LABORATORY NOTEBOOK

CNWRA/SwRI

NOTEBOOK NO.__________

ISSUED TO__________

ON__________ 19____

DEPARTMENT__________

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—SCIENTIFIC NOTEBOOK CO.—
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616-429-8285

INSTRUCTIONS

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

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

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

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

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

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

Form 590

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TITLE USFIC

Project No. 1402-861

Book No. 384

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This Notebook starts a new Project.
Namely development and testing/implementation
of an approach to seepage abstraction.
However, the work follows logically
from Notebooks 285 & 326 and
is strongly correlated with Notebook 301

Continuing on with Sensitivity Analyses
of TEF using MULTIFLO 1.2
and TPA 4.0

Debra L Hughson
210 522 3805

To Page No. ____

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by DLH	Jan 6 2000

Seepage into Drifts: an Approach to Abstraction

Debra L Hughson
Jan 4, 2000

Big Assumption

- Balkanize the repository area into N discrete catchment areas for N individual seeps.
- The probability that a seep path encounters a waste package (WP) is indepedant of all other seeps.

First Big Assumption, Bakanization

Figure 1.

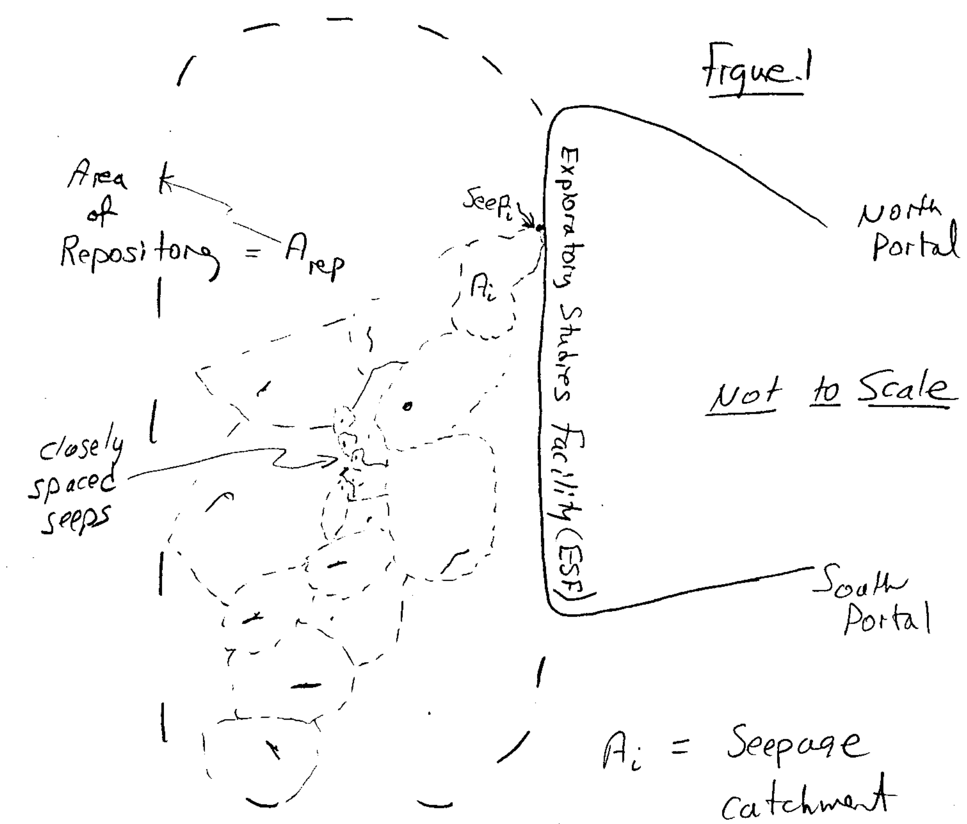
Suppose you tag every water particle entering the Yucca Mountain (YM) vadose zone, I hypothesize the tags would allow identification of seepage catchment areas on the surface, specific to each seep.

Jan 6 2000

A moderate assumption is that liquid flow through unsaturated fractured rock occurs primarily in discrete "fingers" or rivulets.

Ref. Bob Glass' "Blue dye" exper. at the LBT on fran ridge

NRC theoretical review of gravity unstable wetting phase invasion



A_i = Seepage catchment area specific to seep$_i$

For large area, perhaps $A_{rep} = 3 \times 10^6\ m^2$

$$A_{rep} \approx \sum_{i=1}^{N} A_i$$

Jan 6 2000

Assume A_i is iid Log Normal (μ_A, σ_A^2)

Since Bomb Pulse ^{36}Cl spacing interval in ESF is Log Normal $(4, 1.8) \sim (\mu, \sigma)$

$A_i = L_i^2$ is also Log Normal $(\mu_A^2\ \sigma_A^2)$

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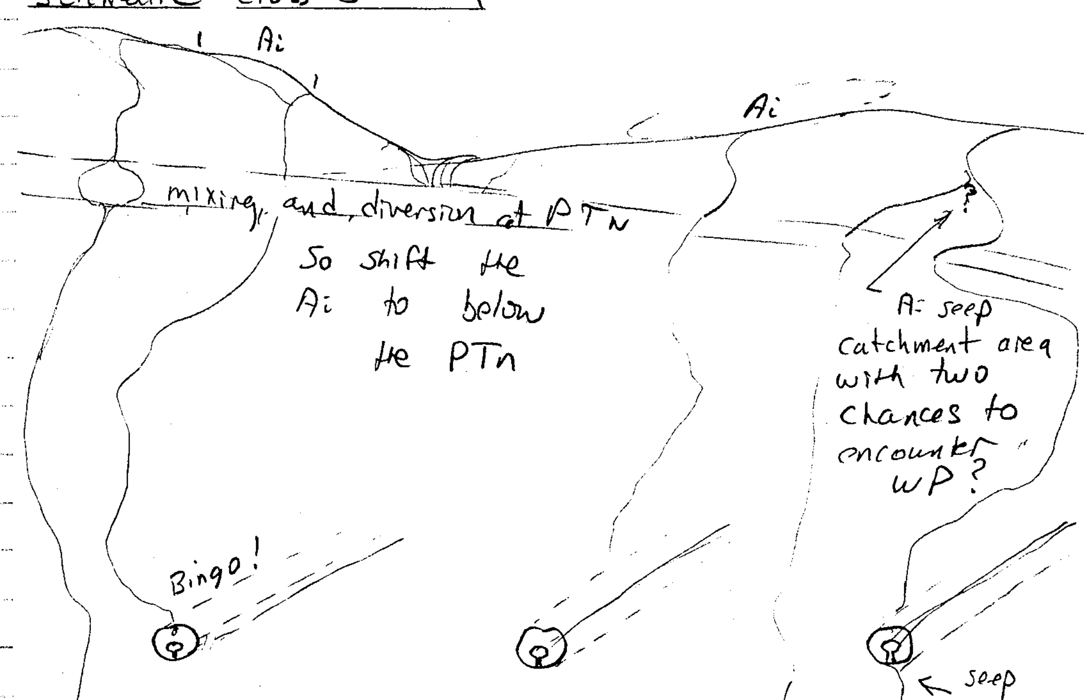
Jan 4, 2000 (3)

Therefore the flow rate in each seep

$Q_i = q\, A_i$ q is net infiltration flux [L/T] uniform constant or LogNormal based on surface infiltration map.

is also Log Normal $\sim \mu_Q\ \sigma_Q$

Schematic Cross-section



A_{wp} = (width of WP) X (entire length of emplacement)

Jan 6 2000

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Second Big Assumption

If you knew nothing other than a seep existed somewhere in A_{rep} and you were going to bet whether or not it dripped, how would you bet? I think the probability a PARTICULAR seep existing near the drift wall crown must be about $p \approx \frac{A_{wp}}{A_{rep}}$

If true and seeps are independent then the Number of seeps in the repository at the drift crown (within the width of WP) is

$\sim \text{Binomial}(Np,\ Np(1-p))$

and their flow rate is

$\sim \text{Log Normal}(\mu_Q\ \sigma_Q^2)$

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Jan 4, 2000 (5)

Given:

- q - infiltration map
- A_{rep} - site design
- A_{wp} - site design

Estimate:

μ, σ^2 } from elevated ^{36}Cl (length scale); secondary minerals (area scale)

Draw realizations of

$$A_i = L_i^2 \quad \text{from } L_N \sim (\mu, \sigma^2)$$

$$\sum_{i=1}^{N} A_i \approx A_{rep} \quad \text{is } N \text{ of seeps}$$

# of seeps with potential to drip

$$\sim \text{Binomial}(Np,\ Np(1-p))$$

Flow rate of seeps $Q_i = q A_i$

$$\sim \text{Log Normal}(\mu_Q\ \sigma_Q^2)$$

Jan 13 2000

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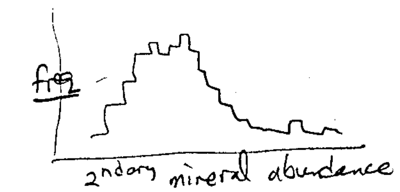
Jan 4 2000 (6)

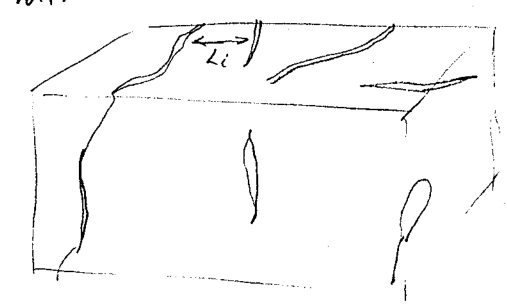
How to Estimate μ, σ^2 ?

Length scale of elev ^{36}Cl, longer L_i
Biased towards
N too small ~ 20 for $\mu = 4 \ln(m)$, $\sigma = 1.8$

Area scale A_i ?
2^{ndary} mineral abundance % on ESF survey



both, use spacing on 2^{ndary} mineralized zones and toss wide intervals or use lower ^{36}Cl cut off



Should

$$N \approx \frac{A_{rep}}{A_{ESF}} (\#\text{ of "fast paths" id in ESF}) \quad ?$$

then $A_i = \pi L_i^2$?

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Jan 8 2000 (7)

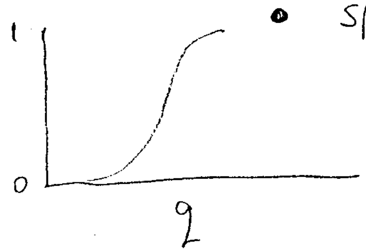
Abstraction

A_{rep} $A_i \sim$ Log Normal$(\mu\ \sigma)$

$\sum_{i=1}^{N} A_i \approx A_{rep}$ A_{rep} = Area of repository

q = infiltration — get from Stu's map

- histogram
- spatial map corr to $A(x_i)$



Histogram means

$Q_i = q A_i \sim LN(\mu_Q\ \sigma_Q)$

Spatially corelated $q \sim A_i$

Higher q with smaller A_i

$Q = q(x_i) A(x_i) \sim$?

smaller σ_Q ?

1 seep hits 1 WP

N_{wp} = # of WP

N_{wp}^d = # WP dripped

$N_{wp}^d = F_{wet} N_{wp}$ $N_{wp}^d \sim$ Binomial$(Np, Np(1-p))$

A_{wp} = area of WP $p = \frac{A_{wp}}{A_{Rep}}$

Jan 13 2000 DH

Estimate μ σ of $A_i \sim LN(\mu\ \sigma)$ (8)

$A_i = \lambda L_i^2$ λ = dimensionless factor relating seepage catchment area to seepage spacing

$L \sim$ from Features of Interest

$\mu_L \cong .95$

$\sigma_L \cong 1.55$

$\sum_{i=1}^{N} \lambda L_i^2 \approx A_{rep}$

$A_i = \lambda L_i^2$ ~ analytical expression → μ σ

~~Distr of N~~ DH Sept 7 2000

Draw A_i from $LN(\mu\ \sigma)$

Find N $\sum_{i=1}^{N} A_i \approx A_{rep}$

Draw N_{wp}^d from Binomial$(Np, Np(1-p))$

$F_{wet} = \frac{N_{wp}^d}{N_{wp}}$ $Q(N_{wp}^d) \sim \mu_Q\ \sigma_Q$ probably LN

F_{ov} =

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Jan 8 2000

TPA 3.2 Review

Deep percolation = avg MAI (t) for each subarea
q = MAI(t) after reflux (if any)

$q_{in} = q\, F_{ow}\, F_{mult}$

q_{in} (plan area of WP) = flow ~~potentially~~ contacting WP $[L^3/T]$ DJ 9/7/00

F_{ow} = focusing of flow > 1 or divergence < 1

F_{mult} = rear drift diversion

F_{wet} = fraction of WP contacted

	⟨MAI⟩	$\langle K_{sat}^{matrix} \rangle$	F_{wet}	F_{ow}
⟨MAI⟩	1	0	.631	-.224
$\langle K_{sat}^{matrix} \rangle$		1	-.623	.13
F_{wet}			1	-.366
F_{ow}				1

LogNormal .2e-19 m² .2e-17

DJ Jan 13 2000

F_{ow} Log Normal (.01, 3.0)
F_{mult} Log Normal (.01, .2)
F_{wet} = Uniform (0., 1.)

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From TPA 3.2 $(A_{swp}\, q\, F_{ow} F_{mult})\, F_{wet}\, N_{wp} = Q_T$
flow rate /WP

I Presume

$A_i \sim$ Log Normal $(\mu\ \sigma)$

$\sum_{i=1}^{N} A_i \approx A_{rep}$ sub-area, repository

$N_{wp}^{d} \approx$ Binomial $(Np, Np(1-p))$

[which A_i are the subset A_j $j=1..N_{wp}^{d}$?]

subsample choose N_{wp}^{d} of the A_i

DJ Jan 13 2000

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Project No. 1402-861
Book No. 384 TITLE USFIC

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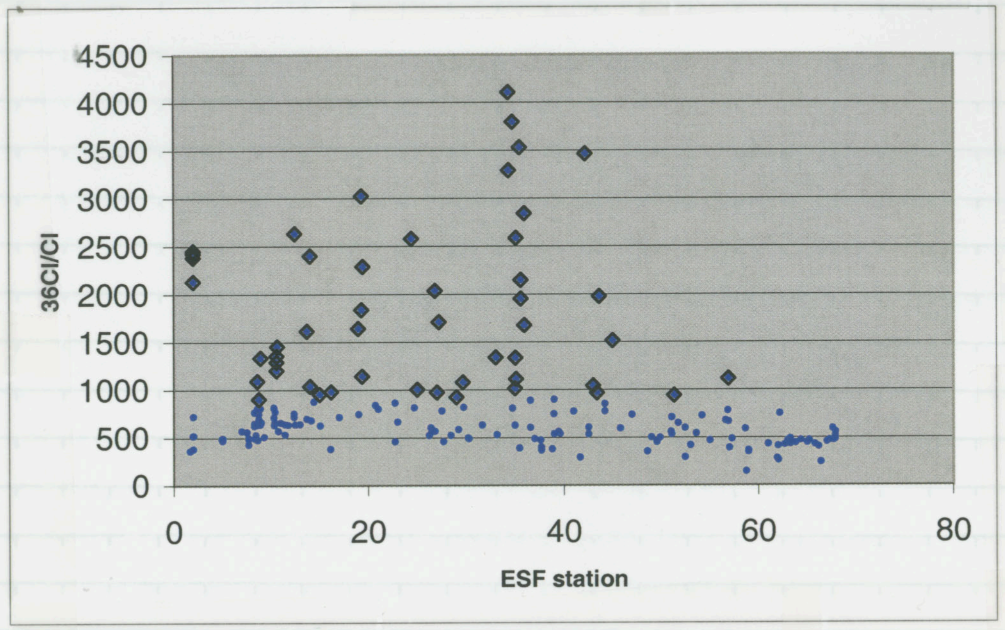
^{36}Cl data that Bill Murphy gave me.
Presumeably from the Fabryka-Martin et al 1996 or 1997 paper.



Selected all data > 900

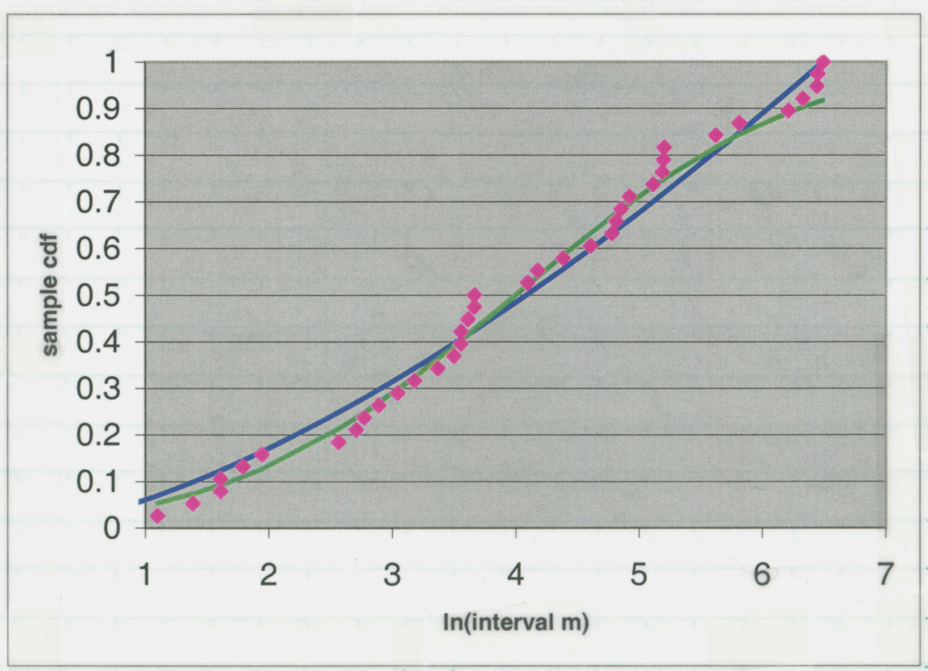
ln(L)

L = interval between >900 $^{36}Cl/Cl$

Green line
$LN(\mu_{lnL}, \sigma_{lnL})$

Blue line
$\frac{x^{1.5}}{m^{1.5}}$

m = maximum ln(L)



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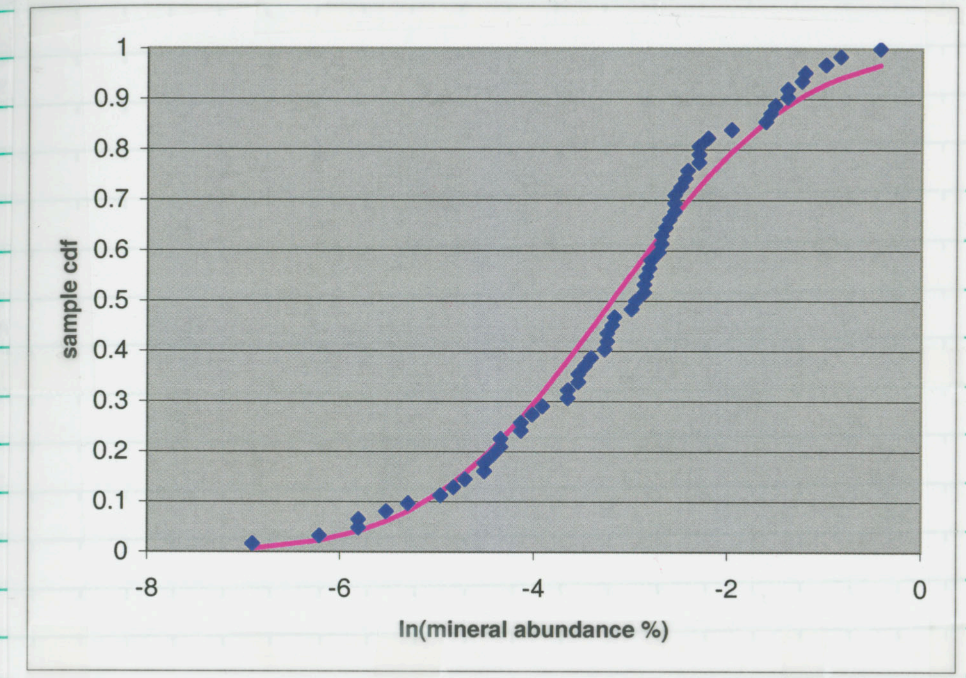
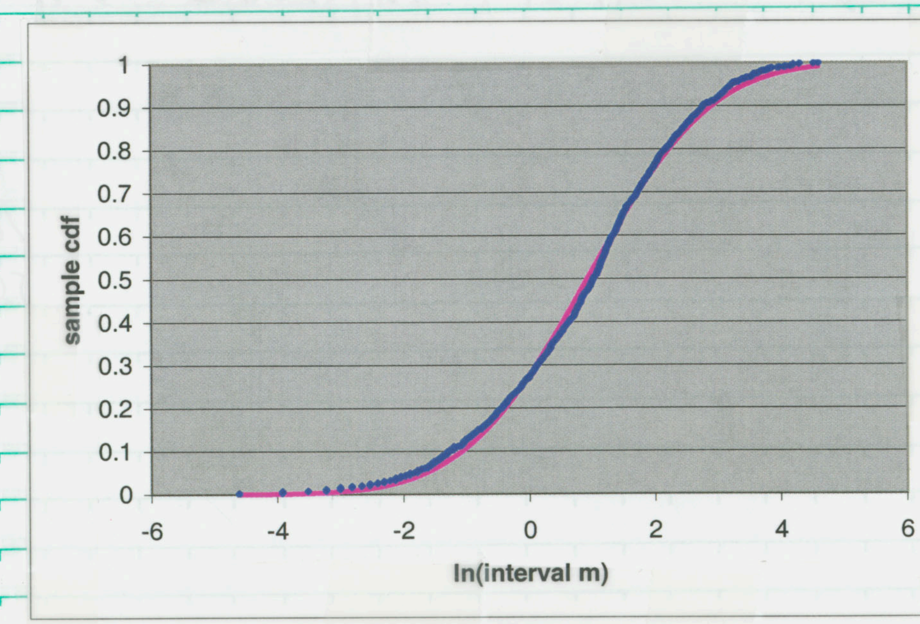


Calcite & Opal Abundance %
from USGS SPC 237M4
Paces et al 1998

$\mu_{lnA} = -3.2$
$\sigma_{lnA} = 1.5$

Features of Interest from Deb Waiting DTN (following pg)
Faults, Fault zone
Fracture
shear zone



$\mu_{lnL} = .92$

$\sigma_{lnL} = 1.55$

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Relationship between Length scale distribution and area distribution.

random number seed idum = 77

~dhughson/seepage/aldist.f

Generate uniform (0,1) distribution of points on an 1733 m x 1733 m area.

Select all points $866 \le y < 873$ as in-drift

Saturday, January 15, 2000

Scott Painter reminded me uniform points on a line, interval ~ exp(λ)

Checked this with code aldist.f

Data ⟹ 36 Cl/Cl intervals and Features of Interest

BOTH are almost log Normal, not very exp

Simulation 1735 m x 1733 m generate 10000 = N points uniform in space choose subset all 866 m ≤ y ≤ 873 L = intervals in x

A mesh dirchlet cells of all N

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Features of Interest L = intervals
features scale.xls
⟹ Log Normal (pretty good) μ = .95 σ = 1.55 (sample μ = .866 σ = 1.555)

Exponential (not as good) λ = .15

36Cl/Cl Data L = intervals
Cl-36scale.xls
⟹ Log Normal (pretty good) μ = 4 σ = 1.8 (sample μ = 4.005 σ = 1.547)

Exponential (not as good) λ = .009

fitted by eye

Simulation 1733 m x 1733 m 7m interval on y.
area.xls
on 7m width 36 points 35 = #of L intervals

Length $N_L = 35$

Log Normal (OK) μ = 3.5 σ = 1 (sample μ = 3.359 σ = 1.295)

Exponential (pretty good) λ = .02

fitted by eye

AREA N = 10000 cells

Log Normal (pretty good) μ = 5.56 σ = .56 (sample μ = 5.536 σ = .569)

Gamma (OK) α = 6 β = 1/λ = 50

1/15/2000

Conclusion ⟹ ~~Go with~~ DH Let the Data decide, Go with Log Normal

fit by eye

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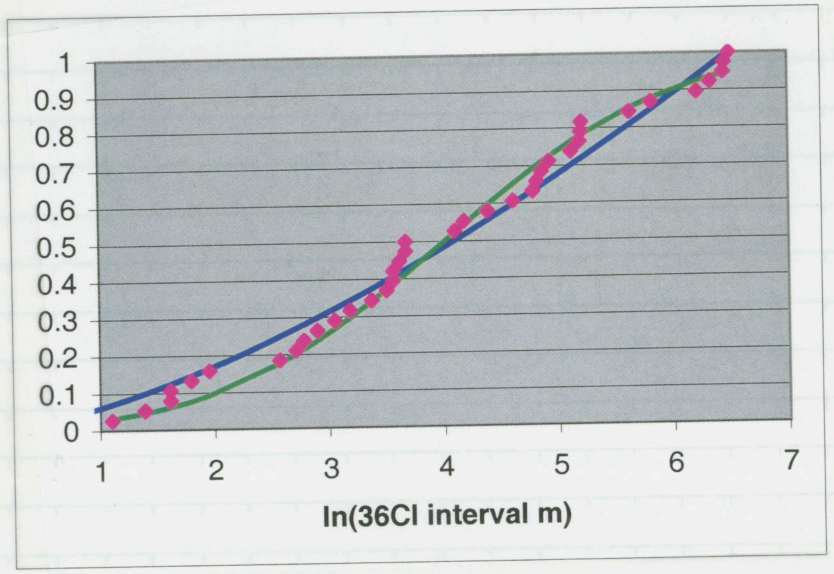
CDF of bomb pulse 36Cl /Cl

Log Transform L = interval between elev 36Cl/Cl

μ = 4.005

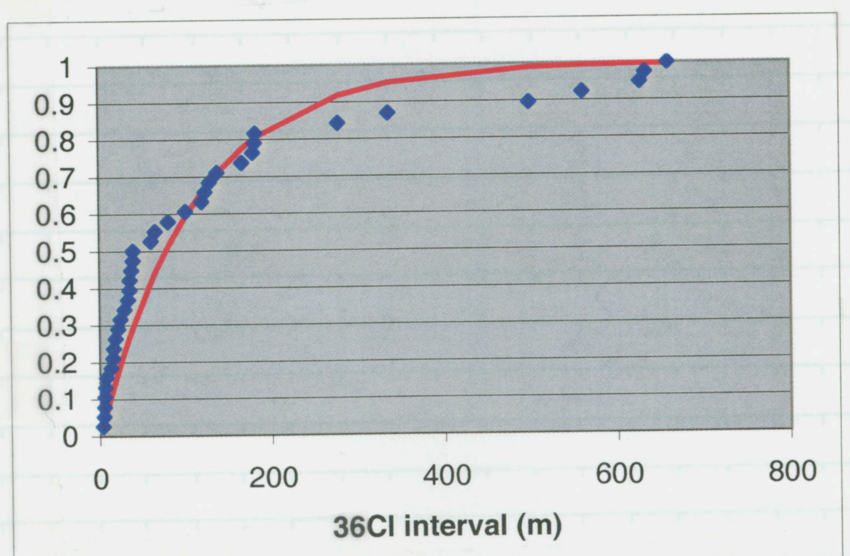
σ = 1.547



NOT Ln transform

exp

λ = ,009



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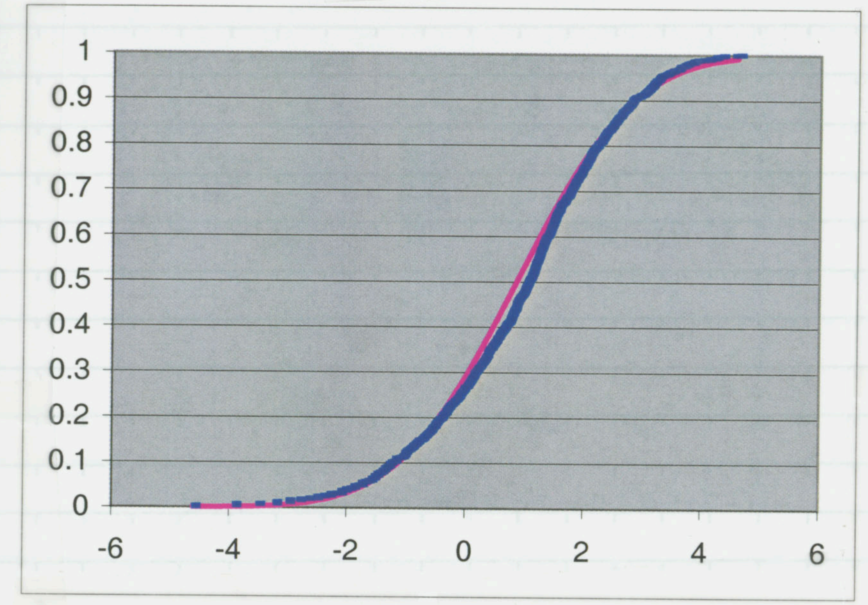
Features of Interest

Log transform L = interval between

μ = 0.866

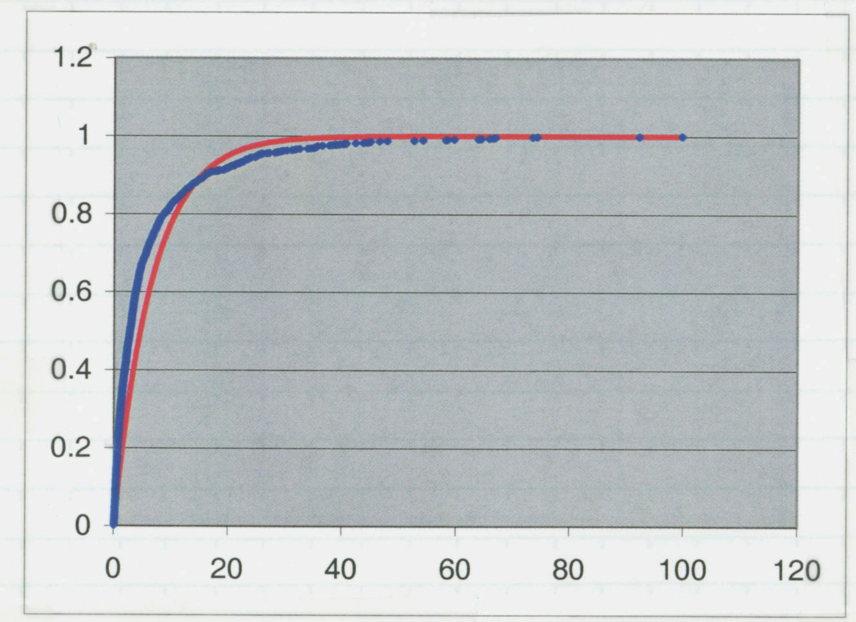
σ = 1.555



NOT Ln Transfm

exp

λ = 0.15



ESF Data ~~appears~~ Interval appears more
Log Normal than Exponential

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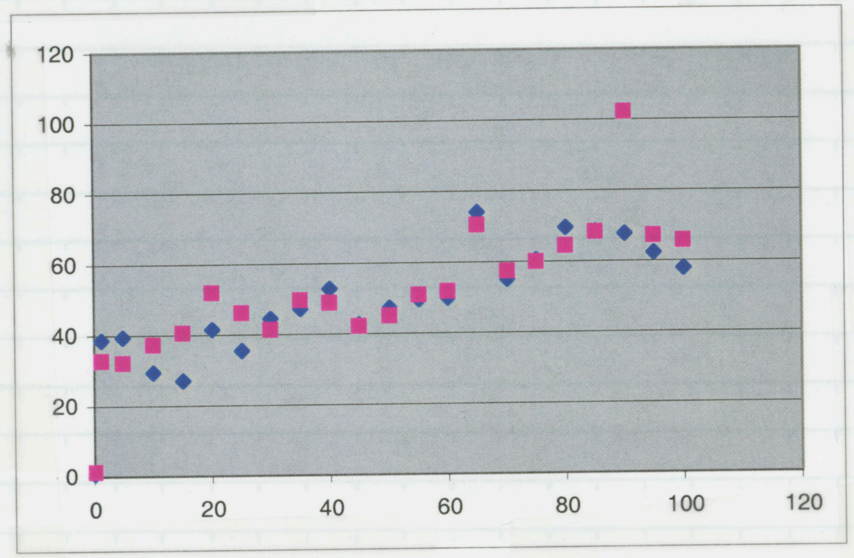
Variogram of Interval - L interval assigned to beginning and to ending point of interval From Features of Interest

γ(log)



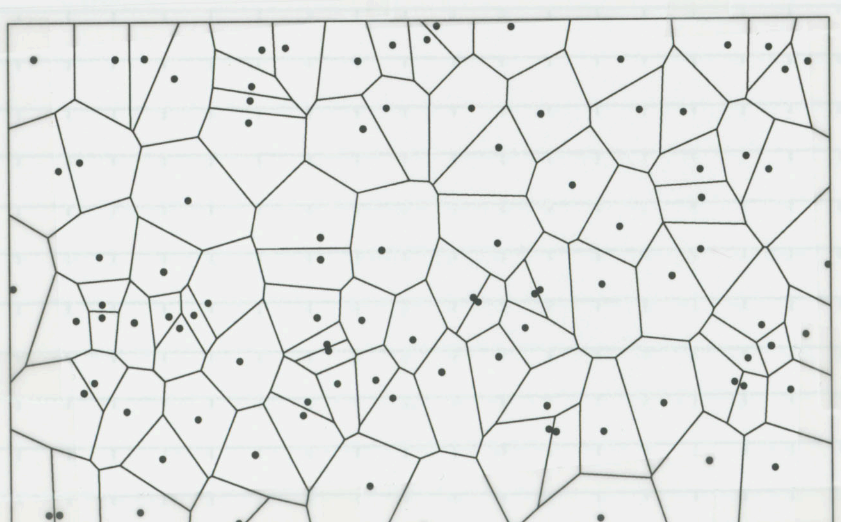
length of Interval variogram

log (m)

White noise — very little correlation — independent L

100 pts uniformly scattered over
x = 2000 m
y = 1000 m

Area from Amesh



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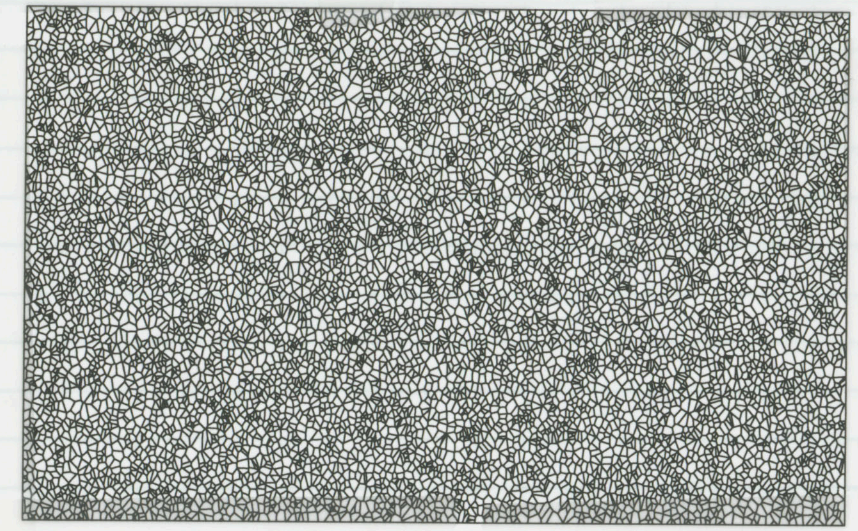

10,000 pts scattered uniformly over
0 ≤ x ≤ 2000 m   0 ≤ y ≤ 1000 m
Get line data from 500 ≤ y ≤ 507
Find intervals from x-coordinate
Find areas from amesh
look at CDF's of log transformed LogN
& un-transformed data Exp

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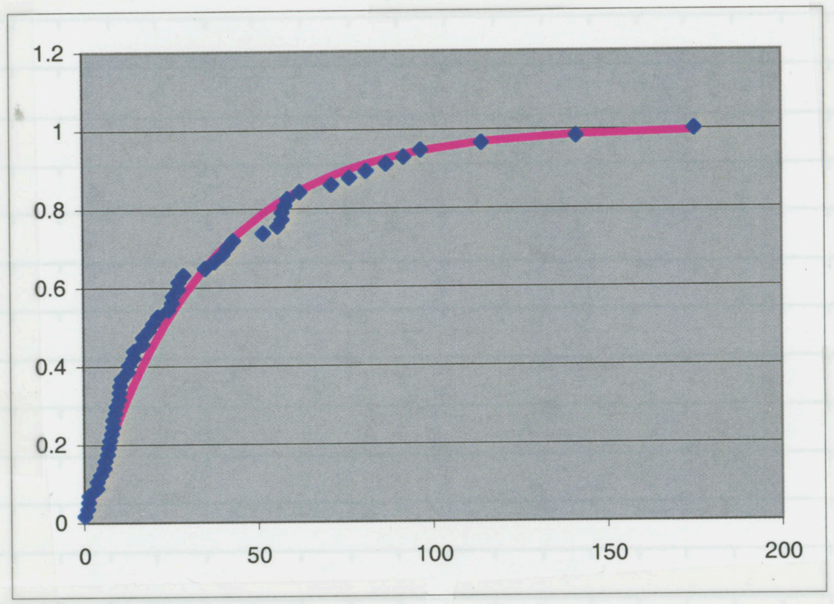
Length scale from Intervals $N = 57$

EXP

$\lambda = .03$



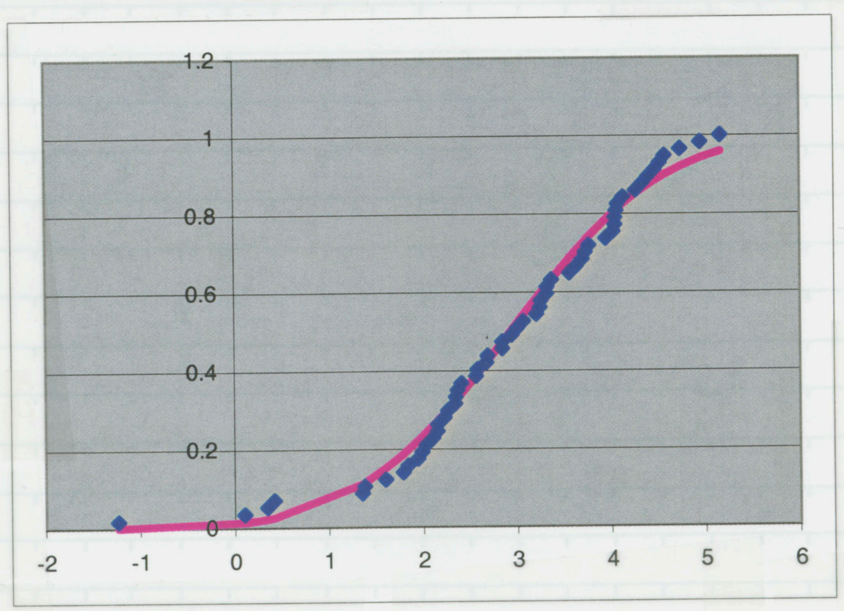
LogNormal

$\mu = 2.927$

$\sigma = 1.289$

K-S d
6.63e-2

Significance
.957



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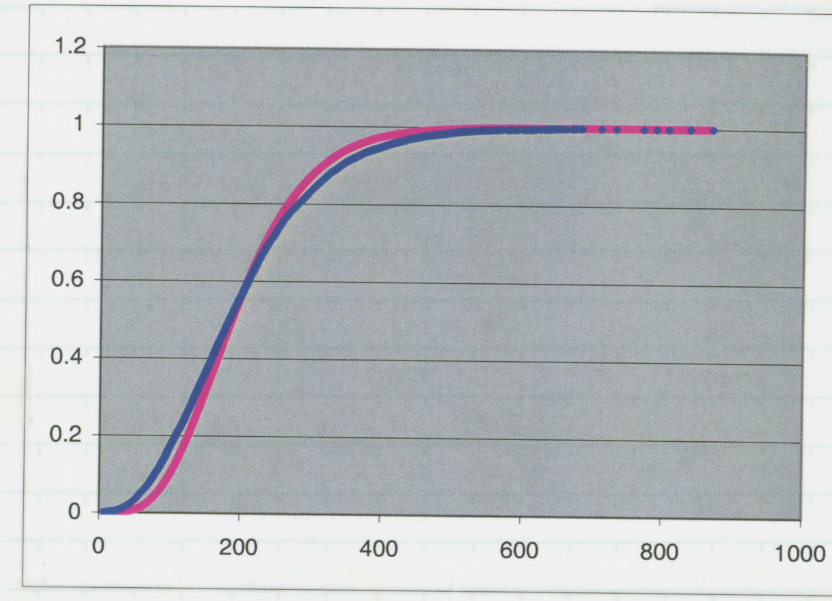
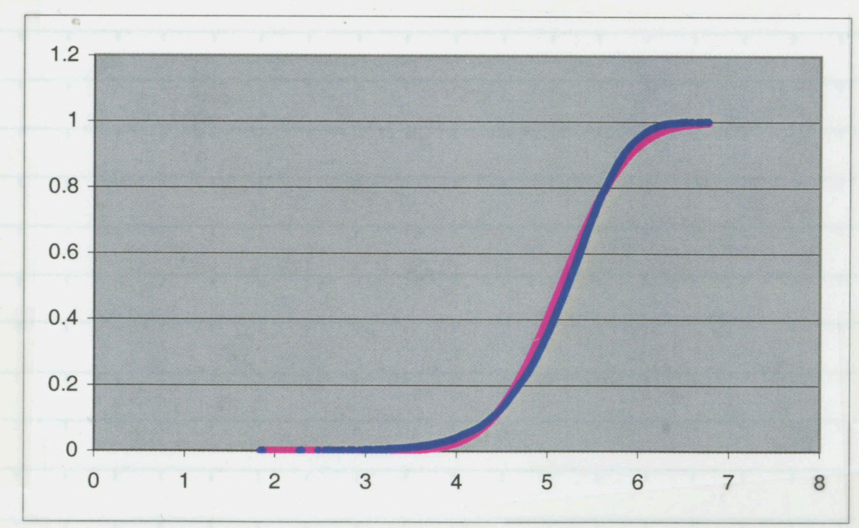
Area Scale (Anesh) $N = 10000$



GAMMA

$\alpha = 5.4$

$\beta = 37$



LogNormal

$\mu = 5.146$

$\sigma = .5847$

K-S $d = 4.82e-2$ Significance $= 0$

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simulations on area $0 \le x \le 2000$ $0 \le y \le 1000$
to find relationship between intervals and areas

N_A	N_L	μ_L	σ_L	d_L	$sign_L$	random seed idum
10,000	58	2.927	1.289	.0663	.957	77
10000	68	2.873	1.172	.0928	.590	
10000	80	2.746	1.074	.0831	.628	-999
10,000	91	2.476	1.287	.1011	.30	-1234
10,000	80	2.697	1.172	.0992	.400	-4321
10 000	69	2.813	1.172	.1242	.22	-555
10,000	74	2.689	1.396	.1336	.136	-3367
5000	35	3.619	1.025	.1323	.561	-999
5000	27	3.856	1.025	.090	.98	-111
5000	43	3.3595	1.143	.208	0	-222
5000	44	3.1594	1.282	.123	.51	-333
5000	36	3.570	.9557	.156	.33	-555
5000	39	3.152	1.467	.166	.22	-777
5000	36	3.336	1.498	.124	.63	-888
15000	97	2.4246	1.2856	.106	.21	-233
15000	99	2.443	1.235	.095	.32	-332
15000	110	2.3017	1.2361	.105	.17	-456
15000	98	2.389	1.3181	.103	.24	-654
20000	147	2.0338	1.2737	.092	.16	-987
20000	132	2.0784	1.2888	.109	.08	-665
20 000	129	2.1673	1.2709	.114	.07	-666
20000	132	2.1303	1.2012	.06	.69	-998
25000	175	1.8413	1.2397	.072	.32	-889
25000	219	1.7044	1.1909	.081	.11	-775
25000	184	1.785	1.301	.098	.06	-678
25000	169	1.9274	1.1806	.069	.39	-212

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μ_A	σ_A	d_A	$sign_A$	f_μ	f_σ
5.1466	.5847	.0482	0	1.258	.454
5.153	.5658	.0373	0	1.794	.483
5.144	.5855	.0383	0	1.873	.545
5.149	.5740	.0360	0	2.080	.4460
5.150	.5770	.0453	0	1.910	.492
5.146	.5851	.0453	0	1.829	.499
5.147	.5785	.0406	0	1.914	.4144
5.840	.5806	.0465	0	1.614	.5664
5.831	.5979	.0427	0	1.512	.5833
5.830	.6002	.041	0	1.735	.525
5.834	.5918	.043	0	1.847	.462
5.838	.5876	.041	0	1.635	.615
5.841	.5765	.041	0	1.853	.393
5.841	.5773	.040	1e-7	1.751	.385
4.741	.5814	.04	0	1.955	.452
4.742	.5771	.043	0	1.941	.467
4.738	.5887	.044	0	2.058	.476
4.7408	.5825	.042	0	1.984	.442
4.4575	.5724	.039	0	2.192	.449
4.4581	.5727	.043	0	2.145	.44437
4.456	.5726	.038	0	2.056	.4505
4.4554	.5758	.041	0	2.091	.479
4.231	.5812	.041	0	2.298	.4688
4.2311	.5809	.042	0	2.482	.4878
4.232	.5769	.038	0	2.371	.4434
4.232	.5784	.038	0	2.196	.4899

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N_A	N_L	μ_L	σ_L	d_L	Prob d	idem
30000	192	1.7936	1.275	.092	.076	-123
30000	232	1.5366	1.3615	.107	.009	-707
30000	201	1.7358	1.2869	.111	.012	-757
30000	220	1.6386	1.2429	.085	.08	-557
40000	291	1.4153	1.1729	.081	.04	-606
40000	276	1.38675	1.1892	.057	.32	-400
50000	348	1.2784	1.3472	.08	.02	-456
50000	333	1.2633	1.2084	.07	.08	-654
60000	422	.97568	1.2356	.084	.005	-923
60000	397	1.0482	1.2551	.08	.01	-765

Working directory is ~dhughson/seepage

code to distribute points over the x=2000 m y= 1000m domain is aldist.f

outputs two files:
aldistmap.dat coordinates of points on the map
~~aldistmap~~ Jan 28 2000 DLL
aldistline.dat coordinates of points in 500 ≤ y ≤ 507

Random Number generator Uniform ~(0,1)
rnun01 from Numerical Recipes

Mathematica notebook D:\documents\seepage\aldist.nb to plot figures and write input for amesh

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μ_A	σ_A	d_A	prob d	f_{μ}	f_{σ}
4.052	.57344	.044	0		
4.05	.5777	.041	0		
4.0513	.5750	.042	0		
4.0508	.5745	.041	0		
3.7608	.5801	.039	0		
3.7644	.5723	.038	0		
3.5391	.5774	.04	0		
3.5403	.5749	.039	0		
3.3587	.5728				
3.3581	.5737				

Code AMESH to calculate areas
~~Code~~ DLL Jan 28 2000 Code lnorm.f calculates means and standard deviations for ln(L) and ln(A) and uses these in a Kolmogorov-Smirnov test for normality. The KS routine is ksone from Numerical Recipes and the cummulative normal cdfnor I got from ~~netlib~~ DLL Jan 28 2000 netlib at ornl.gov

lnormd.f is modified to test KS stat for any old data set.

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From the NRC/DOE Tech Exchange Fall 1999 the following information regarding EDA II design was obtained

$A_{rep} \approx 1060$ acres

$1060 \text{ acre} \cdot \frac{43560 \text{ ft}^2}{\text{acre}} \left(\frac{\text{m}}{3.28 \text{ ft}}\right)^2 \simeq 4.3 \times 10^6 \text{ m}^2$

Length of emplacement drift = 54000 m

* Assume WP width ≈ 1.6 m

$A_{EWP} \approx 86400 \text{ m}^2$

$p = \frac{A_{EWP}}{A_{rep}} \approx 0.02$

# of WP = 10039

simulator nuweeps.f

normal deviates normal from Numerical Recipes which uses ran01

Binomial deviates from bnldev also from Numerical Recipes

$\sigma_{\ln A} \stackrel{\sim}{=} 0.6$

$\mu_{\ln A} = (.995)\mu_{\ln L} + 2.39$

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from
$^{36}Cl/Cl$ $\mu_{\ln L} = 4.0$ $\mu_{\ln A} = 6.37$ $\sigma_{\ln A} = .6$

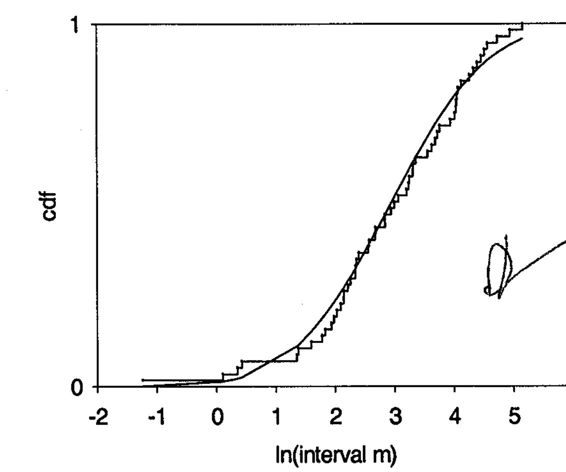

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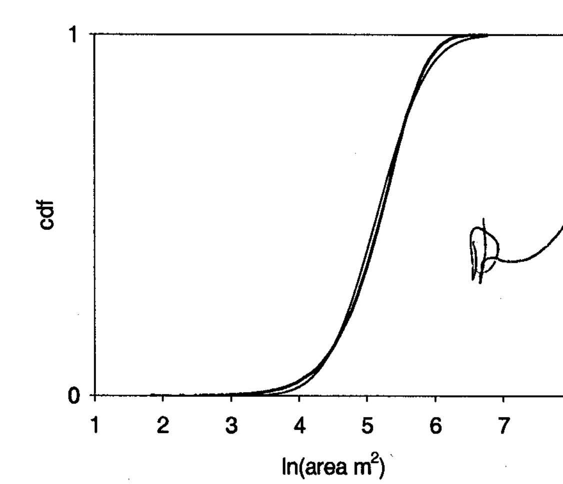
Figure 8. Sample cdf of log-transformed intervals (*x* coordinate) of simulated points falling within a 7 m wide band. The cumulative normal cdf shown has mean 2.93 and standard deviation 1.29.



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on page 19 in this book

Figure 9. Sample cdf of the 10000 areas shown in Figure 7. The cumulative normal distribution has a mean of 5.15 and standard deviation 0.585.

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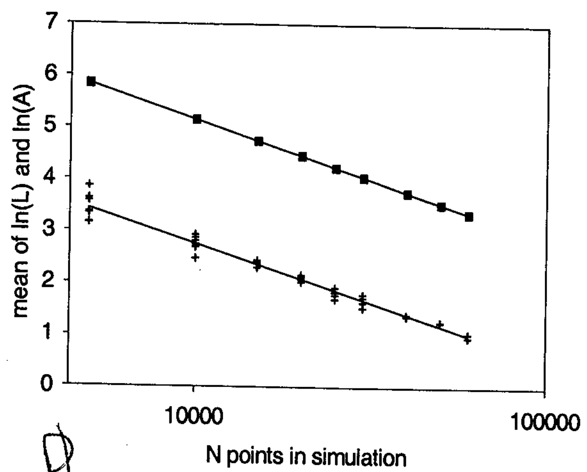

Figure 10. Means of simulated ln(L) (+ symbols) and simulated ln(A) (solid square symbols) showing a linear relationship with ln(N).

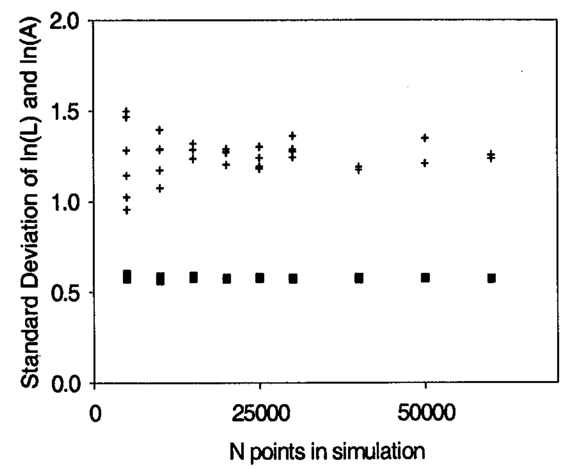

Figure 11. Standard deviations of simulated ln(L) (+ symbols) and ln(A) (solid square symbols) appear to be relatively constant at about 1.25 and 0.58, respectively, independent of N.

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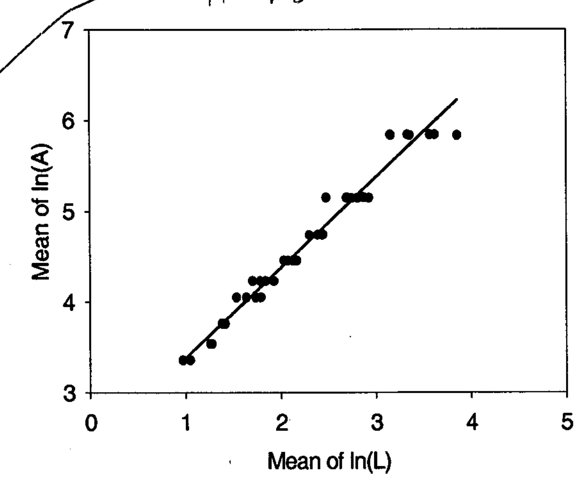

Figure 12. Linear relationship between simulated means of ln(L) and ln(A).

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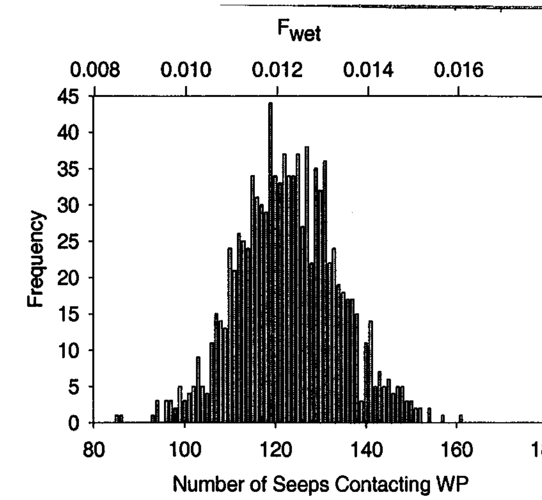

Figure 13. Monte Carlo simulations of number of seeps contacting WP and fraction of wetted WP, F_{wet}, based on intervals between bomb pulse ^{36}Cl samples in the ESF.

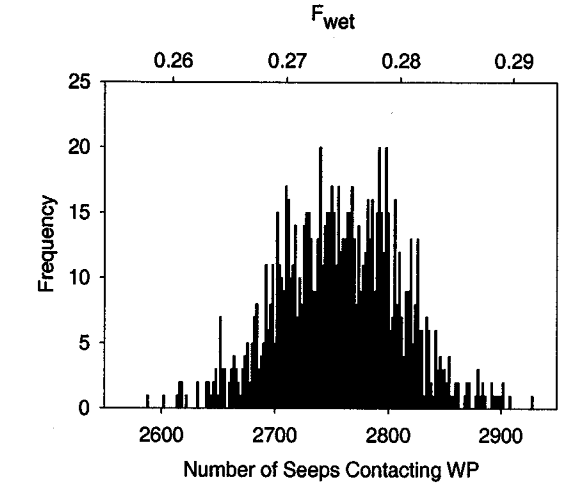

Figure 15. Monte Carlo simulations of the number of seeps contacting WP and fraction of wetted WP, F_{wet}, based on intervals between features in the ESF identified as faults, fracture zones, and shear zones.

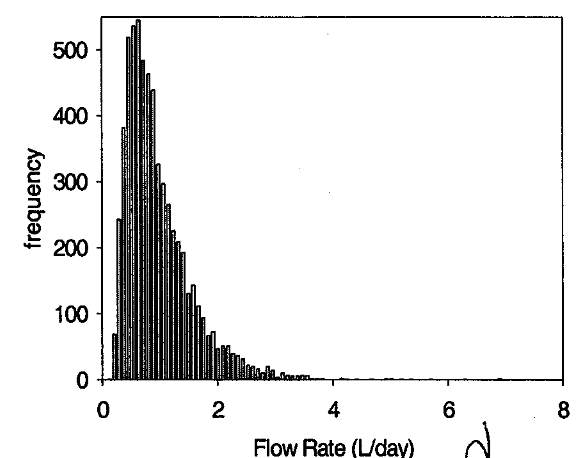

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Figure 14. Histogram of flow rates from a single Monte Carlo realization using frequency of preferential flow based on ^{36}Cl intervals.

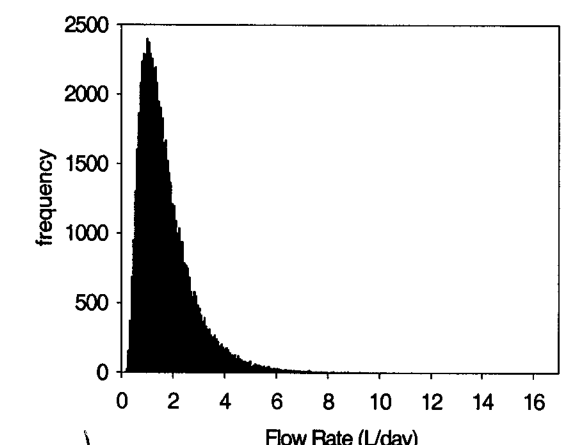

Figure 16. Histogram of flow rates from a single Monte Carlo realization using frequency of preferential flow based geologic features in the ESF identified as faults, fracture zones, and shear zones.

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~dhughson/seepage/nuweeps.f

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30 m 60 cm 100 200

Table 1. Calcite and opal abundances in the Exploratory Studies Facility (ESF)

[Individual survey intervals are 60-centimeter-wide bands centered on a 30-meter-long tape stretched along the right rib of the ESF at a height of about 1.2 to 1.7 meters above the concrete invert. Thickness and width of individual calcite and opal deposits in this band are used to calculate areas of hydrogenic minerals, which are summed and divided by the total area of uncovered rock wall within the band to obtain abundances in percent. ESF stations are linear distances in meters starting from the north portal. Stratigraphic units are from Buesch and others (1996). No., number; lith, lithophysal; nonlith, nonlithophysal; Tpc-w, Tiva Canyon welded; PTn, Paintbrush Tuff nonwelded; Tpt-w, Topopah Spring welded; (—), tuffs not belonging to Paintbrush Group; n.a., not applicable; dup, duplicate]

Survey identifier	ESF station, start	No. of deposits	Calcite and opal abundance: All forms[1]	Calcite and opal abundance: Lithophysae only	Hydro-geologic unit	Stratigraphic unit: Abbrev-iation	Stratigraphic unit: Formation	Stratigraphic unit: Zone
19971202-01a	100	18	0.20	0.002	Tpc-w	Tpcpmn	Tiva Canyon Tuff	Middle nonlith
19971202-02a	200	3	0.089	0.000	n.a.	Pre-Rainier BT	—	—
19971202-03a	300	1	0.008	0.000	n.a.	Tuff 'X'	—	—
19971202-04a	400	3	0.068	0.000	Tpc-w	Tpcm	Tiva Canyon Tuff	Nonlith
19971202-05a	500	8	0.083	0.006	Tpc-w	Tpcpul	Tiva Canyon Tuff	Upper lith
19971202-06a	600	13	0.078	0.000	Tpc-w	Tpcpll-Tpcpln	Tiva Canyon Tuff	Lower lith-lower nonlith
19971202-07a	700	8	0.042	0.000	Tpc-w	Tpcpln	Tiva Canyon Tuff	Lower nonlith
19971202-08a	800	0	0.000	0.000	PTn	Tpcpv	Tiva Canyon Tuff	Vitric
19971202-09a	900	0	0.000	0.000	PTn	Tpp	Pah Canyon Tuff	n.a.
19971202-10a	1000	1	0.007	0.000	PTn	Tpp	Pah Canyon Tuff	n.a.
19960625-11a	1100	3	0.013	0.000	PTn	Tptrv	Topopah Spring Tuff	Nonlith
19960625-12a	1200	4	0.061	0.000	Tpt-w	Tptrn	Topopah Spring Tuff	Nonlith
19960625-13a	1300	10	0.37	0.000	Tpt-w	Tptrn	Topopah Spring Tuff	Nonlith
19960625-14a	1400	2	0.10	0.000	Tpt-w	Tptrn	Topopah Spring Tuff	Nonlith
19960625-15a	1500	8	0.10	0.009	Tpt-w	Tptrn	Topopah Spring Tuff	Nonlith
19960625-16a	1600	4	0.25	0.001	Tpt-w	Tptrn	Topopah Spring Tuff	Nonlith
19960625-17a	1700	0	0.000	0.000	Tpt-w	Tptrn-Tptrl	Topopah Spring Tuff	Nonlith – lith transition
19960625-18a	1800	0	0.000	0.000	Tpt-w	Tptpul	Topopah Spring Tuff	Upper lith
19960625-19a	1900	1	0.013	0.000	Tpt-w	Tptpul	Topopah Spring Tuff	Upper lith
19960625-20a	2000	2	0.016	0.016	Tpt-w	Tptpul	Topopah Spring Tuff	Upper lith
19960625-21a	2100	0	0.000	0.000	Tpt-w	Tptpul	Topopah Spring Tuff	Upper lith

Tpt

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Table 1. Calcite and opal abundances in the Exploratory Studies Facility (ESF) – Continued

Survey identifier	ESF station, start	No. of deposits	Calcite and opal abundance: All forms[1]	Calcite and opal abundance: Lithophysae only	Hydro-geologic unit	Stratigraphic unit: Abbrev-iation	Stratigraphic unit: Formation	Stratigraphic unit: Zone
19960712-22a	2200	36	0.65	0.25	Tpt-w	Tptpul	Topopah Spring Tuff	Upper lith
19960625-22a (dup)[2]	2200	29	0.48	0.31	Tpt-w	Tptpul	Topopah Spring Tuff	Upper lith
19960712-23a	2300	1	0.003	0.003	Tpt-w	Tptpul	Topopah Spring Tuff	Upper lith
19960712-24a	2400	8	0.057	0.057	Tpt-w	Tptpul	Topopah Spring Tuff	Upper lith
19960712-25a	2500	6	0.026	0.026	Tpt-w	Tptpul	Topopah Spring Tuff	Upper lith
19960712-26a	2600	17	0.14	0.14	Tpt-w	Tptpul	Topopah Spring Tuff	Upper lith
19960712-27a	2700	14	0.30	0.30	Tpt-w	Tptpul-Tptpmn	Topopah Spring Tuff	Upper lith-middle nonlith
19960712-27b	2750	2	0.009	0.009	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19960712-29a	2900	12	0.25	0.10	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19960712-30a	3000	4	0.43	0.43	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19971201-31a	3120	13	0.036	0.036	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19971201-32a	3200	2	0.004	0.004	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19971201-33a	3300	7	0.076	0.060	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19971202-34a	3400	8	0.087	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961218-35a	3500	12	0.068	0.004	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961218-36a	3600	2	0.001	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19971202-36b	3670	2	0.018	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961218-38a	3800	4	0.011	0.011	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961218-39a	3900	8	0.066	0.010	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961218-40a	4000	1	0.003	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961218-41a	4100	5	0.039	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961218-42a	4200	8	0.031	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961218-43a	4300	4	0.016	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961218-44a	4400	1	0.005	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961218-45a	4500	3	0.10	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961218-46a	4600	5	0.026	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith

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Book No. 384 TITLE USFIC

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Table 1. Calcite and opal abundances in the Exploratory Studies Facility (ESF) – Continued

Survey identifier	ESF station, start	No. of deposits	Calcite and opal abundance: All forms[1]	Calcite and opal abundance: Lithophysae only	Hydro-geologic unit	Stratigraphic unit: Abbrev-iation	Stratigraphic unit: Formation	Stratigraphic unit: Zone
19961218-47a	4700	4	0.011	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961218-48a	4800	6	0.029	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961218-49a	4900	11	0.078	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961008-49a (dup)[2]	4900	4	0.029	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961008-50a	5000	2	0.052	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961008-51a	5100	9	0.29	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961008-52a	5200	2	0.050	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961008-53a	5300	6	0.041	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961008-54a	5400	5	0.058	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961008-55a	5500	7	0.057	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961008-56a	5600	14	0.074	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961008-57a	5700	1	0.002	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961008-58a	5800	0	0.000	0.000	Tpt-w	Tptpll	Topopah Spring Tuff	Lower lith
19961008-59a	5900	0	0.000	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961008-60a	6000	6	0.11	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961008-61a	6100	3	0.039	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961008-62a	6200	4	0.071	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith
19961217-63a	6300	17	0.12	0.012	Tpt-w	Tptpmn-Tptpul	Topopah Spring Tuff	Middle nonlith - upper lith
19961008-63a (dup)[2]	6300	23	0.22	0.032	Tpt-w	Tptpmn-Tptpul	Topopah Spring Tuff	Middle nonlith - upper lith
19961217-64a	6400	2	0.020	0.020	Tpt-w	Tptpul	Topopah Spring Tuff	Upper lith
19961217-65a	6500	3	0.012	0.012	Tpt-w	Tptrl-Tptm	Topopah Spring Tuff	Lith – nonlith
19961217-66a	6600	1	0.033	0.000	Tpt-w	Tptm	Topopah Spring Tuff	Nonlith
19961217-67a	6700	0	0.000	0.000	PTn	Tpcpv	Tiva Canyon Tuff	Vitric
19961217-68a	6800	1	0.060	0.060	Tpt-w	Tptpul	Topopah Spring Tuff	Upper lith
19961217-69a	6900	2	0.029	0.000	Tpt-w	Tptm	Topopah Spring Tuff	Nonlith
19970715-71a	7100	4	0.21	0.000	Tpt-w	Tptpmn	Topopah Spring Tuff	Middle nonlith

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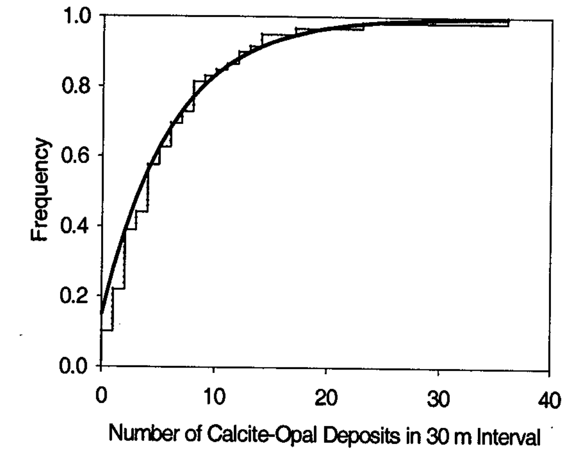

Figure 17. Sample cdf of number of secondary mineral deposits in the 30 m intervals of the detailed line survey of the ESF. The solid line is a geometric distribution function with parameter p = *0.15*.

DH

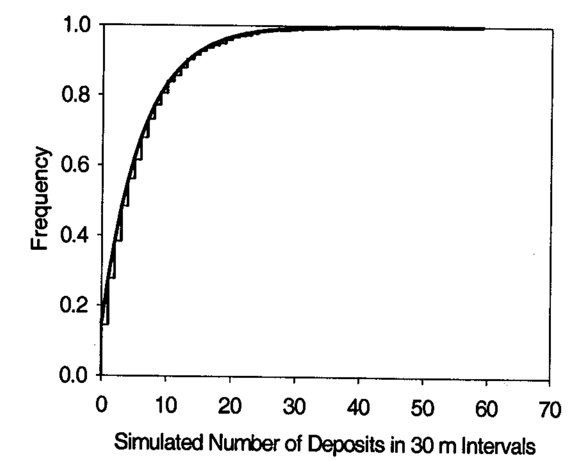

Figure 18. Simulated cdf of number of secondary mineral deposits per 30 m interval compared to a geometric distribution function with parameter $p = 0.15$.

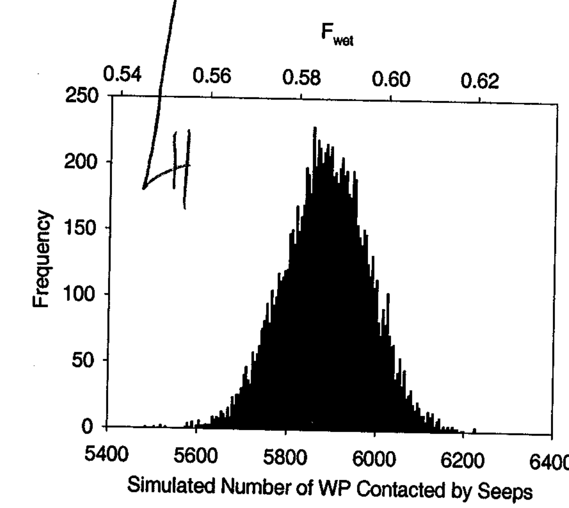

Figure 19. Simulated number of WP potentially contacted by seeps of low flux rate from the fracture network.

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~dhughson/seepage/fnseeps.f

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Completion of IM 861-010 &
delivered March 3, 2000.
Work is still in progress as
I am expecting the complete data
set on secondary minerals in
the ESF from USGS. Photocopy
made for QA record. Codes,
routines, spreadsheets, graphs, etc.
all in ~~~dhuh~~ DH 9/7/00 ~dhughson/seepage
or d:\documents\seepage. Backed
up to zip disk.

March 7, 2000
Debra Hughson

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1402-661-040 IM Process-Level Sensitivity
Analysis - Status Report DUE July 30 2000
Start Internal Review by Friday July 7 2000

Topics

1. Implement new Fow Fwet factors in Appendix F TPA code
2. Evaluate Flow volume vs fraction WP wet
3. Check REFLUX parameters against EDA II multiflo runs
4. Start with extensive sensitivity runs of TPA code 4.0

May 17, 2000 Start with 4) Sensitivity runs

Base case - tpa.inp mean values run for 1e+5yr
tot dose,res = 5.838e-4 rem/yr
peak 1.5512e-3 rem/yr @ 7.3763e+4 yr

Sensitivity 1 - drip shield failure time = 0 yr
dsft0

5.8378e-4 rem/yr @ 1e+5yr
1.5529e-3 rem/yr @ ~~de~~ 7.3763e+4 yr

Sensitivity 2 - drip shield failure time = 0 yr DH 5/17/2000
wp thickness = 0
dsft0nowp

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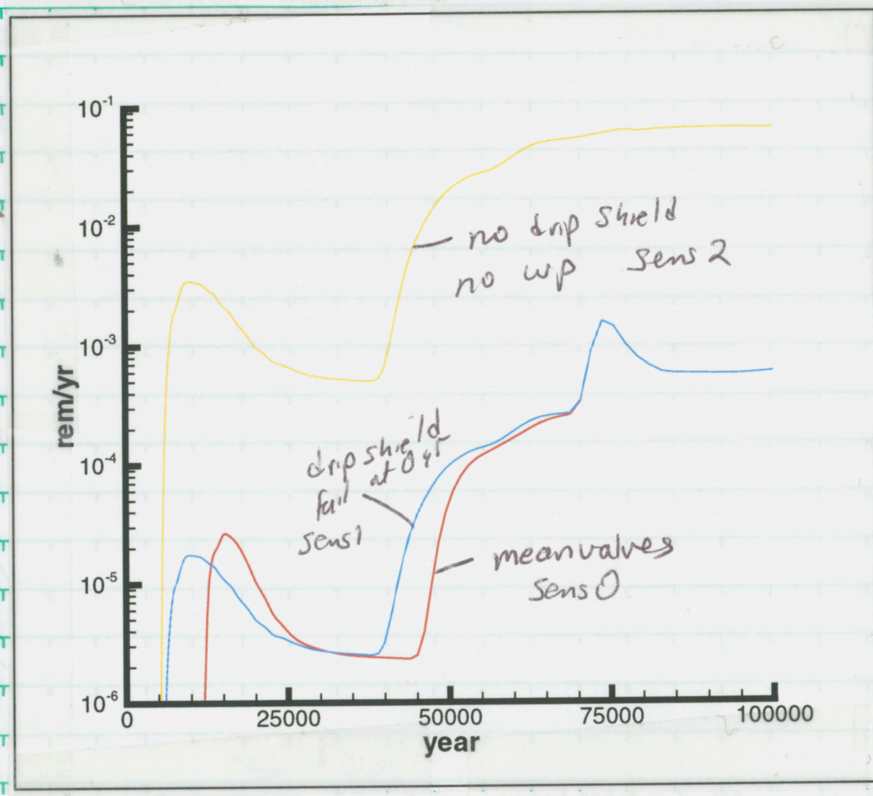

Compare sensitivities ~~of~~ to thermal reflux 3 parameters to sens 0 and sens 2 DH 9/7/00

File /solapps/cnwra/A-tpa4.0/data/dry thick.dat is for old VA-design

compare to max 6.5 m dryout in ~dhughson/tparm/thparm sens3.dat

∗ makes zero difference to meanvalue

try with geology only, no ebs sens4.dat

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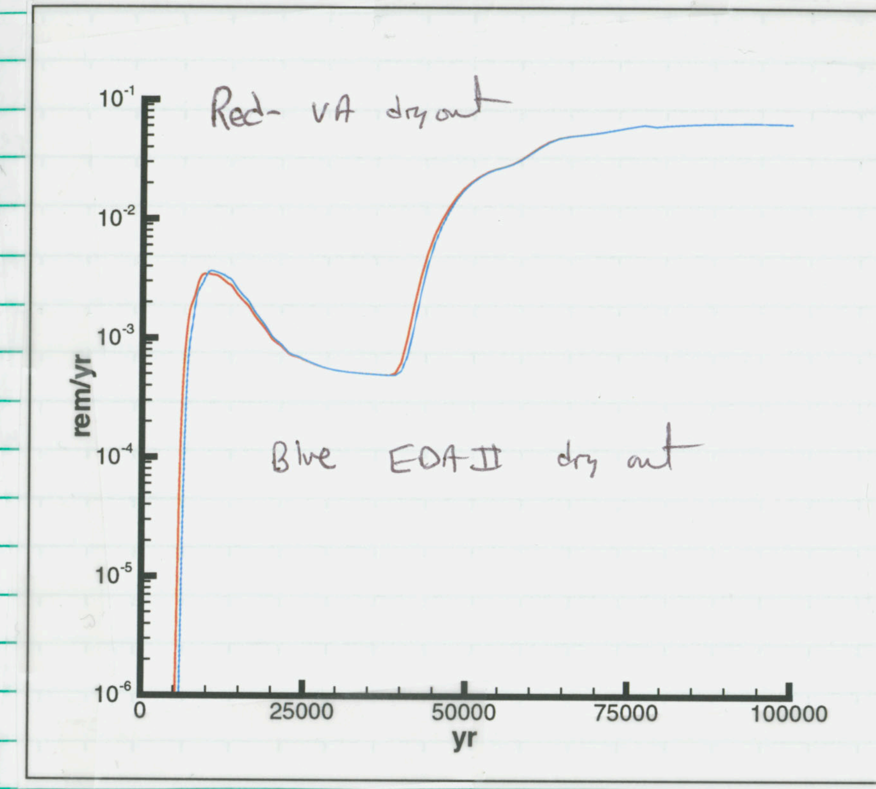

file /solapps/cnwra/A_tpa4.0/data/dry thick.dat has max dryout thickness of 80.7 m at 1000 yr

blue line sets max dryout thickness of 6.5m at 500 yr

use mean values w/ EBS & change from reflux 3 to reflux 1 sens5.dat

∗ zero difference

dsft0 nowp (geology only) change from reflux3 to reflux1 sens6.dat

micro difference, very similar to plot above

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Book No. 384 TITLE TEF

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3 parameters for reflux 1
look at q perc after reflux in infilper.res
no change except λ_{reflux} = 0.1 caused
small difference in one number, slightly larger
than q infiltration.

DO NOT USE REFLUX 1 (Mohanty)

As is drythick.dat
~dhughson/multiflo/mhill/fortpa/13.dat

yr	thick		
1.0	1.0		0.0
10	4.9		1.0
20	8.2		1.5
30	12.1		2.0
40	16.7		2.5
50	21.5		3.0
60	23.7		3.0
70	24.9		2.5
80	25.9		2.5
100	27.6		2.0
200	33.6		2.0
400	49.5		1.0
600	70.7	500	1.0
800	78.7	600	0.5
1000	80.7	700	0.0
2000	7.3	800	0.0
4000	0	900	0.0

To Page No.

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Recorded by [signature]

TITLE TEF

Project No. 661
Book No. 384

From Page No.

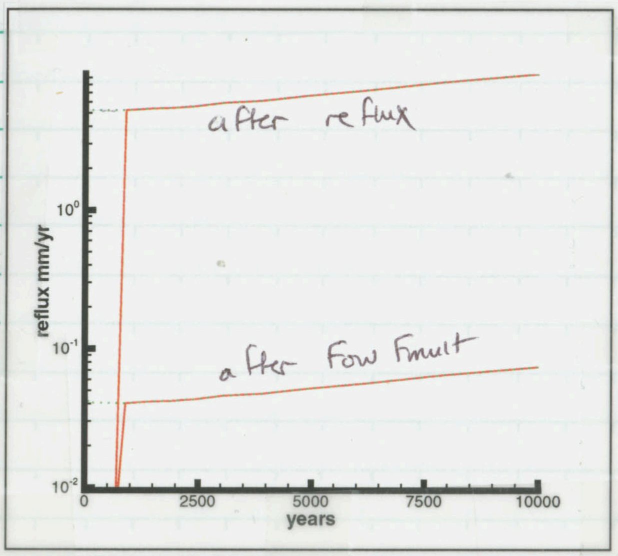
Fraction of Condensate Removed = 0.
Fraction of Condensate Towards Repository = 1.0
Fraction of Condensate Toward Repository Removed = 0.

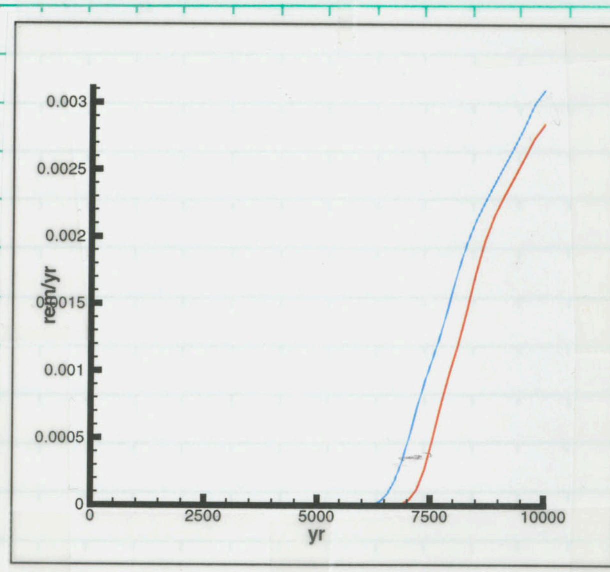
Temperature gradient = 1e+29 no penetration of boiling isotherm

Directory thparg

infilper.res → flux0.dat | flux1.dat
totdose.res → dose0.dat | dose1.dat
near fld → nfe0.dat | nfe1.dat

same fraction – ΔT = 50.5





Directory thparm
With drip shield & WP
same Fraction
ΔT = 1.e+29 ΔT = 50.5

NO dose at 10 000 yr
NO difference at 100 000 yr

infilper.res → flux0.dat flux1.dat
totdos.res → dose0.dat dose1.dat
nearfld.res → nfe0.dat nfe1.dat

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Invented by

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Date may 22 2000

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~dhughson/tparun/ (subdirectories)

Sample from distr. for 100 simulations

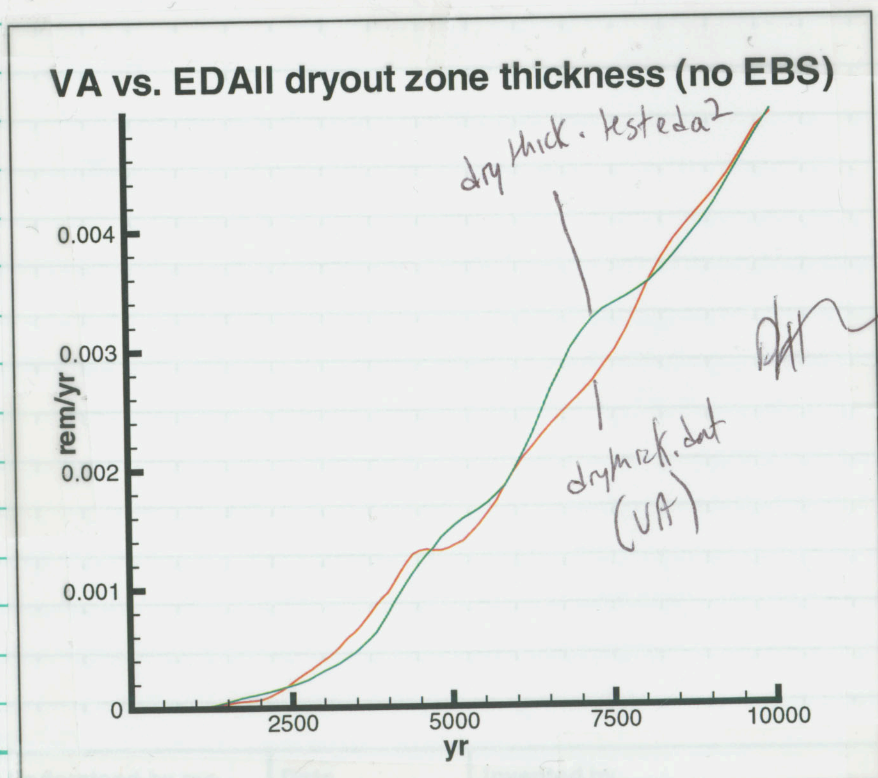
subdirectory

geosamp — no WP no drip shield
use VA dry thick. dat

geosamp1 — no WP no drip shield
use eda2 drythick. testeda2

geosamp2 — no WP no drip shield
~~eda2~~ dry thick = 0
frac cond rem = 0
frac cond towards rep = 1
frac cond toward rep removed = 0
temp grad = 1

This setup gives water after reflux = water before reflux = net percolation — only diversion is from flow Fmult. This simulates no diversion due to thermal response.



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Recorded by DH June 12 2000

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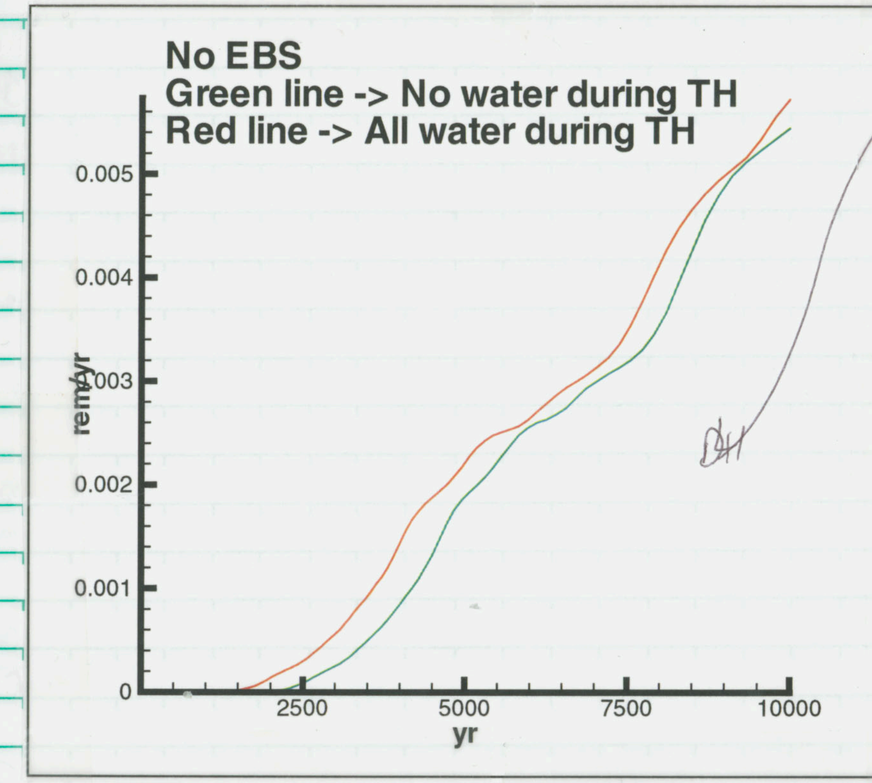
geosamp3 — using dry thick. testeda2, collapse of dryout zone by 700 yr. Set ΔT to 1e+29 results in [no water during thermal period.]

Geo — no EBS Samp — 100 realizations



Ebsamp2 = same as geosamp2 but with WP and dripshield in-place, water before reflux = water after reflux — no diversion due to TH

Ebsamp3 = same as geosamp3 but with EBS WP & drip shield in place. No water during TH

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Date June 16 2000

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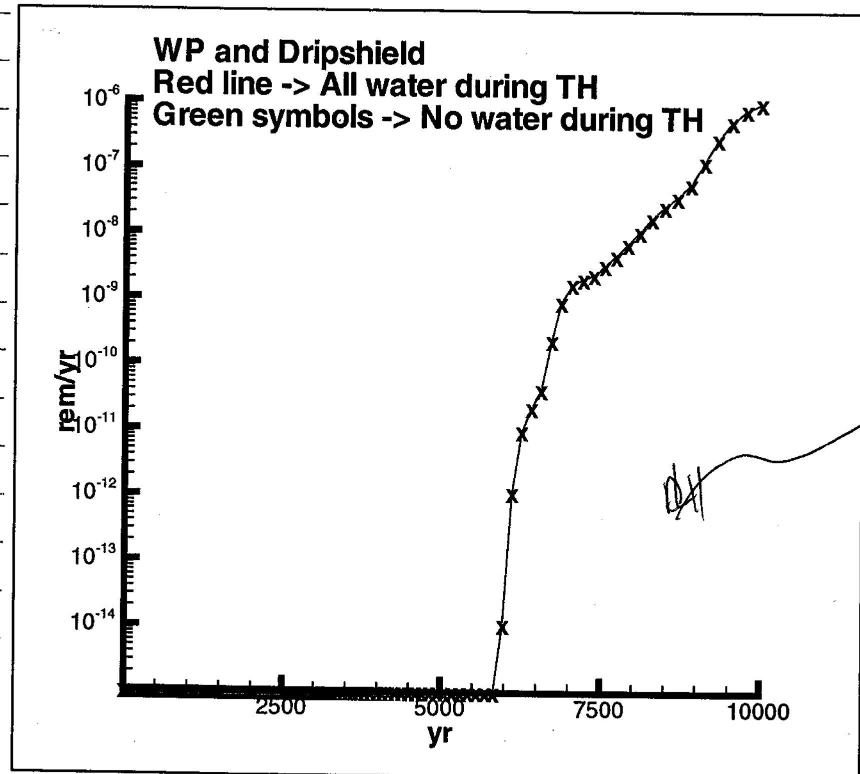

[illegible] 2000 — DH

Smeared Heat Load 26 y.o fuel 0.35 bwr 0.65 pwr

$$\left(\frac{60\ MTU}{acre}\right)\left(\frac{920\ W}{MTU}\right)\left(\frac{acre}{43560\ ft^2}\right)\left(\frac{10.76\ ft^2}{m^2}\right)\left(40.5\ m^2\right) = 552\ W \text{ heater block}$$

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Thermal load check file ~dhughson/multiflo/mhill/fortpu/13cs.dat

ramps up to 472.3 W in heater block at 12 yr

Smeared heat load 60 MTU / acre

20 y.o. fuel 0.35 bwr 0.65 pwr = 1042 W/MTU

$$\left(\frac{60\ MTU}{acre}\right)\left(\frac{1042\ W}{MTU}\right)\left(\frac{acre}{43560\ ft^2}\right)\left(\frac{10.76\ ft^2}{m^2}\right) = 15.45\ \frac{W}{m^2}$$

for area of $40.5\ m^2$ = 625.7 W in heater block

Line Heat Load (60 MTU/acre)(1050 acre) = 63 000 MTU

$$\frac{63000\ MTU}{10\ 039\ WP} = 6.28\ \frac{MTU}{WP} \qquad 54 \times 10^3\ m \text{ drift}$$

$$\frac{63\ 000\ MTU}{54 \times 10^3\ m} = 1.17\ \frac{MTU}{m}\left(\frac{1042\ W}{MTU}\right) = \frac{1216\ \frac{W}{m}}{2}$$

← Symmetry Boundary

= 608 W in heater block

WP Payload = 9.76 MTU ? 25 y.o. old fuel 973.8 W/MTU
WP length = 5.275 + 10 cm spacing = 5.375

$$\left(9.76\ MTU/WP\right)\left(973.8\ W/MTU\right)\left(\frac{WP}{5.375\ m}\right) = \frac{1.768\ kW/m}{2}$$

= 884 W in heater block

$$X \text{ Factor} = \frac{625.7}{973.8} = .6425344$$

Continued Previous Page ←

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geosamp 4

Fraction of Condensate Removed (loguniform 1e-8, 1)

meant to account for shedding off repository edges while boiling isotherms are coalesced.

Look at end cases all or none. Geosamp4 is
Fraction of Condensate Removed = constant = 0 No EBS,
all other parameters regularly sampled.

geosamp 5
DH 6/19/00
~~Same~~ Compare to geosamp4

Fraction of Condensate Removed = constant = 1 No EBS

geosamp 6

Fraction of Condensate Toward Repository =
constant = 0
all others Sampled

geosamp 7

Fraction of Condensate Toward Repository =
constant = 1.0
all others Sampled

Fraction of Condensate Toward Repository ~ uniform (0, 1)

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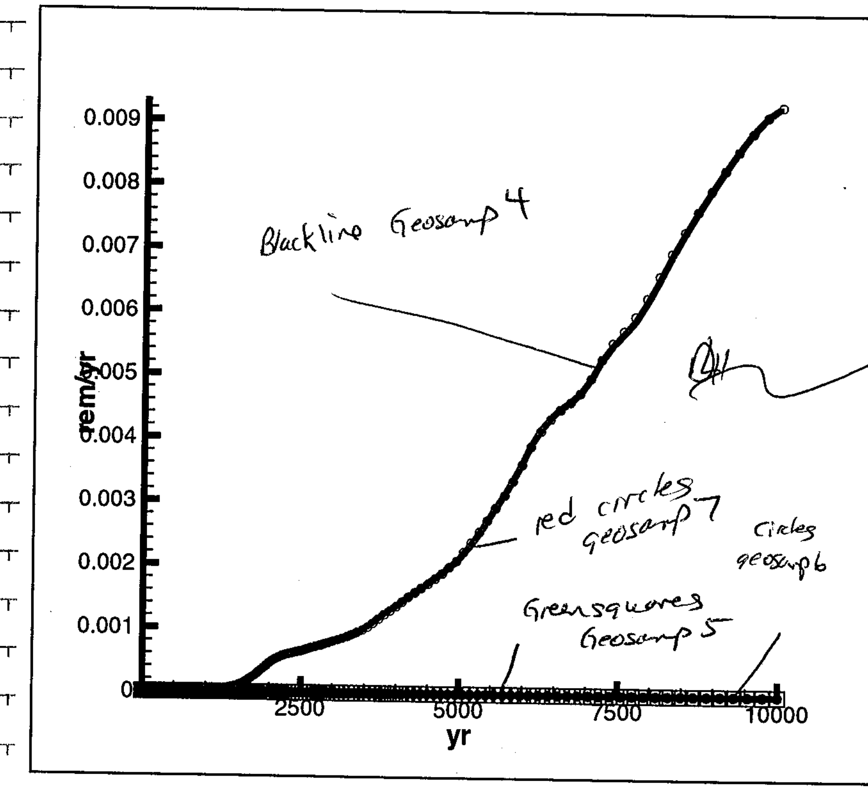

Fraction of Condensate Removed ~ loguniform ~ (1e-8 1)
can take on value of 1 → bogus result shown
in green squares above

Fraction of Condensate Toward Repository ~ uniform (0, 1)
can take on the value of 0 → bogus result shown
in dark filled circles above

Geosamp8 Fraction of Condensate Toward Repository Removed =
constant = 0

Geosamp9 Fraction of Condensate Toward Repository Removed =
Constant = 1
All others sampled
No EBS

Fraction of Condensate Toward Repository Removed
~ loguniform ~ (1e-8, 1)

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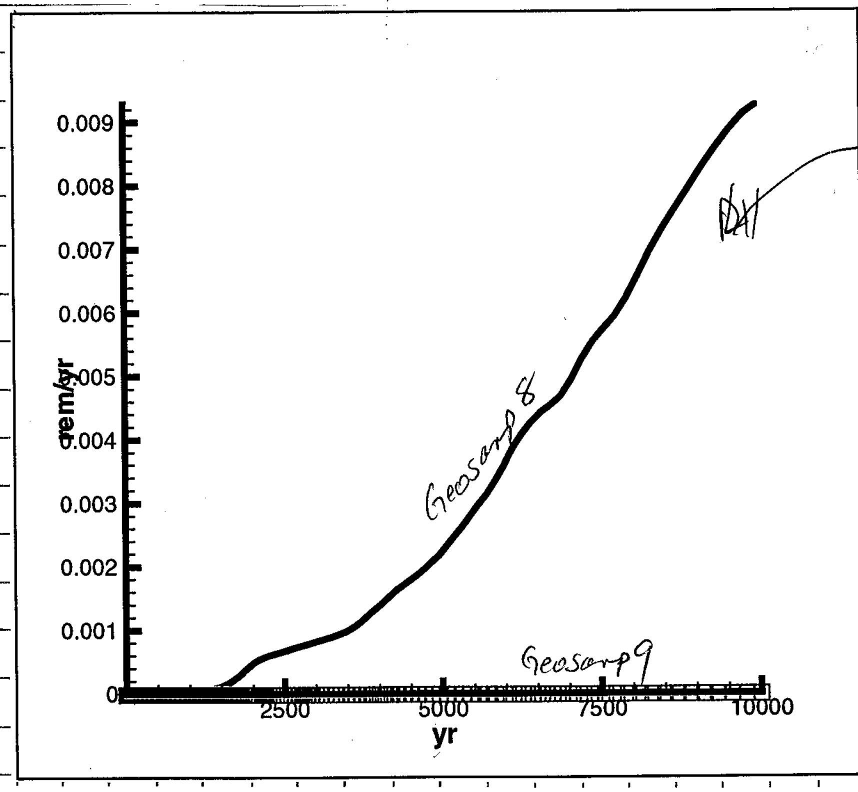

Geosamp10

Temperature Gradient In Vicinity Of Boiling Isotherm = constant = 1.0

Geosamp11

Temperature Gradient In Vicinity Of Boiling Isotherm = constant = 100

Distr.

Temperature Gradient In Vicinity Of Boiling Isotherm ~

~ uniform (1, 100)

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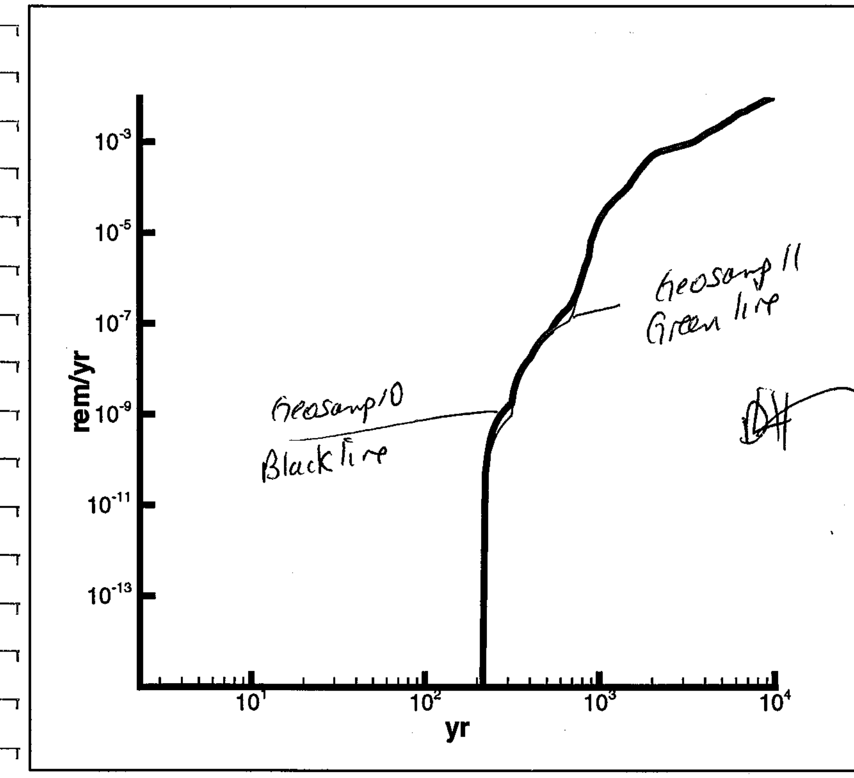

Geosamp 12

Fraction of Condensate Removed = constant = 0

Fraction of Condensate Toward Repository = constant = 0.5

Geosamp13

Fraction of Condensate Removed = constant = 0

Fraction of Condensate Toward Repository Removed = constant = 0.5

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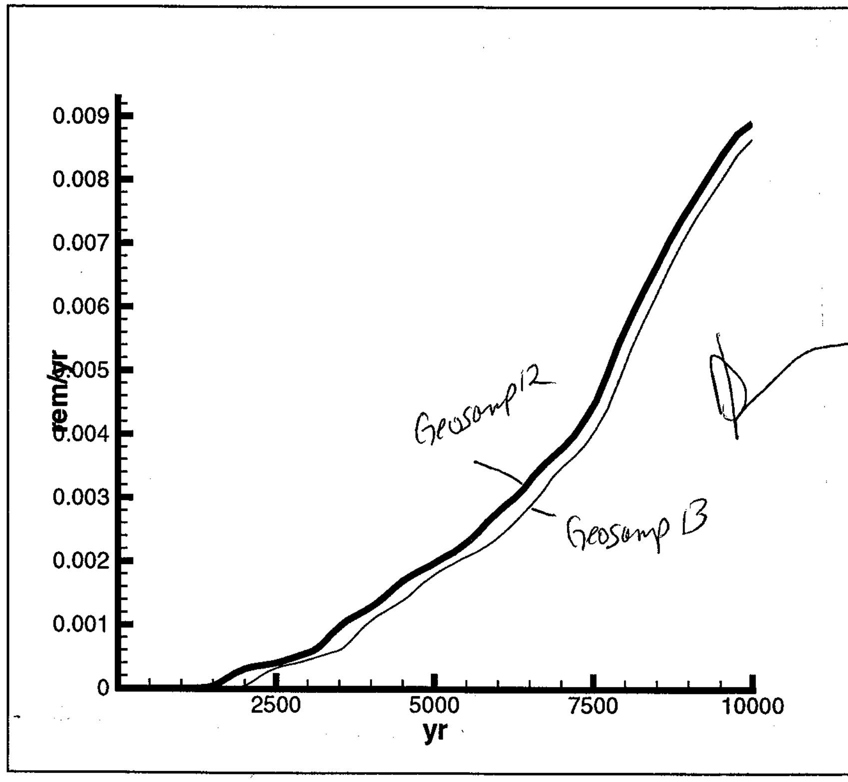

June 20 1999 2000
DH June 20 2000

Geosamp14

Same as geosamp12 but with

FractionOfCondensateToward Repository = constant = 0.9

Geosamp15

Same as geosamp14 but with

FractionOfCondensateToward Repository = constant = 0.1

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geosamp16

Same as geosamp13 but with

Fraction of Condensate Towards Repository Removed = constant = .05

geosamp17 Same as geosamp16 but with

Fraction of Condensate Towards Repository Removed = constant = .95

geosamp18

base case sample all for 100 realizations

geosamp19

Same as geosamp4 but with

FractionOfCondensateRemoved = constant = 2e-8

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Notes on reflux3

Fraction Of Condensate Removed loguniform (1e-8, 1.0)

sledfact1 = fracndrm

Fraction Of Condensate Towards Repository uniform (0,1)

fracndto = qfact

Fraction Of Condensate Toward Repository Removed loguniform (1e-8, 1.0)

Sledfact2 = fracndtorm

cellwidth = WP Unit Cell Width = 81 m = wpcellwidth

celllength = WP Spacing Along Emplacement Drift = wpspacedrift = 6.1392 m

cellarea = cellwidth * celllength

equivThick(I) = xmaxthick (xmprs - tsw(satinit - residSat))

$D = T_n (S_i - S_r)$

First year

perchedVol(I) = (xinterp_xmperyrinsa(I) + equivThick(I)) * cellarea DH

thereafter call losses

~~minus~~ plus delEqTh DH 9/7/00

perchedVol(I) = perchedVol(I-1) + (xinterp_xmperyrinsa(I)) * cellarea - xloss(I)

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xmperyrinsa = qm3peryrinsa(i) / saarea

qm3peryrinsa = deep percolation in m^3/yr

qm3peryrinsaatrep = output of reflux3
water that gets to qreflux

When drythick is decreasing and delEqTh(I) is negative, delEqTh(I) is set to 0.0

sted1(I) = perchedVol(I-1) * sled1Fact

Zero flow first year

xloss(I) = sted1(I) + sted2(I) + qm3peryrinsaatrep(I)

$$Q(I) = \frac{(\text{perchedVol}(I-1) - \text{sted1}(I))}{86400 * 365} * \text{QFact}$$

sted2(I) = Q(I) * Sted2Fact

$$\text{depress}(I) = \text{SQRT}\left[\frac{\text{rholiq} * Q(I) * h}{\text{xkRock} * \text{delT}}\right]$$

$$\text{vaporize}(I) = \left[\frac{\text{xinterp\_thick}(I)}{\text{depress}(I)}\right](Q(I) - \text{sted2}(I))$$

qm3peryrinsaatrep(I) = Q(I) - sted2(I) - vaporize

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Book No. 384 TITLE TEF

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Look into results from 2D model of EDA II

~dhughson/multiflo/mhill/13cs.dat

Top BC type 5

$7.47e{-4}\ kg/m^2/s \left(\frac{m^3}{998kg}\right)(2.33e{-4})\ 606024365\ \frac{1000mm}{m} = 5.5 \frac{mm}{yr}$

Top Block z = 3.5m

v1fz = .5473e-2 m/yr   v1mz = .5668e-4 m/yr

= 5.53 mm/yr

Recheck the dry thick.dat calculation

using file for 50% heat reduction for 50yr

Look at where matrix saturation is reduced and $T \geq 97°C$

Heater element Center at z = 386.25 m
x = 0.25 m

~~Block size~~

DH July 10 2000

DH

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TITLE TEF
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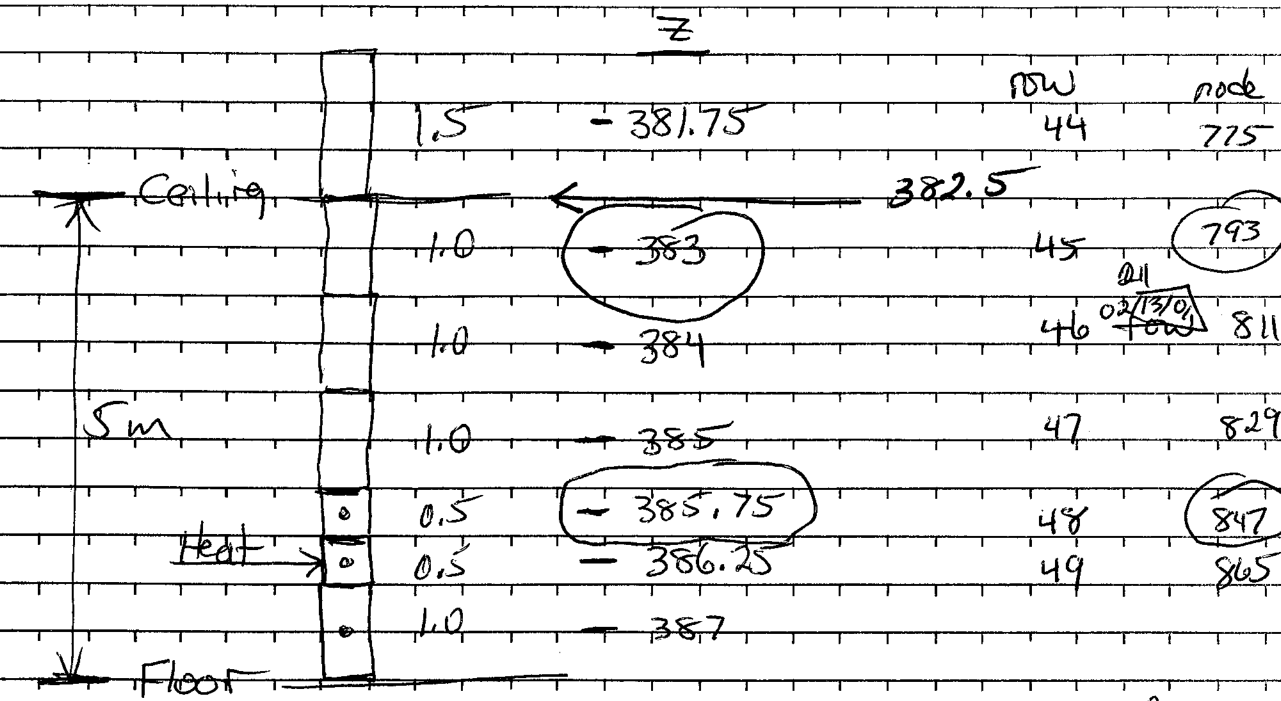

year 1 z=386.25 T=32.7 S_e = .8674 ← residual for element

10	z	T	S_e	P_g
	386.25	127.0		
	385.75	123.0	.3302	1.6522E+5
	385.0	118.1	.4939	1.8080E+5
	384.0	114.8	.6729	1.6670E+5
	383.0	112.5	.7986	1.5532E+5
	381.75	101.0	.9078	1.0562E+5
	380.0	86.11	.9529	9.4626E+4

20	z	T	S_e	P_g
	386.25	135.7	—	
	385.75	132.2	0	9.8277E+4
	385.0	127.9	0	1.0257E+5
	384.0	124.9	.0637	1.3187E+5
	383.0	122.8	.2889	1.2348E+5
	381.75	111.2	.5058	1.4678E+5
	380.0	95.73	.7766	9.5284E+4
	377.75	82.32	.9029	9.5101E+4

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30 yr	Z	T	S_e	P_g
	386.25	131.8	—	
	385.75	128.9	0	
	385.0	125.3	0	
	384.0	122.8	0	
	383.0	121.0	0	
	381.75	110.6	.3578	
	380.0	95.83	.6489	
	377.75	83.96	.8421	
	375.0	73.91	.9203	

40 yr			
	386.25	127.4	—
	385.75	124.8	0
	385.0	121.7	0
	384	119.5	0
	383	117.9	0
	381.75	108.4	.3202
	380	94.83	.586
	377.75	84.09	.801
	375	75.11	.9

50 yr			
	386.25	121.9	—
	385.75	119.6	0
	385	116.8	0
	384	114.9	0
	383	113.6	0
	381.75	105.2	.3125
	380	93.02	.5570
	377.75	83.4	.7768
	375	75.37	.8855
	371	66.83	.9364

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Recorded by

TITLE TEF
Project No. 601
Book No. 384

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60 yr	Z	T	Se
	386.25	119.8	—
	385.75	117.6	0
	385	114.9	0
	384	113.1	0
	383	111.7	0
	381.75	103.6	.3131
	380	91.95	.5471
	377.75	82.81	.7643
	375	75.31	.8761
	371	67.43	.9307

70 yr			
	386.25	135.6	—
	385.75	132.9	0
	385	129.6	0
	384	127.3	0
	383	125.7	0
	381.75	115.4	.2508
	380	100.6	.4774
	377.75	89.44	.7280
	375	80.49	.8644
	371	71.32	.9267

80 yr			
	386.25	159.5	—
	385.75	156.3	0
	385	152.4	0
	384	149.6	0
	383	147.7	0
	381.75	132.3	0
	380	111.6	.3357
	377.75	98.1	.6286
	375	87.69	.8307
	371	77.08	.9191

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100yr	z	T	Se
	386.25	169.6	—
	385.75	166.6	0
	385	163.0	0
	384	160.5	0
	383	158.8	0
	381.75	144.5	0
	380	122.1	0
	377.75	105.6	.3618
	375	94.78	.6544
	371	84.24	.8620
	365.75	74.72	.9346

remainder of this sequence of data in spreadsheet file

D:\documents\Tef\661-040\drythick.dat

these results from circled run

Results from

~ ~~hash~~ DH 7/19/00 ~dhughson/multiflo/mhill/25y00v

EDAII with no heat reduction

~dhughson/multiflo/mhill/25y30v

EDAII 30% heat reduction for 50yr

~dhughson/multiflo/mhill/25y50v

EDAII 50% heat reduction for 50yr

Runs in these directories have too much downward gas flow so that condensate does not build up above heat source.

Adjusted pressure gradient by trial & error to get stagnant gas phase - rerun

~dhughson/multiflo/mhill/noblow00 no heat red

~dhughson/multiflo/mhill/noblow30 red 30% for 50yr

~dhughson/multiflo/mhill/noblow50 red 50% for 50yr

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Sat of matrix & T from noblow?? runs in

D:\documents\Tef\661-040\drythicknoblow

& used for Figure 2-5 in IM661-040

Dryout thickness drythick.dat calculated from saturation change for each block

~~Sat − Sat initial~~ DH July 19 2000

$D = \sum (\text{Sat initial} - \text{Sat})(\text{porosity})(\text{Block thickness})$

and summed. then calculate Thickness of dryout zone for drythick.dat (Appendix B)

$T = \frac{D}{n(S_m - S_r)}$ where n, S_m, and S_r are parameters from TPA 40

$n = 0.14$ $S_m = .9$ $S_r = .1$

Pressure at rep level in noblow?? runs is too high raising nominal boiling temp. Needs to be reduced to ~ 8.7e+5 Pa

---

This is the end of work for IM 1402-661-040 which is in review now as of July 19, 2000. This work starts on page 35 and ends here on page 57.

Files used for this deliverable backed up to zip drive for QA archive

DH July 19 2000

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Project No. 661
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Sensitivity Runs Around Matrix Saturation

~ dhughson/multiflo/matrixS

run1

Modified TH property set 5.5 mm/y infiltration
$d = 1.5m$

run2

same w/ $d = 0.33m$

run 3

same as run2 except change all
Fracture/Matrix Interaction Parameters to 1.0

compare matrix saturations at $x = .25$ $z = 383$

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		Recorded by	July 19 2000

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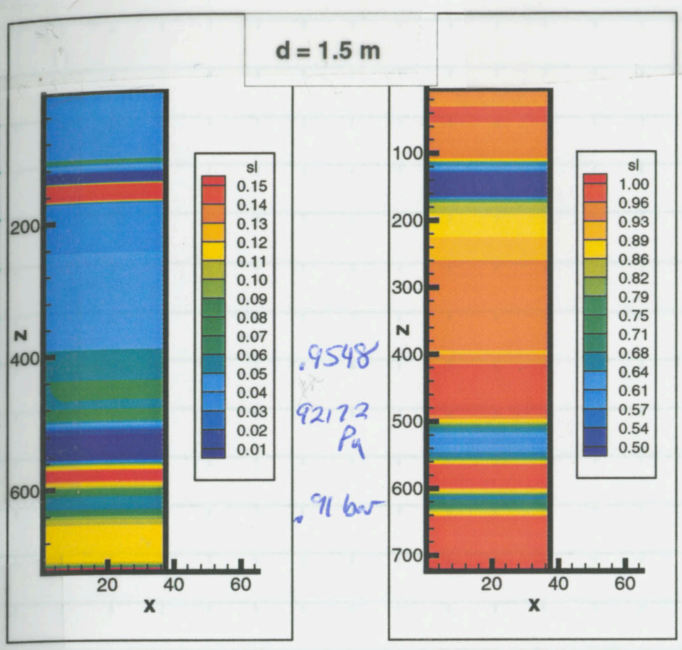
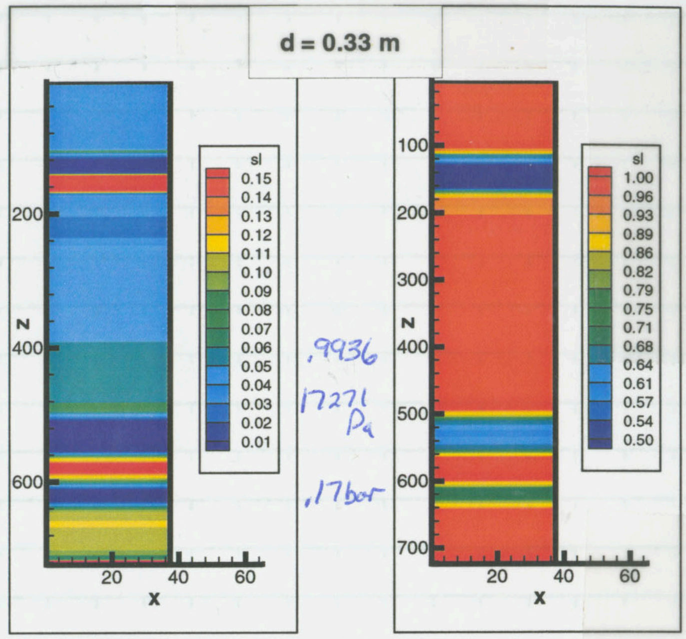


.9548

92172 Pa

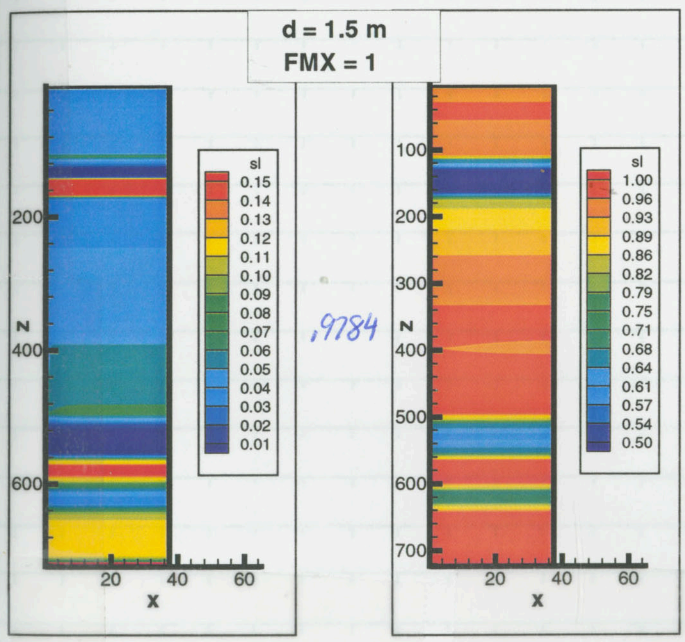
.91 bar



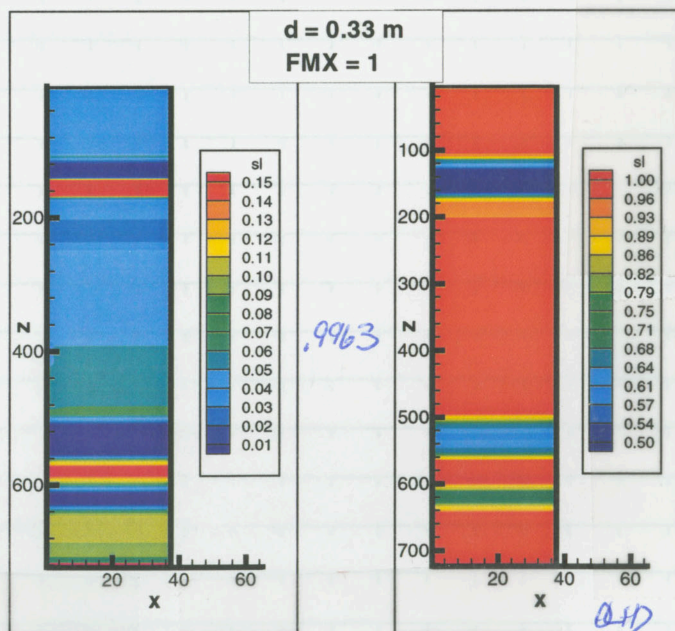
.9936

17271 Pa

.17 bar



.9784



.9963

QHD July 19 2000

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From Page No.

Look at small ~~flow~~ [DH Aug 8 2000] flow rate fuet = .5

~~Geosamp20~~ [DH Aug 8 2000] No EBS Geosamp 21

WP flow multiplication factor = 1 Subarea wet fraction = 0.5

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		Recorded by	Aug 8 2000

From Page No.

Work on reply to a comment from AR Kacimov

Reference CNWRA controlled notebook # 326 pages 23 to 69 and 92 to 96

For angular cavity wall perturbation

1) check against Philip's soln for no perturbation
TOOK N=13 terms

~ D:\documents\aquspring1999\reply1.mcd

2) check for series convergence for
s=4 d=.025 w=.1
~ D:\documents\aquspring1999\reply2.mcd
Appears to converge at around N=50 to 12.2222
Then diverges. Increasing integral tolerance ~~to~~ (DH 02/12/01) from 0.001 to 1E-6 did not help.

For wavy wall perturbation

1) check against Philip soln for zero pert.
took N=13 terms - file not saved separately.

2) Appeared to converge at around N=45 to 12.6092. Did not diverge for up to N=70 (last test). Change in tolr from 0.001 to 0.0001 did not affect the result significantly

~ D:\documents\aquspring1999\Reply3.mcd

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		Recorded by DH	Feb 12 2001

TITLE Reply to Comment

From Page No.

Need to check integrals done numerically in Mathcad with mathematica

OK - checked integrals up to N = 4 between mathcad & mathematica for A_{mn} and C_n

compare
D:\documents\aguspring1999\checkintegrals.mcd
D:\documents\aguspring 1999\checkintegral.nb

check results for zero perturbation to N = 13

From mathcad $\theta = 9.70875$
from mathematica $\theta = 9.70875$

Also compare & check integrals C_n & A_n up to N = 4

D:\documents\aguspring 1999\zeropert.mcd
D:\documents\aguspring 1999\zero pert.nb

note that mathematica gives lots of warnings & error message for the numerical integration but converges to Philip's soln $\theta = 9.7088$

Check for convergence wavy pert s=4 M=8 δ=-.025

Result from Mathematica $\theta = 12.6092$
from mathcad $\theta = 12.6092$

D:\documents\aguspring 1999\reply3.nb
D:\documents\aguspring 1999\Reply3.mcd

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		DH	Feb 14 2001

TITLE Cross Drift thermal Test Calc.

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Seepage threshold for horizontal borehole 0.101 m in diameter

$\mu = 1.002 \times 10^{-3}$ kg/m·s $g = 9.81$ kg/m³ $\rho = 998.3$ kg/m³

assume vanGenuchten α = Gardner α = 7.39e-4 /Pa

$k = 1.29e{-12}$ m²   mathematica file

D:\documents\Tef\2001\Cdtt\phillip1   274827 mm/yr

For a strip

D:\documents\Tef\2001\Cdtt\strip.nb

Conduction only calculation

D:\documents\Tef\2001\Cdtt\conduction.mcd

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Model of the Cross Drift thermal Test CDTT

multiflo 1.2.3

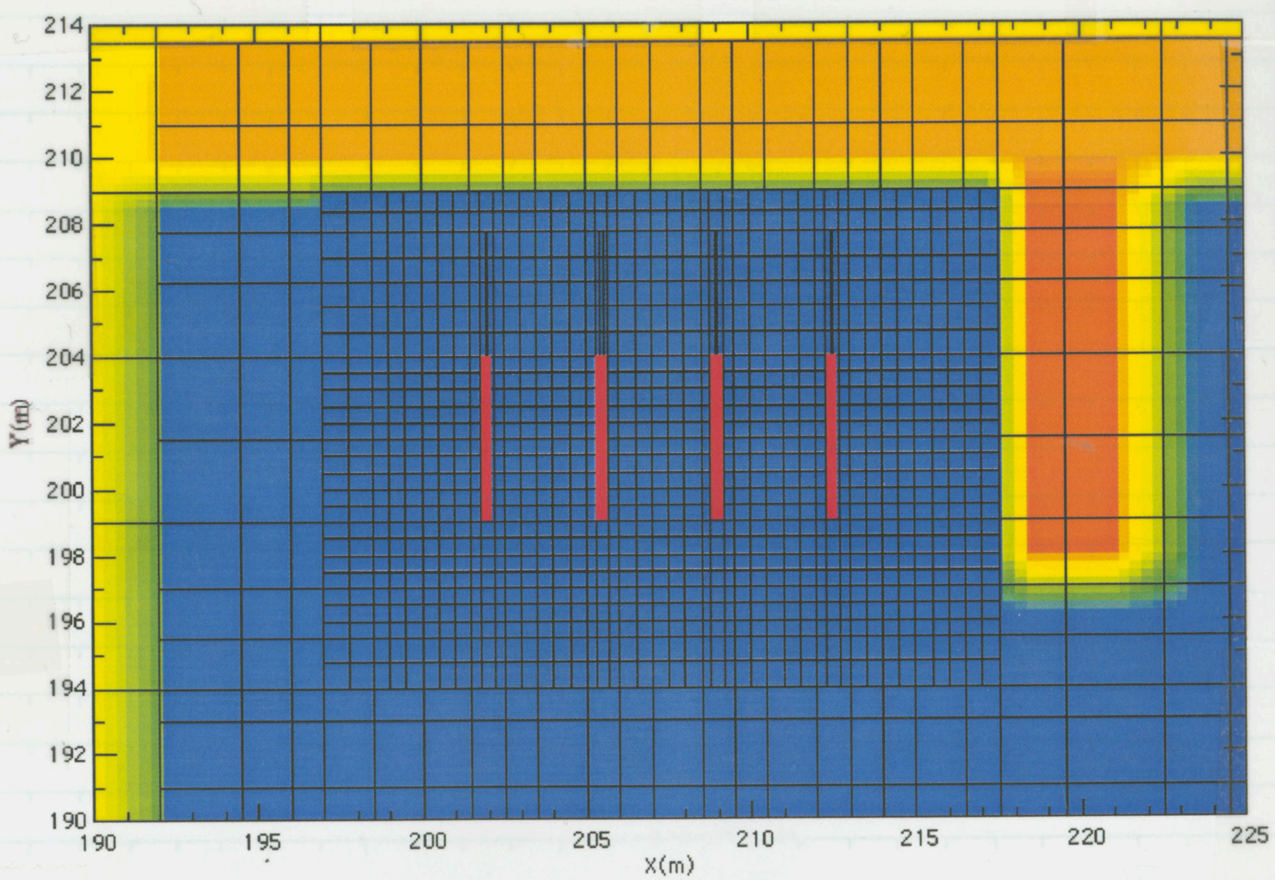

Figure 4-7. Cross Drift Thermal Test Layout showing heater locations and discretization used in NUFT scoping calculations.

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Table 5-1 Borehole information for the Cross Drift Thermal Test.

CROSS DRIFT THERMAL TEST ALCOVE

Administrative Borehole Layout Table

Borehole #	Borehole ID	Primary Purpose	Collar Coordinates (Cartesian)[1] x meters	y meters	z meters	Hole Diameter m	Core Bit	Hole Length** m	Orientation	Core Requirements	Video Requirements
1	ECRB-CDTT-HEA-1	Heater Hole #1	-6.00	0.00	0.00	0.101	HQ	10.0	Horizontal	Allocated Core	Video Required
2	ECRB-CDTT-HEA-2	Heater Hole #2	-4.00	0.00	0.00	0.101	HQ	10.0	Horizontal	Allocated Core	Video Required
3	ECRB-CDTT-HEA-3	Heater Hole #3	0.00	0.00	0.00	0.101	HQ	10.0	Horizontal	Allocated Core	Video Required
4	ECRB-CDTT-HEA-4	Heater Hole #4	4.00	0.00	0.00	0.101	HQ	10.0	Horizontal	Allocated Core	Video Required
5	ECRB-CDTT-HEA-5	Heater Hole #5	6.00	0.00	0.00	0.101	HQ	10.0	Horizontal	Allocated Core	Video Required
6	ECRB-CDTT-COL-1	Collection Hole #1	-2.00	0.00	-2.00	0.101	HQ	11.0	3 degrees up	Allocated Core	Video Required
7	ECRB-CDTT-COL-2	Collection Hole #2	-0.50	0.00	-2.00	0.101	HQ	11.0	3 degrees up	Allocated Core	Video Required
8	ECRB-CDTT-COL-3	Collection Hole #3	3.50	0.00	-2.00	0.101	HQ	11.0	3 degrees up	Allocated Core	Video Required
9	ECRB-CDTT-TEMP-1	Temperature/Neutron/GPR #1	-6.00	0.00	0.50	0.076	NQ	17.1	Horizontal, 40 deg off Alcove Face	Allocated Core	Video Required
10	ECRB-CDTT-TEMP-2	Temperature/Neutron/GPR #2	6.00	0.00	-0.50	0.076	NQ	17.1	Horizontal, 40 deg off Alcove Face	Allocated Core	Video Required
11	ECRB-CDTT-TEMP-3	Temperature/Neutron/GPR #3	-10.75	9.00	-1.00	0.076	NQ	17.0	Horizontal	Allocated Core	Video Required
12	ECRB-CDTT-TEMP-4	Temperature/Neutron/GPR #4	-10.75	6.00	-1.00	0.076	NQ	17.0	Horizontal	Allocated Core	Video Required
13	ECRB-CDTT-TEMP-5	Temperature/Neutron/GPR #5	-10.75	7.00	1.00	0.076	NQ	17.0	Horizontal	Allocated Core	Video Required
14	ECRB-CDTT-TEMP-6	Temperature/Neutron/GPR #6	-10.75	7.00	-1.20	0.076	NQ	17.0	Horizontal	Allocated Core	Video Required
15	ECRB-CDTT-TEMP-7	Temperature/Neutron/GPR #7	-10.75	9.00	1.50	0.076	NQ	17.0	Horizontal	Allocated Core	Video Required
16	ECRB-CDTT-INJ-1	Injection Hole #1	-10.75	7.50	1.50	0.076	NQ	17.0	2 degrees up	Allocated Core	Video Required
17	ECRB-CDTT-ERT-1	ERT Hole #1	-10.75	4.50	1.00	0.076	NQ	20.0	Horizontal	Allocated Core	Video Required
18	ECRB-CDTT-ERT-2	ERT Hole #2	-10.75	10.50	1.00	0.076	NQ	20.0	Horizontal	Allocated Core	Video Required
19	ECRB-CDTT-ERT-3	ERT Hole #3	14.75	4.50	-3.00	0.076	NQ	23.0	Horizontal	Allocated Core	Video Required
20	ECRB-CDTT-ERT-4	ERT Hole #4	14.75	7.50	-3.00	0.076	NQ	23.0	Horizontal	Allocated Core	Video Required
21	ECRB-CDTT-ERT-5	ERT Hole #5	14.75	10.50	-3.00	0.076	NQ	23.0	Horizontal	Allocated Core	Video Required
22	ECRB-CDTT-AE-1	AE Hole # 1	-10.75	10.00	1.50	0.076	NQ	17.0	Flat, parallel to thermal alcove	Allocated Core	Video Required
23	ECRB-CDTT-AE-2	AE Hole #2	-10.75	0.75	-1.25	0.076	NQ	17.0	Flat, parallel to thermal alcove	Allocated Core	Video Required
24	ECRB-CDTT-AE-3	AE Hole #3	-9.25	0.00	-0.50	0.076	NQ	12.0	Flat, parallel to thermal alcove	Allocated Core	Video Required
25	ECRB-CDTT-TILT-1	Tiltmeter Hole #1	-13.50	8.00	Invert	0.076	NQ	5.0	Vertically down - Invert of Injection Alcove	Allocated Core	Video Required
26	ECRB-CDTT-TILT-2	Tiltmeter Hole #2	-5.00	-1.00	Invert	0.076	NQ	5.0	Vertically down	Allocated Core	Video Required
27	ECRB-CDTT-TILT-3	Tiltmeter Hole #3	16.00	7.50	Invert	0.076	NQ	5.0	Vertically down	Allocated Core	Video Required
28	ECRB-CDTT-TILT-4	Tiltmeter Hole #4	-15.25	-4.50	Crown	0.076	NQ	5.0	Vertically Up	Allocated Core	Video Required
29	ECRB-CDTT-TILT-5	Tiltmeter Hole #5	12.25	-5.00	Crown	0.076	NQ	5.0	Vertically Up	Allocated Core	Video Required
30	ECRB-CDTT-PLT-1	PLT Area Heater Hole #1	To Be Field Determined by PI			0.101	HQ	2.5	Horizontal - PLT Left Rib	Allocated Core	Video Required
31	ECRB-CDTT-PLT-2	PLT Area Heater Hole #2	To Be Field Determined by PI			0.101	HQ	2.5	Horizontal - PLT Left Rib	Allocated Core	Video Required
32	ECRB-CDTT-PLT-3	T.Expansion MPBX #1	To Be Field Determined by PI			0.076	NQ	2.5	Horizontal - PLT Left Rib	Allocated Core	Video Required
33	ECRB-CDTT-PLT-4	T.Expansion MPBX #2	To Be Field Determined by PI			0.076	NQ	2.5	Horizontal - PLT Left Rib	Allocated Core	Video Required
34	ECRB-CDTT-PLT-5	PLT MPBX#1	To Be Field Determined by PI			0.076	NQ	2.5	Horizontal - PLT Left Rib	Allocated Core	Video Required
35	ECRB-CDTT-PLT-6	PLT MPBX#2	To Be Field Determined by PI			0.076	NQ	2.5	Horizontal - PLT Right Rib	Allocated Core	Video Required

Notes:

[1] Borehole collar coordinates are referenced to a theoretical 0,0,0 coordinate located at the borehole collar center of borehole #3, ECRB-CDTT-HEA-3.

** All holes will be cored dry.

Short, convergence pin holes drilled by the PI or designee are not included on this table or the illustrations.

Surface instrumentation are not included on this table or illustrations.

References:

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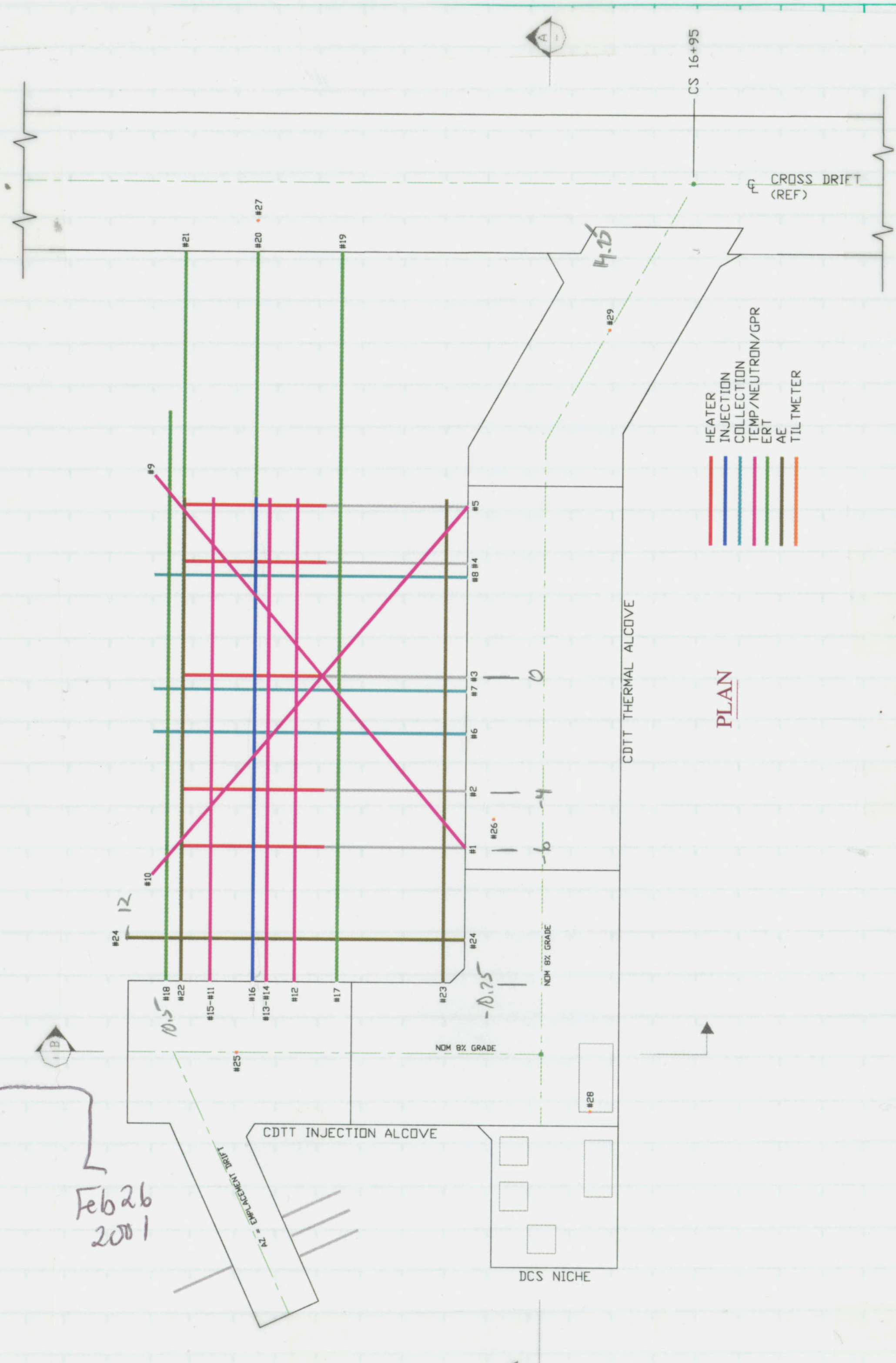

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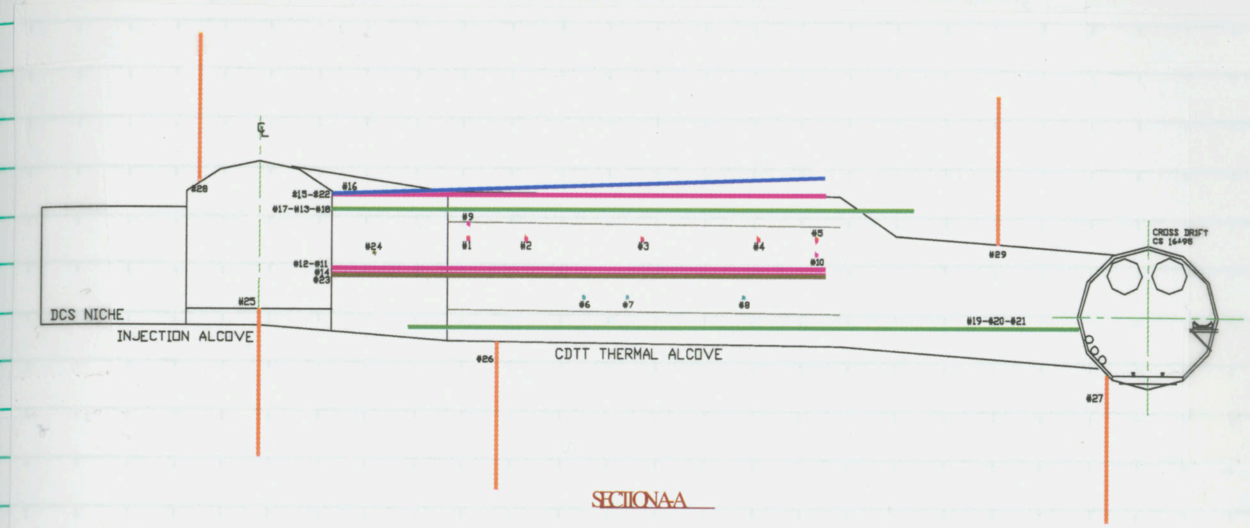

SECTION A-A

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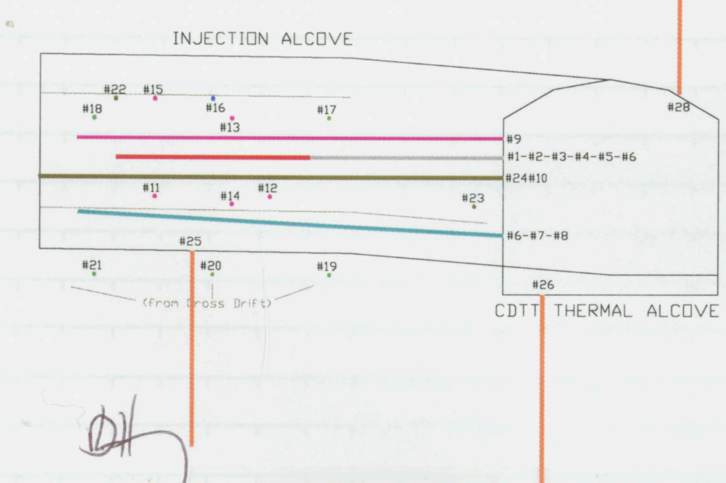

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SECTION B-B

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Property	Driftscale
Matrix permeability (m^2)	3.04×10^{-17}
Fracture permeability (m^2)	1.29×10^{-12}
Matrix porosity, ϕ_m	0.131
Fracture porosity, ϕ_f	1.10×10^{-2}
Matrix van Genuchten $\square_m$ (1/Pa)	6.44×10^{-6}
Fracture van Genuchten $\square_f$ (1/Pa)	7.39×10^{-4}
Matrix van Genuchten m_m	0.236
Fracture van Genuchten, m_f	0.611
Matrix residual saturation, S_{lrm}	0.12
Fracture residual saturation, S_{lrf}	1.00×10^{-2}
Dry thermal conductivity, λ_{dry} (W/m°C)	1.20
Wet thermal conductivity, λ_{wet} (W/m°C)	2.02
Specific heat, C_p (J/kg°C)	900
Grain density, ρ_g (kg/m^3)	2540
Tortuosity, τ	0.7
Active fracture parameter, γ	0.41
Fracture frequency, f (m^{-1})	3.16
Fracture-to-matrix connection area, A (m2/m3)	9.68

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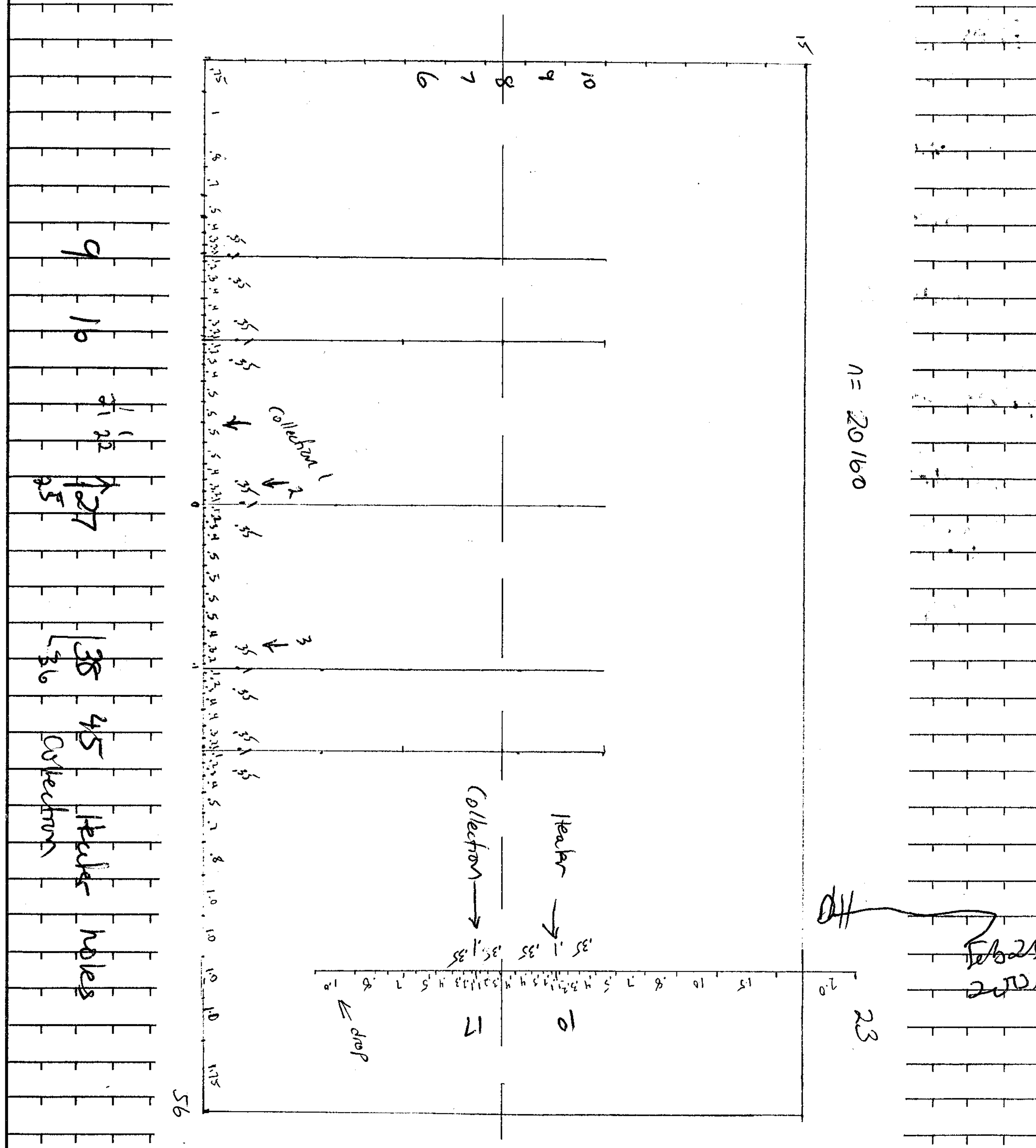

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Files for cross drift thermal test
preliminary modeling with multiflo

~ dhughson/multiflo/cdtt

directories unif hetero2 hetero3

backed up to CD

Files for report preparation 661.130
located at

D:\documents\tef\2001\030

backed up to zip disks

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the end should be
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[signature] Sept 28 2001

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