 USGS-OFR-94-431

U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

USER'S MANUAL FOR *SIMULPS12* FOR IMAGING v_P AND v_P/v_S: A DERIVATIVE OF THE "THURBER" TOMOGRAPHIC INVERSION *SIMUL3* FOR LOCAL EARTHQUAKES AND EXPLOSIONS

by

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Open-file Report 94-431

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Introduction

Seismic tomography is a technique for imaging two- or three-dimensional Earth structure from a large set of observations at the periphery of a targeted Earth volume. Some property (typically arrival times, sometimes t^*—a measure of attenuation) of a dense set of rays criss-crossing and sampling this volume are used to locate anomalies in space (respectively velocity or Q) and to find their magnitude. Hence the method is critically dependent on the size and homogeneity of this ray set. The problem is linearized in some manner, *a-priori* constraints on the solution are added to make it solvable, and the velocity or Q structure is computed by a matrix inversion or approximation thereof.

Seismic velocity tomography is more difficult than medical tomography, since seismic waves *strongly* interact with the structures being imaged—the raypath becomes part of the problem but depends upon its answer. Hence seismic tomography is inherently non-linear and sometimes very ill-behaved. The data generally are available at only a few points on the Earth's surface, or perhaps in boreholes, and typically are badly aliased spatially. The resolution of the image therefore is limited by the distribution of rays within the target volume (both their location *and their direction*); this distribution nearly always is less optimal than what one really needs. Lastly, the result is surprisingly sensitive to even a small number of bad data errors—quality control is essential. (This is so because any one spot in the model usually is sampled by only a few rays, so errors don't average out well, and because linearized least-squares problems in general are badly affected by large data errors (e.g., Claerbout and Muir, 1973).)

Hence, it is better to think of tomographic "images" as only transforms of the data, not pictures of the Earth. This distinction is equivalent to the difference between a migrated seismic reflection section and an actual geological cross section. The process of interpreting a tomographic model includes careful evaluation of formal resolution and covariance, knowledge of common artifacts that may not be apparent in these matrices, and folding in all available geological, geochemical, and other geophysical data. Careful, conservative use of the inversion programs is critical—wrong results (local minima) are relatively easy to fall into. So it also makes sense to try several things to find out just how stable one's principal result is (for example, different subsets of your data, different node configurations, different starting models, different modeling sequences, different ray tracers, different inversion schemes). And at the end, a clear sense of "geological reasonableness", though hard to gain, justify, or teach, probably is the best test of the result. Roecker (1993) extends this notion to the "principal of least astonishment", that is, taking the most conservative path at each step to produce the geologically least-surprising result (which may be astonishing enough, anyway).

These points cannot be overemphasized. It is *easy* to get a wrong answer—you *must not* treat this inversion as a black box. Before continuing with this *User's Manual*, for example, read Thurber (1993), Eberhart-Phillips (1993), and sections 21.1–21.4 of Roecker (1993). These are modern, conservative treatments of **simulps12** and similar codes, and of the inversion process more generally. Indeed, Eberhart-Phillips (1993) is the authoritative source of such information for **simulps12**; this *User's Manual* is intended mainly to give the details required to run and modify the program. It is essential that users understand the pitfalls, tradeoffs, and assumptions inherent to this inversion. This software will not just politely hand one "the right answer", nor always say so when it returns garbage.

Seismic tomography can be classified by the type and distribution of sources and receivers, by whether the whole ray or only part of it is modeled, by the type of data used, by the type of error minimization (usually least squares), by the *a-priori* covariance constraints (the problem is insoluble without some additional constraints, usually a correlation length—hence model smoothness—or some model-complexity minimization), by the type of inversion (full matrix or row-active), and no doubt by things we haven't thought of yet. The "Thurber inversion" (Thurber, 1981, 1983, 1993) is a damped-least-squares, full matrix inversion intended for use with natural local earthquakes, with or without shots and blasts ("blasts" are shots of unknown origin time but known location). The events must occur within the target volume and be measured by a grossly-homogeneous network of seismographs approximately spanning the target volume.

Arrival times are used to produce a velocity model. Most often, v_P is modeled from *P*-wave arrival times, but modified versions of the program model v_S. However, greatly differing artifacts and modeling errors between direct v_P and direct v_S models (due to differences in data quality and abundance, and different raypaths) make simple division of the models to get v_P/v_S inappropriate—the result typically is uninterpretable. A better approach, the one used by **simulps12**, is to invert $t_S - t_P$ directly for v_P/v_S, using the method of Thurber

(1993).

Other versions of the program (cf. Jay Zucca, LLNL) model Q_P and presumably could be used for Q_S. The v_P/v_S ratio and attenuation measurements are very diagnostic of pore-fluid and temperature conditions when used in conjunction with v_P.

"Damped-least-squares" means that the norm of the model perturbations (more or less the complexity of the model) is weighted and combined with the squared data misfit—the *combination* is minimized at each iteration. Since earthquakes of unknown location inside the target volume are used, at least four sources of non-linearity arise: (1) the dependence of the ray (especially near its turning point) upon the velocity structure being modeled, (2) the dependence of recomputed hypocenters and origin times on this velocity structure, (3) the non-linearity of the hypocenter-location problem itself, and (4) the choice to down-weight data of large misfit at some point during the inversion (one may choose the wrong data to believe or disbelieve). Though the Thurber inversion is one of the more routinely successful methods, nevertheless a conservative sequence of inversions is preferable, based on testing done by Ellsworth *et al.* (1991) and Kissling *et al.* (1994). They recommend working from a 1-D model (typically derived *via* the **velest** inversion program (Ellsworth, 1977; Roecker, 1981; Kradolfer, 1989)) gradationally to the most detailed 3-D model from **simulps12**. Eberhart-Phillips *et al.* (1995) show that solving for a coarse node-grid prior to a fine node-grid typically gives much more accurate results. In another case, however, an apparently underdetermined problem seemed to require substantial *a-priori* structural information to obtain a credible solution (Chiarabba *et al.*, 1991), while the gradational approach drove too much compensating structure from the well-observed into the poorly-observed parts of that model (*but note the strong caveat below* about introducing *a-priori* structure into your model).

Though the Thurber inversion has a strong track record and many experienced practitioners are available, it is far from fool-proof. It also is rather slow, owing to the full matrix inversion and lots of ray tracing. In return it gives one formal resolution and covariance matrices that are essential in interpretive stages. (Row-active methods must approximate these diagnostics by some other means.)

The USGS's most experienced practitioner is the second author (Donna Eberhart-Phillips). Until recently she was at the Pasadena USGS office. However, she is now permanently in New Zealand. The other authors are likely to know her E-mail address at any given moment.

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The second author's current, authoritative version of the code, this *User's Manual*, UNIX **Make** file and shell script, and Angus Miller's test case are all available *via* anonymous **ftp** from "andreas.wr.usgs.gov". The test case also appears in Appendix D. Sadly, the messy file distribution shown in the table probably will change. In any case, your best bet is to dig around in the "andreas.wr.usgs.gov" anonymous **ftp** directory, or to contact the first or second author. The third author is the authoritative source for **simul3**.

Paths to Available Software and Documentation

Description	Path on computer "andreas.wr.usgs.gov"
Authoritative source code Authoritative "include file"	˜ftp/pub/outgoing/simulps/simulps12.for† ˜ftp/pub/outgoing/simulps/simulps_common.inc
This *User's Manual* (troff script) This *User's Manual* (POSTSCRIPT®) Backup copy of source code Backup copy of include fil	˜ftp/pub/outgoing/evans/simulps12/simulps.ms ˜ftp/pub/outgoing/evans/simulps12/simulps.ms.ps ˜ftp/pub/outgoing/evans/simulps12/simulps12.f ˜ftp/pub/outgoing/evans/simulps12/simulps_common.inc
UNIX shell script to run **simulps12** UNIX **Make** file to compile **simulps12**	˜ftp/pub/outgoing/evans/simulps12/simul ˜ftp/pub/outgoing/evans/simulps12/Makefile
Angus Miller's comprehensive test case	˜ftp/pub/outgoing/evans/simulps12/test_case
velest source code and related files	˜ftp/pub/outgoing/VELEST (a directory)

†Rename this file "simulps12.f" for UNIX systems. Note that anonymous **ftp** always puts you into the "˜ftp" directory when you log in.

Whenever you take a copy of any of these items, kindly send us (at least the first and second authors) your name, institution, ground address, E-mail address, the date you copied the item, and a short description of your intended use(s). That would help us track usage, tell you of bugs, answer questions, and feel generally warm and cozy. Messages regarding **velest** should be directed to Bill Ellsworth, "ellswrth@andreas.wr.usgs.gov" [*sic*].

The Sun version is now tested and functioning, with assistance from Angus Miller, the first author, and others. In the process of getting **simulps12** working on Suns and making the code identical to the baseline VAX/VMS version, systematic indentation and loop termination has been added and a few statements slightly modified. These changes are now in The second author's baseline version of the code. She also recently moved the common blocks and declarations to an "include file" ("simulps_common.inc") to make changing array sizes easier and less error-prone.

Here is a brief history of **simulps12**:

- **simul3** written by Cliff Thurber (1981) as part of his Ph.D. thesis.
- Modified by Bill Prothero, UCSB, to include station delays.
- Parts programmed by Steve Taylor of LLNL.
- Obtained from Prothero and Thurber in 1983 and subsequently modified extensively by the second author, Donna Eberhart-Phillips, USGS, through many versions (now "**simulps** version 12").

As one might guess, it suffers some from this long, multi-authored history. It is a large and complicated piece of code, not always with the best modular programming style. If you think you see a bug, you may be seeing a bug—please report it to the second author with copies of all I/O files for that run.

There are a number of alternatives to **simulps12**. Lees and Crosson (1989) use a horizontal-smoothness constraint (minimizing a first difference rather than the model's norm), to make the problem soluble. This is a physically more understandable method, while **simulps12**'s damping can create some oscillatory artifacts that one must learn to look past. On the other hand, damped inversions have proven to be rather reliable in Earth applications and have the longest track record. **simulps12** uses a linear interpolation of velocity between its modeled velocity nodes, while Michelini and McEvilly (1991) use "cubic B-splines" for a smoother result more consistent with real Earth structure measured by waves of finite wavelength (and because they wanted a smooth second derivative for their subsequent applications of the models (D. Eberhart-Phillips, 1993, written communication)). This method may be applied if **simulps12** model does not seem stable or produces a questionable result, however, the two methods yield similar results with good data (Eberhart-Phillips, 1993; her Figure 22.14). Bill Prothero at UCSB also has modified the Thurber inversion by adding a more precise ray tracer. This difference had some effect on the resulting models in the underdetermined case of Chiarabba *et al.* (1991). If such sensitivity is observed in one's own inversions, it may be symptomatic of an ill-constrained model—be cautious.

In **simulps12**, nodes where velocity (or Q) is computed are defined by the intersections of a set of planes in three orthogonal directions, one horizontal and two vertical. The vertical planes can be rotated to match the geology somewhat. At The Geysers, California, for example, nodal planes parallel and perpendicular to the NW-striking strike-slip faults (and the felsite reservoir rock) were used by Eberhart-Phillips (1986) and again by Ross *et al*. (1993). Typically, the planes are closely spaced in the center of the target volume, where the most rays should be, and more widely spaced in the periphery.

There also *must* be planes of nodes around *all* sides of the model, including top, bottom, and four sides, placed effectively at infinity (i.e., several hundred km away). Be forewarned that this requirement can be a problem, since it may lead to long columnar velocity anomalies around the periphery of the model. A ray getting too far into this region will invariably behave unrealistically—the columnar anomalies act as wave guides or wave excluders. Hence, you may also need planes of unmodeled, but realistic-velocity nodes close to the modeled volume, but beyond the most distal rays on at least the four vertical sides of the model.

A strongly worded caveat is in order with regard to introducing any *a-priori* structure into your model. This practice is very tempting but introduces a *major* risk of biasing your result and introducing artifacts having nothing to do with the real world (Eberhart-Phillips, 1990; Kissling *et al*., 1994). One should *always* try the simplest thing first—a graded inversion from **velest** through a fine three-dimensional node-grid in **simulps12**. If problems are suspected after this effort, it may be worth experimenting with *a-priori* structure in poorly-sampled regions only. For example, Chiarabba *et al*. (1991) retained closer agreement with gravity and seismic refraction results in an undersampled situation if the principal structure indicated by those other means was introduced *a priori*. There was evidence that this information was needed to constrain raypaths and to obviate smearing out of the large, ill-resolved feature. In another example, Dawson *et al*. (1992; and personal communication, 1994) found that it was helpful to include a layer of unmodeled nodes a short distance above the highest-elevation stations (with reasonable *a-priori* upper-crustal velocities) at Redoubt volcano, a situation with very large topographic relief and very shallow earthquakes (many within the massif itself).

Every node can either be held fixed or included in the inversion (except the outermost nodes, which are always fixed). Plan on fixing some of the nodes in poorly observed areas, at least during less-damped runs and runs with the greatest node density. The variable *hitct* can be used to make a comprehensive cut at any particular "derivative weight sum" (DWS). (The DWS (variable *hit*) is similar to the integer ray-node "hit count" (the "OBSERVATION MATRIX", *khit*), but weighted by ray-node separation and raypath length in the vicinity of the node. The DWS describes the amount of data actually constraining the velocity at that node. All nodes with $DWS < hitct$ are held fixed.)

Damping should be selected empirically, by running a series of single-iteration inversions with a *large* range of damping values, and plotting data misfit *versus* model variance for these runs (e.g., Eberhart-Phillips, 1986, 1993). It is important to explore a wide range of damping values (i.e., 1 to 1000) to be sure you are not just looking at a portion of the trade-off curve. The required values can be found most easily in the iteration-summary file (Unit 36). The data variance after modeling can be found in the line reading "new variance and ndof =" (the fractional value on the left). Model complexity (variance) is found in the lines "For all .... P-Vel gridpts, variance=" or "For all .... Vp/Vs gridpts, variance=".

Once these values are plotted for a (logarithmic or "..., 1, 2, 5, 10, ...") series of damping values, you should see a concave, roughly hyperbolic trade-off curve. Below some damping value, the modeling results will start to wander away from this simple hyperbola. *This wandering indicates that the inversion is not behaving linearly—you* **must** *stay somewhat above that damping value*. Other than that, choose a value that is a good compromise between data misfit (too smooth a model) and a large model variance (too complex, hence fitting to noise in the data). Also beware of forcing unaccounted effects (e.g., anisotropy) into "structure" that is not real. That is, don't be afraid of an ending RMS greater than your picking error (a common situation), as long as those remaining traveltime residuals can be explained reasonably by anisotropy or some other effect not built into **simulps12** or not accommodated by your parameterization choices (node-grid, station corrections, etc.).

Please note: the too-common practices of choosing node spacing and damping to yield high diagonal elements of the resolution matrix, and then claiming that these nodes are "well resolved" is complete nonsense. Choose the damping as above, and the node spacing *via* inspection of the DWS and **R**. Do not be afraid of low diagonal elements of **R**, and do not fail to inspect *all* of **R** to infer where and in what direction your model may be distorted (e.g., Eberhart-Phillips, 1993). Also, remember that some artifacts are not obvious in **R** or are not described there at all (namely artifacts implicit in the assumptions used to do the inversion in the first place—linearization and parameterization. Lastly, remember that **R** really is singular, which implies that no sort of **R** will save you reliably from artifacts—if it could, we would compute $\mathbf{R}^{-1}$ and use it to remove the artifacts. (Do be aware, however, that **C**, and therefore standard errors, are limited from above in a way that makes them unintuitively small for low diagonal elements of **R** (e.g., Evans and Achauer, 1993). Estimates of model uncertainty should be taken from **C** of a coarser, previous run with high diagonal elements of **R**, or best of all should be computed by testing synthetic data.)

How to Use *simulps12* for v_P

Sources of non-linearity include inadequate spatial sampling and hypocenters that are strongly interdependent with the velocity model. Further, undersampled volumes in the model are sensitive to noise, while oversampled areas can dominate and bias the result. Hence, begin by (1) choosing a data set with homogeneously distributed rays (in x, y, z, **and** orientation—hence a homogeneous distribution of hypocenters too), and (2) choosing events with intrinsically well-constrained hypocenters (lots of clear picks per event and broad azimuthal coverage around the hypocenter). Infer from (1) that adding redundant well-constrained hypocenters in one spot will not improve your solution, and can even degrade it by overweighting corresponding raypaths in the solution. Using well-constrained hypocenters (and a simultaneous inversion technique like **simulps12**) are important to stabilizing the structure-hypocenter interaction (Thurber, 1992, 1993). Rays without turning points, traveling upward directly from source to receiver, also help stabilize the velocity solution; hence the emphasis on diverse ray orientations. The hypocenter-stability restriction may have to be relaxed somewhat to get events near the periphery of the array, but watch for and remove any ill-constrained hypocenters as the inversion progresses.

There are two well-tested ways to proceed (also see Roecker, 1993, section 21.3.2; and Eberhart-Phillips, 1993 section 22.4). You should always try the first, or something equivalent, while the second is used mainly to verify or if some question of data sufficiency exists. In either case, one must start simple (with a coarse model), and at that relatively simple stage get to know the program and the data set thoroughly. Hence, plot lots of rays, look at residuals and hypocenter relocations, twiddle parameters, etc. Immerse yourself in this familiarization process until you can't stand it anymore.

(1) The procedure most likely to produce a reasonable result in well-observed regions (i.e., in well-constrained models) is to begin with **velest** to compute a best-fitting 1-D velocity model and corresponding hypocenters. (The source code for **velest** is available *via* anonymous **ftp** at "andreas.wr.usgs.gov" in "~ftp/pub/outgoing/VELEST". An important, relevant discussion of using **velest** for this purpose is given by Kissling *et al.*, 1994.) The starting model to **velest**, in turn, may come from nearby refraction lines or from models used in that region to locate earthquakes, give or take some geological good sense. The **velest** layered model is used to initialize the velocities of the first, coarse (in x and y), **simulps12** model. One then iterates through finer and finer 3-D models, initializing each finer model from the velocities computed in the preceding coarser model, until the most detailed model supported by the data set is obtained. This procedure is called a "graded inversion" by some authors.

Alternatively, (2) it is often useful to make an additional, parallel sequence of inversions using different assumptions. The results of (1) and (2) can then be compared. For example, if enough information about local structure is available, or if the tomographic data set appears inadequate to constrain the velocity model fully, one may begin with an *a-priori* velocity model of some detail. This model should contain at least the first-order structure—the regional 1-D velocity distribution plus any large, local deviations from it. One then inverts for 3-D structure as above, starting at whatever level of detail is supported by the *a-priori* velocity model. Be cautioned, once again, that this is a dangerous game that can deteriorate into circular logic—in the end, be guided by the data, not by your biases and "wisdom".

In any case, design the final 3-D set of nodes to be consistent with the available ray set and local geology. You should begin with a pretty clear idea of where the rays are going, and make the spacing between nodes large enough to be well sampled (a large enough DWS, "derivative weight sum") but small enough not to throw away valid structural information. Also, putting nodes too close together may risk oscillatory instabilities induced by damping (cf. Evans and Achauer, 1993). Lastly, straddle suspected, major velocity boundaries (both horizontal and vertical) with nodes so that the inversion can put large velocity gradients there. In sum, one must ask as much of the data as one can but make the question realistic—well posed.

The coarser models of the graded inversion generally will be a subset in x and y of this final-model node-grid.

Check the quality of your data set by all reasonable means. Use simple event-location routines to identify really bad picks (large residuals) and determine what (if any) problem exists with those picks. As you progress, beginning with **velest**, compare the observed to the predicted traveltimes for the velocity model, and again take a close look *at the seismograms* yielding any large misfits (a *lot* of work, but necessary). In the first several runs of **simulps12**, look over the entire output file carefully for data problems and other glitches. **Do not simply look at the final velocity results.** And again, remember at every step that these metrics are only *guidelines*. If the pick belongs where it makes a large residual, so be it; it is our explanation of the data that needs correction—**don't cook the data set!**

Appendices A and B are largely taken from the extensive comments in the **simulps12** source code, with many clarifications, corrections, and notes by the first author. Input formats, and definitions of the things being input and output, are given in Appendix A. Appendix B gives the dimensions required for numerous arrays used in the code, and definitions of many variables. Appendix B is useful when one must change these array dimensions to fit particular problems better. Appendix C is the third author's *User's Manual* for **simul3**, the v_P antecedent to the **simulps** series. It contains additional explanations and caveats that may help. Appendix D is the now-standard test-case example (for v_P and v_P/v_S) for a real problem in a volcanic area (Miller *et al.*, 1993). Appendix E is the simpler test case (for v_P and v_P/v_S) that is shipped with the source code.

It is worth mentioning that runs of **simulps12** will terminate for any of four reasons: (1) the F-test fails; (2) the solution norm falls below *snrmct*; (3) the number of iterations exceeds *nitmax*; or (4) the *weighted* data RMS falls below *rmstop*. The latter can be quite obscure in the output, especially since the *unweighted* data RMS is likely to be *above* this threshold at termination. Also, note that the function of *rmstop* differs from that of *rmscut*.

How to Use *simulps12* for v_P/v_S

Various attempts have been made recently to combine *P* and *S* data for some type of joint interpretation. Inverting separately for these parameters and ratioing the models fails badly, since the data are invariably of different quality and number (so different artifacts are present in each model). For example, Eberhart-Phillips (1990), studying the complex fold-and-thrust structure around Coalinga, California, found that direct inversion of 1511 t_S for v_S produced a much less resolved model than the 8392 t_P used for v_P. For example, a clear velocity reversal in v_P appeared only as a broad inflection in v_S. These differences precluded any detailed analysis of v_P/v_S in that study.

Even using ray sets carefully tailored to be similar has proven ineffective in at least one case known to us. *S* arrives within the *P* coda, is more attenuated than *P*, has *S*-to-*P* converted precursors, and routinely exhibits polarization and splitting due to anisotropy—there is no such thing as a "matched" data set.

Attempts now are centering on inverting $t_S - t_P$ directly for v_P/v_S, using damping selected specifically for that problem (*via* a trade-off curve, in the same way one does for v_P). The theory for such inversions is covered by Thurber (1993). Two examples of I/O for a v_P/v_S run are in Appendices D and E. Appendix D is one of the few available examples of v_P/v_S inversions for "real" data, since high-quality three-component data have only recently become plentiful, while direct inversion for v_P/v_S dates only to Walck (1988). So proceed with caution—this is a new field, and even the experts are novitiates.

In solving for v_P and v_P/v_S, you probably should do several series of inversions using slightly different strategies. At the end, carefully consider which of these series is preferable. The most important guide is good sense—Roecker's (1993) "principal of least astonishment". Keep in mind the assumptions that are made in solving for v_P/v_S rather than v_S. Where one has little *P* data, the best estimate for v_P is taken from the **velest** or a coarse **simulps12** result. Where there is little *S* information, on the other hand, the best estimate for v_S is assumed to come from the current **simulps12** v_P model and a uniform v_P/v_S, rather than from some one-dimensional v_S starting model.

Thus there is no need to solve for an initial one-dimensional v_P/v_S model. It is best just to use the most appropriate uniform v_P/v_S for your data (try a Wadati diagram). Your decision about where in your series of inversions to begin solving for v_P/v_S should be driven by your ray distribution—are the assumptions made about v_P and v_P/v_S appropriate to your data? At Loma Prieta, Eberhart-Phillips and Michael (1995) solved for v_P only in one- and then two-dimensional inversions. Then they also solved for v_P/v_S in the coarse and then fine three-dimensional inversions. For a rather homogeneous Icelandic data set, on the other hand, Foulger *et al.*

(1994) decided to reserve solving for v_P/v_S *until their final iterations, after the fine three-dimensional* v_P *model had been derived (see below).*

Appendix D is the now-standard test case penned by Angus Miller (Durham University, U.K.), from the study of Hengill, Iceland, that he did with the first author of this Manual, B. R. Julian, and G. R. Foulger. Miller designed this test to exercise most parts of the code, including v_P and v_P/v_S inversions. This test case is also in the anonymous **ftp** directories, as described elsewhere.

The procedure followed by Angus Miller (Foulger *et al*., 1994) begins with producing a detailed v_P model as described in the previous section. They used a constant v_P/v_S (chosen from a Wadati diagram of their data) to permit use of t_S in constraining hypocenters, but (by holding all v_P/v_S nodes fixed) they did not allow v_P/v_S to vary.

With the detailed model of v_P complete, they proceeded to a full inversion for both v_P and v_P/v_S, starting with the detailed three-dimensional v_P model and the constant v_P/v_S but now allowing inversion for both. Going directly to a detailed, rather than coarse, model of v_P/v_S generally should work because the v_P/v_S field typically is much smoother than either raw velocity field. Miller *et al*. chose damping for v_P/v_S with a trade-off curve, as before, with v_P damping held at its previous value. (The v_P model changes very little at this stage if one has done that problem correctly to begin with. One can save computational time by fixing all the v_P nodes at this step, but the human time spent manipulating the input file for Unit 03 probably obviates this strategy.)

It is worth noting that you *can* use $t_S - t_P$ from stations for which the absolute time has been lost through instrument or operator malfunction. This time *difference* is used correctly to constrain the hypocenter as well as the v_P/v_S model. Simply give a value for $t_S - t_P$ with no corresponding t_P in Unit 04. (Yes, clock failures and all other sorts *will* happen to you too—someday, sometime, somehow! Murphy's First Law of Field Work: (1*a*) It already went wrong, so kick the instrument twice to be sure. (1*b*) See doctor to fix broken toe.)

Appendix A: I/O Formats and Definitions of Variables

("Unit" means Fortran Logical Unit (I/O channel). *Variables* are in italics; **routines** are in bold. **R** is the resolution matrix; **C** is the covariance matrix. Explicit blank spaces are indicated by "␢".)

Input Files

Unit 01—Control File

Line 1 (in free format):

neqs — number of earthquakes in data set
nsht — number of shots in data set (i.e., known (x, y, z, t))
nbls — number of blasts (i.e., shots of known location but unknown origin time)
wtsht — weighting of shots relative to earthquakes

kout — output-file control parameter (see **Output Files**, below):

kout	Files created (by Unit)								
0	16*								26
1	16*		13						26
2	16*		13	22‡	23	24,28†			26
3	16*		13	22‡	23	24,28†		34	26
4	16*		13	22‡	23	24,28†	25	34	26
5	16*	12	13	22‡	23	24,28†	25	34	26

*File 16 lacks residuals unless **simulps12** terminates by exceeding iteration count, *nitmax*.
†File 28 is created whenever the data include blasts.
‡Not created if *invdel* = 0 (see below).

Files 15 and 19, see *kout*3, below. Created when *kout*3 = 1
File 18 is created whenever any nodes are held fixed.
File 20, see *kout2*, below. Created when *kout*2 is 0 or 1.
File 45, see *kout2*, below. Created when *ires* ≥ 2 and *kout*2 = 5.

kout2—"printout" (Unit 16) control parameter

kout2	Result
0	Full printout, including station residuals and location steps.‡
1	Print station residuals.‡
2	Print event-location steps.
3	Don't print location steps or station residuals ...
4	... also don't print stations (from **input2** routine) ...
5	... but do output 1/diag(**C**) to Unit 16 and Unit 45 if *ires* > 0.

Counterintuitively, bigger numbers give less output.
‡Creates File 20 if **simulps12** terminates by exceeding iteration count, *nitmax*.

kout3—Yet another output-control parameter

kout3	Result
0	Don't output raypath points or traveltime differences.
1	Output raypath points to Unit 15, for all raypaths. Output traveltime differences between ART and pseudo-bending to Unit 19. This option is useful for making plots of raypaths. (For instance, to test a range of pseudo-bending parameters (*xfac*, *tlim*, *nitpb*).) **Note** that this option should *not* be used routinely, but only to check a few selected events—it creates a lot of output.

Line 2 (in free format):

nitloc — maximum number of iterations for hypocenter location.

wtsp — for hypocenter solution, the weight of the $t_S - t_P$ residual relative to t_P residual (i.e., *wtsp* = **1.** gives equal weights, to both, while *wtsp* < **1.** down-weights $t_S - t_P$).

eigtol — singular value decomposition (SVD) cutoff in hypocentral adjustments. If the smallest eigenvalue of Geiger's matrix is < *eigtol*, the **depth** is not adjusted, and a message is printed.

rmscut — value of RMS residual below which hypocentral adjustments are terminated.

zmin — minimum hypocenter depth (which can be, and probably should be, negative to allow events above sea level, but, hopefully, below the Earth's surface). Try values equal to the lowest, the mean, or the highest station elevation to avoid "airquakes" without forcing shallow events too deep. Better solutions are possible: Phil Dawson has a version of the older **simulps11** that knows about the surface explicitly as digital topography, as required for his models of Redoubt volcano—where many events are *above* many stations, high in the cone of the volcano. This issue can be important in high-relief areas with shallow seismicity (volcanoes, geothermal areas, areas of induced seismicity). The standard version of **simulps** may eventually be taught about topography.

dxmax — maximum horizontal hypocentral adjustment allowed in each hypocenter iteration (km).

rderr — estimate of traveltime reading/picking error (often in the range 0.01-0.05 s). Used to estimate hypocenter errors.

ercof — for **hypoinverse**-like error calculations. Set 0.0<*ercof* <1.0 to include RMS residual in hypocenter error estimate ($sigsq = rderr^2 + ercof \times rms^2$).

Line 3 (in free format):

hitct — minimum DWS for a parameter to be included in the inversion (usually ≥5).

dvpmx — maximum v_P adjustment allowed per iteration (enforced by truncation).

dvsmx — maximum v_P/v_S adjustment allowed per iteration (enforced by truncation).

idmp — **1** to recalculate the damping value for succeeding iterations.
0 to keep damping constant.

vdamp — damping parameter used in velocity inversion.

Element	To damp	Units
vdamp (1)	v_P	s^2
vdamp (2)	v_P/v_S	unitless
vdamp (3)	Station delays.	unitless?

stepl — step length (km) used for calculation of partial derivatives along the raypath. Make *stepl* smaller than the smallest node spacing, but beware that computation time increases quickly as *stepl* decreases.

Line 4 (in free format):

ires — controls computation of **R** and **C**:

ires	Result
0	No resolution calculations.
1	Compute the resolution and print diagonal elements. Also print 1/diag(**C**).
2	Output, to Unit 17, the full resolution (recomputed at each iteration).
3	Calculate full resolution on first iteration only.

It is a matter of some discussion whether one should use the resolution from the first (*ires* =3) or last (*ires* =2) iteration. The damping generally will be higher on the last iterations if *idmp* =1, so the first iteration will make the largest change to velocities and may be the more appropriate for resolution. Also, recall the introductory caveats about the limitations of diagonal-elements of **R** and **C** (standard errors)—they are not complete.

The output file on Unit 16 prints the standard errors below the title "VELOCITY WITH STANDARD ERROR(km/s) AND RESOLUTION" [*sic*]. If *ires* =3, this will be from the first iteration; if *ires* =2, it will be from the last iteration. Standard errors under this heading are in units of km/s. Unit 17 has the full resolution matrix (diagonal elements are an insufficient statement of resolution effects). Unit 45 has a copy of the the standard errors.

These standard errors are formal estimates of 1σ from the diagonal of the *a posteriori* covariance matrix. The third author suggests a guideline of 2σ as a realistic uncertainty estimate in well-resolved regions. More recent comparisons of inversions for the same region using similar but independent data sets suggest that a wider margin is appropriate—as high as 6σ (Foulger *et al*., 1994).

i3d — flag for using ray pseudo-bending (a simplified version of Um and Thurber's, 1987, method):

i3d	Result
0	No pseudo-bending.
1	Use pseudo-bending only in forward problem to compute velocity partial derivatives ...
2	... also use pseudo-bending in earthquake-location subroutine ...
3	... also use diminished curvature below "Moho" for initial arcuate rays. (**Note: assumes last *z* node-grid (*nz* −1) is "Moho".** Also, users must place an appropriate Moho velocity jump between the (*nz* −1) and (*nz* −2) node-grids, and fix the velocities at (*nz* −1), the uppermost mantle. One rarely has data to control the depth of Moho or the upper-mantle velocity, yet one needs reasonable raypaths to distal stations. **Do not set *i3d* =3 without such a Moho.**)

nitmax — maximum number of iterations of the velocity-inversion/hypocenter-relocation loop. To calculate only hypocenter locations, set *nitmax* = **0**. If *nitmax* = **-1**, synthetic travel times are calculated by ray-tracing through the input model. For events input as "shots" (i.e., via Unit 07), travel times are output to Unit 24 for rays from these **fixed** hypocenters to the observing stations. Events input as "earthquakes" (Unit 04) are first relocated, which may not be what you intended. In either case, of course, station coordinates are input on Unit 02. Rays are traced, however, only for the stations listed to Unit 07, making it easy to generate ray sets equivalent to your real data set.

snrmct — cutoff value for solution norm. **simulps12** will stop iterating if the solution norm is less than *snrmct*.

ihomo — force raytracing to be in vertical planes for *ihomo* iterations. Typically, *ihomo* = 1 when starting with a 1-D model, and *ihomo* = 0 when starting with a 3-D model.

rmstop — overall RMS residual for termination of program.

ifixl — number of velocity inversion steps to keep hypocenters fixed at start of progressive inversion.

Line 5 (in free format):

delt1, *delt2*—epicentral-distance weighting factors for all parts of the inversion. The weight used is **1** closer than *delt1*, **0** beyond *delt2*, and tapers linearly from *delt1* to *delt2*.

res1, *res2*, *res3*—controls weighting as a function of residual.

Weight is 1.0 below *res1*, 0.0 above *res3*, and 0.02 at *res2*, with linear tapers from *res1* to *res2*, and *res2* to *res3*. Note that *res3* probably should be set very high (e.g., 3 s) in early inversion steps to evaluate the entire data set for high residual data that would otherwise be discarded automatically.

Line 6 (in free format):

ndip — number of rotation angles (from **–90**° to **+90**°) of the plane of the ray to be used in the search for the fastest traveltime.

iskip — number of (higher) rotation angles to be skipped on either side of vertical in this search. For example, *ndip* = **9** and *iskip* = **3** yields a vertical plane plus 2 swung at angles of 22.5° on either side. *ndip* = **9** and *iskip* = **4** yields only the vertical plane, and should be used for 1-D models to save computer time. *Most of the computer's time is spent in the raytracing*. Careful selection of the starting model and *iskip* can save a lot of time.

scale1—set *scale1* to the step length (km) for the traveltime computation. Set no larger than the node-grid spacing.

scale2—scale (km) for the number of paths tried in the raytracing (roughly, the interval between bends in a ray). Cliff Thurber uses a value of 1 km, and this seems OK, but needs to be tested in detail. If *scale2* is smaller, the number of paths increases, and the computation time also goes up.

Line 7 (in free format):

xfac — convergence enhancement factor for pseudo-bending. Cliff Thurber suggests $\mathbf{1.2} \le xfac \le \mathbf{1.5}$.

tlim — traveltime difference below which to terminate iteration (use $\mathbf{0.0005} \le tlim \le \mathbf{0.002}$ s).

nitpb — maximum number of iterations allowed for pseudo-bending (use **5** to **10**).

Of this two-element array, *nitpb* (1) constrains raypaths shorter than *delt1* and *nitpb* (2) constrains raypaths longer than *delt1*.

Line 8 (in free format):

iusep — **1** to invert t_P for v_P. **0** to prevent inversion for v_P.

iuses — **1** to invert $t_S - t_P$ for v_P/v_S. **0** to prevent inversion for v_P/v_S.

invdel — **1** to invert for station delays; **0** not to. Station delays are unsatisfying in that they have no precise structural interpretation. However, they are appropriate (1) for distal stations, which are often needed to constrain hypocenters but do not yield enough information for good velocity modeling at the periphery, and (2) in a final iteration of the detailed three-dimensional model to absorb remaining near-surface structure—"station statics". Weathering, alteration, sedimentation, and fracturing often produce *very* large velocity variations in the shallowest 100 m, or so, and these are hard to model otherwise.

Unit 02—Station Data File

Line 1 (in free format): The origin point and rotation of the coordinate system. Before rotation, the y axis points North and the x axis points West (the z axis points down, so this is a right-handed coordinate system). Put this origin wherever makes sense, which is often in the center. (It is an anachronism that this information is here, rather than in Unit 03—it was once used to convert station geographic coordinates into Cartesian.)

ltdo, *oltm* — North latitude (°, ')
lndo, *olnm* — West longitude (°, ')
rota — angle of rotation, counterclockwise (°). Rotates the entire coordinate system (e.g., 45° points the y axis to geographic northwest).

Line 2 (in free format):
nsts — number of stations in station list to follow.

Station list—format(2x,a4,i2,1x,f5.2,i4,1x,f5.2,i5,2f5.2,i3)
station name, latitude (° '), longitude (° '), elevation (m), v_P then v_P/v_S station corrections (s), and finally a flag (**0** to let station correction change, **1** to keep it constant).
The ray tracer does seem to work correctly with regard to elevation, actually ending at the station, but it can be important to have a "buffer" layer of nodes above the highest station, as described elsewhere.
It is worth noting that **simulps12** allows one's elevation datum to be at sea level (or anywhere you want). There is a similar option in **velest**, with the caveat that the top of the top layer be above the highest station (e.g., at –0.6 km if the highest station is at 599 m).
So it is possible to make the datum equal in both programs, and most use sea level. Even so, translating a **velest** 1-D model into a **simulps12** starting model implies casting layers to nodes. So choose **velest** layers that straddle your planned nodal planes.
(e.g., "bbBVLM36b34.51b121b11.34bb510b0.00b0.00bb0")

Unit 03—Node-Grid and Initial-Velocity Model

This file contains the number of nodal planes in the x, y, and z directions, and the initial-velocities at each node:

Line 1 (format(f4.1, 3i3))
bld — Increment size for *ixkms*, *iykms*, and *izkms*. Must be **0.1** or **1.0** km. Note that this choice also limits the size of the model, respectively, to 149.9 km or 1499 km (see subroutine **bldmap**).
nx — Number of velocity nodes in the x direction.
ny — Number of velocity nodes in the y direction.
nz — Number of velocity nodes in the z direction.

Lines 2, 3, 4, ... (each set on a separate line (or set of lines, should the code be changed one day to allow more than 20 planes), format(20f6.1))
xn — Node positions in the x direction‡.
yn — Node positions in the y direction‡.
zn — Node positions in the z direction‡.
‡Must be integral multiples of *bld*, hence **1.0** km or **0.1** km.

Following the node-grid specification, indicate which nodes (if any) to hold at fixed velocity (i.e., remove from the inversion). For example, "bb2bb3bb4" means leave the node at *xn*(2) (2nd column), *yn*(3) (3rd row), *zn*(4) (4th layer) out of the velocity inversion.

Since all peripheral nodes are always fixed, the top-most, "southeast"-most node that one can choose to fix is "bb2bb2bb2". (This geographic characterization of node position holds for unrotated models, hence the quotes, **and only if you follow the convention**, as in the examples, that node positions should be in numerically increasing order, from most negative to most positive, in all three axes. As noted above, North, *West*, and down are positive in **simulps12**.)

Line "5", ... (format(3i3))
ixf — *ixf* th node from the right (the "East") edge.
iyf — *iyf* th node from the "South" edge.
izf — *izf* th node from the upper edge.

Terminate with a blank line or "bb0bb0bb0". Note that it is handy to follow these triples with an explanation (e.g., Appendix E).

Following the list of fixed nodes, give the initial velocities of *all* the nodes (including the peripheral, fixed nodes). First give all of v_P, then all of v_P/v_S. For each velocity model, start at the "southeast" corner of the top layer (including the outer set of nodes), and proceed through all of each layer in turn. That is, x increments fastest and z slowest. Each row is in format (20f5.2), then a new line starts each new row. Since the code currently is limited to 20 planes in each direction the velocity model may look like a series of map views, concatenated one against the other. **But it isn't**, unless you count Gnomic projections—"southeast" is in the upper left corner:

$v_P(1,1,1)$ $v_P(2,1,1)$ ... $v_P(nx,1,1)$
$v_P(1,2,1)$ $v_P(2,2,1)$ ... $v_P(nx,2,1)$
...
$v_P(1,ny,1)$ $v_P(2,ny,1)$ ... $v_P(nx,ny,1)$
$v_P(1,1,2)$ $v_P(2,1,2)$ ... $v_P(nx,1,2)$
...
...
$v_P(1,ny,nz)$ $v_P(2,ny,nz)$ ... $v_P(nx,ny,nz)$

and then the same again for v_P/v_S (which may start out with a rather monotonous ball-park guess, like $\sqrt{3} = 1.73$ at every node).

Unit 04—Traveltime Data for Earthquakes

Use program **convert6** to convert **hypo71** summary and phase data into this format. (**simulps12** should still work with old **convert3** files also, and with Michelini's format.) For picks from **epick**, there is a conversion program named **ep2simul12**.

Note that one must substitute $t_S - t_P$ in place of the t_S that would normally appear in this format for microearthquake work. **convert6** and **ep2simul12** will do this, and use the convention of changing the "polarity" field of the comment to "P", yielding comments (*rmki*) like "ESP2" ("emergent S–P of quality 2").

Event origin time, location, and magnitude, in format(a4,a2,1x,a2,i2,1x,f5.2,i3,1x,f5.2,1x,i3,1x,f5.2,2f7.2):
- *iyrmo*, *iday* —year, month, and day (YYMMDD)
- *ihr*, *mino*, *seco* —hour, minute, and second
- *ltde*, *eltm* —latitude (° ’)
- *lnde*, *elnm* —longitude (° ’)
- *dep* —depth (km)
- *rmag* —magnitude

(e.g., "891019bb612b13.07b36b57.24b121b40.44bbb7.49bbb1.60")

Observed traveltimes to stations, six sets per line.
Each set is in format(2a4,f6.2), and sets abut:
- *sta* —station name
- *rmki* —4-character remark (e.g., "ISP1" or "EP-1"). The "SP" or "P" and the weight are extracted from this field ("P" meaning a t_P value, and "SP" meaning a $t_S - t_P$ value, of course).
- *tt* —traveltime (s)

(e.g., "L141ESD1bb1.56L145ESN0bb1.31L149ISD0bb1.28L142ESU0bb1.50L148ISD0bb1.28L143ESU0bb1.41")
Blanks terminate that event's data.

Unit 07—Traveltime Data for Shots

Use the same format as for the earthquake data read on Unit 04.

Unit 08—Traveltime Data for Blasts

Use the same format as for the earthquake data read on Unit 04.

Output Files

Unit 12—Hypocenters from each Iteration

In **hypoinverse** format with error ellipses.

Unit 13—Final Hypocenters

In **hypo71** summary-card format.

Unit 15—All the Raypath Points

Creates a separate file for each event. These files are named "ev*nnn*.rp", where *nnn* is a sequential event number. Useful for plotting rays. (cf. *kout3*, Unit 01)

Unit 16—"Printed" Output

The principal output file. (Residuals are written to this file only when **simulps12** terminates *via* iteration count—as with all output to Unit 20.)

Unit 17—Full Resolution Matrix

Unit 18—Node-Grid Map

Map from full node-grid to nodes participating in the inversion. Output when any nodes are held fixed.

Unit 19—Difference in Traveltimes Between ART and Pseudo-Bending

Unit 20—Station Traveltime Residuals

Can be used to help identify bad picks. Written only upon the last (i.e., *nitmax*'th) iteration, so File 20 will not appear when **simulps12** terminates due to failing F-test, low solution norm (*snrmct*), or low data RMS (*rmstop*).

Unit 22—Station Data

Includes new *P* and *S–P* delays. This information can be used as input to subsequent runs. *Not* created if *invdel* = 0 (i.e., when no station delays are inverted for).

Unit 23—Final Velocity Model

This information can be used as input to subsequent runs. Also useful as input to any graphics system that reads array format, rather than the point-wise format of Unit 25.

Unit 24—Earthquake Traveltime Data for Recomputed Hypocenters

This information can be used as input to subsequent runs.

Unit 25—New Velocities

In "station" format (velocity, latitude, longitude)—the format required if one wishs to plot the velocity result *via* **qplot** (Klein, 1983), as is a common practice. Also use this file to plot the node-grid on a map.

Unit 26—Errant Rays

A list of rays that used up the maximum allowed number of pseudo-bending iterations (*nitpb*, Unit 01) without converging.

Unit 28—Blast Traveltime Data and Recomputed Origin Times

Unit 34—Similar to a *hypo71* **Listing File**

Output from this unit can be used as input to the **fpfit** fault-plane solution program. The output contains only output for earthquakes and blasts (not shots), since the output routine is called from **loceqk**, itself not called for shots. (Note that *dist* is the hypocentral distance, whereas **hypo71** outputs the epicentral distance.) Written upon the last (the *nitmax*'th) iteration.

Unit 36—Iteration Summary

Contains F-tests, statistics on solution vectors, number of data, and related information summarizing the progress of inversion iterations. A useful distillation of the primary output file (Unit 16), for example, when comparing similar runs for damping trade-off curves.

Unit 45—1/diag(**C**)

Hence, the estimated model variance. In the same format as the velocity-model input and output.

Hints and Pitfalls

1. Invert for a one-dimensional model first. One could use $nx = 3$, $ny = 3$, and $nz =$ whatever you want to have in the final 3-D model. Set $ndip = 9$ and $iskip = 4$ to keep the rays in vertical planes (this has the same result as $ndip = 1$ and $iskip = 0$). Or use the more optimal 1-D program, **velest**, to locate the events with the **velest** model, then fix the earthquake locations on the first iteration of **simulps12**.

   velest does not have a functioning v_S option, let alone the more appropriate v_P/v_S. In any case, we advise starting with the 1-D v_P model from **velest** and a constant v_P/v_S, typically picked from a Wadati plot of your data.

2. Run the inversion on synthetic data for a simple structural model with features similar to what you think actually exists in the Earth. Use a ray set identical to the one you actually have, so resolution artifacts and any non-linear effects will be similar to the real data. This test tells one what kind of averaging and artifacts are inherent in the inversion process, since the result inevitably will be different from the original input model.

3. When the program crashes due to "divide by 0", the cause most often can be traced to errors in the setup of the velocity model. For example, no part of a ray may reach over halfway to an outer node, due to algorithmic limitations. Try increasing the distance of the outer node, or, better, arranging the model to avoid columnar "anomalies" at the periphery.

4. To clarify formats and usage, an example of I/O for a simple test problem is appended to this writeup. But don't just transliterate that example for your own use—think about each parameter and tailor them to your own problem.

5. Use the "derivative weight sums" (DWS) to find poorly sampled nodes and possibly remove them from the inversion *a la* Unit 03. Remember that DWSs are relative numbers, but an appropriate threshold often will be about 50. High DWS values, in contrast, may suggest where the node-grid can be made finer. DWS values are output to Unit 16 under the obvious heading "DERIVATIVE WEIGHT SUM".

Appendix B: Definitions of Parameters, and Array Dimensioning

When it becomes necessary to change array sizes to fit one's particular problem, follow this Appendix. The relevant parameters and common blocks are now collected in a single "include file" for convenience and editing accuracy; this file is "simulps_common.inc". Change "parameter" statements for the following as needed:

Parameters Controlling Array Sizes

Parameter Name	Definition	May User Vary It?	Value as Shipped
maxev	Maximum number of events (earthquakes+blasts+shots).	Yes	600
maxobs	Maximum number of arrivals per event‡.	Yes	180
maxsta	Maximum number of stations in station list.	Yes	1800
mxpari	Maximum number of parameters to invert for†.	Yes	2000
maxpar	Maximum number of parameters declarable†.	Yes	5200
maxnx	Maximum number of nodes in x direction.	Yes	20
maxny	Maximum number of nodes in y direction.	Yes	20
maxnz	Maximum number of nodes in z direction.	Yes	20
*maxnz*2	A function of other parameters.	**No**	2**maxnz*
ixkms	Maximum distance between edge nodes in x direction.	**No**	1500
iykms	Maximum distance between edge nodes in y direction.	**No**	1500
izkms	Maximum distance between edge nodes in z direction.	**No**	1500
mxdtm	A function of other parameters.	**No**	*maxobs***mxpari*
mgsol	A function of other parameters.	**No**	*mxpari** (*mxpari* +1))/2
mxpri 1	A function of other parameters.	**No**	*mxpari* +1

‡Note that *maxobs* typically can be set much lower than *maxsta* since events rarely yield picks at all stations.

†*mxpari* must provide space for v_P and v_P/v_S nodes as well as station corrections for each. *mxpari* will typically be much lower than *maxpar* since velocity nodes and station corrections often are fixed in some areas. (Station corrections are usually fixed to zero in the region of the velocity inversion, used principally to accommodate ill-modeled structure between there and distal stations.) *maxpar* includes all nodes and station correction terms, except the edge nodes.

Definitions of Some Internal Variables

Name	Definition
nobs	Number of observations for a given event.
nparv *nparvi*	The number of velocity parameters. Number of velocity parameters to be inverted for.
npar *npari*	*nparv*, if station delays are not calculated. *nparvi*, if station delays are not calculated.
n	Number of observed nodes.
nseg *nrc* *sep*	Number of segments in the longest ray†. Number of curves for segmented circular rays†. Maximum allowed distance from event to station.

†In **simulps12**, $nseg = 130$, **and these ray-tracing parameters are not designed for user modification** (other arrays are affected). For a given ray $nseg = 2^{(1+\mathrm{nint}(3.32193 * \mathrm{alog10}(sep/scale1)))}$, but this is limited to $nseg \le 2^7$ by subroutine **setup**. **setup** computes $ncr = 1 + 0.5 \times sep/scale$, the maximum number of curves for the circular rays. *sep* is the maximum distance between event and station and is computed in **rayweb**.

Common Block Array Dimensions

Common block /*observ*/

Array dimension(s)	Apply to variable(s)
(*nsts*) (*nobs*, *neqs* +*nbls* +*nsht*) (3, *nsts*)	*stn*, *ltds*, *sltm*, *lnds*, *slnm* *isto*, *wt*, *secp*, *intsp* *stc*

Common block /*nrdsta*/

Array dimension(s)	Apply to variable(s)
(*nsts*, 2)	*nrd*

Common block /*obsiw*/

Array dimension(s)	Apply to variable(s)
(*nobs*, *neqs* +*nbls* +*nsht*)	*iw*

Common block /*vmod* 3*d*/

Array dimension(s)	Apply to variable(s)
(nx)	*xn*
(ny)	*yn*
(nz)	*zn*
$(nx, ny, 2 \times nz)$	*vel* (first half is v_P, the second v_P/v_S)

Common block /*modinv*/

Array dimension(s)	Apply to variable(s)
$(npar)$	*hit*, *vadj*, *khit*, *nfix*, *ndexfx*
$(npari)$	*mdexfx*
$(nobs \times npari)$	*dtm*, *dtmp*
$(nobs)$	*resp*

Common block /*hypinv*/

Array dimension(s)	Apply to variable(s)
$(nobs)$	*res*
$(nobs, 4)$	*dth*, *dthp*
$(nobs, neqs + nbls + nsht)$	*dlta*

Common block /*solutn*/

Array dimension(s)	Apply to variable(s)
$(n(n+1)/2)$	*g*, *g1*
$(npari+1)$	*rhs*, *rhs1*
$(npari)$	*index*, *jndex*

Common block /*locate*/

Array dimension(s)	Apply to variable(s)
$(ixkms)$ = the size† of map in x direction (i.e., the distance between the furthest nodes)	*ixloc*
$(iykms)$ = the size† of map in y direction	*iyloc*
$(izkms)$ = the size† of map in z direction	*izloc*

†Size in integer multiples of *bld* km, hence, $0.1m$ km or $1.0m$ km, with m some positive integer (currently restricted to $m < 1500$).

Common block /*events*/

Array dimension(s)	Apply to variable(s)
(*neqs* +*nbls* +*nsht*)	*mino*, *seco*, *ltde*, *eltm*, *ihr*, *lnde*, *elnm*, *kobs*, *iyrmo*, *iday*, *rmag*
(3, *neqs* +*nbl* +*nsht*)	*evc*

Common block /*rpath*/

Array dimension(s)	Apply to variable(s)
(3, *nseg*, *nobs*)	*rp*
(*nobs*)	*nrp*, *pl*, *tt*

Common block /*resltn*/

Array dimension(s)	Apply to variable(s)
(*npar*)	*drm*, *stderr*

Some Subroutine Array Dimensions and Call-Parameters

Many of the "variables" in the following subroutines are, in fact, parameters in the call list. The last (often only) dimension of these parameters is, therefore, redundant, since FORTRAN passes by pointer and the space is allocated in a preceding routine. They are shown equal to the dimensions in the calling routines only for completeness, and are indicated by ‡, below.

Dimensions in subroutine **ludecp**

Array dimension(s)	Apply to variable(s)
(*n*(*n* + 1)/2‡)	*a*, *ul*

Dimensions in subroutine **luelmp**

Array dimension(s)	Apply to variable(s)
(*n*(*n* + 1)/2‡)	*a*
(*npari* + 1‡)	*b*, *x*

Dimensions in subroutine **fksvd**

Array dimension(s)	Apply to variable(s)
(*nobs*)	*as1*, *as2*, *v1*, *v2*
(*nobs*, *nobs*‡)	*a*
(4, 4‡)	*v*
(4‡)	*s*
(250)	*t* (this is a temporary array)

Dimensions in subroutine **rayweb**

Array dimension(s)	Apply to variable(s)
(3×*nseg*)	*strpth*, *fstpth*, *trpth1*
(*nseg*)	*pthsep*
(3, 9)	*dipvec*
(3×*nseg*, 9)	*disvec*, *trpath*
(9)	*trtime*

Additional variables initialized near the top of **main**:
(used for array-bound checking)

Name	Definition	Now at
iastns	Maximum number of stations.	1300
iaobs	Maximum number of observations per event (including t_P and $t_S - t_P$).	180
iaeqs	Maximum number of earthquakes+blasts+shots.	600
ianod	Maximum number of velocity nodes in model (both v_P and v_P/v_S, but not edge nodes)†.	3200
ianodi	Maximum number of velocity nodes to invert (both v_P and v_P/v_S, but not edge nodes)†.	700
iasltn	Solution array size, $n(n+1)/2$, where n nodes are observed.	180300

†Currently must include room for any computed station delays (both *P* and *S–P*), so the actual velocity node-grid must be smaller if one computes these delays.

Appendix C: Cliff Thurber's User's Manual

USER'S MANUAL FOR SIMUL3

Third Edition

2/1/85
(with a correction 05/94)

C. Thurber

S.U.N.Y. at
Stony Brook

INTRODUCTION

The computer algorithm SIMUL3 is designed to use first-P arrival time data from local earthquakes (and quarry blasts or shots) recorded by a network of stations to derive a three-dimensional seismic velocity model for the crust beneath the network. The final solution is achieved using an iterative procedure, and refined earthquake locations are also determined. At present, approximate ray tracing is used to compute travel times of seismic waves in the crustal model, which is given by the velocity defined at a set of points constituting a three-dimensional grid and interpolated in between. Parameter separation is used to minimize computer storage requirements. Background information on simultaneous inversion can be found in Aki and Lee (1976), Spencer and Gubbins (1980), Pavlis and Booker (1980), and Thurber (1983, 1984). SIMUL3 is a completely self-contained algorithm, requiring about 320 K of memory storage. Machine dependent constants required for the singular value decomposition routine are computed internally.

CAVEAT

SIMUL3 is a complex algorithm, and the problem of inferring crustal structure from arrival time data is not yet truly "routine". Therefore it is strongly advised that all users generate appropriate test cases, modeled on the actual data set(s) to be analyzed, to confirm that SIMUL3 will perform adequately when applied to the actual data. This is currently the only reasonable means of testing the method for each application. Note that one built-in limitation of the program is the size of region that can be modeled accurately—SIMUL3 is not expected to perform well for arrays extending more than 50 by 50 kilometers, and thus should not be applied to regional networks without careful testing.

PROGRAM INPUT

Four types of input data are required for SIMUL3: control parameters, station list, velocity model, and event data. The control parameters and other inputs are defined, and their proper formats are described here. The following section discusses guidelines for appropriate input values, etc. Depending on the computer used, these four input types can be stored in four separate files, or concatenated into a single file. The SIMUL3 distribution version assumes a single file is used. Data is read from the file sim.dat via FORTRAN I/O file number 4.

CONTROL FILE

The control file contains parameter values which direct the execution of the algorithm and which affect the ray tracing, location, and inversion routines. Some parameters have rather obvious meanings—for example, NEQS, NQRY, and NSHT represent the number of earthquakes, quarry blasts, and shots, respectively. Other parameters are relatively obscure, and therefore will be described in some detail.

Ray tracing methods and parameters

Two forms of ray tracing are available within SIMUL3, but NEITHER is a "true" three-dimensional ray tracer—this remains the single most important limitation of SIMUL3 at the present time. The search for a reliable, efficient ray tracer continues. Presently, approximate ray tracing (ART) is the work-horse ray tracer—it is described only briefly by Thurber (1983), so a more complete discussion is presented here. The second ray tracer uses what I (CHT) call a "pseudo-bending" method, designed to perturb an ART ray path closer to the "true" ray path, without actually solving the full ray equations rigorously. For both methods, the same simple method of interpolation is used (Thurber, 1983).

The ART method adopts a brute-force approach to finding the minimum time ray path (actually an ESTIMATE of the true path). A large set of smooth curves connecting the source and receiver are constructed using an efficient but somewhat arbitrary scheme. The travel time along each such curve is calculated numerically, and an estimate of the true ray path is obtained by sorting through these computed travel times to find the "fastest" curve. For paths which are not too long (50 km or less in general) the travel time estimate agrees quite well with the "true" travel time (standard deviation of 0.02 sec) for all hypothetical crustal models tested to date. An inherent limitation of this method is that the path curvature is constant along a given curve, and each curve lies within a plane.

The pseudo-bending method takes a geometric approach to the estimation of the true ray path. The ray equations can be written in a form which shows that, for a true ray path, the path curvature is anti-parallel to the component of the local velocity gradient normal to the path at each point (Cerveny *et al.*, 1977). This fact can be used to perturb the ART path piecewise to bring it closer to satisfying this property. This permits a given ray path estimate to have a curvature which varies along the ray, as well as allowing the path to deviate from a single plane. Tests of this method are in progress—users are encouraged to compare results obtained using the two methods. Parameter I3D effects the choice of ray tracing.

CONTROL FILE FORMAT

Line #	Columns	Format	Variable	Explanation
1	1 - 3	I3	NEQS	Number of earthquakes
	4 - 6	I3	NQRY	Number of quarry blasts
	7 - 9	I3	NSHT	Number of shots
	10 - 13	F4.1	WTSHT	Weighting factor for shot data
2	1 - 3	I3	NITLOC	Maximum number of hypocenter relocations each step
	4 - 8	F5.3	EIGTOL	Singular value cutoff for relocations
	9 - 13	F5.3	RMSCUT	Cutoff value for event RMS residual to terminate relocation
3	1 - 3	I3	NHITCT	Minimum number of "observations" of a grid point for it to be included in inversion
	4 - 8	F5.3	DVMAX	Maximum velocity perturbation per iteration
	9 - 13	F5.3	VDAMP	Damping parameter for velocity inversion step
	14 - 18	F5.3	STEPL	Step length for accumulating velocity partials along ray path
4	1 - 3	I3	IRES	Flag for computing resolution and standard error (1=yes; 0=no)
	4 - 6	I3	I3D	Flag for using pseudo-bending (1=yes; 0=no)
	7 - 9	I3	NITMAX	Maximum number of velocity inversion steps
	10 - 12	I3	IHOMO	Flag for starting 1-D velocity model (1=yes; 0=no)
	13 - 17	F5.3	RMSTOP	Cutoff for overall RMS to terminate velocity inversion steps
	14 - 16	I3	IFIX	Number of velocity inversion steps to keep hypocenters fixed at start of progressive inversion
5	1 - 5	F5.1	DELT1	Epicentral distance below which data is fully weighted
	6 - 10	F5.1	DELT2	Epicentral distance above which data is zero-weighted (linear taper in between)
	11 - 15	F5.2	RES1	Residual below which data is fully weighted
	16 - 20	F5.2	RES2	Residual above which data is zero-weighted (linear taper in between)

CONTROL FILE FORMAT (continued)

Line #	Columns	Format	Variable	Explanation
6	1 - 3	I3	NDIP	Number of rotated planes on which ART path search is carried out (1,3,5,9)
	4 - 6	I3	NSKIP	Number of shallowest NDIP planes to skip to speed up the ART search
	7 - 11	F5.2	SCALE1	Path segment length limit for ART travel time calculations
	12 - 16	F5.2	SCALE2	Scale-length for maximum separation between adjacent paths within one search plane in ART
7	1 - 5	F5.2	XFAC	Convergence enhancement factor for pseudo-bending
	6 - 12	F7.4	TLIM	Cutoff value for travel time difference to terminate iteration
	13 - 15	I3	NITPB	Maximum permitted iterations for pseudo-bending

CONTROL FILE NOTES AND COMMENTS

Line 1:

Total number of events currently cannot exceed 90.

Value of WTSHT is up to the user, depending on amount of shot data relative to earthquake data, and the reliability of the former.

Line 2:

Reasonable values for NITLOC and EIGTOL are 3 to 5 and 0.01 to 0.02.

Appropriate RMSCUT depends on data quality, etc.

Line 3:

NHITCUT: about 25, depending on available data and fineness of grid.

DVMAX: NEVER > 1 km/sec; 0.25 to 0.50 is OK, depending on severity of inhomogeneities and quality of starting model.

VDAMP: Requires experimentation—0.1 to 10.0 is a minimum range.

STEPL: 0.5 to 1.0 km (affects computation time significantly).

Line 4:

NITMAX: 3 to 6, depending on heterogeneity and starting model.

RMSTOP: depends on data quality.

IFIX: 0 to 2 or more, depending on your faith in initial estimates of hypocenters.

Line 5:

DELT1, DELT2: no firm rules; depends on network, data quality, etc. I (CHT) generally use 20 and 100 km for good data.

RES1, RES2: ditto. I (CHT) generally use 0.2 sec and 1.0 sec.

Line 6:

NDIP: Permitted values are 1, 3, 5, 9. Affects fineness of lateral sampling for possible minimum time ray path:

1 → sample vertical plane only
3 → add horizontal planes

5 → add two 45 degree dipping planes
9 → add four intervening planes at
22.5 degree intervals.

Ideally, use 9 always (see below), but travel time computation is lengthened noticeably.

NSKIP: Permitted values are 0 to 4. If you desire fine sampling (large NDIP) but don't think nearly horizontal ray paths occur, use NSKIP to ignore the NSKIP shallowest pairs of planes (i.e., NSKIP=1 → skip horizontal planes; NSKIP=2 → skip two 22.5 degree dipping planes, etc.). Good way to compromise on computation time, although some program efficiency enhancements have reduced the importance of this.

SCALE1: For ART, maximum permitted interval between adjacent points along a given path, for numerical computation of travel time. Construction scheme prohibits more than 129 points per path, so SCALE1 MUST BE LARGER‡ THAN the maximum possible path length divided by 129. Otherwise serious array problems will result, and computations will be MEANINGLESS. WARNING: SCALE1 has DRAMATIC effect on computation time.

(‡There is a typo here in the original notes, which indicated "SMALLER".)

SCALE2: Maximum permitted maximum separation between adjacent ART paths within a given plane—controls fineness of sampling in each plane.

Line 7:

XFAC: reasonable enhancement factor is 1.2 to 1.5.

TLIM: stop iterations when delta-t is below 0.0005 to 0.002 seconds.

NITPB: how good a ray path do you desire? Reasonable value is 5 to 10. More experimentation required here.

STATION LIST FILE

The station list file identifies the coordinate system, both the origin and any rotation from NS-EW axes. The +Y axis points North for zero rotation and the +X axis points West; the rotation angle (in degrees) is measured COUNTERCLOCKWISE from North. WARNING—The algorithm is ONLY prepared to accept coordinates in terms of degrees North and degrees West. A maximum of twenty five stations are permitted. Stations are modeled at their TRUE elevations, i.e., they are not assumed to all lie on a horizontal plane.

STATION LIST FORMAT

Line #	Columns	Format	Variable	Explanation
1	1 - 3	i3	ltdo	Degree part of coordinate origin latitude
	5 - 9	f5.2	oltm	Minute part of coordinate origin latitude
	10 - 13	i4	lndo	Degree part of coordinate origin longitude
	15 - 19	f5.2	olnm	Minute part of coordinate origin longitude
	20 - 26	f7.2	rota	Angle (in DEGREES) of counterclockwise rotation of coordinate axes (X - Y)
2	1 - 3	i3	nsts	Number of stations (≤25)
3 to nsts + 2	3 - 6	a4	stn(j)	Station name
	7 - 8	i2	ltds(j)	Station latitude—degrees
	10 - 14	f5.2	sltm(j)	Station latitude—minutes
	15 - 18	i4	lnds(j)	Station longitude—degrees
	20 - 24	f5.2	slnm(j)	Station longitude—minutes
	25 - 29	i5	ielev	Station elevation in METERS

VELOCITY MODEL FILE

The velocity model is represented by velocity values specified on a three-dimensional grid of nodes (grid points). The nodes are located at the intersections of three sets of planes with normals in the X, Y and Z directions. The spacing between any pair of adjacent planes is arbitrary. One built-in requirement for the grid is the need for a set of 6 bounding planes positioned at a "significant" distance from the rest of the grid, one pair each in the X, Y, and Z directions. By significant, it is meant that no seismic ray will ever extend more than 5% of the way towards a bounding plane from one of the adjacent inner planes. These bounding planes are explicitly ignored in the velocity inversion.

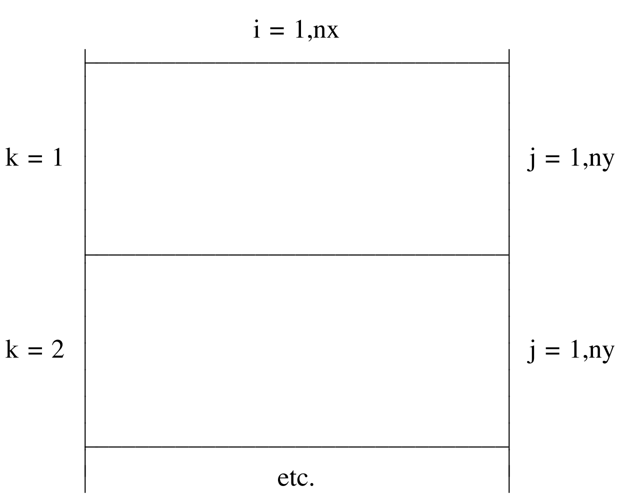
Experience has shown that better resolution of velocity values is obtained if the network of stations encompasses the velocity grid, excluding the bounding grid planes. In other words, given a map of the seismic stations and the velocity grid, the bounding planes should be positioned well away from the model area, and otherwise the velocity grid should be contained WITHIN the seismic array.

Velocity values at points within the grid are calculated using a simple interpolation scheme. Given the velocity values at the eight grid points surrounding a certain point P within the model, the velocity at P is a weighted sum of those eight values. The weights are products of three linear tapers in the X, Y, and Z directions. These weights are also used in apportioning the velocity partial derivatives in the inversion step.

VELOCITY MODEL FORMAT

Line #	Columns	Format	Variable	Explanation
1	1 - 3 4 - 6 7 - 9	i3 i3 i3	nx ny nz	Number of nodes in the X, Y, and Z directions. Maximum values: 12 for nx,ny; 7 for nz (THIS INCLUDES BOUNDING PLANES)
2	1 - 6nx	nx(f6.0)	xn(1:nx)	X coordinates of the nodes.
3	1 - 6ny	ny(f6.0)	yn(1:ny)	Y coordinates of the nodes.
4	1 - 6nz	nz(f6.0)	zn(1:nz)	Z coordinates of the nodes.
5 to 4+nz×ny	1 - 5nx	nx(f5.2)	vel(i,j,k)	Velocity values at the nodes.

NOTE: read in velocity values as follows:



VELOCITY MODEL NOTES

As noted above, nx and ny cannot exceed 12, and nz cannot exceed 7. In addition, the product (nx-2)*(ny-2)*(nz-2) MUST NOT EXCEED 120!!! The numerical values of the grid point coordinates MUST be INTEGRAL, that is to say values such as zn(3)=12.5 km are NOT permitted. The maximum range for one coordinate direction, for example xn(nx)-xn(1), is limited to 499 km, although this is a dimension which is easy to change (the array sizes for ixloc, iyloc, and izloc, and in the call to subroutine intmap). A final critical point concerns the bounding nodes—as stated above, these nodes must be displaced sufficiently far from the interior grid points, those which are actually part of the model, so that no ray ever strays farther than 1/20'th of the way past the outermost interior grid points. For example, if xn(1)=-200. and xn(2)=0., then there will be no problem if no ray strays past x=-10.

EVENT DATA FILE

The summary and phase data (trial locations and arrival times) are combined in a compact format containing, for each event, a beginning line for the trial location and subsequent lines listing sets of station names, reading weights, and TRAVEL times (observed arrival time minus estimated origin time). The summary card line is identical to **hypo71** format. Event data must be supplied in the order: earthquakes, quarry blasts, shots. By "quarry blasts", we mean man-made explosions of known location but unknown origin time, while "shots" have known origin times. The number of each type of event must be known and supplied as input parameters in the control file.

Reading weights represent the estimated precision of the arrival time reading, with weights of 0,1,2,3,4 indicating weights of 1.0, 0.5, 0.25, 0.125, and 0.0.

EVENT DATA FORMAT

Line #	Columns	Format	Variable	Explanation
1	1 - 4	a4	iyrmo	Year and month of event
	5 - 6	a2	iday	Day of event
	7 - 9	a3	ihr	Hour of event
	10 - 11	i2	mino(n)	Event minute
	13 - 17	f5.2	seco(n)	Event second
	18 - 20	i3	ltde(n)	Degree part of event latitude
	22 - 26	f5.2	eltm(n)	Minute part of event latitude
	28 - 30	i3	lnde(n)	Degree part of event longitude
	32 - 36	f5.2	elnm(n)	Minute part of event longitude
	37 - 43	f7.2	dep	Event depth
2 on		6(a4,1x,i1,f6.2)	sta(j),ip(j),tt(j),j=1,6	Station name, reading weight, and travel time (which is the *observed* arrival time minus the *computed* origin time!)

FOLLOWED BY BLANK LINE

Repeated for each event.

Carefully inspect the sample input and output files for a realistic application, using synthetic data.

GOOD LUCK!

Appendix D: *simulps12* **I/O example for** v_P **and** v_P/v_S **(that of directory "test_case")**
Contributed by A. D. Miller, Durham University, U.K.

In I/O listings in this manual, spelling errors and abbreviations are left as they appear in the real output.

Input Files

Unit 01—Control File

```
 93   0   0 1.0   4 1 0            neqs, nshot, nblast, wtsht, kout, kout2, kout3
10   1.0   0.020   0.01   0.0   0.50   0.01   0.00   nitloc, wtsp, eigtol, rmscut, zmin, dxmax, rderr, ercof
30   0.10   0.03   1   20.0   30.0   99.00   0.50   hitct, dvpmax, dvpvsmax, idmp, vpdmp, vpvsdmp, stadmp, stepl
1   2   2   0.005   0 0.02   0     ires, i3d, nitmax, snrmct, ihomo, rmstop, ifixl
20.0   35.0   0.10   0.25   0.30    delt1, delt2, res1, res2, res3
9  2   0.5   0.5                   ndip, iskip, scale1, scale2
1.2   0.001   15   15        xfax, tlim, nitpb1, nitpb2
1  1   0                           iusep, iuses, invdel
```

Unit 02—Station Data File

```
64   2.50   21 17.0   0.0
  33
  H00163 56.67   21 24.75   268 0.00 0.00   0
  H00363 57.08   21  6.81    93 0.00 0.00   0
  H00464  0.56   21 28.04   353 0.00 0.00   0
  H00564  0.18   21 15.06   388 0.00 0.00   0
  H00663 59.91   21  5.76   186 0.00 0.00   0
  H00764  1.10   21 11.56   155 0.00 0.00   0
  H00864  2.00   21  3.39   165 0.00 0.00   0
  H00964  2.66   21  9.06   510 0.00 0.00   0
  H01064  1.89   21 12.91   309 0.00 0.00   0
  H01164  2.23   21 15.23   435 0.00 0.00   0
  H01264  3.08   21 11.75   333 0.00 0.00   0
  H01464  3.99   21 13.58   470 0.00 0.00   0
  H01564  3.11   21 16.01   467 0.00 0.00   0
  H01664  1.69   21 19.04   419 0.00 0.00   0
  H01764  1.98   21 21.99   453 0.00 0.00   0
  H01864  2.88   21 13.82   404 0.00 0.00   0
  H01964  3.00   21 24.73   319 0.00 0.00   0
  H02064  4.88   21 31.65   270 0.00 0.00   0
  H02164  6.01   21 21.67   361 0.00 0.00   0
  H02264  7.28   21 24.97   391 0.00 0.00   0
  H02364  5.07   21 16.09   425 0.00 0.00   0
  H02464  4.62   21 12.61   390 0.00 0.00   0
  H02564  4.40   21 10.13   418 0.00 0.00   0
  H02664  4.65   21  5.16   258 0.00 0.00   0
  H02764  7.12   21  5.41   182 0.00 0.00   0
  H02864  7.72   21 12.71   202 0.00 0.00   0
  H02964  6.58   21 18.46   407 0.00 0.00   0
  H03064  9.01   21 16.35   302 0.00 0.00   0
  H03364  3.16   21 19.09   495 0.00 0.00   0
  H03464  5.11   21 15.49   369 0.00 0.00   0
  H03564  7.09   21  5.53   192 0.00 0.00   0
  H03663 56.58   21  6.51    80 0.00 0.00   0
   bja63 56.74   21 18.14   118 0.00 0.00   0
```

Unit 03—Node-Grid and Initial-Velocity Model

```
 1.0   7   7 11
-245.0 -12.0   -6.0    0.0    6.0   12.0 245.0
-245.0 -12.0   -6.0    0.0    6.0   12.0 245.0
-150.0   -1.0    0.0    1.0    2.0    3.0    4.0    5.0    6.0    8.0 150.0
  2   2   2
  3   2   2
  4   2   2
  5   2   2
  6   2   2
  2   3   2
  3   3   2
  4   3   2
  5   3   2
  6   3   2
  2   4   2
  3   4   2
  4   4   2
  5   4   2
  6   4   2
  2   5   2
```

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6	2	19
2	6	19
6	6	19
2	2	20
6	2	20
2	6	20
6	6	20
0	0	0

1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00
2.10	2.10	2.10	2.10	2.10	2.10	2.10
2.10	2.10	2.10	2.10	2.10	2.10	2.10
2.10	2.10	2.10	2.10	2.10	2.10	2.10
2.10	2.10	2.10	2.10	2.10	2.10	2.10
2.10	2.10	2.10	2.10	2.10	2.10	2.10
2.10	2.10	2.10	2.10	2.10	2.10	2.10
2.10	2.10	2.10	2.10	2.10	2.10	2.10
3.23	3.23	3.23	3.23	3.23	3.23	3.23
3.23	3.15	3.17	3.19	3.20	3.21	3.23
3.23	3.31	3.28	3.24	3.21	3.17	3.23
3.23	3.48	3.38	3.29	3.21	3.13	3.23
3.23	3.31	3.27	3.23	3.20	3.18	3.23
3.23	3.14	3.15	3.16	3.19	3.23	3.23
3.23	3.23	3.23	3.23	3.23	3.23	3.23
4.36	4.36	4.36	4.36	4.36	4.36	4.36
4.36	4.17	4.24	4.30	4.33	4.35	4.36
4.36	4.38	4.41	4.43	4.39	4.34	4.36
4.36	4.58	4.58	4.57	4.46	4.34	4.36
4.36	4.40	4.39	4.38	4.38	4.38	4.36
4.36	4.22	4.21	4.20	4.30	4.41	4.36
4.36	4.36	4.36	4.36	4.36	4.36	4.36
5.38	5.38	5.38	5.38	5.38	5.38	5.38
5.38	5.17	5.21	5.25	5.31	5.37	5.38
5.38	5.38	5.41	5.44	5.40	5.37	5.38
5.38	5.59	5.61	5.63	5.50	5.36	5.38
5.38	5.41	5.41	5.41	5.41	5.41	5.38
5.38	5.23	5.21	5.19	5.32	5.45	5.38
5.38	5.38	5.38	5.38	5.38	5.38	5.38
5.93	5.93	5.93	5.93	5.93	5.93	5.93
5.93	5.72	5.75	5.77	5.84	5.92	5.93
5.93	5.88	5.94	6.00	5.95	5.91	5.93
5.93	6.03	6.13	6.23	6.06	5.89	5.93
5.93	5.91	5.94	5.97	5.97	5.97	5.93
5.93	5.79	5.75	5.72	5.88	6.05	5.93
5.93	5.93	5.93	5.93	5.93	5.93	5.93
6.26	6.26	6.26	6.26	6.26	6.26	6.26
6.26	6.11	6.11	6.10	6.17	6.24	6.26
6.26	6.21	6.28	6.36	6.31	6.25	6.26

```
6.26 6.30 6.46 6.62 6.45 6.27 6.26
6.26 6.25 6.32 6.38 6.33 6.28 6.26
6.26 6.19 6.17 6.15 6.22 6.29 6.26
6.26 6.26 6.26 6.26 6.26 6.26 6.26
6.42 6.42 6.42 6.42 6.42 6.42 6.42
6.42 6.38 6.32 6.25 6.33 6.41 6.42
6.42 6.42 6.48 6.53 6.48 6.42 6.42
6.42 6.47 6.64 6.81 6.62 6.44 6.42
6.42 6.44 6.58 6.72 6.57 6.42 6.42
6.42 6.41 6.53 6.64 6.51 6.39 6.42
6.42 6.42 6.42 6.42 6.42 6.42 6.42
6.50 6.50 6.50 6.50 6.50 6.50 6.50
6.50 6.51 6.53 6.55 6.52 6.49 6.50
6.50 6.51 6.57 6.62 6.56 6.50 6.50
6.50 6.52 6.60 6.68 6.60 6.52 6.50
6.50 6.51 6.55 6.59 6.55 6.51 6.50
6.50 6.50 6.50 6.51 6.51 6.51 6.50
6.50 6.50 6.50 6.50 6.50 6.50 6.50
6.60 6.60 6.60 6.60 6.60 6.60 6.60
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6.60 6.60 6.60 6.60 6.60 6.60 6.60
8.00 8.00 8.00 8.00 8.00 8.00 8.00
8.00 8.00 8.00 8.00 8.00 8.00 8.00
8.00 8.00 8.00 8.00 8.00 8.00 8.00
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8.00 8.00 8.00 8.00 8.00 8.00 8.00
8.00 8.00 8.00 8.00 8.00 8.00 8.00
1.78 1.78 1.78 1.78 1.78 1.78 1.78
1.78 1.78 1.78 1.78 1.78 1.78 1.78
1.78 1.78 1.78 1.78 1.78 1.78 1.78
```

(71 identical lines deleted for brevity in this *Open-file Report*)

```
1.78 1.78 1.78 1.78 1.78 1.78 1.78
1.78 1.78 1.78 1.78 1.78 1.78 1.78
1.78 1.78 1.78 1.78 1.78 1.78 1.78
```

Unit 04—Traveltime Data for Earthquakes

```
910814 1948 37.39 63 56.66  21 22.74   3.95
H001_Pu0 0.940H004_Pu0 1.939H006_Pd0 3.043H007_Pd0 2.459H008_Pd0 3.477H009_Pd1 3.054
H009_SP2 2.321H010_Pd0 2.584H011_P_1 2.528H012_Pd0 2.881H015_Pd0 2.693H015_SP2 2.130
H018_Pd0 2.734H019_Pu0 2.463H019_SP2 1.920H020_Pu0 3.193H020_SP2 2.520H021_Pu0 3.305
H022_Pu0 3.713H024_Pd0 3.231H024_SP2 2.530H026_Pd0 3.775H026_SP2 2.939H033_Pd0 2.560
H033_SP2 2.040

910814 1018 38.75 63 56.53  21 22.74   4.51
H001_Pu1 1.005H004_Pu1 1.986H004_SP2 1.521H005_Pd1 2.130H007_Pd0 2.509H007_SP2 1.850
H008_Pd0 3.500H008_SP3 2.729H009_Pd0 3.086H009_SP2 2.320H010_Pd0 2.625H010_SP2 1.989
H011_Pd0 2.559H012_Pd1 2.921H012_SP2 2.320H014_Pd1 3.080H015_Pu0 2.677H015_SP2 2.179
H017_Pu0 2.234H017_SP2 1.861H018_Pd0 2.755H018_SP2 2.110H019_Pu0 2.504H019_SP2 1.931
H020_Pu0 3.212H020_SP2 2.470H021_Pu0 3.336H021_SP2 2.520H022_Pu0 3.763H023_Pd0 3.203
H023_SP2 2.400H024_Pd0 3.262H024_SP2 2.540H025_Pd1 3.354H025_SP2 2.570H027_Pd0 4.309
H027_SP2 3.340H028_Pd1 4.035H029_Pu1 3.567H029_SP2 2.790H031_Pu0 4.863H031_SP2 3.780
H033_Pd0 2.591H033_SP3 2.001
```

(89 other events deleted for brevity in this *Open-file Report*)

```
910820 1949 28.34 64 06.37  21 16.01   5.91
H005_Pu0 2.440H005_SP2 1.880H009_Pu0 2.084H009_SP2 1.530H010_Pu0 1.991H010_SP2 1.430
H012_Pu0 1.804H012_SP1 1.300H014_Pu0 1.623H014_SP2 1.160H015_Pu0 1.682H016_Pu1 2.150
H016_SP3 1.538H018_Pu0 1.750H018_SP2 1.240H019_Pu0 2.065H019_SP2 1.571H020_Pu0 2.711
H020_SP1 1.918H021_Pd0 1.599H021_SP2 1.050H022_Pd0 1.928H022_SP2 1.480H024_Pu0 1.500
H024_SP2 1.100H025_Pu0 1.731H025_SP2 1.210H028_Pu0 1.330H028_SP2 1.150H029_Pd0 1.238
H030_Pd0 1.479H030_SP2 1.119H031_Pu0 2.202H031_SP2 1.690H033_Pu0 1.764H033_SP2 1.410
H034_Pu0 1.294H034_SP2 0.930H035_Pu0 2.009H035_SP2 1.550

910921 0408 09.28 64 06.80  21 13.00   5.63
H006_Pu1 2.764H007_Pu0 2.200H007_SP2 1.600H008_Pu0 2.448H008_SP2 1.860H009_Pu0 2.010
H009_SP2 1.469H010_Pu0 2.029H010_SP2 1.510H011_Pu4 2.004H012_Pu0 1.786H012_SP2 1.279
H014_Pu0 1.658H014_SP2 1.240H016_Pu0 2.323H017_Pd4 2.532H017_SP2 2.010H018_Pu0 1.810
H019_Pu0 2.429H019_SP2 1.789H020_Pu0 3.031H021_Pu0 1.834H022_Pd1 2.287H025_Pu0 1.582
H025_SP2 1.140H026_Pu1 1.847H026_SP2 1.420H028_Pd0 1.136H028_SP2 1.070H029_Pd0 1.488
H029_SP2 1.110H030_Pd1 1.474H030_SP2 1.170H031_Pu0 2.210H031_SP3 1.610H033_Pu0 1.996
H033_SP3 1.390H035_Pu0 1.608H035_SP2 1.240
```

Output Files

Unit 12—Hypocenters from each Iteration

No file is produced on Unit 12 in this test case.

Unit 13—Final Hypocenters

No file is produced on Unit 13 in this test case.

Unit 16—"Printed" output

```
Computation began at 13-Apr-94 11:06:02
Program Simulps12 (15-Mar-94 DMEP) Solves for Vp and Vp/Vs; Input data is P travel-time and S-P time.
      Can vary relative weighting of S-P times in hypocenter location.
      Allows fixed nodes (up to  5200 parameters, up to   700 solution parameters);
      up to  600 events,  1800 stations,  180 observations per event
      Psuedo-bending; Allows less curvature "Moho" for initial arcuate paths.

control parameters
kout kout2 kout3
  4    1     0

neqs nsht nbls wtsht nitloc wtsp  zmin eigtol  rmscut hitct dvpmx dvpvsmx
  93   0   0     1.0  10    1.00  0.00 0.020    0.010   30.  0.10  0.03

idmp  vpdamp vpvsdmp stadamp ires nitmax snrmct dxmax rderr ercof
 1     20.00   30.00   99.00  1      2  0.00500  0.50  0.01  0.00
# its. for 1-d vel. model =   0
rms for term. = 0.020
fix locations for iterations =   0
distance weighting:  20.00  35.00; residual weighting: 0.10 0.25 0.30
step length for integration: 0.500
parameters for approximate ray tracer
     ndip iskip scale1 scale2
       9     2   0.50   0.50
 parameters for pseudo-bending:
 i3d xfac   tlim  nitpb(1) nitpb(2)
  2  1.20 0.0010    15        15

Both P-velocity and Vp/Vs are included in inversion  (iusep= 1, iuses= 1)

 computed machine constants eta and tol:     0.119209E-06    0.986076E-31

 origin :  latitude   longitude   rotation
           64  2.50     21 17.00      0.00
    short distance conversion factors
         one min lat    1.8580 km
         one min lon    0.8143 km

  station   latitude   longitude   elev     x      y      z   pdl s-pdl nfixst
    1   H001  63 56.67    21 24.75   268    6.32 -10.83  -0.27 0.00 0.00   0
    2   H003  63 57.08    21  6.81    93   -8.31 -10.07  -0.09 0.00 0.00   0
    3   H004  64  0.56    21 28.04   353    9.00  -3.60  -0.35 0.00 0.00   0
    4   H005  64  0.18    21 15.06   388   -1.58  -4.31  -0.39 0.00 0.00   0
    5   H006  63 59.91    21  5.76   186   -9.16  -4.81  -0.19 0.00 0.00   0
    6   H007  64  1.10    21 11.56   155   -4.43  -2.60  -0.16 0.00 0.00   0
    7   H008  64  2.00    21  3.39   165  -11.08  -0.93  -0.17 0.00 0.00   0
    8   H009  64  2.66    21  9.06   510   -6.47   0.30  -0.51 0.00 0.00   0
    9   H010  64  1.89    21 12.91   309   -3.33  -1.13  -0.31 0.00 0.00   0
   10   H011  64  2.23    21 15.23   435   -1.44  -0.50  -0.44 0.00 0.00   0
   11   H012  64  3.08    21 11.75   333   -4.27   1.08  -0.33 0.00 0.00   0
   12   H014  64  3.99    21 13.58   470   -2.78   2.77  -0.47 0.00 0.00   0
   13   H015  64  3.11    21 16.01   467   -0.81   1.13  -0.47 0.00 0.00   0
   14   H016  64  1.69    21 19.04   419    1.66  -1.51  -0.42 0.00 0.00   0
   15   H017  64  1.98    21 21.99   453    4.06  -0.97  -0.45 0.00 0.00   0
   16   H018  64  2.88    21 13.82   404   -2.59   0.71  -0.40 0.00 0.00   0
   17   H019  64  3.00    21 24.73   319    6.29   0.93  -0.32 0.00 0.00   0
   18   H020  64  4.88    21 31.65   270   11.92   4.42  -0.27 0.00 0.00   0
   19   H021  64  6.01    21 21.67   361    3.80   6.52  -0.36 0.00 0.00   0
   20   H022  64  7.28    21 24.97   391    6.48   8.88  -0.39 0.00 0.00   0
   21   H023  64  5.07    21 16.09   425   -0.74   4.78  -0.43 0.00 0.00   0
   22   H024  64  4.62    21 12.61   390   -3.57   3.94  -0.39 0.00 0.00   0
   23   H025  64  4.40    21 10.13   418   -5.59   3.53  -0.42 0.00 0.00   0
   24   H026  64  4.65    21  5.16   258   -9.64   3.99  -0.26 0.00 0.00   0
   25   H027  64  7.12    21  5.41   182   -9.42   8.58  -0.18 0.00 0.00   0
   26   H028  64  7.72    21 12.71   202   -3.49   9.70  -0.20 0.00 0.00   0
   27   H029  64  6.58    21 18.46   407    1.19   7.58  -0.41 0.00 0.00   0
   28   H030  64  9.01    21 16.35   302   -0.53  12.10  -0.30 0.00 0.00   0
   29   H033  64  3.16    21 19.09   495    1.70   1.23  -0.50 0.00 0.00   0
   30   H034  64  5.11    21 15.49   369   -1.23   4.85  -0.37 0.00 0.00   0
   31   H035  64  7.09    21  5.53   192   -9.33   8.53  -0.19 0.00 0.00   0
```

```
   32   H036  63 56.58    21  6.51     80   -8.56 -11.00  -0.08 0.00 0.00  0
   33    bja  63 56.74    21 18.14    118    0.93 -10.70  -0.12 0.00 0.00  0


 velocity grid size:
bld = 1.0      nx =  7     ny =  7     nz = 11

 xgrid
   -245.0 -12.0  -6.0   0.0   6.0  12.0 245.0

 ygrid
   -245.0 -12.0  -6.0   0.0   6.0  12.0 245.0

 zgrid
   -150.0  -1.0   0.0   1.0   2.0   3.0   4.0   5.0   6.0   8.0 150.0


 velocity values on three-dimensional grid

 layer  1     P velocity         z = -150.0
  1.00  1.00  1.00  1.00  1.00  1.00  1.00
  1.00  1.00  1.00  1.00  1.00  1.00  1.00
  1.00  1.00  1.00  1.00  1.00  1.00  1.00
  1.00  1.00  1.00  1.00  1.00  1.00  1.00
  1.00  1.00  1.00  1.00  1.00  1.00  1.00
  1.00  1.00  1.00  1.00  1.00  1.00  1.00
  1.00  1.00  1.00  1.00  1.00  1.00  1.00

 layer  2     P velocity         z =   -1.0
  2.10  2.10  2.10  2.10  2.10  2.10  2.10
  2.10  2.10  2.10  2.10  2.10  2.10  2.10
  2.10  2.10  2.10  2.10  2.10  2.10  2.10
  2.10  2.10  2.10  2.10  2.10  2.10  2.10
  2.10  2.10  2.10  2.10  2.10  2.10  2.10
  2.10  2.10  2.10  2.10  2.10  2.10  2.10
  2.10  2.10  2.10  2.10  2.10  2.10  2.10

 layer  3     P velocity         z =    0.0
  3.23  3.23  3.23  3.23  3.23  3.23  3.23
  3.23  3.15  3.17  3.19  3.20  3.21  3.23
  3.23  3.31  3.28  3.24  3.21  3.17  3.23
  3.23  3.48  3.38  3.29  3.21  3.13  3.23
  3.23  3.31  3.27  3.23  3.20  3.18  3.23
  3.23  3.14  3.15  3.16  3.19  3.23  3.23
  3.23  3.23  3.23  3.23  3.23  3.23  3.23

 layer  4     P velocity         z =    1.0
  4.36  4.36  4.36  4.36  4.36  4.36  4.36
  4.36  4.17  4.24  4.30  4.33  4.35  4.36
  4.36  4.38  4.41  4.43  4.39  4.34  4.36
  4.36  4.58  4.58  4.57  4.46  4.34  4.36
  4.36  4.40  4.39  4.38  4.38  4.38  4.36
  4.36  4.22  4.21  4.20  4.30  4.41  4.36
  4.36  4.36  4.36  4.36  4.36  4.36  4.36

 layer  5     P velocity         z =    2.0
  5.38  5.38  5.38  5.38  5.38  5.38  5.38
  5.38  5.17  5.21  5.25  5.31  5.37  5.38
  5.38  5.38  5.41  5.44  5.40  5.37  5.38
  5.38  5.59  5.61  5.63  5.50  5.36  5.38
  5.38  5.41  5.41  5.41  5.41  5.41  5.38
  5.38  5.23  5.21  5.19  5.32  5.45  5.38
  5.38  5.38  5.38  5.38  5.38  5.38  5.38

 layer  6     P velocity         z =    3.0
  5.93  5.93  5.93  5.93  5.93  5.93  5.93
  5.93  5.72  5.75  5.77  5.84  5.92  5.93
  5.93  5.88  5.94  6.00  5.95  5.91  5.93
  5.93  6.03  6.13  6.23  6.06  5.89  5.93
  5.93  5.91  5.94  5.97  5.97  5.97  5.93
  5.93  5.79  5.75  5.72  5.88  6.05  5.93
  5.93  5.93  5.93  5.93  5.93  5.93  5.93

 layer  7     P velocity         z =    4.0
  6.26  6.26  6.26  6.26  6.26  6.26  6.26
  6.26  6.11  6.11  6.10  6.17  6.24  6.26
  6.26  6.21  6.28  6.36  6.31  6.25  6.26
  6.26  6.30  6.46  6.62  6.45  6.27  6.26
  6.26  6.25  6.32  6.38  6.33  6.28  6.26
  6.26  6.19  6.17  6.15  6.22  6.29  6.26
  6.26  6.26  6.26  6.26  6.26  6.26  6.26

 layer  8     P velocity         z =    5.0
  6.42  6.42  6.42  6.42  6.42  6.42  6.42
  6.42  6.38  6.32  6.25  6.33  6.41  6.42
  6.42  6.42  6.48  6.53  6.48  6.42  6.42
  6.42  6.47  6.64  6.81  6.62  6.44  6.42
  6.42  6.44  6.58  6.72  6.57  6.42  6.42
  6.42  6.41  6.53  6.64  6.51  6.39  6.42
  6.42  6.42  6.42  6.42  6.42  6.42  6.42

 layer  9     P velocity         z =    6.0
  6.50  6.50  6.50  6.50  6.50  6.50  6.50
```

6.50	6.51	6.53	6.55	6.52	6.49	6.50
6.50	6.51	6.57	6.62	6.56	6.50	6.50
6.50	6.52	6.60	6.68	6.60	6.52	6.50
6.50	6.51	6.55	6.59	6.55	6.51	6.50
6.50	6.50	6.50	6.51	6.51	6.51	6.50
6.50	6.50	6.50	6.50	6.50	6.50	6.50

layer 10 P velocity z = 8.0

6.60	6.60	6.60	6.60	6.60	6.60	6.60
6.60	6.60	6.60	6.60	6.60	6.60	6.60
6.60	6.60	6.60	6.60	6.60	6.60	6.60
6.60	6.60	6.60	6.60	6.60	6.60	6.60
6.60	6.60	6.60	6.60	6.60	6.60	6.60
6.60	6.60	6.60	6.60	6.60	6.60	6.60
6.60	6.60	6.60	6.60	6.60	6.60	6.60

layer 11 P velocity z = 150.0

8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00

layer 1 Vp/Vs z = -150.0

1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78

layer 2 Vp/Vs z = -1.0

1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78

layer 3 Vp/Vs z = 0.0

1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78

layer 4 Vp/Vs z = 1.0

1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78

layer 5 Vp/Vs z = 2.0

1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78

layer 6 Vp/Vs z = 3.0

1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78

layer 7 Vp/Vs z = 4.0

1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78

layer 8 Vp/Vs z = 5.0

1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78

1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78

layer 9 Vp/Vs z = 6.0

1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78

layer 10 Vp/Vs z = 8.0

1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78

layer 11 Vp/Vs z = 150.0

1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78

layer 1 S velocity z = -150.0

0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56

layer 2 S velocity z = -1.0

1.18	1.18	1.18	1.18	1.18	1.18	1.18
1.18	1.18	1.18	1.18	1.18	1.18	1.18
1.18	1.18	1.18	1.18	1.18	1.18	1.18
1.18	1.18	1.18	1.18	1.18	1.18	1.18
1.18	1.18	1.18	1.18	1.18	1.18	1.18
1.18	1.18	1.18	1.18	1.18	1.18	1.18
1.18	1.18	1.18	1.18	1.18	1.18	1.18

layer 3 S velocity z = 0.0

1.81	1.81	1.81	1.81	1.81	1.81	1.81
1.81	1.77	1.78	1.79	1.80	1.80	1.81
1.81	1.86	1.84	1.82	1.80	1.78	1.81
1.81	1.96	1.90	1.85	1.80	1.76	1.81
1.81	1.86	1.84	1.81	1.80	1.79	1.81
1.81	1.76	1.77	1.78	1.79	1.81	1.81
1.81	1.81	1.81	1.81	1.81	1.81	1.81

layer 4 S velocity z = 1.0

2.45	2.45	2.45	2.45	2.45	2.45	2.45
2.45	2.34	2.38	2.42	2.43	2.44	2.45
2.45	2.46	2.48	2.49	2.47	2.44	2.45
2.45	2.57	2.57	2.57	2.51	2.44	2.45
2.45	2.47	2.47	2.46	2.46	2.46	2.45
2.45	2.37	2.37	2.36	2.42	2.48	2.45
2.45	2.45	2.45	2.45	2.45	2.45	2.45

layer 5 S velocity z = 2.0

3.02	3.02	3.02	3.02	3.02	3.02	3.02
3.02	2.90	2.93	2.95	2.98	3.02	3.02
3.02	3.02	3.04	3.06	3.03	3.02	3.02
3.02	3.14	3.15	3.16	3.09	3.01	3.02
3.02	3.04	3.04	3.04	3.04	3.04	3.02
3.02	2.94	2.93	2.92	2.99	3.06	3.02
3.02	3.02	3.02	3.02	3.02	3.02	3.02

layer 6 S velocity z = 3.0

3.33	3.33	3.33	3.33	3.33	3.33	3.33
3.33	3.21	3.23	3.24	3.28	3.33	3.33
3.33	3.30	3.34	3.37	3.34	3.32	3.33
3.33	3.39	3.44	3.50	3.40	3.31	3.33
3.33	3.32	3.34	3.35	3.35	3.35	3.33
3.33	3.25	3.23	3.21	3.30	3.40	3.33
3.33	3.33	3.33	3.33	3.33	3.33	3.33

layer 7 S velocity z = 4.0

3.52	3.52	3.52	3.52	3.52	3.52	3.52
3.52	3.43	3.43	3.43	3.47	3.51	3.52
3.52	3.49	3.53	3.57	3.54	3.51	3.52
3.52	3.54	3.63	3.72	3.62	3.52	3.52
3.52	3.51	3.55	3.58	3.56	3.53	3.52
3.52	3.48	3.47	3.46	3.49	3.53	3.52
3.52	3.52	3.52	3.52	3.52	3.52	3.52

```
layer  8      S velocity          z =    5.0
 3.61  3.61  3.61  3.61  3.61  3.61  3.61
 3.61  3.58  3.55  3.51  3.56  3.60  3.61
 3.61  3.61  3.64  3.67  3.64  3.61  3.61
 3.61  3.63  3.73  3.83  3.72  3.62  3.61
 3.61  3.62  3.70  3.78  3.69  3.61  3.61
 3.61  3.60  3.67  3.73  3.66  3.59  3.61
 3.61  3.61  3.61  3.61  3.61  3.61  3.61

layer  9      S velocity          z =    6.0
 3.65  3.65  3.65  3.65  3.65  3.65  3.65
 3.65  3.66  3.67  3.68  3.66  3.65  3.65
 3.65  3.66  3.69  3.72  3.69  3.65  3.65
 3.65  3.66  3.71  3.75  3.71  3.66  3.65
 3.65  3.66  3.68  3.70  3.68  3.66  3.65
 3.65  3.65  3.65  3.66  3.66  3.66  3.65
 3.65  3.65  3.65  3.65  3.65  3.65  3.65

layer 10      S velocity          z =    8.0
 3.71  3.71  3.71  3.71  3.71  3.71  3.71
 3.71  3.71  3.71  3.71  3.71  3.71  3.71
 3.71  3.71  3.71  3.71  3.71  3.71  3.71
 3.71  3.71  3.71  3.71  3.71  3.71  3.71
 3.71  3.71  3.71  3.71  3.71  3.71  3.71
 3.71  3.71  3.71  3.71  3.71  3.71  3.71
 3.71  3.71  3.71  3.71  3.71  3.71  3.71

layer 11      S velocity          z =  150.0
 4.49  4.49  4.49  4.49  4.49  4.49  4.49
 4.49  4.49  4.49  4.49  4.49  4.49  4.49
 4.49  4.49  4.49  4.49  4.49  4.49  4.49
 4.49  4.49  4.49  4.49  4.49  4.49  4.49
 4.49  4.49  4.49  4.49  4.49  4.49  4.49
 4.49  4.49  4.49  4.49  4.49  4.49  4.49
 4.49  4.49  4.49  4.49  4.49  4.49  4.49

velocity FIXED at the following nodes(1):

layer  2      P-velocity nodes         z =    -1.0
        1     1     1     1     1
        1     1     1     1     1
        1     1     1     1     1
        1     1     1     1     1
        1     1     1     1     1

layer  3      P-velocity nodes         z =     0.0
        1     0     0     0     1
        0     0     0     0     0
        0     0     0     0     0
        0     0     0     0     0
        1     0     0     0     1

layer  4      P-velocity nodes         z =     1.0
        1     0     0     0     1
        0     0     0     0     0
        0     0     0     0     0
        0     0     0     0     0
        1     0     0     0     1

layer  5      P-velocity nodes         z =     2.0
        1     0     0     0     1
        0     0     0     0     0
        0     0     0     0     0
        0     0     0     0     0
        1     0     0     0     1

layer  6      P-velocity nodes         z =     3.0
        1     0     0     0     1
        0     0     0     0     0
        0     0     0     0     0
        0     0     0     0     0
        1     0     0     0     1

layer  7      P-velocity nodes         z =     4.0
        1     0     0     0     1
        0     0     0     0     0
        0     0     0     0     0
        0     0     0     0     0
        1     0     0     0     1

layer  8      P-velocity nodes         z =     5.0
        1     0     0     0     1
        0     0     0     0     0
        0     0     0     0     0
        0     0     0     0     0
        1     0     0     0     1

layer  9      P-velocity nodes         z =     6.0
        1     0     0     0     1
        0     0     0     0     0
        0     0     0     0     0
        0     0     0     0     0
        1     0     0     0     1
```

```
layer 10     P-velocity nodes          z =    8.0
         1      1      1      1      1
         1      1      1      1      1
         1      1      1      1      1
         1      1      1      1      1
         1      1      1      1      1

layer  2     Vp/Vs             z =   -1.0
         1      1      1      1      1
         1      1      1      1      1
         1      1      1      1      1
         1      1      1      1      1
         1      1      1      1      1

layer  3     Vp/Vs             z =    0.0
         1      0      0      0      1
         0      0      0      0      0
         0      0      0      0      0
         0      0      0      0      0
         1      0      0      0      1

layer  4     Vp/Vs             z =    1.0
         1      0      0      0      1
         0      0      0      0      0
         0      0      0      0      0
         0      0      0      0      0
         1      0      0      0      1

layer  5     Vp/Vs             z =    2.0
         1      0      0      0      1
         0      0      0      0      0
         0      0      0      0      0
         0      0      0      0      0
         1      0      0      0      1

layer  6     Vp/Vs             z =    3.0
         1      0      0      0      1
         0      0      0      0      0
         0      0      0      0      0
         0      0      0      0      0
         1      0      0      0      1

layer  7     Vp/Vs             z =    4.0
         1      0      0      0      1
         0      0      0      0      0
         0      0      0      0      0
         0      0      0      0      0
         1      0      0      0      1

layer  8     Vp/Vs             z =    5.0
         1      0      0      0      1
         0      0      0      0      0
         0      0      0      0      0
         0      0      0      0      0
         1      0      0      0      1

layer  9     Vp/Vs             z =    6.0
         1      0      0      0      1
         0      0      0      0      0
         0      0      0      0      0
         0      0      0      0      0
         1      0      0      0      1

layer 10     Vp/Vs             z =    8.0
         1      1      1      1      1
         1      1      1      1      1
         1      1      1      1      1
         1      1      1      1      1
         1      1      1      1      1
INPUT3:npar,nparv,npari,nparvi   450   450   294   294


iteration step  0; hypocenter adjustments
--------------------------------------------------------------------------------------------------------


trial event locations:
    n    origin time      latitude longitude  depth   mag     x     y     z    nob np ns
Blank-station observation ignored
Blank-station observation ignored
Blank-station observation ignored
Blank-station observation ignored
Blank-station observation ignored
**   1 910814 1948 37.39 63n56.66  21w22.74   3.95   0.00  4.68-10.85  3.95    25 18  7
 event   1; nit=  2; wtd rms res= 0.029; ot,x,y,z = 37.40  4.96-10.83  3.94; St.Er.=  0.0099(ot)  0.044(x)  0.077(y)    0.078(z)
    nwr= 25, ** total rms = 0.03557  **  model rms = 0.03191 **
--------------------------------------------------------------------------------------------------------
** WARNING:  Observed station "H031" (event 910814 1018 38.75) is not in station list--observation ignored **
** WARNING:  Observed station "H031" (event 910814 1018 38.75) is not in station list--observation ignored **
Blank-station observation ignored
Blank-station observation ignored
Blank-station observation ignored
```

```
Blank-station observation ignored
**   2 910814 1018 38.75 63n56.53  21w22.74   4.51   0.00  4.68-11.09  4.51    42 24 18
 event   2; nit=  2; wtd rms res= 0.030; ot,x,y,z = 38.75  4.94-11.12  4.70; St.Er.=  0.0066(ot)  0.029(x)  0.043(y)    0.065(z)
    nwr= 42, ** total rms = 0.04727  **  model rms = 0.03494 **
```

(89 other events deleted for brevity in this *Open-file Report*)

```
--------------------------------------------------------------------------------------------------------------------------------
** WARNING:  Observed station "H031" (event 910820 1949 28.34) is not in station list--observation ignored **
** WARNING:  Observed station "H031" (event 910820 1949 28.34) is not in station list--observation ignored **
Blank-station observation ignored
Blank-station observation ignored
**  92 910820 1949 28.34 64n 6.37  21w16.01   5.91   0.00 -0.81  7.19  5.91    38 20 18
 event  92; nit=  3; wtd rms res= 0.043; ot,x,y,z = 28.40 -0.81  7.35  5.27; St.Er.=  0.0025(ot)  0.016(x)  0.017(y)    0.042(z)
    nwr= 38, ** total rms = 0.05446  **  model rms = 0.04885 **
--------------------------------------------------------------------------------------------------------------------------------
** WARNING:  Observed station "H031" (event 910921 04 8  9.28) is not in station list--observation ignored **
** WARNING:  Observed station "H031" (event 910921 04 8  9.28) is not in station list--observation ignored **
Blank-station observation ignored
Blank-station observation ignored
Blank-station observation ignored
**  93 910921 04 8  9.28 64n 6.80  21w13.00   5.63   0.00 -3.25  7.99  5.63    35 20 15
 event  93; nit=  3; wtd rms res= 0.031; ot,x,y,z =  9.32 -3.21  8.19  5.29; St.Er.=  0.0037(ot)  0.019(x)  0.028(y)    0.039(z)
    nwr= 35, ** total rms = 0.06240  **  model rms = 0.03722 **


unweighted rms= 0.04838; weighted rms= 0.03837 data var.(ssqrw/wnobt ie:rms**2)= 0.00147
                                                        P data var.= 0.00102  S-P data var.= 0.00362
subroutine decide, mbl0 =     262 mbl1 =       0

 Unweighted:  ssqr =       7.677    var. (ssqr/ndof) = 0.00290
 Weighted:   ssqrw =       4.829  varw.(ssqrw/wndof) = 0.00182



 iteration step  1; simultaneous inversion

Compute velocity adjustments to model-Veladj
 total nodes observed= 290, nodes inverted for= 262, P-Velocity : 133, Vp/Vs ratio: 129, Sta. Corr. :   0
 iteration  1 rhs solution vector:
         Velocity    : mean -0.000204462, variance  0.000057824, norm squared  0.015160840, norm  0.123129360
         P-Velocity : mean  0.000004620, variance  0.000108296, norm squared  0.014403382, norm  0.120014094
         Vp/Vs ratio: mean -0.000420027, variance  0.000005695, norm squared  0.000757461, norm  0.027522013
Damping: P-Velocity  damp =   20.00, c1 =  0.1047, damp(c1) =    0.00
Damping: Vp/Vs ratio damp =   30.00, c1 =  0.0109, damp(c1) =    0.00
       262 velocity adjustments,         0 station corr. adjustments

 sum of squared residuals =     7.677; total number of observations =  3280, P obs =  1942, S obs =  1338
                                                earthquake obs.=  3280, explosion obs.=     0 (wtsht= 1.00)
                    with non-zero wt:                           nwrt=  3280,           nswrt=     0
 rms residual = 0.04838   model rms = 0.03802

 weighted sum of squared residuals =     4.829; weighted total number of obs =  3279.999; weighted rms res =    0.03837

 DERIVATIVE WEIGHT SUM

 layer  2     P-Vel nodes          z =   -1.0
 0.     0.     0.     0.     0.     0.     0.
 0.     0.     0.     0.     0.     0.     0.
 0.     0.     0.     0.     0.     0.     0.
 0.     0.     0.     0.     0.     0.     0.
 0.     0.     0.     0.     0.     0.     0.

 layer  3     P-Vel nodes          z =    0.0
 0.     0.    58.    20.   243.     0.     0.
 0.   142.   340.   367.   259.   108.     0.
 0.   313.  1862.  2088.   914.   191.     0.
 0.   222.   772.   999.   501.   308.     0.
 0.     0.   151.   333.   139.     0.     0.

 layer  4     P-Vel nodes          z =    1.0
 0.     0.   100.    53.   301.     0.     0.
 0.   207.   628.   535.   406.   100.     0.
 0.   485.  2757.  3015.  1160.   265.     0.
 0.   308.  1103.  1497.   748.   396.     0.
 0.     0.   209.   390.   148.     0.     0.

 layer  5     P-Vel nodes          z =    2.0
 0.     0.    94.    92.   224.     0.     0.
 0.   197.  1078.   833.   591.    39.     0.
 0.   538.  3707.  3778.  1276.   265.     0.
 0.   269.  1447.  2027.   971.   318.     0.
 0.     0.   163.   306.    96.     0.     0.

 layer  6     P-Vel nodes          z =    3.0
 0.     0.   123.   155.   126.     0.     0.
 0.   197.  2265.  1692.   734.    16.     0.
 0.   728.  4827.  4555.  1475.   235.     0.
 0.   193.  1940.  2949.  1261.   168.     0.
 0.     0.   113.   263.    73.     0.     0.

 layer  7     P-Vel nodes          z =    4.0
 0.     0.   417.   379.   197.     0.     0.
```

```
0.    159.  3163.  3068.   753.    29.     0.
0.    417.  4264.  4620.  1675.   153.     0.
0.     67.  1595.  3112.  1430.    33.     0.
0.      0.    54.   202.    66.     0.     0.

layer  8     P-Vel nodes          z =    5.0
0.      0.   468.   693.   312.     0.     0.
0.     82.  2475.  3143.   894.    76.     0.
0.     55.  1657.  2755.  1444.   222.     0.
0.      1.   622.  1960.  1162.    50.     0.
0.      0.    28.   201.    84.     0.     0.

layer  9     P-Vel nodes          z =    6.0
0.      0.   412.   973.   478.     0.     0.
0.     72.  1214.  2154.   824.     6.     0.
0.     11.   160.   451.   311.    18.     0.
0.      0.    19.   104.   129.    15.     0.
0.      0.     1.     4.     0.     0.     0.

layer 10     P-Vel nodes          z =    8.0
0.      0.     0.     0.     0.     0.     0.
0.      0.     0.     0.     0.     0.     0.
0.      0.     0.     0.     0.     0.     0.
0.      0.     0.     0.     0.     0.     0.
0.      0.     0.     0.     0.     0.     0.

 velocity model changes

layer  3     P-Vel nodes          z =    0.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.01  0.00  0.06  0.00  0.00
 0.00 -0.03  0.01 -0.04 -0.05 -0.03  0.00
 0.00 -0.05  0.10 -0.03  0.00 -0.01  0.00
 0.00  0.01 -0.04  0.04 -0.03  0.04  0.00
 0.00  0.00  0.00  0.03 -0.05  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  4     P-Vel nodes          z =    1.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.01 -0.01  0.09  0.00  0.00
 0.00 -0.05  0.01 -0.08 -0.07 -0.04  0.00
 0.00 -0.08  0.10 -0.03  0.00  0.01  0.00
 0.00  0.03 -0.05  0.06 -0.04  0.06  0.00
 0.00  0.00  0.00  0.03 -0.07  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  5     P-Vel nodes          z =    2.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.01  0.01  0.07  0.00  0.00
 0.00 -0.06  0.00 -0.10 -0.10 -0.01  0.00
 0.00 -0.05  0.10  0.00 -0.03  0.02  0.00
 0.00  0.04 -0.05  0.03 -0.04  0.05  0.00
 0.00  0.00  0.00  0.03 -0.04  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  6     P-Vel nodes          z =    3.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.01  0.03  0.04  0.00  0.00
 0.00 -0.05 -0.04 -0.09 -0.10  0.00  0.00
 0.00 -0.02  0.10  0.10 -0.06  0.02  0.00
 0.00  0.03 -0.05 -0.03  0.01  0.02  0.00
 0.00  0.00  0.00  0.01 -0.01  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  7     P-Vel nodes          z =    4.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00 -0.01  0.03  0.00  0.00  0.00
 0.00 -0.03 -0.02 -0.08 -0.06  0.00  0.00
 0.00  0.01  0.10  0.10 -0.01  0.00  0.00
 0.00  0.01 -0.01  0.02  0.04  0.01  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  8     P-Vel nodes          z =    5.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00 -0.02 -0.02  0.00  0.00  0.00
 0.00 -0.01  0.03  0.00 -0.02  0.00  0.00
 0.00  0.01  0.08  0.03  0.00  0.01  0.00
 0.00  0.00  0.00  0.10  0.02  0.00  0.00
 0.00  0.00  0.00 -0.01  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  9     P-Vel nodes          z =    6.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00 -0.01 -0.01  0.00  0.00  0.00
 0.00  0.00 -0.01  0.03 -0.04  0.00  0.00
 0.00  0.00  0.01 -0.01 -0.01  0.00  0.00
 0.00  0.00  0.00  0.00  0.01  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

corrected velocity model
```

```
layer  3     P-Vel nodes         z =    0.0
 3.23  3.23  3.23  3.23  3.23  3.23  3.23
 3.23  3.15  3.18  3.19  3.26  3.21  3.23
 3.23  3.28  3.29  3.20  3.16  3.14  3.23
 3.23  3.43  3.48  3.26  3.21  3.12  3.23
 3.23  3.32  3.23  3.27  3.17  3.22  3.23
 3.23  3.14  3.15  3.19  3.14  3.23  3.23
 3.23  3.23  3.23  3.23  3.23  3.23  3.23

layer  4     P-Vel nodes         z =    1.0
 4.36  4.36  4.36  4.36  4.36  4.36  4.36
 4.36  4.17  4.25  4.29  4.42  4.35  4.36
 4.36  4.33  4.42  4.35  4.32  4.30  4.36
 4.36  4.50  4.68  4.54  4.46  4.35  4.36
 4.36  4.43  4.34  4.44  4.34  4.44  4.36
 4.36  4.22  4.21  4.23  4.23  4.41  4.36
 4.36  4.36  4.36  4.36  4.36  4.36  4.36

layer  5     P-Vel nodes         z =    2.0
 5.38  5.38  5.38  5.38  5.38  5.38  5.38
 5.38  5.17  5.22  5.26  5.38  5.37  5.38
 5.38  5.32  5.41  5.34  5.30  5.36  5.38
 5.38  5.54  5.71  5.63  5.47  5.38  5.38
 5.38  5.45  5.36  5.44  5.37  5.46  5.38
 5.38  5.23  5.21  5.22  5.28  5.45  5.38
 5.38  5.38  5.38  5.38  5.38  5.38  5.38

layer  6     P-Vel nodes         z =    3.0
 5.93  5.93  5.93  5.93  5.93  5.93  5.93
 5.93  5.72  5.76  5.80  5.88  5.92  5.93
 5.93  5.83  5.90  5.91  5.85  5.91  5.93
 5.93  6.01  6.23  6.33  6.00  5.91  5.93
 5.93  5.94  5.89  5.94  5.98  5.99  5.93
 5.93  5.79  5.75  5.73  5.87  6.05  5.93
 5.93  5.93  5.93  5.93  5.93  5.93  5.93

layer  7     P-Vel nodes         z =    4.0
 6.26  6.26  6.26  6.26  6.26  6.26  6.26
 6.26  6.11  6.10  6.13  6.17  6.24  6.26
 6.26  6.18  6.26  6.28  6.25  6.25  6.26
 6.26  6.31  6.56  6.72  6.44  6.27  6.26
 6.26  6.26  6.31  6.40  6.37  6.29  6.26
 6.26  6.19  6.17  6.15  6.22  6.29  6.26
 6.26  6.26  6.26  6.26  6.26  6.26  6.26

layer  8     P-Vel nodes         z =    5.0
 6.42  6.42  6.42  6.42  6.42  6.42  6.42
 6.42  6.38  6.30  6.23  6.33  6.41  6.42
 6.42  6.41  6.51  6.53  6.46  6.42  6.42
 6.42  6.48  6.72  6.84  6.62  6.45  6.42
 6.42  6.44  6.58  6.82  6.59  6.42  6.42
 6.42  6.41  6.53  6.63  6.51  6.39  6.42
 6.42  6.42  6.42  6.42  6.42  6.42  6.42

layer  9     P-Vel nodes         z =    6.0
 6.50  6.50  6.50  6.50  6.50  6.50  6.50
 6.50  6.51  6.52  6.54  6.52  6.49  6.50
 6.50  6.51  6.56  6.65  6.52  6.50  6.50
 6.50  6.52  6.61  6.67  6.59  6.52  6.50
 6.50  6.51  6.55  6.59  6.56  6.51  6.50
 6.50  6.50  6.50  6.51  6.51  6.51  6.50
 6.50  6.50  6.50  6.50  6.50  6.50  6.50

 STATISTICS, by Depth, excluding edge nodes

grid z= -1.00     P-Vel
 For    25 gridpts, av=   2.10, sd=  0.000

grid z=  0.00     P-Vel
 For    25 gridpts, av=   3.22, sd=  0.086

grid z=  1.00     P-Vel
 For    25 gridpts, av=   4.36, sd=  0.114

grid z=  2.00     P-Vel
 For    25 gridpts, av=   5.37, sd=  0.128

grid z=  3.00     P-Vel
 For    25 gridpts, av=   5.92, sd=  0.139

grid z=  4.00     P-Vel
 For    25 gridpts, av=   6.28, sd=  0.138

grid z=  5.00     P-Vel
 For    25 gridpts, av=   6.50, sd=  0.144

grid z=  6.00     P-Vel
 For    25 gridpts, av=   6.54, sd=  0.048

grid z=  8.00     P-Vel
 For    25 gridpts, av=   6.60, sd=  0.000

VARIANCE OF THIS VELOCITY MODEL
```

```
 For all  225 P-Vel gridpts, variance=  0.01088429, sd=  0.104328

DERIVATIVE WEIGHT SUM

layer  2     Vp/Vs nodes          z =   -1.0
0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.

layer  3     Vp/Vs nodes          z =    0.0
0.      0.     43.      7.    117.      0.      0.
0.     97.    227.    193.    154.     67.      0.
0.    228.   1452.   1461.    617.    109.      0.
0.    144.    538.    677.    289.    166.      0.
0.      0.     67.    192.     56.      0.      0.

layer  4     Vp/Vs nodes          z =    1.0
0.      0.     76.     18.    149.      0.      0.
0.    142.    426.    281.    246.     67.      0.
0.    356.   2155.   2130.    794.    154.      0.
0.    193.    732.    999.    420.    215.      0.
0.      0.    100.    229.     63.      0.      0.

layer  5     Vp/Vs nodes          z =    2.0
0.      0.     74.     37.    115.      0.      0.
0.    128.    746.    461.    372.     30.      0.
0.    393.   2821.   2680.    850.    161.      0.
0.    156.    888.   1335.    530.    174.      0.
0.      0.     94.    184.     46.      0.      0.

layer  6     Vp/Vs nodes          z =    3.0
0.      0.     90.     65.     63.      0.      0.
0.    137.   1591.    983.    475.     12.      0.
0.    500.   3541.   3185.    918.    149.      0.
0.    105.   1156.   1932.    691.     88.      0.
0.      0.     88.    162.     37.      0.      0.

layer  7     Vp/Vs nodes          z =    4.0
0.      0.    267.    187.    106.      0.      0.
0.    109.   2007.   1880.    523.     26.      0.
0.    219.   2772.   2993.   1012.    102.      0.
0.     36.   1015.   1905.    796.     18.      0.
0.      0.     42.    120.     33.      0.      0.

layer  8     Vp/Vs nodes          z =    5.0
0.      0.    298.    478.    236.      0.      0.
0.     55.   1379.   1999.    663.     54.      0.
0.     28.    823.   1433.    845.    120.      0.
0.      1.    430.   1255.    684.     35.      0.
0.      0.     22.    149.     58.      0.      0.

layer  9     Vp/Vs nodes          z =    6.0
0.      0.    234.    700.    376.      0.      0.
0.     40.    535.   1432.    594.      4.      0.
0.      8.     53.    283.    196.      6.      0.
0.      0.     11.     48.     76.     10.      0.
0.      0.      1.      0.      0.      0.      0.

layer 10     Vp/Vs nodes          z =    8.0
0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.

 velocity model changes

layer  3     Vp/Vs nodes          z =    0.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00 -0.01  0.00  0.00  0.00  0.00
 0.00  0.00  0.00 -0.01  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  4     Vp/Vs nodes          z =    1.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00 -0.01  0.00  0.00  0.00  0.00
 0.00  0.00  0.00 -0.01  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  5     Vp/Vs nodes          z =    2.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00 -0.01  0.00  0.00  0.00
```

```
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  6     Vp/Vs nodes          z =    3.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.01  0.00  0.00  0.00  0.00
 0.00  0.00  0.00 -0.01  0.00  0.00  0.00
 0.00  0.00  0.00 -0.01  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  7     Vp/Vs nodes          z =    4.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00 -0.01  0.00  0.00  0.00
 0.00  0.00  0.00 -0.01  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  8     Vp/Vs nodes          z =    5.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  9     Vp/Vs nodes          z =    6.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

corrected velocity model


layer  3     Vp/Vs nodes          z =    0.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.77  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78

layer  4     Vp/Vs nodes          z =    1.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.77  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78

layer  5     Vp/Vs nodes          z =    2.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78

layer  6     Vp/Vs nodes          z =    3.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.79  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78

layer  7     Vp/Vs nodes          z =    4.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78

layer  8     Vp/Vs nodes          z =    5.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
```

```
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78

 layer  9     Vp/Vs nodes          z =    6.0
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78

  STATISTICS, by Depth, excluding edge nodes

 grid z= -1.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.000

 grid z=  0.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.002

 grid z=  1.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.002

 grid z=  2.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.002

 grid z=  3.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.003

 grid z=  4.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.002

 grid z=  5.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.001

 grid z=  6.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.000

 grid z=  8.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.000

 VARIANCE OF THIS VELOCITY MODEL
  For all  225 Vp/Vs gridpts, variance=  0.00000327, sd=  0.001808



 iteration step  1; hypocenter adjustments
  event   1; nit=  2; wtd rms res= 0.025; ot,x,y,z = 37.40  5.00-10.79  4.00; St.Er.=  0.0094(ot)  0.040(x)  0.078(y)   0.082(z)
     nwr= 25, ** total rms = 0.03126  **  model rms = 0.02752 **
  event   2; nit=  2; wtd rms res= 0.026; ot,x,y,z = 38.75  4.97-11.05  4.64; St.Er.=  0.0060(ot)  0.027(x)  0.047(y)   0.066(z)
     nwr= 42, ** total rms = 0.04223  **  model rms = 0.02989 **
```

(89 other events deleted for brevity in this *Open-file Report*)

```
  event  92; nit=  1; wtd rms res= 0.041; ot,x,y,z = 28.42 -0.81  7.37  5.23; St.Er.=  0.0032(ot)  0.017(x)  0.019(y)   0.040(z)
     nwr= 38, ** total rms = 0.05144  **  model rms = 0.04708 **
  event  93; nit=  2; wtd rms res= 0.030; ot,x,y,z =  9.32 -3.23  8.25  5.28; St.Er.=  0.0042(ot)  0.019(x)  0.027(y)   0.042(z)
     nwr= 35, ** total rms = 0.06005  **  model rms = 0.03473 **


 unweighted rms= 0.04585; weighted rms= 0.03563 data var.(ssqrw/wnobt ie:rms**2)= 0.00127
                                                  P data var.= 0.00082  S-P data var.= 0.00337
 subroutine decide, mbl0 =    266 mbl1 =    262

  Unweighted:  ssqr =      6.895   var. (ssqr/ndof) = 0.00261
  Weighted:   ssqrw =      4.163  varw.(ssqrw/wndof) = 0.00158



*****WEIGHTED****** use for f-test since weighted throughout inversion



 f-test iteration  1
 new variance and ndof =   0.00158  2642
 old variance and ndof =   0.00182  2646
 variance ratio and critical ratio =     1.158     1.021



 iteration step  2; simultaneous inversion

 Compute velocity adjustments to model-Veladj
 total nodes observed= 290, nodes inverted for= 266, P-Velocity : 135, Vp/Vs ratio: 131, Sta. Corr. :   0
 iteration  2 rhs solution vector:
        Velocity   : mean  0.000170786, variance  0.000028770, norm squared  0.007660493, norm  0.087524243
        P-Velocity : mean  0.000297489, variance  0.000053859, norm squared  0.007282948, norm  0.085340187
        Vp/Vs ratio: mean  0.000040214, variance  0.000002880, norm squared  0.000377545, norm  0.019430509
Damping: P-Velocity  damp =   20.00, c1 =  0.1047, damp(c1) =   32.00
Damping: Vp/Vs ratio damp =   30.00, c1 =  0.0109, damp(c1) =   56.13
     266 velocity adjustments,        0 station corr. adjustments

 sum of squared residuals =     6.895; total number of observations =  3280, P obs =  1942, S obs =  1338
                                                    earthquake obs.=  3280, explosion obs.=     0 (wtsht= 1.00)
```

```
                with non-zero wt:                          nwrt=  3280,          nswrt=     0
rms residual = 0.04585   model rms = 0.03474

weighted sum of squared residuals =     4.163; weighted total number of obs =  3279.985; weighted rms res =    0.03563

 velocity model changes

layer  3     P-Vel nodes          z =     0.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.01  0.00  0.04  0.00  0.00
 0.00 -0.03  0.01 -0.03 -0.04 -0.03  0.00
 0.00 -0.04  0.10 -0.01  0.01 -0.01  0.00
 0.00  0.01 -0.03  0.03 -0.02  0.02  0.00
 0.00  0.00  0.00  0.02 -0.05  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  4     P-Vel nodes          z =     1.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.01 -0.01  0.07  0.00  0.00
 0.00 -0.05  0.01 -0.06 -0.05 -0.03  0.00
 0.00 -0.06  0.10 -0.02  0.01  0.00  0.00
 0.00  0.03 -0.04  0.04 -0.03  0.03  0.00
 0.00  0.00  0.00  0.02 -0.06  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  5     P-Vel nodes          z =     2.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.01  0.00  0.05  0.00  0.00
 0.00 -0.05  0.00 -0.08 -0.07 -0.01  0.00
 0.00 -0.04  0.10  0.00 -0.02  0.02  0.00
 0.00  0.04 -0.04  0.01 -0.03  0.02  0.00
 0.00  0.00  0.00  0.02 -0.03  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  6     P-Vel nodes          z =     3.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.01  0.02  0.03  0.00  0.00
 0.00 -0.04 -0.03 -0.07 -0.06  0.00  0.00
 0.00 -0.01  0.10  0.09 -0.04  0.01  0.00
 0.00  0.03 -0.04 -0.04  0.00  0.01  0.00
 0.00  0.00  0.00  0.01 -0.01  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  7     P-Vel nodes          z =     4.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00 -0.01  0.01  0.00  0.00  0.00
 0.00 -0.02 -0.02 -0.02 -0.02  0.01  0.00
 0.00  0.01  0.08  0.05 -0.01 -0.01  0.00
 0.00  0.01 -0.01  0.02  0.02  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  8     P-Vel nodes          z =     5.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00 -0.02 -0.02  0.00  0.00  0.00
 0.00  0.00  0.02  0.00 -0.01  0.00  0.00
 0.00  0.01  0.05 -0.01  0.00  0.01  0.00
 0.00  0.00 -0.01  0.06  0.01  0.00  0.00
 0.00  0.00  0.00 -0.02  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  9     P-Vel nodes          z =     6.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00 -0.01 -0.01  0.00  0.00  0.00
 0.00  0.00  0.00  0.02 -0.05  0.00  0.00
 0.00  0.00  0.01  0.00 -0.01  0.00  0.00
 0.00  0.00  0.00  0.00  0.01  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

corrected velocity model


layer  3     P-Vel nodes          z =     0.0
 3.23  3.23  3.23  3.23  3.23  3.23  3.23
 3.23  3.15  3.18  3.19  3.30  3.21  3.23
 3.23  3.26  3.30  3.17  3.12  3.11  3.23
 3.23  3.38  3.58  3.24  3.21  3.12  3.23
 3.23  3.33  3.20  3.30  3.15  3.24  3.23
 3.23  3.14  3.15  3.21  3.09  3.23  3.23
 3.23  3.23  3.23  3.23  3.23  3.23  3.23

layer  4     P-Vel nodes          z =     1.0
 4.36  4.36  4.36  4.36  4.36  4.36  4.36
 4.36  4.17  4.27  4.27  4.48  4.35  4.36
 4.36  4.28  4.43  4.29  4.26  4.28  4.36
 4.36  4.43  4.78  4.52  4.47  4.34  4.36
 4.36  4.46  4.30  4.47  4.31  4.47  4.36
 4.36  4.22  4.21  4.25  4.18  4.41  4.36
 4.36  4.36  4.36  4.36  4.36  4.36  4.36

layer  5     P-Vel nodes          z =     2.0
 5.38  5.38  5.38  5.38  5.38  5.38  5.38
```

```
 5.38  5.17  5.24  5.25  5.43  5.37  5.38
 5.38  5.27  5.40  5.27  5.23  5.35  5.38
 5.38  5.50  5.81  5.63  5.45  5.40  5.38
 5.38  5.49  5.32  5.45  5.33  5.48  5.38
 5.38  5.23  5.21  5.23  5.25  5.45  5.38
 5.38  5.38  5.38  5.38  5.38  5.38  5.38

layer  6     P-Vel nodes          z =    3.0
 5.93  5.93  5.93  5.93  5.93  5.93  5.93
 5.93  5.72  5.76  5.82  5.90  5.92  5.93
 5.93  5.78  5.87  5.84  5.79  5.91  5.93
 5.93  5.99  6.33  6.42  5.97  5.92  5.93
 5.93  5.97  5.86  5.91  5.98  6.00  5.93
 5.93  5.79  5.76  5.74  5.86  6.05  5.93
 5.93  5.93  5.93  5.93  5.93  5.93  5.93

layer  7     P-Vel nodes          z =    4.0
 6.26  6.26  6.26  6.26  6.26  6.26  6.26
 6.26  6.11  6.09  6.14  6.17  6.24  6.26
 6.26  6.16  6.25  6.26  6.24  6.26  6.26
 6.26  6.31  6.64  6.77  6.43  6.26  6.26
 6.26  6.27  6.29  6.43  6.39  6.29  6.26
 6.26  6.19  6.17  6.15  6.22  6.29  6.26
 6.26  6.26  6.26  6.26  6.26  6.26  6.26

layer  8     P-Vel nodes          z =    5.0
 6.42  6.42  6.42  6.42  6.42  6.42  6.42
 6.42  6.38  6.28  6.22  6.33  6.41  6.42
 6.42  6.41  6.53  6.53  6.45  6.43  6.42
 6.42  6.49  6.77  6.82  6.62  6.46  6.42
 6.42  6.44  6.57  6.88  6.60  6.42  6.42
 6.42  6.41  6.53  6.61  6.51  6.39  6.42
 6.42  6.42  6.42  6.42  6.42  6.42  6.42

layer  9     P-Vel nodes          z =    6.0
 6.50  6.50  6.50  6.50  6.50  6.50  6.50
 6.50  6.51  6.52  6.53  6.51  6.49  6.50
 6.50  6.51  6.56  6.67  6.48  6.50  6.50
 6.50  6.52  6.62  6.67  6.59  6.52  6.50
 6.50  6.51  6.55  6.59  6.57  6.51  6.50
 6.50  6.50  6.50  6.51  6.51  6.51  6.50
 6.50  6.50  6.50  6.50  6.50  6.50  6.50

 STATISTICS, by Depth, excluding edge nodes

grid z= -1.00     P-Vel
 For    25 gridpts, av=   2.10, sd=  0.000

grid z=  0.00     P-Vel
 For    25 gridpts, av=   3.22, sd=  0.103

grid z=  1.00     P-Vel
 For    25 gridpts, av=   4.36, sd=  0.134

grid z=  2.00     P-Vel
 For    25 gridpts, av=   5.37, sd=  0.145

grid z=  3.00     P-Vel
 For    25 gridpts, av=   5.91, sd=  0.161

grid z=  4.00     P-Vel
 For    25 gridpts, av=   6.28, sd=  0.153

grid z=  5.00     P-Vel
 For    25 gridpts, av=   6.50, sd=  0.154

grid z=  6.00     P-Vel
 For    25 gridpts, av=   6.54, sd=  0.051

grid z=  8.00     P-Vel
 For    25 gridpts, av=   6.60, sd=  0.000

VARIANCE OF THIS VELOCITY MODEL
 For all  225 P-Vel gridpts, variance=  0.01392055, sd=  0.117985

 velocity model changes

layer  3     Vp/Vs nodes          z =    0.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  4     Vp/Vs nodes          z =    1.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00 -0.01  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
```

```
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  5     Vp/Vs nodes           z =     2.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00 -0.01  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  6     Vp/Vs nodes           z =     3.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.01  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00 -0.01  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  7     Vp/Vs nodes           z =     4.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.01  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  8     Vp/Vs nodes           z =     5.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

layer  9     Vp/Vs nodes           z =     6.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00

corrected velocity model


layer  3     Vp/Vs nodes           z =     0.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.79  1.77  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.77  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78

layer  4     Vp/Vs nodes           z =     1.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.79  1.77  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.77  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78

layer  5     Vp/Vs nodes           z =     2.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.79  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78

layer  6     Vp/Vs nodes           z =     3.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.79  1.79  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78

layer  7     Vp/Vs nodes           z =     4.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.79  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
```

```
  1.78  1.78  1.78  1.78  1.78  1.78  1.78

 layer  8     Vp/Vs nodes          z =    5.0
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.79  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78

 layer  9     Vp/Vs nodes          z =    6.0
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78
  1.78  1.78  1.78  1.78  1.78  1.78  1.78

  STATISTICS, by Depth, excluding edge nodes

 grid z= -1.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.000

 grid z=  0.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.004

 grid z=  1.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.004

 grid z=  2.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.004

 grid z=  3.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.005

 grid z=  4.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.004

 grid z=  5.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.002

 grid z=  6.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.001

 grid z=  8.00     Vp/Vs
  For    25 gridpts, av=   1.78, sd=  0.000

 VARIANCE OF THIS VELOCITY MODEL
  For all  225 Vp/Vs gridpts, variance=  0.00000941, sd=  0.003067



 iteration step  2; hypocenter adjustments
  event    1; nit=  2; wtd rms res= 0.023; ot,x,y,z = 37.39  5.04-10.80  4.06; St.Er.=  0.0097(ot)  0.040(x)  0.079(y)    0.081(z)
     nwr= 25, ** total rms = 0.02832  **  model rms = 0.02490 **
0 residuals and weights(parsep) for event=   1   910814 1948 37.39  mag 0.00
 sta  ph  wt  res:O-C ttobs delta sta  ph  wt  res:O-C ttobs delta sta  ph  wt  res:O-C ttobs delta sta  ph  wt  res:O-C ttobs delta
 H001_Pu0 1.34 -0.009  0.94  4.53 H004_Pu0 1.34  0.031  1.93  9.47 H006_Pd0 1.34  0.050  3.04 15.66 H007_Pd0 1.34 -0.039  2.45 12.96
 H008_Pd0 1.34 -0.014  3.47 19.08 H009_Pd1 0.67 -0.032  3.05 16.38 H009_SP2 0.34 -0.071  2.32 16.38 H010_Pd0 1.34  0.015  2.58 13.30
 H011_P_1 0.67  0.008  2.52 12.80 H012_Pd0 1.34 -0.021  2.88 15.52 H015_Pd0 1.34  0.000  2.69 13.90 H015_SP2 0.34  0.045  2.13 13.90
 H018_Pd0 1.34 -0.005  2.73 14.33 H019_Pu0 1.34  0.014  2.46 12.63 H019_SP2 0.34  0.017  1.92 12.63 H020_Pu0 1.34 -0.016  3.19 17.42
 H020_SP2 0.34  0.032  2.52 17.42 H021_Pu0 1.34 -0.011  3.30 17.92 H022_Pu0 1.32 -0.008  3.71 20.28 H024_Pd0 1.34  0.010  3.23 17.48
 H024_SP2 0.34  0.040  2.53 17.48 H026_Pd0 1.25  0.009  3.77 21.05 H026_SP2 0.31  0.012  2.94 21.05 H033_Pd0 1.34 -0.031  2.56 13.21
 H033_SP2 0.34  0.033  2.04 13.21


  event    2; nit=  2; wtd rms res= 0.024; ot,x,y,z = 38.75  5.01-11.02  4.57; St.Er.=  0.0061(ot)  0.028(x)  0.047(y)    0.067(z)
     nwr= 42, ** total rms = 0.04109  **  model rms = 0.02769 **
0 residuals and weights(parsep) for event=   2   910814 1018 38.75  mag 0.00
 sta  ph  wt  res:O-C ttobs delta sta  ph  wt  res:O-C ttobs delta sta  ph  wt  res:O-C ttobs delta sta  ph  wt  res:O-C ttobs delta
 H001_Pu1 0.89 -0.022  1.00  5.06 H004_Pu1 0.89  0.031  1.98  9.92 H004_SP2 0.44  0.000  1.52  9.92 H005_Pd1 0.89  0.018  2.13 10.45
 H007_Pd0 1.78 -0.008  2.51 13.30 H007_SP2 0.41 -0.112  1.85 13.30 H008_Pd0 1.78  0.008  3.50 19.33 H008_SP3 0.22  0.006  2.73 19.33
 H009_Pd0 1.78 -0.012  3.08 16.71 H009_SP2 0.44 -0.083  2.32 16.71 H010_Pd0 1.78  0.034  2.62 13.66 H010_SP2 0.44 -0.024  1.99 13.66
 H011_Pd0 1.78  0.012  2.56 13.20 H012_Pd1 0.89  0.001  2.92 15.87 H012_SP2 0.44  0.057  2.32 15.87 H014_Pd1 0.89  0.026  3.08 16.51
 H015_Pu0 1.78 -0.042  2.67 14.30 H015_SP2 0.44  0.075  2.18 14.30 H017_Pu0 1.78  0.005  2.23 11.29 H017_SP2 0.36  0.129  1.86 11.29
 H018_Pd0 1.78 -0.006  2.75 14.70 H018_SP2 0.44 -0.027  2.11 14.70 H019_Pu0 1.78  0.020  2.50 13.05 H019_SP2 0.44  0.003  1.93 13.05
 H020_Pu0 1.78 -0.022  3.21 17.77 H020_SP2 0.44 -0.037  2.47 17.77 H021_Pu0 1.78 -0.002  3.33 18.30 H021_SP2 0.44 -0.060  2.52 18.30
 H022_Pu0 1.70  0.016  3.76 20.64 H023_Pd0 1.78  0.007  3.20 17.48 H023_SP2 0.44 -0.066  2.40 17.48 H024_Pd0 1.78  0.023  3.26 17.84
 H024_SP2 0.44  0.036  2.54 17.84 H025_Pd1 0.89 -0.002  3.35 18.54 H025_SP2 0.44 -0.028  2.57 18.54 H027_Pd0 1.22 -0.017  4.31 24.66
 H027_SP2 0.31 -0.021  3.34 24.66 H028_Pd1 0.72  0.004  4.03 22.83 H029_Pu1 0.89  0.021  3.56 19.62 H029_SP2 0.44  0.050  2.79 19.62
 H033_Pd0 1.78 -0.031  2.59 13.63 H033_SP3 0.22 -0.032  2.00 13.63
```

(89 other events deleted for brevity in this *Open-file Report*)

```
  event   92; nit=  1; wtd rms res= 0.040; ot,x,y,z = 28.42 -0.80  7.41  5.21; St.Er.=  0.0032(ot)  0.017(x)  0.019(y)    0.040(z)
     nwr= 38, ** total rms = 0.05024  **  model rms = 0.04573 **
0 residuals and weights(parsep) for event=  92   910820 1949 28.42  mag 0.00
 sta  ph  wt  res:O-C ttobs delta sta  ph  wt  res:O-C ttobs delta sta  ph  wt  res:O-C ttobs delta sta  ph  wt  res:O-C ttobs delta
 H005_Pu0 1.57 -0.010  2.36 13.14 H005_SP2 0.39  0.050  1.88 13.14 H009_Pu0 1.57 -0.002  2.00 10.99 H009_SP2 0.39 -0.015  1.53 10.99
 H010_Pu0 1.57 -0.005  1.91 10.69 H010_SP2 0.39 -0.048  1.43 10.69 H012_Pu0 1.57  0.021  1.72  9.40 H012_SP1 0.78 -0.015  1.30  9.40
```

```
H014_Pu0 1.57  0.053  1.54  8.01 H014_SP2 0.39  0.011  1.16  8.01 H015_Pu0 1.57 -0.034  1.60  8.80 H016_Pu1 0.78  0.046  2.07 11.03
H016_SP3 0.20 -0.024  1.54 11.03 H018_Pu0 1.57 -0.021  1.67  9.23 H018_SP2 0.39 -0.065  1.24  9.23 H019_Pu0 1.57 -0.086  1.98 11.33
H019_SP2 0.39 -0.031  1.57 11.33 H020_Pu0 1.57  0.047  2.63 14.42 H020_SP1 0.78 -0.081  1.92 14.42 H021_Pd0 1.57  0.083  1.52  7.81
H021_SP2 0.39 -0.057  1.05  7.81 H022_Pd0 1.57  0.024  1.84  9.78 H022_SP2 0.39  0.066  1.48  9.78 H024_Pu0 1.57  0.019  1.42  7.61
H024_SP2 0.39  0.019  1.10  7.61 H025_Pu0 1.57  0.029  1.65  8.74 H025_SP2 0.39 -0.044  1.21  8.74 H028_Pu0 1.57 -0.024  1.25  7.13
H028_SP2 0.23  0.163  1.15  7.13 H029_Pd0 1.57 -0.043  1.15  6.64 H030_Pd0 1.57 -0.038  1.40  7.92 H030_SP2 0.39  0.003  1.12  7.92
H033_Pu0 1.57 -0.020  1.68  9.10 H033_SP2 0.39  0.096  1.41  9.10 H034_Pu0 1.57 -0.007  1.21  6.71 H034_SP2 0.39 -0.009  0.93  6.71
H035_Pu0 1.57  0.001  1.93 10.57 H035_SP2 0.39  0.053  1.55 10.57


 event  93; nit=  1; wtd rms res= 0.028; ot,x,y,z =  9.33 -3.24  8.29  5.26; St.Er.=  0.0040(ot)  0.019(x)  0.027(y)   0.042(z)
    nwr= 35, ** total rms = 0.05898  **  model rms = 0.03334 **
0 residuals and weights(parsep) for event=  93   910921 04 8  9.33  mag 0.00
 sta  ph  wt  res:O-C ttobs delta sta  ph  wt  res:O-C ttobs delta sta  ph  wt  res:O-C ttobs delta sta  ph  wt  res:O-C ttobs delta
H006_Pu1 0.82 -0.005  2.72 15.25 H007_Pu0 1.64 -0.017  2.15 12.12 H007_SP2 0.41 -0.085  1.60 12.12 H008_Pu0 1.64  0.021  2.40 13.21
H008_SP2 0.41  0.004  1.86 13.21 H009_Pu0 1.64  0.016  1.96 10.35 H009_SP2 0.41 -0.040  1.47 10.35 H010_Pu0 1.64 -0.015  1.98 10.89
H010_SP2 0.41 -0.035  1.51 10.89 H012_Pu0 1.64  0.018  1.74  9.19 H012_SP2 0.41 -0.055  1.28  9.19 H014_Pu0 1.64  0.051  1.61  8.04
H014_SP2 0.41  0.032  1.24  8.04 H016_Pu0 1.64  0.003  2.28 12.28 H017_SP2 0.30  0.142  2.01 13.07 H018_Pu0 1.64 -0.027  1.76  9.48
H019_Pu0 1.64 -0.046  2.38 13.28 H019_SP2 0.41 -0.089  1.79 13.28 H020_Pu0 1.64  0.018  2.99 16.67 H021_Pu0 1.64  0.014  1.79  9.37
H022_Pd1 0.82  0.080  2.24 11.48 H025_Pu0 1.64  0.015  1.54  7.87 H025_SP2 0.41 -0.041  1.14  7.87 H026_Pu1 0.82  0.007  1.80  9.56
H026_SP2 0.41  0.023  1.42  9.56 H028_Pd0 1.64 -0.030  1.09  6.08 H028_SP2 0.15  0.198  1.07  6.08 H029_Pd0 1.64  0.011  1.44  7.51
H029_SP2 0.41  0.004  1.11  7.51 H030_Pd1 0.82 -0.013  1.43  7.71 H030_SP2 0.41  0.047  1.17  7.71 H033_Pu0 1.64 -0.030  1.95 10.38
H033_SP3 0.15 -0.138  1.39 10.38 H035_Pu0 1.64 -0.020  1.56  8.43 H035_SP2 0.41  0.007  1.24  8.43



 unweighted rms= 0.04452; weighted rms= 0.03406 data var.(ssqrw/wnobt ie:rms**2)= 0.00116
                                                 P data var.= 0.00072  S-P data var.= 0.00324
 subroutine decide, mbl0 =    266 mbl1 =    266

  Unweighted:  ssqr =       6.501    var. (ssqr/ndof) = 0.00246
  Weighted:    ssqrw =      3.806  varw.(ssqrw/wndof) = 0.00144


*****WEIGHTED****** use for f-test since weighted throughout inversion


 f-test iteration  2
 new variance and ndof =   0.00144  2642
 old variance and ndof =   0.00158  2642
 variance ratio and critical ratio =     1.094     1.021

 sum of squared residuals =     6.501; total number of observations =  3280, P obs =  1942, S obs =  1338
                                                earthquake obs.=  3280, explosion obs.=     0 (wtsht= 1.00)
                with non-zero wt:                          nwrt=  3280,          nswrt=     0
 rms residual = 0.04452

 weighted sum of squared residuals =     3.806; weighted total number of obs =  3280.009; weighted rms res =    0.03406

               FINAL LOCATIONS

    YRMODY HRMN  SEC  LATITUDE LONGITUDE  DEPTH    MAG  NO RMSRES     x       y      z
   1 910814 1948 37.39 63n56.69  21w23.18   4.06   0.00  25  0.02   5.04 -10.80   4.06
   2 910814 1018 38.75 63n56.57  21w23.14   4.57   0.00  42  0.02   5.01 -11.02   4.57
```

(89 other events deleted for brevity in this *Open-file Report*)

```
  92 910820 1949 28.42 64n 6.49  21w16.02   5.21   0.00  38  0.04  -0.80    7.41   5.21
  93 910921 04 8  9.33 64n 6.96  21w13.02   5.26   0.00  35  0.03  -3.24    8.29   5.26


               TALLY OF OBSERVATIONS

 station obs  station obs  station obs  station obs  station obs  station obs  station obs  station obs  station obs  station obs
       P  S-P        P  S-P        P  S-P        P  S-P        P  S-P        P  S-P        P  S-P        P  S-P        P  S-P        P  S-P
==== === === ==== === === ==== === === ==== === === ==== === === ==== === === ==== === === ==== === === ==== === === ==== === ===
H001  57  29 H003   5   2 H004  66  43 H005  70  30 H006  50  37 H007  76  59 H008  64  45 H009  79  68 H010  85  72 H011  65  42
H012  78  64 H014  69  57 H015  69  47 H016  69  46 H017  71  51 H018  85  69 H019  88  64 H020  83  46 H021  59  43 H022  57  24
H023  11   7 H024  65  55 H025  66  47 H026  63  50 H027   9   3 H028  53  19 H029  70  41 H030  45  30 H033  85  59 H034  49  39
H035  50  28 H036  24  19  bja   7   3


 FINAL P-VELOCITY MODEL

 layer  3     P-velocity nodes          z =     0.0
  3.23  3.23  3.23  3.23  3.23  3.23  3.23
  3.23  3.15  3.18  3.19  3.30  3.21  3.23
  3.23  3.26  3.30  3.17  3.12  3.11  3.23
  3.23  3.38  3.58  3.24  3.21  3.12  3.23
  3.23  3.33  3.20  3.30  3.15  3.24  3.23
  3.23  3.14  3.15  3.21  3.09  3.23  3.23
  3.23  3.23  3.23  3.23  3.23  3.23  3.23

 layer  4     P-velocity nodes          z =     1.0
  4.36  4.36  4.36  4.36  4.36  4.36  4.36
  4.36  4.17  4.27  4.27  4.48  4.35  4.36
  4.36  4.28  4.43  4.29  4.26  4.28  4.36
  4.36  4.43  4.78  4.52  4.47  4.34  4.36
  4.36  4.46  4.30  4.47  4.31  4.47  4.36
  4.36  4.22  4.21  4.25  4.18  4.41  4.36
```

```
 4.36  4.36  4.36  4.36  4.36  4.36  4.36

layer  5     P-velocity nodes          z =     2.0
 5.38  5.38  5.38  5.38  5.38  5.38  5.38
 5.38  5.17  5.24  5.25  5.43  5.37  5.38
 5.38  5.27  5.40  5.27  5.23  5.35  5.38
 5.38  5.50  5.81  5.63  5.45  5.40  5.38
 5.38  5.49  5.32  5.45  5.33  5.48  5.38
 5.38  5.23  5.21  5.23  5.25  5.45  5.38
 5.38  5.38  5.38  5.38  5.38  5.38  5.38

layer  6     P-velocity nodes          z =     3.0
 5.93  5.93  5.93  5.93  5.93  5.93  5.93
 5.93  5.72  5.76  5.82  5.90  5.92  5.93
 5.93  5.78  5.87  5.84  5.79  5.91  5.93
 5.93  5.99  6.33  6.42  5.97  5.92  5.93
 5.93  5.97  5.86  5.91  5.98  6.00  5.93
 5.93  5.79  5.76  5.74  5.86  6.05  5.93
 5.93  5.93  5.93  5.93  5.93  5.93  5.93

layer  7     P-velocity nodes          z =     4.0
 6.26  6.26  6.26  6.26  6.26  6.26  6.26
 6.26  6.11  6.09  6.14  6.17  6.24  6.26
 6.26  6.16  6.25  6.26  6.24  6.26  6.26
 6.26  6.31  6.64  6.77  6.43  6.26  6.26
 6.26  6.27  6.29  6.43  6.39  6.29  6.26
 6.26  6.19  6.17  6.15  6.22  6.29  6.26
 6.26  6.26  6.26  6.26  6.26  6.26  6.26

layer  8     P-velocity nodes          z =     5.0
 6.42  6.42  6.42  6.42  6.42  6.42  6.42
 6.42  6.38  6.28  6.22  6.33  6.41  6.42
 6.42  6.41  6.53  6.53  6.45  6.43  6.42
 6.42  6.49  6.77  6.82  6.62  6.46  6.42
 6.42  6.44  6.57  6.88  6.60  6.42  6.42
 6.42  6.41  6.53  6.61  6.51  6.39  6.42
 6.42  6.42  6.42  6.42  6.42  6.42  6.42

layer  9     P-velocity nodes          z =     6.0
 6.50  6.50  6.50  6.50  6.50  6.50  6.50
 6.50  6.51  6.52  6.53  6.51  6.49  6.50
 6.50  6.51  6.56  6.67  6.48  6.50  6.50
 6.50  6.52  6.62  6.67  6.59  6.52  6.50
 6.50  6.51  6.55  6.59  6.57  6.51  6.50
 6.50  6.50  6.50  6.51  6.51  6.51  6.50
 6.50  6.50  6.50  6.50  6.50  6.50  6.50

OBSERVATION MATRIX - KHIT - (will be 0 for fixed nodes)

layer  3     P-Vel nodes          z =     0.0
    0     0  1092   258  1896     0     0
    0  2588  2895  2908  2803  2212     0
    0  2704  2908  2908  2908  2718     0
    0  2662  2908  2893  2875  2666     0
    0     0  2452  2505  1981     0     0

layer  4     P-Vel nodes          z =     1.0
    0     0  1092  1235  1877     0     0
    0  2488  2817  2852  2560  2212     0
    0  2704  2908  2908  2908  2718     0
    0  2662  2855  2855  2875  2666     0
    0     0  2439  2505  1981     0     0

layer  5     P-Vel nodes          z =     2.0
    0     0  1131  1371  1877     0     0
    0  2407  2757  2737  2506  1829     0
    0  2682  2908  2908  2870  2666     0
    0  2662  2855  2876  2875  2666     0
    0     0  2320  2213  1981     0     0

layer  6     P-Vel nodes          z =     3.0
    0     0  1430  1540  1877     0     0
    0  1584  2490  2709  2464   345     0
    0  2385  2890  2908  2870  2551     0
    0  1865  2738  2841  2775  2648     0
    0     0  1521  1709   805     0     0

layer  7     P-Vel nodes          z =     4.0
    0     0   854  1150   636     0     0
    0  1013  2336  2387  2400   363     0
    0  1229  2813  2883  2754  1292     0
    0   915  2475  2763  2557   624     0
    0     0   816   974   499     0     0

layer  8     P-Vel nodes          z =     5.0
    0     0   601   737   365     0     0
    0   338  1746  1991  1340   398     0
    0   406  2364  2556  2290   490     0
    0    21  1714  2139  1522   104     0
    0     0   220   436   256     0     0

layer  9     P-Vel nodes          z =     6.0
    0     0   357   517   273     0     0
```

```
    0     72    581    809    725     89      0
    0     21    694   1070    922    104      0
    0      0    125    495    236     41      0
    0      0     31     65      0      0      0

DERIVATIVE WEIGHT SUM

layer  3     P-Vel nodes          z =    0.0
0.      0.     57.     20.    239.      0.      0.
0.    142.    340.    367.    255.    107.      0.
0.    313.   1855.   2073.    916.    190.      0.
0.    222.    775.   1010.    502.    306.      0.
0.      0.    150.    335.    138.      0.      0.

layer  4     P-Vel nodes          z =    1.0
0.      0.    101.     53.    300.      0.      0.
0.    209.    632.    534.    398.     99.      0.
0.    485.   2742.   2974.   1163.    264.      0.
0.    309.   1100.   1505.    746.    398.      0.
0.      0.    206.    390.    149.      0.      0.

layer  5     P-Vel nodes          z =    2.0
0.      0.     97.     94.    227.      0.      0.
0.    201.   1083.    826.    584.     41.      0.
0.    532.   3669.   3760.   1279.    265.      0.
0.    271.   1429.   2030.    977.    317.      0.
0.      0.    161.    307.     98.      0.      0.

layer  6     P-Vel nodes          z =    3.0
0.      0.    139.    168.    131.      0.      0.
0.    201.   2287.   1736.    735.     17.      0.
0.    712.   4721.   4663.   1483.    239.      0.
0.    196.   1901.   2953.   1302.    163.      0.
0.      0.    117.    265.     78.      0.      0.

layer  7     P-Vel nodes          z =    4.0
0.      0.    480.    426.    199.      0.      0.
0.    165.   3367.   3298.    782.     38.      0.
0.    520.   4379.   4773.   1717.    178.      0.
0.     77.   1612.   3070.   1499.     32.      0.
0.      0.     62.    210.     80.      0.      0.

layer  8     P-Vel nodes          z =    5.0
0.      0.    602.    867.    481.      0.      0.
0.     89.   2567.   3473.   1149.     75.      0.
0.     60.   1732.   2725.   1470.    210.      0.
0.      0.    683.   1963.   1108.     57.      0.
0.      0.     32.    198.     72.      0.      0.

layer  9     P-Vel nodes          z =    6.0
0.      0.    313.    833.    399.      0.      0.
0.     75.    916.   1781.    673.      2.      0.
0.      8.     92.    339.    253.      7.      0.
0.      0.     23.     81.     88.      7.      0.
0.      0.      1.      4.      0.      0.      0.

RESOLUTION : GRIDOINT NUMBER, DIAGONAL RESOLUTION ELEMENT (-1.0 indicates fixed velocity gridpoint)

layer  3     P-Vel nodes          z =    0.0
   26:-1.0000   27: 0.0122   28: 0.0000   29: 0.0713   30:-1.0000
   31: 0.0210   32: 0.0351   33: 0.0783   34: 0.0294   35: 0.0214
   36: 0.0628   37: 0.2231   38: 0.2145   39: 0.1877   40: 0.0171
   41: 0.0409   42: 0.1079   43: 0.1502   44: 0.1024   45: 0.0907
   46:-1.0000   47: 0.0187   48: 0.1021   49: 0.0365   50:-1.0000

layer  4     P-Vel nodes          z =    1.0
   51:-1.0000   52: 0.0348   53: 0.0127   54: 0.0926   55:-1.0000
   56: 0.0284   57: 0.0715   58: 0.0817   59: 0.0578   60: 0.0150
   61: 0.1071   62: 0.2018   63: 0.2249   64: 0.2211   65: 0.0283
   66: 0.0580   67: 0.1043   68: 0.1906   69: 0.1267   70: 0.1139
   71:-1.0000   72: 0.0248   73: 0.1130   74: 0.0284   75:-1.0000

layer  5     P-Vel nodes          z =    2.0
   76:-1.0000   77: 0.0260   78: 0.0107   79: 0.0383   80:-1.0000
   81: 0.0169   82: 0.0901   83: 0.0664   84: 0.0894   85: 0.0033
   86: 0.0586   87: 0.2304   88: 0.2208   89: 0.1313   90: 0.0327
   91: 0.0431   92: 0.1247   93: 0.1812   94: 0.1131   95: 0.0498
   96:-1.0000   97: 0.0132   98: 0.0524   99: 0.0085  100:-1.0000

layer  6     P-Vel nodes          z =    3.0
  101:-1.0000  102: 0.0168  103: 0.0228  104: 0.0103  105:-1.0000
  106: 0.0222  107: 0.1773  108: 0.1359  109: 0.1272  110: 0.0000
  111: 0.0349  112: 0.3617  113: 0.3378  114: 0.1360  115: 0.0320
  116: 0.0208  117: 0.1984  118: 0.2274  119: 0.1286  120: 0.0156
  121:-1.0000  122: 0.0115  123: 0.0214  124: 0.0038  125:-1.0000

layer  7     P-Vel nodes          z =    4.0
  126:-1.0000  127: 0.0128  128: 0.0364  129: 0.0055  130:-1.0000
  131: 0.0148  132: 0.2660  133: 0.3422  134: 0.1238  135: 0.0028
  136: 0.0195  137: 0.4084  138: 0.4428  139: 0.2427  140: 0.0205
  141: 0.0029  142: 0.1955  143: 0.2657  144: 0.1632  145: 0.0027
  146:-1.0000  147: 0.0048  148: 0.0082  149: 0.0020  150:-1.0000
```

```
layer  8     P-Vel nodes           z =    5.0
  151:-1.0000  152: 0.0087  153: 0.0297  154: 0.0044  155:-1.0000
  156: 0.0073  157: 0.2035  158: 0.3381  159: 0.1147  160: 0.0042
  161: 0.0099  162: 0.2405  163: 0.3978  164: 0.2345  165: 0.0059
  166: 0.0000  167: 0.0485  168: 0.2543  169: 0.0800  170: 0.0002
  171:-1.0000  172: 0.0005  173: 0.0083  174: 0.0004  175:-1.0000

layer  9     P-Vel nodes           z =    6.0
  176:-1.0000  177: 0.0028  178: 0.0162  179: 0.0022  180:-1.0000
  181: 0.0018  182: 0.0770  183: 0.2497  184: 0.0802  185: 0.0000
  186: 0.0000  187: 0.0108  188: 0.0438  189: 0.0195  190: 0.0000
  191: 0.0000  192: 0.0000  193: 0.0058  194: 0.0056  195: 0.0000
  196:-1.0000  197: 0.0000  198: 0.0000  199: 0.0000  200:-1.0000


FINAL S-VELOCITY MODEL

layer  3     Vp/Vs nodes           z =    0.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.79  1.77  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.77  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78

layer  3     S-velocity nodes          z =    0.0
 1.81  1.81  1.81  1.81  1.81  1.81  1.81
 1.81  1.77  1.79  1.79  1.85  1.80  1.81
 1.81  1.83  1.85  1.78  1.75  1.75  1.81
 1.81  1.89  2.02  1.82  1.81  1.75  1.81
 1.81  1.87  1.80  1.87  1.78  1.82  1.81
 1.81  1.76  1.77  1.80  1.73  1.81  1.81
 1.81  1.81  1.81  1.81  1.81  1.81  1.81

layer  4     Vp/Vs nodes           z =    1.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.79  1.77  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.77  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78

layer  4     S-velocity nodes          z =    1.0
 2.45  2.45  2.45  2.45  2.45  2.45  2.45
 2.45  2.34  2.39  2.40  2.51  2.44  2.45
 2.45  2.40  2.49  2.41  2.39  2.40  2.45
 2.45  2.48  2.70  2.54  2.52  2.44  2.45
 2.45  2.50  2.42  2.53  2.43  2.52  2.45
 2.45  2.37  2.36  2.39  2.35  2.48  2.45
 2.45  2.45  2.45  2.45  2.45  2.45  2.45

layer  5     Vp/Vs nodes           z =    2.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.79  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78

layer  5     S-velocity nodes          z =    2.0
 3.02  3.02  3.02  3.02  3.02  3.02  3.02
 3.02  2.90  2.94  2.95  3.05  3.02  3.02
 3.02  2.95  3.03  2.96  2.94  3.01  3.02
 3.02  3.08  3.27  3.18  3.07  3.03  3.02
 3.02  3.08  2.99  3.08  3.00  3.08  3.02
 3.02  2.94  2.92  2.94  2.95  3.06  3.02
 3.02  3.02  3.02  3.02  3.02  3.02  3.02

layer  6     Vp/Vs nodes           z =    3.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.79  1.79  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.77  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78

layer  6     S-velocity nodes          z =    3.0
 3.33  3.33  3.33  3.33  3.33  3.33  3.33
 3.33  3.21  3.24  3.27  3.32  3.33  3.33
 3.33  3.24  3.28  3.28  3.25  3.32  3.33
 3.33  3.37  3.56  3.63  3.35  3.32  3.33
 3.33  3.35  3.30  3.35  3.36  3.37  3.33
 3.33  3.25  3.23  3.22  3.29  3.40  3.33
 3.33  3.33  3.33  3.33  3.33  3.33  3.33

layer  7     Vp/Vs nodes           z =    4.0
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.78  1.78  1.78  1.78  1.78
 1.78  1.78  1.79  1.78  1.78  1.78  1.78
```

1.78	1.78	1.78	1.77	1.78	1.78	1.78
1.78	1.78	1.78	1.77	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78

layer 7 S-velocity nodes z = 4.0

3.52	3.52	3.52	3.52	3.52	3.52	3.52
3.52	3.43	3.42	3.45	3.47	3.51	3.52
3.52	3.45	3.49	3.51	3.50	3.51	3.52
3.52	3.55	3.73	3.82	3.62	3.52	3.52
3.52	3.52	3.55	3.64	3.60	3.53	3.52
3.52	3.48	3.47	3.45	3.49	3.53	3.52
3.52	3.52	3.52	3.52	3.52	3.52	3.52

layer 8 Vp/Vs nodes z = 5.0

1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.79	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78

layer 8 S-velocity nodes z = 5.0

3.61	3.61	3.61	3.61	3.61	3.61	3.61
3.61	3.58	3.52	3.49	3.56	3.60	3.61
3.61	3.60	3.66	3.67	3.63	3.61	3.61
3.61	3.64	3.80	3.84	3.72	3.63	3.61
3.61	3.62	3.69	3.87	3.71	3.60	3.61
3.61	3.60	3.67	3.71	3.66	3.59	3.61
3.61	3.61	3.61	3.61	3.61	3.61	3.61

layer 9 Vp/Vs nodes z = 6.0

1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78
1.78	1.78	1.78	1.78	1.78	1.78	1.78

layer 9 S-velocity nodes z = 6.0

3.65	3.65	3.65	3.65	3.65	3.65	3.65
3.65	3.66	3.66	3.67	3.66	3.65	3.65
3.65	3.66	3.68	3.74	3.64	3.65	3.65
3.65	3.66	3.72	3.75	3.70	3.66	3.65
3.65	3.66	3.68	3.70	3.69	3.66	3.65
3.65	3.65	3.65	3.66	3.66	3.66	3.65
3.65	3.65	3.65	3.65	3.65	3.65	3.65

OBSERVATION MATRIX - KHIT - (will be 0 for fixed nodes)

layer 3 Vp/Vs nodes z = 0.0

0	0	759	112	1030	0	0
0	2233	2692	2767	2564	1475	0
0	2499	2908	2908	2813	2075	0
0	2039	2837	2822	2512	1612	0
0	0	1752	1870	1014	0	0

layer 4 Vp/Vs nodes z = 1.0

0	0	759	520	1030	0	0
0	2106	2626	2617	2264	1475	0
0	2286	2908	2908	2839	2075	0
0	2039	2780	2759	2555	1653	0
0	0	1721	1883	1014	0	0

layer 5 Vp/Vs nodes z = 2.0

0	0	759	686	1030	0	0
0	2033	2592	2456	1972	1506	0
0	2199	2908	2908	2794	1844	0
0	2039	2709	2677	2433	1653	0
0	0	1495	1476	986	0	0

layer 6 Vp/Vs nodes z = 3.0

0	0	1046	861	1068	0	0
0	1148	2344	2360	1966	267	0
0	1887	2878	2908	2678	1680	0
0	1065	2407	2553	2226	1635	0
0	0	1091	1302	464	0	0

layer 7 Vp/Vs nodes z = 4.0

0	0	794	813	454	0	0
0	681	1989	1990	1817	363	0
0	1022	2689	2818	2266	887	0
0	554	1951	2395	2075	364	0
0	0	596	719	322	0	0

layer 8 Vp/Vs nodes z = 5.0

0	0	601	680	350	0	0
0	307	1402	1570	1058	375	0
0	250	1868	2179	1613	423	0
0	21	1186	1482	984	104	0
0	0	220	337	191	0	0

```
layer  9     Vp/Vs nodes          z =    6.0
     0     0   328   461   273     0     0
     0    72   482   687   451    89     0
     0    21   446   561   515    72     0
     0     0    89   238   170    41     0
     0     0    31    34     0     0     0

DERIVATIVE WEIGHT SUM

layer  3     Vp/Vs nodes          z =    0.0
0.     0.    42.     7.   112.     0.     0.
0.    99.   228.   192.   151.    67.     0.
0.   231.  1456.  1448.   617.   109.     0.
0.   145.   543.   682.   291.   166.     0.
0.     0.    67.   192.    56.     0.     0.

layer  4     Vp/Vs nodes          z =    1.0
0.     0.    78.    18.   147.     0.     0.
0.   143.   430.   279.   241.    67.     0.
0.   360.  2152.  2098.   799.   156.     0.
0.   193.   732.  1006.   420.   217.     0.
0.     0.    99.   229.    64.     0.     0.

layer  5     Vp/Vs nodes          z =    2.0
0.     0.    78.    37.   116.     0.     0.
0.   127.   743.   451.   366.    32.     0.
0.   385.  2811.  2665.   860.   164.     0.
0.   157.   881.  1336.   535.   174.     0.
0.     0.    95.   184.    47.     0.     0.

layer  6     Vp/Vs nodes          z =    3.0
0.     0.    99.    73.    68.     0.     0.
0.   140.  1583.   993.   472.    13.     0.
0.   499.  3467.  3262.   939.   153.     0.
0.   109.  1135.  1943.   714.    86.     0.
0.     0.    89.   162.    38.     0.     0.

layer  7     Vp/Vs nodes          z =    4.0
0.     0.   307.   219.   114.     0.     0.
0.   111.  2136.  1997.   559.    33.     0.
0.   285.  2855.  3117.  1049.   111.     0.
0.    41.  1043.  1932.   843.    17.     0.
0.     0.    46.   130.    44.     0.     0.

layer  8     Vp/Vs nodes          z =    5.0
0.     0.   364.   577.   336.     0.     0.
0.    59.  1378.  2204.   809.    54.     0.
0.    29.   858.  1401.   836.   113.     0.
0.     0.   457.  1210.   646.    39.     0.
0.     0.    25.   145.    50.     0.     0.

layer  9     Vp/Vs nodes          z =    6.0
0.     0.   171.   619.   338.     0.     0.
0.    43.   418.  1220.   504.     1.     0.
0.     7.    39.   238.   167.     4.     0.
0.     0.    13.    35.    51.     5.     0.
0.     0.     0.     1.     0.     0.     0.

RESOLUTION : GRIDOINT NUMBER, DIAGONAL RESOLUTION ELEMENT (-1.0 indicates fixed velocity gridpoint)

layer  3     Vp/Vs nodes          z =    0.0
  251:-1.0000  252: 0.0023  253: 0.0000  254: 0.0075  255:-1.0000
  256: 0.0021  257: 0.0042  258: 0.0039  259: 0.0034  260: 0.0017
  261: 0.0070  262: 0.0457  263: 0.0472  264: 0.0278  265: 0.0020
  266: 0.0037  267: 0.0140  268: 0.0275  269: 0.0131  270: 0.0085
  271:-1.0000  272: 0.0008  273: 0.0103  274: 0.0018  275:-1.0000

layer  4     Vp/Vs nodes          z =    1.0
  276:-1.0000  277: 0.0046  278: 0.0000  279: 0.0086  280:-1.0000
  281: 0.0030  282: 0.0090  283: 0.0045  284: 0.0064  285: 0.0011
  286: 0.0111  287: 0.0519  288: 0.0521  289: 0.0300  290: 0.0027
  291: 0.0041  292: 0.0152  293: 0.0372  294: 0.0138  295: 0.0094
  296:-1.0000  297: 0.0012  298: 0.0102  299: 0.0013  300:-1.0000

layer  5     Vp/Vs nodes          z =    2.0
  301:-1.0000  302: 0.0027  303: 0.0006  304: 0.0039  305:-1.0000
  306: 0.0038  307: 0.0152  308: 0.0053  309: 0.0102  310: 0.0002
  311: 0.0074  312: 0.0637  313: 0.0513  314: 0.0209  315: 0.0027
  316: 0.0023  317: 0.0168  318: 0.0400  319: 0.0117  320: 0.0042
  321:-1.0000  322: 0.0009  323: 0.0049  324: 0.0005  325:-1.0000

layer  6     Vp/Vs nodes          z =    3.0
  326:-1.0000  327: 0.0019  328: 0.0018  329: 0.0014  330:-1.0000
  331: 0.0123  332: 0.0430  333: 0.0182  334: 0.0142  335: 0.0000
  336: 0.0169  337: 0.1011  338: 0.0752  339: 0.0219  340: 0.0024
  341: 0.0013  342: 0.0310  343: 0.0587  344: 0.0146  345: 0.0010
  346:-1.0000  347: 0.0010  348: 0.0022  349: 0.0002  350:-1.0000

layer  7     Vp/Vs nodes          z =    4.0
  351:-1.0000  352: 0.0029  353: 0.0040  354: 0.0014  355:-1.0000
  356: 0.0015  357: 0.0473  358: 0.0587  359: 0.0139  360: 0.0000
  361: 0.0050  362: 0.0989  363: 0.0992  364: 0.0291  365: 0.0014
  366: 0.0003  367: 0.0365  368: 0.0552  369: 0.0207  370: 0.0000
```

```
  371:-1.0000  372: 0.0003  373: 0.0011  374: 0.0002  375:-1.0000

 layer  8    Vp/Vs nodes          z =    5.0
  376:-1.0000  377: 0.0029  378: 0.0100  379: 0.0028  380:-1.0000
  381: 0.0005  382: 0.0357  383: 0.0527  384: 0.0160  385: 0.0005
  386: 0.0004  387: 0.0201  388: 0.0402  389: 0.0259  390: 0.0016
  391: 0.0000  392: 0.0093  393: 0.0490  394: 0.0199  395: 0.0002
  396:-1.0000  397: 0.0000  398: 0.0014  399: 0.0002  400:-1.0000

 layer  9    Vp/Vs nodes          z =    6.0
  401:-1.0000  402: 0.0017  403: 0.0071  404: 0.0019  405:-1.0000
  406: 0.0004  407: 0.0095  408: 0.0328  409: 0.0105  410: 0.0000
  411: 0.0000  412: 0.0003  413: 0.0075  414: 0.0028  415: 0.0000
  416: 0.0000  417: 0.0000  418: 0.0005  419: 0.0010  420: 0.0000
  421:-1.0000  422: 0.0000  423: 0.0000  424: 0.0000  425:-1.0000

          VELOCITY WITH STANDARD ERROR(km/s) AND RESOLUTION
 where error and res are both 0.00, the node was not inverted for, where resol.=-1.00, gridpoint velocity was fixed

 layer  3    P-Vel nodes          z =    0.0
 3.23   3.23        3.23        3.23        3.23        3.23        3.23
03.23  3.15+.0000  3.18+.0026  3.19+.0000  3.30+.0060  3.21+.0000  3.23
 res     (-1.00)     ( 0.01)     ( 0.00)     ( 0.07)     (-1.00)     res
03.23  3.26+.0035  3.30+.0044  3.17+.0063  3.12+.0036  3.11+.0032  3.23
 res     ( 0.02)     ( 0.04)     ( 0.08)     ( 0.03)     ( 0.02)     res
03.23  3.38+.0058  3.58+.0098  3.24+.0080  3.21+.0075  3.12+.0025  3.23
 res     ( 0.06)     ( 0.22)     ( 0.21)     ( 0.19)     ( 0.02)     res
03.23  3.33+.0048  3.20+.0073  3.30+.0077  3.15+.0063  3.24+.0058  3.23
 res     ( 0.04)     ( 0.11)     ( 0.15)     ( 0.10)     ( 0.09)     res
03.23  3.14+.0000  3.15+.0031  3.21+.0067  3.09+.0041  3.23+.0000  3.23
 res     (-1.00)     ( 0.02)     ( 0.10)     ( 0.04)     (-1.00)     res
03.23   3.23        3.23        3.23        3.23        3.23        3.23

 layer  4    P-Vel nodes          z =    1.0
 4.36   4.36        4.36        4.36        4.36        4.36        4.36
04.36  4.17+.0000  4.27+.0060  4.27+.0038  4.48+.0093  4.35+.0000  4.36
 res     (-1.00)     ( 0.03)     ( 0.01)     ( 0.09)     (-1.00)     res
04.36  4.28+.0053  4.43+.0083  4.29+.0085  4.26+.0065  4.28+.0037  4.36
 res     ( 0.03)     ( 0.07)     ( 0.08)     ( 0.06)     ( 0.01)     res
04.36  4.43+.0098  4.78+.0116  4.52+.0103  4.47+.0108  4.34+.0044  4.36
 res     ( 0.11)     ( 0.20)     ( 0.22)     ( 0.22)     ( 0.03)     res
04.36  4.46+.0075  4.30+.0088  4.47+.0107  4.31+.0093  4.47+.0090  4.36
 res     ( 0.06)     ( 0.10)     ( 0.19)     ( 0.13)     ( 0.11)     res
04.36  4.22+.0000  4.21+.0048  4.25+.0093  4.18+.0050  4.41+.0000  4.36
 res     (-1.00)     ( 0.02)     ( 0.11)     ( 0.03)     (-1.00)     res
04.36   4.36        4.36        4.36        4.36        4.36        4.36

 layer  5    P-Vel nodes          z =    2.0
 5.38   5.38        5.38        5.38        5.38        5.38        5.38
05.38  5.17+.0000  5.24+.0064  5.25+.0041  5.43+.0072  5.37+.0000  5.38
 res     (-1.00)     ( 0.03)     ( 0.01)     ( 0.04)     (-1.00)     res
05.38  5.27+.0051  5.40+.0111  5.27+.0093  5.23+.0096  5.35+.0023  5.38
 res     ( 0.02)     ( 0.09)     ( 0.07)     ( 0.09)     ( 0.00)     res
05.38  5.50+.0093  5.81+.0165  5.63+.0138  5.45+.0107  5.40+.0063  5.38
 res     ( 0.06)     ( 0.23)     ( 0.22)     ( 0.13)     ( 0.03)     res
05.38  5.49+.0081  5.32+.0114  5.45+.0128  5.33+.0109  5.48+.0075  5.38
 res     ( 0.04)     ( 0.12)     ( 0.18)     ( 0.11)     ( 0.05)     res
05.38  5.23+.0000  5.21+.0045  5.23+.0079  5.25+.0036  5.45+.0000  5.38
 res     (-1.00)     ( 0.01)     ( 0.05)     ( 0.01)     (-1.00)     res
05.38   5.38        5.38        5.38        5.38        5.38        5.38

 layer  6    P-Vel nodes          z =    3.0
 5.93   5.93        5.93        5.93        5.93        5.93        5.93
05.93  5.72+.0000  5.76+.0057  5.82+.0064  5.90+.0042  5.92+.0000  5.93
 res     (-1.00)     ( 0.02)     ( 0.02)     ( 0.01)     (-1.00)     res
05.93  5.78+.0066  5.87+.0169  5.84+.0149  5.79+.0129  5.91+.0000  5.93
 res     ( 0.02)     ( 0.18)     ( 0.14)     ( 0.13)     ( 0.00)     res
05.93  5.99+.0084  6.33+.0228  6.42+.0211  5.97+.0136  5.92+.0073  5.93
 res     ( 0.03)     ( 0.36)     ( 0.34)     ( 0.14)     ( 0.03)     res
05.93  5.97+.0065  5.86+.0166  5.91+.0174  5.98+.0140  6.00+.0050  5.93
 res     ( 0.02)     ( 0.20)     ( 0.23)     ( 0.13)     ( 0.02)     res
05.93  5.79+.0000  5.76+.0048  5.74+.0060  5.86+.0029  6.05+.0000  5.93
 res     (-1.00)     ( 0.01)     ( 0.02)     ( 0.00)     (-1.00)     res
05.93   5.93        5.93        5.93        5.93        5.93        5.93

 layer  7    P-Vel nodes          z =    4.0
 6.26   6.26        6.26        6.26        6.26        6.26        6.26
06.26  6.11+.0000  6.09+.0053  6.14+.0087  6.17+.0036  6.24+.0000  6.26
 res     (-1.00)     ( 0.01)     ( 0.04)     ( 0.01)     (-1.00)     res
06.26  6.16+.0058  6.25+.0216  6.26+.0223  6.24+.0149  6.26+.0027  6.26
 res     ( 0.01)     ( 0.27)     ( 0.34)     ( 0.12)     ( 0.00)     res
06.26  6.31+.0069  6.64+.0252  6.77+.0247  6.43+.0192  6.26+.0067  6.26
 res     ( 0.02)     ( 0.41)     ( 0.44)     ( 0.24)     ( 0.02)     res
06.26  6.27+.0027  6.29+.0189  6.43+.0219  6.39+.0176  6.29+.0026  6.26
 res     ( 0.00)     ( 0.20)     ( 0.27)     ( 0.16)     ( 0.00)     res
06.26  6.19+.0000  6.17+.0034  6.15+.0044  6.22+.0022  6.29+.0000  6.26
 res     (-1.00)     ( 0.00)     ( 0.01)     ( 0.00)     (-1.00)     res
06.26   6.26        6.26        6.26        6.26        6.26        6.26

 layer  8    P-Vel nodes          z =    5.0
 6.42   6.42        6.42        6.42        6.42        6.42        6.42
06.42  6.38+.0000  6.28+.0046  6.22+.0082  6.33+.0033  6.41+.0000  6.42
 res     (-1.00)     ( 0.01)     ( 0.03)     ( 0.00)     (-1.00)     res
```

```
06.42  6.41+.0043  6.53+.0205  6.53+.0242  6.45+.0160  6.43+.0032  6.42
 res     ( 0.01)     ( 0.20)     ( 0.34)     ( 0.11)     ( 0.00)     res
06.42  6.49+.0051  6.77+.0219  6.82+.0247  6.62+.0210  6.46+.0039  6.42
 res     ( 0.01)     ( 0.24)     ( 0.40)     ( 0.23)     ( 0.01)     res
06.42  6.44+.0000  6.57+.0110  6.88+.0234  6.60+.0141  6.42+.0008  6.42
 res     ( 0.00)     ( 0.05)     ( 0.25)     ( 0.08)     ( 0.00)     res
06.42  6.41+.0000  6.53+.0012  6.61+.0048  6.51+.0011  6.39+.0000  6.42
 res     (-1.00)     ( 0.00)     ( 0.01)     ( 0.00)     (-1.00)     res
06.42   6.42        6.42        6.42        6.42        6.42         6.42

 layer  9     P-Vel nodes          z =     6.0
 6.50   6.50        6.50        6.50        6.50        6.50         6.50
06.50  6.51+.0000  6.52+.0027  6.53+.0065  6.51+.0024  6.49+.0000  6.50
 res     (-1.00)     ( 0.00)     ( 0.02)     ( 0.00)     (-1.00)     res
06.50  6.51+.0022  6.56+.0139  6.67+.0223  6.48+.0136  6.50+.0000  6.50
 res     ( 0.00)     ( 0.08)     ( 0.25)     ( 0.08)     ( 0.00)     res
06.50  6.52+.0000  6.62+.0054  6.67+.0104  6.59+.0071  6.52+.0000  6.50
 res     ( 0.00)     ( 0.01)     ( 0.04)     ( 0.02)     ( 0.00)     res
06.50  6.51+.0000  6.55+.0000  6.59+.0040  6.57+.0039  6.51+.0000  6.50
 res     ( 0.00)     ( 0.00)     ( 0.01)     ( 0.01)     ( 0.00)     res
06.50  6.50+.0000  6.50+.0000  6.51+.0000  6.51+.0000  6.51+.0000  6.50
 res     (-1.00)     ( 0.00)     ( 0.00)     ( 0.00)     (-1.00)     res
06.50   6.50        6.50        6.50        6.50        6.50         6.50

 layer  3     Vp/Vs nodes          z =     0.0
 1.78   1.78        1.78        1.78        1.78        1.78         1.78
01.78  1.78+.0000  1.78+.0006  1.78+.0000  1.78+.0010  1.78+.0000  1.78
 res     (-1.00)     ( 0.00)     ( 0.00)     ( 0.01)     (-1.00)     res
01.78  1.78+.0005  1.78+.0007  1.78+.0007  1.78+.0007  1.78+.0005  1.78
 res     ( 0.00)     ( 0.00)     ( 0.00)     ( 0.00)     ( 0.00)     res
01.78  1.79+.0010  1.77+.0022  1.78+.0023  1.78+.0018  1.78+.0005  1.78
 res     ( 0.01)     ( 0.05)     ( 0.05)     ( 0.03)     ( 0.00)     res
01.78  1.78+.0007  1.78+.0013  1.77+.0018  1.77+.0013  1.78+.0010  1.78
 res     ( 0.00)     ( 0.01)     ( 0.03)     ( 0.01)     ( 0.01)     res
01.78  1.78+.0000  1.78+.0003  1.78+.0012  1.78+.0005  1.78+.0000  1.78
 res     (-1.00)     ( 0.00)     ( 0.01)     ( 0.00)     (-1.00)     res
01.78   1.78        1.78        1.78        1.78        1.78         1.78

 layer  4     Vp/Vs nodes          z =     1.0
 1.78   1.78        1.78        1.78        1.78        1.78         1.78
01.78  1.78+.0000  1.78+.0008  1.78+.0000  1.78+.0011  1.78+.0000  1.78
 res     (-1.00)     ( 0.00)     ( 0.00)     ( 0.01)     (-1.00)     res
01.78  1.78+.0006  1.78+.0011  1.78+.0008  1.78+.0009  1.78+.0004  1.78
 res     ( 0.00)     ( 0.01)     ( 0.00)     ( 0.01)     ( 0.00)     res
01.78  1.79+.0012  1.77+.0023  1.78+.0024  1.78+.0019  1.78+.0006  1.78
 res     ( 0.01)     ( 0.05)     ( 0.05)     ( 0.03)     ( 0.00)     res
01.78  1.78+.0007  1.78+.0014  1.77+.0021  1.77+.0013  1.78+.0011  1.78
 res     ( 0.00)     ( 0.02)     ( 0.04)     ( 0.01)     ( 0.01)     res
01.78  1.78+.0000  1.78+.0004  1.78+.0012  1.78+.0004  1.78+.0000  1.78
 res     (-1.00)     ( 0.00)     ( 0.01)     ( 0.00)     (-1.00)     res
01.78   1.78        1.78        1.78        1.78        1.78         1.78

 layer  5     Vp/Vs nodes          z =     2.0
 1.78   1.78        1.78        1.78        1.78        1.78         1.78
01.78  1.78+.0000  1.78+.0006  1.78+.0003  1.78+.0007  1.78+.0000  1.78
 res     (-1.00)     ( 0.00)     ( 0.00)     ( 0.00)     (-1.00)     res
01.78  1.78+.0007  1.78+.0014  1.78+.0008  1.78+.0011  1.78+.0002  1.78
 res     ( 0.00)     ( 0.02)     ( 0.01)     ( 0.01)     ( 0.00)     res
01.78  1.79+.0010  1.78+.0026  1.77+.0023  1.78+.0016  1.78+.0006  1.78
 res     ( 0.01)     ( 0.06)     ( 0.05)     ( 0.02)     ( 0.00)     res
01.78  1.78+.0006  1.78+.0014  1.77+.0021  1.78+.0012  1.78+.0007  1.78
 res     ( 0.00)     ( 0.02)     ( 0.04)     ( 0.01)     ( 0.00)     res
01.78  1.78+.0000  1.78+.0004  1.78+.0008  1.78+.0003  1.78+.0000  1.78
 res     (-1.00)     ( 0.00)     ( 0.00)     ( 0.00)     (-1.00)     res
01.78   1.78        1.78        1.78        1.78        1.78         1.78

 layer  6     Vp/Vs nodes          z =     3.0
 1.78   1.78        1.78        1.78        1.78        1.78         1.78
01.78  1.78+.0000  1.78+.0005  1.78+.0005  1.78+.0004  1.78+.0000  1.78
 res     (-1.00)     ( 0.00)     ( 0.00)     ( 0.00)     (-1.00)     res
01.78  1.79+.0013  1.79+.0023  1.78+.0015  1.78+.0013  1.78+.0000  1.78
 res     ( 0.01)     ( 0.04)     ( 0.02)     ( 0.01)     ( 0.00)     res
01.78  1.78+.0015  1.78+.0033  1.77+.0028  1.78+.0016  1.78+.0006  1.78
 res     ( 0.02)     ( 0.10)     ( 0.08)     ( 0.02)     ( 0.00)     res
01.78  1.78+.0004  1.78+.0020  1.77+.0026  1.78+.0014  1.78+.0004  1.78
 res     ( 0.00)     ( 0.03)     ( 0.06)     ( 0.01)     ( 0.00)     res
01.78  1.78+.0000  1.78+.0004  1.78+.0005  1.78+.0002  1.78+.0000  1.78
 res     (-1.00)     ( 0.00)     ( 0.00)     ( 0.00)     (-1.00)     res
01.78   1.78        1.78        1.78        1.78        1.78         1.78

 layer  7     Vp/Vs nodes          z =     4.0
 1.78   1.78        1.78        1.78        1.78        1.78         1.78
01.78  1.78+.0000  1.78+.0006  1.78+.0007  1.78+.0004  1.78+.0000  1.78
 res     (-1.00)     ( 0.00)     ( 0.00)     ( 0.00)     (-1.00)     res
01.78  1.78+.0005  1.79+.0024  1.78+.0026  1.78+.0013  1.78+.0000  1.78
 res     ( 0.00)     ( 0.05)     ( 0.06)     ( 0.01)     ( 0.00)     res
01.78  1.78+.0008  1.78+.0033  1.77+.0033  1.78+.0019  1.78+.0004  1.78
 res     ( 0.00)     ( 0.10)     ( 0.10)     ( 0.03)     ( 0.00)     res
01.78  1.78+.0002  1.78+.0021  1.77+.0025  1.78+.0016  1.78+.0000  1.78
 res     ( 0.00)     ( 0.04)     ( 0.06)     ( 0.02)     ( 0.00)     res
01.78  1.78+.0000  1.78+.0002  1.78+.0004  1.78+.0002  1.78+.0000  1.78
 res     (-1.00)     ( 0.00)     ( 0.00)     ( 0.00)     (-1.00)     res
01.78   1.78        1.78        1.78        1.78        1.78         1.78
```

```
 layer  8    Vp/Vs nodes          z =    5.0
 1.78   1.78        1.78        1.78        1.78        1.78        1.78
01.78  1.78+.0000  1.78+.0006  1.78+.0011  1.78+.0006  1.78+.0000  1.78
 res     (-1.00)     ( 0.00)     ( 0.01)     ( 0.00)     (-1.00)     res
01.78  1.78+.0003  1.79+.0021  1.78+.0025  1.78+.0014  1.78+.0003  1.78
 res     ( 0.00)     ( 0.04)     ( 0.05)     ( 0.02)     ( 0.00)     res
01.78  1.78+.0003  1.78+.0016  1.78+.0022  1.78+.0018  1.78+.0005  1.78
 res     ( 0.00)     ( 0.02)     ( 0.04)     ( 0.03)     ( 0.00)     res
01.78  1.78+.0000  1.78+.0011  1.78+.0025  1.78+.0016  1.78+.0002  1.78
 res     ( 0.00)     ( 0.01)     ( 0.05)     ( 0.02)     ( 0.00)     res
01.78  1.78+.0000  1.78+.0000  1.78+.0004  1.78+.0002  1.78+.0000  1.78
 res     (-1.00)     ( 0.00)     ( 0.00)     ( 0.00)     (-1.00)     res
01.78   1.78        1.78        1.78        1.78        1.78        1.78

 layer  9    Vp/Vs nodes          z =    6.0
 1.78   1.78        1.78        1.78        1.78        1.78        1.78
01.78  1.78+.0000  1.78+.0005  1.78+.0009  1.78+.0005  1.78+.0000  1.78
 res     (-1.00)     ( 0.00)     ( 0.01)     ( 0.00)     (-1.00)     res
01.78  1.78+.0002  1.78+.0011  1.78+.0020  1.78+.0012  1.78+.0000  1.78
 res     ( 0.00)     ( 0.01)     ( 0.03)     ( 0.01)     ( 0.00)     res
01.78  1.78+.0000  1.78+.0002  1.78+.0010  1.78+.0006  1.78+.0000  1.78
 res     ( 0.00)     ( 0.00)     ( 0.01)     ( 0.00)     ( 0.00)     res
01.78  1.78+.0000  1.78+.0000  1.78+.0003  1.78+.0004  1.78+.0000  1.78
 res     ( 0.00)     ( 0.00)     ( 0.00)     ( 0.00)     ( 0.00)     res
01.78  1.78+.0000  1.78+.0000  1.78+.0000  1.78+.0000  1.78+.0000  1.78
 res     (-1.00)     ( 0.00)     ( 0.00)     ( 0.00)     (-1.00)     res
01.78   1.78        1.78        1.78        1.78        1.78        1.78

 For      54454 calls to MINIMA, average number psuedo-bending iter. =    2.49

 Computation finished at 13-Apr-94 13:04:18
```

Unit 18—Node-Grid Map

```
    450     450     294     294    0.0001
      1       0
      2       0
```

(22 similar, sequential, 0-ending lines deleted for brevity in this *Open-file Report*)

```
     25       0
     26       0
     27       1
     28       2
     29       3
     30       0
     31       4
     32       5
     33       6
     34       7
     35       8
     36       9
     37      10
     38      11
     39      12
     40      13
     41      14
     42      15
     43      16
     44      17
     45      18
     46       0
     47      19
     48      20
     49      21
     50       0
     51       0
     52      22
     53      23
     54      24
     55       0
     56      25
     57      26
     58      27
     59      28
     60      29
     61      30
     62      31
     63      32
     64      33
     65      34
     66      35
     67      36
     68      37
     69      38
     70      39
     71       0
     72      40
     73      41
     74      42
     75       0
```

76	0
77	43
78	44
79	45
80	0
81	46
82	47
83	48
84	49
85	50
86	51
87	52
88	53
89	54
90	55
91	56
92	57
93	58
94	59
95	60
96	0
97	61
98	62
99	63
100	0
101	0
102	64
103	65
104	66
105	0
106	67
107	68
108	69
109	70
110	71
111	72
112	73
113	74
114	75
115	76
116	77
117	78
118	79
119	80
120	81
121	0
122	82
123	83
124	84
125	0
126	0
127	85
128	86
129	87
130	0
131	88
132	89
133	90
134	91
135	92
136	93
137	94
138	95
139	96
140	97
141	98
142	99
143	100
144	101
145	102
146	0
147	103
148	104
149	105
150	0
151	0
152	106
153	107
154	108
155	0
156	109
157	110
158	111
159	112
160	113
161	114
162	115
163	116
164	117
165	118
166	119
167	120
168	121

169	122
170	123
171	0
172	124
173	125
174	126
175	0
176	0
177	127
178	128
179	129
180	0
181	130
182	131
183	132
184	133
185	134
186	135
187	136
188	137
189	138
190	139
191	140
192	141
193	142
194	143
195	144
196	0
197	145
198	146
199	147
200	0
201	0

(48 similar, sequential, 0-ending lines deleted for brevity in this *Open-file Report*)

250	0
251	0
252	148
253	149
254	150
255	0
256	151
257	152
258	153
259	154
260	155
261	156
262	157
263	158
264	159
265	160
266	161
267	162
268	163
269	164
270	165
271	0
272	166
273	167
274	168
275	0
276	0
277	169
278	170
279	171
280	0
281	172
282	173
283	174
284	175
285	176
286	177
287	178
288	179
289	180
290	181
291	182
292	183
293	184
294	185
295	186
296	0
297	187
298	188
299	189
300	0
301	0
302	190
303	191
304	192
305	0
306	193
307	194

308	195
309	196
310	197
311	198
312	199
313	200
314	201
315	202
316	203
317	204
318	205
319	206
320	207
321	0
322	208
323	209
324	210
325	0
326	0
327	211
328	212
329	213
330	0
331	214
332	215
333	216
334	217
335	218
336	219
337	220
338	221
339	222
340	223
341	224
342	225
343	226
344	227
345	228
346	0
347	229
348	230
349	231
350	0
351	0
352	232
353	233
354	234
355	0
356	235
357	236
358	237
359	238
360	239
361	240
362	241
363	242
364	243
365	244
366	245
367	246
368	247
369	248
370	249
371	0
372	250
373	251
374	252
375	0
376	0
377	253
378	254
379	255
380	0
381	256
382	257
383	258
384	259
385	260
386	261
387	262
388	263
389	264
390	265
391	266
392	267
393	268
394	269
395	270
396	0
397	271
398	272
399	273
400	0

```
401      0
402    274
403    275
404    276
405      0
406    277
407    278
408    279
409    280
410    281
411    282
412    283
413    284
414    285
415    286
416    287
417    288
418    289
419    290
420    291
421      0
422    292
423    293
424    294
425      0
426      0
```

(22 similar, sequential, 0-ending lines deleted for brevity in this *Open-file Report*)

```
449      0
450      0
```

Unit 20—Station Traveltime Residuals

No file is produced on Unit 20 in this test case.

Unit 23—Final Velocity Model

```
 1.0   7   7 11   2        computed  13-Apr-94 13:04:14
-245.0 -12.0  -6.0   0.0   6.0  12.0 245.0
-245.0 -12.0  -6.0   0.0   6.0  12.0 245.0
-150.0  -1.0   0.0   1.0   2.0   3.0   4.0   5.0   6.0   8.0 150.0
  0  0  0
 1.00 1.00 1.00 1.00 1.00 1.00 1.00
 1.00 1.00 1.00 1.00 1.00 1.00 1.00
 1.00 1.00 1.00 1.00 1.00 1.00 1.00
 1.00 1.00 1.00 1.00 1.00 1.00 1.00
 1.00 1.00 1.00 1.00 1.00 1.00 1.00
 1.00 1.00 1.00 1.00 1.00 1.00 1.00
 1.00 1.00 1.00 1.00 1.00 1.00 1.00
 2.10 2.10 2.10 2.10 2.10 2.10 2.10
 2.10 2.10 2.10 2.10 2.10 2.10 2.10
 2.10 2.10 2.10 2.10 2.10 2.10 2.10
 2.10 2.10 2.10 2.10 2.10 2.10 2.10
 2.10 2.10 2.10 2.10 2.10 2.10 2.10
 2.10 2.10 2.10 2.10 2.10 2.10 2.10
 2.10 2.10 2.10 2.10 2.10 2.10 2.10
 3.23 3.23 3.23 3.23 3.23 3.23 3.23
 3.23 3.15 3.18 3.19 3.30 3.21 3.23
 3.23 3.26 3.30 3.17 3.12 3.11 3.23
 3.23 3.38 3.58 3.24 3.21 3.12 3.23
 3.23 3.33 3.20 3.30 3.15 3.24 3.23
 3.23 3.14 3.15 3.21 3.09 3.23 3.23
 3.23 3.23 3.23 3.23 3.23 3.23 3.23
 4.36 4.36 4.36 4.36 4.36 4.36 4.36
 4.36 4.17 4.27 4.27 4.48 4.35 4.36
 4.36 4.28 4.43 4.29 4.26 4.28 4.36
 4.36 4.43 4.78 4.52 4.47 4.34 4.36
 4.36 4.46 4.30 4.47 4.31 4.47 4.36
 4.36 4.22 4.21 4.25 4.18 4.41 4.36
 4.36 4.36 4.36 4.36 4.36 4.36 4.36
 5.38 5.38 5.38 5.38 5.38 5.38 5.38
 5.38 5.17 5.24 5.25 5.43 5.37 5.38
 5.38 5.27 5.40 5.27 5.23 5.35 5.38
 5.38 5.50 5.81 5.63 5.45 5.40 5.38
 5.38 5.49 5.32 5.45 5.33 5.48 5.38
 5.38 5.23 5.21 5.23 5.25 5.45 5.38
 5.38 5.38 5.38 5.38 5.38 5.38 5.38
 5.93 5.93 5.93 5.93 5.93 5.93 5.93
 5.93 5.72 5.76 5.82 5.90 5.92 5.93
 5.93 5.78 5.87 5.84 5.79 5.91 5.93
 5.93 5.99 6.33 6.42 5.97 5.92 5.93
 5.93 5.97 5.86 5.91 5.98 6.00 5.93
 5.93 5.79 5.76 5.74 5.86 6.05 5.93
 5.93 5.93 5.93 5.93 5.93 5.93 5.93
 6.26 6.26 6.26 6.26 6.26 6.26 6.26
```

6.26	6.11	6.09	6.14	6.17	6.24	6.26
6.26	6.16	6.25	6.26	6.24	6.26	6.26
6.26	6.31	6.64	6.77	6.43	6.26	6.26
6.26	6.27	6.29	6.43	6.39	6.29	6.26
6.26	6.19	6.17	6.15	6.22	6.29	6.26
6.26	6.26	6.26	6.26	6.26	6.26	6.26
6.42	6.42	6.42	6.42	6.42	6.42	6.42
6.42	6.38	6.28	6.22	6.33	6.41	6.42
6.42	6.41	6.53	6.53	6.45	6.43	6.42
6.42	6.49	6.77	6.82	6.62	6.46	6.42
6.42	6.44	6.57	6.88	6.60	6.42	6.42
6.42	6.41	6.53	6.61	6.51	6.39	6.42
6.42	6.42	6.42	6.42	6.42	6.42	6.42
6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.50	6.51	6.52	6.53	6.51	6.49	6.50
6.50	6.51	6.56	6.67	6.48	6.50	6.50
6.50	6.52	6.62	6.67	6.59	6.52	6.50
6.50	6.51	6.55	6.59	6.57	6.51	6.50
6.50	6.50	6.50	6.51	6.51	6.51	6.50
6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.60	6.60	6.60	6.60	6.60	6.60	6.60
6.60	6.60	6.60	6.60	6.60	6.60	6.60
6.60	6.60	6.60	6.60	6.60	6.60	6.60
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6.60	6.60	6.60	6.60	6.60	6.60	6.60
6.60	6.60	6.60	6.60	6.60	6.60	6.60
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0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56
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0.56	0.56	0.56	0.56	0.56	0.56	0.56
1.18	1.18	1.18	1.18	1.18	1.18	1.18
1.18	1.18	1.18	1.18	1.18	1.18	1.18
1.18	1.18	1.18	1.18	1.18	1.18	1.18
1.18	1.18	1.18	1.18	1.18	1.18	1.18
1.18	1.18	1.18	1.18	1.18	1.18	1.18
1.18	1.18	1.18	1.18	1.18	1.18	1.18
1.18	1.18	1.18	1.18	1.18	1.18	1.18
1.81	1.81	1.81	1.81	1.81	1.81	1.81
1.81	1.77	1.79	1.79	1.85	1.80	1.81
1.81	1.83	1.85	1.78	1.75	1.75	1.81
1.81	1.89	2.02	1.82	1.81	1.75	1.81
1.81	1.87	1.80	1.87	1.78	1.82	1.81
1.81	1.76	1.77	1.80	1.73	1.81	1.81
1.81	1.81	1.81	1.81	1.81	1.81	1.81
2.45	2.45	2.45	2.45	2.45	2.45	2.45
2.45	2.34	2.39	2.40	2.51	2.44	2.45
2.45	2.40	2.49	2.41	2.39	2.40	2.45
2.45	2.48	2.70	2.54	2.52	2.44	2.45
2.45	2.50	2.42	2.53	2.43	2.52	2.45
2.45	2.37	2.36	2.39	2.35	2.48	2.45
2.45	2.45	2.45	2.45	2.45	2.45	2.45
3.02	3.02	3.02	3.02	3.02	3.02	3.02
3.02	2.90	2.94	2.95	3.05	3.02	3.02
3.02	2.95	3.03	2.96	2.94	3.01	3.02
3.02	3.08	3.27	3.18	3.07	3.03	3.02
3.02	3.08	2.99	3.08	3.00	3.08	3.02
3.02	2.94	2.92	2.94	2.95	3.06	3.02
3.02	3.02	3.02	3.02	3.02	3.02	3.02
3.33	3.33	3.33	3.33	3.33	3.33	3.33
3.33	3.21	3.24	3.27	3.32	3.33	3.33
3.33	3.24	3.28	3.28	3.25	3.32	3.33
3.33	3.37	3.56	3.63	3.35	3.32	3.33
3.33	3.35	3.30	3.35	3.36	3.37	3.33
3.33	3.25	3.23	3.22	3.29	3.40	3.33
3.33	3.33	3.33	3.33	3.33	3.33	3.33
3.52	3.52	3.52	3.52	3.52	3.52	3.52
3.52	3.43	3.42	3.45	3.47	3.51	3.52
3.52	3.45	3.49	3.51	3.50	3.51	3.52
3.52	3.55	3.73	3.82	3.62	3.52	3.52
3.52	3.52	3.55	3.64	3.60	3.53	3.52
3.52	3.48	3.47	3.45	3.49	3.53	3.52
3.52	3.52	3.52	3.52	3.52	3.52	3.52
3.61	3.61	3.61	3.61	3.61	3.61	3.61
3.61	3.58	3.52	3.49	3.56	3.60	3.61
3.61	3.60	3.66	3.67	3.63	3.61	3.61
3.61	3.64	3.80	3.84	3.72	3.63	3.61
3.61	3.62	3.69	3.87	3.71	3.60	3.61
3.61	3.60	3.67	3.71	3.66	3.59	3.61
3.61	3.61	3.61	3.61	3.61	3.61	3.61
3.65	3.65	3.65	3.65	3.65	3.65	3.65
3.65	3.66	3.66	3.67	3.66	3.65	3.65
3.65	3.66	3.68	3.74	3.64	3.65	3.65

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3.65 3.66 3.72 3.75 3.70 3.66 3.65
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1.78 1.78 1.78 1.78 1.78 1.78 1.78
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(13 identical lines deleted for brevity in this *Open-file Report*)

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```

(21 identical lines deleted for brevity in this *Open-file Report*)

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```

Unit 24—Earthquake Traveltimes for Recomputed Hypocenters

```
910814 1948 37.39 63 56.69  21 23.18   4.06   0.00          computed  13-Apr-94 13:04:14
H001_Pu0 0.936H004_Pu0 1.935H006_Pd0 3.039H007_Pd0 2.455H008_Pd0 3.473H009_Pd1 3.050
H009_SP2 2.321H010_Pd0 2.580H011_P_1 2.524H012_Pd0 2.877H015_Pd0 2.689H015_SP2 2.130
H018_Pd0 2.730H019_Pu0 2.459H019_SP2 1.920H020_Pu0 3.189H020_SP2 2.520H021_Pu0 3.301
H022_Pu0 3.709H024_Pd0 3.227H024_SP2 2.530H026_Pd0 3.771H026_SP2 2.939H033_Pd0 2.556
H033_SP2 2.040
0
910814 1018 38.75 63 56.57  21 23.14   4.57   0.00
H001_Pu1 1.003H004_Pu1 1.984H004_SP2 1.521H005_Pd1 2.128H007_Pd0 2.507H007_SP2 1.850
H008_Pd0 3.498H008_SP3 2.729H009_Pd0 3.084H009_SP2 2.320H010_Pd0 2.623H010_SP2 1.989
H011_Pd0 2.557H012_Pd1 2.919H012_SP2 2.320H014_Pd1 3.078H015_Pu0 2.675H015_SP2 2.179
H017_Pu0 2.232H017_SP2 1.861H018_Pd0 2.753H018_SP2 2.110H019_Pu0 2.502H019_SP2 1.931
H020_Pu0 3.210H020_SP2 2.470H021_Pu0 3.334H021_SP2 2.520H022_Pu0 3.761H023_Pd0 3.201
H023_SP2 2.400H024_Pd0 3.260H024_SP2 2.540H025_Pd1 3.352H025_SP2 2.570H027_Pd0 4.307
H027_SP2 3.340H028_Pd1 4.033H029_Pu1 3.565H029_SP2 2.790H033_Pd0 2.589H033_SP3 2.001
0
```

(89 other events deleted for brevity in this *Open-file Report*)

```
910820 1949 28.42 64  6.49  21 16.02   5.21   0.00
H005_Pu0 2.356H005_SP2 1.880H009_Pu0 2.000H009_SP2 1.530H010_Pu0 1.907H010_SP2 1.430
H012_Pu0 1.720H012_SP1 1.300H014_Pu0 1.539H014_SP2 1.160H015_Pu0 1.598H016_Pu1 2.066
H016_SP3 1.538H018_Pu0 1.666H018_SP2 1.240H019_Pu0 1.981H019_SP2 1.571H020_Pu0 2.627
```

```
H020_SP1 1.918H021_Pd0 1.515H021_SP2 1.050H022_Pd0 1.844H022_SP2 1.480H024_Pu0 1.416
H024_SP2 1.100H025_Pu0 1.647H025_SP2 1.210H028_Pu0 1.246H028_SP2 1.150H029_Pd0 1.154
H030_Pd0 1.395H030_SP2 1.119H033_Pu0 1.680H033_SP2 1.410H034_Pu0 1.210H034_SP2 0.930
H035_Pu0 1.925H035_SP2 1.550
0
910921 04 8   9.33 64   6.96   21 13.02    5.26    0.00
H006_Pu1 2.719H007_Pu0 2.155H007_SP2 1.600H008_Pu0 2.403H008_SP2 1.860H009_Pu0 1.965
H009_SP2 1.469H010_Pu0 1.984H010_SP2 1.510H012_Pu0 1.741H012_SP2 1.279H014_Pu0 1.613
H014_SP2 1.240H016_Pu0 2.278H017_SP2 2.010H018_Pu0 1.765H019_Pu0 2.384H019_SP2 1.789
H020_Pu0 2.986H021_Pu0 1.789H022_Pd1 2.242H025_Pu0 1.537H025_SP2 1.140H026_Pu1 1.802
H026_SP2 1.420H028_Pd0 1.091H028_SP2 1.070H029_Pd0 1.443H029_SP2 1.110H030_Pd1 1.429
H030_SP2 1.170H033_Pu0 1.951H033_SP3 1.390H035_Pu0 1.563H035_SP2 1.240
0
```

Unit 25—New Velocities

No file is produced on Unit 25 in this test case.

Unit 26—Errant Rays

```
 **    1 910814 1948 37.39 63n56.66   21w22.74
 Minima: no=  28  H021, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=  29  H022, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=  31  H023, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=  37  H027, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=  40  H029, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=  37  H027, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=  37  H027, used maximum number PB iter.: j= 15, nitpb= 15
 **    2 910814 1018 38.75 63n56.53   21w22.74
 Minima: no=  28  H021, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=  37  H027, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=  40  H029, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=  19  H020, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=  21  H021, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=  22  H022, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=  24  H023, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=  30  H027, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=  30  H027, used maximum number PB iter.: j= 15, nitpb= 15
```

(88 other events deleted for brevity in this *Open-file Report*)

```
 **   91 910825 2126   3.00 64n  6.55   21w15.82
 Minima: no=   1  H001, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=   2  H001, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=   2  H001, used maximum number PB iter.: j= 15, nitpb= 15
 Minima: no=   4  H004, used maximum number PB iter.: j= 15, nitpb= 15
 **   92 910820 1949 28.42 64n  6.37   21w16.01
 **   93 910921 04 8   9.33 64n  6.80   21w13.00
```

Unit 34—Similar to a *hypo71* Listing File

No file is produced on Unit 34 in this test case.

Unit 36—Iteration Summary

```
 Iteration:  0, ssqrw =        4.829   varw.(ssqrw/wndof) = 0.00182
 iteration  1 rhs solution vector:
         Velocity    : mean -0.000204462, variance  0.000057824, norm squared  0.015160840, norm  0.123129360
         P-Velocity : mean  0.000004620, variance  0.000108296, norm squared  0.014403382, norm  0.120014094
         Vp/Vs ratio: mean -0.000420027, variance  0.000005695, norm squared  0.000757461, norm  0.027522013

 sum of squared residuals =      7.677; total number of observations =  3280, P obs =  1942, S obs =  1338
                                                       earthquake obs.=  3280, explosion obs.=      0 (wtsht= 1.00)
                     with non-zero wt:                              nwrt=  3280,          nswrt=      0
  For all  225 P-Vel gridpts, variance=  0.01088429, sd=  0.104328
  For all  225 Vp/Vs gridpts, variance=  0.00000327, sd=  0.001808


 f-test iteration  1
 new variance and ndof =   0.00158  2642
 old variance and ndof =   0.00182  2646
 variance ratio and critical ratio =      1.158      1.021
 iteration  2 rhs solution vector:
         Velocity    : mean  0.000170786, variance  0.000028770, norm squared  0.007660493, norm  0.087524243
         P-Velocity : mean  0.000297489, variance  0.000053859, norm squared  0.007282948, norm  0.085340187
         Vp/Vs ratio: mean  0.000040214, variance  0.000002880, norm squared  0.000377545, norm  0.019430509

 sum of squared residuals =      6.895; total number of observations =  3280, P obs =  1942, S obs =  1338
                                                       earthquake obs.=  3280, explosion obs.=      0 (wtsht= 1.00)
```

```
                  with non-zero wt:                          nwrt=  3280,            nswrt=       0
 For all  225 P-Vel gridpts, variance=  0.01392055, sd=  0.117985
 For all  225 Vp/Vs gridpts, variance=  0.00000941, sd=  0.003067


f-test iteration  2
new variance and ndof =   0.00144  2642
old variance and ndof =   0.00158  2642
variance ratio and critical ratio =      1.094      1.021
```

Unit 45—1/diag(**C**)

No file is produced on Unit 45 in this test case.

Appendix E: *simulps12* I/O example for v_P/v_S, as shipped with the software

Input Files

Unit 01—Control File

```
003 000 000   0.00   5   4   0      neqs,nshot,nblast,wtsht,kout,kout2,kout3
 04 1.0 .020 .005 -0.35 1.25 0.10 0.00     nitloc,wtsp,eigtol,rmscut(hyp),zmin,dxmax,rderr,ercof
 01 0.40 0.14 1 015.0 015.0 2.00 1.00   nhitct,dvpmx,dvpvsmx,idmp,vpdamp,vpvsdamp,stadamp,stepl
  1   3   3 0.03   1 0.005 0    ires,i3d,nitmax,snrmct,ihomo,rmstop,ifixl
  20.00   80.00 0.30 0.75 2.00 delt1,delt2,res1,res2,res3
  9   2 1.25 2.00    ndip,iskip,scale1,scale2
  1.4   0.004   5   12   xfax,tlim,nitpb(1),nitpb(2)
   1   1   1   iuseP,iuseS,invdelay
```

Unit 02—Station Data File

```
 37   4.20 121 50.90 -131.50     origin, rotation angle(n48.5w)
 208                    stations >5km outside grid can invert for station corrections
  BAPM36  10.55 121 38.56 1219 0.00 0.00   0
  BAVM36  38.75 121   1.79   604 0.00 0.00   0
  BBGM36  34.70 121   2.31 1097 0.00 0.00   0
```

(201 other stations deleted for brevity in this *Open-file Report*)

```
  L17837 00.16 121 57.23    37 0.00 0.00   1
  L17936 59.82 121 57.29    24 0.00 0.00   1
  L18036 59.10 121 57.33    12 0.00 0.00   1
```

Unit 03—Node-Grid and Initial-Velocity Model

```
 1.0 11 10   9   2       1d input model like v1lom8.inp with vp/vs=1.75,fixed except z=7km
-788.0 -39.0 -15.0   -5.0   -1.0    2.0    6.0   16.0   27.0   46.0 699.0
-788.0 -58.0 -35.0 -20.0 -10.0    0.0   10.0   20.0   35.0 699.0
-150.0    0.0    3.0    7.0   11.0   16.0   24.0   26.0 650.0
  2 +2  02  z=0
  2 +3  02  z=0
  2 +4  02  z=0
```

(480 similar lines deleted for brevity in this *Open-file Report*)

```
 10 +7  08  z=26
 10 +8  08  z=26
 10 +9  08  z=26
  2 +2  11  z=0 vpvs
  2 +3  11  z=0 vpvs
  2 +4  11  z=0 vpvs
```

(480 similar lines deleted for brevity in this *Open-file Report*)

```
 10 +7  17  z=26 vpvs
 10 +8  17  z=26 vpvs
 10 +9  17  z=26 vpvs
  0   0   0
 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34
 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34
 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34
 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34
 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34
 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34
 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34
 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34
 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34
 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34 3.34
 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63
 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63
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 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63
 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63
 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63
```

5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63
5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63
6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07
6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07
6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07
6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07
6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07
6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07
6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07
6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07
6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07
6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07
6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26
6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26
6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26
6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26
6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26
6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26
6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26
6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26
6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26
6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26
6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

(84 identical lines deleted for brevity in this *Open-file Report*)

1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

Unit 04—Traveltime Data for Earthquakes

```
891019  612 13.07 36 57.24 121 40.44   7.49   1.60
L141ESD1  1.56L145ESN0  1.31L149ISD0  1.28L142ESU0  1.50L148ISD0  1.28L143ESU0  1.41
L144ESU0  1.38L146ISU0  1.40L117ESN2  1.67L118ES+0  1.66L151ISU0  1.48L119ES+0  1.65
L152ESU0  1.61L155ESU0  1.61L116ESN0  1.92L153ISU0  1.73L154ISU0  1.79L120ES+1  1.88
L160ISU0  2.03L115ES+0  2.17L157ESU0  2.08L159ISU0  2.07L158ESU0  2.31L114ESU0  2.48
L112ESU0  2.66L111ISU0  2.66L113ESU0  2.82L110ESU0  2.99L109ESU0  3.34L104ISU0  3.47
L105ESU0  3.47L108ESU1  3.53L103ISU0  3.69L107ISU0  3.68L102ISU0  3.75L101ESU1  3.89
L180ESU3  3.68L179ESU2  3.69L178ISU1  3.69L177ISU1  3.74L176ISU0  3.74L175ISU0  3.72
L174ESU1  3.72L173ISD1  3.89L172ES-1  4.00L169ESD2  4.44L171ES-1  4.23L170ES+1  4.46
L165ES+2  4.75L164ESU1  4.96L163ESU2  5.21L162ESU1  5.41L161ESU1  5.54HPRMXSD0  1.14
HCBMXSD0  1.20HAZMXSD0  1.87HDLMXSD0  2.22JPLMXSU0  2.31JBZMXSU0  2.38JECMXSD1  2.64
JTGMXSU0  3.01HSPMXSD0  3.44JRGMXSU0  3.97JSTMXSU0  4.66JUCMXSD1  4.73BSRMXSU0  4.85
CAOMXSD0  6.24L141EPD1  2.09L145EPN0  1.74L149IPD0  1.72L142EPU0  2.01L148IPD0  1.70
L143EPU0  1.90L144EPU0  1.85L146IPU0  1.88L117EPN2  2.24L118EP+0  2.24L151IPU0  1.99
L119EP+0  2.21L152EPU0  2.15L155EPU0  2.16L116EPN0  2.58L153IPU0  2.30L154IPU0  2.39
L120EP+1  2.52L160IPU0  2.73L115EP+0  2.91L157EPU0  2.80L159IPU0  2.79L158EPU0  3.08
L114EPU0  3.29L112EPU0  3.41L111IPU0  3.43L113EPU0  3.54L110EPU0  3.76L109EPU0  4.10
L104IPU0  4.19L105EPU0  4.15L108EPU1  4.29L103IPU0  4.46L107IPU0  4.38L102IPU0  4.54
L101EPU1  4.67L180EPU3  4.95L179EPU2  5.00L178IPU1  5.02L177IPU1  5.07L176IPU0  5.07
L175IPU0  5.07L174EPU1  5.06L173IPD1  5.16L172EP-1  5.20L169EPD2  5.41L171EP-1  5.62
L170EP+1  5.67L165EP+2  5.74L164EPU1  6.06L163EPU2  6.36L162EPU1  6.60L161EPU1  6.80
HPRMXPD0  1.52HCBMXPD0  1.61HAZMXPD0  2.52HDLMXPD0  2.97JPLMXPU0  3.09JBZMXPU0  3.18
JECMXPD1  3.44JTGMXPU0  4.08HSPMXPD0  4.61JRGMXPU0  5.43JSTMXPU0  5.49JUCMXPD1  6.40
BSRMXPU0  6.49CAOMXPD0  8.35

891019  634 41.76 37  5.12 121 49.36   5.05   1.30
L103ISU0  1.10L104ISU0  1.05L102ISU0  1.15L101ISU0  1.23L112ISU0  1.27L158ESN0  1.37
L111ESU0  1.43L157ES+1  1.52L110ES+0  1.58L107ESU0  1.61L169ES+1  1.70L159ESD1  1.63
L172ISD0  1.67L114ESU1  1.75L109ES-1  1.76L173ESD1  1.73L108ES-1  1.81L160ESD0  1.80
L171ISD0  1.81L174ISD0  1.78L168ESN3  1.93L120ES-2  1.95L165ES+1  1.97L115ESD1  1.99
L154ES-2  1.95L175ES-1  1.91L176ESD1  1.95L153ES+1  2.20L167ESN3  2.23L177ESD1  2.02
L164ESU1  2.23L152ES+1  2.42L178ESD0  2.14L151ESU1  2.46L179ESD1  2.22L146ISU0  2.64
L116ESU1  2.70L163ESN1  2.48L180ESD1  2.36L144ISD1  2.80L145ISU1  2.82L148ESD2  2.81
L143ES+0  2.89L162ESD1  2.67L161ESD0  2.81L142ISD2  3.06JHLMXSU0  1.11JECMXSU1  1.12
JBZMXSD0  1.48JTGMXSD0  1.48JALMXSU1  1.53JPLMXSD1  2.07JRGMXSU2  2.00JSTMXSD0  2.17
JUCMXSD1  2.83L103IPU0  1.42L104IPU0  1.33L102IPU0  1.47L101IPU0  1.58L112IPU0  1.59
L158EPN0  1.68L111EPU0  1.75L157EP+1  1.83L110EP+0  1.92L107EPU0  1.98L169EP+1  2.25
L159EPD1  1.99L172IPD0  2.29L114EPU1  2.07L109EP-1  2.15L173EPD1  2.37L108EP-1  2.20
L160EPD0  2.21L171IPD0  2.51L174IPD0  2.43L168EPN3  2.58L120EP-2  2.25L165EP+1  2.59
L115EPD1  2.31L154EP-2  2.36L175EP-1  2.65L176EPD1  2.90L153EP+1  2.65L167EPN3  2.98
L177EPD1  2.99L164EPU1  2.93L152EP+1  2.85L178EPD0  3.16L151EPU1  2.83L179EPD1  3.24
L146IPU0  2.90L116EPU1  2.94L163EPN1  3.25L180EPD1  3.40L144IPD1  3.06L145IPU1  3.12
L148EPD2  3.14L143EP+0  3.19L162EPD1  3.49L161EPD0  3.68L142IPD2  3.40JHLMXPU0  1.42
JECMXPU1  1.41JBZMXPD0  1.85JTGMXPD0  1.94JALMXPU1  1.96JPLMXPD1  2.60JRGMXPU2  2.98
JSTMXPD0  2.76JUCMXPD1  4.49

891019  636 33.18 37  6.06 121 55.88  12.92   1.80
L170ISD1  1.60L172ISD0  1.55L169ES-2  1.69L168ISD1  1.71L165ISD1  1.73L167ISD0  1.87
L174ISD0  1.65L164ISD0  1.92L101ES 2  1.88L175ISD1  1.74L102ES-1  1.98L176ES-2  1.81
L177ES+1  1.85L103ES+1  2.13L162ES 2  2.26L178ES+2  1.94L179ES 3  1.99L161ES-2  2.40
L104ES+2  2.24L180ES 3  2.13L112ISU0  2.76L107ISU0  2.64L157ES-2  2.77L111ES+1  2.89
L110ISU0  2.91L108ISU1  2.90L154ES-2  3.09L109ISU0  2.96L114ES-1  3.24L153ES-2  3.18
L155ES 3  3.33L120ES-2  3.48L152ES 3  3.40L115ES+2  3.54L151ES 3  3.55L119ES 3  3.93
L146ES+2  3.89L148ISU1  3.82L149ES 3  3.83L145ES 3  4.04L118ES+1  4.12L144ES 3  4.08
L116ES-2  4.17L143ES 2  4.18L142ES 2  4.33L141ES 3  4.46JSSMXSU1  2.10JRGMXSU0  1.77
JHLMXSU1  2.16JTGMXSD1  1.89JALMXSU0  2.12JBCMYSD0  2.38JECMXSU0  2.33JLXMYSU0  2.42
JBZMXSD0  2.43JUCMXSU0  2.53JPLMXSD1  2.65JSTMXSU0  2.75JBLMYSU0  3.44JSGMYSD2  3.48
CSCMXSU0  3.66JSJMYSD3  4.23JPPMYSU3  4.41JBMMYSD2  4.58CMHMXSU0  4.70HSPMXSU0  5.34
HDLMXSU2  5.36CALMXSU0  5.55CAOMXSU1  6.13CMJMXSU0  6.34CMMMXSU0  7.46BPCMXSD2  8.39
BJCMXSU1  9.96L170IPD1  2.60L172IPD0  2.55L169EP-2  2.51L168IPD1  2.55L165IPD1  2.54
L167IPD0  2.71L174IPD0  2.71L164IPD0  2.68L101EP 2  2.74L175IPD1  2.85L102EP-1  2.88
L176EP-2  2.97L177EP+1  3.05L103EP+1  2.99L162EP 2  3.05L178EP+2  3.21L179EP 3  3.28
L161EP-2  3.22L104EP+2  3.11L180EP 3  3.41L112IPU0  3.54L107IPU0  3.53L157EP-2  3.70
L111EP+1  3.67L110IPU0  3.74L108IPU1  3.80L154EP-2  4.03L109IPU0  3.82L114EP-1  3.95
L153EP-2  4.26L155EP 3  4.25L120EP-2  4.12L152EP 3  4.44L115EP+2  4.17L151EP 3  4.46
L119EP 3  4.48L146EP+2  4.66L148IPU1  4.82L149EP 3  4.89L145EP 3  4.85L118EP+1  4.74
L144EP 3  4.82L116EP-2  4.74L143EP 2  4.96L142EP 2  5.17L141EP 3  5.45JSSMXPU1  2.97
JRGMXPU0  2.89JHLMXPU1  3.03JTGMXPD1  3.08JALMXPU0  2.90JBCMYPD0  3.20JECMXPU0  3.33
JLXMYPU0  3.26JBZMXPD0  3.47JUCMXPU0  3.65JPLMXPD1  3.93JSTMXPU0  3.65JBLMYPU0  4.60
JSGMYPD2  4.66CSCMXPU0  4.89JSJMYPD3  5.66JPPMYPU3  5.89JBMMYPD2  6.12CMHMXPU0  6.28
HSPMXPU0  6.93HDLMXPU2  7.17CALMXPU0  7.43CAOMXPU1  8.19CMJMXPU0  8.47CMMMXPU0  9.99
BPCMXPD2 11.20BJCMXPU1 13.29
```

(A blank line just above this one terminates the event and the file.)

Unit 07—Traveltime Data for Shots

Unit 08—Traveltime Data for Blasts

No shot or blast data are used in this test case.

Output Files

Unit 12—Hypocenters from each Iteration

```
 iteration step=  0  computed 21-May-93 12:07:45 hyp error ellipse
 Date HrMn Sec    Lat     Long DepthMgNwr       RmsAz1D1Ser1Az2D2Ser2Mg    Ser3     Erh Erz
891019 612130236n5715121w4015  75416134  0  0   9 4721  1424367  1416     9   0  14  13 0  0  0  0  0
891019 634416737n 535121w4953  55313110  0  0  10 2975  1418613  1013     9   0  10  14 0  0  0  0  0
891019 636332637n 615121w5556 121418146  0  0  1120258  1034325   918     7   0   8   9 0  0  0  0  0
 iteration step=  1  computed 21-May-93 12:08:56 hyp error ellipse
 Date HrMn Sec    Lat     Long DepthMgNwr       RmsAz1D1Ser1Az2D2Ser2Mg    Ser3     Erh Erz
891019 612130536n5713121w4028  74316134  0  0   7 5227  1423462  1316     9   0  13  12 0  0  0  0  0
891019 634416737n 535121w4953  55313110  0  0   9 2672  1418716  1013     8   0  10  13 0  0  0  0  0
891019 636332737n 611121w5565 119218146  0  0   922473  11352 9   918     7   0   9  11 0  0  0  0  0
 iteration step=  2  computed 21-May-93 12:09:59 hyp error ellipse
 Date HrMn Sec    Lat     Long DepthMgNwr       RmsAz1D1Ser1Az2D2Ser2Mg    Ser3     Erh Erz
891019 612130836n5716121w4036  73216134  0  0   5 5414  1423575  1316     9   0  14  13 0  0  0  0  0
891019 634417037n 529121w4959  54213110  0  0   8 1480  14189 8  1013     8   0  10  14 0  0  0  0  0
891019 636332837n 609121w5573 118518146  0  0   822674  11351 8   918     8   0  10  11 0  0  0  0  0
 iteration step=  3  computed 21-May-93 12:11:04 hyp error ellipse
 Date HrMn Sec    Lat     Long DepthMgNwr       RmsAz1D1Ser1Az2D2Ser2Mg    Ser3     Erh Erz
891019 612131036n5719121w4040  72716134  0  0   4 54 6  1424083  1316     9   0  14  14 0  0  0  0  0
891019 634417037n 529121w4959  54213110  0  0   8 1182  13189 7  1013     8   0  10  14 0  0  0  0  0
891019 636332737n 609121w5575 118218146  0  0   722173  1135110   918     7   0  10  11 0  0  0  0  0
```

Unit 13—Final Hypocenters

```
   3                                                                           computed  21-May-93 12:11:53
891019  612 13.10 36n57.19 121w40.40   7.27   1.60134          0.04
891019  634 41.70 37n 5.29 121w49.59   5.42   1.30110          0.08
891019  636 33.27 37n 6.09 121w55.75  11.82   1.80146          0.07
```

Unit 15—All the Raypath Points

No file is produced on Unit 15 in this test case.

Unit 16—"Printed" Output

```
 Computation began at 21-May-93 12:07:32
 Program Simulps12 (27-apr-93 DMEP) Solves for Vp and Vp/Vs; Input data is P travel-time and S-P time.
       Can vary relative weighting of S-P times in hypocenter location.
       Allows fixed nodes (up to 3200 nodes, up to 700 soln nodes); up to 600 events, 1300 stations.
       Psuedo-bending; Allows less curvature "Moho" for initial arcuate paths.

 control parameters
 kout kout2 kout3
   5    4     0

 neqs nsht nbls wtsht nitloc wtsp  zmin eigtol  rmscut hitct dvpmx dvpvsmx
    3   0   0     0.0    4    1.00 -0.35 0.020    0.005    1.  0.40  0.14

 idmp  vpdamp vpvsdmp stadamp ires nitmax snrmct dxmax rderr ercof
  1     15.00   15.00    2.00  1       3  0.03000  1.25  0.10  0.00
 # its. for 1-d vel. model =   1
 rms for term. = 0.005
 fix locations for iterations =   0
 distance weighting:  20.00  80.00; residual weighting: 0.30 0.75 2.00
 step length for integration: 1.000
 parameters for approximate ray tracer
      ndip iskip scale1 scale2
        9     2   1.25   2.00
  parameters for pseudo-bending:
  i3d xfac   tlim  nitpb(1) nitpb(2)
   3  1.40 0.0040      5         12

 Both P-velocity and Vp/Vs are included in inversion  (iusep= 1, iuses= 1)

 Station P and S-P delays included in inversion


  computed machine constants eta and tol:    0.119209E-06    0.117549E-37
```

```
 origin :  latitude   longitude   rotation
           37  4.20   121 50.90   -131.50
    short distance conversion factors
         one min lat   1.8497 km
         one min lon   1.4822 km

  station   latitude   longitude   elev     x      y      z   pdl s-pdl nfixst
  1   BAPM  36 10.55   121 38.56   1219  -62.13  79.53  -1.22 0.00 0.00  0
 number of stations read in Input2 =  208 (print 1st and last only)
208   L180  36 59.10   121 57.33     12  -13.38  -0.89  -0.01 0.00 0.00  1


 velocity grid size:
bld = 1.0      nx = 11     ny = 10     nz =  9

 xgrid
  -788.0 -39.0 -15.0  -5.0  -1.0   2.0   6.0  16.0  27.0  46.0 699.0

 ygrid
  -788.0 -58.0 -35.0 -20.0 -10.0   0.0  10.0  20.0  35.0 699.0

 zgrid
  -150.0   0.0   3.0   7.0  11.0  16.0  24.0  26.0 650.0


 velocity values on three-dimensional grid

 layer  1     P velocity        z = -150.0
  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07
  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07
  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07
  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07
  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07
  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07
  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07
  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07
  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07
  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07

 layer  2     P velocity        z =    0.0
  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34
  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34
  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34
  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34
  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34
  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34
  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34
  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34
  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34
  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34  3.34

 layer  3     P velocity        z =    3.0
  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63
  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63
  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63
  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63
  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63
  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63
  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63
  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63
  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63
  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63  5.63

 layer  4     P velocity        z =    7.0
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07

 layer  5     P velocity        z =   11.0
  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26
  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26
  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26
  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26
  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26
  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26
  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26
  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26
  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26
  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26  6.26

 layer  6     P velocity        z =   16.0
  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50
  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50
  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50
  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50
  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50  6.50
```

6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50

layer 7 P velocity z = 24.0

6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80

layer 8 P velocity z = 26.0

8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00

layer 9 P velocity z = 650.0

8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50

layer 1 Vp/Vs z = -150.0

1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

layer 2 Vp/Vs z = 0.0

1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

layer 3 Vp/Vs z = 3.0

1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

layer 4 Vp/Vs z = 7.0

1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

layer 5 Vp/Vs z = 11.0

1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

layer 6 Vp/Vs z = 16.0

1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

layer 7 Vp/Vs z = 24.0

1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

layer 8 Vp/Vs z = 26.0

1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

layer 9 Vp/Vs z = 650.0

1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

layer 1 S velocity z = -150.0

0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04

layer 2 S velocity z = 0.0

1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91
1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91
1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91
1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91
1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91
1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91
1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91
1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91
1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91
1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91

layer 3 S velocity z = 3.0

3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22
3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22
3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22
3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22
3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22
3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22
3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22
3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22
3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22
3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22

```
layer  4     S velocity          z =    7.0
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47

layer  5     S velocity          z =   11.0
 3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58
 3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58
 3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58
 3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58
 3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58
 3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58
 3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58
 3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58
 3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58
 3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58  3.58

layer  6     S velocity          z =   16.0
 3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71
 3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71
 3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71
 3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71
 3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71
 3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71
 3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71
 3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71
 3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71
 3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71  3.71

layer  7     S velocity          z =   24.0
 3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89
 3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89
 3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89
 3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89
 3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89
 3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89
 3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89
 3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89
 3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89
 3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89  3.89

layer  8     S velocity          z =   26.0
 4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57
 4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57
 4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57
 4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57
 4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57
 4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57
 4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57
 4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57
 4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57
 4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57  4.57

layer  9     S velocity          z =  650.0
 4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86
 4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86
 4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86
 4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86
 4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86
 4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86
 4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86
 4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86
 4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86
 4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86  4.86

velocity FIXED at the following nodes(1):

layer  2     P-velocity nodes          z =    0.0
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1

layer  3     P-velocity nodes          z =    3.0
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
```

layer 4 P-velocity nodes z = 7.0

1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	0	0	0	0	0	0	1	1
1	0	0	0	0	0	0	1	1
1	0	0	0	0	0	0	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1

layer 5 P-velocity nodes z = 11.0

1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1

layer 6 P-velocity nodes z = 16.0

1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1

layer 7 P-velocity nodes z = 24.0

1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1

layer 8 P-velocity nodes z = 26.0

1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1

layer 2 Vp/Vs z = 0.0

1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1

layer 3 Vp/Vs z = 3.0

1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1

layer 4 Vp/Vs z = 7.0

1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	0	0	0	0	0	0	1	1
1	0	0	0	0	0	0	1	1
1	0	0	0	0	0	0	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1

layer 5 Vp/Vs z = 11.0

1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1

layer 6 Vp/Vs z = 16.0

1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1

```
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1

layer  7     Vp/Vs          z =   24.0
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1

layer  8     Vp/Vs          z =   26.0
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
        1     1     1     1     1     1     1     1     1
INPUT3:npar,nparv,npari,nparvi  1424  1008   140    36


iteration step  0; hypocenter adjustments
-----------------------------------------------------------------------------------------------------------------------


trial event locations:
    n    origin time     latitude longitude  depth   mag     x     y     z    nob np ns
**   1 891019  612 13.07 36n57.24 121w40.44   7.49   1.60  0.64 20.15  7.49   134 67 67
 event   1; nit=  2; wtd rms res= 0.089; ot,x,y,z = 13.02  0.81 20.58  7.54; St.Er.=  0.0164(ot)  0.147(x)  0.094(y)    0.144(z)
    nwr=134, ** total rms = 0.11507  **  model rms = 0.09573 **
-----------------------------------------------------------------------------------------------------------------------
**   2 891019  634 41.76 37n 5.12 121w49.36   5.05   1.30  2.79  0.58  5.05   110 55 55
 event   2; nit=  3; wtd rms res= 0.102; ot,x,y,z = 41.67  2.94  0.12  5.53; St.Er.=  0.0160(ot)  0.103(x)  0.095(y)    0.144(z)
    nwr=110, ** total rms = 0.12457  **  model rms = 0.11143 **
-----------------------------------------------------------------------------------------------------------------------
**   3 891019  636 33.18 37n 6.06 121w55.88  12.92   1.80 -2.31 -7.81 12.92   146 73 73
 event   3; nit=  3; wtd rms res= 0.111; ot,x,y,z = 33.26 -1.87 -7.57 12.14; St.Er.=  0.0125(ot)  0.089(x)  0.089(y)    0.102(z)
    nwr=146, ** total rms = 0.16644  **  model rms = 0.13361 **


unweighted rms= 0.13891; weighted rms= 0.11364 data var.(ssqrw/wnobt ie:rms**2)= 0.01291
                                            P data var.= 0.00775  S-P data var.= 0.01813
subroutine decide, mb10 =     38 mb11 =      0

 Unweighted:  ssqr =       7.526    var. (ssqr/ndof) = 0.02213
 Weighted:   ssqrw =       5.036  varw.(ssqrw/wndof) = 0.01481



iteration step  1; simultaneous inversion

Compute velocity adjustments to model-Veladj
total nodes observed=  38, nodes inverted for=  38, P-Velocity :  18, Vp/Vs ratio:  18, Sta. Corr. :   2
rhs solution vector:
        Velocity   : mean  0.001580840, variance  0.001496908, norm squared  0.055478070, norm  0.235537827
        P-Velocity : mean -0.004188264, variance  0.001180371, norm squared  0.021562416, norm  0.146841466
        Vp/Vs ratio: mean  0.007046307, variance  0.001735384, norm squared  0.033915658, norm  0.184162036
        Sta. Corr. : mean  0.009867297, variance  0.000000000, norm squared  0.000097364, norm  0.009867297
Damping: P-Velocity  damp =   15.00, c1 =  0.2128, damp(c1) =    0.00
Damping: Vp/Vs ratio damp =   15.00, c1 =  0.1447, damp(c1) =    0.00
       36 velocity adjustments,        2 station corr. adjustments

sum of squared residuals =     7.526; total number of observations =   390, P obs =   195, S obs =   195
                                         earthquake obs.=   390, explosion obs.=     0 (wtsht= 0.00)
                   with non-zero wt:                    nwrt=   390,          nswrt=     0
rms residual = 0.13891   model rms = 0.11547

weighted sum of squared residuals =     5.036; weighted total number of obs =   390.000; weighted rms res =    0.11364

     STATION CORRECTIONS AND ADJUSTMENTS
station  Pdelay Adjusted S-Pdelay Adjusted
CMMM    -0.002   -0.002     0.010    0.010

DERIVATIVE WEIGHT SUM

layer  2     P-Vel nodes          z =    0.0
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
```

```
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.

layer  3      P-Vel nodes           z =    3.0
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.

layer  4      P-Vel nodes           z =    7.0
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.    15.    81.   153.   113.    32.    31.     0.     0.     0.
0.     0.    22.   153.   286.   463.   183.    17.     0.     0.     0.
0.     0.     8.   143.   312.   347.   175.    30.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.

layer  5      P-Vel nodes           z =   11.0
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.

layer  6      P-Vel nodes           z =   16.0
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.

layer  7      P-Vel nodes           z =   24.0
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.

layer  8      P-Vel nodes           z =   26.0
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.

 velocity model changes

layer  4      P-Vel nodes           z =    7.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.05 -0.21 -0.23  0.05  0.16  0.07  0.00  0.00  0.00
 0.00  0.00  0.00 -0.34 -0.20  0.26  0.40  0.05  0.00  0.00  0.00
 0.00  0.00  0.00 -0.18 -0.08  0.40  0.25  0.07  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00

corrected velocity model


layer  4      P-Vel nodes           z =    7.0
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.12  5.86  5.84  6.12  6.23  6.14  6.07  6.07  6.07
 6.07  6.07  6.07  5.73  5.87  6.33  6.47  6.12  6.07  6.07  6.07
 6.07  6.07  6.07  5.89  5.99  6.47  6.32  6.14  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07

 STATISTICS, by Depth, excluding edge nodes
```

```
grid z=  0.00     P-Vel
 For    72 gridpts, av=   3.34, sd=  0.000

grid z=  3.00     P-Vel
 For    72 gridpts, av=   5.63, sd=  0.000

grid z=  7.00     P-Vel
 For    72 gridpts, av=   6.08, sd=  0.104

grid z= 11.00     P-Vel
 For    72 gridpts, av=   6.26, sd=  0.000

grid z= 16.00     P-Vel
 For    72 gridpts, av=   6.50, sd=  0.000

grid z= 24.00     P-Vel
 For    72 gridpts, av=   6.80, sd=  0.000

grid z= 26.00     P-Vel
 For    72 gridpts, av=   8.00, sd=  0.000

VARIANCE OF THIS VELOCITY MODEL
 For all  504 gridpts, variance=  0.00153779, sd=  0.039215

DERIVATIVE WEIGHT SUM

layer  2     Vp/Vs nodes          z =    0.0
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.

layer  3     Vp/Vs nodes          z =    3.0
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.

layer  4     Vp/Vs nodes          z =    7.0
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.     15.     81.    152.    113.     33.     31.      0.      0.      0.
0.      0.     22.    153.    286.    462.    182.     17.      0.      0.      0.
0.      0.      8.    142.    311.    345.    172.     30.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.

layer  5     Vp/Vs nodes          z =   11.0
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.

layer  6     Vp/Vs nodes          z =   16.0
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.

layer  7     Vp/Vs nodes          z =   24.0
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.

layer  8     Vp/Vs nodes          z =   26.0
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
```

```
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.

 velocity model changes

layer  4     Vp/Vs nodes          z =    7.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00 -0.02 -0.08 -0.01  0.00  0.00  0.01  0.00  0.00  0.00
 0.00  0.00  0.00 -0.06 -0.02  0.05  0.05  0.01  0.00  0.00  0.00
 0.00  0.00  0.00  0.01  0.02  0.10  0.07  0.02  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00

corrected velocity model


layer  4     Vp/Vs nodes          z =    7.0
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.73  1.67  1.74  1.75  1.75  1.76  1.75  1.75  1.75
 1.75  1.75  1.75  1.69  1.73  1.80  1.80  1.76  1.75  1.75  1.75
 1.75  1.75  1.75  1.76  1.77  1.85  1.82  1.77  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75

 STATISTICS, by Depth, excluding edge nodes

grid z=  0.00     Vp/Vs
 For    72 gridpts, av=   1.75, sd=  0.000

grid z=  3.00     Vp/Vs
 For    72 gridpts, av=   1.75, sd=  0.000

grid z=  7.00     Vp/Vs
 For    72 gridpts, av=   1.75, sd=  0.022

grid z= 11.00     Vp/Vs
 For    72 gridpts, av=   1.75, sd=  0.000

grid z= 16.00     Vp/Vs
 For    72 gridpts, av=   1.75, sd=  0.000

grid z= 24.00     Vp/Vs
 For    72 gridpts, av=   1.75, sd=  0.000

grid z= 26.00     Vp/Vs
 For    72 gridpts, av=   1.75, sd=  0.000

VARIANCE OF THIS VELOCITY MODEL
 For all  504 gridpts, variance=  0.00006678, sd=  0.008172



iteration step  1; hypocenter adjustments
 event    1; nit=  2; wtd rms res= 0.068; ot,x,y,z = 13.05  0.65 20.46  7.43; St.Er.=  0.0163(ot)  0.139(x)  0.094(y)    0.137(z)
    nwr=134, ** total rms = 0.08093  **  model rms = 0.07260 **
 event    2; nit=  2; wtd rms res= 0.093; ot,x,y,z = 41.67  2.94  0.12  5.53; St.Er.=  0.0144(ot)  0.104(x)  0.094(y)    0.138(z)
    nwr=110, ** total rms = 0.11177  **  model rms = 0.10110 **
 event    3; nit=  2; wtd rms res= 0.092; ot,x,y,z = 33.27 -2.03 -7.61 11.92; St.Er.=  0.0136(ot)  0.089(x)  0.089(y)    0.111(z)
    nwr=146, ** total rms = 0.14317  **  model rms = 0.11155 **


unweighted rms= 0.11596; weighted rms= 0.09575 data var.(ssqrw/wnobt ie:rms**2)= 0.00917
                                                  P data var.= 0.00455  S-P data var.= 0.01382
subroutine decide, mbl0 =     38 mbl1 =     38

 Unweighted:  ssqr =       5.245    var. (ssqr/ndof) = 0.01543
 Weighted:   ssqrw =       3.575  varw.(ssqrw/wndof) = 0.01052



f-test
new variance and ndof =   0.01543   340
old variance and ndof =   0.02213   340
variance ratio and critical ratio =     1.435     1.151


*****WEIGHTED****** use for f-test since weighted throughout inversion



f-test
new variance and ndof =   0.01052   340
old variance and ndof =   0.01481   340
variance ratio and critical ratio =     1.409     1.151
```

```
 iteration step  2; simultaneous inversion

 Compute velocity adjustments to model-Veladj
 total nodes observed=  38, nodes inverted for=  38, P-Velocity :  18, Vp/Vs ratio:  18, Sta. Corr. :   2
 rhs solution vector:
        Velocity   : mean  0.002132573, variance  0.000909387, norm squared  0.033815600, norm  0.183890179
        P-Velocity : mean -0.001554011, variance  0.000588341, norm squared  0.010633602, norm  0.103119358
        Vp/Vs ratio: mean  0.005625127, variance  0.001188463, norm squared  0.023181999, norm  0.152256355
        Sta. Corr. : mean  0.006231213, variance  0.000000000, norm squared  0.000038828, norm  0.006231213
Damping: P-Velocity  damp =   15.00, c1 =  0.2128, damp(c1) =   17.80
Damping: Vp/Vs ratio damp =   15.00, c1 =  0.1447, damp(c1) =   16.76
       36 velocity adjustments,         2 station corr. adjustments

 sum of squared residuals =     5.245; total number of observations =   390, P obs =   195, S obs =   195
                                                 earthquake obs.=   390, explosion obs.=     0 (wtsht= 0.00)
                   with non-zero wt:                         nwrt=   390,          nswrt=     0
 rms residual = 0.11596   model rms = 0.09671

 weighted sum of squared residuals =     3.575; weighted total number of obs =   390.000; weighted rms res =    0.09575

      STATION CORRECTIONS AND ADJUSTMENTS
 station  Pdelay Adjusted S-Pdelay Adjusted
 CMMM    -0.008    -0.006     0.016    0.006

  velocity model changes

 layer  4     P-Vel nodes          z =    7.0
  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  0.00  0.00  0.04 -0.19 -0.16  0.04  0.12  0.02  0.00  0.00  0.00
  0.00  0.00  0.00 -0.24 -0.15  0.17  0.31  0.03  0.00  0.00  0.00
  0.00  0.00  0.00 -0.11 -0.05  0.27  0.16  0.06  0.00  0.00  0.00
  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00

 corrected velocity model


 layer  4     P-Vel nodes          z =    7.0
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
  6.07  6.07  6.16  5.66  5.68  6.17  6.35  6.16  6.07  6.07  6.07
  6.07  6.07  6.08  5.49  5.73  6.50  6.78  6.16  6.07  6.07  6.07
  6.07  6.07  6.07  5.78  5.94  6.74  6.48  6.21  6.07  6.07  6.07
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07

  STATISTICS, by Depth, excluding edge nodes

 grid z=  0.00     P-Vel
  For    72 gridpts, av=   3.34, sd=  0.000

 grid z=  3.00     P-Vel
  For    72 gridpts, av=   5.63, sd=  0.000

 grid z=  7.00     P-Vel
  For    72 gridpts, av=   6.08, sd=  0.179

 grid z= 11.00     P-Vel
  For    72 gridpts, av=   6.26, sd=  0.000

 grid z= 16.00     P-Vel
  For    72 gridpts, av=   6.50, sd=  0.000

 grid z= 24.00     P-Vel
  For    72 gridpts, av=   6.80, sd=  0.000

 grid z= 26.00     P-Vel
  For    72 gridpts, av=   8.00, sd=  0.000

 VARIANCE OF THIS VELOCITY MODEL
  For all  504 gridpts, variance=  0.00455452, sd=  0.067487

  velocity model changes

 layer  4     Vp/Vs nodes          z =    7.0
  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  0.00  0.00 -0.01 -0.06 -0.01  0.00  0.00  0.01  0.00  0.00  0.00
  0.00  0.00  0.00 -0.05 -0.03  0.04  0.05  0.01  0.00  0.00  0.00
  0.00  0.00  0.00  0.00  0.01  0.08  0.06  0.01  0.00  0.00  0.00
  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
```

```
 corrected velocity model


 layer  4     Vp/Vs nodes          z =    7.0
  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
  1.75  1.75  1.72  1.61  1.72  1.75  1.75  1.77  1.75  1.75  1.75
  1.75  1.75  1.74  1.63  1.70  1.85  1.85  1.76  1.75  1.75  1.75
  1.75  1.75  1.75  1.76  1.79  1.94  1.88  1.78  1.75  1.75  1.75
  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75

  STATISTICS, by Depth, excluding edge nodes

 grid z=  0.00     Vp/Vs
  For    72 gridpts, av=   1.75, sd=  0.000

 grid z=  3.00     Vp/Vs
  For    72 gridpts, av=   1.75, sd=  0.000

 grid z=  7.00     Vp/Vs
  For    72 gridpts, av=   1.75, sd=  0.039

 grid z= 11.00     Vp/Vs
  For    72 gridpts, av=   1.75, sd=  0.000

 grid z= 16.00     Vp/Vs
  For    72 gridpts, av=   1.75, sd=  0.000

 grid z= 24.00     Vp/Vs
  For    72 gridpts, av=   1.75, sd=  0.000

 grid z= 26.00     Vp/Vs
  For    72 gridpts, av=   1.75, sd=  0.000

 VARIANCE OF THIS VELOCITY MODEL
  For all  504 gridpts, variance=  0.00022201, sd=  0.014900



 iteration step  2; hypocenter adjustments
  event   1; nit=  2; wtd rms res= 0.049; ot,x,y,z = 13.08  0.61 20.34  7.32; St.Er.=  0.0162(ot)  0.140(x)  0.095(y)    0.137(z)
     nwr=134, ** total rms = 0.05702  **  model rms = 0.05496 **
  event   2; nit=  2; wtd rms res= 0.084; ot,x,y,z = 41.70  2.80  0.11  5.42; St.Er.=  0.0138(ot)  0.101(x)  0.093(y)    0.139(z)
     nwr=110, ** total rms = 0.10118  **  model rms = 0.09261 **
  event   3; nit=  2; wtd rms res= 0.079; ot,x,y,z = 33.28 -2.13 -7.67 11.85; St.Er.=  0.0138(ot)  0.089(x)  0.090(y)    0.112(z)
     nwr=146, ** total rms = 0.12487  **  model rms = 0.09684 **


 unweighted rms= 0.09921; weighted rms= 0.08266 data var.(ssqrw/wnobt ie:rms**2)= 0.00683
                                                      P data var.= 0.00309  S-P data var.= 0.01058
 subroutine decide, mbl0 =      38 mbl1 =      38

  Unweighted:  ssqr =       3.838    var. (ssqr/ndof) = 0.01129
  Weighted:   ssqrw =       2.665  varw.(ssqrw/wndof) = 0.00784



 f-test
 new variance and ndof =   0.01129   340
 old variance and ndof =   0.01543   340
 variance ratio and critical ratio =     1.366     1.151


*****WEIGHTED****** use for f-test since weighted throughout inversion



 f-test
 new variance and ndof =   0.00784   340
 old variance and ndof =   0.01052   340
 variance ratio and critical ratio =     1.342     1.151



 iteration step  3; simultaneous inversion

 Compute velocity adjustments to model-Veladj
 total nodes observed=  38, nodes inverted for=  38, P-Velocity :  18, Vp/Vs ratio:  18, Sta. Corr. :   2
 rhs solution vector:
         Velocity   : mean  0.001661002, variance  0.000442313, norm squared  0.016467646, norm  0.128326327
         P-Velocity : mean  0.000442621, variance  0.000201218, norm squared  0.003625443, norm  0.060211651
         Vp/Vs ratio: mean  0.002815257, variance  0.000667980, norm squared  0.012842203, norm  0.113323443
         Sta. Corr. : mean  0.002813444, variance  0.000000000, norm squared  0.000007915, norm  0.002813444
Damping: P-Velocity  damp =   17.80, c1 =  0.2128, damp(c1) =   35.46
Damping: Vp/Vs ratio damp =   16.76, c1 =  0.1447, damp(c1) =   23.22
        36 velocity adjustments,         2 station corr. adjustments

 sum of squared residuals =     3.838; total number of observations =   390, P obs =   195, S obs =   195
                                                     earthquake obs.=   390, explosion obs.=     0 (wtsht= 0.00)
```

```
                  with non-zero wt:                              nwrt=   390,           nswrt=     0
rms residual = 0.09921   model rms = 0.08347

weighted sum of squared residuals =     2.665; weighted total number of obs =   390.000; weighted rms res =    0.08266

     STATION CORRECTIONS AND ADJUSTMENTS
station  Pdelay Adjusted S-Pdelay Adjusted
CMMM    -0.022   -0.014     0.019    0.003

 velocity model changes

layer  4     P-Vel nodes          z =    7.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.03 -0.14 -0.09  0.03  0.07  0.01  0.00  0.00  0.00
 0.00  0.00  0.00 -0.16 -0.09  0.08  0.17  0.01  0.00  0.00  0.00
 0.00  0.00  0.00 -0.06 -0.03  0.12  0.08  0.03  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00

corrected velocity model


layer  4     P-Vel nodes          z =    7.0
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.19  5.52  5.59  6.20  6.41  6.17  6.07  6.07  6.07
 6.07  6.07  6.08  5.33  5.63  6.58  6.95  6.17  6.07  6.07  6.07
 6.07  6.07  6.07  5.72  5.91  6.86  6.56  6.24  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07

 STATISTICS, by Depth, excluding edge nodes

grid z=  0.00     P-Vel
 For    72 gridpts, av=   3.34, sd=  0.000

grid z=  3.00     P-Vel
 For    72 gridpts, av=   5.63, sd=  0.000

grid z=  7.00     P-Vel
 For    72 gridpts, av=   6.08, sd=  0.221

grid z= 11.00     P-Vel
 For    72 gridpts, av=   6.26, sd=  0.000

grid z= 16.00     P-Vel
 For    72 gridpts, av=   6.50, sd=  0.000

grid z= 24.00     P-Vel
 For    72 gridpts, av=   6.80, sd=  0.000

grid z= 26.00     P-Vel
 For    72 gridpts, av=   8.00, sd=  0.000

VARIANCE OF THIS VELOCITY MODEL
 For all  504 gridpts, variance=  0.00695065, sd=  0.083371

 velocity model changes

layer  4     Vp/Vs nodes          z =    7.0
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00 -0.01 -0.05 -0.01  0.00  0.00  0.01  0.00  0.00  0.00
 0.00  0.00  0.00 -0.04 -0.03  0.03  0.04  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.01  0.06  0.05  0.01  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00

corrected velocity model


layer  4     Vp/Vs nodes          z =    7.0
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.71  1.56  1.71  1.74  1.75  1.78  1.75  1.75  1.75
 1.75  1.75  1.74  1.59  1.67  1.88  1.89  1.77  1.75  1.75  1.75
 1.75  1.75  1.75  1.76  1.79  1.99  1.93  1.79  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
```

```
 STATISTICS, by Depth, excluding edge nodes

grid z=  0.00     Vp/Vs
 For    72 gridpts, av=   1.75, sd=  0.000

grid z=  3.00     Vp/Vs
 For    72 gridpts, av=   1.75, sd=  0.000

grid z=  7.00     Vp/Vs
 For    72 gridpts, av=   1.75, sd=  0.053

grid z= 11.00     Vp/Vs
 For    72 gridpts, av=   1.75, sd=  0.000

grid z= 16.00     Vp/Vs
 For    72 gridpts, av=   1.75, sd=  0.000

grid z= 24.00     Vp/Vs
 For    72 gridpts, av=   1.75, sd=  0.000

grid z= 26.00     Vp/Vs
 For    72 gridpts, av=   1.75, sd=  0.000

VARIANCE OF THIS VELOCITY MODEL
 For all  504 gridpts, variance=  0.00039456, sd=  0.019864


 iteration step  3; hypocenter adjustments
  event   1; nit=  2; wtd rms res= 0.041; ot,x,y,z = 13.10  0.61 20.25  7.27; St.Er.=  0.0163(ot)  0.142(x)  0.095(y)   0.138(z)
     nwr=134, ** total rms = 0.04714  **  model rms = 0.04501 **
  event   2; nit=  2; wtd rms res= 0.079; ot,x,y,z = 41.70  2.80  0.11  5.42; St.Er.=  0.0138(ot)  0.101(x)  0.093(y)   0.139(z)
     nwr=110, ** total rms = 0.09385  **  model rms = 0.08565 **
  event   3; nit=  1; wtd rms res= 0.071; ot,x,y,z = 33.27 -2.15 -7.70 11.82; St.Er.=  0.0139(ot)  0.090(x)  0.090(y)   0.113(z)
     nwr=146, ** total rms = 0.11214  **  model rms = 0.08601 **


 unweighted rms= 0.08919; weighted rms= 0.07415 data var.(ssqrw/wnobt ie:rms**2)= 0.00550
                                                  P data var.= 0.00237  S-P data var.= 0.00863
 subroutine decide, mbl0 =     38 mbl1 =     38

  Unweighted:  ssqr =       3.103    var. (ssqr/ndof) = 0.00913
  Weighted:   ssqrw =       2.144  varw.(ssqrw/wndof) = 0.00631



 f-test
 new variance and ndof =   0.00913   340
 old variance and ndof =   0.01129   340
 variance ratio and critical ratio =     1.237     1.151


*****WEIGHTED****** use for f-test since weighted throughout inversion



 f-test
 new variance and ndof =   0.00631   340
 old variance and ndof =   0.00784   340
 variance ratio and critical ratio =     1.243     1.151

 sum of squared residuals =     3.103; total number of observations =   390, P obs =    195, S obs =   195
                                            earthquake obs.=   390, explosion obs.=     0 (wtsht= 0.00)
              with non-zero wt:                         nwrt=   390,          nswrt=     0
 rms residual = 0.08919

 weighted sum of squared residuals =     2.144; weighted total number of obs =   390.000; weighted rms res =    0.07415


             FINAL LOCATIONS

    YRMODY HRMN  SEC  LATITUDE LONGITUDE  DEPTH    MAG  NO RMSRES     x       y       z
  1 891019  612 13.10 36n57.19 121w40.40   7.27   1.60 134  0.04   0.61  20.25   7.27
  2 891019  634 41.70 37n 5.29 121w49.59   5.42   1.30 110  0.08   2.80   0.11   5.42
  3 891019  636 33.27 37n 6.09 121w55.75  11.82   1.80 146  0.07  -2.15  -7.70  11.82


             TALLY OF OBSERVATIONS

 station obs  station obs  station obs  station obs  station obs  station obs  station obs  station obs  station obs  station obs
       P  S-P       P  S-P       P  S-P       P  S-P       P  S-P       P  S-P       P  S-P       P  S-P       P  S-P       P  S-P
 ==== === === ==== === === ==== === === ==== === === ==== === === ==== === === ==== === === ==== === === ==== === === ==== === ===
 BAPM   0   0 BAVM   0   0 BBGM   0   0 BBMM   0   0 BBNM   0   0 BCGM   0   0 BCWM   0   0 BEHM   0   0 BEMM   0   0 BHRM   0   0
 BHSM   0   0 BJCM   1   1 BJOM   0   0 BKSB   0   0 BLRM   0   0 BMCM   0   0 BMHM   0   0 BMSM   0   0 BPCM   1   1 BPFM   0   0
 BPIM   0   0 BPNM   0   0 BPPM   0   0 BPRM   0   0 BPYM   0   0 BR1M   0   0 BRMM   0   0 BRVM   0   0 BS2M   0   0 BS3M   0   0
 BS4M   0   0 BSBM   0   0 BSCM   0   0 BSGM   0   0 BSLM   0   0 BSMM   0   0 BSRM   1   1 BVLM   0   0 BVYM   0   0 CACM   0   0
 CADM   0   0 CAIM   0   0 CALM   1   1 CAOM   2   2 CBRM   0   0 CBSM   0   0 CBWM   0   0 CCOM   0   0 CCRM   0   0 CCYM   0   0
 CDAL   0   0 CDOM   0   0 CDSM   0   0 CDUM   0   0 CDVL   0   0 CLCM   0   0 CMCM   0   0 CMHM   1   1 CMJM   1   1 CMLM   0   0
 CMMM   1   1 CMNL   0   0 CMOM   0   0 CMPM   0   0 CMRM   0   0 COSM   0   0 CPAM   0   0 CPLM   0   0 CRAM   0   0 CRPM   0   0
 CSAL   0   0 CSCM   1   1 CSHM   0   0 CSPM   0   0 CSTL   0   0 CVAL   0   0 CVLL   0   0 CYHM   0   0 HAZM   1   1 HBTM   0   0
 HCAM   0   0 HCBM   1   1 HCCM   0   0 HCOM   0   0 HCPM   0   0 HCRM   0   0 HCZM   0   0 HDLM   2   2 HFEM   0   0 HFHM   0   0
 HFOM   0   0 HFPM   0   0 HGSM   0   0 HGWM   0   0 HJGM   0   0 HJSM   0   0 HKRM   0   0 HLTM   0   0 HMOM   0   0 HNUM   0   0
 HORM   0   0 HPHM   0   0 HPLM   0   0 HPRM   1   1 HQRM   0   0 HS8M   0   0 HSFM   0   0 HSLM   0   0 HSPM   2   2 JALM   2   2
```

```
JBCM   1   1 JBEM   0   0 JBGM   0   0 JBLM   1   1 JBMM   1   1 JBZM   3   3 JCBM   0   0 JECM   3   3 JEGM   0   0 JEMM   0   0
JHLM   2   2 JHPM   0   0 JKRM   0   0 JLTM   0   0 JLXM   1   1 JMBM   0   0 JMGM   0   0 JMOM   0   0 JPLM   3   3 JPPM   1   1
JPRM   0   0 JPSM   0   0 JRGM   3   3 JRIM   0   0 JRRM   0   0 JSAM   0   0 JSCM   0   0 JSFM   0   0 JSGM   1   1 JSJM   1   1
JSMM   0   0 JSNM   0   0 JSSM   1   1 JSTM   3   3 JTGM   3   3 JTWM   0   0 JUCM   3   3 JWSM   0   0 L101   3   3 L102   3   3
L103   3   3 L104   3   3 L105   1   1 L106   0   0 L107   3   3 L108   3   3 L109   3   3 L110   3   3 L111   3   3 L112   3   3
L113   1   1 L114   3   3 L115   3   3 L116   3   3 L117   1   1 L118   2   2 L119   2   2 L120   3   3 L141   2   2 L142   3   3
L143   3   3 L144   3   3 L145   3   3 L146   3   3 L147   0   0 L148   3   3 L149   2   2 L150   0   0 L151   3   3 L152   3   3
L153   3   3 L154   3   3 L155   2   2 L156   0   0 L157   3   3 L158   2   2 L159   2   2 L160   2   2 L161   3   3 L162   3   3
L163   2   2 L164   3   3 L165   3   3 L166   0   0 L167   2   2 L168   2   2 L169   3   3 L170   2   2 L171   2   2 L172   3   3
L173   2   2 L174   3   3 L175   3   3 L176   3   3 L177   3   3 L178   3   3 L179   3   3 L180   3   3
```

```
FINAL STATION CORRECTIONS
stn  typ Delay  StErr Resol   nobs  stn  stn grdpt  inv soln
                             nrd hit name num   num arry arry
                                                    num  num

____ ___ ______ _____ _____ ___ ___ ____ ____ ____ ____ ____
CMMM P   -0.022 0.022 0.243   1   1 CMMM   61 1069   72   37
     S-P  0.019 0.022 0.246   1   1 CMMM   61 1277  124   38
```

```
FINAL P-VELOCITY MODEL

layer  4     P-velocity nodes          z =    7.0
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.19  5.52  5.59  6.20  6.41  6.17  6.07  6.07  6.07
 6.07  6.07  6.08  5.33  5.63  6.58  6.95  6.17  6.07  6.07  6.07
 6.07  6.07  6.07  5.72  5.91  6.86  6.56  6.24  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07
 6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07  6.07

OBSERVATION MATRIX - KHIT - (will be 0 for fixed nodes)

layer  4     P-Vel nodes          z =    7.0
    0     0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0     0
    0     0   272   248   248   378   378   142     0     0     0
    0     0   378   378   378   378   378   378     0     0     0
    0     0   130   272   378   378   378   272     0     0     0
    0     0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0     0

DERIVATIVE WEIGHT SUM

layer  4     P-Vel nodes          z =    7.0
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.    16.    85.   112.   124.    47.    39.     0.     0.     0.
0.     0.    25.   140.   204.   576.   208.    17.     0.     0.     0.
0.     0.     8.   135.   199.   515.   178.    36.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.

RESOLUTION : GRIDOINT NUMBER, DIAGONAL RESOLUTION ELEMENT (-1.0 indicates fixed velocity gridpoint)

layer  4     P-Vel nodes          z =    7.0
  145:-1.0000  146:-1.0000  147:-1.0000  148:-1.0000  149:-1.0000  150:-1.0000  151:-1.0000  152:-1.0000  153:-1.0000
  154:-1.0000  155:-1.0000  156:-1.0000  157:-1.0000  158:-1.0000  159:-1.0000  160:-1.0000  161:-1.0000  162:-1.0000
  163:-1.0000  164:-1.0000  165:-1.0000  166:-1.0000  167:-1.0000  168:-1.0000  169:-1.0000  170:-1.0000  171:-1.0000
  172:-1.0000  173: 0.0533  174: 0.0652  175: 0.1391  176: 0.0969  177: 0.0956  178: 0.1579  179:-1.0000  180:-1.0000
  181:-1.0000  182: 0.0090  183: 0.0791  184: 0.1220  185: 0.1677  186: 0.2163  187: 0.0051  188:-1.0000  189:-1.0000
  190:-1.0000  191: 0.0010  192: 0.1040  193: 0.1224  194: 0.2791  195: 0.1420  196: 0.1230  197:-1.0000  198:-1.0000
  199:-1.0000  200:-1.0000  201:-1.0000  202:-1.0000  203:-1.0000  204:-1.0000  205:-1.0000  206:-1.0000  207:-1.0000
  208:-1.0000  209:-1.0000  210:-1.0000  211:-1.0000  212:-1.0000  213:-1.0000  214:-1.0000  215:-1.0000  216:-1.0000
```

```
FINAL S-VELOCITY MODEL

layer  4     Vp/Vs nodes          z =    7.0
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.71  1.56  1.71  1.74  1.75  1.78  1.75  1.75  1.75
 1.75  1.75  1.74  1.59  1.67  1.88  1.89  1.77  1.75  1.75  1.75
 1.75  1.75  1.75  1.76  1.79  1.99  1.93  1.79  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75
 1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75  1.75

layer  4     S-velocity nodes          z =    7.0
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47
 3.47  3.47  3.62  3.53  3.26  3.55  3.67  3.46  3.47  3.47  3.47
 3.47  3.47  3.49  3.35  3.36  3.50  3.68  3.49  3.47  3.47  3.47
```

```
 3.47  3.47  3.47  3.25  3.30  3.44  3.40  3.49  3.47  3.47  3.47
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47
 3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47  3.47

OBSERVATION MATRIX - KHIT - (will be 0 for fixed nodes)

layer  4    Vp/Vs nodes          z =    7.0
    0     0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0     0
    0     0   378   248   378   378   378   142     0     0     0
    0     0   378   378   378   378   378   378     0     0     0
    0     0   130   272   378   378   378   272     0     0     0
    0     0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0     0

DERIVATIVE WEIGHT SUM

layer  4    Vp/Vs nodes          z =    7.0
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.    16.    90.   121.   119.    48.    39.     0.     0.     0.
0.     0.    22.   147.   227.   522.   184.    16.     0.     0.     0.
0.     0.     8.   137.   249.   422.   162.    31.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.

RESOLUTION : GRIDOINT NUMBER, DIAGONAL RESOLUTION ELEMENT (-1.0 indicates fixed velocity gridpoint)

layer  4    Vp/Vs nodes          z =    7.0
  649:-1.0000  650:-1.0000  651:-1.0000  652:-1.0000  653:-1.0000  654:-1.0000  655:-1.0000  656:-1.0000  657:-1.0000
  658:-1.0000  659:-1.0000  660:-1.0000  661:-1.0000  662:-1.0000  663:-1.0000  664:-1.0000  665:-1.0000  666:-1.0000
  667:-1.0000  668:-1.0000  669:-1.0000  670:-1.0000  671:-1.0000  672:-1.0000  673:-1.0000  674:-1.0000  675:-1.0000
  676:-1.0000  677: 0.0634  678: 0.1252  679: 0.1732  680: 0.0917  681: 0.1162  682: 0.1783  683:-1.0000  684:-1.0000
  685:-1.0000  686: 0.0091  687: 0.1087  688: 0.1728  689: 0.2567  690: 0.2363  691: 0.0093  692:-1.0000  693:-1.0000
  694:-1.0000  695: 0.0010  696: 0.1242  697: 0.1848  698: 0.2418  699: 0.1623  700: 0.1089  701:-1.0000  702:-1.0000
  703:-1.0000  704:-1.0000  705:-1.0000  706:-1.0000  707:-1.0000  708:-1.0000  709:-1.0000  710:-1.0000  711:-1.0000
  712:-1.0000  713:-1.0000  714:-1.0000  715:-1.0000  716:-1.0000  717:-1.0000  718:-1.0000  719:-1.0000  720:-1.0000

        VELOCITY WITH STANDARD ERROR(km/s) AND RESOLUTION
 where error and res are both 0.00, the node was not inverted for, where resol.=-1.00, gridpoint velocity was fixed

layer  4    P-Vel nodes          z =    7.0
 6.07   6.07        6.07        6.07        6.07        6.07        6.07        6.07        6.07        6.07        6.07
06.07  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07
 res     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)    res
06.07  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07
 res     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)    res
06.07  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07
 res     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)    res
06.07  6.07+.0000  6.19+.0229  5.52+.0216  5.59+.0311  6.20+.0303  6.41+.0298  6.17+.0363  6.07+.0000  6.07+.0000  6.07
 res     (-1.00)     ( 0.05)     ( 0.07)     ( 0.14)     ( 0.10)     ( 0.10)     ( 0.16)     (-1.00)     (-1.00)    res
06.07  6.07+.0000  6.08+.0096  5.33+.0234  5.63+.0302  6.58+.0397  6.95+.0466  6.17+.0071  6.07+.0000  6.07+.0000  6.07
 res     (-1.00)     ( 0.01)     ( 0.08)     ( 0.12)     ( 0.17)     ( 0.22)     ( 0.01)     (-1.00)     (-1.00)    res
06.07  6.07+.0000  6.07+.0033  5.72+.0284  5.91+.0314  6.86+.0504  6.56+.0381  6.24+.0343  6.07+.0000  6.07+.0000  6.07
 res     (-1.00)     ( 0.00)     ( 0.10)     ( 0.12)     ( 0.28)     ( 0.14)     ( 0.12)     (-1.00)     (-1.00)    res
06.07  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07
 res     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)    res
06.07  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07+.0000  6.07
 res     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)    res
06.07   6.07        6.07        6.07        6.07        6.07        6.07        6.07        6.07        6.07        6.07

layer  4    Vp/Vs nodes          z =    7.0
 1.75   1.75        1.75        1.75        1.75        1.75        1.75        1.75        1.75        1.75        1.75
01.75  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75
 res     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)    res
01.75  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75
 res     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)    res
01.75  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75
 res     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)    res
01.75  1.75+.0000  1.71+.0071  1.56+.0086  1.71+.0109  1.74+.0085  1.75+.0091  1.78+.0114  1.75+.0000  1.75+.0000  1.75
 res     (-1.00)     ( 0.06)     ( 0.13)     ( 0.17)     ( 0.09)     ( 0.12)     ( 0.18)     (-1.00)     (-1.00)    res
01.75  1.75+.0000  1.74+.0028  1.59+.0083  1.67+.0107  1.88+.0137  1.89+.0134  1.77+.0028  1.75+.0000  1.75+.0000  1.75
 res     (-1.00)     ( 0.01)     ( 0.11)     ( 0.17)     ( 0.26)     ( 0.24)     ( 0.01)     (-1.00)     (-1.00)    res
01.75  1.75+.0000  1.75+.0010  1.76+.0097  1.79+.0118  1.99+.0145  1.93+.0121  1.79+.0096  1.75+.0000  1.75+.0000  1.75
 res     (-1.00)     ( 0.00)     ( 0.12)     ( 0.18)     ( 0.24)     ( 0.16)     ( 0.11)     (-1.00)     (-1.00)    res
01.75  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75
 res     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)    res
01.75  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75+.0000  1.75
 res     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)     (-1.00)    res
01.75   1.75        1.75        1.75        1.75        1.75        1.75        1.75        1.75        1.75        1.75

For      9525 calls to MINIMA, average number psuedo-bending iter. =    2.76

Computation finished at 21-May-93 12:11:56
```

Unit 17—Full Resolution Matrix

No file is produced on Unit 17 in this test case.

Unit 18—Node-Grid Map

```
1424   1008
 140     36
   1      0
   2      0
   3      0
```

(166 similar, sequential, 0-ending lines deleted for brevity in this *Open-file Report*)

```
 170      0
 171      0
 172      0
 173      1
 174      2
 175      3
 176      4
 177      5
 178      6
 179      0
 180      0
 181      0
 182      7
 183      8
 184      9
 185     10
 186     11
 187     12
 188      0
 189      0
 190      0
 191     13
 192     14
 193     15
 194     16
 195     17
 196     18
 197      0
 198      0
 199      0
```

(474 similar, sequential, 0-ending lines deleted for brevity in this *Open-file Report*)

```
 674      0
 675      0
 676      0
 677     19
 678     20
 679     21
 680     22
 681     23
 682     24
 683      0
 684      0
 685      0
 686     25
 687     26
 688     27
 689     28
 690     29
 691     30
 692      0
 693      0
 694      0
 695     31
 696     32
 697     33
 698     34
 699     35
 700     36
 701      0
 702      0
 703      0
```

(302 similar, sequential, 0-ending lines deleted for brevity in this *Open-file Report*)

```
1006      0
1007      0
1008      0
1009     37
1010     38
1011     39
1012     40
1013     41
1014      0
1015     42
1016     43
```

1017	44
1018	0
1019	45
1020	0
1021	0
1022	46
1023	0
1024	0
1025	0
1026	47
1027	0
1028	48
1029	49
1030	0
1031	50
1032	51
1033	0
1034	0
1035	0
1036	52
1037	53
1038	54
1039	55
1040	0
1041	56
1042	57
1043	0
1044	58
1045	0
1046	59
1047	0
1048	60
1049	0
1050	61
1051	0
1052	0
1053	0
1054	62
1055	63
1056	0
1057	64
1058	0
1059	65
1060	66
1061	67
1062	68
1063	69
1064	70
1065	71
1066	0
1067	0
1068	0
1069	72
1070	73
1071	74
1072	75
1073	76
1074	77
1075	0
1076	0
1077	78
1078	79
1079	80
1080	0
1081	0
1082	81
1083	82
1084	0
1085	0
1086	0

(37 similar, sequential, 0-ending lines deleted for brevity in this *Open-file Report*)

1124	0
1125	0
1126	0
1127	83
1128	0
1129	0
1130	0
1131	0
1132	0
1133	0
1134	0
1135	84
1136	0
1137	0
1138	0
1139	85
1140	0
1141	0
1142	86
1143	0
1144	87

1145	0
1146	0
1147	0
1148	0
1149	0
1150	0
1151	0
1152	0
1153	0
1154	88
1155	0
1156	0
1157	0

(56 similar, sequential, 0-ending lines deleted for brevity in this *Open-file Report*)

1214	0
1215	0
1216	0
1217	89
1218	90
1219	91
1220	92
1221	93
1222	0
1223	94
1224	95
1225	96
1226	0
1227	97
1228	0
1229	0
1230	98
1231	0
1232	0
1233	0
1234	99
1235	0
1236	100
1237	101
1238	0
1239	102
1240	103
1241	0
1242	0
1243	0
1244	104
1245	105
1246	106
1247	107
1248	0
1249	108
1250	109
1251	0
1252	110
1253	0
1254	111
1255	0
1256	112
1257	0
1258	113
1259	0
1260	0
1261	0
1262	114
1263	115
1264	0
1265	116
1266	0
1267	117
1268	118
1269	119
1270	120
1271	121
1272	122
1273	123
1274	0
1275	0
1276	0
1277	124
1278	125
1279	126
1280	127
1281	128
1282	129
1283	0
1284	0
1285	130
1286	131
1287	132
1288	0
1289	0
1290	133
1291	134

1292	0
1293	0
1294	0

(37 similar, sequential, 0-ending lines deleted for brevity in this *Open-file Report*)

1332	0
1333	0
1334	0
1335	135
1336	0
1337	0
1338	0
1339	0
1340	0
1341	0
1342	0
1343	136
1344	0
1345	0
1346	0
1347	137
1348	0
1349	0
1350	138
1351	0
1352	139
1353	0
1354	0
1355	0
1356	0
1357	0
1358	0
1359	0
1360	0
1361	0
1362	140
1363	0
1364	0
1365	0

(56 similar, sequential, 0-ending lines deleted for brevity in this *Open-file Report*)

1422	0
1423	0
1424	0

Unit 19—Difference in Traveltimes Between ART and Pseudo-Bending

No file is produced on Unit 19 in this test case.

Unit 20—Station Traveltime Residuals

No file is produced on Unit 20 in this test case.

Unit 22—Station Data

```
 37   4.20 121 50.90 -131.50
208                              computed   21-May-93 12:11:53
   BCGM36 42.55 121 20.60   305 0.00 0.00   1
   BHRM36 43.67 121 15.83   213 0.00 0.00   1
   BJCM36 32.82 121 23.53   207 0.00 0.00   1
```

(151 other stations deleted for brevity in this *Open-file Report*)

```
   L17837   0.16 121 57.23    37 0.00 0.00   1
   L17936 59.82 121 57.29    24 0.00 0.00   1
   L18036 59.10 121 57.33    12 0.00 0.00   1
```

Unit 23—Final Velocity Model

```
 1.0 11 10   9   2          computed   21-May-93 12:11:53
-788.0 -39.0 -15.0   -5.0   -1.0    2.0    6.0   16.0   27.0   46.0 699.0
-788.0 -58.0 -35.0 -20.0 -10.0    0.0   10.0   20.0   35.0 699.0
-150.0     0.0     3.0     7.0   11.0   16.0   24.0   26.0 650.0
  0   0   0
 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
```

(24 lines identical to Unit 03 input deleted for brevity in this *Open-file Report*)

```
 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63
 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63
 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63 5.63
 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07
 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07
 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07
 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07
 6.07 6.07 6.19 5.52 5.59 6.20 6.41 6.17 6.07 6.07 6.07
 6.07 6.07 6.08 5.33 5.63 6.58 6.95 6.17 6.07 6.07 6.07
 6.07 6.07 6.07 5.72 5.91 6.86 6.56 6.24 6.07 6.07 6.07
 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07
 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07
 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07 6.07
 6.26 6.26 6.26 6.26 6.26 6.26 6.26 6.26 6.26 6.26 6.26
 6.26 6.26 6.26 6.26 6.26 6.26 6.26 6.26 6.26 6.26 6.26
 6.26 6.26 6.26 6.26 6.26 6.26 6.26 6.26 6.26 6.26 6.26
```

(44 lines identical to Unit 03 input deleted for brevity in this *Open-file Report*)

```
 8.50 8.50 8.50 8.50 8.50 8.50 8.50 8.50 8.50 8.50 8.50
 8.50 8.50 8.50 8.50 8.50 8.50 8.50 8.50 8.50 8.50 8.50
 8.50 8.50 8.50 8.50 8.50 8.50 8.50 8.50 8.50 8.50 8.50
 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04
 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04
 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04
 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04
 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04
 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04
 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04
 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04
 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04
 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04
 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91
 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91
 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91
 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91
 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91
 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91
 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91
 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91
 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91
 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91 1.91
 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22
 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22
 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22
 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22
 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22
 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22
 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22 3.22
```

3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22
3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22
3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22
3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47
3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47
3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47
3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47
3.47	3.47	3.62	3.53	3.26	3.55	3.67	3.46	3.47	3.47	3.47
3.47	3.47	3.49	3.35	3.36	3.50	3.68	3.49	3.47	3.47	3.47
3.47	3.47	3.47	3.25	3.30	3.44	3.40	3.49	3.47	3.47	3.47
3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47
3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47
3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47
3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71
3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71
3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71
3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71
3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71
3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71
3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71
3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71
3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71
3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71
3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89
3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89
3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89
3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89
3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89
3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89
3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89
3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89
3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89
3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89
4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57
4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57
4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57
4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57
4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57
4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57
4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57
4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57
4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57
4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57
4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86
4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86
4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86
4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86
4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86
4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86
4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86
4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86
4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86
4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

(27 identical lines deleted for brevity in this *Open-file Report*)

1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.71	1.56	1.71	1.74	1.75	1.78	1.75	1.75	1.75
1.75	1.75	1.74	1.59	1.67	1.88	1.89	1.77	1.75	1.75	1.75
1.75	1.75	1.75	1.76	1.79	1.99	1.93	1.79	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

(47 identical lines deleted for brevity in this *Open-file Report*)

1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

Unit 24—Earthquake Traveltime Data for Recomputed Hypocenters

```
891019  612 13.10 36 57.19 121 40.40   7.27   1.60            computed  21-May-93 12:11:53
L141ESD1   1.56L145ESN0   1.31L149ISD0   1.28L142ESU0   1.50L148ISD0   1.28L143ESU0   1.41
L144ESU0   1.38L146ISU0   1.40L117ESN2   1.67L118ES+0   1.66L151ISU0   1.48L119ES+0   1.65
L152ESU0   1.61L155ESU0   1.61L116ESN0   1.92L153ISU0   1.73L154ISU0   1.79L120ES+1   1.88
```

```
L160ISU0   2.03L115ES+0   2.17L157ESU0   2.08L159ISU0   2.07L158ESU0   2.31L114ESU0   2.48
L112ESU0   2.66L111ISU0   2.66L113ESU0   2.82L110ESU0   2.99L109ESU0   3.34L104ISU0   3.47
L105ESU0   3.47L108ESU1   3.53L103ISU0   3.69L107ISU0   3.68L102ISU0   3.75L101ESU1   3.89
L180ESU3   3.68L179ESU2   3.69L178ISU1   3.69L177ISU1   3.74L176ISU0   3.74L175ISU0   3.72
L174ESU1   3.72L173ISD1   3.89L172ES-1   4.00L169ESD2   4.44L171ES-1   4.23L170ES+1   4.46
L165ES+2   4.75L164ESU1   4.96L163ESU2   5.21L162ESU1   5.41L161ESU1   5.54HPRMXSD0   1.14
HCBMXSD0   1.20HAZMXSD0   1.87HDLMXSD0   2.22JPLMXSU0   2.31JBZMXSU0   2.38JECMXSD1   2.64
JTGMXSU0   3.01HSPMXSD0   3.44JRGMXSU0   3.97JSTMXSU0   4.66JUCMXSD1   4.73BSRMXSU0   4.85
CAOMXSD0   6.24L141EPD1   2.06L145EPN0   1.71L149IPD0   1.69L142EPU0   1.98L148IPD0   1.67
L143EPU0   1.87L144EPU0   1.82L146IPU0   1.85L117EPN2   2.21L118EP+0   2.21L151IPU0   1.96
L119EP+0   2.18L152EPU0   2.12L155EPU0   2.13L116EPN0   2.55L153IPU0   2.27L154IPU0   2.36
L120EP+1   2.49L160IPU0   2.70L115EP+0   2.88L157EPU0   2.77L159IPU0   2.76L158EPU0   3.05
L114EPU0   3.26L112EPU0   3.38L111IPU0   3.40L113EPU0   3.51L110EPU0   3.73L109EPU0   4.07
L104IPU0   4.16L105EPU0   4.12L108EPU1   4.26L103IPU0   4.43L107IPU0   4.35L102IPU0   4.51
L101EPU1   4.64L180EPU3   4.92L179EPU2   4.97L178IPU1   4.99L177IPU1   5.04L176IPU0   5.04
L175IPU0   5.04L174EPU1   5.03L173IPD1   5.13L172EP-1   5.17L169EPD2   5.38L171EP-1   5.59
L170EP+1   5.64L165EP+2   5.71L164EPU1   6.03L163EPU2   6.33L162EPU1   6.57L161EPU1   6.77
HPRMXPD0   1.49HCBMXPD0   1.58HAZMXPD0   2.49HDLMXPD0   2.94JPLMXPU0   3.06JBZMXPU0   3.15
JECMXPD1   3.41JTGMXPU0   4.05HSPMXPD0   4.58JRGMXPU0   5.40JSTMXPU0   5.46JUCMXPD1   6.37
BSRMXPU0   6.46CAOMXPD0   8.32
0
891019  634 41.70 37  5.29 121 49.59   5.42   1.30
L103ISU0   1.10L104ISU0   1.05L102ISU0   1.15L101ISU0   1.23L112ISU0   1.27L158ESN0   1.37
L111ESU0   1.43L157ES+1   1.52L110ES+0   1.58L107ESU0   1.61L169ES+1   1.70L159ESD1   1.63
L172ISD0   1.67L114ESU1   1.75L109ES-1   1.76L173ESD1   1.73L108ES-1   1.81L160ESD0   1.80
L171ISD0   1.81L174ISD0   1.78L168ESN3   1.93L120ES-2   1.95L165ES+1   1.97L115ESD1   1.99
L154ES-2   1.95L175ES-1   1.91L176ESD1   1.95L153ES+1   2.20L167ESN3   2.23L177ESD1   2.02
L164ESU1   2.23L152ES+1   2.42L178ESD0   2.14L151ESU1   2.46L179ESD1   2.22L146ISU0   2.64
L116ESU1   2.70L163ESN1   2.48L180ESD1   2.36L144ISD1   2.80L145ISU1   2.82L148ESD2   2.81
L143ES+0   2.89L162ESD1   2.67L161ESD0   2.81L142ISD2   3.06JHLMXSU0   1.11JECMXSU1   1.12
JBZMXSD0   1.48JTGMXSD0   1.48JALMXSU1   1.53JPLMXSD1   2.07JRGMXSU2   2.00JSTMXSD0   2.17
JUCMXSD1   2.83L103IPU0   1.48L104IPU0   1.39L102IPU0   1.53L101IPU0   1.64L112IPU0   1.65
L158EPN0   1.74L111EPU0   1.81L157EP+1   1.89L110EP+0   1.98L107EPU0   2.04L169EP+1   2.31
L159EPD1   2.05L172IPD0   2.35L114EPU1   2.13L109EP-1   2.21L173EPD1   2.43L108EP-1   2.26
L160EPD0   2.27L171IPD0   2.57L174IPD0   2.49L168EPN3   2.64L120EP-2   2.31L165EP+1   2.65
L115EPD1   2.37L154EP-2   2.42L175EP-1   2.71L176EPD1   2.96L153EP+1   2.71L167EPN3   3.04
L177EPD1   3.05L164EPU1   2.99L152EP+1   2.91L178EPD0   3.22L151EPU1   2.89L179EPD1   3.30
L146IPU0   2.96L116EPU1   3.00L163EPN1   3.31L180EPD1   3.46L144IPD1   3.12L145IPU1   3.18
L148EPD2   3.20L143EP+0   3.25L162EPD1   3.55L161EPD0   3.74L142IPD2   3.46JHLMXPU0   1.48
JECMXPU1   1.47JBZMXPD0   1.91JTGMXPD0   2.00JALMXPU1   2.02JPLMXPD1   2.66JRGMXPU2   3.04
JSTMXPD0   2.82JUCMXPD1   4.55
0
891019  636 33.27 37  6.09 121 55.75  11.82   1.80
L170ISD1   1.60L172ISD0   1.55L169ES-2   1.69L168ISD1   1.71L165ISD1   1.73L167ISD0   1.87
L174ISD0   1.65L164ISD0   1.92L101ES 2   1.88L175ISD1   1.74L102ES-1   1.98L176ES-2   1.81
L177ES+1   1.85L103ES+1   2.13L162ES 2   2.26L178ES+2   1.94L179ES 3   1.99L161ES-2   2.40
L104ES+2   2.24L180ES 3   2.13L112ISU0   2.76L107ISU0   2.64L157ES-2   2.77L111ES+1   2.89
L110ISU0   2.91L108ISU1   2.90L154ES-2   3.09L109ISU0   2.96L114ES-1   3.24L153ES-2   3.18
L155ES 3   3.33L120ES-2   3.48L152ES 3   3.40L115ES+2   3.54L151ES 3   3.55L119ES 3   3.93
L146ES+2   3.89L148ISU1   3.82L149ES 3   3.83L145ES 3   4.04L118ES+1   4.12L144ES 3   4.08
L116ES-2   4.17L143ES 2   4.18L142ES 2   4.33L141ES 3   4.46JSSMXSU1   2.10JRGMXSU0   1.77
JHLMXSU1   2.16JTGMXSD1   1.89JALMXSU0   2.12JBCMYSD0   2.38JECMXSU0   2.33JLXMYSU0   2.42
JBZMXSD0   2.43JUCMXSU0   2.53JPLMXSD1   2.65JSTMXSU0   2.75JBLMYSU0   3.44JSGMYSD2   3.48
CSCMXSU0   3.66JSJMYSD3   4.23JPPMYSU3   4.41JBMMYSD2   4.58CMHMXSU0   4.70HSPMXSU0   5.34
HDLMXSU2   5.36CALMXSU0   5.55CAOMXSU1   6.13CMJMXSU0   6.34CMMMXSU0   7.46BPCMXSD2   8.39
BJCMXSU1   9.96L170IPD1   2.51L172IPD0   2.46L169EP-2   2.42L168IPD1   2.46L165IPD1   2.45
L167IPD0   2.62L174IPD0   2.62L164IPD0   2.59L101EP 2   2.65L175IPD1   2.76L102EP-1   2.79
L176EP-2   2.88L177EP+1   2.96L103EP+1   2.90L162EP 2   2.96L178EP+2   3.12L179EP 3   3.19
L161EP-2   3.13L104EP+2   3.02L180EP 3   3.32L112IPU0   3.45L107IPU0   3.44L157EP-2   3.61
L111EP+1   3.58L110IPU0   3.65L108IPU1   3.71L154EP-2   3.94L109IPU0   3.73L114EP-1   3.86
L153EP-2   4.17L155EP 3   4.16L120EP-2   4.03L152EP 3   4.35L115EP+2   4.08L151EP 3   4.37
L119EP 3   4.39L146EP+2   4.57L148IPU1   4.73L149EP 3   4.80L145EP 3   4.76L118EP+1   4.65
L144EP 3   4.73L116EP-2   4.65L143EP 2   4.87L142EP 2   5.08L141EP 3   5.36JSSMXPU1   2.88
JRGMXPU0   2.80JHLMXPU1   2.94JTGMXPD1   2.99JALMXPU0   2.81JBCMYPD0   3.11JECMXPU0   3.24
JLXMYPU0   3.17JBZMXPD0   3.38JUCMXPU0   3.56JPLMXPD1   3.84JSTMXPU0   3.56JBLMYPU0   4.51
JSGMYPD2   4.57CSCMXPU0   4.80JSJMYPD3   5.57JPPMYPU3   5.80JBMMYPD2   6.03CMHMXPU0   6.19
HSPMXPU0   6.84HDLMXPU2   7.08CALMXPU0   7.34CAOMXPU1   8.10CMJMXPU0   8.38CMMMXPU0   9.90
BPCMXPD2  11.11BJCMXPU1  13.20
0
```

Unit 25—New Velocities

```
 LAYR   2          0.00k
  3.3437 9.19 12237.67              -39.00 -58.00    0.00
  3.343718.90 12226.97              -15.00 -58.00    0.00
  3.343722.95 12222.51               -5.00 -58.00    0.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

```
  3.343658.14 12126.08               16.00  35.00    0.00
  3.3437 2.59 12121.15               27.00  35.00    0.00
  3.343710.29 12112.62               46.00  35.00    0.00
 LAYR   3          3.00k
  5.6337 9.19 12237.67              -39.00 -58.00    3.00
  5.633718.90 12226.97              -15.00 -58.00    3.00
  5.633722.95 12222.51               -5.00 -58.00    3.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

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  5.633658.14 12126.08               16.00  35.00    3.00
  5.6337 2.59 12121.15               27.00  35.00    3.00
  5.633710.29 12112.62               46.00  35.00    3.00
```

```
LAYR   4          7.00k
 6.0737 9.19 12237.67          -39.00 -58.00   7.00
 6.073718.90 12226.97          -15.00 -58.00   7.00
 6.073722.95 12222.51           -5.00 -58.00   7.00
 6.073724.57 12220.72           -1.00 -58.00   7.00
 6.073725.79 12219.38            2.00 -58.00   7.00
 6.073727.41 12217.59            6.00 -58.00   7.00
 6.073731.46 12213.12           16.00 -58.00   7.00
 6.073735.91 122 8.20           27.00 -58.00   7.00
 6.073743.60 12159.68           46.00 -58.00   7.00
 6.0737 0.95 12226.01          -39.00 -35.00   7.00
 6.073710.66 12215.31          -15.00 -35.00   7.00
 6.073714.71 12210.84           -5.00 -35.00   7.00
 6.073716.33 122 9.06           -1.00 -35.00   7.00
 6.073717.55 122 7.72            2.00 -35.00   7.00
 6.073719.17 122 5.93            6.00 -35.00   7.00
 6.073723.22 122 1.45           16.00 -35.00   7.00
 6.073727.67 12156.53           27.00 -35.00   7.00
 6.073735.36 12148.01           46.00 -35.00   7.00
 6.073655.57 12218.42          -39.00 -20.00   7.00
 6.0737 5.29 122 7.71          -15.00 -20.00   7.00
 6.0737 9.34 122 3.25           -5.00 -20.00   7.00
 6.073710.96 122 1.46           -1.00 -20.00   7.00
 6.073712.17 122 0.12            2.00 -20.00   7.00
 6.073713.79 12158.33            6.00 -20.00   7.00
 6.073717.84 12153.86           16.00 -20.00   7.00
 6.073722.30 12148.93           27.00 -20.00   7.00
 6.073729.99 12140.41           46.00 -20.00   7.00
 6.073651.99 12213.36          -39.00 -10.00   7.00
 6.1937 1.71 122 2.66          -15.00 -10.00   7.00
 5.5237 5.76 12158.19           -5.00 -10.00   7.00
 5.5937 7.38 12156.40           -1.00 -10.00   7.00
 6.2037 8.59 12155.06            2.00 -10.00   7.00
 6.413710.21 12153.27            6.00 -10.00   7.00
 6.173714.26 12148.80           16.00 -10.00   7.00
 6.073718.72 12143.87           27.00 -10.00   7.00
 6.073726.41 12135.35           46.00 -10.00   7.00
 6.073648.41 122 8.31          -39.00   0.00   7.00
 6.083658.13 12157.60          -15.00   0.00   7.00
 5.3337 2.18 12153.13           -5.00   0.00   7.00
 5.6337 3.79 12151.35           -1.00   0.00   7.00
 6.5837 5.01 12150.01            2.00   0.00   7.00
 6.9537 6.63 12148.22            6.00   0.00   7.00
 6.173710.68 12143.74           16.00   0.00   7.00
 6.073715.13 12138.81           27.00   0.00   7.00
 6.073722.83 12130.29           46.00   0.00   7.00
 6.073644.83 122 3.26          -39.00  10.00   7.00
 6.073654.54 12152.55          -15.00  10.00   7.00
 5.723658.59 12148.08           -5.00  10.00   7.00
 5.9137 0.21 12146.30           -1.00  10.00   7.00
 6.8637 1.43 12144.95            2.00  10.00   7.00
 6.5637 3.05 12143.17            6.00  10.00   7.00
 6.2437 7.10 12138.69           16.00  10.00   7.00
 6.073711.55 12133.76           27.00  10.00   7.00
 6.073719.24 12125.24           46.00  10.00   7.00
 6.073641.24 12158.21          -39.00  20.00   7.00
 6.073650.96 12147.50          -15.00  20.00   7.00
 6.073655.01 12143.04           -5.00  20.00   7.00
 6.073656.63 12141.25           -1.00  20.00   7.00
 6.073657.84 12139.91            2.00  20.00   7.00
 6.073659.46 12138.12            6.00  20.00   7.00
 6.0737 3.51 12133.64           16.00  20.00   7.00
 6.0737 7.97 12128.71           27.00  20.00   7.00
 6.073715.66 12120.19           46.00  20.00   7.00
 6.073635.87 12150.65          -39.00  35.00   7.00
 6.073645.59 12139.94          -15.00  35.00   7.00
 6.073649.64 12135.47           -5.00  35.00   7.00
 6.073651.26 12133.69           -1.00  35.00   7.00
 6.073652.47 12132.34            2.00  35.00   7.00
 6.073654.09 12130.55            6.00  35.00   7.00
 6.073658.14 12126.08           16.00  35.00   7.00
 6.0737 2.59 12121.15           27.00  35.00   7.00
 6.073710.29 12112.62           46.00  35.00   7.00
LAYR   5         11.00k
 6.2637 9.19 12237.67          -39.00 -58.00  11.00
 6.263718.90 12226.97          -15.00 -58.00  11.00
 6.263722.95 12222.51           -5.00 -58.00  11.00
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(66 similar lines deleted for brevity in this *Open-file Report*)

```
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 6.2637 2.59 12121.15           27.00  35.00  11.00
 6.263710.29 12112.62           46.00  35.00  11.00
LAYR   6         16.00k
 6.5037 9.19 12237.67          -39.00 -58.00  16.00
 6.503718.90 12226.97          -15.00 -58.00  16.00
 6.503722.95 12222.51           -5.00 -58.00  16.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

```
 6.503658.14 12126.08           16.00  35.00  16.00
 6.5037 2.59 12121.15           27.00  35.00  16.00
 6.503710.29 12112.62           46.00  35.00  16.00
LAYR   7         24.00k
 6.8037 9.19 12237.67          -39.00 -58.00  24.00
```

```
  6.803718.90 12226.97          -15.00 -58.00  24.00
  6.803722.95 12222.51           -5.00 -58.00  24.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

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  6.803658.14 12126.08           16.00  35.00  24.00
  6.8037 2.59 12121.15           27.00  35.00  24.00
  6.803710.29 12112.62           46.00  35.00  24.00
 LAYR   8         26.00k
  8.0037 9.19 12237.67          -39.00 -58.00  26.00
  8.003718.90 12226.97          -15.00 -58.00  26.00
  8.003722.95 12222.51           -5.00 -58.00  26.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

```
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  8.0037 2.59 12121.15           27.00  35.00  26.00
  8.003710.29 12112.62           46.00  35.00  26.00
 LAYR   2          0.00k
  1.9137 9.19 12237.67          -39.00 -58.00   0.00
  1.913718.90 12226.97          -15.00 -58.00   0.00
  1.913722.95 12222.51           -5.00 -58.00   0.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

```
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  1.9137 2.59 12121.15           27.00  35.00   0.00
  1.913710.29 12112.62           46.00  35.00   0.00
 LAYR   3          3.00k
  3.2237 9.19 12237.67          -39.00 -58.00   3.00
  3.223718.90 12226.97          -15.00 -58.00   3.00
  3.223722.95 12222.51           -5.00 -58.00   3.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

```
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  3.2237 2.59 12121.15           27.00  35.00   3.00
  3.223710.29 12112.62           46.00  35.00   3.00
 LAYR   4          7.00k
  3.4737 9.19 12237.67          -39.00 -58.00   7.00
  3.473718.90 12226.97          -15.00 -58.00   7.00
  3.473722.95 12222.51           -5.00 -58.00   7.00
  3.473724.57 12220.72           -1.00 -58.00   7.00
  3.473725.79 12219.38            2.00 -58.00   7.00
  3.473727.41 12217.59            6.00 -58.00   7.00
  3.473731.46 12213.12           16.00 -58.00   7.00
  3.473735.91 122 8.20           27.00 -58.00   7.00
  3.473743.60 12159.68           46.00 -58.00   7.00
  3.4737 0.95 12226.01          -39.00 -35.00   7.00
  3.473710.66 12215.31          -15.00 -35.00   7.00
  3.473714.71 12210.84           -5.00 -35.00   7.00
  3.473716.33 122 9.06           -1.00 -35.00   7.00
  3.473717.55 122 7.72            2.00 -35.00   7.00
  3.473719.17 122 5.93            6.00 -35.00   7.00
  3.473723.22 122 1.45           16.00 -35.00   7.00
  3.473727.67 12156.53           27.00 -35.00   7.00
  3.473735.36 12148.01           46.00 -35.00   7.00
  3.473655.57 12218.42          -39.00 -20.00   7.00
  3.4737 5.29 122 7.71          -15.00 -20.00   7.00
  3.4737 9.34 122 3.25           -5.00 -20.00   7.00
  3.473710.96 122 1.46           -1.00 -20.00   7.00
  3.473712.17 122 0.12            2.00 -20.00   7.00
  3.473713.79 12158.33            6.00 -20.00   7.00
  3.473717.84 12153.86           16.00 -20.00   7.00
  3.473722.30 12148.93           27.00 -20.00   7.00
  3.473729.99 12140.41           46.00 -20.00   7.00
  3.473651.99 12213.36          -39.00 -10.00   7.00
  3.6237 1.71 122 2.66          -15.00 -10.00   7.00
  3.5337 5.76 12158.19           -5.00 -10.00   7.00
  3.2637 7.38 12156.40           -1.00 -10.00   7.00
  3.5537 8.59 12155.06            2.00 -10.00   7.00
  3.673710.21 12153.27            6.00 -10.00   7.00
  3.463714.26 12148.80           16.00 -10.00   7.00
  3.473718.72 12143.87           27.00 -10.00   7.00
  3.473726.41 12135.35           46.00 -10.00   7.00
  3.473648.41 122 8.31          -39.00   0.00   7.00
  3.493658.13 12157.60          -15.00   0.00   7.00
  3.3537 2.18 12153.13           -5.00   0.00   7.00
  3.3637 3.79 12151.35           -1.00   0.00   7.00
  3.5037 5.01 12150.01            2.00   0.00   7.00
  3.6837 6.63 12148.22            6.00   0.00   7.00
  3.493710.68 12143.74           16.00   0.00   7.00
  3.473715.13 12138.81           27.00   0.00   7.00
  3.473722.83 12130.29           46.00   0.00   7.00
  3.473644.83 122 3.26          -39.00  10.00   7.00
  3.473654.54 12152.55          -15.00  10.00   7.00
  3.253658.59 12148.08           -5.00  10.00   7.00
  3.3037 0.21 12146.30           -1.00  10.00   7.00
  3.4437 1.43 12144.95            2.00  10.00   7.00
  3.4037 3.05 12143.17            6.00  10.00   7.00
  3.4937 7.10 12138.69           16.00  10.00   7.00
  3.473711.55 12133.76           27.00  10.00   7.00
  3.473719.24 12125.24           46.00  10.00   7.00
  3.473641.24 12158.21          -39.00  20.00   7.00
  3.473650.96 12147.50          -15.00  20.00   7.00
  3.473655.01 12143.04           -5.00  20.00   7.00
  3.473656.63 12141.25           -1.00  20.00   7.00
```

```
  3.473657.84 12139.91              2.00  20.00   7.00
  3.473659.46 12138.12              6.00  20.00   7.00
  3.4737 3.51 12133.64             16.00  20.00   7.00
  3.4737 7.97 12128.71             27.00  20.00   7.00
  3.473715.66 12120.19             46.00  20.00   7.00
  3.473635.87 12150.65            -39.00  35.00   7.00
  3.473645.59 12139.94            -15.00  35.00   7.00
  3.473649.64 12135.47             -5.00  35.00   7.00
  3.473651.26 12133.69             -1.00  35.00   7.00
  3.473652.47 12132.34              2.00  35.00   7.00
  3.473654.09 12130.55              6.00  35.00   7.00
  3.473658.14 12126.08             16.00  35.00   7.00
  3.4737 2.59 12121.15             27.00  35.00   7.00
  3.473710.29 12112.62             46.00  35.00   7.00
 LAYR   5            11.00k
  3.5837 9.19 12237.67            -39.00 -58.00  11.00
  3.583718.90 12226.97            -15.00 -58.00  11.00
  3.583722.95 12222.51             -5.00 -58.00  11.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

```
  3.583658.14 12126.08             16.00  35.00  11.00
  3.5837 2.59 12121.15             27.00  35.00  11.00
  3.583710.29 12112.62             46.00  35.00  11.00
 LAYR   6            16.00k
  3.7137 9.19 12237.67            -39.00 -58.00  16.00
  3.713718.90 12226.97            -15.00 -58.00  16.00
  3.713722.95 12222.51             -5.00 -58.00  16.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

```
  3.713658.14 12126.08             16.00  35.00  16.00
  3.7137 2.59 12121.15             27.00  35.00  16.00
  3.713710.29 12112.62             46.00  35.00  16.00
 LAYR   7            24.00k
  3.8937 9.19 12237.67            -39.00 -58.00  24.00
  3.893718.90 12226.97            -15.00 -58.00  24.00
  3.893722.95 12222.51             -5.00 -58.00  24.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

```
  3.893658.14 12126.08             16.00  35.00  24.00
  3.8937 2.59 12121.15             27.00  35.00  24.00
  3.893710.29 12112.62             46.00  35.00  24.00
 LAYR   8            26.00k
  4.5737 9.19 12237.67            -39.00 -58.00  26.00
  4.573718.90 12226.97            -15.00 -58.00  26.00
  4.573722.95 12222.51             -5.00 -58.00  26.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

```
  4.573658.14 12126.08             16.00  35.00  26.00
  4.5737 2.59 12121.15             27.00  35.00  26.00
  4.573710.29 12112.62             46.00  35.00  26.00
  1.7537 9.19 12237.67            -39.00 -58.00   0.00
  1.753718.90 12226.97            -15.00 -58.00   0.00
  1.753722.95 12222.51             -5.00 -58.00   0.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

```
  1.753658.14 12126.08             16.00  35.00   0.00
  1.7537 2.59 12121.15             27.00  35.00   0.00
  1.753710.29 12112.62             46.00  35.00   0.00
  1.7537 9.19 12237.67            -39.00 -58.00   3.00
  1.753718.90 12226.97            -15.00 -58.00   3.00
  1.753722.95 12222.51             -5.00 -58.00   3.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

```
  1.753658.14 12126.08             16.00  35.00   3.00
  1.7537 2.59 12121.15             27.00  35.00   3.00
  1.753710.29 12112.62             46.00  35.00   3.00
  1.7537 9.19 12237.67            -39.00 -58.00   7.00
  1.753718.90 12226.97            -15.00 -58.00   7.00
  1.753722.95 12222.51             -5.00 -58.00   7.00
  1.753724.57 12220.72             -1.00 -58.00   7.00
  1.753725.79 12219.38              2.00 -58.00   7.00
  1.753727.41 12217.59              6.00 -58.00   7.00
  1.753731.46 12213.12             16.00 -58.00   7.00
  1.753735.91 122 8.20             27.00 -58.00   7.00
  1.753743.60 12159.68             46.00 -58.00   7.00
  1.7537 0.95 12226.01            -39.00 -35.00   7.00
  1.753710.66 12215.31            -15.00 -35.00   7.00
  1.753714.71 12210.84             -5.00 -35.00   7.00
  1.753716.33 122 9.06             -1.00 -35.00   7.00
  1.753717.55 122 7.72              2.00 -35.00   7.00
  1.753719.17 122 5.93              6.00 -35.00   7.00
  1.753723.22 122 1.45             16.00 -35.00   7.00
  1.753727.67 12156.53             27.00 -35.00   7.00
  1.753735.36 12148.01             46.00 -35.00   7.00
  1.753655.57 12218.42            -39.00 -20.00   7.00
  1.7537 5.29 122 7.71            -15.00 -20.00   7.00
  1.7537 9.34 122 3.25             -5.00 -20.00   7.00
  1.753710.96 122 1.46             -1.00 -20.00   7.00
  1.753712.17 122 0.12              2.00 -20.00   7.00
  1.753713.79 12158.33              6.00 -20.00   7.00
  1.753717.84 12153.86             16.00 -20.00   7.00
  1.753722.30 12148.93             27.00 -20.00   7.00
  1.753729.99 12140.41             46.00 -20.00   7.00
```

```
1.753651.99  12213.36        -39.00  -10.00    7.00
1.7137 1.71  122 2.66        -15.00  -10.00    7.00
1.5637 5.76  12158.19         -5.00  -10.00    7.00
1.7137 7.38  12156.40         -1.00  -10.00    7.00
1.7437 8.59  12155.06          2.00  -10.00    7.00
1.753710.21  12153.27          6.00  -10.00    7.00
1.783714.26  12148.80         16.00  -10.00    7.00
1.753718.72  12143.87         27.00  -10.00    7.00
1.753726.41  12135.35         46.00  -10.00    7.00
1.753648.41  122 8.31        -39.00    0.00    7.00
1.743658.13  12157.60        -15.00    0.00    7.00
1.5937 2.18  12153.13         -5.00    0.00    7.00
1.6737 3.79  12151.35         -1.00    0.00    7.00
1.8837 5.01  12150.01          2.00    0.00    7.00
1.8937 6.63  12148.22          6.00    0.00    7.00
1.773710.68  12143.74         16.00    0.00    7.00
1.753715.13  12138.81         27.00    0.00    7.00
1.753722.83  12130.29         46.00    0.00    7.00
1.753644.83  122 3.26        -39.00   10.00    7.00
1.753654.54  12152.55        -15.00   10.00    7.00
1.763658.59  12148.08         -5.00   10.00    7.00
1.7937 0.21  12146.30         -1.00   10.00    7.00
1.9937 1.43  12144.95          2.00   10.00    7.00
1.9337 3.05  12143.17          6.00   10.00    7.00
1.7937 7.10  12138.69         16.00   10.00    7.00
1.753711.55  12133.76         27.00   10.00    7.00
1.753719.24  12125.24         46.00   10.00    7.00
1.753641.24  12158.21        -39.00   20.00    7.00
1.753650.96  12147.50        -15.00   20.00    7.00
1.753655.01  12143.04         -5.00   20.00    7.00
1.753656.63  12141.25         -1.00   20.00    7.00
1.753657.84  12139.91          2.00   20.00    7.00
1.753659.46  12138.12          6.00   20.00    7.00
1.7537 3.51  12133.64         16.00   20.00    7.00
1.7537 7.97  12128.71         27.00   20.00    7.00
1.753715.66  12120.19         46.00   20.00    7.00
1.753635.87  12150.65        -39.00   35.00    7.00
1.753645.59  12139.94        -15.00   35.00    7.00
1.753649.64  12135.47         -5.00   35.00    7.00
1.753651.26  12133.69         -1.00   35.00    7.00
1.753652.47  12132.34          2.00   35.00    7.00
1.753654.09  12130.55          6.00   35.00    7.00
1.753658.14  12126.08         16.00   35.00    7.00
1.7537 2.59  12121.15         27.00   35.00    7.00
1.753710.29  12112.62         46.00   35.00    7.00
1.7537 9.19  12237.67        -39.00  -58.00   11.00
1.753718.90  12226.97        -15.00  -58.00   11.00
1.753722.95  12222.51         -5.00  -58.00   11.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

```
1.753658.14  12126.08         16.00   35.00   11.00
1.7537 2.59  12121.15         27.00   35.00   11.00
1.753710.29  12112.62         46.00   35.00   11.00
1.7537 9.19  12237.67        -39.00  -58.00   16.00
1.753718.90  12226.97        -15.00  -58.00   16.00
1.753722.95  12222.51         -5.00  -58.00   16.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

```
1.753658.14  12126.08         16.00   35.00   16.00
1.7537 2.59  12121.15         27.00   35.00   16.00
1.753710.29  12112.62         46.00   35.00   16.00
1.7537 9.19  12237.67        -39.00  -58.00   24.00
1.753718.90  12226.97        -15.00  -58.00   24.00
1.753722.95  12222.51         -5.00  -58.00   24.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

```
1.753658.14  12126.08         16.00   35.00   24.00
1.7537 2.59  12121.15         27.00   35.00   24.00
1.753710.29  12112.62         46.00   35.00   24.00
1.7537 9.19  12237.67        -39.00  -58.00   26.00
1.753718.90  12226.97        -15.00  -58.00   26.00
1.753722.95  12222.51         -5.00  -58.00   26.00
```

(66 similar lines deleted for brevity in this *Open-file Report*)

```
1.753658.14  12126.08         16.00   35.00   26.00
1.7537 2.59  12121.15         27.00   35.00   26.00
1.753710.29  12112.62         46.00   35.00   26.00
```

Unit 26—Errant Rays

```
Minima: no=  1  L141, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  4  L142, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  9  L117, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  9  L117, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no= 10  L118, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no= 10  L118, used maximum number PB iter.: j=  5, nitpb=  5
```

(43 similar, sequential-"no=" lines deleted for brevity in this *Open-file Report*)

```
Minima: no= 22  L159, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no= 45  L172, used maximum number PB iter.: j= 12, nitpb= 12
```

```
Minima: no=  56  HAZM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  56  HAZM, used maximum number PB iter.: j=  5, nitpb=  5
**   1 891019  612 13.10 36n57.24 121w40.44
Minima: no=   1  L141, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=   9  L117, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=   9  L117, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  10  L118, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  10  L118, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  12  L119, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  12  L119, used maximum number PB iter.: j=  5, nitpb=  5
```

(20 similar, sequential-"no=" lines deleted for brevity in this *Open-file Report*)

```
Minima: no=  84  L154, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  86  L160, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no= 123  HAZM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=   5  L112, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=   6  L158, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=   6  L158, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=   7  L111, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=   7  L111, used maximum number PB iter.: j=  5, nitpb=  5
```

(54 similar, sequential-"no=" lines deleted for brevity in this *Open-file Report*)

```
Minima: no= 105  JTGM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no= 106  JALM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no= 107  JPLM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=   6  L158, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=   7  L111, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=   8  L157, used maximum number PB iter.: j=  5, nitpb=  5
```

(25 similar, sequential-"no=" lines deleted for brevity in this *Open-file Report*)

```
Minima: no=  50  JTGM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  51  JALM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  52  JPLM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=   6  L158, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=   7  L111, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=   8  L157, used maximum number PB iter.: j=  5, nitpb=  5
```

(23 similar, sequential-"no=" lines deleted for brevity in this *Open-file Report*)

```
Minima: no=  50  JTGM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  51  JALM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  52  JPLM, used maximum number PB iter.: j=  5, nitpb=  5
**   2 891019  634 41.70 37n 5.12 121w49.36
Minima: no=   5  L112, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=   6  L158, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=   6  L158, used maximum number PB iter.: j=  5, nitpb=  5
```

(56 similar, sequential-"no=" lines deleted for brevity in this *Open-file Report*)

```
Minima: no= 105  JTGM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no= 106  JALM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no= 107  JPLM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  19  L104, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  20  L180, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  52  JBCM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  66  HSPM, used maximum number PB iter.: j= 12, nitpb= 12
Minima: no=  71  CMMM, used maximum number PB iter.: j= 12, nitpb= 12
Minima: no= 139  HSPM, used maximum number PB iter.: j= 12, nitpb= 12
Minima: no=  14  L103, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  49  JHLM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  66  HSPM, used maximum number PB iter.: j= 12, nitpb= 12
**   3 891019  636 33.27 37n 6.06 121w55.88
Minima: no=  19  L104, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  20  L180, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  52  JBCM, used maximum number PB iter.: j=  5, nitpb=  5
Minima: no=  66  HSPM, used maximum number PB iter.: j= 12, nitpb= 12
Minima: no=  71  CMMM, used maximum number PB iter.: j= 12, nitpb= 12
Minima: no= 139  HSPM, used maximum number PB iter.: j= 12, nitpb= 12
```

Unit 28—Blast Traveltime Data and Recomputed Origin Times

No file is produced on Unit 28 in this test case.

Unit 34—Similar to a *hypo71* Listing File

(One blank line at start of file.)

```
 AZIM and TOA calculated with 3D velocity model (SIMULPS12) 21-May-93 12:11:16

  DATE    ORIGIN    LATITUDE LONGITUDE  DEPTH    MAG NO          RMS
 891019  612 13.10 36n57.19 121w40.40    7.27    1.60134          0.04

  STN  DIST   AZ TOA PRMK HRMN   PSEC  TPOBS               PRES   PWT
 L141  10.8   34 132 EPD1  612 15.16   2.06               -0.01  0.65
 L145   8.9  341 149 EPN0  612 14.81   1.71                0.00  1.30
 L149   8.9  274 147 IPD0  612 14.79   1.69                0.00  1.30
```

(61 similar lines deleted for brevity in this *Open-file Report*)

```
JUCM  34.6 279  77 XPD1  612 19.47  6.37          -0.03  0.49
BSRM  35.7 157  78 XPU0  612 19.56  6.46          -0.01  0.96
CAOM  46.3  16  81 XPD0  612 21.42  8.32           0.05  0.73

 DATE    ORIGIN   LATITUDE LONGITUDE  DEPTH    MAG NO          RMS
891019  634 41.70 37n 5.29 121w49.59   5.42   1.30110          0.08

 STN  DIST  AZ TOA PRMK HRMN  PSEC TPOBS           PRES  PWT
L103   6.6 337 158 IPU0  634 43.18  1.48           0.02  1.53
L104   6.2  27 160 IPU0  634 43.09  1.39          -0.01  1.53
L102   6.8 294 154 IPU0  634 43.23  1.53           0.03  1.53
```

(48 similar lines deleted for brevity in this *Open-file Report*)

```
JRGM  14.7 245  84 XPU2  634 44.74  3.04           0.11  0.38
JSTM  14.6  11  83 XPD0  634 44.52  2.82           0.03  1.53
JUCM  22.8 244  85 XPD1  634 46.25  4.55           0.18  0.73

 DATE    ORIGIN   LATITUDE LONGITUDE  DEPTH    MAG NO          RMS
891019  636 33.27 37n 6.09 121w55.75  11.82   1.80146          0.07

 STN  DIST  AZ TOA PRMK HRMN  PSEC TPOBS           PRES  PWT
L170  13.5 302 171 IPD1  636 35.78  2.51           0.12  1.06
L172  13.4 193 165 IPD0  636 35.73  2.46           0.12  2.12
L169  13.5  12 171 EP-2  636 35.69  2.42           0.04  0.53
```

(67 similar lines deleted for brevity in this *Open-file Report*)

```
CMMM  57.1  45  79 XPU0  636 43.17  9.90          -0.05  0.81
BPCM  66.0 155  79 XPD2  636 44.38 11.11          -0.11  0.12
BJCM  79.1 142  75 XPU1  636 46.47 13.20          -0.11  0.02
```

(Two blank lines at end of file.)

Unit 45—1/diag(**C**)

No file is produced on Unit 45 in this test case.

Acknowledgements

We wish to thank Phil Dawson, G. R. Foulger, Bruce Julian, Angus Miller, and H. M. Iyer for extensive reviews and suggestions at various stages in the evolution of this Manual. We thank Angus Miller in particular for creating and verifying the comprehensive test case presented in Appendix D and for posing a series of particularly cogent questions and suggestions.

Various trademark names appear throughout this *Open-file Report*. They are cited subject to the disclaimer on the title page.

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