Heat Flow Data Analysis

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Abstract. Six hundred and eighty-seven heat flow data from more than 780 individual determinations and estimations were compiled. Of these, 634 data were analyzed. The range of the present heat flow per unit area is approximately 0 to 8 μcal/cm^2 sec. The world's arithmetic mean is 1.62, and the standard deviation of a datum is 1.21. The data do not seem to form any simple distribution. Since the sampling is poor and biased, a weighted mean technique is developed. On the basis of three assumptions, the world's average heat flow per unit area was found to be 1.5 $\pm$ 10 per cent at 95 per cent confidence. This is significantly higher than the value 1.2 suggested in 1954. There is no simple dependence of heat flow per unit area on latitude and longitude. A spherical harmonic analysis indicates that all the coefficients of the harmonics are at least an order of magnitude less than the mean of about 1.5. Heat flow and geological parameters, as well as difficulties in heat flow research and sources of heat, are briefly discussed. The purpose of this study is to summarize all the available data in a comprehensive list with extensive bibliographies and to set up computer programs for data analysis that can be used in the future.

INTRODUCTION

Although heat flow has long been considered one of the important geophysical problems, serious investigations began only recently. The *heat flow per unit area* is determined as the product of a temperature gradient and a thermal conductivity. Since the experimental techniques are very complicated, heat flow data are few in number and very unevenly distributed over the earth. Furthermore, the heat flow research has been reported in journals of many different fields, and no comprehensive list of data is available.

It is the purpose of this paper to summarize all the heat flow data available in a comprehensive list and to develop some numerical techniques to analyze them. It is hoped that the present study will give some idea as to what our present knowledge of heat flow is, and the computer programs written for the analysis may be applicable in the future.

All computation and plotting (except a few cases) were programmed on a CDC 1604 computer in the Fortran language. Throughout this paper, the unit of measure of heat flow per unit area is understood to be μcal/cm^2 sec and will be omitted.

HEAT FLOW DATA

More than 780 heat flow *values* have been calculated in the past. After averaging those of very nearby locations, 687 heat flow *data* were obtained and are listed in the appendix. A heat flow *value* means one heat flow measurement or estimate while a heat flow *datum* represents one heat flow value or the average of more than one heat flow value from nearby stations. Oceanic depths are corrected values. The list of heat flow data is the revised version of the one used for the analysis.

References to heat flow work before 1939 are *British Association Reports*, 1868, p. 510; 1869, p. 176; 1878, p. 133; 1881, p. 126; 1938, p. 271.

Since the modern techniques of heat flow measurements were not available until about 1939, the list in the appendix does not include any heat flow values given before that date. Furthermore, 49 data have been rejected from the analysis for at least one of the following reasons:

1. The original investigators consider their values not reliable.
2. Thermal gradient and/or thermal conductivity measurements are questionable.
3. Station location in latitude and longitude was not given by the original investigators, and we do not have enough information to locate the heat flow station.

These criteria reject unreliable data as well as a few that are reliable. Since the reliable data rejected are very few in number, their exclusion will not change the present analysis significantly.

Among the 634 heat flow data analyzed, about 31 per cent have been published, 44 per cent are in press, and 25 per cent are as yet unpublished. There are many more oceanic heat flow data than continental ones, 89 versus 11 per cent. Since the oceans occupy some 71 per cent of the earth's surface, we have about 3 times more data per unit area at sea than on land (see Table 1).

Figures 1*a* and 1*b* give the number of analyzed heat flow data in a 5° by 5° grid of a world map. The geographical distribution of heat flow data is very uneven. Moreover, there are more heat flow measurements per unit area on the oceanic ridges than on any other geological regions.

Many authors have discussed the errors of heat flow measurements. Generally speaking, the error in the analyzed heat flow data is about ±10 per cent. The position of heat flow station at sea is accurate to a few kilometres. On land, if the investigators have omitted the position in latitude and longitude, the station location has been taken from the *Times Atlas of the World* or other source and may be good to within ±0.5°. It is also noted that more than 90 per cent of the analyzed data are obtained by the Scripps (75 per cent), Cambridge (10 per cent), and Tokyo (5 per cent) heat flow groups.

TABLE 1

Division	No. of Values	No. of Data	No. of Data Rejected	No. of Data Analyzed
Continental	>193	110	37	73
Oceanic	>587	573	12	561
Total (world)	>780	683	49	634

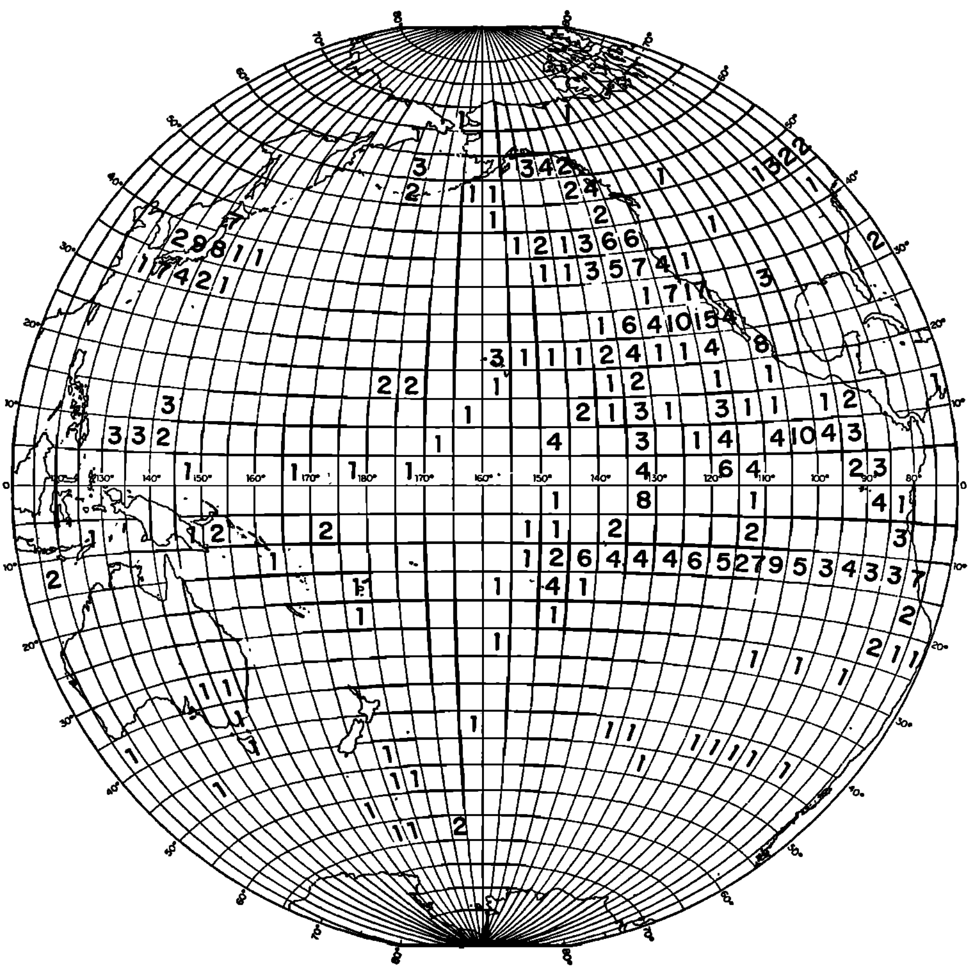

Fig. 1a. Number of heat flow data in 5° by 5° grid.

FORMULATION OF THE DATA ANALYSIS

At any location on the surface of the earth, the amount of heat flow per unit area from the earth's interior is a definite physical quantity. The rate Q of heat flowing from the earth's interior is obtained by integrating the heat flow per unit area over the entire surface of the earth, or by simply taking the *world's average H of heat flow per unit area* times the surface area of the earth. Since H is so important in many geophysical calculations, we will develop several methods of estimating its value and confidence limits.

Since the heat flow per unit area is a function of many variables, it will also be interesting to find out what these variables are and how they are related to the heat flow per unit area. Unfortunately, we are at present very ignorant about these variables, and hence a quantitative analysis is not possible. Since the latitude and longitude of a heat flow station are well defined, their relationships to the heat flow per unit area will be investigated.

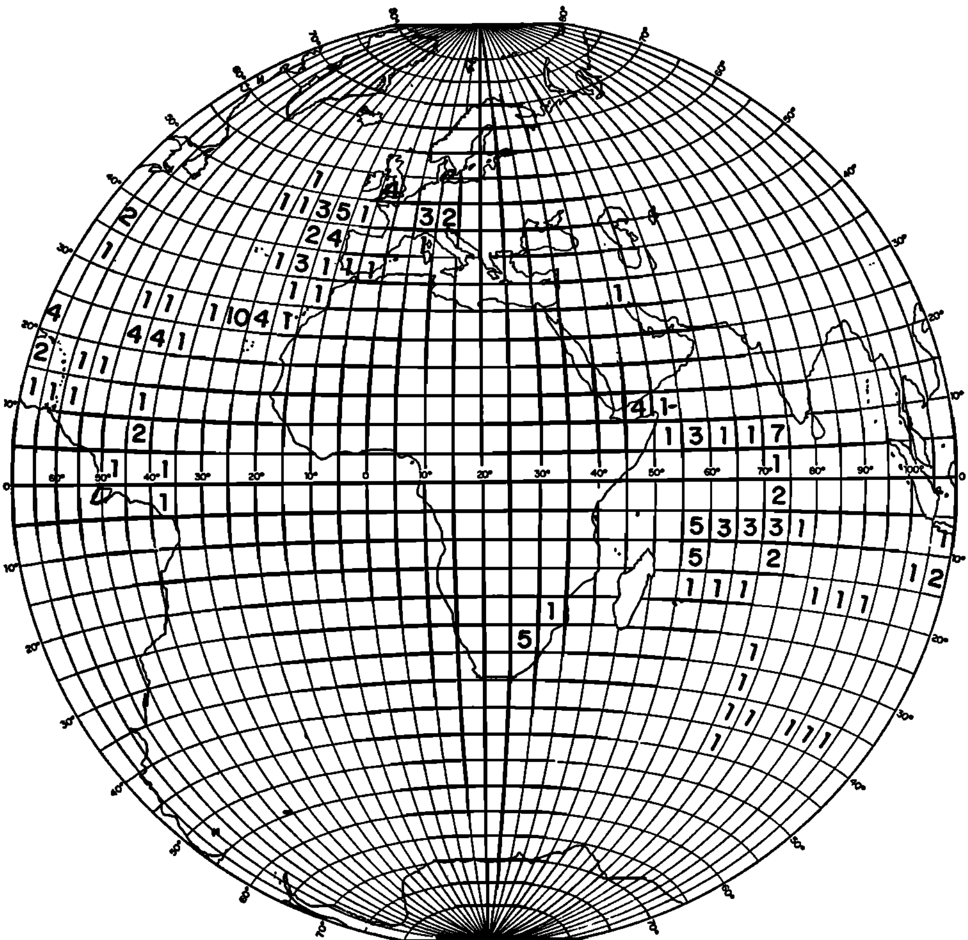

Fig. 1*b*. Number of heat flow data in 5° by 5° grid.

ESTIMATION OF THE WORLD'S AVERAGE OF HEAT FLOW PER UNIT AREA

Arithmetic mean. The arithmetic mean of a sample of N heat flow data h_i is defined by

$$\hat{H} = \sum_{i=1}^{N} h_i/N \tag{1}$$

and the standard deviation of a datum by

$$\hat{\sigma} = \sqrt{\sum_{i=1}^{N} (h_i - \hat{H})^2/(N - 1)} \tag{2}$$

If the values h_i form a normal distribution, then at 95 per cent confidence the population mean is

$$H = \hat{H} \pm 2\hat{\sigma}/\sqrt{N} \tag{3}$$

Let us consider the heat flow measurement at any given location on earth as a sample from a population of mean H (the world's average of heat flow per unit area) and standard deviation σ. If the sampling is random with respect to area, the sample mean is the best estimate of the population mean. Unfortunately the sampling of the world's heat flow data is far from being random with respect to area, as we have shown. Hence the world's average of heat flow per unit area can not be best estimated from the sample mean. Furthermore, the histogram of the world's heat flow data does not show any simple distribution, and hence nonparametric statistics must be used. For example, the Chebyshev inequality must be used, with the standard deviation, to show the dispersion of the data about the sample mean, and (3) is not applicable.

We can generalize the above discussion to various regions of interest instead of the whole world. Table 2 lists the heat flow sample mean and standard deviation for various regions computed by (1) and (2). The corresponding histograms are given in Figures 2*a* to 2*f*, and their characteristics are also summarized in Table 2. Since the sampling is poor and biased, it is rather doubtful that these results will have much significance.

Weighted mean. The weighted mean according to area for M heat flow data $h(\theta_i, \varphi_i)$ in a given grid is defined by

$$\hat{H}_w(\text{center of the grid}) = \sum_{i=1}^{M} (\sin \theta_i) h(\theta_i, \varphi_i) \Big/ \sum_{i=1}^{M} \sin \theta_i \tag{4}$$

and the weighted standard deviation of a datum by

$$\hat{\sigma}_w = \sqrt{\sum_{i=1}^{M} (\sin \theta_i)[h(\theta_i, \varphi_i) - \hat{H}_w]^2 \Big/ \sum_{i=1}^{M} \sin \theta_i} \tag{5}$$

where θ is the colatitude and φ the east longitude. The weighted mean so defined

TABLE 2. Heat Flow Sample Mean, Standard Deviation, and Characteristics of Histogram

Sample Region	N	$\hat{H}$	$\hat{\sigma}$	Min.	Max.	Mode	Data at Mode ± 0.05, %
World	634	1.62	1.21	−.01	8.09	1.1	9
Continents	73	1.43	0.57	.52	3.49	1.1	12
Oceans	561	1.65	1.27	−.01	8.09	1.1	8
Atlantic Ocean	78	1.36	0.98	.3	6.5	1.1	18
Indian Ocean	66	1.59	1.00	.00	5.98	1.7	12
Pacific Ocean	417	1.71	1.35	−.01	8.09	1.1	7
Australia	4	2.09	0.13				
Austria	2	1.85	0.06				
Canada (with Alaska)	11	1.07	0.38				
Great Britain	4	1.35	0.63				
Iran	1	0.87					
Japan	35	1.54	0.63				
South Africa	6	1.13	0.21				
Switzerland	3	1.90	0.29				
U. S. A. (without Alaska)	7	1.13	0.31				

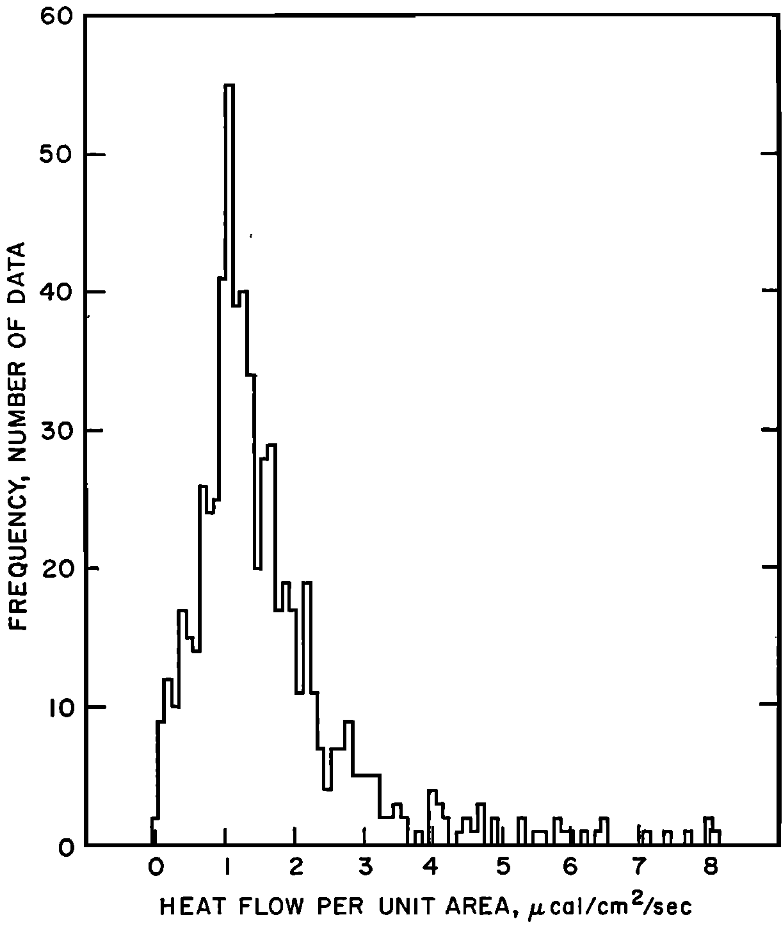

Fig. 2*a*. Histogram of world's 634 heat flow data.

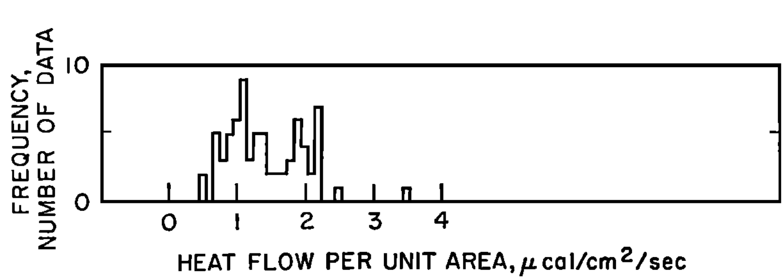

Fig. 2*b*. Histogram of 73 continental heat flow data.

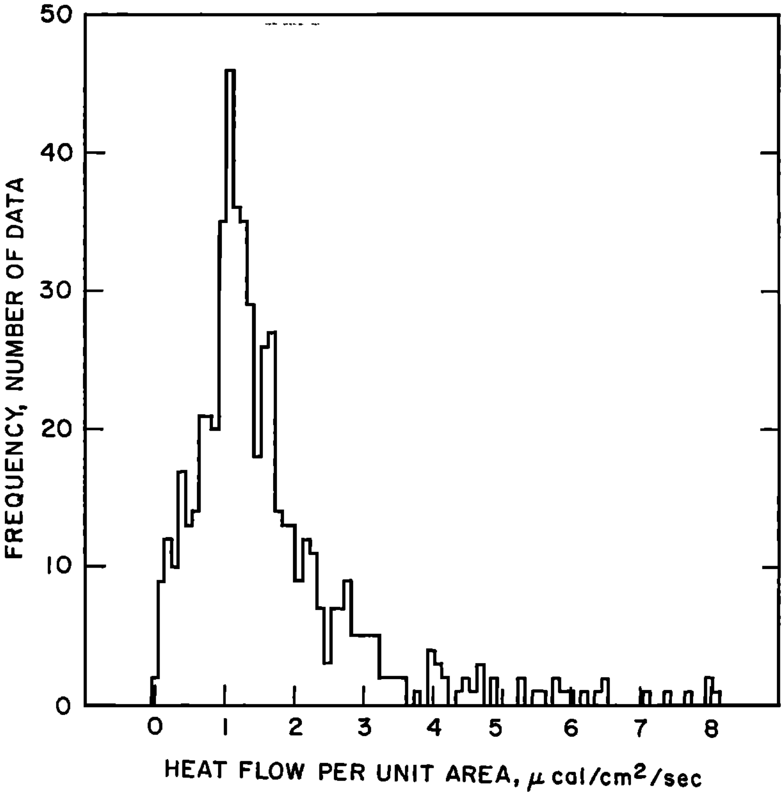

Fig. 2*c*. Histogram of 561 oceanic heat flow data.

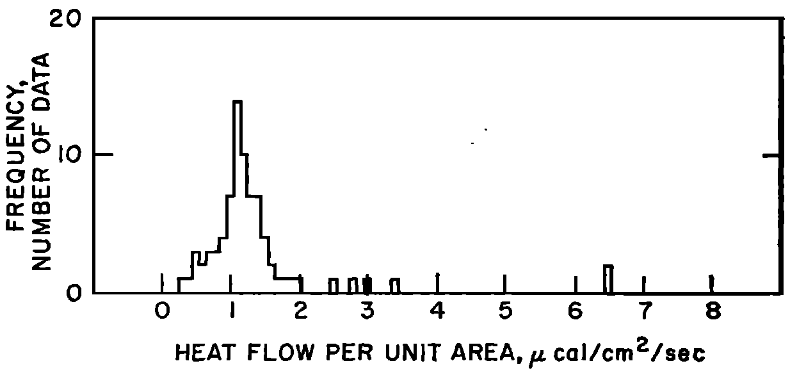

Fig. 2*d*. Histogram of 78 Atlantic heat flow data.

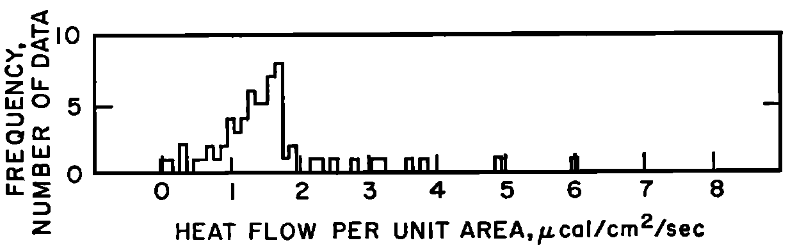

Fig. 2e. Histogram of 66 Indian Ocean heat flow data.

is obviously weighted against the area, for the surface area of a sphere of a given grid is proportional to the cosine of the latitude.

We can use (4) repeatedly to obtain weighted means for successive grid sizes, and from each weighted mean we can compute the arithmetic mean by (1). This kind of successive averaging gives equal consideration to the mean of each grid, regardless of how many data are in the grid. Thus regions where the data are dense are not over-weighted. We may not consider it proper to give a grid of 1 datum, say, as much importance as a grid of 10 data. In practice, however, successive averaging is often preferred, for it tends to smooth the data and to reduce the bias in sampling.

Successive weighted averaging was carried out by means of (4) for grids of 0.5°, 1.6°, 5°, 15°, and 45° (i.e. combining 9 preceding grids each time). Grids without data were neglected in the computation. The arithmetic means and standard deviations for each of these sets are given in Table 3. Smoothing of data is indicated by the decrease of the standard deviation. The sampling bias toward too high a value is reduced by the decrease of the mean.

Since the intermediate grid size is arbitrary, there will be infinite ways to obtain the 5° weighted means. The size of a 5° grid at the equator is about 500

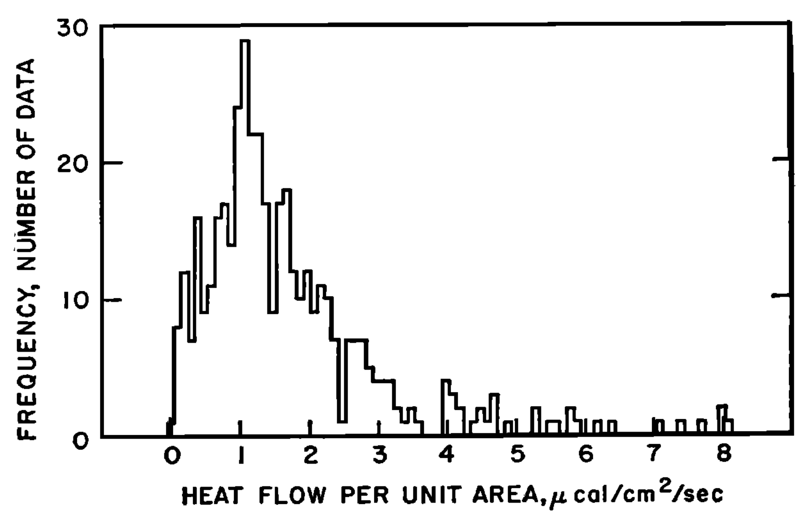

Fig. 2f. Histogram of 417 Pacific heat flow data.

TABLE 3

Grid Size	World			Continents			Oceans		
	N	$\hat{h}$	$\hat{\sigma}$	N	$\hat{h}$	$\hat{\sigma}$	N	$\hat{h}$	$\hat{\sigma}$
0.5°	579	1.59	1.15	68	1.44	0.58	513	1.62	1.20
1.6°	451	1.50	1.01	53	1.46	0.58	408	1.50	1.06
5°	252	1.47	0.82	29	1.49	0.50	226	1.47	0.85
15°	95	1.47	0.65	17	1.35	0.44	82	1.49	0.68
45°	26	1.45	0.37	12	1.41	0.43	22	1.49	0.36

by 500 km. It is thought that this is a convenient size, because neither regions of many data nor regions of very few data are over-weighted. Table 4 gives the results obtained through coarse, medium, and fine grids. There appears to be no difference between the means of these three sets of 5° weighted means.

A final weighted mean was also obtained by successive averaging. The results are listed in Table 5. These means are lower than their corresponding straight means, indicating that sampling bias toward too high a value is reduced. The world's final weighted mean is essentially the same for different intermediate grid sizes; its value is about 1.5.

Since the histograms do not indicate any simple distribution, (3) is again not applicable. Although $\hat{\sigma}_w$'s are computed, they should be interpreted with the Chebyshev inequality. The weighted mean is a better estimate of the world's average of heat flow per unit area than the arithmetic mean, but its confidence limits are difficult to estimate.

Spherical harmonic analysis. Since the heat flow data have a large local variation, higher harmonics (of the order of tens or hundreds) are significant. Clearly a spherical harmonic analysis can not be carried out at present to higher-order harmonics for the heat flow data because of the small number of data and uneven distribution. Spherical harmonic expansion of heat flow is justified because it is the most convenient expansion over the surface of a sphere, and, for the steady state, the equation of heat flow becomes the Laplace equation of which the spherical harmonics are its solution in spherical polar coordinates.

Heat flow data can be fitted by a least-squares method to a spherical harmonic expansion to order $N_{\max}$:

$$h(\theta_k, \varphi_k) = \sum_{n=0}^{N_{\max}} \sum_{m=0}^{n} [A_n^m P_n^m(\cos \theta_k) \cos (m\varphi_k) + B_n^m P_n^m(\cos \theta_k) \sin (m\varphi_k)] \quad (6)$$

TABLE 4. Sample Mean and Standard Deviation for 3 Sets of 5° Weighted Means

Method of Obtaining 5° Weighted Means	N	$\hat{h}$	$\hat{\sigma}$
data → 5°	252	1.48	0.82
data → 1° → 5°	252	1.48	0.82
data → 0.5° → 1.6° → 5°	252	1.47	0.82

TABLE 5. Final Weighted Mean and Final Weighted Standard Deviation

Method of Successive Averaging	World		Continents		Oceans	
	$\hat{H}_w$	$\hat{\sigma}_w$	$\hat{H}_w$	$\hat{\sigma}_w$	$\hat{H}_w$	$\hat{\sigma}_w$
data → 0.5° → 1.6° → 5° → 15° → 45° → 90° → 360°	1.50	0.22	1.42	0.35	1.55	0.28
data → 0.5° → 1.6° → 5° → 45° → 360°	1.51	0.36				
data → 30° → 360°	1.52	0.53				

for $k = 1, 2, \cdots, N$, where $P_n^m(\cos\theta_k)$ are the associated Legendre functions of colatitude θ_k, and φ_k is the east longitude. The coefficients A_n^m and B_n^m are determined by solving the normal equations:

$$\begin{cases} \sum_{k=1}^{N}\left\{\sum_{n=0}^{N_{\max}}\sum_{m=0}^{n}[A_n^m\cos(m\varphi_k)+B_n^m\sin(m\varphi_k)]P_n^m(\cos\theta_k)\right\}\cos(i\varphi_k)P_j^i(\cos\theta_k) \\ \qquad = \sum_{k=1}^{N}h(\theta_k,\varphi_k)P_j^i(\cos\theta_k)\cos(i\varphi_k) \\ \sum_{k=1}^{N}\left\{\sum_{n=0}^{N_{\max}}\sum_{m=0}^{n}[A_n^m\cos(m\varphi_k)+B_n^m\sin(m\varphi_k)]P_n^m(\cos\theta_k)\right\}\sin(i\varphi_k)P_j^i(\cos\theta_k) \\ \qquad = \sum_{k=1}^{N}h(\theta_k,\varphi_k)P_j^i(\cos\theta_k)\sin(i\varphi_k) \end{cases} \tag{7}$$

for $i = 0, 1, 2, \cdots, j$; $j = 0, 1, 2, \cdots, N_{\max}$.

Let us assume that the weighted means of 45° grid ($\hat{H}_{45}$) have averaged out local variations of short wavelength; $\hat{H}_{45}$ can be expanded in spherical harmonics to certain order $N_{\max}$; and the differences Δi between $\hat{H}_{45}$'s and the computed values are independent of one another and form a normal distribution. Then at $(1 - P)$ per cent confidence,

$$H = A_0^0 \pm \epsilon \qquad \epsilon \equiv t(P,\nu)\cdot\sqrt{\sum_{i=1}^{N}(\Delta_i)^2/N\nu} \tag{8}$$

where A_0^0 is the first coefficient determined by (8), and P is the probability of having $t \geq t(P, \nu)$ by chance for the degrees of freedom $\nu = N - (N_{\max} + 1)^2$.

The coefficients of A_n^m and B_n^m were obtained for (1) available weighted means of 45° grid, $\hat{H}_{45}$, only; (2) available $\hat{H}_{45}$ with the missing $\hat{H}_{45}$'s filled by 1.5 to obtain a first set of coefficients; the predicted values of missing $\hat{H}_{45}$'s were then used to redetermine the coefficients; and (3) same as (2), but certain available $\hat{H}_{45}$'s were rejected because of poor sampling. The results are listed in Table 6 for the first two expansions with standard errors ϵ computed by (8) for 95 and 99 per cent confidence.

Using the values in Table 6 we find that the world's average of heat flow per unit area is essentially

$$H = 1.5 \pm 0.15 \quad \text{at } 95\% \text{ confidence} \tag{9}$$

TABLE 6. Coefficients of Spherical Harmonic Expansions of 45° Grid Weighted Heat Flow Means to 1st and 2nd Orders

Coefficients	To 1st Order			To 2nd Order		
	(1)	(2)	(3)	(1)	(2)	(3)
A_0^0	1.47620	1.46000	1.50625	1.48455	1.49889	1.49712
A_1^0	0.26500	0.14078	0.06360	0.28768	0.14078	0.06360
A_1^1	0.02997	0.12593	−0.00912	0.02811	0.12593	−0.00912
A_2^0				−0.07976	−0.15556	0.03653
A_2^1				0.11951	0.04838	−0.01514
A_2^2				−0.00126	0.00251	−0.03360
B_1^1	0.03413	0.14023	0.04834	0.04371	0.14023	0.04834
B_2^1				0.05525	0.06228	0.04451
B_2^2				0.02306	0.03742	0.02327
$\text{Sum} = \sum_{i=1}^{N} (\Delta_i)^2$	1.72	2.81	0.95	1.43	2.40	0.81
N	23	32	32	23	32	32
$\sigma = \sqrt{\text{Sum}/(N-1)}$	0.27	0.30	0.17	0.25	0.27	0.13
ν	19	28	28	14	23	23
ϵ (95% confidence)	0.14	0.12	0.07	0.14	0.12	0.07
ϵ (99% confidence)	0.19	0.16	0.09	0.20	0.16	0.09

Then using (9) and 5.101×10^{18} cm^2 as the surface area of the earth, at 95 per cent confidence

$$Q = (3.2 \pm 0.32) \times 10^{20} \text{ ergs/sec} \tag{10}$$

The world's average of heat flow per unit area of 1.5 is significantly higher than the previous value of 1.2 suggested by *Bullard* [1954*b*] on the basis of data available at that time (about 5 per cent of our present data). However, our present error estimate is based on the three assumptions mentioned before. The second assumption is justified because the 45° grid is so large that we can expand the spherical harmonics to very low order. The third assumption is rather reasonable because the Δ_i's do distribute roughly normal. The first assumption is, however, rather debatable.

RELATIONSHIP BETWEEN HEAT FLOW PER UNIT AREA AND LATITUDE AND LONGITUDE

Frequency and heat flow arithmetic means of data in 10° latitude intervals are plotted against colatitude in Figure 3*a*, and those in 10° longitude intervals are plotted against east longitude in Figure 3*b*. Similar plots for 5° weighted means are given in Figures 4*a* and 4*b*. Since the standard deviations are large (about 1) and sampling is poor, as is seen in the histograms, it is rather premature to conclude that there is any relationship between heat flow per unit area and latitude and longitude. (The plots indicate that the values scatter about 1.5.)

Spherical harmonic analysis is probably the best method for determining the relationship between heat flow per unit area and latitude and longitude.

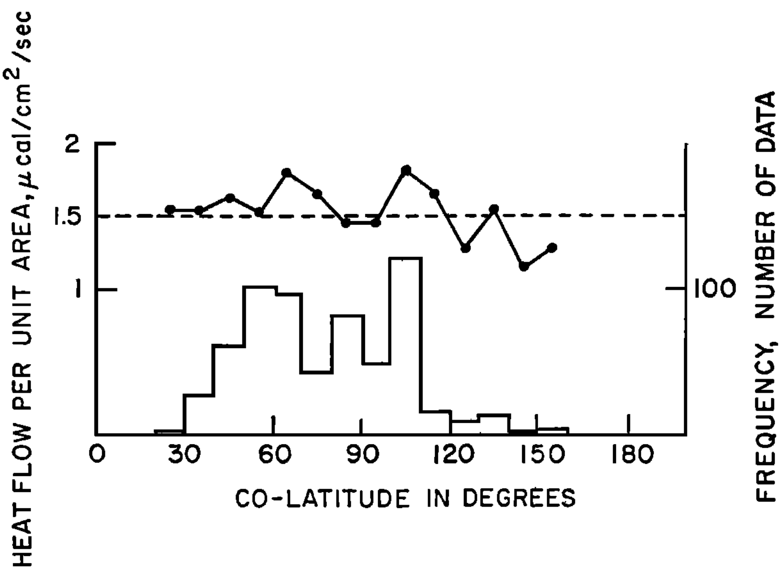

Fig. 3*a*. Histogram and arithmetic mean of heat flow data versus colatitude.

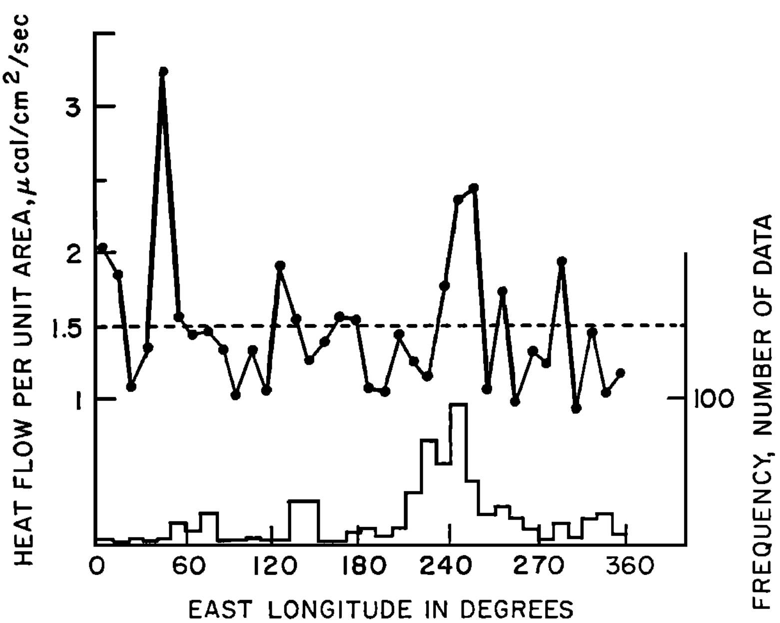

Fig. 3*b*. Histogram and arithmetic mean of heat flow data versus east longitude.

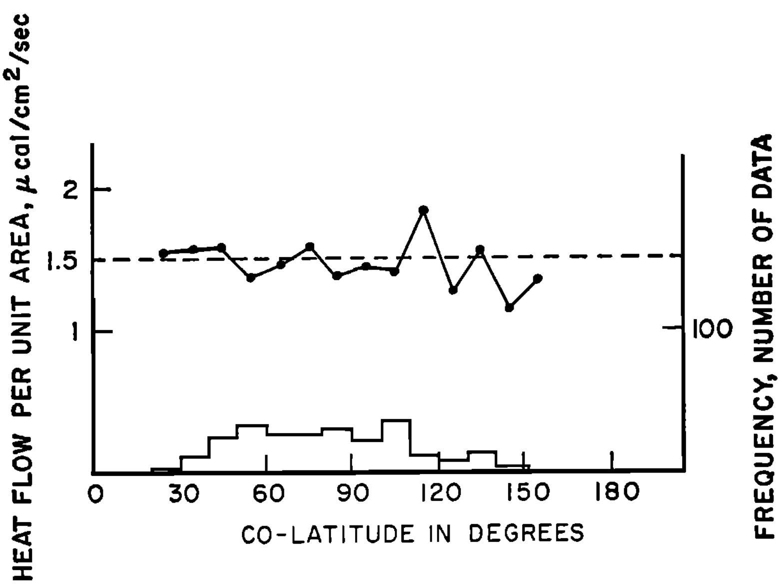

Fig. 4*a*. Histogram and arithmetic mean of 5° weighted heat flow means versus colatitude.

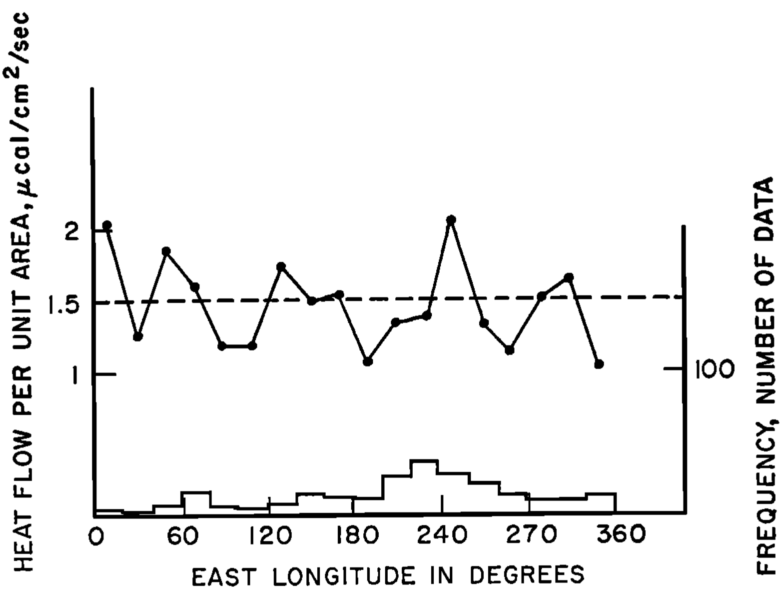

Fig. 4*b*. Histogram and arithmetic mean of 5° weighted heat flow means versus east longitude.

Unfortunately, we do not at present have enough data to determine satisfactorily the coefficients other than A_0. Several expansions up to order 5 were carried out, and it was found that all coefficients of harmonics are at least an order of magnitude less than A^0.

DISCUSSION

Heat flow and geological parameters. So far we have merely analyzed rudimentarily the heat flow data from a more or less mathematical point of view. Correlations with geological parameters have been attempted but without success because of the present ignorance of these variables.

Since more than 65 per cent of the analyzed data are from the Pacific, these data are classified into four topographical regions: basins, ridges, old ridges, and trenches. Because much of the geological data are unknown and uncertain, there are no clear-cut divisions. The final weighted mean of heat flow per unit area from the ridges is higher than 1.5, and that from the other three regions is slightly less. The data from the ridges show a wide range of values, whereas those from other regions do not. Heat flow profiles have been made across the east Pacific rise and the mid-Atlantic ridge by *Von Herzen and Uyeda* [1963] and *Nason and Lee* [1962], respectively. The patterns for the two studies are similar and are thought to be related to convection currents according to *Menard* [1961, 1963] and *Von Herzen and Uyeda* [1963]. An alternative explanation by heat flow refraction has been given by *McBirney* [1962, 1963].

The range of the continental heat flow per unit area will extend to higher values if we have reliable data from the geothermal areas. Heat flow values are slightly lower in continents than at sea, but the numerical difference may not be significant. The analyzed continental heat flow data are uncorrected values, and the corrections will in general increase the values. Unfortunately the corrections are hard to estimate, and their reliability is debatable. However, a few authors have provided such estimates. (See the appendix, which also lists corrected heat flow per unit area if it is available.) The continental data fall roughly into two groups: those from the shield areas have a mean heat flow per unit area of about 1.1, and those from the young mountain belts about 2.

Difficulties in heat flow research. The present experimental techniques are tedious (e.g., *Misener and Beck* [1960] and *Bullard* [1963*b*]). Heat flow per unit area is measured not much deeper than 2000 meters on land and less than 15 meters at sea. It is extremely desirable to have measurement over a greater depth. It has been pointed out by *Von Herzen and Uyeda* [1963] that some isolated low heat flow values may not be representative. Furthermore hardly any of the data have thermal conductivity measured in situ. This may not be serious at sea because the thermal conductivity of deep-sea sediments does not vary more than ±25 per cent [*Von Herzen and Uyeda,* 1963].

In addition to instrumental errors, there are errors due to sources such as glaciation effect, ground water circulation, etc. These errors are hard to estimate, and measurement over a greater depth will probably reduce them. Another basic difficulty is that we do not know how large an area is represented by a heat flow measurement. For example, the heat flow per unit area differs by a factor of 20 over a distance of about 120 km in the mid-Atlantic ridge. Because of cost, heat flow measurements are made wherever it is convenient. There are very few systematic investigations over an area, but fortunately more are planned in the future.

The difficulty of heat flow data analysis at present is the small number of data and the uneven geographical distribution. Furthermore, geological parameters are vague and quantitatively difficult to evaluate.

Sources of heat. Many authors (e.g., *Birch* [1954*c*], *Bullard* [1954*b*], and *Gutenberg* [1959]) have explained the sources of heat mainly by radioactivity. It can be shown that the total heat flow over the entire surface of the earth can be completely accounted for if we assume that the earth has the same potassium, thorium, and uranium content as chondritic meteorites and that the heat arrives at the surface instantaneously. Heat flow due to other sources such as tidal dissipation, energy transmitted by earthquake waves and volcanic eruption, etc., is estimated to be at least an order of magnitude less than the observed value.

Since the thermal conductivity of solid rock is rather low, it can be shown that heat generated below a few hundred kilometers has not been conducted to the surface in geological time. To explain the observed heat flow by radioactive decay will require either that the radioactive elements are concentrated in the outer few hundred kilometers or that there be some other mechanism to transfer heat more quickly than the assumed conduction. Currently *MacDonald* [1963*b*] is developing a theory of the thermal history of the earth, and his results may provide some explanation of our presently observed data.

MacDonald [1963*a*] has also developed some techniques for the representation of heat flow data from stations irregularly distributed on the earth. A joint investigation on this aspect is under way by MacDonald and me, and the result will be reported later.

APPENDIX: A LIST OF HEAT FLOW DATA

The following notations are used:

The symbol in the first column on the extreme left indicates whether this particular datum has been published (blank), is in press (asterisk), is unpublished (plus sign), or is rejected from analysis (times sign).

The code is the number we assigned to a heat flow datum to identify it in the analysis.

Latitude and longitude values given in parentheses have not been confirmed by the original authors and were obtained from *Times Atlas of the World* or another source.

No. indicates the number of values of very nearby stations that have been averaged to get the mean listed in the next column under heat flow per unit area.

The unit of measure of heat flow per unit area and corrected heat flow per unit area is μcal/cm^2 sec. For the oceanic data under 'Heat Flow per Unit Area,' parentheses indicate that the value of the thermal conductivity is taken from a nearby station, and an asterisk indicates that there is a range of thermal gradient.

The numbers in the last column refer to the numbers given in the reference section of this paper.

Data 684 to 687 were too late to be included in the analysis, and data from *Beck* [1962] and *Mullins and Hinsley* [1957] were too late to be listed.

I will appreciate any corrections and comments. Readers are encouraged to send new data (or old ones that have been omitted in the list) to me so that an up-to-date list of heat flow data is available.

CONTINENTAL HEAT FLOW DATA

Code	Station	Latitude	Longitude	No.	Heat Flow per Unit Area	Corrected Heat Flow per Area	References
	South Africa						
001	Dubbeldevlei	30°30′S	21°30′E	1	1.52		23, 28, 48
002	Kestell	(28 19 S	28 43 E)	1	1.29		34
×003	Doornkloof	26 18 S	27 30 E	1	1.20		23, 28, 48
004	Gerhardminnebron	26 30 S	27 12 E	1	1.28		23, 28, 48
005	Jacoba-Doornhou.	27 18 S	26 24 E	2	0.96		23, 28, 48
006	Klerksdorp HB15	(26 48 S	26 54 E)	1	1.05		34, 48
007	Messina	(22 18 S	30 06 E)	1	1.37		34, 48
×008	Reef-Nigel	26 18 S	28 18 E	1	1.03		23, 28, 48
009	Roodepoort	(26 54 S	26 36 E)	1	0.86		34, 48
*684	Sambokkraal	32 42 S	21 18 E	1	1.39	1.44	48
*685	Koegelfontein	33 00 S	21 18 E	1	1.45	1.57	48
*686	Bothadale	32 48 S	22 36 E	1	1.28	1.34	48
*687	Kalkkop	32 42 S	24 24 E	1	1.21	1.31	48
	Iran						
010	Masjed Soleymān	(31 59 N	49 18 E)	18	0.87		41
	Japan						
*011	Haboro	44 21 N	141 52 E	1	1.87		100, 105
*012	Shimokawa	44 14 N	142 41 E	1	1.71		100, 105
*013	Konomai	44 08 N	143 21 E	1	2.54		100, 105
*014	Akabira	43 32 N	142 02 E	1	1.07		100, 105
*015	Asibetsu	43 33 N	142 12 E	1	1.35		100, 105
×016	Toyoha	42 54 N	141 05 E	1	>5		100, 105
*017	Hitachi	36 38 N	140 38 E	2	0.75		100, 105
*018	Katsuta	36 24 N	140 30 E	1	0.91		100, 105
*019	Kashima	35 57 N	140 41 E	1	0.76		100, 105
*020	Mobara	35 24 N	140 20 E	1	0.54		100, 105
*021	Tokyo	35 42 N	139 46 E	1	0.74		100, 105
*022	Ashio	36 39 N	139 27 E	1	2.23		100, 105
×023	Kusatsu-Shirane	36 37 N	138 34 E	1	10.8		100, 105
*024	Chichibu	36 01 N	138 48 E	1	1.34		100, 105
*025	Sasago	35 37 N	138 48 E	1	2.06		100, 105
*026	Kamioka	36 22 N	137 18 E	1	1.80		100, 105
*027	Nakatatsu	35 53 N	136 35 E	1	1.95		100, 105
*028	Kune	35 05 N	137 50 E	1	1.60		100, 105
*029	Nako	35 03 N	137 52 E	1	1.44		100, 105
*030	Minenosawa	35 00 N	137 51 E	1	1.79		100, 105
*031	Ikuno	35 10 N	134 50 E	1	1.38		100, 105

CONTINENTAL HEAT FLOW DATA (Continued)

Code	Station	Latitude	Longitude	No.	Heat Flow per Unit Area	Corrected Heat Flow per Area	References
*032	Nakaze	35°21′N	134°57′E	1	2.21		100, 105
*033	Yanahara	34 57 N	134 04 E	1	1.20		100, 105
*034	Isotake	35 11 N	132 26 E	1	3.49		100, 105
*035	Tsumo	34 37 N	132 00 E	1	1.09		100, 105
*036	Kawayama	34 15 N	132 59 E	1	1.00		100, 105
*037	Naka	34 15 N	135 25 E	1	1.79		100, 105
*038	Hidaka	33 57 N	135 05 E	1	2.12		100, 105
*039	Kiwa	33 50 N	135 53 E	1	1.31		100, 105
*040	Beshi	34 01 N	133 09 E	1	1.22		100, 105
*041	Izuhara	34 13 N	129 14 E	1	2.18		100, 105
*042	Takamatsu	33 00 N	130 43 E	1	1.92		100, 105
*043	Taio	33 07 N	130 52 E	1	1.05		100, 105
*044	Makimine	32 38 N	131 27 E	1	1.79		100, 105
×045	Kushikino	31 44 N	130 16 E	1	0.71		100, 105
*046	Yabase	39 44 N	140 06 E	1	2.01		100, 105
*047	Innai	39 16 N	139 58 E	1	1.49		100, 105
*048	Osarizawa	40 11 N	140 45 E	1	2.24		100, 105
*049	Noda-Tamagawa	40 04 N	141 50 E	1	1.14		100, 105
*050	Kamaishi	39 16 N	141 42 E	1	0.52		100, 105
	Australia						
051	Snowy Mts.	(36 30 S	148 30 E)	10	2.2	2.1	3, 5
*052	Broken Hill	31 57 S	141 28 E	18	1.93		91, 62, 54
053	Cobar, N. S. W.	(31 32 S	145 51 E)	2	2.18		63, 54
054	No. 1, Gt. Lake	(41 58 S	146 11 E)	1	2.04	2.46	86, 5
×055	No. 2, Dee T. L.	(41 58 S	146 11 E)	1	2.06		86
×056	No. 3, Dee T. L.	(41 58 S	146 11 E)	1	2.07		86
×057	No. 4, Rosebery	(41 46 S	145 34 E)	1	2.47		86
×058	No. 5, Rosebery	(41 46 S	145 34 E)	1	2.54		86
	Austria						
059	Arlberg	(46 55 N	10 10 E)	1	1.9		37
060	Tauern	(46 50 N	13 05 E)	1	1.8		37
	East Germany						
×061	Erzgebirge				1.9		93
×062	Other parts				1.4		93
	Great Britain						
063	Cambridge	(51 44 N	2 22 W)	1	1.28	1.48	35
×064	Durham	(54 45 N	1 38 W)	1	1.47	1.82	2
×065	Dysart	56 08 N	3 07 W	2	0.89	1.24	2, 6
×066	Glasgow	(55 53 N	4 20 W)	2	1.39	1.91	2, 6
×067	Hankham Bore	(50 55 N	0 15 W)	1	0.71	1.12	6, 2, 24
068	Holford Bore	(53 20 N	2 30 W)	1	0.74	1.43	6, 2, 24
069	Nottinghamshire	53 08 N	0 59 W	6	2.24		32, 24
×070	Wigan	(53 30 N	2 20 W)	1	1.01	1.34	2
071	Yorkshire	54 34 N	1 03 W	2	1.16		32, 24
	Hungary (see end of appendix for latest data)						
072	Hungary Plain	45 48 N	19 22 E	1 •	2.6		19, 20, 21

CONTINENTAL HEAT FLOW DATA (Continued)

Code	Station	Latitude	Longitude	No.	Heat Flow per Unit Area	Corrected Heat Flow per Area	References
*073	Komlo-Zobak	46°11′N	18°14′E	2	3.31		18
074	Nagylengyel	46 46 N	16 45 E	1	1.95		22
×075	S. Transdanubia	45 46 N	18 19 E	1	2.6		17, 21
*076	Hosszuheteny	46 10 N	18 22 E	1	2.49		
	Poland						
×077	Ciechocinek			1	1.23		98
	Switzerland						
078	Gotthard	(46 25 N	8 35 E)	1	1.6		40
079	Loetschberg	(46 35 N	7 45 E)	1	1.9		40
080	Simplon	(46 25 N	8 05 E)	1	2.2		40
	USSR						
×081	Mazesta-Hosta			3	0.88		67
	Canada						
×082	Leduc	53 23 N	113 48 W	1	1.6		46, 45
083	Redwater	53 59 N	113 07 W	1	1.46		46, 45
084	Norman Well	65 18 N	126 51 W	1	2.00		46, 45
×085	Resolute Bay	74 41 N	94 54 W	1	2.9	1.25	80, 58, 59
086	Larder Lake	(48 06 N	79 44 W)	1	0.88		82
087	Kirkland Lake	(48 10 N	80 02 W)	3	1.00		82, 61
088	Sudbury	(46 30 N	81 01 W)	1	1.01		82
089	Timmins	(48 30 N	81 20 W)	2	0.73		82
090	Toronto	(43 42 N	79 25 W)	1	1.03		82
×091	Calumet Is.	(45 49 N	74 41 W)	1	1.32		82
092	Malartic	(48 09 N	78 09 W)	1	0.69		82
093	Montreal	(45 30 N	73 36 W)	4	0.79		92
094	Thetford	(46 06 N	71 18 W)	1	1.05		82
	Alaska						
*095	Cape Thompson	68 06 N	165 44 W	1	1.1		59, 60
	United States						
×096	Grass Valley	39 12 N	121 03 W	2	0.69		96
097	Grass Valley	(39 12 N	121 03 W)	1	0.69		36
098	Kern County	(35 28 N	119 45 W)	1	1.29		7
099	Adams Tunnel	(40 15 N	105 40 W)	1	1.7	1.93	11
×100	Red Creek			1	1.4		11
×101	Griffin, Lagrange			1	1.4		11
×102	Syracuse			1	1.6		11
103	Calumet	(47 17 N	88 28 W)	1	0.9	0.93	12
104	Carlsbad, etc.	(32 25 N	104 14 W)	3	1.1		50
×105	Carlsbad, etc.			3	1.1		50
×106	Pa., W. Va.	40 N	80 W	6	1.3		56
107	Big Lake, etc.	(31 12 N	101 29 W)	7	1.1		50
×108	Big Lake, etc.			7	1.1		50
109	Gulf 1, Northrup	(31 10 N	103 25 W)	1	1.1		50
	Pacific Island						
×110	Eniwetok Atoll			1	0.9		15

OCEANIC HEAT FLOW DATA

Code	Depth, meters	Latitude	Longitude	No.	Heat Flow per Unit Area	References
			Atlantic Ocean and Mediterranean Sea			
111	4647	16°24′N	57°39′W	1	0.7	84, 85
112	5344	19 10 N	52 03 W	1	1.4	84, 85
113	4632	20 12 N	49 01 W	1	0.5	84, 85
114	3914	21 06 N	46 30 W	1	0.3	84, 85
115	3255	21 04 N	44 57 W	1	1.8	84, 85
116	3372	21 56 N	45 46 W	1	6.5	84, 85
117	3983	23 06 N	45 39 W	1	3.0	84, 85
118	4960	23 34 N	44 14 W	1	1.6	84, 85
119	3493	23 57 N	44 59 W	1	2.8	84, 85
120	4113	23 36 N	42 28 W	1	0.5	84, 85
121	5439	24 16 N	39 06 W	1	0.4	84, 85
122	5602	25 05 N	34 13 W	1	0.7	84, 85
123	5210	26 14 N	26 27 W	1	1.2	84, 85
124	4298	26 57 N	19 58 W	1	1.0	84, 85
+125	4232	13 36 N	71 59 W	1	1.4	85
+126	5042	13 43 N	68 38 W	1	1.1	85
+127	2877	14 22 N	62 19 W	1	1.4	85
128	4745	35 35 N	61 08 W	1	1.20	88
129	4840	35 35 N	61 15 W	1	1.31	88
×130	3323	51 18 N	29 35 W	1	>(6.2)*	88
131	3419	53 53 N	24 05 W	1	1.54	88
132	4137	00 59 S	38 10 W	1	1.52	47
133	4111	00 12 N	39 54 W	1	1.07	47
134	4285	02 30 N	40 55 W	1	1.38	47
135	4544	05 04 N	41 01 W	1	1.85	47
136	4636	06 59 N	41 04 W	1	2.03	47
137	5002	10 45 N	41 21 W	1	3.37	47
138	5002	14 14 N	57 06 W	1	1.60	47
139	4169	17 21 N	65 11 W	1	1.16	47
140	5227	20 49 N	66 25 W	1	1.52	47
141	5605	23 14 N	66 36 W	1	1.36	47
142	5115	21 34 N	67 06 W	1	1.67	47
143	7934	19 50 N	65 53 W	1	1.16	47
144	4521	32 35 N	74 24 W	1	1.03	47
145	4462	32 47 N	74 49 W	1	1.04	47
146	3020	39 36 N	12 13 W	1	1.06	30
147	4534	35 59 N	09 59 W	1	0.87	30
148	1251	35 58 N	04 34 W	1	1.22	30
149	4592	45 28 N	05 47 W	1	0.75	30
150	4413	46 32 N	13 04 W	1	1.09	30
151	4084	46 30 N	22 58 W	1	1.29	30
152	4109	46 37 N	27 18 W	1	6.52	30
153	4844	36 20 N	21 00 W	1	1.14	30
154	5375	35 36 N	19 02 W	1	1.34	30
155	5380	35 34 N	18 56 W	1	0.93	30
156	5146	36 39 N	17 21 W	1	1.14	30
157	4844	44 55 N	10 45 W	1	1.39	30
158	5305	40 59 N	15 09 W	1	1.14	30

OCEANIC HEAT FLOW DATA (Continued)

Code	Depth, meters	Latitude	Longitude	No.	Heat Flow per Unit Area	References
159	3063	42°18′N	11°53′W	1	0.78	30
160	5260	41 27 N	14 40 W	1	1.21	30
161	5030	43 42 N	12 39 W	1	1.16	30
162	2032	49 46 N	12 30 W	1	1.04	25, 30
163	4017	49 58 N	18 33 W	1	1.33	25, 30
164	4532	49 09 N	17 38 W	1	0.54	25, 30
165	4670	48 14 N	16 58 W	1	0.55	25, 30
166	4710	48 52 N	15 00 W	1	1.13	25, 30
*167	4143	45 19 N	11 27 W	1	1.13	64
*168	4125	45 19 N	11 28 W	1	1.00	64
*169	4262	31 54 N	64 44 W	1	0.97	64
*170	5781	20 12 N	66 36 W	1	1.54	64
*171	4373	28 56 N	46 44 W	1	0.67	64
×172	3084	29 04 N	43 12 W	1	<1	64
*173	3519	28 51 N	42 49 W	1	0.81	64
*174	3810	34 00 N	15 51 W	1	0.57	64
*175	4315	34 06 N	14 24 W	1	0.94	64
×176	2826	39 31 N	05 26 E	1	>0.87	64
*177	2731	42 14 N	07 09 E	1	2.5	64
*178	5342	29 02 N	25 27 W	1	1.39	64
*179	5344	28 59 N	25 26 W	1	1.20	64
*180	5342	29 03 N	25 33 W	1	1.13	64
*181	5339	29 04 N	25 27 W	1	1.21	64
*182	5299	29 05 N	25 15 W	1	1.29	64
*183	4702	27 10 N	21 06 W	1	1.06	64
×184	4682	27 10 N	21 00 W	1	~1.2	64
*185	4707	27 13 N	21 05 W	1	0.92	64
*186	5240	29 35 N	23 52 W	1	1.13	64
*187	4871	28 51 N	25 27 W	1	1.11	64
*188	4862	28 50 N	25 24 W	1	1.05	64
*189	5400	29 34 N	25 18 W	1	1.03	64
*190	5297	29 35 N	25 23 W	1	1.23	64
*191	5281	29 08 N	24 19 W	1	1.33	64
*192	5959	43 06 N	19 50 W	1	1.30	64
			Black Sea			
×193	2269			7	1.9	95
			Indian Ocean			
*194	1820	12 27 N	47 07 E	1	5.98	108
*195	2205	12 57 N	48 16 E	1	(3.62)	108
*196	2425	13 17 N	49 15 E	1	3.22	108
*197	2200	12 54 N	49 38 E	1	(2.47)	108
*198	2420	12 25 N	50 33 E	1	3.09	108
+199 to 259 unpublished data from Indian Ocean						109
			Pacific Ocean			
260	1840	27 08 N	111 38 W	1	2.80	107, 108
261	1870	27 17 N	111 22 W	1	2.94	107, 108
262	1775	27 38 N	111 44 W	1	4.19	107, 108

OCEANIC HEAT FLOW DATA (Continued)

Code	Depth, meters	Latitude	Longitude	No.	Heat Flow per Unit Area	References
263	1750	26°46′N	111°04′W	1	2.95	107, 108
264	3020	24 09 N	108 55 W	1	4.24	107, 108
265	2900	22 58 N	108 04 W	1	0.62	107, 108
266	3055	21 59 N	107 41 W	1	5.51	107, 108
267	3300	21 00 N	107 04 W	1	3.98	107, 108
268	4450	20 55 N	106 25 W	1	2.14	107, 108
269	3290	20 10 N	107 43 W	1	1.25	107, 108
270	2600	19 45 N	108 28 W	1	1.43	107, 108
271	2910	20 48 N	109 34 W	1	2.40	107, 108
272	2860	22 33 N	109 29 W	1	6.15	107, 108
273	4720	20 48 N	159 42 W	1	1.16	31, 89
274	4064	18 18 N	173 23 W	1	0.72	31, 89
275	5152	19 28 N	174 35 W	1	1.29	31, 89
276	5303	16 45 N	176 24 W	1	1.19	31, 89
277	4985	19 02 N	177 19 W	1	1.09	31, 89
278	4174	32 35 N	122 30 W	1	(1.27)	31, 89
279	4310	0 40 N	169 17 E	1	1.88	31
280	5000	9 04 S	174 51 E	1	1.35	31
281	2700	18 59 S	177 36 E	1	1.51	31
282	3900	21 56 S	178 33 E	1	2.58	31
283	4880	17 28 S	158 40 W	1	1.58	31
284	4300	12 48 S	143 33 W	1	0.36	31
285	3020	14 45 S	112 11 W	1	5.25	31
286	4100	5 52 N	123 55 W	1	1.65	31
287	4350	14 59 N	124 12 W	1	2.43	31
288	6170	13 08 N	91 57 W	1	0.47	31
289	3600	11 55 N	91 37 W	1	0.76	31
290	3730	9 49 N	93 02 W	1	0.25	31
291	3500	12 14 N	98 44 W	1	0.69	31
×292	3300	10 52 N	105 04 W	1	>3.57*	31
293	2950	10 54 N	104 25 W	1	(2.73)	31
294	3600	12 12 N	111 04 W	1	(0.93)	31
295	3910	20 44 N	115 42 W	1	1.19	31
296	4300	25 01 N	123 04 W	1	1.11	31
297	4200	24 54 N	123 05 W	1	1.13	31
298	4450	1 23 S	131 31 W	1	0.14	106
×299	4510	14 59 S	136 01 W	1	~0.65*	106
300	4760	21 40 S	147 41 W	1	0.97	106
301	5120	40 37 S	132 52 W	1	1.1	106
302	4620	42 16 S	125 50 W	1	0.14	106
303	4140	46 44 S	123 18 W	1	0.73	106
304	3180	44 27 S	110 44 W	1	2.06	106
305	3180	43 43 S	107 33 W	1	3.06	106
306	3850	43 44 S	104 25 W	1	2.09	106
307	4580	42 44 S	96 03 W	1	2.30	106
308	3310	41 06 S	86 38 W	1	(1.0)	106
×309	4110	23 23 S	72 10 W	1	>0.89*	106
310	3750	23 28 S	72 58 W	1	0.80	106
311	4550	21 33 S	79 09 W	1	1.62	106
312	2340	20 49 S	81 08 W	1	0.79	106

OCEANIC HEAT FLOW DATA (Continued)

Code	Depth, meters	Latitude	Longitude	No.	Heat Flow per Unit Area	References
313	2400	20°48′S	81°09′W	1	1.54	106
314	4440	13 35 S	79 09 W	1	1.46	106
315	2260	12 49 S	77 53 W	1	2.72	106
316	3700	12 54 S	78 06 W	1	1.07	106
317	5950	12 38 S	78 38 W	1	0.17	106
318	5900	12 59 S	78 21 W	1	0.17	106
319	4220	18 26 S	78 16 W	1	0.26	106
320	3090	18 20 S	79 21 W	1	0.98	106
321	4230	19 01 S	81 29 W	1	1.02	106
322	3880	27 04 S	88 53 W	1	2.12	106
323	3200	28 00 S	96 20 W	1	0.23	106
324	2910	27 55 S	106 57 W	1	4.54	106
×325	3500	23 15 S	117 48 W	1	~1.77*	106
326	3060	14 44 S	112 06 W	1	7.66	106
327	3580	13 30 S	108 31 W	1	1.01	106
328	3280	11 39 S	109 48 W	1	8.09	106
329	2840	9 55 S	110 39 W	1	7.95	106
330	4040	5 56 S	112 29 W	1	0.87	106
331	4330	3 40 S	114 13 W	1	1.71	106
332	3810	1 28 N	116 04 W	1	0.56	106
333	4200	4 06 N	115 41 W	1	0.43	106
334	1300	33 13 N	118 36 W	1	1.8	44
335	3320	36 40 N	123 03 W	1	2.2	44
336	3470	36 39 N	123 16 W	1	2.3	44
337	3770	36 34 N	123 41 W	1	(2.3)	44
338	4220	44 17 N	138 36 W	1	1.0	44
339	5220	48 20 N	157 22 W	1	0.5	44
340	3240	52 33 N	175 09 W	1	1.0	44
341	3740	54 17 N	176 15 W	1	0.9	44
342	4160	55 41 N	177 40 W	1	1.3	44
343	3690	56 05 N	176 10 W	1	1.1	44
344	3670	56 13 N	176 18 W	1	1.0	44
345	4230	53 23 N	163 20 W	1	0.4	44
346	5680	54 08 N	156 52 W	1	(2.7)	44
347	2950	57 11 N	149 38 W	1	1.1	44
348	4880	57 34 N	147 37 W	1	(1.2)	44
349	4220	59 05 N	145 05 W	1	2.2	44
350	4000	59 07 N	144 20 W	1	1.5	44
351	3920	59 09 N	143 39 W	1	1.7	44
352	2670	59 14 N	142 50 W	1	1.3	44
353	2910	58 11 N	139 31 W	1	1.5	44
354	3310	57 42 N	140 08 W	1	1.3	44
355	3340	56 58 N	139 12 W	1	2.2	44
356	2560	54 27 N	134 41 W	1	(4.1)	44
357	2900	54 13 N	135 27 W	1	2.7	44
358	2740	54 07 N	135 51 W	1	2.2	44
359	2900	53 07 N	133 27 W	1	1.6	44
360	2910	53 15 N	133 30 W	1	1.1	44
361	3100	50 04 N	132 25 W	1	0.7	44
362	3050	48 19 N	131 38 W	1	1.2	44

OCEANIC HEAT FLOW DATA (Continued)

Code	Depth, meters	Latitude	Longitude	No.	Heat Flow per Unit Area	References
363	3290	46°15′N	131°59′W	1	0.8	44
364	3320	43 51 N	130 55 W	1	3.2	44
365	3430	42 19 N	130 39 W	1	0.5	44
366	3760	40 36 N	130 26 W	1	0.1	44
367	3240	40 35 N	129 22 W	1	3.6	44
368	4630	38 35 N	127 45 W	1	0.6	44
369	4620	36 19 N	125 56 W	1	2.0	44
370	1710	38 09 N	142 58 E	1	0.27	104
371	7345	37 59 N	143 59 E	1	1.14	104
372	5631	38 12 N	147 55 E	1	2.05	104
*373	4930	23 15 N	130 46 W	1	0.22	112
*374	5180	20 02 N	135 11 W	1	1.56	112
*375	5070	10 34 S	151 05 W	1	1.18	112
*376	5190	8 17 S	151 36 W	1	1.44	112
*377	5160	5 55 S	149 39 W	1	0.75	112
*378	4600	4 22 S	149 29 W	1	0.74	112
*379	5090	5 20 N	146 13 W	1	1.03	112
*380	5100	7 02 N	145 38 W	1	1.51	112
*381	5000	8 07 N	145 24 W	1	1.34	112
*382	5300	9 06 N	145 18 W	1	1.40	112
*383	4890	10 59 N	142 37 W	1	(4.46)	112
*384	5000	11 03 N	142 28 W	1	1.06	112
*385	5000	13 04 N	138 59 W	1	0.64	112
*386	4990	15 11 N	136 52 W	1	1.28	112
*387	4750	24 18 N	126 30 W	1	0.90	112
*388	4080	29 07 N	121 03 W	1	0.19	112
*389	3620	31 01 N	119 04 W	1	2.73	112
*390	3900	28 02 N	117 12 W	1	2.52	112
*391	4000	26 11 N	117 18 W	1	1.95	112
*392	3935	24 12 N	117 23 W	1	1.26	112
*393	3890	22 13 N	117 21 W	1	2.69	112
*394	4010	20 18 N	117 27 W	1	0.60	112
*395	4090	18 46 N	117 14 W	1	2.16	112
*396	4110	14 26 N	117 12 W	1	2.82	112
*397	4230	12 54 N	117 24 W	1	0.41	112
*398	4310	11 28 N	117 38 W	1	0.99	112
*399	4230	9 43 N	117 32 W	1	0.54	112
*400	3880	8 06 N	117 51 W	1	1.15	112
*401	4000	6 45 N	117 51 W	1	0.76	112
*402	4355	5 20 N	117 52 W	1	0.71	112
*403	4110	3 54 N	118 08 W	1	0.69	112
*404	4160	4 03 N	117 01 W	1	(0.91)	112
*405	4120	4 03 N	115 53 W	1	(1.66)	112
*406	4170	4 03 N	115 36 W	1	(0.40)	112
*407	4210	4 13 N	114 58 W	1	(0.70)	112
*408	3980	4 25 N	113 41 W	1	0.60	112
*409	3950	4 34 N	112 31 W	1	(1.07)	112
*410	4060	4 44 N	111 33 W	1	1.21	112
*411	3980	5 04 N	109 11 W	1	2.57	112
*412	3760	5 13 N	107 59 W	1	(1.99)	112

OCEANIC HEAT FLOW DATA (Continued)

Code	Depth, meters	Latitude	Longitude	No.	Heat Flow per Unit Area	References
*413	3820	5°14′N	106°33′W	1	2.32	112
*414	3645	5 24 N	105 41 W	1	(1.55)	112
*415	3570	5 37 N	104 27 W	1	1.61	112
*416	3305	5 43 N	103 29 W	1	(3.98)	112
*417	3400	5 37 N	104 03 W	1	(1.63)	112
*418	3300	5 34 N	103 08 W	1	1.58	112
*419	3130	5 41 N	102 36 W	1	(4.86)	112
*420	3175	5 39 N	102 06 W	1	7.42	112
*421	3440	5 42 N	101 43 W	1	(0.67)	112
*422	3250	5 36 N	101 09 W	1	1.78	112
*423	3405	5 41 N	100 50 W	1	(1.25)	112
*424	3285	5 44 N	101 56 W	1	(1.20)	112
*425	3420	5 43 N	99 55 W	1	1.12	112
*426	3470	6 05 N	98 47 W	1	(0.94)	112
*427	3520	6 41 N	97 25 W	1	0.37	112
*428	3785	6 58 N	96 06 W	1	(0.08)	112
*429	3740	6 57 N	94 58 W	1	1.17	112
*430	3540	5 05 N	93 56 W	1	(1.13)	112
*431	3150	4 07 N	92 09 W	1	0.55	112
*432	2360	3 16 N	90 42 W	1	(0.87)	112
*433	2160	2 17 N	89 28 W	1	0.51	112
*434	2480	1 13 N	88 32 W	1	5.27	112
*435	2760	0 15 N	86 23 W	1	(4.66)	112
*436	2750	0 09 S	85 58 W	1	0.65	112
*437	2440	1 41 S	85 33 W	1	(5.94)	112
*438	2385	1 45 S	85 31 W	1	(1.98)	112
*439	3220	2 44 S	85 29 W	1	3.03	112
*440	3395	3 52 S	84 50 W	1	(2.42)	112
*441	4700	9 07 S	81 33 W	1	0.87	112
*442	6280	8 51 S	80 53 W	1	(0.91)	112
*443	2975	8 47 S	80 35 W	1	(1.07)	112
*444	5940	12 34 S	78 35 W	1	(0.26)	112
*445	4630	12 46 S	80 00 W	1	(1.14)	112
*446	4800	12 59 S	81 32 W	1	2.04	112
*447	4990	13 04 S	82 58 W	1	(2.56)	112
*448	4740	13 11 S	84 25 W	1	1.48	112
*449	4500	13 24 S	86 15 W	1	(0.36)	112
*450	4240	13 32 S	87 26 W	1	0.48	112
*451	4080	13 33 S	89 05 W	1	(1.05)	112
*452	3900	13 43 S	90 30 W	1	0.15	112
*453	3830	13 40 S	92 00 W	1	(1.57)	112
*454	3880	13 35 S	93 28 W	1	3.22	112
*455	3720	13 37 S	94 58 W	1	(2.08)	112
*456	4150	13 37 S	96 44 W	1	2.04	112
*457	3740	13 32 S	97 48 W	1	1.28	112
*458	3950	13 26 S	99 11 W	1	(1.66)	112
*459	4210	13 23 S	100 30 W	1	0.39	112
*460	4300	13 16 S	101 24 W	1	(3.14)	112
*461	4430	13 18 S	102 18 W	1	1.75	112
*462	4170	13 11 S	103 30 W	1	(1.63)	112

OCEANIC HEAT FLOW DATA (Continued)

Code	Depth, meters	Latitude	Longitude	No.	Heat Flow per Unit Area	References
*463	3720	13°03′S	104°41′W	1	0.79	112
*464	3910	12 59 S	105 31 W	1	(1.37)	112
*465	3720	12 54 S	106 29 W	1	3.02	112
*466	3710	12 50 S	107 31 W	1	(0.92)	112
*467	3550	12 48 S	107 59 W	1	1.09	112
*468	3550	12 43 S	108 32 W	1	(2.13)	112
*469	3415	12 44 S	109 02 W	1	(1.97)	112
*470	3405	12 40 S	109 30 W	1	(2.31)	112
*471	3255	12 39 S	110 01 W	1	2.93	112
*472	3180	12 35 S	110 29 W	1	(4.74)	112
*473	3165	12 35 S	110 15 W	1	(2.96)	112
*474	3010	12 33 S	110 47 W	1	(2.18)	112
*475	3105	12 33 S	111 13 W	1	2.76	112
*476	3030	12 32 S	111 29 W	1	(3.08)	112
*477	3075	12 33 S	112 01 W	1	(6.35)	112
*478	3175	12 32 S	112 16 W	1	(3.50)	112
*479	3170	12 30 S	112 37 W	1	2.00	112
*480	3230	12 26 S	113 05 W	1	(2.94)	112
*481	3325	12 25 S	113 31 W	1	(1.79)	112
*482	3240	13 02 S	113 17 W	1	(4.00)	112
*483	3025	13 36 S	112 42 W	1	3.24	112
*484	2960	14 02 S	112 20 W	1	(2.59)	112
*485	3020	14 47 S	112 32 W	1	(1.34)	112
*486	3065	14 47 S	112 54 W	1	(1.93)	112
*487	3010	14 41 S	113 30 W	1	7.10	112
*488	3170	14 40 S	113 45 W	1	(8.04)	112
*489	2975	14 38 S	114 02 W	1	(4.65)	112
*490	3045	14 15 S	113 11 W	1	(5.80)	112
*491	3020	14 15 S	113 33 W	1	(4.03)	112
*492	3045	14 15 S	113 50 W	1	0.84	112
*493	3015	14 15 S	114 09 W	1	(3.27)	112
*494	3120	14 17 S	114 32 W	1	(1.87)	112
*495	3210	14 17 S	114 59 W	1	(1.17)	112
*496	3440	14 18 S	115 37 W	1	0.97	112
*497	3280	14 15 S	116 23 W	1	(1.72)	112
*498	3440	14 14 S	117 35 W	1	1.00	112
*499	3380	13 59 S	118 33 W	1	(0.70)	112
*500	3270	14 00 S	119 39 W	1	0.13	112
*501	3600	14 04 S	120 16 W	1	(1.48)	112
*502	3680	14 03 S	121 17 W	1	(0.67)	112
*503	3935	14 01 S	122 28 W	1	0.07	112
*504	3860	14 07 S	123 47 W	1	(1.39)	112
*505	3640	13 33 S	121 48 W	1	(1.60)	112
*506	3665	13 33 S	121 50 W	1	(0.25)	112
*507	3680	13 52 S	125 20 W	1	1.04	112
*508	3930	14 02 S	127 07 W	1	(0.18)	112
*509	3995	14 02 S	128 25 W	1	1.02	112
*510	4120	14 02 S	129 48 W	1	(2.60)	112
*511	4090	14 03 S	130 18 W	1	(0.82)	112
*512	4010	14 03 S	131 44 W	1	0.48	112

OCEANIC HEAT FLOW DATA (Continued)

Code	Depth, meters	Latitude	Longitude	No.	Heat Flow per Unit Area	References
*513	4290	14°02′S	133°45′W	1	(0.79)	112
*514	4220	14 02 S	134 55 W	1	1.17	112
*515	4290	14 03 S	136 34 W	1	(0.57)	112
*516	4040	14 09 S	138 06 W	1	1.70	112
*517	3925	14 03 S	139 35 W	1	1.67	112
*518	2610	14 55 S	141 34 W	1	(1.8)	112
*519	3725	15 15 S	142 26 W	1	1.12	112
×520	1440	16 30 S	145 07 W	1	~1.7*	112
*521	2750	16 52 S	145 49 W	1	1.35	112
*522	4190	17 05 S	147 13 W	1	0.21	112
*523	4200	16 46 S	148 52 W	1	(0.16)	112
*524	4250	16 34 S	148 30 W	1	1.13	112
*525	2770	14 43 S	145 40 W	1	1.20	112
*526	4390	13 37 S	145 03 W	1	0.29	112
*527	4960	13 03 S	144 03 W	1	1.29	112
*528	4480	12 46 S	143 34 W	1	(1.10)	112
*529	4520	11 58 S	142 27 W	1	1.19	112
*530	4270	11 05 S	140 57 W	1	(0.46)	112
*531	4140	10 30 S	139 59 W	1	0.37	112
*532	4080	8 38 S	138 18 W	1	1.67	112
×533	4400	7 27 S	137 11 W	1	~(0.78)*	112
*534	4350	6 23 S	136 11 W	1	1.31	112
*535	4445	4 06 S	133 59 W	1	1.22	112
*536	4350	2 46 S	132 58 W	1	(1.63)	112
*537	4345	1 40 S	131 52 W	1	0.63	112
*538	4510	1 21 S	131 31 W	1	(0.23)	112
*539	4480	1 25 S	131 04 W	1	(0.74)	112
*540	4580	1 27 S	130 34 W	1	(0.40)	112
*541	4425	0 47 S	131 42 W	1	(0.78)	112
*542	4410	0 18 N	132 00 W	1	(0.80)	112
*543	4305	2 04 N	132 32 W	1	0.42	112
*544	4375	3 36 N	133 00 W	1	(−.01)	112
*545	4375	3 58 N	133 09 W	1	(0.19)	112
*546	4390	5 38 N	133 26 W	1	0.44	112
*547	4410	7 14 N	133 47 W	1	(1.7)	112
*548	4980	9 03 N	133 40 W	1	1.80	112
*549	4910	10 57 N	133 56 W	1	(1.42)	112
*550	4810	12 56 N	133 36 W	1	(1.07)	112
*551	4775	14 58 N	133 42 W	1	1.34	112
*552	5190	18 15 N	133 06 W	1	2.00	112
*553	5060	19 59 N	133 03 W	1	(1.23)	112
*554	4880	23 30 N	132 43 W	1	(1.23)	112
*555	4530	25 19 N	132 37 W	1	0.89	112
*556	4815	27 15 N	132 28 W	1	(1.02)	112
*557	4740	28 26 N	135 54 W	1	1.59	112
*558	4660	28 29 N	134 35 W	1	(0.71)	112
*559	4385	28 18 N	133 21 W	1	1.43	112
*560	3700	27 54 N	132 37 W	1	(0.98)	112
*561	4550	28 10 N	131 04 W	1	(2.16)	112
*562	4740	28 17 N	129 36 W	1	1.05	112

OCEANIC HEAT FLOW DATA (Continued)

Code	Depth, meters	Latitude	Longitude	No.	Heat Flow per Unit Area	References
*563	4660	28°21′N	127°59′W	1	(1.92)	112
*564	4500	28 27 N	126 37 W	1	1.73	112
*565	4445	28 35 N	125 00 W	1	(2.22)	112
*566	4370	28 47 N	123 37 W	1	1.66	112
*567	4220	28 56 N	122 27 W	1	(2.16)	112
*568	4005	29 33 N	121 44 W	1	(2.36)	112
+569 to 580 unpublished data from Pacific Ocean						109
*581	7490	34 23 N	142 15 E	1	1.39	100, 105
*582	5110	34 04 N	142 56 E	1	1.24	100, 105
*583	5770	33 53 N	145 26 E	1	0.99	100, 105
*584	5480	39 22 N	150 03 E	1	3.30	100, 105
×585	2800	39 30 N	143 28 E	1	~1.18*	100, 105
*586	1710	34 32 N	139 46 E	1	1.46	100, 105
+587 to 683 unpublished data from Pacific Ocean						109

In a letter of April 22, 1963, Professor T. Boldizsár has supplied the following interesting results (asterisk denotes data that are in press or unpublished).

Location	Latitude	Longitude	Heat Flow per Unit Area, μcal/cm² sec
Hungary			
Hosszúhetény	46°10′N	18°22′E	2.49 ± 0.02
Zobák	46 11	18 14	3.31 ± 0.04
Hajdussoboszló*	47 26	21 23	2.2 to 2.6
Nagylengyel	46 46	16 45	1.9
Czechoslovakia			
Banska Stiavnica* (Selmecbánya)	48 27	18 53	2.6
Italy			
Larderello, Tuscany*	43 12	10 54	13.8
Iceland (G. Bodvarsson: Terrestrial Heat Balance in Iceland, Timarit Verk. Islands, Vol. 39. No. 6, 1–8, 1955.)			4 to 5

Note added in proof. In June 1963 a second heat flow data analysis was carried out with the addition of 123 new data. The results indicate no change from those described here.

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