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QUANTITATIVE DATA ON THE ABUNDANCES AND DISTRIBUTION OF SEAMOUN--ETC(U)
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# McDonnell Center For the Space Sciences

(12) LEVEL II

QUANTITATIVE DATA ON THE ABUNDANCES
AND DISTRIBUTION OF SEAMOUNTS IN THE PACIFIC OCEAN

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ABSTRACT

The purpose of this report is to outline the methods used in the course of work on "Statistical Studies of Oceanic Volcanoes" (ONR grant No. N00014-80-C-0856). It includes a description of the procedures used in the study, a description of the data base of Pacific Ocean seamounts which was compiled as part of the study, and descriptions of FORTRAN programs which were written to facilitate data analysis. In addition, this report contains examples of data tables and graphs of raw data to show their format and contents. This report is intended to facilitate use of the seamount data base by others and to provide the materials necessary for implementing use of the data base for purposes other than those of the present study. Complete listings of the data and plots are available from the author.

## INTRODUCTION: CMOUNT DATA BASE

The Pacific Ocean seamount data base (CMOUNT) which this report describes was compiled from the set of 21 oceanographic charts of the North and South Pacific by Scripps Institution of Oceanography, Institute of Marine Resources. The use of this chart set offers several advantages: (1) they were compiled by one group and are thus of similar format and scale, (2) they are based on fairly up-to-date and well-navigated track coverage of the Pacific, and (3) they are easy to obtain and their use does not involve any additional contouring or track-line data plotting. The major disadvantages of using these charts are: (1) they do not represent aggregate and fully up-to-date information on positions of Pacific seamounts and (2) they are contour charts and thus, unavoidably, partly interpretive. These are not major disadvantages since the data base can easily be added to from other data sources and can be edited in other ways for updating.

The criteria used for distinguishing between seamounts and other elevated submarine landforms were as follows: (1) the feature must be of at least 200 fathom elevation (the contour interval of the charts), (2) the feature must be a closed bathymetric high with length to width ratio of less than or equal to two. On the basis of these criteria, each seamount in the main Pacific Ocean basin which appears on each of the Scripps charts was numbered. The numbers run sequentially starting with number 1 for each chart. Thus each seamount in the Pacific is identified by chart number and its arbitrarily assigned sequence number. Copies of the charts bearing these seamount identification numbers are not included in this report; however, copies can be obtained from the author upon request.

After numbering all of the seamounts, crustal age boundaries from Heezen and Fornari's (1971) geologic map of the Pacific were transcribed to the SIO-series charts. This was done by construction of an interpolated, one-degree transparent grid which overlays onto the Heezen and Fornari map. With the aid of this grid, it was a simple matter to transcribe crustal age boundaries (between geologic epochs) to the SIO charts.

Once these steps were complete, data for each seamount of each chart were tabulated. For each seamount the following were recorded: (1) chart number, (2) sequence number, (3) latitude, (4) longitude, (5) size, and (6) age of the crust upon which the seamount is located. Latitude and longitude were estimated to the nearest and largest (numberically) 5° marks. Thus all the seamounts within even 5° squares all have the latitude of the northwest corner of the square (northern hemisphere) or southwest corner of the square (southern hemisphere). Latitude conventions used are positive for north and negative for south. For longitudes, west longitudes are as listed but east longitudes are > 180°. For example, 170°E is listed as 190° longitude (180 + 1 (180-actual east longitude)1).

Sizes of seamounts were measured with a drafting template of circles of various sizes. Thus in this study, basal diameters of seamounts rather than their elevations were measured. These sizes are listed in CMOUNT as arbitrary size codes which can be converted to seamount volumes by assuming slope angles and correcting the measured seamount diameters for latitude-dependent size distortion which is a feature of mercator projections (such as the Scripps series charts).

Table 1 gives the actual size of the template circles in millimeters with their corresponding size codes and seamount radii in kilometers at the equator. Size codes were corrected for latitudinal-dependent distortion empirically and this correction is applied to data in the CMOUNT data file by the program NMOUNT.

In this study we have assumed slope angles of 15° for volume calculations. These slopes are intermediate between those observed for large submarine shield volcanoes (5°-7°) and much smaller seamounts (18°-22°). For this reason, the volumes which are listed on the data matrices later in this report are probably somewhat low for small volcanoes and high for large ones. This is not a particularly serious problem, since the CMOUNT file contains the raw data (seamount diameters) and the seamount volumes need not be calculated or could be calculated in a different manner if more accurate volumes are desired.

The crustal age codes listed for seamonts in CMOUNT are those used by Heezen and Fornari. Table 2 gives the geologic epoch corresponding to each age code.

The CMOUNT file is available on request on either magtape or RL01 disk.

TABLE 1

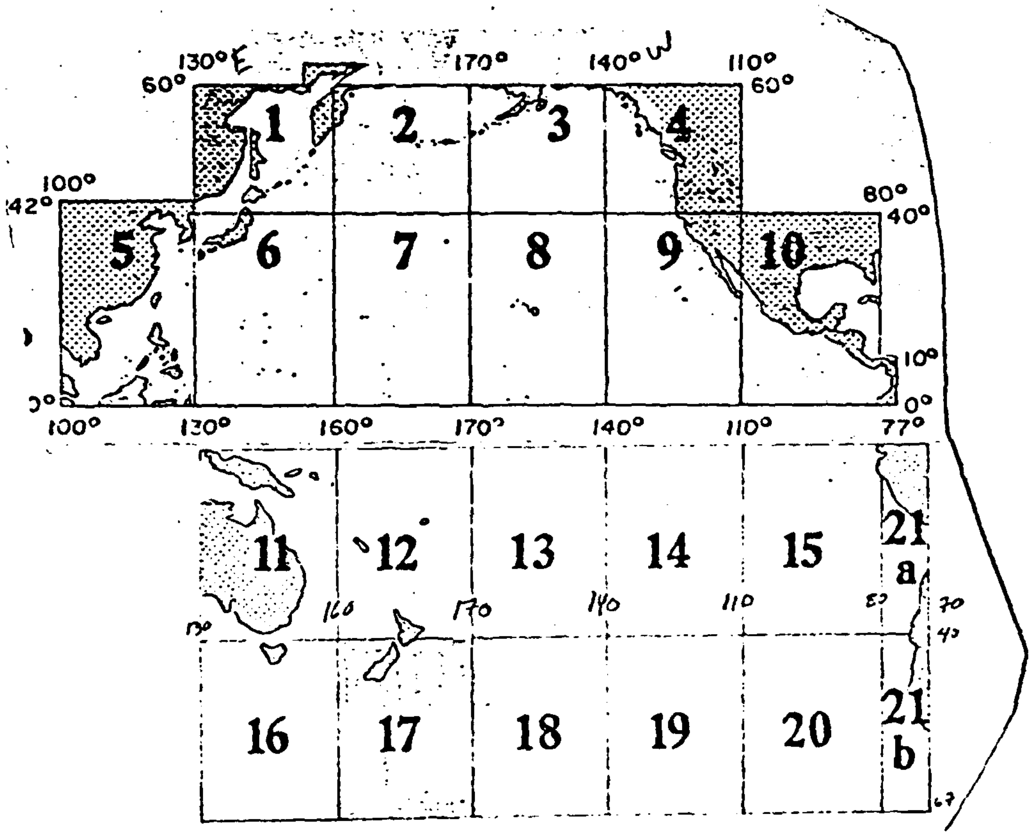
Size Code Data

| Size Code | Diameter (mm) | Seamount Radius (km at the equator) | Size Code | Diameter (mm) | Seamount Radius (km at the equator) |
|---|---|---|---|---|---|
| 1 | 1.6 | 2.9 | 24 | 12.7 | 23.0 |
| 2 | 2.0 | 3.6 | 25 | 13.5 | 24.4 |
| 3 | 2.4 | 4.3 | 26 | 14.3 | 25.8 |
| 4 | 2.8 | 5.0 | 27 | 15.0 | 27.3 |
| 5 | 3.2 | 5.7 | 28 | 15.9 | 28.7 |
| 6 | 3.6 | 6.5 | 29 | 16.7 | 30.2 |
| 7 | 4.0 | 7.2 | 30 | 17.5 | 31.6 |
| 8 | 4.4 | 7.9 | 31 | 28.3 | 33.0 |
| 9 | 4.7 | 8.6 | 32 | 19.0 | 34.5 |
| 10 | 5.2 | 9.3 | 33 | 20.6 | 37.4 |
| 11 | 5.5 | 10.0 | 34 | 22.2 | 40.3 |
| 12 | 5.9 | 10.8 | 35 | 23.8 | 43.1 |
| 13 | 6.3 | 11.5 | 36 | 25.4 | 46.0 |
| 14 | 6.7 | 12.2 | 37 | 28.6 | 51.7 |
| 15 | 7.2 | 12.9 | 38 | 31.7 | 57.5 |
| 16 | 7.6 | 13.6 | 39 | 34.9 | 63.2 |
| 17 | 7.9 | 14.4 | 40 | 38.0 | 68.8 |
| 18 | 8.3 | 15.1 | 41 | 42.0 | 76.0 |
| 19 | 8.7 | 15.8 | 42 | 45.0 | 81.5 |
| 20 | 9.5 | 17.2 | 43 | 48.0 | 86.9 |
| 21 | 10.3 | 18.7 | 44 | 50.0 | 90.5 |
| 22 | 11.1 | 20.1 | 45 | >50.0 | >90.5 |
| 23 | 11.9 | 21.5 | | | |

TABLE 2

Age Codes

| Age Code | Geologic Epoch or Period | Time Interval (millions of years) |
|---|---|---|
| Q | Pleistocene | 0-2.4 |
| N2 | Pliocene | 2.4-6.9 |
| N1 | Miocene | 6.9-25.7 |
| PG3 | Oligiocene | 25.7-37.3 |
| PG2 | Eocene | 37.3-53.3 |
| PG1 | Paleocene | 53.3-64.9 |
| K2 | Upper Cretaceous | 64.9-100 |
| K1 | Lower Cretaceous | 100-136 |
| J | Jurassic | 136-157 |


130°E
170°
140°W
110°
60°
60°
100°
42°
80°
40°
10°
0°
100°
130°
160°
170°
140°
110°
77°
1
2
3
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a
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19
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21
b

FILE CONTAINS 11806 RECORDS        LMUUNI : LISTING



| REC # | CHART | MOUNT | LAT | LONG | SIZE | AGE |
|---|---|---|---|---|---|---|
| 52: | 1 | 39 | 45 | 150 | 25 | K1 |
| 54: | 1 | 40 | 45 | 150 | 12 | K1 |
| 55: | 1 | 41 | 45 | 150 | 13 | K1 |
| 56: | 1 | 42 | 45 | 150 | 3 | K1 |
| 57: | 1 | 43 | 45 | 150 | 3 | K1 |
| 59: | 1 | 45 | 45 | 150 | 20 | K1 |
| 60: | 1 | 46 | 45 | 150 | 20 | K1 |
| 61: | 1 | 47 | 45 | 150 | 10 | K1 |
| 62: | 1 | 48 | 45 | 150 | 3 | K1 |
| 63: | 1 | 49 | 45 | 150 | 3 | K1 |
| 64: | 1 | 50 | 45 | 150 | 5 | K1 |
| 65: | 1 | 51 | 45 | 150 | 2 | K1 |
| 66: | 1 | 52 | 45 | 150 | 4 | K1 |
| 67: | 1 | 53 | 45 | 150 | 5 | K1 |
| 68: | 1 | 54 | 45 | 150 | 14 | K1 |
| 69: | 1 | 55 | 45 | 150 | 1 | K1 |
| 70: | 1 | 56 | 45 | 150 | 6 | K1 |
| 71: | 1 | 57 | 45 | 150 | 2 | K1 |
| 72: | 1 | 58 | 45 | 150 | 7 | K1 |
| 73: | 1 | 59 | 45 | 150 | 2 | K1 |
| 74: | 1 | 60 | 45 | 150 | 8 | K1 |
| 75: | 1 | 61 | 45 | 150 | 11 | K1 |
| 76: | 1 | 62 | 45 | 155 | 17 | K1 |
| 77: | 1 | 63 | 45 | 155 | 3 | K1 |
| 78: | 1 | 64 | 45 | 155 | 7 | K1 |
| 79: | 1 | 65 | 45 | 155 | 1 | K1 |
| 80: | 1 | 66 | 45 | 155 | 3 | K1 |
| 81: | 1 | 67 | 45 | 155 | 24 | K1 |
| 82: | 1 | 68 | 45 | 155 | 5 | K1 |
| 83: | 1 | 69 | 45 | 155 | 2 | K1 |
| 84: | 1 | 70 | 45 | 155 | 5 | K1 |
| 85: | 1 | 71 | 45 | 155 | 5 | K1 |
| 86: | 1 | 72 | 45 | 155 | 4 | K1 |
| 87: | 1 | 73 | 45 | 155 | 16 | K1 |
| 88: | 1 | 74 | 45 | 155 | 18 | K1 |
| 89: | 1 | 75 | 45 | 160 | 9 | K1 |
| 90: | 1 | 76 | 45 | 160 | 16 | K1 |
| 91: | 1 | 77 | 45 | 160 | 16 | K1 |
| 92: | 1 | 78 | 45 | 160 | 9 | K1 |
| 93: | 1 | 79 | 45 | 160 | 9 | K1 |
| 94: | 1 | 80 | 45 | 155 | 23 | K2 |
| 95: | 1 | 81 | 45 | 160 | 7 | K1 |
| 96: | 1 | 82 | 45 | 160 | 6 | K2 |
| 97: | 1 | 83 | 45 | 160 | 1 | K2 |
| 98: | 1 | 84 | 45 | 155 | 6 | K2 |
| 99: | 1 | 85 | 45 | 155 | 11 | K2 |
| 100: | 1 | 86 | 45 | 155 | 12 | K2 |
| 101: | 1 | 87 | 45 | 155 | 6 | K2 |
| 102: | 1 | 88 | 45 | 155 | 9 | K2 |
| 103: | 1 | 89 | 45 | 150 | 5 | K2 |
| 104: | 1 | 90 | 45 | 150 | 5 | K2 |
| 105: | 1 | 91 | 45 | 150 | 3 | K2 |
| 106: | 1 | 92 | 45 | 150 | 4 | K2 |
| 107: | 1 | 93 | 45 | 150 | 2 | K2 |
| 108: | 1 | 94 | 45 | 150 | 22 | K2 |
| 109: | 1 | 95 | 45 | 150 | 18 | K2 |
| 110: | 1 | 96 | 45 | 150 | 27 | K2 |
| 111: | 1 | 97 | 45 | 155 | 6 | K2 |
| 112: | 1 | 98 | 45 | 155 | 13 | K2 |

FORTRAN PROGRAMS

This section describes the Fortran Programs which were written for use in this study. Table 3 gives a list of the programs and their uses. Each program is interactive and has several straightforward and self-explanatory commands. All programs are very easy to use and thus detailed documentation is not provided. All programs were written for use on a PDP 11/34 computer with RSX-11M time-sharing operating system and Plots were produced with a Tektronics 4006-1 and 4662 plotting and graphics package. More detailed information on the computer hardware, operating system and peripherals is available on request.

CMOUNT: Program CMOUNT is used to enter data and edit the CMOUNT data file. It has the options: ADD, EDIT, DUMP and EXIT, which are described in detail in the instructions for using CMOUNT. CMOUNT essentially creates an individual record for each seamount. This record can then be edited, deleted or printed as desired. By entering "zero" for the "seamount number," instead of a proper sequence number, the user may effectively "ignore" a record or group of records. This is useful in creating various subsets of the data via NMOUNT and SUBSET because particular seamounts can be left out without deleting the entire record. Later, the record can be restored by entering the correct "seamount number."

NMOUNT: Corrects the size codes of seamounts in the CMOUNT data file for latitude-dependent distortion as described previously. After each modification of the CMOUNT data file, it is necessary to run the program NMOUNT to create an up-to-date corrected CMOUNT file. This is because SUBSET uses the latest NMOUNT file rather than the latest CMOUNT file.

TABLE 3

Fortran Programs

| PROGRAM | USE |
|---|---|
| CMOUNT | Used to enter and edit data in CMOUNT file. Uses subroutines TTYIN and CDUMP. |
| NMOUNT | CORRECTS the size codes of seamounts in the CMOUNT file. |
| SUBSET | Creates subsets of NMOUNT and uses subroutine AGESIZ to print age vs. size matrices for these subsets. These matrices may also be saved for plotting. |
| PLOT | Creates plots of data from SUBSET. |

<u>SUBSET</u>: This program creates various subsets of NMOUNT and uses subroutine AGESIZ to print an age vs. size matrix of the data for each subset. Subsets are created interactively by adding data for whole charts, 5° x 5° areas or both to the "NULL" subset. The commands in SUBSET are NULL, ADD, RESET (which calls entire NMOUNT file), MATRIX (which prints age-size matrix) DELETE (which has same options as ADD) and EXIT. MATRIX will print the age-size matrix for any specified subset of the data. Additional density and density difference matrices will only be printed if the specified subset consists of an integral number of whole chart areas. This is because the density matrices are obtained by dividing the number of seamounts in each age-size category by the appropriate area of sea floor ($km^2$) to obtain seamount density or abundance (number of seamounts per $10^6 km^2$). Such data are not available for 5° squares but only for each whole chart area (see Table 4).

<u>PLOT</u>: Uses data from SUBSET to plot various x-y plots of the data in NMOUNT for any subset of the data file. It has three plotting options which are accessed via the command PLOT. These are: (1) abundance (density) or abundance difference versus age for any specified size code range, (2) abundance or abudance difference versus log volume for each age category and (3) mean, maximum and median volume versus age.

Other possible commands are GROW which simulates seamount growth by various optional growth by various optional growth rate laws and rates, BURY, which simulates sediment burial of seamounts, RESTORE, which essentially resets the program to the original data subset and PRINT which prints the data to be used for a particular plot. The plotting program is very flexible, easy to use and is a great help in data analysis.

TABLE 4

Areas of Pacific Sea Floor

| Chart Number | Age | Area ($10^6 km^2$) |
|---|---|---|
| 1 | K2 | 0.26 |
| | K1 | 0.41 |
| 2 | PG1 | 0.20 |
| | K2 | 2.02 |
| | K1 | 0.69 |
| 3 | PG3 | 0.99 |
| | PG2 | 0.86 |
| | PG1 | 0.70 |
| | K2 | 1.09 |
| 4 | Q | 0.07 |
| | N2 | 0.24 |
| | N1 | 0.88 |
| | PG3 | 0.30 |
| | PG2 | 0.01 |
| 6 | PG3 | 1.87 |
| | K1 | 1.86 |
| | J | 4.12 |
| 7 | K2 | 0.54 |
| | K1 | 8.57 |
| | J | 4.17 |
| 8 | PG2 | C.24 |
| | PG1 | 1.73 |
| | K2 | 8.14 |
| | K1 | 3.02 |
| 9 | N1 | 3.75 |
| | PG3 | 3.62 |
| | PG2 | 3.70 |
| | PG1 | 0.64 |
| | K2 | 0.02 |

Table 4 (Continued)

| Chart Number | Age | Area ($10^6 km^2$) |
|---|---|---|
| 10 | Q | 0.50 |
| | N2 | 1.18 |
| | N1 | 2.31 |
| | PG3 | 0.42 |
| | PG2 | 0.70 |
| 11 | N1 | 0.10 |
| | PG3 | 0.21 |
| | PG2 | 0.29 |
| | PG1 | 1.58 |
| | K2 | 0.34 |
| | K1 | 0.50 |
| 12 | K1 | 5.51 |
| 13 | PG2 | 0.08 |
| | PG1 | 1.28 |
| | K2 | 7.64 |
| | K1 | 4.03 |
| 14 | Q | 0.58 |
| | N2 | 1.35 |
| | N1 | 5.17 |
| | PG3 | 3.05 |
| | PG2 | 2.37 |
| | PG1 | 0.53 |
| | K2 | 0.02 |
| 15 | Q | 0.33 |
| | N2 | 1.35 |
| | N1 | 7.82 |
| | PG3 | 2.92 |
| | PG2 | 0.68 |
| 16 | Q | 0.14 |
| | N2 | 0.73 |
| | N1 | 1.51 |
| | PG3 | 0.64 |
| | PG2 | 0.81 |
| | PG1 | 0.59 |
| | K2 | 0.63 |

Table 4 (Continued)

| Chart Number | Age | Area ($10^6 km^2$) |
|---|---|---|
| 17 | Q | 0.08 |
| | N2 | 0.41 |
| | N1 | 0.30 |
| | PG3 | 0.27 |
| | PG2 | 0.22 |
| | PG1 | 0.43 |
| | K2 | 1.49 |
| | K1 | 0.38 |
| 18 | Q | 0.14 |
| | N2 | 0.37 |
| | N1 | 1.07 |
| | PG3 | 0.64 |
| | PG2 | 0.47 |
| | PG1 | 0.48 |
| | K2 | 2.17 |
| | K1 | 0.16 |
| 19 | Q | 0.38 |
| | N2 | 0.71 |
| | N1 | 1.25 |
| | PG3 | 0.97 |
| | PG2 | 1.04 |
| | PG1 | 0.56 |
| | K2 | 0.56 |
| 20 | Q | 0.06 |
| | N2 | 0.23 |
| | N1 | 1.43 |
| | PG3 | 1.39 |
| | PG2 | 0.96 |
| | PG1 | 0.39 |
| | K2 | 0.90 |
| 21 | Q | 0.009 |
| | N2 | 0.03 |
| | N1 | 0.44 |
| | PG3 | 0.67 |
| | PG2 | 1.84 |
| | K2 | 0.09 |

## DATA MATRICES

This section contains an example of the age-size matrices and seamount abundance matrices which may be obtained for each individual chart area of the Pacific as well as larger subsets such as the North Pacific, South Pacific and entire Pacific. These are produced by program SUBSET from the latest NMOUNT file via the command MATRIX.

| SIZE | Q | N2 | N1 | G3 | G2 | G1 | K2 | K1 | J | TOTALS | VOL.KM^3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 32 | 109 | 750 | 638 | 703 | 323 | 693 | 316 | 31 | 3595 | 7. |
| 2 | 9 | 32 | 277 | 144 | 170 | 102 | 134 | 121 | 25 | 1064 | 13. |
| 3 | 15 | 51 | 170 | 159 | 129 | 69 | 184 | 124 | 27 | 928 | 22. |
| 4 | 9 | 37 | 149 | 134 | 128 | 62 | 124 | 92 | 29 | 764 | 36. |
| 5 | 9 | 37 | 109 | 86 | 73 | 46 | 109 | 95 | 17 | 581 | 53. |
| 6 | 4 | 17 | 82 | 93 | 42 | 48 | 101 | 74 | 25 | 486 | 76. |
| 7 | 7 | 23 | 72 | 76 | 44 | 37 | 76 | 59 | 18 | 412 | 104. |
| 8 | 14 | 23 | 59 | 38 | 36 | 28 | 78 | 34 | 16 | 326 | 138. |
| 9 | 8 | 17 | 38 | 44 | 41 | 23 | 57 | 49 | 28 | 305 | 180. |
| 10 | 5 | 16 | 43 | 30 | 24 | 13 | 47 | 38 | 16 | 232 | 228. |
| 11 | 7 | 17 | 54 | 27 | 26 | 9 | 33 | 50 | 13 | 236 | 285. |
| 12 | 7 | 14 | 39 | 40 | 25 | 14 | 38 | 46 | 22 | 245 | 352. |
| 13 | 5 | 12 | 35 | 32 | 20 | 21 | 31 | 42 | 21 | 219 | 425. |
| 14 | 5 | 8 | 34 | 22 | 15 | 8 | 32 | 41 | 18 | 183 | 509. |
| 15 | 3 | 3 | 24 | 20 | 13 | 17 | 27 | 33 | 12 | 152 | 606. |
| 16 | 2 | 5 | 17 | 19 | 10 | 9 | 25 | 27 | 15 | 129 | 713. |
| 17 | 2 | 5 | 8 | 8 | 12 | 13 | 18 | 19 | 6 | 91 | 832. |
| 18 | 1 | 14 | 25 | 23 | 13 | 11 | 31 | 36 | 27 | 181 | 961. |
| 19 | 2 | 10 | 18 | 17 | 9 | 7 | 27 | 37 | 20 | 147 | 1106. |
| 20 | 1 | 6 | 28 | 21 | 15 | 6 | 19 | 41 | 25 | 162 | 1437. |
| 21 | 0 | 5 | 12 | 13 | 7 | 11 | 21 | 42 | 25 | 136 | 1828. |
| 22 | 1 | 3 | 15 | 15 | 12 | 6 | 29 | 38 | 26 | 145 | 2280. |
| 23 | 0 | 3 | 19 | 13 | 8 | 6 | 10 | 36 | 38 | 133 | 2800. |
| 24 | 0 | 2 | 6 | 8 | 8 | 3 | 3 | 30 | 26 | 86 | 3400. |
| 25 | 1 | 2 | 10 | 3 | 3 | 0 | 4 | 29 | 15 | 67 | 4100. |
| 26 | 0 | 1 | 4 | 5 | 3 | 3 | 5 | 18 | 10 | 49 | 4850. |
| 27 | 0 | 1 | 4 | 7 | 2 | 1 | 5 | 19 | 15 | 54 | 5700. |
| 28 | 0 | 0 | 0 | 3 | 0 | 0 | 4 | 19 | 16 | 42 | 6450. |
| 29 | 2 | 1 | 5 | 3 | 3 | 2 | 1 | 7 | 13 | 37 | 7700. |
| 30 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 11 | 9 | 24 | 8850. |
| 31 | 0 | 1 | 1 | 1 | 5 | 0 | 2 | 13 | 14 | 37 | 10100. |
| 32 | 0 | 0 | 2 | 1 | 0 | 2 | 0 | 11 | 13 | 29 | 11500. |
| 33 | 0 | 1 | 5 | 1 | 0 | 1 | 2 | 9 | 9 | 28 | 14600. |
| 34 | 0 | 2 | 2 | 0 | 2 | 0 | 2 | 3 | 4 | 15 | 18300. |
| 35 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 5 | 8 | 17 | 22500. |
| 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 4 | 11 | 27250. |
| 37 | 0 | 0 | 1 | 1 | 0 | 0 | 3 | 2 | 2 | 9 | 38800. |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 53200. |
| 39 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 70800. |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 91200. |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 123200. |
| 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 151500. |
| 43 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 170000. |
| 44 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 250000. |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 300000. |
| TOTAL | 151 | 478 | 2119 | 1746 | 1602 | 901 | 2031 | 1676 | 659 | | |
| MEAN VOL. KM^3 | 314. | 418. | 333. | 303. | 245. | 263. | 534. | 1509. | 2804. | | |

DENSITY MATRIX- (#MOUNTS/KM^2) *10^6

| SIZE | Q | N2 | N1 | G3 | G2 | G1 | K2 | K1 | J | TOTALS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 13.91 | 16.44 | 28.77 | 35.48 | 49.20 | 35.42 | 26.72 | 12.56 | 3.73 | 222.23 |
| 2 | 3.91 | 4.83 | 10.63 | 8.01 | 11.90 | 11.18 | 7.09 | 4.81 | 3.01 | 65.37 |
| 3 | 6.52 | 7.69 | 6.52 | 8.84 | 9.03 | 7.57 | 7.09 | 4.93 | 3.25 | 61.4[illegible] |
| 4 | 3.91 | 5.58 | 5.72 | 7.45 | 8.96 | 6.80 | 4.78 | 3.66 | 3.49 | 50.3[illegible] |
| 5 | 3.91 | 5.58 | 4.18 | 4.78 | 5.11 | 5.04 | 4.20 | 3.78 | 2.05 | 38.64 |
| 6 | 1.74 | 2.56 | 3.15 | 5.17 | 2.94 | 5.26 | 3.89 | 2.94 | 3.01 | 30.67 |
| 7 | 3.04 | 3.47 | 2.76 | 4.23 | 3.08 | 4.06 | 2.93 | 2.35 | 2.17 | 28.09 |
| 8 | 6.09 | 3.47 | 2.26 | 2.11 | 2.52 | 3.07 | 3.01 | 1.35 | 1.93 | 25.81 |
| 9 | 3.48 | 2.56 | 1.46 | 2.45 | 2.87 | 2.52 | 2.20 | 1.95 | 3.37 | 22.86 |
| 10 | 2.17 | 2.41 | 1.65 | 1.67 | 1.68 | 1.43 | 1.81 | 1.51 | 1.93 | 16.26 |
| 11 | 3.04 | 2.56 | 2.07 | 1.50 | 1.82 | 0.99 | 1.27 | 1.99 | 1.57 | 16.81 |
| 12 | 3.04 | 2.11 | 1.50 | 2.22 | 1.75 | 1.54 | 1.46 | 1.83 | 2.65 | 18.10 |
| 13 | 2.17 | 1.81 | 1.34 | 1.78 | 1.40 | 2.30 | 1.20 | 1.67 | 2.53 | 16.20 |
| 14 | 2.17 | 1.21 | 1.30 | 1.22 | 1.05 | 0.88 | 1.23 | 1.63 | 2.17 | 12.87 |
| 15 | 1.30 | 0.45 | 0.92 | 1.11 | 0.91 | 1.86 | 1.04 | 1.31 | 1.45 | 10.36 |
| 16 | 0.87 | 0.75 | 0.65 | 1.06 | 0.70 | 0.99 | 0.96 | 1.07 | 1.81 | 8.86 |
| 17 | 0.87 | 0.75 | 0.31 | 0.44 | 0.84 | 1.43 | 0.69 | 0.76 | 0.72 | 6.81 |
| 18 | 0.43 | 2.11 | 0.96 | 1.28 | 0.91 | 1.21 | 1.20 | 1.43 | 3.25 | 12.7[illegible] |
| 19 | 0.87 | 1.51 | 0.69 | 0.95 | 0.63 | 0.77 | 1.04 | 1.47 | 2.41 | 10.3[illegible] |
| 20 | 0.43 | 0.90 | 1.07 | 1.17 | 1.05 | 0.66 | 0.73 | 1.63 | 3.01 | 10.66 |
| 21 | 0.00 | 0.75 | 0.46 | 0.72 | 0.49 | 1.21 | 0.81 | 1.67 | 3.01 | 9.13 |
| 22 | 0.43 | 0.45 | 0.58 | 0.83 | 0.84 | 0.66 | 1.12 | 1.51 | 3.13 | 9.56 |
| 23 | 0.00 | 0.45 | 0.73 | 0.72 | 0.56 | 0.66 | 0.39 | 1.43 | 4.58 | 9.52 |
| 24 | 0.00 | 0.30 | 0.23 | 0.44 | 0.56 | 0.33 | 0.12 | 1.19 | 3.15 | 6.31 |
| 25 | 0.43 | 0.30 | 0.38 | 0.17 | 0.21 | 0.00 | 0.15 | 1.15 | 1.81 | 4.61 |
| 26 | 0.00 | 0.15 | 0.15 | 0.28 | 0.21 | 0.33 | 0.19 | 0.72 | 1.20 | 3.23 |
| 27 | 0.00 | 0.15 | 0.15 | 0.39 | 0.14 | 0.11 | 0.19 | 0.76 | 1.81 | 3.70 |
| 28 | 0.00 | 0.00 | 0.00 | 0.17 | 0.00 | 0.00 | 0.15 | 0.76 | 1.93 | 3.00 |
| 29 | 0.87 | 0.15 | 0.19 | 0.17 | 0.21 | 0.22 | 0.04 | 0.28 | 1.57 | 3.69 |
| 30 | 0.00 | 0.00 | 0.04 | 0.06 | 0.07 | 0.00 | 0.04 | 0.44 | 1.08 | 1.72 |
| 31 | 0.00 | 0.15 | 0.04 | 0.06 | 0.35 | 0.00 | 0.08 | 0.52 | 1.69 | 2.89 |
| 32 | 0.00 | 0.00 | 0.08 | 0.06 | 0.00 | 0.22 | 0.00 | 0.44 | 1.57 | 2.36 |
| 33 | 0.00 | 0.15 | 0.19 | 0.06 | 0.00 | 0.11 | 0.08 | 0.36 | 1.08 | 2.03 |
| 34 | 0.00 | 0.30 | 0.08 | 0.00 | 0.14 | 0.00 | 0.08 | 0.12 | 0.48 | 1.20 |
| 35 | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.12 | 0.20 | 0.96 | 1.32 |
| 36 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 | 0.48 | 0.76 |
| 37 | 0.00 | 0.00 | 0.04 | 0.06 | 0.00 | 0.00 | 0.12 | 0.08 | 0.24 | 0.53 |
| 38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.12 | 0.16 |
| 39 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.08 |
| 40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 41 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 44 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 | 0.04 |
| 45 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.04 |
| TOTAL | 65.65 | 72.10 | 81.28 | 97.11 | 112.11 | 98.79 | 78.30 | 66.64 | 79.40 | |

DENSITY DIFFERENCE MATRIX

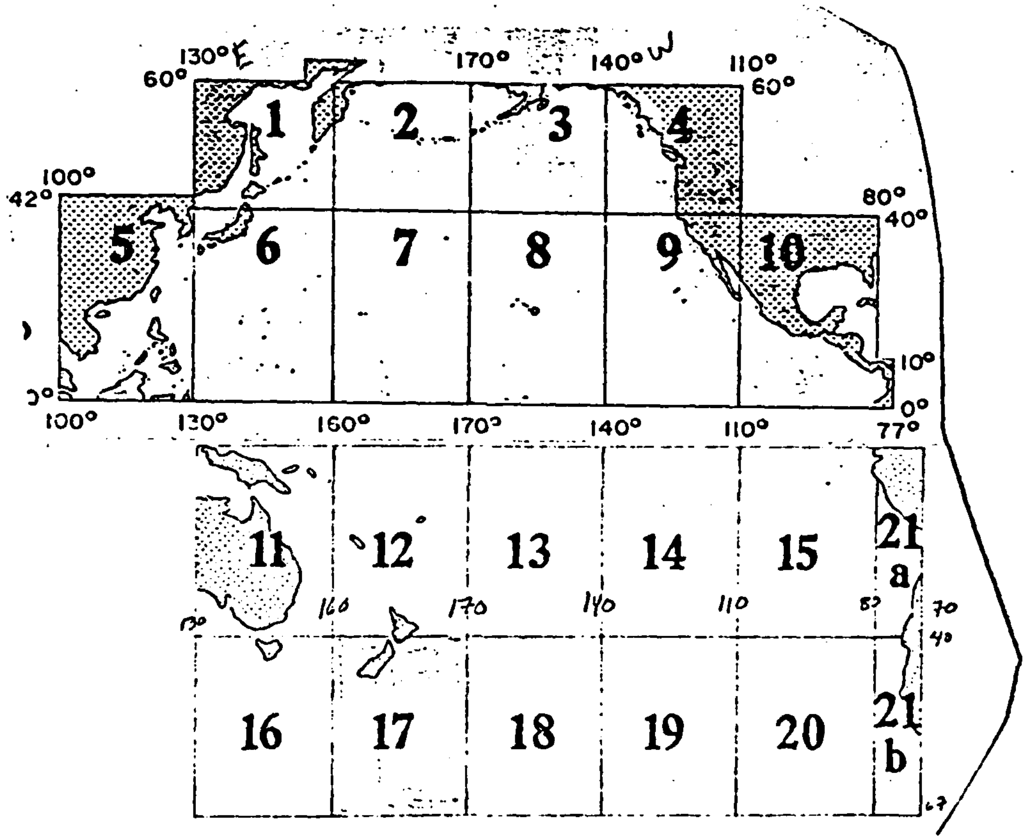
| SIZE | N2-Q | N1-N2 | G3-N1 | G2-G3 | G1-G2 | K2-G1 | K1-K2 | J -K1 | TOTALS |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.53 | 12.33 | 6.72 | 13.71 | -13.78 | -8.70 | -14.15 | -8.83 | -10.18 |
| 2 | 0.91 | 5.30 | -2.62 | 3.89 | -0.71 | -4.09 | -2.28 | -1.80 | -0.90 |
| 3 | 1.17 | -1.17 | 2.32 | 0.18 | -1.46 | -0.47 | -2.16 | -1.68 | -3.27 |
| 4 | 1.67 | 0.13 | 1.74 | 1.50 | -2.16 | -2.02 | -1.12 | -0.16 | -0.42 |
| 5 | 1.67 | -1.40 | 0.60 | 0.33 | -0.06 | -0.84 | -0.42 | -1.73 | -1.86 |
| 6 | 0.82 | 0.58 | 2.03 | -2.23 | 2.32 | -1.37 | -0.95 | 0.07 | 1.27 |
| 7 | 0.43 | -0.71 | 1.47 | -1.15 | 0.98 | -1.13 | -0.58 | -0.18 | -0.87 |
| 8 | -2.62 | -1.21 | -0.15 | 0.41 | 0.55 | -0.06 | -1.66 | 0.58 | -4.16 |
| 9 | -0.91 | -1.11 | 0.99 | 0.42 | -0.35 | -0.32 | -0.25 | 1.43 | -0.10 |
| 10 | 0.24 | -0.76 | 0.02 | 0.01 | -0.25 | 0.39 | -0.30 | 0.42 | -0.25 |
| 11 | -0.48 | -0.49 | -0.57 | 0.32 | -0.83 | 0.29 | 0.72 | -0.42 | -1.48 |
| 12 | -0.93 | -0.62 | 0.73 | -0.48 | -0.21 | -0.07 | 0.36 | 0.82 | -0.39 |
| 13 | -0.36 | -0.47 | 0.44 | -0.38 | 0.90 | -1.11 | 0.47 | 0.86 | 0.36 |
| 14 | -0.97 | 0.10 | -0.08 | -0.17 | -0.17 | 0.36 | 0.40 | 0.54 | -0.01 |
| 15 | -0.85 | 0.47 | 0.19 | -0.20 | 0.95 | -0.82 | 0.27 | 0.13 | 0.14 |
| 16 | -0.12 | -0.10 | 0.40 | -0.36 | 0.29 | -0.02 | 0.11 | 0.73 | 0.94 |
| 17 | -0.12 | -0.45 | 0.14 | 0.39 | 0.59 | -0.73 | 0.06 | -0.03 | -0.15 |
| 18 | 1.68 | -1.15 | 0.32 | -0.37 | 0.30 | -0.01 | 0.24 | 1.82 | 2.82 |
| 19 | 0.64 | -0.82 | 0.26 | -0.32 | 0.14 | 0.27 | 0.43 | 0.94 | 1.54 |
| 20 | 0.47 | 0.17 | 0.09 | -0.12 | -0.39 | 0.07 | 0.90 | 1.38 | 2.58 |
| 21 | 0.75 | -0.29 | 0.26 | -0.23 | 0.72 | -0.40 | 0.86 | 1.34 | 3.01 |
| 22 | 0.02 | 0.12 | 0.26 | 0.01 | -0.18 | 0.46 | 0.39 | 1.62 | 2.70 |
| 23 | 0.45 | 0.28 | -0.01 | -0.16 | 0.10 | -0.27 | 1.05 | 3.15 | 4.58 |
| 24 | 0.30 | -0.07 | 0.21 | 0.11 | -0.23 | -0.21 | 1.08 | 1.94 | 3.13 |
| 25 | -0.13 | 0.08 | -0.22 | 0.04 | -0.21 | 0.15 | 1.00 | 0.65 | 1.37 |
| 26 | 0.15 | 0.00 | 0.12 | -0.07 | 0.12 | -0.14 | 0.52 | 0.49 | 1.20 |
| 27 | 0.15 | 0.00 | 0.24 | -0.25 | -0.03 | 0.08 | 0.56 | 1.05 | 1.31 |
| 28 | 0.00 | 0.00 | 0.17 | -0.17 | 0.00 | 0.15 | 0.60 | 1.17 | 1.73 |
| 29 | -0.72 | 0.04 | -0.02 | 0.04 | 0.01 | -0.18 | 0.24 | 1.29 | 0.70 |
| 30 | 0.00 | 0.04 | 0.02 | 0.01 | -0.07 | 0.04 | 0.40 | 0.65 | 1.08 |
| 31 | 0.15 | -0.11 | 0.02 | 0.29 | -0.35 | 0.08 | 0.44 | 1.17 | 1.69 |
| 32 | 0.00 | 0.08 | -0.02 | -0.06 | 0.22 | -0.22 | 0.44 | 1.13 | 1.57 |
| 33 | 0.15 | 0.04 | -0.14 | -0.06 | 0.11 | -0.03 | 0.28 | 0.73 | 1.08 |
| 34 | 0.30 | -0.22 | -0.08 | 0.14 | -0.14 | 0.08 | 0.04 | 0.36 | 0.48 |
| 35 | 0.00 | 0.04 | -0.04 | 0.00 | 0.00 | 0.12 | 0.08 | 0.77 | 0.96 |
| 36 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 | 0.20 | 0.48 |
| 37 | 0.00 | 0.04 | 0.02 | -0.06 | 0.00 | 0.12 | -0.04 | 0.16 | 0.24 |
| 38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | -0.04 | 0.12 | 0.12 |
| 39 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | -0.08 | 0.00 |
| 40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 41 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 44 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | -0.04 | 0.00 | 0.00 |
| 45 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | -0.04 | 0.00 |
| TOTAL | 6.4 | 9.2 | 15.8 | 15.0 | -13.3 | -20.5 | -11.7 | 12.8 | |
| MEAN VOL/ AREA | 1222. | 329. | 414. | 337. | 1062. | 9242. | 5878. | 5054. | |

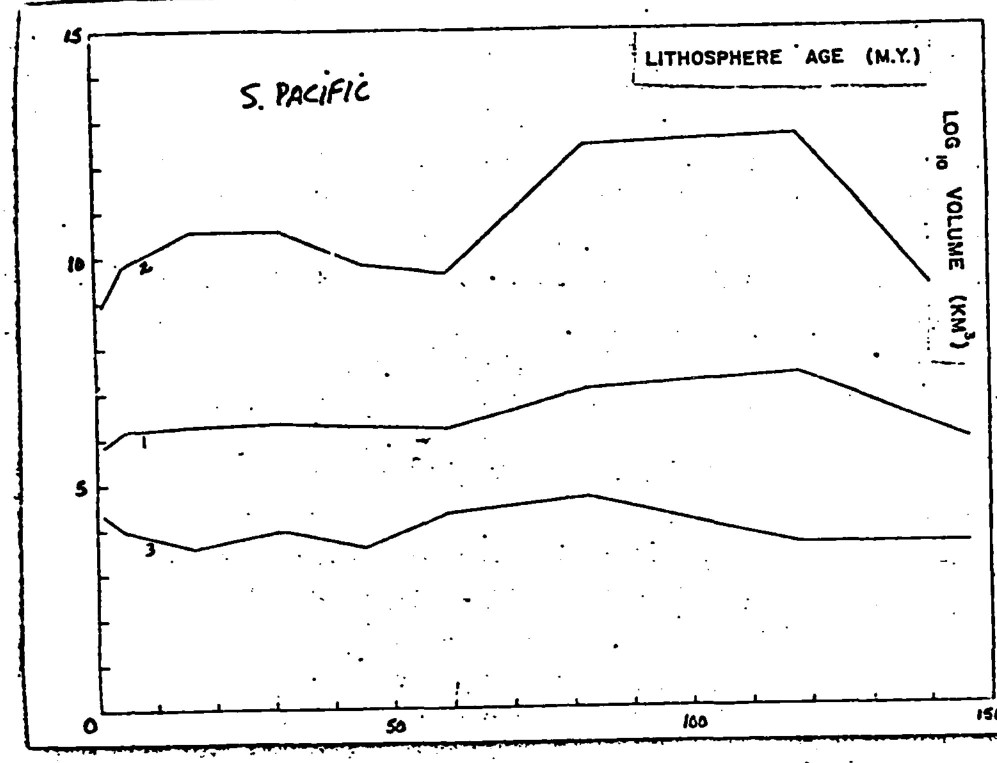
DO YOU WANT TO STORE THESE MATRICES IN A FILE
TO BE USED BY THE PLOT PROGRAM?
YES
TO USE THIS FILE TYPE 'EXIT', THEN 'RUN PLOT'

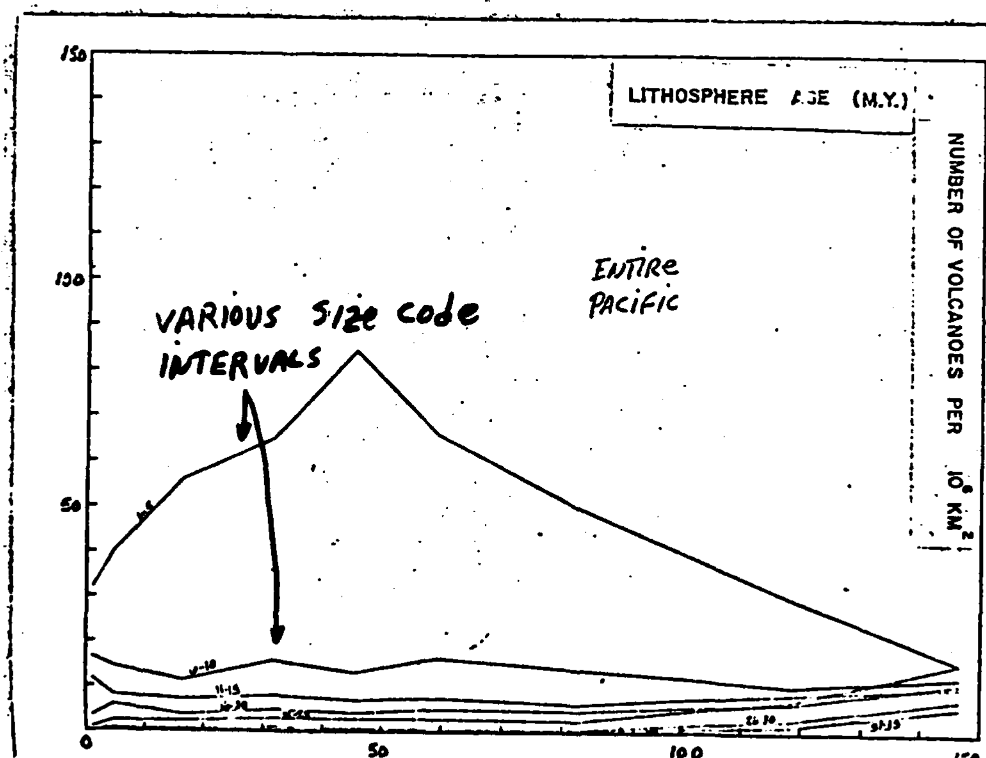
MATRIX GENERATED

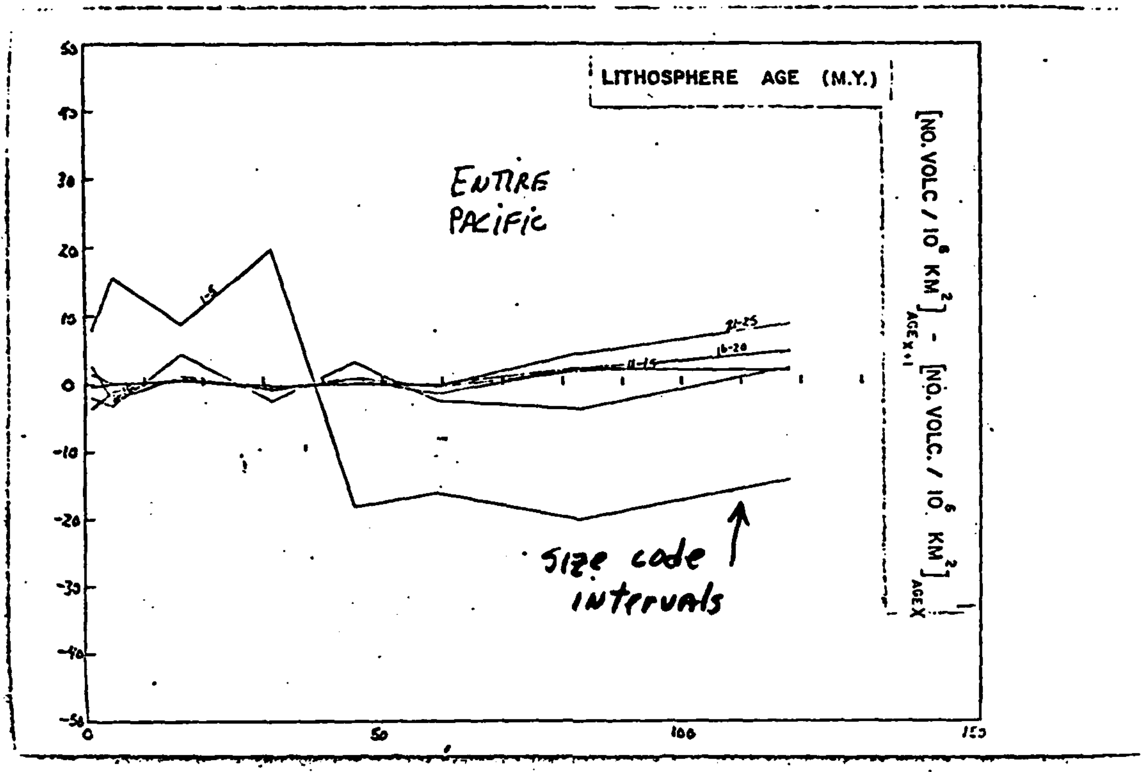
PLOTS OF DATA

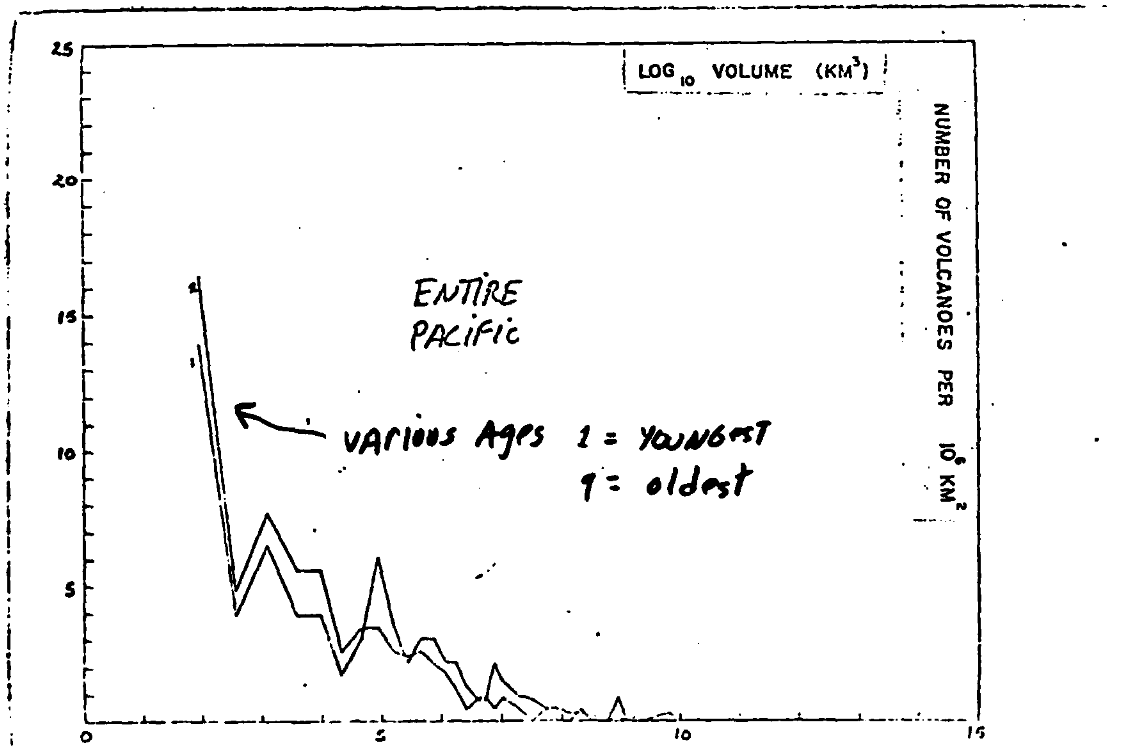
This section contains plots from all three options of the PLOT command of the PLOT program. These are arranged geographically by chart area and are each appropriately labelled. Plots resulting from use of the GROW and BURY options are not included here but can easily be produced.

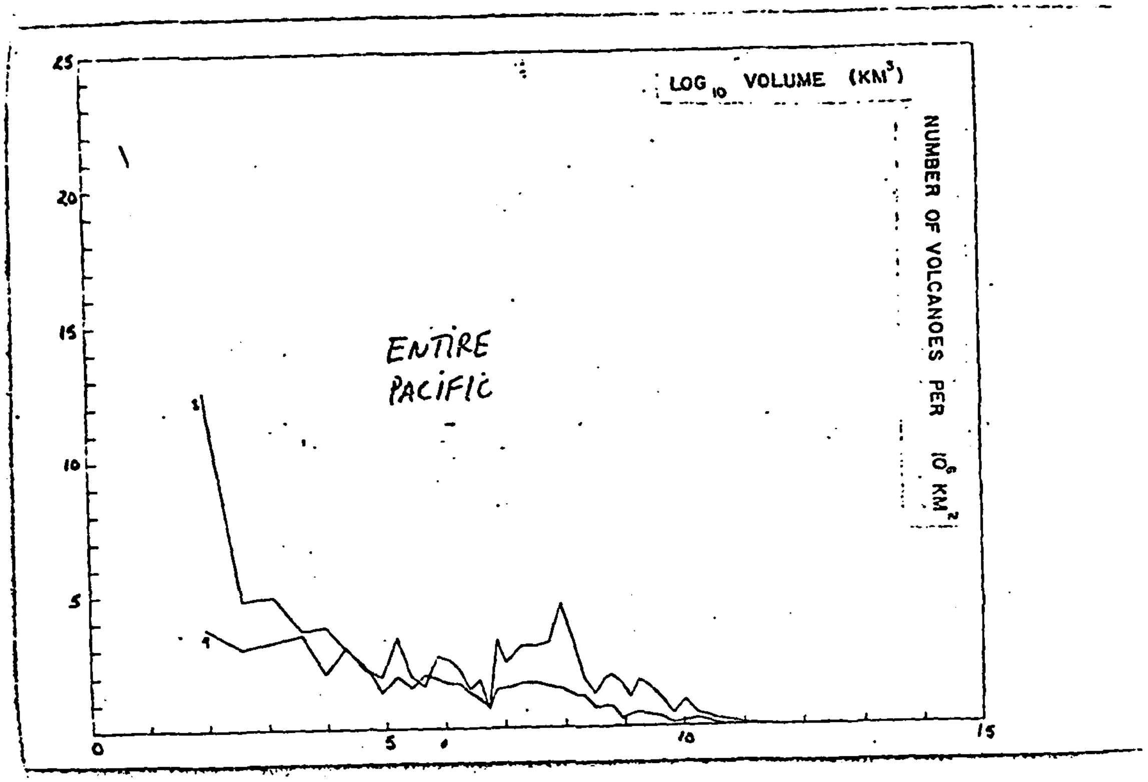

130°E
170°
140°W
110°
60°
60°
100°
42°
80°
40°
10°
0°
100°
130°
160°
170°
140°
110°
77°
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
21
a
16
17
18
19
20
21
b

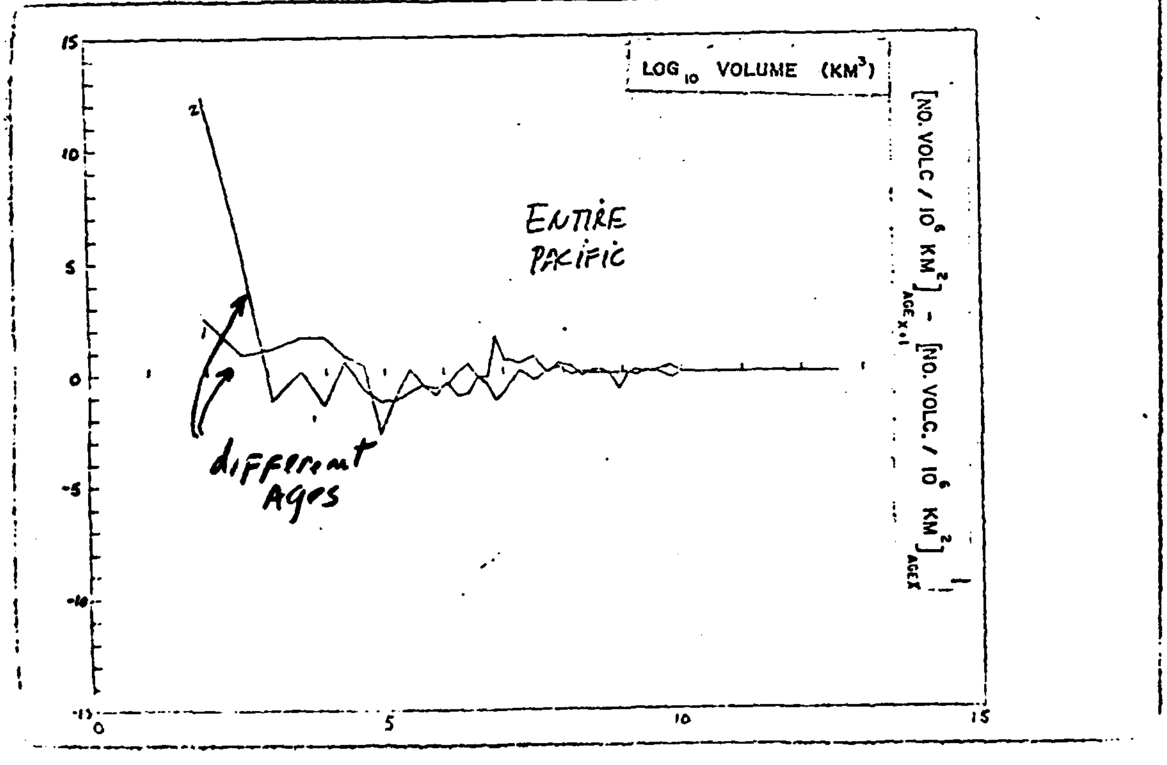

LITHOSPHERE AGE (M.Y.)
S. PACIFIC
LOG 10 VOLUME (KM³)
15
10
5
0
50
100
150
1
2
3

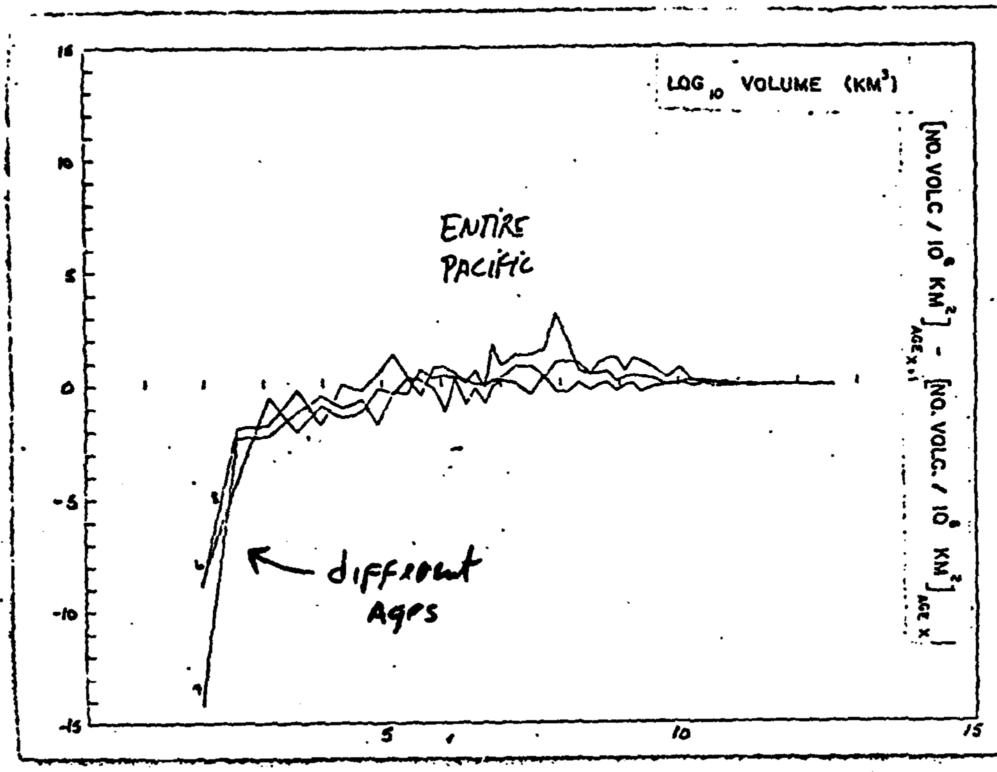

LITHOSPHERE AGE (M.Y.)
NUMBER OF VOLCANOES PER 10⁶ KM²
ENTIRE PACIFIC
VARIOUS SIZE CODE INTERVALS
150
100
50
0
50
100
150

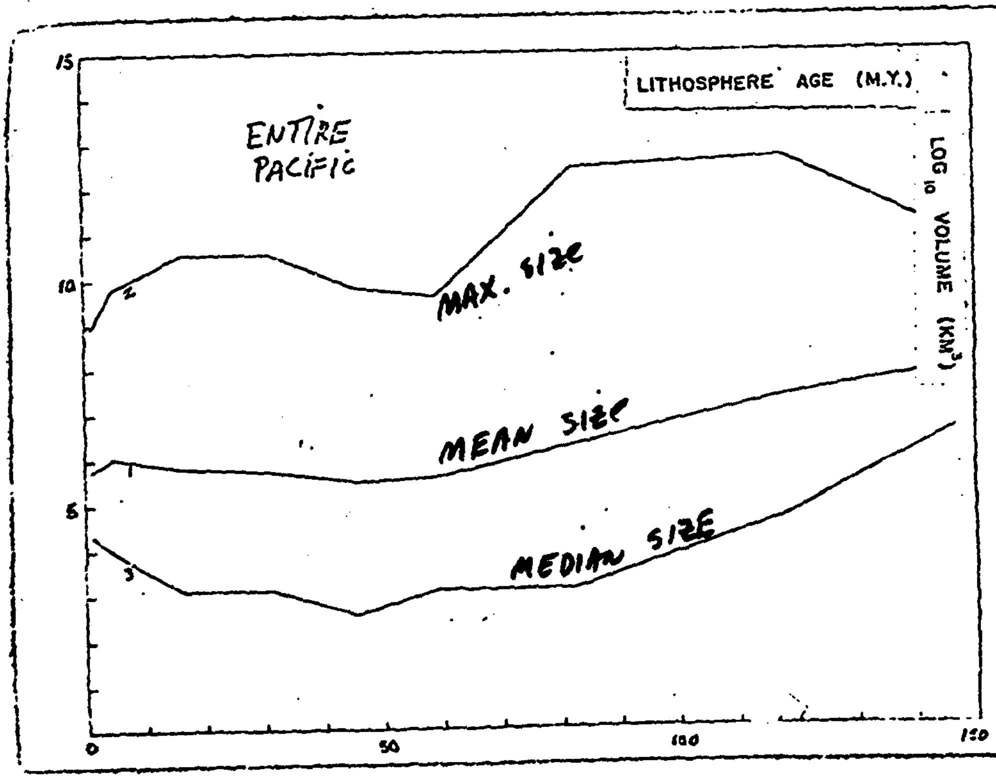

LITHOSPHERE AGE (M.Y.)
ENTIRE PACIFIC
size code intervals
[NO. VOLC / 10⁶ KM²]AGE X+1 - [NO. VOLC. / 10⁶ KM²]AGE X
1-5
21-25
16-20
11-15
50
40
30
20
10
0
-10
-20
-30
-40
-50
0
50
100
150


LOG10 VOLUME (KM³)
NUMBER OF VOLCANOES PER 10⁶ KM²
ENTIRE PACIFIC
various Ages 1 = youngest
9 = oldest
25
20
15
10
5
0
5
10
15


LOG 10 VOLUME (KM3)
NUMBER OF VOLCANOES PER 10^6 KM^2
ENTIRE PACIFIC
25
20
15
10
5
0
5
10
15


LOG 10 VOLUME (KM3)
[NO. VOLC / 10^6 KM^2] AGE X+1 - [NO. VOLC. / 10^6 KM^2] AGE X
ENTIRE PACIFIC
different Ages
15
10
5
0
-5
-10
-15
0
5
10
15


LOG10 VOLUME (KM3)
[NO. VOLC / 10^6 KM^2]AGE X+1 - [NO. VOLC. / 10^6 KM^2]AGE X
ENTIRE PACIFIC
different Ages


LITHOSPHERE AGE (M.Y.)
LOG10 VOLUME (KM3)
ENTIRE PACIFIC
MAX. SIZE
MEAN SIZE
MEDIAN SIZE

DATE
ILME