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Computer program for the Hewlett-Packard-9825A to contour
and plot data collected from helium surveys

By

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INTRODUCTION

A computer program was written principally by V. C. Dean for the Hewlett Packard 9825A option 2 desktop computer, 9871A impact printer, and 9872A plotter to contour and plot data collected from helium surveys.¹ The computer equipment is compact and can be taken to the field. As many as 50-100 helium analyses can be obtained daily from field surveys, and a contour map can provide a valuable guide in planning the following day's sample-collecting pattern.

As the program is written, up to as many as 300 entries may be made in the form of sample number, X (coordinate), Y (coordinate), and Z (helium value). These data can be corrected, if necessary, and stored on a tape file. The program includes numerous subroutines that could be stored on separate tape files. Split or integer precision rather than full precision could be used for the data, thus enabling computers with less than 23K bytes of memory to utilize the program.

SUBROUTINE EXPLANATION

Various program commands allow the user to select the subroutines to be executed:

HELP:	lists the commands
NEW:	allows new data to be entered
UPDATE:	corrects specific sample data

¹Use of a brand name is for descriptive purposes and does not constitute endorsement by the U.S. Geological Survey.

SAVE.	records the current data on tape
LIST:	lists current data on the printer
OLD:	recalls previous data from a tape file
CONTOUR:	prints a contour map on the printer
PLOT:	plots sample points and values on the plotter
GRID:	plots interpolated values on the plotter

The CONTOUR subroutine allows the user to select the lowest contour point and the contour interval, to a maximum of 12 intervals. Also specified by the user are the minimum and maximum search radii and the weight-by-distance factor to be used when averaging the sample points within the search radius. The use of a minimum search radius avoids an overwhelming influence on averaging when a sample point coincides with a character plotted on the map. The width of the printed map can be specified to a maximum of 25.4 cm. The CONTOUR subroutine sorts the data in descending order of Y. If the SAVE subroutine is then used, the data are recorded on tape in sorted order.

The PLOT subroutine plots sample points within selected X and Y boundaries. The sample values can be plotted either as the Z value or as an averaged value. This latter selection can be used for hand contouring, if desired.

The GRID subroutine plots intercept points and values of an artificially generated grid placed over the sampling coordinates. The grid spacing is selected on both the X and Y axes by specifying Delta X and Delta Y, both scale units of X and Y.

The program listing is presented on the following pages. The program requires a total memory of 14160 bytes. Data files require 7208 bytes of memory. The general I/O, extended I/O, advanced programming, matrix, and plotter ROM's are also required.

PROGRAM LISTING

```

0: if flgl;gto "mainloop"
1: sfg 1
2: prt "Enter data as";prt "requested, then";prt "press CONTINUE.";spc
3: prt "Press CONTINUE";prt "without entering";prt "anything to"
4: prt "get default,";prt "shown in";prt "brackets: []."
5: dim Q$(25),T$(25)
6: dim N,X(300),Y(300),Z(300)
7: dim A$(25);"0123456789<>"→A$
8: dim B$(100),C$(100)
9: for I=1 to 100;" "→B$(I,I);next I
10: "mainloop":
11: "help"→Q$
12: dsp "Command? [Help!]"
13: ent "",Q$
14: if cap(Q$)="HELP";gsb "help"
15: if cap(Q$)="NEW";gsb "new"
16: if cap(Q$)="OLD";gsb "old"
17: if cap(Q$)="PLOT";gsb "plot"
18: if cap(Q$)="CONTOUR";gsb "map"
19: if cap(Q$)="SAVE";gsb "save"
20: if cap(Q$)="LIST";gsb "verify"
21: if cap(Q$)="UPDATE";gsb "nextpoint"
22: if cap(Q$)="GRID";gsb "grid"
23: gto "mainloop"
24: "new":
25: prt "New data set.";spc 2
26: dsp "No. of samples? [",N,"]"
27: ent "",N
28: if N>0 and N<=300;jmp 3
29: beep;dsp "Must have 0 < N <= 300"
30: wait 2000;jmp -3
31: prt "Samples:",N;spc
32: ina X:9e99
33: ina Y:9e99
34: ina Z:9e99
35: "nextpoint":
36: ent "Sample #? [exit]",I
37: if flgl3;prt "---End input.---";spc 2;ret
38: ent "X:",X[I];if flgl3;gto "nextpoint"
39: ent "Y:",Y[I];if flgl3;gto "nextpoint"
40: ent "Z:",Z[I];if flgl3;gto "nextpoint"
41: prt "Sample:",I
42: prt " X:",X[I]
43: prt " Y:",Y[I]
44: prt " Z:",Z[I]
45: spc
46: gto "nextpoint"
47: "print":
48: if pl=9e99;wrt 6.7;ret
49: wrt 6.8,pl;ret
50: "line":wrt 6.9;ret

```

```

51: "verify":
52: fmt 7,"          *****",z
53: fmt 8,f12.4,z
54: fmt 9,
55: dsp "LIST: Load printer, then cont.";stp
56: wrt 6.9
57: wrt 6,"Data set has",N," samples.";wrt 6.9
58: l→E;N→F
59: dsp "From sample #? [",E,"]";ent "",E
60: dsp "To sample #? [",F,"]";ent "",F
61: wrt 6,"          Sample          X          Y          Z"
62: wrt 6.9
63: for I=E to F
64: cll 'print'(I)
65: cll 'print'(X[I])
66: cll 'print'(Y[I])
67: cll 'print'(Z[I])
68: cll 'line'
69: if (I-E)mod50=49;dsp "Change paper, then continue.";stp
70: next I
71: "-----":ret
72: "map":
73: prt "Contouring";prt "  routine.";spc 2
74: gsb "inlimits"
75: gsb "inscale"
76: gsb "insmooth"
77: dsp "Least contour value? [",P,"]"
78: ent "",P
79: dsp "Contour interval? [",O,"]"
80: ent "",O
81: prt "Contours run"
82: prt " from Z=",P
83: prt " by",O
84: dsp "Symbols? [",A$,"]"
85: ent "",A$
86: if len(A$)=12;jmp 3
87: beep;dsp "Enter exactly 12 chars."
88: wait 1000;jmp -4
89: prt "Symbols:";prt "  0123456789<>"
90: prt "  "&A$
91: fmt 1,c100
92: fmt 2,
93: wrt 6.2
94: gsb "sort"
95: l→E→F
96: for Y=r5 to r4 by -Q/6
97: if Y[E]-Y>U and E<N;E+1→E;jmp 0
98: if Y-Y[F]<U and F<N;F+1→F;jmp 0
99: B$+C$;l→r9
100: for X=r1 to r2 by Q/10

```

```

101: 0→S→T
102: for K=E to F
103: if Z[K]=9e99;gto "endloop"
104:  $\sqrt{(X[K]-X)^2+(Y[K]-Y)^2}$ →R
105: if R>U;gto "endloop"
106: if R<V;V→R
107: 1/R^L→W;S+Z[K]W→S;T+W→T
108: "endloop":next K
109: if T=0;jmp 6
110: S/T→Z
111: int((Z-P)/O)→A
112: if A>=0 and A<=9;A$[A+1,A+1]→C$[r9,r9];jmp 3
113: if A<0;A$[11,11]→C$[r9,r9];jmp 2
114: if A>9;A$[12,12]→C$[r9,r9]
115: r9+1→r9
116: next X
117: wrt 6.1,C$
118: next Y
119: prt "----End map.----";spc 2
120: ret
121: "sort":
122: prt "Sorting."
123: for I=1 to N-1
124: for J=I+1 to N
125: if Y[I]>=Y[J];gto "nextj"
126: X[I]→C;X[J]→X[I];C→X[J]
127: Y[I]→C;Y[J]→Y[I];C→Y[J]
128: Z[I]→C;Z[J]→Z[I];C→Z[J]
129: "nextj":
130: next J
131: next I
132: prt "Sort complete.";spc 2
133: ret
134: "plot":
135: prt "Plotting";prt " routine:";spc
136: gsb "inlimits"
137: gsb "plotinit"
138: wrt 705,"SM+"
139: for I=1 to N
140: if Z[I]=9e99;jmp 2
141: plt X[I],Y[I],-2;pen
142: next I
143: wrt 705,"SM"
144: ent "Plot values? (yes or no)",T$
145: if cap(T$)="NO";prt "----End plot.----";spc 2;ret
146: if cap(T$)#"YES";beep;jmp -2
147: csiz 1,2,1,45
148: dsp "No. of dec. places? [",H,"]"
149: ent "",H
150: ent "Smoothed? (yes or no)",T$

```

```

151: if cap(T$)="YES";gto "plotsmooth"
152: if cap(T$)!="NO";beep;jmp -2
153: prt "Unsmoothed";prt " values.";spc
154: fxd H
155: for I=1 to N
156: if Z[I]=9e99;jmp 2
157: plt X[I],Y[I],-2;lbl Z[I];pen
158: next I
159: fxd 2
160: prt "----End plot.----";spc 2
161: ret
162: "plotsmooth":
163: dsp "Max smoothing radius? [",U,"]"
164: ent "",U
165: dsp "Weight by 1/R^(?): [",L,"]"
166: ent "",L
167: dsp "Fract. wt on point? [",M,"]"
168: ent "",M;if M<0 or M>1;beep;jmp -1
169: prt "Smoothed";prt " values.";spc
170: prt " for points";prt " w/in:",U
171: prt " weighted by:";prt " 1/R^",L
172: prt " weight on";prt " sample:",M
173: fxd H
174: for I=1 to N
175: if Z[I]=9e99;gto "outerloop"
176: 0→S→T
177: for J=1 to N
178: if I=J or Z[J]=9e99;gto "innerloop"
179:  $\sqrt{(X[J]-X[I])^2+(Y[J]-Y[I])^2}$ →R
180: if R>U;gto "innerloop"
181:  $1/R^L$ →W;S+WZ[J]→S;T+W→T
182: "innerloop":next J
183: if T=0;Z[I]→Z;jmp 2
184: MZ[I]+(1-M)S/T→Z
185: plt X[I],Y[I],-2;lbl Z;pen
186: "outerloop":next I
187: prt "----End plot.----";spc 2
188: pen# ;csiz
189: fxd 2
190: ret
191: "help":
192: prt "----Commands----";spc
193: prt " HELP: lists";prt " commands.";spc
194: prt " NEW: to enter";prt " new set of";prt " data.";spc
195: prt " OLD: to recall";prt " old data from";prt " tape.";spc
196: prt " UPDATE: to";prt " correct a";prt " sample.";spc
197: prt " SAVE: to record";prt " current data";prt " on tape.";spc
198: prt " LIST: to list";prt " data set on";prt " the printer.";spc
199: prt " CONTOUR: to";prt " draw a contour";prt " map on the"
200: prt " printer.";spc

```



```

201: prt " PLOT: to plot";prt " sample points";prt " and values"
202: prt " on the plotter,"
203: prt " (smoothed or";prt " unsmoothed.)";spc
204: prt " GRID: to plot";prt " a grid of";prt " interpolated"
205: prt " values on the";prt " plotter.";spc 2
206: ret
207: "old":
208: prt "Old data set:";spc
209: ent "File number? [exit]",A
210: if flgl3;ret
211: if A<=0;beep;jmp -2
212: fxd 0;prt "File no.",A;fxd 2
213: trk 0;ldf A,N,X[*],Y[*],Z[*]
214: prt " Loaded.";spc 2
215: ret
216: "save":
217: prt "Save on file:"
218: ent "Save on file #? [exit]",A
219: if flgl3;ret
220: if A<=0;beep;jmp -2
221: prt A
222: trk 0;rcf A,N,X[*],Y[*],Z[*]
223: prt " Recorded."
224: ret
225: "inlimits":
226: dsp "X min? [",r1,"]";ent "",r1
227: dsp "X max? [",r2,"]";ent "",r2
228: dsp "Y min? [",r4,"]";ent "",r4
229: dsp "Y max? [",r5,"]";ent "",r5
230: prt "For X=",r1;prt " to",r2
231: prt "For Y=",r4;prt " to",r5;spc
232: "-----":ret
233: "indelta":
234: dsp "Delta X: [",r3,"]";ent "",r3
235: dsp "Delta Y: [",r6,"]";ent "",r6
236: prt "Delta X=",r3;prt "Delta Y=",r6;spc
237: "-----":ret
238: "insmooth":
239: dsp "Max averaging radius? [",U,"]";ent "",U
240: dsp "Min averaging radius? [",V,"]";ent "",V
241: dsp "Weight by 1/R^(?) [",L,"]";ent "",L
242: prt "Averaging:";prt " for R<",U
243: prt " and R>",V;prt "weighted by";prt " 1/R^",L
244: "-----":ret
245: "inscale":
246: dsp "Scale? [",Q,"]";ent "",Q
247: if (r2-r1)/Q<=10 and (r5-r4)/Q<=10;jmp 2
248: beep;dsp "Map too big. Re-enter.";wait 1500;jmp -2
249: prt "Scale:",Q;spc
250: "-----":ret

```

```

251: "grid":
252: prt "Gridding";prt " routine.";spc 2
253: gsb "inlimits"
254: gsb "indelta"
255: gsb "insmooth"
256: l→H
257: dsp "No. of dec. places? [",H,"]";ent "",H
258: gsb "sort";gsb "plotinit"
259: wrt 705,"SM+"
260: for Y=r5 to r4 by -r6
261: for X=r1 to r2 by r3
262: plt X,Y,-2;pen
263: next X
264: next Y
265: wrt 705,"SM"
266: csiz 1,1,1,45
267: l→E→F;fxd H
268: for Y=r5 to r4 by -r6
269: if Y[E]-Y>U and E<N;E+1→E;jmp 0
270: if Y-Y[F]<U and F<N;F+1→F;jmp 0
271: for X=r1 to r2 by r3
272: 0→S→T
273: for I=E to F
274: if Z[I]=9e99;jmp 5
275:  $\sqrt{((X[I]-X)^2+(Y[I]-Y)^2)}\rightarrow R$ 
276: if R>U;jmp 3
277: if R<V;V→R
278:  $1/R^L\rightarrow W$ ;S+WZ[I]→S;T+W→T
279: next I
280: if T=0;jmp 3
281: S/T→Z
282: plt X,Y,-2;lbl Z;pen
283: next X
284: next Y
285: csiz ;pen# ;fxd 2
286: "-----":ret
287: "plotinit":
288: pclr;pen# 1
289: dsp "Set P1,P2 on plotter, then cont.";stp
290: scl r1,r2,r4,r5
291: xax r4;xax r5;yax r1;yax r2
292: plt r2,r5,-2;lbl " ",r5;pen
293: plt r2,r4,-2;lbl " ",r4;pen
294: csiz 1.5,2,1,90
295: plt r1,r5,-2;lbl " ",r1;pen
296: plt r2,r5,-2;lbl " ",r2;pen
297: csiz ;ret

```

Figures 1, 2, 3 and table 1 are examples of the output of CONTOUR, PLOT, GRID, and LIST subroutines, respectively. These examples use 54 sample points of soil-gas helium concentrations. The area surveyed is 0.8 by 1.6 km and is directly over a low-grade uranium deposit.

```

LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL22233333
LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL2222233333
LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL2222233333
LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL222222333333
LLLLLLLL222222LLLLLLLL22222233334434
LLLLLLLL22222222LLLLLLLL22222223334444
LLLLLLLL2222222222LLLLLLLL22223333334444
LLLLLLLL222222222222LLLLLLLL222222233333
LLLL2222233222222222LLLLL2L222222222
LLLLL222222222222LLLLL222222L22222
LLLLL222222222222LLLLL222L22222L2222
LLLLL222222222222L2222233222222222
LLLLL2222222222222222334433222222
LLLLL22222222222222223334433332222
LLLLL222222222222222233344443332222
L22L2222222222222222233444433332222
22222222222222222222233333332222
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L22L2222222222222222222222333333
LLLLL2222222222222222222222333333
LLLLL2222222222222222222222333333
LLLLL2223333233333222222222333333
LLLLL22233333333333322222223222223
LLLLL2223333333333332222222222222
LLLLL2223333333332222222222222222
LLLLL2223333333222222L2222222222
LLLLL22233333332222222222222222
LLLLL2223333332222222L2222222222

```

Figure 1a. Printer contour map of helium soil-gas concentrations. The area covered is approximately 1.6 x 0.8 km. The starting contour value is -10 with an interval of 10 ppb. The search radii are 1.8 and 0.1 units, and the weight-by-distance factor is 1.

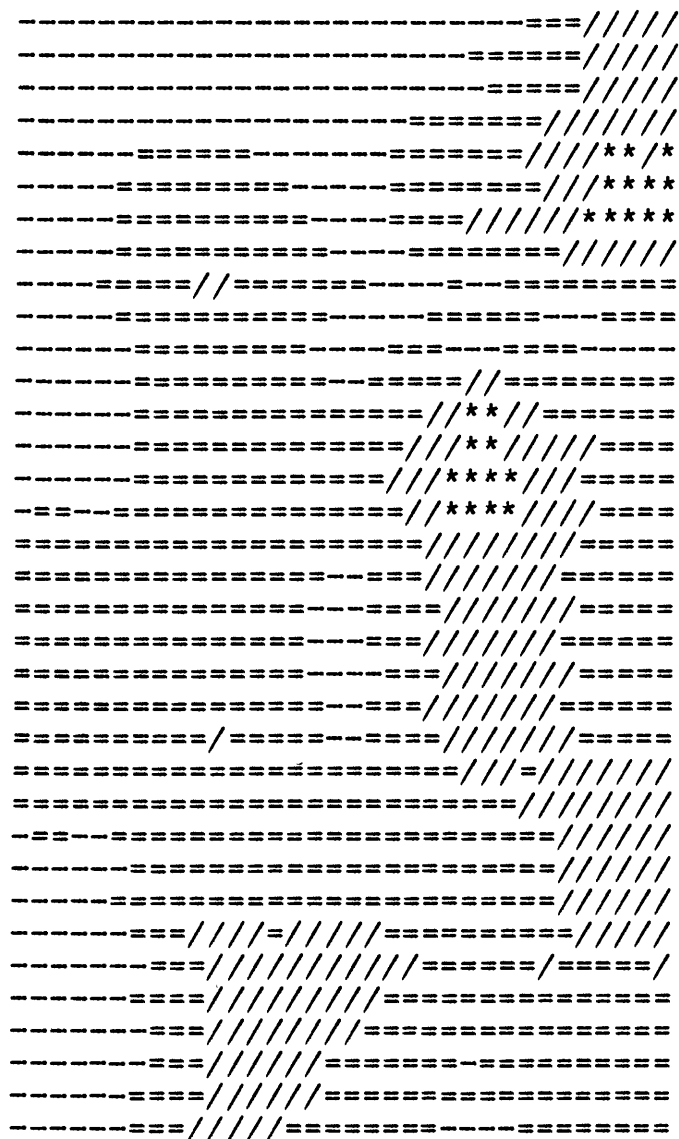


Figure 1b. Printer contour map of helium soil-gas concentrations using symbols to enhance visual perception. The contour parameters are identical to figure 1a.

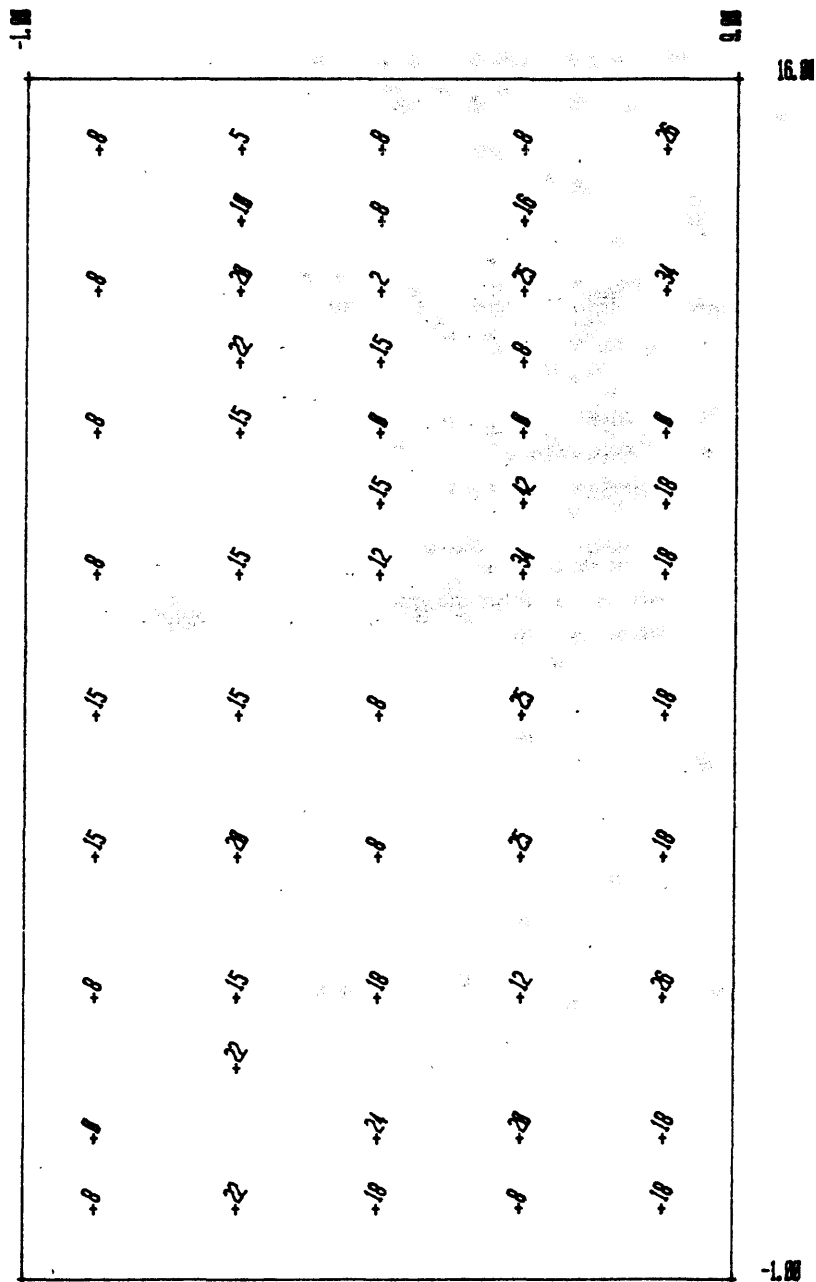


Figure 2. Plotter map of sample locations and actual values.

The area is identical to figure 1. The boundary scale units are arbitrary.

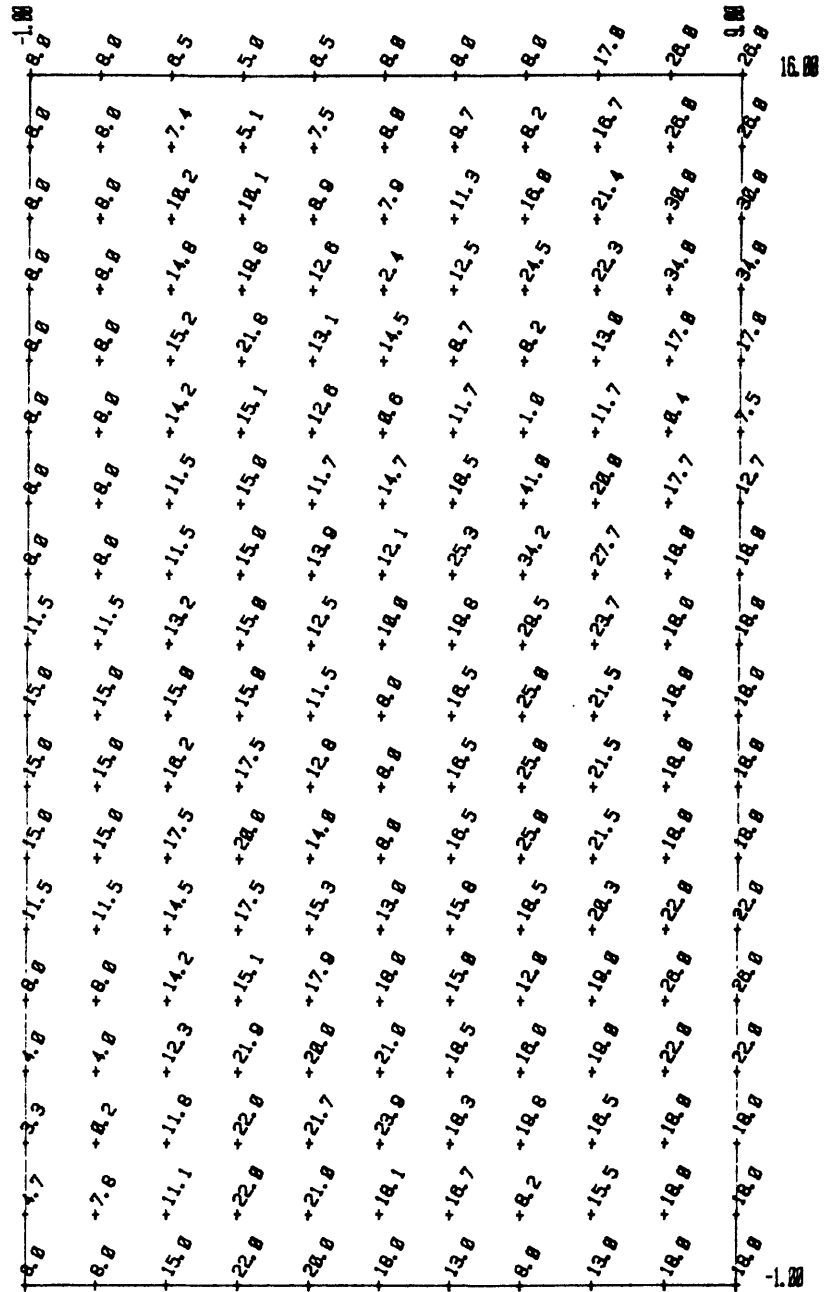


Figure 3. Plotter map of grid intersection points and interpolated values. The grid intersects on 0.5 unit increments. The search parameters are the same as for figure 1.

Table 1. List of sample numbers, X and Y coordinates, and soil-gas helium concentrations (Z) generated by the list command.

Data set has 54.00 samples.

Sample	X	Y	Z
1.0000	0.0000	0.0000	8.0000
2.0000	2.0000	0.0000	22.0000
3.0000	4.0000	0.0000	18.0000
4.0000	6.0000	0.0000	8.0000
5.0000	8.0000	0.0000	18.0000
6.0000	0.0000	1.0000	0.0000
7.0000	4.0000	1.0000	24.0000
8.0000	6.0000	1.0000	20.0000
9.0000	8.0000	1.0000	18.0000
10.0000	2.0000	2.0000	22.0000
11.0000	0.0000	3.0000	8.0000
12.0000	2.0000	3.0000	15.0000
13.0000	4.0000	3.0000	18.0000
14.0000	6.0000	3.0000	12.0000
15.0000	8.0000	3.0000	26.0000
16.0000	0.0000	5.0000	15.0000
17.0000	2.0000	5.0000	20.0000
18.0000	4.0000	5.0000	8.0000
19.0000	6.0000	5.0000	25.0000
20.0000	8.0000	5.0000	18.0000
21.0000	0.0000	7.0000	15.0000
22.0000	2.0000	7.0000	15.0000
23.0000	4.0000	7.0000	8.0000
24.0000	6.0000	7.0000	25.0000
25.0000	8.0000	7.0000	18.0000
26.0000	0.0000	9.0000	8.0000
27.0000	2.0000	9.0000	15.0000
28.0000	4.0000	9.0000	12.0000
29.0000	6.0000	9.0000	34.0000
30.0000	8.0000	9.0000	18.0000
31.0000	4.0000	10.0000	15.0000
32.0000	6.0000	10.0000	42.0000
33.0000	8.0000	10.0000	18.0000
34.0000	0.0000	11.0000	8.0000
35.0000	2.0000	11.0000	15.0000
36.0000	4.0000	11.0000	0.0000
37.0000	6.0000	11.0000	0.0000
38.0000	8.0000	11.0000	0.0000
39.0000	2.0000	12.0000	22.0000
40.0000	4.0000	12.0000	15.0000

Sample	X	Y	Z
41.0000	6.0000	12.0000	8.0000
42.0000	0.0000	13.0000	8.0000
43.0000	2.0000	13.0000	20.0000
44.0000	4.0000	13.0000	2.0000
45.0000	6.0000	13.0000	25.0000
46.0000	8.0000	13.0000	34.0000
47.0000	2.0000	14.0000	10.0000
48.0000	4.0000	14.0000	8.0000
49.0000	6.0000	14.0000	16.0000
50.0000	0.0000	15.0000	8.0000
51.0000	2.0000	15.0000	5.0000
52.0000	4.0000	15.0000	8.0000
53.0000	6.0000	15.0000	8.0000
54.0000	8.0000	15.0000	26.0000