New and updated web applet Explorers

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ABSTRACT

New and updated interactive web applet programs have been created. The TI and HTI Explorers make use an exact method of calculating HTI reflection coefficients which was not present in earlier explorers. Two updates have been made for the Zoeppritz Explorer, one is to make possible the display of negative angles of incidence, and another is to allow the creation of ASCII output. A new Fluid Properties Calculator assists with obtaining acoustic properties and viscosity for use in fluid substitution problems. The Hodogram Explorer allows one to readily produce hodograms and calculate polarization angles from 3-C data in ASCII format. The implementation of double buffering is a general improvement to any of the applets which involve plotting data on the screen. It reduces flickering and thus assists in viewing the results of interactive adjustment of parameters.

TI EXPLORER

The CREWES TI Explorer is an expansion and improvement upon the AniZoeppritz and VTI Explorers. "TI" refers to transverse isotropy, and it is used to calculate reflection coefficients in media displaying both vertical TI (VTI) and horizontal TI (HTI). The most important improvement over previous explorers is that it incorporates exact HTI P-wave reflection coefficients, whereas only a linearized HTI solution was available previously. As seen in Figure 1, reflection coefficients are displayed as functions of the polar angle of incidence. For displays as a function of azimuthal angle of incidence, see the description of the HTI Explorer in the next section.
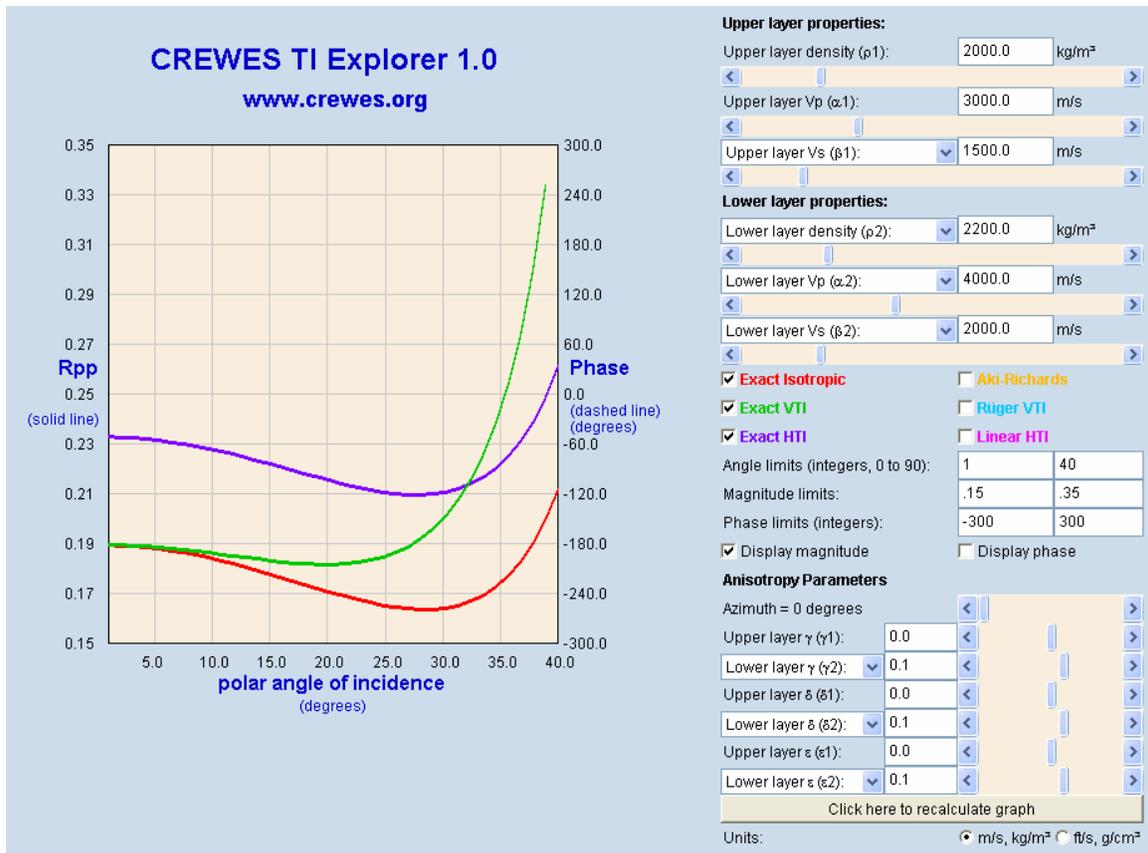
FIG. 1. Screen capture of the CREWES TI Explorer.

In Figure 2 we see detail of the control panel. Required input includes density, velocities along the symmetry axis, and Thomsen anisotropy parameters. It is important to note that the HTI coefficients are not always defined directly in these terms. Rüger and Tsvankin (1997) for instance give a linearized expression in terms of the vertical velocities and in terms of anisotropy parameters defined relative to the vertical. These issues are discussed throroughly in the web page notes accompanying this explorer. Note that at present it is assumed that if two HTI media overlay one another that their symmetry axes are both aligned along the x_1 direction, and this is a requirement of the linearized expression of Rüger and Tsvankin (1997). It is anticipated that this requirement will be relaxed in future versions.

The user may also note obvious numerical instability of the exact HTI solution for some parameters. These are most likely to occur at azimuthal angles near multiples of 90°, and at a polar angle of 0°. They do not represent any real effects, and it is anticipated that such instabilities will be removed in a future version. Post-critical values of the exact HTI solution will also be implemented in future.

Upper layer properties:

Upper layer density (ρ1):   2000.0   kg/m³

Upper layer Vp (α1):   3000.0   m/s

Upper layer Vs (β1):   1500.0   m/s

Lower layer properties:

Lower layer density (ρ2):   2200.0   kg/m³

Lower layer Vp (α2):   4000.0   m/s

Lower layer Vs (β2):   2000.0   m/s

☑ **Exact Isotropic**   ☐ **Aki-Richards**

☑ **Exact VTI**   ☐ **Rüger VTI**

☑ **Exact HTI**   ☐ **Linear HTI**

Angle limits (integers, 0 to 90):   1   40

Magnitude limits: .15   .35

Phase limits (integers):   -300   300

☑ Display magnitude   ☐ Display phase

Anisotropy Parameters

Azimuth = 0 degrees

Upper layer γ (γ1):   0.0

Lower layer γ (γ2):   0.1

Upper layer δ (δ1):   0.0

Lower layer δ (δ2):   0.1

Upper layer ε (ε1):   0.0

Lower layer ε (ε2):   0.1

Click here to recalculate graph

Units: ● m/s, kg/m³ ○ ft/s, g/cm³

FIG. 2. Detail of the control panel for the TI Explorer.

HTI EXPLORER

The CREWES HTI Explorer functions in a manner complementary to the TI Explorer (previous section). Whereas the TI explorer displays reflection coefficients as a function of polar angle of incidence, the HTI explorer displays HTI reflection coefficients as a function of azimuthal angle of incidence, as shown in Figure 3. For comparison it also displays isotropic reflection coefficients, which are constant in this domain. Both exact and linearized solutions are available.
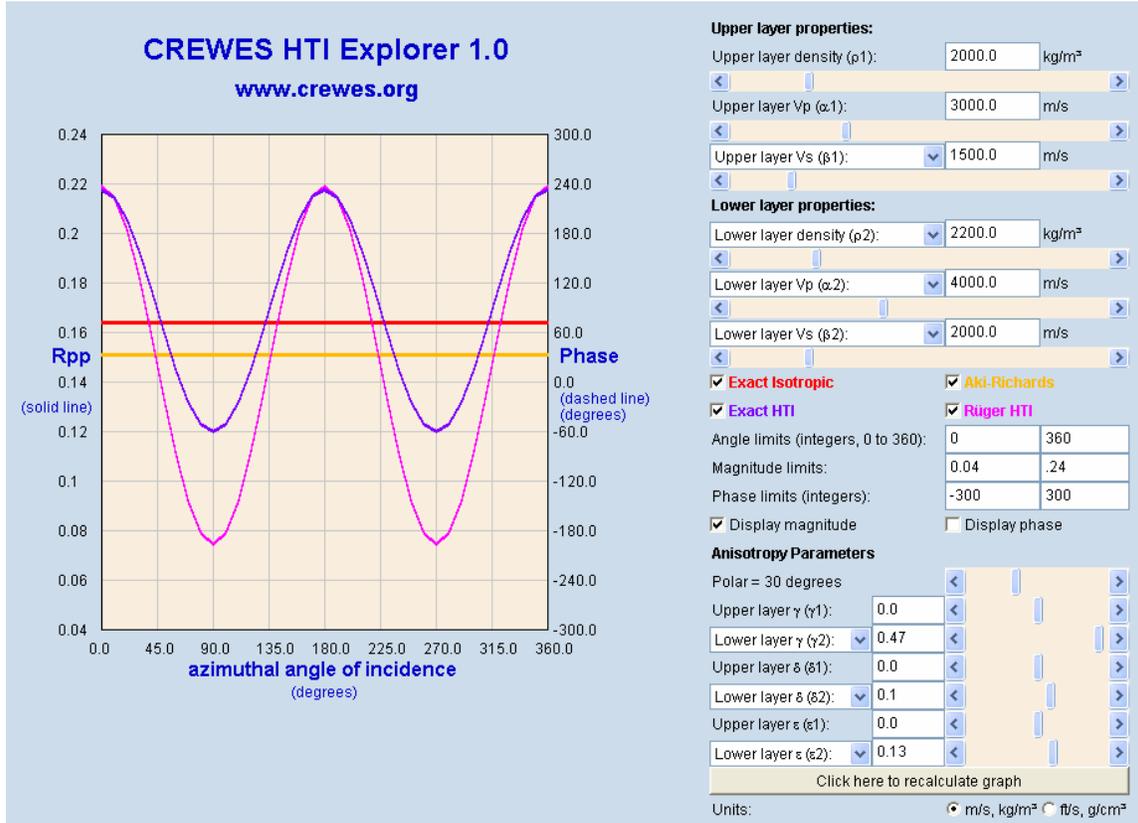

FIG. 3. Screen capture of the CREWES HTI Explorer.

Note that although azimuthal angles range from 0° to 360°, it is only necessary to display the domain from 0° to 90°, as each of the three remaining quadrants is related to by symmetry to the first. It is straightforward to modify this and other parameters through the display panel. Also note that this explorer suffers from certain instabilities discussed above in connection with the TI explorer.

ZOEPPRITZ EXPLORER WITH NEGATIVE ANGLES

The Zoeppritz Explorer was originally designed to display reflection coefficients in the incidence angle range of 0° to 90°. A new version has been created which the range can be increased –90° to 90°. Although the positive and negative ranges are related by symmetry, being able to display the full range is of pedagogical value. This version, denoted 2.1, will replace the publicly available version on our website.
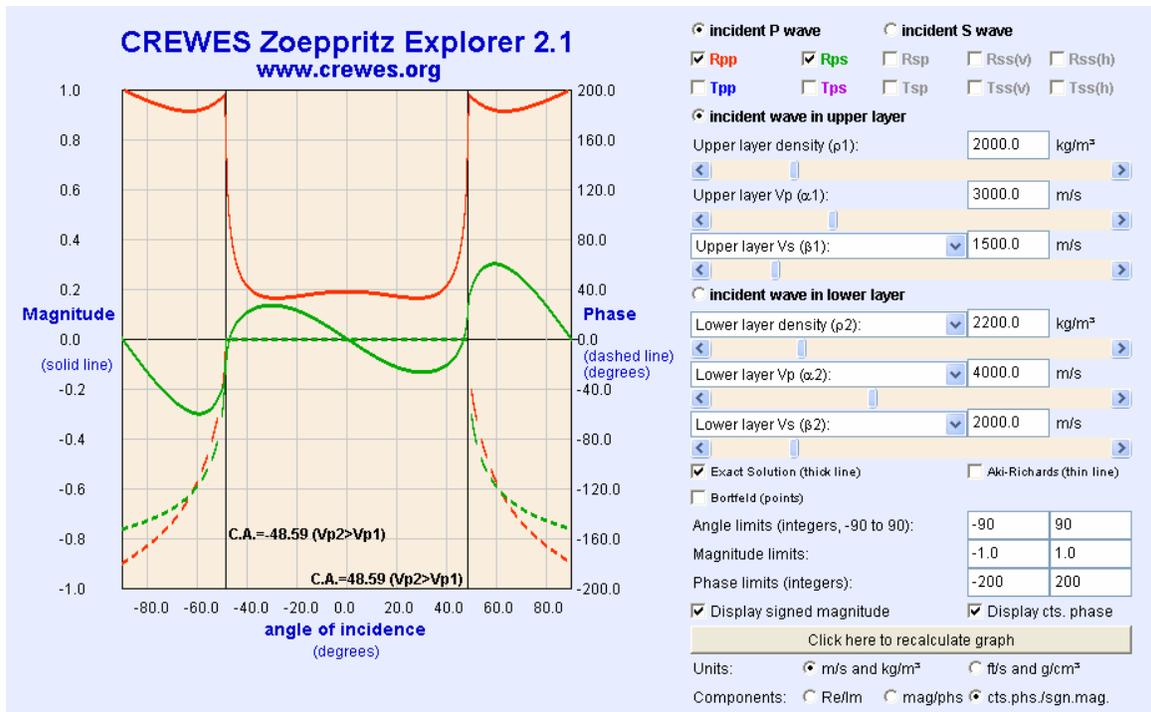
FIG. 4. Screen capture of version 2.1 of the CREWES Zoeppritz Explorer. As shown here, the angle of incidence may now be adjusted to display behavior at negative angles.

ZOEPPRITZ EXPLORER WITH ASCII OUTPUT

A number of queries have been received regarding the possibility of obtaining ASCII output from the Zoeppritz Explorer to use as input into other routines. The principle obstacle to doing this is that, for security reasons, Java applets cannot read or write files from within a browser. It is easy to imagine the sort of difficulties that might arise in browsing the internet if a user were to open an untrusted webpage and it were able to start reading or writing files on the client machine. Thus in general the convenience of using a web applet program, such as the Zoeppritz Explorer, comes at the price I/O being limited to whatever can entered into textboxes, etc.

It is possible however to run an applet in an environment other than a browser. Most computers today have enough Java installed on them to run web applets, but if one installs the full Java development kit, available free of charge from java.sun.com, then one can run the applet from a DOS window and this will allow one to perform I/O with files.

A version of the Zoeppritz Explorer has been created which will write ASCII output to a file. As shown in Figure 5, it differs in appearance only by the text on a single button, which initiates the write. This version of the Zoeppritz Explorer is available only to sponsors, and can be obtained on this year's software release or downloaded from www.crewes.org. An accompanying README files gives complete instructions on how to see if the full Java development kit is already installed on your system, how to obtain it if it is not there already, and how to run the applet to obtain ASCII files.
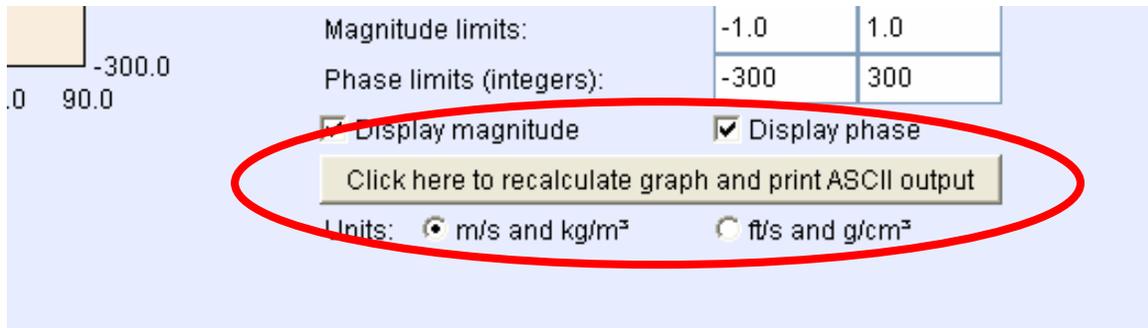
FIG. 5. Detail of a screen capture of the Zoeppritz Explorer modified to allow output of ASCII data.

Note, an alternative method of communiciating input into an applet is demonstrated in the hodogram explorer, discussed below.

FLUID PROPERTIES CALCULATOR

Knowledge of fluid acoustic properties is important in fluid substitution problems. The most common pore fluids are of course gas, oil, and brine. A reservoir will give different seismic responses depending on which fluids are occupying its pore space, and this provides the basis both for distinguishing water and hydrocarbon zones in exploration, as well as for delineating swept regions in a time-lapse injection program. In order to model the changes in seismic response that occur upon fluid substitution in a reservoir, the changes in elastic properties must be calculated using, e.g., Gassmann's equation. The acoustic properties of both fluids are a prerequisite for such a calculation, and the CREWES Fluid Properties Calculator is designed to assist with obtaining the fluid properties.

Figure 6 contains a screen capture of this calculator. It can be opened through a web browser set to www.crewes.org and the operation is largely self-explanatory. The webpage also contains a set of notes describing the theory.

FIG. 6. Screen capture of the Fluid Properties Calculator, prior to executing calculations.

HODOGRAM EXPLORER

In exploration seismology a hodogram is a crossplot of the particle motion of two orthogonal elements of a geophone. Generally there is a specific time window that is of interest. The key information obtained from a hodogram is the polarization angle, indicating the direction in which a wave has been traveling. The hodogram is a standard tool in VSP analysis (Esmersoy, 1990; Miao et al., 1994; Gulati et al., 2004) and has been studied in surface seismic analysis as well (Guevara and Stewart, 2000). It has also been studied as an AVO attribute (Anderson, 2003; Mahob and Castagna, 2003; Whitcombe et al., 2004).

The CREWES Hodogram Explorer was created as a convenient tool for plotting hodograms of 3-component traces. Prior to running the explorer, one should have four columns of ASCII data. These may be in one file (possibly with other columns of data as well) or in separate files. One column should represent time values and the other three columns the corresponding vertical and horizontal traces from a 3-C receiver.

To enter data into the program, cut and paste one or more columns of data in the large text area of Figure 7a. Use checkboxes to indicate which data of interest is included in the pasted data, and then use the text boxes to indicate which columns contain those data of interest. Clicking the "Read Data" button will then read in the data, and a record of inputted data will appear in the control panel. This input process is repeated until all

columns of data have been read in, and then plotting is accomplished by clicking the appropriate button. The final result is illustrated in Figure 7b.

Both the three original traces as well as their three possible crossplot hodograms are shown in the display area. All are plotted on the same scale, which is determined by the maximum amplitude of any trace within the specified time window. On each hodogram plot a line is displayed showing a least-squares fit line passing through the origin. The polarization angle associated with this line is given as well.

Two options are available for customizing the display. A drop-down menu controls the color scheme of the display. Vertical slider bars on the left side of the control panel control the plotting limits.

(a)
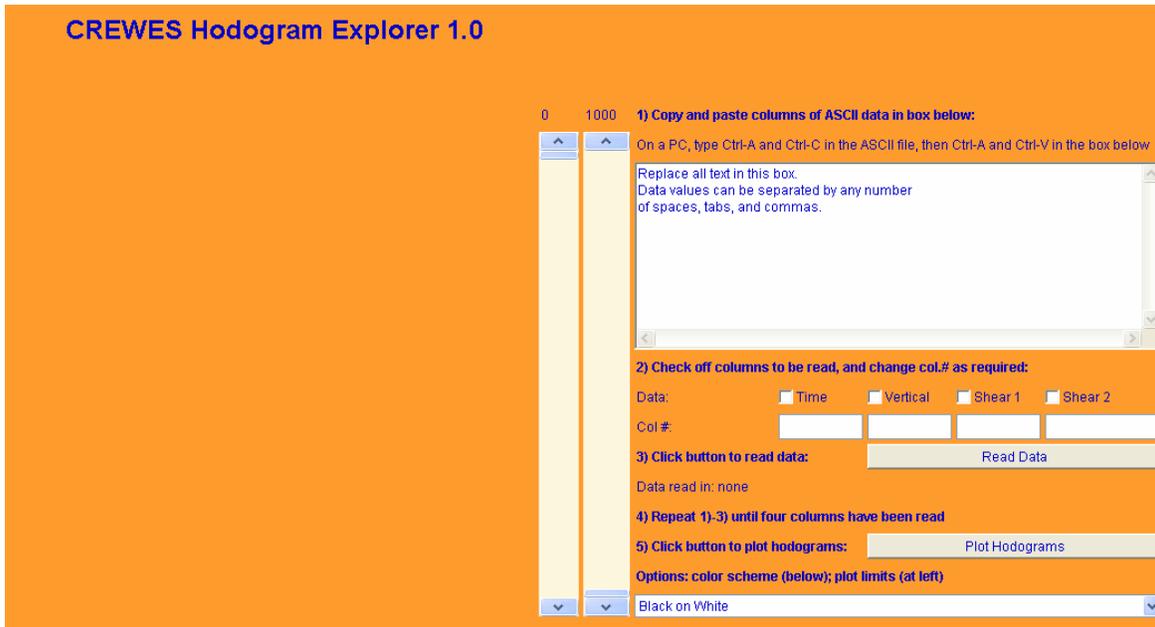
(b)
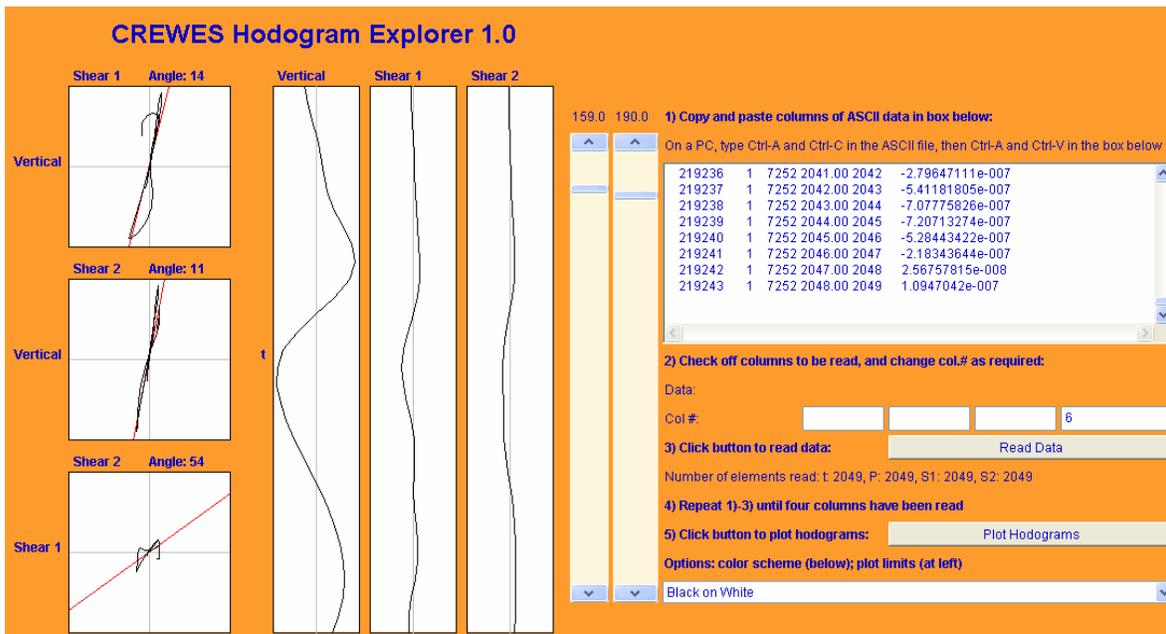
Figure 3. Screen capture images of the CREWES Hodogram Explorer. (a) Appearance upon first opening in browser. (b) Appearance after entering data, plotting, and windowing.

DOUBLE BUFFERING

One additional improvement has been made this year to a number of explorers, which former users will perhaps notice. Previously, the explorers which create plots, such as the Zoeppritz Explorer, would experience flickering of the display when using a slider to

adjust parameter values. This has been removed through the use of double buffering, which facilitates the observation of trends in the plot as parameters are varied.

ACKNOWLEDGEMENTS

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