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## GEDESS: A Series of Computer Programs for Deriving Information at Selected Seismic Recording Sites, for Signals from Known Hypocentres

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## SUMMARY

This report describes a set of computer programs - called GEDESS - which produce chronological listings of seismic events with estimates of the arrival time of the P and L waves, phase velocity of the P wave, distance and bearings, at selected recording stations. The formulae and equations involved in the computations are described and the input, output and data storage arrangements are explained.


## 1. INTRODUCTION

A number of centres, throughout the world, collect data from seismic stations and use them to compute the origin time, position (epicentre) depth etc of all events for which they receive sufficient data. The United States Coast and Geodetic Survey (USCGS) [1], and Bureau Central International de Seismologie (BCIS) for example, publish epicentral data of some 6000 events per year. GEDESS was designed to store these data month by month and to link with a companion program called SORTER, which enables events to be sorted and listed in accordance with criteria required for specific research programmes. GEDESS is also used to produce a routine monthly list of earthquakes for distribution to the following centres:-

| | |
|---|---|
| Blacknest | - AWRE |
| EKA Array Station | - Eskdalemuir, Scotland |
| YKA Array Station | - Dominion Observatory, Ottawa, Canada |
| GBA Array Station (Gauribidanur) | - Bhabha Atomic Research Centre, Bombay, India |
| WRA Array Station | - Australian National University, Canberra, Australia |
| International Seismic Centre (ISC) | - Edinburgh, Scotland |
| Durham University | |
| Aberdeen University | |
| Kew Observatory | |
| Brasilia Array Station | - ISC, Brazil |
| School of Cosmic Physics | - Dublin, Ireland |
| Bureau Central International de Seismologie | - Strasbourg, France |

## TABLE OF CONTENTS

Since July 1964 one of two similar formats has been used. These match the punched cards provided by USCGS. Format 2 is used for the monthly printouts, but Format 3 is necessary if greater accuracy of co-ordinates is available and required. These formats are as follows:-

| FORMAT 2 | | FORMAT 3 |
|---|---|---|
| Columns 4 - 10 | Origin Time (Hours, Minutes, Seconds) | Columns 4 - 10 |
| 11 - 15 | Latitude | 11 - 16 |
| 18 - 22 | Longitude | 18 - 23 |
| 25 - 29 | Depth (km) | 25 - 29 |
| 31 - 35 | Magnitude | 31 - 35 |
| 37 - 41 | No. of Values Used in Computing the Magnitude | 37 - 41 |
| 42 - 43 | Seismic Region Number | 42 - 43 |
| 44 - 46 | PDE Card Number | 44 - 46 |
| 47 - 49 | Geographic Region Number | 47 - 49 |
| 50 - 55 | Standard Error | 50 - 55 |
| 56 - 59 | Number of Stations Used in Computing the Epicentre | 56 - 59 |
| 60 - 64 | Date (Month, Day) | 60 - 64 |
| 68 - 74 | Identification Number | 68 - 74 |
| 75 - 80 | Date (Day, Month, Year) | 75 - 80 |

## 3. OUTPUT

The output from GEDESS can be obtained in the form of tape, printout or SC4020 output (both microfilm and hardcopy). The standard form of output is printout on 14 in. wide unlined paper.

The program estimates the parameters at the recording station of seismic events. All versions of the program compute:-

Phase Velocity (velocity across the earth's surface at the site)

Estimated Time of Arrival (ETA) of the P phase (or PKP)

Distance )
)
Back Bearing ) Definitions in appendix A.
)
Azimuth )

The programs were developed by one of the authors (J.B. Young) from an original program written by T.L. van Raalte. They are written in FORTRAN IV for the IBM7030 (STRETCH) computer. From any given epicentre and station co-ordinates GEDESS computes the azimuth, back-bearing and angular distance between epicentre and recording site. The travel times are found from the computed distance by interpolation in the travel time tables; adding this travel time to the published origin time gives the estimated time of arrival at the corresponding stations. Phase velocity, predicted ground velocity at period T = 1 s and predicted $\log \frac{A}{T}$ (for P waves) are also computed for each station included in GEDESS. The following sections describe the physical constants, tables, corrections etc necessary, as input, for these computations.

## 2. INPUT

### 2.1 Data

Two kinds of input are required for GEDESS:-

(a) Standard information required by all versions, as follows:-

Constants of the earth's dimensions
Table of amplitude as a function of depth and distance
Tables of travel times for body waves - P and PKP
Correction factors for ellipticity
List of seismic and geographic regions
List of recording sites.

(b) Hypocentre data: Any available hypocentre data can be used. The routine monthly output of worldwide epicentres is prepared from the USCGS summary of preliminary epicentres (PDE) obtained in punched card form; the monthly output for epicentres in and around Europe is taken from "Determinations Preliminaires" published by Bureau Central International de Seismologie (BCIS).

### 2.2 Formats

There are 3 input formats in use. Format 1 is used only with cards punched for the original form of the program, when these are used in conjunction with the SORTER.

FORMAT 1

| | | |
|---|---|---|
| Columns | 2 - 4 | PDE Card Number |
| | 6 - 11 | Date (Day, Month, Year) |
| | 13 - 20 | Origin Time (Hours, Minutes, Seconds) |
| | 22 - 26 | Latitude |
| | 27 - 32 | Longitude |
| | 34 - 36 | Depth |
| | 37 - 39 | Number of Stations Reporting |
| | 41 - 43 | Magnitude |
| | 45 - 72 | Name of the Area |

6. NUMBER OF STATIONS USED TO COMPUTE MAGNITUDE

7. STANDARD ERROR

8. NUMBER OF VALUES USED IN COMPUTATION OF EPICENTRE

9. SEISMIC REGION NUMBER

10. GEOGRAPHIC REGION NUMBER

11. PDE or BCIS CARD NUMBER and YEAR

12. MONTH (or MONTH and DAY) and YEAR

13. EVENT NUMBER and YEAR

14. ESTIMATED TIME OF ARRIVAL

15. DISTANCE

16. TRAVEL TIME - P, PKP or $L_R$

17. PHASE VELOCITY

18. AZIMUTH and BACKBEARING

## 4. DATA STORAGE

### 4.1 Long term

This type of storage is primarily punched cards and contains the input information for GEDESS. There are four separate groups containing:-

(a) Input tables - as listed in section 2.1(a) - stored on tape for some versions and punched cards for others.

(b) List of seismic stations - this is a catalogue of stations with their co-ordinates and contains both USCGS and Long Range Seismic Measurement (LRSM) stations. This catalogue, which is regularly updated, is also stored on tape. Both punched cards and tape are required for all versions of GEDESS, except one which uses punched cards only.

(c) Source data - USCGS Preliminary Determination Data are kept in 2 forms:

Format 1 for 1963, 1964 and 1965.
Format 2 from July 1964 to date.

BCIS Determination Preliminaire Data are kept in Format 2 from November 1965.

Hypocentre data are also kept on tape in two ways:-

(i) Tapes containing data for 1 year only.

(ii) Tapes containing as many years as possible.

In addition to this information, some versions of GEDESS give the expected peak/peak ground velocity, and the expected log A/T, where A = amplitude in microns, T = period in seconds.

Other versions omit the predicted amplitude data, and give the estimated time of arrival for surface waves ($L_R$) at period T = 40 s.

The output includes site information for each event, printed adjacent to the corresponding hypocentre information. The page width available is 128 characters of which columns 2 to 62 contain the hypocentre information, and columns 63 to 127 the site data (details of the various forms of printout are given in appendix A). The pages and events are numbered in sequence afresh at the beginning of each year. The program is so arranged that both page numbers and event numbers are stored on tape at the end of each month's output, and the sequence of numbering is continuous from month to month. The sets of input tables, referred to in section 2, are printed annually in pages 1 to 36. Event data follow commencing on page 37, and the system is arranged to start each day on a new page.

The events are listed in chronological order of origin times, consequently arrival times can be out of chronological order. These are indicated by an "equals" sign to the right of the ETA. This, and other symbols used to warn users of possible confusion, is explained in appendix A.

A plot of each month's epicentres is produced on a Mercator projection of the world; centred on the Pacific Ocean. Event plots on a Azimuthal Great Circle Projection are also available for each of the 4 UK arrays. Both maps are produced on the SC4020 and all epicentres are indicated by the letter E. These plotting routines are described elsewhere [2].

Two companion programs are used in conjunction with GEDESS. One is the Tape Manipulative Program (TMP), to produce GEDESS in conjunction with the USCGS data. This program is run monthly; it produces 2 versions of output with a single computer run, and updates the storage tapes at the same time. The other companion program is SORTER which is used in conjunction with a special version of GEDESS (see appendix A). Any data available can be used with the SORTER, so long as it conforms to one of the formats described in section 2.2. The most convenient data are described in section 4.1.

Events can be sorted according to the following criteria:-

1. YEAR - By choice of tapes
2. TIME - Time of day (Origin)
3. LAT and LONG - Region search
4. DEPTH
5. MAGNITUDE

4.2 Short term

Tapes containing the GEDESS output information are retained for a maximum of 6 months.

## 5. CONSTANTS, FORMULAE AND CORRECTIONS

### 5.1 Constants

The following constants are used in the GEDESS programs:-

A = equatorial radius of the earth = 6378.160 km

B = polar radius of the earth = 6356.775 km

R = radius of the sphere of equal volume to the earth (the mean sphere) = 6371.024 km

E = the flattening factor (ellipticity) = $\frac{1}{298.25}$ = (0.003353)

G = the geocentric factor = 0.993305

H = depth interval (used in Jeffreys' and Bullen's tables [3]) = 63.3802 km

A and E are both obtained from Wilkins [4]. The remainder of the constants are derived by the following formulae:-

$$B = A\{1 - E\} \qquad R = \sqrt[3]{A^2B}$$

$$G = B^2/A^2 \qquad H = \frac{R - 33}{100}.$$

### 5.2 Formulae

(a) The formulae for distance ($\Delta$), azimuth (AZ) and back bearing (BB), are calculated with reference to the geocentric latitudes of the epicentre and recording station. For this purpose Modified Direction Cosines are used, as follows:-

$$A = \cos \phi_1 \cos \lambda$$

$$B = \cos \phi_1 \sin \lambda$$

$$C = \sin \phi_1,$$

where A, B and C are the modified direction cosines,
$\lambda$ is the east longitude from Greenwich,
$\phi_1$ is the geocentric latitude,
$\phi$ is the geographic latitude,
and $\tan \phi_1 = G.\tan \phi$, where $G = 0.993305$.

A similar set of modified direction cosines: a, b and c refer to the recording station.

The formulae used in the program are:-

$$\cos DIST = aA + bB + cC$$

$$\sin AZ = -\{aD + bE\} \text{ cosec } DIST$$

$$\cos AZ = -\{aG + bH + cK\} \text{ cosec } DIST$$

$$\sin BB = -\{Ad + Be\} \text{ cosec } DIST$$

$$\cos BB = -\{Ag + Bh + Ck\} \text{ cosec } DIST,$$

where $D = \sin \lambda$

$E = -\cos \lambda$

$G = \sin \phi_1 \cos \lambda$

$H = \sin \phi_1 \sin \lambda$

$K = -\cos \phi_1$.

(b) Formula for predicted peak to peak amplitude

Predicted amplitude is derived from the average (USCGS) magnitude, using the equation from Gutenberg and Richter [5]:-

$$m = \log \left\{ \frac{A}{T} \right\} + Q,$$

where A = amplitude in microns,
T = period in seconds,
Q = depth/distance function.

(c) Formula for phase velocity

Phase velocity is obtained by evaluating the reciprocal of the differential coefficient of the travel time curve at tabular points, and then interpolating to obtain precise value.

Figure 1 shows three adjacent tabular points: $f_{-1}$, $f_o$ and $f_1$. The gradient to the curve at $f_o$ is $f_o^1$,

$$\text{where } f_o^1 = \tan \theta = \frac{f_1 - f_{-1}}{2h} \text{ s/km.}$$

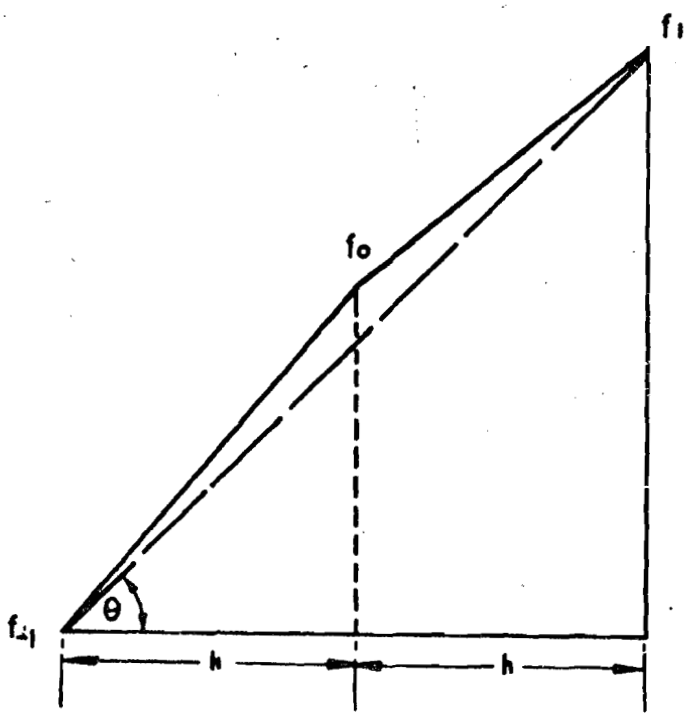


FIGURE 1

This is sufficiently accurate over short ranges of the curve, and corresponds with the first term for gradient given in Interpolation and Allied Tables [6]. Tabular values from Jeffreys' and Bullen's tables [3] are used in the formula

$$F_{ij} = \frac{2H}{T_{(i+1)j} - T_{(i-1)j}} \text{ km/s},$$

where F is the phase velocity,
T is the travel time,
H is the number of kilometres in a degree of latitude,
the range of i is from 0 to 3,
the range of j is from 1 to 2.

By this means a small table of values for $F_{ij}$, is computed, in which 8 travel times are used (see figure 2) to produce four values $F_{11}$, $F_{12}$, $F_{21}$ and $F_{22}$. Interpolation is then performed using equation (4) (described below).

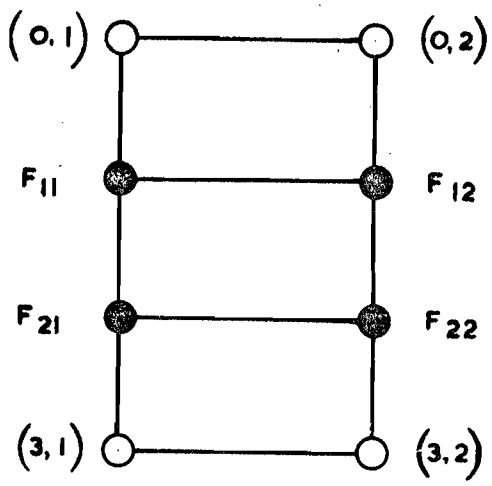


FIGURE 2

(d) Interpolation for travel times and phase velocity

Values of travel times are given in the Jeffreys' and Bullen's tables [3] at degree intervals of distance and depth intervals of one hundredth of the earth's radius, from the Mohorovicic Discontinuity (0.0) down to a depth of 0.12R, as well as travel times for events on the surface. Epicentres are quoted by USCGS to 0.1° of latitude and longitude and to 1 or 2 km depth. It is therefore necessary to interpolate between tabular values.

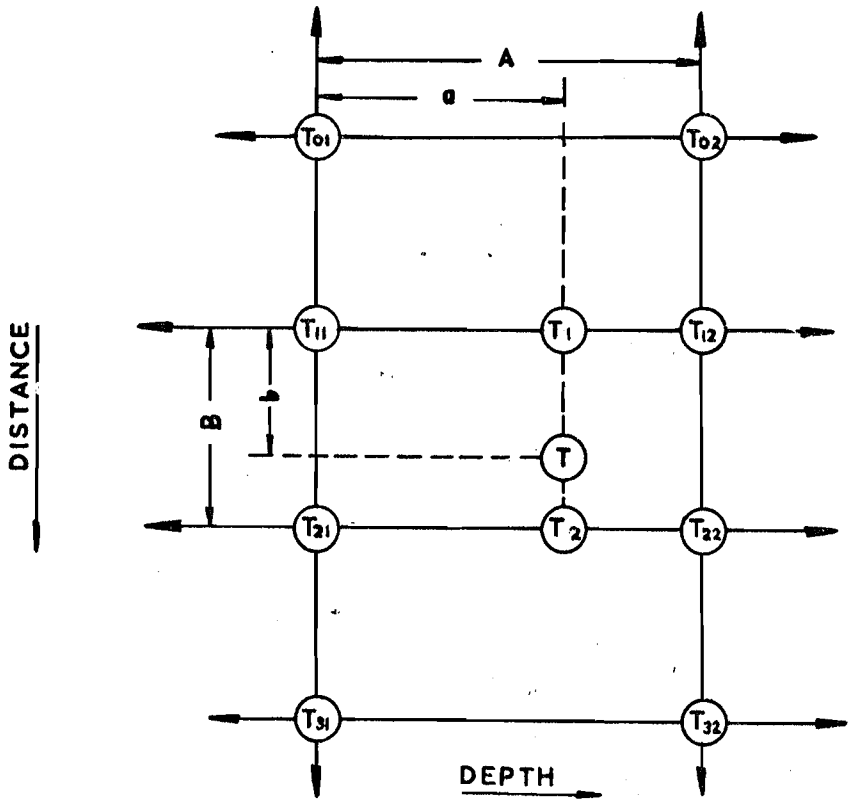


FIGURE 3

Figure 3 represents part of a large matrix of tabular values in which $T_{01}$, $T_{11}$ etc are adjacent tabulated values.

$T_1$ is a value between $T_{11}$ and $T_{12}$,

$T_2$ is a value between $T_{21}$ and $T_{22}$

and T is a value between $T_1$ and $T_2$.

To obtain the required interpolated value T, 3 interpolations are necessary: for $T_1$, $T_2$ and finally for T.

Interpolation and Allied Tables [6] gives Bessel's interpolation formula (first 2 terms) as

$$y_p = y_o + p\delta_{1/2},$$

where $y_p = T$,

$p = \frac{a}{A}$ or $\frac{b}{B}$ .... the fraction of interval required,

$\delta_{1/2}$ is the difference between adjacent table values,

viz, $(T_{12} - T_{11})$ etc.

From figure 3 it can be seen that

$$T_1 = T_{11} + \frac{a}{A}(T_{12} - T_{11}) \qquad \ldots\ldots(1)$$

$$T_2 = T_{21} + \frac{a}{A}(T_{22} - T_{21}) \qquad \ldots\ldots(2)$$

$$T = T_1 + \frac{b}{B}(T_2 - T_1). \qquad \ldots\ldots(3)$$

By substitution from (1) and (2) in equation (3), and using

$$\frac{a}{A} = \text{DDEPTH} \qquad \frac{b}{B} = \text{DDIST},$$

the equation simplifies to

$$T = T_{11} + \text{DDEPTH}\ (T_{12} - T_{11}) + \text{DDIST}\ (T_{21} - T_{11})$$
$$+ \text{DDIST} \times \text{DDEPTH}\ (T_{11} - T_{12} - T_{21} + T_{22}). \qquad \ldots\ldots(4)$$

Hence the interpolated travel time T is obtained. Similarly by using the F values referred to in section 5.2 in equation (4), the phase velocity is obtained.

## 5.3 CORRECTIONS

### 5.3.1 Ellipticity

Travel times from Jeffreys' and Bullen's tables [3] are for the mean sphere. GEDESS makes an ellipticity correction to obtain conditions nearer to those for the true earth, Bullen [7] gives

$$\delta T = f(\Delta)(h_o + h_1),$$

where $\delta T$ is the required ellipticity correction,
$f(\Delta)$ is a function of distance - tabulated by Bullen in "Encyclopaedia of Physics" [7],
$h_o$ is the height of the epicentre above the mean sphere,
$h_1$ is the height of the station above the mean sphere,
$h_o$ and $h_1$ are obtained from the equation

$$h = E.R(1/3 - \sin^2 \phi_1)[7],$$

where E is the ellipticity,
R is the radius of the mean sphere,
$\phi_1$ is the geocentric latitude.

Ellipticity correction is made for the P phase for distances from 0° to 110°. No correction is made for PKP (110° to 180°).

### 5.3.2 Station

GEDESS has an option for applying station corrections for both amplitude and time. Methods for determining time corrections have been described by Cleary and Hales [8] and by Douglas [9]. A method for obtaining amplitude corrections is described by Carpenter, Marshall and Douglas [10] using explosion data.

## 6. SURFACE WAVES

The ETA of Rayleigh waves of period T = 40 s is provided in the routine versions of GEDESS. This period was chosen because its group velocity is less likely to be affected by local crustal structure; the quoted ETA will be almost the same whether the phase travels by oceanic or continental transmission path. To compute the ETA, GEDESS uses the value

$$\frac{dt}{d\Delta} = 0.4674 \pm 0.0011 \text{ min/degree},$$

obtained from Sir H. Jeffreys', "The Earth". Any other value of $\frac{dt}{d\Delta}$ can be used to satisfy specific research programmes.

## 7. ACKNOWLEDGMENTS

The authors wish to express their thanks to ISC, Edinburgh for supplying the USCGS data on punched cards, Professor J.P. Rothé, BCIS for supplying the "Determinations Preliminaires" and Dr. A.E. Flinn for supplying the seismic and geographic regions. They would also like to thank Dr. H.I.S. Thirlaway and Mr. A. Douglas for critical reading of the report.

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8. J. Cleary and A. Hales: "An Analysis of the Travel Times for P Waves to N. American Stations, in the Distance Range 32° to 100°". Bull. of the Seis. Soc. Amer., 56, 2, 467-489 (April 1966)

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## APPENDIX A

## GEDESS

### A1. GEDESS VERSIONS

G1 Produces arrival data of P or PKP phases at up to 10 stations. It also provides predicted amplitude data, based on the USCGS average values of $m_b$. This program is used to provide information for the four UKAEA array stations EKA, GBA, WRA and YKA.

G2 Produces arrival data of P or PKP phases and the surface wave $L_R$ (for period T = 40 s). It can be used for a maximum of 1000 stations.

G3 Is the general form of GEDESS and has great flexibility. It produces either of the G1 or G2 forms, as required, and can be used with any of the formats described. This is used for special purposes, such as the expression of distances in kilometers and is available for up to 3000 stations.

G4 Is the program used to printout the production of SORTER and can be worked in any form previously described.

G5 Is a special version of the general program, also written in the FORTRAN IV dialect, in a form suitable for use on computers other than STRETCH.

### A2. GUIDE TO PRINTOUT

There are two parts to the routine printout: part 1 (pages 1 to 36) which is produced annually and part 2 (from page 37 onwards) which begins on the 1st January each year and is produced monthly. The contents are as follows:-

PART 1

| | |
|---|---|
| Page 1 | Title.<br>List of constants.<br>List of contents of GEDESS. |
| Pages 2 - 5 | Table of amplitude, as a function of depth and distance, for PZ. The table was obtained from "Elementary Seismology" by Richter (figure VIII - 6 on page 668), and is arranged to match the travel time table for P [3]. |
| Pages 6 - 9 | Table 2A contains travel times of P - for distances from 0° to 110°. This table is obtained from Jeffreys' and Bullen's "Seismological Tables" [3]. |

| | |
|---|---|
| Pages 10 - 12 | Table 2B contains travel times of PKP, for distances from 110° to 180° [3]. |
| Page 13 | Table 3 contains the distance function for ellipticity correction. See "Encyclopaedia for Physics" (table 3 on p.96) [7]. |
| Pages 14 - 35 | Table 4 Seismic and geographical regions, from "A Proposed Basis for Geographical and Seismic Regionalisation" by A.E. Flinn and E.R. Engdahl [11]. Each seismic region contains a number of geographic regions. For convenience of the Blacknest programme some geographic regions are underlined in various ways. The significance of the under lining is as follows:-<br><br>*** Part of the USSR, Eastern Europe and China TTT Region including a known Test Site. |
| Page 36 | Table 5 is a list of the seismic recording stations used in GEDESS, together with their co-ordinates, and corrections where available. |

PART 2

Lists of earthquakes, hypocentre and site data. Each day begins on a fresh page with a set of column headings, which are in two parts as follows:-

(a) HYPOCENTRE DATA - from EVENT NO to NO OF STNS USED.

(b) SITE DATA - from STN to right-hand margin.

The routine epicentre data is supplied as input to the program from USCGS summary of epicentres (PDE) and from BCIS "Determinations Preliminaires".

The site data are output from the program. Headings are printed at the start of each day, whilst the code numbers, date and page numbers are printed at the top of each page.

(a) HYPOCENTRE DATA - is printed in two lines, one above the other.

Top Line:-

EVENT NO - a count of events from the beginning of the year.

| | | |
|---|---|---|
| ORIGIN TIME<br>H | - | in Universal Time (GMT) is used for obtaining a chronological sequence of events. |
| LAT LONG | - | the coordinates of the epicentre. |
| DEPTH<br>KMS | - | as quoted on the PDE cards. |
| MAG<br>CGS | - | magnitude - USCGS average as quoted on the PDE cards. |
| NO | - | the number printed beneath the magnitude is the number of stations used to produce the average value quoted. The USCGS constraint is that all stations magnitudes should lie within 0.7 of the average magnitude. |
| SE | - | is the standard error of the time residual (in seconds) for the data used. |
| NO OF STNS<br>USED | - | is the number of stations used by USCGS to compute the epicentre. |

Lower Line

| | | |
|---|---|---|
| CARD NO | - | the number of the PDE card on which the event has been listed by USCGS (or BCIS card number). |
| R E G I O N | - | each seismic region contains a number of geographic regions, both of which are printed under the heading REGION. The geographic region number is printed in line with and to the left of the region name. The seismic region number is printed below the geographic region number. Note: Some regions are underlined as previously described. |

(b) SITE DATA - in this half of the printout, one line is used for each seismic recording station included in table 5 (Part 1 - p.36).

| | | |
|---|---|---|
| STN | - | code letters of recording stations (USCGS). |
| PHASE VEL<br>KMS/SEC | - | is the velocity of the P wave across the earth's surface at the station and is quoted as follows:- |

0° - 110° - velocity of P to 0.1 km/s. 110° - 180° - velocity of PKP to 2 figures. Note: Values in excess of 100 km/s are printed as 100 km/s.

| | | |
|---|---|---|
| T I M E S<br>ETA<br>GMT | - | the estimated time of arrival (ETA) calculated by adding the J and B travel time to the USCGS origin time and correcting for ellipticity. A star (*) after the ETA signifies that the time quoted is on the day following the date printed at the top of the page. An equals (=) sign after the ETA signifies that it is not in chronological order. This may occur because the list is chronological with respect to origin times.<br><br>Brackets ( ) enclose ETA's where the distance lies between 100° and 115° to warn the user that the time quoted may not correspond with the first arrival at the station concerned. |
| A N G L E ( DIST | - | is the great circle distance between epicentre and recording station. |
| A N G L E ( BB | - | is the back bearing - station to epicentre in degrees - measured in degrees East of North. |
| A N G L E ( AZ | - | azimuth is a similar angle - epicentre to station measured in degrees East of North. |
| PK/PK VEL<br>X $10^{-5}$ CM/SEC | - | is the value q which when multiplied by $10^{-5}$ expresses the peak to peakground velocity in cm $s^{-1}$ - where $q = 40\pi(A/T)$ - and is predicted from the USCGS magnitude. It is given to an accuracy of two significant figures. |
| LOG A/T | - | is derived from the magnitude where A = ½PK/PK amplitude in mμ, T = period of oscillation in seconds. |

The foregoing describes the G1 and G5 printouts. In the G2 and G2E versions the columns PK/PK VEL and LOG A/T are omitted, and the ETA for Rayleigh waves LR(3.97)* are printed adjacent to the ETA for P or PKP. Consequently the angles - DIST, BB and AZ are moved over to the extreme right of the printout. G3 and G4 printouts can be in either form.

*Note LR(3.97) ... 3.97 km/s is the velocity of Rayleigh waves of period T = 40 s.

## A3. PROGRAM DETAILS

Each version of the program incorporates the following introductory cards:-

Job Card

TYPE GO FORTRAN

IOD CARD )
REEL CARD ) in pairs according to computing requirements

BINARY CARDS ( FIOD CARDS
( SETS of Program Cards, according to version in use (see
( following lists)

Branch Card

TO

Station Cards ... To call stations required

FROM

Data Cards

Note: GEDESS is intended as a flexible system of computer programs. The program listings published in this section will therefore vary to accommodate new requirements and can only be taken as a guide to the system.

### G1 List of Subprograms

INTRODUCTORY CARDS

| | | |
|---|---|---|
| MG1 | | Calls MAIN program |
| GX1 | MAIN | Sets up tapes, counts etc |
| GS1 | SET UP | Tables set up for use |
| GD1 | GEDESS | Produces printout |
| GP1 | PICKING LIST AND MAPS | Produces list of P, PKP on G1 (also calls map program) |
| GG1 | GEORGE | Geocentric values - DIST, AZ, BB |
| GC1 | CONSTANTS | Modified cosines etc for GEORGE |
| GT1 | TIME | ETA's for P, LR. Also phase velocity |
| GL1 | LINEAR | Interpolation for TIME |

| | | |
|---|---|---|
| GM1 | MAGNITUDE | Predicts ground velocity and log A/T |
| GR1 | REGION | Look up where necessary |
| GK1 | CLOCK | Computer running time |
| APMAP )<br>APCOD )<br>APPOL )<br>SPACE ) | MAP<br>PROGRAM | Uses SC 4020 to produce epicentres on azimuthal map |

Branch Card etc.

At present other versions are similar to G1. The differences are as follows:-

| G2 and G2E | G3 | G5 |
|---|---|---|
| - | MG omitted | MG omitted |
| - | GP omitted | GP omitted |
| - | - | GR omitted |
| GM omitted | - | - |
| - | - | GK omitted |
| GP2 or GP2E )<br>GQ2 or GQ2E ) | No maps | No maps |

Note 1: The Sections GP2, GQ2 are used to produce plots of epicentres on Mercator projections of the world in G2, and similarly GP2E, GQ2E for the G2E version.

Note 2: The G3 version uses a set of tables in punched card form. This is at the back of the deck, immediately after the branch card.

Note 3: G5 is the simplest version of the program and does not incorporate the underlining of regions, and only works with punched cards.

G4 is a special purpose program of wide flexibility,

INTRODUCTORY CARDS

GX4

GS4

SORTER ..... details in appendix B, section B1

MAPPING .... details in appendix B, section B2

GD4

GG4

GC4

GT4

GL4

GM4

Branch card etc.

Note 4: G4 also includes a set of punch cards containing the input tables. These come immediately after the branch card.

## APPENDIX B

## ASSOCIATED PROGRAMS

### B1. SORTER

This program works in conjunction with GEDESS and acts as a sub-program to the G4 version. It contains the following 6 sub-programs:-

| | | |
|---|---|---|
| UDS | - | Main sorter. |
| SUDS | - | Sorts on data of a selected site. |
| COMPAR | - | Fixes limits of sorted parameters. |
| CONCOD | - | Converts latitudes to 0 to 180° from North Pole. |
| | | longitudes to 0 to 360° from Greenwich. |
| INPUT | - | Reads in data to Format 1 or Format 2. |
| REGION | - | Seismic and geographic regions. |

### B2. MAPPING

A program by Young and Douglas [2] is used to provide maps which show the location of epicentres. This operates with most versions of GEDESS and the SORTER.

### B3. TAPE MANIPULATIVE PROGRAM (TMP)

The program is written with special emphasis on the card image (80 characters) GEDESS tapes. The G1 and G2 versions of GEDESS are published regularly and require the same input data. TMP will produce both at a single computer run. The use of G4 with the SORTER requires input data in chronological order and TMP is arranged to update the tape stores referred to in section 4.1(c).

The program is controlled by instruction cards which are read as data, and a series of code words is used in conjunction with them.

| HYPOCENTRE DATA | | | | | | | SITE DATA | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EVENT NO CARD NO | ORIGIN TIME H | LAT | LONG | DEPTH KMS | MAG CGS NO | SE - NO OF STNS USED | STN | PHASE VEL KMS/SEC | TIMES ETA GMT | DIST | ANGLE BB DEGREES | AZ | PK/PK VEL * 10-5 CM/SEC | LOG A/T |
| 3657 | 5-35-57.0 | 40.4S | 174.8E | 33 | .0 | 1.9- 9 | YKA | 59.0 | 3-54-38.5 | 117.0 | 233.9 | 29.4 | .0 | .0 |
| | | | | | 0 | | EKA | 100.0 | 3-55-57.4 | 165.0 | 6.0 | 355.5 | .0 | .0 |
| 76 | | 163 | COOK STRAIT, NEW ZEALAND | | | | GBA | 25.3 | (3-49-59.3) | 104.2 | 128.6 | 275.8 | .0 | .0 |
| | | 11 | | | | | WRA | 13.4 | 3-43-30.6 | 40.0 | 129.6 | 288.4 | .0 | .0 |
| 3658 | 4-17- 2.1 | 37.4N | 114.2W | 33 | .0 | .9- 5 | YKA | 11.7 | 4-22-25.1 | 25.1 | 179.2 | 359.6 | .0 | .0 |
| | | | | | 0 | | EKA | 18.4 | 4-28-15.2 | 70.6 | 308.0 | 34.4 | .0 | .0 |
| 70 | | 41 | SOUTHERN NEVADA | | | | GBA | 57.0 | 4-36- 5.1 | 128.1 | 11.8 | 345.6 | .0 | .0 |
| | | 3 | TTTTTTTTTTTTTTT | | | | WRA | 57.0 | 4-35-46.7 | 118.6 | 57.6 | 265.9 | .0 | .0 |
| 3659 | 4-22-51.2 | 22.3N | 117.9E | 19 | 5.5 | .9- 22 | YKA | 22.6 | 4-35-30.5 | 85.8 | 312.5 | 21.7 | 4.0 | 1.5 |
| | | | | | 3 | | EKA | 23.1 | 4-35-40.7 | 87.9 | 52.5 | 330.7 | 4.0 | 1.5 |
| 71 | | 243 | TAIWAN REGION | | | | GBA | 13.4 | 4-30-21.5= | 39.4 | 71.4 | 264.3 | 13.0 | 2.0 |
| | | 21 | | | | | WRA | 13.9 | 4-31- 7.3= | 45.0 | 338.2 | 157.9 | 10.0 | 1.9 |
| 3660 | 5-10-58.1 | 27.5N | 92.6E | 33 | 5.6 | 1.0- 35 | YKA | 23.1 | 5-23-44.1 | 87.7 | 336.0 | 12.3 | 5.0 | 1.6 |
| | | | | | 8 | | EKA | 18.5 | 5-22-13.9 | 71.0 | 69.2 | 323.0 | 10.0 | 1.9 |
| 67 | | 313 | INDIA-CHINA BORDER REGION | | | | GBA | 10.2 | 5-15-28.5 | 19.8 | 43.3 | 228.7 | 50.0 | 2.6 |
| | | 26 | ********** | | | | WRA | 16.6 | 5-21-18.5 | 62.1 | 318.0 | 134.9 | 6.3 | 1.7 |
| 3661 | 6- 3-48.4 | 27.6N | 92.7E | 33 | 4.2 | 1.4- 6 | YKA | 23.1 | 6-16-33.9 | 87.6 | 336.0 | 12.3 | .2 | .2 |
| | | | | | 1 | | EKA | 18.5 | 6-15- 4.1 | 70.9 | 69.1 | 323.0 | .4 | .5 |
| 74 | | 313 | INDIA-CHINA BORDER REGION | | | | GBA | 10.3 | 6- 8-20.3 | 19.9 | 43.3 | 228.7 | 2.0 | 1.2 |
| | | 26 | ********** | | | | WRA | 16.6 | 6-14- 8.8 | 62.1 | 318.1 | 135.0 | .3 | .3 |
| 3662 | 6-10- 8.2 | 16.0S | 175.7W | 145 | 4.7 | .9- 18 | YKA | 24.1 | 6-22-59.2 | 91.5 | 237.4 | 24.0 | 1.0 | .9 |
| | | | | | 3 | | EKA | 59.0 | 6-29-20.0 | 141.3 | 348.7 | 6.7 | .0 | .0 |
| 76 | | 173 | TONGA ISLANDS | | | | GBA | 25.3 | (6-24-21.1) | 109.6 | 102.3 | 279.0 | .1 | .0 |
| | | 12 | | | | | WRA | 14.3 | 6-18-31.1 | 47.5 | 93.7 | 257.4 | 2.5 | 1.3 |

| HYPOCENTRE DATA | | | | | | | SITE DATA | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EVENT NO / CARD NO | ORIGIN TIME H | LAT / REGION | LONG | DEPTH KMS | MAG CGS NC | SE - NO OF STNS USED | STN | PHASE VEL (P) KMS/SEC | TIMES P OR PKP GMT | TIMES ETA LR (3.97) GMT | DIST | ANGLE BB DEGREES | ANGLE AZ DEGREES |
| 3657 | 3-35-57.0 | 40.4S | 174.8E | 33 | .C | 1.9- 9 | YKA | 59.0 | 3-54-38.5 | 4-31-35 | 117.0 | 233.9 | 29.4 |
| | | | | | 0 | | EKA | 100.0 | 3-55-57.4 | 4-54- 2 | 165.0 | 6.0 | 355.5 |
| 76 | | 163 | COOK STRAIT, NEW ZEALAND | | | | GBA | 25.3 | (3-49-59.3) | 4-25-38 | 104.2 | 128.6 | 275.8 |
| | | 11 | | | | | WRA | 13.4 | 3-43-30.6 | 3-55-37 | 40.0 | 129.6 | 288.4 |
| | | | | | | | WOL | 100.0 | 3-56- .0 | 4-55-46 | 168.7 | 15.8 | 347.1 |
| | | | | | | | VAL | 100.0 | 3-55-59.6 | 4-55-24 | 167.9 | 341.2 | 15.1 |
| | | | | | | | BRL | 57.0 | (3-54-27.8) | 4-29- 2 | 111.5 | 213.9 | 135.3 |
| | | | | | | | ROO | 100.0 | 3-55-57.8 | 4-54-15 | 165.5 | 9.5 | 352.8 |
| | | | | | | | ABE | 100.0 | 3-55-55.5 | 4-53- 8 | 163.1 | 8.2 | 354.2 |
| | | | | | | | KEW | 100.0 | 3-55-59.9 | 4-55-38 | 168.4 | 18.9 | 344.6 |
| 3658 | 4-17- 2.1 | 37.4N | 114.2W | 33 | .0 | .9- 5 | YKA | 11.7 | 4-22-25.1 | 4-29-44= | 25.1 | 179.2 | 359.6 |
| | | | | | 9 | | EKA | 18.4 | 4-28-15.2 | 4-50-58= | 70.6 | 308.0 | 34.4 |
| 70 | | 41 | SOUTHERN NEVADA | | | | GBA | 57.0 | 4-36- 5.1 | 5-17-52 | 128.1 | 11.8 | 345.6 |
| | | 3 | ????????????????? | | | | WRA | 57.0 | 4-35-46.7 | 5-13-26 | 118.6 | 57.6 | 265.9 |
| | | | | | | | WOL | 19.2 | 4-28-35.7 | 4-52-35= | 74.0 | 310.3 | 36.9 |
| | | | | | | | VAL | 18.1 | 4-28- 6.7 | 4-50-18= | 69.1 | 304.2 | 40.0 |
| | | | | | | | BRL | 21.4 | 4-29-18.0 | 4-56- 5 | 81.5 | 312.5 | 116.9 |
| | | | | | | | ROO | 18.6 | 4-28-20.1 | 4-51-21= | 71.4 | 308.9 | 34.5 |
| | | | | | | | ABE | 18.2 | 4-28-11.1 | 4-50-39= | 69.9 | 308.2 | 32.5 |
| | | | | | | | KEW | 19.2 | 4-28-37.6 | 4-52-44= | 74.3 | 310.9 | 36.4 |
| 3659 | 4-22-51.2 | 22.3N | 117.9E | 19 | 5.5 | .9- 22 | YKA | 22.6 | 4-35-30.5 | 5- 3-56 | 85.8 | 312.5 | 21.7 |
| | | | | | 2 | | EKA | 23.1 | 4-35-40.7 | 5- 4-54 | 87.9 | 52.5 | 330.7 |
| 71 | | 243 | TAIWAN REGION | | | | GBA | 13.4 | 4-30-21.5= | 4-42-12= | 39.4 | 71.4 | 264.3 |
| | | 21 | | | | | WRA | 13.9 | 4-31- 7.3= | 4-44-49= | 45.0 | 338.2 | 157.9 |
| | | | | | | | WOL | 23.5 | 4-35-47.8 | 5- 5-35 | 89.4 | 54.0 | 326.7 |
| | | | | | | | VAL | 24.3 | 4-36- 6.0 | 5- 7-26 | 93.3 | 46.8 | 330.6 |
| | | | | | | | BRL | 100.0 | 4-42-54.0 | 5-40-59 | 165.1 | 61.4 | 294.0 |
| | | | | | | | ROO | 23.1 | 4-35-39.9 | 5- 4-49 | 87.7 | 53.4 | 329.9 |
| | | | | | | | ABE | 22.7 | 4-35-33.0 | 5- 4- 9 | 86.3 | 53.5 | 331.6 |
| | | | | | | | KEW | 23.4 | 4-35-45.2 | 5- 5-20 | 88.8 | 54.7 | 326.5 |

| HYPOCENTRE DATA | | | | | | | SITE DATA | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EVENT NO CARD NO | ORIGIN TIME H | LAT LONG REGION | DEPTH KMS | MAG BCIS NC | SD - NO OF STNS USED | STN | PHASE VEL (R) KMS/SEC | TIMES P OR PKP GMT | TIMES ETA LR (3.97) GMT | DIST | ANGLE BB DEGREES | ANGLE AZ DEGREES |
| 198 | 10-59- 6.0 | 51.0N 1.2E | 0 | .0 | .0- 28 | YKA | 15.5 | 11- 8-48.1 | 11-26-15 | 56.0 | 43.3 | 329.7 |
| | | | | 0 | | EKA | 7.9 | 11- 0-25.0 | 11- 2-26 | 5.1 | 147.1 | 330.6 |
| 980 | | 533 UNITED KINGDOM | | | | GBA | 18.4 | 11-10-26.9 | 11-33-11 | 70.9 | 319.5 | 91.9 |
| | | 36 | | | | WRA | 59.0 | 11-18-21.8 | 12- 1-46 | 132.0 | 321.6 | 67.5 |
| 199 | 16-56-52.0 | 40.7N 30.8E | 33 | .0 | .0- 70 | YKA | 19.0 | 17- 8-22.1 | 17-32- 9 | 73.5 | 26.8 | 344.0 |
| | | | | 0 | | EKA | 12.1 | 17- 2-29.7 | 17-10-18 | 26.7 | 109.0 | 314.7 |
| 099 | | 366 TURKEY | | | | GBA | 14.4 | 17- 5-35.6 | 17-20-36 | 48.7 | 312.7 | 109.9 |
| | | 30 | | | | WRA | 56.0 | (17-15-25.3) | 17-50-33 | 112.8 | 306.7 | 97.1 |
| 200 | 17-48- 5.0 | 40.8N 30.5E | 33 | .0 | .0- 0 | YKA | 18.9 | 17-59-34.2 | 18-23-18 | 73.3 | 27.0 | 343.9 |
| | | | | 0 | | EKA | 12.0 | 17-53-40.5 | 18- 1-24 | 26.5 | 109.2 | 314.7 |
| 100 | | 366 TURKEY | | | | GBA | 14.4 | 17-56-50.5 | 18-11-56 | 49.0 | 312.7 | 109.7 |
| | | 30 | | | | WRA | 56.0 | (18- 6-38.8) | 18-41-53 | 113.1 | 306.8 | 96.9 |
| 201 | 18- 9-52.0 | 40.9N 30.4E | 33 | .0 | .0- 0 | YKA | 18.9 | 18-21-20.5 | 18-45- 2 | 73.2 | 27.0 | 343.8 |
| | | | | 0 | | EKA | 12.0 | 18-15-26.4 | 18-23- 8 | 26.3 | 109.2 | 314.6 |
| 100 | | 366 TURKEY | | | | GBA | 14.5 | 18-18-38.3 | 18-33-46 | 49.1 | 312.8 | 109.7 |
| | | 30 | | | | WRA | 56.0 | (18-28-26.0) | 19- 3-43 | 113.1 | 306.9 | 96.8 |
| 202 | 23-41-56.0 | 40.8N 30.8E | 33 | .0 | .0- 0 | YKA | 19.0 | 23-53-25.6 | 0-17-11* | 73.4 | 26.7 | 344.0 |
| | | | | 0 | | EKA | 12.1 | 23-47-33.0 | 23-55-20 | 26.6 | 108.9 | 314.6 |
| 100 | | 366 TURKEY | | | | GBA | 14.4 | 23-50-39.9 | 0- 5-41* | 48.8 | 312.8 | 110.0 |
| | | 30 | | | | WRA | 56.0 | (0- 0-29.4*) | 0-35-38* | 112.8 | 306.8 | 97.1 |

| HYPOCENTRE DATA | | | | | | | SITE DATA | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EVENT NO / CARD NO | ORIGIN TIME H | LAT | LONG | DEPTH KMS | MAG CGS NC | SE - NO OF STNS USED | STN | PHASE VEL (P) KMS/SEC | TIMES ETA P OR PKP GMT | TIMES ETA LR (3.97) GMT | DIST | ANGLE BB DEGREES | ANGLE AZ DEGREES |
| 3657 | 3-35-57.0 | 40.4S | 174.8E | 33 | .0 | 1.9- 9 | AAA | 57.0 | 3-54-46.6 | 4-33-32 | 121.1 | 117.9 | 302.3 |
| | | | | | 0 | | AAB | 57.0 | 3-54-46.0 | 4-33-24 | 120.9 | 118.1 | 302.5 |
| 76 | | 163 | COOK STRAIT, NEW ZEALAND | | | | AAC | 100.0 | 3-55-59.0 | 4-54-57 | 167.0 | 41.5 | 326.6 |
| | | 11 | | | | | AAE | 59.0 | 3-55- 3.7 | 4-37-42 | 130.1 | 136.2 | 243.6 |
| | | | | | | | AAM | 57.0 | 3-54-50.3 | 4-34-27 | 123.1 | 243.3 | 60.2 |
| | | | | | | | ABA | 100.0 | 3-56- 2.3 | 4-57-35 | 172.6 | 121.6 | 243.5 |
| | | | | | | | ABC | 64.0 | 3-55-31.0 | 4-44-43 | 145.1 | 144.2 | 228.1 |
| | | | | | | | ABE | 100.0 | 3-55-55.5 | 4-53- 8 | 163.1 | 8.2 | 354.2 |
| | | | | | | | ABJ | 23.3 | 3-48-46.6 | 4-18-14 | 88.4 | 157.2 | 338.5 |
| | | | | | | | ABK | 70.0 | 3-55-37.6 | 4-46-37 | 149.1 | 37.3 | 342.9 |
| | | | | | | | ABS | 64.0 | 3-55-29.3 | 4-44-16 | 144.1 | 104.3 | 288.3 |
| | | | | | | | ABU | 21.8 | 3-48-20.9 | 4-15-46 | 83.2 | 150.9 | 328.4 |
| | | | | | | | AD- | 24.2 | 3-49- 4.1 | 4-19-60 | 92.2 | 186.5 | 5.3 |
| | | | | | | | ADA | 24.2 | 3-49- 4.0 | 4-19-60 | 92.2 | 186.5 | 5.3 |
| | | | | | | | ADE | 12.5 | 3-41-55.2 | 3-50-26 | 28.9 | 111.6 | 269.1 |
| | | | | | | | ADH | 100.0 | 3-55-55.3 | 4-53- 3 | 162.9 | 257.2 | 88.7 |
| | | | | | | | ADK | 24.2 | 3-49- 4.2 | 4-20- 0 | 92.2 | 186.6 | 5.3 |
| | | | | | | | AFI | 12.5 | 3-41-55.0 | 3-50-25 | 28.9 | 201.5 | 27.8 |
| | | | | | | | AGE | 13.4 | 3-43-25.5 | 3-55-20 | 39.4 | 147.3 | 315.6 |
| | | | | | | | AGR | 57.0 | (3-54-28.5) | 4-29-13 | 111.9 | 125.2 | 287.5 |
| | | | | | | | AHA | 17.4 | 3-46-40.4 | 4- 7-36 | 65.7 | 204.7 | 31.1 |
| | | | | | | | AHU | 25.2 | (3-49-53.4) | 4-25- 1 | 102.9 | 231.3 | 82.7 |
| | | | | | | | AIA | 17.3 | 3-46-36.2 | 4- 7-21 | 65.1 | 226.2 | 156.5 |
| | | | | | | | AID | 22.0 | 3-48-24.4 | 4-16- 6 | 83.9 | 154.1 | 332.9 |
| | | | | | | | AIK | 22.4 | 3-48-29.7 | 4-16-36 | 84.9 | 152.8 | 331.8 |
| | | | | | | | AJI | 21.6 | 3-48-14.8 | 4-15-13 | 82.0 | 153.3 | 331.1 |
| | | | | | | | AKH | 64.0 | 3-55-28.4 | 4-44- 1 | 143.6 | 105.0 | 287.9 |
| | | | | | | | AKI | 22.6 | 3-48-34.0 | 4-17- 0 | 85.8 | 154.2 | 333.9 |
| | | | | | | | AKU | 81.0 | 3-55-44.3 | 4-48-42 | 153.6 | 337.4 | 12.0 |
| | | | | | | | AKU1 | 81.0 | 3-55-44.3 | 4-48-42 | 153.6 | 337.4 | 12.0 |
| | | | | | | | ALB | 25.3 | (3-49-57.1) | 4-25-29 | 103.9 | 223.2 | 35.9 |
| | | | | | | | ALE | 60.0 | 3-55-11.1 | 4-39-32 | 134.0 | 296.9 | 8.8 |
| | | | | | | | ALG | 100.0 | 3-56- 2.3 | 4-57-34 | 172.6 | 121.8 | 243.4 |
| | | | | | | | ALI | 100.0 | 3-56- 3.3 | 4-59- 5 | 175.8 | 120.7 | 242.3 |
| | | | | | | | ALM | 100.0 | 3-56- 3.4 | 4-59- 6 | 175.9 | 149.6 | 212.1 |

| HYPOCENTRE DATA | | | | | | | SITE DATA | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EVENT NO CARD NO | ORIGIN TIME H | LAT | LONG | DEPTH KMS | MAG CGS NO | SE - NO OF STNS USED | STN | PHASE VEL (P) KMS/SEC | TIMES P OR PKP GMT | TIMES ETA LR (3.97) | DIST | ANGLE BB DEGREES | AZ |
| 3658 | 4-17- 2.1 | 37.4N | 114.2W | 33 | .C | .9- 5 | YKA | 11.7 | 4-22-25.1= | 4-29-44 | 25.1 | 179.2 | 359.6 |
| | | | | | C | | EKA | 18.4 | 4-28-15.2= | 4-50-58 | 70.6 | 308.0 | 34.4 |
| 70 | | 41 | SOUTHERN NEVADA | | | | GBA | 57.0 | 4-36- 5.1= | 5-17-52 | 128.1 | 11.8 | 345.6 |
| | | 3 | TTTTTTTTTTTTTTT | | | | WRA | 57.0 | 4-35-46.7= | 5-13-26 | 118.6 | 57.6 | 265.9 |
| 3660 | 5-10-58.1 | 27.5N | 92.6E | 33 | 5.6 | 1.0- 35 | YKA | 23.1 | 5-23-44.1 | 5-52-55 | 87.7 | 336.0 | 12.3 |
| | | | | | 8 | | EKA | 18.5 | 5-22-13.9 | 5-45- 6 | 71.0 | 69.2 | 323.0 |
| 67 | | 313 | INDIA-CHINA BORDER REGION | | | | GBA | 10.2 | 5-15-28.5 | 5-21-10 | 19.8 | 43.3 | 228.7 |
| | | 26 | ********** | | | | WRA | 16.6 | 5-21-18.5 | 5-40-58 | 62.1 | 318.0 | 134.9 |
| 3661 | 6- 3-48.4 | 27.6N | 92.7E | 33 | 4.2 | 1.4- 6 | YKA | 23.1 | 6-16-33.9 | 6-45-42 | 87.6 | 336.0 | 12.3 |
| | | | | | 1 | | EKA | 18.5 | 6-15- 4.1 | 6-37-55 | 70.9 | 69.1 | 323.0 |
| 74 | | 313 | INDIA-CHINA BORDER REGION | | | | GBA | 10.3 | 6- 8-20.3 | 6-14- 4 | 19.9 | 43.3 | 228.7 |
| | | 26 | ********** | | | | WRA | 16.6 | 6-14- 8.8 | 6-33-48 | 62.1 | 318.1 | 135.0 |
| 3664 | 7-13-11.3 | 37.3N | 114.2W | 33 | .0 | 1.2- 7 | YKA | 11.7 | 7-18-35.3 | 7-25-56 | 25.2 | 179.2 | 359.6 |
| | | | | | 0 | | EKA | 18.4 | 7-24-24.9 | 7-47- 9 | 70.6 | 307.9 | 34.4 |
| 69 | | 41 | SOUTHERN NEVADA | | | | GBA | 57.0 | 7-32-14.5 | 8-14- 4 | 128.2 | 11.8 | 345.5 |
| | | 3 | TTTTTTTTTTTTTTT | | | | WRA | 57.0 | 7-31-55.9 | 8- 9-35 | 118.6 | 57.7 | 265.9 |

| HYPOCENTRE DATA | | | | | | | SITE DATA | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EVENT NO CARD NO | ORIGIN TIME H | LAT | LONG | DEPTH KMS | MAG CGS NC | SE - NO OF STNS USED | STN | PHASE VEL KMS/SEC | TIMES ETA GMT | DIST | ANGLE BB DEGREES | AZ | PK/PK VEL * 10-5 CM/SEC | LCG A/T |
| 3657 | 3-35-57.0 | 40.4S | 174.8E | 33 | .C | 1.9- 9 | YKA | 59.0 | 3-54-38.5 | 117.0 | 233.9 | 29.4 | .0 | .C |
| | | | | | C | | EKA | 100.0 | 3-55-57.4 | 165.0 | 6.0 | 355.5 | .0 | .C |
| 76 | | 163 | COOK STRAIT, NEW ZEALAND | | | | GBA | 25.3 | (3-49-59.3) | 104.2 | 128.6 | 275.8 | .C | .C |
| | | 11 | | | | | WRA | 13.4 | 3-43-3C.6 | 40.0 | 129.6 | 288.4 | .C | .C |
| 3658 | 4-17- 2.1 | 37.4N | 114.2W | 33 | .C | .9- .5 | YKA | 11.7 | 4-22-25.1 | 25.1 | 179.2 | 359.6 | .C | .C |
| | | | | | C | | EKA | 18.4 | 4-28-15.2 | 70.6 | 3C8.0 | 34.4 | .C | .C |
| 70 | | 41 | SOUTHERN NEVADA | | | | GBA | 57.0 | 4-36- 5.1 | 128.1 | 11.8 | 345.6 | .0 | .0 |
| | | 3 | | | | | WRA | 57.0 | 4-35-46.7 | 118.6 | 57.6 | 265.9 | .0 | .C |
| 3659 | 4-22-51.2 | 22.3N | 117.9E | 19 | 5.5 | .9- 22 | YKA | 22.6 | 4-35-30.5 | 85.8 | 312.5 | 21.7 | 4.0 | 1.5 |
| | | | | | 3 | | EKA | 23.1 | 4-35-4C.7 | 87.9 | 52.5 | 33C.7 | 4.0 | 1.5 |
| 71 | | 243 | TAIWAN REGION | | | | GBA | 13.4 | 4-30-21.5* | 39.4 | 71.4 | 264.3 | 13.C | 2.C |
| | | 21 | | | | | WRA | 13.9 | 4-31- 7.3* | 45.0 | 338.2 | 157.9 | 1C.C | 1.9 |
| 3660 | 5-10-58.1 | 27.5N | 92.6E | 33 | 5.6 | 1.C- 35 | YKA | 23.1 | 5-23-44.1 | 87.7 | 336.0 | 12.3 | 5.C | 1.6 |
| | | | | | 8 | | EKA | 18.5 | 5-22-13.9 | 71.0 | 69.2 | 323.C | 1C.C | 1.9 |
| 67 | | 313 | INDIA-CHINA BORDER REGION | | | | GBA | 10.2 | 5-15-28.5 | 19.8 | 43.3 | 228.7 | 5C.0 | 2.6 |
| | | 26 | | | | | WRA | 16.6 | 5-21-18.5 | 62.1 | 318.0 | 134.9 | 6.3 | 1.7 |
| 3661 | 6- 3-48.4 | 27.6N | 92.7E | 33 | 4.2 | 1.4- 6 | YKA | 23.1 | 6-16-33.9 | 87.6 | 336.0 | 12.3 | .2 | .2 |
| | | | | | 1 | | EKA | 18.5 | 6-15- 4.1 | 7C.9 | 69.1 | 323.C | .4 | .5 |
| 74 | | 313 | INDIA-CHINA BORDER REGION | | | | GBA | 10.3 | 6- 8-2C.3 | 19.9 | 43.3 | 228.7 | 2.C | 1.2 |
| | | 26 | | | | | WRA | 16.6 | 6-14- 8.8 | 62.1 | 318.1 | 135.C | .3 | .3 |
| 3662 | 6-10- 8.2 | 16.0S | 175.7W | 145 | 4.7 | .9- 18 | YKA | 24.1 | 6-22-59.2 | 91.5 | 237.4 | 24.C | 1.C | .9 |
| | | | | | 3 | | EKA | 59.0 | 6-29-2C.0 | 140.3 | 348.7 | 6.7 | .C | .0 |
| 76 | | 173 | TONGA ISLANDS | | | | GBA | 25.3 | (6-24-21.1) | 109.6 | 102.3 | 279.C | .1 | .C |
| | | 12 | | | | | WRA | 14.3 | 6-18-31.1 | 47.5 | 93.7 | 257.4 | 2.5 | 1.3 |

## APPENDIX C

## PROGRAM LISTING

```
                                                        GEDESS G5
B         TYPE,COMPILE,F4
T         SUBTYPE,FIOD
B       1DIOD,$READER
B       2DIOD,$PRINTER
B       3DIOD,$PUNCH
          END
T         SUBTYPE,FORTRAN
C                   GEDESS MAIN PROGRAM  (GX)
C                   ------ ---- -------  ----
C
C         GEDESS  --  A FRAMEWORK FOR PREDICTING ARRIVAL DATA AT SEISMIC STATIONS
C         ------
C
C
C      THE MAIN PROGRAM SETS UP --
C
C
C      1)  THE SYMBOLS REQUIRED BY THE PROGRAM FROM THE CARD -
CJANFEBMARAPRMAYJUNJULAUGSEPOCTNOVDEC  * = ) *)=)   1 2 ((1(2  CNSEW  TO   FROM
C
C
C      2)  THE CONSTANTS -
C
C            GIVEN   A  THE EQUATORIAL RADIUS
C                ELLIP  THE ELLIPTICITY FACTOR
C
C            THE PROGRAM COMPUTES THE OTHER CONSTANTS REQUIRED FROM THESE TWO -
C                    B  THE POLAR RADIUS
C                    R  THE RADIUS OF THE MEAN SPHERE
C                GFACT  THE GEOCENTRIC FACTOR
C                   ER  CONSTANT FOR COMPUTING HEIGHT ABOVE MEAN SPHERE
C                   DH  JB TABLES INTERVAL
C               PCONST  DISTANCE IN TWO DEGREES IN KILOMETRES
C
C         AND ALSO  PI
C                 DTOR  DEGREES TO RADIANS
C                 RTOD  RADIANS TO DEGREES
C                  CEX  CONVERSION FACTOR FOR COMMON TO HYPERBOLIC LOGS




C               SECDAY  SECONDS IN A DAY
C                THIRD,ROUND
C
C
C      3)  THE COUNT CARD WHICH IS AS FOLLOWS -
C            COLS. 1-5   EVENT COUNT
C            COLS. 6-10  PAGE COUNT (SEE 4)
C          * COLS.11-13  NUMERIC CODE FOR MONTH (OR BLANK)
C            COL. 14     STAR (*) OPTIONAL
C            COLS.15-17  ALPHANUMERIC CODE FOR MONTH
C            COLS.18-20  NUMERIC CODE FOR YEAR (LAST TWO DIGITS)
C
C          * IF COLS.11-13 HAVE A NUMERIC CODE FOR MONTH (OTHER THAN ZERO)
C            THE EVENT CARDS ARE CHECKED THAT THEY ARE FOR THAT MONTH
C            AND ARE IN CHRONOGICAL ORDER
C            IF COLS.11-13 ZERO OR BLANK THE EVENT CARDS ARE NOT CHECKED
C            FOR ORDER
C
C      EXAMPLES -
C4127 1356 11*NOV 67
C 165    9     JUL 67
C
C
C      4)  TABLES  (BY GS - GEDESS SETUP PROGRAM)
C          IF THE PAGE COUNT IS ZERO THE TABLES ARE PRINTED OUT
C
C
C      5)  CALLS GEDESS (GD)
C
C
C      6)  PRINTS AND PUNCHES COUNT CARDS FOR FUTURE USE
C
C
C
      COMMON              ITAPE,NTAPE,A,B,R,ELLIP,GFACT,ER,DH,PCONST,
     1                    PI,DTOR,RTOD,CEX,SECDAY,THIRD,ROUND
      COMMON              Q(14,111), P(14,112), PKP(14,73), FD(180)
      COMMON              NEVENT,NPAGE,IMONTH,AMONTH,IYEAR,IDAY,
     1                    MYEAR,MONTH,MDAY,MHOUR,MIN,SEC,
     2                    HMONTH,NDAY,MHOURP,MINP,SECP,DIAG,
     3                    ELAT,DRCLAT,ELONG,DRCLNG,HO,NDEPTH,
     4                    DEPTH,DIST,AZ,NA,BB,NB,TTIME,PHASEV,VEL,ABYT,
     5                    UMAG,NO,IGREG,ISREG,CARD,SSE,NSTN,NC,NEP,KNEP,
     6                    TIME,TIMEP,ATIME,CTIME(20)
      COMMON              NOSTNS, STN(20), SLAT(20), SLONG(20),
```

```
     1                    SA(20), SB(20), SC(20),
     2                    SD(20), SE(20),
     3                    SG(20), SH(20), SK(20),
     4                    H1(20), ELEV(20)
      COMMON              SREG(5,50), GREG(4,730), NGREG(730), NSREG(730)
      COMMON              TO,FROM,C,CN,CS,CE,CW,BLANK,STAR,EQUALS,
     1                    BR,STARB,EQUALB,SY(6),BMONTH(12),IND
      ITAPE = 1
      NTAPE = 2
C
C READ IN SYMBOLS
      READ  (ITAPE,8) (BMONTH(I),I=1,12),BLANK,STAR,EQUALS,
     1   BR,STARB,EQUALB,(SY(I),I=1,6),C,CN,CS,CE,CW,TO,FROM
      WRITE (NTAPE,9) (BMONTH(I),I=1,12),BLANK,STAR,EQUALS,
     1   BR,STARB,EQUALB,(SY(I),I=1,6),C,CN,CS,CE,CW,TO,FROM
 8    FORMAT(1X,12A3,12A2,2X,5A1,2X,2A5)
 9    FORMAT(1X,12A8/1X,17A4/1X,2A8)
C
C SET UP CONSTANTS
      A = 6378.160
      ELLIP = 1./298.25
C-----------------------------
      PI = 4.*ATAN(1.)
      DTOR=PI/180.
      RTOD=180./PI
      CEX = ALOG(10.)
      B=A*(1.-ELLIP)
      R=EXP(((ALOG10(A)+ALOG10(A)+ALOG10(B))/3.)*CEX)
      GFACT=(B*B)/(A*A)
      ER=ELLIP*R
      DH=(R-33.)/100.
      PCONST=(2.*PI*R)/180.
      SECDAY = 24.*60.*60.
      THIRD = 1./3.
      ROUND = 0.5
      WRITE (NTAPE,1)
 1    FORMAT(1H1)
      WRITE (NTAPE,2)   A,B,R,ELLIP,GFACT,ER,DH,PCONST,
     1                  PI,DTOR,RTOD,CEX,SECDAY,THIRD,ROUND
 2    FORMAT(2X,E16.11)
      WRITE (NTAPE,3)
 3    FORMAT(/////////////)
C
C READ IN COUNT CARD AND SETUP OPTION
      READ  (ITAPE,101) NEVENT,NPAGE,IMONTH,AMONTH,IYEAR




 101  FORMAT(1X,I4,I5,I3,1H*,A3,I3)
      IND=1
      IF(IMONTH) 110,110,140
 110  IND=2
 120  DO 130 IMONTH=1,12
      IF(AMONTH-BMONTH(IMONTH))130,150,130
 130  CONTINUE
      IMONTH=0
      AMONTH=BLANK
      IND=2
      GO TO 150
 140  IF(AMONTH-BMONTH(IMONTH))120,150,120
 150  WRITE (NTAPE,102) NEVENT,NPAGE,IMONTH,AMONTH,IYEAR
 102  FORMAT(I5,I5,I3,1H*,A3,I3)
C SET UP TABLES AND PRINT IF NPAGE.EQ.0
      KTAB=1
      IF(NPAGE) 160,160,170
 160  KTAB=2
      NPAGE=1
      WRITE (NTAPE,111) NPAGE
      WRITE (NTAPE,112)
      WRITE (NTAPE,113)
      WRITE (NTAPE,112)
      WRITE (NTAPE,114) IYEAR
      WRITE (NTAPE,115)
      WRITE (NTAPE,116) A,B,R,ELLIP,GFACT,DH
      WRITE (NTAPE,117)
      WRITE (NTAPE,118)
      WRITE (NTAPE,119)
 111  FORMAT(13H1GEDESS G5    ,100X,11HPAGE NUMBER,I3/127X/127X/127X/        111
     1127H                          ************************************     111
     2*************************************                                )  111
 112                                                                FORMAT(  112
     1127H                          *                                        112
     2                                        *                           )  112
 113                                                                FORMAT(  113
     1127H                          *      G E D E S S    P R I N T O U T   113
     2   E A R T H Q U A K E    L I S T      *                            )  113
 114                                                                FORMAT(  114
     1 64H                          ********************************       114
     219,12,61H     ******************************                          114
     3    /127X/127X)                                                       114
 115  FORMAT(127X/127X/                                                      115
     1   40X,9HCONSTANTS,78X/40X,9H*********,78X/127X)                      115
 116  FORMAT(40X,33H EQUATORIAL RADIUS OF THE EARTH =,F9.3,5H KMS ,40X/      116
```

```
     1        40X,33H       POLAR RADIUS OF THE EARTH =,F9.3,5H KMS ,40X/      116
     2        40X,33H        MEAN RADIUS OF THE EARTH =,F9.3,5H KMS ,40X/      116
     3  127X/40X,33H                      ELLIPTICITY =,F8.6,46X/              116
     4        40X,33H                GEOCENTRIC FACTOR =,F8.6,46X/              116
     5        40X,33H                0.01R (JB TABLES) =,F8.4,6H KMS  ,40X/     116
     6  127X/127X)                                                              116
 117 FORMAT(40X,37HCONTENTS                                  ,50X/              117
     1        40X,37H********                                ,50X/127X/         117
     2        40X,37HTABLE 1    PAGE  2     Q FOR PZ  1955  ,50X/              117
     3        40X,37HTABLE 2A   PAGE  6     P       JB 1958 ,50X/              117
     4        40X,37HTABLE 2B   PAGE 10     PKP     JB 1958 ,50X)              117
 118 FORMAT(40X,87HTABLE 3    PAGE 13     E(D)      ELLIPTICITY CORRECTION    118
     1S                                                                      /  118
     2        40X,87HTABLE 4    PAGE 14     SEISMIC AND GEOGRAPHICAL REGION   118
     3S                                                                      /  118
     4        40X,87HTABLE 5    PAGE 36     STATIONS                          118
     5                                                                 /127X/   118
     6        40X,87H           PAGE 37     EARTHQUAKE LISTING                118
     7                                                                       /  118
     8        40X,87H           ONWARDS                                       118
     9                                                                       )  118
 119 FORMAT(127X/127X/127X/127X/127X/                                           119
     1127H                        ********  FOR FURTHER DETAILS AND FULL      119
     2 EXPLANATION SEE GEDESS REPORT  ********                               )  119
 170 CALL GS(KTAB)
 190 IDAY=0
C
C CALL GEDESS
 200 CALL GD
C SET COUNT CARDS FOR FUTURE USE
     NEWENT=NEVENT
     IMONTH=IMONTH+1
     IF(IMONTH-12)220,220,210
 210 NEWENT=0
     NPAGE=0
     IMONTH=1
     IYEAR=IYEAR+1
 220 AMONTH=BMONTH(IMONTH)
     GO TO (230,300),IND
 230 WRITE (NTAPE,1)
     WRITE (NTAPE,3)
     WRITE (NTAPE,102) NEWENT,NPAGE,IMONTH,AMONTH,IYEAR
     WRITE (3,102)     NEWENT,NPAGE,IMONTH,AMONTH,IYEAR
     WRITE (3,104)     NEWENT,NPAGE,AMONTH,IYEAR,AMONTH,IYEAR
 104 FORMAT(I5,I5,4X,A3,I3,54X,A3,I3)



 300 RETURN
C    ------
     END
T       SUBTYPE,FORTRAN
C                GEDESS SETUP ROUTINE  (GS)
C                ------ ----- -------  ----
C
C    READS IN AND SETS UP    TABLE 1   MAGNITUDE   Q  A FOR PZ
C                                      -FORMAT(1X,14F5.1)-
C                            TABLE 2A  P  TRAVEL TIMES
C                                      -FORMAT(1X,14F5.1) AND FORMAT(2X,7F10.2)-
C                            TABLE 2B  PKP  TRAVEL TIMES
C                                      -FORMAT(1X,14F5.1) AND FORMAT(2X,7F10.2)-
C                            TABLE 3   ELLIPTICITY CORRECTIONS
C                                      -FORMAT(2X,10F7.4)-
C                            TABLE 4   REGIONS
C                                      -FORMAT(2(1X,2I3,1X,4A8))-
C                            TABLE 5   STATIONS
C                                      -FORMAT(1X,A5,30H
C                                       3HLAT,F10.6,5H LONG,F11.6,5H ELEV,F6.3)-
C
C    USES KEY - KTAB      PRINTS OUT TABLES IF KEY IS 2 - SEE GX FOR SETTING.
C
     SUBROUTINE GS(KTAB)
     COMMON            ITAPE,NTAPE,A,B,R,ELLIP,GFACT,ER,DH,PCONST,
    1                  PI,DTOR,RTOD,CEX,SECDAY,THIRD,ROUND
     COMMON            Q(14,111), P(14,112), PKP(14,73), ED(180)
     COMMON            NEVENT,NPAGE,GEDS(65)
     COMMON            NOSTNS, STN(20), SLAT(20), SLONG(20),
    1                  SA(20), SB(20), SC(20),
    2                  SD(20), SE(20),
    3                  SG(20), SH(20), SK(20),
    4                  HI(20), ELEV(20)
     COMMON            SREG(5,50), GREG(4,730), NGREG(730), NSREG(730)
     COMMON            TO,FROM,C,CN,CS,CF,CW,BLANK,STAR,EQUALS
     DIMENSION HNAME(6),BNAME(4),LABEL(112),MINP(14),SECP(14)
C
C
     ANAME=BLANK
     DO 800 I=1,20
     STN(I)=BLANK
     SLAT(I)=0.
     SLONG(I)=0.
 800 CONTINUE
C
```

```
C
C READ Q TABLE
 1000 READ  (ITAPE,911) HNAME
      READ  (ITAPE,912) ((Q(IDEPTH,IDIST),IDEPTH=1,14),LABEL(IDIST),
     1                  IDIST=1,111)
      DO 1005 IDIST=1,111
      IF(LABEL(IDIST)-IDIST+1)1010,1005,1010
 1005 CONTINUE
      GO TO (2000,1015),KTAB
 1010 WRITE (NTAPE,901)
      STOP
C     ----
C PRINT Q TABLE
 1015 LPAGE=1
      LINE=0
      NPAGE=NPAGE+1
      WRITE (NTAPE,913) HNAME,NPAGE
      WRITE (NTAPE,914)
      DO 1060 IDIST=1,111
      JDIST=IDIST-1
      LINE=LINE+1
 1020 WRITE (NTAPE,915) JDIST,(Q(IDEPTH,IDIST),IDEPTH=1,14),JDIST
      IF(JDIST-30*LPAGE)1030,1050,1050
 1030 IF(LINE-5)1060,1040,1040
 1040 WRITE (NTAPE,914)
      LINE=0
      GO TO 1060
 1050 LPAGE=LPAGE+1
      NPAGE=NPAGE+1
      WRITE (NTAPE,913) HNAME,NPAGE
      WRITE (NTAPE,914)
      GO TO 1020
 1060 CONTINUE
C
C
C     TRAVEL TIMES ARE READ IN AS DEPTH ALLOWANCES AND TIMES FOR SURFACE FOCUS
C READ P TABLE
 2000 IND=0
      READ  (ITAPE,911) HNAME
      READ  (ITAPE,912) ((P(IDEPTH,IDIST),IDEPTH=1,14),LABEL(IDIST),
     1                  IDIST=1,112)
      READ  (ITAPE,911) HNAME
      READ  (ITAPE,922) (P(1,IDIST),IDIST=1,112)
      DO 2020 IDIST=1,112
      DO 2010 IDEPTH=2,14
      P(IDEPTH,IDIST)=P(1,IDIST)-P(IDEPTH,IDIST)
 2010 CONTINUE
      IF(LABEL(IDIST)-IDIST+1)2055,2020,2055
 2020 CONTINUE
      KDIST=0
      LDIST=1
      MDIST=111
      GO TO (2030,2060),KTAB
C READ PKP TABLE
 2030 IND=1
      READ  (ITAPE,911) HNAME
      READ  (ITAPE,912) ((PKP(IDEPTH,IDIST),IDEPTH=1,14),LABEL(IDIST),
     1                  IDIST=1,73)
      READ  (ITAPE,911) HNAME
      READ  (ITAPE,922) (PKP(1,IDIST),IDIST=1,73)
      DO 2050 IDIST=1,73
      DO 2040 IDEPTH=2,14
      PKP(IDEPTH,IDIST)=PKP(1,IDIST)-PKP(IDEPTH,IDIST)
 2040 CONTINUE
      IF(LABEL(IDIST)-IDIST-108)2055,2050,2055
 2050 CONTINUE
      KDIST=110
      LDIST=114
      MDIST=184
      GO TO (2500,2060),KTAB
 2055 WRITE (NTAPE,902)
      STOP
C     ----
C PRINT TRAVEL TIME TABLES
 2060 LPAGE=1
      LINE=0
      NPAGE=NPAGE+1
      WRITE (NTAPE,913) HNAME,NPAGE
      WRITE (NTAPE,923)
      DO 2120 IDIST=LDIST,MDIST
      DO 2070 IDEPTH=1,14
      SECP(IDEPTH)=P(IDEPTH,IDIST)
      MINP(IDEPTH)=SECP(IDEPTH)*0.016666667
      SECP(IDEPTH)=ABS(SECP(IDEPTH)-FLOAT(MINP(IDEPTH))*60.0)
 2070 CONTINUE
      JDIST=IDIST-LDIST+KDIST
      LINE=LINE+1
 2080 WRITE (NTAPE,924) JDIST,(MINP(IDEPTH),SECP(IDEPTH),IDEPTH=1,14),
     1                  JDIST
      IF((JDIST-KDIST)-30*LPAGE)2090,2110,2110
```

```
 2080 IF(LINE-5)2120,2100,2100
 2100 WRITE (NTAPE,914)
      LINE=0
      GO TO 2120
 2110 LPAGE=LPAGE+1
      NPAGE=NPAGE+1
      WRITE (NTAPE,913) HNAME,NPAGE
      WRITE (NTAPE,923)
      GO TO 2080
 2120 CONTINUE
      IND=IND+1
      GO TO (2030,2500),IND
C
C READ AND PRINT ELLIPTICITY CORRECTIONS
 2500 READ  (ITAPE,911) HNAME
      READ  (ITAPE,926) (ED(JDIST),JDIST=1,180)
      GO TO (3000,2510),KTAB
 2510 NPAGE=NPAGE+1
      WRITE (NTAPE,927) HNAME,NPAGE
      WRITE (NTAPE,928) (JDIST,ED(JDIST),JDIST=1,180)
C
C
C READ REGION NUMBERS AND NAMES
 3000 READ  (ITAPE,911) HNAME
 3020 READ  (ITAPE,931) (NGREG(I),NSREG(I),(GREG(J,I),J=1,4),I=1,730)
      READ  (ITAPE,932) ((SREG(J,I),J=1,5),I=1,50)
      DO 3030 I=1,730
      IF(NGREG(I)-I)3040,3030,3040
 3030 CONTINUE
      GO TO (4000,3050),KTAB
 3040 J=I-1
      WRITE (NTAPE,903) NGREG(I),J
      STOP
C     ----
C PRINT REGION NUMBERS AND NAMES
 3050 ICOUNT=0
      LINE=43
      DO 3110 I=1,730
      IF(LINE-43)3070,3060,3060
 3060 LINE=0
      NPAGE=NPAGE+1
      WRITE (NTAPE,933) HNAME,NPAGE
 3070 IF(ICOUNT-NSREG(I))3080,3100,3100
 3080 IF(LINE-39)3090,3060,3060
 3090 ICOUNT=ICOUNT+1
      WRITE (NTAPE,934) ICOUNT,(SREG(J,ICOUNT),J=1,5)
      LINE=LINE+4
 3100 WRITE (NTAPE,935) I,(GREG(J,I),J=1,4)
      LINE=LINE+1
 3110 CONTINUE
C
C
C STATION READ AND PRINT
 4000 READ  911, HNAME
 4030 N=0
      LINE=40
 4040 N=N+1
      READ  (ITAPE,941) ANAME,BNAME,SLAT(N),SLONG(N),ELEV(N)
      IF(ANAME-TO)4045,4030,4045
 4045 IF(ANAME-FROM)4050,4200,4050
 4050 STN(N)=ANAME
      GO TO (4080,4060),KTAB
 4060 IF(LINE-40)4080,4070,4070
 4070 LINE=0
      NPAGE=NPAGE+1
      WRITE (NTAPE,942) HNAME,NPAGE
 4080 GO TO (4040,4090),KTAB
 4090 WRITE (NTAPE,943) ANAME,BNAME,SLAT(N),SLONG(N),ELEV(N)
      LINE=LINE+1
      GO TO 4040
 4200 NOSTNS=N-1
 4210 IF(NOSTNS-3)4230,4220,4220
 4220 IF(NOSTNS-20)4240,4240,4230
 4230 WRITE (NTAPE,905)
      STOP
C     ----
 4240 DO 4250 I=1,NOSTNS
C SET UP STATION CONSTANTS
      CALL GC (SLAT(I),SLONG(I),SA(I),SB(I),SC(I),SD(I),SE(I),
     1                          SG(I),SH(I),SK(I),H1(I))
 4250 CONTINUE
C
 5000 RETURN
C     ------
C
C FORMATS
C
 901  FORMAT(44H)** JOB HALTED  -  SEQUENCE ERROR IN Q TABLE)
 902  FORMAT(48H)** JOB HALTED  -  DEPTH ALLOWANCES OUT OF ORDER)
 903  FORMAT(25H)** JOB HALTED  -  REGION,I4,42H OUT OF SEQUENCE - LAST
```

```
     1CORRECT REGION WAS,I4)
 905 FORMAT(50H1** JOB HALTED  -  INCOMPATIBLE NUMBER OF STATIONS)
 911 FORMAT(I1,5A8,A7,I2,6I5)
 912 FORMAT(1X,14F5.1,5X,I3)
 913 FORMAT(1H1,6A8,12X,9HDEPTH  H=,43X,11HPAGE NUMBER,I3/127X/          913
     1127H          SURFACE    0.00     0.01     0.02     0.03     0.04     0.0    913
     25     0.06     0.07     0.08     0.09     0.10     0.11     0.12       / 913
     3127H DIST                 33 KM   96 KM  160 KM  223 KM  287 KM  350     913
     4KM  413 KM  477 KM  540 KM  603 KM  667 KM  730 KM  794 KM   DIST/      913
     5        5H DEG.,118X,4HDEG.)                                            913
 914 FORMAT(127X)
 915 FORMAT(1X,I4,1X,14F8.1,I9)
 922 FORMAT(2X,7F10.2)
 923 FORMAT(                                                                 923
     1127H           M   S   M   S   M   S   M   S   M   S   M   S   M       923
     2S   M   S   M   S   M   S   M   S   M   S   M   S                  )    923
 924 FORMAT(1X,I4,3X,14(I3,F5.1),I7)
 926 FORMAT(2X,10F7.4)
 927 FORMAT(1H1,6A8,63X,11HPAGE NUMBER,I4/127X/127X)
 928 FORMAT(10(I5,1H*,F6.4),7X/127X)
 931 FORMAT(1X,2I3,1X,4A8,1X,2I3,1X,4A8)
 932 FORMAT(6X,5A8)
 933 FORMAT(1H1,6A8,63X,11HPAGE NUMBER,I4)
 934 FORMAT(127X/127X/41X,I4,2X,5A8,40X/127X)
 935 FORMAT(55X,I5,2X,4A8,33X)
 941 FORMAT(1X,A5,3A8,A6,3HLAT,F10.6,5H LONG,F11.6,5H ELEV,F6.3)
 942 FORMAT(1H1,6A8,63X,11HPAGE NUMBER,I4/127X/                            942
     1127H                    CODE    STATION              REGION    LA     942
     2TITUDE      LONGITUDE       ELEVATION                              /   942
     3127X)                                                                  942
 943 FORMAT(22X,A8,3A8,A6,3HLAT,F10.6,5H LONG,F11.6,5H ELEV,F8.3,22X)
     END
T        SUBTYPE,FORTRAN
C                              GEDESS  (GD)
C                              ------  ----
C
C     GEDESS READS IN EVENT DATA, COMPUTES SITE DATA, AND PRINTS.
C
C
C
C EVENT DATA --
C
C     THE EARTHQUAKE DATA CARD IS AS FOLLOWS --
C     COLS. 4-10    MHOUR,MIN,SEC  ORIGIN TIME H
C     COLS.12-15    ELAT,DRCLAT    EPICENTRAL LATITUDE
C     COLS.18-22    ELONG,DRCLNG   EPICENTRAL LONGITUDE
C     COLS.25-29    NDEPTH  DEPTH OF EVENT (KM)
C     COLS.31-35    UMAG    MAGNITUDE CGS (MAG)
C     COLS.37-41    NO      MAGNITUDE NUMBER (NO)
C     COLS.42-43    ISREG   SEISMIC REGION NUMBER
C     COLS.44-46    CARD    PDE CARD NUMBER
C     COLS.47-49    IGREG   GEOGRAPHIC REGION NUMBER
C     COLS.50-55    SSE     STANDARD ERROR (SE)
C     COLS.56-59    NSTN    NUMBER OF STATIONS USED IN COMPUTING EPICENTRE (N)
C     COLS.60-64    HMONTH,NDAY    MONTH AND DAY OF EVENT
C     COLS.65-69    NC      SEE * BELOW
C     COLS.70-74    NEP     EPICENTRE IDENTIFICATION
C     COLS.75-80    MDAY,MONTH,MYEAR    DATE OF EVENT
C
C
C COMPUTING --
C
C          TIME    ORIGIN TIME IN SECONDS (GMT)
C          TIMEP   ESTIMATED TIME OF ARRIVAL IN SECONDS (GMT)
C          TTIME   TRAVEL TIME IN SECONDS
C          ATIME   CHECK-VARIABLE
C          CTIME   CHECK-VARIABLE
C          NEP     CHECK-VARIABLE
C          KNEP    CHECK-VARIABLE
C          LINE    LINE COUNT
C        * NC      IF COLS.65-69 ZERO (OR BLANK) THE PROGRAM WINDS UP
C
C
C PRINTING --
C
C     HEADING -- 10 LINE AND 2 LINE --
C 10 LINE  PRINTED FOR EACH NEW DAY
C  2 LINE  PRINTED AT THE TOP OF EACH NEW PAGE
C          MDAY    DAY OF MONTH
C          AMONTH  MONTH CODE
C          MYEAR   LAST TWO FIGURES OF YEAR
C          NPAGE   PAGE COUNT
C
C     EVENT DATA -- PRINT TWO DOUBLE LINES --
C  LINE 1  NEVENT  EVENT NUMBER
C          MHOUR,MIN,SEC      ORIGIN TIME (GMT)
C          ELAT,DRCLAT,ELONG,DRCLNG    COORDINATES OF EPICENTRE (DEGREES NS,EW)
C          NDEPTH,(DEPTH)     DEPTH (KILOMETRES)
C          UMAG    MAGNITUDE    (UNDERPRINTED WITH    NO    MAGNITUDE NUMBER
C          SSO     STANDARD DEVIATION (SECONDS)
```

```
C           NSTN     NUMBER OF STATIONS USED IN COMPUTING
C  LINE 2   CARD     PDE CARD NUMBER
C           IGREG    GEOGRAPHIC REGION NUMBER     UNDERPRINTED BY     ISREG
C           GREG     TABLE OF REGION NAMES                  / SEISMIC REGION NUMBER
C
C      SITE DATA -- UP TO 20 STATIONS --
C           STN      STATION CODE
C           PHASEV   PHASE VELOCITY (KILOMETRES/SECOND)
C           SY(MBOL)    TENS OF HOURS OF ETA WITH BRACKET OPTION
C           MHOURP      UNITS OF HOURS OF ESTIMATED TIME OF ARRIVAL (GMT)
C           MINP,SECP   MINUTES AND SECONDS OF ETA (GMT)
C           DIAG     A DIAGNOSTIC FOR ETA DISCONTINUITY, NEXT DAY, OR BRACKET
C           DIST     DISTANCE (DEGREES)
C           BB,(NB)     BACK-BEARING (STATION TO EPICENTRE) (DEGREES)
C           AZ,(NA)     AZIMUTH (EPICENTRE TO STATION) (DEGREES)
C           VEL      PEAK-TO-PEAK GROUND VELOCITY (* 10-5 CM/SEC)
C           ABYT     LOG A/T
C
C
C
C      LIBRARY ROUTINES USED IN GEDESS (NOT INCLUDING INPUT/OUTPUT PACKAGE)
C
C                    SQRT                 SIN                  FLOAT
C                    ALOG                 COS                  IFIX
C                    ALOG10               TAN                  ABS
C                    EXP                  ATAN                 ** (EXPONENTIATION)
C                                         ATAN2
C
C
      SUBROUTINE GD
      COMMON              ITAPE,NTAPE,A,B,R,ELLIP,GFACT,ER,DH,PCONST,
     1                    PI,DTOR,RTOD,CEX,SECDAY,THIRD,ROUND
      COMMON              Q(14,111), P(14,112), PKP(14,73), ED(180)
      COMMON              NEVENT,NPAGE,IMONTH,AMONTH,IYEAR,IDAY,
     1                    MYEAR,MONTH,MDAY,MHOUR,MIN,SEC,
     2                    HMONTH,NDAY,MHOURP,MINP,SECP,DIAG,
     3                    ELAT,DRCLAT,ELONG,DRCLNG,HO,NDEPTH,
     4                    DEPTH,DIST,AZ,NA,BB,NB,TTIME,PHASEV,VEL,ABYT,
     5                    UMAG,ND,IGREG,ISREG,CARD,SSE,NSTN,NC,NEP,KNEP,
     6                    TIME,TIMEP,ATIME,CTIME(20)
      COMMON              NOSTNS, STN(20), SLAT(20), SLONG(20),
     1                    SA(20), SB(20), SC(20),
     2                    SD(20), SE(20),
     3                    SG(20), SH(20), SK(20),
     4                    HI(20), ELEV(20)



      COMMON              SREG(5,50), GREG(4,730), NGREG(730), NSREG(730)
      COMMON              TO,FROM,C,CN,CS,CE,CW,BLANK,STAR,EQUALS,
     1                    BR,STARB,EQUALB,SY(6),BMONTH(12),IND
C
C SET UP LINES/PAGE AND CHECK-VARIABLES
      LIND = 44
      KNEP=0
      ATIME=SECDAY
      DO 10 I=1,20
      CTIME(I)=SECDAY
 10   CONTINUE
C
C
C                    INPUT SECTION
C                    -------------
C
C READ IN EVENT CARD
 100  READ  (ITAPE,811) MHOUR,MIN,SEC,ELAT,DRCLAT,ELONG,DRCLNG,
     1                  NDEPTH,UMAG,ND,ISREG,CARD,IGREG,SSE,NSTN,
     2                  HMONTH,NDAY,NC,NEP,MDAY,MONTH,MYEAR
      IF(NC) 110,101,110
 101  RETURN
C     ------
 110  GO TO (111,120),IND
C CHECK CARD IS FOR CORRECT YEAR, MONTH, AND DAY
 111  IF(MYEAR-IYEAR)115,112,115
 112  IF(MONTH-IMONTH)115,113,115
 113  IF(HMONTH-AMONTH)115,114,115
 114  IF(MDAY-IDAY)116,120,120
 115  WRITE (NTAPE,801)
      IF(KNEP) 117,118,117
 116  WRITE (NTAPE,802)
 117  WRITE (NTAPE,810)
      WRITE (NTAPE,811) MHOUR,MIN,SEC,ELAT,DRCLAT,ELONG,DRCLNG,
     1                  NDEPTH,UMAG,ND,ISREG,CARD,IGREG,SSE,NSTN,
     2                  HMONTH,NDAY,NC,NEP,MDAY,MONTH,MYEAR
 118  STOP
C     ----
C
C                    SETUP SECTION.
C                    --------------
C
C COMPUTE ORIGIN TIME IN SECONDS
 120  AMONTH=BMONTH(MONTH)
      TIME=FLOAT((MHOUR*60+MIN)*60)+SEC
```

```
      IF(MDAY-IDAY)130,140,130
C IF NEW DAY PRINT HEADING AND RESET CHECK-VARIABLES
 130  IDAY=MDAY
      NPAGE=NPAGE+1
      WRITE (NTAPE,812) MDAY,AMONTH,MYEAR,NPAGE
      WRITE (NTAPE,821)
      WRITE (NTAPE,822)
      WRITE (NTAPE,821)
      WRITE (NTAPE,823)
      WRITE (NTAPE,821)
      WRITE (NTAPE,813)
      LINE=10
      ATIME=ATIME-SECDAY
      DO 131 I=1,NOSTNS
      CTIME(I)=CTIME(I)-SECDAY
 131  CONTINUE
      GO TO 200
 140  GO TO (150,170),IND
C CHECK CARDS ARE IN CHRONOLOGICAL ORDER, AND FOR REPEATED EVENTS
 150  IF(TIME-ATIME)116,160,170
 160  IF(NEP-KNEP)170,100,170
C CHECK THAT THERE IS ENOUGH PAGE FOR PRINTING
 170  IF((LINE+6)-LIND)190,190,180
 180  LINE=LIND
      GO TO 200
 190  WRITE (NTAPE,814)
      LINE=LINE+2
C SET CHECK-VARIABLES FOR NEXT EVENT
 200  ATIME=TIME
      KNEP=NEP
C SET UP EPICENTRE CONSTANTS
      IF(DPCLAT-CN)210,230,210
 210  IF(DPCLAT-CS)250,220,250
 220  ELAT=-ELAT
 230  IF(DPCLNG-CE)240,270,240
 240  IF(DPCLNG-CW)250,260,250
 250  WRITE (NTAPE,804)
      GO TO 117
 260  ELONG=-ELONG
 270  CALL GG(0)
      ELAT=ABS(ELAT)
      ELONG=ABS(ELONG)
      DEPTH=FLOAT(NDEPTH)
      IF(IGREG) 290,290,300
 290  IGREG=730
C
C
C                    COMPUTE SECTION
C                    ---------------
C
 300  NEVENT=NEVENT+1
      DO 500 I=1,NOSTNS
C COMPUTE DISTANCE, AZIMUTH, AND BACKBEARING
      CALL GG(I)
C COMPUTE TRAVEL TIME AND PHASE VELOCITY
      CALL GT (DEPTH,DIST,0.,H0,H1(I),TTIME,DUM,PHASEV)
C COMPUTE PK/PK VEL AND LOG A/T
      CALL GM (DEPTH,DIST,0.,UMAG,VEL,ABYT)
      TIMEP=TIME+TTIME
      DIAG=BLANK
      GO TO (310,330),IND
C CHECK IF ESTIMATED TIME OF ARRIVAL IS EARLIER THAN THE PREVIOUS ETA
 310  IF(TIMEP-CTIME(I))320,320,330
 320  DIAG=EQUALS
 330  CTIME(I)=TIMEP
C CHECK IF ESTIMATED TIME OF ARRIVAL IS ON THE NEXT DAY
      IF(TIMEP-SECDAY)390,390,340
 340  TIMEP=TIMEP-SECDAY
      IF(DIAG-BLANK)390,350,390
 350  DIAG=STAR
C COMPUTE ETA IN HOURS, MINUTES, AND SECONDS
 390  MHOURP=IFIX(TIMEP/3600.)
      MINP=(ABS(-(IFIX(TIMEP/60.)-MHOURP*60)))
      SECP=TIMEP-FLOAT((MHOURP*60+MINP)*60)
C BRACKETED TIME SECTION
      MBOL=MHOURP/10+1
      MHOURP=MHOURP-(MBOL-1)*10
      IF(DIST-100.)400,391,391
 391  IF(DIST-115.)392,392,400
 392  MBOL=MBOL+3
      IF(DIAG-BLANK)393,396,393
 393  IF(DIAG-EQUALS)395,394,395
 394  DIAG=EQUALB
      GO TO 400
 395  DIAG=STARB
      GO TO 400
 396  DIAG=BB
C
C
C                    PRINT SECTION
```

```
C                    -------------
C
C PRINT NEW PAGE IF REQUIRED
 420  IF(LINE-LIND)420,410,410
 410  LINE=2
      NPAGE=NPAGE+1
      WRITE (NTAPE,812) MDAY,AMONTH,MYEAR,NPAGE
      WRITE (NTAPE,813)
C PRINT EVENT DATA WITH PREDICTED SITE DATA
 420  IF(I-4)430,430,480
 430  GO TO (440,450,460,470),I
 440  WRITE (NTAPE,815) NEVENT,MHOUR,MIN,SEC,ELAT,DRCLAT,
     1                  ELONG,DRCLNG,NDEPTH,UMAG,SSE,NSTN,
     2                  STN(1),PHASEV,SY(MBOL),MHOURP,MINP,SECP,DIAG,
     3                  DIST,BB,AZ,VEL,ABYT
      GO TO 490
 450  WRITE (NTAPE,816) NO,
     1                  STN(2),PHASEV,SY(MBOL),MHOURP,MINP,SECP,DIAG,
     2                  DIST,BB,AZ,VEL,ABYT
      GO TO 490
 460  WRITE (NTAPE,817) CARD,IGREG,(GREG(J,IGREG),J=1,4),
     1                  STN(3),PHASEV,SY(MBOL),MHOURP,MINP,SECP,DIAG,
     2                  DIST,BB,AZ,VEL,ABYT
      GO TO 490
 470  WRITE (NTAPE,818) ISREG,
     1                  STN(4),PHASEV,SY(MBOL),MHOURP,MINP,SECP,DIAG,
     2                  DIST,BB,AZ,VEL,ABYT
      GO TO 490
 480  WRITE (NTAPE,819) STN(I),PHASEV,SY(MBOL),MHOURP,MINP,SECP,DIAG,
     1                  DIST,BB,AZ,VEL,ABYT
 490  LINE=LINE+1
 500  CONTINUE
      GO TO 100
C
C
C                    FORMATS SECTION
C                    ---------------
C
 801  FORMAT(55H1** JOB HALTED  -  CARDS FOR WRONG MONTH, OR SOMETHING )
 802  FORMAT(51H1** JOB HALTED  -  CARDS NOT IN CHRONOLOGICAL ORDER//)
 804  FORMAT(48H1** JOB HALTED  -  UNKNOWN LATITUDE OR LONGITUDE//)
 810  FORMAT(25H THE INCORRECT CARD IS  -/)
 811  FORMAT(3X,I2,I2,F3.1,F4.1,A1,F6.1,A1,I5,6HKM MAG,F2.1,3H ND,I3,I2,     811
     1       A3,I3,2HSE,F4.1,1HN,I3,A3,I2,I5,I5,I2,I2,I2)                    811
 812  FORMAT(PH1G5      ,I4,1X,A3,I3,92X,11HPAGE NUMBER,I5)
 813  FORMAT(127X)
 814  FORMAT(127X/127X)
 815  FORMAT(1X,I4,I6,1H-,I2,1H-,F4.1,2(F8.1,A1),I8,F7.1,F6.1,1H-,I3,
     1       4X,A5,F6.1,3X,A2,I1,1H-,I2,1H-,F4.1,A2,3F7.1,F8.1,F5.1)
 816  FORMAT(49X,I3,10X,
     1       4X,A5,F6.1,3X,A2,I1,1H-,I2,1H-,F4.1,A2,3F7.1,F8.1,F5.1)
 817  FORMAT(1X,A3,19X,I4,2X,4AR,1X,
     1       4X,A5,F6.1,3X,A2,I1,1H-,I2,1H-,F4.1,A2,3F7.1,F8.1,F5.1)
 818  FORMAT(23X,I4,35X,
     1       4X,A5,F6.1,3X,A2,I1,1H-,I2,1H-,F4.1,A2,3F7.1,F8.1,F5.1)
 819  FORMAT(62X,
     1       4X,A5,F6.1,3X,A2,I1,1H-,I2,1H-,F4.1,A2,3F7.1,F8.1,F5.1)
 821                                                          FORMAT(     821
     1127H ------------------------------------------------------------     821
     2-------------------------------------------------------------)      821
 822                                                          FORMAT(     822
     1127H                          H Y P O C E N T R E   D A T A          822
     2                             S I T E   D A T A                  )   822
 823                                                          FORMAT(     823
     1127H EVENT   ORIGIN TIME    LAT     LONG     DEPTH    MAG   SE - NO  823
     2    STN   PHASE     T I M E S          A N G L E       PK/PK  LOG/   823
     3127H   NO                                                     OF    823
     4            VEL      ETA          DIST      BB      AZ     VEL   A/T/  823
     5127H CARD          H          R E G I O N              CGS     STNS  823
     6                                                      * 10-5     /   823
     7127H  NO                                        KMS     NO      USED 823
     8          KMS/SEC.       GMT                DEGREES     CM/SEC     ) 823
      END
T        SUBTYPE,FORTRAN
C                    GEDESS GEOCENTRIC GEORGE  (GG)
C                    ------ ---------- ------  ----
C
C   THIS SUBROUTINE COMPUTES DISTANCE, BACKBEARING, AND AZIMUTH FROM -
C
C         COS D   =  AS*AE + BS*BE + CS*CE
C        SIN AZ   = -(AS*DE + BS*EE) * COSEC D
C        COS AZ   = -(AS*GE + BS*HE + CS*KE) * COSEC D
C        SIN BB   = -(AE*DS + BE*ES) * COSEC D
C        COS BB   = -(AE*GS + BE*HS + CE*KS) * COSEC D
C
C   WHERE  AS, BS, CS, ETC.  ARE STATION CONSTANTS
C     AND  AE, BE, CE, ETC.  ARE EPICENTRE CONSTANTS CALCULATED BY GG.
C
C     STATION CONSTANTS ARE IN COMMON ARRAYS AND PREFIXED BY S
C     EPICENTRE CONSTANTS ARE VARIABLES OF THIS PROGRAM AND PREFIXED BY E
```

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C
C     FOR  I.EQ.0  SETS UP ALL EPICENTRE CONSTANTS
C     FOR  I.NE.0  USES I AS INDEX FOR STATION CONSTANTS
C                          AND COMPUTES AZ, BB, AND DIST.
C
C     FOR FORMULAE AND EXPLANATION SEE ANY I.S.S.
C     SEE ALSO EPICENTRE CONSTANTS ROUTINE GC
C
      SUBROUTINE GG(I)
      COMMON              ITAPE,NTAPE,A,B,P,ELLIP,GFACT,ER,DH,PCONST,
     1                    PI,DTOR,RTOD,CEX,SECDAY,THIRD,ROUND
      COMMON              Q(14,111), P(14,112), PKP(14,73), FD(180)
      COMMON              NEVENT,NPAGE,IMONTH,AMONTH,IYEAR,IDAY,
     1                    MYEAR,MONTH,MDAY,MHOUR,MIN,SEC,
     2                    HMONTH,NDAY,MHOURP,MINP,SECP,DIAG,
     3                    ELAT,DRCLAT,ELONG,DRCLNG,HO,NDEPTH,
     4                    DEPTH,DIST,AZ,NA,BB,NB,TTIME,PHASEV,VEL,ABYT,
     5                    UMAG,ND,IGREG,ISREG,CARD,SSE,NSTN,NC,NEP,KNEP,
     6                    TIME,TIMEP,ATIME,CTIME(20)
      COMMON              NDSTNS, STN(20), SLAT(20), SLONG(20),
     1                    SA(20), SB(20), SC(20),
     2                    SD(20), SE(20),
     3                    SG(20), SH(20), SK(20),
     4                    HI(20), ELEV(20)
      IF(I) 10,10,20
C
 10   CALL GC (ELAT,ELONG,EA,EB,EC,ED,EE,EG,EH,EK,HO)
      RETURN
C
 20   COSD=SA(I)*EA+SB(I)*EB+SC(I)*EC
      SIND=SQRT(1.-COSD*COSD)
      IF(SIND) 60,30,60
 30   AZ=180.
      BB=0.
      IF(COSD) 50,20,40
 40   DIST=0.
      GO TO 110
 50   DIST=180.
      GO TO 110
 60   COSECD=1./SIND
      SINAZ=-(SA(I)*ED+SB(I)*EE)*COSECD
      COSAZ=-(SA(I)*EG+SB(I)*EH+SC(I)*EK)*COSECD
      SINBB=-(EA*SD(I)+EB*SE(I))*COSECD
      COSBB=-(EA*SG(I)+EB*SH(I)+EC*SK(I))*COSECD
      AZ=ATAN2(SINAZ,COSAZ)
      BB=ATAN2(SINBB,COSBB)
      DIST=ATAN2(SIND,COSD)
      IF(AZ) 70,80,80
 70   AZ=2.*PI+AZ
 80   IF(BB) 90,100,100
 90   BB=2.*PI+BB
C
 100  AZ=AZ*RTOD
      BB=BB*RTOD
      NA=IFIX(AZ+ROUND)
      NB=IFIX(BB+ROUND)
      DIST=DIST*RTOD
 110  RETURN
C     ------
      END
T        SUBTYPE,FORTRAN
C                 GEDESS EPICENTRE CONSTANTS SUBROUTINE  (GC)
C                 ------ --------- --------- ----------  ----
C
C   THIS SUBROUTINE COMPUTES THE EPICENTRE (AND STATION) CONSTANTS  -
C
C        A  =  COS T * COS L
C        B  =  COS T * SIN L
C        C  =  SIN T
C
C        D  =  SIN L
C        E  = -COS L
C
C        G  =  SIN T * COS L
C        H  =  SIN T * SIN L
C        K  = -COS T
C                          WHERE  T = GEOCENTRIC LATITUDE  AND  L = LONGITUDE
C
C   FROM WHICH DISTANCES, BACKBEARINGS, AND AZIMUTHS CAN BE CALCULATED.
C
C   THE RELATIONSHIP BETWEEN  T  (GEOCENTRIC LATITUDE)
C                        AND  TI (GEOGRAPHIC LATITUDE)
C   IS  TAN T  =  .99328 * TAN TI       WHERE .99328 IS GFACT
C
C   ALSO COMPUTES  HO  - THE HEIGHT, IN KILOMETRES, ABOVE THE MEAN SPHERE
C           WHERE  HO  =  ER * (THIRD - SINT * SINT)
C
C     FOR FORMULAE AND EXPLANATION SEE ANY I.S.S.
C     SEE ALSO GEOCENTRIC GEORGE GG
C
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```
      SUBROUTINE GC (ALAT,ALONG,AA,AB,AC,AD,AE,AG,AH,AK,H0)
      COMMON              ITAPE,NTAPE,A,B,R,ELLIP,GFACT,ER,DH,PCONST,
     1                    PI,DTOR,RTOD,CEX,SECDAY,THIRD,ROUND
C
      GLAT=ATAN(GFACT*TAN(ALAT*DTOR))
      GLONG=ALONG*DTOR
      AC=SIN(GLAT)
      AK=COS(GLAT)
      AD=SIN(GLONG)
      AE=COS(GLONG)
      AA=AK*AE
      AB=AK*AD
      AG=AC*AE
      AH=AC*AD
      AE=-AE
      AK=-AK
      H0=ER*(THIRD-AC*AC)
      RETURN
C     ------
      END
T        SUBTYPE,FORTRAN
C                GEDESS TIME SUBROUTINE  (GT)
C                ------ ---- ----------  ----
C
C        THIS SUBROUTINE COMPUTES TRAVEL TIME (TTIME) FOR A GIVEN DEPTH AND DIST
C                 AND ADDS THE STATION TIME CORRECTION (CT)
C            AND ALSO COMPUTES THE PHASE VELOCITY (PHASEV)
C
C        THE TRAVEL TIME OF SURFACE WAVES (RAYLEIGH WAVES) IS ESTIMATED
C            FROM THE FORMULA --  LR.  DT/DD = 0.4674 +/- 0.0011  MIN/1 DEG
C                                WITH VELOCITY = 3.972 +/- 0.009  KM/SEC
C            AND A FIXED ARBITRARY POINT AT 60 DEGREES OF 29 MINS
C     N.B.  SURFACE WAVES NOT USED IN THIS VERSION
C
      SUBROUTINE GT (DEPTH,DIST,CT,H0,H1,TTIME,TTIME2,PHASEV)
      COMMON              ITAPE,NTAPE,A,B,R,ELLIP,GFACT,ER,DH,PCONST,
     1                    PI,DTOR,RTOD,CEX,SECDAY,THIRD,ROUND
      COMMON              Q(14,111), P(14,112), PKP(14,73), FD(180)
C
 10   TTIME2=(29.+(0.4674*(DIST-60.)))*60.
C
      IF(DEPTH-33.)20,30,30
 20   IDEPTH=1
      DDEPTH=DEPTH/33.
      GO TO 40
```

```
 30   DDEPTH=(DEPTH-33.)/DH
      IDEPTH=IFIX(DDEPTH)+2
      DDEPTH=DDEPTH-FLOAT(IDEPTH-2)
 40   IDIST=IFIX(DIST)
      JDIST=IFIX(DIST+ROUND)
      DDIST=DIST-FLOAT(IDIST)
C
C                 DISTANCE   0-1 DEGREES
      IF(IDIST) 110,110,120
 110  PHASEV=0.
      TTIME=GL (P(IDEPTH,1),P(IDEPTH+1,1),
     1          P(IDEPTH,2),P(IDEPTH+1,2),DDEPTH,DDIST)+CT
      RETURN
C     ------
C                 DISTANCE   1-110 DEGREES
 120  IF(IDIST-110)130,140,140
 130  T01 = P  (IDEPTH,IDIST  )
      T11 = P  (IDEPTH,IDIST+1)
      T21 = P  (IDEPTH,IDIST+2)
      T31 = P  (IDEPTH,IDIST+3)
      T02 = P  (IDEPTH+1,IDIST  )
      T12 = P  (IDEPTH+1,IDIST+1)
      T22 = P  (IDEPTH+1,IDIST+2)
      T32 = P  (IDEPTH+1,IDIST+3)
      F11=PCONST/(T21-T01)
      F12=PCONST/(T22-T02)
      F21=PCONST/(T31-T11)
      F22=PCONST/(T32-T12)
      PHASEV=GL (F11,F12,F21,F22,DDEPTH,DDIST)
      TTIME=GL (T11,T12,T21,T22,DDEPTH,DDIST)+CT+FD(JDIST)*(H0+H1)
      RETURN
C     ------
C                 DISTANCE   110-180 DEGREES
 140  IF(IDIST-180)150,190,190
 150  IDIST=IDIST-109
      T01 = PKP(IDEPTH,IDIST  )
      T11 = PKP(IDEPTH,IDIST+1)
      T21 = PKP(IDEPTH,IDIST+2)
      T31 = PKP(IDEPTH,IDIST+3)
      T02 = PKP(IDEPTH+1,IDIST  )
      T12 = PKP(IDEPTH+1,IDIST+1)
      T22 = PKP(IDEPTH+1,IDIST+2)
      T32 = PKP(IDEPTH+1,IDIST+3)
      F11=PCONST/(T21-T01)
      F12=PCONST/(T22-T02)
```

```
      F21=PCONST/(T31-T11)
      F22=PCONST/(T32-T12)
      PHASEV=GL (F11,F12,F21,F22,DDEPTH,DDIST)
      IF(IDIST-66)160,170,170
 160  IVAR=IFIX(PHASEV+0.5)
      PHASEV=FLOAT(IVAR)
      IF(PHASEV-100.)180,180,170
 170  PHASEV=100.
 180  TTIME=GL (T11,T12,T21,T22,DDEPTH,DDIST)+CT+FD(JDIST)*(H0+H1)
      RETURN
C     ------
C                    DISTANCE   180 DEGREES
 190  PHASEV=100.
      TTIME=GL (PKP(IDEPTH,72),PKP(IDEPTH+1,72),
     1          PKP(IDEPTH,73),PKP(IDEPTH+1,73),DDEPTH,DDIST)+CT
     2         +FD(180)*(H0+H1)
      RETURN
C     ------
      END
T        SUBTYPE,FORTRAN
C                    GEDESS LINEAR INTERPOLATION FUNCTION  (GL)
C                    ------ ------ ------------- --------  ----
C
C        LINEAR INTERPOLATION ROUTINE FOR THE TABLES
C
C     FINDS  T  IN THE MATRIX          T11(DDEPTH)      T12
C                                 (DDIST)
C                                                  T
C
C                                      T21              T22
C
      FUNCTION GL (T11,T12,T21,T22,DDEPTH,DDIST)
      GL  = T11+DDEPTH*(T12-T11)+DDIST*(T21-T11)
     1         +DDEPTH*DDIST*(T11-T12-T21+T22)
      RETURN
      END
T        SUBTYPE,FORTRAN
C                    GEDESS MAGNITUDE SUBROUTINE  (GM)
C                    ------ --------- ----------  ----
C
C    THIS ROUTINE COMPUTES  1)  VELOCITY (VEL)  =  40 * PI * ANTILOG((MAG+CP-Q)
C                           2)  LOG A/T   (AT)  =  MAG + CP - Q + 3
C
C        WHERE  MAG = U.S.C.G.S. QUOTED MAGNITUDE
C                CP = MAGNITUDE CORRECTION




C             AND  Q = A FOR PZ  (ROUNDED TO NEAREST DEPTH AND DISTANCE)
C
C    BOTH VEL AND AT GIVEN TO 2 SIG.FIGS.
C
      SUBROUTINE GM (DEPTH,DIST,CP,UMAG,VEL,AT)
      COMMON              ITAPE,NTAPE,A,B,R,ELLIP,GFACT,ER,DH,PCONST,
     1                    PI,DTOR,RTOD,CEX,SECDAY,THIRD,ROUND
      COMMON              Q(14,111)
      VEL=0.
      AT=0.
C
      IF(UMAG) 100,100,10
 10   IF(DIST-110.)20,20,100
 20   IF(DEPTH-33.)30,30,40
 30   IDEPTH=IFIX(DEPTH/33.+ROUND)+1
      GO TO 50
 40   IDEPTH=IFIX((DEPTH-33.)/DH+ROUND)+2
 50   IDIST=IFIX(DIST+ROUND)+1
      QI=Q(IDEPTH,IDIST)
C
      IF(QI) 100,100,60
 60   AMAG=UMAG+CP-QI
      QK=EXP(AMAG*CEX)
      VEL=40.0*PI*QK
      EV=-2.
 70   VEL=VEL*0.1
      EV=EV+1.0
      IF(VEL-1.0)80,70,70
 80   IVEL=IFIX(VEL*100.0+ROUND)
      VEL=FLOAT(IVEL)*10.0**EV
      IF(QK-0.001)100,100,90
 90   AT=AMAG+3.
C
 100  RETURN
C     ------
      END
T        SUBTYPE,DATA
 JANFEBMARAPRMAYJUNJULAUGSEPOCTNOVDEC   * = ) *)=)    1 2 ((1(2  CNSEW  TO    FROM
 3656  710  9*SEP 66
1TABLE 1    Q FOR PZ  1955    GUTENBERG/RICHTER
   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0        Q   000
   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0        Q   001
   5.6  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0        Q   002
   5.8  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0        Q   003
   6.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0        Q   004
```

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.4 | 6.1 | 5.9 | 5.9 | 5.7 | 5.6 | 5.6 | 5.7 | 5.7 | 5.7 | 5.7 | 5.6 | 5.6 | Q | 005 |
| 6.6 | 6.4 | 6.1 | 6.0 | 5.8 | 5.6 | 5.7 | 5.8 | 5.8 | 5.8 | 5.7 | 5.6 | 5.6 | Q | 006 |
| 6.8 | 6.7 | 6.3 | 6.2 | 5.8 | 5.7 | 5.7 | 5.8 | 5.8 | 5.9 | 5.7 | 5.6 | 5.6 | Q | 007 |
| 7.0 | 6.8 | 6.4 | 6.3 | 5.9 | 5.7 | 5.9 | 6.0 | 6.0 | 5.9 | 5.7 | 5.7 | 5.6 | Q | 008 |
| 7.2 | 6.9 | 6.5 | 6.3 | 5.9 | 5.8 | 6.0 | 6.1 | 6.1 | 6.0 | 5.8 | 5.7 | 5.6 | Q | 009 |
| 7.3 | 7.0 | 6.6 | 6.3 | 6.0 | 5.8 | 6.1 | 6.1 | 6.1 | 6.0 | 5.8 | 5.7 | 5.6 | Q | 010 |
| 7.2 | 7.0 | 6.6 | 6.3 | 6.0 | 5.9 | 6.2 | 6.2 | 6.2 | 6.1 | 5.8 | 5.7 | 5.6 | Q | 011 |
| 7.1 | 6.9 | 6.5 | 6.3 | 6.0 | 6.0 | 6.2 | 6.2 | 6.2 | 6.1 | 5.9 | 5.8 | 5.6 | Q | 012 |
| 7.0 | 6.7 | 6.3 | 6.2 | 6.1 | 6.0 | 6.2 | 6.2 | 6.2 | 6.2 | 6.0 | 5.8 | 5.7 | Q | 013 |
| 6.6 | 6.4 | 6.0 | 6.1 | 6.1 | 6.1 | 6.1 | 6.2 | 6.3 | 6.2 | 6.0 | 5.8 | 5.7 | Q | 014 |
| 6.3 | 6.1 | 5.9 | 6.1 | 6.2 | 6.1 | 6.1 | 6.2 | 6.3 | 6.2 | 6.1 | 5.8 | 5.7 | Q | 015 |
| 5.9 | 5.9 | 5.9 | 6.1 | 6.2 | 6.1 | 6.1 | 6.2 | 6.3 | 6.3 | 6.1 | 5.9 | 5.7 | Q | 016 |
| 5.9 | 5.9 | 6.0 | 6.1 | 6.2 | 6.1 | 6.0 | 6.2 | 6.3 | 6.4 | 6.2 | 5.9 | 5.8 | Q | 017 |
| 5.9 | 5.9 | 6.0 | 6.1 | 6.2 | 6.1 | 6.0 | 6.2 | 6.3 | 6.4 | 6.2 | 6.0 | 5.8 | Q | 018 |
| 6.0 | 5.9 | 6.0 | 6.1 | 6.2 | 6.1 | 6.0 | 6.2 | 6.3 | 6.4 | 6.2 | 6.0 | 5.8 | Q | 019 |
| 6.0 | 6.0 | 6.0 | 6.1 | 6.2 | 6.1 | 6.0 | 6.2 | 6.3 | 6.4 | 6.3 | 6.1 | 5.9 | Q | 020 |
| 6.1 | 6.1 | 6.1 | 6.1 | 6.3 | 6.1 | 6.0 | 6.2 | 6.3 | 6.4 | 6.4 | 6.1 | 5.9 | Q | 021 |
| 6.2 | 6.2 | 6.1 | 6.2 | 6.3 | 6.1 | 6.0 | 6.2 | 6.3 | 6.4 | 6.4 | 6.2 | 5.9 | Q | 022 |
| 6.3 | 6.2 | 6.1 | 6.2 | 6.3 | 6.1 | 6.0 | 6.2 | 6.2 | 6.4 | 6.4 | 6.2 | 6.0 | Q | 023 |
| 6.3 | 6.2 | 6.1 | 6.3 | 6.4 | 6.1 | 6.0 | 6.2 | 6.2 | 6.4 | 6.4 | 6.2 | 6.0 | Q | 024 |
| 6.5 | 6.3 | 6.2 | 6.3 | 6.4 | 6.2 | 6.0 | 6.2 | 6.2 | 6.4 | 6.4 | 6.3 | 6.0 | Q | 025 |
| 6.4 | 6.3 | 6.2 | 6.4 | 6.4 | 6.2 | 6.0 | 6.2 | 6.2 | 6.4 | 6.4 | 6.3 | 6.1 | Q | 026 |
| 6.5 | 6.3 | 6.3 | 6.4 | 6.4 | 6.2 | 6.0 | 6.2 | 6.2 | 6.4 | 6.4 | 6.3 | 6.1 | Q | 027 |
| 6.6 | 6.4 | 6.3 | 6.5 | 6.4 | 6.2 | 6.0 | 6.1 | 6.2 | 6.4 | 6.4 | 6.3 | 6.2 | Q | 028 |
| 6.6 | 6.5 | 6.4 | 6.5 | 6.4 | 6.2 | 6.0 | 6.1 | 6.2 | 6.4 | 6.4 | 6.3 | 6.2 | Q | 029 |
| 6.6 | 6.5 | 6.4 | 6.5 | 6.4 | 6.3 | 6.0 | 6.1 | 6.2 | 6.3 | 6.4 | 6.3 | 6.2 | Q | 030 |
| 6.7 | 6.6 | 6.5 | 6.5 | 6.4 | 6.3 | 6.0 | 6.1 | 6.2 | 6.3 | 6.4 | 6.3 | 6.3 | Q | 031 |
| 6.7 | 6.6 | 6.5 | 6.5 | 6.3 | 6.3 | 6.0 | 6.1 | 6.2 | 6.3 | 6.4 | 6.3 | 6.3 | Q | 032 |
| 6.7 | 6.7 | 6.6 | 6.5 | 6.3 | 6.3 | 6.0 | 6.1 | 6.2 | 6.3 | 6.4 | 6.3 | 6.3 | Q | 033 |
| 6.7 | 6.7 | 6.6 | 6.5 | 6.3 | 6.3 | 6.0 | 6.1 | 6.2 | 6.3 | 6.4 | 6.3 | 6.3 | Q | 034 |
| 6.7 | 6.7 | 6.6 | 6.4 | 6.3 | 6.3 | 6.0 | 6.1 | 6.2 | 6.3 | 6.4 | 6.3 | 6.3 | Q | 035 |
| 6.6 | 6.7 | 6.7 | 6.4 | 6.3 | 6.3 | 6.0 | 6.1 | 6.2 | 6.3 | 6.3 | 6.3 | 6.3 | Q | 036 |
| 6.5 | 6.6 | 6.7 | 6.4 | 6.3 | 6.2 | 6.0 | 6.1 | 6.2 | 6.3 | 6.3 | 6.3 | 6.3 | Q | 037 |
| 6.5 | 6.5 | 6.6 | 6.4 | 6.3 | 6.2 | 6.0 | 6.1 | 6.2 | 6.3 | 6.3 | 6.2 | 6.3 | Q | 038 |
| 6.4 | 6.5 | 6.6 | 6.4 | 6.3 | 6.2 | 6.0 | 6.1 | 6.2 | 6.3 | 6.3 | 6.2 | 6.3 | Q | 039 |
| 6.4 | 6.5 | 6.6 | 6.4 | 6.2 | 6.1 | 6.0 | 6.1 | 6.2 | 6.3 | 6.3 | 6.2 | 6.3 | Q | 040 |
| 6.5 | 6.4 | 6.6 | 6.4 | 6.2 | 6.0 | 6.0 | 6.1 | 6.2 | 6.3 | 6.3 | 6.2 | 6.3 | Q | 041 |
| 6.5 | 6.4 | 6.5 | 6.4 | 6.2 | 6.0 | 5.9 | 6.1 | 6.2 | 6.3 | 6.3 | 6.2 | 6.3 | Q | 042 |
| 6.5 | 6.5 | 6.5 | 6.4 | 6.2 | 6.0 | 5.9 | 6.1 | 6.2 | 6.3 | 6.3 | 6.2 | 6.3 | Q | 043 |
| 6.5 | 6.5 | 6.5 | 6.4 | 6.1 | 6.0 | 5.9 | 6.1 | 6.2 | 6.3 | 6.3 | 6.1 | 6.2 | Q | 044 |
| 6.7 | 6.6 | 6.5 | 6.4 | 6.1 | 6.0 | 5.9 | 6.1 | 6.2 | 6.3 | 6.3 | 6.1 | 6.2 | Q | 045 |
| 6.8 | 6.7 | 6.5 | 6.4 | 6.1 | 6.1 | 5.9 | 6.1 | 6.2 | 6.3 | 6.3 | 6.1 | 6.2 | Q | 046 |
| 6.9 | 6.7 | 6.5 | 6.4 | 6.1 | 6.1 | 6.0 | 6.1 | 6.2 | 6.3 | 6.3 | 6.1 | 6.2 | Q | 047 |
| 6.9 | 6.8 | 6.6 | 6.4 | 6.1 | 6.1 | 6.0 | 6.1 | 6.1 | 6.3 | 6.3 | 6.1 | 6.2 | Q | 048 |
| 6.8 | 6.8 | 6.7 | 6.4 | 6.1 | 6.1 | 6.0 | 6.1 | 6.1 | 6.3 | 6.2 | 6.1 | 6.2 | Q | 049 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.7 | 6.8 | 6.7 | 6.4 | 6.1 | 6.1 | 6.0 | 6.1 | 6.1 | 6.2 | 6.2 | 6.1 | 6.2 | Q | 050 |
| 6.7 | 6.7 | 6.8 | 6.4 | 6.2 | 6.1 | 6.0 | 6.0 | 6.1 | 6.1 | 6.2 | 6.0 | 6.2 | Q | 051 |
| 6.7 | 6.7 | 6.8 | 6.4 | 6.2 | 6.1 | 6.1 | 6.0 | 6.1 | 6.1 | 6.1 | 6.0 | 6.1 | Q | 052 |
| 6.7 | 6.7 | 6.8 | 6.5 | 6.2 | 6.1 | 6.1 | 6.0 | 6.1 | 6.1 | 6.1 | 6.0 | 6.1 | Q | 053 |
| 6.8 | 6.7 | 6.8 | 6.5 | 6.3 | 6.1 | 6.1 | 6.0 | 6.1 | 6.1 | 6.1 | 6.0 | 6.1 | Q | 054 |
| 6.8 | 6.8 | 6.8 | 6.5 | 6.3 | 6.2 | 6.1 | 6.0 | 6.1 | 6.0 | 6.1 | 6.0 | 6.1 | Q | 055 |
| 6.8 | 6.8 | 6.8 | 6.6 | 6.3 | 6.2 | 6.1 | 6.1 | 6.1 | 6.0 | 6.0 | 5.9 | 6.0 | Q | 056 |
| 6.8 | 6.8 | 6.8 | 6.6 | 6.4 | 6.2 | 6.1 | 6.1 | 6.1 | 6.0 | 6.0 | 5.9 | 6.0 | Q | 057 |
| 6.8 | 6.8 | 6.8 | 6.6 | 6.4 | 6.2 | 6.1 | 6.1 | 6.1 | 6.0 | 5.9 | 5.9 | 6.0 | Q | 058 |
| 6.8 | 6.8 | 6.8 | 6.6 | 6.4 | 6.2 | 6.2 | 6.1 | 6.1 | 6.0 | 5.9 | 5.9 | 5.9 | Q | 059 |
| 6.8 | 6.8 | 6.8 | 6.6 | 6.4 | 6.3 | 6.2 | 6.2 | 6.2 | 6.1 | 6.0 | 5.9 | 5.9 | Q | 060 |
| 6.9 | 6.9 | 6.8 | 6.6 | 6.4 | 6.3 | 6.2 | 6.2 | 6.2 | 6.1 | 6.0 | 6.0 | 5.9 | Q | 061 |
| 7.0 | 6.9 | 6.8 | 6.6 | 6.4 | 6.4 | 6.3 | 6.3 | 6.2 | 6.2 | 6.0 | 6.0 | 5.9 | Q | 062 |
| 6.9 | 6.9 | 6.7 | 6.6 | 6.4 | 6.4 | 6.3 | 6.3 | 6.3 | 6.2 | 6.1 | 6.0 | 5.9 | Q | 063 |
| 7.0 | 6.8 | 6.6 | 6.6 | 6.4 | 6.4 | 6.4 | 6.3 | 6.3 | 6.2 | 6.1 | 6.0 | 6.0 | Q | 064 |
| 7.0 | 6.8 | 6.6 | 6.6 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.2 | 6.2 | 6.1 | 6.0 | Q | 065 |
| 7.0 | 6.8 | 6.6 | 6.6 | 6.4 | 6.5 | 6.5 | 6.4 | 6.4 | 6.3 | 6.2 | 6.1 | 6.0 | Q | 066 |
| 7.0 | 6.8 | 6.6 | 6.6 | 6.4 | 6.5 | 6.5 | 6.4 | 6.4 | 6.3 | 6.2 | 6.1 | 6.0 | Q | 067 |
| 7.0 | 6.8 | 6.6 | 6.5 | 6.4 | 6.5 | 6.5 | 6.4 | 6.4 | 6.3 | 6.2 | 6.1 | 6.1 | Q | 068 |
| 7.0 | 6.7 | 6.6 | 6.5 | 6.4 | 6.5 | 6.5 | 6.4 | 6.3 | 6.3 | 6.2 | 6.1 | 6.1 | Q | 069 |
| 6.9 | 6.7 | 6.6 | 6.5 | 6.4 | 6.5 | 6.5 | 6.3 | 6.3 | 6.3 | 6.2 | 6.2 | 6.1 | Q | 070 |
| 6.9 | 6.7 | 6.6 | 6.5 | 6.4 | 6.4 | 6.5 | 6.3 | 6.3 | 6.3 | 6.3 | 6.2 | 6.1 | Q | 071 |
| 6.9 | 6.7 | 6.6 | 6.5 | 6.4 | 6.4 | 6.5 | 6.3 | 6.3 | 6.2 | 6.3 | 6.2 | 6.1 | Q | 072 |
| 6.9 | 6.7 | 6.6 | 6.5 | 6.4 | 6.4 | 6.5 | 6.3 | 6.3 | 6.2 | 6.3 | 6.2 | 6.2 | Q | 073 |
| 6.8 | 6.7 | 6.5 | 6.5 | 6.4 | 6.4 | 6.5 | 6.4 | 6.3 | 6.2 | 6.3 | 6.3 | 6.2 | Q | 074 |
| 6.8 | 6.7 | 6.5 | 6.4 | 6.4 | 6.4 | 6.5 | 6.4 | 6.3 | 6.2 | 6.3 | 6.3 | 6.2 | Q | 075 |
| 6.9 | 6.7 | 6.5 | 6.4 | 6.4 | 6.4 | 6.5 | 6.4 | 6.3 | 6.2 | 6.2 | 6.3 | 6.2 | Q | 076 |
| 6.9 | 6.7 | 6.5 | 6.4 | 6.4 | 6.5 | 6.5 | 6.4 | 6.3 | 6.2 | 6.2 | 6.3 | 6.2 | Q | 077 |
| 6.9 | 6.7 | 6.5 | 6.4 | 6.4 | 6.5 | 6.5 | 6.4 | 6.2 | 6.1 | 6.2 | 6.3 | 6.2 | Q | 078 |
| 6.8 | 6.7 | 6.6 | 6.4 | 6.4 | 6.5 | 6.5 | 6.4 | 6.3 | 6.1 | 6.1 | 6.3 | 6.2 | Q | 079 |
| 6.7 | 6.7 | 6.6 | 6.4 | 6.4 | 6.5 | 6.5 | 6.4 | 6.3 | 6.1 | 6.1 | 6.2 | 6.2 | Q | 080 |
| 6.8 | 6.7 | 6.6 | 6.4 | 6.4 | 6.5 | 6.5 | 6.5 | 6.3 | 6.2 | 6.2 | 6.2 | 6.2 | Q | 081 |
| 6.9 | 6.7 | 6.6 | 6.4 | 6.4 | 6.5 | 6.6 | 6.5 | 6.3 | 6.2 | 6.3 | 6.3 | 6.2 | Q | 082 |
| 7.0 | 6.8 | 6.6 | 6.5 | 6.5 | 6.6 | 6.6 | 6.5 | 6.3 | 6.3 | 6.3 | 6.3 | 6.2 | Q | 083 |
| 7.0 | 6.9 | 6.6 | 6.5 | 6.5 | 6.6 | 6.6 | 6.5 | 6.3 | 6.3 | 6.3 | 6.3 | 6.2 | Q | 084 |
| 7.0 | 6.9 | 6.7 | 6.5 | 6.5 | 6.6 | 6.6 | 6.5 | 6.4 | 6.3 | 6.4 | 6.4 | 6.2 | Q | 085 |
| 6.9 | 7.0 | 6.7 | 6.5 | 6.5 | 6.6 | 6.6 | 6.5 | 6.4 | 6.4 | 6.4 | 6.4 | 6.3 | Q | 086 |
| 7.0 | 7.0 | 6.7 | 6.6 | 6.5 | 6.6 | 6.6 | 6.5 | 6.5 | 6.4 | 6.5 | 6.4 | 6.3 | Q | 087 |
| 7.1 | 7.0 | 6.8 | 6.6 | 6.6 | 6.6 | 6.6 | 6.5 | 6.5 | 6.5 | 6.5 | 6.4 | 6.3 | Q | 088 |
| 7.0 | 7.1 | 6.8 | 6.7 | 6.6 | 6.6 | 6.6 | 6.5 | 6.6 | 6.6 | 6.6 | 6.5 | 6.3 | Q | 089 |
| 7.0 | 7.1 | 6.9 | 6.7 | 6.6 | 6.6 | 6.7 | 6.6 | 6.6 | 6.6 | 6.6 | 6.6 | 6.4 | Q | 090 |
| 7.1 | 7.1 | 6.9 | 6.8 | 6.7 | 6.6 | 6.7 | 6.6 | 6.7 | 6.7 | 6.7 | 6.6 | 6.4 | Q | 091 |
| 7.1 | 7.1 | 7.0 | 6.8 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.8 | 6.8 | 6.7 | 6.4 | Q | 092 |
| 7.2 | 7.2 | 7.1 | 6.9 | 6.8 | 6.7 | 6.8 | 6.7 | 6.8 | 6.8 | 6.8 | 6.8 | 6.5 | Q | 093 |
| 7.1 | 7.2 | 7.1 | 6.9 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.9 | 6.9 | 6.8 | 6.6 | Q | 094 |

```
7.2  7.2  7.2  7.0  6.9  6.9  6.8  6.8  6.8  6.9  6.9  6.9  6.7       Q   095
7.3  7.2  7.2  7.1  7.0  6.9  6.9  6.9  6.9  7.0  7.0  6.9  6.8       Q   096
7.4  7.2  7.2  7.1  7.0  7.0  6.9  6.9  7.0  7.0  7.0  7.0  6.8       Q   097
7.5  7.3  7.3  7.2  7.1  7.1  7.0  7.0  7.1  7.1  7.1  7.0  6.9       Q   098
7.5  7.3  7.3  7.2  7.1  7.1  7.1  7.1  7.1  7.1  7.1  7.0  6.9       Q   099
7.4  7.2  7.4  7.2  7.2  7.2  7.2  7.2  7.2  7.2  7.1  7.1  7.0       Q   100
7.3  7.3  7.4  7.3  7.2  7.2  7.2  7.2  7.2  7.2  7.2  7.1  7.0       Q   101
7.4  7.4  7.4  7.4  7.2  7.3  7.3  7.3  7.3  7.3  7.3  7.2  7.0       Q   102
7.5  7.5  7.5  7.5  7.4  7.4  7.4  7.4  7.4  7.4  7.3  7.2  7.0       Q   103
7.6  7.5  7.6  7.7  7.5  7.5  7.5  7.5  7.5  7.5  7.4  7.3  7.1       Q   104
7.7  7.6  7.7  7.8  7.7  7.7  7.7  7.7  7.6  7.5  7.5  7.3  7.1       Q   105
7.8  7.7  7.8  7.8  7.8  7.8  7.8  7.7  7.7  7.6  7.5  7.4  7.2       Q   106
7.9  7.8  7.8  7.8  7.9  7.9  7.9  7.8  7.7  7.6  7.6  7.4  7.3       Q   107
7.9  7.8  7.9  7.9  8.0  8.0  7.9  7.8  7.7  7.7  7.6  7.5  7.3       Q   108
8.0  7.9  8.0  8.0  8.0  8.0  8.0  7.9  7.8  7.7  7.6  7.5  7.4       Q   109
8.0  8.0  8.0  8.0  8.1  8.1  8.0  8.0  7.8  7.7  7.6  7.5  7.4       Q   110
1     P  DEPTH ALLOWANCES        (TO BE SUBTRACTED FROM TIMES FOR SURFACE FOCUS)
     1.4 -6.7-14.6-22.3-29.8-37.1-44.3-51.2-57.7-64.0-70.0-76.0-82.0 P   000
     3.4   .7 -4.7-11.2-18.0-24.8-31.6-38.2-44.6-50.7-56.6-62.5-68.4 P   001
     3.4  2.5  -.6 -5.2-10.4-16.2-22.2-28.0-33.8-39.4-44.9-50.5-56.1 P   002
     3.4  3.0  1.3 -1.6 -5.5-10.0-14.9-20.0-25.1-30.1-35.0-40.1-45.2 P   003
     3.4  3.5  2.6   .7 -2.1 -5.5 -9.5-13.6-17.8-22.3-26.7-31.2-35.8 P   004
     3.4  4.0  3.7  2.5   .6 -2.0 -5.2 -8.4-11.8-15.4-19.2-23.3-27.3 P   005
     3.5  4.5  4.6  3.9  2.7   .8 -1.5 -4.1 -6.7 -9.6-12.6-16.0-19.7 P   006
     3.5  4.7  5.3  5.2  4.5  3.2  1.5  -.2 -2.1 -4.3 -6.8 -9.6-12.6 P   007
     3.6  5.1  6.0  6.3  6.1  5.4  4.2  3.2  2.0   .5 -1.4 -3.7 -6.2 P   008
     3.6  5.5  6.7  7.3  7.6  7.4  6.7  6.3  5.8  4.9  3.5  1.7  -.3 P   009
     3.6  5.8  7.4  8.3  9.0  9.2  9.0  9.4  9.4  9.1  8.1  6.8  5.3 P   010
     3.6  6.1  8.0  9.2 10.3 10.9 11.1 12.4 12.9 13.0 12.6 11.7 10.5 P   011
     3.7  6.4  8.6 10.2 11.5 12.5 13.5 15.4 16.4 16.7 16.7 16.3 15.5 P   012
     3.7  6.6  9.1 11.1 12.7 14.0 15.8 18.2 19.6 20.2 20.6 20.6 20.2 P   013
     3.8  6.9  9.6 11.9 13.8 15.6 18.3 21.0 22.7 23.7 24.3 24.7 24.6 P   014
     3.8  7.1 10.1 12.7 14.9 18.0 21.0 23.9 25.8 27.1 27.9 28.6 28.8 P   015
     3.9  7.5 10.7 13.6 16.7 20.4 23.9 26.8 29.0 30.5 31.6 32.5 32.9 P   016
     4.0  7.8 11.2 14.7 18.8 22.7 26.5 29.5 32.0 33.8 35.2 36.2 36.7 P   017
     4.0  8.0 12.1 16.7 21.0 25.1 28.9 32.1 34.8 36.9 38.5 39.7 40.4 P   018
     4.0  9.0 13.9 18.8 23.2 27.4 31.4 34.7 37.6 39.9 41.7 43.0 43.9 P   019
     4.5  9.9 15.1 20.1 24.8 29.1 33.2 36.7 39.7 42.2 44.2 45.7 46.7 P   020
     4.5 10.1 15.5 20.6 25.4 29.8 34.0 37.7 40.9 43.5 45.6 47.2 48.4 P   021
     4.6 10.3 15.8 21.0 25.8 30.3 34.6 38.5 41.8 44.5 46.7 48.5 49.8 P   022
     4.6 10.5 16.0 21.2 26.2 30.9 35.4 39.3 42.7 45.5 47.8 49.7 51.1 P   023
     4.6 10.6 16.1 21.5 26.6 31.4 36.0 40.0 43.4 46.3 48.7 50.7 52.2 P   024
     4.6 10.6 16.4 21.9 27.2 32.1 36.7 40.7 44.2 47.2 49.7 51.8 53.4 P   025
     4.6 10.7 16.5 22.1 27.5 32.4 37.1 41.2 44.8 47.8 50.4 52.6 54.3 P   026
     4.6 10.7 16.6 22.2 27.6 32.6 37.4 41.5 45.2 48.3 51.0 53.3 55.1 P   027
     4.6 10.7 16.6 22.3 27.7 32.8 37.7 41.9 45.5 48.8 51.6 53.9 55.8 P   028
     4.7 10.8 16.7 22.4 27.9 33.0 38.0 42.1 45.9 49.2 52.1 54.5 56.4 P   029
     4.8 10.9 16.8 22.6 28.1 33.3 38.3 42.5 46.3 49.7 52.6 55.1 57.1 P   030
     4.7 10.9 16.8 22.7 28.2 33.5 38.5 42.7 46.6 50.0 53.0 55.6 57.6 P   031
     4.7 11.0 16.9 22.8 28.4 33.7 38.7 43.0 46.9 50.4 53.4 56.0 58.2 P   032
     4.7 11.0 17.0 22.9 28.5 33.9 38.9 43.3 47.2 50.7 53.8 56.5 58.7 P   033
     4.8 11.1 17.2 23.1 28.7 34.1 39.1 43.6 47.5 51.1 54.2 57.0 59.3 P   034
     4.8 11.2 17.3 23.2 28.9 34.3 39.3 43.8 47.8 51.4 54.6 57.4 59.8 P   035
     4.8 11.2 17.4 23.3 29.0 34.4 39.4 44.0 48.0 51.7 54.9 57.8 60.2 P   036
     4.8 11.2 17.4 23.3 29.0 34.5 39.5 44.1 48.2 51.9 55.1 58.1 60.6 P   037
     4.8 11.3 17.4 23.4 29.1 34.6 39.7 44.3 48.5 52.1 55.4 58.4 61.0 P   038
     4.9 11.4 17.5 23.5 29.3 34.8 39.9 44.5 48.8 52.4 55.8 58.8 61.5 P   039
     4.9 11.4 17.6 23.6 29.4 34.9 40.0 44.7 49.0 52.7 56.1 59.2 62.0 P   040
     4.8 11.4 17.6 23.6 29.4 35.0 40.1 44.8 49.2 52.9 56.4 59.6 62.5 P   041
     4.8 11.4 17.6 23.7 29.5 35.1 40.3 45.0 49.4 53.2 56.7 60.0 63.0 P   042
     4.8 11.4 17.7 23.8 29.7 35.3 40.5 45.3 49.7 53.6 57.2 60.5 63.6 P   043
     4.8 11.4 17.8 23.9 29.8 35.4 40.7 45.5 50.0 53.9 57.5 61.0 64.1 P   044
     4.9 11.5 17.9 24.1 30.0 35.6 40.9 45.8 50.3 54.3 58.0 61.5 64.7 P   045
     4.8 11.5 17.9 24.1 30.1 35.7 41.0 46.0 50.5 54.6 58.3 61.9 65.1 P   046
     4.9 11.5 18.0 24.3 30.2 35.9 41.2 46.2 50.8 54.9 58.7 62.3 65.6 P   047
     4.9 11.6 18.1 24.4 30.4 36.1 41.5 46.5 51.1 55.3 59.2 62.8 66.2 P   048
     4.9 11.6 18.1 24.5 30.5 36.2 41.6 46.7 51.3 55.5 59.5 63.2 66.6 P   049
     4.9 11.6 18.2 24.6 30.7 36.4 41.8 46.9 51.6 55.9 59.9 63.6 67.1 P   050
     4.9 11.6 18.2 24.7 30.9 36.6 42.0 47.1 51.9 56.2 60.3 64.0 67.6 P   051
     5.0 11.7 18.3 24.9 31.1 36.8 42.2 47.4 52.2 56.7 60.8 64.6 68.2 P   052
     5.0 11.7 18.4 25.0 31.3 37.0 42.4 47.7 52.6 57.1 61.2 65.1 68.8 P   053
     4.9 11.7 18.4 25.0 31.4 37.1 42.5 47.9 52.8 57.4 61.5 65.4 69.2 P   054
     5.0 11.8 18.5 25.2 31.6 37.4 42.8 48.2 53.2 57.8 62.0 66.0 69.8 P   055
     5.0 11.8 18.5 25.3 31.7 37.5 43.0 48.4 53.5 58.1 62.4 66.4 70.3 P   056
     5.0 11.9 18.7 25.4 31.9 37.8 43.3 48.8 53.8 58.5 62.8 66.9 70.8 P   057
     5.0 11.9 18.7 25.4 31.9 37.9 43.5 49.0 54.0 58.7 63.1 67.3 71.2 P   058
     5.0 12.0 18.7 25.5 32.0 38.0 43.8 49.3 54.3 59.0 63.5 67.7 71.7 P   059
     5.0 12.0 18.8 25.6 32.1 38.2 44.0 49.5 54.6 59.3 63.8 68.1 72.1 P   060
     5.0 12.0 18.8 25.7 32.2 38.4 44.2 49.7 54.8 59.6 64.1 68.5 72.5 P   061
     5.1 12.1 18.9 25.8 32.4 38.6 44.4 49.9 55.1 59.9 64.5 68.9 72.9 P   062
     5.0 12.0 18.9 25.8 32.5 38.7 44.5 50.0 55.3 60.1 64.7 69.1 73.3 P   063
     5.1 12.1 19.0 25.9 32.6 38.9 44.7 50.2 55.5 60.4 65.0 69.5 73.6 P   064
     5.1 12.1 19.0 26.0 32.7 39.0 44.8 50.4 55.7 60.6 65.3 69.8 74.0 P   065
     5.1 12.1 19.0 26.0 32.8 39.1 44.9 50.6 55.9 60.8 65.5 70.1 74.3 P   066
     5.2 12.2 19.1 26.1 32.9 39.2 45.1 50.8 56.1 61.1 65.9 70.4 74.7 P   067
     5.2 12.3 19.2 26.2 33.0 39.4 45.3 51.0 56.3 61.4 66.1 70.7 75.1 P   068
     5.2 12.3 19.3 26.3 33.1 39.5 45.4 51.2 56.5 61.6 66.4 71.0 75.4 P   069
     5.2 12.3 19.3 26.3 33.1 39.5 45.5 51.3 56.7 61.8 66.6 71.2 75.7 P   070
     5.2 12.4 19.4 26.4 33.2 39.6 45.7 51.5 56.9 62.1 66.9 71.5 76.1 P   071
     5.3 12.4 19.5 26.4 33.2 39.7 45.8 51.7 57.1 62.3 67.2 71.8 76.4 P   072
```

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.2 | 12.5 | 19.5 | 26.4 | 33.2 | 39.7 | 45.9 | 51.8 | 57.3 | 62.5 | 67.4 | 72.1 | 76.8 | P | 073 |
| 5.2 | 12.4 | 19.5 | 26.4 | 33.2 | 39.7 | 46.0 | 51.9 | 57.5 | 62.7 | 67.6 | 72.4 | 77.0 | P | 074 |
| 5.2 | 12.5 | 19.6 | 26.5 | 33.3 | 39.8 | 46.2 | 52.1 | 57.7 | 62.9 | 67.9 | 72.7 | 77.4 | P | 075 |
| 5.2 | 12.5 | 19.7 | 26.6 | 33.4 | 39.9 | 46.3 | 52.3 | 57.9 | 63.1 | 68.1 | 73.0 | 77.7 | P | 076 |
| 5.1 | 12.5 | 19.7 | 26.7 | 33.5 | 40.0 | 46.4 | 52.4 | 58.1 | 63.3 | 68.4 | 73.2 | 78.0 | P | 077 |
| 5.1 | 12.5 | 19.7 | 26.7 | 33.5 | 40.1 | 46.5 | 52.5 | 58.2 | 63.5 | 68.5 | 73.5 | 78.3 | P | 078 |
| 5.1 | 12.5 | 19.8 | 26.8 | 33.7 | 40.3 | 46.7 | 52.7 | 58.4 | 63.7 | 68.8 | 73.7 | 78.6 | P | 079 |
| 5.1 | 12.5 | 19.8 | 26.9 | 33.8 | 40.4 | 46.8 | 52.9 | 58.6 | 63.9 | 69.0 | 74.0 | 78.9 | P | 080 |
| 5.1 | 12.5 | 19.8 | 26.9 | 33.9 | 40.5 | 46.9 | 53.0 | 58.7 | 64.1 | 69.2 | 74.2 | 79.2 | P | 081 |
| 5.1 | 12.5 | 19.8 | 27.0 | 33.9 | 40.5 | 47.0 | 53.1 | 58.9 | 64.2 | 69.3 | 74.4 | 79.4 | P | 082 |
| 5.2 | 12.6 | 19.9 | 27.0 | 34.0 | 40.7 | 47.1 | 53.3 | 59.0 | 64.4 | 69.6 | 74.7 | 79.7 | P | 083 |
| 5.2 | 12.7 | 20.0 | 27.1 | 34.1 | 40.7 | 47.2 | 53.4 | 59.2 | 64.6 | 69.7 | 74.9 | 79.9 | P | 084 |
| 5.2 | 12.7 | 20.0 | 27.1 | 34.1 | 40.8 | 47.3 | 53.5 | 59.3 | 64.7 | 69.9 | 75.1 | 80.1 | P | 085 |
| 5.3 | 12.8 | 20.1 | 27.2 | 34.2 | 41.0 | 47.5 | 53.7 | 59.5 | 64.9 | 70.2 | 75.4 | 80.4 | P | 086 |
| 5.3 | 12.8 | 20.2 | 27.3 | 34.3 | 41.1 | 47.6 | 53.8 | 59.7 | 65.1 | 70.4 | 75.6 | 80.6 | P | 087 |
| 5.3 | 12.8 | 20.2 | 27.4 | 34.4 | 41.1 | 47.7 | 53.9 | 59.8 | 65.2 | 70.5 | 75.7 | 80.8 | P | 088 |
| 5.3 | 12.9 | 20.3 | 27.5 | 34.5 | 41.3 | 47.8 | 54.0 | 59.9 | 65.3 | 70.7 | 75.9 | 81.0 | P | 089 |
| 5.3 | 12.9 | 20.3 | 27.5 | 34.5 | 41.3 | 47.9 | 54.1 | 60.0 | 65.4 | 70.8 | 76.0 | 81.1 | P | 090 |
| 5.2 | 12.8 | 20.2 | 27.5 | 34.5 | 41.3 | 47.9 | 54.1 | 60.0 | 65.4 | 70.8 | 76.0 | 81.1 | P | 091 |
| 5.2 | 12.8 | 20.2 | 27.4 | 34.4 | 41.2 | 47.8 | 54.1 | 60.0 | 65.5 | 70.8 | 76.0 | 81.1 | P | 092 |
| 5.2 | 12.8 | 20.2 | 27.4 | 34.4 | 41.2 | 47.8 | 54.1 | 60.0 | 65.5 | 70.8 | 76.0 | 81.2 | P | 093 |
| 5.3 | 12.9 | 20.3 | 27.5 | 34.5 | 41.3 | 47.9 | 54.1 | 60.0 | 65.6 | 70.8 | 76.0 | 81.2 | P | 094 |
| 5.3 | 12.9 | 20.3 | 27.5 | 34.5 | 41.3 | 47.9 | 54.2 | 60.1 | 65.7 | 70.9 | 76.1 | 81.3 | P | 095 |
| 5.4 | 13.0 | 20.4 | 27.6 | 34.6 | 41.3 | 47.9 | 54.3 | 60.2 | 65.8 | 71.0 | 76.2 | 81.4 | P | 096 |
| 5.3 | 12.9 | 20.3 | 27.5 | 34.5 | 41.3 | 47.9 | 54.2 | 60.1 | 65.8 | 71.0 | 76.2 | 81.3 | P | 097 |
| 5.3 | 12.9 | 20.3 | 27.5 | 34.5 | 41.3 | 47.8 | 54.2 | 60.1 | 65.8 | 71.0 | 76.2 | 81.3 | P | 098 |
| 5.3 | 12.8 | 20.2 | 27.4 | 34.4 | 41.2 | 47.8 | 54.2 | 60.1 | 65.8 | 71.0 | 76.2 | 81.3 | P | 099 |
| 5.3 | 12.9 | 20.3 | 27.5 | 34.5 | 41.3 | 48.0 | 54.3 | 60.2 | 65.8 | 71.1 | 76.3 | 81.4 | P | 100 |
| 5.3 | 12.9 | 20.3 | 27.5 | 34.5 | 41.4 | 48.1 | 54.4 | 60.3 | 65.9 | 71.2 | 76.4 | 81.5 | P | 101 |
| 5.3 | 13.0 | 20.4 | 27.6 | 34.6 | 41.5 | 48.2 | 54.5 | 60.4 | 66.0 | 71.3 | 76.5 | 81.6 | P | 102 |
| 5.3 | 13.0 | 20.4 | 27.6 | 34.6 | 41.5 | 48.2 | 54.5 | 60.4 | 66.0 | 71.3 | 76.5 | 81.6 | P | 103 |
| 5.3 | 13.0 | 20.4 | 27.6 | 34.6 | 41.5 | 48.2 | 54.5 | 60.4 | 66.0 | 71.3 | 76.5 | 81.6 | P | 104 |
| 5.3 | 13.0 | 20.4 | 27.6 | 34.6 | 41.5 | 48.2 | 54.5 | 60.4 | 66.0 | 71.3 | 76.5 | 81.6 | P | 105 |
| 5.3 | 13.0 | 20.4 | 27.6 | 34.6 | 41.5 | 48.2 | 54.5 | 60.4 | 66.0 | 71.3 | 76.5 | 81.6 | P | 106 |
| 5.3 | 13.0 | 20.4 | 27.6 | 34.6 | 41.5 | 48.2 | 54.5 | 60.4 | 66.0 | 71.3 | 76.5 | 81.6 | P | 107 |
| 5.3 | 13.0 | 20.4 | 27.6 | 34.6 | 41.5 | 48.2 | 54.5 | 60.4 | 66.0 | 71.3 | 76.5 | 81.6 | P | 108 |
| 5.3 | 13.0 | 20.4 | 27.6 | 34.6 | 41.5 | 48.2 | 54.5 | 60.4 | 66.0 | 71.3 | 76.5 | 81.6 | P | 109 |
| 5.3 | 13.0 | 20.4 | 27.6 | 34.6 | 41.5 | 48.2 | 54.5 | 60.4 | 66.0 | 71.3 | 76.5 | 81.6 | P | 110 |
| 5.3 | 13.0 | 20.4 | 27.6 | 34.6 | 41.5 | 48.2 | 54.5 | 60.4 | 66.0 | 71.3 | 76.5 | 81.6 | P | 111 |

1TABLE 2A P JB 1958 STANDARD TRAVEL TIMES (TIMES FOR SURFACE FOCUS)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6.8 | 21.1 | 35.4 | 49.7 | 63.9 | 78.1 | 92.2 | 000-006 |
| 106.3 | 120.3 | 134.2 | 148.0 | 161.7 | 175.3 | 188.7 | 007-013 |
| 201.9 | 215.0 | 228.0 | 240.7 | 253.2 | 265.5 | 277.0 | 014-020 |
| 287.4 | 297.5 | 307.4 | 317.1 | 326.8 | 336.2 | 345.4 | 021-027 |
| 354.5 | 363.5 | 372.5 | 381.3 | 390.1 | 398.8 | 407.5 | 028-034 |
| 416.1 | 424.6 | 433.0 | 441.4 | 449.8 | 458.1 | 466.3 | 035-041 |
| 474.5 | 482.7 | 490.8 | 498.9 | 506.8 | 514.7 | 522.6 | 042-048 |
| 530.3 | 538.0 | 545.6 | 553.2 | 560.7 | 568.0 | 575.4 | 049-055 |
| 582.6 | 589.8 | 596.8 | 603.8 | 610.7 | 617.5 | 624.3 | 056-062 |
| 630.9 | 637.5 | 644.0 | 650.4 | 656.8 | 663.1 | 669.3 | 063-069 |
| 675.4 | 681.5 | 687.5 | 693.4 | 699.2 | 705.0 | 710.7 | 070-076 |
| 716.3 | 721.8 | 727.3 | 732.7 | 738.0 | 743.2 | 748.4 | 077-083 |
| 753.5 | 758.5 | 763.5 | 768.4 | 773.2 | 778.0 | 782.7 | 084-090 |
| 787.3 | 791.9 | 796.5 | 801.1 | 805.7 | 810.3 | 814.8 | 091-097 |
| 819.3 | 823.8 | 828.4 | 832.9 | 837.4 | 841.8 | 846.2 | 098-104 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 109 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 110 |

1 PKP DEPTH ALLOWANCES (TO BE SUBTRACTED FROM TIMES FOR SURFACE FOCUS)

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 111 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 112 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 113 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 114 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 115 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 116 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 117 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 118 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 119 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 120 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 121 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 122 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 123 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 124 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 125 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 126 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 127 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 128 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 129 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 130 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 131 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 132 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 133 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 134 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 135 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 136 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 137 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 138 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 139 |
| 5.4 | 13.4 | 21.2 | 28.8 | 36.2 | 43.5 | 50.5 | 57.2 | 63.7 | 69.8 | 75.7 | 81.5 | 87.3 | PKP | 140 |
| 5.3 | 13.3 | 21.0 | 28.6 | 35.9 | 43.0 | 50.0 | 56.6 | 63.0 | 69.1 | 74.9 | 80.6 | 86.3 | PKP | 141 |
| 5.3 | 13.2 | 20.9 | 28.4 | 35.6 | 42.6 | 49.5 | 56.1 | 62.4 | 68.4 | 74.1 | 79.8 | 85.3 | PKP | 142 |

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      5.3 13.2 21.0 28.5 35.8 42.9 49.9 56.5 62.9 69.0 74.8 80.6 86.2 PKP 144
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      5.3 13.3 21.1 28.7 36.1 43.3 50.4 57.1 63.6 69.7 75.6 81.5 87.3 PKP 147
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      5.4 13.4 21.3 28.9 36.4 43.7 50.8 57.6 64.1 70.2 76.2 82.2 88.1 PKP 150
      5.4 13.4 21.3 28.9 36.4 43.7 50.8 57.6 64.1 70.2 76.2 82.2 88.1 PKP 151
      5.4 13.4 21.3 28.9 36.4 43.7 50.8 57.6 64.1 70.2 76.2 82.2 88.2 PKP 152
    850.6      855.0      859.4      863.8      868.2      872.6      877.0 105-111
      5.4 13.4 21.3 28.9 36.4 43.7 50.8 57.7 64.2 70.3 76.3 82.3 88.2 PKP 154
      5.4 13.4 21.3 28.9 36.4 43.7 50.8 57.7 64.2 70.3 76.3 82.3 88.2 PKP 153
      5.4 13.4 21.3 29.0 36.5 43.8 50.9 57.7 64.2 70.3 76.3 82.3 88.3 PKP 155
      5.4 13.4 21.3 29.0 36.5 43.8 50.9 57.7 64.2 70.3 76.3 82.3 88.3 PKP 156
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      5.4 13.4 21.3 29.0 36.5 43.8 50.9 57.8 64.3 70.4 76.4 82.4 88.3 PKP 158
      5.4 13.4 21.3 29.0 36.5 43.8 50.9 57.8 64.3 70.4 76.4 82.4 88.4 PKP 159
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      5.4 13.4 21.3 29.0 36.5 43.8 50.9 57.8 64.3 70.4 76.4 82.4 88.4 PKP 161
      5.4 13.4 21.3 29.0 36.5 43.8 50.9 57.8 64.3 70.5 76.5 82.5 88.5 PKP 162
      5.4 13.4 21.3 29.0 36.5 43.8 51.0 57.9 64.4 70.5 76.5 82.5 88.5 PKP 163
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      5.4 13.5 21.4 29.1 36.6 43.9 51.0 57.9 64.4 70.6 76.6 82.6 88.6 PKP 165
      5.4 13.5 21.4 29.1 36.6 43.9 51.0 57.9 64.4 70.6 76.6 82.6 88.6 PKP 166
      5.4 13.5 21.4 29.1 36.6 43.9 51.0 57.9 64.4 70.6 76.6 82.6 88.6 PKP 167
      5.4 13.5 21.4 29.1 36.6 43.9 51.1 58.0 64.5 70.6 76.6 82.6 88.6 PKP 168
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      5.4 13.5 21.4 29.1 36.6 43.9 51.1 58.0 64.5 70.7 76.7 82.7 88.7 PKP 175
      5.4 13.5 21.4 29.1 36.6 43.9 51.1 58.0 64.5 70.8 76.8 82.8 88.8 PKP 176
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      5.4 13.5 21.4 29.1 36.6 43.9 51.1 58.0 64.5 70.8 76.8 82.8 88.8 PKP 178
      5.4 13.5 21.4 29.1 36.6 43.9 51.1 58.0 64.5 70.8 76.8 82.8 88.8 PKP 179
      5.4 13.5 21.4 29.1 36.6 43.9 51.1 58.0 64.5 70.8 76.8 82.8 88.8 PKP 180
      5.4 13.5 21.4 29.1 36.6 43.9 51.1 58.0 64.5 70.8 76.8 82.8 88.8 PKP 181
1TABLE 2B    PKP   JB 1958   STANDARD TRAVEL TIMES     (TIMES FOR SURFACE FOCUS)
    1111.2     1113.2     1115.2     1117.1     1119.1     1121.1     1123.0 109-115
    1125.0     1126.9     1128.8     1130.8     1132.7     1134.7     1136.6 116-122
    1138.5     1140.5     1142.4     1144.3     1146.2     1148.2     1150.1 123-129
    1152.0     1153.9     1155.8     1157.7     1159.5     1161.4     1163.2 130-136


    1165.0     1166.9     1168.7     1170.5     1172.3     1174.0     1175.7 137-143
    1177.4     1179.2     1180.9     1182.6     1184.2     1185.8     1187.4 144-150
    1188.9     1190.4     1191.8     1193.2     1194.5     1195.8     1197.2 151-157
    1198.5     1199.7     1200.8     1201.8     1202.8     1203.8     1204.8 158-164
    1205.8     1206.7     1207.4     1208.0     1208.6     1209.2     1209.8 165-171
    1210.4     1210.9     1211.2     1211.5     1211.8     1212.0     1212.1 172-178
    1212.1     1212.2     1212.3                                             179-181
1TABLE 3      F(D)      ELLIPTICITY CORRECTIONS
   .001   .0 2   .003   .004   .005   .006   . 07   .0 8   .0 9   .01   001- 1
   .012   .014   .015   .017   .019   .021   .023   .024   .026   .028   011-02
   .029   .029   .030   .031   .032   .032   .033   .034   .034   .035   021-03
   .036   .036   .037   .038   .039   .039   .040   .041   .041   .042   031-040
   .042   .043   .043   .044   .044   .045   .045   .046   .046   .047   041-050
   .047   .048   .048   .048   .048   .049   .049   .049   .050   .050   051-060
   .051   .052   .053   .054   .055   .056   .057   .058   .059   .060   061-070
   .061   .061   .062   .062   .063   .064   .064   .065   .065   .066   071-080
   .066   .066   .066   .066   .066   .066   .066   .066   .066   .066   081-090
   .066   .066   .066   .066   .066   .066   .066   .066   .066   .066   091-100
   .066   .066   .066   .066   .066   .066   .066   .066   .066   .066   101-110
   .      .      .      .      .      .      .      .      .      .      111-120
   .      .      .      .      .      .      .      .      .      .      121-130
   .      .      .      .      .      .      .      .      .      .      131-140
   .      .      .      .      .      .      .      .      .      .      141-150
   .      .      .      .      .      .      .      .      .      .      151-160
   .      .      .      .      .      .      .      .      .      .      161-170
   .      .      .      .      .      .      .      .      .      .      171-180
1TABLE 4    SEISMIC AND GEOGRAPHICAL REGIONS
   1  1 CENTRAL ALASKA                          2  1 SOUTHERN ALASKA
   3  1 BERING SEA                              4  1 KOMANDORSKY ISLANDS REGION
   5  1 NEAR ISLANDS, ALEUTIAN ISLANDS          6  1 RAT ISLANDS, ALEUTIAN ISLANDS
   7  1 ANDREANOF ISLANDS, ALEUTIAN IS.         8  1 PRIBILOF ISLANDS
   9  1 FOX ISLANDS, ALEUTIAN ISLANDS          10  1 UNIMAK ISLAND REGION
  11  1 BRISTOL BAY                            12  1 ALASKA PENINSULA
  13  1 KODIAK ISLAND REGION                   14  1 KENAI PENINSULA, ALASKA
  15  1 GULF OF ALASKA                         16  1 ALEUTIAN ISLANDS REGION
  17  1 SOUTH OF ALASKA                        18  2 SOUTHERN YUKON TERRITORY, CANADA
  19  2 SOUTHEASTERN ALASKA                    20  2 OFF COAST OF SOUTHEASTERN ALASKA
  21  2 WEST OF VANCOUVER ISLAND               22  2 QUEEN CHARLOTTE ISLANDS REGION
  23  2 BRITISH COLUMBIA                       24  2 ALBERTA PROVINCE, CANADA
  25  2 VANCOUVER ISLAND REGION                26  2 OFF COAST OF WASHINGTON
  27  2 NEAR COAST OF WASHINGTON               28  2 WASHINGTON-OREGON BORDER REGION
  29  2 WASHINGTON                             30  3 OFF COAST OF OREGON
  31  3 NEAR COAST OF OREGON                   32  3 OREGON
  33  3 WESTERN IDAHO                          34  3 OFF COAST OF NORTHERN CALIFORNIA
  35  3 NEAR COAST OF N. CALIFORNIA            36  3 NORTHERN CALIFORNIA
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|---|---|---|---|---|---|
| 37 | 3 | NEVADA | 38 | 3 | OFF COAST OF CALIFORNIA |
| 39 | 3 | CENTRAL CALIFORNIA | 40 | 3 | CALIFORNIA-NEVADA BORDER REGION |
| 41 | 3 | SOUTHERN NEVADA | 42 | 3 | WESTERN ARIZONA |
| 43 | 3 | SOUTHERN CALIFORNIA | 44 | 3 | CALIFORNIA-ARIZONA BORDER REGION |
| 45 | 3 | CALIFORNIA-MEXICO BORDER REGION | 46 | 3 | W. ARIZONA-MEXICO BORDER REGION |
| 47 | 4 | OFF W. COAST OF BAJA CALIFORNIA | 48 | 4 | BAJA CALIFORNIA |
| 49 | 4 | GULF OF CALIFORNIA | 50 | 4 | NORTHWESTERN MEXICO |
| 51 | 4 | OFF COAST OF CENTRAL MEXICO | 52 | 4 | NEAR COAST OF CENTRAL MEXICO |
| 53 | 5 | REVILLA GIGEDO ISLANDS REGION | 54 | 5 | OFF COAST OF JALISCO, MEXICO |
| 55 | 5 | NEAR COAST OF JALISCO, MEXICO | 56 | 5 | NEAR COAST OF MICHOACAN, MEXICO |
| 57 | 5 | MICHOACAN, MEXICO | 58 | 5 | NEAR COAST OF GUERRERO, MEXICO |
| 59 | 5 | GUERRERO, MEXICO | 60 | 5 | OAXACA, MEXICO |
| 61 | 5 | CHIAPAS, MEXICO | 62 | 5 | MEXICO-GUATEMALA BORDER REGION |
| 63 | 5 | OFF COAST OF MEXICO | 64 | 5 | OFF COAST OF MICHOACAN, MEXICO |
| 65 | 5 | OFF COAST OF GUERRERO, MEXICO | 66 | 5 | NEAR COAST OF OAXACA, MEXICO |
| 67 | 5 | OFF COAST OF OAXACA, MEXICO | 68 | 5 | OFF COAST OF CHIAPAS, MEXICO |
| 69 | 5 | NEAR COAST OF CHIAPAS, MEXICO | 70 | 5 | GUATEMALA |
| 71 | 5 | NEAR COAST OF GUATEMALA | 72 | 6 | HONDURAS |
| 73 | 6 | EL SALVADOR | 74 | 6 | NEAR COAST OF NICARAGUA |
| 75 | 6 | NICARAGUA | 76 | 6 | OFF COAST OF CENTRAL AMERICA |
| 77 | 6 | OFF COAST OF COSTA RICA | 78 | 6 | COSTA RICA |
| 79 | 6 | NORTH OF PANAMA | 80 | 6 | PANAMA-COSTA RICA BORDER REGION |
| 81 | 6 | PANAMA | 82 | 6 | PANAMA-COLOMBIA BORDER REGION |
| 83 | 6 | SOUTH OF PANAMA | 84 | 7 | YUCUTAN PENINSULA |
| 85 | 7 | CUBA REGION | 86 | 7 | JAMAICA REGION |
| 87 | 7 | HAITI REGION | 88 | 7 | DOMINICAN REPUBLIC REGION |
| 89 | 7 | MONA PASSAGE | 90 | 7 | PUERTO RICO REGION |
| 91 | 7 | VIRGIN ISLANDS | 92 | 7 | LEEWARD ISLANDS |
| 93 | 7 | BRITISH HONDURAS | 94 | 7 | CARIBBEAN SEA |
| 95 | 7 | WINDWARD ISLANDS | 96 | 7 | NEAR NORTH COAST OF COLOMBIA |
| 97 | 7 | NEAR COAST OF VENEZUELA | 98 | 7 | TRINIDAD |
| 99 | 7 | NORTHERN COLOMBIA | 100 | 7 | LAKE MARACAIBO |
| 101 | 7 | VENEZUELA | 102 | 8 | NEAR WEST COAST OF COLOMBIA |
| 103 | 8 | COLOMBIA | 104 | 8 | OFF COAST OF ECUADOR |
| 105 | 8 | NEAR COAST OF ECUADOR | 106 | 8 | COLOMBIA-ECUADOR BORDER REGION |
| 107 | 8 | ECUADOR | 108 | 8 | OFF COAST OF NORTHERN PERU |
| 109 | 8 | NEAR COAST OF NORTHERN PERU | 110 | 8 | PERU-ECUADOR BORDER REGION |
| 111 | 8 | NORTHERN PERU | 112 | 8 | PERU-BRAZIL BORDER REGION |
| 113 | 8 | WESTERN BRAZIL | 114 | 8 | OFF COAST OF PERU |
| 115 | 8 | NEAR COAST OF PERU | 116 | 8 | PERU |
| 117 | 8 | SOUTHERN PERU | 118 | 8 | PERU-BOLIVIA BORDER REGION |
| 119 | 8 | NORTHERN BOLIVIA | 120 | 8 | BOLIVIA |
| 121 | 8 | OFF COAST OF NORTHERN CHILE | 122 | 8 | NEAR COAST OF NOPTHERN CHILE |
| 123 | 8 | NORTHERN CHILE | 124 | 8 | CHILE-BOLIVIA BORDER REGION |
| 125 | 8 | SOUTHERN BOLIVIA | 126 | 8 | PARAGUAY |

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|---|---|---|---|---|---|
| 127 | 8 | CHILE-ARGENTINA BORDER REGION | 128 | 8 | JUYJUY PROVINCE, ARGENTINA |
| 129 | 8 | SALTA PROVINCE, ARGENTINA | 130 | 8 | CATAMARCA PROVINCE, ARGENTINA |
| 131 | 8 | TUCUMAN PROVINCE, ARGENTINA | 132 | 8 | SANTIAGO DEL ESTERO PROV., ARG. |
| 133 | 8 | NORTHEASTERN ARGENTINA | 134 | 8 | OFF COAST OF CENTRAL CHILE |
| 135 | 8 | NEAR COAST OF CENTRAL CHILE | 136 | 8 | CENTRAL CHILE |
| 137 | 8 | SAN JUAN PROVINCE, ARGENTINA | 138 | 8 | LA RIOJA PROVINCE, ARGENTINA |
| 139 | 8 | MENDOZA PROVINCE, ARGENTINA | 140 | 8 | SAN LUIS PROVINCE, ARGENTINA |
| 141 | 8 | CORDOBA PROVINCE, ARGENTINA | 142 | 8 | URUGUAY |
| 143 | 9 | OFF COAST OF SOUTHERN CHILE | 144 | 9 | NEAR COAST OF SOUTHERN CHILE |
| 145 | 9 | S. CHILE-ARGENTINA BORDER REGION | 146 | 9 | ARGENTINA |
| 147 | 10 | TIERRA DEL FUEGO | 148 | 10 | FALKLAND ISLANDS REGION |
| 149 | 10 | DRAKE PASSAGE | 150 | 10 | SCOTIA SEA |
| 151 | 10 | SOUTH GEORGIA ISLAND REGION | 152 | 10 | SOUTH GEORGIA RISE |
| 153 | 10 | SOUTH SANDWICH ISLANDS REGION | 154 | 10 | SOUTH SHETLAND ISLANDS |
| 155 | 10 | PALMER PENINSULA | 156 | 10 | SOUTHWESTERN ATLANTIC OCEAN |
| 157 | 10 | WEDDELL SEA | 158 | 11 | OFF W. COAST OF N. ISLAND, N. Z. |
| 159 | 11 | NORTH ISLAND, NEW ZEALAND | 160 | 11 | OFF E. COAST OF N. ISLAND, N. Z. |
| 161 | 11 | OFF W. COAST OF S. ISLAND, N. Z. | 162 | 11 | SOUTH ISLAND, NEW ZEALAND |
| 163 | 11 | COOK STRAIT, NEW ZEALAND | 164 | 11 | OFF E. COAST OF S. ISLAND, N. Z. |
| 165 | 11 | NORTH OF MACQUARIE ISLAND | 166 | 11 | AUCKLAND ISLANDS REGION |
| 167 | 11 | MACQUARIE ISLAND REGION | 168 | 11 | SOUTH OF NEW ZEALAND |
| 169 | 12 | SAMOA ISLANDS REGION | 170 | 12 | SAMOA ISLANDS |
| 171 | 12 | SOUTH OF FIJI ISLANDS | 172 | 12 | WEST OF TONGA ISLANDS |
| 173 | 12 | TONGA ISLANDS | 174 | 12 | TONGA ISLANDS REGION |
| 175 | 12 | SOUTH OF TONGA ISLANDS | 176 | 12 | NORTH OF NEW ZEALAND |
| 177 | 12 | KERMADEC ISLANDS REGION | 178 | 12 | KERMADEC ISLANDS |
| 179 | 12 | SOUTH OF KERMADEC ISLANDS | 180 | 13 | NORTH OF FIJI ISLANDS |
| 181 | 13 | FIJI ISLANDS REGION | 182 | 13 | FIJI ISLANDS |
| 183 | 14 | SANTA CRUZ ISLANDS REGION | 184 | 14 | SANTA CRUZ ISLANDS |
| 185 | 14 | NEW HEBRIDES ISLANDS REGION | 186 | 14 | NEW HEBRIDES ISLANDS |
| 187 | 14 | NEW CALEDONIA | 188 | 14 | LOYALTY ISLANDS |
| 189 | 14 | LOYALTY ISLANDS REGION | 190 | 15 | NEW IRELAND REGION |
| 191 | 15 | NORTH OF SOLOMON ISLANDS | 192 | 15 | NEW BRITAIN REGION |
| 193 | 15 | SOLOMON ISLANDS | 194 | 15 | DENTRECASTEAUX ISLANDS REGION |
| 195 | 15 | SOLOMON ISLANDS REGION | 196 | 16 | WEST NEW GUINEA REGION |
| 197 | 16 | NEAR N. COAST OF WEST NEW GUINEA | 198 | 16 | NEW GUINEA REGION |
| 199 | 16 | ADMIRALTY ISLANDS REGION | 200 | 16 | NEAR NORTH COAST OF NEW GUINEA |
| 201 | 16 | WEST NEW GUINEA | 202 | 16 | NEW GUINEA |
| 203 | 16 | BISMARCK SEA | 204 | 16 | ARDE ISLANDS REGION |
| 205 | 16 | NEAR S. COAST OF WEST NEW GUINEA | 206 | 16 | NEAR SOUTH COAST OF NEW GUINEA |
| 207 | 16 | EAST NEW GUINEA REGION | 208 | 16 | ARAFURA SEA |
| 209 | 17 | WEST CAROLINE ISLANDS | 210 | 17 | SOUTH OF MARIANA ISLANDS |
| 211 | 18 | SOUTH OF HONSHU, JAPAN | 212 | 18 | BONIN ISLANDS REGION |
| 213 | 18 | VOLCANO ISLANDS REGION | 214 | 18 | WEST OF MARIANA ISLANDS |
| 215 | 18 | MARIANA ISLANDS REGION | 216 | 18 | MARIANA ISLANDS |

217 19 KAMCHATKA
218 19 NEAR EAST COAST OF KAMCHATKA
219 19 OFF EAST COAST OF KAMCHATKA
220 19 NORTHWEST OF KURILE ISLANDS
221 19 KURILE ISLANDS
222 19 KURILE ISLANDS REGION
223 19 EASTERN SEA OF JAPAN
224 19 HOKKAIDO, JAPAN, REGION
225 19 OFF COAST OF HOKKAIDO, JAPAN
226 19 NEAR WEST COAST OF HONSHU, JAPAN
227 19 HONSHU, JAPAN
228 19 NEAR EAST COAST OF HONSHU, JAPAN
229 19 OFF EAST COAST OF HONSHU, JAPAN
230 19 NEAR S. COAST OF HONSHU, JAPAN
231 20 SOUTH KOREA
232 20 SOUTHERN HONSHU, JAPAN
233 20 NEAR S. COAST OF SOUTHERN HONSHU
234 20 EAST CHINA SEA
235 20 KYUSHU, JAPAN
236 20 SHIKOKU, JAPAN
237 20 SOUTHEAST OF SHIKOKU, JAPAN
238 20 RYUKYU ISLANDS
239 20 RYUKYU ISLANDS REGION
240 20 EAST OF RYUKYU ISLANDS
241 20 PHILIPPINE SEA
242 21 NEAR SOUTHEASTERN COAST OF CHINA
243 21 TAIWAN REGION
244 21 TAIWAN
245 21 NORTHEAST OF TAIWAN
246 21 SOUTHWESTERN RYUKYU ISLANDS
247 21 SOUTHEAST OF TAIWAN
248 22 PHILIPPINE ISLANDS REGION
249 22 LUZON, PHILIPPINE ISLANDS
250 22 MINDORO, PHILIPPINE ISLANDS
251 22 SAMAR, PHILIPPINE ISLANDS
252 22 PALAWAN, PHILIPPINE ISLANDS
253 22 SULU SEA
254 22 PANAY, PHILIPPINE ISLANDS
255 22 CEBU, PHILIPPINE ISLANDS
256 22 LEYTE, PHILIPPINE ISLANDS
257 22 NEGROS, PHILIPPINE ISLANDS
258 22 SANGIHE ISLANDS
259 22 MINDANAO, PHILIPPINE ISLANDS
260 22 EAST OF PHILIPPINE ISLANDS
261 23 BORNEO
262 23 CELEBES SEA
263 23 TALAUD ISLANDS
264 23 NORTH OF HALMAHERA
265 23 NORTHERN CELEBES
266 23 MOLUCCA PASSAGE
267 23 HALMAHERA
268 23 CELEBES
269 23 MOLUCCA SEA
270 23 CERAM SEA
271 23 BURU
272 23 CERAM
273 24 SOUTHWEST OF SUMATRA
274 24 SOUTHERN SUMATRA
275 24 JAVA SEA
276 24 SUNDA STRAIT
277 24 JAVA
278 24 BALI SEA
279 24 FLORES SEA
280 24 BANDA SEA
281 24 TANIMBAR ISLANDS REGION
282 24 SOUTH OF JAVA
283 24 BALI ISLAND REGION
284 24 SOUTH OF BALI ISLAND
285 24 SUMBAWA ISLAND REGION
286 24 FLORES ISLAND REGION
287 24 SUMBA ISLAND REGION
288 24 SAWU SEA
289 24 TIMOR
290 24 TIMOR SEA
291 24 SOUTH OF SUMBAWA ISLAND
292 24 SOUTH OF SUMBA ISLAND
293 24 SOUTH OF TIMOR
294 25 BURMA-INDIA BORDER REGION
295 25 BURMA-EAST PAKISTAN BORDER REG.
296 25 BURMA
297 25 BURMA-CHINA BORDER REGION
298 25 SOUTH BURMA
299 25 SOUTHEAST ASIA
300 25 HAINAN ISLAND
301 25 SOUTH CHINA SEA
302 26 EASTERN KASHMIR
303 26 KASHMIR-INDIA BORDER REGION
304 26 KASHMIR-TIBET BORDER REGION
305 26 TIBET-INDIA BORDER REGION
306 26 TIBET

307 26 SZECHWAN PROVINCE, CHINA
308 26 NORTHERN INDIA
309 26 NEPAL-INDIA BORDER REGION
310 26 NEPAL
311 26 SIKKIM
312 26 BHUTAN
313 26 INDIA-CHINA BORDER REGION
314 26 INDIA
315 26 INDIA-EAST PAKISTAN BORDER REG.
316 26 EAST PAKISTAN
317 26 EASTERN INDIA
318 26 YUNAN PROVINCE, CHINA
319 26 BAY OF BENGAL
320 27 KIRGIZ-SINKIANG BORDER REGION
321 27 SOUTHERN SINKIANG PROV., CHINA
322 27 KANSU PROVINCE, CHINA
323 27 NORTHERN CHINA
324 27 KASHMIR-SINKIANG BORDER REGION
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492 34 VIRGINIA
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566 37 CONGO
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568 37 UGANDA
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572 37 LAKE TANGANYIKA REGION
573 37 TANGANYIKA
574 37 NORTHWEST OF MALAGASAY REPUBLIC
575 37 ANGOLA
576 37 NORTHERN RHODESIA

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| 591 | 38 | NORTHERN TERRITORY, AUSTRALIA | 592 | 38 | SOUTH AUSTRALIA |
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| 597 | 38 | NEW CALEDONIA REGION | 598 | 38 | SOUTHWEST OF AUSTRALIA |
| 599 | 38 | OFF SOUTH COAST OF AUSTRALIA | 600 | 38 | NEAR SOUTH COAST OF AUSTRALIA |
| 601 | 38 | NEW SOUTH WALES, AUSTRALIA | 602 | 38 | VICTORIA, AUSTRALIA |
| 603 | 38 | NEAR S.E. COAST OF AUSTRALIA | 604 | 38 | NEAR EAST COAST OF AUSTRALIA |
| 605 | 38 | EAST OF AUSTRALIA | 606 | 38 | NORFOLK ISLAND REGION |
| 607 | 38 | NORTHWEST OF NEW ZEALAND | 608 | 38 | BASS STRAIT |
| 609 | 38 | TASMANIA REGION | 610 | 38 | SOUTHEAST OF AUSTRALIA |
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| 613 | 39 | HAWAIIAN ISLANDS | 614 | 39 | CAROLINE ISLANDS REGION |
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| 619 | 39 | JOHNSON ISLAND REGION | 620 | 39 | LINE ISLANDS REGION |
| 621 | 39 | PALMYRA ISLAND REGION | 622 | 39 | CHRISTMAS ISLAND REGION |
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| 625 | 39 | TEKELAU ISLANDS REGION | 626 | 39 | NORTHERN COOK ISLANDS |
| 627 | 39 | COOK ISLANDS REGION | 628 | 39 | SOCIETY ISLANDS REGION |
| 629 | 39 | TUBUAI ISLANDS REGION | 630 | 39 | MARQUESAS ISLANDS REGION |
| 631 | 39 | TUAMOTU ARCHIPELAGO REGION | 632 | 39 | SOUTH PACIFIC OCEAN |
| 633 | 40 | LOMONOSOV RIDGE | 634 | 40 | ARCTIC OCEAN |
| 635 | 40 | NEAR NORTH COAST OF GREENLAND | 636 | 40 | EASTERN GREENLAND |
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| 639 | 40 | JAN MAYEN ISLAND REGION | 640 | 40 | GREENLAND SEA |
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| 643 | 40 | SVALBARD REGION | 644 | 40 | NORTH OF FRANZ JOSEF LAND |
| 645 | 40 | FRANZ JOSEF LAND | 646 | 40 | NORTHERN NORWAY |
| 647 | 40 | BARENTS SEA | 648 | 40 | NOVAYA ZEMLYA |
| 649 | 40 | KARA SEA | 650 | 40 | NEAR COAST OF WESTERN SIBERIA |
| 651 | 40 | NORTH OF SEVERNAYA ZEMLYA | 652 | 40 | SEVERNAYA ZEMLYA |
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| 663 | 41 | SEA OF OKHOTSK | 664 | 41 | EASTERN CHINA |
| 665 | 41 | YELLOW SEA | 666 | 41 | OFF COAST OF EASTERN CHINA |

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| 669 | 42 | EAST SIBERIAN SEA | 670 | 42 | NEAR N. COAST OF EASTERN SIBERIA |
| 671 | 42 | EASTERN SIBERIA | 672 | 42 | CHUKCHI SEA |
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| 675 | 42 | BEAUFORT SEA | 676 | 42 | ALASKA |
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| 679 | 42 | NORTHWEST TERRITORIES, CANADA | 680 | 42 | WESTERN GREENLAND |
| 681 | 42 | BAFFIN BAY | 682 | 42 | BAFFIN ISLAND REGION |
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| 685 | 43 | EASTER ISLAND REGION | 686 | 43 | WEST CHILE RISE |
| 687 | 43 | JUAN FERNANDEZ ISLANDS REGION | 688 | 43 | EAST OF NORTH ISLAND, N. Z. |
| 689 | 43 | CHATHAM ISLANDS REGION | 690 | 43 | SOUTH OF CHATHAM ISLANDS |
| 691 | 43 | SOUTH PACIFIC CORDILLERA | 692 | 43 | SOUTHERN PACIFIC OCEAN |
| 693 | 44 | EAST CENTRAL PACIFIC OCEAN | 694 | 44 | NORTHERN EASTER I. CORDILLERA |
| 695 | 44 | WEST OF GALAPAGOS ISLANDS | 696 | 44 | GALAPAGOS ISLANDS REGION |
| 697 | 44 | GALAPAGOS ISLANDS | 698 | 44 | SOUTHWEST OF GALAPAGOS ISLANDS |
| 699 | 44 | SOUTHEAST OF GALAPAGOS ISLANDS | 700 | 45 | SOUTH OF TASMANIA |
| 701 | 45 | WEST OF MACQUARIE ISLAND | 702 | 45 | BALLENY ISLANDS REGION |
| 703 | 46 | ANDAMAN ISLANDS REGION | 704 | 46 | NICOBAR ISLANDS REGION |
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| 721 | 49 | FINLAND | 722 | 49 | NORWAY-USSR BORDER REGION |
| 723 | 49 | FINLAND-USSR BORDER REGION | 724 | 49 | WESTERN RUSSIA |
| 725 | 49 | WESTERN SIBERIA | 726 | 49 | CENTRAL SIBERIA |
| 727 | 50 | VICTORIA LAND, ANTARCTICA | 728 | 50 | ROSS SEA |
| 729 | 50 | ANTARCTICA | 730 | | |

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