308 ... Q200002080001
Scientific Notebook # 150 (Initial entry in Notebook # 062)

308 ... Q200002080001
Scientific Notebook # 150 (Initial entry in Notebook # 062)

21
300

R

GEORGE RICE MR

Ronald Green RG

CNWRA
CONTROLLED
COPY 150

Contents | Page

THIS IS A CONTINUATION OF WORK DESCRIBED IN CNWRA NOTEBOOK # 129. MR 1-16-97

6-9-95 MR · KILLED RUN "gwtt-36X14-03i" - STAYED ON 1.58 YRS FOR SEVERAL THOUSAND ITERATIONS.

· BEGIN "gwtt-36X14-07i" - IDENTICAL TO "gwtt-36X14-01i" EXCEPT NO HEAT INPUT.

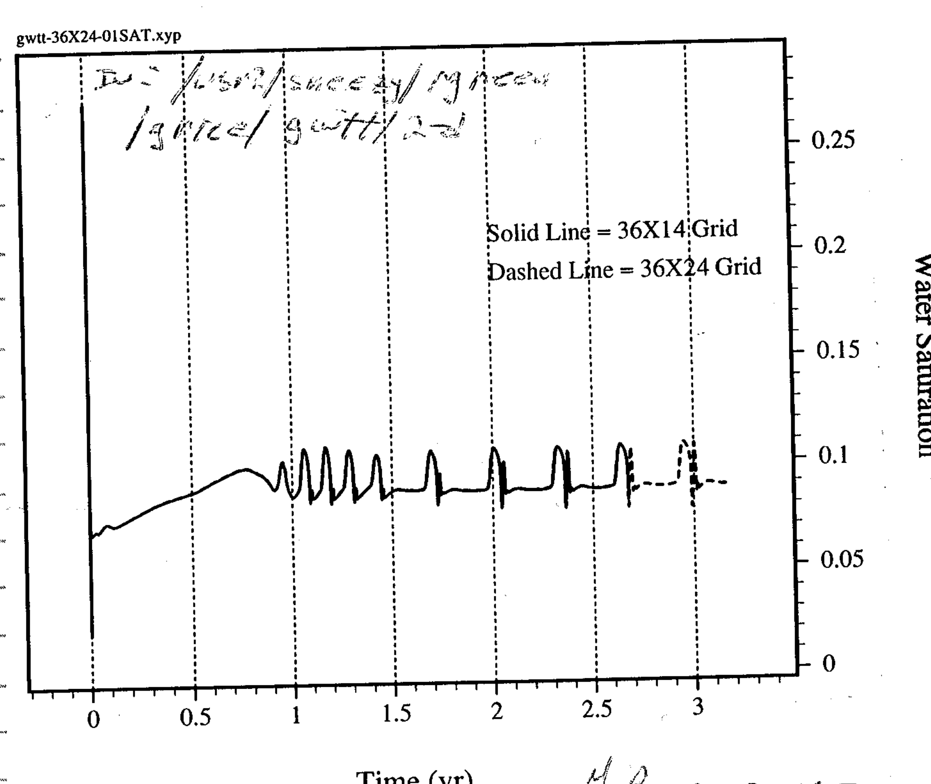
→ DONE ON SKIPPY - CALCULATION TIME = 2109 S, TIMESTEPS = 198, 3.17 YR.

6-12-95 MR · "gwtt-36X14-01i" DONE ON SKIPPY - CALCULATION TIME = 22,036 S, TIMESTEPS = 1675, TIME = 3.17 YR.

· NEW GWTT RUN: "gwtt-36X14-016i" - IDENTICAL TO "gwtt-36X14-01i" EXCEPT PERMEABILITY OF MATRIX INCREASED BY TWO ORDERS OF MAGNITUDE TO XXE-17 m². MR 6-12-95

24 ELEMENT-WIDE GRID AND 14 ELEMENT-WIDE GRID GIVE IDENTICAL RESULTS

36X24 and 36X14 at (A32)



MR 6-12-95

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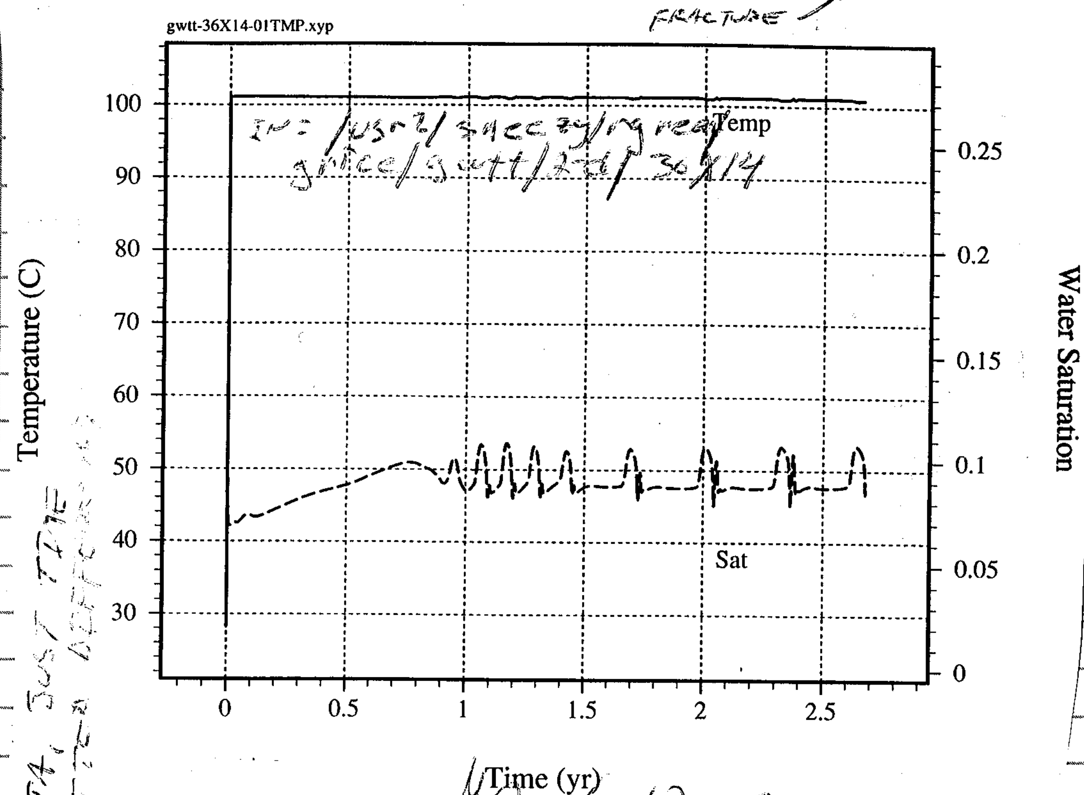
6-12-95
MR

36X14-01, in Fracture, at Heater, k=3.33E-12m^2

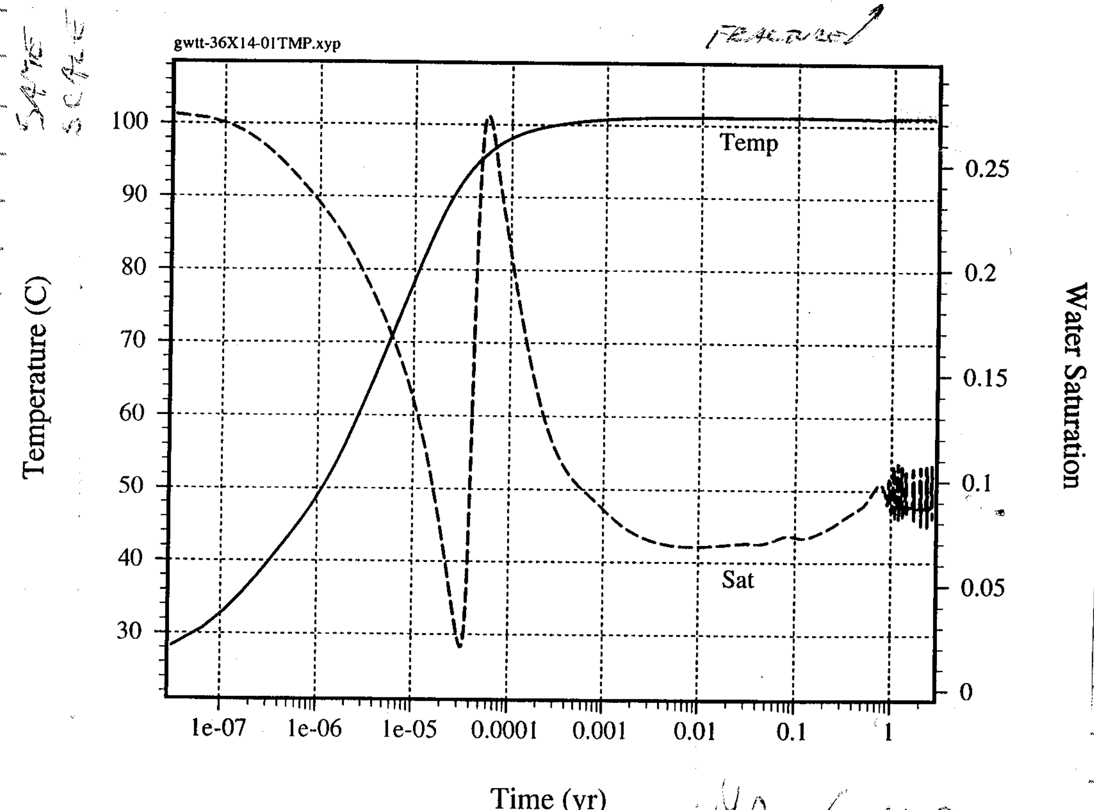
MR 6-12-95



MR 6-12-95

SAME DATA, JUST TIME SCALE ALTERED

36X14-01, in Fracture, at Heater, k=3.33E-12m^2



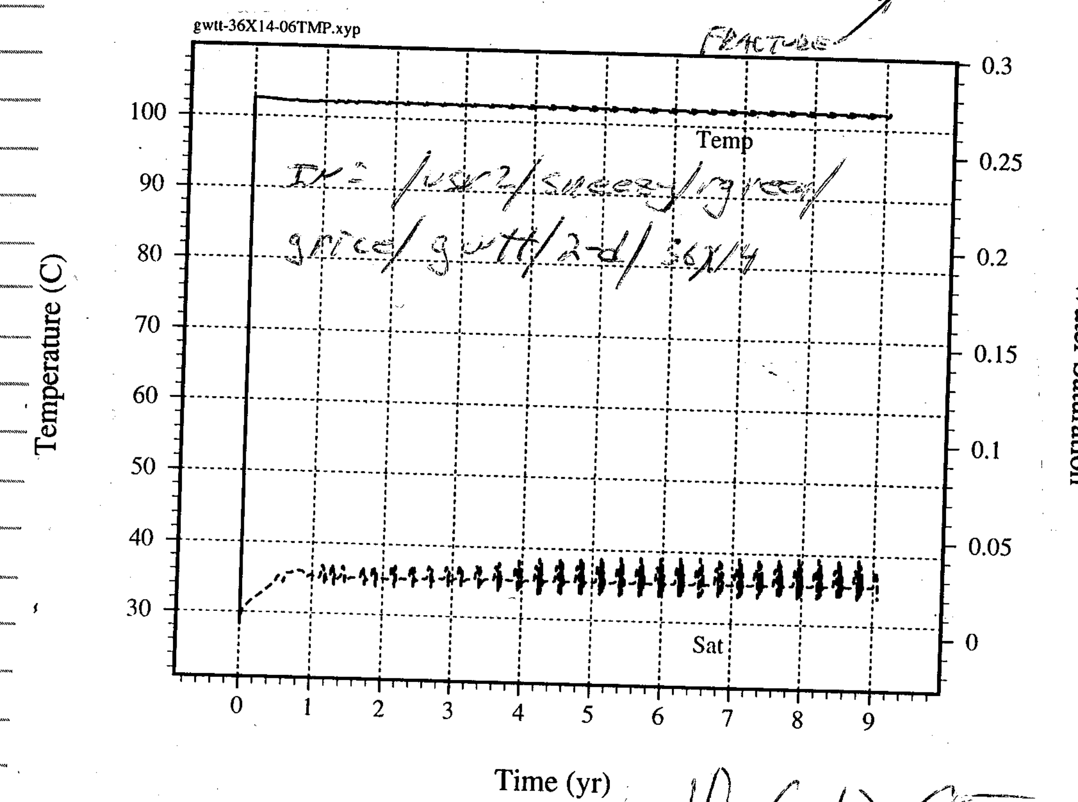
MR 6-12-95

6-12-95
MR

3

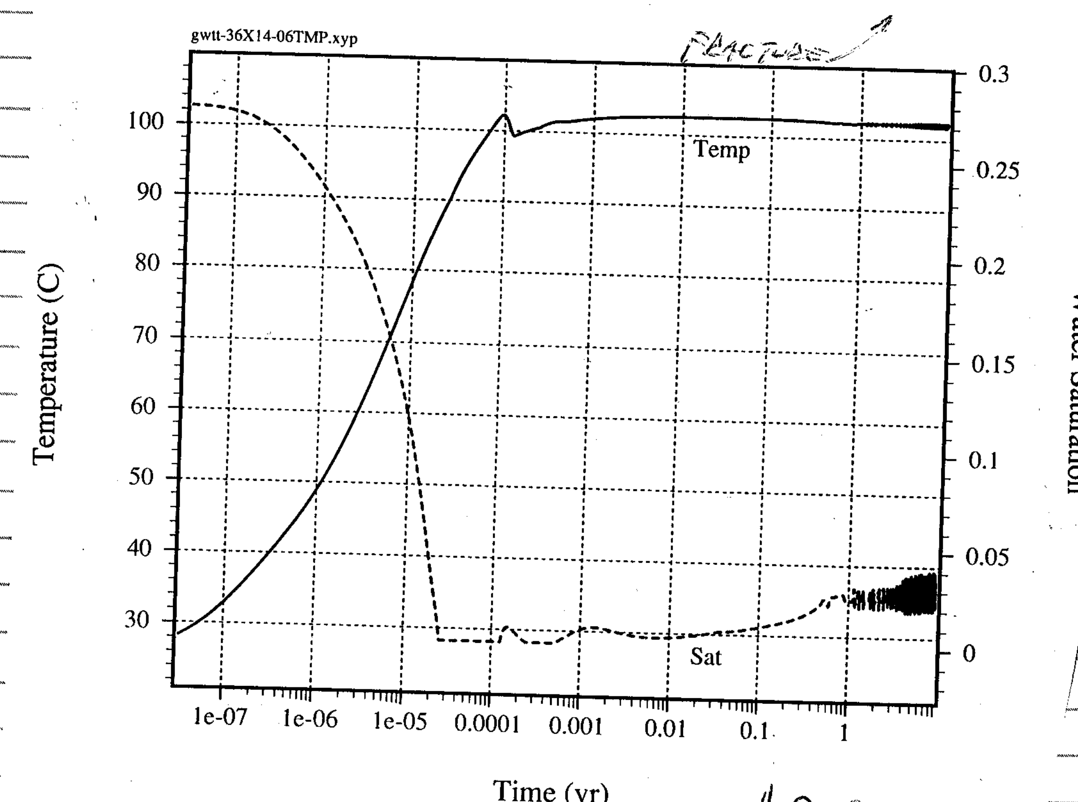
36X14-06, in Fracture, at Heater, k=1.66 E-12m^2

MR 6-12-95



MR 6-12-95

36X14-06, in Fracture, at Heater, k=1.66 E-12m^2

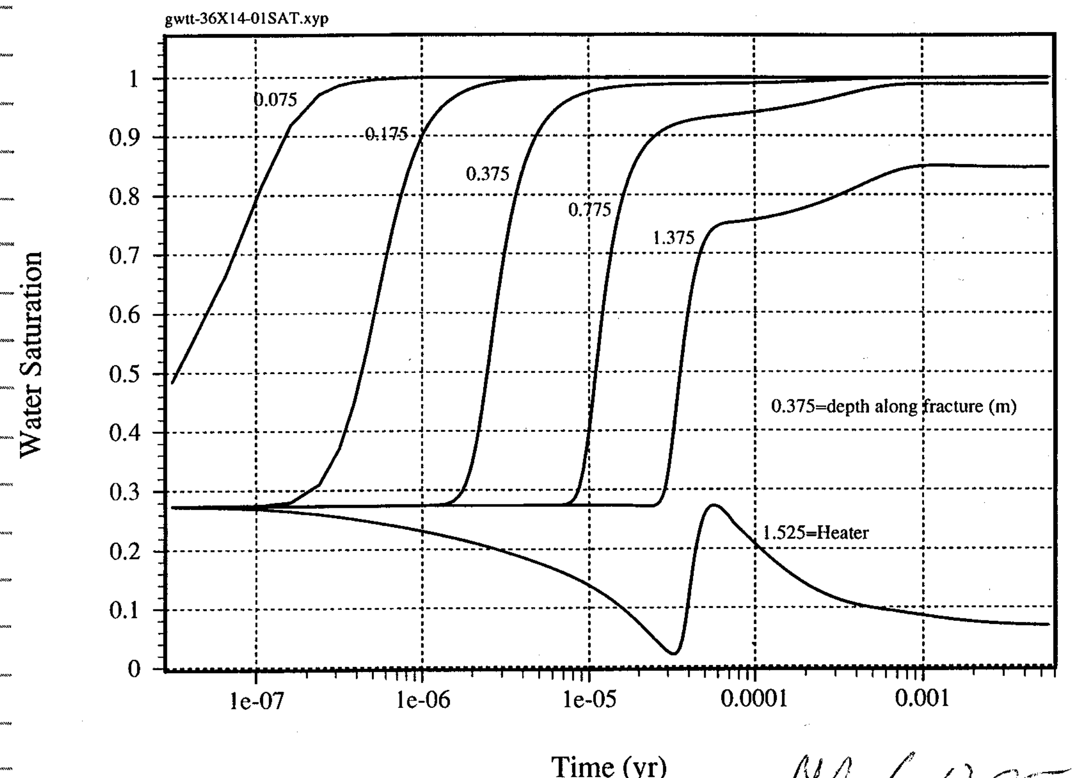


MR 6-12-95

6-12-95
MR

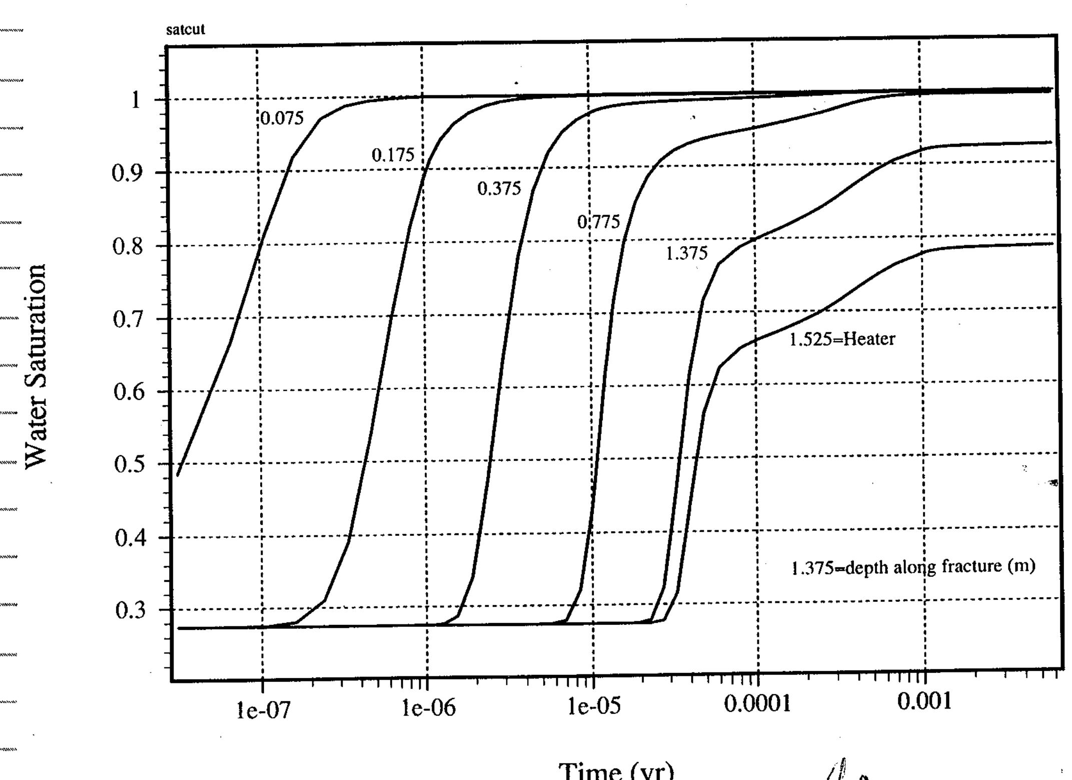
36X14-01, Wetting Front Advance in Fracture, "basecase"

MR 6-12-95



MR 6-12-95

36X14-07, Wetting Front Advance in Fracture, No Heat



MR 6-12-95

6-12-95 MR
• NEW GWTT RUN:
"gwtt-42X18-ØZi" — GRID = 42X18,

GRID MUCH FINER IN VICINITY OF HEATER. IN FRACTURE → REPRESENTED BY 25 ELEMENTS INSTEAD OF ONE. DIMENSIONS OF FRACTURE + HEATER UNCHANGED.

6-13-95 MR
"gwtt-42X18-ØZi" DONE ON SKIPPY, CALCULATION TIME = 41,043 s, TIMESTEPS = 1361, TIME = 2.00 YRS.

6-14-95 MR
• NEW GWTT RUN: "gwtt-51X1-Ø1i" - A 1-D RUN PERFORMED TO EXAMINE HOW HEAT IS CONSUMED, i.e.,
- HEAT WATER, HEAT ROCK, VAPORIZE WATER.
PHYSICAL PROPERTIES IDENTICAL TO "gwtt-36X14-Ø1i"

6-15-95 MR
• NEW GWTT RUN: "gwtt-58X1-Ø1i" - 1-D RUN TO LOOK AT PARTITIONING OF HEAT
PERMEABILITY OF FRACTURE REDUCED BY 10^2.

SPECIFIC HEAT OF WATER = 4186 J/kg-°C

LATENT HEAT OF VAPORIZATION OF WATER = 2.26 X 10^6 J/kg

→ VALUES FROM "COLLEGE PHYSICS" SERWAY + FAUGHN

MR 6-18-95

6-18-95
MR

• 1-D GWTT RUN: "gwtt-56X1-φ1i" IN: /usr2/sneezy/rgreen/grice/gwtt/2-d/~~22X~~ 42X18 MR 6-18-95

- DID FIRST ENERGY BALANCE WITH EXCEL OF "gwtt-56X1-φ1i"

• NEW 2-D GWTT RUN WITH 3 FRACTURES:

"gwtt-36X36-φ1i" IN: /usr2/~~rg~~ sneezy/rgreen/grice/gwtt/2-d/36X14
MR 6-18-95

6-19-95
MR

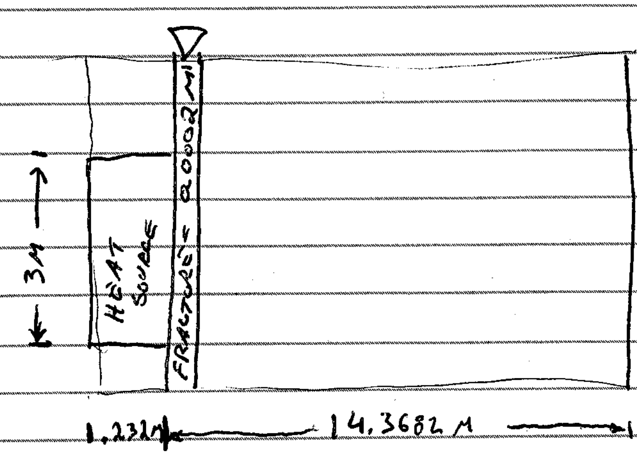
RESTART "gwtt-56X1-φ1i" BECAUSE TEMP → 150 °C, $t \simeq 5 \times 10^{-3}$ YR, TIMESTEP ≃ 2300, $\Delta t \simeq 10^{-8}$ YR.

NEW NOTE - "gwtt-56X1-φ2i" - HEAT INPUT REDUCED FROM 30 J/S TO 20 J/S.

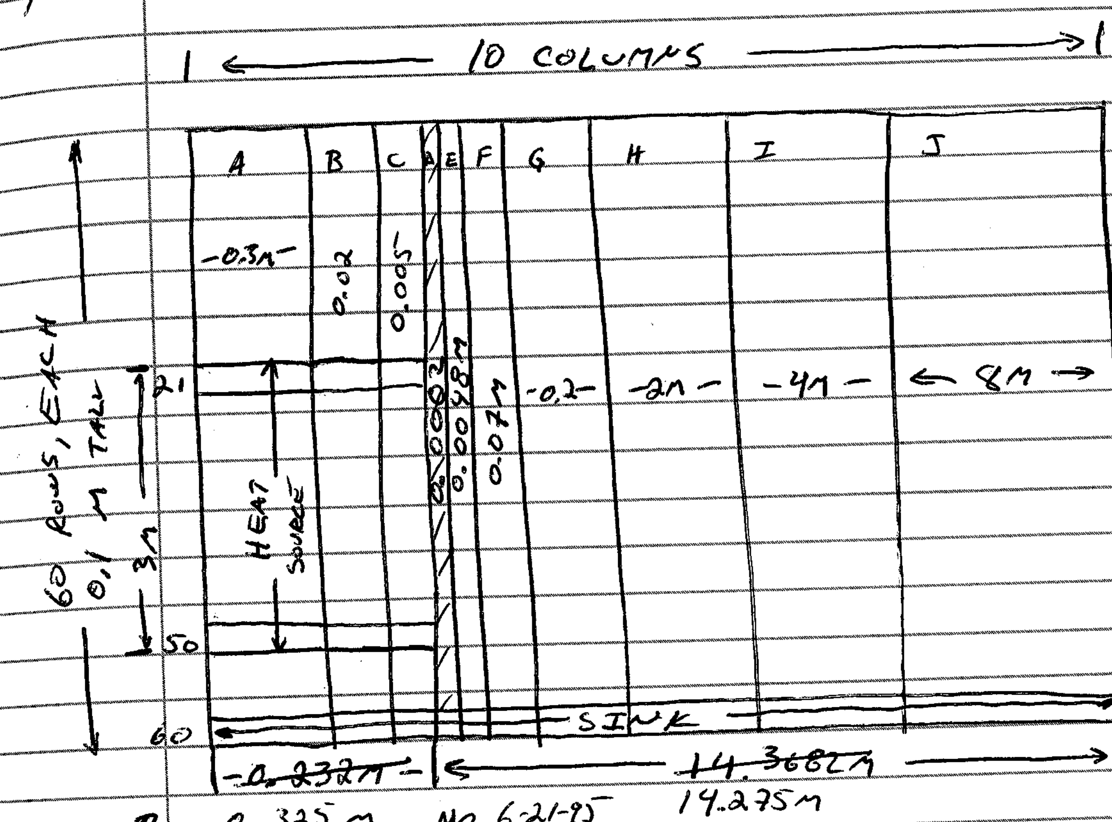
NOTE - TEMPERATURE STILL ≳ 130 °C - RERUN w/ HEAT INPUT REDUCED TO 10 J/S.

6-20-95

NEW TYPE OF GWTT RUNS:



6-20-95
MR



FRACTURE = COLUMN 'D' = 0.0002M WIDE

CHANGED - ~~SEE BELOW~~ MR 6-21-95 SEE RED CHANGES

6-21-95
MR

90 HEATING ELEMENTS IN SOURCE:
A 21 → A50
B 21 → B50
C 21 → C50

HEAT GENERATION DECREASES WITH TIME. INITIAL RATE = 2346.~~96~~98 W/M³ MR 6-21-95

POWER DECAY RATE SHOWN BELOW:

8

6-21-95

POWER DECAY SCHEDULE FOR WASTE CANNISTER - INITIAL POWER INPUT = 2346.64 W / m³

NR 6-24-95

Table 2-1. Normalized thermal power decay (from Brandshaug, 1991)

Time (years)	Normalized Thermal Power
10	1.0000
20	0.7786
50	0.4763
100	0.2618
200	0.1488
500	0.0880
1,000	0.0515
2,000	0.0276
5,000	0.0178
10,000	0.0128

NR 6-21-95

INITIAL POWER TO ELEMENTS A21 → A50 $= 2346.64 \frac{W}{m^3}(1.95\times10^{-2} m^3)$

$= 45.76 W$

" " B21 → B50 $= 2346.64 \frac{W}{m^3}(1.3\times10^{-3} m^3) =$

~~$= 3.05 \times 10^{0} W$~~ NR 6-21-95

$= 3.05 W$

" " C21 → C50 $= 2346.64 \frac{W}{m^3}(3.25\times10^{-4} m^3)$

$= 0.763 W$

• BEGAN 1ST RUN W/CANISTER AS DESCRIBED ABOVE + ON PREVIOUS PAGE:

"gwtt-60X10-ϕ1i", IN:

/usr2/sneezy/rgreen/grice/gwtt/2-d/6-95.

NR

6-22-95
NR

• BEGAN NEW CANISTER (GWTT) RUN:

"gwtt-60X10-ϕ2i" - IDENTICAL TO "gwtt-60X10-ϕ1i" EXCEPT INITIAL SATURATION = 70% WATER

6-23-95
NR

• NEW GWTT CANISTER RUN:

"gwtt-30X10-ϕ2i" IDENTICAL TO "gwtt-60X10-ϕ2i" EXCEPT GRID IS 30 ELEMENTS THICK INSTEAD OF 60 (STILL 6 M TALL) AND CANISTER ELEMENTS ARE IMPERMEABLE - ON:

/home/skippy/rgreen/goodluck

• KILLED "gwtt-60X10-ϕ2i" - GOT TO ≃ 4X10⁻⁶ YR IN 24 HRS, ≃3000 TIMESTEPS, Δt ≃ 1X10⁻⁸ YR. NR 6-23-95

INPUT: "gwtt-30X10-ϕ1i"

```
GWTT,6/23/95, Fracture = 0.2 mm wide, K of fracture = 3.33E-12 m^2
:van Genuchten parameters =  fracture (matr2), t
:grid=30X10
ROCKS----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
: Material 1 = Rock Matrix
:
: mat  nad   drock      por       permx      permy      permz      cwet       spht
matr1  2  2.700E+03 7.500E-02 3.630E-17 3.630E-17 3.630E-17 2.000E-00 7.100E+02
:
:  comp        expan        cdry        tortx
 0.0000E+00  0.0000E-00  1.7000E-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
:
: Material 2 = Fracture
:
: mat  nad   drock      por       permx      permy      permz      cwet       spht
matr2  2  2.700E+03 7.500E-02 3.330E-12 3.330E-12 3.330E-12 2.000E-00 7.100E+02
:
:  comp        expan        cdry        tortx
 0.0000E+00  0.0000E-00  1.7000E-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
:
```

NR 6-23-95

6-23-95
MR

INPUT (CONT) "gwH-30x10-Ø1i"

MR 6-23-95

```
: Material 3 = Canister
:
: mat  nad   drock       por      permx      permy      permz      cwet       spht
matr3  2   2.700E+03 7.500E-09 3.330E-92 3.330E-92 3.330E-92 2.000E-00 7.100E+02
:
:   comp         expan          cdry        tortx
  0.0000E+00  0.0000E-00  1.7000E-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  9999   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+04 -1.000E+00  0.000E+00  D 18  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
```

MR 6-23-95

```
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
   8    8  3.1700E+00  2.0000E+00
:
:  tis(1)      tis(2)      tis(3) ......
 1.000E-06 2.000E-06 1.000E-05 1.000E-02 1.000E-00 1.000E+01 2.000E+00 1.000E+02
:
EVAP
 D  11
 D  18
 D  25
 D  29
:
                                                          :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  3.9000E+12
A    2  0  0  matr1  3.9000E-02
A    9  0  0  matr1  3.9000E-02
A   10  0  0  matr1  3.9000E-02
A   11  0  0  matr3  3.9000E-02
A   12  0  0  matr3  3.9000E-02
A   13  0  0  matr3  3.9000E-02
A   24  0  0  matr3  3.9000E-02
A   25  0  0  matr3  3.9000E-02
```

MR 6-23-95

6-23-95
MR

INPUT (CONT) "gwH-30x10-Ø1i"

MR 6-23-95

```
A   26  0  0. matr1  3.9000E-02
A   30  0  0  matr1  3.9000E+12
B    1  0  0  matr1  2.6000E+13
D    4  0  0  matr2  2.3400E-04
E    2  0  0  matr1  8.8400E-04
J   29  0  0  matr1  1.0400E+00
J   30  0  0  matr1  1.0400E+10
                   :reqd blank line
:
CONNE
: el n1 e2   n2 nsq nd1 nd2 isot d1        d2           areax    betax
:
A     1 B     1 0 0 0  1  1.500E-01  1.000E-02  1.300E-01  0.000E+00 0
A    30 B    30 0 0 0  1  1.500E-01  1.000E-02  1.300E-01  0.000E+00 0
```

MR 6-23-95

```
B     1 C     1 0 0 0  1  1.000E-02  2.500E-03  1.300E-01  0.000E+00 0
B    30 C    30 0 0 0  1  1.000E-02  2.500E-03  1.300E-01  0.000E+00 0
C     1 D     1 0 0 0  1  2.500E-03  9.000E-04  1.300E-01  0.000E+00 0
I    30 J    30 0 0 0  1  2.000E+00  4.000E+00  1.300E-01  0.000E+00 0
A     1 A     2 0 0 0  1  1.000E-01  1.000E-01  1.950E-01  1.000E+00 0
B     2 B     3 0 0 0  1  1.000E-01  1.000E-01  1.300E-02  1.000E+00 0
C     3 C     4 0 0 0  1  1.000E-01  1.000E-01  3.250E-03  1.000E+00 0
GENER----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
: el ne sl ns nsq nad nads ltb  itp   itb   gx         ex         hg
:
A  11 FLX  1    0   0   0  12 HEAT    b  0.0000E+00 0.00E+00 0.000E+00
   0.0000E+00 3.1536E+08 6.3072E+08 1.5678E+09
   3.1536E+09 6.3072E+09 1.5768E+10 3.1536E+10
   6.3072E+10 1.5768E+11 3.1536E+11 1.0000E+12
   2.3466E+03 1.8721E+03 1.1177E+03 6.1435E+02
   3.4918E+02 2.0650E+02 1.2085E+02 6.4767E+01
   4.1770E+01 3.0037E+01 3.0037E+01 3.0037E+01
A  25 FLX  1    0   0   0  12 HEAT    b  0.0000E+00 0.00E+00 0.000E+00
B  11 FLX  1    0   0   0  12 HEAT    b  0.0000E+00 0.00E+00 0.000E+00
   0.0000E+00 3.1536E+08 6.3072E+08 1.5678E+09
   3.1536E+09 6.3072E+09 1.5768E+10 3.1536E+10
   6.3072E+10 1.5768E+11 3.1536E+11 1.0000E+12
   2.3466E+03 1.8721E+03 1.1177E+03 6.1435E+02
   3.4918E+02 2.0650E+02 1.2085E+02 6.4767E+01
   4.1770E+01 3.0037E+01 3.0037E+01 3.0037E+01
B  25 FLX  1    0   0   0  12 HEAT    b  0.0000E+00 0.00E+00 0.000E+00
C  11 FLX  1    0   0   0  12 HEAT    b  0.0000E+00 0.00E+00 0.000E+00
   0.0000E+00 3.1536E+08 6.3072E+08 1.5678E+09
   3.1536E+09 6.3072E+09 1.5768E+10 3.1536E+10
   6.3072E+10 1.5768E+11 3.1536E+11 1.0000E+12
   2.3466E+03 1.8721E+03 1.1177E+03 6.1435E+02
   3.4918E+02 2.0650E+02 1.2085E+02 6.4767E+01
   4.1770E+01 3.0037E+01 3.0037E+01 3.0037E+01
C  25 FLX  1    0   0   0  12 HEAT    b  0.0000E+00 0.00E+00 0.000E+00
INCON
:
: el ne   nsq nadd        porx
A     1  0  0       7.500000E-02
:
:            x1                   x2                  x3
        1.000000E+05          3.00E-01          2.500000E+01
B     1  0  0       7.500000E-02
        1.000000E+05          3.00E-01          2.500000E+01
C     1  0  0       7.500000E-02
        1.000000E+05          3.00E-01          2.500000E+01
D     1  0  0       7.500000E-02
        1.000000E+05          1.00E-09          2.500000E+01
E     1  0  0       7.500000E-02
        1.000000E+05          3.00E-01          2.500000E+01
F     1  0  0       7.500000E-02
        1.000000E+05          3.00E-01          2.500000E+01
SOLVE
:precond accel  nz   nx   ibug
  BAND    NONE  30   10
```

~~ERROR: POWER INPUT RATES SHOULD BE DOUBLED~~

WRONG POWER INPUT COMPLETELY WRONG — SEE PAGE 8. WILL RE-DO POWER INPUT —

SEE PAGE 12.

MR 6-26-95

MR 6-23-95

6-23-95 NR

- NEW CANISTER RUN: "gwtt 30X10-Ø2i" – IDENTICAL TO "gwtt-30X10-Ø1i" EXCEPT THERMAL CONDUCTIVITIES GIVEN BY PRUESS + TSANG (1994) FOR TOPOPAH WELDED USED:

SATURATED = 2.34 W/M-°C

UNSAT = 1.9 W/M-°C

(TRT)

TO DO NXT WEEK:

- INCREASE POROSITY TO 10%
- PUT CLADDING AROUND CANISTER
- MAKE UPPER BOUNDARY LAYER W/SPECIFIC HEAT >10,000 – REMOVES FROM THERMAL COMPUTATIONS – ALSO – DON'T MAKE BOUNDARY LAYER CELLS HUGE.

6-26-95 NR

- "gwtt-30X10-Ø1i" AND "gwtt-30X10-Ø2i" BOTH REACHED 9999 TIMESTEPS WITHOUT FINISHING.

EACH GOT TO $\simeq 1.6\times10^{-5}$ YRS, $\Delta t \simeq 10^{-10}$ YRS.

TOTAL CALCULATION TIME FOR "gwtt-30X10-Ø2i" = 28,994 s ON SNEEZY

INPUT – NEW CANISTER RUN WITH CORRECTED HEAT INPUTS: "gwtt-60X10-Ø3i"

NR 6-26-95

```
GWTT,6/26/95, Fracture = 0.2 mm wide, K of fracture = 3.33E-12 m2
:van Genuchten parameters =  fracture (matr2), t
:grid=60X10
ROCKS----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
:
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr1  2  2.700E+03 7.500E-02 3.630E-17 3.630E-17 3.630E-17 2.000E-00 7.100E+02
:
:   comp          expan          cdry         tortx
  0.0000E+00  0.0000E-00  1.7000E-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
:
```

INPUT – "gwtt-60X10-Ø3i" (CONT)

6-26-95 NR

NR 6-26-95

```
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr2  2  2.700E+03 7.500E-02 3.330E-12 3.330E-12 3.330E-12 2.000E-00 7.100E+02
:
:   comp          expan          cdry         tortx
  0.0000E+00  0.0000E-00  1.7000E-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
:
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr3  2  2.700E+03 7.500E-02 3.330E-99 3.330E-99 3.330E-99 2.000E-00 7.100E+02
:
:   comp          expan          cdry         tortx
  0.0000E+00  0.0000E-00  1.7000E-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  9999   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+04 -1.000E+00  0.000E+00  A 60  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
ELEME
: el ne    nsq  nad mal ma2     volx
:
A    1   0   0  matr1  1.9500E+12
A    2   0   0  matr1  1.9500E-02
A   20   0   0  matr1  1.9500E-02
A   21   0   0  matr3  1.9500E-02
A   50   0   0  matr3  1.9500E-02
A   51   0   0  matr1  1.9500E-02
```

NR 6-26-95

```
A   59   0   0  matr1  1.9500E-02
A   60   0   0  matr1  1.9500E+12
D    1   0   0  matr2  1.1700E+14
D    2   0   0  matr2  1.1700E-04
D   59   0   0  matr2  1.1700E-04
D   60   0   0  matr2  1.1700E+14
E    1   0   0  matr1  4.4200E+14
E    2   0   0  matr1  4.4200E-04
E   59   0   0  matr1  4.4200E-04
E   60   0   0  matr1  4.4200E+14
J    1   0   0  matr1  5.2000E+11
J    2   0   0  matr1  5.2000E-01
J   59   0   0  matr1  5.2000E-01
J   60   0   0  matr1  5.2000E+11
CONNE
: el n1 e2    n2 nsq nd1 nd2 isot d1          d2           areax       betax
A      1 B     1 0 0 0  1  1.500E-01  1.000E-02  6.500E-02  0.000E+00 0
B      2 C     2 0 0 0  1  1.000E-02  2.500E-03  6.500E-02  0.000E+00 0
C      3 D     3 0 0 0  1  2.500E-03  9.000E-04  6.500E-02  0.000E+00 0
H     60 I    60 0 0 0  1  1.000E+00  2.000E+00  6.500E-02  0.000E+00 0
I      1 J     1 0 0 0  1  2.000E+00  4.000E+00  6.500E-02  0.000E+00 0
A      1 A     2 0 0 0  1  5.000E-02  5.000E-02  1.950E-01  1.000E+00 0
B      2 B     3 0 0 0  1  5.000E-02  5.000E-02  1.300E-02  1.000E+00 0
J     59 J    60 0 0 0  1  5.000E-02  5.000E-02  5.200E+00  1.000E+00 0
                          :reqd blank line
```

– INPUT ERROR, MAKES FRACTURE WIDTH = 1.8MM INSTEAD OF 0.2MM

NR 7-12-95

(ERROR IN XZONE.in)

NR 6-26-95

NR 6-26-95

6-26-95 AR

INPUT: "gwtt-60x10-φ3i" (CONT)

```
GENER----1----*----2----*----3----*----4----*----5----*----6----*----7----8
: el ne sl ns nsq nad nads ltb  itp   itb   gx         ex        hg
:
HEATER ELEMENTS: A21 - A50
                 B21 - B50
                 C21 - C50

A  21 FLX  1    0   0   0  12 HEAT    b  0.0000E+00 0.00E+00 0.000E+00
  0.0000E+00 3.1536E+08 6.3072E+08 1.5678E+09
  3.1536E+09 6.3072E+09 1.5768E+10 3.1536E+10
  6.3072E+10 1.5768E+11 3.1536E+11 1.0000E+12
  4.5760E+01 3.5629E+01 2.1795E+01 1.1980E+01
  6.8090E+00 4.0270E+00 2.3570E+00 1.2630E+00
  8.1500E-01 5.8600E-01 5.8600E-01 5.8600E-01
B  21 FLX  1    0   0   0  12 HEAT    b  0.0000E+00 0.00E+00 0.000E+00
  0.0000E+00 3.1536E+08 6.3072E+08 1.5678E+09
  3.1536E+09 6.3072E+09 1.5768E+10 3.1536E+10
  6.3072E+10 1.5768E+11 3.1536E+11 1.0000E+12
  3.0500E+00 2.3750E+00 1.4530E+00 7.9800E-01
  4.5400E-01 2.6800E-01 1.5700E-01 8.4180E-02
  5.4290E-02 3.9040E-02 3.9040E-02 3.9040E-02
C  21 FLX  1    0   0   0  12 HEAT    b  0.0000E+00 0.00E+00 0.000E+00
  0.0000E+00 3.1536E+08 6.3072E+08 1.5678E+09
  3.1536E+09 6.3072E+09 1.5768E+10 3.1536E+10
  6.3072E+10 1.5768E+11 3.1536E+11 1.0000E+12
  7.6300E-01 5.9407E-01 3.6342E-01 1.9975E-01
  1.1353E-01 6.7140E-02 3.9290E-02 2.1060E-02
  1.3580E-02 9.7700E-03 9.7700E-03 9.7700E-03
                                          :reqd blank line
:
INCON
:
: el ne   nsq nadd          porx
A     1  0  0        7.500000E-02
:

:            x1                  x2                x3
         1.000000E+05          3.000000E-01              2.500000E+01
B     1  0  0        7.500000E-02
         1.000000E+05          3.000000E-01              2.500000E+01
C     1  0  0        7.500000E-02
         1.000000E+05          3.000000E-01              2.500000E+01
D     1  0  0        7.500000E-02
         1.000000E+05          1.00E-09                  2.500000E+01
E     1  0  0        7.500000E-02
         1.000000E+05          3.00E-01              2.500000E+01
F     1  0  0        7.500000E-02
         1.000000E+05          3.00E-01              2.500000E+01
E     5  0  0        7.500000E-02
         1.000000E+05          3.00E-01              2.500000E+01
F     5  0  0        7.500000E-02
         1.000000E+05          3.00E-01              2.500000E+01
SOLVE
:precond accel  nz   nx   ibug
  BAND   NONE   60   10
```

AR 6-26-95

AR 6-26-95

AR 6-26-95

NEW CANISTER RUN: "gwtt-60x10-φ4i" - IDENTICAL TO: "gwtt-60x10-φ3i" EXCEPT SEVERAL VARIABLES SET TO THOSE GIVEN IN PRUESS + TSANG FOR TOPOPAH Spr. TUFF (pg 10)

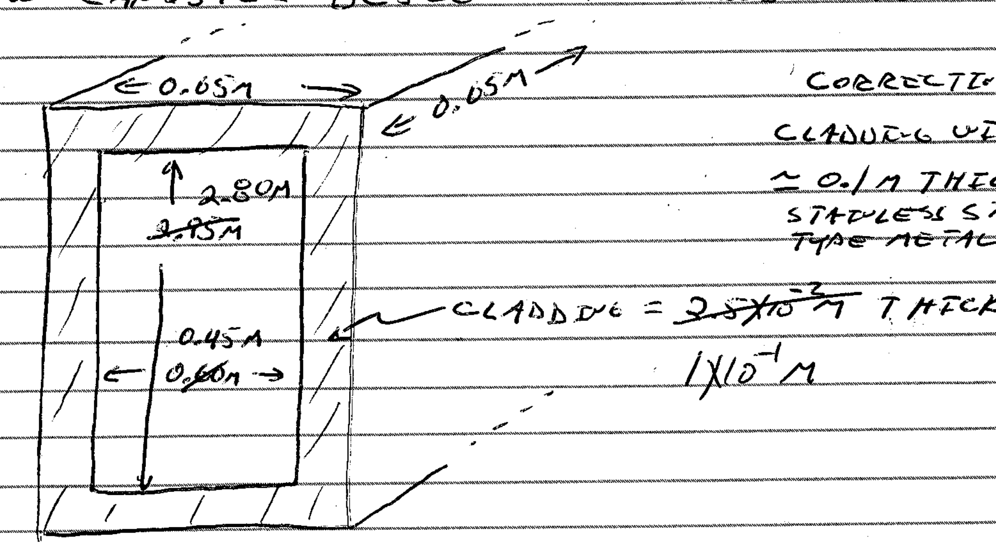
POROSITY = 0.10   ROCK DENSITY = 2480 Kg/m³
CWET = 2.34 W/M-°C   ROCK SPECIFIC
Cdry = 1.90 W/M-°C   HEAT = 840 J/Kg-°C

6-27-95 AR

- NEW CANISTER RUN: "gwtt-60x10-noheati" - IDENTICAL TO "gwtt-60x10-φ4i" EXCEPT NO 'GENER' BLOCK, i.e., NO HEAT GENERATION.

- "gwtt-60x10-noheati" SIMULATED 10^4 YRS IN 6482s ON SKIPPY.
  "gwtt-60x10-φ4i" STUCK ON 5.66×10^{-3} YR, $\Delta t \simeq 10^{-8}$ YR AFTER ≃ 24 HRS ON SNEEZY. - @ 5.66×10^{-3} YR SINCE TIMESTEP # 585, TIMESTEP NOW = 750 (@ 1045)
  .xyp FILES IN:
  /usr2/sneezy/rgreen/grice/gwtt/2-d/6-95

- NEW CANISTER DESIGN - INCLUDES 'CLADDING'



CORRECTION (6-27-95 AR) CLADDING WILL BE ≃ 0.1 M THICK - IRON/STAINLESS STEEL TYPE METAL

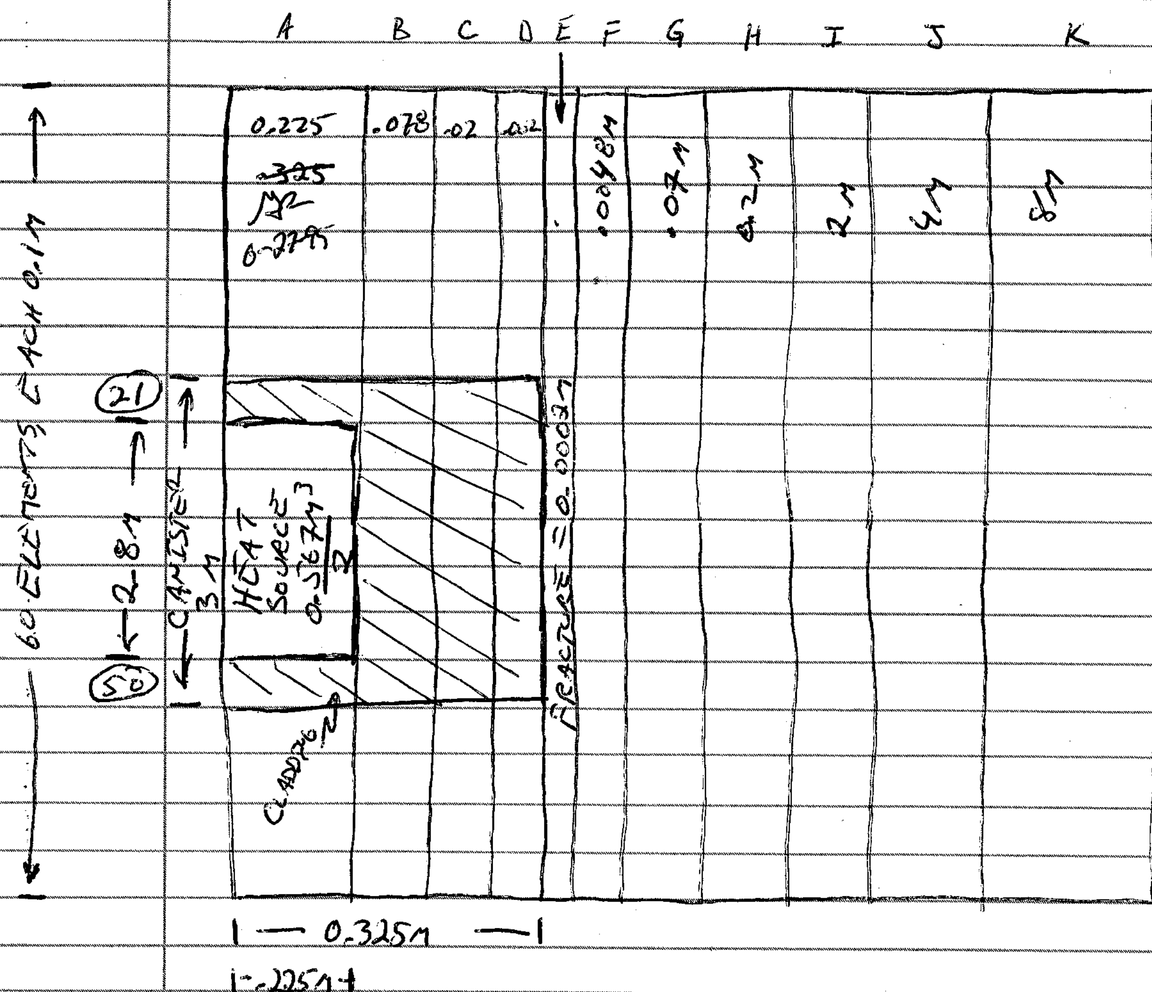
VOLUME OF WASTE IN SIMULATED CANISTER WITH CLADDING: $(\cancel{2.95}\ 2.80\,m)(\cancel{0.60}\ 0.45\,m)^2$

$= \cancel{1.062}\ 0.567\ m^3$

THUS - POWER (INITIAL) OUTPUT PER UNIT VOLUME OF WASTE $= 3000\,W / \cancel{1.062}\ 0.567\ m^3$

$\simeq \cancel{2824.86}\ 5,291\ W/m^3$

6-27-95 MR • NEW GRID – GWTT, CANISTER WITH CLADDING:



HEATER CONSISTS OF 28 ELEMENTS: A22 → A49

VOLUME OF EACH HEATER ELEMENT = $(0.1M)(0.45M)(0.225M)$
$= 1.013 \times 10^{-2}\ M^3$

INITIAL POWER INPUT TO EACH HEATER ELEMENT:

$5291 \frac{W}{M^3} (1.013 \times 10^{-2} M^3) = \underline{53.57W}$

$(53.57 \times 28 = 1500W)$ ✓

6-27-95 MR • NEW CANISTER RUN – CLAD – AS DESCRIBED ON PREVIOUS PAGE: "clad-60x11-ϕ1i" RUN IN: ~~SKIPPY/~~ MR 6-27-95 /home/SKIPPy/rgreen/goodluck

6-28-95 MR • KILLED "clad-60x11-ϕ1i" AFTER RUNNING ≃ 24 HRS. TIMESTEPS = 886 TIME = 5.781×10^{-3} YR, $\Delta t \simeq 1.6 \times 10^{-8}$ – HAD BEEN FOR ENTIRE MORNING (≃ 0900 – 1100)

• NEW CANISTER RUN: "gwtt-60x10-ϕ5i"

MUCH LIKE "gwtt-60x10-ϕ4i" EXCEPT VERY LARGE ($\simeq 10^{10} M^3$) CELLS ON TOP & BOTTOM HAVE BEEN REPLACED W/NORMAL SIZED CELLS THAT HAVE A SPECIFIC HEAT > 10,000 J/kg-°C, i.e., THEY WILL ACT AT HEAT SINKS BUT ARE NOT COUNTED IN THE ENERGY BUDGET. ALSO, A WATER SOURCE (GENER) IS INCLUDED AT CELL DI – WATER INJECTION RATE IS SLIGHTLY LESS THAN THE SATURATED HYDRAULIC CONDUCTIVITY OF THE FRACTURE

WATER INJECTION RATE CALCULATED AS FOLLOWS:

$k = 3.33 \times 10^{-12} M^2, \quad K = \frac{k \rho g}{\mu},$

$\rho = 10^3 \frac{kg}{M^3}, \quad g = 9.8 \frac{M}{S^2}, \quad \mu = 1cp = 10^{-3} \frac{N\text{-}S}{M^2}$

$K = \frac{3.33 \times 10^{-12} M^2 \; 10^3 kg \; 9.8 M \; S^2 M^2}{M^3 S^2 \; 10^{-3} \; kg\, MS \; \cancel{M^2}} = \frac{326 \times 10^{-5}\ kg\, M^5 S^2}{kg\, M^4 S^3}$ MR 6-28-95

$K = 3\cancel{26} \times 10^{-5} \frac{M}{S} \rightarrow$ CALL IT 3×10^{-5} M/S $\Rightarrow$

$(0.1)\, 3 \times 10^{-5} \frac{M}{S}\, 2 \times 10^{-4} M\, (0.65M)\, 10^3 \frac{kg}{M^3} \Rightarrow 3.9 \times 10^{-7} \frac{kg}{S}$ PUT IN GENER

6-29-95 MR — NEW CANISTER RUN: "gwtt-76x10-φ1i"
IDENTICAL TO "gwtt-60x10-φ4i" EXCEPT
GRIDDING FINER AT MATERIAL BOUNDARIES,
i.e., HEATER + ROCK MATRIX
RUN ON: /home/skippy/rgreen/goodluck

KILLED "gwtt-60x10-φ5i" - RAN ≃ 1 DAY,
TIME ≃ 5×10^{-3} YR, $\Delta t \simeq 1 \times 10^{-8}$ YR.

6-30-95 MR
• NEW CANISTER RUN: "gwtt-60x10-φ6i" -
IDENTICAL TO "gwtt-60x10-φ4i" EXCEPT
HEAT INPUT RAMPED UP OVER 9 MOS IN
'GENER'

MR 6-30-95
• KILLED ~~"gwtt-60x10-..."~~ "gwtt-76x10-φ1i",
RAN ≃ 1 DAY (CPU TIME ≃ 790 MIN),
TIME ≃ 5.7×10^{-3} YR, TIMESTEP = 614

7-3-95 MR
• "gwtt-60x10-φ4i" COMPLETED 9999 TIMESTEPS IN
2.86×10^{5} s, TIME = 0.0193 YRS, $\Delta t \simeq 5.6 \times 10^{-8}$ YR

• NEW TYPE OF CANISTER RUN: FRACTURE ZONE
= 0.1 M WIDE:

"zone-60x8-φ1i"

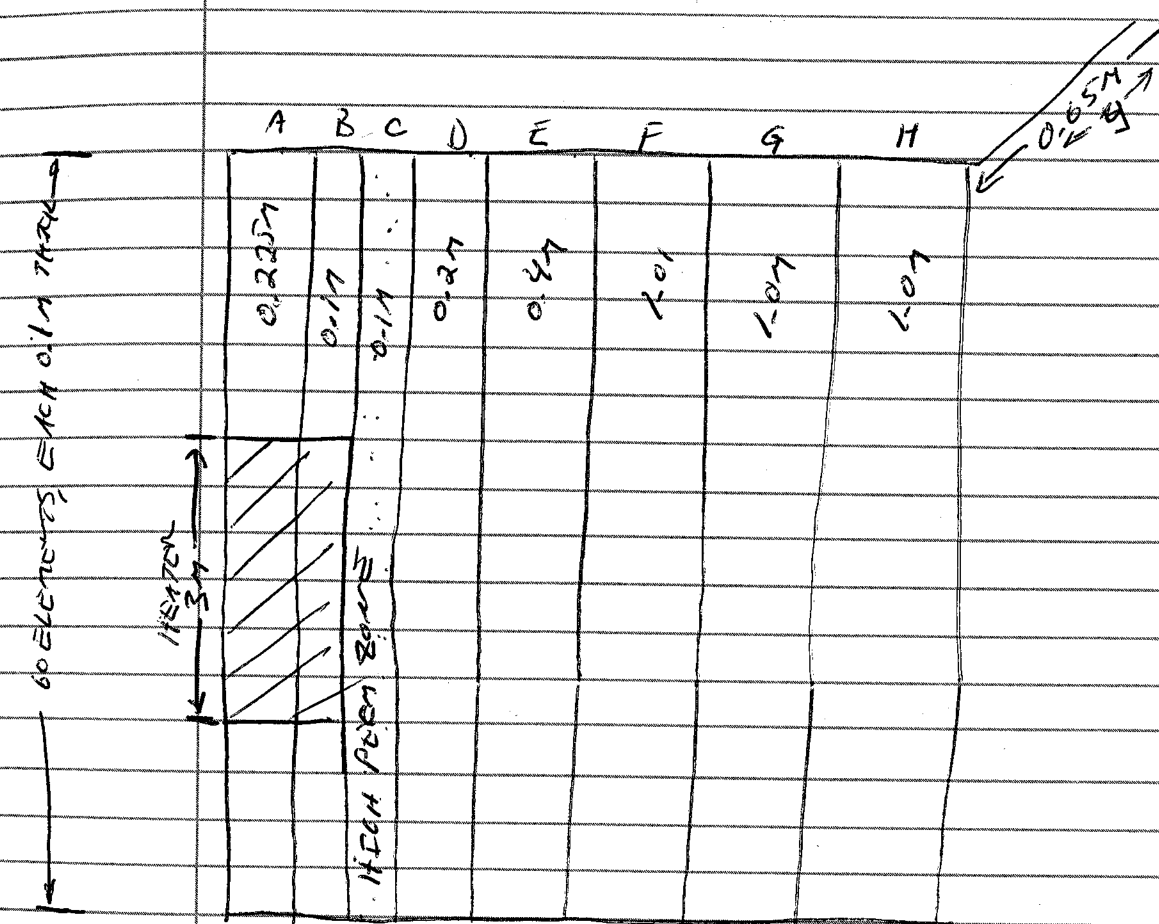
'A' HEATER ELEMENTS VOLUME = 1.4625×10^{-2} m^3
'B' " " " = 6.5000×10^{-3} m^3

HEAT GENERATED BY CANISTER = $\frac{3000\ \text{W}}{1.278\ \text{m}^3}$ = 2.346.64 W/m^3

INITIALLY, EACH 'A' HEATER ELEMENT RECEIVES : 34.32 W
" 'B' " " " : 15.25 W

7-3-95 MR
• KILLED "gwtt-60x8-φ6i" - STEP = 350, TIME
≃ 0.194 YR, $\Delta t \simeq 3.28 \times 10^{-7}$ YR

GWTT - CANISTER - HIGH PERM ZONE:



1ST HIGH PERM ZONE RUN:

"zone-60x8-φ1i" RUN IN
/usr2/sneezy/rgreen/grice/gwtt/2-d/7-95

MR 7-3-95
2ND HIGH PERM ZONE RUN:
"zone-60x8-φ2i" - IDENTICAL TO "zone-60x8-φ1i"
EXCEPT CANISTER IS DRY (INITIALLY S, SAT = φ.)
IN:
/home/skippy/rgreen/goodluck/

7-3-95 MR

INPUT: "ZONE-60X8-01i" MR 7-3-95

```
GWTT,7/3/95, Fracture Zone = 0.1m wide, K of fracture zone = 3.33E-12 m^2)
:van Genuchten parameters
:grid=60X8
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 1.000E-01 3.630E-17 3.630E-17 3.630E-17 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
:
: Fracture Zone
:
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr2  2   2.480E+03 1.000E-01 3.330E-12 3.330E-12 3.330E-12 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
:
: Heater
:
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr3  2   2.480E+03 1.000E-01 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  9999   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+04 -1.000E+00  0.000E+00  A 60  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
:
ELEME
: el ne   nsq  nad ma1 ma2    volx
```

MR 7-3-95

```
:
A    1   0   0   matr1   1.4625E+12
A    2   0   0   matr1   1.4625E-02
A    3   0   0   matr1   1.4625E-02
A    4   0   0   matr1   1.4625E-02
A   18   0   0   matr1   1.4625E-02
A   19   0   0   matr1   1.4625E-02
A   20   0   0   matr1   1.4625E-02
A   21   0   0   matr3   1.4625E-02
A   22   0   0   matr3   1.4625E-02
A   23   0   0   matr3   1.4625E-02
A   49   0   0   matr3   1.4625E-02
A   50   0   0   matr3   1.4625E-02
A   51   0   0   matr1   1.4625E-02
A   52   0   0   matr1   1.4625E-02
A   53   0   0   matr1   1.4625E-02
A   58   0   0   matr1   1.4625E-02
A   59   0   0   matr1   1.4625E-02
A   60   0   0   matr1   1.4625E+12
```

MR 7-3-95

7-3-95 MR

INPUT: "ZONE-60X8-01i" (CONT) MR 7-3-95

```
B    1   0   0   matr1   6.5000E+13
B    2   0   0   matr1   6.5000E-03
B   24   0   0   matr3   6.5000E-03
B   59   0   0   matr1   6.5000E-03
B   60   0   0   matr1   6.5000E+13
C    1   0   0   matr2   6.5000E+13
C    2   0   0   matr2   6.5000E-03
C    3   0   0   matr2   6.5000E-03
C   58   0   0   matr2   6.5000E-03
C   59   0   0   matr2   6.5000E-03
C   60   0   0   matr2   6.5000E+13
D    1   0   0   matr1   1.3000E+12
D    2   0   0   matr1   1.3000E-02
D    3   0   0   matr1   1.3000E-02
:
A     1 B      1 0 0 0   1   1.125E-01   5.000E-02   6.500E-02   0.000E+00 0
A     2 B      2 0 0 0   1   1.125E-01   5.000E-02   6.500E-02   0.000E+00 0
B    24 B     25 0 0 0   1   5.000E-02   5.000E-02   6.500E-02   1.000E+00 0
B    25 B     26 0 0 0   1   5.000E-02   5.000E-02   6.500E-02   1.000E+00 0
H    59 H     60 0 0 0   1   5.000E-02   5.000E-02   6.500E-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  21 FLX  1     0    0    0  12 HEAT     b  0.0000E+00 0.00E+00 0.000E+00
  0.0000E+00 3.1536E+08 6.3072E+08 1.5678E+09
  3.1536E+09 6.3072E+09 1.5768E+10 3.1536E+10
  6.3072E+10 1.5768E+11 3.1536E+11 1.0000E+12
  3.4320E+01 2.6721E+01 1.6346E+01 8.9849E+00
  5.1068E+00 3.0201E+00 1.7675E+00 9.4722E-01
  6.1089E-01 4.3929E-01 4.3929E-01 4.3929E-01
A  48 FLX  1     0    0    0 .12 HEAT     b  0.0000E+00 0.00E+00 0.000E+00
  0.0000E+00 3.1536E+08 6.3072E+08 1.5678E+09
  3.1536E+09 6.3072E+09 1.5768E+10 3.1536E+10
  6.3072E+10 1.5768E+11 3.1536E+11 1.0000E+12
  3.4320E+01 2.6721E+01 1.6346E+01 8.9849E+00
  5.1068E+00 3.0201E+00 1.7675E+00 9.4722E-01
  6.1089E-01 4.3929E-01 4.3929E-01 4.3929E-01
B  21 FLX  1     0    0    0  12 HEAT     b  0.0000E+00 0.00E+00 0.000E+00
  0.0000E+00 3.1536E+08 6.3072E+08 1.5678E+09
```

MR 7-3-95

```
  3.1536E+09 6.3072E+09 1.5768E+10 3.1536E+10
  6.3072E+10 1.5768E+11 3.1536E+11 1.0000E+12
  1.5250E+01 1.1874E+01 7.2636E+00 3.9924E+00
  2.2692E+00 1.3420E+00 7.8538E-01 4.2090E-01
  2.7145E-01 1.9520E-01 1.9250E-01 1.9250E-01
B  48 FLX  1     0    0    0  12 HEAT     b  0.0000E+00 0.00E+00 0.000E+00
  0.0000E+00 3.1536E+08 6.3072E+08 1.5678E+09
  3.1536E+09 6.3072E+09 1.5768E+10 3.1536E+10
  6.3072E+10 1.5768E+11 3.1536E+11 1.0000E+12
  1.5250E+01 1.1874E+01 7.2636E+00 3.9924E+00
  2.2692E+00 1.3420E+00 7.8538E-01 4.2090E-01
  2.7145E-01 1.9520E-01 1.9250E-01 1.9250E-01
INCON
:
: el ne   nsq nadd        porx
A     1  0  0      1.000000E-01
:
:         x1                      x2                  x3
       1.000000E+05           3.000000E-01                      2.500000E+01
B     1  0  0      1.000000E-01
       1.000000E+05           3.000000E-01                      2.500000E+01
C     1  0  0      1.000000E-01
       1.000000E+05           3.000000E-09                      2.500000E+01
D     1  0  0      1.000000E-01
       1.000000E+05           3.000000E-01                      2.500000E+01
E     1  0  0      1.000000E-01
       1.000000E+05           3.000000E-01                      2.500000E+01
F     1  0  0      1.000000E-01
       1.000000E+05           3.000000E-01                      2.500000E+01
B    58  0  0      1.000000E-01
       1.000000E+05           3.000000E-01                      2.500000E+01
C    58  0  0      1.000000E-01
       1.000000E+05           3.000000E-01                      2.500000E+01
D    58  0  0      1.000000E-01
       1.000000E+05           3.000000E-01                      2.500000E+01
```

MR 7-3-95

7-4-95 AR • FOUND ERROR IN "ZONE-60X8-φ2i" – HEATER WAS INITIALLY SATURATED INSTEAD OF INITIALLY WET – CORRECTED + RE-STARTED

• NEW GWTT CANISTER ZONE RUN:
"ZONE-60X8-φ3i" – IDENTICAL TO "ZONE-60X8-φ2i" EXCEPT HEAT LOADS REDUCED BY FACTOR OF 10^3 IN "GENER".

—— / —— / ——

7-5-95 AR • @ ≈ 0830, "ZONE-60X8-φ1i" @ TIMESTEP = 2575, $t \approx 2.4 \times 10^{-4}$ yr, $\Delta t \approx 4 \times 10^{-6}$ yr
KILLED RUN!

• NEW RUN: "ZONE-60X8-φ4i" IDENTICAL TO "ZONE-60X8-φ2i" EXCEPT PERMEABILITY OF MATRIX INCREASED TO THAT GIVEN IN BUSCHECK + NITAO, pg 2456: $2.8 \times 10^{-13} m^2$

IN: /usr2/sneezy/rgreen/grice/gwtt/2-d/7-95

• NEW RUN: "ZONE-60X8-φ5i" – IDENTICAL TO "ZONE-60X8-φ4i" EXCEPT:

- VAN GENUCHTEN λ FOR ROCK MATRIX CHANGED FROM 0.8 TO 0.5 ($n: 5 \rightarrow 2$, $\lambda = 1 - \frac{1}{n}$)

- VAN GENUCHTEN α FOR FRACTURE ZONE CHANGED FROM 1.021×10^{-4} TO 1.021×10^{-1}.

—— / —— / ——

7-6-95 AR • "ZONE-60X8-φ4i" DONE – 10,000 YR SIMULATION DONE IN 828 TIMESTEPS, CALCULATION TIME = 23,038 s.

7-6-95 AR • NEW GWTT/CANISTER/FRACTURE ZONE RUN:
"ZONE-60X8-φ6i" – IDENTICAL TO "ZONE-60X8-φ5i" EXCEPT PERMEABILITY OF ROCK MATRIX REDUCED BY AN ORDER OF MAGNITUDE TO – $2.8 \times 10^{-14} m^2$.

—— (—— (——

7-7-95 AR RUN "ZONE-60X8-φ5i" STOPPED RUNNING ON SKIPPY AFTER TIMESTEP 1656, $t = 76.8$ yrs, $\Delta t = 0.123$ yrs. MESSAGE:
"WARNING: NO CONVERGENCE IN SUBROUTINE PP"
ALSO:
"NOTE: IEEE NaNs WERE WRITTEN TO ASCII STRINGS OR OUTPUT FILES;"

K_f = BUSC HIGH
$K_M = 10^{-17}$

• NEW GWTT/CANISTER/ZONE RUN: "ZONE-60X8-φ7i"

IDENTICAL TO "ZONE-60X8-φ5i" EXCEPT:
- VAN GENUCHTEN α FOR FRACTURE ZONE = 1.021×10^{-2}
- PERMEABILITY OF ROCK MATRIX = $5 \times 10^{-17} m^2$
- PERMEABILITY OF FRACTURE ZONE = 840 DARCY = HIGHEST VALUE USED BY BUSCHECK + NITAO.

$$840 \text{ DARCY} \; \frac{9.87 \times 10^{-9} cm^2}{\text{DARCY}} \; \frac{10^{-4} m^2}{cm^2} = 8.3 \times 10^{-10} m^2$$

IN: /home/SKIPPY/rgreen/goodluck

• NEW GWTT/CANISTER/FRACTURE ZONE RUN:
"ZONE-60X8-φ8i" IDENTICAL TO "ZONE-60X8-φ7i" EXCEPT PERMEABILITY OF ROCK MATRIX = $5 \times 10^{-13} m^2$
IN: /usr2/sneezy/rgreen/grice/gwtt/2-d/7-95
• KILLED "ZONE-60X8-φ6i"

7-7-95
AR

- RUN. "ZONE-60X8-Ø8i" DONE ON SNEEZY - # TIMESTEPS = 330, $t = 10^4$ YRS, $\Delta t = 456$ /YRS, CALCULATION TIME = 7375 s

- NEW GWTT/CANISTER/ZONE RUN: "ZONE-60X8-Ø9i" - IDENTICAL TO "ZONE-60X8-Ø7i" EXCEPT VAN GENUCHTEN α OF FRACTURE ZONE = 1.021×10^{-1} INSTEAD OF 1.021×10^{-2}.

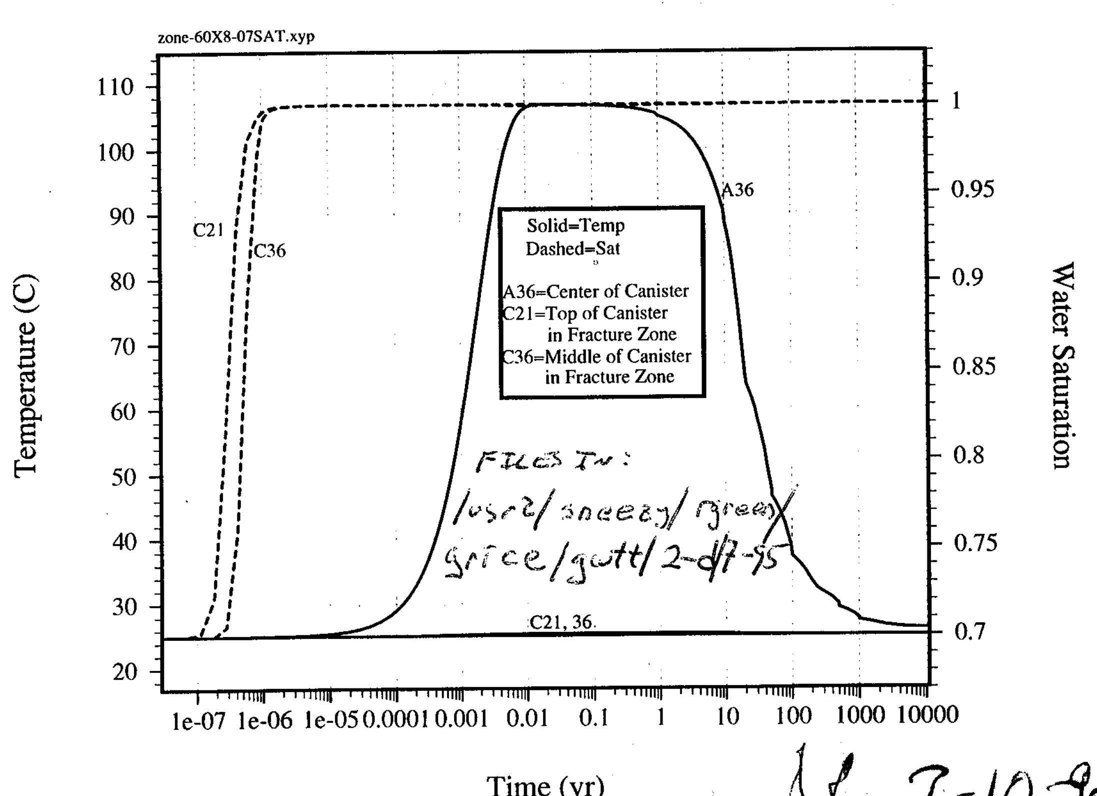
7-10-95
AR

- RUN "ZONE-60X8-Ø7i" DONE ON SKIPPY, 10^4 YRS, TIMESTEPS = 381, CALCULATION TIME = 8,882 S.

- RUN "ZONE-60X8-Ø9i" FAILED ON SNEEZY AFTER 312 TIMESTEPS, 500 YRS, Δt = 0436 YRS - MESSAGE = "WARNING: NO CONVERGENCE IN SUBROUTINE PP".

AR 7-10-95

60X8-07, (k(m)=5e-17m^2, k(f)=8.3e-10m^2, alpha(f)=1e-2)



AR 7-10-95

7-10-95
AR

- NEW RUN: "newgwtt-60X10-Ø3i" - IDENTICAL TO "gwtt-60X10-Ø3i" (SEE pg 12) EXCEPT:

AR 7-10-95

~~HT.~~ PERMEABILITY OF ROCK MATRIX = 5×10^{-17} m²
VAN GENUCHTEN λ OF ROCK MATRIX = 0.5
VAN GENUCHTEN α of FRACTURE = 1.021×10^{-2} /Pa
PERMEABILITY OF FRACTURE = 8.3×10^{-10} m²
POROSITY OF ALL MATERIALS = 0.10
DENSITY OF ALL MATERIALS = 2480 Kg/m³
CWET " " " = 2.34 W/m °C
cdry " " " = 1.90 W/m °C
SPHT " " " = 840 J/Kg °C

RUN IN: /usr2/sneezy/rgreen/grice/gwtt/2-d/7-95

- NEW RUN: "newgwtt-60X10-Ø4i" - IDENTICAL TO ~~"g~~ AR 7-10-95 "newgwtt-60X10-Ø3i" EXCEPT NO LIQUID IN CANISTER @ $t = 0$.

→ MESSAGE @ STEP 3: "WARNING, NO CONVERGENCE IN SUBROUTINE PP.
→ NO WARNING @ STEP 4.

/home/SKIPPY/rgreen/goodluck

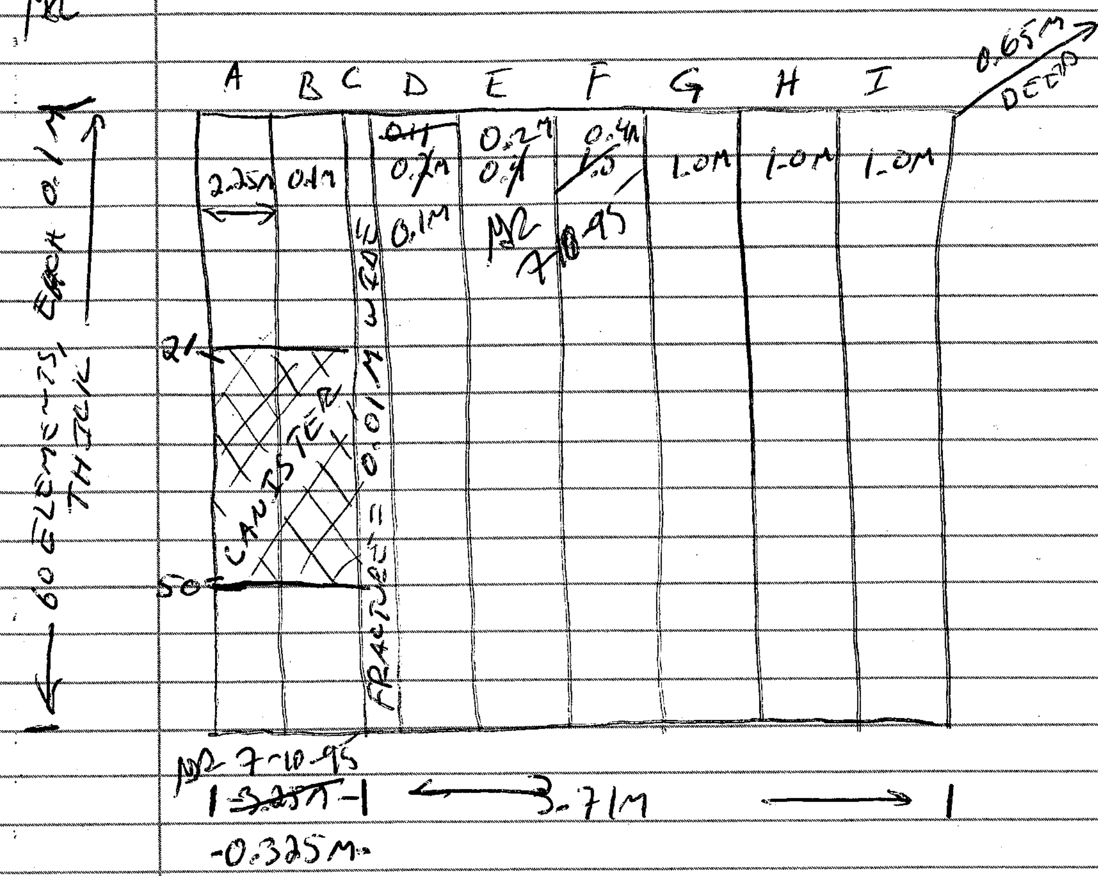
→ WARNINGS KEEP OCCURING - NEW RUN: "newgwtt-60X10-Ø5i" - IDENTICAL TO ~~"gw~~ AR 7-10-95 ~~"g~~ "newgwtt-60X10-Ø4i" EXCEPT AIR SATURATION OF CANISTER = 0.999 INSTEAD OF 0.9999999.

- "newgwtt-60X10-Ø4i" DIED @ TIMESTEP #9, $t = 1.4 \times 10^{-7}$ YR, $\Delta t = 1.7 \times 10^{-9}$ YR.

- RUN "newgwtt-60X10-Ø5i" ON "/home/SKIPPY/rgreen/goodluck

7-10-95
NR

NEW GWTT/CANISTER/ZONE- SET-UP: 60X9



• KILLED "newgwtt-60X10-φ5i" - RUNNING SLIGHTLY SLOWER THAN "newgwtt-60X10-φ3i".

• BEGAN: "ZONE-60X9-φ1i" - IDENTICAL TO "ZONE-60X8-φ7i" EXCEPT FOR EXTRA COLUMN OF ELEMENTS + 1cm WIDE FRACTURE ZONE INSTEAD OF 10 cm WIDE.

7-11-95
NR

• "ZONE-60X9-φ1i" DONE ON SKIPPY, 10^4 YRS, 339 TIMESTEPS, CALCULATION TIME = 8376 S

• NEW RUN: "newgwtt-60X10-φ6i" - IDENTICAL TO "newgwtt-60X10-φ3i" EXCEPT PERMEABILITY OF FRACTURE = 8.3×10^{-11} m^2 INSTEAD OF 8.3×10^{-10} m^2.
RUN ON: /home/skippy/rgreen/goodluck

7-11-95
NR

• NEW RUN: "newgwtt-60X10-φ7i" - IDENTICAL TO "newgwtt-60X10-φ3i" EXCEPT PERMEABILITY OF FRACTURE = 8.3×10^{-12} m^2 INSTEAD OF 8.3×10^{-10} m^2
ON: /usr2/sneezy/rgreen/grice/gwtt/2-d/7-95

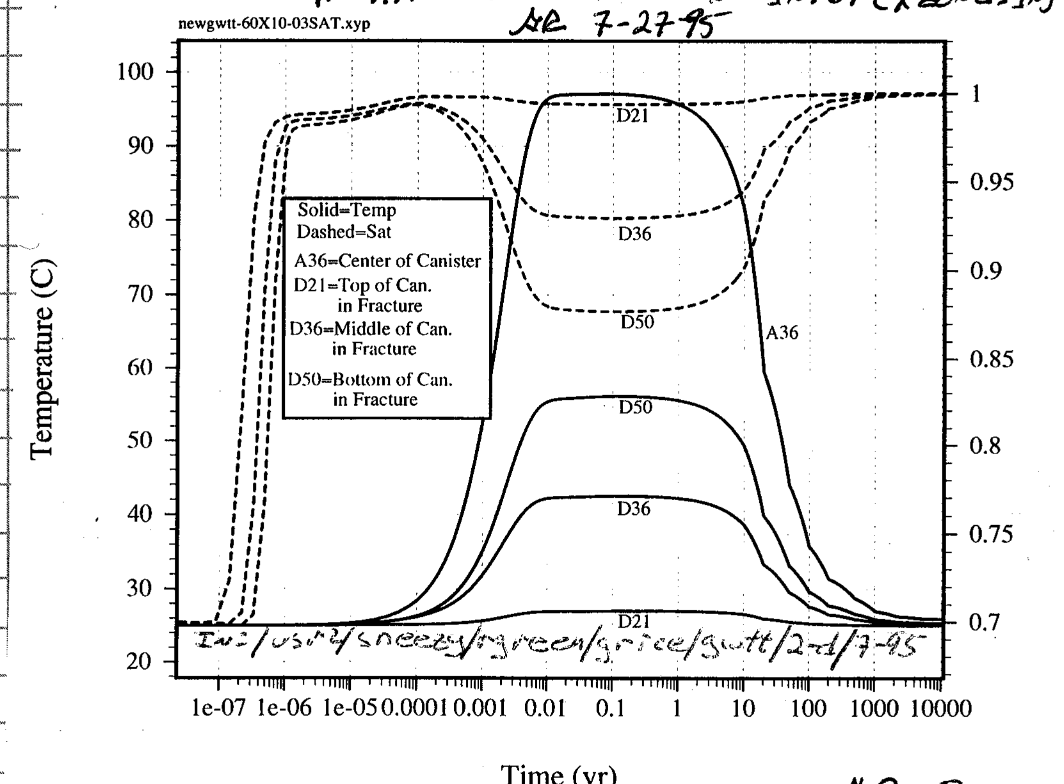
• "newgwtt-60X10-φ3i" FINISHED RUNNING ON SNEEZY, TIMESTEPS = 3053, t = 10^4 YR, CALCULATION TIME = 66,957 S

7-12-95

OUTPUT: "newgwtt-60X10-φ3i"

NR 7-12-95

60X10-03, ~~0.2~~mm Fracture, k(f)=8.3E-10m^2
1.8 MM - ERROR FOUND IN INPUT (XZONE.IN)
NR 7-27-95



NR 7-12-95

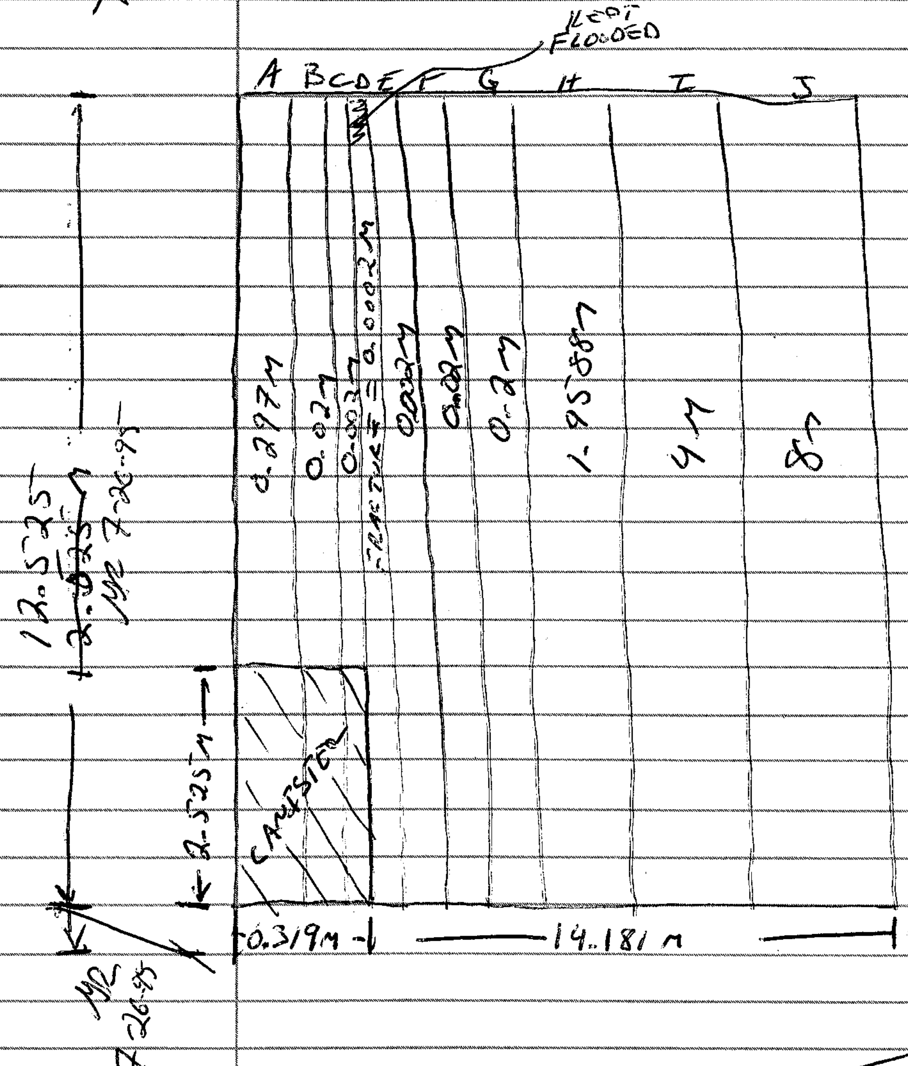
28

7/20/95 RF

Changed porosity of fracture in 0.2mm-60x10-01i to 0.9, it was 0.1
renamed it 0.2mm-60x10-02i and it is in /usr2/sneezy/rgreen/gvice/gwtt/2-d/rg7-5/.
started on sneezy at 9:45 Thur 7/20

7-26-95 MR

· NEW CANISTER RUN: "63X10-φ1i"
GRID SETUP:



MR 7-26-95

29

7-26-95 MR

CANISTER HEAT GENERATION SCHEDULE
(FROM RON GREEN)

CORRECTED VALUE FROM EQN IN NITAO, pg 17

MR 8-2-95

YEAR - 10*	TOTAL WATTS+	W/M³+
0	3400	1654
~~0~~10	2487	1209
~~10~~20 MR	2052	998
~~20~~ ~~30~~ ~~40~~ 30	1730	841
~~40~~50	1285	625 MR 7-26-95
~~60~~70	1000	~~331~~ 486
~~100~~110	680	331
~~200~~210	417	203
~~400~~410	293	143
~~600~~610	228	111
~~1000~~1010	149	72.5

WRONG

* ~~TEN~~ YEARS SUBTRACTED BECAUSE FUEL IS 10 YRS OLD
+ VOLUME OF CANISTER = $\pi(0.36M)^2 5.05M = 2.056M^3$

DT=0 ON THIS TABLE, FUEL IS ALREADY 8.555 YRS OLD. SEE NITAO, "NUMERICAL HORIZ. EMPLACEMENT" pg 17

RON'S CALCULATED VALUES:

WATTS

MR 7-26-95

10.	2486.579213263664
20.	2052.441002371546
30.	1729.931095352348
40.	1481.135263448797
50.	1284.941879528166
60.	1127.738412439674
70.	1000.306209751503
80.	896.118110818533
90.	810.370726844024
100.	739.4176980718426
110.	680.4252129606271
120.	631.1533136811042
130.	589.8104116145847
140.	554.9519632341129
150.	525.4069396524299
160.	500.2226204877825
170.	478.6220421566151
180.	459.9705623114831
190.	443.7492284841351
200.	429.5333680683785
210.	416.9752679773949
220.	405.7901045015533
230.	395.7444821972482
240.	386.6470813094437
250.	378.3410169111519
260.	370.6975917394624
270.	363.6111859934244
280.	356.995075825286
290.	350.7780110310124
300.	344.9014137115286
310.	339.3170850196359
320.	333.985327722183
330.	328.8734091134212
340.	323.954302537470[illegible]
350.	319.2056569923719
360.	314.6089534592562
370.	310.148814103151[illegible]
380.	305.8124366318919
390.	301.58913112496[illegible]
400.	297.4699407577451
410.	293.4473312139666
420.	289.5149363362676
430.	285.6673498214092
440.	281.8999546147257
450.	278.2087831710789
460.	274.5904029881793
470.	271.0418228321715
480.	267.560415905602
490.	264.1438568876078
500.	260.7900703326821
510.	257.4971883699944
520.	254.263516018292
530.	251.0875027368191
540.	247.9677190827541
550.	244.9028375503871
560.	241.8916168348836
570.	238.9328889007091
580.	236.0255483471524
590.	233.1685436553728
600.	230.3608699767159
610.	227.6015631837028
620.	224.8896949555883
630.	222.2243687117166
640.	219.6047162397458
650.	217.0298948935191
660.	214.4990852580506
670.	212.0114891976625
680.	209.5663282185211
690.	207.1628420892682
700.	204.8002876736374
710.	202.4779379372956
720.	200.1950810979773
730.	197.9510198935803
740.	195.7450709474678
750.	193.5765642139768
760.	191.4448424902013
770.	189.3492609826322
780.	187.2891869193008
790.	185.2639991997495
800.	183.2730880765438
810.	181.3158548631613
820.	179.3917116640258
830.	177.5000811232082
840.	175.6403961889391
850.	173.8120998915868
860.	172.0146451331671
870.	170.2474944867983
880.	168.510120004789
890.	166.802003034278
900.	165.1226340395324
910.	163.4715124301645
920.	161.8481463946515
930.	160.2520527386503
940.	158.682756727677[illegible]
950.	157.139791933803[illegible]
960.	155.6227000860526
970.	154.1310309242676
980.	152.6643420562154
990.	151.2221988177547
1000.	149.8041741359099

MR 7-26-95

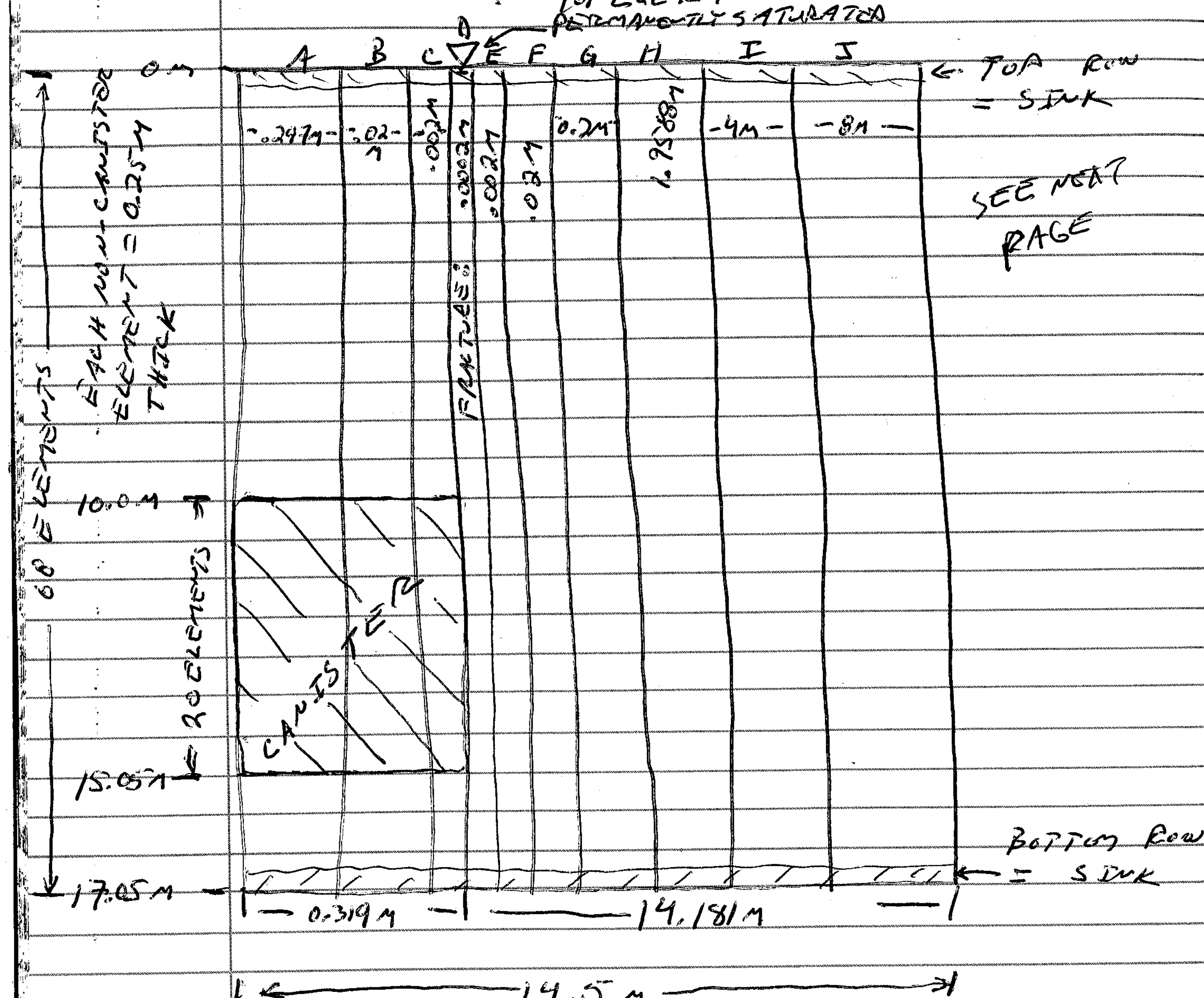
MR 7-26-95

MR 7-26-95

7-27-95
AC

• KILLED "63X10-ϕ1i" - BOGGED DOWN @ 10^{-4} YR.

• NEW CANISTER DESIGN: "68X10-ϕ1i"



"68X10-ϕ1i" USES SAME ENERGY INPUT SCHEDULE AS SHOWN ON PAGE 29

RUN ON:

/usr2/sneezy/rgreen/grice/gwtt/2d/8-95

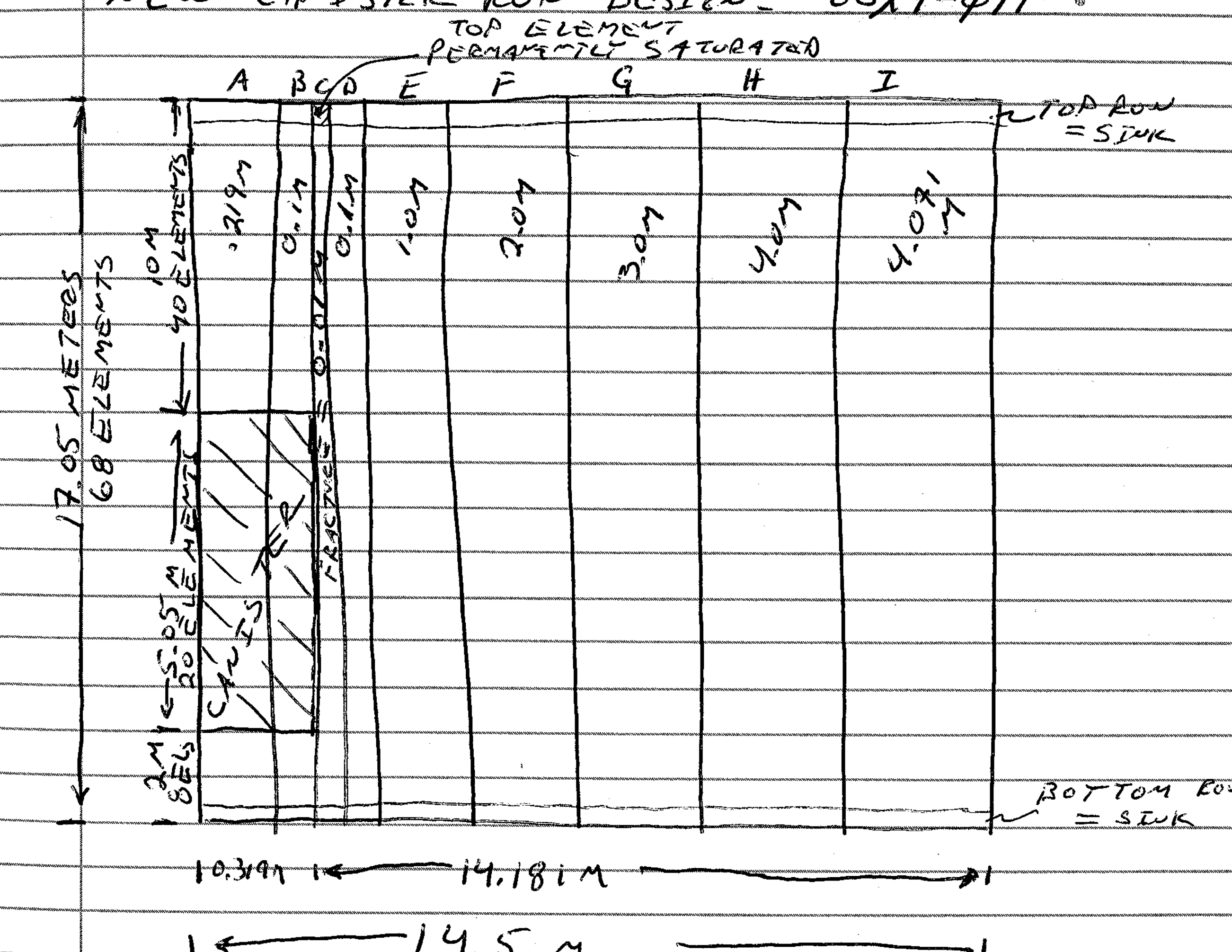
7-27-95
AC

• NEW INPUT: "68X10-ϕ2i" - IDENTICAL TO "68X10-ϕ1i" EXCEPT PERMEABILITY OF FRACTURE = $8.3 \times 10^{-9} m^2$ INSTEAD OF $8.3 \times 10^{-10} m^2$

RUN ON: /home/skippy/rgreen/goodluck - KILLED - PETER L. NEEDED MACHINE

- ERROR FOUND IN "68X10-ϕ1i" - POROSITY OF FRACTURE FOUND TO BE 0.1 INSTEAD OF 0.9. KILLED RUN - RUN "68X9-ϕ1i" INSTEAD.

• NEW CANISTER RUN DESIGN: "68X9-ϕ1i"



AC

7-28-95 MR

INPUT: "68x9-φ/i" IN: /usr2/sneezy/rgreen/grice/gwtt/2-d/8-95

MR 7-28-95

```
GWTT,7/28/95, Fracture = 0.01m wide, k of fracture = 8.3E-10 m^2
:Fracture porosity = 0.9
:grid=68X9
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 1.000E-01 5.000E-17 5.000E-17 5.000E-17 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+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 5.0000E-01 0.0000E-09 1.0210E-04 1.0000E+00 1.0000E+00 2.0000E-02 0.0000E+00
:
: Fracture Zone
:
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr2  2  2.480E+03 9.000E-01 8.300E-10 8.300E-10 8.300E-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 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-02 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-01 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  9999   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+03 -1.000E+00  0.000E+00  A 60  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
```

MR 7-28-95

```
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
   7    7  3.1700E+00   2.0000E+00
:
:  tis(1)     tis(2)     tis(3) ......
 1.000E-06 1.000E-03 1.000E-00 1.000E+01 5.000E+01 1.000E+02 5.000E+02
```

MR 7-28-95

7-28-95 MR

INPUT - "68x9-φ/i" (CONT)

MR 7-28-95

```
:
EVAP
 A  50
 C  11
 C  41
 C  50
 C  60
 D  50
 H  50
:
                                                  :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  3.4931E+12
A    2  0  0  matr1  3.4931E-02
A   38  0  0  matr1  3.4931E-02
A   39  0  0  matr1  3.4931E-02
A   40  0  0  matr1  3.4931E-02
A   41  0  0  matr3  3.5280E-02
A   42  0  0  matr3  3.5280E-02
A   43  0  0  matr3  3.5280E-02
A   59  0  0  matr3  3.5280E-02
A   60  0  0  matr3  3.5280E-02
A   61  0  0  matr1  3.4931E-02
A   62  0  0  matr1  3.4931E-02
A   63  0  0  matr1  3.4931E-02
A   68  0  0  matr1  3.4931E+12
B    1  0  0  matr1  1.5950E+12
B    2  0  0  matr1  1.5950E-02
B   39  0  0  matr1  1.5950E-02
B   40  0  0  matr1  1.5950E-02
B   41  0  0  matr3  1.6109E-02
B   59  0  0  matr3  1.6109E-02
```

MR 7-28-95

```
B   60  0  0  matr3  1.6110E-02
B   61  0  0  matr1  1.5950E-02
B   62  0  0  matr1  1.5950E-02
B   67  0  0  matr1  1.5950E-02
B   68  0  0  matr1  1.5950E+12
C    1  0  0  matr2  1.5950E+13
C    2  0  0  matr2  1.5950E-03
C    3  0  0  matr2  1.5950E-03
C   68  0  0  matr2  1.5950E+13
D    1  0  0  matr1  1.5950E+12
D    2  0  0  matr1  1.5950E-02
D   67  0  0  matr1  1.5950E-02
D   68  0  0  matr1  1.5950E+12
E    1  0  0  matr1  1.5950E+11
E    2  0  0  matr1  1.5950E-01
I   67  0  0  matr1  6.4932E-01
I   68  0  0  matr1  6.4932E+11
                    :reqd blank line
```

MR 7-28-95

MR 7-28-95

7-28-95 INPUT = "68X9-Ø1i" (CONT)

MR

MR 7-28-95

```
CONNE
: el nl e2    n2 nsq nd1 nd2 isot d1        d2          areax      betax
:
A     1 B     1 0 0 0  1  1.095E-01  5.000E-02  1.595E-01  0.000E+00 0
A     2 B     2 0 0 0  1  1.095E-01  5.000E-02  1.595E-01  0.000E+00 0
A     3 B     3 0 0 0  1  1.095E-01  5.000E-02  1.595E-01  0.000E+00 0
A     4 B     4 0 0 0  1  1.095E-01  5.000E-02  1.595E-01  0.000E+00 0
H    68 I    68 0 0 0  1  2.000E+00  2.036E+00  1.595E-01  0.000E+00 0
A     1 A     2 0 0 0  1  1.250E-01  1.250E-01  1.397E-01  1.000E+00 0
A     2 A     3 0 0 0  1  1.250E-01  1.250E-01  1.397E-01  1.000E+00 0
A     3 A     4 0 0 0  1  1.250E-01  1.250E-01  1.397E-01  1.000E+00 0
A     4 A     5 0 0 0  1  1.250E-01  1.250E-01  1.397E-01  1.000E+00 0
I    67 I    68 0 0 0  1  1.250E-01  1.250E-01  2.597E+00  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  41 FLX  1    0    0    0  10 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 1.2614E+10
   1.8922E+10 3.1536E+10
   4.27E+01 3.52E+01 2.97E+01 2.20E+01
   1.71E+01 1.17E+01 7.16E-00 5.04E-00
   3.92E-00 2.56E-00
B  41 FLX  1    0    0    0  10 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 1.2614E+10
   1.8922E+10 3.1536E+10
   1.95E+01 1.61E+01 1.35E+01 1.01E+01
   7.83E-00 5.33E-00 3.27E-00 2.30E-00
   1.79E-00 1.17E-00
INCON
:
: el ne   nsq nadd       porx
A    1  0  0      0.0
:
:          x1                 x2                x3
        1.000000E+05       3.000000E-01        2.500000E+01
B    1  0  0      0.0
        1.000000E+05       3.000000E-01        2.500000E+01
```

MR 7-28-95

```
  C    1  0  0     0.000000E-01
         1.000000E+05        1.000000E-09        2.500000E+01
  D    1  0  0     0.0
         1.000000E+05        3.000000E-01        2.500000E+01
  E    1  0  0     0.0
         1.000000E+05        3.000000E-01        2.500000E+01
  F    1  0  0     0.0
         1.000000E+05        3.000000E-01        2.500000E+01
```

MR 7-28-95

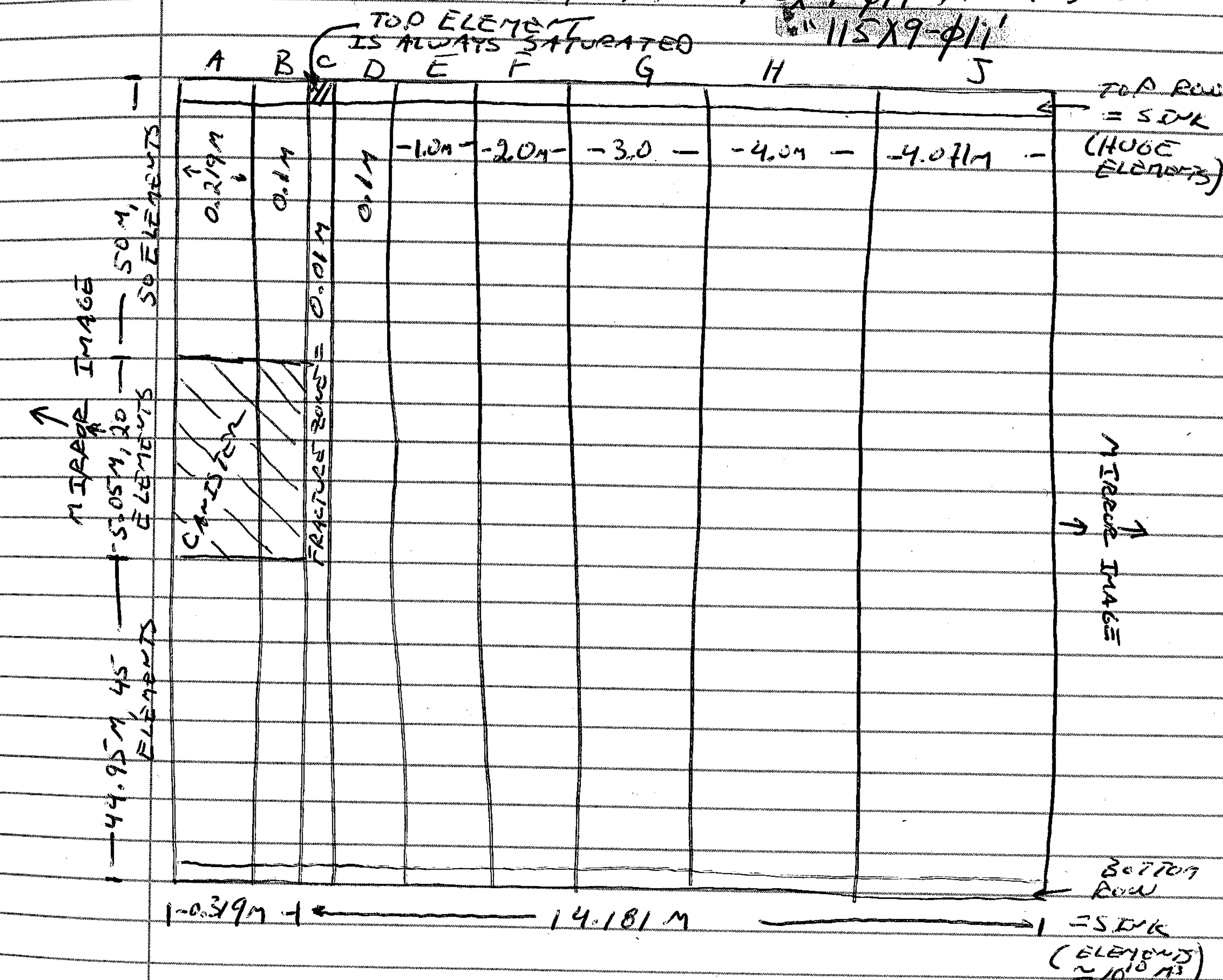
7-31-95 MR

• NEW CANISTER RUN FINISHED IN:
/home/skippy/rgreen/goodluck: "68X9-Ø2i" - IDENTICAL TO "68X9-Ø1i" EXCEPT PERMEABILITY OF FRACTURE = 8.3×10^{-11} m^2 INSTEAD OF 8.3×10^{-10} m^2

7-31-95 MR

• NEW CANISTER RUN: "68X9-Ø3i" - IDENTICAL TO "68X9-Ø1i" EXCEPT PERMEABILITY OF FRACTURE = 8.3×10^{-12} m^2 INSTEAD OF 8.3×10^{-10} m^2

• NEW CANISTER SET-UP: ~~"400X9-Ø1i"~~ MR 7-31-95 "115X9-Ø1i"



8-1-95 MR

• KILLED "68X9-Ø3i" TO START "115X9-Ø1i". AFTER ≃ 1 DAY RUNNING IT GOT TO 1.8×10^{-2} YRS AFTER 940 TIMESTEPS.

8-3-95 MR

• KILLED "115X9-φ1i" AFTER ≈ 2 DAYS, TIMESTEP = ~~30~~ MR 8-3-95 843, T = 30.5 YRS, ΔT = 0.229 YR.

• BEGAN RUNNING "115X9-φ2i" ≈ 1040 IN: /usr2/sneezy/rgreen/grice/gwtt/2-d/8-95

"115X9-φ2i" IDENTICAL TO "115X9-φ1i" EXCEPT POROSITY OF FRACTURE = 0.2 INSTEAD OF 0.9.

8-4-95 MR

• DISCUSSION W/ R. GREEN – TO DO:

- REDUCE K OF "115X9-φXi" RUNS UNTIL TEMP > 100°C

THEN – ADJUST WIDTH (CURRENTLY 1/2 WIDTH = 14.5M) TO SIMULATE HOT REPOSITORY (114 KW/ACRE)

• KEEP FILE ON EACH RUN THAT INCLUDES:

- HEATING & SATURATION HISTORY (T + SAT VS TIME)

- HEAT INPUT SCHEDULE

- WATER FLUX (CUMULATIVE)

- TEMP PROFILE

- SAT PROFILE

MR 8-4-95

8-4-95 MR

INPUT = ~~"115X9-φ1i"~~ "115X9-φ1i" MR 8-4-95

MR 8-4-95

```
GWTT,7/31/95, Fracture = 0.01m wide, k of fracture = 8.3E-10 m^2
:Fracture porosity = 0.9
:grid=115X9
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 1.000E-01 5.000E-17 5.000E-17 5.000E-17 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+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 5.0000E-01 0.0000E-09 1.0210E-04 1.0000E+00 1.0000E+00 2.0000E-02 0.0000E+00
:
: Fracture Zone
:
: mat  nad   drock       por       permx      permy      permz      cwet       spht
matr2  2  2.480E+03 9.000E-01 8.300E-10 8.300E-10 8.300E-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 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-02 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-01 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  9999   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+03 -1.000E+00  0.000E+00  A 60  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
:
```

MR 8-4-95

```
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
   8    8  3.1700E+00  2.0000E+00
:
:  tis(1)      tis(2)     tis(3) ......
 1.000E-06 1.000E-03 1.000E-01 1.000E-00 1.000E+01 5.000E+01 1.000E+02 5.000E+02
:
```

8-4-95
AR

INPUT: "115X9-φ1i" (CONT)

AR 8-4-95

```
EVAP
 A  60
 C  11
 C  51
 C  60
 C  70
 C  90
 H  60
:
                                                    :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  1.3972E+11
A     2   0   0  matr1  1.3972E-01
A     3   0   0  matr1  1.3972E-01
A     4   0   0  matr1  1.3972E-01
A    48   0   0  matr1  1.3972E-01
A    49   0   0  matr1  1.3972E-01
A    50   0   0  matr1  1.3972E-01
A    51   0   0  matr3  3.5280E-02
A    52   0   0  matr3  3.5280E-02
A    68   0   0  matr3  3.5280E-02
A    69   0   0  matr3  3.5280E-02
A    70   0   0  matr3  3.5280E-02
A    71   0   0  matr1  1.3274E-01
A    72   0   0  matr1  1.3972E-01
A   115   0   0  matr1  1.3972E+11
B     1   0   0  matr1  6.3800E+12
B     2   0   0  matr1  6.3800E-02
B     3   0   0  matr1  6.3800E-02
B    50   0   0  matr1  6.3800E-02
B    51   0   0  matr3  1.6109E-02
```

AR 8-4-95

```
B    69   0   0  matr3  1.6110E-02
B    70   0   0  matr3  1.6109E-02
B    71   0   0  matr1  6.0610E-02
B   114   0   0  matr1  6.3800E-02
B   115   0   0  matr1  6.3800E+12
C     1   0   0  matr2  6.3800E+13
C     2   0   0  matr2  6.3800E-03
C   114   0   0  matr2  6.3800E-03
C   115   0   0  matr2  6.3800E+13
D     1   0   0  matr1  6.3800E+12
D     2   0   0  matr1  6.3800E-02
D    53   0   0  matr1  1.6109E-02
D    54   0   0  matr1  1.6109E-02
D   114   0   0  matr1  6.3800E-02
D   115   0   0  matr1  6.3800E+12
E     1   0   0  matr1  6.3800E+11
E     2   0   0  matr1  6.3800E-01
:
CONNE
: el n1 e2    n2 nsq nd1 nd2 isot d1        d2          areax     betax
:
A     1 B      1 0 0 0  1  1.095E-01  5.000E-02  6.380E-01  0.000E+00 0
A     2 B      2 0 0 0  1  1.095E-01  5.000E-02  6.380E-01  0.000E+00 0
B    88 C     88 0 0 0  1  5.000E-02  5.000E-03  6.380E-01  0.000E+00 0
D    59 E     59 0 0 0  1  5.000E-02  5.000E-01  1.611E-01  0.000E+00 0
F    30 G     30 0 0 0  1  1.000E+00  1.500E+00  6.380E-01  0.000E+00 0
H     1 I      1 0 0 0  1  2.000E+00  2.036E+00  6.380E-01  0.000E+00 0
H   115 I    115 0 0 0  1  2.000E+00  2.036E+00  6.380E-01  0.000E+00 0
A     1 A      2 0 0 0  1  5.000E-01  5.000E-01  1.397E-01  1.000E+00 0
D    60 D     61 0 0 0  1  1.263E-01  1.262E-01  6.380E-02  1.000E+00 0
H     5 H      6 0 0 0  1  5.000E-01  5.000E-01  2.552E+00  1.000E+00 0
I   114 I    115 0 0 0  1  5.000E-01  5.000E-01  2.597E+00  1.000E+00 0
                                     :reqd blank line
```

AR 8-4-95

8-4-95
AR

AR 8-4-95

```
:
GENER----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
: el ne sl ns nsq nad nads ltb  itp   itb   gx           ex          hg
:
A  51 FLX  1    0   0   0  10 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 1.2614E+10
   1.8922E+10 3.1536E+10
   4.27E+01 3.52E+01 2.97E+01 2.20E+01
   1.71E+01 1.17E+01 7.16E-00 5.04E-00
   3.92E-00 2.56E-00
B  51 FLX  1    0   0   0  10 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 1.2614E+10
   1.8922E+10 3.1536E+10
   1.95E+01 1.61E+01 1.35E+01 1.01E+01
   7.83E-00 5.33E-00 3.27E-00 2.30E-00
   1.79E-00 1.17E-00
:
INCON
:
: el ne   nsq nadd        porx
A     1  0  0      0.0
:
:             x1                  x2                   x3
          1.000000E+05        3.000000E-01          2.500000E+01
B     1  0  0      0.0

          1.000000E+05        3.000000E-01          2.500000E+01
C     1  0  0      0.0
          1.000000E+05        1.000000E-09          2.500000E+01
D     1  0  0      0.0
          1.000000E+05        3.000000E-01          2.500000E+01
E     1  0  0      0.0
          1.000000E+05        3.000000E-01          2.500000E+01
F     1  0  0      0.0
          1.000000E+05        3.000000E-01          2.500000E+01
G     1  0  0      0.0
```

AR 8-4-95

8-7-95
AR

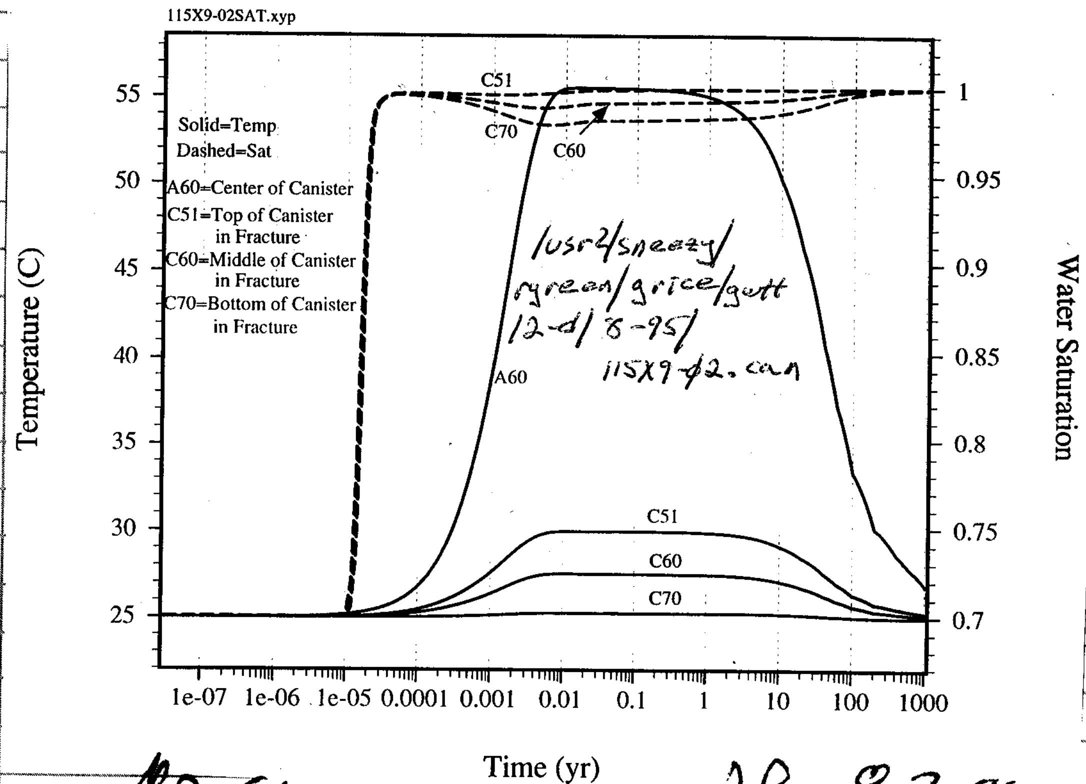
- "115X9-φ2i" DONE, # TIMESTEPS = 113 8,
  CALC TIME = 175,530 S.

- BEGIN NEW RUN ≃ 0815: "115X9-φ3i" -
  IDENTICAL TO "115X9-φ2i" EXCEPT PERMEABILITY
  OF FRACTURE = 8.3X10⁻¹¹ M² INSTEAD OF 8.3X10⁻¹⁰ M²

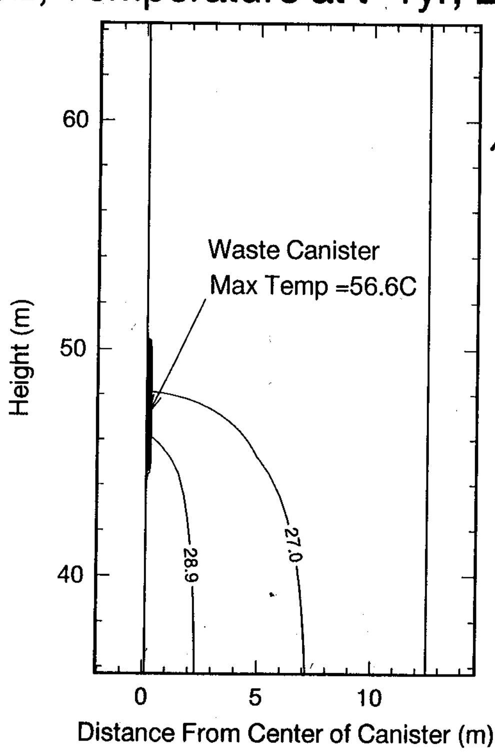
AR
8-7-95

8-7-95 OUTPUT: "115X9-02i"

115X9-02, 10mm Fracture, k(f)=8.3E-10m^2, n(f)=0.2



115X9-02, Temperature at t=1yr, Expanded View



115X9-02VAR4.dat
IN:
/usr2/sneezy/rgreen/grice/gwtt/2-d/8-95
115X9-02temp1.ps

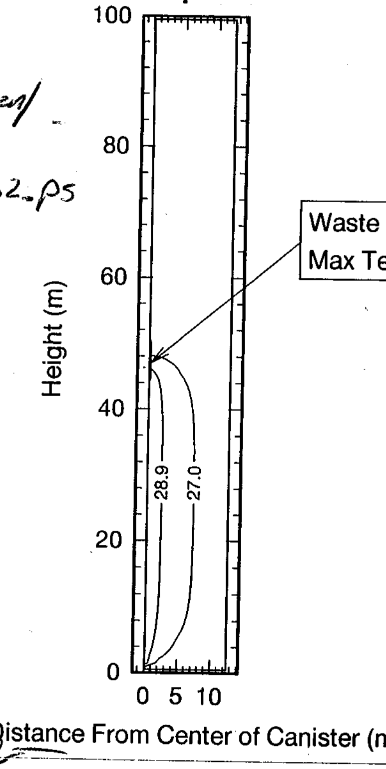
8-8-95

OUTPUT: "115X9-02i"

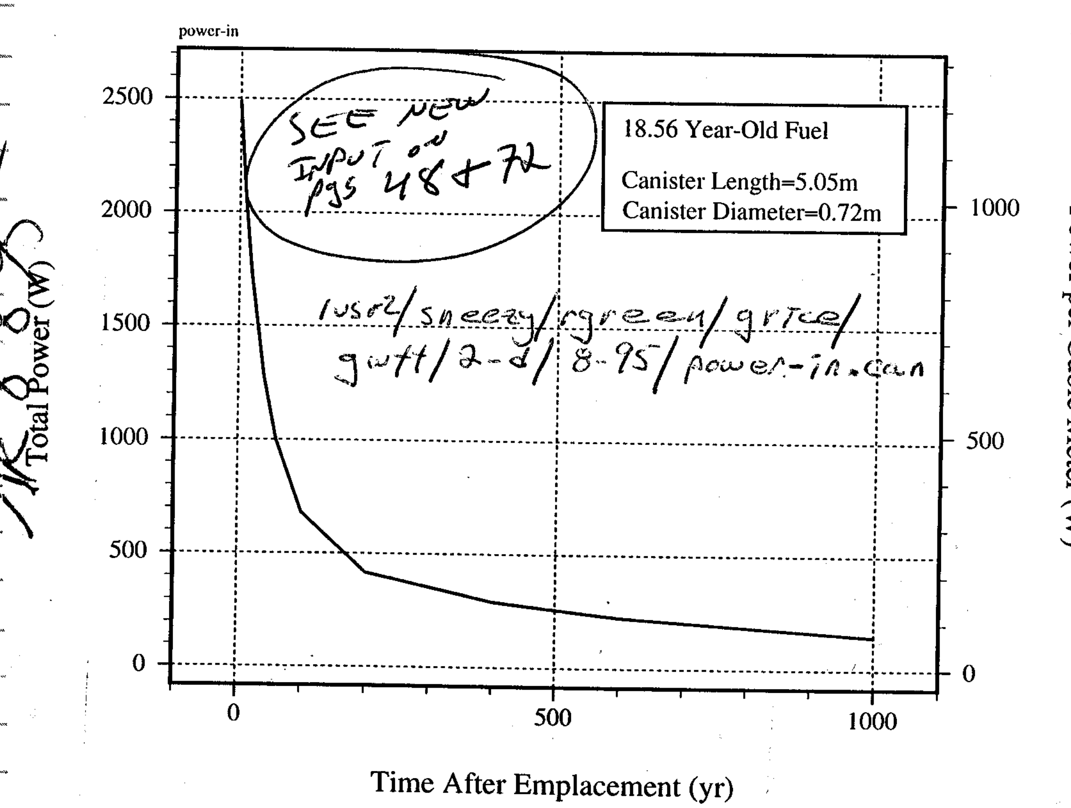
(2D) || Print || 8 Aug 1995 || 115X9-02VAR4.plt || C-TOUGH field variables 3.1536E+07

115X9-02, Temperature at t=1yr

IN:
/usr2/sneezy/rgreen/grice/gwtt/2-d/8-95/115X9-02-temp2.ps
FROM:
115X9-02VAR4.dat

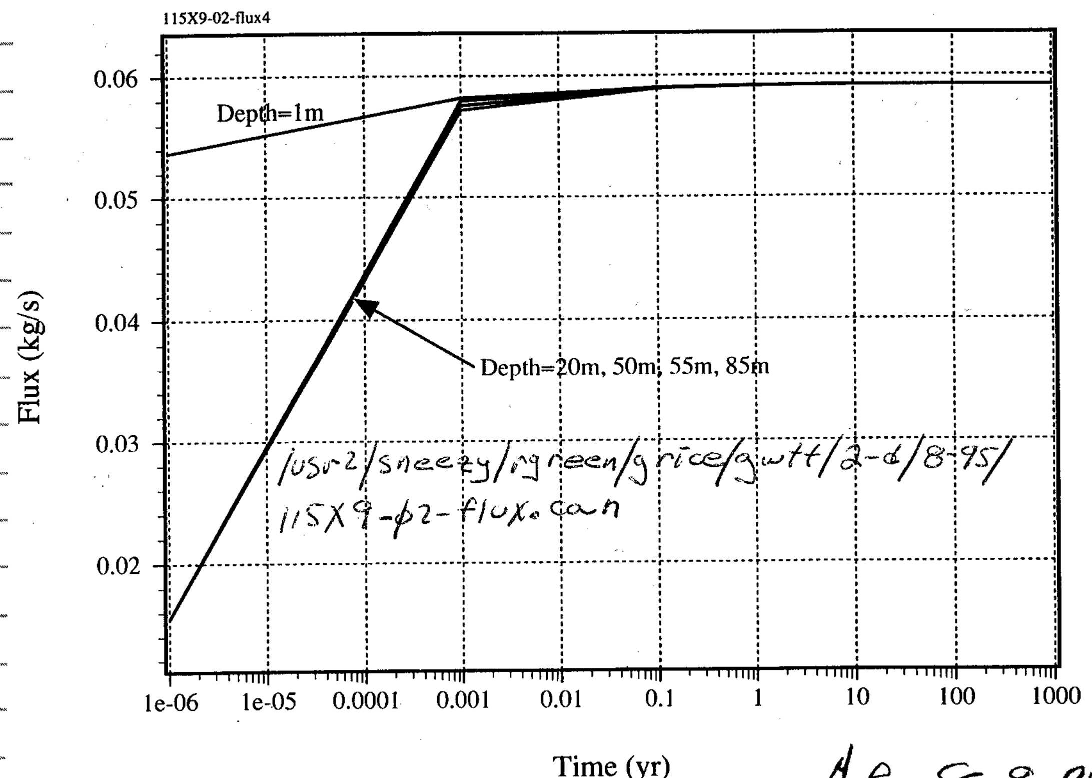


Power Generated by Waste Canister



8-9-95 OUTPUT: "115X9-φ2i"

115X9-02, Liquid Flux Along Fracture

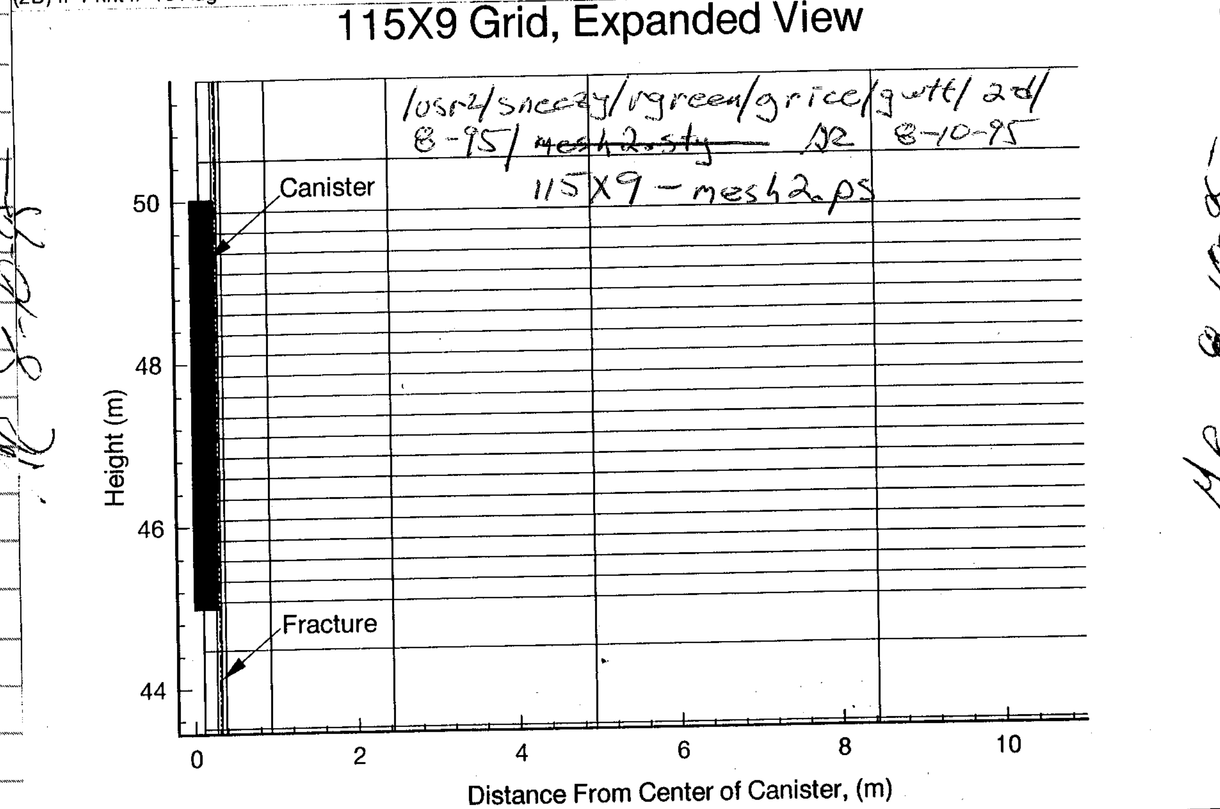


NR 8-9-95

8-10-95 NR

(2D) || Print || 10 Aug 1995 || 115X9-03VAR4.plt || C-TOUGH field variables 3.1536E+07

115X9 Grid, Expanded View



NR 8-10-95

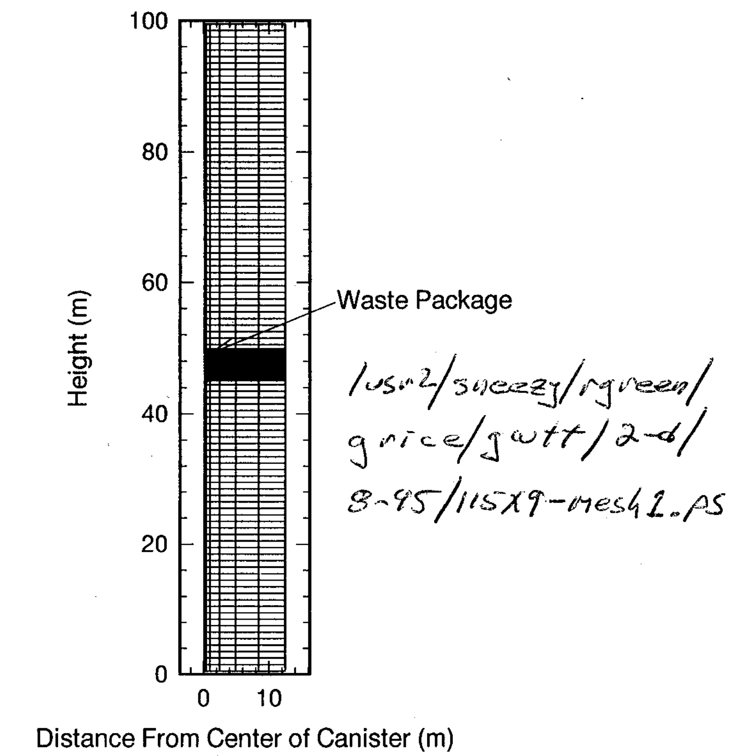
NR 8-10-95

8-10-95 NR NOTE – FOUND ERROR IN "115X9-φ3i" – ELEMENTS C2, C20, C51, C60, C70, +C80 + C100 IN FRACTURE HAVE PERMEABILITY OF 8.3×10^{-10} m² INSTEAD OF 8.3×10^{-11} m².

NR 8-10-95

(2D) || Print || 10 Aug 1995 || 115X9-03VAR4.plt || C-TOUGH field variables 3.1536E+07

Mesh for 115X9 Grid



NR 8-10-95

8-11-95 EFFECTIVE CONDUCTIVITY OF FRACTURE:

$$K_e = \frac{D}{\sum D_i / K_i}, \quad \text{WHERE,} \quad D = \text{TOTAL THICKNESS OF FRACTURE}$$

D_i = THICKNESS OF ELEMENT i

K_i = PERMEABILITY OF ELEMENT i

$$K_e = \frac{100\,m}{\frac{4\,m}{8.3\times10^{-10}\,m^2} + \frac{.7575\,m}{8.3\times10^{-10}\,m^2} + \frac{95.2425\,m}{8.3\times10^{-11}\,m^2}} = \frac{100\,m}{\frac{5.7319\times10^{9}}{m} + \frac{1.1475\times10^{12}}{m}}$$

$K_e = 8.67 \times 10^{-11}$ m² AS OPPOSED TO WHAT IT SHOULD BE = 8.3×10^{-11} m²

$\Delta = 4\%$

8-12-95 ~~8-11-95~~ MR   MR 8-14-95

BEGIN NEW GWTT CANISTER RUN:

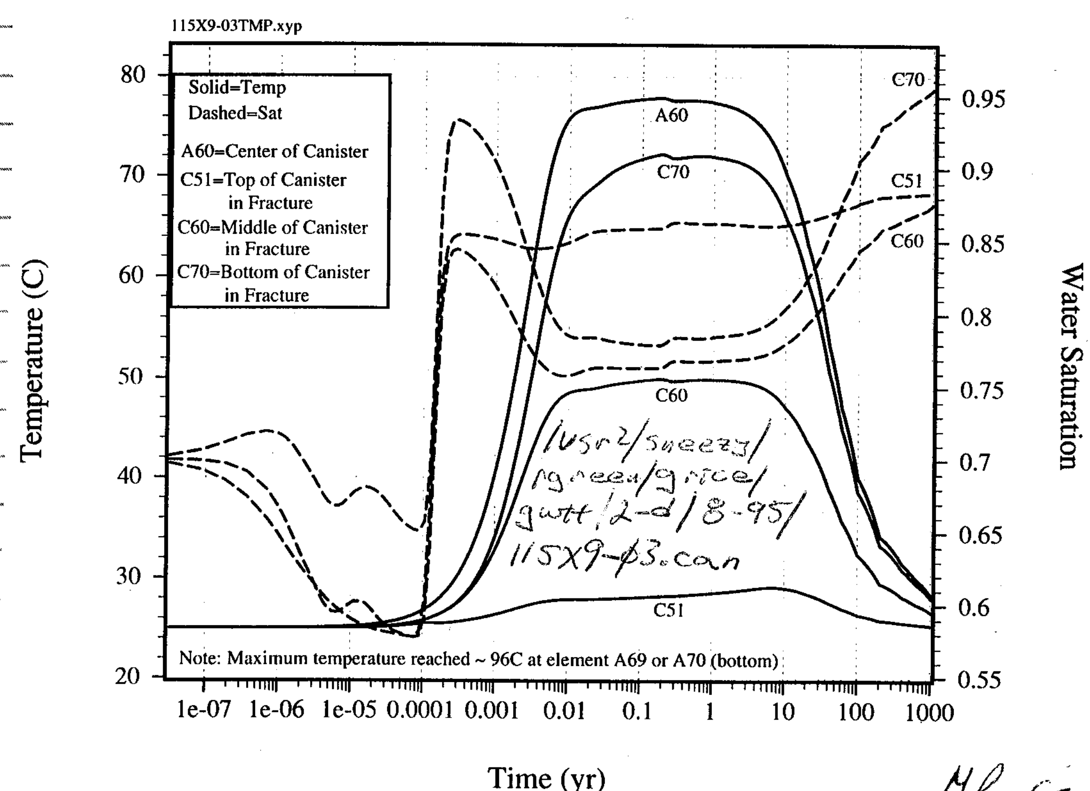
= "115X9-04i" - IDENTICAL TO "115X9-02i" EXCEPT PERMEABILITY OF FRACTURE = $8.3 \times 10^{-12}\ m^2$ INSTEAD OF $8.3 \times 10^{-10}\ m^2$, SAME PLACE AS

• "115X9-03i" COMPLETED ON:
/usr2/sneezy/rgreen/grice/gwtt/2-d/8-95

CALCULATION TIME = 281,690 s, # TIMESTEPS = 1101

8-14-95 MR

115X9-03, 10mm Fracture, k(f)=8.3E-11m^2, n(f)=0.2   MR 8-14-95

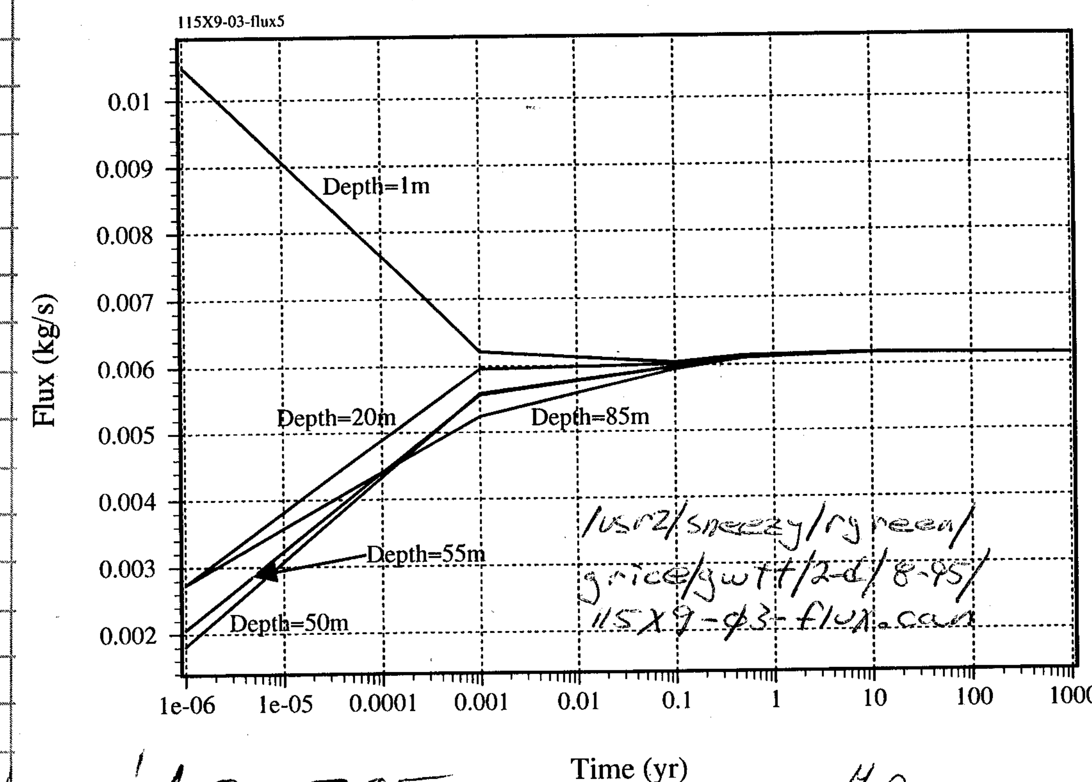


MR 8-14-95

MR 8-14-95

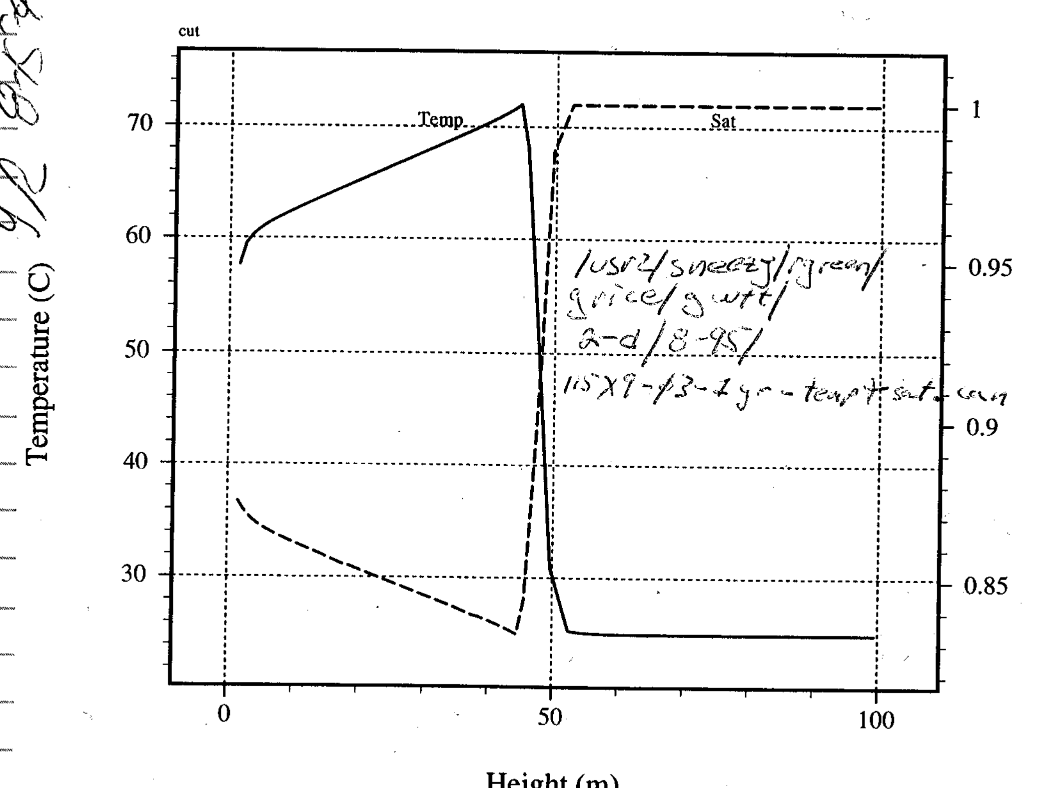
8-14-95 MR

115X9-03, Liquid Flux Along Fracture   MR 8-14-95



8-15-95 MR

115X9-03, In Fracture, Time = 1 Year   MR 8-14-95

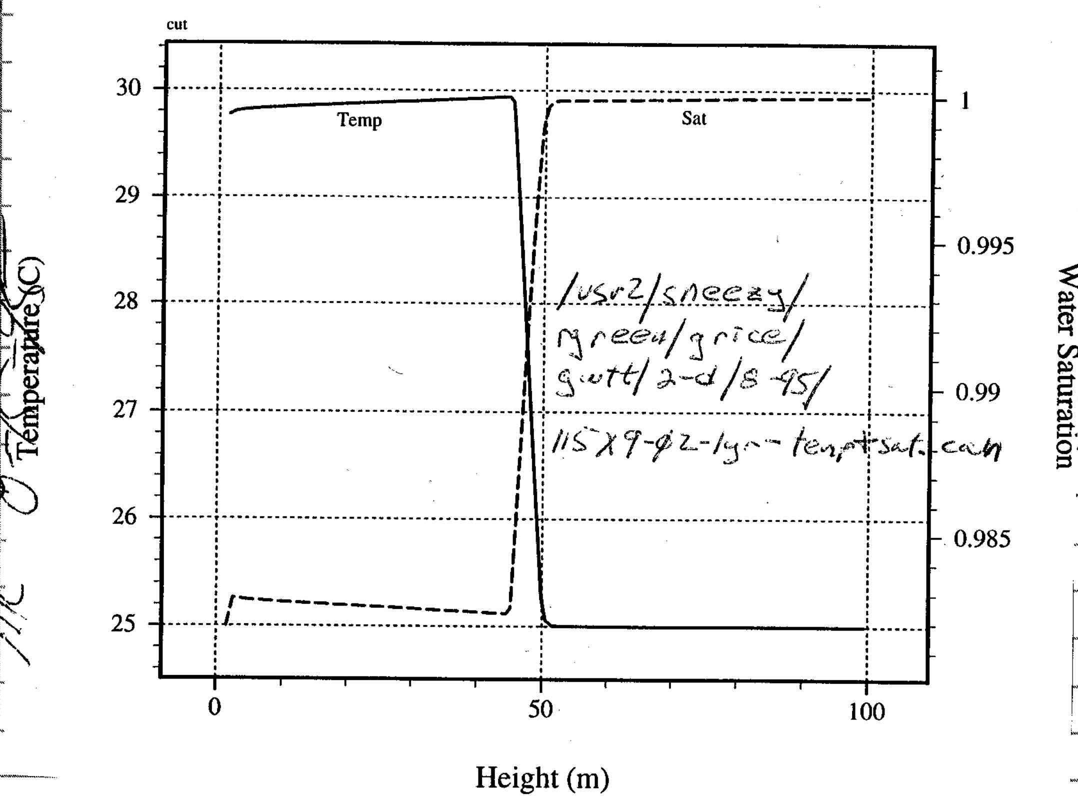


MR 8-15-95

MR 8-15-95

8-15-95
NR

115X9-02, In Fracture, Time ~~≤~~ 1 ~~Year~~ NR 8-15-95



NR

8-18-95
NR

SNF POWER SCHEDULE (FROM pg 29)
AGE OF FUEL AT EMPLACEMENT = 18.555 YRS

TIME AFTER EMPLACEMENT (YR)		TOTAL WATTS	W/m^3
~~0~~	0	2487	1209
~~10~~	10	2052	998
~~20~~	20	1730	841
~~30~~	40	1285	625
NR 8-18-95 ~~40~~ ~~50~~	60	1000	486
	100	680	331
	200	417	203
	400	293	143
	600	228	111
	1000	149	72.5
	100,000	NR 8-18-95 ~~149~~	

SEE NEXT PAGE
NR 8-18-95

8-18-95
NR

~~TO CALCULATE WATTS GENERATED 10^5 YR AFTER FUEL EMPLACEMENT USE FORMULA IN NITAO FOR 8.555 YR OLD FUEL:~~

~~$W = \sum_{i=1}^{6} S_i$~~ NR 8-18-95

SEE BELOW
NR 8-18-95

RE-DOING POWER DATA - WILL USE 8.555 YR SNF - SAME AS PRINTOUT FROM RON GREEN ON pg 29 - THIS INPUT USED UNTIL FURTHER NOTICE:

NR 8-18-95

Waste Package Heat Source Term

5.05 m long container of 8.555 PWR spent fuel

$$H(t) = \sum_{i=1}^{6} b_i \exp(-a_i t) \quad (Watts)$$

t = years emplacement

$b_1 = 31.7$	$a_1 = 2.82 \times 10^{-5}$ year^{-1}
$b_2 = 48.6$	$a_2 = 1.29 \times 10^{-4}$ year^{-1}
$b_3 = 443.3$	$a_3 = 1.76 \times 10^{-3}$ year^{-1}
$b_4 = 2123.$	$a_4 = 2.0 \times 10^{-2}$ year^{-1}
$b_5 = 431.5$	$a_5 = 6.35 \times 10^{-2}$ year^{-1}
$b_6 = 321.9$	$a_6 = 4.4 \times 10^{-1}$ year^{-1}

FROM: NITAO, 1988
"NUMERICAL MODELING OF THE THERMAL AND HYDROLOGICAL ENVIRONMENT AROUND A NUCLEAR WASTE PACKAGE USING THE EQUIVALENT CONTINUUM APPROXIMATION: HORIZONTAL EMPLACEMENT"
pg 17

NR 8-18-95

FOR $t = 10^5$ YR:

$$H(t) = 31.7\, e^{-2.82} + 48.6\, e^{-1.29\times 10^{1}} + 443.3\, e^{-1.76\times 10^{+2}} + 2123\, e^{-2.0\times 10^{3}} + 431.5\, e^{-6.35\times 10^{+3}} + 321.9\, e^{-4.4\times 10^{4}}$$

$$= 1.890 + 1.214\times 10^{-4} + 1.625\times 10^{-74} + \ldots = 1.890$$

FOR $t = 10^4$ YR:

$$H(t) = 23.91 + 13.38 + 2.574\times 10^{-6} + \ldots = 37.29$$

8-18-95
MR

SNF POWER GENERATION SCHEDULE – AGE AT EMPLACEMENT = 8.555 YRS – SEE PREVIOUS PAGE AND PAGE 29.

TIME AFTER EMPLACEMENT (YR)	TOTAL WATTS (VOLUME = 2.056 m^3)	W/m^3
1	3216	1565
0	3400	1654
10	2487	1210
20	2052	998
40	1481	720
60	1128	547
100	739	359
200	430	209
600	230	112
1000	150	73.0
10,000	37.3	18.2
100,000	1.89	0.919
0.1	3379	1644

ADDED 9-13-95 MR

- NEW CANISTER SIMULATION: "115X8-φ1i"

VOLUME OF CANISTER ELEMENTS IN 'A' COLUMN = $4.8328 \times 10^{-2} m^3$ – THUS, WATTS PRODUCED BY A SINGLE 'A' CANISTER ELEMENT @ t = 200 YRS = $4.8328 \times 10^{-2} m^3 (209 W/m^3) = 10.1 W$

VOLUME OF CANISTER ELEMENTS IN 'B' COLUMN = $3.0608 \times 10^{-3} m^3$ – THUS, WATTS PRODUCED BY A SINGLE 'B' CANISTER ELEMENT @ t = 40 YRS = $3.0608 \times 10^{-3} m^3 (720 W/m^3) = 2.20 W$

- NEW CANISTER RUN: "115X8-φ1i"
LIKE "115X9-...i" SERIES EXCEPT FRACTURE WIDTH = 0.001 m + POWER GENERATION SCHEDULE AS SHOWN ABOVE
ON: /home/SKIPPY/rgreen/goodluck

8-18-95
MR

INPUT: "115X8-φ1i"

```
GWTT,8/18/95, Fracture = 0.001m wide, k of fracture = 8.3E-10 m^2
:Fracture porosity = 0.9
:grid=115X8
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 1.000E-01 5.000E-17 5.000E-17 5.000E-17 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+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 5.0000E-01 0.0000E-09 1.0210E-04 1.0000E+00 1.0000E+00 2.0000E-02 0.0000E+00
:
: Fracture
:
: mat  nad   drock       por       permx      permy      permz      cwet      spht
matr2  2  2.480E+03 9.000E-01 8.300E-10 8.300E-10 8.300E-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 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-02 1.0000E+00 1.0000E+00 2.0000E-02 0.0000E+00
:
: Canister
:
: mat  nad   drock       por       permx      permy      permz      cwet      spht
matr3  2  2.480E+03 1.000E-01 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  9999   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  C 60  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
   9    9  3.1700E+00  2.0000E+00
:
:  tis(1)     tis(2)    tis(3) ......
 1.000E-06 1.000E-03 1.000E-02 1.000E-01 1.000E+00 1.000E+01 1.000E+02 1.000E+03
 1.000E+04
:
```

MR 8-18-95

MR 8-18-95

MR 8-18-95

8-18-95
AR

INPUT: "115X8-4/11" (CONT) AR 8-18-95

```
EVAP
 A  51
 A  55
 A  60
 A  67
 A  70
 C   2
 C   6
 C  10
 C  20
 C  30
 C  40
 C  50
 C  51
 C  60
 C  70
 C  71
 C  80
 C 100
 D   2
 D  30
 D  51
 D  70
 D 100
 E  60
 F  60
:
                                                :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  1.9140E+11
```

AR 8-18-95

```
A    2  0  0  matr1  1.9140E-01
A    3  0  0  matr1  1.9140E-01
A   48  0  0  matr1  1.9140E-01
A   49  0  0  matr1  1.9140E-01
A   50  0  0  matr1  1.9140E-01
A   51  0  0  matr3  4.8328E-02
A   68  0  0  matr3  4.8328E-02
A   69  0  0  matr3  4.8329E-02
A   70  0  0  matr3  4.8328E-02
A   71  0  0  matr1  1.8183E-01
A   72  0  0  matr1  1.9140E-01
A  114  0  0  matr1  1.9140E-01
A  115  0  0  matr1  1.9140E+11
B    1  0  0  matr1  1.2122E+12
B    2  0  0  matr1  1.2122E-02
B    3  0  0  matr1  1.2122E-02
B   49  0  0  matr1  1.2122E-02
B   50  0  0  matr1  1.2122E-02
B   51  0  0  matr3  3.0608E-03
B   52  0  0  matr3  3.0608E-03
B   53  0  0  matr3  3.0608E-03
B   69  0  0  matr3  3.0608E-03
B   70  0  0  matr3  3.0608E-03
B   71  0  0  matr1  1.1516E-02
B   72  0  0  matr1  1.2122E-02
B  114  0  0  matr1  1.2122E-02
B  115  0  0  matr1  1.2122E+12
C    1  0  0  matr2  6.3799E+14
C    2  0  0  matr2  6.3799E-04
C    3  0  0  matr2  6.3799E-04
C   49  0  0  matr2  6.3799E-04
C   50  0  0  matr2  6.3799E-04
C   51  0  0  matr2  1.6109E-04
C   68  0  0  matr2  1.6109E-04
```

AR 8-18-95

AR 8-18-95

```
C   69  0  0  matr2  1.6109E-04
C   70  0  0  matr2  1.6109E-04
C   71  0  0  matr2  6.0609E-04
C  114  0  0  matr2  6.3799E-04
C  115  0  0  matr2  6.3799E+14
D    1  0  0  matr1  6.3800E+13
D    2  0  0  matr1  6.3800E-03
D    3  0  0  matr1  6.3800E-03
D  114  0  0  matr1  6.3800E-03
D  115  0  0  matr1  6.3800E+13
E    1  0  0  matr1  6.3800E+12
E    2  0  0  matr1  6.3800E-02
E  114  0  0  matr1  6.3800E-02
E  115  0  0  matr1  6.3800E+12
F    1  0  0  matr1  6.3800E+11
F    2  0  0  matr1  6.3800E-01
F    3  0  0  matr1  6.3800E-01
F  114  0  0  matr1  6.3800E-01
F  115  0  0  matr1  6.3800E+11
G    1  0  0  matr1  1.9140E+10
G    2  0  0  matr1  1.9140E+00
G    3  0  0  matr1  1.9140E+00
G  114  0  0  matr1  1.9140E+00
G  115  0  0  matr1  1.9140E+10
H    1  0  0  matr1  6.4247E+10
H    2  0  0  matr1  6.4247E+00
```

AR 8-18-95

```
H  113  0  0  matr1  6.4247E+00
H  114  0  0  matr1  6.4247E+00
H  115  0  0  matr1  6.4247E+10
                         :reqd blank line
```

AR 8-18-95

8-18-95
AR

INPUT: "115X8-4/11" (CONT) AR 8-18-95

```
:
CONNE
: el nl e2   n2 nsq nd1 nd2 isot d1         d2          areax     betax
:
A     1 B     1 0 0 0  1  1.500E-01  9.500E-03  6.380E-01  0.000E+00 0
A     2 B     2 0 0 0  1  1.500E-01  9.500E-03  6.380E-01  0.000E+00 0
A   115 B   115 0 0 0  1  1.500E-01  9.500E-03  6.380E-01  0.000E+00 0
B     1 C     1 0 0 0  1  9.500E-03  5.000E-04  6.380E-01  0.000E+00 0
B   114 C   114 0 0 0  1  9.500E-03  5.000E-04  6.380E-01  0.000E+00 0
B   115 C   115 0 0 0  1  9.500E-03  5.000E-04  6.380E-01  0.000E+00 0
C     1 D     1 0 0 0  1  5.000E-04  5.000E-03  6.380E-01  0.000E+00 0
C     2 D     2 0 0 0  1  5.000E-04  5.000E-03  6.380E-01  0.000E+00 0
C   115 D   115 0 0 0  1  5.000E-04  5.000E-03  6.380E-01  0.000E+00 0
A     1 A     2 0 0 0  1  5.000E-01  5.000E-01  1.914E-01  1.000E+00 0
A     2 A     3 0 0 0  1  5.000E-01  5.000E-01  1.914E-01  1.000E+00 0
B     1 B     2 0 0 0  1  5.000E-01  5.000E-01  1.212E-02  1.000E+00 0
B     2 B     3 0 0 0  1  5.000E-01  5.000E-01  1.212E-02  1.000E+00 0
B     3 B     4 0 0 0  1  5.000E-01  5.000E-01  1.212E-02  1.000E+00 0
C     2 C     3 0 0 0  1  5.000E-01  5.000E-01  6.380E-04  1.000E+00 0
C     3 C     4 0 0 0  1  5.000E-01  5.000E-01  6.380E-04  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  51 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
  7.99E+01 5.85E+01 4.82E+01 3.48E+01
  2.64E+01 1.73E+01 1.01E+01 5.41E+00
  3.53E+00 8.80E-01 4.44E-02
B  51 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
  5.06E+00 3.70E+00 3.05E+00 2.20E+00
  1.67E+00 1.10E+00 6.40E-01 3.43E-01
  2.23E-01 5.57E-02 3.03E-03
                                                 :reqd blank line
:
INCON
:
: el ne   nsq nadd        porx
A     1  0  0      0.0
:
:          x1                  x2                  x3
        1.000000E+05        3.000000E-01        2.500000E+01
B     1  0  0      0.0
        1.000000E+05        3.000000E-01        2.500000E+01
C     1  0  0      0.0
        1.000000E+05        1.000000E-09        2.500000E+01
D     1  0  0      0.0
        1.000000E+05        3.000000E-01        2.500000E+01
E     1  0  0      0.0
        1.000000E+05        3.000000E-01        2.500000E+01
```

AR 8-18-95

```
F     1  0  0      0.0
        1.000000E+05        3.000000E-01        2.500000E+01
E   115  0  0      0.0
        1.000000E+05        3.000000E-01        2.500000E+01
F   115  0  0      0.0
        1.000000E+05        3.000000E-01        2.500000E+01
G   115  0  0      0.0
        1.000000E+05        3.000000E-01        2.500000E+01
H   115  0  0      0.0
        1.000000E+05        3.000000E-01        2.500000E+01
                      :reqd blank line
:
SOLVE
:precond accel  nz    nx    ibug
 BAND    NONE  115     8
:
ENDCY
```

AR 8-18-95

8-21-95 · NEW RUN: "115X8-02i" - IDENTICAL TO "115X8-01i" EXCEPT PERMEABILITY OF FRACTURE = 8.3×10^{-11} m^2 INSTEAD OF 8.3×10^{-10} m^2.

NR

· NOTE - "115X8-01" DID NOT RUN TO COMPLETION - SKIPPY RAN OUT OF ROOM ON DISK - PUT WHAT OUTPUT THAT WAS PRODUCED IN:
/usr2/sneezy/rgreen/grice/gwtt/from-skippy-8-95

- KILLED "115X9-04i" - CPU TIME = 9762 min, # TIMESTEPS = 2594, TIME = 4.189×10^{-2} yr
$\Delta t = 1.246 \times 10^{-5}$ yr

RE-STARTED "115X8-01i" ON:
/usr2/sneezy/rgreen/grice/gwtt/2-d/8-95

- 1135 - CALLED DERICK RE SETTING UP SNEEZY DISK TO ~~run~~ RUN ON SKIPPY CPU per RON G's REQUEST
NR 8-21-95

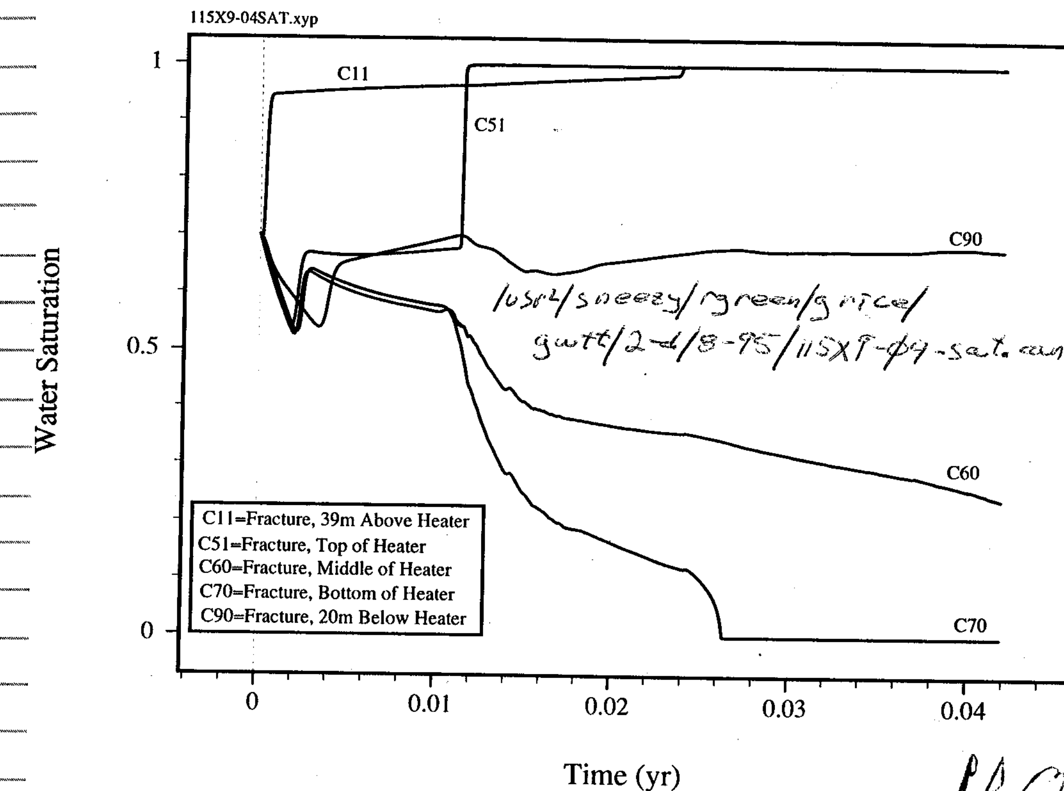
S

NR 8-22-95

8-22-95 OUTPUT: "115X9-04i" NR 8-22-95

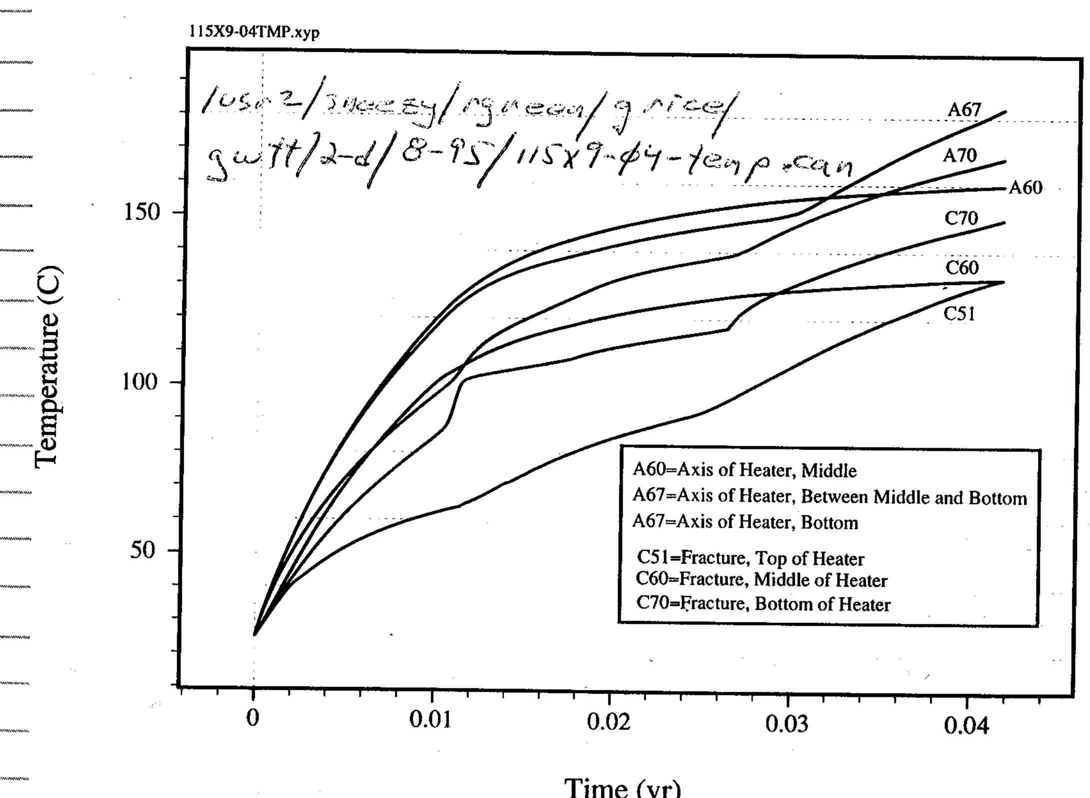
NR

115X9-04, 10mm Fracture, k(f)=8.3E-12m^2, n(f)=0.2



NR 8-22-95

115X9-04, 10mm Fracture, k(f)=8.3E-12m^2, n(f)=0.2



NR 8-22-95

8-25-95 MR

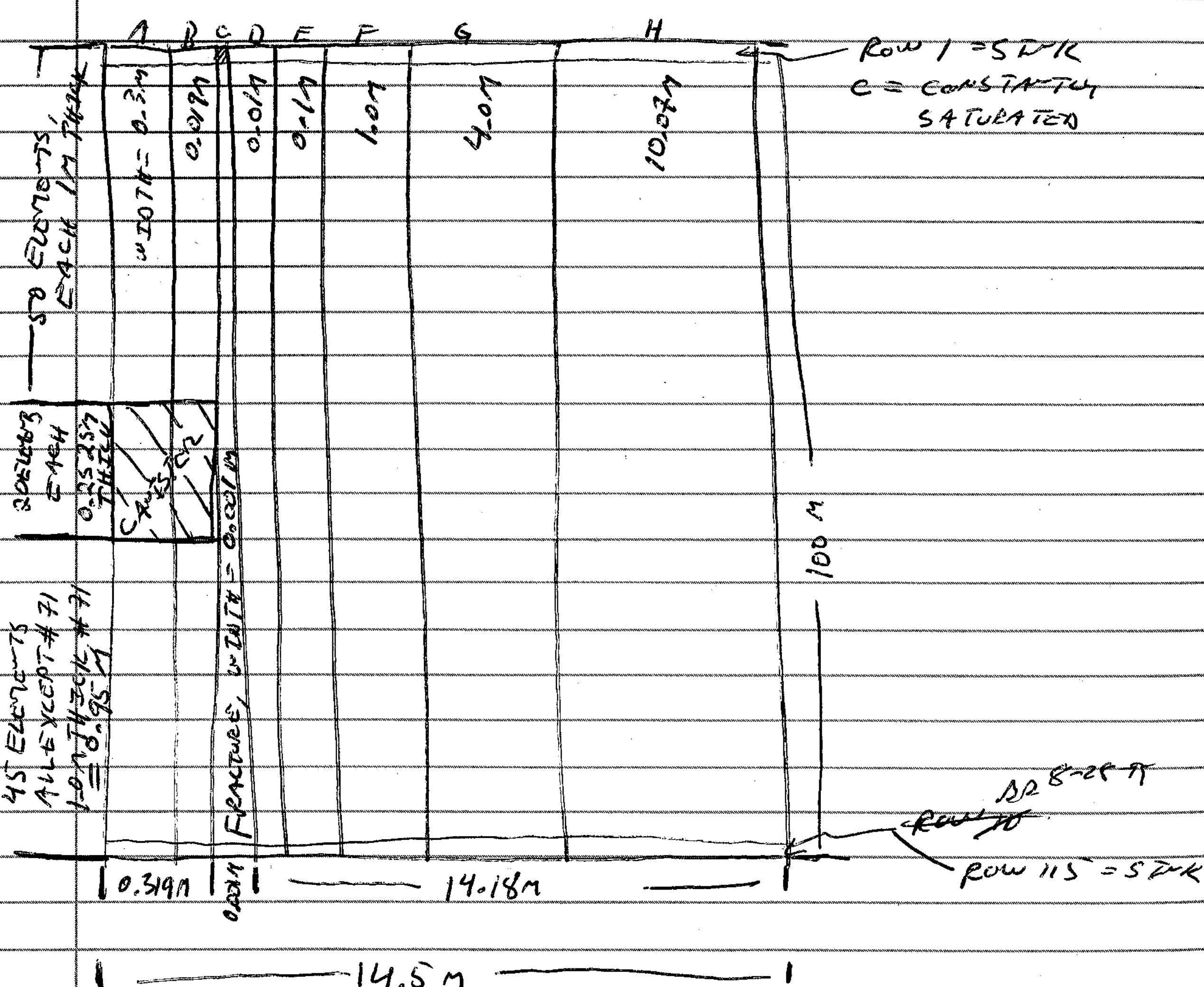
• "115X8-φ1i" DONE – CALCULATION TIME = 3.4267×10^5 s, TIMESTEPS = 1696 FOR 10^5 YR

• STARTED "115X8-φ2i" ON: /usr2/sneezy/rqueen/grice/gutt/2-d/8-95 ≃ 2020.

IDENTICAL TO "115X8-φ1i" EXCEPT K OF FRACTURE = 8.3×10^{-11} M^2 INSTEAD OF 8.3×10^{-10} m^2

8-28-95 MR

GRID FOR "115X8-XXi" RUNS



8-28-95 MR

• KILLED "115X8-φ2i" ≃ 1400 – TIME ≃ 1.1×10^{-2} YR, Δt ≃ 4×10^{-6} YR, TIMESTEPS = 1035

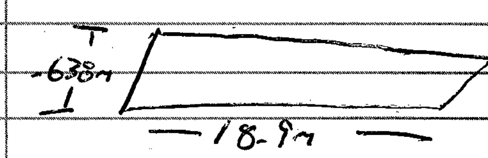
• NEW RUN: "115X7-dry" – NO WATER IN SYSTEM – SEE HOW IT COMPARES TO NITAO'S RESULTS (1988)

8-29-95 MR

• RUN "115X7-dry" – BOGGED DOWN ≃ 9×10^{-2} YR, TEMP = 500 °C, Δt ≃ 10^{-17} YR.

WILL NOW CHANGE (ADJUST, REDUCE) POWER TO BE AN INITIAL DENSITY OF 57 KW/AC.

SURFACE AREA OF "115X7..." =



= 12.06 M^2,

INITIAL POWER (pg 48) = 3.4 KW, ⇒ 1.7 (MODELING ½ ON SYMMETRY) MR 8-29-95

INITIAL POWER DENSITY = $\frac{\cancel{3.4}\ 1.7\ KW}{12.06\ M^2}$

$\Rightarrow \frac{\cancel{3.4}\ 1.7\ KW}{12.06\ M^2} \times \frac{4046.9\ M^2}{AC} = \frac{570.5\ KW}{AC}$; MR 8-29-95

∴ MUST REDUCE HEAT INPUT BY A FACTOR OF 10 IN MODEL →

"115X7-dry2i" = IDENTICAL TO "115X7-dryi" EXCEPT HEAT INPUT REDUCED BY A FACTOR OF 10.

8-30-95 MR

• "115X7-dry2i" DONE, CALCULATION TIME = 49,214 s, TIMESTEPS = 368

8-30-95
AR

- TO SIMULATE 114 KW/AC:

0.17 SEE PREVIOUS PAGE-HIGHLITE

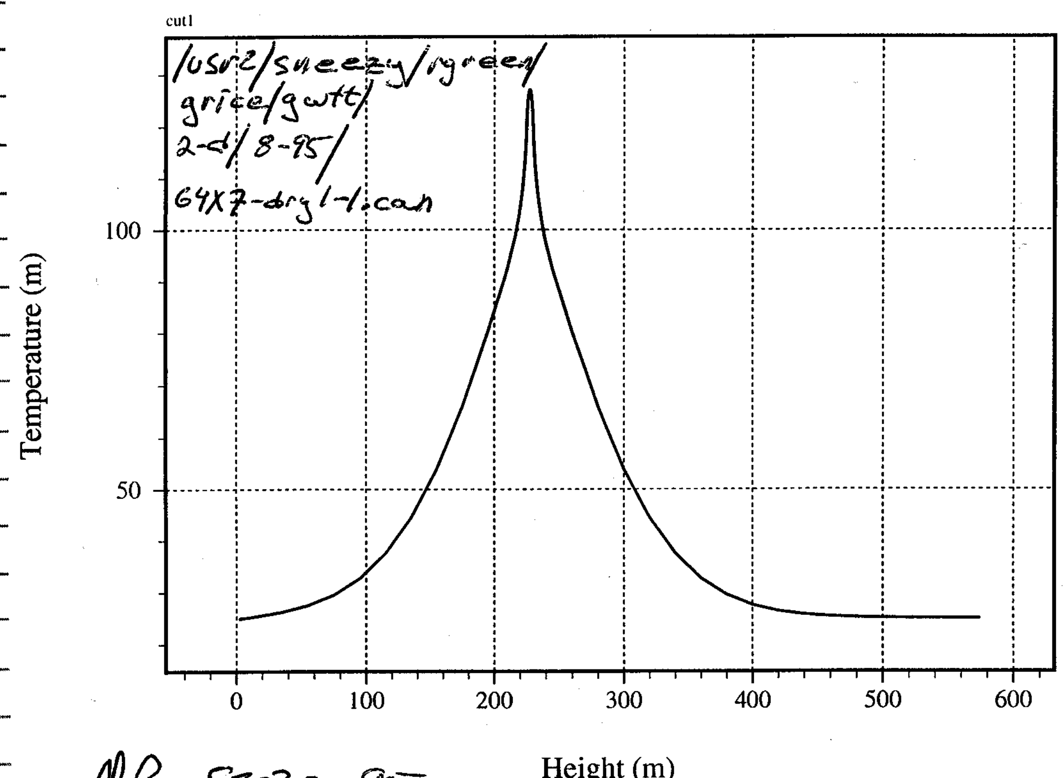
$\frac{\cancel{1.7}\ 0.17\ KW}{\cancel{0.64}\ 0.638\,m\,(x)}\ \frac{4046.9\,m^2}{AC} = \frac{114\,KW}{AC}$

AR 8-30-95

$x = \frac{\cancel{1.7}\ 0.17\ KW \quad 4046.9\,m^2 \quad AC}{AC \quad 0.638\,m \quad 114\,KW} = 9.46\,m$

64X7-dry1, 57KW/Ac, 100 Years

AR 8-30-95



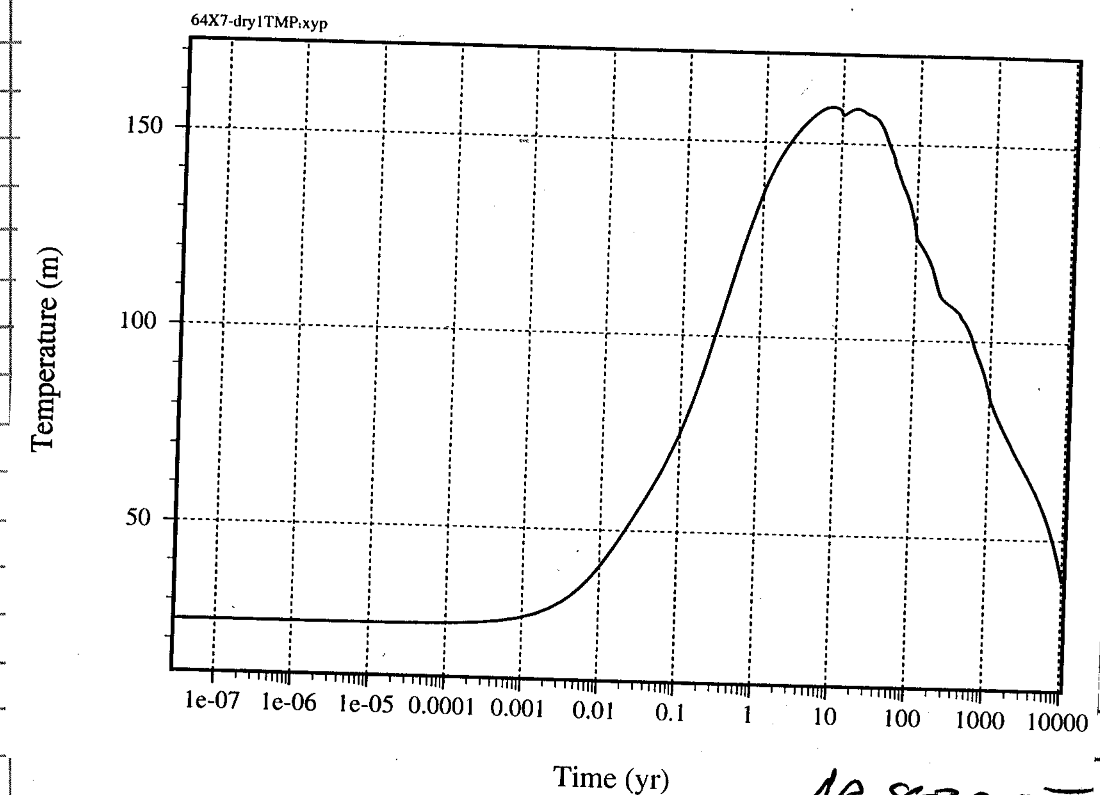
AR 8-30-95

AR 8-30-95

8-30-95
AR

64X7-dry1, 57KW/Ac

AR 8-30-95



AR 8-30-95

- NEW CANISTER SIMULATION: "64X7-ϕ1i" - TOTAL THICKNESS = 578 M - 348 M ABOVE CANISTER AND 224.95 M BELOW CANISTER - CANISTER THICKNESS = 5.05 M. - FRACTURE = 0.001 M WIDE.

8-31-95
AR

- NEW SIMULATION: "64X7-ϕ2i" - IDENTICAL TO "64X7-ϕ1i" EXCEPT PERMEABILITY OF FRACTURE = $8.3\times10^{-12}\,m^2$ INSTEAD OF $8.3\times10^{-11}\,m^2$

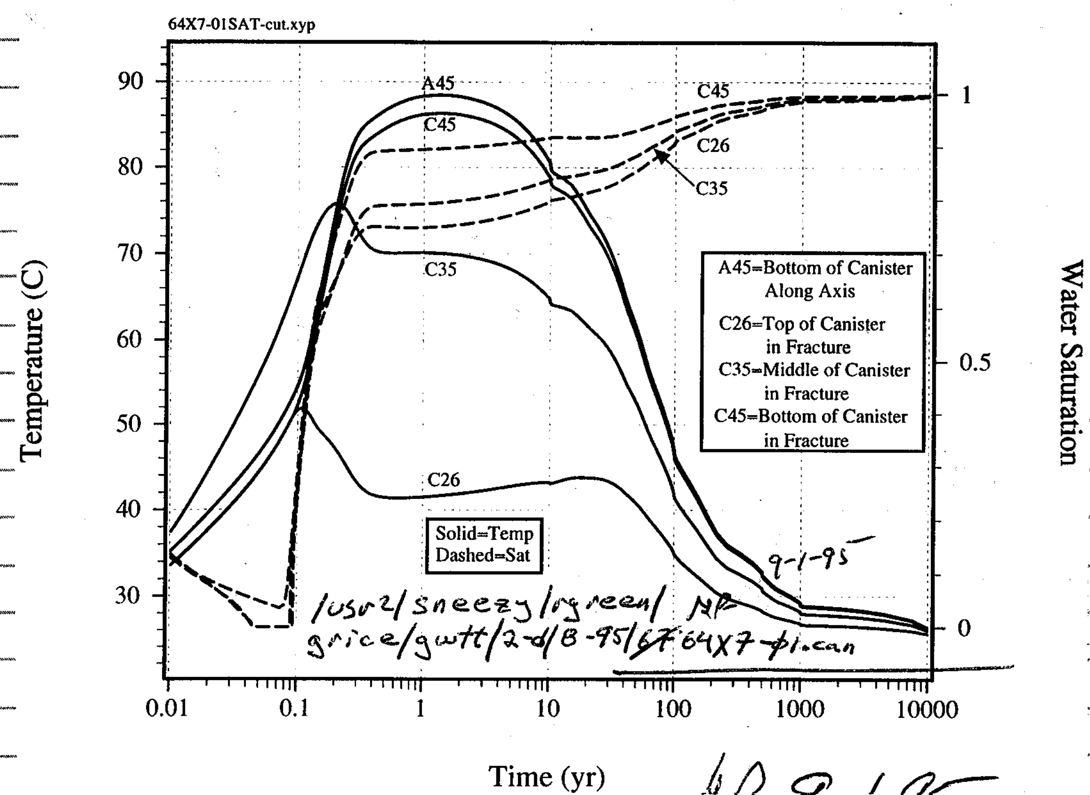
- "64X7-ϕ1i" DONE ON "usr2/sneezy/rgreen/grice/gwtt/2-d/8-95 - CALCULATION TIME = 11,728s; TIMESTEPS = 418, 10^5 YRS.

9-1-95
MR

NOTE, SAME PLOT W/ ONLY 2 LINES: 64X7-φ1-2.can
MR 9-25-95

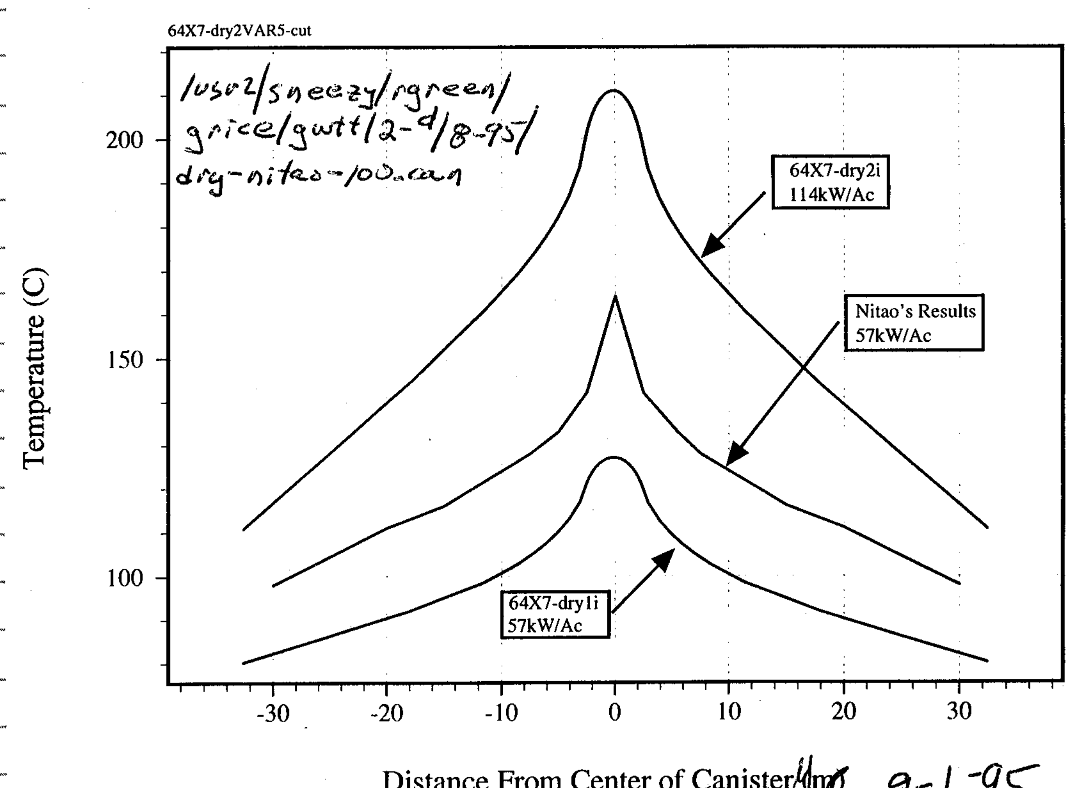
64X7-01, 57kW/Ac, 578m, k(f)=8.3E-11m^2

MR 9-1-95



MR 9-1-95

Temperature at 100 Years, Conduction Through Rock



MR 9-1-95

9-3-95
MR

≈1030 - "64X7-φ2i" = 66.3 YRS, Δt ≈ 5×10⁻⁴ YR, TIMESTEP = 6300
DOING ABOUT SAME AS ON FRIDAY AFTERNOON - KILL IT.

• NEW RUN STARTED: "64X7-φ3i" - IDENTICAL TO "64X7-φ2i" EXCEPT PERMEABILITY OF FRACTURE = 4.15×10⁻¹¹ m² INSTEAD OF 8.3×10⁻¹² m².

9-4-95
MR

• "64X7-φ3i" DONE ON:
/usr2/sneezy/rgreen/grice/gwtt/2-d/8-95

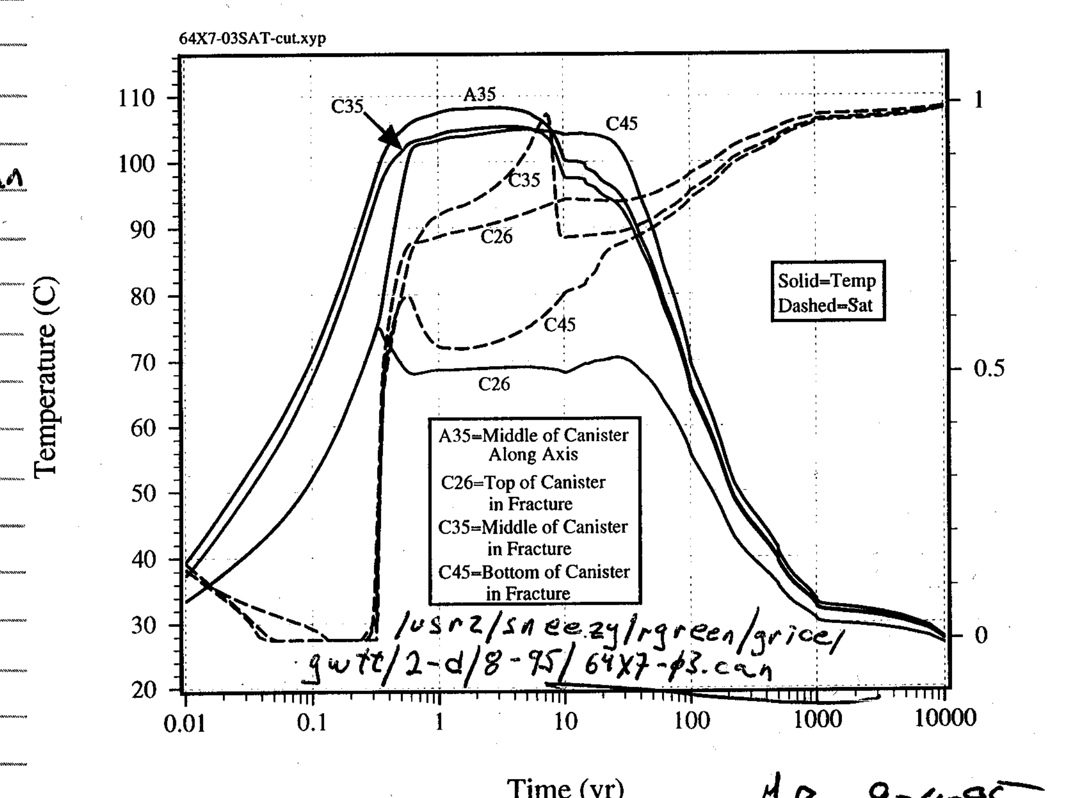
CALCULATION TIME = 20,413 s, TIMESTEPS = 627, 10⁵ YRS.

• NEW RUN: "64X7-φ4i" - IDENTICAL TO "64X7-φ2i" EXCEPT PERMEABILITY OF FRACTURE = 2.1×10⁻¹¹ m².

MR 9-4-95

NOTE, SAME PLOT W/ ONLY 2 LINES = 64X7-φ3-2.can

64X7-03, 57kW/Ac, 578m, k(f)=4.2E-11m^2

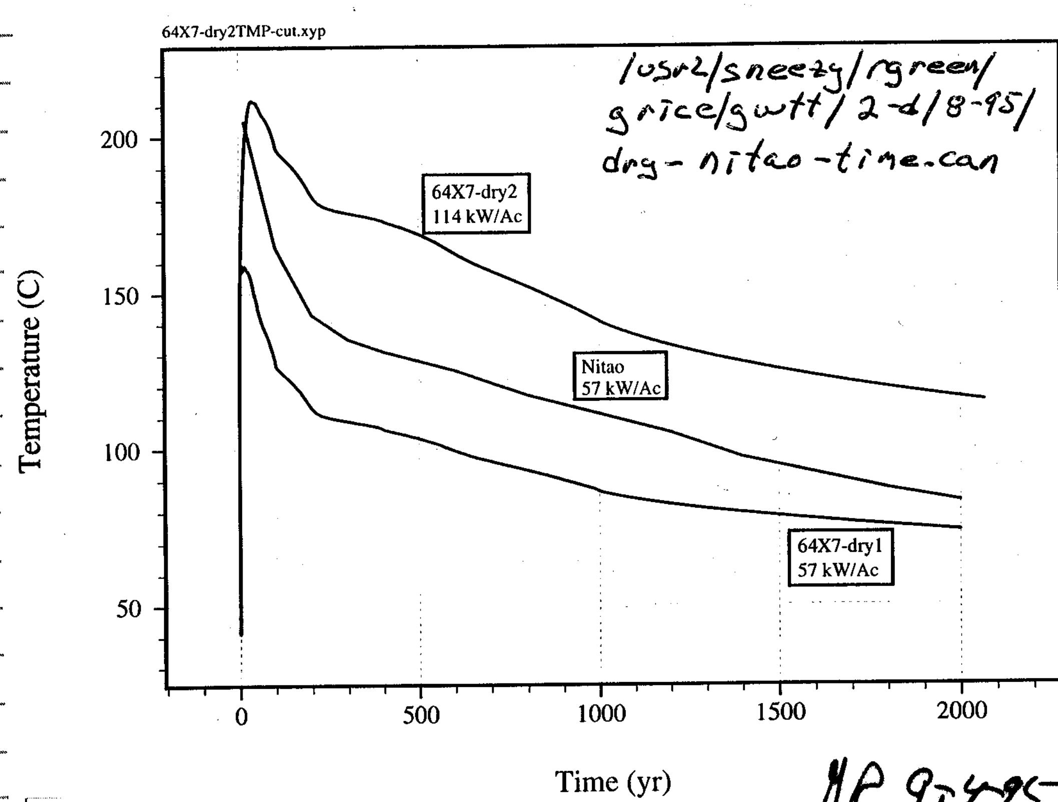


MR 9-4-95

9-4-95
MR

Conduction Through Rock, No ~~Water Present~~

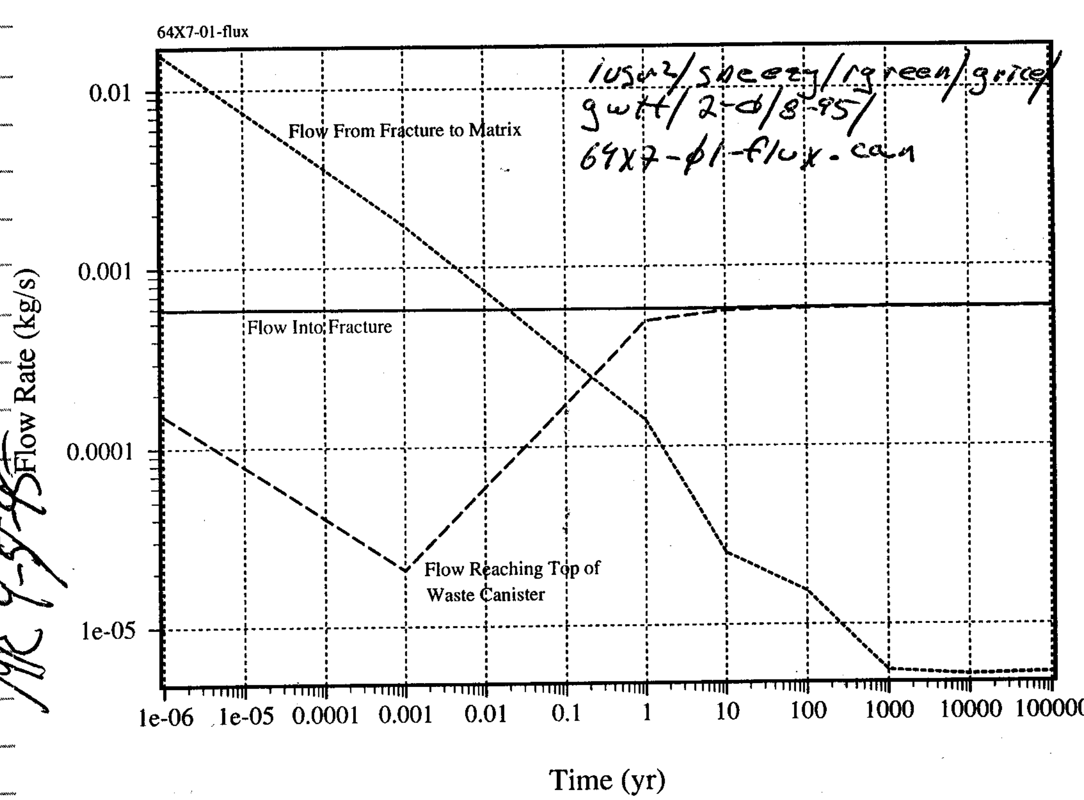
MR 9-4-95



MR 9-4-95

64X7-01, Water Flow Rates Along Fracture, k(f)=8.3E-11m^2

MR 9-4-95

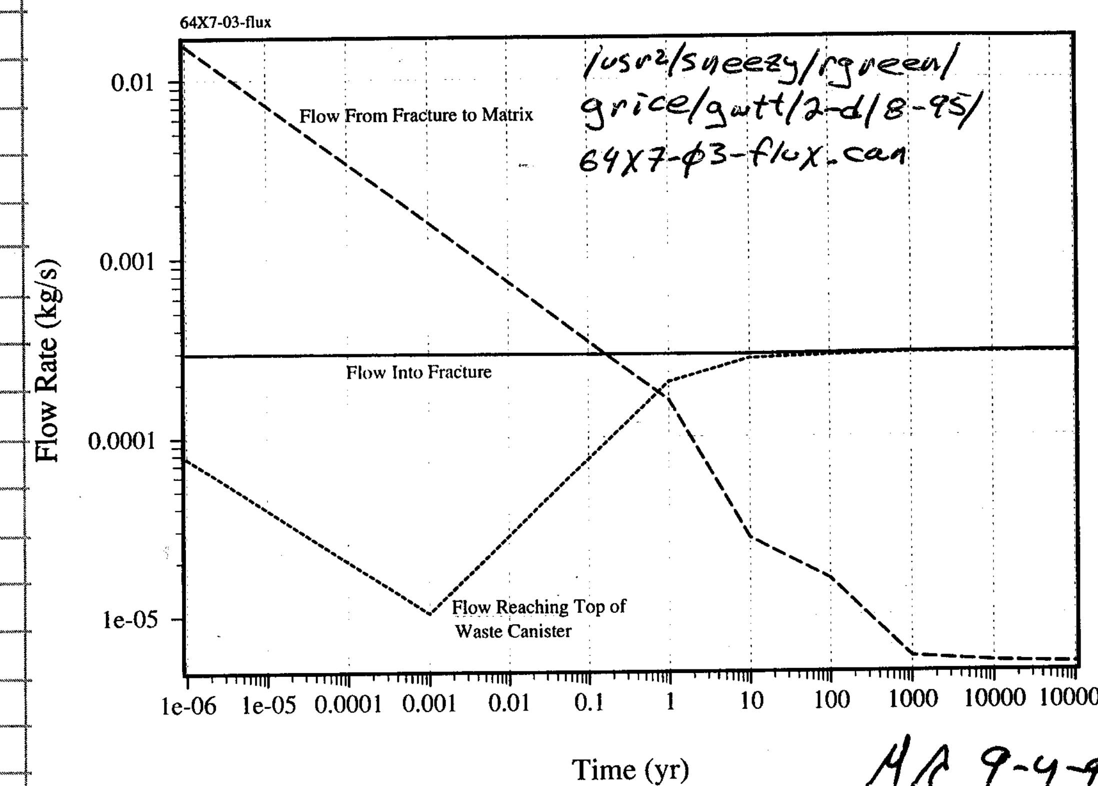


MR 9-5-95
MR 9-4-95

9-4-95
MR

64X7-~~01~~ 03, Water Flow Rates Along Fracture, k(f)=4.15E-11m^2

MR 9-5-95
MR 9-4-95



MR 9-4-95

9-5-95
MR

- KILLED "64X7-04i" ≃ 1100, TIME = 1.4 YRS, Δt ≃ 10^{-4}, TIMESTEPS ≃ 3000

- STARTED NEW RUN: "64X7-114-01i" - IDENTICAL TO "64X7-01i" EXCEPT POWER DOUBLED TO 114 KW/Ac BY CUTTING WIDTH OF SIMULATED AREA IN HALF.

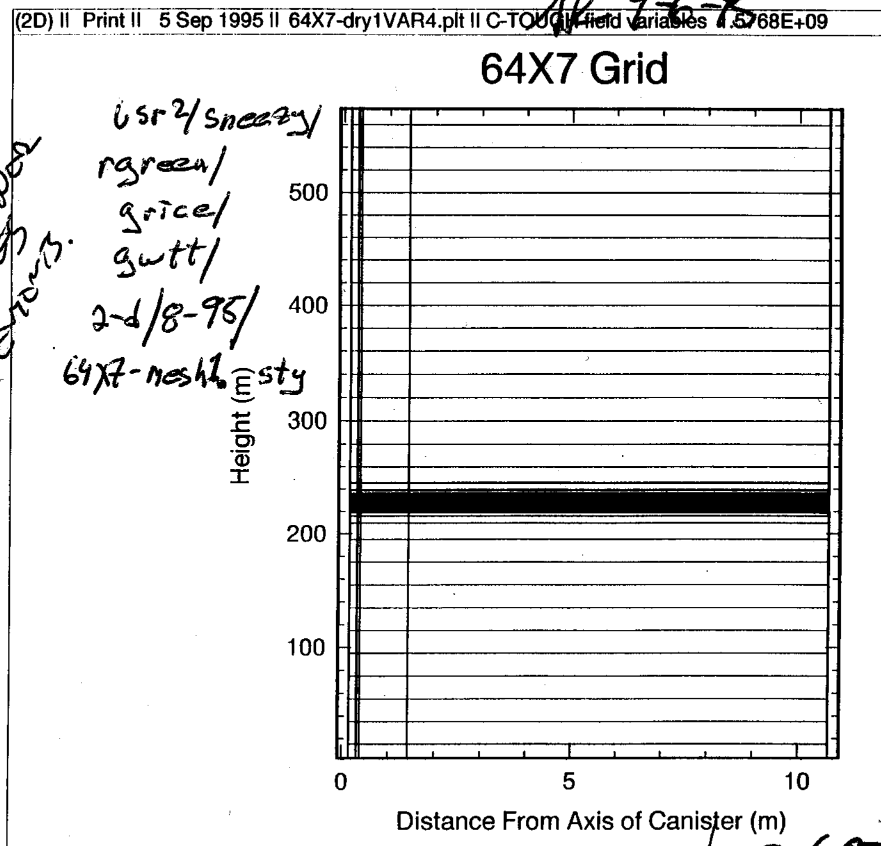
9-6-95
MR

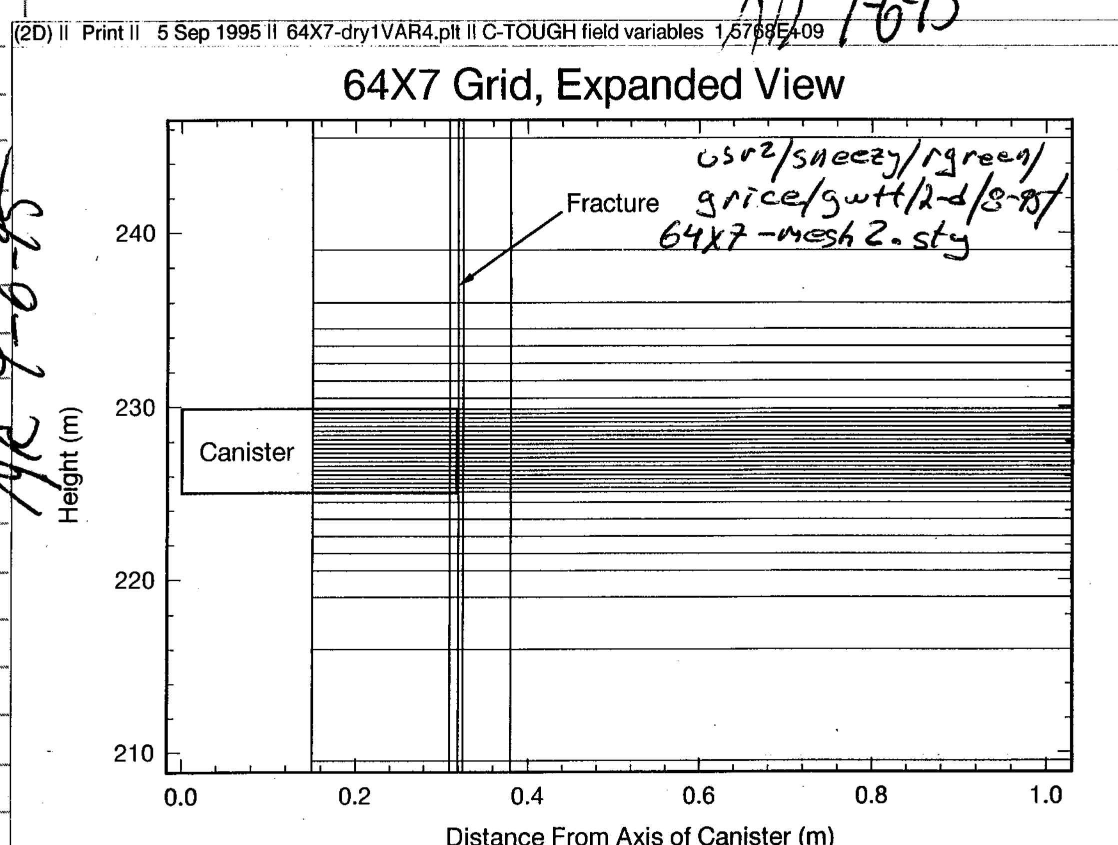
- NEW RUN: "64X7-114-02i" - IDENTICAL TO "64X7-114-01i" EXCEPT PERMEABILITY OF FRACTURE = 4.15×10^{-11} m^2 INSTEAD OF 8.3×10^{-11} m^2. RUNNING IN:

/usr2/sneezy/rgreen/grice/gwtt/2-d/8-95

9-6-95
MR

NOTE: GRID IS 18.9 M WIDE FOR 57 KW/AC CASES. HOWEVER, GRID LOOKS NARROWER BECAUSE VERTICAL LINES ARE AT CENTER OF ELEMENTS. GRID USED FOR 114 KW/AC CASE IS SAME EXCEPT IS ONLY 9.46 M WIDE.
MR 9-6-95





MR 9-6-95

9-6-95
MR

INPUT: "64X7-d1i"

```
GWTT,8/30/95, Fracture = 0.001m wide, k of fracture = 8.3E-11 m^2
:Fracture porosity = 0.9
:grid=64X7
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 1.000E-01 5.000E-17 5.000E-17 5.000E-17 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+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 5.0000E-01 0.0000E-09 1.0210E-04 1.0000E+00 1.0000E+00 2.0000E-02 0.0000E+00
:
: Fracture Zone
:
: mat  nad   drock      por       permx      permy      permz      cwet       spht
matr2  2  2.480E+03 9.000E-01 8.300E-11 8.300E-11 8.300E-11 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-02 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-01 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  9999   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 60  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
   8    8  3.1700E+00  2.0000E+00
:
:  tis(1)     tis(2)    tis(3) ......
 1.000E-06 1.000E-03 1.000E-00 1.000E+01 1.000E+02 5.000E+02 1.000E+03 1.000E+04
.
```

MR 9-6-95

MR 9-6-95

MR 9-6-95

9-6-95
MR

MR 9-6-95

"64x7-φ1i" (CONT)

```
EVAP
 A  26
 A  35
 A  45
 C  10
 C  26
 C  35
 C  45
 G  35
:
                                                 :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  1.5312E+10
A    2  0  0  matr1  3.8280E+00
A   25  0  0  matr1  1.9140E-01
A   26  0  0  matr3  4.8329E-02
A   27  0  0  matr3  4.8329E-02
A   43  0  0  matr3  4.8329E-02
A   44  0  0  matr3  4.8323E-02
A   45  0  0  matr3  4.8329E-02
A   46  0  0  matr1  1.8183E-01
A   47  0  0  matr1  1.9140E-01
A   64  0  0  matr1  9.5700E+11
B    1  0  0  matr1  9.6976E+12
B    2  0  0  matr1  2.4244E-01
B   25  0  0  matr1  1.2122E-02
B   26  0  0  matr3  3.0608E-03
B   45  0  0  matr3  3.0608E-03
B   46  0  0  matr1  1.1516E-02
B   64  0  0  matr1  6.0610E+12
C    1  0  0  matr2  5.1039E+13
```

MR 9-6-95

```
C    2  0  0  matr2  1.2760E-02
C   63  0  0  matr2  1.2760E-02
C   64  0  0  matr2  3.1900E+13
D    1  0  0  matr1  5.1040E+12
D    2  0  0  matr1  1.2760E-01
D   63  0  0  matr1  1.2760E-01
D   64  0  0  matr1  3.1900E+12
E    1  0  0  matr1  5.1040E+11
F    1  0  0  matr1  1.0208E+11
G    1  0  0  matr1  8.4063E+11
                   :reqd blank line
:
CONNE
: el n1 e2   n2 nsq nd1 nd2 isot d1        d2          areax     betax
:
A     1 B     1 0 0 0  1  1.500E-01  9.500E-03  5.104E+00  0.000E+00 0
A     2 B     2 0 0 0  1  1.500E-01  9.500E-03  1.276E+01  0.000E+00 0
B     3 C     3 0 0 0  1  9.500E-03  5.000E-04  1.276E+01  0.000E+00 0
C     4 D     4 0 0 0  1  5.000E-04  5.000E-03  1.276E+01  0.000E+00 0
D     5 E     5 0 0 0  1  5.000E-03  5.000E-02  1.276E+01  0.000E+00 0
A    14 A    15 0 0 0  1  1.000E+01  1.000E+01  1.914E-01  1.000E+00 0
B    16 B    17 0 0 0  1  1.000E+01  1.000E+01  1.212E-02  1.000E+00 0
C    18 C    19 0 0 0  1  4.500E+00  2.000E+00  6.380E-04  1.000E+00 0
F    30 F    31 0 0 0  1  1.263E-01  1.263E-01  1.276E+00  1.000E+00 0
G    32 G    33 0 0 0  1  1.262E-01  1.263E-01  1.050E+01  1.000E+00 0
:
```

MR 9-6-95

9-6-95
MR

"64x7-φ1i" (CONCL)

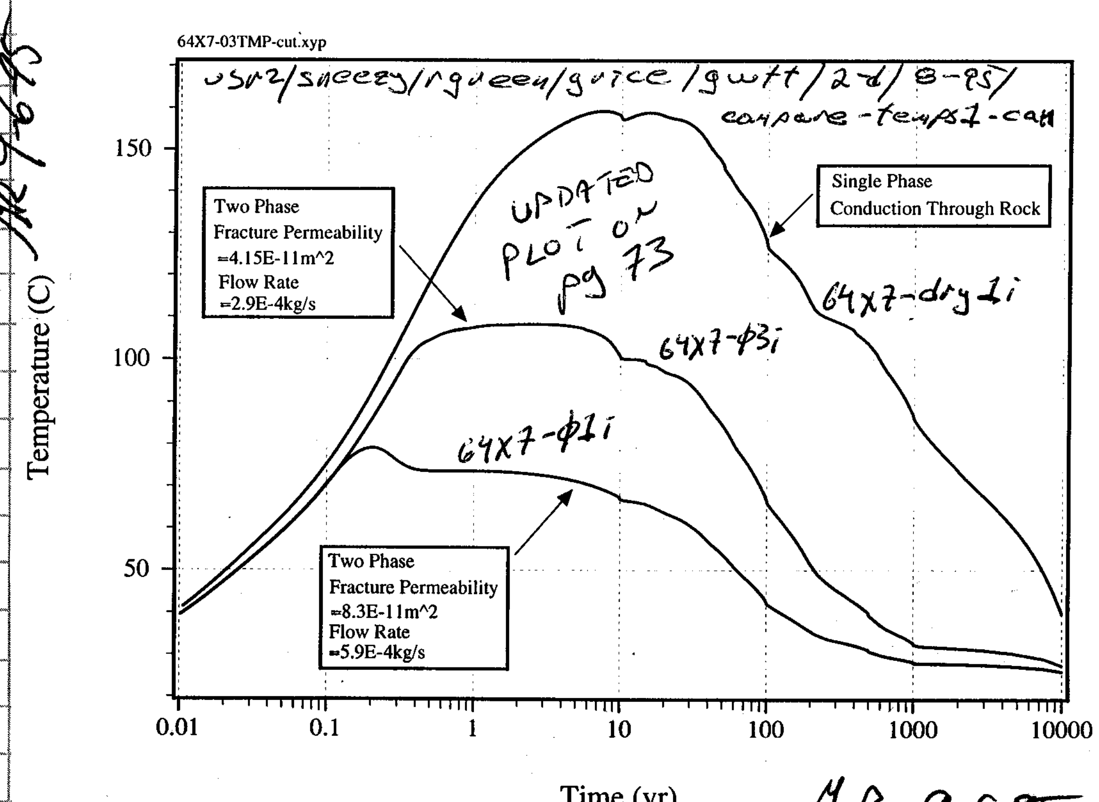
MR 9-6-95

```
GENER----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
: el ne sl ns nsq nad nads ltb  itp   itb   gx        ex        hg
:
A  26 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
  7.99E+00 5.85E+00 4.82E+00 3.48E+00
  2.64E+00 1.73E+00 1.01E+00 5.41E-01
  3.53E-01 8.80E-02 4.44E-03
B  26 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
  5.06E-01 3.70E-01 3.05E-01 2.20E-01
  1.67E-01 1.10E-01 6.40E-02 3.43E-02
  2.23E-02 5.57E-03 3.03E-04
                                                :reqd blank line
:
INCON
:
: el ne   nsq nadd       porx
A    1  0  0      0.0
:
:        x1                x2                x3
     1.000000E+05      3.000000E-01      2.500000E+01
B    1  0  0      0.0
     1.000000E+05      3.000000E-01      2.500000E+01
C    1  0  0      0.0
     1.000000E+05      1.000000E-09      2.500000E+01
D    1  0  0      0.0
     1.000000E+05      3.000000E-01      2.500000E+01
E    1  0  0      0.0
     1.000000E+05      3.000000E-01      2.500000E+01
```

MR 9-6-95

Temperature at Center of Canister, 57kW/Ac

MR 9-6-95



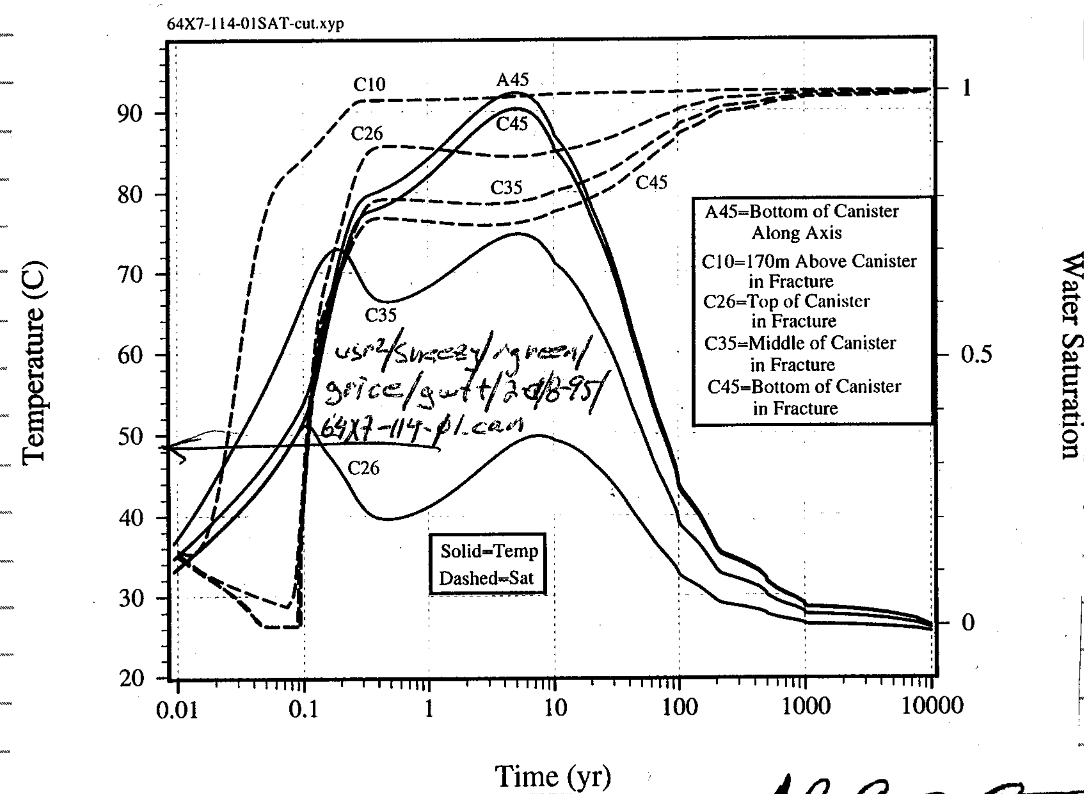
MR 9-6-95

9-7-95
MR

NOTE: SAME PLOT W/ONLY 2 LINES = 64X7-114-φ1-2.can

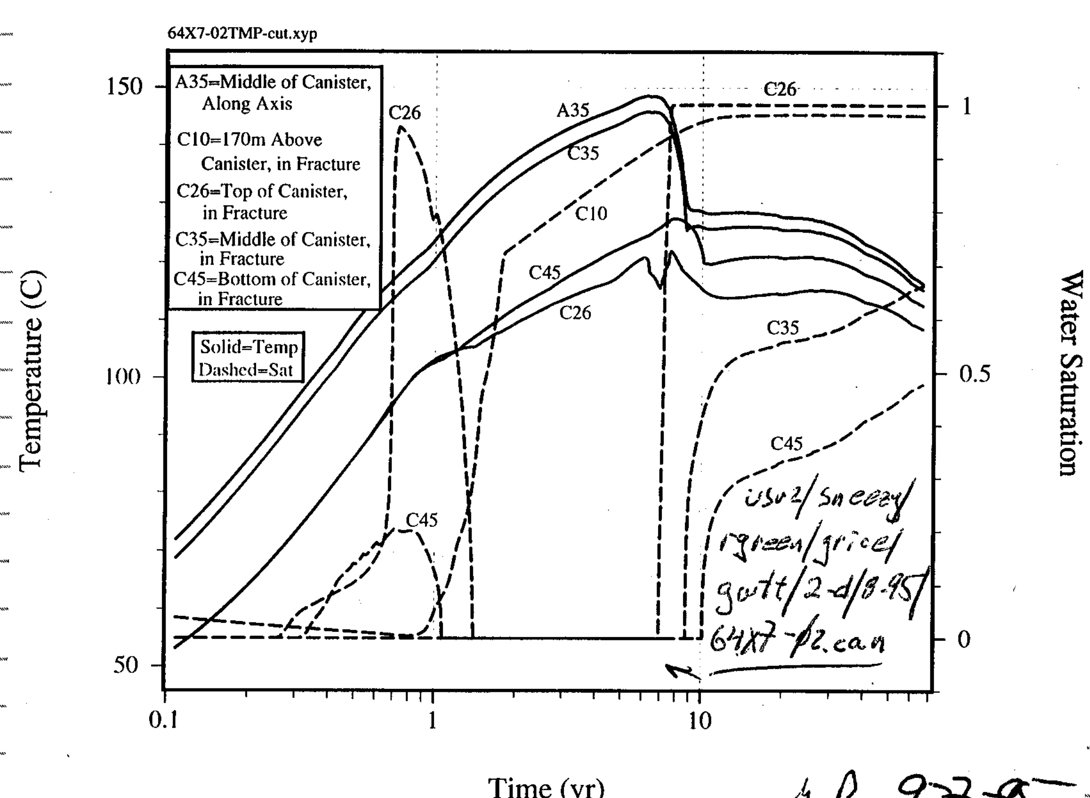
MR 9-15-95

64X7-114-01, 114kW/Ac, 578m, k(f)=8.3E-11m^2 MR 9-7-95



NOTE: SIMPLIFIED VERSION OF PLOT = 64X7-φ2-2.can

64X7-02, 57kW/Ac, 578m, k(f)=8.3E-12m^2 MR 9-7-95



MR 9-7-95

9-9-95 MR · NEW INPUT: "91X7-φ1i" – IDENTICAL TO "64X7-φ1i" EXCEPT THICKNESS OF 8M + 20M ELEMENTS CUT IN HALF – ADDING 27 ELEMENTS.

TO TEST EFFECT OF GRIDDING ON RESULTS

MR 9-9-95

· "91X7-φ1i" DONE BY 2020. CALCULATION TIME = 35,372 S, TIMESTEPS = 413, 10^5 yrs

· NEW INPUT: "145X7-φ1i" – IDENTICAL TO "91X7-φ1i" EXCEPT THICKNESS OF 10 METER ELEMENTS CUT IN HALF, 9 METER ELEMENTS DIVIDED INTO TWO 4.5 METER ELEMENTS

MR 9-12-95

9-10-95 MR · KILLED "145X7-φ1i" – AFTER 100 YRS – GOT NEEDED INFO – SEE BELOW.

· NEW RUN: "64X7-114-φ3i" – IDENTICAL TO "64X7-114-φ1i" EXCEPT PERMEABILITY OF FRACTURE = 8.3×10^{-12} M^2 INSTEAD OF 8.3×10^{-11} M^2. RUNNING IN:

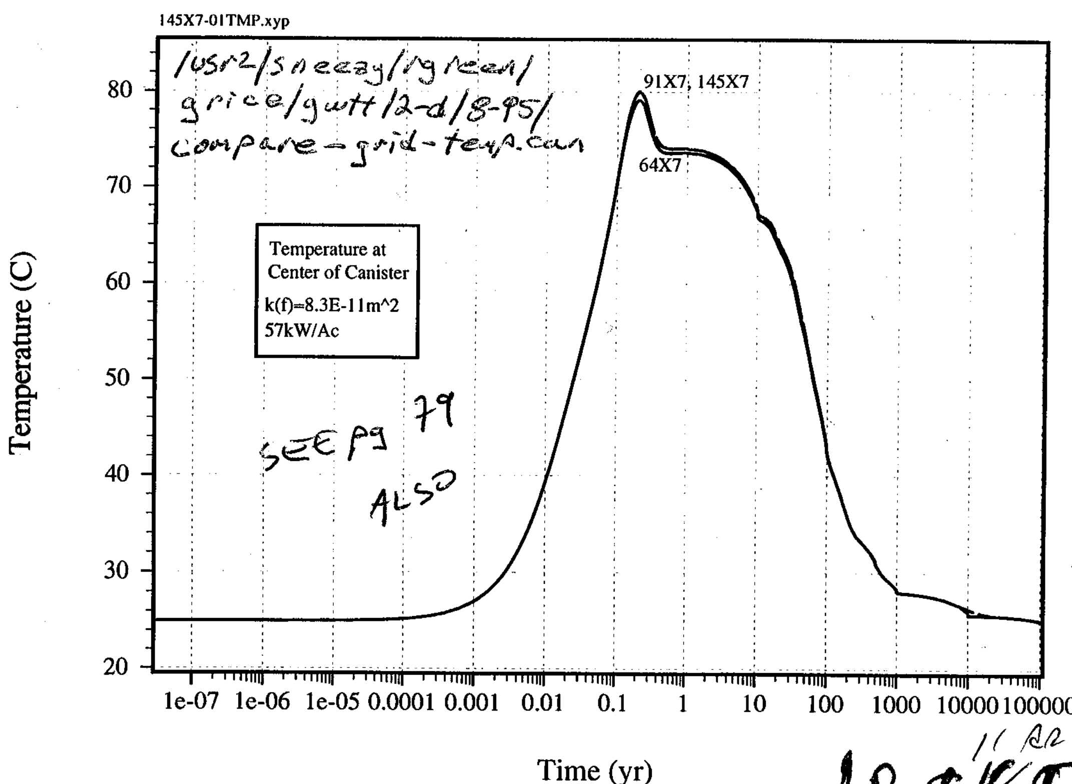
/usr2/sneezy/rgreen/grice/gutt/2-d/8-95

MR 9-10-95

" MR 9-12-95
9-10-95
MR

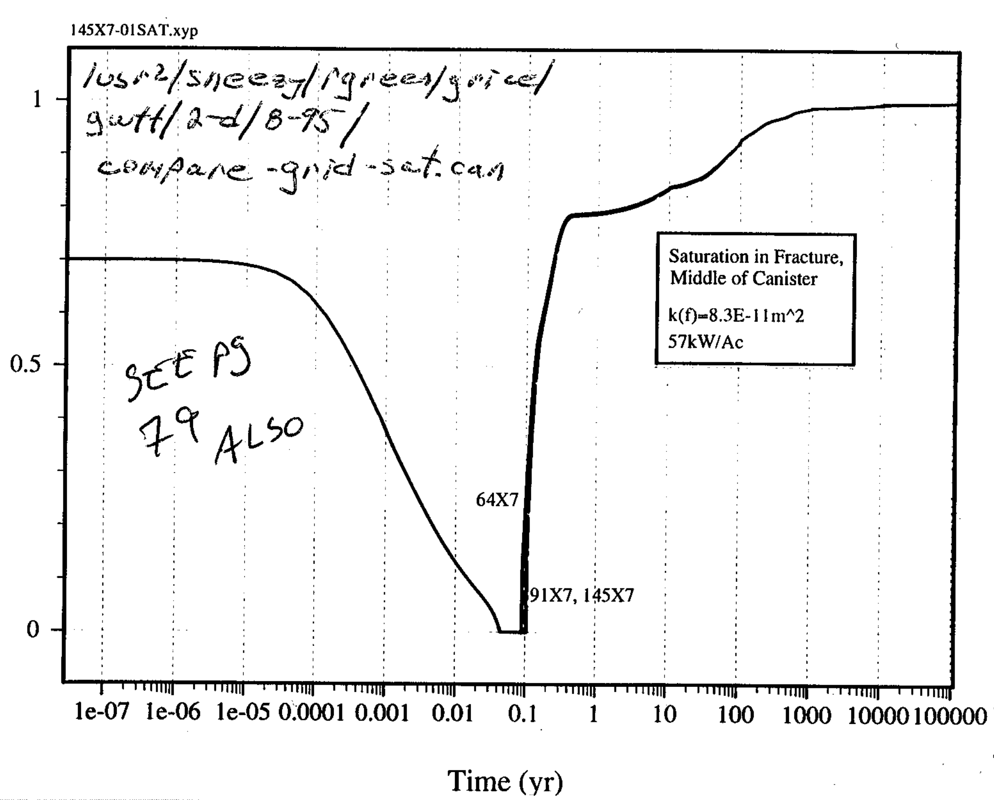
" MR 9-12-95

Effect of Gridding on Temperature



" MR 9-12-95
MR 9-10-95

Effect of Gridding on Water Saturation



MR 9-12-95
" MR 9-10-95

MR 9-12-95
"
9-10-95
MR

NEW RUN USING EQUIVALENT CONTINUUM MODEL OF MATRIX/FRACTURE FLOW (9-9 CTOUGH). "64X7-114-φ3-99i"

IDENTICAL TO "64X7-114-φ3i" EXCEPT FOR ROCK MATRIX PROPERTIES. THE FOLLOWING PARAMETERS ARE USED (matr 1)

TOTAL POROSITY: (FROM NITAO, MAY 1988)

$\phi_b = \phi_f + (1-\phi_f)\phi_m$, WHERE:

ϕ_b = BULK POROSITY

ϕ_f = FRACTURE POROSITY ASSUME = 1.8×10^{-3} (NITAO, pg 13)

ϕ_m = MATRIX POROSITY = 0.10

THEN:

$\phi_b = 1.8\times10^{-3} + (1-1.8\times10^{-3})\,0.10 = 0.102$

BULK PERMEABILITY (FROM NITAO, MAY 1988)

$K_b = K_m(1-\phi_f) + K_f\phi_f$, WHERE:

K_b = BULK PERMEABILITY
K_m = MATRIX PERMEABILITY
K_f = FRACTURE PERMEABILITY

$K_b = 5\times10^{-17}m^2(1-1.8\times10^{-3}) + 8.3\times10^{-12}m^2(1.8\times10^{-3})$

$= 1.500\times10^{-14}m^2$

MR
9-10-95
" MR 9-12-95

9-10-95 (9-11 AR 9-12-95)
AR

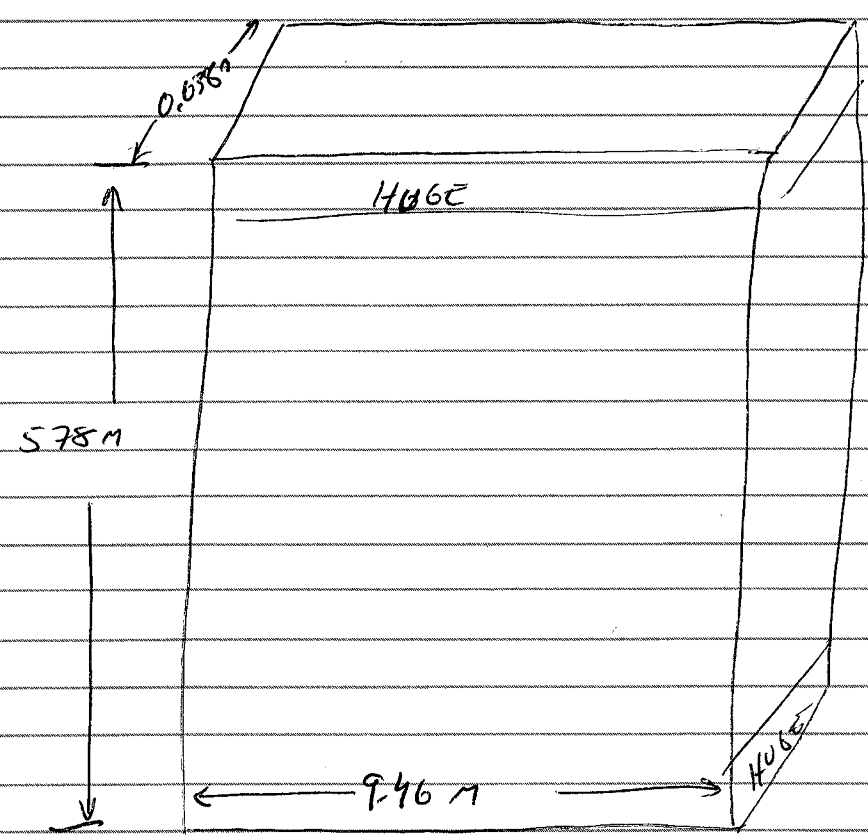
• KILLED "64x7-114-ϕ3i" + STARTED:
"64x7-114-ϕ3-99i" – IDENTICAL TO "64x7-114-ϕ3i" EXCEPT IT USES EQUIVALENT CONTINUUM FOR ROCK MATRIX (SEE pg 69).

• "64x7-114-ϕ2.OUT": TOTAL WATER IN SYSTEM @ $t=0$ = 6.7166×10^{6} kg   AR 9-10-95   AR 9-12-95

NOTE – THIS NUMBER DOES NOT MAKE SENSE!

WHOOPS! FORGOT HUGE ($\sim 10^{10}\,m^3$) CELLS ON BOUNDARIES. (EVEN $10^{13}\,m^3$

DIMENSIONS OF MODEL:



9-12-95
AR

• KILLED RUN "64x7-114-ϕ3-99i" ≃ 0900 – @ STEP 1247, TIME = 3.10 YRS, $\Delta t = 8.5 \times 10^{-5}$ YR, CALCULATION TIME = 1224 MIN.

• REPLACED WITH NEW "64x7-114-ϕ3-99i" – IDENTICAL TO OLD EXCEPT ALMOST NO WATER IN CANISTER ELEMENTS @ $t=0$ (WATER SAT = 0.00001) + POROSITY OF CANISTER = 1×10^{-6}.
NAMED NEW RUN "64x7-114-ϕ3-99-2i"

9-13-95
AR

• KILLED "64x7-114-ϕ3-99-2i" – PERFORMING ABOUT SAME AS "64x7-114-ϕ3-99i":

≃0900: TIME = 3.10 YRS, $\Delta t \simeq 2 \times 10^{-5}$ YRS, CALCULATION TIME = 1377 MIN, TIMESTEP = 1509.

• REPLACED WITH: "64x7-114-ϕ3-99-~~2~~ 3i" – (AR 9-13-95)
IDENTICAL TO "64x7-114-ϕ3-99-2i" EXCEPT POROSITY OF CANISTER = 0.0.

→ RUN FAILED – GOT MESSAGE REFERRING TO IEEE FLOATING-POINT ARITHMETIC EXCEPTIONS, INEXACT; UNDERFLOW.

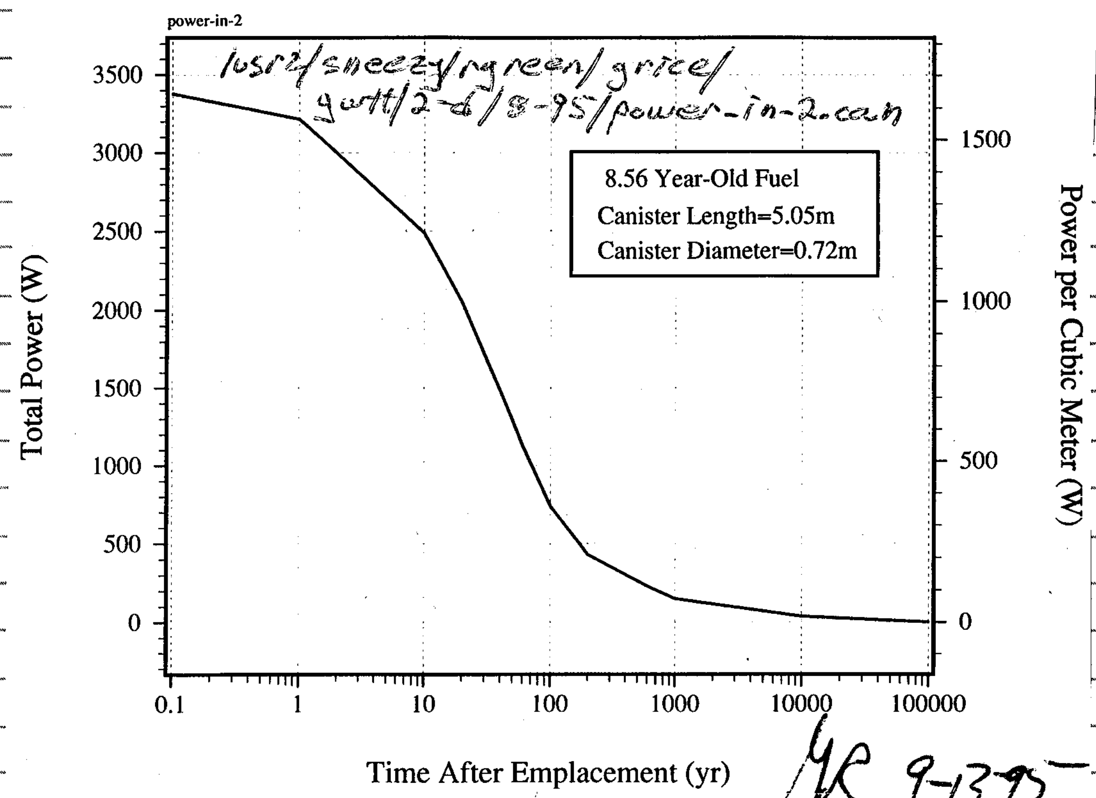
• NEW RUN: "64x7-114-ϕ3-99-4i" – IDENTICAL TO "64x7-114-ϕ3-99i" EXCEPT SINGLE PHASE IN CANISTER – NO WATER PRESENT.

AR
9-13-95

9-13-95
AR

Power Generated by Waste Canister

AR 9-13-95



MR 9-13-95

9-14-95
AR

• KILLED "64X7-114-φ3-99-4i" - ≈ 0830,
TIME ≈ $4X10^{-3}$ YR, TIMESTEP = 5625
$\Delta t \approx 8X10^{-7}$ YR, CALCULATION TIME = 1357 min

• NEW RUN: "64X7-114-φ3-99-5i" —
IDENTICAL TO "64X7-114-φ3-99-2i" EXCEPT
MR 9-14-95 ~~PERMEABILITE~~ PERMEABILITY & POROSITY
OF CANISTER SAME AS THOSE OF
ROCK MATRIX

9-15-95
MR

- RUN "64x7-114-φ3-99-5i" STOPPED WITH
MESSAGE: "*** WARNING: NO CONVERGENCE IN
SUBROUTINE PP" TIMESTEP = 215, TIME = 2.67 YR,
$\Delta t = 1X10^{-3}$ YR

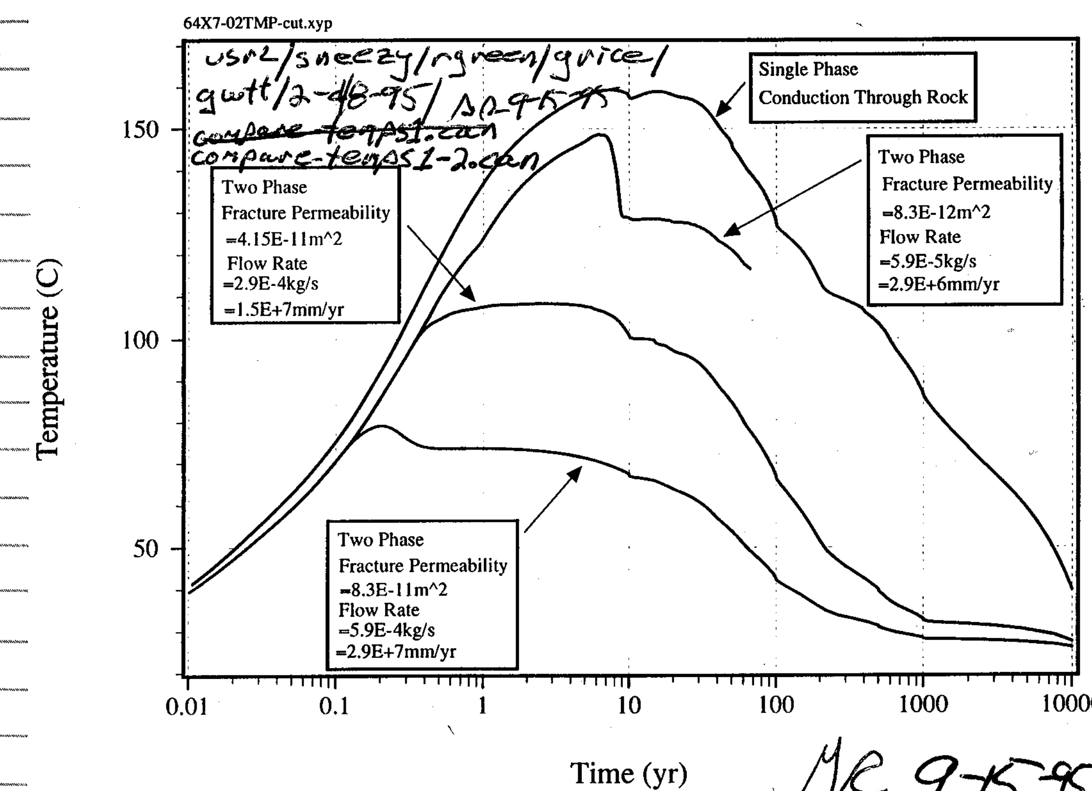
IEEE NaNs WRITTEN TO ASCII strings OR
OUTPUT FILES

9-15-95
MR

NOTE THE COLOR VERSION OF THE COMBINED
GAS + WATER VECTOR PLOTS IS CALLED:
"COMBINE1.ps" — THIS ONE ON
BLACK BACKGROUND

Temperature at Center of Canister, 57kW/Ac

AR 9-15-95



MR 9-15-95

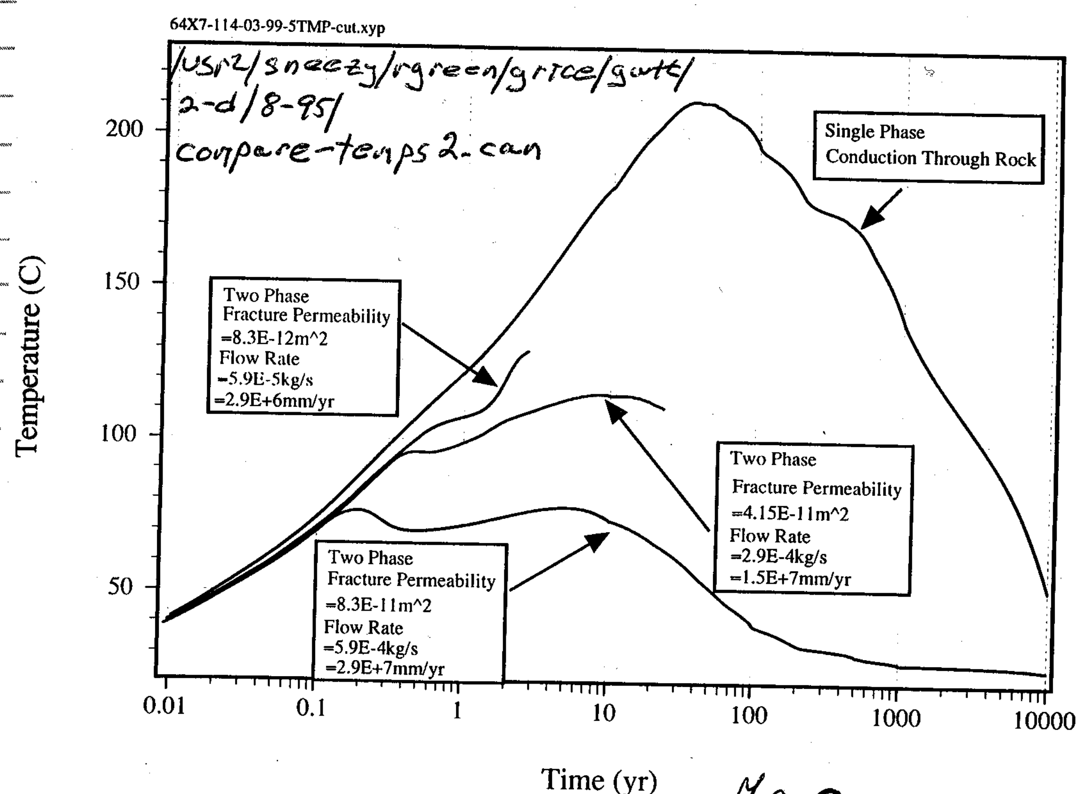
~~RC-A~~

MR 9-15-95

9-15-95
Ne

Temperature at Center of Canister, 114kW/Ac

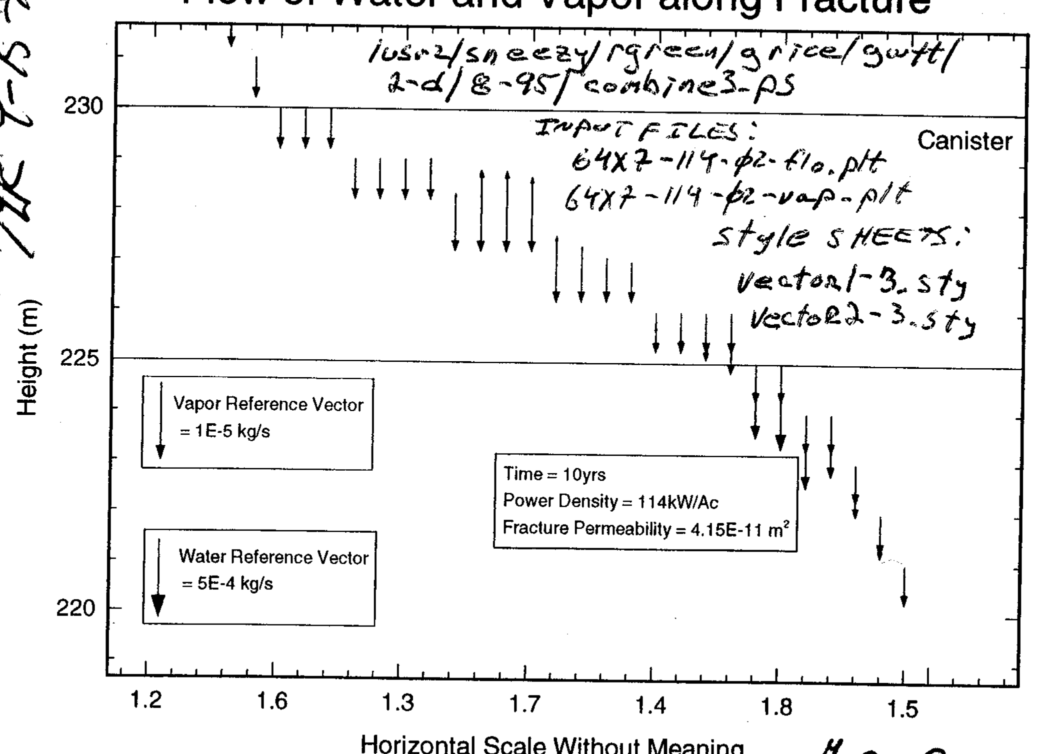
MR 9-15-95



MR 9-15-95

MR 9-15-95

Flow of Water and Vapor along Fracture



MR 9-15-95

9-15-95
MR

- RE-RAN "64X7-114-φ3-99-5T" — DIED IN SAME PLACE AGAIN — SAME MESSAGES
- RE-RUNNING "64X7-114-φ3-99-2" —SEE pg 71

9-17-95
MR

- NEW CANISTER SET-UP: "29X7-99-φ1i"
  — 57 kW/Ac —

VOLUME OF A CANISTER ELEMENTS = $9.6658 \times 10^{-2} m^3$
" " B " " = $6.1217 \times 10^{-3} m^3$

POWER FOR A ELEMENTS = $9.6658 \times 10^{-2} m^3$
(@ t=0)

BECAUSE WE NOW HAVE 10 HEATER ELEMENTS IN EACH ROW INSTEAD OF 20, THE POWER RATE MUST BE DOUBLED.

TOTAL VOLUME OF 1/2 CANISTER = $9.6658 \times 10^{-1} m^3$
$6.1217 \times 10^{-2} m^3$
$1.027797 m^3$

—KILLED RUN "64X7-114-03-99-2i"
STEP = 2923, TIME = 311 yr, $\Delta t = 6 \times 10^{-6}$ yr
CALCULATION TIME = 2792 min.

NEW CANISTER RUN USES 9-9 (EQUIVALENT CONTINUUM) FOR ROCK.

9-18-95
MR

— RUN "29X7-99-φ1i" DIED — GOT MESSAGE:
"*** WARN I-6: NO CONVERGENCE IN SUBROUTINE PP"
@ TIMESTEP # 1599, t = 14.8 yrs, $\Delta t = 6.7 \times 10^{-2}$ yr

9-18-95
MR

- NOTE - WILL RE-RUN "29X7-99-φ1i" WITH K OF FRACTURE = 8.3×10^{-11} m^2 INSTEAD OF 8.3×10^{-12} m^2 — CALL RUN: "29X7-99-φ2i"

• NOTE - TEMPERATURES + SATURATIONS PREDICTED BY "29X7-99-φ2i" DIFFER GREATLY FROM THOSE PREDICTED BY FINER GRIDS - WILL COMPARE A COARSE-GRID-RUN THAT USES 7, 11 SCHEME INSTEAD OF 9, 9 (EQUIVALENT ~~OF~~ MR 9-18-95 CONTINUUM)

"NEW RUN USING 7, 11 SCHEME: "29X7-φ1i"

INPUT: "29X7-99-φ2i"

```
GWTT,9/17/95, Fracture = 0.001m wide, k of fracture = 8.3E-12 m^2
:Fracture porosity = 0.9
:grid=29X7, 114kW/Ac, EQUIVALENT CONTINUUM MODEL (9,9)
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 1.020E-01 1.500E-14 1.500E-14 1.500E-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 5.0000E-17 1.0210E-04 2.0000E+00 1.0000E-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)
  9 8.3000E-12 1.0210E-02 5.0000E-00 1.8000E-03 0.0000E+00 0.0000E-02 0.0000E+00
:
: Fracture Zone
:
: mat   nad   drock      por        permx      permy      permz      cwet       spht
matr2  2   2.480E+03 9.000E-01 8.300E-12 8.300E-12 8.300E-12 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-02 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  9999   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
```

MR 9-18-95

9-18-95
MR

INPUT: "29X7-99-φ2i" (CONT)

MR 9-18-95

```
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
    8    8  3.1700E+00  2.0000E+00
:
:  tis(1)     tis(2)    tis(3) ......
 1.000E-06 1.000E-03 1.000E-00 1.000E+01 1.000E+02 5.000E+02 1.000E+03 1.000E+04
:
EVAP
 A  12
 A  16
 A  21
 C   5
 C  12
 C  16
 C  21
 G  16
:
                                                        :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  1.5312E+10
A    2  0  0  matr1  7.6560E+00
A    3  0  0  matr1  7.6560E+00
A   12  0  0  matr3  9.6658E-02
A   13  0  0  matr3  9.6658E-02
A   21  0  0  matr3  9.6652E-02
A   22  0  0  matr1  1.3302E+00
A   28  0  0  matr1  7.6560E+00
A   29  0  0  matr1  9.5700E+11
B    1  0  0  matr1  9.6976E+12
B    2  0  0  matr1  4.8488E-01
B   11  0  0  matr1  8.4854E-02
B   12  0  0  matr3  6.1217E-03
B   13  0  0  matr3  6.1217E-03
B   21  0  0  matr3  6.1213E-03
B   22  0  0  matr1  8.4248E-02
B   28  0  0  matr1  4.8488E-01
B   29  0  0  matr1  6.0610E+12
C    1  0  0  matr2  5.1039E+13
C    2  0  0  matr2  2.5520E-02
```

MR 9-18-95

```
C   28  0  0  matr2  2.5520E-02
C   29  0  0  matr2  3.1900E+13
D    1  0  0  matr1  5.1040E+12
D    2  0  0  matr1  2.5520E-01
D   29  0  0  matr1  3.1900E+12
E    1  0  0  matr1  5.1040E+11
E    2  0  0  matr1  2.5520E+00
E    3  0  0  matr1  2.5520E+00
G   27  0  0  matr1  4.2031E+02
G   28  0  0  matr1  4.2031E+02
G   29  0  0  matr1  5.2539E+11
                      :reqd blank line
 :
```

MR 9-18-95

9-18-95
NR

INAT: "29X7-99-φZi" (CONT)

NR 9-18-95

```
CONNE
: el nl e2    n2 nsq nd1 nd2 isot d1        d2        areax      betax
:
A     1 B      1 0 0 0  1  1.500E-01  9.500E-03  5.104E+00  0.000E+00 0
A     2 B      2 0 0 0  1  1.500E-01  9.500E-03  2.552E+01  0.000E+00 0
A     3 B      3 0 0 0  1  1.500E-01  9.500E-03  2.552E+01  0.000E+00 0
A    28 B     28 0 0 0  1  1.500E-01  9.500E-03  2.552E+01  0.000E+00 0
A    29 B     29 0 0 0  1  1.500E-01  9.500E-03  3.190E+00  0.000E+00 0
B     1 C      1 0 0 0  1  9.500E-03  5.000E-04  5.104E+00  0.000E+00 0
B     2 C      2 0 0 0  1  9.500E-03  5.000E-04  2.552E+01  0.000E+00 0
B     3 C      3 0 0 0  1  9.500E-03  5.000E-04  2.552E+01  0.000E+00 0
C    19 D     19 0 0 0  1  5.000E-04  5.000E-03  3.222E-01  0.000E+00 0
C    20 D     20 0 0 0  1  5.000E-04  5.000E-03  3.222E-01  0.000E+00 0
C    21 D     21 0 0 0  1  5.000E-04  5.000E-03  3.222E-01  0.000E+00 0
F    23 G     23 0 0 0  1  1.000E+00  8.235E+00  8.294E+00  0.000E+00 0
F    24 G     24 0 0 0  1  1.000E+00  8.235E+00  2.552E+01  0.000E+00 0
F    25 G     25 0 0 0  1  1.000E+00  8.235E+00  2.552E+01  0.000E+00 0
A     1 A      2 0 0 0  1  4.000E+00  2.000E+01  1.914E-01  1.000E+00 0
A     2 A      3 0 0 0  1  2.000E+01  2.000E+01  1.914E-01  1.000E+00 0
A    25 A     26 0 0 0  1  2.000E+01  2.000E+01  1.914E-01  1.000E+00 0
A    26 A     27 0 0 0  1  2.000E+01  2.000E+01  1.914E-01  1.000E+00 0
A    27 A     28 0 0 0  1  2.000E+01  2.000E+01  1.914E-01  1.000E+00 0
C    16 C     17 0 0 0  1  2.525E-01  2.525E-01  6.380E-04  1.000E+00 0
C    17 C     18 0 0 0  1  2.525E-01  2.525E-01  6.380E-04  1.000E+00 0
C    18 C     19 0 0 0  1  2.525E-01  2.525E-01  6.380E-04  1.000E+00 0
G    27 G     28 0 0 0  1  2.000E+01  2.000E+01  1.051E+01  1.000E+00 0
G    28 G     29 0 0 0  1  2.000E+01  2.500E+00  1.051E+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  12 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
  1.60E+01 1.17E+01 9.64E+00 6.96E+00
  5.28E+00 3.46E+00 2.02E+00 1.08E-00
  7.06E-01 1.76E-01 8.88E-03
B  12 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
  1.01E-00 7.40E-01 6.10E-01 4.40E-01
  3.34E-01 2.20E-01 1.28E-01 6.86E-02
  4.46E-02 1.11E-02 6.06E-04
                                        :reqd blank line
```

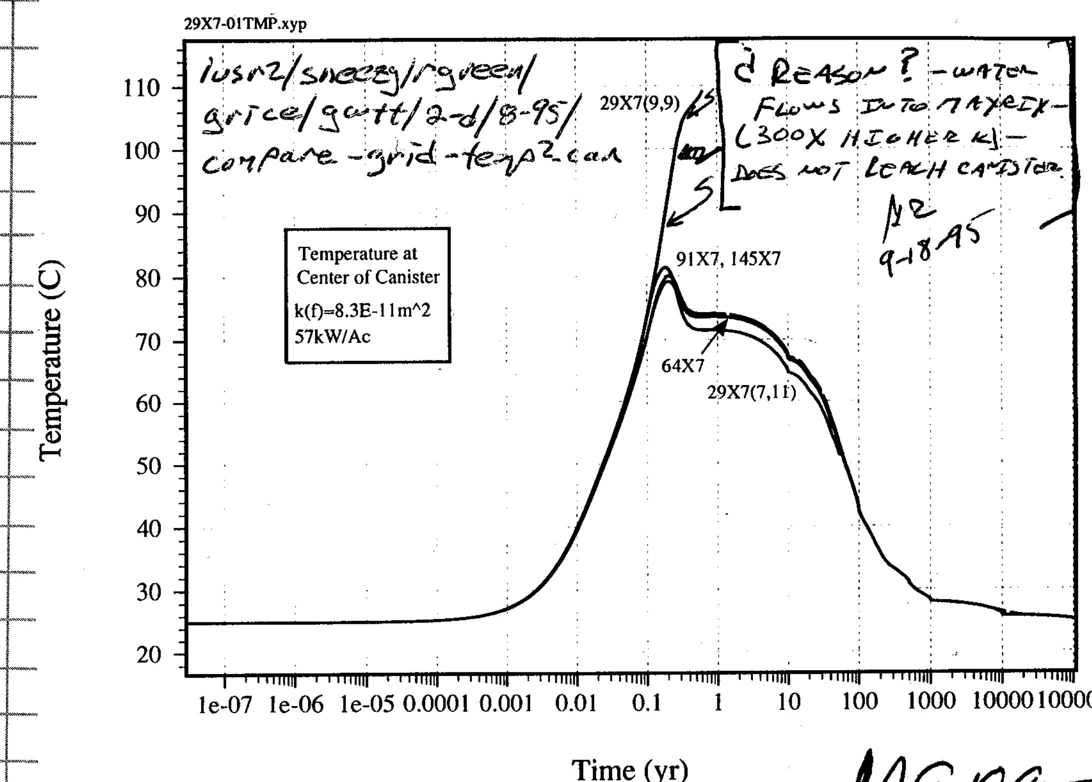
NR 9-18-95

```
 :
 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
          1.000000E+05        3.000000E-01          2.500000E+01
 C     1  0  0      0.000000E+00
          1.000000E+05        1.000000E-09          2.500000E+01
 D     1  0  0      0.000000E+00
          1.000000E+05        3.000000E-01          2.500000E+01
 E     1  0  0      0.000000E+00
          1.000000E+05        3.000000E-01          2.500000E+01
 F     1  0  0      0.000000E+00
          1.000000E+05        3.000000E-01          2.500000E+01
 G     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
 B     2  0  0      0.000000E+00
```

9-18-95
NR

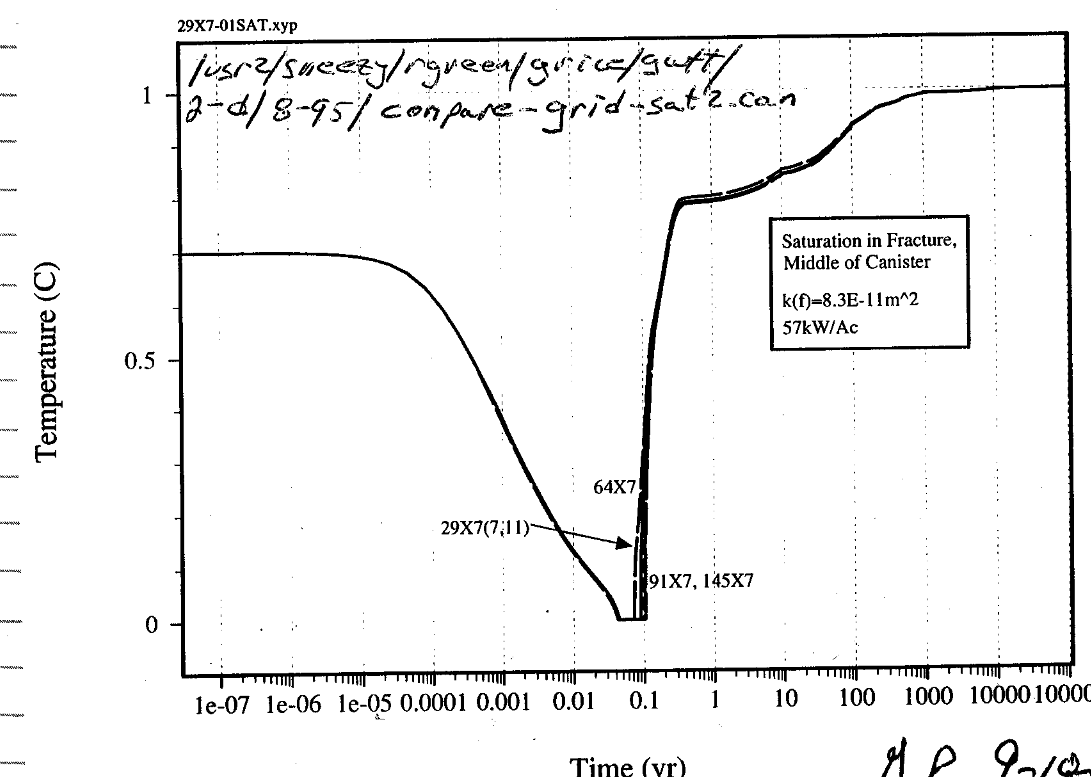
Effect of Gridding on Temperature

NR 9-18-95



NR 9-18-95

Effect of Gridding on Water Saturation



NR 9-18-95

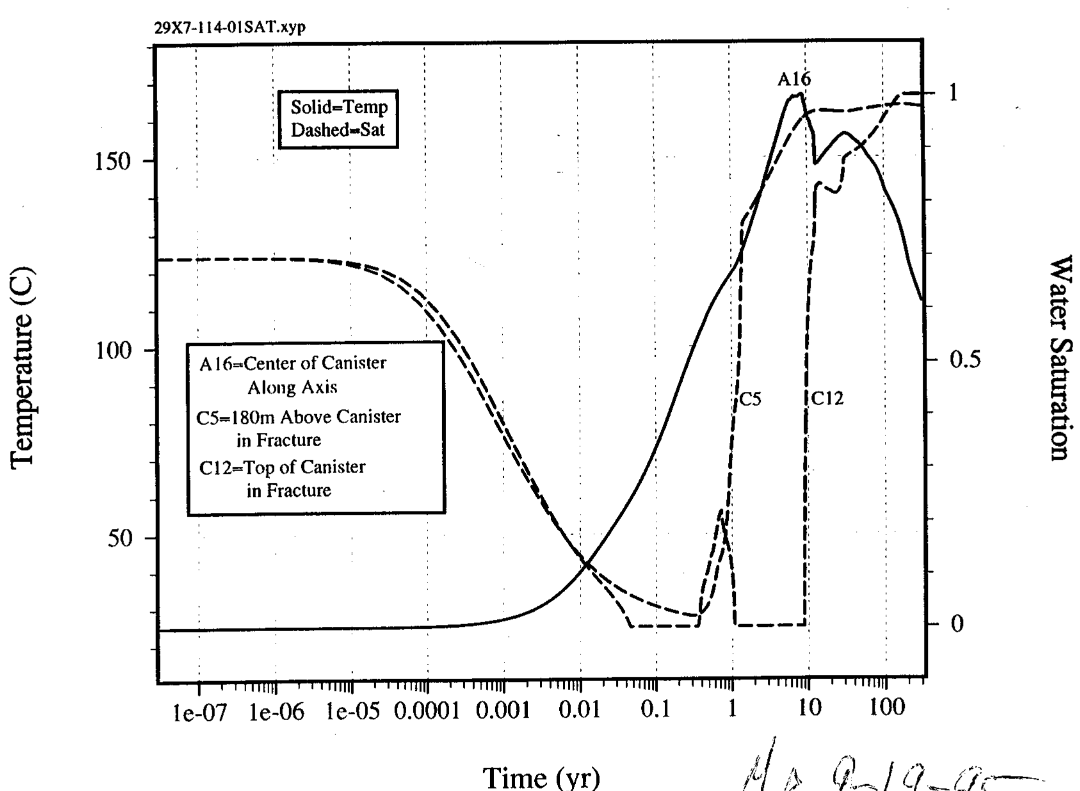
9-19-95
MR

• YESTERDAY CREATED + RAN "29X7-114-φ1i"
K OF FRACTURE = 8.3X10^{-12} M^2 -
RAN TO 9999 TIMESTEPS + QUIT -
TIME = 299 YRS, Δt = 4.35X10^{-3} YRS.
CALCULATION TIME = 20784 s

• NEW RUN = "29X7-114-φ2i" -
IDENTICAL TO "29X7-114-φ1i"
EXCEPT K of FRACTURE = 8.3X10^{-13} M^2
INSTEAD OF 8.3X10^{-12} M^2

~~MR 9-19-95~~

29X7-114-01, 114kW/Ac, 578m, k(f)=8.3E-12m^2



MR 9-19-95

MR 9-19-95

9-19-95
MR

• NEW CTOUGH RUN: "29X7-114-φ3i" - IDENTICAL TO "29X7-114-φ1i" EXCEPT PERMEABILITY OF FRACTURE = 8.3X10^{-14} M^2 INSTEAD OF 8.3X10^{-12} M^2

9-20-95
MR

• RUN "29X7-114-φ2i" WENT TO 9999 TIMESTEPS,
TIME = 279 YRS, Δt = 1.48X10^{-3} YRS

• STARTED ~~"297~~ MR 9-20-95 "29X7-114-φ3i"

• NEW SINGLE PHASE RUN = "64X7-99-dry1i" -
IDENTICAL TO ~~"64X7-99-d~~ MR 9-20-95
"64X7-dry1i" EXCEPT USES EQUIVALENT
CONTINUUM MODEL FOR ROCK MATRIX (9, 9)
AND THE FOLLOWING PROPERTIES (FROM NITAO,
1988, pgs 13-15)

BULK PERMEABILITY:

$K_b = K_f \phi_f + K_m(1-\phi_f)$

$= 1\times10^{-11} m^2 \; 1.8\times10^{-3} + 1.9\times10^{-18} m^2 (1-1.8\times10^{-3})$

$= 1.8\times10^{-14} m^2 + \sim 1.9\times10^{-18} m^2 = 1.8\times10^{-14} m^2$

BULK POROSITY:

$\phi_b = \phi_f + (1-\phi_f)\phi_m = 1.8\times10^{-3} + (1-1.8\times10^{-3})\, 0.11$

$\simeq 0.11$

9-20-95
AR

FROM NITAO 1988, pg 15
FOR FRACTURES, VAN GENUCHTEN PARAMETERS:

$\alpha_f = \frac{1.2851}{m}$

$10^5 Pa = 10^5 \frac{kg\text{-}m}{s^2 m^2} \frac{m^3}{10^3 kg} \frac{1 s^2}{9.8 m} = 10.2 m$ ∴

1 ATM ≃ 10^5 pa ≃ 10.2 m WATER

MORE ACCURATELY:

1 ATM = 1.013×10^5 Pa ⟶ 10.34 m WATER / ATM

$10.34 m \frac{100 cm}{m} \frac{in}{2.54 cm} \frac{FT}{12''} = 33.91$ FT WATER

$\alpha_f = \frac{1.2851}{m} \frac{10.34 m}{1.013 \times 10^5 Pa} = \frac{1.312 \times 10^{-4}}{Pa}$

β_f = ? $\lambda = 1 - \frac{1}{n} = 1 - \frac{1}{\beta}$,

$\beta_f = 4.23$, $\lambda = 1 - \frac{1}{4.23} = 0.764$

FOR MATRIX:

$\alpha_m = 5.67 \times 10^{-3}/m \ \frac{10.34 m}{1.013 \times 10^5 Pa} = 5.788 \times 10^{-7}/Pa$

$\beta_m = 1.798$, $\lambda = 1 - \frac{1}{1.798} = 0.444$

9-20-95
AR

• KILLED "29x7-114-ϕ3i" AFTER ≃ 2000 TIMESTEPS, T ≃ 30 YRS, Δt ≃ 1×10^{-2} YR

– STARTED "64x7-99-dry 2i"

– CREATED "64x7-99-dry2i" – IDENTICAL TO "64x7-99-dy2i" EXCEPT HEAT LOAD = 114 KW/AC.

9-21-95
AR

• NEW "99" RUN: "64x7-99-ϕ2i" – IDENTICAL TO "64x7-ϕ2i" (see pg 68) EXCEPT EQUIVALENT CONTINUUM MODEL USED – SEE ROCK MATRIX PROPERTIES ON pg 76.

AR 9-21-95

BULK PERMEABILITY FOR "64x7-99-ϕ2i":

$K_b = K_f \phi_f + k_m(1-\phi_f)$

$= 8.3 \times 10^{-11} m^2 (1.8 \times 10^{-3}) + 5 \times 10^{-17} m^2 (1 - 1.8 \times 10^{-3})$

$K_b = 1.49 \times 10^{-13} m^2$

9-22-95
AR

RUN "64x7-99-ϕ2i" STOPPED @ TIMESTEP 668, TIME = 1.24 yrs, Δt = 6.95×10^{-3} YR W/MESSAGE:

"WARNING: NO CONVERGENCE IN SUBROUTINE AP"
"NOTE: IEEE NaNs WERE WRITTEN TO ASCII STRINGS OR OUTPUT FILES"

• NEW RUN: "64x7-99-ϕ2i" – IDENTICAL TO "64x7-99-ϕ2i" EXCEPT FRACTURE PERMEABILITY = $8.3 \times 10^{-12} m^2$ & $K_b = 1.5 \times 10^{-14} m^2$

9-22-95 MR

• NOW EQUIV. CONTIN (9,9) RUN:

"64X7-99a-φli" – IDENTICAL TO "64X7-99-φli" EXCEPT MATRIX & FRACTURE PERMEABILITIES & POROSITIES FOUND IN NITAO (1988, pg 5) USED FOR EQUIV. CONTIN.:

$$\phi_s = \phi_f + (1-\phi_f)\phi_m = 1.8\times10^{-3} + (1-1.8\times10^{-3})\,0.11$$

$$= 0.112$$

$$k_s = k_f\phi_f + (1-\phi_f)k_m = 1.0\times10^{-11}m^2(1.8\times10^{-3})$$

$$+ (1-1.8\times10^{-3})\,1.9\times10^{-18}m^2$$

$$= 1.8\times10^{-14}m^2$$

9-26-95 MR

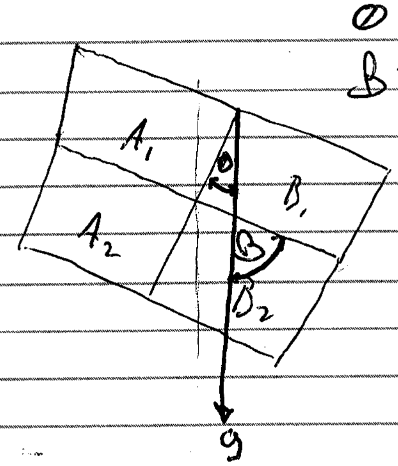
NEW RUN:

"64X7-30φ-φli" – IDENTICAL TO "64X7-φli" EXCEPT SYSTEM TILTED 30°

IN CONNE BLOCK:

$\theta = 30°$, $\cos\theta = 0.866$ = BETAX ($A1 \to B1$)

$\beta = 60°$, $\cos\beta = 0.500$ = BETAX ($A1 \to A2$)



9-29-95 MR

CALCULATING HEAT INPUT FOR 'GENER' ELEMENTS IN NEW TYPE OF SIMULATION:

"2heat-20X9-φli" – TWO HEATERS – UNEQUAL POWER.

VOLUME OF GENER ELEMENT:

~~A9 + A10 = 1.0176 m³~~

~~I9 + I10 = 1.0176 m³~~

WRONG MR 9-30-95

VOLUME OF 1/2 CANISTER:

~~(0.638 m) 0.638 m (5.05 m) = 2.056 m³~~ 3 MR 9-29-95

– OR – WRONG MR 9-29-95

$$(0.319)(0.638)(5.05) = 1.028\,m^3$$

VOLUME OF ELEMENT A11 = $5.0931\times10^{-1}m^3$

" " " A12 = $5.1847\times10^{-1}m^3$

$1.02778\,m^3$

VOLUME OF ELEMENT I11 = $5.0931\times10^{-1}m^3$

" " " I12 = $5.1847\times10^{-1}m^3$

USING TABLE ON pg 48, ELEMENTS A11 + I11 INITIALLY (@t=0) GENERATE $1654\frac{W}{m^3}\;5.0931\times10^{-1}m^3 = 842\,W/m^3$

ELEMENTS A12 + I12 INITIALLY GENERATE: $1654\frac{W}{m^3}\;5.1847\times10^{-1}m^3$

$= 858\,W/m^3$ HOWEVER →

9-29-95
MR

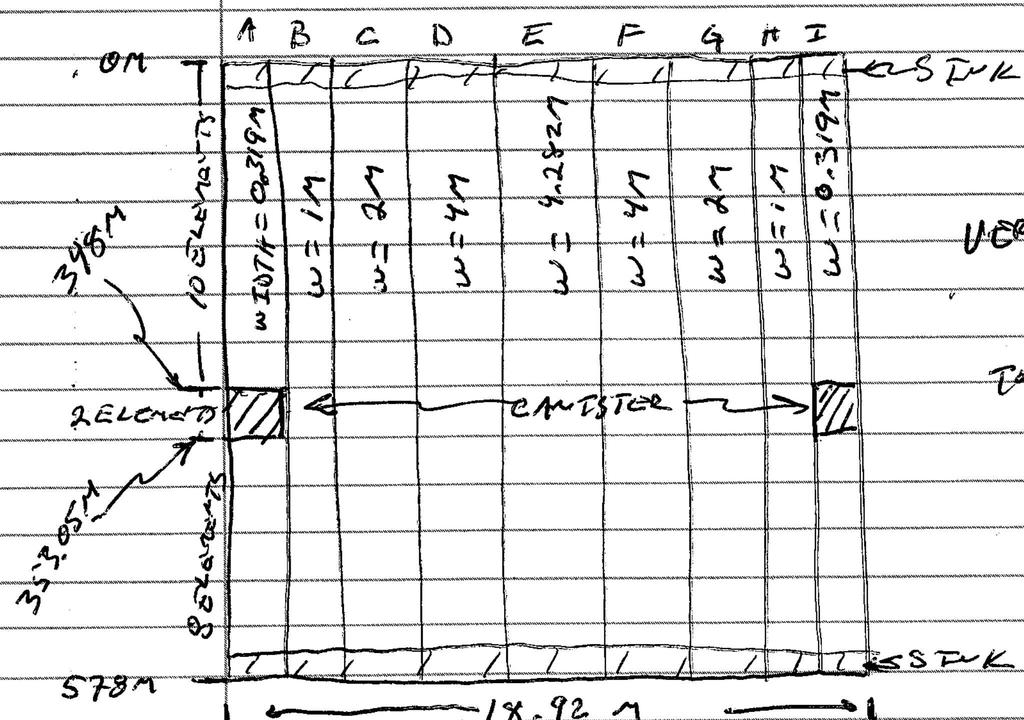
MR 9-29-95

- HEATER IN COLUMN I IS ONLY ~~90%~~ 50% AS STRONG AS HEATER IN COLUMN A. THUS, INITIAL POWER GENERATION = :

$$I11 = 0.50931\,m^3 \left(\frac{1654\,w/m^3}{2}\right) = 422\,w$$

$$I12 = 0.51847\,m^3 \left(\frac{1654\,w/m^3}{2}\right) = 429\,w$$

NEW GRID FOR 2 HEATER SIMULATIONS:
"2heat-20x9-φ1i"



(SIDES)
VERTICAL BOUNDARIES = NO FLOW

TOP + BOTTOM BOUNDARIES = SINKS (HUGE ELEMENTS)

NOTE, THIS CONFIGURATION IS EQUIVALENT TO 114 KW/AC MR 9-29-95

MR 9-29-95

9-29-95
MR

INPUT "2heat-20x9-φ1i" MR 9-29-95

```
GWTT,9/29/95, No Fracture, Two Heaters
:grid=20X9, 57kW/Ac
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 1.000E-01 5.000E-17 5.000E-17 5.000E-17 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
matr2  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  9999   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
   8    8  3.1700E+00  2.0000E+00
:
:  tis(1)     tis(2)    tis(3) ......
 1.000E-03 1.000E-01 1.000E-00 1.000E+01 1.000E+02 5.000E+02 1.000E+03 1.000E+04
```

MR 9-29-95

```
      :
      EVAP
       A    9
       B    9
       C    9
       D    9
       E    9
       F    9
       G    9
       H    9
       I    9
       A   11
       B   11
       C   11
       D   11
       E   11
       F   11
       G   11
       H   11
       I   11
```

MR 9-29-95

9-29-95
AR

"2heat-20X9-Ø1i" (CONT) AR 9-29-95

```
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  matr1  1.6282E+10
A    2  0  0  matr1  8.1409E+00
A   10  0  0  matr1  1.0176E+00
A   11  0  0  matr2  5.0931E-01
A   12  0  0  matr2  5.1847E-01
A   13  0  0  matr1  1.0074E+00
A   19  0  0  matr1  4.0704E+00
A   20  0  0  matr1  2.0352E+10
B    1  0  0  matr1  5.1040E+10
C    1  0  0  matr1  1.0208E+11
D    4  0  0  matr1  2.0416E+02
E    7  0  0  matr1  5.4638E+01
F   10  0  0  matr1  1.2760E+01
G   13  0  0  matr1  6.3162E+00
H   16  0  0  matr1  2.5520E+01
I   10  0  0  matr1  1.0176E+00
I   11  0  0  matr2  5.0931E-01
I   12  0  0  matr2  5.1847E-01
I   13  0  0  matr1  1.0074E+00
I   19  0  0  matr1  4.0704E+00
I   20  0  0  matr1  2.0352E+10
```

AR 9-29-95

```
CONNE
: el nl e2    n2 nsq nd1 nd2 isot d1          d2          areax       betax
:
A     1 B     1 0 0 0  1  1.595E-01  5.000E-01  5.104E+00  0.000E+00 0
A     2 B     2 0 0 0  1  1.595E-01  5.000E-01  2.552E+01  0.000E+00 0
A     3 B     3 0 0 0  1  1.595E-01  5.000E-01  3.828E+01  0.000E+00 0
B     6 C     6 0 0 0  1  5.000E-01  1.000E+00  2.552E+01  0.000E+00 0
C     9 D     9 0 0 0  1  1.000E+00  2.000E+00  3.190E+00  0.000E+00 0
D    12 E    12 0 0 0  1  2.000E+00  2.141E+00  1.625E+00  0.000E+00 0
E    15 F    15 0 0 0  1  2.141E+00  2.000E+00  1.276E+01  0.000E+00 0
F    18 G    18 0 0 0  1  2.000E+00  1.000E+00  3.828E+01  0.000E+00 0
H     1 I     1 0 0 0  1  5.000E-01  1.595E-01  5.104E+00  0.000E+00 0
A     4 A     5 0 0 0  1  4.000E+01  4.000E+01  2.035E-01  1.000E+00 0
B     8 B     9 0 0 0  1  5.000E+00  2.500E+00  6.380E-01  1.000E+00 0
C    12 C    13 0 0 0  1  1.274E+00  2.475E+00  1.276E+00  1.000E+00 0
D    16 D    17 0 0 0  1  2.000E+01  3.000E+01  2.552E+00  1.000E+00 0
F     1 F     2 0 0 0  1  4.000E+00  2.000E+01  2.552E+00  1.000E+00 0
G     5 G     6 0 0 0  1  4.000E+01  2.000E+01  1.276E+00  1.000E+00 0
H     9 H    10 0 0 0  1  2.500E+00  2.500E+00  6.380E-01  1.000E+00 0
H    10 H    11 0 0 0  1  2.500E+00  1.251E+00  6.380E-01  1.000E+00 0
I    14 I    15 0 0 0  1  5.000E+00  1.000E+01  2.035E-01  1.000E+00 0
I    19 I    20 0 0 0  1  1.000E+01  5.000E+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  11 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
  8.42E+02 6.16E+02 5.08E+02 3.67E+02
  2.79E+02 1.83E+02 1.06E+02 5.70E+01
  3.72E+01 9.27E-00 4.68E-01
A  12 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
  8.56E+02 6.27E+02 5.17E+02 3.73E+02
  2.84E+02 1.86E+02 1.08E+02 5.81E+01
  3.78E+01 9.44E-00 4.76E-01
```

ERROR - SEE PAGES 90 & 91

AR 9-25-95

9-29-95
AR

"2heat-20X9-Ø1i" INPUT (CONCL) AR 9-29-95

```
I  11 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
  4.21E+02 3.08E+02 2.54E+02 1.83E+02
  1.39E+02 9.14E+01 5.32E+01 2.85E+01
  1.86E+01 4.63E-00 2.34E-01
I  12 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
  4.29E+02 3.14E+02 2.59E+02 1.87E+02
  1.42E+02 9.31E+01 5.42E+01 2.90E+01
  1.89E+01 4.72E-00 2.38E-01
                                   :reqd blank line
:
INCON
:
```

SEE pg 90 + 91

AR 9-29-95

```
 : 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
          1.000000E+05          3.000000E-01                2.500000E+01
 C     1  0  0       0.000000E+00
          1.000000E+05          3.000000E-01                2.500000E+01
 D     1  0  0       0.000000E+00
          1.000000E+05          3.000000E-01                2.500000E+01
 G    20  0  0       0.000000E+00
          1.000000E+05          3.000000E-01                2.500000E+01
 H    20  0  0       0.000000E+00
          1.000000E+05          3.000000E-01                2.500000E+01
 I    20  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   20     9
 :
 ENDCY
```

AR 9-29-95

- "2heat-20X9-Ø1i" WENT THROUGH 9999 TIMESTEPS IN CALCULATION TIME OF 9359s, $t = 3.57 \times 10^{-2}$ yr, $\Delta t = 22 \times 10^{-6}$ yr

- NEW 2 HEATER RUN: "2heat-20X9-99-Ø1i" - IDENTICAL TO "2heat-20X9-Ø1i" EXCEPT USES EQUIVALENT CONTINUUM MODEL (9,9). VALUES FROM NITAO, SEE BELOW, pgs 81&82.

10-2-95
AR

- "2heat-20X9-99-Ø1i" COMPLETED 9999 TIMESTEPS, CALCULATION TIME = 9109s, $t = 3.23 \times 10^{-2}$ yr, $\Delta t = 4.8 \times 10^{-6}$ yr - RE-STARTED USING newtough-99999

10-2-95 AR

- ERROR IN HEAT LOAD FOR "2heat*.-*" — FORGOT TO ADJUST FOR FACT THAT MODELED AREA IS SMALLER THAN 1ACRE:

→ MODELED AREA = 0.638 M X 18.92 M = 12.07 M^2

$\boxed{\text{SEE ALSO pg 55}}$

→ SINGLE (LEFT) CANISTER HEAT-INPUT:
(SEE pg 86)

$$\frac{1.7\ KW}{12.07\ M^2} \frac{M^2}{10.76\ FT^2} \frac{43560\ FT^2}{AC}$$

$$= \frac{570\ KW}{AC}$$

~~TO MAKE~~ AR 10-2-95

THEN - THE OTHER (RIGHT) CANISTER PRODUCES 285 KW/AC

THUS - TO PRODUCE 114 KW/AC:

$X\,570 + y\,285 = 114, \quad X = 2y$

$y = X/2$

$X(570 + 285/2) = 114, \quad X = 0.16, \; y = 0.08$

SO - TO GET 114 KW/A MULTIPLY 'GENER' VALUES IN 'A' COLUMN BY 0.16 + 'I' COLUMN BY 0.08.

AR 10-2-95
SEE NEXT PAGE

10-2-95 AR

- I WANT TO MAINTAIN POWER OUTPUT OF LEFT CANISTER AT TWICE THAT OF RIGHT CANISTER - THEREFORE MUST USE FOLLOWING EQUATION:

$X\,570 + y\,285 = 114$

$X = y, \quad X(570 + 285) = 114$

$X = 0.1333 = y:$

$0.1333(570) + 0.1333(285) = 114$

AR 10-2-95

```
GENER----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
: el ne sl ns nsq nad nads ltb  itp   itb   gx         ex        hg
:
A  11 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
   1.12E+02 8.21E+01 6.77E+01 4.89E+01
   3.72E+01 2.44E+01 1.41E+01 7.60E+00
   4.96E+00 1.24E-00 6.24E-02
A  12 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
   1.14E+02 8.36E+01 6.89E+01 4.97E+01
   3.79E+01 2.48E+01 1.44E+01 7.75E+00
   5.04E+00 1.26E-00 6.35E-02
I  11 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
   5.61E+01 4.11E+01 3.39E+01 2.44E+01
   1.85E+01 1.22E+01 7.09E+00 3.80E+00
   2.48E+00 6.17E-01 3.12E-02
I  12 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
   5.72E+01 4.19E+01 3.45E+01 2.49E+01
   1.89E+01 1.24E+01 7.23E+00 3.87E+00
   2.52E+00 6.29E-01 3.17E-02
                                              :reqd blank line
:
INCON
:
```

CORRECTED HEAT INPUT - "2heat*.-*"

114 KW/AC

AR 10-2-95

- RE-RUNNING "2heat-20X9-99-ø1i" WITH CORRECTED HEAT INPUT (ABOVE)

10-3-95 AR

- "2heat-20x9-99-ø1i" DONE IN 4057 TIMESTEPS, 10^5 YR, CALCULATION TIME = 4830 s.

10-3-95 MR • NEW RUN: "2heat-35X9-99-φ1i" — IDENTICAL TO "2heat-20X9-99-φ1i" EXCEPT IS 35 ELEMENTS HIGH INSTEAD OF 20. THICKEST ELEMENT = 20M.

10-5-95 MR "2heat-35X9-99-φ1i" DONE RUNNING - 10^5 YR, CALCULATION TIME = 20,570 s.

NEW GRID: "2heat-49X9-99-φ1i" - SAME AS OTHER "2heat..." BUT IS 49 ELEMENTS TALL AND HAS FIVE ELEMENTS IN EACH HEATER INSTEAD OF TWO.

• VOLUME OF EACH "...49X9..." HEATER ELEMENT = $2.0556 \times 10^{-1}\ M^3$

THUS, HEAT (POWER) INPUT SCHEDULE (see pg 48):

TIME (YR)	W/M^3	$W \left(= W/M^3 \, (2.0556 \times 10^{-1} M^3)\right)$
0	1654	340
10	1210	249
20	998	205
40	720	148
60	547	112
100	359	73.8
200	209	43.0
600	112	23.0
1000	73.0	15.0
10,000	18.2	3.74
100,000	0.919	0.189

THEN, THE POWER INPUT MUST BE ADJUSTED TO ACCOUNT FOR FACT THAT PLAN-VIEW AREA OF SIMULATION IS LESS THAN 1 ACRE — WANT ~~INITIAL POWER~~ INPUT TO = 114 KW/AC — SEE PGS 90+91

10-5-95 MR • GIVEN THE ABOVE, EACH POWER INPUT MUST BE MULTIPLIED BY 0.1333 ~~SEE pg 9~~ MR 10-5-95

~~TIME~~ MR 10-5-95

FOR 'A' ELEMENTS & 0.1333/2 FOR 'I' ELEMENTS

INITIAL POWER OUTPUT

A 26 → 30 = 340 W(0.1333) = 45.3 W

I 26 → 30 = 340 W(0.1333/2) = 22.7 W

10-6-95 MR • "2heat-49X9-99-φ1i" DONE IN 4147 TIMESTEPS CALCULATION TIME = 56,160 s, $t = 10^5$ YR

10-7-95 MR - "2heat-56X13-99-φ1i" QUIT AT 667 YRS, TIMESTEP = 3561, Δt = 0.927 YRS - DON'T KNOW WHY.

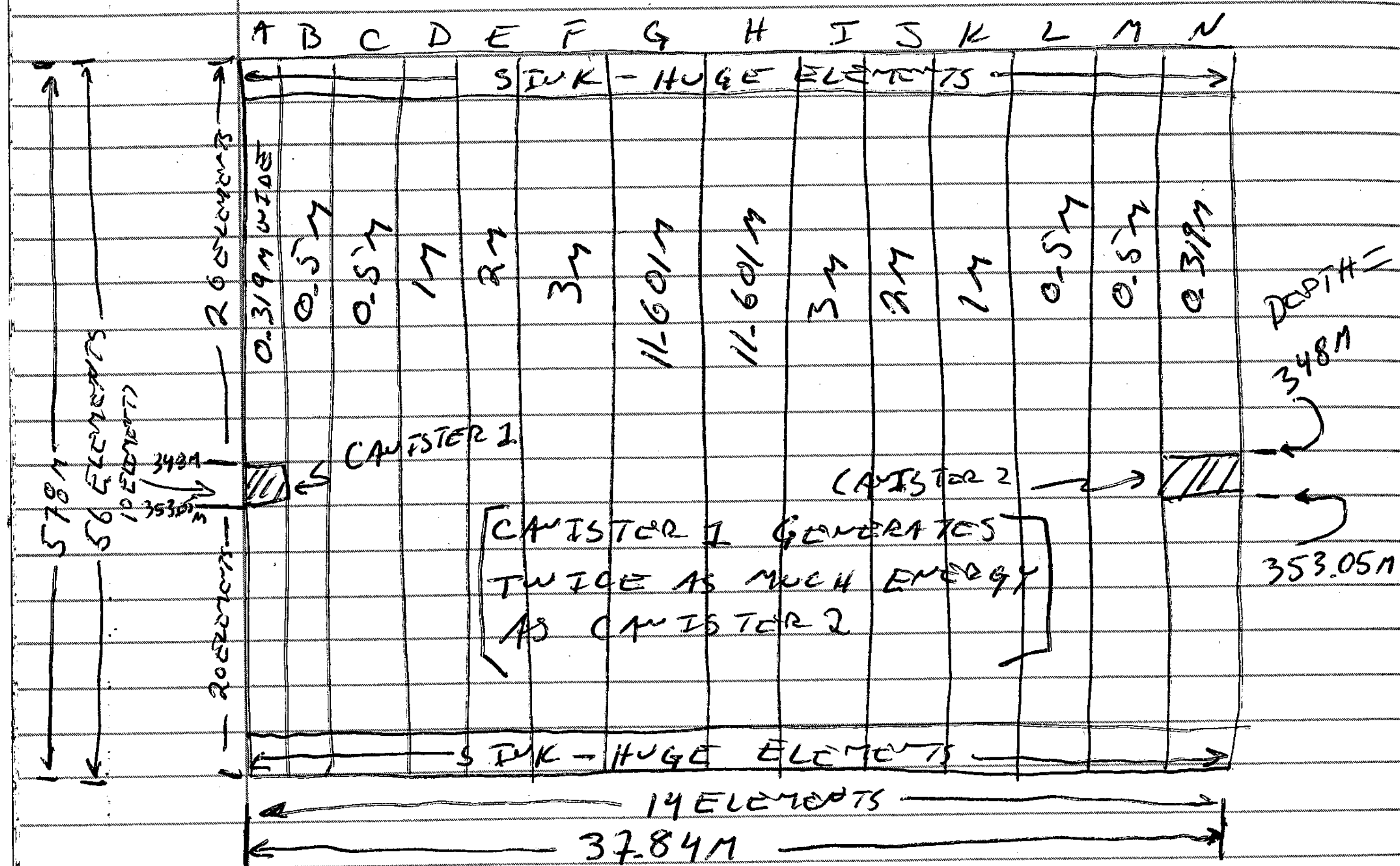
NEW RUN: "2heat-56X14-99-φ1i" - IDENTICAL TO "2heat-56X13-99-φ1i" EXCEPT IS 37.84 M WIDE INSTEAD OF 18.92, i.e., 57 KW/AC INSTEAD OF 114 KW/AC.

10-9-95 MR RUN "2heat-56X14-99-φ1i" DONE - 10^5 YR, 1823 TIMESTEPS, CALCULATION TIME = 64,260 s

BEGIN NEW RUN: "2heat-30X14-99-φ1i" - IDENTICAL TO "2heat-56X14-99-φ1i" EXCEPT FEWER VERTICAL ELEMENTS.

10-9-95 GR

GRID - 56X14 = 57kw/Ac



INPUT - "2heat - 56X14-99-Ø1i"

```
GWTT, 10/7/95, No Fracture, Two Heaters, Equivalent Continuum (9,9
: Using values (for equiv contin) from NITAO, 1988
: Grid=56X14, 37.84m long X 0.638m wide = 57kW/Ac
:
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-18 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
:
: Heater
:
: mat   nad   drock      por       permx      permy      permz      cwet       spht
matr2   2   2.480E+03 1.000E-06 3.330E-99 3.330E-99 3.330E-99 2.340E-00 8.400E+02
```

GR 10-9-95

GR 10-9-95

GR 10-9-95

10-9-95 GR

INPUT - "2heat - 56X14-99-Ø1i" (CONT)

GR 10-9-95

```
:
:    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
    8    8  3.1700E+00  2.0000E+00
.

:  tis(1)     tis(2)     tis(3) ......
 1.000E-03 1.000E-01 1.000E-00 1.000E+01 1.000E+02 5.000E+02 1.000E+03 1.000E+04
:
EVAP
A  27
A  31
A  36
B  31
C  31
D  31
E  31
F  31
G  31
H  31
I  31
J  31
K  31
L  31
M  31
N  31
:
                                              :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+10
A    2  0  0  matr1  4.0704E+00
A   26  0  0  matr1  1.0176E-01
A   27  0  0  matr2  1.0278E-01
A   36  0  0  matr2  1.0277E-01
A   37  0  0  matr1  1.0176E-01
```

GR 10-9-95

GR 10-9-95

10-9-95
AR

INPUT - "2heat-56X14-99-φ1i" (CONT.)

AR 10-9-95

```
A   55  0  0  matr1  2.0352E+00
A   56  0  0  matr1  1.0176E+10
B    1  0  0  matr1  2.5520E+10
B    2  0  0  matr1  6.3800E+00
C    3  0  0  matr1  6.3800E+00
C   56  0  0  matr1  1.5950E+10
D    3  0  0  matr1  1.2760E+01
E    4  0  0  matr1  2.5520E+01
F    5  0  0  matr1  3.8280E+01
G    6  0  0  matr1  1.4803E+02
H    7  0  0  matr1  1.4803E+02
I    8  0  0  matr1  3.8280E+01
J    9  0  0  matr1  2.5520E+01
K   10  0  0  matr1  1.2760E+01
```

AR 10-9-95

```
 N   26  0  0  matr1  1.0176E-01
 N   27  0  0  matr2  1.0278E-01
 N   36  0  0  matr2  1.0277E-01
 N   37  0  0  matr1  1.0176E-01
 N   54  0  0  matr1  4.0704E+00
 N   55  0  0  matr1  2.0352E+00
 N   56  0  0  matr1  1.0176E+10
                  :reqd blank line
 :
 CONNE
 : 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  1.276E+01  0.000E+00 0
 B      4 C     4 0 0 0  1  2.500E-01  2.500E-01  1.276E+01  0.000E+00 0
 B      5 C     5 0 0 0  1  2.500E-01  2.500E-01  1.276E+01  0.000E+00 0
 L      6 M     6 0 0 0  1  2.500E-01  2.500E-01  1.276E+01  0.000E+00 0
 M      7 N     7 0 0 0  1  2.500E-01  1.595E-01  1.276E+01  0.000E+00 0
 M     56 N    56 0 0 0  1  2.500E-01  1.595E-01  3.190E+00  0.000E+00 0
 A      1 A     2 0 0 0  1  4.000E+00  1.000E+01  2.035E-01  1.000E+00 0
 A      2 A     3 0 0 0  1  1.000E+01  1.000E+01  2.035E-01  1.000E+00 0
 B      4 B     5 0 0 0  1  1.000E+01  1.000E+01  3.190E-01  1.000E+00 0
 C      6 C     7 0 0 0  1  1.000E+01  1.000E+01  3.190E-01  1.000E+00 0
 D      8 D     9 0 0 0  1  1.000E+01  1.000E+01  6.380E-01  1.000E+00 0
 M     18 M    19 0 0 0  1  5.000E+00  5.000E+00  3.190E-01  1.000E+00 0
 N     51 N    52 0 0 0  1  1.000E+01  1.000E+01  2.035E-01  1.000E+00 0
 N     53 N    54 0 0 0  1  1.000E+01  1.000E+01  2.035E-01  1.000E+00 0
 N     55 N    56 0 0 0  1  5.000E+00  2.500E+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  27 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
 N  36 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
   1.14E+01 8.30E+00 6.80E+00 4.92E+00
   3.72E+00 2.46E+00 1.43E+00 7.70E-01
   5.00E-01 1.25E-01 6.30E-03
                                         :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
       1.000000E+05         3.000000E-01         2.500000E+01
```

AR 10-9-95

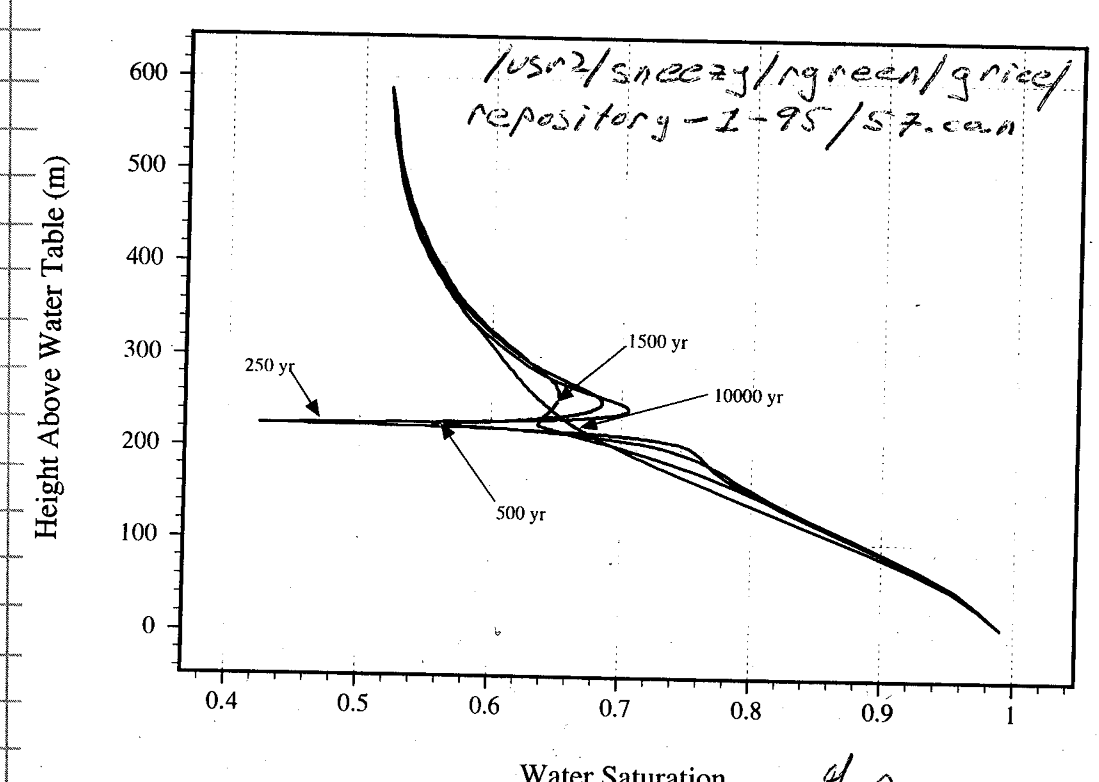
10-11-95
AR

- RUN "2heat-56X14-99-φ1i" DONE IN 1823 TIMESTEPS, t = 10^5 YR, CALCULATION TIME = 64,095 s.

- BEGIN "2heat-30X14-99-φ1i" - IDENTICAL TO "2heat-56X14-99-φ1i" EXCEPT GRID COARSER IN VERTICAL DIRECTION.

NOTE - PROBLEM FOUND + CORRECTED IN MY VERSION OF CTOUGH - IF RUN CONTAINED MORE THAN TEN HORIZONTAL ELEMENTS (X DIRECTION) - HORIZONTAL DISTANCES AFTER THE 10TH ELEMENT MAY BE INCORRECT. RESULTS PRIOR TO 10-10-95 MAY BE AFFECTED.

Saturation vs Time, Repository Scale, 57kW/Ac



AR 10-11-95

AR 10-11-95

10-11-95 AR

• RUN "2heat-30X14-99-φ1i" DONE @ 1846 TIMESTEPS, 10^5 YR, CALCULATION TIME = 10,215 s

• NEW INPUT - "2heat-f-30X15-99-φ1i" - SIMILAR TO "2heat-30X14-99-φ1i" BUT HAS FRACTURE ZONE (10 cm WIDE) NEXT TO RIGHT (COOLER) HEATER. FRACTURE ZONE MATERIAL IS 7-11, NOT 9-9.

~~INPUT = "2heat-f-30X15-99-φ1i"~~

AR 10-11-95

```
GWTT, 10/11/95, Fracture Zone, Two Heaters, Equivalent Continuum
: Using values (for equiv contin) from NITAO, 1988
: 57 kW/Ac, Grid=30X15, 37.84m Wide
:
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-18 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
:
:   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
```

AR 10/11/95

10-11-95 AR

INPUT = "2heat-f-30X15-99-φ1i" (CONT)

AR 10-11-95

```
:
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
    8    8  3.1700E+00  2.0000E+00
:
:  tis(1)     tis(2)    tis(3) ......
 1.000E-03 1.000E-01 1.000E-00 1.000E+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  matr1  1.6282E+10
A    2  0   0  matr1  4.0704E+00
A   14  0   0  matr1  4.0704E-01
A   15  0   0  matr3  2.0556E-01
A   16  0   0  matr3  2.0555E-01
A   17  0   0  matr3  2.0556E-01
A   18  0   0  matr3  2.0556E-01
A   19  0   0  matr3  2.0555E-01
A   20  0   0  matr1  3.9687E-01
A   29  0   0  matr1  3.4599E+00
A   30  0   0  matr1  1.6282E+10
B    1  0   0  matr1  2.5520E+10
B    2  0   0  matr1  6.3800E+00
C    3  0   0  matr1  1.2760E+01
C    4  0   0  matr1  1.2760E+01

I    8  0   0  matr1  7.6560E+01
J    9  0   0  matr1  5.1040E+01
K   10  0   0  matr1  1.2760E+01
L   11  0   0  matr1  3.1900E+00
M   12  0   0  matr1  1.2760E+00
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
N   28  0   0  matr2  2.5520E+00
N   29  0   0  matr2  1.0846E+00
N   30  0   0  matr2  5.1039E+11
O    1  0   0  matr1  1.6282E+10
O    2  0   0  matr1  4.0704E+00
O   14  0   0  matr1  4.0704E-01
O   15  0   0  matr3  2.0556E-01
O   19  0   0  matr3  2.0555E-01
O   20  0   0  matr1  3.9687E-01
O   29  0   0  matr1  3.4599E+00
O   30  0   0  matr1  1.6282E+10
```

SEE GRID pg 103

AR 10-11-95

AR 10-11-95

10-11-95

INPUT: "2heat-f-30X15-99-φ2i" (concl.)

MR 10-11-95

```
                    :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  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
B     3 C     3 0 0 0  1  2.500E-01  2.500E-01  2.552E+01  0.000E+00 0
E     4 F     4 0 0 0  1  1.000E+00  1.500E+00  2.552E+01  0.000E+00 0
I     5 J     5 0 0 0  1  1.500E+00  1.000E+00  2.552E+01  0.000E+00 0
K     6 L     6 0 0 0  1  5.000E-01  2.500E-01  2.552E+01  0.000E+00 0
M     7 N     7 0 0 0  1  2.000E-01  5.000E-02  2.552E+01  0.000E+00 0
N     8 O     8 0 0 0  1  5.000E-02  1.595E-01  2.552E+01  0.000E+00 0
N    30 O    30 0 0 0  1  5.000E-02  1.595E-01  5.104E+00  0.000E+00 0
A     1 A     2 0 0 0  1  4.000E+00  1.000E+01  2.035E-01  1.000E+00 0
F     7 F     8 0 0 0  1  2.000E+01  2.000E+01  1.914E+00  1.000E+00 0
K    13 K    14 0 0 0  1  1.500E+00  1.000E+00  6.380E-01  1.000E+00 0
L    15 L    16 0 0 0  1  5.050E-01  5.050E-01  3.190E-01  1.000E+00 0
N    18 N    19 0 0 0  1  5.050E-01  5.050E-01  6.380E-02  1.000E+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
```

MR 10-11-95

```
  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
         1.000000E+05          3.000000E-01          2.500000E+01
C      1  0  0      0.000000E+00
         1.000000E+05          3.000000E-01          2.500000E+01
D      1  0  0      0.000000E+00
         1.000000E+05          3.000000E-01          2.500000E+01
E      1  0  0      0.000000E+00
         1.000000E+05          3.000000E-01          2.500000E+01
F      1  0  0      0.000000E+00
         1.000000E+05          3.000000E-01          2.500000E+01
G      1  0  0      0.000000E+00
:precond accel  nz   nx   ibug
  BAND   NONE   30   15
:
ENDCY
```

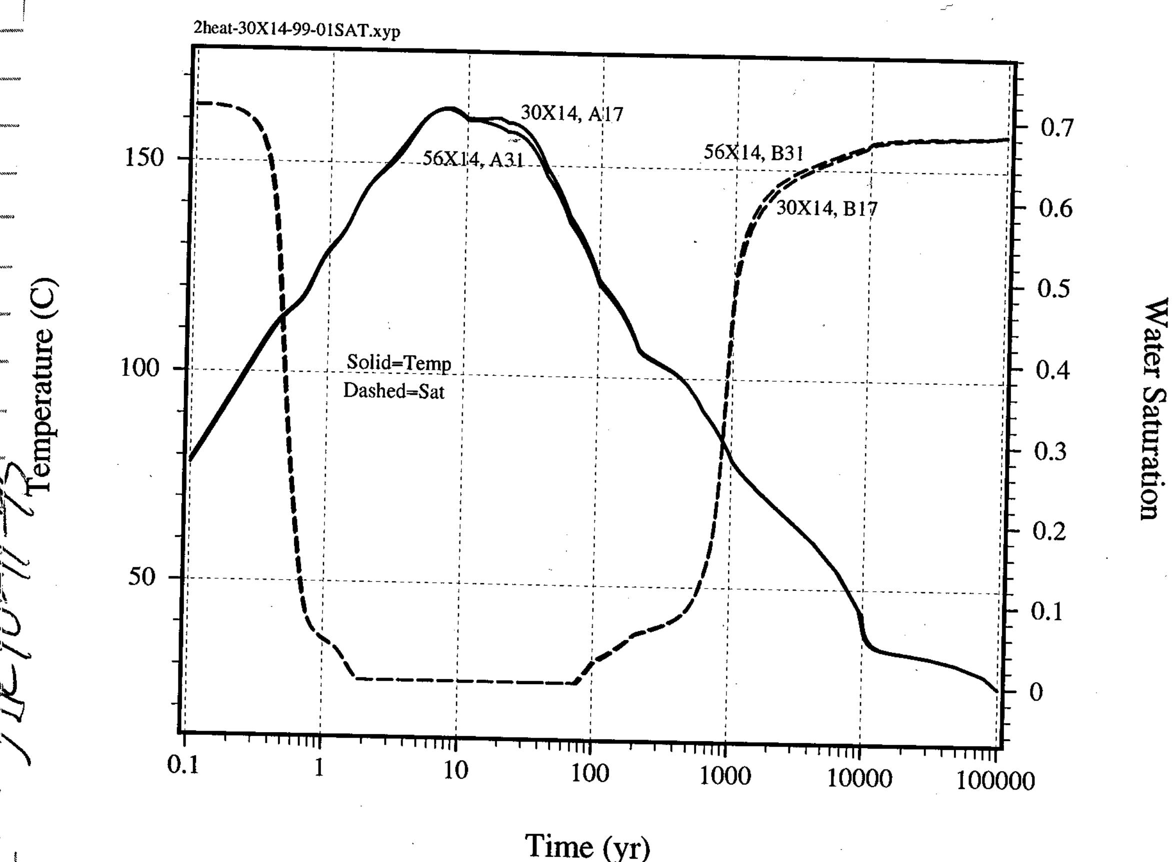
MR 10-11-95

MR 10-11-95

10-11-95 MR

Effect of Gridding on Results, xX14, 57kW/Ac

MR 10-11-95



MR 10-11-95

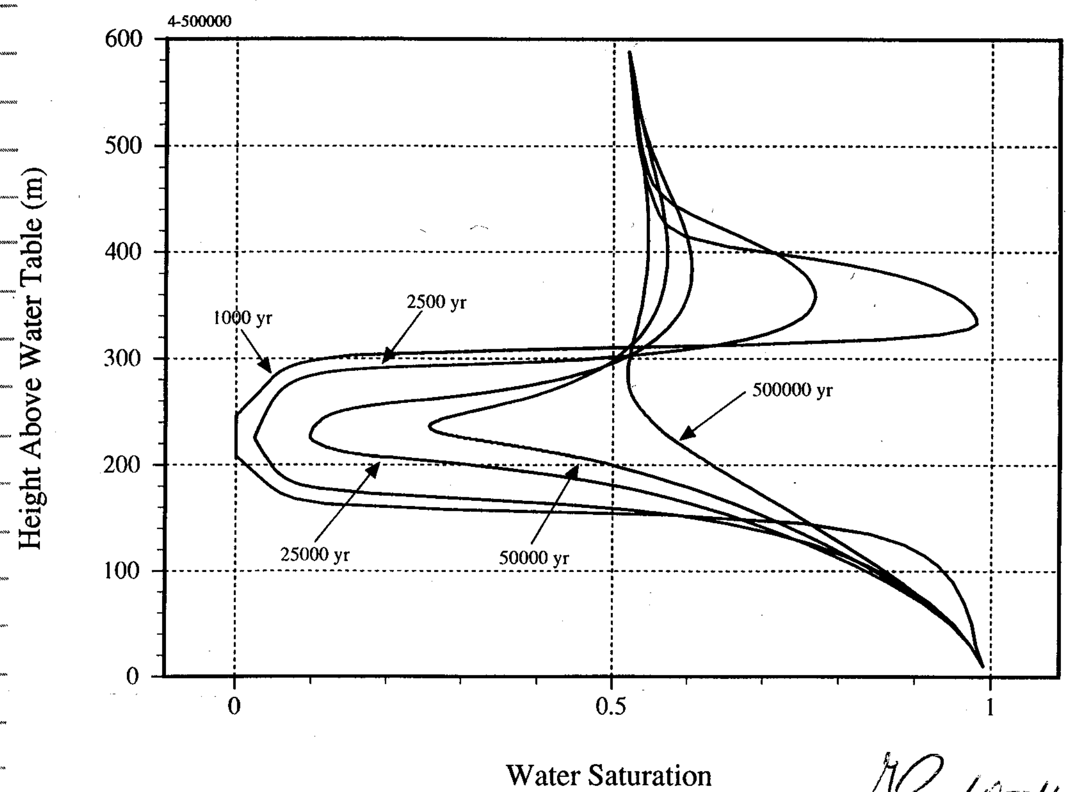
• "2heat-f-30X15-99-φ2i" DONE IN 2069 TIMESTEPS, $t = 10^5$ YR, CALCULATION TIME = 14,981 s

MR 10-11-95

10-11-95
MR

Saturation vs Time, Repository Scale, 114kW/Ac

MR 12-11-95



MR 10-11-95

10-12-95
MR

• NEW RUN: "2heat-f-30X15-99-φ2i" - IDENTICAL TO "2heat-f-30X15-99-φ1i" EXCEPT TOP ROW IS NOT A SINK - IT IS COMPOSED OF NORMAL SIZED CELLS INSTEAD OF HUGE CELLS.

• NEW RUN: "2heat-f-30X15-99-φ3i" - IDENTICAL TO "2heat-f-30X15-99-φ2i" EXCEPT PERMEABILITY OF MATRIX $= 1.9 \times 10^{-15}\ m^2$ INSTEAD OF $1.9 \times 10^{-18}\ m^2$.

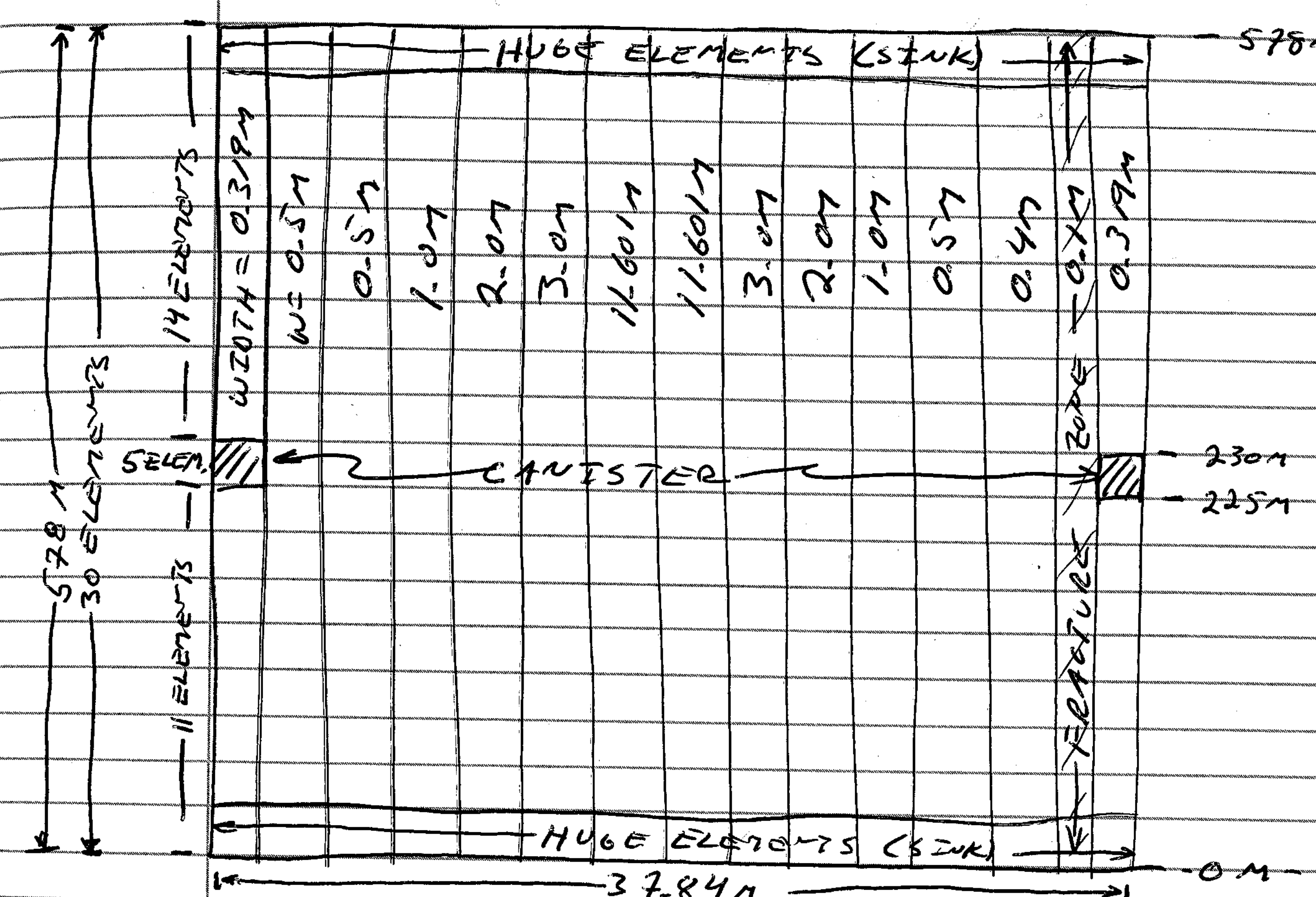
BULK PERMEABILITY OF ROCK MATRIX: (SEE PG 84)

$$k_b = k_F \phi_F + (1-\phi_F) k_m = 1\times10^{-11}\ m^2\ 1.8\times10^{-3} + (1 - 1.8\times10^{-3})\ 1.9\times10^{-15}\ m^2$$

$$= 1.9\times10^{-14}\ m^2.$$

10-12-95
MR

GRID: "2heat-f-30X15-99-φ1i"



10-13-95
MR

RUN: "2heat-f-30X15-99-φ2i" DONE, $t = 10^5$ yr, TIMESTEPS = 2040, CALCULATION TIME = 12,952 s

MR 10-13-95

RUN: "2heat-f-30X15-99-φ3i" DONE, $t = 10^5$ yr, TIMESTEPS = 926, CALCULATION TIME = 6726 s

• NEW RUN: "2heat-f-30X15-99-φ4i" - IDENTICAL TO "2heat-f-30X15-99-φ2i" EXCEPT PERMEABILITY OF ROCK MATRIX = 1.9×10^{-17} INSTEAD OF 1.9×10^{-18}.

MR 10-13-95

BULK PERMEABILITY:

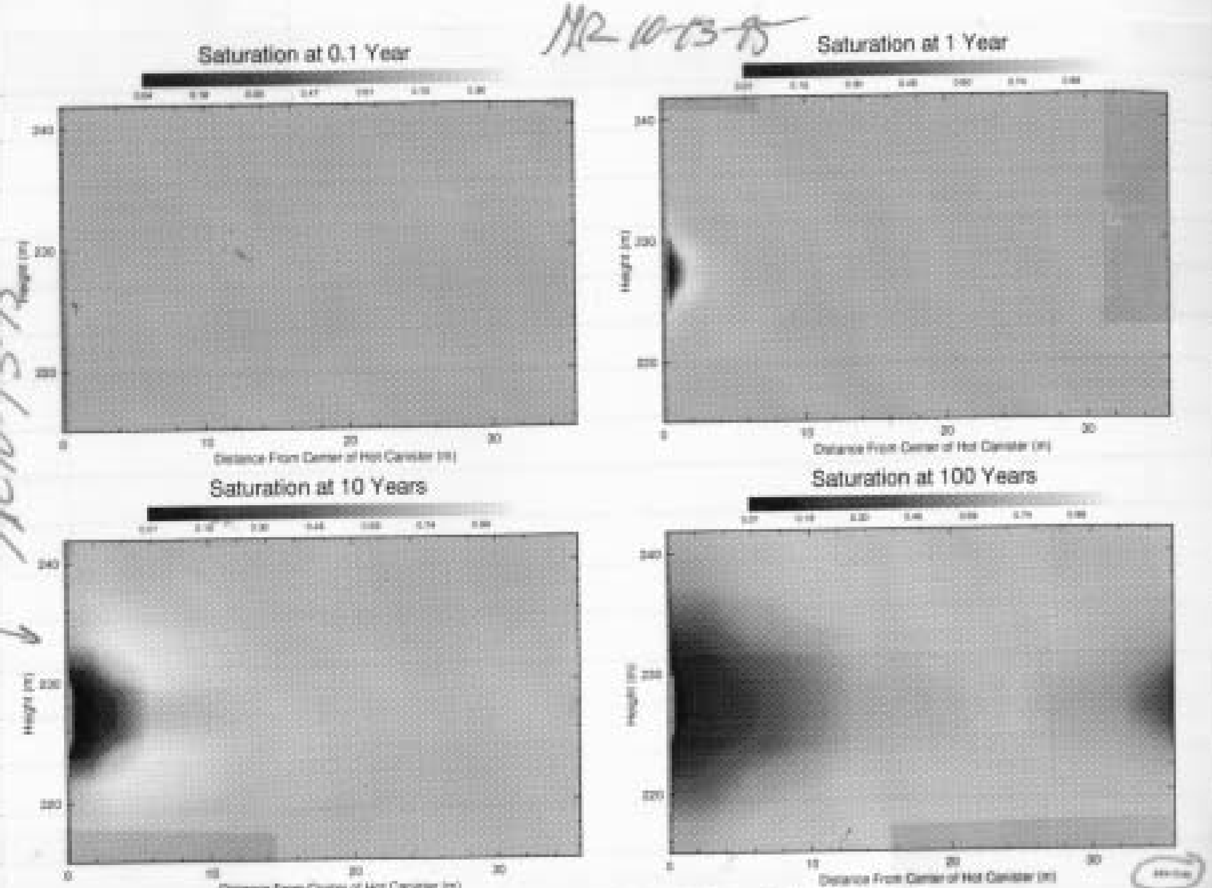
$$K_B = K_F \phi_F + (1-\phi_F) K_m = 1\times10^{-11}\ m^2 (1.8\times10^{-3}) + (1 - 1.8\times10^{-3})\ 1.9\times10^{-17}\ m^2$$

$$= 1.8\times10^{-14}\ m^2$$

10-13-95
AR

FILES LOCATED: /usr2/sneezy/rgreen/grice/~~...~~ 2-D/ RA 10/17/95 /10-95
/4x4-2.1a; /4x4-3.1a
AR 10-13-95

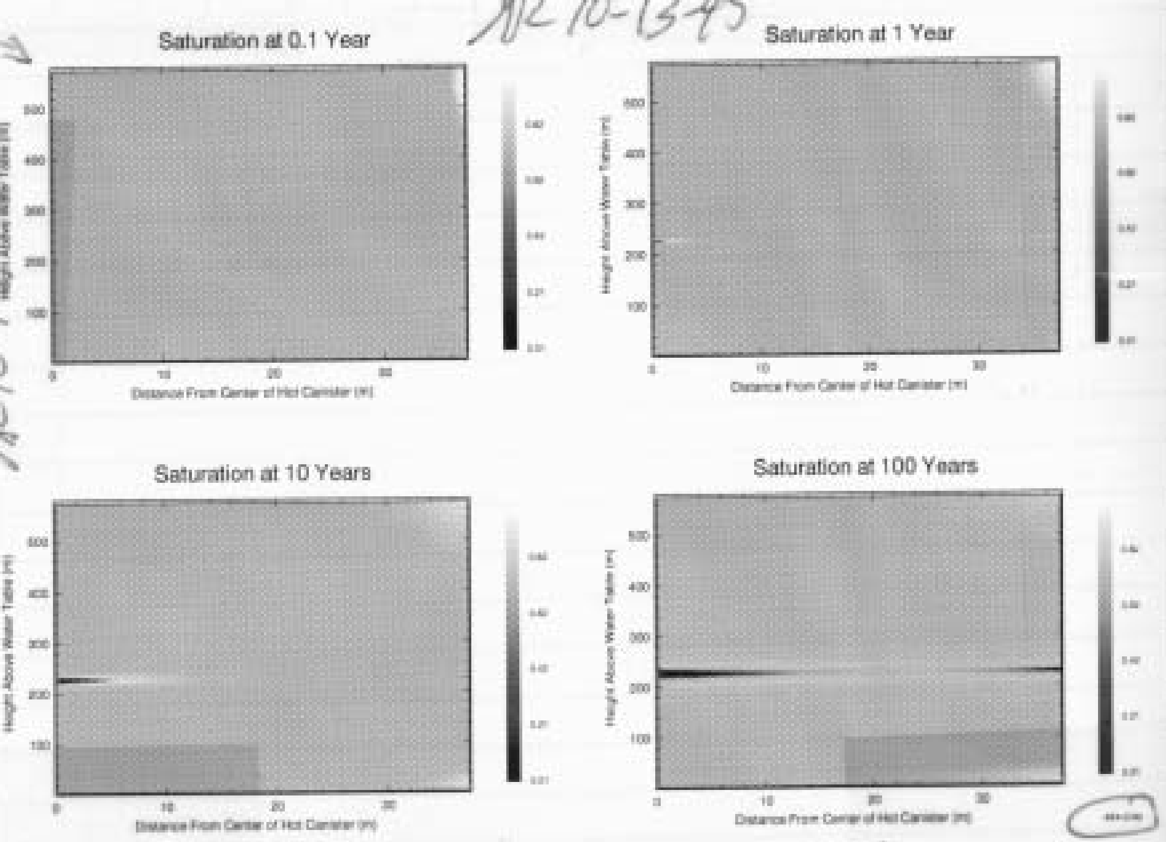
AR 10-13-95



30X15-02, Fracture Zone, 57kW/Ac, Matrix Permeability = 1.9E-18m²

AR 10-13-95

AR 10-13-95



30X15-02, Fracture Zone, 57kW/Ac, Matrix Permeability = 1.9E-18m²

10-13-95
AR

CTOUGH

AR 10-13-95

PARTS

An example of each file (except *newctough**) can be found in: *usr2/sneezy/rgreen/grice/ctough-parts.*

*newctough**

executable CTOUGH file. Found in : *usr2/sneezy/rgreen/grice/newctough* along with FORTRAN files. Can be compiled with the command "*make newctough*"

*rzgrid** located in ~~/rzgrid/....~~ /usr2/sneezy/rgreen/grice 10/24/95 RA

executable file that builds *tufgrid.out*. *tufgrid.out* is the bulk of the CTOUGH input file. Note: *rzgrid-0.638thick** is set-up to produce grids that are 0.638m thick - equivalent thickness of a canister with a radius of 0.3m.

grid.in make input file in /usr2/sneezy/rgreen/grice/ctough-parts

Information about grid characteristics and initial conditions (e.g., x-y or r-z, temperature, pressure). Read by *rzgrid**.

RA 10/24/95

xzone.in, zzone.in

Horizontal and vertical grid dimensions. Read by *rzgrid**.

head

Template for the first eight blocks (above ELEM) of CTOUGH input file. Attach to top of *tufgrid.out*. Note: EVAP block generates *.xyp* files for listed elements.

GENER

GENER block template. To be inserted between blocks CONNE and INCON. For simulations that generate heat.

AR 10-13-95

BUILDING CTOUGH INPUT

1. Modify *grid.in*, *xzone.in*, and *zzone.in* as appropriate.
2. Run *rzgrid** (just enter *rzgrid*) -- this produces *tufgrid.out*.
3. Add *head* to top of *tufgrid.out* and insert *GENER* if required.

TO RUN CTOUGH

Enter: *newctough filename.* Note: filename should be entered w/o the "i" suffix RA 10/25/95

OUTPUT

"VAR.dat* files

Produced for each time specified in the TIME block. *"VAR*.dat* files contain temperature, pressure, saturation, etc. data. *"VAR*.dat* files can be used by TECPLOT after they are "preplotted". Enter: *preplot filename.*

AR 10-13-95

10-13-95

MR 10-13-95

VEL.dat files

If the value of 'kdt' in the PARAM block is '2', *VEL*.dat files are produced for each time specified in the TIME block. *VEL*.dat files contain components of velocity vectors. However, they must be modified (match vertical with horizontal components) before they can be correctly used in TECPLOT.

*.xyp files

Produced only for elements listed in EVAP block. Histories (data produced for every timestep - these files can get big) of temperature, saturation, pressure, etc. for each listed element. Can be read directly by XPLOT.

*.OUT file

Contains all output appearing in *VAR*.dat and *VEL*.dat files, plus information about grid dimensions, and (sometimes much) more. *.OUT files can become very large.

MR 10-13-95

*.SAVE file

Saves initial conditions (INCON block) for each time specified in the TIME block.

*ERRS file

Description of errors that occurred while CTOUGH was running.

*BAL file

Fluxes of fluids and energy between each material type for each time specified in the TIME block.

* HIS file

A list of variable names, elements, and connections.

*PCT and *COEF files

Unknown.

MR 10-13-95

• RUN "2heat-f-30X15-99-φ4i" COMPLETED 10^5 YRS IN 1804 TIMESTEPS.
CALCULATION TIME = 11937 S.

MR 10-13-95

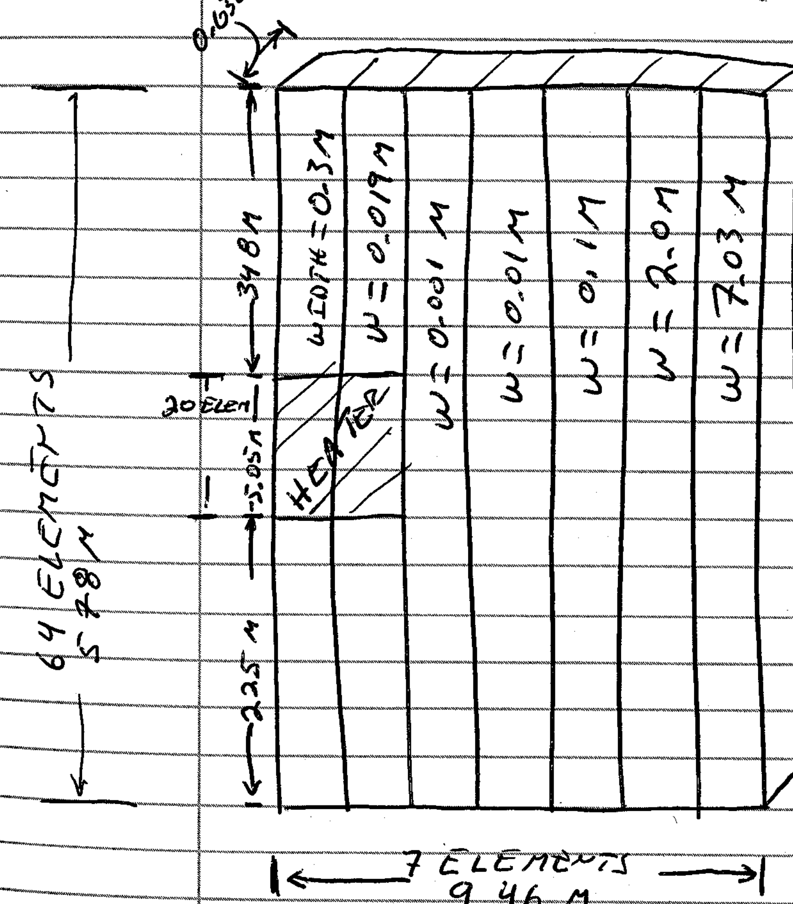
3-7-96 MR INSTALLATION TESTING OF CTOUGH (PER TOP-018)

TEST PROBLEM: HEATING DRY ROCK - TEMPERATURE DISTRIBUTION AFTER 100 YEARS (PROBLEM SIMILAR TO WORK DONE BY NITAO IN: "NUMERICAL MODELING OF THE THERMAL AND HYDROLOGICAL ENVIRONMENT AROUND A NUCLEAR WASTE PACKAGE USING THE CONTINUUM APPROXIMATION: HORIZONTAL EMPLACEMENT" - MAY 1988

3-8-96 MR THE PROBLEM MENTIONED ABOVE WAS RUN ON THE MACHINE CALLED SNEEZY - PATH:

/usr2/sneezy/rgreen/grice/gwtt/2-d/8-95,

INPUT FILE NAME = 64X7-dry2i



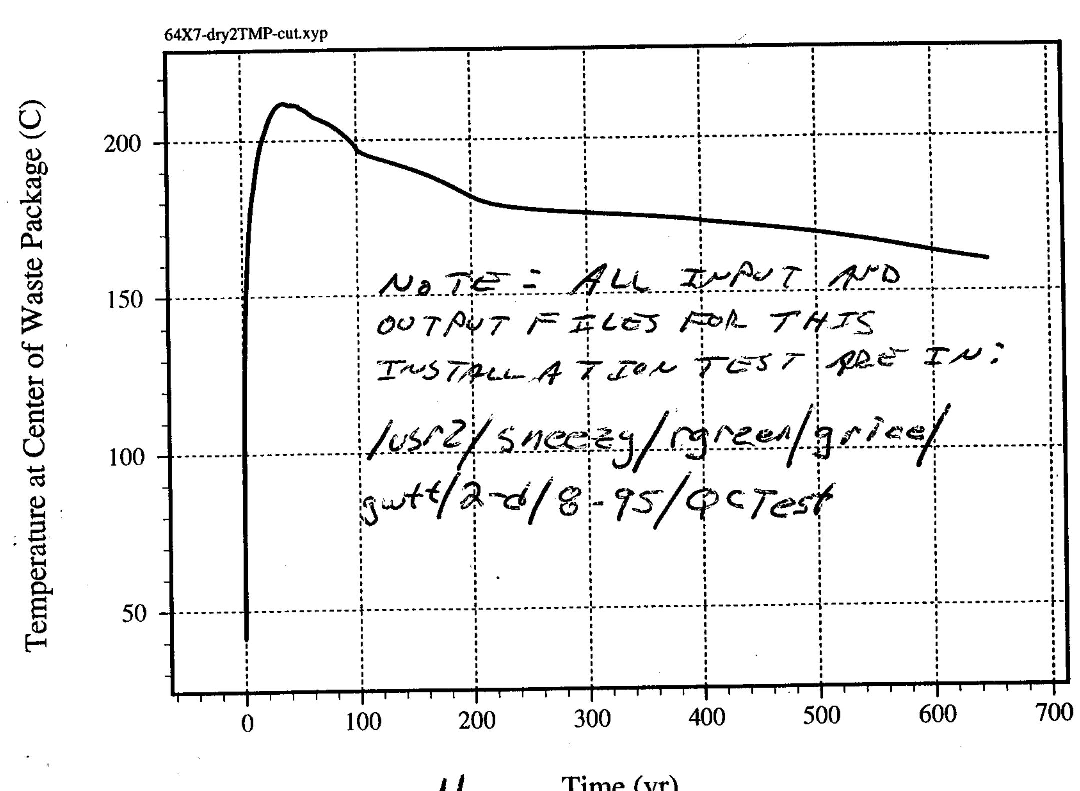
HEATING RATE = 114 KW/AC

3-8-96 RR

THE OUTPUT PRODUCED BY THE CTOUGH RUN DESCRIBED ON THE PRECEEDING PAGE IS REASONABLE AND IS SIMILAR TO THAT DESCRIBED IN NITAO'S PAPER: AFTER 100 YEARS, THE HOTTEST REGION IS AT THE HEATER AND TEMPERATURES ~~CONTIN~~ RR 3-8-94 MONOTONICALLY DECLINE AWAY FROM THE HEATER. ALSO, THE MAXIMUM TEMPERATURE OCCURS IN LESS THAN 100 YEARS AND TEMPERATURES MONOTONICALLY DECLINE THEREAFTER.

RR 3-8-96

Conduction Through Rock, No Water Present



RR 3-8-96

RR 1-16-97 NOTE - THE GWTT WORK, AND THE USE OF CTOUGH ENDS HERE

RR 3-12-96
3-12-96 RR

* THE PROBLEM DOCUMENTED IN RON GREEN'S MEMO OF 3/5/96 IS THE SAME AS THE PROBLEM DESCRIBED IN TSPA 1995 - CHAPTER 4, NEAR FIELD ENVIRONMENT; 6 GEOLOGIC UNITS + DRIFT, ~680 M THICK.

THE WORK DESCRIBED HERE IS A CONTINUATION OF WORK DESCRIBED IN CNWRA NOTEBOOK #5 104 + 129

RR 1-16-97

- RE-RUN TSPA METRA EXAMPLE - SAME ONE RON GREEN DOCUMENTED IN MEMO OF 3/5/96 - 'SIMPLE MULTIFLO PROBLEM'*. PATH:

/home/sneezy/rgreen/multi/tspa/grice :
INPUT FILE = tspa11.dat

- NON-HEATING PORTION OF RUN SEEMED TO GO PROPERLY (TO 2×10^6 YR) BUT STEADY-STATE WITH HEAT TURNED ON CRASHED @ TIMESTEP = 736, TIME = 760 YR, $dpmx = -2.54 \times 10^7$, $dsmx = 4.1 \times 10^{-2}$, $tempmx = -7.77 \times 10^1$.

ERROR MESSAGE: ERRORS IN WATER/STEAM PROPERTIES

"ERROR H2OPUT: WATER DENSITY DERIVATIVES
B40, M = 380, P = 0.243E+03, T = -0.618E+01,
PS = 0.385E+03, dw = 0.554E+02,
3-12-96 RR ~~$\frac{dw}{dt}$~~ $\frac{dw}{dT} = 0.124E-01$, $\frac{dw}{dp} = 0.292E-07$"

FROM FILE: 'tspa11_errs'

- NEW RUN: 'tspa12.dat' - IDENTICAL TO 'tspa11.dat' EXCEPT 'IVPTAB' SET TO 0 INSTEAD OF 1 IN INPUT FILE (ACCORDING TO pg 4.2 OF MULTIFLO USERS MANUAL - IVPTAB SHOULD BE SET TO 0 IF IVPLWR IS TURNED ON (=1)).

IN:
/home/sneezy/rgreen/multi/tspa/grice

3-12-96
[initials]

- Run 'tspa12.DAT' CRASHED AT SAME PLACE 'tspa11.dat' DID - 736 TIMESTEPS, 759.7 YRS. ERROR MESSAGE = SAME.

- SPOKE w/ P. LICHTNER re CRASHS - HE GAVE ME AN EXECUTABLE FILE: METRA_BIG - WILL TRY RUNNING tspa11.dat WITH IT.

3-14-96
[initials]

NEW RUN: "tspa13.dat" - INITIAL CONDITIONS TAKEN FROM "tspa11.dat" - HYDRAULIC CONDITIONS @ 2×10^6 YR. "tspa11.dat CHANGED WITH CORRECTED VALUES OF VAN-GENUCHTEN PARAMETERS & THERMAL PROPERTIES - AS GIVEN IN: TSPA1995:

[initials] 3-14-96

VAN-GENUCHTEN - CHANGES

0.7635 ⟶ 0.7636

1.53E-7 ⟶ 1.53E-6

THERMAL CHANGE

0.42 ⟶ 1.42

IN: /home/sneezy/rgreen/multi/tspa/grice

TO KILL cc MAIL

ps -aux | grep ccmail

[initials] 3-25-96

3-22-96
[initials]

EXAMPLE OF TECPLOT HEADER IN:

/usr2/sneezy/rgreen/grice/fran-1-95/vects/$\boxed{\text{tecplot-head}}$

- PLOTS FOR RON'S RUNS - TSPA13fld12.xyp & tspa15fld 1 THROUGH 6.xyp IN:

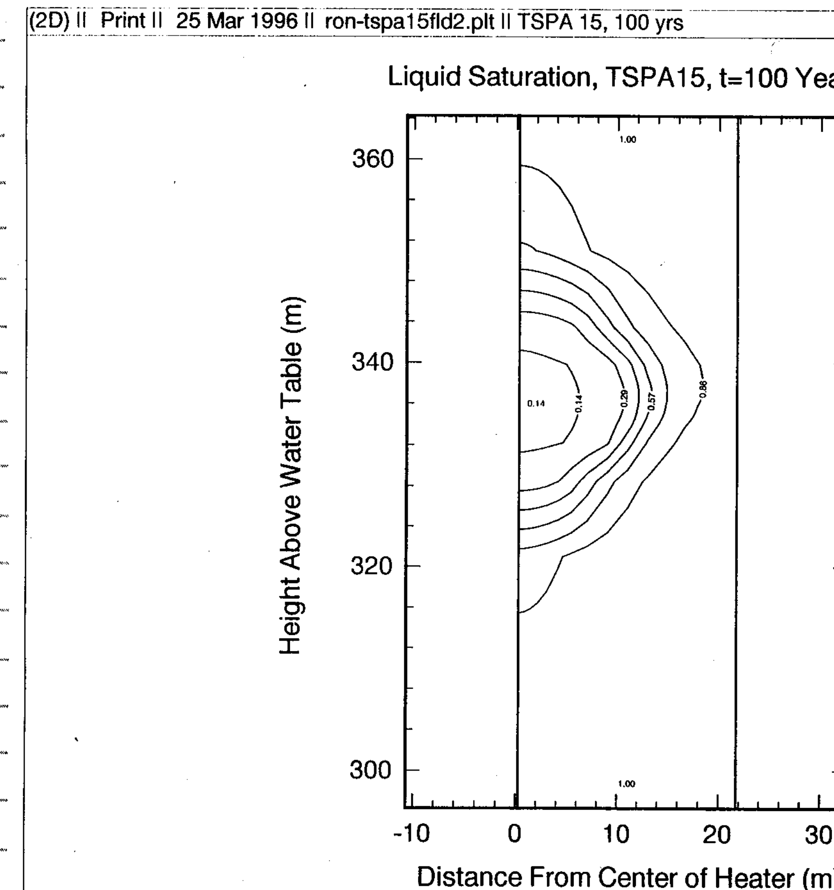
multi [initials] 3-22-96

/Home/sneezy/rgreen/~~motti~~/tspa/grice

3-25-96
[initials]

PLOTS REFERRED TO ABOVE KEPT IN LOOSE-LEAF BINDER - EXAMPLE:

[initials] 3-25-96



IN:

/home/sneezy/rgreen/multi/tspa/grice

[initials] 3-25-96

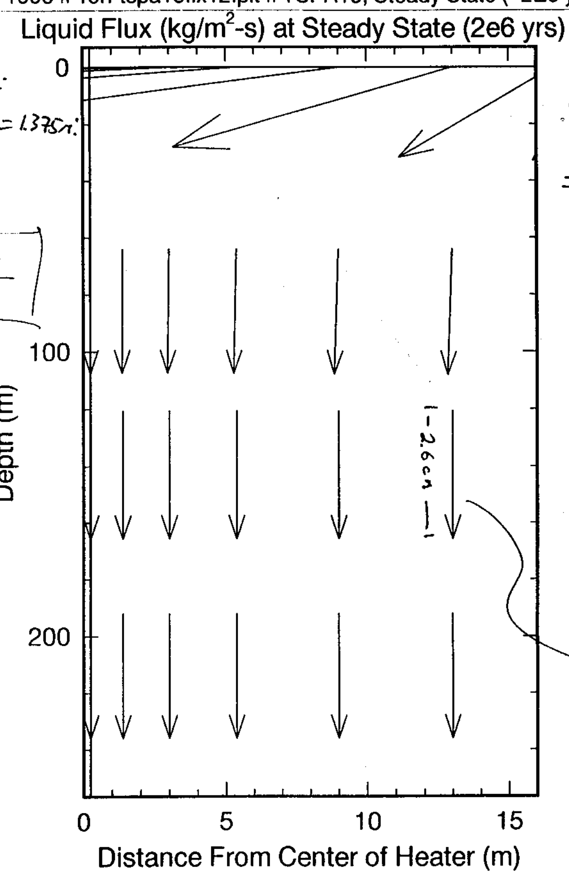
3-27-96
AR

APPARENT PROBLEM WITH METRA OUTPUT: FOR STEADY STATE RUN:

/home/sneezy/rgreen/multi/tspa/grice/ron-tspa13flx12.xyp

AR 3-27-96

(2D) || Print || 27 Mar 1996 || ron-tspa13flx12.plt || TSPA13, Steady State (~2E6 yrs)



METRA OUTPUT:
FOR $z = 79.5m$, $x = 1.375m$:
$f/x = -7.5 \times 10^{-13}$
$f/z = 5.0 \times 10^{-9}$
LIQ. FLUX = $\boxed{5.0 \times 10^{-9} \frac{kg}{m^2\text{-}s}}$

$fgx = 5.8 \times 10^{-15}$
$fgz = 1.5 \times 10^{-9}$
VAP. FLUX = $\boxed{1.5 \times 10^{-9} \frac{kg}{m^2\text{-}s}}$

METRA INPUT: LIQUID SOURCE = 0.3 mm/YR:

$\frac{0.3\ mm}{YR} \frac{10^{-3}\ m}{mm} \frac{YR}{365\ DAY} \frac{DAY}{86{,}400\ s} \frac{10^3\ kg}{m^3} = \boxed{9.5 \times 10^{-9} \frac{kg}{m^2\text{-}s}}$

MAGNITUDE OF VECTOR:

$2.6\ cm \ \frac{1 \times 10^{-8}\ kg}{m^2\text{-}s\ \ 5.10\ cm} = \boxed{5.1 \times 10^{-9} \frac{kg}{m^2\text{-}s}}$

AR 3-27-96

3-29-96
AR

TWO HEATER CASE - STEADY STATE WITHOUT HEAT OR INFILTRATION:
" 24x43-SS-no heat-2.dat " IN:
STEADY STATE REACHED @ YR 376
/home/sneezy/rgreen/multi/tspa/grice/2-heaters

AR 3-29-96

3-29-96
AR

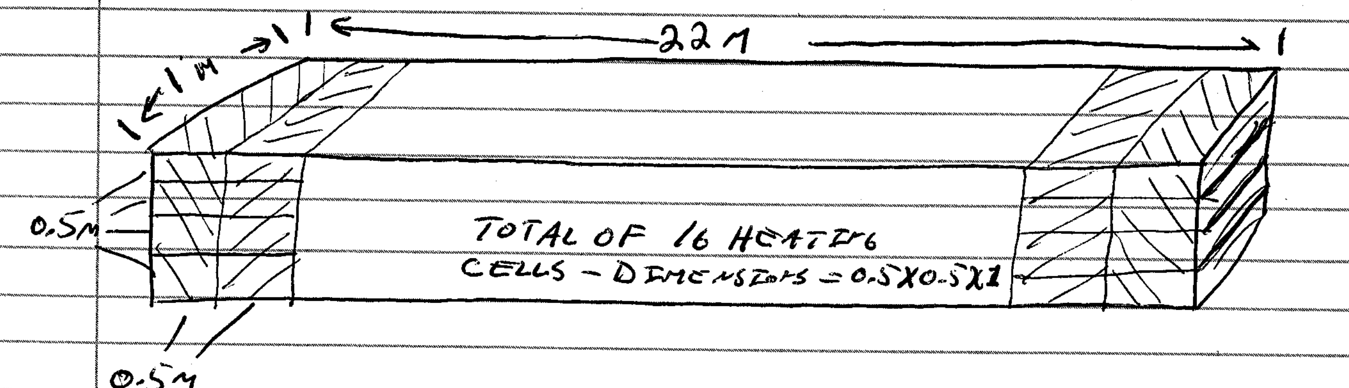
RUN: " 24x43-SS-noheat-3.dat " - IDENTICAL TO " 24x43-SS-noheat-2.dat " BUT CONTAINS 24 SOURCE TERMS TO SIMULATE INFILTRATION RATE OF 0.3mm/YR.

4-1-96
AR

- NEW DATA (INPUT) FILE:

" 24x43-SS-1.dat " - CONTAINS STEADY-STATE CONDITIONS (~ 2.1×10^6 YR) FROM RUN " 24x43-SS-noheat-~~2~~ 3.dat " AS INITIAL CONDITIONS
AR 4-1-96

WANT HEAT OUTPUT OF 83 KW/AC - CURRENT HEAT SOURCE SET-UP:



TOTAL HEAT OUTPUT PER UNIT SURFACE AREA:

$\frac{62.1022\ W}{22\ m^2} (16) \frac{m^2}{10.76\ FT^2} \frac{43{,}560\ FT^2}{AC}$

$= 182.84\ KW/AC$ - ∴ NEED TO REDUCE HEAT INPUT BY FACTOR OF 83/182.84

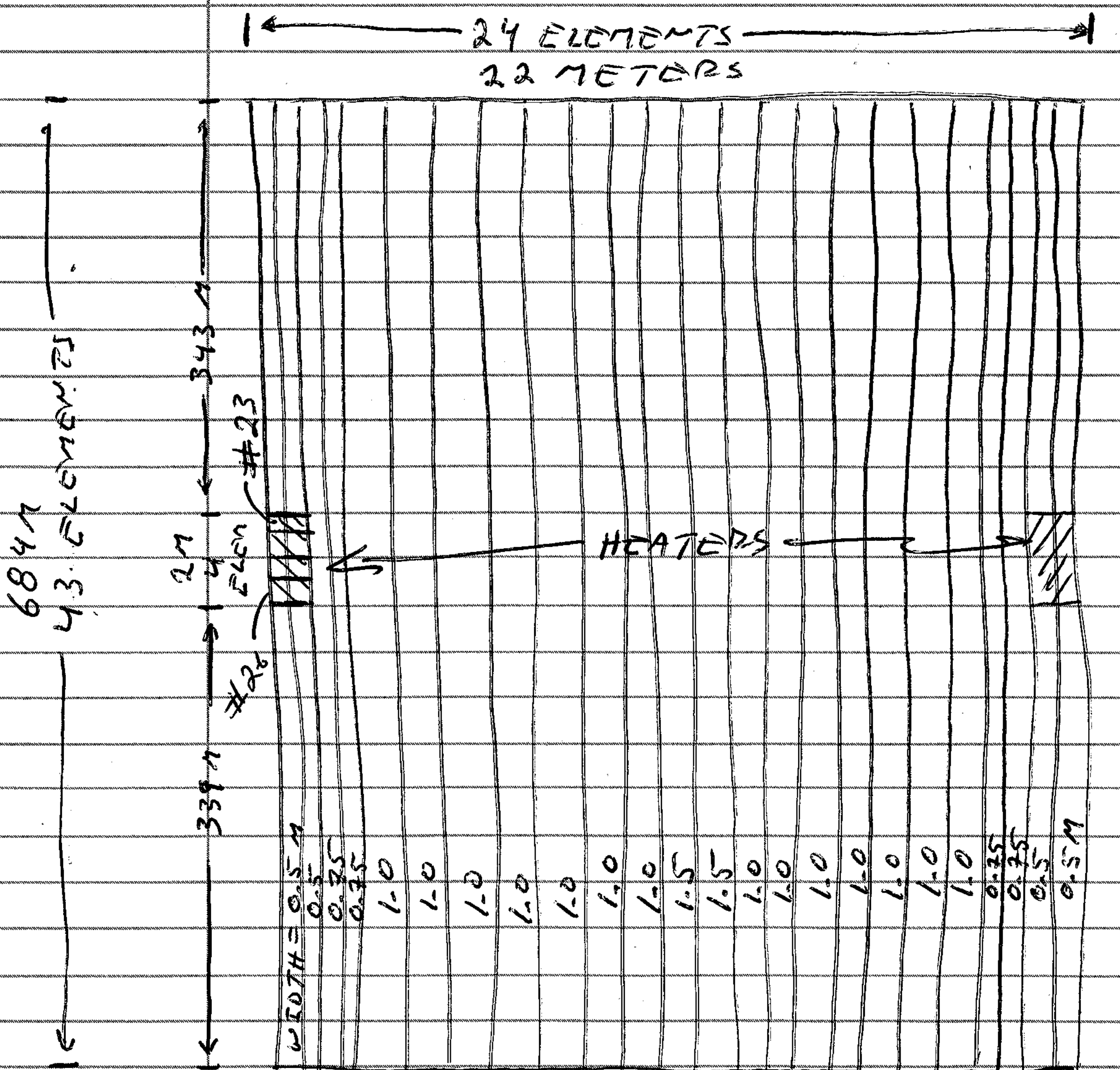
$\underline{= 0.454}$ - THIS DONE BY ADJUSTING SCALE FACTOR IN SOURCE LINE OF INPUT.

4-2-96
RR

2-HEATER PROBLEM – TOTAL HEAT OUTPUT = 83 KW/AC

RUN W/2 HEATERS, EACH GENERATING 41.5KW/AC:
"24x43-41.5+41.5.dat. IN:
/home/sneezy/rgreen/multi/tspa/grice/2-heaters *

GRID FOR 24x43-...:



FILES MOVED TO SEPARATE DIRECTORY:
.../grice/2-heaters/41.5+41.5
MR 4-4-94

MR 4-2-96

4-2-96
RR

INPUT: "24x43-41.5+41.5.dat"

```
Steady State - Two Heaters (initial data : 2D, Yucca Mt.)
                    April 1, 1996
: 24X43 Grid
: added 0.3 mm/yr infiltration using source terms, not bcon
: heat added to 16 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       24  1   43   1       1      1      0    0
:
Monitor
 107
debug 1
0
Pckr                                 :relative perm and pc keyword
:   i  type-curv swir   rpm(lamda)  alpha     pcwmx  sgc  iecm
:                swirm  rpmm(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        1.305e-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        1.305e-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        1.305e-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        1.305e-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        1.305e-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        1.305e-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)
0.5 0.5 0.75 0.75 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.5 1.5 1.0 1.0 1.0 1.0 1.0 1.0 1.0
0.75 0.75 0.5 0.5
: (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 24  1  1  1  1   1    7   0.
    1 24  1  1  2  6   1    1   0.
    1 24  1  1  7 10   2    2   0.
    1 24  1  1 11 35   3    3   0.
    1 24  1  1 36 36   4    4   0.
    1 24  1  1 37 39   5    5   0.
    1 24  1  1 40 42   6    6   0.
    1 24  1  1 43 43   6    6   6.2832e7
 :
```

RR 4-2-96

RR 4-2-96

MR 4-2-96

4-2-96

INPUT: "24x43-41.5+41.5.dat" (cont)

4-2-96

```
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
   21  21   1   1   1   1 9.99999E+04   13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   22  22   1   1   1   1 9.99999E+04   13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   23  23   1   1   1   1 9.99999E+04   13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   24  24   1   1   1   1 9.99999E+04   13.0480 2.3765E-01 0.0000E+00 2.3765E-01
    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
   21  21   1   1  43  43 1.07983E+05   24.9861 1.2282E-05 0.0000E+00 1.2282E-05
   22  22   1   1  43  43 1.07983E+05   24.9867 1.2282E-05 0.0000E+00 1.2282E-05
   23  23   1   1  43  43 1.07983E+05   24.9871 1.2282E-05 0.0000E+00 1.2282E-05
   24  24   1   1  43  43 1.07983E+05   24.9873 1.2282E-05 0.0000E+00 1.2282E-05
0 0 0 0 0 0 0 0 0 0 0 0 0
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+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  40   0.454   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
```

4-2-96

```
    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 9.513e-9
0
    7   1   1   1
0. 13.05 9.513e-9
0
    8   1   1   1
0. 13.05 9.513e-9
0
    9   1   1   1
0. 13.05 9.513e-9
0
   10   1   1   1
0. 13.05 9.513e-9
0
   11   1   1   1
0. 13.05 9.513e-9
0
   12   1   1   1
0. 13.05 1.427e-8
0
   13   1   1   1
0. 13.05 1.427e-8
0
   14   1   1   1
0. 13.05 9.513e-9
0
   15   1   1   1
0. 13.05 9.513e-9
```

4-2-96

```
0
   16   1   1   1
0. 13.05 9.513e-9
0
   17   1   1   1
0. 13.05 9.513e-9
0
   18   1   1   1
0. 13.05 9.513e-9
0
   19   1   1   1
0. 13.05 9.513e-9
0
   20   1   1   1
0. 13.05 9.513e-9
0
   21   1   1   1
0. 13.05 7.135e-9
0
   22   1   1   1
0. 13.05 7.135e-9
0
   23   1   1   1
0. 13.05 4.756e-9
0
```

```
   24   1   1   1
0. 13.05 4.756e-9
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
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
```

4-2-96

4-2-96

4-2-96

INPUT: "24x43-41.5+41.5.dat" (concl)

4-2-96

```
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
0
```

4-2-96

4-2-96

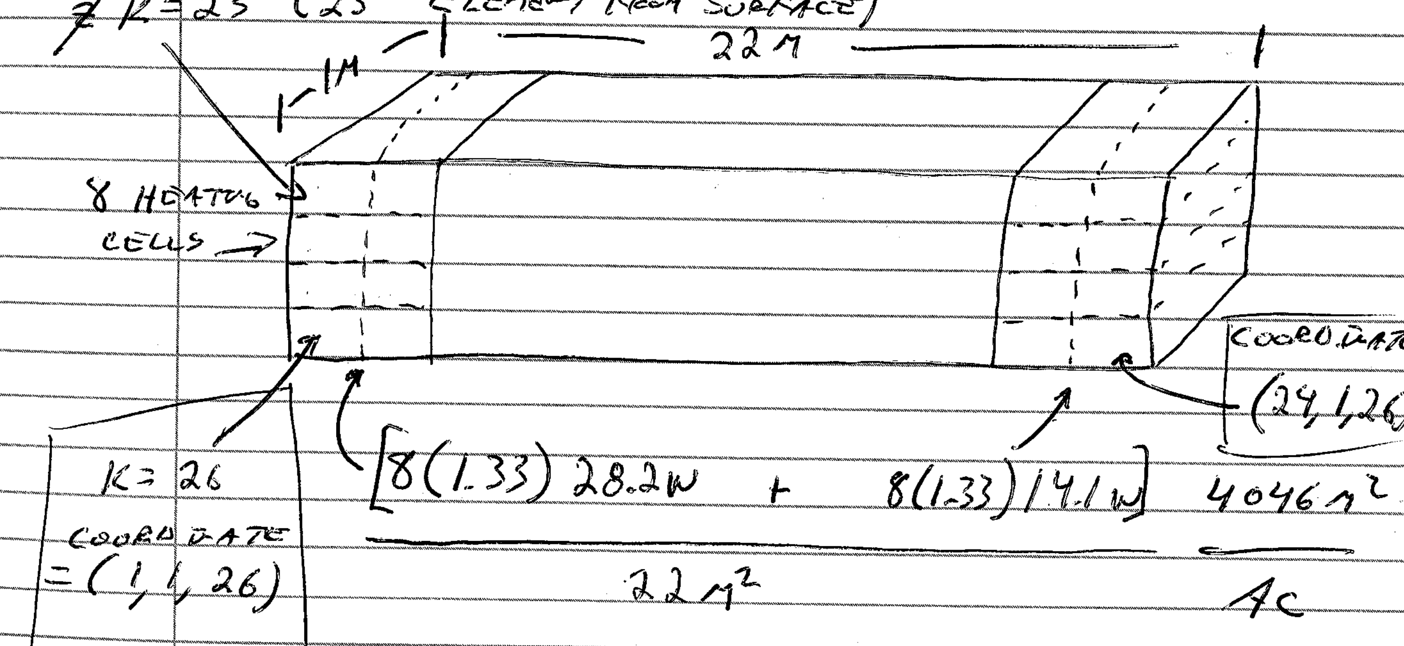
```
:        print all at every target time
PLOTS 1 6 7 20 47 70 87 135
:       target  dt      dpmx    dsmx    dp2mx    dtmpmx
Time[y]  10.
Time[y]  100.
Time[y]  1000.
Time[y]  10000.
Time[y]  20000.
Time[y]  50000.


Time[y]  100000.
rstart 1 0
:
SKIP
Steady[y]  1.e+1 1.e-1 1.e-4
NOSKIP
Ends
```

NEW RUN: "24x43-55.3+27.7.dat" - IDENTICAL TO "24x43-41.5+41.5.dat" EXCEPT POWER OUTPUT IS UNEVENLY DISTRIBUTED:

4-2-96

~~K~~ K=23 (23RD ELEMENT FROM SURFACE)



$$\frac{\left[8(1.33)\,28.2W + 8(1.33)\,14.1W\right]}{22\,m^2} \cdot \frac{4046\,m^2}{Ac}$$

$= 82.8\ KW/AC$

IN: /home/sneezy/rgreen/multi/tspa/grice/2-heaters/55.3+27.7

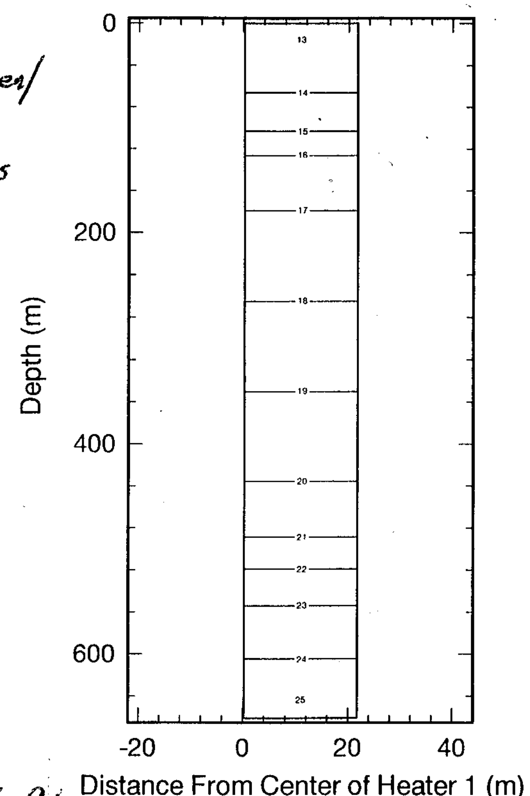
4-5-96

(2D) || Print || 2 Apr 1996 || 24x43-SS-noheat-3fld12.plt || 2-Heaters, Steady State ~2.1E6 yrs

4-4-96

IN:
/home/sneezy/rgreen/multi/tspa/grice/2-heaters

Temperature at Time = 0



4-4-96

NEW RUN: "24X43-83.0+0.0.dat" -
IDENTICAL TO "24X43-55.3+27.7.dat" EXCEPT
ONLY LEFT HEATER IS PRODUCING POWER. - AT
83 KW/AC.
IN: /home/sneezy/rgreen/multi/tspa/
grice/2-heaters/83.0+0.0

FOR INITIAL POWER = 83 KW:

$\dfrac{(8\ \text{ELEMENTS})\ X}{22\ M^2}\ \dfrac{4047\ M^2}{AC} = 83\ KW,$

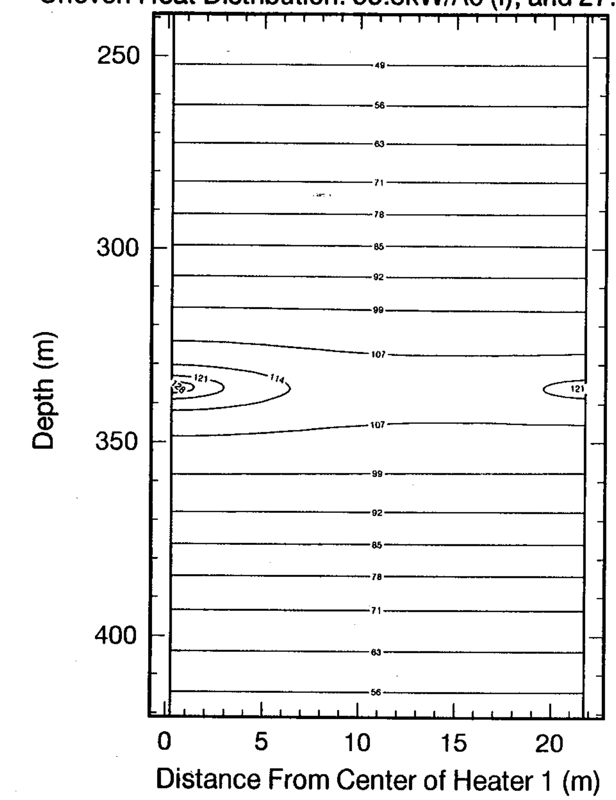
$X = 0.0564\ W = \underline{56.4\ KW}$

4-4-96

(2D) || Print || 3 Apr 1996 || 24x43-55.3+27.7fld2.plt || 2-Heaters, 55.3+27.7 kW, 100 yrs

4-4-96

Temperature at 100 Years
Uneven Heat Distribution: 55.3kW/Ac (l), and 27.7kW/Ac (r)

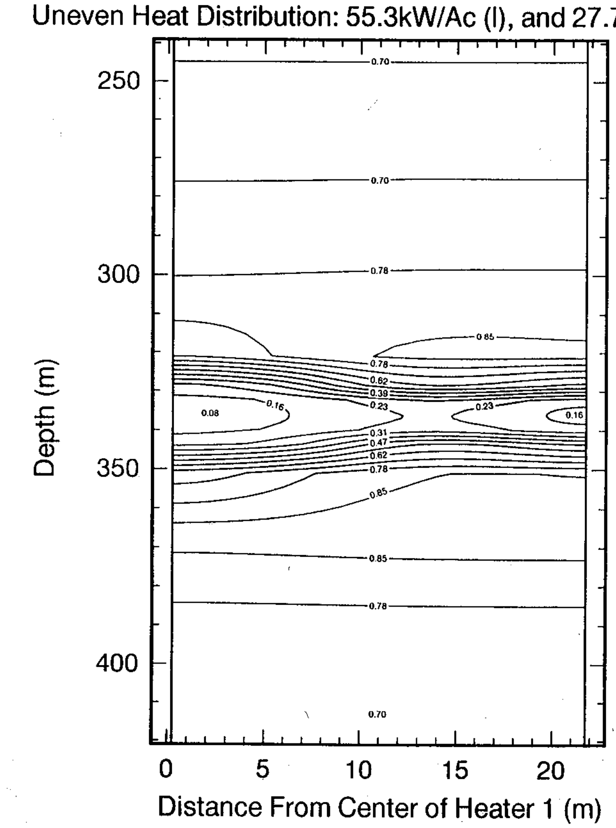


IN:
/home/sneezy/rgreen/multi/tspa/grice/2-heaters/55.3+27.7

4-4-96

(2D) || Print || 3 Apr 1996 || 24x43-55.3+27.7fld2.plt || 2-Heaters, 55.3+27.7 kW, 100 yrs

Liquid Saturation at 100 Years
Uneven Heat Distribution: 55.3kW/Ac (l), and 27.7kW/Ac (r)



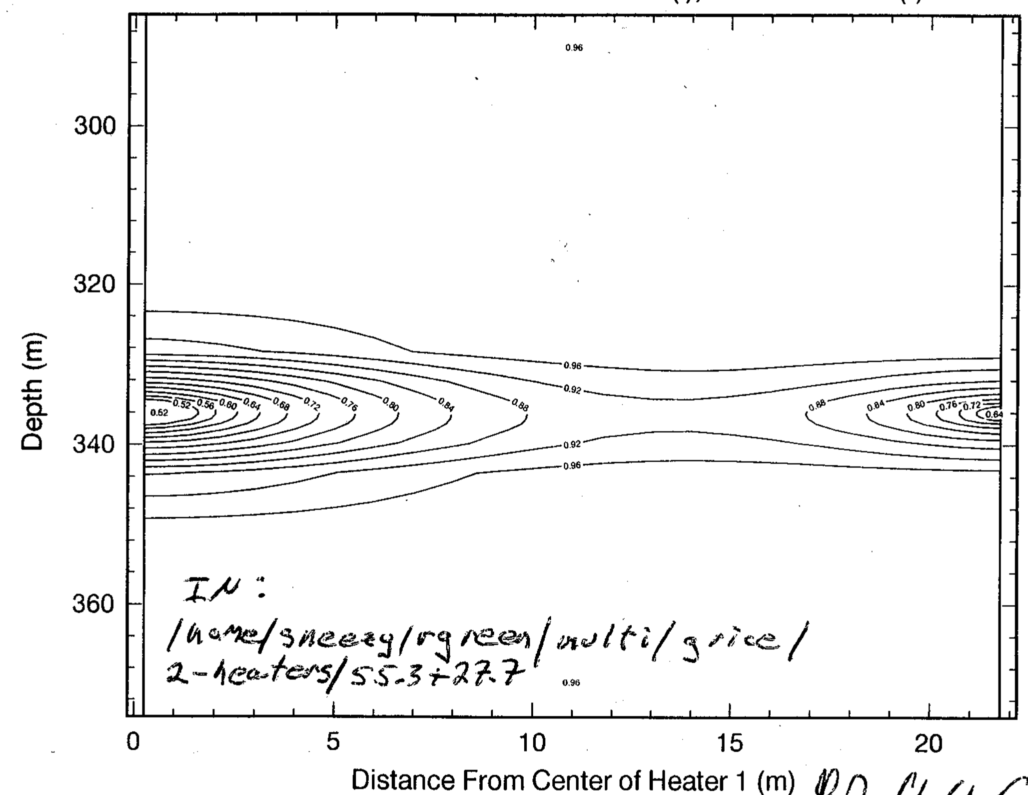
IN SAME DIRECTORY AS FIGURE ABOVE

4-4-96

4-4-96
AR

(2D) || Print || 3 Apr 1996 || 24x43-55.3+27.7fld2.plt || 2-Heaters, 55.3+27.7 kW, 100 yrs AR 4-4-96

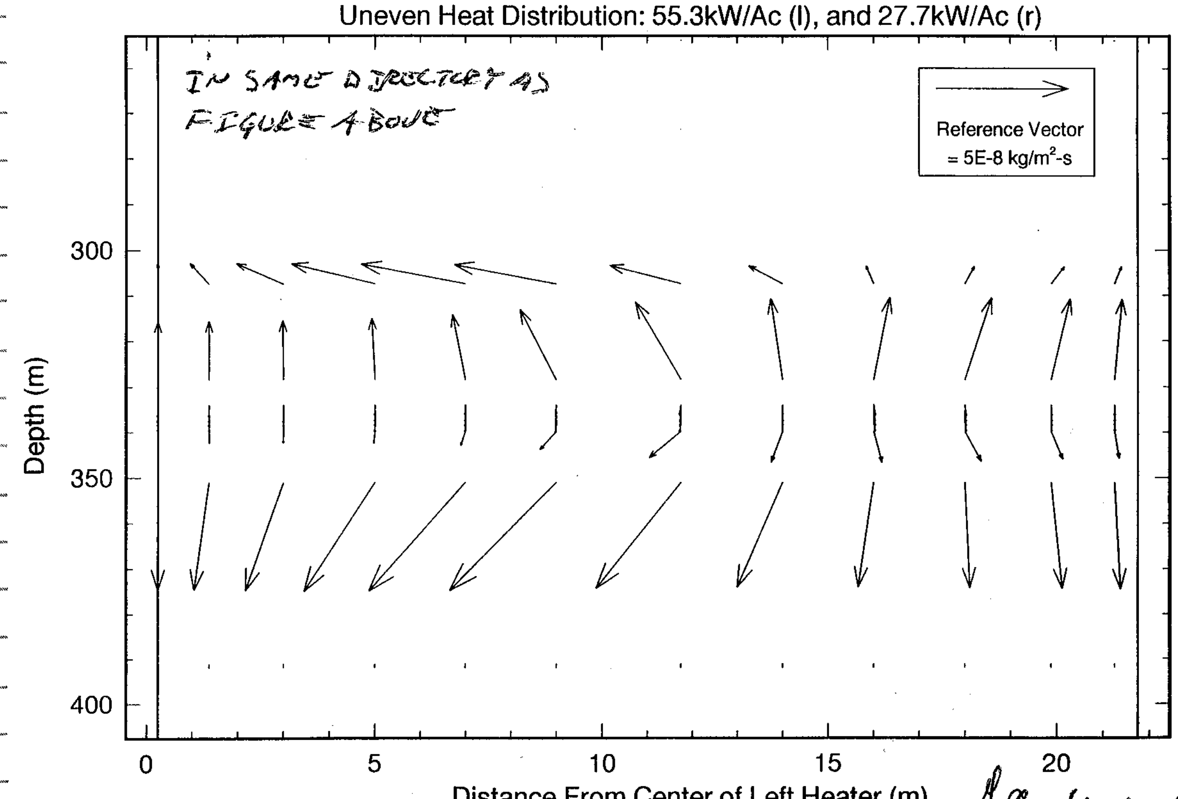
Relative Humidity at 100 Years
Uneven Heat Distribution: 55.3kW/Ac (l), and 27.3kW/Ac (r)



AR 4-4-96

(2D) || Print || 4 Apr 1996 || 24x43-55.3+27.7flx2.plt || 2-Heaters, 55.3+27.7kW, 100 Years

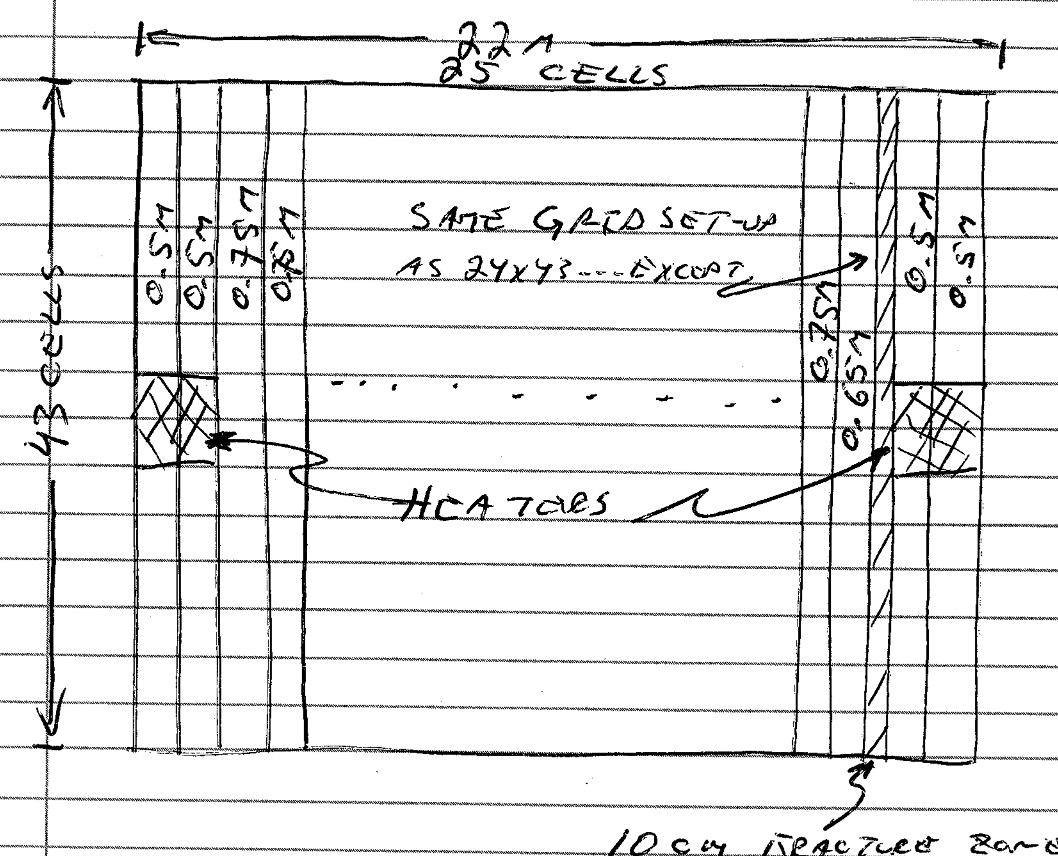
Liquid Flux at 100 Years
Uneven Heat Distribution: 55.3kW/Ac (l), and 27.7kW/Ac (r)



AR 4-4-96

4-5-96
AR

NEW RUN – FRACTURE ZONE (10 cm)
ALONG SIDE OF LOW POWER HEATER:
"25X43-10cm-55.3+27.7.dat"*
SAME GRID SET UP AS '24X43...' EXCEPT:



FRACTURE ZONE (LIKE ALL OTHER MATERIALS)
IS MODELED AS AN EQUIVALENT CONTINUUM.

FRACTURE ZONE PROPERTIES TAKEN FROM
KLAVETTER + PETERS (1985?), pg 21, PTn.

MATRIX ~~/~~ HYDRAULIC CONDUCTIVITY: AR 4-5-96

$\frac{3.9 \times 10^{-7} M}{S}$ TO CONVERT $\frac{M}{S}$ TO M^2,

SEE BELOW.

* IN: /home/sneezy/rgreen/multi/tspa/grice/2-heaters/
fracture/10cm/55.3+27.7

4-5-96
MR

CONVERTING HYDRAULIC CONDUCTIVITY TO PERMEABILITY:

FOR $K = \frac{1\,M}{S}$:

$K = \frac{k\rho g}{\mu}$,

$$k = K\frac{\mu}{\rho g} = \frac{1\,M}{S}\ \frac{1.002\ Ns}{M^2}\ \frac{S^2}{9.8\,M}\ \frac{M^3}{1000\ kg}$$

NOTE: VISCOSITY OF WATER @ 20 °C (CRC, pg F-42)

$$1.002\ cp = 1.002 \times 10^{-2}\ \frac{gm}{s\text{-}cm}$$

$$1.002\times10^{-2}\ \frac{gm}{s\text{-}cm}\ \frac{kg}{10^3 gm}\ \frac{10^2 cm}{m} = 1.002\times \cancel{10^{-2}}\,10^{-3}\ \frac{kg}{s\text{-}m}$$

MR 4-5-96

$$1.002\times10^{-3}\ \frac{kg}{s\text{-}m}\ \frac{s}{s}\ \frac{m}{m} = 1.002\times10^{-3}\ \frac{Ns}{m^2}$$

$$K = \frac{1M}{S}\ \frac{1.002\ Ns}{M^2}\times10^{-3}\ \frac{S^2}{9.8\,M}\ \frac{M^3}{1000\ kg} = 1.022\times10^{-4}\,M^2\times10^{-3}$$

$$\frac{1\,M}{S} = 1.022\times10^{-4}\,M^2\times10^{-3} = 1.022\times10^{-7}\,M^2$$

$$1.022\times10^{-7}\,M^2\ \frac{10^4\ cm^2}{M^2} = 1.022\times10^{-3}\ cm^2$$ – SEE FREEZE & CHERRY, pg 29.

4-5-96
MR

THUS,

$$3.9\times10^{-7}\ \frac{M}{S} = 3.99\times10^{-14}\ M^2 \text{ (MATRIX)}$$

~~16 = 1.64 X 10⁻⁶ M² (FRACTURE)~~ MR 4-5-96

$$6.1\times10^{-4}\ \frac{M}{S} = 6.24\times10^{-11}\ M^2 \text{ (FRACTURE)}$$

TO CONVERT M WATER TO Pa OR ATM:

$$1\ M\ WATER = \frac{M^3}{M^2}\ \frac{10^3\ kg}{M^3} = \frac{10^3\ kg}{M^2}$$

$$\frac{10^3\ kg}{M^2}\ \frac{9.8\,M}{S^2} = \frac{9800\ N}{M^2} = 9800\ Pa$$

$$1\ M\ WATER = \frac{9.8\times10^3\ Pa}{1.013\times10^5\ Pa}\ ATM = 9.67\times10^{-2}\ ATM$$

$$\boxed{1\ ATM = 10.34\ M\ WATER.}$$

THUS, FOR $\alpha = 1.2851/M$:

$$\frac{1.2851}{M}\ \frac{M}{9.8\times10^3\ Pa} = \frac{1.31\times10^{-4}}{Pa}.$$

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MR

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-dat

NEW METRA RUN: "25x43-10cm-41.5+41.5"
IDENTICAL TO "25x43-10cm-55.3+27.7.dat"
EXCEPT POWER EVENLY DISTRIBUTED BETWEEN
HEATERS - BOTH INITIALLY PRODUCING
41.5 KW/ACRE.

IN: /home/sneezy/ngreen/multi/tspa/grice/
2-heaters/fracture/10cm/ 41.5+41.5

INPUT = "25x43-10cm-55.3+27.7.dat"

```
Steady State - Two Unequal Heaters (initial data : 2D, Yucca Mt.)
               April 5, 1996
: 25X43 Grid, Fracture zone(10cm) passes along edge of right heater.
: added 0.3 mm/yr infiltration using source terms, not bcon
: heat added to 16 elements, Left heater = 55.3 kW/AC, Right
:   heater = 27.7 kW/Ac
: 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       25  1   43   1        1      1     0    0
:
Monitor
 578
debug 1
0                                   :relative perm and pc keyword
Pckr
:   i  type-curv swir   rpm(lamda)  alpha     pcwmx  sgc   iecm
:                swirm  rpmm(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        1.305e-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        1.305e-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        1.305e-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        1.305e-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        1.305e-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        1.305e-5  50.      0.   1
                 0.010  0.7000    1.11e-5   0.50    1.8e-3 3.9e-14 3.9e-12
:8 = fracture zone properties. Taken frpm Klavetter & Peters 1985(?),
:"Fluid Flow in Fractured Rock Mass", page 21, PTn.
:   i  type-curv swir   rpm(lamda)  alpha     pcwmx  sgc   iecm
:                swirm  rpmm(lamda) alpham    phim   phif    permm     permf
    8  Van-Gen    0.040  .7636        1.311e-4  50.      0.   1
                 0.100  0.8500    1.53e-6   0.40    2.7e-5 4.0e-14 6.2e-11
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  2.350e+03 840.0    0.60    0.79      0    0     .5   2.13e-5   1.8   1.
 0
```

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```
DXYZ   2
: (dx(i),i=1,nx)
0.5 0.5 0.75 0.75 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.5 1.5 1.0 1.0 1.0 1.0 1.0 1.0 1.0
0.75 0.65 0.1 0.5 0.5
: (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
: il i2 jl j2 kl k2 iist ithrm vb   por permx permy  permz  pormm permm
   1 25  1  1  1  1   1    7   0.
   1 25  1  1  2  6   1    1   0.
   1 25  1  1  7 10   2    2   0.
   1 25  1  1 11 35   3    3   0.
   1 25  1  1 36 36   4    4   0.
   1 25  1  1 37 39   5    5   0.
   1 25  1  1 40 42   6    6   0.
   1 25  1  1 43 43   6    6   6.2832e7
  23 23  1  1  1 43   8    8   0
:
0
Init
:  il   i2   jl   j2   kl   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
   20   20    1    1    1    1 9.99999E+04   13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   21   21    1    1    1    1 9.99999E+04   13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   22   22    1    1    1    1 9.99999E+04   13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   23   23    1    1    1    1 9.99999E+04   13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   24   24    1    1    1    1 9.99999E+04   13.0480 2.3765E-01 0.0000E+00 2.3765E-01
   25   25    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
   24   24    1    1    2    2 1.00190E+05   13.2832 2.5186E-01 0.0000E+00 2.5186E-01
   25   25    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
   24   24    1    1    3    3 1.00380E+05   13.5189 2.7121E-01 0.0000E+00 2.7121E-01
```

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```
   25   25    1    1    3    3 1.00380E+05   13.5189 2.7121E-01 0.0000E+00 2.7121E-01
    1    1    1    1   20   20 1.03978E+05   18.7105 3.1312E-01 0.0000E+00 3.1312E-01
    2    2    1    1   20   20 1.03978E+05   18.7105 3.1312E-01 0.0000E+00 3.1312E-01
   24   24    1    1   20   20 1.03978E+05   18.7105 3.1312E-01 0.0000E+00 3.1312E-01
   25   25    1    1   20   20 1.03978E+05   18.7105 3.1312E-01 0.0000E+00 3.1312E-01
    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
   24   24    1    1   43   43 1.07983E+05   24.9873 1.2282E-05 0.0000E+00 1.2282E-05
   25   25    1    1   43   43 1.07983E+05   24.9873 1.2282E-05 0.0000E+00 1.2282E-05
0 0 0 0 0 0 0 0 0 0 0 0 0
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+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
:
```

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```
:Limit dpmx    dsmx dtmpmx dp2mx dtmn dtmx icutmx
LIMIT  1.e5    .08    10.    1.e5  1.e-5 1.e5
:
Source  41   1.333   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 9.513e-9
0
    7   1   1   1
0. 13.05 9.513e-9
0
    8   1   1   1
0. 13.05 9.513e-9
0
    9   1   1   1
0. 13.05 9.513e-9
0
   10   1   1   1
0. 13.05 9.513e-9
0
   11   1   1   1
0. 13.05 9.513e-9
0
   12   1   1   1
0. 13.05 1.427e-8
0
   13   1   1   1
0. 13.05 1.427e-8
0
   14   1   1   1
0. 13.05 9.513e-9
0
   15   1   1   1
0. 13.05 9.513e-9
0
   16   1   1   1
0. 13.05 9.513e-9
0
   17   1   1   1
0. 13.05 9.513e-9
0
   18   1   1   1
0. 13.05 9.513e-9
0
   19   1   1   1
0. 13.05 9.513e-9
0
   20   1   1   1
0. 13.05 9.513e-9
0
   21   1   1   1
0. 13.05 7.135e-9
0
   22   1   1   1
0. 13.05 6.184e-9
0
   23   1   1   1
0. 13.05 9.513e-10
0
   24   1   1   1
0. 13.05 4.756e-9
0
   25   1   1   1
0. 13.05 4.756e-9
```

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```
:NOTE: all power terms are multiplied by 1.33 (see above)
:41.5 kW Source (for surface area = 22 m^2)
:  is  js  ks  istyp
    1   1  23   3
: timeq(sec)    T/qht (C/(J/s))     qmt (kg/s) 80APD
0.00000E+00     2.82000E+01
6.31152E+07     2.63000E+01
1.26230E+08     2.48000E+01
1.89346E+08     2.36000E+01
2.52461E+08     2.26000E+01
3.15576E+08     2.17000E+01
4.73364E+08     1.98000E+01
6.31152E+08     1.81000E+01
9.46728E+08     1.54000E+01
1.26230E+09     1.32000E+01
1.57788E+09     1.14000E+01
2.36682E+09     8.44000E+00
3.15576E+09     6.72000E+00
4.73364E+09     4.95000E+00
6.31152E+09     4.00000E+00
9.46728E+09     3.20000E+00
1.26230E+10     2.75000E+00
1.57788E+10     2.39000E+00
1.89346E+10     2.08000E+00
2.52461E+10     1.67000E+00
3.15576E+10     1.41000E+00
3.94470E+10     1.15000E+00
4.73364E+10     9.81000E-01
6.31152E+10     7.58000E-01
7.88940E+10     6.63000E-01
9.46728E+10     5.95000E-01
1.26230E+11     5.31000E-01
1.57788E+11     4.90000E-01
1.89346E+11     4.49000E-01
2.20903E+11     4.18000E-01
2.52461E+11     3.93000E-01
2.84018E+11     3.71000E-01
3.15576E+11     3.53000E-01
3.47134E+11     3.25000E-01
3.78691E+11     3.01000E-01
4.10249E+11     2.81000E-01
4.41806E+11     2.64000E-01
4.73364E+11     2.48000E-01
5.52258E+11     2.17000E-01
6.31152E+11     1.93000E-01
7.88940E+11     1.59000E-01
9.46728E+11     1.36000E-01
1.26230E+12     9.72000E-02
1.57788E+12     7.35000E-02
1.89346E+12     5.63000E-02
2.20903E+12     4.53000E-02
2.52461E+12     3.73000E-02
2.84018E+12     3.15000E-02
3.15576E+12     2.71000E-02
4.73364E+12     1.97000E-02
0
:41.5 kW Source (for surface area = 22 m^2)
:  is  js  ks  istyp
    1   1  24   3
: timeq(sec)    T/qht (C/(J/s))     qmt (kg/s) 80APD
0.00000E+00     2.82000E+01
6.31152E+07     2.63000E+01
1.26230E+08     2.48000E+01
1.89346E+08     2.36000E+01
2.52461E+08     2.26000E+01
3.15576E+08     2.17000E+01
4.73364E+08     1.98000E+01
:20.75 kW Source (for surface area = 22 m^2)
:  is  js  ks  istyp
   24   1  23   3
: timeq(sec)    T/qht (C/(J/s))     qmt (kg/s) 80APD
0.00000E+00     1.41000E+01
6.31152E+07     1.32000E+01
1.26230E+08     1.24000E+01
1.89346E+08     1.18000E+01
2.52461E+08     1.13000E+01
3.15576E+08     1.08000E+01
4.73364E+08     9.90000E+00
```

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```
6.31152E+08     9.05000E+00
9.46728E+08     7.70000E+00
1.26230E+09     6.60000E+00
1.57788E+09     5.70000E+00
2.36682E+09     4.22000E+00
3.15576E+09     3.36000E+00
4.73364E+09     2.48000E+00
6.31152E+09     2.00000E+00
9.46728E+09     1.60000E+00
1.26230E+10     1.38000E+00
1.57788E+10     1.20000E+00
1.89346E+10     1.04000E+00
2.52461E+10     8.35000E-01
3.15576E+10     7.05000E-01
3.94470E+10     5.75000E-01
4.73364E+10     4.90000E-01
6.31152E+10     3.79000E-01
7.88940E+10     3.32000E-01
9.46728E+10     2.98000E-01
1.26230E+11     2.66000E-01
1.57788E+11     2.45000E-01
1.89346E+11     2.24000E-01
2.20903E+11     2.09000E-01
2.52461E+11     1.96000E-01
2.84018E+11     1.86000E-01
3.15576E+11     1.76000E-01
3.47134E+11     1.62000E-01
3.78691E+11     1.50000E-01
4.10249E+11     1.40000E-01
4.41806E+11     1.32000E-01
4.73364E+11     1.24000E-01
5.52258E+11     1.08000E-01
6.31152E+11     9.65000E-02
7.88940E+11     7.95000E-02
9.46728E+11     6.80000E-02
1.26230E+12     4.86000E-02
1.57788E+12     3.68000E-02
1.89346E+12     2.82000E-02
2.20903E+12     2.26000E-02
2.52461E+12     1.86000E-02
2.84018E+12     1.58000E-02
3.15576E+12     1.36000E-02
4.73364E+12     9.85000E-02
0
:20.75 kW Source (for surface area = 22 m^2)
:  is  js  ks  istyp
   24   1  24   3
: timeq(sec)    T/qht (C/(J/s))     qmt (kg/s) 80APD
0.00000E+00     1.41000E+01
6.31152E+07     1.32000E+01
1.26230E+08     1.24000E+01
1.89346E+08     1.18000E+01
2.52461E+08     1.13000E+01
3.15576E+08     1.08000E+01
4.73364E+08     9.90000E+00
0
:
:       print all at every target time
PLOTS 1 6 7 25 555
:      target  dt    dpmx  dsmx  dp2mx  dtmpmx
Time[y]  10.
Time[y]  100.
Time[y]  1000.
Time[y]  5000.
Time[y]  10000.
Time[y]  100000.
rstart 1 0
:
SKIP
Steady[y]  1.e+1 1.e-1 1.e-4
NOSKIP
Ends
```

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NEW METRA RUN – "25x43-10cm-noheat-SS.dat", IDENTICAL TO "25x43-10cm-SS.3+27.7.dat" EXCEPT HEAT IS TURNED OFF AND IT WILL RUN UNTIL STEADY-STATE IS REACHED. THE OUTPUT FROM THIS RUN WILL BE USED AS THE INITIAL CONDITIONS FOR RUNS WITH A 10 cm WIDE FRACTURE. RUNS ...SS-3+27.7 AND ...41.5+41.5... WILL BE RE-DONE.

4-9-96
MR

NEW RUN: "25X43-10cm-0.1alpha-SS.dat" -
IDENTICAL TO "25X43-10cm-noheat-SS.dat"
EXCEPT VAN GENUCHTEN α OF FRACTURE IS
DECREASED BY A FACTOR OF 10 TO SEE WHAT
HAPPENS TO FRACTURE SATURATION @ STEADY STATE.

IN: /home/sneezy/rgreen/multi/tspa/grice/
2-heaters/fracture/10cm/SS

NOTE: *0.1alpha* DOES NOT GIVE VALID RESULTS -
OUTPUT FULL OF "NaN"s - NOT A #.
MULTIPLICATION OF α BY 0.5 ALSO RESULTS
IN ERRORS: "WATER DENSITY DERIVATIVES BAD".

- IN "24x43-10cm-SS-3+27.7_out" - ALSO
GET "NaN"s AFTER 10 YEARS -
OUTPUT FOR 10 YEARS APPEARS TO BE
O.K.

CALL PETER LICHTNER: X6084

PUT FILES IN SKIPPY - works &
CRASHS.dat.

NEW RUN: "25X43-1cm-noheat-SS.dat",
IDENTICAL TO "25X43-10cm-noheat-SS.dat"
EXCEPT THAT FRACTURE IS 1cm WIDE INSTEAD
OF 10 cm WIDE.

IN: /home/sneezy/rgreen/multi/tspa/grice/
2-heaters/Fracture/1cm/SS

MR
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MR

NEW RUN: "25X43-1cm-SS-3+27.7" - FRACTURE IS 1cm
WIDE AND INITIAL CONDITIONS ARE TAKEN FROM
STEADY STATE RUN: * "25-43-1cm-noheat-SS.dat"

IN: /home/sneezy/rgreen/multi/tspa/grice/
2-heaters/fracture/1cm/SS-3+27.7

4-11-96
MR

RUN "25X43-1cm-SS-3+27.7.dat" STOPPED AFTER
~ 4300 TIMESTEPS, GOT TO ≅ 14 YRS, Δt = 0.0001 YR.

- RE RUN "25X43-10cm-SS-3+27.7.dat"
WITH LATEST VERSION OF METRA.
~~MISTAKE, THIS FILE WORKED BEFORE~~ MR 4-11-96

DID NOT WORK - SAME AS BEFORE - OUTPUT
FOR 10 YRS O.K. BUT ≥ 100 YRS
CONTAINS "NaN"s IN COLUMNS FOR
press, temp, sl, etc. - CALL PETER &
TELL HIM

4-12-96
MR

DESIGNING NEW MODEL - AFTER TSPA -
MODEL WILL INCORPORATE BACKFILL AND/OR
AIR SPACE AROUND WASTE PACKAGES.

ON NEXT PAGE, SHOW HOW CIRCULAR
DRIFT & WASTE PACKAGE ARE REPRESENTED
IN METRA AS RECTANGLES.

MR 4-12-96

4-12-96
MR

MR 4-12-96

FROM: TASP, 11/95

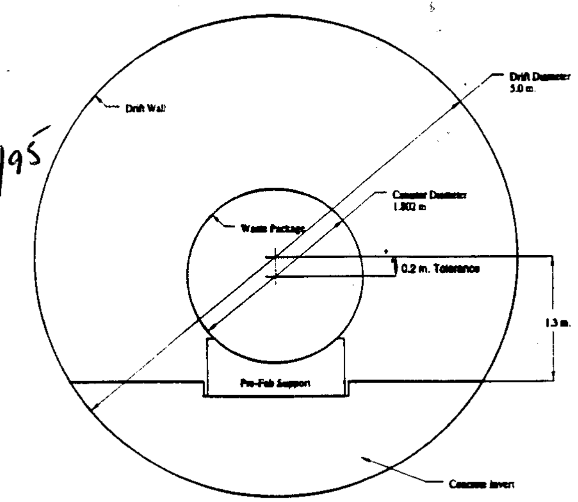


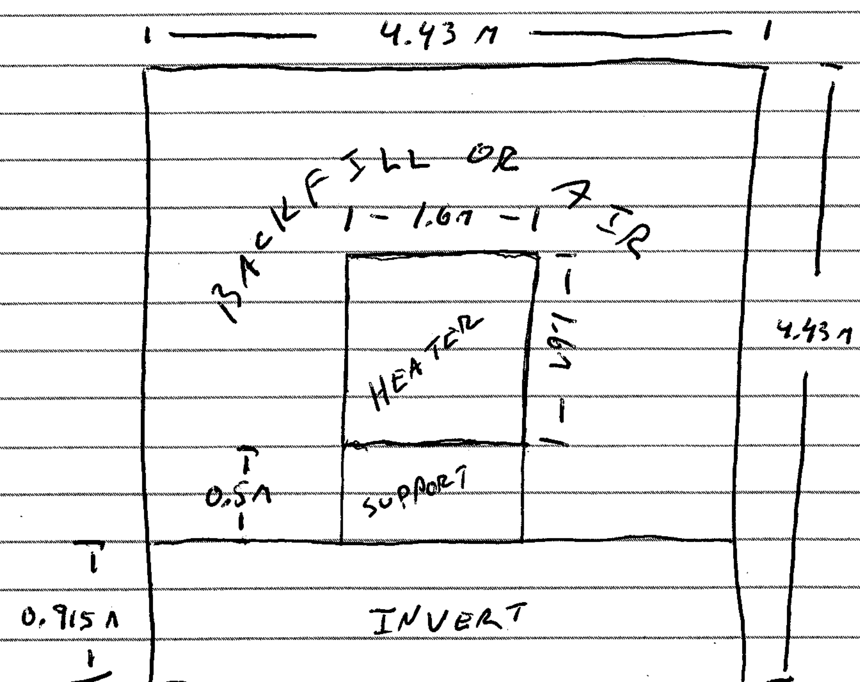
Figure ES.4-3 Emplacement drift design for the CIDP option (after M&O, 1995f)

MR 4-12-96

FOR DIM = 5 M, AREA = $\pi (2.5\,m)^2 = 19.63\,m^2$

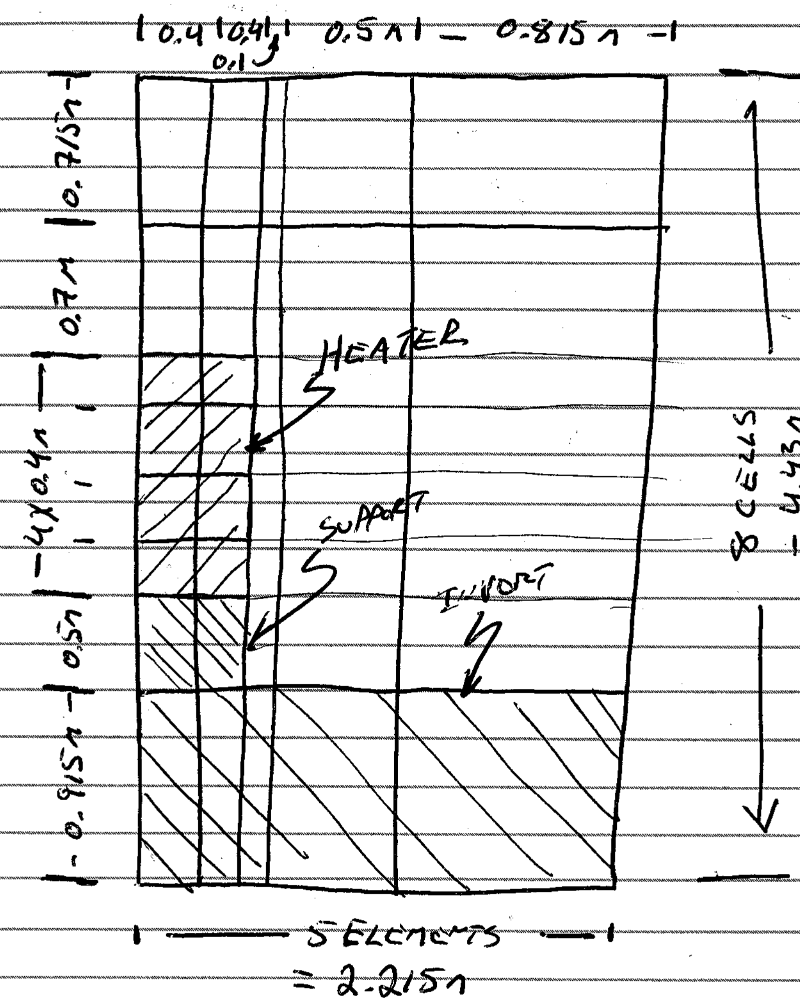
"EQUIVALENT SQUARE" = $(19.63\,m^2)^{\frac{1}{2}} = 4.43\,m \times 4.43\,m$

FOR DIM = 1.8 M, EQUIVALENT SQUARE = ~~2.54 m X 2.54 m~~ 1.60 m X 1.60 m MR 4-12-96



4-12-96
MR

DISCRETIZED 1/2 DRIFT:

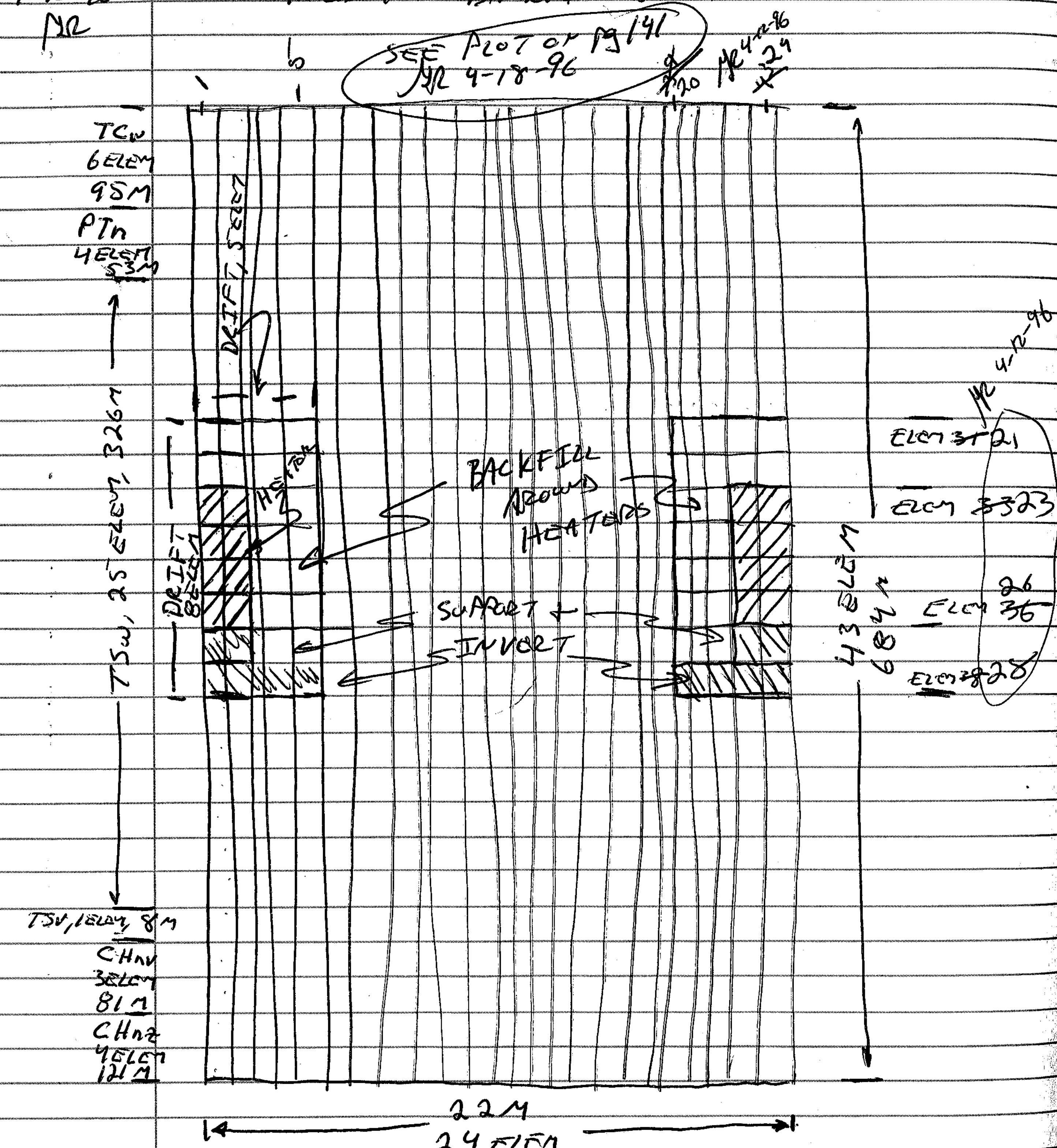


DEPTH OF CENTER OF HEATER = 344 m MR 4-12-96
DEPTH OF BOTTOM OF DRIFT = 344 m + ~~0.5 + 0.5~~ 0.4 + 0.4 + 0.5 + 0.915 = 346.215 M
DEPTH OF TOP OF TOPOPAH SPRINGS UNIT = 148 m
DEPTH OF BOTTOM OF TOPOPAH SPRINGS UNIT = 474 M

MR 4-12-96

4-12-96
NR

GRID FOR BACKFILL SIMULATIONS:



4-12-96
NR

FIRST BACKFILL RUN: "back-1.dat" - GO TO STEADY STATE, USE OUTPUT AS INPUT FOR PROBLEMS WITH HEAT SOURCES.

THIS RUN CONTAINS INITIAL CONDITIONS THAT WERE THE OUTPUT FROM ~~"24x4"~~ NR 4-12-96 "24x43-SS-noheat-3.dat".

IN: /home/sneezy/rgreen/multi/tspa/grice/backfill

RUN FAILED: OUTPUT CONTAINS MANY 'NaN's.

4-15-96
NR

NEW RUN: "noback-1.dat" - SAME AS "back-1.dat" WITH BACKFILL REMOVED - CELLS ARE NOW TSw INSTEAD OF BACKFILL - RUN FINISHED 10^5 YRS IN ≈172 s. 10^5 YR - OUTPUT CONTAINS NO 'NaN's

NEW RUN: "altback-1.dat" - IDENTICAL TO 'back-1.dat' EXCEPT AIR ENTRY VALUE OF BACKFILL MATRIX (α) INCREASED ~~THE~~ NR 4-15-96 BY A FACTOR OF 10: 1/α CHANGED FROM 1.11×10^{-5} TO 1.11×10^{-6} /Pa.

RUN DONE IN ≈180 s, - OUTPUT CONTAINS NO NaN's -

IN: /home/sneezy/rgreen/multi/tspa/grice/backfill
→ multi

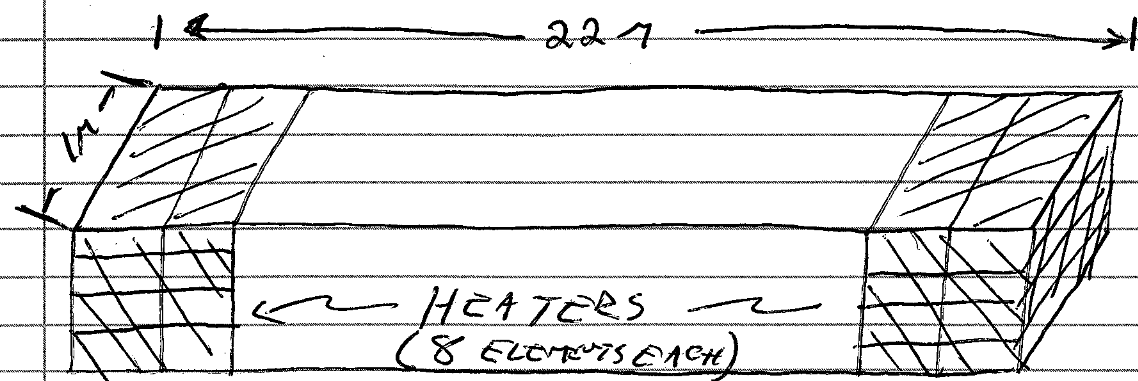
NR 4-15-96

4-15-96
RR

NEW RUN: "altback-1-41.5+41.5.dat" – IDENTICAL TO "altback-1.dat" EXCEPT HEAT TURNED ON. RATE = 83 KW/AC – AS FIGURED BELOW:

IN: /home/sneezy/rgreen/multi/tspa/grice/backfill/heat

HEATING (INITIAL) RATE CALCULATED AS FOLLOWS:



- INITIAL HEAT OUTPUT OF EACH ELEMENT = 62.1 W
- MULTIPLY ALL HEAT OUTPUTS BY FACTOR OF 0.454 ('FAC H' IN METRA)

THEN:

$$\frac{(0.454)8(62.1\,W) + (0.454)8(62.1\,W)}{22\ M^2} \quad \frac{4047\ M^2}{AC}$$

$$= 82{,}981\ \frac{W}{AC} \longrightarrow 83\ KW/AC$$

4-16-95
RR

RUN 'altback-1-41.5+41.5' DONE IN 1126 TIMESTEPS, ~14,966 s.

4-16-96 RR · NEW RUN: 'altback-2-41.5+41.5.dat' – IDENTICAL TO 'altback-1-41.5+41.5.dat' EXCEPT MATRIX α (OF BACKFILL) ONLY REDUCED BY A FACTOR OF TWO FROM VALUE GIVEN IN TSPA.

MATRIX α = 5.55×10^{-6}/Pa INSTEAD OF 1.11×10^{-5}/Pa (TSPA VALUE)

IN: /home/sneezy/rgreen/multi/tspa/grice/backfill/heat

INPUT: 'altback-1-41.5+41.5.dat'

RR 4-16-96

```
Altered Backfill, air entry value of backfill matrix increased by factor of 10 (
  1/alpha changed from 1.11E-5 to 1.11E-6,   April 15, 1996
: 24X43 Grid
: added 0.3 mm/yr infiltration using source terms, not bcon
: heat added to 16 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       24  1   43  1        1      1     0    0
:
Monitor
 555
debug 1
0
Pckr                                :relative perm and pc keyword
:   i  type-curv swir   rpm(lamda)  alpha    pcwmx  sgc  iecm
:              swirm  rpmm(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        1.305e-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        1.305e-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        1.305e-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        1.305e-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        1.305e-5  50.      0.  1
               0.110  0.3800    3.13e-7  .306    1.8e-3 2.0e-18 3.9e-12
: 7 = Backfill, from TSPA '95 pg 4-18.
    7  Van-Gen  0.040  .7636        1.305e-5  50.      0.  1
               0.010  0.7000    1.11e-6  0.50    1.8e-3 3.9e-14 3.9e-12
0          :blank line
:
```

RR 4-16-96

4-16-96

INPUT - 'altback-1-41.5+41.5.dat' (CONT)

4-16-96

SHOULD BE 1.42 4-16-96

CHANGED IN SUBSEQUENT RUNS.

```
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 = Backfill, from TSPA '95 pg 4-18.
  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)
0.4 0.4 0.1 0.5 0.815 0.785 1.33 1.33 1.33 1.33
1.33 1.35 1.35 1.33 1.33 1.33 1.33 1.33 0.785 0.815
0.5 0.1 0.4 0.4
```

4-16-96

```
: (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. 2.785
.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 24  1  1  1  1   1   7   0.
   1 24  1  1  2  6   1   1   0.
   1 24  1  1  7 10   2   2   0.
   1 24  1  1 11 35   3   3   0.
   1 24  1  1 36 36   4   4   0.
   1 24  1  1 37 39   5   5   0.
   1 24  1  1 40 42   6   6   0.
   1 24  1  1 43 43   6   6   6.2832e7
   1  5  1  1 21 28   7   8
  20 24  1  1 21 28   7   8
   1  2  1  1 23 26   3   3
  23 24  1  1 23 26   3   3
:
0
Init
: i1  i2  j1  j2  k1  k2       p            t         sg          xg2         sgm
   1   1   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
   2   2   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
   3   3   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
   4   4   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
   5   5   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
   6   6   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
   7   7   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
   8   8   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
   9   9   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  10  10   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  11  11   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  12  12   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  13  13   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  14  14   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  15  15   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  16  16   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  17  17   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  18  18   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  19  19   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  20  20   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  21  21   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  22  22   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  23  23   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  24  24   1   1   1   1 9.87110E+04   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
   1   1   1   1  42  42 1.06216E+05   24.4366 8.3234E-03 0.0000E+00 8.3234E-03
   2   2   1   1  42  42 1.06216E+05   24.4366 8.3234E-03 0.0000E+00 8.3234E-03
   3   3   1   1  42  42 1.06216E+05   24.4366 8.3234E-03 0.0000E+00 8.3234E-03
   4   4   1   1  42  42 1.06216E+05   24.4366 8.3234E-03 0.0000E+00 8.3234E-03
   5   5   1   1  42  42 1.06216E+05   24.4366 8.3234E-03 0.0000E+00 8.3234E-03
   6   6   1   1  42  42 1.06216E+05   24.4366 8.3234E-03 0.0000E+00 8.3234E-03
   7   7   1   1  42  42 1.06216E+05   24.4366 8.3234E-03 0.0000E+00 8.3234E-03
```

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INPUT - 'altback-1-41.5+41.5.dat' (CONT)

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```
  11  11   1   1  42  42 1.06216E+05   24.4365 8.3234E-03 0.0000E+00 8.3234E-03
  12  12   1   1  42  42 1.06216E+05   24.4365 8.3234E-03 0.0000E+00 8.3234E-03
  13  13   1   1  42  42 1.06216E+05   24.4365 8.3234E-03 0.0000E+00 8.3234E-03
  14  14   1   1  42  42 1.06216E+05   24.4365 8.3234E-03 0.0000E+00 8.3234E-03
  15  15   1   1  42  42 1.06216E+05   24.4365 8.3234E-03 0.0000E+00 8.3234E-03
  16  16   1   1  42  42 1.06216E+05   24.4365 8.3234E-03 0.0000E+00 8.3234E-03
  17  17   1   1  42  42 1.06216E+05   24.4366 8.3234E-03 0.0000E+00 8.3234E-03
  18  18   1   1  42  42 1.06216E+05   24.4366 8.3234E-03 0.0000E+00 8.3234E-03
  19  19   1   1  42  42 1.06216E+05   24.4366 8.3234E-03 0.0000E+00 8.3234E-03
  20  20   1   1  42  42 1.06216E+05   24.4366 8.3234E-03 0.0000E+00 8.3234E-03
  21  21   1   1  42  42 1.06216E+05   24.4366 8.3234E-03 0.0000E+00 8.3234E-03
  22  22   1   1  42  42 1.06216E+05   24.4366 8.3234E-03 0.0000E+00 8.3234E-03
  23  23   1   1  42  42 1.06216E+05   24.4367 8.3234E-03 0.0000E+00 8.3234E-03
  24  24   1   1  42  42 1.06216E+05   24.4367 8.3234E-03 0.0000E+00 8.3234E-03
0 0 0 0 0 0 0 0 0 0 0 0 0 0
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+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  40    0.454    1.000
:  is  js  ks  istyp
    1   1   1   1
0. 13.05 3.805e-9
0
    2   1   1   1
0. 13.05 3.805e-9
0
    3   1   1   1
0. 13.05 9.513e-10
0
    4   1   1   1
0. 13.05 4.756e-9
0
    5   1   1   1
0. 13.05 7.753e-9
0
    6   1   1   1
0. 13.05 7.468e-9
0
    7   1   1   1
0. 13.05 1.265e-8
0
    8   1   1   1
0. 13.05 1.265e-8
0
    9   1   1   1
0. 13.05 1.265e-8
0
   10   1   1   1
0. 13.05 1.265e-8
0
   11   1   1   1
0. 13.05 1.265e-8
0
   12   1   1   1
0. 13.05 1.284e-8
0
   13   1   1   1
0. 13.05 1.284e-8
0
   14   1   1   1
0. 13.05 1.265e-8
0
   15   1   1   1
0. 13.05 1.265e-8
0
   16   1   1   1
0. 13.05 1.265e-8
0
   17   1   1   1
0. 13.05 1.265e-8
0
   18   1   1   1
0. 13.05 1.265e-8
0
   19   1   1   1
0. 13.05 7.468e-9
0
   20   1   1   1
0. 13.05 7.753e-9
0
   21   1   1   1
0. 13.05 4.756e-9
0
   22   1   1   1
0. 13.05 9.513e-10
0
   23   1   1   1
0. 13.05 3.805e-9
0
   24   1   1   1
0. 13.05 3.805e-9
0
:
:SKIP
:
    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
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
```

4-16-96

4-16-96

4-16-96

4-16-96

4-16-96
NR

INPUT - 'altback-1-41.5+41.5-dat' (concl)

NR 4-16-96

```
: is js ks istyp
  24  1  26   3
: timeq(sec)    T/qht (C/(J/s))
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
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
PLOTS 1 6 7 25 555
:       target  dt     dpmx    dsmx    dp2mx    dtmpmx
Time[y]  10.
Time[y]  100.
Time[y]  1000.
Time[y]  5000.
Time[y]  10000.
Time[y]  100000.
rstart 1 0
:
SKIP
Steady[y]  1.e+1 1.e-1 1.e-4
NOSKIP
Ends
```

NR 4-16-96

NR 4-16-96

NEW RUN - "altback-2-52.6+52.6_dat"
- SAME AS "altback-2-41.5+41.5_dat (pg 135)
EXCEPT POWER OUTPUT INCREASED TO ACCOUNT FOR 'SMEARING' AS WAS DONE FOR TSPA (SEE pg 4-5 OF 1995 TSPA). POWER INPUT MULTIPLIED BY 19/15 → 105.1 KW/AC

→ ALSO, HEAT SOURCE TERMS CHANGED SO THEY DECAY AT SAME RATE AS SHOWN IN FIGURE 4.2-3 OF THE '95 TSPA.

4-17-96
NR

RUN "altback-2-52.6+52.6-dat" DONE IN ≃5.8×10⁴s, 3612 TIMESTEPS, (FIRST 3500 TIMESTEPS SPENT ON T < 100 YRS)
→ CRASHED @ ≃ 95 YRS - OUTPUT FOR t ≥ 100 YRS CONTAINS "NaN"'s

NR 4-17-96

4-17-96
NR

NEW RUN: "altback-3-52.6+52.6-dat" -
IDENTICAL TO "altback-2-52.6+52.6-dat"
EXCEPT AIR ENTRY VALUE INCREASED BY A FACTOR OF FOUR — MATRIX α OF BACKFILL DECREASED BY A FACTOR OF 4:
1.11×10^{-5}/Pa (TSPA VALUE)
→ 2.78×10^{-6}/Pa

IN: /home/sneezy/rgreen/multi/tspa/gvice/backfill/heat

4-17-96
NR

POWER INPUT TO "altback-3-52.6+52.6.dat"

```
: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
0
```

NR 4-17-96

NR 4-17-96

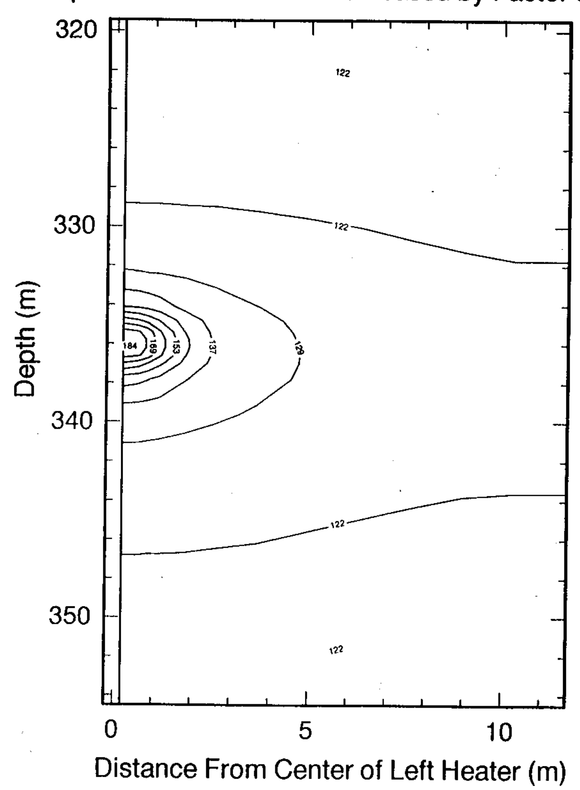
NR 4-17-96

4-18-96
MR

MR 4-18-96

(2D) || Print || 18 Apr 1996 || altback-3-52.6+52.6fld2.plt || Alt-Backfill, Alpha/4, TPPA decay, 2-Heaters, 52.6+52.6 kW, 100 yrs MR 4-18-96

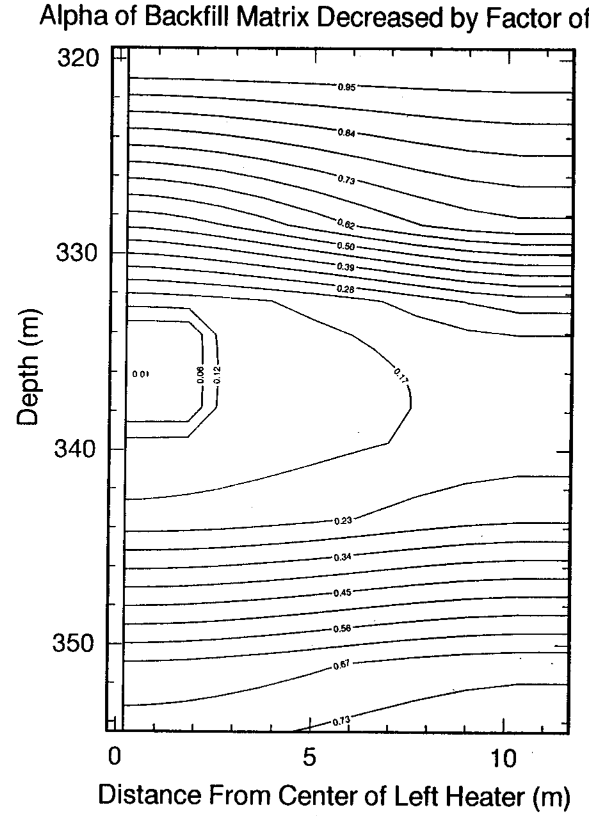
"Smeared" Temperature at 100 Years
Alpha of Backfill Matrix Decreased by Factor of 4



/home/sneezy/rgreen/multi/tspa/grice/backfill/heat/temp-alt-3-52.6-100.ps

(2D) || Print || 18 Apr 1996 || altback-3-52.6+52.6fld2.plt || Alt-Backfill, Alpha/4, TPPA decay, 2-Heaters, 52.6+52.6 kW, 100 yrs MR 4-18-96

Liquid Saturation at 100 Years
Alpha of Backfill Matrix Decreased by Factor of 4



/home/sneezy/rgreen/multi/tspa/grice/backfill/heat/sat-alt-3-526-100.ps

MR 4-18-96

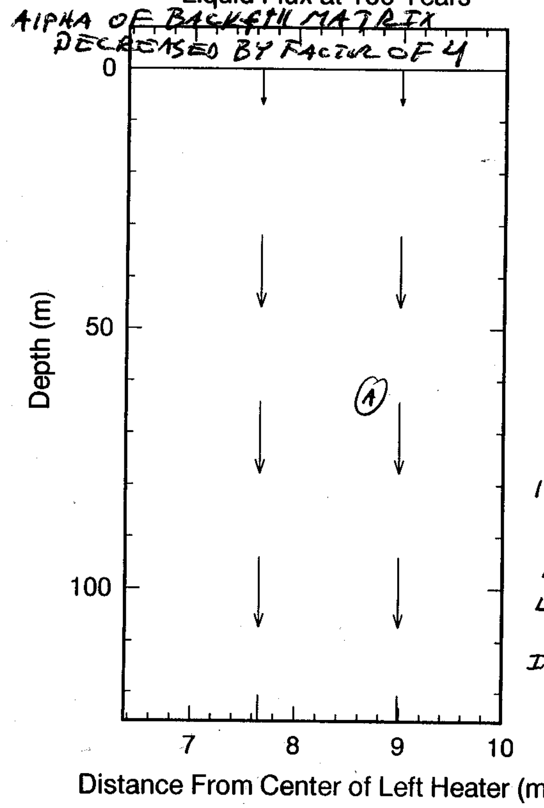
4-18-96
MR

MR 4-18-96

(2D) || Print || 18 Apr 1996 || altback-3-52.6+52.6flx2.plt || 2-Heaters, Alt-3, 52.6+52.6kW, 100 Years MR 4-18-96

Liquid Flux at 100 Years

ALPHA OF BACKFILL MATRIX DECREASED BY FACTOR OF 4



/home/sneezy/rgreen/multi/tspa/grice/backfill/heat/
~~ligflux/~~ MR 4-18-96
ligflux-alt-3-52.6-100-1.ps

CHECK INFILTRATION RATE:

Reference Vector = 1E-8 kg/m²-s

$$1\times10^{-8}\frac{kg}{m^2\text{-}s}\;\frac{m^3}{10^3\,kg}\;\frac{86{,}400\,s}{DAY}\;\frac{365\,DAY}{YR} = 3.15\times10^{-4}\,m/YR$$

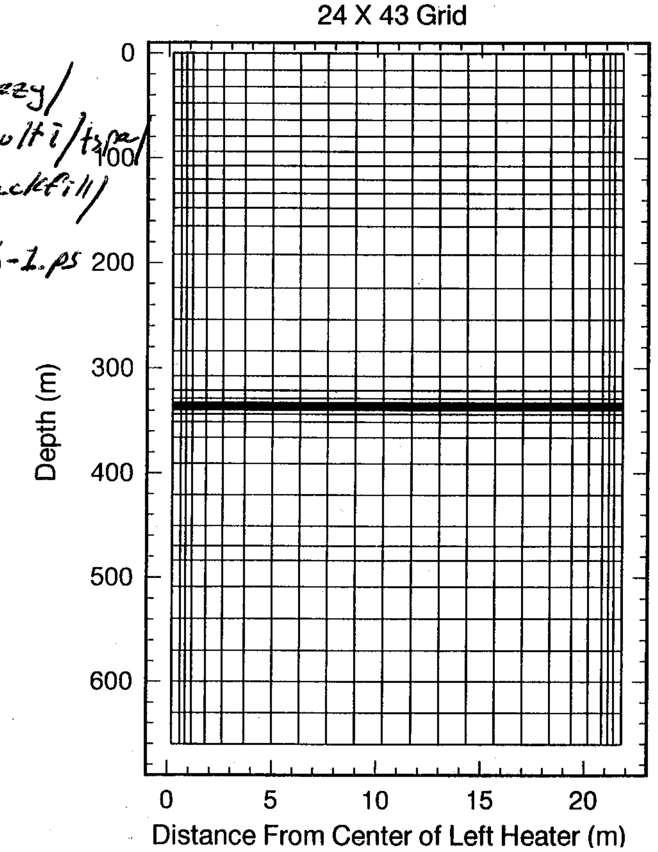
LENGTH OF REFERENCE VECTOR = 1.55 cm = R
LENGTH OF VECTOR A = 1.45 cm = A

INFILTRATION RATE:

$$\frac{A}{R}\,3.15\times10^{-4}\frac{m}{YR} = 2.96\times10^{-4}\frac{m}{YR} \approx 0.3\frac{mm}{YR}$$

(2D) || Print || 18 Apr 1996 || altback-3-52.6+52.6flx2.plt || 2-Heaters, Alt-3, 52.6+52.6kW, 100 Years MR 4-18-96

24 X 43 Grid



/home/sneezy/rgreen/multi/tspa/grice/backfill/heat/mesh-1.ps

MR 4-18-96

4-22-96
MR

NEW INPUT: "AIRBACK-1-52.6+52.6.dat" —
~~IDENTICAL~~ MR 4-22-96, BASED ON
"allback-3-526+52.6.dat" EXCEPT WASTE PACKAGE
IS METAL + DRIFT CONTAINS "AIR".

FROM CRC - PAGE F-11 (62ND ED), DENSITY OF
DRY AIR @ 20°C & 760 mm Hg =

$$\frac{1.204\ mg}{cm^3}\ \frac{10^6\ cm^3}{m^3}\ \frac{g}{10^3\ mg}\ \frac{kg}{10^3\ g} = \frac{1.204\ kg}{m^3}$$

FROM CRC - PAGE F-12, SPECIFIC HEAT OF AIR

$$\simeq \frac{0.24\ cal}{g\,°K}$$

4.184 cal = 1 JOULE (CRC, pg F-284)

MR 4-22-96

$$\frac{0.24\ cal}{g\ K}\ \frac{JOULE}{4.184\ cal}\ \frac{10^3\ g}{kg} = \frac{57.4\ J}{kg\ K}$$

NEW INPUT: "airback-2-52.6+52.6.dat" —
IDENTICAL TO "airback-1-52.6+52.6.dat"
EXCEPT THERMAL CONDUCTIVITY OF AIR
= 0.1 W/m-K INSTEAD OF 50 W/m-K.

IN: /home/sneezy/rgreen/multi/
tspa/grice/backfill2

MR
4-22-96

4-22-96
MR

INPUT: "airback-2-52.6+52.6.dat"

MR 4-22-96

```
Air Backfill with Metal Waste Package, (initial data : 2D, Yucca Mt.)
  Air Thermal K = Low  April 22, 1996
: 24X43 Grid
: added 0.3 mm/yr infiltration using source terms, not bcon
: heat added to 16 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       24  1   43   1      1       1     0    0
:
Monitor
 555
debug 1
0
Pckr                               :relative perm and pc keyword
:   i  type-curv swir   rpm(lamda)  alpha    pcwmx  sgc  iecm
:                swirm  rpmm(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       1.305e-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       1.305e-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       1.305e-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       1.305e-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       1.305e-5  50.      0.  1
                 0.110  0.3800    3.13e-7  .306    1.8e-3 2.0e-18 3.9e-12
: 7 = Backfill, from TSPA '95 pg 4-18.
    7  Van-Gen   0.040  .7636       1.305e-5  50.      0.  1
                 0.010  0.7000    2.78e-6  0.50    1.8e-3 3.9e-14 3.9e-12
: 8 = Metal Waste Package, Assumed Hydraulic Properties, Saturation Set to
: Near Zero in Init.
    8  Van-Gen   0.010  .7636       1.305e-5  50.      0.  1
                 0.010  0.4400     5.8e-7  1.0e-1    1.0e-1 1.0e-99 1.0e-99
: 9 = Air Around Metal Waste Package, Assumed Hydraulic Properties, Saturation S
: Near Zero in Init.
    9  Van-Gen   0.010  .7636       1.305e-5  50.      0.  1
                 0.010  0.4400     5.8e-7  9.999e-1 9.999e-1 1.0e-99 1.0e-99
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.    1.42   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 = Backfill, from TSPA '95 pg 4-18.

  8  2.580e+03 840.0   0.60   0.79     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.
:10 =Air Around Metal Waste Package, rho & cpr from CRC, other Properties Assume
 10  1.200e-00 57.4   0.1    0.1       0    0     0.0  2.13e-0  1.8  1.
0
:     igrid   rw      re
DXYZ   2
: (dx(i),i=1,nx)
0.4 0.4 0.1 0.5 0.815 0.785 1.33 1.33 1.33 1.33
1.33 1.35 1.35 1.33 1.33 1.33 1.33 1.33 0.785 0.815
0.5 0.1 0.4 0.4
: (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.
```

MR 4-22-96

4-22-96
NR

INPUT "airback-2-52.6+52.6.dat" (concl.)

```
PhiK
: il i2 j1 j2 k1 k2 iist ithrm vb  por permx permy  permz  pormm permm
   1 24  1  1  1  1   1    7   0.
   1 24  1  1  2  6   1    1   0.
   1 24  1  1  7 10   2    2   0.
   1 24  1  1 11 35   3    3   0.
   1 24  1  1 36 36   4    4   0.
   1 24  1  1 37 39   5    5   0.
   1 24  1  1 40 42   6    6   0.
   1 24  1  1 43 43   6    6   6.2832e7
   1  5  1  1 21 28   9   10
  20 24  1  1 21 28   9   10
   1  2  1  1 23 26   8    9
  23 24  1  1 23 26   8    9
:
0
```

NR 4-22-96

NR 4-22-96

4-23-96
NR

RUN "airback-2-52.6+52.6.dat" FAILED AFTER ~ 0.3 YEARS. — PRODUCED OUTPUT FOR t=1 yr & t=10 yr WITH NaN's.

NEW METRA RUN: "airback-3-52.6+52.6.dat" IDENTICAL TO "airback-2-52.6+52.6.dat" EXCEPT THERMAL CONDUCTIVITY OF AIR CHANGED FROM 0.1 W/M-K TO 0.2 W/M-K.

IN: /home/sneezy/rgreen/multi/tspa/grid/backfill2

NOTE — "airback-3-52.6+52.6.dat" ALSO FAILED — NaN's.

NEW RUN: "airback-4-41.5+41.5.dat" — IDENTICAL TO "airback-1-52.6+52.6.dat" EXCEPT THERMAL CONDUCTIVITY OF AIR = 20 W/m-K AND TOTAL POWER OUTPUT @ t=0 = 83 kW/Ac.

OUTPUT @ 100 YEARS FROM THIS RUN WILL BE USED AS INITIAL CONDITIONS FOR NEXT RUN — AIR REPLACED WITH ROCK BACKFILL FOR t > 100 YRS. RUN NAME = "Rockback-4-41.5+41.5.dat" IN: /home/sneezy/rgreen/multi/tspa/grid/backfill2

4-24-96
~~4-23-96~~
NR

INPUT "ROCKBACK-4-41.5+41.5.dat"

NR 4-24-96

```
Rock after 100 yrs of Air Backfill.  Metal Waste Package, (initial data : 2D, Yu
83kW/Ac, Two Heaters: 41.5+41.4kW/Ac, Air Thermal K = High (20W/m-K)  April 23,
: The initial conditions used here were produced by a 100 year run with air surr
: the waste package. Input file = 'airback-4-41.5+41.5.dat'.
: Alpha of backfill matrix reduced by a factor of 5.
: 24X43 Grid
: added 0.3 mm/yr infiltration using source terms, not bcon
: heat added to 16 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       24  1   43   1       1      1     0    0
:
Monitor
 555
debug 1
0
Pckr                                  :relative perm and pc keyword ,
:   i  type-curv swir   rpm(lamda)  alpha    pcwmx  sgc  iecm
:              swirm  rpmm(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        1.305e-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        1.305e-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        1.305e-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        1.305e-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        1.305e-5  50.      0.  1
                0.110  0.3800     3.13e-7  .306     1.8e-3 2.0e-18 3.9e-12
: 7 = Backfill, from TSPA '95 pg 4-18.  Original alpham = 1.11e-5/Pa: value
: below reduced by a factor of 5.
   7  Van-Gen   0.040  .7636        1.305e-5  50.      0.  1
                0.010  0.7000     2.22e-6  0.50     1.8e-3 3.9e-14 3.9e-12
: 8 = Metal Waste Package, Assumed Hydraulic Properties, Saturation Set to
: Near Zero in Init.
   8  Van-Gen   0.010  .7636        1.305e-5  50.      0.  1
                0.010  0.4400     5.8e-7   1.0e-1    1.0e-1 1.0e-99 1.0e-99
: 9 = Air Around Metal Waste Package, Assumed Hydraulic Properties, Saturation S
: Near Zero in Init.
   9  Van-Gen   0.010  .7636        1.305e-5  50.      0.  1
                0.010  0.4400     5.8e-7  9.999e-1 9.999e-1 1.0e-99 1.0e-99
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.    1.42   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 = Backfill, from TSPA '95 pg 4-18.
  8  2.580e+03 840.0   0.60   0.79     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.
:10 =Air Around Metal Waste Package, rho & cpr from CRC, other Properties Assume
 10  1.200e-00 57.4   20.0   20.0      0    0     0.0  2.13e-0  1.8   1.
0
:     igrid   rw      re
DXYZ    2
: (dx(i),i=1,nx)
0.4 0.4 0.1 0.5 0.815 0.785 1.33 1.33 1.33 1.33
1.33 1.35 1.35 1.33 1.33 1.33 1.33 1.33 0.785 0.815
0.5 0.1 0.4 0.4
: (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.
```

NR 4-24-96

NR 4-24-96

4-24-96
MR

INPUT : ROCKBACK-4-41.5+41.5.dat (CONT)

MR 4-24-96

```
PhiK
: il i2 j1 j2 k1 k2 iist ithrm vb  por permx permy permz  pormm permm
   1 24  1  1  1  1   1   7   0.
   1 24  1  1  2  6   1   1   0.
   1 24  1  1  7 10   2   2   0.
   1 24  1  1 11 35   3   3   0.
   1 24  1  1 36 36   4   4   0.
   1 24  1  1 37 39   5   5   0.
   1 24  1  1 40 42   6   6   0.
   1 24  1  1 43 43   6   6   6.2832e7
   1  5  1  1 21 28   7   8
  20 24  1  1 21 28   7   8
   1  2  1  1 23 26   8   9
  23 24  1  1 23 26   8   9
:
0
Init
: il   i2  j1  j2  k1  k2          p            t            sg            xg2          sgm
: From 'airback-4-41.5+41.5' @ 100 yrs.   Time =   0.315360E+10 secs
  1    1    1   1   1    1 1.02880E+05   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  2    2    1   1   1    1 1.02880E+05   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  3    3    1   1   1    1 1.02880E+05   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
 23   23    1   1   1    1 1.02880E+05   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
 24   24    1   1   1    1 1.02880E+05   13.0480 3.6805E-02 0.0000E+00 3.6805E-02
  1    1    1   1   2    2 1.03076E+05   13.2837 3.6835E-02 0.0000E+00 3.6835E-02
  2    2    1   1   2    2 1.03076E+05   13.2837 3.6835E-02 0.0000E+00 3.6835E-02
  3    3    1   1   2    2 1.03076E+05   13.2837 3.6835E-02 0.0000E+00 3.6835E-02
 23   23    1   1   2    2 1.03076E+05   13.2837 3.6835E-02 0.0000E+00 3.6835E-02
 24   24    1   1   2    2 1.03076E+05   13.2837 3.6835E-02 0.0000E+00 3.6835E-02
  1    1    1   1  24   24 1.90189E+05  119.7767 9.9925E-01 0.0000E+00 9.9925E-01
  2    2    1   1  24   24 1.90024E+05  119.6985 9.9925E-01 0.0000E+00 9.9925E-01
  3    3    1   1  24   24 1.45262E+05  119.5673 9.9898E-01 0.0000E+00 9.9898E-01
  4    4    1   1  24   24 1.45098E+05  119.2959 9.9898E-01 0.0000E+00 9.9898E-01
  5    5    1   1  24   24 1.44850E+05  118.8812 9.9898E-01 0.0000E+00 9.9898E-01
  6    6    1   1  24   24 1.47483E+05  117.7312 8.4031E-01 0.0000E+00 8.4031E-01
  7    7    1   1  24   24 1.47418E+05  115.3653 8.1003E-01 0.0000E+00 8.1003E-01
```

MR 4-24-96

MR 4-24-96

```
   8    8   1   1  24   24 1.47231E+05  113.3064 7.4600E-01 0.0000E+00 7.4600E-01
   9    9   1   1  24   24 1.46907E+05  111.9777 6.2549E-01 0.0000E+00 6.2549E-01
  10   10   1   1  24   24 1.46305E+05  111.2585 4.5701E-01 0.0000E+00 4.5701E-01
  11   11   1   1  24   24 1.45681E+05  110.9188 3.3903E-01 0.0000E+00 3.3903E-01
  12   12   1   1  24   24 1.45327E+05  110.7741 2.8567E-01 0.0000E+00 2.8567E-01
  13   13   1   1  24   24 1.45327E+05  110.7741 2.8567E-01 0.0000E+00 2.8567E-01
  14   14   1   1  24   24 1.45681E+05  110.9188 3.3903E-01 0.0000E+00 3.3903E-01
  15   15   1   1  24   24 1.46305E+05  111.2585 4.5701E-01 0.0000E+00 4.5701E-01
  16   16   1   1  24   24 1.46907E+05  111.9777 6.2549E-01 0.0000E+00 6.2549E-01
  17   17   1   1  24   24 1.47231E+05  113.3064 7.4600E-01 0.0000E+00 7.4600E-01
  18   18   1   1  24   24 1.47418E+05  115.3653 8.1003E-01 0.0000E+00 8.1003E-01
  19   19   1   1  24   24 1.47483E+05  117.7312 8.4031E-01 0.0000E+00 8.4031E-01
  20   20   1   1  24   24 1.44850E+05  118.8812 9.9898E-01 0.0000E+00 9.9898E-01
  21   21   1   1  24   24 1.45098E+05  119.2959 9.9898E-01 0.0000E+00 9.9898E-01
  22   22   1   1  24   24 1.45262E+05  119.5673 9.9898E-01 0.0000E+00 9.9898E-01
  23   23   1   1  24   24 1.90024E+05  119.6985 9.9925E-01 0.0000E+00 9.9898E-01
  24   24   1   1  24   24 1.90189E+05  119.7767 9.9925E-01 0.0000E+00 9.9925E-01
   1    1   1   1  42   42 1.06349E+05   24.4568 8.3184E-03 0.0000E+00 9.9925E-01
   2    2   1   1  42   42 1.06349E+05   24.4568 8.3184E-03 0.0000E+00 8.3184E-03
  23   23   1   1  42   42 1.06348E+05   24.4568 8.3184E-03 0.0000E+00 8.3184E-03
  24   24   1   1  42   42 1.06348E+05   24.4568 8.3184E-03 0.0000E+00 8.3184E-03
0 0 0 0 0 0 0 0 0 0 0 0                  24.4568 8.3184E-03 0.0000E+00 8.3184E-03
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+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
```

MR 4-24-96

4-24-96
MR

INPUT: ROCKBACK-4-41.5+41.5.dat (CONT)

```
:
Source  40   0.454   1.000
:  is  js  ks  istyp
    1   1   1   1
0. 13.05 3.805e-9
0
    2   1   1   1
0. 13.05 3.805e-9
0
    3   1   1   1
0. 13.05 9.513e-10
0
    4   1   1   1
0. 13.05 4.756e-9
0
    5   1   1   1
0. 13.05 7.753e-9
0
    6   1   1   1
0. 13.05 7.468e-9
0
    7   1   1   1
0. 13.05 1.265e-8
```

MR 4-24-96

```
0
    8   1   1   1
0. 13.05 1.265e-8
0
    9   1   1   1
0. 13.05 1.265e-8
0
   10   1   1   1
0. 13.05 1.265e-8
0
   11   1   1   1
0. 13.05 1.265e-8
0
   12   1   1   1
0. 13.05 1.284e-8
0
   13   1   1   1
0. 13.05 1.284e-8
0
   14   1   1   1
0. 13.05 1.265e-8
0
   15   1   1   1
0. 13.05 1.265e-8
0
   16   1   1   1
0. 13.05 1.265e-8
0
   17   1   1   1
0. 13.05 1.265e-8
0
   18   1   1   1
0. 13.05 1.265e-8
0
   19   1   1   1
0. 13.05 7.468e-9
0
   20   1   1   1
0. 13.05 7.753e-9
0
   21   1   1   1
0. 13.05 4.756e-9
0
   22   1   1   1
0. 13.05 9.513e-10
0
   23   1   1   1
0. 13.05 3.805e-9
0
   24   1   1   1
0. 13.05 3.805e-9
0
:
```

MR 4-24-96

MR 4-24-96

```
: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
```

MR 4-24-96

```
 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
0
:       print all at every target time
PLOTS 1 2 25 555
:       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
```

MR 4-24-96

4-25-96
MR

- SNEEZY GOT UNPLUGGED LAST NIGHT, - RUN "rockback-4-41.5+41.5.dat" WAS KILLED. RUN WAS AT 2999 TIMESTEPS & ~270 YEARS. I WILL START A NEW RUN:

"rockback-5-41.5+41.5.dat" - IDENTICAL TO "rockback-4-41.5+41.5.dat EXCEPT THAT THE VAN GENUCHTEN ALPHA FOR THE BACKFILL MATRIX IS REDUCED BY A FACTOR OF 10 INSTEAD OF 5. IN:

/home/sneezy/rgreen/multi/tspa/grice/backfill2

"rockback-5-41.5+41.5.dat" RUN KILLED TO START NEW RUN.

"ss-airback-1-12.0+12.0.dat" - LOW POWER (24 KW/Ac) RUN. GRID = 33X43, DRIFT SPACING = 45M. THIS RUN IS UNHEATED IT WILL GO TO STEADY STATE AND IT'S OUTPUT WILL BE USED AS INIT IN SUBSEQUENT RUNS. IN:

/home/sneezy/rgreen/multi/tspa/grice/lowpower

NEW RUN: "airback-1-12.0+12.0.dat" - METAL WASTE PACKAGE AIR IN DRIFT, USES OUTPUT FROM "ss-airback-1-12.0+12.0.dat" AS INITIAL CONDITIONS. IN:

/home/sneezy/rgreen/multi/tspa/grice/lowpower

4-25-96
MR

NEW RUN: "rockback-1-12.0+12.0.dat" CONTAINS ROCK BACKFILL. SATURATION OF BACKFILL EMPLACED AT 100 YEARS SET TO ≃ 90%. OTHERWISE INITIAL CONDITIONS TAKEN FROM OUTPUT OF "airback-1-12.0+12.0.dat" IN:

/home/sneezy/rgreen/multi/tspa/grice/lowpower
INPUT: rockback-1-12.0+12.0.dat

MR 4-25-96

```
Rock Backfill with Metal Waste Package, (initial data : 2D, Yucca Mt.)
25kW/Ac, Two Heaters: 12.0+12.0kW/Ac, Alpha of backfill matrix reduced
: by a factor of 10.
: April 25, 1996
: Initial Conditions from 100 year run without backfill: 'airback-1-12.0+12.0.da
: Saturation of backfill emplaced at 100 years set to ~90%.
: 33X43 Grid
: added 0.3 mm/yr infiltration using source terms, not bcon
: heat added to 16 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       33  1   43   1       1      1     0    0
:
Monitor
762
debug 1
0
Pckr                           :relative perm and pc keyword
:   i  type-curv swir   rpm(lamda)  alpha    pcwmx  sgc  iecm
:                swirm  rpmm(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       1.305e-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       1.305e-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       1.305e-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       1.305e-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       1.305e-5  50.     0.  1
                 0.110  0.3800    3.13e-7   .306    1.8e-3 2.0e-18 3.9e-12
: 7 = Backfill, from TSPA '95 pg 4-18.  Original alpham = 1.11e-5/Pa: value
: below reduced by a factor of 10.
    7  Van-Gen   0.04  .7636       1.305e-5  50.     0.  1
                 0.01  0.7000   1.11e-6  0.50    1.8e-3 3.9e-14 3.9e-12
: 8 = Metal Waste Package, Assumed Hydraulic Properties, Saturation Set to
: Near Zero in Init.
    8  Van-Gen   0.010  .7636       1.305e-5  50.     0.  1
                 0.010  0.4400    5.8e-7  1.0e-1    1.0e-1 1.0e-99 1.0e-99
: 9 = Air Around Metal Waste Package, Assumed Hydraulic Properties, Saturation S
: Near Zero in Init.
    9  Van-Gen   0.010  .7636       1.305e-5  50.     0.  1
                 0.010  0.4400    5.8e-7  9.999e-1 9.999e-1 1.0e-99 1.0e-99
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.
```

4-25-96

```
  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.     1.42    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 = Backfill, from TSPA '95 pg 4-18.
  8  2.580e+03 840.0    0.60    0.79     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.
:10 =Air Around Metal Waste Package, rho & cpr from CRC, other Properties Assume
 10  1.200e-00 57.4   20.0    20.0      0      0    0.0  2.13e-0  1.8  1.
0
:      igrid   rw       re
DXYZ    2
: (dx(i),i=1,nx)
0.4 0.4 0.1 0.5 0.815 0.785 1.33 1.33 1.33 1.33
1.33 1.35 2.66 2.66 2.66 2.66 1.72 2.66 2.66 2.66
2.66 1.35 1.33 1.33 1.33 1.33 1.33 0.785 0.815 0.5
0.1 0.4 0.4
: (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 33  1  1  1  1   1    7   0.
   1 33  1  1  2  6   1    1   0.
   1 33  1  1  7 10   2    2   0.
   1 33  1  1 11 35   3    3   0.
   1 33  1  1 36 36   4    4   0.
   1 33  1  1 37 39   5    5   0.
   1 33  1  1 40 42   6    6   0.
   1 33  1  1 43 43   6    6   6.2832e7
: Drifts
   1  5  1  1 21 28   7    8
  29 33  1  1 21 28   7    8
: Waste Packages
   1  2  1  1 23 26   8    9
  32 33  1  1 23 26   8    9
: Supports
   1  2  1  1 27 27   7    8
  32 33  1  1 27 27   7    8
: Inverts
   1  5  1  1 28 28   7    8
  29 33  1  1 28 28   7    8
:
0
Init
: Initial conditions from 100 yr run without backfill: 'airback-1-12.0+12.0.dat'
:
:                Cut & Paste Initilization Variables for Restart
:                ===============================================
:
:    Time =  0.315360E+10 secs   Days =  0.365000E+05   years =  0.100000E+03
:
: i1   i2   j1   j2   k1   k2          p            t           sg        xg2         sgm
   1    1    1    1    1    1 9.86063E+04    13.0480 3.6805E-02 0.0000E+00 3.6805E-02

  30   30    1    1    5    5 9.93569E+04    14.0079 4.5580E-02 0.0000E+00 4.5580E-02
  31   31    1    1    5    5 9.93569E+04    14.0079 4.5580E-02 0.0000E+00 4.5580E-02
  32   32    1    1    5    5 9.93569E+04    14.0079 4.5580E-02 0.0000E+00 4.5580E-02
  33   33    1    1    5    5 9.93569E+04    14.0079 4.5580E-02 0.0000E+00 4.5580E-02
   1    1    1    1    6    6 9.95391E+04    14.2543 9.1488E-02 0.0000E+00 9.1488E-02
   2    2    1    1    6    6 9.95391E+04    14.2543 9.1488E-02 0.0000E+00 9.1488E-02
  32   32    1    1   23   23 1.19740E+05    58.3222 9.9901E-01 0.0000E+00 9.9901E-01
  33   33    1    1   23   23 1.19775E+05    58.3856 9.9901E-01 0.0000E+00 9.9901E-01
   1    1    1    1   24   24 1.19822E+05    58.4640 9.9901E-01 0.0000E+00 9.9901E-01
   2    2    1    1   24   24 1.19787E+05    58.4002 9.9901E-01 0.0000E+00 9.9901E-01
   3    3    1    1   24   24 1.16390E+05    58.2974 9.9899E-02 0.0000E+00 9.9899E-02
   4    4    1    1   24   24 1.16311E+05    58.0777 9.9899E-02 0.0000E+00 9.9899E-02
   5    5    1    1   24   24 1.16184E+05    57.7255 9.9899E-02 0.0000E+00 9.9899E-02
   6    6    1    1   24   24 1.02491E+05    56.7577 3.5589E-02 0.0000E+00 3.5589E-02
   7    7    1    1   24   24 1.02487E+05    54.8738 3.5439E-02 0.0000E+00 3.5439E-02
   8    8    1    1   24   24 1.02485E+05    53.2429 3.5255E-02 0.0000E+00 3.5255E-02
   9    9    1    1   24   24 1.02483E+05    52.0551 3.5120E-02 0.0000E+00 3.5120E-02
  10   10    1    1   24   24 1.02481E+05    51.1431 3.5020E-02 0.0000E+00 3.5020E-02
  11   11    1    1   24   24 1.02480E+05    50.4171 3.4943E-02 0.0000E+00 3.4943E-02
  12   12    1    1   24   24 1.02480E+05    49.8222 3.4879E-02 0.0000E+00 3.4879E-02
```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```
  26   26    1    1   24   24 1.02485E+05    53.2429 3.5255E-02 0.0000E+00 3.5255E-02
  27   27    1    1   24   24 1.02487E+05    54.8738 3.5439E-02 0.0000E+00 3.5439E-02
  28   28    1    1   24   24 1.02491E+05    56.7577 3.5589E-02 0.0000E+00 3.5589E-02
  29   29    1    1   24   24 1.16184E+05    57.7255 9.9899E-02 0.0000E+00 9.9899E-02
  30   30    1    1   24   24 1.16311E+05    58.0777 9.9899E-02 0.0000E+00 9.9899E-02
  31   31    1    1   24   24 1.16390E+05    58.2974 9.9899E-02 0.0000E+00 9.9899E-02
  32   32    1    1   24   24 1.19787E+05    58.4002 9.9901E-01 0.0000E+00 9.9901E-01
  33   33    1    1   24   24 1.19822E+05    58.4640 9.9901E-01 0.0000E+00 9.9901E-01
   1    1    1    1   25   25 1.19848E+05    58.5031 9.9901E-01 0.0000E+00 9.9901E-01
   2    2    1    1   25   25 1.19810E+05    58.4342 9.9901E-01 0.0000E+00 9.9901E-01
   3    3    1    1   25   25 1.16403E+05    58.3236 9.9899E-02 0.0000E+00 9.9899E-02
   4    4    1    1   25   25 1.16318E+05    58.0878 9.9899E-02 0.0000E+00 9.9899E-02
   5    5    1    1   25   25 1.16187E+05    57.7222 9.9899E-02 0.0000E+00 9.9899E-02
   6    6    1    1   25   25 1.02495E+05    56.6872 3.5809E-02 0.0000E+00 3.5809E-02
   7    7    1    1   25   25 1.02491E+05    54.7870 3.5593E-02 0.0000E+00 3.5593E-02
   8    8    1    1   25   25 1.02489E+05    53.1841 3.5352E-02 0.0000E+00 3.5352E-02
   9    9    1    1   25   25 1.02487E+05    52.0164 3.5187E-02 0.0000E+00 3.5187E-02
  10   10    1    1   25   25 1.02486E+05    51.1164 3.5072E-02 0.0000E+00 3.5072E-02
  11   11    1    1   25   25 1.02485E+05    50.3979 3.4986E-02 0.0000E+00 3.4986E-02
0 0 0 0 0 0 0 0 0 0 0 0 0
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+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  49   0.00197   1.000
:  is  js  ks  istyp
    1   1   1   1
0. 13.05 3.805e-9
0
    2   1   1   1
0. 13.05 3.805e-9
0
    3   1   1   1
0. 13.05 9.513e-10
0
    4   1   1   1
0. 13.05 4.756e-9
0
    5   1   1   1
0. 13.05 7.753e-9
0
    6   1   1   1
0. 13.05 7.468e-9
0
    7   1   1   1
0. 13.05 1.265e-8
0
    8   1   1   1
0. 13.05 1.265e-8
0
    9   1   1   1
0. 13.05 1.265e-8
0
   10   1   1   1
0. 13.05 1.265e-8
0
   11   1   1   1
0. 13.05 1.265e-8
0
   12   1   1   1
0. 13.05 1.284e-8
0
   13   1   1   1
0. 13.05 2.530e-8
0
   14   1   1   1
0. 13.05 2.530e-8
0
   15   1   1   1
0. 13.05 2.530e-8
0
   16   1   1   1
0. 13.05 2.530e-8
0
   17   1   1   1
0. 13.05 1.636e-8
0
   18   1   1   1
0. 13.05 2.530e-8
0
   19   1   1   1
0. 13.05 2.530e-8
0
   20   1   1   1
0. 13.05 2.530e-8
0
   21   1   1   1
0. 13.05 2.530e-8
0
   22   1   1   1
0. 13.05 1.284e-8
0
   23   1   1   1
0. 13.05 1.265e-8
0
   24   1   1   1
0. 13.05 1.265e-8
0
   25   1   1   1
0. 13.05 1.265e-8
0
   26   1   1   1
0. 13.05 1.265e-8
0
   27   1   1   1
0. 13.05 1.265e-8
0
   28   1   1   1
0. 13.05 7.468e-9
0
   29   1   1   1
0. 13.05 7.753e-9
0
   30   1   1   1
0. 13.05 4.756e-9
0
   31   1   1   1
0. 13.05 9.513e-10
0
   32   1   1   1
0. 13.05 3.805e-9
0
   33   1   1   1
0. 13.05 3.805e-9
0
:Power decay data from Randy Manteufel, 4/25/96
:  is  js  ks  istyp
    1   1  23    3
 0.3156E+06  0.8469E+04
 0.9467E+07  0.8423E+04
 0.1578E+08  0.8391E+04
 0.3156E+08  0.8314E+04
 0.3541E+08  0.8296E+04
 0.3973E+08  0.8276E+04
 0.4458E+08  0.8253E+04
 0.5002E+08  0.8228E+04
 0.5612E+08  0.8199E+04
 0.6297E+08  0.8168E+04
 0.7065E+08  0.8131E+04
 0.7927E+08  0.8089E+04
 0.8894E+08  0.8043E+04
 0.9979E+08  0.7993E+04
 0.1120E+09  0.7937E+04
 0.1256E+09  0.7876E+04
 0.1410E+09  0.7810E+04
 0.1582E+09  0.7737E+04
 0.1775E+09  0.7658E+04
 0.1991E+09  0.7572E+04
```

NOTE, INCORRECT
POWER INPUT. SHOULD
START WITH
POWER @ t=100 YRS
BECAUSE
RUN
THIS
FOLLOWS
100 YR RUN
WITHOUT
BACKFILL.
SEE CORRECT
INPUT ON NEXT
PAGE. 4-26-96

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AR

```
0.2234E+09  0.7477E+04
0.2507E+09  0.7355E+04
0.2813E+09  0.7224E+04
0.3156E+09  0.7084E+04
0.3541E+09  0.6936E+04
0.3973E+09  0.6780E+04
0.4458E+09  0.6615E+04
0.5002E+09  0.6443E+04
0.5612E+09  0.6250E+04
0.6297E+09  0.6029E+04
0.7065E+09  0.5802E+04
0.7927E+09  0.5571E+04
0.8894E+09  0.5326E+04
0.9979E+09  0.5059E+04
0.1120E+10  0.4793E+04
0.1256E+10  0.4541E+04
0.1410E+10  0.4298E+04
0.1582E+10  0.4002E+04
0.1775E+10  0.3675E+04
```

```
0.1991E+10  0.3393E+04
0.2234E+10  0.3126E+04
0.2507E+10  0.2880E+04
0.2813E+10  0.2666E+04
0.3156E+10  0.2464E+04
0.3541E+10  0.2273E+04
0.3973E+10  0.2093E+04
0.4458E+10  0.1925E+04
0.5002E+10  0.1767E+04
0.5612E+10  0.1623E+04
0.6297E+10  0.1523E+04
0.7065E+10  0.1429E+04
0.7927E+10  0.1339E+04
0.8894E+10  0.1255E+04
0.9979E+10  0.1179E+04
0.1120E+11  0.1107E+04
0.1256E+11  0.1036E+04
0.1410E+11  0.9655E+03
0.1582E+11  0.8926E+03
0.1775E+11  0.8164E+03
0.1991E+11  0.7463E+03
0.2234E+11  0.6821E+03
0.2507E+11  0.6231E+03
0.2813E+11  0.5691E+03
0.3156E+11  0.5179E+03
0.3541E+11  0.4650E+03
0.3973E+11  0.4174E+03
0.4458E+11  0.3746E+03
0.5002E+11  0.3361E+03
```

```
0.5612E+11  0.3016E+03
0.6297E+11  0.2713E+03
0.7065E+11  0.2519E+03
0.7927E+11  0.2339E+03
0.8894E+11  0.2172E+03
0.9979E+11  0.2049E+03
0.1120E+12  0.1961E+03
0.1256E+12  0.1877E+03
0.1410E+12  0.1797E+03
0.1582E+12  0.1719E+03
0.1775E+12  0.1630E+03
0.1991E+12  0.1545E+03
0.2234E+12  0.1465E+03
0.2507E+12  0.1389E+03
0.2813E+12  0.1317E+03
0.3156E+12  0.1247E+03
0
:      print all at every target time
PLOTS 1 1 762
:     target  dt    dpmx   dsmx   dp2mx   dtmpmx
rstart 1 0
Time[y]  10.
Time[y]  100.
Time[y]  1000.
Time[y]  5000.
Time[y]  10000.
Time[y]  100000.
:
Ends
```

AR 4-25-96

AR 4-25-96

AR 4-26-96

4-26-96
AR

```
0
:Revised Power decay data from Randy Manteufel, 4/26/96.
:Begins with power input for t = 100yrs.
:  is  js  ks  istyp
    1   1  23     3
  0.3156E+06  0.2464E+04
  0.9467E+07  0.2459E+04
  0.1578E+08  0.2455E+04
  0.3156E+08  0.2447E+04
  0.3541E+08  0.2445E+04
  0.3973E+08  0.2442E+04
  0.4458E+08  0.2440E+04
  0.5002E+08  0.2437E+04
  0.5612E+08  0.2434E+04
  0.6297E+08  0.2430E+04
  0.7065E+08  0.2426E+04
  0.7927E+08  0.2422E+04
  0.8894E+08  0.2417E+04
  0.9979E+08  0.2411E+04
  0.1120E+09  0.2405E+04
  0.1256E+09  0.2398E+04
  0.1410E+09  0.2390E+04
  0.1582E+09  0.2381E+04
  0.1775E+09  0.2372E+04
  0.1991E+09  0.2361E+04
  0.2234E+09  0.2349E+04
  0.2507E+09  0.2336E+04
  0.2813E+09  0.2321E+04
```

CORRECTED POWER INPUT FOR "rockback-1-12.0+12.0.dat."
SEE PREVIOUS PAGE

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AR

CORRECTED POWER INPUT (CONT)

```
0.3156E+09  0.2305E+04
0.3541E+09  0.2287E+04
0.3973E+09  0.2267E+04
0.4458E+09  0.2245E+04
0.5002E+09  0.2222E+04
0.5612E+09  0.2195E+04
0.6297E+09  0.2167E+04
0.7065E+09  0.2136E+04
0.7927E+09  0.2102E+04
0.8894E+09  0.2066E+04
0.9979E+09  0.2027E+04
0.1120E+10  0.1984E+04
0.1256E+10  0.1939E+04
0.1410E+10  0.1891E+04
0.1582E+10  0.1840E+04
0.1775E+10  0.1786E+04
0.1991E+10  0.1730E+04
0.2234E+10  0.1671E+04
0.2507E+10  0.1615E+04
0.2813E+10  0.1569E+04
0.3156E+10  0.1521E+04
0.3541E+10  0.1472E+04
0.3973E+10  0.1422E+04
0.4458E+10  0.1370E+04
0.5002E+10  0.1318E+04
0.5612E+10  0.1265E+04
0.6297E+10  0.1214E+04
0.7065E+10  0.1164E+04
0.7927E+10  0.1113E+04
0.8894E+10  0.1062E+04
0.9979E+10  0.1008E+04
0.1120E+11  0.9549E+03
```

```
0.1256E+11  0.8969E+03
0.1410E+11  0.8345E+03
0.1582E+11  0.7750E+03
0.1775E+11  0.7186E+03
0.1991E+11  0.6652E+03
0.2234E+11  0.6148E+03
0.2507E+11  0.5676E+03
0.2813E+11  0.5222E+03
0.3156E+11  0.4737E+03
0.3541E+11  0.4292E+03
0.3973E+11  0.3885E+03
0.4458E+11  0.3513E+03
0.5002E+11  0.3173E+03
0.5612E+11  0.2864E+03
0.6297E+11  0.2629E+03
0.7065E+11  0.2449E+03
0.7927E+11  0.2281E+03
0.8894E+11  0.2123E+03
0.9979E+11  0.2025E+03
0.1120E+12  0.1941E+03
0.1256E+12  0.1860E+03
0.1410E+12  0.1782E+03
0.1582E+12  0.1703E+03
0.1775E+12  0.1617E+03
0.1991E+12  0.1534E+03
0.2234E+12  0.1456E+03
0.2507E+12  0.1381E+03
0.2813E+12  0.1310E+03
0.3156E+12  0.1237E+03
0
```

AR 4-26-96

AR 4-26-96

- NEW RUN: "airback-01-41.5+41.5.dat"
  USES HEAT DECAY PROVIDED BY R. MANTEUFEL.
  IN:
  /home/sneezy/rgreen/multi/tspa/grace/backfill2/83kw

4-28-96
AR

- "OUTPUT FROM: "airback-01-41.5+41.5.dat"
  CONTAINS 'NaNs'

- NEW RUN - ~~"airback-01~~ AR 4-28-96
  "airback-02-41.5+41.5.dat" - IDENTICAL TO "airback-01-41.5+41.5.dat" EXCEPT THAT RESIDUAL SATURATIONS FOR METAL WASTE CANISTER AND AIR CHANGED FROM 0.01 TO 0.0001.

IN:
/home/sneezy/ AR 4-28-96

SEE NEXT PAGE

4-28-96
MR

- ERROR IN INPUT FOR "airback-φ1-41.5+41.5"
  FACH = 0.454. CORRECT VALUE CALCULATED BELOW:

$$\frac{X\,16\,(\cancel{84{,}690\,W})^{\;8{,}469}}{22\,m^2} = \frac{83{,}000\,W}{Ac}$$

8,469 MR 4-29-96

WHERE, 16 = # OF HEATING ELEMENTS
22m² = AREA OF MODEL (HORIZONTAL = 1M X 22M)
84,690W = INITIAL POWER INPUT
X = FACH IN METRA.
SEE SIMILAR CALCULATION ON PG 117

$$X = \frac{83{,}000\,W}{16\,(\cancel{84{,}690\,W})_{8{,}469}}\;\frac{22\,m^2}{Ac}\;\frac{Ac}{4047\,m^2} \simeq 3.33 \times 10^{-4}$$

3 MR 4-29-96

ADDITIONAL CHANGE TO "airback-φ1-41.5+41.5.dat" -
RUN CRASHED AFTER ≃ 20 TIMESTEPS - PROBLEM
W/ BACKFILL MATERIAL OF PEDASTAL. CHANGED
RESIDUAL SATURATION OF BACKFILL FRACTURES &
MATRIX FROM 0.04 & 0.01 TO 0.001.

4-29-96
MR

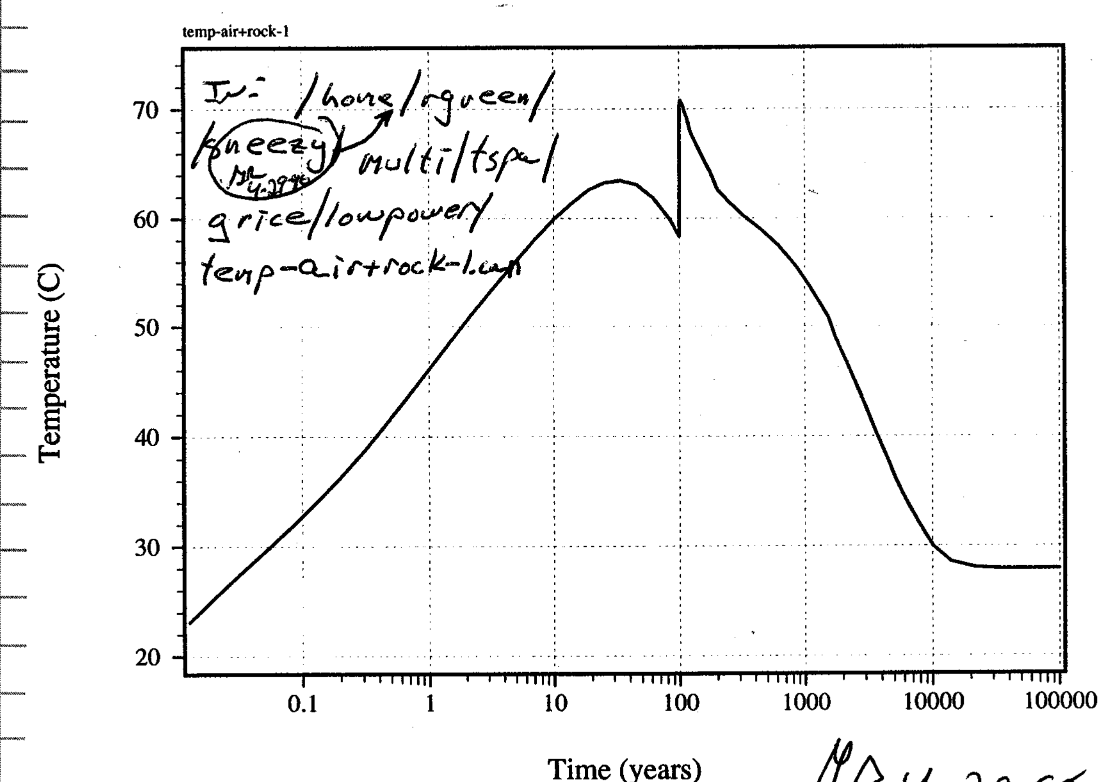
NEW METRA RUN:
"rockback-φ1-41.5+41.5.dat"
SAME AS "airback-φ1-41.5+41.5.dat" EXCEPT
DRIFT FILLED WITH ROCK INSTEAD OF
AIR. INITIAL CONDITIONS ARE OUTPUT OF
"airback..." @ 100 YEARS. HEAT SOURCE HAS
DECAYED FOR 100 YRS @ t=0.

4-28-96
MR

OUTPUT: "airback-1-12.0+12.0.dat" +
"rockback-1-12.0+12.0.dat"

MR 4-29-96

Temperature Next to Waste Package (24kW/Ac)



MR 4-29-96

4-30-96
MR

- NEW RUN: "rockback-φ1a-41.5+41.5.dat" - IDENTICAL
  TO "rockback-φ1-41.5+41.5.dat" EXCEPT THERMAL
  CONDUCTIVITY OF BACKFILL IS AS GIVEN IN TSPA -
  A CONSTANT 0.60 - INSTEAD OF VARYING BETWEEN 0.60 + 0.79 AS
  A FUNCTION OF SATURATION. PREVIOUS RUN "...φ1..."
  SHOWS AN INCREASE IN TEMPERATURE AT ~ 400 YEARS

IN: /home/sneezy/rgreen/multi/tspa/
grice/backfill2/ 83KW

MR 4-30-96

4-30-96
NR

NEW RUN: "rock-90%init" - IDENTICAL TO "rockback-φ1a-41.5+41.5.dat" EXCEPT RESIDUAL SATURATION OF BACKFILL LEFT AT 0.04 + 0.07, AND INITIAL SATURATION OF BACKFILL ≃ 90%.

5-1-96
NR

NEW LOW POWER RUNS: "airback-2-12.0+12.0.dat" & "rockback-2-12.0+12.0.dat" - CONSTANT THERMAL CONDUCTIVITY = 0.6 W/m-C, PROPERTIES PLOTTED @ DRIFT WALL. IN:
/home/sneezy/rgreen/multi/tspa/grice/lowpower

5-3-96
NR

NEW SET OF METRA RUNS:

"air-1.dat" & "rock-1.dat" - LOW POWER, (24 kW/AC) - SIMILAR TO PREVIOUS RUNS EXCEPT:

- THERMAL CONDUCTIVITIES OF ALL MATERIALS ARE CONSTANT & SET TO VALUE FOR DRY MATERIAL
- THERMAL CONDUCTIVITY OF AIR = 10 W/m-C
- VAN GENUCHTEN α OF BACKFILL MATRIX SET TO VALUE GIVEN IN TSPA (1.11×10^{-5}/Pa) - RUNNING NEW VERSION OF METRA.
- SATURATION OF BACKFILL SET TO 10% @ 100 YEARS.

IN: /home/sneezy/rgreen/multi/tspa/grice/lowpower/randy

RUN CRASHED: "rock-1.dat" CRASHED BETWEEN 10 & 100 YEARS; OUTPUT AFTER 10 YRS CONTAINED 'NaN's. NEW RUN -

'rock-2.dat' - IDENTICAL TO 'rock-1.dat' EXCEPT VAN GENUCHTEN ALPHA OF BACKFILL MATRIX

5-3-96
NR

REDUCED BY A FACTOR OF 10.

5-6-96
NR

"FINAL" RUNS DONE FOR RANDY MANTEUFEL IN:
/home/sneezy/rgreen/multi/tspa/grice/lowpower/randy

24kW RUNS:
- 'air-1.dat'
- 'rock-2.dat'

83kW RUNS:
- 'air-83.dat'
- 'rock-83.dat'

THESE RUNS HAVE THE FOLLOWING IN COMMON:

- CONSTANT THERMAL CONDUCTIVITIES FOR ALL MATERIALS per 95 TSPA
- VAN GENUCHTEN ALPHA OF BACKFILL MATRIX REDUCED BY A FACTOR OF 10
- FOR THE 'ROCK' RUNS - THEY USE OUTPUT OF 'air' RUNS AS INPUT - LIQUID SATURATION OF BACKFILL SET TO 10%.

INPUT in 'rock-2.dat'
NR 5-6-96

```
Rock Backfill with Metal Waste Package, (initial data : 2D, Yucca Mt.)
24kW/Ac, Two Heaters: 12.0+12.0kW/Ac, May 3, 1996
: Initial Conditions from 100yr run without rock backfill: 'air-1.dat'
: Alpha of Backfill matrix reduced by a factor of 10:
: from 1.11E-05 to 1.11E-06
: Thermal conductivities of all rocks are constant and set to dry cond.
: 33X43 Grid
: Monitor = 762 = element (24,3) = Backfill next to heater ([33x23]+3).
: added 0.3 mm/yr infiltration using source terms, not bcon
: heat added to 16 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       33  1  43  1        1      1    0    0
:
Monitor
762
debug 1
0
Pckr                              :relative perm and pc keyword
:   i  type-curv swir   rpm(lamda)  alpha    pcwmx  sgc  iecm
:                swirm  rpmm(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       1.305e-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       1.305e-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       1.305e-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       1.305e-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       1.305e-5  50.      0.  1
                 0.110  0.3800      3.13e-7  .306     1.8e-3 2.0e-18 3.9e-12
: 7 = Backfill, from TSPA '95 pg 4-18. Alpha of matrix reduced by a factor of 10.
    7  Van-Gen   0.040  .7636       1.305e-5  50.      0.  1
                 0.010  0.7000      1.11e-6  0.50     1.8e-3 3.9e-14 3.9e-12
: 8 = Metal Waste Package, Assumed Hydraulic Properties, Saturation Set to
: Near Zero in Init.
    8  Van-Gen   0.010  .7636       1.305e-5  50.      0.  1
                 0.010  0.4400      5.8e-7   1.0e-1   1.0e-1 1.0e-99 1.0e-99
: 9 = Air Around Metal Waste Package, Assumed Hydraulic Properties, Saturation Set to
: Near Zero in Init.
    9  Van-Gen   0.010  .7636       1.305e-5  50.      0.  1
                 0.010  0.4400      5.8e-7   9.999e-1 9.999e-1 1.0e-99 1.0e-99
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.
```

NR 5-6-96

NR 5-6-96

5-6-96 INPUT: 'rock-2-dat' (CONT)

MR 5-6-96

```
  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  0.80   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.
:10 =Air Around Metal Waste Package, rho & cpr from CRC, other Properties Assumed
 10 1.200e-00 57.4  10.0  10.0    0   0  0.0 2.13e-0 1.8  1.
0
:     igrid   rw      re
DXYZ   2
: (dx(i),i=1,nx)
0.4 0.4 0.1 0.5 0.815 0.785 1.33 1.33 1.33 1.33
1.33 1.35 2.66 2.66 2.66 2.66 1.72 2.66 2.66 2.66
2.66 1.35 1.33 1.33 1.33 1.33 1.33 0.785 0.815 0.5
0.1 0.4 0.4
: (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 perma
   1 33  1  1  1  1   1   7   0.
   1 33  1  1  2  6   1   1   0.
   1 33  1  1  7 10   2   2   0.
   1 33  1  1 11 35   3   3   0.
   1 33  1  1 36 36   4   4   0.
   1 33  1  1 37 39   5   5   0.
   1 33  1  1 40 42   6   6   0.
   1 33  1  1 43 43   6   8   6.2832e7
: Drifts
   1  5  1  1 21 28   7   8
  29 33  1  1 21 28   7   8
: Waste Packages
   1  2  1  1 23 26   8   9
  32 33  1  1 23 26   8   9
: Supports
   1  2  1  1 27 27   7   8
  32 33  1  1 27 27   7   8
: Inverts
   1  5  1  1 28 28   7   8
  29 33  1  1 28 28   7   8
:
0
Init
: Initial conditions from 100yr run: 'air-1.dat' except saturation of
: backfill set to 10% (sg=90%)
:               Cut & Paste Initilization Variables for Restart
:
:    Time =  0.315360E+10 secs   Days =  0.365000E+05   years =  0.100000E+03
: i1  i2  j1  j2  k1  k2        p          t        sg         xg2        sgm
   1   1   1   1   1   1 9.85761E+04   13.0480 3.7089E-02 0.0000E+00 3.7089E-02
   2   2   1   1   1   1 9.85761E+04   13.0480 3.7089E-02 0.0000E+00 3.7089E-02
   3   3   1   1   1   1 9.85761E+04   13.0480 3.7089E-02 0.0000E+00 3.7089E-02

  31  31   1   1   1   1 9.85761E+04   13.0480 3.7089E-02 0.0000E+00 3.7089E-02
  32  32   1   1   1   1 9.85761E+04   13.0480 3.7089E-02 0.0000E+00 3.7089E-02
  33  33   1   1   1   1 9.85761E+04   13.0480 3.7089E-02 0.0000E+00 3.7089E-02
   1   1   1   1  21  21 1.37857E+05   62.2056 9.0000E-01 0.0000E+00 9.0000E-01
   2   2   1   1  21  21 1.37748E+05   62.1219 9.0000E-01 0.0000E+00 9.0000E-01
   3   3   1   1  21  21 1.37619E+05   62.0218 9.0000E-01 0.0000E+00 9.0000E-01
   4   4   1   1  21  21 1.37451E+05   61.8907 9.0000E-01 0.0000E+00 9.0000E-01
   5   5   1   1  21  21 1.36986E+05   61.5272 9.0000E-01 0.0000E+00 9.0000E-01
   6   6   1   1  21  21 1.02455E+05   60.1720 3.0267E-02 0.0000E+00 3.0267E-02
   7   7   1   1  21  21 1.02451E+05   58.0665 3.0294E-02 0.0000E+00 3.0294E-02
   8   8   1   1  21  21 1.02447E+05   56.2318 3.0335E-02 0.0000E+00 3.0335E-02
  25  25   1   1  21  21 1.02445E+05   54.8488 3.0358E-02 0.0000E+00 3.0358E-02
  26  26   1   1  21  21 1.02447E+05   56.2318 3.0335E-02 0.0000E+00 3.0335E-02
  27  27   1   1  21  21 1.02451E+05   58.0665 3.0294E-02 0.0000E+00 3.0294E-02
  28  28   1   1  21  21 1.02455E+05   60.1720 3.0267E-02 0.0000E+00 3.0267E-02
  29  29   1   1  21  21 1.36986E+05   61.5272 9.0000E-01 0.0000E+00 9.0000E-01
  30  30   1   1  21  21 1.37451E+05   61.8907 9.0000E-01 0.0000E+00 9.0000E-01
  31  31   1   1  21  21 1.37619E+05   62.0218 9.0000E-01 0.0000E+00 9.0000E-01
  32  32   1   1  21  21 1.37748E+05   62.1219 9.0000E-01 0.0000E+00 9.0000E-01
  33  33   1   1  21  21 1.37857E+05   62.2056 9.0000E-01 0.0000E+00 9.0000E-01
   1   1   1   1  24  24 1.24126E+05   63.4041 9.8987E-01 0.0000E+00 9.8987E-01
   2   2   1   1  24  24 1.24086E+05   63.3442 9.8987E-01 0.0000E+00 9.8987E-01
   3   3   1   1  24  24 1.39193E+05   63.2195 9.0000E-01 0.0000E+00 9.0000E-01
   4   4   1   1  24  24 1.38666E+05   62.8160 9.0000E-01 0.0000E+00 9.0000E-01
   5   5   1   1  24  24 1.37805E+05   62.1556 9.0000E-01 0.0000E+00 9.0000E-01
   6   6   1   1  24  24 1.02474E+05   60.8313 3.0650E-02 0.0000E+00 3.0650E-02
   7   7   1   1  24  24 1.02469E+05   58.4716 3.0557E-02 0.0000E+00 3.0557E-02
  28  28   1   1  24  24 1.02474E+05   60.8313 3.0650E-02 0.0000E+00 3.0650E-02
  29  29   1   1  24  24 1.37805E+05   62.1556 9.0000E-01 0.0000E+00 9.0000E-01
  30  30   1   1  24  24 1.38666E+05   62.8160 9.0000E-01 0.0000E+00 9.0000E-01
  31  31   1   1  24  24 1.39193E+05   63.2195 9.0000E-01 0.0000E+00 9.0000E-01
  32  32   1   1  24  24 1.24086E+05   63.3442 9.8987E-01 0.0000E+00 9.8987E-01
  33  33   1   1  24  24 1.24126E+05   63.4041 9.8987E-01 0.0000E+00 9.8987E-01
0 0 0 0 0 0 0 0 0 0 0 0 0
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+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 ioutmx
LIMIT  1.e5    .08   10.   1.e5  1.e-5 1.e5
:

: SKIP
:
Source  49   0.00197   1.000
:  is  js  ks  istyp
    1   1   1   1
0. 13.05 3.805e-9
0
    2   1   1   1
0. 13.05 3.805e-9
0
    3   1   1   1

   0. 13.05 9.513e-10
   0
      4   1   1   1
   0. 13.05 4.756e-9
   0
      5   1   1   1
   0. 13.05 7.753e-9
   0
      6   1   1   1
   0. 13.05 7.468e-9
   0
      7   1   1   1
   0. 13.05 1.265e-8
   0
      8   1   1   1
   0. 13.05 1.265e-8
   0
      9   1   1   1
   0. 13.05 1.265e-8
   0
     10   1   1   1
   0. 13.05 1.265e-8
   0
     11   1   1   1
   0. 13.05 1.265e-8
   0
     12   1   1   1
   0. 13.05 1.284e-8
   0
     13   1   1   1
   0. 13.05 2.530e-8
   0
     14   1   1   1
   0. 13.05 2.530e-8
   0
     15   1   1   1
   0. 13.05 2.530e-8
   0
     16   1   1   1
   0. 13.05 2.530e-8
   0
     17   1   1   1

0. 13.05 1.636e-8
0
   18   1   1   1
0. 13.05 2.530e-8
0
   19   1   1   1
0. 13.05 2.530e-8
0
   20   1   1   1
0. 13.05 2.530e-8
0
   21   1   1   1
0. 13.05 2.530e-8
0
   22   1   1   1
0. 13.05 1.284e-8
0
   23   1   1   1

0. 13.05 1.265e-8
0
   24   1   1   1
0. 13.05 1.265e-8
0
   25   1   1   1
0. 13.05 1.265e-8
0
   26   1   1   1
0. 13.05 1.265e-8
0
   27   1   1   1
0. 13.05 1.265e-8
0
   28   1   1   1
0. 13.05 7.468e-9
0
   29   1   1   1
0. 13.05 7.753e-9
0
   30   1   1   1
0. 13.05 4.756e-9
0

   31   1   1   1
0. 13.05 9.513e-10
0
   32   1   1   1
0. 13.05 3.805e-9
0
   33   1   1   1
0. 13.05 3.805e-9
0
```

MR 5-6-96

5-6-96 INPUT 'rock-~~83~~ 2.dat' (CONT.)

MR 5-14-96

```
:Revised Power decay data from Randy Manteufel, 4/26/96.
:Begins with power input for t = 100yrs.
:  is  js  ks  istyp
    1   1  23    3
  0.0000E+00  0.2464E+04
  0.9467E+07  0.2459E+04
  0.1578E+08  0.2455E+04
  0.3156E+08  0.2447E+04
  0.3541E+08  0.2445E+04
  0.3973E+08  0.2442E+04
  0.4458E+08  0.2440E+04
  0.5002E+08  0.2437E+04
  0.5612E+08  0.2434E+04
  0.6297E+08  0.2430E+04
  0.7065E+08  0.2426E+04
  0.7927E+08  0.2422E+04
  0.8894E+08  0.2417E+04
  0.9979E+08  0.2411E+04
  0.1120E+09  0.2405E+04
  0.1256E+09  0.2398E+04
  0.1410E+09  0.2390E+04
  0.1582E+09  0.2381E+04
  0.1775E+09  0.2372E+04
  0.1991E+09  0.2361E+04
  0.2234E+09  0.2349E+04
  0.2507E+09  0.2336E+04
  0.2813E+09  0.2321E+04
  0.3156E+09  0.2305E+04

  0.3541E+09  0.2287E+04
  0.3973E+09  0.2267E+04
  0.4458E+09  0.2245E+04
  0.5002E+09  0.2222E+04
  0.5612E+09  0.2195E+04
  0.6297E+09  0.2167E+04
  0.7065E+09  0.2136E+04
  0.7927E+09  0.2102E+04
  0.8894E+09  0.2066E+04
  0.9979E+09  0.2027E+04
  0.1120E+10  0.1984E+04
  0.1256E+10  0.1939E+04
  0.1410E+10  0.1891E+04
  0.1582E+10  0.1840E+04
  0.1775E+10  0.1786E+04
  0.1991E+10  0.1730E+04
  0.2234E+10  0.1671E+04
  0.2507E+10  0.1615E+04
  0.2813E+10  0.1569E+04
  0.3156E+10  0.1521E+04
  0.3541E+10  0.1472E+04
  0.3973E+10  0.1422E+04
  0.4458E+10  0.1370E+04
  0.5002E+10  0.1318E+04
  0.5612E+10  0.1265E+04
  0.6297E+10  0.1214E+04
  0.7065E+10  0.1164E+04
  0.7927E+10  0.1113E+04
  0.8894E+10  0.1062E+04
  0.9979E+10  0.1008E+04
  0.1120E+11  0.9549E+03
  0.1256E+11  0.8969E+03
  0.1410E+11  0.8345E+03
  0.1582E+11  0.7750E+03
  0.1775E+11  0.7186E+03
  0.1991E+11  0.6652E+03
  0.2234E+11  0.6148E+03
  0.2507E+11  0.5676E+03
  0.2813E+11  0.5222E+03

  0.3156E+11  0.4737E+03
  0.3541E+11  0.4292E+03
  0.3973E+11  0.3885E+03
  0.4458E+11  0.3513E+03
  0.5002E+11  0.3173E+03
  0.5612E+11  0.2864E+03
  0.6297E+11  0.2629E+03
  0.7065E+11  0.2449E+03
  0.7927E+11  0.2281E+03
  0.8894E+11  0.2123E+03
  0.9979E+11  0.2025E+03
  0.1120E+12  0.1941E+03
  0.1256E+12  0.1860E+03
  0.1410E+12  0.1782E+03
  0.1582E+12  0.1703E+03
  0.1775E+12  0.1617E+03
  0.1991E+12  0.1534E+03
  0.2234E+12  0.1456E+03
  0.2507E+12  0.1381E+03
  0.2813E+12  0.1310E+03
  0.3156E+12  0.1237E+03

   0
:
:NOSKIP
:
:          print all at every target time
PLOTS 1 1 762
:       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.
:
SKIP
:
rstart 1 0
Steady[y]  1.e+1 1.e-1 1.e-4
NOSKIP
Ends
```

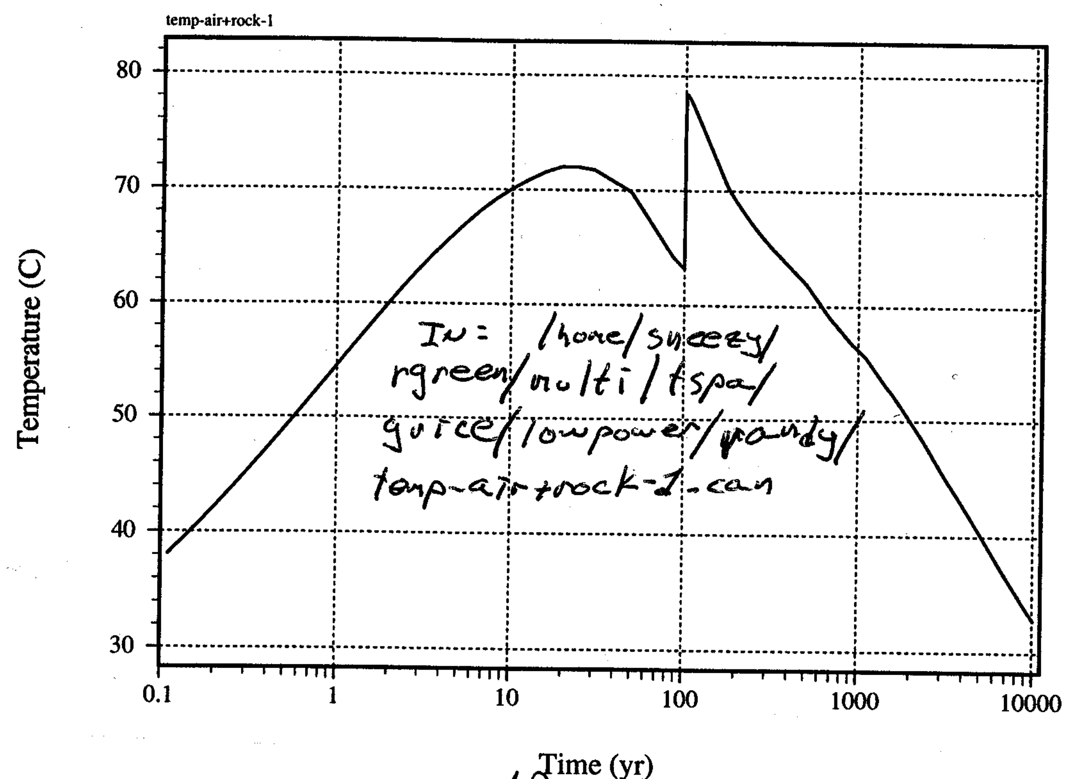
MR 5-6-96

5-6-96
MR

OUTPUT: air-1.dat' + 'rock-2.dat'

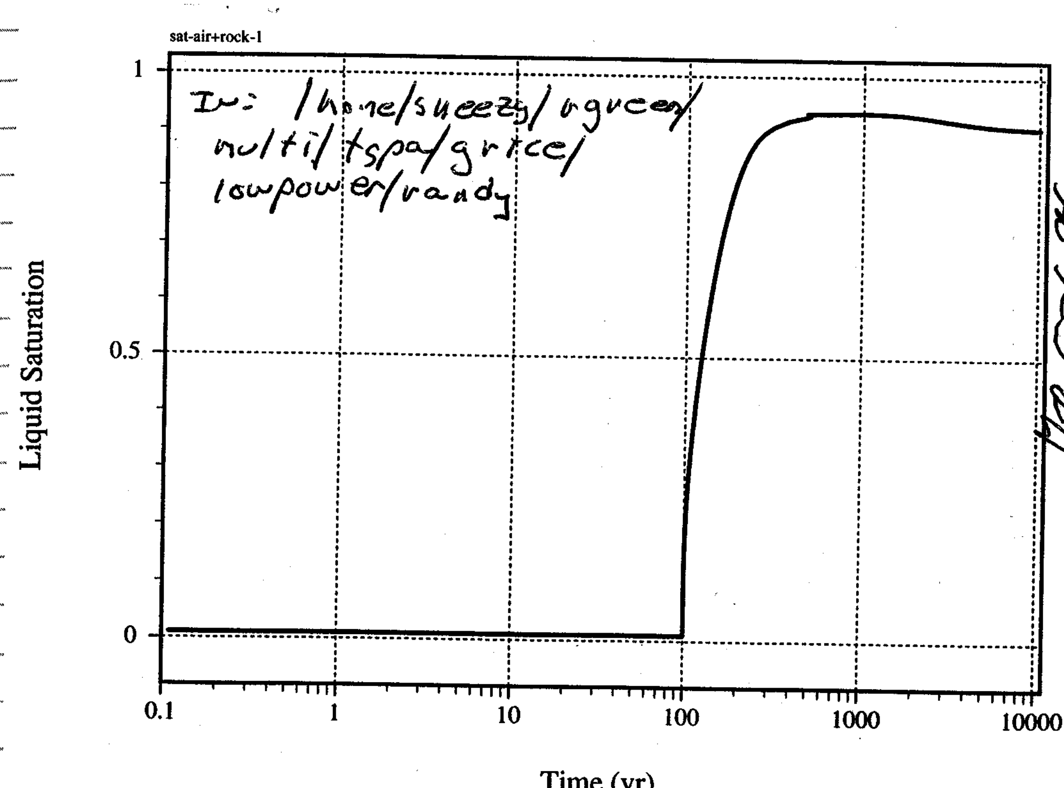
MR 5-6-96

Temperature Next to Heater (24kW)



MR 5-6-96

Saturation Next to Heater (24kW, sat@100=0.1)



MR 5-6-96

5-7-96
MR

RUNNING METRA IN CONDUCTION ONLY MODE - POROSITY SET TO ZERO FOR ALL MATERIALS, 'air-24-ϕ.dat' IN:

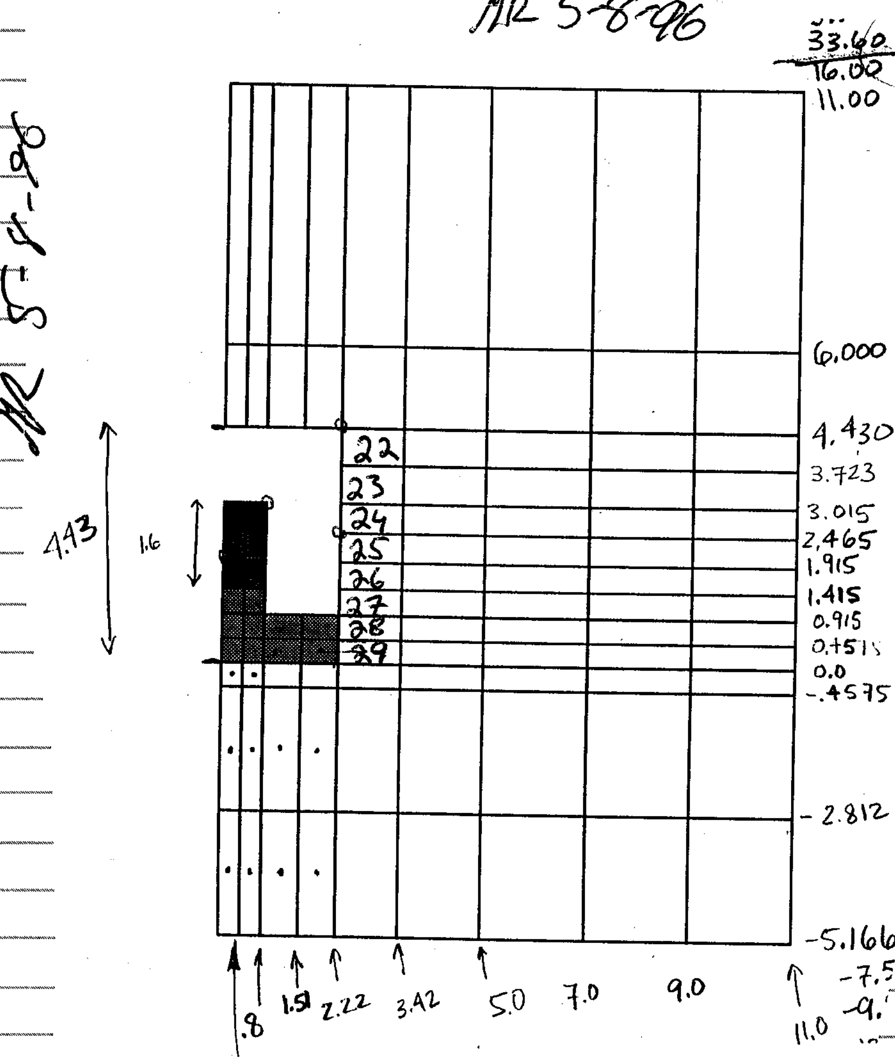
/home/sneezy/rgreen/multi/tspa/grice/lowpower/randy

5-8-96
MR

NEW METRA RUNS - GRID IDENTICAL TO GOODLUCK OFOEGBU'S ABACUS GRID:

MR 5-8-96

MR 5-8-96



- "air-24-ss.dat" - STEADY STATE RUN USING GRID SHOWN ABOVE. INFILTRATION RATE = 0.3 mm/yr, NO HEAT. OUTPUT TO GO INTO "air-24-1.dat'
IN: /home/sneezy/rgreen/multi/tspa/grice/lowpower/randy/ss_abacus

5-8-96 MR — run "air-24-SS.dat" CRASHED AFTER ~ 1 YEAR. USED OUTPUT FROM 1 YR AS INITIAL CONDITIONS IN NEW RUN OF "air-24-SS.dat".

"air-24-SS.dat" CRASHED AGAIN. WILL SET ALPHA OF BACKFILL MATRIX TO 1.11x10^-5/Pa INSTEAD OF 1.11x10^-5/Pa.

5-9-96 MR — EXAMPLE OF NEW METRA INPUT FORMAT = 'rock.dat' & 'rock.int' + 'rock.src' IN:

/lan/cnwra11/PLICHTNER/multiflo/examples/rock

- ON PERFORMER WORKING IN:

/pscr1/randall/d/multiflo/george

- INPUT files 'rock.*' ARE RUNNING UNDER new version of METRA ON PERFORMER

- NEW METRA INPUT SET THAT RUNS BUT CRASHES @ ~ 4 YEARS:
'air.dat', 'air.int', + 'air.src' - IN:
/home/sneezy/rgreen/multi/tspa/grice/lowpower/randy/as_abacus

5-11-96 MR — RE-RUN "air.**" WITH RESIDUAL SATURATIONS OF ALL MATERIALS REDUCED BY AN ORDER OF MAGNITUDE - CALL FILES "air-resid.**"

5-14-96 MR — "air-resid.dat" CRASHED AFTER ~ 4 YEARS - PRODUCING NaNs IN OUTPUT.

- RE-RUNNING "air-resid.dat" WITH INITIAL WATER SATURATIONS NEARLY EQUAL TO 1 IN ALL MATERIALS.

5-14-96 MR — ~~"air-resid.dat" CRASHED ≈~~ MR 5-14-96
"air.dat" WITH INITIAL SATURATIONS OF ALL MATERIALS SET TO ~1.0 RUNS AND CRASHES AT ~ 4 YEARS.

- RUNNING "air.dat" WITHOUT ANY SOURCE (WATER OR HEAT) - CRASHES AFTER ~0.4 YEARS

- RUNNING "air.dat" WITH 'isolve' = 3 = WATSOLVE INSTEAD OF 'isolve' = 2 = D4 METHOD (DIRECT)
RUN DIED AFTER ~ 0.5 YRS - MESSAGE ON SCREEN SAID 'BUS ERROR'

- NEW VERSION OF METRA - FROM PETER L. @ ~1115.
RUNNING 'air.dat' w/D4 SOLVER

RUN CRASHED @ ~ 16.8 YRS. USED OUTPUT FROM 16.8 YRS AS INITIAL CONDITIONS FOR ANOTHER RUN: INPUT FILES 'air.dat', 'air2.int', + 'air.src' IN:

/home/sneezy/rgreen/multi/tspa/grice/lowpower/randy/as_abacus

RUN CRASHED @ 2381 YEARS, ~ 1400 TIMESTEPS, ERROR IN H2Opot, CELL #496, z = 55, x = 1

USE OUTPUT FROM RUN ABOVE AS INITIAL CONDITIONS FOR ANOTHER RUN:
'air.dat', 'air3.int' + 'air.src'

RUN CRASHED @ ~0.07 YRS, ~1200 TIMESTEPS.

MR 5-16-96

5-15-96 MR

NEW SET OF RUNS – LOOKING AT EFFECTS OF FRACTURES AND FRACTURE ZONES IN:

/home/sneezy/rgreen/multi/tspa/grice/busc-frac

STEADY STATE RUN; INPUT FILES:

"air-83-SS.dat", "83ss.int", 83ss.src

RUN REACHED STEADY STATE ~ 408 YEARS.

OUTPUT FROM "air-83-SS... et al WILL BE USED AS INITIAL CONDITIONS IN:

"air-83.dat", "air-83.int", "air-83.src" – IN SAME DIRECTORY AS ABOVE

5-16-96 MR

NEW RUNS – "rock-83.dat", "rock_int", + "rock-src" – RUNS WIHT BACKFILL – THEY USE OUTPUT OF "air-83.**" AS INITIAL CONDITIONS. IN:

/home/sneezy/rgreen/multi/tspa/grice/busc-frac

5-17-96 MR

STOPPED "rock-83.dat" AFTER ~24 HRS. ITERATIONS ≈ 8200, TIME ≈ 0.62 YRS.

NEW RUNS: 24 KW/AC:

"air.dat", "air.int", + "air.src". IN:

/home/sneezy/rgreen/multi/tspa/grice/busc-frac/0.3mm/24KW

OUTPUT FROM "air.**" USED AS INITIAL CONDITIONS IN:

"rock-dat", "rock.int", + rock.src – SAME DIRECTORY

5-20-96 MR

WORKING WITH RUI CHEN, TRYING TO FIND OUT WHY HER RUNS CRASH WHEN SHE USES THE ORIGINAL VAN GENUCHTEN ALPHA FOR THE BACKFILL MATRIX.

RUI'S ORIGINAL FILES:

"tspab1.dat" + "tspa~~b1~~b1.int" IN: MR 5-20-96

/home/sneezy/rgreen/~~grice~~ multi/tspa/grice/chen MR 5-20-96

RUN TO STEADY STATE – WITH $\alpha = 1.11e^{-5}$/Pa (ORIGINAL VALUE IN TSPA) AND NO HEAT:

"test-ss.dat" + "tspab1.int"

RUN COMPLETED SUCCESSFULLY, STEADY STATE REACHED IN 11,351 YRS.

STEADY-STATE OUTPUT USED AS INPUT FOR "TEST1.dat" + "SS.int" – $\alpha = 1.11e^{-5}$/Pa AND HEAT ON. 'TEST1.dat' based on RUI'S ORIGINAL INPUT – tspab1. ONLY + .int FILE CHANGED.

'test1.**' CRASHED ~ 0.2 YRS. – WILL ALTER PROPERTIES OF BACKFILL – CHANGE RESIDUAL SATURATIONS FROM 0.01 + 0.04 TO 0.001 + 0.001.

– NEW 'test1.**' CRASHED ~ 0.055 YRS. – RE-RUN WITH RESIDUAL SATURATIONS PUT BACK AS BEFORE – USING NEW VERSION OF METRA – RON JUST LINKED IT TO SNEEZY ~1415.

– CRASHED SAME PLACE AS BEFORE – 0.2027 YEARS – USING NEW VERSION OF METRA.

5-20-96
MR

PUT RUNS THAT CRASH ON SKIPPY FOR MOHAN IN:
/home/skippy/rgreen

RE-RUNNING "test1.xx" - IDENTICAL TO RUN JUST COMPLETED EXCEPT VOLUME OF LOWEST ROW SET TO 0. IN Phik INSTEAD OF 6.2832e7 (v6).

NEW RUN: "test2.dat" + "ss.int" - MOHAN S. SAYS - VARIABLE MISSING IN 'Pckr' - 2ND LINE OF VAN GENUCHTEN PARAMETERS SHOULD HAVE RPMF INSERTED BETWEEN SWIRF & ALPHAF. ALSO, IN THERMAL PROPERTIES, CHANGE eabd FROM 1. TO 0. THOSE CHANGES MADE IN test2.dat.

ALSO, vb reset TO 6.3e7 IN Phik.

IN: /home/sneezy/rgreen/multi/tspa/grice/chen

RUN CRASHED ~ 46 YEARS, 330 TIMESTEPS.

5-~~20~~ 21-96 MR 5-22-96
MR

~~RE-RUN "test2.dat" +~~ MR 5-20-96

RE-RUN "test-ss.dat" WITH VAN-GENUCHTEN λs (RPMF) THAT WERE MISSING IN PREVIOUS RUN. RUN WITHOUT BACKFILL - ONLY NATURAL MATERIALS - OUTPUT WILL BE USED AS INPUT FOR RUNS WITH HEAT. SATURATION OF BACKFILL WILL BE SET TO ~50%.
IN SAME DIRECTORY AS SHOWN ABOVE.

RUN "test-ss.dat" COMPLETED IN 34 TIMESTEPS, TIME AT STEADY STATE = 14,492 YEARS.

MR 5-22-96
5-~~20~~ 21-96
MR

NEW "test2.dat" + "ss.int" RUN. USING INITIAL CONDITIONS GENERATED BY "test-ss.dat" WITH INITIAL SATURATIONS OF HEATER + BACKFILL SET TO 1% + 50%, RESPECTIVELY. ALSO, INCLUDED NEW MATERIAL TYPE - HEATER (METAL WASTE PACKAGE). IN:

/home/sneezy/rgreen/multi/tspa/grice/chen

RUN CRASHED @ ~ 26.10 YEARS, ~ 403 TIMESTEPS

NEW RUN: "test3.dat" + "ss-2.int", SAME AS "test2.dat" + "ss.int" EXCEPT BACKFILL ~~REPLA~~ MR 5-20-96 ON TOP + SIDE OF HEATER REPLACED BY AIR. IN:

/home/sneezy/rgreen/multi/tspa/grice/chen

"test3.dat" CRASHED @ ~ 36.8 YRS, 205 TIMESTEPS.
PROBLEM: CELL # 423

"RE-RUN "test3.dat" - REDUCE HEAT BY FACTOR OF 2 - SEE WHAT HAPPENS.

RUN SUCCESSFUL - TO 10,000 YEARS IN 96 TIMESTEPS.

NOW - RE-RUN "test3.dat" @ 83 kW/Ac - MULTIPLY RUI'S HEATING RATE BY 0.91.

5-22-96
MR

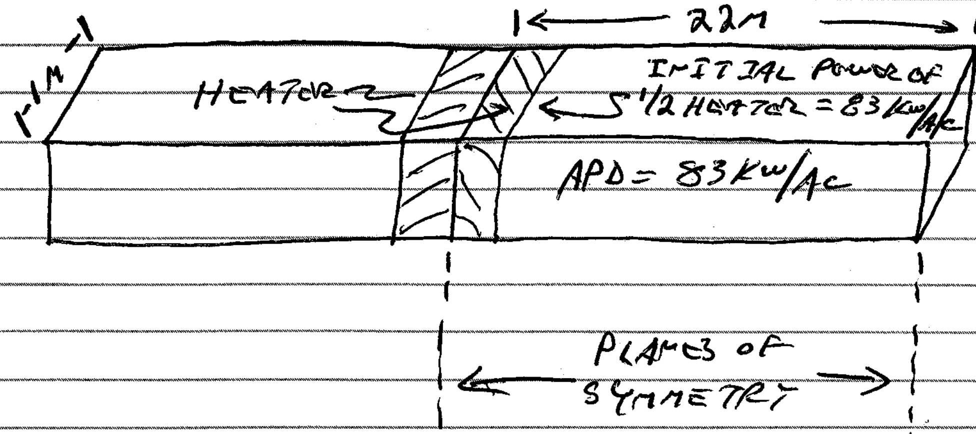
- KILLED "test3.dat" AFTER ~ 65.6 YRS, 13,864 TIMESTEPS, $\Delta t = 0.10^{-5}$

NEW RUN: "test4.dat" + "ss-2.int" IN:
/home/sneezy/rgreen/multi/tspa/grice/chen

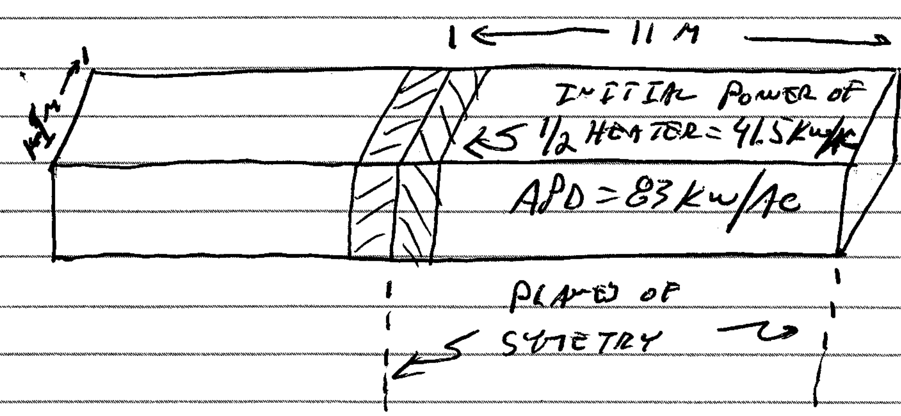
5-22-96
MR

"test4.dat" IS IDENTICAL TO "test3.dat"
EXCEPT THAT DRIFT SPACING IS 22M
INSTEAD OF 44M.

DRIFT SPACING IN "test3.dat" = 44M:



DRIFT SPACING IN "test4.dat" = 22M:



MR 5-22-96

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MR

INPUT = "test4.dat"

MR 5-22-96

```
Test Data for Multiflo simulator (initial data : 2D, Yucca Mt.)
                    22 May, 1996
::::::::::
: THE DRIFT SPACING OF THIS MODEL IS 22m
: initial conditions from test-ss.dat, steady-state run without heat, alpha as i
: xz-multiple layer model of Yucca Mountain with repository heat source and back
: added 0.3 mm/yr infiltration using source terms, not boundary conditions
: heat added to 8 elements
: set upper element to large heat capacity
: moved water infiltration into heat source area  ??
::::::::::
:
RSTART  0                 : Designates the frequency of writing restart files (0 -

Pckr                              :relative perm and pc keyword
:   i  type-curv     swirm   rpmm(lamda) alpham        swext   sgc         iecm
:                    swirf   rpmf(lamda) alphaf        phim           phif      permm
: (TCw)
    1  Van-Gen       0.002   0.3600      8.4e-7        0.0     0.0         1
                     0.040   0.7636      1.305e-5      0.087          1.8e-3  9.7e-19
: (PTn)
    2  Van-Gen       0.100   0.8500      1.53e-6       0.0     0.0         1
                     0.040   0.7636      1.305e-5      0.421          1.8e-3  3.9e-14
: (TSw)
    3  Van-Gen       0.080   0.4400      5.8e-7        0.0     0.0         1
                     0.040   0.7636      1.305e-5      0.139          1.8e-3  1.9e-18
: (TSv)
    4  Van-Gen       0.080   0.4438      5.8e-7        0.0     0.0         1
                     0.040   0.7636      1.305e-5      0.065          1.8e-3  1.9e-18
: (CHnv)
    5  Van-Gen       0.041   0.7400      1.63e-6       0.0     0.0         1
                     0.040   0.7636      1.305e-5      0.331          1.8e-3  2.7e-14
: (CHn2)
    6  Van-Gen       0.110   0.3800      3.13e-7       0.0     0.0         1
                     0.040   0.7636      1.305e-5      0.306          1.8e-3  2.0e-18
:
: ******************
:  Backfill material
: ******************
    7  Van-Gen       0.01    0.7000      1.11e-5       0.0     0.0         1
                     0.04    0.7636      1.305e-5      0.50           1.8e-3  3.9e-14
:
: ******************
: Metal Waste Package
: ******************
    8  Van-Gen       0.01    0.4400      5.80e-7       0.0     0.0         1
                     0.01    0.7636      1.305e-5      0.1               0.1  3.9e-99
:
: *****
:  Air
: *****
    9  Van-Gen       0.01    0.4400      5.80e-7       0.0     0.0         1
                     0.01    0.7636      1.305e-5      0.99999 0.99999        3.9e-99
:
0          :  blank line to end pckr data
.

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   0.
  2  2.580e+03 422.     0.61   0.81     0     0      .5    2.13e-5  1.8   0.
  3  2.580e+03 840.0    2.10   2.78     0     0      .5    2.13e-5  1.8   0.
  4  2.580e+03 948.     1.28   1.69     0     0      .5    2.13e-5  1.8   0.
  5  2.580e+03 488.0    0.84   1.11     0     0      .5    2.13e-5  1.8   0.
  6  2.580e+03 526.     0.42   1.88     0     0      .5    2.13e-5  1.8   0.
  7  2.580e+03 9e+50    1.69   2.23     0     0      .5    2.13e-5  1.8   0.
:
: ******************
:  Backfill material
: ******************
:
  8  2.580e+03 840.0    0.60   0.79     0     0      .5    2.13e-5  1.8   0.
:
: ******************
: Metal Waste Package
: ******************
:
  9 7.800e+03 450.0     50.0   50.0           0      .5    2.13e-5  1.8   0.
.
```

MR 5-22-96
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MR 5-22-96
MR 5-22-96

5-22-96 INPUT: "test4.dat" (cont)

MR

MR 5-22-96

```
: *****
:  Air
: *****
:
 10 1.2       57.4      20.0  20.0      0      0     .5  2.13e-5  1.8  0.
:
0
: ****************************
:  Define size of grid-blocks
: ****************************
: igrid = grid-type (0 - block centered, 1 - point-distributed, 2 - bounda
: dx = block sizes in x-direction
: dy = block sizes in y-direction
: dz = block sizes in z-direction
:
DXYZ   2
: (dx(i),i=1,nx)
.25 .25 .375 .375 0.5 0.625 0.625 1. 1. 1.
1. 1. 0.625 0.625 0.5 .375 .375 .25 .25
: (dy(j),j=1,ny)
1.
: (dz(k),k=1,nz)
: element 1-6 TCw
: element 7-10 PTn
: element 11-20 TSw above the opening
: element 21-22 backfill above the heater
: element 23-26 heater
: element 27-28 backfill below the heater
: element 29-35 TSw below the opneing
: element 36 TSv
```

MR 5-22-96

```
   : element 37-39 CHnv
   : element 40-43 CHnz
   16.00  16.00  16.00  16.00  16.00  15.00  14.00  13.00  13.00  13.00
   15.00  20.00  34.00  30.00  30.00  30.00  17.00  10.00   5.00   2.50
     .75    .75    .50    .50    .50    .50    .75    .75   2.50   5.00
   10.00  20.00  30.00  30.00  30.00   8.00  20.00  30.00  31.00  30.00
   30.00  30.00  31.00
   :
```

MR 5-22-96

```
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.                : Top boundary with very high sp
   1 19  1  1  2  6   1    1   0.                : TCw
   1 19  1  1  7 10   2    2   0.                : PTn
   1 19  1  1 11 20   3    3   0.                : TSw
   1  4  1  1 21 22   9   10   0.                : AIR above the heater
   5 19  1  1 21 22   3    3   0.                : TSw right of opening
   1  2  1  1 23 26   8    9   0.                : heater
   3  4  1  1 23 26   9   10   0.                : AIR right of heater
   5 19  1  1 23 26   3    3   0.                : TSw righ of the opening
   1  4  1  1 27 28   7    8   0.                : backfill below the heater
   5 19  1  1 27 28   3    3   0.                : TSw right of opneig
   1 19  1  1 29 35   3    3   0.                : TSw below the opening
   1 19  1  1 36 36   4    4   0.                : TSv
   1 19  1  1 37 39   5    5   0.                : CHnv
   1 19  1  1 40 42   6    6   0.                : CHnz
   1 19  1  1 43 43   6    6   6.3e7
   0
:
: ***************************************************************
:  Initial pres, saturation, temp. and mole fractions of gas phase
: ***************************************************************
: i j k = region for property data
: p = pressure for the defined region (Pa)
: T = temperature for the defined region (C)
: sg = gas phase satuation for the defined region (fraction)
: xa = mole fraction of air in the defined region
: sgm = matrix gas phase saturation for the defined region (ignored if ECM is no
:
Init ss-2
: i1  i2  j1  j2  k1  k2        p        t         sg         xg2       sgm
:
:
: ***************************
:  End of initialization data
: ***************************
Recurrent-data
```

MR 5-22-96

5-22-96 INPUT: "test4.dat" (concl.)

MR

MR 5-22-96

```
: source  NS   FACE   FACM
Source    10   0.455   0.5    :19 water sources along the top surface, 8 heater
:
: sources at the top boundary surface
:
: timeq(sec)   T/qht (C/(J/s))    qmt (kg/s) 80APD
:  is1  is2  js1 js2 ks1 ks2 istype
```

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```
    1   2   1   1  1  1  11
0. 13.05 4.756e-9
0
:
    3   4   1   1  1  1  11
0. 13.05 7.135e-9
0
:
    5   5   1   1  1  1  11
0. 13.05 9.513e-9
0
:
    6   7   1   1  1  1  11
0. 13.05 1.189e-8
0
:
    8  12   1   1  1  1  11
0. 13.05 1.903e-8
0
:
   13  14   1   1  1  1  11
0. 13.05 1.189e-8
0
:
   15  15   1   1   1  1  11
0. 13.05 9.513e-9
0
:
   16  17   1   1   1  1  11
0. 13.05 7.135e-9
0
:
   18  19   1   1   1  1  11
0. 13.05 4.756e-9
0
:
: 8 time declaying heat sources (heat rate with no mass
:
:  is1  is2  js1  js2  ks1  ks2  istype
    1    2    1    1   23   26   31
: timeq(sec)   T/qht (C/(J/s))    qmt (kg/s) 80APD
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
```

MR 5-6-96

5-22-96 MR

INPUT – INITIAL DATA FILE FOR "test4.dat" – "ss-2.int'

MR 5-22-96

: Cut & Paste Initilization Variables for Restart
: ==
: Output from 'test-ss.dat' Saturation of heater and air set to 1%.
: Time = 0.455456E+12 secs Days = 0.527147E+07 years = 0.144424E+05

: i1	i2	j1	j2	k1	k2	p	t	sg	xg2	sgm	
1	1	1	1	1	1	1.03228E+05	13.0480	3.7156E-02	0.0000E+00	3.7156E-02	
2	2	1	1	1	1	1.03228E+05	13.0480	3.7156E-02	0.0000E+00	3.7156E-02	
3	3	1	1	1	1	1.03228E+05	13.0480	3.7156E-02	0.0000E+00	3.7156E-02	
1	1	1	1	21	21	1.07395E+05	18.7924	0.99	0.0000E+00	0.99	
2	2	1	1	21	21	1.07395E+05	18.7924	0.99	0.0000E+00	0.99	
3	3	1	1	21	21	1.07395E+05	18.7924	0.99	0.0000E+00	0.99	
4	4	1	1	21	21	1.07395E+05	18.7924	0.99	0.0000E+00	0.99	
5	5	1	1	21	21	1.07395E+05	18.7924	4.2321E-02	0.0000E+00	4.2321E-02	
6	6	1	1	21	21	1.07395E+05	18.7924	4.2321E-02	0.0000E+00	4.2321E-02	
7	7	1	1	21	21	1.07395E+05	18.7924	4.2321E-02	0.0000E+00	4.2321E-02	
16	16	1	1	21	21	1.07395E+05	18.7924	4.2321E-02	0.0000E+00	4.2321E-02	
17	17	1	1	21	21	1.07395E+05	18.7924	4.2321E-02	0.0000E+00	4.2321E-02	
18	18	1	1	21	21	1.07395E+05	18.7924	4.2321E-02	0.0000E+00	4.2321E-02	
19	19	1	1	21	21	1.07395E+05	18.7924	4.2321E-02	0.0000E+00	4.2321E-02	
1	1	1	1	22	22	1.07404E+05	18.8011	0.99	0.0000E+00	0.99	– AIR IN DRIFT
2	2	1	1	22	22	1.07404E+05	18.8011	0.99	0.0000E+00	0.99	
3	3	1	1	22	22	1.07404E+05	18.8011	0.99	0.0000E+00	0.99	
4	4	1	1	22	22	1.07404E+05	18.8011	0.99	0.0000E+00	0.99	
5	5	1	1	22	22	1.07404E+05	18.8011	4.2455E-02	0.0000E+00	4.2455E-02	
6	6	1	1	22	22	1.07404E+05	18.8011	4.2455E-02	0.0000E+00	4.2455E-02	
7	7	1	1	22	22	1.07404E+05	18.8011	4.2455E-02	0.0000E+00	4.2455E-02	
17	17	1	1	22	22	1.07404E+05	18.8011	4.2455E-02	0.0000E+00	4.2455E-02	
18	18	1	1	22	22	1.07404E+05	18.8011	4.2455E-02	0.0000E+00	4.2455E-02	
19	19	1	1	22	22	1.07404E+05	18.8011	4.2455E-02	0.0000E+00	4.2455E-02	
1	1	1	1	23	23	1.07412E+05	18.8084	9.9E-01	0.0000E+00	9.9E-01	
2	2	1	1	23	23	1.07412E+05	18.8084	9.9E-01	0.0000E+00	9.9E-01	
3	3	1	1	23	23	1.07412E+05	18.8084	0.99	0.0000E+00	0.99	
4	4	1	1	23	23	1.07412E+05	18.8084	0.99	0.0000E+00	0.99	
5	5	1	1	23	23	1.07412E+05	18.8084	4.2569E-02	0.0000E+00	4.2569E-02	
6	6	1	1	23	23	1.07412E+05	18.8084	4.2569E-02	0.0000E+00	4.2569E-02	
7	7	1	1	23	23	1.07412E+05	18.8084	4.2569E-02	0.0000E+00	4.2569E-02	
18	18	1	1	23	23	1.07412E+05	18.8084	4.2569E-02	0.0000E+00	4.2569E-02	
19	19	1	1	23	23	1.07412E+05	18.8084	4.2569E-02	0.0000E+00	4.2569E-02	
1	1	1	1	24	24	1.07418E+05	18.8143	9.9E-01	0.0000E+00	9.9E-01	– HEATER
2	2	1	1	24	24	1.07418E+05	18.8143	9.9E-01	0.0000E+00	9.9E-01	
3	3	1	1	24	24	1.07418E+05	18.8143	0.99	0.0000E+00	0.99	– AIR
4	4	1	1	24	24	1.07418E+05	18.8143	0.99	0.0000E+00	0.99	
5	5	1	1	24	24	1.07418E+05	18.8143	4.2661E-02	0.0000E+00	4.2661E-02	
6	6	1	1	24	24	1.07418E+05	18.8143	4.2661E-02	0.0000E+00	4.2661E-02	
7	7	1	1	24	24	1.07418E+05	18.8143	4.2661E-02	0.0000E+00	4.2661E-02	
18	18	1	1	24	24	1.07418E+05	18.8143	4.2661E-02	0.0000E+00	4.2661E-02	
19	19	1	1	24	24	1.07418E+05	18.8143	4.2661E-02	0.0000E+00	4.2661E-02	
1	1	1	1	25	25	1.07425E+05	18.8201	9.9E-01	0.0000E+00	9.9E-01	
2	2	1	1	25	25	1.07425E+05	18.8201	9.9E-01	0.0000E+00	9.9E-01	
3	3	1	1	25	25	1.07425E+05	18.8201	0.99	0.0000E+00	0.99	
4	4	1	1	25	25	1.07425E+05	18.8201	0.99	0.0000E+00	0.99	
5	5	1	1	25	25	1.07425E+05	18.8201	4.2754E-02	0.0000E+00	4.2754E-02	
6	6	1	1	25	25	1.07425E+05	18.8201	4.2754E-02	0.0000E+00	4.2754E-02	
7	7	1	1	25	25	1.07425E+05	18.8201	4.2754E-02	0.0000E+00	4.2754E-02	

MR 5-22-96

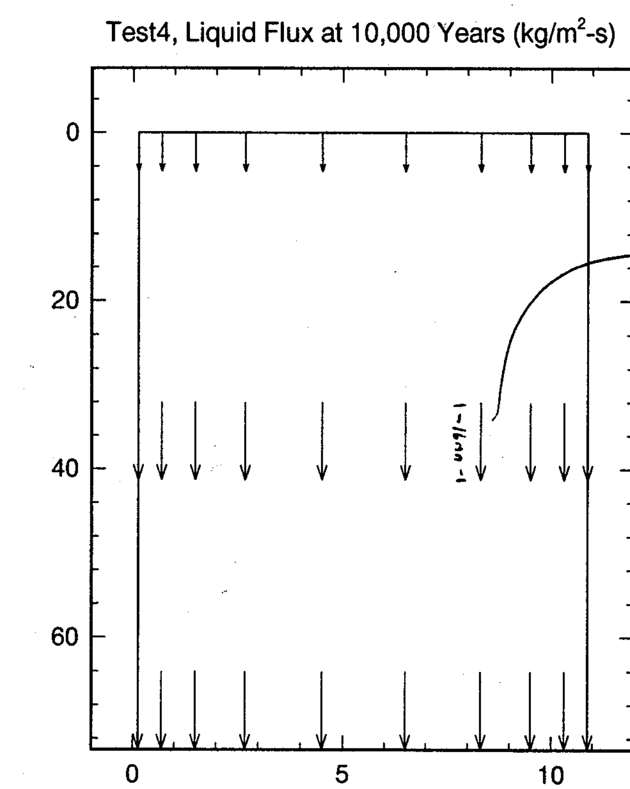
MR 5-22-96

5-22-96 MR

OUTPUT = "test4.dat" + "ss-2.int" – CHECKING TO MAKE SURE FLUX = 3mm/YR AT LARGE TIMES:

MR 5-22-96

(2D) || Print || 22 May 1996 || test4flx6.plt || Time = 10,000 Years)



REF VECT:

$1\times10^{-8} \frac{kg}{m^2\text{-}s} \cdot \frac{m^3}{10^3 kg} \cdot \frac{86400 s}{DAY} \cdot \frac{365 DAY}{YR}$

$\simeq 3.15\times10^{-4} \frac{m}{YR}$

$\frac{16mm}{17mm} \cdot 3.15\times10^{-4} \frac{m}{YR} \simeq 2.97\times10^{-4} \frac{m}{YR}$

Reference Vector = 1E-8 kg/m²-s

1–17mm–1

IN: /home/sneezy/rgreen/multi/tspa/grice/chen

5-24-96 MR

FRACTURE FLOW SIMULATIONS:

STEADY STATE:

"air-1-ss.dat" + "1-ss.int" + "1-ss.src"

NO HEAT – ALL WATER FORCED THROUGH 100m FRACTURE AT SURFACE (ONLY ONE SOURCE ELEMENT)

IN: /home/sneezy/rgreen/multi/tspa/grice/basc-frac/0.3mm/83KW

REACHED STEADY STATE IN 3014 YEARS, CPU TIME ~ 1100 s, # TIMESTEPS = 159

5-24-96
MR

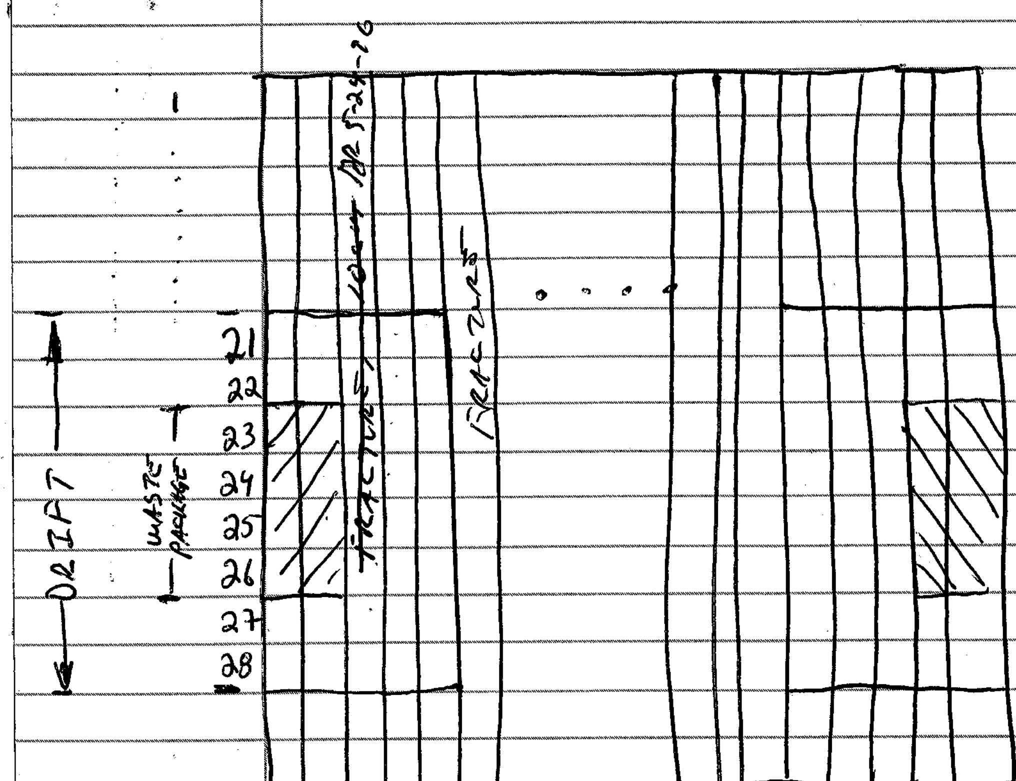
FRACTURE RUN:

"air-1.dat", "air-1.int", & "air-1.src" –

~~10~~ 785 MR 5-27-96 cm FRACTURE NEXT TO LEFT ~~WASTE PACKAGE~~ DRIFT –
ALL WATER FORCED INTO FRACTURE AT SURFACE.

INITIAL CONDITIONS FROM STEADY STATE RUN:
"air-1-ss.dat" EXCEPT INITIAL SATURATIONS OF WASTE PACKAGES + AIR IN DRIFT SET TO 1%.

IN: /home/sneezy/rgreen/multi/tspa/grice/6usc-frac/0.3mm/83kw



5-27-96
MR

NEW RUN: "rock-AT-φ.dat" & ~~"ss-2.int"~~ "rock-φ.int" MR 5-27-96 – SAME AS "test4.dat" EXCEPT BACKFILL IS ROCK INSTEAD OF AIR. ALSO – INITIAL SATURATION OF BACKFILL SET TO 50%. IN:

/home/sneezy/rgreen/multi/tspa/grice/chen

5-28-96
MR

MR 5-28-96 TEMP = 180.6 °C @ HEATER

AFTER ~ 990 MIN CPU TIME, + 12090 TIMESTEPS, "rock-ATφ.dat" IS AT 12.53 YEARS, ~ SAME TIME IT WAS AT 1/2 HOUR AFTER RUN BEGAN. RUN KILLED – INITIAL SATURATION OF BACKFILL SET TO 90%.

MR 5-28-96 REACHED 12.24 YRS IN 93 TIMESTEPS

- RESTART "rock-at-φ.dat" WITH INITIAL SATURATION OF BACKFILL SET TO 90%.
  TIME = 12.46 YRS @ 97 TIMESTEPS
  RUN @ 12.47 YRS AFTER 229 TIMESTEPS. RUN KILLED.

- RUN RESTARTED – EXACTLY AS ABOVE BUT WITH MINIMUM TIMESTEP LEV674 CHANGED FROM 1×10^{-5} YRS TO 1×10^{-12} YRS (dtmn)
  - TIME = 12.67 YRS AFTER 122 TIMESTEPS
  - TIME = 12.67 YRS AFTER 415 TIMESTEPS

- RUN RESTARTED – EXACTLY AS ABOVE BUT WITH MINIMUM TIMESTEP (dtmn) CHANGED TO 1×10^{-3} YR).
  - TIME = 12.66 YRS AFTER 93 TIMESTEPS

EXAMINE EFFECTS OF MINIMUM TIMESTEP ON RESULTS (dtmn)

ALL RUNS IDENTICAL TO "rock-at-φ.dat" EXCEPT:

- RUN 1 = "rock-at-φ-90-1.dat" (BACKFILL = 90% SATURATION, dtmn = 1 YEAR).

5-28-96
MR

• Run 1: "rock-at-ϕ-90-1.dat" CRASHED ON TIMESTEP #3.
"rock-at-ϕ-90.old.dat" MR 5-28-96

• Run 2: "~~rock-at-ϕ-90-2.dat~~" — SAME AS Run #1
PUT dtmn = 0.1 YRS
Run 2 CRASHED ON TIMESTEP #3

• Run 3: AS ABOVE BUT dtmn = 0.01 yrs.
"rock-at-ϕ-90-0.01.dat" MR 5-28-96
Run 3 CRASHED AFTER TWO TIMESTEPS.

Run 4: SAME AS LAST "rock-at-ϕ.dat" MR 5-28-96 ON PREVIOUS PAGE - dtmn = 1×10^{-3} YR.
"rock-at-ϕ-90-0.001.dat"

~1100 - CALL MOHAN SETH re METRA GETTING "BOGGED DOWN - ANY SUGGESTIONS?
20 # 71-214-699-3610 - BUSY

~1110 - TRY AGAIN — BUSY

~1125 TRY AGAIN
TRY CHANGING AUTO-STEP VARIABLES
ALSO CHANGE ON LIMIT CARD

• Run 4: TIME = 13.45 YRS AFTER 856 TIMESTEPS.
KILLED RUN - RE-RUN PROBLEM AS "rock-at-ϕ-90-0.0016.dat" CHANGED PRESSURE

MOHAN SAYS, VALUES ON LIMIT CARD SHOULD BE MORE THAN TWICE AS LARGE AS VALUES ON AUTO STEP CARD.

VARIABLES ON AUTO STEP CARD FROM 1e4 TO 1e5, CHANGED PRESSURE VARIABLE ON LIMIT CARD FROM 1e5 TO 1e6.

5-28-96
MR

- Run 4 BOGGED DOWN AGAIN @ ~12-13 YRS - CHANGED MAX SATURATION CHANGE TO 0.8 IN LIMIT & TO 0.3 IN AUTO STOP — RUN CRASHED.

WILL CHANGE DSMXE IN AUTO STEP TO 0.1, AND dsmx IN LIMIT TO 0.2.

RUN STILL CRASHES - CHANGE SAT VARIABLES TO 0.05 AND 0.1.

RUN BOGGED DOWN ~ 12.7 YRS - TEMP CHANGES ~20 °C - CHANGED ALLOWABLE TEMP CHANGE IN LIMIT TO 60 °C & IN AUTO STEP TO 30 °C (THEY WERE 30 MR 5-28-96 10 & 5, RESPECTIVELY)

MR RUN NOW BOGS DOWN @ ~ 9.9 YRS - PUT ~~SAT~~ TEMP VARIABLES BACK TO THE WAY THEY WERE: 5 & 10 °C.

~1350 - MOHAN SETH re METRA RUNS, TEMP SOMETIMES TAKES 20 °C JUMPS,
20 # 71-214-699-3610
→ MOHAN WILL LOOK AT FILE

- GOT NEW VERSION OF METRA FROM MOHAN - RUNS NOW COMPLETE SIMULATION TO 10^4 YEARS.
COMPLETED RUN: "rock-at-ϕ-90-0.0016.dat"

5-29-96
MR

1-ss.int MR 5-29-96
NEW STEADY-STATE FRACTURE RUN: "air-2-ss.dat" + "~~2-ss.int~~" + "2-ss.src" IN:
/home/sneezy/rgreen/multi/tspa/grice/base-frac/0.3mm/83kW

5-28-96 ~~MR 5-28-96 RUN "rock-at-φ-90-1.dat" CRASHED ON TIMESTEP #3~~

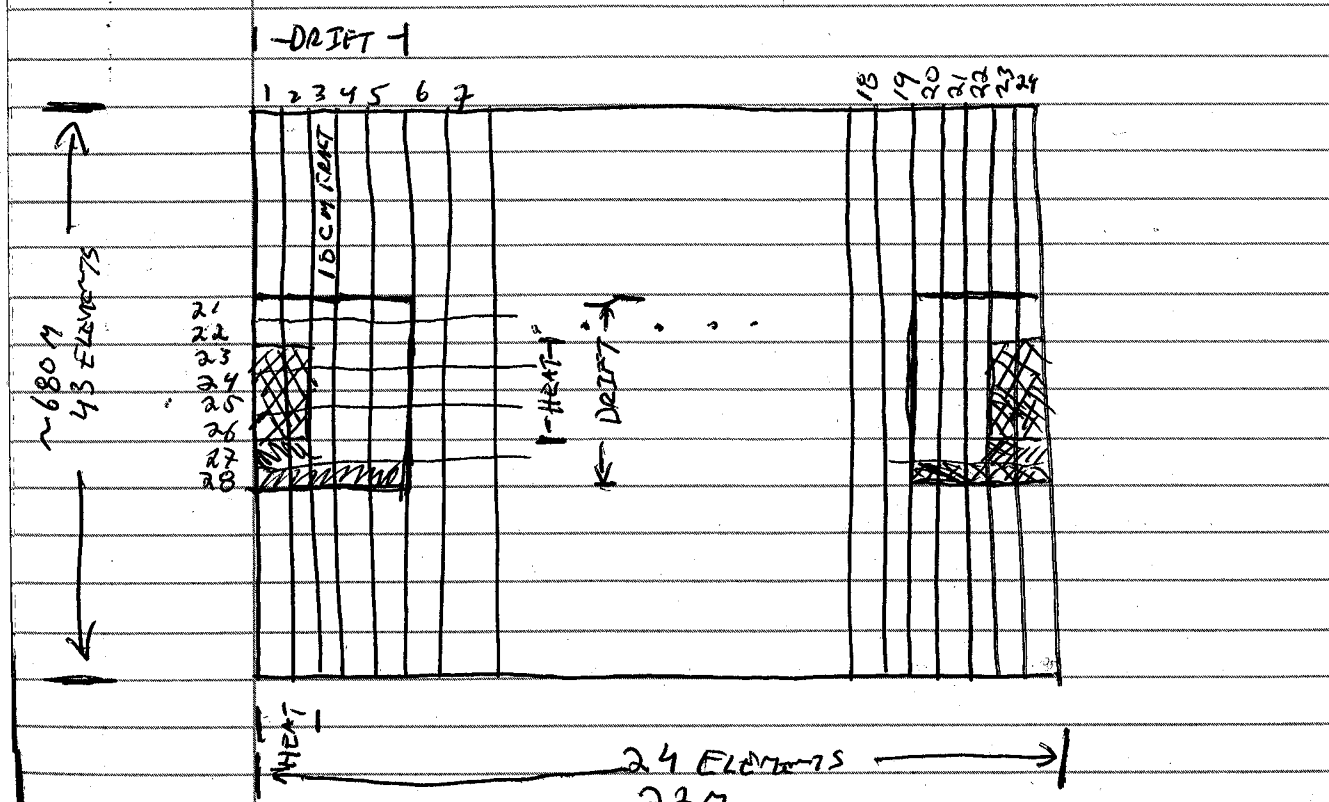
5-30-96 MR "air-2-ss.dat" et al. COMPLETED, STEADY STATE REACHED IN 1995 YEARS, 127 TIMESTEPS

NEXT RUN = "air-2.dat", "air-2.int", + "air-2.src" – USES STEADY-STATE OUTPUT FROM "air-2-ss.dat" et al. AS INITIAL CONDITIONS. IN:

/home/sneezy/rgreen/multi/tspa/grice/busc-frac/0.3mm/83kw

NEXT RUN = "rock-2.dat", "rock-2.int", + "rock-2.src" – USES OUTPUT FROM "air-2.dat" @ 100 YEARS AS INITIAL CONDITIONS. IN:

/home/sneezy/rgreen/multi/tspa/grice/busc-frac/0.3mm/83kw



5-30-96 MR

INPUT: "air-2.dat" MR 5-30-96

```
Steady State (initial data : 2D, Yucca Mt.)
May 30, 1996
: 10cm fracture zone next to waste.
: Initial conditions from ss run: "air-2-ss.dat" et al.i
: Initial saturations of waste packages and air set to 1%.
: Thermal conductivities of all materials are constants per TSPA 95
:  24X43 Grid
:Power Decay curve from R, Manteufel, 4/25/96.
: set upper element to large heat capacity
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       24  1   43   1       1      1      0    0
:
Monitor 555
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 S
: 1% in initial conditions file (air-2.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
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.
 :10 =Air Around Metal Waste Package, rho & cpr from CRC, other Properties Assume
  10  1.200e-00 57.4  10.0   10.0       0     0    0.0  2.13e-0  1.8  1.
 0
 :     igrid   rw      re
 DXYZ   2
 : (dx(i),i=1,nx)
 0.4 0.4 0.1 0.5 0.815 0.785 1.33 1.33 1.33 1.33
 1.33 1.35 1.35 1.33 1.33 1.33 1.33 1.33 0.785 0.815
 0.5 0.1 0.4 0.4
 : (dy(j),j=1,ny)
 1.
```

MR 5-30-96

MR 5-30-96

5-30-96
MR

"air-2-dat" (concl)

MR 5-30-96

```
: (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 24  1  1  1  1   1    7   0.
   1 24  1  1  2  6   1    1   0.
   1 24  1  1  7 10   2    2   0.
   1 24  1  1 11 35   3    3   0.
   1 24  1  1 36 36   4    4   0.
   1 24  1  1 37 39   5    5   0.
   1 24  1  1 40 42   6    6   0.
   1 24  1  1 43 43   6    6   6.2832e7
:Drifts
   1  5  1  1 21 28   9   10
  20 24  1  1 21 28   9   10
:Waste Packages
   1  2  1  1 23 26   8    9
  23 24  1  1 23 26   8    9
:Supports (Pedestal)
   1  2  1  1 27 27   7    8
  23 24  1  1 27 27   7    8
:Inverts (Floor)
   1  5  1  1 28 28   7    8
  20 24  1  1 28 28   7    8
:Fracture
    3  3  1  1  1 43  10    2
:
0
Init air-2
:
Recurrent-data
Output   A=1   C=1
:
:  isolv  newtnmn  newtnmx
Solve 2     2        8         4  0  4
```

NOTE: FRACTURE SHOULD STOP AT TOP OF DRIFT THEN CONTINUE FROM FLOOR TO WATER TABLE. THIS IS CORRECTED IN SUBSEQUENT RUNS.
MR 5-31-96

MR 5-30-96

```
: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-8 1.e5
:
: SKIP
:
Source  40   0.00333  1.000 air-2
:
:NOSKIP
:
:        print all at every target time
PLOTS 1 1 555
:      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
```

MR 5-30-96

5-30-96
MR

"air-2.int" - INPUT

MR 5-30-96

```
        Cut & Paste Initilization Variables for Restart
        ===============================================
 From "air-2-ss.dat" et al., initial sat of air & waste package set to 1%.
  Time =  0.629185E+11 secs  Days =  0.728223E+06   years =  0.199513E+04
 i1  i2  j1  j2  k1  k2        p          t        sg         xg2        sgm
  1   1   1   1   1   1 9.66473E+04  13.0480 2.0966E-01 0.0000E+00 2.0966E-01
  2   2   1   1   1   1 9.66473E+04  13.0480 2.1006E-01 0.0000E+00 2.1006E-01
  3   3   1   1   1   1 9.66473E+04  13.0480 8.5029E-01 0.0000E+00 8.5029E-01
 21  21   1   1  20  20 1.00537E+05  18.5887 1.2461E-01 0.0000E+00 1.2461E-01
 22  22   1   1  20  20 1.00537E+05  18.5887 1.2461E-01 0.0000E+00 1.2461E-01
 23  23   1   1  20  20 1.00537E+05  18.5887 1.2460E-01 0.0000E+00 1.2460E-01
 24  24   1   1  20  20 1.00537E+05  18.5887 1.2460E-01 0.0000E+00 1.2460E-01
  1   1   1   1  21  21 1.00558E+05  18.6094 9.9E-01 0.0000E+00 9.9E-01
  2   2   1   1  21  21 1.00558E+05  18.6094 9.9E-01 0.0000E+00 9.9E-01
  3   3   1   1  21  21 1.00558E+05  18.6094 9.9E-01 0.0000E+00 9.9E-01
  4   4   1   1  21  21 1.00558E+05  18.6095 9.9E-01 0.0000E+00 9.9E-01
  5   5   1   1  21  21 1.00558E+05  18.6095 9.9E-01 0.0000E+00 9.9E-01
  6   6   1   1  21  21 1.00558E+05  18.6095 1.2961E-01 0.0000E+00 1.2961E-01
  7   7   1   1  21  21 1.00558E+05  18.6095 1.2906E-01 0.0000E+00 1.2906E-01
  8   8   1   1  21  21 1.00558E+05  18.6095 1.2841E-01 0.0000E+00 1.2841E-01
 18  18   1   1  21  21 1.00558E+05  18.6096 1.2473E-01 0.0000E+00 1.2473E-01
 19  19   1   1  21  21 1.00558E+05  18.6096 1.2464E-01 0.0000E+00 1.2464E-01
 20  20   1   1  21  21 1.00558E+05  18.6096 9.9E-01 0.0000E+00 9.9E-01
 21  21   1   1  21  21 1.00558E+05  18.6096 9.9E-01 0.0000E+00 9.9E-01
 22  22   1   1  21  21 1.00558E+05  18.6096 9.9E-01 0.0000E+00 9.9E-01
 23  23   1   1  21  21 1.00558E+05  18.6096 9.9E-01 0.0000E+00 9.9E-01
 24  24   1   1  21  21 1.00558E+05  18.6096 9.9E-01 0.0000E+00 9.9E-01
  1   1   1   1  22  22 1.00566E+05  18.6179 9.9E-01 0.0000E+00 9.9E-01
  2   2   1   1  22  22 1.00566E+05  18.6179 9.9E-01 0.0000E+00 9.9E-01
  3   3   1   1  22  22 1.00566E+05  18.6179 9.9E-01 0.0000E+00 9.9E-01
  4   4   1   1  22  22 1.00566E+05  18.6179 9.9E-01 0.0000E+00 9.9E-01
  5   5   1   1  22  22 1.00566E+05  18.6179 9.9E-01 0.0000E+00 9.9E-01
  6   6   1   1  22  22 1.00566E+05  18.6180 1.2958E-01 0.0000E+00 1.2958E-01
  7   7   1   1  22  22 1.00566E+05  18.6180 1.2903E-01 0.0000E+00 1.2903E-01
  8   8   1   1  22  22 1.00566E+05  18.6180 1.2839E-01 0.0000E+00 1.2839E-01
 17  17   1   1  22  22 1.00566E+05  18.6181 1.2486E-01 0.0000E+00 1.2486E-01
 18  18   1   1  22  22 1.00566E+05  18.6181 1.2471E-01 0.0000E+00 1.2471E-01
 19  19   1   1  22  22 1.00566E+05  18.6181 1.2463E-01 0.0000E+00 1.2463E-01
 20  20   1   1  22  22 1.00566E+05  18.6181 9.9E-01 0.0000E+00 9.9E-01
 21  21   1   1  22  22 1.00566E+05  18.6181 9.9E-01 0.0000E+00 9.9E-01
 22  22   1   1  22  22 1.00566E+05  18.6181 9.9E-01 0.0000E+00 9.9E-01
 23  23   1   1  22  22 1.00566E+05  18.6181 9.9E-01 0.0000E+00 9.9E-01
 24  24   1   1  22  22 1.00566E+05  18.6181 9.9E-01 0.0000E+00 9.9E-01
  1   1   1   1  23  23 1.00573E+05  18.6245 9.9E-01 0.0000E+00 9.9E-01
  2   2   1   1  23  23 1.00573E+05  18.6245 9.9E-01 0.0000E+00 9.9E-01
  3   3   1   1  23  23 1.00573E+05  18.6245 9.9E-01 0.0000E+00 9.9E-01
  4   4   1   1  23  23 1.00573E+05  18.6245 9.9E-01 0.0000E+00 9.9E-01
  5   5   1   1  23  23 1.00573E+05  18.6245 9.9E-01 0.0000E+00 9.9E-01
  6   6   1   1  23  23 1.00573E+05  18.6245 1.2956E-01 0.0000E+00 1.2956E-01
  7   7   1   1  23  23 1.00573E+05  18.6246 1.2901E-01 0.0000E+00 1.2901E-01
  8   8   1   1  23  23 1.00573E+05  18.6246 1.2837E-01 0.0000E+00 1.2837E-01
  9   9   1   1  23  23 1.00573E+05  18.6246 1.2778E-01 0.0000E+00 1.2778E-01
 10  10   1   1  23  23 1.00573E+05  18.6246 1.2725E-01 0.0000E+00 1.2725E-01
 11  11   1   1  23  23 1.00573E+05  18.6246 1.2676E-01 0.0000E+00 1.2676E-01
```

MR 5-30-96

5-31-96
MR

"air-2.src" - INPUT

```
Source  40   0.00333  1.000
 is  js  ks  istyp
  1 1    1 1    1 1    11
. 13.05 3.805e-9

  2 2    1 1    1 1    11
. 13.05 3.805e-9

  3 3    1 1    1 1    11
. 13.05 9.513e-10

  4 4    1 1    1 1    11
. 13.05 4.756e-9

  5 5    1 1    1 1    11
. 13.05 7.753e-9

  6 6    1 1    1 1    11
. 13.05 7.468e-9

  7 7    1 1    1 1    11
. 13.05 1.265e-8

  8 8    1 1    1 1    11
. 13.05 1.265e-8

  9 9    1 1    1 1    11
13.05 1.265e-8

10 10    1 1    1 1    11
. 13.05 1.265e-8

11 11    1 1    1 1    11
. 13.05 1.265e-8

12 12    1 1    1 1    11
. 13.05 1.284e-8

13 13    1 1    1 1    11
. 13.05 1.284e-8

14 14    1 1    1 1    11
. 13.05 1.265e-8

15 15    1 1    1 1    11
. 13.05 1.265e-8

16 16    1 1    1 1    11
. 13.05 1.265e-8

17 17    1 1    1 1    11
. 13.05 1.265e-8

18 18    1 1    1 1    11
. 13.05 1.265e-8

19 19    1 1    1 1    11
. 13.05 7.468e-9

20 20    1 1    1 1    11

. 13.05 7.753e-9

21 21    1 1    1 1    11
. 13.05 4.756e-9

22 22    1 1    1 1    11
. 13.05 9.513e-10

23 23    1 1    1 1    11
. 13.05 3.805e-9

24 24    1 1    1 1    11
. 13.05 3.805e-9
```

MR 5-31-96

MR 5-31-96

5-31-96 AR

INPUT: "air-2.src" (cont.)

```
)
:Power decay data from Randy Manteufel, 4/2?/96
:  is  js  ks  istyp
     1 1   1 1  23 23     31
  0.3156E+06  0.8469E+04
  0.9467E+07  0.8423E+04
  0.1578E+08  0.8391E+04
  0.3156E+08  0.8314E+04
  0.3541E+08  0.8296E+04
  0.3973E+08  0.8276E+04
  0.4458E+08  0.8253E+04
  0.5002E+08  0.8228E+04
  0.5612E+08  0.8199E+04
  0.6297E+08  0.8168E+04
  0.7065E+08  0.8131E+04
  0.7927E+08  0.8089E+04
  0.8894E+08  0.8043E+04
  0.9979E+08  0.7993E+04
  0.1120E+09  0.7937E+04
  0.1256E+09  0.7876E+04
  0.1410E+09  0.7810E+04
  0.1582E+09  0.7737E+04
  0.1775E+09  0.7658E+04
  0.1991E+09  0.7572E+04
  0.2234E+09  0.7477E+04
  0.2507E+09  0.7355E+04
  0.2813E+09  0.7224E+04
  0.3156E+09  0.7084E+04
  0.3541E+09  0.6936E+04
  0.3973E+09  0.6780E+04
  0.4458E+09  0.6615E+04
```

AR 5-31-96

NEW SET OF RUNS BEGINNING WITH:
"air-3-ss.dat" - IDENTICAL TO "air-2-ss.dat"
EXCEPT INFILTRATION RATE AT TOP OF FRACTURE
IS 3 mm/yr INSTEAD OF 0.3mm/yr. IN:

/home/sneezy/rgreen/multi/tspa/grice/bosc-frac/0.3mm/83kw

• "air-3-ss.dat" REACHED STEADY-STATE AT YEAR 2207,
TIMESTEP #127

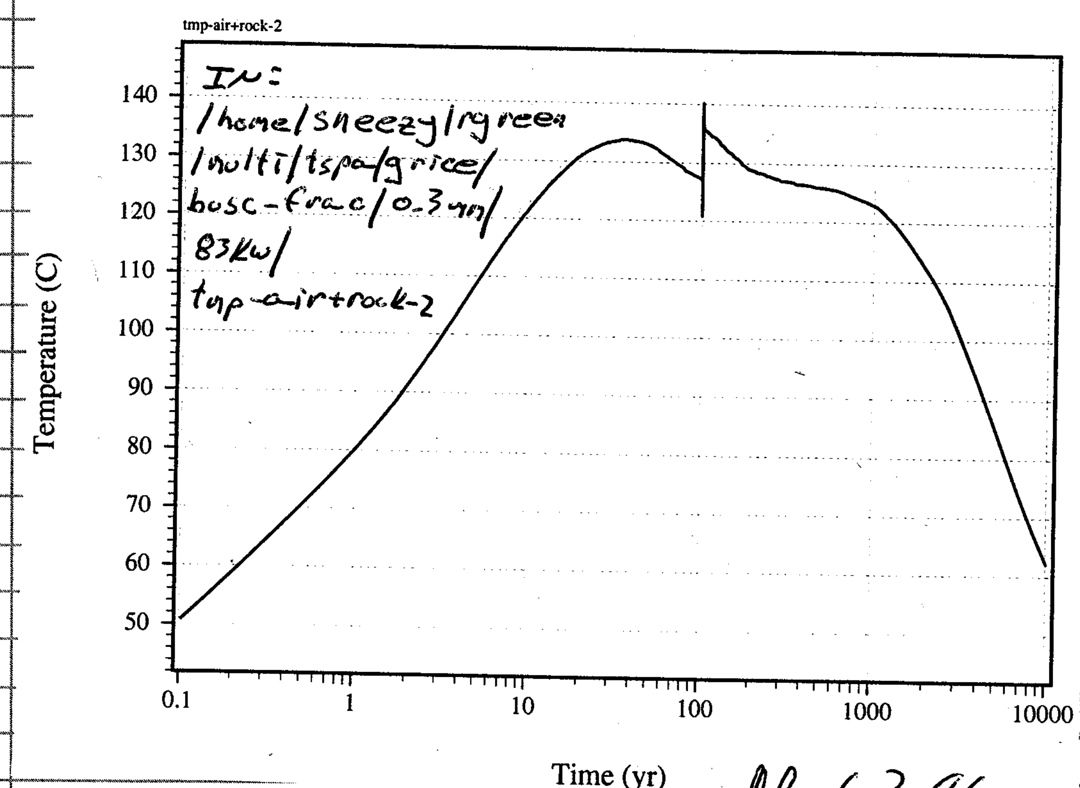
6-1-96 AR • RE-RUN "air-2.dat" + "rock-2.dat" et al.
WITH DRIFT INTERRUPTING FRACTURE.

6-3-96 AR "rock-2.dat" et al. - DONE - RUN TOOK 79,105 s CPU TIME
ON BILBO.

• NEW RUN - "air-4-ss.dat", "4-ss.int", "4-ss.src" -
SAME AS "air-2 ..." + "air-3 ..." BUT INFIL-
TRATION RATE ABOVE FRACTURE = 3 cm/yr.

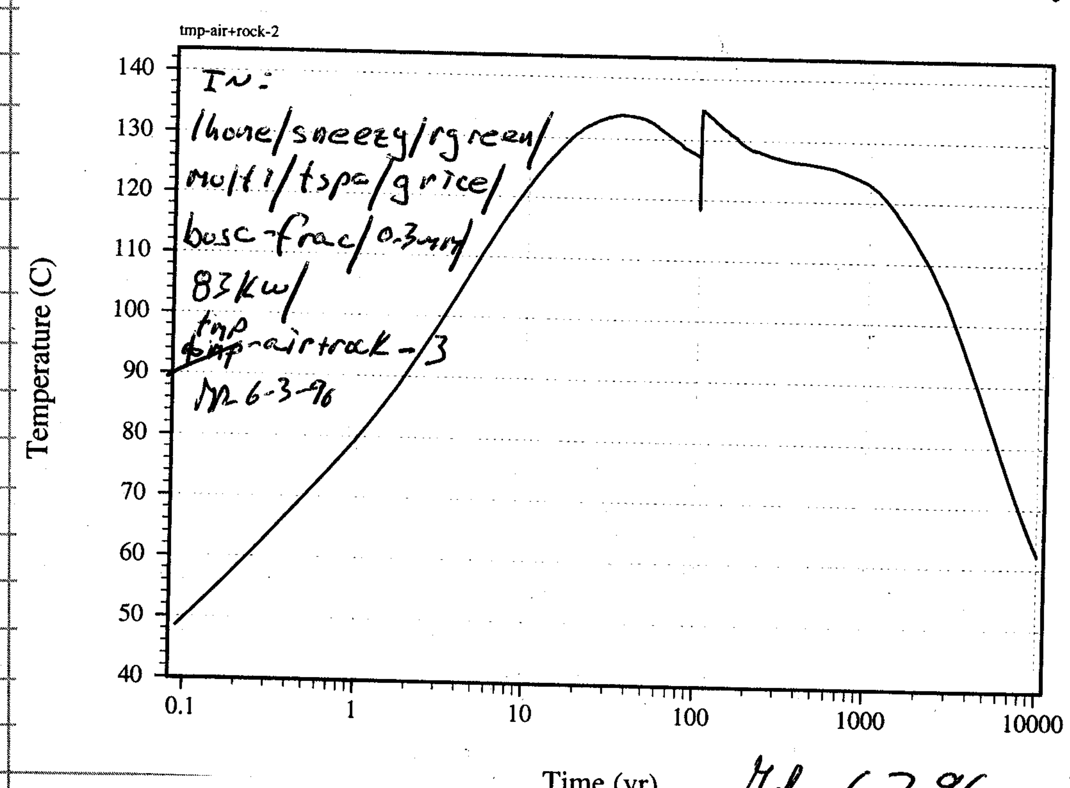
6-3-96 AR

air/rock-2, Infiltration Rate Above Fracture = 0.3mm/yr AR 6-3-96



AR 6-3-96

air/rock-3, Infiltration Rate Above Fracture = 3.0mm/yr



AR 6-3-96

6-3-96
MR

NEW RUN: "air-5-ss.dat", et al., SAME AS "air-2-" etc. BUT INFILTRATION RATE FOCUSED AT FRACTURE = 10 cm/yr.

IN: /home/sneezy/rgreen/multi/tspa/grice/busc-frac/0.3mm/83kw

6-5-96
MR

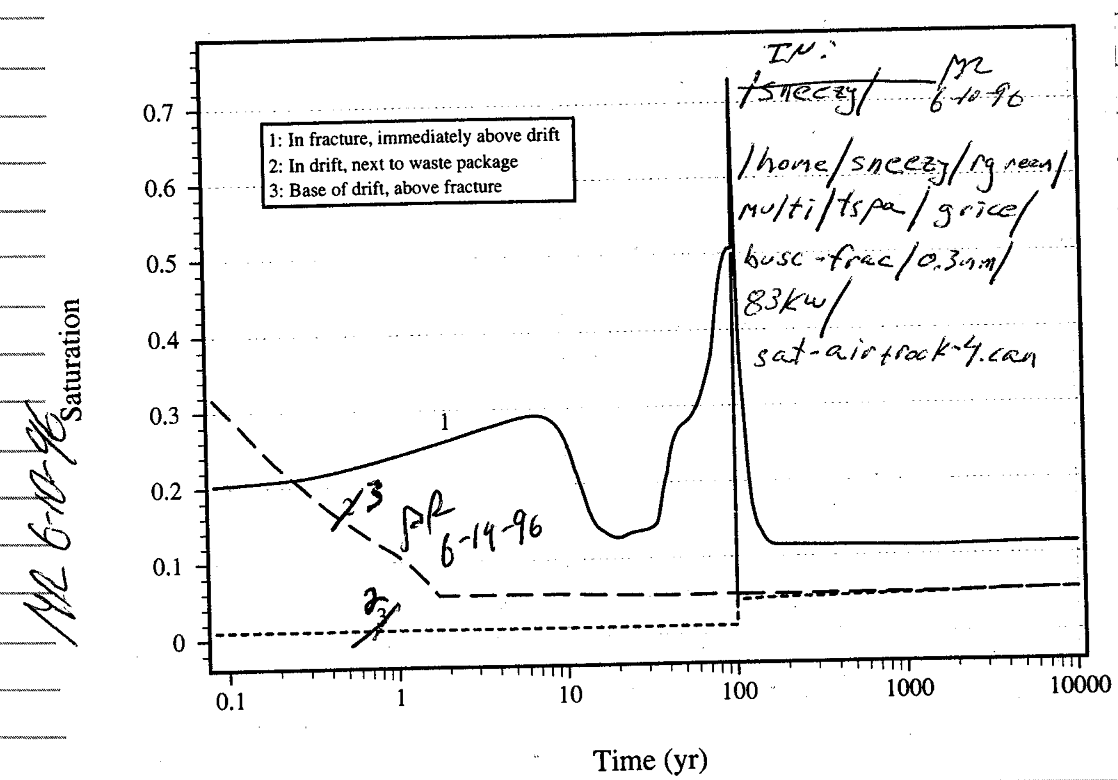
NEW METRA RUN: "air-6-ss.dat", "6-ss.int", + "6-ss.src" - IDENTICAL TO "air-5..." et al EXCEPT INFILTRATION RATE FOCUSED AT FRACTURE = 100 cm/yr. IN:

/home/sneezy/rgreen/multi/tspa/grice/busc-frac/0-3mm/83kw

~~6-10-95~~ 6-10-96 6 AR
MR

MR 6-10-96

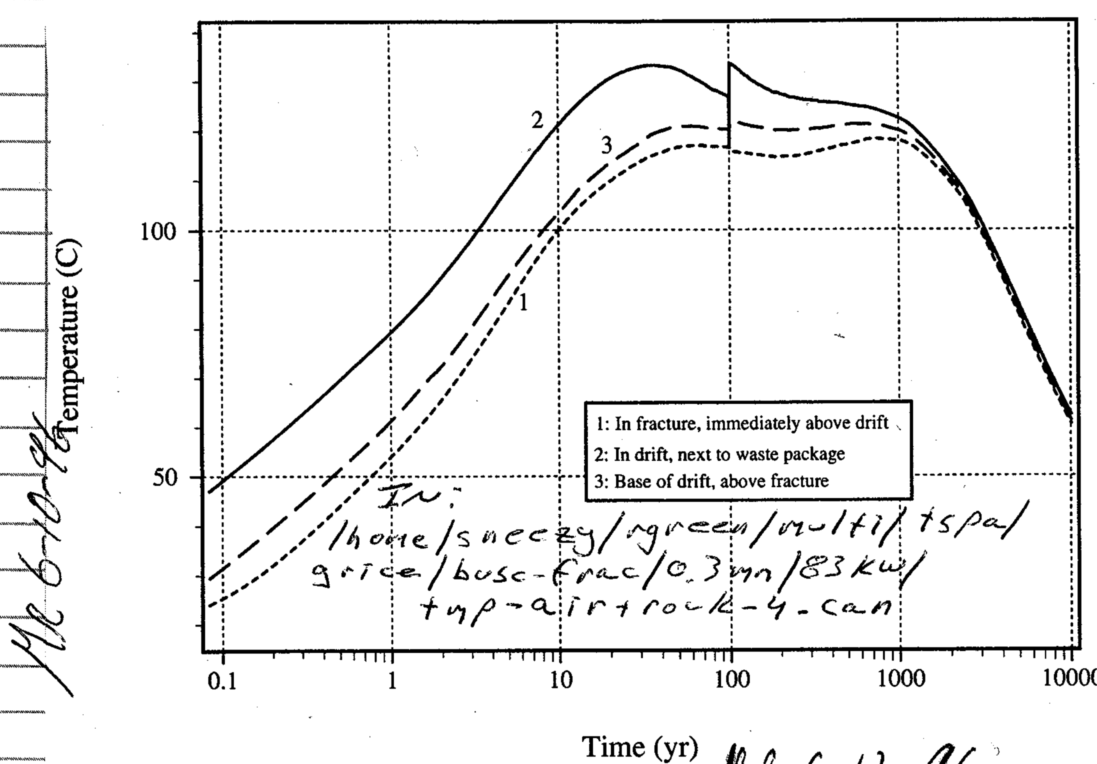
Infiltration Focused On Fracture, 3.0 cm/yr



6-10-96
MR

MR 6-10-96

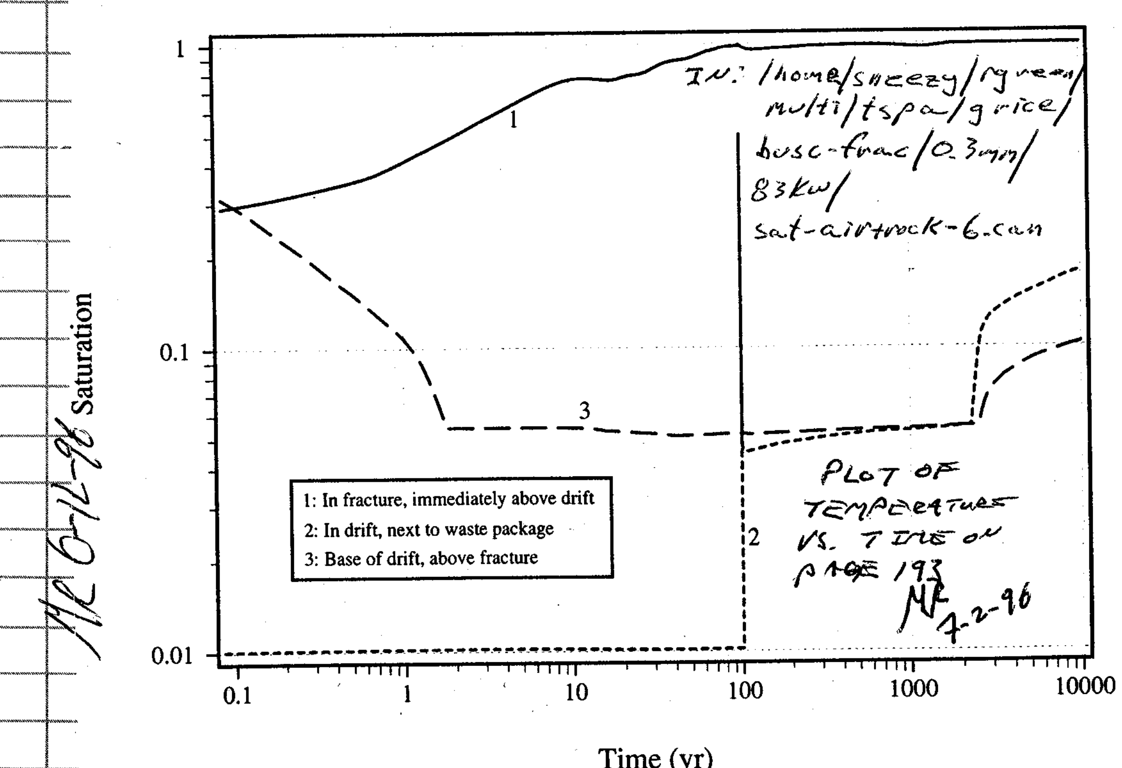
Infiltration Focused on Fracture, 3.0 cm/yr



MR 6-12-96

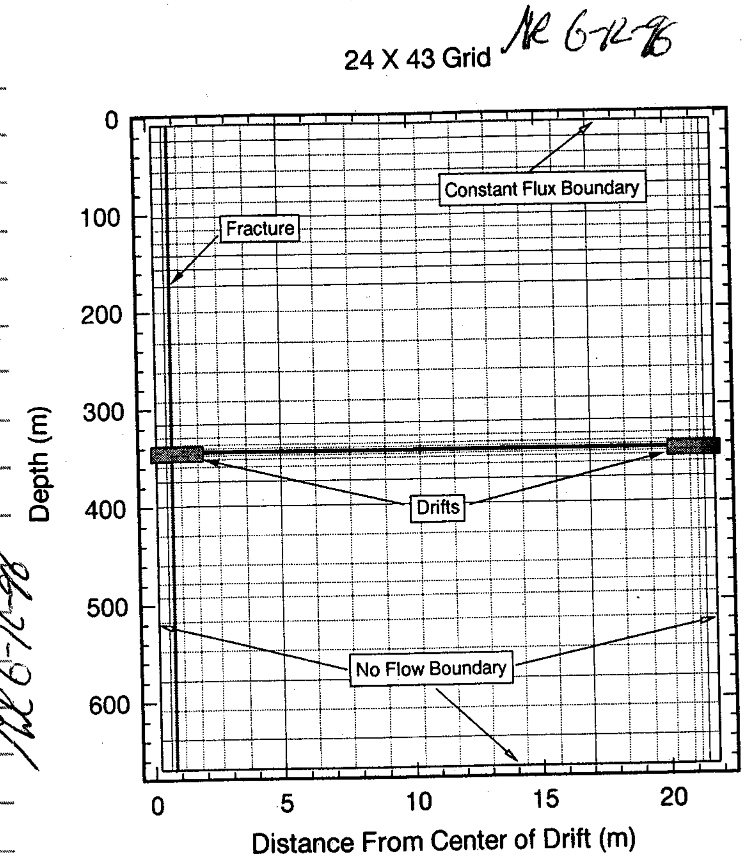
6-12-96
MR

Infiltration Focused On Fracture, 100 cm/yr



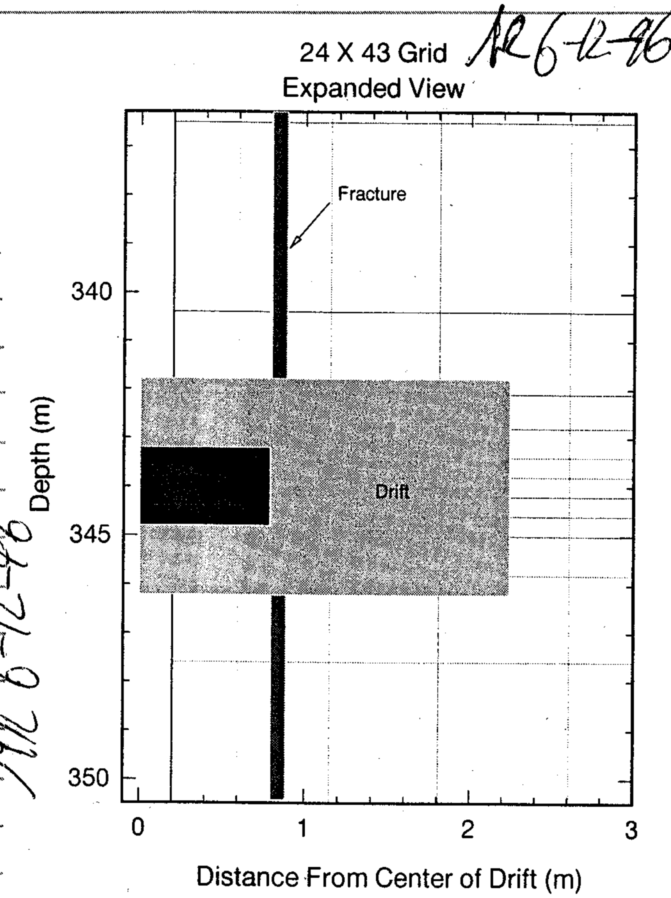
6-12-96
MR

24 X 43 Grid MR 6-12-96



MR 6-12-96

24 X 43 Grid MR 6-12-96
Expanded View



MR 6-12-96

IN: /home/sneezy/rgreen/multi/tspa/grice/busc-frac/0.3mm/83kw/mesh-1.cps (TOP FIGURE) + mesh-2.cps (BOTTOM FIGURE)

6 MR 6-12-96
6-12-96
MR

NEW RUN: "air-4-ss.dat" et al. - IN: /home/sneezy/rgreen/multi/tspa/grice/frac-1 - IDENTICAL TO SAME-NAMED RUN IN OTHER DIRECTORY: ... grice/busc-frac/0.3mm/83kw EXCEPT MATRIX POROSITY OF FRACTURE ZONE REDUCED FROM 0.421 TO 0.21.

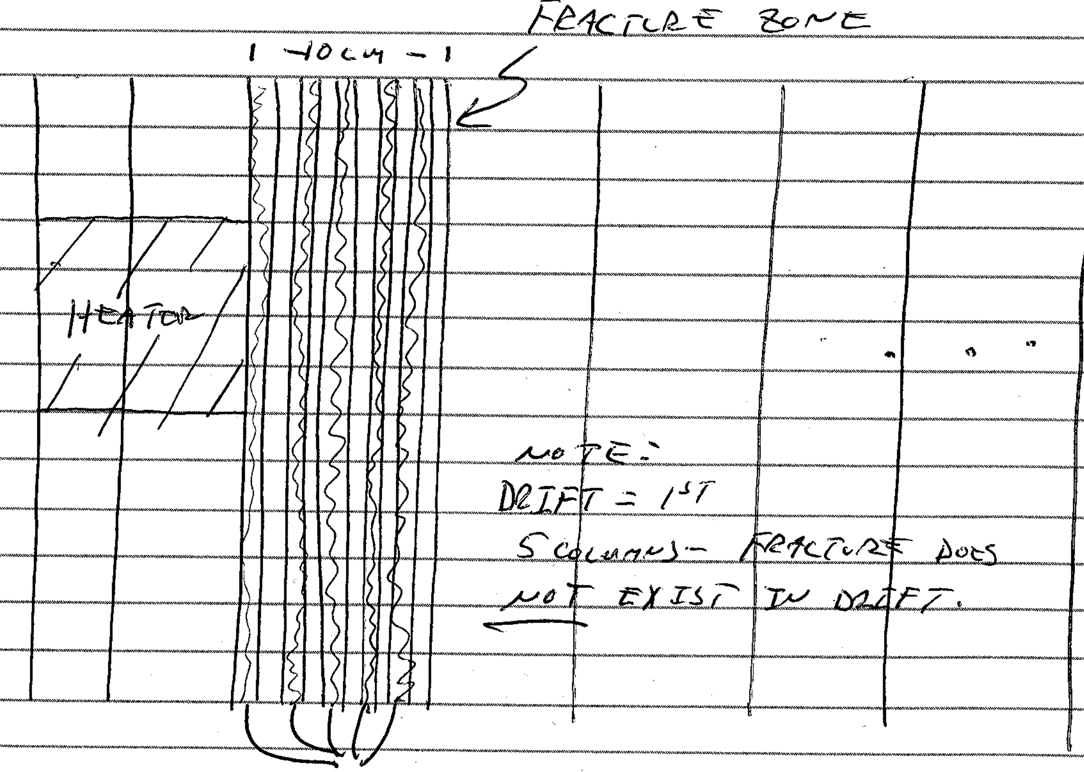
6-14-96
MR

- NEW RUN: "air-6-ss.dat" et al - IN: /home/sneezy/rgreen/multi/tspa/grice/frac-1 - IDENTICAL TO SAME-NAMED RUN IN OTHER DIRECTORY: ... grice/busc-frac/0.3mm/83kw - EXCEPT MATRIX POROSITY OF FRACTURE REDUCED FROM 0.421 TO 0.21.

6-18-96
MR

- NEW SET OF RUNS - FRACTURE ZONE = 10 cm, 5 - 1 cm FRACTURES EVENLY SPACED W/I ZONE: GRID = 33X43

FRACTURE ZONE



5 - 1cm-WIDE FRACTURES

6-18-96

INPUT: "rock-4.dat" + "rock-4.src" - In:

/home/sneezy/rgreen/multi/tspa/grice/frac-2

6-18-96

MR

MR

MR 6-18-96

```
initial data : 2D, Yucca Mt.)
une 18, 1996
 10cm fracture zone with 5-1cm fractures next to waste. Infiltration focused on
 Rate above fracture zone is 3cm/yr.  Rate elsewhere is 0.3mm/yr.
 Initial conditions from air run: "air-4.dat" et al.
 Initial saturation of backfill set to 50%.
 Thermal conductivities of all materials are constants per TSPA 95
  33X43 Grid
Power Decay curve from R, Manteufel, 4/25/96.
 set upper element to large heat capacity
START  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
rid   XYZ       33  1   43   1       1      1     0    0

lonitor 531
ebug 1

ckr                               :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
 Near Zero in Init.
   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 S
 Near Zero in Init.
   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 and matrix porosity decreased by a factor
  10  Van-Gen   0.100  .8500     1.53e-6      0.      0.  1
                0.040  0.7636    1.305e-5 .21    1.8e-3 3.9e-13 3.9e-12
           :blank line

ebug  1

hermal-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.
```

MR 6-18-96

```
 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.
10 =Air Around Metal Waste Package, rho & cpr from CRC, other Properties Assume
10  1.200e-00 57.4  10.0   10.0      0    0    0.0  2.13e-0  1.8  1.
```

MR 6-18-96

INPUT: "rock-4.dat" + "rock-4.src" (CONT)

MR 6-18-96

```
     igrid   rw      re
XYZ   2
 (dx(i),i=1,nx)
.4 0.4 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01
.01 0.01 0.5 0.815 0.785 1.33 1.33 1.33 1.33 1.33
.35 1.35 1.33 1.33 1.33 1.33 1.33 0.785 0.815 0.5
.1 0.4 0.4
 (dy(j),j=1,ny)
.
 (dz(k),k=1,nz)
6. 16. 16. 16. 16. 15. 14. 13. 13. 13.
5. 20. 34. 30. 30. 30. 17. 10. 5. 2.785
715 .7 .4 .4 .4 .4 .5 .915 2.785 5.
0. 20. 30. 30. 30. 8. 20. 30. 31. 30.
0. 30. 31.
hiK
 i1 i2 j1 j2 k1 k2 iist ithrm vb  por permx permy  permz  pormm permm
  1 33  1  1  1  1   1    7   0.
  1 33  1  1  2  6   1    1   0.
  1 33  1  1  7 10   2    2   0.
  1 33  1  1 11 35   3    3   0.
  1 33  1  1 36 36   4    4   0.
  1 33  1  1 37 39   5    5   0.
  1 33  1  1 40 42   6    6   0.
  1 33  1  1 43 43   6    6   6.2832e7
Drifts (w/backfill)
  1 14  1  1 21 28   7    8
 29 33  1  1 21 28   7    8
Waste Packages
  1  2  1  1 23 26   8    9
 32 33  1  1 23 26   8    9
Supports (Pedestal, backfill)
  1  2  1  1 27 27   7    8
 32 33  1  1 27 27   7    8
Inverts (Floor, backfill)
  1 14  1  1 28 28   7    8
 29 33  1  1 28 28   7    8
Fracture
  3  3  1  1  1 20  10    2
  3  3  1  1 29 43  10    2
  5  5  1  1  1 20  10    2
  5  5  1  1 29 43  10    2
  7  7  1  1  1 20  10    2
  7  7  1  1 29 43  10    2
  9  9  1  1  1 20  10    2
  9  9  1  1 29 43  10    2
 11 11  1  1  1 20  10    2
```

MR 6/18/96

```
 11 11  1  1 29 43  10    2

nit rock-4

ecurrent-data
utput   A=1   C=1

  isolv  newtnmn  newtnmx
olve 2     2        8        4  0  4
AUTO-step  DPMXE    DSMXE  DTMPMXE    DP2MXe
UTO-step   1.0E+4   0.03    5.0        1.e4

TOLR TOLP  TOLS  TOLT  TOLP2  TOLM  TOLA  TOLE
olr   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
IMIT  1.e5    .08    10.   1.e5  1.e-8 1.e5

 SKIP

ource  26   0.00333  1.000 rock-4

NOSKIP

       print all at every target time
LOTS 1 3 459 531 651
      target  dt    dpmx   dsmx   dp2mx   dtmpmx
start 1 0
IME[y]  1.
ime[y]  10.
ime[y]  100.
ime[y]  1000.
ime[y]  10000.
```

MR 6-18-96

6-18-96

INPUT: "rock-4.dat" + "rock-4.src" (cont'd)

6-18-96

```
Source  26   0.00333  1.000
  is  js  ks  istyp
   1 1   1 1   1 1   11
 . 13.05 3.805e-9

   2 2   1 1   1 1   11
 . 13.05 3.805e-9

 Infiltration rate above fracture
 Note, rate below is above each of
   3 12   1 1   1 1   11
 . 13.05 9.513e-9

  13 13   1 1   1 1   11
 . 13.05 4.756e-9

  14 14   1 1   1 1   11
 . 13.05 7.753e-9

  15 15   1 1   1 1   11
  13.05 7.468e-9

  16 16   1 1   1 1   11
  13.05 1.265e-8

  17 17   1 1   1 1   11
 . 13.05 1.265e-8

  18 18   1 1   1 1   11
 . 13.05 1.265e-8

  19 19   1 1   1 1   11
  13.05 1.265e-8

  20 20   1 1   1 1   11
 . 13.05 1.265e-8

  21 21   1 1   1 1   11
 . 13.05 1.284e-8

  22 22   1 1   1 1   11
 . 13.05 1.284e-8

  23 23   1 1   1 1   11
 . 13.05 1.265e-8

  24 24   1 1   1 1   11
 . 13.05 1.265e-8

  25 25   1 1   1 1   11
 . 13.05 1.265e-8

  26 26   1 1   1 1   11
 . 13.05 1.265e-8

  27 27   1 1   1 1   11
 . 13.05 1.265e-8

  28 28   1 1   1 1   11
 . 13.05 7.468e-9

  29 29   1 1   1 1   11
). 13.05 7.753e-9

  30 30   1 1   1 1   11
). 13.05 4.756e-9

  31 31   1 1   1 1   11
). 13.05 9.513e-10

  32 32   1 1   1 1   11
). 13.05 3.805e-9

  33 33   1 1   1 1   11
). 13.05 3.805e-9

:Revised Power decay data from Randy Manteufel, 4/26/96.
:Begins with power input for t = 100yrs.
  is  js  ks  istyp
   1 2 1  1   23 26   31
 0.0000E+00  0.2464E+04
 0.9467E+07  0.2459E+04
 0.1578E+08  0.2455E+04
 0.3156E+08  0.2447E+04
 0.3541E+08  0.2445E+04
 0.3973E+08  0.2442E+04
 0.4458E+08  0.2440E+04
 0.5002E+08  0.2437E+04
 0.5612E+08  0.2434E+04
 0.6297E+08  0.2430E+04
 0.7065E+08  0.2426E+04
 0.7927E+08  0.2422E+04
 0.8894E+08  0.2417E+04
 0.9979E+08  0.2411E+04
 0.1120E+09  0.2405E+04
 0.1775E+09  0.2372E+04
 0.1991E+09  0.2361E+04
 0.2234E+09  0.2349E+04
 0.2507E+09  0.2336E+04
 0.2813E+09  0.2321E+04
 0.3156E+09  0.2305E+04
 0.3541E+09  0.2287E+04
 0.3973E+09  0.2267E+04
 0.4458E+09  0.2245E+04
 0.5002E+09  0.2222E+04
 0.5612E+09  0.2195E+04
 0.6297E+09  0.2167E+04
 0.7065E+09  0.2136E+04
 0.7927E+09  0.2102E+04
 0.8894E+09  0.2066E+04
 0.9979E+09  0.2027E+04
 0.1120E+10  0.1984E+04
 0.1256E+10  0.1939E+04
 0.1410E+10  0.1891E+04
 0.1582E+10  0.1840E+04
 0.1775E+10  0.1786E+04
 0.1991E+10  0.1730E+04
 0.2234E+10  0.1671E+04
 0.2507E+10  0.1615E+04
 0.2813E+10  0.1569E+04
```

6-18-96 (signed across printout)

NEW SET OF RUNS – SEE HOW FLUIDS MOVE IN VICINITY OF HEATER – IN:

/home/sneezy/rgreen/multi/tspa/grice/pipe-1

RUN: "pipe-1.dat" et al.

6-20-96

- GOING BACK TO DRIFT SCALE RUNS – SEE HOW MUCH WATER NEEDED TO REDUCE TEMPERATURE OF WASTE PACKAGE.

- RUN WITHOUT ANY INFILTRATION FOCUSED ON FRACTURE:
  "air-0a.dat" + "air-0a.int" + "air-0a.src"
  AIR IN DRIFT HAS MATRIX + FRACTURE PERMEABILITIES OF 10^{-9} m^2. IN:
  /home/sneezy/rgreen/multi/tspa/grice/flood-1

- SAME RUN AS ABOVE BUT WITH 100 cm/yr INFILTRATION FOCUSED ON FRACTURE:
  "air-6a.dat" et al. IN SAME DIRECTORY AS ABOVE

- NEW RUN: "air-7a.dat" et al. – SAME AS "air-6a.dat" et al. BUT WITH 200cm/yr INFILTRATION FOCUSED AT FRACTURE.
  IN: /home/SKIPPY/rgreen/multi/tspa/grice/flood-1

6-24-96

NEW SETS OF RUNS ARE CRASHING – RUNS WITHOUT DRIFTS. CALL MOHAN SETH – ASK HIM TO CHECK INPUT FILES: "0.dat", "0.int", + "0.src" IN:
/home/sneezy/rgreen/multi/tspa/grice/flood-1/nodrift
214/699-3610 – MOHAN WILL LOOK AT FILES + LET ME KNOW IF HE IDENTIFIED A PROBLEM.

6-25-96

- NEW RUN: "6b.dat" et al. – IDENTICAL TO "air-6.dat" (see pgs 184+185 – "air-6.dat" uses output of "air-6-ss.dat" as initial conditions) EXCEPT DRIFT IS ELIMINATED – ONLY SIMULATES WASTE PACKAGES + FRACTURE – BUT – RUN CRASHES – DON'T KNOW WHY. IN: /home/sneezy/rgreen/multi/tspa/grice/flood-1/nodrift.

6-25-96
MR

- NEW STEADY-STATE RUN: "66-ss.dat" + "66-ss.int" + "66-ss.src" - IDENTICAL TO "air-6.dat" etal EXCEPT: 1) NO DRIFT, 2) NO HEAT, 3) RUN TO STEADY STATE. IN:
/home/sneezy/rgreen/multi/tspa/grice/flood-1/nodrift

7-1-96
MR

RUN STARTED ON 6-25: "66.dat" + "66.int" + "66.src" - SAME AS "66-ss..." - EXCEPT USES ITS OUTPUT AS INITIAL CONDITIONS AND INCLUDES A FRACTURE ~~+ A DRIFT~~ MR 7-1-96. - RUN CRASHED @ ≈ 25 sec - PRODUCED NaN's. → ALSO HEATED! MR 7-1-96
→ SHOULD HAVE SAID HEATERS.

- NEW RUN: "comp-abacus-1.dat" etal - IDENTICAL TO "air-2.dat" etal in: /home/sneezy/rgreen/multi/tspa/grice/busc-frac/0.3mm/83kW EXCEPT FRACTURE HAS BEEN REMOVED. IN:
/home/sneezy/rgreen/multi/tspa/grice/abacus-nofrac

7-2-96
MR

CONTINUATION OF RUN STARTED YESTERDAY: "comp-abacus-1r.dat" - USES OUTPUT (MODIFIED - INITIAL SATURATION OF ROCK BACKFILL EMPLACED AT 100 YEARS = 50%) OF "comp-abacus-1.dat" etal. AS INITIAL CONDITIONS. SIMULATES SYSTEM AFTER 100 YEARS OF AIR FILLED DRIFT — DRIFT BACKFILLED WITH CRUSHED ROCK. IN:
/home/sneezy/rgreen/multi/tspa/grice/abacus-nofrac

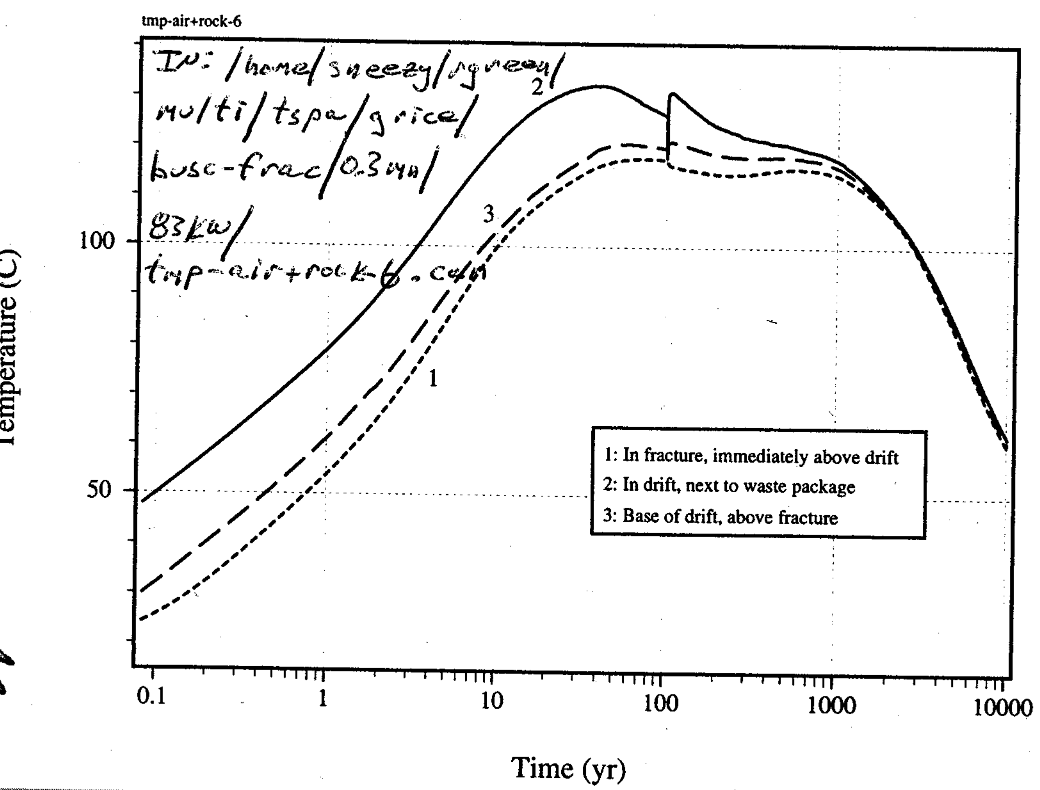
7-2-96 MR 7-2-96

- NEW RUN: "1.dat" etal, IDENTICAL TO "comp-..." DESCRIBED IN ENTRIES ABOVE, EXCEPT THERE IS A SOURCE OF WATER IMMEDIATELY ABOVE THE LEFT HEATER - STRENGTH = 1 kg/yr. IN:
/home/sneezy/rgreen/multi/tspa/grice/source

7-2-96
MR

Infiltration Focused on Fracture, 100 cm/yr

MR 7-2-96



MR 7-2-96

- NEW RUN (SET OF): "air-7-ss.dat" etal - SAME AS "air-6-ss.dat" etal. EXCEPT FOCUSED INFILTRATION RATE AT FRACTURE = 1000 cm/yr INSTEAD OF 100 cm/yr. IN: /home/sneezy/rgreen/multi/tspa/grice/busc-frac/0.3mm/83kW

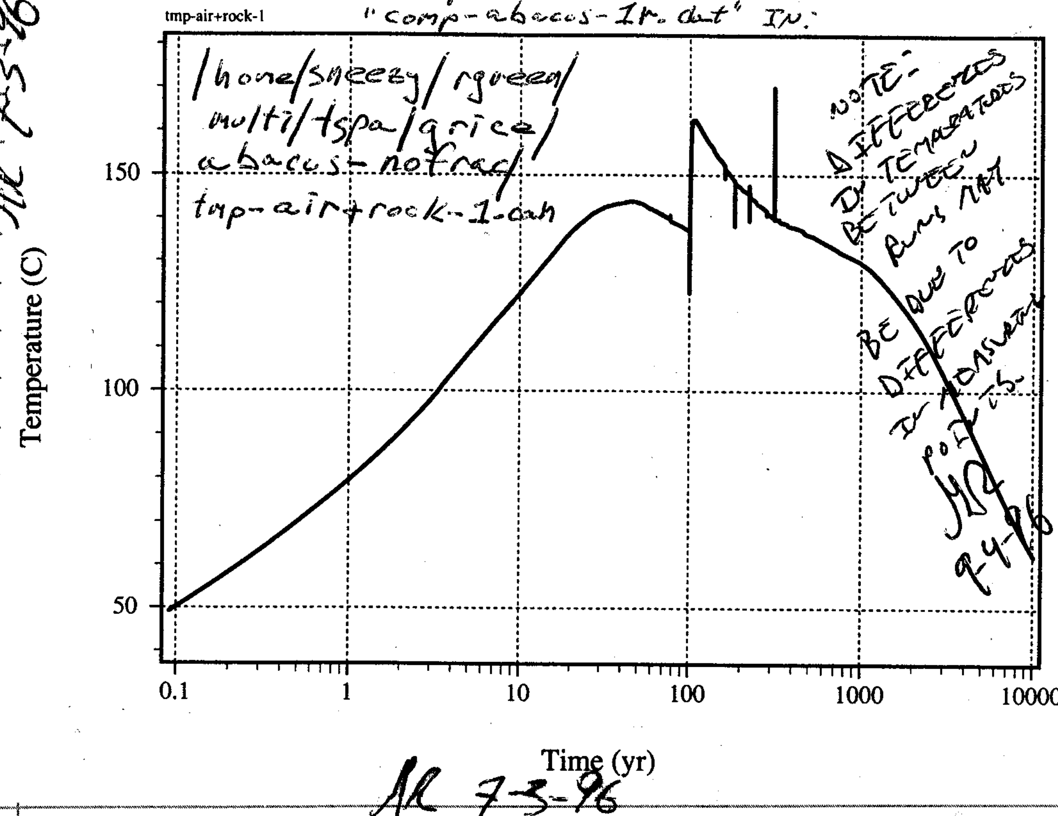
7-3-96
MR

NEW SERIES OF RUNS TO EXAMINE EFFECTS OF DEGREE OF SATURATION OF BACKFILL: "air.dat" etal. AND rock (BACKFILL EMPLACED @ 100 YRS) RUNS WITH VARYING BACKFILL SATURATIONS - "rock-1.dat" etal = 1% SATURATION OF BACKFILL. IN:
/home/sneezy/rgreen/multi/tspa/grice/backfill

7-3-96
AR

2 Heaters, 83kW/Ac, Infiltration Rate = 0.3mm/yr

OUTPUT OF: "comp-abacus-1.dat" + "comp-abacus-1r.dat" IN:

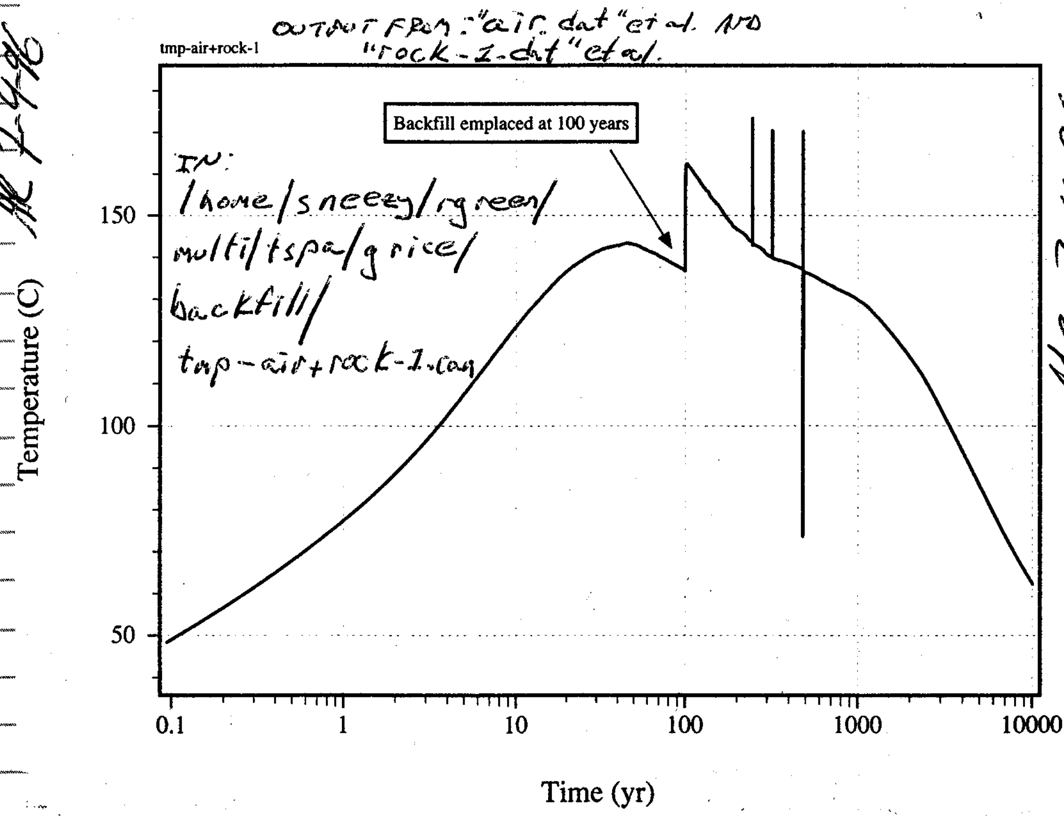


AR 7-3-96

7-4-96
AR

83kW/Ac, Initial Saturation of Backfill = 1%

OUTPUT FROM: "air.dat" et al. AND "rock-1.dat" et al.

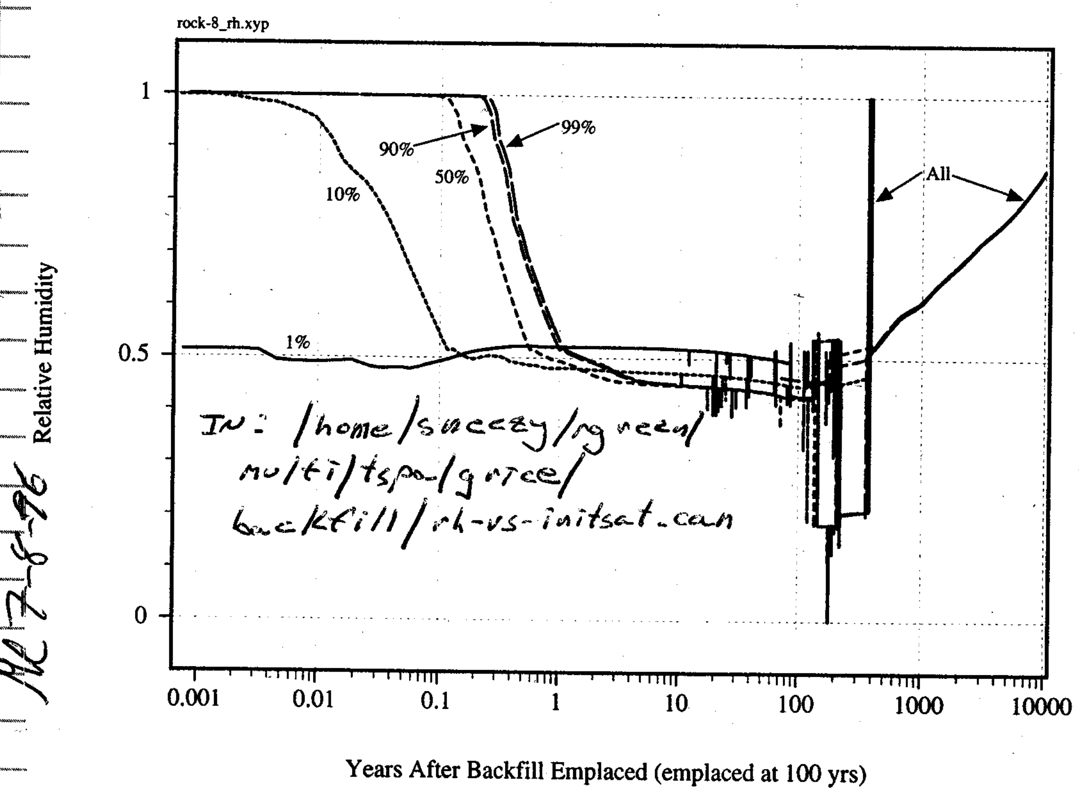


AR 7-4-96

7-8-96
AR

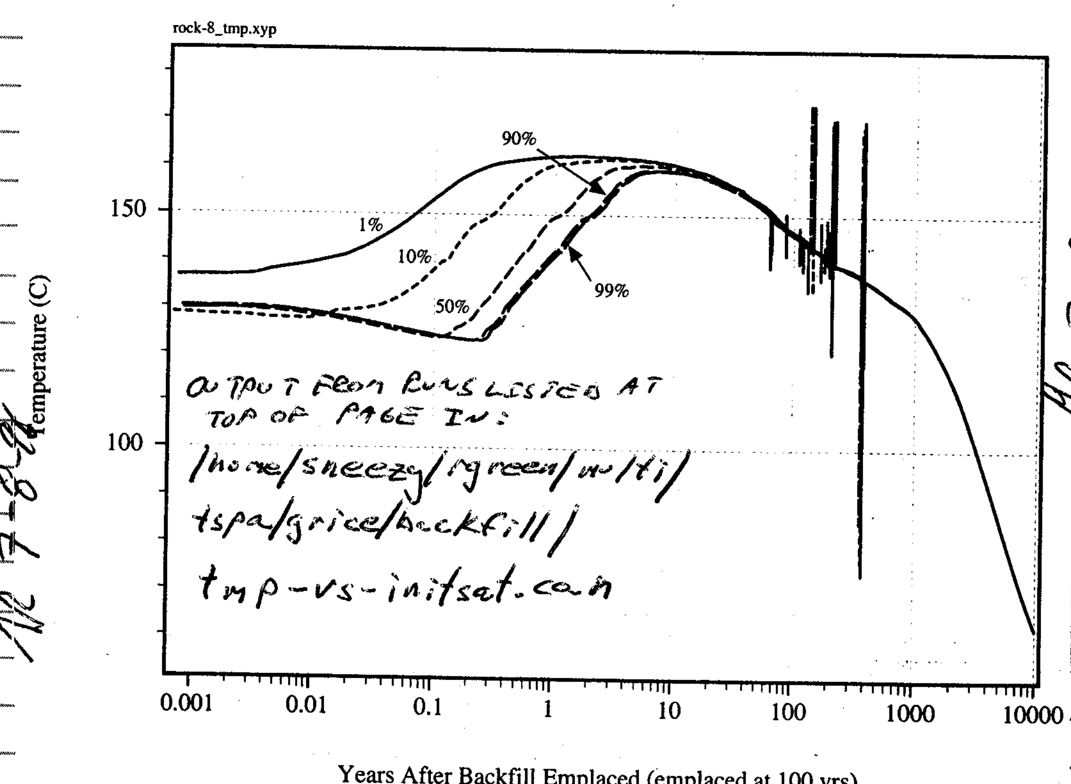
OUTPUT FROM: "rock-1.dat", "rock-2.dat", "rock4.dat", "rock6.dat", + "rock8.dat" AR 7-8-96

Relative Humidity as a Function of Initial Saturation of Backfill (83kW/Ac)



AR 7-8-96

Temperature as a Function of Initial Saturation of Backfill (83kW/Ac)

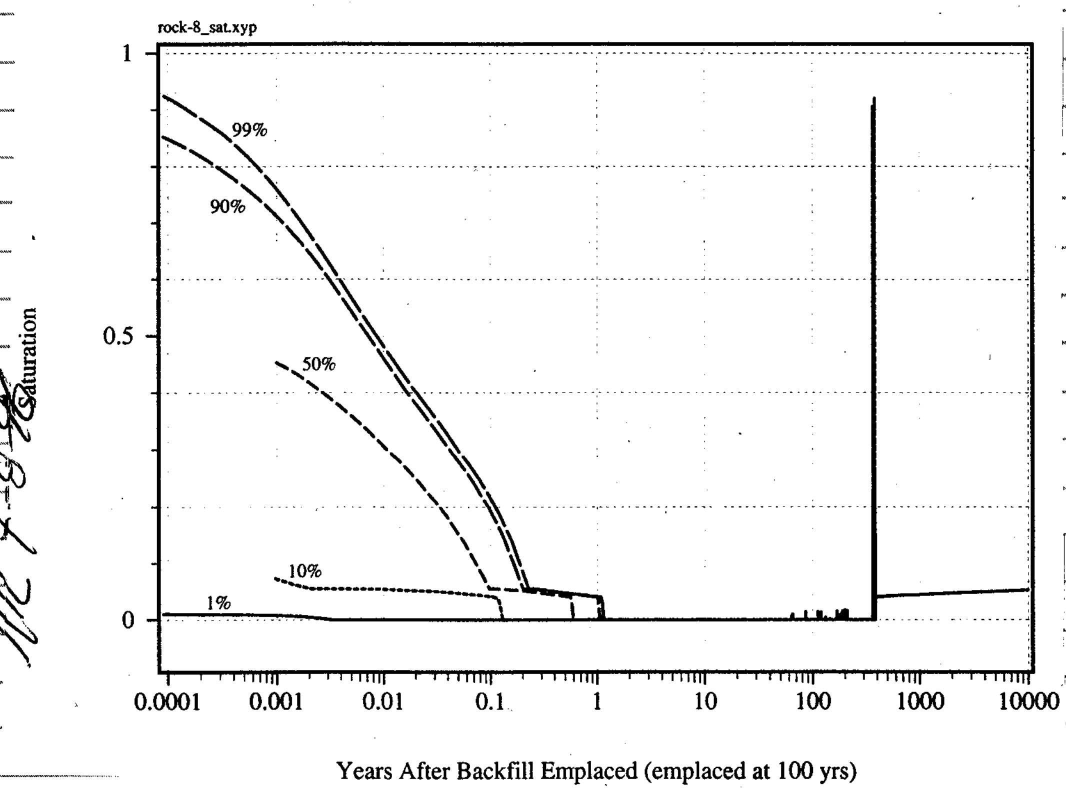


AR 7-8-96

7-8-96
NR

OUTPUT FROM: "rock-1.dat", "rock-2.dat", "rock-4.dat", "rock-6.dat", + "rock-8.dat". NR 7-8-96

Saturation as a Function of Initial Saturation of Backfill (83kW/Ac)



NR 7-8-96

INPUT: "rock-4.dat", "rock-4.int", + "rock.src"

In: /home/sneezy/rgreen/multi/tspa/grice/backfill

NR 7-8-96

```
ucca Mt.)
uly 5, 1996
 Saturation of backfill emplaced at 100 years = 50%.
 NO fracture zone next to waste.
 Initial conditions from run: "air.dat" et al.
 Thermal conductivities of most materials are constants per TSPA 95
  24X43 Grid
Power Decay curve from R, Manteufel, 4/25/96.
 set upper element to large heat capacity
START  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
rid   XYZ       24  1   43   1      1      1      0    0

onitor 555
ebug 1

ckr                                :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
```

NR 7-8-96

INPUT = "rock-4.dat" (cont)

7-8-96
NR

NR 7-8-96

```
  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
 0.1% 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 S
 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
           :blank line

ebug  1
```

NR 7-8-96

```
hermal-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.
10 =Air Around Metal Waste Package, rho & cpr from CRC, other Properties Assume
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.

     igrid   rw      re
XYZ  0
 (dx(i),i=1,nx)
.4 0.4 0.1 0.5 0.815 0.785 1.33 1.33 1.33 1.33
.33 1.35 1.35 1.33 1.33 1.33 1.33 1.33 0.785 0.815
.5 0.1 0.4 0.4
 (dy(j),j=1,ny)
.
 (dz(k),k=1,nz)
6. 16. 16. 16. 16. 15. 14. 13. 13. 13.
5. 20. 34. 30. 30. 30. 17. 10. 5. 2.785
715 .7 .4 .4 .4 .4 .5 .915 2.785 5.
0. 20. 30. 30. 30. 8. 20. 30. 31. 30.
0. 30. 31.
hiK
 i1 i2 j1 j2 k1 k2 iist ithrm vb  por permx permy  permz  pormm permm
  1 24  1  1  1  1   1    7   0.
  1 24  1  1  2  6   1    1   0.
  1 24  1  1  7 10   2    2   0.
  1 24  1  1 11 35   3    3   0.
  1 24  1  1 36 36   4    4   0.
  1 24  1  1 37 39   5    5   0.
  1 24  1  1 40 42   6    6   0.
  1 24  1  1 43 43   6    6   6.2832e7
Drifts
  1  5  1  1 21 28   7    8
 20 24  1  1 21 28   7    8
Waste Packages
  1  2  1  1 23 26   8    9
 23 24  1  1 23 26   8    9
```

NR 7-8-96

7-8-96
NR

INPUT: "rock-4.dat" (concl.)

```
Supports (Pedestal)
   1  2  1  1 27 27  11  11
 23 24  1  1 27 27  11  11
Inverts (Floor)
   1  5  1  1 28 28  11  11
 20 24  1  1 28 28  11  11
Fracture
    3  3  1  1  1 20  10   2
    3  3  1  1 29 43  10   2

nit rock-4

ecurrent-data
utput   A=1   C=1

  isolv  newtnmn  newtnmx
olve 2    2        8        4  0  4
AUTO-step  DPMXE    DSMXE  DTMPMXE   DP2MXe
UTO-step   1.0E+4   0.03    5.0       1.e4

TOLR TOLP  TOLS  TOLT  TOLP2  TOLM  TOLA  TOLE
olr   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
IMIT  1.e5    .08    10.   1.e5  1.e-8 1.e5

 SKIP

ource  40   0.00333  1.000 rock

NOSKIP

       print all at every target time
LOTS 1 1 555
      target  dt    dpmx   dsmx   dp2mx   dtmpmx
start 1 0
IME[y]  1.
ime[y]  10.
ime[y]  100.
ime[y]  1000.
Time[y]  5000.
ime[y]  10000.
Time[y]  100000.

KIP

start 1 0
teady[y]  1.e+1 1.e-1 1.e-4
OSKIP
nds
```

NR 7-8-96

NR 7-8-96

INPUT: "rock-4.int"

Cut & Paste Initilization Variables for Restar
==

NR 7-9-96

From "air.dat" et al., initial sat of backfill emplaced at 100 years set to
Time = 0.315360E+10 secs Days = 0.365000E+05 years = 0.100000E+03

i1	i2	j1	j2	k1	k2	p	t	sg	xg2	sgm
1	1	1	1	1	1	9.75015E+04	13.0480	1.3844E-01	0.0000E+00	1.3844E-01
2	2	1	1	1	1	9.75015E+04	13.0480	1.3808E-01	0.0000E+00	1.3808E-01
1	1	1	1	20	20	1.74903E+05	128.9487	8.7072E-01	0.0000E+00	8.7072E-01
2	2	1	1	20	20	1.74895E+05	128.8564	8.7048E-01	0.0000E+00	8.7048E-01
3	3	1	1	20	20	1.74885E+05	128.7415	8.7018E-01	0.0000E+00	8.7018E-01
4	4	1	1	20	20	1.74871E+05	128.5865	8.6977E-01	0.0000E+00	8.6977E-01
5	5	1	1	20	20	1.74824E+05	128.0616	8.6840E-01	0.0000E+00	8.6840E-01
6	6	1	1	20	20	1.74733E+05	127.0432	8.6550E-01	0.0000E+00	8.6550E-01
7	7	1	1	20	20	1.74640E+05	125.5462	8.5791E-01	0.0000E+00	8.5791E-01
8	8	1	1	20	20	1.74554E+05	123.8272	8.4913E-01	0.0000E+00	8.4913E-01
9	9	1	1	20	20	1.74490E+05	122.4423	8.3831E-01	0.0000E+00	8.3831E-01
10	10	1	1	20	20	1.74444E+05	121.4204	8.2705E-01	0.0000E+00	8.2705E-01
11	11	1	1	20	20	1.74418E+05	120.7500	8.1746E-01	0.0000E+00	8.1746E-01
12	12	1	1	20	20	1.74409E+05	120.4130	8.1203E-01	0.0000E+00	8.1203E-01
13	13	1	1	20	20	1.74412E+05	120.4110	8.1198E-01	0.0000E+00	8.1198E-01
14	14	1	1	20	20	1.74429E+05	120.7443	8.1733E-01	0.0000E+00	8.1733E-01
15	15	1	1	20	20	1.74461E+05	121.4112	8.2690E-01	0.0000E+00	8.2690E-01
16	16	1	1	20	20	1.74512E+05	122.4302	8.3817E-01	0.0000E+00	8.3817E-01
17	17	1	1	20	20	1.74581E+05	123.8126	8.4902E-01	0.0000E+00	8.4902E-01
18	18	1	1	20	20	1.74672E+05	125.5295	8.5779E-01	0.0000E+00	8.5779E-01

NR 7-8-96

7-8-96
NR

INPUT: "rock-4.int" (concl.)

NR 7-8-96

19	19	1	1	20	20	1.74769E+05	127.0255	8.6537E-01	0.0000E+00	8.6537E-01
20	20	1	1	20	20	1.74862E+05	128.0435	8.6833E-01	0.0000E+00	8.6833E-01
21	21	1	1	20	20	1.74910E+05	128.5682	8.6970E-01	0.0000E+00	8.6970E-01
22	22	1	1	20	20	1.74924E+05	128.7231	8.7011E-01	0.0000E+00	8.7011E-01
23	23	1	1	20	20	1.74935E+05	128.8379	8.7041E-01	0.0000E+00	8.7041E-01
24	24	1	1	20	20	1.74943E+05	128.9302	8.7065E-01	0.0000E+00	8.7065E-01
1	1	1	1	21	21	2.49325E+05	134.9343	5.0E-01	0.0000E+00	5.0E-01
2	2	1	1	21	21	2.48820E+05	134.7954	5.0E-01	0.0000E+00	5.0E-01
3	3	1	1	21	21	2.48221E+05	134.6295	5.0E-01	0.0000E+00	5.0E-01
4	4	1	1	21	21	2.47439E+05	134.4124	5.0E-01	0.0000E+00	5.0E-01
5	5	1	1	21	21	2.45300E+05	133.8129	5.0E-01	0.0000E+00	5.0E-01
6	6	1	1	21	21	1.74316E+05	131.5854	8.7806E-01	0.0000E+00	8.7806E-01
7	7	1	1	21	21	1.74288E+05	128.2376	8.6917E-01	0.0000E+00	8.6917E-01
8	8	1	1	21	21	1.74245E+05	125.4986	8.5809E-01	0.0000E+00	8.5809E-01
9	9	1	1	21	21	1.74209E+05	123.6193	8.4843E-01	0.0000E+00	8.4843E-01
10	10	1	1	21	21	1.74182E+05	122.3457	8.3803E-01	0.0000E+00	8.3803E-01
11	11	1	1	21	21	1.74166E+05	121.5485	8.2922E-01	0.0000E+00	8.2922E-01
12	12	1	1	21	21	1.74160E+05	121.1579	8.2466E-01	0.0000E+00	8.2466E-01
13	13	1	1	21	21	1.74163E+05	121.1563	8.2463E-01	0.0000E+00	8.2463E-01
14	14	1	1	21	21	1.74174E+05	121.5439	8.2915E-01	0.0000E+00	8.2915E-01
15	15	1	1	21	21	1.74195E+05	122.3383	8.3795E-01	0.0000E+00	8.3795E-01
16	16	1	1	21	21	1.74226E+05	123.6094	8.4836E-01	0.0000E+00	8.4836E-01
17	17	1	1	21	21	1.74266E+05	125.4865	8.5800E-01	0.0000E+00	8.5800E-01
18	18	1	1	21	21	1.74312E+05	128.2238	8.6912E-01	0.0000E+00	8.6912E-01
19	19	1	1	21	21	1.74341E+05	131.5708	8.7801E-01	0.0000E+00	8.7801E-01
20	20	1	1	21	21	2.45248E+05	133.7983	5.0E-01	0.0000E+00	5.0E-01
21	21	1	1	21	21	2.47386E+05	134.3977	5.0E-01	0.0000E+00	5.0E-01
22	22	1	1	21	21	2.48168E+05	134.6149	5.0E-01	0.0000E+00	5.0E-01
23	23	1	1	21	21	2.48767E+05	134.7807	5.0E-01	0.0000E+00	5.0E-01
24	24	1	1	21	21	2.49271E+05	134.9196	5.0E-01	0.0000E+00	5.0E-01
1	1	1	1	22	22	2.53177E+05	135.9795	5.0E-01	0.0000E+00	5.0E-01
2	2	1	1	22	22	2.52497E+05	135.7963	5.0E-01	0.0000E+00	5.0E-01
3	3	1	1	22	22	2.51519E+05	135.5317	5.0E-01	0.0000E+00	5.0E-01
4	4	1	1	22	22	2.50273E+05	135.1922	5.0E-01	0.0000E+00	5.0E-01
5	5	1	1	22	22	2.47533E+05	134.4366	5.0E-01	0.0000E+00	5.0E-01
6	6	1	1	22	22	1.74161E+05	132.4580	8.8032E-01	0.0000E+00	8.8032E-01
7	7	1	1	22	22	1.74146E+05	128.9038	8.7103E-01	0.0000E+00	8.7103E-01

NR 7-8-96

INPUT: "rock.svc"

```
Source  40   0.00333  1.000
  is  js  ks  istyp
   1 1   1 1   1 1    11
. 13.05 3.805e-9

   2 2   1 1   1 1    11
. 13.05 3.805e-9

   3 3   1 1   1 1    11
. 13.05 9.513e-10

   4 4   1 1   1 1    11
. 13.05 4.756e-9

   5 5   1 1   1 1    11
. 13.05 7.753e-9

   6 6   1 1   1 1    11
  13.05 7.468e-9

   7 7   1 1   1 1    11
  13.05 1.265e-8

   8 8   1 1   1 1    11
. 13.05 1.265e-8

   9 9   1 1   1 1    11
. 13.05 1.265e-8

  10 10   1 1   1 1    11
. 13.05 1.265e-8

  11 11   1 1   1 1    11
. 13.05 1.265e-8

  12 12   1 1   1 1    11
. 13.05 1.284e-8

  13 13   1 1   1 1    11
. 13.05 1.284e-8

  14 14   1 1   1 1    11
  13.05 1.265e-8

  15 15   1 1   1 1    11
  13.05 1.265e-8

  16 16   1 1   1 1    11
  13.05 1.265e-8

  17 17   1 1   1 1    11
. 13.05 1.265e-8

  18 18   1 1   1 1    11
. 13.05 1.265e-8

  19 19   1 1   1 1    11
. 13.05 7.468e-9

  20 20   1 1   1 1    11
  13.05 7.753e-9

  21 21   1 1   1 1    11
. 13.05 4.756e-9

  22 22   1 1   1 1    11
. 13.05 9.513e-10

  23 23   1 1   1 1    11
. 13.05 3.805e-9

  24 24   1 1   1 1    11
. 13.05 3.805e-9

Revised Power decay data from
Begins with power input for t
  is  js  ks  istyp
   1 1 1  1   23 23    31
 0.0000E+00  0.2464E+04
 0.9467E+07  0.2459E+04
 0.1578E+08  0.2455E+04
 0.3156E+08  0.2447E+04
 0.3541E+08  0.2445E+04
 0.3973E+08  0.2442E+04
 0.4458E+08  0.2440E+04
 0.5002E+08  0.2437E+04
 0.5612E+08  0.2434E+04
 0.6297E+08  0.2430E+04
 0.7065E+08  0.2426E+04
```

NR 7-8-96

NR 7-8-96

NR 7-8-96

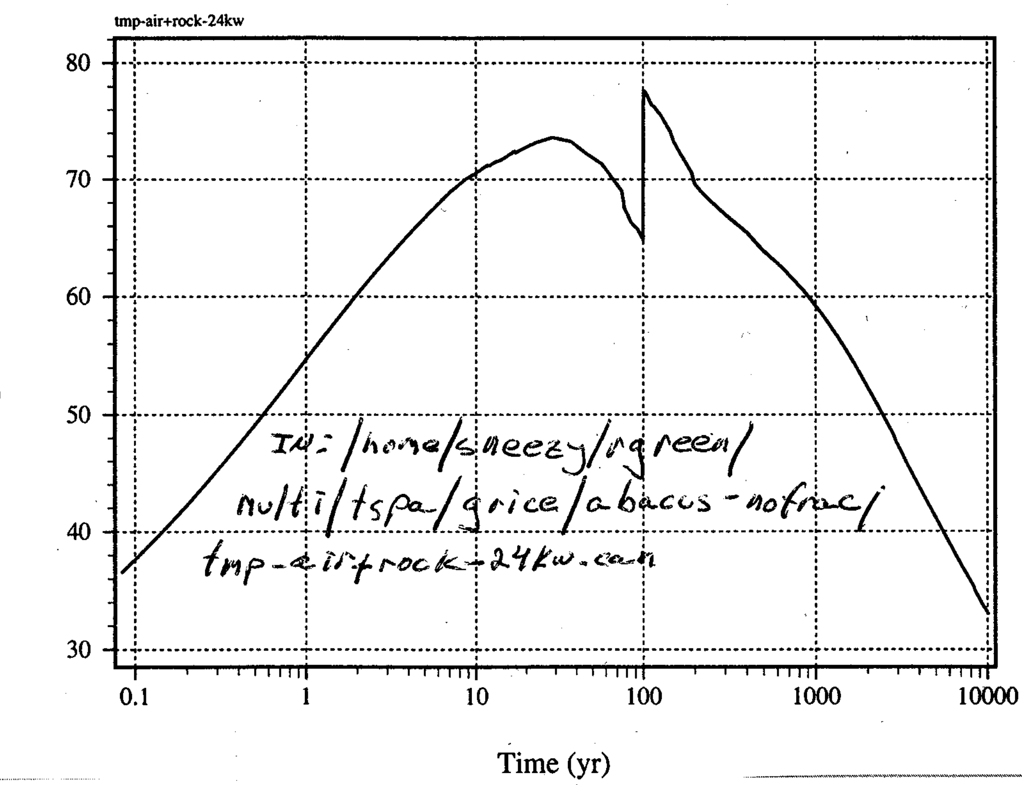
NR 7-8-96

7-9-96
MR

OUTPUT: "comp-24kw-rock.dat"

MR 7-9-96

2 Heaters, 24kW/Ac, Infiltration Rate = 0.3mm/yr



7-11-96
MR

NEW SET OF FRACTURE RUNS IN:
/home/sneezy/rgreen/multi/tspa/grice/frac-3

10 cm WIDE FRACTURE EXTENDS FROM SURFACE TO DRIFT BUT DOES NOT EXTEND BELOW DRIFT.

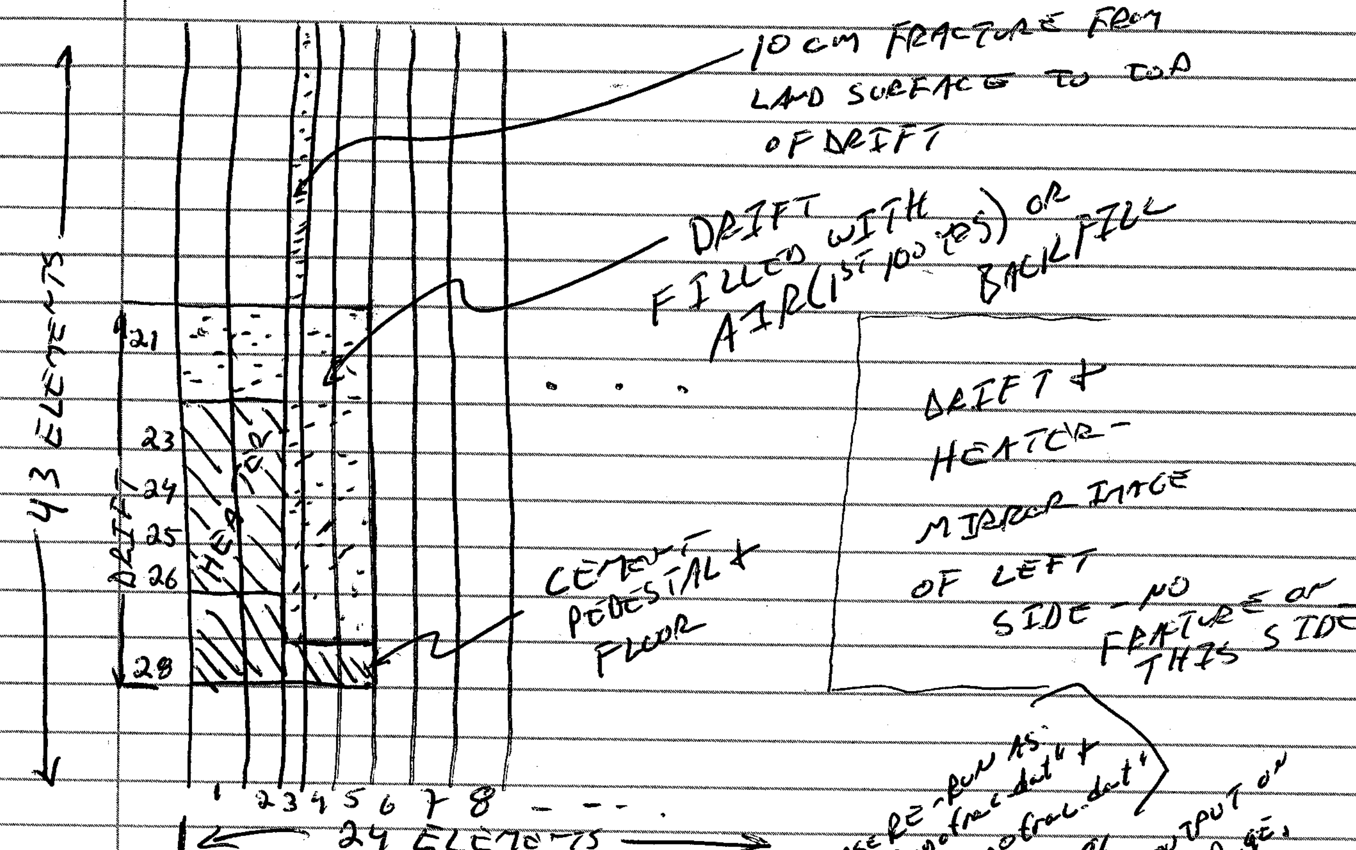
FIRST SET OF RUNS:

"air-0.0003.dat", "air.int", + "air-1.src":
FOCUSED INFILTRATION RATE THROUGH FRACTURE IS SAME AS INFILTRATION RATE ACROSS ENTIRE UPPER SURFACE OF MODEL = 0.0003 M/YR = 0.3 MM/YR.

FOLLOWED BY: "rock-0003.dat" et al.

7-11-96
MR

GRID FOR NEW SET OF FRACTURE RUNS:



BASE CASE RE-RUN AS: "air-0.0003-nofrac.dat" + "rock-0.0003-nofrac.dat"
MR 7-15-96
SEE OUTPUT ON NEXT PAGE.

NOTE - THE BASE-CASE ~~FOR~~ THIS SET OF RUNS IS: "rock-4.dat" et al. IN:
/home/sneezy/rgreen/multi/tspa/grice/backfill
→ IDENTICAL TO "air-0.0003.dat" + "rock-0.0003.dat" et al. BUT CONTAINS NO FRACTURE.

7-12-96
MR

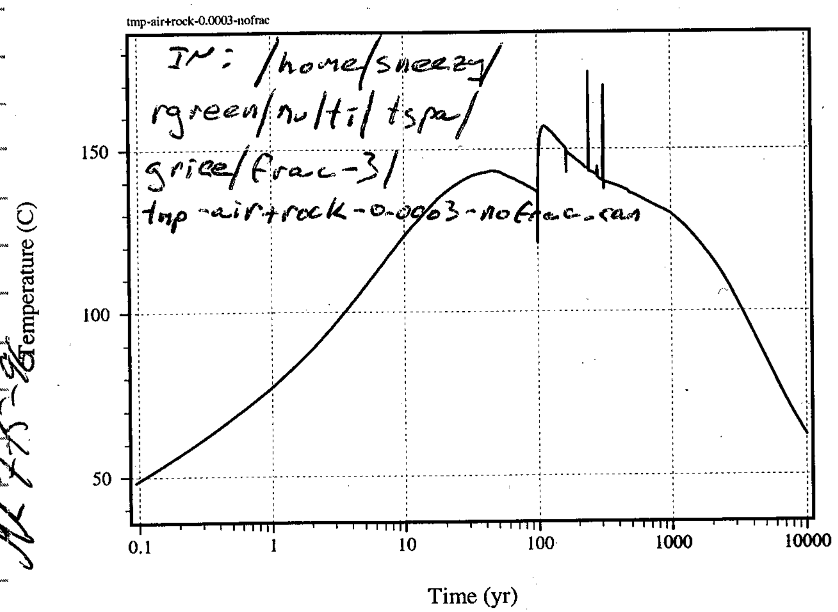
NEW TYPE OF FRACTURE RUN:
"air-20cmfrac.dat" - IDENTICAL TO "air-0.0003.dat" EXCEPT FRACTURE ZONE IS 20 cm WIDE INSTEAD OF 10 cm. TOTAL WIDTH STILL 11.0 M - ELEMENT TO RIGHT OF FRACTURE REDUCED FROM WIDTH OF 0.5 M TO 0.4 M. IN SAME DIRECTORY AS ABOVE: ../frac-3.

7-15-96
MR

OUTPUT: "air-0.0003-nofrac.dat" + "rock-0.0003-nofrac.dat" et al.

MR 7-15-96

83 kW/Ac, No Fracture, Infiltration Rate = 0.0003 m/yr

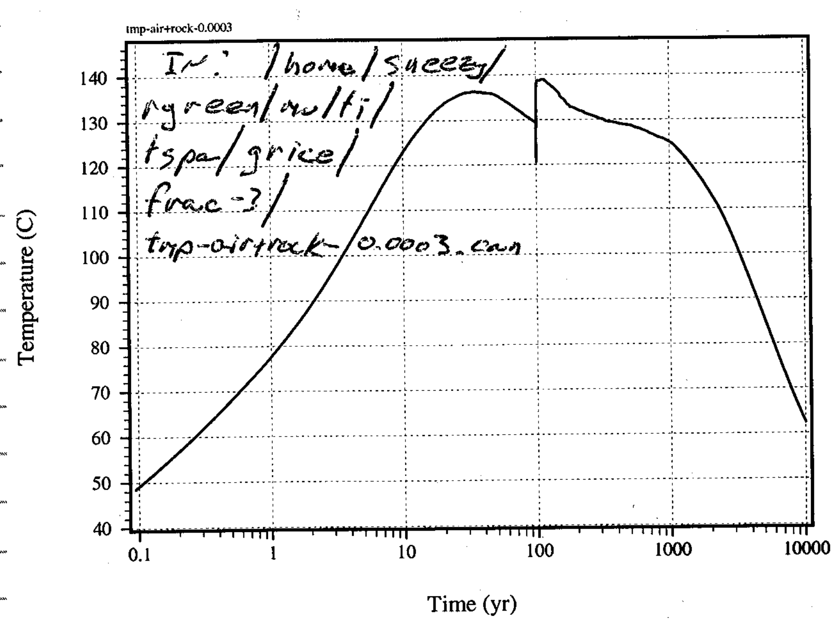


MR 7-15-96

OUTPUT: ~~"air +~~ MR 7-15-96 "air-0.0003.dat" + "rock-0.0003.dat" et al.

MR 7-15-96

83 kW/Ac, 10 cm Fracture, Focused Infiltration Rate = 0.0003 m/yr



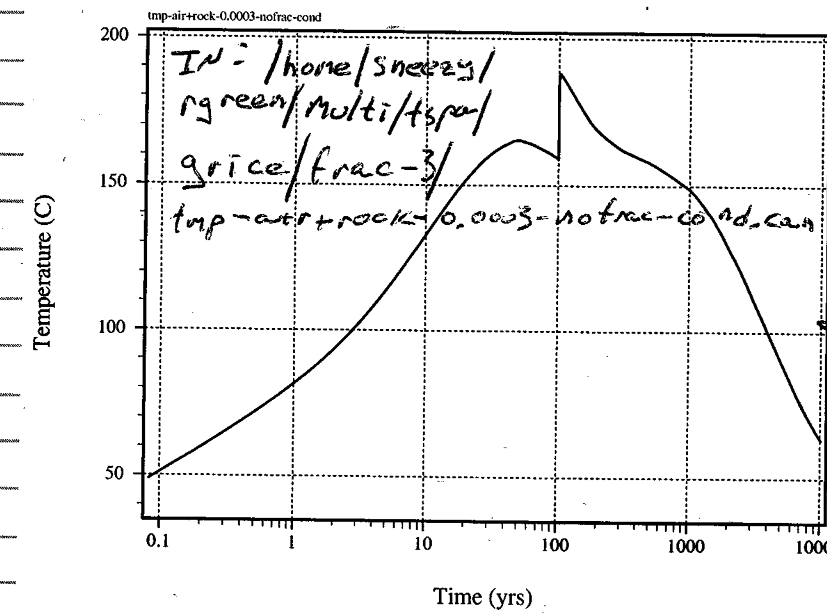
MR 7-15-96

7-15-96
MR

OUTPUT: "air-0.0003-nofrac-cond.dat" + "rock-0.0003-nofrac-cond.dat" et al.

MR 7-15-96

83 kW/Ac, Heat Conduction Only, n = k = 0



MR 7-15-96

7-16-96
MR

NEW RUN: "air-0.0003-1.415mfrac.dat" et al.
IDENTICAL TO: "air-0.0003.dat" EXCEPT FRACTURE ZONE EXTENDS ACROSS ALL THREE DRIFT ELEMENTS NEXT TO THE WASTE PACKAGE - TOTAL WIDTH = 0.1 M + 0.5 M + 0.815 M = 1.415 M.
IN:
/home/sneezy/rgreen/multi/tspa/grice/frac-3

7-19-96
MR

RAN 2 VERSIONS OF SAME SIMULATION MR 7-19-96 ~~TO~~ PER MOHAN SETH'S REQUEST - ONLY DIFFERENCE WAS BINARY DIFFUSION COEFFICIENT WAS CUT IN HALF FOR 1 OF THE SIMULATIONS. - BOTH CRASHED BUT OUTPUT (TEMP) APPEARS IDENTICAL.
"air-0.0003-1.415mfrac.dat" et al. +
"air-1.415-0.5diffuse.dat" et al IN: /home/sneezy/rgreen/multi/tspa/grice/frac-3

7-22-96
AR

NEW SET OF FRACTURE RUNS:
"air-40cmfrac.dat" et al. + "rock-40cmfrac.dat" et al.
SAME AS ~~AR 7-22~~ air, rock, -0.0003 dat et al. EXCEPT
FRACTURE WIDTH = 40 cm INSTEAD OF 10 cm. IN:
/home/sneezy/rgreen/multi/tspa/grice/frac-3

7-25-96
AR

STARTED: "rock-80cmfrac.dat" et al IN

7-26-96
AR

NEW SET OF RUNS:
"air-100cmfrac.dat" et al. +
"rock-100cmfrac.dat" et al. IN:
/home/sneezy/rgreen/multi/tspa/grice/frac-3

7-27-96
AR

NEW RUN "air-120cmfrac.dat" et al. IN

7-30-96
AR

RE-RUNNING THE FRACTURE RUNS:

air AND rock:
... -0.0003-nofrac
... -0.0003-1cm
... -0.0003

BECAUSE: TEMPERATURE NEXT TO WASTE PACKAGE WAS MONITORED AT ELEMENT # 555:

HOWEVER - SIZE OF ELEMENT WAS CHANGED AS SIZE OF FRACTURE (WIDTH) WAS CHANGED. THUS, CENTER OF ELEMENT RANGED FROM 0.005 M FROM HEATER (1cm FRAC) TO 0.02 m FROM HEATER (40 cm FRAC)

IN THE NEW RUNS, TEMPERATURES ARE MONITORED AT ELEMENT # 506,

7-30-96
AR

WHICH DOES NOT CHANGE SIZE AS WIDTH OF FRACTURE IS CHANGED.

OTHER FRACTURE RUNS WILL ALSO BE RE-DONE.

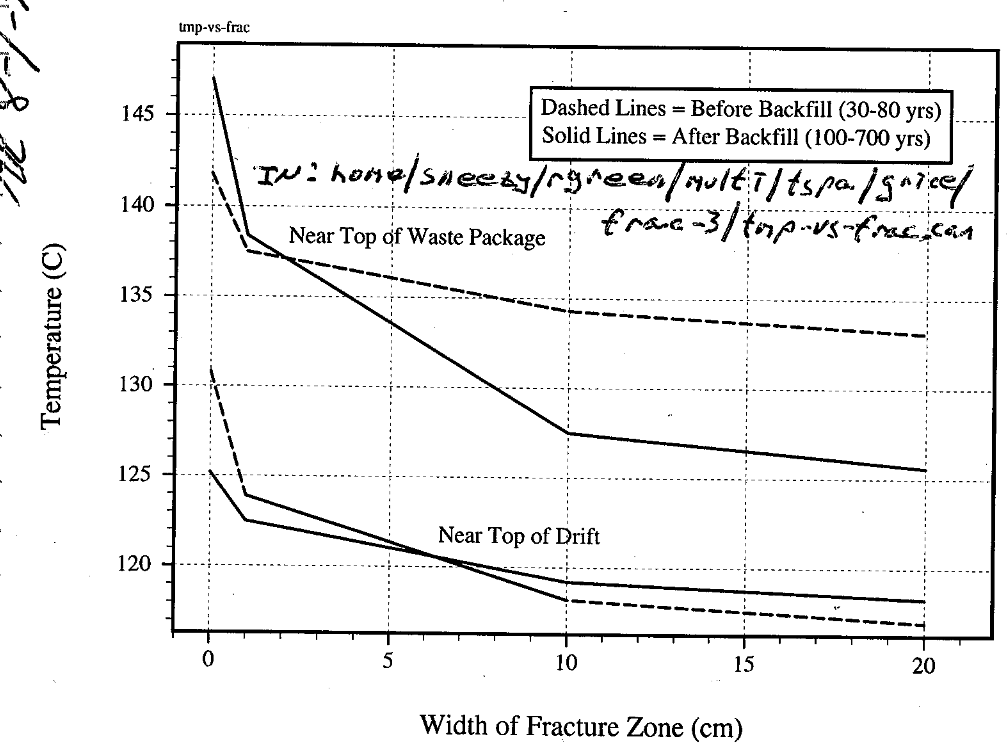
THE CENTER OF ELEMENT 506 IS ALWAYS 0.35 m ABOVE THE TOP OF THE HEATER.

8-1-96
AR

AR 8-1-96

AR 8-1-96

Peak Temperature at 83 kW/Ac

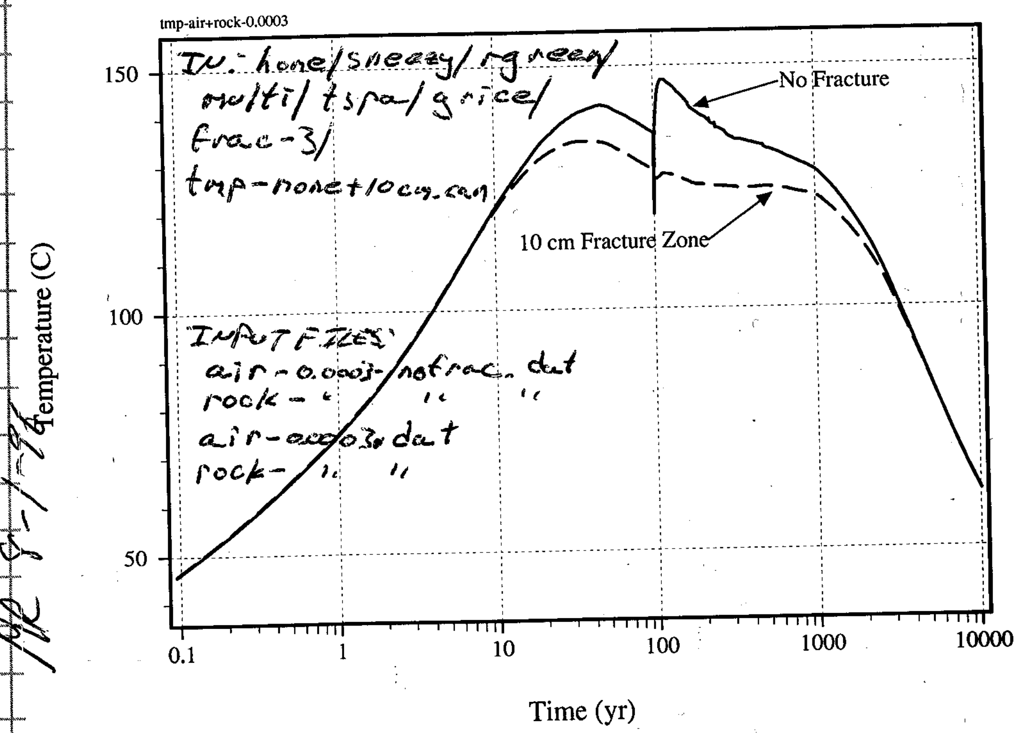


AR
8-1-96

8-1-96
MR

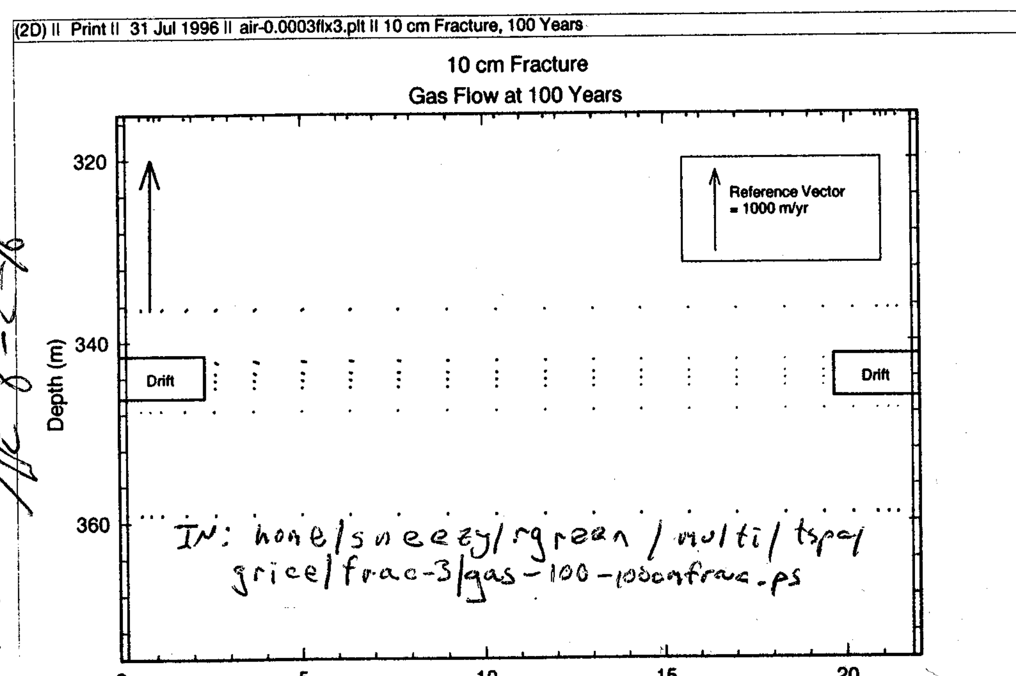
MR 8-1-96

Effect of Fracture Zone on Temperature 35 cm Above Waste Package



8-2-96
MR

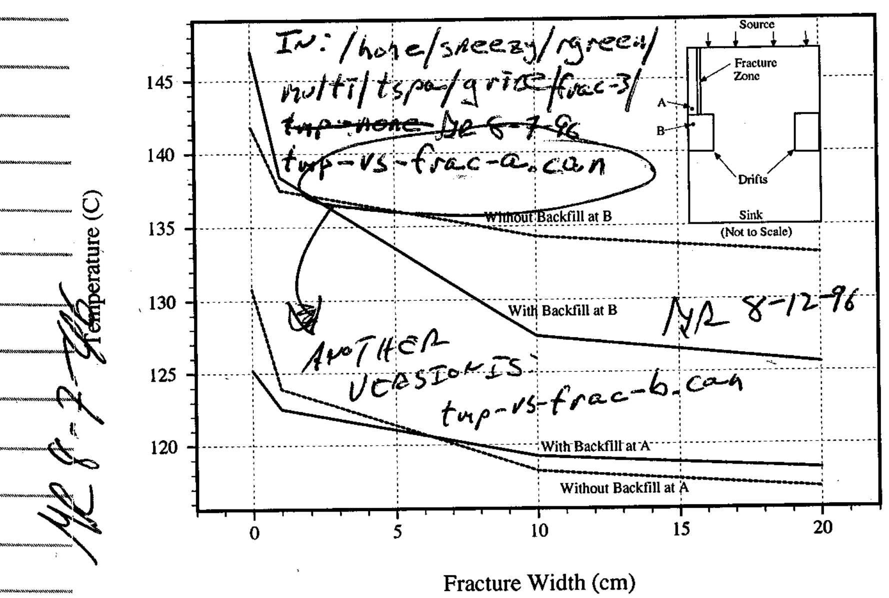
MR 8-2-96



8-7-96
MR

MR 8-7-96

Effect of Fracture Width on Peak Temperatures (83 kW/Acre)

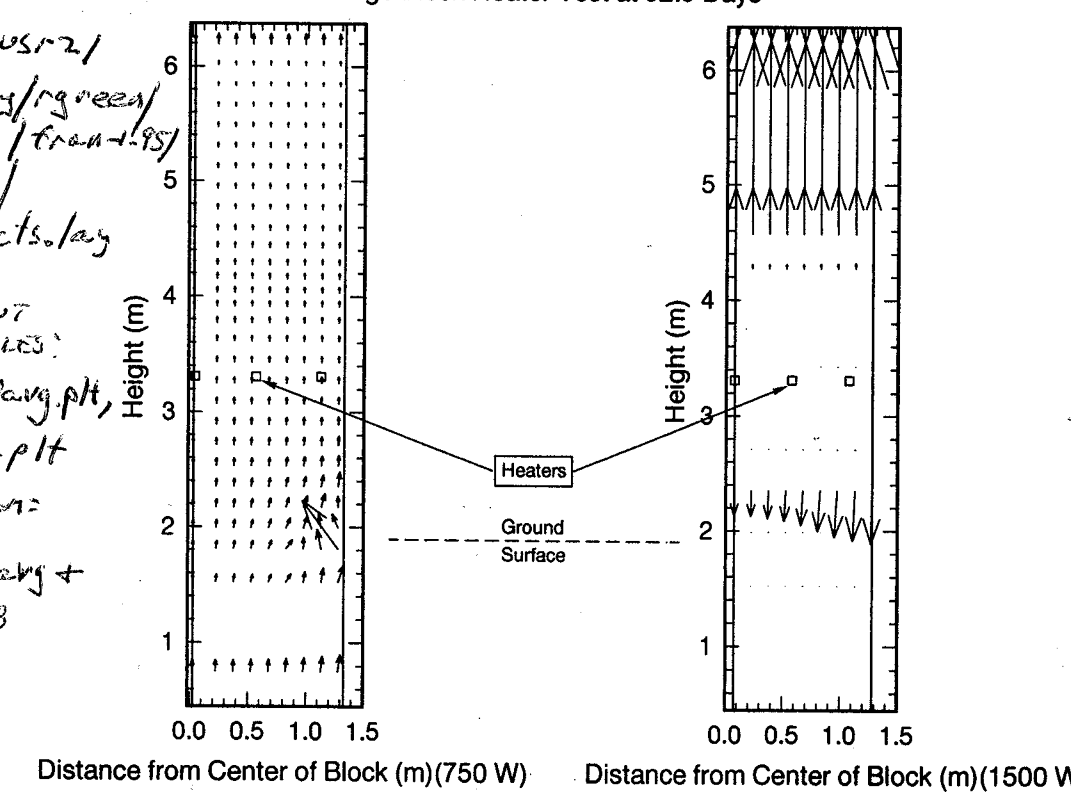


MR 8-7-96

Gas Flow Velocity Vectors of Fran Ridge
Large Block Heater Test at 92.5 Days

IN: /usr2/
sneezy/rgreen/
grice/fran-1-95/
vects/
26-vects.ay

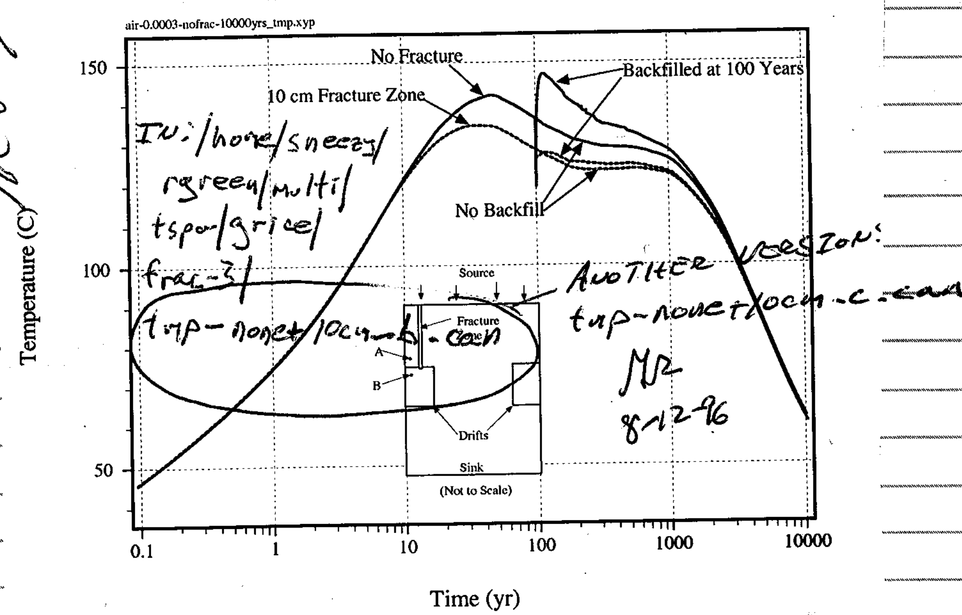
INPUT
FILES:
100-8avg.plt,
50-8.plt
From:
100-8 avg +
50-8



8-7-96
MR

MR 8-7-96

Effect of Fracture Zone on Temperature at Point B



IN: /home/sneezy/rgreen/multi/tspa/grice/frac-3/
tmp-nonet10cm-b-c.ean

ANOTHER VERSION:
tmp-nonet10cm-c.ean
MR
8-12-96

MR 8-7-96

8-15-96
MR

METRA RUNS THAT LOOK AT BEHAVIOR OF TEMP, R.H., + SAT ON SIDEWALL OF DRIFT.

"rock-0.6-side.dat" et al. IN:

/home/sneezy/rgreen/multi/tspa/grice/frac-3/back-therm

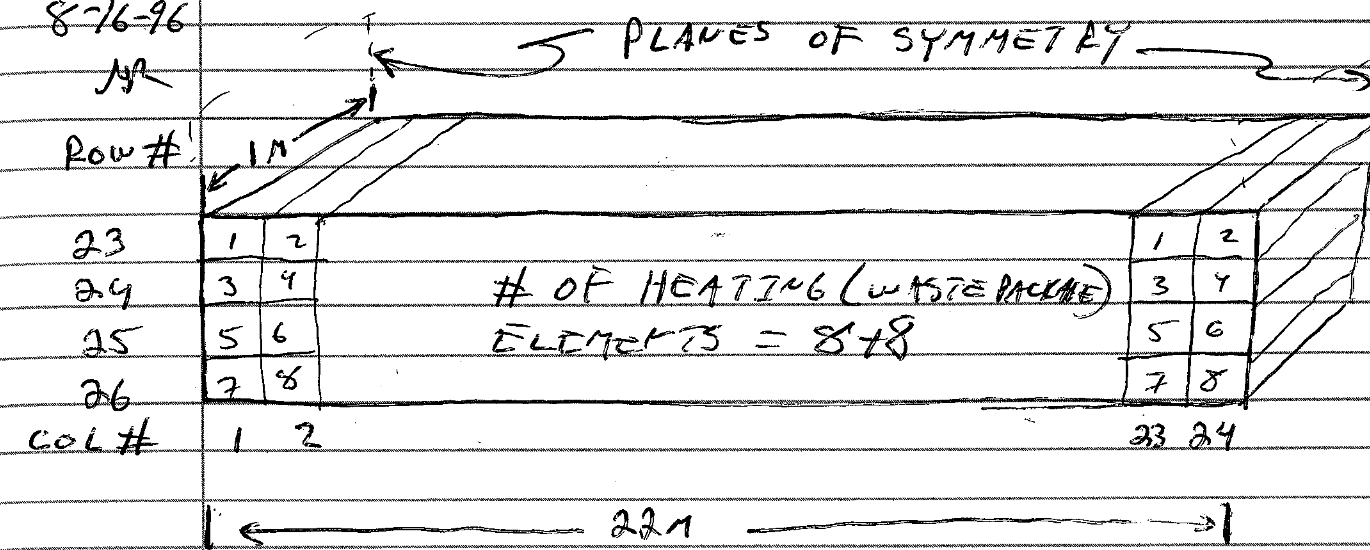
8-16-96
MR

CALCULATING AREAL POWER DENSITY (INITIAL). THE VALUES USED IN THE CALCULATION ON THE NEXT PAGE ARE FROM THE FOLLOWING INPUT FILES:

"air-0.0003.dat" + "air-1.src" IN:

/home/sneezy/rgreen/multi/grice/frac-3

8-16-96
MR



INITIAL HEAT RATE:

'SCALH' IN METRA   'QHT' IN METRA

$$\frac{0.00333\,(16)\,(8469\ \mathrm{W})}{22\mathrm{M}\ (1\mathrm{M})}\ \frac{4047\ \mathrm{M}^2}{\mathrm{AC}} = \boxed{83.0\ \frac{\mathrm{KW}}{\mathrm{AC}}}$$

NEW RUN - ATTEMPTING TO FIND OUT WHY RUI CHEN'S SATURATION RESULTS DIFFER FROM MINE - 1 DIFFERENCE, I INVOKE ENHANCED BINARY DIFFUSION, SHE DOES NOT - THUS I TURNED IT OFF ('enbd' IN THERMAL-PROP) IN THE RUN;

'rock-0.6-side-enbd.dat' et al. IN:

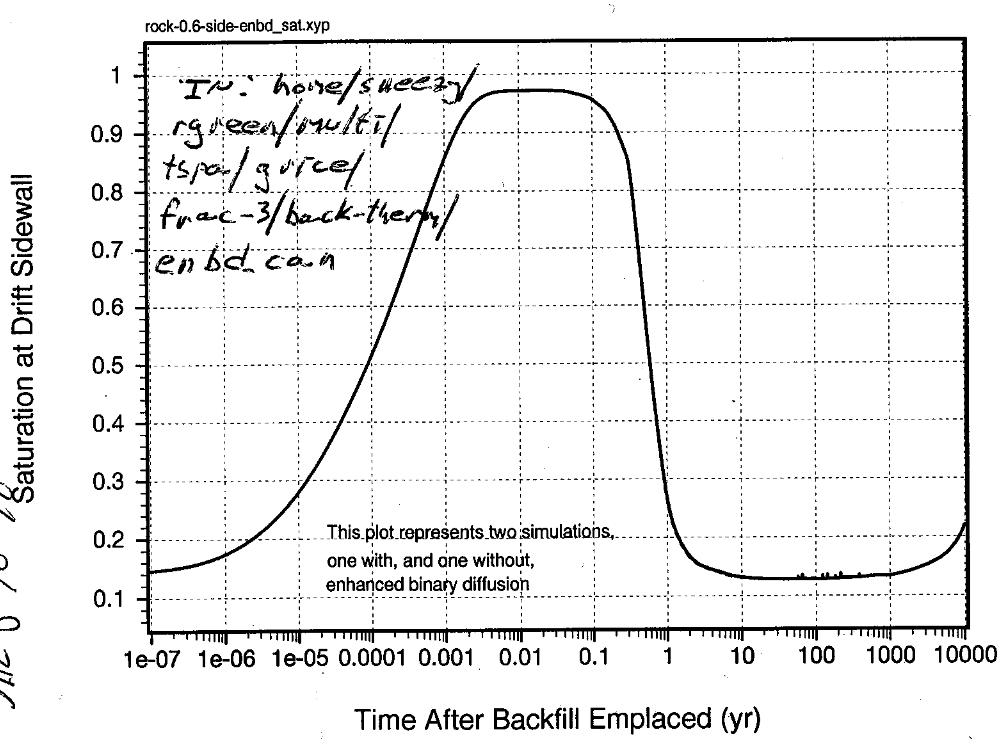
/home/sneezy/rgreen/multi/tspa/grice/frac-3/back-therm.

MR
8-16-96

8-16-96
NR

NR 8-16-96

Effect of Enhanced Binary Diffusion



NR 8-16-96

NEW RUN - "rock-0.6-side-therm.dat" - IDENTICAL TO "rock-0.0003-nofrac.dat" EXCEPT THERMAL CONDUCTIVITIES OF MOST MATERIALS INCREASE WITH INCREASING SATURATION ~ IN:
/home/sneezy/rgreen/multi/tspa/grice/frac-3/back-therm

NR 8-16-96

```
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.     1.42   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 = Backfill, from TSPA '95 pg 4-18.
  8  2.580e+03 840.0    0.60   0.79     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.
:10 =Air Around Metal Waste Package, rho & cpr from CRC, other Properties Assume
 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.
```

INCREASED THERMAL CONDUCTIVITY

NR 8-16-96

8-16-96
NR

INPUT FILE: "rock-0.0003-nofrac.dat"

NR 8-16-96

```
Yucca Mt.)
July 12, 1996
: Identical to rock-0.0003.dat except fracture removed.
: Saturation of backfill emplaced at 100 years = 50%.
: 10 cm fracture zone next to waste. Zone does not extend below drift.
: Initial conditions from run: "air-0.0003.dat" et al.
: Thermal conductivities of most materials are constants per TSPA 95
:  24X43 Grid
:Power Decay curve from R, Manteufel, 4/25/96.
: set upper element to large heat capacity
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       24  1   43   1       1      1     0    0
:
Monitor 506
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
: 0.1% 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 S
: 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
0             :blank line
:
```

NR 8-16-96

```
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.
:10 =Air Around Metal Waste Package, rho & cpr from CRC, other Properties Assume
 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.
```

NR 8-16-96

8-16-96
MR

IPUT (CONT) "rock-0-0003-nofrac.dat"
MR 8-16-96

```
0
:     igrid   rw       re
DXYZ  0
: (dx(i),i=1,nx)
0.4 0.4 0.1 0.5 0.815 0.785 1.33 1.33 1.33 1.33
1.33 1.35 1.35 1.33 1.33 1.33 1.33 1.33 0.785 0.815
0.5 0.1 0.4 0.4
: (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 24  1  1  1  1   1   7   0.
   1 24  1  1  2  6   1   1   0.
   1 24  1  1  7 10   2   2   0.
   1 24  1  1 11 35   3   3   0.
   1 24  1  1 36 36   4   4   0.
   1 24  1  1 37 39   5   5   0.
   1 24  1  1 40 42   6   6   0.
   1 24  1  1 43 43   6   6   6.2832e7
:Drifts
   1  5  1  1 21 28   7   8
  20 24  1  1 21 28   7   8
:Waste Packages
   1  2  1  1 23 26   8   9
  23 24  1  1 23 26   8   9
:Supports (Pedestal, Cement)
   1  2  1  1 27 27  11  11
  23 24  1  1 27 27  11  11
:Inverts (Floor, Cement)
   1  5  1  1 28 28  11  11
  20 24  1  1 28 28  11  11
:Fracture
:    3  3  1  1  1 20  10   2
:    3  3  1  1 29 43  10   2
```

MR 8-16-96

```
:
0
Init rock-1
:
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+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-8 1.e5
:
: SKIP
:
Source  40   0.00333  1.000 rock-1
:
:NOSKIP
:
:       print all at every target time
PLOTS 1 3 458 506 674
:      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
```

MR 8-16-96

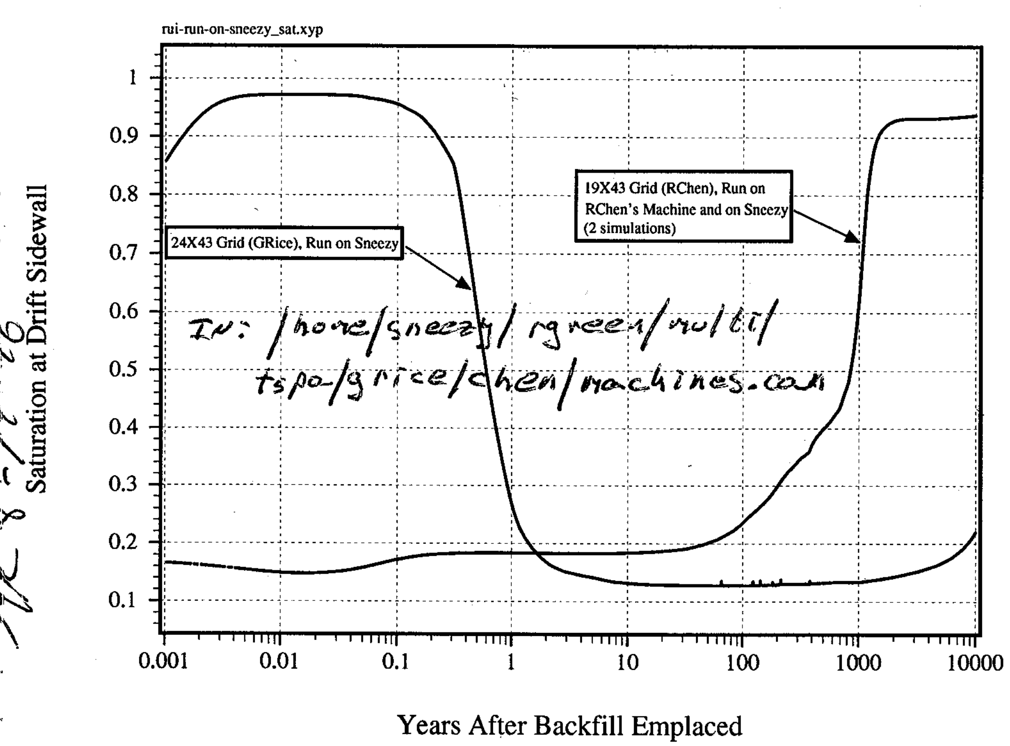
8-19-96
MR

- STILL ATTEMPTING TO DETERMINE WHY RUI CHEN'S SATURATION VALUES DIFFER FROM THESE THAT MY SIMULATIONS YIELD. RUNNING RUI'S INPUT ON SNEEZY - NO CHANGES - FILE + LOCATION:

"rui-run-on-sneezy" IN:
/home/sneezy/rgreen/multi/tspa/grice/chen - NOTE, RUN COMPLETED IN 636 CPU SECONDS - FAST!

MR 8-19-96

Results do not Depend on Machine Used to Perform Simulations



IN: /home/sneezy/rgreen/multi/tspa/grice/chen/machines.com

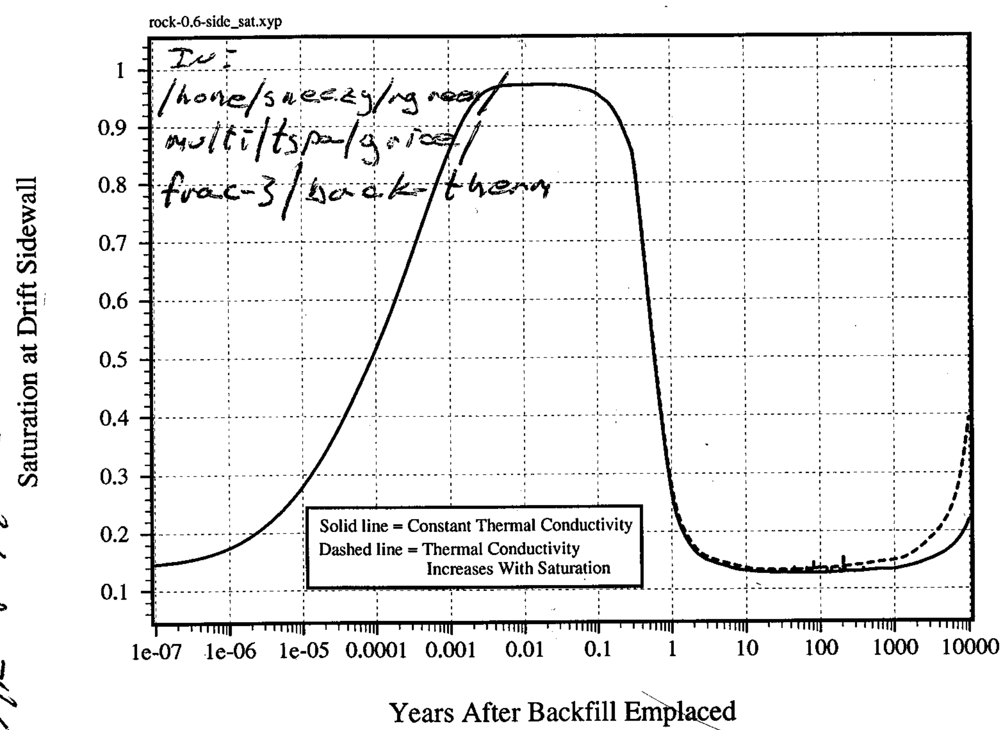
MR 8-19-96

MR

8-19-96
MR

MR 8-19-96

Effect of Thermal Conductivity on Saturation



MR 8-19-96

NEW SET OF RUNS DESIGNED TO ELIMINATE IMBIBITION ALONG FRACTURE WALLS – FRACTURE LINED WITH IMPERMEABLE CELLS:

IMPERMEABLE LINING, $k = 10^{-99}\,m^2$, WIDTH = 1 cm
CHANGED TO $10^{-22}\,m^2$
MR 8-21-96

FRACTURE, WIDTH = 10 cm

STEADY STATE RUN, WITHOUT DRIFTS, WASTE, etc.:
"air-SS-10cm.dat" et al. IN:
~~/home/sneezy/rgreen/multi/tspa/grice/26x43~~
REPLACED BY "ss-test-dat"
MR 8-20-96

8-20-96
MR

INPUT: "air-0.0003-10cm.dat" – USES STEADY-STATE OUTPUT FROM "ss-test-dat" et al. AS INITIAL CONDITIONS – GRID = 26X43 – LINED FRACTURE

MR 8-20-96

IN:
/home/sneezy/rgreen/multi/tspa/grice/26X43

```
Yucca Mt.)
August 20, 1996
: 10 cm fracture zone next to waste. Zone does not extend from bottom of drift.
: Fracture lined with impermeable material.
: 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
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 548
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 2.1e-99 2.1e-99
 0            :blank line
```

CHANGED TO $2.1 \times 10^{-22}\,m^2$
MR 8-21-96

MR 8-20-96

```
:
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.
: 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.
```

MR 8-20-96

8-20-96
MR

INPUT: "air-0.0003-10cm.dat" (CONT)

```
: 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)
0.4 0.4 0.01 0.1 0.01 0.48 0.815 0.785 1.33 1.33
1.33 1.33 1.33 1.35 1.35 1.33 1.33 1.33 1.33 1.33
0.785 0.815 0.5 0.1 0.4 0.4
: (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
   1  7  1  1 21 28   9  10
  22 26  1  1 21 28   9  10
:Waste Packages
   1  2  1  1 23 26   8   9
  25 26  1  1 23 26   8   9
:Supports (Pedestal, Cement)
   1  2  1  1 27 27  11  11
  25 26  1  1 27 27  11  11
:Inverts (Floor, Cement)
   1  7  1  1 28 28  11  11
  22 26  1  1 28 28  11  11
```

MR 8-20-96

```
: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
:
0
Init air
:
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+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-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  42   0.00333  1.000 air
:
:NOSKIP
:
```

MR 8-20-96

8-20-96
MR

INPUT (CONCL) "air-0.0003-10cm.dat"

```
:       print all at every target time
PLOTS 1 3 496 548 606
:        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
```

MR 8-20-96

NEW RUN - "ss-0.03-10cm.dat" et al.,
FOCUSED INFILTRATION RATE AT FRACTURE
= 3 cm/YR. PERMEABILITY OF FRACTURE
LINING = 1×10^{-22} m^2. OTHERWISE
IDENTICAL TO "ss-test.dat" IN:

/home/sneezy/rgreen/multi/tspa/grice/26X43

8-23-96
MR

- NEW SET OF RUNS BEGINNING WITH:
"ss-0.003-10cm.dat" et al. PROPERTIES
SAME AS "air-0.0003-10cm.dat" et al. EXCEPT
FOCUSED INFILTRATION RATE = 3 mm/yr
INSTEAD OF 0.3 mm/YR. IN:

/home/sneezy/rgreen/multi/tspa/grice/26x43

NEW SET OF RUNS - CHANGING PERMEABILITY OF
FRACTURE LINING TO DETERMINE WHEN CHANGES
IN RESULTS STOP - PROGRAM TENDS TO CRASH
WHEN PERMEABILITY SET TO 10^{-99} m^2.

"ss-0.03-22.dat" et al IN:
/home/sneezy/rgreen/multi/tspa/grice/26X43/line

8-29-96 MR "air-0.03-44.dat" etal.

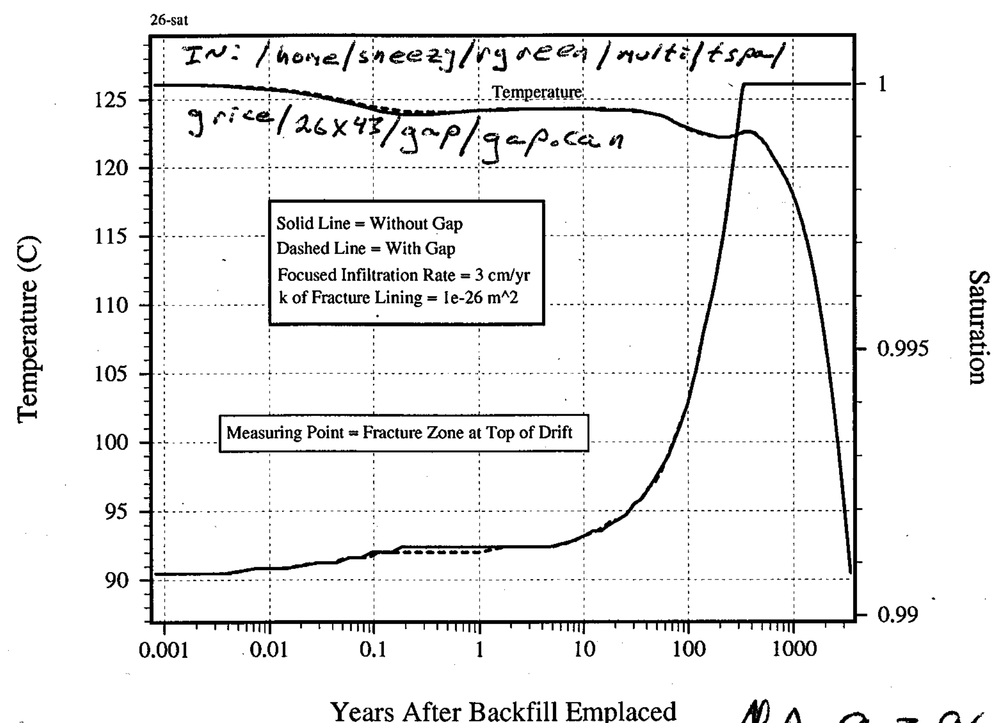
9-2-96 MR NEW SET OF RUNS WITH AN AIR GAP BETWEEN THE BACKFILL AND THE TOP OF THE DRIFT

"rock-0.03-26-gap.dat" IN:
/home/sneezy/rgreen/multi/tspa/grice/26x43/gap

9-3-96 MR

MR 9-3-96

Effect of Gap Between Backfill and Top of Drift



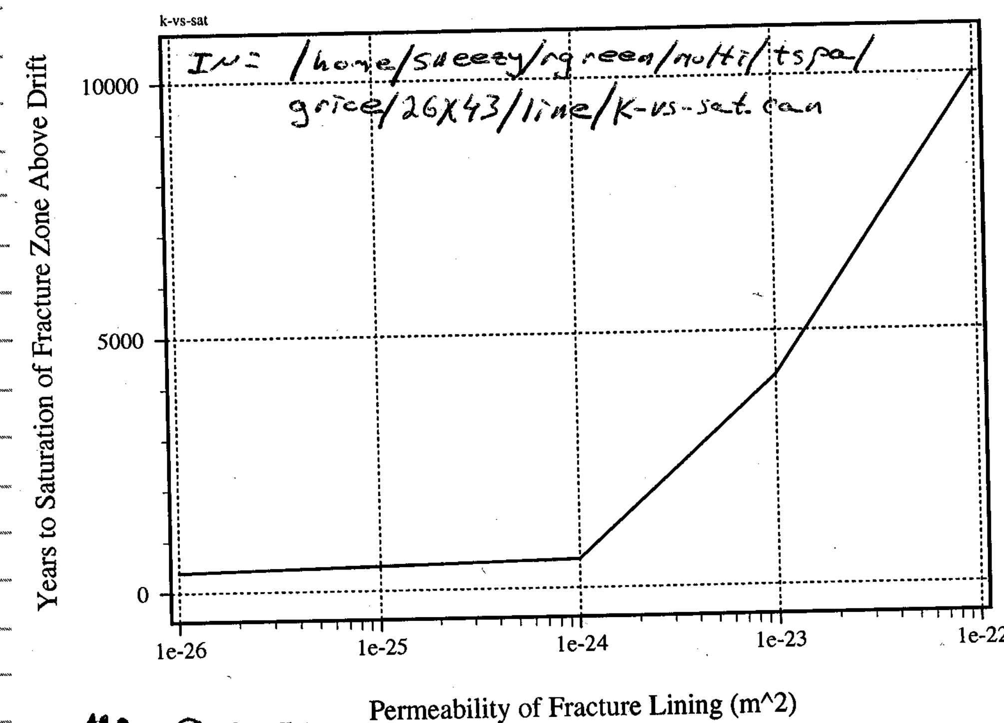
MR 9-3-96

MR 9-3-96

9-3-96 MR

MR 9-3-96

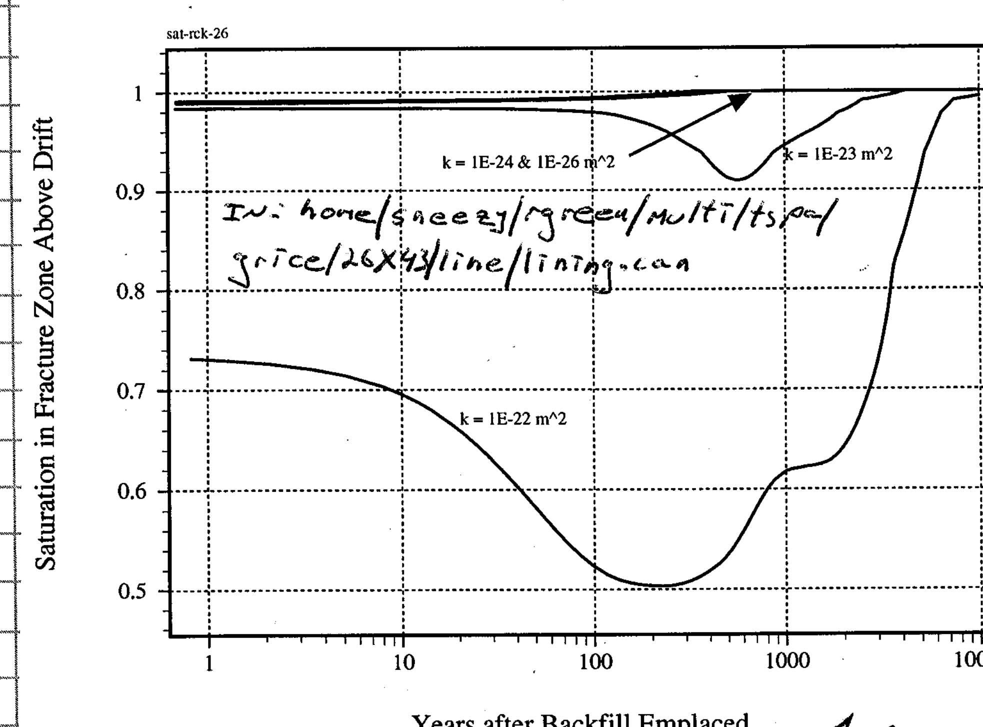
Time to Saturation vs Permeability of Lining



MR 9-3-96

MR 9-3-96

Effect of Fracture Lining Permeability on Saturation



MR 9-3-96

9-6-94
NR

INPUT: "rock-0.03-26.dat"

9-6-94
NR

NR 9-6-96

```
Yucca Mt.)
August 26, 1996
: 10 cm fracture zone next to waste. Zone does not extend from bottom of drift.
: Fracture lined with impermeable material, k=1e-26 m^2.
: Focused infiltration rate = 3 cm/yr.
: Initial conditions from "air-0.03-26.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
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)
:   1  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     Q     .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.
: 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.
```

NR 9-6-96

NR 9-6-96

INPUT: "rock-0.03-26.dat"

NR 9-6-96

```
: 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)
0.4 0.4 0.01 0.1 0.01 0.48 0.815 0.785 1.33 1.33
1.33 1.33 1.33 1.35 1.35 1.33 1.33 1.33 1.33 1.33
0.785 0.815 0.5 0.1 0.4 0.4
: (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  7  1  1 21 28   9    8
  22 26  1  1 21 28   9    8
:Waste Packages
   1  2  1  1 23 26   8    9
  25 26  1  1 23 26   8    9
:Supports (Pedestal, Cement)
   1  2  1  1 27 27  11   11
  25 26  1  1 27 27  11   11
:Inverts (Floor, Cement)


    1  7  1  1 28 28  11   11
   22 26  1  1 28 28  11   11
 :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
 :
 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  42   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.
```

In:
/home/sneezy/
rgreen/[illegible]/
t[illegible]/g[illegible]/
26x43/linc

NR 9-6-96

NR 9-6-96

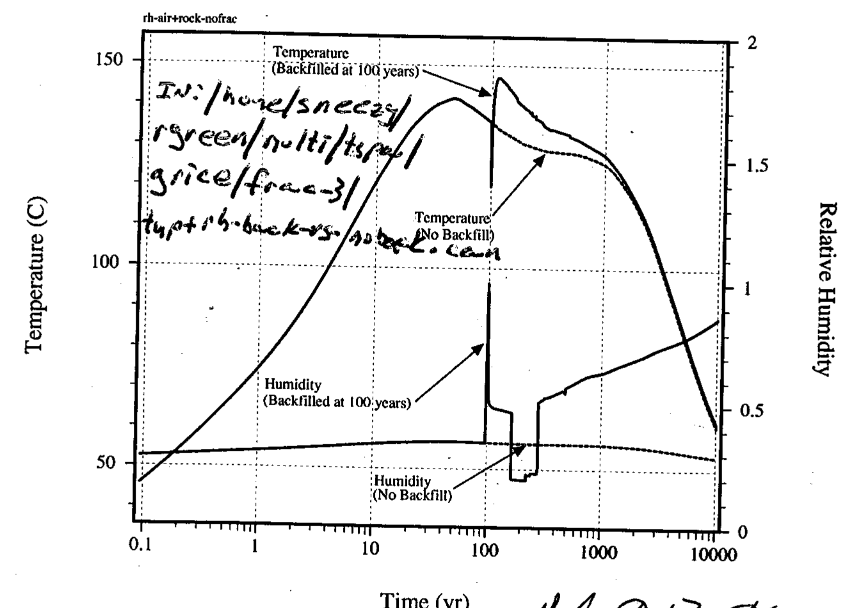
9-6-96
MR

NEW SERIES OF RUNS WITHOUT BACKFILL IN:
/home/sneezy/rgreen/multi/tspa/grice/26x43/line/noback , FIRST RUN:
"noback-0.03.dat" et al.

9-13-96
MR

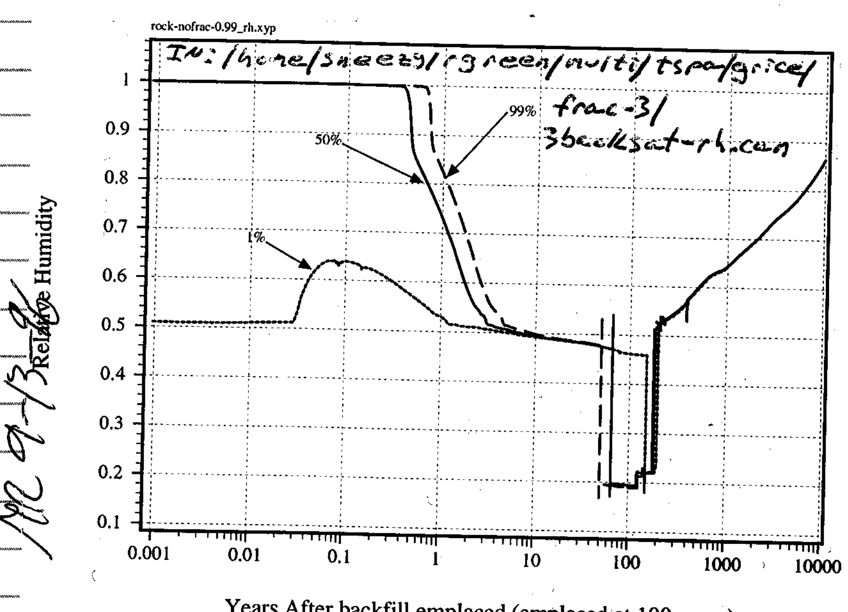
MR 9-13-96

Effects of Backfill on Temperature and Relative Humidity (83 kW/Ac)



MR 9-13-96

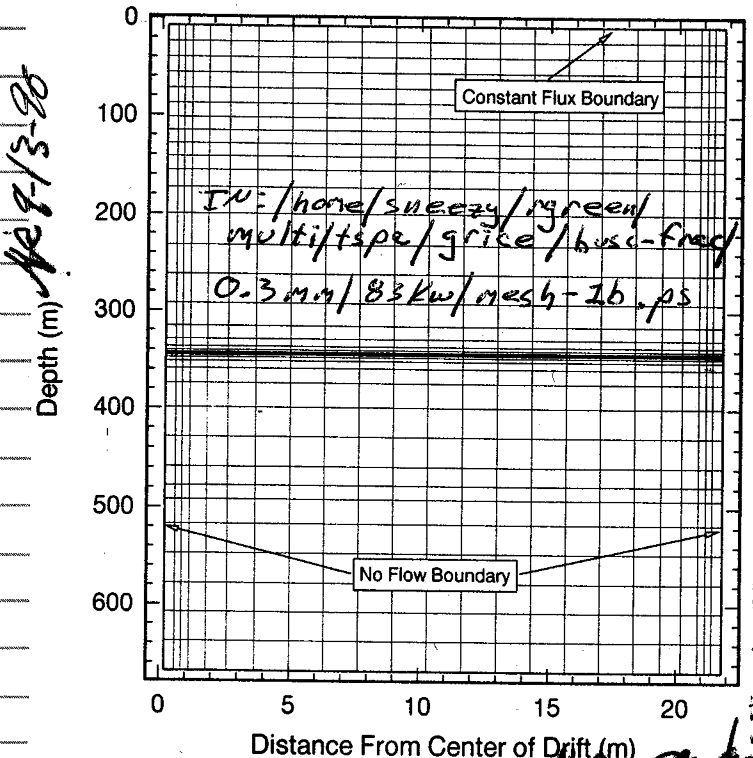
Relative Humidity as a Function of Initial Saturation of Backfill (83 kW/Ac)



MR 9-13-96

9-13-96
MR

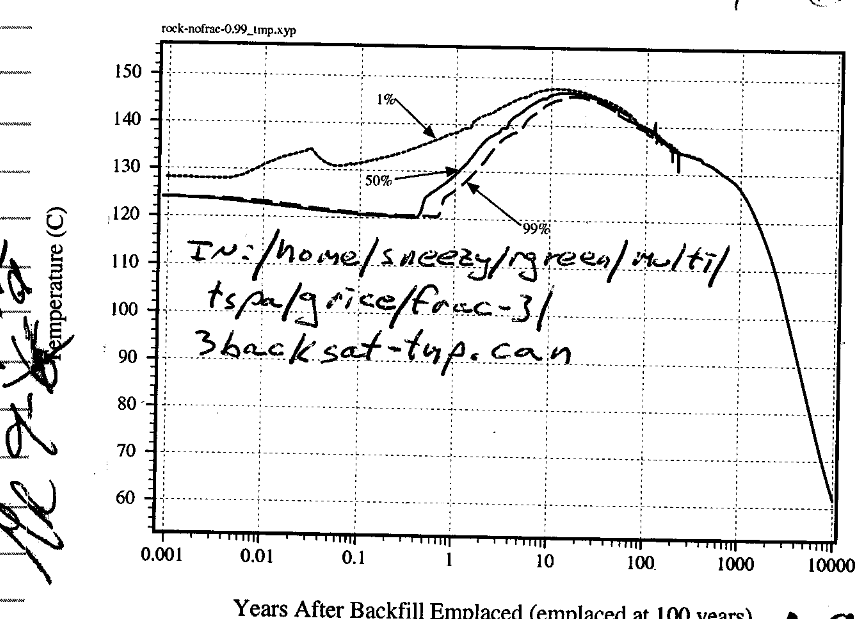
24 X 43 Grid MR 9-13-96



MR 9-13-96

MR 9-13-96

Temperature as a Function of Initial Saturation of Backfill (83 kW/Ac)



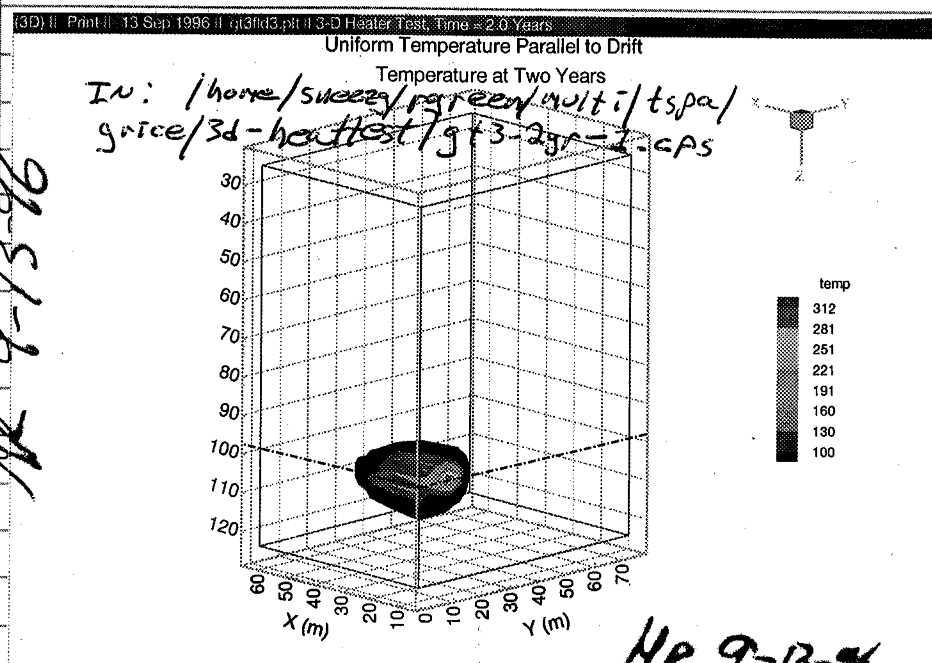
MR 9-13-96

MR 9-13-96

MR
9-13-96

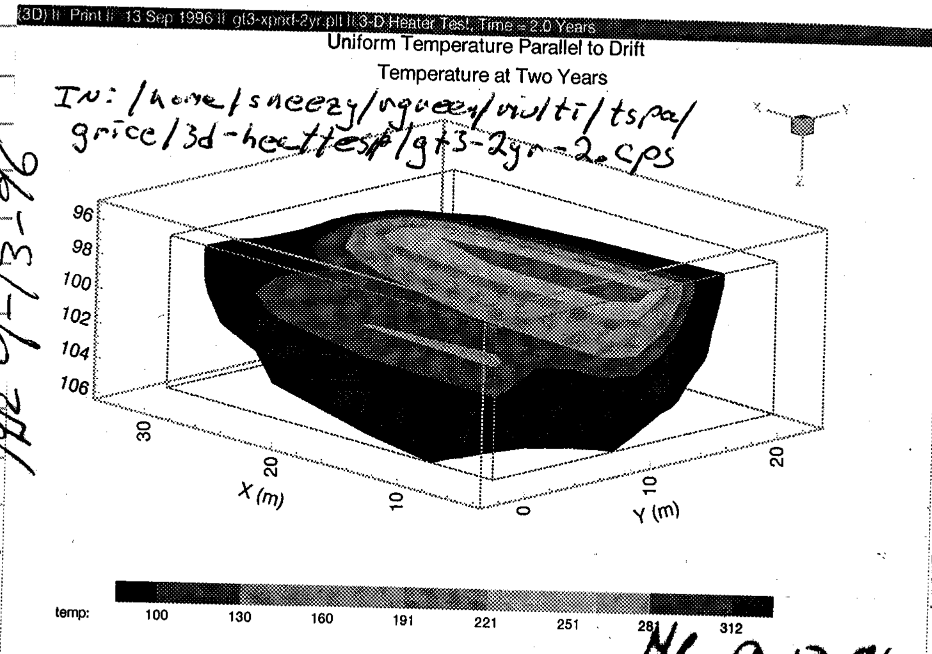
9-13-96
ML

NOTE- INPUT FILE "gt3.dat"
IN: /home/sneezy/rgreen/multi/drift
ML 9-13-96



ML 9-13-96

ML 9-13-96

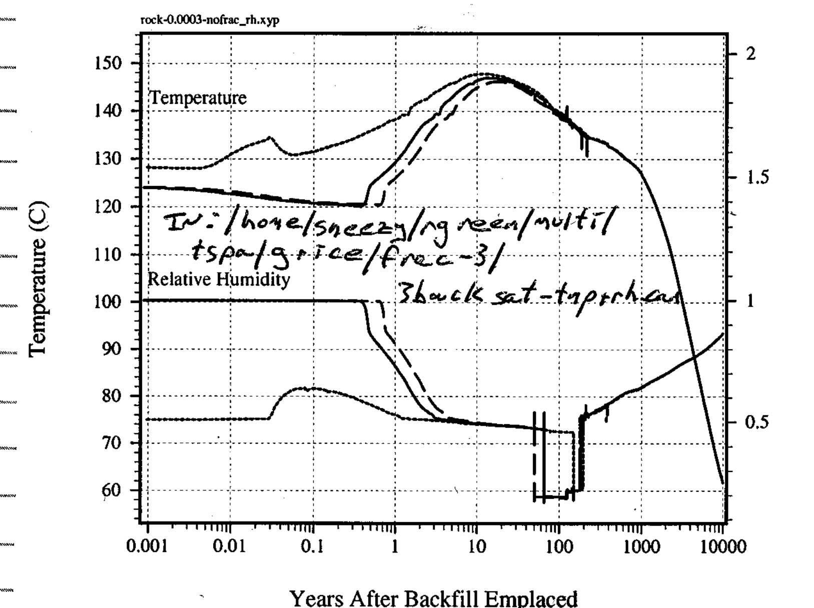


ML 9-13-96

9-18-96
ML

Effects of Initial Saturation of Backfill (83 kW/Ac)

ML 9-18-96

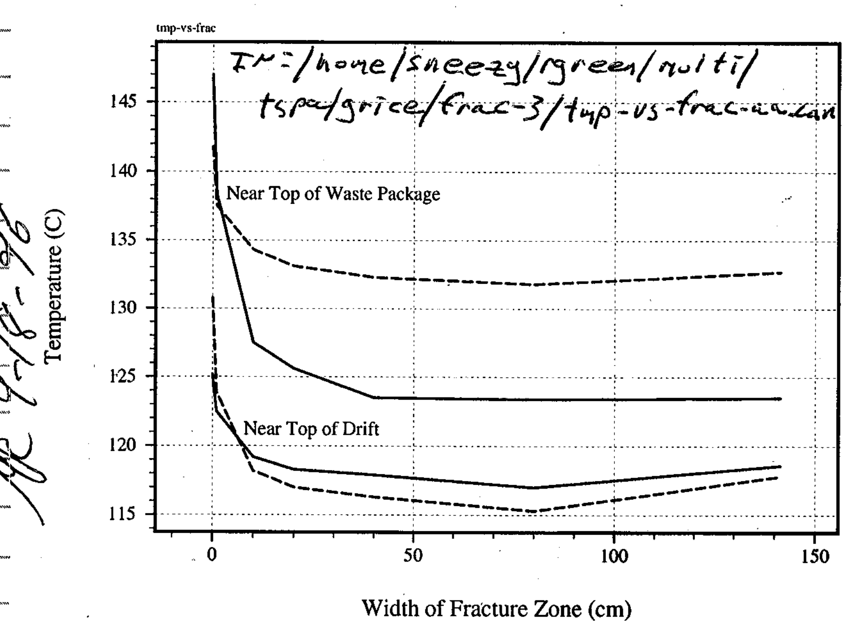


ML 9-18-96

Peak Temperature at 83 kW/Ac

ML 9-18-96

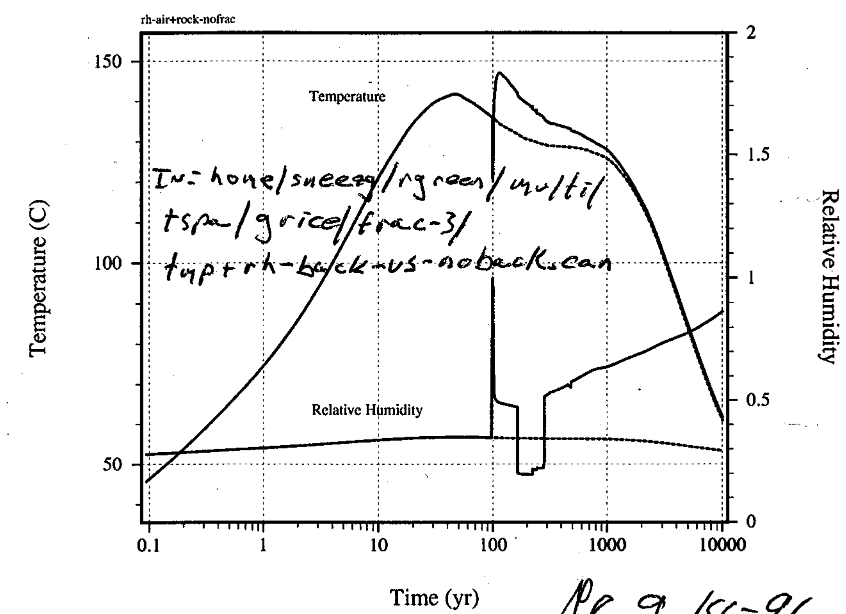
ML 9-18-96



9-18-96
AR

AR 9-18-96

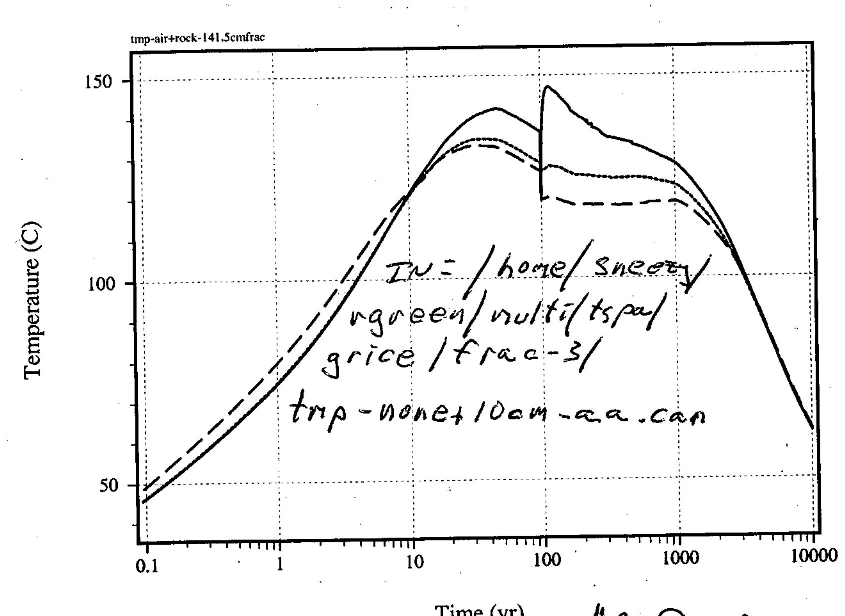
Effects of Backfill on Temperature and Relative Humidity (83 kW/Ac)



AR 9-18-96

AR 9-18-96

Effect of Fracture Zone on Temperature (83 kW/Ac)



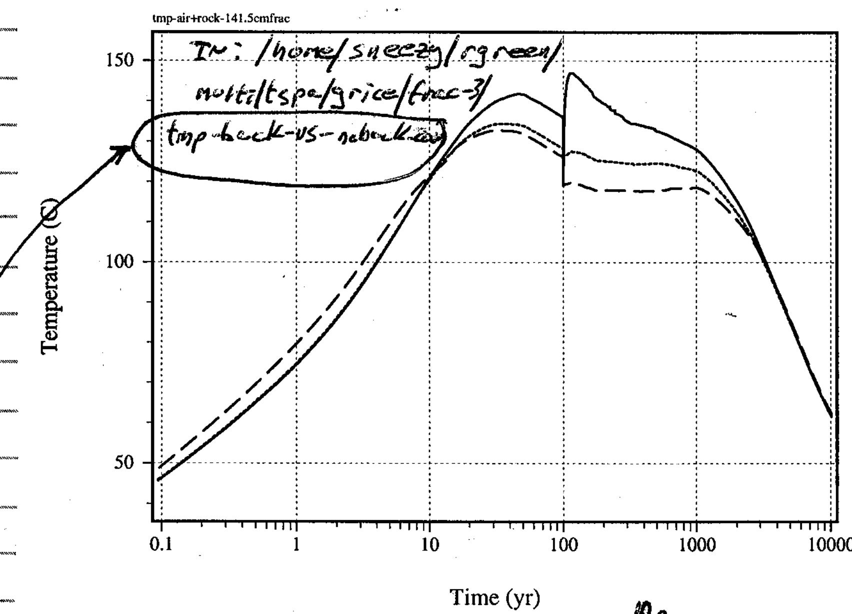
AR 9-18-96

11/7/96
AR
12-16-96

* .can LABELS SWITCHED
AR 1-2-97

AR 11-7-96

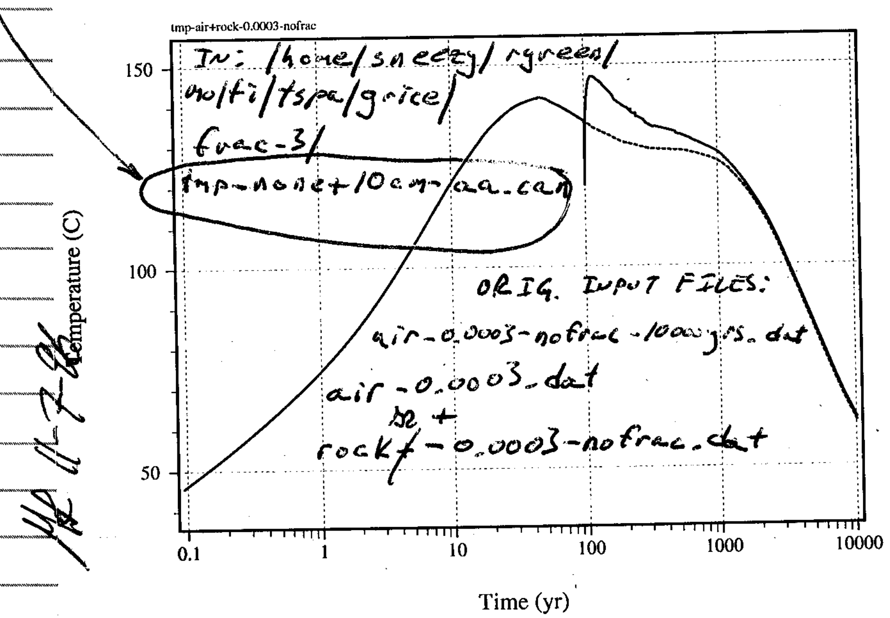
Effect of Fracture Zone on Temperature (83 MTU/acre)



AR 11-7-96

AR 11-7-96

Effect of Backfill on Temperature (83 MTU/acre)



AR 11-7-96

12-16-96

- IN:

SNEEZY/:

/home/sneezy/rgreen/multi/tspa/grice/drip/slim

run: "air-0.003.dat" → IDENTICAL TO RUNS IN:
/home.../grice/frac-3 EXCEPT

K OF AIR AROUND METAL WASTE PACKAGE — K OF AIR CHANGED FROM $1e^{-99} m^2$ TO:

$1e^{-99} m^2$ - RUNS FINE

$1e^{-0} m^2$ - STOPS RUNNING AFTER 1 TIME STEP

$1e^{-10} m^2$ - RUNS FINE

$1e^{-08} m^2$ - ERROR IN WATER/STEAM PROPERTIES
@ STEP #46, $t = 1.78 \times 10^{-3}$ YRS
ERROR @ TS = 63, $t = 2.29 \times 10^{-3}$
DONE (100 YRS) IN ~(6 MIN)
302 TS's.

NEW RUN: "halfair-0.003.dat" - IDENTICAL TO "air-0.003.dat" w/ $K = 1e^{-08} m^2$ EXCEPT ONLY HAS LEFT SIDE OF GRID - GRID IS 12X43 INSTEAD OF 24X43.

IN:
/home/sneezy/rgreen/multi/tspa/grice/drip/slim

NOTE - $t = 2.38 \times 10^{-3}$ YRS - ERROR OCCURS, TS = 58
DONE (100 YRS) IN ~11 MIN, 229 TS's

Ran halfair-0.003.dat AGAIN, THIS TIME w/ $K = 1e^{-06} m^2$
ERROR @ TS 15, $t = 4.56 \times 10^{-5}$ YR
STOPPED RUNNING AFTER $t = 1.16 \times 10^{-3}$ YR, TS = 43

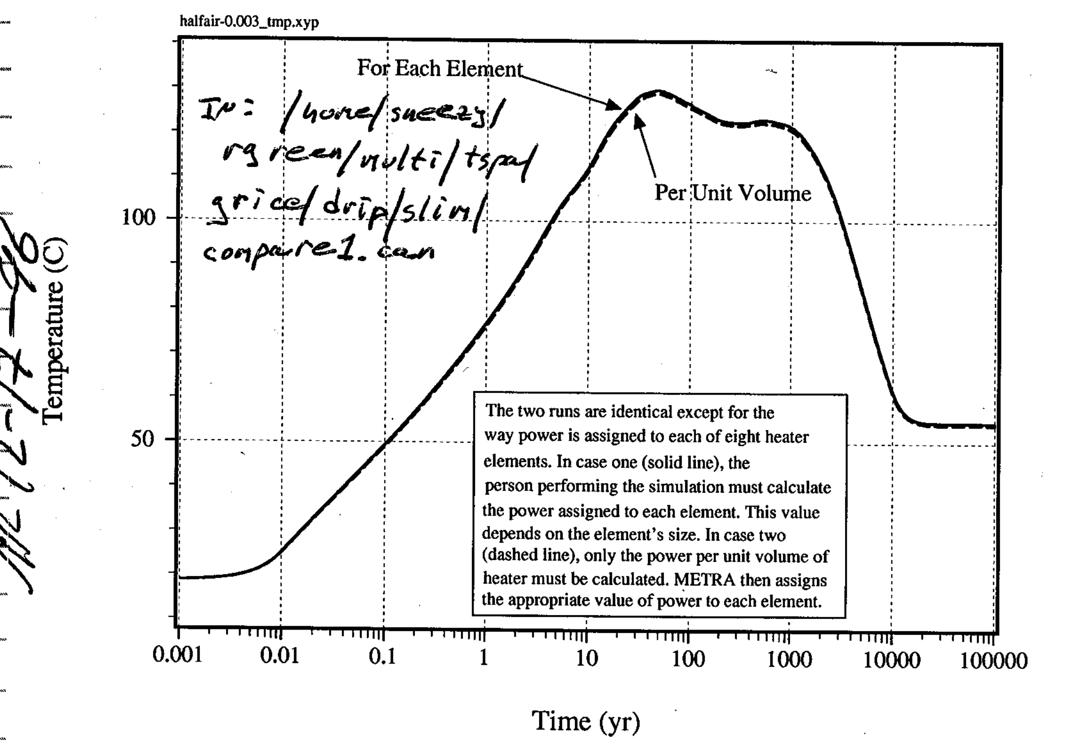
12-16-96

NEW RUN - SAME AS ABOVE w/ $K = 1.0e^{-07} m^2$.
- ERROR @ TS#'s 38 + 41, $t = 1.21 + 1.36 \times 10^{-3}$ YR
" " 80, " 2.33×10^{-3}

12-17-96

12-17-96

Compare: Specify Power For Each Heater Element vs Power per Unit Volume



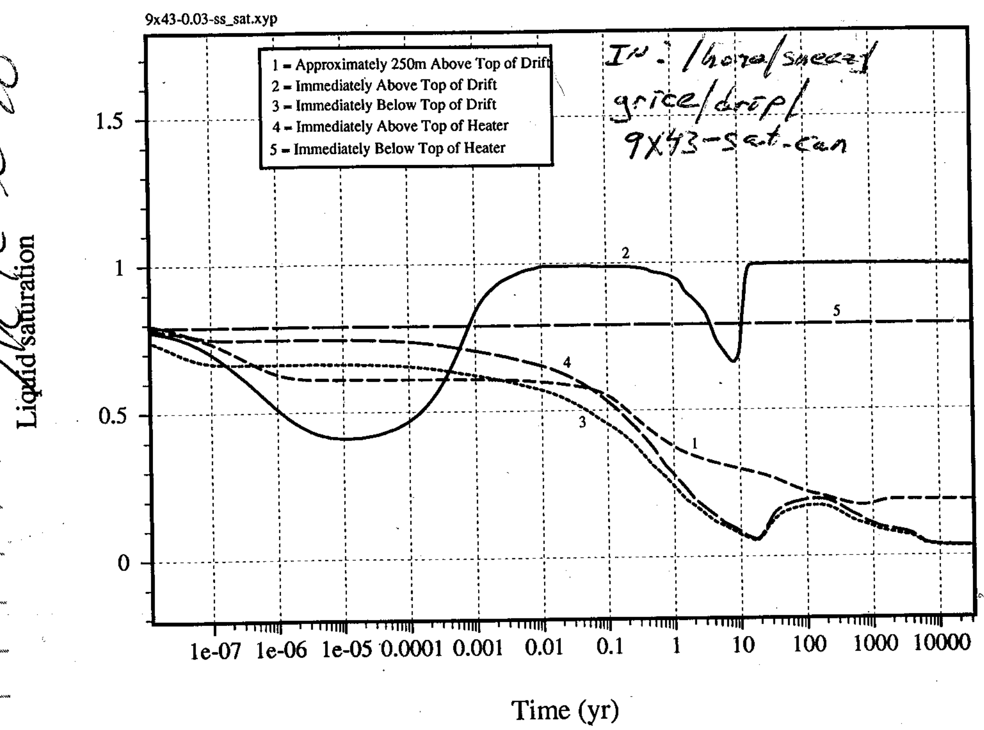
12-17-96

12-30-96

12-30-96
AR

Saturation at Steady-State (9x43)

AR 12-30-96

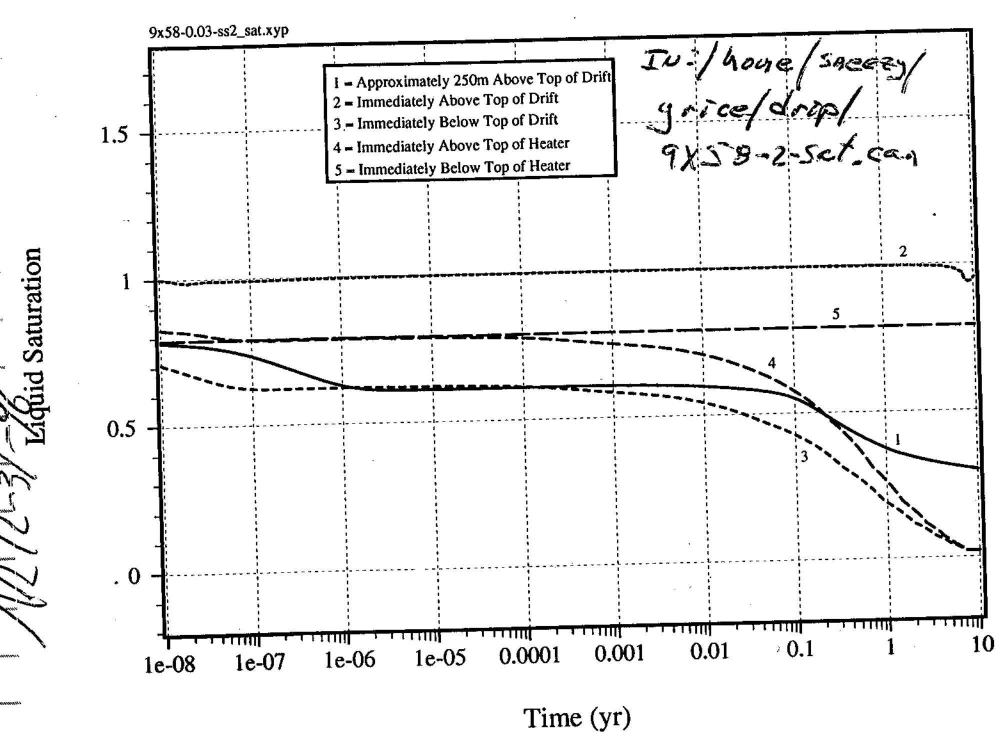


AR 12-30-96

12/31/96
AR

First Ten Years, 9x58 Grid

AR 12-31-96

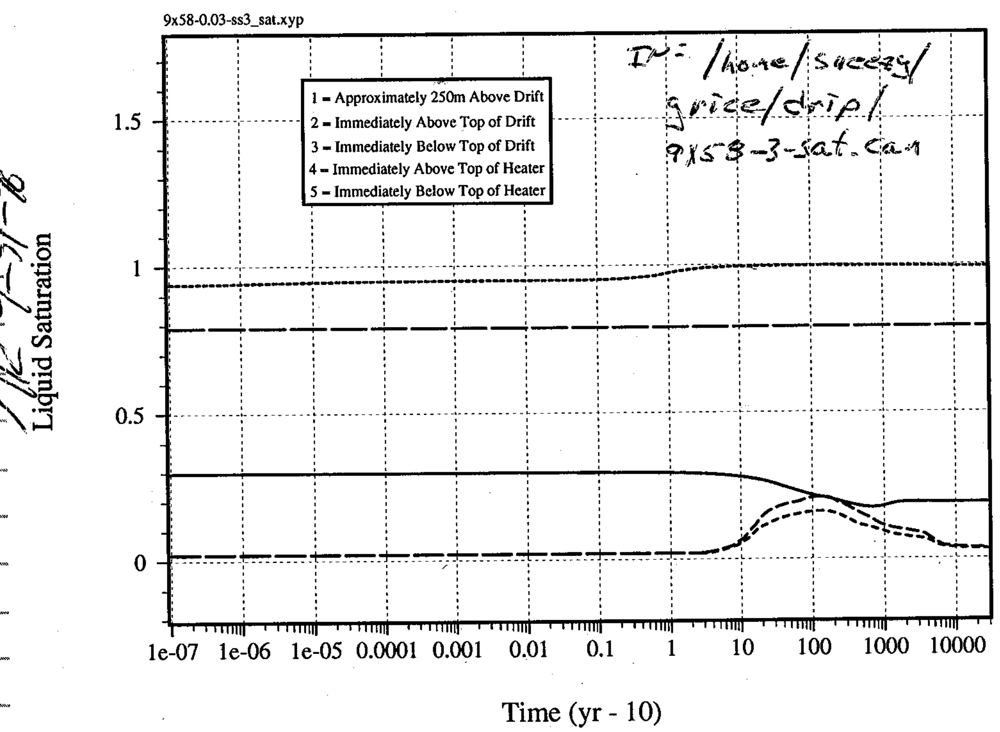


AR 12-31-96

12-31-96

9x58 Grid, Ten Years to Steady State

AR 9-31-96

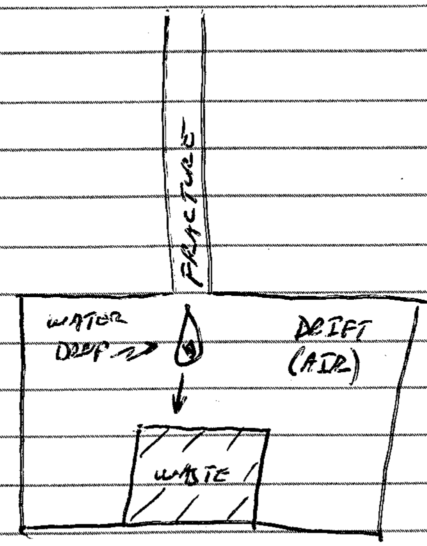


AR 9-31-96

THE THREE PRECEEDING FIGURES ILLUSTRATE THE EFFECTS OF GRIDDING. THE GRIDS ARE THE SAME EXCEPT THE 9X58 GRID CONTAINS 15 ADDITIONAL ELEMENTS BETWEEN THE TOP OF THE DRIFT AND TOP OF THE HEATER. ALTHOUGH DIFFERENCES APPEAR AT RELATIVELY EARLY TIMES (< ~20 YR), STEADY STATE CONDITIONS ARE NEARLY IDENTICAL FOR BOTH GRIDS. THE 9X58 GRID REQUIRED 2 RUNS BECAUSE OF CRASHES. A FIRST RUN TO 10 YEARS USING SMALL TIME STEPS (10^{-2} YR), THEN A SECOND RUN THAT USED THE RESULTS FROM THE FIRST AS INITIAL CONDITIONS (TIME STEP LIMIT = 10^{5} YRS).

1-17-97
MR

METRA SIMULATIONS – ATTEMPTING TO MIMIC DRIPPING FROM DRIFT CEILING, THROUGH OPEN DRIFT (AIR) – ONTO WASTE PACKAGE.



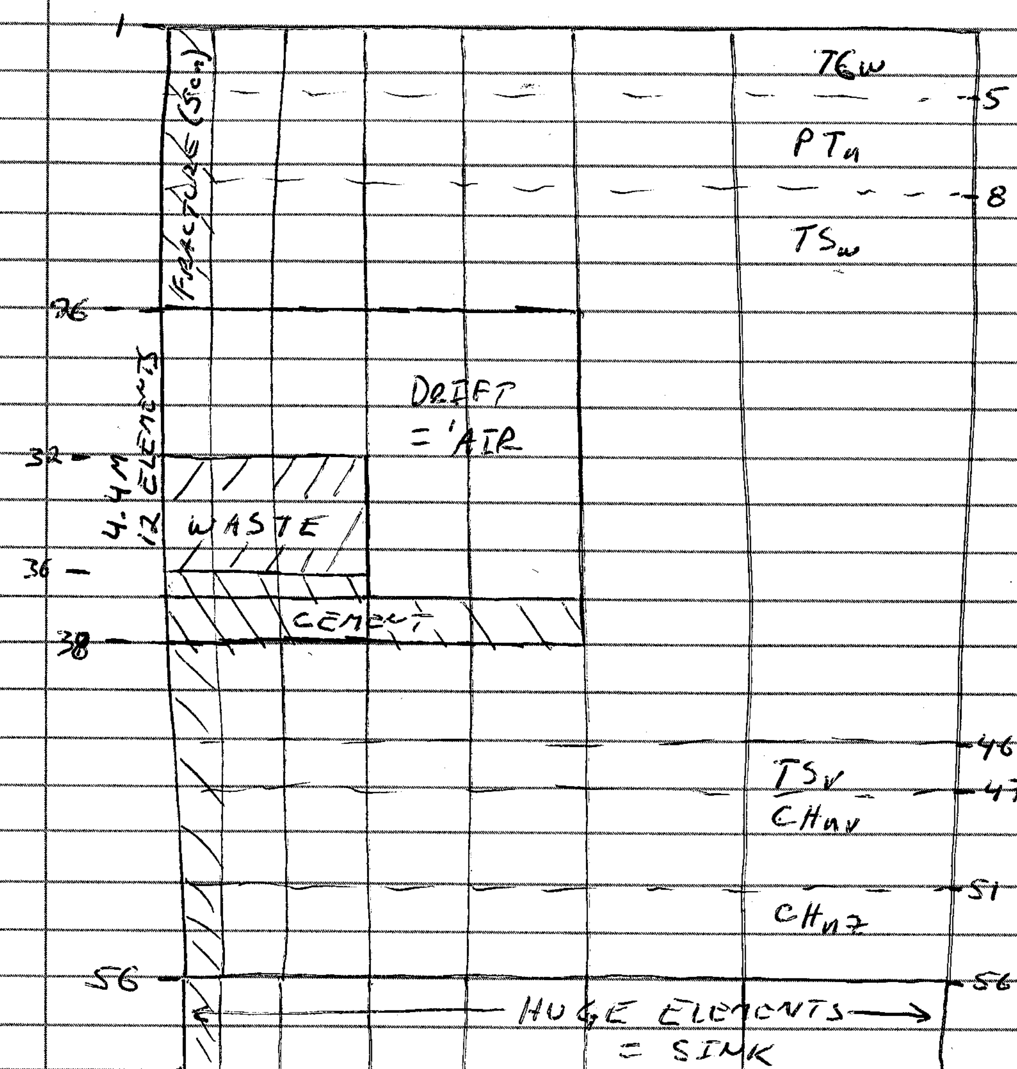
THE METRA SIMULATIONS TREAT 'AIR' AS A POROUS MEDIUM AND THE WASTE AS AN IMPERMEABLE SURFACE.

THE SIMULATIONS WILL BE CONSIDERED SUCCESSFUL IF WATER INFILTRATING THROUGH THE FRACTURE CAN BE MADE TO RAPIDLY TRAVEL THROUGH THE 'AIR' AND POND ON THE IMPERMEABLE SURFACE.

MR 1-17-97

1-17-97
MR

7 X 56 GRID



SAMPLE INPUT: "strat1a.dat" IN:
/home/sneezy/grice/drip/yucca

MR 1-17-97

(Yucca Mt.)
January 15, 1997

Purpose of simulation: attempt to mimic dripping water from drift ceiling onto waste canister.

First step: Steady-state run to get initial water distribution with focused infiltration along a discrete fracture but without presence of drift or waste packages. Done in "ss-strat1a.dat" et al.

Second step: Use output of "ss-strat1a.dat" as initial conditions for run that contains drift, heaters (not producing heat) and cement.

MR 1-17-97

SAMPLE INPUT (CONT)

1-17-97 AR

AR 1-17-97

```
:       run = "strat1a.dat": Identical to "ss-strat1.dat" except as
:                            stated above. Also, area occupied by 'air' and
:                            heaters in initial conditions file set to
:                            liquid saturations of 0.01. Residual saturations
:                            of air and heaters set to 0.001.
:
:                      Also: vapor pressure lowering turned OFF.
:
: 7x56 grid.
:
: Fractures for ECM are impermeable.
:
: Focused infiltration along fracture = 0.003m/yr.
:
: Material properties for Yucca Mountain units taken from TSPA '95.
: EXCEPT: Fractures impermeable.
:
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        7  1   56   0      1       1     0    0 .
:
Monitor 211
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
: Tiva Canyon (TCw, 0-95m)
     1  Van-Gen  0.002   0.3600     8.4e-7    0.      0.       1
                 0.040   0.7636     1.305e-5  0.087   1.8e-3   9.7e-19   1.0e-99
:
: Paintbrush (PTn, 95-148m)
     2  Van-Gen  0.100   0.8500     1.53e-6   0.      0.       1
                 0.040   0.7636     1.305e-5  0.421   1.8e-3   3.9e-14   1.0e-99
:
: Topopah Springs Welded (TSw, 148-474m)
     3  Van-Gen  0.080   0.4400     5.8e-7    0.      0.       1
                 0.040   0.7636     1.305e-5  0.139   1.8e-3   1.9e-18   1.0e-99
```

AR 1-17-97

```
: Topopah Springs Vitric (TSv, 474-482m)
    4  Van-Gen  0.080  0.4438    5.8e-7     0.      0.       1
                0.040  0.7636    1.305e-5   0.065   1.8e-3   1.9e-18   1.0e-99
:
: Calico Hills Vitric (CHnv, 482-563m)
    5  Van-Gen  0.041  0.7400    1.63e-6    0.      0.       1
                0.040  0.7636    1.305e-5   0.331   1.8e-3   2.7e-14   1.0e-99
:
: Calico Hills Zeolitic (CHnz, 563-684m)
    6  Van-Gen  0.110  0.3800    3.13e-7    0.      0.       1
                0.040  0.7636    1.305e-5   0.306   1.8e-3   2.0e-18   1.0e-99
:
: Fracture Zone (0-341.8m, 1/2 of 10cm wide fracture)
   Identical to TSw except matrix permeability increased by factor of 1.0e+10
    7  Van-Gen  0.080  0.4400    5.8e-7     0.      0.       1
                0.040  0.7636    1.305e-5   0.139   1.8e-3   1.9e-08   1.0e-99
:
: 'Air' Zone (Drift, 341.8-346.2m)
   Identical to TSw except matrix permeability set to 1.0e-8, matrix porosity
   set to 0.999, and residual sats set to 0.001
    8  Van-Gen  0.001  0.4400    1.0e-9     0.      0.       1
                0.001  0.7636    1.305e-5   0.999   1.8e-3   1.0e-8    1.0e-9
:
: Impermeable Zone (Heaters/Wasre Packages, 343.2-344.8m)
:   Identical to TSw except pososity and permeability set to 1.0e-99 and
:   residual sats set to 0.001
    9  Van-Gen  0.001  0.4400    5.8e-7     0.      0.       1
                0.001  0.7636    1.305e-5   1.0e-99 1.0e-99  1.0e-99   1.0e-99
:
: Cement pedestal and floor (344.8-346.2m)
: Properties taken from NUREG/CR-6348 (Thermally driven moist..., Slurry C3)
   10  Van-Gen  0.05   0.272     6.36e-7    0.      0.       1
                0.05   0.272     6.36e-7    5.0e-01 1.8e-03  2.1e-18   1.0e-99
0          :blank line
:
Debug  1
```

AR 1-17-97

SAMPLE INPUT (CONT) "strat1a.dat"

AR 1/17/97

1-17-97 AR

```
0
Thermal-prop
: no rho        cpr    ckdry  cksat    crp  crt   tau  cdiff    cexp  enbd
 TCw
  1  2.580e+03 728.0   1.69   1.69     0    0    .5  2.13e-5  1.8  1.
 PTn
  2  2.580e+03 422.0   0.61   0.61     0    0    .5  2.13e-5  1.8  1.
 TSw
  3  2.580e+03 840.0   2.10   2.10     0    0    .5  2.13e-5  1.8  1.
 TSv
  4  2.580e+03 948.0   1.28   1.28     0    0    .5  2.13e-5  1.8  1.
 CHnv
  5  2.580e+03 488.0   0.84   0.84     0    0    .5  2.13e-5  1.8  1.
 CHnz
  6  2.580e+03 526.0   1.42   1.42     0    0    .5  2.13e-5  1.8  1.
 Fracture Zone (Thermal properties assumed = TSw)
  7  2.580e+03 840.0   2.10   2.10     0    0    .5  2.13e-5  1.8  1.
: 'Air' (Drift, rho & cpr from CRC, other properties assumed)
  8  1.200e+00  57.4   10.0   10.0     0    0    .5  2.13e-5  1.8  1.
: Impermeable Zone (Waste, rho, cpr, ck* from Manteufel, 3-96)
  9  7.800e+03 450.0   50.0   50.0     0    0    .5  2.13e-5  1.8  1.
: Cement, properties taken from NUREG/CR-6348 (Thermally driven moist...
: cement slurry C3, cpr assumed same as TSw)
```

AR 1-17-97

```
  10 1.600e+03 840.0   0.502  1.021    0    0    .5  2.13e-5  1.8  1.
0
:    igrid   rw      re
DXYZ  0
: (dx(i),i=1,nx)
0.05 0.25 0.5 0.415 1.0 1.785 7.0
: (dy(j),j=1,ny)
1.0
: (dz(k),k=1,nz)
19.0 19.0 19.0 19.0 19.0 17.67 17.67 17.66 20.0 20.0
20.0 20.0 20.0 20.0 20.0 20.0 10.0 10.0 10.0 2.0
1.0 0.3 0.3 0.1 0.1 0.1 0.1 0.5 0.5 0.1
0.1 0.1 0.1 0.4 1.0 0.5 0.9 2.8 5.0 20.0
20.0 20.0 20.0 20.0 20.0 8.0 20.0 20.0 20.0 21.0
20.0 20.0 20.0 20.0 20.0 21.0
PhiK
: i1 i2 j1 j2 k1 k2 iist ithrm vb  por permx permy  permz  pormm permm
: TCw
   1  7  1  1  1  5   1   1   0.
: PTn
   1  7  1  1  6  8   2   2   0.
: TSw
   1  7  1  1  9 45   3   3   0.
: TSv
   1  7  1  1 46 46   4   4   0.
: CHnv
   1  7  1  1 47 50   5   5   0.
: CHnz
   1  7  1  1 51 56   6   6   0.
: Fracture
   1  1  1  1  1 56   7   7   0.
: 'AIR'
   1  5  1  1 26 37   8   8   0.
: Impermeable Zone
   1  3  1  1 32 35   9   9   0.
: Cement (pedestal)
   1  3  1  1 36 36  10  10   0.
: Cement (floor)
   1  5  1  1 37 37  10  10   0.
: CHnz, Huge Volume
   1  7  1  1 56 56   6   6   1.0e8
: Fracture, Huge Volume
   1  1  1  1 56 56   7   7   1.0e8
0
Init ssa
:
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+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-8 1.e+5
```

AR 1-17-97

SAMPLE INPUT (CONCLUDED)

1-17-97 ML

ML 1-17-97

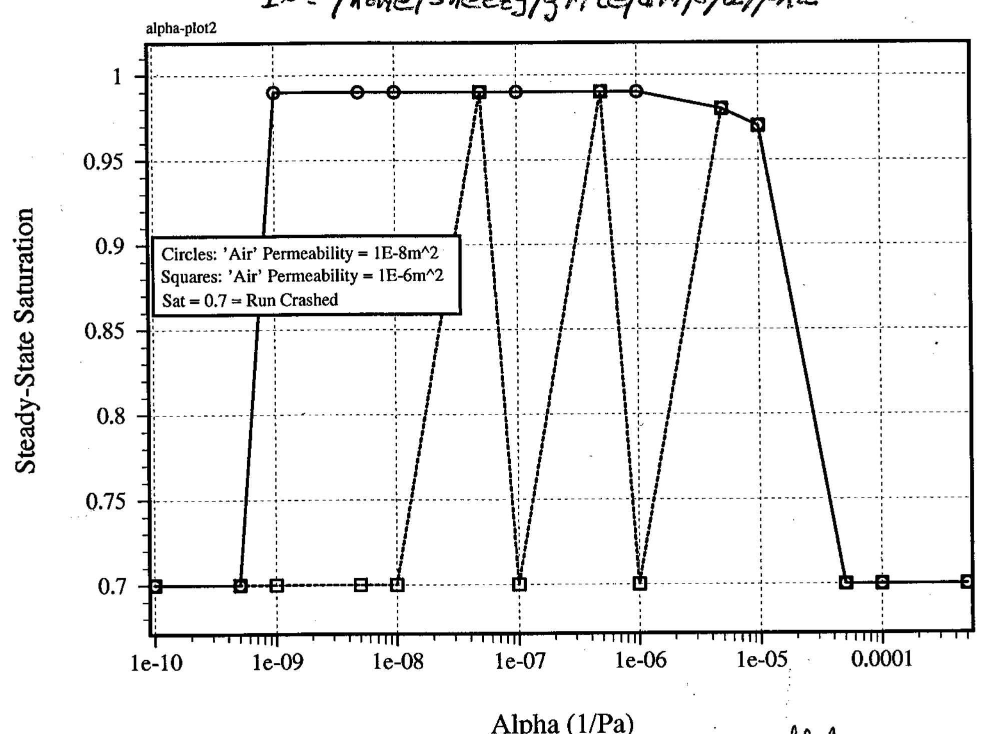
```
: SKIP
:
: Note, scalh = 0.0208==> ~83kW/ac initial APD.
:       For a heater with dimensions 0.8mx1.6mx1m heating
:       a 11mx1m area, this equals ~ 176 W/m^3.
:       ns    scalh     scalm    fn
Source   7    0.0208    1.000    ssa
:
:NOSKIP
:
:       print all at every target time
PLOTS 1 2 169, 211
:       target  dt    dpmx    dsmx    dp2mx    dtmpmx
rstart 1 0
Time[y] 1
Time[y] 10
Time[y] 100
Time[y] 1000
Time[y] 10000
:
SKIP
:
rstart 1 0
:            dPRES dSAT  dTMP
Steady[y]    1.e+1 1.e-5 1.e-4
NOSKIP
Ends
```

ML 1-17-97

ML 1-17-97

Sensitivity of METRA to van Genuchten Alpha

IN: /home/sneezy/grice/drip/alpha



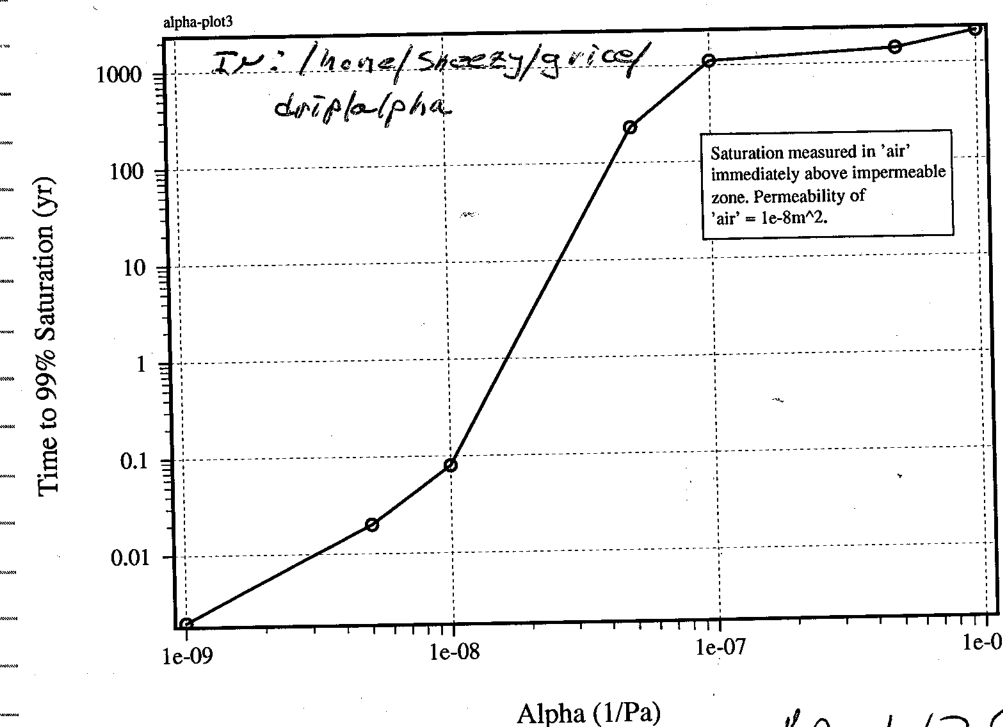
ML 1-17-97

1-17-97 ML

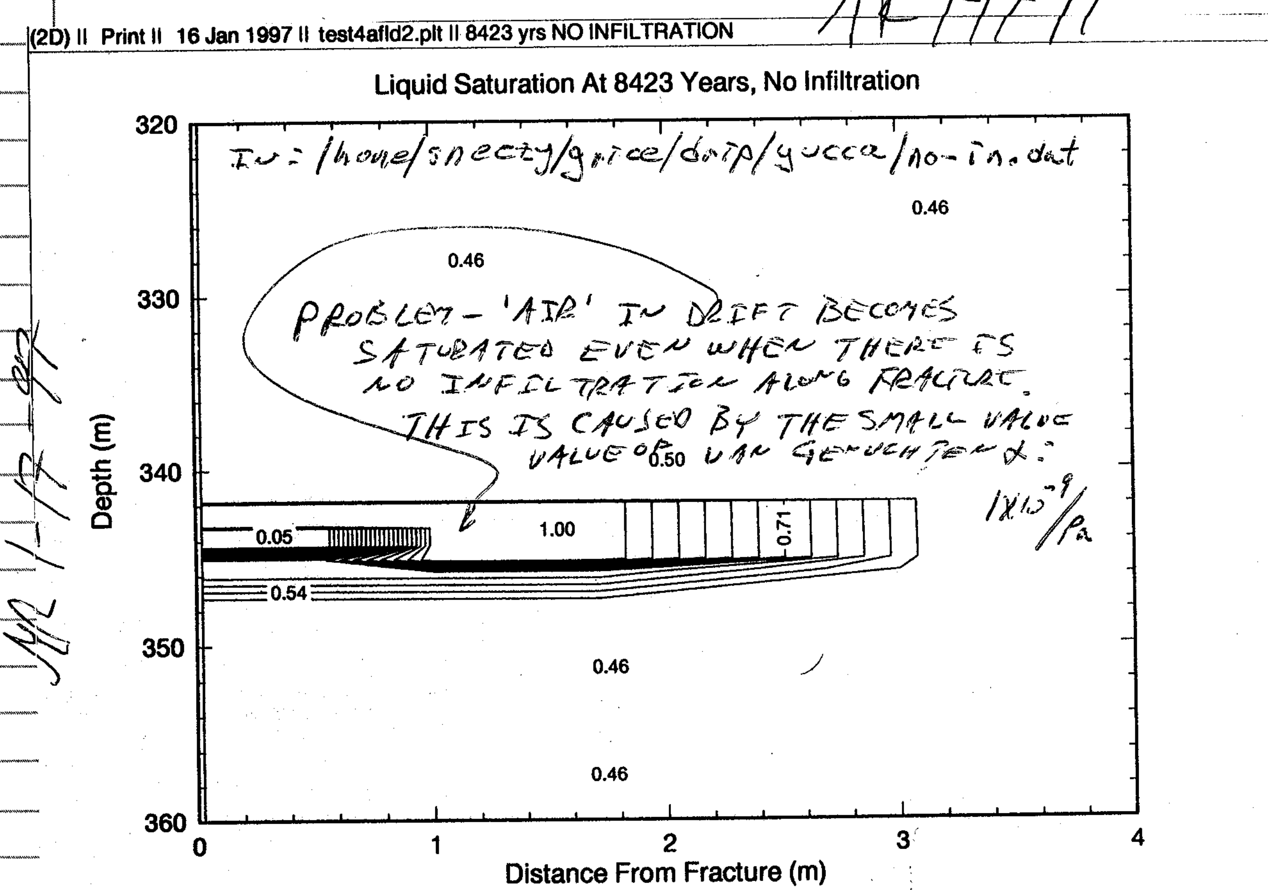
ML 1-17-97

ML 1-17-97

Sensitivity of METRA to van Genuchten Alpha



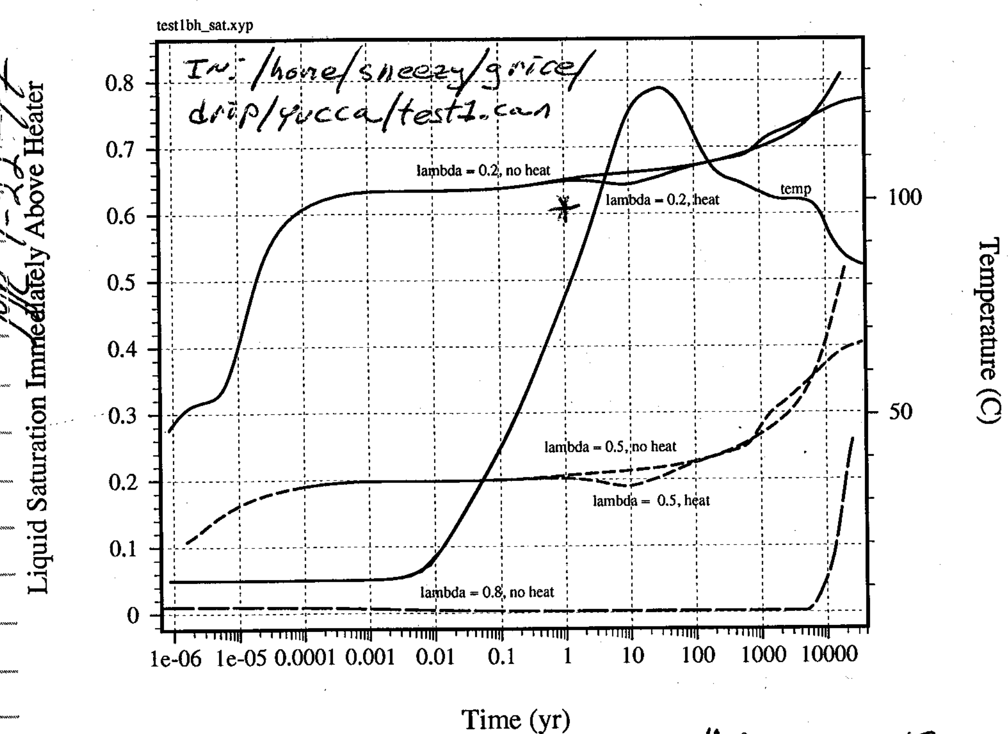
ML 1-17-97



1-22-97
MR

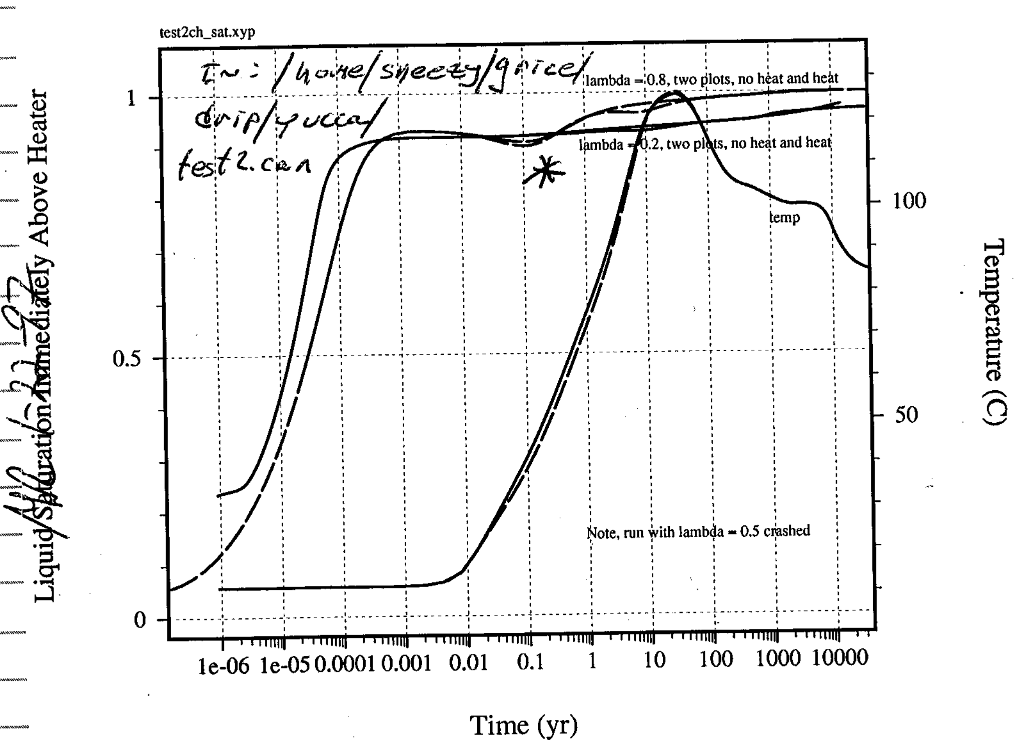
NOTE: THE FOLLOWING 3 FIGURES ILLUSTRATE THE EFFECTS OF THE VAN GENUCHTEN PARAMETERS ON METRA RESULTS.

van Genuchten Alpha = 1E-6



MR 1-22-97

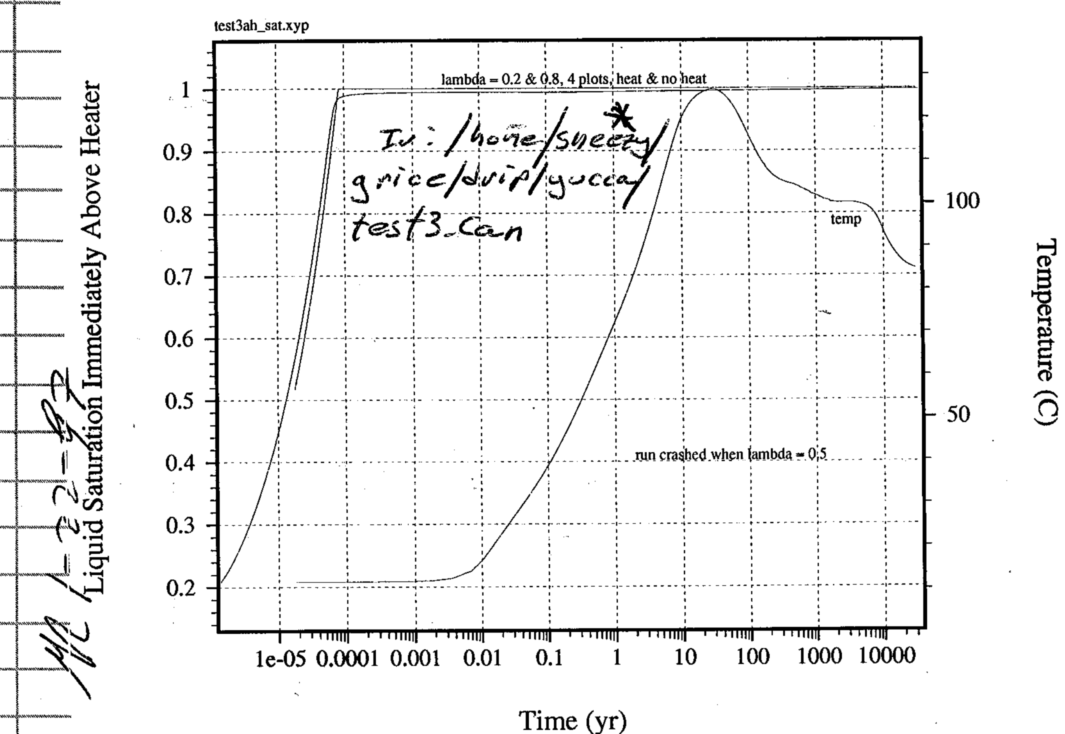
van Genuchten Alpha = 1E-7



1-22-97
MR

van Genuchten Alpha = 1E-8

MR 1-22-97



* PROBLEM WITH RUNS: MATERIAL DOES NOT DE-SATURATE AS TEMPERATURE RISES ABOVE 100°C. PRESSURE BUILDS UP - HOW TO RELIEVE PRESSURE SO MATERIAL WILL DRY AS WATER TEMP EXCEEDS 100°C?

1-23-97 RUNNING OLDER GRIDS/METRA TO SEE IF THEY CAN MIMIC DRIPPING -

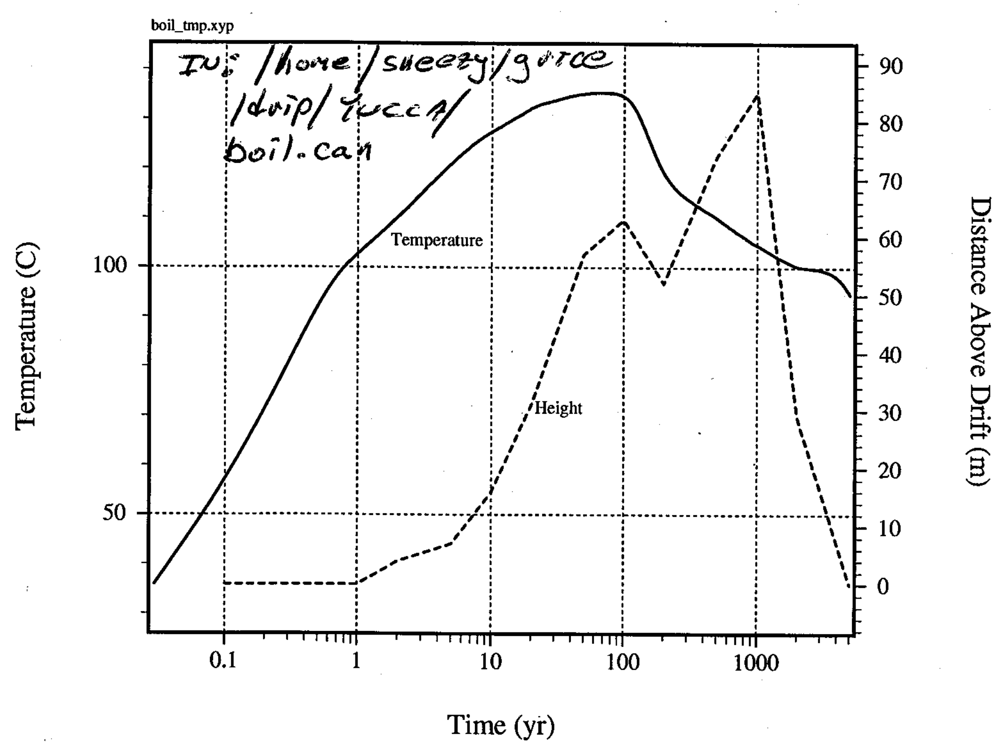
"air-0.0003-nofrac-10000yrs" et al.

MR 2-10-97

2-10-97
MR

MR 2-10-97

Temperature At Heater and Height of Boiling Isotherm Above Drift



MR 2-10-97

QUESTION - HOW MUCH WATER MIGHT BE AVAILABLE TO FLOW THROUGH FRACTURES.

1 mm/yr INFILTRATION

$\frac{1\,mm}{yr}$ HECTR $= \frac{10^{-3}M\ 10^4 M^2}{yr} = 10\,m^3/yr \rightarrow 10^4\,kg/yr$

$1\,m^3$ TSw: POROSITY RESIDUAL SAT SATURATION

$1\,m^3\,(n - r)\,0.9$

$\longrightarrow 1\,m^3\,(0.14-0.08)\,0.9$

TSw

$= 5.4 \times 10^{-2}\,m^3 \rightarrow 54\,kg$ WATER

2-17-97
MR

TWO METHODS OF ANALYZING ~~FILM~~ FLOW ALONG A FRACTURE AS INFLUENCED BY HEAT RESULTING IN CONDENSATION OR EVAPORATION. MR 2-17-97

MR 2-17-97

Information potentially subject to copyright protection was redacted from this location. The redacted material is from the following reference:
Mills, A.F. "Basic Heat and Mass Transfer." Figure 7.2. 1995.

The Fluid Dynamics Problem

MR 2-17-97

Information potentially subject to copyright protection was redacted from this location. The redacted material is from the following reference:
Phillips, O.M. "The Infiltration of a Liquid Finger Down a Fracture into Superheated Rock." Paper. 1994.

MR 2-17-97

2-17-97
MR

delta-3.nb

MR 2-17-97

Nusselt analysis - steady-state condensation of water vapor on a vertical surface:

h = 2.432 10^6
l = 1.0
g = 9.81
ρl = 958
ρv = 1.1
k = 0.681
Ts = 101
Tw = 99
νl = 3.0 10^-7
μl = nl rl

In: /home/sneezy/grice/math/delta-3.nb

MOVED TO:
/usr2/sneezy/grice/math/delta-3.nb
MR 10-6-98

□Where:

h = enthalpy of phase change [J / kg]
l = distance from top of condensate film [m]
g = gravitational constant [m / s^2]
ρl = density of liquid [kg / m^3]
ρv = density of vapor [kg / m^3]
k = thermal conductivity of fluid [W / m - C]
Ts = temperature of saturated vapor [C]
Tw = temperature of wall [C]
νl = kinematic dynamic viscosity of fluid = nl rl [kg / m - s]

```
The average heat transfer
coefficient for the wall:
```

hl = 0.943 ((h g (ρl - ρv) k^3) / (l (Ts - Tw) νl))^.25

2.432×10^6

1.

9.81

958

1.1

MR 2-17-97

0.681

101

99

$3. \times 10^{-7}$

0.0002874

```
Set::write : Tag Times in average for heat the
```

9873.22

MR 2-17-97

2-17-97

MR 2-17-97

□Rate at which vapor condenses on the wall [kg / s]:

m = (hl (Ts - Tw) 1 (1)) / h

0.00811943

□Thickness of film [m]:

d = ((4 k l (Ts - Tw) νl) / (h g (ρl - ρv)))^0.25

0.0000919845

Maximum flow velocity within film [m / s]:

MR 2-17-97

umax = g (rl - rv) d^2 / (2 μl)

0.138181

Mass flow rate per unit width of film [kg / s]:

G = d^3 g(rl - rv)/(3 nl)

0.00811778

Owen Phillips' 2-D solution for depth water will penetrate beneath the boiling isotherm:

ρl = 958
q = 8.1 10^-6
h = 2.432 10^6
km = 2.1
β = 1.0
c = 840
ρm = 2580
κm = km / (ρm c)

q = Steady volumetric flow rate per unit width of water flowing beyond the boiling isotherm [m^3 / m - s]
km = thermal conductivity of rock matrix [W /m - C]
β = thermal gradient in vicinity of boiling isotherm [C / m]
c = specific heat of rock matrix [J / kg - C]
ρm = density of rock matrix [kg / m^3]
κm = thermal diffusivity of rock matrix = km / (ρm c) [m^2 / s]
t = time after water reaches the boiling isotherm [s]

Plot[(2 / π)^0.25 + (((ρl q h) / (km β))^0.5) (κm t)^0.25, {t, 0, 1.0 10^9}]

MR 2-17-97

2-17-97
NR

NR 2-17-97

958

8.1×10^{-6}

2.432×10^{6}

2.1

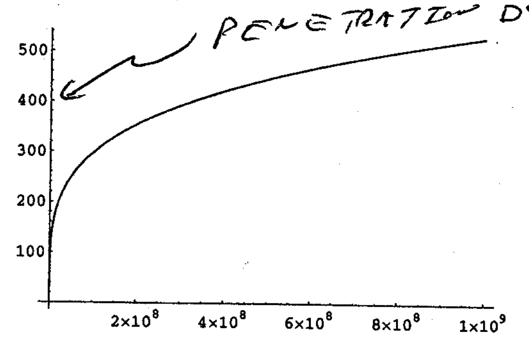
1.

840

2580

2-D ANALYSIS

9.68992×10^{-7}



- Graphics -

Owen Phillips' 2-D solution for depth water will penetrate beneath the boiling isotherm at long times with steady infiltration rate q [m^3 / m – s]:

NR 2-17-97

NR 2-17-97

```
In[3]:=
    ρl = 958
    q = 8.1 10^-6
    h = 2.432 10^6
    km = 2.1
    β = 1.0
    c = 840
    ρm = 2580
    κm = km / (ρm c)

    Plot[ 0.5 ( ( ρl q h ) / ( km β ) ),
        { q, 3.2 10^-11, 3.2 10^-7 } ]
```

Out[3]= 958

Out[4]= 8.1×10^{-6}

Out[5]= 2.432×10^{6}

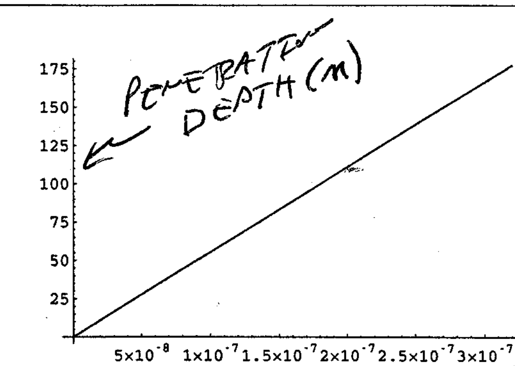
Out[6]= 2.1

Out[7]= 1.

Out[8]= 840

2-17-97
NR

NR 2-17-97



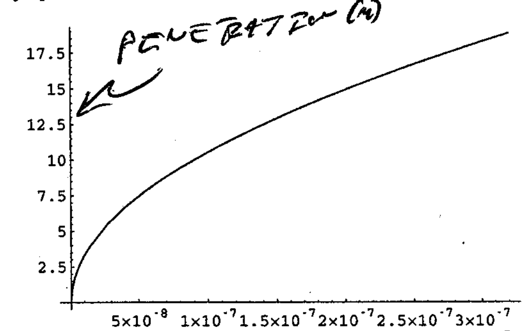
Out[11]= - Graphics -

Owen Phillips' 3-D solution for depth water will penetrate beneath the boiling isotherm at long times with steady infiltration rate Q [m^3 / s]:

```
ρl = 958
Q = 8.1 10^-6
h = 2.432 10^6
km = 2.1
β = 1.0
c = 840
ρm = 2580
κm = km / ( ρm c )

Plot[ ( ( ρl Q h ) / ( km β ) )^0.5,
    { Q, 3.2 10^-11, 3.2 10^-7 } ]
```

NR 2-17-97

Out[19]= 9.68992×10^{-7}



Out[20]= - Graphics -

NR 2-17-97

2-24-97
MR 3-5-97 - NEW VERSION OF METRA - METRA12 - SEEMS TO CRASH RATHER EASILY - "STRAT2.dat" IN home/sneezy/drip/yucca, CRASHED @ STEP #76 WITH MESSAGE: FLOATING POINT EXCEPTION 64 OCCURRED AT ADDRESS 74a4c.

- SPOKE W/ MOHAN SETH - HE SUGGESTED I TRY NEW VERSION OF METRA - (METRA13) - SIMULATIONS STILL CRASH.

- NOTE, METRA SEEMS TO RUN BETTER WHEN THE PERMEABILITY OF THE FRACTURE + DRIFT ARE RELATIVELY LOW ($10^{-10} m^2$ VS $10^{-7} m^2$)

I have reviewed this scientific notebook and find it in compliance with QAP-001
3-5-97

3-13-97
MR

THE MATERIAL OF THE NEXT FEW PAGES REPRESENTS A SOLUTION TO THE CONDUCTION PORTION OF THE ANALYTICAL CONDUCTION-CONDENSATION PROBLEM. OTHER SOLUTIONS, SUCH AS LINE OR CYLINDRICAL SOURCES ARE POSSIBLE AND MAY BE USED IN THE FUTURE.
MR 3-13-97

Information potentially subject to copyright protection was redacted from this location. The redacted material is from the following reference:
Mills, A.F. Heat Flux into Semi-Infinite Solid. "Basic Heat and Mass Transfer." 1995

IN: /home/sneezy/grice/math/mills-4.nb
MOVED TO: /usr2/sneezy/grice/math...
MR 8-18-97

MR 3-13-97

MR 3-13-97

The temperature resulting from an arbitrary transient heat source may be calculated by superposition, as demonstrated below.

```
In[1259]:= To = 0.0;
           q = 1000;
           k = 2.1;
           ρ = 2580;
           c = 840;
           α = k/(ρc);
           x = 8;

           T11[t_]:= To + q/k(((4αt)/π))^0.5 Exp[-x^2/(4αt)]
              - x Erfc[x/(4αt)^0.5]

           t01 = 1 10^5;
           T12[t_]:=
           If[t >= t01, - q/k(((4α(t - t01))/π))^0.5 Exp[-x^2/(4α(t - t01))]
              - x Erfc[x/(4α(t - t01))^0.5], 0]

           T21[t_]:=
```

3-13-97

MR 3-13-97

```
If[t >= t01,  0.5 q/k(((4 α (t - t01))/π))^0.5 Exp[-x^2/(4 α (t - t01))]
    - x Erfc[x/(4 α (t - t01))^0.5],  0]

t02 = 5 10^5;

T22[t_]:=
 If[t > t02,  - 0.5 q/k(((4 α (t - t02))/π))^0.5 Exp[-x^2/(4 α (t - t02))]
    - x Erfc[x/(4 α (t - t02))^0.5],  0]

T31[t_]:=
 If[t >= t02,  0.25 q/k(((4 α (t - t02))/π))^0.5 Exp[-x^2/(4 α (t - t02))]
    - x Erfc[x/(4 α (t - t02))^0.5],  0]

t03 = 1 10^6;

T32[t_]:=
 If[t >= t03,  - 0.25 q/k(((4 α (t - t03))/π))^0.5 Exp[-x^2/(4 α (t - t03))]
    - x Erfc[x/(4 α (t - t03))^0.5],  0]
```

MR 3-13-97

⋮ etc. ⋮

MR 3-13-97

mills-4.nb 5

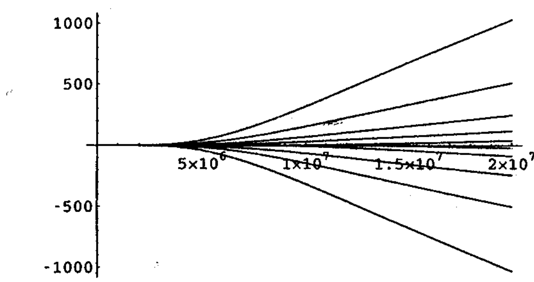
```
T61[t_]:=
 If[t >= t05,  0.03125 q/k(((4 α (t - t05))/π))^0.5 Exp[-x^2/(4 α (t - t05))]
    - x Erfc[x/(4 α (t - t05))^0.5],  0]

t06 = 5 10^7;

T62[t_]:=
 If[t >= t06,  -0.03125 q/k(((4 α (t - t06))/π))^0.5 Exp[-x^2/(4 α (t - t06))]
    - x Erfc[x/(4 α (t - t06))^0.5],  0]

Plot[{T11[t], T12[t], T21[t], T22[t], T31[t], T32[t],
T41[t], T42[t], T51[t], T52[t]},
{t, 0, 2 10^7}, PlotRange -> All]

X[t_] := T11[t] + T12[t] + T21[t] + T22[t] + T31[t] + T32[t] + T41[t] + T42[t]
       + T51[t] + T52[t] + T61[t] + T62[t]

Plot[X[t], {t, 0, 1 10^8}, PlotRange -> All]
```

MR 3-13-97

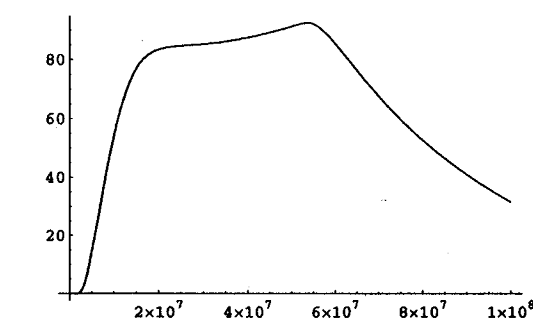
MR 3-13-97

3-13-97
MR

mills-4.nb



Out[1271]= - Graphics -



Out[1273]= - Graphics -

MR 3-13-97

3-20-97
MR

RUNNING 3-D SIMULATION IN METRA -
"half-3d.dat" - RUN FAILS WITH MESSAGE:
"bad up press in putup".

"whole-3d.dat" ALSO FAILED w/SAME MESSAGE - RUN UNTIL
TIMESTEP # 27, $t = 2.66 \times 10^{-2}$ YR.

RE-RUNNING "half-3d.dat" - WITH PRESCRIBED P&T
AT BASE OF GRID.

4-9-97
MR

3-D RUN: "half-3d-frac-ss.dat" IN:
/home/sneezy/grice/3d - TIMESTEP # 1781, $t = 1.949 \times 10^{-2}$ YR
$\Delta t = 1.69 \times 10^{-5}$ YR, CPU TIME = 2148 MIN.
- RUN KILLED - STARTED AGAIN WITH
SAME MAT BUT FRACTURE PERMEABILITY
CHANGED FROM 1.0×10^{-9} M^2 TO 1.0×10^{-12} M^2.

4-9-97
MR

CHANGE OF FRACTURE PERMEABILITY APPEARS TO MAKE LARGE DIFFERENCE FOR "half-3d-frac-ss.dat"
TIMESTEP = 20, $t = 4.82 \times 10^{-2}$ YRS, $\Delta t = 1.62 \times 10^{-2}$ YRS,
CPU TIME ≈ 22 MIN.

– RE-RUN w/ INITIAL SATURATION = 95% INSTEAD OF 90%.

4-10-97
MR

KILLED 3-D RUN STARTED YESTERDAY – t = 3 YRS AFTER ~ 800 TIMESTEPS –

RESTARTED "half-3d-frac-ss.dat" WITH ECM TURNED OFF.

STARTED NEW RUN: "half-3d-frac-ss-2.dat" – IDENTICAL TO RUN IMMEDIATELY ABOVE BUT USING SOLVER # 3 INSTEAD OF # 4.

4-11-97
MR

KILLED RUN: "half ... -ss-2.dat" – IT WAS RUNNING SLIGHTLY SLOWER THAN "half...-ss.dat".
[(306 TIMESTEPS IN 480 CPU MIN → 0.148 YRS) VS
(409 TIMESTEPS IN 607 CPU MIN → 0.175 YRS)]

RESTARTED "half-3d-frac-ss-2.dat" USING BOUNDARY CONDITIONS INSTEAD OF SOURCE TERMS TO APPLY INFILTRATION. ALSO – USING SOLVER # 4 INSTEAD OF #3.

RUN KILLED AFTER 18 TIMESTEPS – APPEARS TO BE GOING NO FASTER THAN OTHER RUNS –
$T = 2.66 \times 10^{-2}$ YRS, $\Delta T = 8.05 \times 10^{-3}$ YRS.

RUN "half-3d-frac-ss.dat" STILL GOING.

MR 4-14-97

4-14-97
MR

– KILLED "half-3d-frac-ss.dat" – 1848 TIMESTEPS, $t = 2.129$ YRS, $\Delta t = 2.48 \times 10^{-3}$ YRS. 3166 CPU MIN.

NEW RUN: "half-3d-frac-ss-3.dat" – IDENTICAL TO "half-3d-frac-ss.dat" EXCEPT PERMEABILITY OF FRACTURES = 1×10^{-14} m² INSTEAD OF 1×10^{-11} m² AND SOLVER # 3 USED INSTEAD OF # 4.

NEW RUN: "2d.dat" – IDENTICAL TO: "half-3d-frac-ss-3.dat" EXCEPT IS ONLY 1 ELEMENT THICK IN Y DIRECTION.

KILLED "half-3d-frac-ss-3.dat"
0.3054 YRS IN 72 TIMESTEPS, $\Delta t = 6.1 \times 10^{-5}$ YRS,
CPU TIME = 282 MIN.

IN: /home/sneezy/grice/3d

RE-RUN: "half-3d-frac-ss.dat" BUT WITH "EQUIL" OPTION INVOKED. – MOHAN SETH SAYS THIS ALLOWS RUNS TO REACH STEADY STATE FASTER.

4/15/97
MR

"half-3d-frac-ss.dat" RAN TO STEADY STATE ~ 4200 YRS
OUTPUT FROM THIS MODEL USED AS INPUT FOR:
"heat-half-3d-frac.dat".

4-16-97
MR

"heat-half-3d-frac.dat" CRASHED ON TIMESTEP 335, t = 104 YRS. MESSAGE: 'STOP: bad vp in pvtvp.f – see lfn_errs file"
MESSAGE IN *___ errs file: "... bad VAPOR PRESS IN blk m = 805"

blk 805 = PTn,

4-16-97
MR

RE-RUN "heat-half-3d-frac" AS:
"h-h-3d-f-2.dat" - WITH FOLLOWING
CHANGES:

- UPPERMOST LAYER HAS HIGH
SPECIFIC HEAT = 9e50 J/kg-K

- IN INITIAL CONDITIONS FILE -
AIR + HEATER SATURATION SET TO
0.1 %:

X	Y	Z	
1-9	1-5	21-26	= AIR
1-5	1-3	23-26	= HEATER

ALSO, MADE FRACTURE STOP AT TOP OF DRIFT AND
CONTINUE FROM BOTTOM.

IN: /home/sneezy/grice/3d

4-17-97
MR

RUN: "h-h-3d-f-2-dat" @ T = 250 C,
t = 5.867 YRS, P = 316307 PA @ TIMESTEP # 292.
RUN KILLED. NEW RUN:

"h-h-3d-f-3.dat" - IDENTICAL TO "h-h-3d-f-2.dat"
EXCEPT VAPOR PRESSURE LOWERING TURNED OFF
AND PERMEABILITY OF FRACTURE INCREASED FROM
10^{-12} m^2 TO 10^{-10} m^2.

4-21-97
MR

NEW 3-d RUN - "finer-ss-1.dat" - SAME AS
"half-3d-frac-ss.dat" BUT WITH 3 EXTRA ROWS
OF ELEMENTS NEAR ROCK-AIR INTERFACE.

KILLED: "h-h-3d-f-3.dat" @ TIMESTEP = 1004,
t = 201 YRS, ΔT = 0.308 YRS, CPU TIME = 5907 MIN.

4-23-97
MR

RUN "finer-1.dat" IS HEATED AND USES 2000 YR
OUTPUT FROM "finer-ss-1.dat" AS INITIAL
CONDITIONS (MODIFIED TO MAKE DRIFT +
HEATER DRY - WATER SAT = 0.001).
@ TIMESTEP 297, t = 47.37 YRS, Δt = 7.64×10^{-3} YRS,
CPU TIME = 1194 min. - RUN KILLED -
RE-RUN WITH 'RTWOMAX', 'RMXTOL', +
'SMXTOL' IN 'TOLR' SECTION CHANGED
FROM 10^{-25} TO DEFAULT = 10^{-7}.

NOTE IN ELEMENT 2501, T = 174.6 @
47.23 YRS. 2501 = TOP ELEMENT IN
HEATER.

ADDITIONAL CHANGE - UPPER LAYER NOW
HAS HIGH SPECIFIC HEAT: 'cpr' = 9×10^{50}.

NOTE - HEATER IN RUNS "finer-..." PLACED
INCORRECTLY - RESTARTED "finer-1.dat"
WITH CORRECT HEATER PLACEMENT.
RUN HAD GOT TO 1.0254×10^{-3} YRS IN 156 TIMESTEPS.
ΔT ~ 10^{-6} - 10^{-4}

• DISCUSSED METRA RUNS w/ MOHAN SETH. HE SAID
HE WAS UNABLE TO SPEED RUNS UP MUCH
BUT SUGGESTED I DO THE FOLLOWING:
1- IN SOLVE - SET LEVEL TO 1
2- START WITH EVEN SMALLER GRID.

SO: "finer-ss-2.dat" IS BASED ON "finer-ss-1.dat"
WITH FOLLOWING CHANGES:
GRID = 20 X 2 X 46
LEVEL IN SOLVE = 1
VARIABLES IN 'TOLR' SET TO 10^{-7} INSTEAD OF 10^{-25}
(SEE ABOVE)

4-23-97

- "finer-2.dat" USED OUTPUT FROM "finer-SS-2.dat" AS INPUT - CRASHED @ TIMESTEP #107, TIME = 2.50x10^-4 YR, Δt = 1.51x10^-5, DIVIDE BY ZERO.

RE-RUN "finer-2.dat" WITH LEVEL IN 'SOLV' SET TO 1.

4-24-97

RE-RUN OF "finer-1.dat" CRASHED @ TIMESTEP = 196
- ~~SAME MESSAGE~~ - MESSAGE = FLOATING POINT EXCEPTION BY OVERFLOW AT ADDRESS 89250.

RE-RUN "finer-2.dat" WITH LEVEL SET BACK TO 2.

4-25-96

RE-RUN OF "finer-2.dat" ALSO CRASHED. RUNNING AGAIN WITH VARIABLES IN 'TOLR' SET BACK TO 10^{-25}.

4-28-97

"finer-2.dat" @ TIMESTEP # 2043, t = 11.66 YRS, Δt = 7.01x10^-3 YRS, CPU TIME = ~~505~~ 4053 MIN. KILLED IT.

NOW IN: /usr2/sneezy/grice/3d

WILL RE-RUN "finer-1.dat" WITHOUT UPPER LAYER HAVING AN EXTREMELY LARGE SPECIFIC HEAT (10^{50}). ALSO, "level" IN 'Solve' set to 1 + VARIABLES IN 'TOLR' SET FROM 10^{-25} TO 10^{-7}.

4-28-96

TO RUN METRA ON P.C.

RUN OF METRA DOS SCREEN

C.d METRA
RUN → METRA FILENAME

4-30-96

TRYING OLDER METRA RUNS THAT WORKED WELL AS 2-D SIMULATIONS - NOW TURNED INTO 3-D SIMULATIONS.

"strat1a.dat" WITH 's1a.int' AND 'ss5.~~sfe~~ src' AS INPUT FILES. USED OUTPUT OF "ss-strat1a.dat" AS INITIAL CONDITIONS (MODIFIED LIQUID SATURATIONS OF AIR + HEATER).

WITH PERMEABILITY OF FRACTURE + AIR = 1×10^{-12} M^2 - RUN BOGS DOWN @ ~ 5×10^{-3} YRS. TIMESTEP = 634, TIME = 4.989×10^{-3} YRS, Δt = 9.2×10^{-7}, CPU TIME = 1163 MIN. RUN KILLED.

"strat2a.dat" MODIFIED - 'K' OF AIR AND FRACTURE REDUCED TO 10^{-14} M^2. 'K' OF FRACTURES INCREASED FROM 10^{-99} M^2 TO ORIGINAL VALUES. IN: /usr2/sneezy/grice/3d

ALSO - NO ECM FOR FRACTURE, AIR, AND HEATER.

NOTE - 'EQUIL' OPTION ADDED TO STEADY-STATE RUN FOR: "3d-air-2-ss.dat" - THIS IS A MODIFIED VERSION OF "air-2-ss.dat" - SEE PAGE 177.

NOTE - "strat1a.dat" @ 2.79×10^{-2} YRS @ TIMESTEP = 412 - RE-RUN WITH VAPOR PRESSURE LOWERING TURNED ON.

THIS CAUSED RUN TO CRASH IMMEDIATELY - "DIVISION BY ZERO" = MESSAGE ON SCREEN.

5-1-97
MR

INPUT: "3d-air-4.dat" et al.

IN: /usr2/sneezy/grice/3d

5-1-97
MR

```
Steady State (initial data : 2D, Yucca Mt.)
April 30, 1997
:
: 3-D simulation made from "air-2-ss.dat" - Cut along symmetry line
: between heaters. Change from 24x43 to 12x2x43.
:
: transient simulation uses output from "3d-air-3-ss.dat" et al as
: initial conditions. Modified so that saturation of 'air' and heater
: = 0.001.
:
: 10cm fracture zone next to waste. Infiltration focused at fracture.
: Thermal conductivities of all materials are constants per TSPA 95
:Power Decay curve from R, Manteufel, 4/25/96.
: set upper element to large heat capacity
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        12  2   43   1      1       1     0    0
:
Monitor 505
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
: Near Zero in Init.
     8  Van-Gen   0.0001  .4400      5.8e-7    0.       0.  1
                  0.0001   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 S
: Near Zero in Init.
     9  Van-Gen   0.0001  .4400      5.8e-7    0.       0.  1
               0.0001    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
0             :blank line
```

MR 5-1-97

MR 5-1-97

MR 5-1-97

```
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.
:10 =Air Around Metal Waste Package, rho & cpr from CRC, other Properties Assume
 10  1.200e-00 57.4   10.0    10.0      0     0      0.0  2.13e-0  1.8  1.
0
:      igrid    rw       re
```

MR 5-1-97

INPUT: "3d-air-4.dat" (CONT) MR 5-1-97

```
DXYZ   2
: (dx(i),i=1,nx)
0.4 0.4 0.1 0.5 0.815 0.785 1.33 1.33 1.33 1.33
1.33 1.35
: (dy(j),j=1,ny)
3.0 6.0
: (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 12  1  2  1  1   1    7   0.
    1 12  1  2  2  6   1    1   0.
    1 12  1  2  7 10   2    2   0.
    1 12  1  2 11 35   3    3   0.
    1 12  1  2 36 36   4    4   0.
    1 12  1  2 37 39   5    5   0.
    1 12  1  2 40 42   6    6   0.
    1 12  1  2 43 43   6    6   6.2832e7
:Drifts
    1  5  1  2 21 28    9  10
:Waste Packages
    1  2  1  1 23 26    8   9
:Supports (Pedestal)
    1  2  1  2 27 27    7   8
:Inverts (Floor)
    1  5  1  2 28 28    7   8
:Fracture
     3  3  1  2  1 43   10   2
:
0
Init 3-tr
:
```

MR 5-1-97

```
Output    A=1    C=1
:
:  isolv  newtnmn   newtnmx  north nitmax level
Solve 3      2         8         3     50     1
: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-7 1.e-7 1.e-7
:
:Limit dpmx    dsmx dtmpmx dp2mx dtmn dtmx icutmx
LIMIT 1.e5     .08    10.   1.e5  1.e-6 1.e5
:
: SKIP
:
Source  3   0.00333  1.000 3-tr
:
:NOSKIP
:
:          print all at every target time
PLOTS 1 1 2
459, 505
:        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
```

MR 5-1-97

5-2-97 MR – "3d-air-4.dat" KILLED – T INESTEP = 7774, t ≃ 8.08×10⁻³ yr, ΔT ≃ 1×10⁻⁶ yr

5-2-97 MR — RUNNING MODIFICATION of g-tunnel run (SEE Page 224)

"3dtest-mod.dat" IN:

/usr2/sneezy/grice/3d

5-5-97 MR — "3dtest-mod.dat" RAN TO 10^4 YRS IN 1081 TIMESTEPS, CPU TIME ≈ 23,700 s. — CONTINUING TO MODIFY TO BE MORE LIKE Y.M.

5-12-97 MR — "3dtest-mod-5" CRASHED AFTER 19,290 YRS, TIMESTEP = 1369, Δt = 51.7 YRS — MESSAGE = "FLOATING POINT EXCEPTION #8, DIVIDE BY ZERO" — 10,000 YRS @ STEP 1135, Δt = 8.1 YRS.

— KILLED "3dtest-mod-2.dat" AFTER 8639 STEPS t = 25,350 YRS, Δt = 9.2 YRS, CPU TIME ≈ 5126 [illegible]

5-19-97 MR — "3dtest-mod-6.dat" RAN SUCCESSFULLY IN ~ 0.95 DAYS — CHANGING POROSITY OF "air" FROM 0.139 (Tsw) TO 0.9 INCREASED RUN TIME TO ~ 2.5 DAYS.

NEW RUN USING MATERIAL PROPERTIES USED IN TPA CODE (SITAKANTA/NRC etc)

MR 5-19-97

"3d-tpa-1.~~6~~.dat", STEADY-STATE Run = "3d-tpa-ss.dat"

MR 5-19-97

5-19-97 MR — PROGRAM TO CALCULATE REFLUXING ABOVE + "THROUGH" A HOT ZONE / DRY-OUT ZONE

MR 5-19-97

"reflux5.f"

IN: /usr2/sneezy/grice/code

SEE REVISED CODE ON PAGE 275

MR 6-2-97

```
* NOTE:
*
*       The PROGRAM above SUBROUTINE reflux2 is included only to allow
*       variables to be passed. This is done to see if the subroutine is
*       working properly. This will be deleted when the subroutine is
*       incorporated into the main program.
*
*       Also, delete WRITE statements, and subroutine gsarea at end of this file.
*

      PROGRAM reflux
*
* April 28, 1997
*

      REAL tim(10000), Qm3PerYrinSA(10000), reflux_i(10000),
     &     reflux_d(10000), Qm3PerYRinSAatRep(10000)

      INTEGER iSA, ntim

      ntim = 3000

      tim(1) = 1.0

      Qm3PerYrinSA(1) = 1.0

      DO 10 I = 2, ntim

         tim(I) = tim(I-1) + 1

         Qm3PerYrinSA(I) = 1.0 * Qm3PerYrinSA(I-1)

10    CONTINUE

      CALL reflux2 (iSA, ntim, tim, Qm3PerYrinSA,
     &              reflux_i, reflux_d, Qm3PerYrinSAatRep)

* Write results to file

*       OPEN(12, FILE = 'reflux.out')

*       DO 20 I = 1, ntim

*          WRITE(12,*) I, Qm3PerYrinSA(I), reflux_i(I),
*     &                reflux_d(I), Qm3PerYrinSAatRep(I)

*          WRITE(12,*) I, Qm3PerYrinSA(I), reflux_i(I),
*     &                reflux_d(I), Qm3PerYrinSAatRep(I)

*20     CONTINUE

      END

*****************************************************************************
*****************************************************************************

      SUBROUTINE reflux2 (iSA, ntim, tim, Qm3PerYrinSA,
     &                    reflux_i, reflux_d, Qm3PerYrinSAatRep)

* Calculates the amount of water that refluxes to the boiling
* zone each year. The refluxing water comes from one of
* two sources: infiltration from ground surface, or vaporized water from the
* dry-out zone around the package. Reflux is expressed as a depth (volume/unit a
*

* by G. Rice, April 29, 1997, Revised May 7, 1997

*
```

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MR

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```
* Variables:
*
*       SAarea: area of subarea currently being evaluated. Passed from subroutin
*            gsarea. Units = m^2.
*       tim: array containing times for which reflux is calculated. Passed from
*            program. Units = years
*       Qm3PerYrinSA: water infiltrating from ground surface in a given year. Ca
*            by UZFLOW and passed from main. Units = m^3/yr
*       loss_i: fraction of infiltration-derived water that escapes the reflux c
*            each year. User input; range = 0.0 - 1.0.
*       reflux_i: amount of infiltration-derived water that refluxes each year.
*            Calculated below. Units = m/yr.
*       loss_d: fraction of dry-out zone-derived water that escapes the reflux c
*            each year. User input, range = 0.0 - 1.0.
*       reflux_d: amount of dry-out zone-derived water that refluxes each year.
*            Calculated below. Units = m/yr.
*       Qm3PerYrinSAatRep: total amount of water that escapes the reflux cycle
*            each year. A portion of this water may drip onto the waste and the
*            rest will be diverted elsewhere. These portions are calculated outs
*            of this subroutine.
*            Qm3PerYrinSAatREP = loss_i*reflux_i + loss_d*reflux_d.
*            Calculated below. Units = m/yr.
*
*
*
* Constants:
*
*       iSA: subarea (SA) number currently being evaluated. Passed from main.
*       SAarea: Area of subarea. Passed from main. Units = m^2.
*       ntim: number of times in ntim array. Passed from main.
*       thick: thickness of dry-out zone around waste package. User input, range
*            Range may be refined based on output of models (e.g. METRA). Units
*       porosity: porosity of rock in dry-out zone (TSw). From TSPA 95.
*       sat_init: initial saturation of dry-out zone rock (TSw). From TSPA 95.
*       sat_resid: residual saturation of dry-out zone rock (TSw). From TSPA 95.
*       boil: amount of water vaporized from dry-out zone. Calculated below. Uni
*       period: number of years required for all dry-out zone-derived water to p
*            a reflux cycle. User input, range = 1 - 1000(?).
*            Range may be refined based on output of models (e.g. METRA). Units
*

      REAL Qm3PerYrinSA(ntim), loss_i(10000), reflux_i(10000)

      REAL loss_d(10000), reflux_d(10000), Qm3PerYrinSAatRep(10000)

      REAL thick, porosity, sat_init, sat_resid, boil, period, SAarea

      INTEGER ntim, iSA
```

MR 5-19-97

```
* Subroutine that converts UZFLOW output from m^3/yr to m/yr.
*
      CALL convertUZ (iSA, ntim, Qm3PerYrinSA)
*
* Subroutine that reads input variables and constants.
*
      CALL fill (loss_i, ntim, thick, loss_d,
     &           porosity, sat_init, sat_resid, period)
*
* Subroutine that calculates yearly reflux derived from Qm3PerYrinSA (reflux_i).

      CALL infil_calc (Qm3PerYrinSA, loss_i, reflux_i, ntim)

* Subroutine that calculates amount of water vaporized from dry-out zone (boil).

      CALL rock (thick, porosity, sat_init, sat_resid, boil)

* Subroutine that calculates yearly reflux deruved from dry-out zone (reflux_d).

      CALL dryout (boil, ntim, loss_d, period, reflux_d)
*
* Calculate total amount of refluxing water that escapes the
* cycle (Qm3PerYrinSAatRep) and output yearly values.
*
```

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MR

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```
      DO 10 I = 1, ntim

        Qm3PerYrinSAatRep(I) = loss_i(I)*reflux_i(I)
     &                       + loss_d(I)*reflux_d(I)

        WRITE(6,*) I, Qm3PerYrinSA(I), reflux_i(I),
     &             reflux_d(I), Qm3PerYrinSAatRep(I)

10    CONTINUE

* Write results to file

      OPEN(12, FILE = 'reflux.out')

      DO 20 I = 1, ntim

        WRITE(12,*) I, Qm3PerYrinSA(I), reflux_i(I),
     &              reflux_d(I), Qm3PerYrinSAatRep(I)

20    CONTINUE

      RETURN
```

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```
      REAL thick, porosity, sat_init, sat_resid, boil

      boil = thick * porosity * (sat_init - sat_resid)

      RETURN

      END

*****************************************************************
*****************************************************************

      SUBROUTINE dryout (boil, ntim, loss_d, period, reflux_d)

*
* Calculate:
*
*       Rd = ( B (P-L)**(N-1) ) / P**N
*
* Where:
*
*       Rd = reflux_d
*       N = ntim
*       B = boil
*       L = loss_d
*       P = period
*
```

MR

NOTE – THIS MATERIAL IS OUT OF ORDER!

```
      REAL boil, loss_d(10000), period, reflux_d(10000)

      INTEGER ntim

      DO 10 I = 1, ntim

        reflux_d(I) = ( (-1)**(I-1) * boil * ( (loss_d(I)-period)
     &                / period)**(I-1) ) / period

10    CONTINUE

      RETURN

      END

*****************************************************************
*****************************************************************

      SUBROUTINE gsarea (iSA, SAarea)

      REAL SAarea

      INTEGER iSA

      SAarea = 100.0

      RETURN

      END
```

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MR

MR 5-19-97

```
10      CONTINUE
        RETURN
        END

**************************************************************
**************************************************************

        SUBROUTINE infil_calc (Qm3PerYrinSA, loss_i, reflux_i, ntim)

*
* Calculate:
*
*            Ri = I + I( sum(from j=1 to N-1) (1-L)**j)
*
* Where:
*
*            Ri = reflux_i
*            I = Qm3PerYrinSA
*            sum = summation
*            j = index
*            N = ntim
*            L = loss_i
*

        REAL sum(10000), Qm3PerYrinSA(ntim), loss_i(ntim)
        REAL reflux_i(ntim)
        INTEGER ntim
        reflux_i(1) = Qm3PerYrinSA(1)
        sum(1) = 1-loss_i(1)
        DO 10 I = 2, ntim-1
           sum(I) = sum(I-1) + (1-loss_i(I))**I
10      CONTINUE
        DO 20 I = 2, ntim
          reflux_i(I) = Qm3PerYrinSA(I) + sum(I-1) * Qm3PerYrinSA(I)
20      CONTINUE
        RETURN
        END

**************************************************************
**************************************************************

        SUBROUTINE rock (thick, porosity, sat_init, sat_resid, bob)

        END
```

MR 5-19-97

✱

```
**************************************************************
**************************************************************

        SUBROUTINE convertUZ (iSA, ntim, Qm3PerYrinSA)
        REAL SAarea, Qm3PerYrinSA(ntim)
        INTEGER iSA, ntim
        CALL gsarea (iSA, SAarea)
        DO 10 I=1, ntim
*          WRITE(6,*) Qm3PerYrinSA(I)
          Qm3PerYrinSA(I) = Qm3PerYrinSA(I) / SAarea
*          WRITE(6,*) SAarea, Qm3PerYrinSA(I)
10      CONTINUE
        RETURN
```

THIS + FORTRAN ON NEXT PAGE SHOULD BE WHERE ✱ IS ON PAGE 261

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```
        END

**************************************************************
**************************************************************

        SUBROUTINE fill (loss_i, ntim, thick,
     &                   loss_d, porosity, sat_init, sat_resid, period)
        REAL loss_i(ntim), loss_d(ntim),
     &                   thick, porosity, sat_init, sat_resid, period
        INTEGER ntim
        thick = 10.0
        porosity = 0.14
        sat_init = 0.9
        sat_resid = 0.0
        period = 100.0
        DO 10 I = 1, ntim
           loss_i(I) = 0.1
           loss_d(I) = 0.1
```

MR 5-19-97

5-20-97 MR — NEW 3d RUN: "3d-tpa-2.dat" – IDENTICAL TO "3d-tpa-1dat" EXCEPT FRACTURE PERMEABILITIES FROM TSPA '95 USED INSTEAD OF THOSE FROM TSPA '93.

IN: /usr2/sneezy/grice/3d

5-21-97 MR TSPA '95 BASECASE – RUNS ~ 0.95 DAYS – "3dtest-mod-6.dat" IN: /usr2/sneezy/grice/3d.

MR 5-21-97

```
  Simulation of G-Tunnel Experiment Using ECM with floor and wing heater
 Modified to become Yucca Mountain Model
:  5 May 1997
:
:
RSTART   0
:
:      XYZ                       = 1 table look-up,; pref = ref. press.
:      RADIAL                    = 0 correlations;   tref = ref temp.
:      OTHER                        ^
:                                   |
:grid  geometry  nx ny   nz ivplwr ipvtab  iout    pref tref  href
Grid   XYZ       8  6   23  0       1      3     0    0
:
Monitor 433
:
: *****************************************************************
: i = sequential number of material types
: type = the characteristic curves (Van-Gen, Linear, tabular, and corey)
: swirm = irreducible liquid saturation for the matrix
: rpmm = Van Genuchten parameter for matrix
: alpham = Van Genuchten parameter for matrix
: swext = liquid saturation below which the capillary pressure is calculated bas
:         on the slope dPcw/dSw evaluated at SWEXT.
```

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MR

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```
: sgc = residual (immobile) gas saturation, fraction
: iecm = Equivalent Continuum Model (ECM) formulation 0 do not invoke, 1 invoke
: swirf = residual liquid saturation for fracture, fraction
: alphaf = parameter in Van-Genuchten equation for fracture (1/Pa)
: phim = matrix porosity (fraction)
: phif = fracture porosity (fraction)
: permm = intinsic matrix permeability (m^2)
: permf = intrinsic fracture permeability
:
Pckr                        :relative perm and pc keyword
:   i  type-curv    swirm   rpmm(lamda) alpham      swext   sgc       iecm
:                   swirf   rpmf(lamda) alphaf      phim          phif     permm
: (TCw)
    1  Van-Gen      0.002   0.3600      8.4e-7      0.0     0.0       1
                    0.040   0.7636      1.305e-5    0.087         1.8e-3  9.7e-19
: (PTn)
    2  Van-Gen      0.100   0.8500      1.53e-6     0.0     0.0       1
                    0.040   0.7636      1.305e-5    0.421         1.8e-3  3.9e-14
: (TSw)
    3  Van-Gen      0.001   0.4400      5.8e-7      0.0     0.0       1
                    0.001   0.7636      1.305e-5    0.139         1.8e-3  1.9e-18
: (TSv)
    4  Van-Gen      0.080   0.4438      5.8e-7      0.0     0.0       1
                    0.040   0.7636      1.305e-5    0.065         1.8e-3  1.9e-18
: (CHnv)
    5  Van-Gen      0.041   0.7400      1.63e-6     0.0     0.0       1
                    0.040   0.7636      1.305e-5    0.331         1.8e-3  2.7e-14
: (CHn2)
    6  Van-Gen      0.110   0.3800      3.13e-7     0.0     0.0       1
                    0.040   0.7636      1.305e-5    0.306         1.8e-3  2.0e-18
:
: ******************
:  Backfill material
: ******************
    7  Van-Gen      0.01   0.7000     1.11e-5     0.0     0.0       1
                    0.04   0.7636     1.305e-5    0.50           1.8e-3  3.9e-14
```

MR 5-21-97

```
: *******************
: Metal Waste Package
: *******************
    8  Van-Gen      0.0001   0.4400      5.80e-7     0.0      0.0       0
:                     0.0001   0.7636      1.305e-5    0.0               0.0  0.0e-9
:
: *****
:  Air
: *****
    9  Van-Gen      0.0001   0.4400      5.80e-7     0.0      0.0       1
                    0.001    0.7636      1.305e-5    0.9      0.9       1.0e-12  1.
:
: *********
:  Fracture
: *********
   10  Van-Gen      0.080   0.4400      5.8e-7      0.0     0.0       1
                    0.040   0.7636      1.305e-5    0.139         1.8e-3  1.0e-12
:
0            :  blank line to end pckr data
:
: ***************
:  Debug options
: ***************
Debug  1
0
:
: ********************
:  Thermal properties
: ********************
: no = sequential number of data set
: rho = rock density (kg/m^3)
: cpr = rock specific heat (J/kg-K)
: ckdry = thermal conductivity of dry rock (J/s/m-K)
: cksat = thermal conductivity of liquid saturated rock (J/s/m-K)
: crp = pore compressibility with pressure at constant T (1/Pa)
: crt = absolute value of pore compressibility with pressure at constant T (1/Pa
: tau = tortuosity for binary diffusion
: cdiff = vapor-dir diffusion coefficient, (m^2/s)
: cexp = exponent for binary diffusion
: enbd = enhanced binary diffusion coefficient
:
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   0.
  2  2.580e+03 422.    0.61   0.81      0    0     .5  2.13e-5  1.8   0.
  3  2.580e+03 840.0   2.10   2.78      0    0     .5  2.13e-5  1.8   0.
  4  2.580e+03 948.    1.28   1.69      0    0     .5  2.13e-5  1.8   0.
```

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MR

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```
  5  2.580e+03 488.0   0.84   1.11     0     0    .5  2.13e-5  1.8  0.
  6  2.580e+03 526.    1.42   1.88     0     0    .5  2.13e-5  1.8  0.
  7  2.580e+03 9e+50   1.69   2.23     0     0    .5  2.13e-5  1.8  0.
:
: ******************
:  Backfill material
: ******************
:
  8  2.580e+03 840.0   0.60   0.79     0     0    .5  2.13e-5  1.8  0.
:
: ******************
: Metal Waste Package
```

MR 5-21-97

```
 9 7.800e+03 450.0    50.0  50.0      0     0    .5  2.13e-5  1.8  0.
:
: *****
:  Air
: *****
:
10 1.2         57.4    20.0  20.0      0     0    .5  2.13e-5  1.8  0.
:
: ********
: Fracture
: ********
:
11 2.580e+03 840.0    2.10  2.78      0     0    .5  2.13e-5  1.8  0.
:
0
: *****************************
:  Define size of grid-blocks
: *****************************
: igrid = grid-type (0 - block centered, 1 - point-distributed, 2 - boundary nod
: dx = block sizes in x-direction
: dy = block sizes in y-direction
: dz = block sizes in z-direction
:
:     igrid   rw      re
DXYZ   0
: (dx(i),i=1,nx)
0.4 0.4 0.4 0.5 0.515 1.0 3.0 4.785
: (dy(j),j=1,ny)
1. 1.  1.  2.  2.  2.
: (dz(k),k=1,nz)
45.0 50.0 53.0 100.0 60.0 30.0 3.785 0.715 0.7 0.4
0.4 0.4 0.4  1.415 7.785 30.0 60.0 30.0 8.0 40.0
41.0 60.0 61.0
PhiK
: i1 i2 j1 j2 k1 k2 iist ithrm vb  por permx permy  permz  pormm permm
   1  8  1  6  1  2  1    1     0.                     : TCw
   1  8  1  6  3  3  2    2     0.                     : PTn
   1  8  1  6  4 19  3    3     0.                     : TSw
   1  8  1  6 19 19  4    4     0.                     : TSv
   1  8  1  6 20 21  5    5     0.                     : CHnv
   1  8  1  6 22 23  6    6     0.                     : CHnz
:
: NOTE: Drift, Waste, & Backfill have the rock properties (iist)
:       of TSw (3) but their own thermal properties.
:
   1  5  1  6  8 15  3   10     0.                     : Drift
   1  2  1  3 10 13  3    9     0.  0.0 0.0 0.0 0.0 : Waste Package
   1  5  1  6 14 15  3    8     0.                     : Backfill/Pedestal/Floor
   1  8  1  6 23 23  6    6     1.0E8                  : Sink for water
    0
:
Init   mod5
:
:Equil  depth  pdepth   tdepth   tgrad  param iequil
:Equil   653.5   101325    20.       0.   0.    -1

Recurrent
```

MR 5-21-97

```
           Source   2   0.0624   1.
           :  is1 is2 js1 js2 ks1 ks2  istyp
                1   8   1   6   1   1    12
             0 13.05   9.52E-09
           0
           :SKIP
           :Power decay data from Randy Manteufel, 4/25/96
           :  is  js  ks  istyp
                1 2   1 3   10 13     32
             0.3156E+06  0.8469E+04
             0.9467E+07  0.8423E+04
             0.1578E+08  0.8391E+04
             0.3156E+08  0.8314E+04
```

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MR

```
0.3541E+08  0.8296E+04
0.3973E+08  0.8276E+04
0.4458E+08  0.8253E+04
0.5002E+08  0.8228E+04
0.5612E+08  0.8199E+04
0.6297E+08  0.8168E+04
0.7065E+08  0.8131E+04
0.7927E+08  0.8089E+04
0.8894E+08  0.8043E+04
0.9979E+08  0.7993E+04
0.1120E+09  0.7937E+04
0.1256E+09  0.7876E+04
0.1410E+09  0.7810E+04
0.1582E+09  0.7737E+04
0.1775E+09  0.7658E+04
0.1991E+09  0.7572E+04
0.2234E+09  0.7477E+04
0.2507E+09  0.7355E+04
0.2813E+09  0.7224E+04
0.3156E+09  0.7084E+04
0.3541E+09  0.6936E+04
0.3973E+09  0.6780E+04
0.4458E+09  0.6615E+04
0.5002E+09  0.6443E+04
0.5612E+09  0.6250E+04
0.6297E+09  0.6029E+04
0.7065E+09  0.5802E+04
0.7927E+09  0.5571E+04
0.8894E+09  0.5326E+04
0.9979E+09  0.5059E+04
0.1120E+10  0.4793E+04
0.1256E+10  0.4541E+04
0.1410E+10  0.4298E+04
0.1582E+10  0.4002E+04
0.1775E+10  0.3675E+04
0.1991E+10  0.3393E+04
0.2234E+10  0.3126E+04
0.2507E+10  0.2880E+04
0.2813E+10  0.2666E+04
0.3156E+10  0.2464E+04
0.3541E+10  0.2273E+04
0.3973E+10  0.2093E+04
0.4458E+10  0.1925E+04
0.5002E+10  0.1767E+04
0.5612E+10  0.1623E+04
0.6297E+10  0.1523E+04
0.7065E+10  0.1429E+04
0.7927E+10  0.1339E+04
0.8894E+10  0.1255E+04
0.9979E+10  0.1179E+04
0.1120E+11  0.1107E+04
0.1256E+11  0.1036E+04
0.1410E+11  0.9655E+03
0.1582E+11  0.8926E+03
0.1775E+11  0.8164E+03
0.1991E+11  0.7463E+03
0.2234E+11  0.6821E+03
0.2507E+11  0.6231E+03
0.2813E+11  0.5691E+03
0.3156E+11  0.5179E+03
0.3541E+11  0.4650E+03
0.3973E+11  0.4174E+03
0.4458E+11  0.3746E+03
0.5002E+11  0.3361E+03
0.5612E+11  0.3016E+03
0.6297E+11  0.2713E+03
0.7065E+11  0.2519E+03
0.7927E+11  0.2339E+03
0.8894E+11  0.2172E+03
0.9979E+11  0.2049E+03
0.1120E+12  0.1961E+03
0.1256E+12  0.1877E+03
0.1410E+12  0.1797E+03
0.1582E+12  0.1719E+03
0.1775E+12  0.1630E+03
0.1991E+12  0.1545E+03
0.2234E+12  0.1465E+03
0.2507E+12  0.1389E+03
0.2813E+12  0.1317E+03
0.3156E+12  0.1247E+03
0
:
:NOSKIP
:
Output   A=1  C=1
```

MR 5-21-97
MR 5-21-97
MR 5-21-97

MR 5-21-97

```
:
:  isolv  newtnmn  newtnmx
Solve 4     2        7        2
:
:AUTO-step  DPMXE    DSMXE  DTMPMXE    DP2MXe
AUTO-step   5.0E+4   0.03    5.0         1.e4
:
:TOLR TOLP  TOLS  TOLT  TOLP2  TOLM  TOLA  TOLE
Tolr   1. 5.e-4  5.e-3  1.    1.e-3 1.e-3 1.e-3  1.e-12  1.e-12   1.e-12
:
:Limit dpmx    dsmx dtmpmx dp2mx dtmn dtmx icutmx
LIMIT  1.e5    .08    10.    1.e5 1.e-9 1.e5
:
:      target  dt     dpmx    dsmx    dp2mx    dtmpmx
:
:       print all at every target time
PLOTS 1 1 2
385, 433
rstart 1 0
Time[y]  1.0E+0
Time[y]  1.0E+01
Time[y]  1.0E+02
```

MR 5-21-97

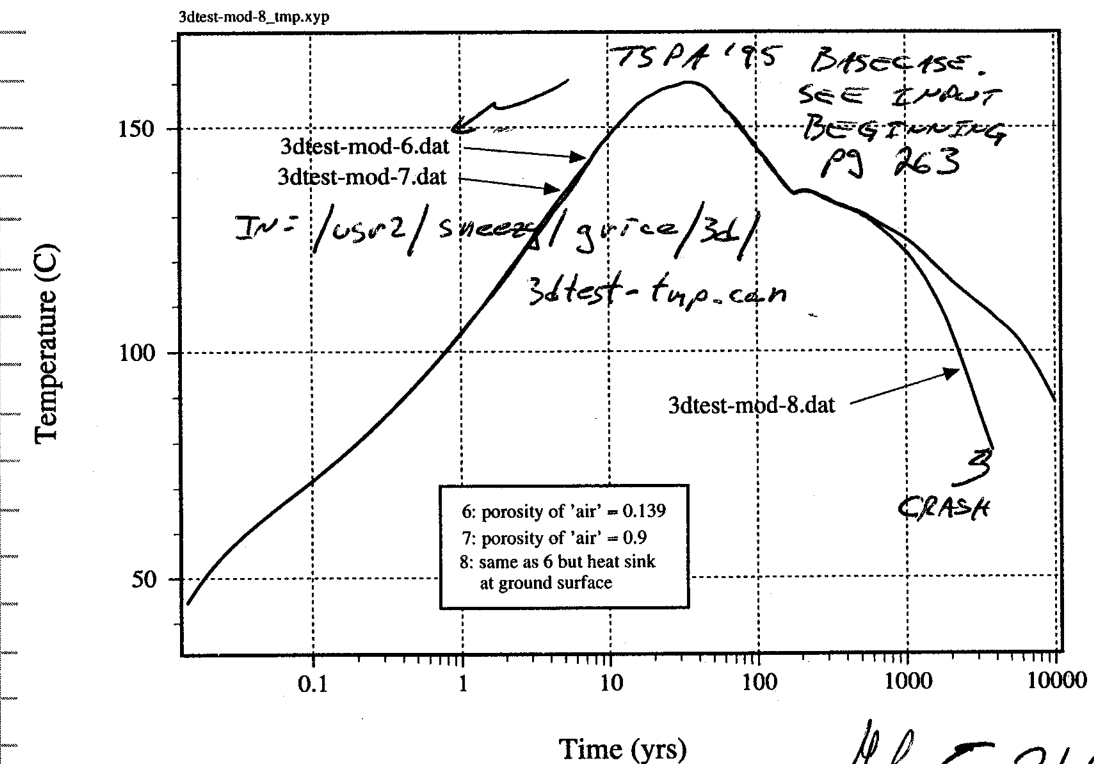
```
Time[y]  1.0E+03
Time[y]  1.0E+04
:
:rstart 1 0
:
:STEADY[y] 1.0E+01 1.0E-01 1.0E-04
Ends
```

MR 5-21-97

5-21-97
MR

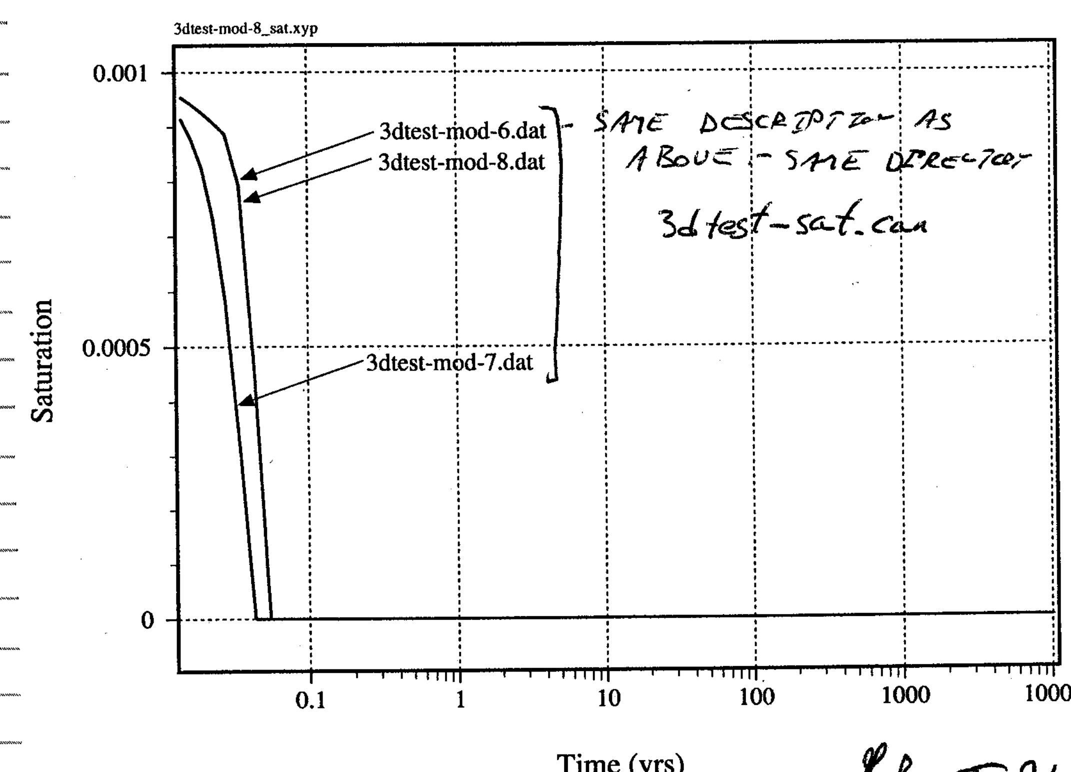
3-D METRA

MR 5-21-97



MR 5-21-97

3-D METRA



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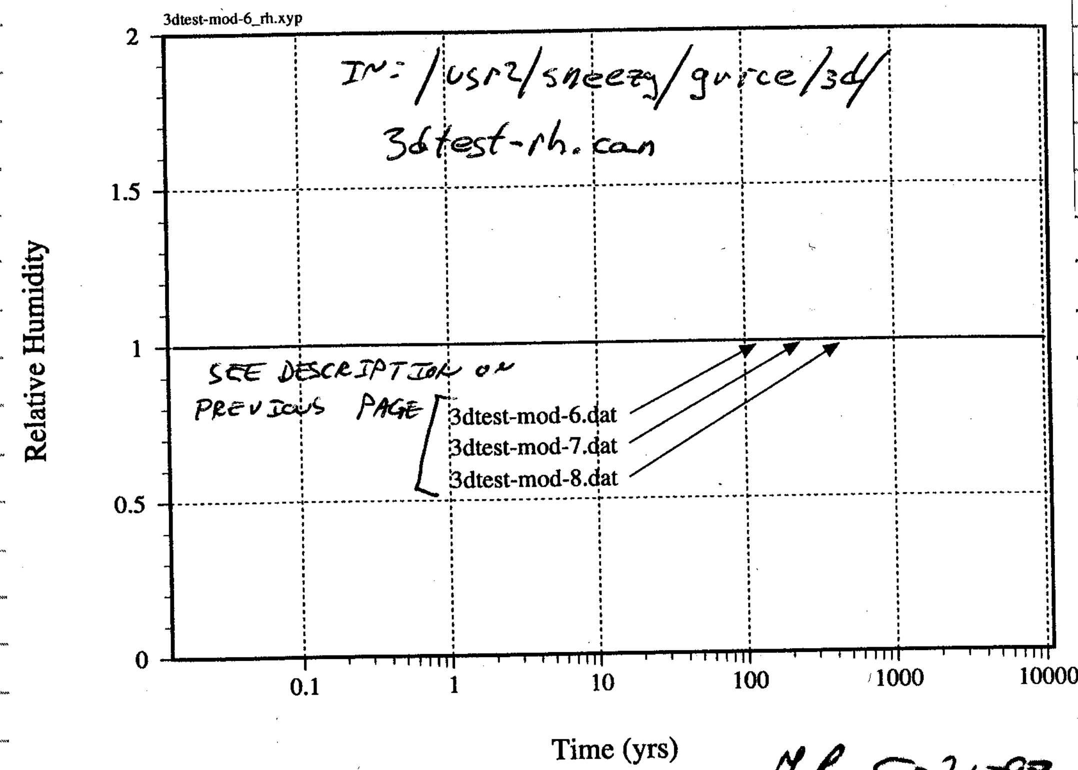
MR

3-D METRA MR 5-21-97



MR 5-21-97

5-22-97
MR

"3d-tpa-6.dat" - DONE IN 767 TIMESTEPS (t=10⁴ yrs), CPU TIME = 37,338 s. THIS RUN USES MATERIAL PROPERTIES FROM TSPA '93 EXCEPT THE FOLLOWING FROM TSPA '95:

- PERMEABILITY OF FRACTURES
- POROSITY OF FRACTURES
- THERMAL CONDUCTIVITIES OF SATURATED MATERIAL (TSPA '93 THERMAL CONDUCTIVITIES ARE CONSTANTS, FOR DRY MATERIALS).

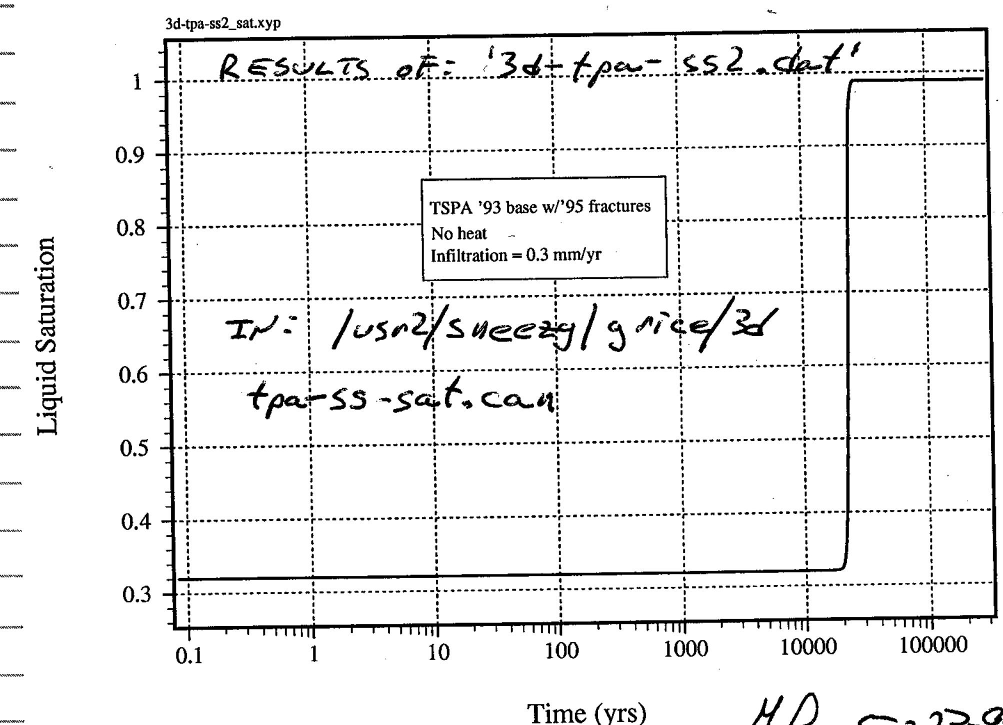
5-23-97
MR

- "3d-tpa-~~8~~7.dat" - COMPLETED 10⁴ YR SIMULATION IN 798 TIMESTEPS, 2X10⁴ YRS IN 969 TIMESTEPS, CPU TIME = 47,765 s FOR 2X10⁴ YRS. MR 5-23-97

5-23-97
MR

NEW RUN STARTED YESTERDAY - "3d-tpa-ss2.dat" - THIS RUN WAS ALLOWED TO GO TO 200,000 YRS TO REACH STEADY-STATE. IT'S OUTPUT WAS USED AS INITIAL CONDITIONS FOR: "3d-tpa-8.dat".

Saturation at Repository MR 5-23-97



MR 5-23-97

APPROXIMATE DEPTH OF BOILING (100 C) ISOTHERM FROM "3d-tpa-8.dat"

TIME (YR)	DEPTH OF T>100C (M) (°C)	DEPTH OF T<100C (M) (°C)	INTERPOLATED DEPTH* (M)	HEIGHT+ ABOVE HEATER (M)
42.9	339.9 (116.16)	323.0 (99.01)	324.0	19.6

* CALCULATION OF INTERPOLATED DEPTH: $-\left[339.9-323.0\ \frac{16.1}{17.15}\right]+339.9$

\+ HEATER AT 343.6 M (TOP OF WASTE PACKAGE)

5-23-97
MR

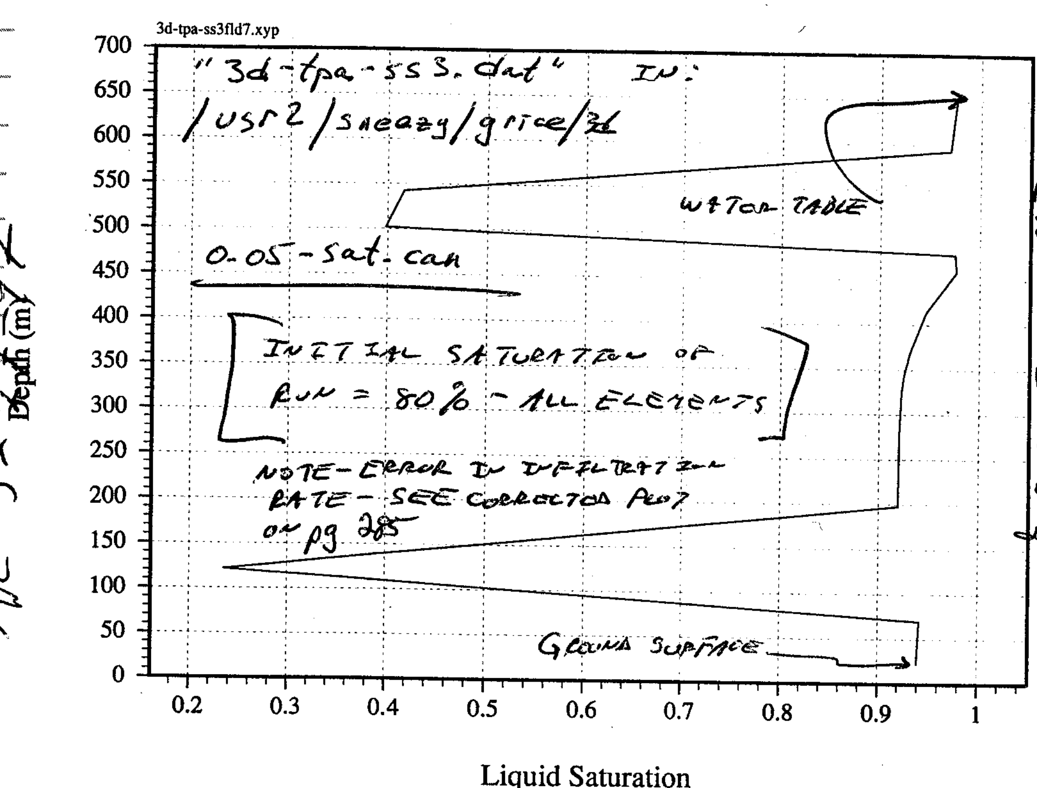
TABLE (con't)

TIME YR	DEPTH >100C (M)(C)	DEPTH <100C (M)(C)	INTERPOLATED DEPTH (M)	HEIGHT (M)
50	323(102.7)	278(49.9)	320.9*	22.7+
~~6660~~ MR 5-23-97				

5-27-97
MR

BASE CASE FOR TPA RE-DONE BASED ON CONVERSATIONS WITH RON GREEN, RUI CHEN, AND MIKKO AHOLA. INFILTRATION RATE NOW 0.05 mm/yr.

Steady-State Saturation Profile (10^6 yrs, 0.05 mm/yr)



MR 5-27-97

MR 5-27-97

$$* \quad -45\,M \; \frac{2.7C}{58.51C} + 323\,M = 320.9\,M$$

$$+ \quad 343.6\,M - 320.9\,M$$

MR 5-29-97

5-27-97
MR

NEW TPA BASE CASE: "3d-tpa-9.dat" & ~~"0.5ss.int"~~ MR 5-27-97 "05ss.int"

IN: /usr2/sneezy/grice/3d

MR 5-27-97

```
  Simulation of G-Tunnel Experiment Using ECM with floor and wing heater
  Modified to become Yucca Mountain Model
: Using base case parameters provided by Rui Chen for TEF dose-sensitivity analy
:  26 May 1997
: Identical to "3d-tpa-1.dat" except using fracture permeabilities AND fracture
: porosities from TSPA '95.
: ALSO, using wet and dry thermal conductivities.
:
: Identical to '3d-tpa-6.dat' except heat capacity of top layer increased.
:
: Identical to 3d-tpa-7.dat except using initial conditions from 3d-tpa-ss3.dat
: AND infiltration rate reduced from 0.3 mm/yr to 0.05 mm/yr.
:

RSTART  0
:
:       XYZ                          = 1 table look-up,; pref = ref. press.
:       RADIAL                       = 0 correlations;   tref = ref temp.
:       OTHER                             ^
:                                         |
:grid  geometry   nx ny   nz ivplwr ipvtab  iout    pref tref  href
Grid   XYZ         8  6   23  0       1      3    0    0
:
Monitor 433
:
: *****************************************************************
: i = sequential number of material types
: type = the characteristic curves (Van-Gen, Linear, tabular, and corey)
: swirm = irreducible liquid saturation for the matrix
: rpmm = Van Genuchten parameter for matrix
: alpham = Van Genuchten parameter for matrix
: swext = liquid saturation below which the capillary pressure is calculated bas
          on the slope dPcw/dSw evaluated at SWEXT.
: sgc = residual (immobile) gas saturation, fraction
: iecm = Equivalent Continuum Model (ECM) formulation (0 do not invoke, 1 invoke
: swirf = residual liquid saturation for fracture, fraction
: alphaf = parameter in Van-Genuchten equation for fracture (1/Pa)
: phim = matrix porosity (fraction)
: phif = fracture porosity (fraction)
: permm = intinsic matrix permeability (m^2)
: permf = intrinsic fracture permeability
:
Pckr                         :relative perm and pc keyword
:    i  type-curv     swirm   rpmm(lamda) alpham     swext   sgc      iecm
:                     swirf   rpmf(lamda) alphaf     phim       phif     permm
:
: (TCw)
    1  Van-Gen       0.021   0.3830      7.907e-7     0.0     0.0       1
                     0.040   0.764       1.23e-3     0.087   .0018  2.083e-18  3.
: (PTn)
    2  Van-Gen       0.154   0.578       5.559e-5     0.0     0.0       1
                     0.040   0.764       1.40e-3     0.421   .0018  3.879e-14  3.
: (TSw)
    3  Van-Gen       0.045   0.444       1.355e-6     0.0     0.0       1
                     0.040   0.764       1.22e-3     0.139   .0018  2.131e-18  3.
: (TSv)
    4  Van-Gen       0.118   0.551       2.193e-7     0.0     0.0       1
                     0.040   0.764       1.31e-3     0.065   .0018  9.967e-19  3.
: (CHnv)
    5  Van-Gen       0.097   0.593       2.786e-6     0.0     0.0       1
                     0.040   0.764       1.22e-3     0.331   .0018  1.118e-16  3.

: (CHnz)
    6  Van-Gen       0.121   0.414       5.943e-7     0.0     0.0       1
                     0.040   0.764       7.30e-4     0.306   .0018  1.617e-18  3.
:
: ******************
:  Backfill material
: ******************
    7  Van-Gen       0.01    0.7000      1.106e-5     0.0     0.0       1
                     0.04    0.764       1.305e-5    0.50    1.8e-3     3.9e-14
```

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5-27-97
ML

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```
:
: *******************
: Metal Waste Package
: *******************
    8  Van-Gen       0.0001   0.4400       5.80e-7     0.0      0.0      0
:                     0.0001   0.764        1.305e-5    0.0               0.0  0.0e-99
:
: *****
:  Air
: *****
    9  Van-Gen       0.0001   0.4400       1.355e-6     0.0      0.0      1
                     0.0001   0.764        1.22e-3     0.139    .0018      2.131e-18
:
: *********
:  Fracture
: *********
   10  Van-Gen       0.080    0.4400       5.8e-7      0.0      0.0      1
                     0.040    0.764        1.305e-5    0.139          1.8e-3  1.0e-12
:
0                  :  blank line to end pckr data
:
: ***************
:  Debug options
: ***************
Debug  1
0
:
: ********************
:  Thermal properties
: ********************
: no = sequential number of data set
: rho = rock density (kg/m^3)
: cpr = rock specific heat (J/kg-K)
: ckdry = thermal conductivity of dry rock (J/s/m-K)
: cksat = thermal conductivity of liquid saturated rock (J/s/m-K)
: crp = pore compressibility with pressure at constant T (1/Pa)
: crt = absolute value of pore compressibility with pressure at constant T (1/Pa
: tau = tortuosity for binary diffusion
: cdiff = vapor-dir diffusion coefficient, (m^2/s)
: cexp = exponent for binary diffusion
: enbd = enhanced binary diffusion coefficient
:
Thermal-prop
: no rho        cpr     ckdry   cksat    crp  crt   tau  cdiff    cexp  enbd
  1  2.580e+03 728.      1.69    2.23     0    0     .5  2.13e-5  1.8  0.
  2  2.580e+03 422.      0.61    0.81     0    0     .5  2.13e-5  1.8  0.
  3  2.580e+03 840.      2.10    2.78     0    0     .5  2.13e-5  1.8  0.
  4  2.580e+03 948.      1.28    1.69     0    0     .5  2.13e-5  1.8  0.
  5  2.580e+03 488.      0.84    1.11     0    0     .5  2.13e-5  1.8  0.
  6  2.580e+03 526.      1.42    1.88     0    0     .5  2.13e-5  1.8  0.
  7  2.580e+03 1e+6      1.69    2.23     0    0     .5  2.13e-5  1.8  0.
```

ML 5-27-97

```
: *******************
:  Backfill material
: *******************
:
 8  2.580e+03 840.0   0.26   0.49    0    0    .5  2.13e-5  1.8  0.
:
: *******************
: Metal Waste Package
: *******************
:
 9 7.800e+03 450.0    50.0  50.0     0    0    .5  2.13e-5  1.8  0.
:
: *****
:  Air
: *****
:
10 1.2         57.4    20.0  20.0     0    0    .5  2.13e-5  1.8  0.
:
: ********
: Fracture
: ********
:
11 2.580e+03 840.0    2.10   2.78    0    0    .5  2.13e-5  1.8  0.
:
0
: ****************************
:  Define size of grid-blocks
: ****************************
: igrid = grid-type (0 - block centered, 1 - point-distributed, 2 - boundary nod
: dx = block sizes in x-direction
: dy = block sizes in y-direction
: dz = block sizes in z-direction
```

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5-27-97
ML

ML 5-27-97

```
:
:      igrid    rw       re
DXYZ   0
: (dx(i),i=1,nx)
0.4 0.4 0.4 0.5 0.515 1.0 3.0 4.785
: (dy(j),j=1,ny)
1. 1.  1.  2.  2.  2.
: (dz(k),k=1,nz)
45.0 50.0 53.0 100.0 60.0 30.0 3.785 0.715 0.7 0.4
0.4 0.4 0.4  1.415 7.785 30.0 60.0 30.0 8.0 40.0
41.0 60.0 61.0
PhiK
: i1 i2 j1 j2 k1 k2 iist ithrm vb  por permx permy  permz  pormm permm
  1   8  1  6  1  2   1    7    0.                        : TCw = huge heat capacity, hea
  1   8  1  6  3  3   2    2    0.                        : PTn
  1   8  1  6  4 19   3    3    0.                        : TSw
  1   8  1  6 19 19   4    4    0.                        : TSv
  1   8  1  6 20 21   5    5    0.                        : CHnv
  1   8  1  6 22 23   6    6    0.                        : CHnz
:
: NOTE: Drift, Waste, & Backfill have the rock properties (iist)
:       of TSw (3) but their own thermal properties. Residual saturation
:       of drift reduced so it can dry out.
:
  1   5  1  6  8 15   9   10    0.                        : Drift
  1   2  1  3 10 13   3    9    0.   0.0 0.0 0.0 0.0 : Waste Package
  1   5  1  6 14 15   3    8    0.                        : Backfill/Pedestal/Floor

   1   8  1  6 23 23  6    6     1.0E12                   : Sink for water
    0
:
Init  05ss
:
:Equil  depth  pdepth   tdepth   tgrad  param iequil
:Equil   684   101325    20.         0.    0.    -1
:
Recurrent
:
Source   2   0.0624   1.
:  is1 is2 js1 js2 ks1 ks2  istyp
    1   8   1   6   1   1    12
  0 13.05  1.59E-09
0
:SKIP
:Power decay data from Randy Manteufel, 4/25/96
:  is  js  ks  istyp
    1 2   1 3  10 13    32
  0.3156E+06  0.8469E+04
  0.9467E+07  0.8423E+04
  0.1578E+08  0.8391E+04
  0.3156E+08  0.8314E+04
  0.3541E+08  0.8296E+04
  0.3973E+08  0.8276E+04
  0.4458E+08  0.8253E+04
  0.5002E+08  0.8228E+04
  0.5612E+08  0.8199E+04
  0.6297E+08  0.8168E+04
  0.7065E+08  0.8131E+04
  0.7927E+08  0.8089E+04
  0.8894E+08  0.8043E+04
  0.9979E+08  0.7993E+04
  0.1120E+09  0.7937E+04
  0.1256E+09  0.7876E+04
  0.1410E+09  0.7810E+04
  0.1582E+09  0.7737E+04
  0.1775E+09  0.7658E+04
  0.1991E+09  0.7572E+04
  0.2234E+09  0.7477E+04
  0.2507E+09  0.7355E+04
  0.2813E+09  0.7224E+04
  0.3156E+09  0.7084E+04
  0.3541E+09  0.6936E+04
  0.3973E+09  0.6780E+04
  0.4458E+09  0.6615E+04
  0.5002E+09  0.6443E+04
  0.5612E+09  0.6250E+04
  0.6297E+09  0.6029E+04
  0.7065E+09  0.5802E+04
  0.7927E+09  0.5571E+04
  0.8894E+09  0.5326E+04
  0.9979E+09  0.5059E+04
  0.1120E+10  0.4793E+04
  0.1256E+10  0.4541E+04
  0.1410E+10  0.4298E+04
  0.1582E+10  0.4002E+04
  0.1775E+10  0.3675E+04
  0.1991E+10  0.3393E+04
  0.2234E+10  0.3126E+04
  0.2507E+10  0.2880E+04
  0.2813E+10  0.2666E+04
  0.3156E+10  0.2464E+04
  0.3541E+10  0.2273E+04
  0.3973E+10  0.2093E+04
  0.4458E+10  0.1925E+04
  0.5002E+10  0.1767E+04
  0.5612E+10  0.1623E+04
  0.6297E+10  0.1523E+04
  0.7065E+10  0.1429E+04
  0.7927E+10  0.1339E+04
  0.8894E+10  0.1255E+04
  0.9979E+10  0.1179E+04
  0.1120E+11  0.1107E+04
  0.1256E+11  0.1036E+04
  0.1410E+11  0.9655E+03
  0.1582E+11  0.8926E+03
  0.1775E+11  0.8164E+03
  0.1991E+11  0.7463E+03
  0.2234E+11  0.6821E+03
  0.2507E+11  0.6231E+03
  0.2813E+11  0.5691E+03
  0.3156E+11  0.5179E+03
  0.3541E+11  0.4650E+03
  0.3973E+11  0.4174E+03
  0.4458E+11  0.3746E+03
  0.5002E+11  0.3361E+03
  0.5612E+11  0.3016E+03
  0.6297E+11  0.2713E+03
  0.7065E+11  0.2519E+03
  0.7927E+11  0.2339E+03
  0.8894E+11  0.2172E+03
  0.9979E+11  0.2049E+03
  0.1120E+12  0.1961E+03
  0.1256E+12  0.1877E+03
  0.1410E+12  0.1797E+03
  0.1582E+12  0.1719E+03
  0.1775E+12  0.1630E+03
  0.1991E+12  0.1545E+03
  0.2234E+12  0.1465E+03
  0.2507E+12  0.1389E+03
  0.2813E+12  0.1317E+03
  0.3156E+12  0.1247E+03
  0
:
:NOSKIP
:
Output    A=1  C=1
:
```

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```
:  isolv  newtnmn  newtnmx
Solve 4     2        7       2
:
:AUTO-step  DPMXE    DSMXE  DTMPMXE   DP2MXe
AUTO-step   5.0E+4   0.03   5.0       1.e4
:
:TOLR TOLP  TOLS  TOLT   TOLP2  TOLM  TOLA  TOLE
Tolr  1. 5.e-4  5.e-3  1.    1.e-3 1.e-3 1.e-3  1.e-12  1.e-12   1.e-12
:
:Limit dpmx   dsmx dtmpmx dp2mx dtmn dtmx icutmx
LIMIT  1.e5    .08    10.    1.e5 1.e-9 1.e5
:
:       target  dt    dpmx   dsmx  dp2mx   dtmpmx
:
:        print all at every target time
PLOTS 1 1 3
1, 385, 433
rstart 1 0
Time[y]   4.29E+1
Time[y]   5.0E+01
Time[y]   6.0E+01
Time[y]   7.0E+01
Time[y]   8.0E+01
Time[y]   1.0E+02
Time[y]   4.0E+02
Time[y]   6.0E+02
Time[y]   8.0E+02
Time[y]   1.0E+03
Time[y]   2.0E+03
Time[y]   4.0E+03
Time[y]   6.0E+03
Time[y]   8.0E+03
Time[y]   1.0E+04
Time[y]   2.0E+04
:
:rstart 1 0
:
:STEADY[y] 1.0E+01 1.0E-01 1.0E-04
Ends
```

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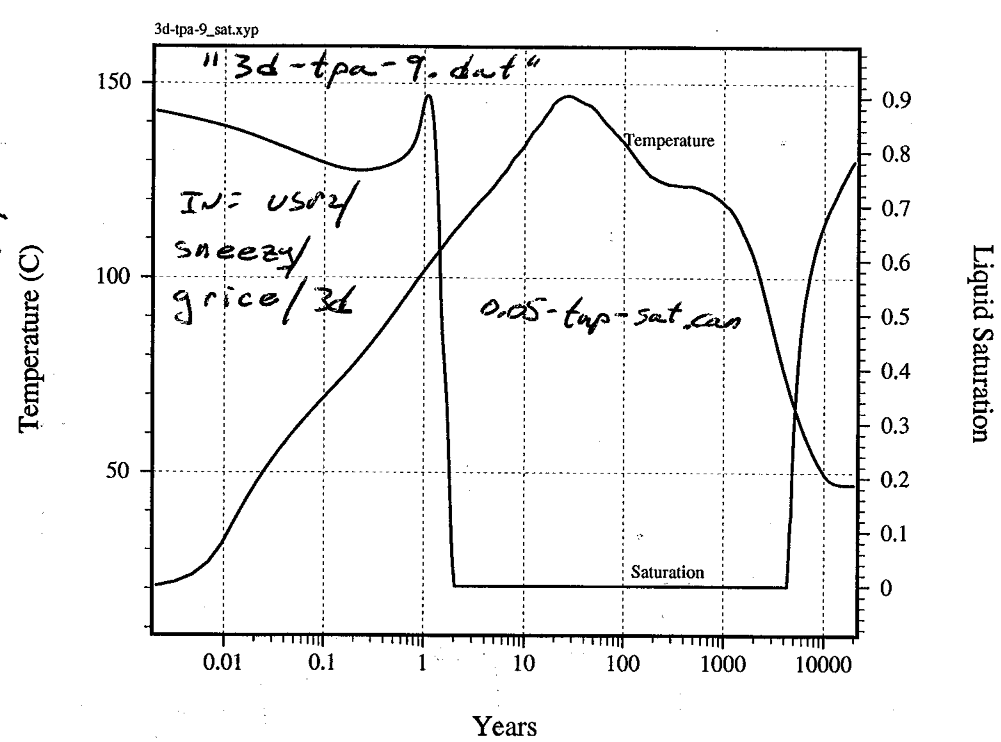
TPA Base Case, Conditions at Heater, Infiltration = 0.05 mm/yr



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MR

REVISED REFLUX CODE: "reflux6.f" IN: /usr2/sneezy/grice/code

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```
* NOTE:
*
*     The PROGRAM above SUBROUTINE reflux2 is included only to allow
*     variables to be passed. This is done to see if the subroutine is
*     working properly. This will be deleted when the subroutine is
*     incorporated into the main program.
*
*     Also, delete WRITE statements, and subroutine gsarea at end of this file.
*

      PROGRAM refluxer
*
* April 28, 1997
*

      REAL tim(10000), Qm3PerYrinSA(10000), reflux_i(10000),
     &     reflux_d(10000), Qm3PerYRinSAatRep(10000),
     &     escape_i(10000), escape_d(10000)

      INTEGER iSA, ntim

      ntim = 10

      tim(1) = 1.0

      Qm3PerYrinSA(1) = 1.0

      DO 10 I = 2, ntim

         tim(I) = tim(I-1) + 1

         Qm3PerYrinSA(I) = 1.0

10    CONTINUE

      CALL reflux2 (iSA, ntim, tim, Qm3PerYrinSA,
     &              reflux_i, reflux_d, Qm3PerYrinSAatRep,
     &              escape_i, escape_d)


      END

*************************************************************************
*************************************************************************

      SUBROUTINE reflux2 (iSA, ntim, tim, Qm3PerYrinSA,
     &                    reflux_i, reflux_d, Qm3PerYrinSAatRep,
     &                    escape_i, escape_d)

*
* Calculates the amount of water that refluxes to the boiling
* zone each year, and the amount thatescapes the reflux cycle.
* The amount that escapes is passed back to the main program.
* The refluxing water comes from one of txo sources:
* infiltration from ground surface, or vaporized water from the
* dry-out zone around the package. Reflux and the amount of water that escapes
* are expressed as a depths (volume/unit area).
*

* by G. Rice, April 29, 1997, Revised May 7, 1997, May 29, 1997
*
* Parameters:
*
*      tim: array containing times for which reflux is calculated. Passed from
*           program. Units = years
*      Qm3PerYrinSA: water infiltrating from ground surface in a given year. Ca
*           by UZFLOW and passed from main. Units = m^3/yr
*      loss_i: fraction of infiltration-derived water that escapes the reflux c
*           each year. User input; range = 0.0 - 1.0.
*      reflux_i: amount of infiltration-derived water that refluxes each year.
*           Calculated below. Units = m/yr.
*      escape_i: amount of infiltration-derived water that escapes the reflux c
*           each year. Product of reflux_i and loss_i. Calculated below. U
*      loss_d: fraction of dry-out zone-derived water that escapes the reflux c
*           each year. User input, range = 0.0 - 1.0.
*      reflux_d: amount of dry-out zone-derived water that refluxes each year.
*           Calculated below. Units = m/yr.
*      escape_d: amount of dry-out zone-derived water that escapes the reflux c
*           each year. Product of reflux_d and loss_d. Calculated below. U
```

SEE pg 282 FOR A DISCUSSION OF REFLUXING
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NOTE - THIS VERSION PERMITS CYCLES (PERIODS) OF LESS THAN A YEAR - SEE SUBROUTINE "multicycle", pg 279

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```
*         Qm3PerYrinSAatRep: total amount of water that escapes the reflux cycle
*              each year. A portion of this water may drip onto the waste and the
*              rest will be diverted elsewhere. These portions are calculated outs
*              of this subroutine.
*              Qm3PerYrinSAatREP = escape_i(I) + escape_d(I).
*              Calculated below. Units = m/yr.
*         iSA: subarea (SA) number currently being evaluated. Passed from main.
*         SAarea: area of subarea currently being evaluated. Passed from subroutin
*              gsarea. Units = m^2.
*         ntim: number of times in ntim array. Passed from main.
*         thick: thickness of dry-out zone around waste package. User input, range
*              Range may be refined based on output of models (e.g. METRA). Units
*         porosity: porosity of rock in dry-out zone (TSw). From TSPA 95.
*         sat_init: initial saturation of dry-out zone rock (TSw). From TSPA 95.
*         sat_resid: residual saturation of dry-out zone rock (TSw). From TSPA 95.
*         boil: amount of water vaporized from dry-out zone. Calculated below. Uni
*         period: number of years required for all dry-out zone-derived water to p
*              a reflux cycle. User input, range = 1 - 1000(?).
*              Range may be refined based on output of models (e.g. METRA). Units
*

      REAL Qm3PerYrinSA(ntim), loss_i(10000), reflux_i(10000)

      REAL loss_d(10000), reflux_d(10000), Qm3PerYrinSAatRep(10000)

      REAL escape_i(ntim), escape_d(10000)

      REAL thick, porosity, sat_init, sat_resid, boil, period, SAarea

      INTEGER ntim, iSA

*
* Subroutine that converts UZFLOW output from m^3/yr to m/yr.
*

      CALL convertUZ (iSA, ntim, Qm3PerYrinSA)
```

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```
* Subroutine that reads input variables and constants.
*

      CALL fill (loss_i, ntim, thick, loss_d,
     &          porosity, sat_init, sat_resid, period)

*
* Subroutine that calculates yearly reflux derived from Qm3PerYrinSA (reflux_i).
*

      CALL infil_calc (Qm3PerYrinSA, loss_i, reflux_i, ntim,
     &          escape_i)

*
* Subroutine that calculates amount of water vaporized from dry-out zone (boil).
*

      CALL rock (thick, porosity, sat_init, sat_resid, boil)

*
* Subroutine that calculates yearly reflux deruved from dry-out zone (reflux_d).
*

      CALL dryout (boil, ntim, loss_d, period, reflux_d, escape_d)

*
* Calculate total amount of refluxing water that escapes the
* cycle (Qm3PerYrinSAatRep) and output yearly values.
*

      DO 10 I = 1, ntim

         Qm3PerYrinSAatRep(I) = escape_i(I) + escape_d(I)

         WRITE(6,*) I, escape_i(I), escape_d(I),
     &          Qm3PerYrinSAatRep(I)

10    CONTINUE
```

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```
* Write results to file

      OPEN(12, FILE = 'reflux.out')

      DO 20 I = 1, ntim

         WRITE(12,*) I, escape_i(I), escape_d(I),
     &          Qm3PerYrinSAatRep(I)

20    CONTINUE

      RETURN

      END
```

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```
      SUBROUTINE convertUZ (iSA, ntim, Qm3PerYrinSA)

      REAL SAarea, Qm3PerYrinSA(ntim)

      INTEGER iSA, ntim

      CALL gsarea (iSA, SAarea)

      DO 10 I=1, ntim

         Qm3PerYrinSA(I) = Qm3PerYrinSA(I) / SAarea

10    CONTINUE

      RETURN

      END

******************************************************************
******************************************************************

      SUBROUTINE fill (loss_i, ntim, thick,
     &          loss_d, porosity, sat_init, sat_resid, period)

      REAL loss_i(ntim), loss_d(ntim),
     &          thick, porosity, sat_init, sat_resid, period

      INTEGER ntim

      thick = 10.0

      porosity = 0.14

      sat_init = 0.9

      sat_resid = 0.0

      period = 0.5

      DO 10 I = 1, ntim

         loss_i(I) = 0.1

         loss_d(I) = 0.1

10    CONTINUE

      RETURN

      END
```

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```
      SUBROUTINE infil_calc (Qm3PerYrinSA, loss_i, reflux_i,
     &          ntim, escape_i)

*
* Calculate:
*
*          Ri = I + I( sum(from j=1 to N-1) (1-L)**j)
*
* Where:
*
*          Ri = reflux_i
*          I = Qm3PerYrinSA
*          sum = summation
*          j = index
```

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```
*          N = ntim
*          L = loss_i
*

      REAL sum(10000), Qm3PerYrinSA(ntim), loss_i(ntim), escape_i(ntim)
      REAL reflux_i(ntim)
      INTEGER ntim
      reflux_i(1) = Qm3PerYrinSA(1)
      escape_i(1) = loss_i(1)*reflux_i(1)
      sum(1) = 1-loss_i(1)
      DO 10 I = 2, ntim-1
         sum(I) = sum(I-1) + (1-loss_i(I))**I
10    CONTINUE
      DO 20 I = 2, ntim
        reflux_i(I) = Qm3PerYrinSA(I) + sum(I-1) * Qm3PerYrinSA(I)
        escape_i(I) = loss_i(I)*reflux_i(I)
20    CONTINUE
     RETURN
     END

****************************************************************
****************************************************************

     SUBROUTINE rock (thick, porosity, sat_init, sat_resid, boil)
     REAL thick, porosity, sat_init, sat_resid, boil
     boil = thick * porosity * (sat_init - sat_resid)
     Write(6,*) boil

      RETURN
      END
```

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```
****************************************************************
****************************************************************

       SUBROUTINE dryout (boil, ntim, loss_d, period, reflux_d,
     &                    escape_d)
*
* Calculate:
*
*           Rd = ( B (P-L)**(N-1) ) / P**N
*
* Where:
*
*           Rd = reflux_d
*           N = ntim
*           B = boil
*           L = loss_d
*           P = period
*

       REAL boil, loss_d(10000), period, reflux_d(10000),
     &      escape_d(10000)
       INTEGER ntim
       If (period .LT. 1.0) THEN
          CALL multicycle (loss_d, reflux_d, boil, period, ntim,
     &                     escape_d)
       ELSE
          GO TO 1
```

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```
       END IF
         GO TO 2
1      DO 10 I = 1, ntim
         reflux_d(I) = ( (-1)**(I-1) * boil * ( (loss_d(I)-period)
     &                 / period)**(I-1) ) / period
         escape_d(I) = loss_d(I)*reflux_d(I)
10     CONTINUE
2      RETURN
       END
```

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```
********************************************************************

       SUBROUTINE gsarea (iSA, SAarea)
       REAL SAarea
       INTEGER iSA
       SAarea = 100.0
       RETURN
       END

********************************************************************
********************************************************************

       SUBROUTINE multicycle (loss_d, reflux_d, boil, period, ntim,
     &                        escape_d)
       REAL loss_d(10000), reflux_d(10000), boil, period,
     &      escape_d(10000)
       REAL refluxx
       INTEGER ntim
       k = 1
       DO 10 I = 1, ntim
       reflux_d(I) = 0.0
          DO 20 J = 1, 1/period - MOD(1,period)
          refluxx = boil*(1-loss_d(I))**(k-1)
          reflux_d(I) = refluxx + reflux_d(I)
          k = k + 1
20        CONTINUE
          escape_d(I) = loss_d(I)*reflux_d(I)
10     CONTINUE
       RETURN
       END
```

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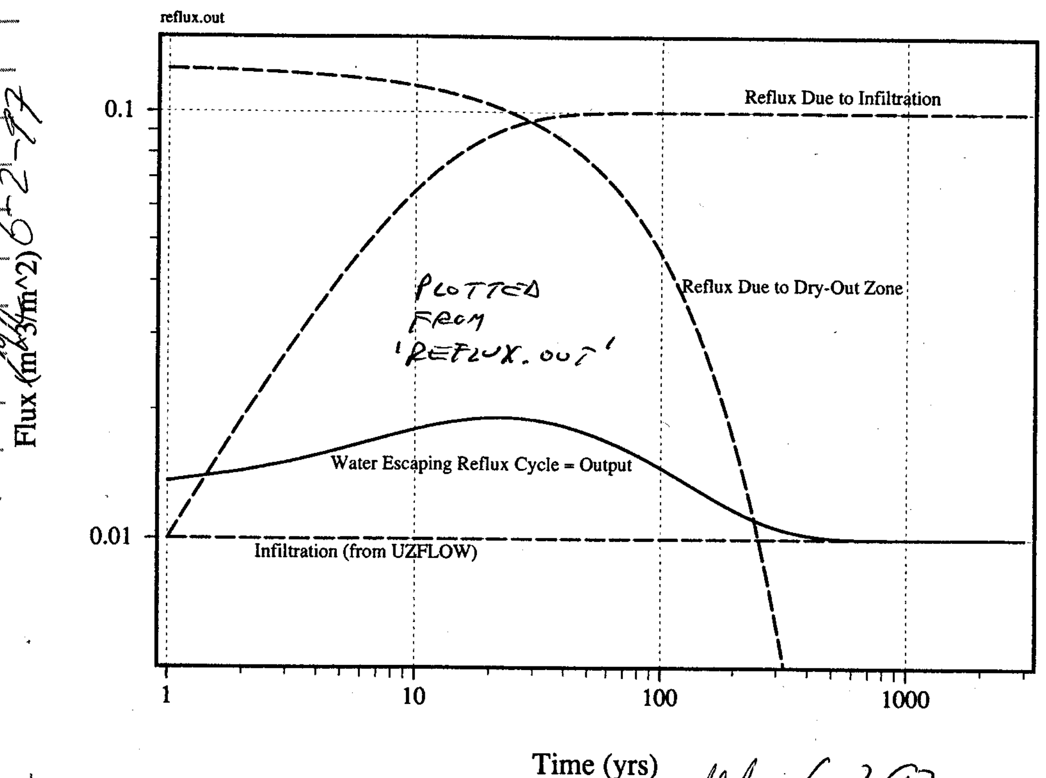
MR

OUTPUT FROM REFLUX CODE:

REFLUX (I=0.01m, Li=0.1, T=10m, Ld=0.1, P=10)



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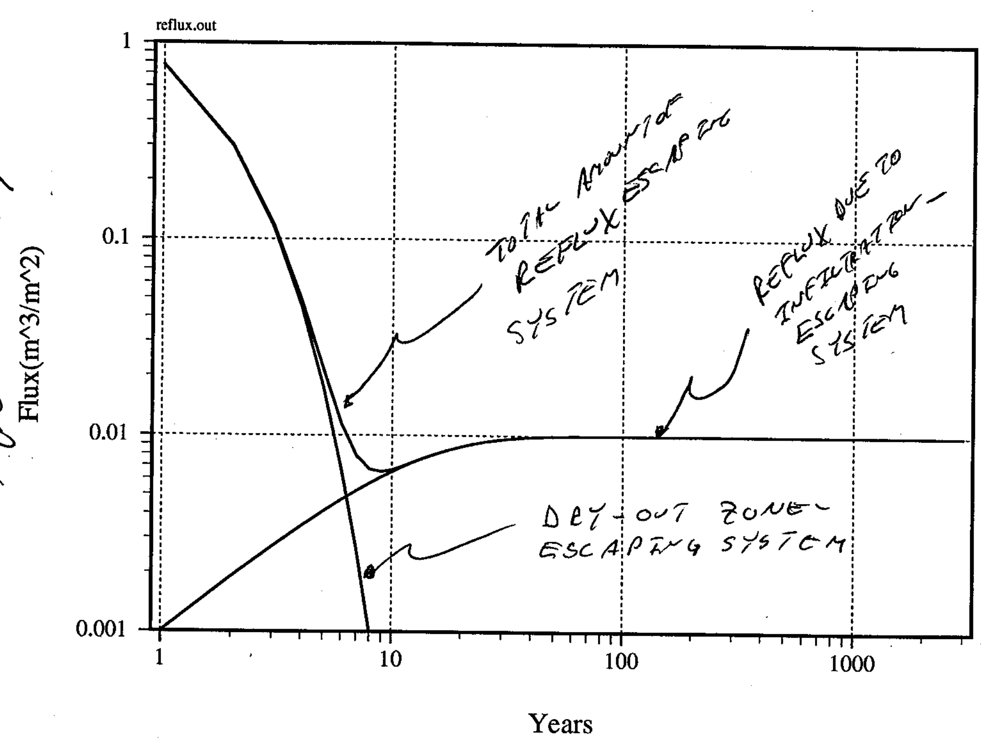
REFLUX (I=0.01m, Li=0.1, T=10m, Ld=0.1, P=0.1)



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MR

INCREASING INFILTRATION RATES:

RUN	TYPE	INFILTRATION RATE (mm/yr)
3d-tpa-ss3b.dat	STEADY-STATE	0.05
3d-tpa-11.dat	83KW/ACRE	0.05
3d-tpa-ss3c.dat	SS	0.5
3d-tpa-12.dat	83KW	0.5
3d-tpa-ss13.dat	SS	1.0
3d-tpa-13.dat	83KW	1.0
3d-tpa-ss14.dat	SS	6.0
3d-tpa-14.dat	83KW	6.0

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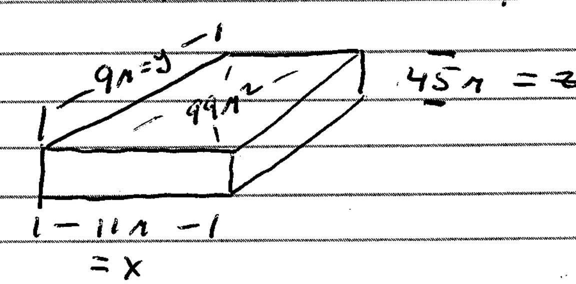
3d-tpa-14.dat:

CALCULATING INFILTRATION RATE USED IN METRA RUNS WITH OPTION 1,2 (SEE MULTIFLO USERS MANUAL, PAGE 5-14).

PORE VOLUME OF LAYER 1 - TCw, POROSITY = 0.087



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PORE VOLUME = 11m 9m 45m 0.087 = 388 m³

FOR INFILTRATION RATE OF 1mm/yr, CONVERT TO Kg/s-m³:

$$\frac{10^{-3}\,m}{yr}\;\frac{99\,m^2}{388\,m^3}\;\frac{10^3\,kg}{m^3}\;\frac{yr}{365\,day}\;\frac{day}{86{,}400\,s} = 8.09\times10^{-9}\,\frac{kg}{s\text{-}m^3} = \frac{1\,mm}{yr}$$

6-10-97

FOUND THAT RELATIVE HUMIDITY OF METRA RUNS DOES NOT CHANGE (REMAINS 1.000) UNLESS THE VAPOR PRESSURE LOWERING OPTION IS INVOKED. RE-RUNNING SIMULATIONS WITH VAPOR PRESSURE LOWERING INVOKED.

NEW RUN: "3d-tpa-12v.dat" - IDENTICAL TO "3d-tpa-12.dat" EXCEPT VAPOR PRESSURE LOWERING INVOKED. IN:
/usr2/sneezy/grice/3d

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6/9/97

Calculating Reflux of Condensate to the Boiling Zone

Heat produced by the decay of spent fuel will cause waste package temperatures to exceed the boiling point of water. A portion of this heat may be consumed by vaporization of water dripping onto the packages, resulting in reduction of package temperature. A similar reduction in the temperature of the drift wall may be caused by vaporization of water in the surrounding rock. Water will vaporize as long as temperatures remain above boiling. The vapor will flow away from the boiling zone and condense where temperatures are below boiling. The condensate may then flow back to the boiling zone. This return of condensate to the boiling zone is called *refluxing*. A particular unit of water may participate in the reflux cycle many times. With every cycle, some portion of the refluxing water may escape and flow away from the heat source, possibly toward the water table.

Refluxing water may originate from two sources: 1) infiltration from ground surface, and 2) water boiled out of a dry-out zone in rock surrounding the waste package.

A method of calculating the amount of water that refluxes each year is presented below. However, it should be noted that some of the important variables that control refluxing are poorly constrained. Reliable estimates cannot be made until more precise values of these variables are obtained.

SEE Pg 275 FOR A FORTRAN CODE THAT CALCULATES LOSS OF REFLUXING WATER

Reflux Derived From Infiltration

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The amount of infiltration-derived water that refluxes in year 'N', is:

$$R_I = I + (I)\,[\,_{j=1}\Sigma^{N-1}(1-L_I)^j\,]$$

Where:

- I = amount of infiltration in year N [m]
- j = summation index
- N = years since start of refluxing
- L_I = fraction of infiltration that escapes the reflux cycle each year

Note: R_I converges to I/L_I.

Reflux Derived From the Dry-Out Zone

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The total amount of water vaporized from the dry-out zone and available for refluxing is:

$$D = (T)\,(n)\,(S - S_r)$$

Where:

- T = thickness of dry-out zone [m]
- n = porosity of rock
- S = liquid saturation
- S_r = residual saturation

As with refluxing infiltration, some portion of refluxing dry-out zone water may escape the cycle each year (L_D). In addition, dry-out zone condensate may take more or less than a year to participate in a reflux cycle. The number of years required for water to complete one reflux cycle is 'P'. This gives rise to two cases:

<u>Case I, P >= 1.0</u>

The amount of dry-out zone water that refluxes in year 'N' is:

$$R_D = [\,(D)\,(P-L_D)^{N-1}\,] / P^N$$

<u>Case II, P < 1.0</u>

In this case, the amount of dry-out zone water that refluxes in a given year is:

$$R_D = {}_{j=0}\Sigma^{1/P-1}\, D\,(1-L_D)^{1/P\,(N-1)+j}$$

Total Reflux

The total amount of refluxing water derived from both infiltration and the dry-out zone in year 'N' is:

$$R_T = R_I + R_D$$

For Case I, this is:

$$R_T = I + (I)\,[\,_{j=1}\Sigma^{N-1}\,(1-L_I)^j\,] + [\,(D)\,(P-L_D)^{N-1}\,] / P^N$$

For Case II:

$$R_T = I + (I)\,[\,_{j=1}\Sigma^{N-1}\,(1-L_I)^j\,] + {}_{j=0}\Sigma^{1/P-1}\, D\,(1-L_D)^{1/P\,(N-1)+j}$$

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The predominant source of refluxing water may change with time. At early times, refluxing water may be dominated by water derived from the dry-out zone. At later times, water derived from infiltration may dominate. If water escapes the reflux cycle, all dry-out zone water will eventually be lost and the amount of refluxing water will stabilize to the value of R_I. If no losses occur, the amount of refluxing water will grow at a rate equal to 'I'. The reflux cycle will stop once waste package temperatures drop below boiling.

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Example Calculation

Calculate the amount of reflux occurring in year four. That is, four years after refluxing begins. Assume:

Infiltration Derived Reflux

- $I = 1X10^{-3}$ m
- $L_I = 0.1$

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Dry-Out Zone Derived Reflux

- T = 20 m
- n = 0.15
- S = 0.9
- Sr = 0.0

Then:

D = (20 m) (0.15) (0.9 - 0.0) = 2.7 m.

- $L_D = 0.2$
- P = 1/3 (Case II)

In year 4, the amount of reflux due to infiltration and dry-out zone water is:

$R_T = R_I + R_D = I + (I) [\,_{j=1}\Sigma^{N-1} (1-L_I)^j\,] + \,_{j=0}\Sigma^{1/P-1} D\,(1-L_D)^{1/P\,(N-1)+j}$

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$= 1X10^{-3} + 1X10^{-3} [\,_{j=1}\Sigma^{3} (1-0.1)^j\,] + \,_{j=0}\Sigma^{2}\, 2.7\,(1-0.2)^{9+j}$

$= 1X10^{-3}\,m + 1X10^{-3}\,m\,[(0.9)^1 + (0.9)^2 + (0.9)^3] + 2.7\,m\,[\,(0.8)^9 + (0.8)^{10} + (0.8)^{11}\,]$

$= 1X10^{-3}\,m + 1X10^{-3}\,m\,[\,2.44\,] + 2.4\,m\,[\,0.327\,]$

= 0.888 m.

NOTE: this result represents the amount of refluxing water, not water escaping the reflux cycle.

Derivation of Reflux Expressions

Dry-Out Zone Derived Reflux

Case II

For P = 1/3

Year	Cycle	Reflux	Loss	Storage
0	0	0	0	D
1	1	D	$L_D D$	$D - L_D D = D(1-L_D)$
	2	$D(1-L_D)$	$L_D D(1-L_D)$	$D(1-L_D) - L_D D(1-L_D) = D(1-L_D)^2$
	3	$D(1-L_D)^2$	$L_D D(1-L_D)^2$	$D(1-L_D)^2 - L_D D(1-L_D)^2 = D(1-L_D)^3$
2	1	$D(1-L_D)^3$	$L_D D(1-L_D)^3$	$L_D D(1-L)^4$
	2	$D(1-L_D)^4$	$L_D D(1-L_D)^4$	$L_D D(1-L)^5$
	3	$D(1-L_D)^5$	$L_D D(1-L_D)^5$	$L_D D(1-L)^6$

and so on ...

Thus, the amount of dry-out zone water that refluxes in year 2 is:

$R_D = \,_{j=0}\Sigma^{1/P-1} D\,(1-L_D)^{1/P\,(N-1)+j}$

$= \,_{j=0}\Sigma^{2} D\,(1-L_D)^{3+j}$

$= D\,[\,(1-L_D)^3 + (1-L_D)^4 + (1-L_D)^5\,]$

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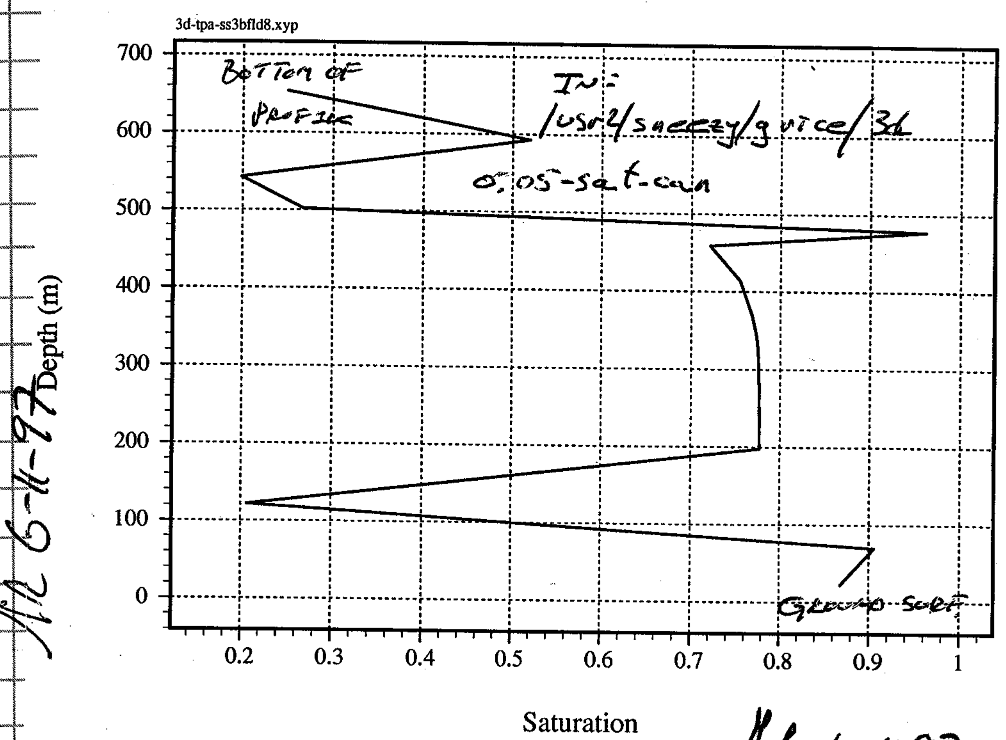
AR

Steady-State Saturation Profile (1.1E6 yr, 0.05 mm/yr)



AR 6-11-97

AR 6-11-97

6-12-97
AR

2 NEW STEADY-STATE RUNS: STARTED YESTERDAY
IN: /usr2/sneezy/grice/3d
"3d-0.36ss.dat" - INFILTRATION RATE = 0.36 mm/yr
"3d-3.6ss.dat" - INFILTRATION RATE = 3.6 mm/yr

"3d-3.6ss.dat" CRASHED AFTER 41,780 YRS (1100 TIME-STEPS) WITH MESSAGE:
"BAD vp PRESS IN pvtvp.f".

STARTED NEW RUN: "3d-3.6ss-2.dat" THAT USES LOOKUP TABLES TO CALCULATE WATER PVT PROPERTIES INSTEAD OF CORRELATIONS.

"3d-0.36ss.dat" RAN TO STEADY STATE (1.1×10^6 YRS) IN 262 TIMESTEPS - (CPU TIME = 7389s)

6-12-97
MR STARTED "3d - 0.36. dat" IN: /usr2/sneezy/grice/3d
· 0.36 mm/YR INFILTRATION
· 83 KW/ACRE

MR
6-16-97
MR "3d-0.36ss.dat" RESTARTED WITH SATURATION OF LOWEST LAYER = 99%.

MR 6-16-97
~~"3d-3.6ss.dat"~~ "3d-3.6ss-2.dat" STARTED on 6/13
FINISHED IN 7586 s, 203 TIMESTEPS.
IN:
/usr2/sneezy/grice/3d

6-17-97
MR "3d-0.36ss.dat" RAN TO COMPLETION.

"3d-3.6-2.dat" CRASHED @ 2015 YRS,
583 TIMESTEPS. THIS RUN USED CORRELATIONS FOR WATER PROPERTIES (IPVCAL[IPVTAB] = 1).

NEW RUN: "3d-3.6-3.dat" - IDENTICAL TO "3d-3.6-2.dat" EXCEPT IPVCAL = ϕ (USING LOOKUP TABLE FOR WATER PROPERTIES

→ MESSAGE AT CRASH: BAD VP PRESS IN pvtvp.f

→ COMPLETED IN 296 TIMESTEPS (1.1×10^6 YRS),
CPU TIME = 15,339 s.

6-23-97
MR COMPLETED RUNS:

"3d-0.36.dat" - CPU TIME = 136,831 s, 1125 TIMESTEPS

"3d-3.6-3.dat" - CPU TIME = 168,540 s, 1158 TIMESTEPS

IN: /usr2/sneezy/grice/3d

6-25-97
MR NEW METRA RUN: "3d-3.6-4.dat" - IDENTICAL TO "3d-3.6-3.dat" EXCEPT:

- AREA OCCUPIED BY DRIFT CORRECTED - IN NEW RUN, DRIFT EXTENDS DOWN THROUGH LAYER 14 INSTEAD OF LAYER 15.

- WATER PROPERTIES CALCULATED BY CORRELATIONS INSTEAD OF USING LOOK-UP TABLES

6-26-97
MR RUN FINISHED: "3d-3.6-4.dat" DONE IN 63,302 CPU s, 823 TIMESTEPS.

$= \frac{168540}{63302} = 2.66$ TIMES FASTER

THAN "3d-3.6-3.dat"

NEW RUN: "3d-0.36-2.dat" - SAME AS "3d-0.36.dat" EXCEPT (LIKE "3d-3.6-4.dat")

- AREA OCCUPIED BY DRIFT CORRECTED

- USING CORRELATIONS INSTEAD OF LOOK-UP TABLES

IN: /usr2/sneezy/grice/3d

6-30-97
MR RUN "3d-0.36-2.dat" FINISHED IN 51,633 CPU s, 712 TIMESTEPS.

7-8-97
MR "3d-0.36-3.dat" DONE IN 56,493 CPU s, 756 TIMESTEPS. IDENTICAL TO "3d-0.36-2.dat" EXCEPT PERMEABILITY OF "AIR" = E-99 INSTEAD OF E-18.

7-8-97

G-TUNNEL RUN - INPUT FROM MIKKO AHOLA.

"gtun4C2.dat" - SIMULATED 365 DAYS IN 54342 CPUs, 465 TIMESTEPS

GRID = 20X15X30; 6.5m X 5.0m X 10m

NEW G-TUNNEL RUN: "gtun1.dat" - IDENTICAL TO "gtun4C2.dat" EXCEPT THERMAL CONDUCTIVITY OF HEATER REDUCED FROM 10 W/m-K TO 5 W/m-K

7-10-97

"gtun1.dat" DONE IN 56,264 CPUs, 478 TIMESTEPS

"gtun1-f.dat" SIMILAR TO "gtun1.dat" EXCEPT IT CONTAINS A FRACTURE PERPENDICULAR TO HEATER.

IN: /usr2/sneezy/grice/gtunnel

NEW RUN: "3d-0.36-4.dat" - IDENTICAL TO "3d-0.36-2.dat" EXCEPT PERMEABILITY OF "AIR" SET TO E-8 (BOTH MATRIX + FRACTURE)

IN: /usr2/sneezy/grice/3d

7-14-97

"gtun1-f.dat" DONE IN 106,757 CPUs, 695 TIMESTEPS

"3d-0.36-4.dat" CRASHED AFTER 815 TIMESTEPS, 4.125 YEARS: "BAD PVTVP.F" ERROR FILE SAYS: "bad vapor press in blk m=1".

"3d-0.36-4.dat" RE-RUN WITH VAPOR PRESSURE LOWERING TURNED OFF.

7-16-97

RE-RUN OF "3d-0.36-4.dat" ALSO CRASHED: 890 TIMESTEPS, SIMULATED TIME = 4.718 YRS.

NEW RUN: "3d-0.36-5".dat - SAME AS "3d-0.36-4.dat" EXCEPT:
- VAPOR PRESSURE LOWERING TURNED ON
- K OF "AIR" LOWERED FROM 10^{-8} m^2 TO 10^{-10} m^2.

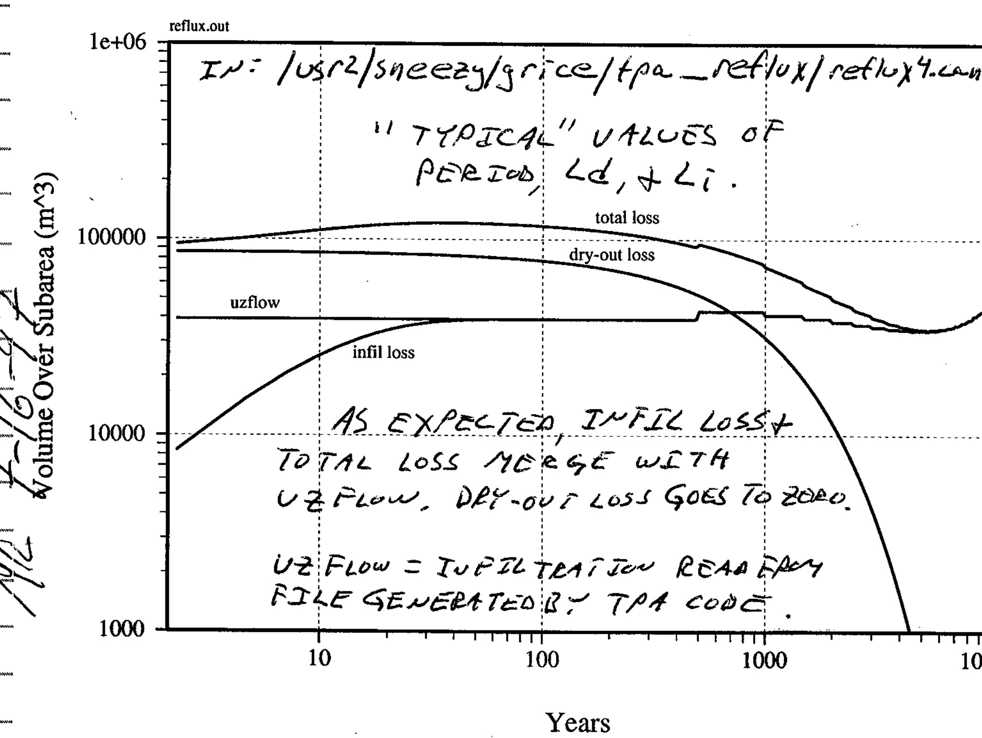
TESTING STAND ALONE VERSION OF REFLUX2 CODE - SEE pg 275 - CODE MODIFIED BY SITAKANTA MOHANTY TO BE MORE COMPATIBLE WITH TPA CODE. IN:

/usr2/sneezy/grice/tpa_reflux

TESTING "TYPICAL" AND EXTREME VALUES
Ld = DRY-OUT ZONE LOSS, Li = INFILTRATION LOSS,
THICK = THICKNESS OF DRY-OUT ZONE (m)

THE CODE PRODUCES REASONABLE RESULTS: 7-16-97

Period = 100, Thick = 20, Ld = 0.1, Li = 0.1

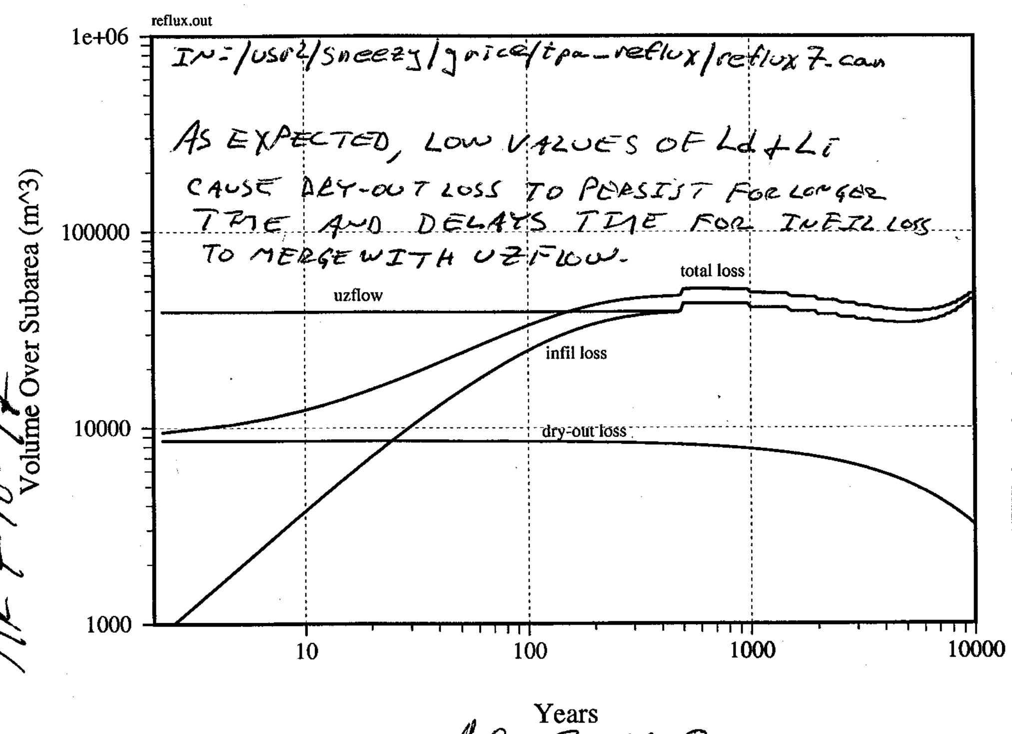


7-16-97
MR

MORE REFLUX2 RESULTS - SEE PREVIOUS PAGE

MR 7-16-97

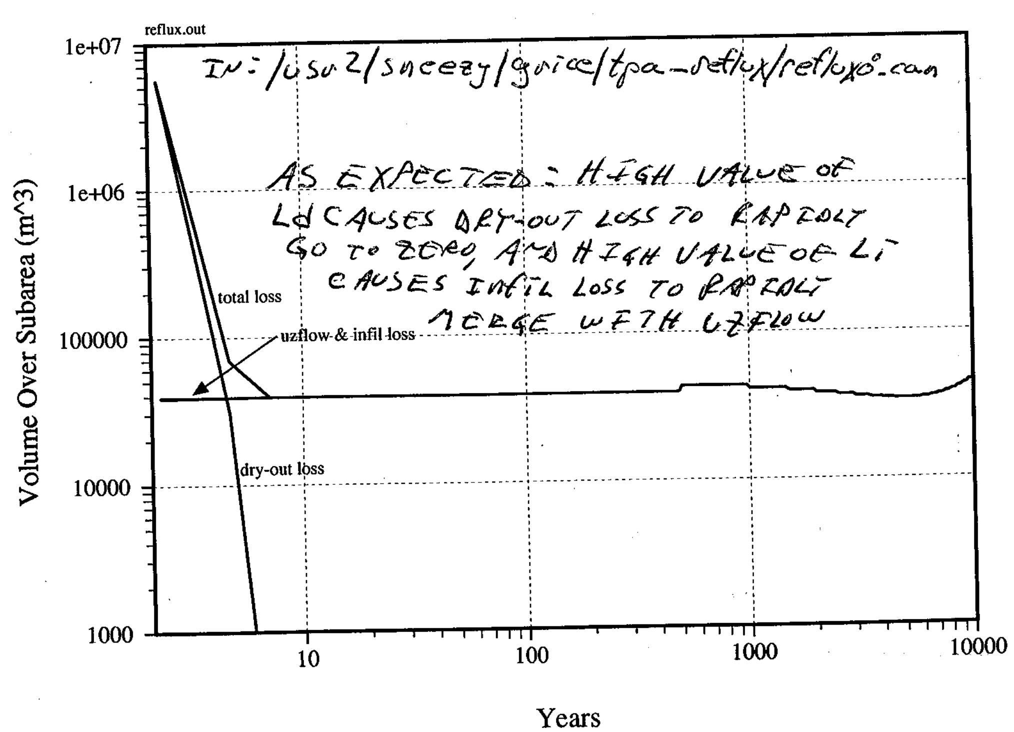
Period = 100, Thick = 20, Ld = 0.01, Li = 0.01



MR 7-16-97

MR 7-16-97

Period = 1, Thick = 20, Ld = 0.9, Li = 0.9



MR 7-16-97

7-17-97
MR

"RUN "3d-0.36-5.dat" CRASHED AFTER 281 TIMESTEPS, SIMULATION TIME = 4.956 YRS. MESSAGE IN *_eors FILE: "bad vapor press in blk m = 1".

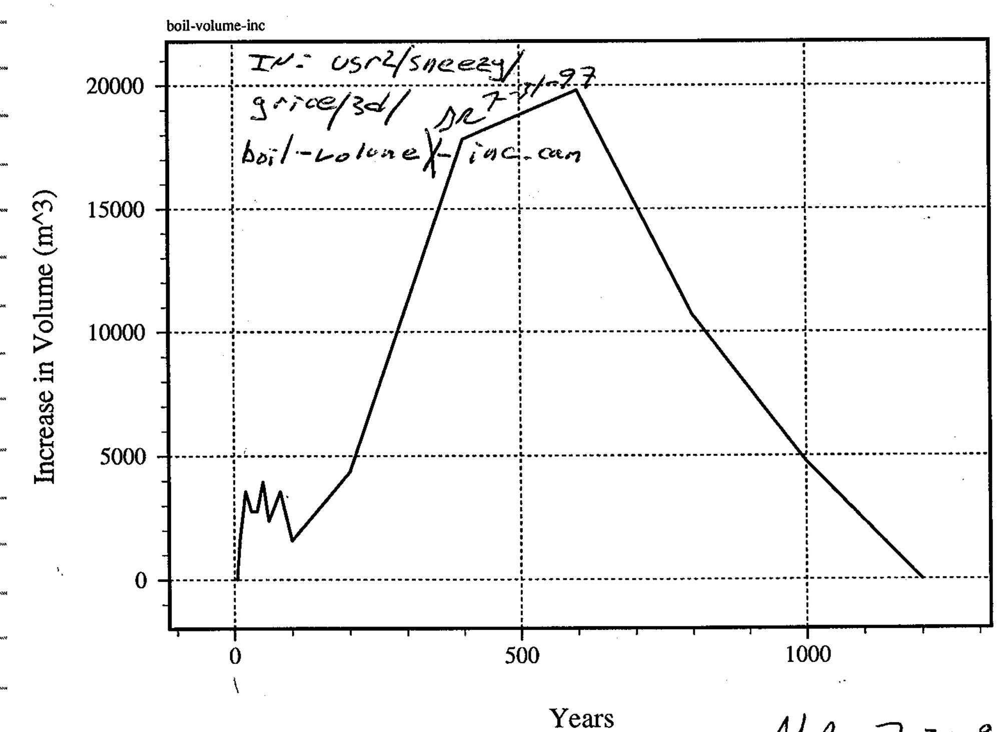
NEW 3d METRA RUN: "3d-0.36-6.dat" - IDENTICAL TO "3d-0.36-5.dat" EXCEPT "air" CONTAINS NO FRACTURES - NO ECM USED FOR AIR. IN:

/usr2/sneezy/grice/3d

7-31-97
MR

MR 7-31-97

Incremental Dry-Out Zone Volume (83 kW/ac, 3.6 mm/yr)

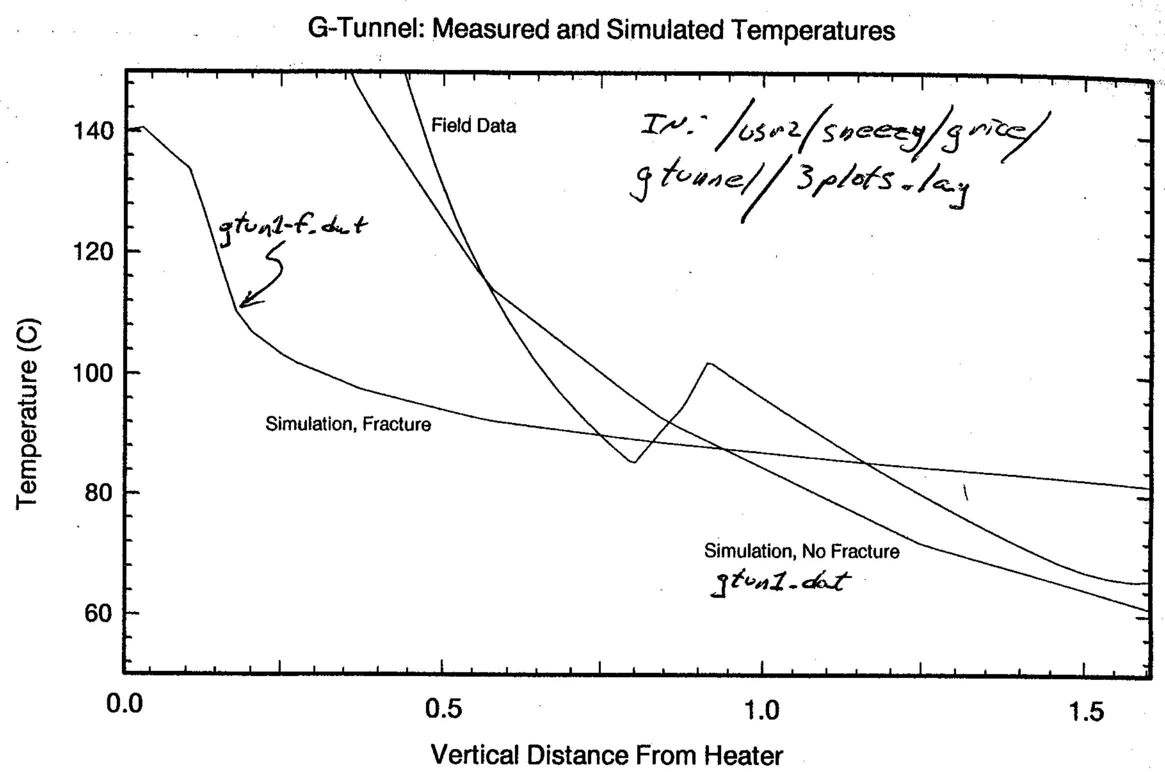


MR 7-31-97

MR 8-5-97

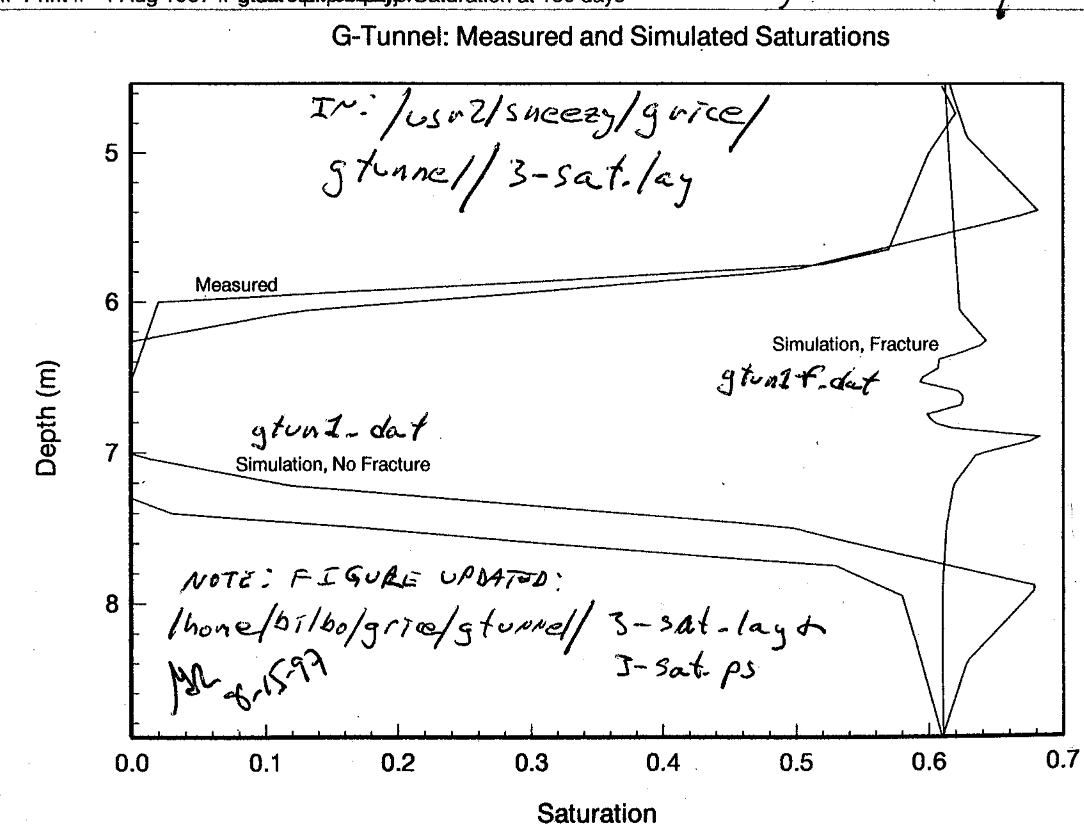
8-5-97
MR

MR 8-5-97



MR 8-5-97

(2D) II Print II 4 Aug 1997 II Saturation at 130 days



MR 8-5-97

~~8-7-97 NEW G-TUNNEL FRACTURE RUNS~~ MR 8-11-97
8-11-97 "gtun1-f-dat",
MR ~~"Gtun1-f.dat:"~~ AR 8-1-97
MR 8-11-97

```
Test  Data for G-tunnel simulation (initial data : gt_in2.int)
     July 8, 1997
: Identical to Mikko Ahola's "gtun4c2f.dat' except
: initial conditions file contains 22 x-dir elements and
: permeability of fracture increased
: gtun1-f
: single fracture incorporated (5 cm thickness)
: the heater materials are incorporated
: air space in borehole included
: initial matrix liquid saturation = 60%
RSTART  0
:
:       XYZ
:       RADIAL
:       OTHER
:
:grid  geometry  nx ny nz ivplwr ipvtab  idir    pref tref  href
Grid   XYZ       22 15 30   1       0      0      0    0
:
Monitor 4951 4956 3961 2971 7921
debug 1
0
Pckr                            :relative perm and pc keyword
: 1 = properties for g-tunnel rock based on equivalent continuum model
: data source for van Genuchten parameters is NRC IPA Phase 2, App. B
: assuming g-tunnel rock is of similar nature to Topopah Springs welded tuff.
:
:   i  type-curv swirm  rpmm(lamda)  alpham  swext  sgc  iecm
:                swirf  rpmf(lamda)  alphaf  phim   phif   permm   permf
    1  Van-Gen   0.080  0.444        5.8e-7  0.     0.   1
                 0.040  0.7636       1.31e-5 0.139  4.8e-3 1.9e-18 3.9e-12
:
: *** properties of heater element ***********
:   i type-cur   swirm  rpm(lamda)  alpham  swext  sgc  iecm
    2  Van-Gen   0.010  .44         5.8e-7   0.     0.
:
: *** properties of air in heater borehole ***********
:   i type-cur   swirm  rpm(lamda)  alpham  swext  sgc  iecm
    3  Van-Gen   0.010  .44         5.8-7    0.     0.   1
                 0.01   0.7636      1.305e-5  0.1   0.1  3.9e-99  3.9e-99
: 4 = properties for fracture
:   i  type-curv swirm  rpmm(lamda)  alpham  swext  sgc  iecm
:                swirf  rpmf(lamda)  alphaf  phim   phif   permm   permf
    4  Van-Gen   0.080  0.444        5.8e-7  0.     0.   0
:                  0.040  0.7636       1.31e-5 0.139  4.8e-3 1.9e-18 3.9e-12
0
:
Debug  1
0
Thermal-prop
: no rho        cpr    ckdry  cksat    crp  crt   tau  cdiff   cexp  enbd
: 1 = thermal properties for g-tunnel rock
: assume g-tunnel rock is similar in nature to Topopah Springs welded tuff
  1  2.580e+03 840.0  2.10   2.78     0    0    .5   2.13e-5  1.8  0.
: 2 = properties for heater element
  2  3.580e+03 840.0   5.0    5.0     0    0    .5   2.13e-5  1.8  0.
: 3 = properties for air
  3  1.200e+00 57.4   10.0   10.0     0    0    .5   2.13e-5  1.8  0.
0
:      igrid   rw      re
```

AR 8-11-97

```
 DXYZ   2
 : (dx(i),i=1,nx)
 : total length in x-direction is 6.5 m
 : half-length of heater is represented by x1-x6 (1.5m) - symmetry assumed
 0.05 0.05 0.075 0.075 0.125 0.125 0.2 0.2 0.2 0.2
 0.2 0.4 0.4 0.4 0.4 0.4 0.5 0.5 0.5 0.5
 0.5 0.5
 :
 : (dy(j),j=1,ny)
 : total length in y-direction is 5 m
 : half-diameter of heater (15 cm) is in y1-y2 - symmetry assumed
 .075 .075 .075 .075 .15 .25 .3 .5 .5 .5
 .5 .5 .5 .5 .5
 :
```

MR 8-11-97

8-11-97
AR

"gtun1-f.dat" (cont)
AR 8-11-97

```
: (dz(k),k=1,nz)
: total length in z-direction is 10 m. Diameter of heater (30 cm) is
: represented by z14-z17
.5 .5 .5 .5 .5 .5 .5 .5 .3 .25
.15 .075 .075 .075 .075 .075 .075 .075 .075 .15
.25 .3 .5 .5 .5 .5 .5 .5 .5 .5
:
: -------------------------------
: assign rock hydraulic properties defined in PCKR to the cells
PhiK
: i1 i2 j1 j2 k1 k2 iist ithrm vb   por   permx  permy  permz  pormm  permm
: Bulk rock matrix-fracture system
   2 22  1 15  1 13   1   1   0.
   2 22  1 15 18 30   1   1   0.
   2 22  3 15 14 17   1   1   0.
   1  1  1 15  1 13   4   1   0.    0.2   1.0e-8 1.0e-8 1.0e-8
   1  1  1 15 18 30   4   1   0.    0.2   1.0e-8 1.0e-8 1.0e-8
   1  1  3 15 14 17   4   1   0.    0.2   1.0e-8 1.0e-8 1.0e-8
: Properties of heater element
   1 11  1  2 14 17   2   2   0.    0.1  1.e-20 1.e-20 1.e-20
: Properties of air at end of heater in heater borehole
  12 22  1  2 14 17   3   3   0.
    0
Init ss1f
: i1  i2  j1  j2  k1  k2        p         t         sg         xg2    sgm
Recurrent-data
Output   A=1   C=1
:
:  isolv  newtnmn  newtnmx
Solve 3     2        8        4  100  2
:
:Bcon       2
:ityp fac     j1  j2  k1  k2
:  1  RIGHT   1   15  1   30
:time   qflx   p       T   sg
: 0.     0.0   100000.  18. 0.95
:1.e10   0.0   100000.  18. 0.95
: 0
:ityp fac   i1 i2    k1 k2
: 1    BACK  1  20    1  30
:time qflx    p        T      sg
: 0.    0.0    100000.  18.   0.95
:1.e10  0.0    100000.  18.   0.95
:0
:AUTO-step  DPMXE    DSMXE  DTMPMXE   DP2MXe
AUTO-step   1.0E+4   0.03    5.0       1.e4
```

AR 8-11-97

```
:
: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-7 1.e-7 1.e-7
:
:Limit dpmx    dsmx dtmpmx dp2mx dtmn dtmx icutmx
LIMIT  1.e5     .08    10.    1.e5  3.171e-8 1.e5
:
: SKIP
:
:  Total Heat Source Strength = 3.3 kW = 3300 W
:  Two planes of symmetry assumed, thus 1/4 total heat source used = 825 W
Source  1   1.   1.
:  is1  is2  js1  js2  ks1  ks2  istyp
    1   11    1    2   14   17     33
0.0        825.0
1.1232e7   825.0
1.2636e7   618.8
1.4040e7   412.5
1.5444e7   206.3
1.6848e7     0.1
 0
rstart 1 0
PLOTS 1 1 5
4951 4956 3961 2971 7921
:Steady[y]  1.e-6  1.e-5  1.e-8
: time in days
Time[d] 130.0
Time[d] 195.0
Time[d] 365.0
Ends
```

AR 8-11-97

8-11-97
AR

TWO NEW G-TUNNEL RUNS:

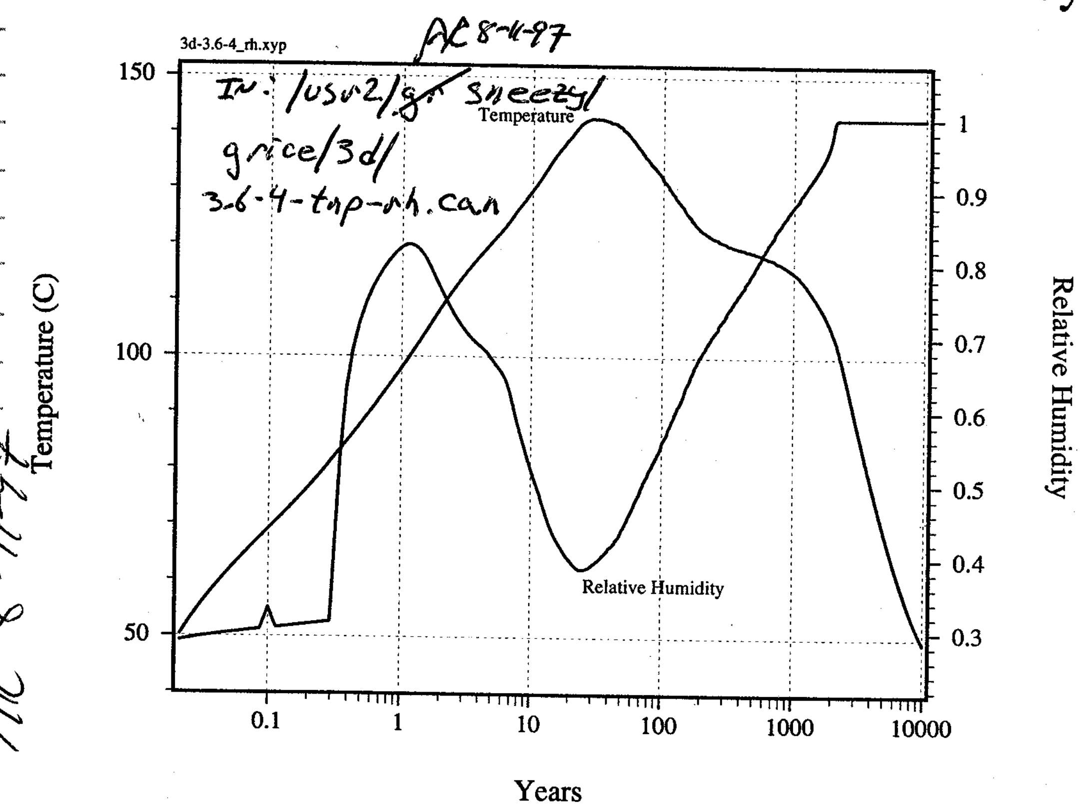
"gtun1-fa.dat" - IDENTICAL TO "gtun1-f.dat" EXCEPT 'ALPHA' OF FRACTURE (1/AIR-ENTRY VALUE) CHANGED FROM 5.8×10^{-7}/Pa TO 0.1/Pa.

"gtun1-fb.dat" - IDENTICAL TO "gtun1-fa.dat" EXCEPT PERMEABILITY OF FRACTURE CHANGED FROM 1×10^{-8} m² TO 1×10^{-10} m².

AR 8-11-97

Conditions at Heater, Infiltration Rate = 3.6 mm/yr

AR 8-11-97

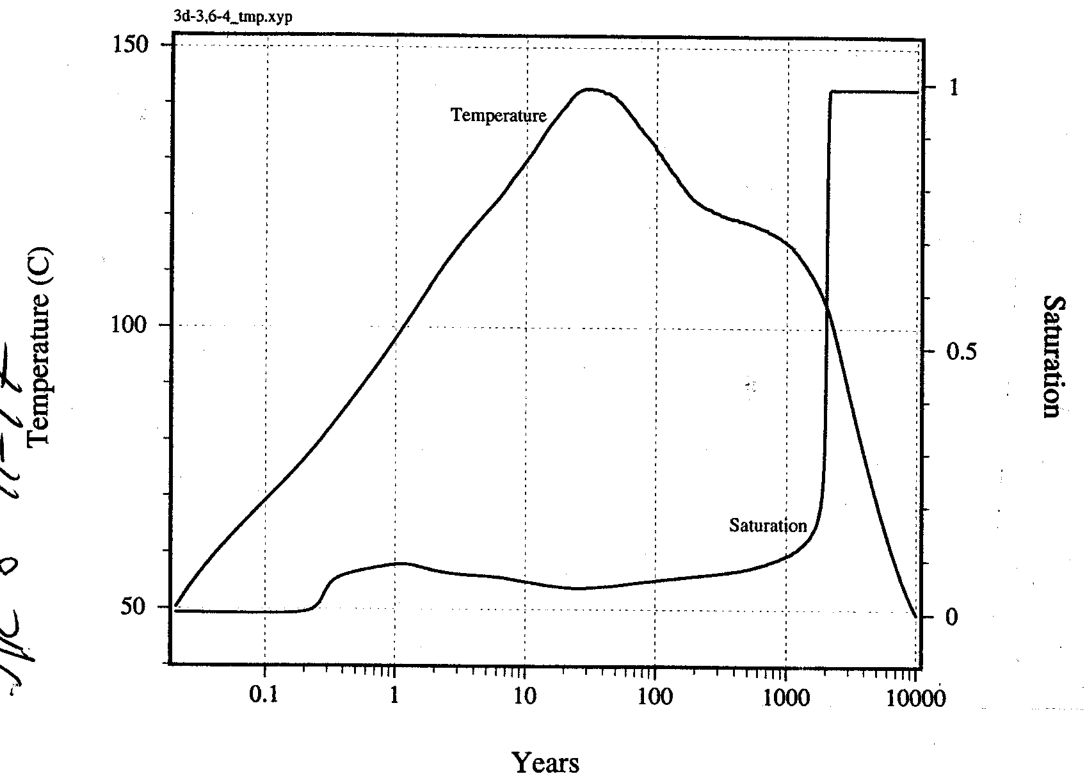


AR 8-11-97

8-11-97
JR

Conditions at Heater, Infiltration Rate = 3.6 mm/yr

JR 8-11-97



JR 8-11-97

8-12-97
JR

- KILLED "gtun1-fa.dat" AFTER ~520 CPU min
  t = 4.089 DAYS, Δt = 1.07 x10⁻², 426 TIMESTEPS

- "gtun1-fb.dat" STILL RUNNING @ ~638 CPU min
  t = 45.5 DAYS, Δt = 0.328, 382 TIMESTEPS

8-14-97
JR

NEW STEADY STATE 3-D RUN: "3d-10.0ss.dat"
IDENTICAL TO "3d-3.6ss-2.dat" EXCEPT
INFILTRATION RATE = 10.0 mm/yr INSTEAD
OF 3.6 mm/yr.

NOTE — THIS IS THE FIRST RUN I'VE DONE
USING THE VERSION OF METRA THAT'S IN
SOLAPPS DIRECTORY. PREVIOUS RUNS DONE
USING METRA14 ON SNEEZY.

8-14-97
JR

NOTE: "gtun1-fa.dat" AND "gtun1-fb.dat" BOTH
WERE KILLED TO START WORKING ON 3-D BASECASE

8-15-97
JR

"3d-10.0ss.dat" DONE IN 11,212 CPU s,
IN: /home/bilbo/grice/3d

NEW 3-D RUN — 83 KW/AC, 10.0 mm/yr INFIL:
"3d-10.0-1.dat" — USES OUTPUT FROM
"3d-10.0ss.dat" AS INITIAL CONDITIONS.
IN:
/home/bilbo/grice/3d

8-18-97
JR

RUN "3d-10.0-1.dat" CRASHED AFTER 1369
TIMESTEPS, t = 3528 YRS, Δt = 7.94 YRS.
MESSAGE:
"STOP: bad vp press in putvp.f -
see lfn_errs file"

NEW RUN: "3d-10.0-2.dat" - IDENTICAL TO
"3d-10.0-1.dat" EXCEPT VAPOR PRESSURE
LOWERING TURNED OFF IN:
/home/bilbo/grice/3d

→ THE FILE "3d-10.0-1_errs" HAS THE
FINAL ENTRY: "ERROR IN putvp.f - bad
VAPOR press IN blk n = 241". "vp = -0.37...E+03"

BLOCK 241 = 1ST ELEMENT IN LAYER #6 —
THIS IS IN THE TSw WHICH RANGES FROM
LAYER #4 THROUGH LAYER #18 — THE
TOP OF THE DRIFT ~~BEGINS~~ IS AT LAYER # ~~10~~ 6 JR 8-18-97
JR 8-18-97
AND THE TOP OF THE HEATER IS AT LAYER #10.

8-18-97 MR

RUN "3d-10.0-2.dat" KILLED BECAUSE RELATIVE HUMIDITY IS NOT BEING CALCULATED - ALL VALUES = 1.000 THROUGH YEAR 19.855.

3 MR 8-18-97

NEW RUN: "3d-10.0-3.dat" - IDENTICAL TO "3d-10.0-2.dat" EXCEPT "ipvcal" IN "GRID" = ∅ INSTEAD OF 1.

IN: /home/bilbo/grice/3d

8-20-97 MR

NEW 3D RUN: "3d-3.6-5.dat" - IDENTICAL TO "3d-3.6-4.dat" EXCEPT THAT A LINEAR RELATIONSHIP IS USED FOR "AIR" INSTEAD OF VAN GENUCHTEN RELATIONSHIPS, AND OUTPUT FOR VARIABLES AT THE DRIFT WALL IS PRODUCED.

IN:

/home/bilbo/grice/3d

8-21-97 MR

RUN "3d-3.6-5.dat" CRASHED AT TIMESTEP 559, t = 285.6 YRS, Δt = 9.72 YRS - MESSAGE: "FLOATING POINT EXCEPTION 3, DIVISION BY ZERO, OCCURRED AT ADDRESS 86f40". CORE DUMPED

- RE-RUN "3d-3.6-5.dat" WITH IPUTAB = ∅ INSTEAD OF 1. MR 8-25-97

8-25-97 MR

RUN "3d-3.6-5.dat" CRASHED AT TIMESTEP 614, t = 667 YRS.

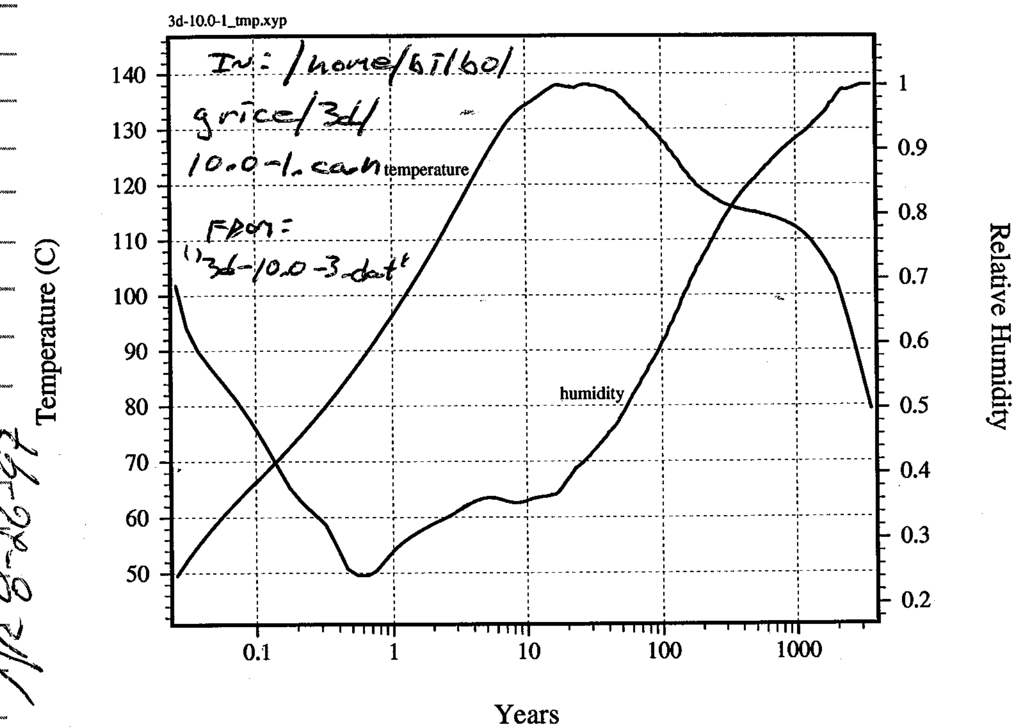
- RE-RUN "3d-3.6-5.dat" WITH "swext" = 10.0 INSTEAD OF 0.005.

- RUN "3d-10.0-3.dat" RUNNING FOR ~ 5930 CPU ... TIME = 6517 YR, Δt = 1×10^{-9} yr, TIMESTEP = 59,976 - STUCK HERE SINCE TIMESTEP # 2598 - KILLED RUN.

8-26-97 MR

MR 8-26-97

3-D, 10 mm/yr, "Air" Above Heater



MR 8-26-97

- Run "3d-3.6-5.dat" CRASHED AT TIMESTEP # 887 TIME = 2376 YRS. MESSAGE = "[1] Bus Error". RE-STARTED RUN.

8-28-97 MR

- Run "3d-3.6-5.dat" CRASHED @ TIMESTEP # 1268, t = 2897 yrs, Δt = 3.09 yrs, MESSAGE ON SCREEN = 'temperature beyond table look-up range in prtfunc' - MESSAGE IN "3d-3.6-5.ems" = : "*** Error in prtfunc - temperature out of range tk = -0.727366E+02".

- NEW RUN: "3d-3.6-6.dat" - IDENTICAL TO "3d-3.6-5.dat" EXCEPT PERMEABILITY OF "AIR" REDUCED FROM 10^{-12} m^2 TO 10^{-14} m^2.

IN:

/home/bilbo/grice/3d

9-1-97 MR "3d-3.6-6.dat" FINISHED (10^4 YRS) IN 1159 TIMESTEPS, CPU TIME = 100,757 S.

NEW RUN STARTED 8-30-97: "3d-10.0-4.dat" - IDENTICAL TO "3d-10.0-3.dat" EXCEPT PERMEABILITY OF "AIR" REDUCED FROM 10^{-12} m^2 TO 10^{-14} m^2. RUN FINISHED (10^4 YRS) IN 1458 TIMESTEPS, CPU TIME = 105,537 S. IN: /home/bilbo/grice/3d.

RE-RUN "3d-10.0-3.dat" - SEE IF NEW VERSION OF METRA (AUG 97) MAKES A DIFFERENCE

9-3-97 MR RE-RUN OF CRASHED - TIMESTEP = 1739, t = 3603 YRS - MESSAGE IN "3d-10.0-3_errs" FILE: "ERROR IN ptfunc - temperature out of range tk = -0.330384E+02".

9-4-97 MR NEW RUN: "3d-0.36-7.dat" - INFILTRATION RATE = 0.36 mm/YR - USES LINEAR CAPILLARY-MOISTURE RELATIONSHIP INSTEAD OF VAN GENUCHTEN RELATIONSHIPS. IN: /home/bilbo/grice/3d

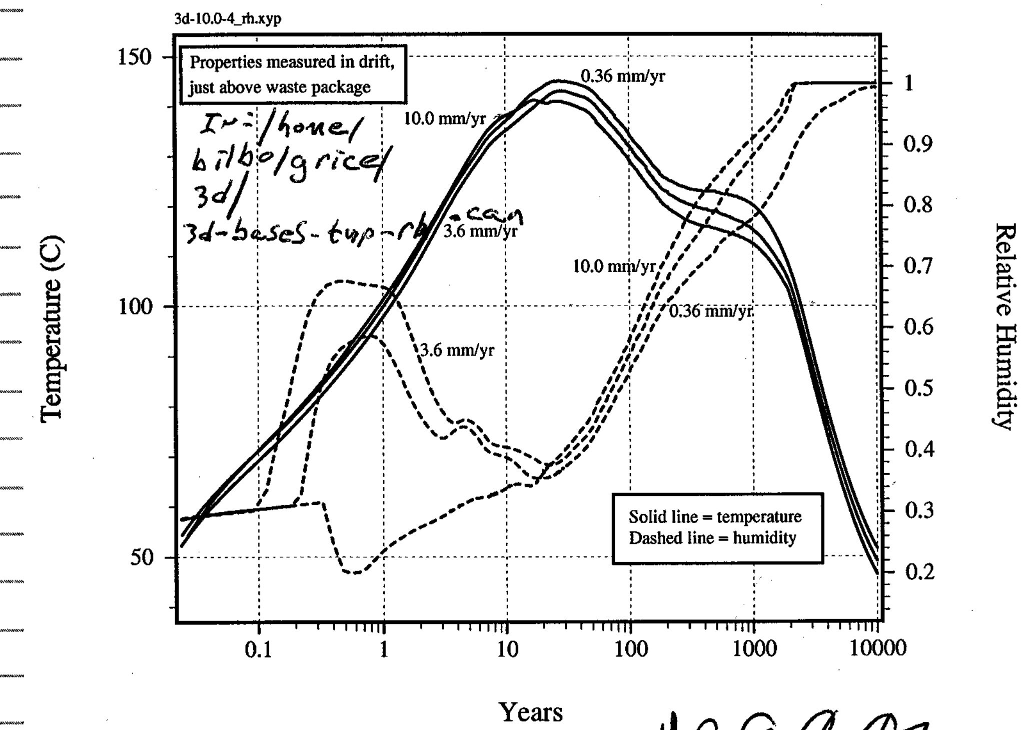
9-9-97 MR Run "3d-0.36-7.dat" COMPLETED (10^4 yrs) IN 974 TIMESTEPS, CPU TIME = 75,084 s.

MR 9-9-97

9-9-97 MR

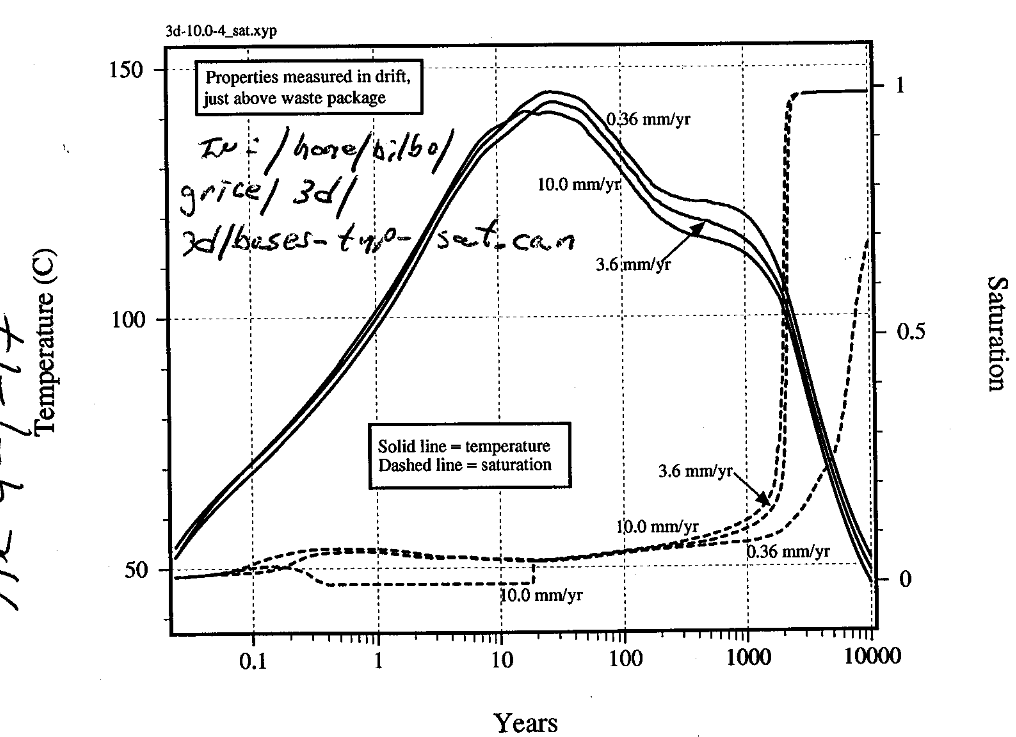
MR 9-9-97

3-D Base Cases, METRA Simulations



MR 9-9-97

3-D Base Cases, METRA Simulations



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9-24-97 MR NEW METRA BASECASE - INFILTRATION RATE = 5.5 mm/yr.

STEADY-STATE RUN = '5.5ss.dat" IN: /home/bilbo/grice/3d/newbase

9-25-97 MR RUN "5.5ss.dat" CRASHED @ TIMESTEP 242, t = 164.6 yrs MESSAGE = "bad up press in putup.f" IN errs file: "H2oput: WATER DENSITY DERIVATIVE bad" ALSO - MESSAGES re bad gas density & vapor press, BLOCKS n1=1 & n1=865

RE-RUN '5.5ss.dat" WITH ipvcal = 1 INSTEAD OF ZERO - USE CORRELATIONS FOR WATER PROPERTIES INSTEAD OF LOOK-UP TABLES.

9-29-97 MR "5.5ss.dat' RAN SUCCESSFULLY - 1.1×10^6 YRS IN 123,504 CPU SECONDS, 1418 TIMESTEPS.

10-1-97 MR MODIFIED "5.5ss.dat" TO MAKE HEATER + DRIFT DIMENSIONS SAME AS IN TPA CODE - NUMBER + ARRANGEMENT OF ELEMENTS NOT CHANGED - LENGTH OF WP CHANGED FROM 6.0m TO 5.682m. LENGTH OF DRIFT CHANGED FROM 18 TO 19 m THIS VERSION CRASHED AT t = 23.89 YRS, TIMESTEP # 48.

MADE NEW SS RUN - "5.5ss-2.dat" IDENTICAL TO MODIFIED "5.5ss.dat" EXCEPT USES SOLVER # 3 INSTEAD OF 4. - CRASHED AT t = 346.3 yrs, TIMESTEP = 643. "bad vp press"

RERUN "5.5ss-2.dat" WITH isolve = 4, 'EQUIL' OPTION INVOKED

10-2-97 MR RE-RUN OF "5.5ss-2.dat" RAN SUCCESSFULLY. CPU TIME = 31,193 s. - NOTE - TEMPERATURE IS CONSTANT FROM TOP TO BOTTOM OF PROFILE - WILL RE-RUN - ATTEMPT TO FORCE GEOTHERMAL GRADIENT.

NEW RUN WITH GEOTHERMAL GRADIENT INCORPORATED INTO 'Equil' - "5.5ss-3.dat" IN: /home/bilbo/grice/3d/newbase

10-4-97 MR RUN CRASHED - "5.5ss-3.dat" - "bad up press in putup.f" 1265 TIMESTEPS, time = 16,720 yrs

NEW RUN - "5.5ss-4.dat" SAME AS "5.5ss-3.dat" EXCEPT HEAT CAPACITY OF BOTTOM LAYER SET TO 10^{10} FROM 1.42 - ALSO - SAT OF BOTTOM LAYER = 1.0 - IN mobss.inf

"5.5ss-4.dat" CRASHED - SAME MESSAGE AS ABOVE, 77 TIME STEPS, 78.41 YRS - RERUN WITH SATURATION OF BOTTOM LAYER SET BACK TO 0.99.

RERUN OF "5.5ss-4.dat" CRASHED AT SAME PLACE AS ABOVE

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RE-RUN "5.5ss-3.dat" AS "5.5~~ss-4~~.dat" - ONLY CHANGE = ALLOW PROGRAM TO DETERMINE STEADY STATE AFTER 10^4 YRS.

10-5-97 MR - "5.5ss-5.dat" FINISHED, TIME TO STEADY-STATE = 10,095 YEARS, TIMESTEPS = 834, TIMESTEPS TO 10,000 YEARS = 736, CPU TIME TO STEADY-STATE = 48,456 s

NOTE - NEW RUN = "5.5ss-6.dat" - IDENTICAL TO "5.5ss-5.dat" EXCEPT GEOTHERMAL GRADIENT IN 'EQUIL' CORRECTED TO 0.02047 FROM 0.0247.

10-6-97 MR — Run "5-5ss-6.dat" crashed at timestep = 505, time = 6141 yrs. Message = "bad vp press in putup.e"

Re-running "5-5ss-6.dat" using the output file produced at 1000 years as initial conditions.

10-7-97 MR — Run "5-5ss-6.dat" reached steady-state at 10,799 years. CPU time = 32,018 s.

10-8-97 MR — New basecase run with heater turned on: "5-5-1.dat" - uses output from "5-5ss-6.dat" as initial conditions.

Run "5-5-1.dat" crashed on Sisyphus Dt = 1 yr, timestep 45: "division by zero".

Note: "5-5-1.dat" also crashed on Sneezy — same time, timestep + error message.

Note - "5-5-1.dat" also crashed when the linear capillary relationship for 'air' was replaced with a van Genuchten relationship - crashed at one year - just as before.

Note - Metra is crashing when it writes to file - for "5-5-1.dat" - changed 1st write time from 1 to 10 yrs - now crashes @ exactly 10 yrs instead of exactly 1.0 yr.

New run - 1st printout @ 0.1 yr for "5-5-1.dat" will run crash @ 0.1 yr - when it prints? - yes! w/ same message - divide by zero!

10-10-97 MR - Re-run "5-5-1.dat without specifying printouts until year 10,000. Run

Appears to comply w/ QAP-001. L. C. [signature] 2/8/2000