VOLCANIC SYSTEMS OF THE BASIN AND RANGE RESEARCH PROJECT

Scientific Notebook No. 1
November 8, 1995 – Brittain Hill

VOLCANIC SYSTEMS OF THE BASIN AND RANGE RESEARCH PROJECT

Scientific Notebook No. 1
November 8, 1995 – Brittain Hill

Volcanic Systems of the Basin and Range Research Project Scientific Notebook #1, Started November 8, 1995 - Brittain Hill

This notebook is a continuation of controlled scientific notebook #56, issued to Brittain Hill

Purpose: Research to support the Volcanic Systems of the Basin and Range Research Project, which examines the processes that control mafic igneous activity at the Yucca Mountain and analogous volcanic fields in the western U.S. Goals and methodologies are outlined in the Volcanic Systems of the Basin and Range Project Plan. Notebook is divided into specific **Projects** that are organized by date.

Investigators: PI's are Charles Connor and Brittain Hill, CNWRA.

Project: Compilation of Sr and Nd isotopic analyses for the western U.S. This compilation is being undertaken as part of research conducted for task #6, petrology of western Great Basin/YMR volcanic fields. Idea is to examine the isotopic composition of relatively primitive Pliocene and younger basalts, to see if other volcanic fields in the WGB share the same unusual isotopic characteristics as the YMR. G. Yogodzinski (UNLV) gave a presentation at the May 16, 1995 Geomatrix probabilistic volcanic hazards meeting that showed basalts of the Greenwater Range area of Death Valley have the same unusual isotopic characteristics ($^{87}Sr/^{86}Sr > 0.707$, $\epsilon Nd < -8.5$) as the YMR.

Data sources for compilation:

Asmerom, Y., S.B. Jacobsen, and B.P. Wernicke. 1994. Variations in magma source regions during large–scale continental extension, Death Valley region, western United States. *Earth and Planetary Science Letters* 125: 235–254.

Bradshaw, T.K., C.J. Hawkesworth, and K. Gallagher. 1993. Basaltic volcanism in the southern Basin and Range: no role for a mantle plume. *Earth and Planetary Science Letters* 116: 45–62.

Daley, E.E., and D.J. DePaolo. 1992. Isotopic evidence for lithospheric thinning during extension: Southeastern Great Basin. *Geology* 20: 104–108.

Farmer, G.L., Perry, F.V., Semken, S., Crowe, B., Curtis, D., and DePaolo, D.J., 1989. Isotopic evidence on the structure and origin of subcontinental lithospheric mantle in southern Nevada. *Journal of Geophysical Research* 94: 7885–7898.

Farmer, G.L., A.F. Glazner, H.G. Wilshire, J.L. Wooden, W.J. Pickthorn, and M. Katz. 1995. Origin of late Cenozoic basalts at the Cima Volcanic Field, Mojave Desert, California. *Journal of Geophysical Research* 100: 8399–8415.

Feuerbach, D.L., E.I. Smith, J.D. Walker, and J.A. Tangeman. 1993. The role of the mantle during crustal extension: Constraints from geochemistry of volcanic rocks in the Lake Mead area, Nevada and Arizona. *Geological Society of America Bulletin* 105: 1561–1575.

Fitton, J.G., D. James, P.D. Kempton, D.S. Ormerod, and W.P. Leeman. 1988. The role of lithospheric mantle in the generation of late Cenozoic basic magmas in the western United States. *Journal of Petrology, Special Lithosphere Issue* 331–349.

Glazner, A.F., and G.L. Farmer. 1992. Production of isotopic variability in continental basalts by cryptic

crustal contamination. *Science* 255: 72–74.

Glazner, A.F., G.L. Farmer, W.T. Hughes, J.L. Wooden, and W. Pickthorn. 1991. Contamination of basaltic magma by mafic crust at Amboy and Pisgah Craters, Mojave Desert,California. *Journal of Geophysical Research* 96(B8): 13,673–13,691.

Hoffine, S.R. 1993. *Geochemistry of the volcanic rocks of the Saline Range, California: Implications for mantle composition and involvement in extension beneath the Basin and Range.* M.S. Thesis. Lawrence, KS: University of Kansas.

Kempton, P.D., J.G. Fitton, C.J. Hawkesworth, and D.S. Ormerod. 1991. Isotopic and trace element constraints on the composition and evolution of the lithosphere beneath the southwestern United States. *Journal of Geophysical Research* 96(B8): 13,713–13,735.

Lum, C.C. 1986. *Aspects of the Petrogenesis of Alkali Basalts from the Lunar Crater Volcanic Field, Nevada.* M.S. Thesis. Ohio State University.

Lum, C.C. 1992. *Major and Trace Element Compositions and Sr, Nd, and Pb Isotopic Ratios of Late Cenozoic Mafic Lavas from the Northern Basin and Range Province.* Ph.D. Dissertation. Houston, TX: Rice University.

Menzies, M.A., W.P. Leeman, and C.J. Hawkesworth. 1983. Isotope geochemistry of Cenozoic volcanic rocks reveals mantle heterogeneity below western USA. *Nature* 303: 205–209.

Ormerod, D.S. 1988. *Late–to Post–Sbuduction Magmatic Transitions in the Western Great Basin, USA.* Ph.D. Thesis. United Kingdom: Open University.

Perry, F.V. 1995. Presentation to Geomartix Consultants/U.S. Department of Energy Panel on Probabilistic Volcanic Hazards Assessment, May 16–17, 1995, in Las Vegas, NV. San Francisco, CA: Geomatrix Consultants.

Perry, F.V., and Crowe, B.M., 1992. Geochemical evidence for waning magmatism and polycyclic volcanism at Crater Flat, Nevada. *Proceedings of Third International Conference on High–Level Radioactive Waste Management.* La Grange Park, IL: American Nuclear Society: 2356–2365.

Perry, F.V., W.S. Baldridge, and D.J. DePaolo. 1987. Role of asthenosphere and lithosphere in the genesis of Late Cenozoic basaltic rocks from the Rio Grande Rift and adjacent regions of the southwestern United States. *Journal of Geophysical Research* 92(B9): 9193–9213.

Smith, E.I., and T. Bradshaw. 1994. *Annual report of the Center for Volcanic and Tectonic Studies for the period 10–1–92 to 9–30–93.* Carson City, Nevada: The Nuclear Waste Project Office, Report 41.

Smith, E.I., D.L. Feuerbach, T.R. Naumann, and J.E. Faulds. 1990. *Annual report of the Center for Volcanic and Tectonic Studies for the period 10–1–89 to 9–30–90.* Carson City, Nevada: The Nuclear Waste Project Office, Report 41.

Walker, J.D., and D.S. Coleman. 1991. Geochemical constraints on mode of extension in the Death Valley region. *Geology* 19: 971–974.

Project: Determine the values for data points in x-y graphs in publications without data tables. Use Arc/Info to accurately digitize values.

Setup Arc/Info: a 7/5/96

1) DIGITIZER mgrid3 /dev/ttyb:9600:7bit:even /* Setupt digitizer
2) DIGTEST /* Test digitizer

Enlarge graph to digitize, label corners row, column (11, 12, 21, 22)

3) Use textedit to create the PLOT.TIC file with x, y values for graph corners:

```
11, 0.702, -13.0
12, 0.710, -13.0
21, 0.702, 13.0
22, 0.710, 13.0
END                                   /* Don't forget the END at end of file
```

4) GENERATE plot_fn

```
G> INPUT plot.tic
G> TICS
G> quit
```

5) Digitize points in Arc Edit

```
AE> EDIT plot_fn
AE> de points
AE> ef points
AE> COORDINATE DIGITIZER DEFAULT
      - From digpad, put x-hairs on origin (1,1), hit "1", "1", "A", "A" on pad to set coordinates
      - "0", "A" to end
AE> ADD                               /* Now digitize the data points
AE> "8"          /* Use to set a new ID for data sequence. Distinguish different symbols etc.
AE> "0"          /* End digitizing
AE> SAVE
```

6) Get data out of coverage

```
Arc> BUILD plot_fn POINT
Arc> UNGENERATE POINT plot_fn /bscr0/fn.txt
```

Example on next page is a data extraction from Walker and Coleman (1991 Geology), for Nd and Sr isotopic data for Pliocene volcanic rocks of the Nova Fm, Death Valley area, CA.

Data for the Nova Fm basalts, From Walker and Coleman (1991) Geology paper, digitized from figure 2, Sr and Nd isotopic data points for basalts with SiO2 <= 52%. BHill 11/9/95

1	0.703876	5.487458
2	0.703856	1.875154
3	0.704488	2.385107
4	0.704935	0.776285
5	0.705060	1.652826
6	0.705186	1.129009
7	0.705179	0.662520
8	0.705093	0.631506
9	0.705120	0.440207
10	0.705207	0.160059
11	0.705376	-0.140810
12	0.705401	-0.452989
13	0.705223	-1.240935
14	0.705642	-0.393760
15	0.705657	-0.878426
16	0.705715	-1.330298
17	0.705653	-1.656204
18	0.705675	-1.743528
19	0.705674	-2.227559
20	0.705664	-2.711207
21	0.705673	-2.815310
22	0.706101	-2.158671
23	0.706224	-1.212856
24	0.706339	-0.750817
25	0.707006	-0.207689

END

Information potentially subject to copyright protection was redacted from this location. The redacted material (a plot) is from the following reference:

Walker and Coleman. Figure 2: SR and Nd isotopic data points for basalts with SiO2. Geology Paper. 1991. No additional information is known.

Data from the Reveille Range and Lunar Crater Volcanic Field, Nevada, digitized from following graphs. Graphs enlarged from Foland and Bergman (1992) and digitized using previously described procedure. Only samples with identifiable ages and isotopic abundances were digitized. Although there is no actual spatial information here, the distances from Lunar Crater allow assignment into Lunar or Reveille fields.

Area	*Age*	*Sample*	*87Sr/86Sr*	*143/144*	*ENd*
Reveille	6.8	1	0.70530	0.512743	2.05
Reveille	6	2	0.70589	0.512628	-0.20
Reveille	6.7	3	0.70442	0.512762	2.42
Reveille	6	4	0.70424	0.512810	3.36
Reveille	6.2	5	0.70415	0.512836	3.86
Reveille	6.2	6	0.70578	0.512630	-0.16
Reveille	4.8	7	0.70357	0.512868	4.49
Reveille	6.5	8	0.70577	0.512625	-0.25
Reveille	4.5	9	0.70449	0.512828	3.71
Reveille	5.9	10	0.70504	0.512782	2.81
Reveille	6.2	11	0.70550	0.512672	0.66
Lunar	3.2	12	0.70356	0.512880	4.72
Lunar	3.3	13	0.70339	0.512878	4.68
Lunar	2.1	14	0.70342	0.512875	4.62
Lunar	3	15	0.70332	0.512921	5.52
Lunar	2.6	16	0.70335	0.512872	4.56
Lunar	1.2	17	0.70325	0.512904	5.19
Lunar	1.1	18	0.70333	0.512912	5.34
Lunar	1.8	19	0.70341	0.512912	5.34
Lunar	0.7	20	0.70324	0.512912	5.34
Lunar	1.2	21	0.70362	0.512871	4.55
Lunar	0.5	22	0.70331	0.512925	5.60

Enlarged figure 3 from Foland and Bergman (1992) showing age (upper) and composition (lower) against distance from Lunar Crater volcano. Plot used to determine ages and assign sample numbers.

Information potentially subject to copyright protection was redacted from this location. The redacted material (a plot) is from the following reference:

Foland and Bergman. Figure 3: age and composition against distance from Lunar Crater volcano. 1992. No additional information is known.

Enlarged figure 5 from Foland and Bergman (1992) showing Sr (upper) and Nd (lower) isotopic abundances against distance from Lunar Crater volcano. Plot used to determine isotope abundances.

Information potentially subject to copyright protection was redacted from this location. The redacted material (a plot) is from the following reference:

Foland and Bergman. Figure 5: Sr and Nd isotopic abundances against dance from Lunar Crater volcano. 1992. No other additional information is know.

Volcanic Systems of the Basin and Range Brittain Hill Hill 3/6/96

Compilation of data contained in BRISOTOP.XLS culled from preceding literature.

Information potentially subject to copyright protection was redacted from this location. The redacted material (data table, pages 29 through 35 of this scientific notebook) is from the following references:

Lum 1992; Ormerod, 1988; Menzies, et al., 1983; Foland and Bergman, 1992; Lum, 1986; Kempton, et al., 1991; Lum et al., 1989; Farmer, et al., 1989; Smith, et al., 1990; Bradshaw, et al., 1993; Ellen, 1992; Feuerbach, et al., 1993; Daley and DePaolo, 1992; Glazner et al., 1991; Farmer et al., 1995; Glazner and Farmer, 1992; Asmerom, et al., 1994; Walker and coleman, 1991; Hoffine, 1993; Smith, et al., 1994; Perry and Crowe, 1992; Perry, 1995; Smith and Bradshaw, 1994.

See page 29 of this scientific notebook.

The details of the analysis and interpretation into regional volcanic-structural setting is presented in Hill and Connor (1996) Volcanic Systems of the Basin and Range Semi-Annual Report, chapter 5.

PROJECT: Modification of YMR local and regional basalt distribution maps in Arc/Info. This project is to clean up the previous overlapping coverages in the Volcanism GIS for the YMR, and incorporate the newly released digital version of the Frizzell and Shulters NTS geologic map.

The following changes were made to these polygon coverages:

- ALLBAS (**YMRBAS50**): Contain overlapping, manually digitized versions of some YMR basalt, digitized from original USGS 7.5' maps. This coverage was checked against the same areas in FS95BAS (see below), and most areas within the NTS map were deleted because the FS95BAS coverage was more complete or accurate. NTS areas that remain in ALLBAS were at Paiute Ridge, Nye Canyon, and Specter Mountains. Renamed **YMRBAS50** to reflect coverage of basalt within 50 km of repository site.
- YMRBAS50: Basalt dikes at Solitario Canyon and the Prow added from the Scott and Trask (1985) geologic map. Dikes were widened slightly so that they will plot at regional scales.
- YMRBAS50: Basalt at Cinder Hill and Shoreline Butte in S. Death Valley were added from 1:250,000 geologic map, base topographic maps, and Landsat image of area.
- YMRBAS50: Basalt distribution in the Grapevine mountains were shifted about 200m N to correspond to coregistered Landsat image of area. Apparent digitizing error in that markers were shifted N.
- YMRBAS50: Basalt distribution in the northern Funeral Fm., Greenwater Range, was corrected from significant errors in the digitized version of McAllister (1970). Landsat TM image was placed in background and basalt distrubution in northern Greenwater Range was corrected based on TM image. Digitized coverage in southern Greenwaters was checked against TM image and found accurate. Must have been an error in registering the McAllister (1970) map during digitizing.

- LUEDKE5MY: Regional 5 Ma and younger basalt coverage from Luedke and Smith (1981 map I-1091-C) cleaned to remove basalt in the NTS region, Reveille-Lunar Crater, Coso, Big Pine, and Cima Volcanic Fields, which will be represented by detailed coverages for these areas. For remaining basalts, divide into ages of 2Ma and 5Ma based on the original map and additional information in Smith and Luedke (1985).

- LUEDKE10MY: Regional 5-10 Ma basalt coverage from Luedke and Smith (1981 map I-1091-C) cleaned to remove basalt in the NTS region, Reveille-Lunar Crater, Coso, Big Pine, and Cima Volcanic Fields, which will be represented by detailed coverages for these areas. Lat-Long grid lines and California-Nevada state outlines removed for clarity.

Other basalt and relevant coverages remaining in BREN/u4/phunka/ai/region:

AMARGOSA: Point coverage of Amargosa Valley aeromagnetic anomalies (Langenheim et al. 1993).

AV1LINE: Seismic reflection line AV1, from Brocher et al. (1993).

AVMILETICS: Tics on AV1 line at 1-mile intervals.

AVTBASALTS: Basalt in the Amargosa Valley (i.e., Stealth basalt).

BASALTWELLS: Drill holes that have penetrated basalt in Yucca Flat, Frenchman Flat, Crater Flat, and the Amargosa Valley.

FS95BAS: Digital Frizzell and Shulters (1995) NTS map, copied from /u6/gisdb/usgs/frizshul/geol_poly and projected into UTM, NV zone 11, NAD27, Clarke 1866.

FS95CALDERA: Digital Frizzell and Shulters (1995) NTS map, copied from /u6/gisdb/usgs/frizshul/geol_cald and projected into UTM, NV zone 11, NAD27, Clarke 1866.

FS95FAULTS: Digital Frizzell and Shulters (1995) NTS map, copied from /u6/gisdb/usgs/frizshul/geol_flts and projected into UTM, NV zone 11, NAD27, Clarke 1866.

REGION2MY: Original Luedke and Smith (1981) digitized map containing 2 Ma and younger basalt only.

REGION5MY: Original Luedke and Smith (1981) digitized map containing 5 Ma and younger basalt only.
REGIONTIC: Regional 7.5' tics, very large coverage
REPOSITORY: Medium thermal load repository, from DOE 1993 GIS tape
YMLOC_5K: Grid with 5 km cells centered on the repository, for 50 km outward
YMRLABELS: Common formation/volcano names and average ages, following Connor and Hill (1995).

Tic files: These tic files were created using the following macro in Microsoft Excel to create a column delineated file:

grid coords (g)
=SET.NAME("row",0)
=SET.NAME("col",0)
=SET.NAME("utme",448000)
=SET.NAME("UTMN",3963000)
=FOR("counter2",3963000,4153000,5000)
=SET.NAME("row",0)
=SET.NAME("col",col+1)
=SET.NAME("utme",448000)
=SET.NAME("UTMN", UTMN+5000)
=FOR("counter1", 448000,608000,5000)
=SET.NAME("row", row+1)
=SET.NAME("utme", utme+5000)
=SELECT("R[+1]C")
=TEXT(row,0)
=TEXT(col,0)
=FORMULA(col&"0"&row,ACTIVE.CELL())
=SELECT("RC[+1]")
=FORMULA(utme, ACTIVE.CELL())
=SELECT("RC[+1]")
=FORMULA(UTMN, ACTIVE.CELL())
=SELECT("RC[-2]")
=NEXT()
=NEXT()
=RETURN()

Output:

Row&col	UTM N	UTM E
101	453000	3968000
102	458000	3968000
103	463000	3968000
104	468000	3968000
105	473000	3968000
106	478000	3968000
107	483000	3968000
108	488000	3968000
109	493000	3968000
1010	498000	3968000
1011	503000	3968000
1012	508000	3968000
1013	513000	3968000
1014	518000	3968000
1015	523000	3968000
1016	528000	3968000
1017	533000	3968000
1018	538000	3968000
1019	543000	3968000
1020	548000	3968000
1021	553000	3968000
1022	558000	3968000
1023	563000	3968000
1024	568000	3968000
1025	573000	3968000
1026	578000	3968000
1027	583000	3968000
1028	588000	3968000
1029	593000	3968000
1030	598000	3968000
1031	603000	3968000

UTM1: Regional tics used for original digitizing and coregistration
UTMTIC15: Regional lat-long tics at 15' intervals, projected into UTM coordinates
UTMTIC5KM: 5 km grid tics centered on the repository and extending for 50 km N, S, E, and W from repository.
UTMTIC75: Regional lat-long tics at 7.5' intervals, projected into UTM coordinates

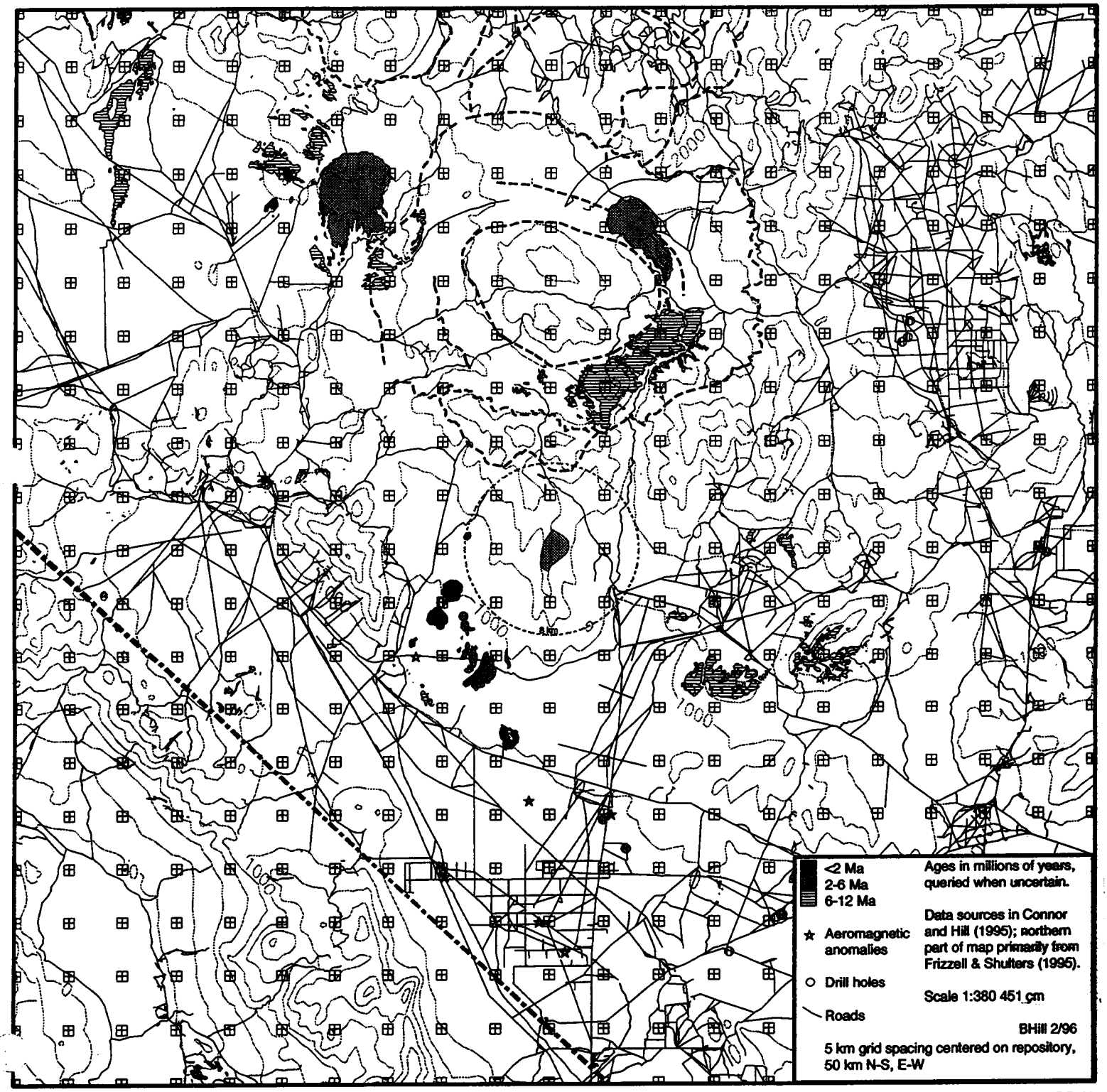
Using the following AML, produce YMR maps for region as well as 50 km local showing basalt, ages, names. Other options include contours, roads, state and county boundaries:

```
/* YMRBAS.AML Basalts of YMR, with Frizzel &
Schulters 1995 YMR basalt map  bhill 2/22/96

kill ymrbas.map
map ymrbas.map

/* Set for region vs local: extent, scale, box, tic

/*map for region ~1x1 map
/*mapextent 455000 3970000 608000 4152000
/*mapextent for repository 50 km outward
/*mapextent 497800 4027900 598300 4128200
mapextent 537000 4030000 565000 4070000
pagesize 11 17
maplimits 0.3 0.3 10.7 16.7
/*pagesize 17 11
/*maplimits 0.3 0.3 16.7 10.7
mapposition cen cen
mapunits meters
/*mapscale 579194
/*map scale for 50 km YMlocal map
/*mapscale 380451
mapscale 100000

shadeset colornames.shd
markerset plotter.mrk
lineset carto.lin

/* create a colored background to save eyes
shadesymb  2
shadecolor white
/*shadecolor moccasin
units page
patch 0 0 11.0 17.0
linesymbol 1
linecolor grey0
/*box 50 km local
/*box 0.3 3.3 10.7 13.7
/*box region
/*box 0.3 2.31 10.7 14.7

/* Gives 15' tics or 5 km tics
markersymbol 37
markercolor grey0
markersize 0.1
/*tics utmtic15 noids
tics utmtic5km noids
/*arcs ymloc_5k

/*set variables for color or b&w map
/*&setvar map = color
&setvar map = bw

/*amargosa valley amag points, wells, bas
markersymbol 45
markersize 0.1
&if %map% = bw &then markercolor grey0; &else
markercolor green;
points amargosa
markerset water.mrk
markersymbol 107
markersize 0.15
&if %map% = bw &then markercolor grey0; &else
markercolor dodgerblue
points basaltwells
linesymbol 101
linecolor gray0
arcs av1line
markerset municipal.mrk
markersymbol 115
markersize 0.15
markercolor grey0
points avmiletics

/*&goto finito

linesymbol 110
linecolor gray0
/*arcs fs95caldera

/* CA-NV border
linesymbol 123
linecolor gray0
/*arcs %.ymr%/geopoli/reg68utm

/* Use ymrbas50 for basalts, removed Qcf, Buck, TM,
```

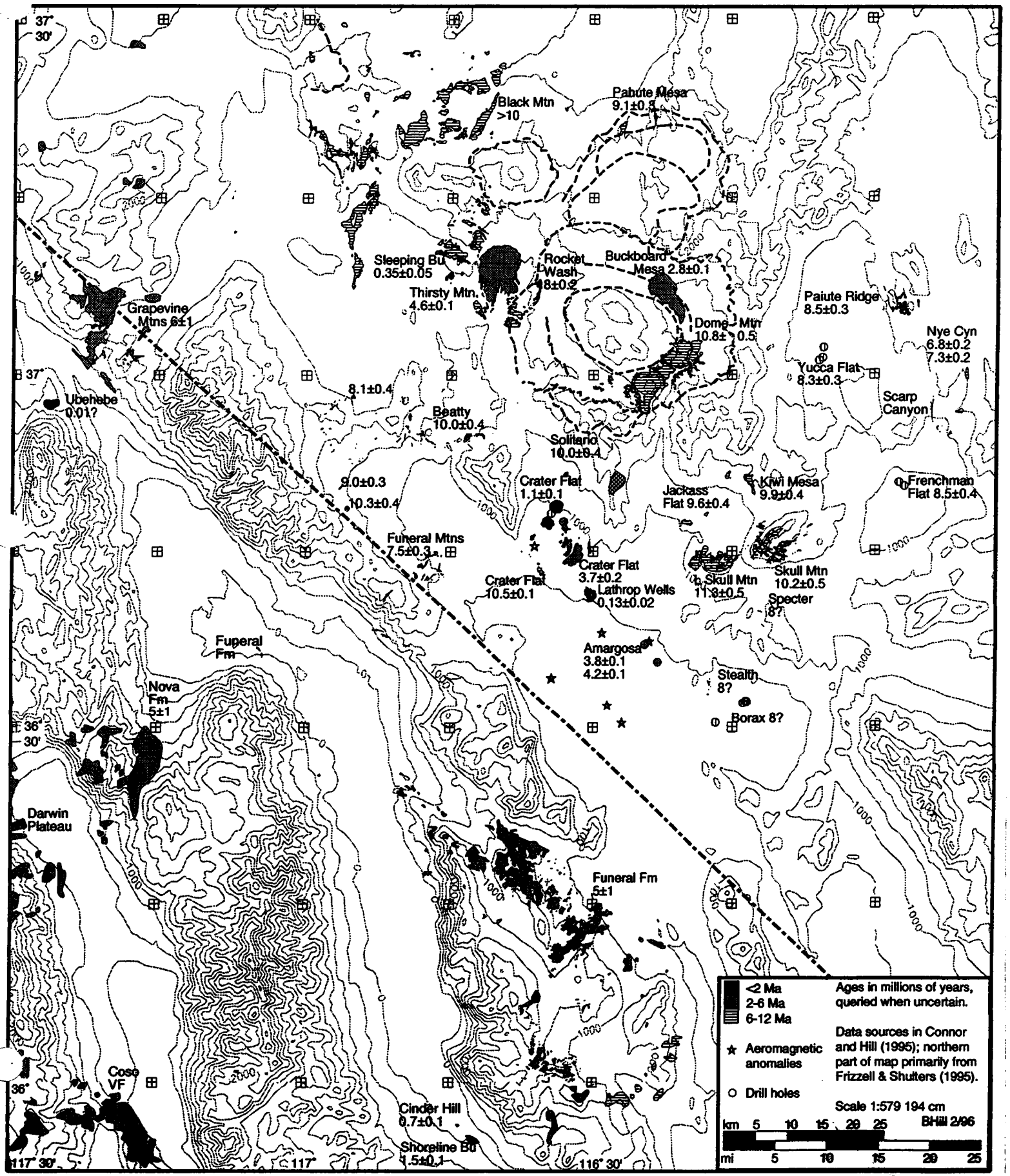
```
PCF and LW from allbas, to avoid duplicates with
Friz-Schul 95 cover

linesymbol 101
linecolor gray0

clearselect
reselect fs95bas poly MUNIT_NAME = 'Qbo'
aselect fs95bas poly MUNIT_NAME = 'Qby'
&if %map% = bw &then polygonshade fs95bas 27;
&else polygonshade fs95bas 110;
polygonlines fs95bas 1

clearselect
reselect fs95bas poly MUNIT_NAME = 'Typ'
aselect fs95bas poly MUNIT_NAME = 'Top'
&if %map% = color &then polygonshade fs95bas 70;
&else polygonshade fs95bas 32;
polygonlines fs95bas 1

clearselect
reselect ymrbas50 poly AGE <= 2 and AGE > 0
&if %map% = color &then polygonshade ymrbas50
110; &else polygonshade ymrbas50 27;
polygonlines ymrbas50 1

clearselect
reselect ymrbas50 poly AGE <= 6 and AGE > 2
&if %map% = color &then
 &do
 polygonshade ymrbas50 70
 polygonshade luedke5my 70
&end
&else
 &do
 polygonshade ymrbas50 32
 polygonshade luedke5my 32
&end
polygonlines ymrbas50 1
polygonlines luedke5my 1

/* Use template.shd for b&w patterns

&if %map% = bw &then
&do
 shadeset template.shd
 symbolscale 0.5
 shadecolor grey0
 polygonshade repository 1019
 polygonshade repository 1018
&end
&else polygonshade repository 104
linesymbol 101
linecolor grey0
arcs repository

clearselect
reselect fs95bas poly MUNIT_NAME = 'Tyb'
aselect fs95bas poly MUNIT_NAME = 'Tob'
&if %map% = color &then polygonshade fs95bas 44;
&else polygonshade fs95bas 1016;
polygonlines fs95bas 1

clearselect
reselect ymrbas50 poly AGE > 6
&if %map% = color &then
&do
 polygonshade ymrbas50 44
 polygonshade avtbasalts 44
&end
&else polygonshade ymrbas50 1016; polygonshade
avtbasalts 1016
polygonlines ymrbas50 1
polygonlines avtbasalts 1

&goto contour
linesymbol 101
linecolor dimgray
arcs %.ymr%/hypso/reg6x8/utm/w118n35
arcs %.ymr%/hypso/reg6x8/utm/w117n35
arcs %.ymr%/hypso/reg6x8/utm/w116n35
arcs %.ymr%/hypso/reg6x8/utm/w118n36
arcs %.ymr%/hypso/reg6x8/utm/w117n36
arcs %.ymr%/hypso/reg6x8/utm/w116n36
arcs %.ymr%/hypso/reg6x8/utm/w118n37
arcs %.ymr%/hypso/reg6x8/utm/w117n37
arcs %.ymr%/hypso/reg6x8/utm/w116n37
&label contour

/*give a readable font
symbolscale 1
textset font.txt
textfont 'Univers Medium'
textquality kern
textsize 10 pt
textcolor black
/*pointtext ymrlabels name # LL

/*Fault coverages
linecolor grey0
/*arcs %.ymr%/faults/allflts/allutm
/*arcs %.ymr%/faults/dohren/allutm
arcs fs95faults

/*&goto finito
```

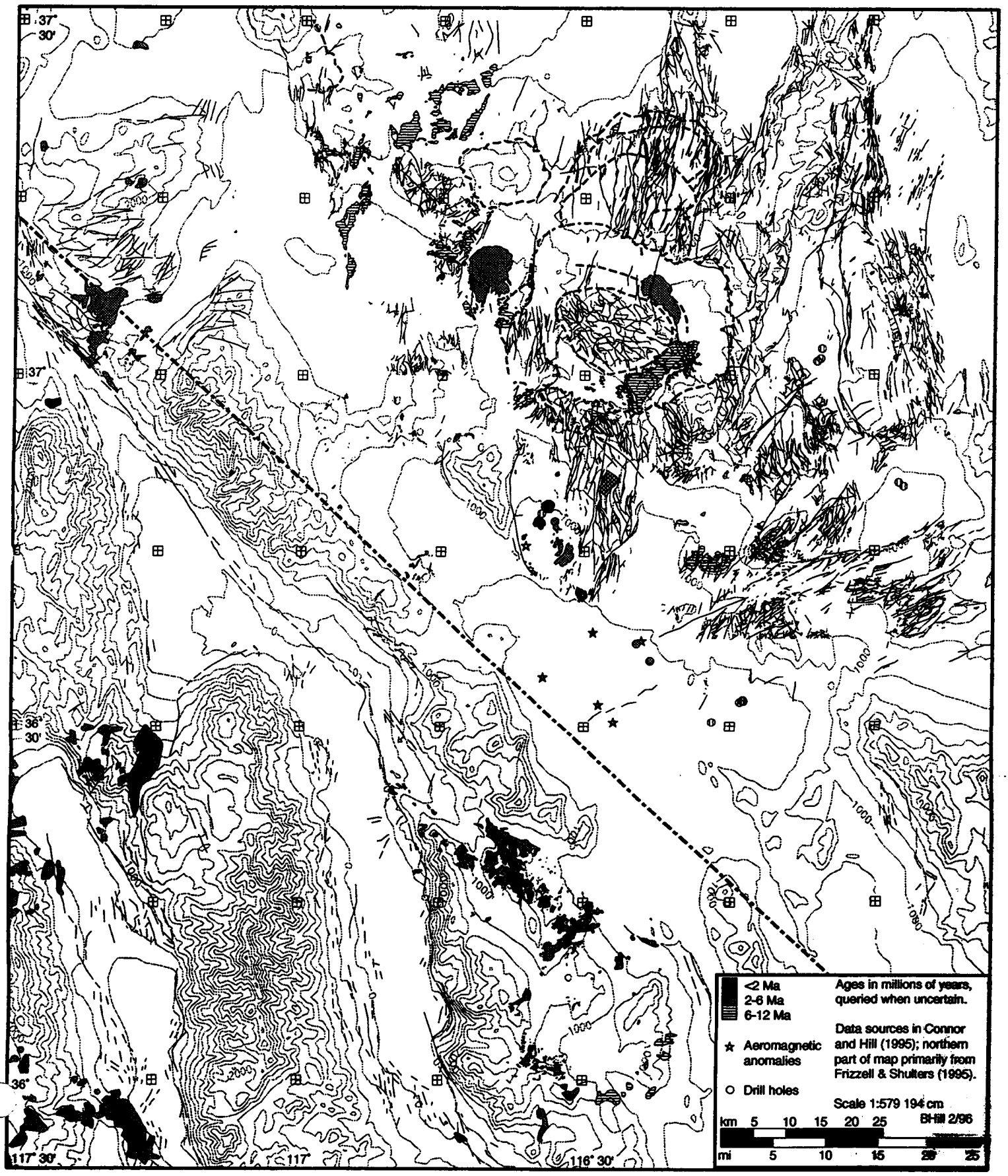
```
/*Roads & Counties for hazard modelsbc
linesymbol 123
linecolor grey0
arcs %.ymr%/geopoli/nvca_cntysutm

linesymbol 101
&if %map% = bw &then linecolor grey0; &else
linecolor saddlebrown;

arcs %.ymr%/roads/usgs100k/utm/lastchance
arcs %.ymr%/roads/usgs100k/utm/pahutemesa
arcs %.ymr%/roads/usgs100k/utm/pahranagat
arcs %.ymr%/roads/usgs100k/utm/salinevalley
arcs %.ymr%/roads/usgs100k/utm/beatty
arcs %.ymr%/roads/usgs100k/utm/indiansprings
arcs %.ymr%/roads/usgs100k/utm/darwinhills
arcs %.ymr%/roads/usgs100k/utm/dvjunction
arcs %.ymr%/roads/usgs100k/utm/lasvegas

&label finito

mapinfo
/* map end
```

Maps on the following pages were originally printed on 11x17 format, but have been reduced to fit on these pages. Stated scales have not been corrected for this reduction, but scale bar is of course still accurate.


2000
1000
1000
1000
<2 Ma
2-6 Ma
6-12 Ma
Ages in millions of years, queried when uncertain.
Aeromagnetic anomalies
Drill holes
Roads
Data sources in Connor and Hill (1995); northern part of map primarily from Frizzell & Shulters (1995).
Scale 1:380 451 cm
BHill 2/96
5 km grid spacing centered on repository, 50 km N-S, E-W

YM50BWRD.AI


Black Mtn >10
Pahute Mesa 9.1±0.3
Sleeping Bu 0.35±0.05
Rocket Wash 8±0.2
Buckboard Mesa 2.8±0.1
Thirsty Mtn. 4.6±0.1
Grapevine Mtns 6±1
Paiute Ridge 8.5±0.3
Dome Mtn 10.8±0.5
Nye Cyn 6.8±0.2 7.3±0.2
Yucca Flat 8.3±0.3
Scarp Canyon
Ubehebe 0.01?
8.1±0.4
Beatty 10.0±0.4
Solitario 10.0±0.4
9.0±0.3
10.3±0.4
Crater Flat 1.1±0.1
Jackass Flat 9.6±0.4
Kiwi Mesa 9.9±0.4
Frenchman Flat 8.5±0.4
Funeral Mtns 7.5±0.3
Crater Flat 3.7±0.2
Crater Flat 10.5±0.1
Lathrop Wells 0.13±0.02
Skull Mtn 11.3±0.5
Skull Mtn 10.2±0.5
Specter 8?
Amargosa 3.8±0.1 4.2±0.1
Stealth 8?
Borax 8?
Fuperal Fm
Nova Fm 5±1
Darwin Plateau
Funeral Fm 5±1
Coso VF
Cinder Hill 0.7±0.1
Shoreline Bu 1.5±0.1
37° 30'
36° 30'
36°
117° 30'
117°
116° 30'
1000
2000
<2 Ma
2-6 Ma
6-12 Ma
Aeromagnetic anomalies
Drill holes
Ages in millions of years, queried when uncertain.
Data sources in Connor and Hill (1995); northern part of map primarily from Frizzell & Shutters (1995).
Scale 1:579 194 cm
km 5 10 15 20 25
mi 5 10 15 20 25
BHill 2/96


37° 30'
37°
36° 30'
36°
117° 30'
117°
116° 30'
1000
<2 Ma
2-6 Ma
6-12 Ma
Aeromagnetic anomalies
Drill holes
Ages in millions of years, queried when uncertain.
Data sources in Connor and Hill (1995); northern part of map primarily from Frizzell & Shulters (1995).
Scale 1:579 194 cm
km 5 10 15 20 25
mi 5 10 15 20 25
BHill 2/96

YMRBWRL_AI

Project: Modify Luedke & Smith (1981) regional basalt map using detailed information for distribution of QT basalts in Esmeralda County, from County map by Albers, J.P., and J.H. Stewart. 1972. Geology and Mineral Deposits of Esmeralda County, Nevada. *Nevada Bureau of Mines and Geology Bulletin* 78. This consisted of adding large amount of QTb that was left off of Luedke and Smith (1981) in the area between 38°00'N 117°45'W and 38°15'N 117°30'W. In addition, small scattered patches of QTb were added between 37°30'N 118°00'W and 38°15'N 117°15'W.

- Moved /u4/phunka/ai/region/AVTBASALT basalt outcrops into the YMRBAS50 coverage:

```
AE> edit YMRBAS50
AE> ef arc                  /* selects the feature to be copied from other coverage
AE> GET AVTBASALT           /* copies features into coverage. Can also select features in edited
                               coverage and PUT into another coverage, which can be the
                               backcoverage also.
AE> ef label
AE> GET AVTBASALT

AE> sel for age = 0.0       /* Copied labels loose their attributes
AE> calc age = 8.0          /* reset age with best estimate

Arc> Build YMRBAS50 poly    /* restore topology since added arcs.
```

Used REGIONBAS.AML to create map after AML listing. Original map is printed at 11x17 for clarity, but 8x10 is shown here for completeness.

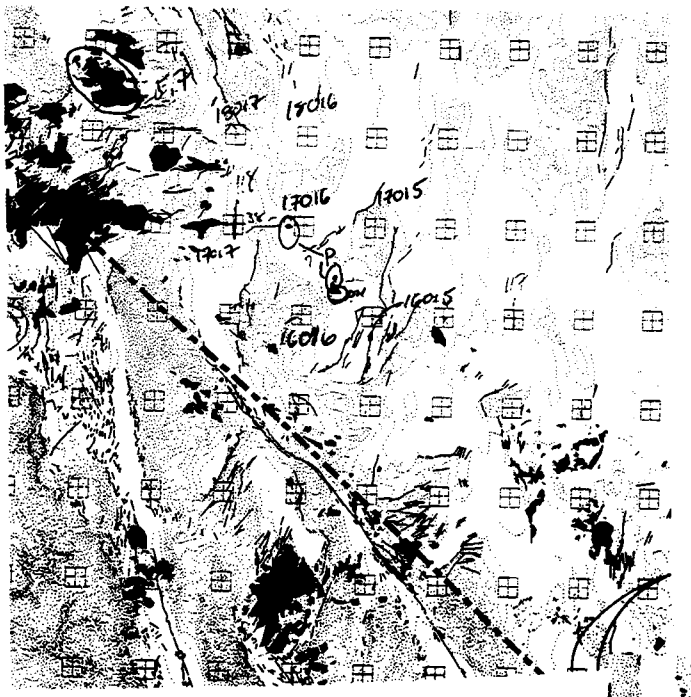
```
/* REGIONBS.AML Basalts of western US, based primarily on Luedke and Smith (1981) with Frizzel & Schulters 1995
YMR basalt map  bhill 4/4/96

kill regionbas.map
map regionbas.map
/* Set for region vs local: extent, scale, box, tic
/*map for region ~1x1 map
/*mapextent 455000 3970000 608000 4152000
mapextent luedke5my
pagesize 11 17
maplimits 0.3 0.3 10.7 16.7
/*pagesize 17 11
/*maplimits 0.3 0.3 16.7 10.7
mapposition cen cen
mapunits meters
mapscale auto

shadeset colornames.shd
markerset plotter.mrk
lineset carto.lin

/* create a colored background to save eyes
shadesymb  2
shadecolor white
/*shadecolor moccasin
units page
patch 0 0 11.0 17.0
linesymbol 1
linecolor grey0
/*box region
/*box 0.3 2.31 10.7 14.7

/*mapwarp %.ymr%/namerica/dnaggrav/grvstm.bil
/*image %.ymr%/namerica/dnaggrav/grvstm.bil

/* Gives 15' tics or 5 km tics
markersymbol 37
markercolor dimgrey
markersize 0.1
/*tics utmtic15 noids
/*tics utmtic5km noids
/*tics region15tic noids

/*set variables for color or b&w map
&setvar map = color
/*&setvar map = bw

/*amargosa valley amag points, wells, bas
markersymbol 45
markersize 0.05
```

```
&if %map% = bw &then markercolor grey0; &else
markercolor green;
points amargosa
markerset water.mrk
markersymbol 107
markersize 0.15
&if %map% = bw &then markercolor grey0; &else
markercolor dodgerblue
/*points basaltwells
linesymbol 101
linecolor gray0

/* CA-NV border
linesymbol 123
linecolor gray0
arcs %.ymr%/geopoli/reg68utm

linesymbol 101
linecolor gray0

/* Select the Quaternary basalts
clearselect
reselect fs95bas poly MUNIT_NAME = 'Qbo'
aselect fs95bas poly MUNIT_NAME = 'Qby'
reselect ymrbas50 poly AGE <= 2 and AGE > 0
reselect luedke5my poly AGE = 2.0
reselect %.k%/pancake/lctic/flowsfin poly AGE <= 2
and AGE > 0
reselect %.k%/coso/cosotic/flowsfin poly AGECODE
<= 2 and AGECODE > 0
reselect %.k%/cima/cimatic/flowsll poly AGE <= 2 and
AGE > 0
&if %map% = color &then
 &do
  polygonshade fs95bas 110
  polygonshade ymrbas50 110
  polygonshade luedke5my 110
  polygonshade %.k%/pancake/lctic/flowsfin 110
  polygonshade %.k%/coso/cosotic/flowsfin 110
  polygonshade %.k%/bigpine/flows 110
  polygonshade %.k%/cima/cimatic/flowsll 110
 &end
&else
 &do
  polygonshade fs95bas 27
  polygonshade ymrbas50 27
  polygonshade luedke5my 27
  polygonshade %.k%/pancake/lctic/flowsfin 27
  polygonshade %.k%/coso/cosotic/flowsfin 27
  polygonshade %.k%/bigpine/flows 27
  polygonshade %.k%/cima/cimatic/flowsll 27
 &end
 polygonlines fs95bas 1
 polygonlines ymrbas50 1
 polygonlines luedke5my 1
 polygonlines %.k%/pancake/lctic/flowsfin 1
 polygonlines %.k%/coso/cosotic/flowsfin 1
 polygonlines %.k%/bigpine/flows 1
 polygonlines %.k%/cima/cimatic/flowsll 1

 /* Select Plio basalts
 clearselect
 reselect ymrbas50 poly AGE <= 6 and AGE > 2
 reselect luedke5my poly AGE <= 6 and AGE > 2
 reselect fs95bas poly MUNIT_NAME = 'Typ'
 aselect fs95bas poly MUNIT_NAME = 'Top'
 reselect %.k%/pancake/lctic/flowsfin poly AGE <= 6 and
 AGE > 2
 reselect %.k%/coso/cosotic/flowsfin poly AGECODE = 3
 reselect %.k%/cima/cimatic/flowsll poly AGE <= 6 and
 AGE > 2
 &if %map% = color &then
  &do
   polygonshade fs95bas 70
   polygonshade ymrbas50 70
   polygonshade luedke5my 70
   polygonshades %.k%/pancake/lctic/flowsfin 70
   polygonshades %.k%/coso/cosotic/flowsfin 70
   polygonshades %.k%/cima/cimatic/flowsll 70
  &end
 &else
  &do
   polygonshade fs95bas 32
   polygonshade ymrbas50 32
   polygonshade luedke5my 32
   polygonshades %.k%/pancake/lctic/flowsfin 32
   polygonshades %.k%/coso/cosotic/flowsfin 32
   polygonshades %.k%/cima/cimatic/flowsll 32
  &end
 polygonlines fs95bas 1
 polygonlines ymrbas50 1
 polygonlines luedke5my 1
 polygonlines %.k%/pancake/lctic/flowsfin 1
 polygonlines %.k%/coso/cosotic/flowsfin 1
 polygonlines %.k%/cima/cimatic/flowsll 1

 /* Add Repository
 /* Use template.shd now for b&w lined patterns

 &if %map% = bw &then
 &do
  shadeset template.shd
  symbolscale 0.5
  shadecolor grey0
```

```
  polygonshade repository 1019
  polygonshade repository 1018
&end
&else polygonshade repository 104
polygonlines repository 1

/*&goto mioskip
/* Select basalts > 6 Ma
clearselect
reselect fs95bas poly MUNIT_NAME = 'Tyb'
aselect fs95bas poly MUNIT_NAME = 'Tob'
reselect ymrbas50 poly AGE > 6
reselect %.k%/pancake/lctic/flowsfin poly AGE >= 6
reselect %.k%/coso/cosotic/flowsfin poly AGECODE
= 4
reselect %.k%/cima/cimatic/flowsll poly AGE > 6

&if %map% = color &then
 &do
  polygonshade fs95bas 44
  polygonshade ymrbas50 44
  polygonshade luedke10my 44
  polygonshade %.k%/pancake/lctic/flowsfin 44
  polygonshade %.k%/coso/cosotic/flowsfin 44
  polygonshade %.k%/cima/cimatic/flowsll 44
 &end
 &else
 &do
  polygonshade ymrbas50 1016
  polygonshade fs95bas 1016
  polygonshade luedke10my 1016
  polygonshade %.k%/pancake/lctic/flowsfin 1016
  polygonshade %.k%/coso/cosotic/flowsfin 1016
  polygonshade %.k%/cima/cimatic/flowsll 1016
 &end
polygonlines ymrbas50 1
polygonlines avtbasalts 1
polygonlines fs95bas 1
polygonlines luedke10my 1
polygonlines %.k%/pancake/lctic/flowsfin 1
polygonlines %.k%/coso/cosotic/flowsfin 1
polygonlines %.k%/cima/cimatic/flowsll 1

/*&goto contour
linesymbol 101
linecolor gray
arcs %.ymr%/hypso/reg6x8/utm/w120n34
arcs %.ymr%/hypso/reg6x8/utm/w119n34
arcs %.ymr%/hypso/reg6x8/utm/w118n34
arcs %.ymr%/hypso/reg6x8/utm/w117n34
arcs %.ymr%/hypso/reg6x8/utm/w116n34
arcs %.ymr%/hypso/reg6x8/utm/w115n34
arcs %.ymr%/hypso/reg6x8/utm/w120n35
arcs %.ymr%/hypso/reg6x8/utm/w119n35
arcs %.ymr%/hypso/reg6x8/utm/w118n35
arcs %.ymr%/hypso/reg6x8/utm/w117n35
arcs %.ymr%/hypso/reg6x8/utm/w116n35
arcs %.ymr%/hypso/reg6x8/utm/w115n35
arcs %.ymr%/hypso/reg6x8/utm/w120n36
arcs %.ymr%/hypso/reg6x8/utm/w119n36
arcs %.ymr%/hypso/reg6x8/utm/w118n36
arcs %.ymr%/hypso/reg6x8/utm/w117n36
arcs %.ymr%/hypso/reg6x8/utm/w116n36
arcs %.ymr%/hypso/reg6x8/utm/w115n36
arcs %.ymr%/hypso/reg6x8/utm/w120n37
arcs %.ymr%/hypso/reg6x8/utm/w119n37
arcs %.ymr%/hypso/reg6x8/utm/w118n37
arcs %.ymr%/hypso/reg6x8/utm/w117n37
arcs %.ymr%/hypso/reg6x8/utm/w116n37
arcs %.ymr%/hypso/reg6x8/utm/w115n37
arcs %.ymr%/hypso/reg6x8/utm/w120n38
arcs %.ymr%/hypso/reg6x8/utm/w119n38
arcs %.ymr%/hypso/reg6x8/utm/w118n38
arcs %.ymr%/hypso/reg6x8/utm/w117n38
arcs %.ymr%/hypso/reg6x8/utm/w116n38
arcs %.ymr%/hypso/reg6x8/utm/w115n38
arcs %.ymr%/hypso/reg6x8/utm/w120n39
arcs %.ymr%/hypso/reg6x8/utm/w119n39
arcs %.ymr%/hypso/reg6x8/utm/w118n39
arcs %.ymr%/hypso/reg6x8/utm/w117n39
arcs %.ymr%/hypso/reg6x8/utm/w116n39
arcs %.ymr%/hypso/reg6x8/utm/w115n39
&label contour

/*Fault coverages
linesymbol 101
linecolor grey0
arcs %.ymr%/faults/allflts/allutm
arcs %.ymr%/faults/dohren/allutm
/*arcs fs95faults
/*arcs %.k%/bigpine/faults
/*arcs %.k%/coso/cosotic/faultsfin
arcs %.k%/cima/cimatic/faults02
/*arcs %.k%/pancake/lctic/faultsfin

/*Roads & Counties for hazard modelsbc
linesymbol 123
linecolor grey0
arcs %.ymr%/geopoli/nvca_cntysutm

linesymbol 101
&if %map% = bw &then linecolor grey0; &else linecolor
saddlebrown;
```

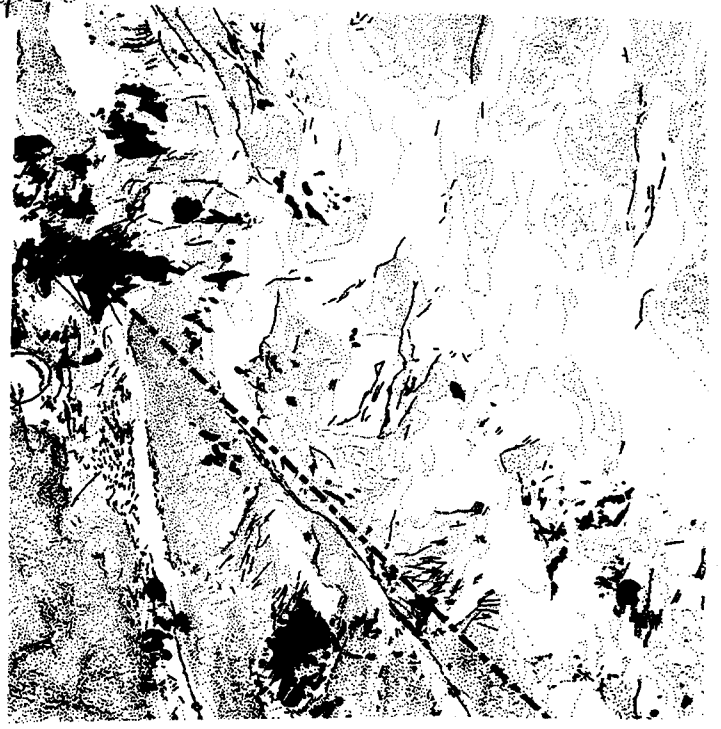
```
arcs %.ymr%/roads/usgs100k/utm/lastchance
arcs %.ymr%/roads/usgs100k/utm/pahutemesa
arcs %.ymr%/roads/usgs100k/utm/pahranagat
arcs %.ymr%/roads/usgs100k/utm/salinevalley
arcs %.ymr%/roads/usgs100k/utm/beatty
arcs %.ymr%/roads/usgs100k/utm/indiansprings
arcs %.ymr%/roads/usgs100k/utm/darwinhills
arcs %.ymr%/roads/usgs100k/utm/dvjunction
arcs %.ymr%/roads/usgs100k/utm/lasvegas

&label finito
mapinfo
/* map end
```

Copy of the appropriate section from the older map coverage on left. Areas modified are circled in yellow. New map on right.



OLD

NEW



Volcanic Systems of the Basin and Range Brittain Hill 6/13/96

Project: Compile volcanological data from known basaltic eruptions into Arc/info coverages, check reported eruption volumes with accurately calculated data, compare these eruptions to other volcanic data in previously entered A/I coverages, and plot these data on constant scale with Yucca Mountain physiography and geology for scale. Supports informal ACNW meeting in March, 1996.

Much of the volume estimates in the geological literature were done using simple planimetry on basic topographic maps. However, the quality of these base maps are unknows and it is clear from the literature that multiple enlargements and duplications have occurred. In addition, planimetry often yields 10% plus accuracy errors. Need to accurately compare eruptions to assess accuracy of precise performance models, which are highly dependent on volcanic intensive and extensive variables.

Data for YMR Volcanoes:
Volumes of lavas calculated from Frizell and Shulters (1995) coverage of the NTS geology, which includes the Quaternary basalts. From field observations and topographic maps, flow thicknesses were estimated as follows:

Age	Lathrop 120±20 ka	Hidden 350±50 ka	L Blk Pk 350±50 ka	SW Little 1.1±0.1 Ma	NE Little 1.1±0.1 Ma	Red Cone 1.1±0.1 Ma	Black Cone 1.1±0.1 Ma	North Cone 1.1±0.1 Ma	*TOTAL Crater Flat*
Location	W Gt Basin	W Gt Basin	W Gt Basin	W Gt Basin	W Gt Basin	W Gt Basin	W Gt Basin	W Gt Basin	
Volumes (km3)									
Cone	0.024	0.019	0.006	0.001	0.000	0.004	0.010	0.000	0.016
Lavas	0.034	0.005	0.003	0.003	0.001	0.089	0.065	0.004	0.162
Falls	0.048	0.038	0.012	0.002	0.0007	0.004	0.010	0.0001	0.017
N.B.	2x cone	2x cone	2x cone	2x cone	2x cone	1x cone	1x cone	1x cone	0.195
BULK									
Fall/cone	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	
Fall/lava	1.4	8.1	3.5	0.7	0.7	0.05	0.2	0.03	
Cone/lava	0.7	4.1	1.8	0.4	0.3	0.05	0.2	0.03	
Estimated DRE with Calcd magma density									
Cone 1.7 g/cm3	0.016	0.013	0.004	0.001	0.000	0.003	0.006	0.000	0.010
Lavas 2.4 g/cm3	0.031	0.004	0.003	0.003	0.001	0.08	0.06	0.004	0.151
Falls 1.3 g/cm3	0.024	0.019	0.006	0.001	0.000	0.002	0.005	0.000	0.009
TOTAL	0.071	0.036	0.013	0.005	0.001	0.09	0.07	0.004	0.169
MAGMATIC									
Fall/cone	1.5	1.5	1.5	1.5	1.5	0.8	0.8	0.8	0.8
Fall/lava	0.8	4.4	1.9	0.4	0.4	0.0	0.1	0.0	0.1
Cone/lava	0.5	2.9	1.2	0.3	0.2	0.03	0.1	0.0	0.1
Cone Parameters									
Cone height (m)	140	140	70	25	20	65	91	n/a	
Basal radius (m)	700	600	500	300	200	400	500	n/a	
Crater radius (m)	190	200	120	100	30	50	100	n/a	
Frustum volume (km3)	0.02	0.02	0.01	0.001	3.27E-04	0.004	0.01	1.00E-04	
				+1/3 for eros	+1/3 for eros	+1/3 for eros	+1/3 for eros	??	
Physical Properties									
Crystallinity (vol%)	3	3	3	3	3	3	3	3	
Erupt T (°C)	1100	1100	1100	1100	1100	1100	1100	1100	
Magmatic H2O (wt%)	2	2	2	2	2	2	2	2	
Density Magma (g/cm3)	2.59	2.59	2.59	2.59	2.59	2.59	2.59	2.59	
Visc w/ Xtl (Pa s)	36	36	36	65	65	65	65	65	

Lathrop Wells: 12m Hidden Cone and Little Black Peak: 10m
Little Cones: 10m Red Cone: 30m Black Cone: 25m Northern Cone: 5m.

Cone dimensions were derived from 7.5' topographic maps along with field observations regarding true base of the cone. Cone volumes were increased by 33% for the Quaternary Crater Flat volcanoes to account for a assummed amount of erosion; this value may underestimate the amount of erosion. Fall volumes were estimated at 2x cone volume for more fragmented deposits at Lathrop and Sleeping Butte, and 1x cone volume for the rest of Quaternary Crater Flat. Physical properties were calculated from geochemical analyses (B. Hill, unpub., Crowe et al., 1986) with estimated eruption temperatures and water contents. Densities calculated using partial molar volumes of Lange and Carmichael (1987) and Lange (1994). Viscosities calculated using the method of Shaw (1972) with apparent viscosities of crystals + melt using Pinkerton and Stevenson (1992).

Crowe et al (1995) report the following DRE volumes, but provide no explanation for the methods used to estimate these volumes: Lathrop Wells, 0.14 km^3, Sleeping Butte 0.06 km^3, and Quaternary Crater Flat 0.23 km^3.

Determining the density of the in-situ deposits is difficult, as there are few values presented in the literature for basaltic eruptions and these values have a large amount of variation. Lava flow density assumes that most blocky flows have relatively massive interiors with a rubbly outer carapace, and that flow vesicularities are 10-20%. Fall deposits range in the literature from <0.8 g/cm^3 to >1.3 g/cm^3. Data from the 1995 Cerro Negro eruption (see field volcanism notebook) show in-situ, uncompacted ash-fall deposits 22 km from the vent have an average density of 0.6 g/cm^3 and fresh scoria falls 1-5 km from the vent average 1.1 g/cm^3. I assume that a decade or so of settling due to rain and minor seismicity should increase the deposit density a bit, and thus use a density of 1.3 g/cm^3.

Base Map:
- Modified YMRBAS50 Arc/Info coverage to correct the location and shape of the Solitario Canyon basaltic dikes, based on mapping from Scott and Bonk (1984) and copying these dikes onto a correct topo base map with accurate UTM locations; it was sketched into the coverage before.
- Added 8km circle to show extent of most tephra in DOE/Sandia PA models.

Arc/Info Stupid Pet Tricks:

- New Coverages: To make a blank coverage to enter data into:

  Arc> CREATE new_cov_name old_cov_name

- When making a point coverage, don't use BUILD; points goto polygon attributes

- Adding a ± to labels:

  Need SUN keyboard with Compose key
  AE> Textset FONT.TXT
  AE> FONT 'Univers Medium'
  AE> ef point; add; sel
  AE> calc NAME = 'Funeral\Fm 5{compose key, +, -}1'
  Gives label **Funeral**
  Fm 5±1

- In AE, diameter of cursor for selects etc:

  AE> EDITDISTANCE * or ED *, use mouse to draw circle for sel distance etc.

- Automatically add labels to polygons:

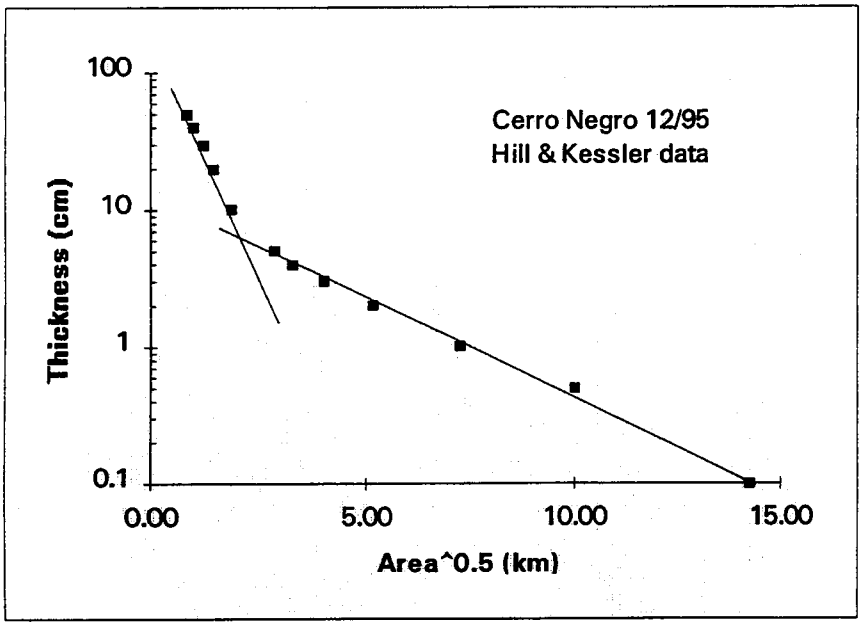
  ARC> CREATELABELS cov_name

- When using Tips/Illustrator command in ARC>, Don't use a numeric file name else won't work. Must start file name w/ character BH 6/13/96

Determining fall volumes from literature data.

General Procedure: Use the method of Fierstein and Nathenson (1992, Bull. Volc. 54:156-167), which is a general solution to the straight-line method of Pyle (1989). The 2-slope line method successfully integrates the proximal and medial deposits, and extrapolates to the finer fraction accurately (i.e., <1cm isopach, which is common lower limit in literature).

Construct plots of log thickness versus area$^{1/2}$. Important difference here is that you measure the total area enclosed by an isopach, not the effective area of the isopach. Arc/Info coverages give the actual (i.e.,effective) area of each isopach, which can then be simply multiplied by unit thickness to derive volumes. A common mistake in the literature is to measure the area of the isopach contour but to forget to subtract out the area of the enclosed, thicker isopachs before multiplying by the isopach thickness. This effectively stacks the isopachs like discrete layers, significantly overestimating the total thickness of the deposit. Actually need to think of isopach as a cylinder of constant thickness down to base of deposit.



Using data from the 1995 Cerro Negro Eruption, can see the proximal line with intercept T0 of about 120, distal intercept T1 of about 10, and Aip of about 3.

From Fierstein and Nathenson (1992), for 2-part lines:

$$V=\frac{2T_0}{k^2} + 2T_0\left|\frac{(k_1 A_{ip}^{1/2}+1)}{k_1^2}-\frac{(kA_{ip}^{1/2}+1)}{k^2}\right| \exp^{(-kA_{ip}^{1/2})}$$

and

$$A_{ip}^{1/2}=\frac{\left[\ln(T_1 \_ T_0)\right]}{(-k+k_1)}$$

Enter these equations into Excel spreadsheed FALLAREA.XLS and use the intercept and slope values for 1971 Cerro Negro eruption in Fierstein and Nathenson (1992):

To (km)	k	T1 (km)	k1		
1.83E-03	0.34	1.20E-04	0.11		
Aip^0.5 =	[ln (Ti/To)]/(-k+ki) =		11.85		
Firestein & Nathenson (1992)					
Volume=	2To/k^2	2To	k1*Aip+1/k1^2	k*Aip+1/k^2	e^-kAip
	0.031661	0.00366	190.3355175	43.4916891	0.017816
Volume	**0.041236**	**km^3**			
	4.12E+07				

Spreadsheet calculates the same A_{ip} and Volume as values in the paper, thus works OK

General Procedure: Create a 1x1km grid on the published isopach maps then scan the isopach maps from publications into TIF files. Use Arc/Info REGISTER function to transform the TIF file into real-world coordinates, using the 1x1 km points on the file. This gives accurate absolute areas, although coverages aren't registered to UTM coordinates. Add arcs to registered coverage to vectorize the isopachs, volcano locations, and associated lava flows. Plotted these coverages at a constant scale (1:380,451 cm) and overlaid them onto the YMR geologic base map at same scale, to give a better understanding of process scale and performance models.

After editing, construct polygon topology and use the isopach areas in the polygon attribute table. Enter areas into spreadsheet and get initial thickness-volume estimates. Plot thickness-area distribution and determine the break in slope. Use SigmaPlot to fit exponential curves to the proximal and medial points, which derived the T and k parameters for the equations above.

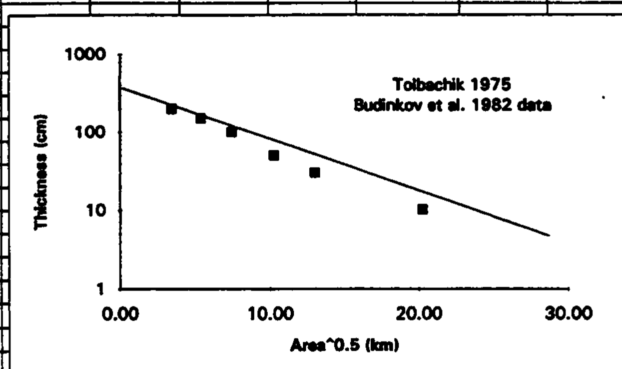
Specific Data Used:
Tolbachik: Isopach data from Budinkov et al., (1982, GTFE redbook). Already digitized and coregistered Arc/Info coverage. Lavas from detailed topographic base map.

```
/* geology map for 1975 N Cones
/* file name isopach.aml

/* INITIAL SETUP
kill isopach.map
map isopach.map
mapextent isopach
/*mapextent tolbcont20
/*mapextent to focus on O&P
Tolb + falls
/*mapextent  557000  6152000
599000 6198000
pagesize 11 8.5
maplimits 10.7 8.2
mapposition cen cen
mapunits meters
/*mapscale 380451
mapscale auto

lineset color.lin
shadeset colornames.shd

shadesymb 2
shadecolor white
units page
patch 0 0 11 17

/*polygonshades isopach 32
linesymbol 1
linesize 0.3
```

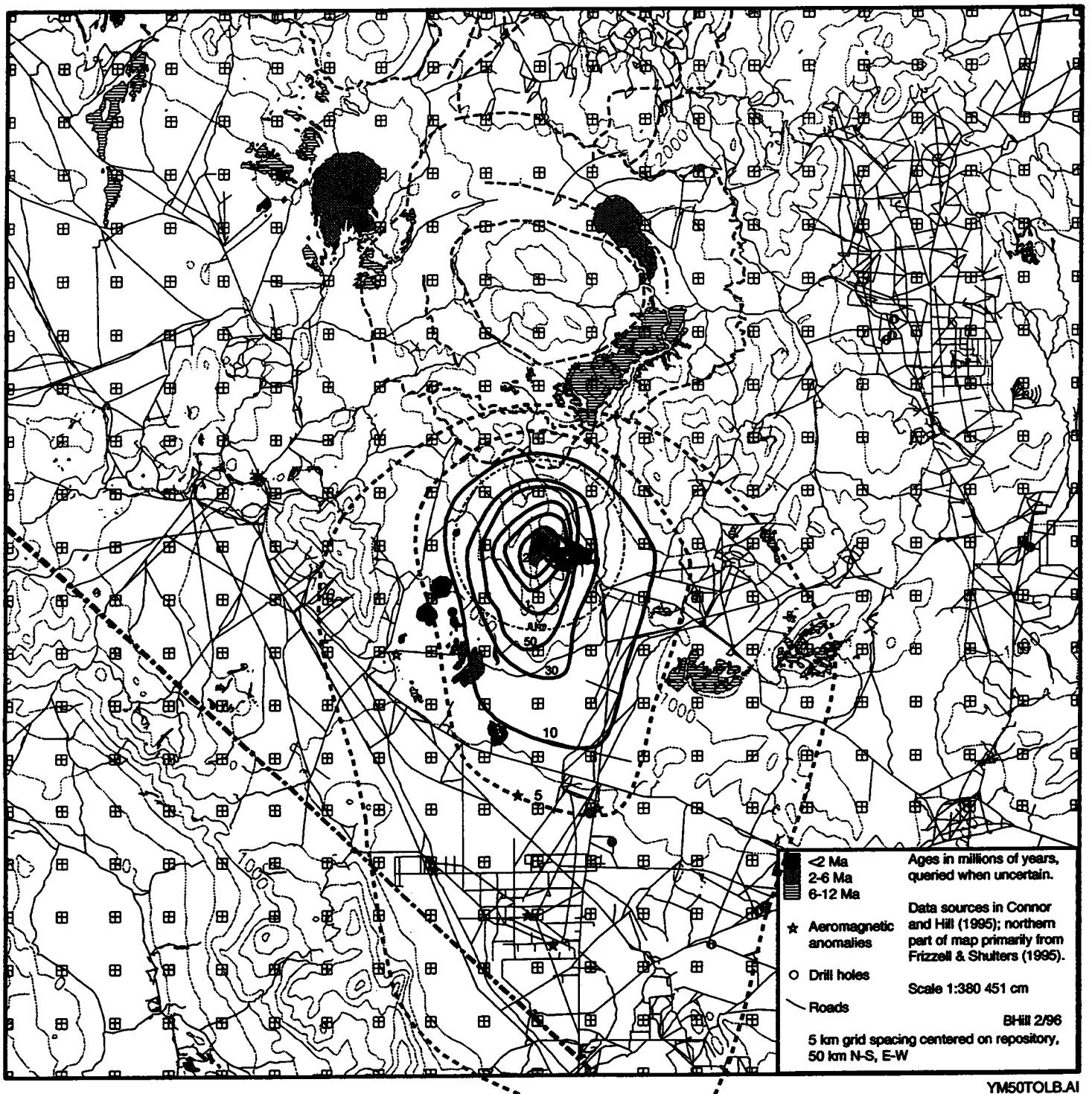
```
linecolor black
/* arcs isopach

textfont 'Univers Medium'
textquality kern
textsize 10 pt
textcolor black

clearselect
reselect isopach poly
ISOPACH-ID > 0
/* polygontext isotest code
/* labeltext isopach ISOPACH-ID
# LC

/*&goto bypass

linesize 0.1
arcs kamcont50

clearselect
reselect geology poly code < 30
polygonshades geology 32
polygonshades southcone 32
linesymbol 1
arcs geology
/*arcs southcone

/* Draw sample locations
markerset usgs.mrk
markersymbol 109
markercolor black
markersize 0.1
/*points vents
points fallsamps
points rocksamps

pointtext fallsamps
FALLSAMPS-ID ll
pointtext rocksamps
ROCKSAMPSID UR

&label bypass

mapinfo
map end
```

Extrapolate the 5 & 1 cm isopachs from the 10 cm isopach, which is the limit to the data presented in Budinkov et al. (1982).

Tolbachik 1975. Budinkov et al. 1982									
Pyle plot	A/I isopak	TOTAL	Area^0.5	Thick		From SigmaPlot curve fits			Volume
Isopach	area m2	area m2	(km)	(cm)		To (km)	k		Isopach m
10	2.41E+08	4.10E+08	20.24	10		0.003926	0.188395		2.41E+07
30	6.34E+07	1.69E+08	12.99	30					1.90E+07
50	4.97E+07	1.05E+08	10.26	50					2.48E+07
100	2.64E+07	5.57E+07	7.46	100					2.64E+07
150	1.73E+07	2.92E+07	5.41	150		Firestein & Nathenson (1992)			2.60E+07
200	1.19E+07	1.19E+07	3.45	200		Volume=	2To/k^2		2.38E+07
									1.44E+08
						Volume=	0.221	km^3	
							2.21E+08	m^3	
	Using SigmaPlot 2.0 for exp curve fit to data:								
	where y = a exp^(-bx)								
	PROXIMAL								
	10-200 cm curve								
a	392.64067	8.66928							
b	0.1883947	33.97577							
		56.82436							
		96.30019							
		141.6954							
		204.9842							
Extrapolate for									
Other Isopachs		%10cm area							
5	5.36E+08	131		5					2.68E+07
1	1.01E+09	245		1					1.01E+07
									1.81E+08



Scenario: 1975 Tolbachik eruption occurring at repository site, main dispersal to South. Same scales.



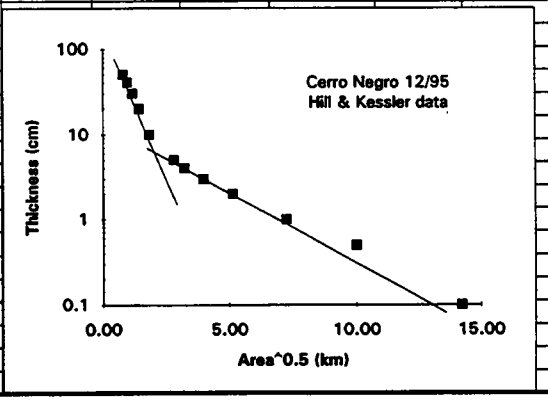
	DRE Lava	Cone	Falls	Total Volume DRE km3	
Lathrop Wells	0.031	0.016	0.02?	0.07	(Crowe et al. 1995 - 0.14)
Sleeping Butte	0.007	0.017	0.02?	0.05	(Crowe et al. 1995 - 0.06)
Quat Crater Flat	0.15	0.01	0.01?	0.17	(Crowe et al. 1995 - 0.23)
Tolbachik 1-3	0.28	0.12	0.11	0.52	
Cerro Negro 1995	0.004	0.003	0.002	0.008	
Cerro Negro 1992	0.0	0.0	0.012	0.012	
Sunset AZ	0.13	0.18	0.21	0.53	(Amos, 1986 - 0.70)
Heimay 1973	0.21	0.008	0.007	0.23	(USGS 1974 - 0.19)
Serra Gorda	0.014	0.02	0.022	0.06	
Okmarek 1977	0.001	n/a	0.0005	0.002	(Self et al., 1980)

1975 Tolbachik, Northern Cones eruption
- 5 & 1 cm extrapolated from 10 cm isopach
- Data from Budinkov et al. (1982)

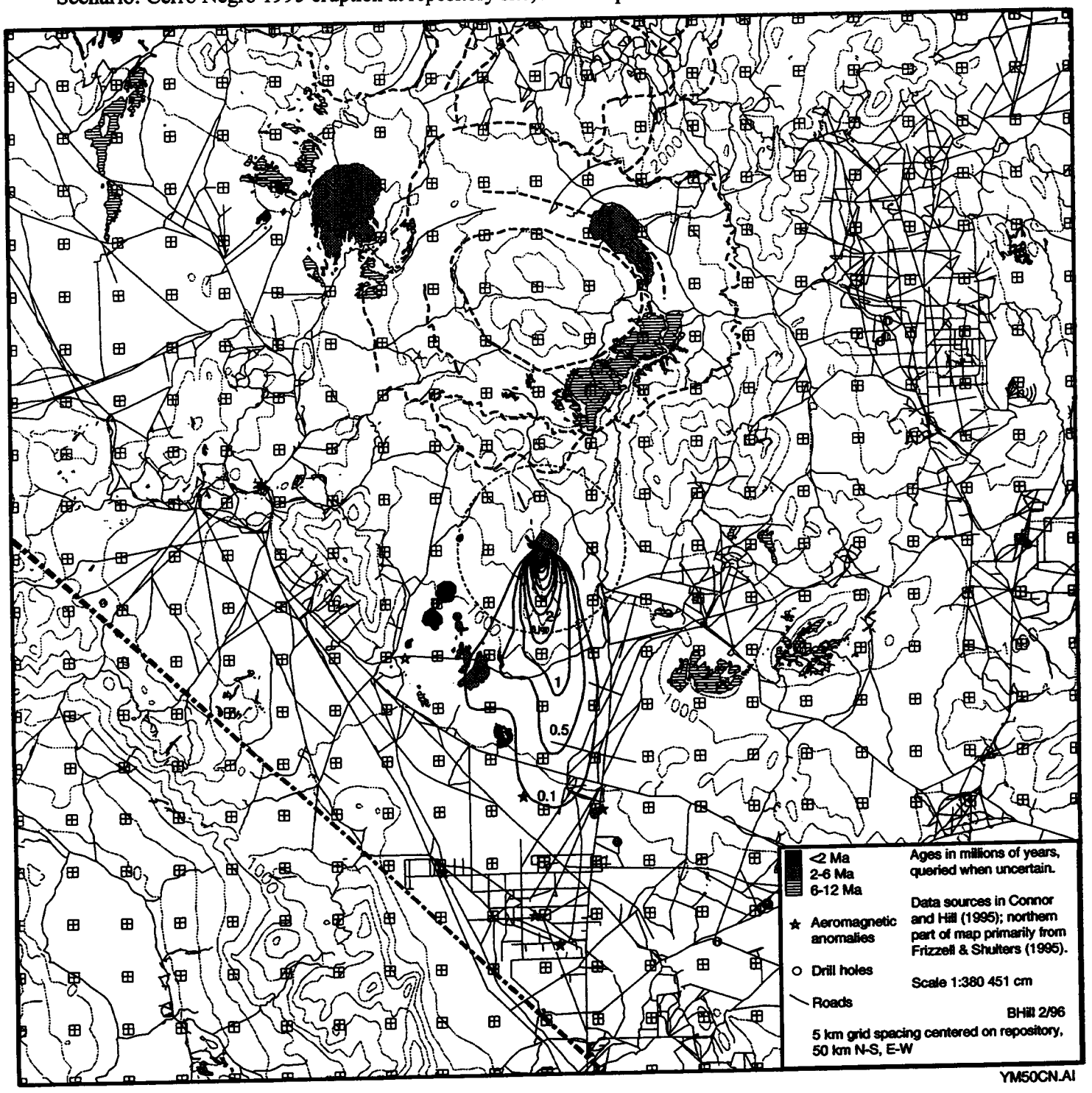
Cerro Negro, 1995. Data from Hill and Kessler (unpub., documented in Field Volcanism scientific notebook.

```
/* CNFALL.AML - Fall deposit
maps for 1968, 1971, 1992 and
1995 eruptions

kill cnfall.map
map cnfall.map

mapextent 497000 1362000
535000 1398000
/* map area for lavas only
/* mapextent 530000 1381000
533000 1385000
/*pagesize 17 11
pagesize 11 8.5
mapposition cen cen
maplimits 0.3 0.3 16.7 10.7
mapunits meters
/*mapscale 100000
mapscale 380451

/* create a white background to
save eyes
shadeset color.shd
shadesymb 2
shadecolor white
units page
patch 0 0 17.0 11.0

shadeset colornames.shd

linecolor dimgray
polygonshade lavas 27
/*polygonshade leon 29
/*arcs contour

linecolor gray0
arcs 1995iso
/*arcs 1992iso
/*arcs 1971iso
/*arcs 1968iso

/*give a readable font
textfont 'Times'
textquality kern
textsize 16 pt
textcolor black

labeltext 1995iso isopach
tics cntics5 noids

mapinfo
map end
```

DEC 1995 Cerro Negro						From SigmaPlot curve fits							Volume
Pyle plot	A/I isopak	TOTAL	Area^0.5	Thick		To (km)	k	T1 (km)	k1				Isopach m
Isopach	area m2	area m2	(km)	(cm)		0.001695	1.484939	0.000142	0.377957				1.03E+05
Iso 0.1	1.03E+08	2.03E+08	14.24	0.1									2.37E+05
Iso 0.5	4.75E+07	1.00E+08	10.01	0.5		Aip^0.5 =	[ln (Ti/To)]/(-k+ki) =		2.24				2.62E+05
Iso 1	2.62E+07	5.27E+07	7.26	1									2.09E+05
Iso 2	1.05E+07	2.65E+07	5.15	2		Firestein & Nathenson (1992)							1.61E+05
Iso 3	5.35E+06	1.60E+07	4.00	3		Volume=	2To/k^2	2To	k1*Aip+1/k	k*Aip+1/k^2	e^-kAip		1.02E+05
Iso 4	2.55E+06	1.07E+07	3.27	4			0.001537	0.003389	12.92866	1.9624431	0.035891		2.32E+05
Iso 5	4.64E+06	8.13E+06	2.85	5									
Iso 10	1.40E+06	3.48E+06	**1.87**	**10**		**Volume**	**0.002871**	km^3					1.40E+05
Iso 20	6.87E+05	2.08E+06	**1.44**	**20**			**2.87E+06**						1.37E+05
Iso 30	4.45E+05	1.39E+06	**1.18**	**30**									1.34E+05
Iso 40	2.81E+05	9.48E+05	**0.97**	**40**									1.13E+05
Iso 50	6.67E+05	**6.67E+05**	**0.82**	**50**									3.33E+05
													2.16E+06
	Using SigmaPlot 2.0 for exp curve fit to data:												
	where y = a exp^(-bx)												
	10-50 cm curve			***0.1-5 cm curve***									
a	169.46576	10.54672	**a**	14.18604	0.07								
b	1.4849392	19.97214	**b**	0.377957	0.32								
		29.38319			0.91								
		40.13544			2.03								
		50.14911			3.13								
					4.12								
					4.83								



Scenario: Cerro Negro 1995 eruption at repository site, main dispersal to south. Same scale.



	DRE Lava	Cone	Falls	Total Volume DRE km3	
Lathrop Wells	0.031	0.016	0.02?	0.07	(Crowe et al. 1995 - 0.14)
Sleeping Butte	0.007	0.017	0.02?	0.05	(Crowe et al. 1995 - 0.06)
Quat Crater Flat	0.15	0.01	0.01?	0.17	(Crowe et al. 1995 - 0.23)
Tolbachik 1-3	0.28	0.12	0.11	0.52	
Cerro Negro 1995	0.004	0.003	0.002	0.008	
Cerro Negro 1992	0.0	0.0	0.012	0.012	
Sunset AZ	0.13	0.18	0.21	0.53	(Amos, 1986 - 0.70)
Heimay 1973	0.21	0.008	0.007	0.23	(USGS 1974 - 0.19)
Serra Gorda	0.014	0.02	0.022	0.06	
Ukinrek 1977	0.001	n/a	0.0005	0.002	(Self et al., 1980)

Cerro Negro, Nicaragua
November-December 1995 eruption
- Data from M.Kesseler & B.Hill
- Isopachs in cm.

Cerro Negro, 1992. Data from Connor (unpub). No lavas produced during this eruption. Used same CNFALL.AML as 1995 eruption for isopach map and areas.

APRIL 1992 Cerro Negro

Pyle plot	A/I isopak	TOTAL	Area^0.5	Thick
Isopach	area m2	area m2	(km)	(cm)
1	2.40E+08	4.68E+08	21.64	1
2.5	1.11E+08	2.28E+08	15.10	2.5
5	6.81E+07	1.17E+08	10.83	5
10	4.06E+07	4.93E+07	7.02	10
100	8.70E+06	8.70E+06	2.95	100

Using SigmaPlot 2.0 for exp curve fit to data:
where y = a exp^(-bx)

PROXIMAL			DISTAL	
10-100 cm curve			*1-5 cm curve*	
a	35.863584	5	26.78092	0.93
b	0.1819284	10	0.15534	2.57
				4.98

From SigmaPlot curve fits

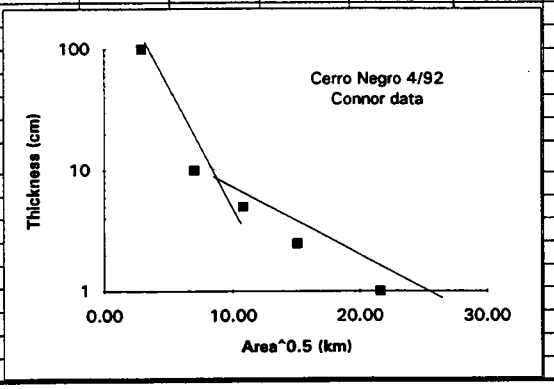
To (km)	k	T1 (km)	k1
0.000359	0.181928	0.000268	0.15534

Aip^0.5 = [ln (Ti/To)]/(-k+ki) = 10.98

Firestein & Nathenson (1992)

Volume=	2To/k^2	2To	k1*Aip+1/k	k*Aip+1/k^2	e^-kAip
	0.021671	0.000717	112.1467	90.585001	0.135582

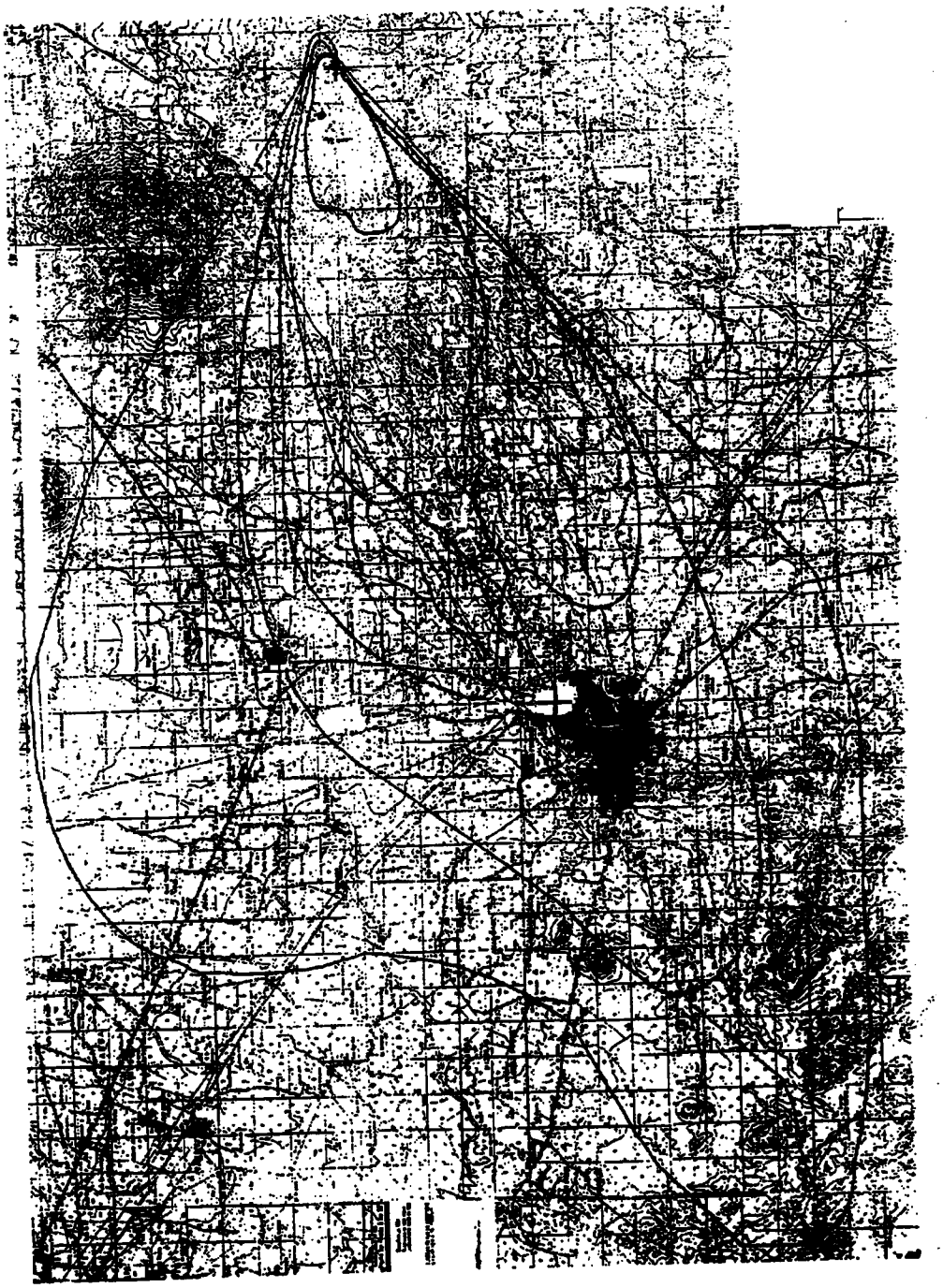
Volume	0.023768	km^3
	2.38E+07	m^3



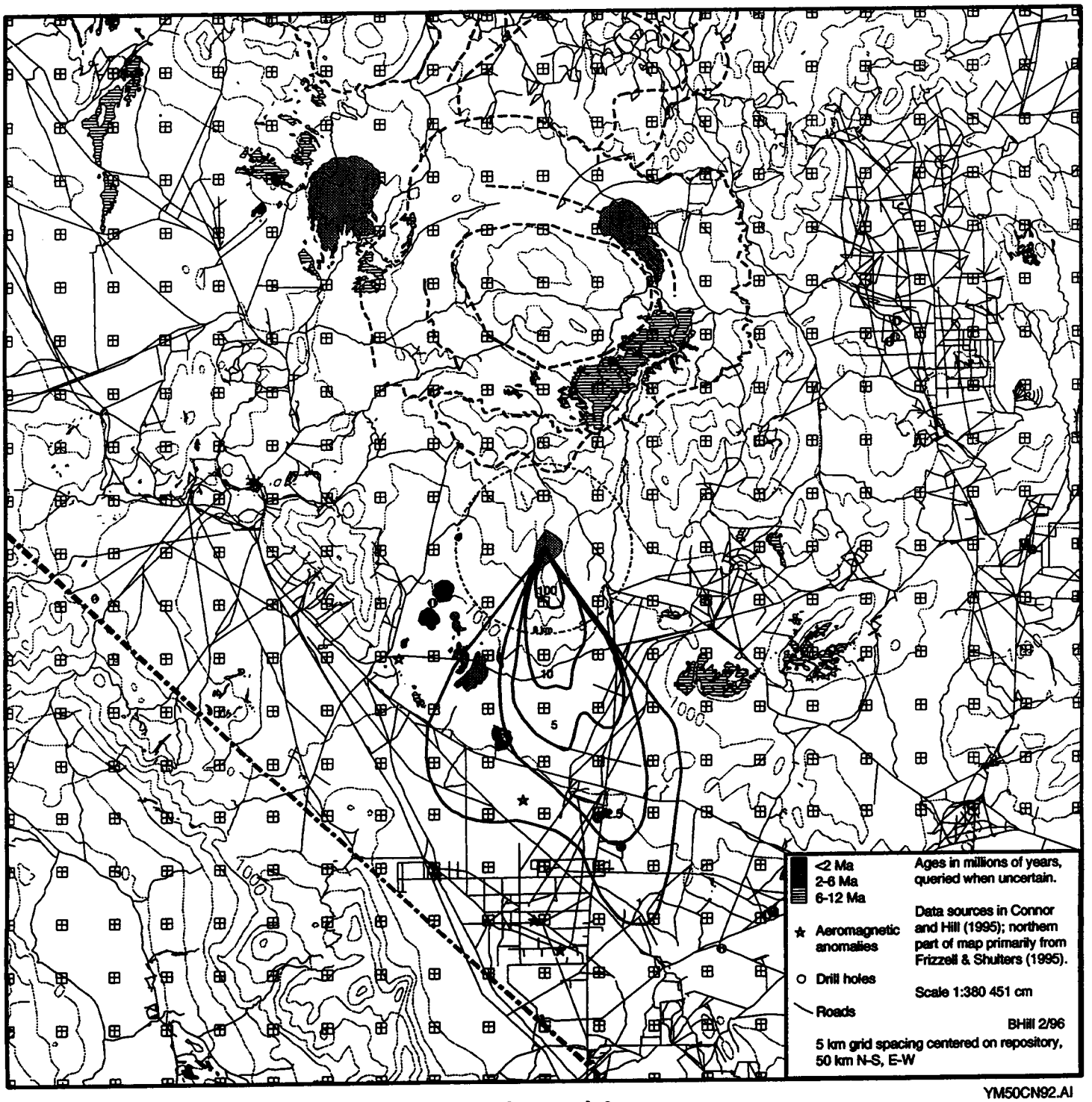
Volume
Isopach m
2.40E+06
2.77E+06
3.40E+06
4.06E+06
8.70E+06
2.13E+07

6/13/96

Scanned map from Connor (unpub) for 1992 Cerro Negro isopachs



Scenario: Cerro Negro 1992 eruption at repository site, main dispersal to south. Same scale.



YM50CN92.AI

	DRE Lava	Cone	Falls	Total Volume DRE km3	
Lathrop Wells	0.031	0.016	0.02?	0.07	(Crowe et al. 1995 = 0.14)
Sleeping Butte	0.007	0.017	0.02?	0.05	(Crowe et al. 1995 = 0.06)
Quat Crater Flat	0.15	0.01	0.01?	0.17	(Crowe et al. 1995 = 0.23)
Tolbachik 1-3	0.28	0.12	0.11	0.52	
Cerro Negro 1995	0.004	0.003	0.002	0.008	
Cerro Negro 1992	0.0	0.0	0.012	0.012	
Sunset AZ	0.13	0.18	0.21	0.53	(Amos, 1986 = 0.70)
Heimay 1973	0.21	0.008	0.007	0.23	(USGS 1974 = 0.19)
Serra Gorda	0.014	0.02	0.022	0.06	
Ukinrek 1977	0.001	n/a	0.0005	0.002	(Self et al., 1980)

Sunset Crater, Arizona:
Isopach data from Amos (1986) MS thesis, ASU. Coregister to locations of lavas and main Sunset cone. Use the existing map base from San Francisco Volcanic Field Arc/Info coverage for distribution of lavas and cones, add isopachs as separate coverage.

```
/* Print out of general geology
/* File name sunset.aml
/* INITIAL SETUP
kill esfvf.map
map esfvf.map
pagesize  17 11
maplimits 0.3 0.3 16.7 10.7
/* mapextent eastsfvf
mapextent 445000 3895000 485000 3930000
/*mapscale auto
mapscale 380451
mapposition cen cen
mapunits  meters

shadeset colornames.shd
lineset carto.lin
markerset water.mrk

/* create a white background to save eyes
shadesymb  2
shadecolor white
units page
patch 0 0 17 11

/* DRAW POLYGONS
clearselect
reselect eastsfvf poly UNIT = 'Qbsbf'
aselect eastsfvf poly UNIT = 'Qbsb'
/*aselect eastsfvf poly UNIT = 'Qbsbp'
polygonshades eastsfvf 27
/*polygonshades eastsfvf code code.eastsfvf.lut

linesymbol 101
linecolor dimgrey
/*arcs eastsfvf
/*arcs sunset_net

linesymbol 102
linecolor grey0
arcs sunsetiso
/* Isopach thicknesses
textset font.txt
textfont 'Univers Medium'
textquality kern
textsize 10 pt
textcolor grey0
polygontext sunsetiso sunsetiso-id
&goto finito

/* DRAW FAULTS
linesymbol 102
linecolor grey0
arcs eastfaults


/*DRAW VENTS
markersymbol 125
markersize 0.1
markercolor grey0
labels eastvents noids

/* DRAW TICS
markerset plotter.mrk
markersymbol 37
markersize 0.1
markercolor grey0
/*tics eastsfvf noids

&label finito

mapinfo
map end
```

Information potentially subject to copyright protection was redacted from this location. The redacted material is from the following reference:

Amos. Map: Sunset AZ. 1986. No additional information is available.

Problem in that areas determined by Amos (1986) are significantly different from those on the map.

Sunset Crater (Amos 1986)

Pyle plot Isopach	A/I isopak area m2	TOTAL area m2	Area^0.5 (km)	Thick (cm)
4		9.00E+08	30.00	4
10		5.50E+08	23.45	10
30		3.00E+08	17.32	30
50		2.10E+08	14.49	50
75		1.20E+08	10.95	75
100		9.50E+07	9.75	100
200		4.20E+07	6.48	200
400		1.80E+07	4.24	400
1000		6.00E+06	2.45	1000

Using SigmaPlot 2.0 for exp curve fit to data:
where y = a exp^(-bx)

	PROXIMAL			DISTAL	
	200-1000 cm curve			*4-100 cm curve*	
a	3054.5436	155.6947	a	440.4727	4.18
b	0.4593346	435.6358	b	0.155229	11.56
		991.2984			29.94
		456.4459			46.46
		982.0098			80.49

Extrapolate for DISTAL Isopachs %4cm area

1	1.54E+09	171		5

From SigmaPlot curve fits

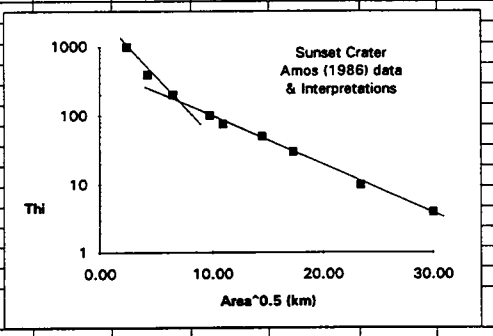
To (km)	k	T1 (km)	k1
0.030545	0.459335	0.004405	0.155229

Aip^0.5 = [ln (Ti/To)]/(-k+ki) = 6.37

Firestein & Nathenson (1992)

Volume=	2To/k^2	2To	k1*Aip+1/k	k*Aip+1/k^2	e^-kAip
	0.289546	0.061091	82.52348	18.60309	0.053663

Volume	0.499097	km^3	*Note: Amos added interior polys*
	4.99E+08	m^3	*See next interp*



Volume Isopach m
3.60E+07
5.50E+07
9.00E+07
1.05E+08
9.00E+07
9.50E+07
8.40E+07
7.20E+07
6.00E+07
6.87E+08
7.69E+07
7.64E+08

Sunset Crater. Amos (1986) map

Pyle plot Isopach	A/I isopak area m2	TOTAL area m2	Area^0.5 (km)	Thick (cm)
5	1.83E+08	6.75E+08	25.98	5
10	2.18E+08	4.92E+08	22.18	10
50	1.12E+08	2.74E+08	16.55	50
75	5.39E+07	1.62E+08	12.72	75
100	4.41E+07	1.08E+08	10.39	100
200	3.77E+07	6.38E+07	7.99	200
400	2.08E+07	2.61E+07	5.11	400
1200	5.31E+06	5.31E+06	2.30	1200

Using SigmaPlot 2.0 for exp curve fit to data:
where y = a exp^(-bx)

	PROXIMAL			DISTAL	
	200-1000 cm curve			*4-100 cm curve*	
a	2619.5257	0.345676	a	440.4727	4.18
b	0.3438415	1.276783	b	0.155229	11.56
		8.847825			29.94
		33.01905			46.46
		73.56985			80.49
		167.9145			96.97

Extrapolate for DISTAL Isopachs %5cm area

1	1.54E+09	228		5

From SigmaPlot curve fits

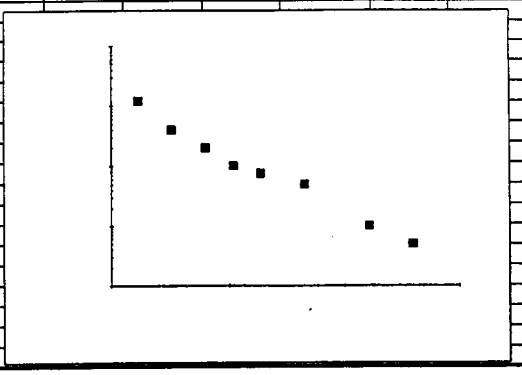
To (km)	k	T1 (km)	k1
0.026195	0.343842	0.004405	0.155229

Aip^0.5 = [ln (Ti/To)]/(-k+ki) = 9.45

Firestein & Nathenson (1992)

Volume=	2To/k^2	2To	k1*Aip+1/k	k*Aip+1/k^2	e^-kAip
	0.443135	0.052391	102.3957	35.949839	0.038765

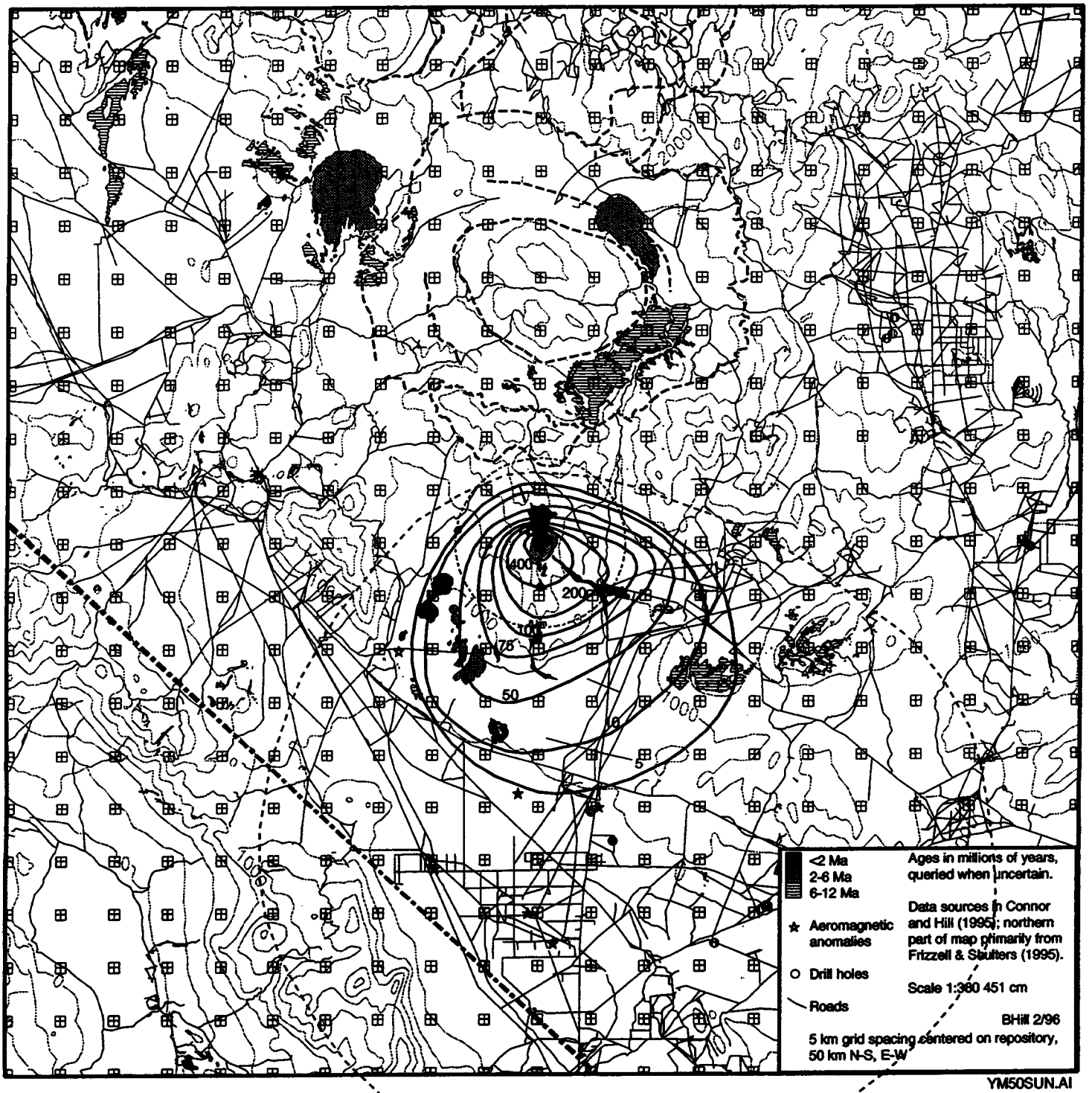
Volume	0.578081	km^3	*Note: Amos added interior polys*
	5.78E+08	m^3	*See next interp*



Volume Isopach m
9.15E+06
2.18E+07
5.60E+07
4.04E+07
4.41E+07
7.54E+07
8.32E+07
6.37E+07
3.94E+08
7.69E+07
4.71E+08

After checking scanned image for correspondence with published map of SFVF, I conclude that Amos grossly miscalculated the areas of the isopachs. Amos also added the area of his interior polygons incorrectly to the totalvolume, greatly overestimating the eruptive volume in tephra.

Scenario: Sunset Crater eruption occurring at repository site, main dispersal to South. Same scales.



	DRE Lava	Cone	Falls	Total Volume DRE km3	
Lathrop Wells	0.031	0.016	0.02?	0.07	(Crowe et al. 1995 = 0.14)
Sleeping Butte	0.007	0.017	0.02?	0.05	(Crowe et al. 1995 = 0.06)
Quat Crater Flat	0.15	0.01	0.01?	0.17	(Crowe et al. 1995 = 0.23)
Tolbachik 1-3	0.28	0.12	0.11	0.52	
Cerro Negro 1995	0.004	0.003	0.002	0.008	
Cerro Negro 1992	0.0	0.0	0.012	0.012	
Sunset AZ	0.13	0.18	0.21	0.53	(Amos, 1986 = 0.70)
Heimay 1973	0.21	0.008	0.007	0.23	(USGS 1974 = 0.19)
Serra Gorda	0.014	0.02	0.022	0.06	
Ukinrek 1977	0.001	n/a	0.0005	0.002	(Self et al., 1980)

Sunset Crater, AZ, 1064 A.D.
- Amos (1986) data.
- 1 cm isopach extrapolated from 5 cm

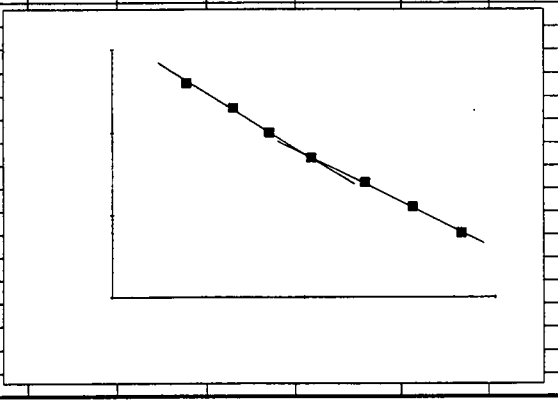
Heimaey, Iceland 1973. Basic eruption data from Self et al. (1974), with supplemental information from USGS (1974), and Thorarinsson et al. (1973). Problem in that about 60% of the fall was blown out to sea. Based on wind dispersion and characteristics of the eruption, I've interpreted the isopachs over the ocean to make a volume estimate. This estimate is in general agreement for the generalized volume estimates in the cited literature.

```
/* analog.AML Make analog fall maps for overlays with YMRBAS map series  bhill 2/27/96

kill analog.map
map analog.map
/*mapextent for repository 50 km outward
mapextent /u4/phunka/ai/region/ymloc_5k
/*mapextent 497800 4027900 598300 4128200
pagesize 11 17
maplimits 0.3 0.3 10.7 16.7
mapposition cen cen
mapunits meters
mapscale 380451

shadeset colornames.shd
markerset plotter.mrk
lineset carto.lin

/* create a colored background to save eyes
shadesymb  2
shadecolor white
/*shadecolor moccasin
units page
patch 0 0 11.0 17.0

/* Gives 15' tics or 5 km tics
markersymbol 37
markercolor grey0
markersize 0.1
/*tics /u4/phunka/ai/region/utmtic5km noids
arcs /u4/phunka/ai/region/ymloc_5k

linesymbol 101
linecolor grey0
arcs /u4/phunka/ai/region/repository
/*arcs heimaey
/*arcs gorda
arcs ukinrek

/*give a readable font
symbolscale 1
textset font.txt
textfont  'Univers Medium'
textquality kern
textsize   6 pt
textcolor  black
clearselect
/*aselect heimaey poly HEIMAEY-ID > 1
/*polygontext heimaey HEIMAEY-ID
/*polygontext gorda GORDA-ID

mapinfo
/* map end
```

BH 6/13

Scanned map of Heimaey, from Self et al. (1974) w/ USGS (1974) lava flow outlines

Heimaey, 1973. Self et al. 1974														
Pyle plot	**A/I isopak**	**TOTAL**	**Area^0.5**	**Thick**		From SigmaPlot curve fits								Volume
Isopach	**area m2**	**area m2**	**(km)**	**(cm)**		**To (km)**	**k**	**T1 (km)**	**k1**					Isopach m
6	3.50E+06	1.33E+07	3.65	6		0.013082	1.531123	0.0012	0.2					2.10E+05
12.5	2.89E+06	9.80E+06	3.13	12.5										3.61E+05
25	2.62E+06	6.91E+06	2.63	25		**Aip^0.5 =**	[ln (Ti/To)]/(-k+ki) =		1.79					6.55E+05
50	1.59E+06	4.29E+06	2.07	50										7.95E+05
100	1.11E+06	2.70E+06	1.64	100		Firestein & Nathenson (1992)								1.11E+06
200	9.94E+05	1.59E+06	1.26	200		Volume=	2To/k^2	2To	k1*Aip+1/k	k*Aip+1/k^2				1.99E+06
400	5.97E+05	5.97E+05	0.77	400			0.01116	0.026163	33.97323	1.5986706				2.39E+06
														7.51E+06
						Volume	**0.01116**	**km^3**						
							1.12E+07	**m^3**						
	Using SigmaPlot 2.0 for exp curve fit to data:													
	where y = a exp^(-bx)													
	PROXIMAL			DISTAL										
	50-400 cm curve			***6-25 cm curve***										
a	1308.1737	54.9796	**a**	120	0.00									
b	1.5311233	106.2022	**b**	0.2	0.00									
		190.0281			0.00									
		402.3903												
Extrapolate for														
DISTAL Isopachs		%12.5 area												
5	1.48E+08	216		5										
1	3.62E+08	529		1										



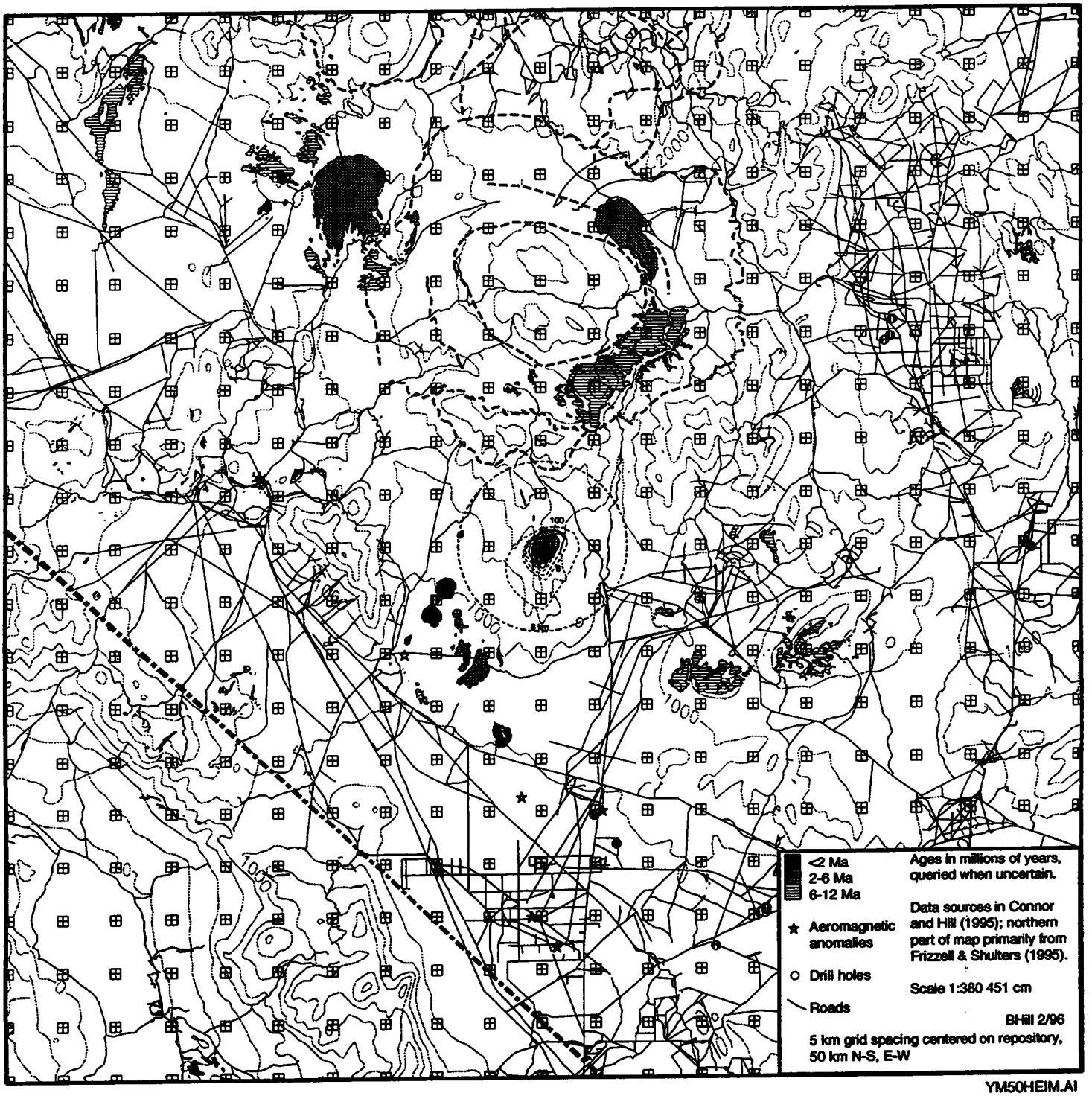
Volume estimates:

Self et al. (1974): Cone+scoria 0.04 km^3 DRE, fall density 1.1 kg/m^2

USGS: 0.02 km^3 fall (0.01 km^3 DRE), 0.22 km^3 lava

BA 6/13/96

Scenario: Heimaey eruption at repository, dispersal to the South. All at same scale.



YM50HEIM.AI

	DRE Lava	Cone	Falls	Total Volume DRE km3	
Lathrop Wells	0.031	0.016	0.02?	0.07	(Crowe et al. 1995 - 0.14)
Sleeping Butte	0.007	0.017	0.02?	0.05	(Crowe et al. 1995 - 0.06)
Quat Crater Flat	0.15	0.01	0.01?	0.17	(Crowe et al. 1995 - 0.23)
Tolbachik 1-3	0.28	0.12	0.11	0.52	
Cerro Negro 1995	0.004	0.003	0.002	0.008	
Cerro Negro 1992	0.0	0.0	0.012	0.012	
Sunset AZ	0.13	0.18	0.21	0.53	(Amos, 1986 - 0.70)
Heimay 1973	0.21	0.008	0.007	0.23	(USGS 1974 - 0.19)
Serra Gorda	0.014	0.02	0.022	0.06	
Ukinrek 1977	0.001	n/a	0.0005	0.002	(Self et al., 1980)

Heimaey, Iceland 1973
- Data from Self et al. 1974 & USGS
- 1 cm isopach extrapolated from 6 cm

Serra Gorda, Azores. Estimated eruption date <5,000 yr. Data from Booth et al. (1978, Phil. Trans. R. Soc. Lond. A., 288:271-319). Used the ANALOGS.AML for Heimaey to construct base map. Scanned map on next page.

Serra Gorda, <5ka. Booth ea 1978

Pyle plot	A/I isopak	TOTAL	Area^0.5	Thick
Isopach	area m2	area m2	(km)	(cm)
12.5	4.01E+07	6.84E+07	8.27	12.5
25	1.45E+07	2.84E+07	5.32	25
50	8.16E+06	1.38E+07	3.72	50
100	3.41E+06	5.67E+06	2.38	100
200	2.26E+06	2.26E+06	1.50	200

Using SigmaPlot 2.0 for exp curve fit to data:
where y = a exp^(-bx)

PROXIMAL			DISTAL	
50-200 cm curve			***12.5-25 cm curve***	
a	557.67014	42.52408	a	87.25985	12.50
b	0.6918541	107.4639	b	0.234965	25.00
		197.549		

Extrapolate for DISTAL Isopachs %12.5 area

5	1.48E+08	216	5	7.41E+06
1	3.62E+08	529	1	3.62E+06
				3.17E+07

From SigmaPlot curve fits

To (km)	k	T1 (km)	k1
0.005577	0.691854	0.000873	0.234965

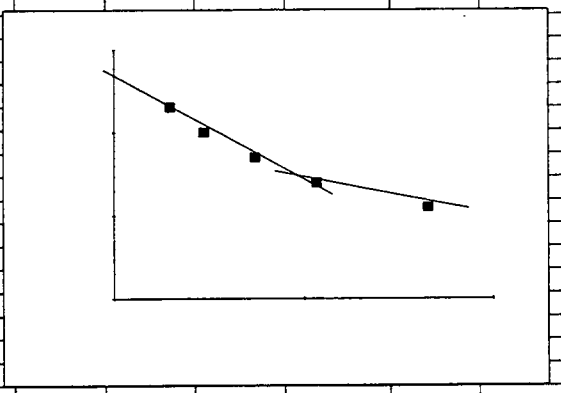
Aip^0.5 = [ln (Ti/To)]/(-k+ki) = 4.06

Firestein & Nathenson (1992)

Volume=	2To/k^2	2To	k1*Aip+1/k	k*Aip+1/k^2	e^-kAip
	0.023301	0.011153	35.39142	7.9571561	0.060278

Volume **0.041745** **km^3**
4.17E+07 **m^3**

Volume Isopach m
5.01E+06
3.63E+06
4.08E+06
3.41E+06
4.52E+06
2.07E+07

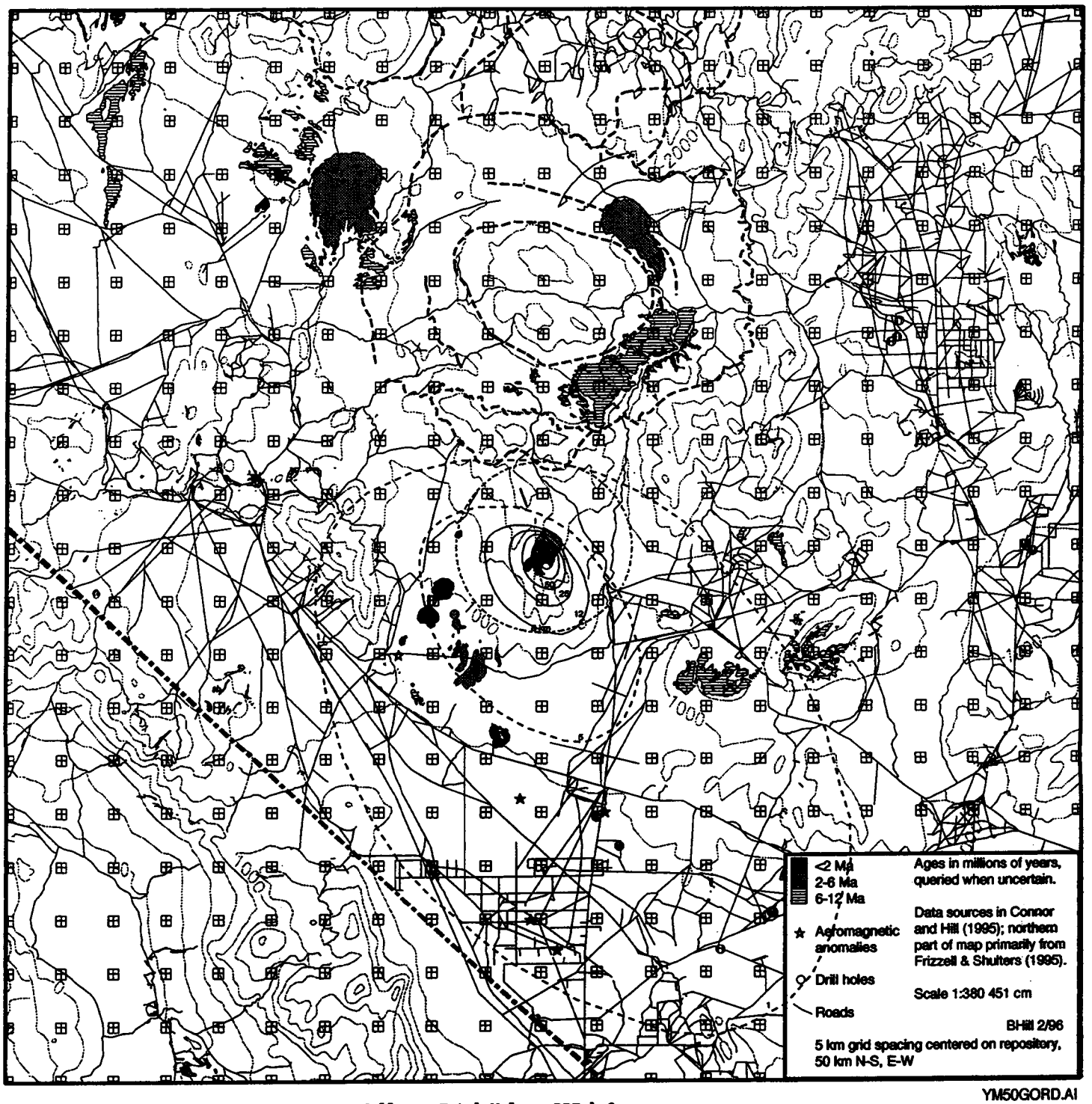


Booth et al. 1978 volume estimates:
Fall: 0.03 km^3, Cone: 0.06 km^3, Lava: 0.02 km^3
DRE: Fall+Cone: 0.03 km^3, Total eruption 0.055 km^3.

BH 6/13

Scanned map of Serra Gorda, from Booth et al., 1978.

Scenerio: Serra Gorda eruption at repository, main dispersal direction to south. Same scale.



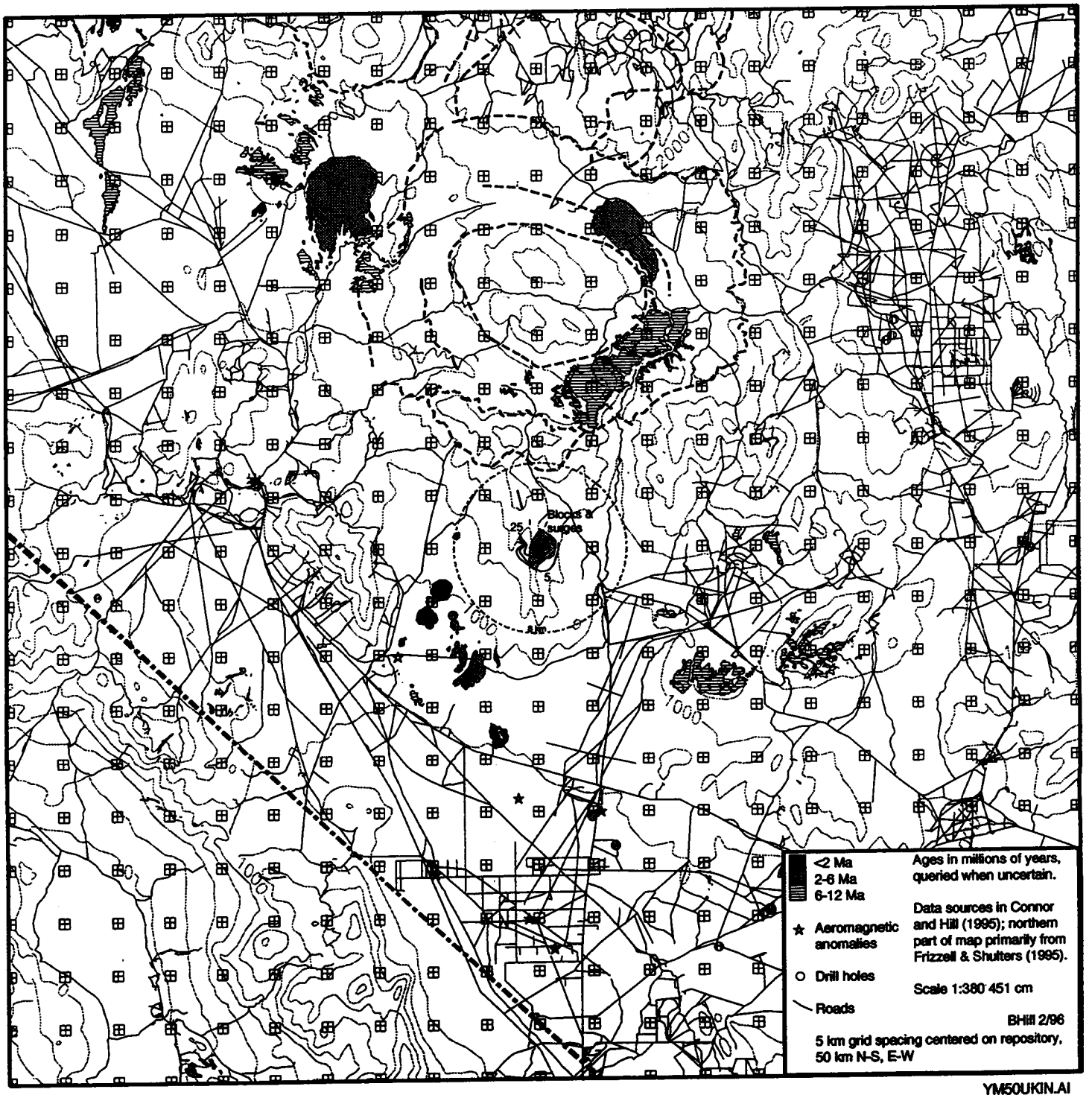
YM50GORD.AI

	DRE Lava	Cone	Falls	Total Volume DRE km3	
Lathrop Wells	0.031	0.016	0.02?	0.07	(Crowe et al. 1995 - 0.14)
Sleeping Butte	0.007	0.017	0.02?	0.05	(Crowe et al. 1995 - 0.06)
Quat Crater Flat	0.15	0.01	0.01?	0.17	(Crowe et al. 1995 - 0.23)
Tolbachik 1-3	0.28	0.12	0.11	0.52	
Cerro Negro 1995	0.004	0.003	0.002	0.008	
Cerro Negro 1992	0.0	0.0	0.012	0.012	
Sunset AZ	0.13	0.18	0.21	0.53	(Amos, 1986 - 0.70)
Beimay 1973	0.21	0.008	0.007	0.23	(USGS 1974 - 0.19)
Serra Gorda	0.014	0.02	0.022	0.06	
Ukinrek 1977	0.001	n/a	0.0005	0.002	(Self et al., 1980)

Serra Gorda, Azores. Booth et al. (1978)
1 & 5 cm isopachs extrapolated from 12.5 cm

Ukinrek Maar, 1977. Main data from Self et al. (1980, JVGR 7:39-65). Hydrovolcanic eruptions, no lava produced. Limited amounts of fall due to dilute cloud suspension. Lithic block fields shown on map. Volume estimates (DRE) from Self et al.: Juvenile fall: 0.5×10^6 m^3, lavas: 1×10^6m^3

Scenario: Ukinrek maar eruption at repository site, main dispersal direction to the south. Same scale.



YM50UKIN.AI

	DRE Lava	Cone	Falls	Total Volume DRE km3	
Lathrop Wells	0.031	0.016	0.02?	0.07	(Crowe et al. 1995 - 0.14)
Sleeping Butte	0.007	0.017	0.02?	0.05	(Crowe et al. 1995 - 0.06)
Quat Crater Flat	0.15	0.01	0.01?	0.17	(Crowe et al. 1995 - 0.23)
Tolbachik 1-3	0.28	0.12	0.11	0.52	
Cerro Negro 1995	0.004	0.003	0.002	0.008	
Cerro Negro 1992	0.0	0.0	0.012	0.012	
Sunset AZ	0.13	0.18	0.21	0.53	(Amos, 1986 - 0.70)
Heimay 1973	0.21	0.008	0.007	0.23	(USGS 1974 - 0.19)
Serra Gorda	0.014	0.02	0.022	0.06	
Ukinrek 1977	0.001	n/a	0.0005	0.002	(Self et al., 1980)

Ukinrek Maar, AK, 1977
- Data from Self et al. 1980
- Isopachs in cm, shaded area is maximum extent of blocks and surges.

CCCOMP.XLS: BHill 2/96	Tolbachik C1	Tolbachik C2	Sunset	Heimaey	Serra Gorda	Cerro Negro	Cerro Negro	Ukinrek
Age	1975 AD	1976 AD	1200 AD	1973 AD	<5ka	1995 AD	1992 AD	1977 AD
Location	Kamchat Arc	Kamchat Arc	CO Plateau	MOR-HS	Azores	Nica Arc	Nica Arc	Alaska
Volumes (km3)								
Cone	0.09	0.10	0.28	0.015	0.03	0.004	0.000	n/a
Lavas	0.09	0.22	0.15	0.180	0.015	0.004	0.000	0.001
Falls	**0.12**	**0.10**	0.44	0.019	0.042	0.003	0.024	0.001
N.B.	**55% total**	**45% total**						**Maar**
BULK								
Fall/cone	1.3	1.0	1.6	1.250	1.400	0.8	n/a	n/a
Fall/lava	1.4	0.5	2.9	0.105	2.800	0.7	n/a	n/a
Cone/lava	1.1	0.4	1.9	0.084	2.000	1.0	n/a	n/a
Estimated DRE with								
Calcd magma density								
Cone 1.7 g/cm3	0.06	0.06	0.18	0.010	0.020	0.003	0.000	n/a
Lavas 2.4 g/cm3	0.08	0.20	0.13	0.162	0.014	0.004	0.000	0.001
Falls 1.3 g/cm3	0.06	0.05	0.21	0.009	0.022	0.002	0.012	0.0005
TOTAL	**0.20**	**0.32**	**0.53**	**0.181**	**0.057**	**0.008**	**0.012**	**0.0015**
MAGMATIC								
Fall/cone	1.0	0.8	1.2	0.96	1.1	0.6	n/a	n/a
Fall/lava	0.8	0.2	1.6	0.06	1.5	0.4	n/a	0.5
Cone/lava	0.8	0.3	1.3	0.06	1.4	0.7	n/a	n/a
Cone Parameters								
Cone height (m)	240	240	300	200	n/a	n/a	n/a	n/a
Basal radius (m)	1000	1000	1600	500	n/a	n/a	n/a	n/a
Crater radius (m)	350	400	500	70	n/a	n/a	n/a	n/a
Frustum volume (km3)	0.09	0.10	0.28	0.02	n/a	0.004	n/a	n/a
Physical Properties								
Crystallinity (vol%)	3	3	5	49.6	n/a	35	35	n/a
Erupt T (°C)	1200	1200	1200	1075	n/a	1100	1100	n/a
Magmatic H2O (wt%)	2	2	0.5	0.05	n/a	3.5	3.5	n/a
Density Magma (g/cm3)	2.64	2.61	2.68	2.67	2.5	2.6	2.56	2.6
Visc w/ Xtl (Pa s)	5	7	13	19000	n/a	50-60	50-60	n/a