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Preliminary reference Earth model *

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A large data set consisting of about 1000 normal mode periods, 500 summary travel time observations, 100 normal mode Q values, mass and moment of inertia have been inverted to obtain the radial distribution of elastic properties, Q values and density in the Earth's interior. The data set was supplemented with a special study of 12 years of ISC phase data which yielded an additional 1.75×10^6 travel time observations for P and S waves. In order to obtain satisfactory agreement with the entire data set we were required to take into account anelastic dispersion. The introduction of transverse isotropy into the outer 220 km of the mantle was required in order to satisfy the shorter period fundamental toroidal and spheroidal modes. This anisotropy also improved the fit of the larger data set. The horizontal and vertical velocities in the upper mantle differ by 2–4%, both for P and S waves. The mantle below 220 km is not required to be anisotropic. Mantle Rayleigh waves are surprisingly sensitive to compressional velocity in the upper mantle. High S_n velocities, low P_n velocities and a pronounced low-velocity zone are features of most global inversion models that are suppressed when anisotropy is allowed for in the inversion.

The Preliminary Reference Earth Model, PREM, and auxiliary tables showing fits to the data are presented.

Preamble

The study of precession and nutation in astronomy and geodesy, and of Earth tides and free oscillations in geophysics, need knowledge of the internal structure of the Earth. The importance of free and forced nutations, for instance, polar motion, Chandler and annual components, and diurnal motion of the Earth, in different fields of science, emphasizes the value of the contribution of seismology for these researches.

It was very difficult to set up models of the Earth's structure before the advent of computers; the more important ones were set up by Bullen, and his models A and B were employed extensively.

Seismological studies of the structure of the Earth have developed rapidly since 1950, much aided by the fast improvement in computer techniques.

Expansion in the utilization of computers made it possible to construct many types of Earth models. The consequent proliferation of Earth models had two consequences:

(1) There was a difficulty of choice of an adequate Earth model for researchers that depend on the structure of the Earth, such as those listed in the first paragraph.

(2) Several researchers adopted some properties from one model and other properties from a second model, with the consequence that their models were not self-compatible.

These difficulties were pointed out, at a Sym-

* With a preamble by the Standard Earth Committee of the I.U.G.G. Followed by "A note on the calculation of travel times in a transversely isotropic Earth model" by J.H. Woodhouse (this issue, pp. 357–359).

posium on Earth Tides, during the 1971 IUGG General Assembly in Moscow (Vicente, R.O., 1973, Bull. Geodesique No. 107, p. 105), and informal discussions on the subject led to the setting up of a working group, composed of members of IAG and ISPEI, called the "Standard Earth Model Committee"; the chairman was the late Professor K.E. Bullen.

The objective of the working group was to set up a standard model for the structure of the Earth, from the center to the surface, defining the main parameters and principal discontinuities in such a way that they could be adopted by the international scientific community in any studies that depended on the Earth's structure.

The initial approach was to appoint several sub-committees dealing with different regions of the Earth, composed of scientists specialising in those areas. The original sub-committees were on: (1) the hydrostatic equilibrium problem; (2) the crust; (3) the upper mantle; (4) region D″; (5) core radius; (6) P-velocity distribution in the core; and (7) density and rigidity of the inner core.

During the meeting of the Symposium on Mathematical Geophysics (Banff, 1972), three research groups, headed by D.L. Anderson, F. Gilbert and F. Press, presented models giving the main parameters; in spite of the fact that these models employed different data sets and computation techniques, the values obtained for the core radius agreed within 0.2%, which was a remarkable result. The papers were published in *Geophys. J.*, vol. 35 (1973); there was by then a general feeling that it was possible to set up an adequate standard Earth model.

During the IASPEI meeting in Lima (1973) there was agreement about the need for a *parametrisation* of the model to be adopted. It was decided to call the model for the Earth's structure a "*reference* model", following the example of geodesy where there is a reference ellipsoid. In spite of this change in the name, it was agreed to keep the same name for the Committee. The reports of the sub-committees were published in *Phys. Earth Planet. Inter.*, vol. 9 (1974).

By the time of the 1975 IUGG General Assembly (Grenoble) it was evident that it would be difficult for several sub-committees to work separately and produce a consistent reference model. Several approaches to the problem of setting up a reference model were discussed, including allowance for attenuation; it was decided to invite colleagues to produce and present complete models worked out by themselves and satisfying the guidelines laid down by the Committee. The guidelines were published during 1976 in several scientific journals (*Bull. Seismol. Soc. Am.*, *Geophys. J.*, *EOS*, etc.) with the announcement that proposed models should be presented during the IASPEI meeting in 1977.

The meeting of the Committee during the IASPEI assembly in Durham (1977) was concerned with the presentation and discussion of three different proposals, corresponding to researches done by D.L. Anderson, B. Bolt and A.M. Dziewonski. It appeared to be possible to construct models taking account of damping, that is, of Q values. The Committee members present considered that the effects of attenuation were important and should be considered; but, since Q was not well determined, instead of having one reference model, we should have two reference models—one including Q values and the other without Q values.

At this meeting it was evident that the original reference model envisaged was growing more and more detailed, thanks to the rapid progress of seismology. Several features that could not have been considered in 1971 were now feasible. It was decided to entrust to D.L. Anderson and A.M. Dziewonski the task of presenting a suitable reference model.

The first report on the reference model of Anderson and Dziewonski was presented at the meeting of the Committee on Mathematical Geophysics (Caracas, 1978), with the statement that the gross Earth data employed for the construction of the model was being enlarged, using the ISC tapes.

During the 1979 IUGG General Assembly (Canberra) a preliminary report on the Interim Reference Earth Model was presented by A.M. Dziewonski and D.L. Anderson. It was agreed by the Committee that the report should be submitted to *Physics of the Earth and Planetary Interiors*, and that interested seismologists should be encouraged to use the Preliminary Earth Model and send comments to the authors. In order that the authors should be able to consider such comments, and to modify the model in the light of them if they think fit, such comments should be in the hands of Dziewonski and Anderson as soon as possible.

Professors Dziewonski and Anderson have been asked to make a further Report, which the Committee hopes to be able to regard as the conclusion of its work, at the IASPEI Assembly in 1981.

E.R. Lapwood, Chairman
R.O. Vicente, Secretary
For the Standard Earth Model Committee
May 5, 1980

1. Introduction

A variety of geophysical, geochemical and astronomical studies require an accurate description of the variation of elastic properties and density in the interior of the Earth. This paper contains a brief description of a new Earth model, PREM, that satisfies the guidelines established by the Standard Earth Model (S.E.M.) Committee at its meeting in Grenoble in 1975. In order to satisfy the large amount of precise normal mode, surface wave and body wave data, we have found it necessary to introduce anelastic dispersion and anisotropy. The model is therefore frequency-dependent and, for the upper mantle, transversely isotropic. We present tables containing the velocities, elastic constants and Q as a function of radius, and auxiliary parameters such as gravity, pressure, $\mathrm{d}K/\mathrm{d}P$ and the Bullen parameter, η_B.

The model is parametric in nature, a concept discussed, and, in general terms, found acceptable during the meeting of the S.E.M. Committee, chaired by the late Professor Keith Bullen, in Lima, 1973. We have provided analytic formulae for the seismic velocities, density and quality factor Q as a function of radius. For this purpose we use low-order polynomials in radius, of order between zero and three, to describe seismic velocities, density and attenuation in the various regions of the Earth.

Section 2 deals with the basic concept of the model. The division of the Earth into regions within which the properties are assumed to vary smoothly predetermines the general features of the final model and must be done with care. In general terms, we follow the recommendations of the Subcommittee on Parameterization, whose findings were published among reports of the other subcommittees in *Phys. Earth Planet. Inter.*, vol. 9 (1974).

Section 3 contains a description of the datasets that we use in inversion for the final model. Section 4 describes procedures adopted in formulation of the starting model. In Section 6 we provide a brief outline of the inversion method used, the final (in terms of this report only, of course) model and discussion of the fit to the data.

There have been a number of important problems and decisions that we have faced during the course of this work. Some of these decisions required choices between conflicting datasets. Others were resolved by accepting that the velocities in the real Earth are dispersive. The most difficult decision to make was whether we should drop the assumption of isotropy. A large amount of important data could not be fit adequately with the preliminary isotropic Earth models. So we view anisotropy and anelastic dispersion as essential complexities. We have, however, tabulated results for the "equivalent" isotropic Earth. "Equivalent" means that the model has approximately the same bulk modulus and shear modulus as the anisotropic model, not that it provides an equivalent, or satisfactory, fit to the data. The isotropic moduli are calculated with a Voigt averaging scheme and, therefore, represent the least upper bound. We encourage the geophysical community to test and evaluate the model and the tables and to contribute to refinement of what we call the Preliminary Reference Earth Model, or PREM.

2. The concept of the model

An average Earth model, the subject of this work, is a mathematical abstraction. The lateral heterogeneity in the first few tens of kilometers is so large that an average model does not reflect the actual Earth structure at any point. In construction of the structure within the first 100 km we have adopted the concept of weighted average: assuming that oceanic crust covers two-thirds of the Earth's surface and that the average depth to the Moho is 11 km under oceans and 35 km under continents, we arrive at a figure of 19 km for the depth to the Moho for the average Earth. This is used as the trial starting value.

We recognize the following principal regions within the Earth:

(1) Ocean layer.
(2) Upper and lower crust.
(3) Region above the low velocity zone (LID), considered to be the main part of the seismic lithosphere. When we finally dropped the assumption of isotropy the distinction between LID and LVZ became less pronounced.
(4) Low velocity zone (LVZ).
(5) Region between low velocity zone and 400 km discontinuity.
(6) Transition zone spanning the region between the 400 and 670 km discontinuities.
(7) Lower mantle. In our work we found it necessary to subdivide this region into three parts connected by second-order discontinuities.
(8) Outer core.
(9) Inner core.

While the existence of most of the regions listed above has been recognized for some time, the subdivision of the upper mantle is still subject to some differences of opinion. We feel that evidence for the world-wide existence of a zone of low velocity gradient in the upper mantle is very strong and that the same is true with respect to at least two major discontinuities, although the actual velocity gradients are still unresolved.

From a practical viewpoint, such a modular construction is very convenient. It is much easier to perturb a particular feature of a model when it is separated from the remaining ones by clearly defined discontinuities than to alter a model that by definition is continuous. Other practical reasons have to do with numerical applications. Many methods of construction of synthetic seismograms can satisfactorily treat abrupt discontinuities, but are not suitable for regions with very steep velocity gradients. Another important issue is the inverse problem: there exist formulae for the effect of change in the radius of a discontinuity on periods of free oscillations or travel times of body waves, but there are no equivalent expressions for diffused transitions.

The preceding discussion dealt only with the elastic properties of the Earth. One fundamental assumption that we make an interpretation of the data in the seismic frequency band is that the seismic quality factor Q is independent of the frequency. This hypothesis seems to be consistent with most of the currently available information except perhaps for periods shorter than 5–10 s. We in no way imply that Q is exactly independent of frequency at all depths and over the entire seismic frequency band but only that most data can be satisfactorily fitted with this assumption.

3. The gross Earth data set

There are three principal subsets of data:

1. Astronomic-geodetic data

Radius of the Earth: 6371 km. Mass: 5.974×10^{24} kg. I/MR^2: 0.3308. These values, listed in the guideline of the SEM Committee, were used as constraints.

2. Free oscillation and long-period surface wave data

There is an impressive set of measurements of eigenfrequencies for over 1000 normal modes. The precision of measurements varies appreciably: from up to 4×10^{-3} for some of the toroidal overtones to the 4×10^{-6} recently reported for the fundamental radial mode.

Our set of normal mode data consists of about 900 modes collected from early observations compiled by Derr (1969), Dziewonski and Gilbert (1972, 1973), Mendiguren (1973), Gilbert and Dziewonski (1975), and Buland et al. (1979). This dataset has been supplemented by measurements of dispersion of surface waves by Kanamori (1970), Dziewonski (1971), Dziewonski et al. (1972), Mills (1977), and Robert North (personal communication, 1980).

The data on attenuation are important in the context of this report only to a limited extent. The anelastic component of our model is primarily meant as a tool for taking into account the small, but important, frequency-dependence of the elastic parameters. The published data on attenuation of normal modes is of variable quality. We have chosen a relatively small set of data based on measurements of Kanamori (1970), Dratler et al. (1971), Sailor (1978), Sailor and Dziewonski (1978), Stein and Geller (1978), Buland et al. (1979), Geller and Stein (1979), and Stein and Dziewonski (1980).

3. Body waves

Observations of travel times of body waves are most numerous; there have been hundreds of studies dealing with this subject. The advantage of the body wave data over the normal mode observations is that, because of shorter periods, they are capable of higher radial resolution. The disadvantage lies in the somewhat relative nature of their absolute values. The problem of base-line differences is well known and need not be discussed here. There is also the question of small differences in the overall slope of the teleseismic travel-time curve; some of the controversies on this subject are now over a decade old and still remain unresolved. The body wave dataset is important in defining the regions of the mantle which we discussed above and in improving the resolving power of the dataset.

In order to obtain a representative global body-wave dataset we have studied the P- and S-wave travel times using the arrival time data from Bulletins of the International Seismological Centre for years 1964–1975. Rejecting events with fewer than 30 stations reporting, one retains approximately 26000 events with reports of nearly 2000000 P-wave arrival times and 250000 S-wave arrival times. Since neither the distribution of stations nor earthquakes is uniform, there exists the important question of an appropriate averaging method. After many experiments, a decision was made to divide the Earth into a number of sections of equal area, derive a travel-time curve for sources in each of the areas and then average all these travel-time curves. This would tend to eliminate the bias introduced by unequal seismicity in the presence of lateral heterogeneity. In actual experiments we have used 72 regions, each 30° wide in longitude and of the appropriate latitudinal extent to assure equality of the area. Average travel times were computed only if at least five readings for a given 1° cell were available. Figures 1 and 2 show the deviations of our global average travel-time curve from Jeffreys–Bullen travel times. Also shown are residuals for other travel-time studies; these two figures will be discussed more extensively later on in the text.

All events analyzed were shallow, between 0 and 100 km in depth. For reasons that, at least originally, were not particularly relevant to this report, we have also derived average travel-time curves separately for regions with shallow and deep seismicity (but for shallow events only). There are significant and systematic differences between these two types of regions. The P-wave intercept time for shallow seismicity regions is earlier by about 0.6 s; the deep seismicity areas are earlier by about 0.4 s at 90°. This is not purely a problem of a tilt in the travel-time curves as there are at least two intersections of the curves at intermediate distances. While the broad-scale features for both curves are virtually identical, the short wavelength structure is markedly different.

For the S-wave data, differences between travel times for regions of deep and shallow seismicity are much greater. The difference in the intercept time is 5–6 s and, what is even more surprising, there is a systematic difference of 3–4 s in the distance range from 90 to 100°. The wide scatter of data in the interval 80–90° can probably be explained by interference with the SKS phase, which begins to arrive before S at approximately 82°.

It would appear that the events for regions with deep seismicity (trenches) are systematically mislocated. The near-source stations tend to be grouped only on one side of the event, and an epicentral mislocation is very plausible, particularly if S-wave data are not used. This error in the position and the origin time must be compensated by an equivalent error in depth. This is reflected in the baseline and tilt of a derived travel-time curve.

Because of the very large differences between various datasets, a meaningful average is difficult to determine. Various datasets are shown in Fig. 2. Substantial adjustments in the absolute values of the travel times appear to be necessary.

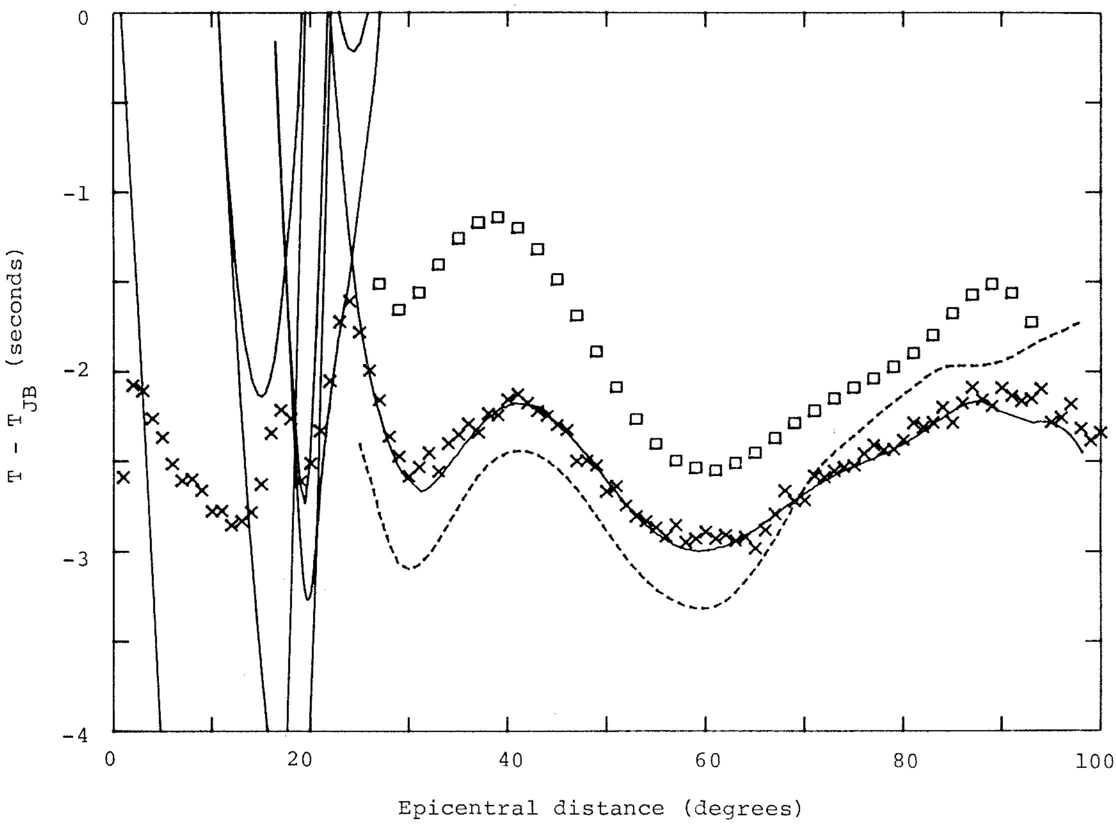

Fig. 1. Surface focus P-wave travel-time residuals with respect to JB times. Crosses are ISC data. Boxes are from Hales et al. (1968). Dashed line is from Herrin et al. (1968). Solid line is anisotropic PREM. ISC times have been corrected with -1.88 s baseline and -0.0085 s deg^{-1} slope. Residuals calculated at a period of 1 s.

Because of the baseline and tilt uncertainty of travel-time observations from natural sources we use body-wave data as a constraint on the fine structure of velocity variations rather than as a strong constraint on absolute velocities. Thus, we are mainly concerned with fitting the shape of the travel-time curves. Differential travel times and the normal mode dataset provide constraints on absolute velocities. Even these datasets contain a source and path bias but we have been able to find a spherically symmetric Earth model which satisfies these data to high precision.

Other subsets of teleseismic travel times, used mostly for comparison, include deep source P-wave data of Sengupta and Julian (1976) and S-wave data of Sengupta (1975), Hales et al. (1968), and Gogna et al. (1981). Differential travel times, PcP–P (Engdahl and Johnson, 1974) and ScS–S (Jordan and Anderson, 1974), are important for the control of the outer core radius.

If the issues are somewhat unclear with respect to the mantle travel times, the difficulties increase by an order of magnitude in the outer core. To obtain reasonably good control over velocities in the outer core, one must combine the data from four travel-time branches: SKKS, SKS, PKP(AB) and PKP(BC). Some attempts to combine these data have resulted in a marked roughness of the derived model at depth intervals corresponding to junctures between segments. In addition, SKKS data are likely to suffer from a $\pi/2$ phase shift with respect to the SKS phase (Choy and Richards, 1975), unless SKKS is Hilbert transformed before cross-correlation with SKS (or vice versa).

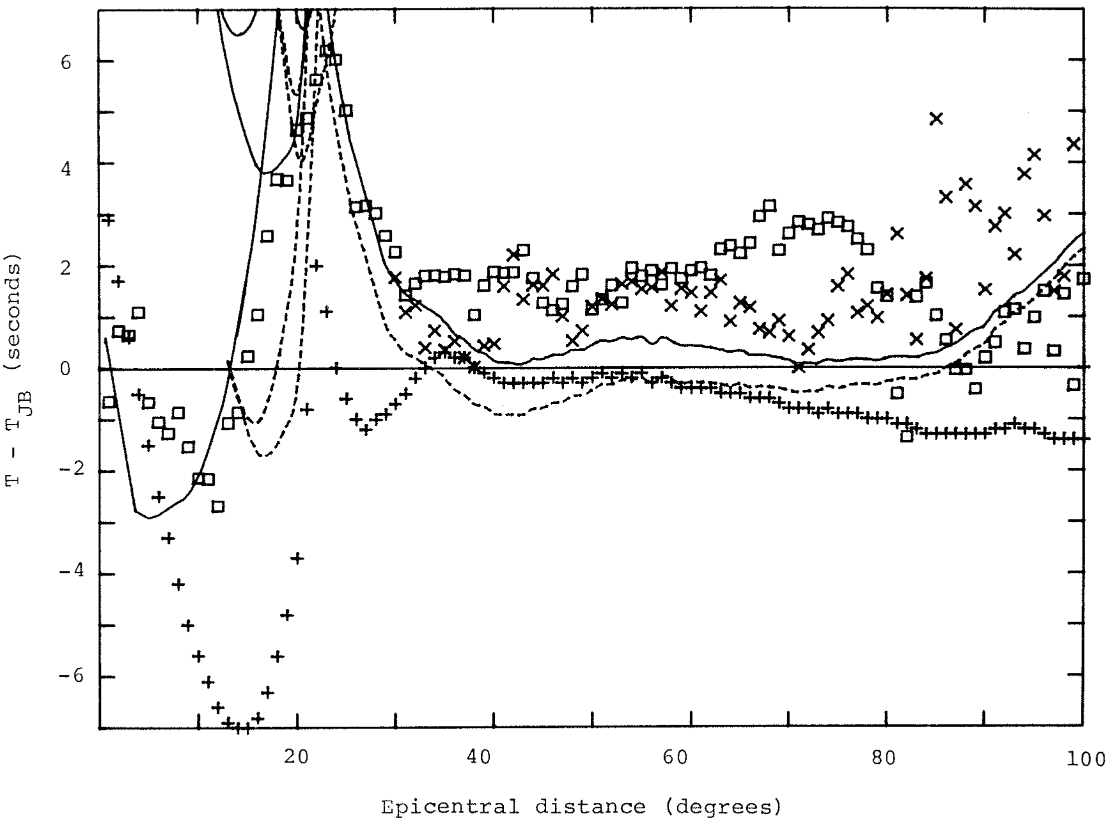

Fig. 2. Surface focus S-wave travel-time residuals with respect to JB. Boxes are ISC data. +: from Gogna et al. (1981). ×: from Hales and Roberts (1970). Solid line is for the vertically polarized (SV) shear wave and dashed line is for the horizontally polarized (SH) shear wave in the anisotropic PREM model. No baseline or slope corrections. Residuals calculated at a period of 1 s.

We use the SKS data of Hales and Roberts (1970), core phase data for the AB, BC and DF branches of Gee and Dziewonski (unpublished) and PKiKP–PcP differential travel times of Engdahl et al. (1974). The latter study gives the best available control of the inner core radius.

4. The starting model

Design of the velocity models for the upper mantle represented the most involved part of this stage of our work. Our decision to locate discontinuities at 220, 400 and 670 km was based on results of many other studies. The bottom of the lithosphere was initially placed at a depth of 80 km. Then, the velocities were adjusted to satisfy the ISC travel time data for distances up to 25°, allowing for an arbitrary base-line correction. A decrease in S-velocity gradient below 600 km was dictated by the need to obtain intersection with the teleseismic branch at 24°; without that feature the intersection occurs at 21.5°, which is distinctly inappropriate.

Once the starting velocity models for the uppermost 670 km were designed, it was possible to strip the upper mantle and invert the stripped data to obtain the lower mantle structure. It was at this stage that the need for introduction of the features in the lower mantle became obvious. One, and perhaps the most important, is the second-order discontinuity some 150 km above the core–mantle boundary. The velocity gradient at this depth changes abruptly and could become negative. This feature is clear on a $dT/d\Delta$ plot, where a sudden change in the slope of $dT/d\Delta$ occurs at 90°. The other feature is a region of steep velocity gradient just below the 670 km discontinuity extending to a depth that is not particularly easy to define exactly, but 771 km (5600 km radius) appeared to be a reasonable estimate. The model of the lower mantle was formed by representing the velocity between 3485 and 3630 km as well as between 5600 and 5701 km by linear segments and the region between by a cubic in radius requiring that there should be continuity at the points of junction. The starting model for P-velocities predicts travel times that match observations with an r.m.s. error of 0.06 s, roughly the average s.e.m. of a single observation in our global averaging procedure.

The scatter of the S-wave data is larger by more than an order of magnitude, and these data could not be expected to reveal independently the fine features demanded by the P-wave data. The S-wave data were inverted *assuming* that first- and second-order discontinuities exist at the same depths as in the P-velocity model.

In view of the fact that our knowledge of the structure of the inner and outer core is still rather poor, we began with the hypothesis that both cores are individually homogeneous. For this reason we have used the results of fourth-order finite strain theory to construct the starting model of P-velocity in the outer core, and P- and S-velocities in the inner core. The starting density distribution was obtained by a variation of the method proposed by Birch (1964). We assumed that the Adams–Williamson equation is satisfied in each subregion from the center of the Earth up to the 670 km discontinuity. Following Birch, we assume that the density in the upper mantle is linearly related to P-velocity: $\rho = a + bv_{\mathrm{p}}$. Given the mass and the moment of inertia of the Earth, we can find the density at the center of the Earth and the jump of density at the 670 km discontinuity if we specify the following parameters: density jump across the inner–outer core boundary; density at the base of the mantle; and density below the Mohorovičić discontinuity (Birch had only one free parameter, but he did not treat the inner core separately and his density distribution was continuous from the Moho to the core). Our choice of the free parameters was -0.5, 5.55, and 3.32 g cm^{-3}, respectively. This yielded a central density of 12.97 g cm^{-3} and a density jump at 670 km of -0.35 g cm^{-3}. These assigned and derived parameters were free to change in the inversion. Derivation of the starting density distribution completes this stage of our work.

5. Anisotropy

Global inversions of seismic data, such as presented here, usually give very high shear velocities, $\sim$4.8 km s^{-1}, in the uppermost mantle. Such models do not satisfy short period (<200 s) Love and Rayleigh wave data or shear wave travel times at short distances ($<20°$). Very pronounced low-velocity zones (LVZ) are a prominent feature of most models. We have found it impossible to simultaneously satisfy the data which are relevant to the upper 200 km or so of the mantle with an isotropic model. The discrepancy between Love wave and Rayleigh wave data suggests that the upper mantle is anisotropic (Anderson, 1966). The discrepancy is also pronounced for relatively homogeneous oceanic paths (Forsyth, 1975a,b; Schlue and Knopoff, 1977; Yu and Mitchell, 1979). Th suggests that lateral variations are not the primary cause of the discrepancies. Although azimuthal anisotropy is important just below the Moho in oceanic environments (Hess, 1964; Backus, 1965; Raitt et al. 1969), it appears to be less important at surface wave periods (Forsyth, 1975a; Yu and Mitchell, 1979). Transverse isotropy, or polarization anisotropy, has been invoked to explain the Love wave–Rayleigh wave discrepancy. Since our data represent an average over many azimuths any residual azimuthal anisotropy will be effectively averaged out. We therefore deal only with the spherical equivalent of transverse isotropy. The symmetry axis is vertical (radial).

For this type of anisotropy there are five elastic constants, A, C, F, L and N, following the notation of Love (1927, p. 196). A and C can be determined from measurements of the velocity of P waves propagating perpendicular and parallel to the axis of symmetry. Since in our case the axis of symmetry is vertical (radial)

$A = \rho V_{PH}^2$

$C = \rho V_{PV}^2$

where ρ is the density.

In general, the shear-wave velocity depends on polarization and direction of propagation. In the direction perpendicular to the axis of symmetry:

$N = \rho V_{SH}^2$

$L = \rho V_{SV}^2$

In the radial direction, parallel to the symmetry axis, there is no splitting and both polarizations are controlled by the elastic constant L. Therefore, both horizontally and vertically travelling SV waves have the same velocity. The elastic constant N controls the propagation of fundamental mode Love waves. All five elastic constants enter into the dispersion equation for Rayleigh waves but L is the more important shear-type modulus (Anderson, 1965). For this reason, vertically travelling S or ScS waves are controlled by the same set of elastic constants that control Rayleigh wave dispersion.

The fifth constant, F, is a function of the velocities at intermediate incidence angles. It is convenient to introduce a non-dimensional parameter $\eta = F/(A-2L)$ (Anderson, 1961; Harkrider and Anderson, 1962; Takeuchi and Saito, 1972). In Fig. 3 we show the P and S velocities as a function of incidence angle for five values of η ranging from 0.9 to 1.1. For an isotropic solid, $A = C$, $L = N$, and $\eta = 1$. It is clear that variations in η can lead to substantial differences in velocities at intermediate incidence angles and also in average values of velocity. Anderson (1966) showed that fundamental mode Rayleigh wave dispersion is also very sensitive to this parameter.

It is often assumed that Rayleigh waves are controlled by the horizontal SV velocity so that isotropic programs can be used to compute dispersion curves. It is also often assumed that the compressional velocity is unimportant in Rayleigh wave inversion. These assumptions are not strictly valid (Anderson, 1966) and we have inverted for the five independent elastic parameters. The fundamental mode Love and Rayleigh modes are

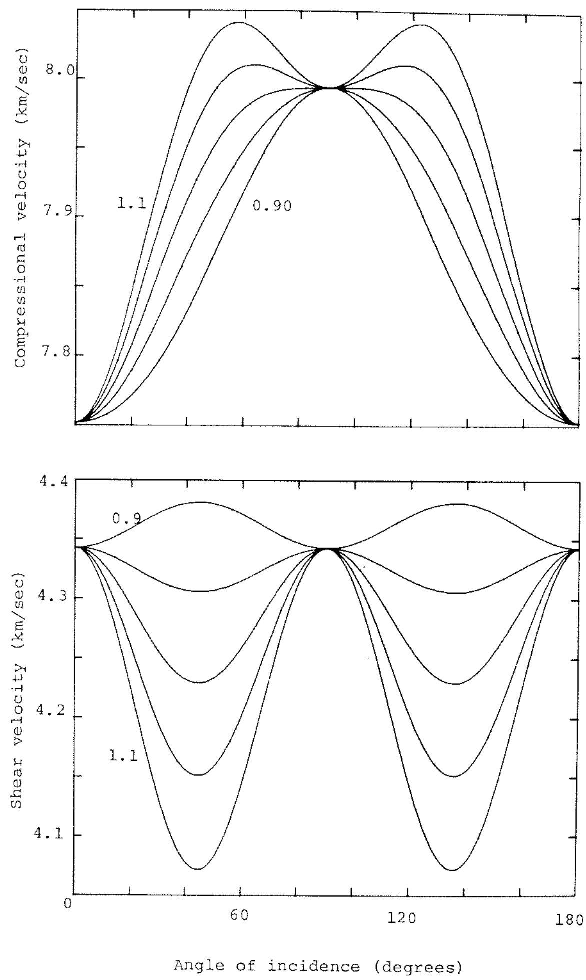

Fig. 3. P- and S-velocities as a function of angle of incidence and the anisotropic parameter η, which is varied from 0.9 to 1.1 at intervals of 0.05. The values of velocities used in the calculation are $V_{PV} = 7.752$ km s^{-1}; $V_{PH} = 7.994$ km s^{-1} and $V_{SV} = 4.343$ km s^{-1}.

almost independent of SV and SH, respectively, but Rayleigh waves are sensitive to η, PV and PH. In this sense an isotropic solid is a degenerate case.

We shall show later that it is possible to satisfy the global dataset with anisotropy restricted to the upper 200 km of the mantle. The anisotropy required is about 2–4% for both P and S waves. The resulting models do not have the pronounced decrease in velocity from the LID to the LVZ that characterizes most surface wave models, particularly for global and oceanic paths. In fact, the variations with depth of all the velocities is rather mild in this region of the mantle. It appears that some of the features of isotropic or pseudo-isotropic (SH, SV) models are due to the neglect of parameters, such as η, PV and PH, which are important in anisotropic Rayleigh wave dispersion.

The anisotropic upper mantle reconciles the Rayleigh and Love wave data and also permits a fit of the short period Rayleigh wave group velocity data. This is important for surface wave studies of seismic sources.

In the course of this study we have, of course, calculated partial derivatives for anisotropic structures. The results can be summarized as follows:

As expected the fundamental toroidal mode is primarily controlled by SH. The toroidal overtones, however, are sensitive to both SV and SH. The spheroidal modes are only slightly sensitive to SH. However, PV, PH, SV, and η all have a significant effect on the spheroidal modes and there is no a priori relationship between these parameters. It is necessary, therefore, to invert for five elastic parameters. We cannot assume, for example, that P-wave velocities are isotropic and invert only for P, SV, and SH. This would be a reasonable procedure only if the compressional wave partials were very much less than the shear wave partials or if naturally occurring upper mantle minerals had a more pronounced shear wave anisotropy. Neither is the case.

Figures 4, 5, and 6 show the effects of perturbing the shear and compressional velocities in an anisotropic Earth model. The formulae used to evaluate these partials are given in the Appendix. As expected, fundamental mode Rayleigh waves, in this case the mode ${}_0S_{80}$ with a period of 120 s, are mainly controlled by SV (short dashes) and are little influenced by SH (long dashes). The total shear wave partial derivative is shown as the solid curve. The parameter plotted is the relative change in period of ${}_0S_{80}$ for a change in shear velocity as a function of depth.

A more surprising effect is the nature of perturbations in the PV and PH velocities, shown in Fig. 5. The isotropic partial derivative (solid line) shows that compressional wave velocities are only important near the top of the structure. At depth the PV and PH partials are nearly equal and opposite. Individually they are significant but in the isotropic case they nearly cancel. Changes of opposite sign of the component velocities cause an additive effect and the net partial is nearly as significant as the SV partial. The same effect persists for all the spheroidal modes so that there is good control on the anisotropic P-velocities and better control on P-velocities in the upper mantle in general than is usually considered to be the

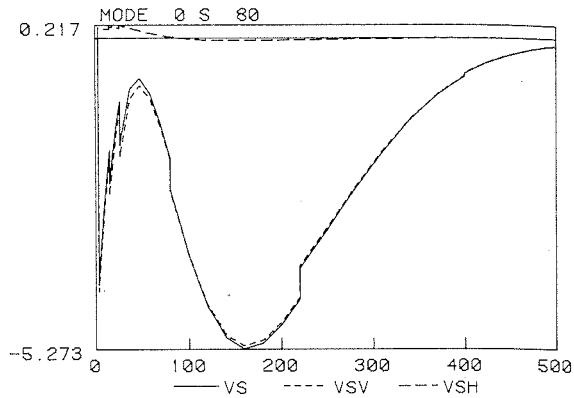

Fig. 4. Partial derivatives for a relative change in period of mode ${}_0S_{80}$ ($T \sim 120$ s) as a function of depth. The short dashed line corresponds to perturbation in SV velocity and long dashed line SH velocity; $\tilde{S}_V$ and $\tilde{S}_H$ of eq. A6 of the Appendix. The continuous line corresponds to the isotropic case (eq. A9).

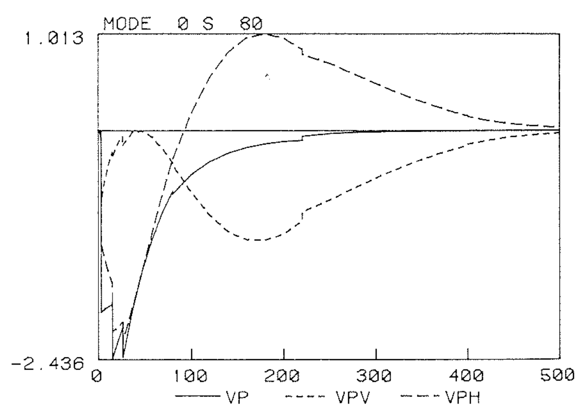

Fig. 5. Partial derivatives for a relative change in period of mode ${}_0S_{80}$ ($T \sim 120$ s) as a function of depth. The short dashed line corresponds to perturbation in PV velocity and long-dashed line in PH velocity; $\tilde{P}_V$ and $\tilde{P}_H$ of eq. A6 of the Appendix. The solid line corresponds to the isotropic case (eq. A9).

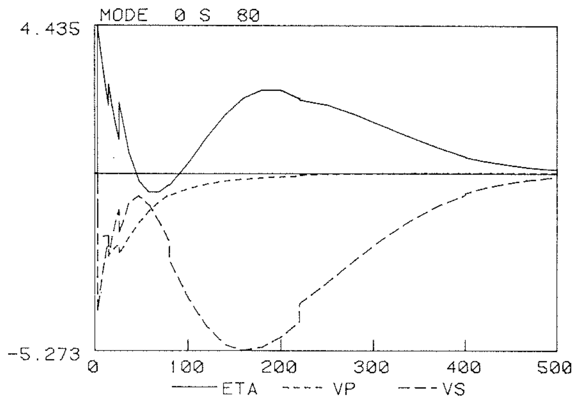

Fig. 6. Partial derivatives giving the relative change in period with respect to the anisotropic parameter η (solid line) and the isotropic velocities V_P (short-dashed line) and V_S (long-dashed line). See eqs. A6 and A9 of the Appendix.

case. Mantle Rayleigh wave data are often inverted for shear velocity alone. Even in the isotropic case this is not good practice since a wrong P-velocity at shallow depths can cause a large perturbation in shear velocity at greater depth.

The isotropic P and S partials are shown in Fig. 6 along with the η partial; it is clear that perturbations in the anisotropic parameter η can lead to substantial changes in the periods of free oscillations.

6. Inversion and the final model

Our starting model at a reference period of, say, 1 s is defined by a set of five functions of radius (V_P, V_S, ρ, q_μ, q_K), where $q = Q^{-1}$ and q_μ and q_κ relate to isotropic dissipation of the shear and compressional energy, respectively. For an isotropic region of the Earth, perturbation in a period of free oscillation or travel time of a body wave can be expressed by

$$\frac{\delta T}{T} = \int_0^1 \mathrm{d}r\left(\delta v_P \cdot \tilde{P} + \delta v_S \cdot \tilde{S} + \delta\rho \cdot \tilde{R} + \delta q_\mu \tilde{M} \cdot \ln\tau + \delta q_K \tilde{K} \cdot \ln\tau\right) \quad (1)$$

+ (terms related to changes in radii of discontinuities)

where τ represents either the period of free oscillation ($\tau = T$ in that case) or the appropriate period for the body wave under consideration. The perturbation in attenuation factor q is

$$\delta q = \int_0^1 \mathrm{d}r\left(\delta q_\mu \cdot Q\tilde{M} + \delta q_K \cdot Q\tilde{K}\right) \quad (2)$$

It is clear that given the observed values for the travel times, periods of free oscillations and their attenuation factors, the inverse problems for the elastic and anelastic parameters can be solved simultaneously. An additional advantage of proceeding in this manner is that presence of the δq_μ, δq_K terms in eq. 1 above may provide additional resolution for the anelastic structure, since ln τ in the seismic frequency band varies from 0 to 8, roughly. Generalization of eq. 1 for the case of transverse anisotropy is considered in the Appendix.

Another feature of our particular inversion procedure was that we optionally could introduce a baseline correction or linear slope for a given branch of the travel times as additional unknowns. Our starting model and perturbations thereto were assumed to have, for each of the regions, a form of a low-order polynomial in radius. For example

$$\delta v_P = a_0 + a_1 r + a_2 r^2 + a_3 r^3 \quad \text{for} \quad r_1 \leqslant r \leqslant r_2$$

Substitution into the integral leads to a familiar form of the system of equations of condition which then can be solved by standard procedures. The order of the polynomials needed to satisfy the data was determined by trial and error.

The method was extended to the problem of transverse isotropy by modifying equations given by Takeuchi and Saito (1972), as described in the Appendix and utilizing the formulas derived by Woodhouse (1981), in the note accompanying this report, for the travel times. We solve for five elastic constants which we take as the horizontal P-velocity, *PH*; vertical P-velocity, *PV*; horizontal and vertical S-velocities, *SH* and *SV*; and an anisotropic parameter (Anderson, 1966; Takeuchi and Saito, 1972). We found it necessary to introduce anisotropy into the outer part of the upper mantle but not elsewhere.

Parameters of the final model are listed in Table I. Graphical representation of the model is

TABLE I

Coefficients of the polynomials describing the Preliminary Reference Earth Model (PREM). The variable x is the normalized radius: $x=r/a$ where $a=6371$ km. The parameters listed are valid at a reference period of 1 s

Region	Radius (km)	Density (g cm^{-3})	V_P (km s^{-1})	V_S (km s^{-1})	Q_μ	Q_K
Inner core	0–1221.5	13.0885 $-8.8381x^2$	11.2622 $-6.3640x^2$	3.6678 $-4.4475x^2$	84.6	1327.7
Outer core	1221.5–3480.0	12.5815 $-1.2638x$ $-3.6426x^2$ $-5.5281x^3$	11.0487 $-4.0362x$ $+4.8023x^2$ $-13.5732x^3$	0	∞	57823
Lower mantle	3480.0–3630.0	7.9565 $-6.4761x$ $+5.5283x^2$ $-3.0807x^3$	15.3891 $-5.3181x$ $+5.5242x^2$ $-2.5514x^3$	6.9254 $+1.4672x$ $-2.0834x^2$ $+0.9783x^3$	312	57823
	3630.0–5600.0	7.9565 $-6.4761x$ $+5.5283x^2$ $-3.0807x^3$	24.9520 $-40.4673x$ $+51.4832x^2$ $-26.6419x^3$	11.1671 $-13.7818x$ $+17.4575x^2$ $-9.2777x^3$	312	57823
	5600.0–5701.0	7.9565 $-6.4761x$ $+5.5283x^2$ $-3.0807x^3$	29.2766 $-23.6027x$ $+5.5242x^2$ $-2.5514x^3$	22.3459 $-17.2473x$ $-2.0834x^2$ $+0.9783x^3$	312	57823
Transition zone	5701.0–5771.0	5.3197 $-1.4836x$	19.0957 $-9.8672x$	9.9839 $-4.9324x$	143	57823
	5771.0–5971.0	11.2494 $-8.0298x$	39.7027 $-32.6166x$	22.3512 -18.5856	143	57823
	5971.0–6151.0	7.1089 $-3.8045x$	20.3926 $-12.2569x$	8.9496 $-4.4597x$	143	57823
			V_{PV}	V_{SV}	Q_μ	Q_K
LVZ*	6151.0–6291.0	2.6910 $+0.6924x$	0.8317 $+7.2180x$	5.8582 $-1.4678x$	80	57823
			V_{PH}	V_{SH}	η	
			3.5908 $+4.6172x$	-1.0839 $+5.7176x$	3.3687 $-2.4778x$	
			V_{PV}	V_{SV}	Q_μ	Q_K
LID *	6291.0–6346.6	2.6910 $+0.6924x$	0.8317 $+7.2180x$	5.8582 $-1.4678x$	600	57823
			V_{PH}	V_{SH}	η	
			3.5908 $+4.6172x$	-1.0839 $+5.7176x$	3.3687 $-2.4778x$	
					Q_μ	Q_K
Crust	6346.6–6356.0	2.900	6.800	3.900	600	57823
	6356.0–6368.0	2.600	5.800	3.200	600	57823
Ocean	6368.0–6371.0	1.020	1.450	0	∞	57823

* The region between 24.4 and 220 km depths is transversely isotropic with the symmetry axis vertical. The effective isotropic velocities over this interval can be approximated by

$V_P = 4.1875 + 3.9382x$

$V_S = 2.1519 + 2.3481x$

shown in Figs. 7 and 8. It is important to remember that these parameters are valid at a reference period of 1 s. For other periods the velocities must be modified according to equations given in Kanamori and Anderson (1977)

$$V_S(T) = V_S(1)\cdot\left(1 - \frac{\ln T}{\pi} q_\mu\right)$$

$$V_P(T) = V_P(1)\cdot\left\{1 - \frac{\ln T}{\pi}\left[(1-E)\, q_K + E q_\mu\right]\right\} \tag{3}$$

where

$$E = \tfrac{4}{3}(V_S/V_P)^2$$

(The particular distribution of bulk dissipation and shear dissipation in the inner core given in Table I should be only understood as a way to lower the Q of radial modes in order to make them more compatible with observations. The problem is highly non-unique and its early resolution is not likely.)

The velocities, density and several other parameters of geophysical interest are listed in Table II. In the depth range from 24.4 to 220 km, in which our structure is anisotropic, we also give the values for the "equivalent" isotropic solid. This corresponds to an appropriate averaging over all angles of incidence; the general equations have been given by Woodhouse and Dahlen (1978). For the case of transverse isotropy, the Voigt bulk and shear moduli are

$$K = \tfrac{1}{9}(4A + C + 4F - 4N)$$

$$\mu = \tfrac{1}{15}(A + C - 2F + 5N + 6L)$$

these represent upper bounds on the effective elastic moduli.

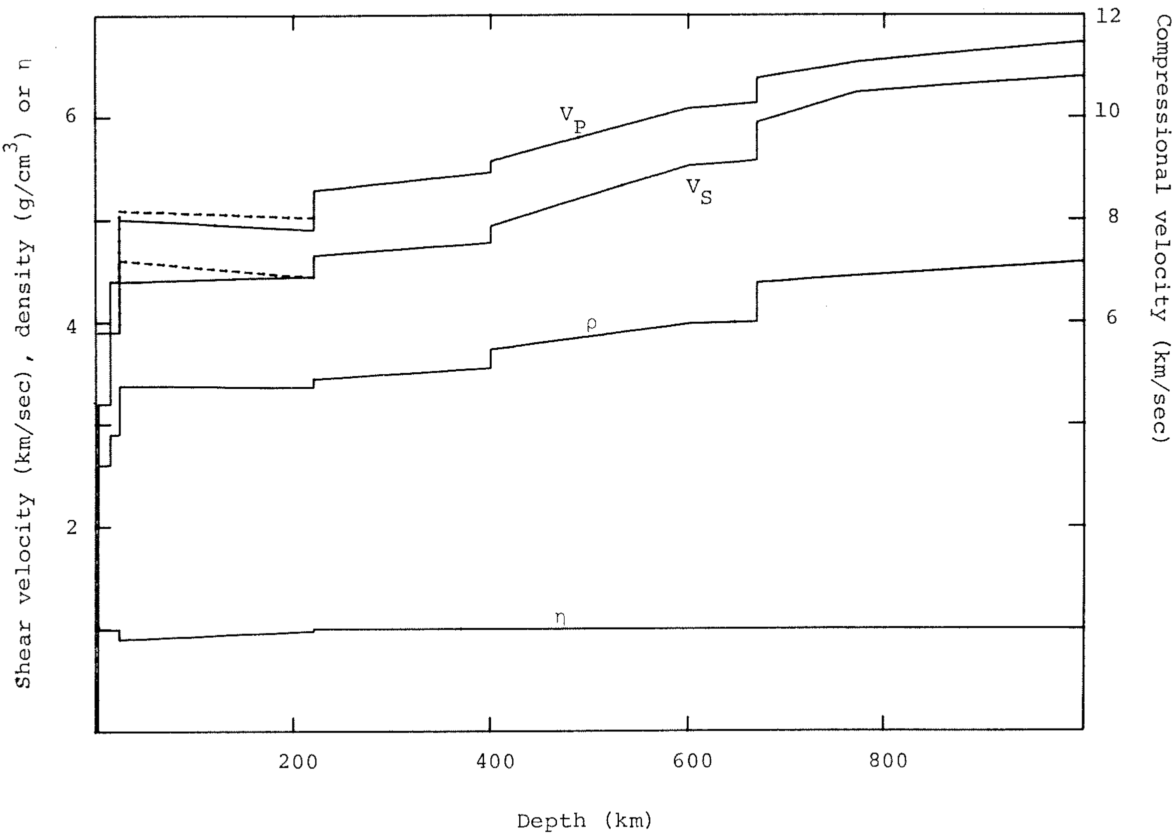

Fig. 7. Upper mantle velocities, density and anisotropic parameter η in PREM. The dashed lines are the horizontal components of velocity. The solid curves are η, ρ and the vertical, or radial, components of velocity.

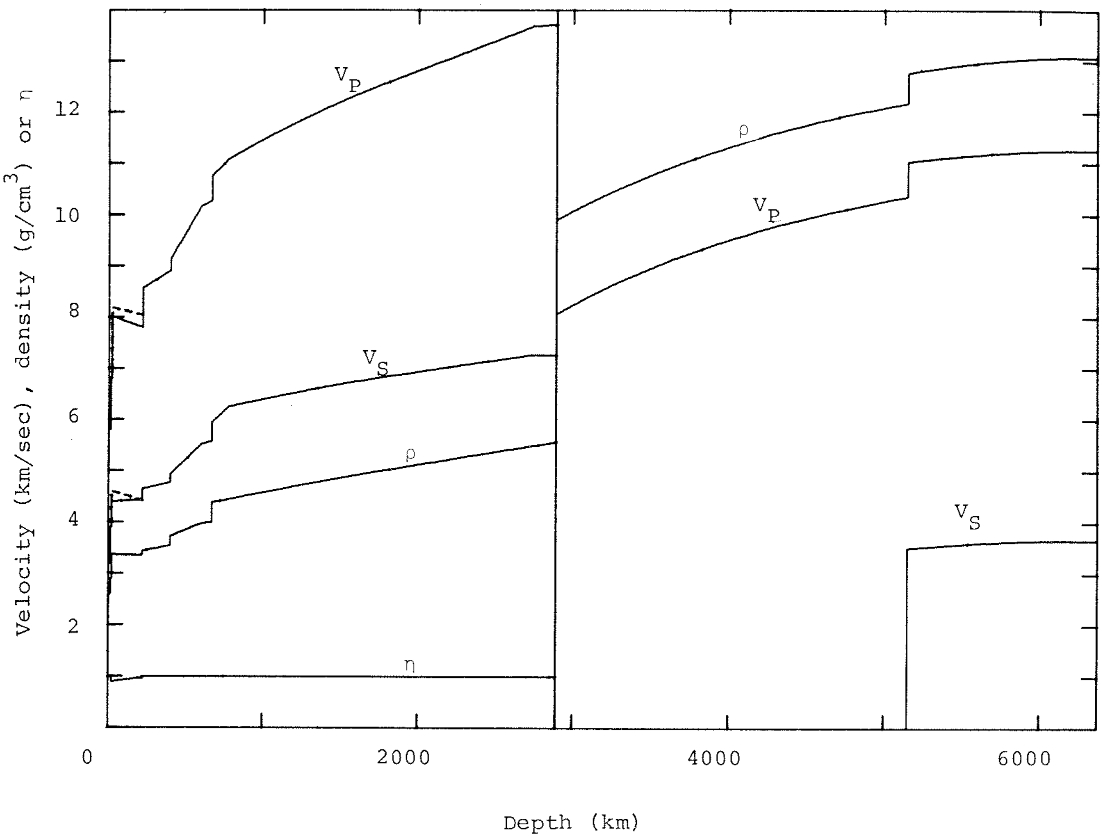

Fig. 8. The PREM model. Dashed lines are the horizontal components of velocity. Where η is 1 the model is isotropic. The core is isotropic.

One of the entries in Table II is the parameter η_B of Bullen (to be distinguished from the anisotropic parameter η), which represents a measure of deviation of a model from the Adams–Williamson equation

$$\eta_B = \frac{\mathrm{d}K}{\mathrm{d}P} + \frac{1}{g}\frac{\mathrm{d}\Phi}{\mathrm{d}r} \tag{4}$$

For the most part η_B in the core and lower mantle is very close to unity. Small deviations are, in some cases, an artifact of the polynomial representation. The parameter $\mathrm{d}K/\mathrm{d}P$ is another measure of homogeneity. The values for the lower mantle (except for the region immediately above the core–mantle boundary) and outer core can be considered normal.

In Table III we give the model parameters at a period of 200 s; the velocities at other periods can be determined from eq. 3. Table IV lists the anisotropic and anelastic parameters in the crust and upper mantle computed at a reference frequency of 1 s (above) and 200 s (below). Notice that the effect of the velocity dispersion due to anelasticity leads to the development, at long periods, of a low velocity zone in a depth range from 80 to 220 km. This is due to the low Q in this region.

In Fig. 9 the relative changes in P- and S-wave velocities are shown as a function of incidence angle for three depths: 24.4, 100 and 200 km. The angular dependence of SV and SH explains the fact that the "effective" shear velocity at a depth of 200 km is lower than either SV or SH.

The Q distribution is modelled with a small number of homogeneous regions. The radial modes are the main control on Q_K and these essentially constrain only the average value in large regions.

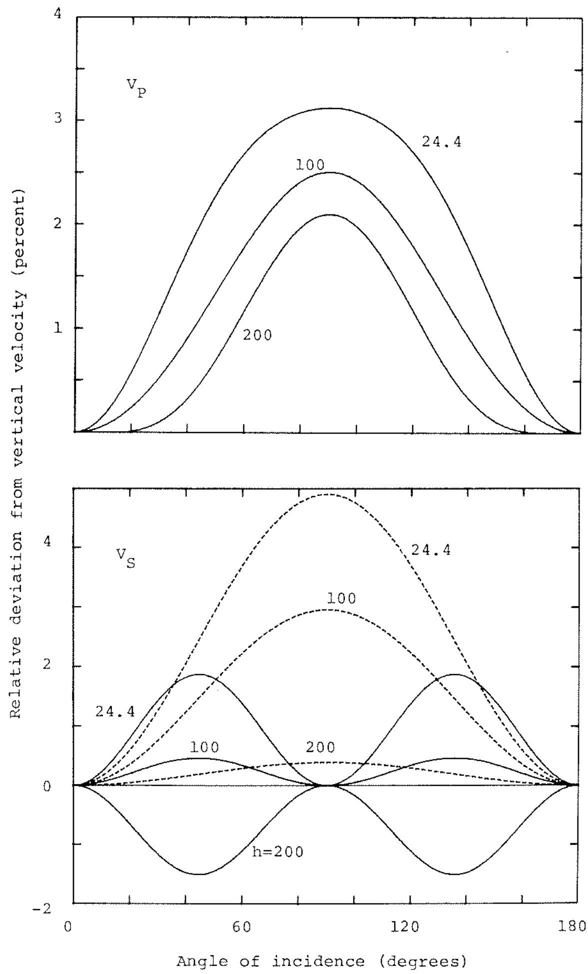

Fig. 9. Velocity as a function of direction of angle of incidence for three depths in the anisotropic region of the PREM model. Upper curves are compressional velocities; lower panel gives V_{SV} (solid) and V_{SH} (dashed).

Table V lists the observed and computed periods of the normal mode data used in this study. For comparison we list the theoretical results for the "equivalent" isotropic model discussed above. It may be noted that at high phase velocities or very long periods, the equivalent isotropic model fits the data nearly as well as the anisotropic model. For example, the periods of radial modes predicted by both models are nearly identical and the same is true with respect to modes ${}_0S_2-{}_0S_6$. But for short-period fundamental modes the differences are substantial. Group velocities computed for the anisotropic model are consistent with the observations of Mills (1977) and Kanamori (1970). There is satisfactory agreement between the observed and predicted values of Q of the normal modes.

The theoretical periods for the "equivalent" isotropic model are systematically too short for the fundamental spheroidal mode.The reverse is the case for the fundamental toroidal mode. The same trend is evident for the first overtones. The isotropic model is an adequate fit to the longer period spheroidal overtones but the fit degenerates at the shorter periods. All of this is suggestive of an anisotropic upper mantle, such as we have adopted here. We see no need to invoke deep anisotropy. The highly anisotropic minerals olivine and pyroxene, in fact, are restricted to the upper mantle.

The travel-time data and theoretical fits are given in Table VI. The original data are also given. In some cases we correct the data for an offset and a tilt. The baseline for most travel-time studies is arbitrary and, for our purposes, adjustable.

There are several effects which contribute to an offset and tilt among various travel-time datasets and between these and global models. First, there are the well known source and receiver effects. Secondly, the origin time and location of the event are in error if the travel-time table used in their location is in error. An error in assigned depth of an event also causes an error in both baseline and tilt. Published depths are sometimes based on minimization of the residual vs. distance relative to a standard curve. Thirdly, the effect of attenuation makes the frequency content of the arrivals vary with distance. In addition, in calculating theoretical travel times we must assume a period and correct for Q. Uncertainties in Q and a frequency dependence of Q give rise to a change in baseline and tilt. The effects of dispersion and the depth variation of Q give an offset and a variation of travel time with distance that depends on period. Differential travel times also contain these effects and have different effective Q's for the two phases in question. For these reasons we calculate all theoretical travel times at a period of one-second and, in Tables VIa–v, compute the baseline and, in some cases, a tilt that gives the best match

TABLE II

Earth model PREM and its functionals evaluated at a reference period of 1 s. Above 220 km the mantle is transversely isotropic; the parameters given are "equivalent" isotropic moduli and velocities. See Table IV for complete elastic constants in this region.

LEVEL	RADIUS KM	DEPTH KM	DENSITY G/CCM	VP KM/S	VS KM/S	QMU	QK	QAL	PHI KM2/S2	KAPPA KBAR	MU KBAR	SIGMA	PRESSURE KBAR	DK/DP	E.P.	GRAVITY CM/S2
1	0.	6371.0	13.08848	11.26220	3.66780	85	1328	431	108.90	14253	1761	0.4407	3638.524	2.3360	0.99	0.
2	100.0	6271.0	13.08630	11.26064	3.66670	85	1328	431	108.88	14248	1759	0.4407	3636.131	2.3363	0.99	36.56
3	200.0	6171.0	13.07977	11.25593	3.66342	85	1328	431	108.80	14231	1755	0.4408	3628.956	2.3365	0.99	73.11
4	300.0	6071.0	13.06888	11.24809	3.65794	85	1328	432	108.68	14203	1749	0.4409	3617.011	2.3369	0.99	109.61
5	400.0	5971.0	13.05364	11.23712	3.65027	85	1328	432	108.51	14164	1739	0.4410	3600.315	2.3375	0.99	146.04
6	500.0	5871.0	13.03404	11.22301	3.64041	85	1328	433	108.29	14114	1727	0.4412	3578.894	2.3382	0.99	182.39
7	600.0	5771.0	13.01009	11.20576	3.62835	85	1328	434	108.02	14053	1713	0.4414	3552.783	2.3391	0.99	218.62
8	700.0	5671.0	12.98178	11.18538	3.61411	85	1328	436	107.70	13981	1696	0.4417	3522.024	2.3402	0.99	254.73
9	800.0	5571.0	12.94912	11.16186	3.59767	85	1328	437	107.33	13898	1676	0.4420	3486.665	2.3414	0.99	290.68
10	900.0	5471.0	12.91211	11.13521	3.57905	85	1328	439	106.91	13805	1654	0.4424	3446.764	2.3428	0.99	326.45
11	1000.0	5371.0	12.87073	11.10542	3.55823	85	1328	440	106.45	13701	1630	0.4428	3402.383	2.3443	0.99	362.03
12	1100.0	5271.0	12.82501	11.07249	3.53522	85	1328	443	105.94	13586	1603	0.4432	3353.596	2.3460	1.00	397.39
13	1200.0	5171.0	12.77493	11.03643	3.51002	85	1328	445	105.38	13462	1574	0.4437	3300.480	2.3480	1.00	432.51
14	1221.5	5149.5	12.76360	11.02827	3.50432	85	1328	445	105.25	13434	1567	0.4438	3288.513	2.3486	1.00	440.02
15	1221.5	5149.5	12.16634	10.35568	0.	0	57822	57822	107.24	13047	0	0.5000	3288.502	3.7545	1.03	440.03
16	1300.0	5071.0	12.12500	10.30971	0.	0	57822	57822	106.29	12888	0	0.5000	3245.423	3.6539	1.02	463.68
17	1400.0	4971.0	12.06924	10.24959	0.	0	57822	57822	105.05	12679	0	0.5000	3187.493	3.5478	1.01	494.13
18	1500.0	4871.0	12.00989	10.18743	0.	0	57822	57822	103.78	12464	0	0.5000	3126.159	3.4649	1.01	524.77
19	1600.0	4771.0	11.94682	10.12291	0.	0	57822	57822	102.47	12242	0	0.5000	3061.461	3.4017	1.00	555.48
20	1700.0	4671.0	11.87990	10.05572	0.	0	57822	57822	101.12	12013	0	0.5000	2993.457	3.3552	1.00	586.14
21	1800.0	4571.0	11.80900	9.98554	0.	0	57822	57822	99.71	11775	0	0.5000	2922.221	3.3230	1.00	616.69
22	1900.0	4471.0	11.73401	9.91206	0.	0	57822	57822	98.25	11529	0	0.5000	2847.839	3.3028	1.00	647.04
23	2000.0	4371.0	11.65478	9.83496	0.	0	57822	57822	96.73	11273	0	0.5000	2770.407	3.2927	1.00	677.15
24	2100.0	4271.0	11.57119	9.75393	0.	0	57822	57822	95.14	11009	0	0.5000	2690.035	3.2911	1.00	706.97
25	2200.0	4171.0	11.48311	9.66865	0.	0	57822	57822	93.48	10735	0	0.5000	2606.838	3.2966	1.00	736.45
26	2300.0	4071.0	11.39042	9.57881	0.	0	57822	57822	91.75	10451	0	0.5000	2520.942	3.3080	1.00	765.56
27	2400.0	3971.0	11.29298	9.48409	0.	0	57822	57822	89.95	10158	0	0.5000	2432.484	3.3242	1.00	794.25
28	2500.0	3871.0	11.19067	9.38418	0.	0	57822	57822	88.06	9855	0	0.5000	2341.603	3.3441	1.00	822.48
29	2600.0	3771.0	11.08335	9.27876	0.	0	57822	57822	86.10	9542	0	0.5000	2248.453	3.3670	1.00	850.23
30	2700.0	3671.0	10.97091	9.16752	0.	0	57822	57822	84.04	9220	0	0.5000	2153.189	3.3919	1.00	877.46
31	2800.0	3571.0	10.85321	9.05015	0.	0	57822	57822	81.91	8889	0	0.5000	2055.978	3.4180	1.00	904.14
32	2900.0	3471.0	10.73012	8.92632	0.	0	57822	57822	79.68	8550	0	0.5000	1956.991	3.4448	1.00	930.23
33	3000.0	3371.0	10.60152	8.79573	0.	0	57822	57822	77.36	8202	0	0.5000	1856.409	3.4714	1.00	955.70
34	3100.0	3271.0	10.46727	8.65805	0.	0	57822	57822	74.96	7846	0	0.5000	1754.418	3.4972	1.00	980.51
35	3200.0	3171.0	10.32726	8.51298	0.	0	57822	57822	72.47	7484	0	0.5000	1651.209	3.5215	1.00	1004.64
36	3300.0	3071.0	10.18134	8.36019	0.	0	57822	57822	69.89	7116	0	0.5000	1546.982	3.5437	0.99	1028.04
37	3400.0	2971.0	10.02940	8.19939	0.	0	57822	57822	67.23	6743	0	0.5000	1441.941	3.5629	0.99	1050.65
38	3480.0	2891.0	9.90349	8.06482	0.	0	57822	57822	65.04	6441	0	0.5000	1357.510	3.5769	0.98	1068.23
39	3480.0	2891.0	5.56645	13.71660	7.26466	312	57822	826	117.78	6556	2938	0.3051	1357.509	1.6435	0.99	1068.23
40	3500.0	2871.0	5.55641	13.71168	7.26486	312	57822	826	117.64	6537	2933	0.3049	1345.619	1.6434	1.00	1065.32
41	3600.0	2771.0	5.50642	13.68753	7.26575	312	57822	823	116.96	6440	2907	0.3038	1287.067	1.6424	1.01	1052.04
42	3630.0	2741.0	5.49145	13.68041	7.26597	312	57822	822	116.76	6412	2899	0.3035	1269.742	1.6420	1.01	1048.44
43	3630.0	2741.0	5.49145	13.68041	7.26597	312	57822	822	116.76	6412	2899	0.3035	1269.741	3.3344	1.01	1048.44
44	3700.0	2671.0	5.45657	13.59597	7.23403	312	57822	819	115.08	6279	2855	0.3026	1229.719	3.2957	1.01	1040.66
45	3800.0	2571.0	5.40681	13.47742	7.18892	312	57822	815	112.73	6095	2794	0.3012	1173.465	3.2443	1.01	1030.95
46	3900.0	2471.0	5.35706	13.36074	7.14423	312	57822	811	110.46	5917	2734	0.2998	1118.207	3.2029	1.00	1022.72
47	4000.0	2371.0	5.30724	13.24532	7.09974	312	57822	807	108.23	5744	2675	0.2984	1063.864	3.1716	1.00	1015.80

LEVEL	RADIUS KM	DEPTH KM	DENSITY G/CCM	VP KM/S	VS KM/S	QMU	QK	QAL	PHI KM2/S2	KAPPA KBAR	MU KBAR	SIGMA	PRESSURE KBAR	DK/DP	B.P.	GRAVITY CM/S2
48	4100.0	2271.0	5.25729	13.13055	7.05525	312	57822	803	106.04	5575	2617	0.2971	1010.363	3.1503	1.00	1010.06
49	4200.0	2171.0	5.20713	13.01579	7.01053	312	57822	799	103.88	5409	2559	0.2957	957.641	3.1393	1.00	1005.35
50	4300.0	2071.0	5.15669	12.90045	6.96538	312	57822	795	101.73	5246	2502	0.2943	905.646	3.1383	1.00	1001.56
51	4400.0	1971.0	5.10590	12.78389	6.91957	312	57822	792	99.59	5085	2445	0.2928	854.332	3.1472	1.00	998.59
52	4500.0	1871.0	5.05469	12.66550	6.87289	312	57822	788	97.43	4925	2388	0.2913	803.660	3.1657	1.00	996.35
53	4600.0	1771.0	5.00299	12.54466	6.82512	312	57822	784	95.26	4766	2331	0.2898	753.598	3.1935	0.99	994.74
54	4700.0	1671.0	4.95073	12.42075	6.77606	312	57822	779	93.06	4607	2273	0.2881	704.119	3.2302	0.99	993.69
55	4800.0	1571.0	4.89783	12.29316	6.72548	312	57822	775	90.81	4448	2215	0.2864	655.202	3.2750	0.99	993.14
56	4900.0	1471.0	4.84422	12.16126	6.67317	312	57822	770	88.52	4288	2157	0.2846	606.830	3.3276	0.99	993.01
57	5000.0	1371.0	4.78983	12.02445	6.61891	312	57822	766	86.17	4128	2098	0.2826	558.991	3.3871	0.99	993.26
58	5100.0	1271.0	4.73460	11.88209	6.56250	312	57822	761	83.76	3966	2039	0.2805	511.676	3.4527	0.99	993.83
59	5200.0	1171.0	4.67844	11.73357	6.50370	312	57822	755	81.28	3803	1979	0.2783	464.882	3.5236	0.99	994.67
60	5300.0	1071.0	4.62129	11.57828	6.44232	312	57822	750	78.72	3638	1918	0.2758	418.606	3.5989	0.99	995.73
61	5400.0	971.0	4.56307	11.41560	6.37813	312	57822	743	76.08	3471	1856	0.2731	372.852	3.6775	0.98	996.98
62	5500.0	871.0	4.50372	11.24490	6.31091	312	57822	737	73.34	3303	1794	0.2701	327.623	3.7582	0.98	998.36
63	5600.0	771.0	4.44317	11.06557	6.24046	312	57822	730	70.52	3133	1730	0.2668	282.928	3.8403	0.97	999.85
64	5600.0	771.0	4.44316	11.06556	6.24046	312	57822	730	70.52	3133	1730	0.2668	282.927	2.9819	0.97	999.85
65	5650.0	721.0	4.41241	10.91005	6.09418	312	57822	744	69.51	3067	1639	0.2732	260.783	3.0086	0.97	1000.63
66	5701.0	670.0	4.38071	10.75131	5.94508	312	57822	759	68.47	2999	1548	0.2798	238.342	3.0358	0.98	1001.43
67	5701.0	670.0	3.99214	10.26622	5.57020	143	57822	362	64.03	2556	1239	0.2914	238.334	2.4000	0.37	1001.43
68	5736.0	635.0	3.98399	10.21203	5.54311	143	57822	362	63.32	2523	1224	0.2911	224.364	2.3868	0.37	1000.88
69	5771.0	600.0	3.97584	10.15782	5.51602	143	57822	362	62.61	2489	1210	0.2909	210.426	2.3734	0.37	1000.38
70	5771.0	600.0	3.97584	10.15782	5.51600	143	57822	362	62.61	2489	1210	0.2909	210.425	8.0910	1.98	1000.38
71	5821.0	550.0	3.91282	9.90185	5.37014	143	57822	363	59.60	2332	1128	0.2917	190.703	7.8833	1.92	999.65
72	5871.0	500.0	3.84980	9.64588	5.22428	143	57822	364	56.65	2181	1051	0.2924	171.311	7.6761	1.86	998.83
73	5921.0	450.0	3.78678	9.38990	5.07842	143	57822	365	53.78	2037	977	0.2933	152.251	7.4695	1.79	997.90
74	5971.0	400.0	3.72378	9.13397	4.93259	143	57822	366	50.99	1899	906	0.2942	133.527	7.2633	1.73	996.86
75	5971.0	400.0	3.54325	8.90522	4.76989	143	57822	372	48.97	1735	806	0.2988	133.520	3.3718	0.83	996.86
76	6016.0	355.0	3.51639	8.81867	4.73840	143	57822	370	47.83	1682	790	0.2971	117.702	3.3369	0.82	995.22
77	6061.0	310.0	3.48951	8.73209	4.70690	143	57822	367	46.71	1630	773	0.2952	102.027	3.3017	0.80	993.61
78	6106.0	265.0	3.46264	8.64552	4.67540	143	57822	365	45.60	1579	757	0.2933	86.497	3.2662	0.79	992.03
79	6151.0	220.0	3.43578	8.55896	4.64391	143	57822	362	44.50	1529	741	0.2914	71.115	3.2305	0.78	990.48
80	6151.0	220.0	3.35950	7.98970	4.41885	80	57822	195	37.80	1270	656	0.2797	71.108	-0.7364	-0.12	990.48
81	6186.0	185.0	3.36330	8.01180	4.43108	80	57822	195	38.01	1278	660	0.2797	59.466	-0.7200	-0.12	989.11
82	6221.0	150.0	3.36710	8.03370	4.44361	80	57822	195	38.21	1287	665	0.2796	47.824	-0.7035	-0.12	987.83
83	6256.0	115.0	3.37091	8.05540	4.45643	80	57822	195	38.41	1295	669	0.2795	36.183	-0.6868	-0.13	986.64
84	6291.0	80.0	3.37471	8.07688	4.46953	80	57822	195	38.60	1303	674	0.2793	24.546	-0.6700	-0.13	985.53
85	6291.0	80.0	3.37471	8.07689	4.46954	600	57822	1447	38.60	1303	674	0.2793	24.539	-0.6700	-0.13	985.53
86	6311.0	60.0	3.37688	8.08907	4.47715	600	57822	1447	38.71	1307	677	0.2792	17.891	-0.6603	-0.13	984.93
87	6331.0	40.0	3.37906	8.10119	4.48486	600	57822	1446	38.81	1311	680	0.2790	11.239	-0.6505	-0.13	984.37
88	6346.6	24.4	3.38076	8.11061	4.49094	600	57822	1446	38.89	1315	682	0.2789	6.043	-0.6428	-0.13	983.94
89	6346.6	24.4	2.90000	6.80000	3.90000	600	57822	1350	25.96	753	441	0.2549	6.040	-0.0000	-0.00	983.94
90	6356.0	15.0	2.90000	6.80000	3.90000	600	57822	1350	25.96	753	441	0.2549	3.370	0.0000	0.00	983.32
91	6356.0	15.0	2.60000	5.80000	3.20000	600	57822	1456	19.99	520	266	0.2812	3.364	0.0000	0.00	983.31
92	6368.0	3.0	2.60000	5.80000	3.20000	600	57822	1456	19.99	520	266	0.2812	0.303	-0.0000	-0.00	982.22
93	6368.0	3.0	1.02000	1.45000	0.	0	57822	57822	2.10	21	0	0.5000	0.299	-0.0000	-0.00	982.22
94	6371.0	0.	1.02000	1.45000	0.	0	57822	57822	2.10	21	0	0.5000	-0.000	0.0000	0.00	981.56

TABLE III
Same as Table II except the reference period is 200 s

LEVEL	RADIUS KM	DEPTH KM	DENSITY G/CCM	VP KM/S	VS KM/S	QMU	QK	QAL	PHI KM2/S2	KAPPA KBAR	MU KBAR	SIGMA	PRESSURE KBAR	DK/DP	E.F.	GRAVITY CM/S2
1	0.	6371.0	13.08848	11.21818	3.59469	85	1328	440	108.62	14216	1691	0.4428	3638.524	2.3298	0.99	0.
2	100.0	6271.0	13.08630	11.21662	3.59362	85	1328	440	108.59	14211	1690	0.4428	3636.131	2.3301	0.99	36.56
3	200.0	6171.0	13.07977	11.21197	3.59040	85	1328	441	108.52	14194	1686	0.4429	3628.956	2.3304	0.99	73.11
4	300.0	6071.0	13.06888	11.20421	3.58503	85	1328	441	108.40	14166	1680	0.4430	3617.011	2.3308	0.99	109.61
5	400.0	5971.0	13.05364	11.19334	3.57751	85	1328	442	108.23	14127	1671	0.4431	3600.315	2.3314	0.99	146.04
6	500.0	5871.0	13.03404	11.17937	3.56785	85	1328	443	108.01	14077	1659	0.4433	3578.894	2.3321	0.99	182.39
7	600.0	5771.0	13.01009	11.16229	3.55603	85	1328	444	107.74	14017	1645	0.4435	3552.783	2.3330	0.99	218.62
8	700.0	5671.0	12.98178	11.14211	3.54207	85	1328	445	107.42	13945	1629	0.4438	3522.024	2.3340	0.99	254.73
9	800.0	5571.0	12.94912	11.11883	3.52597	85	1328	447	107.05	13862	1610	0.4441	3486.665	2.3352	0.99	290.68
10	900.0	5471.0	12.91211	11.09244	3.50771	85	1328	448	106.64	13769	1589	0.4444	3446.764	2.3366	0.99	326.45
11	1000.0	5371.0	12.87073	11.06294	3.48731	85	1328	450	106.17	13665	1565	0.4448	3402.383	2.3382	0.99	362.03
12	1100.0	5271.0	12.82501	11.03034	3.46475	85	1328	452	105.66	13551	1540	0.4453	3353.596	2.3399	0.99	397.39
13	1200.0	5171.0	12.77493	10.99463	3.44005	85	1328	455	105.10	13427	1512	0.4457	3300.480	2.3418	0.99	432.51
14	1221.5	5149.5	12.76360	10.98656	3.43447	85	1328	455	104.98	13399	1506	0.4458	3288.513	2.3424	0.99	440.02
15	1221.5	5149.5	12.16634	10.35538	0.	0	57822	57822	107.23	13046	0	0.5000	3288.502	3.7543	1.03	440.03
16	1300.0	5071.0	12.12500	10.30941	0.	0	57822	57822	106.28	12887	0	0.5000	3245.423	3.6537	1.02	463.68
17	1400.0	4971.0	12.06924	10.24930	0.	0	57822	57822	105.05	12679	0	0.5000	3187.493	3.5476	1.01	494.13
18	1500.0	4871.0	12.00989	10.18713	0.	0	57822	57822	103.78	12464	0	0.5000	3126.159	3.4647	1.01	524.77
19	1600.0	4771.0	11.94682	10.12262	0.	0	57822	57822	102.47	12242	0	0.5000	3061.461	3.4015	1.00	555.48
20	1700.0	4671.0	11.87990	10.05543	0.	0	57822	57822	101.11	12012	0	0.5000	2993.457	3.3550	1.00	586.14
21	1800.0	4571.0	11.80900	9.98525	0.	0	57822	57822	99.71	11774	0	0.5000	2922.221	3.3228	1.00	616.69
22	1900.0	4471.0	11.73401	9.91177	0.	0	57822	57822	98.24	11528	0	0.5000	2847.839	3.3026	1.00	647.04
23	2000.0	4371.0	11.65478	9.83467	0.	0	57822	57822	96.72	11273	0	0.5000	2770.407	3.2925	1.00	677.15
24	2100.0	4271.0	11.57119	9.75364	0.	0	57822	57822	95.13	11008	0	0.5000	2690.035	3.2909	1.00	706.97
25	2200.0	4171.0	11.48311	9.66837	0.	0	57822	57822	93.48	10734	0	0.5000	2606.838	3.2964	1.00	736.45
26	2300.0	4071.0	11.39042	9.57853	0.	0	57822	57822	91.75	10451	0	0.5000	2520.942	3.3078	1.00	765.56
27	2400.0	3971.0	11.29298	9.48381	0.	0	57822	57822	89.94	10157	0	0.5000	2432.484	3.3240	1.00	794.25
28	2500.0	3871.0	11.19067	9.38390	0.	0	57822	57822	88.06	9854	0	0.5000	2341.603	3.3439	1.00	822.48
29	2600.0	3771.0	11.08335	9.27849	0.	0	57822	57822	86.09	9542	0	0.5000	2248.453	3.3668	1.00	850.23
30	2700.0	3671.0	10.97091	9.16726	0.	0	57822	57822	84.04	9220	0	0.5000	2153.189	3.3917	1.00	877.46
31	2800.0	3571.0	10.85321	9.04988	0.	0	57822	57822	81.90	8889	0	0.5000	2055.978	3.4178	1.00	904.14
32	2900.0	3471.0	10.73012	8.92606	0.	0	57822	57822	79.67	8549	0	0.5000	1956.991	3.4446	1.00	930.23
33	3000.0	3371.0	10.60152	8.79547	0.	0	57822	57822	77.36	8201	0	0.5000	1856.409	3.4712	1.00	955.70
34	3100.0	3271.0	10.46727	8.65780	0.	0	57822	57822	74.96	7846	0	0.5000	1754.418	3.4970	1.00	980.51
35	3200.0	3171.0	10.32726	8.51273	0.	0	57822	57822	72.47	7484	0	0.5000	1651.209	3.5213	1.00	1004.64
36	3300.0	3071.0	10.18134	8.35995	0.	0	57822	57822	69.89	7116	0	0.5000	1546.982	3.5435	0.99	1028.04
37	3400.0	2971.0	10.02940	8.19915	0.	0	57822	57822	67.23	6742	0	0.5000	1441.941	3.5627	0.99	1050.69
38	3480.0	2891.0	9.90349	8.06458	0.	0	57822	57822	65.04	6441	0	0.5000	1357.510	3.5767	0.98	1068.23
39	3480.0	2891.0	5.56645	13.68862	7.22538	312	57822	832	117.77	6556	2906	0.3069	1357.509	1.6434	0.99	1068.23
40	3500.0	2871.0	5.55641	13.68369	7.22559	312	57822	831	117.63	6536	2901	0.3067	1345.619	1.6433	1.00	1065.32
41	3600.0	2771.0	5.50642	13.65949	7.22647	312	57822	828	116.95	6440	2876	0.3057	1287.067	1.6423	1.01	1052.04
42	3630.0	2741.0	5.49145	13.65234	7.22670	312	57822	827	116.75	6411	2868	0.3054	1269.742	1.6419	1.01	1048.44
43	3630.0	2741.0	5.49145	13.65234	7.22670	312	57822	827	116.75	6411	2868	0.3054	1269.741	3.3342	1.01	1048.44
44	3700.0	2671.0	5.45657	13.56798	7.19492	312	57822	824	115.07	6279	2825	0.3044	1229.719	3.2955	1.01	1040.66
45	3800.0	2571.0	5.40681	13.44953	7.15006	312	57822	820	112.73	6095	2764	0.3030	1173.465	3.2441	1.01	1030.95
46	3900.0	2471.0	5.35706	13.33296	7.10561	312	57822	816	110.45	5917	2705	0.3017	1118.207	3.2027	1.00	1022.72
47	4000.0	2371.0	5.30724	13.21765	7.06136	312	57822	812	108.22	5744	2646	0.3003	1063.864	3.1714	1.00	1015.80

LEVEL	RADIUS KM	DEPTH KM	DENSITY G/CCM	VP KM/S	VS KM/S	QMU	QK	QAL	PHI KM2/S2	KAPPA KBAR	MU KBAR	SIGMA	PRESSURE KBAR	DK/DP	E.P.	GRAVITY CM/S2
48	4100.0	2271.0	5.25729	13.10299	7.01711	312	57822	808	106.04	5575	2589	0.2989	1010.363	3.1501	1.00	1010.06
49	4200.0	2171.0	5.20713	12.98835	6.97264	312	57822	804	103.87	5409	2532	0.2976	957.641	3.1390	1.00	1005.35
50	4300.0	2071.0	5.15669	12.87311	6.92772	312	57822	801	101.73	5246	2475	0.2962	905.646	3.1380	1.00	1001.56
51	4400.0	1971.0	5.10590	12.75667	6.88216	312	57822	797	99.58	5084	2418	0.2947	854.332	3.1469	1.00	998.59
52	4500.0	1871.0	5.05469	12.63839	6.83574	312	57822	793	97.43	4925	2362	0.2932	803.660	3.1655	1.00	996.35
53	4600.0	1771.0	5.00299	12.51767	6.78823	312	57822	789	95.25	4765	2305	0.2917	753.598	3.1933	0.99	994.74
54	4700.0	1671.0	4.95073	12.39389	6.73943	312	57822	784	93.05	4607	2249	0.2901	704.119	3.2299	0.99	993.69
55	4800.0	1571.0	4.89783	12.26642	6.68912	312	57822	780	90.81	4448	2192	0.2884	655.202	3.2748	0.99	993.14
56	4900.0	1471.0	4.84422	12.13466	6.63710	312	57822	775	88.52	4288	2134	0.2866	606.830	3.3274	0.99	993.01
57	5000.0	1371.0	4.78983	11.99798	6.58313	312	57822	771	86.17	4127	2076	0.2846	558.991	3.3868	0.99	993.26
58	5100.0	1271.0	4.73460	11.85576	6.52702	312	57822	765	83.76	3966	2017	0.2825	511.676	3.4525	0.99	993.83
59	5200.0	1171.0	4.67844	11.70739	6.46855	312	57822	760	81.27	3802	1958	0.2803	464.882	3.5234	0.99	994.67
60	5300.0	1071.0	4.62129	11.55225	6.40749	312	57822	754	78.71	3638	1897	0.2778	418.606	3.5987	0.99	995.73
61	5400.0	971.0	4.56307	11.38972	6.34365	312	57822	748	76.07	3471	1836	0.2751	372.852	3.6772	0.98	996.98
62	5500.0	871.0	4.50372	11.21918	6.27680	312	57822	741	73.34	3303	1774	0.2722	327.623	3.7580	0.98	998.36
63	5600.0	771.0	4.44317	11.04002	6.20673	312	57822	734	70.52	3133	1712	0.2689	282.928	3.8400	0.97	999.85
64	5600.0	771.0	4.44316	11.04001	6.20672	312	57822	734	70.52	3133	1712	0.2689	282.927	2.9817	0.97	999.85
65	5650.0	721.0	4.41241	10.88533	6.06124	312	57822	748	69.51	3067	1621	0.2753	260.783	3.0084	0.97	1000.63
66	5701.0	670.0	4.38071	10.72743	5.91294	312	57822	764	68.46	2999	1532	0.2818	238.342	3.0355	0.98	1001.43
67	5701.0	670.0	3.99214	10.21852	5.50452	143	57822	368	64.02	2556	1210	0.2956	238.334	2.3998	0.37	1001.43
68	5736.0	635.0	3.98399	10.16454	5.47775	143	57822	367	63.31	2522	1195	0.2954	224.364	2.3866	0.37	1000.88
69	5771.0	600.0	3.97584	10.11055	5.45097	143	57822	367	62.61	2489	1181	0.2951	210.426	2.3732	0.37	1000.38
70	5771.0	600.0	3.97584	10.11055	5.45095	143	57822	367	62.61	2489	1181	0.2951	210.425	8.0901	1.98	1000.38
71	5821.0	550.0	3.91282	9.85588	5.30682	143	57822	368	59.59	2332	1102	0.2959	190.703	7.8824	1.92	999.65
72	5871.0	500.0	3.84980	9.60122	5.16268	143	57822	369	56.65	2181	1026	0.2966	171.311	7.6752	1.86	998.83
73	5921.0	450.0	3.78678	9.34655	5.01854	143	57822	370	53.78	2036	954	0.2975	152.251	7.4687	1.79	997.90
74	5971.0	400.0	3.72378	9.09193	4.87442	143	57822	371	50.98	1898	885	0.2983	133.527	7.2624	1.73	996.86
75	5971.0	400.0	3.54325	8.86489	4.71364	143	57822	377	48.96	1735	787	0.3029	133.520	3.3715	0.83	996.86
76	6016.0	355.0	3.51639	8.77848	4.68252	143	57822	375	47.83	1682	771	0.3012	117.702	3.3366	0.82	995.22
77	6061.0	310.0	3.48951	8.69204	4.65139	143	57822	373	46.70	1630	755	0.2994	102.027	3.3013	0.80	993.61
78	6106.0	265.0	3.46264	8.60561	4.62027	143	57822	370	45.59	1579	739	0.2975	86.497	3.2659	0.79	992.03
79	6151.0	220.0	3.43578	8.51920	4.58914	143	57822	368	44.50	1529	724	0.2956	71.115	3.2302	0.78	990.48
80	6151.0	220.0	3.35950	7.92008	4.32499	80	57822	200	37.79	1269	628	0.2875	71.108	-0.6961	-0.12	990.48
81	6186.0	185.0	3.36330	7.94153	4.33752	80	57822	200	37.98	1277	633	0.2874	59.466	-0.6803	-0.12	989.11
82	6221.0	150.0	3.36710	7.96278	4.35034	80	57822	200	38.17	1285	637	0.2873	47.824	-0.6643	-0.12	987.83
83	6256.0	115.0	3.37091	7.98383	4.36344	80	57822	200	38.36	1293	642	0.2870	36.183	-0.6481	-0.13	986.64
84	6291.0	80.0	3.37471	8.00468	4.37682	80	57822	200	38.53	1300	646	0.2868	24.546	-0.6318	-0.13	985.53
85	6291.0	80.0	3.37471	8.06715	4.45717	600	57822	1452	38.59	1302	670	0.2803	24.539	-0.6649	-0.13	985.53
86	6311.0	60.0	3.37688	8.07928	4.46480	600	57822	1451	38.70	1307	673	0.2802	17.891	-0.6552	-0.13	984.93
87	6331.0	40.0	3.37906	8.09135	4.47253	600	57822	1450	38.80	1311	676	0.2800	11.239	-0.6455	-0.13	984.37
88	6346.6	24.4	3.38076	8.10074	4.47863	600	57822	1450	38.88	1314	678	0.2799	6.043	-0.6378	-0.13	983.94
89	6346.6	24.4	2.90000	6.79151	3.88904	600	57822	1354	25.96	753	439	0.2561	6.040	-0.0000	-0.00	983.94
90	6356.0	15.0	2.90000	6.79151	3.88904	600	57822	1354	25.96	753	439	0.2561	3.370	-0.0000	0.00	983.32
91	6356.0	15.0	2.60000	5.79328	3.19101	600	57822	1460	19.99	520	265	0.2822	3.364	0.0000	0.00	983.31
92	6368.0	3.0	2.60000	5.79328	3.19101	600	57822	1460	19.99	520	265	0.2822	0.303	-0.0000	-0.00	982.22
93	6368.0	3.0	1.02000	1.44996	0.	0	57822	57822	2.10	21	0	0.5000	0.299	-0.0000	-0.00	982.22
94	6371.0	0.	1.02000	1.44996	0.	0	57822	57822	2.10	21	0	0.5000	-0.000	0.0000	0.00	981.56

TABLE IV
Crust and upper mantle of PREM including directional velocities, anisotropic elastic constants and "equivalent" isotropic velocities. Evaluated at reference periods of 1 s (top) and 200 s (bottom)

RADIUS KM	DEPTH KM	DENSITY G/CCM	VPV KM/S	VPH KM/S	VSV KM/S	VSH KM/S	ETA	QMU	QKAPPA	A KB	C KB	L KB	N KB	F KB	VP KM/S	VS KM/S
6151.0	220.0	3.35950	7.80050	8.04862	4.44110	4.43629	0.97654	80	57822	2176	2044	663	661	831	7.98970	4.41885
6171.0	200.0	3.36167	7.82315	8.06310	4.43649	4.45423	0.96877	80	57822	2186	2057	662	667	835	8.00235	4.42580
6191.0	180.0	3.36384	7.84581	8.07760	4.43189	4.47218	0.96099	80	57822	2195	2071	661	673	839	8.01494	4.43285
6211.0	160.0	3.36602	7.86847	8.09209	4.42728	4.49013	0.95321	80	57822	2204	2084	660	679	843	8.02747	4.44000
6231.0	140.0	3.36819	7.89113	8.10659	4.42267	4.50807	0.94543	80	57822	2213	2097	659	685	847	8.03992	4.44724
6251.0	120.0	3.37036	7.91378	8.12108	4.41806	4.52602	0.93765	80	57822	2223	2111	658	690	851	8.05231	4.45458
6271.0	100.0	3.37254	7.93644	8.13558	4.41345	4.54397	0.92987	80	57822	2232	2124	657	696	854	8.06463	4.46201
6291.0	80.0	3.37471	7.95909	8.15006	4.40885	4.56191	0.92210	80	57822	2242	2138	656	702	857	8.07688	4.46953
6291.0	80.0	3.37471	7.95911	8.15008	4.40884	4.56193	0.92209	600	57822	2242	2138	656	702	857	8.07689	4.46954
6311.0	60.0	3.37688	7.98176	8.16457	4.40424	4.57987	0.91432	600	57822	2251	2151	655	708	860	8.08907	4.47715
6331.0	40.0	3.37906	8.00442	8.17906	4.39963	4.59782	0.90654	600	57822	2260	2165	654	714	863	8.10119	4.48486
6346.6	24.4	3.38076	8.02212	8.19038	4.39603	4.61184	0.90047	600	57822	2268	2176	653	719	866	8.11061	4.49094
6346.6	24.4	2.90000	6.80000	6.80000	3.90000	3.90000	1.00000	600	57822	1341	1341	441	441	459	6.80000	3.90000
6356.0	15.0	2.90000	6.80000	6.80000	3.90000	3.90000	1.00000	600	57822	1341	1341	441	441	459	6.80000	3.90000
6356.0	15.0	2.60000	5.80000	5.80000	3.20000	3.20000	1.00000	600	57822	875	875	266	266	342	5.80000	3.20000
6368.0	3.0	2.60000	5.80000	5.80000	3.20000	3.20000	1.00000	600	57822	875	875	266	266	342	5.80000	3.20000
6368.0	3.0	1.02000	1.45000	1.45000	0.	0.	1.00000	0	57822	21	21	0	0	21	1.45000	0.
6371.0	0.	1.02000	1.45000	1.45000	0.	0.	1.00000	0	57822	21	21	0	0	21	1.45000	0.

RADIUS KM	DEPTH KM	DENSITY G/CCM	VPV KM/S	VPH KM/S	VSV KM/S	VSH KM/S	ETA	QMU	QKAPPA	A KB	C KB	L KB	N KB	F KB	VP KM/S	VS KM/S
6151.0	220.0	3.35950	7.72930	7.97975	4.34748	4.34277	0.97654	80	57822	2139	2007	635	634	849	7.92008	4.32495
6171.0	200.0	3.36167	7.75230	7.99380	4.34297	4.36033	0.96877	80	57822	2148	2020	634	639	853	7.93236	4.33212
6191.0	180.0	3.36384	7.77531	8.00786	4.33846	4.37790	0.96099	80	57822	2157	2034	633	645	856	7.94457	4.33934
6211.0	160.0	3.36602	7.79831	8.02192	4.33395	4.39547	0.95321	80	57822	2166	2047	632	650	859	7.95673	4.34665
6231.0	140.0	3.36819	7.82132	8.03598	4.32943	4.41304	0.94543	80	57822	2175	2060	631	656	863	7.96882	4.35406
6251.0	120.0	3.37036	7.84432	8.05004	4.32492	4.43061	0.93765	80	57822	2184	2074	630	662	866	7.98084	4.36155
6271.0	100.0	3.37254	7.86732	8.06410	4.32041	4.44818	0.92987	80	57822	2193	2087	630	667	869	7.99279	4.36914
6291.0	80.0	3.37471	7.89031	8.07815	4.31590	4.46574	0.92210	80	57822	2202	2101	629	673	871	8.00468	4.37682
6291.0	80.0	3.37471	7.94982	8.14037	4.39645	4.54911	0.92209	600	57822	2236	2133	652	698	859	8.06715	4.45717
6311.0	60.0	3.37688	7.97251	8.15480	4.39186	4.56700	0.91432	600	57822	2246	2146	651	704	862	8.07928	4.46480
6331.0	40.0	3.37906	7.99522	8.16924	4.38726	4.58490	0.90654	600	57822	2255	2160	650	710	865	8.09135	4.47253
6346.6	24.4	3.38076	8.01295	8.18051	4.38368	4.59887	0.90047	600	57822	2262	2171	650	715	867	8.10074	4.47863
6346.6	24.4	2.90000	6.79151	6.79151	3.88904	3.88904	1.00000	600	57822	1338	1338	439	439	460	6.79151	3.88904
6356.0	15.0	2.90000	6.79151	6.79151	3.88904	3.88904	1.00000	600	57822	1338	1338	439	439	460	6.79151	3.88904
6356.0	15.0	2.60000	5.79328	5.79328	3.19101	3.19101	1.00000	600	57822	873	873	265	265	343	5.79328	3.19101
6368.0	3.0	2.60000	5.79328	5.79328	3.19101	3.19101	1.00000	600	57822	873	873	265	265	343	5.79328	3.19101
6368.0	3.0	1.02000	1.44996	1.44996	0.	0.	1.00000	0	57822	21	21	0	0	21	1.44996	0.
6371.0	0.	1.02000	1.44996	1.44996	0.	0.	1.00000	0	57822	21	21	0	0	21	1.44996	0.

TABLE V

Observed and theoretical parameters of the normal modes used in this study including period and Q. Periods are given for anisotropic PREM and an isotropic model having the bulk modulus and rigidity evaluated according to a Voigt averaging scheme. The group velocity is calculated for the anisotropic model; see Note added in proof

MODE	OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
0 S 0	1227.52	0.01	1228.02	-0.04	1228.07	-0.05	5230.0	9.0	5327.6	
1 S 0	612.99	0.01	612.99	0.00	612.99	0.	1970.0	18.8	1499.0	
2 S 0	398.55	0.05	398.33	0.06	398.30	0.06	1170.0	15.0	1241.6	
3 S 0	305.84	0.05	305.70	0.05	305.65	0.06	874.0	15.0	1083.4	
4 S 0	243.67	0.06	243.56	0.04	243.49	0.07	989.0	9.9	969.1	
5 S 0	204.61	0.05	204.74	-0.07	204.65	-0.02	824.0	16.8	920.8	
6 S 0	174.25	0.06	174.21	0.03	174.12	0.07	933.0	15.0	913.1	
0 S 2	3233.25	0.01	3233.34	-0.00	3233.45	-0.01	463.0	17.8	509.6	7.086
0 S 3	2134.67	0.02	2134.22	0.02	2134.44	0.01	421.0	17.5	417.4	6.904
0 S 4	1545.60	0.05	1545.43	0.01	1545.73	-0.01	355.0	18.2	373.1	7.596
0 S 5	1190.13	0.05	1189.88	0.02	1190.19	-0.00	352.0	32.1	355.5	7.929
0 S 6	963.18	0.05	963.20	-0.00	963.51	-0.03	357.0	25.0	347.3	7.906
0 S 7	811.45	0.05	811.83	-0.05	812.16	-0.09	330.0	12.8	342.0	7.566
0 S 8	707.66	0.05	707.47	0.03	707.83	-0.02	338.0	5.0	337.3	6.954
0 S 9	633.89	0.05	633.61	0.04	634.01	-0.02	319.0	5.0	332.7	6.239
0 S 11	536.89	0.05	536.94	-0.01	537.35	-0.09	315.0	5.0	322.1	5.254
0 S 12	502.36	0.05	502.42	-0.01	502.83	-0.09	306.0	5.0	315.2	4.997
0 S 13	473.17	0.05	473.28	-0.02	473.68	-0.11	299.0	5.0	307.2	4.813
0 S 14	448.21	0.05	448.15	0.01	448.53	-0.07	290.0	5.0	298.3	4.665
0 S 15	426.15	0.05	426.19	-0.01	426.55	-0.10	295.0	5.0	288.8	4.533
0 S 16	406.76	0.05	406.80	-0.01	407.15	-0.09	278.0	5.0	278.9	4.411
0 S 17	389.30	0.05	389.55	-0.06	389.87	-0.15	273.0	5.0	268.9	4.298
0 S 18	373.94	0.05	374.07	-0.04	374.37	-0.12	282.0	5.0	259.1	4.193
0 S 19	360.14	0.05	360.11	0.01	360.38	-0.07	255.0	5.0	249.7	4.097
0 S 20	347.50	0.05	347.42	0.02	347.67	-0.05	231.0	5.0	240.8	4.011
0 S 21	335.81	0.05	335.83	-0.01	336.06	-0.07	237.0	5.0	232.4	3.934
0 S 22	325.06	0.05	325.18	-0.04	325.38	-0.10	228.0	5.0	224.8	3.866
0 S 23	315.30	0.05	315.34	-0.01	315.51	-0.07	216.0	5.0	217.7	3.808
0 S 24	306.20	0.05	306.20	0.00	306.35	-0.05	219.0	5.0	211.3	3.758
0 S 25	297.67	0.05	297.68	-0.00	297.81	-0.04	207.0	5.0	205.4	3.716
0 S 26	289.67	0.05	289.70	-0.01	289.80	-0.05	202.0	5.0	200.0	3.681
0 S 27	282.21	0.05	282.20	0.00	282.28	-0.03	203.0	5.0	195.1	3.652
0 S 28	275.11	0.05	275.13	-0.01	275.19	-0.03	199.0	5.0	190.7	3.629
0 S 29	268.43	0.05	268.44	-0.00	268.48	-0.02	191.0	5.0	186.6	3.611
0 S 30	262.09	0.05	262.09	0.00	262.11	-0.01	188.0	5.0	182.9	3.597
0 S 31	256.02	0.05	256.06	-0.02	256.06	-0.01	184.0	5.0	179.5	3.586
0 S 32	250.29	0.05	250.32	-0.01	250.29	-0.00	180.0	5.0	176.4	3.578
0 S 33	244.88	0.05	244.83	0.02	244.79	0.04	177.0	5.0	173.4	3.573
0 S 34	239.62	0.05	239.59	0.01	239.53	0.04	173.0	5.0	170.7	3.570
0 S 35	234.60	0.05	234.57	0.01	234.49	0.05	172.0	5.0	168.2	3.568
0 S 36	229.79	0.05	229.76	0.01	229.66	0.06	170.0	5.0	165.9	3.568
0 S 37	225.17	0.05	225.14	0.01	225.02	0.07	167.0	5.0	163.6	3.569
0 S 38	220.71	0.05	220.70	0.00	220.56	0.07	162.0	5.0	161.6	3.571
0 S 39	216.45	0.05	216.43	0.01	216.27	0.08	161.0	5.0	159.6	3.573
0 S 40	212.35	0.05	212.32	0.02	212.15	0.10	159.0	5.0	157.7	3.577
0 S 41	208.33	0.05	208.35	-0.01	208.17	0.08	156.0	5.0	156.0	3.580
0 S 42	204.56	0.05	204.53	0.02	204.33	0.11	155.0	5.0	154.3	3.584
0 S 43	200.90	0.05	200.85	0.02	200.63	0.13	154.0	5.0	152.7	3.588
0 S 44	197.31	0.05	197.28	0.01	197.05	0.13	152.0	5.0	151.2	3.593
0 S 45	193.91	0.05	193.84	0.03	193.60	0.16	151.0	5.0	149.7	3.597
0 S 46	190.56	0.05	190.51	0.02	190.25	0.16	147.0	5.0	148.3	3.602
0 S 47	187.33	0.05	187.29	0.02	187.02	0.17	144.0	5.0	146.9	3.606
0 S 48	184.21	0.05	184.18	0.02	183.89	0.17	139.0	5.0	145.7	3.611
0 S 49	181.16	0.05	181.16	-0.00	180.86	0.17	136.0	5.0	144.4	3.615

TABLE V (continued)

M O D E	OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
0 S 50	178.28	0.05	178.24	0.02	177.92	0.20	133.0	5.0	143.2	3.620
0 S 51	175.36	0.05	175.40	-0.02	175.07	0.17	134.0	5.0	142.1	3.624
0 S 52	172.59	0.05	172.65	-0.04	172.31	0.16	136.0	5.0	140.9	3.629
0 S 53	169.99	0.05	169.98	0.00	169.63	0.21	139.0	5.0	139.9	3.633
0 S 54	167.41	0.05	167.39	0.01	167.03	0.22	136.0	5.0	138.8	3.637
0 S 55	164.88	0.05	164.88	0.00	164.51	0.23	134.0	5.0	137.8	3.641
0 S 56	162.42	0.05	162.44	-0.01	162.05	0.22	133.0	5.0	136.9	3.645
0 S 57	160.11	0.05	160.06	0.03	159.67	0.28	131.0	5.0	135.9	3.649
0 S 58	157.75	0.05	157.76	-0.00	157.35	0.25			135.0	3.653
0 S 59	155.38	0.05	155.51	-0.09	155.10	0.18			134.1	3.656
0 S 60	153.24	0.05	153.33	-0.06	152.91	0.22			133.3	3.660
0 S 61	151.19	0.05	151.20	-0.01	150.77	0.28			132.5	3.663
0 S 62	149.16	0.05	149.13	0.02	148.69	0.31			131.7	3.667
0 S 63	147.14	0.05	147.12	0.02	146.67	0.32			130.9	3.670
0 S 64	144.96	0.09	145.15	-0.13	144.70	0.18			130.2	3.673
0 S 66	141.22	0.09	141.37	-0.11	140.91	0.22			128.9	3.679
0 S 67	139.73	0.11	139.56	0.12	139.08	0.46			128.2	3.682
0 S 68	137.94	0.11	137.78	0.12	137.30	0.47			127.6	3.685
0 S 69	136.19	0.12	136.05	0.10	135.57	0.46			127.0	3.688
0 S 70	134.48	0.12	134.36	0.09	133.87	0.45			126.4	3.691
0 S 71	132.79	0.13	132.71	0.06	132.21	0.43			125.8	3.694
0 S 72	131.14	0.13	131.10	0.03	130.60	0.41			125.3	3.696
0 S 73	129.50	0.13	129.53	-0.03	129.02	0.37			124.8	3.699
0 S 74	127.89	0.12	127.99	-0.08	127.48	0.32			124.3	3.702
0 S 75	126.29	0.11	126.49	-0.16	125.97	0.25			123.8	3.704
0 S 76	125.04	0.30	125.03	0.01	124.50	0.43	127.0	15.0	123.4	3.707
0 S 80	119.51	0.30	119.47	0.03	118.93	0.48			121.8	3.717
0 S 85	113.22	0.30	113.17	0.04	112.61	0.53			120.3	3.728
0 S 90	107.54	0.30	107.48	0.05	106.91	0.58			119.1	3.739
0 S 100	97.73	0.30	97.63	0.10	97.05	0.70			118.0	3.758
0 S 105	93.46	0.40	93.34	0.13	92.75	0.76			117.9	3.768
0 S 110	89.54	0.50	89.40	0.15	88.81	0.81			118.1	3.776
0 S 115	85.91	0.60	85.77	0.16	85.18	0.85			118.6	3.784
0 S 120	82.57	0.60	82.42	0.19	81.83	0.90			119.3	3.792
0 S 125	79.49	0.70	79.31	0.22	78.73	0.96			120.3	3.799
0 S 130	76.60	0.70	76.43	0.23	75.84	0.99			121.4	3.806
0 S 135	73.93	0.80	73.74	0.26	73.16	1.04			122.8	3.812
0 S 140	71.43	0.80	71.23	0.28	70.66	1.09			124.3	3.817
0 S 145	69.10	0.80	68.89	0.31	68.32	1.13			126.1	3.822
0 S 150	66.90	0.80	66.69	0.32	66.13	1.16			128.0	3.827
0 S 155	64.85	0.80	64.62	0.34	64.07	1.20			130.1	3.831
0 S 160	62.91	0.80	62.68	0.36	62.13	1.23			132.3	3.834
0 S 165	61.08	0.80	60.85	0.38	60.31	1.27			134.8	3.837
1 S 2	1470.85	0.08	1470.98	-0.01	1471.32	-0.03			310.3	10.913
1 S 3	1063.96	0.11	1064.04	-0.01	1064.36	-0.04			282.7	9.881
1 S 4	852.67	0.05	852.63	0.00	852.84	-0.02			271.1	8.712
1 S 5	730.56	0.06	729.79	0.11	729.83	0.10			291.9	6.975
1 S 6	657.61	0.05	657.02	0.09	657.00	0.09			345.7	5.472
1 S 7	603.92	0.05	604.05	-0.02	604.05	-0.02	484.0	17.6	372.2	5.464
1 S 8	556.03	0.07	555.77	0.05	555.78	0.04			379.4	6.170
1 S 9	509.96	0.05	509.23	0.14	509.23	0.14			380.3	7.039
1 S 10	465.46	0.06	465.46	0.00	465.45	0.00			378.3	7.745
1 S 16	299.57	0.05	299.53	0.01	299.52	0.02			165.9	6.363
1 S 17	286.22	0.07	286.22	0.	286.19	0.01			158.5	6.094

MODE	OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
1 S 19	263.63	0.07	263.59	0.02	263.52	0.04			155.6	5.921
1 S 20	253.97	0.07	253.72	0.10	253.63	0.13			155.4	5.879
1 S 22	236.21	0.07	236.17	0.02	236.06	0.06			155.8	5.822
1 S 23	228.42	0.09	228.33	0.04	228.21	0.09			156.1	5.798
1 S 24	220.99	0.07	221.02	-0.01	220.89	0.05			156.5	5.774
1 S 26	207.71	0.07	207.80	-0.04	207.65	0.03			157.0	5.725
1 S 27	201.70	0.07	201.80	-0.05	201.64	0.03			157.2	5.697
1 S 28	196.31	0.07	196.17	0.07	196.00	0.16			157.2	5.668
1 S 35	164.60	0.10	164.78	-0.11	164.55	0.03			153.9	5.402
1 S 36	161.38	0.05	161.20	0.11	160.97	0.26			153.0	5.358
1 S 37	157.67	0.10	157.80	-0.08	157.56	0.07			152.0	5.313
1 S 38	154.73	0.05	154.57	0.10	154.32	0.26			150.9	5.267
1 S 39	151.64	0.07	151.50	0.09	151.24	0.26			149.7	5.221
1 S 40	148.61	0.07	148.57	0.03	148.31	0.20			148.5	5.175
1 S 41	145.78	0.05	145.77	0.00	145.51	0.19			147.2	5.130
1 S 42	143.12	0.07	143.11	0.01	142.83	0.20			145.9	5.085
1 S 43	140.61	0.07	140.56	0.04	140.27	0.24			144.6	5.041
1 S 44	138.25	0.09	138.12	0.10	137.83	0.30			143.3	4.998
1 S 50	125.33	0.10	125.41	-0.07	125.10	0.18			135.8	4.773
1 S 52	121.87	0.05	121.79	0.06	121.46	0.33			133.6	4.712
1 S 53	120.00	0.05	120.07	-0.06	119.74	0.22			132.5	4.684
1 S 54	118.50	0.10	118.40	0.08	118.08	0.36			131.5	4.658
1 S 55	116.81	0.13	116.79	0.01	116.46	0.30			130.5	4.634
1 S 56	115.32	0.10	115.24	0.07	114.90	0.36			129.6	4.611
1 S 58	112.25	0.10	112.26	-0.01	111.93	0.29			127.9	4.571
1 S 59	110.91	0.10	110.84	0.06	110.51	0.37			127.1	4.553
1 S 75	92.48	0.10	92.51	-0.04	92.20	0.31			119.1	4.399
2 S 4	724.87	0.05	725.08	-0.03	725.36	-0.07	350.0	5.0	380.2	5.336
2 S 5	660.41	0.05	660.12	0.04	660.55	-0.02			302.2	6.005
2 S 6	594.80	0.05	594.96	-0.03	595.44	-0.11			237.9	7.201
2 S 8	488.18	0.05	488.00	0.04	488.36	-0.04			197.7	7.285
2 S 9	448.35	0.05	448.69	-0.08	449.00	-0.14			188.2	7.069
2 S 10	415.92	0.05	416.17	-0.06	416.42	-0.12			181.2	6.858
2 S 12	365.13	0.05	365.33	-0.06	365.50	-0.10			173.3	6.536
2 S 13	344.72	0.05	344.85	-0.04	344.97	-0.07			174.3	6.481
2 S 14	326.59	0.05	326.42	0.05	326.51	0.03			188.0	6.685
2 S 15	308.42	0.05	308.56	-0.04	308.60	-0.06	244.0	20.0	258.1	7.645
2 S 26	179.24	0.05	179.13	0.06	179.40	-0.09			194.2	6.568
2 S 27	174.03	0.05	174.07	-0.02	174.33	-0.17			188.1	6.451
2 S 28	169.29	0.05	169.32	-0.02	169.58	-0.17			185.4	6.414
2 S 29	164.74	0.05	164.85	-0.07	165.09	-0.21			183.1	6.384
2 S 30	160.53	0.05	160.63	-0.06	160.86	-0.20			181.0	6.353
2 S 31	156.58	0.05	156.64	-0.04	156.85	-0.17			179.1	6.322
2 S 33	149.27	0.05	149.28	-0.01	149.46	-0.13			175.5	6.256
2 S 34	145.95	0.05	145.88	0.05	146.05	-0.07			173.9	6.222
2 S 36	139.58	0.05	139.57	0.01	139.71	-0.09			171.0	6.153
2 S 37	136.66	0.05	136.64	0.02	136.76	-0.07			169.8	6.118
2 S 38	133.88	0.05	133.85	0.02	133.96	-0.06			168.6	6.082
2 S 39	131.10	0.05	131.18	-0.06	131.28	-0.13	179.0	20.0	167.5	6.047
2 S 40	128.57	0.05	128.64	-0.05	128.72	-0.11			166.5	6.013
2 S 42	123.84	0.05	123.87	-0.02	123.92	-0.06			164.8	5.944
2 S 43	121.65	0.05	121.63	0.01	121.67	-0.02			164.0	5.910
2 S 44	119.49	0.05	119.49	0.	119.52	-0.02			163.3	5.877
2 S 45	117.34	0.05	117.43	-0.08	117.45	-0.09			162.6	5.844

TABLE V (continued)

MODE			OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
2	S	48	111.87	0.20	111.73	0.13	111.71	0.14			160.8	5.745
2	S	49	110.07	0.20	109.96	0.10	109.94	0.12			160.3	5.713
2	S	50	108.37	0.20	108.27	0.10	108.23	0.13			159.7	5.680
2	S	51	106.71	0.20	106.63	0.07	106.59	0.11			159.2	5.647
2	S	58	96.61	0.20	96.65	-0.04	96.57	0.05			155.1	5.405
2	S	60	94.14	0.20	94.20	-0.06	94.11	0.03	151.0	20.0	153.8	5.333
2	S	64	89.66	0.20	89.75	-0.10	89.64	0.02			151.0	5.188
2	S	65	88.65	0.20	88.72	-0.07	88.61	0.05			150.3	5.152
2	S	66	87.66	0.22	87.71	-0.06	87.60	0.07			149.6	5.118
2	S	71	82.97	0.20	83.12	-0.18	83.00	-0.03			146.1	4.956
2	S	74	80.53	0.20	80.65	-0.14	80.52	0.01			144.2	4.872
2	S	76	78.89	0.20	79.10	-0.26	78.97	-0.10			143.1	4.823
3	S	1	1058.10	0.08	1059.40	-0.12	1059.45	-0.13	1020.0	20.1	826.9	7.951
3	S	2	904.30	0.05	904.00	0.03	904.10	0.02			366.6	7.586
3	S	6	392.34	0.05	392.21	0.03	392.30	0.01			275.5	5.572
3	S	8	354.41	0.05	354.66	-0.07	354.79	-0.11			263.6	5.297
3	S	9	338.97	0.05	338.80	0.05	338.96	0.00			258.7	5.292
3	S	11	310.45	0.05	310.44	0.00	310.64	-0.06			249.9	5.542
3	S	12	297.45	0.05	297.44	0.01	297.66	-0.07			245.4	5.723
3	S	13	285.10	0.05	285.11	-0.00	285.35	-0.09			240.9	5.902
3	S	14	273.33	0.05	273.44	-0.04	273.70	-0.14			236.2	6.063
3	S	15	262.42	0.05	262.44	-0.01	262.71	-0.11			231.5	6.197
3	S	16	252.17	0.05	252.09	0.03	252.38	-0.08			226.9	6.303
3	S	17	242.46	0.05	242.39	0.03	242.69	-0.09			222.4	6.382
3	S	18	233.25	0.05	233.32	-0.03	233.63	-0.16			218.1	6.438
3	S	19	224.99	0.05	224.85	0.06	225.15	-0.07			213.9	6.476
3	S	20	216.99	0.05	216.93	0.03	217.24	-0.11	229.0	20.0	210.1	6.498
3	S	21	209.63	0.05	209.53	0.05	209.84	-0.10			206.4	6.509
3	S	22	202.69	0.05	202.61	0.04	202.92	-0.11			203.0	6.512
3	S	23	196.18	0.06	196.14	0.02	196.44	-0.13			200.1	6.511
3	S	24	190.07	0.05	190.07	0.	190.35	-0.15			198.0	6.516
3	S	25	184.32	0.06	184.32	0.00	184.56	-0.13			207.0	6.708
3	S	41	113.35	0.05	113.38	-0.03	113.50	-0.14			227.3	6.261
3	S	42	111.41	0.05	111.41	0.00	111.53	-0.11			224.5	6.232
3	S	43	109.42	0.06	109.51	-0.08	109.64	-0.20			221.8	6.204
3	S	44	107.77	0.05	107.68	0.08	107.81	-0.04			219.1	6.178
3	S	45	106.00	0.06	105.92	0.08	106.05	-0.05			216.6	6.153
3	S	46	104.20	0.10	104.23	-0.03	104.36	-0.15			214.1	6.130
3	S	47	102.51	0.06	102.59	-0.08	102.72	-0.21			211.7	6.108
3	S	48	101.08	0.05	101.01	0.07	101.14	-0.06			209.4	6.087
3	S	49	99.46	0.08	99.48	-0.02	99.61	-0.15			207.3	6.066
3	S	50	97.99	0.05	98.00	-0.01	98.13	-0.14			205.2	6.046
3	S	53	93.73	0.06	93.85	-0.13	93.97	-0.26			199.7	5.989
3	S	56	90.10	0.05	90.07	0.04	90.17	-0.08			195.1	5.933
3	S	57	88.83	0.05	88.88	-0.06	88.98	-0.17			193.8	5.915
3	S	58	87.65	0.05	87.73	-0.09	87.82	-0.20			192.6	5.897
3	S	63	82.38	0.10	82.43	-0.06	82.50	-0.14			187.7	5.815
3	S	67	78.76	0.10	78.68	0.11	78.72	0.05			185.1	5.757
3	S	70	76.11	0.10	76.10	0.01	76.13	-0.03			183.7	5.717
3	S	73	73.78	0.10	73.70	0.11	73.72	0.08			182.4	5.676
4	S	2	580.81	0.12	580.62	0.03	580.59	0.04			434.2	13.261
4	S	3	489.04	0.07	488.05	0.20	488.02	0.21			480.2	13.386
4	S	4	439.17	0.11	438.68	0.11	438.73	0.10			290.2	5.018

M O D E			OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
4	S	5	414.62	0.06	414.69	-0.02	414.76	-0.03			282.4	5.534
4	S	9	269.63	0.05	269.63	-0.00	269.61	0.01			339.0	6.613
4	S	10	258.75	0.05	258.76	-0.01	258.76	-0.00			302.4	5.975
4	S	11	249.38	0.05	249.35	0.01	249.36	0.01			284.6	5.744
4	S	12	240.78	0.05	240.79	-0.00	240.82	-0.01			274.5	5.681
4	S	13	232.75	0.05	232.82	-0.03	232.85	-0.04			268.2	5.713
4	S	14	225.08	0.05	225.27	-0.08	225.31	-0.10	288.0	20.0	264.3	5.804
4	S	15	218.19	0.05	218.07	0.05	218.11	0.03			261.8	5.930
4	S	16	211.24	0.05	211.16	0.04	211.21	0.02			260.3	6.071
4	S	17	204.66	0.05	204.53	0.06	204.58	0.04			259.5	6.212
4	S	18	198.16	0.05	198.16	-0.00	198.22	-0.03			259.1	6.343
4	S	19	191.96	0.05	192.07	-0.06	192.13	-0.09	291.0	20.0	258.9	6.457
4	S	20	186.33	0.05	186.25	0.04	186.31	0.01			258.9	6.552
4	S	24	165.68	0.05	165.67	0.01	165.74	-0.03			258.8	6.735
4	S	30	141.97	0.05	141.97	0.00	142.05	-0.05			253.9	6.651
4	S	31	138.72	0.05	138.70	0.02	138.78	-0.05	264.0	20.0	252.3	6.618
4	S	32	135.65	0.05	135.59	0.04	135.68	-0.02			250.5	6.583
4	S	34	129.87	0.05	129.83	0.03	129.92	-0.04	234.0	20.0	246.2	6.509
4	S	35	127.18	0.05	127.15	0.02	127.25	-0.05	246.0	20.0	243.8	6.471
4	S	36	124.66	0.05	124.59	0.06	124.69	-0.02			241.2	6.433
4	S	37	122.22	0.05	122.15	0.05	122.26	-0.03			238.5	6.396
4	S	38	119.87	0.05	119.82	0.04	119.93	-0.05			235.8	6.360
4	S	39	117.65	0.05	117.58	0.06	117.69	-0.04			233.0	6.325
4	S	40	115.42	0.05	115.44	-0.01	115.55	-0.11			230.7	6.305
4	S	63	76.65	0.10	76.67	-0.03	76.69	-0.05			237.4	6.221
5	S	3	460.78	0.05	460.90	-0.03	460.94	-0.03			292.4	3.870
5	S	4	420.36	0.05	420.25	0.03	420.20	0.04			489.1	13.233
5	S	5	369.92	0.05	369.91	0.00	369.84	0.02			502.5	12.722
5	S	6	332.11	0.05	332.15	-0.01	332.07	0.01			506.3	11.853
5	S	7	303.98	0.05	303.88	0.03	303.79	0.06	496.0	20.0	492.8	10.458
5	S	8	283.56	0.05	283.64	-0.03	283.57	-0.00			418.2	8.272
5	S	11	224.45	0.05	224.39	0.03	224.25	0.09			374.7	9.735
5	S	13	203.09	0.05	203.07	0.01	202.91	0.09			386.1	8.850
5	S	14	194.61	0.05	194.68	-0.03	194.52	0.05			371.6	8.118
5	S	19	166.78	0.05	166.79	-0.00	166.73	0.03			284.7	6.399
5	S	20	162.45	0.05	162.44	0.00	162.40	0.03			279.4	6.415
5	S	23	150.57	0.05	150.58	-0.00	150.54	0.02			268.8	6.516
5	S	24	146.98	0.05	146.96	0.01	146.93	0.03			265.9	6.534
5	S	25	143.59	0.05	143.52	0.05	143.48	0.08			263.0	6.540
5	S	26	140.25	0.05	140.23	0.02	140.19	0.04			260.0	6.532
5	S	27	137.12	0.05	137.09	0.02	137.05	0.05			257.0	6.513
5	S	28	134.08	0.05	134.10	-0.02	134.06	0.01			253.9	6.485
5	S	29	131.18	0.05	131.25	-0.06	131.21	-0.03			250.8	6.452
5	S	30	128.49	0.05	128.54	-0.03	128.50	-0.00	248.0	20.0	247.9	6.418
5	S	31	125.90	0.05	125.94	-0.03	125.91	-0.01			245.1	6.386
5	S	32	123.40	0.05	123.46	-0.05	123.43	-0.02			242.6	6.357
5	S	33	121.02	0.05	121.09	-0.05	121.06	-0.03			240.4	6.335
5	S	34	118.76	0.05	118.81	-0.05	118.78	-0.02			238.6	6.320
5	S	35	116.65	0.05	116.62	0.02	116.59	0.05			237.1	6.312
5	S	36	114.57	0.05	114.52	0.04	114.49	0.07			236.0	6.310
5	S	37	112.55	0.05	112.48	0.06	112.45	0.09			235.3	6.315
5	S	38	110.57	0.05	110.52	0.05	110.49	0.08	223.0	20.0	234.9	6.325
5	S	39	108.66	0.05	108.62	0.04	108.59	0.07			234.8	6.339
5	S	40	106.84	0.05	106.77	0.06	106.75	0.08			234.9	6.355

TABLE V (continued)

MODE			OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
5	S	41	105.06	0.05	104.99	0.07	104.97	0.09			235.3	6.372
5	S	42	103.36	0.05	103.26	0.10	103.24	0.12			235.9	6.389
5	S	43	101.69	0.05	101.58	0.11	101.56	0.12			236.5	6.406
5	S	44	100.09	0.05	99.95	0.14	99.94	0.15			237.3	6.421
5	S	45	98.45	0.05	98.37	0.08	98.36	0.09			238.1	6.434
5	S	46	97.01	0.05	96.84	0.18	96.83	0.19			239.0	6.445
5	S	47	95.51	0.05	95.35	0.17	95.34	0.18			239.8	6.453
5	S	51	89.91	0.05	89.82	0.10	89.81	0.11			242.3	6.455
6	S	9	252.63	0.07	252.19	0.18	252.10	0.21	292.0	20.0	320.6	9.638
6	S	14	185.15	0.05	184.84	0.17	184.80	0.19			259.3	7.368
6	S	15	178.76	0.07	178.49	0.15	178.41	0.19			272.2	8.002
6	S	16	172.29	0.05	172.16	0.07	172.05	0.14			287.9	8.418
6	S	17	166.09	0.06	166.08	0.01	165.93	0.10			300.8	8.571
6	S	18	160.46	0.07	160.37	0.05	160.20	0.16			309.0	8.540
6	S	19	155.08	0.05	155.10	-0.01	154.91	0.11			312.7	8.389
6	S	20	150.13	0.05	150.28	-0.10	150.07	0.04			312.2	8.158
6	S	21	145.75	0.05	145.88	-0.09	145.67	0.05			308.0	7.875
6	S	22	141.87	0.05	141.88	-0.01	141.67	0.14			300.8	7.572
6	S	23	138.23	0.05	138.24	-0.01	138.03	0.15			292.0	7.288
6	S	24	134.82	0.05	134.90	-0.06	134.69	0.09			282.9	7.053
6	S	25	131.80	0.05	131.80	-0.00	131.61	0.15			274.7	6.882
6	S	26	128.79	0.05	128.90	-0.09	128.72	0.06			267.9	6.771
6	S	27	125.96	0.05	126.16	-0.16	125.99	-0.02			262.4	6.707
6	S	28	123.49	0.05	123.55	-0.05	123.39	0.08			258.3	6.677
6	S	29	121.01	0.05	121.06	-0.04	120.90	0.09			255.2	6.669
6	S	30	118.75	0.07	118.66	0.07	118.51	0.20			253.0	6.673
6	S	31	116.40	0.07	116.36	0.04	116.21	0.16			251.5	6.684
6	S	33	112.06	0.07	111.99	0.06	111.85	0.18			250.0	6.708
6	S	34	109.90	0.07	109.92	-0.02	109.79	0.10			249.7	6.716
6	S	35	107.96	0.07	107.93	0.03	107.80	0.15			249.6	6.720
6	S	36	106.06	0.07	106.01	0.05	105.88	0.17			249.6	6.718
6	S	37	104.18	0.07	104.15	0.02	104.03	0.14			249.7	6.711
6	S	38	102.38	0.07	102.37	0.01	102.24	0.13			249.7	6.698
6	S	39	100.68	0.07	100.64	0.04	100.52	0.16			249.7	6.680
6	S	40	98.97	0.07	98.98	-0.01	98.86	0.11			249.6	6.657
6	S	42	95.80	0.07	95.84	-0.04	95.72	0.09			249.1	6.598
6	S	43	94.32	0.07	94.35	-0.03	94.23	0.10			248.6	6.563
6	S	48	87.62	0.07	87.66	-0.05	87.55	0.08			244.7	6.360
6	S	49	86.41	0.07	86.46	-0.06	86.35	0.07			243.8	6.321
6	S	51	84.07	0.07	84.17	-0.12	84.06	0.01			241.9	6.251
6	S	52	82.99	0.07	83.08	-0.11	82.97	0.02			241.1	6.222
6	S	53	81.93	0.07	82.02	-0.11	81.92	0.02			240.4	6.198
6	S	55	79.95	0.07	79.99	-0.06	79.90	0.07			239.2	6.164
6	S	56	78.92	0.07	79.02	-0.13	78.93	-0.01			238.9	6.156
6	S	57	77.97	0.07	78.07	-0.13	77.98	-0.01			238.7	6.152
6	S	58	77.11	0.07	77.14	-0.04	77.06	0.07			238.7	6.153
6	S	59	76.20	0.07	76.24	-0.05	76.16	0.06			238.8	6.158
6	S	60	75.33	0.07	75.35	-0.03	75.28	0.07			239.0	6.167
6	S	61	74.46	0.07	74.49	-0.03	74.41	0.06			239.4	6.179
7	S	2	397.37	0.05	397.25	0.03	397.22	0.04			341.4	15.311
7	S	4	293.25	0.05	292.98	0.09	292.94	0.11			333.8	7.703
7	S	5	273.43	0.05	273.24	0.07	273.20	0.09			477.4	11.638
7	S	6	252.66	0.05	252.61	0.02	252.56	0.04			504.3	12.075

MODE	OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
7 S 7	236.04	0.05	235.97	0.03	235.93	0.05			415.1	10.086
7 S 8	224.36	0.10	224.59	-0.10	224.56	-0.09			321.5	7.366
7 S 9	216.62	0.10	216.55	0.03	216.52	0.04			281.9	6.167
7 S 10	209.42	0.10	209.74	-0.15	209.72	-0.15			266.3	5.938
7 S 11	203.09	0.10	203.38	-0.14	203.36	-0.13			258.4	6.046
7 S 12	197.12	0.10	197.20	-0.04	197.18	-0.03			254.1	6.314
7 S 18	147.82	0.07	147.79	0.02	147.76	0.04			241.0	6.144
7 S 20	141.23	0.07	141.20	0.02	141.17	0.04			239.2	6.507
7 S 21	138.06	0.07	137.98	0.06	137.93	0.09			240.1	6.743
7 S 22	134.81	0.07	134.78	0.02	134.73	0.06			242.3	6.992
7 S 24	128.57	0.07	128.53	0.03	128.44	0.10			249.2	7.394
7 S 25	125.48	0.07	125.52	-0.04	125.42	0.05			252.5	7.507
7 S 28	117.21	0.07	117.18	0.02	117.03	0.15			258.0	7.549
7 S 29	114.65	0.07	114.65	-0.00	114.49	0.14			258.4	7.509
7 S 30	112.16	0.07	112.24	-0.07	112.08	0.07			258.4	7.459
7 S 35	101.74	0.07	101.78	-0.04	101.61	0.13			255.9	7.188
7 S 36	99.98	0.07	99.96	0.02	99.79	0.19			255.3	7.137
7 S 37	98.19	0.07	98.21	-0.02	98.05	0.15			254.7	7.087
7 S 38	96.51	0.07	96.54	-0.03	96.37	0.14			254.1	7.038
7 S 39	94.89	0.07	94.93	-0.04	94.77	0.13			253.6	6.990
7 S 43	88.99	0.07	89.09	-0.11	88.94	0.05			251.9	6.828
7 S 45	86.37	0.07	86.47	-0.11	86.33	0.05			251.6	6.770
7 S 46	85.13	0.07	85.22	-0.11	85.09	0.05			251.5	6.748
7 S 48	82.76	0.07	82.84	-0.10	82.72	0.04			251.8	6.716
7 S 55	75.53	0.07	75.51	0.02	75.43	0.14			255.0	6.682
7 S 56	74.59	0.07	74.57	0.02	74.49	0.13			255.6	6.677
7 S 57	73.68	0.07	73.66	0.03	73.58	0.14			256.0	6.671
8 S 1	348.12	0.05	348.02	0.03	347.98	0.04			930.2	14.177
8 S 5	239.96	0.05	240.03	-0.03	239.95	0.01			611.6	12.457
8 S 6	225.28	0.05	225.47	-0.08	225.38	-0.04			441.0	9.202
8 S 7	215.13	0.05	215.03	0.04	214.95	0.08			351.6	9.011
8 S 9	191.89	0.07	191.87	0.01	191.76	0.07	483.0	20.0	501.3	12.448
8 S 15	158.50	0.07	158.30	0.12	158.26	0.15			250.6	5.878
8 S 23	120.87	0.07	120.67	0.16	120.62	0.21			237.8	6.052
8 S 24	118.67	0.07	118.48	0.16	118.43	0.20			237.5	6.176
8 S 29	108.08	0.07	108.02	0.06	107.98	0.09			243.1	6.895
8 S 30	106.04	0.07	106.02	0.01	105.98	0.05			244.9	7.019
8 S 32	102.20	0.07	102.16	0.04	102.12	0.08			248.5	7.219
8 S 38	91.81	0.07	91.79	0.02	91.73	0.09			256.1	7.435
8 S 41	87.28	0.07	87.33	-0.05	87.26	0.03			257.9	7.400
8 S 46	80.79	0.07	80.85	-0.08	80.78	0.01			258.5	7.247
8 S 47	79.78	0.07	79.69	0.12	79.61	0.21			258.3	7.208
8 S 48	78.57	0.07	78.56	0.01	78.49	0.11			257.9	7.167
9 S 3	281.39	0.05	281.30	0.03	281.23	0.06			777.7	13.266
9 S 4	258.10	0.07	257.87	0.09	257.80	0.12			515.2	13.197
9 S 6	216.37	0.05	216.41	-0.02	216.37	0.			331.1	8.510
9 S 7	205.16	0.05	205.23	-0.04	205.18	-0.01			489.9	11.072
9 S 8	194.22	0.07	194.38	-0.08	194.34	-0.06			472.3	10.581
9 S 11	170.01	0.05	169.90	0.07	169.80	0.12			413.9	11.972
9 S 12	161.64	0.05	161.62	0.01	161.50	0.09			465.0	12.017
9 S 13	154.30	0.07	154.24	0.04	154.10	0.13			484.6	11.659
9 S 14	147.87	0.05	147.75	0.08	147.60	0.18			484.7	11.062
9 S 15	142.23	0.05	142.25	-0.02	142.10	0.09			430.1	9.635

TABLE V (continued)

M O D E			OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
9	S	18	132.47	0.07	132.40	-0.05	132.33	0.11			255.9	5.860
9	S	19	129.87	0.07	129.90	-0.02	129.83	0.03			248.2	5.797
9	S	29	100.32	0.07	100.27	0.05	100.20	0.12			243.4	6.373
9	S	35	91.16	0.07	91.18	-0.02	91.13	0.03			242.7	6.854
9	S	37	88.49	0.07	88.39	0.11	88.35	0.16			241.6	6.956
10	S	2	247.74	0.05	247.99	-0.10	247.96	-0.09			192.4	20.486
10	S	10	161.65	0.05	161.53	0.08	161.49	0.10			376.2	10.614
10	S	13	145.46	0.07	145.47	-0.00	145.42	0.03			277.7	6.861
10	S	14	142.06	0.05	142.07	-0.01	142.02	0.03			259.1	6.491
10	S	17	130.34	0.05	130.28	0.05	130.13	0.16			387.5	10.444
10	S	18	126.00	0.05	125.97	0.02	125.81	0.15			410.7	10.490
10	S	19	121.93	0.05	121.98	-0.05	121.80	0.10			411.8	10.218
10	S	20	118.37	0.05	118.39	-0.02	118.21	0.14			390.5	9.599
10	S	21	115.20	0.05	115.30	-0.09	115.12	0.07			342.3	8.457
10	S	28	95.58	0.07	95.59	-0.01	95.43	0.15			300.1	7.715
10	S	29	93.90	0.07	93.93	-0.03	93.78	0.13			279.9	7.180
10	S	31	91.14	0.07	91.00	0.15	90.88	0.28			257.0	6.606
10	S	32	89.78	0.07	89.67	0.13	89.56	0.25			251.1	6.496
10	S	34	87.21	0.07	87.15	0.07	87.05	0.18			244.1	6.441
10	S	36	84.86	0.07	84.76	0.12	84.68	0.22			240.2	6.489
10	S	37	83.58	0.07	83.61	-0.03	83.53	0.06			238.9	6.530
10	S	41	79.18	0.07	79.21	-0.04	79.15	0.04			236.2	6.734
10	S	44	76.05	0.07	76.13	-0.11	76.08	-0.04			236.1	6.873
11	S	1	271.36	0.09	271.33	0.01	271.28	0.03			663.6	15.152
11	S	3	223.93	0.05	224.09	-0.07	224.02	-0.04			447.5	10.680
11	S	4	209.55	0.05	209.78	-0.11	209.70	-0.07	652.0	20.0	701.6	12.690
11	S	5	197.14	0.05	197.07	0.04	196.99	0.08			665.4	12.013
11	S	6	186.83	0.05	186.86	-0.01	186.79	0.02			463.4	10.022
11	S	7	179.70	0.10	179.74	-0.02	179.69	0.01			280.6	7.570
11	S	9	155.49	0.05	155.35	0.09	155.22	0.17			627.1	11.964
11	S	10	149.03	0.05	148.98	0.03	148.85	0.12			426.3	9.483
11	S	13	134.99	0.07	134.82	0.13	134.76	0.17			420.4	11.095
11	S	15	126.44	0.07	126.28	0.13	126.22	0.18			332.1	8.347
11	S	16	123.22	0.07	123.35	-0.11	123.29	-0.05			284.6	6.849
11	S	17	120.89	0.07	120.95	-0.05	120.88	0.01			261.8	6.144
11	S	21	112.16	0.07	112.30	-0.13	112.24	-0.07			277.3	7.668
11	S	22	109.66	0.07	109.75	-0.08	109.65	0.00			317.1	8.831
11	S	23	107.15	0.07	107.05	0.09	106.93	0.21			349.1	9.411
11	S	24	104.36	0.05	104.38	-0.02	104.23	0.12			363.1	9.504
11	S	31	87.29	0.07	87.42	-0.15	87.30	-0.01			335.4	8.641
11	S	32	85.78	0.07	85.81	-0.04	85.68	0.12			332.1	8.486
11	S	34	82.87	0.07	82.90	-0.03	82.75	0.14			307.3	7.844
11	S	35	81.45	0.07	81.60	-0.18	81.46	-0.01			291.9	7.473
11	S	37	79.15	0.07	79.28	-0.16	79.15	0.			268.3	6.929
11	S	39	77.24	0.07	77.19	0.06	77.08	0.20			255.9	6.708
11	S	40	76.21	0.07	76.21	0.00	76.11	0.14			252.4	6.678
11	S	41	75.21	0.07	75.25	-0.05	75.15	0.07			250.0	6.678
11	S	43	73.39	0.07	73.40	-0.01	73.31	0.11			247.3	6.726
11	S	44	72.53	0.07	72.50	0.04	72.42	0.15			246.6	6.760
11	S	46	70.68	0.07	70.76	-0.11	70.68	0.			245.6	6.824
12	S	7	170.67	0.05	170.77	-0.06	170.65	0.01			423.8	10.271
12	S	10	145.67	0.05	145.74	-0.05	145.69	-0.01			330.9	9.171

M O D E	OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
12 S 11	140.25	0.05	140.08	0.12	139.99	0.18			511.1	12.324
12 S 12	134.24	0.05	134.14	0.07	134.03	0.15			570.0	12.859
12 S 13	128.68	0.05	128.59	0.08	128.47	0.17			568.6	12.883
12 S 14	123.57	0.05	123.50	0.06	123.37	0.16			552.7	12.743
12 S 15	118.93	0.05	118.89	0.03	118.75	0.15			543.2	12.228
12 S 16	115.11	0.05	115.05	0.05	114.94	0.15			449.6	10.261
12 S 17	111.79	0.07	111.93	-0.13	111.84	-0.04			382.9	9.131
12 S 18	109.39	0.07	109.34	0.05	109.25	0.13			325.3	7.865
12 S 22	102.08	0.07	102.05	0.02	101.99	0.09			253.5	6.027
12 S 23	100.48	0.07	100.50	-0.02	100.44	0.04			252.0	6.094
12 S 26	95.80	0.07	95.87	-0.07	95.82	-0.02			265.4	6.914
12 S 33	81.43	0.07	81.42	0.01	81.37	0.07			267.4	6.970
13 S 1	222.27	0.05	222.43	-0.08	222.35	-0.04			735.1	14.369
13 S 2	206.57	0.05	206.39	0.09	206.30	0.13			878.5	13.939
13 S 3	192.71	0.05	192.54	0.09	192.45	0.13			908.6	14.039
13 S 8	152.39	0.10	152.59	-0.13	152.52	-0.08			278.4	5.358
13 S 12	125.76	0.10	125.71	0.04	125.64	0.10			247.4	5.134
13 S 14	120.96	0.10	121.08	-0.10	121.02	-0.05			285.7	7.587
13 S 18	106.77	0.10	106.71	0.06	106.59	0.17			490.5	12.196
13 S 19	103.41	0.05	103.36	0.05	103.23	0.17			486.8	11.789
13 S 21	97.65	0.10	97.68	-0.03	97.54	0.12			440.0	10.566
13 S 22	95.32	0.10	95.36	-0.04	95.23	0.10			378.6	9.237
13 S 23	93.62	0.10	93.48	0.15	93.38	0.26			316.8	7.652
13 S 25	90.52	0.10	90.62	-0.11	90.54	-0.03			267.8	6.228
13 S 26	89.31	0.10	89.38	-0.08	89.31	-0.00			259.6	6.042
13 S 29	85.94	0.10	85.93	0.02	85.87	0.08			251.6	6.073
13 S 37	73.52	0.10	73.51	0.02	73.46	0.09			250.1	6.431
13 S 38	72.74	0.10	72.63	0.14	72.59	0.20			254.2	6.634
14 S 4	180.81	0.10	180.45	0.20	180.36	0.25			742.4	13.843
14 S 7	147.79	0.05	147.65	0.10	147.59	0.14			330.4	9.582
14 S 8	142.02	0.05	141.89	0.10	141.83	0.14			483.1	12.058
14 S 9	136.13	0.05	135.98	0.11	135.92	0.16			528.4	12.226
14 S 10	131.27	0.10	130.96	0.23	130.91	0.27			388.4	9.760
14 S 17	104.97	0.07	104.97	0.00	104.92	0.05			316.2	8.241
14 S 19	99.99	0.05	100.02	-0.03	99.98	0.01			406.9	10.022
14 S 25	87.15	0.07	87.30	-0.17	87.16	-0.02			434.3	10.451
14 S 28	82.07	0.07	82.08	-0.02	81.94	0.15			331.8	8.221
14 S 31	78.89	0.07	78.79	0.13	78.70	0.24			253.9	6.034
15 S 3	165.83	0.05	165.69	0.08	165.61	0.13			805.8	14.327
15 S 11	122.85	0.07	122.99	-0.11	122.87	-0.02			500.5	11.355
15 S 12	118.59	0.05	118.59	0.00	118.48	0.09			572.3	12.417
15 S 16	100.69	0.05	100.71	-0.02	100.59	0.10			538.1	13.254
15 S 18	96.03	0.07	96.07	-0.04	95.99	0.04			281.3	6.544
15 S 28	80.39	0.07	80.45	-0.07	80.39	0.			324.4	8.142
15 S 30	77.63	0.07	77.63	-0.00	77.53	0.13			392.7	9.538
15 S 31	76.21	0.07	76.22	-0.01	76.10	0.14			392.2	9.474
15 S 32	74.83	0.07	74.89	-0.08	74.77	0.08			371.5	9.071
16 S 5	146.45	0.05	146.28	0.12	146.19	0.18			581.1	12.415
16 S 6	139.87	0.05	139.79	0.06	139.69	0.13			739.3	12.890
16 S 7	133.90	0.07	133.80	0.08	133.69	0.16			800.0	12.770
16 S 10	118.58	0.05	118.52	0.06	118.43	0.13			774.3	12.609

TABLE V (continued)

MODE			OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
16	S	19	91.18	0.07	91.20	-0.02	91.08	0.11			543.2	13.034
16	S	20	88.61	0.07	88.62	-0.01	88.49	0.14			521.2	12.457
16	S	25	80.23	0.07	80.23	0.01	80.17	0.07			393.3	9.373
16	S	26	78.81	0.07	78.77	0.05	78.71	0.12			373.6	8.943
16	S	31	73.61	0.07	73.57	0.06	73.52	0.12			272.9	6.604
17	S	12	109.11	0.07	109.27	-0.15	109.19	-0.07			462.0	10.800
17	S	13	105.93	0.07	105.98	-0.05	105.89	0.04			553.8	11.501
17	S	14	102.96	0.07	102.96	0.	102.88	0.08			459.1	10.157
17	S	15	100.48	0.07	100.60	-0.12	100.52	-0.04			350.7	8.117
17	S	22	83.54	0.07	83.49	0.07	83.40	0.17			406.5	10.528
17	S	23	81.61	0.07	81.59	0.03	81.47	0.17			465.9	11.450
17	S	26	76.47	0.07	76.39	0.11	76.27	0.26			427.8	10.525
17	S	28	73.56	0.07	73.51	0.07	73.42	0.18			414.0	9.964
17	S	29	72.26	0.07	72.22	0.05	72.15	0.16			386.7	9.349
17	S	30	71.11	0.07	71.08	0.05	71.01	0.15			347.8	8.476
17	S	31	69.98	0.07	70.07	-0.13	70.01	-0.04			314.6	7.635
18	S	3	145.28	0.05	145.10	0.12	145.00	0.19			851.4	14.056
18	S	4	138.11	0.05	138.10	0.00	138.00	0.08			943.1	13.726
18	S	15	95.68	0.07	95.65	0.03	95.60	0.08			381.7	9.762
18	S	16	93.28	0.07	93.28	0.00	93.23	0.05			474.4	11.332
18	S	17	90.84	0.07	90.86	-0.02	90.81	0.03			480.2	11.169
18	S	25	76.19	0.07	76.11	0.11	76.06	0.17			307.9	7.518
18	S	27	73.62	0.07	73.63	-0.02	73.59	0.05			425.4	10.101
19	S	9	110.62	0.05	110.53	0.08	110.43	0.17			612.4	12.165
19	S	10	106.86	0.05	106.87	-0.00	106.77	0.09			675.8	12.402
19	S	11	103.66	0.05	103.55	0.10	103.46	0.19			531.4	11.082
19	S	14	93.36	0.07	93.37	-0.01	93.23	0.13			646.4	11.600
19	S	15	90.91	0.07	90.99	-0.09	90.85	0.07			521.3	10.321
20	S	4	123.18	0.05	123.20	-0.02	123.12	0.05			782.5	15.087
20	S	5	118.06	0.05	118.04	0.02	117.96	0.08			636.8	12.844
20	S	15	89.12	0.05	89.12	0.00	89.07	0.06			301.9	6.601
20	S	16	87.39	0.07	87.46	-0.07	87.40	-0.01			458.8	10.481
20	S	17	85.30	0.07	85.31	-0.01	85.24	0.07			606.2	12.088
20	S	18	83.16	0.07	83.14	0.02	83.06	0.12			634.4	12.273
20	S	19	81.12	0.07	81.11	0.01	81.03	0.11			565.7	11.677
20	S	20	79.46	0.07	79.35	0.13	79.28	0.23			417.9	10.104
20	S	25	70.75	0.07	70.60	0.22	70.53	0.31			547.0	12.876
21	S	6	112.96	0.05	112.99	-0.02	112.87	0.08			739.8	12.736
21	S	7	109.02	0.05	109.01	0.01	108.90	0.11			799.9	12.970
21	S	8	105.37	0.05	105.30	0.07	105.19	0.17			667.3	13.043
21	S	10	98.70	0.05	98.71	-0.01	98.60	0.10			833.9	12.812
21	S	11	95.84	0.05	95.75	0.09	95.65	0.20			747.8	12.111
21	S	12	93.32	0.05	93.25	0.08	93.15	0.18			516.9	10.000
22	S	12	89.88	0.07	89.87	0.02	89.81	0.08			309.0	6.971
22	S	13	88.23	0.07	88.14	0.10	88.09	0.16			442.9	10.365
22	S	14	86.08	0.07	85.98	0.11	85.93	0.18			591.3	12.088
22	S	23	70.88	0.07	70.93	-0.06	70.89	-0.02			394.9	9.572

M O D E			OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
23	S	4	111.88	0.05	111.84	0.04	111.73	0.13			809.3	13.920
23	S	5	107.57	0.05	107.65	-0.07	107.54	0.03			899.2	13.971
23	S	7	100.14	0.07	100.14	0.00	100.04	0.09			660.4	13.593
23	S	8	97.06	0.07	96.90	0.16	96.81	0.26			740.2	12.991
23	S	9	94.16	0.07	94.12	0.04	94.04	0.13			553.6	10.985
23	S	10	92.14	0.07	92.21	-0.08	92.14	-0.00			322.0	6.608
23	S	22	69.59	0.07	69.57	0.03	69.49	0.14			509.4	11.659
24	S	10	89.52	0.10	89.62	-0.11	89.54	-0.02			449.2	9.875
24	S	11	87.33	0.10	87.42	-0.10	87.32	0.01			673.3	12.088
24	S	12	85.06	0.10	85.12	-0.07	85.02	0.05	1125.0	20.0	744.1	12.472
24	S	14	80.65	0.10	80.70	-0.06	80.63	0.03			742.8	12.516
24	S	15	78.63	0.10	78.69	-0.08	78.62	0.02			814.6	12.747
24	S	16	76.71	0.10	76.77	-0.08	76.70	0.01			795.8	12.532
24	S	17	75.20	0.10	75.10	0.13	75.04	0.22			482.8	9.577
24	S	18	74.26	0.10	74.19	0.09	74.13	0.18			277.8	5.146
25	S	1	115.46	0.07	115.54	-0.07	115.43	0.02			843.4	14.375
25	S	2	110.89	0.05	110.83	0.05	110.73	0.15			787.6	15.431
25	S	3	106.05	0.05	106.11	-0.05	106.02	0.03			376.8	16.618
25	S	5	98.65	0.10	98.66	-0.02	98.57	0.08			766.3	14.552
25	S	6	95.32	0.10	95.39	-0.07	95.29	0.03			724.1	13.155
25	S	10	84.78	0.10	84.82	-0.05	84.70	0.09			537.1	10.397
25	S	18	72.99	0.10	72.99	0.	72.93	0.09			574.1	11.733
26	S	8	89.19	0.07	89.25	-0.07	89.15	0.05			698.3	12.347
26	S	9	86.82	0.07	86.76	0.06	86.67	0.17			325.0	14.111
26	S	11	81.77	0.07	81.68	0.11	81.63	0.17			536.0	11.748
26	S	12	79.66	0.07	79.62	0.05	79.56	0.12			763.9	13.159
26	S	13	77.58	0.07	77.61	-0.04	77.56	0.03			704.6	12.533
27	S	2	101.44	0.07	101.35	0.09	101.25	0.19			797.3	14.802
27	S	4	94.37	0.07	94.37	0.00	94.27	0.10			576.7	13.198
27	S	14	75.18	0.15	75.06	0.16	74.98	0.26			420.9	9.752
27	S	15	73.43	0.15	73.45	-0.03	73.38	0.07			680.1	12.495
27	S	16	71.60	0.15	71.82	-0.31	71.76	-0.22			625.0	11.971
28	S	5	91.39	0.07	91.19	0.21	91.09	0.33			683.8	13.244
28	S	6	88.61	0.07	88.47	0.15	88.37	0.27			756.4	13.555
28	S	10	78.59	0.07	78.47	0.16	78.40	0.24			762.0	13.264
28	S	11	76.75	0.07	76.78	-0.04	76.72	0.04			288.0	5.868
29	S	1	97.04	0.10	96.99	0.05	96.89	0.16			734.5	15.708
30	S	3	90.61	0.07	90.49	0.13	90.39	0.24			715.6	15.394
30	S	7	79.69	0.07	79.69	0.01	79.61	0.10			848.0	14.177
30	S	8	77.52	0.07	77.53	-0.02	77.46	0.07			798.1	13.594
32	S	1	90.03	0.07	89.94	0.10	89.93	0.11			89.8	11.653
33	S	6	77.00	0.10	76.82	0.24	76.75	0.33			606.6	14.012
34	S	1	83.83	0.10	83.76	0.08	83.68	0.18	630.0	20.0	754.0	15.822

TABLE V (continued)

MODE			OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
0	T	2	2636.38	0.08	2637.45	-0.04	2639.40	-0.11			250.4	9.179
0	T	3	1705.95	0.15	1706.07	-0.01	1707.61	-0.10			240.0	7.613
0	T	4	1305.92	0.07	1306.11	-0.01	1307.55	-0.13			228.2	6.796
0	T	5	1075.98	0.12	1077.34	-0.13	1078.79	-0.26			216.4	6.233
0	T	6	925.84	0.09	926.96	-0.12	928.45	-0.28			205.4	5.826
0	T	7	819.31	0.08	819.22	0.01	820.77	-0.18			195.6	5.528
0	T	8	736.86	0.20	737.42	-0.08	739.03	-0.29	170.0	20.0	187.1	5.304
0	T	9	671.80	0.20	672.69	-0.13	674.35	-0.38	180.0	20.0	179.7	5.132
0	T	10	618.97	0.20	619.88	-0.15	621.59	-0.42			173.3	4.995
0	T	12	538.05	0.20	538.25	-0.04	540.05	-0.37			162.9	4.794
0	T	13	506.07	0.20	505.84	0.05	507.67	-0.32			158.8	4.720
0	T	14	477.53	0.20	477.49	0.01	479.35	-0.38			155.3	4.659
0	T	16	430.01	0.20	430.08	-0.02	432.00	-0.46			149.5	4.567
0	T	17	410.24	0.20	410.00	0.06	411.93	-0.41			147.2	4.533
0	T	18	391.82	0.20	391.83	-0.00	393.77	-0.50			145.2	4.505
0	T	20	360.03	0.08	360.16	-0.03	362.11	-0.58			141.9	4.462
0	T	21	346.50	0.08	346.25	0.07	348.20	-0.49			140.5	4.447
0	T	22	333.69	0.08	333.41	0.08	335.37	-0.50	114.0	20.0	139.3	4.434
0	T	23	321.70	0.08	321.52	0.05	323.48	-0.55			138.3	4.423
0	T	24	310.63	0.07	310.48	0.05	312.43	-0.58			137.4	4.414
0	T	25	300.37	0.06	300.18	0.06	302.13	-0.59	110.0	23.0	136.6	4.407
0	T	26	290.77	0.06	290.56	0.07	292.50	-0.60	113.0	22.3	135.9	4.402
0	T	27	281.75	0.06	281.55	0.07	283.48	-0.61	115.0	21.4	135.2	4.397
0	T	28	273.27	0.06	273.09	0.07	275.01	-0.64	116.0	20.0	134.7	4.393
0	T	29	265.30	0.06	265.12	0.07	267.04	-0.65	115.0	18.0	134.2	4.390
0	T	30	257.76	0.06	257.62	0.06	259.52	-0.68	113.0	16.1	133.7	4.388
0	T	31	250.66	0.06	250.53	0.05	252.42	-0.70	112.0	15.0	133.3	4.386
0	T	32	243.95	0.06	243.82	0.05	245.70	-0.72	112.0	15.2	133.0	4.385
0	T	33	237.59	0.05	237.46	0.05	239.33	-0.73	112.0	16.5	132.7	4.384
0	T	34	231.56	0.05	231.43	0.06	233.29	-0.75	113.0	18.3	132.4	4.383
0	T	35	225.83	0.05	225.70	0.06	227.54	-0.76	113.0	20.0	132.2	4.382
0	T	36	220.37	0.05	220.24	0.06	222.07	-0.77	113.0	21.2	132.0	4.382
0	T	37	215.17	0.05	215.05	0.06	216.86	-0.79	112.0	22.0	131.8	4.382
0	T	38	210.21	0.05	210.09	0.06	211.90	-0.80	111.0	22.5	131.7	4.382
0	T	39	205.47	0.05	205.35	0.06	207.15	-0.82	111.0	22.8	131.5	4.381
0	T	40	200.95	0.05	200.83	0.06	202.61	-0.83	111.0	23.0	131.4	4.382
0	T	41	196.60	0.05	196.50	0.05	198.26	-0.85	112.0	23.3	131.3	4.382
0	T	42	192.50	0.05	192.35	0.08	194.10	-0.83	113.0	23.6	131.2	4.382
0	T	43	188.51	0.05	188.38	0.07	190.12	-0.85	115.0	23.9	131.2	4.382
0	T	44	184.70	0.05	184.56	0.08	186.29	-0.86	117.0	24.2	131.1	4.382
0	T	45	181.04	0.05	180.89	0.08	182.61	-0.87	119.0	24.5	131.1	4.382
0	T	46	177.52	0.05	177.37	0.08	179.07	-0.87	121.0	24.8	131.1	4.383
0	T	47	174.10	0.05	173.99	0.06	175.68	-0.91	122.0	25.0	131.1	4.383
0	T	48	170.87	0.05	170.72	0.09	172.40	-0.90	123.0	25.1	131.1	4.383
0	T	49	167.73	0.05	167.58	0.09	169.25	-0.90	123.0	25.1	131.1	4.383
0	T	50	164.70	0.05	164.56	0.09	166.21	-0.91	122.0	25.1	131.1	4.384
0	T	51	161.78	0.05	161.64	0.09	163.27	-0.92	121.0	25.1	131.1	4.384
0	T	52	158.95	0.05	158.82	0.08	160.44	-0.94	120.0	25.0	131.1	4.384
0	T	53	156.23	0.05	156.10	0.09	157.71	-0.95	119.0	25.0	131.2	4.384
0	T	54	153.59	0.05	153.46	0.08	155.07	-0.96	118.0	25.0	131.3	4.384
0	T	55	151.04	0.05	150.92	0.08	152.51	-0.97	117.0	25.0	131.3	4.385
0	T	56	148.57	0.05	148.46	0.07	150.04	-0.99	116.0	25.1	131.4	4.385
0	T	57	146.19	0.05	146.08	0.08	147.64	-0.99	116.0	25.1	131.4	4.385
0	T	58	143.87	0.05	143.77	0.07	145.33	-1.01	115.0	25.5	131.5	4.385
0	T	59	141.63	0.05	141.54	0.07	143.08	-1.02	115.0	25.8	131.6	4.385

MODE			OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
0	T	60	139.46	0.05	139.37	0.06	140.90	-1.03	116.0	26.2	131.7	4.385
0	T	61	137.35	0.05	137.27	0.06	138.79	-1.05	116.0	26.6	131.8	4.385
0	T	62	135.30	0.06	135.23	0.05	136.74	-1.07	116.0	27.1	131.9	4.385
0	T	63	133.32	0.06	133.25	0.05	134.75	-1.07	117.0	27.6	132.0	4.385
0	T	64	131.39	0.06	131.33	0.05	132.82	-1.09	117.0	28.1	132.1	4.385
0	T	65	129.51	0.06	129.46	0.04	130.94	-1.10	118.0	28.7	132.3	4.385
0	T	66	127.69	0.06	127.65	0.03	129.12	-1.12	118.0	29.3	132.4	4.385
0	T	67	125.92	0.07	125.88	0.03	127.34	-1.13	119.0	30.0	132.5	4.385
1	T	2	756.57	0.08	757.50	-0.12	757.54	-0.13			256.4	4.103
1	T	3	695.18	0.07	694.86	0.05	694.95	0.03			252.9	5.361
1	T	6	519.09	0.06	519.32	-0.04	519.45	-0.07			242.2	7.102
1	T	7	475.17	0.13	475.33	-0.03	475.47	-0.06	238.0	20.0	237.3	7.112
1	T	8	438.49	0.05	438.55	-0.01	438.70	-0.05			232.1	6.979
1	T	9	407.74	0.07	407.75	-0.00	407.91	-0.04			227.3	6.790
1	T	10	381.65	0.10	381.68	-0.01	381.84	-0.05			223.3	6.607
1	T	11	359.13	0.05	359.28	-0.04	359.45	-0.09			220.0	6.454
1	T	12	339.54	0.06	339.76	-0.07	339.93	-0.12	195.0	20.0	217.4	6.334
1	T	13	322.84	0.12	322.53	0.10	322.70	0.04			215.1	6.240
1	T	15	293.35	0.05	293.34	0.00	293.51	-0.06			211.3	6.097
1	T	16	280.56	0.05	280.84	-0.10	281.00	-0.16			209.4	6.036
1	T	17	269.51	0.05	269.47	0.02	269.63	-0.04			207.3	5.977
1	T	18	259.00	0.05	259.08	-0.03	259.24	-0.09			205.2	5.919
1	T	19	249.41	0.05	249.55	-0.06	249.71	-0.12	195.0	20.0	202.9	5.860
1	T	20	240.88	0.05	240.79	0.04	240.95	-0.03			200.4	5.800
1	T	21	232.53	0.05	232.70	-0.07	232.86	-0.14			197.8	5.740
1	T	22	225.22	0.05	225.21	0.00	225.37	-0.07			195.2	5.678
1	T	23	218.31	0.05	218.26	0.02	218.43	-0.05	182.0	20.0	192.4	5.617
1	T	24	211.91	0.05	211.80	0.05	211.96	-0.03	164.0	20.0	189.6	5.555
1	T	25	205.80	0.05	205.78	0.01	205.94	-0.07	192.0	20.0	186.7	5.493
1	T	26	200.24	0.05	200.15	0.05	200.31	-0.04			183.9	5.432
1	T	27	194.83	0.05	194.87	-0.02	195.04	-0.11			181.0	5.373
1	T	28	189.94	0.05	189.93	0.01	190.09	-0.08			178.2	5.314
1	T	29	185.26	0.05	185.27	-0.00	185.43	-0.09			175.5	5.257
1	T	30	180.80	0.05	180.88	-0.05	181.05	-0.14			172.9	5.203
1	T	31	176.85	0.07	176.74	0.06	176.90	-0.03			170.4	5.150
1	T	32	172.98	0.05	172.82	0.09	172.99	-0.01			168.0	5.100
1	T	33	169.22	0.05	169.11	0.06	169.27	-0.03			165.8	5.053
1	T	34	165.72	0.05	165.59	0.08	165.75	-0.02			163.6	5.008
1	T	35	162.34	0.05	162.23	0.06	162.40	-0.04			161.6	4.966
1	T	36	159.09	0.05	159.04	0.04	159.20	-0.07			159.7	4.927
1	T	37	156.03	0.05	155.99	0.03	156.15	-0.08			157.9	4.890
1	T	38	153.13	0.05	153.08	0.04	153.24	-0.07			156.3	4.856
1	T	39	150.26	0.05	150.29	-0.02	150.45	-0.12			154.7	4.825
1	T	40	147.63	0.05	147.62	0.01	147.78	-0.10			153.3	4.795
1	T	41	145.05	0.05	145.05	0.	145.22	-0.11			152.0	4.768
1	T	42	142.60	0.05	142.59	0.00	142.75	-0.11			150.8	4.743
1	T	43	140.21	0.05	140.22	-0.01	140.38	-0.12			149.6	4.720
1	T	45	135.64	0.24	135.74	-0.08	135.90	-0.19			147.7	4.680
1	T	46	133.63	0.05	133.62	0.01	133.78	-0.11			146.8	4.662
1	T	47	131.54	0.05	131.57	-0.03	131.73	-0.15			146.0	4.646
1	T	48	129.56	0.05	129.59	-0.02	129.75	-0.15			145.3	4.631
1	T	49	127.72	0.05	127.68	0.03	127.83	-0.09			144.6	4.618
1	T	50	125.92	0.10	125.82	0.08	125.98	-0.05			144.0	4.605
1	T	51	124.18	0.10	124.02	0.12	124.18	-0.00			143.4	4.594

TABLE V (continued)

M O D E	OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
1 T 52	122.26	0.10	122.28	-0.02	122.44	-0.14			142.9	4.583
1 T 54	118.99	0.10	118.95	0.03	119.10	-0.09			142.0	4.565
1 T 57	114.41	0.10	114.30	0.09	114.45	-0.04			140.9	4.542
1 T 58	112.92	0.10	112.84	0.07	112.99	-0.06			140.6	4.536
1 T 59	111.40	0.10	111.41	-0.01	111.56	-0.14	134.0	20.0	140.4	4.530
1 T 60	110.24	0.10	110.02	0.20	110.17	0.07			140.1	4.524
1 T 62	107.44	0.10	107.35	0.09	107.49	-0.05	138.0	20.0	139.8	4.514
1 T 64	104.94	0.10	104.81	0.13	104.95	-0.01			139.4	4.506
1 T 66	102.59	0.10	102.39	0.20	102.53	0.06			139.2	4.498
2 T 4	420.46	0.07	420.19	0.06	420.21	0.06			209.4	3.803
2 T 7	363.65	0.07	363.14	0.14	363.19	0.13			223.4	6.092
2 T 8	343.34	0.06	343.17	0.05	343.22	0.04			229.2	6.697
2 T 17	219.95	0.05	220.03	-0.03	220.06	-0.05			235.6	6.844
2 T 18	211.90	0.05	212.10	-0.10	212.13	-0.11			233.6	6.738
2 T 19	204.63	0.05	204.83	-0.10	204.86	-0.11			231.6	6.646
2 T 21	191.91	0.05	191.91	-0.00	191.94	-0.01			227.3	6.494
2 T 22	186.19	0.05	186.14	0.03	186.16	0.02			225.2	6.430
2 T 25	171.12	0.12	170.98	0.08	171.00	0.07			219.3	6.266
2 T 26	166.50	0.05	166.54	-0.02	166.55	-0.03			217.5	6.220
2 T 28	158.42	0.05	158.38	0.03	158.40	0.02			214.3	6.137
2 T 29	154.64	0.05	154.63	0.00	154.65	-0.01			212.9	6.100
2 T 31	147.71	0.05	147.70	0.01	147.71	-0.00			210.3	6.033
2 T 32	144.59	0.06	144.49	0.07	144.50	0.06			209.1	6.001
2 T 33	141.54	0.05	141.43	0.08	141.44	0.07			207.9	5.970
2 T 34	138.62	0.05	138.51	0.08	138.52	0.07			206.7	5.939
2 T 35	135.73	0.05	135.72	0.00	135.73	-0.00			205.6	5.908
2 T 36	133.14	0.05	133.06	0.06	133.07	0.06	183.0	20.0	204.4	5.877
2 T 38	128.15	0.05	128.08	0.05	128.08	0.05	172.0	20.0	201.8	5.812
2 T 40	123.56	0.05	123.50	0.05	123.51	0.05			199.0	5.742
2 T 41	121.43	0.05	121.36	0.06	121.36	0.06			197.4	5.705
2 T 44	115.49	0.05	115.42	0.06	115.42	0.06			192.3	5.586
2 T 47	110.22	0.05	110.15	0.06	110.15	0.07	182.0	20.0	186.6	5.458
2 T 49	106.98	0.05	106.96	0.02	106.95	0.03	207.0	20.0	182.7	5.370
2 T 51	104.01	0.05	103.99	0.02	103.99	0.02	178.0	20.0	178.6	5.282
2 T 52	102.60	0.05	102.59	0.01	102.58	0.02	162.0	20.0	176.7	5.239
2 T 54	99.93	0.05	99.92	0.01	99.91	0.02			172.8	5.156
2 T 55	98.61	0.05	98.65	-0.04	98.65	-0.04			170.9	5.116
2 T 56	97.40	0.05	97.43	-0.03	97.42	-0.02			169.1	5.077
2 T 58	95.08	0.05	95.09	-0.01	95.08	-0.00			165.6	5.004
2 T 61	91.85	0.05	91.84	0.01	91.84	0.02			160.9	4.907
3 T 9	259.26	0.07	259.48	-0.09	259.48	-0.08			233.9	5.454
3 T 11	240.49	0.07	240.86	-0.15	240.86	-0.15			240.1	6.439
3 T 18	184.09	0.07	184.26	-0.09	184.25	-0.09			236.3	7.317
3 T 19	178.13	0.05	178.31	-0.10	178.30	-0.10			232.8	7.156
3 T 20	172.74	0.05	172.85	-0.07	172.85	-0.06			229.5	7.004
3 T 21	167.69	0.05	167.82	-0.08	167.81	-0.07			226.7	6.873
3 T 24	154.67	0.05	154.70	-0.02	154.68	-0.01			221.4	6.628
3 T 26	147.11	0.05	147.20	-0.06	147.18	-0.05			219.9	6.546
3 T 27	143.67	0.05	143.74	-0.05	143.73	-0.04			219.5	6.517
3 T 28	140.40	0.05	140.46	-0.04	140.44	-0.03			219.2	6.492
3 T 29	137.21	0.05	137.33	-0.08	137.31	-0.07			219.1	6.470
3 T 30	134.23	0.05	134.35	-0.09	134.33	-0.07	215.0	20.0	219.0	6.448
3 T 31	131.37	0.05	131.50	-0.10	131.48	-0.09			218.9	6.427

MODE	OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
3 T 32	128.68	0.05	128.78	-0.08	128.76	-0.06			218.7	6.405
3 T 33	126.16	0.05	126.18	-0.02	126.16	-0.00			218.5	6.382
3 T 34	123.75	0.05	123.70	0.04	123.68	0.06			218.3	6.358
3 T 37	116.89	0.05	116.84	0.04	116.82	0.06			217.0	6.277
3 T 38	114.66	0.05	114.74	-0.07	114.72	-0.05			216.4	6.248
3 T 41	108.87	0.05	108.92	-0.05	108.90	-0.03			214.2	6.157
3 T 42	107.04	0.05	107.13	-0.08	107.10	-0.06			213.4	6.127
3 T 46	100.56	0.05	100.58	-0.02	100.56	0.00			210.2	6.015
3 T 47	99.08	0.05	99.09	-0.01	99.06	0.02			209.5	5.990
3 T 54	89.90	0.07	89.86	0.04	89.84	0.07			206.1	5.851
3 T 57	86.41	0.07	86.46	-0.06	86.44	-0.03			205.0	5.803
3 T 58	85.33	0.07	85.39	-0.07	85.37	-0.04			204.6	5.786
3 T 59	84.35	0.07	84.35	-0.00	84.33	0.03			204.2	5.769
3 T 62	81.44	0.07	81.39	0.06	81.37	0.09			202.6	5.713
3 T 65	78.69	0.07	78.66	0.03	78.64	0.06			200.4	5.647
3 T 68	76.19	0.07	76.14	0.06	76.12	0.09			197.4	5.568
3 T 69	75.42	0.07	75.35	0.10	75.32	0.13			196.3	5.539
3 T 72	73.16	0.07	73.08	0.11	73.06	0.14			192.3	5.446
3 T 73	72.36	0.07	72.36	0.00	72.34	0.03			190.8	5.413
4 T 11	199.74	0.15	200.14	-0.20	200.10	-0.18			221.1	4.726
4 T 20	155.64	0.15	155.75	-0.07	155.72	-0.05			231.7	7.482
4 T 21	151.15	0.15	151.33	-0.12	151.30	-0.10			232.2	7.493
4 T 25	136.30	0.15	136.18	0.09	136.15	0.11			231.6	7.162
4 T 27	130.03	0.15	129.91	0.09	129.88	0.11			231.1	6.998
4 T 40	101.27	0.07	101.43	-0.16	101.39	-0.12			219.9	6.352
4 T 41	99.71	0.07	99.82	-0.11	99.79	-0.08			219.0	6.320
4 T 45	93.79	0.07	93.94	-0.16	93.90	-0.12			217.3	6.231
4 T 47	91.11	0.07	91.27	-0.18	91.24	-0.14			217.3	6.206
4 T 50	87.46	0.07	87.56	-0.11	87.52	-0.07			217.9	6.185
4 T 54	82.95	0.07	83.06	-0.14	83.03	-0.10			219.1	6.164
4 T 62	75.46	0.45	75.38	0.10	75.36	0.14			219.0	6.082
4 T 64	73.77	0.07	73.70	0.10	73.68	0.13			218.2	6.051
4 T 65	72.94	0.07	72.89	0.07	72.86	0.10			217.6	6.034
4 T 67	71.07	0.47	71.32	-0.35	71.30	-0.32			216.5	5.998
4 T 80	63.06	0.45	62.77	0.45	62.76	0.48			206.5	5.740
4 T 90	57.69	0.45	57.67	0.03	57.66	0.05			197.8	5.516
4 T 95	55.43	0.45	55.49	-0.11	55.48	-0.09			192.1	5.381
4 T 97	54.95	0.45	54.68	0.50	54.66	0.52			189.6	5.323
4 T 98	54.50	0.45	54.28	0.41	54.27	0.43			188.3	5.294
4 T 99	53.94	0.45	53.89	0.08	53.88	0.10			187.0	5.265
5 T 38	97.11	0.07	97.25	-0.15	97.21	-0.10			224.5	6.584
5 T 40	94.12	0.07	94.24	-0.13	94.20	-0.08			225.4	6.569
5 T 41	92.65	0.07	92.80	-0.16	92.76	-0.12			226.1	6.568
5 T 42	91.34	0.07	91.41	-0.07	91.37	-0.03			227.0	6.569
5 T 43	89.97	0.07	90.05	-0.09	90.02	-0.05			227.9	6.572
5 T 44	88.64	0.07	88.74	-0.11	88.71	-0.07			228.9	6.575
5 T 45	87.47	0.07	87.46	0.01	87.43	0.05			229.8	6.576
5 T 46	86.26	0.07	86.22	0.04	86.19	0.08			230.7	6.577
5 T 47	85.08	0.07	85.02	0.07	84.99	0.11			231.5	6.575
5 T 50	81.60	0.07	81.60	0.	81.57	0.04			233.1	6.554
5 T 51	80.55	0.07	80.52	0.03	80.50	0.07			233.4	6.541
5 T 52	79.52	0.07	79.48	0.05	79.45	0.09			233.4	6.526
5 T 55	76.52	0.07	76.51	0.01	76.49	0.04			232.6	6.462

TABLE V (continued)

M O D E	OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
5 T 56	75.67	0.07	75.58	0.12	75.55	0.15			232.0	6.436
5 T 57	74.75	0.07	74.68	0.10	74.65	0.14			231.2	6.408
5 T 60	72.13	0.42	72.10	0.04	72.08	0.07			228.3	6.314
5 T 77	60.87	0.42	60.80	0.11	60.78	0.14			212.3	5.884
5 T 79	59.69	0.42	59.73	-0.07	59.71	-0.03			211.7	5.864
5 T 105	48.79	0.42	48.76	0.07	48.75	0.09			204.9	5.720
5 T 107	47.94	0.45	48.09	-0.31	48.08	-0.29			204.1	5.702
5 T 109	47.68	0.43	47.44	0.50	47.43	0.52			203.3	5.680
5 T 110	47.23	0.42	47.12	0.23	47.11	0.25			202.8	5.667
5 T 111	46.77	0.42	46.81	-0.09	46.80	-0.07			202.2	5.653
5 T 118	44.68	0.42	44.76	-0.18	44.75	-0.17			197.0	5.519
6 T 34	97.13	0.07	97.14	-0.01	97.10	0.03			233.1	7.138
6 T 35	95.46	0.07	95.49	-0.04	95.46	0.01			233.7	7.081
6 T 37	92.29	0.07	92.39	-0.11	92.35	-0.07			235.6	7.007
6 T 41	86.70	0.07	86.80	-0.11	86.76	-0.07			239.9	6.941
6 T 45	81.85	0.07	81.88	-0.04	81.85	-0.01			241.7	6.868
6 T 47	79.71	0.07	79.65	0.07	79.62	0.11			241.3	6.811
6 T 49	77.65	0.07	77.56	0.12	77.53	0.15			239.9	6.740
6 T 71	60.82	0.40	60.98	-0.26	60.96	-0.23			223.3	6.201
6 T 72	60.12	0.40	60.41	-0.48	60.39	-0.44			223.5	6.200
6 T 81	56.02	0.40	55.72	0.54	55.70	0.57			222.9	6.144
6 T 89	51.97	0.40	52.18	-0.40	52.16	-0.37			218.0	6.027
6 T 91	51.38	0.40	51.37	0.01	51.36	0.04			216.7	5.997
6 T 92	51.02	0.40	50.98	0.09	50.96	0.12			216.1	5.982
6 T 98	48.62	0.40	48.76	-0.29	48.75	-0.26			212.9	5.903
6 T 117	43.24	0.40	42.98	0.62	42.96	0.65			207.2	5.724
6 T 125	40.98	0.40	40.97	0.04	40.96	0.06			204.5	5.667
6 T 131	39.67	0.40	39.59	0.19	39.58	0.21			202.4	5.628
6 T 132	39.43	0.40	39.37	0.14	39.37	0.16			202.1	5.620
6 T 141	37.36	0.40	37.52	-0.41	37.51	-0.40			197.9	5.526
6 T 145	36.89	0.40	36.76	0.35	36.76	0.37			195.2	5.460
6 T 149	35.90	0.40	36.04	-0.41	36.04	-0.39			191.9	5.379
6 T 154	35.19	0.40	35.20	-0.04	35.19	-0.02			186.9	5.259
6 T 163	33.71	0.40	33.82	-0.32	33.82	-0.31			176.8	5.020
7 T 8	129.66	0.38	129.58	0.06	129.50	0.13			211.2	2.097
7 T 34	91.46	0.10	91.44	0.02	91.40	0.06			246.6	7.701
7 T 38	85.45	0.10	85.47	-0.02	85.44	0.01			249.5	7.494
7 T 40	82.84	0.10	82.85	-0.01	82.82	0.03			248.6	7.313
7 T 42	80.51	0.10	80.44	0.09	80.41	0.13			246.9	7.149
7 T 45	77.23	0.10	77.16	0.09	77.13	0.13			242.8	6.938
7 T 46	76.18	0.10	76.14	0.05	76.11	0.09			241.1	6.874
7 T 48	74.28	0.10	74.22	0.09	74.18	0.13			237.6	6.757
7 T 49	73.36	0.10	73.30	0.08	73.27	0.13			235.9	6.704
7 T 66	60.54	0.38	60.91	-0.61	60.88	-0.57			232.6	6.488
7 T 77	54.70	0.38	55.00	-0.54	54.98	-0.50			227.2	6.300
7 T 81	53.04	0.38	53.16	-0.24	53.15	-0.21			223.8	6.219
7 T 82	52.76	0.38	52.73	0.06	52.71	0.09			223.1	6.202
7 T 83	52.15	0.38	52.30	-0.29	52.28	-0.26			222.5	6.188
7 T 102	45.31	0.38	45.38	-0.14	45.37	-0.11			222.4	6.098
7 T 106	44.26	0.38	44.16	0.22	44.15	0.25			221.1	6.051
7 T 109	43.12	0.38	43.29	-0.41	43.28	-0.38			219.4	6.005
7 T 130	38.33	0.38	38.22	0.29	38.21	0.32			207.7	5.726
7 T 144	35.65	0.38	35.51	0.39	35.50	0.41			206.0	5.679

M O D E	OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
7 T 151	34.43	0.38	34.30	0.37	34.30	0.39			204.1	5.643
7 T 152	34.23	0.38	34.14	0.27	34.13	0.29			203.8	5.637
7 T 165	32.18	0.38	32.15	0.12	32.14	0.13			197.4	5.491
7 T 178	30.45	0.38	30.43	0.06	30.43	0.07			186.7	5.228
7 T 187	29.37	0.38	29.40	-0.09	29.40	-0.08			177.3	5.023
7 T 191	28.75	0.38	28.97	-0.79	28.97	-0.79			173.0	4.940
8 T 9	113.82	0.38	113.88	-0.06	113.79	0.03			202.3	1.967
8 T 14	109.65	0.38	110.02	-0.34	109.93	-0.26			204.9	2.957
8 T 75	53.33	0.38	53.59	-0.50	53.57	-0.46			227.6	6.391
8 T 88	47.99	0.38	48.23	-0.49	48.21	-0.46			231.3	6.393
8 T 92	46.70	0.38	46.79	-0.19	46.77	-0.15			231.6	6.362
8 T 93	46.58	0.38	46.44	0.29	46.43	0.32			231.4	6.348
8 T 94	46.09	0.38	46.10	-0.02	46.09	0.01			230.9	6.332
8 T 95	45.64	0.38	45.77	-0.29	45.75	-0.26			230.4	6.314
8 T 116	39.88	0.38	39.92	-0.10	39.91	-0.06			217.4	5.977
8 T 121	38.79	0.38	38.76	0.08	38.75	0.11			219.3	6.003
8 T 123	38.15	0.38	38.32	-0.42	38.30	-0.39			220.1	6.013
8 T 125	37.85	0.38	37.88	-0.06	37.87	-0.03			220.7	6.019
8 T 173	30.10	0.38	30.04	0.21	30.03	0.22			199.2	5.551
8 T 188	28.26	0.38	28.26	-0.02	28.26	-0.01			195.7	5.585
8 T 193	27.70	0.38	27.72	-0.07	27.72	-0.06			193.4	5.552
8 T 195	27.45	0.38	27.51	-0.22	27.51	-0.21			192.3	5.530
8 T 202	26.84	0.38	26.80	0.13	26.80	0.14			187.4	5.413
8 T 212	25.92	0.38	25.89	0.13	25.89	0.14			178.9	5.163
8 T 216	25.43	0.38	25.55	-0.49	25.55	-0.49			175.3	5.052
9 T 10	101.29	0.37	101.63	-0.34	101.55	-0.26			213.3	2.032
9 T 84	47.69	0.37	47.82	-0.28	47.80	-0.25			237.9	6.579
9 T 99	42.76	0.37	42.91	-0.36	42.89	-0.31			223.6	6.188
9 T 103	41.76	0.37	41.80	-0.11	41.79	-0.07			223.3	6.171
9 T 104	41.67	0.37	41.53	0.34	41.52	0.38			223.7	6.175
9 T 105	41.24	0.37	41.27	-0.08	41.25	-0.04			224.2	6.182
9 T 106	40.86	0.37	41.01	-0.36	40.99	-0.32			224.8	6.191
9 T 130	35.59	0.37	35.58	0.04	35.57	0.07			219.9	6.019
9 T 135	34.77	0.37	34.66	0.32	34.65	0.35			214.8	5.891
9 T 136	34.51	0.37	34.48	0.08	34.47	0.12			214.1	5.870
9 T 138	34.08	0.37	34.14	-0.18	34.13	-0.15			212.9	5.835
9 T 140	33.84	0.37	33.80	0.12	33.79	0.15			212.1	5.810
9 T 183	28.05	0.37	27.92	0.46	27.92	0.48			198.9	5.661
9 T 185	27.76	0.37	27.70	0.20	27.70	0.22			198.3	5.642
9 T 194	26.83	0.37	26.77	0.21	26.77	0.22			196.9	5.566
9 T 211	25.19	0.37	25.19	-0.01	25.19	-0.00			195.6	5.461
9 T 217	24.65	0.37	24.68	-0.15	24.68	-0.15			194.5	5.423
9 T 220	24.33	0.37	24.44	-0.45	24.44	-0.44			193.6	5.399
9 T 229	23.68	0.37	23.74	-0.23	23.74	-0.23			189.4	5.299
9 T 237	23.19	0.37	23.16	0.14	23.16	0.14			183.5	5.167
9 T 241	22.81	0.37	22.89	-0.32	22.89	-0.32			180.1	5.089
10 T 11	91.24	0.36	91.07	0.19	91.00	0.26			228.9	2.045
10 T 18	87.29	0.36	87.41	-0.14	87.35	-0.07			231.1	3.182
10 T 109	38.80	0.36	38.90	-0.25	38.88	-0.22			236.8	6.453
10 T 113	38.03	0.36	37.95	0.22	37.93	0.26			233.9	6.386
10 T 115	37.70	0.36	37.49	0.55	37.48	0.58			231.6	6.334
10 T 117	37.10	0.36	37.06	0.11	37.04	0.14			229.0	6.276

TABLE V (continued)

MODE	OBSERVATION PERIOD SEC	S.D. %	ANISOTROPIC PERIOD SEC	DEV %	ISOTROPIC PERIOD SEC	DEV %	Q OBS VALUE	S.D. %	Q COM	GROUP VEL. KM/S
10 T 118	36.78	0.36	36.84	-0.17	36.83	-0.14			227.7	6.244
10 T 134	34.01	0.36	33.82	0.57	33.80	0.60			220.3	6.000
10 T 144	32.16	0.36	32.17	-0.03	32.16	0.			221.9	6.055
10 T 149	31.52	0.36	31.40	0.36	31.40	0.39			219.0	6.035
10 T 152	30.94	0.36	30.96	-0.09	30.96	-0.07			216.5	6.007
10 T 154	30.75	0.36	30.68	0.22	30.67	0.24			214.7	5.985
10 T 199	25.79	0.36	25.54	0.95	25.54	0.97			203.1	5.614
10 T 202	25.42	0.36	25.27	0.57	25.27	0.59			201.8	5.574
10 T 210	24.79	0.36	24.58	0.83	24.58	0.84			199.7	5.511
10 T 213	24.52	0.36	24.33	0.76	24.33	0.77			199.3	5.502
10 T 214	24.34	0.36	24.25	0.37	24.25	0.38			199.2	5.500
10 T 233	22.81	0.36	22.81	0.02	22.81	0.02			195.9	5.480
10 T 245	21.85	0.36	21.99	-0.62	21.99	-0.63			191.7	5.395
10 T 262	20.98	0.36	20.95	0.14	20.95	0.12			182.9	5.167
10 T 265	20.75	0.36	20.78	-0.14	20.78	-0.16			180.9	5.119
11 T 13	82.63	0.35	82.29	0.41	82.21	0.50			221.9	2.067
11 T 20	79.27	0.35	79.37	-0.12	79.29	-0.03			219.9	3.035
12 T 14	75.81	0.35	75.74	0.09	75.67	0.19			216.1	2.021
12 T 22	72.62	0.35	72.91	-0.39	72.84	-0.31			220.9	3.108
13 T 15	70.04	0.35	69.97	0.10	69.91	0.19			226.5	2.062
13 T 24	67.02	0.35	67.19	-0.26	67.14	-0.18			229.1	3.170
14 T 16	65.10	0.34	64.98	0.19	64.92	0.28			222.2	1.983
14 T 25	62.52	0.34	62.70	-0.29	62.65	-0.21			219.7	2.970
15 T 17	60.79	0.34	60.83	-0.06	60.78	0.03			216.5	1.960
15 T 27	58.33	0.34	58.59	-0.45	58.55	-0.37			222.8	3.074
16 T 18	57.03	0.34	57.02	0.01	56.98	0.08			229.7	2.035
16 T 29	54.67	0.34	54.77	-0.19	54.74	-0.12			234.3	3.177
17 T 20	53.54	0.34	53.40	0.26	53.36	0.34			228.5	2.081
17 T 31	51.45	0.34	51.46	-0.02	51.41	0.06			223.9	3.048
18 T 21	50.59	0.33	50.53	0.11	50.48	0.20			216.8	1.961
18 T 33	48.58	0.33	48.69	-0.23	48.65	-0.14			222.2	3.028

between theory and observation. The uncorrected data are also given.

The parameter T^* is equal to the ratio of the travel time to Q of a given phase. In addition to its application in calculations of a change in the spectrum of a phase, it can be used to correct the theoretical travel times computed at a certain reference frequency (1 s in our case) to the frequency appropriate for the observed waveform. The formula is

$$T_{corr} = T_{\mathrm{ref}} - \frac{\ln f}{\pi} \cdot T^*$$

If we assume, for example, that the appropriate frequency for observations of the travel times of the S-waves by Hales and Roberts (1970) is 0.2 Hz, then at 30° distance the correction is 2 s and at 90°, 3 s. The same approach can be used to

TABLE VI a
P travel times: global average from ISC data. Baseline correction −1.88 s; slope −0.0085 s deg^{-1}

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
25.00	327.09	325.00	0.06	325.08	-0.09	9.135	324.74	0.26	9.128	0.9
26.00	336.31	334.20	0.06	334.19	0.01	9.083	333.84	0.36	9.075	0.9
27.00	345.43	343.31	0.06	343.25	0.06	9.021	342.88	0.43	9.011	0.9
28.00	354.38	352.26	0.06	352.23	0.03	8.947	351.85	0.41	8.936	0.9
29.00	363.32	361.18	0.06	361.14	0.04	8.864	360.75	0.43	8.851	0.9
30.00	372.14	370.00	0.06	369.98	0.03	8.810	369.59	0.41	8.807	0.9
31.00	381.05	378.90	0.06	378.78	0.12	8.806	378.40	0.50	8.797	0.9
32.00	389.89	387.74	0.06	387.56	0.17	8.765	387.18	0.56	8.758	0.9
33.00	398.49	396.32	0.06	396.31	0.02	8.718	395.91	0.41	8.712	0.9
34.00	407.28	405.11	0.06	405.01	0.10	8.668	404.60	0.51	8.658	0.9
35.00	415.90	413.72	0.06	413.64	0.08	8.614	413.23	0.49	8.608	0.9
36.00	424.48	422.29	0.06	422.23	0.07	8.556	421.81	0.48	8.549	0.9
37.00	432.91	430.71	0.06	430.75	-0.05	8.496	430.33	0.38	8.488	0.9
38.00	441.43	439.22	0.06	439.22	0.00	8.434	438.79	0.43	8.428	1.0
39.00	449.79	447.57	0.06	447.62	-0.05	8.369	447.18	0.39	8.360	1.0
40.00	458.20	455.97	0.06	455.96	0.01	8.303	455.51	0.46	8.297	1.0
41.00	466.49	464.26	0.06	464.23	0.02	8.235	463.77	0.48	8.228	1.0
42.00	474.66	472.42	0.06	472.44	-0.02	8.166	471.97	0.45	8.159	1.0
43.00	482.77	480.52	0.06	480.57	-0.05	8.096	480.09	0.43	8.090	1.0
44.00	490.85	488.59	0.06	488.64	-0.05	8.026	488.15	0.44	8.015	1.0
45.00	498.84	496.57	0.06	496.61	-0.04	7.955	496.13	0.45	7.948	1.0
46.00	506.80	504.52	0.06	504.53	-0.01	7.883	504.04	0.48	7.873	1.0
47.00	514.53	512.25	0.06	512.38	-0.13	7.811	511.88	0.37	7.804	1.0
48.00	522.38	520.09	0.06	520.15	-0.06	7.738	519.64	0.45	7.728	1.0
49.00	530.14	527.83	0.06	527.85	-0.02	7.665	527.34	0.50	7.659	1.0
50.00	537.70	535.39	0.06	535.48	-0.09	7.592	534.96	0.43	7.581	1.0
51.00	545.36	543.04	0.06	543.04	0.00	7.519	542.51	0.53	7.513	1.1
52.00	552.81	550.48	0.06	550.52	-0.04	7.446	549.98	0.50	7.436	1.1
53.00	560.22	557.88	0.06	557.93	-0.04	7.372	557.38	0.50	7.366	1.1
54.00	567.59	565.25	0.06	565.26	-0.01	7.300	564.71	0.54	7.292	1.1
55.00	574.88	572.52	0.06	572.52	0.00	7.226	571.97	0.55	7.219	1.1
56.00	582.06	579.70	0.06	579.71	-0.02	7.153	579.15	0.55	7.147	1.1
57.00	589.28	586.91	0.06	586.83	0.08	7.080	586.26	0.64	7.072	1.1
58.00	596.25	593.87	0.06	593.87	0.00	7.007	593.29	0.58	7.002	1.1
59.00	603.26	600.87	0.06	600.84	0.03	6.934	600.26	0.61	6.925	1.1
60.00	610.20	607.80	0.06	607.73	0.07	6.861	607.15	0.65	6.855	1.1
61.00	616.99	614.58	0.06	614.56	0.02	6.788	613.97	0.61	6.782	1.1

(continued)

correct the differential travel times, such as ScS–S, and in this case the parameter T^* has a meaning only in terms of this specific application. This illustrates the large effect on both baseline and tilt that can occur by this process alone. Each source region has its own upper mantle velocity and Q and these variations contribute to variations in these "static" values from one travel-time study to another.

The observed travel times from Tables VIa–c are compared with the results of calculations for model PREM in Fig. 1. After the global average of the ISC data is corrected for baseline and slope, the fit of the predicted travel times is very good to

TABLE VI a (continued)

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
62.00	623.75	621.33	0.06	621.31	0.02	6.715	620.71	0.62	6.709	1.1
63.00	630.38	627.96	0.06	627.99	-0.04	6.643	627.39	0.57	6.638	1.1
64.00	636.98	634.55	0.06	634.60	-0.05	6.570	633.99	0.56	6.562	1.1
65.00	643.43	640.99	0.06	641.13	-0.14	6.497	640.52	0.47	6.492	1.1
66.00	649.96	647.51	0.06	647.59	-0.08	6.425	646.97	0.54	6.419	1.2
67.00	656.40	653.94	0.06	653.98	-0.03	6.352	653.35	0.59	6.346	1.2
68.00	662.81	660.35	0.06	660.29	0.06	6.279	659.66	0.69	6.274	1.2
69.00	668.96	666.49	0.06	666.53	-0.05	6.206	665.90	0.59	6.199	1.2
70.00	675.11	672.63	0.06	672.71	-0.08	6.133	672.06	0.56	6.128	1.2
71.00	681.31	678.82	0.06	678.80	0.02	6.061	678.15	0.67	6.056	1.2
72.00	687.30	684.81	0.06	684.83	-0.02	5.987	684.17	0.63	5.980	1.2
73.00	693.27	690.76	0.06	690.78	-0.02	5.914	690.12	0.64	5.909	1.2
74.00	699.15	696.63	0.06	696.65	-0.03	5.841	695.99	0.64	5.836	1.2
75.00	704.94	702.42	0.06	702.46	-0.04	5.767	701.79	0.63	5.760	1.2
76.00	710.72	708.19	0.06	708.19	0.00	5.693	707.51	0.68	5.688	1.2
77.00	716.41	713.87	0.06	713.84	0.03	5.619	713.16	0.71	5.614	1.2
78.00	721.95	719.40	0.06	719.42	-0.02	5.544	718.74	0.66	5.539	1.2
79.00	727.44	724.88	0.06	724.93	-0.04	5.469	724.24	0.64	5.464	1.2
80.00	732.90	730.33	0.06	730.36	-0.02	5.394	729.67	0.66	5.389	1.2
81.00	738.33	735.75	0.06	735.71	0.04	5.318	735.02	0.74	5.313	1.2
82.00	743.55	740.97	0.06	740.99	-0.02	5.241	740.30	0.67	5.236	1.2
83.00	748.75	746.16	0.06	746.20	-0.04	5.165	745.49	0.67	5.160	1.2
84.00	753.93	751.33	0.06	751.32	0.01	5.088	750.61	0.72	5.083	1.2
85.00	758.87	756.26	0.06	756.37	-0.11	5.010	755.66	0.60	5.005	1.3
86.00	763.92	761.30	0.06	761.34	-0.04	4.931	760.62	0.68	4.926	1.3
87.00	768.89	766.26	0.06	766.23	0.03	4.852	765.51	0.75	4.847	1.3
88.00	773.64	771.00	0.06	771.04	-0.04	4.772	770.32	0.69	4.767	1.3
89.00	778.36	775.72	0.06	775.77	-0.06	4.691	775.04	0.67	4.686	1.3
90.00	783.17	780.52	0.06	780.43	0.09	4.617	779.70	0.82	4.614	1.3
91.00	787.79	785.13	0.06	785.05	0.08	4.597	784.33	0.80	4.595	1.3
92.00	792.40	789.73	0.06	789.66	0.07	4.606	788.94	0.78	4.601	1.3
93.00	797.02	794.34	0.06	794.25	0.09	4.606	793.53	0.80	4.591	1.3
94.00	801.66	798.97	0.06	798.84	0.13	4.573	798.11	0.86	4.566	1.3
95.00	806.04	803.35	0.06	803.40	-0.05	4.544	802.67	0.68	4.539	1.3
96.00	810.63	807.93	0.06	807.93	-0.00	4.513	807.19	0.73	4.509	1.3
97.00	815.26	812.55	0.06	812.43	0.12	4.479	811.68	0.86	4.477	1.3
98.00	819.67	816.95	0.06	816.89	0.06	4.444	816.15	0.80	4.442	1.3

distances as short as 20°; in particular, the 24° discontinuity is well matched. At shorter distances, the difference between the upper mantle velocity of model PREM (8.2 km s^{-1}) and the apparent velocity of the P_n phase from the ISC data (~ 8.0 km s^{-1}) leads to a several second difference. The data of Hales et al. (1968) and Herrin et al. (1968) show differences in slope of opposite sign with respect to PREM, but reproduce well the details of the travel–time curve.

The surface focus S-wave travel times of Gogna et al. (1981, Table VIk) and Hales and Roberts (1970, Table VIm) are compared with the global average of the ISC data and SV and SH travel times of the PREM model in Fig. 2. The overall shape of the SV first arrival travel times matches that of the ISC data well up to a distance of approximately 80°. In a distance range from 30 to 80° all three data sets are in reasonable agreement if allowance for tilt and baseline corrections are made. Beyond 80°, the shape of the SV and SH travel–time curves are most consistent with the data of Hales and Roberts.

TABLE VI b
P travel times: Hales et al. (1968). Baseline correction -1.18 s; slope 0.0085 s deg^{-1}

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
27.00	343.98	343.04	0.30	343.25	-0.21	9.021	342.88	0.15	9.011	0.9
29.00	362.02	361.09	0.30	361.14	-0.05	8.864	360.75	0.34	8.851	0.9
31.00	379.89	378.98	0.30	378.78	0.20	8.806	378.40	0.58	8.797	0.9
33.00	397.50	396.61	0.30	396.31	0.30	8.718	395.91	0.70	8.712	0.9
35.00	414.84	413.97	0.30	413.64	0.32	8.614	413.23	0.73	8.608	0.9
37.00	431.90	431.04	0.30	430.75	0.29	8.496	430.33	0.71	8.488	0.9
39.00	448.70	447.86	0.30	447.62	0.24	8.369	447.18	0.68	8.360	1.0
41.00	465.21	464.39	0.30	464.23	0.15	8.235	463.77	0.61	8.228	1.0
43.00	481.45	480.64	0.30	480.57	0.07	8.096	480.09	0.55	8.090	1.0
45.00	497.41	496.62	0.30	496.61	0.01	7.955	496.13	0.50	7.948	1.0
47.00	513.09	512.32	0.30	512.38	-0.06	7.811	511.88	0.44	7.804	1.0
49.00	528.50	527.75	0.30	527.85	-0.10	7.665	527.34	0.41	7.659	1.0
51.00	543.62	542.88	0.30	543.04	-0.15	7.519	542.51	0.37	7.513	1.1
53.00	558.46	557.74	0.30	557.93	-0.19	7.372	557.38	0.36	7.366	1.1
55.00	573.02	572.32	0.30	572.52	-0.20	7.226	571.97	0.35	7.219	1.1
57.00	587.30	586.62	0.30	586.83	-0.21	7.080	586.26	0.36	7.072	1.1
59.00	601.30	600.63	0.30	600.84	-0.21	6.934	600.26	0.37	6.925	1.1
61.00	615.00	614.35	0.30	614.56	-0.21	6.788	613.97	0.38	6.782	1.1
63.00	628.43	627.80	0.30	627.99	-0.19	6.643	627.39	0.41	6.638	1.1
65.00	641.56	640.95	0.30	641.13	-0.18	6.497	640.52	0.43	6.492	1.1
67.00	654.41	653.81	0.30	653.98	-0.16	6.352	653.35	0.46	6.346	1.2
69.00	666.97	666.39	0.30	666.53	-0.14	6.206	665.90	0.49	6.199	1.2
71.00	679.23	678.67	0.30	678.80	-0.13	6.061	678.15	0.52	6.056	1.2
73.00	691.21	690.66	0.30	690.78	-0.11	5.914	690.12	0.54	5.909	1.2
75.00	702.90	702.37	0.30	702.46	-0.09	5.767	701.79	0.58	5.760	1.2
77.00	714.29	713.78	0.30	713.84	-0.06	5.619	713.16	0.62	5.614	1.2
79.00	725.39	724.90	0.30	724.93	-0.03	5.469	724.24	0.65	5.464	1.2
81.00	736.19	735.71	0.30	735.71	0.00	5.318	735.02	0.70	5.313	1.2
83.00	746.70	746.24	0.30	746.20	0.04	5.165	745.49	0.75	5.160	1.2
85.00	756.92	756.48	0.30	756.37	0.11	5.010	755.66	0.82	5.005	1.3
87.00	766.83	766.41	0.30	766.23	0.18	4.852	765.51	0.90	4.847	1.3
89.00	776.45	776.04	0.30	775.77	0.27	4.691	775.04	1.00	4.686	1.3
91.00	785.76	785.37	0.30	785.05	0.32	4.597	784.33	1.04	4.595	1.3
93.00	794.82	794.45	0.30	794.25	0.20	4.606	793.53	0.91	4.591	1.3

7. Discussion

When the upper mantle was allowed to be anisotropic, the inversion decreased the shear velocity of the LID and increased the velocity of the LVZ. The SH and SV velocities, although different, were individually almost continuous from the Moho to 220 km. It appeared that the LID, or seismic lithosphere, could not be resolved with the data being used. The shortest periods used in the inversion were 61 and 126 s for fundamental model Rayleigh and Love waves, respectively. These modes have wavelengths of >240 km so we can only determine average properties of the upper mantle. Short-period Rayleigh waves, <20 s, suggest that SV in the uppermost mantle is about 4.6 km s^{-1}, 5% greater than the average upper mantle SV determined in this study.

Since the thickness of the LID and velocities in the LID and LVZ can be expected to vary with the

TABLE VI c
P travel times: Herrin et al. (1968). Baseline correction −0.94 s; slope −0.0141 s deg^{-1}

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
25.00	324.39	324.98	0.10	325.08	-0.11	9.135	324.74	0.23	9.128	0.9
26.00	333.63	334.20	0.10	334.19	0.01	9.083	333.84	0.37	9.075	0.9
27.00	342.71	343.27	0.10	343.25	0.02	9.021	342.88	0.38	9.011	0.9
28.00	351.68	352.23	0.10	352.23	-0.01	8.947	351.85	0.37	8.936	0.9
29.00	360.60	361.14	0.10	361.14	-0.00	8.864	360.75	0.38	8.851	0.9
30.00	369.51	370.03	0.10	369.98	0.05	8.810	369.59	0.44	8.807	0.9
31.00	378.38	378.88	0.10	378.78	0.10	8.806	378.40	0.48	8.797	0.9
32.00	387.19	387.68	0.10	387.56	0.12	8.765	387.18	0.50	8.758	0.9
33.00	395.96	396.44	0.10	396.31	0.13	8.718	395.91	0.53	8.712	0.9
34.00	404.68	405.14	0.10	405.01	0.14	8.668	404.60	0.55	8.658	0.9
35.00	413.34	413.79	0.10	413.64	0.15	8.614	413.23	0.56	8.608	0.9
36.00	421.95	422.38	0.10	422.23	0.15	8.556	421.81	0.57	8.549	0.9
37.00	430.49	430.91	0.10	430.75	0.16	8.496	430.33	0.58	8.488	0.9
38.00	438.96	439.37	0.10	439.22	0.15	8.434	438.79	0.58	8.428	1.0
39.00	447.37	447.76	0.10	447.62	0.13	8.369	447.18	0.57	8.360	1.0
40.00	455.70	456.08	0.10	455.96	0.12	8.303	455.51	0.57	8.297	1.0
41.00	463.97	464.33	0.10	464.23	0.10	8.235	463.77	0.56	8.228	1.0
42.00	472.17	472.52	0.10	472.44	0.09	8.166	471.97	0.55	8.159	1.0
43.00	480.31	480.64	0.10	480.57	0.07	8.096	480.09	0.55	8.090	1.0
44.00	488.37	488.69	0.10	488.64	0.05	8.026	488.15	0.54	8.015	1.0
45.00	496.36	496.67	0.10	496.61	0.05	7.955	496.13	0.54	7.948	1.0
46.00	504.28	504.57	0.10	504.53	0.04	7.883	504.04	0.53	7.873	1.0
47.00	512.12	512.40	0.10	512.38	0.03	7.811	511.88	0.52	7.804	1.0
48.00	519.89	520.16	0.10	520.15	0.00	7.738	519.64	0.51	7.728	1.0
49.00	527.58	527.83	0.10	527.85	-0.02	7.665	527.34	0.49	7.659	1.0
50.00	535.20	535.44	0.10	535.48	-0.04	7.592	534.96	0.48	7.581	1.0
51.00	542.74	542.97	0.10	543.04	-0.07	7.519	542.51	0.46	7.513	1.1
52.00	550.22	550.42	0.10	550.52	-0.09	7.446	549.98	0.44	7.436	1.1
53.00	557.62	557.81	0.10	557.93	-0.12	7.372	557.38	0.43	7.366	1.1
54.00	564.95	565.13	0.10	565.26	-0.13	7.300	564.71	0.42	7.292	1.1
55.00	572.21	572.38	0.10	572.52	-0.14	7.226	571.97	0.41	7.219	1.1
56.00	579.40	579.55	0.10	579.71	-0.16	7.153	579.15	0.40	7.147	1.1
57.00	586.51	586.65	0.10	586.83	-0.18	7.080	586.26	0.39	7.072	1.1
58.00	593.55	593.68	0.10	593.87	-0.19	7.007	593.29	0.38	7.002	1.1
59.00	600.52	600.63	0.10	600.84	-0.21	6.934	600.26	0.37	6.925	1.1
60.00	607.42	607.51	0.10	607.73	-0.22	6.861	607.15	0.36	6.855	1.1
61.00	614.24	614.33	0.10	614.56	-0.24	6.788	613.97	0.35	6.782	1.1

age of the lithosphere we have chosen to treat the entire upper mantle to a depth of 220 km as a smooth entity.

The final model predicts significantly different travel times for SV and SH waves. The effect is most pronounced at short distances, $<25°$, but is maintained at teleseismic distances. SH is faster by 1.16 s at 30° and 0.34 s at 90°. This, plus variations in Q and period, may contribute to the large scatter which is typical of S-wave studies. Other contributors to S-wave scatter are: (1) the difficulty of identifying and picking later arrivals; (2) the longer period nature of S; (3) the fact that locations are based on P-wave times; and (4) the finiteness of natural sources and rupture velocities which are close to shear velocities.

As can be seen from Fig. 1 and the tables, PREM is an excellent fit to P-wave travel-time

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
62.00	621.01	621.08	0.10	621.31	-0.23	6.715	620.71	0.36	6.709	1.1
63.00	627.71	627.76	0.10	627.99	-0.23	6.643	627.39	0.37	6.638	1.1
64.00	634.35	634.38	0.10	634.60	-0.22	6.570	633.99	0.40	6.562	1.1
65.00	640.91	640.94	0.10	641.13	-0.19	6.497	640.52	0.42	6.492	1.1
66.00	647.41	647.42	0.10	647.59	-0.17	6.425	646.97	0.45	6.419	1.2
67.00	653.85	653.84	0.10	653.98	-0.13	6.352	653.35	0.49	6.346	1.2
68.00	660.22	660.20	0.10	660.29	-0.10	6.279	659.66	0.53	6.274	1.2
69.00	666.51	666.48	0.10	666.53	-0.05	6.206	665.90	0.58	6.199	1.2
70.00	672.74	672.69	0.10	672.71	-0.01	6.133	672.06	0.63	6.128	1.2
71.00	678.88	678.82	0.10	678.80	0.02	6.061	678.15	0.67	6.056	1.2
72.00	684.94	684.86	0.10	684.83	0.04	5.987	684.17	0.69	5.980	1.2
73.00	690.91	690.82	0.10	690.78	0.04	5.914	690.12	0.70	5.909	1.2
74.00	696.81	696.70	0.10	696.65	0.05	5.841	695.99	0.71	5.836	1.2
75.00	702.63	702.51	0.10	702.46	0.05	5.767	701.79	0.73	5.760	1.2
76.00	708.38	708.25	0.10	708.19	0.07	5.693	707.51	0.74	5.688	1.2
77.00	714.07	713.92	0.10	713.84	0.08	5.619	713.16	0.76	5.614	1.2
78.00	719.67	719.51	0.10	719.42	0.09	5.544	718.74	0.77	5.539	1.2
79.00	725.19	725.02	0.10	724.93	0.09	5.469	724.24	0.78	5.464	1.2
80.00	730.63	730.45	0.10	730.36	0.09	5.394	729.67	0.78	5.389	1.2
81.00	736.00	735.80	0.10	735.71	0.09	5.318	735.02	0.78	5.313	1.2
82.00	741.29	741.07	0.10	740.99	0.08	5.241	740.30	0.78	5.236	1.2
83.00	746.49	746.26	0.10	746.20	0.07	5.165	745.49	0.77	5.160	1.2
84.00	751.61	751.36	0.10	751.32	0.04	5.088	750.61	0.75	5.083	1.2
85.00	756.63	756.37	0.10	756.37	-0.00	5.010	755.66	0.71	5.005	1.3
86.00	761.56	761.29	0.10	761.34	-0.05	4.931	760.62	0.67	4.926	1.3
87.00	766.43	766.15	0.10	766.23	-0.08	4.852	765.51	0.64	4.847	1.3
88.00	771.25	770.95	0.10	771.04	-0.10	4.772	770.32	0.63	4.767	1.3
89.00	776.01	775.69	0.10	775.77	-0.08	4.691	775.04	0.65	4.686	1.3
90.00	780.72	780.39	0.10	780.43	-0.04	4.617	779.70	0.69	4.614	1.3
91.00	785.40	785.06	0.10	785.05	0.01	4.597	784.33	0.73	4.595	1.3
92.00	790.06	789.70	0.10	789.66	0.05	4.606	788.94	0.76	4.601	1.3
93.00	794.69	794.32	0.10	794.25	0.07	4.606	793.53	0.78	4.591	1.3
94.00	799.30	798.91	0.10	798.84	0.07	4.573	798.11	0.80	4.566	1.3
95.00	803.89	803.49	0.10	803.40	0.09	4.544	802.67	0.82	4.539	1.3
96.00	808.47	808.05	0.10	807.93	0.13	4.513	807.19	0.86	4.509	1.3
97.00	813.04	812.61	0.10	812.43	0.18	4.479	811.68	0.93	4.477	1.3
98.00	817.60	817.16	0.10	816.89	0.27	4.444	816.15	1.01	4.442	1.3

data from about 22 to 90°. The simplified upper-mantle structure we adopted is inappropriate for local and regional travel-time studies. In addition to a good fit to the travel times, PREM is also an excellent fit to $\mathrm{d}t/\mathrm{d}\Delta$ data. Gogna et al. (1981), hereafter GJS, tabulate results from a recent study. PREM fits $\mathrm{d}t/\mathrm{d}\Delta$ for P-waves, from this study, with an average error of only 0.004 s deg^{-1}, over the interval 40–77°. Maximum isolated errors are only 0.008 s deg^{-1}. Beyond 77° PREM deviates from GJS but is within the scatter of other studies out to about 94°. At larger distances, $\mathrm{d}t/\mathrm{d}\Delta$ for PREM is up to 0.1 s deg^{-1}, low compared to the majority of recent data. This indicates that velocities in the lowermost mantle should be decreased slightly.

The $\mathrm{d}t/\mathrm{d}\Delta$ for S-waves for PREM falls in the midst of the rather widely-scattered published values in the distance range 30–40°. Compared to GJS the errors are 0.03 s deg^{-1} (36–40°), 0.04 (41–51°), 0.03 (51–60°), 0.02 (61–70°), 0.05 (71–80°), 0.11 (81–90°) and 0.16 (91–95°). The correc-

TABLE VI d

Deep focus (550 km) P travel times: Sengupta and Julian (1976). Baseline correction 0.67 s; slope −0.0173 s deg^{-1}

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
23.00	263.30	263.57	0.30	262.87	0.70	8.888	262.68	0.89	8.883	0.6
25.00	279.90	280.13	0.30	280.61	-0.48	9.021	280.35	-0.22	8.812	0.6
27.00	297.40	297.60	0.30	298.10	-0.50	8.741	297.91	-0.31	8.739	0.6
29.00	315.40	315.56	0.30	315.50	0.07	8.648	315.29	0.27	8.645	0.6
31.00	332.70	332.83	0.30	332.69	0.14	8.543	332.48	0.35	8.539	0.7
33.00	349.40	349.49	0.30	349.66	-0.17	8.428	349.45	0.05	8.427	0.7
35.00	366.40	366.46	0.30	366.40	0.06	8.307	366.17	0.29	8.305	0.7
37.00	382.90	382.92	0.30	382.89	0.03	8.181	382.66	0.26	8.175	0.7
39.00	399.10	399.09	0.30	399.13	-0.05	8.051	398.89	0.20	8.047	0.7
41.00	415.40	415.35	0.30	415.09	0.26	7.919	414.85	0.50	7.915	0.8
43.00	430.90	430.82	0.30	430.79	0.03	7.784	430.54	0.28	7.781	0.8
45.00	446.30	446.19	0.30	446.22	-0.04	7.648	445.97	0.22	7.645	0.8
47.00	461.70	461.55	0.30	461.38	0.17	7.511	461.12	0.43	7.509	0.8
49.00	476.40	476.22	0.30	476.26	-0.05	7.374	476.00	0.21	7.371	0.8
51.00	491.00	490.78	0.30	490.88	-0.10	7.236	490.60	0.18	7.234	0.8
53.00	505.30	505.05	0.30	505.21	-0.16	7.098	504.93	0.11	7.095	0.9
55.00	519.30	519.01	0.30	519.27	-0.25	6.960	518.98	0.03	6.957	0.9
57.00	533.40	533.08	0.30	533.05	0.03	6.823	532.76	0.32	6.819	0.9
59.00	546.90	546.54	0.30	546.56	-0.02	6.684	546.26	0.28	6.680	0.9
61.00	560.20	559.81	0.30	559.79	0.02	6.547	559.49	0.32	6.543	0.9
63.00	573.30	572.87	0.30	572.74	0.13	6.409	572.43	0.44	6.406	0.9
65.00	585.80	585.34	0.30	585.42	-0.08	6.270	585.11	0.23	6.268	0.9
67.00	598.40	597.90	0.30	597.82	0.08	6.131	597.51	0.40	6.129	0.9
69.00	610.40	609.87	0.30	609.94	-0.07	5.992	609.62	0.25	5.988	1.0
71.00	622.30	621.73	0.30	621.78	-0.05	5.852	621.46	0.27	5.849	1.0
73.00	634.20	633.60	0.30	633.35	0.25	5.711	633.02	0.58	5.709	1.0
75.00	645.30	644.66	0.30	644.63	0.04	5.568	644.29	0.38	5.565	1.0
77.00	656.50	655.83	0.30	655.62	0.21	5.425	655.28	0.55	5.423	1.0
79.00	667.10	666.40	0.30	666.33	0.07	5.280	665.98	0.41	5.278	1.0
81.00	677.60	676.86	0.30	676.73	0.13	5.133	676.39	0.47	5.130	1.0
83.00	687.50	686.73	0.30	686.85	-0.13	4.984	686.50	0.23	4.982	1.0
85.00	697.50	696.69	0.30	696.67	0.02	4.832	696.31	0.38	4.830	1.0
87.00	707.10	706.26	0.30	706.18	0.08	4.678	705.82	0.44	4.676	1.1
89.00	716.20	715.32	0.30	715.45	-0.13	4.598	715.10	0.23	4.597	1.1
91.00	725.30	724.39	0.30	724.65	-0.26	4.603	724.30	0.09	4.589	1.1

TABLE VIe

PKP travel times, AB branch: Gee and Dziewonski (unpublished). Baseline correction −4.22 s

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
152.00	1209.51	1205.29	0.50	1204.90	0.39	4.151	1204.15	1.14	4.153	1.2
154.00	1217.67	1213.45	0.50	1213.27	0.18	4.214	1212.52	0.93	4.216	1.2
156.00	1226.08	1221.86	0.50	1221.75	0.11	4.262	1221.00	0.86	4.263	1.2
158.00	1234.60	1230.38	0.50	1230.31	0.07	4.301	1229.57	0.81	4.302	1.2
160.00	1243.25	1239.03	0.50	1238.95	0.08	4.332	1238.21	0.83	4.333	1.2
162.00	1251.52	1247.30	0.50	1247.63	-0.33	4.356	1246.90	0.41	4.357	1.2
164.00	1260.04	1255.82	0.50	1256.37	-0.55	4.376	1255.63	0.19	4.376	1.2
166.00	1269.17	1264.95	0.50	1265.14	-0.18	4.391	1264.40	0.55	4.392	1.3
168.00	1278.36	1274.14	0.50	1273.93	0.22	4.402	1273.20	0.95	4.404	1.3

TABLE VI f

PKP travel times, BC branch: Gee and Dziewonski (unpublished). Baseline correction −2.18 s

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
46.00	1182.67	1180.50	0.30	1180.51	-0.01	3.025	1179.72	0.78	3.017	1.0
47.00	1185.28	1183.11	0.30	1183.43	-0.32	2.822	1182.63	0.48	2.815	1.0
48.00	1188.28	1186.11	0.30	1186.16	-0.06	2.660	1185.36	0.75	2.655	1.0
49.00	1191.02	1188.85	0.30	1188.75	0.09	2.515	1187.94	0.91	2.510	1.0
50.00	1193.42	1191.25	0.30	1191.20	0.05	2.385	1190.39	0.86	2.382	1.0
51.00	1195.80	1193.63	0.30	1193.52	0.10	2.262	1192.70	0.92	2.257	1.0
52.00	1198.04	1195.87	0.30	1195.72	0.14	2.147	1194.90	0.96	2.143	1.0

TABLE VI g

PKIKP travel times: Gee and Dziewonski (unpublished). Baseline correction −2.18 s

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
122.00	1136.94	1134.75	0.30	1134.78	-0.03	1.934	1133.97	0.79	1.933	1.0
124.00	1140.76	1138.57	0.30	1138.63	-0.06	1.929	1137.82	0.75	1.929	1.0
126.00	1144.69	1142.50	0.30	1142.48	0.03	1.924	1141.66	0.84	1.923	1.0
128.00	1148.68	1146.49	0.30	1146.31	0.18	1.917	1145.50	0.99	1.917	1.0
130.00	1152.59	1150.40	0.30	1150.14	0.26	1.910	1149.33	1.07	1.910	1.0
132.00	1156.41	1154.22	0.30	1153.95	0.27	1.901	1153.14	1.08	1.900	1.0
134.00	1160.22	1158.03	0.30	1157.74	0.29	1.888	1156.93	1.10	1.888	1.1
136.00	1163.94	1161.75	0.30	1161.51	0.25	1.873	1160.69	1.06	1.872	1.1
138.00	1167.70	1165.51	0.30	1165.23	0.28	1.852	1164.42	1.10	1.852	1.1
152.00	1191.18	1188.99	0.30	1189.23	-0.24	1.506	1188.40	0.59	1.505	1.2
154.00	1194.30	1192.11	0.30	1192.17	-0.06	1.421	1191.33	0.78	1.421	1.3
156.00	1196.90	1194.71	0.30	1194.93	-0.22	1.329	1194.08	0.63	1.329	1.3
158.00	1199.68	1197.49	0.30	1197.49	0.00	1.232	1196.64	0.85	1.231	1.3
160.00	1202.02	1199.83	0.30	1199.85	-0.01	1.130	1199.00	0.83	1.129	1.3
162.00	1204.08	1201.89	0.30	1202.02	-0.13	1.022	1201.15	0.74	1.023	1.4
164.00	1205.78	1203.59	0.30	1203.98	-0.38	0.912	1203.09	0.50	0.913	1.4
166.00	1207.51	1205.32	0.30	1205.69	-0.37	0.801	1204.81	0.51	0.803	1.4
168.00	1209.34	1207.15	0.30	1207.20	-0.04	0.688	1206.30	0.85	0.690	1.4
170.00	1210.82	1208.63	0.30	1208.51	0.12	0.568	1207.57	1.06	0.577	1.4
172.00	1211.64	1209.45	0.30	1209.59	-0.14	0.447	1208.61	0.84	0.462	1.4

TABLE VI h

PKiKP travel times: Engdahl et al. (1974). Baseline correction −2.59 s

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
1.00	995.80	993.21	0.30	992.87	0.34	0.022	992.03	1.18	0.022	0.9
10.00	996.90	994.31	0.30	993.98	0.33	0.224	993.14	1.17	0.224	0.9
20.00	1000.10	997.51	0.30	997.33	0.18	0.445	996.49	1.02	0.445	0.9
30.00	1005.70	1003.11	0.30	1002.85	0.26	0.659	1002.02	1.09	0.660	0.9
40.00	1013.20	1010.61	0.30	1010.49	0.12	0.865	1009.65	0.96	0.865	0.9
50.00	1022.80	1020.21	0.30	1020.12	0.09	1.060	1019.29	0.92	1.060	0.9
60.00	1034.20	1031.61	0.30	1031.63	-0.02	1.240	1030.80	0.81	1.241	0.9
70.00	1047.40	1044.81	0.30	1044.88	-0.06	1.405	1044.05	0.76	1.406	0.9
80.00	1062.20	1059.61	0.30	1059.69	-0.07	1.554	1058.86	0.75	1.554	0.9
90.00	1078.20	1075.61	0.30	1075.89	-0.28	1.684	1075.06	0.55	1.684	0.9
100.00	1095.50	1092.91	0.30	1093.29	-0.38	1.795	1092.48	0.44	1.795	1.0
110.00	1113.80	1111.21	0.30	1111.72	-0.50	1.886	1110.90	0.31	1.887	1.0

TABLE VI i
Differential travel times, PcP–P: Engdahl and Johnson (1974)

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
32.00	169.00	169.00	0.20	169.73	-0.73	-6.052	169.31	-0.31	-6.044	0.1
35.00	151.50	151.50	0.20	152.08	-0.58	-5.711	151.69	-0.19	-5.704	0.1
38.00	135.20	135.20	0.20	135.48	-0.28	-5.354	135.11	0.09	-5.346	0.0
41.00	119.20	119.20	0.20	119.95	-0.75	-4.992	119.62	-0.42	-4.983	0.0
44.00	105.10	105.10	0.20	105.50	-0.40	-4.632	105.21	-0.11	-4.620	0.0
47.00	92.00	92.00	0.20	92.16	-0.16	-4.279	91.87	0.13	-4.271	0.0
50.00	79.40	79.40	0.20	79.84	-0.44	-3.935	79.58	-0.18	-3.923	0.0
53.00	68.40	68.40	0.20	68.53	-0.13	-3.603	68.31	0.09	-3.595	0.0
56.00	58.10	58.10	0.20	58.22	-0.12	-3.281	58.01	0.09	-3.274	0.0
59.00	48.80	48.80	0.20	48.84	-0.04	-2.971	48.66	0.14	-2.961	-0.0
62.00	40.20	40.20	0.20	40.38	-0.18	-2.671	40.22	-0.02	-2.664	-0.0
65.00	32.70	32.70	0.20	32.81	-0.11	-2.382	32.66	0.04	-2.376	-0.0
75.00	13.40	13.40	0.20	13.58	-0.18	-1.475	13.51	-0.11	-1.468	-0.0

TABLE VI j
Differential travel times, PKiKP–PcP: Engdahl et al. (1974)

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
10.90	477.50	477.50	0.40	477.34	0.16	-0.784	477.34	0.16	-0.785	0.0
11.73	477.20	477.20	0.40	476.67	0.53	-0.842	476.67	0.53	-0.843	-0.0
21.34	464.90	464.90	0.40	465.54	-0.64	-1.457	465.53	-0.63	-1.459	-0.0
26.64	457.40	457.40	0.40	457.02	0.38	-1.752	457.01	0.39	-1.753	-0.0
27.71	454.80	454.80	0.40	455.12	-0.32	-1.807	455.10	-0.30	-1.808	-0.0
29.69	451.15	451.15	0.40	451.44	-0.29	-1.904	451.42	-0.27	-1.906	-0.0
30.50	450.40	450.40	0.40	449.89	0.51	-1.943	449.86	0.54	-1.944	-0.0
30.60	449.50	449.50	0.40	449.69	-0.19	-1.947	449.67	-0.17	-1.949	-0.0
31.08	448.20	448.20	0.40	448.75	-0.55	-1.969	448.73	-0.53	-1.971	-0.0
35.94	438.35	438.35	0.40	438.67	-0.32	-2.177	438.63	-0.28	-2.178	-0.1
36.04	438.75	438.75	0.40	438.45	0.30	-2.181	438.41	0.34	-2.182	-0.1
38.17	433.50	433.50	0.40	433.72	-0.22	-2.261	433.68	-0.18	-2.263	-0.1
47.18	411.85	411.85	0.40	412.04	-0.19	-2.533	411.99	-0.14	-2.534	-0.1

tion to a period of 5 s increases $dt/d\Delta$ of PREM by about 0.02 s deg^{-1}. Beyond 95°, PREM has $dt/d\Delta$ values which are 0.17 to 0.38 s deg^{-1} higher than GJS. This suggests that the shear velocities at the base of the mantle should be increased or that the structure in this region is more complicated than that given by PREM.

Considering all data sets, the discrepancy starts to set in at about 93° with $dt/d\Delta$ of 8.85 s deg^{-1}. This means that the error is in the lower 195 km of the mantle.

Travel times out to distances of about 20° vary substantially from region to region. For example, in the GJS study, P-wave times are up to 3.2 s short and S-times up to 6.9 s short in the Hindu Kush area compared to previous travel-time studies, and the tilts from 30–90° differ by about 0.01 s deg^{-1}. This is of the order of the tilt correction required to reconcile PREM travel times with observed travel times.

Region D″

The lowermost mantle, region D″ in Bullen's notation, clearly has a different velocity gradient than the rest of the lower mantle. For simplicity

TABLE VI k

S travel times (SH): Gogna et al. (1981). Baseline correction -1.87 s; slope 0.0329 deg^{-1}

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
32.00	701.46	700.64	0.75	701.81	-1.17	15.484	702.02	-1.38	15.474	4.0
33.00	717.27	716.48	0.75	717.27	-0.78	15.429	717.46	-0.97	15.417	4.0
34.00	732.96	732.21	0.75	732.67	-0.46	15.369	732.85	-0.64	15.360	4.1
35.00	748.52	747.80	0.75	748.00	-0.20	15.305	748.19	-0.39	15.296	4.1
36.00	763.94	763.25	0.75	763.28	-0.03	15.236	763.44	-0.19	15.225	4.2
37.00	779.20	778.55	0.75	778.47	0.07	15.163	778.63	-0.08	15.149	4.2
38.00	794.34	793.72	0.75	793.60	0.12	15.086	793.75	-0.03	15.076	4.2
39.00	809.38	808.79	0.75	808.65	0.14	15.005	808.78	0.01	14.995	4.3
40.00	824.33	823.77	0.75	823.60	0.17	14.922	823.73	0.04	14.907	4.3
41.00	839.18	838.66	0.75	838.49	0.17	14.835	838.60	0.06	14.825	4.4
42.00	853.94	853.45	0.75	853.29	0.16	14.746	853.38	0.07	14.734	4.4
43.00	868.60	868.14	0.75	867.99	0.16	14.654	868.06	0.08	14.640	4.4
44.00	883.16	882.74	0.75	882.60	0.14	14.560	882.66	0.07	14.549	4.5
45.00	897.63	897.24	0.75	897.12	0.12	14.464	897.17	0.07	14.450	4.5
46.00	912.00	911.64	0.75	911.52	0.13	14.366	911.56	0.09	14.355	4.5
47.00	926.26	925.93	0.75	925.83	0.11	14,266	925.86	0.07	14.253	4.6
48.00	940.43	940.14	0.75	940.04	0.10	14.165	940.07	0.07	14.151	4.6
49.00	954.49	954.23	0.75	954.15	0.08	14.061	954.16	0.07	14.050	4.6
50.00	968.46	968.23	0.75	968.16	0.07	13.957	968.17	0.07	13.940	4.7
51.00	982.31	982.12	0.75	982.07	0.04	13.851	982.05	0.07	13.840	4.7
52.00	996.07	995.91	0.75	995.86	0.05	13.744	995.84	0.07	13.729	4.8
53.00	1009.72	1009.59	0.75	1009.55	0.04	13.637	1009.52	0.08	13.626	4.8
54.00	1023.26	1023.17	0.75	1023.14	0.03	13.528	1023.08	0.08	13.513	4.8
55.00	1036.70	1036.64	0.75	1036.61	0.03	13.419	1036.55	0.09	13.408	4.9
56.00	1050.03	1050.00	0.75	1049.98	0.02	13.308	1049.90	0.10	13.293	4.9
57.00	1063.25	1063.25	0.75	1063.22	0.03	13.197	1063.15	0.11	13.186	4.9
58.00	1076.36	1076.40	0.75	1076.37	0.03	13.085	1076.27	0.13	13.070	5.0
59.00	1089.37	1089.44	0.75	1089.40	0.04	12.973	1089.28	0.16	12.962	5.0
60.00	1102.26	1102.36	0.75	1102.31	0.05	12.860	1102.19	0.17	12.844	5.0
61.00	1115.04	1115.18	0.75	1115.11	0.07	12.747	1114.98	0.20	12.736	5.1
62.00	1127.70	1127.87	0.75	1127.80	0.07	12.632	1127.66	0.21	12.619	5.1
63.00	1140.26	1140.46	0.75	1140.37	0.09	12.518	1140.23	0.24	12.507	5.1
64.00	1152.70	1152.93	0.75	1152.84	0.10	12.403	1152.67	0.26	12.392	5.2
65.00	1165.02	1165.29	0.75	1165.18	0.11	12.287	1165.01	0.28	12.276	5.2
66.00	1177.23	1177.53	0.75	1177.41	0.12	12.172	1177.22	0.31	12.161	5.2

(continued)

we have assumed that the top of this region is a second-order discontinuity. The inversion results in a nearly constant velocity in the lower 150 km of the mantle. The P-wave travel-times beyond 90° are at least 0.08 s fast relative to baseline- and tilt-corrected travel-time data. This is a small error but is indicated by all datasets. Apparently, the average time spent in region D″ by rays at near grazing incidence should be longer by about 0.27%. This can be accomplished by reducing the P-velocity by about 0.04 km s^{-1} or by decreasing the velocity gradient somewhere near 3630 km radius. The study of amplitudes and wave-forms should resolve the possibilities.

Radius of the core

The radius of the outer core in PREM is 3480 km. It may be noted that PcP–P times for the model are systematically slow with respect to the

TABLE VI k (continued)

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
67.00	1189.32	1189.65	0.75	1189.52	0.13	12.055	1189.33	0.32	12.042	5.3
68.00	1201.30	1201.67	0.75	1201.52	0.15	11.939	1201.31	0.36	11.929	5.3
69.00	1213.15	1213.55	0.75	1213.40	0.15	11.821	1213.18	0.37	11.809	5.3
70.00	1224.89	1225.32	0.75	1225.15	0.17	11.704	1224.93	0.39	11.693	5.4
71.00	1236.50	1236.96	0.75	1236.80	0.16	11.586	1236.56	0.41	11.576	5.4
72.00	1248.00	1248.50	0.75	1248.33	0.17	11.467	1248.08	0.42	11.455	5.4
73.00	1259.37	1259.90	0.75	1259.73	0.17	11.349	1259.48	0.42	11.339	5.4
74.00	1270.62	1271.18	0.75	1271.02	0.16	11.229	1270.75	0.43	11.219	5.5
75.00	1281.75	1282.35	0.75	1282.19	0.16	11.109	1281.91	0.43	11.099	5.5
76.00	1292.75	1293.38	0.75	1293.24	0.14	10.989	1292.96	0.42	10.980	5.5
77.00	1303.63	1304.29	0.75	1304.17	0.13	10.868	1303.87	0.42	10.856	5.6
78.00	1314.38	1315.08	0.75	1314.97	0.11	10.747	1314.66	0.41	10.737	5.6
79.00	1325.01	1325.74	0.75	1325.66	0.08	10.625	1325.34	0.40	10.616	5.6
80.00	1335.50	1336.26	0.75	1336.22	0.04	10.502	1335.89	0.37	10.491	5.7
81.00	1345.87	1346.66	0.75	1346.66	0.00	10.379	1346.32	0.34	10.369	5.7
82.00	1356.11	1356.94	2.25	1356.98	-0.04	10.255	1356.63	0.30	10.246	5.7
83.00	1366.22	1367.08	2.25	1367.17	-0.09	10.131	1366.81	0.27	10.120	5.7
84.00	1376.19	1377.08	2.25	1377.24	-0.16	10.005	1376.88	0.21	9.995	5.8
85.00	1386.04	1386.97	2.25	1387.18	-0.21	9.879	1386.81	0.16	9.870	5.8
86.00	1395.75	1396.71	2.25	1396.99	-0.28	9.753	1396.62	0.09	9.743	5.8
87.00	1405.33	1406.32	2.25	1406.68	-0.36	9.625	1406.30	0.03	9.615	5.8
88.00	1414.77	1415.79	2.25	1416.24	-0.45	9.496	1415.84	-0.05	9.487	5.9
89.00	1424.08	1425.14	2.25	1425.67	-0.53	9.367	1425.27	-0.13	9.358	5.9
90.00	1433.25	1434.34	2.25	1434.98	-0.63	9.236	1434.56	-0.22	9.227	5.9
91.00	1442.28	1443.40	2.25	1444.15	-0.75	9.105	1443.72	-0.32	9.096	5.9
92.00	1451.18	1452.34	2.25	1453.18	-0.84	8.973	1452.75	-0.42	8.964	6.0
93.00	1459.94	1461.13	2.25	1462.09	-0.96	8.840	1461.65	-0.52	8.831	6.0
94.00	1468.56	1469.78	2.25	1470.86	-1.08	8.708	1470.41	-0.63	8.700	6.0
95.00	1477.04	1478.29	2.25	1479.55	-1.26	8.713	1479.12	-0.83	8.666	6.1
96.00	1485.44	1486.73	2.25	1488.22	-1.50	8.794	1487.83	-1.10	8.681	6.1
97.00	1493.85	1495.17	2.25	1496.90	-1.73	8.766	1496.50	-1.33	8.653	6.1
98.00	1502.26	1503.61	2.25	1505.57	-1.96	8.631	1505.13	-1.52	8.614	6.1
99.00	1510.67	1512.06	2.25	1514.17	-2.11	8.577	1513.72	-1.66	8.568	6.2
100.00	1519.07	1520.49	2.25	1522.72	-2.23	8.524	1522.26	-1.77	8.518	6.2

observations, indicating that the core should be slightly larger. The ScS–S times are also marginally too long. Taking into account the slower velocities which may exist in D″, good agreement with these two datasets can be obtained with a core radius 1.7 km larger, or 3481.7 km.

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TABLE VI 1
S travel times (SV): Gogna et al. (1981). Baseline correction -0.29 s; slope 0.0188 s $\deg^{-1}$

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
32.00	701.46	701.77	0.75	702.94	-1.17	15.474	702.02	-0.26	15.474	4.0
33.00	717.27	717.60	0.75	718.39	-0.79	15.418	717.46	0.14	15.417	4.0
34.00	732.96	733.31	0.75	733.78	-0.47	15.358	732.85	0.46	15.360	4.1
35.00	748.52	748.89	0.75	749.10	-0.22	15.292	748.19	0.70	15.296	4.1
36.00	763.94	764.32	0.75	764.35	-0.03	15.223	763.44	0.88	15.225	4.2
37.00	779.20	779.60	0.75	779.54	0.06	15.149	778.63	0.98	15.149	4.2
38.00	794.34	794.76	0.75	794.66	0.11	15.072	793.75	1.02	15.076	4.2
39.00	809.38	809.82	0.75	809.69	0.13	14.991	808.78	1.04	14.995	4.3
40.00	824.33	824.79	0.75	824.64	0.15	14.907	823.73	1.06	14.907	4.3
41.00	839.18	839.66	0.75	839.50	0.16	14.820	838.60	1.06	14.825	4.4
42.00	853.94	854.44	0.75	854.29	0.15	14.730	853.38	1.06	14.734	4.4
43.00	868.60	869.12	0.75	868.98	0.14	14.638	868.06	1.05	14.640	4.4
44.00	883.16	883.69	0.75	883.57	0.12	14.544	882.66	1.03	14.549	4.5
45.00	897.63	898.18	0.75	898.06	0.12	14.448	897.17	1.02	14.450	4.5
46.00	912.00	912.57	0.75	912.44	0.13	14.350	911.56	1.02	14.355	4.5
47.00	926.26	926.85	0.75	926.74	0.11	14.250	925.86	0.99	14.253	4.6
48.00	940.43	941.04	0.75	940.94	0.10	14.149	940.07	0.97	14.151	4.6
49.00	954.49	955.12	0.75	955.04	0.08	14.045	954.16	0.96	14.050	4.6
50.00	968.46	969.11	0.75	969.03	0.07	13.941	968.17	0.94	13.940	4.7
51.00	982.31	982.98	0.75	982.92	0.05	13.836	982.05	0.93	13.840	4.7
52.00	996.07	996.76	0.75	996.70	0.05	13.729	995.84	0.91	13.729	4.8
53.00	1009.72	1010.42	0.75	1010.38	0.04	13.621	1009.52	0.91	13.626	4.8
54.00	1023.26	1023.98	0.75	1023.94	0.04	13.512	1023.08	0.90	13.513	4.8
55.00	1036.70	1037.44	0.75	1037.40	0.04	13.403	1036.55	0.89	13.408	4.9
56.00	1050.03	1050.79	0.75	1050.76	0.03	13.293	1049.90	0.89	13.293	4.9
57.00	1063.25	1064.03	0.75	1063.98	0.04	13.182	1063.15	0.88	13.186	4.9
58.00	1076.36	1077.16	0.75	1077.12	0.04	13.070	1076.27	0.89	13.070	5.0
59.00	1089.37	1090.19	0.75	1090.13	0.06	12.958	1089.28	0.90	12.962	5.0
60.00	1102.26	1103.10	0.75	1103.03	0.07	12.845	1102.19	0.91	12.844	5.0
61.00	1115.04	1115.89	0.75	1115.82	0.08	12.732	1114.98	0.91	12.736	5.1
62.00	1127.70	1128.57	0.75	1128.48	0.09	12.619	1127.66	0.92	12.619	5.1
63.00	1140.26	1141.15	0.75	1141.04	0.11	12.504	1140.23	0.93	12.507	5.1
64.00	1152.70	1153.61	0.75	1153.50	0.11	12.389	1152.67	0.94	12.392	5.2
65.00	1165.02	1165.95	0.75	1165.82	0.13	12.273	1165.01	0.94	12.276	5.2
66.00	1177.23	1178.18	0.75	1178.04	0.14	12.158	1177.22	0.95	12.161	5.2

(continued)

Appendix. Differential kernels for perturbation of eigenfrequencies of normal modes in a transversely isotropic medium

Equations for differential kernels given by Backus and Gilbert (1967) can be easily expanded to accommodate transversely isotropic medium. A relative change in the squared eigenfrequency is

$$\frac{\delta\omega^2}{\omega^2} = \int_0^1 r^2\,\mathrm{d}r\big(\delta\tilde{A}\cdot A + \delta C\cdot\tilde{C} + \delta F\cdot\tilde{F} + \delta L\cdot\tilde{L} + \delta N\cdot\tilde{N} + \delta\rho\cdot\tilde{R}\big) \tag{A1}$$

where A, C, F, N, and L are the five independent elastic constants as defined by Love (1927, p. 196). The problem of differential kernels for this case has been presented by Takeuchi and Saito (1972),

TABLE VI 1 (continued)

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
67.00	1189.32	1190.29	0.75	1190.15	0.14	12.042	1189.33	0.96	12.042	5.3
68.00	1201.30	1202.29	0.75	1202.12	0.16	11.925	1201.31	0.98	11.929	5.3
69.00	1213.15	1214.15	0.75	1213.99	0.16	11.808	1213.18	0.97	11.809	5.3
70.00	1224.89	1225.91	0.75	1225.74	0.18	11.691	1224.93	0.98	11.693	5.4
71.00	1236.50	1237.54	0.75	1237.37	0.18	11.573	1236.56	0.98	11.576	5.4
72.00	1248.00	1249.06	0.75	1248.88	0.18	11.454	1248.08	0.99	11.455	5.4
73.00	1259.37	1260.45	0.75	1260.27	0.18	11.336	1259.48	0.97	11.339	5.4
74.00	1270.62	1271.72	0.75	1271.55	0.17	11.217	1270.75	0.96	11.219	5.5
75.00	1281.75	1282.87	0.75	1282.71	0.16	11.097	1281.91	0.95	11.099	5.5
76.00	1292.75	1293.89	0.75	1293.75	0.14	10.977	1292.96	0.93	10.980	5.5
77.00	1303.63	1304.78	0.75	1304.66	0.12	10.856	1303.87	0.91	10.856	5.6
78.00	1314.38	1315.55	0.75	1315.45	0.10	10.735	1314.66	0.89	10.737	5.6
79.00	1325.01	1326.20	0.75	1326.12	0.08	10.613	1325.34	0.86	10.616	5.6
80.00	1335.50	1336.71	0.75	1336.68	0.03	10.491	1335.89	0.82	10.491	5.7
81.00	1345.87	1347.10	0.75	1347.11	-0.01	10.367	1346.32	0.78	10.369	5.7
82.00	1356.11	1357.36	2.25	1357.41	-0.05	10.244	1356.63	0.73	10.246	5.7
83.00	1366.22	1367.49	2.25	1367.59	-0.10	10.120	1366.81	0.68	10.120	5.7
84.00	1376.19	1377.48	2.25	1377.65	-0.18	9.994	1376.88	0.60	9.995	5.8
85.00	1386.04	1387.35	2.25	1387.58	-0.23	9.868	1386.81	0.54	9.870	5.8
86.00	1395.75	1397.07	2.25	1397.38	-0.31	9.742	1396.62	0.45	9.743	5.8
87.00	1405.33	1406.67	2.25	1407.06	-0.39	9.614	1406.30	0.38	9.615	5.8
88.00	1414.77	1416.13	2.25	1416.61	-0.48	9.486	1415.84	0.29	9.487	5.9
89.00	1424.08	1425.46	2.25	1426.03	-0.57	9.357	1425.27	0.19	9.358	5.9
90.00	1433.25	1434.65	2.25	1435.32	-0.67	9.227	1434.56	0.09	9.227	5.9
91.00	1442.28	1443.70	2.25	1444.48	-0.78	9.095	1443.72	-0.02	9.096	5.9
92.00	1451.18	1452.62	2.25	1453.51	-0.89	8.963	1452.75	-0.13	8.964	6.0
93.00	1459.94	1461.40	2.25	1462.40	-1.01	8.830	1461.65	-0.25	8.831	6.0
94.00	1468.56	1470.03	2.25	1471.17	-1.14	8.702	1470.41	-0.38	8.700	6.0
95.00	1477.04	1478.53	2.25	1479.86	-1.32	8.719	1479.12	-0.59	8.666	6.1
96.00	1485.44	1486.95	2.25	1488.52	-1.57	8.798	1487.83	-0.88	8.681	6.1
97.00	1493.85	1495.38	2.25	1497.20	-1.82	8.755	1496.50	-1.12	8.653	6.1
98.00	1502.26	1503.81	2.25	1505.87	-2.06	8.626	1505.13	-1.32	8.614	6.1
99.00	1510.67	1512.24	2.25	1514.46	-2.23	8.573	1513.72	-1.48	8.568	6.2
100.00	1519.07	1520.66	2.25	1523.01	-2.36	8.520	1522.26	-1.61	8.518	6.2

but their expressions are inconvenient to apply in our formulation of the parameters sought in inversion.

The expressions for the differential kernels in terms of the eigenfunctions for spheroidal modes are

$$\tilde{C} = \dot{U}^2$$

$$\tilde{A} = r^{-2}\left[2U - l(l+1)V\right]^2$$

$$\tilde{F} = 2r^{-1}\dot{U}\left[2U - l(l+1)V\right] \tag{A2}$$

$$\tilde{L} = l(l+1)\left[\dot{V} + (U-V)/r\right]^2$$

$$\tilde{N} = r^{-2}\left\{(l+2)(l+1)l(l-1)V^2 - \left[2U - l(l+1)V\right]^2\right\}$$

where the dot signifies differentiation with respect to the radius and the eigenfunctions are normalized

$$\omega^2 \int_0^1 \rho\left[U^2 + l(l+1)V^2\right] r^2 \, dr = 1$$

For toroidal modes

$$\tilde{L} = \left(\dot{W} - W/r\right)^2$$

$$\tilde{N} = (l+2)(l-1)(W/r)^2 \tag{A3}$$

TABLE VI m
S travel times (SH): Hales and Roberts, (1970). Baseline correction -1.14 s; slope -0.0068 s deg^{-1}

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
30.00	671.97	670.62	0.75	670.74	-0.12	15.580	670.98	-0.35	15.567	3.9
31.00	687.09	685.73	0.75	686.30	-0.57	15.534	686.52	-0.78	15.524	4.0
32.00	702.82	701.46	0.75	701.81	-0.35	15.484	702.02	-0.57	15.474	4.0
33.00	717.59	716.22	0.75	717.27	-1.05	15.429	717.46	-1.24	15.417	4.0
34.00	733.43	732.05	0.75	732.67	-0.61	15.369	732.85	-0.79	15.360	4.1
35.00	748.55	747.17	0.75	748.00	-0.84	15.305	748.19	-1.02	15.296	4.1
36.00	764.22	762.83	0.75	763.28	-0.45	15.236	763.44	-0.61	15.225	4.2
37.00	779.20	777.80	0.75	778.47	-0.67	15.163	778.63	-0.82	15.149	4.2
38.00	794.32	792.92	0.75	793.60	-0.68	15.086	793.75	-0.83	15.076	4.2
39.00	809.83	808.42	0.75	808.65	-0.23	15.005	808.78	-0.36	14.995	4.3
40.00	824.97	823.55	0.75	823.60	-0.05	14.922	823.73	-0.18	14.90[illegible]	4.3
41.00	840.99	839.57	0.75	838.49	1.08	14.835	838.60	0.97	14.825	4.4
42.00	856.40	854.97	0.75	853.29	1.68	14.746	853.38	1.59	14.734	4.4
43.00	870.23	868.79	0.75	867.99	0.81	14.654	868.06	0.73	14.640	4.4
44.00	885.01	883.57	0.75	882.60	0.97	14.560	882.66	0.90	14.549	4.5
45.00	899.50	898.05	0.75	897.12	0.93	14.464	897.17	0.88	14.450	4.5
46.00	914.02	912.56	0.75	911.52	1.05	14.366	911.56	1.01	14.355	4.5
47.00	927.50	926.04	0.75	925.83	0.21	14.266	925.86	0.17	14.253	4.6
48.00	941.12	939.65	0.75	940.04	-0.39	14.165	940.07	-0.42	14.151	4.6
49.00	955.42	953.94	0.75	954.15	-0.21	14.061	954.16	-0.22	14.050	4.6
50.00	969.79	968.31	0.75	968.16	0.14	13.957	968.17	0.14	13.940	4.7
51.00	983.74	982.25	0.75	982.07	0.18	13.851	982.05	0.20	13.840	4.7
52.00	997.43	995.93	0.75	995.86	0.07	13.744	995.84	0.09	13.729	4.8
53.00	1011.42	1009.92	0.75	1009.55	0.36	13.637	1009.52	0.40	13.626	4.8
54.00	1025.07	1023.56	0.75	1023.14	0.42	13.528	1023.08	0.47	13.513	4.8
55.00	1038.33	1036.81	0.75	1036.61	0.20	13.419	1036.55	0.26	13.408	4.9
56.00	1051.86	1050.33	0.75	1049.98	0.35	13.308	1049.90	0.44	13.293	4.9
57.00	1065.26	1063.73	0.75	1063.22	0.51	13.197	1063.15	0.58	13.186	4.9
58.00	1077.80	1076.26	0.75	1076.37	-0.11	13.085	1076.27	-0.01	13.070	5.0
59.00	1091.24	1089.69	0.75	1089.40	0.30	12.973	1089.28	0.41	12.962	5.0
60.00	1104.06	1102.51	0.75	1102.31	0.20	12.860	1102.19	0.32	12.844	5.0
61.00	1116.50	1114.94	0.75	1115.11	-0.17	12.747	1114.98	-0.04	12.736	5.1
62.00	1129.56	1127.99	0.75	1127.80	0.19	12.632	1127.66	0.34	12.619	5.1
63.00	1142.41	1140.84	0.75	1140.37	0.47	12.518	1140.23	0.61	12.507	5.1
64.00	1154.10	1152.52	0.75	1152.84	-0.32	12.403	1152.67	-0.15	12.392	5.2

(continued)

with the normalization

$$\omega^2 \int_0^1 \rho W^2 r^2 \, \mathrm{d}r = 1$$

The differential kernel for the density, $\tilde{R}$, is the same as given by Backus and Gilbert (1967).

As in our inversion we consider simultaneously periods of free oscillations and travel times of body waves, it is desirable to recast the problem in terms of the perturbations in velocities and a non-dimensional parameter η

$$\begin{aligned} V_{\mathrm{PH}} &= (A/\rho)^{1/2} \\ V_{\mathrm{PV}} &= (C/\rho)^{1/2} \\ V_{\mathrm{SH}} &= (N/\rho)^{1/2} \\ V_{\mathrm{SV}} &= (L/\rho)^{1/2} \\ \eta &= F/(A-2L) \end{aligned} \tag{A4}$$

TABLE VI m (continued)

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
65.00	1166.76	1165.17	0.75	1165.18	-0.00	12.287	1165.01	0.17	12.276	5.2
66.00	1178.97	1177.38	0.75	1177.41	-0.03	12.172	1177.22	0.15	12.161	5.2
67.00	1190.65	1189.05	0.75	1189.52	-0.47	12.055	1189.33	-0.28	12.042	5.3
68.00	1202.58	1200.97	0.75	1201.52	-0.55	11.939	1201.31	-0.34	11.929	5.3
69.00	1214.71	1213.10	0.75	1213.40	-0.30	11.821	1213.18	-0.08	11.809	5.3
70.00	1226.21	1224.59	0.75	1225.15	-0.57	11.704	1224.93	-0.34	11.693	5.4
71.00	1237.29	1235.66	0.75	1236.80	-1.14	11.586	1236.56	-0.90	11.576	5.4
72.00	1249.15	1247.52	0.75	1248.33	-0.81	11.467	1248.08	-0.56	11.455	5.4
73.00	1260.88	1259.24	0.75	1259.73	-0.49	11.349	1259.48	-0.24	11.339	5.4
74.00	1272.31	1270.66	0.75	1271.02	-0.36	11.229	1270.75	-0.09	11.219	5.5
75.00	1284.18	1282.53	0.75	1282.19	0.34	11.109	1281.91	0.61	11.099	5.5
76.00	1295.42	1293.76	0.75	1293.24	0.52	10.989	1292.96	0.80	10.980	5.5
77.00	1305.57	1303.90	0.75	1304.17	-0.26	10.868	1303.87	0.03	10.856	5.6
78.00	1316.50	1314.83	0.75	1314.97	-0.14	10.747	1314.66	0.16	10.737	5.6
79.00	1326.97	1325.29	0.75	1325.66	-0.37	10.625	1325.34	-0.05	10.616	5.6
80.00	1337.93	1336.24	0.75	1336.22	0.02	10.502	1335.89	0.35	10.491	5.7
81.00	1349.50	1347.80	0.75	1346.66	1.14	10.379	1346.32	1.48	10.369	5.7
82.00	1358.61	1356.91	0.75	1356.98	-0.07	10.255	1356.63	0.28	10.246	5.7
83.00	1367.94	1366.23	2.25	1367.17	-0.94	10.131	1366.81	-0.58	10.120	5.7
84.00	1379.14	1377.42	2.25	1377.24	0.19	10.005	1376.88	0.55	9.995	5.8
85.00	1392.14	1390.42	2.25	1387.18	3.24	9.879	1386.81	3.61	9.870	5.8
86.00	1400.31	1398.58	2.25	1396.99	1.59	9.753	1396.62	1.96	9.743	5.8
87.00	1407.34	1405.60	2.25	1406.68	-1.08	9.625	1406.30	-0.69	9.615	5.8
88.00	1419.57	1417.83	2.25	1416.24	1.58	9.496	1415.84	1.99	9.487	5.9
89.00	1428.44	1426.69	2.25	1425.67	1.02	9.367	1425.27	1.42	9.358	5.9
90.00	1436.02	1434.26	2.25	1434.98	-0.71	9.236	1434.56	-0.30	9.227	5.9
91.00	1446.15	1444.39	2.25	1444.15	0.24	9.105	1443.72	0.66	9.096	5.9
92.00	1455.30	1453.53	2.25	1453.18	0.35	8.973	1452.75	0.78	8.964	6.0
93.00	1463.20	1461.42	2.25	1462.09	-0.67	8.840	1461.65	-0.23	8.831	6.0
94.00	1473.47	1471.69	2.25	1470.86	0.82	8.708	1470.41	1.27	8.700	6.0
95.00	1482.35	1480.56	2.25	1479.55	1.01	8.713	1479.12	1.44	8.666	6.1
96.00	1489.66	1487.86	2.25	1488.22	-0.36	8.794	1487.83	0.03	8.681	6.1
97.00	1496.69	1494.89	2.25	1496.90	-2.01	8.766	1496.50	-1.61	8.653	6.1
98.00	1505.38	1503.57	2.25	1505.57	-2.00	8.631	1505.13	-1.56	8.614	6.1

We seek an expression for a relative perturbation in a period of a normal mode in the form

$$\frac{\delta T}{T}=\int_0^1 \mathrm{d}r\big(\delta\rho R'+\delta v_{\mathrm{PV}}\cdot\tilde{P}_{\mathrm{V}}+\delta V_{\mathrm{PH}}\cdot\tilde{P}_{\mathrm{H}} + \delta V_{\mathrm{SV}}\cdot\tilde{S}_{\mathrm{V}}+\delta V_{\mathrm{SH}}\cdot\tilde{S}_{\mathrm{H}}+\delta\eta\cdot\tilde{E}\big) \qquad \text{(A5)}$$

After simple algebraic transformations, the appropriate expressions are

$$R'=-\tfrac{1}{2}r^2\big[\tilde{R}+V_{\mathrm{PV}}^2\cdot\tilde{C}+\big(\tilde{A}+\eta\tilde{F}\big)V_{\mathrm{PH}}^2 + \big(\tilde{L}-2\eta\tilde{F}\big)V_{\mathrm{SV}}^2+\tilde{N}V_{\mathrm{SH}}^2\big]$$

$$\tilde{P}_{\mathrm{V}}=-r^2\rho V_{\mathrm{PV}}\tilde{C}$$

$$\tilde{P}_{\mathrm{H}}=-r^2\rho V_{\mathrm{PH}}\big(\tilde{A}+\eta\tilde{F}\big) \qquad \text{(A6)}$$

$$\tilde{S}_{\mathrm{V}}=-r^2\rho V_{\mathrm{SV}}\big(\tilde{L}-2\eta\tilde{F}\big)$$

$$\tilde{S}_{\mathrm{H}}=-r^2\rho V_{\mathrm{SH}}\tilde{N}$$

$$\tilde{E}=-\tfrac{1}{2}r^2\rho\tilde{F}\big(V_{\mathrm{PH}}^2-2V_{\mathrm{SV}}^2\big)$$

For toroidal modes, $\tilde{A}$, $\tilde{C}$, and $\tilde{F}$ are set to zero, of course.

In calculation of the kernels for Q_μ and Q_K we use the concept of an equivalent isotropic medium (Woodhouse and Dahlen, 1978) with the bulk and

TABLE VI n
S travel times (SV): Hales and Roberts (1970). Baseline correction 0.44 s; slope −0.021 s deg^{-1}

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
30.00	671.97	671.78	0.75	671.90	-0.12	15.571	670.98	0.80	15.567	3.9
31.00	687.09	686.88	0.75	687.45	-0.57	15.525	686.52	0.36	15.524	4.0
32.00	702.82	702.59	0.75	702.94	-0.35	15.474	702.02	0.56	15.474	4.0
33.00	717.59	717.34	0.75	718.39	-1.06	15.418	717.46	-0.12	15.417	4.0
34.00	733.43	733.16	0.75	733.78	-0.62	15.358	732.85	0.31	15.360	4.1
35.00	748.55	748.25	0.75	749.10	-0.85	15.292	748.19	0.07	15.296	4.1
36.00	764.22	763.90	0.75	764.35	-0.45	15.223	763.44	0.46	15.225	4.2
37.00	779.20	778.86	0.75	779.54	-0.68	15.149	778.63	0.24	15.149	4.2
38.00	794.32	793.96	0.75	794.66	-0.69	15.072	793.75	0.21	15.076	4.2
39.00	809.83	809.45	0.75	809.69	-0.24	14.991	808.78	0.67	14.995	4.3
40.00	824.97	824.57	0.75	824.64	-0.07	14.907	823.73	0.84	14.907	4.3
41.00	840.99	840.57	0.75	839.50	1.07	14.820	838.60	1.97	14.825	4.4
42.00	856.40	855.96	0.75	854.29	1.67	14.730	853.38	2.58	14.734	4.4
43.00	870.23	869.77	0.75	868.98	0.79	14.638	868.06	1.70	14.640	4.4
44.00	885.01	884.53	0.75	883.57	0.95	14.544	882.66	1.86	14.549	4.5
45.00	899.50	898.99	0.75	898.06	0.93	14.448	897.17	1.83	14.450	4.5
46.00	914.02	913.49	0.75	912.44	1.05	14.350	911.56	1.94	14.355	4.5
47.00	927.50	926.95	0.75	926.74	0.21	14.250	925.86	1.09	14.253	4.6
48.00	941.12	940.55	0.75	940.94	-0.39	14.149	940.07	0.49	14.151	4.6
49.00	955.42	954.83	0.75	955.04	-0.21	14.045	954.16	0.67	14.050	4.6
50.00	969.79	969.18	0.75	969.03	0.15	13.941	968.17	1.01	13.940	4.7
51.00	983.74	983.11	0.75	982.92	0.19	13.836	982.05	1.06	13.840	4.7
52.00	997.43	996.78	0.75	996.70	0.07	13.729	995.84	0.94	13.729	4.8
53.00	1011.42	1010.75	0.75	1010.38	0.36	13.621	1009.52	1.23	13.626	4.8
54.00	1025.07	1024.38	0.75	1023.94	0.43	13.512	1023.08	1.29	13.513	4.8
55.00	1038.33	1037.61	0.75	1037.40	0.21	13.403	1036.55	1.06	13.408	4.9
56.00	1051.86	1051.12	0.75	1050.76	0.37	13.293	1049.90	1.22	13.293	4.9
57.00	1065.26	1064.50	0.75	1063.98	0.52	13.182	1063.15	1.36	13.186	4.9
58.00	1077.80	1077.02	0.75	1077.12	-0.10	13.070	1076.27	0.76	13.070	5.0
59.00	1091.24	1090.44	0.75	1090.13	0.31	12.958	1089.28	1.16	12.962	5.0
60.00	1104.06	1103.24	0.75	1103.03	0.21	12.845	1102.19	1.05	12.844	5.0
61.00	1116.50	1115.66	0.75	1115.82	-0.16	12.732	1114.98	0.68	12.736	5.1
62.00	1129.56	1128.70	0.75	1128.48	0.21	12.619	1127.66	1.04	12.619	5.1
63.00	1142.41	1141.53	0.75	1141.04	0.48	12.504	1140.23	1.30	12.507	5.1
64.00	1154.10	1153.20	0.75	1153.50	-0.30	12.389	1152.67	0.52	12.392	5.2

(continued)

shear moduli defined as

$$K = (1/9)(4A + C + 4F - 4N)$$

$$\mu = (1/15)(A + C - 2F + 5N + 6L)$$

Attenuation of a normal mode is evaluated from an integral

$$Q^{-1} = \int_0^1 r^2 \, dr\left(\mu \tilde{M} Q_\mu^{-1} + K \cdot \tilde{K} Q_K^{-1}\right) \qquad (A7)$$

where

$$\tilde{K} = \tilde{A} + \tilde{C} + \tilde{F}$$

and

$$\tilde{M} = \tilde{L} + \tilde{N} - \tfrac{2}{3}\tilde{K} \qquad (A8)$$

For the isotropic (or "equivalent") structure the kernels for perturbations in the density and velocities are

TABLE VI n (continued)

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
65.00	1166.76	1165.83	0.75	1165.82	0.01	12.273	1165.01	0.83	12.276	5.2
66.00	1178.97	1178.02	0.75	1178.04	-0.02	12.158	1177.22	0.80	12.161	5.2
67.00	1190.65	1189.68	0.75	1190.15	-0.46	12.042	1189.33	0.35	12.042	5.3
68.00	1202.58	1201.59	0.75	1202.12	-0.53	11.925	1201.31	0.28	11.929	5.3
69.00	1214.71	1213.70	0.75	1213.99	-0.29	11.808	1213.18	0.52	11.809	5.3
70.00	1226.21	1225.18	0.75	1225.74	-0.56	11.691	1224.93	0.25	11.693	5.4
71.00	1237.29	1236.24	0.75	1237.37	-1.13	11.573	1236.56	-0.32	11.576	5.4
72.00	1249.15	1248.08	0.75	1248.88	-0.80	11.454	1248.08	0.00	11.455	5.4
73.00	1260.88	1259.79	0.75	1260.27	-0.49	11.336	1259.48	0.31	11.339	5.4
74.00	1272.31	1271.20	0.75	1271.55	-0.35	11.217	1270.75	0.44	11.219	5.5
75.00	1284.18	1283.04	0.75	1282.71	0.33	11.097	1281.91	1.13	11.099	5.5
76.00	1295.42	1294.26	0.75	1293.75	0.52	10.977	1292.96	1.31	10.980	5.5
77.00	1305.57	1304.39	0.75	1304.66	-0.27	10.856	1303.87	0.52	10.856	5.6
78.00	1316.50	1315.30	0.75	1315.45	-0.15	10.735	1314.66	0.64	10.737	5.6
79.00	1326.97	1325.75	0.75	1326.12	-0.37	10.613	1325.34	0.41	10.616	5.6
80.00	1337.93	1336.69	0.75	1336.68	0.01	10.491	1335.89	0.80	10.491	5.7
81.00	1349.50	1348.24	0.75	1347.11	1.13	10.367	1346.32	1.92	10.369	5.7
82.00	1358.61	1357.33	0.75	1357.41	-0.08	10.244	1356.63	0.70	10.246	5.7
83.00	1367.94	1366.64	2.25	1367.59	-0.95	10.120	1366.81	-0.18	10.120	5.7
84.00	1379.14	1377.82	2.25	1377.65	0.16	9.994	1376.88	0.94	9.995	5.8
85.00	1392.14	1390.79	2.25	1387.58	3.22	9.868	1386.81	3.99	9.870	5.8
86.00	1400.31	1398.94	2.25	1397.38	1.56	9.742	1396.62	2.32	9.743	5.8
87.00	1407.34	1405.95	2.25	1407.06	-1.11	9.614	1406.30	-0.34	9.615	5.8
88.00	1419.57	1418.16	2.25	1416.61	1.55	9.486	1415.84	2.32	9.487	5.9
89.00	1428.44	1427.01	2.25	1426.03	0.98	9.357	1425.27	1.74	9.358	5.9
90.00	1436.02	1434.57	2.25	1435.32	-0.75	9.227	1434.56	0.01	9.227	5.9
91.00	1446.15	1444.68	2.25	1444.48	0.20	9.095	1443.72	0.96	9.096	5.9
92.00	1455.30	1453.81	2.25	1453.51	0.30	8.963	1452.75	1.06	8.964	6.0
93.00	1463.20	1461.69	2.25	1462.40	-0.72	8.830	1461.65	0.04	8.831	6.0
94.00	1473.47	1471.94	2.25	1471.17	0.77	8.702	1470.41	1.52	8.700	6.0
95.00	1482.35	1480.79	2.25	1479.86	0.94	8.719	1479.12	1.67	8.666	6.1
96.00	1489.66	1488.08	2.25	1488.52	-0.43	8.798	1487.83	0.26	8.681	6.1
97.00	1496.69	1495.09	2.25	1497.20	-2.10	8.755	1496.50	-1.41	8.653	6.1
98.00	1505.38	1503.76	2.25	1505.87	-2.11	8.626	1505.13	-1.37	8.614	6.1

$$R' = -\tfrac{1}{2}r^2\left[\tilde{R} + \left(\mu\tilde{M} + K\cdot\tilde{K}\right)/\rho\right]$$
$$\tilde{P} = -r^2\rho V_P\tilde{K} \qquad \text{(A9)}$$
$$\tilde{S} = -r^2\rho V_s\left(\tilde{M} - \tfrac{4}{3}\tilde{K}\right)$$

Note added in proof

An error in code for evaluation of group velocity of spheroidal modes has recently been discovered. The error was in a term associated with the gravitational potential in the fluid core and, therefore, it only affects results for the gravest modes. For example, for ${}_0S_{11}$ and all following ${}_0S_l$ modes the results in Table V are correct to all decimal places listed. Also, none of the theoretical calculations of periods of normal modes have been corrected for the second order effects. For example, the appropriate correction of the period of ${}_0S_0$ brings it much closer to the observed value.

TABLE VI o

Deep focus (550 km) S travel times (SH): Sengupta (1975). Baseline correction 2.28 s; slope −0.0433 s deg^{-1}

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
31.00	596.02	596.96	3.00	599.61	-2.65	15.241	599.71	-2.75	15.236	2.9
33.00	628.98	629.83	0.60	629.95	-0.11	15.099	630.03	-0.20	15.095	3.0
35.00	659.95	660.72	0.60	660.00	0.72	14.944	660.07	0.64	14.937	3.1
37.00	689.81	690.49	0.60	689.73	0.76	14.779	689.78	0.71	14.774	3.2
39.00	719.34	719.93	0.60	719.12	0.82	14.604	719.14	0.79	14.599	3.3
41.00	748.38	748.89	0.60	748.15	0.74	14.421	748.17	0.72	14.412	3.3
43.00	776.32	776.74	0.60	776.79	-0.05	14.232	776.81	-0.07	14.225	3.4
45.00	804.11	804.44	0.60	805.05	-0.61	14.037	805.07	-0.63	14.032	3.5
47.00	833.60	833.85	0.60	832.92	0.92	13.838	832.93	0.92	13.833	3.6
49.00	861.37	861.53	0.60	860.40	1.13	13.634	860.39	1.14	13.629	3.7
51.00	886.17	886.24	0.60	887.46	-1.22	13.426	887.43	-1.19	13.422	3.7
53.00	912.18	912.17	0.60	914.10	-1.93	13.216	914.07	-1.90	13.211	3.8
55.00	939.75	939.65	0.60	940.32	-0.67	13.003	940.27	-0.62	12.998	3.9
57.00	964.84	964.65	0.60	966.10	-1.45	12.787	966.05	-1.40	12.783	4.0
59.00	991.84	991.57	0.60	991.46	0.10	12.570	991.40	0.17	12.565	4.0
61.00	1017.14	1016.78	0.60	1016.38	0.40	12.350	1016.30	0.48	12.346	4.1
63.00	1040.74	1040.29	0.60	1040.86	-0.56	12.129	1040.77	-0.48	12.124	4.2
65.00	1064.96	1064.43	0.60	1064.89	-0.47	11.906	1064.80	-0.37	11.901	4.2
67.00	1088.39	1087.77	0.60	1088.48	-0.71	11.681	1088.37	-0.60	11.675	4.3
69.00	1113.09	1112.38	0.60	1111.62	0.77	11.454	1111.50	0.88	11.447	4.4
71.00	1136.64	1135.85	0.60	1134.30	1.55	11.227	1134.17	1.67	11.221	4.4
73.00	1157.00	1156.12	0.60	1156.52	-0.40	10.997	1156.38	-0.26	10.992	4.5
75.00	1179.51	1178.54	0.60	1178.28	0.27	10.764	1178.13	0.42	10.759	4.6
77.00	1200.23	1199.18	0.60	1199.57	-0.39	10.529	1199.41	-0.24	10.524	4.6
79.00	1221.03	1219.89	0.60	1220.38	-0.49	10.293	1220.23	-0.34	10.288	4.7
81.00	1241.47	1240.24	0.60	1240.73	-0.49	10.053	1240.56	-0.32	10.049	4.8
83.00	1261.23	1259.92	0.60	1260.60	-0.68	9.811	1260.41	-0.50	9.806	4.8
85.00	1281.21	1279.81	0.60	1279.97	-0.16	9.567	1279.78	0.03	9.561	4.9
87.00	1301.62	1300.13	3.00	1298.85	1.28	9.317	1298.66	1.48	9.313	4.9
89.00	1318.88	1317.31	3.00	1317.24	0.07	9.066	1317.03	0.28	9.060	5.0
91.00	1337.81	1336.15	0.60	1335.11	1.04	8.810	1334.90	1.25	8.805	5.0
93.00	1355.44	1353.69	0.60	1352.54	1.15	8.725	1352.35	1.34	8.670	5.1
95.00	1373.80	1371.97	3.00	1369.89	2.07	8.730	1369.72	2.25	8.648	5.1

TABLE VI p
Deep focus (550 km) S travel times (SV): Sengupta (1975). Baseline correction 3.00 s; slope -0.0495 s deg^{-1}

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
31.00	596.02	597.48	3.00	600.15	-2.66	15.235	599.71	-2.22	15.236	2.9
33.00	628.98	630.35	0.60	630.48	-0.13	15.092	630.03	0.31	15.095	3.0
35.00	659.95	661.22	0.60	660.52	0.70	14.937	660.07	1.14	14.937	3.1
37.00	689.81	690.98	0.60	690.22	0.75	14.771	689.78	1.20	14.774	3.2
39.00	719.34	720.41	0.60	719.60	0.81	14.596	719.14	1.26	14.599	3.3
41.00	748.38	749.35	0.60	748.62	0.73	14.414	748.17	1.18	14.412	3.3
43.00	776.32	777.19	0.60	777.25	-0.06	14.225	776.81	0.38	14.225	3.4
45.00	804.11	804.88	0.60	805.50	-0.62	14.030	805.07	-0.19	14.032	3.5
47.00	833.60	834.27	0.60	833.35	0.92	13.830	832.93	1.34	13.833	3.6
49.00	861.37	861.94	0.60	860.80	1.14	13.626	860.39	1.55	13.629	3.7
51.00	886.17	886.64	0.60	887.86	-1.21	13.419	887.43	-0.79	13.422	3.7
53.00	912.18	912.56	0.60	914.49	-1.93	13.209	914.07	-1.51	13.211	3.8
55.00	939.75	940.03	0.60	940.68	-0.66	12.996	940.27	-0.24	12.998	3.9
57.00	964.84	965.02	0.60	966.46	-1.45	12.780	966.05	-1.04	12.783	4.0
59.00	991.84	991.92	0.60	991.80	0.12	12.563	991.40	0.52	12.565	4.0
61.00	1017.14	1017.12	0.60	1016.71	0.41	12.344	1016.30	0.82	12.346	4.1
63.00	1040.74	1040.62	0.60	1041.18	-0.56	12.122	1040.77	-0.15	12.124	4.2
65.00	1064.96	1064.74	0.60	1065.19	-0.45	11.900	1064.80	-0.06	11.901	4.2
67.00	1088.39	1088.07	0.60	1088.76	-0.69	11.675	1088.37	-0.30	11.675	4.3
69.00	1113.09	1112.67	0.60	1111.89	0.78	11.448	1111.50	1.17	11.447	4.4
71.00	1136.64	1136.12	0.60	1134.56	1.56	11.221	1134.17	1.95	11.221	4.4
73.00	1157.00	1156.38	0.60	1156.76	-0.38	10.991	1156.38	0.00	10.992	4.5
75.00	1179.51	1178.80	0.60	1178.52	0.27	10.758	1178.13	0.67	10.759	4.6
77.00	1200.23	1199.42	0.60	1199.79	-0.38	10.524	1199.41	0.00	10.524	4.6
79.00	1221.03	1220.12	0.60	1220.61	-0.49	10.288	1220.23	-0.11	10.288	4.7
81.00	1241.47	1240.46	0.60	1240.94	-0.48	10.048	1240.56	-0.11	10.049	4.8
83.00	1261.23	1260.12	0.60	1260.80	-0.68	9.806	1260.41	-0.30	9.806	4.8
85.00	1281.21	1280.00	0.60	1280.16	-0.16	9.561	1279.78	0.22	9.561	4.9
87.00	1301.62	1300.31	3.00	1299.03	1.28	9.312	1298.66	1.66	9.313	4.9
89.00	1318.88	1317.47	3.00	1317.40	0.08	9.061	1317.03	0.44	9.060	5.0
91.00	1337.81	1336.30	0.60	1335.27	1.04	8.805	1334.90	1.41	8.805	5.0
93.00	1355.44	1353.83	0.60	1352.77	1.06	8.727	1352.35	1.48	8.670	5.1
95.00	1373.80	1372.09	3.00	1370.06	2.03	8.722	1369.72	2.38	8.648	5.1

TABLE VI q
Deep focus (550 km) ScS travel times (SH): Sengupta (1975). Baseline correction -0.57 s

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
32.50	909.93	909.36	1.00	908.42	0.94	5.227	908.13	1.23	5.229	3.6
37.50	936.92	936.35	1.00	936.01	0.34	5.796	935.73	0.63	5.798	3.7
42.50	966.47	965.90	1.00	966.27	-0.36	6.294	965.99	-0.09	6.296	3.8
47.50	998.04	997.47	1.00	998.84	-1.36	6.723	998.57	-1.10	6.725	3.9
52.50	1032.81	1032.24	1.00	1033.39	-1.15	7.088	1033.13	-0.89	7.089	4.0
57.50	1068.02	1067.45	1.00	1069.62	-2.17	7.394	1069.37	-1.92	7.395	4.2
62.50	1109.34	1108.77	1.00	1107.24	1.53	7.647	1107.00	1.78	7.648	4.3
67.50	1146.76	1146.19	1.00	1146.01	0.18	7.852	1145.77	0.42	7.853	4.4
72.50	1187.62	1187.05	1.00	1185.69	1.36	8.015	1185.46	1.59	8.016	4.5
77.50	1227.35	1226.78	1.00	1226.09	0.69	8.140	1225.86	0.92	8.141	4.7

TABLE VI r
Deep focus (550 km) ScS travel times (SV): Sengupta (1975). Baseline correction −0.47 s

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
32.50	909.93	909.46	1.00	908.48	0.99	5.230	908.13	1.33	5.229	3.6
37.50	936.92	936.45	1.00	936.08	0.38	5.799	935.73	0.73	5.798	3.7
42.50	966.47	966.00	1.00	966.35	-0.35	6.296	965.99	0.01	6.296	3.8
47.50	998.04	997.57	1.00	998.92	-1.35	6.725	998.57	-1.00	6.725	3.9
52.50	1032.81	1032.34	1.00	1033.49	-1.15	7.090	1033.13	-0.79	7.089	4.0
57.50	1068.02	1067.55	1.00	1069.72	-2.17	7.396	1069.37	-1.82	7.395	4.2
62.50	1109.34	1108.87	1.00	1107.36	1.51	7.648	1107.00	1.88	7.648	4.3
67.50	1146.76	1146.29	1.00	1146.13	0.16	7.853	1145.77	0.52	7.853	4.4
72.50	1187.62	1187.15	1.00	1185.82	1.33	8.016	1185.46	1.69	8.016	4.5
77.50	1227.35	1226.88	1.00	1226.23	0.65	8.141	1225.86	1.02	8.141	4.7

TABLE VI s
SKS travel times (SV): Hales and Roberts (1970). Baseline correction −3.13 s

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
84.00	1377.11	1373.98	2.00	1374.70	-0.72	6.510	1373.99	-0.01	6.509	4.8
85.00	1385.70	1382.57	2.00	1381.16	1.41	6.409	1380.45	2.12	6.410	4.8
86.00	1392.06	1388.93	2.00	1387.52	1.41	6.308	1386.81	2.12	6.311	4.8
87.00	1397.90	1394.77	2.00	1393.78	0.99	6.207	1393.07	1.70	6.206	4.7
88.00	1404.10	1400.97	2.00	1399.94	1.04	6.107	1399.23	1.74	6.107	4.7
89.00	1408.63	1405.50	2.00	1405.99	-0.49	6.007	1405.29	0.22	6.010	4.7
90.00	1414.03	1410.90	2.00	1411.95	-1.04	5.910	1411.24	-0.34	5.909	4.7
91.00	1419.44	1416.31	2.00	1417.81	-1.50	5.812	1417.11	-0.80	5.810	4.6
92.00	1425.96	1422.83	2.00	1423.57	-0.74	5.716	1422.87	-0.04	5.718	4.6
93.00	1432.41	1429.28	2.00	1429.24	0.04	5.622	1428.54	0.74	5.623	4.6
94.00	1438.41	1435.28	2.00	1434.82	0.47	5.528	1434.11	1.17	5.525	4.6
95.00	1442.97	1439.84	2.00	1440.30	-0.46	5.437	1439.60	0.24	5.438	4.6
96.00	1449.20	1446.07	2.00	1445.69	0.39	5.346	1444.99	1.08	5.349	4.6
97.00	1454.34	1451.21	2.00	1450.99	0.22	5.257	1450.29	0.92	5.254	4.5
98.00	1459.55	1456.42	2.00	1456.20	0.22	5.169	1455.50	0.92	5.170	4.5
99.00	1464.11	1460.98	2.00	1461.33	-0.34	5.083	1460.63	0.35	5.085	4.5
100.00	1469.99	1466.86	2.00	1466.36	0.50	4.998	1465.67	1.19	4.997	4.5
101.00	1475.02	1471.89	2.00	1471.32	0.57	4.913	1470.63	1.26	4.913	4.5
102.00	1480.18	1477.05	2.00	1476.19	0.86	4.830	1475.50	1.55	4.832	4.5
103.00	1485.55	1482.42	2.00	1480.98	1.45	4.749	1480.29	2.13	4.749	4.5
104.00	1491.73	1488.60	2.00	1485.69	2.92	4.667	1485.00	3.60	4.666	4.5
105.00	1495.28	1492.15	2.00	1490.31	1.84	4.588	1489.63	2.53	4.589	4.5
106.00	1498.73	1495.60	2.00	1494.86	0.74	4.509	1494.17	1.43	4.510	4.4
107.00	1502.30	1499.17	2.00	1499.33	-0.16	4.430	1498.64	0.53	4.428	4.4
108.00	1506.62	1503.49	2.00	1503.72	-0.23	4.353	1503.03	0.46	4.354	4.4
109.00	1511.82	1508.69	2.00	1508.04	0.66	4.277	1507.35	1.34	4.278	4.4
110.00	1517.59	1514.46	2.00	1512.28	2.18	4.201	1511.59	2.88	4.199	4.4
111.00	1519.03	1515.90	2.00	1516.44	-0.54	4.127	1515.75	0.15	4.127	4.4
112.00	1521.40	1518.27	2.00	1520.52	-2.25	4.053	1519.84	-1.57	4.054	4.4
113.00	1527.40	1524.27	2.00	1524.54	-0.27	3.979	1523.86	0.42	3.976	4.4
114.00	1532.11	1528.98	2.00	1528.48	0.50	3.906	1527.80	1.18	3.906	4.4
115.00	1536.32	1533.19	2.00	1532.35	0.84	3.834	1531.67	1.52	3.835	4.4

(continued)

TABLE VI s (continued)

116.00	1538.58	1535.45	2.00	1536.15	-0.70	3.763	1535.47	-0.02	3.762	4.4
117.00	1540.86	1537.73	2.00	1539.88	-2.15	3.691	1539.20	-1.46	3.691	4.4
118.00	1545.67	1542.54	2.00	1543.53	-0.99	3.621	1542.85	-0.31	3.622	4.4
119.00	1549.66	1546.53	2.00	1547.12	-0.58	3.552	1546.44	0.10	3.551	4.4
120.00	1551.99	1548.86	2.00	1550.64	-1.77	3.481	1549.95	-1.09	3.480	4.3
121.00	1555.93	1552.80	2.00	1554.08	-1.28	3.413	1553.40	-0.60	3.413	4.3
122.00	1560.67	1557.54	2.00	1557.45	0.09	3.344	1556.78	0.76	3.344	4.3
123.00	1563.67	1560.54	2.00	1560.77	-0.23	3.276	1560.09	0.46	3.274	4.3
124.00	1566.87	1563.74	2.00	1564.01	-0.27	3.208	1563.33	0.41	3.208	4.3
125.00	1568.57	1565.44	2.00	1567.18	-1.74	3.141	1566.50	-1.06	3.141	4.3
126.00	1572.53	1569.40	2.00	1570.29	-0.89	3.073	1569.61	-0.21	3.072	4.3

TABLE VI t
Deep focus (600 km) differential travel times ScS(SH)–S(SH): Jordan and Anderson (1974). No baseline correction

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
35.00	259.40	259.40	0.71	258.57	0.83	-9.352	258.22	1.18	-9.343	0.6
40.00	215.70	215.70	0.66	214.22	1.48	-8.386	213.91	1.79	-8.377	0.5
45.00	174.30	174.30	0.52	174.67	-0.37	-7.449	174.39	-0.09	-7.439	0.4
50.00	138.60	138.60	0.69	139.70	-1.10	-6.549	139.45	-0.85	-6.540	0.3
55.00	108.50	108.50	0.58	109.11	-0.61	-5.690	108.91	-0.41	-5.684	0.2
60.00	82.00	82.00	0.52	82.73	-0.73	-4.874	82.55	-0.55	-4.866	0.2
65.00	59.70	59.70	0.44	60.32	-0.62	-4.095	60.17	-0.47	-4.088	0.1
70.00	40.60	40.60	0.46	41.72	-1.12	-3.351	41.60	-1.00	-3.345	0.1
75.00	25.50	25.50	0.60	26.76	-1.26	-2.635	26.68	-1.18	-2.629	0.0
80.00	14.00	14.00	0.37	15.34	-1.34	-1.940	15.28	-1.28	-1.933	0.0

TABLE VI u
Deep focus (600 km) differential travel times ScS(SH)–S(SH): Jordan and Anderson (1974). Baseline correction 0.68 s

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
35.00	259.40	260.08	0.71	258.57	1.51	-9.352	258.22	1.86	-9.343	0.6
40.00	215.70	216.38	0.66	214.22	2.16	-8.386	213.91	2.46	-8.377	0.5
45.00	174.30	174.98	0.52	174.67	0.31	-7.449	174.39	0.59	-7.439	0.4
50.00	138.60	139.28	0.69	139.70	-0.42	-6.549	139.45	-0.17	-6.540	0.3
55.00	108.50	109.18	0.58	109.11	0.06	-5.690	108.91	0.27	-5.684	0.2
60.00	82.00	82.68	0.52	82.73	-0.05	-4.874	82.55	0.13	-4.866	0.2
65.00	59.70	60.38	0.44	60.32	0.06	-4.095	60.17	0.20	-4.088	0.1
70.00	40.60	41.28	0.46	41.72	-0.44	-3.351	41.60	-0.33	-3.345	0.1
75.00	25.50	26.18	0.60	26.76	-0.58	-2.635	26.68	-0.50	-2.629	0.0
80.00	14.00	14.68	0.37	15.34	-0.66	-1.940	15.28	-0.60	-1.933	0.0

TABLE VI v
Deep focus (600 km) differential travel times ScS(SV)−S(SV): Jordan and Anderson (1974). No baseline correction

DELTA	OBSERVATION			ANISOTROPIC			ISOTROPIC			T*
	T OBS	T CORR	ERROR	T COMP	(O-C)	P	T COMP	(O-C)	P	
DEG	SEC	SEC	SEC	SEC	SEC	SEC/DEG	SEC	SEC	SEC/DEG	SEC
35.00	259.40	259.40	0.71	258.11	1.29	-9.342	258.22	1.18	-9.343	0.6
40.00	215.70	215.70	0.66	213.81	1.89	-8.376	213.91	1.79	-8.377	0.5
45.00	174.30	174.30	0.52	174.31	-0.01	-7.439	174.39	-0.09	-7.439	0.4
50.00	138.60	138.60	0.69	139.38	-0.78	-6.540	139.45	-0.85	-6.540	0.3
55.00	108.50	108.50	0.58	108.84	-0.34	-5.682	108.91	-0.41	-5.684	0.2
60.00	82.00	82.00	0.52	82.51	-0.51	-4.866	82.55	-0.55	-4.866	0.2
65.00	59.70	59.70	0.44	60.14	-0.44	-4.088	60.17	-0.47	-4.088	0.1
70.00	40.60	40.60	0.46	41.58	-0.98	-3.344	41.60	-1.00	-3.345	0.1
75.00	25.50	25.50	0.60	26.66	-1.16	-2.629	26.68	-1.18	-2.629	0.0
80.00	14.00	14.00	0.37	15.25	-1.25	-1.934	15.28	-1.28	-1.933	0.0

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