

Apparent to true dip restoration with graphics:
user's manual for
APP2TRUEDIPG versions ≤ 4.4

Version 1.0

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Chapter 1

Purpose and methods

1.1 Purpose

APP2TRUEDIPG can carry out three tasks:

1. restore strike and dip of planar structures measured as two apparent dips along two azimuths;
2. plot orientations statistics (histograms and roses of orientation parameters);
3. plot the restored planar structures on a core section similar to the Visual Core Description (VCD) used in the Ocean Drilling Program (ODP) (see Table 1.1 for symbols and acronyms used in this document).

Originally designed for structural measurements on cores from the Ocean Drilling Program it can be used for structural measurements on cores with conventions similar to those used in ODP. It is derived from APP2TRUEDIP that is simpler to use but only carries out the first of these three tasks. The first two tasks require only orientation data whereas the third one requires additional depth information.

1.2 Structural measurements on ODP cores

1.2.1 Planar structures orientations

ODP cores are longitudinally split into working and archive halves. This results in two directions along which apparent dips of planar structures can easily be measured: one parallel and the other perpendicular to the cut surface (Figs. 1.1-A and 1.1-B) (*Shipboard Scientific Party*, 2003).

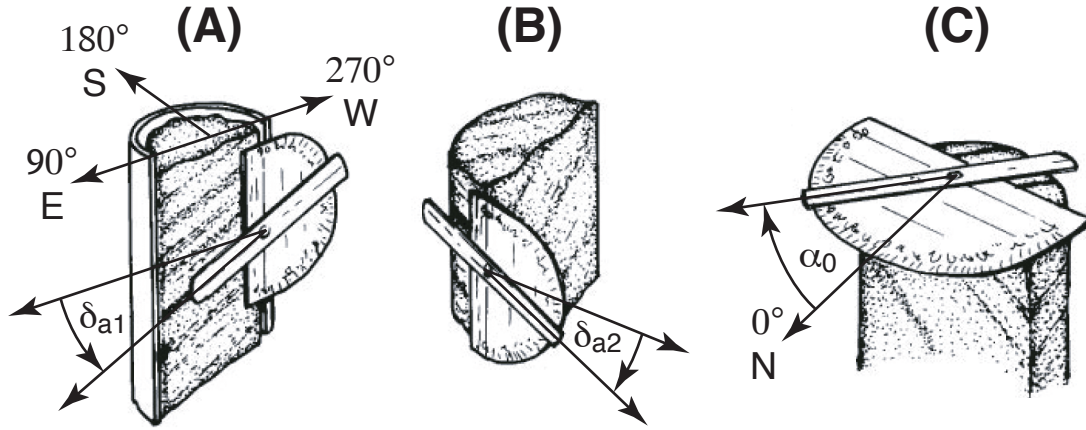
Leg 131 structural geologists defined a conventional local frame of reference attached to these directions (*Shipboard Scientific Party*, 1991a); this frame was also used during leg 134 (*Shipboard Scientific Party*, 1992a).

During leg 135 this frame was rotated by 180° so as to be identical to that used in paleomagnetism (*Shipboard Scientific Party, 1992b*); this new frame has been used henceforth, for examples during legs 140, 147, 153, 176, 180, and 206 (*Shipboard Scientific Party, 1992c, 1993a, 1995, 1999a,b, 2003*), so that the usual convention is (Fig. 1.1-A):

- the archive half rounded surface faces South (180°) and
- when facing the upright plane cut surface with the top of the core upward, East (90°) is to the left and West (270°) to the right.

A direct strike measurement can also be made when a structure intersects an horizontal section of the core (Fig. 1.1-C).

True dip and dip direction can thus be computed either from two apparent dip measurements along two directions, or from one apparent dip measurement along one direction coupled with a strike measurement.



Archive half core - Top part of the core up

Figure 1.1: ODP core structural measurements on an archive half core piece. The top part of the core is oriented upwards. (A) Conventional reference frame and apparent dip, δ_{a1} , measurement in the East - West vertical plane; (B) Apparent dip, δ_{a2} , measurement in the North - South vertical plane; (S) Strike, α_0 , measurement on an horizontal cut plane. Modified after *Shipboard Scientific Party (1991a, 2003)*.

1.2.2 Depth information

ODP cores, that are 9.5 m long when recovery is full, are cut in 1.5 m sections, and structural features depth is recorded in cm from the top of each section; planar structures depth is defined as the depth of the intersection of the plane with the borehole axis (*Shipboard Scientific Party, 1993a, 1999b*). APP2TRUEDIPG can generate VCD like plots per section by using section number and features depths within each section.

Table 1.1: Symbols and acronyms used in this document

Symbol	Comments
DSDP	Deep Sea Drilling Project (1966-1983)
ODP	Ocean Drilling Program (1985-2003); this acronym is used sensu lato in this document to refer to DSDP, ODP and IODP indistinctly
IODP	Integrated Ocean Drilling Program (2003-2013) and International Ocean Discovery Program (2013-2024)
VCD	Visual Core Description
N	North
E	East
S	South
W	West
α_0	Strike
β_0	True Dip direction
δ_0	True Dip
β_{a1}	Apparent dip direction 1
δ_{a1}	Apparent dip 1 along direction 1
β_{a2}	Apparent dip direction 2
δ_{a2}	Apparent dip 1 along direction 2

1.3 Methods

Given a 1st apparent dip, δ_{a1} , along direction, β_{a1} , and a 2nd apparent dip, δ_{a2} , along direction, β_{a2} , true dip, δ_0 , and true dip direction, β_0 , are the two unknowns of the system of two equations:

$$\tan(\delta_{a1}) = \cos(\beta_0 - \beta_{a1})\tan(\delta_0) \quad (1.1)$$

$$\tan(\delta_{a2}) = \cos(\beta_0 - \beta_{a2})\tan(\delta_0) \quad (1.2)$$

The algorithm implemented in APP2TRUEDIPG proceeds in three steps:

1. it first validates input;
2. it then checks whether the system of equations (1.1) and (1.2) falls in the case that yields a single solution;
3. if both above verifications are successfull, it finally computes the single solution (δ_0 , β_0).

If input validation fails or if the equation system does not yield a single solution, an explanation is given in the output and a message is written in the terminal.

1.4 Using App2truedipG

1.4.1 Input and Output

Input can be read either from the keyboard, or from a text file. Similarly output can be directed either to the screen terminal, or to a text file.

The simplest way to run the program when a couple of data need be processed is to choose keyboard input and screen output. Each output result is then displayed after each input is entered. Alternatively, output can be directed to a file to keep a record.

Input and output files become more appropriate as the number of data increases. In that case, the program is designed with the idea of easily creating the input file by exporting the relevant data from a structural spreadsheet and of generating an output file that can also easily be imported back in the spreadsheet.

1.4.2 Input

Four different input types are available: two for orientation data only and two for depth and orientation data. They are summarized below and described in detail in [Chapter 2](#).

1.4.2.1 Orientation data only

If only orientation data are needed, two types of input file can be used:

- the [alphanumeric orientation input file](#) type designed to accommodate apparent dip measurements made along North, East, South and West directions only, and recorded as N, E, S and W in structural spreadsheets;
- alternatively, the [numerical orientation input file](#) type is designed to accommodate apparent dip measurements along any direction recorded as a number in the structural spreadsheet.

These data allow only orientation restoration and statistics plots.

1.4.2.2 Depth and orientation data

If VCD plots are wanted, section number and depth from the top of the section need be added to input. Section number is used to start a new page upon reaching a new section. This gives rise to two additional types of input files:

- the [alphanumeric depth+orientation input file](#) type to accommodate measurements recorded as N, E, S and W;

- alternatively, the [numerical depth+orientation input file](#) type designed to accommodate directions recorded as numbers in the structural spreadsheet.

1.4.3 Running the program

The program is menu driven, and one can proceed in three steps.

1. First use the menu set up commands to
 - define input origin (default is file);
 - define output destination (default is file);
 - define input type (default is alphanumerical orientation only);
 - choose what plots should be generated (default is to generate all possible plots).
2. Then use the menu command 1000 to launch the computations and plots generation.
3. Finally use the menu command 9999 to quit the program properly, ensuring that all output files are closed.

1.4.4 Output

Output is tab delimited characters and numbers so as to facilitate importation into a spreadsheet. There are four different output types that correspond to the four input types and are described in detail in Chapter 3.

1.4.5 Plots

Two types of plots may be generated:

1. orientation statistics plots, and
2. VCD section plots.

1.4.5.1 Orientation statistics plots

Orientation statistics plots are enabled by default but can be disabled from the main menu. An example of statistics plots generated from input file [1109D47R2.in4.txt](#) (*Shipboard Scientific Party, 1999c*) is given in Fig. 1.2.

1.4.5.2 Section plots

The section plot represents the computed fault traces along the E-W saw cut of the core and follows the format of VCDs used on board to record structural observations. It can thus be compared with the VCD to verify that the input data and computation results are consistent with the visual observations. A new page is generated for each new section, which is detected by a changing section number.

Section plots are enabled by default if the input file contains depth information and can be disabled from the main menu. The main menu also allows two further set ups.

1. It allows to choose which section should be plotted:
 - either the archive (E-W section with W to the right),
 - or the working (W-E section with E to the right)half core.
2. It also allows to choose which VCD template to follow:
 - either two boxes each representing 75 cm of the 150 cm section (Leg 180 template, Fig. 1.3),
 - or a single box representing the full 150 cm section (Leg 209 template, Fig. 1.4).

Examples of section plots generated from input file [1109D47R2.in4.txt](#) (*Shipboard Scientific Party*, 1999c) are given in Fig. 1.5 with the leg 180 VCD template, and in Fig. 1.6 with the leg 209 VCD template.

1.5 About App2truedipG

Versions history of APP2TRUEDIPG is summarized in Chapter 6 and a few relevant references can be found in Chapter 5.

Input format: Numer: sect+depth+2di main program app2truedip v 3.1 on 22-11-2004
Input file: 1109D47R2.in4.txt Run on MacOS1036-PPC7450-550MHz on 26-11-2004 at 18:49:07
Title: 1109D-47R
Number of data read = 13
Number of data converted = 13

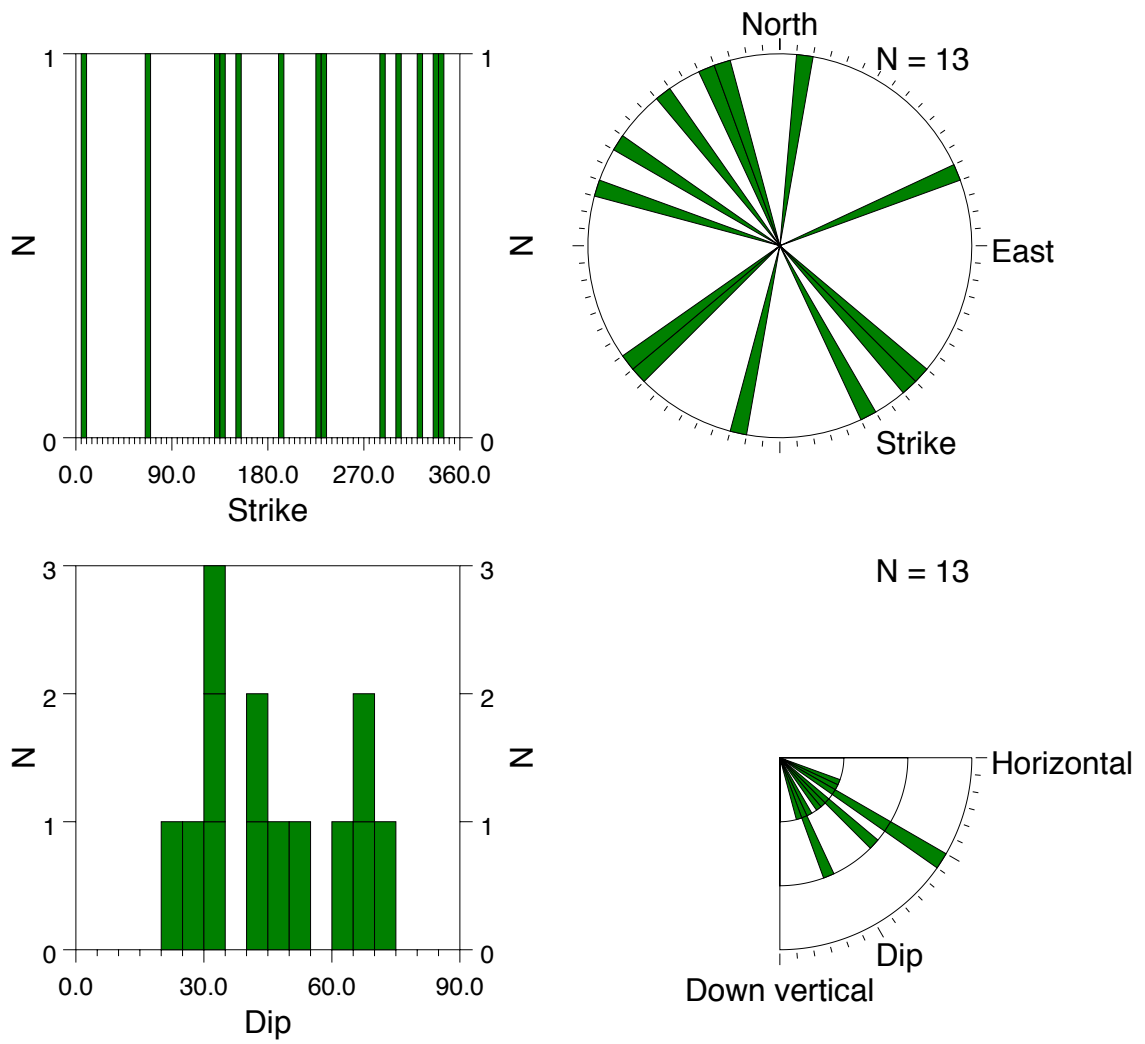


Figure 1.2: Structural measurements statistics for core section 1109D47R2.

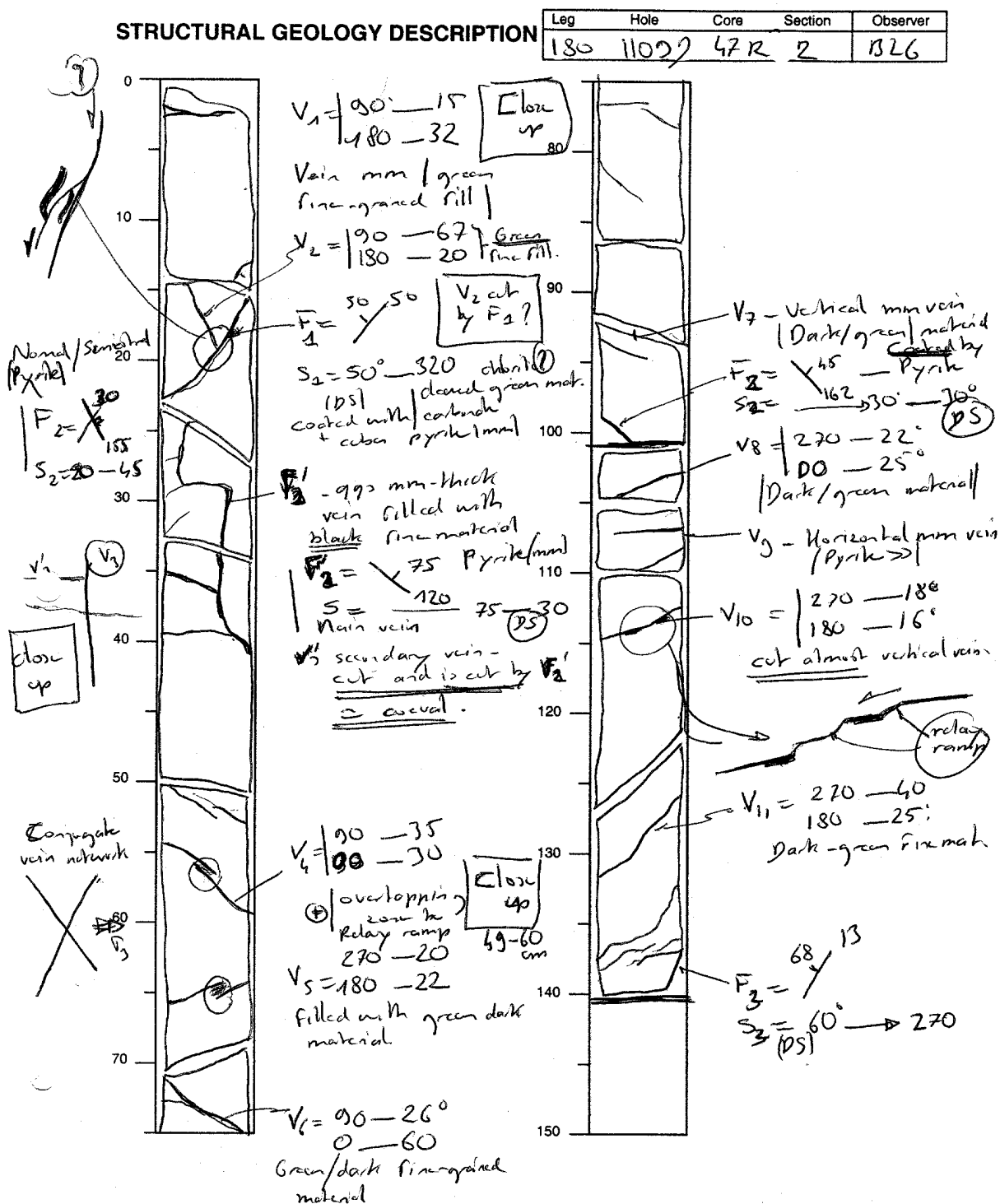
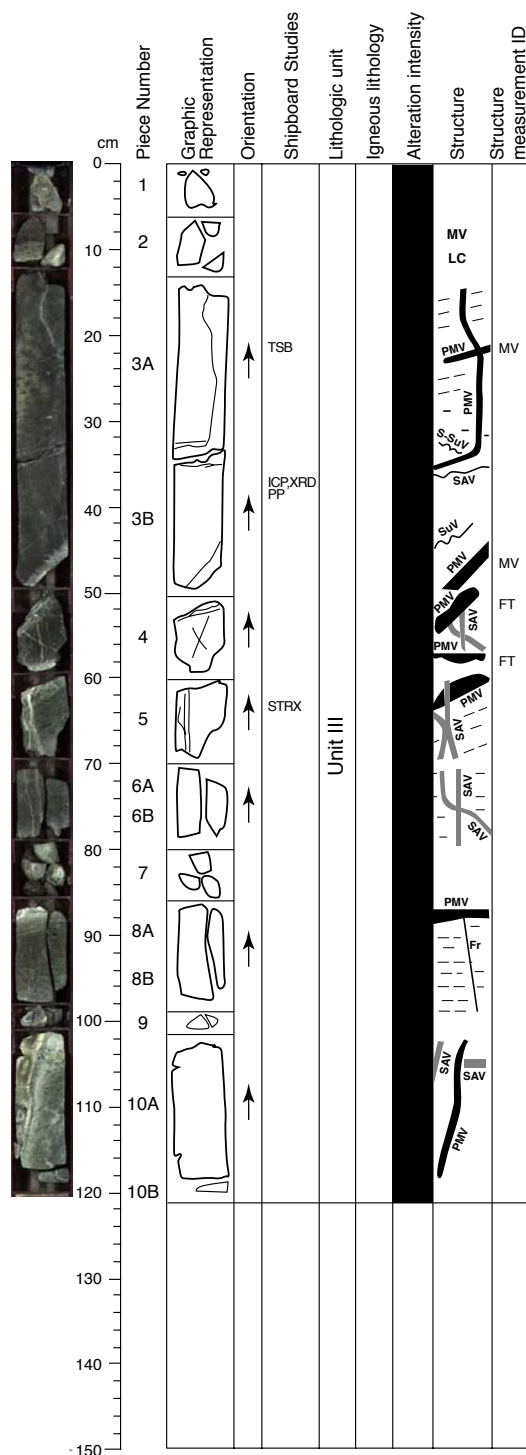


Figure 1.3: Leg 180 structural VCD: working half core section 1109D47R2 ([Shipboard Scientific Party, 1999c](#)).



209-1268A-16R-1 (Section top: 82.40 mbsf)

UNIT-III: Harzburgite/Dunite

Pieces 1–10

COLOR: Green in serpentinized harzburgite. Gray in talc altered gabbroic dikelets.

PRIMARY MINERALOGY:

Olivine	Mode 82%
Orthopyroxene	Mode 18%
	Size 3–10 mm
	Shape/Habit Anhedral
Spinel	Mode 1%

COMMENTS: This section consists of serpentinized harzburgite with porphyroclastic texture. Gabbroic segregations characterized by large spinel grains are present at 24 cm and 109 cm. A gabbroic dike cuts the sequence at 50 cm. Locally, mylonitic bands are associated with dikelets and segregations.

SECONDARY MINERALOGY:

COMMENTS: This section consists of green, completely serpentinized harzburgite (SHz) with local occurrences of crosscutting, completely chlorite-talc altered gabbroic dikelets (Pieces 3, 4, 8, and 10). Typically these dikelets have black and green alteration halos. Late serpentine veins cut across and splice the dikelets. The lower part of Piece 2 is a completely altered pyroxenite.

VEIN ALTERATION: This section contains three generations of veins. An earlier generation of wispy serpentine veins is well developed in the green serpentinized harzburgite (SHz). This generation cuts across magmatic features and offsets them (e.g., Piece 3A). Associated with this generation are also massive pyrite-iron oxide veinlets. Perpendicular thick serpentine-talc veins crosscut these two generations of veins. These veins run parallel to the gabbro layer. Thicker gabbroic veins display cross-fracture of chrysotile-talc veins.

THIN SECTIONS: 1268A-16R-1 21-24cm

STRUCTURE:

The section is characterized by weakly foliated porphyroclastic serpentinized harzburgite. The crystal-plastic foliation has a nearly horizontal trace in core cut face. Pieces 2–4, 6, 8, and 10 are cut by a altered pyroxenitic magmatic veins (PMV) and Piece 8 is cut by an altered pyroxenitic-gabbroic composite vein (CMV). Darker to light green serpentine alteration veins (SAV1) or tension gashes cut the PMV perpendicular to its vein wall. The gashes are widest in the center of the vein and taper and terminate in the serpentinized harzburgite accommodating volume expansion in the altered olivine-rich rock. Prominent white and light green non-differentiated serpentine/talc veins (SAV2) in turn cut the MV, the orthogonal tension gashes and each other. Sulfide veins (SuV) appear to cut many of the SAV2 or earlier veins. All magmatic and alteration veins are post-kinematic with respect to the crystal-plastic deformation. Crosscutting relationships demonstrate that CP>MV>SAV1>SAV2>SuV.

Figure 1.4: Leg 209 structural VCD: core section 1268A16R1 (*Shipboard Scientific Party, 2004*).

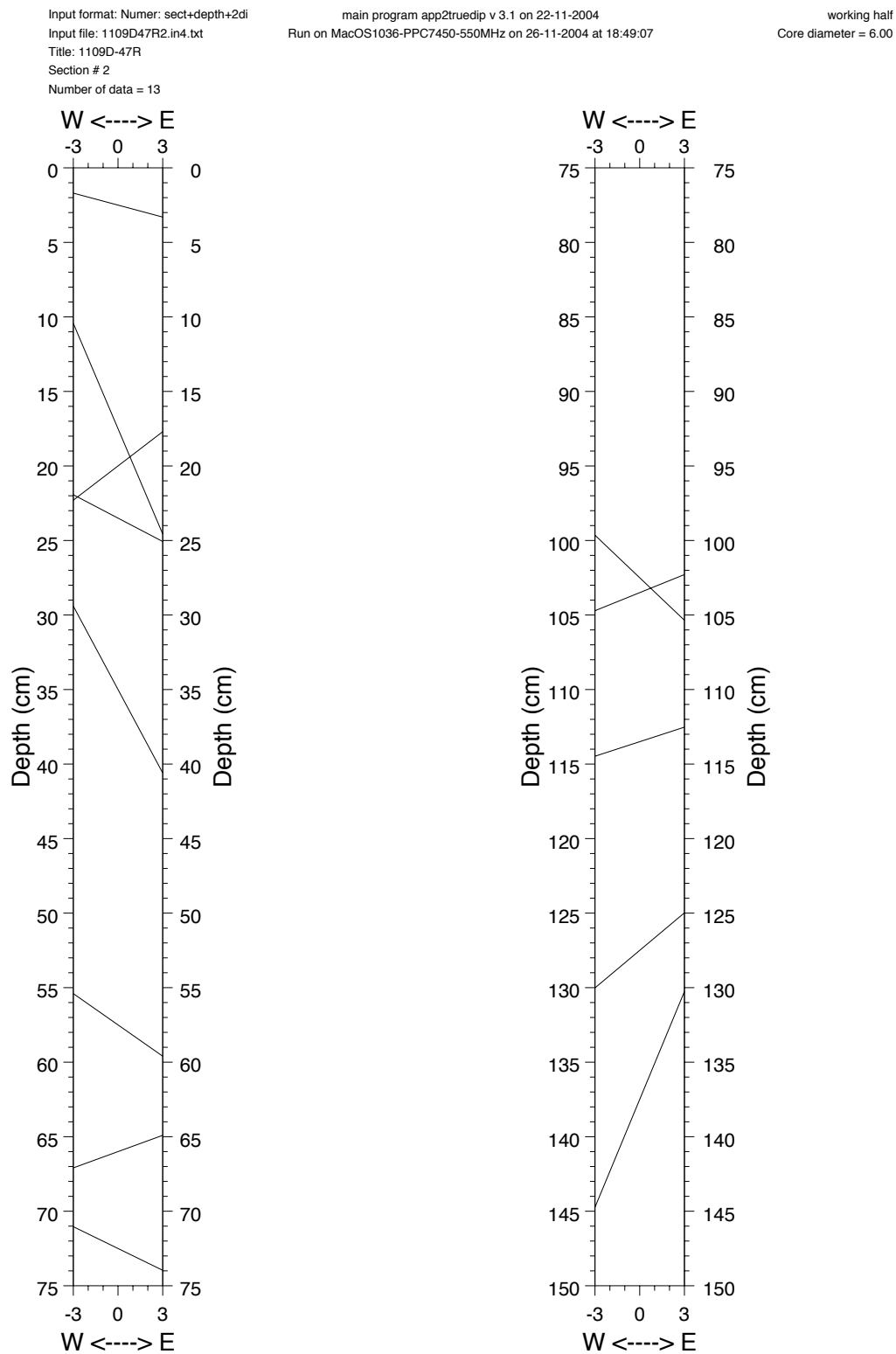


Figure 1.5: Section plot for working half of 1109D47R2 with leg 180 VCD template of Fig. 1.3

Input format: Numer: sect+depth+2di
 Input file: 1109D47R2.in4.txt
 Title: 1109D-47R
 Section # 2
 Number of data = 13

main program app2truedip v 3.1 on 22-11-2004
 Run on MacOS1036-PPC7450-550MHz on 26-11-2004 at 18:49:07

working half
 Core diameter = 6.00

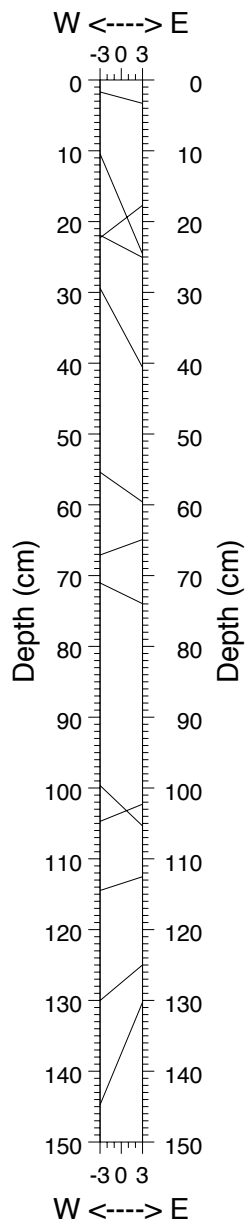


Figure 1.6: Section plot for working half of 1109D47R2 with leg 209 VCD template of Fig. 1.4

Chapter 2

Input files

2.1 Introduction

APP2TRUEDIPG accepts 4 types of structural measurements input files:

1. **alphanumeric orientation input files** that were designed for core structural measurements made in ODP legs where apparent dip directions were measured along North, East, South, and West conventional directions and labeled by the characters E, W, N, S;
2. **numerical orientation input files** that are made for measurements of apparent dips along any azimuth and where the azimuth is thus given as a number.
3. **alphanumeric depth+orientation input files** where section number and depth is added to alphanumeric orientation;
4. **numerical depth+orientation input files** where section number and depth is added to numerical orientation;

The first 2 types allow dip restoration and orientation statistics plots, whereas the last 2 types allow additional plots of structures on a VCD template. This chapter describes the formats of these 4 data files.

2.2 Common conventions for the 4 types of input files

The input files are **FORTRAN sequential input files** that are read in **FORTRAN free format**. They are **ASCII** text files containing space or tab delimited character strings or numbers, where character strings need further be delimited by single quotes. They can be created in and then exported from **text editors**, **spreadsheets**, or **word processors** as detailed in section 4.4. Further sequential files details and caveats are set out in Chapter 4.

Input files follow a [standard file](#) structure that begins with a [standard header](#) which is followed by [standard data lines](#).

The [standard header](#) contains two lines with a title in the first line and columns headers in the second line.

The [data lines](#) formats are specific for each type of file and cannot be mixed in the same file. They are described below.

2.3 Orientation only input files

2.3.1 Alphanumerical orientation input files

There are 2 cases for input data lines that correspond to two different couples of measurements:

- case 1: two apparent dips or
- case 2: one apparent dip with one strike direction.

These cases can be mixed at will in the input file.

2.3.1.1 Alphanumerical orientation data line case 1: two apparent dips

Table 2.1: Alphanumerical orientation input data line case 1.

Column ¹	Parameter	Type	units	Range	Comments
1	apparent dip 1	real	degrees	[0°, 90°]	Dip = 0° not allowed in this column, except for horizontal planes
2	azimuth 1	character		'E','W' ²	Only E or W azimuths in this column
3	apparent dip 2	character	degrees	[0°, 90°]	Dip = 0° allowed here; if along E or W, must be entered as strike instead (case 2)
4	azimuth 2	real		'N','S' ²	Only N or S azimuths in this column

¹ Column number refers to spreadsheet columns, i.e., to the tab-separated entries in the text file.

² N, E, S, W are upper case, single character variables delimited by single quotes. N, E, S, W = North, East, South, West.

Three rules must be followed:

- E or W apparent dip measurements must be in columns 1 and 2;

- S or N apparent dip measurements must be in columns 3 and 4;
- 0° dip measurements must not be in columns 1 and 2, but in columns 3 and 4. The only exception is for horizontal planes where both apparent dips are zero and thus zero dip is accepted in the first column.

Particular cases:

- horizontal planes: both apparent dips = 0° can be entered; this is the only case where dip = 0° is accepted in column 1;
- non horizontal planes striking E or W, thus with one apparent dip = 0° measurement along E or W directions, cannot be entered in alphanumerical data line case 1: they have to be entered as dip and strike measurements in alphanumerical data line case 2;
- vertical plane measurements should be entered as dip and strike measurements in alphanumerical data line case 2.

The alphanumerical data line case 1 is described in Table 2.1.

2.3.1.2 Alphanumerical orientation data line case 2: one apparent dip with one strike direction

Table 2.2: Alphanumerical orientation input data line case 2.

Column ¹	Parameter	Type	units	Range	Comments
1	apparent dip 1	real	degrees	[0°, 90°]	Dip = 0° not allowed in this column, except for horizontal planes
2	azimuth 1	character		'E', 'W', 'N', 'S' ²	
3	strike	real	degrees	[-360°, +360°]	
4	strike indicator	character		'A' ³	

¹ Column number refers to spreadsheet columns, i.e., to the tab-separated entries in the text file.

² N, E, S, W are upper case, single character variables delimited by single quotes. N, E, S, W = North, East, South, West.

³ A is an upper case, single character variable delimited by single quotes that indicates that strike is given in column 3.

Rules to follow:

- Apparent dip data is given in columns 1 and 2 and can be along E, W, N or S
- Strike is given in column 3 followed by 'A' (for Azimuth) in column 4
- Strike should be chosen so that dip is to the right (if not, it will be corrected)

The alphanumerical data line case 2 is described in Table 2.2.

2.3.2 Numerical orientation input files

Only one restriction must be followed:

- 0 dip measurements must not be in columns 1 and 2, but in columns 3 and 4. The only exception is for horizontal planes where both apparent dips are zero and thus zero dip is accepted in the first column.

The numerical orientation data line is described in Table 2.3.

Table 2.3: Numerical orientation input data line.

Column ¹	Parameter	Type	units	Range	Comments
1	apparent dip 1	real	degrees	[0°, 90°]	Dip = 0° not allowed in this column, except for horizontal planes
2	azimuth 1	real	degrees	[-360°, +360°]	
3	apparent dip 2	real	degrees	[0°, 90°]	Dip = 0° allowed here
4	azimuth 2	real	degrees	[-360°, +360°]	

¹ Column number refers to spreadsheet columns, i.e., to the tab-separated entries in the text file.

2.4 Depth+orientation input files

2.4.1 Alphanumerical depth+orientation input files

This format is similar to that of [alphanumerical orientation input files](#), but for the addition of section number and depth in the first two columns. There are 2 cases for input data lines that correspond to two different couples of measurements:

- case 1: two apparent dips or
- case 2: one apparent dip with one strike direction.

These cases can be mixed at will in the input file.

2.4.1.1 Alphanumerical depth+orientation data line case 1: two apparent dips

Three rules must be followed:

- E or W apparent dip measurements must be in columns 3 and 4;
- S or N apparent dip measurements must be in columns 5 and 6;

- 0° dip measurements must not be in columns 3 and 4, but in columns 5 and 6. The only exception is for horizontal planes where both apparent dips are zero and thus zero dip is accepted in the 3rd column.

Particular cases:

- horizontal planes: both apparent dips = 0° can be entered; this is the only case where dip = 0° is accepted in column 3;
- non horizontal planes striking E or W, thus with one apparent dip = 0° measurement along E or W directions, cannot be entered in alphanumerical data line case 1: they have to be entered as dip and strike measurements in alphanumerical data line case 2;
- vertical plane measurements should be entered as dip and strike measurements in alphanumerical data line case 2.

The alphanumerical depth+orientation data line case 1 is described in Table 2.4.

Table 2.4: Alphanumerical depth+orientation input data line case 1.

Column ¹	Parameter	Type	units	Range	Comments
1	section number	integer		[1, 7]	
2	depth ²	real	cm	[0, 150]	
3	apparent dip 1	real	degrees	[0° , 90°]	Dip = 0° not allowed in this column, except for horizontal planes
4	azimuth 1	character		'E', 'W' ³	Only E or W azimuths in this column
5	apparent dip 2	character	degrees	[0° , 90°]	Dip = 0° allowed here; if along E or W, must be entered as strike instead (case 2)
6	azimuth 2	real		'N', 'S' ³	Only N or S azimuths in this column

¹ Column number refers to spreadsheet columns, i.e., to the tab-separated entries in the text file.

² Depth is measured downwards from the top of the section.

³ N, E, S, W are upper case, single character variables delimited by single quotes. N, E, S, W = North, East, South, West.

2.4.1.2 Alphanumerical depth+orientation data line case 2: one apparent dip with one strike direction

Rules to follow:

- Apparent dip data is given in columns 3 and 4 and can be along E, W, N or S

- Strike is given in column 5 followed by 'A' (for Azimuth) in column 6
- Strike should be chosen so that dip is to the right (if not, it will be corrected)

The alphanumerical depth+orientation data line case 2 is described in Table 2.5.

Table 2.5: Alphanumerical depth+orientation input data line case 2.

Column ¹	Parameter	Type	units	Range	Comments
1	section number	integer		[1, 7]	
2	depth ²	real	cm	[0, 150]	
3	apparent dip 1	real	degrees	[0°, 90°]	Dip = 0° not allowed in this column, except for horizontal planes
4	azimuth 1	character		'E', 'W', 'N', 'S' ³	
5	strike	real	degrees	[-360°, +360°]	
6	strike indicator	character		'A' ⁴	

¹ Column number refers to spreadsheet columns, i.e., to the tab-separated entries in the text file.

² Depth is measured downwards from the top of the section.

³ N, E, S, W are upper case, single character variables delimited by single quotes. N, E, S, W = North, East, South, West.

⁴ A is an upper case, single character variable delimited by single quotes that indicates that strike is given in column 5.

2.4.2 Numerical depth+orientation input files

Table 2.6: Numerical depth+orientation input data line.

Column ¹	Parameter	Type	units	Range	Comments
1	section number	integer		[1, 7]	
2	depth ²	real	cm	[0, 150]	
3	apparent dip 1	real	degrees	[0°, 90°]	Dip = 0° not allowed in this column, except for horizontal planes
4	azimuth 1	real	degrees	[-360°, +360°]	
5	apparent dip 2	real	degrees	[0°, 90°]	Dip = 0° allowed here
6	azimuth 2	real	degrees	[-360°, +360°]	

¹ Column number refers to spreadsheet columns, i.e., to the tab-separated entries in the text file.

² Depth is measured downwards from the top of the section.

This format is similar to that of [numerical orientation input files](#), but for the addition of section number and depth in the first two columns.

Only one restriction must be followed:

- 0 dip measurements must not be in columns 3 and 4, but in columns 5 and 6. The only exception is for horizontal planes where both apparent dips are zero and thus zero dip is accepted in the 3rd column.

The numerical depth+orientation data line is described in [Table 2.6](#).

2.5 Input examples

2.5.1 Input data examples

Examples of acceptable and erroneous orientation data are given for

- alphanumeric input in [Table 2.7](#),
- and for numerical input in [Table 2.8](#).

2.5.2 Input files samples

Samples for each type of input file are available in the 'Sample_files' folder as follows:

- alphanumeric orientation input file: [894G8R1_in1_aln.txt](#) (*Shipboard Scientific Party, 1993b*)
- numerical orientation input files: [1109D47R2.in2.txt](#) (*Shipboard Scientific Party, 1999c*)
- alphanumeric depth+orientation input file: [894G8R1_in1_zaln.txt](#) (*Shipboard Scientific Party, 1993b*)
- numerical depth+orientation input file: [1109D47R2.in4.txt](#) (*Shipboard Scientific Party, 1999c*)

Table 2.7: Examples of alphanumerical input data lines.

Columns				Comments
1	2	3	4	
41	'E'	56	'S'	OK case 1: 2 dips
41	'W'	56	'S'	OK case 1: 2 dips (*)
41	'E'	56	'N'	OK case 1: 2 dips
41	'W'	56	'N'	OK case 1: 2 dips
60	'W'	0	'S'	OK case 1: dip + strike
0	'W'	0	'N'	OK case 1: horizontal plane
56	'S'	41	'W'	Faulty case 1: 2 dips, the E-W data should be first as in (*)
0	'W'	60	'N'	Faulty case 1: dip + strike, dip = 0° should be entered as strike as in (**)
90	'E'	30	'A'	OK case 2: vertical plane
60	'E'	0	'A'	OK case 2: dip + strike
60	'S'	90	'A'	OK case 2: dip + strike
60	'W'	180	'A'	OK case 2: dip + strike
60	'N'	270	'A'	OK case 2: dip + strike (**)
60	'N'	90	'A'	Flawed case 2: dip + strike, strike will be corrected to 270° (dip to the right)

Table 2.8: Examples of numerical input data lines.

Columns				Comments
1	2	3	4	
41	90	56	180	OK 2 dips
41	270	56	180	OK 2 dips
56	0	41	90	OK 2 dips
56	0	41	270	OK 2 dips
60	270	0	180	OK dip + strike
0	270	0	0	OK 2 dips: horizontal plane
0	270	60	0	Faulty dip + strike: dip = 0° should be entered second as in (*)
90	90	0	30	OK dip + strike: vertical plane
60	90	0	0	OK dip + strike
60	180	0	90	OK dip + strike
60	270	0	180	OK dip + strike
60	0	0	270	OK dip + strike (*)
60	0	0	90	Flawed dip + strike: strike will be corrected to 270° (dip to the right)

Chapter 3

Output files

3.1 Introduction

APP2TRUEDIPG generates 4 types of output files:

1. **alphanumeric orientation output files** when the input file is **alphanumeric orientation**;
2. **numerical orientation output files** when the input file is **numerical orientation**;
3. **alphanumeric depth+orientation output files** when the input file is **alphanumeric depth+orientation**;
4. **numerical depth+orientation output files** when the input file is **numerical depth+orientation**.

This chapter describes the formats of these 4 output files.

3.2 Common characteristics of the 4 types of output files

The output files are **FORTRAN sequential output files**. They are **ASCII** text files containing tab delimited characters and numbers so as to facilitate importing the results into a spreadsheet. Character strings are delimited by single quotes so that the output file can also be used as **input file** for APP2TRUEDIPG. Further sequential files specifications can be found in Chapter 4.

The 4 types of output files follow a **standard file** structure that begins with a **standard header** which is followed by **standard data lines**.

The **standard header** contains two lines with a title in the first line and columns headers in the second line.

Data lines are specific to each type of output file and are described below.

3.3 Orientation only output files

In both types of orientation output files, the [data lines](#) contain 7 columns:

- Columns 1 to 4 repeat the input data in the same format as in the input file,
- Columns 5 and 6 contain the results of the restoration: strike (with dip to the right convention) and true dip,
- Column 7 contains comments.

3.3.1 Alphanumerical orientation output files

There are 2 formats for output data lines that correspond to the two different input couples of measurements:

1. two apparent dips or
2. one apparent dip with one strike direction.

3.3.1.1 Alphanumerical orientation data line case 1: two apparent dips input

The alphanumerical orientation output data line case 1 is described in [Table 3.1](#).

Table 3.1: Alphanumerical orientation output data line case 1.

Column ¹	Parameter	Type	units	Range
1	apparent dip 1	real	degrees	[0°, 90°]
2	azimuth 1	character		'E', 'W' ²
3	apparent dip 2	real	degrees	[0°, 90°]
4	azimuth 2	character		'N', 'S' ²
5	strike ³	real	degrees	[0°, +360°]
6	true dip	real	degrees	[0°, 90°]
7	comments ⁴	character		

¹ Column number refers to spreadsheet columns, i.e., to the tab-separated entries in the text file.

² N, E, S, W = North, East, South, West.

³ Such that dip is to the right.

⁴ Eventual explanation of the input data problem that precluded computation.

3.3.1.2 Alphanumerical orientation data line case 2: one apparent dip with one strike direction input

The alphanumerical orientation output data line case 2 is described in Table 3.2.

Table 3.2: Alphanumerical orientation output data line case 2.

Column ¹	Parameter	Type	units	Range
1	apparent dip 1	real	degrees	[0°, 90°]
2	azimuth 1	character		'E', 'W', 'N', 'S' ²
3	strike ³	real	degrees	[-360°, +360°]
4	strike indicator	character		'A' ⁴
5	strike ⁵	real	degrees	[0°, +360°]
6	true dip	real	degrees	[0°, 90°]
7	comments ⁶	character		

¹ Column number refers to spreadsheet columns, i.e., to the tab-separated entries in the text file.

² N, E, S, W = North, East, South, West.

³ Eventually corrected so that dip is to the right.

⁴ A indicates that strike is given in column 3.

⁵ Such that dip is to the right.

⁶ Eventual explanation of the input data problem that precluded computation.

3.3.2 Numerical orientation output files

The numerical orientation data line is described in Table 3.3.

Table 3.3: Numerical orientation output data line.

Column ¹	Parameter	Type	units	Range
1	apparent dip 1	real	degrees	[0°, 90°]
2	azimuth 1	real	degrees	[-360°, +360°]
3	apparent dip 2	real	degrees	[0°, 90°]
4	azimuth 2	real	degrees	[-360°, +360°]
5	strike ²	real	degrees	[0°, +360°]
6	true dip	real	degrees	[0°, 90°]
7	comments ³	character		

¹ Column number refers to spreadsheet columns, i.e., to the tab-separated entries in the text file.

² Such that dip is to the right.

³ Eventual explanation of the input data problem that precluded computation.

3.4 Depth+orientation output files

In both types of depth+orientation output files, the [data lines](#) contain 9 columns

- Columns 1 to 6 repeat the input data in the same format as in the input file,
- Columns 7 and 8 contain the results of the restoration: strike (with dip to the right convention) and true dip,
- Column 9 contains comments.

3.4.1 Alphanumerical depth+orientation output files

This format is similar to that of [alphanumerical orientation output files](#), but for the addition of section number and depth in the first two columns. Two cases of output data lines correspond to the two different input couples of measurements:

1. two apparent dips or
2. one apparent dip with one strike direction.

3.4.1.1 Alphanumerical depth+orientation data line case 1: two apparent dips input

The alphanumerical depth+orientation output data line case 1 is described in [Table 3.4](#).

Table 3.4: Alphanumerical depth+orientation output data line case 1.

Column ¹	Parameter	Type	units	Range
1	section number	integer		[1, 7]
2	depth	real	cm	[0, 150]
3	apparent dip 1	real	degrees	[0°, 90°]
4	azimuth 1	character		'E', 'W' ²
5	apparent dip 2	real	degrees	[0°, 90°]
6	azimuth 2	character		'N', 'S' ²
7	strike ³	real	degrees	[0°, +360°]
8	true dip	real	degrees	[0°, 90°]
9	comments ⁴	character		

¹ Column number refers to spreadsheet columns, i.e., to the tab-separated entries in the text file.

² N, E, S, W = North, East, South, West.

³ Such that dip is to the right.

⁴ Eventual explanation of the input data problem that precluded computation.

3.4.1.2 Alphanumerical depth+orientation data line case 2: one apparent dip with one strike direction input

The alphanumerical depth+orientation output data line case 2 is described in Table 3.5.

Table 3.5: Alphanumerical depth+orientation output data line case 2.

Column ¹	Parameter	Type	units	Range
1	section number	integer		[1, 7]
2	depth	real	cm	[0, 150]
3	apparent dip 1	real	degrees	[0°, 90°]
4	azimuth 1	character		'E', 'W', 'N', 'S' ²
5	strike ³	real	degrees	[-360°, +360°]
6	strike indicator	character		'A' ⁴
7	strike ⁵	real	degrees	[0°, +360°]
8	true dip	real	degrees	[0°, 90°]
9	comments ⁶	character		

¹ Column number refers to spreadsheet columns, i.e., to the tab-separated entries in the text file.

² N, E, S, W = North, East, South, West.

³ Eventually corrected so that dip is to the right.

⁴ A indicates that strike is given in column 3.

⁵ Such that dip is to the right.

⁶ Eventual explanation of the input data problem that precluded computation.

3.4.2 Numerical depth+orientation output files

This format is similar to that of [numerical orientation output files](#) but for the addition of section number and depth in the first two columns. The numerical depth+orientation data line is described in Table 3.6.

3.5 Output example

An example of numerical depth+orientation output file is available in the 'Sample_files' folder: [1109D47R2.out4.txt](#) which is generated from the input file [1109D47R2.in4.txt](#).

Table 3.6: Numerical depth+orientation output data line.

Column ¹	Parameter	Type	units	Range
1	section number	integer		[1, 7]
2	depth	real	cm	[0, 150]
3	apparent dip 1	real	degrees	[0°, 90°]
4	azimuth 1	real	degrees	[-360°, +360°]
5	apparent dip 2	real	degrees	[0°, 90°]
6	azimuth 2	real	degrees	[-360°, +360°]
7	strike ²	real	degrees	[0°, +360°]
8	true dip	real	degrees	[0°, 90°]
9	comments ³	character		

¹ Column number refers to spreadsheet columns, i.e., to the tab-separated entries in the text file.

² Such that dip is to the right.

³ Eventual explanation of the input data problem that precluded computation.

Chapter 4

Fortran sequential files

4.1 Introduction

This chapter describes a few common attributes of sequential files used as input for or output from FORTRAN programs.

4.2 Fortran input/output sequential files

- Input or output sequential files are ASCII files, i.e. plain text files without accentuated characters. If input files are prepared within a software other than a pure [text editor](#), such as a [word processor](#) or a [spreadsheet](#), they need be exported as text only files.
- During input, each reading statement normally focusses on one input line with the following conventions:
 - if all the data to be read within a line are found, the rest of the line is not read; the next input statement will seek its data in the next line; this implies that extra information can be added AFTER the required data without affecting the input;
 - if all the data to be read are not found within a line, the missing data will be sought in the next line; this implies that an incomplete line will be completed by the probably misinterpreted next line.
- There are two possible formats for FORTRAN sequential files: [free](#) or [fixed](#) formats.

4.2.1 Fortran free format

- Input reading rules:
 - numbers must be delimited by empty spaces or tabulations;

- character strings must be delimited by single quotes, ' , to be read properly.
- Possible file preparation:
 - in a [text editor](#), [spreadsheet](#), or [word processor](#), and saved as text only;
 - saving as tab separated text is most convenient, as it is easily exchanged with [spreadsheets](#).

Free format is preferred and used as much as possible for input, not only because it is insensitive to exact data placement in the line (it is only sensitive to data order sequence and delimiters), which avoids many causes of input error, but also because it can easily be exchanged with [spreadsheets](#).

4.2.2 Fortran fixed format

- Input reading rules:
 - numbers and character strings are read within a specific column location; column here meaning the number of characters (or spaces) counted from the beginning of the line;
 - no delimiters are necessary: character strings or numbers are delimited by their column location;
 - a column offset in a data line will result in misinterpreted data; for instance, if '1234' or 'abcd' are offset by one column to the left, they will be read in input as '2340' and 'bcd '.
- Possible file preparation:
 - in a [text editor](#) (recommended) or a [word processor](#) and saved as text only; each character or digit position must be counted from the beginning of each line.

Fixed format thus does not tolerate errors in data placement in the line, but does not require delimiters, which make it convenient in some circumstances.

4.3 Operating system issues

4.3.1 Encoding

Text encoding systems that are compatible with [ASCII](#) should work. On MacOS X both Mac OS Roman and UTF-8 work.

4.3.2 End of line

The special character used to mark the end of line (EOL) in the input file must be consistent with the system used to run the software (Table [4.1](#)). If the end of line is not

recognized, the whole input file may appear as a single line to the program. Problems tend to arise when the file is transferred from one operating system to another, or when the file is exported from a [word processor](#) or [spreadsheet](#). If ftp is used between systems, setting text, instead of binary, transfer of data files should translate the end of line.

It is therefore recommended to use a [text editor](#) to check, and eventually correct, end of line characteristics of data files that have been exchanged between systems or that have been exported from a [word processor](#) or a [spreadsheet](#).

Table 4.1: End of line (EOL) coding in common operating systems.

Operating system	EOL symbol	EOL description
MacOS X	LF	Line Feed
Unix	LF	Line Feed
Windows	CRLF	Carriage Return + Line Feed
MacOS Classic	CR	Carriage Return

4.3.3 End of file

- Always terminate the file with an empty line (extra line with no space). This avoids putting the end of file (EOF) tag in the last data line. In some systems, including MacOS X, such a situation can result in the last data line not being read.
- Always check that the number of data stored in the program is exactly the expected number of data. If one datum is missing, the above most likely applies.

4.4 Creating input files

Data files can be created with a [text editor](#) (recommended) or exported from a [word processor](#). [Free format](#) data files can also be exported from a [spreadsheet](#).

4.4.1 Text editors

Preparing an input file with a text editor has the advantage of directly creating a plain text file. There then only remain two issues to deal with when saving the file:

1. check and eventually modify [end of line](#) coding, and
2. make sure the [end of file](#) is below the last data line.

Here are a few text editors that allow to verify and alter end of line and text encoding of text files:

- under MacOS X: [TextWrangler](#), [BBEdit](#), [Smultron](#), and [Plain Text Editor](#);
- under Windows: [ConTEXT](#).

4.4.2 Spreadsheets

Input files that are read in [free format](#) can be exported from spreadsheet. There are then four issues to deal with:

1. exporting the file as tab delimited text,
2. making sure that character strings are enclosed within quotes for [free format](#) files,
3. checking and eventually correcting [end of line](#) coding, and
4. making sure the [end of file](#) is below the last data line.

The last three issues are best dealt with by importing the file into a [text editor](#).

4.4.3 Word processors

Finally, input files can also be exported from a word processor. Three issues must be dealt with:

1. exporting the file in plain text (tab delimited columns recommended),
2. checking and eventually correcting [end of line](#) coding, and
3. making sure the [end of file](#) is below the last data line.

Again, the last two issues are best dealt with by importing the file into a [text editor](#).

4.5 Standard input/output files

A file format designed to be easily exchanged with [spreadsheets](#) is called 'standard file' in this documents and used as much as possible by the software.

4.5.1 Standard file structure

- Data files are [ASCII](#) files.
- They are made of a header followed by data lines.

4.5.2 Standard header

The standard header is made of two lines:

1. Title line: the first line contains the title.
2. Columns headers line: the second line contains the columns headers

The standard header is read in [free format](#): title and column headers are character strings and need be delimited by single quotes ' , so as to be read properly.

4.5.3 Standard data line

- All parameters for each datum are given in a single data line.
- Data line are read in [free format](#). Parameters may be separated by empty spaces or tabs. Character strings need be delimited by single quotes '.

4.5.4 Standard file example

Example of a standard data file with 2 reals, 1 integer and 1 character string per data. Here are the 3 first lines of the file with two header lines and the first data line:

1. 'Title'
2. 'Parameter-1' 'Parameter-2' 'Parameter-3' 'Parameter-4'
3. 12000.6 2999.4567 245 'label-of-data1'

Chapter 5

How to refer to App2truedipG and relevant references

5.1 How to refer to App2truedipG

If you publish results obtained with APP2TRUEDIPG, it would be appreciated that you referred to:

- the software version and its location as:
Celerier, B., YYYY, APP2TRUEDIPG: Apparent to true dip restoration with graphics software, version XX.X,
<http://www.celerier.gm.univ-montp2.fr/software/dcmt/app2truedipg/app2truedipg.html>.
where XX.X and YYYY are the version and year of the software used that are displayed in the console when the program starts and terminates.

5.2 Other relevant references

- Early ODP conventions for structural measurements in boreholes with reference frame different from that in paleomagnetism: *Shipboard Scientific Party* (1991a, 1992a).
- Usual ODP conventions for structural measurements in boreholes with same reference frame as that in paleomagnetism: *Shipboard Scientific Party* (1992b,c, 1993a, 1995, 1999a,b, 2003).
- Core structures reoriented with paleomagnetism: *Shipboard Scientific Party* (1991b); *Lallemant et al.* (1993).
- Core structures reoriented with imaging logs: *MacLeod et al.* (1992); *MacLeod and Pratt* (1994).

Chapter 6

App2truedipG revision history

APP2TRUEDIP was originally designed in summer 1997 to restore strike and dip of planar structures measured as two apparent dips on ODP Leg 176 cores. Numerical input format was added during Leg 180 in summer 1998. Originally developed on MacOS Classic, it was ported to SUNOS workstations, and to MacOS X. APP2TRUEDIPG branched out from version 2.1 to add graphics. Version history is summarized in Table 6.1.

Table 6.1: APP2TRUEDIPG program versions

Version	Date	Comments
4.4	21 March 2025	Restructure input validation tests, revise menus, dialogs and output comments, add run information in output files, f90.
4.3	29 August 2022	Adapt to upgraded libraries.
4.2	1 January 2018	Adapt to upgraded libraries.
4.1	17 May 2012	Adapt to new library, improve plot axes.
4.0	17 May 2012	Adapt to upgraded libraries, last MacOS Classic version.
3.1	26 November 2004	Introduce plots, standard file header
3.0	15 November 2004	APP2TRUEDIPG branches out from APP2TRUEDIP, restructure with main loop and menu.
2.1	10 November 2004	Allows input from file or keyborad, output to file or screen; MacOS X version.
2.0	22 June 1998	Add numerical input format.
1.0	30 July 1997	Alphanumerical input format only.

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