UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GEOPROGRAM

A PROGRAM FOR GEOLOGIC PHOTOGRAMMETRY ON THE KERN DSR ANALYTICAL PLOTTER

USERS MANUAL

by
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BRIEF DESCRIPTION

GEOPROGRAM aids in geologic mapping from aerial and terrestrial photographs using the Kern DSR analytical plotter. Via the program, geologists can: manipulate and manage three-dimensional data digitized from stereo photographs; calculate geologic parameters, such as, strike and dip of bedding, plunge and direction of fold axes, and true thickness of bedding; project planes that represent geological surfaces into the stereoscopic model allowing for visual extrapolation from, and interpolation between, measured outcrops. Data management includes storing, retrieving, plotting, and displaying of geologic line-work, symbols, and text. Various plot and display projections are available.

The program was implemented on the Kern DSR series of analytical plotters with a PDP11/53-RT11 plate processor and a MicroVAXII-VMS main processor. Executable modules of GEOPROGRAM (GEOP.EXE) and the necessary plate processor program (KDPP88.SAV) are available on request from the author at the Institute of Surveying and Photogrammetry, Technical University of Denmark, DK2800 Lyngby, Denmark.

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0. INTRODUCTION

GEOPROGRAM aids in geologic mapping from aerial and terrestrial photographs using the Kern DSR analytical plotter. Via the program, geologists can: manipulate and manage three-dimensional data digitized from stereo photographs; calculate geologic parameters, such as, strike and dip of bedding, plunge and direction of fold axes, and true thickness of bedding; project planes that represent geological surfaces into the stereoscopic model allowing for visual extrapolation from, and interpolation between, measured outcrops. Data management includes storing, retrieving, plotting, and displaying of geologic line-work, symbols, and text. Various plot and display projections are available.

Chapter I of this manual gives a generalized outline of the program's capabilities extracted from Dueholm and Coe, 1989, chapter II explains how to define the various program parameters, chapter III explains how to operate the program, and chapter IV gives detailed descriptions of all program modules organized according to the menu structure of the program. Chapter IV should be used as a reference rather than a comprehensive text.

First time users must read chapter I and II, other users can start with chapter III and use chapter IV as a reference for detailed information. Routine users may only need the help screens available in the program.

I. PROGRAM DESCRIPTION

Geologic Functions

The core geological functions of GEOPROGRAM are the calculation of mathematical planes called geoplanes , which represent the attitudes of geological surfaces, and projection of these planes throughout the stereoscopic model (Dueholm, 1981). These functions were originally developed for the Kern PG2 photogrammetric plotting instrument at the Geological Survey of Greenland in Copenhagen, and also implemented on the Computerized Photogrammetric Mapping System (CPMS) at the USGS in Denver (Pillmore et al., 1981; Dueholm and Pillmore, 1989).

Geoplanes are calculated from points measured on visible geological horizons, contacts, and geomorphic surfaces in the stereoscopic model. As the geologist traces an outcrop with the floating mark, points can be digitized continuously, according to a time or distance/angle criteria, or as individual points when a foot switch is activated. A

plane is fitted to the measured points by means of least-squares adjustment and the attitude (strike and dip) is calculated. If more than three points have been measured, standard deviation on strike and dip is calculated as well. If the distribution of the measured points is linear, only the apparent dip of the plane is calculated.

The accuracy of geoplanes depends on the interpretability (visibility) of the outcrops, the distribution of the points measured on the outcrops, and the attitude of the plane. On nearly horizontal bedding with clearly visible outcrops, standard deviation on dip is commonly as low as 0.1 to 0.3 degrees, while the standard deviation obtained on diffuse, small, and steeply dipping outcrops may be as high as 2 to 5 degrees.

Two or more geoplanes may be combined to form a composite plane defining the attitude of a horizon. Geoplanes measured on "layer-cake" stratigraphy may be combined to give the composite orientation of the structure (this facility is called foliation in the program). Two or more apparent dip measurements can be added to form the true attitude of a plane. Geoplanes can be shifted stratigraphically parallel to bedding to define the level of another unit. True and apparent thickness of bedding can be calculated and displayed. This is accomplished by establishing a plane on a geologic horizon, and continuously displaying the vertical and perpendicular distances from the plane to the current position of the floating mark. Two geoplanes measured on the same horizon on opposite sides of a fault can be used for the calculation of fault displacement. While the floating mark is guided along the fault line, the distance between the two geoplanes, representing the vertical fault displacement at the current location, is continuously calculated and displayed. The axis of a folded unit of beds is calculated by combining two or more geoplanes each measured on different outcrops of the folded beds. Each geoplane is measured within small areas that can be considered planar.

The projection of a geoplane, which defines a geologic horizon, into the stereoscopic model is achieved by limiting the movements of the floating mark. As the geologist moves the tracing assembly in X, Y, and Z, the floating mark is guided by the program to move only within the geoplane. Thus, the intersection of the geoplane with the stereoscopically perceived terrain can be traced with the floating mark. This can be used to interpolate or extrapolate from measured outcrops: making the identification of new outcrops of the same horizon possible; and allowing the geologist to map areas where the horizon, defined by the geoplane, is covered with debris and/or vegetation. From the least-squares adjustment error surfaces on both sides of the geoplane are calculated. During projection, the standard deviation of the plane at the current position of the float-

ing mark is continuously computed, based on the error surfaces, and displayed. A new outcrop found above or below the exact plane position can be evaluated against the standard deviation to help the geologist judge whether or not the outcrop in question belongs to the horizon defined by the plane (figure 1).

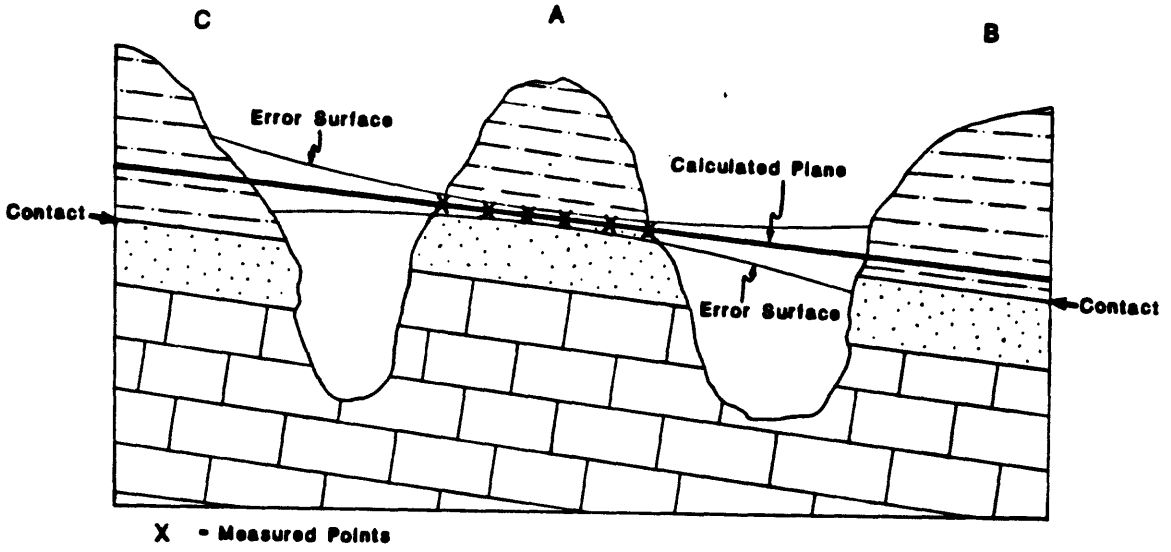

Figure 1. Sketch illustrating in two dimensions a geoplane calculated from points measured along a contact at outcrop A and the associated standard deviation error surfaces. The contact at outcrop B falls within the error surfaces and thus the probability is high that the contact lies in the same plane as the contact at A. The contact at outcrop C does not fall within the error surfaces, inferring either that the contacts do not correspond or that vertical movement has taken place between outcrops B and C.

Data Recording and Plotting

Recording and plotting of data are done simultaneously or independently according to the setting of record on/off and plot on/off keys. Line types and symbols can be defined individually and data can be labeled. Data can be displayed on a graphical screen, plotted on a pen plotter, or both at the same time in any chosen plot projection. Off-line plotting of data files can be directed to various other devices including a film recorder.

A GEOPROGRAM function provides the ability to scroll through recorded data. As this is done, the floating mark of

the photogrammetric instrument simultaneously moves to the coordinate positions of the data points. Foot switches control the direction and speed of scroll. In effect, this facility superimposes previously measured and recorded data onto the stereoscopic image of the terrain, providing a means for verification of recorded data or for visually locating spatial data from any source.

The data recording function includes a simple backstep editor. While the geologist scrolls up through the recording file, data from the current file position to the end of the file may be deleted. This function is meant for immediate correcting of errors discovered during data capture. For more advanced editing the files should be transferred to a geographical information system. An interface from GEOPROGRAM to the Kork Geographical Information System (KGIS) is available at the USGS.

Plot Projections

During map compilation several plot areas (windows) with different projections may be in use simultaneously. Geologists can switch between plot areas by merely entering the area number. The following plot projections are available: 1) Orthographic- where the geologist can generate normal map projections and stratigraphic profiles; 2) Perspective views- seen from any direction at any angle; 3) Axonometric- for isometric and diametric drawings; 4) Full Periphery- an exotic specialty for mapping the walls of drifts (tunnels) and shafts.

The capability of simultaneous plotting in several plot areas allows the geologist to inspect and evaluate compiled data from many view angles during interpretation and mapping work. For example, one window could produce a traditional orthogonal map projection, another, a vertical profile plane onto which data are projected, and a third, a perspective view of the data. Since recorded data are stored in three dimensions they may be subsequently plotted in any of the projections available.

II. PROJECT DEFINITION

The program is menu driven and allows the user to immediately start on-line plotting, data recording, and/or measurement of geological parameters. Program parameter settings are saved between sessions so that the program will restart in the same mode(s) as it was left in. At the start of a new project the initialize project and define plot menus should be checked to ensure that all parameters are set correctly.

Initialize Project

Under this menu the project name and users name are entered, and the files for recording of plot data (Rc.File) and storing of measured geoplanes (Pl.File) are named, opened, and checked.

The program uses various files for storing of plot area, line type, and symbol records. These files may be initialized under this menu. Initializing the files erases all previously defined records. The files can hold an unlimited number of records and should be added to rather than initialized. Specifically, line types and symbols can be reused from project to project making initialization unnecessary. Previously defined plot areas are reused when plotting recorded data in the off-line plotting mode. Therefore, do not initialize these files unconsciously. If initializing is necessary, then first backup the old files. The files are located in the $DISK3:[KERN.DSR.DATA] directory and named: GEOPLT.DAT, GEOLIN.DAT, and GEOSYM.DAT.

Define Plot

Projections for on-line and off-line plotting are defined under this menu.

The transformation from ground coordinates to plot coordinates are divided into two separate steps: the "ground-to-trans" transformation and the "trans-to-plot" transformation. Ground coordinates are transformed to an unscaled transformation plane 'parallel' to the desired plot coordinate system by the ground-to-trans transformation. Coordinates in the transformation plane are transformed to the manuscript sheet on the plotting media by the trans-to-plot transformation. The ground-to-trans transformation can be orthographic, isometric, dimetric, perspective, or any of three full periphery projections for drift and shaft mapping. The trans-to-plot transformation is a plane similarity transformation (scale, rotation, and two translations). For orthographic projections the axes can be scaled individually.

For the orthographic, isometric, dimetric, and perspective transformation the transformation plane can be rotated to any position before the projection. The rotations are described by two angles, view direction from south and view angle from vertical (fig. 2) defined by the user. Envision that the projection plane is viewed face on. The view direction is the counter clock wise angle between south and the horizontal projection of the line of sight. The view angle is the angle between vertical and the line of sight. The transformation coordinate system has a horizontal x-axis orthogonal to the view direction, a "vertical" y-axis in the plane, and a z-axis out of the plane towards the observer. For a normal map projection with X increasing east and Y increasing north the view direction from south is 0 degrees

and the view angle from vertical is 0 degrees. For a profile with the x direction increasing south the view direction from south is 270 degrees and the view angle from vertical 90 degrees.

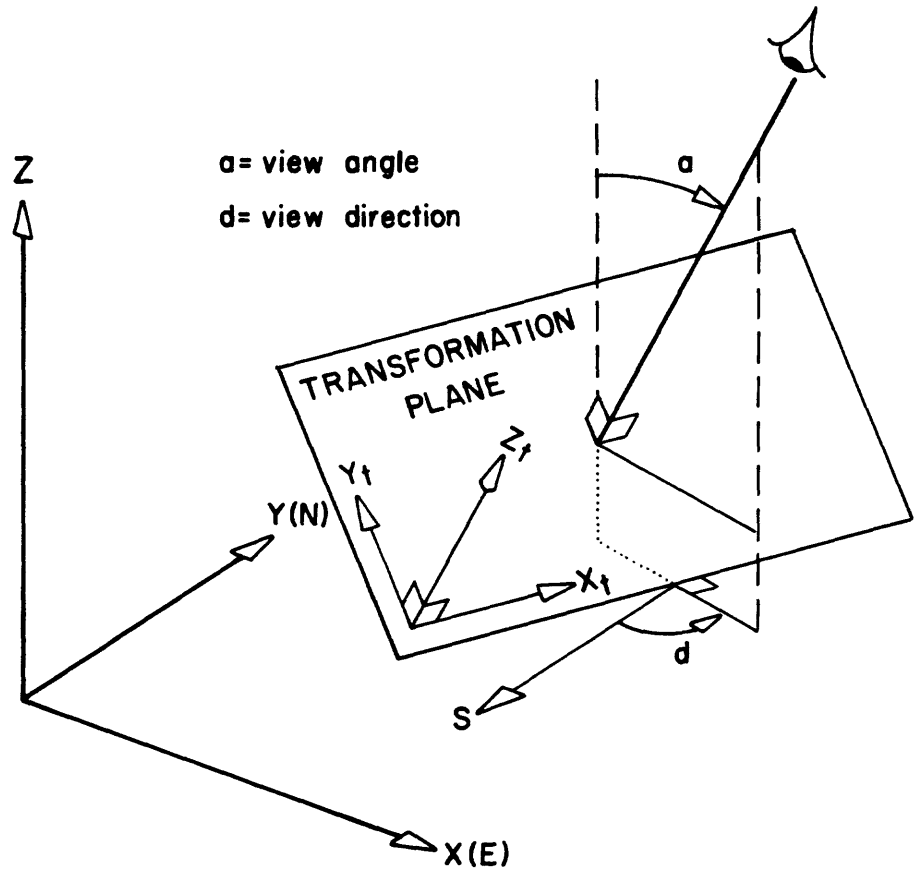

Figure 2. Sketch showing the definitions of the two angles, "view direction" and "view angle" used to define projection planes, and the 'trans. coordinate system' (Xt, Yt, Zt).

In orthographic projections data are projected along parallel lines orthogonal to the transformation plane defined by the view direction and the view angle. The transformation coordinate system is described by defining ground coordinates for the index point. The index point is the origin of the transformation coordinate system.

Isometric and dimetric projections are defined as orthographic projections by entering an index point, the view direction and the view angle. In the isometric projec-

tion the z-axis of the transformation coordinate system is then plotted at an angle of -30 degrees to horizontal and the x-axis at 30 degrees. In the dimetric projection the rotated z-axis is plotted at -45 degrees and the x-axis at 20 degrees.

Perspective projections are defined by entering a center point and an eye point. The center point is the point on which the eye is directed. Normally, a point in the approximate center of the object is preferable, but any point can be chosen. The eye point can be defined by entering the ground coordinates of the point or by entering the view distance from the center point, as well as the view direction and the view angle. Any of the coordinate axes can be extended or foreshortened in the perspective view by entering exaggeration factors.

In full periphery projections plot data are projected onto the theoretically defined walls of drifts and shafts and then unfolded. These projections are defined by entering ground coordinates for two points on the drift or shaft centerline. These points describe the direction of the drift or shaft. In addition, the drift width, height and back (or shaft) radius are entered. Two drift projections are available: the normal and the radial drift projection. In the normal projection plot data are projected orthogonal to the defined walls and back of the drift. In the radial projection data are projected along lines radiating from the center line of the drift. In the shaft projection data are projected along lines radiating from the shaft center line giving a radial, as well as a normal projection due to the circular profile of the shaft.

Any defined plot projection is assigned to a plot area number.

A function is available to plot frame lines, tick marks, and coordinate system on the manuscript map sheet.

Sheet Orientation

Manuscript map sheets plotted in orthographic projection that have been removed from the pen plotter can be reorientated on the plotter by measuring previously plotted tick marks. A sheet orientation menu is available that allows measurement, re-measurement, editing, deleting, and disregarding of up to 8 tick marks. Affine or conform transformation adjustments are performed. When orienting a sheet the plot area parameters used during the original plotting have to be loaded into the program.

Point Rate for Continuous Digitizing.

Increments between points measured in continuous mode are defined by the user. Continuous data collection can be controlled by maximum and minimum spatial distances, heading change angle, time, or any combination of these.

A point is digitized if the spatial distance from the last point digitized exceeds a distance test value; or if the distance exceeds a heading test distance, and the spatial angle-change between the two vectors connecting the last three points exceeds a heading test angle; and if the time elapsed since the last point was digitized exceeds a digitize sample rate. The distance test value, heading test distance, heading test angle, and digitize sample rate are defined by the user. Default values can be calculated for the photo scale in use. The default heading test distance is set to 30 microns multiplied by the photo scale, the default distance test value to 5 times the heading test distance, the default heading test angle to 5 degrees, and the digitize sample rate to 0 seconds (not used).

Line and Symbol Types.

Line and symbol types can be individually defined by the user. Defined line and symbol types are stored and can be used in any project. A list of the lines and symbols available can be plotted on the pen plotter by means of functions residing in the 'Initialize Project' menu.

Symbols are defined by referring hardware symbols available on the plotting media or by digitizing and scaling a hand-drawn symbol mounted on the upper stage plate of the analytical plotter. Symbol rotation is set by the user. Annotation can be plotted with the symbol. The annotation can be a fixed string, a variable string (entered when plotting), the most recently recorded geolabel, any of the coordinates at which the symbol is plotted, strike & dip of geoplanes, or plunge & direction of fold axes. Strike & dip or plunge & direction symbols are rotated according to the direction of dip.

Lines are defined by referring hardware line types available on the plotting media, and by defining line and gab sizes of broken lines.

On-line Plotting and Data Recording

Plotting and data recording is performed simultaneously or individually depending on the setting of plot on-off and record on-off switches. Lines can be digitized continuously or point by point, and plotted as polygons or smoothed by a spline function. Plotting and recording takes place from the plot on-line menu where functions for change of plot area, line type, symbol type, and pen number are also located.

Off-line Plotting

Recorded data can be plotted in any defined projection under the off-line plot menu. When off-line plotting is initiated the plot area used during data collection can be changed to any other defined plot area.

During off-line plotting symbols and line types are read from the symbol and line type definition files. If the definitions have changed since data recording the newly defined symbols and line types will be used. Thus, different symbols and line types can be used for off-line plotting by using different symbol and line type files.

Files with recorded plot data can be translated to text files for inspection and editing by use of a standard VAX/VMS editor. Text files are also convenient for data transport between different computers. After editing the text files can be translated to the recording format used by GEOPROGRAM and used for continuing data recording or for off-line plotting.

Geoplanes

Geoplanes can be measured in three different ways:

1) Point by point: Selected, discrete points are measured on a geological outcrop. After each point is measured the best fit plane through all of the measured points is calculated and the geoplanes attitude with associated standard deviation is displayed. If only two points are measured or if the measured points constitute a straight line the apparent dip and direction is displayed.

2) Horizon: Points are measured in continuous mode on one or more outcrops of the same horizon (geological bed or contact that is assumed to be an even plane). The digitizing increment is determined by the previously described point rate parameters. After each outcrop is measured the best fit plane through that outcrop is calculated and the attitude with associated standard deviation is displayed. In addition, the composite plane through all measured outcrops is calculated and displayed.

3) Foliation: Points are measured in continuous mode on one or more outcrops of a "layer-cake" stratigraphy. After each outcrop is measured the best fit plane through that outcrop is calculated and attitude with associated standard deviation is displayed. In addition, the composite orientation of the "layer-cake" structure is calculated and displayed.

Measured geoplanes are automatically stored in the planes buffer where they are numbered from 1 to 99. The planes buffer holds the 99 most recently measured geoplanes. Buffered geoplanes can be named and stored permanently in the planes file.

Geoplanes to be used for guiding of the floating mark must be down loaded to the DSR plate processor by the user. A loaded plane guides the floating mark if the guide on-off switch is on.

III. OPERATING THE PROGRAM

Environment

The program runs on a MicroVAX computer using the VMS operating system, and it controls the Kern DSR series of analytical plotters.

The plate processor program needed for the PDP11/53 computer integrated in the DSR is a modified version of Kerns's original software. It is called KDPP88.SAV (Keld Dueholm Plate Processor, 1988). The source code is located on logical disk DUE.DSK.

Start the Program

GEOPROGRAM is located in directory $DISK3:[KERN.DSR] under user 'KERN'. Type 'RGEO' and wait for the main menu to appear. Follow prompts and select menus and functions according to the guidelines described below.

Menus

The program is menu driven. The menu items are displayed in a four by four highlighted matrix (fig. 3) symbolizing the keypad of the DSR. The operator selects program functions by depressing the appropriate key on the keypad.

The menus are arranged in a hierarchy. The <ENTER> key returns to the previous menu, or stops the program from the main menu.

Help

All menus include on-screen help texts. Press the 'Help' function and then the function key for which to display help text. The text is displayed in the scroll area (fig. 3). Use the arrow keys (up and down) on the terminal keyboard to scroll through the text. Press the <ENTER> key to return to menu selection mode. For general information on the entire displayed menu press the 'Help' function twice.

Enter commands and text

The bottom line of the display is the command line (fig. 3). The program prompts for input in this line. Numbers can be entered from the DSR keypad or the terminal keyboard. Letters and special symbols must be entered from the keyboard.

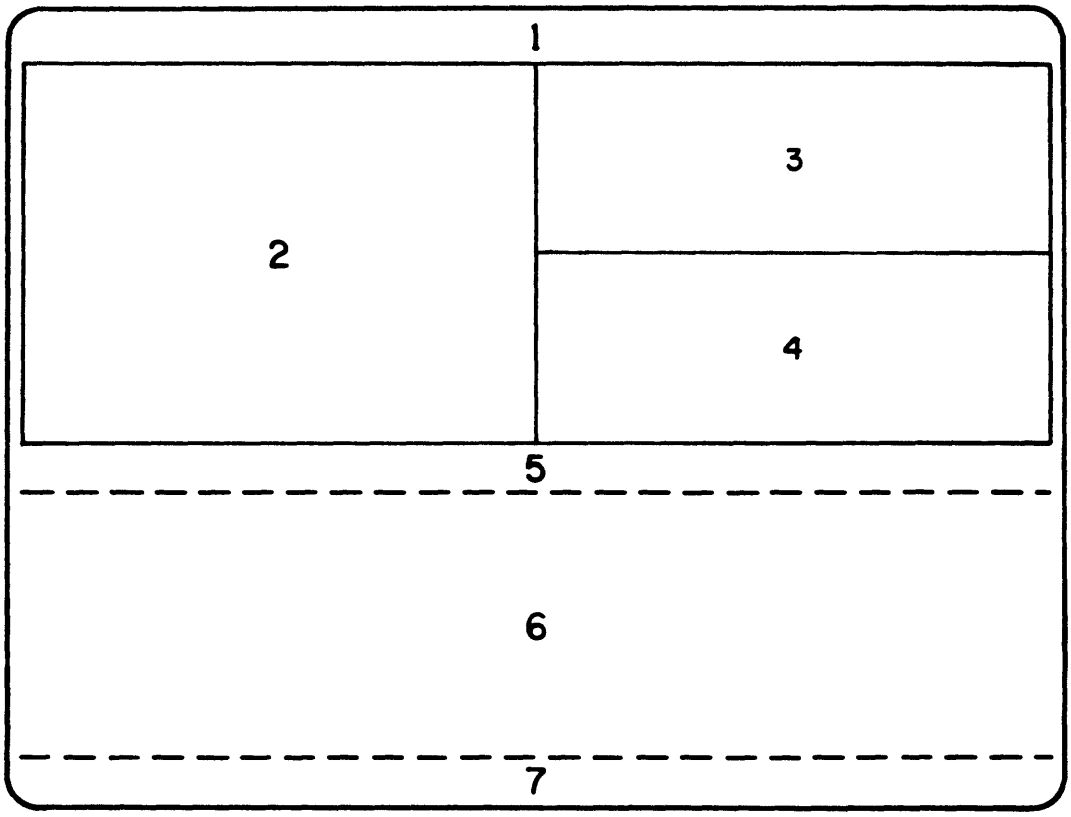

Figure 3. The GEOPROGRAM display is divided into 7 areas:

1) The 'project' line at the top of the screen, showing the program name, the current menu, and the project name.
2) The 'menu' area, showing the currently active menu functions.
3) The 'status' area, showing current ground coordinates, plot area, symbol type, line type, pen number, and line modes.
4) The 'result' area where calculation results are displayed.
5) The 'legend' line in which headings for the scroll area are written.
6) The 'scroll' area with 8 scrolling lines for general program output.
7) The 'command' line at the bottom of the screen.

IV PROGRAM MODULES

This chapter gives detailed descriptions of program functions organized according to the program menu structure. Functions that are repeated in many menus are described below and will not reappear under the individual menu descriptions.

Help

Gives information on the keys in the displayed menu. After pressing 'Help', then press the key for which you need information.

Main Menu

This key has two functions. In "Select Function" mode the key returns you to the main menu. When entering numbers or characters from the keyboard it acts as the <ENTER> key.

Return

This key has two functions. In "Select Function" mode the key returns you to the previous menu. When entering numbers or characters from the keyboard it acts as the <ENTER> key.

Plot

Switch for on-line plotting. Keep pressing the key until the desired mode appears. The modes are:
- <GPX> : Plotting on the graphical screen.
- <HP> : Plotting on the pen plotter.
- <BOTH>: Plotting on both the graphical screen and the pen plotter.
- <NONE>: Plotting is turned off. Data recording is still possible when plotting is off.

When plotting is on the cursor (GPX) or the pen (HP) tracks the floating mark. Plotting takes place when you press the right and/or left pedal. Line type and line mode are set under the 'Plot On-line' menu.

Record

Switch for data recording. The modes are:
- <ON> : All plot data are recorded in a file specified under the 'Plot On-line', 'Plot Off-line', or 'Initialize Project' menus. Note that recording takes place even if the on-line plotting is set to OFF.
- <OFF>: No recording of plot data takes place. Note that the recording of geological features, e.g. geoplanes, are independent of the setting of the 'record' switch.

Guide

Switch for computer guiding of the floating mark in geoplanes. The modes are:

- <ON> : The floating mark is guided by the computer to follow a geoplane. Note that the plane should first be loaded using the 'Load Plane' function under the 'Measure Plane', 'Recall Plane', or 'Planes Utility' menu.
- <OFF>: The computer guiding is set off, but the loaded plane remains ready for guiding until another plane is loaded or the DSR analytical plotter is turned off.

DSR11

Switch to change the DSR guiding system. The modes are:
- <MODEL> : Move in the model coordinate system with Z in and out of the model.
- <OBJECT>: Move in the object (ground) coordinate system.

1: MAIN MENU

Initialize Project Menu

Enter project parameters: project name and users name. Initialization of planes buffer, display buffer, plot areas, line types and symbol types. Change recording file (Rc.File) and planes file (Pl.File). Plot the defined symbol and line types.

Print Results Menu

Write results (attitudes of geoplanes) and parameters (plot area -, line type -, and symbol type parameters) to the system printer.

Define Plot Menu

Define plot areas (projections), line types, symbol types and point rate for digitizing. Plotting of map frame and tick marks. Orientation of sheets (maps) on the pen plotter.

Measure Fracture Menu

Special menu for measurement of fractures including plotting and recording of lines measured continuously, and simultaneous calculation and recording of a fracture plane (dip & strike) through the measured points. The lines are measured as continuous lines without smoothing.

Plot Off-line Menu

Plotting of previously recorded data, changing recording file, translating the recording file between the GEOPROGRAM record format and text (Ascii) format, and refreshing the graphical screen.

Plot On-line Menu

Plotting (and recording) of lines, symbols, and text. Setting of pen number, line type, symbol type, plot area, line modes (continuous or point by point, smooth or sharp). Editing the recording file.

Measure Planes Menu

Measuring, calculating, and recording of dip and strike of geoplanes. - Parallel displacement of geoplanes. - Down loading of geoplanes to guide the floating mark.

Recall Planes Menu

Recalling of previously recorded geoplanes. - Parallel displacement of geoplanes. - Down loading of geoplanes to guide the floating mark.

Planes Utility Menu

Measurement of true thickness of beds and displacements along faults. - Calculation of plunge and direction of fold axis.

Stop Program

Ends GEOPROGRAM and returns to VMS. Current program parameter settings are saved and the program will restart in the same mode(s) as it was left in. However, because restarting takes time you will be prompted to confirm this action.

Start Multi-Model Driving

Starts (re-starts) the plate processor to handle single or multiple models. The model(s) have to have been previously down loaded by ORIPROGRAM. The floating mark will be positioned at the down load point of the upper left model if multiple models are used.

In multi-model driving the floating mark automatically jumps to a neighbor model when crossing a frame boundary. Measurement and digitizing of lines can be performed continuously across model boundaries.

1.1: Initialize Project Menu

Enter project parameters: project name and users name. Initialization of planes buffer, display buffer, plot areas, line types and symbol types. Change recording file (Rc.File) and planes file (Pl.File). Plot defined symbols and line types.

Initialize Plot Areas

Plot Areas should NOT be initialized. Preferably, you should redefine selected areas under the 'Define Plot' menu.

If you insist, then before initializing, stop GEOPROGRAM and back-up the file 'GEOPLT.DAT' residing in the '[KERN.DSR.DATA]' directory.

Initialize Symbol Types

Symbols should NOT be initialized. Preferably, you should redefine selected symbols under the 'DEFINE PLOT' menu.

If you insist, then before initializing, stop GEOPROGRAM and back-up the file 'GEOSYM.DAT' residing in the '[KERN.DSR.DATA]' directory.

Initialize Line Types

Line Types should NOT be initialized. Preferably, you should redefine selected lines under the 'DEFINE PLOT' menu.

If you insist, then before initializing, stop GEOPROGRAM and back-up the file 'GEOLIN.DAT' residing in the '[KERN.DSR.DATA]' directory.

Enter Project Name

Enter the project name (20 characters or less). The name will be displayed on the first line of every menu screen, and printed to all output.

Enter Users Name

Enter the name of the operator (20 characters or less). The name will be displayed in the display result area during program startup, and printed to all output.

Change Record File

Enter the name (directory path, name, and extension) of the file for recording of plot data (30 characters or less).

Initialize Display Buffer

Erases the current content of the Display Buffer. Before initializing you are recommended to print the content of the buffer under the 'Print Results' menu.

Initialize Planes Buffer

Erases the current content of the Planes Buffer. Before initializing you are recommended to print the content of the buffer under the 'Print Results' menu.

Change Planes File

Enter the name (directory path, name, and extension) of the file for recording of named geoplanes (30 characters or less).

Plot Defined Symbols

Plots a list of all currently available user-defined symbols on the pen plotter.

Plot Lines
Plots a list of all currently available line types on the pen plotter.

1.2: Print Results Menu

Write results (attitudes of geoplanes) and parameters (plot area -, line type -, and symbol type parameters) to the system printer.

Print Plot Areas
Writing parameters for a specified plot area to the system printer. Enter the code number of the plot area to print.

Print Symbol Types
Writing parameters for a specified symbol definition to the system printer. Enter the code number of the symbol to print.

Print Line Types
Writing parameters for a specified line type definition to the system printer. Enter the code number of the line type to print.

Print Display Buffer
Writing the pending content of the display buffer to the system printer. The content of the display buffer is automatically printed and initialized when ever the buffer is full. The buffer holds 64 lines of results displayed in the scroll area of the screen during plane measurements.

Print Planes Buffer
Writing the current content of the planes buffer to the system printer. The planes buffer holds 99 geoplanes.

Print Planes File
Writing the content of the planes file to the system printer (named and stored dip & strike and plunge & direction measurements).

1.3: Define Plot Menu

Define plot areas (projections), line types, symbol types and point rate for digitizing. Plotting of map frame and tick marks. Orientation of sheets (maps) on the pen plotter.

The current plot area number, name, and transformation type are shown in the display scroll area and may be changed

by the 'Area Number' or 'Transformation Type' functions. 'Define Transformation Parameters', 'Define Manuscript Parameters', 'Orient Sheet', and 'Plot Frame' all use the plot area and plot transformation shown in the scroll area. Symbols, line types, and point rates are defined independently and not in relation to a specific plot area.

Copy Plot Area

Copies parameters from one plot area definition to another. The plot area shown in the display is copied to a destination area number entered by the user.

Enter Area Number

Enter the number and name for the plot area that you want to inspect, edit, or define.

Any number of plot areas (windows) can be defined and used simultaneously. Plot coordinates are transformed according to transformation parameters defined in the current plot area. Plot areas may be changed during plotting.

The functions 'Transformation Type', 'Define Transformation', 'Define Manuscript Parameters', 'Plot Frame', 'Orient Sheet' all refer to the plot area displayed by number and name in the display scroll region.

Enter Transformation Type

Define the transformation type to be use between object coordinates and an unscaled transformation plane parallel to the map sheet.

Orthographic (o), perspective (p), isometric (i), dimetric (d), and normal drift (n), radial drift (r), and shaft (s) full periphery projections are possible.

Enter the transformation desired (only the first letter of the above listed words is needed).

Define Transformation Parameters

Define parameters for transformation of the three dimensional object coordinates to two dimensional unscaled coordinates in a transformation plane parallel to the map sheet (trans. coordinates). Different menus will come up depended on the transformation type selected under 'Transformation Type'. The transformation of trans. coordinates to plot coordinates takes place according to parameters defined under the 'Define Manuscript Parameters' menu.

Define Manuscript Parameters

Define transformation parameters for the manuscript map sheet, that is: sheet rotation, table index coordinates, sheet size, tick mark interval, and plot scale.

Plot Frame

Define and plot the map frame, tick marks, and coordinate annotation.

Orient Sheet

Orientation of an old sheet or map on the pen plotter. Before orienting an old sheet make sure that the transformation parameters of the plot area in use match the transformation parameters used for plotting the old sheet. The manuscript definition menu is updated with the resulting orientation parameters.

Design Line Types

Design the line types to be used during on-line and off-line plotting.

Design Symbols

Design the symbols to be used during on-line and off-line plotting.

Create Symbol File

Measure and digitize a new users symbol and create the symbol file in directory [KERN.DSR.SYMBOLS]. Symbol files are created by digitizing a drawing mounted on the upper stage plate of the analytical plotter.

Define Point Rate

Whenever measurements are performed in continuous mode the Point Rate set under this menu dictates the frequency with which the data is collected.

Continuous data collection can be controlled by minimum and maximum spatial distances, heading change angle, time, or any combination of these.

1.3.1: Define Transformation (Orthographic, Isometric, Dimetric)

Define the parameters for transformation of the three dimensional object coordinates to two dimensional unscaled coordinates in the transformation plane parallel to the map sheet (trans. coordinates). The further transformation of the plane trans. coordinates to plotting table coordinates is defined under the 'Define Manuscript Parameters' menu.

Transformation Type

Shows the transformation type to be used between object (ground) coordinates and the unscaled transformation plane parallel to the map sheet. Use 'Transformation Type' under the 'Define Plot' menu to change the transformation.

Ground Index Point X

The object (ground) X coordinate of what is to be the lower left corner of the map sheet. Enter the coordinate

from key board or digitize in the DSR. If you want to digitize, then select any of the function keys for 'ground index point' X, Y, or Z, press right foot switch and all three coordinates are entered from the DSR.

Ground Index Point Y

The object (ground) Y coordinate of what is to be the lower left corner of the map sheet. Enter the coordinate from key board or digitize in the DSR. If you want to digitize, then select any of the function keys for 'ground index point' X, Y, or Z, press right foot switch and all three coordinates are entered from the DSR.

Ground Index Point Z

The object (ground) Y coordinate of what is to be the lower left corner of the map sheet. Enter the coordinate from key board or digitize in the DSR. If you want to digitize, then select any of the function keys for 'ground index point' X, Y, or Z, press right foot switch and all three coordinates are entered from the DSR.

View Direction From South

The 'view direction' and the 'view angle' define the orientation of the projection plane. The angles describe the line of sight, when you observe the plot plane.

The 'view direction' is the horizontal angle to the line of sight, measured counter clock wise from south.

View Angle From Vertical

The 'view direction' and the 'view angle' define the orientation of the projection plane. The angles describe the line of sight, when you observe the plot plane.

The 'view angle' is the angle between vertical and the line of sight. The 'view angle' is zero if you look right down (normal map projection), and 90 degrees for horizontal sight (vertical plots).

Plot Axis (X and Y)

The plot axis parameters describe which of the three translated and rotated axis (X, Y, Z) is assigned to the two table axes. A '+' or '-' indicate the positive direction of the axes. For example,

Plot Axes (X and Y) = -Y +X

means that decreasing Y coordinates will be plotted in the increasing table horizontal direction and that increasing X coordinates will be plotted in the increasing table vertical direction.

1.3.2: Define Transformation (Perspective)

Define the parameters for perspective transformation of the three dimensional object coordinates to two dimensional unscaled coordinates in the transformation plane parallel to the map sheet (trans. coordinates). Further transformation of the plane trans. coordinates to plotting table coordinates is defined under the 'Define Manuscript Parameters' menu.

Eye Point or View Angles

The perspective view may be defined in two different ways:

- Eye point: Define coordinates (X, Y, Z) in the object (ground) coordinate system of the point from where you want to see the plot.
- View Angles: Define the direction and inclination of the line of sight and give the distance from which you want to see the plot.

Ground Center Point (X)

The object (ground) X coordinate of the point on which you direct the eye. Normally one would select a point in the approximate center of the object, but any point may be chosen.

Enter the coordinate from key board or digitize in the DSR11. If you want to digitize, then select any of the function keys for 'center point' X, Y, or Z, press right foot switch, and all three coordinates are entered from the DSR.

Ground Center Point (Y)

The object (ground) Y coordinate of the point on which you direct the eye. Normally one would select a point in the approximate center of the object, but any point may be chosen.

Enter the coordinate from key board or digitize in the DSR11. If you want to digitize, then select any of the function keys for 'center point' X, Y, or Z, press right foot switch, and all three coordinates are entered from the DSR.

Ground Center Point (Z)

The object (ground) Z coordinate of the point on which you direct the eye. Normally one would select a point in the approximate center of the object, but any point may be chosen.

Enter the coordinate from key board or digitize in the DSR11. If you want to digitize, then select any of the function keys for 'center point' X, Y, or Z, press right foot switch, and all three coordinates are entered from the DSR.

Eye Point (X) or View Direction From South

This entry depends on the selection under item 1.

- Eye Point: The object (ground) X coordinate of the eye point.
- View Angles: The 'view direction' and the 'view angle' define the orientation of the line of sight. The 'view direction' is the horizontal angle to the line of sight measured counter clock wise from south.

Eye Point (Y) or View Angle From Vertical

This entry depends on the selection under item 1.

- Eye Point: The object (ground) Y coordinate of the eye point.
- View Angles: The 'view direction' and the 'view angle' define the orientation of the line of sight. The 'view angle' is the angle between vertical and the line of sight. The 'view angle' is zero if you look right down (normal map projection), and 90 degrees for horizontal sight (vertical plots).

Eye Point (Z) or Perspective View Distance

This entry depends on the selection under item 1.

- Eye Point: The object (ground) Z coordinate of the eye point.
- View Angles: The distance from which you want to see the plot, measured from the ground center point along the line of sight.

Exaggeration Factor (X, Y, Z)

The exaggeration factor to be applied on the original object (ground) coordinates before the perspective projection.

Plot Axis (X and Y)

The plot axis parameters describe which of the three translated and rotated axis (X, Y, Z) is assigned to the two table axes. A '+' or '-' indicate the positive direction of the axes. For example,

Plot Axes (X and Y) = -Y +X

means that decreasing Y coordinates will be plotted in the increasing table horizontal direction and that increasing X coordinates will be plotted in the increasing table vertical direction.

1.3.3: Define Transformation (Drift And Shaft)

Define the parameters for full periphery transformation of the three dimensional object coordinates to two dimensional unscaled coordinates in the transformation plane parallel to the map sheet (Trans. coordinates). The further transformation of the plane 'Trans' coordinates to plotting table coordinates are defined under the 'Define Manus.' menu.

Drift (Shaft) Index

A reference point should be established at the start of a drift or shaft so that distance or depth from that point can be used to describe the relative location in the drift or shaft of the map area.

The index point is a point on the drift or shaft axis that describes the up-tunnel boundary of the drift or shaft section to be mapped. In drifts the axis is the centerline of the cylinder surface that describes the back (roof), in shafts it is the centerline of the cylinder describing the shaft.

Enter the distance or depth along the axis from the reference point to the index point.

Ground Index (X)

See under 'Drift (Shaft) Index' for a description of the index point. Enter the ground X coordinate for the point.

Ground Index (Y)

See under 'Drift (Shaft) Index' for a description of the index point. Enter the ground Y coordinate for the point.

Ground Index (Z)

See under 'Drift (Shaft) Index' for a description of the index point. Enter the ground Z coordinate for the point.

Direction Point (X)

The direction point is a point on the drift or the shaft axis deeper then the index point. The point is used to describe the drift or shaft direction. Enter the ground X coordinate for the point.

Direction Point (Y)

The direction point is a point on the drift or the shaft axis deeper then the index point. The point is used to describe the drift or shaft direction. Enter the ground Y coordinate for the point.

Direction Point (Z)

The direction point is a point on the drift or the shaft axis deeper then the index point. The point is used to describe the drift or shaft direction. Enter the ground Z coordinate for the point.

Back (Shaft) Radius

Enter the radius of the cylinder surface describing the drift back (tunnel roof) or the shaft.

Drift Width and Height

Enter the width and the height of the drift. The drift height is measured from the floor to the highest point on the back (roof).

1.3.4: Define Manuscript Parameters

Define transformation parameters for the manuscript map sheet, that is: sheet rotation, table index coordinates, sheet size, tick mark interval, and plot scale.

The parameters entered under this function are used to define the transformation between the unscaled transformation plane coordinates created by the object-to-trans transformation and the actual plot on the pen plotter or the graphical screen.

Plot Rotation

The plot rotation is measured by the angle between the vertical plotting table axis and the manuscript Y axis. The positive direction is from the table axis counter clock wise to the manuscript axis.

Plot Index (Lower Left)

The table coordinates of the plot index. In case of orthographic, isometric, dimetric or full periphery projections the plot index is the lower left corner of the manuscript. For perspective projections it is the ground center point.

Enter the coordinate from key board or digitize from the pen plotter. If you want to digitize, first select function 'plot index', then move the pen/microscope to the desired point and press the digitize key on the plotter control panel.

Plot Size (Upper Right)

Enter the horizontal and the vertical plot size in table units (millimeters).

Enter the values from key board or digitize the upper right corner of the plot on the pen plotter. If you want to digitize, first select function 'plot size', then move the pen/microscope to the desired point and press digitize (enter) on the plotter control panel. The displayed values are the plot size and not the coordinates of upper right corner.

Tick Mark Interval (X and Y)

Enter tick mark spacing along the X axis and the Y axis of the manuscript in table units (millimeters).

Plot Scale (X and Y)

Enter the absolute scale of the desired plot. In case of orthographic and full periphery projections individual scales for manuscript X and Y directions can be given. For full periphery projections the plot sizes are automatically calculated in the Y direction for drifts and the X direction for shafts. These directions are around the periphery of the drift or the shaft. For isometric, dimetric or perspective plots the scale refers to a plane through the plot index point orthogonal to the line of sight.

1.3.5: Plot Map Frame Menu

Define and plot the map frame, tick marks, and coordinate system.

Plot Frame

The frame of the plot area specified under the 'Define Manuscript Parameters' menu is plotted with a solid line.

Plot Frame Ticks

Dashes are plotted inside and at rights angle to the frame at a grid spacing specified under the 'Define Manuscript Parameters' menu.

Plot Tick Marks

A cross is plotted at all intersections between grid lines at a grid spacing specified under the 'Define Manuscript Parameters' menu.

Tick Mark Size

Size in plotter units (millimeters) of the frame tick and the tick marks.

Plot Annotation

Plots coordinate values at each frame tick mark outside the frame.

Annotation Height

Height of characters for the coordinate annotation.

Show Frame on Peripheral

The pen will follow the map frame without plotting, just to show the position of the map on the plotter.

Plot on Peripheral

Plotting of the specified map frame system.

1.3.6: Orient Sheet Menu

Orientation of an old sheet or map on the pen plotter. Before orienting an old sheet make sure that the transformation parameters of the plot area match the transformation parameters from the plot area used for plotting the old sheet.

Trans

Switch between conform and affine plane transformations. After pressing the function, the selected transformation parameters are computed and shown in the display result area.
- Conform transformation allows for two translations, rotation and a common scale.
- Affine transformation allows for two translations, rotation, axis skew, and individual scalings in the X and Y directions.

New Sheet

Clear out data from previous orientations referring to the selected plot area. Use the 'add point' function to start measuring the new sheet.

Measure All

Measure all points for which the point name and the sheet coordinates have been previously entered. A calculation of orientation parameters are performed after each measured point, and the microscope on the pen plotter automatically drives to the next point, based on a transformation of the sheet coordinates using the parameters calculated.

Re-measure All

Remeasure all points. The microscope on the pen plotter automatically drives to the points based on table coordinates from previous measurements.

Kill Point

Deletes a specified point and performs a new adjustment using the remaining points.

Enter the ID of the point to delete. It is not necessary to enter the complete ID string. Only the rightmost characters that uniquely identify the point are needed.

Disregard Point

Perform a new adjustment without a specified disregarded point. The point is marked with an '*' at the right margin. Residuals are displayed for the disregarded point although it has not influenced the adjustment.

Enter the ID of the point to disregard. It is not necessary to enter the complete ID string. Only the

rightmost characters that uniquely identify the point are needed.

Use the 'include point' function to again include a disregarded point in the adjustment.

Include Point

Include a previously disregarded point in the adjustment.

Enter the ID of the point to include. It is not necessary to enter the complete ID string. Only the rightmost characters that uniquely identify the point are needed.

Add Point

Add new points to the adjustment. You are prompted to enter point ID, and sheet X and Y coordinates. Press <ENTER> after each entry. After these entries you are given the option to measure the point on the pen plotter. Press <ENTER> if you do not want to measure the point.

Return from the 'add point' function by pressing <ENTER> at the point ID prompt.

Edit Point

Edit a previously entered/digitized point. Point ID, and sheet X Sheet Y coordinates are flagged. Type the new value followed by <ENTER>. Pressing <ENTER> without a new value preserves the old value.

Enter the ID of the point to edit. It is not necessary to enter the complete ID string. Only the rightmost characters that uniquely identify the point are needed.

Re-measure Point

Re-measure a point. The microscope on the pen plotter automatically drives to the point based on table coordinates from the previous measurement.

Enter the ID of the point to re-measure. It is not necessary to enter the complete ID string. Only the rightmost characters that uniquely identify the point are needed.

1.3.7: Design Line Types

Design the line types to be used during on-line and off-line plotting.

First enter the code number for the line type to inspect, design, or edit using the key labeled '1', and then enter the desired parameters for that line.

Define Line Number

Enter the code number for the line type to inspect, edit, and/or define.

Once a line type definition is entered it remains the same until the line file is changed again in this menu or initialized under the 'Initialize Project' menu.

Alphanumeric Description

Enter an alpha numeric description of up to 16 characters of the line type. The ten first letters of this description will be written to the display status area during plotting and/or recording.

Pen Number

Enter the pen number selection (between 0 and 8). The numbers refer to the pen numbers on the pen plotter or colors on the graphical screen. Pen 8 on the pen plotter is the microscope. Pen 0 means no pen change, the pen currently in use remains active.

Hardware Line Number

Enter the hardware line type number. Refer to the pen plotter manual for a complete listing of the hardware line types.

Gap Size

The line gap size is:

- the length of the pen-up section when using a discontinuous hardware line type.
- the symbol cell size when using a hardware line type that included symbols.

The gap size is the distance 'b' in the following example:

```
-----         -----         -----
     <   b   >     <   b   >
```

NB: This Gap Size function is not supported by the Hewlett Packard pen plotter at the USGS. See 'Ratio' for information on how to scale the line pattern.

Ratio (Line/Gap)

The Line/Gab Ratio is the ratio between:

- the pen-down section and the pen-up section when using a discontinuous hardware line type.
- the line section and the symbol section when using a hardware line type with included symbols.

The Line/Gab Ratio is the value 'a/b' in the following examples:

```
-----         -----         -----
< a ><   b   >< a ><   b   >< a >
```

NB: For the Hewlett Packard (HP) pen plotter at the USGS the ratio is the 'pattern length' used by Hewlett Pack-

ard. Standard pattern length's are shown in the HP manual. 'Ratio' scales the standard pattern length.

Hardware Symbol

Enter the number or the hardware symbol to be included in the line. Refer to the manual for the pen plotter for a complete listing of the hardware symbols.

NB: Embedded hardware symbols are not supported by the Hewlett Packard pen plotter at the USGS.

Symbol Rotation

Enter the rotation angle for the symbol included in the line (positive counter clock wise).

NB: Embedded hardware symbols are not supported by the Hewlett Packard pen plotter at the USGS.

1.3.8: Design Symbols

Design the symbols to be used during on-line and off-line plotting.

First enter the code number for the symbol to inspect, design, or edit using the key labeled '1', and then enter the desired parameters for that symbol.

Define Symbol Number

Enter the code number for the symbol to inspect, design, or edit.

Once a symbol definition is entered, it remains the same until the symbol file changed again in this menu or is initialized under the 'Initialize Project' menu.

Alphanumeric Description

Enter an alpha numeric description of up to 16 characters of the symbol. The ten first letters of this description will be written to the display status area during plotting and/or recording.

Pen Number

Enter the pen number selection (between 0 and 8). The numbers refer to the pen numbers on the pen plotter or colors on the graphical screen. Pen 8 on the pen plotter is the microscope. Pen 0 means no pen change, the pen currently in use remains active.

Hardware Symbol Number

Enter the hardware symbol number. Refer to the manual for the pen plotter for a complete listing of the hardware symbols.

NB: Hardware symbols are not enabled at the USGS. Use digitized users symbols in stead (see 'Users Symbol File Name' below and the 'Create Symbol' menu).

Users Symbol File Name

Enter the name of the file from directory [KERN.DSR.SYMBOLS] in which the symbol was recorded using the 'Create Symbol' menu. [KERN.DSR.SYMBOLS] is the default directory and should not be entered as part of the filename.

Symbol Size and Rotation

Enter the size and the rotation of the symbol.

The size is described by entering the diameter of the smallest possible prescribed circle around the symbol.

The rotation angle is positive counter clock wise.

Annotation Type

Chose annotation type by entering one or two of the listed letters:

- L: Annotation text defined by the current geolabel.
- F: Fixed annotation text, defined by the 'Fixed Text' function.
- V: Variable annotation test. The operator is prompted for the text whenever the symbol is plotted.
- X: The X-coordinate at which the symbol is plotted.
- Y: The Y-coordinate at which the symbol is plotted.
- Z: The Z-coordinate at which the symbol is plotted.
- D: Strike and dip of planes is plotted as annotation. The operator is prompted to enter the strike and dip, unless a plane already resides in memory. The symbol is rotated according to the dip direction.
- P: Plunge and direction of fold axes is plotted as annotation. The operator is prompted to enter the plunge and direction. The symbol is rotated according to the direction angle.

L, F, and V can be combined with D and P. Coordinate are plotted with two decimals, unless the desired number of decimals (between 1 and 9) is enter after X, Y, or Z.

Fixed Text

Enter the alphanumeric text (20 characters or less) used for fixed text annotation of the symbol. Specify 'F' under the 'Annotation Type' function.

Text Size, Slant, and Rotation

Enter size, slant and rotation of the symbol annotation.

The rotation angle is positive counter clock wise. If the angle is zero the annotation is plotted to the right of the symbol.

1.3.9: Create Symbol File

Measure and digitize a new users symbol and create the symbol file. Symbol files are created by digitizing a drawing mounted on the upper stage plate of the analytical plotter.

The first three points recorded in the file are scaling points and should be digitized in <POINT> mode at the middle, bottom, and top of the symbol. Start at the bottom of the symbol and digitize using right foot pedal, move to the center and digitize with right foot pedal, and finally, digitize a point at the top of the symbol using left foot pedal.

Plot

Plotting is not possible under this menu. The function is therefore fixed at <NONE>

DSR11

In this menu the DSR11 reading mode is internally set to read the upper stage plate coordinates only.

Record

Switch for data recording in the symbol file.
- <ON> : All digitized data are recorded in the defined symbol file.
- <OFF>: No recording of data takes place.

Arc

Switch for plotting of circle arcs based on three digitized points. The modes are:
- <ON> Plots a circle arc through three digitized points, starting at the first point, proceeding through the second, and ending at the last point. Measure the three points by pressing the right foot switch.
- <OFF> Circle arc mode off.

Mode

The Mode refer to the way, lines are digitized. The modes are:
- <CONT> : Points are digitized automatically, when the right foot pedal is held down. In this menu the continous mode sampling rate is set internally according to the following 'point rate' parameters: 'distance test value'= 0.5 mm, 'heading test value'= 0.1 mm, 'heading test angle'= 5 degrees, and 'digitize sample rate'= 0.0.
- <POINT>: Points are digitized every time the right foot pedal is pressed. End the digitizing in point mode by pressing the left foot-pedal on the last point.

The mode currently active is displayed under P in the display status region.

Change Symbol File

Enter the name (name, and extension) of the file for recording of the symbol (26 characters or less). The directory defaults to [KERN.DSR.SYMBOLS].

Edit Symbol File

Allows simple editing of the symbol file. The function only works if recording is set to <ON>.

Press the function and use left foot-pedal to step back in the file line by line. Use right foot-pedal to step forward. The floating mark in the DSR tracks the steps. When the foot-pedal is kept down, the stepping continues automatically at the maximum speed allowed by the computer, until the foot-pedal is released or a 'CHANGE TO' command is reached. During editing, two flagged functions are available:

- 'delete rest' erases all entries in the file from the current position of the file pointer to the end of the file. Position the cursor at the last line you want to keep in the file and then press the 'delete rest' function.
- 'escape edit' returns to the create symbol menu without erasing entries in the file.

Warning: If any of the 'CHANGE TO' lines in the file are deleted, conflicts may arise between the last active selection in the file and the current selection in the program. In this case make new selections immediately after returning from the edit function. One exception is the last 'CHANGE TO PEN UP' that is automatically preserved.

1.3.10: Define Point Rate

Whenever measurements are performed in continuous mode the Point Rate set under this menu dictates the frequency with which the data is collected.

Continuous data collection may be controlled by defined minimum and maximum spatial distances, heading change angle, time, or any combination of these.

A point is digitized if the spatial distance to the last point digitized exceeds 'distance test value'; or the spatial angle-change between the two vectors connecting the last three points exceeds 'heading test angle', and the distance exceeds the 'heading test distance'; and the time elapsed since the last digitized point exceeds 'digitize sample rate'.

Current Photo Scale

Enter the photo scale for which the suggested values for the point rate distance parameters are computed. The suggested values are shown in quotes after the parameters 'distance test value' and 'heading test distance'.

Distance Test Value

Maximum spatial distance in object (ground) units between points when measuring in continuous mode. A recommended value based on the photo scale given in line one is shown in brackets.

Note that this parameter works in relation to the 'heading test distance', the 'heading test angle', and the 'digitize sample rate':

- the sampling distance might be shorter than the 'distance test value', but not less than the 'heading test distance'. If the angular change of line direction between three points is larger than the 'heading test angle' and the distance is larger than 'heading test distance' a point is digitized.
- both the distance and the time rate condition have to be fulfilled before a point is sampled. Set the 'digitize sample rate' to 0.0, if you want a pure distance/angle condition.

Heading Test Distance

Minimum spatial distance in object (ground) units between points when measuring in continuous mode. A recommended value based on the photo scale given in line one is shown in brackets.

Note that this parameter works in relation to the 'distance test value', the heading test angle', and the 'digitize sample rate':

- the 'heading test distance' is used rather than the 'distance test value' if the angular change of line direction between three points is larger than the 'heading test angle'.
- both the distance and the time rate condition have to be fulfilled before a point is sampled. Set the 'digitize sample rate' to 0.0, if you want a pure distance/angle condition.

Heading Test Angle

Maximum change of spatial line direction between three points when measuring in continuous mode. A recommended value is shown in brackets.

Note that this parameter works in relation to the 'distance test value', the 'heading test distance', and the 'digitize sample rate':

- the 'heading test distance' is used rather than the 'distance test value' if the change of line direction is larger than the 'heading test angle'.
- both the distance and the time rate condition have to be fulfilled before a point is sampled. Set the 'digitize sample rate' to 0.0, if you want a pure distance/angle condition.

Digitize Sample Rate

Time Interval (in seconds) between points when measuring in continuous mode.

Note that this parameter works in relation to the 'distance test value', the 'heading test distance', and the 'heading test angle':

- both the distance and the time rate condition have to be fulfilled before a point is sampled. Set the 'distance test value', the 'heading test distance', and the 'heading test angle' to 0.0, if you want a pure time condition.

Normally, you should use a distance condition. Therefore, the recommended value for the 'digitize sample rate' given in brackets is 0.0.

1.4: Measure Fracture Menu

Composite menu for measurement of fractures including plotting and recording of lines measured continuously, and simultaneous calculation and recording of fracture planes (dip & strike) through the measured points. The lines are measured as continuous lines without smoothing.

Change Plot Area

To change plot area enter the code number of the desired area. The area currently active is displayed under A in the display status region.

Change Symbol

To change symbol type enter the code number of the desired symbol. The symbol currently active is displayed under S in the display status region.

Symbols are plotted by pressing the left foot-pedal.

Change Line Type

To change line type enter the code number of the desired line type. The line type currently active is displayed under L in the display status region.

Lines are plotted by pressing the right foot-pedal.

Change Pen

To change pen enter the pen number (between 1 & 8) of the desired pen. Pen 8 on the Hewlett Packard pen plotter is the microscope! The pen currently active is displayed under P in the display status region.

Note that the pen is automatically changed, when you select a symbol or a line type with a defined pen selection.

Measure Fracture

Digitize and record points along a fracture outcrop. A "best fit" plane is calculated by least-squares adjustment

through the measured points. The fracture plane is named and stored in the planes file, and strike and dip with standard deviations are displayed.

Points are digitized automatically, when the right foot pedal is held down. The sampling rate is set according to your specifications under the 'Define Plot' menu.

You will be prompted to enter a fracture label. The entered label will be stored as geolabel in the recording file and used to name the calculated fracture plane.

Load Plane

A fracture plane that is to be used to guide the floating mark of the DSR has to be down-loaded to the DSR plate processor. When pressing this function the plane currently in memory (work plane) is down loaded. The plane is now available for guiding by using the 'Guide ON/OFF' function key.

The plane remains in the DSR plate processor until another plane is loaded or the DSR is turned off.

Recall Horizon

This function is used to recall and combine fracture planes previously recorded in the planes buffer or the planes file. If more than one plane is recalled, the planes will be added as if they were measured on the same fracture, and a composite plane will be calculated.

When pressing the key you will be prompted to enter the ID for the fracture plane to recall. Enter number or name and press <ENTER>. The prompt will then reappear. Enter number or name for the next plane to recall and press <ENTER>.

When all planes are entered, then press <ENTER> to exit the function. The composite plane will be numbered and stored in the planes buffer, and it will stay in memory for any further manipulation.

Measure Horizon

This function allows you to measure points continuously on a fracture (plane) for calculation of strike and dip without recording the measured points. When the right foot switch is held down, points on the fracture, you are following with the floating mark, are read into the computer.

When you lift the right foot switch, a "best fit" plane through the measured points will be calculated by least squares adjustment and the dip and strike with standard deviations are displayed.

You can now jump to another exposure of the same fracture and continue the measurements. A plane through these points will be calculated along with a composite plane through all points from the previous and the current measurement. You can measure any number of individual outcrops.

When all outcrops are measured, then press the function key for your next operation. The best fit plane through all measured outcrops will be numbered and stored in the planes buffer.

Review

Switch to view the plot on the pen plotter: The modes are:

- <ON> : The drawing tool on the pen plotter is moved aside to allow for review of the plotting area.
- <OFF>: The tool moves back to track the floating mark, when the 'review' switch or any function key is pressed again.

Edit Recording File

Allows simple editing of the recording file. The function only works if recording is set to <ON>.

Press the function and use left foot-pedal to step back in the file line by line. Use right foot-pedal to step forward. The floating mark in the DSR, the pen plotter drawing tool, and the graphical screen cursor tracks the steps. When the foot-pedal is kept down, the stepping continues automatically at the maximum speed allowed by the computer, until the foot-pedal is released or a 'CHANGE TO' command is reached. During editing, two flagged function keys are available:

- 'delete rest' erases all entries in the file from the current position of the file pointer to the end of the file. Position the cursor at the last line you want to keep in the file and then press 'delete rest'.
- 'escape edit' returns to the plot menu without erasing entries in the file.

Warning: If any of the 'CHANGE TO' lines in the file are deleted, conflicts may arise between the last active selection in the file and the current selection in the program. In this case make new selections immediately after returning from the Edit function. One exception is the last 'CHANGE TO PEN UP' that is automatically preserved.

1.5: Plot Off-line Menu

Plotting of previously recorded data, changing recording file, translating the recording file between the program format and text (Ascii) format, and refreshing the graphical screen.

Stop

This key breaks the off-line plotting. The plotting can be resumed only from the top of the file using the 'plot Rc.File' function.

Pause

This key allows you to halt off-line plotting. The plotting can be continued from where it was stopped by pressing the 'go-on' function key.

Go On

This key is used to continue off-line plotting after halted with the 'pause' function key.

Convert to Record

Convert recording files to text (Ascii) files that can be edited by a standard VAX/VMS editor. Enter the directory path, name, and extension for the recording file and the destination text file.

Convert to Text

Convert a text file to a recording file that can be used by GEOPROGRAM. Enter the directory path, name, and extension for the text file and the destination recording file.

Plot Recording File

Plots data from a recording file (not a text file) collected with GEOPROGRAM. You are prompted to enter the directory path, name, and extension of the recording file to plot. Whenever the program reads a change plot area command from the file with an area number different from the area currently used you will be prompted to verify the change or enter another area number. Make sure that the currently defined plot areas, symbols, and line types match the ones needed by the recording file to be plotted.

Change Record File

Enter the name (directory path, name, and extension) of the file for recording of plot data (30 characters or less).

Review

Switch to view the plot on the pen plotter: The modes are:

- <ON> : The drawing tool on the pen plotter is moved aside to allow for review of the plotting area.
- <OFF>: The tool moves back to track the floating mark, when the 'review' switch or any function key is pressed again.

Refresh Display

Erases the current drawing on the graphical screen and leaves a blank screen for drawing.

1.6: Plot On-line Menu

Plotting (and recording) of lines and symbols. Setting of pen number, line type, symbol type, plot area, line mode (continuous or point by point, smooth or sharp). Editing the recording file.

Change Plot Area

To change plot area enter the code number of the desired area. The area currently active is displayed under A in the display status region.

Change Symbol

To change symbol type enter the code number of the desired symbol. The symbol currently active is displayed under S in the display status region.

Symbols are plotted by pressing the left foot-pedal.

Change Line Type

To change line type enter the code number of the desired line type. The line type currently active is displayed under L in the display status region.

Lines are plotted by pressing the right foot-pedal.

Change Pen

To change pen enter the pen number (between 1 & 8) of the desired pen. Pen 8 on the Hewlett Packard pen plotter is the microscope! The pen currently active is displayed under P in the display status region.

Note that the pen is automatically changed, when you select a symbol or a line type with a defined pen selection.

Mode

Switch to control the way lines are digitized. The modes are:

- <CONT> : Points are digitized automatically, when the right foot pedal is held down. The sampling rate is set according to your specifications under the 'Define Plot' menu.
- <POINT>: Points are digitized every time the right foot pedal is pressed. End the digitizing in point mode by pressing the left foot-pedal on the last point.

The mode currently active is displayed under P in the display status region.

Smooth

Switch to control the way digitized points are connected under line plotting. The modes are:

- <ON> : A smooth line is drawn through the digitized points by means of a Spline function. Nothing is plotted before 3 points have been digitized.

- <OFF>: Digitized points are connected with straight lines (polygon).

The mode currently active is displayed under P in the display status region.

Change Label

Enter an alphanumeric label (geolabel) that will be written to the recording file at the current file pointer. The last geolabel entered is shown in the display result region.

Change Record File

Enter the name (directory path, name, and extension) of the file for recording of plot data (30 characters or less).

Review

Switch to view the plot on the pen plotter: The modes are:

- <ON> : The drawing tool on the pen plotter is moved aside to allow for review of the plotting area.
- <OFF>: The tool moves back to track the floating mark, when the 'review' switch or any function key is pressed again.

Edit Record File

Allows simple editing of the recording file. The function only works if recording is set to <ON>.

Press the function and use left foot-pedal to step back in the file line by line. Use right foot-pedal to step forward. The floating mark in the DSR, the pen plotter drawing tool, and the graphical screen cursor tracks the steps. When the foot-pedal is kept down, the stepping continues automatically at the maximum speed allowed by the computer, until the foot-pedal is released or a 'CHANGE TO' command is reached. During editing, two flagged keys are available:

- 'delete rest' erases all entries in the file from the current position of the file pointer to the end of the file. Position the cursor at the last line you want to keep in the file and then press 'delete rest'.
- 'escape edit' returns to the plot menu without erasing entries in the file.

Warning: If any of the 'CHANGE TO' lines in the file are deleted, conflicts may arise between the last active selection in the file and the current selection in the program. In this case make new selections immediately after returning from the edit function. One exception is the last 'CHANGE TO PEN UP' that is automatically preserved.

1.7: Measure Planes Menu

Measuring, calculating, and recording of dip and strike of planar surfaces. - Parallel displacement of geoplanes. - Down loading of geoplanes for Z-guiding.

Plot Dip & Strike

Plots the dip and strike symbol for the geoplane residing in memory (work plane) located at the mean coordinates of the points measured for the plane. If no geoplane is in memory you will be prompted to recall a plane.

Name and Store

Name and store the geoplane reciding in computer memory, recall a geoplane from the planes buffer and name and store this plane, or rename an already named and stored geoplane. Names may be 20 characters or less, including spaces between letters, if desired. A named geoplane is stored in the planes file defined in the 'Initialize Project' menu.

If a geoplane resides in computer memory (work plane) when the 'name and store' function is invoked you will be asked to name this plane. Enter the name and press <RETURN>.

If no geoplane is in memory when the function is invoked, you will be prompted to enter the old plane ID. Enter the buffered planes number or the name of an old plane to rename and press <RETURN>. Then enter the (new) name.

Parallel Shift

Raises or lowers (shifts) a geoplane to another level. Place the floating mark on the point in the model to where you want the plane raised or lowered and press the right foot-pedal. The new shifted geoplane will be numbered and stored in the planes buffer.

If no geoplane is in the computer when the function is invoked, you will be prompted to enter the buffered planes number or stored planes name of the plane to be shifted.

Load Plane

A geoplane that is to be used to guide the floating mark of the DSR has to be down-loaded to the DSR plate processor. When pressing this function the plane currently in memory (work plane) is down loaded. The plane is now available for guiding by using the 'Guide ON/OFF' key.

The plane remains in the DSR plate processor until another plane is loaded or the DSR is turned off.

Measure Point by Point

This function allows you to select and measure individual points on a geological outcrop (plane). Measurements are taken each time the right foot switch is pressed.

Immediately after each measurement a "best fit" plane through the so-far-measured points will be calculated by least squares adjustment, and the dip and strike with standard deviations are displayed.

When all points are measured, then press the function key for your next operation. The best fit plane (geoplane) through all measured points will be numbered and stored in the planes buffer.

Measure Horizon

This function allows you to measure points continuously on a geological outcrop (plane). When the right foot switch is held down, points on the horizon, you are following with the floating mark, are read into the computer.

When you lift the right foot switch, a "best fit" plane through the measured points will be calculated by least squares adjustment and the dip and strike with standard deviations are displayed.

You can now jump to another outcrop of the same horizon and continue the measurements. A plane through these points will be calculated along with a composite plane through all points from the previous and the current measurement. You can measure any number of individual outcrops.

When all outcrops are measured, then press the function key for your next operation. The best fit plane (geoplane) through all measured outcrops will be numbered and stored in the planes buffer.

Measure Foliation

This function allows you to measure points continuously on a foliated (layer-cake-like) structure. When the right foot switch is held down, points on the outcrop, you are following with the floating mark, are read into the computer.

When you lift the right foot switch, a "best fit" plane through the measured points will be calculated by least squares adjustment, and the dip and strike with standard deviations are displayed.

You are then allowed to measure another outcrop within the same layer-cake-like structure. A plane through these points will be calculated along with a composite orientation of the stratigraphic section described by the previous and the current measurement. You can measure any number of individual outcrops.

When all outcrops are measured, then press the function key for your next operation. The best fit orientation plane (geoplane) will be numbered and stored in the planes buffer. The plane calculated will be raised to the mean coordinates of all the measured outcrops.

1.8: Recall Planes Menu

Recalling of previously recorded geoplanes. - Parallel displacement of geoplanes. - Down loading of geoplanes for Z-guiding.

Plot Dip & Strike

Plots the dip and strike symbol for the geoplane residing in memory (work plane) located at the mean coordinates of the points measured for the plane. If no geoplane is in memory you will be prompted to recall a plane.

Name and Store

Name and store the geoplane reciding in computer memory, recall a geoplane from the plane buffer and name and store this plane, or rename an already named and stored geoplane. Names may be 20 characters or less, including spaces between letters, if desired. A named geoplane is stored in the planes file defined in the 'Initialize Project' menu.

If a geoplane resides in computer memory (work plane) when the 'name and store' function is invoked you will be asked to name this plane. Enter the name and press <RETURN>.

If no geoplane is in memory when the function is invoked, you will be prompted to enter the old plane ID. Enter the buffered planes number or the name of an old plane to rename and press <RETURN>. Then enter the (new) name.

Parallel Shift

Raises or lowers (shifts) a geoplane to another level. Place the floating mark on the point in the model to where you want the plane raised or lowered and press the right foot-pedal. The new shifted geoplane will be numbered and stored in the planes buffer.

If no geoplane is in the computer when the function is invoked, you will be prompted to enter the buffered planes number or stored planes name of the plane to be shifted.

Load Plane

A geoplane that is to be used to guide the floating mark of the DSR has to be down-loaded to the DSR plate processor. When pressing this function the plane currently in memory (work plane) is down loaded. The plane is now available for guiding by using the 'Guide ON/OFF' key.

The plane remains in the DSR plate processor until another plane is loaded or the DSR is turned off.

Recall Plane

This function is used to recall a previously recorded geoplane or fold axes from the planes buffer or the planes file.

When pressing the function you will be prompted to enter the ID for the geoplane or fold axes to recall. Enter buffered planes number or stored planes name and press <RETURN>.

Recall Horizon

This function is used to recall and combine geoplanes previously recorded in the planes buffer or the planes file. If more than one geoplane is recalled, the planes will be added as if they were measured on the same horizon, and a composite plane will be calculated.

When pressing the key you will be prompted to enter the ID for the plane to recall. Enter buffered planes number or stored planes name and press <RETURN>. The prompt will then reappear. Enter number or name for the next plane to recall and press <RETURN>.

When all planes are entered, then press <RETURN> to exit the function. The composite geoplane will be numbered and stored in the planes buffer, and it will stay in memory for any further manipulation.

Recall Foliation

This function is used to recall and combine geoplanes previously recorded in the planes buffer or the planes file. If more than one geoplane is recalled, the planes will be added as if they were measured on a layer-cake-like structure (foliation) and a composite orientation of the whole stratigraphic section will be calculated. The geoplane calculated will be raised to the mean coordinates of all the recalled planes.

When pressing the key you will be prompted to enter the ID for the geoplane to recall. Enter buffered planes number or stored planes name and press <RETURN>. The prompt will then reappear. Enter number or name for the next plane to recall and press <RETURN>.

When all planes are entered, then press <RETURN> to exit the function. The composite geoplane will be numbered and stored in the planes buffer and will stay in memory for any further manipulation.

1.9: Planes Utility Menu

Measurement of true chickness of beds and displacements along faults. - Calculation of plunge and direction of fold axes.

True Thickness

Calculation of the stratigraphic and vertical distances from the position of the floating mark in the DSR to the geoplane residing in computer memory. The stratigraphic

distance represent true thickness of the unit between the floating mark and the geoplane.

The distances are displayed continuously as the floating mark is moved around in the model.

Fold Axis

Plunge and direction of fold axes are calculated from local dip and strike (geoplane) measurements.

When pressing the key you will be prompted to enter the ID for the first geoplane to recall. Enter buffered planes number or stored planes name and press <RETURN>. The prompt will then reappear. Enter number or name for the next plane to recall and press <RETURN>. Plunge and direction are now calculated and displayed. Continue with as many planes as desired for the calculation.

When all planes are entered, then press <RETURN> to exit the function. The calculated fold axis data will be numbered and stored in the planes buffer.

Name and Store

Name and store the geoplane reciding in computer memory, recall a geoplane from the plane buffer and name and store this plane, or rename an already named and stored geoplane. Names may be 20 characters or less, including spaces between letters, if desired. A named geoplane is stored in the planes file defined in the 'Initialize Project' menu.

If a geoplane resides in computer memory (work plane) when the 'name and store' function is invoked you will be asked to name this plane. Enter the name and press <RETURN>.

If no geoplane is in memory when the function is invoked, you will be prompted to enter the old plane ID. Enter the buffered planes number or the name of an old plane to rename and press <RETURN>. Then enter the (new) name.

Parallel Shift

Raises or lowers (shifts) a geoplane to another level. Place the floating mark on the point in the model to where you want the plane raised or lowered and press the right foot-pedal. The new shifted geoplane will be numbered and stored in the planes buffer.

If no geoplane is in the computer when the function is invoked, you will be prompted to enter the buffered planes number or stored planes name of the plane to be shifted.

Load Plane

A geoplane that is to be used to guide the floating mark of the DSR has to be down-loaded to the DSR plate processor. When pressing this function the plane currently in memory (work plane) is down loaded. The plane is now available for guiding by using the 'Guide ON/OFF' key.

The plane remains in the DSR plate processor until another plane is loaded or the DSR is turned off.

Recall Plane

This function is used to recall a previously recorded geoplane or fold axes from the planes buffer or the planes file.

When pressing the function you will be prompted to enter the ID for the geoplane or fold axes to recall. Enter buffered planes number or stored planes name and press <RETURN>.

V. REFERENCES

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