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Computer-Generated Mineral Commodity Deposit Maps

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Abstract

This report describes an automated method of generating deposit maps of mineral commodity information. In addition, it serves as a user's manual for the authors' mapping system. Procedures were developed which allow commodity specialists to enter deposit information, retrieve selected data, and plot deposit symbols in any geographic area within the conterminous United States. The mapping system uses both micro- and mainframe computers. The microcomputer is used to input and retrieve information, thus minimizing computing charges. The mainframe computer is used to generate map plots which are printed by a Calcomp plotter.

Selector V data base system is employed for input and retrieval on the microcomputer. A general mapping program (Genmap) was written in FORTRAN for use on the mainframe computer. Genmap can plot fifteen symbol types (for point locations) in three sizes. The user can assign symbol types to data items interactively. Individual map symbols can be labeled with a number or the deposit name. Genmap also provides several geographic boundary file and window options.

Introduction

This report describes an efficient, user-friendly method of deposit information manipulation and plotting for the commodity geologist. Recent advances in microcomputer technology offer the geologist a practical alternative to the mainframe computer. Microcomputers often have advantages in cost and reduced down time and usually have simpler operating systems that are easier to learn than those of mainframes. Small data files (less than 300,000 characters) can be accommodated on many inexpensive microcomputers. With the addition of a hard disk mass-storage device, larger files can be processed.

The Intertec Superbrain microcomputer and Selector V data base manager (Robinson and Robinson, 1980) were chosen for this information system because both are inexpensive and supported by in-house computing staff. However, similar hardware and software could be substituted.

A FORTRAN map program, Genmap, was written for a Honeywell Multics mainframe computer. It uses Disspla (ISSCO, 1970) subroutines for most plotting functions. It is an interactive program that prompts the user with menu lists for the following map variables:

window size (that can be):

1. entered by latitude, longitude limits
2. entered by state name
3. entire U.S.

symbol type (that can be used to indicate):

1. major commodity
2. minor commodity
3. deposit type
4. depositional environment
5. age of deposition
6. user inputted field descriptors

labels adjacent to map symbols (to show):

1. deposit number
2. deposit name

The maps are Mercator projection and are accompanied by a legend for symbol type. Each plot can be previewed on the Tektronix screen or printed by a Calcomp plotter. The Calcomp map plots are approximately 25 inches in the vertical dimension.

Data Input and Retrieval

The mapping system described in this report uses Selector V (Robinson and Robinson, 1980), a general purpose data-base-management system, for initial file-building and manipulation. It allows data input under format control, sorting, retrievals and listings. Any similar program, such as Micro-Grasp, capable of producing an ASCII file in the format shown in table 1 is compatible with Genmap. The last three fields in table 1 (user 1-3) are for additional data types such as mineral names, alteration types, etc. The record definition is constructed using option "A" on the Selector V main menu (Robinson and Robinson, 1980, p. 47). Variables can be any of three types:

N = numeric data only allowed in this field
A = alphabetic or numeric data allowed
K = key field - for either "N" or "A" variables
can be "searched" for when editing records

See Robinson and Robinson (1980, p. 16) for further details on these types. The following restrictions apply to all Selector V data sets on the Intertec Superbrain:

maximum record length	1500 characters
maximum field length	62 characters
maximum number of fields	99

The record definition can be used to enter data at the keyboard under program control or to read a pre-existing data file of the same format. Data are entered or edited by choosing option "B" on the Selector V main menu (Robinson and Robinson, 1980, p. 181). Each field in the record definition is displayed with underscores indicating available field size for each data item. The data are entered by typing the value for each field followed by a carriage return. Selector V will not allow alphabetic data to be entered accidentally in a field that has been designated numeric (N). When each record is complete, press the "escape" key to start the next record. Data from the last record will remain on the screen until new data are typed in. Information that you wish to repeat from the last record need not be retyped - merely press "ctrl" and "v" simultaneously for each field to be repeated. After all deposits are entered press "ctrl x" (exit to module menu). Then press "4" to return to main menu. Data may be lost if disks are removed before the main menu appears.

Retrievals from the data file consist of a two-step process: 1. creation of a pointer file, and 2. conversion of the pointer file to a separate file suitable for map plotting. A pointer file contains only a list of the retrieved deposit numbers or "pointers" referring to the main file. Pointer files conserve storage space because the original data are not repeated in each retrieved file.

1. Pointer file creation

A pointer file is created with options "C" and "D" on the Selector V main menu. Option "C" (Robinson and Robinson, 1980, p. 75) creates the select definition containing the conditions and logic for retrieval. The commands in table 2 create a select definition for retrieving all deposits in which

Table 1.--Record definition

Record definition file: B:GENMAP as of February 2, 1983

Data file drive: B Key/Support drive: B

Data record length: 262 Key record length: 19

##	Name	Type	Data size	Key size	Byte offset
1	deposit no.	NK	3	3	1
2	country	A	2		4
3	state	A	2		6
4	deposit name	AK	50	10	8
5	lat degrees	N	2		58
6	lat minutes	N	2		60
7	lat n/s	A	1		62
8	long degrees	N	3		63
9	long minutes	N	2		66
10	long e/w	A	1		68
11	major commod	A	15		69
12	minor commod	A	15		84
13	size	N	1		99
14	deposit type	A	30		100
15	dep environ	A	50		130
16	deposit age	A	21		180
17	user field 1	A	10		201
18	user field 2	A	20		211
19	user field 3	A	30		231

Table 2.--Creating select definition

Notes and prompts	User responses	Explanation
(at main menu)	C	
enter source file	B:MAINFL	
continue?	(press any key)	
enter	E	enter conditions
line #	3	choose any odd #
to be tested field	11	major commodity field
test condition	CN	contains
value	F	fluorspar
line #	4	logic on even numbers
level	1	horizontal axis, table 3
connector	AND	logical and
line #	5	2nd condition
to be tested field	14	deposit type field
test condition	CN	contains
value	VEIN	
line #	0	end entries
save definition?	Y	
enter name	B:F-VEIN.SEL	
(at module menu)	M	

"FLUORSPAR" is the "MAJOR COMMODITY" and "VEIN" is the "DEPOSIT TYPE". The resulting select definition is displayed in table 3. The commands listed in table 4 execute the select definition resulting in a pointer file for all the fluorspar vein deposits.

2. File conversion

Before plotting the retrieved data, the pointer file must be converted. Choose option "K" on the main menu (Robinson and Robinson, 1980, p. 207). Table 5 shows the commands that create the next file named B:F-VEIN, from a pointer file named F-VEIN.L01.

The converted file (F-VEIN.DAT) must be transmitted to Multics. Follow the procedures in the ISD Superbrain manual (Jones and others, 1981, p. 59) for communication with Multics.

Map Plotting

Genmap should be executed on a Tektronix or Tektronix-compatible terminal which permits the user to preview the maps before sending them to the Calcomp plotter. Due to the great time and expense involved in each Calcomp plot, previewing the plots is strongly recommended.

The user must supply a tape to the Multics system operator if Calcomp plots are desired. Multics resident tapes are stored in the computer room (6-A-315) of the National Center in Reston. They can be acquired using the Multics "tpms" command. Type "tpms", request an unlabeled tape and make a note of the assigned tape number. Then send a message to the system operator informing him of your tape number.

```
sm sys op please locate tape _ _ _ _ _
```

Multics non-resident tapes are kept by the user and hand-carried to room 6-A-331A on the day of the plot. The same message must be sent to the system operator to locate the tape.

When running Genmap for the first time you must type:

```
.ab genmap >udd>ORA>library>genmap
genmap
```

This sets up an abbreviated command in your directory and invokes the program. On subsequent runs type only:

```
genmap
```

Q1: enter name of file to be plotted:

R: mainf1

Enter the name of the Multics segment containing your file.

Q2: choose either a Calcomp plot "cal" or a Tektronix screen display "tek"

R: tek

Table 3.--Select definition

0	1	2	3	4	5	6	7	8	9
1									
2									
3	MAJOR COMMOD CN F								
4	AND								
5	DEPOSIT TYPE CN VEIN								
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									

Table 4.--Execute select definition

Notes and prompts	User responses
(at main menu)	D
(at module menu)	1
enter source file name	B:MAINFL
enter select definition file	B:F-VEIN.SEL
enter pointer file suffix	01
(at module menu)	M

Choose "tek" if you are unsure how the map will look, otherwise choose "cal"
and program execution will skip to Q2a, p. 11.

Q3: do you wish to map

1. the entire conterminous U.S.
 2. a single state with county boundaries
 3. a single state without county boundaries
 4. any geographic window in the U.S. with coordinates of your choice?
- enter 1, 2, 3 or 4:

R: 2

if R = 1 then program execution skips to Q7

if R = 2 or 3 then program execution skips to Q6

if R = 4 then

Q4: enter longitude min, max (e.g. -106.5,-104):

Q5: enter latitude min, max:

program execution skips to Q7

Q6: enter state postal code (e.g., Az):

R: Co

Use post office-approved state code but with lower case for second letter.

Alaska and Hawaii are not available.

Q7: the map symbols can reflect any one of the following variables:

1. major commodities
2. minor commodities
3. deposit type
4. depositional environment
5. age of deposition
6. user field 1
7. user field 2
8. user field 3
9. none of the above (a "+" symbol will be plotted)

choose a number (1 to 9):

R: 5

Genmap reads the file and prepares a dictionary of all file entries in the category chosen above. If the user chooses "5. age of deposition", Genmap lists all the ages present in the data file. The list of ages in the authors' Colorado file follows:

- Q8:
1. CRETACEOUS+
 2. TERTIARY
 3. TRIASSIC-JURASSIC
 4. PRECAMBRIAN 2

enter map symbol number (0-14) after each item or carriage return for not plotted:

R:	CRETACEOUS+	1
	TERTIARY	2
	TRIASSIC-JURASSIC	3
	PRECAMBRIAN 2	4

Genmap displays each dictionary item (CRETACEOUS+, etc) and waits for the user to enter his choice for symbol type (0-14), or a carriage return which indicates that this item is not to be plotted. See figure 1 for a list of available symbols. In the above example, symbol 1 was assigned to represent "CRETACEOUS+" and so on.

Q9: the following information can be plotted next to each map symbol:

1. deposit number
 2. deposit name
 3. both
 4. neither
- enter 1, 2, 3 or 4

R: 1

The Tektronix screen plot appears on the screen. It looks the same as the Calcomp plot (figure 2).

R: type any character, then carriage return

Q10: do you want another plot? (y or n)

R: y

if R = n program will end

if R = y then program execution continues below

Q2: choose either a Calcomp plot "cal" or a Tektronix screen display "tek"

R: cal

Choose "cal" to make a Calcomp plot.

Q2a: choose a plot tape with a six-digit name: " _ _ _ _ _ "

R: 123456

enter the six-digit number of your tape

Q3-Q9 same as above

Q10: do you want another plot (y or n)

R: n

choose "n" to exit the program.

Go to room 6-A-331A and submit a tape removal request. Carry the tape to the Calcomp room, B-C-400.

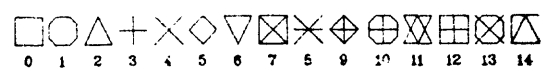


Figure 1. Symbols available in Genmap

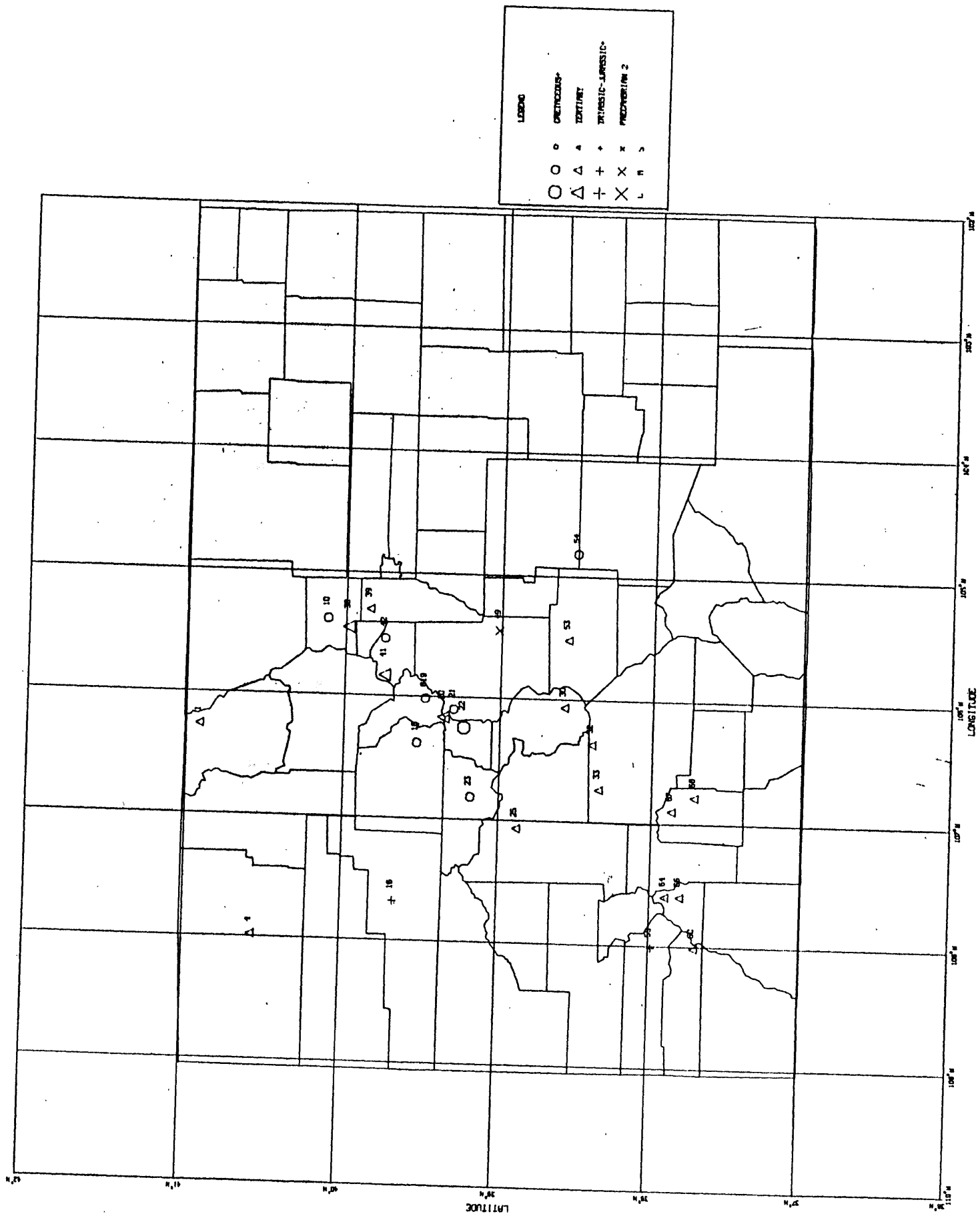


Figure 2. Example deposit map of Colorado data.

Bibliography

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System/Stand-Alone Applications System: Micro-Ap, Inc., Dublin, Ca.

Appendix A.

Genmap program listing

```
c      GENERALIZED MAPPING PROGRAM
c
c      Input files:
c          geographic - county boundary, one for each state
c          statwndo - lat, long coordinates for each state
c          vstates9 - state outlines
c
c          data - deposit information for point plot and legend
c              deposit number          a3
c              deposit name            a50
c              latitude degrees        f2.0
c              latitude minutes        f2.0
c              latitude N/S            a1
c              longitude degrees       f3.0
c              longitude minutes       f2.0
c              longitude E/W           a1
c              major commodity         a15
c              minor commodity         a15
c              deposit size            i1
c              deposit type            a30
c              depositional environment a50
c              age of deposition       a21
c
c      Necessary subroutines:
c
c          Honeywell Multics commands and active functions
c              ioa_$nnl
c              setup_calcomp
c              setup_tektronix_tcs
c              open
c              close
c
c          DISSPLA (Integrated Software Systems Corp. (ISSCO))
c              calcmp      inch30      page
c              nhance      height      nochek
c              physor      grace       project
c              title       mapgr       grid
c              messaq      sclpic      curve
c              rlmess      mapfil      endpl
c              reset       endgr       ore1
c              area2d      frame       graph
c              marker
c
c          Tektronix Plot 10 (called from DISSPLA subroutines)
c
c      %global ansi77
```

```

external ioa_$nnl(descriptors),setup_tektronix_tcs(descriptors)
external asr(descriptors),dsr(descriptors)
external close_file(descriptors),project(descriptors)
external setup_calcomp(descriptors),reset(descriptors)
external rlmess(descriptors),title(descriptors),lines(descriptors)
external mapfil(descriptors)
external messag(descriptors)
dimension x(300), y(300), xc(300), yc(300)
integer symbol(300), size(300), mark(50)
character*3 dsptyp, number(300)
character*6 tapenum
character*50 v(300,8), legend(50), name(300)
character*2 state,statw
character*4 mess(15)
character*1 xs,vs,resp
character*54 titl
character*30 infl
character*20 path /">udd>ORA>RMTurner>"/
70 print 90
90 format("enter name of file to be plotted: ",%)
read, infl
call ioa_$nnl("^/choose either a calcomp plot 'cal' ")
call ioa_$nnl("^/or a tektronix screen display 'tek' ")
200 read, dsptyp
if(dsptyp.ne."cal")go to 220
210 call ioa_$nnl("^/choose a plot tape with a 6 digit name: '_____'")
read, tapenum
call setup_calcomp("-un","16","-tp","-nm",tapenum)
call setup_calcomp("-un","16","-fl","-nm","pfile")
215 call calcmp(16)
call inch30
call page(30.,120.)
go to 250
220 call setup_tektronix_tcs
call nhance(960)
call height(.2)
call page(14.44,19.)
250 print 100
100 format("enter a title for the map (50 char or less) ",%)
read,titl
titl(51:51)="$"
252 call ioa_$nnl ("^/do you wish to map")
call ioa_$nnl ("^/      1) the entire conterminous U.S.")
call ioa_$nnl ("^/      2) a single state with county boundaries")
call ioa_$nnl ("^/      3) a single state without county boundaries")
call ioa_$nnl ("^/      4) any geographic window in the U.S. with
coordinates of your choice?")
call ioa_$nnl ("^/enter 1,2,3 or 4: ")
read, impty
259 goto (260,262,262,269) impty
260 xmin=-125.; xmax=-65.; xstp=5.
ymin=25.; ymax=50.; ystp=5.
goto 270
261 close (10)
call ioa_$nnl ("^/bad postal code")

```

```

262 xsto=1; ystp=1
    call ioa_$nnl ("^/enter state postal code (ie. Az): ")
    read (0,299) state
299 format(a2)
839 open (10,form="formatted",file=">udd>ORA>RMTurner>statwndo")
    do 264 i=1,100
        read (10,263,end=261) statw,xmin,xmax,ymin,ymax
263 format (a2,2f4.0,2f3.0)
        if (state.eq.statw) goto265
264 continue
265 close (10)
    goto270
269 call ioa_$nnl ("^/enter longitude min, max (ie. -106.5,-104): ")
    read, xmin,xmax
    call ioa_$nnl ("^/enter latitude min, max: ")
    read, ymin,ymax
    xstp=1; ystp=1
270 call nochek
    call physor(.6,1.)
    call grace(0,0)
    call projct("merca")
    open (10,form="formatted",file=infl)
c
c         main read loop (data file)
c
272 do 274 k=1,300
    read (10,271,end=276) number(k),name(k),yd,ym,ys,xd,xm,xs,v(k,1),
    v(k,2),size(k),v(k,3),v(k,4),v(k,5),v(k,6),v(k,7),v(k,8)
271 format (a3,4x,a50,2f2.0,a1,f3.0,f2.0,a1,2a15,i1,a30,a50,a21,a10,
    a20,a30)
    x(k)=xd+xm/60
    if (xs.eq."W") x(k)=x(k)*(-1)
    y(k)=yd+ym/60
    if (ys.eq."S") y(k)=y(k)*(-1)
274 continue
c
276 k=k-1; close (10)
300 call ioa_$nnl ("^/the map symbols can reflect any one of the
    following variables:")
    call ioa_$nnl ("^/      1) major commodities")
    call ioa_$nnl ("^/      2) minor commodities")
    call ioa_$nnl ("^/      3) deposit type")
    call ioa_$nnl ("^/      4) depositional environment")
    call ioa_$nnl ("^/      5) age of deposition")
    call ioa_$nnl ("^/      6) user field 1")
    call ioa_$nnl ("^/      7) user field 2")
    call ioa_$nnl ("^/      8) user field 3")
    call ioa_$nnl ("^/      9) none of the above (a '+' symbol will be
    plotted)")
    call ioa_$nnl ("^/choose a number (1 to 9): ")
    read, l
841 o=1
    if (l.eq.6)goto328
310 legend(i)=v(1,1)
    do 314 m=2,k

```

```

do 312 j=1,o
  if (v(m,l).eq.legend(j)) goto314
312 continue
  o=o+1; legend(o)=v(m,l)
314 continue
  print 120
120 format("this is a list of available map legend items"/)
  print 320, (m,legend(m),m=1,o)
320 format(10x,i2," " ,a50)
  print 110
110 format("enter map symbol number (0-14) after each item or carriage
  return for not plotted"/)
  do 324 m=1,o
    print 911, legend(m)
911 format(v,$)
324 read, mark(m)
  do 328 m=1,o
    do 326 n=1,k
      if (v(n,l).eq.legend(m)) symbol(n)=mark(m)
326 continue
328 continue
330 call ioa_$nnl ("^/the following information can be plotted next to
  each map symbol:")
  call ioa_$nnl ("^/      1) deposit number")
  call ioa_$nnl ("^/      2) deposit name")
  call ioa_$nnl ("^/      3) both")
  call ioa_$nnl ("^/      4) neither")
  call ioa_$nnl ("^/enter 1,2,3 or 4: ")
  read, label
c
c      main plotting sequence
c
  xd=xmax-xmin; yd=ymax-ymin
440 if (dsptyp.eq."tek") goto441
  yaxis=amini(yd/xd*28.,28.)
  call title(" ",-1,"longitude",9,"latitude",8,110.,yaxis)
  goto442
441 yaxis=amini(yd/xd*12.,12.)
  xstp=amax1(1.,aint((xd+10)/13))
  call title(" ",-1,"longitude",9,"latitude",8,11.,yaxis)
442 call mapgr(xmin,xstp,xmax,ymin,ystp,ymax)
  call grid(1,1)
  legendx=xposn(xmax,ymin)+1
  titlex=xposn(xmin,ymax)+1.5
  titley=yposn(xmin,ymax)+1
  titl(51:51)="$"; call messag(titl,50,titlex,titley)
450 do 500 m=1,k
  xc(1)=x(m); yc(1)=y(m)
  call sclpic (size(m)*1,1)
  if (symbol(m).eq." ") goto500
  if (l.eq.6) call marker(3)
  if (l.ne.6) call marker(symbol(m))
  call curve (xc(1),yc(1),1,-1)
  call height(.12)
c

```

```

c           place annotation next to each symbol
c
    titl=" "; is=0
    goto(455,460,455,500)label
455 do 459 i=1,3; if (number(m)(i:i).eq." ")goto459
    is=is+1; titl(is:is)=number(m)(i:i)
459 continue
    if(label.eq.1)goto490;is=is+1
460 do 464 i=1,50; is=is+1; titl(is:is)=name(m)(i:i)
464 continue
490 xc(1)=xc(1)+size(m)*.05
    call rlmess(titl,54,xc(1),yc(1))
500 continue
c
c           plot geographical boundaries
c
540 if (imapty.eq.2) goto550
    infl="ustates9"
    call mapfil(infl)
    goto900
550 infl(1:18)=path
    infl(19:20)=state
    call endpl(0)
    call reset("all")
    open (10,form="unformatted",file=infl)
800 read(10,end=888)n,(xc(i),i=1,n),(yc(i),i=1,n)
    call curve(xc,yc,n,0)
    goto800
888 close(10)
c
c           make legend
c
900 if (1.eq.6)goto950
    call height(.12)
    call endgr(0)
    call orel(legendx,.6)
    call area2d(7.,10.)
    call frame
    call graph(0.,1.,0.,1.)
    do 902 n=1,3
    do 901 m=1,o
    call marker(mark(m))
    call sclpic(n*1.1)
    xc(1)=1.25-(n-1)*.5
    yc(1)=9.25-m*.5
901 call curve(xc,yc,1,-1)
902 continue
    titl="legend$"
    call messag(titl,6,1.8,9.5)
    do 903 i=1,o; titl=legend(i); titl(51:51)="$"
903 call messag(titl,50,1.8,9.18-i*.5)
    titl="L      M      S$"
    call messag(titl,11,.2,8.75-o*.5)
    call messag(titl,11,200.,200.)
c

```

```

950 call endpl(0)
    call reset("all")
    call ioa_$nnl("^/Do you want another plot? (y or n) ")
    read, resp
    if(resp.eq."y")go to 70
    if (dsptyp.eq."tek") call setup_tektronix_tcs("-reset")
    if (dsptyp.eq."cal") call setup_calcomp("-reset")
990 stop
    end

```