

## 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  $1.75 \times 10^6$  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 sep-

arately 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,  $dK/dP$  and the Bullen parameter,  $\eta_B$ .

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 difused 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:  $5.974 \times 10^{24}$  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  $4 \times 10^{-3}$  for some of the toroidal overtones to the  $4 \times 10^{-6}$  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.

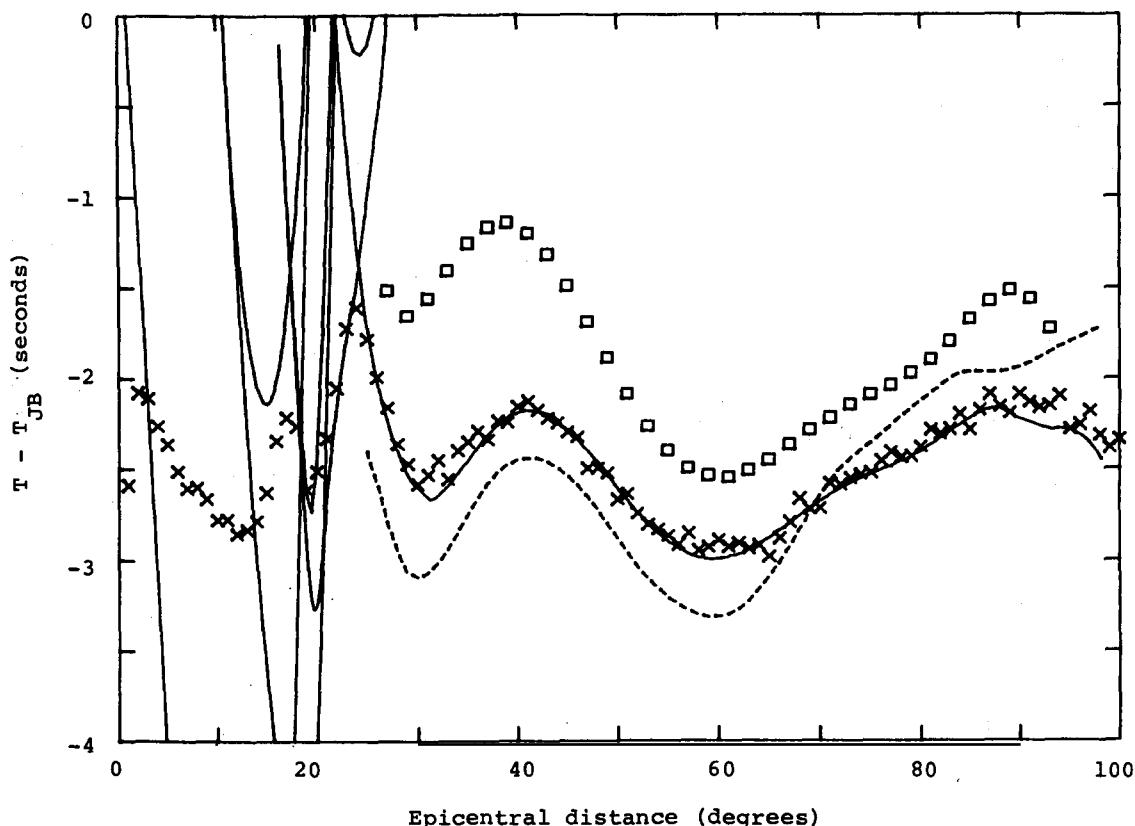


Fig. 1. Surface focus P-wave travel-time residuals with respect to JB times. Crosses are ISC data. Boxes are from Hales et al. (1968). Dashed line is from Herrin et al. (1968). Solid line is anisotropic PREM. ISC times have been corrected with  $-1.88\text{ s}$  baseline and  $-0.0085\text{ s deg}^{-1}$  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,  $\text{PcP}-$

$\text{P}$  (Engdahl and Johnson, 1974) and  $\text{ScS-S}$  (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).

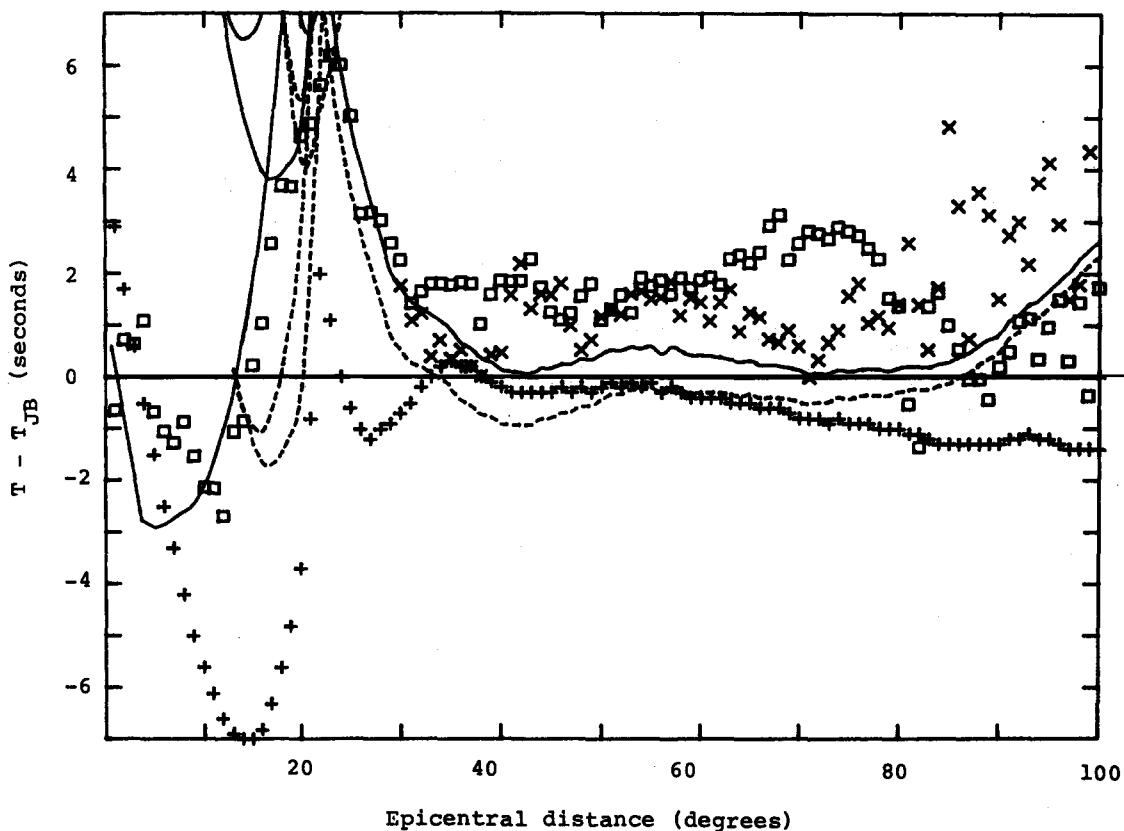


Fig. 2. Surface focus S-wave travel-time residuals with respect to JB. Boxes are ISC data. + : from Gogna et al. (1981).  $\times$  : from Hales and Roberts (1970). Solid line is for the vertically polarized (SV) shear wave and dashed line is for the horizontally polarized (SH) shear wave in the anisotropic 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  $25^\circ$ , 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  $24^\circ$ ; without that feature the intersection occurs at  $21.5^\circ$ , 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  $90^\circ$ . 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:  $\rho = a + bv_p$ . 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  $3.32 \text{ g cm}^{-3}$ , respectively. This yielded a central density of  $12.97 \text{ g cm}^{-3}$  and a density jump at 670 km of  $-0.35 \text{ g cm}^{-3}$ . 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,  $\sim 4.8 \text{ km s}^{-1}$ , in the uppermost mantle. Such models do not satisfy short period ( $< 200 \text{ s}$ ) Love and Rayleigh wave data or shear wave travel times at short distances ( $< 20^\circ$ ). 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). This 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)

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

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

where  $\rho$  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:

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

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

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  $\eta$  ranging from 0.9 to 1.1. For an isotropic solid,  $A = C$ ,  $L = N$ , and  $\eta = 1$ . It is clear that variations in  $\eta$  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

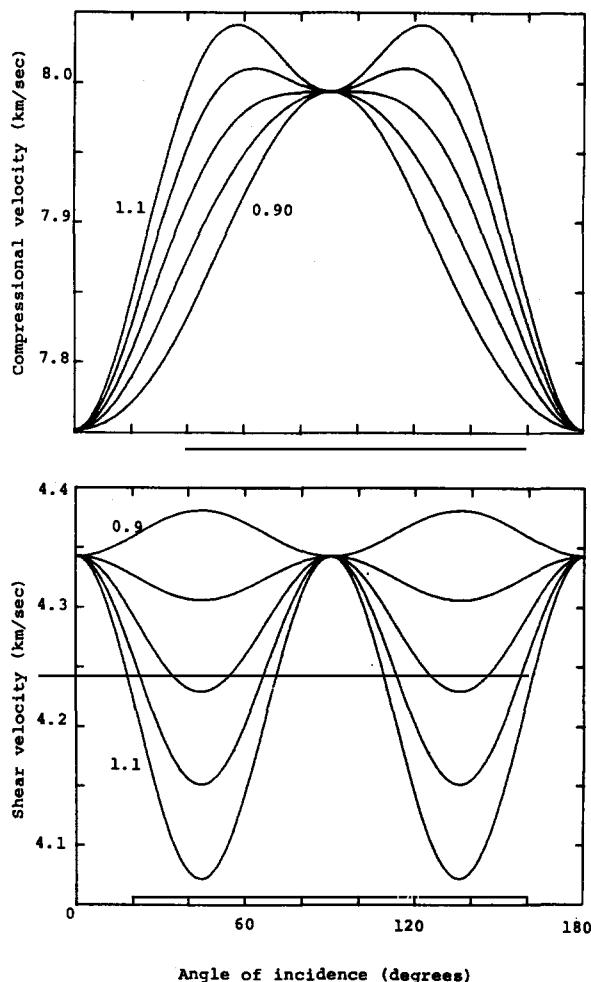


Fig. 3. P- and S-velocities as a function of angle of incidence and the anisotropic parameter  $\eta$ , which is varied from 0.9 to 1.1 at intervals of 0.05. The values of velocities used in the calculation are  $V_{\text{PV}} = 7.752 \text{ km s}^{-1}$ ;  $V_{\text{PH}} = 7.994 \text{ km s}^{-1}$  and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

almost independent of SV and SH, respectively, but Rayleigh waves are sensitive to  $\eta$ , 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, particu-

larly 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  $\eta$ , 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  $\eta$  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

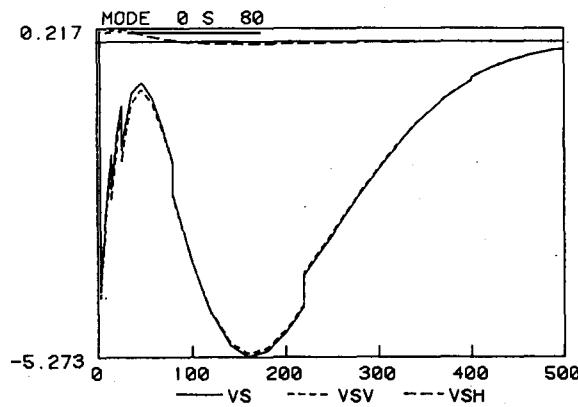


Fig. 4. Partial derivatives for a relative change in period of mode  ${}_0S_{80}$  ( $T \sim 120$  s) as a function of depth. The short dashed line corresponds to perturbation in SV velocity and long dashed line SH velocity;  $\tilde{S}_V$  and  $\tilde{S}_H$  of eq. A6 of the Appendix. The continuous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

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

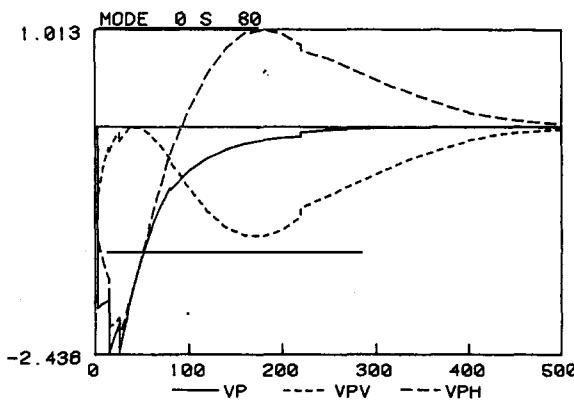


Fig. 5. Partial derivatives for a relative change in period of mode  ${}_0S_{80}$  ( $T \sim 120$  s) as a function of depth. The short dashed line corresponds to perturbation in PV velocity and long-dashed line in PH velocity;  $\tilde{P}_V$  and  $\tilde{P}_H$  of eq. A6 of the Appendix. The solid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

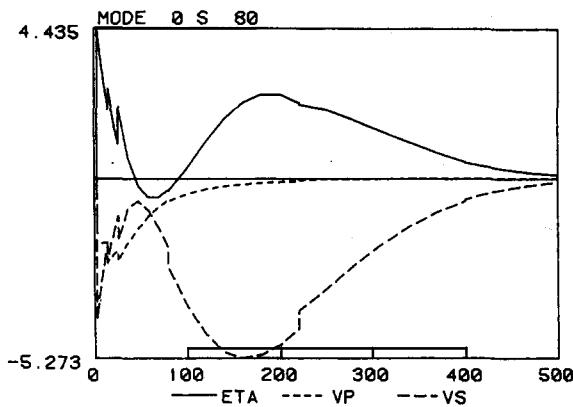


Fig. 6. Partial derivatives giving the relative change in period with respect to the anisotropic parameter  $\eta$  (solid line) and the isotropic velocities  $V_p$  (short-dashed line) and  $V_s$  (long-dashed line). See eqs. A6 and A9 of the Appendix.

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  $\eta$  partial; it is clear that perturbations in the anisotropic parameter  $\eta$  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 ( $V_p$ ,  $V_s$ ,  $\rho$ ,  $q_\mu$ ,  $q_K$ ), where  $q = Q^{-1}$  and  $q_\mu$  and  $q_K$  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

$$\begin{aligned} \frac{\delta T}{T} &= \int_0^1 dr (\delta v_p \cdot \tilde{P} + \delta v_s \cdot \tilde{S} + \delta \rho \cdot \tilde{R} \\ &\quad + \delta q_\mu \tilde{M} \cdot \ln \tau + \delta q_K \tilde{K} \cdot \ln \tau) \quad (1) \\ &\quad + (\text{terms related to changes in radii of discontinuities}) \end{aligned}$$

where  $\tau$  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

$$\delta q = \int_0^1 dr (\delta q_\mu \cdot Q \tilde{M} + \delta q_K \cdot Q \tilde{K}) \quad (2)$$

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  $\delta q_\mu$ ,  $\delta q_K$  terms in eq. 1 above may provide additional resolution for the anelastic structure, since  $\ln \tau$  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

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

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

$$\begin{aligned} V_S(T) &= V_S(1) \cdot \left( 1 - \frac{\ln T}{\pi} q_\mu \right) \\ V_P(T) &= V_P(1) \cdot \left\{ 1 - \frac{\ln T}{\pi} [(1-E) q_K + E q_\mu] \right\} \end{aligned} \quad (3)$$

where

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

(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

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

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

these represent upper bounds on the effective elastic moduli.

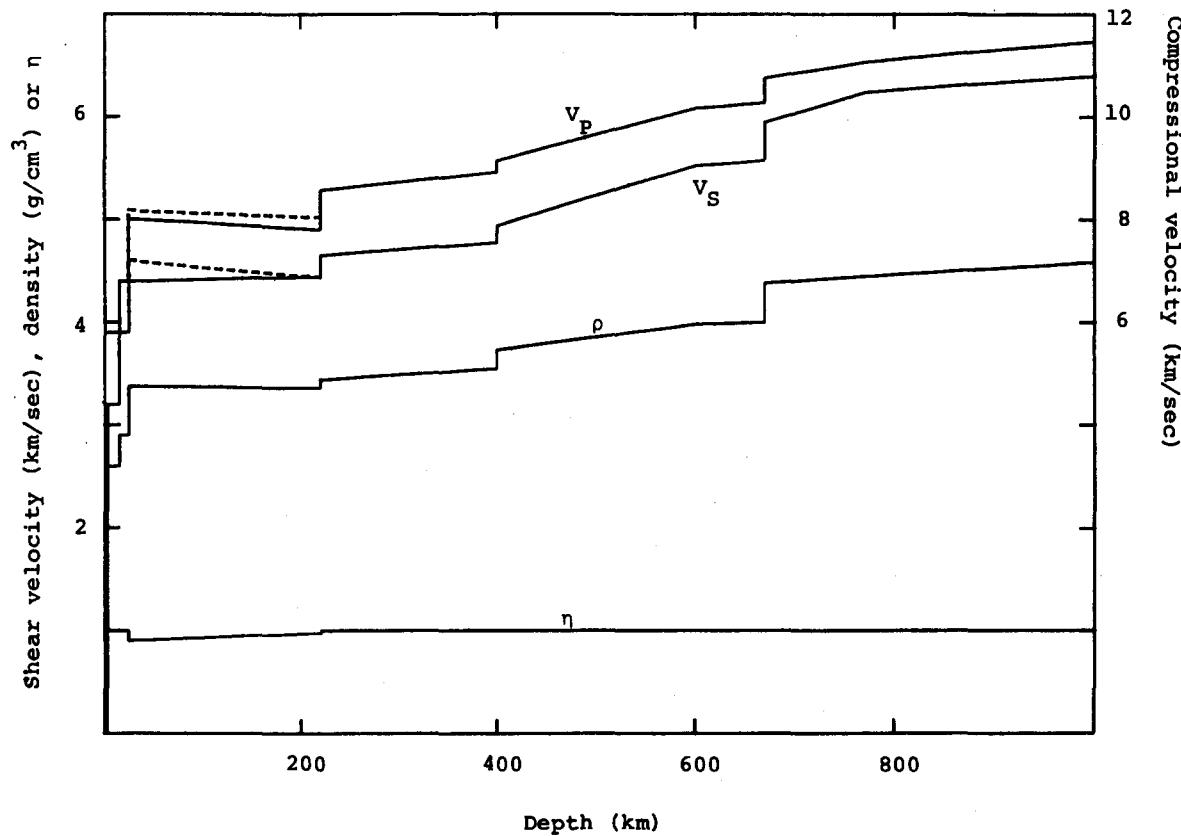


Fig. 7. Upper mantle velocities, density and anisotropic parameter  $\eta$  in PREM. The dashed lines are the horizontal components of velocity. The solid curves are  $\eta$ ,  $\rho$  and the vertical, or radial, components of velocity.

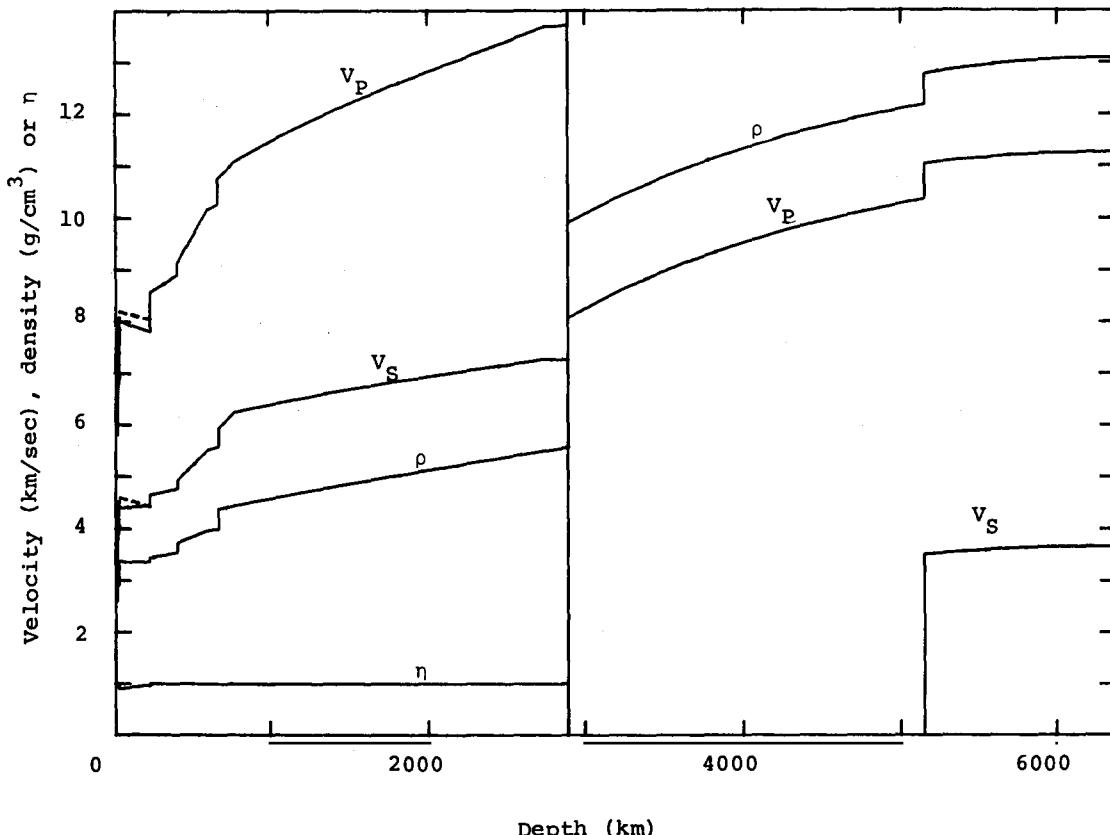


Fig. 8. The PREM model. Dashed lines are the horizontal components of velocity. Where  $\eta$  is 1 the model is isotropic. The core is isotropic.

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

$$\eta_B = \frac{dK}{dP} + \frac{1}{g} \frac{d\Phi}{dr} \quad (4)$$

For the most part  $\eta_B$  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  $dK/dP$  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.

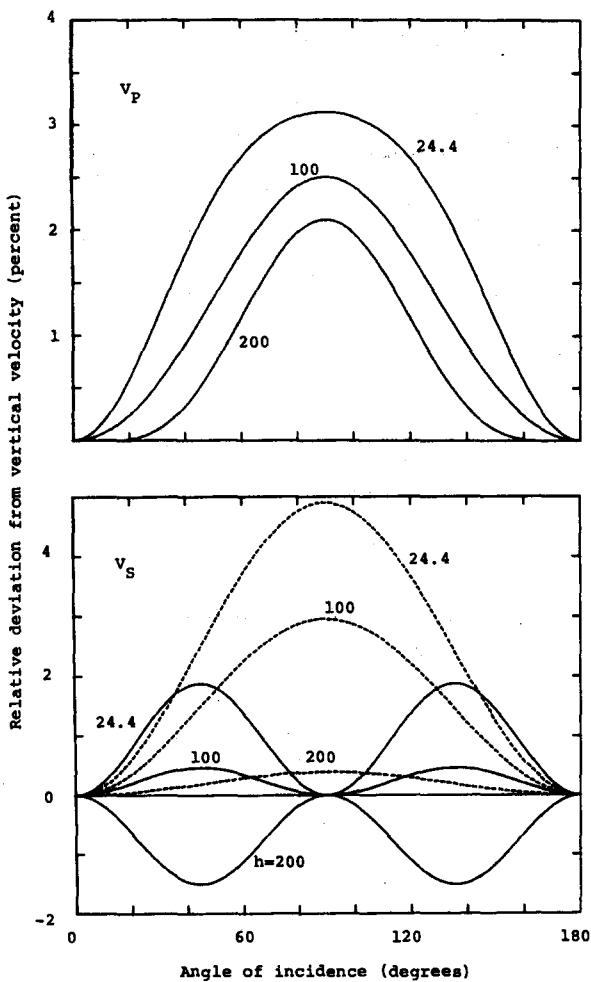


Fig. 9. Velocity as a function of direction of angle of incidence for three depths in the anisotropic region of the PREM model. Upper curves are compressional velocities; lower panel gives  $V_{SV}$  (solid) and  $V_{SH}$  (dashed).

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 dif-

ferences 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 | DEPTH  | DENSITY           | VP        | VS      | QMU  | QK    | QAL   | PHI                             | KAPPA | MU   | SIGMA  | PRESSURE | DK/DP             | E.P. | GRAVITY |
|-------|--------|--------|-------------------|-----------|---------|------|-------|-------|---------------------------------|-------|------|--------|----------|-------------------|------|---------|
|       | KM     | KM     | G/CM <sup>3</sup> | KM/S      | KM/S    | KM/S | KM/S  | KM/S  | KM <sup>2</sup> /S <sup>2</sup> | KBAR  | KBAR | KBAR   | KBAR     | CM/S <sup>2</sup> |      |         |
| 1     | 0.     | 6371.0 | 13.08848          | 11.262220 | 3.66780 | 85   | 1328  | 431   | 108.90                          | 14253 | 1761 | 0.4407 | 3638.524 | 2.3356            | 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 | 11.09777          | 11.25593  | 3.66342 | 85   | 1328  | 431   | 108.86                          | 14231 | 1755 | 0.4408 | 3622.956 | 2.3356            | 0.99 | 73.11   |
| 4     | 300.0  | 6071.0 | 13.08888          | 11.24809  | 3.65794 | 85   | 1328  | 432   | 108.68                          | 14203 | 1759 | 0.4409 | 3617.011 | 2.3356            | 0.99 | 109.61  |
| 5     | 400.0  | 5971.0 | 13.08564          | 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 | 13.08404          | 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 | 13.08079          | 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 | 1676 | 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 | 12.92111          | 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 | 12.89073          | 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 | 12.88501          | 11.07249  | 3.53522 | 85   | 1328  | 443   | 105.94                          | 13586 | 1603 | 0.4432 | 3355.956 | 2.3460            | 1.00 | 397.39  |
| 13    | 1200.0 | 5171.0 | 12.77993          | 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 | 12.73636          | 11.02827  | 3.50432 | 85   | 1328  | 445   | 105.23                          | 13434 | 1567 | 0.4438 | 3281.513 | 2.3486            | 1.00 | 440.02  |
| 15    | 1221.5 | 5149.5 | 12.19634          | 10.35568  | 0.      | 0    | 57822 | 57822 | 107.24                          | 13047 | 0    | 0.5010 | 3288.502 | 3.7545            | 1.03 | 440.03  |
| 16    | 1300.0 | 5071.0 | 12.15500          | 10.30971  | 0.      | 0    | 57822 | 57822 | 106.29                          | 12888 | 0    | 0.5010 | 3245.423 | 3.6539            | 1.02 | 463.68  |
| 17    | 1400.0 | 4971.0 | 12.09924          | 10.24959  | 0.      | 0    | 57822 | 57822 | 105.05                          | 12679 | 0    | 0.5010 | 3187.943 | 3.5478            | 1.01 | 494.13  |
| 18    | 1500.0 | 4871.0 | 12.08989          | 10.18743  | 0.      | 0    | 57822 | 57822 | 103.78                          | 12464 | 0    | 0.5010 | 3126.159 | 3.4649            | 1.01 | 524.77  |
| 19    | 1600.0 | 4771.0 | 11.96882          | 10.12291  | 0.      | 0    | 57822 | 57822 | 102.47                          | 12242 | 0    | 0.5010 | 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    | 0.5010 | 2993.457 | 3.3552            | 1.00 | 586.14  |
| 21    | 1800.0 | 4571.0 | 11.85900          | 9.98554   | 0.      | 0    | 57822 | 57822 | 99.71                           | 11775 | 0    | 0.5010 | 2922.221 | 3.3230            | 1.00 | 616.69  |
| 22    | 1900.0 | 4471.0 | 11.73011          | 9.91206   | 0.      | 0    | 57822 | 57822 | 98.25                           | 11529 | 0    | 0.5010 | 2847.839 | 3.3038            | 1.00 | 647.04  |
| 23    | 2000.0 | 4371.0 | 11.64976          | 9.83496   | 0.      | 0    | 57822 | 57822 | 96.73                           | 11273 | 0    | 0.5010 | 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    | 0.5010 | 2690.035 | 3.2911            | 1.00 | 706.97  |
| 25    | 2200.0 | 4171.0 | 11.43311          | 9.66865   | 0.      | 0    | 57822 | 57822 | 93.48                           | 10735 | 0    | 0.5010 | 2601.461 | 3.4017            | 1.00 | 736.45  |
| 26    | 2300.0 | 4071.0 | 11.30402          | 9.57881   | 0.      | 0    | 57822 | 57822 | 91.75                           | 10451 | 0    | 0.5010 | 2520.942 | 3.3080            | 1.00 | 765.56  |
| 27    | 2400.0 | 3971.0 | 11.20298          | 9.48409   | 0.      | 0    | 57822 | 57822 | 89.95                           | 10158 | 0    | 0.5010 | 2432.484 | 3.3242            | 1.00 | 794.55  |
| 28    | 2500.0 | 3871.0 | 11.10667          | 9.38418   | 0.      | 0    | 57822 | 57822 | 88.06                           | 9855  | 0    | 0.5010 | 2341.603 | 3.3441            | 1.00 | 822.48  |
| 29    | 2600.0 | 3771.0 | 10.9335           | 9.27876   | 0.      | 0    | 57822 | 57822 | 86.10                           | 9542  | 0    | 0.5010 | 2248.553 | 3.4977            | 1.00 | 867.04  |
| 30    | 2700.0 | 3671.0 | 10.92091          | 9.16752   | 0.      | 0    | 57822 | 57822 | 84.04                           | 9220  | 0    | 0.5010 | 2153.169 | 3.3919            | 1.00 | 877.46  |
| 31    | 2800.0 | 3571.0 | 10.85321          | 9.05015   | 0.      | 0    | 57822 | 57822 | 82.30                           | 10451 | 0    | 0.5010 | 2055.978 | 3.4180            | 1.00 | 904.14  |
| 32    | 2900.0 | 3471.0 | 10.75012          | 8.92632   | 0.      | 0    | 57822 | 57822 | 79.68                           | 8550  | 0    | 0.5010 | 1976.991 | 3.4448            | 1.00 | 930.23  |
| 33    | 3000.0 | 3371.0 | 10.61052          | 8.79573   | 0.      | 0    | 57822 | 57822 | 77.36                           | 8202  | 0    | 0.5010 | 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    | 0.5010 | 1754.418 | 3.4977            | 1.00 | 980.51  |
| 35    | 3200.0 | 3171.0 | 10.32726          | 8.51298   | 0.      | 0    | 57822 | 57822 | 72.47                           | 7484  | 0    | 0.5010 | 1651.209 | 3.5215            | 1.00 | 1004.64 |
| 36    | 3300.0 | 3071.0 | 10.18334          | 8.36019   | 0.      | 0    | 57822 | 57822 | 69.89                           | 7116  | 0    | 0.5010 | 1546.982 | 3.5437            | 1.00 | 1028.04 |
| 37    | 3400.0 | 2971.0 | 10.02940          | 8.19939   | 0.      | 0    | 57822 | 57822 | 67.23                           | 6743  | 0    | 0.5010 | 1441.941 | 3.5622            | 0.99 | 1050.65 |
| 38    | 3480.0 | 2891.0 | 9.90319           | 8.06482   | 0.      | 0    | 57822 | 57822 | 65.04                           | 6441  | 0    | 0.5010 | 1357.510 | 3.5769            | 0.98 | 1068.23 |
| 39    | 3480.0 | 2891.0 | 9.56645           | 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 | 9.55641           | 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 | 9.50642           | 13.68753  | 7.26575 | 312  | 57822 | 823   | 116.96                          | 6440  | 2907 | 0.3038 | 1287.067 | 1.6424            | 1.01 | 1055.04 |
| 42    | 3630.0 | 2741.0 | 9.49145           | 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 | 9.49445           | 13.68041  | 7.26597 | 312  | 57822 | 822   | 116.76                          | 6412  | 2899 | 0.3035 | 1269.741 | 3.3344            | 1.01 | 1044.44 |
| 44    | 3700.0 | 2671.0 | 9.46645           | 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 | 9.46881           | 13.47742  | 7.18892 | 312  | 57822 | 815   | 112.73                          | 6095  | 2794 | 0.3012 | 117.465  | 3.2443            | 1.01 | 1030.95 |
| 46    | 3800.0 | 2471.0 | 9.35706           | 13.36074  | 7.14423 | 312  | 57822 | 811   | 110.46                          | 5917  | 274  | 0.2998 | 1118.207 | 3.2029            | 1.00 | 1022.72 |
| 47    | 4000.0 | 2371.0 | 9.31724           | 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/CM <sup>3</sup> | VP KM/S  | VS KM/S | KH/S | GRU   | OK    | QAL    | PHI KM <sup>2</sup> /S <sup>2</sup> | KM <sup>2</sup> /S <sup>2</sup> | KAPPA KBAR | MU KBAR  | SIGMA KBAR | PRESSURE KBAR | DK/DP   | E.P. | GRAVITY CM/S <sup>2</sup> |
|-----------------|----------|---------------------------|----------|---------|------|-------|-------|--------|-------------------------------------|---------------------------------|------------|----------|------------|---------------|---------|------|---------------------------|
| 48 4100.0       | 2271.0   | 5.25729                   | 13.13055 | 7.05525 | 312  | 57622 | 803   | 106.04 | 5575                                | 2617                            | 0.2971     | 1010.363 | 3.1503     | 1.00          | 1010.06 |      |                           |
| 49 4200.0       | 2171.0   | 5.2713                    | 13.01579 | 7.01053 | 312  | 57622 | 799   | 103.68 | 5409                                | 2559                            | 0.2957     | 957.641  | 3.1393     | 1.00          | 1005.35 |      |                           |
| 50 4300.0       | 2071.0   | 5.15669                   | 12.90045 | 6.96538 | 312  | 57622 | 795   | 101.73 | 5246                                | 2502                            | 0.2943     | 905.646  | 3.1353     | 1.00          | 1001.56 |      |                           |
| 51 4400.0       | 1971.0   | 5.1959                    | 12.78389 | 6.91957 | 312  | 57622 | 792   | 99.59  | 5085                                | 2445                            | 0.2928     | 854.532  | 3.1412     | 1.00          | 998.59  |      |                           |
| 52 4500.0       | 1871.0   | 5.08669                   | 12.66550 | 6.87289 | 312  | 57622 | 788   | 97.43  | 4925                                | 2388                            | 0.2913     | 803.660  | 3.1657     | 1.00          | 996.35  |      |                           |
| 53 4600.0       | 1771.0   | 5.0299                    | 12.54466 | 6.82512 | 312  | 57622 | 784   | 95.46  | 4765                                | 2331                            | 0.2898     | 753.598  | 3.1935     | 0.99          | 994.4   |      |                           |
| 54 4700.0       | 1671.0   | 4.98073                   | 12.42075 | 6.77606 | 312  | 57622 | 779   | 93.06  | 4607                                | 2273                            | 0.2881     | 704.119  | 3.2502     | 0.99          | 993.69  |      |                           |
| 55 4800.0       | 1571.0   | 4.88783                   | 12.30316 | 6.72548 | 312  | 57622 | 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  | 57622 | 770   | 88.52  | 4288                                | 2157                            | 0.2846     | 606.830  | 3.3216     | 0.99          | 993.01  |      |                           |
| 57 5000.0       | 1371.0   | 4.79883                   | 12.02445 | 6.61891 | 312  | 57622 | 766   | 86.17  | 4128                                | 2098                            | 0.2826     | 558.991  | 3.3811     | 0.99          | 993.26  |      |                           |
| 58 5100.0       | 1271.0   | 4.7460                    | 11.88209 | 6.56250 | 312  | 57622 | 761   | 83.16  | 3966                                | 2039                            | 0.2805     | 511.676  | 3.4522     | 0.99          | 993.83  |      |                           |
| 59 5200.0       | 1171.0   | 4.6744                    | 11.73357 | 6.50370 | 312  | 57622 | 755   | 81.28  | 3803                                | 1979                            | 0.2783     | 464.882  | 3.5236     | 0.99          | 994.67  |      |                           |
| 60 5300.0       | 1071.0   | 4.62129                   | 11.7828  | 6.44232 | 312  | 57622 | 750   | 78.72  | 3638                                | 1918                            | 0.2758     | 418.605  | 3.5939     | 0.99          | 995.3   |      |                           |
| 61 5400.0       | 971.0    | 4.5607                    | 11.41560 | 6.37613 | 312  | 57622 | 743   | 76.08  | 3471                                | 1856                            | 0.2731     | 372.852  | 3.6775     | 0.98          | 996.98  |      |                           |
| 62 5500.0       | 871.0    | 4.50312                   | 10.24490 | 6.31091 | 312  | 57622 | 737   | 73.34  | 3303                                | 1794                            | 0.2701     | 327.623  | 3.7612     | 0.98          | 998.36  |      |                           |
| 63 5600.0       | 771.0    | 4.43317                   | 11.06557 | 6.24046 | 312  | 57622 | 730   | 70.52  | 3133                                | 1730                            | 0.2668     | 282.928  | 3.8412     | 0.97          | 999.85  |      |                           |
| 64 5600.0       | 771.0    | 4.44316                   | 11.06556 | 6.24046 | 312  | 57622 | 730   | 70.52  | 3133                                | 1730                            | 0.2668     | 282.927  | 2.9819     | 0.97          | 999.85  |      |                           |
| 65 5650.0       | 721.0    | 4.41491                   | 10.91005 | 6.09418 | 312  | 57622 | 744   | 69.51  | 3067                                | 1639                            | 0.2792     | 260.783  | 3.0086     | 0.97          | 1000.63 |      |                           |
| 66 5701.0       | 670.0    | 4.38071                   | 10.75131 | 5.94508 | 312  | 57622 | 759   | 68.47  | 2999                                | 1548                            | 0.2798     | 238.342  | 3.0358     | 0.98          | 1001.43 |      |                           |
| 67 5701.0       | 670.0    | 3.9214                    | 10.26622 | 5.57020 | 143  | 57622 | 362   | 64.03  | 2556                                | 1259                            | 0.2914     | 238.334  | 2.9000     | 0.97          | 1001.3  |      |                           |
| 68 5736.0       | 635.0    | 3.9399                    | 10.21203 | 5.54311 | 143  | 57622 | 362   | 63.32  | 2523                                | 1224                            | 0.2911     | 224.364  | 2.3868     | 0.97          | 998.88  |      |                           |
| 69 5751.0       | 600.0    | 3.97584                   | 10.15782 | 5.51602 | 143  | 57622 | 362   | 62.61  | 2489                                | 1210                            | 0.2909     | 210.426  | 3.3734     | 0.97          | 1000.38 |      |                           |
| 70 5771.0       | 600.0    | 3.97584                   | 10.15782 | 5.51600 | 143  | 57622 | 362   | 62.61  | 2489                                | 1210                            | 0.2909     | 210.425  | 0.0921     | 1.98          | 1000.38 |      |                           |
| 71 5821.0       | 550.0    | 3.9282                    | 9.50185  | 5.37014 | 143  | 57622 | 363   | 59.60  | 2332                                | 1128                            | 0.2917     | 190.703  | 7.8883     | 1.92          | 999.65  |      |                           |
| 72 5871.0       | 500.0    | 3.85980                   | 9.64588  | 5.24248 | 143  | 57622 | 364   | 56.65  | 2161                                | 1051                            | 0.2924     | 171.311  | 7.6761     | 1.86          | 998.83  |      |                           |
| 73 5921.0       | 450.0    | 3.78618                   | 9.38990  | 5.07842 | 143  | 57622 | 365   | 53.78  | 2037                                | 977                             | 0.2933     | 152.251  | 1.7462     | 1.79          | 999.70  |      |                           |
| 74 5971.0       | 400.0    | 3.72378                   | 9.33397  | 4.93259 | 143  | 57622 | 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  | 57622 | 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  | 57622 | 370   | 47.63  | 1682                                | 790                             | 0.2971     | 117.702  | 3.3359     | 0.82          | 995.22  |      |                           |
| 77 6061.0       | 310.0    | 3.49951                   | 8.73209  | 4.70690 | 143  | 57622 | 367   | 46.71  | 773                                 | 0.2952                          | 102.027    | 3.3017   | 0.80       | 993.61        |         |      |                           |
| 78 6106.0       | 265.0    | 3.46264                   | 8.44552  | 4.67540 | 143  | 57622 | 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  | 57622 | 362   | 44.50  | 1529                                | 741                             | 0.2914     | 71.115   | 3.2315     | 0.78          | 990.48  |      |                           |
| 80 6151.0       | 220.0    | 3.35950                   | 8.55896  | 4.64391 | 143  | 57622 | 195   | 37.80  | 1270                                | 656                             | 0.2797     | 44.539   | -0.6700    | -0.13         | 985.53  |      |                           |
| 81 6186.0       | 185.0    | 3.36330                   | 8.01180  | 4.43108 | 600  | 57622 | 195   | 38.01  | 1278                                | 660                             | 0.2797     | 77.108   | -0.7344    | -0.12         | 984.93  |      |                           |
| 82 6221.0       | 150.0    | 3.36710                   | 8.03370  | 4.44361 | 600  | 57622 | 195   | 38.21  | 1287                                | 665                             | 0.2796     | 59.466   | -0.7200    | -0.12         | 987.03  |      |                           |
| 83 6256.0       | 115.0    | 3.37091                   | 8.03554  | 4.45643 | 600  | 57622 | 195   | 38.41  | 1295                                | 669                             | 0.2795     | 47.824   | 7.7035     | -0.12         | 987.03  |      |                           |
| 84 6291.0       | 80.0     | 3.37271                   | 8.03768  | 4.46953 | 600  | 57622 | 195   | 38.60  | 1303                                | 674                             | 0.2793     | 36.183   | -0.6888    | -0.13         | 986.64  |      |                           |
| 85 6291.0       | 80.0     | 3.37471                   | 8.03768  | 4.46954 | 600  | 57622 | 1447  | 38.60  | 1303                                | 674                             | 0.2793     | 24.556   | -0.6700    | -0.13         | 985.53  |      |                           |
| 86 6311.0       | 60.0     | 3.37688                   | 8.06907  | 4.47715 | 600  | 57622 | 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  | 57622 | 1446  | 38.81  | 1311                                | 680                             | 0.2790     | 11.239   | -0.6515    | -0.13         | 984.37  |      |                           |
| 88 6346.6       | 24.4     | 3.38076                   | 8.10161  | 4.49094 | 600  | 57622 | 1446  | 38.89  | 1315                                | 682                             | 0.2789     | 6.043    | -0.6426    | -0.13         | 983.94  |      |                           |
| 89 6346.6       | 24.4     | 2.99000                   | 6.00000  | 3.96000 | 600  | 57622 | 1350  | 25.96  | 753                                 | 441                             | 0.2549     | 6.040    | -0.0000    | -0.00         | 983.94  |      |                           |
| 90 6356.0       | 15.0     | 2.99000                   | 6.00000  | 3.96000 | 600  | 57622 | 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  | 57622 | 1456  | 19.99  | 520                                 | 266                             | 0.2812     | 3.364    | 0.0000     | 0.00          | 983.31  |      |                           |
| 92 6368.0       | 3.0      | 2.60000                   | 5.00000  | 3.20000 | 600  | 57622 | 1456  | 19.99  | 520                                 | 266                             | 0.2812     | 0.303    | -0.0000    | -0.00         | 982.82  |      |                           |
| 93 6368.0       | 3.0      | 1.02000                   | 1.45000  | 1.45000 | 0.   | 57622 | 57622 | 2.10   | 21                                  | 0                               | 0.5000     | 0.2299   | -0.0000    | -0.00         | 982.22  |      |                           |
| 94 6371.0       | 0.       | 1.02000                   | 1.45000  | 1.45000 | 0.   | 57622 | 57622 | 2.10   | 21                                  | 0                               | 0.5000     | -0.0000  | -0.0000    | -0.00         | 981.56  |      |                           |

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

| LEVEL | RADIUS | DEPTH  | DENSITY  | VP       | VS      | QMU  | QK    | QAL   | KM/S   | KM/S   | KM/S | KM/S   | KM/S     | KM/S     | KM/S   | KM/S    | KBAR    | KBAR | KBAR | CM/S2 |  |
|-------|--------|--------|----------|----------|---------|------|-------|-------|--------|--------|------|--------|----------|----------|--------|---------|---------|------|------|-------|--|
|       | KM     | KM     | G/CCM    | KM/S     | KM/S    | KM/S | KM/S  | KM/S  | KM/S   | KM/S   | KM/S | KM/S   | KM/S     | KM/S     | KM/S   | KM/S    | KM/S    | KBAR | KBAR | KBAR  |  |
| 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 | 11.22166 | 3.59362 | 85   | 1328  | 440   | 108.59 | 14211  | 1690 | 0.4428 | 3638.131 | 2.3301   | 0.99   | 36.56   |         |      |      |       |  |
| 3     | 200.0  | 6171.0 | 13.07977 | 11.22197 | 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 | 11.22021 | 3.58503 | 85   | 1328  | 441   | 108.40 | 14166  | 1680 | 0.4430 | 3617.052 | 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 | 13.01099 | 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   | 254.75  |         |      |      |       |  |
| 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 | 11.06394 | 3.08731 | 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 | 3.06475 | 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 | 12.76364 | 10.95538 | 0.      | 0    | 57822 | 57822 | 107.23 | 13046  | 0    | 0.5000 | 3288.502 | 1.03     | 440.03 |         |         |      |      |       |  |
| 16    | 1300.0 | 5071.0 | 12.12500 | 10.35354 | 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 | 3181.493 | 3.5476   | 1.01   | 494.13  |         |      |      |       |  |
| 18    | 1500.0 | 4871.0 | 12.09889 | 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 | 10.12626 | 0.      | 0    | 57822 | 57822 | 102.47 | 12242  | 0    | 0.5000 | 3040.461 | 3.4015   | 1.00   | 555.48  |         |      |      |       |  |
| 20    | 1700.0 | 4671.0 | 11.87990 | 10.05553 | 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 | 9.98825  | 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 | 9.81467  | 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 | 11.39402 | 9.57853  | 0.      | 0    | 57822 | 57822 | 91.75  | 10451  | 0    | 0.5000 | 2520.942 | 3.3050   | 1.00   | 765.56  |         |      |      |       |  |
| 27    | 2400.0 | 3971.0 | 11.29298 | 9.06381  | 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 | 231.603  | 3.3439   | 1.00   | 822.48  |         |      |      |       |  |
| 29    | 2600.0 | 3771.0 | 11.08335 | 9.2849   | 0.      | 0    | 57822 | 57822 | 86.09  | 9542   | 0    | 0.5000 | 228.453  | 3.3668   | 1.00   | 850.23  |         |      |      |       |  |
| 30    | 2700.0 | 3671.0 | 10.97091 | 9.14726  | 0.      | 0    | 57822 | 57822 | 84.04  | 9220   | 0    | 0.5000 | 213.189  | 3.3917   | 1.00   | 877.44  |         |      |      |       |  |
| 31    | 2800.0 | 3571.0 | 10.85321 | 9.04988  | 0.      | 0    | 57822 | 57822 | 81.90  | 8889   | 0    | 0.5000 | 205.978  | 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 | 1750.418 | 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 | 8.35959  | 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 | 1411.941 | 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 | 9.56645  | 13.68862 | 7.22538 | 312  | 57822 | 57822 | 63.32  | 117.77 | 6556 | 2906   | 0.3669   | 1357.509 | 1.6434 | 0.99    | 1068.23 |      |      |       |  |
| 40    | 3500.0 | 2871.0 | 9.55641  | 13.63369 | 7.22559 | 312  | 57822 | 57822 | 63.31  | 117.63 | 6536 | 2901   | 0.3667   | 1345.619 | 1.6433 | 1.00    | 1065.32 |      |      |       |  |
| 41    | 3600.0 | 2771.0 | 9.50642  | 13.55949 | 7.22647 | 312  | 57822 | 57822 | 62.88  | 116.95 | 6440 | 2876   | 0.3577   | 1287.067 | 1.6423 | 1.00    | 1052.04 |      |      |       |  |
| 42    | 3630.0 | 2741.0 | 9.49145  | 13.62334 | 7.22670 | 312  | 57822 | 57822 | 62.27  | 116.75 | 6411 | 2868   | 0.3554   | 1269.742 | 1.6419 | 1.00    | 1048.44 |      |      |       |  |
| 43    | 3630.0 | 2741.0 | 9.49145  | 13.62334 | 7.22670 | 312  | 57822 | 57822 | 62.27  | 116.75 | 6411 | 2868   | 0.3554   | 1269.741 | 1.6419 | 1.00    | 1048.44 |      |      |       |  |
| 44    | 3700.0 | 2671.0 | 9.45657  | 13.56798 | 7.19492 | 312  | 57822 | 57822 | 62.24  | 115.07 | 6279 | 2764   | 0.3530   | 1173.465 | 3.2441 | 1.01    | 1040.66 |      |      |       |  |
| 45    | 3800.0 | 2571.0 | 9.40681  | 13.44953 | 7.50006 | 312  | 57822 | 57822 | 62.0   | 112.73 | 6095 | 2705   | 0.3517   | 1118.207 | 3.2027 | 1.00    | 1030.55 |      |      |       |  |
| 46    | 3900.0 | 2471.0 | 9.35706  | 13.33296 | 7.10561 | 312  | 57822 | 57822 | 61.16  | 110.45 | 5917 | 2705   | 0.3517   | 1118.207 | 3.1714 | 1.00    | 1022.72 |      |      |       |  |
| 47    | 4000.0 | 2371.0 | 9.30724  | 13.21765 | 7.06136 | 312  | 57822 | 57822 | 61.12  | 108.22 | 5744 | 2646   | 0.3503   | 1063.864 | 3.1714 | 1.00    | 1015.80 |      |      |       |  |

| LEVEL RADIUS KM | DEPTH KM | DENSITY g/cm³ | VP KM/S  | VS KM/S  | QMU     | QK    | GAL   | KM2/S2 | PHI KBAR | KAPPA KBAR | MU KBAR | SIGMA KBAR | PRESSURE KBAR | DK/DP   | E.P.    | GRAVITY CM/S² |
|-----------------|----------|---------------|----------|----------|---------|-------|-------|--------|----------|------------|---------|------------|---------------|---------|---------|---------------|
| 48              | 4100.0   | 2271.0        | 5.25729  | 13.10299 | 7.01711 | 312   | 57622 | 808    | 106.04   | 5575       | 2589    | 0.2989     | 1010.363      | 3.1501  | 1.00    | 1010.06       |
| 49              | 4200.0   | 2171.0        | 5.297264 | 12.97264 | 312     | 57622 | 804   | 103.87 | 5409     | 2532       | 0.2976  | 905.641    | 3.1390        | 1.00    | 1005.35 |               |
| 50              | 4300.0   | 2071.0        | 5.15669  | 12.87311 | 6.92772 | 312   | 57622 | 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   | 57622 | 797    | 99.58    | 5084       | 2418    | 0.2947     | 854.532       | 3.1469  | 1.00    | 998.59        |
| 52              | 4500.0   | 1871.0        | 5.04669  | 12.63839 | 6.83574 | 312   | 57622 | 793    | 97.43    | 4925       | 2362    | 0.2932     | 803.660       | 3.1655  | 1.00    | 996.35        |
| 53              | 4600.0   | 1771.0        | 5.0299   | 12.51767 | 6.78623 | 312   | 57622 | 789    | 95.25    | 4765       | 2305    | 0.2917     | 753.598       | 3.1933  | 0.99    | 994.74        |
| 54              | 4700.0   | 1671.0        | 4.9073   | 12.39389 | 6.73943 | 312   | 57622 | 784    | 93.05    | 4607       | 2249    | 0.2901     | 704.119       | 3.2299  | 0.99    | 993.69        |
| 55              | 4800.0   | 1571.0        | 4.89703  | 12.26642 | 6.69912 | 312   | 57622 | 780    | 90.81    | 4448       | 2192    | 0.2884     | 655.202       | 3.2748  | 0.99    | 993.14        |
| 56              | 4900.0   | 1471.0        | 4.88422  | 12.13466 | 6.63710 | 312   | 57622 | 775    | 88.52    | 2134       | 2084    | 0.2866     | 606.830       | 3.3274  | 0.99    | 993.01        |
| 57              | 5000.0   | 1371.0        | 4.79583  | 11.99798 | 6.58313 | 312   | 57622 | 771    | 86.17    | 4127       | 2076    | 0.2846     | 558.991       | 3.3868  | 0.99    | 993.26        |
| 58              | 5100.0   | 1271.0        | 4.74960  | 11.85576 | 6.52702 | 312   | 57622 | 765    | 83.76    | 3966       | 2017    | 0.2825     | 511.676       | 3.4525  | 0.99    | 993.83        |
| 59              | 5200.0   | 1171.0        | 4.6844   | 11.70739 | 6.46855 | 312   | 57622 | 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   | 57622 | 754    | 78.71    | 3638       | 1897    | 0.2778     | 418.696       | 3.5987  | 0.99    | 995.73        |
| 61              | 5400.0   | 971.0         | 4.53037  | 11.38972 | 6.39365 | 312   | 57622 | 748    | 76.07    | 3471       | 1836    | 0.2751     | 372.852       | 3.6772  | 0.98    | 996.98        |
| 62              | 5500.0   | 871.0         | 4.53372  | 11.21918 | 6.27680 | 312   | 57622 | 741    | 73.54    | 3303       | 1774    | 0.2722     | 327.623       | 3.7580  | 0.98    | 998.36        |
| 63              | 5600.0   | 771.0         | 4.4316   | 11.04002 | 6.20673 | 312   | 57622 | 734    | 70.52    | 3133       | 1712    | 0.2689     | 282.928       | 3.8400  | 0.97    | 999.85        |
| 64              | 5600.0   | 671.0         | 4.44316  | 11.04001 | 6.20672 | 312   | 57622 | 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   | 57622 | 748    | 69.51    | 3067       | 1621    | 0.2753     | 260.763       | 3.0084  | 0.97    | 1000.63       |
| 66              | 5701.0   | 670.0         | 4.35071  | 10.72743 | 5.91294 | 312   | 57622 | 764    | 68.46    | 2999       | 1532    | 0.2818     | 238.342       | 3.0355  | 0.98    | 1001.43       |
| 67              | 5701.0   | 670.0         | 4.39214  | 10.21852 | 5.05452 | 143   | 57622 | 368    | 64.02    | 2556       | 1210    | 0.2956     | 234.334       | 2.3998  | 0.37    | 1001.43       |
| 68              | 5736.0   | 635.0         | 3.93399  | 10.16454 | 5.47775 | 143   | 57622 | 367    | 63.31    | 2522       | 1195    | 0.2954     | 224.364       | 2.3868  | 0.37    | 1000.88       |
| 69              | 5771.0   | 600.0         | 3.97584  | 10.11055 | 5.45097 | 143   | 57622 | 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   | 57622 | 367    | 62.61    | 2489       | 1181    | 0.2951     | 210.425       | 8.0901  | 1.98    | 1000.38       |
| 71              | 5821.0   | 550.0         | 3.9282   | 9.85588  | 5.30682 | 143   | 57622 | 368    | 59.59    | 2332       | 1102    | 0.2959     | 190.703       | 1.8824  | 1.92    | 999.65        |
| 72              | 5871.0   | 500.0         | 3.8980   | 9.60122  | 5.16268 | 143   | 57622 | 369    | 56.65    | 2181       | 1026    | 0.2966     | 171.311       | 7.6752  | 1.86    | 998.03        |
| 73              | 5921.0   | 450.0         | 3.76678  | 9.34655  | 5.01854 | 143   | 57622 | 370    | 53.78    | 2036       | 954     | 0.2975     | 152.251       | 7.4687  | 1.79    | 997.90        |
| 74              | 5974.0   | 400.0         | 3.72378  | 9.09193  | 4.87442 | 143   | 57622 | 371    | 50.58    | 1898       | 885     | 0.2983     | 133.527       | 7.2624  | 1.73    | 996.86        |
| 75              | 5971.0   | 400.0         | 3.53235  | 8.86489  | 4.71364 | 143   | 57622 | 377    | 48.96    | 1735       | 787     | 0.3029     | 133.520       | 3.3751  | 0.83    | 996.86        |
| 76              | 6016.0   | 355.0         | 3.56339  | 8.77848  | 4.68252 | 143   | 57622 | 375    | 47.83    | 1682       | 771     | 0.3012     | 117.702       | 3.3366  | 0.82    | 995.22        |
| 77              | 6061.0   | 310.0         | 3.49551  | 8.69204  | 4.65139 | 143   | 57622 | 373    | 46.70    | 1630       | 755     | 0.2994     | 102.027       | 3.3013  | 0.80    | 993.61        |
| 78              | 6106.0   | 265.0         | 3.42664  | 8.60561  | 4.62027 | 143   | 57622 | 370    | 45.59    | 739        | 642     | 0.2870     | 3.2659        | 0.79    | 992.03  |               |
| 79              | 6151.0   | 220.0         | 3.35758  | 8.51920  | 4.58914 | 143   | 57622 | 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    | 57622 | 200    | 37.79    | 1269       | 628     | 0.2875     | 71.108        | -0.6961 | -0.12   | 990.48        |
| 81              | 6186.0   | 185.0         | 3.35330  | 8.9153   | 4.33752 | 80    | 57622 | 200    | 37.98    | 1277       | 633     | 0.2874     | 59.466        | -0.6803 | -0.12   | 989.11        |
| 82              | 6221.0   | 150.0         | 3.36710  | 7.96270  | 4.35034 | 80    | 57622 | 200    | 38.17    | 1285       | 637     | 0.2873     | 47.824        | -0.6643 | -0.12   | 987.83        |
| 83              | 6256.0   | 115.0         | 3.35091  | 7.98383  | 4.36344 | 80    | 57622 | 200    | 38.36    | 1293       | 642     | 0.2870     | 36.183        | -0.6481 | -0.13   | 986.64        |
| 84              | 6291.0   | 80.0          | 3.31471  | 8.00468  | 4.37682 | 80    | 57622 | 200    | 38.53    | 1300       | 646     | 0.2868     | 24.546        | -0.6338 | -0.13   | 985.53        |
| 85              | 6291.0   | 80.0          | 3.31471  | 8.06715  | 4.45717 | 600   | 57622 | 1452   | 38.59    | 1302       | 670     | 0.2803     | 24.539        | -0.6649 | -0.13   | 985.53        |
| 86              | 6311.0   | 60.0          | 3.35688  | 8.07928  | 4.46480 | 600   | 57622 | 1451   | 38.70    | 1307       | 673     | 0.2802     | 17.891        | -0.6552 | -0.13   | 984.93        |
| 87              | 6331.0   | 40.0          | 3.35706  | 8.09135  | 4.47253 | 600   | 57622 | 1450   | 38.80    | 1311       | 676     | 0.2800     | 11.239        | -0.6435 | -0.13   | 984.37        |
| 88              | 6346.6   | 24.4          | 3.38076  | 8.10074  | 4.47863 | 600   | 57622 | 1450   | 38.88    | 1314       | 678     | 0.2799     | 6.043         | -0.6378 | -0.13   | 983.94        |
| 89              | 6346.6   | 24.4          | 2.99000  | 6.79151  | 3.88904 | 600   | 57622 | 1354   | 25.96    | 753        | 439     | 0.2561     | 6.040         | -0.6090 | -0.00   | 983.94        |
| 90              | 6356.0   | 15.0          | 2.99000  | 6.79151  | 3.88904 | 600   | 57622 | 1354   | 25.96    | 753        | 439     | 0.2561     | 3.370         | -0.6090 | 0.00    | 983.32        |
| 91              | 6356.0   | 15.0          | 2.66000  | 5.79328  | 3.19101 | 600   | 57622 | 1460   | 19.99    | 520        | 265     | 0.2822     | 3.364         | -0.6090 | 0.00    | 983.31        |
| 92              | 6368.0   | 3.0           | 2.66000  | 5.79328  | 3.19101 | 600   | 57622 | 1460   | 19.99    | 520        | 265     | 0.2822     | 0.303         | -0.6090 | -0.00   | 982.22        |
| 93              | 6368.0   | 3.0           | 1.02000  | 1.44996  | 0.      | 0     | 57622 | 57822  | 2.10     | 21         | 0       | 0.5000     | 0.229         | -0.6090 | -0.00   | 982.22        |
| 94              | 6371.0   | 0.            | 1.44996  | 0.       | 0       | 0     | 57622 | 57822  | 2.10     | 21         | 0       | 0.5000     | -0.000        | 0.000   | 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 | DEPTH | DENSITY | V <sub>PY</sub> | V <sub>PH</sub> | V <sub>SV</sub> | V <sub>SH</sub> | ETA     | QMU QKAPPA | A     | C    | L    | N   | F    | V <sub>P</sub> | V <sub>S</sub> |         |
|--------|-------|---------|-----------------|-----------------|-----------------|-----------------|---------|------------|-------|------|------|-----|------|----------------|----------------|---------|
| KM     | KM    | G/CCM   | KM/S            | KM/S            | KM/S            | KM/S            |         | KM         | KM    | KM   | KM   | KM  | KM/S | KM/S           |                |         |
| 6151.0 | 220.0 | 3.35950 | 7.72930         | 7.97975         | 4.34748         | 4.34277         | 0.97654 | 80         | 57822 | 2176 | 2094 | 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 | 7.84531         | 8.07760         | 4.43589         | 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 | 3.36913 | 7.89113         | 8.16559         | 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 | 7.93544         | 8.15558         | 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 | 60.0  | 3.37688 | 7.95111         | 8.05008         | 4.40884         | 4.56193         | 0.92209 | 600        | 57822 | 2242 | 2138 | 656 | 702  | 857            | 8.07689        | 4.46954 |
| 6311.0 | 60.0  | 3.37800 | 7.90176         | 8.16557         | 4.40824         | 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         | 4.35963         | 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         | 4.35903         | 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  | 2.00000 | 5.80000         | 5.80000         | 3.20000         | 3.20000         | 1.00000 | 600        | 57822 | 875  | 875  | 266 | 266  | 342            | 5.80000        | 5.20000 |
| 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        | 5.20000 |
| 6368.0 | 3.0   | 1.02800 | 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.      |
| 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         | 7.92380         | 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        | 4.33354 |
| 6211.0 | 160.0 | 3.36602 | 7.79831         | 8.02192         | 4.33395         | 4.39547         | 0.95321 | 80         | 57822 | 2166 | 2097 | 632 | 650  | 859            | 7.95673        | 4.34665 |
| 6231.0 | 140.0 | 3.36819 | 7.82132         | 8.03598         | 4.32943         | 4.41304         | 0.93765 | 80         | 57822 | 2175 | 2080 | 631 | 656  | 863            | 7.96882        | 4.35406 |
| 6231.0 | 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 |
| 6271.0 | 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 | 60.0  | 3.37741 | 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  | 3.37888 | 7.97251         | 8.15480         | 4.39186         | 4.56700         | 0.91432 | 600        | 57822 | 2246 | 2146 | 651 | 704  | 862            | 8.07228        | 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 |
| 6336.6 | 24.4  | 3.38076 | 8.01295         | 8.18051         | 4.38368         | 4.59887         | 0.90047 | 600        | 57822 | 2262 | 2171 | 650 | 715  | 867            | 8.10074        | 4.47663 |
| 6346.6 | 24.4  | 2.90000 | 6.79151         | 6.79151         | 3.88904         | 3.88904         | 1.00000 | 600        | 57822 | 1358 | 1358 | 439 | 439  | 460            | 5.88904        | 5.79151 |
| 6356.0 | 15.0  | 2.90000 | 6.79151         | 6.79151         | 3.88904         | 3.88904         | 1.00000 | 600        | 57822 | 1336 | 1336 | 439 | 439  | 460            | 5.88904        | 5.79151 |
| 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 | 1.42000         | 1.44996         | 0.              | 0.              | 1.00000 | 0          | 57822 | 21   | 21   | 0   | 0    | 21             | 1.44996        | 0.      |
| 6371.0 | 0.    | 1.02000 | 1.42000         | 1.44996         | 1.44996         | 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

| M O D E | OBSERVATION  | ANISOTROPIC   |     | ISOTROPIC     |     | Q OBS       | Q COM  | GROUP |
|---------|--------------|---------------|-----|---------------|-----|-------------|--------|-------|
|         | PERIOD S.D.  | PERIOD        | DEV | PERIOD        | DEV | VALUE S.D.  | VEL.   | KM/S  |
|         | SEC %        | SEC %         |     | SEC %         |     | %           |        |       |
| 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  | ANISOTROPIC |       | ISOTROPIC |       | Q OBS<br>VALUE | Q COM<br>S.D. | GROUP<br>VEL.<br>KM/S |
|---------|--------------|-------------|-------|-----------|-------|----------------|---------------|-----------------------|
|         |              | PERIOD      | S.D.  | PERIOD    | DEV   |                |               |                       |
|         |              | SEC         | %     | SEC       | %     |                |               |                       |
| 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           |

| M O D E | OBSERVATION | ANISOTROPIC   |           | ISOTROPIC     |          | Q OBS<br>VALUE | Q COM<br>S.D. | GROUP<br>VEL.<br>KM/S |
|---------|-------------|---------------|-----------|---------------|----------|----------------|---------------|-----------------------|
|         |             | PERIOD<br>SEC | S.D.<br>% | PERIOD<br>SEC | DEV<br>% |                |               |                       |
| 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)

| M O D E | OBSERVATION<br>PERIOD S.D. | ANISOTROPIC<br>PERIOD DEV | ISOTROPIC<br>PERIOD DEV | Q OBS<br>VALUE S.D. | Q COM | GROUP<br>VEL.<br>KM/S |
|---------|----------------------------|---------------------------|-------------------------|---------------------|-------|-----------------------|
|         | SEC %                      | SEC %                     | SEC %                   | %                   |       |                       |
| 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 | ANISOTROPIC |       | ISOTROPIC |       | Q OBS<br>VALUE | Q COM<br>S.D. | GROUP<br>VEL.<br>KM/S |
|---------|-------------|-------------|-------|-----------|-------|----------------|---------------|-----------------------|
|         |             | PERIOD      | S.D.  | PERIOD    | DEV   |                |               |                       |
|         |             | SEC         | %     | SEC       | %     |                |               |                       |
| 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)

| M O D E | OBSERVATION |      |        | ANISOTROPIC |        | ISOTROPIC |       | Q OBS<br>VALUE | Q COM<br>S.D. | GROUP<br>VEL.<br>KM/S |
|---------|-------------|------|--------|-------------|--------|-----------|-------|----------------|---------------|-----------------------|
|         | PERIOD      | S.D. | SEC    | PERIOD      | DEV    | PERIOD    | DEV   |                |               |                       |
| 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        |                       |

| M O D E | OBSERVATION<br>PERIOD S.D. | ANISOTROPIC   |       | ISOTROPIC     |       | Q OBS<br>VALUE S.D. | Q COM | GROUP<br>VEL.<br>KM/S |
|---------|----------------------------|---------------|-------|---------------|-------|---------------------|-------|-----------------------|
|         |                            | PERIOD<br>SEC | %     | PERIOD<br>SEC | %     |                     |       |                       |
| 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 |      | ANISOTROPIC |       | ISOTROPIC |       | Q OBS<br>VALUE | Q COM | GROUP  |        |
|---------|-------------|------|-------------|-------|-----------|-------|----------------|-------|--------|--------|
|         | PERIOD      | S.D. | PERIOD      | DEV   | PERIOD    | DEV   |                |       |        |        |
|         | SEC         | %    | SEC         | %     | SEC       | %     |                |       |        |        |
| 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 | ANISOTROPIC   |           | ISOTROPIC     |           | Q OBS<br>VALUE | Q COM<br>S.D. | GROUP<br>VEL.<br>KM/S |
|---------|-------------|---------------|-----------|---------------|-----------|----------------|---------------|-----------------------|
|         |             | PERIOD<br>SEC | S.D.<br>% | PERIOD<br>SEC | DEV.<br>% |                |               |                       |
| 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)

| M O D E | OBSERVATION | ANISOTROPIC |       | ISOTROPIC |       | Q OBS | Q COM | GROUP  |
|---------|-------------|-------------|-------|-----------|-------|-------|-------|--------|
|         |             | PERIOD      | S.D.  | PERIOD    | DEV   |       |       | VEL.   |
|         |             | SEC         | %     | SEC       | %     | SEC   | S.D.  | 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  |

| MODE    | OBSERVATION<br>PERIOD S.D. | ANISOTROPIC<br>PERIOD % | ISOTROPIC<br>PERIOD % | Q OBS<br>VALUE S.D. | Q COM | GROUP<br>VEL.<br>KM/S |
|---------|----------------------------|-------------------------|-----------------------|---------------------|-------|-----------------------|
|         | SEC %                      | SEC %                   | SEC %                 | %                   |       |                       |
| 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)

| M | O | D      | E       | OBSERVATION | ANISOTROPIC | ISOTROPIC | Q OBS   | Q COM | GROUP |       |
|---|---|--------|---------|-------------|-------------|-----------|---------|-------|-------|-------|
|   |   | PERIOD | S.D.    | PERIOD      | DEV         | PERIOD    | VALUE   | VEL.  |       |       |
|   |   | SEC    | %       | SEC         | %           | SEC       | S.D.    | 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  |
| 0 | T | 9      | 671.80  | 0.20        | 672.69      | -0.13     | 674.35  | -0.38 | 180.0 | 20.0  |
| 0 | T | 10     | 618.97  | 0.20        | 619.88      | -0.15     | 621.59  | -0.42 |       | 173.3 |
| 0 | T | 12     | 538.05  | 0.20        | 538.25      | -0.04     | 540.05  | -0.37 |       | 162.9 |
| 0 | T | 13     | 506.07  | 0.20        | 505.84      | 0.05      | 507.67  | -0.32 |       | 158.8 |
| 0 | T | 14     | 477.53  | 0.20        | 477.49      | 0.01      | 479.35  | -0.38 |       | 155.3 |
| 0 | T | 16     | 430.01  | 0.20        | 430.08      | -0.02     | 432.00  | -0.46 |       | 149.5 |
| 0 | T | 17     | 410.24  | 0.20        | 410.00      | 0.06      | 411.93  | -0.41 |       | 147.2 |
| 0 | T | 18     | 391.82  | 0.20        | 391.83      | -0.00     | 393.77  | -0.50 |       | 145.2 |
| 0 | T | 20     | 360.03  | 0.08        | 360.16      | -0.03     | 362.11  | -0.58 |       | 141.9 |
| 0 | T | 21     | 346.50  | 0.08        | 346.25      | 0.07      | 348.20  | -0.49 |       | 140.5 |
| 0 | T | 22     | 333.69  | 0.08        | 333.41      | 0.08      | 335.37  | -0.50 | 114.0 | 20.0  |
| 0 | T | 23     | 321.70  | 0.08        | 321.52      | 0.05      | 323.48  | -0.55 |       | 138.3 |
| 0 | T | 24     | 310.63  | 0.07        | 310.48      | 0.05      | 312.43  | -0.58 |       | 137.4 |
| 0 | T | 25     | 300.37  | 0.06        | 300.18      | 0.06      | 302.13  | -0.59 | 110.0 | 23.0  |
| 0 | T | 26     | 290.77  | 0.06        | 290.56      | 0.07      | 292.50  | -0.60 | 113.0 | 22.3  |
| 0 | T | 27     | 281.75  | 0.06        | 281.55      | 0.07      | 283.48  | -0.61 | 115.0 | 21.4  |
| 0 | T | 28     | 273.27  | 0.06        | 273.09      | 0.07      | 275.01  | -0.64 | 116.0 | 20.0  |
| 0 | T | 29     | 265.30  | 0.06        | 265.12      | 0.07      | 267.04  | -0.65 | 115.0 | 18.0  |
| 0 | T | 30     | 257.76  | 0.06        | 257.62      | 0.06      | 259.52  | -0.68 | 113.0 | 16.1  |
| 0 | T | 31     | 250.66  | 0.06        | 250.53      | 0.05      | 252.42  | -0.70 | 112.0 | 15.0  |
| 0 | T | 32     | 243.95  | 0.06        | 243.82      | 0.05      | 245.70  | -0.72 | 112.0 | 15.2  |
| 0 | T | 33     | 237.59  | 0.05        | 237.46      | 0.05      | 239.33  | -0.73 | 112.0 | 16.5  |
| 0 | T | 34     | 231.56  | 0.05        | 231.43      | 0.06      | 233.29  | -0.75 | 113.0 | 18.3  |
| 0 | T | 35     | 225.83  | 0.05        | 225.70      | 0.06      | 227.54  | -0.76 | 113.0 | 20.0  |
| 0 | T | 36     | 220.37  | 0.05        | 220.24      | 0.06      | 222.07  | -0.77 | 113.0 | 21.2  |
| 0 | T | 37     | 215.17  | 0.05        | 215.05      | 0.06      | 216.86  | -0.79 | 112.0 | 22.0  |
| 0 | T | 38     | 210.21  | 0.05        | 210.09      | 0.06      | 211.90  | -0.80 | 111.0 | 22.5  |
| 0 | T | 39     | 205.47  | 0.05        | 205.35      | 0.06      | 207.15  | -0.82 | 111.0 | 22.8  |
| 0 | T | 40     | 200.95  | 0.05        | 200.83      | 0.06      | 202.61  | -0.83 | 111.0 | 23.0  |
| 0 | T | 41     | 196.60  | 0.05        | 196.50      | 0.05      | 198.26  | -0.85 | 112.0 | 23.3  |
| 0 | T | 42     | 192.50  | 0.05        | 192.35      | 0.08      | 194.10  | -0.83 | 113.0 | 23.6  |
| 0 | T | 43     | 188.51  | 0.05        | 188.38      | 0.07      | 190.12  | -0.85 | 115.0 | 23.9  |
| 0 | T | 44     | 184.70  | 0.05        | 184.56      | 0.08      | 186.29  | -0.86 | 117.0 | 24.2  |
| 0 | T | 45     | 181.04  | 0.05        | 180.89      | 0.08      | 182.61  | -0.87 | 119.0 | 24.5  |
| 0 | T | 46     | 177.52  | 0.05        | 177.37      | 0.08      | 179.07  | -0.87 | 121.0 | 24.8  |
| 0 | T | 47     | 174.10  | 0.05        | 173.99      | 0.06      | 175.68  | -0.91 | 122.0 | 25.0  |
| 0 | T | 48     | 170.87  | 0.05        | 170.72      | 0.09      | 172.40  | -0.90 | 123.0 | 25.1  |
| 0 | T | 49     | 167.73  | 0.05        | 167.58      | 0.09      | 169.25  | -0.90 | 123.0 | 25.1  |
| 0 | T | 50     | 164.70  | 0.05        | 164.56      | 0.09      | 166.21  | -0.91 | 122.0 | 25.1  |
| 0 | T | 51     | 161.78  | 0.05        | 161.64      | 0.09      | 163.27  | -0.92 | 121.0 | 25.1  |
| 0 | T | 52     | 158.95  | 0.05        | 158.82      | 0.08      | 160.44  | -0.94 | 120.0 | 25.0  |
| 0 | T | 53     | 156.23  | 0.05        | 156.10      | 0.09      | 157.71  | -0.95 | 119.0 | 25.0  |
| 0 | T | 54     | 153.59  | 0.05        | 153.46      | 0.08      | 155.07  | -0.96 | 118.0 | 25.0  |
| 0 | T | 55     | 151.04  | 0.05        | 150.92      | 0.08      | 152.51  | -0.97 | 117.0 | 25.0  |
| 0 | T | 56     | 148.57  | 0.05        | 148.46      | 0.07      | 150.04  | -0.99 | 116.0 | 25.1  |
| 0 | T | 57     | 146.19  | 0.05        | 146.08      | 0.08      | 147.64  | -0.99 | 116.0 | 25.1  |
| 0 | T | 58     | 143.87  | 0.05        | 143.77      | 0.07      | 145.33  | -1.01 | 115.0 | 25.5  |
| 0 | T | 59     | 141.63  | 0.05        | 141.54      | 0.07      | 143.08  | -1.02 | 115.0 | 25.8  |

| MODE   | OBSERVATION | ANISOTROPIC  | ISOTROPIC    | Q OBS      | Q COM | GROUP |
|--------|-------------|--------------|--------------|------------|-------|-------|
|        | PERIOD S.D. | PERIOD DEV   | PERIOD DEV   | VALUE S.D. | %     | VEL.  |
|        | SEC %       | SEC %        | SEC %        |            |       | 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<br>PERIOD S.D. | ANISOTROPIC<br>PERIOD DEV | ISOTROPIC<br>PERIOD DEV | Q OBS<br>VALUE S.D. | Q COM | GROUP<br>VEL.<br>KM/S |
|---|---|----|---|----------------------------|---------------------------|-------------------------|---------------------|-------|-----------------------|
|   |   |    |   | SEC %                      | SEC %                     | SEC %                   | %                   |       |                       |
| 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                 |

| M O D E | OBSERVATION | ANISOTROPIC |       | ISOTROPIC |       | Q OBS      | Q COM | GROUP        |
|---------|-------------|-------------|-------|-----------|-------|------------|-------|--------------|
|         | PERIOD S.D. | PERIOD      | DEV   | PERIOD    | DEV   | VALUE S.D. |       | VEL.<br>KM/S |
|         | SEC %       | SEC %       |       | SEC %     |       | %          |       |              |
| 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<br>PERIOD | ANISOTROPIC |       | ISOTROPIC |       | Q OBS<br>VALUE | Q COM<br>S.D. | GROUP<br>VEL.<br>KM/S |
|---------|-----------------------|-------------|-------|-----------|-------|----------------|---------------|-----------------------|
|         |                       | S.D.        | %     | PERIOD    | DEV   |                |               |                       |
| SEC     | %                     | SEC         | %     | SEC       | %     |                |               |                       |
| 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 | ANISOTROPIC |       | ISOTROPIC |       | Q OBS      | Q COM | GROUP        |
|----------|-------------|-------------|-------|-----------|-------|------------|-------|--------------|
|          | PERIOD S.D. | PERIOD      | DEV   | PERIOD    | DEV   | VALUE S.D. | %     | VEL.<br>KM/S |
|          | SEC %       | SEC %       | SEC % | SEC %     | SEC % |            |       |              |
| 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)

| M O D E  | OBSERVATION | ANISOTROPIC   |           | ISOTROPIC     |          | Q OBS<br>VALUE | Q COM<br>S.D. | GROUP<br>VEL.<br>KM/S |
|----------|-------------|---------------|-----------|---------------|----------|----------------|---------------|-----------------------|
|          |             | PERIOD<br>SEC | S.D.<br>% | PERIOD<br>SEC | DEV<br>% |                |               |                       |
| 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 for-

mula is

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

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  $30^\circ$  distance the correction is 2 s and at  $90^\circ$ , 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<sup>-1</sup>

| DELTA<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*  |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |     |
| 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<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T#<br>SEC |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |           |
| 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<sup>-1</sup>) and the apparent velocity of the P<sub>n</sub> phase from the ISC data (~8.0 km s<sup>-1</sup>) 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<sup>-1</sup>

| DELTA<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*  |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |     |
| 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<sup>-1</sup>, 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 VIc  
P travel times: Herrin et al. (1968). Baseline correction  $-0.94$  s; slope  $-0.0141$  s deg $^{-1}$

| DELTA<br>DEG | OBSERVATION  |               |              | ANISOTROPIC         |          |         | ISOTROPIC           |          |         | T*  |
|--------------|--------------|---------------|--------------|---------------------|----------|---------|---------------------|----------|---------|-----|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP (O-C)<br>SEC | P<br>SEC | SEC/DEG | T COMP (O-C)<br>SEC | P<br>SEC | SEC/DEG |     |
| 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,  $< 25^\circ$ , but is maintained at teleseismic distances. SH is faster by 1.16 s at  $30^\circ$  and 0.34 s at  $90^\circ$ . 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<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*  |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |     |
| 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  $d\tau/d\Delta$  data. Gogna et al. (1981), hereafter GJS, tabulate results from a recent study. PREM fits  $d\tau/d\Delta$  for P-waves, from this study, with an average error of only 0.004 s deg<sup>-1</sup>, over the interval 40–77°. Maximum isolated errors are only 0.008 s deg<sup>-1</sup>. Beyond 77° PREM deviates from GJS but is within the scatter of other studies

out to about 94°. At larger distances,  $d\tau/d\Delta$  for PREM is up to 0.1 s deg<sup>-1</sup>, low compared to the majority of recent data. This indicates that velocities in the lowermost mantle should be decreased slightly.

The  $d\tau/d\Delta$  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<sup>-1</sup> (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  $-0.0173 \text{ s deg}^{-1}$ 

| DELTA<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*<br>SEC |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |           |
| 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 VI e

PKP travel times, AB branch: Gee and Dziewonski (unpublished). Baseline correction  $-4.22 \text{ s}$ 

| DELTA<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*<br>SEC |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |           |
| 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<br>DEG | OBSERVATION  |               |              | ANISOTROPIC         |          |         | ISOTROPIC           |          |         | T#<br>SEC |
|--------------|--------------|---------------|--------------|---------------------|----------|---------|---------------------|----------|---------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP (O-C)<br>SEC | P<br>SEC | SEC/DEG | T COMP (O-C)<br>SEC | P<br>SEC | SEC/DEG |           |
| 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<br>DEG | OBSERVATION  |               |              | ANISOTROPIC         |          |         | ISOTROPIC           |          |         | T#<br>SEC |
|--------------|--------------|---------------|--------------|---------------------|----------|---------|---------------------|----------|---------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP (O-C)<br>SEC | P<br>SEC | SEC/DEG | T COMP (O-C)<br>SEC | P<br>SEC | SEC/DEG |           |
| 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<br>DEG | OBSERVATION  |               |              | ANISOTROPIC         |          |         | ISOTROPIC           |          |         | T#<br>SEC |
|--------------|--------------|---------------|--------------|---------------------|----------|---------|---------------------|----------|---------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP (O-C)<br>SEC | P<br>SEC | SEC/DEG | T COMP (O-C)<br>SEC | P<br>SEC | SEC/DEG |           |
| 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<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*   |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |      |
| 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<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*   |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |      |
| 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  $0.02 \text{ s deg}^{-1}$ . Beyond  $95^\circ$ , PREM has  $dt/d\Delta$  values which are  $0.17$  to  $0.38 \text{ s deg}^{-1}$  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  $93^\circ$  with  $dt/d\Delta$  of  $8.85 \text{ s deg}^{-1}$ . This means that the error is in the lower 195 km of the mantle.

Travel times out to distances of about  $20^\circ$  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  $30$ – $90^\circ$  differ by about  $0.01 \text{ s deg}^{-1}$ . 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<sup>-1</sup>

| DEG   | OBSERVATION  |               |              | ANISOTROPIC            |          |         | ISOTROPIC              |          |         | T*  |
|-------|--------------|---------------|--------------|------------------------|----------|---------|------------------------|----------|---------|-----|
|       | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>(O-C)<br>SEC | P<br>SEC | SEC/DEG | T COMP<br>(O-C)<br>SEC | P<br>SEC | SEC/DEG |     |
| 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<sup>-1</sup> 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<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*  |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |     |
| 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<br>DEG | OBSERVATION  |               |              | ANISOTROPIC         |              |                     | ISOTROPIC    |          |        | T#<br>SEC |
|--------------|--------------|---------------|--------------|---------------------|--------------|---------------------|--------------|----------|--------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP (O-C)<br>SEC | P<br>SEC/DEG | T COMP (O-C)<br>SEC | P<br>SEC/DEG | T<br>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

$$\frac{\delta\omega^2}{\omega^2} = \int_0^1 r^2 dr (\delta\tilde{A} \cdot A + \delta C \cdot \tilde{C} + \delta F \cdot \tilde{F} + \delta L \cdot \tilde{L} + \delta N \cdot \tilde{N} + \delta\rho \cdot \tilde{R}) \quad (A1)$$

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<br>DEG | OBSERVATION  |               |              |               | ANISOTROPIC  |              |               | ISOTROPIC    |              |     | T*<br>SEC |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |     |           |
|              |              |               |              |               |              |              |               |              |              |     |           |
| 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

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

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

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

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

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

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

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

For toroidal modes

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

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

TABLE VI m

S travel times (SH): Hales and Roberts, (1970). Baseline correction - 1.14 s; slope - 0.0068 s deg<sup>-1</sup>

| DELTA<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T#<br>SEC |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |           |
| 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        | 14.901       | 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

$$\omega^2 \int_0^1 \rho W^2 r^2 dr = 1$$

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  $\eta$ 

$$V_{PH} = (A/\rho)^{1/2}$$

$$V_{PV} = (C/\rho)^{1/2}$$

$$V_{SH} = (N/\rho)^{1/2} \quad (A4)$$

$$V_{SV} = (L/\rho)^{1/2}$$

$$\eta = F/(A - 2L)$$

TABLE VI m (continued)

| DELTA<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T#<br>SEC |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |           |
| 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

$$\frac{\delta T}{T} = \int_0^1 dr (\delta \rho R' + \delta v_{PV} \cdot \tilde{P}_V + \delta V_{PH} \cdot \tilde{P}_H + \delta V_{SV} \cdot \tilde{S}_V + \delta V_{SH} \cdot \tilde{S}_H + \delta \eta \cdot \tilde{E}) \quad (A5)$$

After simple algebraic transformations, the appropriate expressions are

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

$$\tilde{P}_V = -r^2 \rho V_{PV} \tilde{C}$$

$$\tilde{P}_H = -r^2 \rho V_{PH} (\tilde{A} + \eta \tilde{F}) \quad (A6)$$

$$\tilde{S}_V = -r^2 \rho V_{SV} (\tilde{L} - 2\eta \tilde{F})$$

$$\tilde{S}_H = -r^2 \rho V_{SH} \tilde{N}$$

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

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

In calculation of the kernels for  $Q_u$  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  $-0.021 \text{ s deg}^{-1}$ 

| DELTA<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*<br>SEC |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |           |
| 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

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

where

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

and

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

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

TABLE VI n (continued)

| DELTA<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*<br>SEC |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |           |
| 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       |

$$R' = -\frac{1}{2}r^2[\tilde{R} + (\mu\tilde{M} + K \cdot \tilde{K})/\rho]$$

$$\tilde{P} = -r^2\rho V_p \tilde{K}$$

$$\tilde{S} = -r^2\rho V_s(\tilde{M} - \frac{1}{3}\tilde{K})$$

#### Note added in proof

An error in code for evaluation of group velocity of spheroidal modes has recently been dis-

covered. 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  ${}_0S$ , 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  $-0.0433 \text{ s deg}^{-1}$ 

| DELTA<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*<br>SEC |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |           |
| 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  $-0.0495 \text{ s deg}^{-1}$ 

| DELTA<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*  |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |     |
| 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  $-0.57 \text{ s}$ 

| DELTA<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*  |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |     |
| 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<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*<br>SEC |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |           |
| 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<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*<br>SEC |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |           |
| 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<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*SEC |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |       |
| 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<br>DEG | OBSERVATION  |               |              | ANISOTROPIC   |              |              | ISOTROPIC     |              |              | T*<br>SEC |
|--------------|--------------|---------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG | T COMP<br>SEC | (O-C)<br>SEC | P<br>SEC/DEG |           |
| 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<br>DEG | OBSERVATION  |               |              | ANISOTROPIC         |          |         | ISOTROPIC           |          |         | T#<br>SEC |
|--------------|--------------|---------------|--------------|---------------------|----------|---------|---------------------|----------|---------|-----------|
|              | T OBS<br>SEC | T CORR<br>SEC | ERROR<br>SEC | T COMP (O-C)<br>SEC | P<br>SEC | SEC/DEG | T COMP (O-C)<br>SEC | P<br>SEC | SEC/DEG |           |
| 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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