UNITED STATES DEPARTMENT OF INTERIOR
GEOLOGICAL SURVEY

GSLITH Version 1.0: A program to draw cross sections and plot plan views from regional-scale drill hole data using an IBM PC (or compatible) microcomputer, digitizer, and plotter.

by

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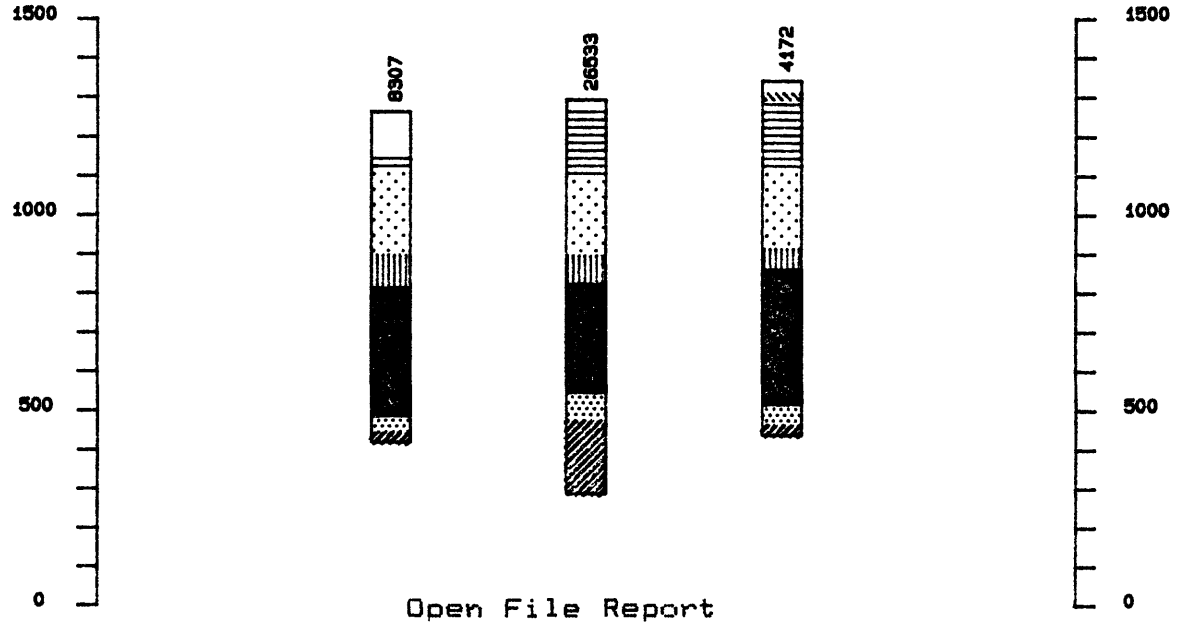

Open File Report
87-126
Program disk
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Disclaimer

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards. Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.

Although program tests have been made, no guarantee (expressed or implied) is made by the authors regarding program correctness, accuracy, or proper execution on all computer systems.

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INTRODUCTION

GSLITH is a microcomputer program for IBM PC or compatible computers with GTCO or compatible digitizer and Hewlett Packard or compatible plotter. GSLITH is designed to process data that define the "vertical" sequence of rock units at specified locations. The program allows a user to digitize the locations of drill holes, measured sections, or other places where such information has been obtained, store information about the vertical extent of units at each locality, and construct plan views or cross sections from this data. It employs a user-defined "standard set" of unit identifiers. Input of data for units at each locality is checked against this standard set to guarantee consistency. Plotter patterns are specified by the user for each unit, and are used in drawing plan views and cross sections. The program was designed to accommodate drill hole data, but can be used to plot and analyze data defining the vertical sequence of rock units from any source, so long as it is tied to a specific geographic position.

HARDWARE ENVIRONMENT

GSLITH is one of a series of computer programs for geologists, for use in an office environment. The programs use an IBM PC (or compatible) running the MS-DOS or PC_DOS operating system. The programs require a minimum hardware configuration as follows:

IBM PC or PC/XT
128K Random Access Memory
Two DS/DD Floppy disk drives or Hard disk
Two serial ports (or one port with T-Switch to switch between digitizer and plotter)
GTCO DigiPad Model 5 Digitizer
Hewlett-Packard Plotter.
8087 Coprocessor Chip

GSMAP and GSDRAW (Selner and others, 1986) probably provide the easiest introduction to this series of programs. The seeming complexities of GSLITH are more due to its many options than to intrinsic complexity.

INSTALLATION

The disk contains the program , a configuration file specifying the ports and speeds for a digitizer and plotter, and a file providing a standard set of symbols. The program (GSLITH.EXE) can be stored on floppy disks or on any sub-directory on a hard disk that is contained within the current search list (see PATH command in DOS manual). The other files should be stored on a separate floppy disk that is used for storing data, or within the default sub-directory where data files are to reside. The user should employ the standard DOS COPY command to place the program and other files on the appropriate disks, or in appropriate sub-directories on hard disks.

APPLICATIONS OF GSLITH

The GSLITH program was designed for preliminary analysis of lithologic and/or stratigraphic data from drill holes. It is not a replacement for the sophisticated stratigraphic or surface modeling problems available on larger computers. The program is latitude/longitude based and does not provide for slant holes, test for dip and strike of beds, or allow entry of data profiles such as those generated by electric logs. It is a start for data analysis. The word "well" is used generically in this documentation to indicate a place where data are available.

Cross sections

The program can draw a series of cross sections from well data to show the vertical extent of units in the wells plotted at true elevation, thus providing a quick way of 1) determining the consistency of a data set, 2) locating the critical wells, and 3) starting the process of data analysis. The program provides the capability of adjustment so that plots of wells on cross sections can be aligned at a specified contact plotted at a specified elevation. Such alignment of well data on cross-sections facilitates stratigraphic analysis. If a particular contact is specified. the program will draw cross-sections on which only those wells where this contact has been identified in the data will be plotted; wells lacking this contact will not be plotted. If alignment on the bottom of a bed is specified, there may be uncertainties about the stratigraphic meaning of the "bottom" or top of a bed as present in a data set. A type of block diagram can be constructed on a single sheet of paper by drawing a series of stacked cross sections.

Where stratigraphic thicknesses are needed, data from drill logs should be corrected for the dip of units when data is entered. so as to provide consistent information. Similarly, unit thicknesses derived from slant holes should be corrected before entry, if stratigraphic thicknesses are desired in cross sections.

Plan views

A series of plan views can be drawn to provide information on the stratigraphic and structural framework of an area. A plot of the elevation of the contact of two units provides the basis for construction of a structure contour map. A plot of the thickness of a unit provides a start for construction of an isopach map. ASCII files generated by GSLITH can be used with computer-driven contouring programs. If the elevation data from a series of wells are adjusted to bring a particular contact to a specified vertical position by the program, a plot of the vertical offset required for this adjustment provides insight into the shape of this contact in three dimensions, and a series of plots based on adjustments of a series of contacts map provide information on the initial form of a sedimentary basin and also on post-depositional modifications by warping, compaction and faulting. Horizontal slices through well data sets provides elements of a subsurface geologic map for the chosen elevation.

With the addition of fold axes and faults projected from surface data, insight on three dimensional geology is gained.

GRAPHICAL OUTPUT FROM GSLITH

Examples of drawings

These drawings were made from part of a larger set of well data from AVA 30 x 60 minute quadrangle in Missouri. We are indebted to the Missouri Geological Survey for these data which provide an excellent test of the capabilities of the GSLITH program. The plot control files and output files shown on these figures provide examples that will help in acquiring familiarity with the operation of the GSLITH program.

The ASCII output files generated by GSLITH can be used by other programs to make contoured drawings.

The GSLITH program provides several options for the adjustment of the positions of wells on cross sections. An understanding of some of the algorithms used by the program is important in following these procedures. In this description, the base or top of a unit refers to the bottom or top of a unit recorded in the log of a well. They are not necessarily used in the sense of stratigraphic base or top. The contact of two units refers to a position in a log where the elevation of the base of the upper unit is **identical** to the elevation of the top of the lower unit. Once again, this position is not necessarily a stratigraphic contact. The base and top depend on a single record in the log, a contact depends on two.

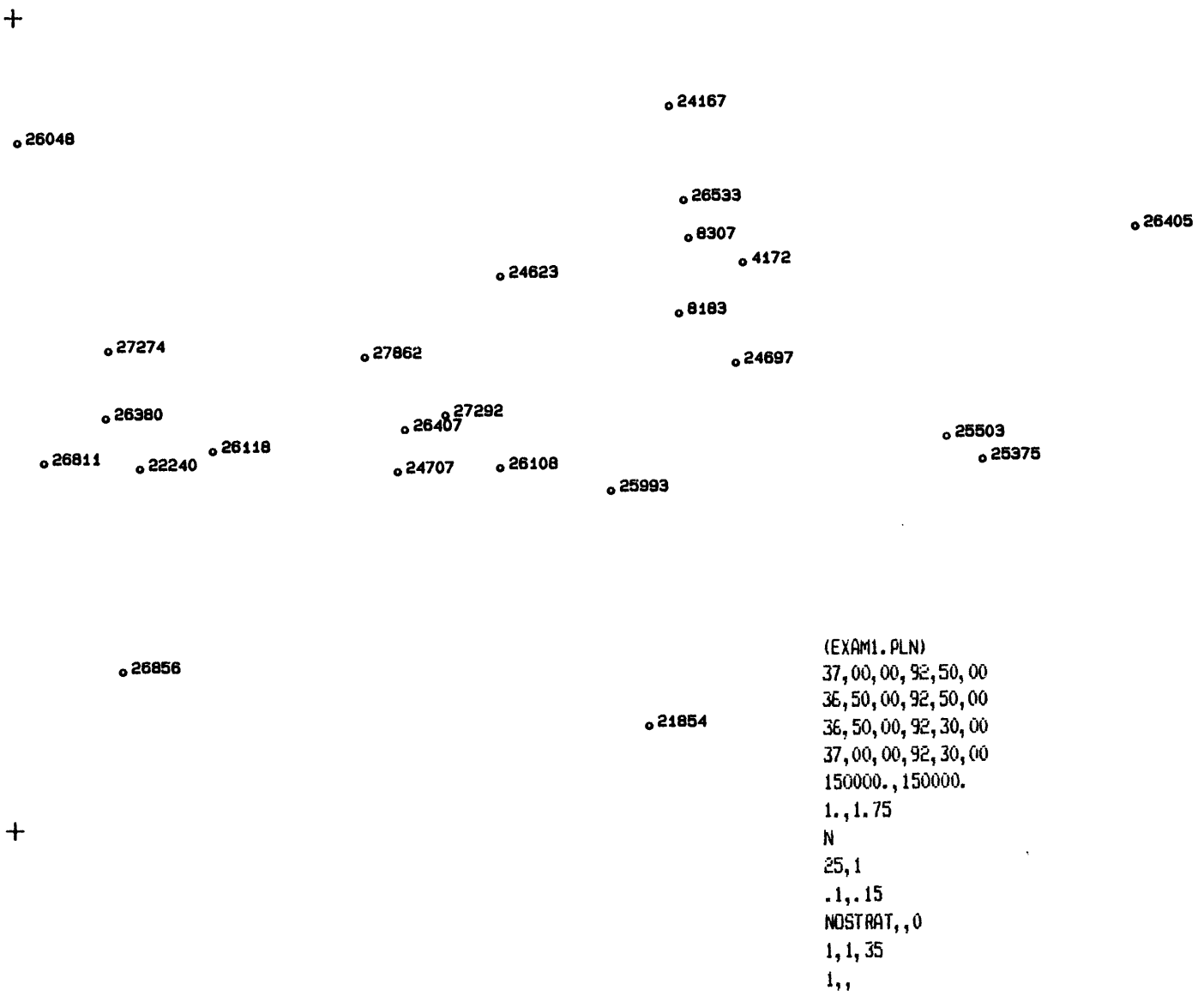
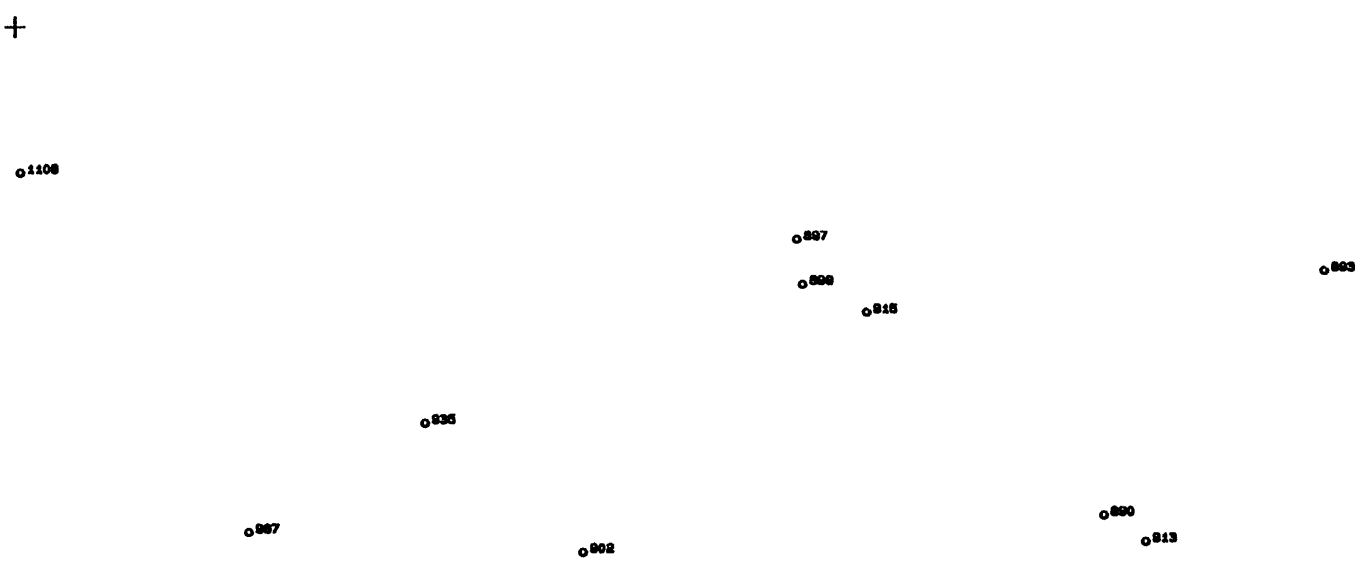
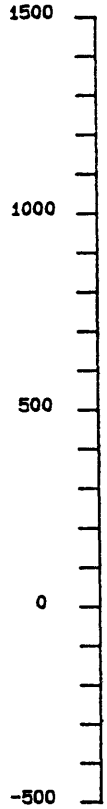


Figure 1. Plot of all wells, with well numbers posted.



(EXAM2.PLN)
37,00,00,92,50,00
36,50,00,92,50,00
36,50,00,92,30,00
37,00,00,92,30,00
150000.,150000.
1.,1.75
N
25,1
.07,.1
NOSTRAT,,0
1,1,35
8,Or,Duga

Figure 2. Plot of all wells where the contact between the Or and Duga is present, with the elevation of the Or-Duga contact posted.




```
(EXAM6.SEC)
1
-500,1500,500,100,.1
150000
.6,1
Y
25,1
.1,.15
Ojc,Or,1000
Y,4.25,9.5
36,52,0,92,50,0
37,0,0,92,32,0
-10.
```

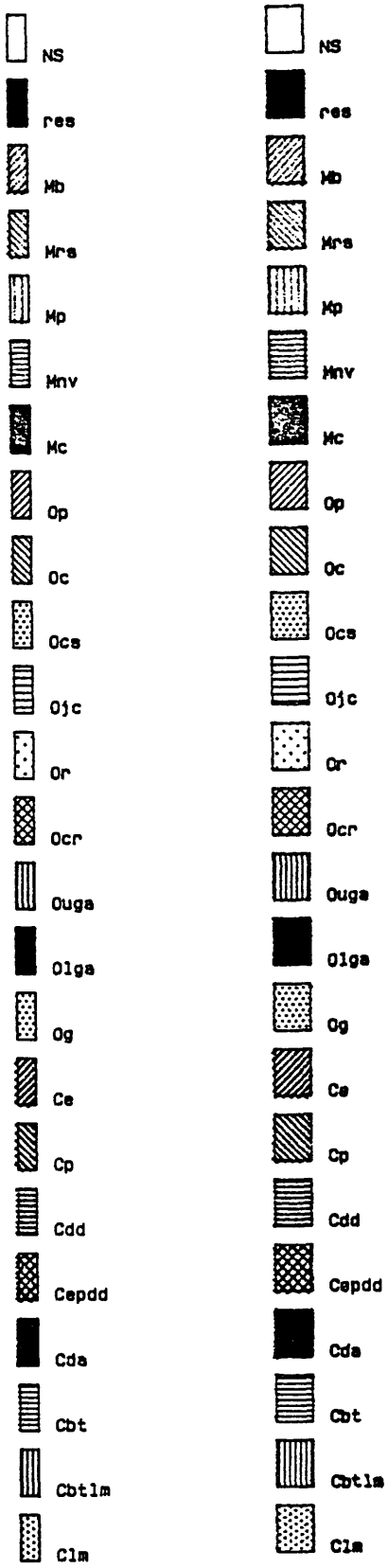
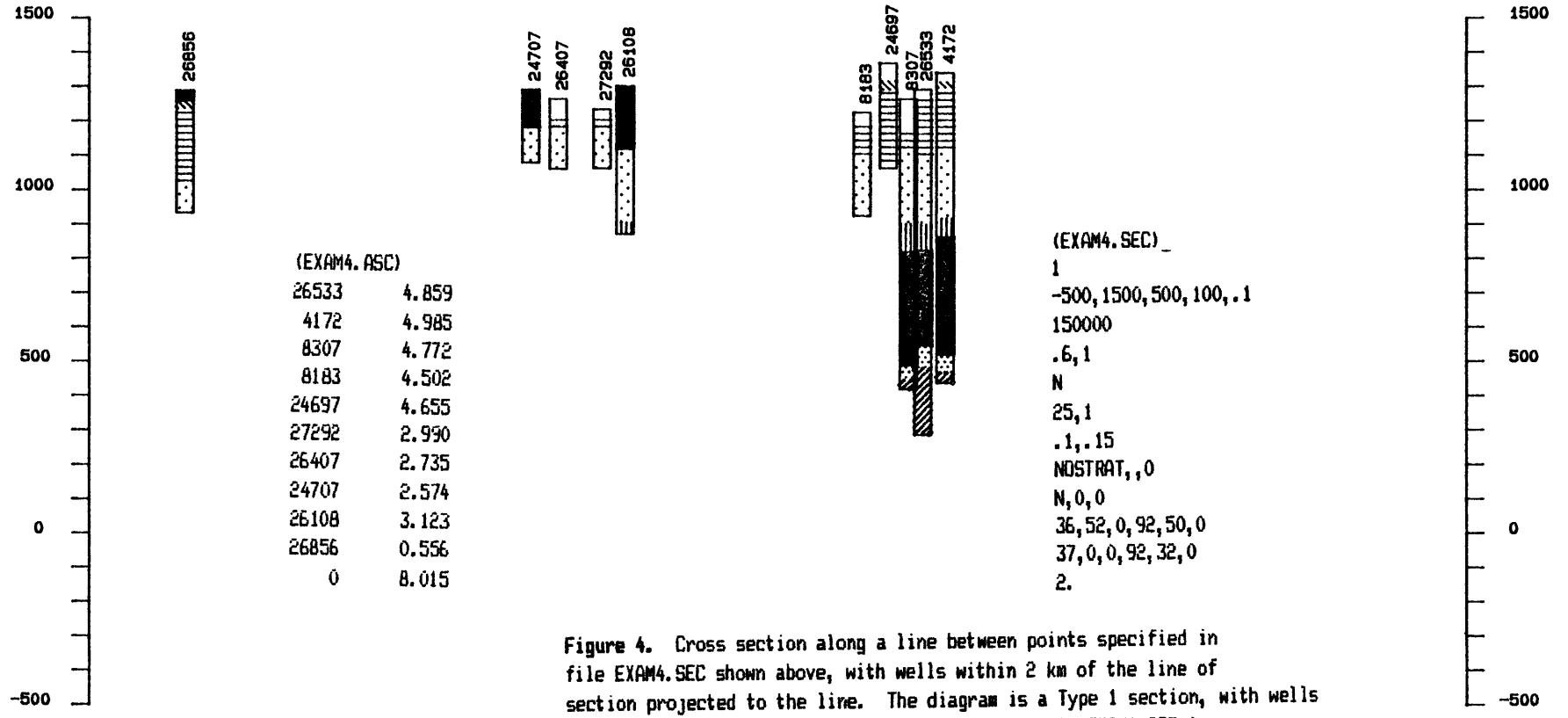


Figure 6. Samples of the legend; column to the left created with the plot file shown, column to the right would require change of line 2 of the plot file to -500,1500,500,100,.25

```
(EXAM3.PLN)
37,00,00,92,50,00
36,50,00,92,50,00
36,50,00,92,30,00
37,00,00,92,30,00
150000.,150000.
1.,1.75
N
25,1
.07,.1
NOSTRAT,,0
1,1,35
9,Ojc,Or
Or,Ouga
```

Figure 3. Plot of all wells where the Ojc-Or contact and the Or-Ouga are both present, with posting of the thickness between these two contacts (the thickness of the Or unit).



(EXAM4.ASC)

26533	4.859
4172	4.985
8307	4.772
8183	4.502
24697	4.655
27292	2.990
26407	2.735
24707	2.574
26108	3.123
26856	0.556
0	8.015

(EXAM4.SEC)_
1
-500,1500,500,100,.1
150000
.6,1
N
25,1
.1,.15
NOSTRAT,,0
N,0,0
36,52,0,92,50,0
37,0,0,92,32,0
2.

Figure 4. Cross section along a line between points specified in file EXAM4.SEC shown above, with wells within 2 km of the line of section projected to the line. The diagram is a Type 1 section, with wells plotted at their true elevation. The table EXAM4.ASC is an example of the ASCII file output with columns giving well number and distance along the line of section.

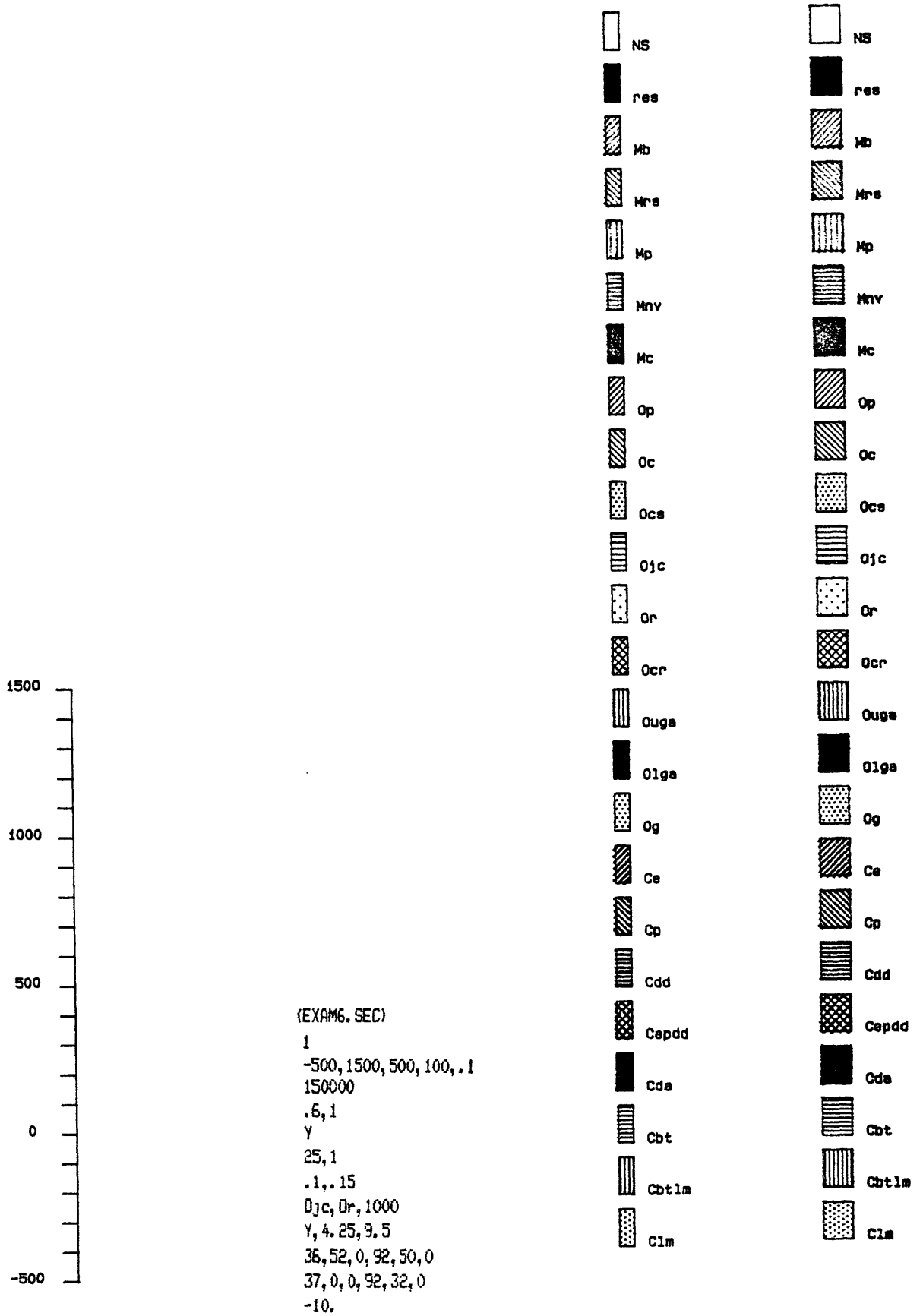


Figure 6. Samples of the legend; column to the left created with the plot file shown, column to the right would require change of line 2 of the plot file to -500,1500,500,100,.25

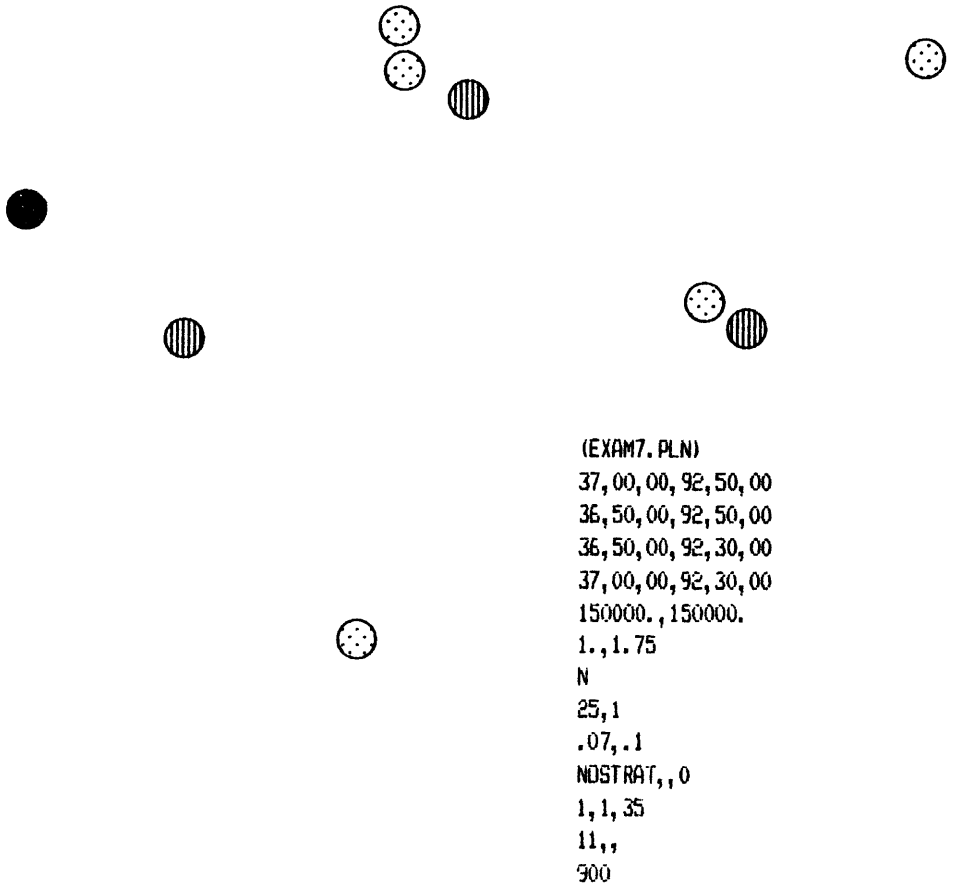


Figure 7. Patterns in circles show geologic units intersected by wells at an elevation of 900 feet.

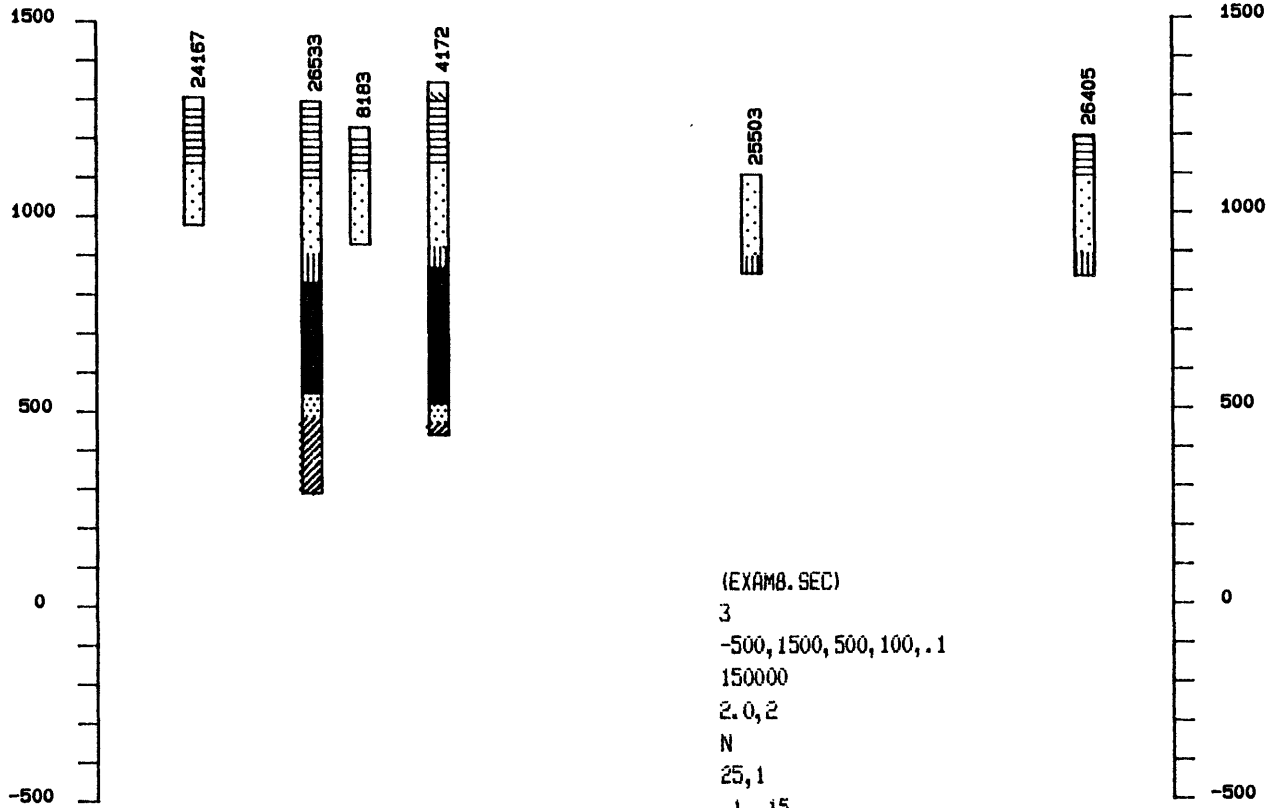


Figure 8. Plot of specifically chosen wells along line of section from plot file EXAM8.SEC shown. File EXAM8.INP specifies the wells to be plotted and their position along the line of section

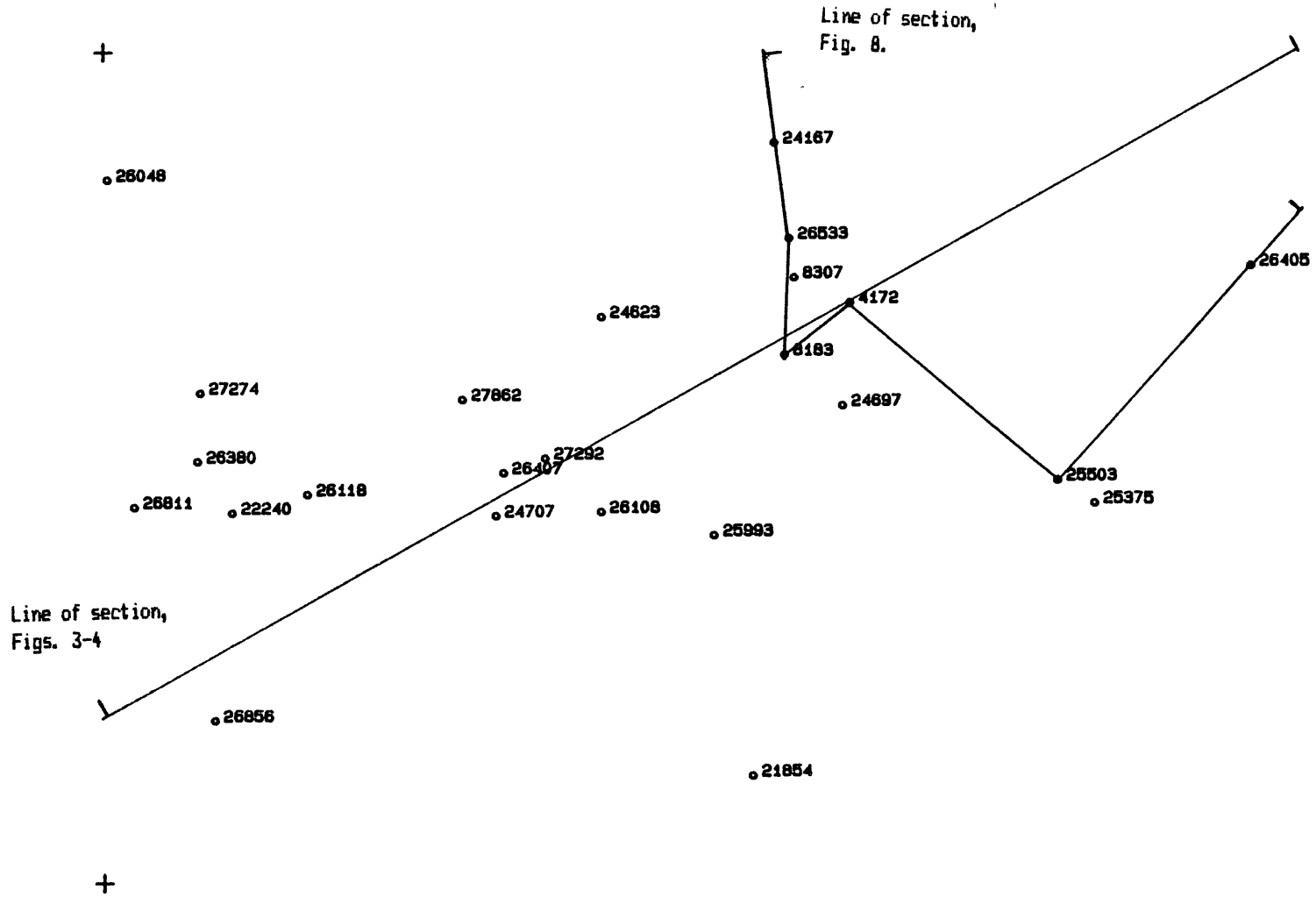


Figure 9. Plot of well locations with lines of sections drawn for fig. 3 and 4, and fig. 8.

Cross-Sections

Cross sections drawn by the GSLITH program show the units encountered in the well using the plotter patterns specified by the user in the file containing the "standard set" of unit identifiers. All wells are plotted vertically in cross sections. Plots of well data can be made at their correct elevation, can be adjusted vertically to bring a specified contact between two units to a specifiedelevation or can be adjusted to align the plots at a specified elevation for the base of a designated unit. Vertical lines are drawn at both ends of the cross-section, tick marks are drawn on these end lines at user specified intervals, to make a vertical scale, and numerical elevations are posted at appropriate tick marks near these end lines at user specified intervals. A "Legend" - a series of rectangles filled with the patterns for each unit specified by the user, followed by the identifier for the unit - can be drawn on the cross section, if desired.

Three different methods of drawing cross sections are available, as explained below.

Type 1. The beginning and ending points of a line of cross section are defined by latitude/longitude of the end points. Wells within a specified distance of this line are selected, by specifying this distance (in kilometers). Wells within this distance (from both sides of the line) are projected to the line of cross section (perpendicular to the line of section, and drawn in cross section. An ASCII file can be created during this procedure and used to generate a section of Type 3.

Type 2. The beginning and ending points of a line of cross-section are defined by latitude/longitude; wells designated by number, are projected to this line of section, and drawn in cross section. An ASCII file can be created during this procedure and used to generate a section of Type 3.

Type 3. All parameters of the cross section are specified in an ASCII file: these include the beginning and ending points of the line of section (measured in inches), and listings of well numbers, and their desired position along the line of section.

The first two types of cross sections facilitate plotting and analysis of well data. The third allows easy editing to eliminate overlap of wells on cross sections, deletion of wells with inconsistent data, and is useful in producing edited cross sections for publication.

Plan view maps

Plan view maps from this program are delimited by latitude/ longitude-defined corners and can be drawn in UTM, Lambert Conformal Conic, or Albers Equal Area map projections.
For one group of plan views numerical data from the well log is posted immediately to the right of a symbol (of user's choice) that is plotted at the well location. The posted data may be any of the following:

- the number used as the identifier of the well.
- the elevation of the base or top of a unit in the well (if the unit is present more than once, the elevations will be posted in sequence, that of the upper unit above those of lower units).
- the elevation of a contact between two specified units in the well.
- the thickness of the interval between two contacts in the well.
- the vertical adjustment required to bring the contact between two specified units to a specified elevation.

A second kind of plan view shows the unit present at a designated elevation (as if cut by in a horizontal slice. The units are shown by patterns specified by the user.

A third kind of plan (another flat slice) shows the units present at a designated elevation; but if a contact between two units has been adjusted to a specified elevation, the slice is cut and well intersections drawn as adjusted to the specified contact, not at a "true" elevation of intersection.

TUTORIAL SECTION

It seems to us that the easiest way to get started with GSLITH is to go- hands on and do a small project. **First.** Turn all of the hardware on - , plotter, digitizer, printer, moniter - if this must be done separately and computer. Boot up the computer **last.** Let's assume now that all hardware is operative and properly connected, and that the release disk is available and contains the following files: The first three files are necessary to the operation of GSLITH; the other files are specific to the sample project.

GSCAD.SYM ... This file contains definitions of symbols
CONFIG.CAD ... This file sets communication parameters between computer, digitizer and plotter
GSLITH.EXE ... This file contains the executable code for GSLITH
AVA.PRJ ... This is the projection file specific to the project
AVA.BED ... This the unit identifier file specific to the project
EXAM1.PLN ... Example of plan view plot control file
EXAM4.SEC ... Example of cross-section plot control file

In addition to files on the release disk, A word processing program must be available.

Getting started.

All projects start by creating a map projection file and a unit identifier file using the word processing program.

We should make you create files like AVA.PRJ and AVA.BED on your own, but let's cheat just a bit to speed things along, and use the files (AVA.PRJ and AVA.BED included on the release disk.

When you create such files on your own, be sure that your word processing program doesn't leave non printing embedded characters like document mode WORDSTAR does. We use non-document mode WORDSTAR and SIDEKICK. We assume that you know how to create ASCII files. Such files will be required many times when using GSLITH.

The Hard copy needed for this project starts with figure 1. Small circles on this map indicate the locations of 24 wells. A five digit number Immediately to the right of each circle provides the number of the well. The four corners of the map are shown by plus signs. The northwest corner is at latitude 37 degrees N, longitude 92 degrees 50 minutes W, the southwest corner is at latitude 36 degrees 50 minutes north, longitude 92 degrees 50 minutes W, the southeast corner is at latitude 36 degrees 50 minutes north and longitude 92 degrees 30 minutes west, the northeast corner is at longitude 37 degrees N and longitude 92 degrees 30 minutes W. In subsequent references to the corners these coordinates will be entered into the program in the following way: NW corner, 37,0,0,92,50,0, SW corner, 36,50,0,92,50,0, SE corner, 36,50,0,92,30,0, NE corner, 37,0,0,92,30,0

Projection files.

During digitizing, the projection file furnishes information to the computer about the map being used to digitize the locations of the wells. This projection file is used later by the GSLITH program when making drawings.

The projection file for the test project is AVA.PRJ, and is printed below, along with with a few explanatory notes that aren't actually a part of the projection file. The records in the projection file are as follows.

```
1          (NW quadrant of the earth
3          (UTM projection) (to match the map)
6378.2064  (Equatorial radius in km
6356.5838  (Polar radius in Km
93,00,00   (Standard meridian for the UTM zone of the map
```

Without the notes, the actual projection file is printed below.

```
1
3
6378.2064
6356.5838
93,00,00
```

THE UNIT IDENTIFIER FILE

The second file needed before operating the GSLITH program is the file which contains identifying names and graphic patterns for each unit that will be distinguished in the well records.

The rock unit identifier file printed below is AVA.BED. Its six columns contain the data needed by the GSLITH program for data entry and for definition of the patterns used to represent rock units in the drawings produced by the program. Each record ("line") contains information for one unit.

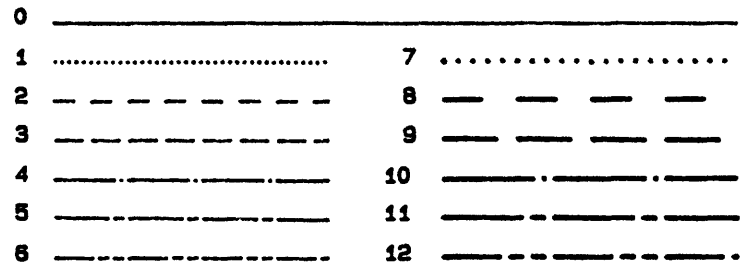
AVA.BED will be used as the unit identifier file for our sample project.

```
NS,      1,    0,    0,    0,    0
res,     8,    0,    1,   30,    0
Mb,      3,    0,    3,   30,   45
Mrs,     3,    0,    3,   30,  -45
Mp,      3,    0,    3,   40,   90
Mnv,     3,    0,    3,   30,    0
Mc,      3,    0,    1,   30,    0
Op,      4,    0,    3,   30,   45
Oc,      4,    0,    3,   30,  -45
Ocs,     4,    1,    3,   30,    0
Ojc,     4,    0,    3,   40,    0
Bjc,     4,    0,    0,   40,    0
Or,      4,    7,    3,   40,   00
Ocr,     4,    0,    4,   40,   45
Ouga,    4,    0,    3,   30,   90
Olga,    4,    0,    1,   30,    0
Og,      4,    1,    3,   30,    0
Ce,      7,    0,    3,   30,   45
Cp,      7,    0,    3,   30,  -45
Cdd,     7,    0,    3,   30,    0
Cepdd,   7,    0,    4,   40,   45
Cda,     7,    0,    1,   30,    0
Cbt,     2,    0,    3,   30,    0
Cbtlm,   2,    0,    3,   30,   90
Clm,     2,    1,    3,   30,   90
```

The units should be listed from top to bottom in this file in order of increasing age, The youngest in the first record, the oldest in the last. This gives the vertical sequence (arranged from top to bottom by increasing age that we expect in the legend, see fig. 6

The left (first) column of the bed file contains the identifier to be used for each unit present in the well data set. Data in the next five columns of each record specify the pen numbers, line patterns, and "fill" types to be used in the graphical representation of the unit. These are discussed in the documentation that came with the plotter. and reviewed on pages 28-37 of the GSDRAW-GSMAP documentation (Selner and others, 1986).

The second column of this file specifies the line type to be used in the graphical rrepresentation of the unit. The line type is specified by providing a number from 0 to 12. These line types are shown in the diagram below.



The third column of the bed file is made up of entries that specify the fill type to be used in representation of the unit.
The combination of line type and fill type defines the geometric pattern that will be drawn by the plotter for each unit. The fill type is designated by a number from 0 to 4, or from 7-10. It is defined by plotter firmware.

A fill type of 0 draws only the outline of the area.

Fill type 1 is a solid fill drawn with closely spaced parallel lines, all drawn in the same direction; after filling the area, it is edged (a line is drawn around it to smooth the outline).

Fill type 2 is a solid fill drawn with closely spaced parallel lines, drawn first in one direction, then in the other; the area is edged, after the fill is completed.

Fill type 3 is a set of parallel lines that fill the area; the area is edged after the fill has been completed.

Fill type 4 consists of two sets of mutually perpendicular parallel lines that form a grid that fills the area; the area is edged after the fill has been completed.

Fill types 7, 8, 9, and 10 correspond to 1, 2, 3, and 4 except that they are NOT edged ie. (the outline of the area isn't drawn.

In summary, Fill type 0 is no fill at all, fill types 1,or 2 produce a solid fill, fill type 3 is a series of parallel lines (closely spaced parallel dotted lines (line types 1 and 7) make a stipple pattern, Fill type 4 draws a grid; areas drawn with fill types 0-4 are edged, Fill types 7-10 are not edged, but otherwise are the same as Fill types 1-4.

The fourth column of the table contains the number of the pen that will be used to draw the unit, The carousel of the plotter has numbered positions. The pen you get as called by the GSLITH program will be the pen you load into the specified position in the carousel.

The fifth column of the table contains a number that specifies the separation in thousandths of an inch between parallel lines drawn as polygon fills types 3,4,9, and 10.
The sixth column of the table specifies the angle of the first set

of parall lines from the horizontal measured in degrees (+ angles are counterclockwise), - angles clockwise may also be used. Fill types are discussed in the plotter manual. Note that the angle zero (0) specifies horizontal lines, 90 specifies vertical lines. In the bed file, the entry in each column is ended by a comma, as shown shown in the example, AVA.BED on the preceeding page. Comparison of the entries in this table with the plots on figure 6 may help you visualize the graphical results of these plotter instructions.

Using the program

With AVA.PRJ and AVA.BED available, it's time to begin using the GSLITH program, so -- enter GSLITH from the keyboard. Follow instructions provided by screen prompts. From the main Menu, begin by invoking option 1 to start a new data base. The screen prompts will then direct you to make a series of entries.
ENTER DATA BASE NAME: The name SAMPLE might be used.
Next another screen prompt directs
ENTER MAP TITLE (16 CHARACTERS): The title Tutorial might be used. Then, more screen prompts ask for entry of the
LATITUDE,LONGITUDE OF NW CORNER then
LATITUDE LONGITUDE OF SW CORNER then
LATITUDE LONGITUDE OF SE CORNER then
LATITUDE LONGITUDE OF NE CORNER

Each of the latitude lLongitude entries must be in the form requested D,M,S,D,M,S NOTE positions of commas separating the numbers for degrees, minutes, and seconds, and latitude from longitude. Get the proper coordinates for the sample exercise from the previous page page describing the coordinates of Fig. 1, or from the plot file on Fig. 1.
Completion of these entries will cause return of the screen to the main Menu.

Digitizing locations

Next, Select option 3 so that digitizing of well locations can begin.

A screen prompt will call for the file name of the projection file

ENTER FILENAME OF PROJECTION PARAMETERS: enter AVA.PRJ, the projection file previously prepared to match the map on Fig. 1.

A SCREEN PROMPT WILL ASK
ENTER 0 (ZERO) KEY ON CURSOR KEYPAD TO SYNCHRONIZE DIGITIZER INPUT. for this first digitizer input the position of the cursor within the active area of the digitizer is not important -- just lightly press the zero key.

Next, be sure that Figure 1 is taped firmly to the digitizer table and that it is inside the active area of the digitizer. The next part of the digitizing procedure indexes the map to the digitizer table using the latitude longitude ticks at the map corners. **These corners must be the same** as the corners entered for the test project database. The map must not move during digitizing. Follow the directions provided by the screen prompts

ENTER NORTHWEST CORNER ON DIGITIZER
ENTER SOUTHWEST CORNER ON DIGITIZER
ENTER SOUTHEAST CORNER ON DIGITIZER
ENTER NORTHEAST CORNER ON DIGITIZER

These entries are made using the zero key on the keypad of the

cursor, with the cross hair of the cursor carefully positioned on the map at the position called for. These entries complete the indexing of the map to the digitizer tablet, and the work of digitizing the well locations can begin.

Now choose a well to start digitizing. Using the keypad of the digitizer enter the well number (digits in sequence from left to right), then use the "A" key to signal that the entire number has been entered. The number is entered beginning with the leftmost digit, the last digit on the right is entered last, and then the "A" is depressed. During these entries, the digitizer keypad can be at any position within the active area of the digitizer table.

Next accurately position the cross hair of the cursor at the location of the well being entered, and depress the "1" key to record this location. After this has been done, the system is ready to accept another well number. Continue the procedure as described to enter a new well number, then digitize the location of the new well. Continue until all wells have been entered. Then enter a well number of 0 (zero) followed by the "A" key to indicate that this is the complete entry. This will cause return of the computer to the main Menu, so that entry of data for each well can begin.

Entering other data

Choose option 6, and begin the process of entering data for the wells in this project.

Immediately following this paragraph is a list of the data for the wells of this sample project. This list is the output from the GSLITH program for a data base that includes the area of this test project. When you select option 8 from the Main Menu you will see the contents of the data base in this format, either on the screen or the printer as you specify. Examination of the listing will provide both the well data needed and an introduction to the output format for GSLITH data. For data entry follow directions of the screen prompts. When data for all wells have been entered, end the data entry procedure by entering two commas ,, instead of a well number. This will return the screen to the main menu.

In this list the unit data that you will need for all of the 24 wells in this test project is printed in the following format:

At the left end of the first line for a well you will find the Well number. it is followed by the latitude in degrees, minutes and seconds (with decimal seconds; the Longitude in degrees, minutes, seconds with decimal seconds; the elevation of the well collar; and finally by the total depth of the well.
On the second line for each well you will first find the unit identifier for the uppermost unit in the well, then the depth to the top and bottom of the unit.
succeeding lines for the well contain unit identifiers for other units and depths to the top and bottom of these other units.

List 1.

The list starts with data for well numbered 26048

26048	36	58 27.97	92	49 56.46	1228		310
				res	0	40	
				Or	40	120	
				Ouga	120	250	
				Olga	250	310	
24167	36	58 54.20	92	39 55.36	1304		327
				NS	0	25	
				Ojc	25	175	
				Or	175	327	
26533	36	57 44.84	92	39 42.61	1292		1005
				NS	0	20	
				Ojc	20	205	
				Or	205	395	
				Ouga	395	465	
				Olga	465	750	
				Og	750	815	
				Ce	815	1005	
				Oc	30	45	
				Ojc	45	225	
				Or	225	425	

4172	36	56	58.31	92	38	48.39		1340		903
						NS	0		30	
						Oc		30		45
						Ojc	45		225	
						Or	225		425	
						Ouga		425		475
						Olga		475		825
						Og	825		875	
						Ce	875		903	
8307	36	57	16.50	92	39	38.37		1264		845
						NS	0		100	
						Ojc	100		150	
						Or	150		365	
						Ouga		365		445
						Olga		445		780
						Og	780		820	
						Ce	820		845	
8183	36	56	20.83	92	39	47.47		1225		300
						NS	0		27	
						Ojc	27		125	
						Or	125		300	
24697	36	55	44.35	92	38	55.44		1368		305
						NS	0		55	
						Oc	55		80	
						Ojc	80		290	
						Or	290		305	
24623	36	56	48.41	92	42	31.77		1249		345
						NS	0		40	
						Ojc	40		195	
						Or	195		345	
26405	36	57	23.22	92	32	47.91		1198		360
						NS	0		5	
						Ojc	5		105	
						Or	105		305	
						Ouga		305		360
27274	36	55	54.05	92	48	32.78		1303		290
						NS	0		90	
						Ojc	90		168	
						Or	168		290	
26380	36	55	4.208	92	48	35.28		1256		275
						NS	0		50	
						Ojc	50		192	
						Or	192		275	
26811	36	54	31.35	92	49	32.57		1281		325
						NS	0		185	
						Ojc	185		250	
						Or	250		325	
22240	36	54	27.03	92	48	3.742		1282		295
						NS	0		40	
						Ojc	40		170	
						Or	170		295	
26118	36	54	40.24	92	46	56.10		1217		290
						NS	0		20	
						Or	20		230	
						Ouga		230		290

27862	36	55	49.07	92	44	36.42	1105	250
					res	0	30	
					NS	30	55	
					Or	55	170	
					Ouga	170	195	
					Olga	195	250	
27292	36	55	6.296	92	43	22.39	1234	172
					NS	-30	20	
					Ojc	20	65	
					Or	65	173	
26407	36	54	55.75	92	43	59.97	1264	203
					NS	0	50	
					Ojc	50	95	
					Or	95	203	
24707	36	54	24.68	92	44	6.872	1291	212
					res	0	110	
					Ojc	110	125	
					Or	125	212	
26108	36	54	27.43	92	42	32.06	1302	430
					res	0	185	
					Or	185	400	
					Ouga	400	430	
25993	36	54	10.58	92	40	50.45	1242	243
					NS	0	10	
					Ojc	10	190	
					Or	190	243	
25503	36	54	49.42	92	35	42.13	1100	252
					NS	0	15	
					Or	15	210	
					Ouga	210	252	
25375	36	54	32.66	92	35	9.280	1008	115
					NS	0	50	
					Or	50	95	
					Ouga	95	115	
26856	36	51	57.24	92	48	20.18	1288	355
					res	0	30	
					Oc	30	55	
					Ojc	55	270	
					Or	270	355	
2771	36	49	39.33	92	48	46.61	1115	292
					NS	0	20	
					Ojc	20	200	
					Or	200	292	
21854	36	51	16.96	92	40	16.62	1175	305
					res	0	40	
					Ojc	40	186	
					Or	186	305	

The data for well **21854** ends List 1.

PLOTTING THE DATA: PLOT CONTROL FILES

GSLITH requires user-created files which control the drawing of cross sections and plan views. These files are called Plot Control files (or plot files). They consist of a series of records created by using a word processing program. The contents of the Plot Control Files for each of the examples (figures 1-9 are shown on thse figures. To save time we have included the plot control file for figure 1 and the plot file for figure 4 on the release disk. Before we use the files let's examine the contents of each the file, and then have the plotter draw the figure as an example.

Plan view example

EXAM1.PLN is the plot file used to draw figure 1. The first four records provide the latitude and longitude of the corners of the map to be plotted. These may be, but do not have to be the same as the corners of the data base. The corners in turn are the NW, SW, SE, and last the NE.

```
37,00,00,92,50,00      NW
36,50,00,92,50,00      SW
36,50,00,92,30,00      SE
37,00,00,92,30,00      NE
150000.,150000.          X Scale (E-W) and Y scale (N-S)
```

1.,1.75 This record specifies the Xoffset, and Yoffset (in inches for the diagram. from the corner of the paper. "Offset" in X and in Y permits you to move the plotted diagram from one place on the paper to another place.

N This record either contains an N or a Y; N specifies do not "Rotate", Y specifies "Rotate". Y changes the X and Y axes from the default position. Refer to the plotter manual for further details. As the default orientation which is changed by a Y is dependant on the size of the paper in the plotter, please consult your manual.

25,1 This record specifies the pen velocity (cm/sec) and pressure (1 is about 10 grams, and minimizes wear on the pen point in cm.

NOSTRAT,,0 This entry tells the program that any elevations to be posted should be posted at their true figure.

1,1,35 This entry specifies use of pen 1,symbol number 1 (an open circle and that it is to be drawn 35 rasters in size (35/1016 inches)

1,,

Now let's plot figure 1 using this plot control file. From the Main Menu choose option 10. The program will request the name of the projection file enter AVA.PRJ. The next question is the name of the plot control file, respond EXAM1.PLN. The plotter will then draw figure 1 and return to the Main Menu.

Cross-section example

EXAM4.SEC is the plot control file used to draw Figure 4. Before we actually plot the cross-section, let's examine the contents of this file.

1 This record specifies that a section of Type 1 is to be drawn. As you obviously remember from page 11, this kind of section is defined by specifying the latitude and longitude of the starting and ending points and plots wells within a specified distance of this line projected perpendicularly to this line (both sides of the line)

-500,1500,5,500,100,.1 This record (the second in the plot file) specifies parameters for the lines that are drawn at the two ends of the cross section. From the left, the elevation of the base of the section, the elevation of the top, the tick mark interval, and finally the width in inches for the plots of the well columns

150000 This record specifies the horizontal scale. It does not have to be the same as the vertical scale specified in the previous record

diagram relative to the plotter paper, see notes above on the plan view plot file.

N This record specifies that the plot should not be rotated on the paper.

25,1 Speed and force see previous example

NOSTRAT,,0 As in the previous example, this entry specifies that all plots are to be drawn at their proper elevation

N,0,0 This record is used to ask that a legend be plotted or to specify that no legend should be plotted. The entry here tells the computer not to plot a legend.

36,52,0,92,50,0 This record specifies the position of the starting point of the cross section (latitude and longitude).

-

37,0,0,92,32,0 This record specifies the end point of the cross section (latitude and longitude).

2. This record specifies the distance in km (both sides of the line of section for selection of wells for plotting. This plot file tells the computer to plot wells within 2 km of the line of section (projecting them to the line of section along a line perpendicular to the line of section.

Now let's actually plot figure 4. From the Main Menu choose option 9. The program will request the name of the projection file, respond AVA.PRJ. The program will then request the name of the plot control file, respond EXAM4.SEC. The plotter will then draw figure 4 and return to the Main Menu.

Review

The user first constructs a file that identifies standard units and specifies graphical plot patterns for these units. This unit identifier file (or bed file) is utilized by the program to check the well data as they are entered, to verify consistency of the unit identifiers as entered. This insures that a standard terminology is used and that all identifiers have been specified, and that graphical patterns are defined for all of them.

Before digitizing, the user constructs a projection file that applies specifically to the map used for digitizing well locations. The user invokes Option 1 from the main GSLITH Menu to to create a database for the project at hand. The latitude/longitude corners specified for the database must match the corners of the map that will be used for digitizing well locations.

Next, one uses Option 3 from the main GSLITH Menu to enter the well numbers and to digitize the locations for wells from the map. Then, using option 6 of the main GSLITH Menu, data on the units in each well log is entered into the data base.

At this point the fun starts. Data can be edited, wells deleted and recovered, and drawing of maps and cross sections can begin. You have draw an example of a plan view and a cross-section. Please note that the plot files used to create Figures 1-9 are included on each figure. Using your word processing program you can create the plot control files for each figure and redraw the examples.

Plan views drawn at the same scale as the base, with well numbers posted enable easy checking of the data entered from the digitizer keypad. Data dumps made using Option 3 or 8 can be compared with well data to check keyboard entry of unit data. Needed editing can be done from the keyboard of the computer except for latitude and longitude. These values can only be changed by redigitizing the location of the well. The program allows the user to change unit lithology, depth to top and depth to bottom for individual units, and provides for the deletion or addition of unit records in all wells. Changes in the latitude longitude values from the keyboard are not possible. Errors in copying seem likely, and changes by digitizing are easy and accurate.

We have found that the drawing of cross sections is useful at this stage to check accuracy of data entry and the consistency of the well data.

At the data entry stage, data bases and digitizing are tied to one specific map. Later, if larger areas are needed in a single data base, another data base can be created and the databases created for parts of this area merged to cover the entire area.

REFERENCE SECTION

The GSLITH program is menu driven. The user operates the program by making choices from the menus and responding to instructions and information requests that are typed on the screen. The program operates in the following sequence:

1) A data base is created, or an existing data base opened.

2) Wells are entered, by entering identification numbers from the digitizer and then the latitude and longitude of their location are digitized.

3) Well data (elevation of the top of the well, bottom of the well, units encountered, depth to their top and bottom) are entered.

4) Plots and files can then be created from the data base.

5) Revisions and editing of data are done, locations can be revised by re-digitizing their latitude/longitude, and other data can be changed from the keyboard of the computer.

The user should start the program running by typing GSLITH followed by a carriage return, from the keyboard while at the DOS prompt. A disclaimer screen will be displayed on the monitor. The user should type a space using the space bar and the program will display the menu.

THE MAIN MENU

G S L I T H

CURRENT DATA BASE:

1 - START A NEW DATA BASE
2 - OPEN AN EXISTING DATA BASE
3 - DIGITIZE NEW WELL LOCATIONS
4 - DELETE A WELL
5 - RECOVER A WELL
6 - ENTER UNIT DETAILS FOR A WELL
7 - EDIT UNIT RECORDS FOR A WELL
8 - LIST CONTENTS OF DATA BASE
9 - PLOT SECTION VIEW ON THE PLOTTER
10 - PLOT PLAN VIEW ON THE PLOTTER(POSTING)
11 - MERGE ANOTHER DATA BASE INTO THE CURRENT DATA BASE
12 - EXIT

ENTER CHOICE BY NUMBER:

Main Menu

The Main Menu is displayed above. The user expresses his desire by entering the number for the appropriate choice and then striking the carriage return (Enter or <-- key).

The user must start up a data base before you can use the other options listed. This process establishes an Index File and a Data File for the data base. The Unit Identifier File and the Map Projection File also will be needed after opening the data base. A data base is only started once (choice = 1). After it is established, the data base is opened (choice = 2) for subsequent sessions.

1 - START A NEW DATA BASE

The program will clear the screen and request the user to provide a name for the data base. This name will be used to form the filenames for the two parts of the data base: the index file and the data file. The data base name can consist of up to six alphanumeric characters containing no blanks, periods or commas. The extension .NDX will be added for the index file; .LSF will be added for the data file. The program will then request a title (up to 16 characters) and then request the user to supply the latitude of the four corners of the map area. These correspond to the map corners, which will be used for digitizing, and must be entered in the format specified on the screen. After these entries, the database files will be created, and the program will ask for the name of the table (including extension) containing the valid bed identifiers. After this is supplied, the program will return to the main menu. The user will not need to open the data base if you have just started it to continue operation of

the program.

2 - OPEN AN EXISTING DATA BASE

Normally the user will be working with a data base which was started in a previous session, and for which the database files already exist. Selection of a "2" will clear the screen and a prompt will request the name of the data base. The name of the data base should be entered. The program will add the extension of .NDX and .LSF to the data base name and will check to see if the files exist, and open the data base if it exists. Next, the program will ask for the name of the file (including extension) containing thr valid bed identifiers. After this entry, the program will return the screen to the main menu.

3 - DIGITIZE NEW WELL LOCATIONS

The program will clear the screen and request the full filename (including extension) of a projection file which applies to the map from which well locations are to be digitized. Follow directions on-screen for synchronizing communication between the digitizer and the computer. The program will then request the user to enter the location of the northwest corner of the map by centering the cursor over the location and depressing the "0" key. Each of the four corners are entered in sequence (NW, SW, SE, and NE) as requested. Well locations are then digitized in response to requests from the screen. All information is entered from the cursor keypad. When the program requests the well number, depress the keys on the cursor keypad to enter the number of the well, reading from left to right; after the last number is entered, depress the A key to signify that the well number has been entered. The location of the well is then digitized by placing the cursor over the exact well location and depressing the "1" key. If the well number has already been entered, the program will ask if you wish to redigitize the location for this well before allowing the position to be re-digitized. A "Y" from the keyboard of the computer will allow you to re-digitize this position. A "N" from the keyboard will return the digitizing procedure to permit entry of a new well identifier. Each well number and location is entered in turn from the keypad. After all locations have been entered, enter an A on the keypad instead of a numerical well identifier (the equivalent of a well number of zero; this tells the program to return to the main menu.

Note that wells must be designated by number; letters may not be used. This requirement is necessitated by the code that operates the program.

4 - DELETE A WELL

The program will clear the screen and request the well number of the well to be deleted. After entering the numbers of all wells to be deleted, each in response to this question, enter a well number of zero to return to the main menu.

5 - RECOVER A WELL

This option allows you to recover a well that was deleted by mistake. The program will clear the screen and request the number of the well that was previously digitized (and for which data may have been entered), and subsequently deleted. Enter a well number of zero to return to the main menu.

6 - ENTER UNIT DETAILS FOR A WELL

After the location of a well has been digitized, the user should supply the detailed information about the units in the well. The program will request the well number, then request the elevation of the top of the well and then the total depth of the well. Next the program will ask the user to supply information about the units cut by the well. Each unit identifier, depth to top, and depth to bottom, should be entered and separated by commas. The program will check each unit identifier to verify that it is a legitimate unit identifier. After all unit records are entered, type two commas and a carriage return to indicate end of unit information.

7 - EDIT UNIT RECORDS FOR A WELL

Once a well location has been digitized and the unit record detail entered, any changes to the values must be made using this option. The screen will clear and the user will be requested to enter the well number to be edited. The well number, top elevation and total depth will appear across the top of the screen and will be followed by the first ten unit records. Across the last line of the screen will appear a series of options; the program will pause waiting for the user to enter his choice. The choices are as follows:

1 - CHANGE
Change the well number, top elevation, total depth, or any unit record.

2 - DELETE
Delete any unit record

3 - PRINT NEXT SECTION
Print the next ten unit records

4 - INSERT AFTER
Insert a new unit record after an existing unit record

5 - QUIT
Returns to the well number to edit question

Each of the choices will be followed by specific questions as to the unit record to edit, and the new values to be entered. When all editing has been done, respond with a zero to the well number question and the program will return to the main menu.

8 - LIST CONTENTS OF DATA BASE

The program will clear the screen and request the user to indicate whether the data should be printed to the screen or to the printer. The user is then requested to indicate whether he wishes to see records for a specific well or all wells. A response of -1 will create a listing of the data for all wells; entry of a specific well number entry will cause the program to list the data for that well only. After the data are listed, the program will return to the well number question. A well number of zero will cause the program to return to the main menu.

9 - PLOT SECTION VIEW ON THE PLOTTER

The screen will clear and the user will be asked to supply the filename of a projection file and the name of a plot control file. If the user has specified method 1 or 2, he will be asked if the program should save a file containing the well number and distance along the section line. If he responds Y, then he is asked to supply a filename for the data.

10 - PLOT PLAN VIEW ON THE PLOTTER (POSTING)

The screen will clear and the user will be requested to enter the complete filename of a projection file that contains the information for the plot to be created. The program will then request the filename of a plot control file. The user is then asked if the well number, latitude, longitude, and the selected value for posting should be saved in an output file. If he responds Y, then he is asked to supply a filename. This option is designed to allow the user to export the well data to gridding and contouring programs for the creation of isopach maps, etc. The program will then search through the data base and post the indicated symbol at the well location and the chosen data value on the right side of the symbol.

11 - MERGE ANOTHER DATA BASE INTO THE CURRENT DATA BASE

The screen will clear and the user will be requested to enter the data base name of a data base which is to be merged into the current data base. The information contained on the specified data base will be added to the end of the current data base.

12 - EXIT

The program will exit to the DOS operating system.

MORE ABOUT PROJECTION FILES

Each projection file consists of a series of ASCII records that provide information about the map projection needed when digitizing or plotting a geographic area. The projection file is identical to that utilized by the GSMAP program (Selner and others, 1986).

Record 1

A code identifying the quadrant of the earth.

1 - North Latitude, West longitude
2 - North Latitude, East Longitude
3 - South Latitude, East Longitude
4 - South Latitude, West longitude

Example 1 for US

Record 2

A code describing the type of projection.

1 - Lambert Conformal Conic projection (1 standard parallel
2 - Lambert Conformal Conic projection (2 standard parallels
3 - Universal Transverse Mercator

4 - Albers Equal Area

Example 2 for Lambert Conformal Conic (2 standard parallels)

Record 3

The earth's equatorial radius: for the Clarke 1866 Spheroid, use a value of 6378.2064

Record 4

The earth's polar radius: for the Clarke 1866 Spheroid, use a value of 6356.5838.

Record 5

This record is dependent on the type of projection chosen.

Lambert Conformal Conic (1 parallel)
Enter the applicable value.

Lambert Conformal Conic (2 parallels)
In the US enter 45,33.

Universal Transverse Mercator
Enter the standard meridian of the applicable zone

Albers Equal Area (standard parallels)
In the US enter 45.5,29.5.
In Alaska enter 65,55.
In Hawaii, enter 18,8

Record 6

This record is dependent on the type of projection selected.

Lambert Conformal Conic (1 parallel), Lambert Conformal Conic (2 parallels) and Albers Equal Area

Enter the central meridian of the map.

Universal Transverse Meridian

Enter the scale factor. (Usually 0.9996)

EXAMPLES

Lambert Conformal Conic - two parallels

1	Northwest quadrant of Earth
2	"2" specifies LCC - two standard parallels
6378.2064	Equatorial radius in KM, Clarke, 1866
6356.5838	Polar radius in KM, Clarke, 1866
45,33	Standard parallels for map
105,0,0	Central meridian for map

Universal Transverse Mercator - UTM

1	Northwest quadrant of Earth
3	"3" specifies UTM projection
6378.2064	Equatorial radius in KM, Clarke, 1866
6356.5838	Polar radius in KM, Clarke, 1866
105,0,0	Standard meridian for map
0.996	Scale factor

MORE ABOUT UNIT IDENTIFIER FILES

The unit identifier file is created with the aid of an ASCII word processing program (like SIDEKICK or non-document mode WORDSTAR). Each record in the Unit Identifier File contains an identifier assigned to a lithologic or stratigraphic unit, followed by parameters that define the pen and pattern to be plotted as graphic output. A maximum of 99 different units can be specified.

Unit Identifier	up to eight alphanumeric characters no blanks or commas
Pen number*	1-8 (depending on plotter)
Line type*	0-12
Pattern Type*	0-10
Line Spacing in rasters*	1 raster = 1/1016 inch
Angle of lines*	measured in degrees in a counterclockwise direction

* See GSMAP/GSDRAW documentation for definition.

EXAMPLE OF A UNIT IDENTIFIER FILE

```
C1,7,0,1,50,0
C2,8,0,1,50,0
C,8,0,1,50,0
CS,8,1,3,20,90
S,2,1,3,40,90
G,3,7,3,60,90
B1,6,0,4,50,0
B2,6,0,4,50,0
B,6,0,4,50,0
BR,1,0,3,50,-60
X,0,0,0,0,0
```

Records should be entered into the unit identifier file in the sequence desired when plotting the legend. Stratigraphic units should generally be entered in order of increasing age (top to bottom). Units lacking age or order significance can be entered in any order. Fill patterns 0, 7, 8, 9, or 10 are suggested to avoid overprinting of the contacts of units caused by the outlining of polygons of fill patterns 1, 2, 3, and 4.

MORE ABOUT PLOT CONTROL FILES

Cross Sections

Plot control files for sections allow the user to specify the plot parameters and select the data to be plotted. The plot control file consists of a series of ASCII records in a file with a name specified by the user.

Record 1 specifies the method of defining the cross section that is to be drawn. The user enters the number that corresponds to the procedure selected to draw the type of section desired.

1 = Beginning and ending points to be specified by latitude and longitude, and well data to be projected (perpendicularly) to this cross-section line if the wells are located within a specified distance (Km) of this line of cross-section.

2 = Beginning and ending points to be specified by latitude and longitude, and wells specified by number to be projected (perpendicularly) to this line of cross section.

3 = An ASCII text file specifies the beginning and ending points of the cross-section (inches along the cross section), the wells to be plotted by well number, and the positions of their plots along the cross section.

Example 1

Record 2 specifies the base elevation, final elevation, vertical scale, tick mark interval (in feet) and the width of the well column in inches. The program will construct a vertical scale on the left and right sides of the cross-section. The scale will be labeled on even multiples of the vertical scale.

Example 3600,4600,200,20,0.25

Record 3 specifies the horizontal scale.

Example 250000

Record 4 specifies the offset, in inches, for the lower left corner of the cross section from the default position of the plotter on the paper.

Example 1,1

Record 5 contains a code of Y or N specifying whether or not the plot is to be rotated on the plotter paper.

Example Y

Record 6 specifies the speed and force at which the plotter is to draw the map or cross-section. Normally the speed is 15 centimeters per second (cps) for final drawings and 55 cps

for drafts. Minimal force is generally used to minimize the wear on the pen points (value of 1 or 2).

Example 25,1

Record 7 specifies the width and height, in centimeters, for letters and numbers that are posted.

Example 0.1,0.15

Record 8 specifies parameters that determine (1) whether the plots of well data are drawn to their correct elevation (based on the elevation entered for the top of the hole); (2) are to be aligned at a specified elevation for the bottom of a chosen unit if it was encountered in the hole; or (3) are to be aligned at a specified elevation on the contact of two specified units.

- To draw plots that show wells at their actual elevation, enter "NOSTRAT",,0 for Record 8.
- To draw plots of wells in which the bottom of a unit is fixed at a specified elevation, enter the unit identifier and the elevation desired, e.g.

Or,,1000 for Record 8.

- To draw plots that show wells in which a contact is fixed at a specified elevation, enter the two unit identifiers and the elevation desired eg. Or,Oc,1000. A plot of the well will be drawn only if both units are present in the well and the depth of the base of the first unit (here Or) matches the depth of the top of the second unit (here Oc).

Record 9 specifies whether a legend is to be plotted or not. To plot a legend, enter Y and the position of the top left corner location (in inches) where the legend is to be plotted; to not plot a legend, enter N,0,0

Examples

- To plot a legend with top at position X=6,Y=9 on the paper, enter Y,6,9
- To make a plot without a legend enter N,0,0

Beyond this record, the contents of the Plot Control File differ according to the type of section to be drawn as specified in record 1.

For a section of Type 1

Record 10 specifies the starting point of the cross section as specified by latitude-longitude expressed in degrees, minutes, seconds.

Example 43,37,30,112,30,0

Record 11 specifies the ending point of the cross section as specified by latitude-longitude expressed in degrees, minutes, seconds.

Example 43,37,30,112,22,30

Record 12

This record specifes the distance (in kilometers) on both sides of the cross-section line that selects wells for inclusion in the cross-section.

Example 0.5

For a section of Type 2

Record 10

This record determines the starting point of the cross-section as specified by latitude-longitude expressed in degrees, minutes, seconds.

Example 43,37,30,112,30,0

Record 11

This record determines the ending point of the cross-section as specified by latitude-longitude expressed in degrees, minutes, seconds.

Example 43,37,30,112,22,30

Record 12 through N+1

These record specify the well numbers to be projected to the section line.

- One well number should be written on each line
- The last line should contain only a zero (0), to indicate the end of the list.

Example

```
12345
12346
12347
0
```

For a section of Type 3

Record 10
This record specifies the name of a file that contains a list of well numbers and distance in inches along section with the last line containing a well number of zero (0) and the total length of the section in inches.

Example
TESTSECT.FIL

This file is generally created while making sections of Type 1 or 2, but can be written using a word processing program that does not use embedded (non-printing) characters.

PLOT CONTROL FILES FOR
Plan Views

Plot control files for plan views (maps) consist of a series of ASCII records that specify the kind of plot desired.

Record 1
This record specifies the latitude-longitude of the NW corner of the area.
Example 43,15,00,112,52,30

Record 2
This record specifies the latitude-longitude of the SW corner of the area.
Example 42,45,00,112,52,30

Record 3
This record specifies the latitude-longitude of the SE corner of the area.
Example 42,45,00,112,07,30

Record 4
This record specifies the latitude-longitude of the NE corner of the area.
Example 43,15,00,112,07,30

Record 5
This record specifes the map scale for the x direction and the y direction
Example 125000,125000

Record 6
This record specifies the offset (in inches) from the corner of the paper where the SW corner of the map is to be drawn.
Example 1,1

Record 7
This record indicates whether the plot is to be rotated on the plotter paper, value of Y; or not rotated, value of N.
Example Y

Record 8

This record specifies the speed and force at which the plotter is to draw the map or section. Normally the speed is 15 centimeters per second (cps) or less for drawings using technical pens and ink, and up to 55 cps for drafts using fibertip pens. Minimal force is generally used to minimize wear on the pen points, value of 1 or 2.

Example 25,1

Record 9

This record specifies the size (width and height) in centimeters of the characters that are to be posted.

Example 0.1,0.15

Record 10

This record contains the specifications that control the vertical parameters of data plots. Vertical positioning can be based on the elevation of the top of the well (true elevation), on a selected (and fixed) elevation for the bottom of a unit, or on a fixed elevation for a contact of two units.

- If plots are to be based on the elevations of the well tops (true elevations without adjustment), the entry is:

"NOSTRAT",,0

- If plots are to be based on the elevation of the bottom of a unit (adjustments based on that position), the entry is the unit identifier, a second comma, and the elevation specified for alignment: Or,,10000

- If plots are to be aligned at a stratigraphic contact, the entry consists of the identifier of the upper unit, followed by the identifier of the lower unit, followed by the fixed elevation

"Ocs","Or",1000

Record 11

This record specifies the pen number to be used, the symbol number and the size of the symbol in rasters.

Example 1,5,35 (specifies pen number 1, symbol type 5 at a size of 35 rasters (about 1/1000 inch). (Symbols and procedures for coding of additional symbols are described in the appendix.

Record 12

Record 12 specifies the kind of value to be posted.

1 = Well Number
2 = Elevation at the top of the well
3 = Elevation at the bottom of the well
4 = Depth of the well
5 = Elevation at the top of a unit
6 = Elevation at the bottom of a unit
7 = Thickness of a unit
8 = Elevation of a contact between two units
9 = Thickness of a unit between two contacts
10 = The computed vertical offset necessary for stratigraphic alignment
(See Note Below)
11 = Plot horizontal slice at a specified elevation

Note: when the stratigraphic sequence of a well (or series of wells) is adjusted to the base of a rock unit, contact, or other geologic horizon, the values plotted are relative to the fixed elevation.

Examples of the contents of Record 12

1,, Post well numbers
2,, Post elevations at tops of wells
3,, Post elevations at bottoms of wells
4,, Post depths of wells
5,Ocs, Post the elevation of the top of the Ocs unit as entered in the well data (this is not necessarily the stratigraphic top)
6,Ocs, Post the elevation of the bottom of the Ocs unit as entered in the well data (this is not necessarily the stratigraphic base)
7,Ocs, Post the thickness of unit Ocs encountered in the well (this may or may not be the stratigraphic thickness, depending on data entry practice)
8,Ocs,Or Post the elevation of the contact between the base of the Ocs and the top of the Or
9,Ocs,Om Post the thickness of the unit between the contact defined by the base of the Ocs and the top of the Om and a second contact which will be identified in Record 13
10,, Post the offset required to align horizon specified in record 10 at elevation specified in that record
11,, Plot unit (a circle filled with the specified pattern) for a specific kind of rock intersected by a horizontal slice through the wells at a specified stratigraphic position. The vertical distance above the specified position is given in Record 13.

Record 13 (only used for plot options 9 and 11)

- For plot option 9, enter the second (lower) contact
- For Plot option 11, enter the vertical distance required.

Note: If Record 10 specifies "NOSTRAT",,0, this gives a sort of geologic map drawn at the specified elevation, here 1000 feet

above sea level. If the data of Record 10 are aligned on a specified horizon, the geologic slice would be drawn 1000 feet above the specified horizon.

REFERENCES

Selner, G. I., Taylor, R. B., and Johnson, B. R., 1986, GSDRAW and GSMAP Version 3.0: Prototype Programs for the IBM PC or Compatible Microcomputers to assist Compilation and Publication of Geologic Maps and Illustrations: U.S. Geological Survey Open-File Report 86-447A, Program Disks 86-447B, 53 p., 2 disks.

APPENDIX

Data Base Structure

Each data base contains records for wells within a study area. The data base consists of two data files: an index file and a data file. Both files use direct access methodology with the data stored in binary format. The index file contains one record for each well; the data file contains one record for each unit within a well.

INDEX FILE

Well Id.	8 bytes	Identification of the well, integer value
Latitude	8 bytes	Latitude of the well collar
Longitude	8 bytes	Longitude of the well collar
Top Elevation	4 bytes	Elevation of well collar
Total Depth	4 bytes	Depth to bottom of well
First Record	4 bytes	Starting record number within the data file
Last Record	4 bytes	Final record number within the data file

First record of the file contains an eight character identification of the data base, a latitude-longitude value of 0, the total number of wells, a depth of 0, a starting record number of 1 and a final record number equal to the last record used in the data file.

DATA FILE

Unit ID	8 bytes	Identification of the unit
Top Depth	4 bytes	Depth to the top of the unit
Bottom Depth	4 bytes	Depth to the bottom of the unit

SOFTWARE

Version 1.0 of GSLITH was written and tested using the MicroSoft QuickBASIC Compiler to improve execution speed. The program cannot be tested or executed under BASICA, but must be compiled using Microsoft QUICKBASIC. Because the program supports the 8087 co-processor, a product such as 87BASIC from Microway is needed: this product modifies the standard libraries from Microsoft to call the 8087 chip. The program can be compiled and executed using the standard Microsoft compiler and libraries after removing one line (CALL MICROSOFT), but the execution time is slower. The compilation should include the compiler switches /O, /E and /V. The program is linked with an object module called GWCOM.OBJ that is supplied with the QuickBasic Compiler to support the transmission of data through the RS-242 Communications Adaptors. The program has been tested using 128K of RAM memory and should run on versions of 2.1 DOS and greater. The release disk contains the source code in ASCII format, the executable code generated by the QuickBASIC compiler and the LINK program (supplied with the QuickBasic compiler), the symbol file (GSCAD.SYM), and a file named CONFIG.CAD used to set communication parameters among computer, digitizer, and plotter.

The minimum software requirements for utilizing the programs are PC/DOS 2.1 or higher, the release diskettes and a word processing program capable of producing ASCII files. The authors utilize Wordstar in non-document mode as the word processing program.

CONFIG.CAD

The file named CONFIG.CAD is included for use with GSLITH to set proper communications between computer, plotter, and digitizer. The file contains two lines of text enclosed in quotes. The first line applies to the digitizer, the second to the plotter. In each line the text specifies the asynchronous transmission port to which the device is attached, the transmission speed (baud), and other parameters that apply to communication between hardware device and computer. The user is referred to the OPEN COM .. statement in the IBM Basic manual for explanation of these parameters. The user normally would not change the contents of the file, which looks like the example below:

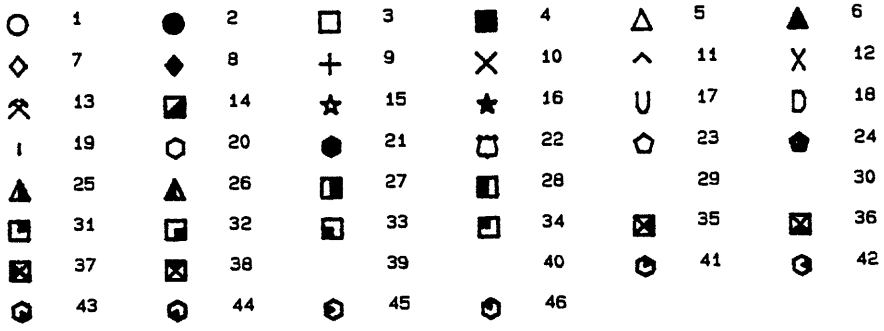
```
"COM2:1200,N,8,1"
"COM1:2400,N,8,1,RS,CS65535,DS,CD"
```

SYMBOLS

GSCAD.SYM

The file named GSCAD.SYM is included for use with GSLITH to provide a standard set of symbols that can be used in drawing plan view plots. This symbol set was created during the development of the GSMAP/GSDRAW software and contains many commonly used symbols. Additional symbols can be coded by the user using a word processing program such as non document mode WORDSTAR. Knowledge of a programming language is not required.

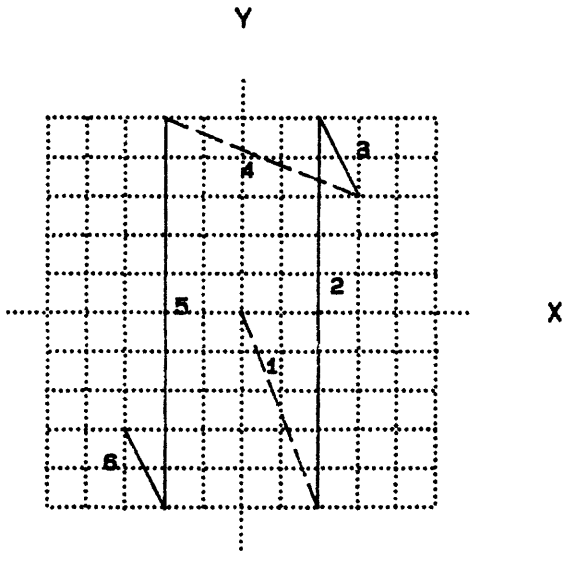
Standard symbols



CODING OF NEW SYMBOLS

New symbols can be coded by the user and included in the GSCAD.SYM file. The coding is easier than might be anticipated. Sketch a square of unit edge, with a point at the center. Begin specifying each symbol assuming that the pen is at the center point. Each line of the code tells the pen to move to a new position in the square; a "PU" specifies that the move is with the PEN UP (no line drawn), a "PD" specifies that the move is made with PEN DOWN (drawing a line). All moves are relative to the last point, not to the center of the square.

- The center of the square is the point that is digitized and the center of the plotted symbol.
- The first line of the symbol specifies the number assigned to the symbol, the number of moves, and if the polygon defined by the symbol is to be filled "Y", or is not to be filled "N".
- Each subsequent line begins with a "PU" or "PD" instruction, and defines the move in the X direction, and the move in the Y direction.
- The pen need not be returned to the center point at the end of drawing the symbol.

EXAMPLE OF CODING OF A USER DEFINED SYMBOL

```
209,6,"N"
"PU",0.2,-0.5
"PD",0.0,1.0
"PD",0.1,-0.2
"PU",-0.5,0.2
"PD",0.0,1.0
"PD",-0.1,0.2
```