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User's Manual for MAPGEN (UNIX version): a method of transforming digital cartographic data to a map.

by

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1. Woods Hole, Massachusetts.

CONTENTS

LIST OF FIGURES

until the desired graphic is attained and the final plots can be made.

1.2 Caveat

The program descriptions in this manual are considered operational and syntactically correct at the time of printing. Because any document is static, it cannot reflect upgrades, additions, modifications, etc. Therefore, the user is advised to consult the authors or system librarian for any information regarding changes to the MAPGEN system as it is presented herein.

MAPGEN is designed to generate maps of large to medium scale. Depending on the projection, some small scales can be accommodated. In most circumstances, MAPGEN cannot be used for very small scales such as semi-global or global maps.

The reason for this limitation is that the projection polynomial surface approximations degenerate at very small scales or where the non-linearity of the transformation becomes excessive. On the other hand, at very large scales MAPGEN will function to the extent of the applicability of the selected projection. Exact map scales that define incipient degeneration have not been determined for the various MAPGEN projections.

It is recommended that any desired projection and scale be attempted at least once. If the preview of the geographic grid overlay is acceptable, it is likely that no significant degeneration has occurred.

1.3 UNIX environment

MAPGEN was developed and written for execution in the UNIX operating system environment. Although this might be considered a dependency, UNIX has such a broad spectrum of powerful features and is so widely used that UNIX is really an enhancement. The user will find great utility in UNIX concepts such as standard-in, standard-out, shellscripting and pipelining, all of which relate to the facility of declaring input and output files, and to the automatic flow of results from one process to another.

With respect to data editing and manipulation, there are a number of UNIX utility programs that can be viewed as filters to be interposed between MAPGEN programs and the original data. The filters act as data reorganizers that capture the original data, reformat them, and pipeline the newly reformatted data directly into the selected program.

It is important to note that the reformatting is done outside of MAPGEN, and it is strongly suggested that the user become as proficient as possible with appropriate UNIX editing programs as well as the programs that facilitate data flux and file management.

1.4 Overview of this manual

This manual is intended to be used as a MAPGEN user reference. The following constitute the basic working set of programs necessary to execute any anticipated cartographic application: mapdef, grid, legend, lines, points, coast, preview, and plotter. For these programs, all options, input data constraints, and proper syntax are explained in detail. Annotated examples are provided wherever necessary.

The four appendices of the manual include variables requisite to each of MAPGEN's cartographic projections, official program documentation for all current MAPGEN programs, the complete set of MAPGEN fonts, and the set of World Data Bank II feature codes used in the program coast.

There is one specialized program: proj. This is for advanced applications and the user is referred to APPENDIX II, Program documentation for all MAPGEN programs, for details regarding its implementation.

Many of the figures in this manual are composed of overlays created external to the example being presented. In these cases the source data, control files, and/or the overlay generating procedures are omitted because if presented, they would detract from the example. Externally derived procedures, controls, and data are presented where relevant and contributive.

2. The MAPGEN Programs

This section of the manual presents a syntactically detailed program description for each MAPGEN program. These are intended as tutorials and, where necessary, each contains annotated examples. In general, each program description consists of a brief overview, a synoptic runline statement, detailed descriptions of all options and their respective arguments, and example maps and relevant annotated control files. Except for actual examples and the name and synopsis sections of program descriptions, underlines (_) are used to distinguish program and argument names.

The most basic of MAPGEN applications require that the user be at least minimally proficient with the use of UNIX; i.e., edit files, compose simple shell scripts, implement sound file management practices, and understand the fundamentals of standard-in, standard-out, and pipelining.

For all point and line data, it is assumed that a single tab is the standard string (or field) delimiter within a record. Control strings, however, will accept one or more contiguous blanks or tabs (whitespace) as delimiters.

It is advisable to be careful when composing file names because MAPGEN provides no duplicate file name overwrite protection. It is assumed that the user will properly organize and protect files outside of the context of MAPGEN.

2.1 Common MAPGEN features

Many of the programs in the MAPGEN package have certain options and features in common. For example, the overlay producing programs grid, legend, lines, points, and coast all have the runline options -m, -o, -i, and file[s]. The program preview uses -m, -i, and file[s], and mapdef uses -m. Other common features include the continuous or disaggregated sequence of runline options, DMS format, the dashed-line mask, and the pound sign (#) convention for indicating control lines and comments.

Inasmuch as the syntax and application of these options and features are identical in all of the above programs, they will be explained in detail here to avoid repetition in each of the program descriptions. Future reference to these options will be sans explanations.

2.1.1 Common options and descriptions

-m file
The -m (map definition file) option is used to declare

the map definition file, file, which is used to window, project, and scale cartographic operations.

THIS OPTION IS MANDATORY FOR preview AND ALL OVERLAY GENERATING PROGRAMS.

-o file
The -o (overlay) option is where the user specifies the name of the output metagraphic overlay file, file, to be generated.

-i
The -i (inspect) option provides a preview of the metagraphic overlay file generated by the program. If an overlay file is not being generated, -i is implied and therefore need not be specified. In this case, a preview of the graphic will automatically be returned to the user's screen.

file[s]
All graphics options, control parameters and data (other than those entered directly in the runline) MUST be entered from one or more files whose names, file[s], are specified in the runline. These files are read, in order, from left to right. A solitary dash (-) denotes the position of standard-in in the string of file[s].

2.1.2 Runline option sequence

If the runline options are used singly, each option must be immediately preceded by a dash (-) and followed by any required arguments. For example, consider the following runline:

```
mapdef -m deffile -v
```

In this case, the options -m and -v are used singly. However, -m requires a runline argument which must occur before the next option. Therefore, the argument value deffile, which is the name of the map definition file to be created, is placed immediately after -m.

If the options are grouped, the group must be preceded by a dash (-) and can not contain whitespace. For example, consider the following runline:

```
mapdef -mcspvk deffile 400 <control_file
```

In this case, -m and -k are the only options requiring runline arguments. These are deffile and 400, in order. <control_file is the standard-in file containing control

parameters required by other options. The arguments for these options must be in the order established in the option group Note that the left arrow (<) designates the file as standard-in.

2.1.3 DMS format

DMS format refers to the orderly expression of geographic coordinates in Degrees, Minutes, and Seconds. The syntax of this format requires annotation of each of the three components of a degrees-minutes-seconds expression. Degrees are the highest order of component, and seconds are the lowest. Any components in an expression must be arranged in decreasing order from left to right.

Except where permissable, all components of any expression must be annotated. Default situations, for which annotation of a component or expression is not necessary, are as follows:

1. If the coordinate expression is north or east;
2. If the only component of the expression is degrees;
3. If the last component of the expression is the next lower order from the previous component.

Note: Decimal values (floating point numbers) should only be used in the lowest order component of an expression.

The following list shows the allowable annotation for components and expressions in DMS format.

North = N or n (expression suffixes).

East = E or e (expression suffixes).

South = S or s (expression suffixes),
or - (expression prefix).

West = W or w (expression suffixes),
or - (expression prefix).

Degrees = D, d, or blank (component suffixes).

Minutes = apostrophe (') or blank (component suffixes).

Seconds = quotation marks (") or blank (component suffixes).

For example, consider a coordinate of 123 degrees 15 minutes 30 seconds west longitude. Four DMS forms of this expression are as follows: -123d15'30", 123d15'30"w, -123d15'30, and 123d15'30w.

2.1.4 Dashed-line mask

The programs legend, lines, and coast provide a dashed-line drafting option. In all cases, the user must specify the mask or pattern of the dashed-line. For example, to distinguish between two separate features, one may choose a pattern with three long dashes separated by short spaces for one, and another pattern, with alternating long and short dashes separated by short spaces for the other. This is accomplished by specifying the dash pattern mask which is a hexadecimal number representing a 16-bit dash pattern where each bit that is set to 1 is a line segment of length size. Coast and legend include size in the argument list for the dashed-line option. Lines uses a separate option for size.

For example, the hexadecimal number 0X6666 is a 16-bit binary pattern 0110 0110 0110 0110 yielding a dashed-line that has evenly spaced solid and blank segments. The bits are presented in groups of four to facilitate interpretation. Also, note that the hexadecimal number is composed of the digit zero (0) and the letter x followed by four hexadecimal digits.

For convenience in setting masks, there is a provision for using octal or decimal mask patterns as well as hexadecimal. Octal numbers must be preceded by the digit zero (0), and

decimal numbers may be entered as is.

Hexadecimal notation is recommended for the novice user.

2.1.5 Pound sign (#) delimiter

In any control line a pound sign (#) can be used to inhibit further reading to the right of the sign. This allows the insertion of useful annotation that is retained with the file but is not processed by the program.

Two exceptions to this are the programs lines and points which require a pound sign in the first character position of every control line. In these cases, a second pound sign on the line will inhibit further reading to the right.

2.2 The mapdef program

The mapdef (map definition) program is the key program in the MAPGEN series since it establishes the cartographic controls needed by the overlay programs. Scale, map and data window, and map projection parameters are computed from user specifications and are output in a file referred to as the map definition file. This file controls the generation of overlays, and is unique to every new set of map specifications. For user review purposes, mapdef can also be used to display projection, scale, and window parameters of previously existing map definition files.

2.2.1 Synopsis

```
mapdef [-mcspvk [args]]
```

2.2.2 Options and descriptions

There are six mapdef runline options; -m, -c, -s, -p, -v, and -k. These can be in any order on the runline.

-v

The -v (verbose) option causes mapdef to provide the user with diagnostics that are very helpful, particularly to the novice user. This mode of operation is especially helpful during the first few stages of map design because of the presentation of various map and window dimensions and because of the orderly sequence of prompts. However, a user that has reached the final stages of map control parameter selection may find the verbosity tiresome. If -v is not used, only error messages will be printed.

By using -v together with the mandatory -m option as, for example in

```
mapdef -mv file
```

the user can review the parameters of any pre-existing mapdef file, file, in the system.

-c

The -c (create) option is used to specify the geographic range and projection of the desired map. When this option is selected, mapdef automatically creates the file named in option -m. This means that any previously existing file of the same name will be overwritten. Two lines of input from standard-in are required arguments. These must be entered exactly as indicated below.

Line 1:
W-Long E-Long S-Lat N-Lat [Central-Meridian]

where W-Long, E-Long, S-Lat, and N-Lat are the west and east longitude, and south and north latitude coordinates that bound the subject region. These coordinates MUST be input in DMS format. Central-Meridian is the optional user-selected central meridian to be used for the application. If not selected by the user, mapdef computes one based on the mean of the entered longitudes.

Line 2:
[degree] +proj=name [+projarg=value]

On line 2, degree is the optional argument for entering the number corresponding to the degree of the polynomial used to approximate the map projection surface. The default (i.e., blank or non-numeric character) is an 8th degree surface. The highest degree possible is the 12th degree. Unless special requirements specifically dictate a change in the degree of the polynomial the user is well advised to accept the default.

+proj=name is form for input of the selected map projection, where name is any one of the allowable map projection mnemonics. For example,

+proj=utm

is the correct form for input of the Universal Transverse Mercator projection.

If the selected projection requires entry of control parameters, they MUST be entered in the form of the optional +projarg=value construct, where value is the required entry. Note: whitespace is not allowed within the construct.

The above constructs, arguments, and values are requisite to the program proj which performs forward or inverse transformations on cartographic data. For more information on proj, the user is referred to APPENDIX II, Program documentation for all MAPGEN programs. The complete set of arguments and values is presented in APPENDIX I, Supplementary notes on projection parameters.

-s

The -s (scaling) option is the mechanism for establishing map scale, map rotation, map boundaries, and data

window. By ignoring the -c option, the user can change (i.e., rescale) these parameters in a pre-existing mapdef file. This is useful when it is desirable to retain the existing geographic control parameters and change only scale, data window, or map rotation.

The -s option requires 4 lines of control parameters from standard-in. For each line, the parameters must be in the sequence indicated as follows:

Line 1:
The denominator of the map scale fraction.

If entry is Ø, then go to Line 1a.
If entry is not Ø, go to Line 2.

In this line, the user has the option to either enter the denominator of a conventional scale fraction or, by entering Ø, to invoke the calibration-mode scale option. In calibration-mode, mapdef computes the scale of the map after the user enters the coordinates of two known points on the map and the desired map distance (in centimeters) between them.

Calibration mode data are entered as shown in Line 1a.

Line 1a:
The longitude-latitude pair for each of two points, followed by their map distance separation in centimeters.

Line 2:
The number of degrees of counterclockwise rotation of the geographic map axes relative to the map plot. Blank or Ø cause no rotation.

This line allows the user to rotate the map geographic axes to optimize the orientation of the plot area with respect to the border of the map. This is especially useful for portraying data that were captured in a pattern whose long axis is parallel to a coastline that is not approximately parallel to a meridian or parallel.

Line 3:
Map position of data origin and window boundaries. Up to five coordinate pairs may be entered, and they MUST be in the following order:

Pair 1 - x and y coordinates, in centimeters, of the lower left corner of the data window relative to the map origin. (Default: x = y = 3.Ø centimeters)

Pair 2 - Longitude and latitude for the minimum x direction data boundary.

Pair 3 - Longitude and latitude for the minimum y direction data boundary.

Pair 4 - Longitude and latitude for the maximum x direction data boundary.

Pair 5 - Longitude and latitude for the maximum y direction data boundary.

This line allows selection of the origin and extents of the data window, which is rectangular and has its sides parallel to respective map sheet boundaries. The data window offset is useful when lower and left map margins are required for legend information. Data window boundaries are usually adjusted to accommodate legend information and to balance the graphic.

On succussive executions of mapdef, if no changes in the nature of the window and/or its origin are desired, the line must be entered but may be left blank.

For example, if the user wishes to select new values for Pair 4 and retain all others as they exist, having been originally entered in option -c, one dash (-) is required as the entry for each of the coordinates in Pair 1, and one dash is required for the entire coordinate pair in Pairs 2 and 3, respectively. The desired coordinates are entered as Pair 4. Trailing control parameters (Pair 5) can be left blank.

For example:

- - - - 1Ø4w 49n

will result in retention of the map origin position (the first 2 dashes), and the minimum x and y data boundaries (one dash for each coordinate pair). The maximum x data boundary is changed to 1Ø4 degrees west longitude and 49 degrees north latitude.

If the verbose option -v has been selected, mapdef will display the resultant map size information after completing computations based on the parameters of this

control line.

Line 4:
The width of the right map margin and/or the height of the top map margin, respectively, can be entered on this control line. The default values are 3.Ø centimeters each.

For example:

- 5

yields a right margin of 3.Ø centimeters (default) and a top margin of 5.Ø centimeters. (Note the space between the dash (-) and the 5.)

-p
This option converts standard-in longitude and latitude coordinate data to map space coordinates which are expressed in both centimeters and plotter counts. It is useful when establishing the spatial relations between various components of a map, and functions only if the -s option had been previously invoked (i.e., the map definition file is in scaled state).

-k cpc
The -k option is used to adjust the resolution of the intended output plotting device; cpc is the number of plotter counts per centimeter intended to produce a true scale map. The default value is installation dependent, and any changes should be made only after consultation with the system manager.

2.2.3 Example

In the following example the objective is to create a map definition file for the conterminous United States. The desired scale is 1:1Ø,ØØØ,ØØØ and the projection is a Lambert conformal conic.

The first step is to determine the geographic extents of the subject area. After perusing an existing map of the United States, it is established that the desired map will be bounded by 125 degrees and 65 degrees west longitude, and 2Ø degrees and 53 degrees north latitude.

Next, the decision must be made as to whether or not to create a file of control parameters or to enter them interactively. Generally, for serious work, it is wise to create a file of input control parameters that if necessary, can be referenced at some later time.

The following file xxx contains the control parameters for a first pass through mapdef. Note that line numbers have been added for convenience in reading the file and that these numbers are not part of the file. The control parameter records are in the Parameters column.

File name: xxx

Line#	Parameters
1	128w 65w 20N 53N
2	+proj=lcc
3	10000000
4	
5	
6	

The next step is to formulate the mapdef run line. The above parameter file indicates that the geographic extents and projection (lines 1 and 2) both require option -c, and that the scale requires option -s (line 3). The following is a mapdef run line appropriate to the initial map requirements, and one that will execute properly with the parameter file xxx.

```
mapdef -mvcs mg.def < xxx
```

In the above run line -mvcs are the options that require the name of the output file, return verbose processing diagnostics and results, establish the projection parameters and geographic limits of the map, and scale the map, respectively. Lines 1 and 2 of the file xxx provide control parameters for the -c option, and lines 3-6 are requisite to the -s option. Note that although lines 4-6 are required for the -s option, they are left blank, thereby accepting the default values.

Figure 1 is a plot of the subject area. It shows the shape of the Lambert conformal grid and the outline of the conterminous United States. The procedures for generating the plot and the overlays will be discussed in later sections of this manual. Most importantly, this figure shows the relation of the original geographic extents to the body of the projected data. In this case, the bounding outer rectangle is tangent to the projected data at the appropriate coordinate maxima and minima. This provides the user with an initial picture of the entire projected geographic area defined in the mapdef run.

By executing mapdef again, but selecting only the -mv options,

```
mapdef -mv mg.def
```

the following information is returned to the user:

```
Mapgen - mapdef file initialization (Ver: II (4/24/85)
   file name: /usr/jmb/d.mapgen/mg.def

projection:  +proj=lcc  +lon_0=-96.500000000000
longitude range: 128dw 65dw
 latitude range: 20dn 53dn
scale 1 : 10000000.0
map size x: 73.69, y: 46.69
data window x from 3.00 to 70.69, y from 3.00 to 43.69
plotter counts/cm: 200.00
```

At this point the user knows the size of the map, the size of the original data window and its bounding coordinates.

Now, assume that only the east coast is the desired data window. Therefore, the original window must be partitioned. This is done most conveniently by re-running mapdef with the -ms or -mvs options and the control file zzz (cf., below) as input. In this way, the original map definition file retains the same name, and now becomes scaled to accommodate the new data window.

The following is the control parameter file zzz. Only two of the -s lines are selected, viz., the scale and definition of the new data window. The other lines must be present, but are not used.

```
File name: zzz
      Line#   Parameters
        1     10000000
        2
        3       - - 85w 40n 80w 23n 66w 40n 70w 47n
        4
```

The following is the mapdef run line.

```
mapdef -mvs mg.def < zzz
```

The -v option yields the following information regarding the new scaling:

```
Mapgen - mapdef file initialization (Ver: II (4/24/85)
   file name: /usr/jmb/d.mapgen/mg.def

projection:  +proj=lcc  +lon_0=-96.500000000000
longitude range: 128dw 65dw
 latitude range: 20dn 53dn
scale 1 : 10000000.0
map size x: 21.68, y: 34.09
data window x from 3.00 to 18.68, y from 3.00 to 31.09
plotter counts/cm: 200.00
```

Figure 2 shows the new data partition which is represented by the bounding rectangle. Because of the shape of the projection, notice that in the northeast corner of the map, a small portion of the original geographic boundary is showing inside of the data window. No data can be plotted outside the geographic boundary regardless of the fact that it intersects the data window.

Figure 3 is a rotated version of the data window in Figure 2. In this case, Line 2 of the -s option is set to 30 (degrees), and mapdef is executed with the -ms options. The result is a rotated version of the definition file used in Figure 2.

Figure 1. Conterminous United States Subject Area

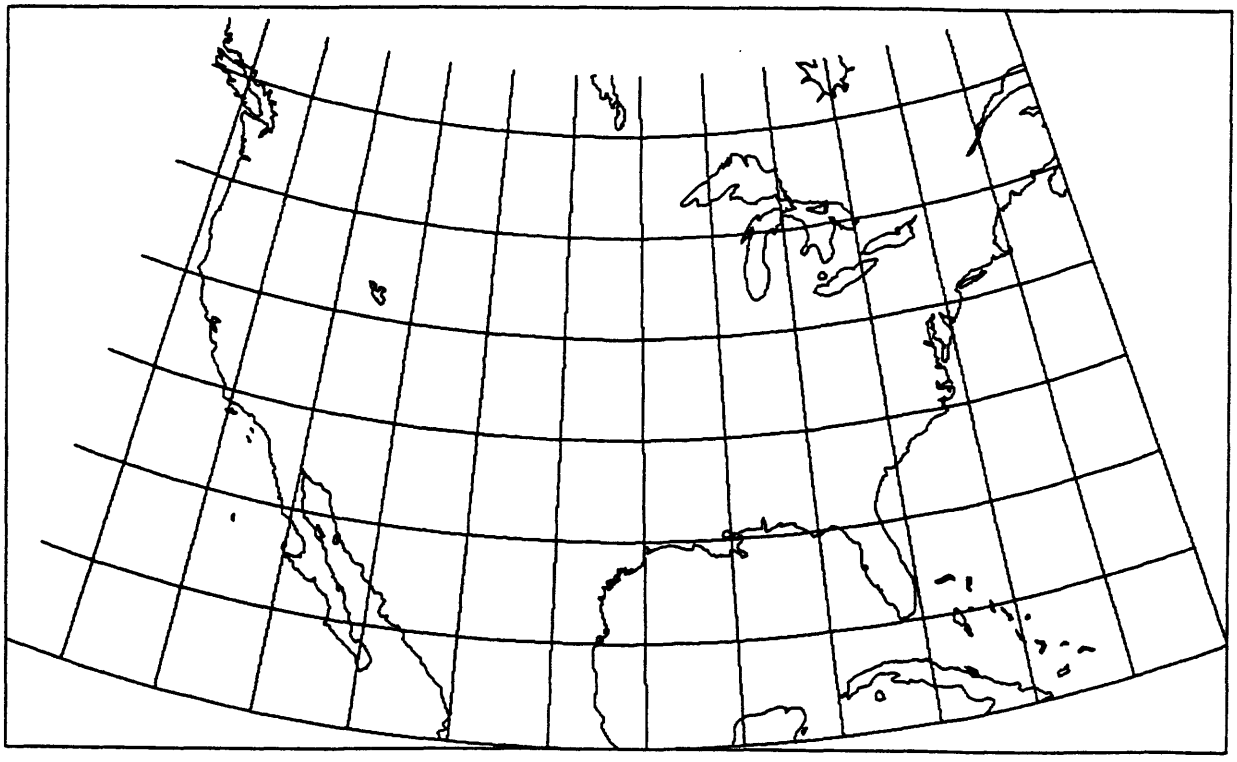
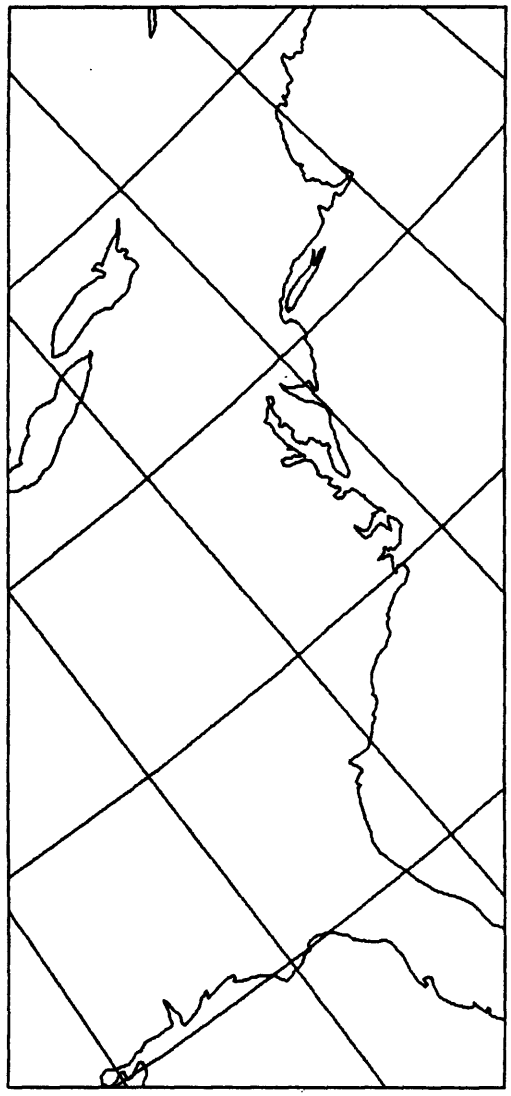


Figure 2. Eastern United States Data Partition

Figure 3. Eastern United States data partition, rotated



2.3 The grid program

Grid is used to generate overlays of geographic coordinate grids (or graticules). In composing a network of coordinate lines, grid parameters control the interval of space between lines in both the x and y directions as well as the graphic and annotation nature of the lines themselves.

When considering the application of grid, an effective conceptual approach is to divide the data region into major geographic partitions which are, in turn, further subdivided into minor partitions. Then, for each interval in each direction, to establish the type of line (i.e., solid or tick) that will represent the boundary between each type of interval. By visualizing these partitions as a first attempt at composing a coordinate grid, the user has a sensible starting point for determining an appropriate grid for the desired map.

Annotation is strictly a matter of preference. Grid provides mechanisms for selecting the size, placement, and (if a suitable plotter is available) width of lines and characters.

2.3.1 Synopsis

```
grid [ -moi [args]] file[s]
```

2.3.2 Options and descriptions

There are four grid runline options; -m, -o, -i, and file[s]. These can be in any order on the runline.

The following graphics options and their associated arguments may only appear in the control file[s].

-d n
: The d (distance) option specifies the the offset distance of grid line labels where the decimal value of n is this distance in centimeters.

-s size
: The -s (size) option specifies the nominal size of the selected font where size is the measurement in centimeters.

-f font
: The -f (font) option is used to specify the graphics system font, font, to be employed (cf. APPENDIX III, The complete set of MAPGEN fonts). The system default font, -sr, can be selected either by name or by

entering a dash (-) for font.

-a sides
The -a (annotate) option specifies which sides, sides, of the grid are to be annotated. Any combination of l, r, b, and t (left, right, bottom, and top, respectively) can be used. For example,

-a lrt

means that the left, right, and top sides of the grid will be annotated. If any letter other than l, r, b, or t is used, annotation will be suppressed. If the option is omitted, all sides will be annotated. Annotation is always horizontal regardless of grid line orientation.

The following four options -i, -j, -u, and -v use the construct (m|p) as a prefix which is interpreted as "meridian or parallel", and signifies that either m or p must be used as a prefix to the indicated option. For example,

-(m|p)i dms

indicates that the -i option must be prefixed by either m or p as follows:

-mi dms or -pi dms

Another aspect to the (m|p) notation is that the options may be conveniently grouped as shown in the following example:

-pijuv (etc.) or -miv (etc.)

where (etc.) refers to the arguments and/or control parameters required by the options. These are entered in the sequence of their occurrence in the option statement.

-(m|p)i dms
The -(m|p)i (interval) option establishes the geographic spacing, dms, of the major grid lines in DMS-formatted units. Grid lines will fall on coordinates that are evenly divisible by this factor.

-(m|p)j n
The -(m|p)j option establishes the number, n, of intervals defined by tick marks to be evenly distributed in one major grid interval. Obviously, if n=<1 or is omitted (the

default), no minor intervals will be generated.

-(m|p)u cm

The -(m|p)u option causes the major grid lines to be generated as tick marks of size cm centimeters. If omitted, major grid lines will be solid.

-(m|p)v cm

The -(m|p)v option causes the minor grid tick marks to be set at size cm centimeters. If omitted, minor tick marks will not be generated.

-b n

The -b option permits selection of a mechanical pen n for grid line drafting.

-c n

The -c option permits selection of a mechanical pen n for character drafting. If -c is not selected, the default is -b.

2.3.3 Example

Figure 4 shows both the grid lines and annotation generated by grid for the east coast partition in Figure 2. Figure 5 shows the same annotation and lines, but applied to a data window that has been rotated 30 degrees counterclockwise.

The following is the actual grid control parameter file, usgrid, used to create the grid lines and annotation for both figures. Note that it is commented by using pound sign (#) notation.

```
-pi 5   -mi 5  #5 deg. maj. interval for parallels and meridians.
-pj 4   -mj 4  #There are 4 intervals between major grid lines.
-pv .2  -mv .2 #Tick size is 0.2 cm.
-s .6          #Character annotation size is 0.6 cm.
-d .5          #Grid annotation is offset 0.5 cm. from lines.
-a tlr         #Annotate only the top, left, and right sides.
```

The grid runline used to generate the features in both Figures 4 and 5 is as follows:

```
grid -mo mg.def1 mg.gd2.ov usgrid
```

where -mo are the map definition file and output overlay

file runline options, mg.defl and mg.gd2.ov are the definition and overlay file names, and usgrid is the name of the above control file.

In Figure 4, note that a four-interval minor subdivision results in map intervals of 1.25 degrees each. This is obviously difficult to work with, and a next cycle through grid might be well undertaken with -(m|p)j n set to some other more convenient number.

Although the annotation was set for left, top, and right the northwest corner is annotated within the data window. This is because the actual geographic data boundary for the selected projection intersects the rectangular data window boundary. On the left side of the map there is an annotation overwrite conflict for the 40- and 80- degree coordinate intersection. Also, in Figure 5 the left side of the 30- degree parallel is annotated on the bottom of the map. This is because the rotation caused the true left side of the data window to fall on the bottom side of the graphic. These conditions can be resolved by decreasing the annotation character size, rewindowing the data window, or by selectively relabeling the axes by generating a series of single coordinate overlays.

Figure 4. Grid and annotation of data partition

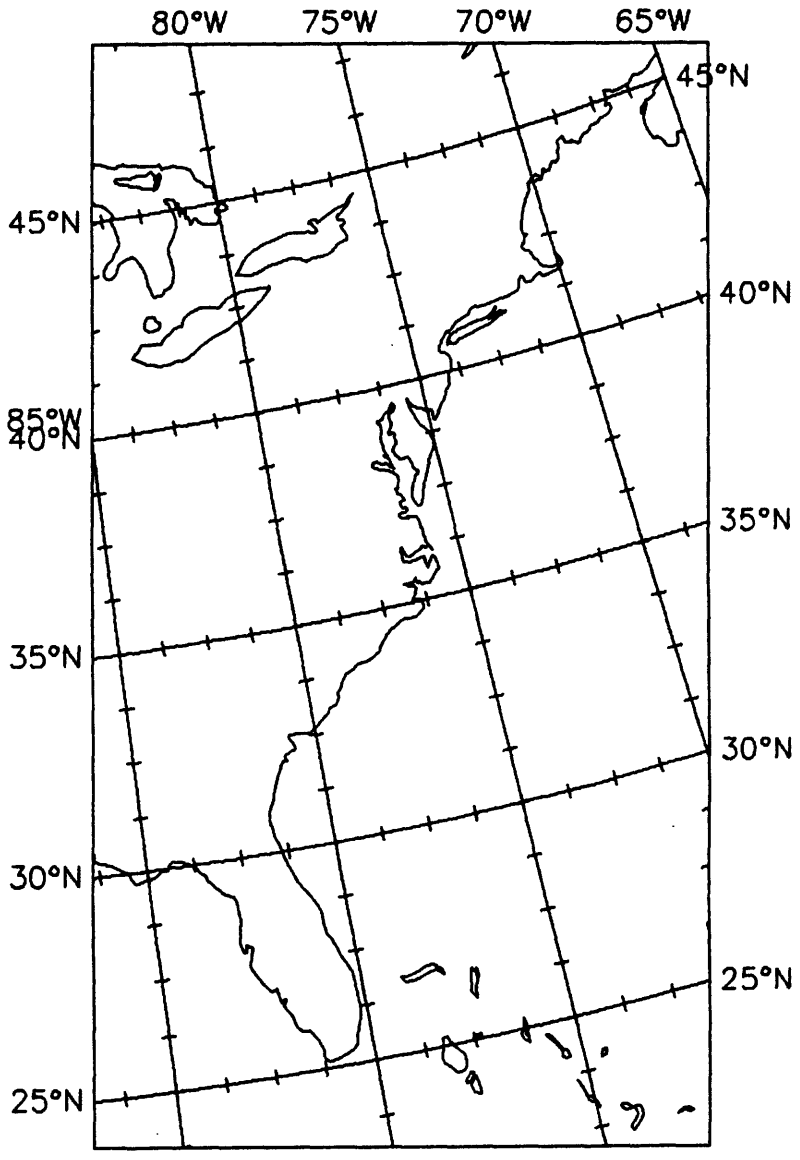
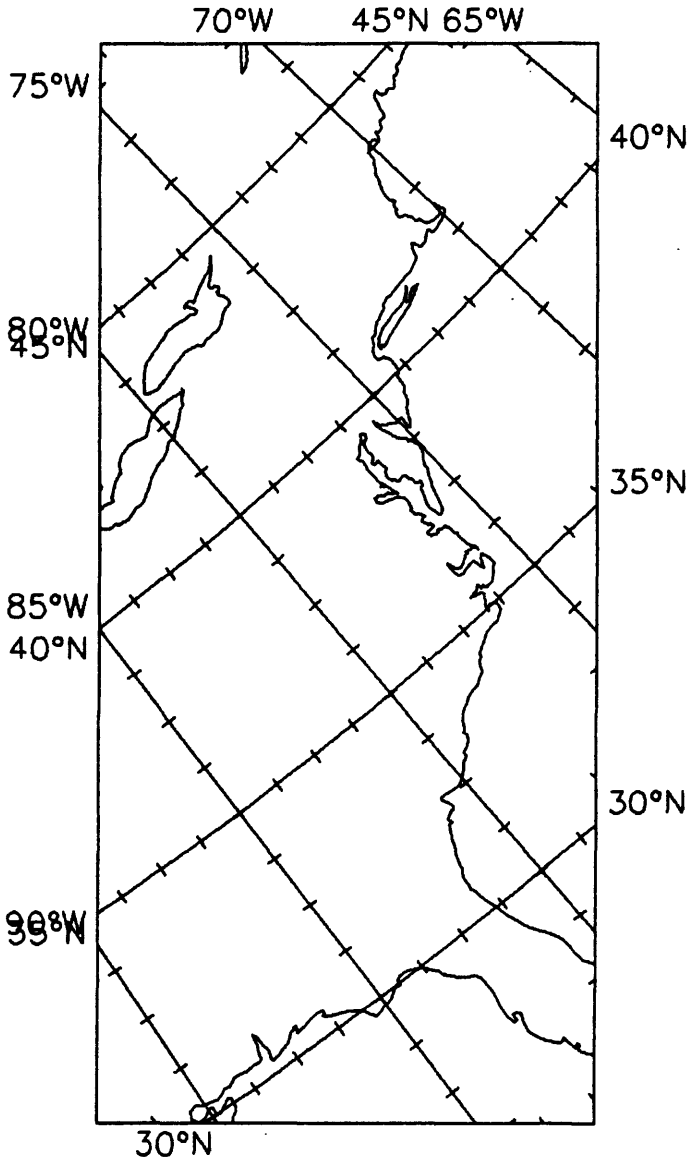


Figure 5. Grid and annotation of rotated data partition



2.4 The legend program

The legend program is used to generate map legend overlays. Legends consist of a scale bar(s), character annotation such as titles, descriptions, etc., and lines that may enclose the various parts of the legend and/or its components as well as other parts of the graphic, including the map and/or data window. Because the lines of the enclosing legend boundaries are drawn from specified point to point, the boundaries can take any desired shape. However, features are provided that can be used to maintain parallelism with map sheet or data window boundaries.

The various options of legend can be repeated as often as desired within one execution, thereby allowing composition of complete legends in one pass. Or, if the user prefers, he may chose to generate a series of legend overlay files by executing legend for each component of the map legend.

It is well for the user to note the sizes of the various windows that were established during execution of mapdef. In this way, measurement and placement of map legend components is simplified.

2.4.1 Synopsis

```
legend [ -moi [args]] file[s]
```

2.4.2 Options and descriptions

There are four legend runline options; -m, -o, -i, and file[s]. They can be in any order on the runline.

The following graphics options and their associated control parameters only appear in the control file[s]. Except for the -t and -L options, all other options may be grouped in any order provided that their respective arguments are in the same order.

-f font
: The -f (font) option is used to specify the graphics system font, font, to be employed (cf., APPENDIX III, The complete set of MAPGEN fonts). The system default font, -sr, can be selected either by name or by entering a dash (-) for font.

-s size
: The -s (size) option is used to select the nominal character size, size, of the selected font in centimeters.

-l leading

The -l (leading) (pronounced "ledding") option permits selection of the leading (i.e., spacing) between multiple lines of character annotation. Leading is expressed in centimeters.

-x coord

The -x option is used to set the x-axis position coord, in centimeters, as the base for subsequent graphic options. The measurement of -x is relative to the current region selection (cf., the -w option). To facilitate positioning within the current region, two symbols may be used to prefix coord; a right arrow (>) or a stroke (|), signifying that the measurement is to made relative to the right or middle, respectively, of the horizontal axis of the region. For example,

```
-x >-10
```

means that the x position is 10 centimeters to the left of the right hand edge of the region. If no symbol is used, it is assumed that the measurement is relative to the left side of the region.

-y coord

The -y option is syntactically identical to the -x option except that positioning refers to distance along the y-axis of the current region, and the right arrow (>) and stroke (|) refer to the top and middle of the vertical axis of the current region.

For example,

```
-xy 0 |
```

positions the base of further character plotting half way up the left side of the current region.

-w region

The -w (window) option selects one of the two basic regions of the map sheet that will be referred to as the current region; the principial map sheet or the data window. Region is designated as p or d to correspond with the the principal map sheet or the the data window.

The default region is p.

-b size,unit,rep[,left[,name]]

The -b (bar) option generates a scale bar. The

position of the bar on the map is determined from the previously selected -x and -y options that fix the position of the bottom of the 0 part of the bar. This also facilitates alignment of the 0's of multiple bar sets. Characters that annotate the bar are plotted using current character font and size attributes previously selected with the -f and -s options. The vertical height of the bar and its annotation are approximately three times the height of the selected font. The scale bar is numerically annotated above each major numeric subdivision. The name of the unit of measure (parenthetically listed below) is printed to the right of the scale bar and on the same level as the numeric annotation.

There are five arguments for this option; size, unit, rep, left and name. The format requires that they be entered in the above order, that they be separated by commas, and they they contain no whitespace. Size, unit, and rep are mandatory. Left and name are optional, and name can only be used if left has been selected. These relations are shown above in lexical form in the synoptic statement of this option.

size
is the number of map measurement units that compose one major scale bar interval to the right of 0 on the scale bar. For example, if the user wishes to let 100 nautical miles be the major interval, the first argument of -b is 100.

unit
is entered as the abbreviation of unit of measure that is to be used, and can be any of the following:

ft	(feet)
kf	(kilofeet)
m	(meters)
km	(kilometers)
yd	(yards)
ky	(kiloyards)
mi	(statute miles)
kn	(nautical miles)

If some other unit of measure is desired, the number of these measures in a scale bar unit must be converted (manually) to meters. This metric conversion number must then be used as the unit argument.

rep
is the number of times the basic unit is repeated to

right of the 0 on the scale bar.

left
is the optional argument that sets the number of subdivisions of one major scale bar unit to the left of 0 on the scale bar. For example, if the major unit of scale bar measure is 100 nautical miles, entering a value of 10 for this argument will cause a single unit of 100 nautical miles to be drawn to the left of 0, and this unit will be divided into 10 parts.

name
is the optional annotation identifying the units of scale bar measure. This is only used if the units of measure are not from the above list.

-d
The -d (scale display) option causes the scale fraction to be printed at the present coordinates (i.e. -x and -y) and at the present character size (-s) in the present font (-f). Keep in mind that these parameters can be reset any number of times in the control parameter string.

-j opt
The -j (justify) option causes subsequent character annotation to be left, right, or center justified to the current posting position (-x, -y). The opt argument can be either l, r, or c to correspond with left, right, or center, respectively. This option has no effect on the placement of the scale bar.

-t
The -t (text) option indicates that all lines following the option are to be considered text that will be plotted relative to the current posting position (-x, -y). A a period (.) in the first character position of a record must be used to terminate the text.

This option should not be used on the same control line as the -L option.

-r ang
The -r (rotate) option rotates character plotting ang degrees counterclockwise from the positive x direction.

-p pen
The -p (pen) option selects the number of the mechanical pen, pen, to be used in subsequent plotting of all features except lines generated by the -L option (below).

-L pen[,mask,size]

The -L (Lines) option drafts lines with the mandatory mechanical pen number, pen. This pen applies only to drafting done with the -L option. Coordinates defining the trace of the line to be drafted must immediately follow the option declaration, and must be in the form

x y

with one coordinate pair per control parameter line. Coordinates are expressed as in -x and -y (above), and are relative to the boundaries of the current region (cf., -w, above). A period (.) in the first character position of a record terminates the string of coordinates.

The dash pattern mask and dashed-line component length size are used for dashed-line plotting where mask is a hexadecimal number representing a 16-bit dash pattern where each binary digit that is equal to 1 is a line segment of length size. Size is in centimeters.

2.4.3 Example

The following example demonstrates the various features of legend. The results of the various options are shown in Figure 6. In order to simplify the presentation of the features in a map graphic, the original map definition file mg.defl was rescaled to a margin of 5 centimeters on all sides of the data window. Also, the original grid was changed to major intervals of 10 degrees each, with one tick mark in the center of each interval. Obviously, because of the redefinition of the map definition file, the grid and coastline overlays were regenerated.

The commented grid control file for Figure 6 is as follows:

```
-pi 10  -mi 10  #Major interval for parallels & meridians is 10 deg
-pj 2   -mj 2   #There are 2 intervals between major grid lines
-pv .2  -mv .2  #Tick size is 0.2 centimeters.
-s .5           #Character annotation size is 0.5 cm.
-d .5           #Grid annotation is offset 0.5 cm. from lines.
-a tlrb         #Annotate the top, left, right and bottom sides.
```

Three separate commented legend control files were used for the features in Figure 6, and each of these produced a separate legend overlay. The first control file produces the scale bar and data window boundary, and is as follows:

```
-w d # Select the data window
-L 1 # Draw a line using pen #1
> Ø  # Start drawing from the right hand edge at the bottom
> >  # Continue to the right edge on the top
Ø >  # Continue to the left edge at the top
Ø Ø  # Continue to the left eadge at the bottom
> Ø  # Continue to the right edge at the bottom
.    # Close the line.
-fs  - .6       # font = default, char. size = .6
-xy 4 -3        # measure from 4,-3
-b 1ØØ,kn,3,5  # Scale bar, 1ØØ nm/unit, 3 units, 5 ints. left of
```

The next legend control file is used to define the map boundary with both solid and dashed lines.

```
-w m          #Select the map window
-L 1,Ø x6666,1 #Draw line, pen #1, dash pattern=Ø x6666, 1 cm. long
1 1           #Begin line at 1 cm. from left, 1 cm. up
>-1 1         #Continue to 1 cm. from right edge, 1 cm. up
>-1 >-1       #Continue to 1 cm. from right, 1 cm. from top
1 >-1         #Continue to 1 cm. from left, 1 cm. from top
1 1           #Return to starting point
.             #Close line
-L 1      #Draw a solid line (same window, same pen)
Ø Ø.1     #Begin at left edge, slightly above bottom
> Ø.1     #Continue to right edge, slightly above bottom
> >       #Continue to right edge, top
Ø >       #Continue to left edge, top
Ø Ø.1     #Return to origin
.         #Close line
```

The final legend control file generates the map title and rotates and places the word form of the scale fraction.

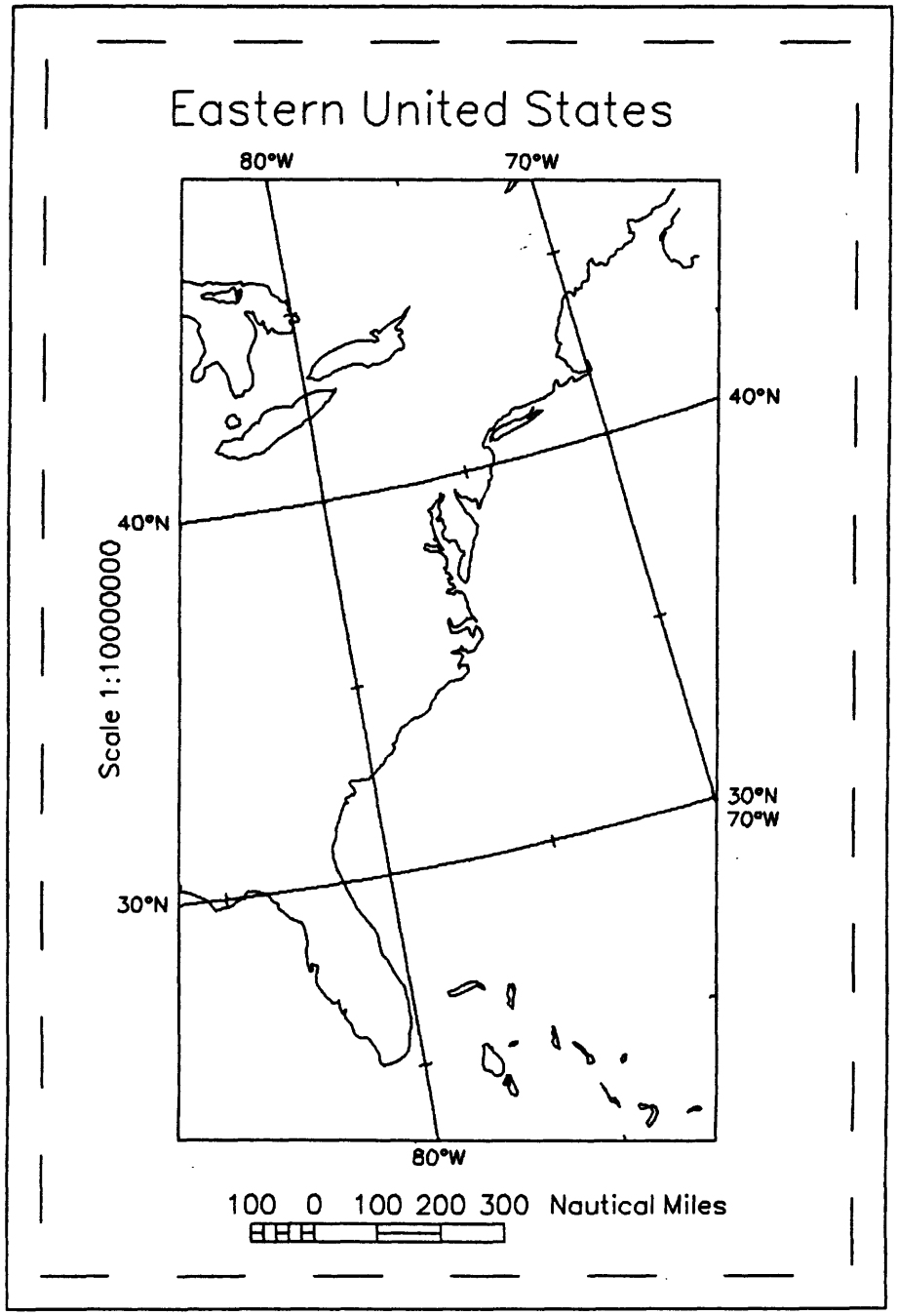
```
-s 1    #Char. size = 1 cm.
-f -    #Default to system font
-w m    #Select the map region
-x 5    #x start is 5 cm. from left
-y >-3 #y start is 3 cm. from top
-j 1    #Left justify text to start position
-t      #Subsequent line(s) are text to be posted at x, y
Eastern United States
.       #End of text
-r 90   #rotate text 90 degrees
-xy 3 |         #Set new x, y to 3, and half way up
-s .6   #New char. size = 0.6 cm.
-j c    #Center justify the following text
-d      #Print the scale as text
```

Since three overlays were desired, legend was executed three times as follows:

```
legend -mo mg.def1 le01.ov usleg1
legend -mo mg.def1 le02.ov usleg2
legend -mo mg.def1 le03.ov usleg3
```

where mg.def1 is the map definition file, the *.ov files are the overlays, and the us* files are the control parameter files.

Figure 6. Data partition with annotated legend and grid



2.5 The lines program

Lines is a MAPGEN program that draws lines, plots symbols, and posts character string annotation at points. In general, the majority of work to be done by lines should be line drawing with a minimum of symbol plotting or character string posting. This is because the computing overhead in line drawing makes the posting and/or plotting inefficient. For heavily post and/or plot bound overlays, the points program is recommended.

The most frequent use of lines will probably be with data files containing the sequential coordinates of data capture positions. Other data (for plotting and/or posting) in the file may contain variables that the user wishes to use as annotation. In these cases, the annotation should best be left to points and only the line aspects of the data be treated with lines.

In any case, the user will be required to specify the coordinate data fields and the fields containing annotation information. As with other MAPGEN programs, character size, type font, annotation position, and mechanical pen number are necessary control parameters.

2.5.1 Synopsis

```
lines [ -moic [args]] [files]
```

2.5.2 Options and descriptions

There are five lines runline options; -m, -o, -i, -c and file[s]. They can be in any order on the runline.

-c string
: The -c (character string) option permits runline inclusion of graphics options where string is the ordered option and argument list. Options include all of those listed below. If there is more than one option or embedded blanks, string must be enclosed in quotation marks (" ") or apostrophes (' ').

The following graphics options and their associated control parameters may only appear in the control file[s], or in the -c runline field. Control parameters in any file[s] must be on lines that have a pound sign (#) in the first character position of the line.

There are three distinct modes of lines operation: symbol plotting, character string posting, and line drawing. These operations are referred to in the following options by the

characters s, c, and l, respectively. It minimizes possible confusion attendant to selection of options if the user keeps these distinctions in mind.

-b

The -b (break) option causes line drawing to be discontinued at the first data point preceding the option, and to begin again at the first data point after the option. Thus, the user must insert the -b option throughout the data wherever breaks in lines are desired.

Or, if each of a number of separate lines is in a different input data file, a -b control option must be inserted between the files. If not, they will all be drawn continuously.

DO NOT FORGET that -b is a control option, and that it must occur on a control line that has a pound sign (#) as the first character of the line.

-c

When used as a solitary option, -c (character string) indicates that subsequent selected data fields are to be posted. These fields are identified using the -f option discussed below.

-sc arg

The -sc option is used to select the symbol to be used for symbol plotting where arg can be either an ASCII symbol or the numeric designation of a special symbol (cf. APPENDIX III, The complete set of MAPGEN fonts).

-d m[,n]

The -d option is used to designate the fields containing longitude and latitude data. m is the number of the longitude field, and n is the number of the latitude field. If n is omitted, it is assumed to be m+1.

If the option is omitted, it is assumed that longitude and latitude are fields 2 and 1, respectively. Note that if m and n are used, they must be separated by a comma and cannot contain whitespace.

In addition to the field designation syntax specified above, syntax for sub-field formatting is presented in APPENDIX II, Program documentation for all MAPGEN programs.

-ld

The -ld (line dash) option selects the dashed-line mode

for line drawing.

-f n[,...,m]
The -f (fields) option is used to specify the number(s) of the data field(s) to be posted. The format for designation of the fields requires that the first field number, n, be followed by any subsequent field numbers, (through m), and that all numbers be separated by commas. Whitespace is not allowed in the string of field numbers. The sequence in which the field numbers is entered is the sequence in which they will be posted, ONE FIELD PER LINE.

In addition to the field designation syntax specified above, syntax for sub-field formatting is presented in APPENDIX II, Program documentation for all MAPGEN programs.

-[s|c]f name
The -[s|c]f (symbol or character string font) option is used to select the font for symbol plotting or character string posting. Name is the designation of the desired font (cf. APPENDIX III, The complete set of MAPGEN fonts). The system default font, -sr, can be selected either by name or by entering a dash (-) for name.

-j chr
The -j (justification) option selects the justification mode for posting character string data where chr can be l (left), r (right), or c (center). Default justification is l.

-l
When used as a solitary option, -l (line) is used to indicate that line drawing is to commence with subsequent data values.

-cl n
The -cl (character string leading) option is used to specify the interline leading (spacing) where n/8 is the desired leading. Normally a value of n=12 (a factor of 1.5 times the character size) works well. If not specified for multiple fields, the posting will overplot.

-ll
The -ll option changes any previously established line drawing mode to solid line drawing. Solid line mode is the lines default.

-lm mask
The -m (mask) option is used to set the dashed-line mask where mask is a hexadecimal number representing a 16-bit dash pattern where each binary digit equal to 1 is a line segment of length size. Size is the argument for the option -[s|c|l]s.

-p n
The -p (pen) option is used to select mechanical pen number n.

-[s|c|l]q
The -[s|c|l]q (symbol, or character string, or line, quit) option is used to discontinue symbol plotting, character string posting, or line drawing.

-[s|c]r ang
The -[s|c]r (symbol or character string rotate) option sets the number of counterclockwise degrees, ang, that the symbol or character string will be rotated about a geographic point. If ang is either of the characters o or p, posting or plotting will be either orthogonal or parallel, respectively, to the track of the data points.

-s
When used as a solitary option, -s (symbol) indicates that symbol plotting is to begin with subsequent data values.

-[s|c|l]s size
The -[s|c|l]s (symbol, or character, or dashed-line interval, size) option sets the size, size, in centimeters, of symbols, characters, or dashed-line intervals, respectively.

-t c
The -t (tab) option is used to designate the delimiter, c, between data fields in data records. Note that some special characters may require quotes. The default is (tab).

-cx cm
The -cx option is used to designate the posting string x-axis offset, cm, in centimeters from the geographic coordinate position of the data point.

-cy cm
The -cy option is used to designate the posting string y-axis offset, cm, in centimeters from the geographic coordinate position of the data point.

-z chr
The -z option is used to replace the pound sign (#), which indicates a control parameter or comment, with chr.

2.5.3 Example

The following commented control file li.ex2 was used to compose a solid-line trace of coordinate data shown in Figure 8. The data are in a file named bbb which was extracted from a local library of trackline tapes. In order to prepare the data for plotting, a sed filter was used to extract every fourth point, and vi was used to substitute a tab for the original multiple space field delimiters.

Notice the options related to character definition, viz., -c, -f, -cf, -cr, -cs, and -cx. Obviously, if posting was not desired, the line trace could have been effected with only two options, viz., -l, and -d. If the original coordinate data fields were reversed, only the -l option would have been necessary.

File name: li.ex2

```
#-c      # begin posting subsequent data fields
#-l      # begin line plotting at subsequent data fields
#-d 2,1 # longitude is field 2, latitude is field 1
#-f 3    # post field 3
#-cf -   # default system posting font (-sr)
#-cr o   # post annotation orthogonal to line
#-cs 0.5 # character size is 0.5 cm.
#-cx 0.5 # offset posting 0.5 cm.
```

The runline used to generate the solid-line data-trace metagraphic overlay file used in the composition of Figure 8 is as follows:

```
lines -mo f8.def ov8.li2 li.ex2 bbb
```

where f8.def is the previously created map definition file, ov8.li2 is the metagraphic overlay file to be generated, ex.li2 is the above control file, and bbb is the data file.

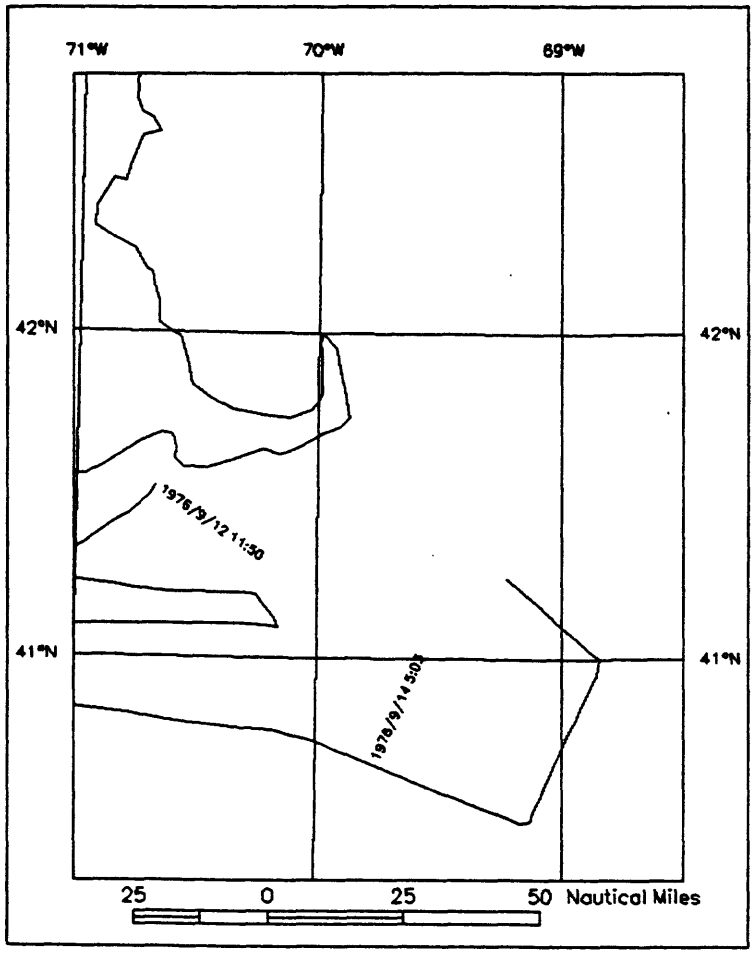
The coastline, grid and legend metagraphic overlay files were generated previously, and are all named with the prefix ov8. In this way, when all overlay files are required for a final composite, they can be referenced by the declaration ov8*, thereby avoiding entry of each overlay file name and the attendant high likelihood of keying errors.

The MAPGEN runline used to create the total composite in Figure 8 is as follows:

```
preview -d ge -m f8.def ov8* | geplot | lpr &
```

where the ge plotting device is declared first, followed by the map definition file and the aggregate of ov8 files. Next, the output from preview is pipelined into geplot, which is a local program used for rasterizing. After this, the output from geplot is pipelined to the program lpr for output on the plotting printer. The ampersand (&) is used to free the user's terminal for immediate use on other computing activities.

Figure 7. Annotated solid-line track line plot



In the following example, lines is used to generate a dashed-line trace of a series of data coordinates, and to post any information in the data file that is relevant to the points. This is shown in Figure 9.

The file ex.li, below, is the commented lines control file used to generate the desired metagraphic overlay.

File name: ex.li

```
#-c              # begin posting subsequent data fields
#-l              # begin line plotting at subsequent data fields
#-d 2,1          # longitude is field 2, latitude is field 1
#-f 3            # post field 3
#-cf -           # default system posting font (-sr)
#-cr o           # post annotation orthogonal to line
#-cs Ø.5         # character size is Ø.5 cm.
#-cx Ø.5         # offset posting Ø.5 cm.
#-lm Øx6666      # dash mask in hex.
#-ls Ø.Ø5        # dash size interval is Ø.Ø5 cm.
#-ld             # select dashed-line
```

The runline for lines is as follows:

```
lines -mo f8.def ov8.li ex.li bbb
```

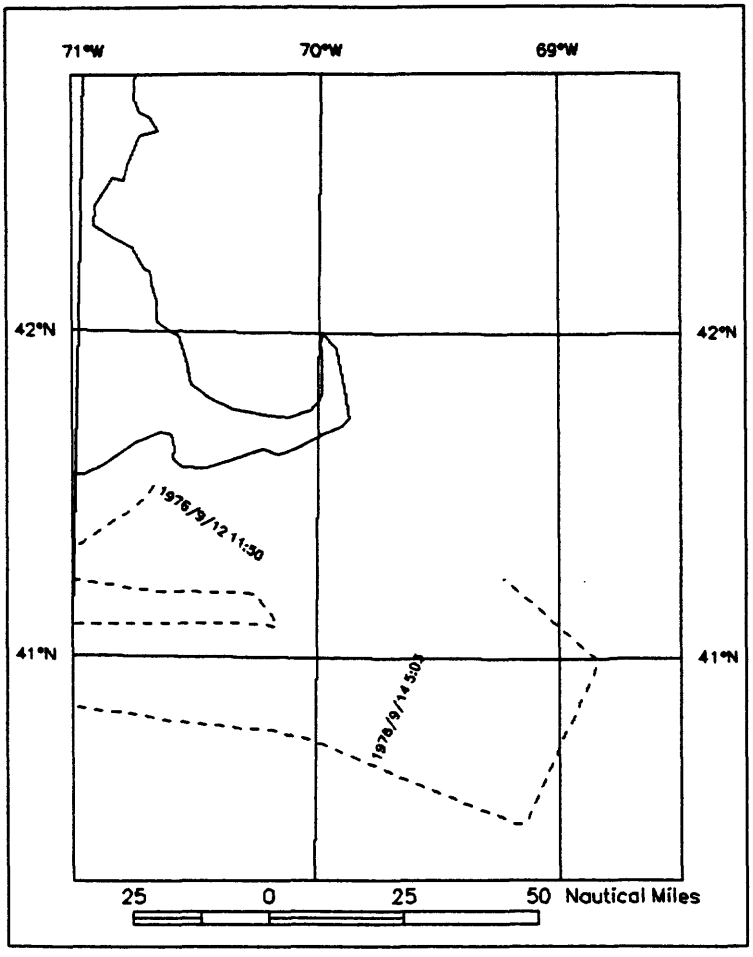
where f8.def is the map definition file, ov8.li is the metagraphic overlay file, ex.li is the above control file, and bbb is the data file. The map definition, coastline, grid and legend metagraphic overlay files were all previously computed and named with the prefix ov8.

The runline used to create the graphic is:

```
preview -d ge -m f8.def ov8* | geplot | lpr &
```

One lines metagraphic overlay file was created for this example, and one was created for the example shown in Figure 8. Although the preview runlines for both Figures 8 and 9 are identical, the lines output for Figure 9 was suppressed (by file renaming) for the plotting of Figure 8, and conversely.

Figure 8. Annotated dashed-line track line plot



2.6 The points program

The points program is used to generate metagraphic overlays of plotted symbols or character string annotation at points defined by geographic coordinates.

2.6.1 Synopsis

```
points [ -moic [args]] [files]
```

2.6.2 Options and descriptions

There are five points runline options; -m, -o, -i, -c and file[s]. They can be in any order on the runline.

-c string
: The -c (character string) option permits runline inclusion of graphics options where string is the ordered option and argument list. Options include all of those listed below. If there is more than one option or embedded blanks, string must be enclosed in quotation marks (" ") or apostrophes (' ').

The following graphics options and their associated control parameters may only appear in the control file[s], or in the -c runline field. Control parameters in any file[s] must have a pound sign (#) in the first character position of the lines on which they appear.

There are two distinct modes of points operation; symbol plotting and character string posting. These operations are referred to in the following options by the characters s and c, respectively. It minimizes possible confusion attendant to selection of options if the user keeps these distinctions in mind.

-c
: When used as a solitary option, -c (character string) indicates that the subsequent selected data fields are to be posted. These fields are identified with the -f option (discussed below).

-sc arg
: The -sc option is used to select the symbol to be used for point plotting where arg can be either an ASCII symbol or the numeric designation of a special symbol (cf. APPENDIX III, The complete set of MAPGEN fonts).

-d m[,n]
: The -d option is used to designate the fields containing longitude and latitude data. m is the number of

the longitude field, and n is the number of the latitude field. If n is omitted, it is assumed to be m+1.

If the option is omitted, it is assumed that longitude and latitude are fields 2 and 1, respectively. Note that if m and n are used, they must be separated by a comma and cannot contain whitespace.

In addition to the field designation syntax specified above, syntax for sub-field formatting is presented in APPENDIX II, Program documentation for all MAPGEN programs.

-f n[,...,m]

The -f (fields) option is used to specify the number(s) of the data field(s) to be posted. The format for designation of the fields requires that the first field number, n, be followed by any subsequent field numbers through m, and that all numbers be separated by commas. Whitespace is not allowed in the string of field numbers. The sequence in which the field numbers is entered is the sequence in which they will be posted, one field per line.

In addition to the field designation syntax specified above, syntax for sub-field formatting is presented in APPENDIX II, Program documentation for all MAPGEN programs.

-[s|c]f name

The [s|c]f (symbol or character string font) option is used to select the font for symbol plotting or character string posting. Name is the designation of the desired font (cf. APPENDIX III, The complete set of MAPGEN fonts). The system default font, -sr, can be invoked either by name or by entering a dash (-) for name.

-j chr

The -j (justification) option selects the justification mode for posting character string data where chr can be l (left), r (right), or c (center). Default justification is l.

-l cm

The -l (leading) option is used to specify the interline leading (spacing), cm, in centimeters. If not specified for multiple fields, the posting will overplot.

-p n
The -p (pen) option is used to select mechanical pen number, n.

-[s|c]q
The -[s|c]q (symbol or character string quit) option is used to discontinue symbol plotting or character string posting.

-[s|c]r ang
The -[s|c]r (symbol or character string rotate) option sets the number of counterclockwise degrees, ang, that the symbol or character string will be rotated about the geographic point. Note that orthogonal or parallel to line trace posting or plotting must be done using lines.

-s
When used as a solitary option, -s (symbol) indicates that symbol plotting is to begin with subsequent data values.

-[s|c]s size
The -[s|c]s (symbol or character size) option sets the size, size, in centimeters, of symbols or characters.

-t c
The -t (tab) option is used to designate the delimiter, c, between data fields in data records. Note that some special characters may require quotation marks. The default is (tab).

-cx cm
The -cx option is used to designate the posting string x-axis offset, cm, in centimeters from the geographic coordinate position of the data point.

-cy cm
The -cy option is used to designate the posting string y-axis offset, cm, in centimeters from the geographic coordinate position of the data point.

-z chr
The -z option is used to replace the normal pound sign (#), which indicates a control sign or comment, with the replacement character chr.

2.6.3 Example

The example shown in Figure 9 illustrates how points is used to plot and annotate data points.

The following is the commented points control file, ex.po.

File name: ex.po

```
#-sc 3      # point symbol is a circle (#3 of -sr)
#-d 2,1     # longitude is field 2, latitude is field 1
#-sf -      # default to system font (-sr) for symbols
#-p 1       # mechanical pen #1
#-ss Ø.3    # size of symbol is Ø.3 cm.
#-f 3       # field #3 is to posted
#-cs .5     # size of characters is Ø.5 cm.
#-cf -      # default to system font (-sr) for characters
#-c         # begin character posting with 1st subsequent data recor
#-s         # begin symbol posting with 1st subsequent data record
#-cx 1      # offset character posting 1 cm. in the x direction
```

The following is the points runline:

```
points -mo po.def ov7.po ex.po bbb
```

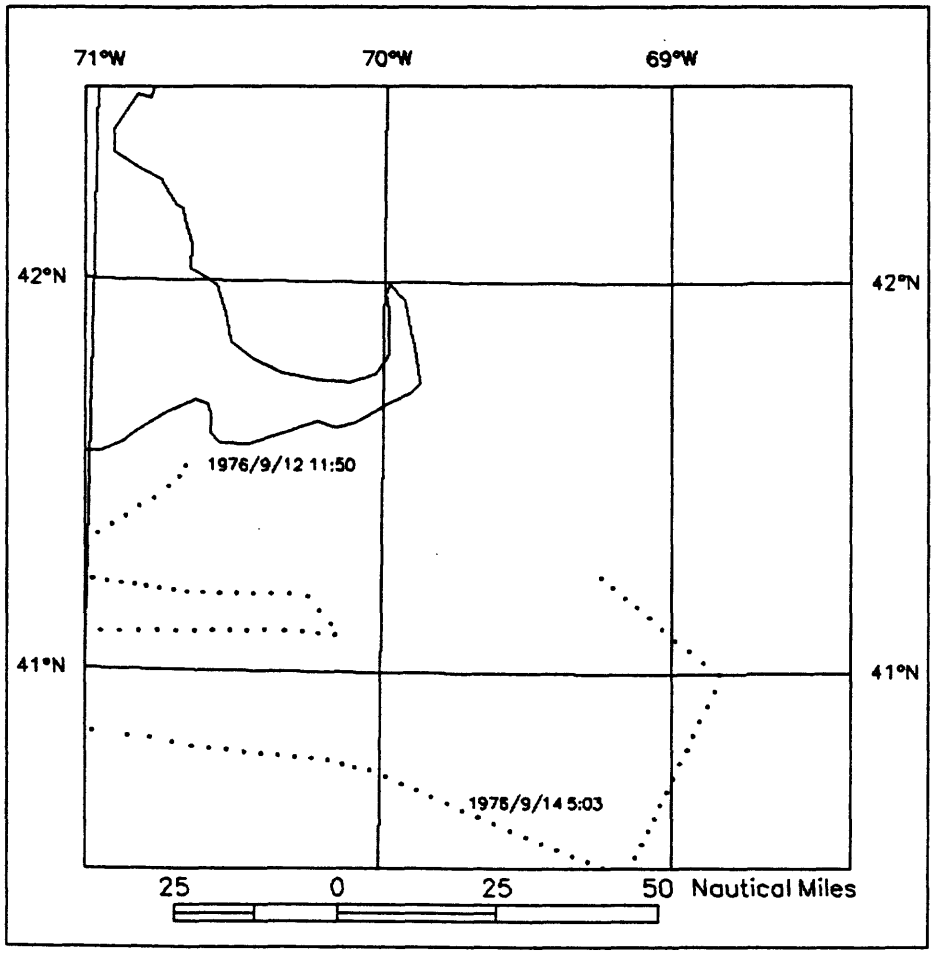
where po.def and ov7.po are the map definition and overlay file names, ex.po is the above control file, and bbb is the data file.

Once the lines metagraphic overlay file was created, all overlay files needed to compose Figure 9 were aggregated using the ov7* construct, and were plotted using the following runline:

```
preview -d ge -m po.def ov7* | geplot | lpr &
```

where ge is the selected plotting device, po.def is the name of the map definition file, ov7* is the overlay file aggregate. This output is pipelined into the geplot program for rasterizing and preparation for final output. Finally, the program lpr is used to output the graphic to a plotting printer. The ampersand (&) frees the user's terminal for use on other computing activities.

Figure 9. Annotated point plot



2.7 The coast program

The coast program generates a metagraphic overlay file of coastline and/or similar line data from compressed line data files. Typically these data consist of coastlines, political boundaries, rivers of various classes, etc.

The names of the system files containing coastlines and similar or related data should be obtained from the local system manager.

2.7.1 Synopsis

```
coast [ -mosci [args]] [files]
```

2.7.2 Options and descriptions

There are six coast runline options; -m, -o, -s, -c, -i and file[s]. They can be in any order on the runline.

-s file
: The -s option permits the entry of graphic control options from the file, file. This is the only way, other than the -c option (below), to enter control options for coastline data.

-c string
: The -c (character string) option permits runline inclusion of graphics options where string is the ordered option and argument list. Options include all of those listed below. If there is more than one option or embedded blanks, string must be enclosed in quotation marks (" ") or apostrophes (' ').

The following graphics options and their associated control parameters may only appear in the -s control file, or in the -c runline field.

-f ns[-ne][,ns2[-ne2]...]
: The -f (feature code) selection option permits selection of only those feature codes that are of relevance to the map at hand. For example, one may chose to ignore political boundaries but select lakes, class I rivers, and coastlines.

  In this option ns represents the lower number of a continuous range of numbers to be selected, -ne is the upper limit of the range. For example,

```
-f 10-13
```

represents the feature codes 10 through 13. There can be any number of repetitions of the ns[-ne] pairs. Also, ns can be used by itself to represent a single feature code. For example,

```
-f 10-12,15,21-23
```

represents the codes 10 through 12, 15, and 21 through 23. Number range pairs and single values must be separated by commas, and no whitespace is allowed.

If this option is not used, the default is ALL feature codes. Cf. APPENDIX IV, Feature codes for World Data Bank II.

-d size,mask

The -d (dashed line) option is used to specify that dashed lines will be used with a component size, size, in centimeters, and with a dashed-line pattern defined by mask. Size and mask must be separated by a comma and no whitespace is allowed.

-m n

The -m (mechanical pen) option sets the mechanical pen number, n, that will be used to draw the coastline features.

2.7.3 Example

The file /usr/coast/W_I_500 was used as a coastline data source file for the composition of the maps in Figures 1-9 of this manual. In every case, only the coast runline, sans control files, was needed to generate the overlays. Because the execution of coast is so straightforward, the same coast runline presented below was used to generate the coastlines in Figures 2-6, all of which use the same map definition file. For convenience in composing the different figures, the name of the overlay file was occasionally changed.

```
coast -mo mg.defl out.ov /usr/coast/W_I_500
```

In this case, mg.defl is the map definition file, out.ov is the output metagraphic overlay file, and /usr/coast/W_I_500 is the coastline data source file. No feature codes were needed, and the default solid line was selected.

2.8 The preview program

Preview allows the user to graphically portray any combination of metagraphic overlays relevant to a given map definition file. The program provides a means of rapidly reviewing map components, separately or in concert.

Most use of preview's use is expected to be on the user's graphics terminal, which is the most rapid and convenient method to peruse various overlays. The program automatically scales the graphics such that at least one axis of the graphic fills the screen of the particular terminal in use. The originally intended map design scale may not be true, but the user can certainly see the placement of features, line types, posting and plotting.

One can also direct the output of preview to devices other than the user's terminal. In these cases, preview scales the graphic as mentioned above except when the output device has the same number of plotter counts per centimeter as specified in mapdef option -k. In this case, the map will be to true scale.

2.8.1 Synopsis

```
preview [plotter_options] -m file[s]
```

2.8.2 Options and descriptions

There are three preview runline options: plotter_options, -m, and file[s]. These must occur in the above sequence.

[plotter_options]
: Any of the options for the program plotter may be used. These include such features as axis rotation, raster conversion, etc. (Cf., the program plotter.)

file[s]
: The file[s] option allows the user to declare the metagraphic overlay files to be displayed. The user should take care to ensure that the overlay files were generated using the previously named map definition file.

2.8.3 Example

For examples of preview, consider Figure 6 from the standpoints of local terminal display and display on another device in the system. Three overlay files were generated in legend; le01.ov, le02.ov, and le03.ov. These contained the scale bar and data window boundary, the solid line and dashed map boundaries, and the map title and character

string annotation. The coastline overlay file, co01.ov, was generated in coast, and the grid overlay file, gr01.ov, was generated in grid.

Using the above files, the following preview control line will display Figure 6 on the terminal;

```
preview -m mg.defl *.ov
```

No plotter options are necessary to display the graphic on the user terminal.

The mandatory -m option is used to declare the name of the map definition file.

Notice that all of the overlay files had names ending in .ov. By using the * notation to refer to any characters in front of the .ov, all files ending in .ov are automatically queued for display by preview. In a more laborious way, each of these files could have been named separately in order to achieve the same result.

In the case where Figure 6 was drafted on a raster-type hard copy plotting device, plotter commands are necessary. The following run line was used;

```
preview -rd ge -m mg.defl *.ov | geplot | lpr &
```

where the -r and -d options of plotter are used to rotate the plot (to take advantage of the long direction of the plotter), and to identify ge to plotter as the name of the local output device. Note that the combination -rd ge could also be expressed -r -d ge. The rest of the preview part of the runline is exactly as above.

The vertical stroke (|) indicates that the output of preview is to be pipelined into a program called geplot. This program prepares the data for output to the raster-type ge device declared in preview.

Finally, the output of geplot is pipelined directly into lpr which is the system routine for outputting the plot. The ampersand (&) is a runline terminator that returns control directly to the terminal. Each runline process is numbered separately so the user can trace their progress in the system as they are being processed. At the same time, the user has full use of the system from his terminal.

2.9 The plotter program

Plotter is the principal program used to draft MAPGEN metagraphic overlay files. Basically, plotter interprets the metagraphic stream and manipulates the data into a format suitable for the selected output device. Any graphics device in the system can be utilized as an output mechanism.

The recommended plotter output scenario is to compose a shell script containing the plotter runline(s), and to execute the shell script at a convenient time.

2.9.1 Synopsis

```
plotter [ -doris] file[s]
```

2.9.2 Options and descriptions

There are six plotter runline options: -d, -o, -r, -i, -s, and file[s]. These can be grouped in any order as long as their respective arguments are in the same order. For example;

```
plotter -do c970 /dev/tty03 -s 0.5
```

shows the -d and -o option grouping followed by their respective arguments c970 (which is the output device name) and /dev/tty03 (which is the name of destination of the plot). Next, the -s (scale) option is followed by the desired scale factor, 0.5.

-d [name]

The -d (device) option specifies the device, name, that will be used to draft the graphic. Since there is a large variety of devices throughout the graphics community, any one installation would most likely have its own unique set and, therefore, its own device name acronyms. In this regard, it is suggested that the user consult his local system manager for the name list in his own computer laboratory.

If name is omitted, plotter assumes the TERM (a UNIX declaration) entry of the processes' environment. This means that the TERM name of the user's terminal becomes the designated output device name. Obviously, one would hope that the terminal is appropriately designated. If the user's terminal is not an implemented device, plotter will still function as if the output device were TERM and the results will be unpredictable.

-o output

The -o (output file) option specifies any non-standard-out destination, output, of plotter. For example, if plotter ABC with destination designation /dev/ttyh is the intended destination of the output from a given pass through plotter, /dev/ttyh would be the requisite argument for -o. This means that the output from plotter would be fed directly to /dev/ttyh, and thereby be plotted on plotter ABC. The same rationale applies to writing on magnetic tape, writing to files, and writing back to the user's terminal. The user should ask the local system manager for a list of the various destinations in the local system.

-o should be used when the output device is not a terminal. When -o is omitted, plotter output is directed to standard-out, and can be pipelined to some other program (such as geplot) for pre-display preparation.

-r

The -r (rotate) option is used to rotate the entire graphic fully 90 degrees. This is effective when the graphic is to be optimally accommodated by the long axis of the plotting device. In instances where the scale and orientation of the graphic will not fit on a particular device, -r is essential if the graphic is is to be in one piece as opposed to multiple strips.

-i m.n

The -i option is never used in applications. It is a useful tool in a programming environment, and to that end the reader is referred to APPENDIX II, Program documentation for all MAPGEN programs, plotter.

-s scale

The -s (scale) option is the mechanism used to rescale the coordinates of the input metagraphic overlay data. Scale is a real number by which the coordinates are multiplied. For example, -s 2 means that the coordinate axes will be multiplied by 2, thereby doubling the size of each axis and quadrupling the total plot area.

file[s]

The file[s] option is the list of metagraphic overlay files to be plotted. The files are processed in order from left to right. A solitary dash (-) instead of a file name indicates that input is from standard in.

3. APPENDIX I. Supplementary notes on projection parameters

by

Gerald I. Evenden

1. Introduction.

The following sections contain tabulations of the parameters associated with each of the cartographic projections currently supported by program proj. In certain situations, particularly where proj is employed by program mapdef for mapping purposes, many of the parameters can be ignored and omitted (e.g., false northing and easting, central parallel and meridian). In the case of ellipsoid parameters, Clark's 1866 default values are suitable for most North American applications. Default parameters for standard parallels for Alber's Equal Area and Lambert's Conformal Conic projection are based on standards for maps of the conterminous United States.

In all other situations, the user must be familiar with the requirements of the particular projection when determining appropriate values as well as the basic characteristics and limitations of the projections. If there are questions, the user should refer to standard cartographic references or the local cartographic guru.

In addition to parameter tabulation there are usage examples for each of the projections. In most cases the example values are based upon parameters employed in Appendix A of Map Projections Used by the U. S. Geological Survey (Snyder, 1984, USGS Bulletin 1532).

4. APPENDIX II. Program documentation for all MAPGEN programs

The following program documentation is the official statement of syntax and protocol for all MAPGEN programs. The programs are described in the following order:

mapdef
grid
legend
lines
points
coast
preview
plotter
proj

4.0.1 CAVEAT

Because of the static nature of a printed document, the following documentation, although official, is only valid at the time of publication. For up-to-date versions of the programs as well as modifications, additions, and upgrades, the user should consult the author or the designated system librarian.

18. Van der Grinten projection.

Projection Parameters

Name	Default	Description
a	6370997.0 *	sphere radius.
lon_0	0 Deg.	Central meridian.
x_0	0 *	False easting.
y_0	0 *	False northing.

* - Units should be consistent. Values shown are in meters.

Examples:

The following is an forward and inverse projection example:

```
# do forward
proj +proj=vandg +a=1 +lon_0=85w -w "%.8f" <<EOF >forwd
160w            50s
EOF
# do inverse of previous forward
proj +proj=vandg +a=1 +lon_0=85w +inv \
    -w "%.7f" forwd >invrs
cat forwd invrs
-1.19541536    -0.99607334
-160.0000000   -50.0000002
```

Projection Notes

17. Universal Transverse Mercator projection.

Projection Parameters

Name	Default	Description
es	0.006768658 Clark 1866	Ellipsoid eccentricity squared. When assigned value is 0, spheroid evaluation is performed.
a	6378206.4 * (6370997.0)	Major ellipsoid axis or sphere radius (es = 0).
lon_0	0 Deg.	Central meridian.
lat_0	0 Deg.	Central parallel.

* - Values shown are in meters.

Examples:

The following is an example of forward and inverse transformation using the Clark 1866 spheroid:

```
# do forward
proj +proj=utm +lon_0=75w -w "%.1f" <<EOF >forwd
73d30w          40d30n
EOF
# do inverse of previous forward
proj +proj=utm +inv +lon_0=75w -w "%.8f" <forwd >invrs
cat forwd invrs
627106.5        4484124.4
-73.49999962    40.49999986
```

A forward and inverse projection example for a unit sphere:

```
# do forward
proj +proj=tmerc +lon_0=75w +es=0 +a=1 \
    -w "%.9f" <<EOF >forwd
73d30w          40d30n
EOF
# do inverse of previous forward
proj +proj=tmerc +inv +lon_0=75w +es=0 +a=1 \
    -w "%.8f" <forwd >invrs
cat forwd invrs
0.019907737     0.707027609
-73.50000001    40.50000002
```

16. Transverse Mercator projection.

Projection Parameters

Name	Default	Description
es	0.006768658 Clark 1866	Ellipsoid eccentricity squared. When assigned value is 0, spheroid evaluation is performed.
a	6378206.4 * (6370997.0)	Major ellipsoid axis or sphere radius (es = 0).
lon_0	0 Deg.	Central meridian.
lat_0	0 Deg.	Central parallel.
x_0	0 *	False easting.
y_0	0 *	False northing.
k	1.	Scale factor at central meridian.

* - Units should be consistent. Values shown are in meters.

Examples:

The following is an example of forward and inverse transformation using the Clark 1866 spheroid:

```
# do forward
proj +proj=tmerc +lon_0=75w +k=.9996 \
    -w "%.1f" <<EOF >forwd
73d30w          40d30n
EOF
# do inverse of previous forward
proj +proj=tmerc +inv +lon_0=75w +k=.9996 \
    -w "%.8f" <forwd >invrs
cat forwd invrs
127106.5        4484124.4
-73.49999962    40.49999986
```

A forward and inverse projection oblique aspect example for a sphere with unit radius:

```
# do forward
proj +proj=stere +lat_0=40n +lon_0=100w +a=1 \
    +es=0 -w "%.8f" <<EOF >forwd
75w             30n
EOF
# do inverse of previous results
proj +proj=stere +a=1 +es=0 +lat_0=40n +lon_0=100w \
    +inv -w "%.7f" forwd >invrs
cat forwd invrs
0.38072239      -0.12638018
-75.0000001     30.0000003
```

Polar aspect example with International ellipsoid and know scale factor at pole:

```
# do forward
proj +proj=stere +k=.994 +lat_0=90s +lon_0=100w \
    +a=6378388 +es=.00672267 -w "%.2f" <<EOF >forwd
150e            75s
EOF
# do inverse of previous results
proj +proj=stere +k=.994 +a=6378388 +es=.00672267 \
    +lat_0=90s +lon_0=100w +inv -w "%.7f" forwd >invrs
cat forwd invrs
-1573645.26     -572760.03
150.0000001     -75.0000000
```

Polar aspect example with International ellipsoid with specified latitude of true scale:

```
# do forward
proj +proj=stere +lat_ts=71s +lat_0=90s +lon_0=100w \
    +a=6378388 +es=.00672267 -w "%.2f" <<EOF >forwd
150e            75s
EOF
# do inverse of previous results
proj +proj=stere +lat_ts=71s +a=6378388 +es=.00672267 \
    +lat_0=90s +lon_0=100w +inv -w "%.7f" forwd >invrs
cat forwd invrs
-1540033.61     -560526.39
150.0000001     -75.0000000
```

15. Stereographic projection.

Projection Parameters

Name	Default	Description
es	0.006768658 Clark 1866	Ellipsoid eccentricity squared. When assigned value is 0, spheroid evaluation is performed.
a	6378206.4 * (6370997.0)	Major ellipsoid axis or sphere radius (es = 0).
lon_0	0 Deg.	Central meridian.
lat_0	0 Deg.	Central parallel.
x_0	0 *	False easting.
y_0	0 *	False northing.
lat_ts	0 *	Latitude of true scale. Polar aspect only (lat_0 = +/- 90).
k	1.	Scale factor. Ignored if lat_ts applicable.

* - Units should be consistent. Values shown are in meters.

Examples:

The following is an oblique aspect example of forward and inverse transformation using the Clark 1866 spheroid:

```
# do forward
proj +proj=stere +k=.9999 +lat_0=40n +lon_0=100w \
    <<EOF >forwd
90w             30n
EOF
# do inverse of previous results
proj +proj=stere +k=.9999 +lat_0=40n +lon_0=100w \
   +inv -w "%.7f" forwd >invrs
cat forwd invrs
971630.80       -1063049.27
-90.0000000     30.0000000
```

Projection Notes

14. Sinusoidal projection.

Projection Parameters

Name	Default	Description
a	6370997.0 *	Sphere radius.
lon_0	0 Deg.	Central meridian.
x_0	0 *	False easting.
y_0	0 *	False northing.

* - Units should be consistent. Values shown are in meters.

Examples:

The following is an forward and inverse projection example:

```
# do forward
proj +proj=sinu +a=1 +lon_0=90w -w "%.8f" <<EOF >forwd
75w            50s
EOF
# do inverse of previous results
proj +proj=sinu +a=1 +lon_0=90w +inv \
    -w "%.7f" forwd >invrs
cat forwd invrs
0.16828140     -0.87266463
-75.0000002    -50.0000002
```

A forward and inverse projection example for a sphere with unit radius:

```
# do forward
proj +proj=poly +lat_0=30n +lon_0=96w +es=0 +a=1 \
    -w "%.9f" <<EOF >forwd
75w            40n
EOF
# do inverse of previous forward
proj +proj=poly +inv +lat_0=30n +lon_0=96w +es=0 +a=1 \
    -w "%.8f" <forwd >invrs
cat forwd invrs
0.278179818    0.207454082
-75.00000000   40.00000000
```

13. Polyconic projection.

Projection Parameters

Name	Default	Description
es	0.006768658 Clark 1866	Ellipsoid eccentricity squared. When assigned value is 0, spheroid evaluation is performed.
a	6378206.4 * (6370997.0)	Major ellipsoid axis or sphere radius (es = 0).
lon_0	0 Deg.	Central meridian.
lat_0	0 Deg.	Central parallel.
x_0	0 *	False easting.
y_0	0 *	False northing.

* - Units should be consistent. Values shown are in meters.

Examples:

The following is an example of ellipsoidal forward and inverse transformation using the Clark 1866 spheroid:

```
# do forward
proj +proj=poly +lat_0=30n +lon_0=96w \
    -w "%.1f" <<EOF >forwd
75w             40n
EOF
# do inverse of previous forward
proj +proj=poly +inv +lat_0=30n +lon_0=96w \
    -w "%.8f" <forwd >invrs
cat forwd invrs
1776774.5       1319657.8
-75.00000034    40.00000045
```

Projection Notes

12. Orthographic projection.

Projection Parameters

Name	Default	Description
a	6370997.0 *	sphere radius.
lon_0	0 Deg.	Central meridian.
lat_0	0 Deg.	Central parallel.
x_0	0 *	False easting.
y_0	0 *	False northing.

* - Units should be consistent. Values shown are in meters.

Examples:

The following is an forward and inverse projection example:

```
# do forward
proj +proj=ortho +lat_0=40n +lon_0=100w +a=1 \
    -w "%.8f" <<EOF >forwd
110w            30n
EOF
# do inverse of previous results
proj +proj=ortho +a=1 +lat_0=40n +lon_0=100w +inv \
    -w "%.7f" forwd >invrs
cat forwd invrs
-0.15038373    -0.16519110
-109.9999998   30.0000002
```

Examples:

The following is an example of ellipsoidal forward and inverse transformation using the Clark 1866 spheroid:

```
# do forward
proj +proj=omerc +k=.9996 +lat_0=40 +lat_1=47d30 \
    +lon_1=122d18w +lat_2=25d42 +lon_2=80d12w \
    +x_0=4000000 +y_0=500000 -w "%.2f" <<EOF >forwd
74w             40d48n
EOF
# do inverse of previous forward
proj +proj=omerc +inv +k=.9996 +lat_0=40 +lat_1=47d30 \
    +lon_1=122d18w +lat_2=25d42 +lon_2=80d12w \
    +x_0=4000000 +y_0=500000 <forwd >invrs
cat forwd invrs
963436.09       4369142.81
74dw            40d48'n
```

A forward and inverse example employing azimuth of center line:

```
# do forward
proj +proj=omerc +mode=3 +lat_0=36 +lonc=77.7610558w \
    +alpha=14.3394883 <<EOF >forwd
76d52'14.863"w 38d48'33.166"
EOF
# do inverse of previous forward
proj +proj=omerc +inv +mode=3 +lat_0=36 +lonc=77.7610558w \
    +alpha=14.3394883 <forwd >invrs
cat forwd invrs
-2356.25        4414439.02
76d52'14.863"w 38d48'33.166"n
```

A forward and inverse projection example for a sphere with unit radius:

```
# do forward
proj +proj=omerc +a=1 +es=0 +lat_1=45 +lon_1=0 \
    +lat_2=0 +lon_2=90w -w "%.8f" <<EOF >forwd
120e            30s
EOF
# do inverse of previous forward
proj +proj=omerc +inv +a=1 +es=0 +lat_1=45 +lon_1=0 \
    +lat_2=0 +lon_2=90w <forwd >invrs
cat forwd invrs
-2.42013350     -0.04740265
120de           30d0'0.001"s
```

11. Oblique Mercator projection.

Projection Parameters

Name	Default	Description
es	0.006768658 Clark 1866	Ellipsoid eccentricity squared. When assigned value is 0, spheroid evaluation is performed.
a	6378206.4 * (6370997.0)	Major ellipsoid axis or sphere radius (es = 0).
lat_0	0 Deg.	Central parallel.
x_0	0 *	False easting.
y_0	0 *	False northing.
k	1.	Scale factor at center of projection.
mode	0	If mode odd then employ 'alpha'-method. If mode >1 x-y un-rectified.
alpha	0 Deg.	Angle of azimuth east of north for centrol line.
lonc	0 Deg.	Longitude of pt. on central line from which 'alpha' measured.
lon_1	0 Deg.	Longitude of first point defining geodetic.
lat_1	0 Deg.	Latitude of first point defining geodetic.
lon_2	0 Deg.	Longitude of second point defining geodetic.
lat_2	0 Deg.	Latitude of second point defining geodetic.

* - Units should be consistent. Values shown are in meters.

Projection Notes

10. Near-sided Prespective projection.

Projection Parameters

Name	Default	Description
a	6370997.0 *	sphere radius.
lon_0	0 Deg.	Central meridian.
lat_0	0 Deg.	Central parallel.
x_0	0 *	False easting.
y_0	0 *	False northing.
h	0 *	Height of perspective pt.

* - Units should be consistent. Values shown are in meters.

Examples:

The following is an forward and inverse projection example:

```
# do forward
proj +proj=nsper +lat_0=40n +lon_0=100w +h=1e10 \
    +a=1 -w "%.8f" <<EOF >forwd
110w            30n
EOF
# do inverse of previous results
proj +proj=nsper +a=1 +lat_0=40n +lon_0=100w +h=1e10 \
    +inv -w "%.7f" forwd >invrs
cat forwd invrs
-0.15038373    -0.16519110
-109.9999998   30.0000002
```

Compare the above with the Orthographic projection example.
For a closer view:

```
# do forward
proj +proj=nsper +lat_0=40n +lon_0=100w +h=3 \
    +a=1 -w "%.8f" <<EOF >forwd
110w            30n
EOF
# do inverse of previous results
proj +proj=nsper +a=1 +lat_0=40n +lon_0=100w +h=3 \
    +inv -w "%.7f" forwd >invrs
cat forwd invrs
-0.14912753    -0.16381121
-109.9999998   30.0000002
```

Projection Notes

9. Miller projection.

Projection Parameters

Name	Default	Description
a	6370997.0 *	sphere radius.
lon_0	0 Deg.	Central meridian.
x_0	0 *	False easting.
y_0	0 *	False northing.

* - Units should be consistent. Values shown are in meters.

Examples:

The following is an forward and inverse projection example:

```
# do forward
proj +proj=mill +a=1 -w "%.8f" <<EOF >forwd
75w             50n
EOF
# do inverse of previous results
proj +proj=mill +a=1 +inv -w "%.7f" forwd >invrs
cat forwd invrs
-1.30899694     0.95363707
-75.0000001     50.0000002
```

The following table contains additional examples of Miller transformations.

A forward and inverse projection example for a sphere with unit radius:

```
# do forward
proj +proj=merc +lon_0=180w +es=0 +a=1 \
    -w "%.9f" <<EOF >forwd
75w            35n
EOF
# do inverse of previous forward
proj +proj=merc +inv +lon_0=180w +es=0 +a=1 \
    -w "%.8f" <forwd >invrs
cat forwd invrs
1.832595715    0.65283658
-74.99999998   35.00000001
```

8. Mercator projection.

Projection Parameters

Name	Default	Description
es	0.006768658 Clark 1866	Ellipsoid eccentricity squared. When assigned value is 0, spheroid evaluation is performed.
a	6378206.4 * (6370997.0)	Major ellipsoid axis or sphere radius (es = 0).
lon_0	0 Deg.	Central meridian.
lat_0	0 Deg.	Central parallel.
x_0	0 *	False easting.
y_0	0 *	False northing.
lat_ts	0 *	Latitude of true scale.

* - Units should be consistent. Values shown are in meters.

Examples:

The following is an example of forward and inverse transformation using the Clark 1866 spheroid:

```
# do forward
proj +proj=merc +lon_0=180w -w "%.1f" <<EOF >forwd
75w             35n
EOF
# do inverse of previous forward
proj +proj=merc +inv +lon_0=180w -w "%.8f" \
    <forwd >invrs
cat forwd invrs
11688673.7      4139145.7
-75.00000014    35.00000028
```

A forward and inverse projection example for a sphere with unit radius:

```
# do forward
proj +proj=lcc +lat_0=23n +lon_0=96w +es=0 +a=1 \
    -w "%.9f" <<EOF >forwd
75w             35n
EOF
# do inverse of previous forward
proj +proj=lcc +inv +lat_0=23n +lon_0=96w +es=0 +a=1 \
    -w "%.8f" <forwd >invrs
cat forwd invrs
0.296678460     0.246211229
-75.00000000    34.99999998
```

7. Lambert Conformal Conic projection.

Projection Parameters

Name	Default	Description
es	0.006768658 Clark 1866	Ellipsoid eccentricity squared. When assigned value is 0, spheroid evaluation is performed.
a	6378206.4 * (6370997.0)	Major ellipsoid axis or sphere radius (es = 0).
lon_0	0 Deg.	Central meridian.
lat_0	0 Deg.	Central parallel.
x_0	0 *	False easting.
y_0	0 *	False northing.
lat_1	33 Deg.	First standard parallel.
lat_2	45 Deg.	Second standard parallel. lat_1 != -lat_2 (cylinder). Defaults for conterminous U. S. map.

* - Units should be consistent. Values shown are in meters.

Examples:

The following is an example of ellipsoidal forward and inverse transformation using the Clark 1866 spheroid:

```
# do forward
proj +proj=lcc +lat_0=23n +lon_0=96w \
    -w "%.1f" <<EOF >forwd
75w             35n
EOF
# do inverse of previous forward
proj +proj=lcc +inv +lat_0=23n +lon_0=96w \
    -w "%.8f" <forwd >invrs
cat forwd invrs
1894410.9       1564649.5
-74.99999993    35.00000019
```

A forward and inverse projection example for a sphere with radius of 3:

```
# do forward
proj +proj=laea +lat_0=40n +lon_0=100w +a=3 \
    +es=0 -w "%.8f" <<EOF >forwd
100e           20s
EOF
# do inverse of previous results
proj +proj=laea +a=3 +es=0 +lat_0=40n +lon_0=100w \
    +inv -w "%.7f" forwd >invrs
cat forwd invrs
-4.23393032    4.02577749
100.0000001    -19.9999999
```

6. Lambert Azimuthal Equal Area projection.

Projection Parameters

Name	Default	Description
es	0.006768658 Clark 1866	Ellipsoid eccentricity squared. When assigned value is 0, spheroid evaluation is performed.
a	6378206.4 * (6370997.0)	Major ellipsoid axis or sphere radius (es = 0).
lon_0	0 Deg.	Central meridian.
lat_0	0 Deg.	Central parallel.
x_0	0 *	False easting.
y_0	0 *	False northing.

* - Units should be consistent. Values shown are in meters.

Examples:

The following is an example of forward and inverse transformation using the Clark 1866 spheroid:

```
# do forward
proj +proj=laea +lat_0=40n +lon_0=100w \
    -w "%.1f" <<EOF >forwd
110w            30n
EOF
# do inverse of previous results
proj +proj=laea +lat_0=40n +lon_0=100w +inv \
    -w "%.7f" forwd >invrs
cat forwd invrs
-965932.1       -1056814.9
-109.9999999    30.0000002
```

Projection Notes

5. Gnomonic projection.

Projection Parameters

Name	Default	Description
a	6370997.0 *	sphere radius.
lat_0	0 Deg.	Central parallel.
lon_0	0 Deg.	Central meridian.
x_0	0 *	False easting.
y_0	0 *	False northing.

* - Units should be consistent. Values shown are in meters.

Examples:

The following is an forward and inverse projection example:

```
# do forward
proj +proj=gnom +a=1 +lon_0=90w +lat_0=45n \
    -w "%.8f" <<EOF >forwd
75w             50n
EOF
# do inverse of previous results
proj +proj=gnom +a=1 +lon_0=90w +lat_0=45n +inv \
    -w "%.7f" forwd >invrs
cat forwd invrs
0.16963846      0.10466234
-74.9999995     50.0000002
```

A forward and inverse projection example for a sphere with unit radius:

```
# do forward
proj +proj=eqdc +lat_0=23n +lon_0=96w +es=0 +a=1 \
    -w "%.9f" <<EOF >forwd
75w             35n
EOF
# do inverse of previous forward
proj +proj=eqdc +inv +lat_0=23n +lon_0=96w \
    +es=0 +a=1 -w "%.8f" <forwd >invrs
cat forwd invrs
0.300041794    0.236589419
-74.99999999   34.99999998
```

4. Equidistant Conic projection.

Projection Parameters

Name	Default	Description
es	0.006768658 Clark 1866	Ellipsoid eccentricity squared. When assigned value is 0, spheroid evaluation is performed.
a	6378206.4 * (6370997.0)	Major ellipsoid axis or sphere radius (es = 0).
lon_0	0 Deg.	Central meridian.
lat_0	0 Deg.	Central parallel.
x_0	0 *	False easting.
y_0	0 *	False northing.
lat_1	33 Deg.	First standard parallel.
lat_2	45 Deg.	Second standard parallel. lat_1 != -lat_2 (cylinder).

* - Units should be consistent. Values shown are in meters.

Examples: The following is an example of ellipsoidal forward and inverse transformation using the Clark 1866 spheroid:

```
# do forward
proj +proj=eqdc +lat_0=23n +lon_0=96w \
    -w "%.1f" <<EOF >forwd
75w             35n
EOF
# do inverse of previous forward
proj +proj=eqdc +inv +lat_0=23n +lon_0=96w \
    -w "%.8f" <forwd >invrs
cat forwd invrs
1885051.9       1540507.6
-74.99999958    34.99999977
```

Projection Notes

3. Equidistant Cylindrical projection.

Projection Parameters

Name	Default	Description
a	6370997.0 *	sphere radius.
lon_0	0 Deg.	Central meridian.
lat_1	0 Deg.	Standard parallel.
x_0	0 *	False easting.
y_0	0 *	False northing.

* - Units should be consistent. Values shown are in meters.

Examples:

The following is an forward and inverse projection example:

```
# do forward
proj +proj=eqc +lon_0=85w +lat_1=45 \
    -w "%.1f" <<EOF >forwd
99w             50n
EOF
# do inverse of previous results
proj +proj=eqc +lon_0=85w +lat_1=45 +inv \
    -w "%.7f" forwd >invrs
cat forwd invrs
-1100773.1      5559743.7
-99.0000001     49.9999999
```

Projection Notes

2. Azimuthal Equidistant projection.

Projection Parameters

Name	Default	Description
a	6370997.0 *	sphere radius.
lon_0	0 Deg.	Central meridian.
lat_0	0 Deg.	Central parallel.
x_0	0 *	False easting.
y_0	0 *	False northing.

* - Units should be consistent. Values shown are in meters.

Examples:

The following is an forward and inverse projection example:

```
# do forward
proj +proj=aeqd +lat_0=40n +lon_0=100w +a=3 \
    -w "%.8f" <<EOF >forwd
100e           20s
EOF
# do inverse of previous results
proj +proj=aeqd +a=3 +lat_0=40n +lon_0=100w +inv \
    -w "%.7f" forwd >invrs
cat forwd invrs
-5.83113984    5.54446336
100.0000000    -20.0000000
```

A forward and inverse projection example for a sphere with unit radius:

```
# do forward
proj +proj=aea +lat_0=23n +lon_0=96w +es=0 +a=1 \
    -w "%.9f" <<EOF >forwd
75w             35n
EOF
# do inverse of previous forward
proj +proj=aea +inv +lat_0=23n +lon_0=96w +es=0 +a=1 \
    -w "%.8f" <forwd >invrs
cat forwd invrs
0.295272007    0.241677449
-75.00000000   34.99999999
```

1. Alber's Equal Area projection.

Projection Parameters

Name	Default	Description
es	0.006768658 Clark 1866	Ellipsoid eccentricity squared. When assigned value is 0, spheroid evaluation is performed.
a	6378206.4 * (6370997.0)	Major ellipsoid axis or sphere radius (es = 0).
lon_0	0 Deg.	Central meridian.
lat_0	0 Deg.	Central parallel.
x_0	0 *	False easting.
y_0	0 *	False northing.
lat_1	29.5 Deg.	First standard parallel.
lat_2	49.5 Deg.	Second standard parallel. lat_1 != -lat_2 (cylinder). Defaults for conterminous U. S. map.

* - Units should be consistent. Values shown are in meters.

Examples:

The following is an example of ellipsoidal forward and inverse transformation using the Clark 1866 spheroid:

```
# do forward
proj +proj=aea +lat_0=23n +lon_0=96w \
    -w "%.1f" <<EOF >forwd
75w             35n
EOF
# do inverse of previous forward
proj +proj=aea +inv +lat_0=23n +lon_0=96w \
    -w "%.8f" <forwd >invrs
cat forwd invrs
1885472.7       1535925.0
-75.00000029    35.00000001
```

NAME

mapdef - create, modify or display map definition file

SYNOPSIS

mapdef [-mcspvk [args]]

DESCRIPTION

Mapdef is used for creating the map definition file required by all MAPGEN programs creating overlays. Modifying scale and window parameters and displaying current characteristcs of definition file parameters may also be performed by mapdef.

The following options can appear in any order:

-m file
File is the name of the map definition file and must be specified.

-c This option specifies that geographic elements of the map definition (ie. geographic range, projection, etc.) are to be specified by subsequent stdin data. If the map definition file already exits, the new information will overwrite the previous definitions. Unless the -s switch is also selected the map definition file will not be in a scaled state upon completion of execution.

-s This option indicates that scaling (and optional rescaling) as well as boundary control of the map definition file will be specified by subsequent stdin data.

-p This option provides for conversion of stdin longitude-latitude geographic data to map space (both centimeters and plotter counts). This option only applies when the definition file is in a scaled state.

-v This option makes MAPGEN verbose in its prompting and diagnostics.

-k cpc
Cpc is a real number denoting the graphic device counts per centimeter for the plotter device intended to produce a true scale map. The default value is installation dependent and usually tailored to the principle hard copy plotter. See your MAPGEN system manager if there are special requirements. Ignoring this option should produce desired results.

Subsequent control input information determined by the option switches is obtained from stdin in a fixed order shown in the following description. Data responses for switch -c are:

-c line 1
Geographic range in the form of westerly, easterly longitude, southerly and northerly latitude optionally followed by central meridian value. If the central meridian is omitted, the mean of the specified longitude range is used as a default.

-c line 2
This line contains + projection control options as employed by program proj and must, at least, define the projection to be employed by a "+proj=name" entry. A reference to program proj documentation is required for available projections and associated parameters.

In certain situations, it may be desirable to increase the degree of polynomial approximation employed by the MAPGEN system by beginning this line with a integral value of the polynomial degree. When omitted, the default is 8 and the maximum value is currently 12.

At the completion of the -c option phase several minutes of compute time may be required to determine the approximating polynomial coefficients employed by the system.

-s line 1
A scale fraction denominator value is expected. If a '0' is entered the system goes into calibration mode.

-s line 1a (calibration mode only)
longitude-latitude coordinate pair of two points followed by their separation in centimeters.

-s line 2
This line should contain the counter-clockwise rotation (in degrees) of the geographic axis relative to the plot. A '0' or <cr> causes no rotation.

At this time the size in centimeters of the area required by the full range of geographic data is displayed when in verbose mode. The following lines will define the final data and map windowing.

-s line 3
The purpose of this control line is two-fold: specify the origin of the data area relative to the lower-left corner of the plot and adjust the data limits defined by the geographic range. The first two values are the respective x-y coordinates of the lower-left corner of the data area in centimeters (default value 3 cm.).

Redefining the data region is performed by following the origin data with up to four geographic longitude-

latitude coordinate pairs for respective minimum x and y range and maximum x and y range. Default values are determined by original geographic range.

Since this information is dependent upon its relative position on the data line, indication of acceptance of leading default values is indicated by a - for both x and y origin coordinates and a single hyphen for longitude-latitude pairs. For example: "- - - 140w 45n" will cause a default data origin of 3 cm. and a new minimum y data range value determined by the given geographic coordinates.

Mapdef will display the resultant size of the map at the completion of this control line in verbose mode.

-s line 4
The size of the right and top margin may be specified by entering their respective values on this line. Default values are 3 cm.

The user may determine the attributes of a previously created definition file by using the "-mv name" option. Note that diagnostic information (except for errors) will not be printed unless the verbosity switch is also selected.

EXAMPLE
The following script file will create a quadrangle definition file for the New York UTM sheet:

```
mapdef -mcs NewYork.def <<EOF
     74dw 72dw 40dn 41dn
     +proj=utm
     250000
     0


     EOF
```

FILES
Mapgen definition file.

SEE ALSO
MAPGEN system documentation,
Proj(1).

DIAGNOSTICS
Error monitoring only.

BUGS
Too early to tell (probably).

AUTHOR/MAINTENANCE

Gerald I. Evenden, USGS, Woods Hole, MA.

NAME

grid - create axis grid overlay

SYNOPSIS

grid [-moi [args]] file[s]

DESCRIPTION

Grid provides a mechanism for producing a coordinate grid overlay for mapgen maps.

The following options can appear in any order:

-m file
This option specifies the required map definition file.

-o file
This option specifies the map overlay meta-graphic file.

-i If this option is specified, a plot of the coastline file is output to the controlling terminal. It the -o option is omitted, then -i is implied.

One or more files containing control and graphic operations associated with the grid overlay.

The following options provide for graphic control and may only appear in the control file[s]. Note that several of the commands must have either a m for meridian or p for parallel prefix to denote the respective axis to which the subsequent option applies.

-d n The decimal value of n specifies the distance in centimeters that the label is to be offset from the beginning or end of the axis line.

-s size
Size is the nominal size of the character set selected in centimeters.

-f font
Font specifies an alternate graphics system font to be employed. Note that the graphics system default standard font is employed to ensure presence of special symbols.

-a sides
Sides may be a sequence of letters l, r, b or t which flag respective left, right, bottom or top edges of the map grid to be annotated. If omitted, all edges are annotated (same as "-a lrbt"). If sides contains any set of letters not in the above set, then annotation is

suppressed (i.e., "-a n"). Note that the relative edge denotation is based on an unrotated geographic axis.

-(m|p)i dms
The dms value is the interval of the major grid elements in DMS format.

-(m|p)j n
N is the number of minor intervals defined by tick marks to be evenly distributed in the major grid interval. A value of <= 1 or omitted (default) denotes no minor interval.

-(m|p)u cm
If ticked mode selected u sets the size of the major tick marks in centimeters. If omitted, then solid lines generated.

-(m|p)v cm
Similar to u option except applies to minor ticks. If omitted, minor ticks not generated.

-b n Selects mechanical pen n for grid drafting.

-c n Selects mechanical pen n for character drafting. If not selected then -b is employed if selected.

EXAMPLE
The following example will generate a solid line grid on 20-degree intervals with one intermediate tick mark.

```
grid -moi world.def grid.ov gridcon
```

where "gridcon" contains:

```
-s .3 -d .5 # using standard font
-mi 20 -mj 2 -mv .3 # meridians
-pijv 20 2 .3 # parallels (same but different form)
```

FILES
Mapgen definition file.

SEE ALSO
Mapgen system documentation.

DIAGNOSTICS
Error monitoring only.

BUGS
Too early to tell (probably).

AUTHOR/MAINTENANCE

Gerald I. Evenden, USGS, Woods Hole, MA.

NAME

legend - create map overlay of legend information

SYNOPSIS

legend [-moi [args]] files[s]

DESCRIPTION

Legend is a graphic function in the mapgen graphic series which provides for creating map overlays of legend information such as titles, scale bars, etc..

The following options can appear in any order:

-m file
This option specifies the required map definition file.

-o file
This option specifies the map overlay metagraphic file.

-i If this option is specified a preview of the plot is output to the controlling terminal. If the -o option is omitted, then -i is implied.

One or more files containing control and graphic operations associated with the legend overlay.

The following options provide for graphic control and may only appear in the control file[s].

-f font
Font is the name of the graphics system character set font to be employed in subsequent character plotting. A - will select the system default font. This option and -s must be selected prior to any character operations.

-a font
Font is similar to the -f option except that it selects an alternate character font. This font will be selected when ^B control character occurs in a text string. A ^A control character will reselect the -f font. Size and other attibutes of the alternate character are set as per the normal font.

-s size
Size is the nominal size of the character set selected in centimeters.

-S[f|s|r|c] arg
This option provides for control of symbol plotting in a manner similar to character control options. -Sf font selects the symbol font, -Ss size sets symbol

size, and -Sr ang sets symbol rotation. -Sc sym will post the symbol selected by sym at the current x-y coordinate. If the first character of sym is a decimal digit then sym is assumed to be the numeric -- decimal (1-9), octal (Øn), or hexadecimal (Øxn) -- value of the selected symbol; otherwise, it is assumed to be the ascii equivalent of the selected symbol.

-l leading
This option selects the desired leading or spacing desired between multiple print lines generated by the -t option. The units of leading are in centimeters.

-ox val
Val sets offset in centimeters of character text from the selected x/y coordinates. Offset is made before rotation.

-oy val
This option is similar to -ox except that val refers to the y-axis.

-x/y coord
The base position of subsequent graphic options is determined by the coordinates specified by -x and -y argument coordinates. The numeric value of the coord argument is always in centimeters. If the value is immediately preceded by a > symbol, then the coordinate is relative to either the right or top edge of the current region. If the value is immediately preceded by a | symbol, it is relative to the median of the respective axis; otherwise, the value is relative to the lower left hand corner of the currently selected region. See also -w command for selection region of reference.

-w region
This option specifies which of the two basic regions of the map sheet are begin referred to with the -x/y coordinate values. The value of region should be either p or d corresponding to the respective basic map sheet or data region. The effect of this command will remain in effect until another -w command. The default region is p.

-b size,unit,rep[,left[,name]]
This option generates a scale bar. Size is the scale bar ticked elements in integral units selected by unit. If unit is a numeric value, it represents the number of meters in one basic unit. Otherwise it must be one of the following unit types:

ft - feet
kf - kilofeet
m - meter
km - kilometers
yd - yards
ky - kiloyards
mi - statute miles
kn - nautical miles

Rep is the number of times the unit part of the scale bar is repeated. If left is given then a unit left of the '0' position of the scale bar is generated with left subdivisions. If a numeric unit is given then name will be used as the source of the titling of the scale bar. In all cases where ascii unit is given the scale bar title name field is generated automatically. Note that currently selected font and character size determine drafting characteristics of the scale bar annotation and the current x/y coordinates determine the location of the bottom of the '0' value of the scale bar. The y-axis size required by the scale bar is about 3 times the character size. Horizontal size depends upon map scale and number of bar elements selected, selection of left as well as units.

-d This option will cause the scale fraction value to be printed at the current coordinates. Character font and size must have been previously specified.

-j opt
Opt must be either l, c or r which respectively select left, centered, or right justification of graphic.

-t All lines following this option are considered text to be plotted at the current coordinate position. A '.' must appear in column 1 to terminate the text. Note that an appropriate value of leading must have been previously made for line spacing. This option should not be employed on the same control line as option -L.

-r ang
Ang is the number of degrees that character plotting operations are to be rotated form the positive x direction.

-p pen
Pen is a mechanical pen number to be employed.

-L pen[,mask,size]
This option provides for drafting lines with pen mechanical pen. If mask and size are present then the line will be drafted in dashed-line mode with mask dash

pattern and size dash size in centimeters. Coordinates of the line to be drafted follow the current command line with one x-y pair per line. The string of coordinates must be terminated with a '.' in column 1 (similar to -t option). Use of + and - sign prefixes follow the same meaning as defined under the -x/y option. This option should not be employed on the same control line as option -t.

FILES

MAPGEN definition file.

SEE ALSO

MAPGEN system documentation

DIAGNOSTICS

Error monitoring only.

BUGS

Too early to tell (probably).

AUTHOR/MAINTENANCE

Gerald I. Evenden, USGS, Woods Hole, MA.

NAME

lines - create line/point data overlay

SYNOPSIS

lines [-moci [args]] [files]

DESCRIPTION

Lines is a graphic function in the MAPGEN graphic series which provides for creating line, point and/or posting map overlays from geographic coordinate data file[s]. Although lines performs many of the same operations as points, it is recomended that points be employed when dealing with purely posting/point operations as it suffers considerably less overhead than lines.

The following options can appear in any order:

-m file
This option specifies the required map definition file.

-o file
This option specifies the map overlay metagraphic file.

-i If this option is specified, a plot of the graphic file is output to the controlling terminal. If the -o option is omitted, then -i is implied.

-c string
This options provides for run-line inclusion of graphic options listed below. If there is more than one option or imbedded blanks, the field must be enclosed in quotes or apostrophies.

One or more data files that contain geographic, posting, and control data.

The following options provide for graphic control and may only appear in the -c run-line field or the data file[s]. Control data in the data files must be on lines with a # character in column one. A second # character on these lines causes the remainder of the line to be ignored and consequently, may be used for comments.

There are three basic modes of points operation: point plotting where a symbol is displayed at each geographic coordinate, posting where one or more fields of data from the data record are printed at the geographic point and line drafting between data points. Consequently, several options require either an s, c or l prefix to denote whether the option applies to the respective point, posting, or line control. For example, -sf selects point font while -sc selects the posting font.

-b This option specifies a break in the line. Line drafting will be discontinued at the last point and restarted at the next data point.

-c When -c occurs as a solitary option, the subsequent data posting fields are to be plotted.

-sc arg
This option selects the point symbol to be employed. If arg is a numeric value then it is the numeric selection of the symbol otherwise the ascii value.

-d flon,flat
Flon and flat are the respective field control words of the longitude and latitude data fields (data must be in DMS format). Both field control words are of the form [f][.[o][.l]] where f is the field number, o is the number of characters to skip from the beginning of the field, and l is the length of the field. If l is not specified or Ø, then the remainder of the field is employed. If f or o are omitted then 1 and Ø are respective assumptions. If this option is omitted then a default value of "-d 2,1" is assumed.

-f ff1[,ff2,...,ffn]
The list of field control words following this option defines the data fields to be posted. The format of ff is the same as for the -d option.

-ld This option selects dashed mode for line drafting.

-[s|c]f name
Name is the name of a graphic system font to be employed for the point (s) or posting (c) operations.

-j chr
Chr selects justification mode for posting data: c for centered, l for left and r for right. Default justification is left.

-l When -l occurs as a solitary option, then line plotting is to commence at subsequent data values.

-cl n
Set the interline spacing (leading) to n / 8 times the character size. If not specified for multiple fields, the posting data will overplot. A typical value of 12 (1.5 times) usually works well.

-ll Turn perform line drafting with a solid line (default option).

-lm arg
Arg is the value for the dash line mask. It is treated as a 16-bit quantity where each on bit is a solid segment of the dashed line. Note that it must be entered as a decimal, octal, or hexadecimal value (e.g., 123, Ø123 or Øx123 respectively).

-p n N is the mechanical pen to be employed.

-[s|c|l]q
Discontinue point (s), posting (c) or line (l) plotting mode.

-[s|c]r ang
If ang is a numeric value, it is is the number of counterclockwise degrees the posted data (c) or point symbol (s) is to be rotated about the geographic point. If ang is the letter o or p, then the point symbol or posting is to be made respectively orthogonal or parallel to the track of data points.

-s When -s occurs as a solitary option, then point plotting is to commence at subsequent data values.

-[s|c|l]s size
Size is the nominal size of the characters for point (s) or posting (c) or the dash line interval (l) in centimeters.

-tc The character c, immediately following -t, delimits data fields on data records (default: "t\t" (tab)). Use of special characters may require quote mark enclosure.

-cx cm
Cm is the number of centimeters along the x-axis the beginning of the posting string is to be offset from the geographic coordinate location. Note: offset is made prior to rotation.

-cy cm
Option similar to -cx except that it is used for offset along the y-axis.

-zc The character c immediately following -z will replace the normal # character that indicate control line and comment.

FILES
Map definition file.

SEE ALSO

MAPGEN system documentation.

DIAGNOSTICS
Error monitoring only.

BUGS
Too early to tell (probably).

AUTHOR/MAINTENANCE
Gerald I. Evenden, USGS, Woods Hole, MA.

NAME

points - create point data overlay

SYNOPSIS

points [-moci [args]] [files]

DESCRIPTION

Points is a graphic function in the MAPGEN graphic series which provides for creating point and/or posting map overlays from geographic coordinate data file[s].

The following options can appear in any order:

-m file
This option specifies the required map definition file.

-o file
This option specifies the map overlay metagraphic file.

-i If this option is specified, a plot of the graphic file is output to the controlling terminal. It the -o option is omitted, then -i is implied.

-c string
This options provides for run-line inclusion of graphic options listed below. If there is more than one option or imbedded blanks, the field must be enclosed in quotes or apostrophies.

One or more data files that contain geographic, posting, and control data.

The following options provide for graphic control and may only appear in the -c run-line field or the data file(s). Control data in the data files must be on lines with a # character in column one. A second # character on these lines causes the remainder of the line to be ignore and, consequently, may be used for comments.

There are two basic modes of points operation: point plotting, where a symbol is displayed at each geographic coordinate; and posting, where one or more fields of data from the data record are printed at the geographic point. Consequently, several options require either an s or c prefix to denote whether the option applies to the respective point or posting control. For example, -sf selects point font and -sc selects the posting font.

-c When -c occurs as a solitary option, the subsequent data posting fields are to be plotted.

-sc arg

This option selects the point symbol to be employed. If arg is a numeric value, then the symbol is selected by the numeric value of the symbol, otherwise the ascii character.

-d flon,flat
Flon and flat are the respective field control words of the longitude and latitude data fields (data must be in DMS format). Both field control words are of the form [f][.[o][.l]] where f is the field number, o is the number of characters to skip from the beginning of the field, and l is the length of the field. If l is not specified or Ø, then the remainder of the field is employed. If f or o are omitted, then l and Ø are respective assumptions. If this option is omitted, then a default of "-d 2,1" is assumed.

-f ff1[,ff2,...,ffn]
The list of field control words following this option defines the data fields to be posted. The format of ff is the same as for the -d option.

-[s|c]f name
Name is the name of a graphic system font to be employed for the point (s) or posting (c) operations.

-j chr
Chr selects justification mode for posting data: c for centered, l for left and r for right. Default justification is left.

-l cm
Set the interline spacing (leading) to cm centimeters. If not specified for multiple fields, the posting data will overplot.

-p n
N is the mechanical pen to be employed.

-[s|c]q
Discontinue point (s) or posting (c) mode.

-[s|c]r ang
Ang is the number of counter clockwise degrees the posted data (c) or point symbol (s) is to be rotated about the geographic point.

-s When -s occurs as a solitary option, point plotting is to commence at subsequent data values.

-[s|c]s size
Size is the nominal size of the point (s) or posting

(c) characters in centimeters.

-tc The character c, immediately following -t delimits data fields on data records (default: -t\^I (tab)).

-cx cm
Cm is the number of centimeters along the x-axis the beginning of the posting string is to be offset from the geographic coordinate location. Note: offset is made prior to rotation.

-cy cm
Option similar to -cx except that it is used for offset along the y-axis.

-zc The character c immediately following -z will replace the normal # character for indicating control line and comment.

FILES
Map definition file.

SEE ALSO
MAPGEN system documentation.

DIAGNOSTICS
Error monitoring only.

BUGS
Too early to tell (probably).

AUTHOR/MAINTENANCE
Gerald I. Evenden, USGS, Woods Hole, MA.

NAME

coast - create an map overlay from a coastline file

SYNOPSIS

coast [-mosci [args]] [files]

DESCRIPTION

Coast is a graphic function in the MAPGEN graphic series which provides for creating map overlays from compressed line data files.

The following options can appear in any order:

-m file
This option specifies the required map definition file.

-o file
This option specifies the map overlay metagraphic file.

-i If this option is specified, a plot of the coastline file is output to the controlling terminal. It the -o option is omitted, then -i is implied.

-c string
This options provides for run-line inclusion of graphic options.

-s file
The optional file contains additional graphic control options.

One or more files of compressed coastline source data may be specified. These file names are ".cdr"/".cdt" suffixed files generally created by mkcoast.

The following options provide for graphic control and may only appear in the -c run-line field or the -s control file.

-f ns[-ne][,ns2[-ne2] ...]
This option provides for selection of only those line segments in the coastline files which have the selected feature codes. Ns specifies the lower range of the feature code number. If ne is specified, it will define the upper range; otherwise, only the ns value is employed. There may be more than one set of ns-ne sets. For example:

-f 0-10,20,30-35

specifies feature codes 0 to 10, 20 and 30 to 35. Omission of this option implies that all feature codes are to be plotted.

-d size,mask
This option specifies that dashed lines are to be employed with size specified in real centimeters. Mask is either a decimal, octal, or hecadecimal number specifying the dash pattern.

-m n
N is a mechanical pen to be employed with the coastline feature.

Each of the above options may be repeated for different sets of feature codes by delimiting each set with a -. If there is an overlap of feature code specification, the last feature code set in the control list is selected.

EXAMPLE
The following line will create a coastline overlay coast.ovr with dashed lines:

```
coast -m *.def /coast/LIM_25 \
  -c "-f 7,11 -d .5,Øxcccc - -f 31-32 -d .5,Øx5555"
```

FILES
.cdr and .cdt compressed compressed coastline files.
MAPGEN definition file.

SEE ALSO
MAPGEN system documentation,
Program mkcoast.

DIAGNOSTICS
Error monitoring only.

BUGS
Too early to tell (probably).

AUTHOR/MAINTENANCE
Gerald I. Evenden, USGS, Woods Hole, MA.

NAME

preview - display overlay files on plotting device

SYNOPSIS

preview [plotter options] -m file files[s]

DESCRIPTION

Preview provides a convenient method for viewing one or more MAPGEN overlay files on the host terminal or on other devices where graphic is to be scaled to the full size of the device.

The following options must appear in order indicated:

[plotter options]
Any of the program plotter options may be specified.

-m file
This option specifies the map definition file.

files[s]
One or more overlay files generated by the MAPGEN system employing the specified definition file.

EXAMPLE

preview -m world.def *.ov

FILES

MAPGEN definition file.

SEE ALSO

MAPGEN system documentation.
Plotter program documentation.

DIAGNOSTICS

Error monitoring only.

BUGS

Too early to tell (probably).

AUTHOR/MAINTENANCE

Gerald I. Evenden, USGS, Woods Hole, MA.

NAME

plotter - plotting of metagraphic stream

SYNOPSIS

plotter [-d device] [-s scale] [-o output] [-i m.n] [-r] [file(s)]

DESCRIPTION

Plotter interprets a metagraphic stream and reformats the data into a form acceptable by the selected graphics device.

The following options can appear in any order:

-d name

name defines the name of the plotting device to which the output is to be directed. If name is omitted, plotter acquires the name of the device from the TERM entry of the processes' environment. If name or the default terminal is not an implemented device, plotter proceeds with a dummy device and effectively acts as a "no_op".

-s scale

Scale must be a floating point value which will scale the coordinates values of the input metagraphic stream.

-o output

This option directs the device dependent graphic command to file output. When omitted, sysout is assumed. This option is required for non-terminal devices, and it is generally recommended that an intermediate disc file be employed so that actual plotting can be performed at convenient times.

-i m.n

This option only applies to the interactive use of plotter by programs performing graphics. It should not be employed by shell execution of plotter. M.n are automatically generated by graphics library software. M is the file descriptor for the input metagraphic data pipe to plotter and n is the file decriptor of the return data pipe to the calling program.

-r If this option is selected, the x and y axis are reversed on the plotting device.

file(s)

The files named must contain metagraphic commands compatible with this system (see Device Independent Graphics manual). The files are processed in a left to right order. A - may be employed to designate input from stdin. If no files are given and option -i is not

employed, stdin is assumed as the source of the meta-graphic stream.

EXAMPLE

```
plotter file1 file2 -s 4
```

will generate a composite plot of both files on the user's terminal and will have the coordinates scaled by a factor of 4. Obviously, the terminal should be a device capable of graphic output.

```
plotter file1 file2 -sdo .25 calcomp caltemp
```

will scale the meta-graphic files by 1/4 and output the calcomp plotter control to the disc file caltemp.

FILES

```
/usr/graph/fonts    font character directory
/usr/graph/fonts/sr     - (default) font character file
```

SEE ALSO

Device Independent Vector Graphics manual.
GRAPHICS(3)

DIAGNOSTICS

If an invalid graphics device is selected, a message is output to errout and all input data are ignored. Additional error conditions are available only though bidirectional linkage with controlling process.

AUTHOR/MAINTENANCE

Gerald I. Evenden, USGS, Woods Hole, MA 02543

NAME

proj - perform forward or inverse cartographic projections

SYNOPSIS

proj proj_name [-bdefiorsw [args]] [+args] [files]

DESCRIPTION

Proj performs forward or inverse transformations of cartographic data with a wide range of projection functions.

The following options can appear in any order:

-b Special option for binary coordinate data input and output through stdin and stdout. Data is assumed to be in system type double words. This option is intended when this program is used as a specialized son process.

-da A specifies the character to be employed as field delimeter (tab is the default value). This character is also employed as the output delimeter.

-e string
String is an arbitrary string to be output if an error is detected during data transformations. The default value is: *. Note that if the -b option is employed, an error is returned as HUGE value for both return values.

-f file
File is the souce file name of additional control data for the projection procedures.

-o file
File is the name of an output file to be employed in lieu of stdout.

-rlist
is one or two numbers (separated by a comma) selecting the respective field position of longitude and latitude (default: -r1,2). If the second number is omitted, the latitude field is assumed to follow the longitude value.

-s Output of lon-lat or x-y will be reversed to respective lat-lon or y-x.

-w format
Format is a printf format string to control the form of the output values. For inverse projections, the output will be in degrees when this option is employed. The default format is "%.2f" for forward projection and DMS for inverse.

+args=val
+ options with imbedded = provide for control information required by the projection functions. The option +proj=acronym is always required for selection of the transformation function and where acronym is selected from the following list:

Acronym	Name
utm	Universal Transverse Mercator
tmerc	Transverse Mercator
omerc	Oblique Mercator
poly	Polyconic
aea	Alber's Equal Area
lcc	Lambert's Conformal Conic
eqdc	Equi-distant conic
merc	Mercator
mill	Miller
stere	Stereographic
vandg	Van der grinten
ortho	Orthographic
sinu	Sinusoidal
gnom	Gnomonic
laea	Lambert Azimuthal Equal-Area
eqc	Equidistant Cylinder
nsper	Near-sided Perspective
aeqd	Azimuthal Equidistant

User must refer to individual projection function documentation to determine applicable options. Option +inv is required for inverse (Cartesian to geographic) projection, otherwise a forward projection (geographic to Cartesian) is performed.

Note: The "+" prefix character is not required if the control values are in the source file selected by the -f option.

Because the list of + options are processed in first occurence order, a second duplication of an option will be ignored.

files
One or more files (processed in left to right order) specify the source of data to be transformed. A - will specify the location of processing stdin. If no files are specified, the input is assumed to be from stdin.

Input geographic data (longitude and latitude) must be in DMS format summarized by the incomplete lexical definition:
[-]xx[dxx['xx.xxx"]][NnSsEeWw].
Output geographic coordinates will be in DMS (if the -w

switch is not employed) and precise to 0.001" with trailing, zero-valued minute-second fields deleted.

The units of Cartesian data is determined by the major axis, +a, units (typically meters).

EXAMPLE

```
proj +proj=utm +lon_0=112w -r2,1 dat1 dat2
```

will perform UTM forward projection, with a central meridian of 112 degrees west, on files dat1 and dat2 with input geographic lat-lon in the respective first two fields.

SEE ALSO

Supplementary projection parameter notes.

DIAGNOSTICS

Error monitoring only.

BUGS

Too early to tell (probably).

AUTHOR/MAINTENANCE

Gerald I. Evenden, USGS, Woods Hole, MA.

5. APPENDIX III. The complete set of MAPGEN fonts

The following type fonts are presently available in the MAPGEN system. The heading on each page is the name of the font, and each character in the tables is referenced by its ASCII character reference (when applicable) as well as the decimal and octal reference numbers. The only time that decimal or octal reference is necessary is for those symbols lacking an ASCII designation.

For example, in the -sr font, the letter A can be referenced by the letter A, 65 (decimal), or 101 (octal).

Listing of Font Symbols
Name: −sr

1/001	·	22/026	×	+/43/053	+	@/64/100	@	U/85/125	U	j/106/152	j
2/002	∘	23/027	←	./44/054	,	A/65/101	A	V/86/126	V	k/107/153	k
3/003	o	24/030	∇	−/45/055	−	B/66/102	B	W/87/127	W	l/108/154	l
4/004	◯	25/031	‡	./46/056	.	C/67/103	C	X/88/130	X	m/109/155	m
5/005	⊙	26/032	§	//47/057	/	D/68/104	D	Y/89/131	Y	n/110/156	n
6/006	□	27/033	†	0/48/060	0	E/69/105	E	Z/90/132	Z	o/111/157	o
7/007	△	28/034	±	1/49/061	1	F/70/106	F	[/91/133	[	p/112/160	p
8/010	◊	29/035	∞	2/50/062	2	G/71/107	G	\/92/134	\	q/113/161	q
9/011	☆	30/036	π	3/51/063	3	H/72/110	H	]/93/135	]	r/114/162	r
10/012	+	31/037	°	4/52/064	4	I/73/111	I	~/94/136	^	s/115/163	s
11/013	×	/32/040		5/53/065	5	J/74/112	J	_/95/137		t/116/164	t
12/014	*	!/33/041	!	6/54/066	6	K/75/113	K	`/96/140	`	u/117/165	u
13/015	●	"/34/042	"	7/55/067	7	L/76/114	L	a/97/141	a	v/118/166	v
14/016	■	#/35/043	#	8/56/070	8	M/77/115	M	b/98/142	b	w/119/167	w
15/017	▲	$/36/044	$	9/57/071	9	N/78/116	N	c/99/143	c	x/120/170	x
16/020	★	%/37/045	%	:/58/072	:	O/79/117	O	d/100/144	d	y/121/171	y
17/021	⚑	&/38/046	&	;/59/073	;	P/80/120	P	e/101/145	e	z/122/172	z
18/022	⚒	'/39/047	'	</60/074	<	Q/81/121	Q	f/102/146	f	{/123/173	{
19/023	⊕	(/40/050	(	=/61/075	=	R/82/122	R	g/103/147	g	|/124/174	|
20/024	✳	)/41/051	)	>/62/076	>	S/83/123	S	h/104/150	h	}/125/175	}
21/025	⌑	*/42/052	*	?/63/077	?	T/84/124	T	i/105/151	i	~/126/176	~

Listing of Font Symbols
Name: –ital

1/001	22/026	+/43/053	@/64/100		U/85/125	𝔘	j/106/152	𝔧
2/002	23/027	./44/054	A/65/101	𝔄	V/86/126	𝔙	k/107/153	𝔨
3/003	24/030	–/45/055	B/66/102	𝔅	W/87/127	𝔚	l/108/154	𝔩
4/004	25/031	./46/056	C/67/103	ℭ	X/88/130	𝔛	m/109/155	𝔪
5/005	26/032	//47/057	D/68/104	𝔇	Y/89/131	𝔜	n/110/156	𝔫
6/006	27/033	0/48/060	E/69/105	𝔈	Z/90/132	ℨ	o/111/157	𝔬
7/007	28/034	1/49/061	F/70/106	𝔉	[/91/133		p/112/160	𝔭
8/010	29/035	2/50/062	G/71/107	𝔊	\/92/134		q/113/161	𝔮
9/011	30/036	3/51/063	H/72/110	ℌ	]/93/135		r/114/162	𝔯
10/012	31/037	4/52/064	I/73/111	ℑ	~/94/136		s/115/163	𝔰
11/013	/32/040	5/53/065	J/74/112	𝔍	_/95/137		t/116/164	𝔱
12/014	!/33/041	6/54/066	K/75/113	𝔎	`/96/140		u/117/165	𝔲
13/015	"/34/042	7/55/067	L/76/114	𝔏	a/97/141	𝔞	v/118/166	𝔳
14/016	#/35/043	8/56/070	M/77/115	𝔐	b/98/142	𝔟	w/119/167	𝔴
15/017	$/36/044	9/57/071	N/78/116	𝔑	c/99/143	𝔠	x/120/170	𝔵
16/020	%/37/045	:/58/072	O/79/117	𝔒	d/100/144	𝔡	y/121/171	𝔶
17/021	&/38/046	;/59/073	P/80/120	𝔓	e/101/145	𝔢	z/122/172	𝔷
18/022	'/39/047	</60/074	Q/81/121	𝔔	f/102/146	𝔣	{/123/173	
19/023	(/40/050	=/61/075	R/82/122	ℜ	g/103/147	𝔤	|/124/174	
20/024	)/41/051	>/62/076	S/83/123	𝔖	h/104/150	𝔥	}/125/175	
21/025	*/42/052	?/63/077	T/84/124	𝔗	i/105/151	𝔦	~/126/176	

Listing of Font Symbols
Name: —tri

1/001	22/026		+/43/053	+	@/64/100		U/85/125	U	j/106/152	j
2/002	23/027		./44/054	,	A/65/101	A	V/86/126	V	k/107/153	k
3/003	24/030		-/45/055	—	B/66/102	B	W/87/127	W	l/108/154	l
4/004	25/031		./46/056	.	C/67/103	C	X/88/130	X	m/109/155	m
5/005	26/032		//47/057	/	D/68/104	D	Y/89/131	Y	n/110/156	n
6/006	27/033		0/48/060	0	E/69/105	E	Z/90/132	Z	o/111/157	o
7/007	28/034		1/49/061	1	F/70/106	F	[/91/133		p/112/160	p
8/010	29/035		2/50/062	2	G/71/107	G	\/92/134		q/113/161	q
9/011	30/036		3/51/063	3	H/72/110	H	]/93/135		r/114/162	r
10/012	31/037	°	4/52/064	4	I/73/111	I	~/94/136		s/115/163	s
11/013	/32/040		5/53/065	5	J/74/112	J	_/95/137		t/116/164	t
12/014	!/33/041	!	6/54/066	6	K/75/113	K	`/96/140		u/117/165	u
13/015	"/34/042	''	7/55/067	7	L/76/114	L	a/97/141	a	v/118/166	v
14/016	#/35/043		8/56/070	8	M/77/115	M	b/98/142	b	w/119/167	w
15/017	$/36/044	$	9/57/071	9	N/78/116	N	c/99/143	c	x/120/170	x
16/020	%/37/045		:/58/072	:	O/79/117	O	d/100/144	d	y/121/171	y
17/021	&/38/046	&	:/59/073	;	P/80/120	P	e/101/145	e	z/122/172	z
18/022	'/39/047	'	</60/074		Q/81/121	Q	f/102/146	f	{/123/173	
19/023	(/40/050	(	=/61/075	‘	R/82/122	R	g/103/147	g	|/124/174	
20/024	)/41/051	)	>/62/076		S/83/123	S	h/104/150	h	}/125/175	
21/025	*/42/052	*	?/63/077	?	T/84/124	T	i/105/151	i	~/126/176	

Listing of Font Symbols
Name: –tr

1/001	22/026		+/43/053	+	@/64/100		U/85/125	U	j/106/152	j
2/002	23/027		./44/054	,	A/65/101	A	V/86/126	V	k/107/153	k
3/003	24/030		–/45/055	–	B/66/102	B	W/87/127	W	l/108/154	l
4/004	25/031		./46/056	.	C/67/103	C	X/88/130	X	m/109/155	m
5/005	26/032		//47/057	/	D/68/104	D	Y/89/131	Y	n/110/156	n
6/006	27/033		0/48/060	0	E/69/105	E	Z/90/132	Z	o/111/157	o
7/007	28/034		1/49/061	1	F/70/106	F	[/91/133		p/112/160	p
8/010	29/035		2/50/062	2	G/71/107	G	\/92/134		q/113/161	q
9/011	30/036		3/51/063	3	H/72/110	H	]/93/135		r/114/162	r
10/012	31/037	°	4/52/064	4	I/73/111	I	~/94/136		s/115/163	s
11/013	/32/040		5/53/065	5	J/74/112	J	_/95/137		t/116/164	t
12/014	!/33/041	!	6/54/066	6	K/75/113	K	`/96/140		u/117/165	u
13/015	"/34/042	''	7/55/067	7	L/76/114	L	a/97/141	a	v/118/166	v
14/016	#/35/043		8/56/070	8	M/77/115	M	b/98/142	b	w/119/167	w
15/017	$/36/044	$	9/57/071	9	N/78/116	N	c/99/143	c	x/120/170	x
16/020	%/37/045		:/58/072	:	O/79/117	O	d/100/144	d	y/121/171	y
17/021	&/38/046	&	;/59/073	;	P/80/120	P	e/101/145	e	z/122/172	z
18/022	'/39/047	'	</60/074		Q/81/121	Q	f/102/146	f	{/123/173	
19/023	(/40/050	(	=/61/075	=	R/82/122	R	g/103/147	g	|/124/174	
20/024	)/41/051	)	>/62/076		S/83/123	S	h/104/150	h	}/125/175	
21/025	*/42/052	*	?/63/077	?	T/84/124	T	i/105/151	i	~/126/176	

Listing of Font Symbols
Name: −sscp

1/001
2/002
3/003
4/004
5/005
6/006
7/007
8/010
9/011
10/012
11/013
12/014
13/015
14/016
15/017
16/020
17/021
18/022
19/023
20/024
21/025
22/026
23/027
24/030
25/031
26/032
27/033
28/034
29/035
30/036
31/037
/32/040
!/33/041
"/34/042
#/35/043
$/36/044
%/37/045
&/38/046
'/39/047
(/40/050
)/41/051
*/42/052
+/43/053
./44/054
−/45/055
./46/056
//47/057
0/48/060
1/49/061
2/50/062
3/51/063
4/52/064
5/53/065
6/54/066
7/55/067
8/56/070
9/57/071
:/58/072
;/59/073
</60/074
=/61/075
>/62/076
?/63/077
@/64/100
A/65/101 
B/66/102 
C/67/103 
D/68/104 
E/69/105 
F/70/106 
G/71/107
H/72/110 
I/73/111
J/74/112 
K/75/113
L/76/114 
M/77/115 
N/78/116
O/79/117 
P/80/120 
Q/81/121 
R/82/122 
S/83/123 
T/84/124 
U/85/125
V/86/126 
W/87/127
X/88/130 
Y/89/131 
Z/90/132
[/91/133
\/92/134
]/93/135
~/94/136
_/95/137
`/96/140
a/97/141 
b/98/142
c/99/143 
d/100/144 
e/101/145 
f/102/146 
g/103/147
h/104/150 
i/105/151
j/106/152
k/107/153
l/108/154
m/109/155
n/110/156
o/111/157
p/112/160
q/113/161
r/114/162
s/115/163
t/116/164
u/117/165
v/118/166
w/119/167
x/120/170
y/121/171
z/122/172
{/123/173
|/124/174
}/125/175
~/126/176

Listing of Font Symbols
Name: −sg

1/001	22/026	+/43/053	@/64/100		U/85/125	Ψ	j/106/152	κ
2/002	23/027	./44/054	A/65/101	A	V/86/126		k/107/153	λ
3/003	24/030	−/45/055	B/66/102	B	W/87/127		l/108/154	μ
4/004	25/031	./46/056	C/67/103	Γ	X/88/130		m/109/155	ν
5/005	26/032	//47/057	D/68/104	Δ	Y/89/131		n/110/156	ξ
6/006	27/033	0/48/060	E/69/105	E	Z/90/132		o/111/157	o
7/007	28/034	1/49/061	F/70/106	Z	[/91/133		p/112/160	π
8/010	29/035	2/50/062	G/71/107	H	\/92/134		q/113/161	ρ
9/011	30/036	3/51/063	H/72/110	Θ	]/93/135		r/114/162	σ
10/012	31/037	4/52/064	I/73/111	I	^/94/136		s/115/163	φ
11/013	/32/040	5/53/065	J/74/112	K	_/95/137		t/116/164	χ
12/014	!/33/041	6/54/066	K/75/113	Λ	`/96/140		u/117/165	ψ
13/015	"/34/042	7/55/067	L/76/114	M	a/97/141	α	v/118/166	
14/016	#/35/043	8/56/070	M/77/115	N	b/98/142	β	w/119/167	
15/017	$/36/044	9/57/071	N/78/116	Ξ	c/99/143	γ	x/120/170	
16/020	%/37/045	:/58/072	O/79/117	O	d/100/144	δ	y/121/171	
17/021	&/38/046	;/59/073	P/80/120	Π	e/101/145	ε	z/122/172	
18/022	'/39/047	</60/074	Q/81/121	P	f/102/146	ζ	{/123/173	
19/023	(/40/050	=/61/075	R/82/122	Σ	g/103/147	η	|/124/174	
20/024	)/41/051	>/62/076	S/83/123	Φ	h/104/150	ϑ	}/125/175	
21/025	*/42/052	?/63/077	T/84/124	X	i/105/151	ι	~/126/176	

Listing of Font Symbols
Name: −cscp

1/001	22/026		+/43/053	+	@/64/100		U/85/125	$\mathcal{U}$	j/106/152	j
2/002	23/027		./44/054	,	A/65/101	$\mathcal{A}$	V/86/126	$\mathcal{V}$	k/107/153	k
3/003	24/030		−/45/055	—	B/66/102	$\mathcal{B}$	W/87/127	$\mathcal{W}$	l/108/154	l
4/004	25/031		./46/056	.	C/67/103	$\mathcal{C}$	X/88/130	$\mathcal{X}$	m/109/155	m
5/005	26/032		//47/057	/	D/68/104	$\mathcal{D}$	Y/89/131	$\mathcal{Y}$	n/110/156	n
6/006	27/033		0/48/060	0	E/69/105	$\mathcal{E}$	Z/90/132	$\mathcal{Z}$	o/111/157	o
7/007	28/034		1/49/061	1	F/70/106	$\mathcal{F}$	[/91/133		p/112/160	p
8/010	29/035		2/50/062	2	G/71/107	$\mathcal{G}$	\/92/134		q/113/161	q
9/011	30/036		3/51/063	3	H/72/110	$\mathcal{H}$	]/93/135		r/114/162	r
10/012	31/037	°	4/52/064	4	I/73/111	$\mathcal{I}$	^/94/136		s/115/163	s
11/013	/32/040		5/53/065	5	J/74/112	$\mathcal{J}$	_/95/137		t/116/164	t
12/014	!/33/041	!	6/54/066	6	K/75/113	$\mathcal{K}$	`/96/140	‘	u/117/165	u
13/015	"/34/042	’’	7/55/067	7	L/76/114	$\mathcal{L}$	a/97/141	a	v/118/166	v
14/016	#/35/043		8/56/070	8	M/77/115	$\mathcal{M}$	b/98/142	b	w/119/167	w
15/017	$/36/044	$	9/57/071	9	N/78/116	$\mathcal{N}$	c/99/143	c	x/120/170	x
16/020	%/37/045		:/58/072	:	O/79/117	$\mathcal{O}$	d/100/144	d	y/121/171	y
17/021	&/38/046	&	:/59/073	;	P/80/120	$\mathcal{P}$	e/101/145	e	z/122/172	z
18/022	'/39/047	’	</60/074		Q/81/121	$\mathcal{Q}$	f/102/146	f	{/123/173	
19/023	(/40/050	(	=/61/075	=	R/82/122	$\mathcal{R}$	g/103/147	g	|/124/174	
20/024	)/41/051	)	>/62/076		S/83/123	$\mathcal{S}$	h/104/150	h	}/125/175	
21/025	*/42/052	*	?/63/077	?	T/84/124	$\mathcal{T}$	i/105/151	i	~/126/176	

Listing of Font Symbols
Name: -dr

1/001	·	22/026	×	+/43/053	+	@/64/100	@	U/85/125	U	j/106/152	j
2/002	∘	23/027	←	./44/054	,	A/65/101	A	V/86/126	V	k/107/153	k
3/003	o	24/030	∇	-/45/055	−	B/66/102	B	W/87/127	W	l/108/154	l
4/004	◯	25/031	‡	./46/056	.	C/67/103	C	X/88/130	X	m/109/155	m
5/005	⊙	26/032	§	//47/057	/	D/68/104	D	Y/89/131	Y	n/110/156	n
6/006	□	27/033	†	0/48/060	0	E/69/105	E	Z/90/132	Z	o/111/157	o
7/007	△	28/034	±	1/49/061	1	F/70/106	F	[/91/133	[	p/112/160	p
8/010	◊	29/035	∞	2/50/062	2	G/71/107	G	\/92/134	\	q/113/161	q
9/011	☆	30/036	π	3/51/063	3	H/72/110	H	]/93/135	]	r/114/162	r
10/012	+	31/037	°	4/52/064	4	I/73/111	I	^/94/136	^	s/115/163	s
11/013	×	/32/040		5/53/065	5	J/74/112	J	_/95/137	_	t/116/164	t
12/014	*	!/33/041	!	6/54/066	6	K/75/113	K	`/96/140	`	u/117/165	u
13/015	●	"/34/042	"	7/55/067	7	L/76/114	L	a/97/141	a	v/118/166	v
14/016	■	#/35/043	#	8/56/070	8	M/77/115	M	b/98/142	b	w/119/167	w
15/017	▲	$/36/044	$	9/57/071	9	N/78/116	N	c/99/143	c	x/120/170	x
16/020	★	%/37/045	%	:/58/072	:	O/79/117	O	d/100/144	d	y/121/171	y
17/021	▶	&/38/046	&	;/59/073	;	P/80/120	P	e/101/145	e	z/122/172	z
18/022	⚒	'/39/047	'	</60/074	<	Q/81/121	Q	f/102/146	f	{/123/173	{
19/023	⊕	(/40/050	(	=/61/075	=	R/82/122	R	g/103/147	g	|/124/174	|
20/024	✳	)/41/051	)	>/62/076	>	S/83/123	S	h/104/150	h	}/125/175	}
21/025	⌑	*/42/052	*	?/63/077	?	T/84/124	T	i/105/151	i	~/126/176	~

Listing of Font Symbols
Name: –cc

1/001	22/026		+/43/053	@/64/100		U/85/125	Ф	j/106/152	Й
2/002	23/027		./44/054	A/65/101	А	V/86/126	Х	k/107/153	К
3/003	24/030		–/45/055	B/66/102	Б	W/87/127	Ц	l/108/154	Л
4/004	25/031		./46/056	C/67/103	В	X/88/130	Ч	m/109/155	М
5/005	26/032		//47/057	D/68/104	Г	Y/89/131	Ш	n/110/156	Н
6/006	27/033		0/48/060	E/69/105	Д	Z/90/132	Щ	o/111/157	О
7/007	28/034		1/49/061	F/70/106	Е	[/91/133	Ъ	p/112/160	П
8/010	29/035		2/50/062	G/71/107	Ж	\/92/134	Ы	q/113/161	Р
9/011	30/036		3/51/063	H/72/110	З	]/93/135	Ь	r/114/162	С
10/012	31/037		4/52/064	I/73/111	И	~/94/136	Э	s/115/163	Т
11/013	/32/040		5/53/065	J/74/112	Й	_/95/137	Ю	t/116/164	У
12/014	!/33/041	Ю	6/54/066	K/75/113	К	`/96/140	Я	u/117/165	Ф
13/015	"/34/042	Я	7/55/067	L/76/114	Л	a/97/141	а	v/118/166	Х
14/016	#/35/043		8/56/070	M/77/115	М	b/98/142	б	w/119/167	Ц
15/017	$/36/044		9/57/071	N/78/116	Н	c/99/143	в	x/120/170	Ч
16/020	%/37/045		:/58/072	O/79/117	О	d/100/144	г	y/121/171	Ш
17/021	&/38/046		;/59/073	P/80/120	П	e/101/145	д	z/122/172	Щ
18/022	'/39/047		</60/074	Q/81/121	Р	f/102/146	е	{/123/173	ъ
19/023	(/40/050		=/61/075	R/82/122	С	g/103/147	ж	|/124/174	ы
20/024	)/41/051		>/62/076	S/83/123	Т	h/104/150	з	}/125/175	ь
21/025	*/42/052		?/63/077	T/84/124	У	i/105/151	и	~/126/176	э

Listing of Font Symbols
Name: –cartr

1/001	○	22/026		+/43/053	+	@/64/100		U/85/125	U	j/106/152	J				
2/002	□	23/027		./44/054	,	A/65/101	A	V/86/126	V	k/107/153	K				
3/003	△	24/030		–/45/055	–	B/66/102	B	W/87/127	W	l/108/154	L				
4/004	◊	25/031		./46/056	.	C/67/103	C	X/88/130	X	m/109/155	M				
5/005	☆	26/032		//47/057	/	D/68/104	D	Y/89/131	Y	n/110/156	N				
6/006	+	27/033	·	0/48/060	0	E/69/105	E	Z/90/132	Z	o/111/157	O				
7/007	×	28/034	×	1/49/061	1	F/70/106	F	[/91/133		p/112/160	P				
8/010	*	29/035	→	2/50/062	2	G/71/107	G	\/92/134		q/113/161	Q				
9/011	●	30/036		3/51/063	3	H/72/110	H	]/93/135		r/114/162	R				
10/012	■	31/037	°	4/52/064	4	I/73/111	I	~/94/136		s/115/163	S				
11/013	▲	/32/040		5/53/065	5	J/74/112	J	_/95/137		t/116/164	T				
12/014	★	!/33/041	!	6/54/066	6	K/75/113	K	`/96/140		u/117/165	U				
13/015		"/34/042	"	7/55/067	7	L/76/114	L	a/97/141	A	v/118/166	V				
14/016		#/35/043	#	8/56/070	8	M/77/115	M	b/98/142	B	w/119/167	W				
15/017		$/36/044	$	9/57/071	9	N/78/116	N	c/99/143	C	x/120/170	X				
16/020		%/37/045		:/58/072	:	O/79/117	O	d/100/144	D	y/121/171	Y				
17/021		&/38/046	&	;/59/073	;	P/80/120	P	e/101/145	E	z/122/172	Z				
18/022		'/39/047	'	</60/074		Q/81/121	Q	f/102/146	F	{/123/173					
19/023		(/40/050	(	=/61/075	=	R/82/122	R	g/103/147	G	|/124/174	I				
20/024		)/41/051	)	>/62/076		S/83/123	S	h/104/150	H	}/125/175					
21/025		*/42/052	*	?/63/077	?	T/84/124	T	i/105/151	I	~/126/176					

Listing of Font Symbols
Name: –cgi

1/001	22/026	+/43/053	@/64/100		U/85/125	Ψ	j/106/152	κ
2/002	23/027	./44/054	A/65/101	A	V/86/126		k/107/153	λ
3/003	24/030	–/45/055	B/66/102	B	W/87/127		l/108/154	μ
4/004	25/031	./46/056	C/67/103	Γ	X/88/130		m/109/155	ν
5/005	26/032	//47/057	D/68/104	Δ	Y/89/131		n/110/156	ξ
6/006	27/033	0/48/060	E/69/105	E	Z/90/132		o/111/157	o
7/007	28/034	1/49/061	F/70/106	Z	[/91/133		p/112/160	π
8/010	29/035	2/50/062	G/71/107	H	\/92/134		q/113/161	ρ
9/011	30/036	3/51/063	H/72/110	Θ	]/93/135		r/114/162	σ
10/012	31/037	4/52/064	I/73/111	I	~/94/136		s/115/163	φ
11/013	/32/040	5/53/065	J/74/112	K	_/95/137		t/116/164	χ
12/014	!/33/041	6/54/066	K/75/113	Λ	`/96/140		u/117/165	ψ
13/015	"/34/042	7/55/067	L/76/114	M	a/97/141	α	v/118/166	
14/016	#/35/043	8/56/070	M/77/115	N	b/98/142	β	w/119/167	
15/017	$/36/044	9/57/071	N/78/116	Ξ	c/99/143	γ	x/120/170	
16/020	%/37/045	:/58/072	O/79/117	O	d/100/144	δ	y/121/171	
17/021	&/38/046	;/59/073	P/80/120	Π	e/101/145	ε	z/122/172	
18/022	'/39/047	</60/074	Q/81/121	P	f/102/146	ζ	{/123/173	
19/023	(/40/050	=/61/075	R/82/122	Σ	g/103/147	η	|/124/174	
20/024	)/41/051	>/62/076	S/83/123	Φ	h/104/150	ϑ	}/125/175	
21/025	*/42/052	?/63/077	T/84/124	X	i/105/151	ι	~/126/176	

Listing of Font Symbols
Name: —cip

1/001
2/002
3/003
4/004
5/005
6/006
7/007
8/010
9/011
10/012
11/013
12/014
13/015
14/016
15/017
16/020
17/021
18/022
19/023
20/024
21/025

22/026
23/027
24/030
25/031
26/032 
27/033 
28/034 
29/035 
30/036 
31/037
/32/040
!/33/041
"/34/042
#/35/043
$/36/044
%/37/045
&/38/046
'/39/047
(/40/050
)/41/051
*/42/052

+/43/053
./44/054
-/45/055
./46/056
//47/057
0/48/060
1/49/061
2/50/062
3/51/063
4/52/064
5/53/065
6/54/066
7/55/067
8/56/070
9/57/071
:/58/072
;/59/073
</60/074
=/61/075
>/62/076
?/63/077

@/64/100
A/65/101
B/66/102
C/67/103
D/68/104
E/69/105
F/70/106
G/71/107
H/72/110
I/73/111
J/74/112
K/75/113
L/76/114
M/77/115
N/78/116
O/79/117
P/80/120
Q/81/121
R/82/122
S/83/123
T/84/124

U/85/125
V/86/126
W/87/127
X/88/130
Y/89/131
Z/90/132
[/91/133
\/92/134
]/93/135
~/94/136
_/95/137
`/96/140
a/97/141
b/98/142
c/99/143
d/100/144
e/101/145
f/102/146
g/103/147
h/104/150
i/105/151

j/106/152
k/107/153
l/108/154
m/109/155
n/110/156
o/111/157
p/112/160
q/113/161
r/114/162
s/115/163
t/116/164
u/117/165
v/118/166
w/119/167
x/120/170
y/121/171
z/122/172
{/123/173
|/124/174
}/125/175
~/126/176

Listing of Font Symbols
Name: —cri

1/001	22/026		+/43/053	+	@/64/100	@	U/85/125	U	j/106/152	j
2/002	23/027		./44/054	,	A/65/101	A	V/86/126	V	k/107/153	k
3/003	24/030		-/45/055	-	B/66/102	B	W/87/127	W	l/108/154	l
4/004	25/031		./46/056	.	C/67/103	C	X/88/130	X	m/109/155	m
5/005	26/032		//47/057	/	D/68/104	D	Y/89/131	Y	n/110/156	n
6/006	27/033		0/48/060	0	E/69/105	E	Z/90/132	Z	o/111/157	o
7/007	28/034		1/49/061	1	F/70/106	F	[/91/133	[	p/112/160	p
8/010	29/035		2/50/062	2	G/71/107	G	\/92/134	\	q/113/161	q
9/011	30/036		3/51/063	3	H/72/110	H	]/93/135	]	r/114/162	r
10/012	31/037	°	4/52/064	4	I/73/111	I	~/94/136	~	s/115/163	s
11/013	/32/040		5/53/065	5	J/74/112	J	_/95/137	∮	t/116/164	t
12/014	!/33/041	!	6/54/066	6	K/75/113	K	`/96/140	`	u/117/165	u
13/015	"/34/042	"	7/55/067	7	L/76/114	L	a/97/141	a	v/118/166	v
14/016	#/35/043	#	8/56/070	8	M/77/115	M	b/98/142	b	w/119/167	w
15/017	$/36/044	$	9/57/071	9	N/78/116	N	c/99/143	c	x/120/170	x
16/020	%/37/045	%	:/58/072	:	O/79/117	O	d/100/144	d	y/121/171	y
17/021	&/38/046	&	;/59/073	;	P/80/120	P	e/101/145	e	z/122/172	z
18/022	'/39/047	'	</60/074	<	Q/81/121	Q	f/102/146	f	{/123/173	{
19/023	(/40/050	(	=/61/075	=	R/82/122	R	g/103/147	g	|/124/174	|
20/024	)/41/051	)	>/62/076	>	S/83/123	S	h/104/150	h	}/125/175	}
21/025	*/42/052	*	?/63/077	?	T/84/124	T	i/105/151	i	~/126/176	~

Listing of Font Symbols
Name: —crp

1/001	22/026		+/43/053	+	@/64/100	@	U/85/125	U	j/106/152	j
2/002	23/027		./44/054	,	A/65/101	A	V/86/126	V	k/107/153	k
3/003	24/030		-/45/055	—	B/66/102	B	W/87/127	W	l/108/154	l
4/004	25/031		./46/056	.	C/67/103	C	X/88/130	X	m/109/155	m
5/005	26/032	ff	//47/057	/	D/68/104	D	Y/89/131	Y	n/110/156	n
6/006	27/033	fi	0/48/060	0	E/69/105	E	Z/90/132	Z	o/111/157	o
7/007	28/034	fl	1/49/061	1	F/70/106	F	[/91/133	[	p/112/160	p
8/010	29/035	ffi	2/50/062	2	G/71/107	G	\/92/134	\	q/113/161	q
9/011	30/036	ffl	3/51/063	3	H/72/110	H	]/93/135	]	r/114/162	r
10/012	31/037	°	4/52/064	4	I/73/111	I	^/94/136	^	s/115/163	s
11/013	/32/040		5/53/065	5	J/74/112	J	_/95/137		t/116/164	t
12/014	!/33/041	!	6/54/066	6	K/75/113	K	`/96/140	`	u/117/165	u
13/015	"/34/042	"	7/55/067	7	L/76/114	L	a/97/141	a	v/118/166	v
14/016	#/35/043	#	8/56/070	8	M/77/115	M	b/98/142	b	w/119/167	w
15/017	$/36/044	$	9/57/071	9	N/78/116	N	c/99/143	c	x/120/170	x
16/020	%/37/045	%	:/58/072	:	O/79/117	O	d/100/144	d	y/121/171	y
17/021	&/38/046	&	;/59/073	;	P/80/120	P	e/101/145	e	z/122/172	z
18/022	'/39/047	'	</60/074	<	Q/81/121	Q	f/102/146	f	{/123/173	{
19/023	(/40/050	(	=/61/075	=	R/82/122	R	g/103/147	g	|/124/174	|
20/024	)/41/051	)	>/62/076	>	S/83/123	S	h/104/150	h	}/125/175	}
21/025	*/42/052	*	?/63/077	?	T/84/124	T	i/105/151	i	~/126/176	~

Listing of Font Symbols
Name: –engl

1/001	22/026		+/43/053	+	@/64/100		U/85/125	U	j/106/152	j
2/002	23/027		./44/054	,	A/65/101	A	V/86/126	V	k/107/153	k
3/003	24/030		–/45/055	–	B/66/102	B	W/87/127	W	l/108/154	l
4/004	25/031		./46/056	.	C/67/103	C	X/88/130	X	m/109/155	m
5/005	26/032		//47/057	/	D/68/104	D	Y/89/131	Y	n/110/156	n
6/006	27/033		0/48/060	0	E/69/105	E	Z/90/132	Z	o/111/157	o
7/007	28/034		1/49/061	1	F/70/106	F	[/91/133		p/112/160	p
8/010	29/035		2/50/062	2	G/71/107	G	\/92/134		q/113/161	q
9/011	30/036		3/51/063	3	H/72/110	H	]/93/135		r/114/162	r
10/012	31/037	°	4/52/064	4	I/73/111	I	^/94/136		s/115/163	s
11/013	/32/040		5/53/065	5	J/74/112	J	_/95/137		t/116/164	t
12/014	!/33/041	!	6/54/066	6	K/75/113	K	`/96/140	‘	u/117/165	u
13/015	"/34/042	’’	7/55/067	7	L/76/114	L	a/97/141	a	v/118/166	v
14/016	#/35/043		8/56/070	8	M/77/115	M	b/98/142	b	w/119/167	w
15/017	$/36/044	$	9/57/071	9	N/78/116	N	c/99/143	c	x/120/170	x
16/020	%/37/045		:/58/072	:	O/79/117	O	d/100/144	d	y/121/171	y
17/021	&/38/046	&	:/59/073	;	P/80/120	P	e/101/145	e	z/122/172	z
18/022	'/39/047	’	</60/074		Q/81/121	Q	f/102/146	f	{/123/173	
19/023	(/40/050	(	=/61/075	=	R/82/122	R	g/103/147	g	|/124/174	
20/024	)/41/051	)	>/62/076		S/83/123	S	h/104/150	h	}/125/175	
21/025	*/42/052	*	?/63/077	?	T/84/124	T	i/105/151	i	~/126/176	

Listing of Font Symbols
Name: –germ

1/001	22/026	+/43/053	@/64/100		U/85/125	𝔘	j/106/152	𝔧
2/002	23/027	./44/054	A/65/101	𝔄	V/86/126	𝔙	k/107/153	𝔨
3/003	24/030	–/45/055	B/66/102	𝔅	W/87/127	𝔚	l/108/154	𝔩
4/004	25/031	./46/056	C/67/103	ℭ	X/88/130	𝔛	m/109/155	𝔪
5/005	26/032	//47/057	D/68/104	𝔇	Y/89/131	𝔜	n/110/156	𝔫
6/006	27/033	0/48/060	E/69/105	𝔈	Z/90/132	ℨ	o/111/157	𝔬
7/007	28/034	1/49/061	F/70/106	𝔉	[/91/133		p/112/160	𝔭
8/010	29/035	2/50/062	G/71/107	𝔊	\/92/134		q/113/161	𝔮
9/011	30/036	3/51/063	H/72/110	ℌ	]/93/135		r/114/162	𝔯
10/012	31/037	4/52/064	I/73/111	ℑ	~/94/136		s/115/163	𝔰
11/013	/32/040	5/53/065	J/74/112	𝔍	_/95/137		t/116/164	𝔱
12/014	!/33/041	6/54/066	K/75/113	𝔎	`/96/140		u/117/165	𝔲
13/015	"/34/042	7/55/067	L/76/114	𝔏	a/97/141	𝔞	v/118/166	𝔳
14/016	#/35/043	8/56/070	M/77/115	𝔐	b/98/142	𝔟	w/119/167	𝔴
15/017	$/36/044	9/57/071	N/78/116	𝔑	c/99/143	𝔠	x/120/170	𝔵
16/020	%/37/045	:/58/072	O/79/117	𝔒	d/100/144	𝔡	y/121/171	𝔶
17/021	&/38/046	;/59/073	P/80/120	𝔓	e/101/145	𝔢	z/122/172	𝔷
18/022	'/39/047	</60/074	Q/81/121	𝔔	f/102/146	𝔣	{/123/173	𝔰
19/023	(/40/050	=/61/075	R/82/122	ℜ	g/103/147	𝔤	|/124/174	ß
20/024	)/41/051	>/62/076	S/83/123	𝔖	h/104/150	𝔥	}/125/175	ß
21/025	*/42/052	?/63/077	T/84/124	𝔗	i/105/151	𝔦	~/126/176	

6. APPENDIX IV. Feature codes for World Data Bank II

The World Data Bank II (National Technical Information Service, 1984) is a database of coastlines, political boundaries, lakes, rivers, etc. The data coverage is global, and it serves well for many of the cartographic applications in marine geology at the U.S. Geological Survey, Branch of Atlantic Marine Geology. Therefore, this database was selected for inclusion in MAPGEN as the principal source of coastline and related data. This does not mean that some other database, private or commercial, would not function just as easily.

The following feature codes are used to selectively extract features encoded in the World Data Bank II coastlines files. Data are divided into three major files: (1) international boundaries or limits of soverignty; (2) coasts, islands, and lakes; (3) rivers. The names of these files are particular to a given computer site, therefore the user should contact the local system administrator for the proper local file names. For each of the above three files, features and their codes are listed below.

File 1. International boundaries or limits of sovereignty

Code	Feature
01	Demarcated or delimited
02	Indefinite or in dispute
03	Otherline of separation or sovereignty on land

File 2. Coasts, islands, and lakes

Code	Feature
01	Coasts, islands, and lakes that appear on all maps
02	Additional major islands and lakes
03	Intermediate islands and lakes
04	Minor islands and lakes
06	Intermittent major lakes
07	Intermittent minor lakes
08	Reefs
09	Salt pans - major
10	Salt pans - minor
13	Ice shelves - major
14	Ice shelves - minor
15	Glaciers

File 3. Rivers

Code	Feature
Ø1	Permanent major rivers
Ø2	Additional major rivers
Ø3	Additional rivers
Ø4	Minor rivers
Ø5	Double-lined rivers
Ø6	Intermittent rivers - major
Ø7	Intermittent rivers - additional
Ø8	Intermittent rivers - minor
1Ø	Major canals
11	Canals of lesser importance
12	Canals - irrigation type

6.Ø.1 Reference

National Technical Information Service, 1984, World Data Bank II: U.S. Department of Commerce, v. 1, no. PB-271 871/2; v. 4, no. PB-271 872/2; v. 5, no. PB-271 873/2.