User's Guide to CHRONOS Age-Depth Plot Version 1.00

Geoffrey C. Bohling

Kansas Geological Survey Open File Report 2004-55
December 2004

Abstract

CHRONOS (www.chronos.org) is an NSF-funded project to develop an interactive network of data and tools for exploration and analysis of earth system history. One of the most important steps in analysis and correlation of stratigraphic data is establishing an age model or line of correlation for an individual core hole or stratigraphic section. The CHRONOS Age-Depth Plot (ADP) is a Java re-implementation of an earlier Macintosh program for plotting the ages of stratigraphic events versus depth and interactively fitting a line of correlation to those data. ADP is delivered from the CHRONOS web site via Java WebStart and runs locally on the user's machine, allowing access to local data files as well as data from the Neptune database via a GIS interface. ADP allows the user to develop a line of correlation (LOC) using a palette of tools for adding, moving, and deleting LOC control points. In addition, the user is able to zoom in to a more detailed view of different plot regions, toggle the display of different plot groups, and edit plot and axis titles and labeling. Output options include saving of the LOC control point data, event data projected to the LOC, and of the plot itself in PNG, JPEG, or SVG (Scalable Vector Graphics) format. SVG is an XML specification for describing vector graphics and the output SVG file is designed for convenient editing of various plot characteristics, with font and line characteristics for various plot elements and the palette of plotting symbols defined at the top of the file. In addition to being a useful application in its own right, ADP serves as a prototype for other clients interfacing with the web services provided by the CHRONOS portal.

1. Introduction

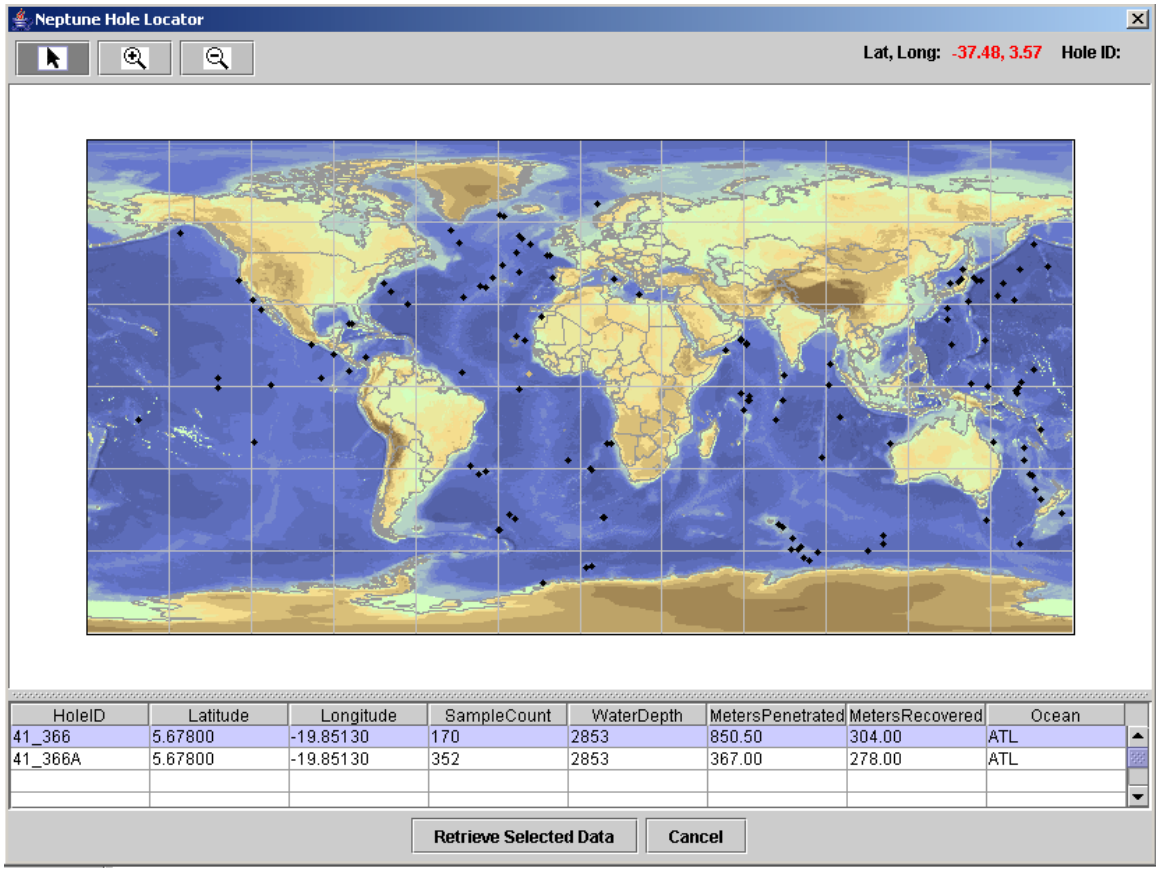
The CHRONOS Age-Depth plotting program, ADP, is a Java re-implementation of the ADP program written by Dave Lazarus for the Macintosh (Lazarus, 1992; Lazarus, 1995). As a Java program, it can run on multiple platforms (Window, Mac, UNIX/Linux) and can take advantage of Java's extensive networking support to access data over the web. ADP reads paleontological age-depth data from CHRONOS's Neptune database or from local files, plots those data, and allows interactive fitting of a line of correlation or age model. The Neptune database contains paleontological data from Deep Sea Drilling Project and Ocean Drilling Project holes (Spencer-Cervato, 1999).

2. Downloading and starting the program

ADP runs under the Java runtime environment (1.4 or higher) and is downloaded and launched from the CHRONOS web site (www.chronos.org) via Java WebStart. With the initial download, the application is cached on your hard drive and run locally. Thereafter, you can run the program offline (without an internet connection). However, if you are online when you start the program, WebStart will automatically check whether an updated version is available from the CHRONOS website. Of course, you will not be able to connect to the Neptune database if you are working offline.

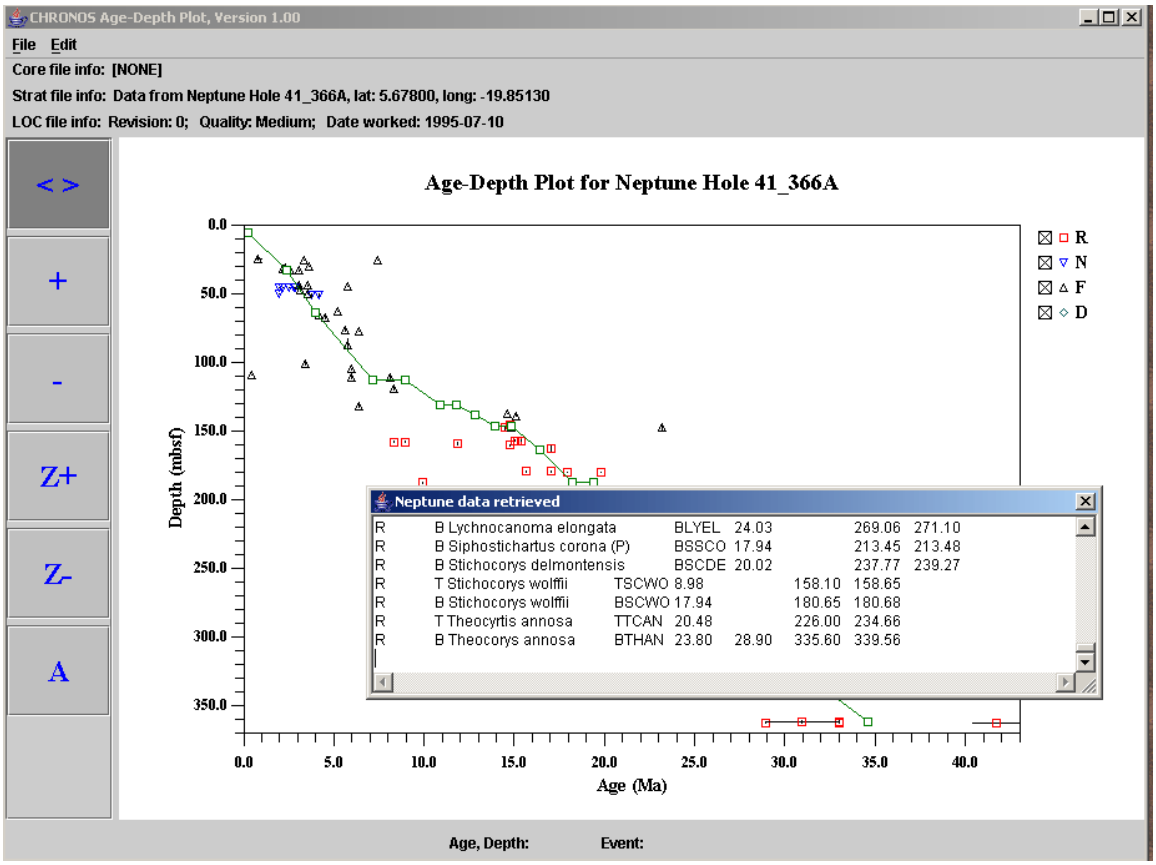
3. Reading stratigraphic data from the Neptune database

To retrieve data from the Neptune database, select **Get Neptune Data...** from the **File** menu. In a moment, you should be presented with a world map showing locations of DSDP and ODP holes represented in the database. Initially, the hole selection tool (pointer) is activated. While this button is activated, you can click on the map to select holes near the cursor location. The information for the selected holes will appear in the data table at the bottom. When working with the map window, choose the **Zoom in** button (magnifying glass with "+") and then drag a rectangle on the map and release to zoom in to that region. Then click on the pointer button to return to hole-selection mode. The **Zoom out** button (magnifying glass with "-") will automatically zoom back out to global extent, leaving the current mode (selection or zoom-in) unchanged. For any zooming operation, there will be a bit of a pause while the code retrieves a new world relief image at the appropriate scale.



To retrieve the data for one of the holes displayed in the data table, select the appropriate row in the table with a single click on any cell in that row and then click **Retrieve Selected Data**. A text window will then appear, displaying the stratigraphic event data as

they are retrieved from the database. Once the all the events for the hole are found, the title of the text window changes from **Retrieving Neptune data...** to **Neptune data retrieved** and the plot is made. You can get the data window out of the way either by closing it (click on the **x** in the corner) or repositioning it or by clicking on the main application (plot) window to bring it to the front. Later, you can re-display the data window by selecting **Show Data Window** from the **Edit** menu.



The data window displays data as tab-delimited fields, in the same format as a local stratigraphic event file (Section 12). On most systems you should be able to select and copy the data and then paste them into a text editor to create a local file. A right-click (Windows) or ctrl-click (Mac) on the text area should bring up an editing pop-up menu.

The code will also attempt to retrieve an age model from the Neptune database and display it, along with information regarding the age model quality and the date it was developed (in the LOC file info line at the top of the application). If it cannot find an age model for the selected hole, it will generate the default straight-line LOC connecting the extreme depth and age values.

4. Reading stratigraphic data from local files

To read data from local files, select **Read data...** from the **File** menu to initiate data input. You will then be presented with two dialog boxes in succession, the first asking you to locate and open a core-depth data file (Section 11) and the second asking you to locate and open a stratigraphic event data file (Section 12). The captions at the top of each dialog box indicate what they are asking for, but you have to pay close attention to notice them.

All ADP data files are plain text files, but the program enforces no file-naming conventions. Use names that help you remember what is in each file.

The information in the core-depth data file is used to interpret any stratigraphic event depths that are in core-section,cm format in the stratigraphic event data file. However, the core-depth data are not required to interpret stratigraphic event depths that are already presented in meters below sea floor (mbsf). You may skip input of core-depth data by clicking **Cancel** on the first dialog box. In this case, the program will still present you with the stratigraphic event data file dialog box and will still read and plot events with depths in mbsf.

As the stratigraphic event file is processed, the data window will show the resulting data values, with the depths in mbsf (rather than core-section,cm format). Once the data have been processed, the plot will update. Again, you can either close the data window or simply switch to the main application (plot) window by clicking on it. The opening comment lines from both the core-depth and stratigraphic data files are displayed at the top of the application. You should check these to make sure that you have read the files you intended to read.

5. Reading line-of-correlation (LOC) data

Whenever you read in new stratigraphic event data from local files, ADP automatically calculates a line-of-correlation (LOC) consisting of a single straight segment connecting the extreme age and depth values in the dataset. At this point you may either use the palette of buttons to modify the LOC or read in a previously existing LOC from a LOC data file (Section 12). To do the latter, select **Read LOC...** from the **File** menu and use the resulting dialog box to navigate to and open the desired LOC data file.

Once the file is read, the program will display the LOC on the plot and will also display the opening comment line from the LOC file after the **LOC file info** label.

6. Modifying the line-of-correlation

The LOC is represented on the plot as a green line, with open green squares representing the control points for the line. You may move, add, or delete points using the first three buttons in the palette at the left. (Let the mouse hover briefly over a button to see a brief description of its function.) The buttons work as follows:

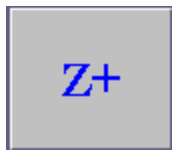
Move a control point. When this button is activated you may use the mouse to grab and drag an existing control point to a new location (click on the point, drag, release). Use the age-depth coordinate label at the bottom of the plot to keep track of the mouse location. Once you grab a point, the program displays light gray lines delimiting the boundaries for a legal move for that point. These boundaries prevent you from creating an age model where age decreases with increasing depth. You may, however, create a hiatus by dragging the mouse beyond the upper or lower bounding line. In this case, the control point will stick at the boundary and will be assigned the bounding depth.

Add a control point. When this button is activated you may add a control point with a single click on the plot. Light gray lines delimit the legal locations for control point additions, again allowing only non-decreasing age with increasing depth.

Delete a control point. When this button is activated you may delete a control point by clicking on it.

7. Changing axis limits

The plot's axis limits may be changed using the following three buttons.



Zoom in. When this button is activated you may zoom in to a rectangular region of interest by clicking and *dragging* out a rectangle on the plot. (If you try to zoom in with just a single click, the plot region will collapse on itself!)

Zoom out. Click this button to zoom the plot back out to the default limits (based on the data range).

Change axis parameters. Click this button to launch a dialog box allowing you to enter numeric values for the axis limits and tick intervals along each axis.

8. Modifying the plot

The plot legend includes checkboxes for toggling the display of the different plot groups. Click in a box to remove the corresponding group from the plot and click it again to re-display that group.

The **Edit** menu contains items for modifying the main plot title and axis titles and for showing and hiding the stratigraphic event labels, which are short character strings read from the stratigraphic event data file. Generally, event labels will overlap unless the density of data in the plot window is fairly low. Lower data densities can be achieved by toggling plot groups off or by zooming in to a more detailed view.

9. Saving the plot

Select **Save plot...** from the **File** menu to save the current plot to a file. The current format options for the output file are SVG (Scalable Vector Graphics), PNG, and JPEG. The latter two options use Java's Robot and ImageIO packages to generate an automatic screen capture of the plot region and write the image to a file. Thus, the output file will contain a raster image of plot region as you see it on the screen (meaning you need to get the data window and other extraneous objects out of the way before using this option). SVG is an XML specification for describing vector graphics and the output SVG file (a plain text file) is designed for convenient editing of various plot characteristics, with font and line characteristics for various plot elements and the palette of plotting symbols defined at the top of the file.

10. Saving data

Use the **Save projected data...** item on the **File** menu to write out a file containing the stratigraphic event data projected to the LOC. You will be asked to enter your name or initials and then a header line comment, both of which will be written to the output file. Then you will be presented with a standard dialog box for specifying the location and name of the output file.

The projection consists of replacing the input age value(s) for each event with the ages on the LOC corresponding to the minimum and maximum depth for that event. The data file will be written in the same format as an input stratigraphic data file, meaning you can read the projected data back in and display them. All the depths in the output file will be in mbsf, so you do not need a core-depth data file to interpret a projected stratigraphic event data file.

Use the **Save LOC...** item to write out the current LOC data to a file. In this case you only get the "save file" dialog box. The first line of the LOC file will contain the hole id and the current date.

11. Core-Depth data file format

The core-depth data file specifies the depth range, in meters below sea floor (mbsf), for each core obtained from a sample hole. It should be a tab-delimited plain text file with two lines of header information, as in the following example:

```
278 2.00   19910225    1       Extracted from CD-ROM
CORE    TOP DEPTH      BOTTOM DEPTH OR BASE RECOVERED SEDS
1        0       6
2        101     110.5
3        110.5   119.5
4        120     127.5
5        129.5   138.5
6        139     148.5
7        148.5   157.8
8        158     167.5
9        167.5   176
```

This file follows the format of the DSDP and ODP core-depth files used in the original (Macintosh) ADP. The five tab-delimited fields in the first line represent the hole ID, a program version number, a date, a file type number, and a comment. The Java version of ADP extracts the hole ID from the first field and displays the entire line following the **Core file info** label at the top of the application. However, after extracting the hole ID, the code does not try to parse the line any further, so the remainder of the line could really contain anything. If you are preparing an input file, use this line to convey the hole ID and any other helpful information regarding the data provenance.

The second line contains headers for the three columns of data. Java ADP simply skips over this line, so its contents have no effect on program operation.

The third and following lines should contain core number, top depth (mbsf), and bottom depth (mbsf) for each core. The cores do not have to be listed sequentially and gaps (no core 6, for example) are allowed.

12. Stratigraphic data file format

The stratigrpahic event data file should be a tab-delimited plain text file containing identifying information, age, and depth values for the events (samples) in a core hole. Event depths may be specified directly as numbers, which are taken to be meters below sea floor (mbsf) or may be entered in core-section,cm format. Events may be assigned either a single age or an age range (minimum to maximum) and similarly either a single depth or a depth range. The opening lines of an example data file follow:

```
278     2       5/7/91    CSC     Schrader  113+119+120
Grp     Event       Plotcode      Y.  Age   Old Age   Top depth Bottom depth
D       FAD N.  curta      bNc     3.64                "16-4,50" "16-5,50"
D       FAD A.  parvulus   bAp     4.58                "29-4,50" "29-6,50"
D       LAD N.  donahuensistNd     5.84                "9-3,50"  "9-4,50 "
D       FAD N.  donahuensisbNd     9.64                "12-2,50" "12-3,50"
D       FAD H.  karstenii  bHk     9.64                "10-6,50" "11-1,50"
```

Like the core-depth data file, this file follows the format of the stratigraphic event files used in the original (Macintosh) ADP. The fields in the first line represent the hole ID, a program version number, a date, initials of the creator of the file, and some comments. The Java version of ADP displays this line following the **Strat file info** label at the top of the application, but does not try to process the line in any way, so its contents do not influence program behavior.

The second line contains headers for the seven columns of data, as a convenience for the human reader. The code skips over this line, so its contents are not crucial.

The third and following lines contain the data. Each line should contain seven tab-delimited fields, as follows:

- **Group code:** A character string (one or more characters) distinguishing and identifying different groups of data, e.g., R for radiolarian, D for diatom, etc. Each group is plotted with a different color and symbol.
- **Event name:** A character string identifying the event. This will be displayed following the **Event** label at the bottom of the application whenever the cursor is over that event.
- **Plot code:** A shorter character string intended as a plotting label for the event. This is not currently used by the program.

- **Minimum age:** Minimum age for the event *or* the single age for the event, if the maximum age field is empty.
- **Maximum age (optional):** Maximum age for the event. If this field is empty (meaning there are two consecutive tabs between the minimum age and minimum depth fields), then the sample will be assigned the minimum age. Events with both a minimum and maximum age will be plotted with a horizontal line representing the age range and with the plotting symbol at the midpoint of the range.
- **Minimum depth:** The minimum or top depth for the event *or* the single depth for the event, if the maximum depth field is empty. Depths may be in mbsf or may be specified in core-section,cm format. Depths in core-section,cm format may be enclosed in double quotes but the quotes are not required.
- **Maximum depth (optional):** The maximum or bottom depth for the event. This may be in mbsf or core-section,cm format. If this field is empty, then the minimum depth will be used as the single depth for the event. Events with both a minimum and maximum depth will be plotted with a vertical line representing the depth range and with the plotting symbol at the midpoint of the range.

Interpreting depths in core-section,cm format

Depths may be specified in core-section,cm format like "5-3,40" (the hyphen and comma are the required delimiters). This means 40 cm below the top of section 3 in core 5. The program assumes that each core is divided into consecutive 1.5-meter sections, so that the top of section 3 is 3.0 meters below the top of core 5. If the top of core 5 is at 60.0 mbsf, then the sample depth in this case is 60.0 + (3-1)*1.5 + 0.40 = 63.4 mbsf.

Depths may also be specified as core-catcher samples. For example, you could use "7-CC" to specify core-catcher samples for core 7. Core-catcher samples are assigned to the bottom depth of the core.

Clearly the core-depth data are required to interpret depths in core-section,cm format. If you cancel reading of the core-depth data file, then only events with depths given in mbsf will be displayed on the plot.

13. LOC data file format

The line-of-correlation (LOC) data file simply contains a sequence of age-depth pairs in two tab-delimited columns, preceded by three header lines, as follows:

```
278     19960813
AGE     DEPTH
 11
 9.08219e-2      .755
 1.99553         167.976
 9.20918         167.976
 11.2385         205.645
 15.8344         269.155
 19.0417         321.457
```

```
19.875          344.554
24.2917         344.554
30.0833         412.402
35.5417         412.402
36.375          424.672
```

The program will display the contents of the first header line following the **LOC file info** label at the top of the application but does not try to process the line, so its contents are immaterial to program operation. The header line in the example above contains a hole ID and a date.

The second line contains headers for the two columns of data and the third line gives the number of data lines to follow. The third line is retained for consistency with LOC data files for the original ADP program. However, the code actually skips over these lines without processing them and will just read data lines until it reaches the end of the file.

The third and following lines should contain tab-delimited age and depth values, both in increasing (or at least non-decreasing) order. These values represent the control points of the LOC. A hiatus is represented by two consecutive ages with the same depth. It is also allowed to have two consecutive depths with the same age, but age may not decrease with increasing depth.

References

D. Lazarus, 1992, Age Depth Plot and Age Maker: Age Modeling of Stratigraphic Sections on the Macintosh Series of Computers, *Geobyte*, February 1992, pages 7-13.

D. Lazarus, 1995, User's Guide to Age-Depth Plot and Age Maker, Version 2.08, August 15, 1995 (unpublished report).

C. Spencer-Cervato, 1999, The Cenozoic deep sea microfossil record: Explorations of the DSDP/ODP sample set using the Neptune database, Palaeontologia Electronica, vol. 2, no. 2 (http://palaeo-electronica.org/1999_2/neptune/issue2_99.htm).