THE DIAMOND DRILL HOLE DATA BASE SYSTEM

SUMMARY DESCRIPTION

003164

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SUMMARY DESCRIPTION

Prepared By

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ICAS Software Services Inc.

for the

CYPRUS ANVIL MINING CORPORATION

March 1983

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SUMMARY DESCRIPTION

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1.0 INTRODUCTION

Geological data is collected at great expense and considerable risk during exploration and development drilling programs on ore bodies. There is a strong incentive, therefore, to acquire the maximum amount of data from the drill-holes and then to make it readily accessible to geologists and mining engineers for subsequent analysis and interpretation. An effective means of accomplishing this is to have the geological data stored in permanent files on a computer. In this way, the data is usually immediately available in verified and correct form for analysis, display and interpretation.

The Diamond Drill Hole Data Base System is a powerful data base management system tailored to fit the DDH data processing needs of the Cyprus Anvil Mining Corporation. It is now operational and will provide the Cyprus Anvil Mining Corporation with the following benefits:

- All current diamond drill-hole data processing operations are performed 'in-house' by CAMC personnel
    - this has largely eliminated costs (cash outflows) for
        - keypunching
        - computing
        - data storage
        - printing
    - and has reduced the costs of plotting and consulting.
- Most data recorded by or associated with diamond drilling of a mining property is
    - organized in one place with consistent and coherent formats.
    - retrievable and usable by geologists and engineers
    - entered, updated and corrected by CAMC clerical staff.
- improved vertical section plotting of single drill-holes
- direct plotting of cross- and long-sections.
- all stored geological data is retrievable (by type) via
    - drill-hole identifier
    - sample number
    - lithology (rock) code
    - depth in drill-hole.

1.0 INTRODUCTION (Continued)

- easier development of special applications programs and analysis procedures
- reduced operating costs for processing geological data, with moderate anticipated increases in future years.
- significant increases in the ability of CAMC personnel and departments to interrogate, analyse, display and interpret vital project geological data.

This document provides a summary description of the Diamond Drill Hole Data Base System.

1.1 History

Cyprus Anvil's Exploration department has been involved in computer processing of geological field data since 1976. This work began with the computerization of diamond drill-hole data collected from the Faro (Anvil) deposits and has now become a standard operating procedure for all of Cyprus Anvil's drilling programs.

Over the intervening years, the formats and specifications for data to be collected in DDH core logging operations have evolved into what appears now to be a relatively mature system. This evolution process has caused a variety of problems in terms of organizing the Cyprus Anvil geological data.

Original data processing efforts consisted of programs and data file structures on Computer Sciences Canada Ltd's Univac computer oriented towards handling individual drill holes. These programs and data files changed with the evolution of the geological logging system. This led to a situation where there were hundreds of individual diamond drill hole data files (of varying formats) and numerous program versions on the external computer system. As this vast amount of DDH data was being collected and computerized it became apparent to all involved in the data processing effort that the data needed to be organized into consistent and coherent formats and integrated into data bases.

As Cyprus Anvil itself started to computerize its business computing operations, some additional geological data processing operations were implemented on its internal Hewlett-Packard HP3000 computers. The success of these early in-house geological data processing activities then led to discussions and evaluations of deriving a new computing facility; one which would contain all the features fantasized about and be run at minimal cost on the internal computers.

These discussions led to the development of design specifications for the Diamond Drill Hole Data Base System. These specifications were included in an AFE which was approved formally in November 1982. Detailed design specifications had been prepared and programming had been started by then. The full Phase 1 Development was completed on budget and reasonably on time in February 1983. It is now operational and is in daily use by many of Cyprus Anvil's Exploration department personnel.

1.2 Current Status

The Cyprus Anvil Diamond Drill Hole Data Base System was developed and is currently operational on the Hewlett-Packard HP-3000 computer located in the Vancouver office. Separate DDHDB Data Bases have been established for the following CAMC properties:-

1. Anvil (in Imperial units)
2. Grum
3. Vangorda
4. Cirque
5. DY
6. Elf
7. Fluke
8. General (Swim, SEA, etc.)

A program of loading these data bases with appropriate data is ongoing and will be complete shortly.

Thus, shortly all data recorded by or associated with diamond drilling of the various Cyprus Anvil properties will be
- organized in one place with consistent and coherent formats,
- retrievable and directly usable by geologists and mining engineers, and
- entered, updated and corrected by CAMC staff (with only minimal involvement of outside consultants).

This facility has already permitted significant increases in productivity and ability of CAMC personnel to interrogate, analyse, display and interpret vital project geological data.

All of the program elements defined in Phase 1 Development of the Diamond Drill Hole Data Base System (cf. CAMC AFE #82-017) are operational. The use of the individual program elements for data base processing is fully detailed in the separate USER'S MANUAL. (The User can print his own copy of this manual by making the appropriate selection in the REPORTS menu). Some additional program elements have also been developed and these are also fully operational.

The various property data bases are accessible to CAMC staff members who have been assigned "User IDs" and "User Passwords" in the "GEOLOGY" Account on the Vancouver HP3000 Computer. User IDs and Passwords can be obtained by suitably qualified CAMC personnel

1.2 Current Status (Continued)

by contacting Wayne Van Damme, the Data Processing Manager.

Nearly all the Data Base Processing functions are accessible through the Program Menus established for the Diamond Drill Hole Data Base System. There is no need for individual users to learn operating system details, functions and control language sequences as all the necessary operations are embedded in the Menu System.

Bob Rollings is the Data Base Manager for all the extant Diamond Drill Hole Data Bases. Users should inform Bob of their needs, and subsequently their progress, for Data Base processing. All problems with programs and stored data should be referred immediately to him. Bob is responsible for all corrections to stored data and programs and will arrange for specialist assistance as necessary.

All plotting of Diamond Drill Holes is done on the Houston Instruments DP-3S 36" plotter located in Tetrad Computer Applications Ltd.'s office at 740 Nicola Street, Vancouver. A 1200-baud data communications telephone line has been established between their plotter and the Vancouver HP3000 computer.

People to contact for assistance are

1. Bob Rollings - general assistance
2. Wayne Van Damme - User ID's and Passwords
3. Stan Gray - plotting (685-2295)
   (Tetrad Computer Applications)
4. Jim Marlon-Lambert - technical questions (985-5131)
   (ICAS Software Services Inc.)
5. Peter Clarke - question re transfer of DDH-Data to the MINTEC mine modelling system.

1.3 Scope of Document

This document has been prepared by Jim Marlon-Lambert to give Users and potential Users of the Diamond Drill Hole Data Base System a summary of its characteristics and capabilities. It is not a Users Manual nor is it a Technical Manual.

This document has been organized into a logical series of sections. It is prepared as a draft to allow for comment and review. Comments, constructive criticisms, additions and compliments will all be gratefully accepted. Time and budget, however, will not allow for a final version to be prepared.

1.4 Related Documents.

A number of documents and manuals are available to provide details of the Diamond Drill Hole Data Base System. They are

(a) Geological Data Preparation
- "FIELD LOGGING MANUAL"
  DIAMOND DRILL HOLE DATA BASE SYSTEM
  by L.C. Pigage, C.W. Jefferson, D.S. Jennings, D.B. Kilby and J.R. Marlon-Lambert
  C.A.M.C. February 1983.

(b) System Development
- " A.F.E. # 82-017 DIAMOND DRILL HOLE DATA BASE SYSTEM"
  C.A.M.C. November 12, 1982.
- " PROGRAMMER'S NOTES"
  C.A.M.C. March 1983. (Collected Notes)
- " PROGRAM LISTINGS"
  C.A.M.C. March 1983.
- HEWLETT-PACKARD HP3000 COMPUTER SYSTEM MANUALS.
  - MPE COMMANDS REFERENCE MANUAL
  - FORTRAN/3000 REFERENCE MANUAL
  - IMAGE Data Base Management System REFERENCE MANUAL.

(c) Usage Instructions.
- " USER'S MANUAL"
  DIAMOND DRILL HOLE DATA BASE SYSTEM
  by J. Marlon-Lambert & P. Pollhammer
  February 1983.
  (AVAILABLE as an OPTION in the 'REPORTS' Menu). *

(d) Historical Context.
- "DRILL-HOLE DATA HANDLING SYSTEM - JULY 1980"
  General System Notes by J.R. Marlon-Lambert
  July 1980
- " DRILL-HOLE DATA HANDLING SYSTEM"
  (Short Notes, for all Geologists Logging C.A.M.C. Core"
  Compiled by: B.V. Hall, C.W. Jefferson, D.S. Jennings, D.B. Kilby, J.R. Marlon-Lambert and L.C. Pigage
  May 1981
- " 1982/83 CHANGES TO THE DDH DATA BASE"
  by D.S. Jennings and G. Jilson
  CAMC November 1982.

2.0 DESCRIPTION OF THE DIAMOND DRILL HOLE DATA BASE SYSTEM.

The DIAMOND DRILL HOLE DATA BASE SYSTEM consists primarily of a suite of computer programs linked through a common data base (hereafter called the 'DDHDB' for Diamond Drill Hole Data Base). An overview of the various operating components of this system is contained on the following page.

The DDHDB Data Base contains various types and levels of data associated with diamond drilling of an orebody. The structure and contents of the Data Base are described in some detail in the next section.

The suite of computer programs comprising the Diamond Drill Hole Data Base System is composed of various types of application programs for

(a) Initial and Subsequent Allocation of the Data Base
(b) Entry of Property and other General Data
(c) Entry of Diamond Drill Hole Data
(d) Calculation of Various DDH parameters
(e) Reporting of DDH data and DDHDB contents
(f) Display (Plotting) of DDH data.
(g) Interface with Orebody and Mine Modelling Packages.
(h) Geological Data Analysis
(i) Data Base Maintenance.

These programs are accessible to various User categories through a MENU system which runs concurrently with any of the above programs. The User thus does not need to learn details of the HP3000 computer operation prior to running most of the programs in the suite.

Each of the above categories of applications programs is described in following sections of this manual.

Specific versions of the DDHDB are created for individual mining properties. These data bases are independent and can only be accessed after the User has specifically indicated (by data input to the System) which property he/she wants to work on.

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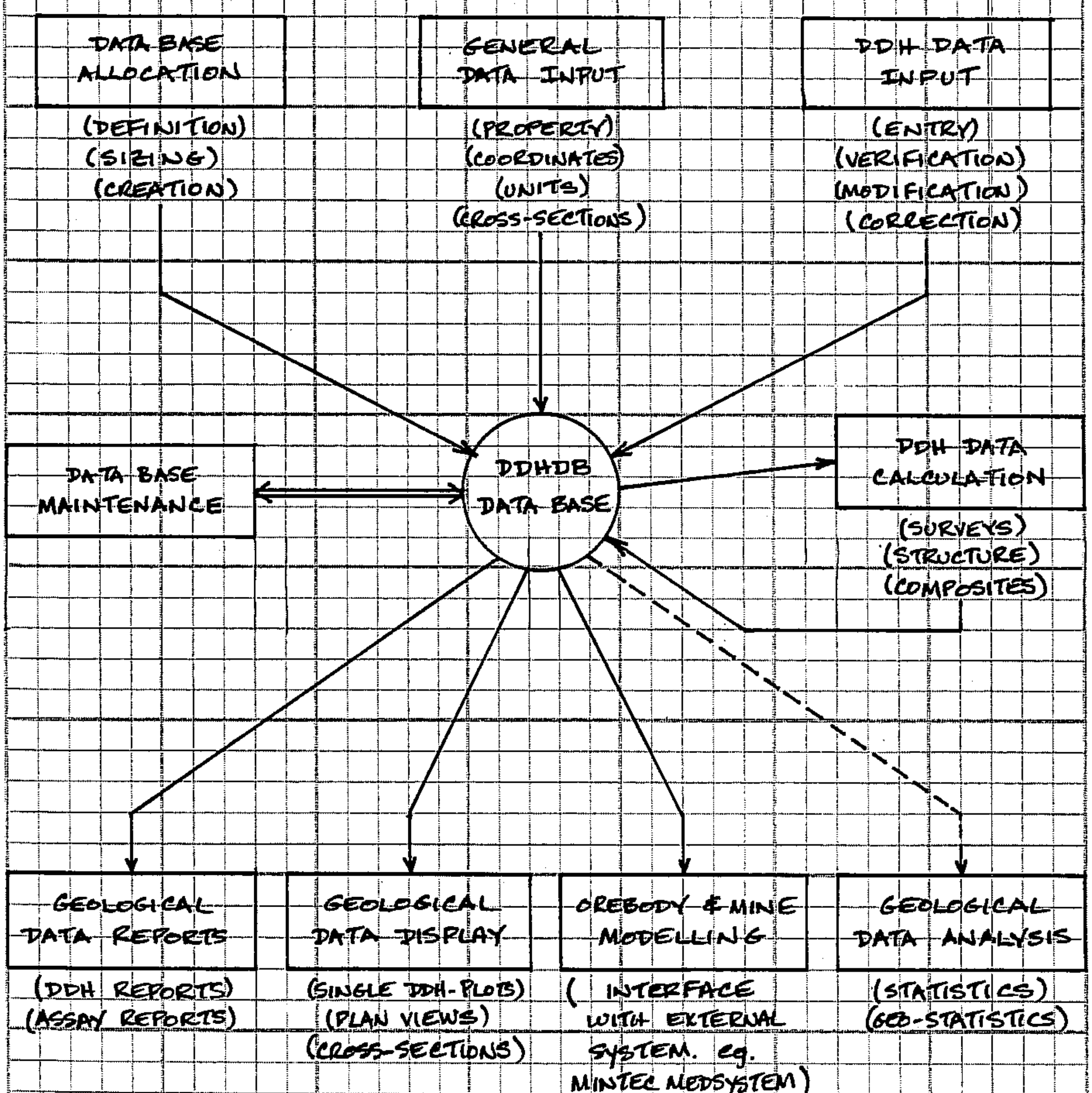
OVERVIEW OF DIAMOND DRILL HOLE DATA BASE SYSTEM OPERATION.



2.1 Programming Details

The current version of the Diamond Drill Hole Data Base System is operational on the HP3000 computer in Cyprus Anvil's Vancouver office. The MPE IV operating system is used on this machine.

The component programs of the system are written (individually) with one of the standard computer languages, either

(a) COBOL II, or
(b) FORTRAN/3000.

The COBOL language is used for the bulk of the programs involved in DDH Data Entry, General Data Reporting, and some simple calculation programs. FORTRAN is used for those programs involved in General Data Input, Geological Data Display, DDH Data Calculation, and the Interface with External Orebody and Mine Modelling Systems. (FORTRAN would also be used for future programs involved in Geological Data Analysis).

An integral part of the Geological Data Display programs is the set of subroutines necessary to drive the output plotter device. Currently this set of subroutines (written in FORTRAN) will allow access only to the HOUSTON INSTRUMENTS DP-8S plotter (available in TETRAD Computer Applications Ltd.'s office). Some conversion work would be necessary if the System were to be moved to Faro, as the Calcomp 1051 plotter there requires a completely different set of subroutines.

All data base allocation, maintenance and usage is performed with the IMAGE data base system available as a standard feature on the Hewlett-Packard HP3000 computer. IMAGE is a general purpose data base management system that allows information to be related logically between data files, minimizing data redundancy and facilitating retrieval. It provides facilities to describe data base structures; create a data base; and access, maintain, re-structure and back-up data bases.

IMAGE consists of three components.

(a) A Data Base Definition Language
(b) Data Base Management Intrinsics - subroutines callable from FORTRAN and COBOL programs
(c) Data Base Utilities (separate programs).

3.0 DESCRIPTION OF THE DIAMOND DRILL HOLE DATA BASE ('DDHDB')

The general configuration of the DDHDB Data Base is indicated on the following page. The DDHDB Data Base is defined as an HP3000 IMAGE data base which provides a two-level network (hierarchical) of logically-related files containing both data and data base structural information. Pointers within the data base allow access to related data and to index data across files.

IMAGE supports two types of data sets, master and detail. Access to data entries in a master data set may be directed or calculated, based on the key value of the data entry. Access to a data entry in a detail data set is usually via a particular master data set entry and a particular relationship between the master and detail data sets.

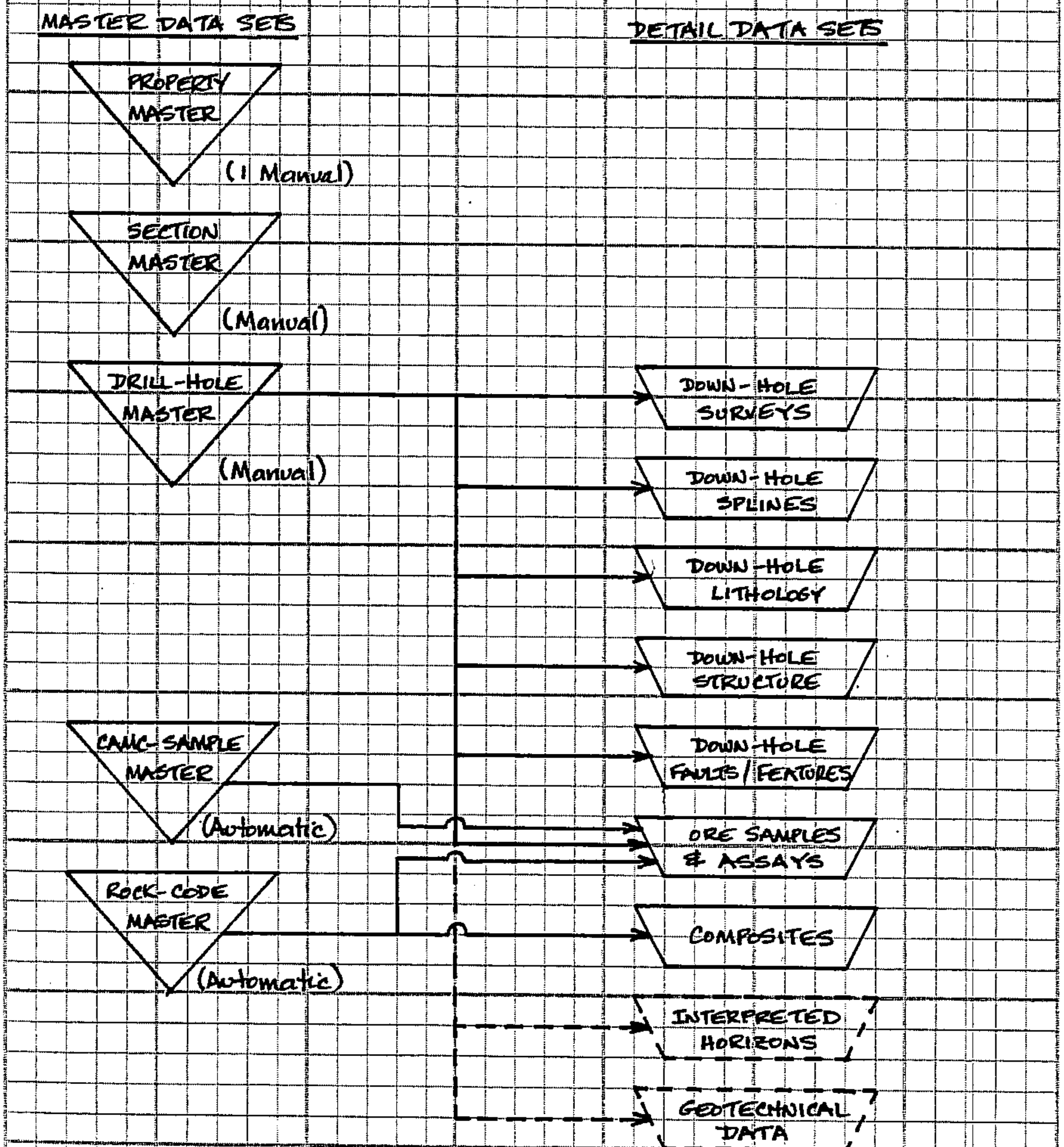
The types of data sets used specifically in the DDHDB are as follows

MASTER	DETAIL
Property Data	
Cross-Section Data	
Drill-Hole Master Data -	Down-Hole Survey Data
	Down-Hole Spline Data
	Down-Hole Lithology Data
	Down-Hole Structure Data
	Down-Hole Fault/Feature Data
	Ore Samples & Assays Data
	Composite Data.
CAMC Sample Master Data	
Rock-Code Master Data	

The linkages between these data set types are shown on the following page.

Each of the above data sets is described in some detail in the following sub-sections.

OVERVIEW OF DIAMOND DRILL HOLE DATA BASE ('DDHDB')



NOTE - SEPARATE DATA BASES ARE SET UP FOR INDIVIDUAL PROPERTIES.

3.1 Property Master Data

There is one (1) Property Master Data Set within each separate Data Base. As the name implies, it contains data defining various attributes of the orebody / mining property. It also contains the 'name' of the property which is used as a control parameter throughout the majority of the Data Base Processing operations. (Most application programs will read the Property Master Data Set immediately after the particular DDHDB was opened, then display the property name on the CRT-screen and ask the User to check it).

Data stored within the Property Master Data Set are:

(a) UTM-coordinate limits of the overall property (i)
- this includes -
  - maximum UTM-northing
  - minimum " "
  - maximum UTM-easting
  - minimum " "
  - UTM-zone no.
  - angle from UTM-North to local True North.

(b) Conversion parameters for up to 3 other secondary coordinate systems (ii)
- Geological Grid
- Mine Model Grid
- Mine Survey Grid.

(c) Indicators to show which secondary grids have been defined

(d) Property (general) Plunge & Trend Angles (integer degrees)

(e) Property name (20 alphanumeric characters).

(The Property-Master Data must be entered prior to any other data in the DDHDB).

Notes - (i) UTM-coordinate limits are for information only, however the angle is necessary input for subsequent correction of down-hole survey measurements

(ii) Refer to the Technical Appendices for details of secondary co-ordinate systems which may be used.

3.2 Section Master Data

There may be many Section Master Data Sets within each DDHDB. Each Section Master Data Set is used to store data relating to one specific geological section (either a CROSS- or LONG-section).

Each section is identified by a unique name and is specified by the co-ordinate locations of its end-points and by limiting elevations. A section is used within the DDHDB System to define an output drawing (or plot(s)). Thus, part of the full specification for a section is the ratio at which it will be plotted. (To plot the same physical section at two different ratios would require the definition of two section master data sets).

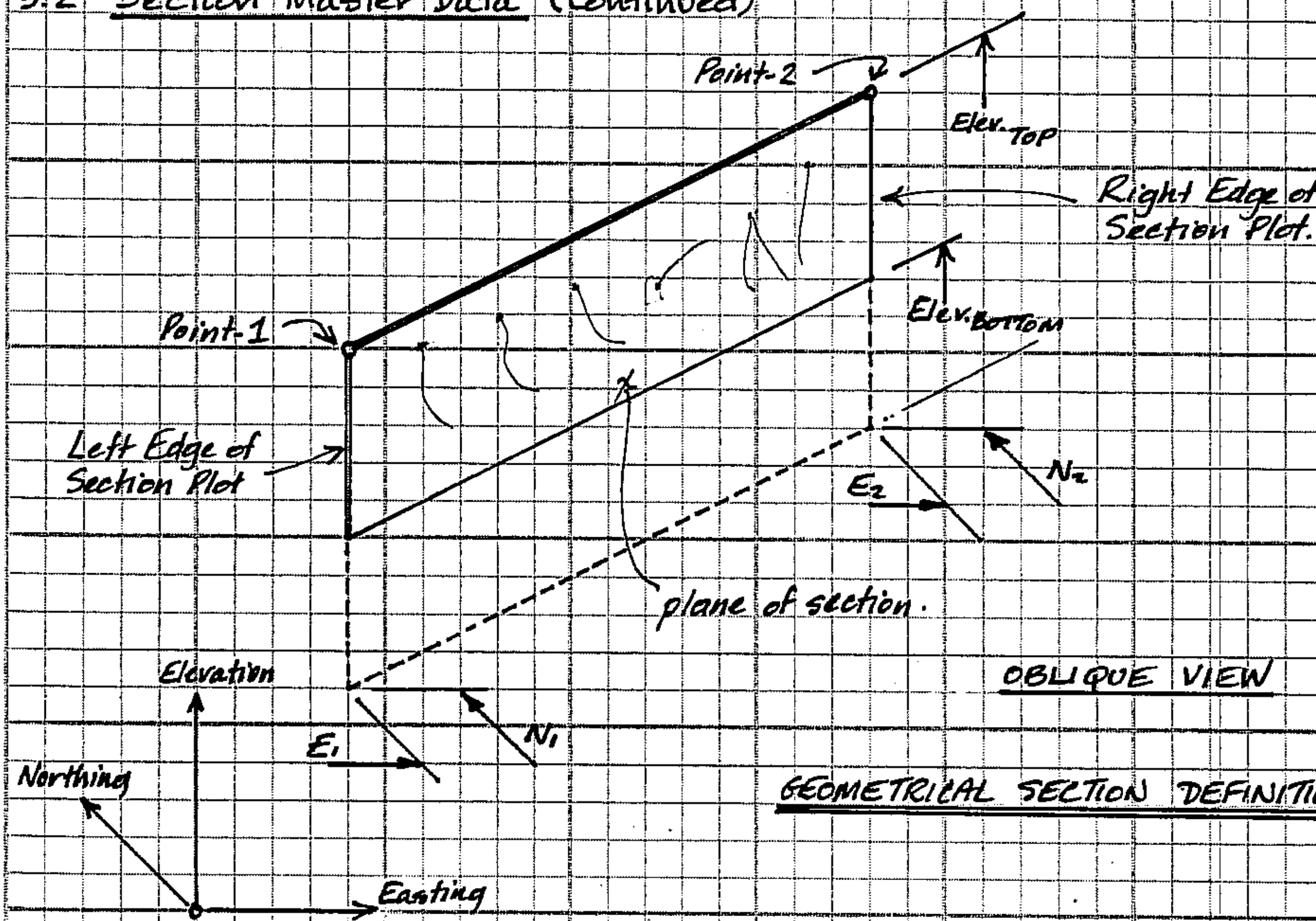
A section may be defined in any one of the coordinate systems available for a property. If a secondary coordinate system is used the UTM-equivalents are automatically calculated and stored in the Section Master Data Set.

A section definition applies to a 'vertical' section (as shown on the following pages). In order that DDH's will be plotted if they occur within a certain distance from the section, a lateral offset value is included in the Section Master Data Set. The trace of the DDH will have different line values (types) plotted to represent gross effects of offset distances from the section.

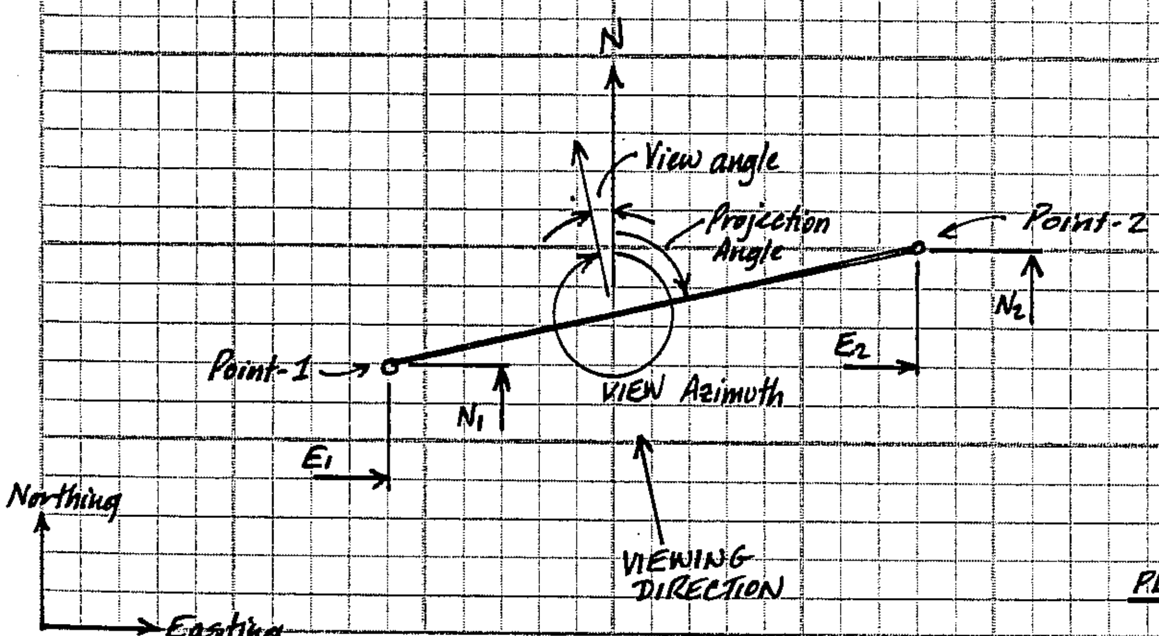
Section Master Data Sets may be added, modified, or deleted at any stage in the life of the property Data Base.

Notes - the first point in the specification of a section defines the LEFT EDGE of the Section Plot.
- the section name may be up to 8 alphanumeric characters long.

3.2 Section Master Data (Continued)



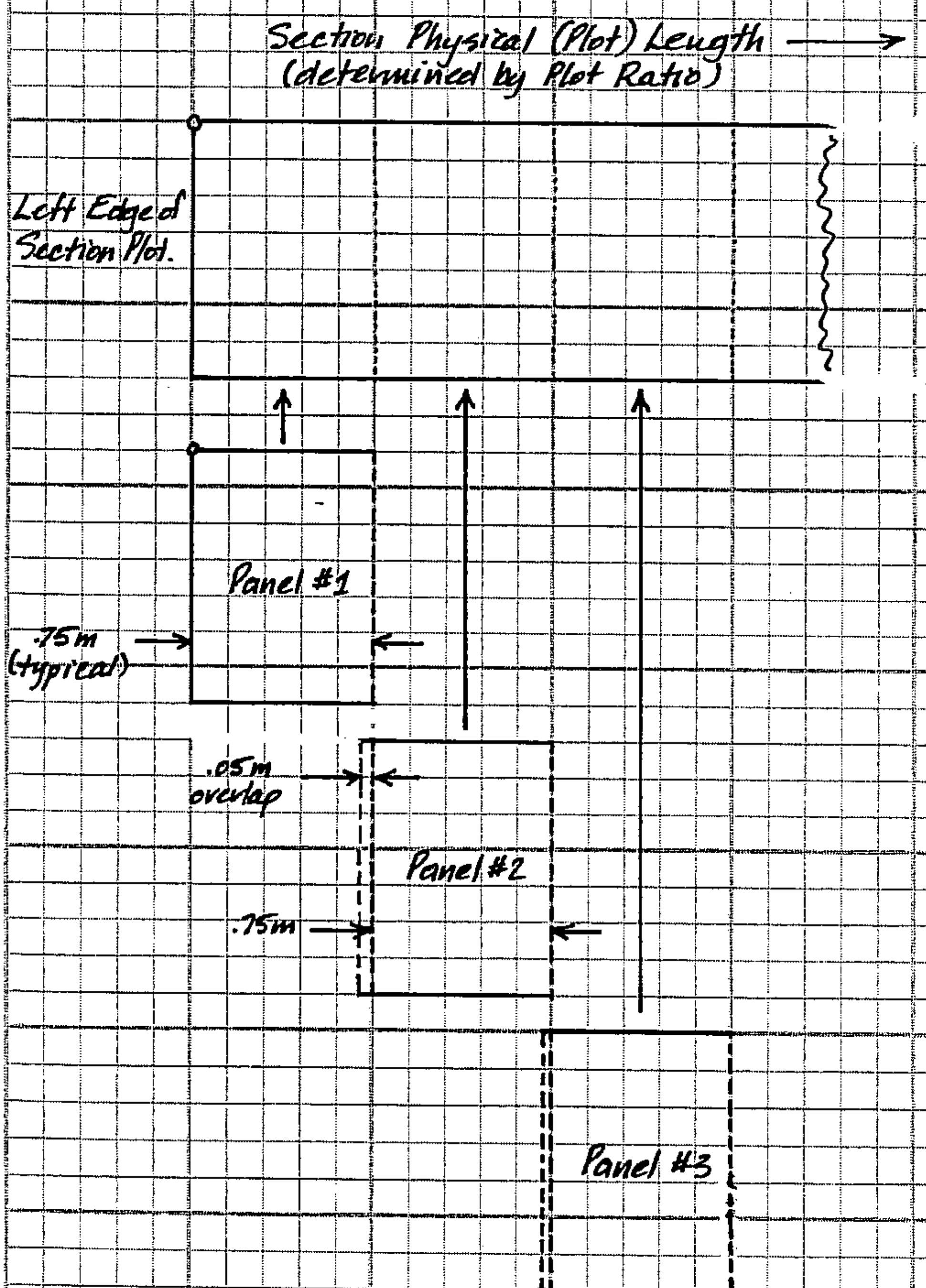
GEOMETRICAL SECTION DEFINITION



PLAN VIEW

3.2 Section Master Data (Continued)

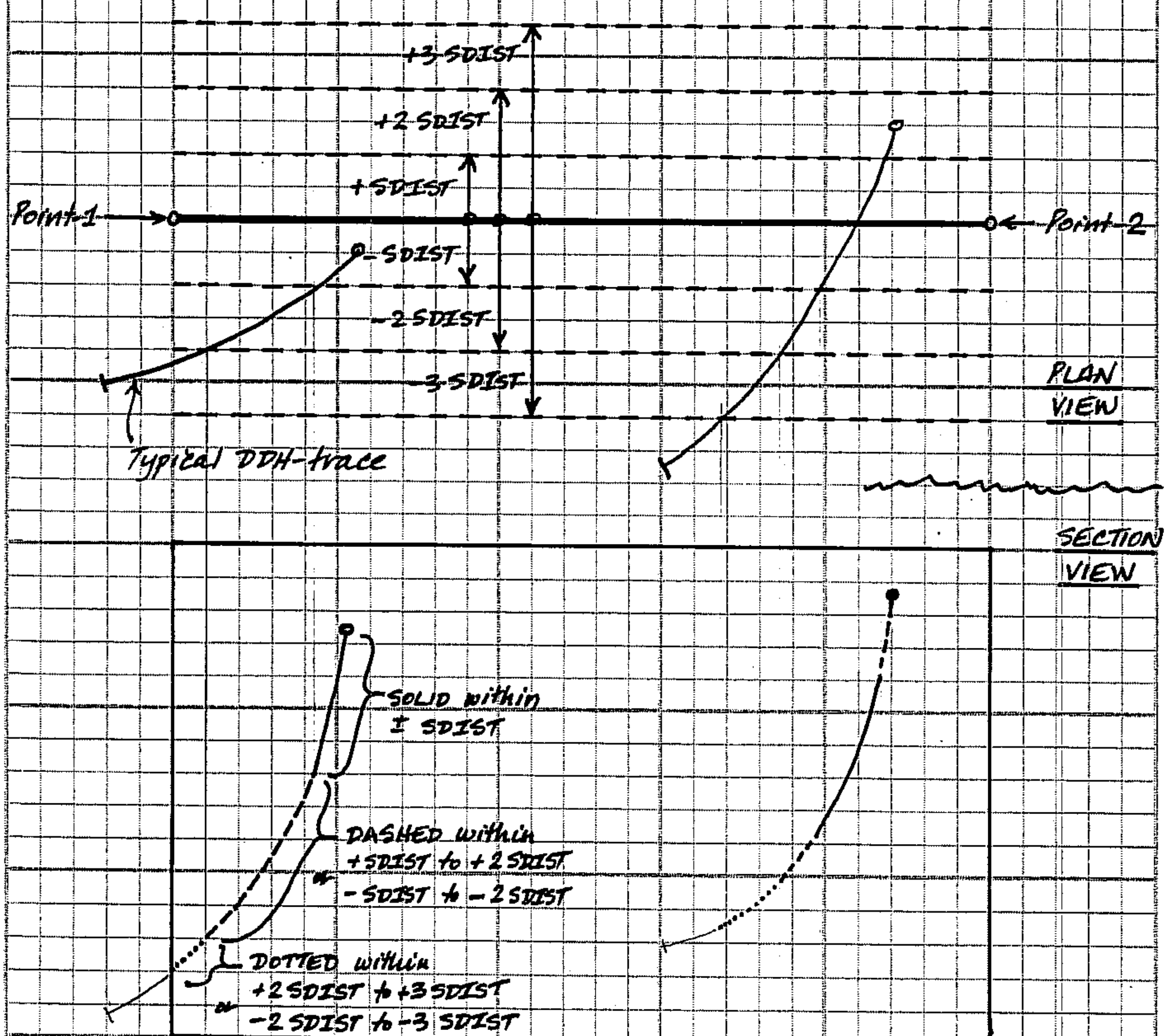
PANELLING OF CROSS-SECTION TO FIT PLOTTER



3.2 Section Master Data (Continued)

EFFECT OF DDH-OFFSET ON TRACE LINE TYPE (as plotted on Section).

SDIST = Specified Section Offset Distance.



3.3 Drill Hole Master Data

There are as many Drill-Hole Master Data Sets as there are drill-holes entered into the DDHDB. Each Drill-Hole Master Data Set is used to store data relating to one DDH.

Each DDH is identified by an unique 8-alphanumeric character identifier. Each time any DDH data is accessed it must be done directly for a particular DDH-identifier. The DDH Master Data Set is used as the primary key for reading/writing/updating/deletion any of the DDH detail data sets.

Data stored within a Drill-Hole Master Data Set are:

(a) Unique DDH-name (up to 8 alphanumeric characters). (Key)

(b) DDH-collar UTM-coordinates

(c) Total DDH-Depth

(d) Nominal Section Code. (4-character identifier) not to be confused with any SECTION Master

(e) Reference Fabric Element type and direction (azimuth)

(f) Specific DDH Plunge/Trend angles. (not currently used).

(g) Secondary co-ordinate system values for DDH-collar.

(h) Calculation indicators - defining if surveys and structure have been calculated.

(i) DDH-Box - maximum & minimum UTM-coordinates of DDH-trace. (determined during survey calculation phase).

3.3.1 Down-Hole Survey Detail Data

Each DDH entered in the DDHDB will have at least one Down-Hole Survey Detail Data Set associated with it. Each Down-Hole Survey Detail Data Set contains the measurements obtained at one (down-hole) survey point.

Survey points are normally set at varying distances down a DDH. A survey must also be taken at the collar of the DDH.

Each Down-Hole Survey Detail Data Set contains:

(a) the DDH-Identifier (Key)

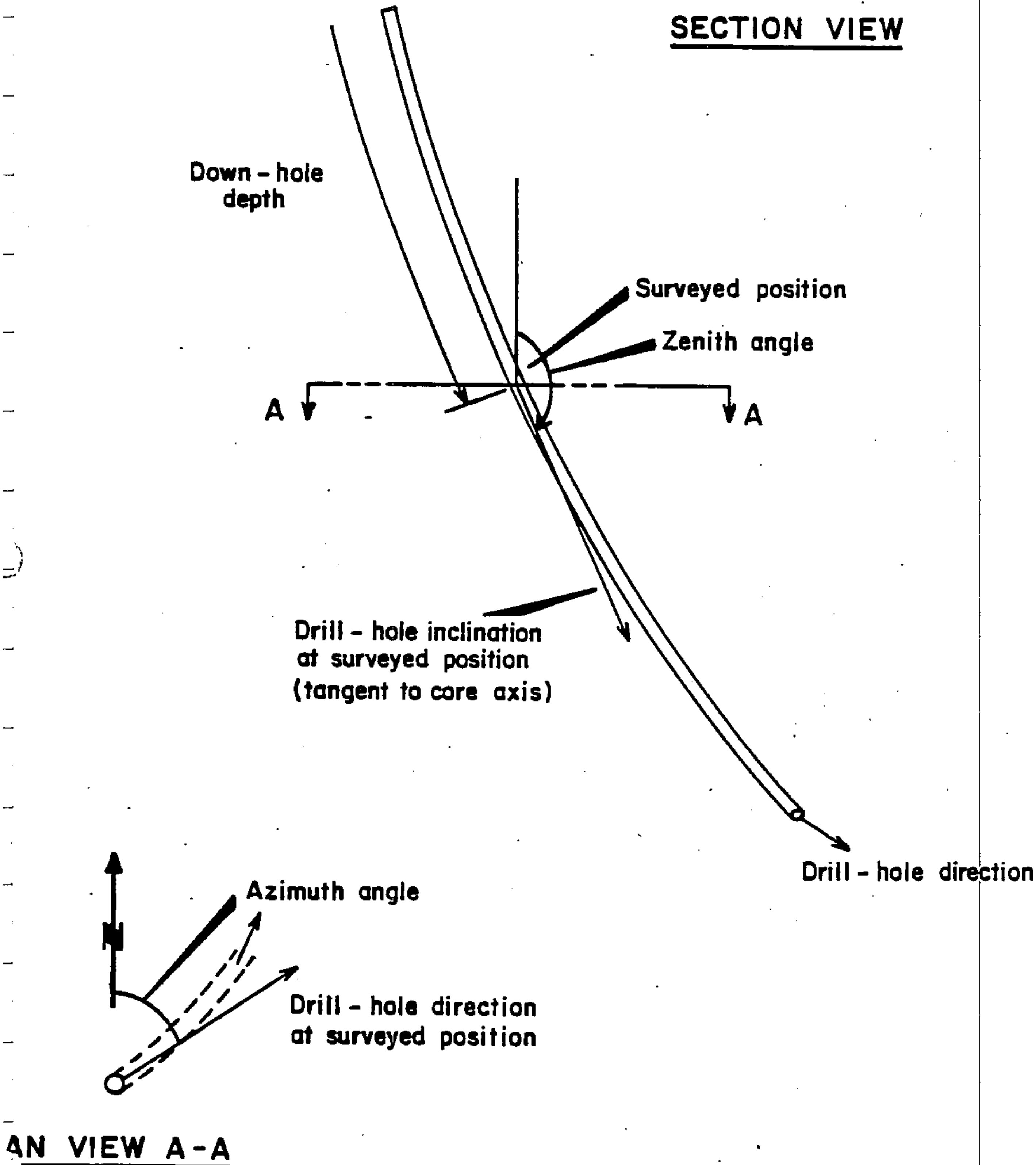
(b) the down-hole distance to the survey point.

(c) the zenith angle of the DDH at the survey point
(Range 0° → 180.0°)

(d) the azimuth angle of the DDH at the survey point.
(Range 0° → 359.9°)

Down-Hole Survey Detail Data Sets will normally be stored in the order they were entered. Thus, when retrieved from the Data Base for survey calculations they must be sorted into Down-Hole Distance (increasing) order.

Down-Hole Survey Detail Data Sets contain the data recorded by the geologist in the 'R-card' sheets.



ure 4 - 3 DEFINITION OF DOWN - HOLE SURVEY ANGLES

3.3.2 Down-Hole Splines Detail Data.

Down-Hole Splines are calculated from input Down-Hole Surveys for individual diamond drill holes. The theory and calculation method for these Splines is contained in Technical Appendix A, "Down-Hole Co-ordinate Calculations".

The Down-Hole Splines are used for the determination of UTM-coordinates for any point on the DDH-trace. One Down-Hole Splines Detail Data Set contains the complete numerical description of the parametric quadratic splines for one DDH-segment.

Each Down-Hole Splines Detail Data Set contains:

(a) The DDH-Identifier (Key)

(b) The from- and to- down-hole distances for the DDH-segment.

(c) The spline/segment No.

(d) A spline condition indicator.

(e) The parametric quadratic spline coefficients.

Down-Hole Splines are calculated and stored by the DH030 Program.

3.3.3 Down-Hole Lithology Detail Data

Down-Hole Lithology Detail Data Sets are created from input 'L-card' sheet data recorded by the core logging geologists. Each Down-Hole Lithology Detail Data Set contains the data in one Lithological Units Record.

Each Down-Hole Lithology Detail Data Set contains:

(a) The DDH-Identifier (Key)

(c) The down-hole 'to' distance of the lithological unit

(d) The sequential lithological unit no.

(e) The primary lithological unit rock code - 8 alphanumeric chars. (only the first 5 characters are currently used).

(f) The measured core recovery (length) of the lithological unit.

(g) A general lithological unit description - up to 30 alphanumeric characters long.

(h) Indicator for down-hole coordinate calculations.

(i) Displacements (calculated) of 'to-depth' position relative to the DDH-Collar. (these displacements are referenced in the UTM-coordinate system). (calculated by the DH030 program).

3.3.4 Down-Hole Structure Detail Data Set.

The Down-Hole Structure Detail Data Sets are created from input "5-card" sheet data recorded by the core logging geologists. Each Down-Hole Structure Detail Data Set contains the data input in one Structure Data Record.

Each Down-Hole Structure Detail Data Set contains:

(a) The DDH-Identifier (Key)

(b) An indicator defining the processability of the contained data (S = 1 = PROCESS ; $ = 0 = DO NOT PROCESS)

(c) A 'from-depth' for zone measurements.

(d) A 'to-depth' for zone and point measurements.

(e) A 3-character Structural Feature Code

(f) A 1-character Structural Symmetry Code.

(g) Up to 3 sets of core angle measurements.

(h) A structural feature (local RFE) code.

(i) An indicator for down-hole co-ordinate calculations.

(j) Displacements (calculated) of 'from-' and 'to-depth' positions relative to the DDH-collar. (Calculated by the DH030 program).

(k) An indicator for structural solution calculations.

(l) Possible structural solutions for each of the input core angle measurements. (calculated by the DH031 program).

(m) The zenith and azimuth angles of the DDH at the 'to-depth' position.

3.3.5 Down-Hole Fault/Feature Detail Data

Down-Hole Fault/Feature Detail Data Sets are created from 'F-card' sheet data recorded by geologists during inspection of discontinuity and dislocation notations in the descriptions column of the lithological units 'L-Card' logging sheets. (In the future, core logging geologists may directly create 'F-card' format sheets for subsequent input to the Diamond Drill Hole Data Base System).

Each Down-Hole Fault/Feature Data Set contains the data in one Fault/Feature Data Record. Each such data set contains:

(a) The DDH-Identifier (Key)

(b) A 'from-depth' for zone measurements.

(c) A 'to-depth' for zone and point measurements

(d) A 3-character Feature Code

(e) A 1-character Fault Core Recovery Code

(f) A 2-character 'parallel to Structure Type' Code.

(g) Up to three sets of measured plane core angles.
(i) Lower core dip and core direction
Internal " " " " "
Upper " " " " "

(h) An indicator for down-hole coordinate calculations.

(i) Displacements (calculated) of 'from-depth' and 'to-depth' positions relative to the DDH-Collar. (Calculated by the DH030 program).

3.3.6 Ore Sample (& Assays) Detail Data

Ore Sample (& Assay) Detail Data Sets contain data from two different sources, namely:

(i) Sampling information recorded by the core logging geologists on 'P-card' format sheets.

(ii) Assay results recorded on assaying laboratory certificates (usually created by external organisations).

Component data from the two sources are entered separately into the DDHDB (generally, as they are received in the Vancouver office). The unique C.A.M.C. sample no. (cf. CAMC Sample Master Data) is used as the key-code for integration of both sets of component data.

Each Ore Sample (& Assays) Detail Data Set contains:

(a) The DDH-Identifier (Key)

(b) The unique C.A.M.C. Sample No. (Key)

(c) The 'from-' and 'to-' depths for the sample.

(d) The core length recovered for the sample

(e) An 8-character Rock Code (Key)

(f) The name of the Assay Laboratory (10 characters)

(g) The Assay Certificate Code (8 characters).

(h) The Recorded Assay Values (up to 20 different elemental assays may be entered).
- see following page for details.

(i) An indicator for down-hole displacement calculations

(j) Displacements (calculated) of 'from-depth' and 'to-depth' positions relative to the DDH-Collar. (Calculated by the DH030 program).

(k) The UTM-coordinates of the mid-point of the sample. (Calculated by the DH030 program).

3.3.6 Ore Samples (& Assays) Detail Data (Continued)

Assay Values Stored in the Detail Data Set (CCAMC Standard)

No.		Assay	Units
1	S.G.	(Specific Gravity (Pulp))	—
2	Cu	Copper	%
3	Pb	Lead	%
4	Zn	Zinc	%
5	Ag (AA)	Silver - Atomic Absorption	g/T
6	Ag (FA)	Silver - Fire Assay	g/T
7	Au (FA)	Gold - Fire Assay	g/T
8	Po	Pyrrhotite	%
9	Py	Pyrite	%
10	BaO	Barium Oxide	%
11	Hg	Mercury	%
12	Mn	Manganese	%
13	As	Arsenic	%
14	Ba	Barium	%
15			
16			
17			
18			
19			
20	WRSG	(Whole Rock Specific Gravity)	—

(Non-assayed values are set to -1.0 throughout)

3.3.7 Composites Detail Data

Weighted average drill-hole segments (composites) are calculated by the DH01B program and the calculated results are stored in the Composite Detail Data Sets. One detail data set contains all the calculated data for a single composite.

The Composite Detail Data Set contains:

(a) The DDH-Identifier (Key)

(b) The 'from-' and 'to-' depths for the composite

(c) The length (interval) of the composite

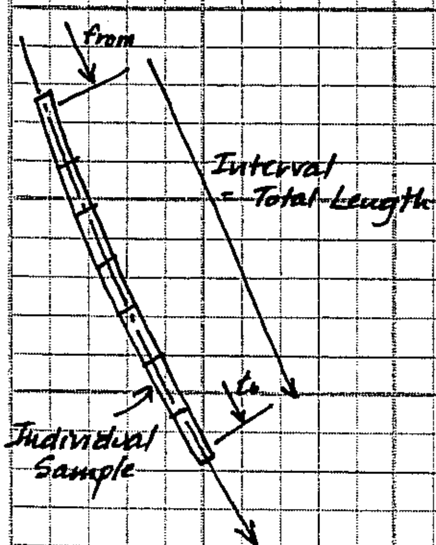
(d) The (length)-weighted assay averages for the composite. (up to 20 corresponding to the assays directly)

(e) An 8-character Rock Code (Key)

(f) The Cut-off-grade used in the weighted average calculations.

(g) The date and time at which the weighted average calculations were carried out.

Note - whenever composites are calculated for a DDH all previously calculated and stored composites are deleted from the DDHDB.



$$\text{Composite-Value}_j = \frac{\sum^{\text{samples}} \text{Length}_i \cdot \text{Effective-Assay}_{ij}}{\text{Total Length}}$$

$$\text{Effective-Assay}_i = \text{Assay}_i \quad \text{if } Pb+Zn \geq \text{Cut-off grade}$$

$$= 0 \quad \text{if } Pb+Zn < \text{Cut-off-grade}$$

3.3.8 Interpreted Horizons Detail Data. (Not currently operational)

Interpreted Horizons Detail Data Sets are created by project geologists during their evaluation of the project (generally after detailed geological cross-sections have been constructed from DDH cross-section plots). They will contain information as to how interpreted geological horizons intersect the DDH-trace.

Each such detail data set would contain the following information:

(a) The DDH-Identifier (Key)

(b) A unique interpreted horizon no. assigned by the geologist.

(c) A 'from' depth

(d) A 'to' depth

(e) The horizon wall 'type' at the 'from' depth position

(f) The horizon wall 'type' at the 'to' depth position

('type' of horizon wall is either 'HANGING-WALL' or 'FOOT-WALL')

Note - this feature was designed for future and further development of the DDHDB System. Space within the DDHDB's for these detail data sets has been defined but not yet allocated. The programs necessary to enter and retrieve these detail data sets have not yet been designed.

3.3.9 <u>Geotechnical Detail Data</u> (Not currently operational)

Geotechnical Detail Data Sets are created from input 'E-card' sheet data recorded during geotechnical logging of DDH-core. Each such detail data set contains recorded data as well as some calculated (on entry) parameters.

Each Geotechnical Detail Data Set contains:

(a) The DDH-Identifier (Key)

(b) A 'from' depth

(c) A 'to' depth

(d) The 'from-to' interval (calculated)

(e) The total length of core pieces > 100mm recovered in the 'from-to' interval.

(f) The no. of fractures in the 'from-to' interval

(g) The fracture frequency (calculated)

= item (f) / item (d) = no. of fractures / 'from-to' interval

(h) The RQD (Rock Quality Designator) (calculated)

= 100 * item (e) / item (d) = 100 * length of core > 100mm / 'from-to' interval

(cf. Deere - University of Illinois)

Note - this feature was designed for future and further development of the DDHDB System. Space within the DDHDB's for these detail data sets has been defined but not yet allocated. The programs necessary to enter and retrieve these detail data sets have not yet been designed.

3.4 C.A.M.C. Sample Master Data

The C.A.M.C. Sample Master Data is an automatic master providing a second form of access to individual Ore Sample & Assay Detail Data Sets. It contains the list of CAMC Sample No.s used in the Ore Sample Detail Data Sets and is used primarily for accessing specific samples for assay value correction and reporting.

As Sample Data is added to the DDHDB, new entries in the CAMC Sample Master Data Sets are created. Conversely, if an Ore Sample & Assay Detail Data Set is deleted from the DDHDB, so will be the corresponding sample number in the CAMC Sample Master.

3.5 Rock-Code Master Data

The Rock-Code Master Data is an automatic master providing a second form of access to individual Ore Sample & Assay Detail Data Sets and to Composite Detail Data Sets. It contains a list of all the different rock codes used within the various detail data sets and the pointers to individual sample and composite detail data sets with specific rock codes.

As Sample and Composite Data is added to the DDHDB, new entries in the Rock-Code Master Detail Data set are created. This Master Detail Data Set will be automatically updated as the rock codes used within the affected detail data sets are modified, added to or deleted.

The Rock-Code Master Data Sets are designed for use in future developments of the Diamond Drill Hole Data Base System (particularly when various statistical and geostatistical analysis programs are developed).

4.0 APPLICATION PROGRAMS

As outlined in Section 2.0 the suite of computer programs comprising the Diamond Drill Hole Data Base System is composed of various types of application programs. In general, these application programs require that a particular property data base be defined before they are run.

Access to the various programs is controlled by the MENU system. In view of the need to maintain the integrity of the various DDHDB data bases, Users should be limited in their access to the applications programs. In general, the two classes of operational User's, namely

(a) Data Entry Personnel, and
(b) Data Display, Reporting and Analysis Personnel

really only need access to a limited range of applications program. The Data Base Administration Personnel (or organizational User's) need to have access to the complete program library.

Usage of the applications programs in the various categories is fully detailed in the User's Manual for the Diamond Drill Hole Data Base System. (An individual copy for a User can be printed simply by selecting the appropriate option in the 'REPORTS' Menu).

The general capabilities and characteristics of each of the applications program categories are outlined in the following sub-sections.

4.1 Initiation and Subsequent Allocation of the Data Base.

These programs are used when a new DDHDB Data Base is to be created for a property. Only the Data Base Administrator should use these programs. (As they are not present in the Menu System the chances for unauthorized use of these programs is minimal).

The first stage in the initiation of a new DDHDB Data Base is the creation and sizing of a SCHEMA for the Data Base. A standard SCHEMA is stored in the GEOLOGY account and this can be copied into a new GROUP (Set up for the property in question). The Data Base Administrator must then estimate the number (i.e. size) of each master and detail data sets likely to occur for the property, and then modify the SCHEMA accordingly. He must then run the DBSCHEMA utility program to create the root segment for the new DDHDB. (This also checks the correctness of the SCHEMA definition)

Once the root segment for the new DDHDB has been created the Data Base Administrator has to create the linked files in which the DDHDB will be loaded. This is done by running the DBUTIL program in the CREATE mode. After a correct DBUTIL run, the physical disk space necessary for the new DDHDB has been allocated, and a 'blank' DDHDB data base is available for use.

4.2 Entry of Property and other General Data.

These programs are used to enter data to the Property Master and the Section Master Data Sets.

Normally, the Data Base Administrator would run these programs when updates, additions or deletions were required for the DDHDB of a particular property.

All these programs run from the Menu System. They require keyed responses to questions posed on the CRT-screen. Printed reports detail the 'before' and 'after' states of the affected Master Data Sets in the particular DDHDB.

Notes for Users

1. Property Master Data Sets.
   - all new properties are measured only in the S.I. METRIC system (only the old "! THE IMPERIAL ANVIL!" DDHDB for the FARO deposits is in Imperial Units (feet, etc.).
   - all new properties use the UNIVERSAL TRANSVERSE MERCATOR system (U.T.M.) as the primary coordinate system.
   - Property data should be entered immediately after a new DDHDB has been created.
2. Section Master Data Sets
   - calculation of section end-point coordinates may be facilitated by use of the DH025 program (see User's Manual).

(By 'entry' this means that the application programs in this category can also be used for modification, correction or deletion operations).

4.3 Entry of Diamond Drill Hole Data

These programs are used to enter data to the Drill-Hole Master and to all the Detail Data Sets (with the exception of the Down-Hole Splines and the Composites Detail Data Sets). ('Entry' means that the application programs in this category can also be used for modification, correction or deletion operations).

To maintain the integrity of the individual DDHDB Data Bases these programs should only be run by Data Entry Personnel at the direction of the Data Base Administrator. Users, such as geologists and mining engineers should direct requests for modifications in the DDHDB to the Data Base Administrator.

These programs have been designed for direct entry of data from the various card-format core logging sheets prepared by the geologists. A variety of checking procedures have been implemented in the programs to check permissible value ranges for many of the input data items.

Whenever the DDH Data Entry programs are run a printed report of what was done is prepared at the end of the run.

The entry of assay data from assaying laboratory certificates is also a function of this applications program category.

Note - Users should try and ensure that all available data for a particular DDH has been entered and verified before running the next series of programs (DDH-parameter calculations) on the particular DDH.

4.4 Calculation of Various DDH-Parameters.

These programs are used at various times after the complete inputdata set for a DDH has been entered. The specific calculations to be carried out are:

(a) down-hole splines,
(b) structural solutions, and
(c) composite evaluation. (weighted average assay calculations)

Down-hole splines must be calculated from the down-hole surveys so that the position (also the zenith and azimuth) of any point on the trace can be calculated. Details of the calculated splines are contained in the Technical Appendices. Before any form of plotting, and the other calculations may take place, a DDH must have a full set of splines calculated.

Structural solutions may then be calculated for DDH's with observed structural plane orientations. These solutions are the possible dips and dip-directions that the structural planes can have.

Composites also may be calculated after the DDH-splines have been determined.

An output report indicating all of the calculated results for each of the above operations is prepared at the end of the runs. All of these application programs are accessed through the MENU systems.

A simple DDH-trace positioning routine may be run on any DDH that has a complete set of splines available. This program will calculate the UTM collar offsets and UTM co-ordinates of any point on the DDH-trace and subsequently print the results.

Examples of the reports from the down-hole splines and the structural solutions calculations programs are contained on the following pages.

```
***********************************************************************
*                                                                     *
*   C Y P R U S   A N V I L   M I N I N G   C O R P O R A T I O N     *
*                                                                     *
***********************************************************************
*                                                                     *
*                      SYSTEM =  DDHDB                                *
*                     PROGRAM =  DH030                                *
*                                                                     *
*                 FRI, MAR 25, 1983,  9:51 AM                         *
*                                                                     *
***********************************************************************
*                                                                     *
*             CREATION OF DIAMOND DRILL HOLE SPLINE                   *
*             FOR CALCULATION OF DOWN-HOLE POSITION                   *
*             OFFSETS FOR OTHER DETAIL DATA RECORDS.                  *
*                                                                     *
***********************************************************************
```

CIRQUE

SPLINE CALCULATIONS

THE FOLLOWING DRILLHOLES ARE TO BE PROCESSED

SGEDC23

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CIRQUE

SPLINE CALCULATIONS FOR DRILLHOLE: EG80C23

*** SURVEY DATA SUMMARY ***

COLLAR COORDINATES:

6375704.00 NORTH
370604.50 EAST
1696.90 ELEVATION

DOWN-HOLE SURVEYS

SURVEY NO.	DEPTH	ZENITH	AZIMUTH
1	.0000E+00	170.0	230.0
2	84.40	178.0	285.0
3	114.9	177.5	280.0
4	145.4	177.0	342.0
5	175.9	174.5	358.0
6	206.3	174.5	12.00
7	236.8	174.0	4.000
8	267.3	172.0	2.000
9	297.8	172.0	359.0

CIRQUE

SPLINE CALCULATIONS FOR DRILLHOLE: EG80C23

*** SPLINE DATA SUMMARY ***

SPLINE COEFFICIENTS

DEPTH	A	B	C	D	E	F	G	H	P	Q	R	S
.00												
	.0000E+00	-.1330	.5883E-03	.0000E+00	.0000E+00	-.1116	.7148E-03	.0000E+00	.0000E+00	-.9848	-.8639E-04	.0000E+00
84.40												
84.40												
	-7.036	-.3371E-01	-.1516E-03	.0000E+00	-4.329	.9033E-02	-.2391E-04	.0000E+00	-83.73	-.9994	.5614E-05	.0000E+UU
114.90												
114.90												
	-8.205	-.4296E-01	.4391E-03	.0000E+00	-4.076	.7574E-02	.6918E-03	.0000E+00	-114.2	-.9990	.6866E-05	.0000E+UU
145.40												
145.40												
	-9.107	-.1617E-01	.2103E-03	.0000E+00	-3.201	.4977E-01	.7543E-03	.0000E+00	-144.7	-.9986	.5301E-04	.0000E+UU
175.90												
175.90												
	-9.405	-.3345E-02	.3828E-03	.0000E+00	-.9815	.9579E-01	-.3349E-04	.0000E+00	-175.1	-.9954	.0000E+00	.0000E+00
206.30												
206.30												
	-9.153	.1993E-01	-.2071E-03	.0000E+00	1.900	.9375E-01	.1725E-03	.0000E+00	-205.3	-.9954	.1433E-04	.0000E+00
236.80												
236.80												
	-8.733	.7292E-02	-.3991E-04	.0000E+00	4.919	.1043	.5707E-03	.0000E+00	-235.7	-.9945	.6973E-04	.0000E+00
267.30												
267.30												
	-8.552	.4857E-02	-.1194E-03	.0000E+00	8.631	.1391	.1043E-05	.0000E+00	-266.0	-.9903	.0000E+00	.0000E+UU
297.80												
297.80												
	-8.515	-.2429E-02	.0000E+00	.0000E+00	12.87	.1392	.0000E+C0	.0000E+00	-296.2	-.9903	.0000E+00	.0000E+UU
297.80												

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CIRQUE

LITHOLOGY DISPLACEMENT CALCULATIONS FOR DRILLHOLE: EG80C23

TO-DEPTH	CODE	LITHOLOGICAL UNIT DESCRIPTION	RECOVERY	NORTHING	EASTING	ELEVATION
64.20	OS		-.50	-4.22	-6.12	-63.58
115.30	DAPHT		-.50	-4.07	-8.22	-114.61
127.10	DGCHM		-.50	-3.88	-8.66	-126.40
146.50	DGTHS		-.50	-3.15	-9.12	-145.77
163.70	DGTHS		-.50	-2.04	-9.33	-162.93
174.00	DGPRS		-.50	-1.16	-9.40	-173.19
174.20	DGSXI		-.50	-1.14	-9.40	-173.39
179.70	DBMSL		-.50	-.62	-9.41	-178.87
180.30	DGPRI		-.50	-.56	-9.41	-179.46
197.40	DBMSL		-.50	1.06	-9.30	-196.48
200.50	DBSBL		-.50	1.35	-9.26	-199.57
202.40	DBBSH		-.50	1.53	-9.22	-201.46
203.30	DBSBH		-.50	1.62	-9.21	-202.36
210.10	DBBSH		-.50	2.26	-9.08	-209.13
210.90	DBSBL		-.50	2.33	-9.07	-209.92
212.00	DGDLP		-.50	2.44	-9.05	-211.02
219.30	DBBSL		-.50	3.15	-8.93	-218.28
220.50	DGDLL		-.50	3.27	-8.91	-219.47
233.50	DBBSL		-.50	4.58	-8.76	-232.41
249.40	DBBSL		-.50	6.32	-8.65	-248.21
250.80	DBBXP		-.50	6.49	-8.64	-249.60
252.10	DGTFP		-.50	6.65	-8.64	-250.89
252.20	DGTFA		-.50	6.66	-8.63	-250.99
252.50	DGTFS		-.50	6.70	-8.63	-251.29
253.70	DGCF		-.50	6.84	-8.63	-252.48
253.90	DGLBO		-.50	6.87	-8.62	-252.68
269.30	DGTFS		-.50	8.91	-8.54	-267.94
269.60	F		-.50	8.95	-8.54	-268.23
269.90	DGCFB		-.50	8.99	-8.54	-268.53
274.40	DGTFS		-.50	9.62	-8.52	-272.99
284.00	DGCFB		-.50	10.95	-8.50	-282.49
286.30	DAPFN		-.50	11.27	-8.50	-284.77
286.60	F		-.50	11.32	-8.50	-285.07
288.60	DAPFU		-.50	11.59	-8.50	-287.05
291.80	F		-.50	12.04	-8.50	-290.22
297.00	DAPFM		-.50	12.76	-8.51	-295.37
299.50	DAPFU		-.50	13.11	-8.52	-297.84
303.50	DGFPP		-.50	13.67	-8.53	-301.80
303.90	F		-.50	13.72	-8.53	-302.20

* CYPRUS ANVIL MINING CORPORATION * SYSTEM = DDHDB * PROGRAM = DH030 * FRI, MAR 25, 1983, 9:51 AM * PAGE 5

CIRQUE

STRUCTURE DISPLACEMENT CALCULATIONS FOR DRILLHOLE: EG80C23

FROM DEPTH	TO DEPTH	FEAT CODE	SYM	FROM DISPLACEMENT NORTHING	FROM DISPLACEMENT EASTING	FROM DISPLACEMENT ELEVATION	TO DISPLACEMENT NORTHING	TO DISPLACEMENT EASTING	TO DISPLACEMENT ELEVATION
.00	123.00			.00	.00	.00	-3.97	-8.52	-122.30
.00	130.00			.00	.00	.00	-3.80	-8.75	-129.29
.00	168.20			.00	.00	.00	-1.67	-9.37	-167.42
.00	176.30			.00	.00	.00	-.94	-9.41	-175.48
.00	180.30			.00	.00	.00	-.56	-9.41	-179.46
.00	183.00			.00	.00	.00	-.30	-9.41	-182.15
.00	184.50			.00	.00	.00	-.16	-9.41	-183.64
.00	185.00			.00	.00	.00	-.11	-9.40	-184.14
.00	189.10			.00	.00	.00	.28	-9.38	-188.22
.00	193.50			.00	.00	.00	.69	-9.34	-192.60
.00	195.00			.00	.00	.00	.84	-9.33	-194.09
.00	198.50			.00	.00	.00	1.17	-9.28	-197.58
.00	201.50			.00	.00	.00	1.45	-9.24	-200.57
.00	203.50			.00	.00	.00	1.64	-9.21	-202.56
.00	206.80			.00	.00	.00	1.95	-9.14	-205.84
.00	207.90			.00	.00	.00	2.05	-9.12	-206.94
.00	209.70			.00	.00	.00	2.22	-9.09	-208.73
.00	213.00			.00	.00	.00	2.54	-9.03	-212.01
.00	217.00			.00	.00	.00	2.92	-8.96	-215.99
.00	220.50			.00	.00	.00	3.27	-8.91	-219.47
.00	223.00			.00	.00	.00	3.51	-8.88	-221.96
.00	225.20			.00	.00	.00	3.73	-8.85	-224.15
.00	228.00			.00	.00	.00	4.02	-8.82	-226.94
.00	230.60			.00	.00	.00	4.28	-8.79	-229.52
.00	234.00			.00	.00	.00	4.63	-8.76	-232.90
.00	239.00			.00	.00	.00	5.05	-8.73	-236.88
.00	241.50			.00	.00	.00	5.42	-8.70	-240.36
.00	245.70			.00	.00	.00	5.89	-8.68	-244.53
.00	247.10			.00	.00	.00	6.05	-8.67	-245.93
.00	250.30			.00	.00	.00	6.43	-8.65	-249.10
.00	251.30			.00	.00	.00	6.55	-8.64	-250.10
.00	254.50			.00	.00	.00	6.94	-8.62	-253.27
.00	261.50			.00	.00	.00	7.84	-8.58	-260.21
.00	265.60			.00	.00	.00	8.42	-8.56	-264.47
.00	269.10		Z	.00	.00	.00	8.88	-8.54	-267.74
.00	273.80			.00	.00	.00	9.53	-8.53	-272.39
.00	277.20		S	.00	.00	.00	10.01	-8.52	-275.76
.00	280.70			.00	.00	.00	10.49	-8.51	-279.23
.00	284.20			.00	.00	.00	10.98	-8.50	-282.69
.00	292.40			.00	.00	.00	12.12	-8.51	-290.81
.00	296.00			.00	.00	.00	12.62	-8.51	-294.38
.00	300.00			.00	.00	.00	13.18	-8.52	-298.34
.00	303.20		Z	.00	.00	.00	13.63	-8.53	-301.51

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CIRQUE

ORE SAMPLES DISPLACEMENT CALCULATIONS FOR DRILLHOLE: EG80C23

FROM	TO	SAMPLE	LITH	FROM DISPLACEMENT			TO DISPLACEMENT			UTM OF MIDPOINT		
DEPTH	DEPTH	NO.	CODE	NORTHING	EASTING	ELEVATION	NORTHING	EASTING	ELEVATION	NORTHING	EASTING	ELEVATION
228.50	230.50	4659	DBBSL	4.07	-8.81	-227.43	4.27	-8.79	-229.42	6375708.00	370595.69	1468.47
249.40	250.80	4670	DBBXP	6.32	-8.65	-248.21	6.49	-8.64	-249.60	6375710.00	370595.88	1448.00
235.50	237.50	4663	DBBSL	4.78	-8.75	-234.40	4.99	-8.73	-236.39	6375709.00	370595.75	1461.51
232.50	233.50	4661	DBBSL	4.47	-8.77	-231.41	4.58	-8.76	-232.41	6375709.00	370595.75	1464.99
247.50	249.40	4669	DBBSL	6.10	-8.66	-246.32	6.32	-8.65	-248.21	6375710.00	370595.81	1449.65
205.00	207.00	4645	DBBSL	1.78	-9.18	-204.05	1.97	-9.14	-206.04	6375706.00	370595.31	1491.86
184.20	186.00	4633	DBMSM	-.19	-9.41	-183.34	-.02	-9.40	-185.14	6375704.00	370595.13	1512.66
219.30	220.50	4654	DBBSL	3.15	-8.93	-218.28	3.27	-8.91	-219.47	6375707.00	370595.56	1478.02
188.10	190.10	4635	DBMSM	.18	-9.39	-187.23	.37	-9.37	-189.22	6375704.00	370595.13	1508.68
202.40	203.30	4643	DBSBL	1.53	-9.22	-201.46	1.62	-9.21	-202.36	6375706.00	370595.31	1494.99
241.50	243.50	4666	DBBSL	5.42	-8.70	-240.36	5.64	-8.69	-242.35	6375710.00	370595.81	1455.54
237.50	239.50	4664	DBBSL	4.99	-8.73	-236.39	5.21	-8.72	-238.37	6375709.00	370595.75	1459.52
196.10	197.40	4639	DBMSM	.94	-9.32	-195.19	1.06	-9.30	-196.48	6375705.00	370595.19	1501.06
200.50	202.40	4642	DBBSL	1.35	-9.26	-199.57	1.53	-9.22	-201.46	6375705.00	370595.25	1496.38
233.50	235.50	4662	DBBSL	4.58	-8.76	-232.41	4.78	-8.75	-234.40	6375709.00	370595.75	1463.50
194.10	196.10	4638	DBMSM	.75	-9.34	-193.20	.94	-9.32	-195.19	6375705.00	370595.19	1502.71
210.10	210.90	4648	DBSBL	2.26	-9.08	-209.13	2.33	-9.07	-209.92	6375706.00	370595.44	1487.38
192.10	194.10	4637	DBMSM	.56	-9.36	-191.21	.75	-9.34	-193.20	6375705.00	370595.13	1504.70
176.00	177.50	4628	DBMSM	-.97	-9.41	-175.18	-.83	-9.41	-176.68	6375703.00	370595.06	1520.97
198.80	200.50	4641	DBSBL	1.19	-9.28	-197.88	1.35	-9.26	-199.57	6375705.00	370595.25	1498.18
224.50	226.50	4657	DBBSL	3.66	-8.86	-223.45	3.86	-8.83	-225.44	6375708.00	370595.63	1472.45
197.40	198.80	4640	DBSBL	1.06	-9.30	-196.48	1.19	-9.28	-197.88	6375705.00	370595.19	1499.72
212.00	213.80	4650	DBBSL	2.44	-9.05	-211.02	2.61	-9.01	-212.81	6375707.00	370595.50	1484.99
177.50	179.70	4629	DBMSM	-.83	-9.41	-176.68	-.62	-9.41	-178.87	6375703.00	370595.06	1519.13
179.70	180.30	4630	DGPRI	-.62	-9.41	-178.87	-.56	-9.41	-179.46	6375703.00	370595.06	1517.74
222.50	224.50	4656	DBBSL	3.46	-8.88	-221.46	3.66	-8.86	-223.45	6375708.00	370595.63	1474.44
180.30	182.20	4631	DBMSM	-.56	-9.41	-179.46	-.38	-9.41	-181.35	6375704.00	370595.06	1516.49
220.50	222.50	4655	DBBSL	3.27	-8.91	-219.47	3.46	-8.88	-221.46	6375707.00	370595.63	1476.45
210.90	212.00	4649	DGDLP	2.33	-9.07	-209.92	2.44	-9.05	-211.02	6375706.00	370595.44	1486.45
226.50	228.50	4658	DBBSL	3.86	-8.83	-225.44	4.07	-8.81	-227.43	6375708.00	370595.69	1470.46
207.00	208.50	4646	DBBSL	1.97	-9.14	-206.04	2.11	-9.11	-207.53	6375706.00	370595.38	1490.11
213.80	215.50	4651	DBBSL	2.61	-9.01	-212.81	2.78	-8.99	-214.50	6375707.00	370595.50	1483.25
230.50	232.50	4660	DBBSL	4.27	-8.79	-229.42	4.47	-8.77	-231.41	6375708.00	370595.69	1466.48
215.50	217.30	4652	DBBSL	2.78	-8.99	-214.50	2.95	-8.96	-216.29	6375707.00	370595.50	1481.50
182.20	184.20	4632	DBMSM	-.38	-9.41	-181.35	-.19	-9.41	-183.34	6375704.00	370595.06	1514.55
186.00	188.10	4634	DBMSM	-.02	-9.40	-185.14	.18	-9.39	-187.23	6375704.00	370595.13	1510.72
208.50	210.10	4647	DBBSL	2.11	-9.11	-207.53	2.26	-9.08	-209.13	6375706.00	370595.38	1488.57
~~203.30~~	~~205.00~~	~~4644~~	~~DBBSL~~	~~1.62~~	~~-9.21~~	~~-202.36~~	~~1.78~~	~~-9.18~~	~~-204.05~~	~~6375706.00~~	~~370595.31~~	~~1493.70~~
243.50	245.50	4667	DBBSL	5.64	-8.69	-242.35	5.87	-8.68	-244.34	6375710.00	370595.81	1453.56
174.20	176.00	4627	DBMSM	-1.14	-9.40	-173.39	-.97	-9.41	-175.18	6375703.00	370595.13	1522.61
217.30	219.30	4653	DBBSL	2.95	-8.96	-216.29	3.15	-8.93	-218.28	6375707.00	370595.56	1479.61

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CIRQUE

ORE SAMPLES DISPLACEMENT CALCULATIONS FOR DRILLHOLE: EG80C23

FROM	TO	SAMPLE	LITH	FROM DISPLACEMENT			TO DISPLACEMENT			UTM OF MIDPOINT		
DEPTH	DEPTH	NO.	CODE	NORTHING	EASTING	ELEVATION	NORTHING	EASTING	ELEVATION	NORTHING	EASTING	ELEVATION
239.50	241.50	4665	DBBSL	5.21	-8.72	-238.37	5.42	-8.70	-240.36	6375709.00	370595.81	1457.53
245.50	247.50	4668	DBBSL	5.87	-8.68	-244.34	6.10	-8.66	-246.32	6375710.00	370595.81	1451.57
190.10	192.10	4636	DBMSM	.37	-9.37	-189.22	.56	-9.36	-191.21	6375704.00	370595.13	1506.69

CIRQUE

*** DRILLHOLE: EG80C23 ***

COLLAR LOCATION (GEOLOGICAL GRID)

NORTHING	EASTING	ELEVATION
.00	.00	.00

DRILLHOLE LOCATION BOX

MINIMUM NORTHING	MAXIMUM NORTHING	MINIMUM EASTING	MAXIMUM EASTING	MINIMUM ELEVATION	MAXIMUM ELEVATION
6375699.09	6375717.14	370595.07	370604.48	1394.70	1696.90

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**********************************************************************
*                                                                    *
*   C Y P R U S   A N V I L   M I N I N G   C O R P O R A T I O N    *
*                                                                    *
**********************************************************************
*                                                                    *
*                       SYSTEM =  DDHDB                              *
*                      PROGRAM =  DH031                              *
*                                                                    *
*                 FRI, MAR 25, 1983,  9:52 AM                        *
*                                                                    *
**********************************************************************
*                                                                    *
*               PERFORM STRUCTURAL CALCULATIONS AND                  *
*               UPDATE DATABASE                                      *
*                                                                    *
*                                                                    *
**********************************************************************
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CIRQUE

STRUCTURAL SOLUTION CALCULATIONS FOR DRILLHOLE: EG80C23

REFERENCE FABRIC ELEMENT IS S1

				SX-1 PLANE				SX PLANE				SX+1 PLANE			
				OBSERVED		CALCULATED		OBSERVED		CALCULATED		OBSERVED		CALCULATED	
DDH METRES	ZENITH ANGLE	AZIMUTH	RFE DEPTH	CA	DIPD	DIP	DIPD	CA	DIPD	DIP	DIPD	CA	DIPD	DIP	DIPD
123.0	177.4	297.7	123.0	50.	0.	39.5	218.0	22.	220.	67.4	220.0	0.	0.	.0	.0
123.0	177.4	297.7	123.0	50.	0.	39.5	217.8	22.	220.	67.4	220.0	0.	0.	.0	.0
123.0	177.4	297.7	123.0	50.	0.	40.6	41.9	22.	220.	68.5	40.0	0.	0.	.0	.0
123.0	177.4	297.7	123.0	50.	0.	40.6	42.1	22.	220.	68.5	40.0	0.	0.	.0	.0
130.0	177.2	313.8	130.0	50.	0.	40.2	218.4	30.	220.	60.1	220.0	0.	0.	.0	.0
130.0	177.2	313.8	130.0	50.	0.	40.2	218.2	30.	220.	60.1	220.0	0.	0.	.0	.0
130.0	177.2	313.8	130.0	50.	0.	39.8	41.6	30.	220.	59.8	40.0	0.	0.	.0	.0
130.0	177.2	313.8	130.0	50.	0.	39.8	41.8	30.	220.	59.8	40.0	0.	0.	.0	.0
168.2	175.0	355.5	168.1	55.	270.	31.1	314.7	70.	220.	23.3	220.0	0.	0.	.0	.0
168.2	175.0	355.5	168.1	55.	270.	39.1	143.3	70.	220.	23.3	220.0	0.	0.	.0	.0
168.2	175.0	355.5	168.1	55.	270.	32.4	294.0	70.	220.	16.1	40.0	0.	0.	.0	.0
168.2	175.0	355.5	168.1	55.	270.	38.0	125.5	70.	220.	16.1	40.0	0.	0.	.0	.0
176.3	174.5	358.2	176.3	65.	0.	29.2	215.1	30.	220.	64.0	220.0	0.	0.	.0	.0
176.3	174.5	358.2	176.3	65.	0.	29.2	214.9	30.	220.	64.0	220.0	0.	0.	.0	.0
176.3	174.5	358.2	176.3	65.	0.	21.0	46.7	30.	220.	55.8	40.0	0.	0.	.0	.0
176.3	174.5	358.2	176.3	65.	0.	21.0	46.9	30.	220.	55.8	40.0	0.	0.	.0	.0
180.3	174.5	.0	180.3	65.	0.	29.3	214.7	20.	220.	74.2	220.0	0.	0.	.0	.0
180.3	174.5	.0	180.3	65.	0.	29.4	214.5	20.	220.	74.2	220.0	0.	0.	.0	.0
180.3	174.5	.0	180.3	65.	0.	21.0	47.3	20.	220.	65.7	40.0	0.	0.	.0	.0
180.3	174.5	.0	180.3	65.	0.	21.0	47.6	20.	220.	65.7	40.0	0.	0.	.0	.0
183.0	174.5	1.3	183.0	70.	0.	24.4	214.1	33.	220.	61.2	220.0	0.	0.	.0	.0
183.0	174.5	1.3	183.0	70.	0.	24.4	213.9	33.	220.	61.2	220.0	0.	0.	.0	.0
183.0	174.5	1.3	183.0	70.	0.	15.9	48.9	33.	220.	52.6	40.0	0.	0.	.0	.0
183.0	174.5	1.3	183.0	70.	0.	15.9	49.2	33.	220.	52.6	40.0	0.	0.	.0	.0
185.0	174.5	2.2	185.0	75.	0.	19.5	212.1	35.	220.	59.3	220.0	0.	0.	.0	.0
185.0	174.5	2.2	185.0	75.	0.	19.5	212.0	35.	220.	59.3	220.0	0.	0.	.0	.0
185.0	174.5	2.2	185.0	75.	0.	11.0	53.9	35.	220.	50.6	40.0	0.	0.	.0	.0
185.0	174.5	2.2	185.0	75.	0.	11.0	54.2	35.	220.	50.6	40.0	0.	0.	.0	.0
189.1	174.5	4.1	189.0	68.	0.	26.6	214.4	20.	220.	74.4	220.0	0.	0.	.0	.0
189.1	174.5	4.1	189.0	68.	0.	26.6	214.2	20.	220.	74.4	220.0	0.	0.	.0	.0
189.1	174.5	4.1	189.0	68.	0.	17.7	48.3	20.	220.	65.5	40.0	0.	0.	.0	.0
189.1	174.5	4.1	189.0	68.	0.	17.7	48.5	20.	220.	65.5	40.0	0.	0.	.0	.0
195.0	174.5	6.8	195.0	72.	0.	22.8	213.3	15.	220.	79.6	220.0	0.	0.	.0	.0
195.0	174.5	6.8	195.0	72.	0.	22.8	213.2	15.	220.	79.6	220.0	0.	0.	.0	.0
195.0	174.5	6.8	195.0	72.	0.	13.7	51.0	15.	220.	70.4	40.0	0.	0.	.0	.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CIRQUE

STRUCTURAL SOLUTION CALCULATIONS FOR DRILLHOLE: EG80C23

REFERENCE FABRIC ELEMENT IS S1

				SX-1 PLANE				SX PLANE				SX+1 PLANE			
				OBSERVED		CALCULATED		OBSERVED		CALCULATED		OBSERVED		CALCULATED	
DDH METRES	ZENITH ANGLE	AZIMUTH	RFE DEPTH	CA	DIPD	DIP	DIPD	CA	DIPD	DIP	DIPD	CA	DIPD	DIP	DIPD
198.5	174.5	8.4	198.5	65.	0.	29.7	217.0	42.	220.	52.6	220.0	0.	0.	.0	.0
198.5	174.5	8.4	198.5	65.	0.	29.7	216.9	42.	220.	52.6	220.0	0.	0.	.0	.0
198.5	174.5	8.4	198.5	65.	0.	20.3	44.2	42.	220.	43.2	40.0	0.	0.	.0	.0
198.5	174.5	8.4	198.5	65.	0.	20.4	44.5	42.	220.	43.2	40.0	0.	0.	.0	.0
201.5	174.5	9.8	201.5	65.	0.	29.8	217.0	40.	220.	54.7	220.0	0.	0.	.0	.0
201.5	174.5	9.8	201.5	65.	0.	29.8	216.8	40.	220.	54.7	220.0	0.	0.	.0	.0
201.5	174.5	9.8	201.5	65.	0.	20.3	44.3	40.	220.	45.2	40.0	0.	0.	.0	.0
201.5	174.5	9.8	201.5	65.	0.	20.3	44.5	40.	220.	45.2	40.0	0.	0.	.0	.0
206.8	174.5	11.9	206.8	80.	0.	15.0	212.2	50.	220.	44.8	220.0	0.	0.	.0	.0
206.8	174.5	11.9	206.8	80.	0.	15.0	212.1	50.	220.	44.8	220.0	0.	0.	.0	.0
206.8	174.5	11.9	206.8	80.	0.	5.5	61.3	50.	220.	35.1	40.0	0.	0.	.0	.0
206.8	174.5	11.9	206.8	80.	0.	5.5	61.7	50.	220.	35.1	40.0	0.	0.	.0	.0
209.7	174.4	11.0	209.7	78.	0.	17.0	212.1	28.	220.	66.8	220.0	0.	0.	.0	.0
209.7	174.4	11.0	209.7	78.	0.	17.0	211.9	28.	220.	66.8	220.0	0.	0.	.0	.0
209.7	174.4	11.0	209.7	78.	0.	7.5	58.0	28.	220.	57.1	40.0	0.	0.	.0	.0
209.7	174.4	11.0	209.7	78.	0.	7.5	58.3	28.	220.	57.1	40.0	0.	0.	.0	.0
213.0	174.4	10.1	213.0	75.	0.	19.9	215.8	60.	220.	34.8	220.0	0.	0.	.0	.0
213.0	174.4	10.1	213.0	75.	0.	19.9	215.7	60.	220.	34.8	220.0	0.	0.	.0	.0
213.0	174.4	10.1	213.0	75.	0.	10.2	48.1	60.	220.	25.0	40.0	0.	0.	.0	.0
213.0	174.4	10.1	213.0	75.	0.	10.2	48.3	60.	220.	25.0	40.0	0.	0.	.0	.0
217.0	174.3	9.0	217.0	65.	0.	29.9	217.0	42.	220.	52.8	220.0	0.	0.	.0	.0
217.0	174.3	9.0	217.0	65.	0.	29.9	216.8	42.	220.	52.8	220.0	0.	0.	.0	.0
217.0	174.3	9.0	217.0	65.	0.	20.2	44.3	42.	220.	43.1	40.0	0.	0.	.0	.0
217.0	174.3	9.0	217.0	65.	0.	20.2	44.6	42.	220.	43.1	40.0	0.	0.	.0	.0
220.5	174.3	8.1	220.5	62.	0.	32.9	216.4	25.	220.	69.8	220.0	0.	0.	.0	.0
220.5	174.3	8.1	220.5	62.	0.	32.9	216.2	25.	220.	69.8	220.0	0.	0.	.0	.0
220.5	174.3	8.1	220.5	62.	0.	23.2	45.0	25.	220.	60.1	40.0	0.	0.	.0	.0
220.5	174.3	8.1	220.5	62.	0.	23.2	45.2	25.	220.	60.1	40.0	0.	0.	.0	.0
225.2	174.2	6.9	225.2	65.	180.	20.7	53.7	55.	220.	39.7	220.0	0.	0.	.0	.0
225.2	174.2	6.9	225.2	65.	180.	30.2	210.5	55.	220.	30.0	40.0	0.	0.	.0	.0
228.0	174.1	6.2	228.0	70.	180.	15.8	57.3	55.	220.	39.7	220.0	0.	0.	.0	.0
228.0	174.1	6.2	228.0	70.	180.	25.3	209.0	55.	220.	30.0	40.0	0.	0.	.0	.0
230.6	174.1	5.5	230.6	60.	180.	25.4	47.6	13.	220.	81.8	220.0	0.	0.	.0	.0
230.6	174.1	5.5	230.6	60.	180.	35.1	214.3	13.	220.	72.1	40.0	0.	0.	.0	.0

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CIRQUE

STRUCTURAL SOLUTION CALCULATIONS FOR DRILLHOLE: EG80C23

REFERENCE FABRIC ELEMENT IS S1

				SX-1 PLANE				SX PLANE				SX+1 PLANE			
				OBSERVED		CALCULATED		OBSERVED		CALCULATED		OBSERVED		CALCULATED	
DDH METRES	ZENITH ANGLE	AZIMUTH	RFE DEPTH	CA	DIPD	DIP	DIPD	CA	DIPD	DIP	DIPD	CA	DIPD	DIP	DIPD
234.0	174.0	4.7	234.0	75.	0.	20.0	212.0	35.	220.	59.8	220.0	0.	0.	.0	.0
234.0	174.0	4.7	234.0	75.	0.	10.5	54.9	35.	220.	50.1	40.0	0.	0.	.0	.0
234.0	174.0	4.7	234.0	75.	0.	10.5	55.1	35.	220.	50.1	40.0	0.	0.	.0	.0
238.0	173.9	3.9	238.0	55.	180.	30.6	50.6	50.	220.	44.8	220.0	0.	0.	.0	.0
238.0	173.9	3.9	238.0	55.	180.	40.3	211.7	50.	220.	34.9	40.0	0.	0.	.0	.0
241.5	173.7	3.6	241.5	60.	0.	35.2	216.0	25.	220.	70.1	220.0	0.	0.	.0	.0
241.5	173.7	3.6	241.5	60.	0.	35.2	215.8	25.	220.	70.1	220.0	0.	0.	.0	.0
241.5	173.7	3.6	241.5	60.	0.	25.0	45.5	25.	220.	59.8	40.0	0.	0.	.0	.0
241.5	173.7	3.6	241.5	60.	0.	25.0	45.8	25.	220.	59.8	40.0	0.	0.	.0	.0
245.7	173.4	3.3	245.7	68.	0.	27.1	219.0	65.	220.	30.0	220.0	0.	0.	.0	.0
245.7	173.4	3.3	245.7	68.	0.	27.1	218.8	65.	220.	30.0	220.0	0.	0.	.0	.0
245.7	173.4	3.3	245.7	68.	0.	16.4	41.6	65.	220.	19.4	40.0	0.	0.	.0	.0
245.7	173.4	3.3	245.7	68.	0.	16.4	41.9	65.	220.	19.4	40.0	0.	0.	.0	.0
247.1	173.3	3.2	247.1	85.	0.	10.9	201.7	60.	220.	35.2	220.0	0.	0.	.0	.0
247.1	173.3	3.2	247.1	85.	0.	3.4	137.3	60.	220.	24.3	40.0	0.	0.	.0	.0
250.3	173.0	3.0	250.3	60.	0.	35.5	217.1	42.	220.	53.4	220.0	0.	0.	.0	.0
250.3	173.0	3.0	250.3	60.	0.	35.6	216.9	42.	220.	53.4	220.0	0.	0.	.0	.0
250.3	173.0	3.0	250.3	60.	0.	24.4	44.1	42.	220.	42.3	40.0	0.	0.	.0	.0
250.3	173.0	3.0	250.3	60.	0.	24.4	44.3	42.	220.	42.3	40.0	0.	0.	.0	.0
254.5	172.8	2.7	254.5	78.	0.	18.1	208.7	40.	220.	55.6	220.0	0.	0.	.0	.0
254.5	172.8	2.7	254.5	78.	0.	18.1	208.6	40.	220.	55.6	220.0	0.	0.	.0	.0
254.5	172.8	2.7	254.5	78.	0.	7.1	69.3	40.	220.	44.1	40.0	0.	0.	.0	.0
254.5	172.8	2.7	254.5	78.	0.	7.2	69.6	40.	220.	44.1	40.0	0.	0.	.0	.0
261.5	172.3	2.3	261.5	80.	0.	16.4	207.1	50.	220.	45.8	220.0	0.	0.	.0	.0
261.5	172.3	2.3	261.5	80.	0.	16.4	207.0	50.	220.	45.8	220.0	0.	0.	.0	.0
261.5	172.3	2.3	261.5	80.	0.	5.3	82.9	50.	220.	33.7	40.0	0.	0.	.0	.0
261.5	172.3	2.3	261.5	80.	0.	5.3	83.2	50.	220.	33.7	40.0	0.	0.	.0	.0
265.8	172.1	2.1	265.8	45.	0.	51.2	218.2	30.	220.	66.1	220.0	0.	0.	.0	.0
265.8	172.1	2.1	265.8	45.	0.	51.2	218.1	30.	220.	66.1	220.0	0.	0.	.0	.0
265.8	172.1	2.1	265.8	45.	0.	38.7	42.2	30.	220.	53.6	40.0	0.	0.	.0	.0
265.8	172.1	2.1	265.8	45.	0.	38.7	42.4	30.	220.	53.6	40.0	0.	0.	.0	.0
269.1	172.0	1.8	269.1	60.	0.	36.2	217.0	45.	220.	51.1	220.0	0.	0.	.0	.0
269.1	172.0	1.8	269.1	60.	0.	36.2	216.9	45.	220.	51.1	220.0	0.	0.	.0	.0
269.1	172.0	1.8	269.1	60.	0.	23.6	44.4	45.	220.	38.5	40.0	0.	0.	.0	.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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CIRQUE

STRUCTURAL SOLUTION CALCULATIONS FOR DRILLHOLE: EG80C23

REFERENCE FABRIC ELEMENT IS S1

DDH METRES	ZENITH ANGLE	AZIMUTH	RFE DEPTH	SX-1 PLANE OBSERVED CA	SX-1 PLANE OBSERVED DIPD	SX-1 PLANE CALCULATED DIP	SX-1 PLANE CALCULATED DIPD	SX PLANE OBSERVED CA	SX PLANE OBSERVED DIPD	SX PLANE CALCULATED DIP	SX PLANE CALCULATED DIPD	SX+1 PLANE OBSERVED CA	SX+1 PLANE OBSERVED DIPD	SX+1 PLANE CALCULATED DIP	SX+1 PLANE CALCULATED DIPD
277.2	172.0	1.0	277.2	*** NO SOLUTION FOR RFE PLANE ***											
280.7	172.0	.7	280.7	75.	0.	21.4	210.9	50.	220.	45.9	220.0	0.	0.	.0	.0
280.7	172.0	.7	280.7	75.	0.	21.4	210.8	50.	220.	45.9	220.0	0.	0.	.0	.0
280.7	172.0	.7	280.7	75.	0.	9.3	60.8	50.	220.	33.5	40.0	0.	0.	.0	.0
280.7	172.0	.7	280.7	75.	0.	9.4	61.1	50.	220.	33.5	40.0	0.	0.	.0	.0
284.2	172.0	.3	284.2	85.	0.	11.7	200.6	70.	220.	25.5	220.0	0.	0.	.0	.0
284.2	172.0	.3	284.2	85.	0.	4.1	148.9	70.	220.	13.2	40.0	0.	0.	.0	.0
284.2	172.0	.3	284.2	85.	0.	4.1	148.8	70.	220.	13.2	40.0	0.	0.	.0	.0
292.4	172.0	359.5	292.3	75.	0.	21.7	207.1	10.	220.	86.1	220.0	0.	0.	.0	.0
292.4	172.0	359.5	292.3	75.	0.	21.7	206.9	10.	220.	86.1	220.0	0.	0.	.0	.0
292.4	172.0	359.5	292.3	75.	0.	10.1	68.1	10.	220.	73.9	40.0	0.	0.	.0	.0
292.4	172.0	359.5	292.3	75.	0.	10.1	68.3	10.	220.	73.9	40.0	0.	0.	.0	.0
296.0	172.0	359.2	296.0	60.	0.	36.1	216.1	40.	220.	55.9	220.0	0.	0.	.0	.0
296.0	172.0	359.2	296.0	60.	0.	36.1	216.0	40.	220.	55.9	220.0	0.	0.	.0	.0
296.0	172.0	359.2	296.0	60.	0.	24.0	45.6	40.	220.	43.7	40.0	0.	0.	.0	.0
296.0	172.0	359.2	296.0	60.	0.	24.0	45.9	40.	220.	43.7	40.0	0.	0.	.0	.0
300.0	172.0	359.0	300.0	45.	0.	51.0	217.9	28.	220.	67.9	220.0	0.	0.	.0	.0
300.0	172.0	359.0	300.0	45.	0.	51.0	217.7	28.	220.	67.9	220.0	0.	0.	.0	.0
300.0	172.0	359.0	300.0	45.	0.	38.9	42.6	28.	220.	55.8	40.0	0.	0.	.0	.0
300.0	172.0	359.0	300.0	45.	0.	38.9	42.9	28.	220.	55.8	40.0	0.	0.	.0	.0
303.2	172.0	359.0	303.2	70.	0.	26.2	212.3	40.	220.	55.9	220.0	0.	0.	.0	.0
303.2	172.0	359.0	303.2	70.	0.	26.2	212.2	40.	220.	55.9	220.0	0.	0.	.0	.0
303.2	172.0	359.0	303.2	70.	0.	14.3	53.8	40.	220.	43.7	40.0	0.	0.	.0	.0
303.2	172.0	359.0	303.2	70.	0.	14.3	54.1	40.	220.	43.7	40.0	0.	0.	.0	.0

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4.5 Reporting of DDH Data and DDHDB Contents.

As indicated in previous sub-sections, action reports are prepared by the various data entry and calculation programs. These reports are complemented by the programs in this category which produce the following reports.

(a) DDH Reports of Samples and Assays (2 types)
- sorted by sample no.
- sorted by down-hole depth (more useful)

(b) General DDH Report
- reports each data set for a particular DDH

(c) Section Data Report
- reports stored data for all section master data sets.

(d) DDH Collar Data Summary
- summary of all DDH Primary data printed in sorted DDH-Identifier Order.

(e) Weighted Average Assay Data Report.
- calculates length-weighted assays of contiguous sampled core.

All of the above programs may be run by any class of User.

Examples of the above reports are contained on the following pages.

DDH: EG80C23 UTM-N: 375703.8 UTM-E: 370604.5 UTM-ELEV: 1696.9 TOTAL DEPTH: 303.8 SECTION:
RFE: S1 RFE DIR: 220 PLUNGE ANGLES: 0 0 DHD CALC: 0 SS CALC: 0

----DEPTHS--- FROM	TO	SAMPLE NO.	INT.	REC.	ROCK UNIT	S.G. PULP	CU %	PB %	ZN %	AG(AA) G/MT	AG(FA) G/MT	AU(FA) G/MT	PO %	PY %	TOT FE	BAO %	HG %	MN %	AS %	BA %	S.G. W.R.
								ASSAYS													
174.2	176.0	04627	1.8	1.8	DBMSM			4.07	9.10	64.00						18.70					
176.0	177.5	04628	1.5	1.5	DBMSM			4.24	11.40	74.00						12.60					
177.5	179.7	04629	2.2	2.2	DBMSM			3.73	11.70	99.50						6.80					
179.7	180.3	04630	.6	.6	DGPRI			.16	.15	7.00						.40					
180.3	182.2	04631	1.9	1.9	DBMSM			2.70	14.60	86.00						.60					
182.2	184.2	04632	2.0	2.0	DBMSM			4.35	12.20	91.00						8.20					
184.2	186.0	04633	1.8	1.8	DBMSM			4.24	12.20	86.00						20.10					
186.0	188.1	04634	2.1	2.1	DBMSM			3.16	12.90	81.00						12.20					
188.1	190.1	04635	2.0	2.0	DBMSM			3.10	11.80	86.00						3.10					
190.1	192.1	04636	2.0	2.0	DBMSM			3.86	11.50	77.00						20.50					
192.1	194.1	04637	2.0	2.0	DBMSM			2.15	11.10	72.00						5.10					
194.1	196.1	04638	2.0	2.0	DBMSM			1.01	14.30	75.50						2.40					
196.1	197.4	04639	1.3	1.3	DBMSM			.22	7.90	46.50						6.10					
197.4	198.8	04640	1.4	1.4	DBSBL			.28	9.40	52.00						10.70					
198.8	200.5	04641	1.7	1.7	DBSBL			.31	11.00	49.00						20.00					
200.5	202.4	04642	1.9	1.9	DBBSL			.83	5.20	25.00						45.30					
202.4	203.3	04643	.9	.9	DBSBL			1.58	11.70	47.50						25.30					
203.3	205.0	04644	1.7	1.7	DBBSL			.32	4.00	24.00						44.50					
205.0	207.0	04645	2.0	2.0	DBBSL			.23	7.40	30.50						38.70					
207.0	208.5	04646	1.5	1.5	DBBSL			.33	5.60	22.00						44.20					
208.5	210.1	04647	1.6	1.6	DBBSL			.17	5.20	22.00						52.00					
210.1	210.9	04648	.8	.8	DBSBL			.26	15.50	58.50						18.00					
210.9	212.0	04649	1.1	1.1	DGDLP			1.10	5.20	74.00						14.50					
212.0	213.8	04650	1.8	1.8	DBBSL			2.60	5.40	36.00						37.00					
213.8	215.5	04651	1.7	1.7	DBBSL			1.38	4.80	22.50						50.90					
215.5	217.3	04652	1.8	1.8	DBBSL			.43	8.30	32.50						45.50					
217.3	219.3	04653	2.0	2.0	DBBSL			.84	6.20	24.50						45.60					
219.3	220.5	04654	1.2	1.2	DBBSL			.36	8.30	30.50						5.50					
220.5	222.5	04655	2.0	2.0	DBBSL			.63	4.90	20.00						52.00					
222.5	224.5	04656	2.0	2.0	DBBSL			.10	4.90	27.50						42.50					
224.5	226.5	04657	2.0	2.0	DBBSL			.62	4.60	16.50						47.00					
226.5	228.5	04658	2.0	2.0	DBBSL			.08	7.60	34.00						41.50					
228.5	230.5	04659	2.0	2.0	DBBSL			.06	7.50	40.50						47.00					
230.5	232.5	04660	2.0	2.0	DBBSL			.06	8.80	39.50						43.50					
232.5	233.5	04661	1.0	1.0	DBBSL			.08	8.50	41.00						43.70					
233.5	235.5	04662	2.0	2.0	DBBSL			.06	7.30	34.50						50.50					
235.5	237.5	04663	2.0	2.0	DBBSL			.12	5.60	23.50						48.50					
237.5	239.5	04664	2.0	2.0	DBBSL			.11	5.30	23.00						51.00					
239.5	241.5	04665	2.0	2.0	DBBSL			.08	5.40	25.00						49.50					
241.5	243.5	04666	2.0	2.0	DBBSL			.05	5.50	29.00						53.00					
243.5	245.5	04667	2.0	2.0	DBBSL			.03	6.00	26.00						52.50					
245.5	247.5	04668	2.0	2.0	DBBSL			.11	4.90	22.00						44.00					
247.5	249.4	04669	1.9	1.9	DBBSL			.12	3.50	16.00						50.80					
249.4	250.8	04670	1.4	1.4	DBBXP			.38	6.30	47.00						39.50					

**THIS REPORT WAS REQUESTED BY: JIM .GEOLOGY AT: 09:46:27

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25MAR83 CIRQUE DRILL HOLE COLLAR DATA (DH021) PAGE: 1

DDH	UTM-N	UTM-E	UTM-ELEV	TOTAL DEPTH	SECTION	RFE	DIR	PLUNGE ANGLE	DHD	SSC
********	0.0	0.0	0.0	0.0						
EG78C01	6,377,367.0	369,763.0	1,511.0	108.5		S1	210		1	
EG78C02	6,377,239.0	369,538.0	1,471.0	68.9		S1	210		1	
EG78C03	6,377,239.0	369,538.0	1,471.0	233.5		S1	210		1	
EG78C04	6,375,758.3	370,742.2	1,620.8	125.9		S1	210			
EG78C05	6,375,353.7	370,833.6	1,634.8	154.3		S1	210			
EG78C06	6,375,535.7	370,833.6	1,634.8	190.8		S1	210			
EG79C01	6,375,878.2	370,664.3	1,649.7	121.9		S1	210			
EG79C02	6,375,878.2	370,664.3	1,649.7	148.4		S1	210			
EG79C03	6,375,561.8	370,711.1	1,635.2	221.1		S1	210			
EG79C04	6,375,389.7	370,666.6	1,678.5	360.6		S1	210			
EG79C05	6,375,598.6	370,589.7	1,699.2	349.6		S1	210			
EG79C06	6,376,164.0	370,933.0	1,581.0	160.0		S1	210		1	
EG79C07	6,375,581.1	370,348.1	1,810.4	477.0		S1	210			
EG79C08	6,375,772.0	370,253.0	1,786.0	484.9		S1	210		1	
EG79C09	6,375,036.0	370,709.0	1,821.0	346.1		S1	210		1	
EG79C10	6,376,027.0	570,473.0	1,758.0	117.4		S1	210		1	
EG79C11	6,376,108.0	370,292.0	1,854.0	60.6		S1	210		1	
EG79C12	6,376,108.0	370,292.0	1,854.0	467.2		S1	210			
EG79C13	6,375,036.0	370,709.0	1,820.9	373.6		S1	210		1	
EG79C14	6,375,480.8	370,610.3	1,681.2	388.8		S1	210			
EG79C15	6,375,399.9	370,800.3	1,652.7	282.2		S1				
EG79C16	6,375,479.1	370,895.1	1,650.8	246.0		S1	210			
EG79C17	6,375,036.2	370,709.7	1,820.9	650.7		S1	210			
EG79C18	6,375,637.0	370,797.6	1,620.9	198.4		S1	210			
EG79C19	6,375,242.5	370,608.9	1,724.3	526.7		S1	210			
EG79C20	6,375,703.8	370,604.5	1,696.9	257.8		S1	210			
EG79C21	6,376,027.4	370,473.0	1,758.1	297.8		S1	210			
EG79C22	6,375,242.5	370,608.9	1,724.3	530.7		S1	210			
EG79C23	6,375,480.8	370,610.3	1,681.2	407.5		S1	210			
EG79C24	6,375,350.7	370,586.8	1,694.4	490.7		S1	210			
EG8013A	6,375,317.0	370,701.0	1,689.0	313.6		S1	220			
EG80C01	6,375,331.6	370,366.0	1,832.9	617.7		S1	220			
EG80C02	6,375,040.0	370,379.6	1,809.7	953.1		S1	220			
EG80C03	6,375,428.0	370,370.7	1,841.1	619.3		S1	220			
EG80C04	6,375,202.0	370,280.0	1,821.0	825.7		S1	220			
EG80C05	6,375,581.1	370,348.1	1,809.3	552.9		S1	220			
EG80C06	6,375,480.8	370,610.3	1,681.2	417.6		S1	220			
EG80C07	6,375,350.7	370,586.8	1,694.4	285.6		S1	220			
EG80C08	6,375,598.6	370,589.7	1,699.2	359.1		S1	220			
EG80C09	6,375,598.6	370,589.7	1,699.2	259.1		S1	220			
EG80C10	6,375,350.6	370,586.7	1,694.4	743.3		S1	220			
EG80C11	6,375,242.5	370,608.9	1,724.3	155.0		S1	220			
~~EG80C12~~	~~6,375,242.5~~	~~370,608.9~~	~~1,724.3~~	~~308.3~~		~~S1~~	~~220~~			
EG80C13	6,375,317.0	370,701.0	1,689.0	328.3		S1	220			
EG80C14	6,375,873.0	370,664.2	1,649.7	175.5		S1	220			
EG80C15	6,373,688.1	372,048.6	1,478.8	614.7		S1	220			
EG80C16	6,375,317.0	370,701.0	1,689.0	644.7		S1	220			
EG80C17	6,373,688.1	372,048.6	1,478.8	163.0		S1	220			
EG80C18	6,375,980.3	370,622.3	1,622.3	172.5		S1	220			
EG80C19	6,373,833.2	372,137.1	1,575.2	317.8		S1	220			

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DDH	UTM-N	UTM-E	UTM-ELEV	TOTAL DEPTH	SECTION	RFE	DIR	PLUNGE ANGLE	DHD	SSC
EG80C20	6,375,980.3	370,622.3	1,622.3	139.6		S1	220			
EG80C21	6,375,980.3	370,622.3	1,622.3	262.7		S1	220			
EG80C22	6,375,455.0	370,791.0	1,644.0	174.3		S1	220			
EG80C23	6,375,703.8	370,604.5	1,696.9	303.8		S1	220			
EG80C24	6,373,314.9	371,998.6	1,306.9	210.6		S1	220			
EG80C25	6,375,314.9	371,998.6	1,306.9	272.2		S1	220			
EG80C26	6,375,455.0	370,791.0	1,644.0	255.4		S1	220			
EG80C27	6,375,758.3	370,742.2	1,620.8	118.9		S1	220			
EG80C7A	6,375,351.0	370,587.0	1,694.4	225.8		S1	220			
EG81C01	6,373,136.0	372,004.2	1,355.0	242.6		S1	210			
EG81C02	6,373,136.0	372,004.2	1,355.0	362.6		S1	210			
EG81C03	6,373,365.5	371,218.6	1,469.6	779.3		S1	210			
EG81C04	6,376,745.0	369,799.0	1,608.0	419.7		S1	210		1	
EG81C05	6,374,275.3	371,402.7	1,923.6	919.6		S1	210			
EG81C06	6,376,111.8	370,522.6	1,715.1	183.5		S1	210			
EG81C07	6,376,111.8	370,522.6	1,715.1	187.4		S1	210			
EG81C08	6,376,111.8	370,533.6	1,715.1	271.3		S1	210			
EG81C09	6,376,111.8	370,522.5	1,715.1	307.6		S1	210			
EG81C10	6,374,054.5	371,872.1	1,604.5	718.1		S1	210			
EG81C11	6,374,645.6	371,931.0	1,719.5	770.2		S1	210			
EG81C12	6,376,172.3	370,488.2	1,736.6	157.3		S1	210			
EG81C13	6,376,172.3	370,488.2	1,736.6	226.4		S1	210			
EG81C14	6,373,738.5	370,793.6	1,567.2	1,078.7		S1	210			
EG81C15	6,376,172.0	370,488.2	1,736.5	363.8		S1	210		1	
EG81C16	6,377,375.0	369,364.0	1,511.3	523.0		S1	210		1	
EG81C17	6,376,362.0	370,852.0	1,546.2	125.0		S1	210		1	
EG81C18	6,376,172.3	370,488.2	1,736.6	298.1		S1	210			
EG81C19	6,376,278.0	370,405.5	1,762.2	392.6		S1	210			
EG81C20	6,376,370.6	370,428.4	1,749.7	257.1		S1	210			
EG81C21	6,376,278.0	370,405.5	1,762.1	309.3		S1	210			
EG81C22	6,377,150.0	369,442.0	1,486.0	372.8		S1	210			
EG81C23	6,376,370.6	370,428.4	1,749.7	264.5		S1	210			
EG81C24	6,376,278.0	370,405.5	1,762.1	225.2		S1	210			
EG81C25	6,375,126.6	370,651.2	1,775.2	639.7		S1	210			
EG81C26	6,376,370.6	370,428.4	1,749.7	289.2		S1	210			
EG81C27	6,376,174.3	370,790.6	1,560.1	102.7		S1	210			
EG81C28	6,373,964.2	371,029.3	1,667.0	885.4		S1	210			
EG81C29	6,377,306.0	369,600.0	1,477.0	337.3		S1	210		1	
EG81C30	6,375,980.3	370,622.3	1,662.3	242.6		S1	210			
EG81C31	6,377,306.0	369,600.0	1,477.0	270.3		S1	210		1	
EG81C32	6,375,878.2	370,664.3	1,649.7	239.0		S1	210			
EG81C33	6,377,512.0	369,679.0	1,497.0	206.0		S1	210		1	
EG81C34	6,374,153.0	370,755.1	1,695.5	1,000.0		S1	210			
~~EG81C35~~	~~6,377,160.0~~	~~379,750.0~~	~~1,537.0~~	~~380.1~~		~~S1~~	~~210~~		~~1~~	
EG81C37	6,373,744.0	371,915.0	1,487.0	424.0		S1	210			
EG81C38	6,375,561.8	370,711.7	1,635.2	224.6		S1	210			
EG81C39	6,376,892.0	369,557.0	1,540.0	532.2		S1	210		1	
EG81C40	6,375,703.8	370,604.5	1,696.9	259.7		S1	210			
EG81C41	6,375,363.7	370,629.1	1,637.2	345.0		S1	210			
EG82C01	6,374,311.5	370,984.5	1,833.0	1,021.7		S1	220		1	
EG82C02	6,374,557.5	370,649.5	1,912.0	1,018.0		S1	220		1	

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DDH	UTM-N	UTM-E	UTM-ELEV	TOTAL DEPTH	SECTION	RFE	DIR	PLUNGE ANGLE	DHD	SSC
EG82C03	6,374,427.0	370,783.0	1,842.5	1,135.7		S1	210		1	
EG82C04	6,374,212.0	370,912.0	1,773.0	1,025.9		S1	220		1	
EG82C05	6,374,089.5	371,157.0	1,743.0	867.7		S1	220		1	
EG82C06	6,373,765.0	371,275.0	1,662.0	803.7		S1	220		1	
EG82C07	6,374,089.5	371,157.0	1,743.0	894.6		S1	220		1	
EG82C08	6,374,330.0	370,595.0	1,835.6	1,205.7		S1	220		1	
EG82C09	6,374,439.0	371,132.0	1,944.0	1,020.2		S1	220		1	
EG82C10	6,374,184.0	371,233.5	1,805.0	919.0		S1	220		1	
EG82C11	6,374,439.0	371,132.0	1,944.0	1,004.0		S1	220		1	
EG82C12	6,374,427.0	370,783.0	1,842.5	1,019.5		S1	220		1	
EG82C13	6,373,942.0	371,685.0	1,646.0	559.6		S1	220		1	

**THIS REPORT WAS REQUESTED BY: JIM .GEOLOGY AT: 09:51:05

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**************************************************************
*                                                            *
*   C Y P R U S   A N V I L   M I N I N G   C O R P O R A T I O N   *
*                                                            *
**************************************************************
*                                                            *
*                   SYSTEM =  DDHDB                          *
*                  PROGRAM =  DHO23                          *
*                                                            *
*              FRI, MAR 25, 1983,  2:36 PM                   *
*                                                            *
**************************************************************
*                                                            *
*         REPORTING OF 'SECTION-MASTER' DATA SETS            *
*            FOR THE CURRENT 'DDHDB' DATA BASE.              *
*                                                            *
**************************************************************
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'PROPERTY-MASTER' DATA SET ITEM VALUES

PROPERTY-NAME = '|THE IMPERIAL ANVIL|'

UTM-LIMITS = .000 NORTHING (MIN)
.000 (MAX)
.000 EASTING (MIN)
.000 (MAX)

UTM-ZONE = 0

TRUE-NORTH TO UTM-NORTH ANGLE = .000000

	GRID ORIGIN NORTHING	GRID ORIGIN EASTING	GRID ORIGIN ELEVATION	ANGLE	SCALE FACTORS HORIZONTAL	SCALE FACTORS VERTICAL	
GEOLOGICAL GRID =	.000	.000	.000	.000000	.00000000	.00000000	0
MINE MODEL GRID =	.000	.000	.000	.000000	1.00000000	1.00000000	1
MINE SURVEY GRID =	.000	.000	.000	.000000	1.00000000	1.00000000	1

26 CROSS-SECTIONS FOUND FOR IN 'DDHDB' = |THE IMPERIAL ANVIL|

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* CYPRUS ANVIL MINING CORPORATION * SYSTEM = DDHDB * PROGRAM = DH023 * FRI, MAR 25, 1983, 2:36 PM * PAGE 2

CROSS-SECTION DATA STORED FOR 'DDHDB' = !THE IMPERIAL ANVIL!
****

SECTION NAME ********	COORDINATE SYSTEM	---- POINT-1 ---- NORTHING	EASTING	---- POINT-2 ---- NORTHING	EASTING	- ELEVATIONS - UPPER	LOWER	- PLOT RATIO - HORIZ.	VERT.	VIEW AZIMUTH (DEGREES)	STRUCTURE PLUNGE	TREND
124+22	UTM	6784.4	13215.6	9534.4	15965.6	4400.0	2900.0	600.0 FEET	600.0 FEET	315.00	22	315
125+00	UTM	6700.0	13300.0	9450.0	16050.0	4400.0	2900.0	600.0 FEET	600.0 FEET	315.00	22	315
126+23	UTM	6583.7	13416.3	9333.7	16166.3	4400.0	2900.0	600.0 FEET	600.0 FEET	315.00	22	315
127+09	UTM	6493.6	13506.4	9243.6	16256.4	4400.0	2900.0	600.0 FEET	600.0 FEET	315.00	22	315
128+20	UTM	6385.9	13614.1	9135.9	16364.1	4400.0	2900.0	600.0 FEET	600.0 FEET	315.00	22	315
129+00	UTM	6300.0	13700.0	9050.0	16450.0	4400.0	2900.0	600.0 FEET	600.0 FEET	315.00	22	315
130+00	UTM	6200.0	13800.0	8950.0	16550.0	4400.0	2900.0	600.0 FEET	600.0 FEET	315.00	22	315
131+22	UTM	6084.4	13915.6	8834.4	16665.6	4400.0	2900.0	600.0 FEET	600.0 FEET	315.00	22	315
132+52	UTM	5963.2	14036.8	8713.2	16786.8	4400.0	2900.0	600.0 FEET	600.0 FEET	315.00	22	315
133+00	UTM	5900.0	14100.0	8650.0	16850.0	4400.0	2900.0	600.0 FEET	600.0 FEET	315.00	22	315
134+47	UTM	5766.8	14233.2	8516.8	16983.2	4400.0	2900.0	600.0 FEET	600.0 FEET	315.00	22	315
135+122	UTM	5613.7	14386.3	8363.7	17136.3	4400.0	2900.0	600.0 FEET	600.0 FEET	315.00	22	315
135+54	UTM	5661.8	14338.2	8411.8	17088.2	4400.0	2900.0	600.0 FEET	600.0 FEET	315.00	22	315
14+00	UTM	3750.0	13250.0	6500.0	15500.0	4400.0	2900.0	600.0 FEET	600.0 FEET	45.00	0	0
14+125	UTM	3833.4	13333.4	6583.4	15583.4	4400.0	2900.0	600.0 FEET	600.0 FEET	45.00	0	0
16+00	UTM	3950.0	13450.0	6700.0	15700.0	4400.0	2900.0	600.0 FEET	600.0 FEET	45.00	0	0
17+00	UTM	4050.0	13550.0	6800.0	15800.0	4400.0	2900.0	600.0 FEET	600.0 FEET	45.00	0	0

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CROSS-SECTION DATA STORED FOR 'DDHDB' = (THE IMPERIAL ANVIL)
****

SECTION NAME ********	COORDINATE SYSTEM	---- POINT-1 ---- NORTHING	EASTING	---- POINT-2 ---- NORTHING	EASTING	- ELEVATIONS - UPPER	LOWER	- PLOT RATIO - HORIZ.	VERT.	VIEW AZIMUTH (DEGREES)	STRUCTURE PLUNGE	TREND
20+26	UTM	9366.4	13868.4	7118.4	16118.4	4400.0	2900.0	600.0 FEET	600.0 FEET	45.00	0	0
21+00	UTM	9450.0	13950.0	7200.0	16200.0	4400.0	2900.0	600.0 FEET	600.0 FEET	45.00	0	0
22+00	UTM	9550.0	14050.0	7300.0	16300.0	4400.0	2900.0	600.0 FEET	600.0 FEET	45.00	0	0
23+00	UTM	9650.0	14150.0	7400.0	16400.0	4400.0	2900.0	600.0 FEET	600.0 FEET	45.00	0	0
24+00	UTM	9750.0	14250.0	7500.0	16500.0	4400.0	2900.0	600.0 FEET	600.0 FEET	45.00	0	0
25+00	UTM	9850.0	14350.0	7600.0	16600.0	4400.0	2900.0	600.0 FEET	600.0 FEET	45.00	0	0

DRILL HOLE : EG80C23

NORTHING : 6,375,703.8

EASTING : 370,604.5

ELEVATION : 1,696.9

TOTAL DEPTH : 303.8

SECTION :

R.F.E. : S1

RFE DIRECTION: 220

PLUNGE ANGLE : 0

PLUNGE DIRECT: 0

DHD CALC: 0

SS CALC: 0

DETAIL RECORD COUNTS:

NOS ORE-SAMPLES: 44

NOS DOWN-H-SURVEYS: 9

NOS DOWN-H-LITHOLOGY: 39

NOS DOWN-H-STRUCTURE: 43

NOS DOWN-H-FAULTS: 0

NOS DOWN-H-SPLINES: 9

NOS COMPOSITES: 0

DDH: EG80C23 UTM-N: 6375,703.8 UTM-E: 370,604.5 UTM-ELEV: 1,696.9 TOTAL DEPTH: 303.8 SECTION:
RFE: S1 RFE DIR: 220 PLUNGE ANGLES: 0 0 DHD CALC: 0 SS CALC: 0

----DEPTHS--- FROM	TO	SAMPLE NO.	INT.	REC.	ROCK UNIT	S.G. PULP	CU %	PB %	ZN %	AG(AA) G/MT	AG(FA) G/MT	AU(FA) G/MT	PO %	PY %	TOT FE	BAO %	HG %	MN %	AS %	BA %	S.G. W.R.
174.2	176.0	04627	1.8	1.8	DBMSM			4.07	9.10	64.00						18.70					
176.0	177.5	04628	1.5	1.5	DBMSM			4.24	11.40	74.00						12.60					
177.5	179.7	04629	2.2	2.2	DBMSM			3.73	11.70	99.50						6.80					
179.7	180.3	04630	.6	.6	DGPRI			.16	.15	7.00						.40					
180.3	182.2	04631	1.9	1.9	DBMSM			2.70	14.60	86.00						.60					
182.2	184.2	04632	2.0	2.0	DBMSM			4.35	12.20	91.00						8.20					
184.2	186.0	04633	1.8	1.8	DBMSM			4.24	12.20	86.00						20.10					
186.0	188.1	04634	2.1	2.1	DBMSM			3.16	12.90	81.00						12.20					
188.1	190.1	04635	2.0	2.0	DBMSM			3.10	11.80	86.00						3.10					
190.1	192.1	04636	2.0	2.0	DBMSM			3.86	11.50	77.00						20.50					
192.1	194.1	04637	2.0	2.0	DBMSM			2.15	11.10	72.00						5.10					
194.1	196.1	04638	2.0	2.0	DBMSM			1.01	14.30	75.50						2.40					
196.1	197.4	04639	1.3	1.3	DBMSM			.22	7.90	46.50						6.10					
197.4	198.8	04640	1.4	1.4	DBSBL			.28	9.40	52.00						10.70					
198.8	200.5	04641	1.7	1.7	DBSBL			.31	11.00	49.00						20.00					
200.5	202.4	04642	1.9	1.9	DBBSL			.83	5.20	25.00						45.30					
202.4	203.3	04643	.9	.9	DBSBL			1.58	11.70	47.50						25.30					
203.3	205.0	04644	1.7	1.7	DBBSL			.32	4.00	24.00						44.50					
205.0	207.0	04645	2.0	2.0	DBBSL			.23	7.40	30.50						38.70					
207.0	208.5	04646	1.5	1.5	DBBSL			.33	5.60	22.00						44.20					
208.5	210.1	04647	1.6	1.6	DBBSL			.17	5.20	22.00						52.00					
210.1	210.9	04648	.8	.8	DBSBL			.26	15.50	58.50						18.00					
210.9	212.0	04649	1.1	1.1	DGDLP			1.10	5.20	74.00						14.50					
212.0	213.8	04650	1.8	1.8	DBBSL			2.60	5.40	36.00						37.00					
213.8	215.5	04651	1.7	1.7	DBBSL			1.38	4.80	22.50						50.90					
215.5	217.3	04652	1.8	1.8	DBBSL			.43	8.30	32.50						45.50					
217.3	219.3	04653	2.0	2.0	DBBSL			.84	8.20	24.50						45.60					
219.3	220.5	04654	1.2	1.2	DBBSL			.36	8.30	30.50						5.50					
220.5	222.5	04655	2.0	2.0	DBBSL			.63	4.90	20.00						52.00					
222.5	224.5	04656	2.0	2.0	DBBSL			.10	4.90	27.50						42.50					
224.5	226.5	04657	2.0	2.0	DBBSL			.62	4.60	16.50						47.00					
226.5	228.5	04658	2.0	2.0	DBBSL			.08	7.60	34.00						41.50					
228.5	230.5	04659	2.0	2.0	DBBSL			.06	7.50	40.50						47.00					
230.5	232.5	04660	2.0	2.0	DBBSL			.06	8.80	39.50						43.50					
232.5	233.5	04661	1.0	1.0	DBBSL			.08	8.50	41.00						43.70					
233.5	235.5	04662	2.0	2.0	DBBSL			.06	7.30	34.50						50.50					
235.5	237.5	04663	2.0	2.0	DBBSL			.12	5.60	23.50						48.50					
237.5	239.5	04664	2.0	2.0	DBBSL			.11	5.30	23.00						51.00					
~~239.5~~	~~241.5~~	~~04665~~	~~2.0~~	~~2.0~~	~~DBBSL~~			~~.08~~	~~5.40~~	~~25.00~~						~~49.50~~					
241.5	243.5	04666	2.0	2.0	DBBSL			.05	8.50	29.00						53.00					
243.5	245.5	04667	2.0	2.0	DBBSL			.08	6.00	26.00						52.50					
245.5	247.5	04668	2.0	2.0	DBBSL			.11	4.90	22.00						44.00					
247.5	249.4	04669	1.9	1.9	DBBSL			.12	3.50	16.00						50.80					
249.4	250.8	04670	1.4	1.4	DBBXP			.38	6.30	47.00						39.50					

WEIGHTED AVERAGE

FROM	TO	INT.	REC.	PB %	ZN %	AG(AA) G/MT	BAO %
174.2	250.8	75.6	76.6	1.21	8.12	45.06	32.39

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DDH: EG80C23 UTM-N: 6375,703.8 UTM-E: 370,604.5 UTM-ELEV: 1,696.9 TOTAL DEPTH: 303.8 SECTION:
RFE: S1 RFE DIR: 220 PLUNGE ANGLES: 0 0 DHD CALC: 0 SS CALC: 0

DEPTH	ZENITH	AZIMUTH
0.000	170.000	230.000
84.400	178.000	285.000
114.900	177.500	280.000
145.400	177.000	342.000
175.900	174.500	358.000
206.300	174.500	12.000
236.800	174.000	4.000
267.300	172.000	2.000
297.800	172.000	359.000

25MAR83 CIRQUE

DOWN-HOLE LITHOLOGY (DHO20)

DDH: EG80C23 UTM-N: 6375,703.8 UTM-E: 370,604.5 UTM-ELEV: 1,696.9 TOTAL DEPTH: 303.8 SECTION:
RFE: S1 RFE DIR: 220 PLUNGE ANGLES: 0 0 DHD CALC: 0 SS CALC: 0

DEPTH	UNIT	CODE	DESC	RECOVERY	IND
64.2	0001	OB		0.5-	1
115.3	0002	DAPHT		0.5-	1
127.1	0003	DGCHM		0.5-	1
146.5	0004	DGTHS		0.5-	1
163.7	0005	DGTHS		0.5-	1
174.0	0006	DGPRS		0.5-	1
174.2	0007	DGSXI		0.5-	1
179.7	0008	DBMSL		0.5-	1
180.3	0009	DGPRI		0.5-	1
197.4	0010	DBMSL		0.5-	1
200.5	0011	DBSBL		0.5-	1
202.4	0012	DBBSH		0.5-	1
203.3	0013	DBSBH		0.5-	1
210.1	0014	DBBSH		0.5-	1
210.9	0015	DBSBL		0.5-	1
212.0	0016	DGDLP		0.5-	1
219.3	0017	DBBSL		0.5-	1
220.5	0018	DGDLL		0.5-	1
233.5	0019	DBBSL		0.5-	1
249.4	0020	DBBSL		0.5-	1
250.8	0021	DBBXP		0.5-	1
252.1	0022	DGTFP		0.5-	1
252.2	0023	DGTFA		0.5-	1
252.5	0024	DGTFS		0.5-	1
253.7	0025	DGCF		0.5-	1
253.9	0026	DGLBO		0.5-	1
269.3	0027	DGTFS		0.5-	1
269.6	0028	F		0.5-	1
269.9	0029	DGCFB		0.5-	1
274.4	0030	DGTFS		0.5-	1
284.0	0031	DGCFB		0.5-	1
286.3	0032	DAPFN		0.5-	1
286.6	0033	F		0.5-	1
288.6	0034	DAPFU		0.5-	1
291.8	0035	F		0.5-	1
297.0	0036	DAPFM		0.5-	1
299.5	0037	DAPFU		0.5-	1
303.5	0038	DGFPP		0.5-	1
303.9	0039	F			

DDH: EG80C23 UTM-N: 6375,703.8 UTM-E: 370,604.5 UTM-ELEV: 1,696.9 TOTAL DEPTH: 303.8 SECTION:
RFE: S1 RFE DIR: 220 PLUNGE ANGLES: 0 0 DHD CALC: 0 SS CALC: 0

DDH	F DEPTH	T DEPTH	FEAT	SYMTRY	S0 ANGLE	DIRECT	S1 ANGLE	DIRECT	S2 ANGLE	DIRECT	RFE CDE	DHDC	SDC	PROCESS
EG80C23	0.0	123.0			50	0	22	220	0	0	0	1	1	1
EG80C23	0.0	130.0			50	0	30	220	0	0	0	1	1	1
EG80C23	0.0	168.2			55	270	70	220	0	0	0	1	1	1
EG80C23	0.0	176.3			65	0	30	220	0	0	0	1	1	1
EG80C23	0.0	180.3			65	0	20	220	0	0	0	1	1	1
EG80C23	0.0	183.0			70	0	33	220	0	0	0	1	1	1
EG80C23	0.0	184.5			80	0	35	220	0	0	0	1	1	0
EG80C23	0.0	185.0			75	0	35	220	0	0	0	1	1	1
EG80C23	0.0	189.1			68	0	20	220	0	0	0	1	1	1
EG80C23	0.0	193.5			60	0	35	220	0	0	0	1	1	0
EG80C23	0.0	195.0			72	0	15	220	0	0	0	1	1	1
EG80C23	0.0	198.5			65	0	42	220	0	0	0	1	1	1
EG80C23	0.0	201.5			65	0	40	220	0	0	0	1	1	1
EG80C23	0.0	203.5			62	0	15	220	0	0	0	1	1	1
EG80C23	0.0	206.8			80	0	50	220	0	0	0	1	1	0
EG80C23	0.0	207.9			62	0	50	220	0	0	0	1	1	1
EG80C23	0.0	209.7			78	0	28	220	0	0	0	1	1	0
EG80C23	0.0	213.0			75	0	60	220	0	0	0	1	1	1
EG80C23	0.0	217.0			65	0	42	220	0	0	0	1	1	1
EG80C23	0.0	220.5			62	0	25	220	0	0	0	1	1	1
EG80C23	0.0	223.0			50	180	30	220	0	0	0	1	1	1
EG80C23	0.0	225.2			65	180	55	220	0	0	0	1	1	0
EG80C23	0.0	228.0			70	180	55	220	0	0	0	1	1	1
EG80C23	0.0	230.6			60	160	13	220	0	0	0	1	1	1
EG80C23	0.0	234.0			75	0	35	220	0	0	0	1	1	1
EG80C23	0.0	238.0			55	180	50	220	0	0	0	1	1	1
EG80C23	0.0	241.5			60	0	25	220	0	0	0	1	1	1
EG80C23	0.0	245.7			68	0	65	220	0	0	0	1	1	1
EG80C23	0.0	247.1			85	0	60	220	0	0	0	1	1	1
EG80C23	0.0	250.3			60	0	42	220	0	0	0	1	1	1
EG80C23	0.0	251.3			70	0	32	220	0	0	0	1	1	1
EG80C23	0.0	254.5			78	0	40	220	0	0	0	1	1	0
EG80C23	0.0	261.5			80	0	50	220	0	0	0	1	1	1
EG80C23	0.0	265.8			45	0	30	220	0	0	0	1	1	1
EG80C23	0.0	269.1		Z	60	0	45	220	0	0	0	1	1	1
EG80C23	0.0	273.8			30	0	0	220	0	0	0	1	1	0
EG80C23	0.0	277.2		S	45	0	89	220	0	0	0	1	1	1
EG80C23	0.0	280.7			75	0	50	220	0	0	0	1	1	1
EG80C23	0.0	284.2			85	0	70	220	0	0	0	1	1	1
EG80C23	0.0	292.4			75	0	10	220	0	0	0	1	1	1
EG80C23	0.0	296.0			60	0	40	220	0	0	0	1	1	1
EG80C23	0.0	300.0			45	0	28	220	0	0	0	1	1	1
EG80C23	0.0	303.2		Z	70	0	40	220	0	0	0	1	1	1

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DDH: EG80C23 UTM-N: 6375,703.8 UTM-E: 370,604.5 UTM-ELEV: 1,696.9 TOTAL DEPTH: 303.8 SECTION:
RFE: S1 RFE DIR: 220 PLUNGE ANGLES: 0 0 DHO CALC: 0 SS CALC: 0

DDH	SEGMENT NOS	COND INDICATOR
EG80C23	1	2
EG80C23	2	2
EG80C23	3	2
EG80C23	4	2
EG80C23	5	2
EG80C23	6	2
EG80C23	7	2
EG80C23	8	2
EG80C23	9	1

**THIS REPORT WAS REQUESTED BY: JIM .GEOLOGY AT: 09:49:28

25MAR83 CIRCUE WEIGHTED AVGS BY SELECTED INTERVAL DH017 PAGE: 1

DDH: EG80C23 UTM-N: 375703.8 UTM-E: 370604.5 UTM-ELEV: 1696.9 TOTAL DEPTH: 303.8 SECTION:
RFE: S1 RFE DIR: 220 PLUNGE ANGLES: 0 0 DHD CALC: 0 SS CALC: 0

----DEPTHS--- FROM	TO	SAMPLE NO.	INT.	REC.	ROCK UNIT	S.G. PULP	CU %	PB %	ZN %	AG(AA) G/MT	AG(FA) G/MT	AU(FA) G/MT	PO %	PY %	TOT FE	BAO %	HG %	MN %	AS %	BA %	S.G. W.G.
176.0	177.5	4628	1.5		DBMSM			4.24	11.40	74.00						12.60					
177.5	179.7	4629	2.2		DBMSM			3.73	11.70	99.50						6.80					
179.7	180.3	4630	.6		DGPRI			.16	.15	7.00						.40					
180.3	182.2	4631	1.9		DBMSM			2.70	14.60	86.00						.60					
182.2	184.2	4632	2.0		DBMSM			4.35	12.20	91.00						8.20					
184.2	186.0	4633	1.8		DBMSM			4.24	12.20	86.00						20.10					
186.0	188.1	4634	2.1		DBMSM			3.16	12.90	81.00						12.20					
188.1	190.1	4635	2.0		DBMSM			3.10	11.80	86.00						3.10					
190.1	192.1	4636	2.0		DBMSM			3.86	11.50	77.00						20.50					
192.1	194.1	4637	2.0		DBMSM			2.15	11.10	72.00						5.10					
194.1	196.1	4638	2.0		DBMSM			1.01	14.30	75.50						2.40					
196.1	197.4	4639	1.3		DBMSM			.22	7.90	46.50						6.10					
197.4	198.8	4640	1.4		DBSBL			.28	9.40	52.00						10.70					
198.8	200.5	4641	1.7		DBSBL			.31	11.00	49.00						20.00					
200.5	202.4	4642	1.9		DBBSL			.83	5.20	25.00						45.30					
202.4	203.3	4643	.9		DBSBL			1.58	11.70	47.50						25.30					
203.3	205.0	4644	1.7		DBBSL			.32	4.00	24.00						44.50					
WEIGHTED AVERAGE																					
176.0	205.0		29.0					2.33	10.71	68.03						14.38					

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4.6 Display (Plotting) of Diamond Drill Hole Data

The primary output from the Diamond Drill Hole Data Base System are the various displays of DDH-data. There are three general types of plots available, namely -

(a) single drill-holes plotted on vertical section
(b) plan-view plots of DDH traces
(c) full vertical (cross- and long-) section plots.

These plots may be done on a variety of plotter media, but the most common are

(a) wet ink on mylar, and
(b) ball point on paper.

At present all plotting is done on the Houston Instruments DP-8S 36" wide drum plotter located in Tetrad Computer Application Ltd's office.

The various types of Diamond Drill Hole Data Displays available in the system are explained in the following sub-sections.

4.6.1 Single DDH plots (on Section)

Single DDH plots are prepared by a set of application programs which have been developed from the original DDHPLT program on the CSC computer. These programs have the following features:-

- the trace of the drill-hole is projected onto a vertical section and plotted at any desired scale. The vertical section may be defined as either:
  - (a) any vertical plane (i.e. at any orientation) passing through the collar of the DDH, or
  - (b) any of the sections previously defined in the DDHDB.

  The projection may be either:
  - (a) an orthogonal horizontal projection, or
  - (b) a non-orthogonal non-horizontal projection taking into account fold plunge & trend angles (see Section 4.6.4 for details.)

- the entire DDH trace is plotted with
  - lithologic unit marks
  - every 5th lithologic unit number
  - elevation reference marks
  - down-hole distance to true depth reference scale
  - trace offset distances to plane of the section

- individual (i.e. separate) plotting programs are available for
  - (a) Detailed Lithology Plots
    - includes
      - sample locations and sample numbers
      - lithological unit detailed rock codes
      - lithological unit descriptions.
  - (b) Detailed Structure Plots
    - includes
      - structure symmetry codes
      - structural plane (solutions) projections corrected for intersection with the vertical plane.
  - (c) Detailed Composite Plots
    - includes
      - composite locations
      - composite assays (Pb%, Zn%, Ag g/T) length and rock type.

(also includes fault/feature notations at their reference locations.)

Examples of Single DDH Plots on Section are contained on the following pages.

DDH: 81016 -- 45 DEGREE PROFILE

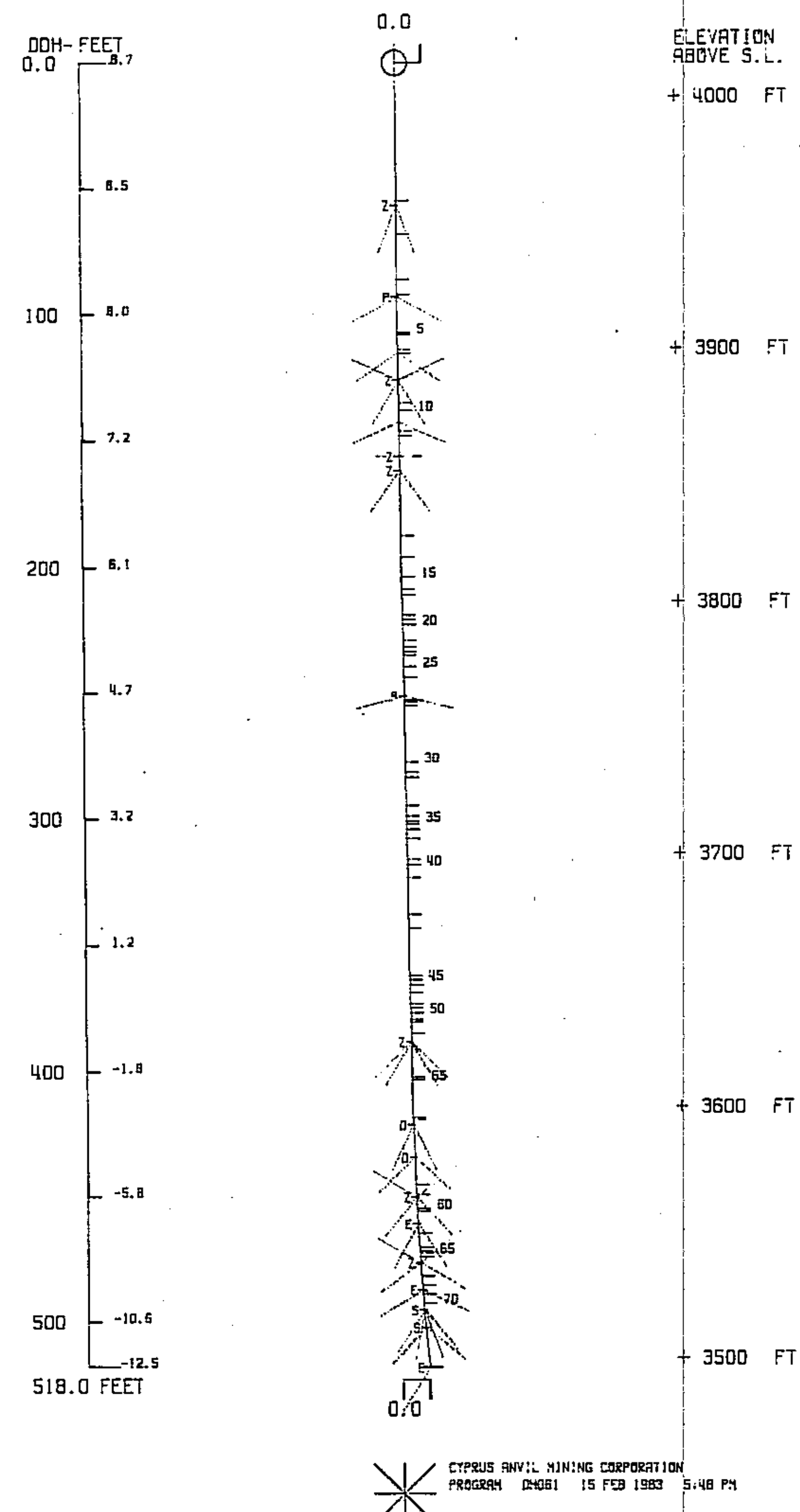
(VIEW AZIMUTH = 315 DEGREES)

ELEV: 4013 15663 E ; 7844 N

PLUNGE ANGLE IS 0.0 TREND ANGLE IS 315.0

CORRECTED COLLAR POSITION: X = 2479.5 Z = 4013.1

SECTION NAME: 131+22



CYPRUS ANVIL MINING CORPORATION
PROGRAM D4061 15 FEB 1983 5:48 PM

Typical DDH-Structure Plot
(Anvil Deposit) N.T.S.

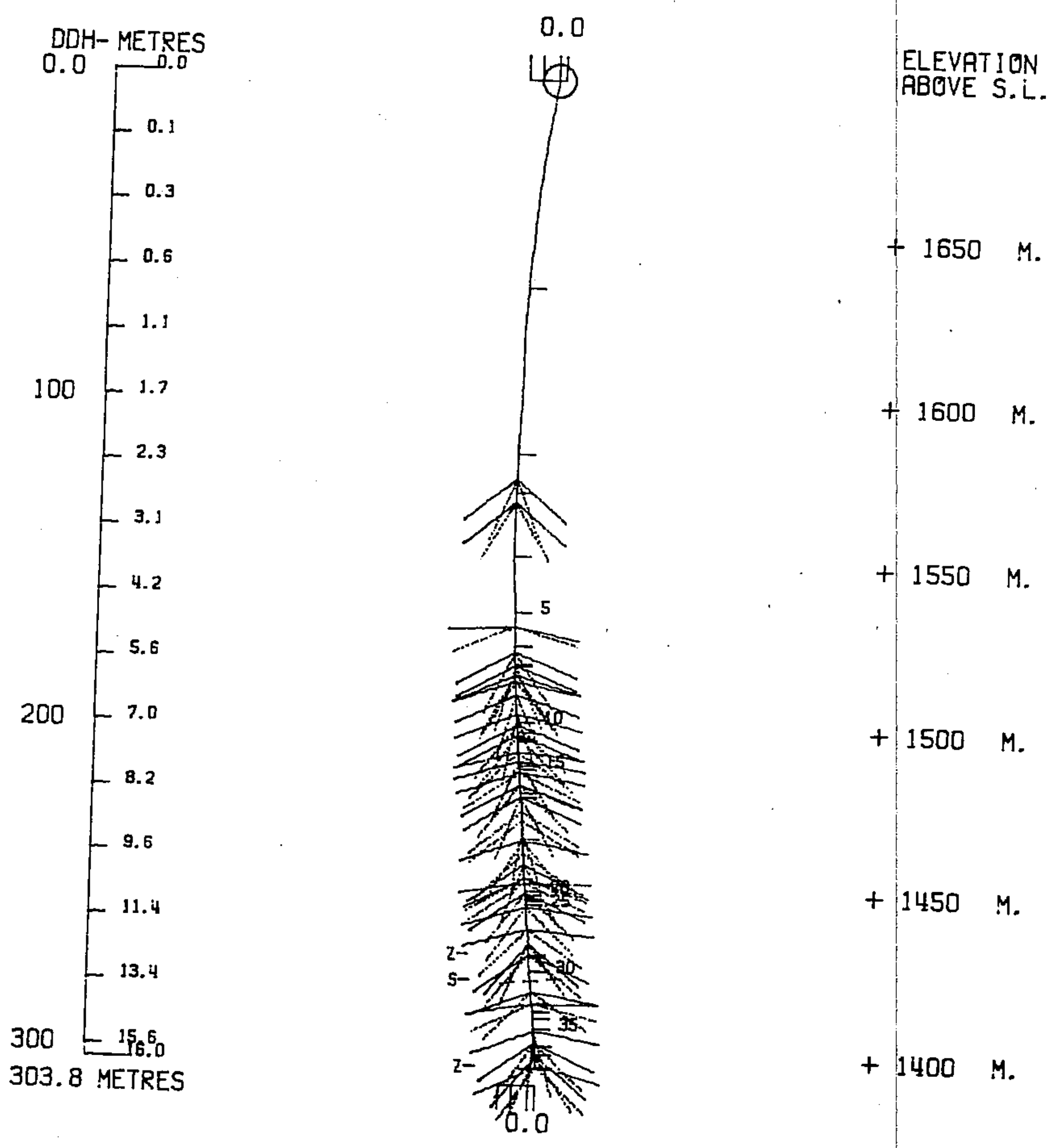
DDH: EG80C23 -- 50 DEGREE PROFILE

(VIEW AZIMUTH = 320 DEGREES)

ELEV: 1697 370604 E , 375704 N

PLUNGE ANGLE IS 0.0 TREND ANGLE IS 320.0

CORRECTED COLLAR POSITION: X = 0.0 Z = 1696.9



Typical DDH-Structure Plot (Cirque Deposit) N.T.S.

CYPRUS ANVIL MINING CORPORATION
PROGRAM DH061 17 FEB 1983 3:50 PM

DDH: 81016 -- 45 DEGREE PROFILE

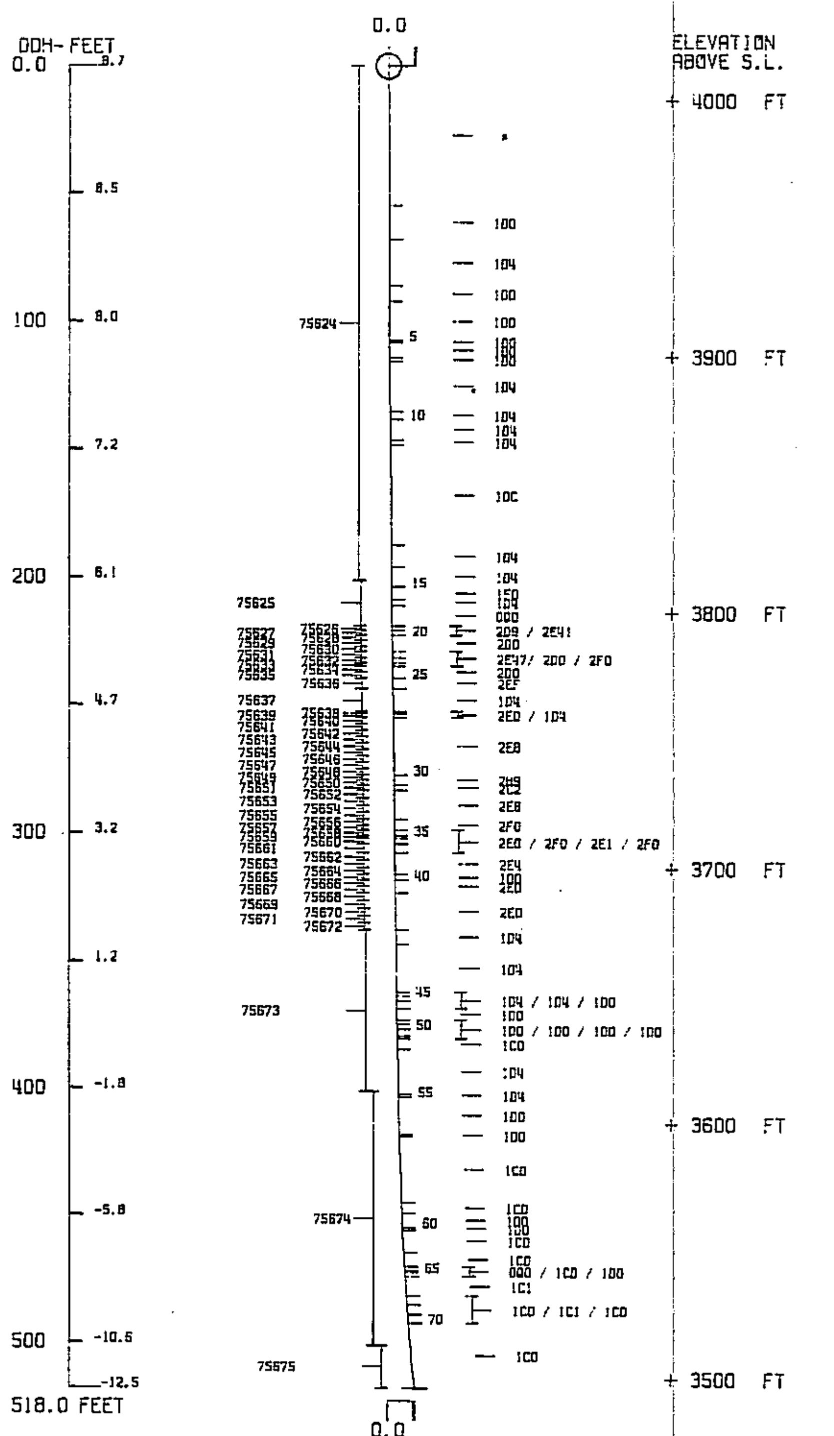
(VIEW AZIMUTH = 315 DEGREES)

ELEV: 4013 15663 E , 7844 N

PLUNGE ANGLE IS 0.0 TREND ANGLE IS 315.0

CORRECTED COLLAR POSITION: X = 2479.5 Z = 4013.1

SECTION NAME: 131+22



CYPRUS ANVIL MINING CORPORATION
PROGRAM DH062 15 FEB 1983 5:31 PM

Typical DDH-Sample with Detailed Lithology Plot (Anvil Deposit) N.T.S.

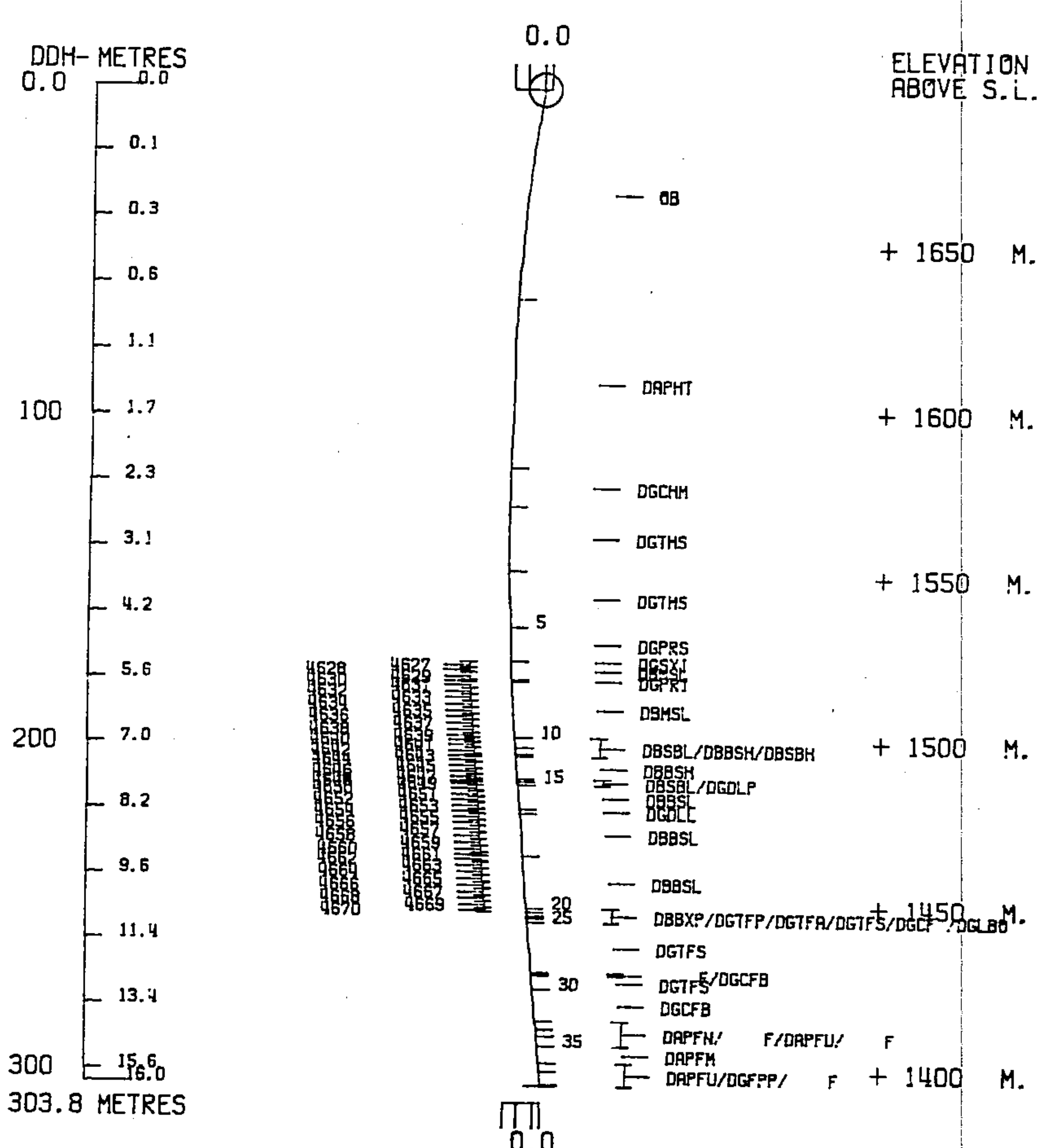
DDH: EG80C23 -- 50 DEGREE PROFILE

(VIEW AZIMUTH = 320 DEGREES)

ELEV: 1697 370604 E , 375704 N

PLUNGE ANGLE IS 0.0 TREND ANGLE IS 320.0

CORRECTED COLLAR POSITION: X = 0.0 Z = 1696.9



CYPRUS ANVIL MINING CORPORATION
PROGRAM DH062 17 FEB 1983 3:56 PM

Typical DDH-Sample with Detailed Lithology Plot

DDH: 81016 -- 45 DEGREE PROFILE

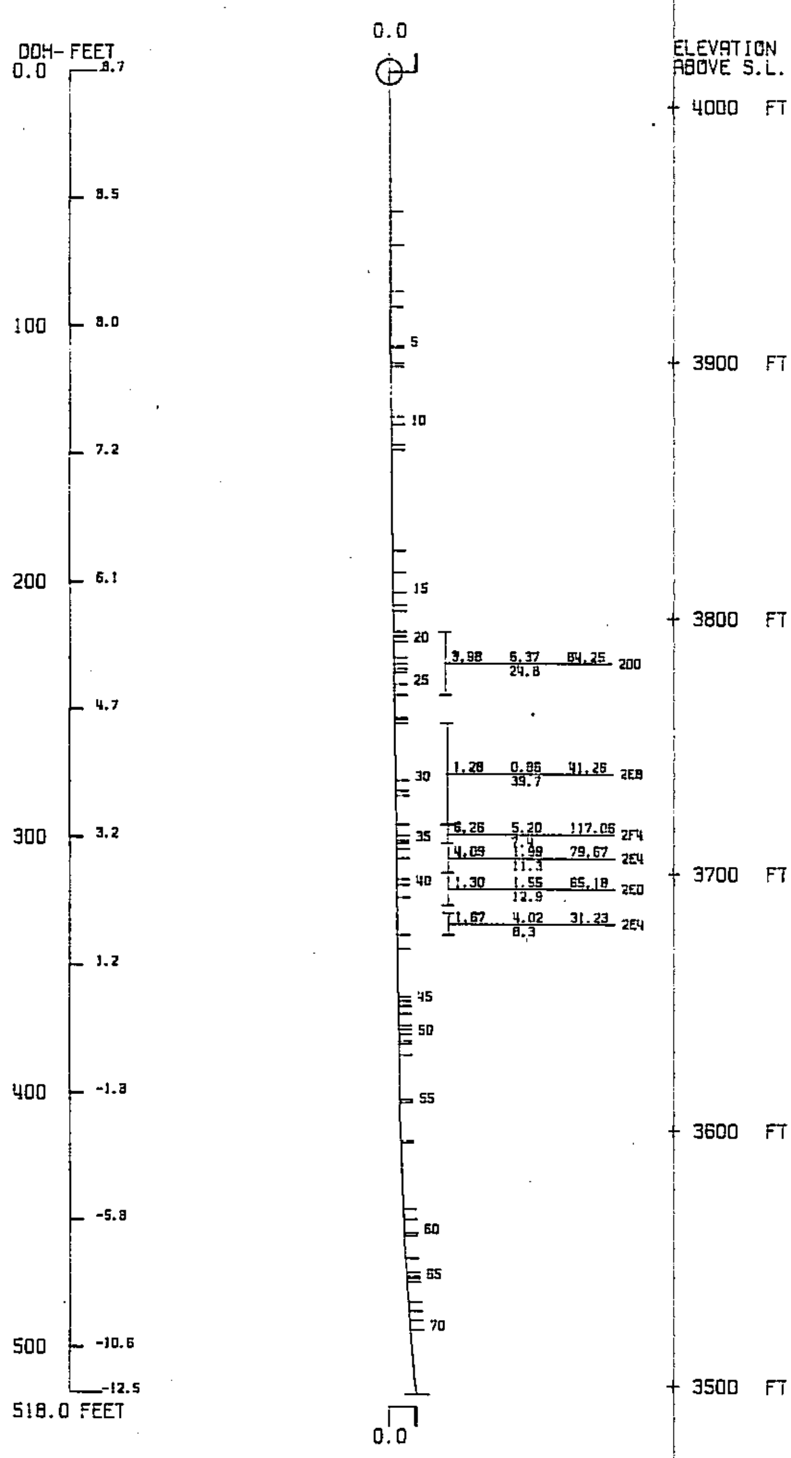
(VIEW AZIMUTH = 315 DEGREES)

ELEV. 4013 15663 E : 7844 N

PLUNGE ANGLE IS 0.0 TREND ANGLE IS 315.0

CORRECTED COLLAR POSITION: X = 2479.5 Z = 4013.1

SECTION NAME: 131+22



CYPRUS ANVIL MINING CORPORATION
PROGRAM DHO64 15 FEB 1983 5:14 PM

Typical DDH-Composite Plot
(Anvil Deposit)

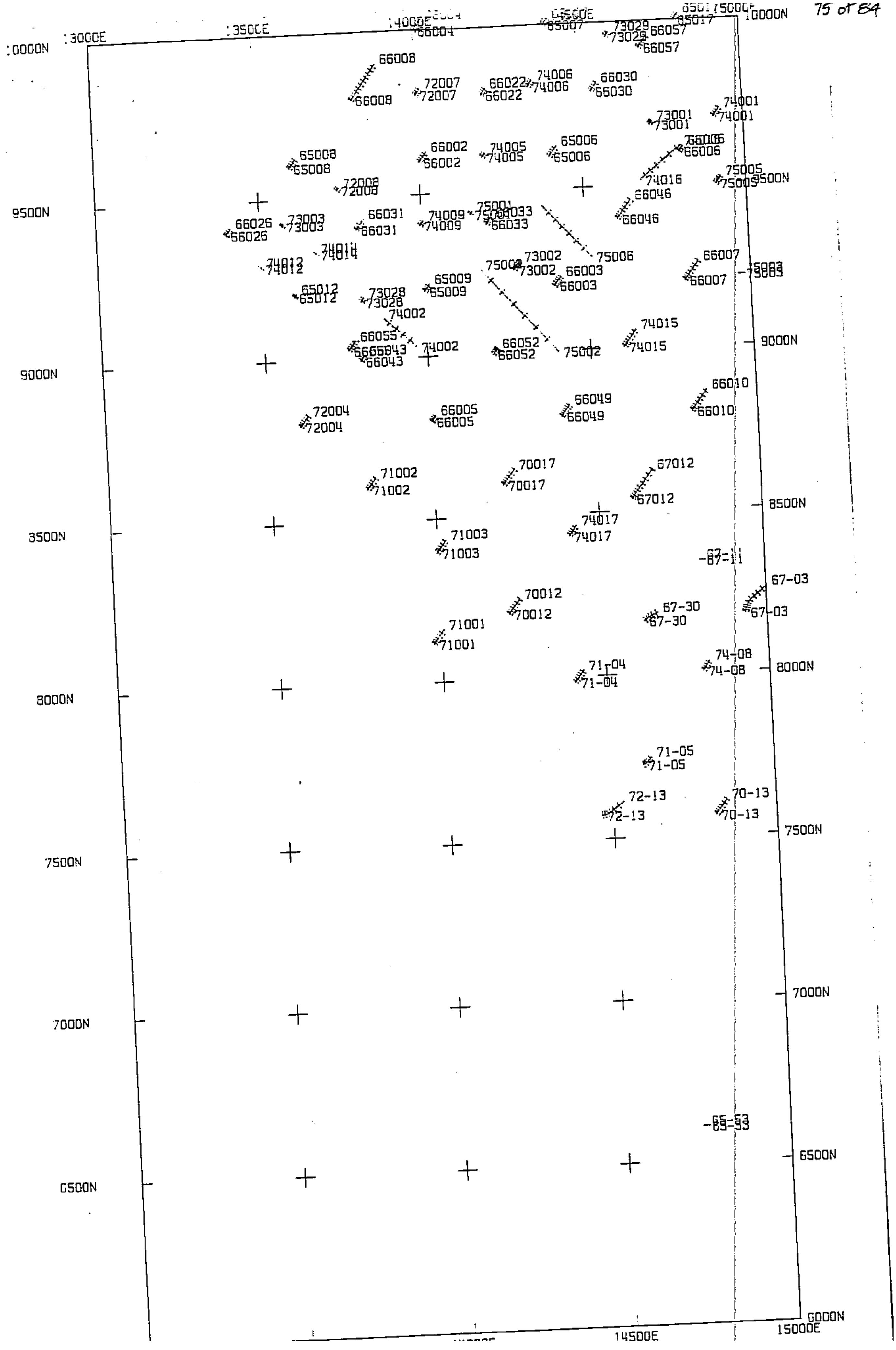
4.6.2 Plan View of DDH-Traces

This application program is used to create horizontal maps of diamond drill hole traces. It has the following features:

- the traces of the diamond drill holes are projected onto a horizontal plan and may be plotted at any scale. This trace plot will show the horizontal displacements of each drill-hole with respect to its collar location.
- equi-distant down-hole distance marks are plotted on each drill-hole trace to indicate the relative (vertical) change in DDH-trace curvature with depth.
- a rectangular plan area is defined limiting drill-hole traces to be plotted and providing a border to the plot. The border is plotted with identified grid marks and values.
- all Diamond Drill Holes stored within the DDHDB are checked for intersection within the defined rectangular plan area.
- each Diamond Drill Hole plotted has its DDH-Identification plotted alongside the collar and the End-of-Hole.

This application program is a direct conversion and extension of the LOCATE program on the CSC system. It is not currently as sophisticated as it should be and thus does require some care when specifying the horizontal rectangular plan area and its attendant plot (scale) ratio.

A very rough example of a plan view plot is contained on the following page.



13000E
13500E
14000E
14500E
15000E
10000N
9500N
9000N
8500N
8000N
7500N
7000N
6500N
6000N
66004
65007
73029
66057
65017
66008
72007
66022
74006
66030
74001
73001
65006
66006
65008
66002
74005
74016
75005
72008
66046
66026
73003
66031
74009
75001
66033
75006
74014
74012
73002
75002
66003
66007
75003
65012
73028
65009
74002
66055
66043
66052
74015
66010
72004
66005
66049
71002
70017
67012
71003
74017
67-11
67-03
70012
67-30
71001
71-04
74-08
71-05
72-13
70-13
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4.6.3 Cross- and Long- Section Plots

Section plots are prepared by a set of application programs which were developed in Phase 1(b) of the Diamond Drill Hole Data Base System. These programs provide a simple and standardized cross- and long-section plotting facility suitable for direct use by project geologists. There are currently two cross-section plotting programs available, namely

(a) standard section plot
(b) section plot with composites.

These programs have the following features:

- traces of Diamond Drill Holes which intersect a defined section volume are projected onto the section and plotted at the pre-defined scale. The projection may be either:
  (a) an orthogonal horizontal projection, or
  (b) a non-orthogonal non-horizontal projection taking into account fold plunge & trend angles (see Section 4.6.4 for details).

- the section plot will be panelled (as described in Section 3.2) so as to fit on the plotter.

- the individual DDH traces will be plotted if they intersect with the defined section volume. The weight of the line used for the trace will vary with the offset from the section plane (see Section 3.2 for details).

- the DDH traces are plotted with
  - lithologic unit marks
  - every 5th lithologic unit number
  - a circle drawn around the DDH-collar position
  - a straight line drawn through the End-of-Hole position
  - the DDH-Identifier plotted next to
    - the DDH-collar position
    - the End-of-Hole position.

- the general section panel will have
  - boundary lines drawn
  - horizontal and vertical grid intersections plotted
  - horizontal and vertical grid values plotted on the border
  - a fully descriptive title block.
  - an overlap strip with the previous panel (on the left).

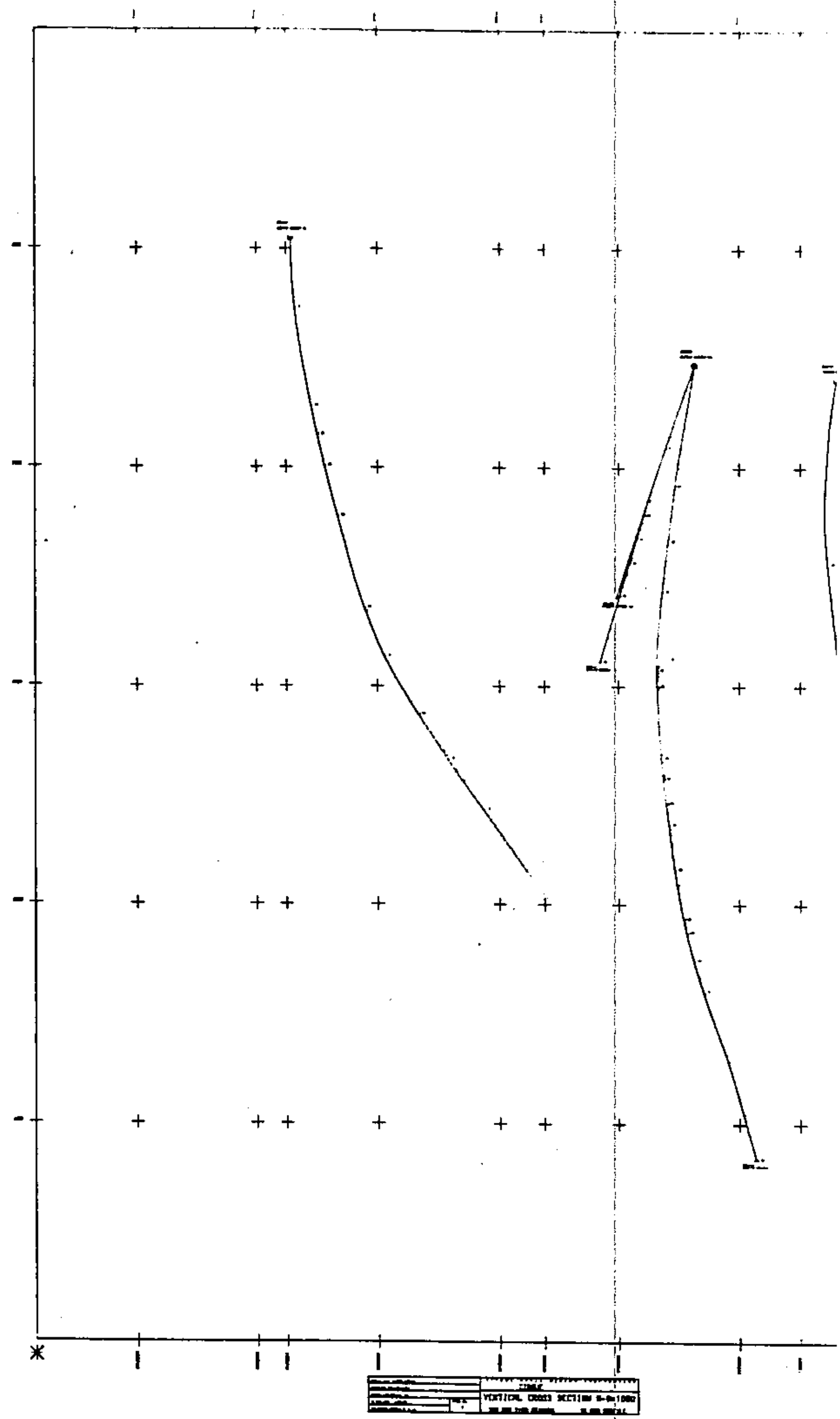
4.6.3 Cross- and Long-Section Plots (Continued)

- composite cross-section plots will have
  - composite locations, and
  - composite assays (Pb%, Zn%, Ag g/T), lengths and rock types

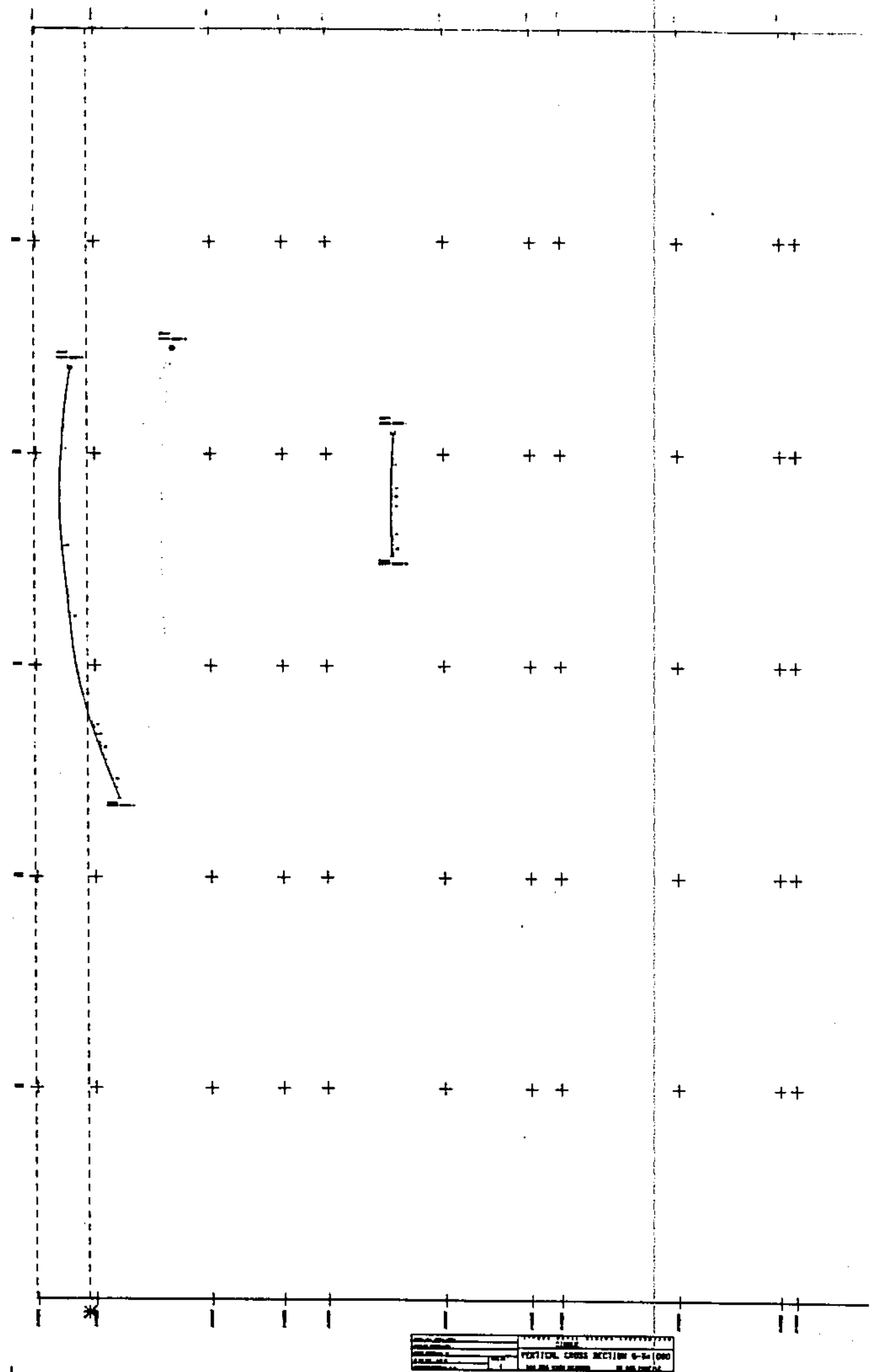
  plotted wherever the composites intersect with the defined section volume.

- the offsets of the DDH-collar and End-of-Hole are also plotted alongside these positions.

A very-much reduced set of cross-section panel plots are contained on the following pages.



Panel #1 Cross-Section Plot
(Cirque Deposit) N.T.S.



Panel #2 Cross-Section Plot
(Cirque Deposit) N.T.S.

4.6.4 Fold Plunge and Trend Corrections.

Traditionally, the most useful tool in the evaluation of an orebody is a set of accurate cross- and long-sections through it. These sections would display the geologists best interpretation of the configuration, zonation and metal content of the potential ore materials. These sections would be developed over a lengthy period of time and would use surface mapping, diamond and other drill holes and subsurface mapping when available. However, apart from the surface mapping the bulk of the deposit would only be delineated and defined through the use of diamond drill hole data projected onto the sections.

General geological exploration and development drilling practice is to place drill holes at regular intervals along the sections. Most of these holes would tend to be drilled vertically, but the results in practice ~~tend~~ are ~~to be~~ that the DDH's are collared somewhat off the section lines and that these DDH's deviate from vertical (and from the section) over their length. The magnitude of the drill hole deviation possible when combined with structural features such as bedding or folds which plunge obliquely to the cross-sections can cause significant positioning errors when DDH positions are projected orthogonally to the section. (see the sketch on the following page). These individual positioning errors could then contribute appreciably to incorrect or even mis-interpretations of the geological nature of the sections.

The Diamond Drill Hole Data Base System incorporates an original technique for providing accurate DDH positioning on section. This method takes into account the effect of geological structure plunging obliquely with respect to the section. The only input data required for this new projection technique is a geologist's definition of the geological structure plunge and trend angles. Normally, each section will have a pre-defined set of structure plunge and trend angles, however, these angles may be modified at the time any of the vertical section plot programs are run. The structure plunge and trend angle corrections are applied to all DDH's which intersect the defined section volume.

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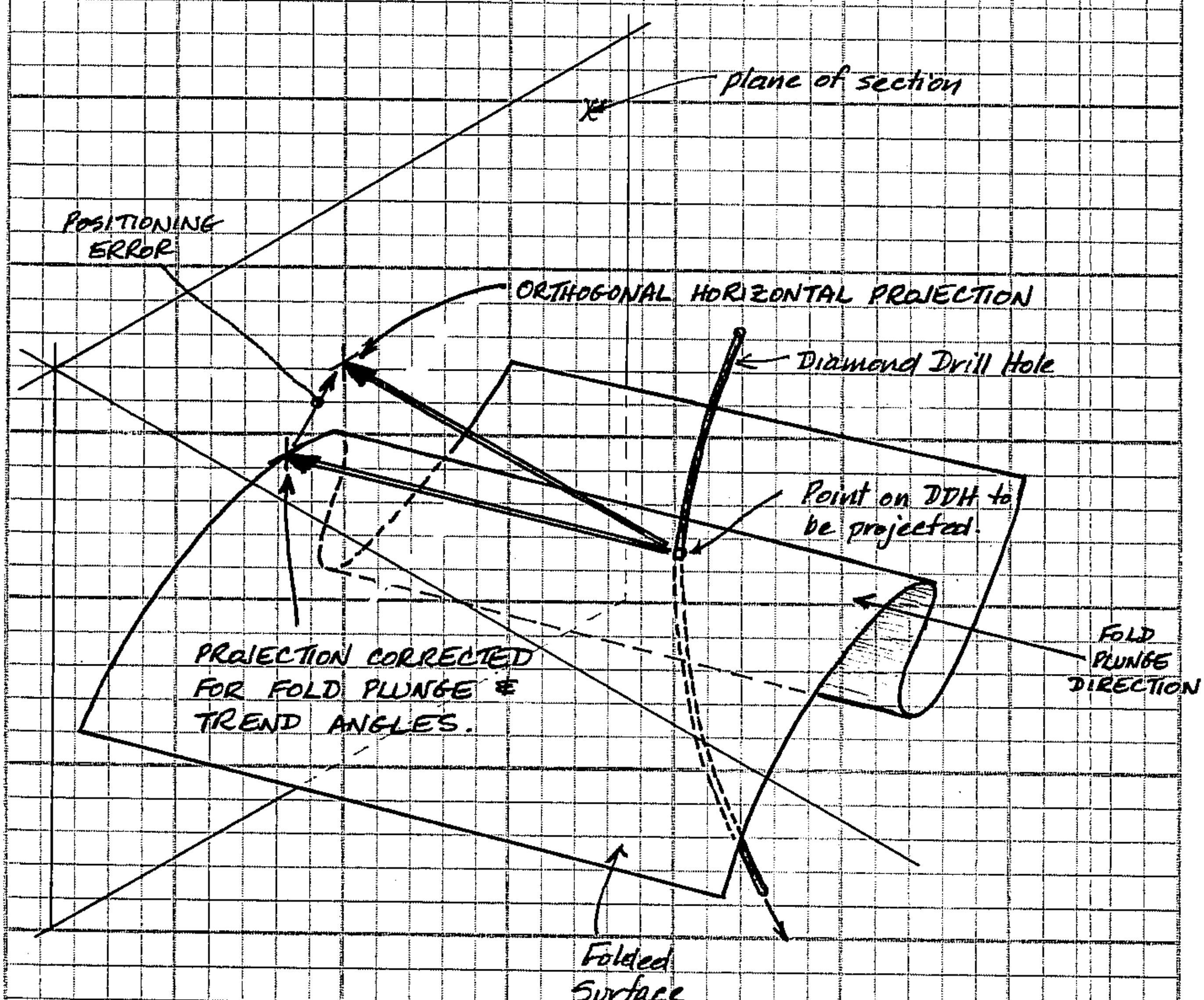
		Routine:	Date:
		By:	Page: 81 of 84

4.6.4 Fold Plunge & Trend Corrections (Continued)



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4.7 Interface with Orebody and Mine Modelling Packages.

After organizing all the DDH data for a property an obvious application is the extraction of assay and survey data from the data base with appropriate reformatting for direct entry into an external orebody and/or mine modelling package.

As the modelling requirements will vary from property to property there will most likely have to be a unique interface program for each property. This has been the experience so far with the Vangorda and Grum properties.

At the current time one such unique interface program exists to transfer DDH survey and assay data from the GRUM DDHDB to the MINTEC MEDSYSTEM (Release 10) on the Computer Sciences Canadas external computer.

4 B Geological Data Analysis. (Not yet designed)

One of the primary capabilities of a geological data base system is that of data analysis. This was not a feature of the Phase 1 development of the Diamond Drill Hole Data Base System but the implications for it were considered and implemented in the DDHDB Data Base Design.

Geological data analysis capabilities would initially comprise simple classical statistics of various assay values. This could easily be extended to statistical studies of assayed metal ratios. The next major development would be for elementary geostatistical analysis - fundamentally variogram calculation of assays and assayed metal ratios.

The development of simple statistical and geostatistical analysis capabilities for the DDHDB system should be relatively straight-forward, now that the basic geological data has been organized.

4.9 Data Base Maintenance

Data Base Maintenance involves three fundamental data processing operations, as follows:

(a) Regular back-up of DDHDB contents to a magnetic tape
(b) Restructuring of an existing DDHDB to allow for
 (i) changed data set (# SCHEMA) definitions
 (ii) increases (decreases) in individual data set sizes.
(c) Unloading and/or Reloading of a DDHDB before and/or after operation (b); or a scheduled unload/reload; or a systems failure.

These operations will normally carried out by Data Processing Personnel or by the Data Base Administrator. Normally, any changed data sets in a DDHDB will be backed up automatically on a daily and then a weekly basis during the scheduled complete system back-up run. (usually conducted during lunch-hour).

Operations (b) and (c) should be carried out at the discretion of the Data Base Administrator.

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THE DIAMOND DRILL HOLE DATA BASE SYSTEM

TECHNICAL APPENDICES

Prepared By

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ICAS Software Services Inc.

for the

CYPRUS ANVIL MINING CORPORATION

March 1983

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THE DIAMOND DRILL HOLE DATA BASE SYSTEM

TECHNICAL APPENDICES

TABLE OF CONTENTS

DOWN-HOLE CO-ORDINATE CALCULATIONS

Diamond-drill-holes are 'surveyed' at selected locations down the hole. These 'surveys' are in fact only rough observations of the zenith and azimuth angles at the selected points. (By rough - this means that although the precision of the angles may be 0.1 degree the accuracy of the instruments is probably at least an order of magnitude greater).

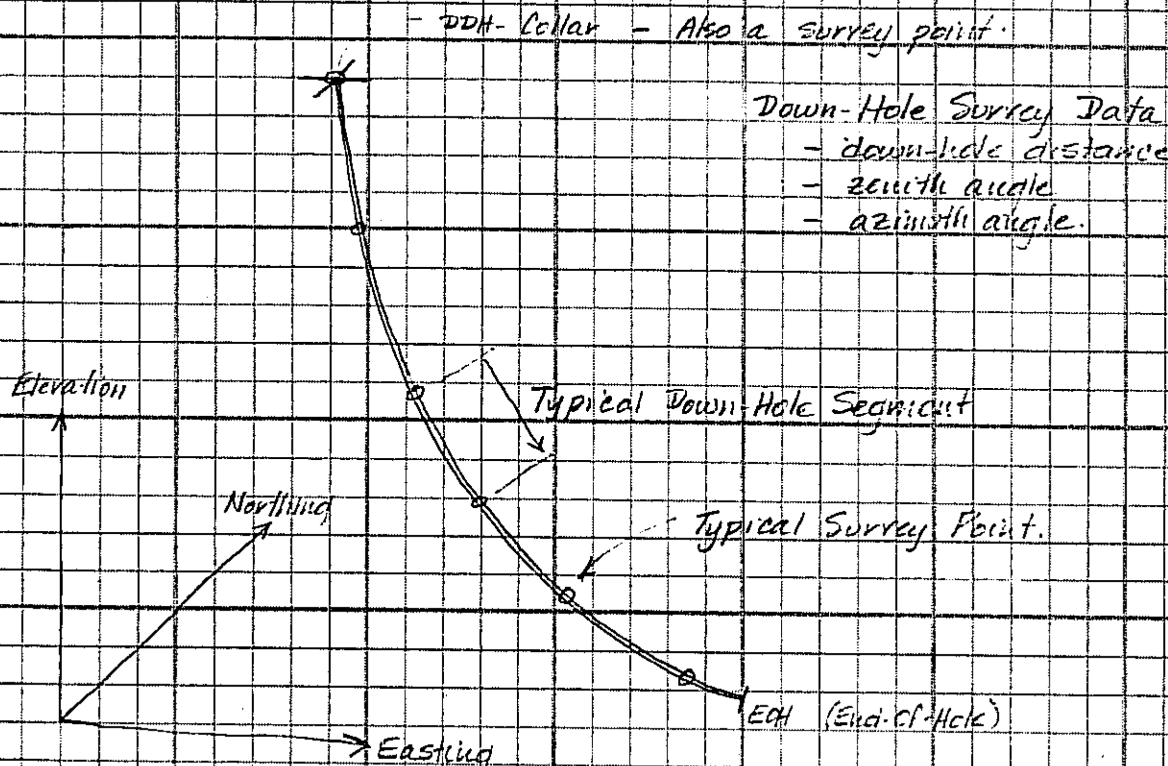
These down-hole surveys are used to orient the Diamond Drill Hole in space. Over the past years a number of analytical methods have been derived to provide geologists and mining engineers with a means to locate (i.e. co-ordinate) any down-hole position on a DDH. These methods range from simple straight lines fitted to or through survey points to complex polynomial representations. In general, these coordinate calculation methods suffer from computational inefficiencies caused by various simplifications involved in their derivation and by a plethora of 'special conditions' (which must be detected and handled by the computer programs). The author has analysed most of the published and some unpublished methods and concluded that although they all provided reasonably consistent co-ordinate values, they were simply not good enough or computationally consistent enough to be included in the Diamond Drill Hole Data Base System.

The requirements of a consistent down-hole coordinate calculation method are :

- special cases (conditions) must be minimal
- down-hole depth must be maintained as an arc-distance rather than a chord-distance
- the formulation (equations) used must be
  - differentiable
  - satisfy the coordinate slopes measured at the survey points
  - should have linearly varying curvature between survey points.
  - be amenable to coordinate system transformation
  - computationally efficient
  - single-valued throughout (i.e. 'indeterminate' and 'multiple' solution conditions are to be avoided.

The author independently derived a new down-hole co-ordinate calculation method which satisfies the above conditions. It is described in detail in this Technical Appendix.

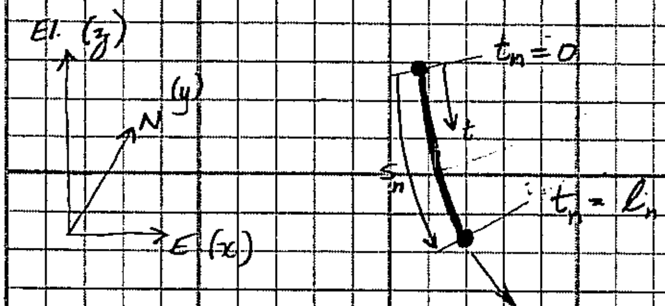
DOWN-HOLE CO-ORDINATE CALCULATIONS (Continued)



The new method for Down-Hole Co-ordinate Calculations involves the determination of 'Parametric Quadratic Splines' (equations) for each 'Down-Hole Segment' of the Drill Hole. The derivation continues on the following pages.

DOWN-HOLE CO-ORDINATE CALCULATIONS (Continued)

Parametric Quadratic Spline Formulation.



DDH-segment-n

(arc length of segment-n)

General Formulation

$$x_n = A_n + B_n \cdot t_n + C_n \cdot t_n^2$$

$$y_n = E_n + F_n \cdot t_n + G_n \cdot t_n^2$$

$$z_n = P_n + Q_n \cdot t_n + R_n \cdot t_n^2$$

where $0 \leq t_n \leq l_n$

We have 3 equations with 9 unknowns for each DDH-segment.

- We will know (after processing the previous DDH-segment) the values for A_n, E_n & P_n

as

$$x_n|_{t_n=0} = A_n + B_n \cdot (0) + C_n \cdot (0)^2 = A_n = y_{n-1}|_{t_{n-1}}$$

$$y_n|_{t_n=0} = E_n + F_n \cdot (0) + G_n \cdot (0)^2 = E_n = x_{n-1}|_{t_{n-1}}$$

$$z_n|_{t_n=0} = P_n + Q_n \cdot (0) + R_n \cdot (0)^2 = P_n = z_{n-1}|_{t_{n-1}}$$

In the case of the first DDH-segment $(n=1)$ then A_1, E_1, P_1 are the (UTM-)coordinates of the collar-position, i.e.

A_1 = Easting_{collar}

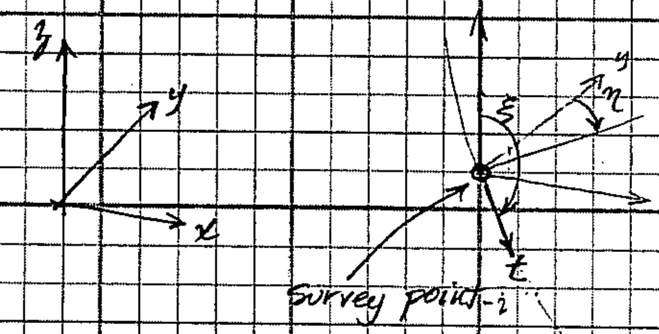
E_1 = Northing_{collar}

P_1 = $\text{Elevation}_{collar}$

DOWN-HOLE CO-ORDINATE CALCULATIONS (Continued)

- We have now reduced the splines to 3 equations with 6-unknowns.

From surveying the DDH at various points and, in particular, the current DDH-segment end-points (by definition), we know the zenith angle and the azimuth angle of the end-points. These angles can be converted into co-ordinate slope components as follows.



ξ_i = zenith angle

η_i = azimuth angle

ξ_i, η_i are surveyed DDH-angles at survey-point-i

The co-ordinate slope components are defined thus

$$\frac{dz}{dt} \approx \frac{\Delta z}{\Delta t} = \cos \xi_i = N_i$$

$$\frac{dx}{dt} \approx \frac{\Delta x}{\Delta t} = -\sin \xi_i \cdot \sin \eta_i = L_i$$

$$\frac{dy}{dt} \approx \frac{\Delta y}{\Delta t} = -\sin \xi_i \cdot \cos \eta_i = M_i$$

The approximations indicated above are exact when used for the individual DDH-segments.

By differentiating the quadratic spline equations we get (in general)

$$\frac{dx_n}{dt_n} = B_n + 2\, C_n \cdot t_n$$

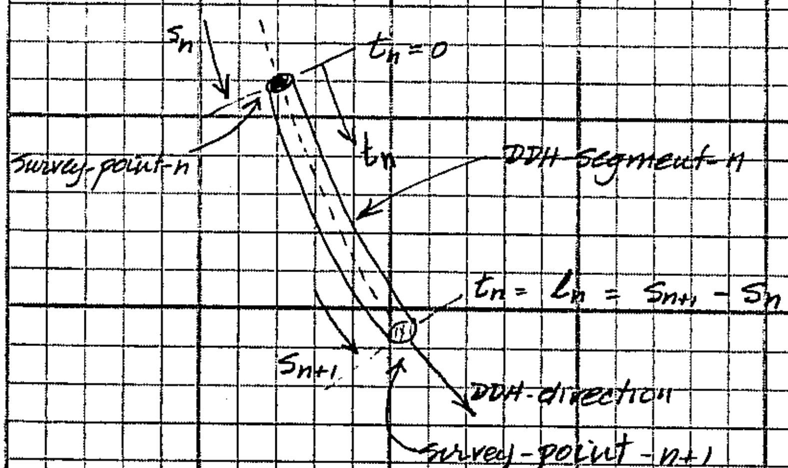
$$\frac{dy_n}{dt_n} = F_n + 2\, G_n \cdot t_n \qquad 0 \leq t_n \leq S_n$$

$$\frac{dz_n}{dt_n} = Q_n + 2\, R_n \cdot t_n$$

DOWN-HOLE CO-ORDINATE CALCULATIONS (Continued)

Using the two-end points of each DDH-segment gives 6 equations in 6 unknowns which is directly solvable.

For segment-n the two survey points are $i = n$ and $i = n+1$



Thus the 6 equations for DDH-segment can be expressed in matrix formation as:

$$\begin{bmatrix} 1 & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & 1 & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & 1 & \cdot \\ 1 & 2 \cdot l_n & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & 1 & 2 \cdot l_n & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & 1 & 2 \cdot l_n \end{bmatrix} \begin{Bmatrix} B_n \\ C_n \\ F_n \\ G_n \\ Q_n \\ R_n \end{Bmatrix} = \begin{Bmatrix} L_n \\ M_n \\ N_n \\ L_{n+1} \\ M_{n+1} \\ N_{n+1} \end{Bmatrix}$$

or in matrix-notation as

$$[\bar{A}] \cdot \{\bar{B}\} = \{\bar{C}\}$$

(Note that vector $\{\bar{B}\}$ is the only set of unknown values)

The above matrix is generally invertible (i.e when $l_n > 0$) and thus

$$\{\bar{B}\} = [A]^{-1} \{\bar{C}\}$$

The indicated inversion can be carried out numerically, but a more computationally acceptable procedure is to carry out the inversion analytically. This analytical inversion is straight forward when the above matrix equations are re-organized and partitioned.

DOWN-HOLE CO-ORDINATE CALCULATIONS (continued)

The analytical inversion process gives:

$$\begin{Bmatrix} B_n \\ C_n \\ F_n \\ G_n \\ Q_n \\ R_n \end{Bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 1/2\,l_n & 0 & 0 & -1/2\,l_n & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1/2\,l_n & 0 & 0 & -1/2\,l_n & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1/2\,l_n & 0 & 0 & -1/2\,l_n \end{bmatrix} \begin{Bmatrix} L_n \\ M_n \\ N_n \\ L_{n+1} \\ M_{n+1} \\ N_{n+1} \end{Bmatrix}$$

One special case exists for this formulation - where only one survey point is available for the DDH-segment. This can occur only when

(a) there is only one survey (at the collar), or

(b) at the end of the DDH where the last survey was taken somewhere before the EOH (End-Of-Hole).

In this case:

$$B_n = L_n$$
$$C_n = 0.0$$
$$F_n = M_n$$
$$G_n = 0.0$$
$$Q_n = N_n$$
$$R_n = 0.0$$

Note that the quadratic-spline formulation is parametric and is independent of special conditions on down-hole survey angles. It is differentiable, as shown above, with a linearly varying curvature in 3-space. There is an exact fit of calculated slopes with observed slopes at the survey points.

Once the parametric quadratic spline coefficients have been determined for each segment of the Diamond Drill Hole, the co-ordinate offsets (and slopes) for any point along the DDH can be calculated directly using the above-noted equations.

DOWN-HOLE CO-ORDINATE CALCULATIONS (Continued)

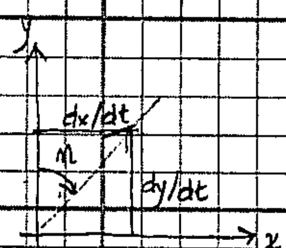
Calculation of Zenith and Azimuth from Parametric Quadratic Splines.

Zenith Angle $\cos \xi = \frac{dz}{dt} = Q_n + 2R_n \cdot t_n \qquad 0 \le t_n \le l_n$

$$\therefore \quad \boxed{\xi = \cos^{-1}(Q_n + 2R_n \cdot t_n)}$$

Azimuth Angle $-\sin \xi \cdot \sin \eta_i = \frac{dx}{dt} = B_n + 2C_n \cdot t_n$

$-\sin \xi \cdot \cos \eta_i = \frac{dy}{dt} = F_n + 2G_n \cdot t_n$



$$\tan \eta = \frac{dx/dt}{dy/dt}$$

$$\therefore \quad \boxed{\eta = \tan^{-1}\left(\frac{B_n + 2C_n \cdot t_n}{F_n + 2G_n \cdot t_n}\right)}$$

STRUCTURAL SOLUTIONS

The Cyprus Anvil method of Structural Synthesis involves the solution of possible directions (dips and dip-directions) for a number of fabric elements. The means by which structural observations on DDH-core are fully explained in the Field Logging Manual. This Technical Note contains the mathematical basis for possible solutions to the fabric directions.

First, the data generally available (as observations) for fabric element directions are:-

(a) the depth (along the DDH) to the structural observations.
- from this depth and the various borehole surveys the local (tangential) direction (i.e. zenith angle and azimuth angle) of the DDH can be calculated.

(b) the definition of a reference fabric element general direction
- obtained from various surface and other observations.

(c) the observation of a reference fabric element on the DDH-core
- comprising a core-axis angle and
- a presumed fabric element dip-direction (optional) (usually the same as item (b) above)

(d) the observation of other fabric element(s) on the DDH-core
- comprising a core-axis angle and a core-rotation angle.

Refer to the Field Logging Manual for the measurement of the above data items.

In general, the above data is notated as follows:

Az = DDH azimuth angle } local to structural observation.
Z = DDH zenith angle }

α = core-axis angle to reference fabric element (RFE)

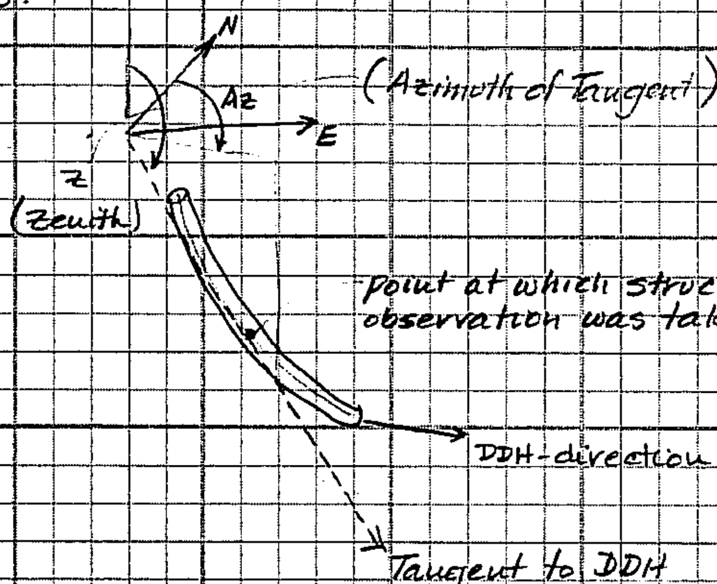
θ = reference fabric element dip-direction (azimuth)

β = core-axis angle to other fabric element
ξ = rotation angle (about core-axis from RFE to other fabric element).

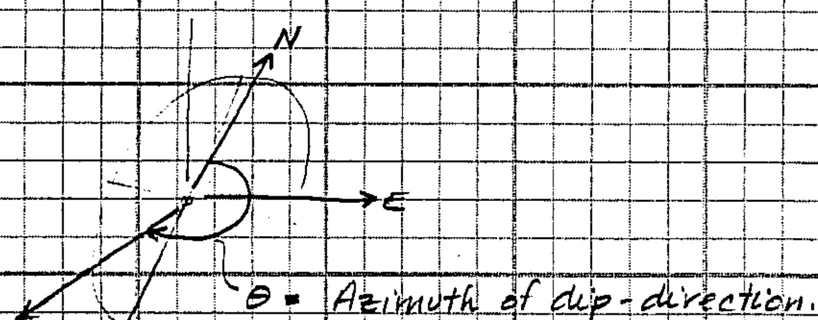
STRUCTURAL SOLUTIONS (Continued)

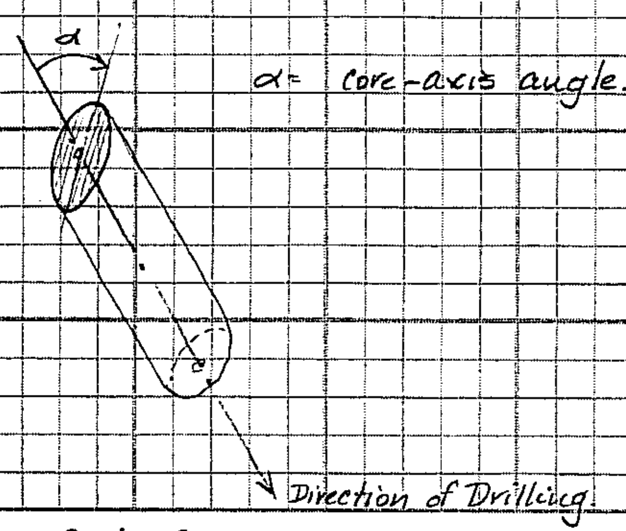
The following sketches indicate the physical significance of the above observations.

DDH



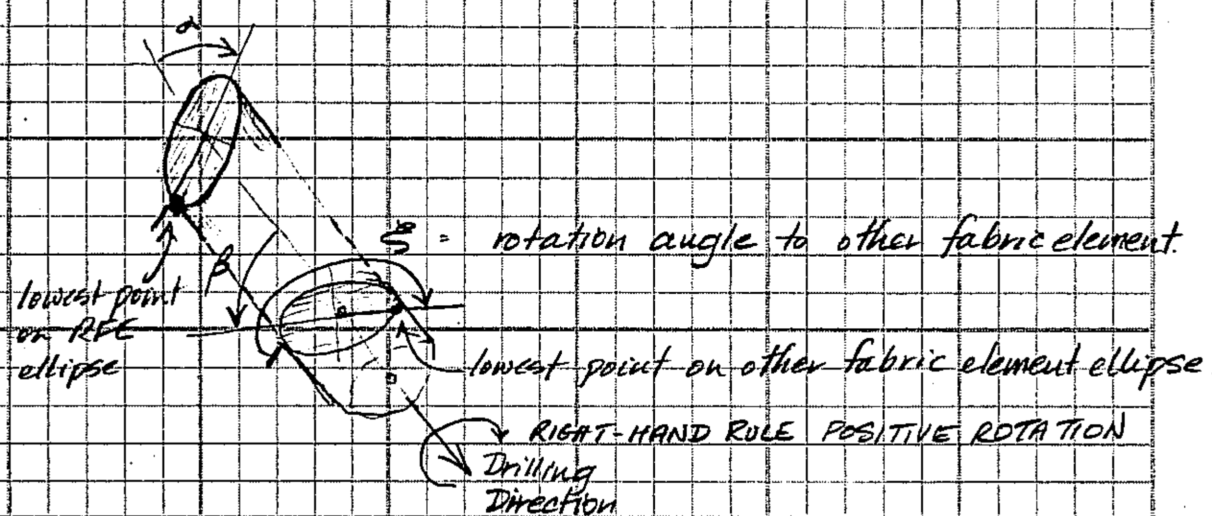
Reference Fabric Element





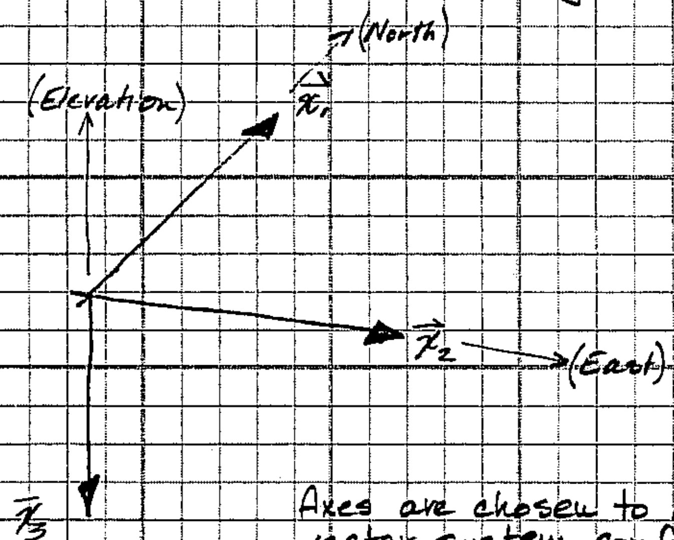
STRUCTURAL SOLUTIONS (Continued)

Referenced Fabric Element



β = other fabric element core-axis angle.

General Structure Solution Co-ordinate System



Axes are chosen to give a right hand vector system conformable to a lower hemispheric projection system.

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STRUCTURAL SOLUTIONS (Continued)

The methodology used in the DDHB Structural Solution Process is that of (Right-Handed System) Vector Algebra using the reference axis system shown in the previous sketch.

We know or must solve for the following vectors

(1) The vector equation of the DDH-direction at the observation point.

$$\vec{A} = a_1 \vec{x_1} + a_2 \cdot \vec{x_2} + a_3 \vec{x_3}$$

(2) The vector equation(s) of the Reference Fabric Element.

$$\vec{B_i} = b_{1i} \cdot \vec{x_1} + b_{2i} \cdot \vec{x_2} + b_{3i} \cdot \vec{x_3} \qquad i = 1 \text{ or } 2$$

(3) The vector equation(s) of the other Fabric Element

$$\vec{C_{ij}} = c_{1ij} \cdot \vec{x_1} + c_{2ij} \cdot \vec{x_2} + c_{3ij} \cdot \vec{x_3} \qquad i = 1 \text{ or } 2, \; j = 1 \text{ or } 2$$

The order of solution is that shown above.

(1) $\vec{A}$ can be directly calculated

(2) $\vec{B_i}$ is calculated from the solution of a quadratic equation

each B_i has to be checked for (a) reality and (b) correctness.

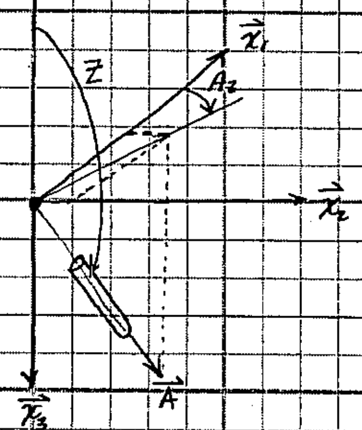
(3) $\vec{C_{ij}}$ is calculated from the available real, correct solutions for B_i

each $\vec{C_{ij}}$ has to be checked for (a) reality and (b) correctness

There are a number of special cases involved in the solution process and they will be indicated appropriately in the following notes.

STRUCTURAL SOLUTIONS (Continued)

Equation for DDH-direction – known zenith angle (Z) and azimuth angle (A_z) at observation point.

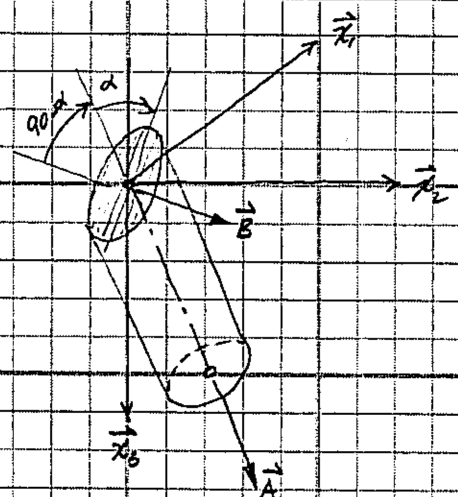


$$\vec{A} = a_1\vec{x}_1 + a_2\vec{x}_2 + a_3\vec{x}_3$$

$$a_1 = \cos(A_z)\cdot\sin(Z)$$
$$a_2 = \sin(A_z)\cdot\sin(Z)$$
$$a_3 = -\cos(Z)$$

a_1, a_2 & a_3 are thus known.

Equation for the Reference Fabric Element – known direction (θ) – unknown dip (ψ)



$$\vec{B} = b_1\vec{x}_1 + b_2\vec{x}_2 + b_3\vec{x}_3$$

$$b_1 = -\cos\theta\cdot\sin\psi$$
$$b_2 = -\sin\theta\cdot\sin\psi$$
$$b_3 = \cos\psi$$

b_1, b_2 & b_3 are thus unknown.

Core angle condition $\quad \vec{A}\cdot\vec{B} = \cos(90-\alpha)$

or

$$a_1b_1 + a_2b_2 + a_3b_3 = \cos(90-\alpha) \qquad (1)$$

Unit vector condition $\quad (b_1)^2 + (b_2)^2 + (b_3)^2 = 1.0 \qquad (2)$

$$(a_1)^2 + (a_2)^2 + (a_3)^2 = 1.0$$

STRUCTURAL SOLUTIONS (Continued)

Equation ① can now be rewritten as:

$$\cos(90-\alpha) = -a_1 \cdot \cos\theta \cdot \sin\psi - a_2 \cdot \sin\theta \cdot \sin\psi + a_3 \cdot \cos\psi$$

re-organizing gives:

$$(a_1 \cos\theta + a_2 \sin\theta) \cdot \sin\psi - a_3 \cdot \cos\psi + \sin\alpha = 0$$

then $(a_1 \cos\theta + a_2 \sin\theta) \cdot \sin\psi + \sin\alpha = a_3 \cdot \cos\psi$

simplifying with $a_4 = a_1 \cos\theta + a_2 \sin\theta$

$$a_4 \cdot \sin\psi + \sin\alpha = a_3 \cdot \cos\psi$$

then squaring both sides, gives

$$a_4^2 \cdot \sin^2\psi + 2a_4 \cdot \sin\psi \cdot \sin\alpha + \sin^2\alpha = a_3^2 \cdot \cos^2\psi$$

$$= a_3^2 \, (1 - \sin^2\psi)$$

and re-arranging

$$(a_3^2 + a_4^2) \cdot \sin^2\psi + 2a_4 \cdot \sin\psi \cdot \sin\alpha - a_3^2 + \sin^2\alpha = 0$$

which is the form of the general quadratic equation

$$ax^2 + bx + c = 0$$

with up to two solutions $x_1 = \dfrac{-b \pm \sqrt{b^2 - 4 \cdot a \cdot c}}{2a}$

thus substituting we get

$$\sin\psi = \frac{-2a_4 \cdot \sin\alpha \pm \sqrt{4a_4^2 \cdot \sin^2\alpha - 4(a_3^2 + a_4^2)(-a_3^2 + \sin^2\alpha)}}{2(a_3^2 + a_4^2)} \qquad ③$$

There may be 0, 1 or 2 possible (i.e. REAL) solutions.

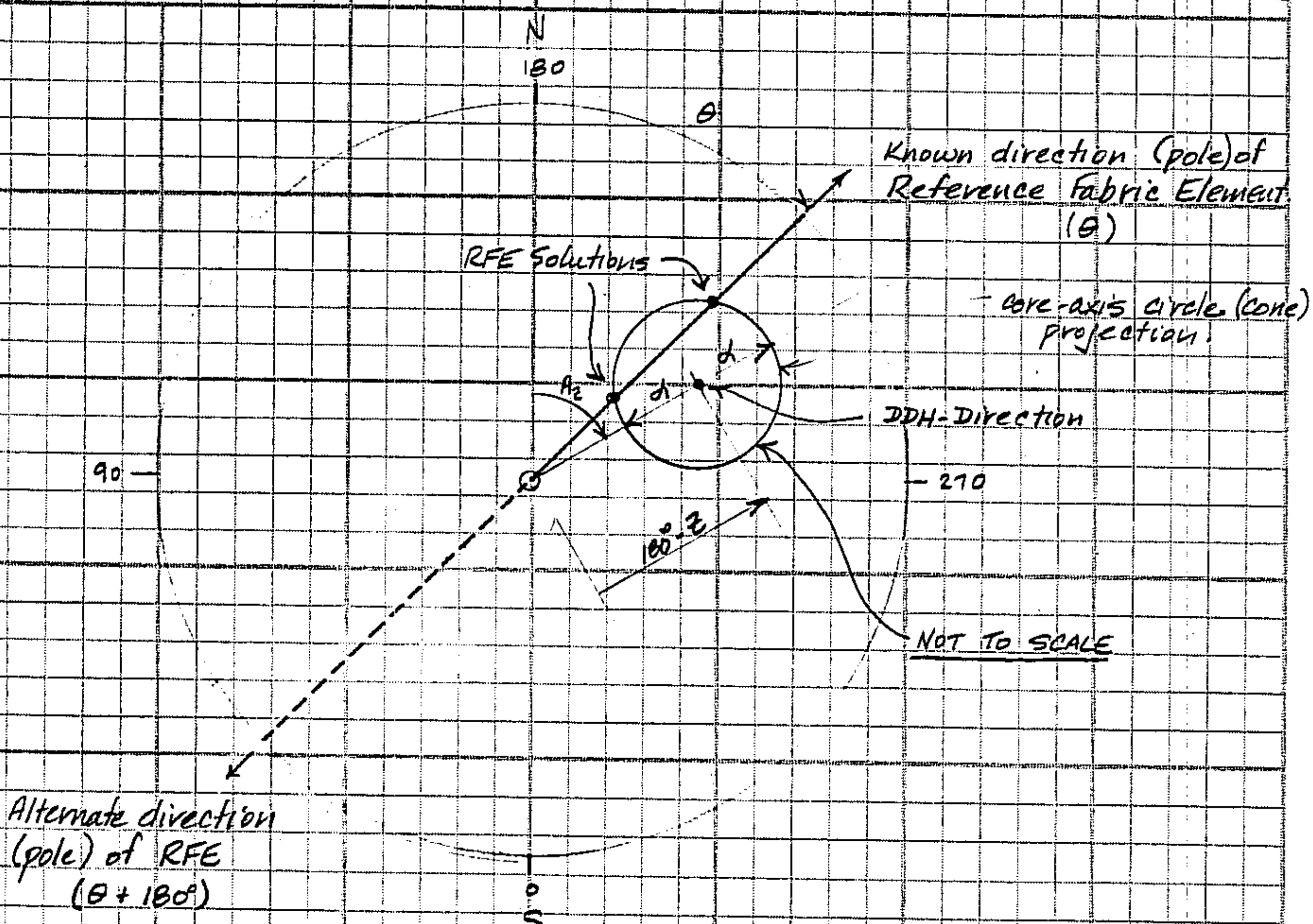
If there are less than 2 possible solutions, then the complement ($\theta + 180°$) of the RFE-direction should be taken and used in place of θ in equation ①.

STRUCTURAL SOLUTIONS (Continued)

The individual structural solutions calculated for the RFE dip angle via equation ③ must be checked to ensure that the proper rotation sense for the core-dip angle 'α' is maintained. This is due to the fact that the term '$\sin^2\alpha$' in the equation loses its 'sign'.

This is easily checked by calculating the components of the $\vec{B}$ vector (b_{i1}, b_{i2}, b_{i3}) and re-substituting them into equation ①. If both sides of the equation are unequal then the calculated solution for '$\sin\phi$' is invalid and must be rejected.

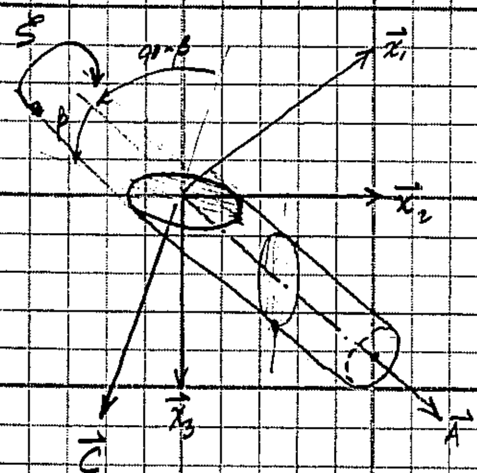
The equivalent operation on a Stereo Net would appear as (approximately):



Poles of Structural Planes (Lower Hemispheric Projection)

STRUCTURAL SOLUTIONS (Continued)

Equation for the Referenced Fabric Element – unknown directions

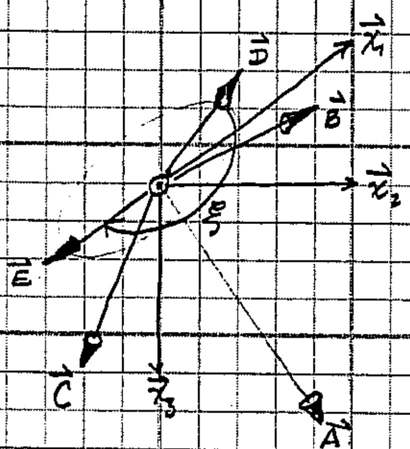


$$\vec{C} = c_1\vec{x}_1 + c_2\vec{x}_2 + c_3\vec{x}_3$$

Unit vector condition

$$(c_1)^2 + (c_2)^2 + (c_3)^2 = 1.0$$

To solve this condition we need to derive 2 new vectors $\vec{D}$ and $\vec{E}$ which are directional vectors in the plane normal to the axis of the DDH.



$$\vec{D} = \vec{A}\wedge\vec{B} = d_1\vec{x}_1 + d_2\vec{x}_2 + d_3\vec{x}_3 \qquad (4)$$

$$\vec{E} = \vec{A}\wedge\vec{C} = e_1\vec{x}_1 + e_2\vec{x}_2 + e_3\vec{x}_3 \qquad (5)$$

(the symbol $\wedge$ denotes a vector cross-product)

From this construction it can also be seen that

$$\vec{D}\cdot\vec{E} = \cos\xi \qquad (6)$$

or

$$d_1e_1 + d_2e_2 + d_3e_3 = \cos\xi$$

By definition $\vec{D}$ and $\vec{E}$ lie in the plane normal to the DDH-axis $\vec{A}$ and

$\vec{D}$ is the 'vector cross-product' of the DDH-axis vector $\vec{A}$ and the RFE-direction vector $\vec{B}$

$\vec{E}$ is the 'vector cross-product' of the DDH-axis vector $\vec{A}$ and the other fabric element direction vector $\vec{C}$

STRUCTURAL SOLUTIONS (Continued)

$\vec{D} = d_1\vec{x}_1 + d_2\vec{x}_2 + d_3\vec{x}_3$

$= (a_1\vec{x}_1 + a_2\vec{x}_2 + a_3\vec{x}_3) \wedge (b_1\vec{x}_1 + b_2\vec{x}_2 + b_3\vec{x}_3)$

all terms $a_1, a_2, a_3;\ b_1, b_2, b_3$ are now known.

then
$d_1 = (a_2 b_3 - a_3 b_2) / \sin(90-\alpha)$
$d_2 = (a_3 b_1 - a_1 b_3) / \sin(90-\alpha)$
$d_3 = (a_1 b_2 - a_2 b_1) / \sin(90-\alpha)$

are also now known so that $\vec{D}$ is completely defined.

$\vec{E} = e_1\vec{x}_1 + e_2\vec{x}_2 + e_3\cdot\vec{x}_3$

$= (a_1\vec{x}_1 + a_2\vec{x}_2 + a_3\vec{x}_3) \wedge (c_1\vec{x}_1 + c_2\vec{x}_2 + c_3\vec{x}_3)$

terms a_1, a_2, a_3 are known while c_1, c_2, c_3 are <u>not</u> known.

then
$e_1 = (a_2 c_3 - a_3 c_2) / \sin(90-\beta)$
$e_2 = (a_3 c_1 - a_1 c_3) / \sin(90-\beta)$
$e_3 = (a_1 c_2 - a_2 c_1) / \sin(90-\beta)$

are also <u>not</u> known

Now ξ is known and

$$\vec{D}\cdot\vec{E} = \cos\xi$$

$$(d_1\vec{x}_1 + d_2\vec{x}_2 + d_3\vec{x}_3)\cdot(e_1\vec{x}_1 + e_2\vec{x}_2 + e_3\cdot\vec{x}_3) = \cos\xi$$

$$\therefore \quad d_1 e_1 + d_2 e_2 + d_3 e_3 = \cos\xi \qquad (7)$$

This turns out to be one equation with 3 unknowns.

We also know that the unit vector condition gives.

$$(c_1)^2 + (c_2)^2 + (c_3)^2 = 1.0 \qquad (8)$$

Furthermore, we also know that

$$\vec{A}\cdot\vec{C} = \cos(90-\beta) \qquad (9)$$

where β is the core-axis angle to the other (referenced) fabric element.

STRUCTURAL SOLUTIONS (Continued)

Equations ⑦, ⑧ and ⑨ are thus three linear equations with three unknowns. (c_1, c_2, c_3)

Expanding equation ⑦ gives

$$d_1(a_2c_3 - a_3c_2) + d_2(a_3c_1 - a_1c_3) + d_3(a_1c_2 - a_2c_1) = \cos\xi \cdot \cos\beta$$

and re-arranging

$$c_1(a_3d_2 - a_2d_3) + c_2(a_1d_3 - a_3d_1) + c_3(a_2d_1 - a_1d_2) = \cos\xi \cdot \cos\beta$$

Expanding equation ⑨ gives

$$a_1 \cdot c_1 + a_2 \cdot c_2 + a_3 \cdot c_3 = \sin\beta$$

and re-arranging

$$c_1 = \frac{\sin\beta - a_2 \cdot c_2 - a_3 \cdot c_3}{a_1} \qquad (a)$$

Inserting (a) into the re-arranged ① gives

$$\frac{\sin\beta - a_2 \cdot c_2 - a_3 \cdot c_3}{a_1}(a_3d_2 - a_2d_3) + c_2(a_1d_3 - a_3d_1) + c_3(a_2d_1 - a_1d_2) = \cos\xi \cdot \cos\beta$$

Further expanding

$$c_2(a_1d_3 - a_3d_1) - \frac{c_2 \cdot a_2}{a_1}(a_3d_2 - a_2d_3) = \cos\xi \cdot \cos\beta - \frac{\sin\beta}{a_1}(a_3d_2 - a_2d_3) - c_3(a_2d_1 - a_1d_2) + \frac{a_3 \cdot c_3}{a_1}(a_3d_2 - a_2d_3)$$

Gives

$$c_2 = \frac{\cos\xi \cos\beta - \frac{\sin\beta}{a_1}(a_3d_2 - a_2d_3) - c_3\left(a_2d_1 - a_1d_2 - \frac{a_3}{a_1}(a_3d_2 - a_2d_3)\right)}{a_1d_3 - a_3d_1 - \frac{a_2}{a_1}(a_3d_2 - a_2d_3)}$$

or $c_2 = m_1 + m_2 \cdot c_3$ (b)

where $m_1 = \left(\cos\xi \cdot \cos\beta - \frac{\sin\beta}{a_1}(a_3d_2 - a_2d_3)\right)/m_3$

$m_2 = -\left(a_2d_1 - a_1d_2 - \frac{a_3}{a_1}(a_3d_2 - a_2d_3)\right)/m_3$

and $m_3 = a_1d_3 - a_3d_1 - \frac{a_2}{a_1}(a_3d_2 - a_2d_3)$

STRUCTURAL SOLUTIONS (Continued)

Inserting (b) into (a) gives

$$c_1 = \frac{\sin\beta}{a_1} - \frac{a_2}{a_1}(m_1 + m_2 \cdot c_3) - \frac{a_3}{a_1} \cdot c_3$$

$$= \frac{\sin\beta - a_2 \cdot m_1}{a_1} - \left(\frac{a_2 \cdot m_2 + a_3}{a_1}\right) c_3$$

or $c_1 = m_4 + m_5 \cdot c_3$ (c)

where $m_4 = \dfrac{\sin\beta - a_2 \cdot m_1}{a_1}$

and $m_5 = -\left(\dfrac{a_2 \cdot m_2 + a_3}{a_1}\right)$

Now from equation (8)

$$(c_1)^2 + (c_2)^2 + (c_3)^2 = 1.0$$

and substituting (b) and (c) we get

$$(m_4 + m_5 \cdot c_3)^2 + (m_1 + m_2 \cdot c_3)^2 + (c_3)^2 = 1.0$$

$$m_4^2 + 2m_4 \cdot m_5 \cdot c_3 + m_5^2 \cdot c_3^2 + m_1^2 + 2m_1 m_2 \cdot c_3 + m_2^2 \cdot c_3^2 + c_3^2 = 1.0$$

Re-organizing

$$(1 + m_2^2 + m_5^2)\, c_3^2 + (2m_1 m_2 + 2m_4 m_5) \cdot c_3 + (m_1^2 + m_4^2 - 1) = 0$$

which gives us the familiar quadratic of the form

$$ax^2 + bx + c = 0$$

with solutions $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Thus

$$c_{ij3} = \frac{-(2m_1 m_2 + 2m_4 m_5) \pm \sqrt{(2m_1 m_2 + 2m_4 m_5)^2 - 4(1 + m_2^2 + m_5^2)(m_1^2 + m_4^2 - 1)}}{2(1 + m_2^2 + m_5^2)}$$

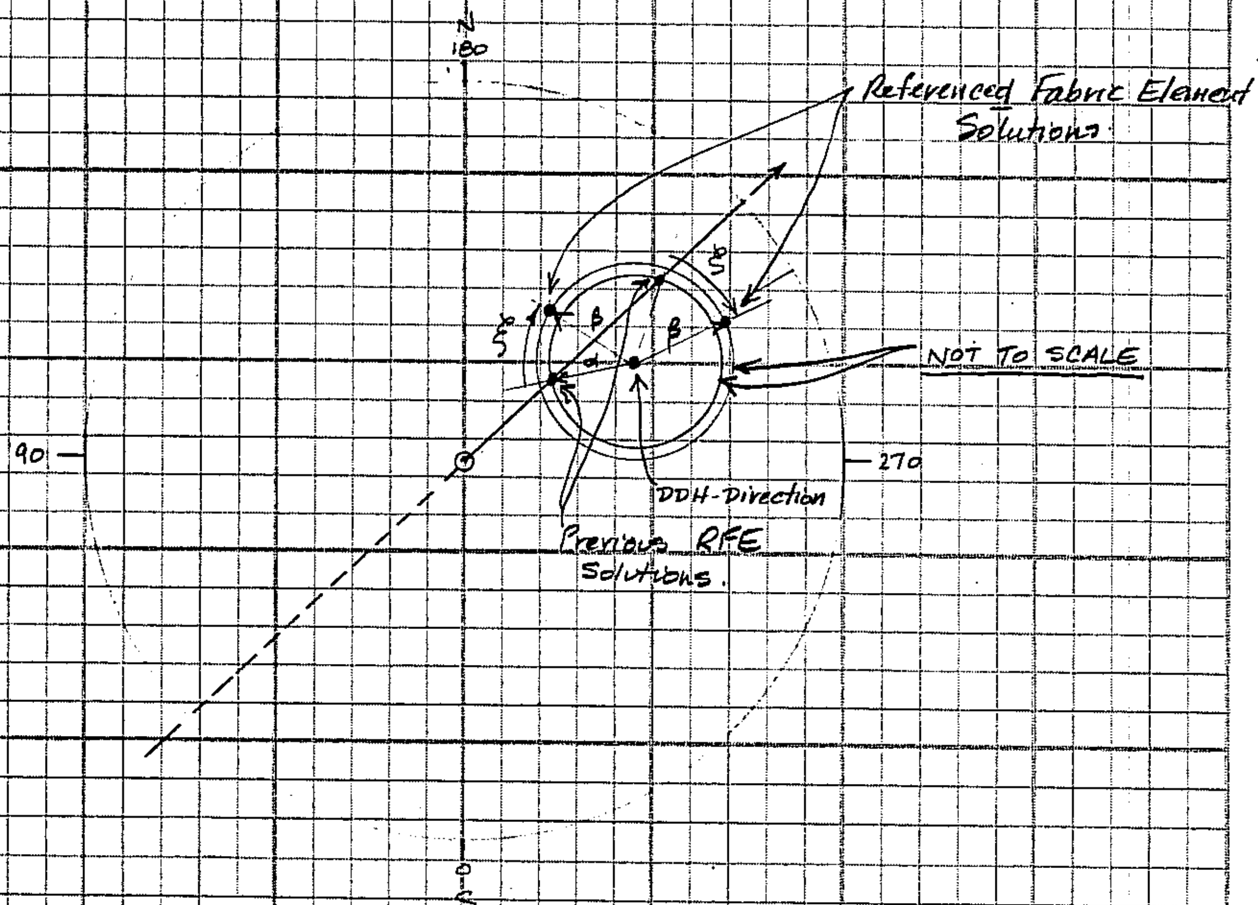
Solutions for c_{ij1} and c_{ij2} are then calculated by back substitution of the solutions into equations (c) and (b) respectively.

STRUCTURAL SOLUTIONS (Continued)

The individual solutions calculated for the referenced fabric element via equations ⓓ, ⓒ and ⓑ must be checked to ensure that the proper rotation senses for the core-dip angle 'β' and the core-rotation angle 'ξ' are maintained. This is due to the fact that the terms 'sin β' and 'cos ξ' become squared in the derivation and thus the 'signs' are lost.

This is easily checked by calculating the components of the $\vec{C}$ vector and re-substituting them into equations ⑦ and ⑨ successively. Solutions which do not satisfy equality are to be rejected.

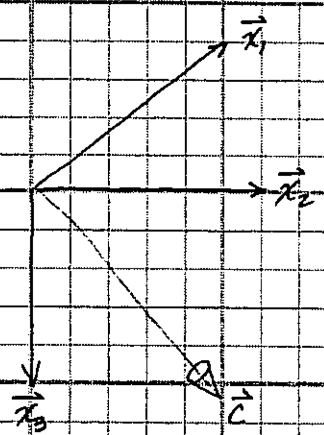
The equivalent operation on the Stereo Net would appear approximately as:



Poles of Structural Planes.
(Lower Hemispheric Projection)

STRUCTURAL SOLUTIONS (Continued)

Calculation of Dip and Dip-Direction of the Referenced Plane



In general

Vector equation of a plane defined by a dip γ and a dip-direction θ is given by

$$\vec{P} = p_1\vec{x}_1 + p_2\vec{x}_2 + p_3\vec{x}_3$$

$$p_1 = -\cos\theta \cdot \sin\gamma$$
$$p_2 = -\sin\theta \cdot \sin\gamma$$
$$p_3 = \cos\gamma$$

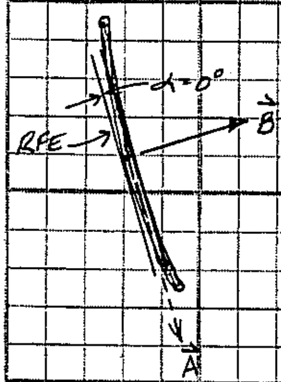
therefore $\gamma = \cos^{-1}(p_3)$

$$\theta = \frac{-p_2}{\sin\gamma}$$

STRUCTURAL SOLUTIONS (Continued)

The formulation of the solutions for the other fabric element directions as presented so-far is a general solution. This formulation fails in a number of aspects - all specific instances when coefficients on the denominator of various equations is zero. These special cases are described as follows:

'RFE' is coincident (i.e. parallel) with DDH-axis



$\cos(90-\alpha) = a_1 b_1 + a_2 \cdot b_2 + a_3 \cdot b_3$

as $\alpha = 0$ then $\cos(90-\alpha) = 0$

$\therefore \quad a_1 b_1 + a_2 b_2 + a_3 b_3 = 0$

we know b_1, b_2 and b_3 and that

$b_1 = -\cos\theta \cdot \sin\phi$
$b_2 = -\sin\theta \cdot \sin\phi$
$b_3 = \cos\phi$

} unknown is ϕ

$$-a_1 \cdot \cos\theta \cdot \sin\phi - a_2 \cdot \sin\theta \cdot \sin\phi + a_3 \cdot \cos\phi = 0$$

$$-(a_1 \cos\theta + a_2 \cdot \sin\theta) \cdot \sin\phi + a_3 \cdot \cos\phi = 0$$

$$\frac{\sin\phi}{\cos\phi} = \frac{-a_3}{-(a_1 \cos\theta + a_2 \sin\theta)}$$

or $$\phi = \tan^{-1}\left(\frac{a_3}{a_1 \cos\theta + a_2 \sin\theta}\right)$$

'RFE' is normal (i.e. perpendicular) to DDH-axis.

$\alpha = 90°$ $\quad \cos(90-\alpha) = 1.0 \quad \cos(90-\alpha) = a_1 b_1 + a_2 b_2 + a_3 b_3$

$1 = a_1 b_1 + a_2 b_2 + a_3 b_3$

$$\therefore \quad 1 = -a_1 \cos\theta \cdot \sin\phi - a_2 \cdot \sin\theta \cdot \sin\phi + a_3 \cdot \cos\phi$$

Still fundamentally the same form as equation ① so it can be solved by the same quadratic equation technique.

STRUCTURAL SOLUTIONS (Continued)

Special Case #1 - DDH is not vertical but lies in East-West plane

DDH equation becomes $\vec{A} = a_2 \cdot \vec{x}_2 + a_3 \cdot \vec{x}_3$ $(a_1 = 0.0)$

This has no effect on the solution for the RFE directions.

However, equations ⑦, ⑧ and ⑨ are affected -

$\vec{A} \cdot \vec{C} = \cos(90 - \beta)$

becomes $a_2 \cdot c_2 + a_3 \cdot c_3 = \sin\beta$ thus $c_3 = \dfrac{\sin\beta - a_2 \cdot c_2}{a_3}$ ⓐ*

$\vec{D} \cdot \vec{E} = \cos\xi$

$d_1 \cdot e_1 + d_2 \cdot e_2 + d_3 \cdot e_3 = \cos\xi$

Expanding gives

$d_1 \cdot (a_2 \cdot c_3 - a_3 \cdot c_2)/\cos\beta + d_2 \cdot (a_3 c_1)/\cos\beta + d_3 (-a_2 c_1)/\cos\beta = \cos\xi$

or

$d_1 (a_2 \cdot c_3 - a_3 c_2) + d_2 (a_3 c_1) + d_3 (-a_2 c_1) = \cos\xi \cdot \cos\beta$

gives

$c_1 (d_2 \cdot a_3 - d_3 a_2) + c_2 (-d_1 a_3) + c_3 (d_1 a_2) = \cos\xi \cdot \cos\beta$ ⓑ*

Substituting ⓐ* into ⓑ* gives.

$c_1 (d_2 a_3 - d_3 a_2) + c_2 (-d_1 a_3) + \left(\dfrac{\sin\beta - a_2 \cdot c_2}{a_3} \right) \cdot d_1 a_2 = \cos\xi \cos\beta$

then

$c_1 (d_2 a_3 - d_3 a_2) + c_2 \left(-d_1 a_3 - \dfrac{d_1 a_2^2}{a_3}\right) = \cos\xi \cdot \cos\beta - \dfrac{\sin\beta}{a_3} (d_1 \cdot a_2)$

thus

$c_1 = \dfrac{\cos\xi \cdot \cos\beta - \frac{\sin\beta}{a_3}(d_1 a_2) + c_2 \left(d_1 a_3 + \frac{d_1 a_2^2}{a_3}\right)}{d_2 a_3 - d_3 a_2}$

which can be re-written as

$c_1 = m_6 + m_7 \cdot c_2$ where $m_6 = \left(\cos\xi \cdot \cos\beta - \dfrac{\sin\beta}{a_3}(d_1 a_2)\right) / m_8$ ⓒ*

$m_7 = \left(d_1 a_3 + \dfrac{d_1 a_2^2}{a_3}\right) / m_8$

and $m_8 = d_2 a_3 - d_3 a_2$

STRUCTURAL SOLUTIONS (Continued)

then from $(c_1)^2 + (c_2)^2 + (c_3)^2 = 1$

$$\left(m_6 + m_7 c_2\right)^2 + (c_2)^2 + \left(\frac{\sin\beta - a_2 c_2}{a_3}\right)^2 = 1$$

$$m_6^2 + 2 m_6 m_7 c_2 + c_2^2 + c_2^2 + \frac{\sin^2\beta}{a_3^2} - \frac{2\sin\beta\, a_2 c_2}{a_3^2} + \frac{a_2^2 c_2^2}{a_3^2} = 1$$

which when re-organized becomes

$$\left(1 + m_7^2 + \frac{a_2^2}{a_3^2}\right) c_2^2 + \left(2 m_6 m_7 - \frac{2\sin\beta \cdot a_2}{a_3^2}\right) \cdot c_2 + \left(m_6 + \frac{\sin^2\beta}{a_3^2} - 1\right) = 0$$

This is again the familiar quadratic equation and can thus be solved for possible (REAL) values of c_2.

Values for c_1 and c_3 are then calculated by back-substituting the real c_2 values into equations ⓑ* and ⓒ* respectively.

Again all solution sets for the $\vec{c}$ vector must be checked for validity.

STRUCTURAL SOLUTIONS (Continued)

Special Case #2 - DDH is horizontal in East-West Direction

DDH equation becomes $\vec{A} = a_2 \cdot \vec{x}_2$ $\quad (a_1 = a_3 = 0.0)$

$$a_2 = \pm 1.0$$

There is no effect on the solution for the RFE-directions.

$\vec{A} \cdot \vec{C} = \cos(90-\beta)$ becomes $a_2 \cdot c_2 = \cos(90-\beta)$

or $c_2 = \dfrac{\sin\beta}{a_2}$

Then

$\vec{D} \cdot \vec{E} = \cos\xi$

or

$$(-a_2 b_1)(-a_2 \cdot c_1) + (a_2 b_3)(a_2 c_3) = \cos\xi \cdot \cos\alpha \cdot \cos\beta$$

$$a_2^2 \cdot b_1 \, c_1 + a_2^2 \cdot b_3 \, c_3 = \cos\xi \cdot \cos\alpha \cdot \cos\beta$$

however $a_2^2 = 1.0$ thus $c_1 = \dfrac{\cos\xi \cdot \cos\alpha \cdot \cos\beta - b_3 \cdot c_3}{b_1}$

and $(c_1)^2 + (c_2)^2 + (c_3)^2 = 1.0$

thus $\left(\dfrac{\cos\xi \cdot \cos\alpha \cdot \cos\beta - b_3 \cdot c_3}{b_1}\right)^2 + \sin^2\beta + c_3^2 = 1.0$

eventually yields.

$$\left(1 + \frac{b_3^2}{b_1^2}\right) \cdot c_3^2 + \left(\frac{-2\cos\xi \cdot \cos\alpha \cdot \cos\beta \cdot b_3}{b_1^2}\right) \cdot c_3 + \left(\sin^2\beta + \frac{\cos^2\xi \cdot \cos^2\alpha \cdot \cos^2\beta}{b_1} - 1\right) = 0.0$$

which is the familiar quadratic equation form again.

A sub-set occurs when $b_1 = 0$ (i.e. RFE points in the East-West Direction)

Then $a_2^2 \cdot b_3 \cdot c_3 = \cos\xi \cdot \cos\alpha \cdot \cos\beta$ or $c_3 = \dfrac{\cos\xi \cdot \cos\alpha \cdot \cos\beta}{b_1}$

and $c_1^2 = 1 - \sin^2\beta - \dfrac{\cos^2\xi \cdot \cos^2\alpha \cdot \cos^2\beta}{b_3^2}$

STRUCTURAL SOLUTIONS (Continued)

Special Case #3 - Vertical Borehole

DDH - Equation $a_1 = a_2 = 0$ $a_3 = \pm 1.0$

$$d_1 = -a_3 b_2 / \sin(90-\alpha)$$
$$d_2 = a_3 b_1 / \sin(90-\alpha)$$
$$d_3 = 0.0$$

$$e_1 = -a_3 c_2 / \sin(90-\beta)$$
$$e_2 = a_3 c_1 / \sin(90-\beta)$$
$$e_3 = 0.0$$

$$\vec{A} \cdot \vec{C} = \cos(90-\beta)$$

$$a_1 \cdot c_1 + a_2 c_2 + a_3 \cdot c_3 = \cos(90-\beta)$$

$$a_3 \cdot c_3 = \cos(90-\beta) \qquad \therefore \quad c_3 = \frac{\sin\beta}{a_3}$$

$$\vec{D} \cdot \vec{E} = \cos\xi$$

$$\frac{1}{\sin(90-\alpha)} \cdot \frac{1}{\sin(90-\beta)} \left(-a_3 \cdot b_2 (-a_3 \cdot c_2) + a_3 b_1 (a_3 c_1)\right) = \cos\xi$$

$$a_3^2 \cdot b_2 \cdot c_2 + a_3^2 \cdot b_1 \cdot c_1 = \cos\xi \cdot \cos\alpha \cdot \cos\beta$$

(remember $a_3^2 = 1$) $\quad \therefore \quad c_1 = \dfrac{\cos\xi \cdot \cos\alpha \cdot \cos\beta - b_2 c_2}{b_1}$

Now $(c_1)^2 + (c_2)^2 + (c_3)^2 = 1$

$$\left(\frac{\cos\xi \cdot \cos\alpha \cdot \cos\beta - b_2 c_2}{c_1}\right)^2 + (c_2)^2 + \left(\frac{\sin\beta}{a_3}\right)^2 = 1$$

$$\frac{\cos^2\xi \cdot \cos^2\alpha \cdot \cos^2\beta}{b_1^2} - \frac{2 b_2 c_2 \cdot \cos\xi \cdot \cos\alpha \cdot \cos\beta}{b_1^2} + \frac{b_2^2 c_2^2}{b_1^2} + c_2^2 + \sin^2\beta = 1$$

Re-organizing

$$\left(1.0 + \frac{b_2^2}{b_1^2}\right) \cdot c_2^2 + \left(\frac{-2 b_2 \cdot \cos\xi \cdot \cos\alpha \cdot \cos\beta}{b_1^2}\right) \cdot c_2 + \left(\sin^2\beta + \frac{\cos^2\xi \cdot \cos^2\alpha \cdot \cos^2\beta}{b_1^2} - 1.0\right) = 0.0$$

STRUCTURAL SOLUTIONS (Continued)

The above equation is again in the familiar quadratic form.

There is one subset of this Special Case – when the RFE direction dips due East or due West.

In this case $d_1 = -a_3 b_2 / \sin(90-\alpha)$
$d_2 = 0.0$
$d_3 = 0.0$

and

$e_1 = -a_3 c_2 / \sin(90-\beta)$

From $\vec{A} \cdot \vec{C} = \cos(90-\beta)$ we get $\boxed{c_3 = \dfrac{\sin\beta}{a_3}}$

From $\vec{D} \cdot \vec{E} = \cos\xi$

$$\frac{1}{\sin(90-\alpha)} \cdot \frac{1}{\sin(90-\beta)} (-a_3 b_2)(-a_3 c_2) = \cos\xi$$

or $\boxed{c_2 = \dfrac{\cos\xi \cdot \cos\alpha \cdot \cos\beta}{b_2}}$

then from $(c_1)^2 + (c_2)^2 + (c_3)^2 = 1$

$$c_1^2 + \frac{\cos^2\xi \cdot \cos^2\alpha \cos^2\beta}{b_2^2} + \frac{\sin^2\beta}{a_3^2} = 1$$

remember that $a_3^2 = 1$, then

$$c_1^2 = 1 - \frac{\cos^2\xi \cdot \cos^2\alpha \cdot \cos^2\beta}{b_2^2} - \sin^2\beta$$

$$\boxed{c_1 = \pm \left(1 - \frac{\cos^2\xi \cdot \cos^2\alpha \cdot \cos^2\beta}{b_2^2} - \sin^2\beta\right)^{1/2}}$$

CO-ORDINATE SYSTEMS

All properties will use the UTM co-ordinate system as the primary definition for the location of major geological, mining, engineering and surveying features and/or facilities.

Location data entered into the Diamond Drill Hole Data Base for a property will consist of the full UTM co-ordinates calculated from high-order observations. Currently, only DDH-COLLAR co-ordinates fit into this category of data, and calculation of UTM-coordinates for DDH-COLLARS is standard CAMC practice at all its properties.

Three secondary co-ordinate systems may be used for various purposes. These secondary co-ordinate systems are local planar grids of limited extent (to minimize distortion from the UTM-curvilinear surface) which are fitted to (or usually above) the UTM-surface to provide convenient location references for geological, mine modelling and mine operations purposes. The three secondary co-ordinate systems are -

(1) The Geological Co-ordinate System. - a local planar grid usually defined by Exploration Geologists to fit perceived strike and dip directions of the orebody being explored. Usually cross- and long-sections will be constructed parallel to the axes of this co-ordinate system.

(2) The Mine Modelling Co-ordinate System - another local planar grid set up for definition of the mine model. This system is required as the MINTEC MEDSYSTEM block model developed for the orebody must have its rows and columns oriented parallel to the principal axes of this co-ordinate system.

(3) The Mine Surveying and Operations Co-ordinate System - the planar grid set up for co-ordination of all mining operations. Ideally, this should be a local direct abstraction of the UTM grid. The Mine North Direction should coincide with UTM-North for a number of reasons, some of which are

- mine operations people understand 'True North' and conciously orient themselves to this direction regardless of various presumed 'Grid-North' definitions presented to them. Serious confusion has and does exist at mines where the mining-North direction is significantly skewed from 'True North'
- dropping of the millions and hundred thousand values from the UTM co-ordinates often presents a very usable scale for mine operations. Standard government maps can often be used

CO-ORDINATE SYSTEMS (Continued)

directly as underlays or overlays of topographical and geographical information.

The above secondary coordinate systems are linearized from the UTM primary co-ordinate systems. Transformations between these systems will be a feature of the DDHDB system.

The above co-ordinate systems are illustrated in the sketch on the following page.

Data Required for Definition of Coordinate Systems (within DDHDB)

1. Primary Co-ordinates - UTM
   - UTM zone (8 for Anvil District)
   - offset angle (UTM-North from True-North for property) (used for correcting down-hole survey azimuths.)

2. Secondary Coordinate Systems.
   - origin of secondary grid in UTM-Co-ordinates
   - horizontal scale-factor
   - vertical scale-factor
   - vertical offset
   - inclination (offset angle) (Grid-North from UTM-North)

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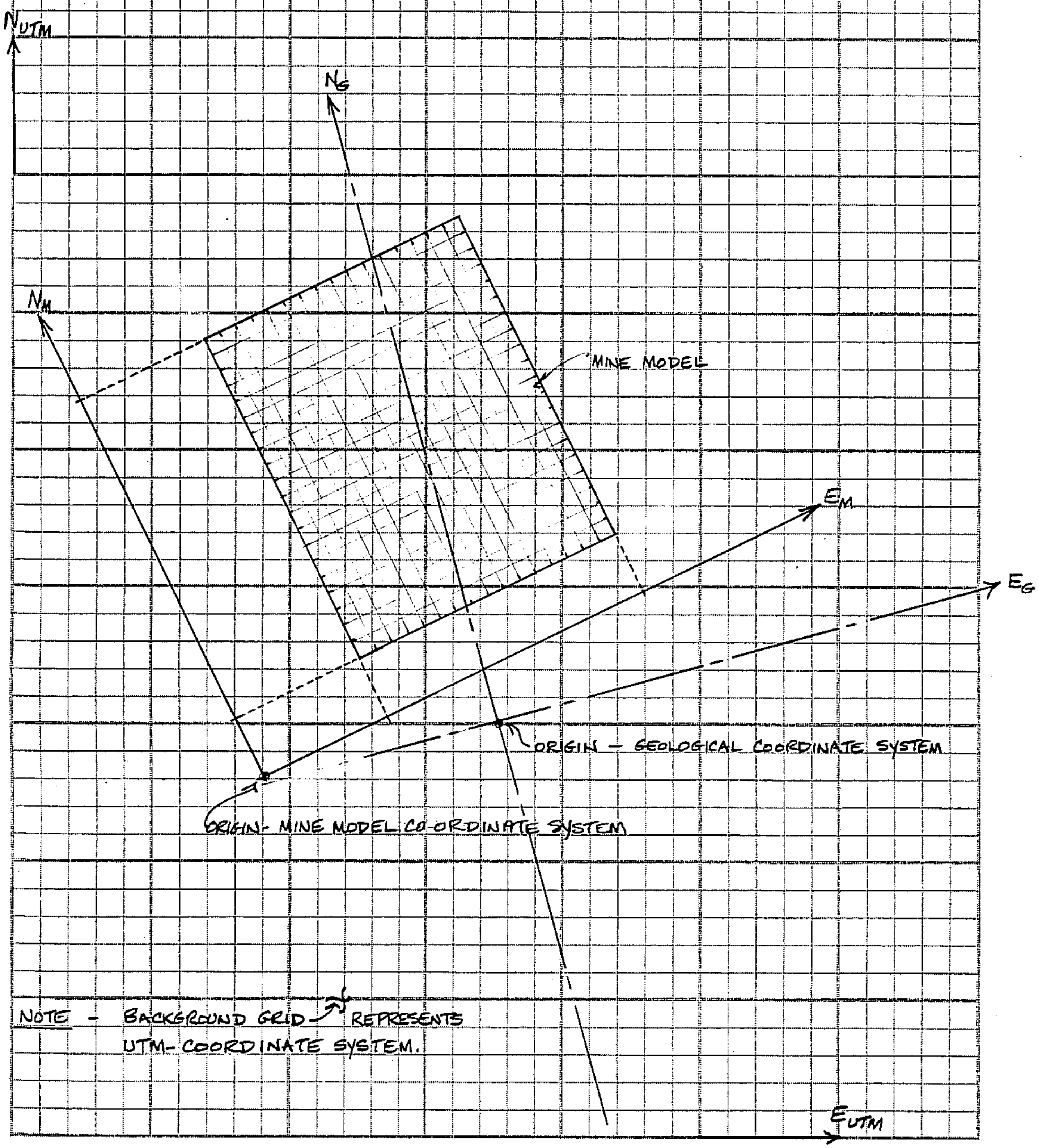
CO-ORDINATE SYSTEMS (Continued)



NOTE – BACKGROUND GRID REPRESENTS UTM-COORDINATE SYSTEM.

CO-ORDINATE SYSTEMS (Continued)

Equations for Transformation of Co-ordinates.

1. UTM → Secondary Grid.

$$N_S = ((N_{UTM} - N_0) \cdot \cos\alpha - (E_{UTM} - E_0) \cdot \sin\alpha) / S_H$$

$$E_S = ((N_{UTM} - N_0) \cdot \sin\alpha + (E_{UTM} - E_0) \cdot \cos\alpha) / S_H$$

$$Z_S = (Z_{UTM} - Z_0) / S_V$$

2. Secondary Grid → UTM

$$N_{UTM} = N_0 + S_H \cdot (N_S \cos\alpha + E_S \cdot \sin\alpha)$$

$$E_{UTM} = E_0 + S_H \cdot (-N_S \cdot \sin\alpha + E_S \cdot \cos\alpha)$$

$$Z_{UTM} = Z_0 + S_V \cdot Z_S$$

where $N_{UTM}, E_{UTM}, Z_{UTM}$ are UTM Northing, Easting and Elevation

N_0, E_0, Z_0 are (UTM-coordinates) of Secondary Grid Origin

N_S, E_S, Z_S are Secondary Grid Coordinates

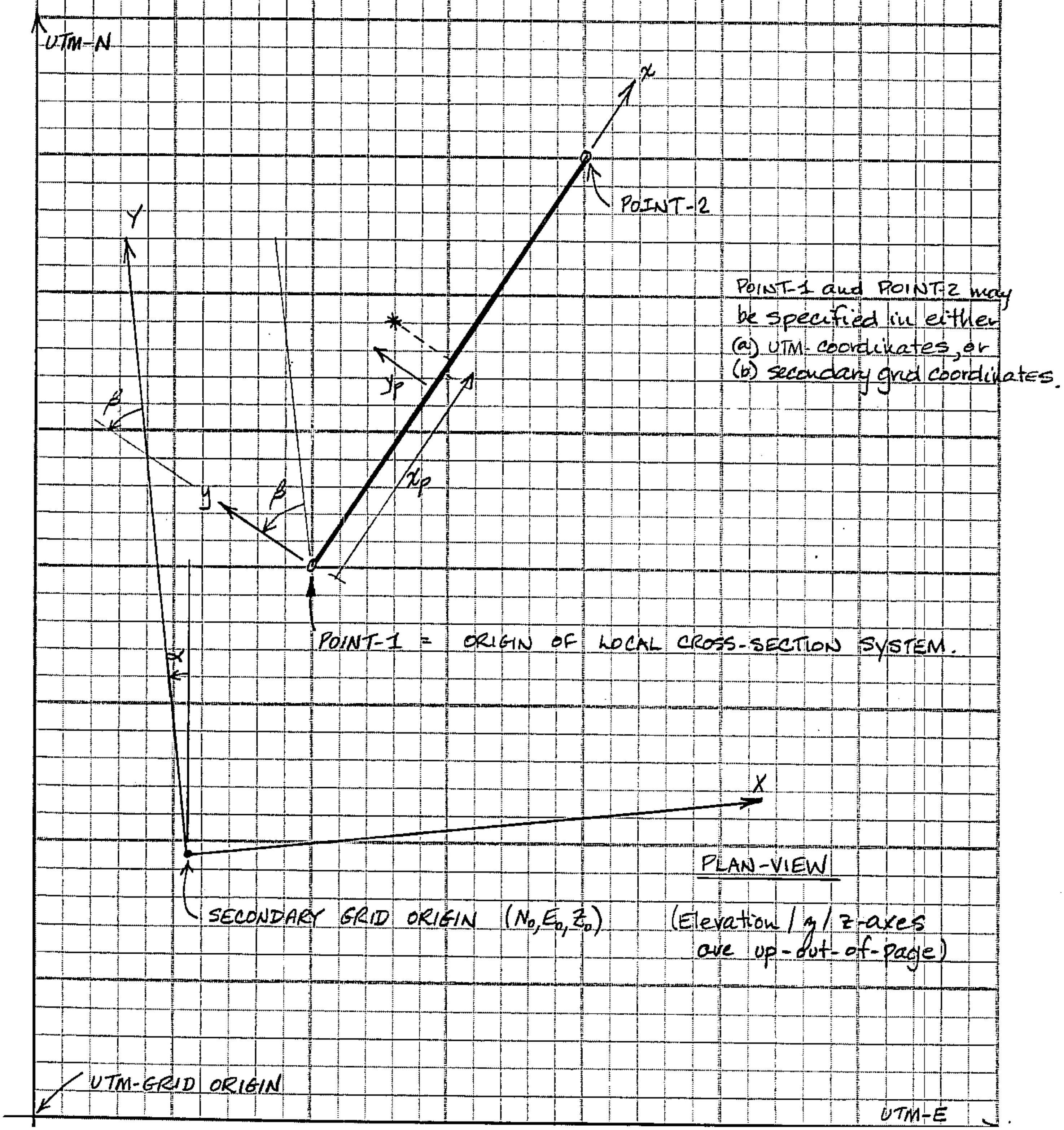
α = clockwise offset angle (secondary grid North to UTM-North)

S_H = horizontal scale factor
UTM-distance = S_H · grid-distance

S_V = vertical scale factor.

↑ Stored in GRGEOL/GRMODL/GRSURV (1) = N_0
" " " (2) = E_0
" " " (3) = Z_0
" " " (4) = α (degrees)
" " " (5) = S_H
" " " (6) = S_V

TRANSFORMATION FROM UTM TO CROSS-SECTION CO-ORDINATES VIA SECONDARY GRID SYSTEM



(1) TRANSFORM UTM. TO SECONDARY GRID SYSTEM

$$\begin{Bmatrix} X \\ Y \\ Z \\ 1 \end{Bmatrix} = \begin{bmatrix} A_{11} & A_{12} & A_{13} & A_{14} \\ A_{21} & A_{22} & A_{23} & A_{24} \\ A_{31} & A_{32} & A_{33} & A_{34} \\ A_{41} & A_{42} & A_{43} & A_{44} \end{bmatrix} \begin{Bmatrix} U_E \\ U_N \\ U_Z \\ 1 \end{Bmatrix}$$

U_E, U_N, U_Z – UTM-coordinates of point

X, Y, Z – secondary-grid coordinates of point.

Equations

$$X = E_S = ((U_N - N_0) * \sin\alpha + (U_E - E_0) * \cos\alpha) / S_H$$

$$Y = N_S = ((U_N - N_0) * \cos\alpha - (U_E - E_0) * \sin\alpha) / S_H$$

$$X = U_N \cdot \sin\alpha / S_H + U_E \cdot \cos\alpha / S_H + (-N_0 \cdot \sin\alpha - E_0 \cdot \cos\alpha) / S_H$$

$$Y = U_N \cdot \cos\alpha / S_H - U_E \cdot \sin\alpha / S_H + (-N_0 \cdot \cos\alpha + E_0 \cdot \sin\alpha) / S_H$$

$$Z = (U_Z - Z_0) / S_H = U_Z / S_H - Z_0 / S_H$$

N_0, E_0, Z_0 – origin of secondary grid in UTM-coordinates.

S_H, S_V – horizontal and vertical scale factors

α – counter-clockwise angle from UTM-N axis to secondary-N axis.

$$\begin{Bmatrix} X \\ Y \\ Z \\ 1 \end{Bmatrix} = \begin{bmatrix} \frac{\cos\alpha}{S_H} & \frac{\sin\alpha}{S_H} & \cdot & \frac{-N_0 \cdot \sin\alpha - E_0 \cdot \cos\alpha}{S_H} \\ \frac{-\sin\alpha}{S_H} & \frac{\cos\alpha}{S_H} & \cdot & \frac{-N_0 \cdot \cos\alpha + E_0 \cdot \sin\alpha}{S_H} \\ \cdot & \cdot & \frac{1}{S_V} & -\frac{Z_0}{S_V} \\ \cdot & \cdot & \cdot & 1 \end{bmatrix} \begin{Bmatrix} U_E \\ U_N \\ U_Z \\ 1 \end{Bmatrix}$$

$$\{\bar{X}\} = [A] \{\bar{U}\}$$

② TRANSLATE SECONDARY GRID TO POINT-1

$X_s = X - X_1$
$Y_s = Y - Y_1$
$Z_s = Z - Z_L$

$$\begin{Bmatrix} X_s \\ Y_s \\ Z_s \\ 1 \end{Bmatrix} = \begin{bmatrix} 1 & \cdot & \cdot & -X_1 \\ \cdot & 1 & \cdot & -Y_1 \\ \cdot & \cdot & 1 & -Z_L \\ \cdot & \cdot & \cdot & 1 \end{bmatrix} \begin{Bmatrix} X \\ Y \\ Z \\ 1 \end{Bmatrix}$$

$$\{\bar{X}_s\} = [B]\{\bar{X}\} = [B]\cdot[A]\cdot\{\bar{U}\}$$

③ ROTATE ABOUT Z-AXIS.

$$\begin{Bmatrix} x \\ y \\ z \\ 1 \end{Bmatrix} = \begin{bmatrix} \cos\beta & \sin\beta & \cdot & \cdot \\ -\sin\beta & \cos\beta & \cdot & \cdot \\ \cdot & \cdot & 1 & \cdot \\ \cdot & \cdot & \cdot & 1 \end{bmatrix} \cdot \begin{Bmatrix} X_s \\ Y_s \\ Z_s \\ 1 \end{Bmatrix}$$

$$\{\bar{x}\} = [C]\{\bar{X}_s\} = [C]\cdot[B]\cdot\{\bar{X}\} = [C]\cdot[B]\cdot[A]\{\bar{U}\}$$

$$= [T]\{\bar{U}\}$$

where $[T] = [C]\cdot[B]\cdot[A]$

$$\begin{bmatrix} T_{11} & T_{12} & T_{13} & T_{14} \\ T_{21} & T_{22} & T_{23} & T_{24} \\ T_{31} & T_{32} & T_{33} & T_{34} \\ T_{41} & T_{42} & T_{43} & T_{44} \end{bmatrix} = \begin{bmatrix} C_{11} & C_{12} & \cdot & \cdot \\ -C_{12} & C_{11} & \cdot & \cdot \\ \cdot & \cdot & 1 & \cdot \\ \cdot & \cdot & \cdot & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & \cdot & \cdot & -X_1 \\ \cdot & 1 & \cdot & -Y_1 \\ \cdot & \cdot & 1 & -Z_L \\ \cdot & \cdot & \cdot & 1 \end{bmatrix} \cdot \begin{bmatrix} A_{11} & A_{12} & \cdot & A_{14} \\ -A_{12} & A_{11} & \cdot & A_{24} \\ \cdot & \cdot & A_{33} & A_{34} \\ \cdot & \cdot & \cdot & 1 \end{bmatrix}$$

$$= \begin{bmatrix} C_{11} & C_{12} & \cdot & -C_{11}\cdot X_1 - C_{12}\cdot Y_1 \\ -C_{12} & C_{11} & \cdot & C_{12}\cdot X_1 - C_{11}\cdot Y_1 \\ \cdot & \cdot & 1 & -Z_L \\ \cdot & \cdot & \cdot & 1 \end{bmatrix} \cdot \begin{bmatrix} A_{11} & A_{12} & \cdot & A_{14} \\ -A_{12} & A_{11} & \cdot & A_{24} \\ \cdot & \cdot & A_{33} & A_{34} \\ \cdot & \cdot & \cdot & 1 \end{bmatrix}$$

$$= \begin{bmatrix} C_{11}\cdot A_{11} - C_{12}\cdot A_{12} & C_{11}\cdot A_{12} + C_{12}\cdot A_{11} & \cdot & C_{11}\cdot A_{14} + C_{12}\cdot A_{24} - C_{11}\cdot X_1 - C_{12}\cdot Y_1 \\ -C_{12}\cdot A_{11} - C_{11}\cdot A_{12} & -C_{12}\cdot A_{12} + C_{11}\cdot A_{11} & \cdot & -C_{12}\cdot A_{14} + C_{11}\cdot A_{24} + C_{12}\cdot X_1 - C_{11}\cdot Y_1 \\ \cdot & \cdot & A_{33} & A_{34} - Z_L \\ \cdot & \cdot & \cdot & 1 \end{bmatrix}$$

$$\begin{bmatrix} T_{11} & T_{12} & \cdot & T_{14} \\ -T_{12} & T_{11} & \cdot & T_{24} \\ \cdot & \cdot & T_{33} & T_{34} \\ \cdot & \cdot & \cdot & 1 \end{bmatrix}$$

6 different terms to evaluate.

$$T_{11} = C_{11}\cdot A_{11} - C_{12}\cdot A_{12} = \cos\beta \cdot \cos\alpha / S_H - \sin\beta \cdot \sin\alpha / S_H$$

$$T_{12} = C_{11}\cdot A_{12} + C_{12}\cdot A_{11} = \cos\beta \cdot \sin\alpha / S_H + \sin\beta \cdot \cos\alpha / S_H$$

$$T_{33} = A_{33} = 1/S_V$$

$$T_{14} = C_{11}\cdot A_{14} + C_{12}\cdot A_{24} - C_{11}\cdot X_1 - C_{12}\cdot Y_1 = \cos\beta\cdot((-N_0\cdot\sin\alpha - E_0\cdot\cos\alpha)/S_H - X_1)$$
$$+ \sin\beta\cdot((-N_0\cdot\cos\alpha + E_0\cdot\cos\alpha)/S_H - Y_1)$$

$$T_{24} = -C_{12}\cdot A_{14} + C_{11}\cdot A_{24} + C_{12}\cdot X_1 - C_{11}\cdot Y_1 = -\sin\beta((-N_0\cdot\sin\alpha - E_0\cdot\cos\alpha)/S_H - X_1)$$
$$+ \cos\beta\,((-N_0\cdot\cos\alpha + E_0\cdot\cos\alpha)/S_H - Y_1)$$

$$T_{34} = A_{34} - Z_L = -Z_0/S_V - Z_L$$

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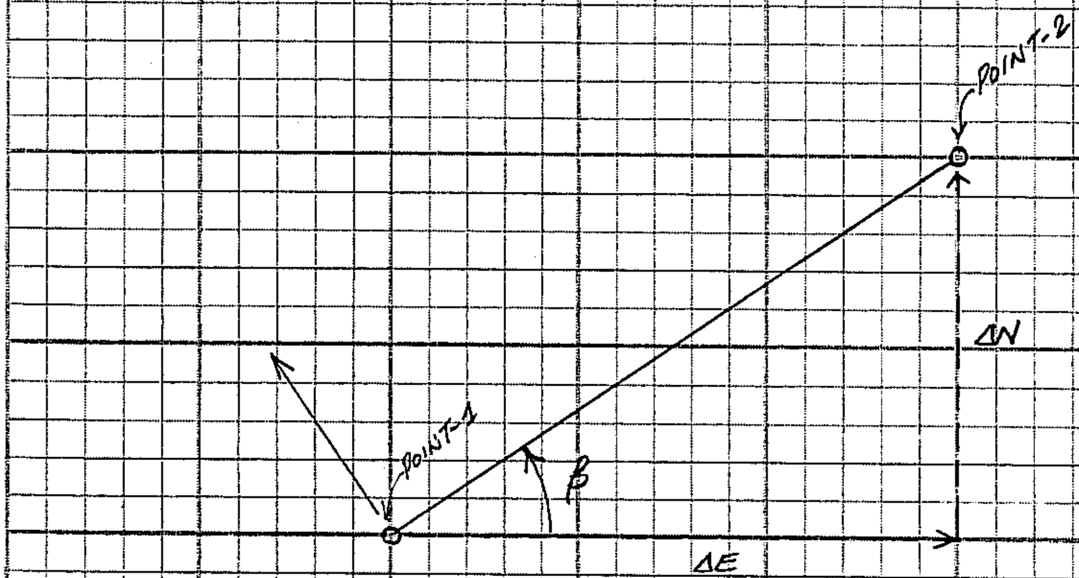
DEFINITION OF CROSS-SECTION ROTATION ANGLE - β



$$\beta^* = \tan^{-1}\left(\frac{|\Delta N|}{|\Delta E|}\right)$$

Decision Table

ΔN	0	0	+ve	-ve	+ve	-ve	-ve	+ve
ΔE	+ve	-ve	0	0	+ve	+ve	-ve	-ve
$\hat{\beta}$	= 0	= π	= $\pi/2$	= $3\pi/2$	= β^*	= $2\pi - \beta$	= $\pi + \beta$	$\pi - \beta$

Note - ΔN, ΔE are distances measured in the SECONDARY grid system.

GRID-N

GRID-E

Special Case

(1.) Cross-Section Passes through DDH-Collar

Set $\{\bar{U}\} = \{\overline{\Delta U}\}$ (i.e. offsets from collar)

then $N_0 = 0$, $E_0 = 0$, $Z_0 = 0$ and $X_1 = 0$, $Y_1 = 0$

also let $S_H = S_V = 1.0$

then

$\bar{\bar{T}}_{11} = \cos\beta \cdot \cos\alpha - \sin\beta \cdot \sin\alpha$

$\bar{\bar{T}}_{12} = \cos\beta \cdot \sin\alpha + \sin\beta \cdot \cos\alpha$

$\bar{\bar{T}}_{33} = 1.$

$\bar{\bar{T}}_{14} = 0.$

$\bar{\bar{T}}_{24} = 0.$

$\bar{\bar{T}}_{34} = -Z_L$

Z_L should be set to lowest elevation of the DDH.

Special Cases (Continued)

② Cross-Section is Specified in UTM-Co-ordinates.

$S_H = 1.0$ $\quad N_0 = E_0 = Z_0 = 0.0$

$S_V = 1.0$ $\quad \alpha + \beta = \gamma$

$T_{11} = \cos\beta \cdot \cos\alpha - \sin\beta \cdot \sin\alpha = \cos(\alpha+\beta) = \cos\gamma$

$T_{12} = \cos\beta \cdot \sin\alpha + \sin\beta \cdot \cos\alpha = \sin(\alpha+\beta) = \sin\gamma$

$T_{33} = 1.0$

$T_{14} = \cos\beta\,(-X_1) + \sin\beta\,(-Y_1) = -\cos\beta \cdot X_1 - \sin\beta \cdot Y_1$

$T_{24} = -\sin\beta\,(-X_1) + \cos\beta\,(-Y_1) = +\sin\beta \cdot X_1 - \cos\beta \cdot Y_1$

$T_{34} = -Z_L$

now $X_1 = \cos\alpha \cdot E_1 + \sin\alpha \cdot N_1$ and $Y_1 = -\sin\alpha \cdot E + \cos\alpha \cdot N$

$T_{14} = \cos\beta\,(-\cos\alpha \cdot E_1 - \sin\alpha \cdot N_1) + \sin\beta\,(+\sin\alpha\, E_1 - \cos\alpha \cdot N_1)$

$= -E_1(\cos\beta \cos\alpha - \sin\beta \cdot \sin\alpha) - N_1(\sin\beta \cdot \cos\alpha + \cos\beta \cdot \sin\alpha)$

$= -E_1 \cdot \cos\gamma - N_1 \cdot \sin\gamma$

$T_{24} = -\sin\beta\,(-\cos\alpha \cdot E_1 - \sin\alpha \cdot N_1) + \cos\beta\,(\sin\alpha \cdot E_1 - \cos\alpha \cdot N_1)$

$= E_1(\cos\beta \cdot \sin\alpha + \sin\beta \cos\alpha) - N_1(-\sin\beta \cdot \sin\alpha + \cos\beta \cdot \cos\alpha)$

$= E_1 \cdot \sin\gamma - N_1 \cdot \cos\gamma$

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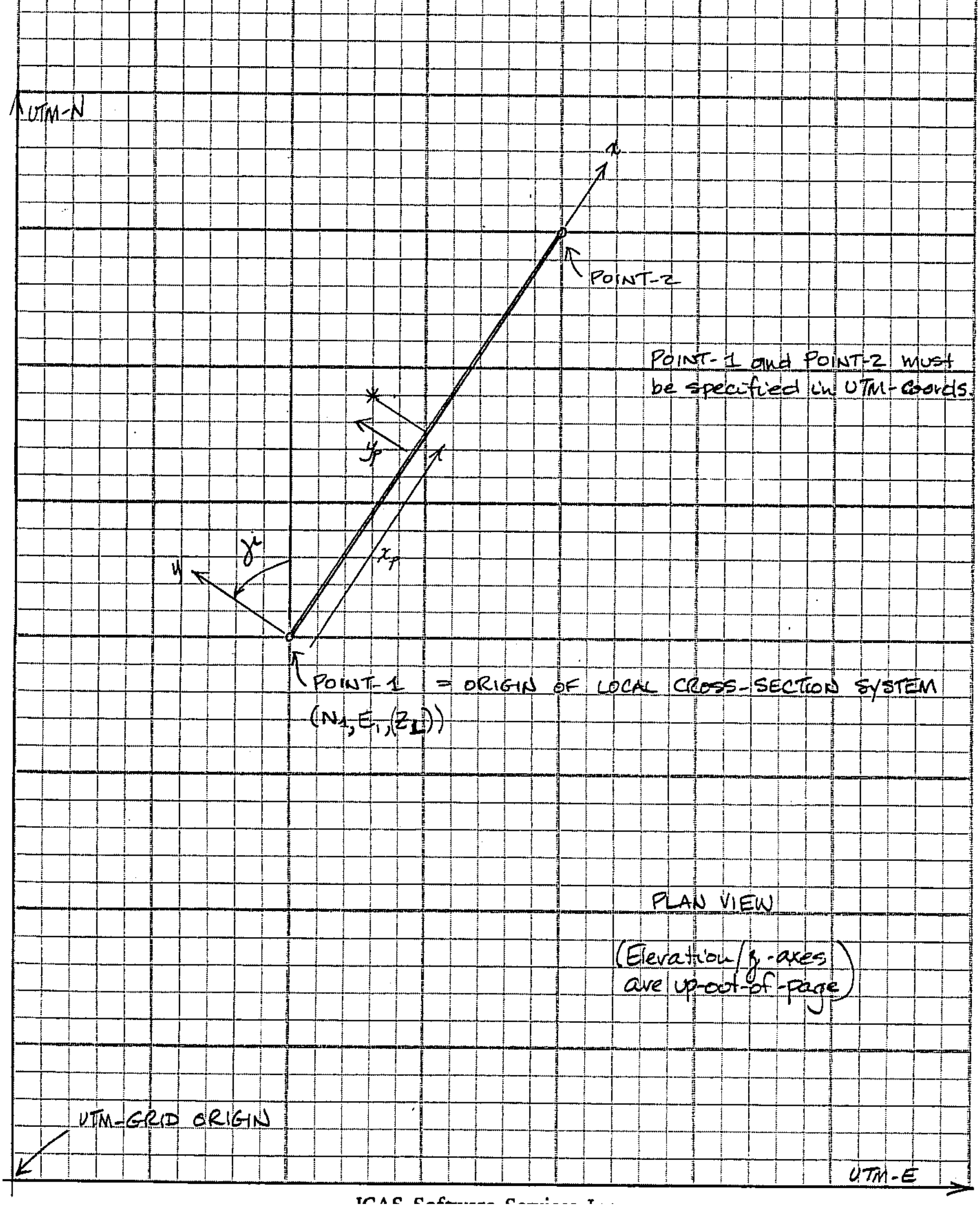
TRANSFORMATION FROM UTM TO CROSS-SECTION COORDINATES DIRECTLY



1. TRANSLATE TO POINT-1

$N_S = U_N - N_1$
$E_S = U_E - E_1$
$Z_S = U_Z - Z_L$

$$\begin{Bmatrix} E_S \\ N_S \\ Z_S \\ 1 \end{Bmatrix} = \begin{bmatrix} 1 & \cdot & \cdot & -E_1 \\ \cdot & 1 & \cdot & -N_1 \\ \cdot & \cdot & 1 & -Z_L \\ \cdot & \cdot & \cdot & 1 \end{bmatrix} \begin{Bmatrix} U_E \\ U_N \\ U_Z \\ 1 \end{Bmatrix}$$

$$\{\bar{U}_S\} = [B^*]\{\bar{U}\}$$

2. ROTATE ABOUT Z-AXIS

$$\begin{Bmatrix} x \\ y \\ z \\ 1 \end{Bmatrix} = \begin{bmatrix} \cos\gamma & \sin\gamma & \cdot & \cdot \\ -\sin\gamma & \cos\gamma & \cdot & \cdot \\ \cdot & \cdot & 1 & \cdot \\ \cdot & \cdot & \cdot & 1 \end{bmatrix} \begin{Bmatrix} E_S \\ N_S \\ Z_S \\ 1 \end{Bmatrix}$$

$$\{\bar{x}\} = [C^*]\{\bar{U}_S\} = [C^*]\cdot[B^*]\cdot\{\bar{U}\} = [T^*]\{\bar{U}\}$$

where $[T^*] = [C^*][B^*]$

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		By: J.M.-L.	Page: D10 of 11

$$\begin{bmatrix} T^*_{11} & T^*_{12} & T^*_{13} & T^*_{14} \\ T^*_{21} & T^*_{22} & T^*_{23} & T^*_{24} \\ T^*_{31} & T^*_{32} & T^*_{33} & T^*_{34} \\ T^*_{41} & T^*_{42} & T^*_{43} & T^*_{44} \end{bmatrix} = \begin{bmatrix} \cos\gamma^c & \sin\gamma^c & \cdot & \cdot \\ -\sin\gamma^c & \cos\gamma^c & \cdot & \cdot \\ \cdot & \cdot & 1 & \cdot \\ \cdot & \cdot & \cdot & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & \cdot & \cdot & -E_1 \\ \cdot & 1 & \cdot & -N_1 \\ \cdot & \cdot & 1 & -Z_L \\ \cdot & \cdot & \cdot & 1 \end{bmatrix}$$

$$= \begin{bmatrix} \cos\gamma^c & \sin\gamma^c & \cdot & -E_1\cos\gamma^c - N_1\sin\gamma^c \\ -\sin\gamma^c & \cos\gamma^c & \cdot & E_1\sin\gamma^c - N_1\cos\gamma^c \\ \cdot & \cdot & 1 & -Z_L \\ \cdot & \cdot & \cdot & 1 \end{bmatrix}$$

$$= \begin{bmatrix} T^*_{11} & T^*_{12} & \cdot & T^*_{14} \\ -T^*_{12} & T^*_{11} & \cdot & T^*_{24} \\ \cdot & \cdot & 1 & T^*_{34} \\ \cdot & \cdot & \cdot & 1 \end{bmatrix}$$

6 different terms to evaluate

$T_{11} = \cos\gamma^c$

$T_{12} = \sin\gamma^c$

$T_{14} = -E_1 \cdot \cos\gamma^c - N_1 \sin\gamma^c$

$T_{24} = E_1 \cdot \sin\gamma^c - N_1 \cos\gamma^c$

$T_{34} = -Z_L$

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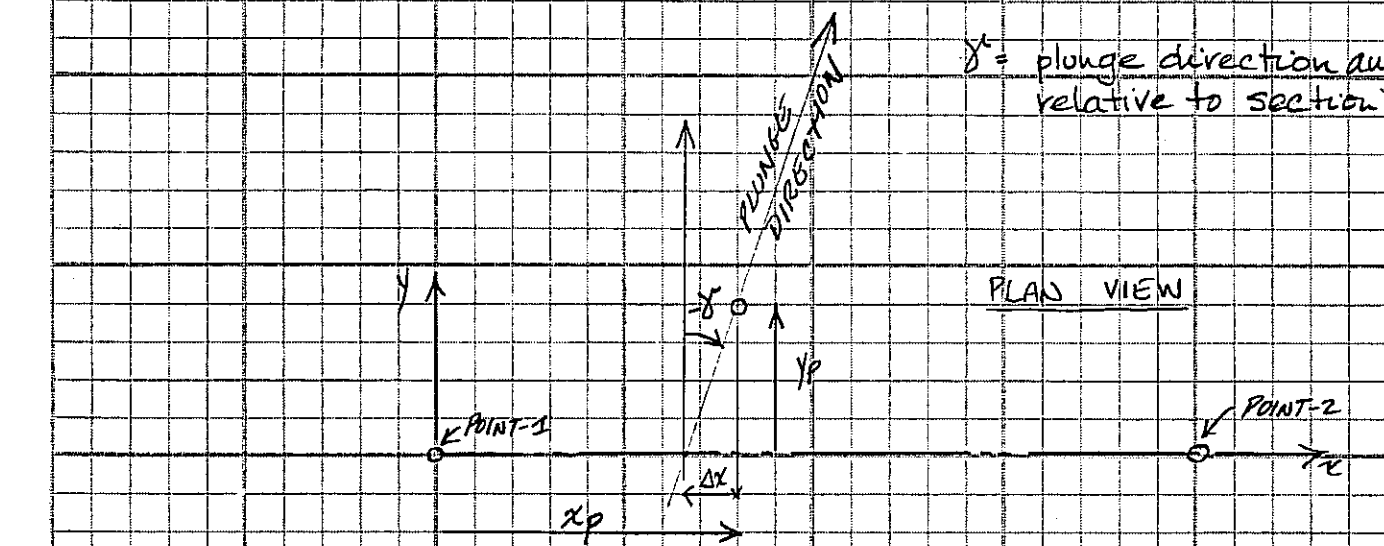
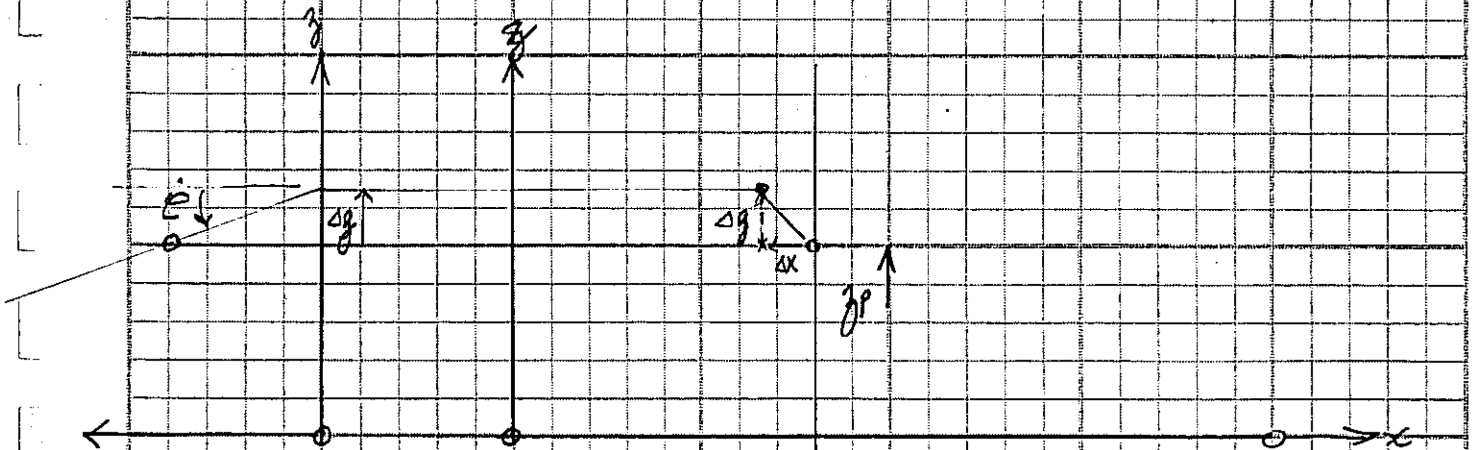
Projection Down Plunge

γ = plunge direction angle relative to section



① $$\Delta x = y_p \cdot \sin \gamma$$



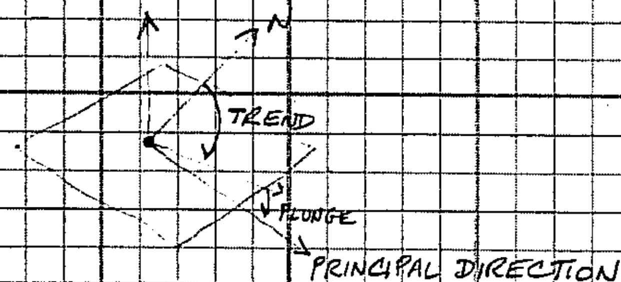
$$\Delta z = \left(y_p^2 + \Delta x^2\right)^{1/2} \cdot \tan \varphi$$ where φ = plunge angle.

PLUNGE / TREND CORRECTED SPLINES ON CROSS-SECTION

Definitions

PLUNGE – angle from the horizontal (+ = depression; – = elevation) at which the principal direction of a planar surface dips

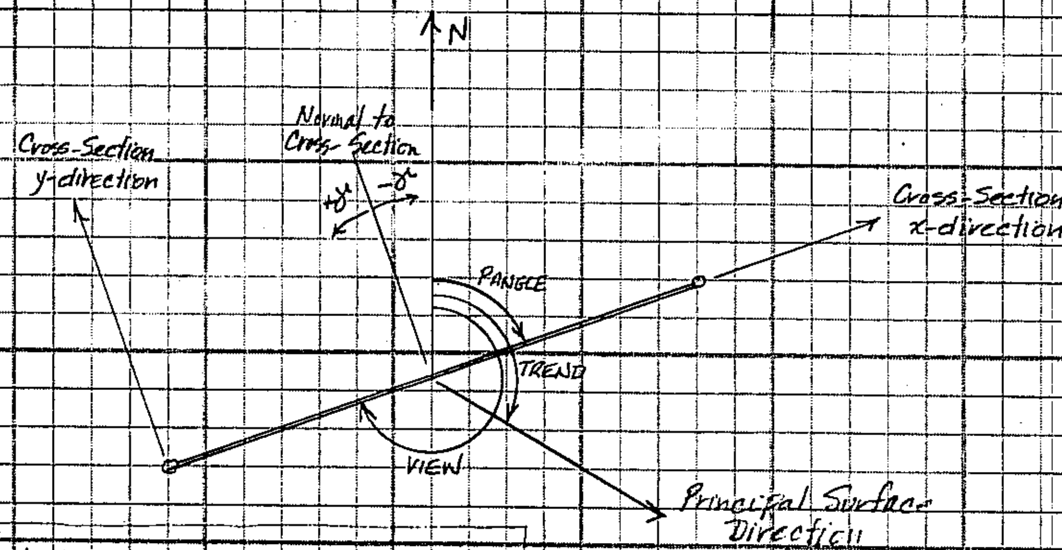
TREND – azimuth of the principal direction of a planar surface.



PLUNGE & TREND values will be derived by a Structural Geologist.

PLUNGE & TREND angles must be converted to γ and φ angles to give a relationship with a defined cross-section as follows

Plan View



$\gamma = \text{VIEW} - \text{TREND}$

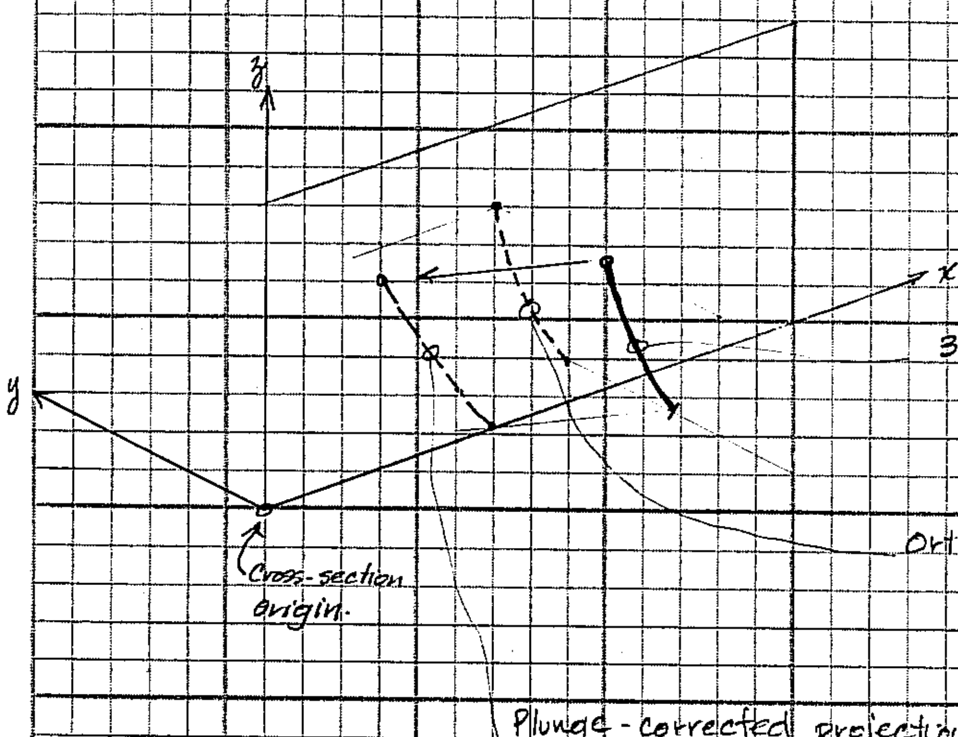
if $\gamma < 0$ then $\gamma := \gamma + 360°$ (useful form is $\tan\gamma$)

from page D11

$$\varphi = \tan^{-1}\left((1+\tan^2\gamma)^{1/2} \cdot \tan(\text{PLUNGE})\right)$$

(a more useful form is $\tan\varphi = (1+\tan^2\gamma)^{1/2} \cdot \tan(\text{PLUNGE})$)

PLUNGE/TREND CORRECTED SPLINES ON CROSS-SECTION (Continued)



3-dimensional Spline

$$x = A + Bt + Ct^2$$
$$y = E + Ft + Gt^2$$
$$z = P + Qt + Rt^2$$

Orthogonal Projection

$$\bar{x} = x = A + Bt + Ct^2$$
$$\bar{y} = 0$$
$$\bar{z} = z = P + Qt + Rt^2$$

Plunge-corrected projection on Cross-Section

$$\hat{x} = A + B \cdot t + C \cdot t^2 + \tan\gamma \, (E + Ft + Gt^2)$$
$$\hat{y} = 0$$
$$\hat{z} = P + Q \cdot t + R \cdot t^2 + \tan\varphi \, (E + Ft + Gt^2)$$

Now γ and φ are constant for any given cross-section (Thus $\tan\gamma$ and $\tan\varphi$ are also constant).

$$\therefore \quad \hat{x} = \hat{A} + \hat{B} t + \hat{C} \cdot t^2, \quad \hat{y} = 0, \quad \hat{z} = \hat{P} + \hat{Q} t + \hat{R} \cdot t^2$$

where

$$\hat{A} = A + \tan\gamma \cdot E$$
$$\hat{B} = B + \tan\gamma \cdot F$$
$$\hat{C} = C + \tan\gamma \cdot G$$

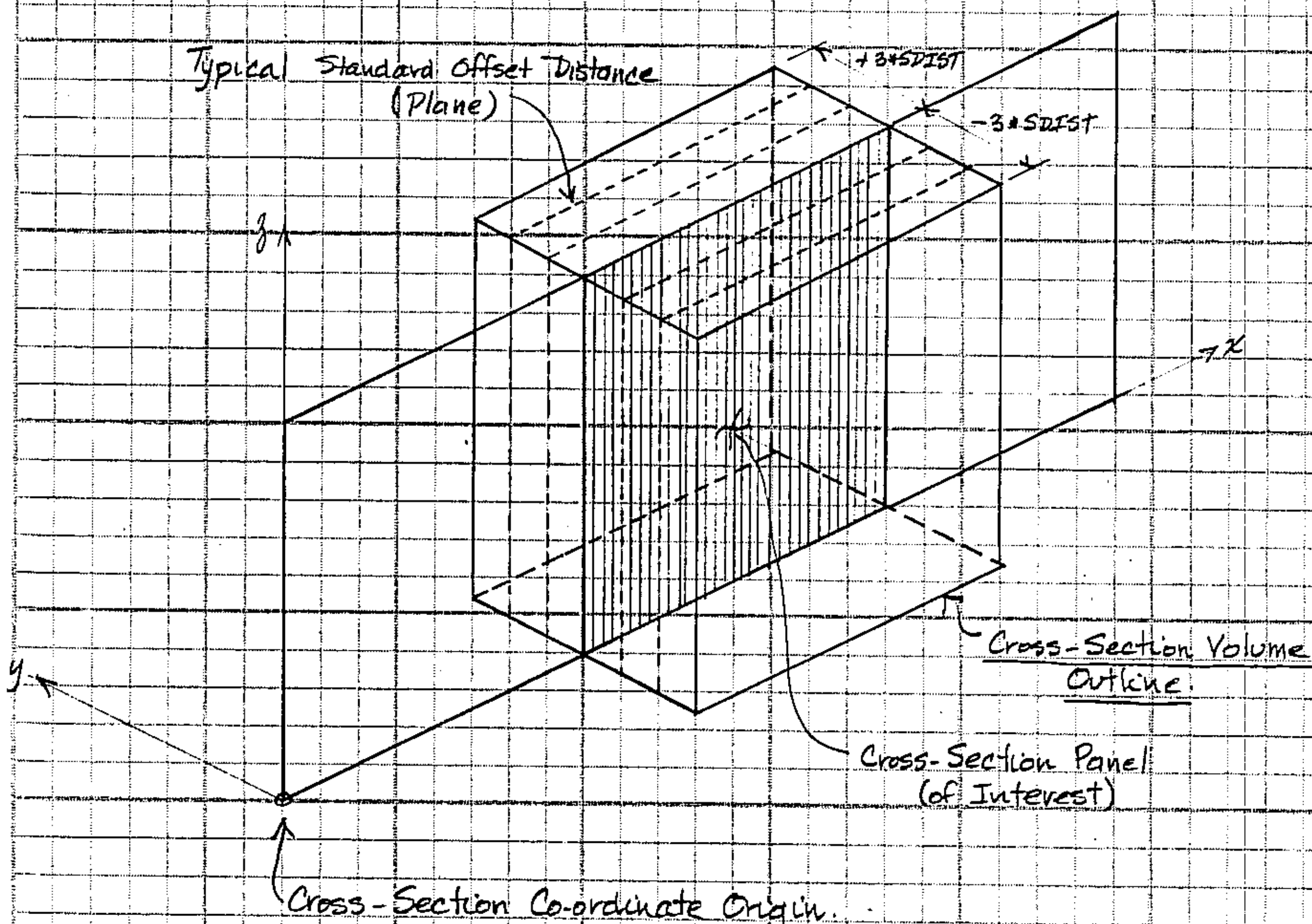
and

$$\hat{P} = P + \tan\varphi \cdot E$$
$$\hat{Q} = Q + \tan\varphi \cdot F$$
$$\hat{R} = R + \tan\varphi \cdot G$$

ICAS Software Services	APPENDIX 'F'	Systems: DDHDB	Project: P32001
	DDH INTERSECTION WITH	Routine:	Date: 11.3.85
	CROSS-SECTION VOLUME	By: J.M.-L.	Page: F1 of 6

DDH INTERSECTION WITH CROSS-SECTION VOLUME

When a Cross-Section Plot is generated – all DDH's within the Info Base must be checked to determine if they are located within the volume defined for the cross-section. If a DDH intersects with the defined it must further be checked to determine where it might intersect the plot perimeter and various offset boundaries. This Appendix details the logic and calculations involved.



Checks To Be Made

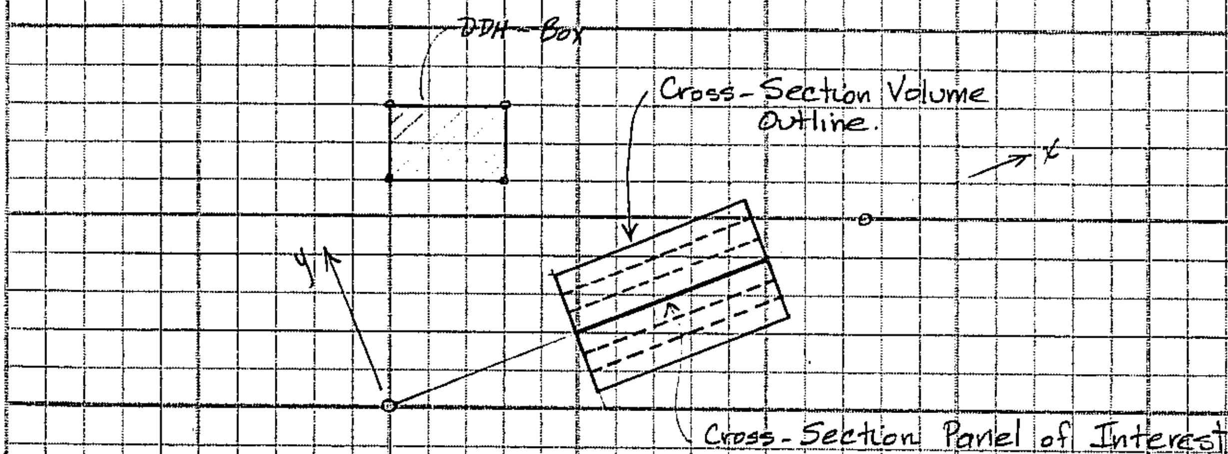
(1) Is DDH within Cross-Section (Panel) Volume
(2) If 'it is IN' then find
  (a) any intersections with plot perimeters.
  (b) any intersections with standard offset distances (planes)

(Item 2(b) controls the line quality when plotting the DDH-trace.

ICAS Software Services		Systems: DDHDB	Project: P82001
		Routine:	Date: 11.3.83
		By: J.M.L.	Page: F2 of 6

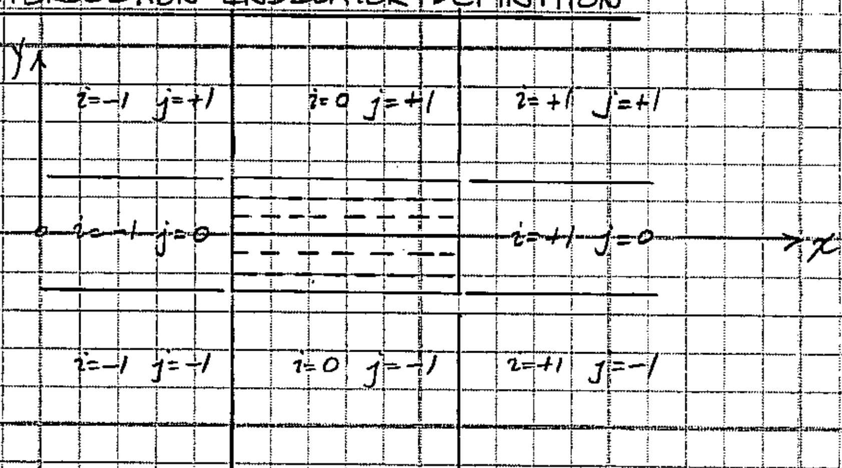
DDH-INTERSECTION WITH CROSS-SECTION VOLUME (Continued)

Plan View



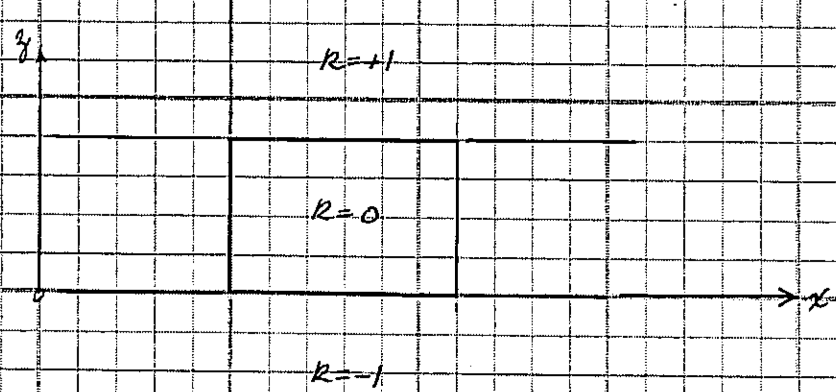
POINT INTERSECTION INDICATOR DEFINITION

PLAN VIEW



IND(i, j, k)

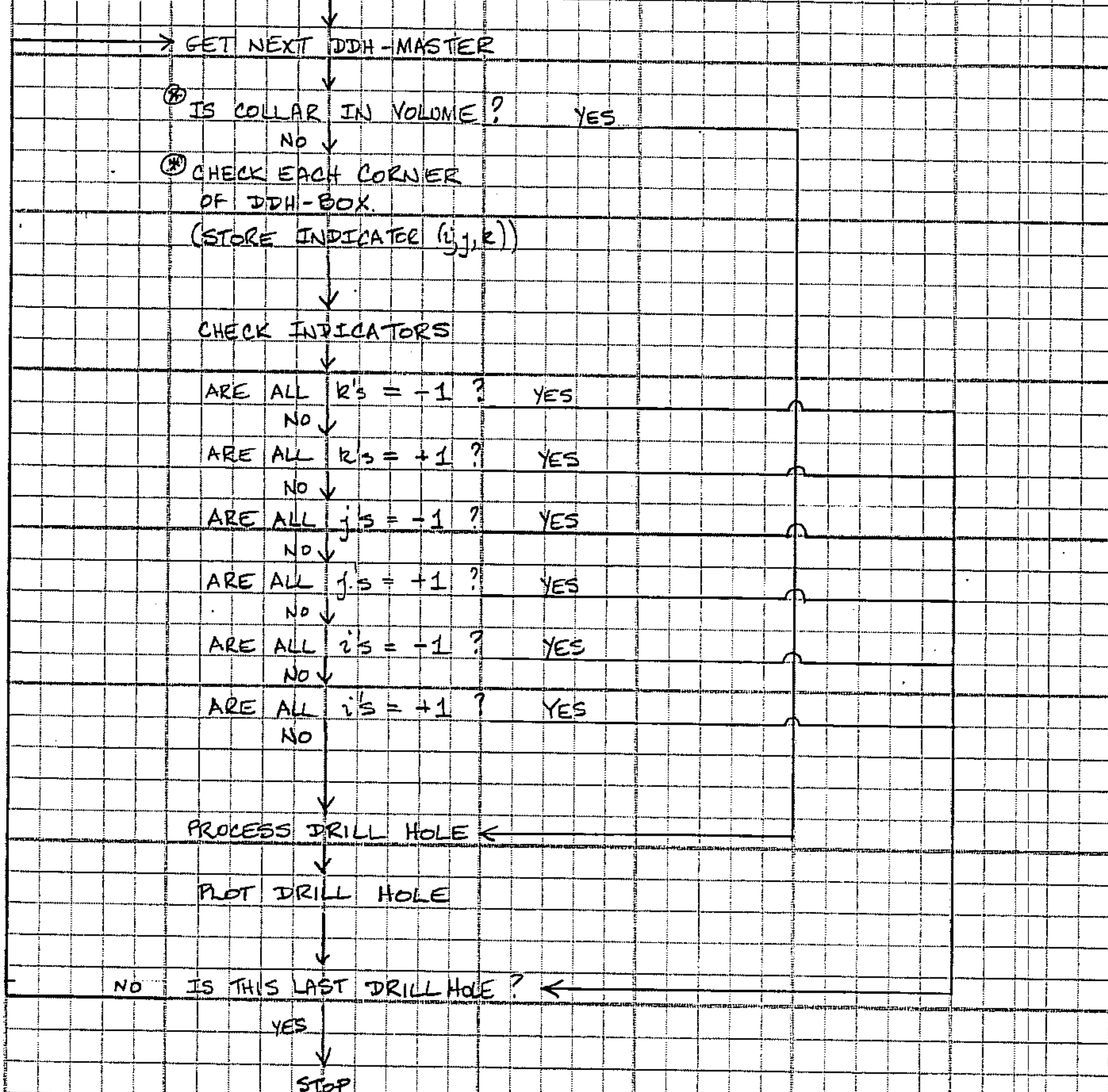
VERTICAL VIEW



ICAS Software Services		Systems: DDHDB	Project: PB2001
		Routine:	Date: 11.3.83
		By: J.M-L.	Page: F3 of 6

DDH-INTERSECTION WITH CROSS-SECTION VOLUME (Continued)

LOGIC FLOW



(*) Step involves calculated plunge/trend calculated position of point in cross-section co-ordinates ($\hat{x}, \hat{y}, \hat{z}$) cf. Appendix E.

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		Routine:	Date: 11.5.83
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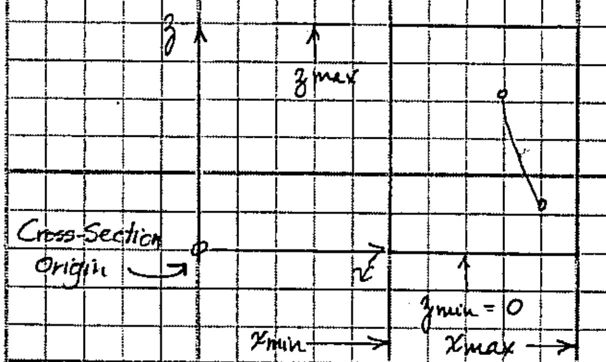
DDH-INTERSECTION WITH CROSS-SECTION VOLUME (Continued)

Solution of Plunge/Trend Corrected Spline Projection Intersection with Perimeter.



Corrected Spline Projection

$$\hat{x} = \hat{A} + \hat{B}t + \hat{C}t^2$$
$$\hat{y} = 0$$
$$\hat{z} = \hat{P} + \hat{Q}t + \hat{R}t^2$$

(a) Intersection with Top and Bottom Edges.

TOP (i) $z_{max} = \hat{P} + \hat{Q}t + \hat{R}t^2$

– if $\hat{R} \neq 0$ then $t^* = \dfrac{-\hat{Q} \pm \sqrt{\hat{Q}^2 - 4\hat{R}(\hat{P} - z_{max})}}{2\hat{R}}$

2 real solutions only if $(\hat{Q}^2 - 4\hat{R}(\hat{P} - z_{max})) > 0$

– if $\hat{R} = 0$ and $\hat{Q} \neq 0$ then
$t^* = \dfrac{-\hat{P} + z_{max}}{\hat{Q}}$

– if $\hat{R} = 0$ and $\hat{Q} = 0$ then spline is parallel to z-axis.
∴ no solutions.

depending on the solution results all t^* are to be checked to ensure that

$0 \leq t^* \leq$ length of current DDH-segment.

BOTTOM (ii) $0 = \hat{P} + \hat{Q} \cdot t + \hat{R} \cdot t^2$

– if $\hat{R} \neq 0$ then $t^* = \dfrac{-Q \pm \sqrt{\hat{Q}^2 - 4\hat{R}\hat{P}}}{2\hat{R}}$

again 2 real solutions only if $(\hat{Q}^2 - 4\hat{R}\hat{P}) > 0$

DDH-INTERSECTION WITH CROSS-SECTION VOLUME (Continued)

- if $\hat{R} = 0$ and $\hat{Q} \neq 0$ then

$$t^* = \frac{-\hat{P}}{\hat{Q}}$$

(One solution)

- if $\hat{R} = 0$ and $\hat{Q} = 0$ then spline is a straight line normal to y-axis at $y = \hat{P}$ (no solutions)

- again depending on the solution results all t^* are to be checked to ensure that

$$0 \leq t^* \leq \text{length of current DDH-segment}$$

(b) Intersection with Left and Right Edges.

$$x_{\substack{max \\ min}} = \hat{A} + \hat{B} \cdot t + \hat{C} t^2$$

- if $\hat{C} \neq 0$ then

$$t^* = \frac{-\hat{B} \pm \sqrt{\hat{B}^2 - 4\hat{C}\left(\hat{A} - x_{\substack{max \\ min}}\right)}}{2\hat{C}}$$

(2 real solutions)

- if $\hat{C} = 0$ and $\hat{B} \neq 0$ then

$$t^* = \frac{x_{\substack{max \\ min}} - \hat{A}}{\hat{B}}$$

(1 real solution)

- if $\hat{C} = 0$ and $\hat{B} = 0$ then the spline is a straight line normal to the x-axis.

- depending on the solution results all t^* are to be checked to ensure that

$$0 \leq t^* \leq \text{length of current DDH-segment}$$

IDH INTERSECTION WITH CROSS-SECTION VOLUME (Continued)

Solution of Plunge/Trend Corrected Spline Projection Intersection with Offset Planes.

This solution process is very similar to the previous one for intersection with the plot perimeter.

In this case, loop $J = -3$ to $+3$ by $+1$

Set $y_i = J * SDIST$ (SDIST = Standard Offset Distance)

from the uncorrected spline $y = E + Ft + Gt^2$

subsut y_i such that $y_i = E + Ft + Gt^2$ and solve for t^*

- if $G \neq 0$ then

$$t^* = \frac{-F \pm \sqrt{F^2 - 4G(E - y_i)}}{2G}$$

up to 2 real roots.

- if $G = 0$ and $F \neq 0$ then

$$t^* = \frac{y_i - E}{F}$$

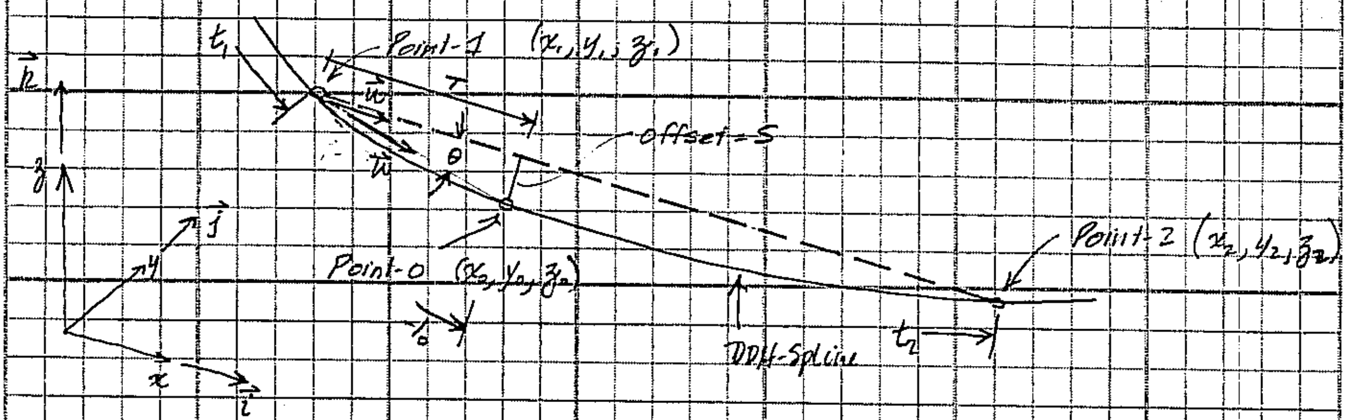
- if $G = 0$ and $F = 0$ then the spline is a straight line perpendicular to the y-axis of the section.

- Note all solution results t^* must be checked to ensure that

$$0 \leq t^* \leq \text{length of current IDH-segment.}$$

ICAS Software Services	APPENDIX 'G'	Systems: DDHDB	Project: PS2001
	MISCELLANEOUS ITEMS	Routine: TECHNICAL APPENDIX	Date: 11.5.23
		By: J.M.-L	

CALCULATION OF DDH-POSITION ON SPLINE OFFSET FROM A STRAIGHT-LINE FIT



Unit Vector from Point-1 to Point-2 = $\vec{u}$

$$\vec{u} = \frac{(x_2-x_1)\cdot\vec{i} + (y_2-y_1)\cdot\vec{j} + (z_2-z_1)\cdot\vec{k}}{\left((x_2-x_1)^2 + (y_2-y_1)^2 + (z_2-z_1)^2\right)^{1/2}} = \frac{(x_2-x_1)}{U}\cdot\vec{i} + \frac{(y_2-y_1)}{U}\cdot\vec{j} + \frac{(z_2-z_1)}{U}\cdot\vec{k}$$

where U is the magnitude of $\vec{u}$

Unit Vector from Point-1 to Point-0 = $\vec{v}$

$$\vec{v} = \frac{(x_0-x_1)\cdot\vec{i} + (y_0-y_1)\cdot\vec{j} + (z_0-z_1)\cdot\vec{k}}{\left((x_0-x_1)^2 + (y_0-y_1)^2 + (z_0-z_1)^2\right)^{1/2}} = \frac{(x_0-x_1)}{V}\cdot\vec{i} + \frac{(y_0-y_1)}{V}\cdot\vec{j} + \frac{(z_0-z_1)}{V}\cdot\vec{k}$$

where V is the magnitude of $\vec{v}$

The angle between vectors $\vec{u}$ and $\vec{v}$

$$\cos\theta = \vec{u}\cdot\vec{v} = \frac{(x_2-x_1)(x_0-x_1) + (y_2-y_1)(y_0-y_1) + (z_2-z_1)(z_0-z_1)}{U\cdot V}$$

Offset Distance

$$S = V\cdot\sin\theta = V\left(1-\cos^2\theta\right)^{1/2}$$

Equivalent to Down-Hole Distance

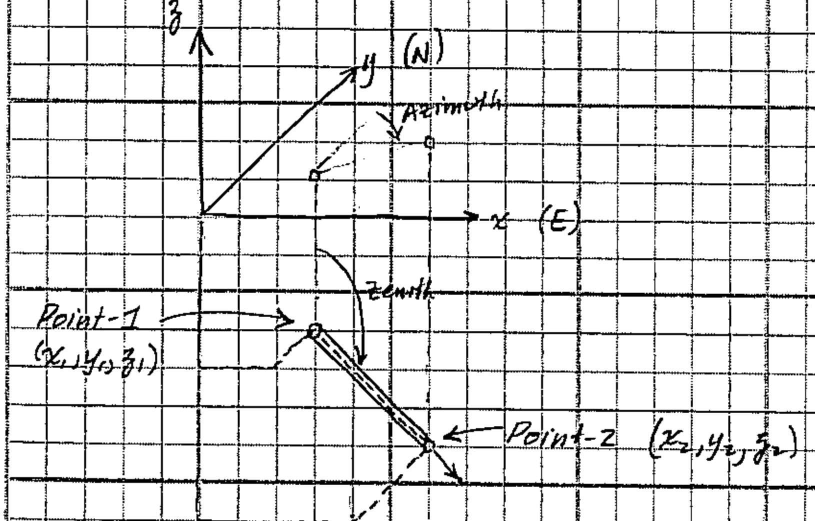
$$T = V\cdot\cos\theta$$

Checks

① $t_1 < t_2$

② $t_1 < t_0 \leq t_2$

ZENITH AND AZIMUTH OF A STRAIGHT-LINE SEGMENT OF A VDH-TRACE



Points on Borehole

Point-1 x_1, y_1, z_1
Point-2 x_2, y_2, z_2

Azimuth and Zenith are for Direction of Point-1 towards Point-2

Length of Segment $L_{1-2} = ((x_2-x_1)^2 + (y_2-y_1)^2 + (z_2-z_1)^2)^{1/2}$

$$\cos(\text{Zenith}) = \frac{z_2 - z_1}{L_{1-2}} \quad \text{or} \quad \text{Zenith} = \cos^{-1}\left(\frac{z_2 - z_1}{L_{1-2}}\right)$$

$$\text{or} \quad \text{Zenith} = \cos^{-1}\left(\frac{z_2 - z_1}{((x_2-x_1)^2 + (y_2-y_1)^2 + (z_2-z_1)^2)^{1/2}}\right)$$

Projected Length of Segment on Horizontal Plane

$$P_{1-2} = ((x_2-x_1)^2 + (y_2-y_1)^2)^{1/2}$$

$$\cos(\text{Azimuth}) = \frac{y_2 - y_1}{P_{1-2}} \quad \text{or} \quad \text{Azimuth} = \cos^{-1}\left(\frac{y_2 - y_1}{P_{1-2}}\right)$$

$$\text{or} \quad \text{Azimuth} = \cos^{-1}\left(\frac{y_2 - y_1}{((x_2-x_1)^2 + (y_2-y_1)^2)^{1/2}}\right)$$

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		Routine:	Date: 11.3.83
		By: J.M.-L.	Page: G3 of 3

INVERSE OF A CROSS-SECTION TRANSFORMATION MATRIX

The General Form for a Vertical Cross-Section Transformation Matrix is

$$[T]_{4\times4} = \begin{bmatrix} t_{11} & t_{12} & \cdot & t_{14} \\ -t_{12} & t_{11} & \cdot & t_{24} \\ \cdot & \cdot & t_{33} & t_{34} \\ \cdot & \cdot & \cdot & 1 \end{bmatrix} \qquad \{x\} = [T]\{U\}$$

The Inverse Matrix is

$$[T]^{-1}_{4\times4} = \begin{bmatrix} \dfrac{t_{11}}{t_{11}^2+t_{12}^2} & \dfrac{-t_{12}}{t_{11}^2+t_{12}^2} & \cdot & \dfrac{t_{12}\cdot t_{24} - t_{11}\cdot t_{14}}{t_{11}^2+t_{12}^2} \\ \dfrac{t_{12}}{t_{11}^2+t_{12}^2} & \dfrac{t_{11}}{t_{11}^2+t_{12}^2} & \cdot & \dfrac{-t_{12}\cdot t_{14} - t_{11}\, t_{24}}{t_{11}^2+t_{12}^2} \\ \cdot & \cdot & \dfrac{1}{t_{33}} & \dfrac{-t_{34}}{t_{33}} \\ \cdot & \cdot & \cdot & 1 \end{bmatrix}$$

$$\{U\} = [T]^{-1}\{x\}$$