Rec. 9/5/95

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: EarthVision Training
(20-5702-621, 20-5702-623, 20-5702-641, and 20-5702-642)

DATE/PLACE: August 1 - August 4, 1995, the NRC Professional Development Center, Two White Flint North, Washington, DC.

AUTHOR: Rui Chen

PERSONS PRESENT: Ten people, including two from CNWRA, attended this first session of the training on EarthVision software.

DISTRIBUTION:

CNWRA	NRC-NMSS	NRC-RES	SwRI
W. Patrick	J. Linehan	J. Philip	S. Rowe
CNWRA Directors	S. Fortuna		
CNWRA Element Managers	B. Stilenpole		
M. Ahola	J. Greeves		
A. Ghosh	B. Meehan		
S. Hsiung	M. Federline		
G. Ofoegbu	M. Bell		
H. Karimi	B. Jagannath		
R. Martin	K. McConnell		
	M. Nataraja		

426.1
WM-11
NH15

9509200082 950905
PDR WASTE
WM-11 PDR

delete all distribution except: CF, PDR + NUDOCS full text

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: EarthVision Training
(20-5702-621, 20-5702-623, 20-5702-641, and 20-5702-642)

DATE/PLACE: August 1 – August 4, 1995, the NRC Professional Development Center, Two White Flint North, Washington, DC.

AUTHOR: Rui Chen

BACKGROUND AND PURPOSE:

This four-day training course on EarthVision was offered by NRC and taught by two instructors from the Dynamic Graphics, Inc.: M.W. Donley and J.H. Penny. The training course covers the theoretical concepts underlying mapping and modeling, techniques in gridding, data analysis and manipulation, two-dimension (2D) and three-dimension (3D) display generation, geologic structure modeling, volumetric calculation, and output presentation. The training uses a series of sequential, hands-on exercises to guide the user through visualization, analyses, and presentation of complex application problems. The handout materials, including the exercises, are available from the author of this report upon request. A list of some of the topics and exercises covered in the training is included in Appendix A.

PERTINENT ACTIVITIES:

The major activities in the training included lectures and exercises. Exercises 1 through 6 used a project data file that contains four subsurface horizons from the Sprayberry Formation in the Permian Basin of West Texas. Exercises 7 through 15 used a client project data of the solvent tetrachloroethylene (pce) plume in an aquifer in Manassas, Virginia. The major topics of the lectures and exercises are summarized in the following sections:

1. Introduction to EarthVision

EarthVision is an integrated product for application to earth science problems, including geologic structure analyses, oil and gas exploration and production, hydrogeology and groundwater investigations, hazardous waste contamination and migration, resource reserve and volume calculation, subsurface dynamics, oceanographic environments, and atmospheric patterns and dynamics. It is a complete set of problem solving tools. It incorporates the following functions in one product: 2D contouring and fault handling; cross sectional and fence diagram 2D displays; complex geologic structure modeling (including thrust faults, reverse faults, recumbent geometries, intersecting tabular surfaces, and multiple fault blocks); true 3D property modeling in X,Y,Z space; precision volumetric calculation capabilities; extensive editing and data manipulation capabilities; simultaneous display of structural geometries and well database graphics; rapid transformation from one earth projection system to another; mathematical formula processing for complex data; surface and volume operations, real-time graphic manipulation and

interpretation capabilities of display products; graphic montage construction; graphic design capabilities; ready data transformation from other formats; data bases; and software products.

2. Files and File Handling

The file handling facilities in EarthVision include a number of user productivity tools that greatly simplify the use of files and handling of data within the structure of EarthVision in order to build maps and models. There are more than 60 kinds of files in EarthVision, each with a unique extension so that it is self-describing. ASCII files can either match program default formats or contain header records describing a unique format. EarthVision files can be grouped into two main categories: input data files and output data files. Input data files are from other sources or created within EarthVision. Scattered data, property data, vertical fault, polygon, traverse, surface annotation, legend annotation, 2D and 3D grid, and vue script files are examples that fit this category. Output data files are created within EarthVision. These include binary scattered data, checkpoint, computer graphics metalfiles, faces, 2D and 3D grid and grid report, intelligent plot, and log files. Also included are script and checkpoint files that record what was done.

Exercise 1: 2D File and File Handling — Familiarize oneself with the project data and learn how to create a header file for scattered data using EarthVision. The horizon values in the project data file are in measured depth (positive values) from the well, or Kelly-Bushing. This exercise converts the measured depths to subsea depths by subtracting the measured depth from the Kelly-Bushing elevation. Finally, the *View* portion of EarthVision is used to view the spatial relationship of the input data in preparation for selecting gridding parameters.

3. 2D Minimum Tension Gridding

2D Gridding builds a two dimensional grid as a basis for single surface mapping and modeling. Surface height estimation from scattered data is very time consuming and requires a global view of the scattered data. Tasks such as contouring, cross section calculation, and volumetrics require too many point height estimates to calculate directly from the scattered data. 2D Gridding calculates Z-values (elevation, depths, or abstract values) at regularly spaced points in a rectangular matrix from scattered data. By calculating a grid, the time consuming height estimation is done only once. The minimum tension gridding iteratively calculates values for the grid nodes by utilizing Briggs' bicubic spline function that distributes the tension among the grid nodes. In general, the minimum tension algorithm will produce smooth surfaces that closely honor the scattered data values. How closely the surface honors the data is affected by factors such as the density of the grid nodes and their location with respect to the data locations. The gridding processes include: selecting the input dada, specifying grid range and cell size, using extra gridding parameters, clipping lateral extent, and calculating the 2D grid. Gridding is as much an art as it is a science. One may need to calculate several approximations before achieving the grid size and shape that is successful in honoring the data points.

Exercise 2: 2D Minimum Tension Gridding — Calculate a series of 2D grids representing the four horizons for the top of the Sprayberry Formation, the top of Zone 2, the top of Zone 3, and the bottom of Zone 3. A fault is presented in the region that causes discontinuity in the vertical distribution of the data set. For a surface to properly model fault information, a vertical fault file need to be specified before gridding. The user will then specify projection parameters, gridding parameters, and then calculate the grids. Confirm graphically that input scattered data and fault information is being honored in the gridding calculation. This is possible by examining each grid in *3D View* and making a visual assessment of the

surface and its relationship to the input data. Also, examine the gridding reports that are calculated automatically with each grid.

4. Base and Contour Mapping

Base and Contour Mapping creates planimetric display of thematic data, including quantitative surface portrayal (contours), annotation, and reference display. It can be used to create complex maps, control quantitative and qualitative design elements, analyze planimetric displays for pattern and relationships, and generate realistic displays for quick, cost-effective interpretation. The steps involved in base and contour mapping include specifying the input files to be used; setting display attributes; defining the X, Y, Z limits of the map; selecting plot scale; entering the map title; specifying a variety of contouring and color options; and calculating the graphics. The 2D Graphic Displays of EarthVision can be used to generate a few types of graphic displays, including two dimensional or plan view maps, base maps, contour maps, sectional views, cross sections, and fence diagrams.

Exercise 3: Contour and Base Map Creation — The previous module for 2D gridding shows that it is possible to "preview" a 2D grid file using the *plot* button. The color-filled grid cells are very helpful for planning the characteristics of a contour map. In this exercise, one can preview a 2D grid file for the purposes of color selection, and then create a color-filled contour map of the data. One may also "customize" the contoured display to improve the information content of the contour map, such as "targeting" a contour or series of contours.

5. Color Table Editor

EarthVision incorporates a default color file of 64 levels of color representing the entire visual spectrum from violet through red. Using the Color Table Editor these colors may be graphically manipulated to satisfy individual design and communication objectives. EarthVision includes four major color systems: RGB, CMY, HSV, and HLS. RGB is an additive color system using the primary hues of red, blue, and green. The combination of the three values ranges from 0 to 255. CMY is a subtractive color system using cyan (blue), magenta (red), and yellow to create a range of 255 colors. HSV is a system based on hue, saturation, and value. Hue is the basic pure color and white (saturation) or black (value) are added to create tints, shades, and tones. HLS is a similar system as HSV but increasing L (lightness) increases light energy from none (black) to overwhelming (white). Saturation here is more a function of the fullness of color — a range from no color to "full" color. The user may manipulate color in a number of ways and can create custom color keys for mapped or modeled distributions.

6. Cross Section Construction

EarthVision can generate cross sections or vertical profiles through a series of 2D grids along a specific line of traverse. This function can be used to visualize, in 2D, the vertical distribution of data, scale vertical relationships, analyze sequential relationships and process, and understand/interpret the vertical dimension in geologic structures/lithologies. The operation sequences of cross section construction include building geologic sequence files/grids, determining relationship of sequence grids, selecting traverse, specifying plot scale/size, and calculating the display. Four geologic rules are included in determining geologic sequences: depositional, unconformities, channel erosional, and reference (e.g. fluid contact). The traverse can be specified from a traverse file, using Graphic Editor, or entering X, Y coordinates.

Exercise 4: Cross Sections — Once a grid or series of grids are defined, a host of multi-surface operations becomes possible. In EarthVision, the creation of traditional cross sections is enhanced by the program's ability to automatically perform a number of different logical operations between surfaces. This means that the 2D structure grids representing, for example, unconformity surfaces or channel erosional surfaces, can be simply defined to the program as such. No intermediate grid operations between surfaces are required. In this exercise, a few cross sections are calculated for the four simple depositional layers of the Sprayberry Formation using the extrapolated grids calculated in previous exercises. The traverses will be specified from a traverse file, using Graphic Editor, or entering X, Y coordinates.

7. Fence Diagrams (2D and 3D)

Fence Diagrams are a perspective view of a series of cross sections that visually display a sample of the third dimension. They are also referred to as 2 1/2D graphics. Constructing a fence diagram in EarthVision is almost identical to the process used to construct cross sections, including selecting data files, selecting and manipulating graphic components, selecting/specifying traverses of fence, and calculating the display. Similar to constructing cross section, the traverse can be selected from a file, using Graphic Editor, or entering X, Y coordinates.

Exercise 5: Fence Displays — Similar to cross sections, fence displays are another multi-surface view defined by traverse lines. 3D fence displays, however, can be viewed and manipulated interactively in three dimensions. In EarthVision, it is also possible to generate vector fence diagrams with fixed inclination and azimuth. Both are calculated with the same logic as cross sections, that is, the "geologic rules" apply in the same way. This exercise uses five traverse lines edited using the Graphic Editor to generate a fence display for the Sprayberry Formation. Once the 3D fence display calculation has completed, the user can change the zone colors using the zone color table. One may also turn off one or more fence traverses and manipulate the model to provide the most optimal view. The user will also calculate a 2D vector fence diagram and compare the 2D vector fence diagram with the 3D fence display.

8. Layer Volumetrics

EarthVision can be used to determine the cubic measure of a volume in a "container" with a top, a bottom, and sides. The top and bottom bounding surfaces are 2D grids. A series of grids or a stack may be used to calculate volumes for single layers or for each layer in a series of layers. The operational sequences include selecting surfaces to define container tops and bottoms, specifying geologic rules, defining container sides (bounding polygons), assigning volumetric zone names, specifying yield factors, specifying Z minima and/or maxima, and calculating the volumes. The bounding polygons can be created by keying in coordinate pairs defining the desired polygon, creating in the Graphic Editor, or importing from external sources. Besides specifying the vertical limits (grids and/or constants) and the lateral limits (polygon files), there are also a number of user-specified volume control parameters: a minimum layer thickness value, a Z-range limit, a yield factor, and a conversion factor for the final units of the volume.

Exercise 6: Layer Volumetrics — The layer volumetrics program is used to calculate the volume of material between any two surfaces and within polygonal areas. The program requires the user to provide surface information in the form of grids or constants and polygon information in the form of a file containing one or more polygon descriptions. Other information may also be supplied. This exercise guides a user through the volumetrics calculation for a single layer defined by two structure grids in the Sprayberry Formation for several polygons defined by an existing bounding polygon file.

9. 3D Minimum Tension Gridding

The 3D Minimum Tension Gridding builds a three dimensional (X, Y, Z, and P) grid as a basis for multiple surface property or zone modeling within a volume. The operation sequences in 3D Minimum Tension Gridding include data/file selection, supplying range and grid spacing information, supplying property data range and vertical influence factor, determining lateral and structural clipping information, supplying zone expansion factors, and calculating the grid. More than one property value per scattered data location may be included by specifying appropriate field names. If a grid P-range limit is imposed during gridding, the 3D grid is calculated without limits and then all nodes above or below the limits are reset to the appropriate range limit. However, if a P-range is imposed on the input scattered data during gridding, then only those data points whose property values fall within the specified range are used to calculate the 3D grid. A vertical influence factor may be used to determine the influence in Z direction relative to X and Y directions. The user can supply 3D scattered input data with up to 20 "slice grids" to add definition in areas where the data alone do not provide adequate control. This is one of the most effective editing processes for controlling 3D grids. After editing, the 2D grid slices are converted to scattered data and used with the input scattered data during grid calculation. Polygon files can be used for laterally clipping of the input scattered data and 2D structure grids can be used to vertically clip the input scattered data. When a structure grid is specified during gridding, it is possible to vertically shrink or enlarge the "gridding zone," a 3D container from which the input for gridding will be taken, using the "zone expansion" factor expressed in Z-units. In general, the minimum tension algorithm will produce smooth isosurfaces that closely honor the scattered data values. How closely the surface honors the data is affected by many factors, such as the density of the grid nodes, their location with respect to the data locations, and how radically the property values change over short spatial distances.

Exercise 7: 3D Files and File Handing — EarthVision typically uses 3D ASCII data sets that contain X,Y,Z, and P fields. "P" can be any property in nature, whether porosity and permeability measurements in an oil field, lead and zinc concentrations at an environmental site, or selenium in overburden at a mining prospect. This exercise uses actual data from a client project site, an aquifer in Manassas, Virginia. The property value in this particular case is "pce." In EarthVision, the basic steps of any project is always data introduction, gridding, and visualization. In this first exercise of a series of exercises in 3D portion of this training on EarthVision, the user will get familiar with the project data file by editing a header file and using the *3D View* portion of EarthVision to view the spatial relationship of the input data in preparation for selecting gridding parameters.

Exercise 8: 2D Gridding for 3D Applications — This exercise calculates a very simple 2D grid representing the top, or potentiometric surface, of the Manassas aquifer in a similar way as in exercise 2 for the subsequent 3D applications.

Exercise 9: 3D Minimum Tension Gridding — This exercise calculates a very simple 3D grid representing the distribution of pce in the Manassas aquifer. When the grid has finished calculating, the user should examine the result in three dimensions by using the *View* file function.

10. Faces Files

A 3D faces file is a binary format file as the input to the visualization portion of an analysis. This binary format file can then be viewed using 3D viewer. The faces files are usually very large because they contain the following information: isosurface intersections with each X, Y, or Z slice plane, the vertices of the polygons that make up each 3D isosurface, the normal of each of these polygons, and a color index

for each of these polygons, the vertices of the polygons that make up each 3D structure surface, the normal of each of these polygons, and a color index for each of these polygons. Operation sequences for creating a faces file include: selection of input data, supplying range and grid parameters, providing information for clipping surfaces, specifying clipping tolerance, specifing isosurface parameters (such as isosurface interval) and titles, and calculating the faces file. Polygon files can be used to limit the lateral extent of a 3D faces file. 2D structure grids can be used to vertically limit the 3D faces file. Polygons and/or 2D structural grids can be used for clipping the 3D faces file regardless of whether they were used to clip the 3D input data during gridding. 3D faces files can be created for several different zones (e.g., lithologic zones) and then those zones can be merged together. The isosurface interval defines the property values at which 3D surfaces are generated. It can be thought of as the 3D equivalent of the 2D contour interval. Up to 20 isosurfaces can be calculated in a faces file. The isosurface interval can be specified as a constant interval, as a constant interval with bounds, as a list of specific property values, or import from the isosurface intervals of another 3D faces file.

Exercise 10: Faces Files — This exercise calculates a "faces" file based on the 3D grid calculated in the 3D Minimum Tension Gridding module (Exercise 9). Faces files are the input to the visualization program component of EarthVision. The user has a number of choices for the method to be used to specify isosurfaces. Upon completion of the faces file calculation, *View* button can be used to bring up the model. One may display the isoshell for certain specific property values, e.g., view only the isoshell of pce for 10000 ppb and above. One may also display the scattered data points along with the isoshells to examine whether the model reflects input data value, what parts of the model are extrapolated, and how will this affect the data interpretation.

11. Merging Faces Files

Merging or combining faces files allow one to create composite models of several layers or zones. This permits portrayal of greater complexity while still permitting real time interactive analysis and manipulation. Merging faces files is a straightforward procedure. However, there are a few requirements that should be kept in mind during this operation in order to calculate "compatible" components: faces files to be merged should have the same grid size (rows, columns, and levels); faces files to be merged must have the same isosurface levels; common 3D bounding surfaces for adjacent faces files should be the same and should have the same tolerance values.

Exercise 11: Faces File Merging — This exercise leads a user through the necessary steps to create a model that is composed of two layers. These layers exhibit independent properties, and therefore need to be comprised of independent grids and faces files. In this exercise, the user creates a faces file of property in the vadose zone and then merge this file with an aquifer zone that uses the top of the water table as the top structure clipping surface.

12. Image Draping

Image Draping function allows draping of aerial photos, satellite images, or any other scanned image onto a 3D volume model for more effective reference and annotation. Draping scanned images is accomplished by building a special type of faces file using a 2D grid surface. This Image Faces File may then be merged with one or more other volumetric faces files to form a complete model of volume portrayal with scanned/raster information draped on the irregular top surface. To proceed image draping, one needs three things: a scanned image in a Silicon Graphics image (RGB) format, registration points (three

identifiable positions on the scanned image with real world coordinate locations), and a 2D grid on which the RGB image may be registered.

Exercise 12: Image Draping — This exercise introduces the image draping software of EarthVision. Three files are provided for this process: the image file scanned from a USGS paper map, the reference annotation file containing the geographic and cultural information of the area, and a 2D grid file onto which the image is to be draped. The user will have to create an image registration file for the scanned image file based on the reference annotation file so that it is possible to find precise geographic locations (e.g. road intersections) on the image file that have exactly the same coordinates as the locations on the 2D grid surface. When registering an image to a 2D surface, three nonlinear points are required to tie the image to the surface. These locations are expressed as pixel pairs with the first value equal to the X location, and the second value equal to the Y location. Find two sets of three points by locating the same features on the image and the annotation file. Try to find control points that are very obvious physical or cultural features, e.g. highway intersections. Should avoid selecting points that form a cluster or a line. Once satisfied with the coordinates, the image faces file may be created.

13. 3D Viewer

The 3D Viewer can be used to view, manipulate, and analyze graphic displays of 2, 2 1/2, and 3D models by using Menu Commands including menu buttons, hot keys, pop-up menus and scroll bars, slider bars, and toggles. Multiple files may be selected at the same time. The selection may be a faces file (3D), a scattered data file, a 2D grid file, a 3D grid file, or structure file. 3D Viewer menus and functionality include: Manipulate Model Menu (slicing, adjusting isosurfaces, and chair mode), View Model Menu (view angle azimuth and inclination, look point position, z-exaggeration, zoom, projection, and via file settings), Zone Display Menu (properties including zone colors, zone removal, Z color-filled contours, zone chair mode, block display, and interior surfaces display), File Selection Menu (file cycling and edit), Data Posting Menu (binary scattered data display, symbol scale factor, data clipping distance, vertical fault display, polygon display, annotation display, and directed well display), Data Capture Menu (3D cursor location, capture file, data point capture, polygon capture, instant volumetric calculation), Screen Display Menu (color key control, model information, screen annotation, screen control, deferred mode and redraw), Color Control Menu (color control functions), Screen Output Menu (image size, output options, actions, and single vs double buffer), ASCII Data Editing Menu (3D cursor location, ASCII data, point, and line display, add data/3D lines, edit data/3D lines, data line tubes, and save ASCII data file), Lighting Menu (light angle, scene and material settings, reset lighting), Transparency Menu (zone transparency display and color), Animation Menu (scripting and data animation), Axes Display Menu (axes and labels display, tick marks, tick mark interval, tick mark reference values, axes captions and reset) and Image Display Menu (draped image display and draped image offset).

Exercise 13: Analyzing the Model in the 3D Viewer — In this exercise, one will use the *3D Viewer* to study the distribution of the pce in the Manassas aquifer by viewing the aquifer zone along with the property data file. The user can manipulate the model with many of the common functions for 3D analysis and answer a number of technical questions about the problem, such as whether the portrayal of the distribution is reasonable, are there parts of the model where finer grid spacing might improve the isosurfaces, if more wells could be drilled, where additional data might be desired to produce a more complete model, etc. One may also analyze the direction of pce migration by observing the shape of the water table and the underlying concentration plume, find the probable point source of the pce, give

suggestions for remediation, and suggest locations for the wells for pumping water out of the ground if treatment is desirable.

14. Property Volumetrics

3D or Property Volumetrics is the second volumetrics option in EarthVision. It can be used to determine the cubic measure contained between two isoshell property surfaces and the manipulations possible with 3D volumetric determinations. Volume calculation in 3D is very similar to the 2D process except it includes isoshell boundaries for volume delimitation as well as the other constraints associated with the 3D procedure. It is actually an extension of the volume calculation process in 2D.

Exercise 14: Property Volumetric — This exercise guides a user through the volumetric calculation for a specific P-range within a single layer defined by a top structure surface and bounding polygons. The user will perform a few volume calculations: using the full gridded area without spatial limitations to calculate a volume for only those concentration levels of interest, using a bounding polygon file to "laterally" limit the volume calculation to only those areas under specific site boundaries for the concentration levels of interest, using a structure clipping surface to limit the model vertically and calculate only those volume with the aquifer and the site boundaries, etc.

15. Formulas

The Formulas Function in EarthVision can be used to perform mathematical operations on data fields, files, and grids (both 2D and 3D) prior to, and within, the mapping and modeling processes. Formula Operations include simple field and grid operations and complex, sequential mathematical processing of multiple field and grid files. The Field Operations can be used to perform field to field operations, field and constant operations, and back interpolation. Use of the Formula Processor for grid operations include making mathematical modifications to all grid node values, modifying the grid range or the density of grid nodes or both, making modifications to grid node values in areas defined by user specified polygons, and performing logical operations on grids. Grid to grid calculations are operations between two grids which produce a resultant grid. The range of the resultant grid covers the area of intersection between the two input grids. When performing grid to grid calculations, the resultant grid cell size will approximate the finer of the two input grids. Grid and constant operations are calculations between a grid and a constant value. The resulting grid has the same X and Y ranges and the same grid node spacing as the input grid, but new grid node values.

Exercise 14: Formula Processor for File and Grid Operations — In this module, the user modifies or calculates files for a number of special purposes. When a data set contains property values that have variations of orders of magnitude, usually gridding process produces an "unacceptable" amount of extrapolation in the areas of the grid range where little or no data exists. In this case, one may use the log function to remove these extreme variations before gridding. This process will flatten the range of variation in the data, and provide a more manageable "slope" for the normal minimum tension gridding algorithm to work with. Then use the anti-log function to return the model to its original units before calculating a faces file. This log/anti-log technique can significantly reduce extrapolation in corners of some areas of the model.

16. Geologic Structure Builder

Geologic Structure Builder can be used to model complex, three dimensional geologies where faults, unconformities, and complex intersections make interpretation and analysis difficult. It provides a unique capability to model multiple intersecting surfaces and layers where X and Y locations may have more than one value (overturned structures). The process of defining a geologic structure model is straight forward and involves five logical and sequential steps: define the planimetric and vertical range of the model, define the blocks and relationships in any existing fault system, name the various zones and establish their geologic relationships (sequence and process), specify the zones or layer sequence present in each block or unit previously defined, and model property distributions in one or more of the structural components. The Range can be entered directly from the keyboard or may alternately be obtained from existing files. The Geologic Structure Builder views the entire model initially as a large single fault block. As a fault is added to the model, the large initial "parent" block is subdivided into two smaller blocks called "children." These children may be successively divided into two "children" of their own until all faults in the model are represented.

Exercise 15: Geologic Structure Builder — In this exercise, the user builds a faulted model using EarthVision's Geologic Structure Builder. The exercise assumes that considerable "preprocessing" has been performed on the exercise data set. This means that the original data, consisting of horizon and fault picks, has already been sorted by fault block, introduced to EarthVision, and gridded. This preprocessing was necessary to ensure that the exercise focuses on the theory and application of the Structure Builder itself. The preprocessed files include 3 nonvertical fault planes (grids) created from scattered data, 16 horizon grids created from scattered data sets of horizon values within each fault block. Each horizon in a sequence is gridded from separated scattered data subset for each fault block. These scattered data subsets are derived for each fault block from larger sets for each horizon. In other words, the scattered data need be to organized by horizon and fault block prior to gridding. When these files are ready, the Structure Builder can be used to build the horizons within each fault block by specifying sequences. After calculation, one may examine the model from all angles and by selecting or deselecting specific fault blocks for viewing to analyze the relationship between adjacent fault blocks.

SUMMARY

The training on EarthVision was well-done and very rewarding. The two instructors from the Dynamic Graphics, Inc. were very good at both lecturing and answering questions. The content of the training covers many basic aspects and functions of EarthVision. After the class, one would be able to use EarthVision to accomplish basic applications and know where to start for more advanced, specific applications.

PROBLEMS ENCOUNTERED:

None

PENDING ACTIONS:

None

SIGNATURE:

Rui Chen
Research Engineer

8/31/95
DATE

CONCURRENCE SIGNATURES AND DATE:

Asadul H. Chowdhury
Manager, RDCO

8/31/95
DATE

Budhi Sagar
Technical Director

8/31/95
DATE

/yl

APPENDIX A

EarthVision Expanded 2-D/3-D Mapping, Modeling, and Analysis

I. **Introduction/Overview**
   A. Class Members, Instructors, DGI, Materials
   B. Course and Exercise Overview
   C. Definition of 2-D/3-D Mapping and Modeling
   D. Relationship of 2-D to 3-D Operations

II. **Background and Basics**
   A. Introduction to EarthVision and the EarthVision Interface
      - *Exercise: EarthVision and Help Files*
   B. Mapping and Modeling; Basics and Underlying Principles
      1. Projections and Coordinate Systems
      2. Datums and Ellipsoids
      3. Computer Mapping and Modeling; Techniques
      4. DGI and Minimum Tension Gridding
   C. Introduction to UNIX

III. **2-D Mapping**
   A. Files and File Handling
      - *Exercise: File Handling*
   B. 2-D Gridding
      - *Exercise: 2-D Grid Construction*
   C. Contour and Base Mapping
      - *Exercise: Contour and Base Map Construction*
   D. Color Table Editor (CTE)

IV. **Non-planimetric 2-D/3-D Displays**
   A. Cross Sections in EarthVision
      - *Exercise: Cross Section Construction*
   B. Fence Diagrams in EarthVision
      - *Exercise: Fence Diagram Construction*

V. **Map Editing**
   A. Introduction to the Graphic Editor
      - *Exercise: Using the Graphic Editor*
   B. Introduction to the Digitizer Editor

VI. **3-D Modeling**
   A. Files and File Handling
      - *Exercise: Files and File Handling*
   B. Using 2-D Surfaces in 3-D
      - *Exercise: 2-D Grid Construction*
   C. 3-D Gridding
      - *Exercise: 3-D Minimum Tension Gridding*
   D. Faces File Generation
      - *Exercise: Building a Faces File*
   E. 3-D Viewer

VII. **Support Utilities**
- A. Data and Grid Manipulation with Formula Processor
  - *Exercise: Grid Operations Using the Formula Processor*

VIII. **Building Multiple Zone Models and Analyzing the Results**
- A. Merging 3-D Zone Models
  - *Exercise: Faces File Merging*
- B. Analyzing the Model
  - *Exercise: Interpreting the Model and Answering Problem Questions*
- C. Other Capabilities
  1. Instant Volumetrics
  2. Color Editors
     - *Exercise: Manipulating Property, Zone, and Z Color Editors*
  3. Project Presentation
     - *Exercise: Use of Vue and Vue Script Files*

IX. **Advanced Capabilities**
- A. Conformal Gridding
  - *Exercise: Conformal Gridding Case Study*
- B. The Geologic Structure Builder
  - *Exercise: Shell Script Files (Sorting Data by Fault Block)*
  - *Exercise: Geologic Structure Builder (Building Fault Blocks with Horizons)*

X. **Other Utilities**
- A. Volumetrics
  - *Exercise: Volumetrics*
- B. Well Database Operations
  - *Exercise: Well Database Operations*
- C. Coordinate Transformations

XI. **Course Summary**
- A. Recap Process and Procedures
- B. Advantages and Benefits of Using DGI Technology
- C. Application Briefs/Sampler