README File for CSHOT

!!! Be sure to adjust ROOT in the Makefile before installing !!!

The Unix (tar) distribution includes the subdirectories Demo01, Demo02, release notes. Several of the Demos (02, 11, 12, 13, 14) highlight new capabilities of CSHOT. It is recommended that users copy these directories to their own work areas in order to preserve the originals and keep the Demo directories from getting cluttered.

```
****************************************************************
 * Running the Xgraph or Psgraph files in a Demo directory,
 * while reading the corresponding example in the Release Notes
 * is the way to learn how to use CSHOT !!!
****************************************************************
```

The "graphics" in the new CSHOT consists of writing an ascii file to stdout that contains groups headed by two integers giving respectively the number of points in the curve and a color code, followed by the (x, z) pairs of floats.

It is then easy to write a program to parse this file and do the graphics with any local package or to change to a binary output format, etc. The program, cshotplot.c, distributed with CSHOT forms an example of such a parser that, in turn, outputs binary data and a parameter file that are the form that the CWP public domain graphics programs require. Of course, to use this implementation you need to install the CWP environment. The files you need are available from CWP by anonymous ftp (hilbert.Mines.Colorado.EDU or 138.67.22.6). Just "cd pub", evoke binary mode and take cwp.tar.Z, plot.tar.Z, xcwp.tar.Z and su.tar.Z (install in that order).

The Demo directories each contain the file, Xcshot, which is as an example run file using CWP's xgraph to do the model/well/ray plots (if any) and xwigb to do the sections (if any). If you prefer grayscale plots to wiggles, replace "xwigb" by "ximage". If you prefer PostScript to X, see the PScshot files in the Demo directories--here at CWP, we use PostScript mainly for getting hard copy, so you will have to make a few simple changes if you want to use Display PostScript instead.

Paul Docherty is still interested in comments/bug reports on CSHOT and I'll relay them to him.

Jack Cohen (jkc@keller.mines.Colorado.EDU) 07/20/91

CWP-U08R
July 1991

Documentation for the 2.5D Common-Shot Modeling Program CSHOT

by

Paul Docherty

Partially supported by the Consortium Project
on Seismic Inverse Methods for Complex Structures
at the Center for Wave Phenomena

Proprietary: 1/27/91

Center for Wave Phenomena
Colorado School of Mines
Golden, Colorado 80401
(303)273-3557

Contents

1 Introduction

This document describes the new version of the common-shot modeling program CSHOT. The new version, like the old, calculates true amplitude shot data in two-and-one-half-dimensional layered acoustic media. Additional features incorporated into this version include:

- surface topography
- VSP capability
- direct waves and head waves
- flexible recording geometry
- common-offset and common-receiver sorted data
- sources deep in the model

The new version is, in fact, two programs, called CSHOT1 and CSHOT2. All of the ray calculations are carried out in CSHOT1. The method of ray tracing employed is the combined shooting+continuation approach described in the CSHOT documentation (CWP-U08). CSHOT1 creates a disk file containing traveltime, amplitude and phase data. CSHOT2 accesses this file for the information it needs to build the time section, i.e., the wiggle traces. One advantage of this two-step approach is a more economic use of disk storage. The ray data file is typically small in size when compared to the trace file. In order to store the results of a modeling run, only the ray data file need be saved; the traces can be quickly and easily constructed at a later date (using CSHOT2). A second advantage is that the characteristics of the wavelet, which are input to CSHOT2, can be altered and a new time section created without the expense of an additional ray tracing run.

Perhaps the main feature of the new version is the downhole or VSP capability. We can direct CSHOT1 to operate in either surface or downhole mode. In surface mode, the source locations are referenced to receiver stations on the upper surface. In downhole mode, a well is described and the sources are distributed throughout the well. An option in CSHOT2 to perform a receiver sort makes it possible to simulate the more typical VSP case in which the receivers, not the sources, are located inside the well.

CSHOT1 and CSHOT2 require a number of input parameter files. These will be described briefly in Section 2 to follow and in detail in the examples of Section 3. The most straightforward approach to realizing the requirements and capabilities of the new programs is to read through and try out the examples. The final section in this document is on graphics. Program CSHOT1 outputs the information (to standard output) necessary to produce the ray pictures shown here. You must provide software to capture this output and generate graphics commands for your machine; or, you can use the CWP graphics implementation.

2 Input Parameter Files

Program CSHOT1 reads parameters from five separate input files:

1. file PARAM1
2. a model file
3. a geometry file
4. a well file
5. a colors file

Program CSHOT2 reads from only one parameter file:

1. file PARAM2

The main parameter file input to CSHOT1, which must have the name PARAM1, controls the shooting mode (surface or downhole), describes the events to be generated for each source (direct waves, reflections, multiples, etc.), specifies the velocities, and defines some ray search angles. File PARAM1 also contains the names of the other parameter files input to CSHOT1. The model file is a list of (x, z) coordinates describing the reflectors and the upper surface, which itself may be curved. The geometry file contains a description of the receiver layout for each shot. It enables the specification of taper-on, rollalong, and taper-off; or, a simple fixed geometry for all shots may be requested. Gapped spreads are also allowed. The well file contains the (x, z) coordinates of the well and is required in downhole mode only. The program fits a spline through the coordinates to produce a curvy well. Finally, when plotting to the screen, CSHOT1 allows the user to specify the colors of various elements of the plot by way of entries in the colors file.

The file input to CSHOT2, which must be called PARAM2, contains the trace length, sample rate and wavelet description. Also found in PARAM2 are the names of the ray data file (generated by CSHOT1) and output trace file to be created. Finally, PARAM2 is where the type of time section is chosen; shot records, common-receiver sorts and common-offset sorts are all possible.

3 Examples

The precise format of the input parameter files is developed and explained by means of the examples in this section. Many of the examples correspond to those in the original CSHOT documentation, so that CSHOT users can quickly identify the differences between the old and new versions. The input parameter files and the output generated for each example can be found at the end of this section.

3.1 Plotting the model

In this example CSHOT1 is used to make a plot of the model. We need three input files: PARAM1, the model file and the colors file. (See the listings of these files under the heading *Example 1* at the end of the section). First, let's take a look at PARAM1.

Record 1 of PARAM1 contains the name of the file describing the model. Here the model file is called *simplemodel.* The number of interfaces described in file *simplemodel* is entered in Record 2 of PARAM1. There are four interfaces in the model in this example (not including the upper surface). The name of the colors file appears in Record 3. Record 4 is a plot descriptor. To get a plot of the model enter m in any of columns 1–3 of Record 4. To quit immediately after plottting the model enter mq within columns 1–3.

File *simplemodel* contains the (x, z) coordinates of four interfaces and the upper surface. The upper surface is described first in the file. We can view the upper surface as being Interface 0, since it may be curvy and will be splined by the program just like the deeper interfaces. In this example, the upper surface is flat at elevation $z = 0$. (The z-coordinate is measured positive downwards. Hills might be described using negative z-coordinates). To terminate the description of an interface, a large negative z-coordinate is used; specifically, $z < -9999$ does the job.

The colors file has the name *plotcolors* here. You can specify the colors in which the interfaces, rays, well, etc., will be drawn (on a color screen). A key is given at the end of the file.

3.2 Plotting the model and the well

In this example we go a little bit further and plot a well within the model. You'll need to describe a well if you plan to shoot in downhole mode. The name of the file describing the well is given in Record 5 of PARAM1 as *curvedwell1* here. The well is described by a list of coordinates which will be splined by the program. The z-coordinate of the top of the well (i.e., its elevation at the upper surface) is not given but instead is calculated by the program. This is because the precise value of this coordinate may not be known if the upper surface is curved. The well itself should not be too curvy and in any case should be single-valued in z. A value $z < -9999$

ends the well definition. To plot the model and the well and then quit, enter *mwq* in Record 4 of PARAM1.

3.3 Ray plot - all primary reflections

This example plots rays for the primary reflection from each interface. In order to produce a ray plot we have to provide a lot more entries in PARAM1. First, we change Record 4 to *m* (plot the model, do not plot the well, do not quit). The file name describing the well should remain in Record 5; however, we will be surface shooting in this example so that the file need not exist (it will not be opened). Record 6 defines the shooting mode: *s* for surface; *d* for downhole. An example of downhole mode will be given later (see Section 3.12). Record 7 contains the name of the file describing the shooting geometry, i.e., the line layout for each shot. In this example the file is called *geometry1*. The precise format of this file will be discussed below.

Record 8 of PARAM1 is another plot descriptor. You can plot the source or receiver locations by entering *s* or *g* (for geophones) here. To plot both sources and receivers enter *sg*. In fact you can also tag on a *q* and quit at this point. (So if you entered *m* in Record 4 and *sgq* in Record 8 you would get a plot of the model along with the source and receiver locations and nothing else. If you choose to quit here then Record 8 can be the last line of PARAM1.) If you don't want to plot either the shot or receiver locations then leave the first three columns of Record 8 blank.

Record 9 is the job descriptor; it determines the output generated by CSHOT1. For a ray plot, enter *r* here. To get two listings of some possibly useful traveltime and ray information enter *l*. For a time section (to be built later by CSHOT2) enter *t*. To get all three at once enter *rlt*, and so on. Record 10 is used in naming the listing files and the time section file output by CSHOT1 (if these have been requested). Appended to Record 10 are *data* and *listing* for the two listing files, and *shot* for the time section file. See Section 3.6 for more details on the listings. The first time section is produced in Section 3.8. Neither listings nor time section is being generated here, so Record 10 is not used.

Record 11 is the range of takeoff angles, in degrees, used in the shooting search. The takeoff angles for upgoing rays are measured from the upward pointing vertical, as shown in Figure 1a. (In the figure, β_i is the initial search angle; β_f is the final search angle.) For downgoing rays, the takeoff angles are measured from the downward pointing vertical, as in Figure 1b. (If the interface at which the first ray intersection occurs lies above the source, at the source location, then the program considers the ray to be upgoing; otherwise, it is taken to downgoing.) The range $-180 \rightarrow +180$ degrees covers all possible takeoff angles; however, a more restricted range, like the one specified for this example, results in a faster run. Record 12 is the increment in takeoff angle as the program sweeps through the range searching for solutions. Be careful not to make this too large or you might miss some solutions. (Users of CSHOT will recall another parameter, used by the program to detect branches of solutions skipped by the continuation procedure. This parameter, which we found rarely changed, is now set in a statement in the source code.)

The layer velocities (shallowest first) are input in Record 13. There should be one more velocity than the number of interfaces specified in Record 2. Next come the event specifications. First, answer *y* or *n* (yes or no) for the direct wave in Record 14. In order to generate head waves enter the refracting interface numbers in Record 15. For example, enter *1 3* for the head waves from interfaces 1 and 3. Note: triplications in head wave arrivals are not supported by the program—ASK FOR HEAD WAVES FROM REASONABLY FLAT LAYERS ONLY. Leave Record 15 blank for no head waves. In Record 16 you have another yes or no choice. Enter *y* to generate a primary refelection from each interface, as we have done here; otherwise, enter *n*.

Now let's take a look at the shooting geometry, described in file *geometry1* in this example. In Record 1 of *geometry1* we specify a station number and define its x-coordinate. All shot and receiver numbers will be referenced to this station. Here we say that Station 1 is located at $x = 1000$. Record 2 contains the receiver spacing and the receiver depth below the upper surface. Note that, while the receivers can be buried, they must always remain within the first (topmost) layer. Next comes the layout for Shot 1. The first four entries in Record 3, which we can refer to as *r1*, *r2*, *r3* and *r4*, describe the receiver locations for this shot. With four receiver entries we can specify a gap in the spread. The first receiver in the spread is at Station *r1*. Station *r2* is the location of the last receiver before the gap. Station *r3* is the location of the first receiver after the gap. The last receiver in the spread is at Station *r4*. A gapped spread might look something like

50 100 120 170   Gapped spread

The gap is between Stations 100 and 120. In a spread without a gap *r2* and *r3* are consecutive

50 100 101 170   No gap

The fifth entry in Record 3 is the station location of the shot. Note that this is a float variable; thus enabling the shot to be positioned in between stations. For example, a shot position of 10.5 is half way between Stations 10 and 11. The final entry in Record 3 of the geometry file is the shot depth, so that a complete geometry description looks like

50 100 120 170   110.   30.   Buried shot inside gap

It should be pointed out that the shot can be anywhere, regardless of the location of the gap. Also, the shot is not restricted to Layer 1, but can be buried deep in the model.

Often, only a single shot is to be specified. In such cases Record 3 is the last line of the geometry file. In the case where many shots are to be described we distinguish between land and marine type surveys. In a land survey, the receivers are constrained to be at station locations. This implies that the spread is not dragged across the surface between shots. In order to describe a land type survey we must provide a record, with the same format as Record 3, for each shot in the survey. Thus, Records 3–(n+2) describe Shots 1–n. There are no restrictions on changing the geometry from one shot to the next.

In marine shooting the shot-receiver geometry is considered fixed for all shots. Further, as the boat steams along, the receivers may move up an amount not determined by the receiver spacing on the cable. This time the geometry file is much more straightforward. Record 3 again defines the locations of the shot and receivers for Shot 1. Record 4 is used to define the total number of shots and the move-up in model units (i.e., feet or meters) from one shot to the next. The move-up is applied to both the source and receiver locations and can be any distance. Record 4 is the last line of the geometry file for marine shooting. (See Section 3.14 below for an example of marine shooting.) Of course, you can use this approach as a quick way to describe a land survey in which the shooting geometry is constant. To do so, simply choose the move-up to be a multiple of the station spacing.

3.4 Specific Reflectors

This example shows how to ask for reflections from specific interfaces, rather than from all of them as above. First enter n (do not seek all primaries) in Record 16. Following Record 16 we can describe as many reflection events as we like by specifying the reflecting interfaces. Here there are two events, a reflection from Interface 1 and another from Interface 4.

3.5 Multiple

We can also specify multiples after Record 16. A multiple is described by a list of numbers representing the interfaces at which reflections occur. The multiple in Record 17 here is

2 1 4 Multiple

which specifies a reflection from Interface 2, followed by a reflection from Interface 1 and then a reflection from Interface 4. Higher order multiples can also be requested; however, make sure that the rays end up at the receivers. The event

3 2 4 1 Invalid event

is not valid because the final reflection, from Interface 1, sends the rays down, never to reach the receivers (remember that the receivers must be located in Layer 1). Any number of events can be specified after Record 16, one record per event. The events will be generated for all shots. (It is possible that an event which is valid for one shot may be invalid for another. For example, a simple reflection from Interface 1 will no longer be valid if the shots become buried beneath Interface 1. The program checks for and ignores invalid events.)

3.6 Listings

This example makes two listings as well as a ray plot (*rl* in Record 9). The first part of the file names for the listings comes from Record 10 of PARAM1, which is given as *demo6* here. File *demo6listing* is meant to be a readable file. It lists the velocities, the locations of shots and receivers, and identifies the type of events generated. Also given for each ray are the coordinates where the ray intersects the interfaces and the traveltime along the ray. File *demo6data* is a more condensed file which might be used as input to other programs. It contains the intersection coordinates of each ray, preceded by the the number of intersections for the ray and the traveltime. Note how two shots were specified in the geometry file *geometry2*.

3.7 Ghosts+multiple

If the source is buried below the upper surface then the program can be directed to generate a source ghost, i.e., an immediate reflection from Interface 0. Similarly, if the receivers are buried, a receiver ghost can be requested. Record 17 of PARAM1 describes a source ghost, a multiple in Layer 4, and a receiver ghost.

3.8 Shot Record

This is the first example of generating shot data. Both CSHOT1 and CSHOT2 must be run this time. In Record 9 of PARAM1 we have specified *r* for ray plot and *t* for time section. When we specify *t* here, CSHOT1 writes out pertinent information needed to construct the time section. Once again, Record 10 provides the first part of the name given to the output file. The last part of the name is always *shot* for the shot data file, so that the file created here will be *demo8shot*. We have asked for data from all primaries and also two reverberation events (described by the last two records in PARAM1).

After *demo8shot* has been created, by running CSHOT1, we can run CSHOT2 and actually construct the wiggle traces. Program CSHOT2 requires only one input parameter file. This file must be called PARAM2. The following is a description of the format of PARAM2.

The first record in PARAM2 is a sort option. Besides constructing shot records it is also possible to produce receiver gathers. The choices for Record 1 are either

s or r. To build shot records choose s in Record 1 of PARAM2. To build receiver gathers choose r in Record 1 of PARAM2. Record 2 of PARAM2 contains two integers, which specify the first and the last shot to include in the sort. When Record 1 = s these are the first and last shot records that will be constructed. When Record 1 = r these are the first and last shot records that will be searched in the receiver sort. (Note: CSHOT1 generates the shots in the order they appear in the geometry file. Each shot is assigned a record number, starting with 1. The integers in Record 2 of PARAM2 refer to the record numbers assigned by CSHOT1 to the shots. They are not the station numbers where the shots were located. So if you generate 100 shots in CSHOT1 then they are referred to as 1-100 here, though the station numbers might have been 5001-5100, say.)

Record 3 of PARAM2 also contains two integers. How these integers are interpreted depends on your choice of s or r in Record 1 as follows:

1. Record 1 = s

   In this case, Record 3 defines the first and last traces to build from each shot. Example. Record 2 = *10 20.* Record 3 = *30 50.* Traces 30–50 from Shots 10-20 will be constructed.
   Example. Record 2 = *5 5.* Record 3 = *1 100.* Traces 1–100 from Shot 5 will be built.

2. Record 1 = r

   This time Record 3 describes the first and last receiver sort to output.
   Example. Record 2 = *1 100.* Record 3 = *10 20.* Shots 1–100 will be searched for data recorded at receivers 10–20. The sort for Receiver 10 will be output first, followed by the sort for Receiver 11, and so on.
   Example. Record 2 = *10 50.* Record 3 = *10 10.* Shots 10–50 will be searched for data recorded at Receiver 10. Only one receiver sort will be output.

The remainder of PARAM2 is more straightforward. Record 4 contains the frequencies of the source wavelet (positive half of symmetric frequency spectrum only). These are the corner frequencies of a trapezoid of unit height. The source wavelet is zero phase with a maximum height equal to twice the area of the trapezoid. At a receiver, the source wavelet is scaled by an amplitude factor determined from spreading and reflection and transmission effects. Phase shifts due to post-critical reflections and caustics are also taken into account.

The wavelet length, in seconds, is provided in Record 5 of PARAM2. Record 6 contains the sample rate and Record 7 the trace length (both given in seconds also). Record 8 is the name of the shot file generated by CSHOT1. It contains the amplitude, phase and traveltime information for all of the shots described in the geometry file. Record 9, the last record in PARAM2, is the name to be given to the output file containing the actual traces built by CSHOT2.

It is also possible to generate a common-offset sort. This is done with the shot option (Record 1 = s) by specifying only one trace to build in Record 3. For example, to construct Trace 10 from each shot defined in Record 2, specify *10 10* in Record 3. (It is assumed, of course, that the trace in question is recorded at a receiver which is always the same distance from the shot. You need to be careful enough in the geometry file if you want to make this happen. What it means is that the shot and receivers must move up the same amount from one shot to the next. The number of output traces will be the number of shots in Record 2.)

3.9 Caustic

The model for this example is a syncline. The syncline causes a ray triplication and the shot record has the familiar bow tie appearance. Each of the rays on the second branch of the syncline reflection has passed through a caustic and this brings about the 90 degree phase shift that is clearly visible on the second leg of the bow tie. The two turning points, where the caustics emerge at the surface, occur beyond the ends of the line and the bow tie has had its ends clipped.

Notice that negative x-coordinates can be used to describe the model. Also, in the geometry file a station can be referenced to a negative x-coordinate. The integers describing the stations should always be positive though, in other words, the minimum station number is 1. It are generally a good idea to stay away from the very edges of the model, so if you must have a receiver at $x = 0$, then start the model at $x < 0$.

3.10 Dome reflections

There are two parts to this example. First we have asked for a ray plot for reflections from Interfaces 2, 4 and 6 in a salt dome model. There are 50 receivers located on the upper surface for the first run. Next, we have asked for time section data for all primaries from 3 shots, each with 100 receivers (see file *geometry7*). Note how Records 4 and 8 of PARAM1 were left blank in order to prevent any plotting in the second run.

3.11 Head waves

There are three parts in this example. First, a ray plot and shot record are generated for 4 primaries from a flat layered model (file *flatmodel*). Notice how a gap is specified in the geometry file *geometry8*. Next, we get a ray plot and data for a direct wave and 4 head waves. Finally, direct wave, primaries and head waves are generated in one run.

For head waves, you may see where the ray hits the interface at the critical angle but there is no receiver segment to the raypath. This is because the receiver segment emerges beyond the limits of the line and is not plotted. In the last trace plot it is difficult to distinguish between head wave and primary wavelets because the arrival times are about the same.

3.12 VSP data

VSP data is produced by setting off a number of sources at various depths in a well. Data is recorded at a line of receivers on the surface. A receiver sort is then performed on the data. We can view the receiver sort as equivalent to the more typical VSP case in which the sources are on the upper surface and the receivers are inside the well.

For CSHOT1 there are a few changes to be made in PARAM1. First we change Record 6 of PARAM1, the shooting mode, to *d* for downhole. The name of the file describing the well should appear in Record 5. To plot the well enter *w* within columns 1–3 of Record 4. The rest of PARAM1 follows the surface source case.

In downhole mode, the locations of the shots are given in the well file and not in the shooting geometry file. The well is decribed by file *curvedwell2* in this example. After the end of the well definition, two more records follow which are used to define the source locations. The depth down the well to the shallowest source is given first. In the next record are the number of sources and the source spacing. (Depth here is really arc length down the well. The program integrates down the well to find the (x, z) coordinates of the sources).

The geometry file for this example is *geometry9*. In downhole mode the geometry file describes the layout of the receivers only; thus, the fifth and sixth entries in Record 3 of *geometry9* are not read and can be left out altogether. You can still move the spread around for different shots by specifying more records after Record 3; however, the total number of geometry records does not have to equal the number of shots requested in the well file. If there are more shots requested in the well file than there are receiver geometries, then the program simply holds the the last geometry fixed for all remaining shots.

Example. 10 shots requested, 10 geometries provided.
shot 1 uses geometry 1 (Record 3)
shot 2 uses geometry 2 (Record 4)
...
shot 10 uses geometry 10 (Record 12)

Example. 10 shots requested, 2 geometries provided.
shot 1 uses geometry 1 (Record 3)
shot 2 uses geometry 2 (Record 4)
shot 3 uses geometry 2 (Record 4)
...
shot 10 uses geometry 2 (Record 4)

Example. 10 shots requested, 1 geometry provided.
shot 1 uses geometry 1 (Record 3)
shot 2 uses geometry 1 (Record 3)
...
shot 10 uses geometry 1 (Record 3)

The last example here is the typical one for VSP data, i.e., we hold the receivers fixed for all shots.

Now let's take a look at PARAM2 for CSHOT2. In Record 1 a receiver sort is requested. Record 2 specifies the range of shot records over which to search for data. There were 25 shots in this example and we will use all of them. Record 3 gives the first and last receiver numbers for which gathers will be constructed. Receiver 1 is the farthest receiver from the well in this particular example and Receiver 10 is the closest. The remainder of PARAM2 follows the shot sort case. All 10 receiver gathers have been plotted (Receiver 1 gather is at the left) indicating how the VSP changes with distance from the well.

3.13 Deep shots

This is an example of surface shooting but with the shot buried successively deeper in the model. We have asked for primaries from all interfaces; however, when the shot is below an interface there is no primary reflection (the program knows this). In order to get reflections from interfaces above the shot you must describe them in the records at the end of PARAM1. Notice how the range of takeoff angle gets wider as the shot approaches the bottom of the syncline. In file PARAM1 the shooting search is defined over all angles ($-180 \rightarrow +180$ degrees).

3.14 Common-offset data

This final example shows how to generate common-offset data. First a plot of the model (file *weathering*) is made. Next, time data is generated for a direct wave, a head wave from Interface 1, and a reflection from Interface 2. In the geometry file, the layout for the first shot is described in Record 3. Record 4 requests a total of 80 shots with a move-up of 200 (ft or m) between shots. (This is the alternative way to specify multiple shots that was referred to in Section 3.3 as marine shooting. The geometry is fixed for all shots and the move-up applies to both shot and receivers.) In file PARAM2 we have asked for a shot sort in which only Trace 1 from each record is to be built. In this way a common-offset section is produced.

The first event on the trace plot is the direct wave. Next, is the head wave followed by the reflection from Interface 2. The disappearance of a portion of the head wave at the right of the common-offset section is due to the thickening of Layer 1. This causes the critical ray to emerge beyond the end of the spread.

File PARAM1

```
simplemodel                          :model file
4                                    :#interfaces in model
plotcolors                           :model colors file
mq                                   :first plot descriptor (mwq)
```

File *simplemodel*

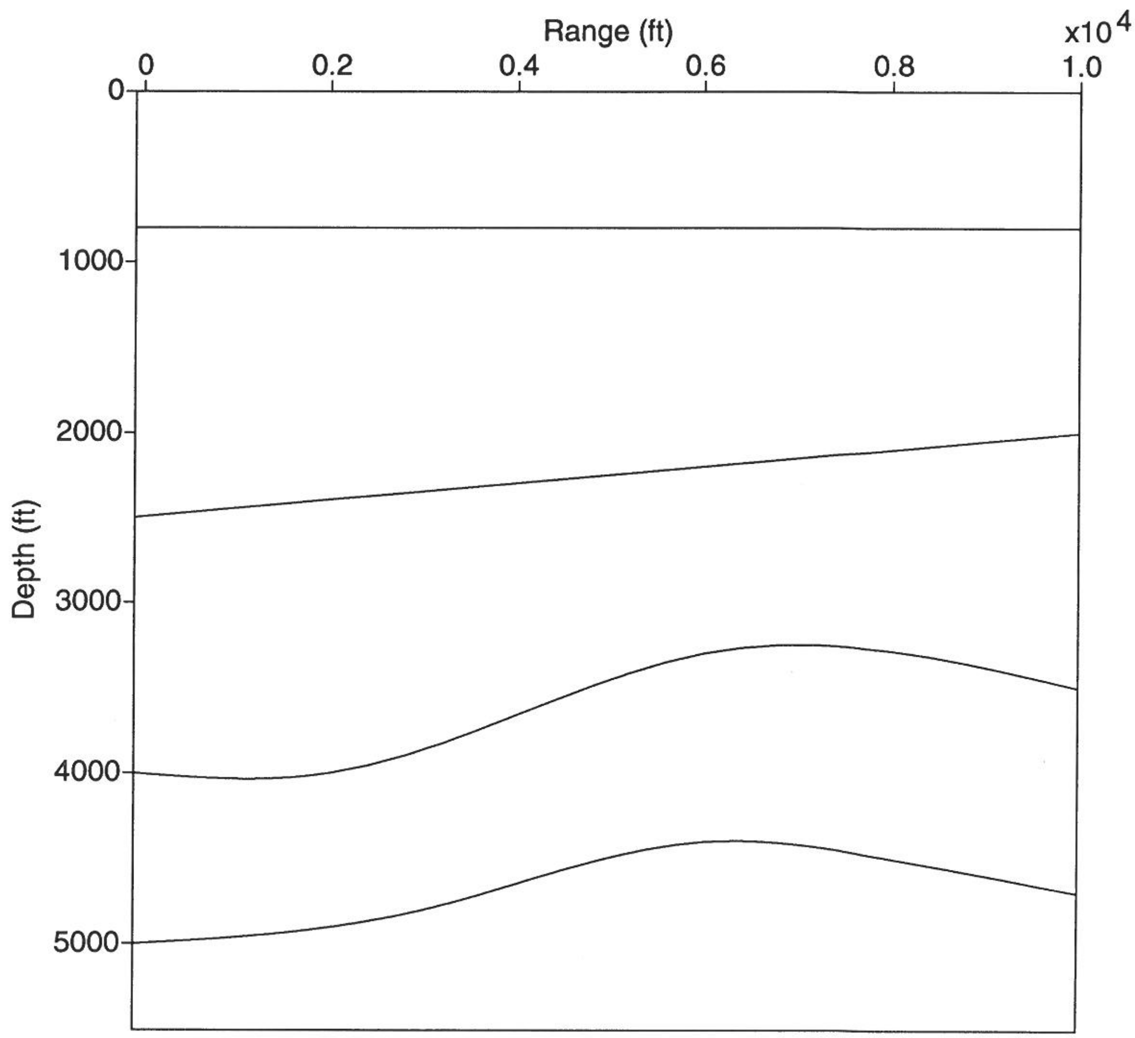
```
 -100.        0.                     :upper surface
10000.        0.                     :
    1.   -99999.                     :end of upper surface
 -100.      800.                     :interface 1
10000.      800.                     :
    1.   -99999.                     :end of interface 1
 -100.     2500.                     :interface 2
10000.     2000.                     :
    1.   -99999.                     :end of interface 2
 -100.     4000.                     :interface 3
 2000.     4000.                     :
 6000.     3300.                     :
10000.     3500.                     :
    1.   -99999.                     :end of interface 3
 -100.     5000.                     :interface 4
 3000.     4800.                     :
 6000.     4400.                     :
 8000.     4500.                     :
10000.     4700.                     :
    1.   -99999.                     :end of interface 4
```

File *plotcolors*

```
5                                    :receivers
3                                    :sources
4                                    :well color
3                                    :caustic rays
2                                    :rays
1                                    :interfaces
```

```
Color Key: CWP graphics

0       black
1       white
2       red
3       green
4       dark blue
5       light blue
6       violet
7       yellow
```



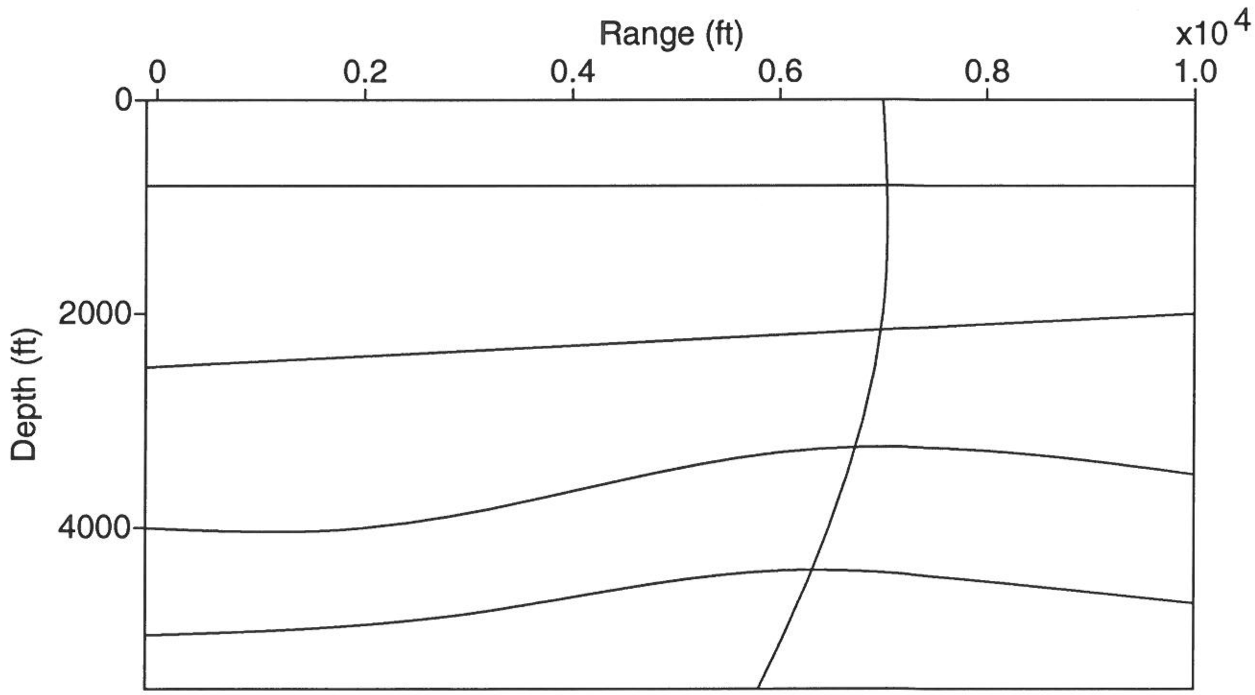
Model for demo1

File PARAM1

```
simplemodel                          :model file
4                                    :#interfaces in model
plotcolors                           :model colors file
mwq                                  :first plot descriptor (mwq)
curvedwell1                          :well coordinates
```

File *curvedwell1*

```
7000.                                :x-coord. of top of well
7000.  2000.                         :x,z coord. pair down the well
5000.  7000.                         :x,z coord. pair at bottom of well
1.    -99999.                        :end of well definition
```



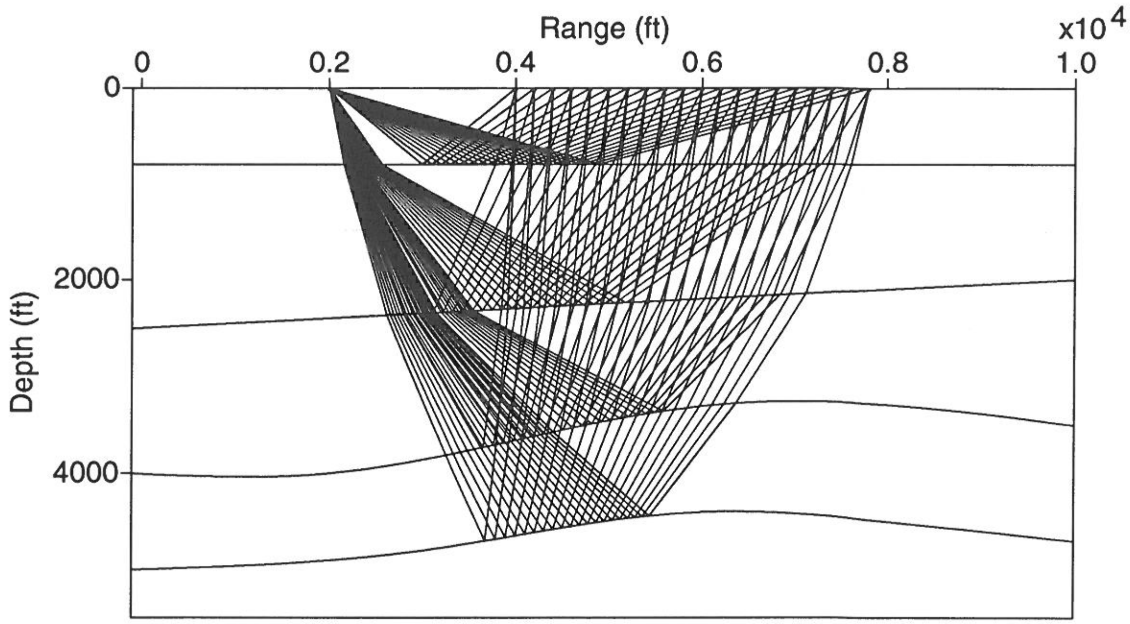
Model for demo2

File PARAM1

```
simplemodel                          :model file
4                                    :#interfaces in model
plotcolors                           :model colors file
m                                    :first plot descriptor (mwq)
don't care                           :well coordinates
s                                    :shooting mode (sd)
geometry1                            :receiver geometry
sg                                   :second plot descriptor (sgq)
r                                    :job descriptor (rlt)
don't care                           :output filename(s)
  0.   80.                           :range of takeoff angles
1.                                   :increment in takeoff angle
4000.0  6000.0  9000.0
10000.0 13000.0                      :velocities
n                                    :direct wave? (y or n)
                                     :headwave interface numbers (1, 2, ...)
y                                    :all primaries? (y or n)
```

File *geometry1*

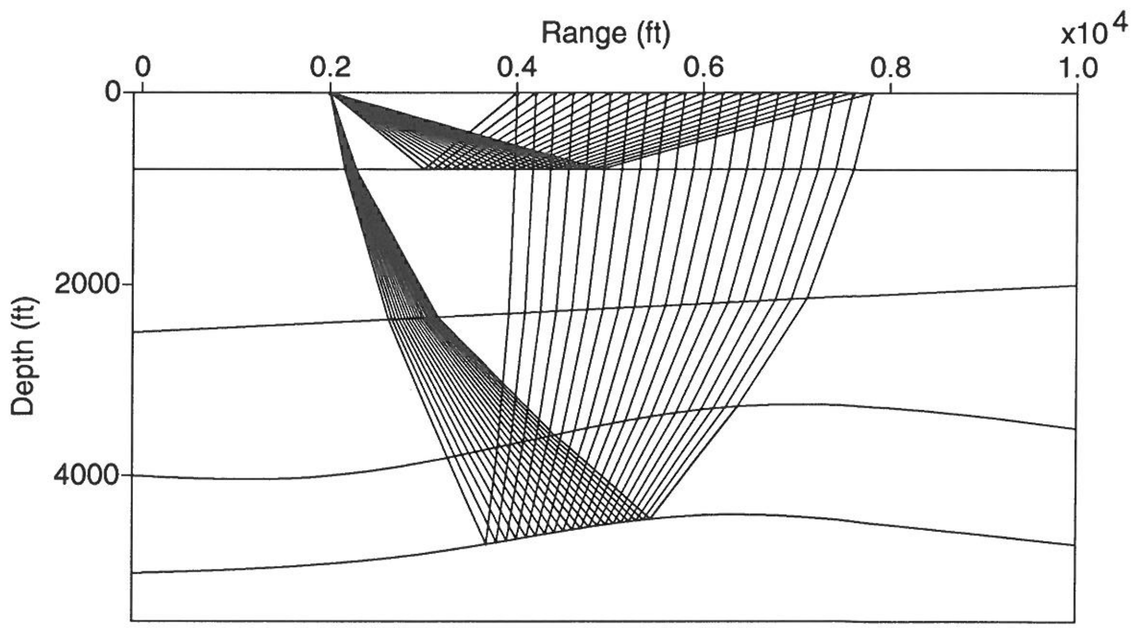
```
1         1000.                      :reference station number and x-coord.
200.         0.                      :station spacing and receiver depth
16  20  21  35       6.    0.        :shot 1 - r1 r2 r3 r4 s sdepth
```



Rays for demo3

File PARAM1

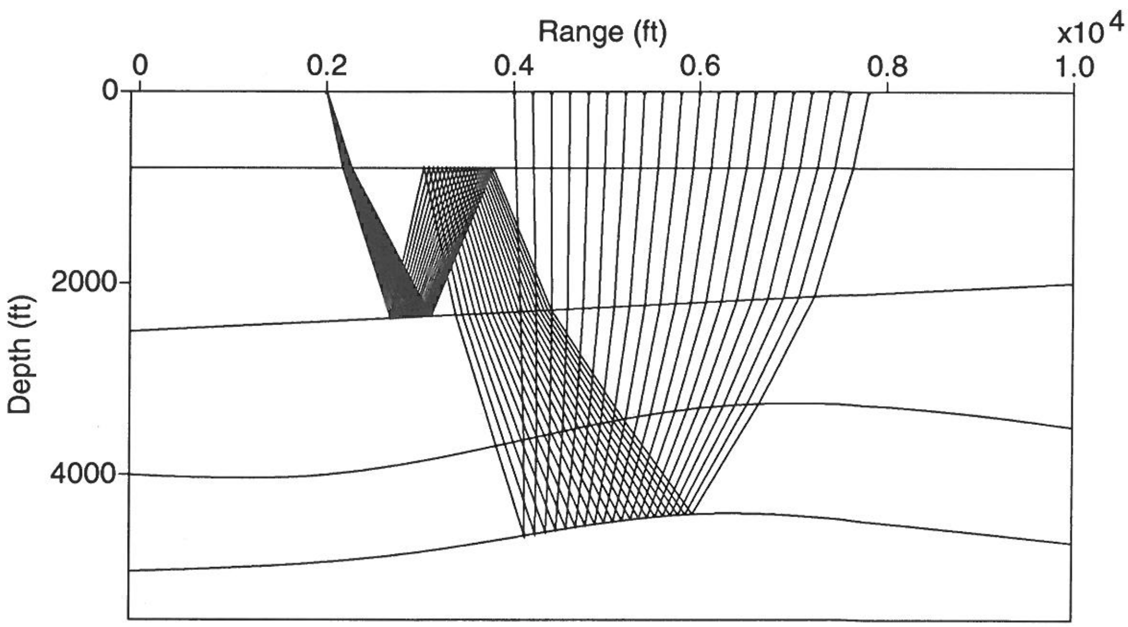
```
simplemodel                        :model file
4                                  :#interfaces in model
plotcolors                         :model colors file
m                                  :first plot descriptor (mwq)
don't care                         :well coordinates
s                                  :shooting mode (sd)
geometry1                          :receiver geometry
sg                                 :second plot descriptor (sgq)
r                                  :job descriptor (rlt)
don't care                         :output filename(s)
  0.   80.                         :range of takeoff angles
1.                                 :increment in takeoff angle
4000.0  6000.0  9000.0
10000.0 13000.0                    :velocities
n                                  :direct wave? (y or n)
                                   :headwave interface numbers (1, 2, ...)
n                                  :all primaries? (y or n)
1                                  :reflection from interface 1
4                                  :reflection from interface 4
```



Rays for demo4

File PARAM1

```
simplemodel                         :model file
4                                   :#interfaces in model
plotcolors                          :model colors file
m                                   :first plot descriptor (mwq)
don't care                          :well coordinates
s                                   :shooting mode (sd)
geometry1                           :receiver geometry
sg                                  :second plot descriptor (sgq)
r                                   :job descriptor (rlt)
don't care                          :output filename(s)
  0.   80.                          :range of takeoff angles
1.                                  :increment in takeoff angle
4000.0  6000.0  9000.0
10000.0 13000.0                     :velocities
n                                   :direct wave? (y or n)
                                    :headwave interface numbers (1, 2, ...)
n                                   :all primaries? (y or n)
2 1 4                               :multiple
```



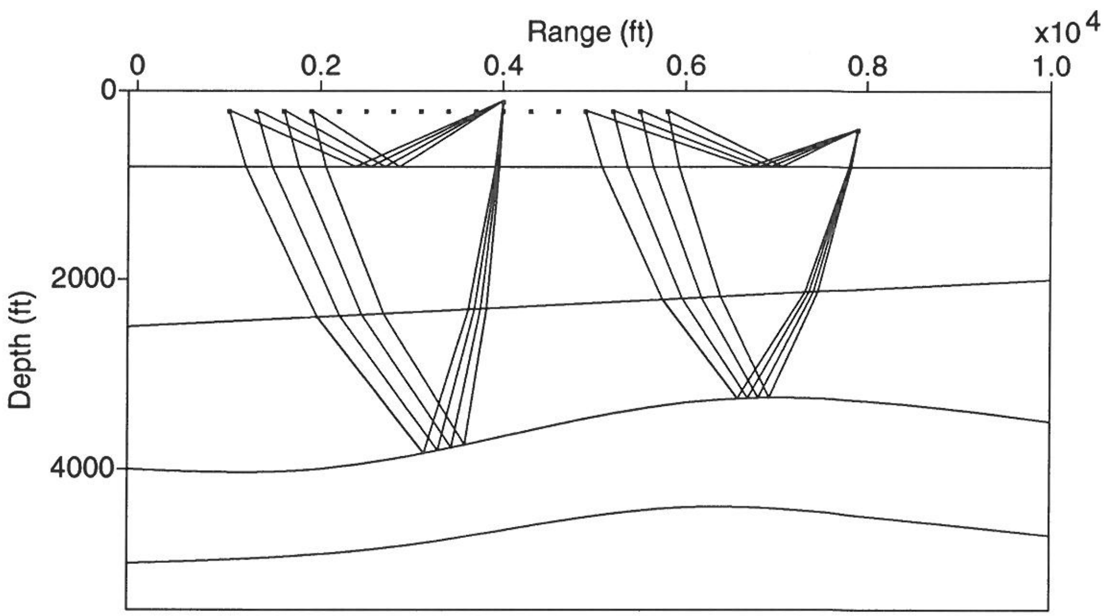
Rays for demo5

File PARAM1

```
simplemodel                         :model file
4                                   :#interfaces in model
plotcolors                          :model colors file
m                                   :first plot descriptor (mwq)
don't care                          :well coordinates
s                                   :shooting mode (sd)
geometry2                           :receiver geometry
sg                                  :second plot descriptor (sgq)
rl                                  :job descriptor (rlt)
demo6                               :output filename(s)
-80.   80.                          :range of takeoff angles
2.                                  :increment in takeoff angle
4000.0  6000.0  9000.0
10000.0 13000.0                     :velocities
n                                   :direct wave? (y or n)
                                    :headwave interface numbers (1, 2, ...)
n                                   :all primaries? (y or n)
1                                   :reflection from interface 1
3                                   :reflection from interface 3
```

File *geometry2*

```
1          100.                     :reference station number and x-coord.
300.       200.                     :station spacing and receiver depth
4   5   6   7      14.  100.        :shot 1 - r1 r2 r3 r4 s sdepth
17  18  19  20     27.  400.        :shot 2 - r1 r2 r3 r4 s sdepth
```



Rays for demo6

OUTPUT CSHOT1—File *demo6listing*

```
                 CSHOT1 Listing File

Velocities:
layer  1   4000.0
layer  2   6000.0
layer  3   9000.0
layer  4  10000.0
layer  5  13000.0

Number of shots =    2
Number of events per shot =    2

x and z coordinates of shot   1
 4000.00    100.00

Number of receivers =    4
x and z coordinates of receivers :
 1000.00    200.00
 1300.00    200.00
 1600.00    200.00
 1900.00    200.00

Shot    1      event    1
This is a reflection event.

 4000.00    100.00
 2384.61    800.00
 1000.00    200.00
 t =    .817389

 4000.00    100.00
 2546.15    800.00
 1300.00    200.00
 t =    .749166

 4000.00    100.00
 2707.69    800.00
 1600.00    200.00
 t =    .682367

 4000.00    100.00
 2869.23    800.00
 1900.00    200.00
 t =    .617454

End of event

Shot    1      event    2
This is a reflection event.

 4000.00    100.00
 3912.44    800.00
 3625.23   2315.58
 3138.23   3835.74
 1966.74   2397.69
 1184.07    800.00
```

```
 1000.00    200.00
 t =   1.270327

 4000.00    100.00
 3927.37    800.00
 3690.39   2312.36
 3291.93   3806.07
 2213.28   2385.48
 1475.79    800.00
 1300.00    200.00
 t =   1.248776

 4000.00    100.00
 3942.44    800.00
 3755.52   2309.13
 3440.90   3776.26
 2456.14   2373.46
 1766.62    800.00
 1600.00    200.00
 t =   1.228188

 4000.00    100.00
 3957.71    800.00
 3820.93   2305.89
 3586.29   3746.36
 2695.56   2361.61
 2056.56    800.00
 1900.00    200.00
 t =   1.208677

End of event

End of Shot

x and z coordinates of shot   2
 7900.00    400.00

Number of receivers =    4
x and z coordinates of receivers :
 4900.00    200.00
 5200.00    200.00
 5500.00    200.00
 5800.00    200.00

Shot    2       event    1
This is a reflection event.

 7900.00    400.00
 6700.00    800.00
 4900.00    200.00
 t =    .790569

 7900.00    400.00
 6820.00    800.00
 5200.00    200.00
 t =    .719809
```

```
 7900.00    400.00
 6940.00    800.00
 5500.00    200.00
 t =    .650000

 7900.00    400.00
 7060.00    800.00
 5800.00    200.00
 t =    .581485

End of event

Shot    2      event    2
This is a reflection event.

 7900.00    400.00
 7804.95    800.00
 7312.05   2133.07
 6573.87   3258.52
 5751.66   2210.31
 5079.62    800.00
 4900.00    200.00
 t =   1.054187

 7900.00    400.00
 7811.80    800.00
 7357.62   2130.81
 6687.49   3254.34
 5965.39   2199.73
 5363.73    800.00
 5200.00    200.00
 t =   1.033548

 7900.00    400.00
 7819.22    800.00
 7406.16   2128.41
 6803.86   3251.33
 6177.16   2189.25
 5646.86    800.00
 5500.00    200.00
 t =   1.014747

 7900.00    400.00
 7827.19    800.00
 7457.47   2125.87
 6922.68   3249.55
 6387.53   2178.84
 5929.09    800.00
 5800.00    200.00
 t =    .997933

End of event

End of Shot

End of listing
```

OUTPUT CSHOT1—File *demo6data*

```
          3     8.173891E-01
4000.00     100.00
2384.61     800.00
1000.00     200.00
          3     7.491662E-01
4000.00     100.00
2546.15     800.00
1300.00     200.00
          3     6.823672E-01
4000.00     100.00
2707.69     800.00
1600.00     200.00
          3     6.174545E-01
4000.00     100.00
2869.23     800.00
1900.00     200.00
          7         1.270327
4000.00     100.00
3912.44     800.00
3625.23    2315.58
3138.23    3835.74
1966.74    2397.69
1184.07     800.00
1000.00     200.00
          7         1.248776
4000.00     100.00
3927.37     800.00
3690.39    2312.36
3291.93    3806.07
2213.28    2385.48
1475.79     800.00
1300.00     200.00
          7         1.228188
4000.00     100.00
3942.44     800.00
3755.52    2309.13
3440.90    3776.26
2456.14    2373.46
1766.62     800.00
1600.00     200.00
          7         1.208677
4000.00     100.00
3957.71     800.00
3820.93    2305.89
3586.29    3746.36
2695.56    2361.61
2056.56     800.00
1900.00     200.00
          3     7.905694E-01
7900.00     400.00
6700.00     800.00
4900.00     200.00
          3     7.198090E-01
7900.00     400.00
6820.00     800.00
5200.00     200.00
```

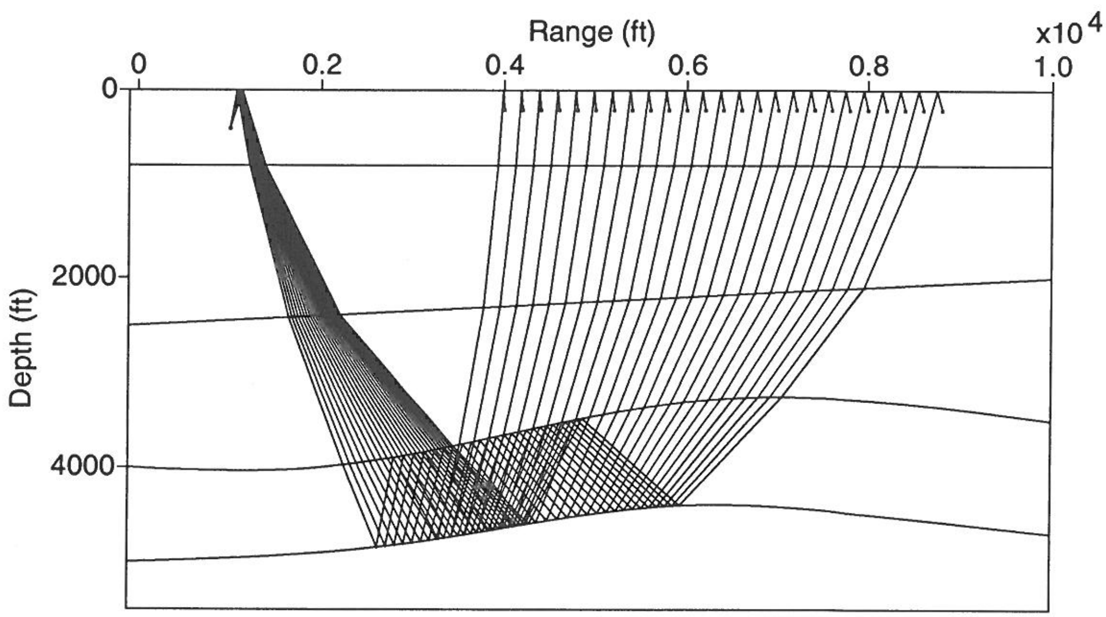
```
          3     6.500000E-01
 7900.00     400.00
 6940.00     800.00
 5500.00     200.00
          3     5.814852E-01
 7900.00     400.00
 7060.00     800.00
 5800.00     200.00
          7         1.054187
 7900.00     400.00
 7804.95     800.00
 7312.05    2133.07
 6573.87    3258.52
 5751.66    2210.31
 5079.62     800.00
 4900.00     200.00
          7         1.033548
 7900.00     400.00
 7811.80     800.00
 7357.62    2130.81
 6687.49    3254.34
 5965.39    2199.73
 5363.73     800.00
 5200.00     200.00
          7         1.014747
 7900.00     400.00
 7819.22     800.00
 7406.16    2128.41
 6803.86    3251.33
 6177.16    2189.25
 5646.86     800.00
 5500.00     200.00
          7     9.979328E-01
 7900.00     400.00
 7827.19     800.00
 7457.47    2125.87
 6922.68    3249.55
 6387.53    2178.84
 5929.09     800.00
 5800.00     200.00
```

File PARAM1

```
simplemodel                    :model file
4                              :#interfaces in model
plotcolors                     :model colors file
m                              :first plot descriptor (mwq)
don't care                     :well coordinates
s                              :shooting mode (sd)
geometry3                      :receiver geometry
sg                             :second plot descriptor (sgq)
r                              :job descriptor (rlt)
don't care                     :output filename(s)
-80.   80.                     :range of takeoff angles
1.                             :increment in takeoff angle
4000.0  6000.0  9000.0
10000.0 13000.0                :velocities
n                              :direct wave? (y or n)
                               :headwave interface numbers (1, 2, ...)
n                              :all primaries? (y or n)
0 4 3 4 0                      :source ghost, multiple, receiver ghost
```

File *geometry3*

```
1          1000.                     :reference station number and x-coord.
200.       200.                      :station spacing and receiver depth
16  25  26  40        1.  400.       :shot 1 - r1 r2 r3 r4 s sdepth
```



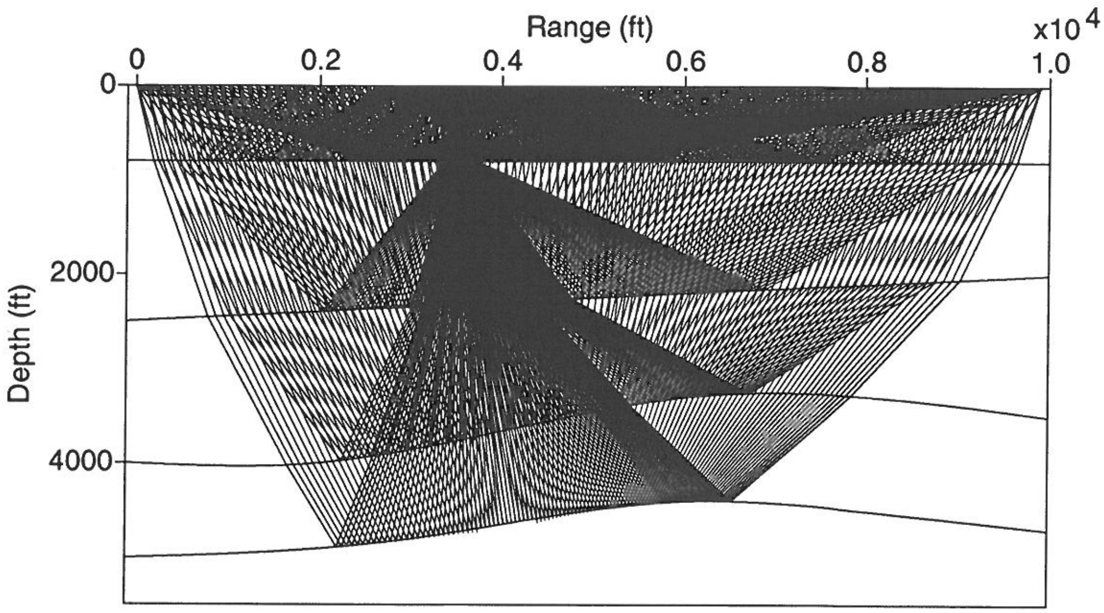
Rays for demo7

File PARAM1

```
simplemodel                       :model file
4                                 :#interfaces in model
plotcolors                        :model colors file
m                                 :first plot descriptor (mwq)
don't care                        :well coordinates
s                                 :shooting mode (sd)
geometry4                         :receiver geometry
sg                                :second plot descriptor (sgq)
rt                                :job descriptor (rlt)
demo8                             :output filename(s)
-90.   90.                        :range of takeoff angles
1.                                :increment in takeoff angle
4000.0  6000.0  9000.0
10000.0 13000.0                   :velocities
n                                 :direct wave? (y or n)
                                  :headwave interface numbers (1, 2, ...)
y                                 :all primaries? (y or n)
0 1                               :reverberation 1 (ghost+reflection)
0 1 0 1                           :reverberation 2
```

File *geometry4*

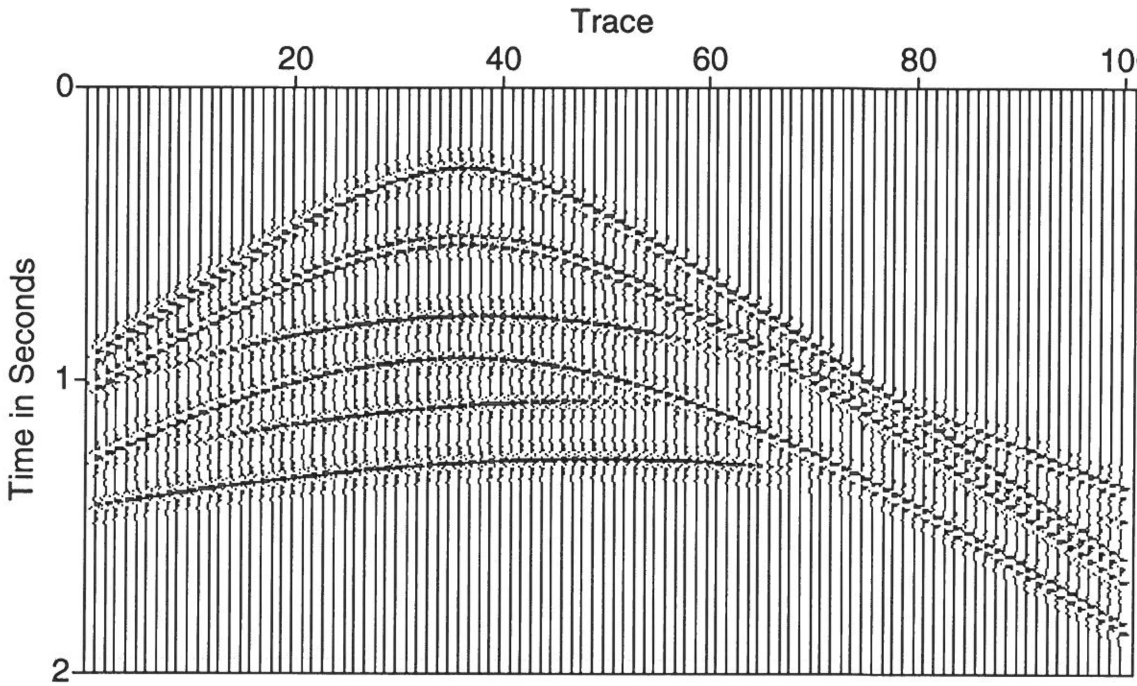
```
1          0.                     :reference station number and x-coord.
100.       0.                     :station spacing and receiver depth
1  10  11  100     36. 500.       :shot 1 - r1 r2 r3 r4 s sdepth
```



Rays for demo8

File PARAM2

```
s                                :sort option (s,r)
1  1                             :first, last shot for sort
1  100                           :first, last trace; OR first, last receiver
10.  25.   35.  50.              :frequency spectrum of wavelet
.150                             :wavelet length (secs)
.004                             :sample rate (secs)
2.                               :trace length (secs)
demo8shot                        :input filename
demo8traces                      :output filename
```



Primaries and Reverberations (agc)

File PARAM1

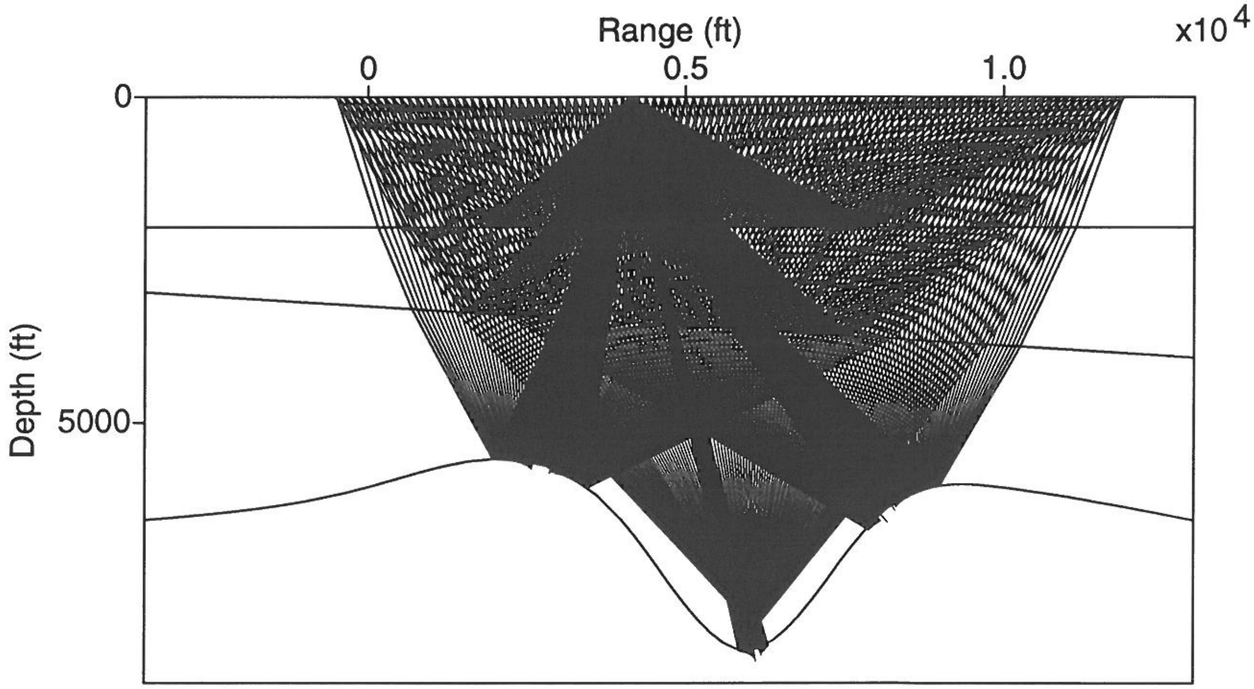
```
syncline                         :model file
3                                :#interfaces in model
plotcolors                       :model colors file
m                                :first plot descriptor (mwq)
don't care                       :well coordinates
s                                :shooting mode (sd)
geometry5                        :receiver geometry
sg                               :second plot descriptor (sgq)
rt                               :job descriptor (rlt)
demo9                            :output filename(s)
-90.   90.                       :range of takeoff angles
1.                               :increment in takeoff angle
8000.0  10000.0  12000.0
13000.0                          :velocities
n                                :direct wave? (y or n)
                                 :headwave interface numbers (1, 2, ...)
y                                :all primaries? (y or n)
```

File *syncline*

```
-3500.        0.                 :upper surface
13000.        0.                 :
1.       -99999.                 :end of upper surface
-3500.     2000.                 :interface 1
13000.     2000.                 :
1.       -99999.                 :end of interface 1
-3500.     3000.                 :interface 2
13000.     4000.                 :
1.       -99999.                 :end of interface 2
-3500.     6500.                 :interface 3
0.         6000.                 :
4000.      6500.                 :
6000.      8500.                 :
8000.      6500.                 :
10000.     6000.                 :
13000.     6500.                 :
1.       -99999.                 :end of interface 3
```

File *geometry5*

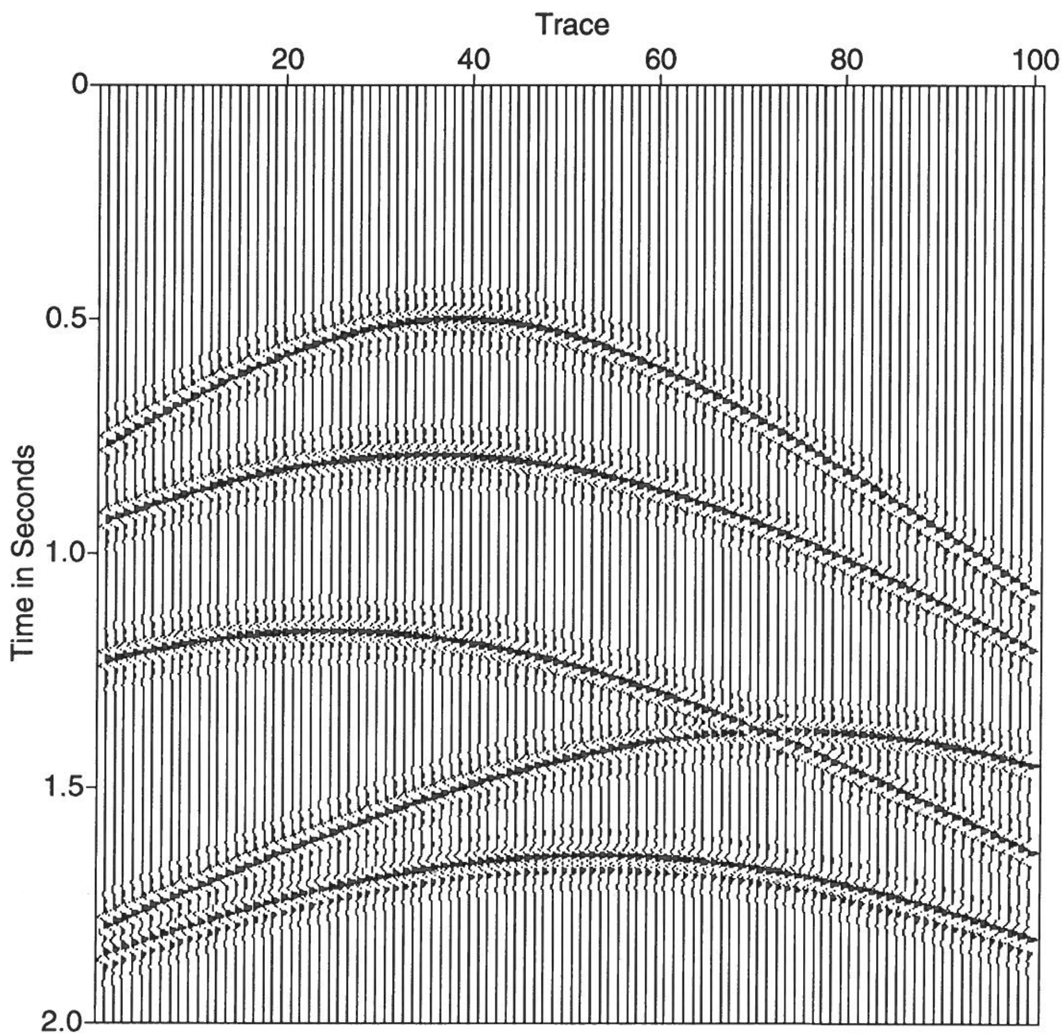
```
1          -500.                 :reference station number and x-coord.
125.          0.                 :station spacing and receiver depth
1   10   11   100      38.   0.  :shot 1 - r1 r2 r3 r4 s sdepth
```



Rays for demo9

File PARAM2

```
s                              :sort option (s,r)
1  1                           :first, last shot for sort
1  100                         :first, last trace; OR first, last receiver
10.  25.   35.  50.            :frequency spectrum of wavelet
.150                           :wavelet length (secs)
.004                           :sample rate (secs)
2.                             :trace length (secs)
demo9shot                      :input filename
demo9traces                    :output filename
```



Caustic (agc)

File PARAM1

```
dome                                 :model file
6                                    :#interfaces in model
plotcolors                           :model colors file
m                                    :first plot descriptor (mwq)
don't care                           :well coordinates
s                                    :shooting mode (sd)
geometry6                            :receiver geometry
sg                                   :second plot descriptor (sgq)
r                                    :job descriptor (rlt)
demo10                               :output filename(s)
-90.   90.                           :range of takeoff angles
1.                                   :increment in takeoff angle
4000.0  5000.0  4000.0
6000.0  8000.0 11000.0
16000.0                              :velocities
n                                    :direct wave? (y or n)
                                     :headwave interface numbers (1, 2, ...)
n                                    :all primaries? (y or n)
2                                    :reflection from interface 2
4                                    :reflection from interface 4
6                                    :reflection from interface 6
```

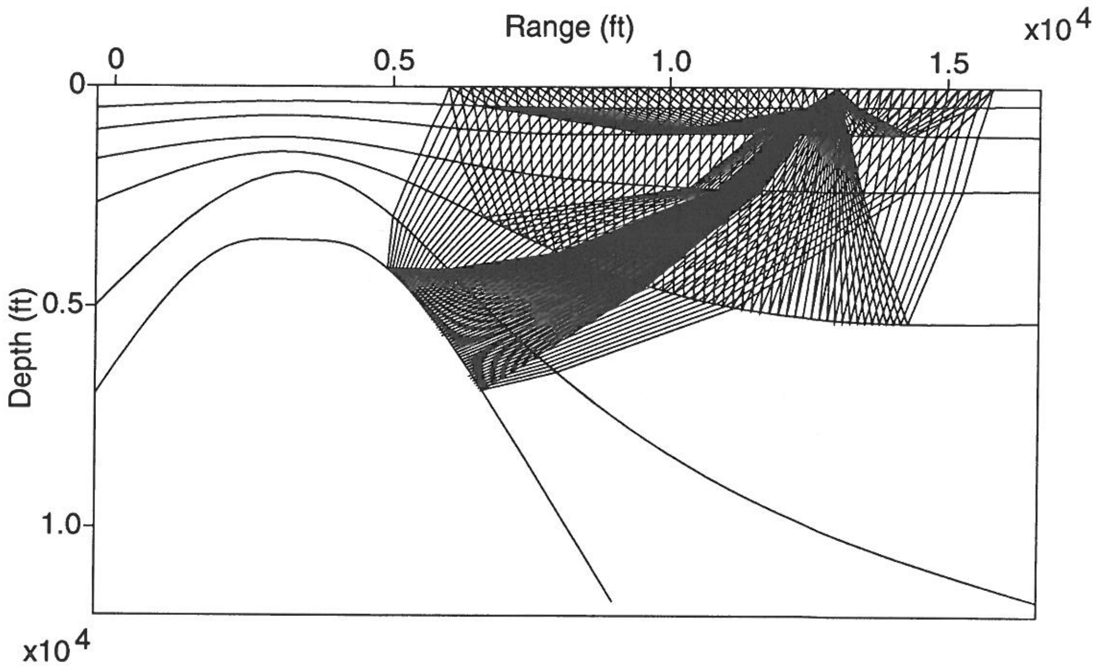
File *dome*

```
 -333.        0.                     :upper surface
16666.        0.
    1.   -99999.                     :end of upper surface
 -333.      500.                     :interface 1
 3333.      333.
 6666.      433.
10000.      466.
16666.      400.
    1.   -99999.                     :end of interface 1
 -333.     1000.                     :interface 2
 3333.      666.
 6666.     1000.
10000.     1066.
16666.     1100.
    1.   -99999.                     :end of interface 2
 -333.     1666.                     :interface 3
 3333.     1166.
 6666.     1833.
10000.     2266.
16666.     2333.
    1.   -99999.                     :end of interface 3
 -333.     2666.                     :interface 4
 3333.     1500.
 6666.     3000.
10000.     4666.
16666.     5333.
    1.   -99999.                     :end of interface 4
 -333.     5000.                     :interface 5
 3666.     2000.
 6666.     5000.
10000.     8333.
```

```
16666.      11666.
1.          -99999.                 :end of interface 5
 -333.       7000.                  :interface 6
 2000.       3666.
 2500.       3500.
 3333.       3500.
 4333.       3666.
 6666.       7000.
 9000.      11666.
    1.      -99999.                 :end of interface 6
```

File *geometry6*

```
1            0.                     :reference station number and x-coord.
200.         0.                     :station spacing and receiver depth
31  33  34  80      66.   0.        :shot 1 - r1 r2 r3 r4 s sdepth
```



Rays for demo10

File PARAM1

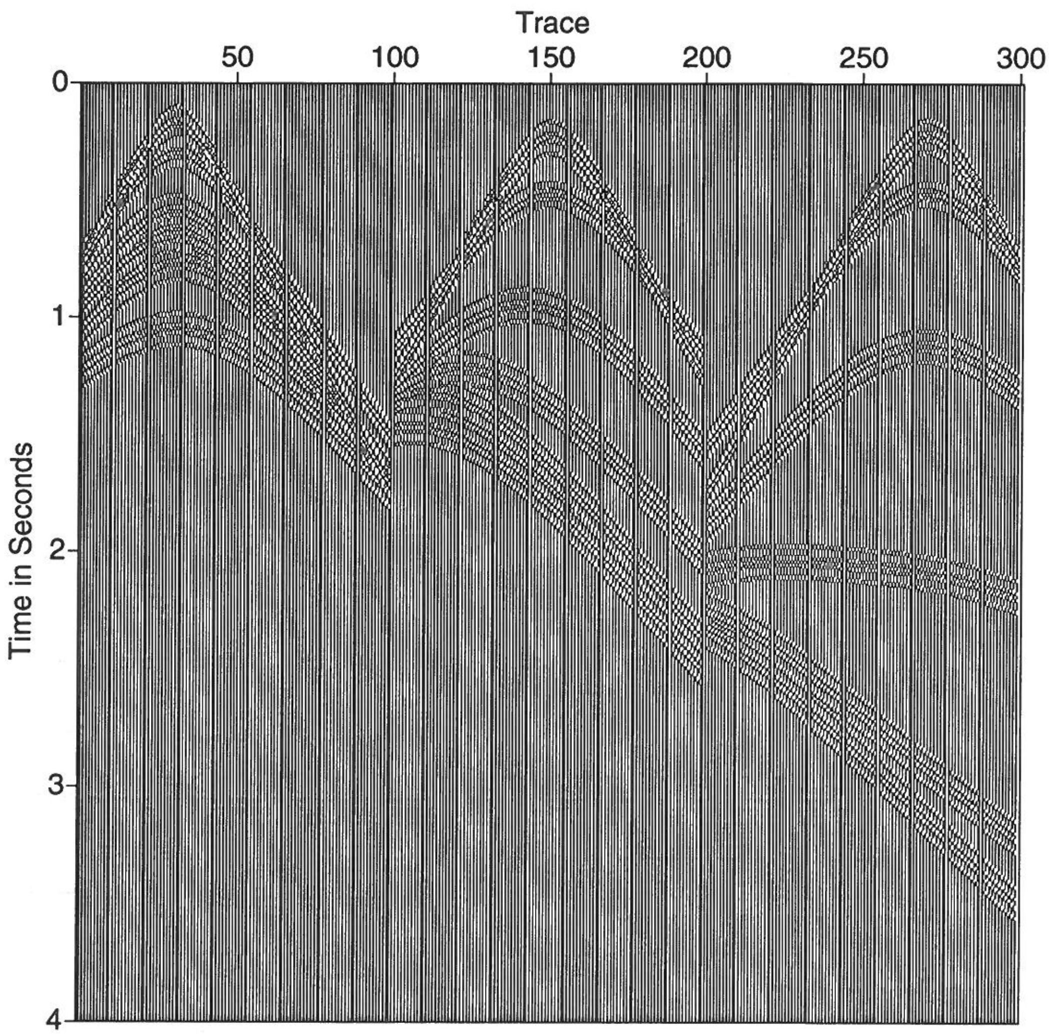
```
dome                               :model file
6                                  :#interfaces in model
plotcolors                         :model colors file
                                   :first plot descriptor (mwq)
don't care                         :well coordinates
s                                  :shooting mode (sd)
geometry7                          :receiver geometry
                                   :second plot descriptor (sgq)
t                                  :job descriptor (rlt)
demo10                             :output filename(s)
-90.   90.                         :range of takeoff angles
1.                                 :increment in takeoff angle
4000.0  5000.0  4000.0
6000.0  8000.0 11000.0
16000.0                            :velocities
n                                  :direct wave? (y or n)
                                   :headwave interface numbers (1, 2, ...)
y                                  :all primaries? (y or n)
```

File *geometry7*

```
1            0.                        :reference station number and x-coord.
100.         0.                        :station spacing and receiver depth
1   10  11  100      31.    0.         :shot 1 - r1 r2 r3 r4 s sdepth
31  40  41  130      81.    0.         :shot 2 - r1 r2 r3 r4 s sdepth
61  70  71  160     131.    0.         :shot 3 - r1 r2 r3 r4 s sdepth
```

File PARAM2

```
s                                  :sort option (s,r)
1  3                               :first, last shot for sort
1  100                             :first, last trace; OR first, last receiver
10.  25.   35.  50.                :frequency spectrum of wavelet
.150                               :wavelet length (secs)
.004                               :sample rate (secs)
4.                                 :trace length (secs)
demo10shot                         :input filename
demo10traces                       :output filename
```



Dome Data (agc)

File PARAM1

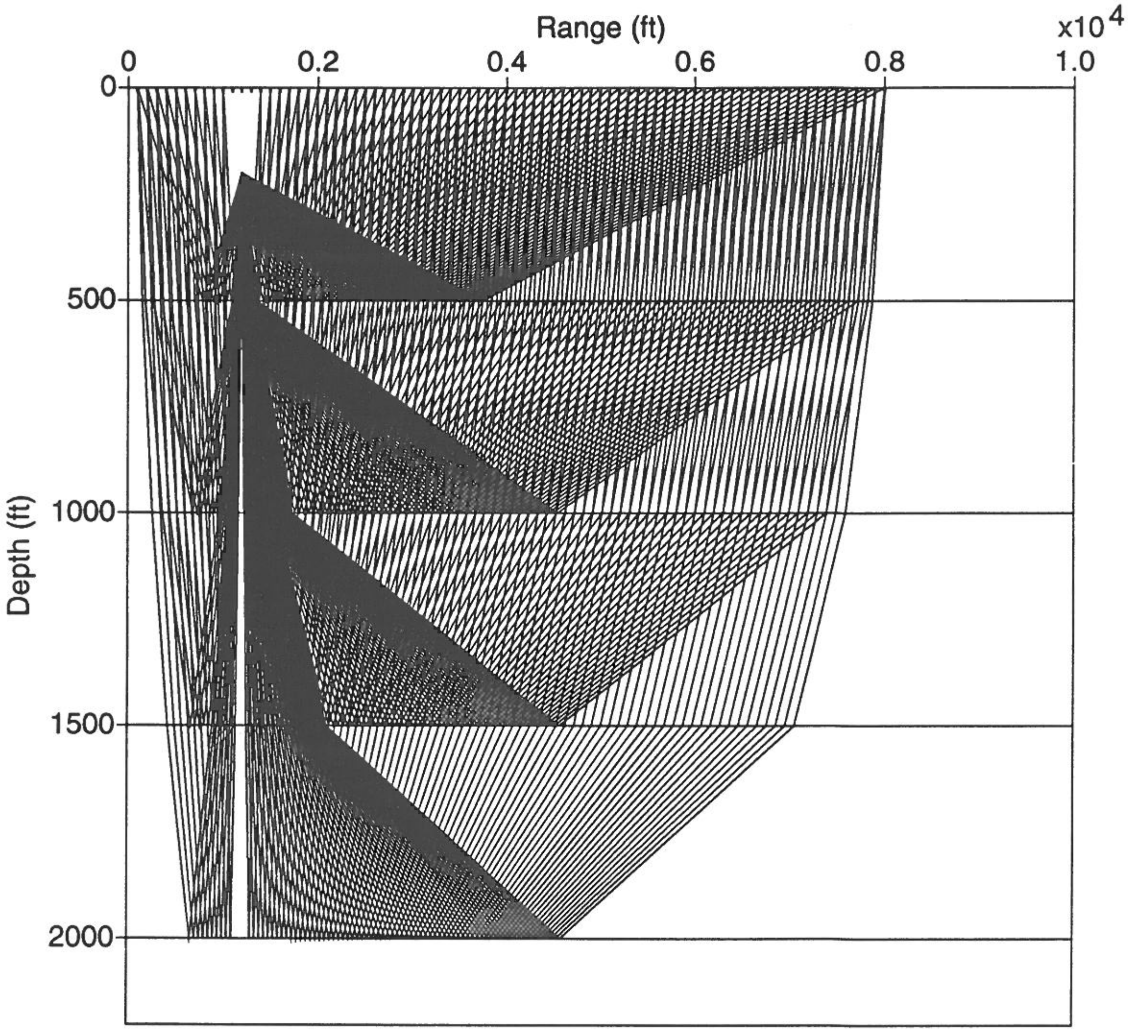
```
flatmodel                              :model file
4                                      :#interfaces in model
plotcolors                             :model colors file
m                                      :first plot descriptor (mwq)
don't care                             :well coordinates
s                                      :shooting mode (sd)
geometry8                              :receiver geometry
sg                                     :second plot descriptor (sgq)
rt                                     :job descriptor (rlt)
demo11                                 :output filename(s)
-40.   90.                             :range of takeoff angles
1.                                     :increment in takeoff angle
2000.0  4000.0  6000.0
8000.   10000.0                        :velocities
n                                      :direct wave? (y or n)
                                       :headwave interface numbers (1, 2, ...)
y                                      :all primaries? (y or n)
```

File *flatmodel*

```
    0.          0.                     :upper surface
10000.          0.                     :
    1.     -99999.                     :end of upper surface
    0.        500.                     :interface 1
10000.        500.                     :
    1.     -99999.                     :end of interface 1
    0.       1000.                     :interface 2
10000.       1000.                     :
    1.     -99999.                     :end of interface 2
    0.       1500.                     :interface 3
10000.       1500.                     :
    1.     -99999.                     :end of interface 3
    0.       2000.                     :interface 4
10000.       2000.                     :
    1.     -99999.                     :end of interface 4
```

File *geometry8*

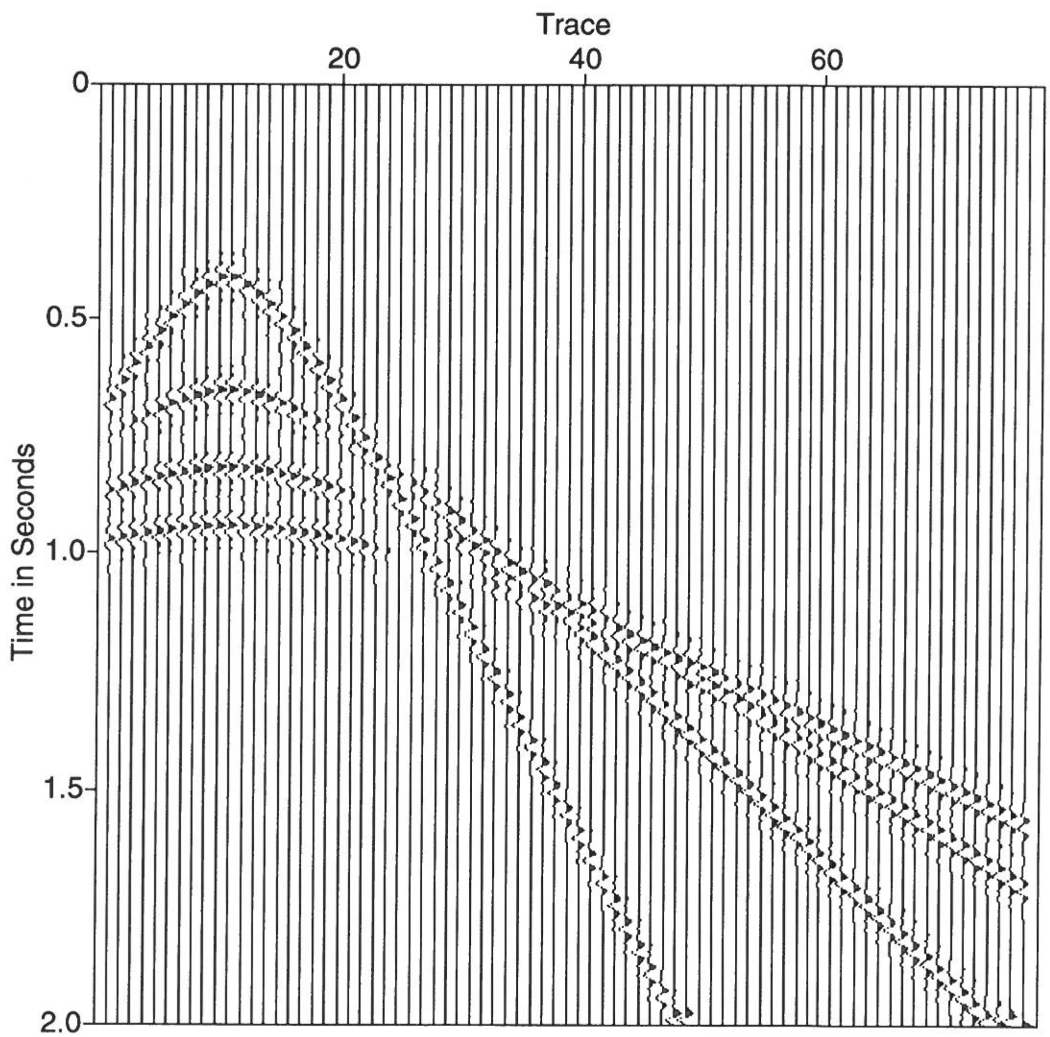
```
1          100.                        :reference station number and x-coord.
100.         0.                        :station spacing and receiver depth
1   10  14  80      12.  200.          :shot 1 - r1 r2 r3 r4 s sdepth
```



Primary Rays

File PARAM2

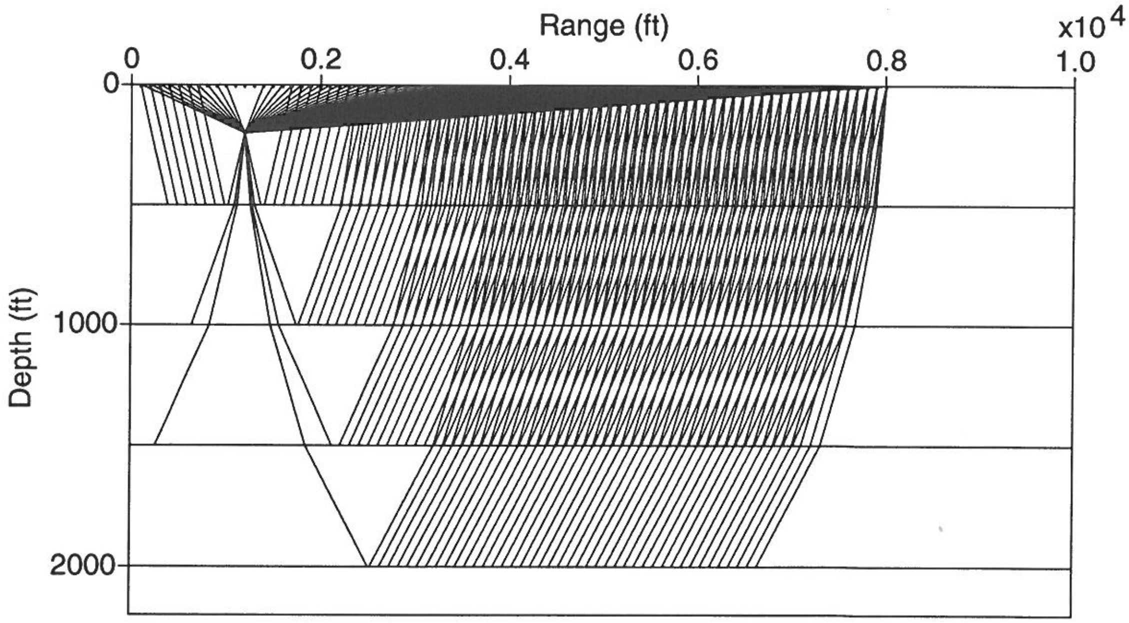
```
s                                 :sort option (s,r)
1  1                              :first, last shot for sort
1  77                             :first, last trace; OR first, last receiver
10.  25.   35.  50.               :frequency spectrum of wavelet
.150                              :wavelet length (secs)
.004                              :sample rate (secs)
2.                                :trace length (secs)
demo11shot                        :input filename
demo11traces                      :output filename
```



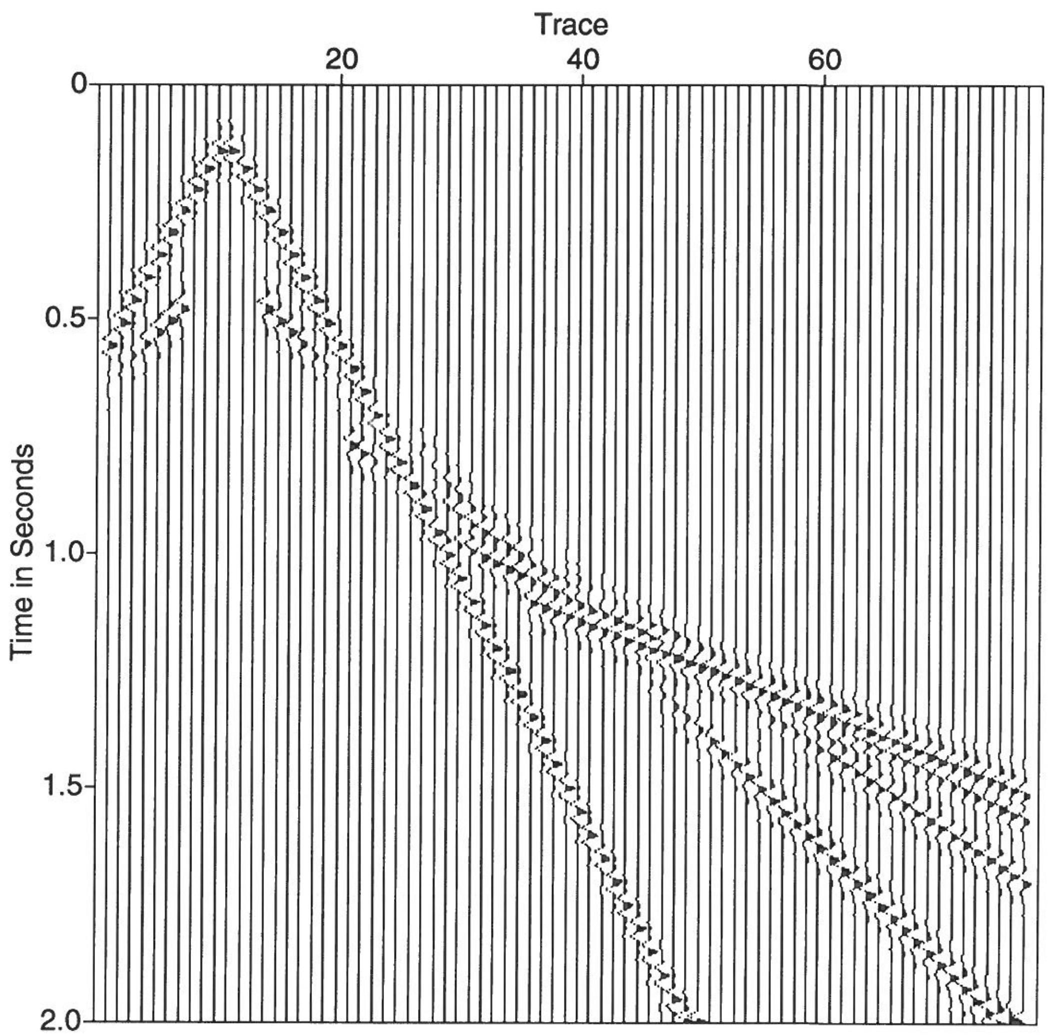
Primaries (agc)

File PARAM1

```
flatmodel                             :model file
4                                     :#interfaces in model
plotcolors                            :model colors file
m                                     :first plot descriptor (mwq)
don't care                            :well coordinates
s                                     :shooting mode (sd)
geometry8                             :receiver geometry
sg                                    :second plot descriptor (sgq)
rt                                    :job descriptor (rlt)
demo11                                :output filename(s)
-40.   90.                            :range of takeoff angles
1.                                    :increment in takeoff angle
2000.0  4000.0  6000.0
8000.   10000.0                       :velocities
y                                     :direct wave? (y or n)
1 2 3 4                               :headwave interface numbers (1, 2, ...)
n                                     :all primaries? (y or n)
```



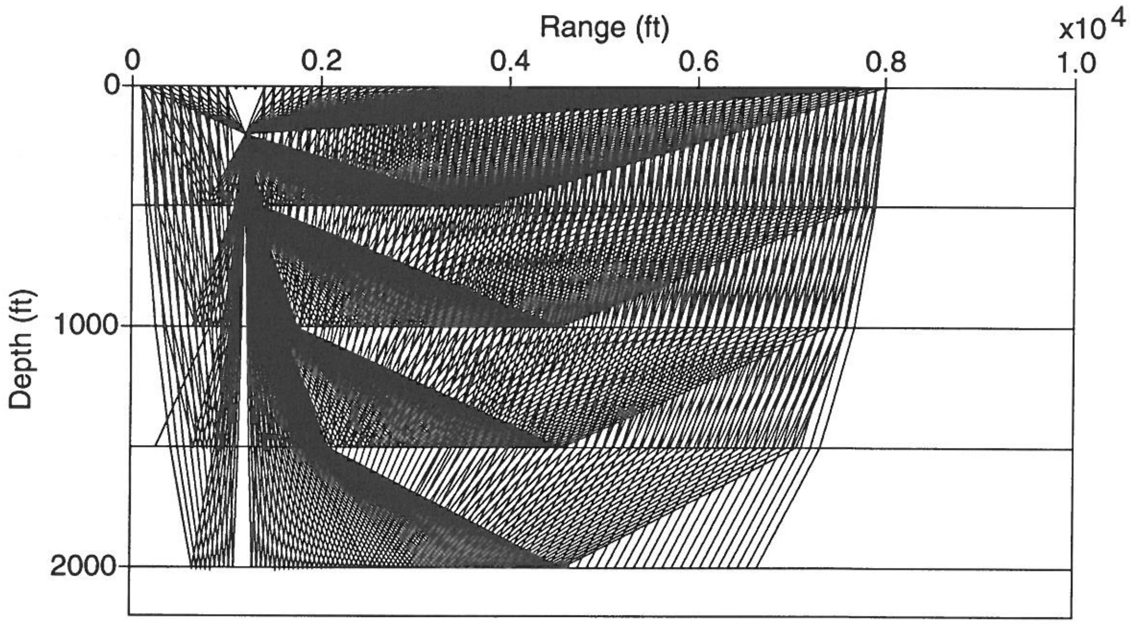
Direct+Head



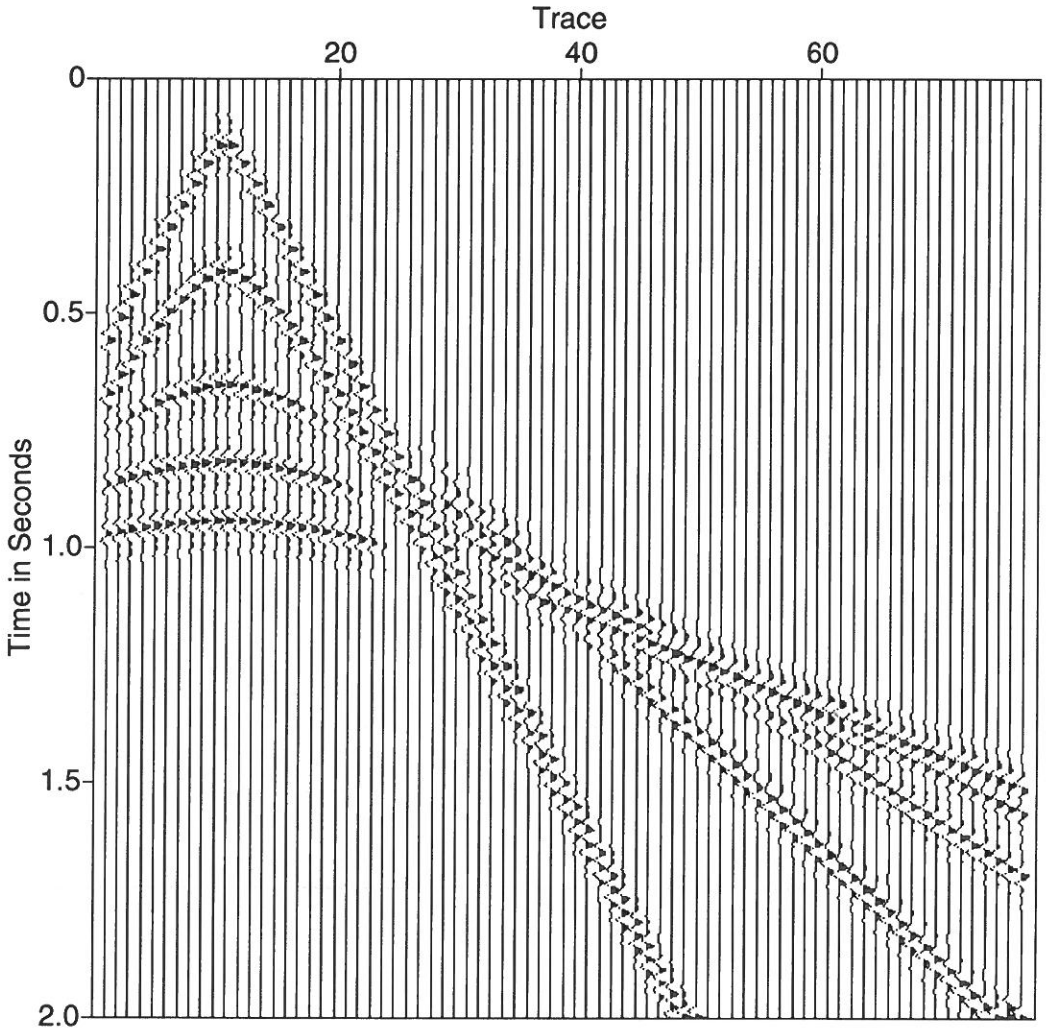
Direct+Head (agc)

File PARAM1

```
flatmodel                         :model file
4                                 :#interfaces in model
plotcolors                        :model colors file
m                                 :first plot descriptor (mwq)
don't care                        :well coordinates
s                                 :shooting mode (sd)
geometry8                         :receiver geometry
sg                                :second plot descriptor (sgq)
rt                                :job descriptor (rlt)
demo11                            :output filename(s)
-40.   90.                        :range of takeoff angles
1.                                :increment in takeoff angle
2000.0  4000.0  6000.0
8000.   10000.0                   :velocities
y                                 :direct wave? (y or n)
1 2 3 4                           :headwave interface numbers (1, 2, ...)
y                                 :all primaries? (y or n)
```



All the Rays



All (agc)

File PARAM1

```
vspmodel                      :model file
4                             :#interfaces in model
plotcolors                    :model colors file
mw                            :first plot descriptor (mwq)
curvedwell2                   :well coordinates
d                             :shooting mode (sd)
geometry9                     :receiver geometry
sg                            :second plot descriptor (sgq)
rt                            :job descriptor (rlt)
demo12                        :output filename(s)
-80.   20.                    :range of takeoff angles
1.                            :increment in takeoff angle
2000.0  4000.0  6000.0
8000.   10000.0               :velocities
y                             :direct wave? (y or n)
                              :headwave interface numbers (1, 2, ...)
y                             :all primaries? (y or n)
```

File *vspmodel*

```
    0.        200.            :upper surface
 2000.          0.            :
 3500.        100.            :
 4000.        200.            :
 5000.        150.            :
 8000.        150.            :
 9000.        450.            :
12000.       1100.            :
    1.     -99999.            :end of upper surface
    0.       1100.            :interface 1
 2000.        900.            :
 4000.        800.            :
 7000.       1200.            :
12000.       2300.            :
    1.     -99999.            :end of interface 1
    0.       1900.            :interface 2
 2000.       1700.            :
 4000.       1600.            :
 7000.       2000.            :
12000.       3400.            :
    1.     -99999.            :end of interface 2
    0.       2900.            :interface 3
 2000.       2700.            :
 4000.       2600.            :
 7000.       3200.            :
10000.       4200.            :
12000.       4800.            :
    1.     -99999.            :interface 4
    0.       4000.            :
 2000.       3500.            :
 4000.       3900.            :
 7000.       6400.            :
 8000.       6600.            :
 9000.       6700.            :
12000.       7400.            :
```

```
1.      -99999.                 :end of interface 4
```

File *curvedwell2*

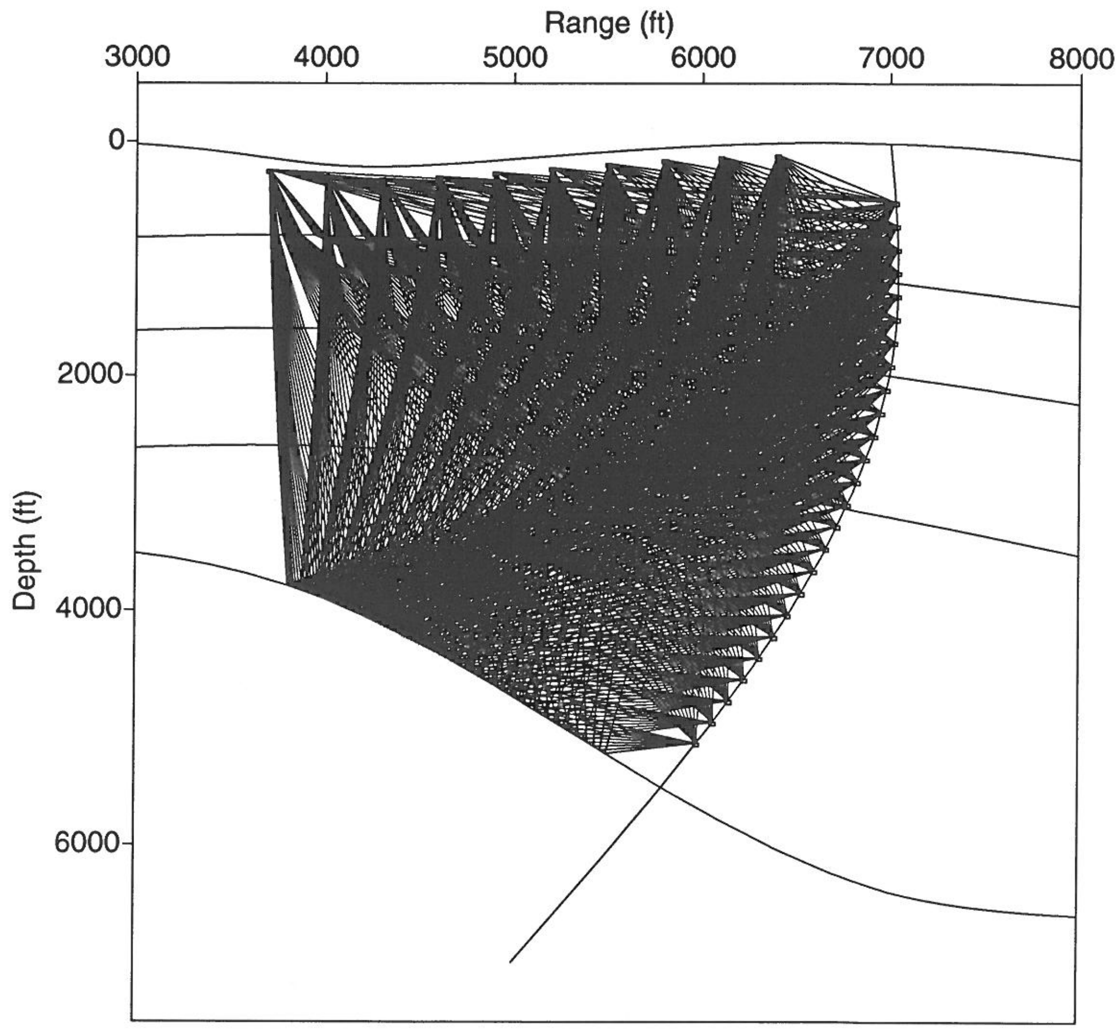
```
7000.                           :x-coord. of top of well
7000.  2000.                    :x,z coord. pair down the well
5000.  7000.                    :x,z coord. pair at bottom of well
1.   -999999.                   :end of well definition
500.                            :depth to first source
25   500.                       :#sources, source spacing
```

File *geometry9*

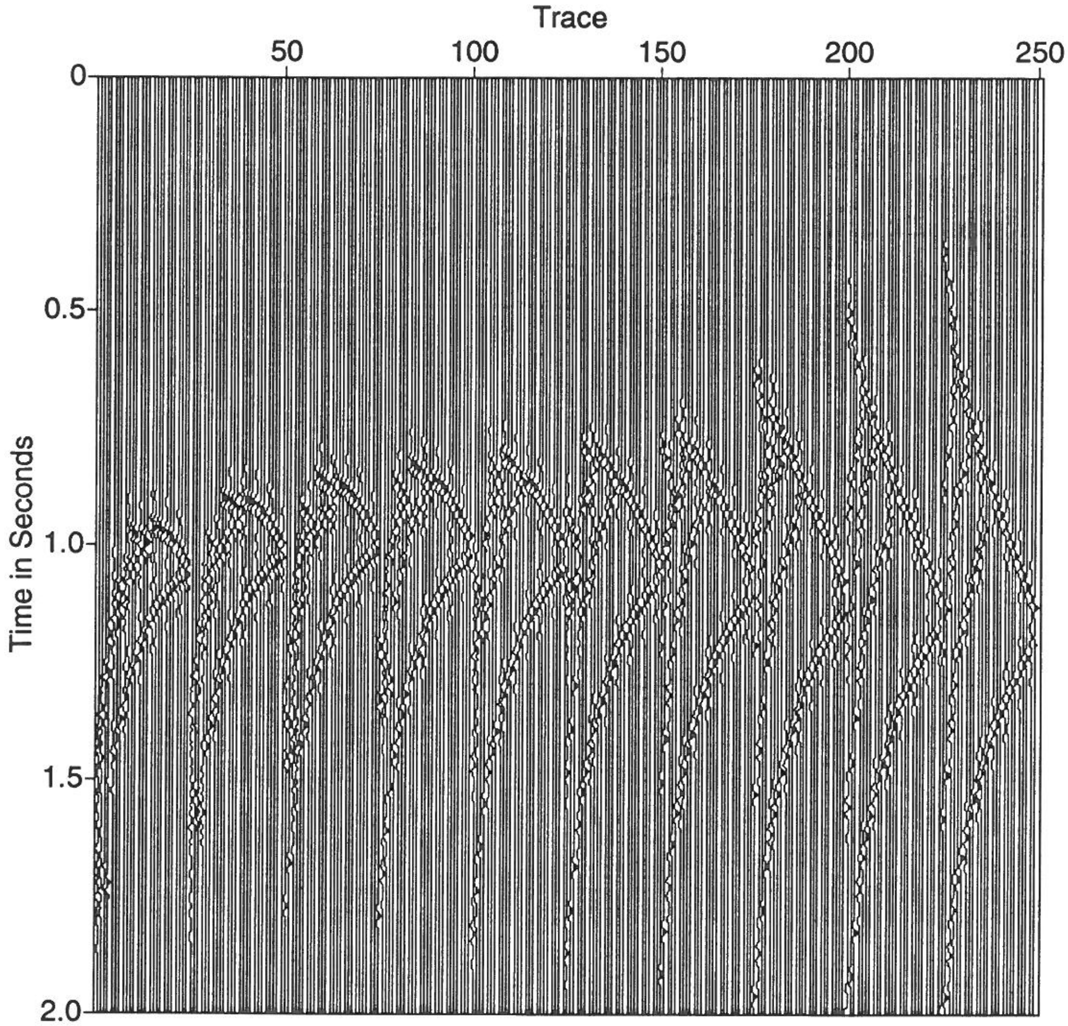
```
1         3700.                 :reference station number and x-coord.
300.       100.                 :station spacing and receiver depth
1   2  3   10       * * * * *   :shot 1 - r1 r2 r3 r4 s sdepth
```

File PARAM2

```
r                               :sort option (s,r)
1  25                           :first, last shot for sort
1  10                           :first, last trace; OR first, last receiver
10.  25.   35.  50.             :frequency spectrum of wavelet
.150                            :wavelet length (secs)
.004                            :sample rate (secs)
2.                              :trace length (secs)
demo12shot                      :input filename
demo12traces                    :output filename
```



Rays for demo12



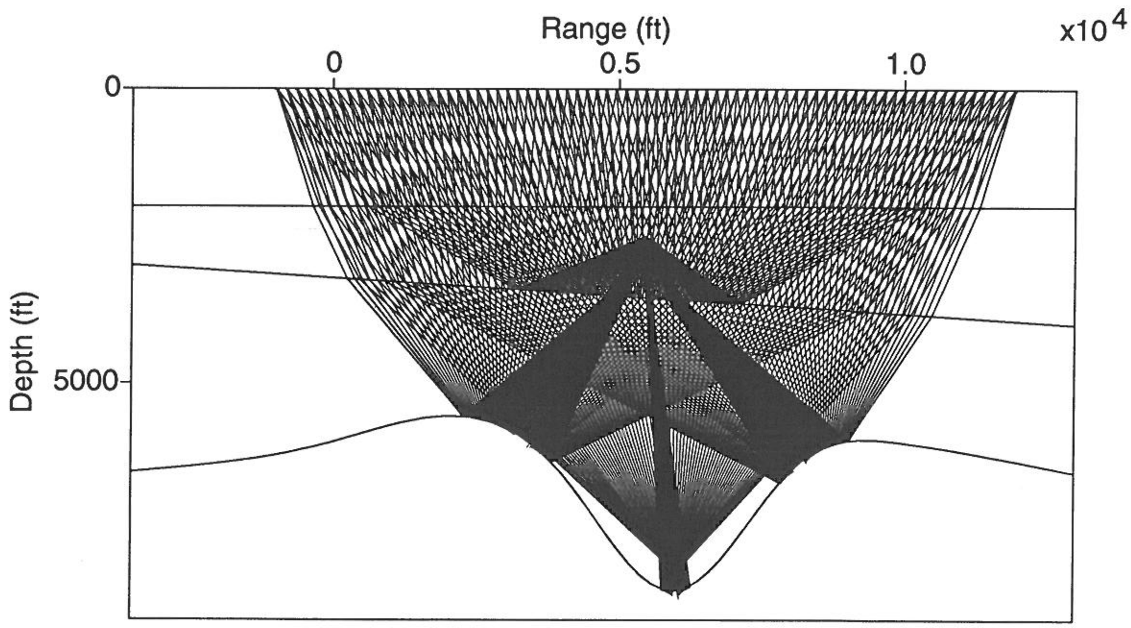
Offset VSP (agc)

File PARAM1

```
syncline                               :model file
3                                      :#interfaces in model
plotcolors                             :model colors file
m                                      :first plot descriptor (mwq)
don't care                             :well coordinates
s                                      :shooting mode (sd)
geometry10                             :receiver geometry
sg                                     :second plot descriptor (sgq)
rt                                     :job descriptor (rlt)
demo13                                 :output filename(s)
-180.  180.                            :range of takeoff angles
.5                                     :increment in takeoff angle
5000.0   7000.0  10000.0
13000.0                                :velocities
n                                      :direct wave? (y or n)
                                       :headwave interface numbers (1, 2, ...)
y                                      :all primaries? (y or n)
```

File *geometry10*

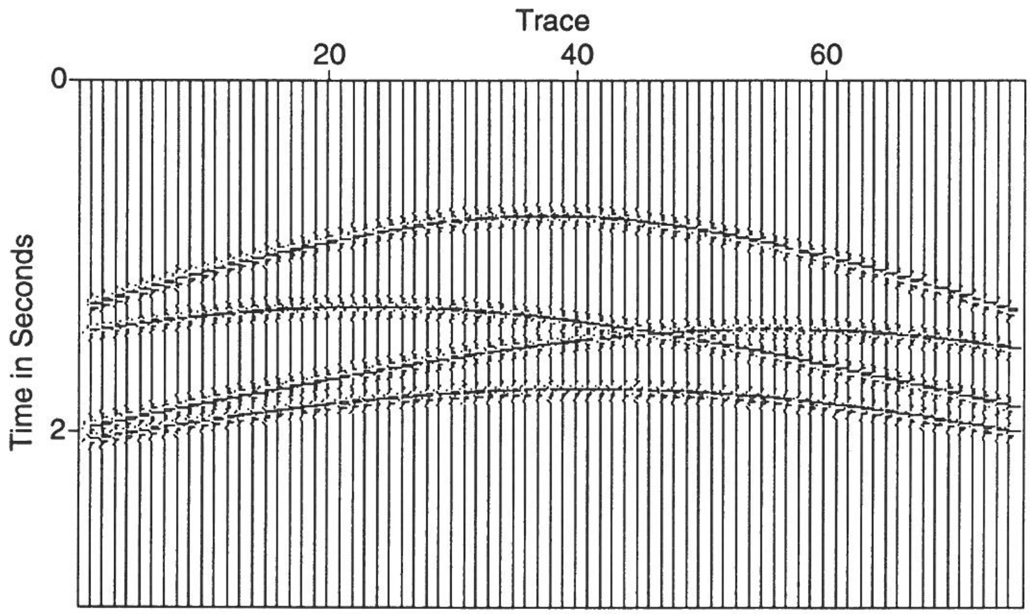
```
1          -1000.                      :reference station number and x-coord.
175.           0.                      :station spacing and receiver depth
1   10  11   75       38.    2500.     :shot 1 - r1 r2 r3 r4 s sdepth
```



Primary Rays

File PARAM2

```
s                              :sort option (s,r)
1  1                           :first, last shot for sort
1  75                          :first, last trace; or first, last receiver
10.  25.   35.  50.            :frequency spectrum of wavelet
.150                           :wavelet length (secs)
.004                           :sample rate (secs)
3.                             :trace length (secs)
demo13shot                     :input filename
demo13traces                   :output filename
```



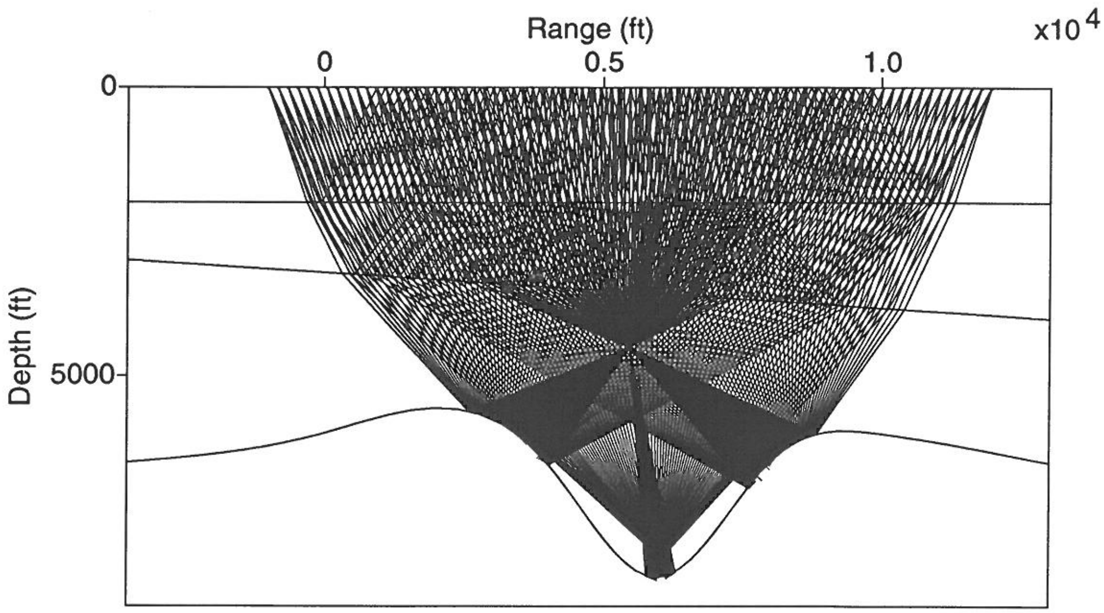
Primaries (agc)

File PARAM1

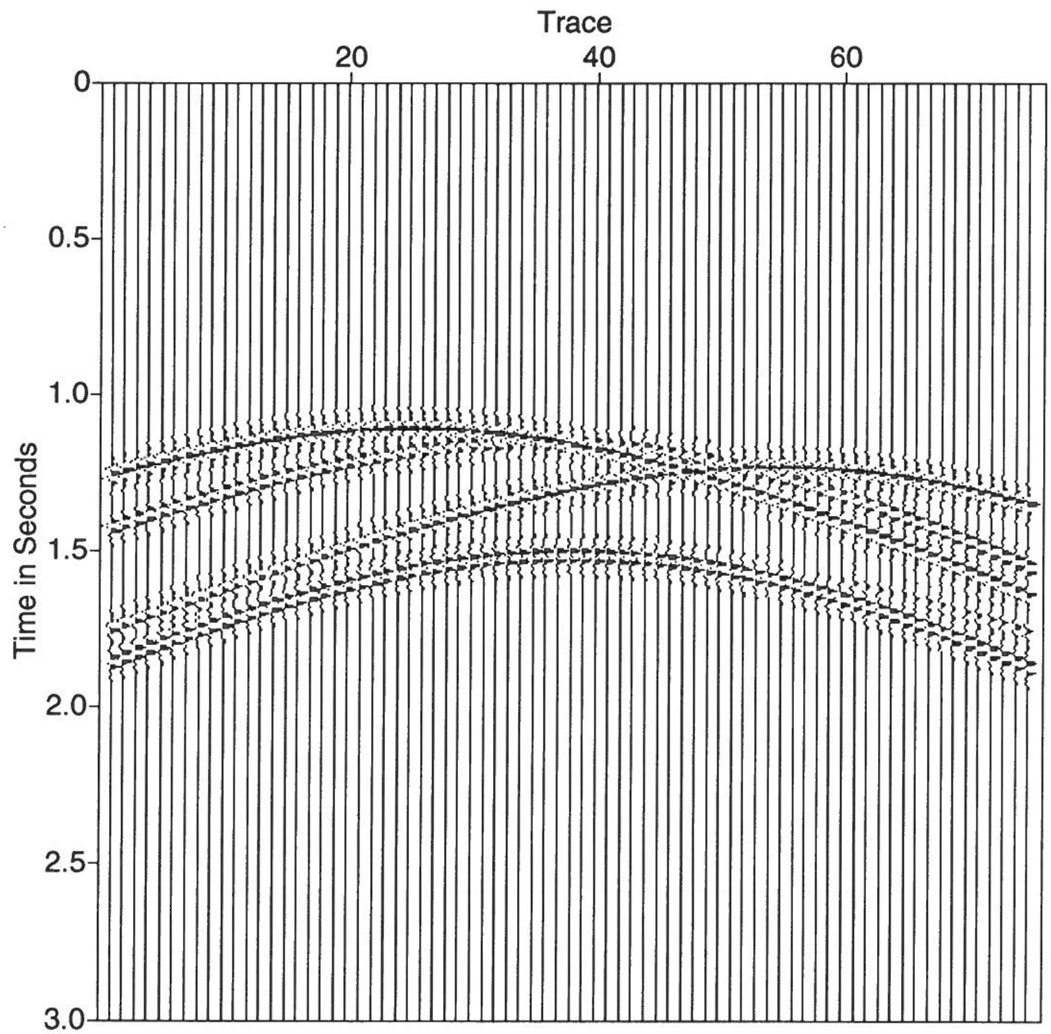
```
syncline                                 :model file
3                                        :#interfaces in model
plotcolors                               :model colors file
m                                        :first plot descriptor (mwq)
don't care                               :well coordinates
s                                        :shooting mode (sd)
geometry11                               :receiver geometry
sg                                       :second plot descriptor (sgq)
rt                                       :job descriptor (rlt)
demo13                                   :output filename(s)
-180.  180.                              :range of takeoff angles
.5                                       :increment in takeoff angle
5000.0   7000.0  10000.0
13000.0                                  :velocities
n                                        :direct wave? (y or n)
                                         :headwave interface numbers (1, 2, ...)
y                                        :all primaries? (y or n)
0 1                                      :extra event
1 2                                      :extra event
```

File *geometry11*

```
1          -1000.                        :reference station number and x-coord.
175.           0.                        :station spacing and receiver depth
1   10  11   75      38.    4500.        :shot 1 - r1 r2 r3 r4 s sdepth
```



Primaries+01+12



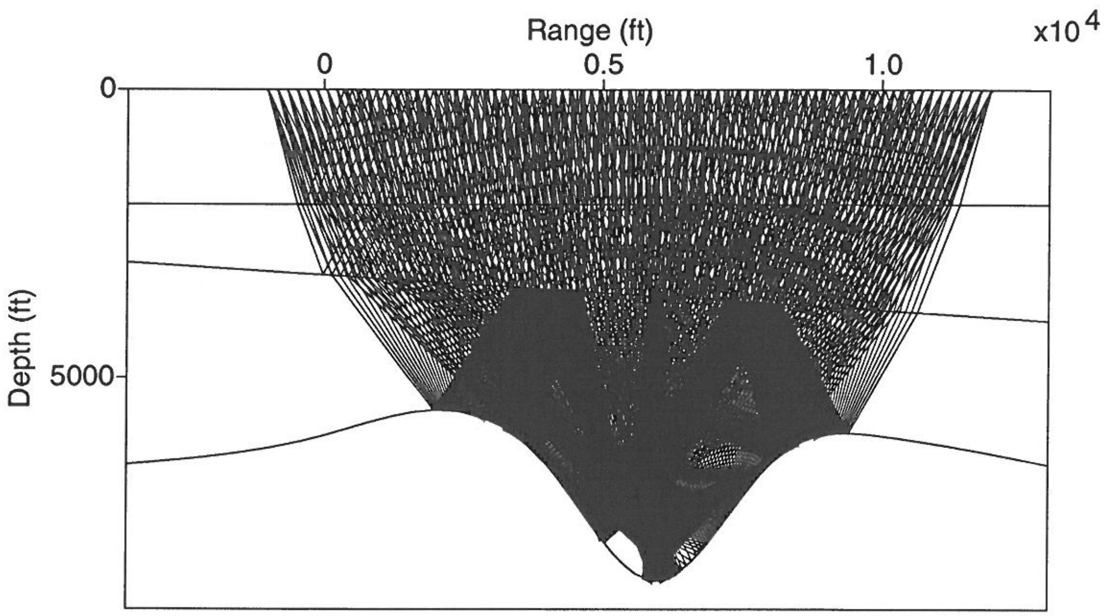
Primaries+01+12 (agc)

File PARAM1

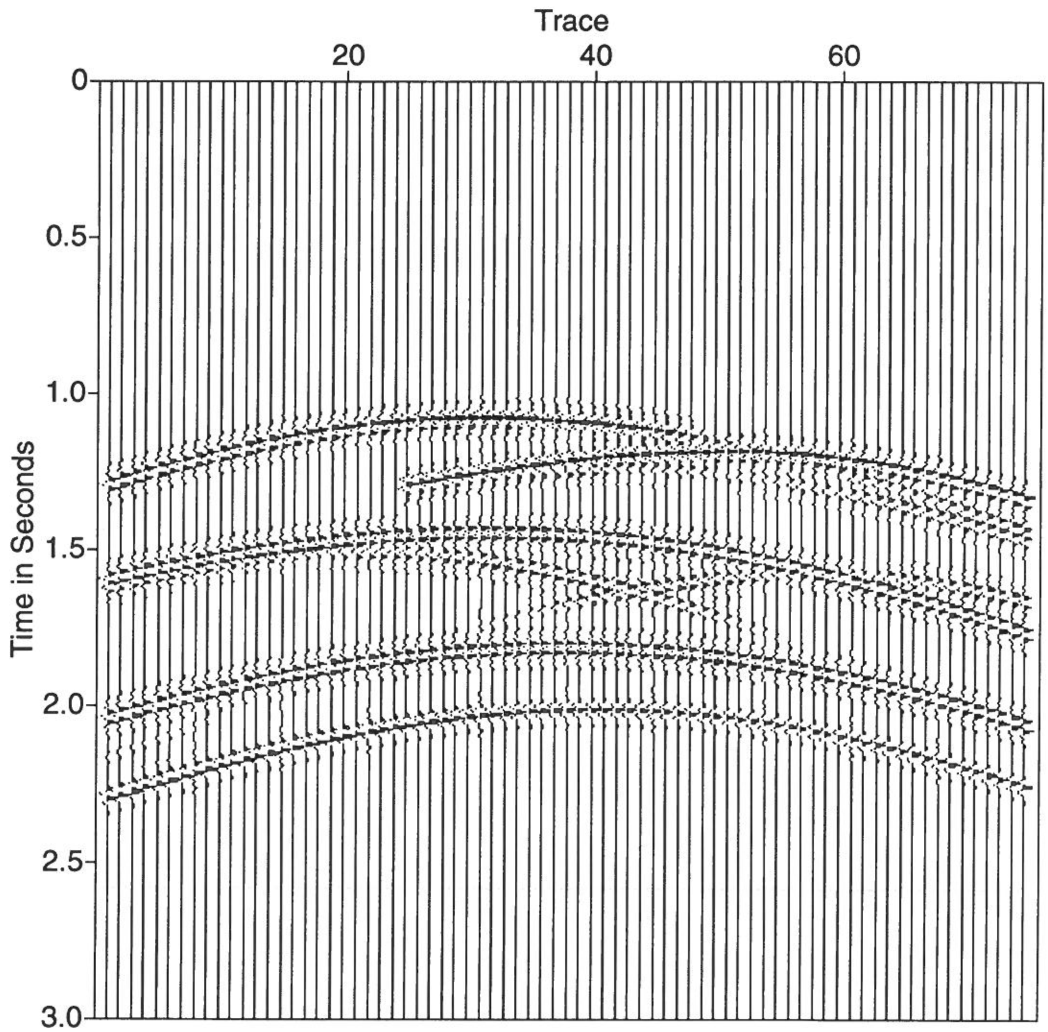
```
syncline                            :model file
3                                   :#interfaces in model
plotcolors                          :model colors file
m                                   :first plot descriptor (mwq)
don't care                          :well coordinates
s                                   :shooting mode (sd)
geometry12                          :receiver geometry
sg                                  :second plot descriptor (sgq)
rt                                  :job descriptor (rlt)
demo13                              :output filename(s)
-180.  180.                         :range of takeoff angles
.5                                  :increment in takeoff angle
5000.0   7000.0  10000.0
13000.0                             :velocities
n                                   :direct wave? (y or n)
                                    :headwave interface numbers (1, 2, ...)
y                                   :all primaries? (y or n)
0 1                                 :extra event
1 2                                 :extra event
2 3                                 :extra event
```

File *geometry12*

```
1          -1000.                   :reference station number and x-coord.
175.           0.                   :station spacing and receiver depth
1   10  11   75       38.   7500.   :shot 1 - r1 r2 r3 r4 s sdepth
```



Primaries+01+12+23



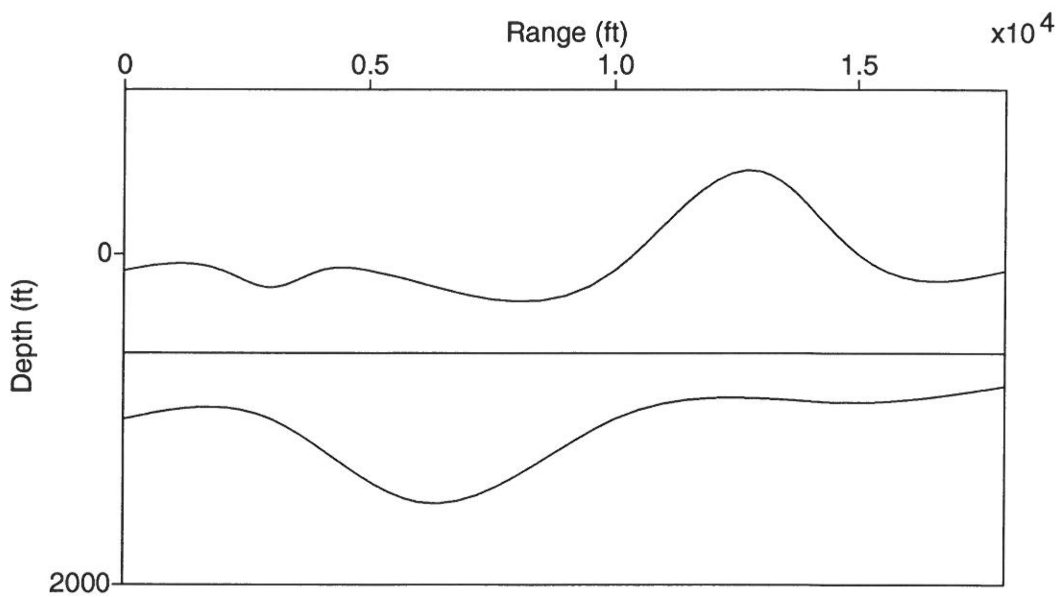
Primaries+01+12+23 (agc)

File PARAM1

```
weathering                     :model file
2                              :#interfaces in model
plotcolors                     :model colors file
mq                             :first plot descriptor (mwq)
```

File *weathering*

```
    0.       100.              :upper surface
 2000.       100.
 3000.       200.
 4000.       100.
 5000.       100.
10000.       100.
13000.      -500.
15000.         0.
18000.       100.
    1.    -99999.              :end of upper surface
    0.       600.              :interface 1
18000.       600.
    1.    -99999.              :end of interface 1
    0.      1000.              :interface 2
 3000.      1000.
 6000.      1500.
10000.      1000.
15000.       900.
18000.       800.
    1.    -99999.              :end of interface 2
```



Weathering Model

File PARAM1

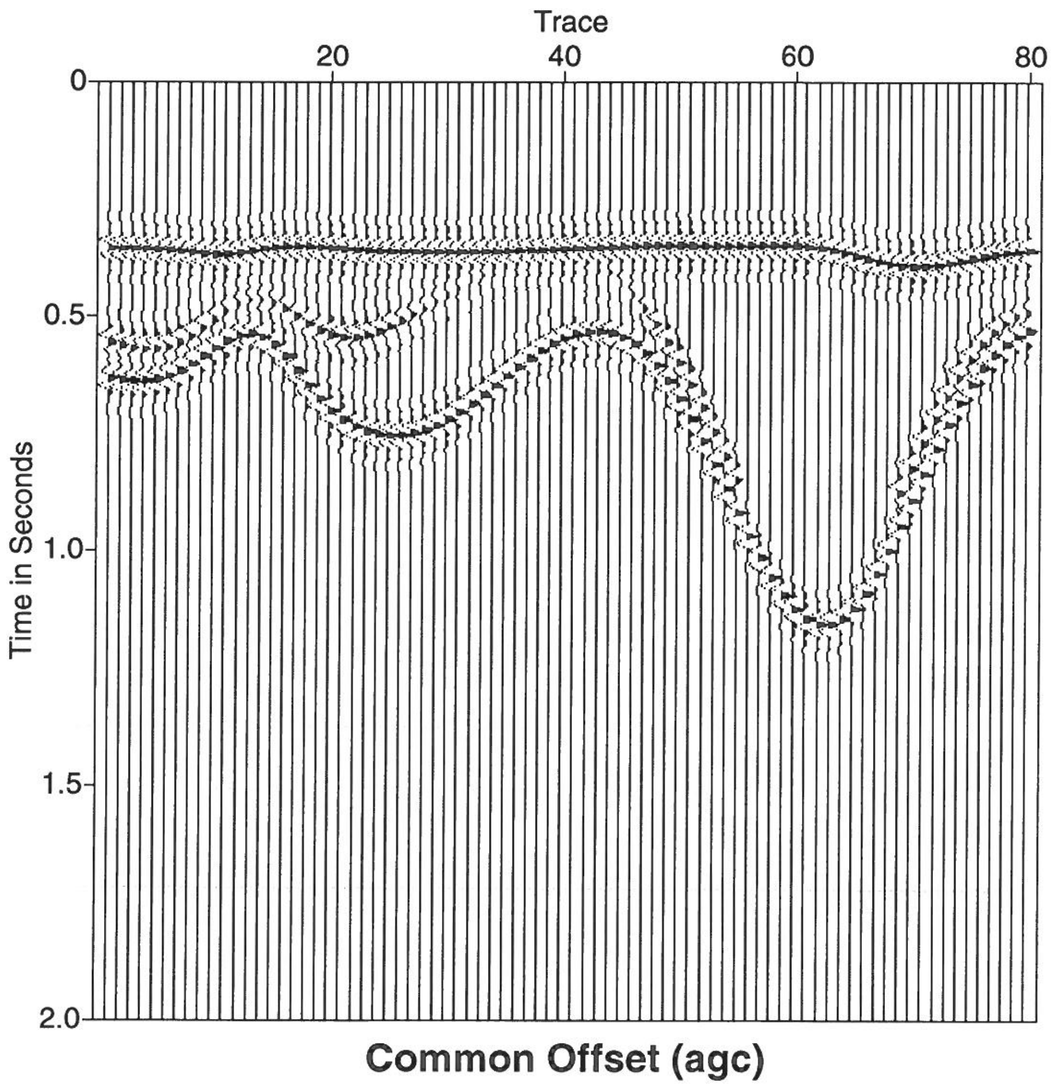
```
weathering                  :model file
2                           :#interfaces in model
plotcolors                  :model colors file
                            :first plot descriptor (mwq)
don't care                  :well coordinates
s                           :shooting mode (sd)
geometry13                  :receiver geometry
                            :second plot descriptor (sgq)
t                           :job descriptor (rlt)
demo14                      :output filename(s)
-40.   40.                  :range of takeoff angles
2.                          :increment in takeoff angle
2000. 5000. 10000.          :velocities
y                           :direct wave? (y or n)
1                           :headwave interface numbers (1, 2, ...)
n                           :all primaries? (y or n)
2                           :reflection from interface 2
```

File *geometry13*

```
1         100.                       :reference station number and x-coord.
100.        0.                       :station spacing and receiver depth
1  5  11  15     8.     150.         :shot 1 - r1 r2 r3 r4 s sdepth
80        200.                       :#shots, shot-receiver move-up
```

File *param2*

```
s                           :sort option (s,r)
1  80                       :first, last shot for sort
1  1                        :first, last trace; or first, last receiver
10.  20.    40.   50.       :frequency spectrum of wavelet
.150                        :wavelet length (secs)
.004                        :sample rate (secs)
2.                          :trace length (secs)
demo14shot                  :input file
demo14traces                :output traces
```



Trace
20
40
60
80
0
0.5
1.0
1.5
2.0
Time in Seconds
Common Offset (agc)

4 Graphics

CSHOT1 issues no graphics commands. Instead, it sends lists of (x, z) coordinates to standard output. You must provide software which reads these lists, performs any necessary scaling, and then joins the coordinate pairs within each list using straight line segments. In this way the ray pictures shown in this document can be reproduced.

The format of the lists are as follows:

np1 icolor1	:#pairs in List 1 and color
x(1) z(1)	:first pair in List 1
x(2) z(2)	
...	
x(np1) z(np1)	:last pair in List 1
np2 icolor2	:#pairs in List 2 and color
x(1) z(1)	:first pair in List 2
x(2) z(2)	
...	
x(np2) z(np2)	:last pair in List 2
...	
...	
...	
npn icolorn	:#pairs in List n and color
x(1) z(1)	:first pair in List n
x(2) z(2)	
...	
x(npn) z(npn)	:last pair in List n

The first record in each list contains two integers: the number of coordinate pairs that follow in the list, and the color in which the line segments joining the coordinates should be drawn on a color screen. The colors correspond to those specified in the colors file (see Section 3.1). The coordinates in any given list may describe a portion of an interface, a portion of the well, a raypath, or possibly a symbol at the location of a source or receiver. The total number of lists is not given and must be counted if required.

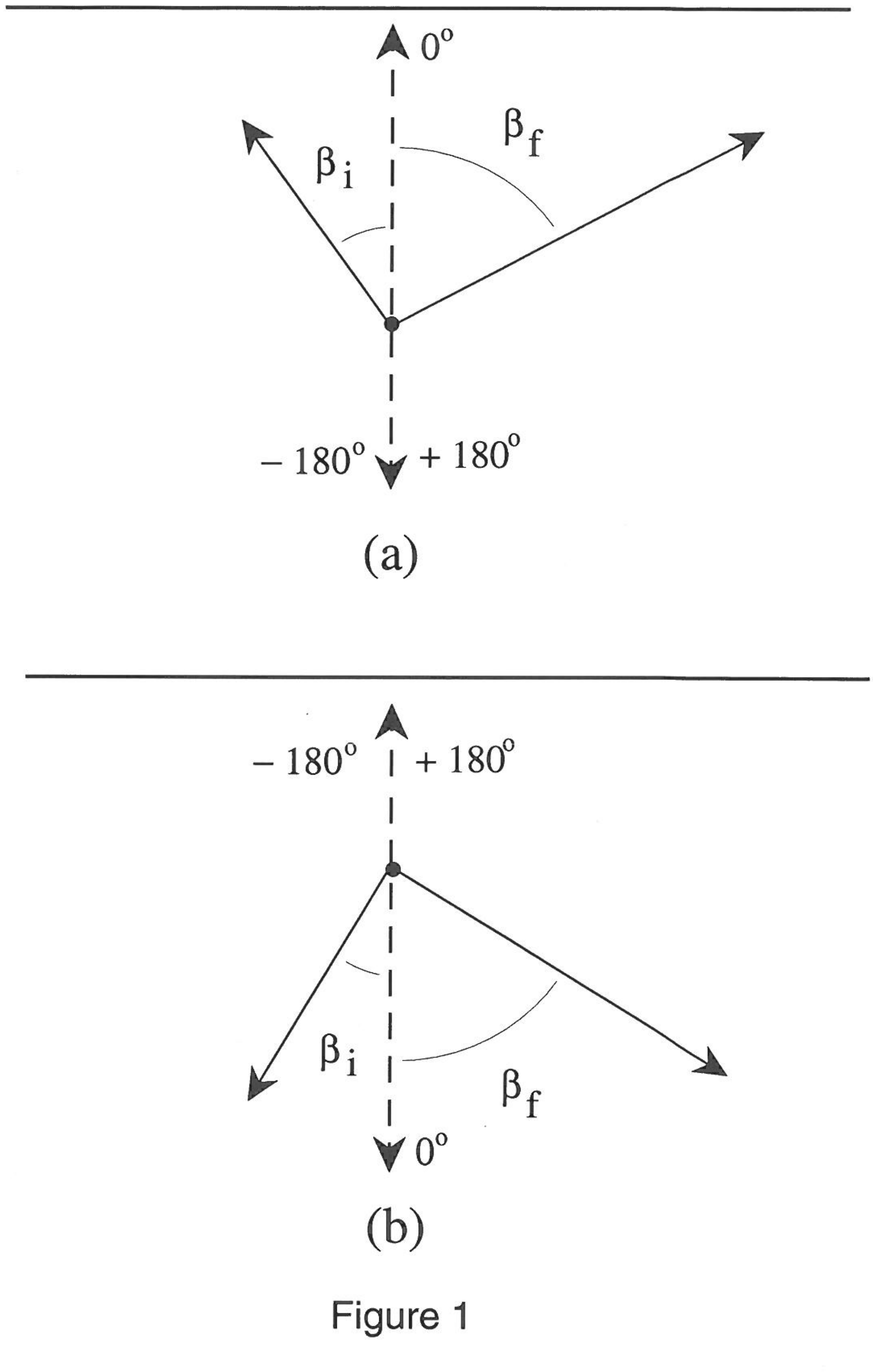


Figure 1