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GEOTOOL SOURCEBOOK: USER'S MANUAL

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This technical report has been reviewed and is approved for publication.

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13. ABSTRACT *(Maximum 200 words)*

This document describes geotool, an interactive data analysis and display program. The first chapter gives an introduction to the program and geotool philosophy. The second chapter discusses installation. The third chapter is a Tutorial, which is good for first time users. The remainder of the document serves as reference material, which discusses the user interface, input files, X resources, and the scheme interface.

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Contents

Chapter 1

Introduction

1.1 What is geotool?

geotool is a data analysis system which strives to reduce the separation between the user and the data. This objective is accomplished by emphasizing visualization and direct manipulation, while minimizing the constraints imposed by the system.

While the seismic capabilities are the most mature, **geotool** can display any time series data, e.g., gravity, tide, acoustic, etc. Data can be read in different formats, including Center for Seismic Studies (CSS) 2.8 and 3.0, SAC, and a generic ASCII format. In addition to reading data stored locally in external files, **geotool** can also read data from commercial Relational Database Management Systems. It can also display data accessed over the World Wide Web (WWW), where it functions as a generic waveform viewer.

This documentation is aimed at a broad audience, from research seismologists, to students, to people surfing the internet. Despite the lack of documentation until recently, **geotool** has many enthusiastic supporters worldwide. We hope that the documentation will enlarge that community.

1.2 Design

In a program as ambitious as **geotool**, a good design is critical to it maintainability and longevity. We believe that **geotool**'s design is well suited to current and future demands.

This design is achieved by modularizing several aspects of the program.

The user interface of **geotool** is completely defined using X resources, using the Widget Creation Library [Smyth and Nye, 1992]. This separates the interface from the C code, and allows the entire interface to be customized on a local or per-user basis.

The C code in **geotool** is divided into three major parts; the I/O routines, the analysis functions, and the core part of **geotool**. The I/O routines and the analysis functions are decoupled from the core of **geotool**, and communicate with the core of **geotool** via an Application Programmer's Interface. Consequently, these parts of **geotool** can be extended without modifying the core part of **geotool** using shared library technology.

The core part of **geotool** manages the data after it has been read, and provides graphic services via the widget set developed for **geotool**. Some data attributes are stored in a local X resource database maintained by **geotool**. The seismic data stored in **geotool** are organized in three autonomous lists of waveforms, arrivals and origins. This strategy provides tremendous flexibility for handling data.

The program was developed under the X window system, in a Sun environment. It has since been ported to a number of UNIX platforms, including HP, IBM, Linux, and SGI.

1.3 Summary of Contents

This document is most effective if each chapter is read in order. First time users will find Chapter 3, the **Tutorial**, most informative. Chapter 4, the **Interface Description**, serves primarily as a reference. This document consists of the following chapters:

- Chapter 1: **Introduction**: Provides an outline and a list of contributors.
- Chapter 2: **Installation Guide**: Explains where to find **geotool**, how to install it, and the contents of the distribution.
- Chapter 3: **Tutorial**: Explains how to run geotool from the perspective of a first time user. Basic functions are explained, as well as the philosophy of interconnected operations, e.g., rotate horizontal components and watch the azimuth line move on the map.

- Chapter 4: **Interface Description**: Explains each option in **geotool**, in the order that the options appear in the various menu items.
- Chapter 5: **File Formats**: Describes the format of non-CSS 3.0 files used by **geotool**.
- Chapter 6: **X resources**: Describes how to use X resources, and those which are specific to **geotool**.
- Chapter 7: **Scheme Interface**: Provides a brief introduction to the scheme interface of geotool. scheme is a scripting language which can be used to automate **geotool**.

1.4 Contributed Software

While the vast majority of the code was written specifically for **geotool**, certain portions of the code came from contributed sources. These sources are:

Butterworth Filter - The Butterworth Filter algorithm used by **geotool** was developed by Dave Harris at Lawrence Livermore National Laboratory. The original FORTRAN code was translated into C by Chris Lynnes at Teledyne Geotech, Alexandria Laboratory.

Dial Widget - The Dial Widget used in the Rotate popup is an enhanced version of the Dial Widget by Douglas A. Young [Young, 1994].

FFT - The Fast Fourier Transform used in the FT popup was developed by Ray Buland while at the University of California at San Diego.

Harvard Moment Tensor Solutions The **Map** popup contains an overlay of global seismicity, which are the Harvard Moment Tensor Solutions from 1977 through 1991 [Dziewonski and Woodhouse, 1983].

IASPEI91 travel time code - The original FORTRAN travel time code was written by Ray Buland [Buland and Chapman, 1983] at the USGS, and was translated into C by Ivan Henson. Due to differences in the files created by the FORTRAN and C codes, the IASPEI travel time tables [Kennett, 1991] used by **geotool** are incompatable with the tables created by the original distribution.

Jeffreys-Bullen [Jeffreys and Bullen, 1940]

Map Data - The baseline map is an indexed version of the World Data Base II, from the Central Intelligence Agency.

Matrix Widget - The Xbae Widget used to display text in matrix form, e.g., the Arrivals popup, was developed by Andrew Wason at Bellcore.

Table Widget - The XmpTable widget used to format some of the popups was developed by David E. Smyth.

Widget Creation Library - The Widget Creation Library is used to completely separate the user interface code, written with X resources, from the underlying code, written in C. The Widget Creation Library was developed by David E. Smyth [Smyth and Nye, 1992].

Chapter 2

Installation

2.1 Introduction

The **geotool** distribution includes the geotool program, an installation script, documentation, associated input files, sample data, auxiliary programs, and source code for the auxiliary programs. This chapter explains how to install **geotool** at your site, and provides a brief explanation of the contents of the distribution.

2.2 Retrieving the Distribution

The most recent **geotool** release can be retrieved with anonymous ftp from the machine `ftp.css.gov` in the directory `/pub/coyne/geotool`. This machine has the IP address `140.162.3.74`, which is subject to change.

The distribution is in standard UNIX compressed tar format. The tar file beginning with `geotool.comp` is the complete distribution, including the sample data and auxiliary programs. The tar file beginning with `geotool.update` contains only files which have changed since the previous release. In the case of **geotool** version 3.0, the `comp` and `update` files will be identical. The name of the tar file after either `comp` or `update` is the name of the operating system for which the binaries were compiled. The primary platforms are Solaris 2.3 and SunOS 4.1. Other platforms are IRIX 5.3 (SGI), HPUX 9.01 (HP), and AIX 3.4 (IBM RS/6000).

The following is an example session of retrieving the SunOS **geotool** distribution. Commands shown in italics are typed by the user.

```
pyrope% ftp ftp.css.gov
% Connected to sol.CSS.GOV.
% 220 sol FTP server (SunOS 4.1) ready.
% Name (ftp.css.gov:coyne): anonymous
331 Guest login ok, send ident as password.
Password:
230 Guest login ok, access restrictions apply.
ftp> cd /pub/coyne/geotool
250 CWD command successful.
ftp> ls
200 PORT command successful.
150 ASCII data connection for /bin/ls (128.253.204.32,2062) (0
bytes).
geotool.comp.v3.0.solaris2.3.tar.Z
geotool.comp.v3.0.sunOS4.1.tar.Z
geotool.update.v3.0.solaris2.3.tar.Z
geotool.update.v3.0.sunOS4.1.tar.Z
226 ASCII Transfer complete.
152 bytes received in 0.35 seconds (0.42 Kbytes/s)
ftp> bin
200 Type set to I.
ftp> get geotool.comp.v3.0.sunOS4.1.tar.Z
200 PORT command successful.
150 Binary data connection for geotool.comp.v3.0.sunOS4.1.tar.
Z (128.253.204.32,2063) (5 bytes).
226 Binary Transfer complete.
local: geotool.comp.v3.0.sunOS4.1.tar.Z remote: geotool.comp.v
3.0.sunOS4.1.tar.Z
5 bytes received in 0.014 seconds (0.35 Kbytes/s)
ftp> quit
221 Goodbye.
```

After the file is back at your site, you will want to uncompress and untar the file. For version 3.0 this will take about 20 megabytes. In the following example the `df` command is used to verify that sufficient disk space is available. The distribution is then uncompressed and untarred.

```
pyrope% df .
```

```
Filesystem            kbytes    used   avail capacity  Mounted on
/dev/sd2g             567452  426769   83938    84%    /disk2
pyrope% zcat geotool.comp.v3.0.sunOS4.1.tar.Z | tar xvf -
```

2.3 Contents

Once the distribution is untarred, the following files and directories should exist in the current working directory:

```
pyrope% ls -F
README        bin/        doc/              lib/            src/
X11/          data/       install.geotool*  release.notes   tables/
```

The following is a brief synopsis of the significant directories:

X11:	contains X resource files
bin:	contains executable files
data/misc:	contains miscellaneous input files
data/tutorial:	contains parametric data used in the tutorial
data/tutorial/w:	contains waveform data used in the tutorial
doc:	contains documentation in PostScript form
lib:	contains geotool-specific shared libraries
src:	contains source code for miscellaneous programs
tables/static:	contains static global input tables
tables/models:	contains model data
tables/dynamic:	contains dynamic global input tables
tables/mapfiles:	contains base map data
tables/mapoverlays:	contains map overlay data
tables/response:	contains instrument responses

2.4 Installing the Distribution

Before **geotool** can run effectively, the installation script `install.geotool` must be run, or the actions performed by `install.geotool` must be done manually. This section describes those actions.

The simplest course of action is to run the script `install.geotool`, follow the instructions in the file generated by `install.geotool`, and skip the rest of this section. If you *really* want to know what `install.geotool` does, or have problems, read on.

The installation script covers two areas:

- Locating global input files
- Locating shared libraries

2.4.1 Locating Global Input Files

There are several global input files which **geotool** needs for certain tasks. These global input files include map data and travel time curves, and are described in Chapter 5. [In addition to these global input files are sample data, which are waveform and related data displayed by **geotool**. Input of these sample data is described in the **Tutorial** in Chapter 3.]

All of the global input files are under the directory `geotool/tables` in the distribution. **geotool** can be informed of these files with different methods. The most common and simple method is to set the environment variable `GEO_TABLE_DIR` to the full path of the directory `geotool/tables`. For example, if the distribution was untarred from the directory `/home/jill/contrib`, the environment variable for C-shell users is set with the command:

```
setenv GEO_TABLE_DIR /home/jill/contrib/geotool/tables
```

For Korn shell users the environment variable is set with the command:

```
export GEO_TABLE_DIR=/home/jill/contrib/geotool/tables
```

After `GEO_TABLE_DIR` is set, **geotool** searches for the following input files:

Models

The `models` directory contains global travel time models and regional velocity models.

crust_models: ASCII file containing the simple 2-layer crustal models used for drawing regional travel time curves. The format of this file is described in Chapter 5.

iasp91.hed: Header file for the IASPEI91 travel-time curves.

iasp91.tbl: Binary file containing the IASPEI91 travel-time curves.

jbtable: Binary file containing the Jeffreys-Bullen travel-time curves.

Static Files

The `static` directory contains files station and channel information.

global.affiliation: CSS 3.0 format affiliation table.

global.instrument: CSS 3.0 format instrument table.

global.network: CSS 3.0 format network table.

global.sensor: CSS 3.0 format sensor table.

global.site: CSS 3.0 format site table.

global.sitechan: CSS 3.0 format sitechan table.

global.priority: File containing priority information used when selecting waveforms from the `Ctype` list in the **File Listing** popup. The format of this file is described in Chapter 5.

Dynamic File

global.lastid: CSS 3.0 format lastid table. This table should be writeable by all **geotool** users.

Base Map Files

mapfiles/deci.bdy: Binary file of decimated boundary data derived from World Data Base II.

mapfiles/deci.cil: Binary file of decimated civil boundary data derived from World Data Base II.

mapfiles/map.bdy: Binary file of boundary data derived from World Data Base II.

mapfiles/map.cil1: Binary file of civil boundary data derived from World Data Base II.

mapfiles/map.cil2: Second binary file of civil boundary data derived from World Data Base II.

Map Overlay Files

mapoverlays/cmt.eq: Locations of Harvard Moment Tensor solutions, which can be plotted on the map.

mapoverlays/example: Example file of different map overlay types. The format of this file is described in Chapter 5.

Verification and Modification

Once **geotool** is running, it is possible to verify which input files **geotool** is expecting. Under the File menu is an option named Tables. Choose this option to activate the **Tables** popup (Figure 1). This popup lists all the global input files and the current paths to those files. To modify a path, type the new path and click on the Apply button.

Alternative Methods

An alternative to identifying the `tables` directory with the environment variable `GEO_TABLE_DIR`, is to set individual environment variables to point to specific input files. Another alternative is to set X resources to point to input files. In increasing order of precedence the methods are:

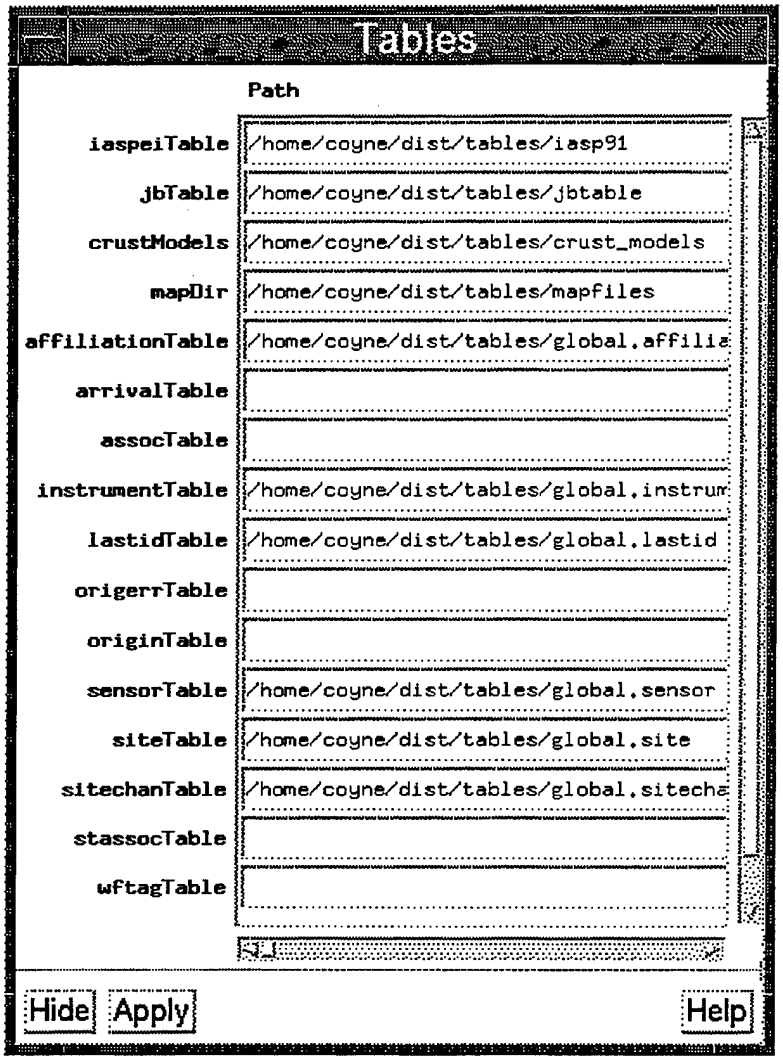

Figure 1: The **Tables** popup in **geotool** lists the current global tables.

input file	environment variable	X resource
crust_models	crustModels	XtNcrustModels
iasp91.hed	iaspeiTable	XtNiaspeiTable
iasp91.tbl		
jbtable	jbTable	XtNjbTable
global.affiliation	affiliationTable	XtNaffiliationTable
global.instrument	instrumentTable	XtNinstrumentTable
global.lastid	lastidTable	XtNlastidTable
global.network	networkTable	XtNnetworkTable
global.sensor	sensorTable	XtNsensorTable
global.site	siteTable	XtNsiteTable
global.sitechan	sitechanTable	XtNsitechanTable
map.bdy	mapDir	XtNmapDir
map.cil1		
map.d150		

Table 1: Table of environment variables and X resources which can point to specific input files.

- Global Environment Variable (`GEO_TABLE_DIR`)
- File specific X resource
- File specific environment variable

The X resources and environment variables which can be used to specify individual input files are listed in Table 1. See Chapter 6 for information on setting X resources.

2.4.2 Shared Libraries

Locating the correct version of a shared library can be a problem at some sites. Consequently, the geotool distribution (for some operating systems) contains two **geotool** binaries. The first binary is named `geotool`, and is linked with a minimum number of shared (dynamic) libraries. This conservative approach creates a larger executable file, but the chances of a problem with shared libraries is minimized. If you want to run **geotool** as quickly

as possible, use the binary named `geotool`, and skip the rest of this section. [Note to Solaris 2.X users: Due to Motif licensing problems, the Solaris 2.X binary named **geotool** requires the Motif shared library. If you don't have this library, contact your system administrator and suggest that your site upgrade to Solaris 2.4, which includes the Motif shared library.]

Dynamically Linked geotool

When a program is linked, it usually needs to include several different libraries. Some of these libraries are loaded directly into the executable file, while other libraries, called shared or shared libraries, are loaded into the executable file only after the program is running and the library is needed. The advantage of using a shared library is that it reduces the size of the executable file. If more than one program which uses that library is running on a machine, the library is only loaded once. This reduces the size of the program in the machine's core memory, which is a more efficient use of resources. The difficulty with using a shared library is that the program must be able to find the library, and the correct version of the library.

The second geotool binary in the distribution is dynamically linked, and is named `geotool.dyn`. To list the shared libraries in a binary, use the command `ldd`. The following is an example of the `ldd` command and its output:

```
faethon-82 ldd geotool
        libXm.so.2 =>    /opt/SUNWmotif/lib/libXm.so.2
        libMrm.so.2 =>   /opt/SUNWmotif/lib/libMrm.so.2
        libXt.so.4 =>    /usr/openwin/lib/libXt.so.4
        libX11.so.4 =>   /usr/openwin/lib/libX11.so.4
        libXmu.so.4 =>   /usr/openwin/lib/libXmu.so.4
        libm.so.1 =>     /usr/lib/libm.so.1
        libdl.so.1 =>    /usr/lib/libdl.so.1
        libsocket.so.1 =>        /usr/lib/libsocket.so.1
        libnsl.so.1 =>   /usr/lib/libnsl.so.1
        libc.so.1 =>     /usr/lib/libc.so.1
        libw.so.1 =>     /usr/lib/libw.so.1
        libXext.so.0 =>  /usr/openwin/lib/libXext.so.0
        libintl.so.1 =>  /usr/lib/libintl.so.1
```

The name of the requested shared library is on the left hand side of the => sign. The path to the requested shared library is on the right hand side of the => sign. If an entry on the right hand side is `File not found`, there is a problem. The required library cannot be found, and the program will not run.

When the program searches for shared libraries, it looks in certain directories. In addition, directories specified with the environment variable `LD_LIBRARY_PATH` are also searched. All of the freely distributable shared libraries needed by `geotool.dyn` are in the directory `geotool/lib`. Consequently, if the full path to the directory `geotool/lib` is appended to `LD_LIBRARY_PATH`, `geotool.dyn` will find the shared libraries, and the binary will work.

2.5 geotool as a World Wide Web Waveform Viewer

geotool can serve as a waveform viewer when connected to World Wide Web browsers, much like **xv** can be used by Web browsers to view images.

The connection between a Web browser and **geotool** can be made quite easily, by adding the following line to a user's `.mailcap` file in their home directory:

```
application/x-geotool; geotool remote ack compressed=%s
```

*Note if **geotool** is not in a user's path, the fullpath to **geotool** must be specified in the `.mailcap` file.*

Currently, Web accessible waveforms are available from the GSE-IDC's Seismic Bulletin Web pages.

2.6 Summary

The latest **geotool** distribution is freely available using anonymous ftp from the machine `ftp.css.gov` in the directory `/pub/coyne/geotool`. The easiest way to install **geotool** is to run the script `install.geotool`. To provide a connection between **geotool** and your World Wide Web browser, add a record to your `.mailcap` file.

Chapter 3

Tutorial

3.1 Introduction

This tutorial introduces some of the fundamental functions of **geotool**. It is not meant to be a comprehensive description of every option, but rather to provide an overview of the program design and capabilities. The data used in this tutorial are included in the **geotool** distribution, so you can follow along while reading.

There are three exercises in this tutorial. Each of these utilizes a separate data set. The first exercise uses a three-component data set to demonstrates the following functions:

- Basic waveform handling
- Spectral analysis
- Butterworth filter
- Adding an arrival
- Component rotation
- Geographic visualization of the rotation azimuth

The second exercise with the network data set demonstrates the following functions:

- Aligning waveforms on predicted arrivals

- Renaming an arrival
- Retiming an arrival
- Record section
- Travel time curves
- Magnify window
- PostScript output

The third exercise demonstrates the following functions that are available for analyzing array data:

- Beamforming
- FK analysis
- Geographic visualization of the FK azimuth

All three exercises use data in CSS 3.0 format. The waveform data are stored in binary form in waveform files and the waveforms' attributes (e.g., station name, channel name, start time, end time, sampling rate, etc.) are stored in *.wfdisc files. Arrival information is stored in *.arrival files and origin information is stored in *.origin files. The asterisk (*) in the preceding discussion represents the prefix of each filename. Files with a common prefix are read and grouped together by geotool. For example, when the wfdisc file named **network.wfdisc** is read, any other existing CSS format tables with the same **network** prefix in the same directory are also read. For example, arrival information is read from the file named **network.arrival**, and origin information is read from the file named **network.origin**.

3.1.1 Starting geotool

Prior to running **geotool** at your site, it must be installed as explained in Chapter 2. Assuming that **geotool** was installed in the directory */install-dir*, change to the directory for following this tutorial by typing the command

`cd` */install-dir*`/geotool/data/tutorial`

Run the program **geotool** by typing the command

`geotool`

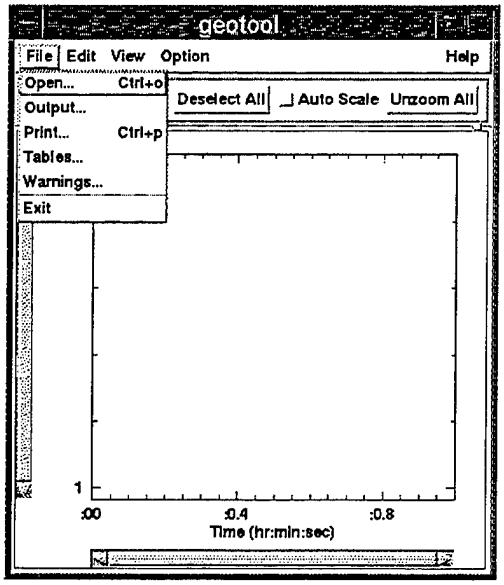

Figure 2: The main window of **geotool**. In this example, the File menu is activated, and the File menu items are displayed.

If **geotool** fails to run or reports errors, your environment might not be correctly configured. See Chapter 2 for detailed instructions on installing **geotool**.

Once **geotool** starts, the main window of **geotool** appears on the screen. The main window consists of the menu bar, tool bar, and main plotting window (Figure 2). The toolbar is a convenient container for frequently used buttons. Buttons in the toolbar also appear as menu items. In this tutorial actions will be described according to their menu position; however, selecting the same item from the toolbar will have the same effect.

3.1.2 Conventions

Buttons on the mouse are referred to as right, middle, and left. This tutorial arrogantly assumes that a right-handed mouse is being used. If a left-handed mouse is being used, transpose the phrases right mouse button and left mouse button.

Most mouse actions in **geotool** are performed with the left mouse button,

unless otherwise noted. The term "click" refers to clicking a mouse button over an object. The term "drag" refers to pressing the mouse button over an object, and dragging the object across the screen until the mouse button is released.

Menu item selections have the form Menu_bar_name/Menu_item_name in this document. For example, File/Exit refers to the menu item named Exit found under the File menu (Figure 2).

Menu selections which end with "..." activate a popup window (subsequently called "popup") with the same name as the menu selection, e.g., File/Open... in the main window activates the **Open** popup.

Keyboard accelerators, or hot keys, exist for some of the more commonly used menu selections. These key sequences are listed beside the menu selection. For example, type the letter o (small letter o) on the keyboard while pressing the control key has the same effect as choosing the main menu item File/Open... (Figure 2). Note that keyboard accelerators listed in the menu selection of a popup are effective only when the mouse cursor is in the plotting window of that popup. These same keyboard accelerators may have different meanings in different popups.

For a popup to receive input, it must have the input focus, i.e., actions done with the mouse and on the keyboard are directed into a particular popup. The way input focus is changed depends on the configuration of the window manager. In this document, the phrase "move the mouse cursor into the **xyz** popup" is a euphemism for moving the input focus into the **xyz** popup. For a window manager with "pointer focus" policy, the input focus is changed by moving the mouse cursor into the **xyz** popup. If a window manager is configured with "click to focus" policy, the input focus is changed by moving the mouse cursor into the **xyz** popup and clicking the left mouse button. This initial click is a signal to the window manager to change the input focus and will not be interpretted by geotool.

3.2 Exercise 1 - Three Component Data

3.2.1 Data Input

Click on the File/Open menu item in the main menu bar to activate the **Open** popup. Select the file named **3c.wfdisc** in the **Files** list in the **Open** popup and click on the Apply button. Progress made in reading the data is

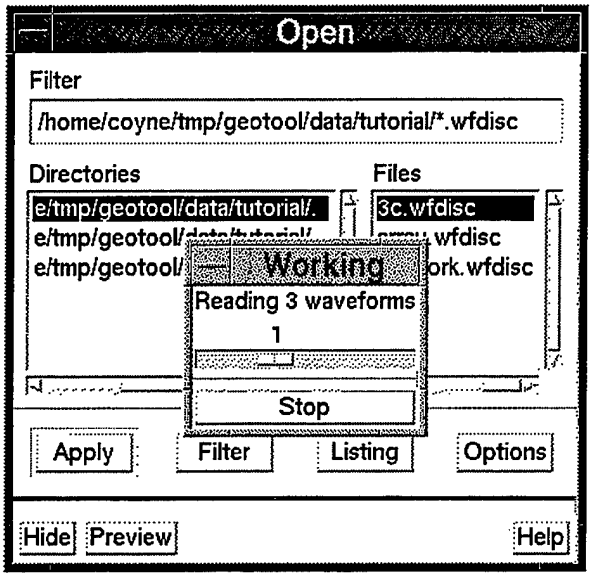

Figure 3: The **Open** popup. The file **3c.wfdisc** is selected in the **Files** window and is read by clicking on the Apply button. The **Working** popup shows the progress as the waveforms in **3c.wfdisc** are read.

given by the **Working** popup (Figure 3). The waveforms referenced in the file **3c.wfdisc** are displayed in the main plotting window.

After the waveforms are read the **Working** popup disappears. Close the **Open** popup by clicking on the Hide button.

3.2.2 Basic Waveform Handling

In order to get a better view of the the first arrival, zoom in over the first third of the waveform. This is done by moving the mouse cursor to the beginning of the waveform, and dragging the mouse cursor to the right with the right mouse button held down. Release the right mouse button after the cursor has passed the first third of the waveform.

The action just described using the right mouse button is one of many mouse and keyboard actions available in the plotting windows in **geotool**. More of these actions will be used throughout this Tutorial. All of these actions are listed in the Mouse Buttons Help popup, which is accessible through

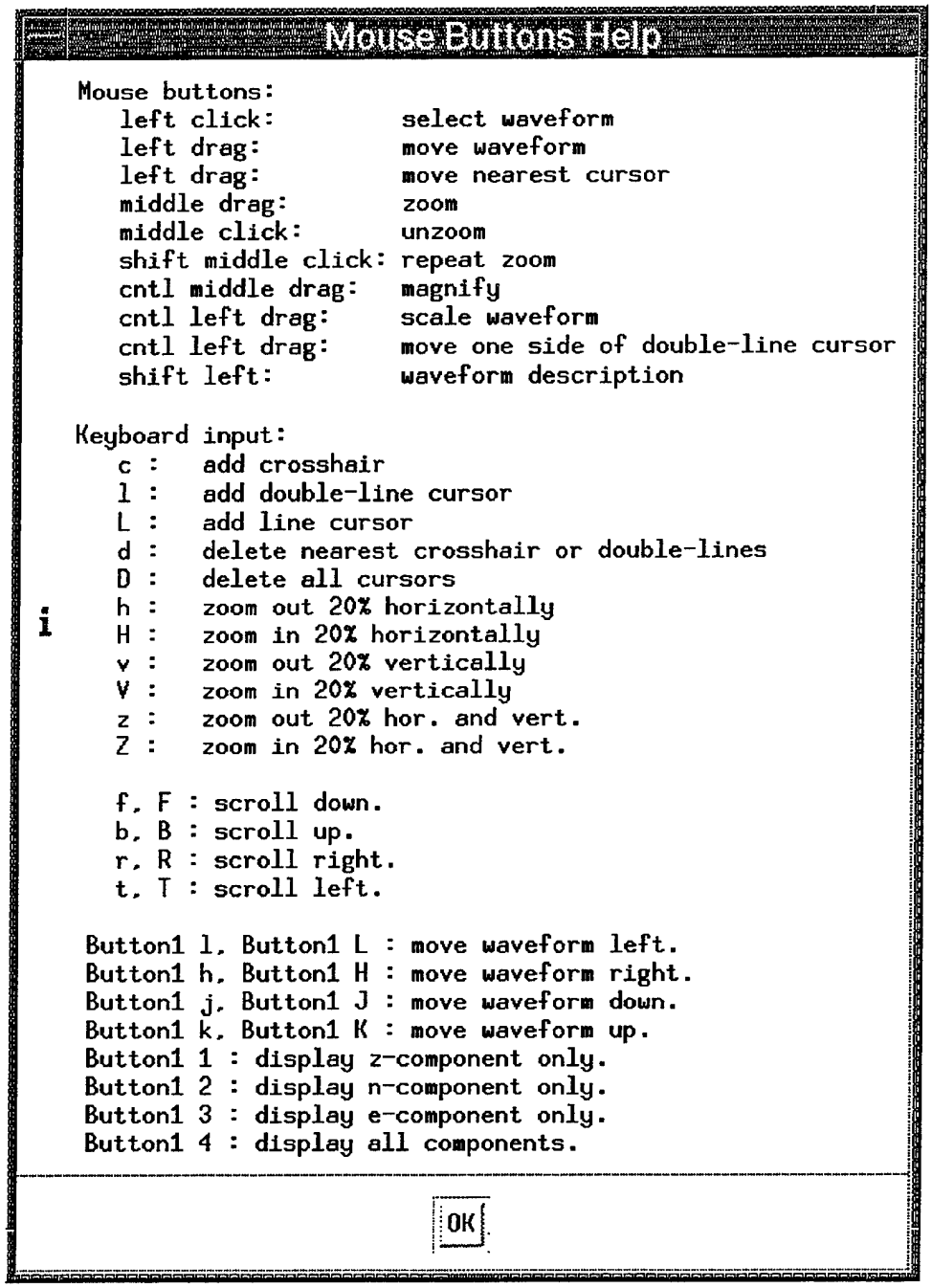

Figure 4: The **Mouse Buttons Help** popup. This popup lists all of the mouse and keyboard commands available in the plotting windows in **geotool**. They are also described in detail in section 4.2 beginning on page 42.

the Help/Mouse Buttons menu item in the main menu bar (Figure 4).

Waveform Color

Each component of the three-component data will initially be displayed with the same color. To change the color scheme, click on the View/Waveform Color menu item in the main menu bar to activate the **Waveform Color** popup. Select the **channel** option from the **Color Code** list in the **Waveform Color** popup to color each channel uniquely. Click on the Hide button to close the **Waveform Color** popup.

3.2.3 Spectral Analysis

Click on the Option/FT menu item in the main menu bar. This activates the **FT** popup window, where spectra will be displayed.

To identify the waveform for calculating spectra, select the LOR/sz waveform by clicking over the waveform. The waveform color changes to dark blue to indicate that it it "selected" and the label (tag) to the left of waveform changes to inverse video.

To specify the particular segment for spectrum calculation, add a double-line cursor by moving the mouse cursor into the main plotting window and type the l (small letter l) on the keyboard. Drag the double-line cursor somewhere before the signal. The numeric label above the cursor specifies the width of the double-line cursor in seconds. Drag one line of the double-line cursor while pressing the control key to change the width of the double-line cursor to be about 10 seconds.

Select the File/Compute menu item in the **FT** popup to calculate the spectrum of the selected waveform segment.

To calculate the spectrum for a different segment, reposition the double-line cursor by dragging the double-line cursor anywhere before the signal and select the File/Compute menu item in the **FT** popup. Notice that the previous spectrum is removed from the display when the new spectrum is displayed.

To save the currently displayed spectrum on the screen, select the Edit/Save menu item in the **FT** popup. The spectrum will remain on the screen until it is cleared with the Edit/Clear menu item.

To calculate spectra as the double-line cursor is dragged, select the Option/Auto Compute menu item in the **FT** popup. Drag the double-line cursor

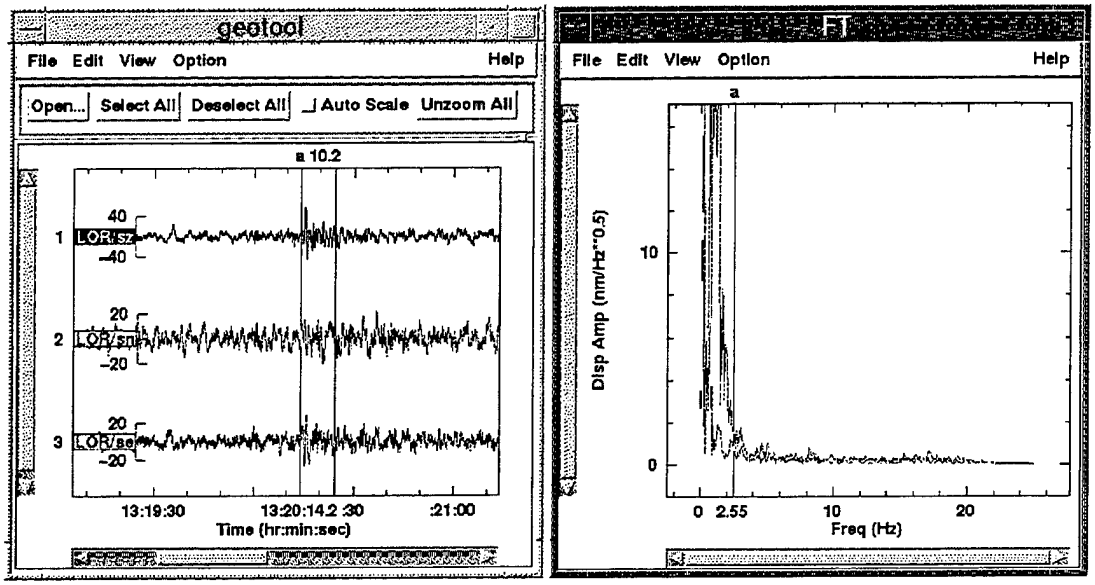

Figure 5: Spectra from LOR/sz displayed in the **FT** popup. The higher amplitude spectrum is that of the seismic event signal, while the lower amplitude spectrum was measured in the noise. The single-line cursor in the **FT** popup can used to measure where the signal rises above and falls below the noise.

until it surrounds the arrival. Note that the spectrum is repeatedly redisplayed as the cursor is dragged.

A single-line cursor is useful for measuring values at a particular point on a plot. Add a single-line cursor to the **FT** plot window by moving the mouse cursor into the **FT** plot window and typing the `L` (capital letter `L`) on the keyboard. Drag the cursor to measure where the signal rises above and falls below the noise (approximately 0.5 to 2.5 Hertz). These values can be used to select the optimum filter to enhance the signal (Figure 5).

Select the Option/Auto Compute menu item to deactivate recomputing spectra each time a double-line cursor is dragged over a selected waveform. Select the File/Hide menu item to close the **FT** popup.

Remove the double-line cursor by moving the mouse cursor into the main plotting window and typing the `d` (small letter `d`) on the keyboard.

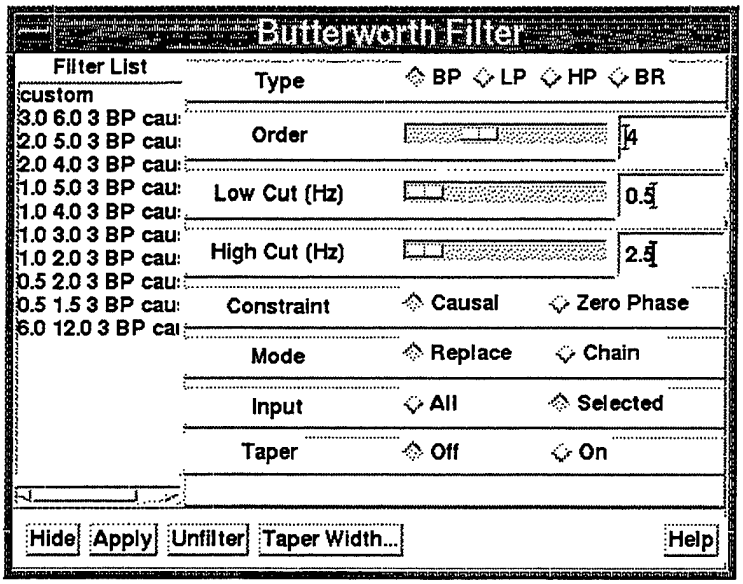

Figure 6: Controls on the right side of the **Butterworth Filter** popup show that the current filter is a third order, Band Pass (BP) filter from 0.5 to 2.0 Hertz.

3.2.4 Butterworth Filter

Select the Edit/Filter/Butterworth Filter menu item from the main menu bar. This activates the **Butterworth Filter** popup, which is used for filtering waveforms.

The LOR/sz channel should still be selected (displayed in dark blue color) from the previous exercise. Select the **0.5 2.0 3 BP causal** filter near the bottom of the **Filter List** on the left side of the **Butterworth** popup (Figure 6). When the filter is selected, it is immediately applied to the selected waveform. In addition, the controls on the right side of the popup show the parameters of the current filter.

To apply a user specified filter from 0.5 to 2.5 Hertz (i.e., a filter not in the **Filter List**), type `2.5` in the text window to the right of the **High Cut** label, and press the Apply button. The new custom filter is applied, and the first entry in the **Filter List** is modified to reflect the current filter parameters.

Select the Hide button to close the **Butterworth Filter** popup.

3.2.5 Adding an Arrival

Zoom in on the seismic event signal by positioning the mouse cursor above and to the left side of the signal on the LOR/sz channel, hold the middle mouse button down, outline a rectangle which includes the signal, and release the mouse button. If there is a need to unzoom and try again, click the middle mouse button.

Activate the **Arrivals** popup by selecting the Option/Arrivals menu item from the main menu bar. A list of phases, known as the phase list, is displayed on the left hand side of the **Arrivals** popup.

[This tutorial assumes that there is no Pn arrival marked on the waveform. However, if a colleague has added an arrival while following this tutorial, you can delete it now. To delete the arrival, select it either by clicking on the arrival entry in the **Arrivals** popup, or by clicking on the arrival label in the main plotting window. The arrival is drawn in inverse video when it is selected. Select the Edit/Delete menu item in the **Arrivals** popup to delete the selected arrival.]

Select the **Pn** entry in the phase list to add a vertical line (phase line) to the main plotting window. The name of the selected phase labels the phase line (Figure 7). Drag the phase line to the position where the arrival should be added. Select the Edit/Add menu item in the **Arrivals** popup to add the arrival.

To prepare for measuring the amplitude and period of the arrival, select the Option/Measure Amp Per menu item in the **Arrivals** popup. This selection activates the **Measure Amp Per** popup. Zoom in closely near the recently added arrival so the x axis displays only about 10 seconds of data. Do this by moving the mouse cursor just to the left of the arrival and drag the mouse cursor to the right with the right mouse button held down. Release the mouse button after the cursor has passed the arrival.

Position the mouse cursor over the waveform where the amplitude and period should be measured. Add the measurement box by clicking the right mouse button over the waveform while holding down the shift key. To move the box to another waveform cycle, move the mouse cursor to the new position and again click the right mouse button while holding down the shift key. Any side of the box can be repositioned by moving the mouse cursor inside the box and dragging the closest side of the box with the right mouse button while

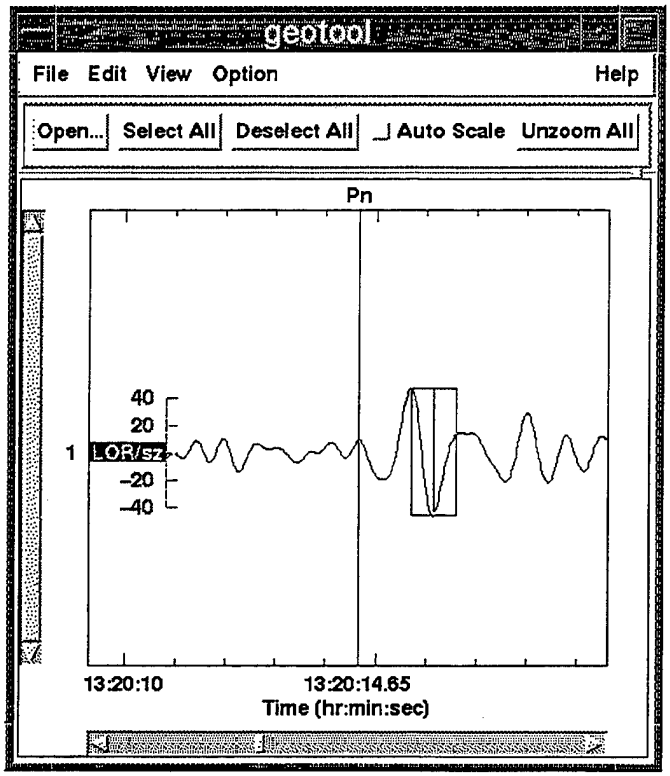

Figure 7: A Pn arrival is added where the phase (vertical) line intersects the selected waveform. The box surrounding the waveform cycle is used to measure amplitude and period.

holding down the shift key (Figure 7). The dimensions of the amplitude and period box are listed in the **Measure Amp Per** popup. The amplitude values are given in units of counts (cnt), nanometers (nm), and nanometers normalized at the calibration frequency (Nnm). (The amplitude is given in nm only if the appropriate instrument response is available).

To save the current amplitude and period measurement, first select the arrival by either clicking on the arrival entry in the **Arrivals** popup, or clicking on the arrival label in the main plotting window. The arrival is drawn in inverse video when it is selected. Select the Edit/Save All menu item in the **Measure Amp Per** popup to associate and save the measurement on disk. Select the File/Hide button in the **Measure Amp Per** popup to

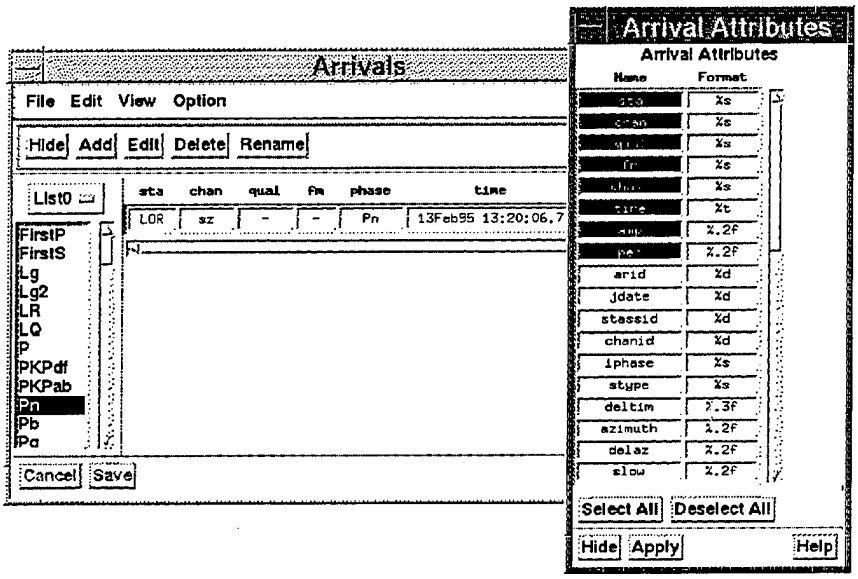

Figure 8: The **Arrival Attributes** popup is used to modify which attributes are displayed in the **Arrivals** popup. Attributes currently displayed in the **Arrivals** popup are displayed in inverse video.

hide this popup.

The **Arrivals** popup lists some parameters of the newly added arrival. The type and position of the parameters displayed in the **Arrivals** popup can be modified by selecting the View/Attributes menu item which activates the **Arrival Attributes** popup (Figure 8). The **Arrival Attributes** popup lists all arrival related parameters. Parameters currently displayed in the **Arrivals** popup are displayed in inverse video.

To display the **slow** (slowness) attribute select the **slow** field in the **Arrival Attributes** popup, and click the Apply button. When the modification of attributes is complete, click on the Hide button to close the **Arrival Attributes** popup.

Select the highlighted **Pn** entry in the phase list in the **Arrivals** popup to hide the **Pn** phase line drawn in the main plotting window. Select the File/Hide button to close the **Arrivals** popup.

3.2.6 Component Rotation

Click the middle mouse button in the main plotting window to unzoom so all the waveforms can be seen. If you zoomed multiple times, you will need to click the middle mouse button multiple times. An alternative to clicking the middle mouse button is to select the View/Unzoom All menu item to unzoom completely.

Select the Edit/Rotate menu item from the main menu bar. This activates the **Rotate** popup, which will be used for rotating horizontal components.

Select the sn and se components by clicking over the LOR/sn and LOR/se waveforms. Deselect the sz component by clicking over the LOR/sz waveform.

Zoom in near the Pn arrival by moving the mouse cursor to the left of the arrival, and drag the mouse cursor to the right with the right mouse button held down. Release the right mouse button after the cursor has passed the Pn arrival.

The components will first be rotated to the azimuth of the associated origin. (The origin information was read from the file **3c.origin** when the file **3c.wfdisc** was read.) Do this by clicking on the Origin button in the **Rotate** popup. This rotates the components so that the radial component (formerly North component) is pointing towards the seismic source of the event, which is at 109 degrees azimuth. This azimuth is shown in the **Rotate** popup as a long red indicator. In addition, a small black line was drawn in the azimuth indicator window which points towards the azimuth of the origin. The black (origin) line will serve as a reference when other angles of rotation are used.

Maximize Radial Amplitude

To find the angle that maximizes the amplitude of the radial component, add a double-line cursor by typing an l (small letter l) in the main plotting window, and position it over the arrival. Drag one line of the double-line cursor while pressing the control key on the keyboard to change the width of the double-line cursor to be about 3 seconds. With the double-line cursor in position over the first arrival, click on the Maximum button in the **Rotate** popup (Figure 9). This rotates the waveforms so the amplitude of the radial component is maximized. In the ideal world, this maximum rotation angle will point towards the seismic source. Note that a blue line was drawn in the azimuth indicator window. (Since there is 180 degree ambiguity in the angle

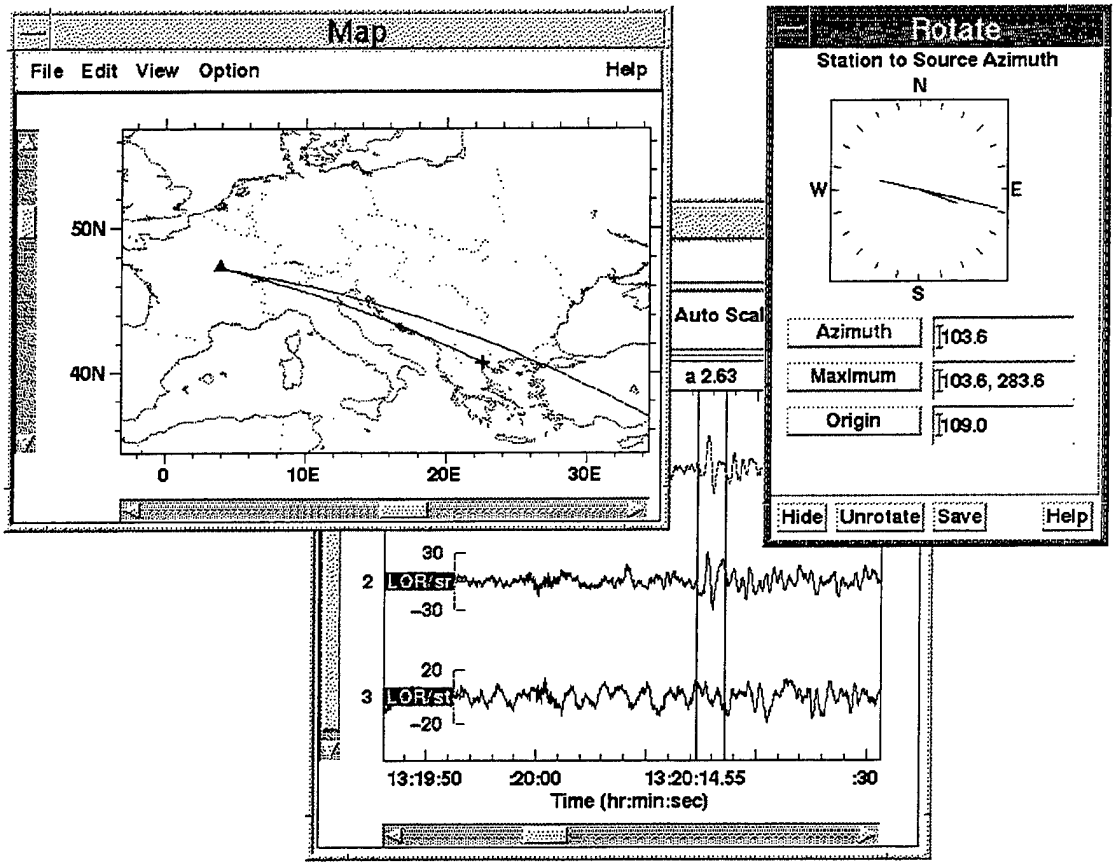

Figure 9: The **Rotate** popup is used to rotate horizontal components. The components are rotated to maximize the amplitude of the radial component, in this example 102.5 degrees, which may vary, depending upon your window selection. This rotation angle is the azimuth on the map which begins at the station in France and extends off the eastern edge of the map. Also shown on the map is the station to origin azimuth which ends at the event in northern Greece.

which maximizes the horizontal component, the blue line is drawn to mark both possibilities.)

Save Rotation Azimuth

To associate the current rotation angle with the recently added arrival, select the arrival with a left mouse click. When the arrival is selected it is drawn in inverse video. Click the Save button in the **Rotate** popup, and the current angle will be saved with the selected arrival. Deselect the arrival with another left mouse click.

Map

To visualize the angle of rotation, activate the map from the Option/Map menu item in the main menu bar. Zoom in on Europe by moving the mouse cursor near England and drag the mouse cursor near Egypt with the middle mouse button held down. Note that the zoom box preserves the aspect ratio.

The seismic source is plotted as a + symbol, the station LOR is plotted as a triangle, the projection of the seismic ray path is drawn as a black line between the source and the station, and the angle of rotation is plotted as a red arc starting from the station and ending on the opposite side of the world.

To label the seismic station, select the View/Station Tags menu item. To remove the ray path from the map, select the View/Paths/Selected menu item in the **Map** popup. Click on the event in northern Greece to select the event. When the event is selected, the ray path is also redrawn in the blue color, since the View/Paths/Selected menu item is currently selected. If View/Paths/None menu item were chosen instead, the ray path would not be drawn when the event was selected.

To choose a map overlay, select the File/Overlays menu item which activates the **Map Overlays** popup. Select the `cmt.eq` entry in the **Map Overlays** popup. This displays the locations of events for Havard Moment Tensor solutions from 1977 through 1991 [Dziewonski and Woodhouse, 1983]. To hide the overlay, deselect the `cmt.eq` entry while pressing the control key. Click on the Hide button to close the **Map Overlays** popup.

Hide the station label on the map by selecting the View/Station Tags menu item.

Manual Rotation

To manually rotate components, left-mouse button click in the azimuth indicator in the **Rotate** popup to specify the new azimuth. Note that the waveforms are rotated and the red arc on the map is redrawn based on the new azimuth.

Another method for rotating components is to type a value into the text window next to the Azimuth button, e.g., `120.`, and click on the Azimuth button.

When finished with this data set, unzoom the map by clicking the middle mouse button in the **Map** popup. Close the **Map** popup with the File/Hide menu item. Unrotate the waveforms by clicking on the Unrotate button, and close the **Rotate** popup by clicking the Hide button.

Clear the current data set from **geotool**'s memory with the Edit/Clear menu item in the main menu bar. Note that this operation has no effect on the data stored on the disk.

3.3 Exercise 2 - Network Data

3.3.1 Data Input

Select the File/Open menu item to activate the **Open** popup. Select the file named **network.wfdisc** in the **Files** list in the **Open** popup. Click on the Listing button to activate the **File Listing** popup, which lists all the records in the selected wfdisc file (Figure 10).

Select the bz and sz channels from the **Chan** list located in the bottom half of the **File Listing** popup by clicking on the bz and sz entries in the **Chan** list while pressing the control key on the keyboard. This highlights all the wfdisc records (waveform segments) recorded by bz or sz channels. Click on the Apply button to read and display the waveforms corresponding to the selected wfdisc records.

Progress made while reading the data is given by the **Working** popup. After the waveforms are read, hide the **Open** and **File Listing** popups by clicking on the Hide button in each popup.

You may noticed that the **Working** popup stated that 6 waveforms were being read. If they are not all visible, select the View/Scale/AutoScale menu item, which will adjust the y-axis so all 6 waveforms are visible.

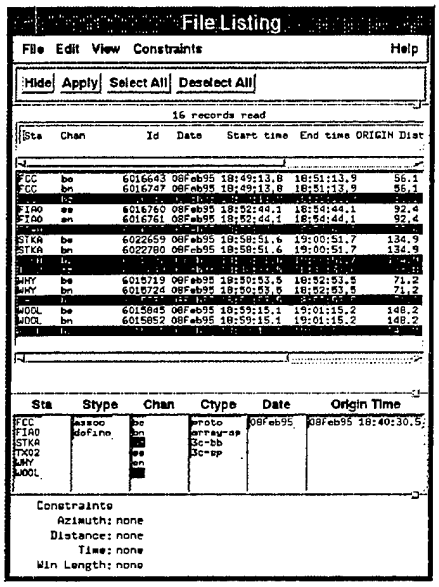

Figure 10: The **File Listing** popup lists records from a wfdisc file. Individual waveform segments to be plotted are specified from this popup.

3.3.2 Aligning on Predicted Arrivals

Activate the **Arrivals** popup by selecting the Option/Arrivals menu item from the main menu bar. A list of phases, known as the phase list, is displayed on the right hand side of the **Arrivals** popup. Select the **FirstP** entry in the phase list to add a phase line to the main plotting window. Drag the **FirstP** phase line so it is positioned near the middle of the graph. The **FirstP** entry is actually an alias for the first arriving P-type arrival at all distances, i.e., the first arriving phase of Pn, Pg, P, Pdiff, or PKP[1].

In the **Arrivals** popup select the View/Align/Align on Predicted menu item. This moves each waveform so the time of the first predicted P-type arrival for each waveform associated with an origin is aligned on the **FirstP** phase line (Figure 11). Note that the waveforms are NOT aligned on the

[1]Beyond a certain distance, the FirstP alias uses PKP instead of Pdiff, even though the Pdiff travel time is less than the PKP travel time. This distinction is made because the PKP amplitude is much larger than the Pdiff amplitude, and is much more commonly observed. By default, the distance beyond which PKP is used instead of Pdiff is 120.0 degrees. This distance can be customized using the X resource named stopPdiff.

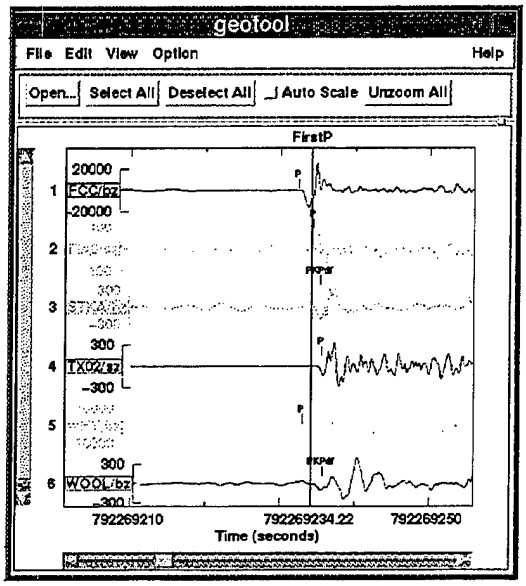

Figure 11: Waveforms are aligned so the first predicted P-type arrival for each waveform is on the phase line **FirstP**.

currently picked P-type arrival, but on the first *predicted* P-type arrival, which requires that the waveforms have associated origin information.

3.3.3 Renaming an Arrival

Zoom in on the P arrival recorded at WOOL/bz by moving the mouse cursor above and to the left of the arrival, hold the middle mouse button down and outline a rectangle with the middle mouse button held down. Once the box encloses the area of interest, release the mouse button and the main plotting window will be redrawn with the limits defined by the outlined box.

Select the WOOL/bz P arrival by clicking on the arrival label. The arrival is drawn in inverse video when it is selected.

[The arrival may be named PKPdf, depending on who last edited the arrival. This tutorial assumes that it is a P arrival which will be renamed PKPdf. If the arrival is currently a PKPdf, because a colleague has already changed the phase while following this tutorial, you may want to substitute P for PKPdf in the following sentence.]

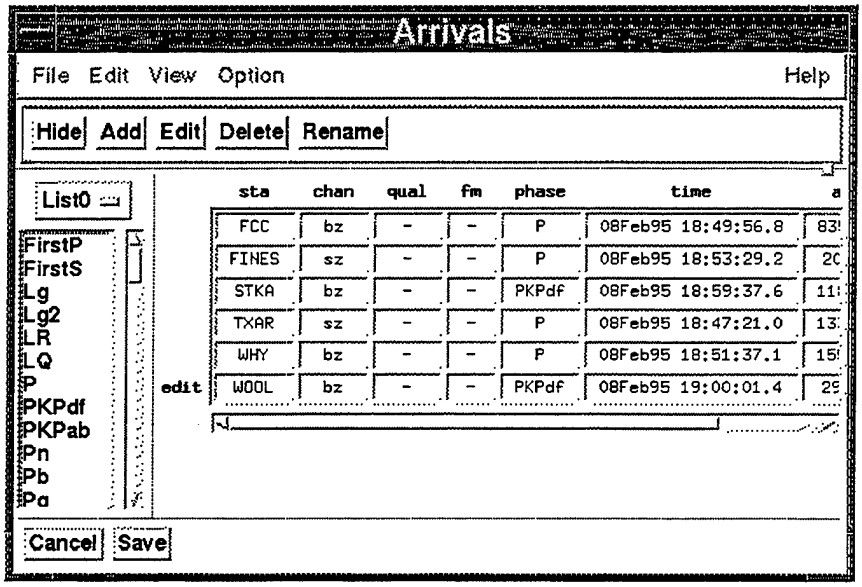

Figure 12: The **Arrivals** popup in edit mode. The arrival in the list preceded by the word **edit** can be either retimed graphically in the main plotting window or edited in text form in the **Arrivals** popup.

Select the **PKPdf** phase from the phase list in the **Arrivals** popup. Select the Edit/Rename menu item in the **Arrivals** popup and the selected arrival will be renamed a PKPdf arrival.

3.3.4 Retiming an Arrival

Prior to retiming an arrival, it must be selected, as described above. Select the Edit/Edit menu item in the **Arrivals** popup. Drag the PKPdf arrival to a new position using the left mouse button. Once the mouse button is released, the arrival remains stationary. If the new position is acceptable, click on the Save button in the **Arrivals** popup. To return the PKPdf arrival to its original position, click on the Cancel button. (If the arrival editting was saved by clicking on the Save button, the new information would be immediately written to disk.)

Note that once the Edit/Edit menu item is selected, the entry for the selected arrival in the **Arrivals** popup is preceded by the word **edit** (Figure

12). This identifies which arrival is being edited. An alternative to retiming the arrival interactively is to edit the arrival text entry directly in the **Arrivals** popup when in edit-mode. Actually, nearly all the fields can be edited when in edit-mode. When finished editing, click on the Save button to save any modifications.

Deselect the **PKPdf** entry in the phase list in the **Arrivals** popup to hide the **PKPdf** phase line in the main plotting window. Select the File/Hide button to close the **Arrivals** popup. Unzoom to the original display limits by clicking the middle mouse button in the main plotting window.

Waveform Tags

Select all the waveforms with the View/Select/Select All menu item. Select the View/Tags/Tag Contents in the main plotting window to display distance information in each waveform tag. This activates the **Tag Contents** popup. Select the the item named **Distance (deg)**. Click on the Apply button. Each waveform tag now includes a value for distance in degrees from the origin. Select the Hide button to hide the **Tag Contents** popup.

3.3.5 Record Section

Generating a record section requires sorting and aligning waveforms. Sort the waveforms by distance with the View/Sort/Distance Degrees menu item. This sorts the waveforms so the y-axis represents the distance from the recording station to the associated origin. Align waveforms by the time after the associated origin with the View/Align/Time Minus Origin menu item. This aligns the waveforms so the x-axis represents the time after the associated origin. Since the x axis currently extends over a few minutes and the first arrival is many minutes after the origin, the waveforms are shifted outside of the current viewing limits. Unzoom to view all the waveforms by moving the mouse cursor into the main plotting window and clicking the middle mouse button. An alternative to clicking the middle mouse button is to select the View/Unzoom All menu item.

3.3.6 Travel Time Curves

After the waveforms are properly aligned, add the travel time curves. Select the Option/Travel Times menu item to activate the **Travel Times** popup.

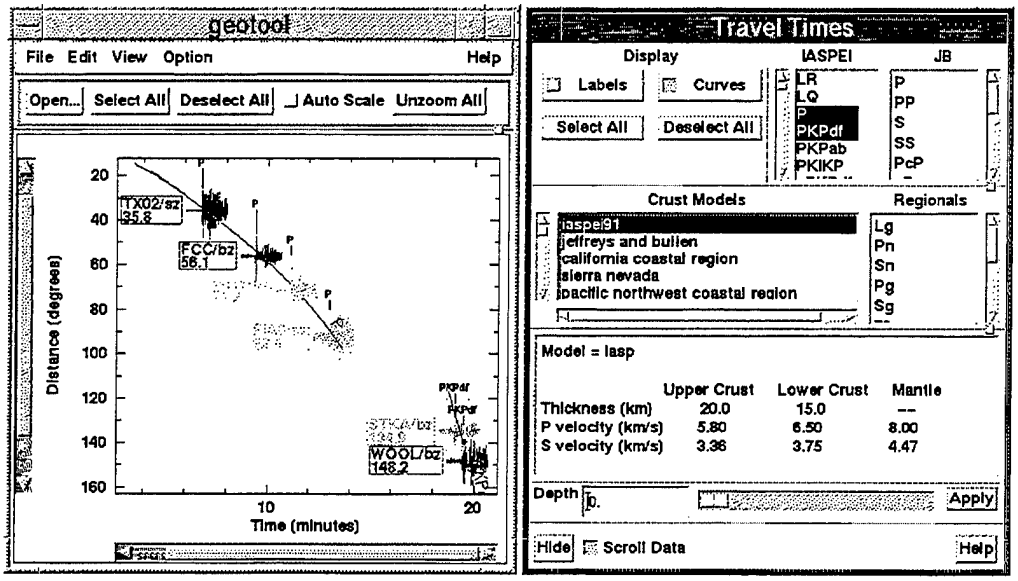

Figure 13: The **Travel Times** popup with the **P** and **PKPdf** phases from the **IASPEI** list selected. The Curves toggle button is turned on and the Labels toggle button is turned off. The waveforms are sorted by distance in degrees and aligned by the time after the associated origin time. Note the distance entry in each waveform tag.

Select the **P** phase from the **IASPEI** list. This adds predicted P arrival labels beneath each waveform. Select the Curves toggle button in the **Travel Times** popup to add the P travel time curve.

An important difference must be pointed out concerning the times used for positioning the phase labels versus the the times used for positioning the travel time curves. The depth of the associated origin is used to calculate the time of the predicted phase labels. The depth at the bottom of the **Travel Times** popup is used to calculate the time of the travel time curves. This distinction is made so different waveforms can be associated with different origins (and hence depths), but only one depth can be used when drawing the travel time curves.

Select the Labels toggle button in the **Travel Times** popup to remove the predicted arrival labels (Figure 13). Add the **PKPdf** travel time curve to the display by selecting the **PKPdf** entry from the **IASPEI** list while

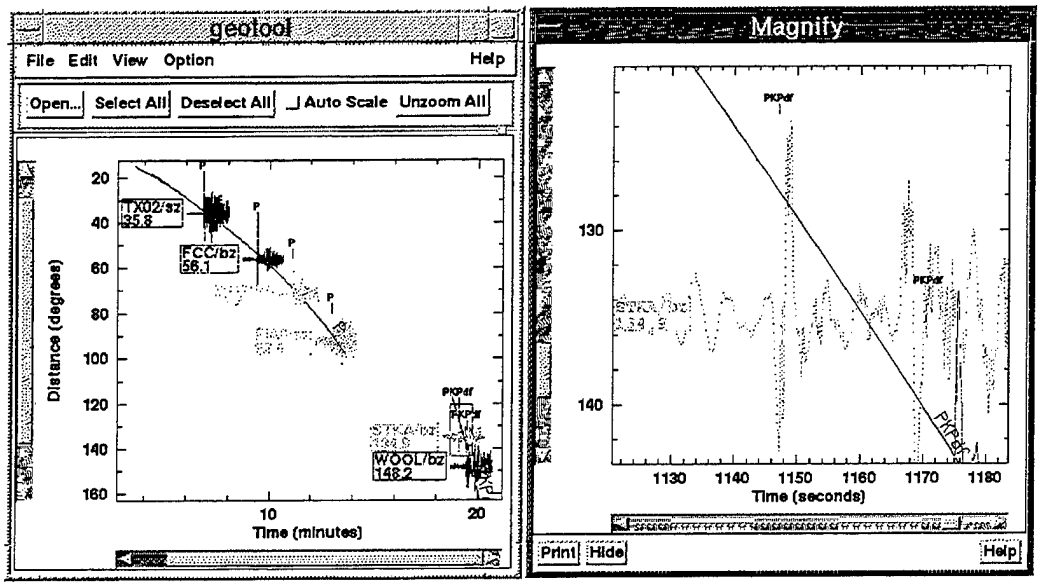

Figure 14: The **Magnify** popup provides a magnified view of a portion of the main plotting window. The outline of the Magnify window can be seen as a red square surrounding the first arrival of the STKA waveform in the bottom right hand corner of the main plotting window.

pressing the control key on the keyboard.

3.3.7 Magnify Window

To see a detailed view while retaining an overview, outline a box around the STKA/bz arrival by dragging the middle mouse button while pressing the control key on the keyboard. To display the contents of the box just drawn, release the mouse button and the **Magnify** popup (Figure 14) will be activated. Note that the PKPdf travel time curve is after the PKPdf arrival, since the travel time curve is currently drawn for an origin at 0.0 depth, while the actual origin occurred at some depth. To change the depth used for positioning the travel time curves, drag the slider to the right of the **Depth** value in the **Travel Times** popup.

Use the scroll bars in the **Magnify** popup to reposition the magnify window in the main plotting window. When finished exploring with the

magnify window, close the **Magnify** popup by clicking on the Hide button.

3.3.8 PostScript Output

To print the contents of the main plotting window, select the File/Print menu item from the main menu bar. This activates the **Print** popup, used to create a PostScript file of the data currently displayed. Click on the Print button to generate the PostScript file. Click on the Hide button to close the **Print** popup.

Remove the travel time curves from the main plotting window by selecting the **P** and **PKPdf** entries in the **Travel Times** popup while pressing the control key on the keyboard. Click on the Hide button to close the **Travel Times** popup.

To prepare for the next exercise, select the menu item View/Sort/Distance Order. Clear the current data set from **geotool**'s memory with the Edit/Clear menu item.

3.4 Exercise 3 - Array Data

3.4.1 Data Input

Select the File/Open menu item in the main menu bar to activate the **Open** popup. Select the file named **array.wfdisc** in the **Files** list in the **Open** popup and click on the Apply button. After the waveforms are read, close the **Open** popup by clicking on the Hide button.

3.4.2 Beamforming

Select the waveform AS15/sz. Select the Option/Beamform/Set Reference menu item. This identifies which station to use for determining the name and reference time for the beam. A * is added to the tag of the reference waveform.

Select the Option/Beamform/On menu item. This activates beamforming. The beam is a new waveform which is calculated by summing all selected waveforms as they are aligned on the display. Since only one channel is contributing to the beam, the beam is an exact copy of the AS15/sz waveform.

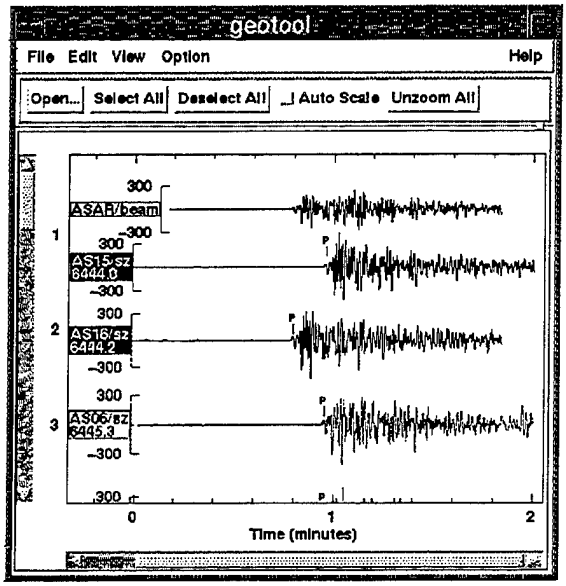

Figure 15: The top waveform is a beam of the selected waveforms AS15/sz and AS16/sz. Note that the beam is only formed where the selected waveforms overlap.

Select the waveform AS16/sz. The beam is recalculated by summing the selected waveforms in their current position. Select the **View/Data Movement/xy movement** menu item so waveforms can be dragged. Drag the AS16/sz waveform across the screen. As the waveform is dragged, the beam is recalculated and redisplayed. Note that the beam duration decreases, since it is only calculated where all the selected waveforms overlap (Figure 15).

Zoom in on the first arrival by moving the mouse cursor to the left of the arrival and drag the mouse cursor to the right with the right mouse button held down. Release the right mouse button after the cursor has passed the arrival.

Drag the AS16/sz waveform so it overlays the AS15/sz waveform. Note how the waveforms can be compared cycle by cycle. Bear in mind that performance is decreased because the beam is recalculated each time a selected waveform is repositioned.

You may have noticed that the **Working** popup stated that 19 waveforms were being read, but now only a handful are visible. To view all the waveforms

at once, select the View/Scale/Auto Scale menu item. Select all the waveforms with the View/Select/Select All menu item. Now all of the waveforms are contributing to the beam.

Select the View/Align/On True Time menu item to align all waveforms in true time. This aligns the waveforms so the earliest sample of any waveform is positioned where the x axis equals 0 and all other waveforms are positioned relative to that start time. With the waveforms aligned in true time, the current beam is a vertical beam.

To hide the waveform tags, select the View/Tags/Display Tags menu item.

3.4.3 FK Analysis

Select the Option/FK menu item from the main menu bar. This activates the **FK** popup, where FK plots will be displayed.

To specify the particular segment for calculating the FK, add a double-line cursor by moving the mouse cursor into the FK plot window and typing the `l` (small letter l) on the keyboard. Adjust the width of the double-line cursor to about 3 seconds. Do this by dragging one line of the cursor while pressing the control key. Note that the label above the double-line cursor is the width of the cursor in seconds. Position the cursor so it is over the arrival.

Select the File/Compute menu item in the **FK** popup to calculate the FK. The FK is displayed as a contour plot and a crosshair cursor is added. The position of the crosshair in the FK plot specifies a unique velocity and azimuth. The cursor is initially positioned at the peak value in the FK plot. The current values of apparent velocity and back azimuth are displayed beneath the FK plot.

Select the Option/Align Waveforms menu item in the **FK** popup. Each time the crosshair cursor is repositioned, the selected waveforms are aligned based on the azimuth and apparent velocity defined by the crosshair cursor position. Drag the crosshair to a new position on the FK plot. The selected waveforms are aligned based on the new azimuth and apparent velocity and the beam is recalculated (Figure 16).

Map

To visualize the back azimuth determined by the FK analysis, activate the map from the Option/Map menu item in the main menu bar. Once the map

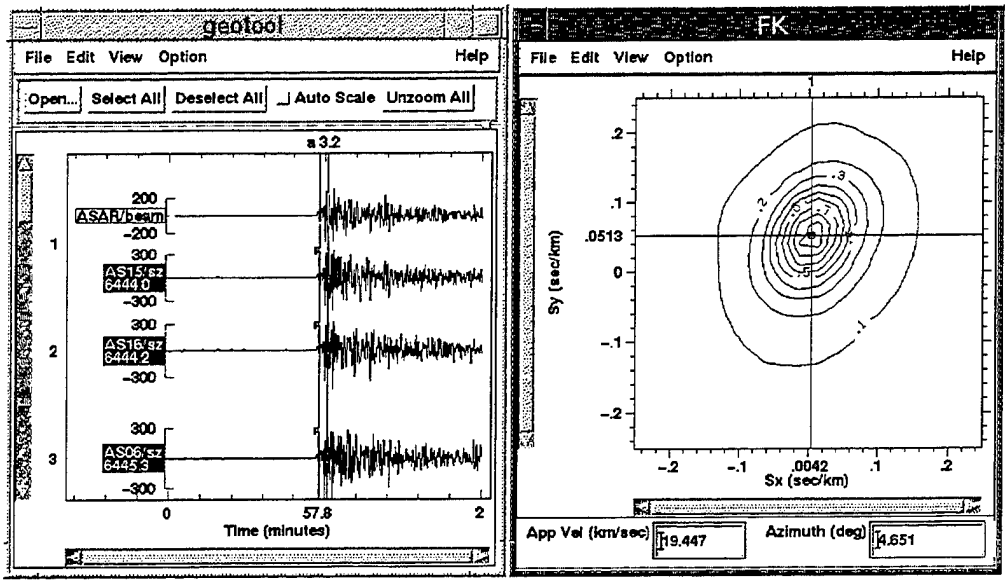

Figure 16: An FK plot of data from the Alice Springs array is displayed in the **FK** popup. The crossahir in the **FK** popup is positioned at the peak of the plot and measures the apparent velocity and azimuth listed in the bottom of the popup.

is displayed, reposition the crosshair cursor in the FK popup. Note that as the waveforms are realigned, the beam is reformed, and the FK azimuth on the map is redrawn each time the crosshair cursor is repositioned.

3.5 Conclusion

The authors hope that this tutorial has provided you with an understanding of **geotool**'s capabilities and design. Some of the more commonly used functions were described in this tutorial, but many more are available. In addition, there are other menu items and alternatives to the functions which were described. For example, arrivals can be added to several waveforms with a single mouse click if multiple waveforms are selected. We hope that this rich environment will encourage you to explore and enjoy **geotool**.

Chapter 4

Interface Description

4.1 Introduction

This chapter describes the standard **geotool** interface. It begins with some keyboard and mouse inputs which are common to all the plotting windows but do not have interface labels. Following that are all the operations which are labeled in the interface, in more or less the order that they appear in the various **geotool** menus. This chapter serves mainly as a reference.

The **geotool** interface follows the OSF/Motif style [OSF, 1991a]. See Motif documentation for a complete description of the Motif interface elements (widgets) [OSF, 1991b]. Some of the Motif widgets used in **geotool** are: XmMenuBar, XmList, XmScale, XmPushButton, XmToggleButton, XmFileSelectionBox, etc. A few widgets from other sources are also used: XmpTable from David E. Smyth, XbaeMatrix from Andrew Wason, and a modified Dial widget from Douglas A. Young [Young, 1994]. Several plotting widgets were written specifically for **geotool**. All interface buttons, scales or scroll bars can be activated with the left mouse button. Individual items in a list can be selected with the left mouse button. In some lists, multiple items can be selected with the left mouse button while pressing the control key. This chater begins with a description of keyboard and mouse interaction with **geotool** plotting widgets.

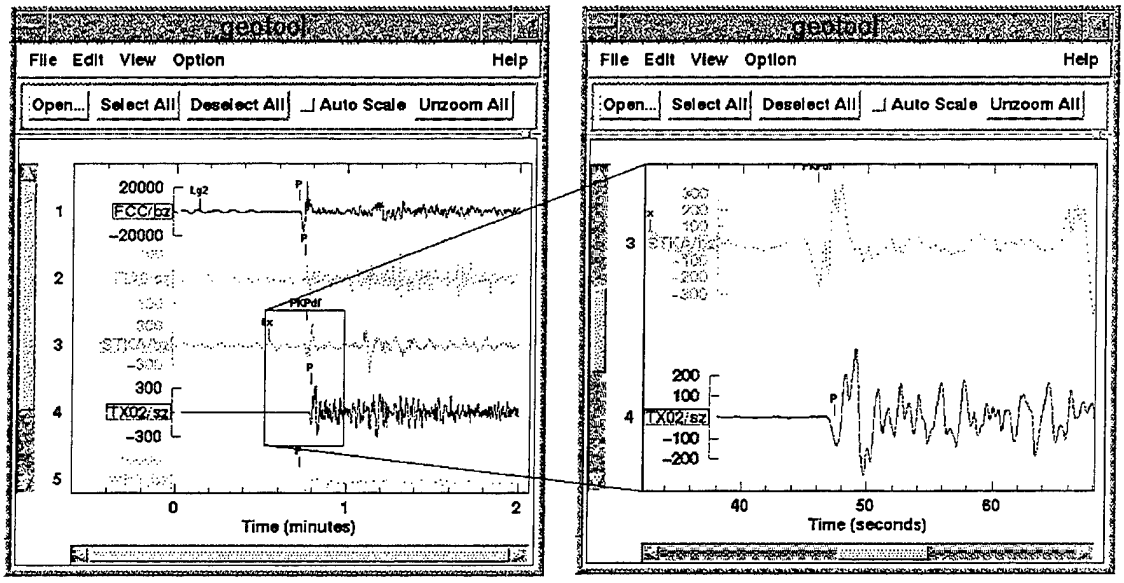

Figure 17: Example of zoom-in operation. In the initial picture on the left hand side, a rectangle is traced in "rubber band mode" using the middle mouse button. After the mouse is released, the display is redrawn with the limits shown in the picture on the right hand side.

4.2 Keyboard and Mouse Operations

4.2.1 Axis Limits

When **geotool** is started, the user is presented with the main window, which contains the menu bar and tool bar at the top and an empty x-y graph The x-y graph is one of several **geotool** plotting widgets. Listed below are the keyboard and mouse button inputs which modify the axis limits of any geotool plotting widget.

Middle Button Drag

In a plotting window, when the middle mouse button is held down and the cursor is moved, a rectangle is traced in "rubber band mode" from the point of the initial button press to the current cursor position. After the mouse

button is released, the plotting window will be redrawn at the limits of the rectangle (Figure 17). This zoom-in operation can be sequentially repeated an indefinite number of times, while the last twenty zoom limits are stored. The zooming operation will stop if either the x or y limits become equivalent, to floating point precision. This limit depends on the scale, and is approximately fabs((max-min)/max) $< 10^{-7}$.

Middle Button Click

To return or zoom-out to the previous window limits, click (press and release) the middle mouse button, without motion, anywhere within the plotting window. For example, after three zoom-ins operations, three middle button clicks will return the window to its original limits.

Shift-Key Middle Button Click

To zoom-in to previously stored window limits, press and hold the shift key while clicking the middle mouse button.

Right Button Drag

In a plotting window, when the right mouse button is held down and the cursor is moved, two vertical lines appear which define the new viewing limits. One vertical line is stationary, and is positioned where the right mouse button is first held down. The second vertical line moves with the mouse cursor, as long as the right mouse button is help down. After the mouse button is released, the plotting window will be redrawn as specified by those vertical lines (Figure 18).

Control-Key Middle Button Drag

A magnify option is available for the main **geotool** plotting window. To magnify a part of the main window, trace out a rectangle with a middle mouse button drag while holding the control key down. When the middle button is released, the **Magnify** popup will be displayed (Figure 19). The axis-limits in the **Magnify** plot window are set by the rectangle drawn in the main window (red on color displays). Without hiding the magnify window, additional control key middle-button-drag operations can be applied in the main window to change the placement of the magnify window. It is also

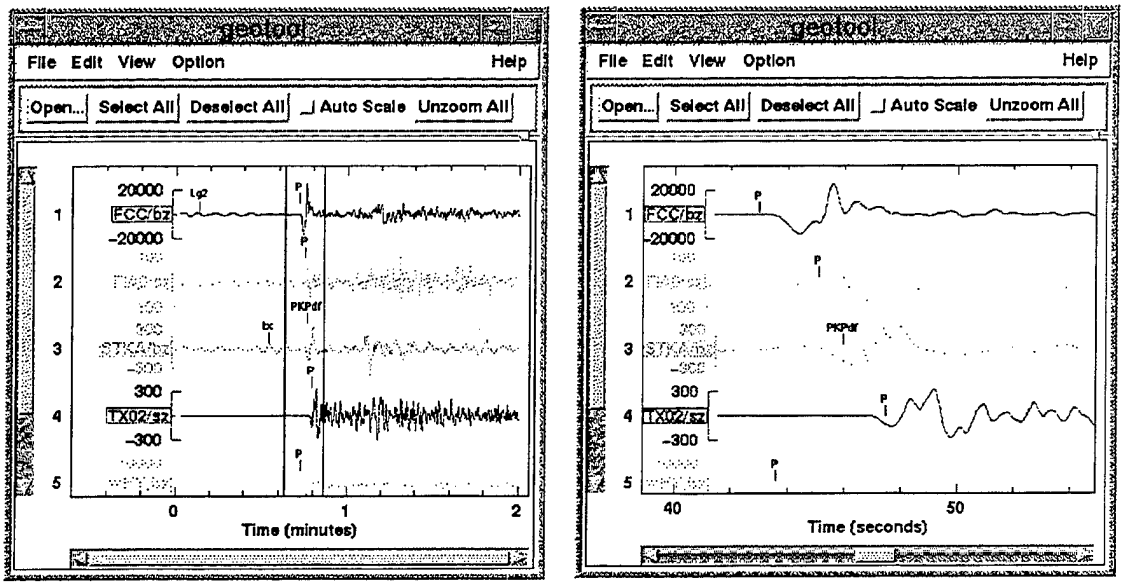

Figure 18: Example of horizontal zoom operation. In the initial picture on the left hand side, two vertical lines are placed using the right mouse button. After the mouse is released, the display is redrawn with the limits shown in the picture on the right hand side.

possible to reposition the magnify window within the main window by using the scroll bars in the **Magnify** popup. The magnify window accepts the same keyboard and mouse input as the main window, except for the magnify operation itself.

Keys h and H

A method of changing the horizontal axis limits by a fixed percentage is also provided. Place the cursor within a plotting widget and type the h key to decrease the horizontal axis limits (zoom-in) by a fixed percentage as determined by the X resource zoomHorizontal. The default value for zoomHorizontal is .2 or 20 percent. The center value of the axis remains the same. Similarly, typing the H key will increase the horizontal axis limits (zoom-out) by zoomHorizontal percent.

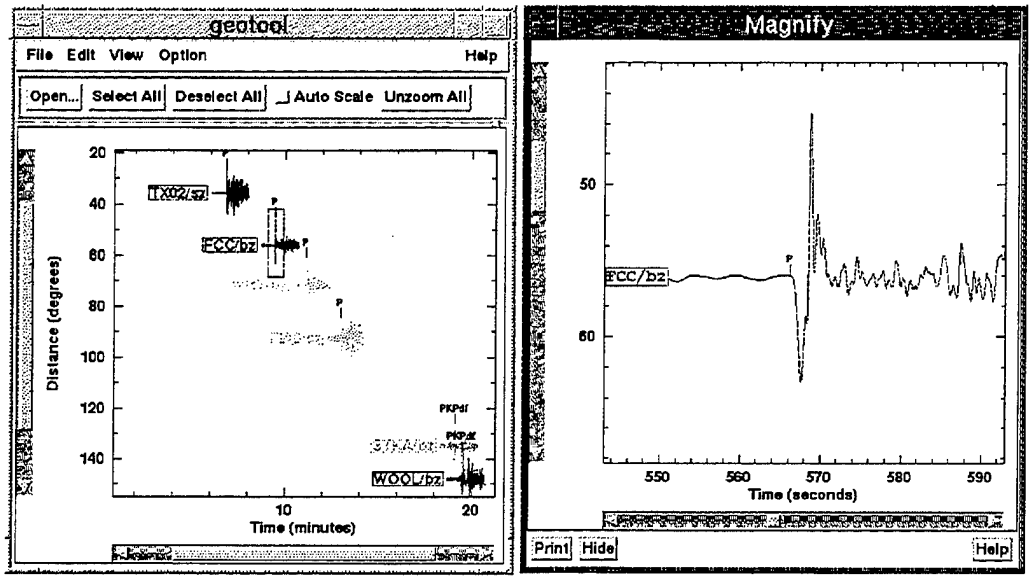

Figure 19: Example of the **Magnify** popup. In the main window is a small rectangle, which outlines the border limits of the **Magnify** popup. The **Magnify** popup is on the right hand side of this figure.

Keys v and V

To decrease the vertical axis limits by a fixed percentage (zoom-in) type the v key. The X resource **zoomVertical** defaults to .2 or 20 percent. The V key will increase the vertical axis (zoom-out) by **zoomVertical** percent.

Keys z and Z

The z key applies the h and v operations at the same time. Typing z inside a plotting widget decreases (zooms-in) the horizontal axis by **zoomHorizontal** percent and decreases the vertical axis by **zoomVertical** percent. Typing the Z key increases (zooms-out) the horizontal and vertical axes by **zoomHorizontal** and **zoomVertical** percent.

4.2.2 Scrolling

Most of the **geotool** plotting widgets contain scroll bars on the left and bottom edges of the window. After zooming-in, the plot can be scrolled either horizontally or vertically by mouse clicks or drags on the scroll bars. To scroll smoothly, drag the scroll bar slider (left-mouse-button-press, hold and move). Clicking on the scroll bar region above or below the slider jump-scrolls the graph by a single page and clicking on the arrows at either end of the scroll bar jump-scrolls the graph by a fraction of a page. In addition to the scroll bars, there are several key-commands for scrolling.

Keys f,F,b,B

The `f` key will jump-scroll down the vertical axis by one page and the `F` key will jump-scroll down the vertical axis by a fraction of one page. To jump-scroll up the vertical axis, use the `b` key for page scrolling and the `B` for fractional page scrolling.

Keys r,R,t,T

Similarly, the `r` key will jump-scroll the horizontal axis to the right by one page and the `R` will jump-scroll to the right by a fraction of a page. The `t` and `T` keys jump-scroll to the left a page and a fraction of a page, respectively.

4.2.3 Cursors

There are three types of cursors available in the plotting widgets. Several cursors of the same or different type can be plotted at the same time. Up to 10 cursors can be displayed simultaneously. Any cursor can be repositioned by dragging it while pressing the left mouse button. The following key and mouse commands are available for cursor manipulation.

Crosshair Cursor: c-Key

A crosshair cursor consists of one horizontal and one vertical line. To add a crosshair cursor, type the `c` key while the mouse cursor is within a plotting widget (Figure 20).

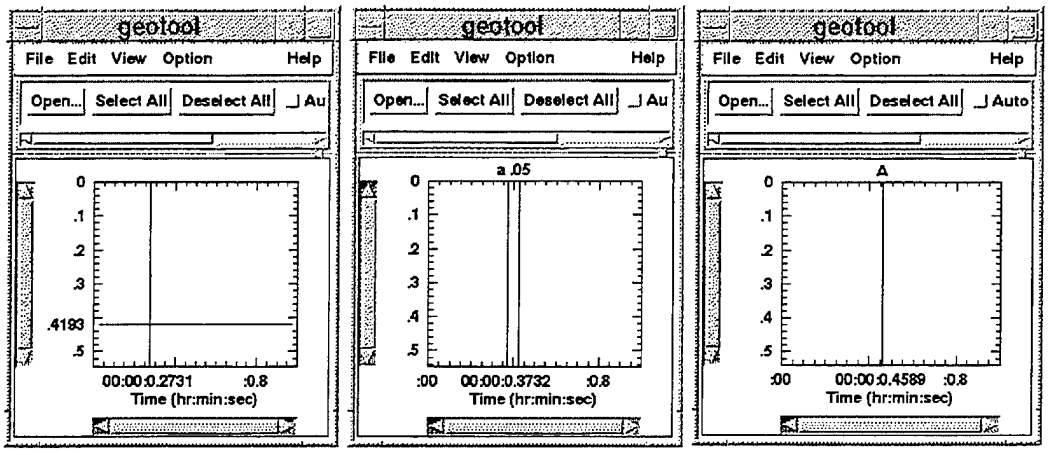

Figure 20: The three types of cursors in **geotool**. From left to right they are the crosshair cursor, double-line cursor, and single-line cursor. They are shown in separate windows for clarity.

Double-Line Cursor: l-Key

A double-line cursor consists of two vertical lines, for which the beginning time and separation time are printed. To add a double-line cursor, type the `l` key while the mouse cursor is within a plotting widget. Double-line cursors are labeled with lower case characters to distinguish them.

Either side (line) can be moved individually to change the time window between the lines by holding the **control** key down and moving one line with a left mouse button drag. Analysis functions obtain input data from a time window specified by a double-line cursor. The default input for all analysis functions is the window defined by the a double-line cursor, i.e., the first double-line cursor added to the window. If no double-line cursor is present, the entire waveform is used for the analysis.

Single-Line Cursor: L-Key

A single-line cursor consists of a single vertical line. To add a single-line cursor, type the `L` key while the mouse cursor is within a plotting widget. Single line cursors are labeled with upper case characters.

Deleting Cursors: d and D Keys

An individual cursor can be deleted by positioning the mouse cursor near the cursor and typing the `d` key. Type `D` to delete all cursors, including cursors outside of the current window limits.

4.2.4 Interacting with Waveforms

After waveforms have been plotted they can be repositioned, scaled and selected with keyboard and mouse input from the main window or the magnify window.

Moving Waveforms

The movement of waveforms can be restricted to either the x or y directions, or completely disallowed with the View/Data Movement option described on page 62. By default data movement is completely disallowed.

Once data movement is allowed, it is possible to reposition a waveform. Position the mouse cursor near a waveform, press and hold the left mouse button while moving the mouse cursor. The waveform will follow the motion of the cursor.

Scaling Waveforms

The scale at which a waveform is draw can be adjusted to enlarge or shrink the waveform image. Position the mouse cursor near a waveform, hold the control key down and press and hold the left mouse button while moving the cursor. Cursor motions away from the mean will enlarge the waveform, while motions towards the mean will shrink the waveform. Global waveform scaling is available in the View/Scale option described below on page 64.

Selecting Waveforms

To select a waveform as the input to a **geotool** operation, position the mouse cursor near the waveform and click on the left mouse button. If the X resource redrawSelectedData is set to True (the default), the selected waveform will be redrawn in the selectColor color (default is blue on color displays) and the waveform tag will be drawn in inverse video. If redrawSelectedData is False, only the tag will be redrawn. Normally, waveforms can be selected when the

mouse cursor is position near the waveform. To restrict the selection process by requiring that the mouse cursor be inside the waveform tag, set the X resource limitSelect to be False.

Multiple waveforms can be selected by dragging the mouse cursor across them. Hold down the shift key and the left mouse button while moving the cursor across several waveforms. To select or deselect all waveforms use the View/Select option described below on page 64.

Displaying Components

When three-component data are read into the program, each component can be displayed by itself, while the other components are hidden. Position the mouse cursor near any of the waveform components z, n, or e. Press and hold the left mouse button and type the key 1, 2, or 3 to display the z, n or e component only, respectively. Type the 4 key to display all three components together. To control which components are displayed globally (for all stations), use the View/Components option described below on page 61.

4.3 File Menu

Items in the File menu are related to reading waveform data and related information from files and creating output files.

4.3.1 Open

Select the File/Open option or type control-o in the main window to display the Open popup window (Figure 21). The text window at the top of the Open popup, labelled Filter, contains the complete path of the directory in which **geotool** was executed, followed by the filter `*.wfdisc`. The Directories list displays all subdirectories, while the Files list displays all files which match the pattern specified in the Filter text window. The default pattern is `*.wfdisc`.

Filter

The Filter text line can be edited, and a new search for files performed by typing the return key inside the Filter text window or selecting the Filter push button. For example the, changing the `*.wfdisc` to `*.arrival` and selecting

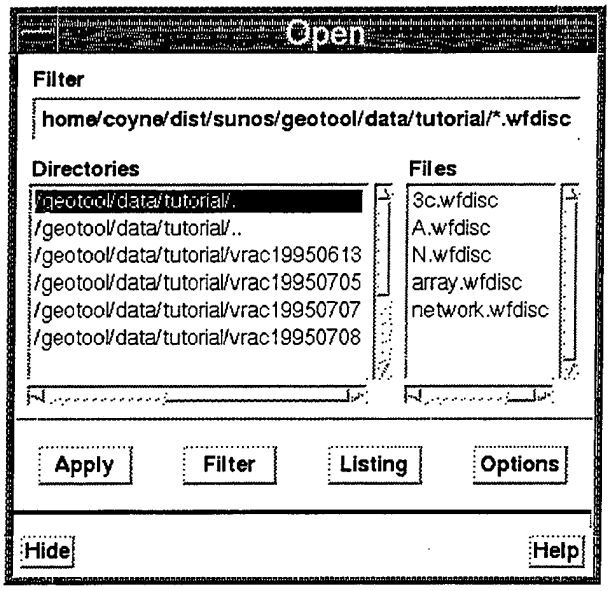

Figure 21: The **Open** popup.

the Filter push button lists all of the files in the current directory with the suffix `.arrival`.

The initial directory can be initialized to something other than the directory where **geotool** was started. For example, to begin in the directory `/tmp`, use the X resource setting:

```
Geotool*_Open*directory: /tmp
```

The search pattern can be initialized to something other than `*.wfdisc`. For example, to list all the files in the directory, initialize the search pattern with the X resource:

```
Geotool*_Open.fsb.pattern: *
```

To change to the parent or a subdirectory, simply select the new directory from the Directories list and click on the Filter push button.

Apply

When the desired files are listed in the Files list, one or more of them can be selected and read by **geotool**. Multiple entries can be selected in the Files list by pressing the `control` key while selecting with the left mouse button. To read the entire contents of the selected file(s) in to the main window, click on the Apply option. The data input can be terminated by clicking on the Stop option in the Working popup window, which displays the number of records actually read. If the Stop option is selected, the waveforms already read will be displayed.

For CSS formatted data, it is common to specify one waveform using several wfdisc records, each record pointing to a segment of the waveform. When multiple wfdisc records with the same station and channel are read at the same time, either by using the Open/Apply option or the File Listing/Apply option, **geotool** will determine if the segments should be joined together and displayed as a single waveform. If the gap between the end time of one segment and the start time of the next segment (with the same station and channel) is less than the X resource joinTimeLimit, the two segments will be joined. The value for this resource is in seconds, and the default is 1800 seconds.

Listing

To view the contents of selected file(s) before displaying their contents into the main window, click on the Listing push button in the Open popup. The File Listing popup will display the contents of the selected file(s) (Figure 22). Information about each waveform record in the file(s) will be listed. Individual records can be selected directly from the list, or by selecting from the Sta, Stype, Chan, Ctype, Date or Origin Time lists.

Sta is a list of all distinct stations from the current data. Chan is a list of all distinct channels from the current data. Date is a list of all distinct Julian dates of waveform start times from the current data. Origin Time is a list of all times of seismic origins which are associated with the current data.

Stype is the station type, which can be defining, associated (for stations with defining or associated arrivals), or some other group of stations. Station groups (besides defining or associated) can be defined in a CSS formatted affiliation table, which is specificed with the X resource listingStype.

Ctype is the channel type, which can be proto, sp-array, sp-3c, bb-3c, etc.

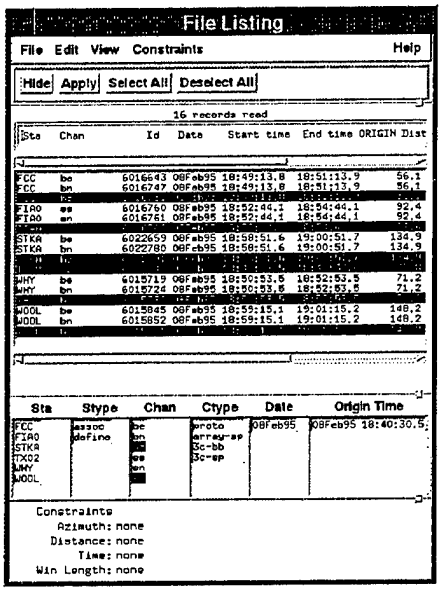

Figure 22: The **File Listing** popup.

proto selects the single best channel from a station, e.g., for 3-component stations, this is usually the z-component, while for arrays this is usually the z-component of the central element. All Ctype information is defined in a file specificed with the X resource listingCtype. The default priority file is *$GEO_TABLE_DIR*/`static/global.priority`, which is described on page 88.

In addition to selecting records from the lists just described, additional selection constraints can be made based on azimuth, distance, time, and time after an associated origin. Each of these constraints can be specified from items in the Constraints menu. *Unlike selecting records from the lists, the constraints do not select data; constraints are used to limit which data can be selected.*

Azimuth and distance constraints can be specified from the Azimuth Constraints and Distance Constraints popups, respectively. Azimuth constraints are given in degress from 0. to 360. Distance constraints are given in degrees from 0. to 180. If a waveform is not associated with an origin, and either of these constraints is set, the waveform will not be selectable in the File Listing popup, since the waveform is outside the range of the constraints.

Time constraints can be specified from the Waveform Layout popup, which is accessible from the Constraints/Time menu option. In addition to specifying start and end times, it is also possible to specify the maximum plotting duration of the waveform. If a waveform exceeds this duration, it is divided into several segments of the specified length.

Time constraints can also be specified from the Segment Window popup, which is accessible from the Constraints/Origin menu option. If the waveforms are associated with an origin, waveform segments can be specified based on theoretical arrival times. Time buffers before and after the theoretical arrivals can also be specified.

Once constraints are set, they are listed at the bottom of the File Listing popup. It is important to remember that these same constraints are applied to data read directly in the Open popup when using the Apply button in the Open popup.

Records in the File Listing can be sorted by several attributes, which are listed in the View/Sort menu option menu. Possible values for this option are: file order, sta/chan/time, time/sta/chan, sta, chan, sta/chan, id, distance, and selected. The sort order in the File Listing popup is initialized with the X resource fileListingSort. For example:

```
Geotool*fileListingSort: sta/chan/time
```

Options

Several controls affecting how waveforms are read and plotted are accessible from the Open/Options popup. When Open Options/Format is set to Auto, **geotool** attempts to read data files using all of its known formats, until a format succeeds. If Open Options/Format is set to a particular format, the program will only read data files in the selected format and will report an error if an attempt is made to read data in any other format. The color of incoming waveforms can be set with the Open Options/Color menu which is described later under View/Waveform Color on page 66. The contents of incoming waveform tags is controlled by the Open Options/Tag Contents, which is described later under View/Tag Contents on page 65. The start time, end time, and duration of waveforms is controlled using the Waveform Layout option which was described just above. Waveform segmentation is controlled

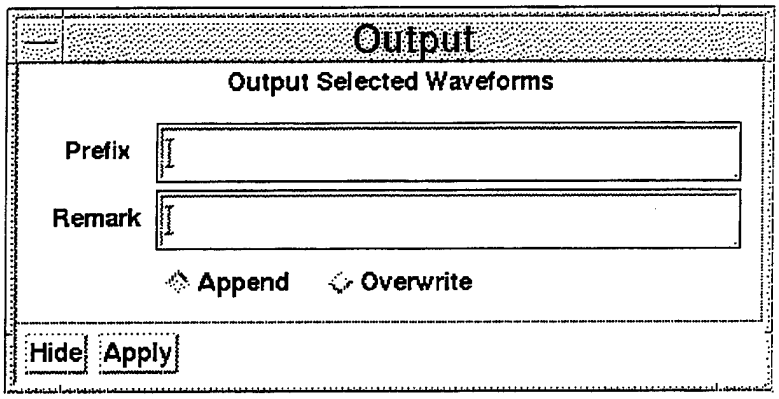

Figure 23: The **Output** popup allows selected waveforms to be written to disk.

using the Segment Window option, which was also described above.

4.3.2 File/Output

The Output popup allows selected waveforms to be saved in CSS 3.0 format (Figure 23). If a double line cursor surrounds a selected waveform, only the segment inside the double line cursor is saved. The prefix given in the Output popup is the prefix of the output wfdisc file.

If a remark is given, it is stored in a CSS 3.0 format remark file with the same specified prefix, and is linked to the wfdisc records using the commid attribute.

If the Append toggle button is selected, the records are appended to any pre-existing file with the same prefix. If the Overwrite toggle button is selected, any pre-existing file with the same prefix will be overwritten.

4.3.3 File/Print

All of **geotool**'s plotting windows have a Print option that generates a PostScript file. All data in the window are redrawn with a resolution of 300 dots/inch. Files can optionally be sent directly to a printer.

The Print popup can be activated from any plotting window by either selecting the corresponding File/Print option or by placing the mouse cursor

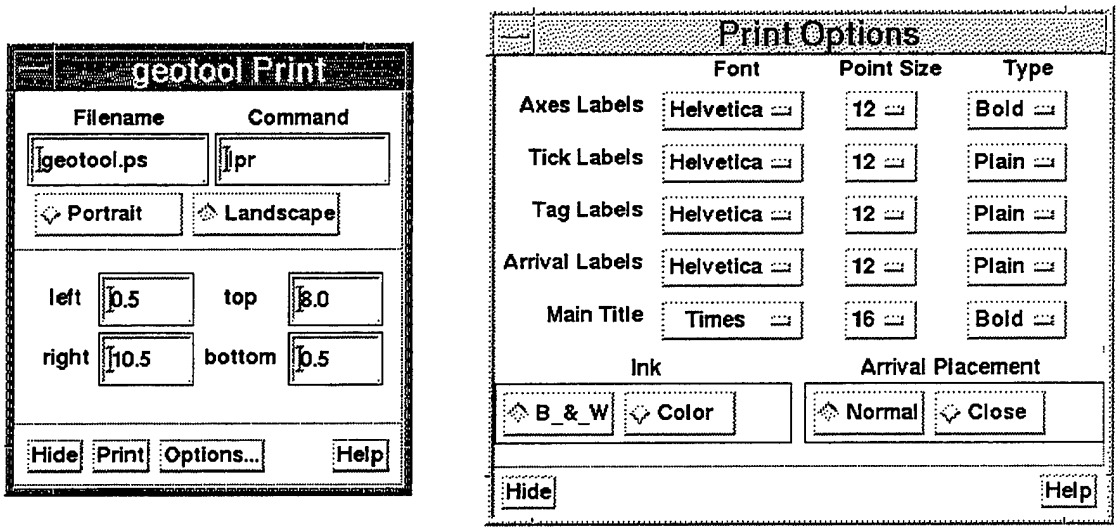

Figure 24: The **Print** and **Print Options** popups. The **Print Options** popup is accessible from the **Options** button in the bottom of the **Print** popup.

in the window that you want to print and typing control-p (Figure 24). Enter the name of the PostScript output file in the text window labelled Filename. If a system command should be executed after the PostScript file is generated, enter the command in the text window labelled Command. The name of the PostScript file will be the argument to the command when it is executed. By default, the PostScript file will be written to the directory where **geotool** was invoked. Set Portrait or Landscape to orient the page. Margins on the page can be specified with the left, right, top and bottom fields.

Select the Print option at the bottom of the Print window to generate the PostScript file and execute the command. If the command is empty, only the PostScript file will be generated.

Print/Options

The Options option at the bottom of the Print window activates the Print Options popup which controls the Font, Point Size, Type, Ink and Arrival Placement options. These parameters apply to printing done in all plotting

windows.

4.3.4 File/Tables

The Tables popup lists the paths to current global input files. These files are described in detail in section 6.4.4 beginning on page 109. To modify a path, type the new path and click on the Apply button.

4.3.5 File/Warnings

The Warnings popup lists all warnings issued during the current **geotool** session.

4.3.6 File/Exit

Terminates the current **geotool** session.

4.4 Edit Menu

The items in the Edit menu either remove waveforms from the program or change the waveform data values in some manner.

4.4.1 Edit/Clear

The Clear option clears the main window and removes all cursors, waveforms, arrivals and origins entries known to **geotool**.

4.4.2 Edit/Copy Data

To make a copy of a selected waveform(s), select the Copy Data option. A copy of each selected waveform is plotted beneath the original waveform.

4.4.3 Edit/Delete Data

The Delete Data option removes any selected waveforms. Any associated arrivals or origins are not removed from memory.

4.4.4 Edit/Filter/Butterworth Filter

The Butterworth Filter popup has controls for applying IIR filters to selected waveforms (see Figure 5 on page 23). IIR digital filters are derived from a Butterworth-pole description. For the mathematical details of the method, see Oppenheim and Schafer, 1975. The algorithm used by **geotool** was developed by Dave Harris at Lawrence Livermore National Laboratory. The filter types are BP (bandpass), LP (lowpass), HP (highpass), and BR (band-reject). The Order, Low Cut, and High Cut can be set with the sliders or by typing into the corresponding text windows. If the Mode is set to Replace, the filter is always be applied to unfiltered data. If the Mode is set to Chain, each filter is applied in addition to any previous filter(s). The Unfilter option will remove the all filter(s) applied to each waveform.

If Taper is set to On, the specified taper is applied to both ends of the waveform after filtering. The width of the taper (as a fraction of the waveform length) can be set in the Filter Taper popup which is raised by the Taper Params option. In addition to the taper width, the minimum and maximum number of points used in the taper can also be specified in the Filter Taper popup. If Input is set to All, all the waveforms are filtered. Otherwise, only the selected waveforms are filtered. After setting the filter parameters, apply the filter by clicking on the Apply option.

Butterworth Filter/Filter List

The Filter List provides an alternative method of applying filters. Selecting an item from the list with a mouse click applies the filter described by that item. The first item in the list (`custom`) is replaced with the parameters of the currently applied filter. Use the following X resources to define the Filter List:

```
Geotool*_Butterworth_Filter*Filter_List.itemCount: 10

Geotool*_Butterworth_Filter*Filter_List.visibleItemCount: 10

Geotool*_Butterworth_Filter*Filter_List.items: \
        custom \
        3.0 6.0 3 BP causal, \
        2.0 5.0 3 BP causal, \
        2.0 4.0 3 BP causal, \
```

```
1.0 5.0 3 BP causal, \
1.0 4.0 3 BP causal, \
1.0 3.0 3 BP causal, \
1.0 2.0 3 BP causal, \
0.5 2.0 3 BP causal, \
0.5 1.5 3 BP causal, \
6.0 12.0 3 BP causal
```

4.4.5 Edit/Filter/Hilbert Transform

The Hilbert Transform popup has controls for applying a Hilbert transform to all or only selected data. The Unfilter option removes the Hilbert transform applied to each waveform.

4.4.6 Edit/Filter/Polarization Filter

A polarization filter can be applied to three-component data with the Polarization Filter popup. The algorithm used was developed by Andy Jurkevics [Jurkevics, 1988] at the Center for Seismic Studies. The output of the filter is a single waveform which represents the rectilinear (body-wave) motion in a direction defined by the azimuth and incidence of the filter. A vector filtering is applied to the polarization ellipse in order to pass linear motion with a specified orientation. The three waveform components are each decomposed into short time windows and narrow frequency bands and the analysis is done separately in each frequency band and time window. The results are summed together in a single output waveform.

Zero phase Butterworth bandpass filters are used to perform the frequency decomposition. The frequency interval between Low Cut and High Cut is divided into frequency bands that are an integral number of octaves wide, so the filter impulse responses are an integral number of cycles in duration. The integer Frequency Cycles relates the bandwidth to frequency,

$$\Delta f = \frac{f_{center}}{n_{fcycles}} \tag{4.1}$$

where Δf is the bandwidth, f_{center} is the center frequency of the band and $n_{fcycles}$ is Frequency Cycles. $n_{fcycles}$ controls frequency resolution. Larger values input for Frequency Cycles will produce narrower filters, but their time response will have a longer duration.

After each bandpass is applied, the polarization analysis is done for a sliding time window whose length is a function of the frequency band. The window length is an integral number of cycles of the passband center frequency. If Δt is the window length, then its relation to center frequency is

$$\Delta t = \frac{n_{tcycles}}{f_{center}} \tag{4.2}$$

where $n_{tcycles}$ is the input parameter Time Cycles that controls time resolution. A polarization ellipse is computed for each time window. The contribution of this frequency band and time window is then weighted by the maximum value of the ellipse amplitude multiplied by the aperture function and by the degree of rectilinearity. The aperture function is $\cos(\theta)^{Aperture}$, where θ is the angle from the pass direction defined by Azimuth and Incidence. Azimuth is degrees clockwise from north, and Incidence is degrees from vertical. Increasing the value of the parameter Aperture decreases the width of the aperture and diminishes contributions to the output waveform which have polarization directions away from the pass direction. The Rectilinearity Scaling parameter controls the scaling by degree of rectilinearity. The contribution is scaled by

$$(1 - \frac{ev_2}{ev_1})^{rect} \tag{4.3}$$

where ev_1, ev_2, are the lengths of major and minor axes of the polarization ellipse, and *rect* is the input parameter Rectilinearity Scaling. Increasing the value of the parameter Rectilinearity Scaling decreases the weight given to contributions which are less rectilinear.

This decomposition scheme assumes that each frequency component has a stable polarization state over a duration of several cycles.

4.4.7 Edit/Unfilter All

The Unfilter All option removes all Butterworth filters and Hilbert tranformations applied to the waveforms.

4.4.8 Edit/Polarity

The Polarity option simply multiplies the amplitude values for selected waveforms by -1.

4.4.9 Edit/Rotate

Component waveform data can be horizontally rotated with the Rotate window controls. Select one or more pairs of horizontal components. To perform a rotation, move the dial hand with the a left-mouse-button-click or drag (north is up), or enter the rotation angle (in degrees) in the window beside the Azimuth option and select Azimuth. Components are demeaned before the rotation. When a single pair of horizontal components is rotated, an arc indicating the angle of rotation is displayed on the map.

The Rotate/Maximum option finds the angle of rotation that maximizes the total power of the radial component minus the total power of the tangential component within a time window. Position a double-line cursor over one or more selected horizontal component pairs. Select the Maximum option to rotate the components to the angle which maximizes the radial component. If only one pair of components is rotated, the angle of rotation is displayed in the text window beside the Maximum label. Due to the inherent ambiguity when using only horizontal components, the angle 180 degrees from the theoretical maximum angle is also given in the text window beside the Maximum label.

The Rotate/Origin option rotates any selected horizontal component pairs to the azimuth of their associated origins. If only one pair is rotated, the azimuth to its origin is displayed in the text window beside the Origin option. The Unrotate option removes all rotations from all selected horizontal component pairs.

An example using the Rotate popup is described in the Tutorial on page 27.

4.5 View Menu

The items in the View menu control the positioning, scaling, coloring, and labelling, of the data. These options change the way data are displayed or provide additional information about the data.

4.5.1 View/Align

There are several options in the View/Align menu for aligning waveforms.

- Align/On First Point - aligns the first point of all waveforms at time x=0.

- Align/On True Time - aligns all waveforms relative to their true starting time. The first point of the waveform with the earliest start time is positioned at time x=0.

- Align/On Time Minus Origin - aligns each waveform with associated origin information so the first point of the waveform is at (waveform start time - origin time). This option is used when drawing record sections, as illustrated on page 34.

To align array data relative to the slowness and azimuth of an arrival, use the Align on Slowness popup. Input slowness in seconds/kilometer or seconds/degree and station-to-source azimuth in degrees. Time lags relative to the geometrical center of the station locations for all selected waveforms are computed. If Type is set to absolute, these time lags are added to the beginning times of each waveform and the waveforms are realigned. If Type is set to relative, each selected waveform is simply shifted from its current position by the computed time lag.

Pressing the Beam button creates a beam based on the azimuth and slowness in the Align on Slowness window. This differs from the beam formed by the Beamform/On Off option in that this beam can be selected and filtered.

Waveforms can also be aligned based based on observed or predicted arrivals from the Option/Arrivals popup.

4.5.2 View/Components

To display only one component waveform for all stations, select the Components/Z Only , Components/N Only or the Components/E Only option. For an individual station, the component displayed can be controlled with the mouse/key commands discussed above in Displaying Components on page 49.

4.5.3 View/Data Movement

The movement of waveforms with the mouse cursor can be prohibited, unrestricted, or restricted to only the horizontal or vertical directions. To restrict waveform movement to vertical directions only, select the Data Movement/y movement option. The Data Movement/x movement will restrict movement to the horizontal directions. To completely disallow movement of the waveforms with mouse, select the Data Movement/no movement option, the default. The Data Movement option can be initialized with the X resource dataMovement, which can be set to XY_MOVEMENT, X_MOVEMENT, Y_MOVEMENT or NO_MOVEMENT. For example, to initialize the Data Movement option to no movement, use the X resource:

Geotool*dataMovement: NO_MOVEMENT

4.5.4 View/Display Arrivals

Select the Display Arrivals/On All Channels option to display arrival labels above the waveforms for all channels. The Display Arrivals/On One Channel option displays arrivals only on the channel that is associated with the arrival. For CSS formatted data, the chan attribute of the arrival structure associates a channel with an arrival. The Display Arrivals option can be initialized with the displayArrivals X resource, which can be set to ARRIVALS_OFF, ARRIVALS_ONE_CHAN or ARRIVALS_ALL_CHAN. For example, to initialize **geotool** to display arrivals on all channels, use the X resource:

Geotool*displayArrivals: ARRIVALS_ALL_CHAN

The font used in the arrival label can be set with the X resource:

Geotool*arrivalFont: *font-description*

4.5.5 View/Display Data

The Display Data option is a general method of displaying some waveforms while others are hidden. The Display Data/Selected Only option displays only the waveforms which are currently selected. Waveforms not selected are hidden.

4.5.6 View/Labels

A single line title, x-axis label and y-axis label for the plotting window can be set with the Labels popup. These annotations are included in the PostScript output. When Time Scale is set to Variable, the x-axis label cannot be set with the Labels option. The screen font used in the plotting window axis labels in the main window, including the tickmark annotations can be set with the X resource:

Geotool*_geotool*plot1.font: *font-description*

4.5.7 View/Limits

The Limits window contains controls for positioning and setting the limits of the x and y axes. The x min, x max, y min and y max text fields display the current limits of the main window. Either axis can be positioned on the top, bottom or left side of the plotting window. The time-axis is restricted to increase from left to right or from top to bottom. The direction of the non-time axis is unrestricted. Although the waveforms can be plotted vertically, not all **geotool** options work in this mode.

4.5.8 View/Time Scale

The Time Scale option controls the units of the x-axis. If set to Seconds, the units along the x-axis are always seconds. If the setting is Variable, the x-axis units are seconds, minutes, hours, etc., depending on the limits of the axis. Option HMS displays the time as hr:min:sec. Waveforms can be plotted using a reduced time scale with the Reduced Time Plot popup. The x-axis becomes t - r/v, where t is time, r is distance,

and v is velocity in sec/km or sec/deg as specified in the Reduced Time Plot popup. The Time Scale option can be initialized with the X resource timeScale, with the values TIME_SCALE_SECONDS, TIME_SCALE_VARIABLE or TIME_SCALE_HMS. For example, to initialize the Time Scale to Variable, use the X resource:

```
Geotool*timeScale: TIME_SCALE_VARIABLE
```

4.5.9 View/Scale

The scale at which waveform amplitudes are drawn can be controlled with the Amplitude Scale popup. If the mode is set to Independent, the maximum amplitude difference for each waveform spans the same number of pixels on the screen, as specified in the Pixels text field. If the setting is Uniform, the maximum amplitude difference of the largest waveform spans the input number of pixels. All other waveforms are drawn at the same relative scale and will span a smaller number of pixels.

4.5.10 View/Select

Select or deselect all waveforms with this option.

4.5.11 View/Sort

Select a View/Sort option to sort all displayed waveforms. When waveforms are input to the window, they are positioned according to the current sort option.

Sort options are: Input Order, File Order, Distance Order, Distance Degrees, Distance Km, Time/Sta/Chan, Sta/Chan, Chan/Sta, Selected, BAZ Order, BAZ, and Sort Off. When waveforms are sorted by Order, the waveforms are evenly spaced when they are sorted, from the mininum number to the maximum number.

When the sort mode is Sort Off, the waveforms are left as they on the screen. When new data are read in, the waveforms are not resorted.

4.5.12 View/Tags

The tags are the labels attached to the left side of each waveform. They can be toggled on or off with the Display Tags option. The appearance of tags can be initialized with the X resource Display Tags:

Geotool*displayTags: True or False

The contents of each waveform tag can be controlled with the Tag Contents popup. Select the waveform(attributes, in the desired order, to be included in the tag. The Text attribute displays any text that is entered using the Tag Contents/Edit Text option. The Apply option sets the tag for all selected waveforms.

The font used in the waveform tags can be set with the X resource:

Geotool*tagFont: *font-description*

4.5.13 View/Time Amplitude

The Amplitude Scale option displays an axis with amplitude labels to the left of each waveform. The axes move with each waveform and scale as the waveforms are scaled. To display the time and amplitude value of individual data points, use the Cursor Position option. When the A single-line cursor is moved over one or more of the selected waveforms, the time and value of the data point nearest the cursor is displayed for each selected waveform in the Time Amplitude popup (Figure 25). An alternative method of displaying amplitude values is the Amplitude Plot option. When the Amplitude Plot window is raised, selecting a waveform in the main window will cause it to be displayed in the Amplitude Plot window, where the y-axis units are raw amplitude values, i.e., the waveform values are not mulitplied by the calib attribute in the wfdisc record.

4.5.14 View/Unzoom All

Select Unzoom All to return to the axes limits before all zoom-ins. After an Unzoom All, a middle-mouse-click in the plotting window will zoom-out

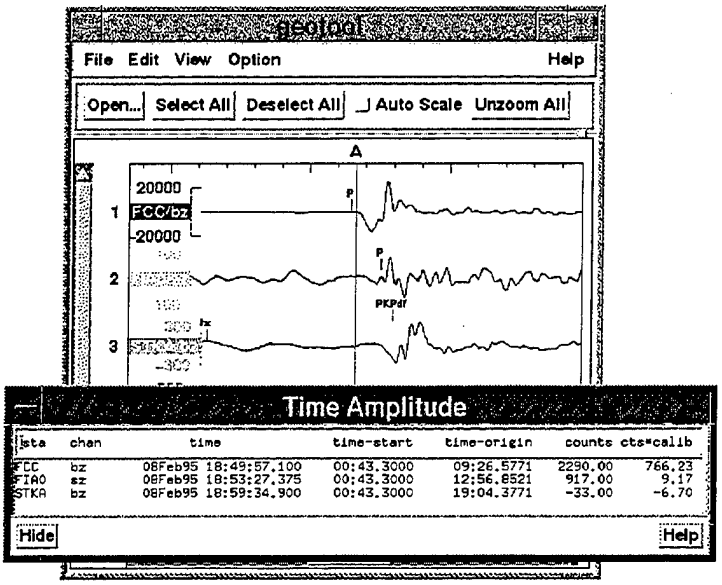

Figure 25: The **Time Amplitude** popup.

slightly if all waveforms are not completely visible.

4.5.15 View/Waveform Color

Waveforms can be colored in **geotool** according to the following criteria: **uniform**, **unique**, **station**, **channel**, **network**, **origin**. Criteria can be specified from the **Waveform Color** popup. Waveforms are colored by **network** by default.

uniform colors all waveforms with the first color in the list. The list of colors is described below. **unique** draws each waveform with a unique color, cycling through the list of colors. **station** colors the waveforms based on station. **channel** colors the waveforms based on channel. **network** colors the waveforms based on stations from the same network, as specified in the *$GEO_TABLE_DIR*/`static/global.affiliation` table. **origin** colors waveforms associated with the same origin the same color.

The list of colors used to draw waveforms is specified with the X resource **waveformColors**. The default setting is:

```
Geotool*waveformColors: forest green, sky blue, orange, brown, \
MediumOrchid, red, thistle, sea green, tan, maroon, slate blue, grey
```

4.6 Option Menu

The items in the Option menu are analysis tools which operate on selected waveform data and produce graphical output in other plotting windows. Usually, the input data can be specified as an entire waveform or a segment of a waveform. To specify a segment as input to an analysis function, position the double-line cursor over the region of interest (see Double-Line Cursor: I-Key, on page 47) and select the waveform.

4.6.1 Option/Arrivals

Arrival attributes are listed in the Arrivals window. Arrivals can be added, editted, and deleted from the Arrivals popup. Waveforms can be aligned based on observed or theoretical arrivals from this popup.

Arrivals File/Open

Allows arrival data to be read into **geotool**. Arrivals read with this method are displayed in the main window only if the associated waveforms have already been read in. Arrivals with no associated waveforms can be listed in the Arrivals popup by using the View/List Main Window Arrivals Only option.

Arrivals File/Hide

Hides the Arrivals popup.

Arrivals Edit/Add

Creates a new arrival record. The position where the phase line intersects a selected waveform(s) is the time of the new arrival. The name above the phase line is the phase of the arrival. The arrival id is obtained from the *$GEO_TABLE_DIR*/`dynamic/global.lastid` table. If the global lastid table does not exist, the lastid table in the current directory is used. If there is no local lastid table, arids are incremented beginning with the current maximum arid in the current arrival file.

Arrivals Edit/Delete

Removes the selected arrivals from the display, and from the disk file.

Arrivals Edit/Edit

Allows attributes in selected arrivals to be editted. An arrival must be selected before it can be editted. See page 24 for an example of editting an arrival.

Arrivals Edit/Rename

Renames to the selected arrival(s) to the next phase selected from the phase list.

Arrivals View/Align

Aligns waveforms based on phase or signal. The choices are:

- `Align on Arrival` - aligns selected waveforms based on observed arrivals.
- `Align on Predicted` - aligns waveforms based on predicted arrivals. Waveforms must be associated with an origin for this option to work.
- `Align on Next Min` - aligns selected waveforms based on the next mininum in the waveform.
- `Align on Next Max` - aligns selected waveforms based on the next maximum in the waveform.

Arrivals View/Attributes

Activates the Arrival Attributes popup, which provides control over which attributes are displayed in the Arrivals popup. For an example of how Arrival attributes can be modified, see page 26.

Arrivals View/List Main Window Arrivals Only

The Arrivals popup lists arrivals which are displayed above waveforms in the main window. However, with this option it is possible to list arrivals which have been read into **geotool** using the Arrivals/Open option but do not have associated waveforms displayed in the main window.

Arrivals View/Remove Selected From List

Removes selected arrivals from the arrival list.

Arrivals View/Select

Select or deselect all arrivals with this option.

Arrivals View/Zoom SP

Zooms in the main window so the phase line is in the center of the window, and the window width is **spArrivalWindow** seconds. **spArrivalWindow** is an X resource, which has a default value of 20 (seconds).

Arrivals View/Zoom LP

Zooms in the main window so the phase line is in the center of the window, and the window width is **lpArrivalWindow** seconds. **lpArrivalWindow** is an X resource, which has a default value of 1200 (seconds).

Arrivals Option/Associate with Origin

Associates the selected arrivals with the origin selected in the **Origins** popup. This action creates CSS assoc records for arrivals in CSS format.

Arrivals Option/Disassociate with Origin

Disassociates the selected arrivals with the origin selected in the **Origins** popup. This action removes the appropriate CSS assoc records.

Arrivals Option/Associate with Stassoc

Associates the selected arrivals with the stassoc selected in the **Stassocs** popup. This action creates CSS 3.0 stassoc records for arrivals in CSS 3.0 format.

Arrivals Option/Disassociate with Stassoc

Disassociates the selected arrivals with the stassoc selected in the **Stassocs** popup. This action removes the appropriate CSS 3.0 stassoc records.

Arrivals Option/Measure Amp Per...

Activates the Measure Amp Per popup, from where amplitude and period measurements can be made.

Arrivals Option/Stassocs...

Activates the Stassocs popup, from where stassoc records can displayed and editted.

4.6.2 Option/Beamform

Beamforming in **geotool** is done by summing selected, overlapping waveforms, and creating a new waveform, or beam. Aligning waveforms can be done interactively (see View/Data Movement, above), or from the menu items View/Align in the main window, or Option/Align Waveforms in the FK popup.

Beamform/On Off

Toggles beamforming off and on. Beamforming is turned off by default.

Beamform/Save

Saves any displayed beam to a temporary CSS 3.0 wfdisc file stored in `/tmp`.

Beamform/Set Reference

Specifies which waveform to use for timing and geographic location for the beam. To select a reference waveform, select the waveform and choose the Option/Beamform/Set Reference menu option. After this option is invoked, the reference waveform is indicated with a "*" appended to its waveform tag.

If the reference is not set, and the input waveforms are from an array where `dnorth` and `deast` are defined in the CSS 3.0 format site relation, this default location is used.

4.6.3 Option/FK

The FK of selected waveforms can be displayed in the FK popup. The simplest way to display an FK is to place a double-line cursor over selected array

data which are aligned in time, and choose the File/Compute option in the FK popup. If there is no double-line cursor, the FK is calculated for the entire waveform segments.

FK File/Compute

This displays new FK plots for the appropriate selected waveform segments. Appropriate in this case is the segment covered by the double-line cursor labelled a, or the entire waveform if the a cursor does not exist. The latter selection is usually a mistake, except in the case of very short segments.

The selected segments are usually elements of an array.

FK File/Print

Generates a PostScript file of currently displayed FK. See File/Print on page 54 for more details.

FK File/Hide

Hides the FK popup.

FK View/Grid

Toggles the grid of evenly spaced points used to draw the the FK contours. By default, the grid is turned on.

FK View/Fine Grid

Toggles the grid of closely points at the peak of the FK plot. By default, this fine grid is turned off. Turning the fine grid on will turn the standard grid off.

FK View/Labels

Allows labels in the FK popup to be modified. See View/Labels above for more details.

FK Option/Auto Compute

By default, the FK is only calculated when the File/Compute menu option is selected. If the Auto Compute option is toggled on, the FK is recalculated as the double-line cursor is dragged.

FK Option/Align Waveforms

Toggles waveform alignment on and off, so that the waveforms are aligned by the slowness and azimuth specified by the crosshair position in the FK plot. The waveforms is realigned as the crosshair in the FK plot is dragged.

FK Option/Beam

Creates a beam based on the azimuth and slowness of the maximum peak in the FK plot. This differs from the beam formed by the Beamform/On Off option in that the FK beam can be selected and filtered.

FK Option/Parameters

Activates the FK Parameters popup, where the input parameters to the FK are listed. s max is the maximum slowness, and num s is the number of S_x and S_y samples. lo freq and hi freq specify the frequency range used. These values are calculated by **geotool** if they are not specified.

These values can be modified if the Auto Window Parameters toggle is turned off. If the Auto Window Parameters toggle is turned on, the default, these values cannot be modified, and are calculated by **geotool**.

FK Option/Save Slowness

Saves the currently displayed slowness value in the FK popup with a selected CSS 3.0 format arrival.

4.6.4 Option/FT

The spectra of selected waveforms can be displayed in the FT popup. The simplest way to display spectra is to place a double-line cursor over a selected waveform, and choose the File/Compute option in the FT popup. If there is no double-line cursor, the spectrum is calculated for the entire selected waveform.

FT File/Compute

This displays new spectra for the appropriate selected waveform segment(s). Appropriate in this case is the entire waveform if no double-line cursor is present, or the segment covered by a double-line cursor if the cursor exists. Specific double-line cursor(s) can be specified from the File/Cursor menu option.

Previously displayed spectra are removed, unless they were retained with the Edit/Save menu option.

FT File/Cursor

This controls which double-line cursor(s) will define the input segment. Multiple cursors can be active simultaneously. The default is cursor a, the first double-line cursor.

FT File/Input

Allows spectra previously written to disk to be read and displayed.

FT File/Output

Allows currently displayed spectra to be written to disk in external files.

FT File/Print

Generates a PostScript file of currently displayed spectra. See File/Print on page 54 for more details.

FT File/Hide

Hides the FT popup.

FT Edit/Clear

Removes all spectra from the current display.

FT Edit/Save

Saves any displayed spectra on the display. The only way to remove "saved" spectra is with the Edit/Clear menu option.

FT Edit/Smooth

Performs smoothing on the spectrum after the Fast Fourier Transform. The width of the smoothing is specified as an input parameter in Hertz. The default is no smoothing, i.e., width = 0.0 Hz.

FT View/X Axis

Specifies if the units of the X axis should be Frequency or Log Frequency. The default is Frequency.

FT View/Y Axis

Specifies the units of the Y axis. The first selection is in terms of Amplitude or Power. The next selection is to plot the spectrum in Displacement, Velocity, or Acceleration. The final selection is the units, where the choices are dB relative to nanometers, dB relative to meters, nanometers, meters, log nanometers, or log meters.

The default is the Displacement Power Spectrum in units of dB rel nm**2/Hz.

FT View/Display Data

Specifies which data are displayed. The choices are Input Traces, Median, Percentiles, Mean, and Std Dev. The Input Traces are the spectra of the waveform segments selected in the main window. This is the default, and the most common selection. The other selections are derived from the Input Traces, and are most commonly used in noise studies.

The default percentiles are 10 and 90. These values are controlled using the X resources percentile1 and percentile2.

FT View/Labels

Allows labels in the FT popup to be modified. See View/Labels on page 63 for more details.

FT View/Limits

Allows limits in the FT popup to be modified. See View/Limits on page 63 for more details.

FT View/Unzoom All

Select Unzoom All to return to the axes limits before all zoom-ins.

FT Option/Auto Compute

By default, spectra are recalculated only when the File/Compute menu option is selected. If the Auto Compute option is toggled on, spectra are recalculated as the double-line cursor is dragged.

FT Option/Taper

Specifies which taper should be applied to the spectra. The choices are Hanning, Hamming, Cosine, Parzen, and None. The default is Hanning.

FT Option/Taper Percent

Specifies the beginning and ending taper percentages for the Cosine taper. The default is 10 percent for both the beginning and ending taper percentages.

FT Option/Instrument Corr

Specifies if the spectra should be corrected for the instrument response. By default, this is not activated.

FT Option/Windows

Activates a popup where the number of input windows and their overlap can be specified. The windowing is done on the input time series trace. By default only one window is used.

4.6.5 Option/Map

The map is a powerful tool for visualizing geographic information. Stations and sources read into **geotool** are plotted on the map, as well as azimuth lines from some operations, i.e., FK and rotation. User defined attributes can also be displayed.

Map File/Open

Activates the **Map Open** popup where user created map input files can be read. The format of map input files is described in Chapter 5 on page 90.

Map File/Overlays

The **Map Overlays** popup lists all overlays read into **geotool**. Selected entries are displayed on the map. To remove an entry from the list, select the entry, and select the Delete button in the **Map Overlays** popup. The default overlays reside in the directory specified with the X resource mapOverlayDir.

Map File/Print

Generates a PostScript file of currently displayed map. See File/Print on page 54 for more details.

Map File/Hide

Hides the **Map** popup.

Map Edit/Clear Distances

Removes all distance circles displayed on the map.

Map Edit/Clear FK Azimuths

Removes all FK azimuth lines displayed on the map.

Map Edit/Clear Rotation Azimuths

Removes all rotation azimuth lines displayed on the map.

Map View/Limits

Allows limits in the **Map** popup to be modified. See View/Limits on page 63 for more details.

Map View/Labels

Allows labels in the **Map** popup to be modified. See View/Labels on page 63 for more details.

Map View/Stations

Toggles stations displayed on the map. The setting can be either All, Selected, or None. All stations are on by default.

Map View/Station Tags

Toggles station tags displayed on the map off and on. Station tags are off by default.

Map View/Origins

Toggles origins displayed on the map. The setting can be either All, Selected, or None. All origins are on by default.

Map View/Origin Tags

Toggles origin tags displayed on the map off and on. Station tags are off by default.

Map View/Paths

Toggles travel paths displayed on the map. The setting can be either All, Selected, or None. Paths are on by default.

Map View/Ellipses

Toggles error ellipses displayed on the map. The setting can be either All, Selected, or None. All error ellipses are on by default.

Map View/Rotation Azimuths

Toggles rotation azimuths displayed on the map. The setting can be either All, Selected, or None. All rotation azimuths are on by default.

Map View/FK Azimuths

Toggles FK azimuths displayed on the map. The setting can be either All, Selected, or None. All FK azimuths are on by default.

Map View/Distances

Toggles distance circles displayed on the map. Distance circles are circles drawn around a station, where the radius is the distance from a station to an associated origin. The setting can be either All, Selected, or None. All distance circles are off by default.

Map View/Grid

Toggles the grid displayed on the map. The grid is intelligent, i.e., the spacing between the grid line changes based on the zoom level. The grid is turned off by default.

Map Option/Projection

Specifies the type of projection to use. The choices are Linear Cylindrical and Orthographic. The default is Linear Cylindrical.

Map Option/Measure...

Distances on the map can be measured from this popup. Actions availble after the **Map Option** popup is activated are:

- `shift right click` - add a distance circle and azimuth arc to the nearest station, source or crosshair.
- `right drag` - move nearest circle or azimuth (or both).
- `control right click` - delete the nearest circle or azimuth.

Map Option/Rotate to Crosshair

Recenters the map to the current crosshair location.

Map Option/Rotate to Station

Recenters the map to the selected station.

Map Option/Rotate to Origin

Recenters the map to the selected origin.

4.6.6 Option/Origins

The **Origins** popup lists all origins read into **geotool**.

Origins File/Open

Allows origin data to be read into **geotool**.

Origins File/Hide

Hides the **Origins** popup.

Origins Edit/Create

Creates a new null origin record. The origin id is obtained from the *$GEO_TABLE_DIR*/`dynamic/global.lastid` table.

Origins Edit/Delete

Removes the selected origins from the display, and from the disk file. The corresponding assoc records are also removed from the disk file.

Origins Edit/Edit

Allows attributes in selected origins to be editted.

Origins View/Attributes

Activates the **Origin Attributes** popup, which provides control over which attributes are displayed in the **Origins** popup. For an example of how Arrival attributes can be modified, see page 26. Origin attributes can be modified in a similiar way.

Origins View/List Main Window Origins Only

The Origin popup lists origins which have associated origins displayed in the main window. However, with this option it is possible to list origins which have been read into **geotool** using the Origins/Open option but do not have associated waveforms displayed in the main window.

Origins View/Remove Selected From List

Removes selected origins from the origin list.

Origins View/Select Associated Arrivals

Selects all associated arrivals of the selected origins.

Origins Option/Set Primary Origin

Sets the active origin, which can then be used for sorting and aligning waveforms.

4.6.7 Option/Particle Motion

This popup plots Particle Motion of the selected three-component traces. For all data samples inside the double-line cursor, a rectangle is drawn in the **Particle Motion** popup. The rectangle's size is proportional to the modulus of the motion vector. The rectangle's location is at (r, phi), with phi = atan2(n-s component, e-w component), and r = sqrt(2.)*sin(theta), where theta is half of the angle the motion vector makes with the vertical axis. The dashed circles are at 15, 30, 45, 60 and 75 degrees. Rectangles for "down" motion are colored red (or filled) and rectangles for "up" motion are colored green (or open). The slider adjusts the scale factor for all rectangles. The color of the "down" and "up" rectangles is defined by the The color of the "down" and "up" rectangles is defined by the X resources downColor and upColor.

4.6.8 Option/Polarization

The **Polarization** popup displays polarization attributes rectilinearity, azimuth, and incidence angle and the vertical trace of the selected 3-component

data. The azimuth is the station to source azimuth, to be consistent with the azimuth displayed in the **Rotate** and **FK** popups.

The simplest way to display the polarization attributes is to place a double-line cursor over selected 3-component data which is aligned in time, and choose the File/Compute option in the **Polarization** popup. If there is no double-line cursor, the polarization attributes are calculated for the entire waveform segments.

Polarization File/Compute

This displays new polarization attributes for the appropriate selected waveform segments. Appropriate in this case is the entire waveform if no double-line cursor is present, or the segment covered by a double-line cursor if the cursor exists. The double-line cursor labelled a is always used.

Polarization File/Print

Generates a PostScript file of currently displayed polarization attributes. See File/Print on page 54 for more details.

Polarization File/Hide

Hides the **Polarization** popup.

Polarization Option/Auto Compute

By default, polarization attributes are recalculated only when the File/Compute menu option is selected. If the Auto Compute option is toggled on, polarization attributes are recalculated as the double-line cursor is dragged.

Polarization Option/Parameters...

This activates the **Polarization Parameters** popup, where the input parameters to polarization are listed. window length is the time in seconds of the window used when calculating the polarization. window overlap is the number of seconds of overlap for adjacent windows.

These values can be modified if the Auto Window Parameters toggle is turned off. If the Auto Window Parameters toggle is turned on, the default, these values cannot be modified, and are calculated by **geotool**.

4.6.9 Option/Response

Instrument responses can be convolved and deconvolved with waveforms from the **Response** popup. Instrument responses can also be plotted in the **Response** popup.

Response File/Print

Generates a PostScript file of currently displayed responses. See File/Print on page 54 for more details.

Response File/Hide

Hides the **Response** popup.

Response View/Axes

Specifies how the axes should be drawn. The options are Log x-y, Log x, Log y, or Linear x-y. The default is Log x-y.

Response View/Display

Specifies if the response displayed should be Power, Amplitude, or Phase. The default is Amplitude.

Response Option/Convolve

Convolves the selected instrument response with the selected waveform.

Response Option/Deconvolve

Deconvolves the selected instrument response with the selected waveform.

Response Option/Auto Deconvolve

Deconvolves the appropriate instrument response with the selected waveform. The appropriate instrument response is found using the waveform's station name, channel, and time compared with the inventory of responses found in the *$GEO_TABLE_DIR*`/static/global.instrument` file.

Response Option/Tapers...

Allows the inverted response to be tapered before the deconvolution. The default low and high pass frequency limits are 0.1 Hz and nyquist, respectively.

4.6.10 Option/Spectogram

Spectogram File/Compute

This displays a new spectrogram for the appropriate selected waveform segment. Appropriate in this case is the segment covered by the double-line cursor labelled a, or the entire waveform if the a cursor does not exist. Only one waveform can be selected.

Spectogram File/Output...

Allows the currently displayed spectrogram to be written to disk in an external file.

Spectogram File/Print

Generates a PostScript file of currently displayed spectrogram See File/Print on page 54 for more details.

Spectogram File/Hide

Hides the **Spectogram** popup.

Spectogram View/Colors...

Activates the **Color Selection** popup, which contains a which contains a histogram of the current data values. Either end of the color bar beneath the histogram can be dragged used the `control` key and the left mouse button. This is effective in examining subtle color differences. By default, only 8 colors are used in the histogram. The can be changed by having a file named `geotool.rgb` in the directory where **geotool** was started. The file should contain Red Green Blue triplets, where the values range from 0 to 255. *In the future this mechanism will be replaced with an X resource specifying the file.*

Spectogram Option/Auto Compute

By default, the spectrogram is recalculated only when the File/Compute menu option is selected. If the Auto Compute option is toggled on, the spectrogram is recalculated as the double-line cursor is dragged.

Spectogram Option/Parameters...

Activates the **Spectogram** popup, where the input parameters to the spectrogram are listed. window length is the time in seconds of the window used when calculating the polarization. window overlap is the number of seconds of overlap for adjacent windows. lo freq and hi freq specify the frequency range used.

These values can be modified if the Auto Window Parameters toggle is turned off. If the Auto Window Parameters toggle is turned on, the default, these values cannot be modified, and are calculated by **geotool**.

Spectogram Option/Bin Average

When the Bin Average toggle is turned off, the minimum and maximum power for the whole picture is determined, and the colors are scaled based on those minimum and maximum values. If the Bin Average toggle is turned on, the minimum and maximum power for each time period window is determined, and the colors for that time period window are scaled based on those minimum and maximum values. This mode is usefull when looking at waveforms where a single large arrival can overwhelm all other signals.

4.6.11 Option/Travel Times

Predicted arrivals can be plotted from the **Travel Times** popup. The arrivals can be displayed as Travel Time curves, or as labels beneath the waveforms. Various travel time models can be used: IASPEI91 and Jeffreys-Bullen for teleseismic phases, and several regional models for regional phases.

Travel Times Display

Theoretical arrivals can be displayed either as curves, using the Curves toggle, or as labels beneath the waveforms, using the Labels toggle. The largest distinction between the two methods is how depth is handled. Since the

curves are continuous across all the waveforms, only a single depth can be used. This is the depth shown towards the bottom of the **Travel Times** popup. Since labels are drawn independently for each waveform/origin pair, the depth of the associated origin is used for each label.

The Select All and Deselect All buttons select and deselect all the phases in the IASPEI91, JB, and Regional lists.

IASPEI91 Travel Times

Lists all the IASPEI91 teleseismic phases. Select an entry in the list to display the phase. Multiple discontinuous entries can be selected by pressing the `control` key while selecting with the left mouse button.

JB Travel Times

Lists all the JB teleseismic phases. Select an entry in the list to display the phase. Multiple discontinuous entries can be selected by pressing the `control` key while selecting with the left mouse button.

Regional Crust Models

Lists all available regional models. Note that this list includes regional crustal models for the IASPEI91 and JB curves. The list of models is stored in the file *$GEO_TABLE_DIR*`/models/crust_models`. This list includes the regional model for the IASPEI91 curves. The format for this file is described in Chapter 5 on page 89.

Travel Times Regionals

Lists all the regional phases. Select an entry in the list to display the phase. Multiple discontinuous entries can be selected by pressing the `control` key while selecting with the left mouse button.

Travel Times Depth

The depth used for the theoretical travel time curves is set using the depth controls. To change the depth, a new value can be typed into the depth text window and the Apply button must be selected, or the slider next to the text window may be adjusted.

4.6.12 Option/Waveforms

Waveforms File/Open

Allows waveform data to be read into **geotool**, using the same mechanism as File/Open, described above.

Waveforms File/Hide

Hides the **Waveforms** popup.

Waveforms Edit/Delete

Removes all selected waveform entries in the **Waveforms** popup from **geotool**. No arrivals or origins are removed.

Waveforms Edit/Edit

Allows attributes in selected wfdisc entries to be editted.

Waveforms View/Attributes

Activates the **Waveform Attributes** popup, which provides control over which attributes are displayed in the **Waveforms** popup.

Waveforms View/Select

Select or deselect all waveforms with this option.

Chapter 5

Input Files

5.1 Introduction

Most of the files read by **geotool** follow established conventions, i.e., Center for Seismic Studies formats 2.8, 3.0, and SAC format. These formats are described elsewhere, and are not addressed here.

This chapter describes input files which do not follow established formats, but can be customized and extended by the user. There are four types of such files in **geotool**: the ASCII waveform file format, which defines a waveform in plain ASCII format; the priority file, which classifies channels in the **File Listing** popup; the regional velocity file format, which is used to calculate regional travel time curves in the **Travel Times** popup; and the map input file format, which describes attributes to draw on the map.

5.2 ASCII Waveform Format

geotool can read a generic ASCII waveform format. The following example waveform is in this format, and is included in the **geotool** distribution as the file *$GEO_TABLE_DIR*/../data/misc/ascii.dat:

```
sta=FAKE1 chan=sz samprate=256.0 time=808444800.
origin_time=808444000. origin_lat=52. origin_lon=-131.0 id=45
data
90. 93. 99. 80. 75. 70. 64. 50. 30. 45. 55. 67. 90. 100. 120. 50.
```

Waveforms read in this format can be manipulated like any other waveforms. The `data` section consists of a free formatted series of numbers, which are terminated by the end of the file. New lines can appear anywhere in the file. `samprate` is the number of samples per second, and `time` is the epoch start time of the waveform, and `id` is a unique numeric identifier.

All parameters except the `data` parameter are optional. The parameters which are given must appear before the `data` parameter. `sta` and `chan` default to `-`, `samprate` defaults to `1.0`, `time` defaults to `0.0`, i.e., 1 January 1970 00:00:00, and the other parameters are ignored if they are not specified.

5.3 Priority File

In the **File Listing** popup, waveform entries can be selected by many different criteria. One of those criteria is ctype (channel type), which can be proto, sp-array, sp-3c, bb-3c, etc. The concept is that when a ctype entry is selected, all channels of that type are selected in the **File Listing** popup as described on page 51. The Priority File provides the mapping between ctype entries and channels.

The format of the Priority File is quite simple. It is station affiliation, station name, channel, and priority number. For example:

```
AAE     AAE     sz              15
AAE     AAE     sn              16
AAE     AAE     se              17
ARCES   ARA0    sz               1
ARCES   ARA1    sz               3
ARCES   ARA2    sz               4
ARCES   ARA3    sz               5
ARCES   ARB1    sz               6
ARCES   ARB3    sz               6
```

In most cases, each channel has a preordained number, as shown here:

```
1       sz of 3c central element of an array
2-6     sz elements of an array
bz      10
bn      11
```

```
be      12
sz      15
sn      16
se      17
lz      20
ln      21
le      22
ez      25
en      26
ee      27
```

The exception is the case of an array, where priorities can be assigned based on the quality of individual sites. Consequently, the central vertical element of an array is usually given the highest priority, i.e., the lowest priority number.

The ctype providing the most confusion is **proto**, or prototypical. For a given station, the reporting channel with the lowest priority value is considered the prototypical channel. In most cases, this is the vertical component of a three-component short period or broad band instrument.

Consequently, when **proto** is selected in the **File Listing** popup, a waveform for each recording station is selected, as long as one waveform is present. The entry with the lowest priority is selected.

5.4 Regional Velocity Model

The regional velocity model file is used to draw regional travel time curves in the **Travel Times** popup. The velocity models are simple 2 layer models over a halfspace. The following four lines are the beginning of the velocity model file, which is included in the **geotool** distribution as the file *$GEO_TABLE_DIR*/models/crust_models

```
iasp     20.0  15.0  5.8  6.5  8.0  3.36 3.75 4.47    iasp = iaspei91
snus     25.0  25.0  6.2  7.0  7.9  3.6  4.0  4.5     snus = sierra nevada
caus     10.0  35.0  6.2  7.0  7.9  3.6  4.0  4.5     caus = columbia plateaus
brus     20.0  10.0  6.2  7.0  7.9  3.6  4.0  4.5     brus = basin and range
```

where

column 1 - identifier name used for the model.

column 2 - layer 1 thickness (km)

column 3 - layer 2 thickness (km)

column 4 - P wave velocity in layer 1

column 5 - P wave velocity in layer 2

column 6 - P wave velocity halfspace

column 7 - S wave velocity in layer 1

column 8 - S wave velocity in layer 2

column 9 - S wave velocity halfspace

column 10 - model name to use in **Travel Times** popup.

5.5 Map Input

Map input data can be read from the **Map Open** popup, or can be upon initialization if the file is in the directory specified with the X resource **mapOverlayDir**.

A map reference data file can contain the following data types: stations, sources, arcs, circles, ellipses, assocs, lines, symbols, and polygons. An arc is a great circle path connecting two points. An assoc is a source and group of stations, and is used to draw the travel paths between the source and receiver(s). Each data group must begin with a keyword, where the keywords are **stations**, **sources**, **arcs**, **circles**, **ellipses**, **assoc**, **line**, **symbols**, and **polygon**. Comments can appear anywhere in the file, and begin with # or ! in the first column position. The following is an example of a map overlay file, and is included in the **geotool** distribution as the file *$GEO_TABLE_DIR*/`mapoverlays/example`:

```
!example map overlay file
stations
sta1  30. 30. size=10 color=blue
sta2  -50. -70. size=15 color=black
```

```
sta3  0. 10. size=20 color=brown
sources
so1 60. -50. size=30 color=orange
!associate sta2 with so1
assoc
sta2
sources
! add a source with an error ellipse
so2 20. 90. smajax=200. sminax=150. strike=45.

!associate sta1 and sta2 with so2
assoc
sta1
sta3
! draw some solid diamonds
symbols symbol=FILLED_DIAMOND color=maroon
34. 67. 10
67. 140. 5
-45. -78. 20
64. 167. 10

# can specify different line characteristics for each arc,ellipse, etc.
# the first arc goes from lat=0 lon=-100 to lat=60 to lon=0.0
arcs
0. -100. 60. 0.
0. -100. 70. 10.        color=aquamarine
0. -100. 80. 20.        dashes 3,5,7
0. -100. 90. 30.
# draw an ellipse centered at lat=50 lon=-20, with major axis=200 km
# minor axis=100. km, and strike=60.
ellipses
50. -20. 200. 100. 60.
40. -30. 500. 350. 330. width=4 color=yellow
# draw a gray 5 pixel wide line which contains the following points
line width=5 color=gray75 join_style=JoinRound
-32.42  -147.78
-31.86  -144.99
-31.3   -143.31
```

```
-30.19  -141.07
-28.51  -136.04
-26.27  -132.13
-21.8   -130.45
-16.77  -129.89
-13.42  -142.19
.56     -147.22
10.     -132.69

#
# draw a filled red polygon which connects the following points
polygon  color=red
-24. -108.
-26. -92.4
-17.2 -85.73
-12. -96.9
-8.3 -108.
-19. -118.
```

Each group of data is preceded with one of the keywords. For each format type, some fields are required, while others fields default to certain values. It is possible to specify an optional field value with an expression of the form *parameter=value*.

The following is a list of the format types and the required, optional, and default parameters:

```
stations        The list following this keyword is the station
                name, latitude, and longitude.

     required:  name lat lon
     optional:  [size] [symbol] [color]
      default:  size=12 symbol=TRIANGLE color=black

sources         The list following this keyword is the source
                name, latitude, and longitude.

     required:  name lat lon
```

```
          optional:  [depth] [size] [symbol] [color]
                     [smajax] [sminax] [strike]
           default:  depth=NA size=XtNmapSourceSize
                     symbol=XtNmapSourceSymbol color=black
                     smajax=NA sminax=NA strike=NA

arcs                 The values following this keyword are the latitude
                     and longitude of the two ends of the arc.

          required:  lat1 lon1 lat2 lon2
          optional:  [label] [color] [dcolor] [width] [dashes] [join_style]
                     [cap_style]
           default:  label="" color=XtNforeground dcolor=XtNbackground
                     width=5 dashes=0 join_style=NA

circles              The list following this keyword is the latitude
                     and longitude of the center of the circle, and
                     radius of the circle in degrees.

          required:  lat lon delta
          optional:  [label] [color] [dcolor] [width] [dashes] [join_style]
                     [cap_style]
           default:  label="" color=XtNforeground dcolor=XtNbackground
                     width=5 dashes=0 join_style=NA cap_style=NA

ellipses             The list following this keyword is the latitude
                     and longitude of the center of the ellipse, the
                     semi-major and semi-minor axes of the ellipse,
                     and the strike of the ellipse.

          required:  lat lon smajax sminax strike
          optional:  [label] [color] [dcolor] [width] [dashes] [join_style]
                     [cap_style]
           default:  label="" color=XtNforeground dcolor=XtNbackground
                     width=5 dashes=0 join_style=NA cap_style=NA

assoc                Associates the stations following this keyword with
                     the origin preceding this keyword.
```

```
line            The latitude and longitude points following this
                keyword define a line.

     required:  list of lat lon points
     optional:  [label] [color] [dcolor] [width] [dashes] [join_style]
                [cap_style]
      default:  label="" color=XtNforeground dcolor=XtNbackground
                width=5 dashes=0 join_style=NA cap_style=NA


symbols         The list of points following this keyword are the
                latitude, longitude, and size of symbols.

     required:  list of lat lon points
     optional:  [size] [symbol] [color]
      default:  size=5 symbol=PLUS color=black

polygon         The latitude and longitude points following this
                keyword define a boundary of a polygon.

     required:  list of lat lon points
     optional:  [color]
      default:  color=black
```

Optional fields:

- **color** - color name used to draw the map object.
- **dashes** - code which defines how dashed arcs are drawn. The code consists of a comma separated group of numbers which specify the number of pixels drawn with **color**, followed by the number of pixels drawn with **dcolor**.
- **dcolor** - second color used to draw dashed arcs.
- **depth** - source depth (in kilometers).
- **label** - the text string used to label the map object.

- **size** - size in pixels.
- **smajax** - semi-major axis of error ellipse.
- **sminax** - semi-minor axis of error ellipse.
- **strike** - strike of error ellipse.
- **symbol** - defines the type of symbol drawn. Symbol choices are:
  - SQUARE
  - TRIANGLE
  - PLUS
  - EX
  - INV_TRIANGLE
  - DIAMOND
  - CIRCLE
  - FILLED_SQUARE
  - FILLED_TRIANGLE
  - FILLED_INV_TRIANGLE
  - FILLED_DIAMOND
  - FILLED_CIRCLE
- **width** - width in pixels.

Chapter 6

X Resources

6.1 Introduction

X resources are expressions which define the appearance and behavior of programs that run under the X Window System. All X resources in **geotool** have default values when the program starts running. However, these defaults can be customized either with a file containing X resource specifications or command line options.

This chapter discusses how resources are specified, their scope, and how they are accessed by an application. The remainder of this chapter describes resources specific to **geotool**.

6.2 Resource Name Specification

In the simplest and most common case, an X resource is specified (user-defined) with an expression of the following form:

application_class*resource_name: resource_value

where **application_class** is the class name of the application. A class name is usually the application name with the first letter capitalized. In cases where the application's first letter is already capitilized, the second letter is also capitilized. In the case of **geotool**, the application class name is `Geotool`.

* is a delimiter which indicates that the resource setting should be effective throughout the entire application, i.e., for the main window and all popups.

resource_name is the name of the resource to be set. Resources specific to **geotool** are described later in this chapter.

: separates the name of the resource on the left hand side, from the value of the resource on the right hand side. The space to the right of the colon is primarily for legibility; it can consist of spaces, tabs, or it can be omitted.

resource_value is the value of the resource, e.g.,

Geotool*font: *courier-medium-r-*140*

This example specifies that **geotool** should use the value ***courier-medium-r-*140*** for the font resource. If a resource request cannot be satisfied, e.g., the ***courier-medium-r-*140*** font cannot be accessed, a warning message will be printed, and the resource will set using a default value.

The syntax of the resource name on the left side of the colon (:) is very significant; it determines the extent of a resource setting. The previous example illustrated how the **font** resource can be set throughout **geotool**. However, the resource setting could alternatively be specified as:

font: *courier-medium-r-*140

The syntax of this specification indicates that the value ***courier-medium-r-*140*** will be used for the **font** resource for all X clients (applications). This occurs because the **application_class** is not specified. The specification can also be used to limit the use of a resource to a single popup within **geotool**. For example:

Geotool*_Open*font: *courier-medium-r-*140*

specifies that the value ***courier-medium-r-*140*** will be used for the **font** resource in the **Open** popup in **geotool**. In this case, **_Open** specifies the scope of the resource setting.

The name of each popup in **geotool** is given in the top border frame. Resources for a particular popup can be specified by taking the name of a

popup and prepending it with an underscore, i.e. _. Any blanks in a popup name should also be substituted with underscores. For example, the **font** resource in the **Travel Times** popup can be specified by:

Geotool*_Travel_Times*font: *courier-medium-r-*140*

In the case where multiple resource settings exist, the most accurate specification will take precedence, i.e., if the following resources are set:

Geotool*font: *courier-medium-r-*140*

Geotool*_Travel_Times*font: *courier-bold-r-*120*

the font in the **Travel Times** popup will be `*courier-bold-r-*120*`, while `*courier-medium-r-*140*` will be used elsewhere in **geotool**. If the **application_class** and **resource_names** are identical, the specification which was made last will be used. When a resource is not correctly specified (e.g., spelling error), the specification is ignored. For more information on X resource syntax, see the **RESOURCES** section of the on-line **X** manual page.

6.3 Resource File Specification

Customized X resources are usually stored in a file. When an X client begins running, or is initialized, the client checks several places for files containing applicable X resources. Any resource which matches the client's specification is merged with the client's default X resources; then the client appears on the display. The specification of X resources can be approached with a variety of methods, as happens with the X window system in general. This section will focus on some of the most commonly used methods for X resource specification; however, additional methods may be used depending on the local system configuration and practices. Check with your system administrator if in doubt.

In addition, this section discusses the location where X resources are stored, and their order of precedence when merged with the client's default X resources. Although there are several ways to specify resources, it is best to minimize the number of different methods employed. If multiple methods

are used, it becomes troublesome to determine which resources are being used, and their order of precedence. X resources can be specified either at a local level for personal use, or on a global level for multiple users. Personal resources are usually specified in a file stored under a user's home directory. On the other hand, global resource files are stored anywhere in the system's directory.

6.3.1 $HOME/.Xdefaults

The typical place for a user to specify local X resources is in the file

$HOME/`.Xdefaults`

where *$HOME* represents the user's home directory. Local resources for a specific machine can be specified in the file

$HOME*/`.Xdefaults-`*$host

where *$host* is the hostname of the machine on which the client is running. The machine may be different from the machine where the client is being displayed. For example, if a memory related resource is needed when a client runs on a machine named `foobar`, the appropriate X resources could be set in the file named

$HOME/`.Xdefaults-foobar`

These resources would only be effective when the client is running on the machine `foobar`, regardless of the machine where the client is displayed.

6.3.2 $HOME/application_class

A third option for storing personal resources is to put them in the file

$HOME/$application_class

where *$application_class* is the class name of the application. In the case of **geotool**, the file is

$HOME/`Geotool`

6.3.3 XAPPLRESDIR

The environment variable **XAPPLRESDIR** provides an option for storing global or personal resources. **XAPPLRESDIR** lists directories which are searched for a file with the name of the **application_class**, e.g., **Geotool**. The path(s) specified by **XAPPLRESDIR** includes key characters with special meaning, usually **%N** and **%T**. When the client interprets **XAPPLRESDIR**, it expands **%N** to the name of the **application_class**, while **%T** is literally expanded to `app-defaults`. For example, if **XAPPLRESDIR** is set to

```
/usr/local/lib/X11/%T/%N:/home/foo/%N
```

geotool checks for resources in the files **/usr/local/lib/X11/app-defaults/Geotool** and **/home/foo/Geotool** during initialization.

6.3.4 XFILESEARCHPATH

The environment variable **XFILESEARCHPATH** is another option for storing global or personal resources. It behaves the same way as **XAPPLRESDIR**, in that it is a colon separated list of directories, where each directory is followed by the key characters described above in the **XAPPLRESDIR** discussion.

6.3.5 XENVIRONMENT

A file containing X resources can also be specified with the environment variable **XENVIRONMENT**. For example, if **XENVIRONMENT** is set to

/home/foo/app-defaults/Geotool2

the file **/home/foo/app-defaults/Geotool2** will be checked for appropriate X resources by each X client during initialization. Appropriate X

resources are those which are associated with a client. In the case of **geotool**, these are resources which begin with either the class name **Geotool**, or with *. As described previously, * is used to specify resources for all X clients.

XENVIRONMENT is convenient when testing new X resources. However, problems can arise if it is employed for daily use. **XENVIRONMENT** can only point to one file; therefore, resetting **XENVIRONMENT** cancels any previous setting.

6.3.6 Command line options

Resources can also be specified on the command line, with the option -xrm. For example,

```
geotool -xrm "Geotool*_Open*font: *courier-medium-r-*140*"
```

instructs **geotool** to use the value ***courier-medium-r-*140*** for the **font** resource in the **Open** popup. Multiple resources are specified on the command line with repetitive -xrm arguments as follows:

```
geotool -xrm "Geotool*_Open*font: 6x12" \
        -xrm "Geotool*font: 8x13"
```

6.3.7 $GEO_TABLE_DIR/../X11/Geotool

In addition to the standard methods used to set X resources, **geotool** also searches for a specific resource file. As described in Chapter 2, *GEO_TABLE_DIR* should be set to the fullpath of the `tables` directory in the **geotool** distribution. A directory named `X11` is next to the `tables` directory, and may contain a resource file named `Geotool`. If that file exists, the path to the file is appended to the list specified by **XFILESEARCHPATH**.

6.3.8 Precedence

During a **geotool**'s initialization, several locations are checked for applicable X resources in the following order:

- *$HOME*/.**Xdefaults**
- *$HOME*/**Geotool**
- **XAPPLRESDIR**
- **XFILESEARCHPATH**[1]
- **XENVIRONMENT**
- *$HOME*/.**Xdefaults**-*$host*
- **command line options specified with the -xrm argument**

Note that *$HOME*/.**Xdefaults**-*$host* is only consulted only if **XENVIRONMENT** is NOT set. If a resources appears multiple times, the setting that appears last will be used.

As discussed, specifying X resources can become tedious. However, the client **appres** can be used to list the X resources which the client will find during initialization. The **application_class** name is usually needed when **appres** is run. For example

appres Geotool

will list all user-defined X resources which **geotool** will find during initialization, except those which are stored in *$GEO_TABLE_DIR*/../X11/Geotool, since this location is endemic to **geotool**. In addition, the default values for **geotool**'s X resources will not be listed by **appres**, since the default resource values are complied into the program, and are not stored in files accessible by **appres**.

[1]The path to the file *$GEO_TABLE_DIR*/../X11/Geotool is appended to **XFILESEARCHPATH** when **geotool** is initialized.

6.4 X Resources Specific to geotool

This section describes X resources which are specific to **geotool**. In addition to the resources listed here, **geotool** also inherits many resources from the Motif Widget Set. For more information on Motif resources, consult a Motif reference book, e.g., [OSF, 1991b]. The resources discussed below are grouped into the following categories:

- Color
- Fonts
- Reading and Grouping
- External Files
- Arrivals
- Travel Time Curves
- Plotting Widgets
- Main Window
- Map
- Fourier Transform (FT)
- Contour Plot (Fk and Spectrogram)
- Particle Motion
- Dial (Rotate)

In instances where a resource fits into 2 categories, it is listed twice, e.g., arrival font information is listed under **Fonts** and **Arrivals**.

6.4.1 Color

This section describes the color related resources in **geotool**. For more information on color names in the X window system, see the **COLOR NAMES** section of the on-line **X** manual page.

waveformColors

The resource **waveformColors** specify the list of colors used to draw waveforms. This list can have any number of colors in it, although it is best to keep the number fairly small, since each color takes up a place in the X server's color map.

Default: `forest green, sky blue, orange, brown, gray75, red, thistle, sea green, tan, maroon, slate blue, grey, NavajoWhite1`

selectColor

Specifies the color of selected waveforms in the main and magnify windows.

Default: `blue`

magRectColor

Specifies the color of magnifying window outline in the main window.

Default: `red`

mapCilColor

Specifies the color used to draw the coastlines, islands, and lakes on the map. The coastlines, islands, and lakes are drawn

Default: `blue`

mapBdyColor

Specifies the color used to draw the international boundaries on the map.

Default: `orange`

mapRivColor

Specifies the color used to draw the rivers on the map.

Default: `blue`

mapStateColor

Specifies the color used to draw the U.S. state boundaries on the map.

Default: `orange`

contourLabelColor

Specifies the font color of annotations in the contour plot, e.g., in the FK popup.
Default: `red`

dataColor

Specifies the contour color in the contour plot, e.g., in the FK popup.
Default: `blue`

indicatorColor

Specifies the color of the current orientation indicator of the dial in the **Rotate** popup.
Default: `red`

arrow1Color

Specifies the color of the Maximum indicator of the dial in the **Rotate** popup.
Default: `blue`

arrow2Color

Specifies the color of the Origin indicator of the dial in the **Rotate** popup.
Default: `black`

upColor

Specifies the color used to draw the up boxes in the **Particle Motion** popup.
Default: `lime green`

downColor

Specifies the color used to draw the down boxes in the **Particle Motion** popup.
Default: `red`

iaspeiColor

Specifies the color of IASPEI91 travel time curves.
Default: `black`

jbColor

Specifies the color of JB travel time curves.
Default: `red`

regionalColor

Specifies the color of the regional (two-layer) travel time curves.
Default: `blue`

6.4.2 Fonts

This section describes the font resources specific to **geotool**. In addition, fonts can also be set for menu items, toolbars, and other popups using the applicable resources. For more information on font names in the X window system, see the **FONT NAMES** section of the on-line **X** manual page.

font

Specifies the font used to draw the plotting widget's title and axes values and labels. This resource can be set for each plotting widget.
Default: `-adobe-helvetica-medium-r-*-*-18-*-*-*-*-*-*-*`

tagFont

Specifies the font used to draw the waveforms' tags. This recource can have separate settings in the main and magnify windows.
Default: `-adobe-helvetica-medium-r-*-*-18-*-*-*-*-*-*-*`

arrivalFont

Specifies the font used to draw the arrivals in the main plotting window.
Default: `-adobe-helvetica-bold-r-normal-*-*-100-*-*-p-*-iso8859-1`

6.4.3 Reading and Grouping

This section describes resources which affect the way the data are read and grouped in **geotool**.

displayComponents

Specifies which components are displayed. The options are

- **ALL_COMPONENTS**
- **Z_COMPONENT**
- **N_COMPONENT**
- **E_COMPONENT**

This resource can also be specified from the Option/Components menu option.

Default: `ALL_COMPONENTS`

joinTimeLimit

Specifies how waveform segments from the same station and channel are grouped together. It is used when waveforms are read from multiple wfdisc records in a single wfdisc file. When the start time of one waveform minus the end time of another waveform with the same station and channel names is less than **joinTimeLimit** seconds, the waveforms will be displayed as one waveform with appropriate time gaps.

If waveforms are read at separate times, **joinTimeLimit** is ignored, and the waveforms are not joined and appear on separate lines.

Default: `1800`

componentTimeLimit

Restricts the grouping of waveforms into component-groups by requiring that the start times of all the components for a station be within **componentTimeLimit** seconds.

The component-groups formed with **componentTimeLimit** are used when working with three-component data, e.g., when rotating waveforms or when displaying only one component at a time.

Default: `600.`

chanSortOrder

Specifies the channel order when waveforms are sorted by channel in **geotool**'s main window.

Default: `zZnNeErRtT`

fileListingSort

Specifies initial sort criteria used to display wfdisc records in the **Open/Listing** popup. The sort types are **time/sta/chan**, **sta/chan/time**, **sta**, **chan**, and **distance**.

Default: `sta/chan/time`

staChanTran

Specifies the full path to the station/channel name translation table, which is used to translate station and channel information in a `.wfdisc` file to another station and channel when displayed by **geotool**. This is an easy way to convert non-standard channel names to names ending in `z`, `n`, or `e`, which **geotool** can then use to deduce channel orientation. The format of the translation table is four columns, original station and channel, followed by the new station and channel names.

Default: `NULL`

queryBuffer

Specifies the duration (in seconds) of the longest wfdisc record in the wfdisc table when retrieving data from an ORACLE database. If wfdisc records exist in the database which are longer than **queryBuffer** seconds, the query used to retrieve waveform records may fail. If data are read from flat files, **queryBuffer** is ignored.

Default: `86400.`

6.4.4 External Files

This section describes resources that point to files needed for different tasks, e.g., map data file, travel time files, etc. Remember that most of these files can be referenced using the environment variable *$GEO_TABLE_DIR*

as described in Chapter 2. If the default file does not exist, it is not created by **geotool**.

affiliationTable

Specifies the full path to the CSS format global affiliation table.
Default: *$GEO_TABLE_DIR*/`static/global.affiliation`

lastidTable

Specifies the full path to the CSS format global lastid table. If the global lastid table is used, the file should have write permission for all users who may be adding arrival or origin records.

If the global lastid table does not exist, the lastid table in the current directory is used. If there is no local lastid table, ids are incremented beginning with the current maximum id in the current file, i.e., wfids are incremented in wfdisc files, arids are incremented in arrival files, and orids are incremented in origin files.

Default: *$GEO_TABLE_DIR*/`static/global.lastid`

sensorTable

Specifies the full path to the CSS format global sensor table.
Default: *$GEO_TABLE_DIR*/`static/global.sensor`

instrumentTable

Specifies the full path to the CSS format global instrument table.
Default: *$GEO_TABLE_DIR*/`static/global.instrument`

siteTable

Specifies the full path to the CSS format global site table.
Default: *$GEO_TABLE_DIR*/`static/global.site`

sitechanTable

Specifies the full path to the CSS format global sitechan table.
Default: *$GEO_TABLE_DIR*/`static/global.sitechan`

staChanTran

Specifies the full path to the station/channel name translation table, which is used to translate station and channel information in a `.wfdisc` file to another station and channel when displayed by **geotool**. This is an easy way to convert non-standard channel names to names ending in `z`, `n`, or `e`, which **geotool** can then use to deduce channel orientation. The format of the translation table is four columns, original station and channel, followed by the new station and channel names.

Default: *$GEO_TABLE_DIR*`/static/global.stachantran`

iaspeiTable

Specifies the prefix name for the header and table files containing the IASPEI travel-time curves. The program will attempt to read prefix.hed and prefix.tbl. Note that the tables produced with the original FORTRAN code are incompatible with those read by **geotool**.

Default: *$GEO_TABLE_DIR*`/models/iasp91`

jbTable

Specifies the full path to the JB travel time table.

Default: *$GEO_TABLE_DIR*`/models/jbtable`

mapOverlayDir

Specifies directory containing the map data files. The format of these files is discussed in Chapter 5 on page 90.

Default: *$GEO_TABLE_DIR*`/mapoverlays`

crustModels

Specifies full path to file containing the simple two layer crustal models used for drawing regional travel time curves from the Travel Times popup. The format of this file is discussed in Chapter 5 on page 89.

Default: *$GEO_TABLE_DIR*`/models/crust_models`

originTable

Specifies the full path to the CSS format global origin table.
Default: *$GEO_TABLE_DIR*/`static/global.stachantran`

origerrTable

Specifies the full path to the CSS format global origerr table
Default: *$GEO_TABLE_DIR*/`static/global.origerr`

ctypeFile

Specifies the full path to the priority file used in the Ctype list in the `File Listing` popup. The format of this file is described in Chapter 5 on page 88.
Default: *$GEO_TABLE_DIR*/`static/global.priority`

stypeFile

Specifies the full path to the priority file used in the Stype list in the **File Listing** popup. The format of this file is CSS 3.0 affiliation. *not yet activated*
Default: `NULL`

6.4.5 Arrivals

This section describes arrival related resources.

displayPredictedArrivals

Specifies whether predicted arrivals are displayed for phases selected in the Travel Times popup. This resource can also be set in the **Travel Times** popup, by selecting the Label option button.
Default: `True`

displayAmplitudeScale

Specifies whether an amplitude scale is drawn on the lefthand side of each waveform. This resource can also be set from the View/Time Amplitude menu option.
Default: `True`

ampInterpolation

When measuring amplitude and period, an interpolation is performed. The interpolation is a cubic spline over a few points about the maximum/minimum value for the half cycle. The width of the amplitude/phase box is affected by this interpolation, but the height is not. The height is always from one data value to another.

Default: `True`

threeHalfCycles

When you click on a waveform to measure amplitude and period, a box appears for measuring the waveform cycles. Although the final measurement will have a box divided equally in two, some users find it more convenient for the initial box to be divided into three. In this case, clicking on one half of the box will make third cycle on the far end to disappear. To deactivate this feature, i.e., to make the initial box only have two sections, set **threeHalfCycles** to **False**.

Default: `False`

arrivalFont

Specifies the font used to draw the arrivals in the main plotting window. See the **FONT NAMES** section of the on-line **X** manual page for more information on font names in the X window system.

Default: `-adobe-helvetica-bold-r-normal--*-100-*-*-p-*-iso8859-1`

ampType

Specifies the type of amplitude measurement saved. Choices are **pp** for peak-to-peak amplitude, **hpp** for half the pp amplitude, and **zp** for zero-to-peak amplitude.

Default: `hpp`

spArrivalWindow

Specifies the window width (in seconds) when the Zoom Sp option is selected in the Arrivals popup.

Default: `20`

lpArrivalWindow

Specifies the window width (in seconds) when the Zoom Lp option is selected in the Arrivals popup.
Default: `1200`

arrivalList1

Alternative arrival lists can be used in the Arrivals popup The following example specifies that the first alternative phase list should consist of the phases **A, B, C, D**.

Geotool*arrivalList1: A, B, C, D

Default: `NULL`

arrivalList2

See description under **arrivalList1**.
Default: `NULL`

arrivalList3

See description under **arrivalList1**.
Default: `NULL`

6.4.6 Travel Time Curve

This section describes resources specific to **Travel Time** popup.

displayTtCurves

Specifies whether travel time curves are drawn when phases are selected in the **Travel Times** popup. This resource can also be set using the **Curves** toggle in the **Travel Times** popup.
Default: `True`

displayTtLabels

Specifies whether theoretical travel time labels are drawn beneath waveforms when phases are selected in the **Travel Times** popup.

This resource can also be set using the **Labels** toggle in the **Travel Times** popup.

Default: `False`

sourceDepth

Specifies the source depth for theoretical phases selected in the Travel Times popup. The resource can also be set using the Depth text window or slider in the **Travel Times** popup.

Default: `0.`

iaspeiColor

Specifies the color of IASPEI91 travel time curves.

Default: `black`

jbColor

Specifies the color of Jeffreys-Bullen travel time curves.

Default: `red`

regionalColor

Specifies the color of regional (two-layer) travel time curves.

Default: `blue`

stopPdiff

Beyond a certain distance, the FirstP alias in the **Travel Times** popup uses PKP instead of Pdiff, even though the Pdiff travel time is less than the PKP travel time. This distinction is made because the PKP amplitude is much larger than the Pdiff amplitude, and is much more commonly observed. By default, the distance beyond which PKP is used instead of Pdiff is 120.0 degrees.

Default: `120.0`

lgVel

Specifies the Lg velocity (km/s) in the **Travel Time** popup.
Default: `3.6`

lg2Vel

Specifies the second Lg velocity (km/s) in the **Travel Time** popup.
Default: `3.3`

lqVel

Specifies the LQ velocity (km/s) in the **Travel Time** popup.
Default: `3.5`

lrVel

Specifies the LR velocity (km/s) in the **Travel Time** popup.
Default: `3.1`

6.4.7 Plotting Widgets

This section describes resources which are common to all plotting widgets in **geotool**. The plotting widgets are in **geotool** popups where plots are displayed. It is possible to set a resource value to a different value for each plotting widget, e.g.,

Geotool*_FT*title: FT for 1994231 ARA0/sz

sets the **title** in the FT popup to be **FT for 1994231 ARA0/sz**, while

Geotool*_FK*title: FK for event 1 Noress

sets the **title** in FK popup to be **FK for event 1 Noress**.

title

Specifies the title above a plot. This resource can also be set from the View/Labels popup.
Default: `NULL`

xLabel

Specifies the x label for a plot. This resource can also be set from the View/Labels popup.
Default: `NULL`

yLabel

Specifies the y label for a plot. This resource can also be set from the View/Labels popup.
Default: `NULL`

displayAxes

Specifies if axes should be displayed.
Default: `True`

usePixmap

Specifies if a pixmap should be used when plotting waveforms. If this resource is set to True, waveforms will scroll smoothly, but may suffer performance problems on slow CPUs. If this resource is set to False, scrolling waveforms may flash, but will drag at a reasonable speed, even with a slow CPU.
Default: `True`

zoomHorizontal

Specifies horizontal zoom factor used by keyboard zoom keys.
Default: `.3`

zoomVertical

Specifies vertical zoom factor used by keyboard zoom keys.
Default: `.3`

horizontalScroll

Specifies if a horizontal scroll bar should be drawn.
Default: `True`

verticalScroll

Specifies if a vertical scroll bar should be drawn.
Default: `True`

tickmarksInside

Specifies if tick marks should be drawn on the inside of the axes. If this resource is False, tick marks are drawn on the outside of the axes.
Default: `True`

zoomControls

Specifies if keyboard zoom keys are available.
Default: `True`

6.4.8 Main Window

This section describes resources specific to the main window in **geotool**.

displayTags

Specifies whether waveform tags are initially displayed. This resource can also be set from the View/Tags menu option.
Default: `True`

tagFont

Specifies the font used to draw the waveforms' tags. See the **FONT NAMES** section of the on-line **X** manual page for more information on font names in the X window system.
Default: `-adobe-courier-bold-r-normal--18-180-75-75-m-110-iso8859-1`

tagMembers

Specifies the elements of the waveform tags. The elements in the resource name are separated by commas, e.g., `station, channel, YYYYDDD`. Element choices are:

- **Text**

- **Station**
- **Channel**
- **Wfid**
- **YYYYDDD**
- **HH:MM:SS**
- **Distance**
- **Azimuth**

This resource can also be specified in the **Tag Contents** popup, which is accessible from the View/Tags menu option.

Default: `Station,Channel`

dataMovement

Specifies orientation in which waveforms can be moved in the main window. The options are

- **X_MOVEMENT**
- **Y_MOVEMENT**
- **XY_MOVEMENT**
- **NO_MOVEMENT**

This resource can also be set from the Option/Data Movement menu option.

Default: `XY_MOVEMENT`

selectColor

Specifies color of selected waveforms in the main window

Default: `blue`

redrawSelectedData

If **redrawSelectedData** is **True**, the color of a selected waveform is **selectColor**, and the tag is drawn in inverse video. If **redrawSelectedData** is **False**, the color of a selected waveform does not change, and the only change is that the tag is drawn in inverse video.

Default: `True`

limitSelect

Specifies if the cursor must be inside a waveform label in order to select or deselect a waveform with the left mouse button.

Default: `False`

displayArrivals

Specifies whether arrivals are displayed in the main plot window. Choices are:

- **ARRIVALS_OFF**
- **ARRIVALS_ONE_CHAN**
- **ARRIVALS_ALL_CHAN**

This resource can also be set from the View/Display Arrivals menu option.

Default: `ARRIVALS_ALL_CHAN`

displayPredictedArrivals

Specifies whether predicted arrivals are displayed for phases selected in the Travel Times popup. This resource can also be set from the View/Label menu option in the Travel Times popup.

Default: `True`

displayAmplitudeScale

Specifies whether an amplitude scale is drawn on the lefthand side of each waveform. This resource can also be set from the View/Time Amplitude menu option.

Default: `True`

timeScale

Specifies the type of time scale. Choices are:

- **TIME_SCALE_SECONDS**
- **TIME_SCALE_VARIABLE**
- **TIME_SCALE_HMS**

This resource can also be set from the View/Time Scale menu option.
Default: `TIME_SCALE_SECONDS`

xAxis

Specifies orientation of X (time) axis. Choices are: **TOP**, **BOTTOM**, or **LEFT**. Note this resource is set in conjunction with **yAxis** resource. This resource can also be set from the View/Limits popup.
Default: `BOTTOM`

yAxis

Specifies orientation of Y axis. Choices are: **TOP**, **BOTTOM**, or **LEFT** Note this resource is set in conjunction with **xAxis** resource. This resource can also be set from the View/Limits popup.
Default: `LEFT`

dataLinewidth

Specifies waveform linewidth used in PostScript output.
Default: `0`

doubleLineWidth

Specifies the width (or separation) of a double line cursor, in seconds. If this resource is 0, the initial width of a double line cursor defaults to 5% of the current window width. For example, if x min is 0 and x max is 100 seconds, a new double line cursor will have a width of 5 seconds.
Default: `0`

6.4.9 Map

This section describes map related resources.

mapDir

Specifies directory containing the map data files.
Default: *$GEO_TABLE_DIR*/`mapfiles`

displayMapCil

Specifies if coasts, islands and lakes should be drawn on the map.
Default: `True`

displayMapBdy

Specifies if international boundaries should be drawn on the map.
Default: `True`

displayMapRiv

Specifies if rivers and canals should be drawn on the map.
Default: `False`

displayMapState

Specifies if US state boundaries should be drawn on the map.
Default: `False`

mapCilColor

Specifies color of coasts, islands and lakes drawn on the map.
Default: `blue`

mapBdyColor

Specifies color of international boundaries drawn on the map.
Default: `orange`

mapRivColor

Specifies color of rivers and canals drawn on the map.
Default: `blue`

mapStateColor

Specifies color of US state boundaries drawn on the map.
Default: `orange`

uniformScale

Specifies if x and y axes should be drawn at the same scale.
Default: `True`

mapRefData

Specifies the directory containing the map overlay data. The format of the map overlay files is described in Chapter 5 on page 90.
Default: *$GEO_TABLE_DIR*`/mapoverlays`

mapBackingStore

Specifies if the X backing store feature should be used by the map. If this resource is True, the contents of the map will always be drawn, even when the window is obscured. The result of this is that map will have less redrawing to do when new objects are added. The penalty is that the X server grows, and must perform extra work.
Default: `False`

mapSourceSymbol

Specifies the default symbol used to plot sources on the map. Symbol choices are:

- **SQUARE**
- **TRIANGLE**
- **PLUS**

- **EX**
- **INV_TRIANGLE**
- **DIAMOND**
- **CIRCLE**
- **FILLED_SQUARE**
- **FILLED_TRIANGLE**
- **FILLED_INV_TRIANGLE**
- **FILLED_DIAMOND**
- **FILLED_CIRCLE**

Default: `PLUS`

mapSourceSize

Specifies the default map source size in pixels.
Default: `12`

projection

Specifies initial map projection. This resoruce can also be set from the Option/Projection menu item in the **Map popup**. Projection choices are:

- **MAP_LINEAR_CYLINDRICAL**
- **MAP_ORTHOGRAPHIC**

Default: `MAP_LINEAR_CYLINDRICAL`

displayStations

Specifies if stations are initially displayed on the map. This resource can also be set using the View/Stations toggle in the Map popup.
Default: `True`

displaySources

Specifies if sources are initially displayed on the map. This resource can also be set using the View/Display Sources toggle in the Map popup. Choices are:

- **MAP_NO_SOURCES**
- **MAP_ALL_SOURCES**
- **MAP_SELECTED_SOURCES**

Default: `MAP_ALL_SOURCES`

displayEllipses

Specifies if ellipses are initially displayed on the map. This resource can also be set using the View/Display Ellipses toggle in the Map popup. Choices are:

- **MAP_NO_SOURCES**
- **MAP_ALL_SOURCES**
- **MAP_SELECTED_SOURCES**

Default: `MAP_ALL_SOURCES`

displayPaths

Specifies if travel paths between stations and selected sources are drawn on the map. This resource can also be set using the View/Paths toggle in the Map popup.

Default: `False`

displayGrid

Specifies if the latitude and longitude grid is drawn on the map. This resource can also be set using the View/Grid toggle in the Map popup.

Default: `False`

displayStationTags

Specifies if the station tags are displayed on the map. This resource can also be set from the **View/Tags** menu option in the **Map** popup.
Default: `False`

lonMin

Specifies the minimum longitude displayed by the map. Longitude values less than this value will not be used by the map.
Default: `-180.`

lonMax

Specifies the maximum longitude displayed by the map. Longitude values greater than this value will not be used by the map.
Default: `180.`

latMin

Specifies the minimum latitude displayed by the map. Latitude values less than this value will not be used by the map.
Default: `-90.`

latMax

Specifies the maximum latitude displayed by the map. Latitude values greater than this value will not be used by the map.
Default: `90.`

6.4.10 Fourier Transform (FT)

This section describes resources specific to the **FT** popup.

taper

Specifies taper type applied to windows prior to Fourier Transform. **taper** choices are:

- **HANN_TAPER**

- **HAMM_TAPER**
- **COSINE_TAPER**
- **PARZEN_TAPER**
- **NO_TAPER**

This resource can also be set from the Option/Taper menu option in the **FT** popup.
Default: `HANN_TAPER`

begLength

Specifies percent of taper applied to beginning of a Cosine taper.
This resource can also be set from the Option/Taper Percent menu option in the **FT** popup.
Default: `.1`, i.e., 10

endLength

Specifies percent of taper applied to the end of a Cosine taper.
This resource can also be set from the Option/Taper Percent menu option in the **FT** popup.
Default: `.1`, i.e., 10

mode

Specifies if FT will be displayed in Amplitude or Power. **mode** choices are: **FT_AMP** or **FT_POWER**.
This resource can also be set from the View/Y Axis menu option in the **FT** popup.
Default: `FT_POWER`

units

Specifies units used to display FT. **units** choices are:

- **FT_DB_RE_NM**
- **FT_DB_RE_M**

- **FT_NM**
- **FT_M**
- **FT_LOG_NM**
- **FT_LOG_NM**

This resource can also be set from the View/Y Axis menu option in the **FT** popup.

Default: `FT_DB_RE_NM`

der

Specifies if FT will be displayed in Displacement, Velocity, or Acceleration. **der** choices are: **FT_DISP**, **FT_VEL**, or **FT_ACC**.

This resource can also be set from the View/Y Axis menu option in the **FT** popup.

Default: `FT_DISP`

smoothingWidth

Specifies width of smoothing window (in Hz) applied to spectra after the Fourier Transform. If width is 0., spectra are not smoothed. This resource can also be set from the Edit/Smooth menu option in the **FT** popup.

Default: `0.`

instrumentCorr

Specifies if spectra are corrected for instrument response. This resource can also be set from the Option/Instrument Corr menu option in the **FT** popup.

Default: `False`

windows

Specifies the number of windows a waveform segment is divided into before the Fourier Transform.

This resource can also be set from the Option/Windows menu option in the **FT** popup.

Default: `1`

overlap

Specifies the percent of overlap between adjacent windows.

This resource can also be set from the Option/Windows menu option in the **FT** popup.

Default: `0`

percentile1

Specifies the lower percentile value displayed in the **FT** popup.

Default: `10`

percentile2

Specifies the upper percentile value displayed in the **FT** popup.

Default: `90`

6.4.11 Contour Plot (FK and Spectrogram)

This section describes resources specific to the contour plot, used in the **FK** and **Spectrogram** popups.

contourLabelSize

Specifies font size for annotations in contour plots (FK).

Default: `5`

contourLabelColor

Specifies font color or annotations in contour plots (FK).

Default: `red`

dataColor

Specifies the contour color in contour plots (FK).

Default: `blue`

matrix

Specifies if position of data values is displayed in contour plots.
This resource can also be set from the View/Matrix menu option in the **FK** popup.
Default: `True`

markMax

Specifies is position of maximum data value should be marked.
Default: `True` in **FK** popup, and `False` in **Spectrogram** popup.
1 in **Spectrogram** popup.

6.4.12 Particle Motion

This section describes resources specific to the **Particle Motion** popup.

upColor

Specifies the color used to draw the up boxes in the **Particle Motion** popup.
Default: `lime green`

downColor

Specifies the color used to draw the down boxes in the **Particle Motion** popup.
Default: `red`

magScale

Specifies magnification value in the **Particle Motion** popup.
default: **1**

6.4.13 Dial (Rotate)

This section describes resources specific to the **Rotate** popup.

markers

Specifies the number of markers used around the dial in the **Rotate** popup.
Default: `24`

indicatorColor

Specifies the color of the current orientation indicator of the dial in the **Rotate** popup.
Default: `red`

arrow1Color

Specifies the color of the Maximum indicator of the dial in the **Rotate** popup.
Default: `blue`

arrow2Color

Specifies the color of the Origin indicator of the dial in the **Rotate** popup.
Default: `black`

markerLength

Specifies the length of the markers (in pixels) in the Dial in the **Rotate** popup.
Default: `5`

foreground

Specifies the color of the markers in the Dial in the **Rotate** popup.
Default: `black`

Chapter 7

Scheme Interface

7.1 Introduction

The primary design goal in adding a scheme interface to **geotool** was to facilitate automated processing. The goal was not to add functionality accessible only from scheme; quite the contrary, scheme was viewed as a way to drive what already exists. The rational for this thinking was to automate **geotool** to do mundane tasks, and to limit scheme's prevalance, since most users are, at best, unfamiliar with the language.

The scheme interface is optional in **geotool** and is invoked only when it is specified as a command line argument:

```
geotool scheme
```

7.2 Naming Convention

Due to the design goal stated above, most of the scheme interface in **geotool** mimics actions which can be done interactively with the mouse. Consequently, many arguments to scheme functions (in **geotool**) are elements in the user interface, e.g., buttons, text windows, cursors, etc. These elements, or widgets, are specified using their names given in the interface.

For example, consider the **Print** popup (Figure 26). The text window in this popup containing the output filename is beneath the label `Filename`. To specify that this is the `Filename` in the **Print** popup, the full specification in scheme is `*_Print*Filename`.

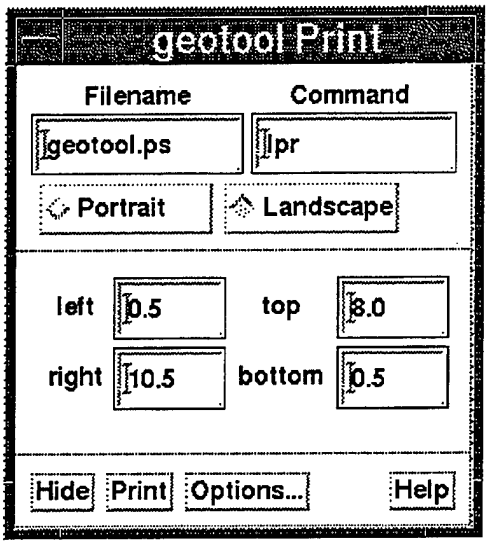

Figure 26: The **Print** popup.

7.3 Basic Functions

There are three low level functions for accessing single elements in the user interface.

- `set-text-string` replaces text in text window. Two arguments are given. The first one is the name of the text window, and the second one is the new text. For example, the following command will insert the string newfile.ps in the filename text window in the **Print** popup:

  `(set-text-string "*_Print*Filename" "newfile.ps").`

- `set-toggle` turns a toggle button off or on. Two arguments are given. The first one is the name of the toggle button, and the second one specifies if the toggle should be on or off, i.e., `off` or `on`. For example, the following command will simulate setting the Landscape toggle button in the **Print** popup to be on:

  `(set-toggle "*_Print*Landscape" "on").`

- `arm-and-activate` simulates pressing a push button. One argument is given, which is the name of the button. For example, the following

command will simulate pressing the Print push button in the **Print** popup:

```
(arm-and-activate "*_Print*Print")
```

In addition to these low level commands, there is another routine, `apply-it`, which allows multiple actions to be executed in one popup. The argument list is *popup_name action1 action2...actionN. popup_name* is the name of the popup, or `_geotool` in the case of the main window.

The actions in `apply-it` have the form *name=value*, where *name* is a name of the widget, as described above. The widget can be either a push button, a toggle button, or a text window. The *value* has different meanings, depending on the type of widget. In the case of a push button, the value argument is not needed, since the push button is just activated, as in the case of the `arm-and-activate` function, described above. In the case of a toggle button, *value* is `on` or `off`, depending on whether the toggle button should be turned off or on. In the case of a text window, *value* is the text string to enter into the window.

Here is an example of `apply-it` which performs the three actions described above:

```
(apply-it "Print Filename=44.ps Landscape=1 Print=1")
```

Note that the actions are performed from left to right.

7.4 Other Functions

- `position-phase-line` Specifies where to position the phase line. The arguments are the name of the phase line and the new position. For example, the following command will position the `P` phase-line cursor at x=60.0:

  ```
  (position-phase-line "P" 60.0)
  ```

- `position-single-line` Specifies where to position a single-line cursor. The arguments are the name of the single-line cursor and the new position. For example, the following command will position the `A` single-line cursor at x=0.5:

  ```
  (position-single-line "A" 0.5)
  ```

- `position-double-line` - Specifies where to position a double-line cursor. The arguments are the name of the double-line cursor, and the positions of the left and right side of the double-line cursor. For example, the following command will position the left side of the a double-line cursor at x=0.5 and the right side at x=2.0:

  ```
  (position-double-line "a" 0.5 2.0)
  ```

- `push-key` - Simulates a keyboard event in the named window. The arguments are the name of the key and the name of the widget. For example, the following command will simulate pressing the `1` key in the main **geotool** window, which will add a double-line cursor to the plot:

  ```
  (push-key "1" "*_geotool*plot1")
  ```

- `read-wfdisc` - Provides a method for reading or listing wfdisc files in **geotool**. The first argument is the full path to the wfdisc file, and the second argument is `read` or **list**. If it is `read`, the file is read. If it is `list`, the file is listed. For example, the following command will list the contents of the specified wfdisc file:

  ```
  (read-wfdisc "/home/coyne/wow.wfdisc" "list")
  ```

- `system` - Provides a scheme interface to the UNIX system call. For example, the following command will list any files in the `/tmp` directory:

  ```
  (system "ls /tmp")
  ```

7.5 Conclusions

This concludes the essential scheme functions in **geotool**. Although the command set is small, it is very powerful. Scheme functions using these commands are used at the GSETT-3 International Data Center to automate noise spectra measurements. Two of the side benefits of this system are that the exact same code can be used for interactive and off-line processing, and that the off-line results are available immediately in interactive form. These capabilities facilitate debugging and verification of results.

Appendix A

NAME

CPlotAddCurve – add curve

SYNOPSIS

```
#include "CPlot.h"
#include "Draw.h"
void CPlotAddCurve(w, npts, x, y, type, lab, on, adjust_limits, pixel)
CPlotWidget    w;
        int            npts;
        float          *x, *y;
        int            type;
        char           *lab;
        Boolean        on;
        short          adjust_limits;
        Pixel          pixel;
```

ARGUMENTS

w Specifies the CPlot widget.

npts Specifies the number of points of input data.

x Specifies array of input values in the x direction.

y Specifies array of input values in the y direction.

type Specifies how data will be presented. Possible values are **CURVE, SQUARE, TRIANGLE, PLUS, EX, INV_TRIANGLE, DIAMOND, CIRCLE, FILLED_SQUARE, FILLED_TRIANGLE FILLED_INV_TRIANGLE, FILLED_DIAMOND**, or **FILLED_CIRCLE.**

lab Specifies identifying label for input data.

on Specifies if data are initially displayed.

adjust_limits Specifies if viewing limits should be modifies to accommodate input data. Possible values are **0** (do not adjust limits), **ADJUST_X_LIMITS**, **ADJUST_Y_LIMITS**, and **ADJUST_LIMITS**.

pixel Specifies pixel value to use for plotting the data.

DESCRIPTION

The **CPlotAddCurve** function adds data curves (or points) to a CPlot widget. Data added with **CPlotAddCurve** may not be repositioned or rescaled.

SEE ALSO

CPlotAddTimeSeries(3g)

AUTHOR

Ivan Henson

NAME

CPlotAddTimeSeries – adds Time Series

SYNOPSIS

```
#include "CPlot.h"
#include "geodata.h"
void CPlotAddTimeSeries(w, ts, input, adjust_limits)
TtPlotWidget    w;
TimeSeries *ts;
CPlotInputStruct *input;
short adjust_limits;
```

ARGUMENTS

w Specifies the CPlot widget.

ts Specifies the time series input.

input Specifies additional input.

adjust_limits Specifies if viewing limits should be modifies to accommodate input data. Possible values are **0** (do not adjust limits), **ADJUST_X_LIMITS**, **ADJUST_Y_LIMITS**, and **ADJUST_LIMITS**.

DESCRIPTION

The **CPlotAddTimeSeries** and **TtPlotAddTimeSeries** functions provide a means to input time series data into the CPlot and TtPlot widgets. **TtPlotAddTimeSeries** calls **CPlotAddTimeSeries**.

SEE ALSO

CPlotGetData(3g)

AUTHOR

Ivan Henson

NAME

CPlotGetPointData – retrieves selected time series data intersecting single line cursor

SYNOPSIS

#include "CPlot.h"
int CPlotGetPointData(w, labels, cd_list)
CPlotWidget w;
char *labels;
CPlotData ***cd_list;
int CPlotGetPointComponents(w, labels, num_components, components, cd_list)
CPlotWidget w;
char *labels;
int num_components;
char *components;
CPlotData ***cd_list;

ARGUMENTS

w Specifies CPlot widget.

labels Specifies the label of target single-line cursor. To specify the single-line cursor named **A**, this argument should be set to **A**.

num_components Specifies the number of components to retrieve. This is usually usually 2 or 3.

components Specifies the final letter of the channel name when grouping components. To obtain horizontal components, this argument should be set to "ne".

cd_list Returns the cd_list structure of appropriate time series data.

DESCRIPTION

The **CPlotGetPointData** function returns selected time series data which intersects the specified single-line cursor.

The **CPlotGetPointComponents** function returns the selected time series data of the specified components which intersects the specified single-line cursor. If not all of the requested components are returned, none are returned.

The return value from **CPlotGetPointData** and **CPlotGetPointComponents** is the number of time series returned.

SEE ALSO

CPlotAddTimeSeries(3g)

AUTHOR

Ivan Henson

NAME

CPlotGetSelected – retrieves all selected time series data

SYNOPSIS

```
#include "CPlot.h"
int CPlotGetSelected(w, cd_list)
CPlotWidget    w;
CPlotData ***cd_list;
int CPlotGetSelectedComps(w, components, cd_list)
CPlotWidget    w;
char *components;
CPlotData ***cd_list;
```

ARGUMENTS

w Specifies CPlot widget.

components Specifies the final letter of the channel name when grouping components.

cd_list Returns the cd_list structure of all time series data.

DESCRIPTION

The CPlotGetSelected function returns the selected time series data. The CPlotGetSelectedComps function returns the selected time series data of the specified components. To obtain horizontal components, the components argument should be set to "ne".
The return value from CPlotGetSelected and CPlotGetSelectedComps is the number of time series returned.

SEE ALSO

CPlotAddTimeSeries(3g)

AUTHOR

Ivan Henson

NAME

CPlotGetWindowedData – retrieves all selected time series data

SYNOPSIS

```
#include "CPlot.h"
int CPlotGetWindowedData(w, labels, cd_list)
CPlotWidget    w;
char *labels;
CPlotData ***cd_list;
int CPlotGetWindowedComponents(w, labels, components, cd_list)
CPlotWidget    w;
char *labels;
char *components;
CPlotData ***cd_list;
```

ARGUMENTS

w Specifies CPlot widget.

labels Specifies the label of target double-line cursor. To specify the double-line cursor named **a**, this argument should be set to **a**.

components Specifies the final letter of the channel name when grouping components. To obtain horizontal components, this argument should be set to "ne".

cd_list Returns the cd_list structure of all time series data.

DESCRIPTION

The **CPlotGetWindowedData** function returns selected time series data within the specified double-line cursor.
The **CPlotGetWindowedComponents** function returns the selected time series data of the specified components within the specified double-line cursor.
The return value from **CPlotGetWindowedData** and **CPlotGetWindowedComponents** is the number of time series returned.

SEE ALSO

CPlotAddTimeSeries(3g)

AUTHOR

Ivan Henson

NAME

ConPlotDisplay – modify data displayed in ConPlot widget

SYNOPSIS

```
#include "ConPlot.h"
void ConPlotDisplay(w, num, ids, display_data, display_grid)
    ConPlotWidget   w;
    int             num;
    int             *ids;
    Boolean         display_data;
    Boolean         display_grid;
```

ARGUMENTS

w ConPlot widget

num Specifies number of unique ConPlots (ids) to modify.

***ids** Specifies the unique ConPlots (ids) to modify.

display_data Specifies if data points should be displayed.

display_grid Specifies if position of input points should be displayed.

DESCRIPTION

The ConPlotDisplay function is a convenience routine for modifying the values display_data and display_grid.

SEE ALSO

ConPlotInput(3g)

BUGS

should really return void

AUTHOR

Ivan Henson

NAME

ConPlotInput – input data to ConPlot widget

SYNOPSIS

```
#include "ConPlot.h"
int ConPlotInput(w, nx, ny, x, y, z, numlines, lines, xmax, ymax,
display_data, display_grid)
        ConPlotWidget   w;
        int             nx, ny;
        float           *x, *y, *z;
        int             num_lines;
        double          *lines;
        double          xmax, ymax;
        Boolean         display_data;
        Boolean         display_grid;
```

ARGUMENTS

w ConPlot widget

nx Specifies number of values in x direction.

ny Specifies number of values in y direction.

x Specifies array of values used to label the X axis.

y Specifies array of values used to label the Y axis.

z Specifies array of values to plot. Orientation of array begins in lower left corner, and increases by row moving to the right.

num_lines Specifies number of groups data will be divided into when plotting solid plot. 0 for contour plot.

lines Specifies boundaries between data groups when plotting solid plot. NULL for contour plot.

xmax Specifies the maximum X-axis data value.

ymax Specifies the maximum Y-axis data value.

display_data Specifies if data values should be displayed.

display_grid Specifies if position of input points should be displayed.

DESCRIPTION

The ConPlotInput function inputs data to the ConPlot widget. Data can be displayed by this widget as either a contour plot (as in the FK popup in **geotool**), or as a solid plot (as in the Spectrogram popup in **geotool**). The type of displayed is controlled by the resource XtNmode, which can have the value CONTOURS_ONLY, COLOR_ONLY, or CONTOURS_AND_COLOR.
ConPlotInput returns a unique identifier for the new plot.

SEE ALSO

ConPlotClear(3g), ConPlotDisplay(3g), ConPlotOutput(3g)

AUTHOR

Ivan Henson

NAME

ConPlotOutput – modify data displayed in ConPlot widget

SYNOPSIS

```
#include "ConPlot.h"
Boolean ConPlotOutput(w, nx, ny, x, y, z)
    ConPlotWidget   w;
    int             *nx;
    int             *ny;
    float **x;
    float **y;
    float **z;
```

ARGUMENTS

w Specifies ConPlot widget.

nx Returns number of values in x direction.

ny Returns number of values in y direction.

x Returns array of values used to label the X-axis.

y Returns array of values used to label the Y-axis.

z Returns array of data values.

DESCRIPTION

The ConPlotOutput function returns the values displayed in a ConPlot display.
ConPlotOutput returns True if it completed successfully.

SEE ALSO

ConPlotInput(3g)

AUTHOR

Ivan Henson

NAME

DoAddArrival – add an arrival to time series data

SYNOPSIS

```
#include <pwd.h>
#include <sys/types.h>
#include "CPlot.h"
#include "geodata.h"
void DoAddArrival(w, arrival, cd, password, time, phase)
        CPlotWidget     w;
        Arrival         *arrival;
        CPlotData       *cd;
        struct passwd   *password;
        double          time;
        char            *phase;
```

ARGUMENTS

w Specifies CPlot widget.

arrival Specifies arrival to add.

cd Specifies the CPlotData structure on which the arrival will be added.

password Specifies password information of user adding arrival.

time Specifies arrival time.

phase Specifies phase name of arrival.

DESCRIPTION

The DoAddArrival function adds an arrival to time series data. The password argument can be set with:
password = getpwuid(getuid());

SEE ALSO

getuid(2), getpwuid(3C)

AUTHOR

Ivan Henson

NAME

HistgmInput – input data to Histogram widget

SYNOPSIS

#include "Histgm.h"
int HistgmInput(w, npts, z, num_bins, num_colors, colors, num_stipples, stipples, lines)
HistgmWidget w;
int npts;
float *z;
int num_bins;
int num_colors;
Pixel *colors;
int num_stipples;
Pixmap *stipples;
double *lines;

ARGUMENTS

w Histogram widget.

npts Specifies number input values for the histogram.

z Specifies input values for the histogram.

num_bins Specifies number of columns in the histogram.

num_colors Specifies number of colors in histogram. num_colors is either the same as num_bins, or 0. If num_colors is 0, num_stipples is set to num_bins.

colors Specifies array pixel colors used to draw histogram. Color is used on color displays to distinguish columns in the histogram.

num_stipples Specifies number of stipples in histogram. num_colors is either the same as num_bins, or 0.

stipples Specifies array of pixmaps used to draw histogram. Pixmaps are used on black and white and color-starved displays to distinguish columns in the histogram.

lines Specifies boundaries between data groups when plotting solid plot.

DESCRIPTION

The HistgmInput function inputs data to the Histogram widget. An example is in the Color Selection popup in Spectrogram.

AUTHOR

Ivan Henson

NAME

MallocWarn – frees allocated memory

SYNOPSIS

```
#include <stdlib.h>
int MallocWarn(ptr, nbytes)
void **ptr;
int nbytes;
```

ARGUMENTS

ptr Specifies pointer to allocated memory.

nbytes Specifies number of bytes to allocate.

DESCRIPTION

The MallocWarn function allocates the specified number of bytes. MallocWarn returns 1 upon success, 0 upon failure. If MallocWarn fails, a warning message is given by calling warn_popup().

SEE ALSO

warn_popup(3g)

AUTHOR

Ivan Henson

NAME

ReallocWarn – reallocates memory

SYNOPSIS

```
#include <stdlib.h>
int ReallocWarn(ptr, nbytes)
void **ptr;
int nbytes;
```

ARGUMENTS

ptr Specifies pointer.

nbytes Specifies number of bytes to reallocate.

DESCRIPTION

The ReallocWarn function reallocates the specified number of bytes. If a NULL pointer is passed, the memory is allocated, i.e., ReallocWarn does the right thing.
ReallocWarn returns 1 upon success, 0 upon failure. If ReallocWarn fails, a warning message is given by calling warn_popup().

SEE ALSO

warn_popup(3g)

AUTHOR

Ivan Henson

NAME

WaitCursor – changes the mouse cursor to and from an hourglass.

SYNOPSIS

void WaitCursor(state)
Boolean state;

ARGUMENTS

state Specifies if mouse cursor should be an hourglass.

DESCRIPTION

The WaitCursor function is called with an argument of True before lengthy operations to change the mouse cursor to an hourglass. Once the operation completes, WaitCursor is called again with an argument of False. If the function returns without calling WaitCursor with a False argument, the mouse cursor will continue to be an hourglass.
X events are not affected by WaitCursor, i.e., the X events are queued until the the program returns to the main X loop.

AUTHOR

Ivan Henson

NAME

ui_get_value – get value from the user interface

SYNOPSIS

```
int ui_get_value(name, value)
        char *name;
char *value;
```

ARGUMENTS

name Specifies name of the widget that contains the value.

value Returns the value from the widget.

DESCRIPTION

The ui_get_value function is a convenience function for obtaining values from widgets of different types. ui_get_value is knowledgable of the following widget classes: xbaeMatrixWidgetClass, xmTextWidgetClass, xmTextFieldWidgetClass, xmLabelWidgetClass, xmToggleButtonWidgetClass, xmScaleWidgetClass, and xmRowColumnWidgetClass.
If the widget is of xmToggleButtonWidgetClass, 1 is returned if the button is on, otherwise 0 is returned.
If the widget is of xmRowColumnWidgetClass and has radioBehavior, the name of the currently selected toggleButton is returned.

AUTHOR

John Coyne

NAME

warn_popup – display warning message

SYNOPSIS

void warn_popup(va_alist)
va_dcl

ARGUMENTS

va_dcl Text of warning message.

DESCRIPTION

The warn_popup function displays a message to the user. The message is displayed in the Warnings popup in geotool.

EXAMPLES

The argument to warn_popup can take various forms since it is a variable declaration. For example:
warn_popup("Don't tread on me!");
warn_popup("%s: read error", path);

AUTHOR

Ivan Henson

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