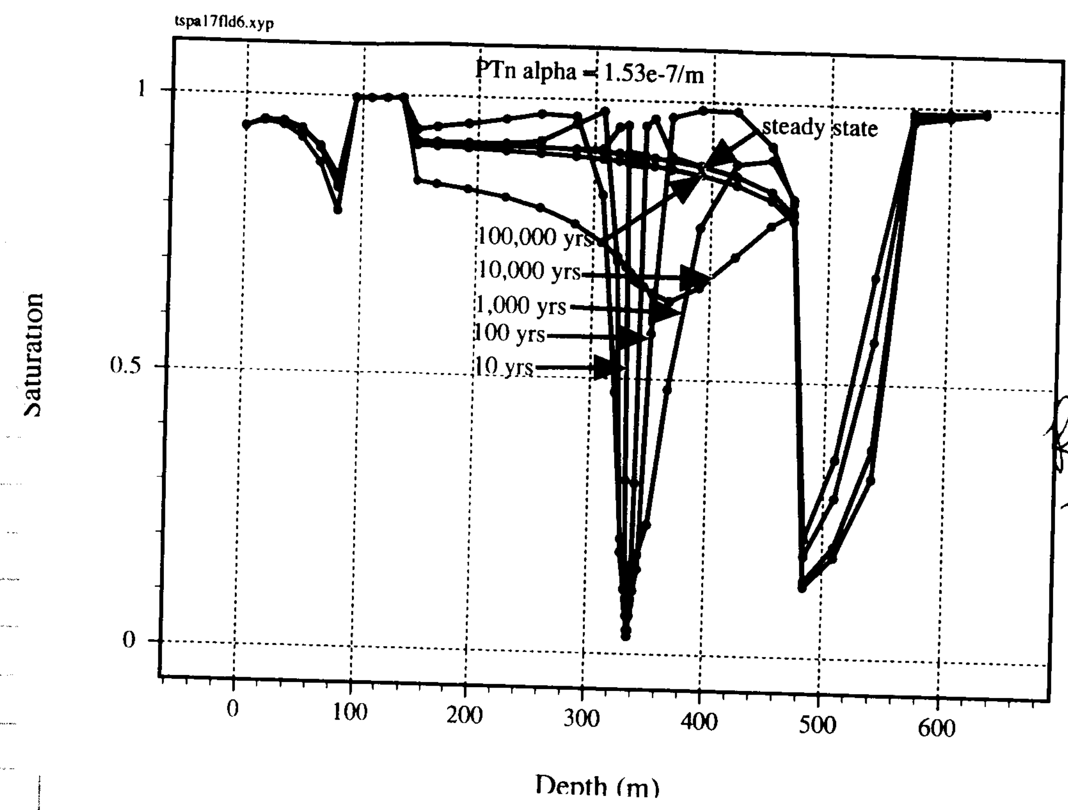


RK 3/20/96

tspa13.dat (3 – RK 3/21/96) has steady state infiltration put in as ~~infil~~ RK 3/20/96 input into tspa15.dat

Changed PTn α to 1.53 e-7 m^{-1} & put into tspa16.dat, ran to steady state, put as input into tspa17.dat & ran for heat at 92.5 kW/acre - Results on pg 170

Yucca Mt - 0.3 mm/yr



RA 3/20/96

tspa17 shown here w/ PTn α changed from 1.53e-6 to 1.53e-7 Pa^{-1}

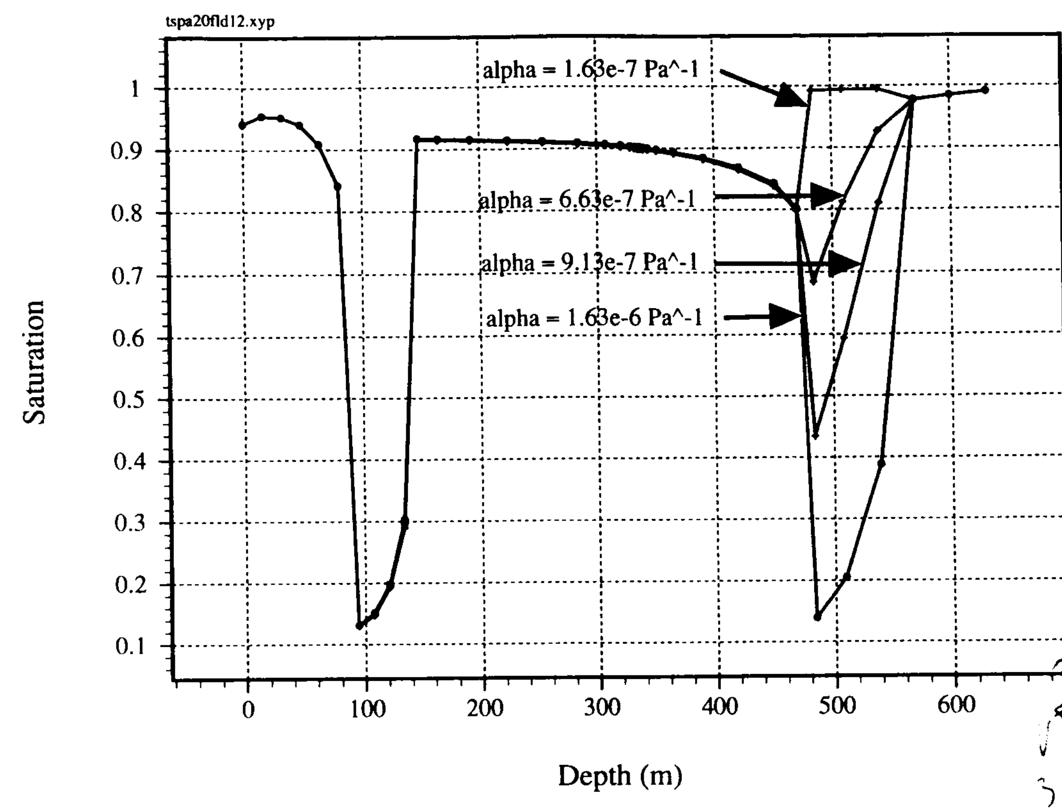
3/21/96

Sensitivity analysis of the α of CHnv

tspa18.dat CHnv 1.63e-7
tspa19.dat CHnv α = 6.63e-7 Pa^{-1}
tspa20.dat CHnv α = 9.13e-7 Pa^{-1}

compared w/ Basecase = tspa13Fld12.xyp

Yucca Mt - 0.3 mm/yr



RA 3/21/96

Comparison of TSPA95 base case (1.63e-6) w/ other values of CHnv α

RA

Objective is to assess ability of MULTIFLO to model Steam Injection/Vapor Extraction. Additional analyses will be to test MULTIFLO for other geologic scenarios for SIVE. RF 3/5/97. These analyses will continue as cases arise.

3/27/96 Used METRA to simulate steam flow experiment reported by Herkelrath, Moench & O'Neal in WRR 19(4) 931-937 1983

Steam introduced into 61 cm cylinder filled with sand/silt/clay

```
Data for Multiflo simulator (initial data : 1D, wrr 19(4) pp931-937)
                    March 27, 1996
RSTART  0
: material properties taken from wrr paper by Herklerath et al. and
: from Las Cruces trench data for a silty sand with some clay
: ~70% sand; ~23% silt; ~7% clay
:
:       XYZ                          = 1 table look-up,; pref = ref. press.
:       RADIAL                       = 0 correlations;   tref = ref temp.
:       OTHER                                  ^
:                                              |
:grid  geometry  nx ny   nz ivplwr ipvtab  idir    pref tref  href
Grid   XYZ        1  1  122   1       1      0      0    0
:
Monitor
 135
debug 1
0
Pckr                              :relative perm and pc keyword
:   i  type-curv swir   rpm(lamda)  alpha     pcwmx   sgc   iecm
    1  Van-Gen   0.040  .3400       4.9e-4    60.        0.  0
0           :blank line
:
Debug  1
0
Thermal-prop
: no rho         cpr    ckdry  cksat    crp   crt    tau   cdiff    cexp   enbd
   1  2.580e+03 840.     1.74    2.3     0     0     .5   2.13e-5   1.8   1.
   2  2.580e+03 840.     1.74    2.3     0     0     .5   2.13e-5   1.8   1.
   3  2.580e+03 840.     1.74    2.3     0     0     .5   2.13e-5   1.8   1.
0
:      igrid    rw       re
DXYZ    2
: (dx(i),i=1,nx)
1.0
: (dy(j),j=1,ny)
1.
: (dz(k),k=1,nz)
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005,0.005
PhiK
:i1  i2  j1  j2  k1  k2  iist  ithrm vb   por   permx     permy     permz     pormm permm
 1   1   1   1   1   1    1     1 1.e+20 0.42 3.60e-12 3.60e-12 3.60e-12 0.42 3.60e-12
 1   1   1   1   2 121    1     2   0.   0.42 3.60e-12 3.60e-12 3.60e-12 0.42 3.60e-12
 1   1   1   1 122 122    1     3   0.   0.42 3.60e-12 3.60e-12 3.60e-12 0.42 3.60e-12
:
  0
Init
:  i1   i2   j1   j2   k1   k2    p        t      sg      x2    sgm
```

RF 3/27/96

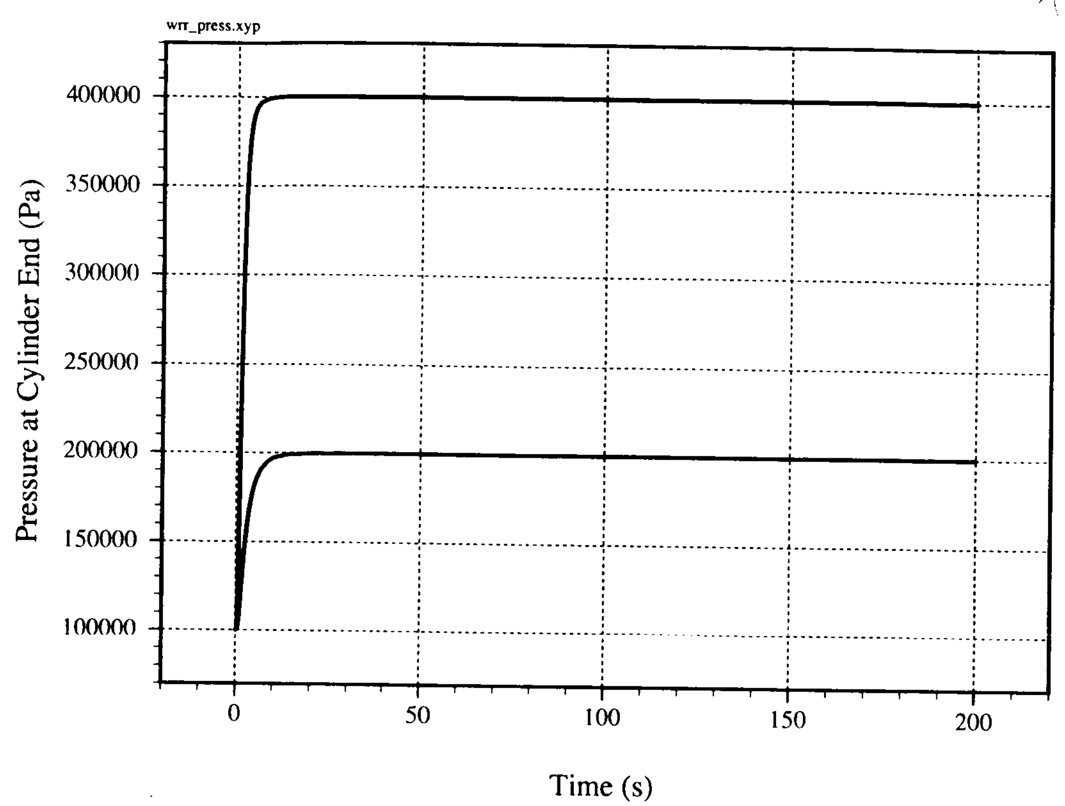

```
 1   1   1   1   1   1     2.0e5   146.   0.960  0.    0.960
 1   1   1   1   2 122     1.0e5   146.   0.960  0.    0.960
 0
Recurrent-data
: SKIP
Bcon        1
:ityp fac   i1 i2 k1 k2
:  3  TOP    1 1   1 1
:time qflx    p         T     sg
: 0.    1.0e-4   100000.  25.  0.
: 0
:ityp fac    i1 i2  k1 k2
  1  LEFT    1  1   1  1
:time qflx    p        T      sg
 0.     0.    2.e+5  146.0 0.960
0
: NOSKIP
:
:AUTO-step  DPMXE    DSMXE  DTMPMXE    DP2MXe
AUTO-step   1.0E+4   0.03   10.0        1.e4
:
:TOLR TOLP  TOLS  TOLT  TOLP2  TOLM  TOLA  TOLE
Tolr   10. 1.e-4  1.e-3  1.e+1 1.e-5 1.e-3 1.e-3 0.  0.  0.
:
:Limit dpmx    dsmx dtmpmx dp2mx  dtmn  dtmx icutmx
LIMIT  5.e4    .05    10.    5.e4  1.e-8 5000.
:
: SKIP
: Source  1  1.  1.
:   is    js   ks   istyp
:     1     1     1     1
: 0.  21. 4.75e-9
: 0
: NOSKIP
:Output   A=1 C=1
:       target  dt      dpmx    dsmx    dp2mx    dtmpmx
:
:         print all at every target time
:Skip
:Time[y]  1.e-12 1.e-12
PLOTS 1 3 1 61 122
Time[s]  1.
Time[s]  10.
Time[s]  50.
Time[s]  100.
Time[s]  200.
rstart 1 0
: STEAdy 1.e-2 1.e-2 1.e-2
Ends
```

3/27/96 RF

RF

Transient Steam Flow

RH 3/27/96



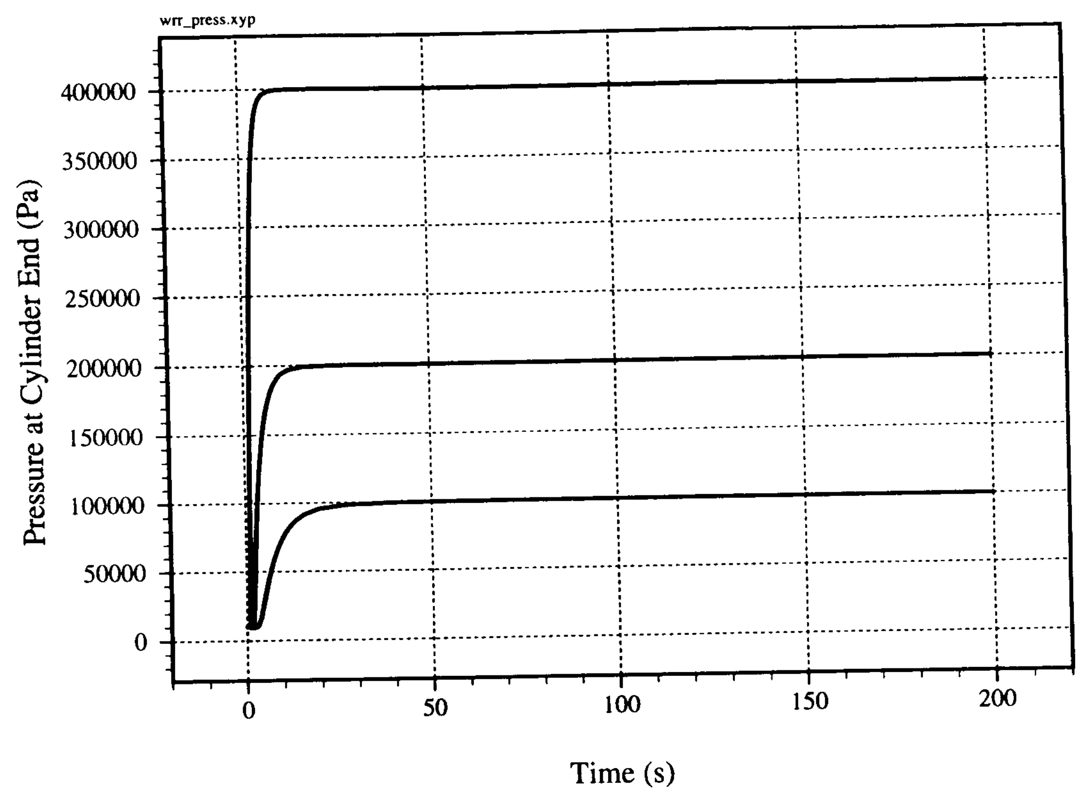
On following page is comparison of METRA & WRR results

WRR.dat was changed to a starting pressure of 1e4 Pa

/home/sneezy/rgreen/mult./wrr/wrr.dat

moved to ~/multi/hunt/. and ~/multi/wang/. 7/19/96 RH

Transient Steam Flow at 146 F



TRANSIENT STEAM FLOW

RH 3/27/96

Information potentially subject to copyright protection was redacted from this location. The redacted material (graph) is from Hunt, et al. "Water Resources Research. 1988.

Fig. 4. Steam pressure at the closed, bottom end of the porous cylinder plotted as a function of time since a step increase in pressure was imposed at the top.

4/17/96 Reran tspa to get sensitivity of
α ~ CHnv

tspa26.dat	1.63e-6
tspa27.dat	1.63e-7
tspa28.dat	6.63e-7
tspa29.dat	9.13e-7

```
Test  Data for Multiflo simulator (initial data : 2D, Yucca Mt.)
                 April 17, 1996
: tspa26
: added 0.3 mm/yr infiltration using source terms, not bcon
: heat not added to 8 elements
: set upper element to large heat capacity
: moved water infiltration into heat source area
: removed Bcon
: cut x increments in half
: heat was cut to 0.45 (~80 kW/acre) and water to 0.5
RSTART  0
:
:      XYZ                          = 1 table look-up,; pref = ref. press.
:      RADIAL                       = 0 correlations;   tref = ref temp.
:      OTHER                          ^
:                                     |
:grid  geometry  nx ny   nz ivplwr ipvtab  idir    pref tref  href
Grid   XYZ       19  1   43   1       1      1      0    0
:
Monitor
 135
debug 1
0
Pckr                                :relative perm and pc keyword
:   i  type-curv swir   rpm(lamda)  alpha     pcwmx  sgc  iecm
:                swirm  rpm(lamda)  alpham  phim     phif   permm    permf
    1  Van-Gen   0.040  .7636        1.305e-5  50.     0.  1
                 0.002  0.3600      8.4e-7   .087   1.8e-3 9.7e-19 3.9e-12
    2  Van-Gen   0.040  .7636        1.315e-5  50.     0.  1
                 0.100  0.8500     1.53e-6   .421   1.8e-3 3.9e-14 3.9e-13
    3  Van-Gen   0.040  .7636        1.315e-5  50.     0.  1
                 0.080  0.4400      5.8e-7   .139   1.8e-3 1.9e-18 3.9e-12
    4  Van-Gen   0.040  .7636        1.315e-5  50.     0.  1
                 0.080  0.4438      5.8e-7   .065   1.8e-3 1.9e-18 3.9e-12
    5  Van-Gen   0.040  .7636        1.315e-5  50.     0.  1
                 0.041  0.7400     1.63e-6   .331   1.8e-3 2.7e-14 3.9e-13
    6  Van-Gen   0.040  .7636        1.315e-5  50.     0.  1
                 0.110  0.3800     3.13e-7   .306   1.8e-3 2.0e-18 3.9e-12
    7  Van-Gen   0.040  .7636        1.315e-5  50.     0.  1
                 0.010  0.7000     1.11e-5   0.50   1.8e-3 3.9e-14 3.9e-12
0           :blank line
:
Debug  1
0
Thermal-prop
: no rho         cpr    ckdry  cksat    crp  crt    tau  cdiff    cexp  enbd
  1  2.580e+03 728.0    1.69    2.23     0     0    .5  2.13e-5  1.8   1.
  2  2.580e+03 422.     0.61    0.81     0     0    .5  2.13e-5  1.8   1.
  3  2.580e+03 840.0    2.10    2.78     0     0    .5  2.13e-5  1.8   1.
  4  2.580e+03 948.     1.28    1.69     0     0    .5  2.13e-5  1.8   1.
  5  2.580e+03 488.0    0.84    1.11     0     0    .5  2.13e-5  1.8   1.
  6  2.580e+03 526.     0.42    1.88     0     0    .5  2.13e-5  1.8   1.
  7  2.580e+03 9e+50    1.69    2.23     0     0    .5  2.13e-5  1.8   1.
  8  2.580e+03 840.0    0.60    0.79     0     0    .5  2.13e-5  1.8   1.
0
:      igrid   rw       re
DXYZ    2
: (dx(i),i=1,nx)
.25 .25 .375 .375 .5 0.625 0.625 1. 1. 1.
1. 1. 0.625 0.625 .5 .375 .375 .25 .25
```

RF 4/17/96


```
: (dy(j),j=1,ny)
1.
: (dz(k),k=1,nz)
16. 16. 16. 16. 16. 15. 14. 13. 13. 13.
15. 20. 34. 30. 30. 30. 17. 10. 5. 2.5
.75 .75 .5 .5 .5 .5 .75 .75 2.5 5.
10. 20. 30. 30. 30. 8. 20. 30. 31. 30.
30. 30. 31.
PhiK
: il i2 j1 j2 k1 k2 iist ithrm vb   por permx permy  permz  pormm permm
   1 19  1  1  1  1   1    7   0.
   1 19  1  1  2  6   1    1   0.
   1 19  1  1  7 10   2    2   0.
   1 19  1  1 11 35   3    3   0.
   1 19  1  1 36 36   4    4   0.
   1 19  1  1 37 39   5    5   0.
   1 19  1  1 40 42   6    6   0.
   1 19  1  1 43 43   6    6   6.2832e7
:
  0
Init
:  i1   i2  j1   j2  k1  k2   p           t      sg     x2  sgm
   1    1   1    1   1   1 8.66143E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
   2    2   1    1   1   1 8.66143E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
===============lines out here
  15   15    1    1   43   43 9.86958E+04   24.9715 1.0720E-05 0.0000E+00 1.0720E-05
  16   16    1    1   43   43 9.89886E+04   24.9722 1.1701E-05 0.0000E+00 1.1701E-05
  17   17    1    1   43   43 9.91617E+04   24.9726 1.2280E-05 0.0000E+00 1.2280E-05
  18   18    1    1   43   43 9.92525E+04   24.9729 1.2618E-05 0.0000E+00 1.2618E-05
  19   19    1    1   43   43 9.92879E+04   24.9730 1.2752E-05 0.0000E+00 1.2752E-05
   0    0
Recurrent-data
Output   A=1   C=1
:
:  isolv  newtnmn  newtnmx
Solve 2     2        8         4  0  4
SKIP
Bcon         1
:ityp fac    i1 i2 k1 k2
:  3  TOP    1 1   1 1
:time qflx    p         T    sg
: 0.    1.0e-4   100000.  25. 0.
: 0
:ityp fac    i1 i2  k1 k2
  1      TOP 1  1   1  1
:time qflx    p         T      sg
 0.     0.   100000.  13.05 0.65
0
NOSKIP
:AUTO-step  DPMXE    DSMXE  DTMPMXE   DP2MXe
AUTO-step   1.0E+4   0.03    5.0       1.e4
:
:TOLR TOLP  TOLS  TOLT  TOLP2  TOLM  TOLA  TOLE
Tolr   10. 1.e-4  1.e-3  1.e+1 1.e-5 1.e-3 1.e-3 1.e-25 1.e-25 1.e-25
:
:Limit dpmx    dsmx dtmpmx dp2mx dtmn dtmx icutmx
LIMIT  1.e5    .08    10.    1.e5  1.e-5 1.e5
:
: SKIP
Source  19   1.   0.500 .
```

RF 4/17/96

Results are similar to pg 171

```
: is js ks istyp
    1  1  1  1
0. 13.05 4.756e-9
0
    2  1  1  1
0. 13.05 4.756e-9
0
    3  1  1  1
0. 13.05 7.135e-9
0
    4  1  1  1
0. 13.05 7.135e-9
0
    5  1  1  1
0. 13.05 9.513e-9
0
    6  1  1  1
0. 13.05 1.189e-8
0
    7  1  1  1
0. 13.05 1.189e-8
0
    8  1  1  1
0. 13.05 1.903e-8
0
    9  1  1  1
0. 13.05 1.903e-8
0
   10  1  1  1
0. 13.05 1.903e-8
0
   11  1  1  1
0. 13.05 1.903e-8
0
   12  1  1  1
0. 13.05 1.903e-8
0
   13  1  1  1
0. 13.05 1.189e-8
0
   14  1  1  1
0. 13.05 1.189e-8
0
   15  1  1  1
0. 13.05 9.513e-9
0
   16  1  1  1
0. 13.05 7.135e-9
0
   17  1  1  1
0. 13.05 7.135e-9
0
   18  1  1  1
0. 13.05 4.756e-9
0
   19  1  1  1
0. 13.05 4.756e-9
0
PLOTS 1
Time[y]  10.
Time[y]  100.
Time[y]  1000.
Time[y]  10000.
Time[y]  20000.
Time[y]  50000.
Time[y]  100000.
Time[y]  200000.
Time[y]  500000.
Time[y]  1000000.
Time[y]  2000000.
rstart 1 0
Steady[y]  1.e+1 1.e-1 1.e-4
: NOSKIP
SKIP
:
Source  27   0.45   0.500
: timeq(sec)   T/qht (C/(J/s))    qmt (kg/s) 80APD
: is  js  ks  istyp
    1   1   1   1
0. 13.05 4.756e-9
0
==============lines out here
Time[y]  10000.
Time[y]  50000.
Time[y]  100000.
: Time[y]  2000000.
rstart 1 0
NOSKIP
Ends
```

RH 4/17/96

This plot is on pg 181 RH 4/22/96

Varied α of PTn & kept α of CHnv at 1.63 e-7

→ (tspa26.dat)	(1.53 e-~~7~~ 6) RH 4/17/96		
tspa30.dat	1.53 e-7	} same	use
tspa31.dat	~~4~~ 8.53 e-7 RH 4/17/96		don't use
tspa32.dat	8.53 e-7	slightly different	don't use
→ tspa33.dat	1.23 e-6	good	use
→ tspa34.dat	1.03 e-6	good	use
→ tspa35.dat and	CHnv to 1.63 e-7 PTn to 1.53 e-7		} use

4/18/96 tspa36.dat has tspa-95 α values, initial conditions from tspa26_out and new heat decay curve (taken from tspa-95)

```
:SKIP
:This decays at the same rate as the
:TSPA waste decays (see figure 4.2-3)
:(first 10,000 years only)
    1    1   23    3
1.00000E+04       6.21022E+01
6.31152E+07       5.65110E+01
1.26230E+08       5.46480E+01
1.89346E+08       5.34060E+01
2.52461E+08       5.21640E+01
3.15576E+08       5.09220E+01
4.73364E+08       4.65750E+01
6.31152E+08       4.22280E+01
9.46728E+08       3.72600E+01
1.26230E+09       3.22920E+01
1.57788E+09       2.79450E+01
2.36682E+09       2.23560E+01
3.15576E+09       1.67670E+01
4.73364E+09       1.36620E+01
6.31152E+09       1.11780E+01
9.46728E+09       9.93600E+00
1.26230E+10       8.69400E+00
1.57788E+10       7.45200E+00
1.89346E+10       6.21000E+00
2.52461E+10       4.96800E+00
3.15576E+10       3.85020E+00
3.94470E+10       3.29130E+00
4.73364E+10       2.73240E+00
6.31152E+10       2.11140E+00
7.88940E+10       2.01830E+00
9.46728E+10       1.92510E+00
1.26230E+11       1.80090E+00
1.57788E+11       1.67670E+00
1.89346E+11       1.55250E-00
2.20903E+11       1.42830E-00
2.52461E+11       1.30410E-00
2.84018E+11       1.17990E-00
3.15576E+11       1.05570E-00
3.47134E+11       7.16013E-01
3.78691E+11       6.63996E-01
4.10249E+11       6.19488E-01
4.41806E+11       5.80940E-01
4.73364E+11       5.47211E-01
5.52258E+11       4.78752E-01
6.31152E+11       4.26408E-01
7.88940E+11       3.51390E-01
9.46728E+11       2.99969E-01
1.26230E+12       2.14482E-01
1.57788E+12       1.61784E-01
1.89346E+12       1.24442E-01
2.20903E+12       9.96789E-02
2.52461E+12       8.22487E-02
2.84018E+12       6.94221E-02
3.15576E+12       5.96569E-02
4.73364E+12       4.33199E-02
```

RH 4/18/96

$\frac{11 m^2}{4046} = 2.719e-3$

$\frac{62.1}{2.719e-3} = 2.284e4$

$= 22.84$ kW/acre

8 elements

182.72 kW/acre need to scale it down by 0.5754 to get 105.1 kW/acre

83 kW/acre smeared over 15 of 19 m in y direction

$\Rightarrow 83\left(\frac{19}{15}\right) = 105.1$ kW/acre

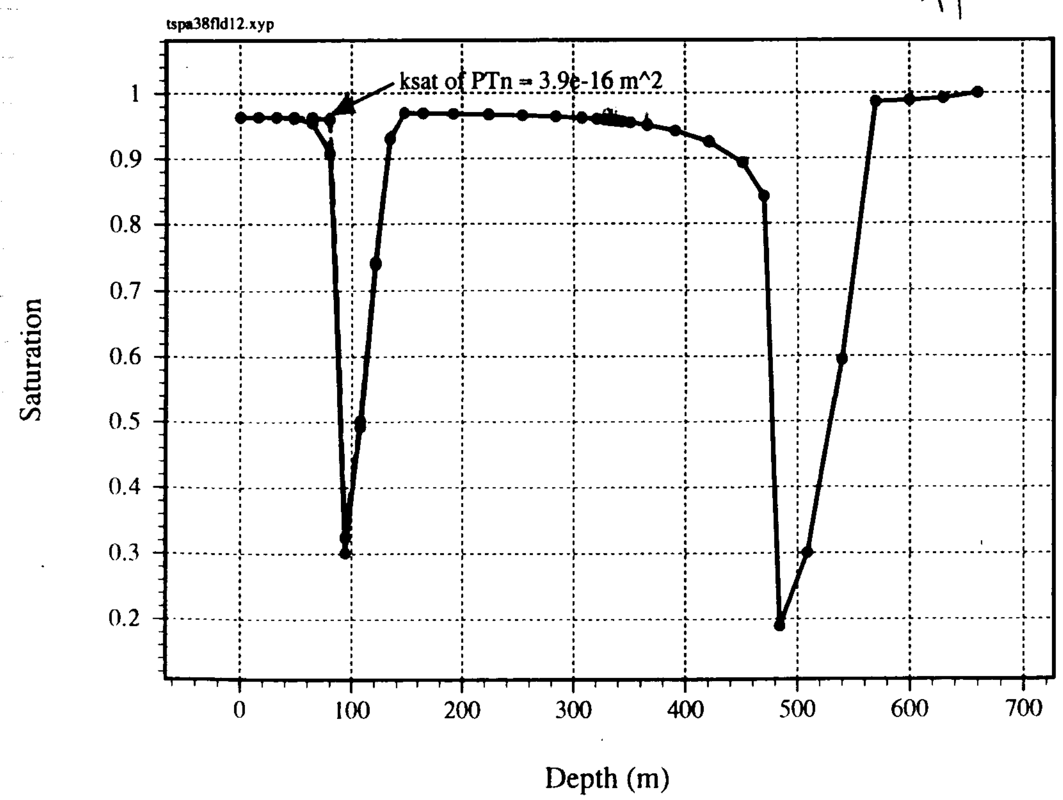
tspa37.dat has both PTn & CHnv at e-7, initial conditions taken from tspa35_out, heat scaled by 0.575 to get ~105.1 KW/acre

4/22/96 Varied other parameters, keeping all others same as in tspa26.dat

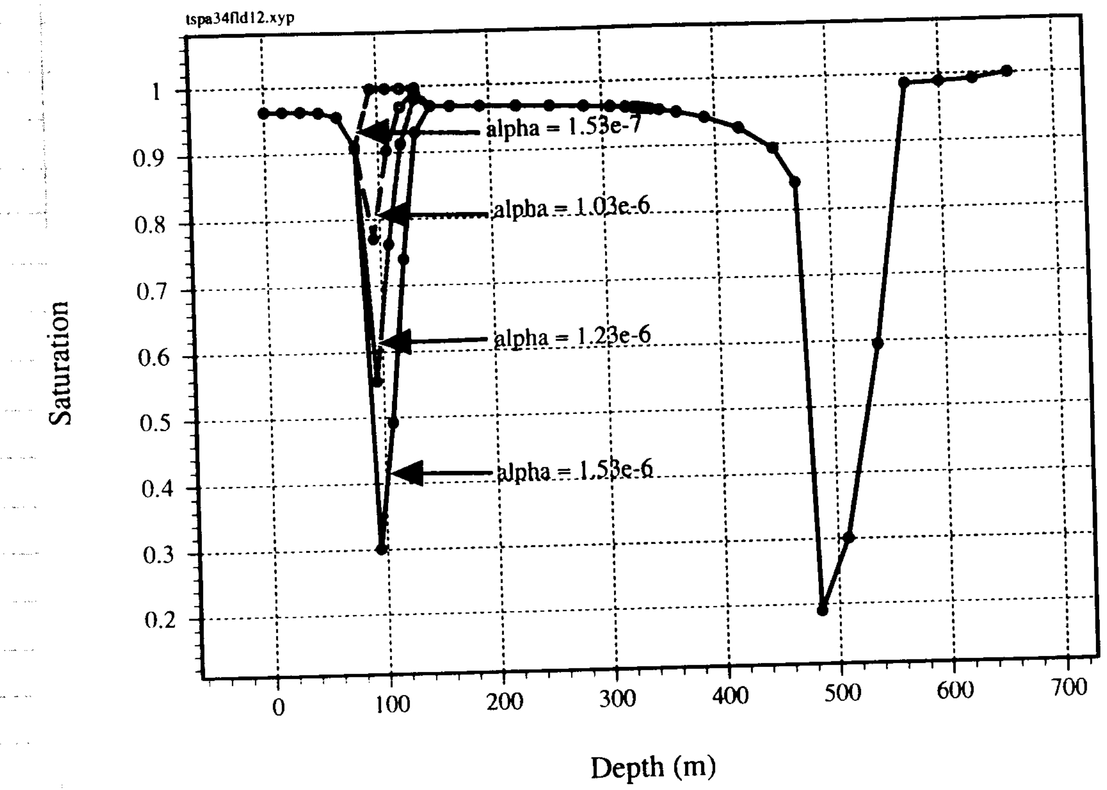
Used tspa38.dat to conduct sensitivity analysis

Changed Ksat of PTn matrix to 3.6e-16 m^2 (increased by a factor of 100) → no change in sat

Yucca Mt - 0.3 mm/yr RH 4/22/96



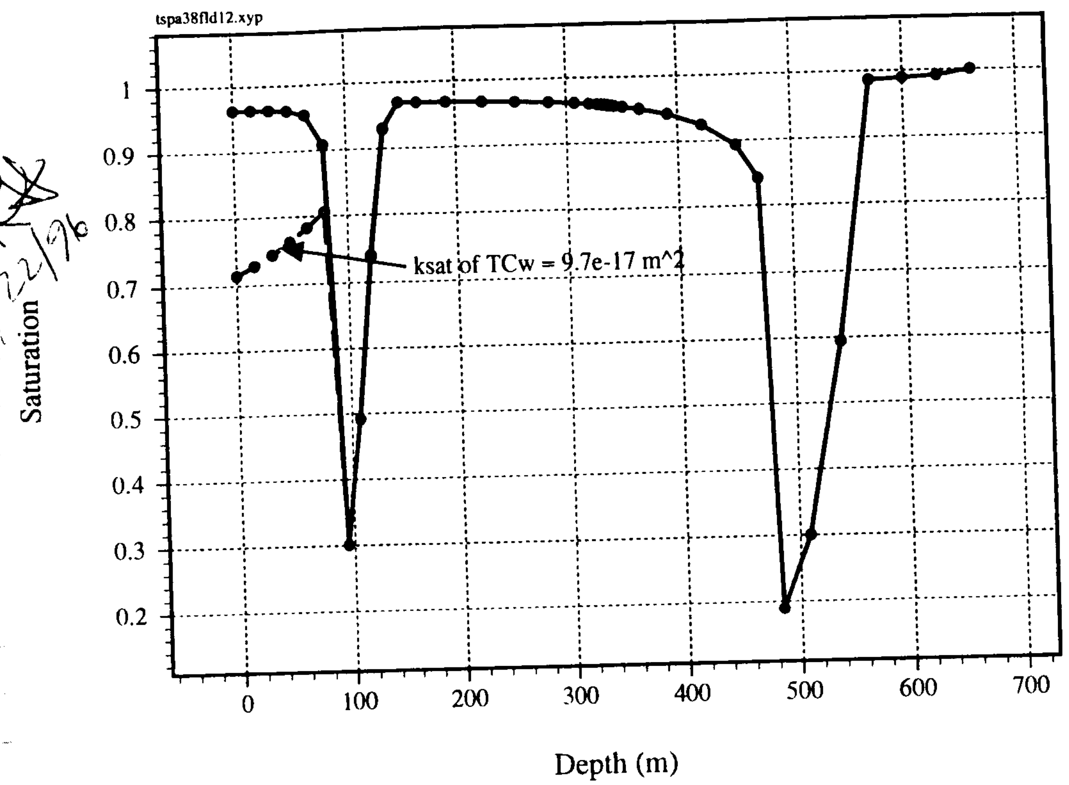
Yucca Mt - 0.3 mm/yr RH 4/22/96



Results of runs listed on top of pg 179 → changing α of PTn for steady state infiltration

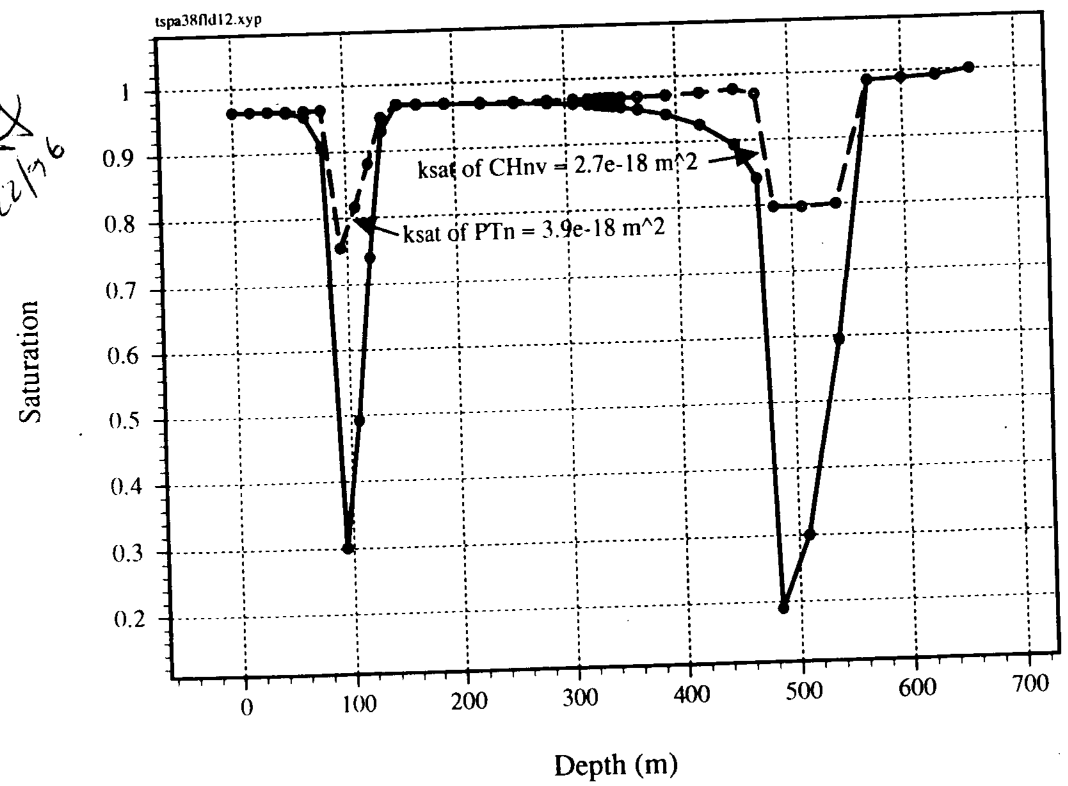
RH

Yucca Mt - 0.3 mm/yr



RK 4/22/96

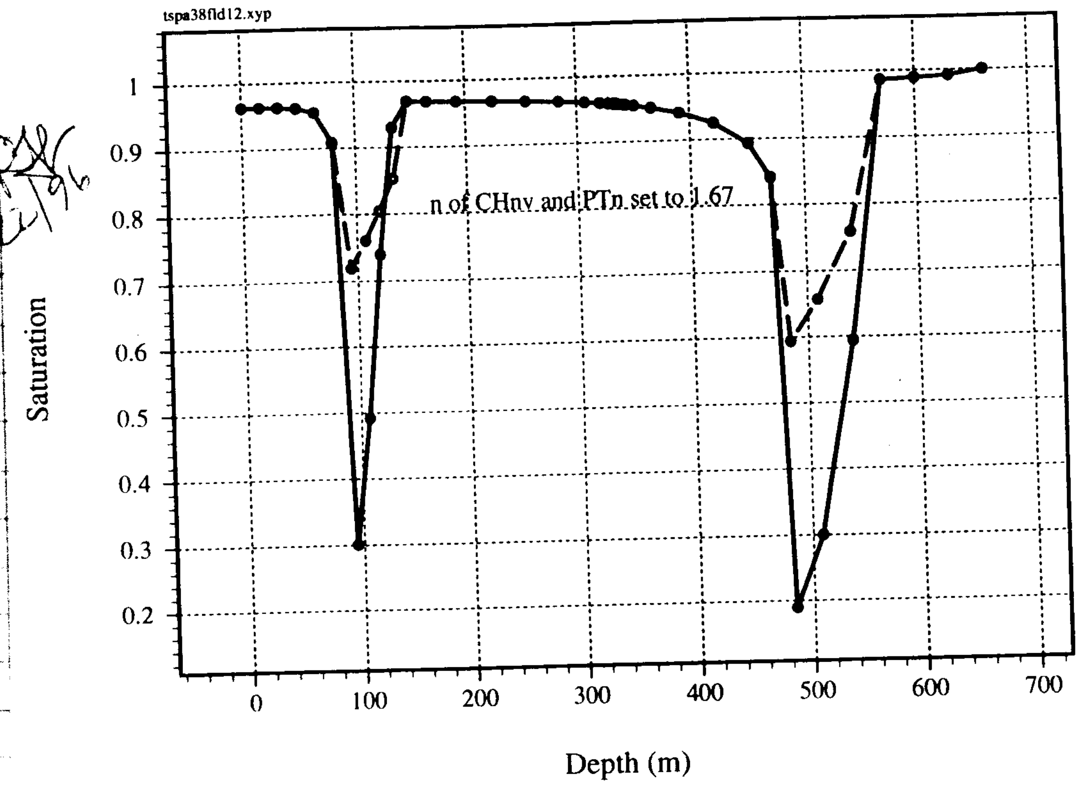
Yucca Mt - 0.3 mm/yr



RK 4/22/96

Effect of decreasing both PTn & CHnv K_{sat} by factor of 10^4

Yucca Mt - 0.3 mm/yr



RK 4/22/96

CHnv was 3.861 & PTn was 6.872
both were set to 1.667

5/29/96 Final simulations used in the ANS Paper "The Effect of Media Properties on Prediction of Moisture Redistribution at a HLW Repository"

These were made using metra1d. Input files are saved in ~/multi/tspa/ans/.

~~filename~~ Case RK 5/29/96	wetted run	last run
RK 5/29/96 ~~tspa66-1d.d~~ basecase	tspa63-1d.dat	tspa67-1d.dat
Case I	tspa64-1d.dat	tspa68-1d.dat
Case II	tspa70-1d.dat	tspa71-1d.dat
Case III	tspa74-1d.dat	tspa75-1d.dat
Case IV	tspa78-1d.dat	tspa79-1d.dat

```
Test  Data for Multiflo simulator (initial data : 2D, Yucca Mt.)
                        May 21, 1996
: tspa63-1d
: added 0.3 mm/yr infiltration using source terms, not bcon
: heat not added to 8 elements
: set upper element to large heat capacity
: moved water infiltration into heat source area
: removed Bcon
: cut x increments in half
: heat was cut to 0.45 (~80 kW/acre) and water to 0.5
: all values are from TSPA-95
RSTART  0
:
:       XYZ                          = 1 table look-up,; pref = ref. press.
:       RADIAL                       = 0 correlations;   tref = ref temp.
:       OTHER                              ^
:                                          |
:grid  geometry  nx ny   nz ivplwr ipvtab  idir    pref tref  href
Grid   XYZ       19  1   43   1       1      1      0    0
:
Monitor
 135
debug 1
0
Pckr                              :relative perm and pc keyword
:   i  type-curv swir   rpm(lamda)  alpha     pcwmx  sgc  iecm
:                swirm  rpm(lamda)  alpham  phim     phif   permm    permf
    1  Van-Gen   0.040  .7636       1.305e-5  50.       0.  1
                 0.002  0.3600     8.4e-7  .087     1.8e-3 9.7e-19 3.9e-12
    2  Van-Gen   0.040  .7636       1.315e-5  50.       0.  1
                 0.100  0.8545    1.53e-6  .421     1.8e-3 3.9e-14 3.9e-13
    3  Van-Gen   0.040  .7636       1.315e-5  50.       0.  1
                 0.080  0.4400     5.8e-7  .139     1.8e-3 1.9e-18 3.9e-12
    4  Van-Gen   0.040  .7636       1.315e-5  50.       0.  1
                 0.080  0.4438     5.8e-7  .065     1.8e-3 1.9e-18 3.9e-12
    5  Van-Gen   0.040  .7636       1.315e-5  50.       0.  1
                 0.041  0.7410    1.63e-6  .331     1.8e-3 2.7e-14 3.9e-13
    6  Van-Gen   0.040  .7636       1.315e-5  50.       0.  1
                 0.110  0.3800    3.13e-7  .306     1.8e-3 2.0e-18 3.9e-12
    7  Van-Gen   0.040  .7636       1.315e-5  50.       0.  1
                 0.010  0.7000    1.11e-5  0.50     1.8e-3 3.9e-14 3.9e-12
0           :blank line
:
Debug  1
0
Thermal-prop
: no rho         cpr     ckdry   cksat     crp   crt     tau   cdiff   cexp   enbd
  1  2.580e+03 728.0    1.69     2.23      0      0      .5   2.13e-5  1.8    1.
  2  2.580e+03 422.     0.61     0.81      0      0      .5   2.13e-5  1.8    1.
  3  2.580e+03 840.0    2.10     2.78      0      0      .5   2.13e-5  1.8    1.
  4  2.580e+03 948.     1.28     1.69      0      0      .5   2.13e-5  1.8    1.
  5  2.580e+03 488.0    0.84     1.11      0      0      .5   2.13e-5  1.8    1.
  6  2.580e+03 526.     0.42     1.88      0      0      .5   2.13e-5  1.8    1.
  7  2.580e+03 9e+50    1.69     2.23      0      0      .5   2.13e-5  1.8    1.
  8  2.580e+03 840.0    0.60     0.79      0      0      .5   2.13e-5  1.8    1.
0
:      igrid    rw        re
DXYZ   2
: (dx(i),i=1,nx)
.25 .25 .375 .375 .5 0.625 0.625 1. 1. 1.

1. 1. 0.625 0.625 .5 .375 .375 .25 .25
: (dy(j),j=1,ny)
1.
: (dz(k),k=1,nz)
16. 16. 16. 16. 16. 15. 14. 13. 13. 13.
15. 20. 34. 30. 30. 30. 17. 10. 5. 2.5
.75 .75 .5 .5 .5 .5 .75 .75 2.5 5.
10. 20. 30. 30. 30. 8. 20. 30. 31. 30.
30. 30. 31.
PhiK
: i1 i2 j1 j2 k1 k2 iist ithrm vb   por permx permy   permz   pormm permm
   1 19  1  1  1  1   1    7    0.
   1 19  1  1  2  6   1    1    0.
   1 19  1  1  7 10   2    2    0.
   1 19  1  1 11 35   3    3    0.
   1 19  1  1 36 36   4    4    0.
   1 19  1  1 37 39   5    5    0.
   1 19  1  1 40 42   6    6    0.
   1 19  1  1 43 43   6    6    6.2832e7
:
   0
```

5/29/96


```
Init
:  i1  i2  j1  j2  k1  k2   p          t      sg    x2  sgm
   1   1   1   1   1   1 8.66143E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  19  19   1   1  43  43 9.92879E+04   24.9730 1.2752E-05 0.0000E+00 1.2752E-05
   0   0
Recurrent-data
Output   A=1   C=1
:
:  isolv  newtnmn  newtnmx
Solve 2     2        8         4  0  4
SKIP
Bcon         1
:ityp fac    i1 i2 k1 k2
:  3  TOP    1 1    1 1
:time qflx    p        T    sg
: 0.   1.0e-4   100000.   25. 0.
: 0
:ityp fac    i1 i2  k1 k2
  1     TOP 1  1    1  1
:time qflx   p       T      sg
 0.    0.   100000.  13.05 0.65
0
NOSKIP
:AUTO-step  DPMXE     DSMXE  DTMPMXE    DP2MXe
AUTO-step  1.0E+4    0.03    5.0          1.e4
:
:TOLR TOLP  TOLS  TOLT  TOLP2  TOLM  TOLA  TOLE
Tolr   10. 1.e-4  1.e-3  1.e+1 1.e-5 1.e-3 1.e-3 1.e-25 1.e-25 1.e-25
:
:Limit dpmx    dsmx dtmpmx dp2mx dtmn dtmx icutmx
LIMIT  1.e5    .08    10.    1.e5  1.e-5 1.e5
:
: SKIP
Source  19   1.    0.500
:  is  js  ks  istyp
   1   1   1   1
0. 13.05 4.756e-9
0
    2   1   1   1

 0. 13.05 4.756e-9
 0
    3   1   1   1
 0. 13.05 7.135e-9
 0
    4   1   1   1
 0. 13.05 7.135e-9
 0
    5   1   1   1
 0. 13.05 9.513e-9
 0
    6   1   1   1
 0. 13.05 1.189e-8
 0
    7   1   1   1
 0. 13.05 1.189e-8
 0
    8   1   1   1
 0. 13.05 1.903e-8
 0
    9   1   1   1
 0. 13.05 1.903e-8
 0
   10   1   1   1
 0. 13.05 1.903e-8
 0
   11   1   1   1
 0. 13.05 1.903e-8
 0
   12   1   1   1
 0. 13.05 1.903e-8
 0
   13   1   1   1
 0. 13.05 1.189e-8
 0
   14   1   1   1
 0. 13.05 1.189e-8
 0
   15   1   1   1
 0. 13.05 9.513e-9
 0
   16   1   1   1
 0. 13.05 7.135e-9
 0
    17   1   1   1
 0. 13.05 7.135e-9
 0
    18   1   1   1
 0. 13.05 4.756e-9
 0
    19   1   1   1
 0. 13.05 4.756e-9
 0
 PLOTS 1
 Time[y]  10.
 Time[y]  100.
 Time[y]  1000.
 Time[y]  10000.
 Time[y]  20000.
 Time[y]  50000.
 Time[y]  100000.
 Time[y]  200000.
 Time[y]  500000.
 Time[y]  1000000.
 Time[y]  2000000.
 rstart 1 0
 Steady[y]  1.e+1 1.e-1 1.e-4
 : NOSKIP
 SKIP
 :
 Source  27    0.575  0.500
 : timeq(sec)    T/qht (C/(J/s))     qmt (kg/s) 80APD
 :  is  js  ks  istyp
     1   1   1   1
 0. 13.05 4.756e-9
 0

 0
     1   1  23    3
 0.00000E+00        6.21022E+01
 6.31152E+07        5.79882E+01
 1.26230E+08        5.47233E+01
 1.89346E+08        5.20440E+01
 2.52461E+08        4.98523E+01
 3.15576E+08        4.78501E+01
 4.73364E+08        4.35616E+01
 6.31152E+08        3.98890E+01
 9.46728E+08        3.38588E+01
 1.26230E+09        2.90845E+01
 1.57788E+09        2.52460E+01
 2.36682E+09        1.85840E+01
 3.15576E+09        1.47704E+01
 4.73364E+09        1.08665E+01
 6.31152E+09        8.80230E+00
 9.46728E+09        7.05269E+00
 1.26230E+10        6.04817E+00
 1.57788E+10        5.26637E+00
 1.89346E+10        4.58451E+00
```

5/29/96

5/29/96

5/29/96

```
2.52461E+10      3.68061E+00
3.15576E+10      3.09849E+00
3.94470E+10      2.53799E+00
4.73364E+10      2.15559E+00
6.31152E+10      1.66775E+00
7.88940E+10      1.45740E+00
9.46728E+10      1.30629E+00
1.26230E+11      1.17340E+00
1.57788E+11      1.07943E+00
1.89346E+11      9.90374E-01
2.20903E+11      9.20813E-01
2.52461E+11      8.64512E-01
2.84018E+11      8.17705E-01
3.15576E+11      7.77674E-01
3.47134E+11      7.16013E-01
3.78691E+11      6.63996E-01
4.10249E+11      6.19488E-01
4.41806E+11      5.80940E-01
4.73364E+11      5.47211E-01
5.52258E+11      4.78752E-01
6.31152E+11      4.26408E-01
7.88940E+11      3.51390E-01
9.46728E+11      2.99969E-01
1.26230E+12      2.14482E-01
1.57788E+12      1.61784E-01
1.89346E+12      1.24442E-01
2.20903E+12      9.96789E-02
2.52461E+12      8.22487E-02
2.84018E+12      6.94221E-02
3.15576E+12      5.96569E-02
4.73364E+12      4.33199E-02
0
: is  js  ks  istyp
   1   1  24    3
: timeq(sec)     T/qht (C/(J/s))     qmt (kg/s) 80APD

2.52461E+12      8.22487E-02
2.84018E+12      6.94221E-02
3.15576E+12      5.96569E-02
4.73364E+12      4.33199E-02
0
:          print all at every target time
PLOTS 1 6 7 20 47 70 87 135
:        target  dt    dpmx    dsmx    dp2mx    dtmpmx
Time[y]  10.
Time[y]  100.
Time[y]  1000.
Time[y]  10000.
Time[y]  50000.
Time[y]  100000.
: Time[y]  2000000.
rstart 1 0
NOSKIP
Ends
```

RK 5/29/96

The base case is taken from TSPA-95 input Chapter 4

Case I uses expected values from TSPA-93 for α, n & K_{sat} of PTn & CHnv
Case II changed to mid-range values for α, n & K_{sat}
Case III changed to minimum values " " "
Case IV changed to K_{sat} at mid-range, α & n at minimum

Table 1a. Matrix property values taken from TSPA-95[1]

Rock Unit Type	Porosity	K_{sat} (m/s)	Residual Saturation	van Genuchten Parameters		
				α (m^{-1})	n	$m=1-1/n$
TCw	0.0870	9.7×10^{-12}	0.002	0.0084	1.558	0.36
PTn	0.4210	3.9×10^{-7}	0.100	0.0153	6.872	0.85
TSw	0.1390	1.9×10^{-11}	0.080	0.0058	1.798	0.44
TSv	0.0650	1.9×10^{-11}	0.080	0.0058	1.798	0.44
CHnv	0.3310	2.7×10^{-7}	0.041	0.0163	3.861	0.74
CHnz	0.3060	2.0×10^{-11}	0.110	0.0031	1.602	0.38

Table 1b. Fracture property values taken from TSPA-95[1]

Rock Unit Type	K_{sat} (m/s)	Residual Saturation	Van Genuchten Parameters		
			α (m^{-1})	n	$m=1-1/n$
TCw	3.9×10^{-5}	0.04	0.1305	4.230	0.7636
PTn	3.9×10^{-6}	0.04	0.1305	4.230	0.7636
TSw	3.9×10^{-5}	0.04	0.1305	4.230	0.7636
TSv	3.9×10^{-5}	0.04	0.1305	4.230	0.7636
CHnv	3.9×10^{-6}	0.04	0.1305	4.230	0.7636
CHnz	3.9×10^{-5}	0.04	0.1305	4.230	0.7636

RK 5/29/96

Table 2. Matrix property values taken from TSPA-93[3]

Rock Unit Type	Parameter	TSPA-93				TSPA-95
		E[x]	Low	High	Mid-Range	
PTn	K_{sat} (m/s)	5.47×10^{-7}	2.86×10^{-12}	2.35×10^{-6}	4.0×10^{-9}	3.9×10^{-7}
CHnv	K_{sat} (m/s)	1.82×10^{-8}	5.13×10^{-12}	2.92×10^{-7}	3.0×10^{-10}	2.7×10^{-7}
PTn	α (m^{-1})	0.2485	0.0104	1.6690	0.1000	0.153 (handwritten correction: 0.0153)
CHnv	α (m^{-1})	0.0531	0.0054	0.3752	0.0200	0.163 (handwritten correction: 0.0163)
PTn	n (–)	2.611	1.187	11.800	1.900	6.872
CHnv	n (–)	2.750	1.249	9.888	2.000	3.861

RK 5/29/96

These are Tables from ANS paper

6/5/96 New model - 1D steam injection.
Modeled using metra
Simulation of experiment by Hunt & Sitar
WRR 24(8) pg 1259-1269 1988
summarized & modeled w/ TOUGH2 in
Falta et al. WRR 28(2) pg 451-465, 1992.

Input file is in /home/sneezy/rgreen/multi/
hunt/hunt.dat

```
Data for Multiflo simulator (initial data : 1D, wrr 28(2) pp451-465)
                  June 5, 1996
: hunt.dat
RSTART  0
: material properties taken from wrr paper by Hunt et al.,
:
:       XYZ                         = 1 table look-up,; pref = ref. press.
:       RADIAL                      = 0 correlations;   tref = ref temp.
:       OTHER                          ^
:                                      |
:grid  geometry  nx ny   nz ivplwr ipvtab  idir    pref tref  href
Grid   XYZ       182  1   1   1       1      0      0    0
:
Monitor 135
:135
debug 1
0
Pckr                               :relative perm and pc keyword
:   i  type-curv swir   rpm(lamda)  alpha     pcwmx  sgc  iecm
    1  Van-Gen   0.000  .4565       5.24e-4    0.    0.000  0
0            :blank line
:
Debug  1
0
Thermal-prop
: no rho         cpr    ckdry  cksat    crp  crt    tau  cdiff    cexp  enbd
  1  2.650e+03 1000.    2.86    3.1      0    0     .5  2.13e-5   1.8  1.
  2  2.580e+03 840.     1.74    2.3      0    0     .5  2.13e-5   1.8  1.
  3  2.580e+03 840.     1.74    2.3      0    0     .5  2.13e-5   1.8  1.
0
:      igrid    rw       re
DXYZ    2
: (dx(i),i=1,nx)
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
0.005,0.005
: (dy(j),j=1,ny)
0.0452
: (dz(k),k=1,nz)
0.0452
PhiK
:i1  i2  j1  j2  k1  k2  iist ithrm vb    por  permx     permy     permz     pormm per
  1   1   1   1   1   1   1    1    0     .385 1.60e-11 1.60e-11 1.60e-11 .385 1.60
  2 181   1   1   1   1   1    1    0.    .385 1.60e-11 1.60e-11 1.60e-11 .385 1.60
```

[signature] 6/5/96


```
 182 182  1   1   1   1   1   1 1.0e20 .385 1.60e-11 1.60e-11 1.60e-11 .385 1.60
:
   0
Init
:  i1   i2  j1  j2  k1  k2   p          t     sg      x2    sgm
   1    1   1   1   1   1  1.013e5    22.   0.005   0.    0.005
   2  181   1   1   1   1  1.013e5    22.   0.005   0.    0.005
  182 182   1   1   1   1  1.014e5    22.   0.005   0.    0.005
    0
Recurrent-data
Output   A=1 C=1
Solve 2       2         8         4       0       4
SKIP
BCON         1
:ityp fac   i1 i2 k1 k2
 2 RIGHT  1 1   1 1
:time qflx        p       T    sg  XABC
0. 0.0173     1.014e5  22.    0.   0.
0
:ityp fac   i1 i2  k1 k2
:  1  LEFT   1  1   1  1
:time qflx   p         T     sg
: 0.    0.   1.e+5   146.0 0.960
: 0
NOSKIP
:
:AUTO-step  DPMXE    DSMXE  DTMPMXE   DP2MXe
AUTO-step   1.0E+4   0.03   10.0       1.e4
:
:TOLR TOLP  TOLS   TOLT  TOLP2  TOLM  TOLA  TOLE
Tolr   10. 1.e-4  1.e-3  1.e+1 1.e-5 1.e-3 1.e-3 1.e-25 1.e-25 1.e-25
:
:Limit dpmx    dsmx dtmpmx dp2mx  dtmn  dtmx icutmx
LIMIT  5.e4    .05    10.    5.e4  1.e-8 5000.

:
: SKIP
Source  1  1.  1.
:    is    js   ks    istyp
    1 1    1 1      1 1   11
0. 105. 3.534e-5
0
: NOSKIP
Output   A=1 C=1
:       target  dt    dpmx   dsmx   dp2mx   dtmpmx
:
:         print all at every target time
:Skip
:Time[y]  1.e-12 1.e-12
PLOTS 1 3 1 61 122
Time[s]  1.
Time[s]  10.
Time[s]  100.
Time[s]  1000.
Time[s]  3000.
Time[s]  10000.
Time[s]  50000.
Time[s]  100000.
rstart 1 0
: STEAdy 1.e-2 1.e-2 1.e-2
Ends
```

[signature] 6/5/96

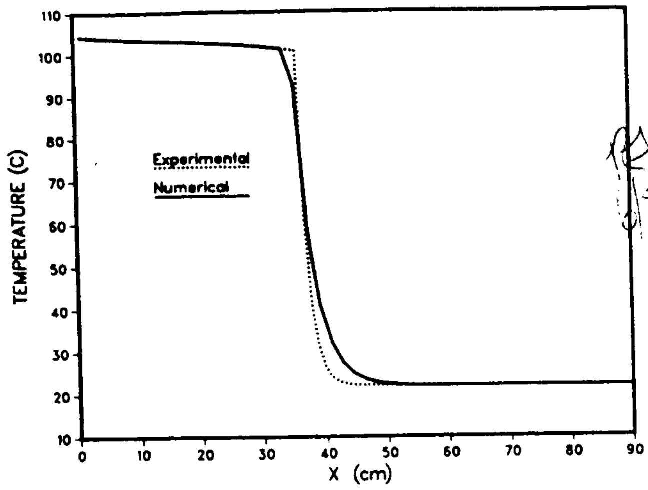
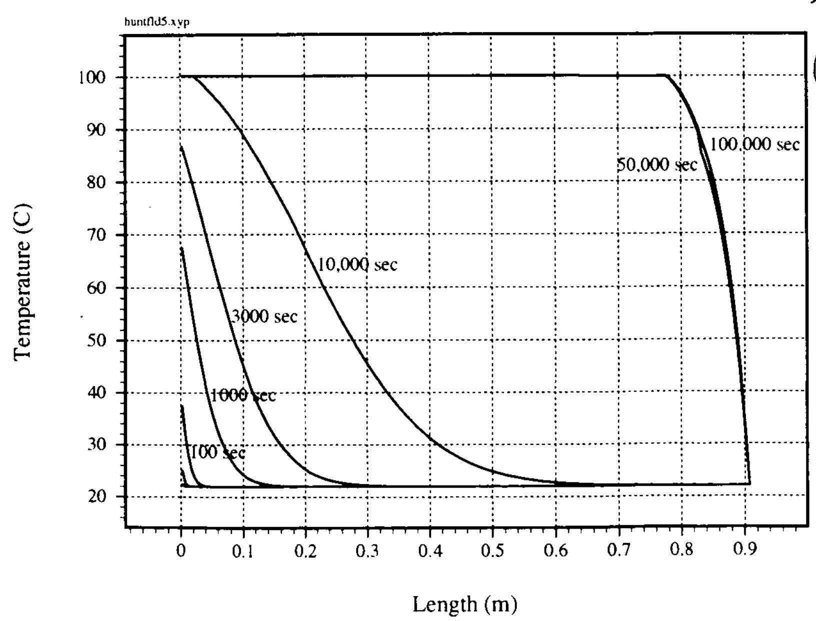


Fig. 4. Comparison of calculated temperature profile with the experimental data of *Hunt et al.* [1988*b*] for the baseline experiment.

These are results of experiment by Hunt & Sita & ~~simulation~~ by Falta et al

RK 6/5/96

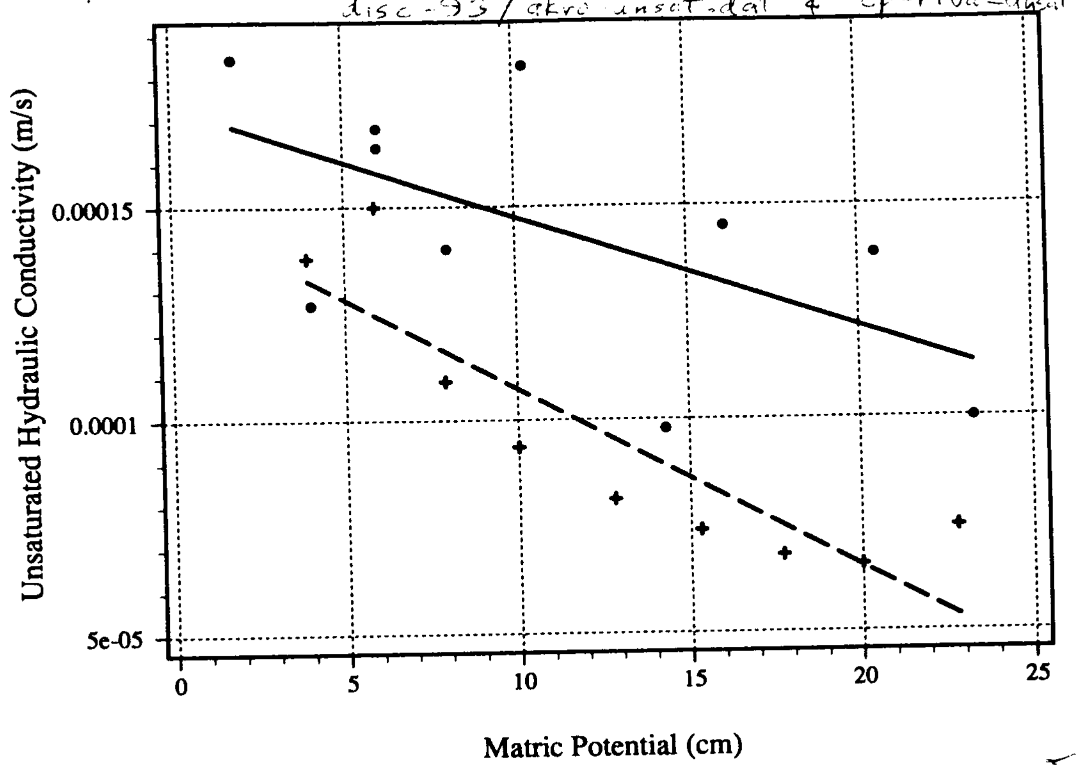
Transient steam flow



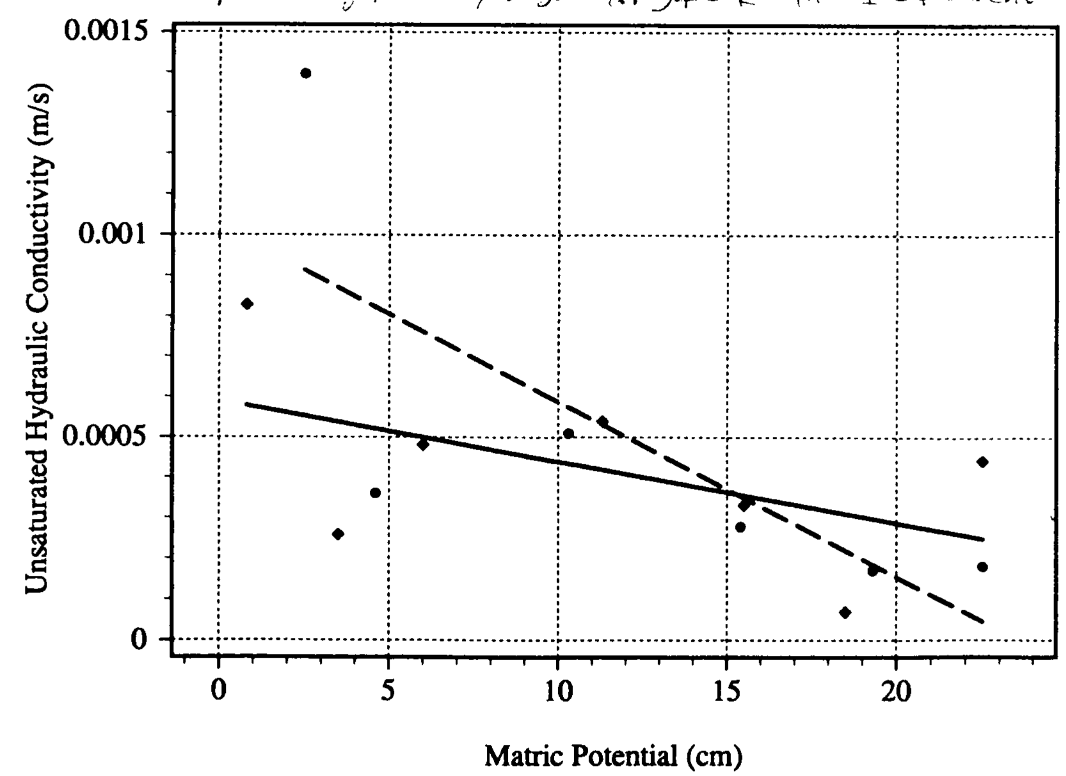
RK 6/5/96

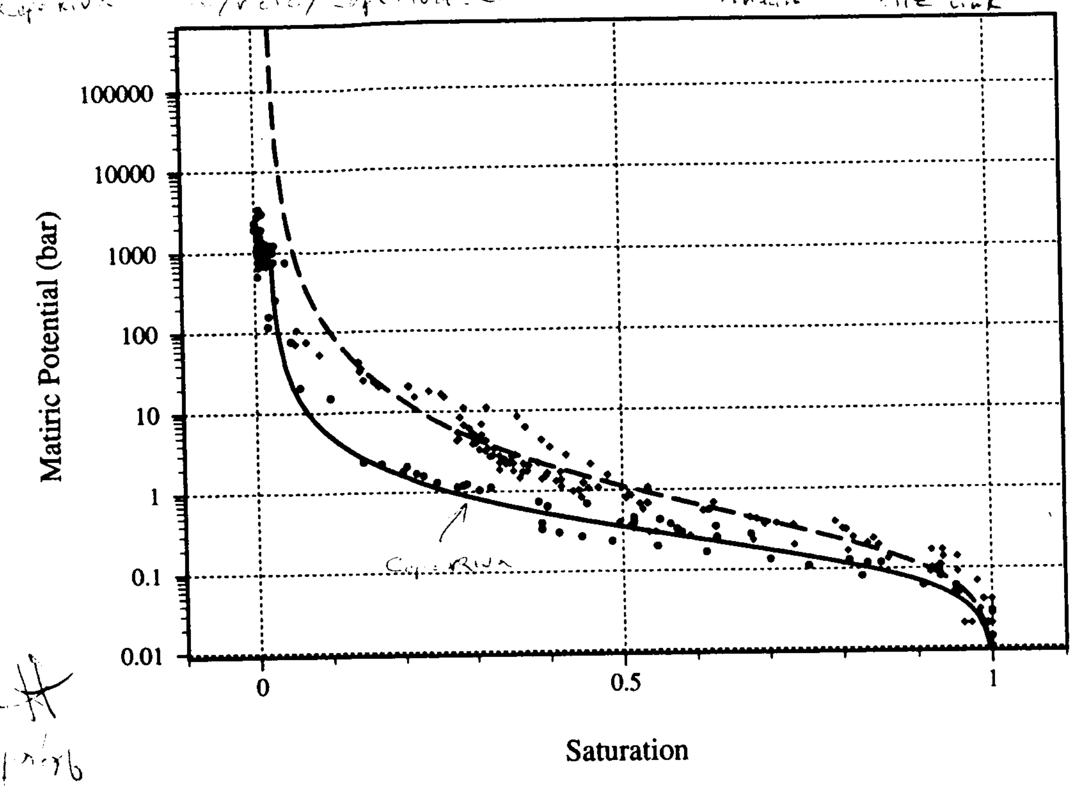
This is simulation using metra

RK 12/13/96 plotted field figures from akrotiri
~/analog/thim/~~disc-94/d-94-k-th-I~~. RK 12/18/96
disc-93/akro-unsat.dat & ep-riva-unsat.dat



RK 12/18/96
~/analog/thim/~~disc~~ di-94-k-th-I-TU... RK 12/19/96





12/20/96

RH 3/5/97 This concludes the Abnatura sample analysis at this time

12/20/96 A series of sensitivity analyses are to be done. A base case is formulated on TSPA-95. Following is the current base case

/home/sneezy/vgreen/mult./sens/basel.dat

which is printed on pgs 193-194. MULTIFLO will be used in the analyses. Objective of the analyses will be (in the big picture) determine the sensitivity-to-dose for selected input model parameters. The first selection of sensitivity parameters will be modified with time. The initial list appears on pg 195


```
Yucca Mt.)
December 13, 1996
: basel.dat
:
: This file was from grice rock-0.3-26.dat but with fracture removed
: 10 cm fracture zone next to waste.
: Also removed right heater and put in a new x coord system
: Infiltration rate along fracture = 0.3 m/yr.
: Fracture lined with impermeable material, k=1e-26 m^2.
: Initial conditions from "air-0.0003-26.dat" et al.
: Thermal conductivities of all materials are constants per TSPA 95
:  26X43 Grid
:Power Decay curve from R, Manteufel, 4/25/96.
: set upper element to large heat capacity
: Backfill removed 12/13/96
RSTART  0
:
:       XYZ                         = 1 table look-up,; pref = ref. press.
:       RADIAL                      = 0 correlations;   tref = ref temp.
:       OTHER                          ^
:                                      |
:grid  geometry  nx ny   nz ivplwr ipvtab  idir    pref tref  href
Grid   XYZ       26  1   43   1       1      1     0    0
:
Monitor 498
debug 1
0
Pckr                                :relative perm and pc keyword
: Matrix and Fracture lines switched per new METRA input req(~5/10/96)
:   i  type-curv swirm  rpmm(lamda) alpham  sgextm  sgc  iecm
:               swirf   rpmf(lamda)  alphaf  phim    phif   permm   permf
    1  Van-Gen   0.040  .3600       8.4e-7   0.       0.  1
                 0.04   0.7636    1.305e-5 .087    1.8e-3 9.7e-19 3.9e-12
    2  Van-Gen   0.100  .8500     1.53e-6    0.       0.  1
                 0.040  0.7636    1.305e-5 .421    1.8e-3 3.9e-14 3.9e-13
    3  Van-Gen   0.080  .4400      5.8e-7    0.       0.  1
                 0.040  0.7636     1.305e-5 .139   1.8e-3 1.9e-18 3.9e-12
    4  Van-Gen   0.080  .4438      5.8e-7    0.       0.  1
                 0.040  0.7636    1.305e-5 .065    1.8e-3 1.9e-18 3.9e-12
    5  Van-Gen   0.041  .7400     1.63e-6    0.       0.  1
                 0.040  0.7636    1.305e-5 .331    1.8e-3 2.7e-14 3.9e-13
    6  Van-Gen   0.110  .3800     3.13e-7    0.       0.  1
                 0.040  0.7636    1.305e-5 .306    1.8e-3 2.0e-18 3.9e-12
:   7 = Backfill, from TSPA '95 pg 4-18.
    7  Van-Gen   0.040  .7000     1.11e-5    0.       0.  1
                 0.040  0.7636    1.305e-5 0.50    1.8e-3 3.9e-14 3.9e-12
:   8 = Metal Waste Package, Assumed Hydraulic Properties, Saturation Set to
:   1% in init cond file.
    8  Van-Gen   0.010  .4400      5.8e-7    0.       0.  1
                 0.010  0.7636     1.305e-5 1.0e-1 1.0e-1 1.0e-99 1.0e-99
:   9 = Air Around Metal Waste Package, Assumed Hydraulic Properties, Saturation
:   0.1% in initial conditions file (air.int).
    9  Van-Gen   0.010  .4400      5.8e-7    0.       0.  1
             0.010    0.7636   1.305e-5 9.999e-1 9.999e-1 1.0e-99 1.0e-99
:   10 = fracture zone.  Identical to material #2 (PTn) except permeabilities
:   are increased by a factor of 10. Alpha of matrix changed from
:   1.53e-6 to 1.53e-6.
    10  Van-Gen   0.100  .8500     1.53e-6    0.       0.  1
                 0.040   0.7636   1.305e-5 .421    1.8e-3 3.9e-13 3.9e-12
:   11 = Cement, properties taken from NUREG/CR-6348 (Thermally driven moist...,

:   cement slurry C3, permeability for cement slurry C4)
    11  Van-Gen   0.05    0.272     6.36e-7     0.       0.  1
                 0.05   0.272     6.36e-7     0.50     1.8e-9 2.1e-18 2.1e-18
:   12 = fracture lining
    12  Van-Gen   0.05    0.272     6.36e-7     0.       0.  1
                 0.05   0.272     6.36e-7     0.2      1.8e-3 1.0e-26 1.0e-26
0             :blank line
:
Debug  1
0
Thermal-prop
: no rho         cpr     ckdry   cksat    crp   crt   tau  cdiff    cexp  enbd
  1  2.580e+03 728.0    1.69    1.69      0     0    .5  2.13e-5  1.8  1.
  2  2.580e+03 422.     0.61    0.61      0     0    .5  2.13e-5  1.8  1.
  3  2.580e+03 840.0    2.10    2.10      0     0    .5  2.13e-5  1.8  1.
  4  2.580e+03 948.     1.28    1.28      0     0    .5  2.13e-5  1.8  1.
  5  2.580e+03 488.0    0.84    0.84      0     0    .5  2.13e-5  1.8  1.
  6  2.580e+03 526.     1.42    1.42      0     0    .5  2.13e-5  1.8  1.
  7  2.580e+03 9e+50    1.69    1.69      0     0    .5  2.13e-5  1.8  1.
: 8 = Backfill, from TSPA '95 pg 4-18.
  8  2.580e+03 840.0    0.60    0.60      0     0    .5  2.13e-5  1.8  1.
: 9 = Metal Waste Package, rho, cpr, and ck*** from Manteufel, 3-96.
  9  7.800e+03 450.0   50.0    50.0       0     0    .5  2.13e-5  1.8  1.
```

RH 12/20/96

```
: 10 =Air Around Metal Waste Package, rho & cpr from CRC, other Properties Assum
  10  1.200e-00 57.4  10.0   10.0      0     0    0.0  2.13e-0  1.8  1.
: 11 = Cement, properties taken from NUREG/CR-6348 (Thermally driven moist...,
:       cement slurry C3, cpr assumed same as TSw)
  11 1.600e+03 840.0   0.502  1.0207  0      0    .5  2.13e-5  1.8  1.
: 12 = fracture lining
  12 1.600e+03 840.0   0.502  1.0207  0      0    .5  2.13e-5  1.8  1.
0
:     igrid   rw      re
DXYZ  0
: (dx(i),i=1,nx)
0.1 0.1 0.1 0.1 0.2 0.2 0.2 0.2 0.2 0.2
0.3 0.3 0.3 0.3 0.3 0.4 0.5 0.5 0.6 0.6
0.7 0.8 0.8 1.0 1.0 1.0
: (dy(j),j=1,ny)
1.
: (dz(k),k=1,nz)
16. 16. 16. 16. 16. 15. 14. 13. 13. 13.
15. 20. 34. 30. 30. 30. 17. 10. 5. 2.785
.715 .7 .4 .4 .4 .4 .5 .915 2.785 5.
10. 20. 30. 30. 30. 8. 20. 30. 31. 30.
30. 30. 31.
PhiK
: i1 i2 j1 j2 k1 k2 iist ithrm vb  por permx permy  permz  pormm permm
   1 26  1  1  1  1   1   7   0.
   1 26  1  1  2  6   1   1   0.
   1 26  1  1  7 10   2   2   0.
   1 26  1  1 11 35   3   3   0.
   1 26  1  1 36 36   4   4   0.
   1 26  1  1 37 39   5   5   0.
   1 26  1  1 40 42   6   6   0.
   1 26  1  1 43 43   6   6   6.2832e7
:Drifts (backfilled)
:   1 12  1  1 21 28   9   8
:Waste Packages
   1  6  1  1 23 26   8   9
:Supports (Pedestal, Cement)

   1  6  1  1 27 27  11  11
:Inverts (Floor, Cement)
   1 12  1  1 28 28  11  11
SKIP
:Fracture
   4  4  1  1  1 20  10   2
:   4  4  1  1 29 43  10   2
:Fracture Lining
   3  3  1  1  1 20  12  12
   5  5  1  1  1 20  12  12
NOSKIP
:
0
Init rck26
:
Recurrent-data
Output   A=1   C=1
:
:  isolv  newtnmn  newtnmx
Solve 2      2        8         4  0  4
:AUTO-step  DPMXE    DSMXE  DTMPMXE   DP2MXe
AUTO-step   1.0E+5   0.03    5.0       1.e5
:
:TOLR TOLP  TOLS  TOLT  TOLP2  TOLM  TOLA  TOLE
Tolr   10. 1.e-4  1.e-3  1.e+1 1.e-5 1.e-3 1.e-3 1.e-25 1.e-25 1.e-25
:
:Limit dpmx    dsmx dtmpmx dp2mx dtmn dtmx icutmx
LIMIT  2.e5    .08    10.   2.e5  1.e-8 1.e5
:
: SKIP
:
Source  34   0.00333  1.000 rck22
:
:NOSKIP
:
:       print all at every target time
PLOTS 1 4 496 498 548 606
:       target  dt    dpmx   dsmx   dp2mx   dtmpmx
rstart 1 0
TIME[y]  1.
Time[y]  10.
Time[y]  100.
Time[y]  1000.
:Time[y]  5000.
Time[y]  10000.
:Time[y]  100000.
:
SKIP
:
rstart 1 0
Steady[y]  1.e+1 1.e-1 1.e-4
NOSKIP
Ends
```

12/20/96

Values for sensitivity analyses

Use hydrostratigraphic units described in TSPA-95

properties to be varied: matrix (k, alpha, porosity); fracture (k, alpha, porosity)

E[x], min and max for matrix K-sat and alpha taken from beta-distributions in TSPA-93, E[x]±σ used for porosity

matrix saturated hydraulic conductivity (m/s)

	E[x]	MIN	MAX
TCw	2.042e-11	6.310e-13	6.166e-9
PTn	3.802e-7	1.175e-9	1.738e-4
TSw	2.089e-11	2.884e-13	1.072e-8
TSv	9.772e-12	2.692e-13	2.239e-10
CHnv	1.096e-9	3.981e-12	1.047e-6
CHnz	1.585e-11	6.761w-15	1.072e-8

matrix alpha (m^{-1})

TCw	7.907e-3	2.588e-4	1.384e-1
PTn	5.559e-1	1.803e-1	1.718
TSw	1.355e-2	2.099e-3	5.000e-1
TSv	2.193e-3	2.193e-3	7.691e-3
CHnv	2.786e-2	1.718e-3	1.109
CHnz	5.943e-3	3.936e-4	3.133e-1

matrix porosity (-)

TCw	0.087	0.03184	0.1422
PTn	0.421	0.3166	0.5254
TSw	0.139	0.08173	0.1963
TSv	0.065	0.02236	0.1076
CHnv	0.331	0.2413	0.4207
CHnz	0.306	0.2421	0.3700

12/20/96

This is a preliminary listing of candidate variable values for sensitivity analyses

1/5/97
RH

Steam injection/vapor extraction sample runs

/home/sneezy/rg.green/multi/miklas/
miklas4.dat

no clay layer, single well for injection at 15-18.5m

```
Data for Multiflo simulator (initial data : 2D, I&M Canal)
                    Dec 30, 1996
:miklas4.dat
: rtg changed miklas3 to have heat at depth only (15-17.5m)
: increased injection from 15-17.5 to 15-18.5
: converted to r-z coordinates
: added five elements to base for total depth of 25 m
: increased enthalpy to 1.00, this = 338 F
: increased k to e-11
: increased extraction to 8 elements 3-10
: bottom layer bc at 20 C
: no top layer bc at 30 C
: increased initial gas sat to 0.8
: decreased porosity from 0.40 to 0.30 in high k zone
: Kt to 0.74, 0.9 in silty clay
: reduced inj well length to ele 12-14
: large volume in outer edge
: added more permeable layer below water table at 1e-10
: turned on vapor extraction on right bc
: silty clay at 3e-14 0.4
: silty sand at 7e-13 0.4
: Mike removed clay layer to test effect of dual injection
RSTART  0
:
:      XYZ                        = 1 table look-up,; pref = ref. press.
:      RADIAL                     = 0 correlations;   tref = ref temp.
:      OTHER
:
: new format for input file
:grid  geometry  nx ny   nz ivplwr ipvtab  idir    pref tref  href
Grid  RADIAL      22  1   46  1       1      3     0    0
:
:Monitor 135
:debug 3
:0
Pckr                                :relative perm and pc keyword
:   i  type-curv swir   rpm(lamda)  alpha     swext  sgc  iecm
    1  Van-Gen   0.080  .2700       5.04e-4   0.      0.  0  :silt
0          :blank line
:
: Debug  3
: 0
Thermal-prop
: no rho        cpr    ckdry  cksat    crp  crt    tau  cdiff   cexp  enbd
  1  2.280e+03 840.     0.74   0.9      0    0     .5  2.13e-5  1.8  :silt clay
0
:     igrid   rw       re
DXYZ   2     0.     11.
: (dr(i),i=1,nx)
0.25 .75 1.25 1.75 2.25 2.75 3.25 3.75 4.25 4.75
5.25 5.75 6.25 6.75 7.25 7.75 8.25 8.75 9.25 9.75
10.25 10.75
: (dy(j),j=1,ny)
360.0
: (dz(k),k=1,nz)
0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5
0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5
0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5
0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5
0.5 0.5 0.5 0.5 0.5 0.5
```

RH
1/5/96


```
PhiK
:i1 i2 j1 j2 k1 k2 iist ithrm vb  por  permx     permy     permz     porm  permm
 1 22  1  1  1  1   1    1   0    0.40 3.00e-14 3.00e-14 3.00e-14 0.40 3.00e-14
 1 22  1  1  2  20  1    1   0    0.40 3.00e-14 3.00e-14 3.00e-14 0.40 3.00e-14
 1 22  1  1 21  45  1    1   0    0.40 7.00e-13 7.00e-13 7.00e-13 0.40 7.00e-13
 1 22  1  1 46  46  1    1 1e+9   0.40 7.00e-13 7.00e-13 7.00e-13 0.40 7.00e-13
   0
Init
:  i1  i2  j1  j2  k1  k2   p         t     sg     x2    sgm
   1  22   1   1   1  10   1.0e5     20.   0.8    0.    0.8
   1  22   1   1  11  46   1.0e5     20.   0.0    0.
    0
:
:Equil  depth  pdepth  tdepth  tgrad  parm  iequil
Equil    5.00   1.013e5  20.    0.     0.    -1
:
Recurrent-data
Output   A=1   C=1
Solve 2      2         8        4      0       4
:
:AUTO-step  DPMXE    DSMXE  DTMPMXE   DP2MXe
AUTO-step   2.0E+4   0.03   10.0       1.e4
:
:TOLR TOLP  TOLS  TOLT  TOLP2  TOLM  TOLA  TOLE
Tolr   10. 1.e-4  1.e-3  1.e+1 1.e-5 1.e-3 1.e-3 1.e-25 1.e-25 1.e-25
:
:Limit dpmx    dsmx dtmpmx dp2mx  dtmn  dtmx icutmx
LIMIT  5.e4    .05    10.   5.e4  1.e-8 1.e7
:
Output   A=1 C=-1
Steady[y]
:
:Limit dpmx    dsmx dtmpmx dp2mx  dtmn  dtmx icutmx
LIMIT  5.e4    .05    10.   5.e4  1.e-8 1.e7
: SKIP
Source  1    1.00  0.30
:  is  js  ks  istyp
   1  1   1 1  30 37  11
0.  -2.769e6  4.367e-2
0
:  is  js  ks  istyp
SKIP
   1  1   1 1  15 17  11
0.  -2.769e6  4.367e-2
0
:  is  js  ks  istyp
   1  1   1 1  21 25  11
0.  -2.769e6  4.367e-2
0
NOSKIP
: SKIP
Bcon       1
: SKIP
:ityp ifac   i1 i2 k1 k2
   1  RIGHT 1 1   3 10
:time qflx           p  ,  T       sg
   0.   0.0           9.25e4  20.00 0.95
   0
: NOSKIP
:   1  BOTTOM 22 22  46 46

:time qflx           p       T        sg
:    0.    0.0          2.90e5  20.00 0.00
:    0
:          print all at every target time
Output  P=1  G=1  T=1  Q=1  B=1
Time[d]  1.e-8
PLOTS 1 2 105 156
Time[d]  1
Time[d]  2
Time[d]  3.
Time[d]  4.
Time[d]  5.
Time[d]  6.
Time[d]  7.
SKIP
Time[d]  50.
Time[d]  75.
Time[d]  100.
Time[d]  125.
Time[d]  150.
Time[d]  175.
Time[d]  200.
Time[d]  225.
Time[d]  240.
NOSKIP
Plots 1
: STEAdy 1.e-3 1.e-3 1.e-3
Ends
```

RH
1/5/96

Variations to SIVE

miklas5.dat: added clay w/ ρ = 0.1, k = 3e-16
injection from 14-17 (7-8.5) & 21-24 (10.5-12)
clay in between 18-20 (9-10)

output in mik5-*.dat, .ps
* = 1-7

miklas6.dat
same as miklas4.dat (no clay, deep injection) but doubled injection rate to 0.6
output in mik6*.dat (15-18.5m inj)

miklas7.dat
same as miklas6.dat but with extraction well at x = 22 z = 30-37 but at 0.5 strength of injection or -2.183e-2

1/7/97 RH

miklas8.dat
same as miklas7.dat but with extraction at same strength as injection
Note: there is not much noticeable effect by extraction well

miklas9.dat
same as miklas5.dat (i.e. clay layer at 9-10.5m and injection at 7.5 & 9.0m and 10.5-12.5m) extraction from 10.5-12.5m is same strength (per element) as injection

miklas10.dat same as miklas9.dat
but lowered lower aquifer to 3e-13 m² and raised upper aquifer to ~~miklas~~ 3e-12 m²
miklas10.dat stalled

miklas11.dat, same as miklas10.dat but changed upper aquifer to 3e-12,
run into errors in output

miklas12.dat same as miklas10 & miklas11
but w/ upper aquifer k = 3e-13 m²

3/5/97 RH Post entry of initial entry for specific analyses:

Groundwater Travel time; first reference on pg 24

Numerical simulation of 2-phase flow using C-TOUGH, Vertical 2D simulations

The objective of the analyses was to model repository-scale liquid flow and stream-lines for 10,000 yrs to assess the GWTT rule. The last documented analysis is on page 117. The task was completed at that time.

Peña Blanca samples analyses - post entry of initial entry. First cited in pg 27. Objective of analyses was to determine van Genuchten parameters for rock samples collected at Peña Blanca. Analyses were conducted using RETC, a commercially available computer code.

3/5/97 Fran Ridge Block Analyses - post entry of initial entry, first cited in pg 28
Objective of analyses is to conduct 2-phase simulation of the Fran Ridge Block experiment. Final entry is in pg 113. Analyses were completed. Numerical analyses were conducted using VTOUGH

Thermohydrology Research Project Numerical Analyses. Post entry of Initial entry first cited on pg 1. A series of Numerical Analyses were conducted to simulate the observations from experiments conducted by the Thermohydrology Research Project. The objective was to gain a better interpretation of the experiments through the numerical analyses. A full description of the experiments is documented in "Thermally Driven Moisture Redistribution in Partially Saturated Porous Media" NUREG/CR-6398 CNWRA 95-005

I have reviewed this scientific notebook and find it in compliance with QAP-001

[signature] 3-5-97