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Compilation of geothermal-gradient data in the conterminous United States

by

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ABSTRACT

Temperature gradients from published temperature/depth measurements made in drill holes generally deeper than 600 m are used to construct a temperature-gradient map of the conterminous United States. The map displays broadly contoured temperature gradients that can be expected to exist regionally in a conductive thermal regime to a depth of 2 km. Patterns of temperature gradients are similar to those for heat flow in some areas, but there are significant differences caused by regional differences in thermal conductivities. The average value of all 284 gradients for the United States is 29°C/km. The average for the eastern United States is 25°C/km and for the west is 34°C/km. Using the temperature gradients found in this study and published heat flows, derived thermal conductivities are calculated for the depth range of a few hundred meters to 2 km. For all data, the average conductivity is 6.0 $\pm$ 1.9 mcal/(cm sec °C).

METHODOLOGY OF MAP CONSTRUCTION

This paper presents basic data used for the map of geothermal gradients in the conterminous United States (Plate 1) by Nathenson and Guffanti (in press), and the reader should refer to that paper for most of the discussion concerning the map. The map shows values for geothermal gradients and the physiographic provinces of Fenneman (1928). Gradient contours are thick lines, dashed where uncertain. Gradients are calculated from equilibrium temperature vs. depth measurements for drill holes generally logged deeper than 600 m, excluding data from convective hydrothermal systems. The primary sources for these data are temperature logs published as part of heat-flow determinations made in deep holes and a compilation of temperature measurements by Spicer (1964). The set of deep equilibrium data used in this study constitutes a unique group of 284 gradients that have not been used before to construct a geothermal-gradient map.

Gradients from published heat-flow determinations comprise 70 per cent of the map data. The gradients reported in this study were selected by us based on analyses of temperature logs and are not necessarily the same as the originally published value. This reinterpretation of the basic data was necessary because a gradient reported as part of a heat-flow study is sometimes given for a restricted depth interval for which there are conductivity measurements and, hence, may not be representative of temperatures over the entire depth. However, large differences between our values and the previously published values are very uncommon.

The map data, current as of April, 1983, are listed by state in Table 1. Latitude, longitude, gradient, calculated surface temperature, logged depth, physiographic province reference (Table 2 and Figure 1), heat flow (when available), and derived conductivity are given for each hole. Units used for heat flow are HFU (1 HFU = 1 μcal/cm^{2}sec = 41.8 mW/m^2) and for thermal conductivity are TCU (1 TCU = 1 mcal/cm sec°C = 0.418 W/m°C) because most of the original data are in those units. The reference codes for the data sources are given in Table 3. Multiple references for a code in Table 3 occur where the temperature log is presented in one source and heat flow or other data in another. A code is given to indicate whether a hole is in the eastern or western U.S. The eastern United States is defined here as that part extending from the eastern coast to about the 105°W meridian, encompassing the drill holes in North and South Dakota, Nebraska, Kansas, Oklahoma, and Texas and also including the two easternmost holes in New Mexico.

The calculated surface intercept T_0 is not intended to be an estimate of the actual ground temperature. Instead, it is a value defined by the line chosen and is combined with the gradient G according to the straight-line equation

$$T = T_O + G z$$

to give the temperature T at a specified depth z. Thus, negative or very high values listed in Table 1 indicate those holes in which the deeper gradient is significantly different from the shallower gradient.

The conductivities listed in Table 1 are not the values measured as part of heat-flow studies, but rather are derived for each hole by dividing the published heat flow by the gradient determined in this study. The conductivities obtained in this manner are nearly the same as the measured values except in a few cases where the gradients used in this study differ substantially from the gradients used in heat-flow determinations. This calculation imposes a single generalized value of conductivity at a site, whereas measured conductivity may actually vary with depth. These derived conductivities are discussed in a subsequent section.

Calculation of Temperature Gradients

Temperature logs were analyzed with the objective of determining a representative gradient for each site from which approximate temperatures within the upper 2 km of the crust can be calculated. For drill holes in which the temperature log is made in rocks of similar conductivity and the gradient is nearly constant with depth, a single straight-line gradient is easily chosen which represents temperatures at all depths very closely.

In instances where marked variations in the gradient occur over the logged interval, gradient selection was subjective and depended on the significance of the changes (hydrologic interference, conductivity contrast, logging artifact) and on the regional geology. Sometimes, an overall gradient was averaged from two or more straight-line segments weighted by depth interval, although in many cases, the shallower (less than about 300 m) data were generally considered less important than deeper portions of the logs in choosing a representative gradient. In some locations, there are thick sections of layered rocks of strongly contrasting thermal conductivities that make it difficult to represent the temperatures with a single gradient.

In the eastern part of the United States, there are a number of drill-hole locations where contrasting conductivities are likely to occur at shallow depths in sedimentary sections, and gradients cannot accurately be extrapolated to 2 km. In Table 4, data are given for 25 drill holes in the eastern and central United States where logged gradients were modified to yield overall gradients applicable to 2 km. In six cases (KS ROOKS, KS BUTLER, KS SMKYHLL, KS E-14, MD DGT-1J, SC CHRLSTN), measured gradients were adjusted for the presence of higher-conductivity basement rock beneath the logged interval by weighting the measured sedimentary gradient and an estimated basement gradient by depth interval for each hole. For the other drill holes, linear segments were weighted by depth interval, assuming in each case that the deepest logged gradient (whether in basement or not) extends to 2 km. Table 4 also includes data for 10 drill holes in the western United States where two gradients are a better representation of the data than a single gradient. No attempt has been made to determine locations where basement might occur between the total depth of the drill hole and a depth of 2 km in the western United States, because in many cases the definition of basement is less clear.

Table 4 lists a total of 35 drill holes where two gradients are the best representation of the data. A remaining question is in how many holes of this group are the differences between gradients significant. Figure 2 shows histograms of the shallow gradient minus the average gradient G_1-G_{av} and the deeper gradient minus the average G_2-G_{av}. The small number of occurrences of G_1-G_{av} near zero is to be expected, since we emphasized the deeper data in selecting a representative gradient. Generally, near-surface gradients G_1 are greater than the average for the drill hole, because near surface rocks tend to be lower in conductivity. However, in a significant number of cases, this common assumption is not true. The relatively large number of occurrences of G_2-G_{av} near zero is also to be expected, since in many cases G_2 occurs over most of the depth range. For the 35 two-gradient holes, the deeper gradient usually occurs over most of the depth range and thus dominates the average (or overall) gradient. Data for twenty two of these drill holes have both the average gradient and the deeper gradient within the same contour interval. Thus, for most of the drill holes used in this study (95 per cent), it is reasonable to use a single gradient to represent temperatures over the depth interval of a few hundred meters to 2 km.

Although some holes presented difficulties, it was possible to analyze most of the available deep data using the methodology of this study. A group of exceptions is data in Judge and Beck (1973) for the western Ontario and Michigan Basins. For some holes of that study, only a high-conductivity, dolomite-rich portion of a complex rock sequence to 2 km was logged, and thus the gradient obtained was considered not to be stratigraphically representative. Only those holes in Judge and Beck (1973) that penetrated a varied section of the sedimentary sequence comprising shale, limestone, and dolomite in that area were incorporated into our map data.

CHARACTERISTICS OF THE DATA SET

A histogram of the number of data points in different gradient classes is shown in Figure 3. The gradients lie between 6 and 69°C/km, an appropriate range for conductive temperature gradients. The mean of the 284 gradients is 29°C/km with a standard deviation of 11°C/km. The eastern data comprise a skewed frequency histogram (Figure 4). The mean of the 137 gradients is 25°C/km with a standard deviation of 10°C/km. The frequency histogram of 147 western data (Figure 4) shows a strong grouping of values between 30° and 39°C/km. The mean western gradient is 34°C/km with a standard deviation of 11°C/km.

CONTOURABILITY OF GEOTHERMAL GRADIENT DATA

In contouring a data set such as geothermal gradients, it is important to assess the validity of the resulting map. We compare the contourability of the geothermal gradient data to the heat-flow data obtained in deep holes. Both maps have broad contour intervals to show regional trends, so we examine the fraction of data points having a value not within a contour interval (outliers) and the number of contoured areas. Clearly, one can reduce the percentage of outliers to zero by simply adding more contours; however, one tries to balance the decision to add contours to reduce the number of outliers with the geologic context of adding another contour.

Rather than use all of the available heat-flow data, we use the subset of values measured in deep holes given in Table 1. Gradients for all of these deep heat flows are in the gradient data set, but not all gradient data have associated heat-flow measurements. In order to judge how representative the subset of deep heat-flow data is of the entire heat-flow data set, we compare histograms and means and standard deviations. Because of the rather different characteristics of heat flow in the east and the west, these data sets are considered separately. Figure 5 shows histograms of the east and west deep heat-flow data. A visual comparison with the corresponding histograms presented in Figure 4 of Lachenbruch and Sass (1977) for the entire heat-flow data set shows that they are similar in appearance. The means and standard deviations for the two heat-flow data sets (Table 5) are similar, although the number of data points differ by factors of 2 and 5. From this comparison, we conclude that the deep heat-flow data set is similar to the entire data set, and it is reasonable to compare the contourability of the gradient data to the deep heat-flow data.

Tables 6 and 7 present data on the characteristics of the temperature gradient and deep heat-flow data sets. The column labeled number of areas is the number of areas that are enclosed by the contour interval given in the first column. The last three columns describe the data within the given contour interval. In both data sets, one contour interval with only one or two occurrences encloses a substantial fraction of the data. For example, in the eastern United States, the 15°-24°C/km contour has two occurrences and encloses 53 per cent of the data; the 1.0-1.49 HFU contour has one occurrence and encloses 60 per cent of the data. There are many more deep gradient data in the east (137) than deep heat-flow data (60) whereas the two data sets are of similar size in the west.

The number of occurrences of various contour intervals in the heat-flow data set (50) is much greater than in the temperature gradient data set (26), because the data set used to contour the heat-flow map includes about ten times the number of data points as there are deep heat flow values. If one were to contour the subset of heat flow obtained from deep holes, there would be far fewer contours enclosing small areas. The heat-flow contouring in the west has 25 areas above 2.5 HFU, but these areas include only 11 data, of which 4 are outliers. Thus, many of the areas contoured as greater than 2.5 HFU are relatively small and show up only in the large data set. Assuming that perhaps 20 contoured areas in the west are not based on a data set comparable to the gradient data set, the remaining number of contoured areas in the heat-flow map is similar to that found in the temperature-gradient map.

The percentage of outliers for an individual contour interval in either data set must be assessed with care, because some of the contours with the largest percentage of outliers involve only a small number of data. It is more reasonable to compare outliers for the east, west, and total data sets (Tables 6 and 7). For the total sets, the percentage of outliers in each data set is similar (gradient data, 19 per cent; heat flow, 17 per cent). In the east, the percentage of outliers is greater in the gradient data (15 per cent versus 8 per cent); however, it is similar in magnitude to that for the heat flow data. The contourability of heat flow is expected to be better in the east, where the range of heat flow is fairly small. In the west, the percentage of outliers in each data set is similar (gradient data, 24 per cent; heat flow, 22 per cent). The percentage of outliers in both heat flow and temperature gradients is higher in the west than the east, which reflects the greater areal variability of heat flow and temperature gradients in the west. The point of this comparison is that the two data sets have similar measures of contourability, though the heat flow appears to be somewhat more contourable.

DERIVED THERMAL CONDUCTIVITIES

Having analyzed the deep temperature data to obtain representative gradients for the upper 2 km, we now have two representative numbers for many of the holes listed in Table 1: the heat flow and the gradient. From these two values, we derive a thermal conductivity that should be representative of the upper 2 km of the earth. This parameter makes it possible to assess how thermal conductivities vary with regional geology. Histograms of the derived thermal conductivities are shown for the total data set, the east, and the west in Figure 6. The mean values for the three populations are between 5.8 and 6.3 mcal/cm sec°C (Table 8).

One contribution of analyzing temperature-depth data to obtain gradients representative to 2 km is the ability to then produce a map of representative thermal conductivities. Plate 2 shows the conductivity values on a map with physiographic provinces from Fenneman (1928). Table 8 gives means and standard deviations for derived thermal conductivities by physiographic province. Some areas show little variation in derived conductivity while others show a wide range of values. The data are too sparse to contour, and the calculation of means and standard deviations for physiographic provinces appears to be the most appropriate representation at this time.

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Table 1. Basic data for drill holes used in this study. Each data entry lists two letter abbreviation for state name, hole name, physiographic province code (Table 2), latitude and longitude in degrees and decimal minutes, geothermal gradient G, heat flow q, derived thermal conductivity k = q/G, intercept T_o used for calculating temperatures as a function of depth, logged depth H, reference code (Table 3), and division of data into eastern and western sets.

State, Hole Name,		Province Code	Lat. Deg.	Lat. Min.	Long. Deg.	Long. Min.	G °C/km	q HFU	k TCU	T_o °C	H m	Ref.		East West
AL	R-10	PD	33	16.0	86	1.0	14	0.95	6.8	14.4	722	R+	68	e
AL	2	GC	34	20.0	87	58.6	18			15.3	762	SP	64	e
AL	9	VR	33	26.6	86	44.8	17			15.4	610	SP	64	e
AL	11	GC	33	45.0	88	12.4	18			15.8	1067	SP	64	e
AR	1	IH	34	23.0	93	50.0	22	1.09	5.0	14.2	530	R+	80	e
AR	6	GC	33	6.2	92	39.6	45			14.4	658	SP	64	e
AZ	A972	BR	31	53.0	111	0	29	2.47	8.5	20.4	600	R+	68	w
AZ	GM-5	BR	33	8.0	109	55.0	34	1.9	5.6	17.6	700	RS	79	w
AZ	NAVAJO-2	CO	36	58.0	109	9.0	26	1.55	6.0	11.6	1402	R+	79b	w
AZ	VD-14	BR	33	23.9	110	51.9	28	2.80	10.0	18.8	580	SH	79	w
AZ	CBH-1	BR	32	57.8	109	37.5	33	1.98	6.0	20.9	1110	SH	79	w
AZ	R-2	BR	34	38.5	113	41.0	30	1.90	6.3	17.0	810	SH	79	w
AZ	807	BR	35	22.1	114	8.1	24	1.76	7.3	18.8	880	SH	79	w
AZ	WA7	BR	32	19.9	112	52.9	29	2.06	7.1	23.8	690	SH	79	w
AZ	42	BR	32	25.3	111	24.4	33			32.4	610	SH	79	w
AZ	43	BR	32	23.8	111	23.9	36	2.25	6.2	28.5	650	SH	79	w
AZ	K1	BR	33	5.6	111	1.4	27	2.26	8.4	22.6	590	SH	79	w
AZ	STNFLD	BR	32	46.6	111	59.6	30	2.62	8.7	27.7	600	SH	79	w
AZ	704	BR	31	22.7	110	41.4	30	2.38	7.9	15.0	570	SH	79	w
AZ	H2	BR	34	26.3	112	29.9	28	2.01	7.2	13.9	740	SH	79	w
AZ	FED1	BR	32	30.0	114	44.5	39			15.0	820	SH	79	w
AZ	PQ-1	BR	34	7.8	112	51.5	28	1.68	6.0	21.0	905	S+	81	w
AZ	PQ-3	BR	34	0.3	113	13.1	34	1.90	5.6	25.5	1317	S+	81	w
AZ	PQ-4	BR	34	9.4	113	10.6	34	1.62	4.8	22.3	1671	S+	81	w
AZ	PQ-8	BR	34	17.0	113	56.6	31	1.68	5.4	33.5	625	S+	81	w
AZ	PQ-9	BR	34	38.5	113	58.6	39	2.19	5.6	24.8	1574	S+	81	w
CA	EG-7	PB	39	42.0	122	48.0	17	1.17	6.9	6.8	1243	S+	71	w
CA	326-28R	PB	35	17.0	119	31.0	36	1.26	3.5	25.3	1989	S+	71	w
CA	366-24Z	PB	35	18.0	119	34.0	37	1.0	2.7	24.6	1876	S+	71	w
CA	385-24Z	PB	35	18.0	119	33.0	37	1.2	3.2	24.7	1855	S+	71	w
CA	343-4G	PB	35	16.0	119	24.0	37	1.12	3.0	22.5	2153	S+	71	w
CA	344-35S	PB	35	17.0	119	22.0	36	1.2	3.3	22.6	2239	S+	71	w
CA	372-35R	PB	35	17.0	119	28.0	36	1.3	3.6	24.8	2159	S+	71	w
CA	382-3G	PB	35	16.0	119	23.0	36	1.26	3.5	21.8	2331	S+	71	w
CA	LB-1	PB	33	53.0	118	2.0	35	1.74	5.0	11.6	3223	S+	71	w
CA	LB-22	PB	33	49.1	118	11.2	37			19.2	1189	CA	30	w

Notes:

A minus following a gradient value indicates that no temperature log was available for that drill hole.

A negative heat flow indicates that the value was obtained by averaging nearby values. These heat flow values are not included in heat flow statistics but are used to calculate derived thermal conductivities.

A $ sign following a surface intercept indicates that the value was obtained from a map of mean-annual air temperatures.

State, Hole Name,	Province Code	Lat. Deg.	Lat. Min.	Long. Deg.	Long. Min.	G °C/km	q HFU	k TCU	T_o °C	H m	Ref.	East West
CA LB-28	PB	33	48.0	118	9.9	37			18.4	2743	VO 41	w
CA F-4	PB	33	54.2	117	56.4	34			22.4	1067	SP 64	w
CA C-8	PB	36	12.4	120	17.6	36			21.9	1317	VO 26	w
CA C-7	PB	36	12.2	120	17.5	35			21.9	1067	SP 64	w
CA SB-2	PB	33	46.2	118	7.4	38			22.7	1372	SP 64	w
CA SF-7	PB	33	57.0	118	4.5	35			18.9	1219	CA 30	w
CA R-3	PB	34	21.3	119	25.9	30			19.3	1067	VO 51	w
CA KR-2	PB	35	32.2	119	1.1	32			20.4	869	SP 64	w
CA KH-2	PB	36	2.8	120	7.1	34			21.0	802	SP 64	w
CA SOB-2	PB	35	27.8	119	45.1	35	1.29	3.7	28.2	2646	BE 47	w
CA LV1	BR	34	37.0	116	43.4	30	1.65	5.5	19.4	700	HW 71	w
CA SN-ST	SN	37	10.0	120	4.0	6	0.45	7.5	22.4	492	LA 68	w
CA SN-SJ	SN	37	6.0	119	44.0	9	0.61	6.8	19.9	459	LA 68	w
CA SN-JB	SN	37	6.0	119	23.0	13	0.77	5.9	13.4	491	LA 68	w
CA SN-HC	SN	37	8.0	118	59.0	18	1.30	7.2	5.6	503	LA 68	w
CA MESA 31-1	BR	32	48.6	115	15.7	40			21.0	1880	U+ 78	w
CA MAN-11	BR	34	38.8	116	20.8	25	1.6	6.4	19.9	762	RO 63	w
CA SV01	PB	38	50.4	121	50.6	20	0.64	3.2	16.8	646	WM 82	w
CA GV29	PB	36	26.4	120	18.4	32			21.6	700	WM 82	w
CA STNCNYN	PB	36	38.4	121	15.5	30	1.79	6.0	17.5	591	LS 80	w
CA USL1-3	PB	36	02.9	120	46.6	49	2.25	4.6	25.0	860	LS 80	w
CO RYMTARS	GP	39	51.0	104	51.0	39	2.0	5.1	6.7	3658	S+ 71	w
CO DDH-K1	CO	37	47.0	108	51.0	37	2.99	8.1	4.5	610	DB 74	w
CO 1	GP	39	0.3	104	20.2	33			8.2	1219	SP 64	w
CO 3	GP	38	21.0	105	8.2	39			12.2	1067	SP 64	w
CO 5	GP	40	44.4	105	3.0	33			10.5	914	SP 64	w
CO 6	GP	40	45.8	105	1.6	36			9.6	1219	SP 64	w
CO 7	GP	40	5.5	105	6.4	44			9.1	1981	SP 64	w
CO CRESTED BUTTE	SR	38	55.0	107	7.0	30	2.40	8.0	-3.6	750	R+ 75	w
CO WETMORE 1	GP	38	14.0	105	5.0	27	1.23	4.6	11.0	580	R+ 75	w
CO WIN-9	SR	38	59.0	106	27.0	40	2.74	6.8	2.4	670	DB 79	w
CO WINFIELD	SR	38	58.0	106	26.0	33	2.84	8.6	-0.4	670	DB 79	w
CO CHICAGO	SR	37	36.0	107	37.0	31	2.45	7.9	1.2	900	DB 79	w
CO LILLY L.	SR	37	34.0	107	35.0	21			-0.1	575	DB 79	w
CO REDWELL	SR	38	54.0	107	3.0	44	3.62	8.2	-1.2	900	DB 79	w
CO L.IRWIN	SR	38	53.0	107	6.0	39			2.8	900	DB 79	w
CO ALMA	SR	39	19.0	106	7.0	41			-1.1	900	DB 79	w
CO BLACK HOLLOW	GP	40	36.0	104	50.0	44	2.4	5.4	6.7	2088	R+79a	w
CO PIERCE	GP	40	39.0	104	50.0	44	2.3	5.2	6.4	2134	R+79a	w
FA GT-1	AC	28	28.0	81	13.3	20	0.92	4.6	15.9	1713	KS 72	e
GA TRT-1	AC	32	56.1	82	36.8	15	-1.0	6.7	19.4	1125	MC 80	e
GA S791	AC	32	57.5	82	38.5	14			19.2	750	MC 80	e
GA MCC1	AC	32	55.0	82	40.0	16			19.2	2115	MC 80	e
IA AND 3	CL	42	38.3	94	1.2	12	0.92	7.7	9.4	645	CS 73	e
IA BOOK 1	CL	41	33.7	94	6.2	18	1.17	6.5	11.7	675	CS 73	e
IA PRICE 1	CL	41	41.5	94	10.4	18	1.16	6.4	10.5	585	CS 73	e
IA SPENCER	CL	43	10.0	95	11.0	8	0.44	5.5	7.6	670	R+ 68	e
ID BOSTIC-1A	CP	43	2.8	115	26.5	62			18.0	2950	A+ 80	w
ID G-W	BR	42	14.2	113	22.0	52	2.5	4.8	18.4	1490	N+ 80	w
ID INEL-1	CP	43	37.1	112	56.8	43	2.60	6.0	6.2	3125	B+ 81	w
ID G2A	CP	43	46.0	112	41.3	60	2.63	4.4	-2.0	790	B+ 81	w

State, Hole Name,	Province Code	Lat. Deg.	Lat. Min.	Long. Deg.	Long. Min.	G °C/km	q HFU	k TCU	T_o °C	H m	Ref.	East West
ID 5N/5E/3CD	NR	43	47.5	115	50.8	28-	2.0	7.1	5.0$	590	B+ 78	w
IL CONDIT 1	CL	40	48.6	87	53.6	20	1.42	7.1	10.5	1065	CS 73	e
IL MUSSER1	CL	41	1.2	88	53.7	18	1.41	7.8	11.5	765	CS 73	e
IL UPH-3	CL	42	26.2	89	51.5	23	1.8	7.8	6.5	1600	SD 80	e
IL 5	CL	39	21.8	87	56.8	20			14.1	686	SP 64	e
IN S-55	CL	40	55.1	86	27.1	15	1.39	9.3	15.0	1050	CS 73	e
KS E-14	CL	37	48.0	96	56.0	29			18.0	737	SP 64	e
KS SMOKYHILL	GP	38	52.3	97	34.5	28	1.36	4.9	15.0	1050	BS 81	e
KS BUTLER	CL	37	49.8	96	58.3	30			18.0	737	BS 81	e
KS ROOKS	GP	39	14.7	99	32.6	24			16.5	1045	BS 81	e
KS GIBS1	GP	39	41.2	101	25.1	33			20.5	1455	BS 82	e
KS FINEGAN	GP	39	32.1	101	30.3	30			21.0	1410	BS 82	e
KS PAUL LS	GP	38	31.5	99	55.1	26			13.7	1350	BS 82	e
KS GIBSON	CL	37	28.7	96	53.9	30			15.0	870	BS 82	e
KS MERZ2	CL	39	59.6	95	44.7	24			17.5	1010	BS 82	e
LA MO-4	GC	32	21.8	91	52.4	42			16.5	610	SP 64	e
LA CL-1	GC	32	50.8	94	1.2	41			20.0	686	SP 64	e
LA BL-1	GC	31	35.5	93	46.2	47			15.8	610	SP 64	e
LA Z-3	GC	31	36.0	93	29.0	45			14.4	762	SP 64	e
LA Z-4	GC	31	35.3	93	27.0	50			11.7	762	SP 64	e
LA PI	GC	32	48.6	93	53.4	36			24.2	1067	SP 64	e
LA SCOTLAND	GC	30	32.8	91	11.8	20	1.24	6.2	20.2	500	SD 82	e
LA BRN	GC	30	26.2	91	08.5	22	1.22	5.5	20.4	500	SD 82	e
LA BRS	GC	30	25.2	91	08.4	24	1.10	4.6	19.4	500	SD 82	e
MD DGT-1J	AC	38	1.0	75	49.5	31	1.82	5.9	18.0	980	DM80a	e
MD PP-1	PD	39	13.8	77	5.2	16	-0.8	5.0	10.2	770	DM80b	e
MI N-65	SU	46	44.0	89	34.0	17	1.06	6.2	5.4	610	R+ 68	e
MI 4	SU	47	1.3	88	41.4	15	0.93	6.2	5.1	504	BI 54	e
MI 2	SU	47	4.0	88	37.7	17	0.93	5.5	2.3	1905	BI 54	e
MI BASIN	CL	43	16.2	84	32.0	22-	1.10	5.0	8.0$	5324	BP 76	e
MI NV-106	CL	42	26.0	83	34.0	12	1.20	10.0	11.2	1006	JB 73	e
MN DDH-4	SU	47	49.0	91	43.0	20	0.87	4.4	3.2	1235	R+ 68	e
MO B-20	IH	38	9.0	91	15.0	15	1.24	8.3	12.1	610	R+ 68	e
MO LEVASY	CL	39	5.0	94	10.0	17	1.17	6.9	11.7	1186	R+ 68	e
MS A-2	GC	33	58.2	88	25.5	21			13.2	762	SP 64	e
MS J-3	GC	32	18.1	90	11.8	45			20.2	686	SP 64	e
MT BUTTE	NR	46	3.0	112	33.0	31	2.1	6.8	6.7	1200	BL 67	w
MT MB-2	NR	47	3.2	114	17.4	21			12.8	692	LW 80	w
MT MB-4	NR	46	57.6	114	3.8	22			12.3	869	LW 80	w
MT C-1	GP	48	21.6	111	57.0	22			7.7	610	SP 64	w
NC SP-3	BL	35	54.8	82	7.3	14	1.02	7.3	11.9	1220	DA 78	e
NC PD-1	PD	35	42.4	80	2.3	14			14.6	630	DA 78	e
NC STUMPY PT	AC	35	42.2	75	46.3	35			18.9	1350	C+ 77	e
NC C14A	AC	33	58.0	77	58.2	22	1.29	5.9	20.0	545	P+ 80	e
NC C15	AC	34	39.0	77	19.0	20	1.23	6.2	19.0	595	P+ 80	e
ND 2894	GP	47	6.6	103	40.1	41	1.51	3.7	2.9	1981	SC 78	e
ND 5086	GP	47	28.4	103	48.0	45	1.62	3.6	4.7	1449	SC 78	e
ND 3479	GP	48	55.3	102	26.0	40	1.6	4.0	3.0	1800	SC 78	e
NH CONWAY	NE	44	1.0	71	6.0	27	1.9	7.0	8.0	900	KY 80	e
NJ 136	VR	41	7.0	74	35.0	13	0.91	7.0	8.9	1067	D+ 72	e
NJ IBEACH	AC	39	48.5	74	5.6	28			12.9	822	DA 78	e

State, Hole Name, Province Code		Lat. Deg.	Min.	Long. Deg.	Min.	G °C/km	q HFU	k TCU	T_o °C	H m	Ref.	East West
NM GB-1	CO	36	41.0	107	12.0	32	2.01	6.3	10.2	1188	S+ 71	w
NM 3	GP	32	33.6	104	2.0	16	-1.1	6.9	14.4	1829	LA 37	e
NM SUN-1	BR	34	0.8	107	48.0	51	1.75	3.4	13.2	1463	R+ 76	w
NM AZTEC-NORTH	CO	36	54.0	108	1.0	39	1.46	3.7	8.0	860	R+ 75	w
NM AZTEC-NE	CO	36	50.0	107	55.0	40	1.47	3.7	8.6	860	R+ 75	w
NM CARRIZO CK	CO	36	39.0	107	40.0	37	1.26	3.4	8.6	900	R+ 75	w
NM CEDAR HILL	CO	36	57.0	107	59.0	37	1.51	4.1	10.7	1000	R+ 75	w
NM CHACO SLOPE	CO	35	51.0	107	24.0	34	1.49	4.4	18.6	830	R+ 75	w
NM GAVILAN-EAST	CO	36	22.0	106	54.0	29	1.51	5.2	9.9	1400	R+ 75	w
NM MUNOZ CK	CO	36	36.0	107	25.0	28	1.29	4.6	11.8	880	R+ 75	w
NM VERMAJO R	GP	36	45.0	104	53.0	48	1.93	4.0	8.4	1350	R+ 75	w
NM ORGAN-1	BR	32	27.0	106	36.0	36	3.12	8.7	18.9	840	R+ 78	w
NM OROGRANDE	BR	32	25.0	106	7.0	34	2.20	6.5	21.0	600	R+ 78	w
NM CARRIZO	BR	34	48.0	107	8.0	36	1.96	5.4	12.3	820	E+ 78	w
NM CHAPELL	GP	35	16.0	103	51.0	23	1.40	6.1	18.3	1400	E+ 78	e
NM ORTIZ-2	BR	35	19.0	106	10.0	19	1.33	7.0	9.9	720	E+ 78	w
NM QUESTA-2	SR	36	42.0	105	31.0	21	1.74	8.3	3.9	690	E+ 78	w
NM COM-8	CO	36	51.0	107	42.0	39	2.19	5.6	11.7	1878	R+79b	w
NM YSIDRO	CO	35	32.0	106	59.0	39	1.7	4.4	9.3	765	R+79a	w
NM WNUCLEAR28	CO	35	30.0	108	12.6	39			5.4	792	LG 80	w
NM SMITH LAKE29	CO	35	31.8	108	07.2	24			13.9	591	LG 80	w
NM GALLUP	CO	35	39.0	108	31.0	33	1.61	4.9	13.9	570	DB 74	w
NV UCE-18	BR	38	35.0	116	12.0	34	1.28	3.8	24.0	1642	S+ 71	w
NV TN-1	BR	40	20.0	116	43.0	31	3.0	9.7	9.6	1218	S+ 71	w
NV IC-1	BR	40	33.0	117	6.0	31	3.50	11.3	14.3	1410	S+ 71	w
NV UCE-9	BR	38	49.0	116	27.0	39	1.2	3.1	6.3	856	S+ 71	w
NV UCE-10	BR	38	41.0	116	28.0	47	1.2	2.6	14.5	901	S+ 71	w
NV UCE-1	BR	38	34.0	116	56.0	25	1.79	7.2	15.1	623	S+ 71	w
NV PM-1	BR	37	17.0	116	24.0	23	1.0	4.3	19.2	1798	S+ 71	w
NV XD-20	BR	39	16.0	114	59.0	31	1.82	5.9	6.8	600	R+ 68	w
NV 14	BR	39	14.0	115	34.0	35	1.77	5.1	13.8	740	R+ 68	w
NV B-1	BR	38	5.0	114	37.0	27	1.67	6.2	12.6	630	R+ 68	w
NV L-77	BR	38	55.8	119	2.5	31	2.8	9.0	27.9	1194	SA 81	w
NV L-5	BR	38	56.1	119	3.9	28	2.4	8.6	18.8	518	RO 63	w
NV UCE-3	BR	38	58.0	116	38.0	53	2.0	3.8	6.5	589	S+ 71	w
NY FMC-1	CL	43	12.0	78	28.0	21	1.18	5.6	12.6	879	D+ 72	e
NY 1075	NE	44	15.0	75	24.0	9	1.08	12.0	7.5	639	D+ 72	e
NY E-TOWN	NE	44	13.0	73	32.0	18	0.81	4.5	6.6	600	R+ 68	e
NY 1	AP	42	10.0	77	40.5	32	-1.4	4.4	4.8	1295	SP 64	e
NY 14269	CL	42	39.5	78	55.5	17			12.8	567	H+ 81	e
NY 13000	CL	42	32.8	79	0.4	17			14.1	618	H+ 81	e
NY 13689	CL	42	50.9	76	50.8	20			12.0	725	HO 80	e
NY 13675	CL	42	51.9	76	50.3	21			12.0	695	HO 80	e
NY 14324	CL	42	43.9	78	37.4	21			15.2	640	H+ 81	e
NY 14310	AP	42	3.6	79	18.5	22			11.2	1311	H+ 81	e
OH BRBTN	AP	41	1.3	81	37.5	24	1.37	5.7	10.1	855	E+ 82	e
OK P-5	CL	36	59.0	94	52.0	21	1.35	6.4	11.0	640	R+ 68	e
OK OC-2	CL	35	31.1	97	30.0	18			14.7	1219	MC 30	e
OK OC-1	CL	35	26.0	97	27.7	21			12.1	1829	SP 64	e
OK 117	CL	35	28.4	96	12.2	42			16.0	838	MC 30	e
OK 116	CL	36	49.6	96	58.2	40			15.5	914	SP 64	e

State, Hole Name, Province Code		Lat. Deg.	Lat. Min.	Long. Deg.	Long. Min.	G °C/km	q HFU	k TCU	T_o °C	H m	Ref.	East West
OK 114	CL	36	13.5	97	24.4	31			15.3	914	SP 64	e
OK 110	CL	36	44.8	97	21.1	38			16.0	875	SP 64	e
OK HE-7	CL	34	11.7	97	23.6	17			16.4	838	SP 64	e
OK T-16	CL	36	31.4	97	20.2	35			15.3	1067	SP 64	e
OK T-1	CL	36	35.2	97	16.5	35			15.5	860	MC 30	e
OK P-2	CL	35	17.6	96	19.2	43			14.7	991	MC 30	e
OK 128	CL	35	0.2	96	29.9	35			14.5	1067	SP 64	e
OK WE-5	CL	35	9.9	96	27.0	39			15.2	914	MC 30	e
OK W-6	CL	34	25.1	98	15.4	17			17.1	610	SP 64	e
OK SA-1	CL	34	28.2	97	33.4	14			16.3	686	SP 64	e
OK 1	CL	34	54.7	96	31.8	29			14.4	799	SP 64	e
OK B-11	CL	36	55.1	97	13.4	37			14.0	1029	SP 64	e
OK BO-2	CL	35	10.1	96	40.1	29			13.8	991	SP 64	e
OK 29	CL	35	10.8	96	45.6	31			11.3	1067	SP 64	e
OK C-4	CL	35	21.4	96	27.0	41			14.0	914	MC 30	e
OK E-5	CL	35	14.0	96	43.0	32			12.4	914	MC 30	e
OK CU-16	CL	35	56.6	96	34.4	32			13.2	838	SP 64	e
OK HOUGH	GP	36	51.6	101	35.7	28			10.0	1920	BS 82	e
OR 11S/15E-22CD	CP	44	35.6	120	55.1	38	2.03	5.3	16.8	820	H+ 78	w
OR W-1A	PB	46	8.7	123	52.7	31			9.8	1152	VO 38	w
OR BLUE MT	BR	42	19.0	117	54.0	40	1.6	4.0	20.9	565	S+ 76	w
OR OMF7A	CA	45	23.7	121	48.3	60	2.84	4.7	12.5	1801	B+82a	w
OR ORE-IDA	CP	44	1.7	116	57.6	58			25.3	3036	GA 81	w
OR 12S/7E-9DA	CA	44	32.7	121	57.8	69	2.27	3.3	-10.4	600	B+82b	w
OR 11N/6W-3BD	CP	44	09.6	117	02.8	59	2.48	4.2	18.0	611	SM 81	w
OR CORRIN	CP	44	22.1	119	01.7	44			9.4	765	B+82a	w
OR PUCCI	CA	45	19.3	121	42.9	67	2.89	4.3	-1.0	1125	SB 82	w
PA 2	AP	41	52.8	77	59.4	32	1.31	4.1	3.1	1600	JO 60	e
PA 4	AP	41	44.4	77	34.8	30	-1.5	5.0	4.2	1676	SP 64	e
PA 5	AP	41	35.9	78	49.9	29	-1.5	5.2	4.2	2134	SP 64	e
PA 8	AP	40	16.2	79	18.0	28	-1.2	4.3	8.9	2338	VO 30	e
PA 9	AP	40	17.1	79	18.2	30	-1.2	4.0	6.1	2077	SP 64	e
SC DRB-2	AC	33	17.0	81	40.0	16	0.99	6.2	18.2	594	D+ 65	e
SC CHRLSTN	AC	32	53.2	80	21.5	21	1.30	6.2	18.0	792	SZ 77	e
SC WIN-1	PD	34	18.8	81	8.7	20	1.47	7.4	15.5	574	C+ 77	e
TN JOY-1	VR	35	55.0	84	19.0	13	0.82	6.3	14.6	871	DR 63	e
TX SHAFTER	BR	29	48.0	104	24.0	19	1.5	7.9	26.6	880	DS 75	e
TX BL-15	GP	31	14.0	101	41.0	11	-1.1	10.0	20.3	882	HA 30	e
TX L-3	GC	29	43.0	97	44.0	43			20.4	686	HA 30	e
TX M-1	GC	31	41.0	96	31.0	43			18.8	910	HA 30	e
TX PO-1	GC	32	4.0	96	23.0	40			20.2	838	HA 30	e
TX 39B	CL	33	43.0	96	59.0	19			16.7	1122	HA 30	e
TX RA-1	CL	32	27.0	98	39.0	41			18.2	914	SP 64	e
TX 46	CL	33	38.0	100	35.0	15			18.9	732	HA 30	e
TX 40	GP	35	50.0	100	19.0	18			15.5	1450	HA 30	e
TX WOC-1	GC	33	22.0	96	4.0	37			17.1	610	SP 64	e
TX P-2	GP	35	35.0	101	1.0	12			16.2	1044	HA 30	e
TX 47	CL	32	30.0	98	49.0	35			18.4	914	SP 64	e
TX UTW	GC	29	7.2	99	40.9	21	1.11	5.3	23.8	610	KS 72	e
UT W-EX-1	CO	39	59.0	109	36.0	32	1.50	4.7	10.5	960	S+ 71	w
UT RED WASH	CO	40	10.0	109	18.0	27	1.56	5.8	8.2	1463	R+79b	w

State, Hole Name, Province Code		Lat. Deg.Min.		Long. Deg.Min.		G °C/km	q HFU	k TCU	T_o °C	H m	Ref.	East West
UT UP.VALLEY	CO	37	41.0	111	44.0	19	1.52	8.0	19.9	1380	R+79b	w
UT SRS-4	CO	38	46.4	111	3.7	16	1.29	8.1	12.0	560	BC 82	w
UT WSR-1	CO	39	10.7	110	24.1	18	1.58	8.8	13.0	575	BC 82	w
UT MCL-1	CO	38	31.0	109	39.2	24	1.55	6.5	16.0	600	BC 82	w
UT D-142	BR	40	32.0	112	9.0	20	2.3	11.5	4.9	1180	CW 73	w
VA CC-E	VR	36	49.0	81	6.0	10	1.03	10.3	9.8	900	RC 73	e
VA C25A	AC	36	54.1	76	28.8	26	1.94	7.5	20.0	612	P+ 80	e
WA R-4	NR	48	54.4	117	20.4	27	2.25	8.3	9.7	701	RO 63	w
WA RS-1	CP	46	26.0	119	47.0	37	1.39	3.8	12.4	2531	S+ 71	w
WA DH-3	CP	46	21.0	119	17.0	40	1.5	3.8	14.0	697	S+ 71	w
WA SU-4	PB	46	32.0	122	50.0	25	0.83	3.3	10.1	760	S+ 71	w
WA NORCO1	CP	47	22.1	120	18.0	27	1.48	5.5	11.4	900	BL 80	w
WA MO1	PB	47	14.3	124	11.5	28	0.86	3.1	5.2	1067	BL 80	w
DC DRB-3	PD	39	0.0	77	0.0	17	1.12	6.6	12.3	1424	DW 64	e
WV 1	AP	39	20.2	80	12.7	27	-1.2	4.4	5.9	2228	SP 64	e
WV 3	AP	39	25.4	80	2.8	28	-1.2	4.3	7.6	2286	SP 64	e
WV 13	AP	39	16.5	80	45.7	27	1.22	4.5	5.4	2134	JO 60	e
WV 15	AP	40	0.2	80	41.9	25	-1.2	4.8	8.4	1360	SP 64	e
WV P-21	VR	38	9.2	80	0.9	22	-1.2	5.5	9.4	3111	H+ 79	e
WY PINEDALE	WB	42	46.0	109	34.0	16	1.3	8.1	11.4	2996	S+ 71	w
WY SC-26	GP	43	25.0	106	15.0	49			4.4	838	VO 26	w
WY SC-27	GP	43	25.0	106	15.0	43			5.8	808	SP 64	w
WY BM-1	GP	42	50.1	105	59.1	37			8.2	991	SP 64	w
WY RF-2	WB	42	10.5	107	9.4	36			5.6	884	SP 64	w
WY C-2	MR	44	22.4	108	57.0	32			10.0	1295	SP 64	w
WY RR-2	WB	41	39.8	106	7.6	24			8.3	884	SP 64	w
WY RR-3	WB	41	39.2	106	7.2	26			7.7	914	SP 64	w
WY BORIE	GP	41	9.0	104	57.0	35	1.5	4.3	5.3	2134	R+79a	w
WY QUEALY DOME	WB	41	36.0	105	59.0	35	1.5	4.3	8.0	1524	R+79a	w
WY PM	WB	42	18.2	106	47.1	14-	1.30	9.3	4.0$	645	D+ 80	w
WY EBET	MR	45	0.0	108	52.2	30-	1.6	5.3	4.0$	1723	D+ 80	w
WY RAWLINS	WB	41	44.0	107	27.0	15	1.1	7.3	11.7	760	DB 79	w
CN OTTAWA	SU	45	23.7	75	42.9	14	1.01	7.2	7.6	630	JJ 71	e
CN WINNIPEG	CL	49	48.7	97	7.9	11	0.91	8.3	5.9	650	JJ 71	e
CN PENTICON	NR	49	19.8	119	37.6	35	1.86	5.3	10.0	660	JJ 71	w
CN KAPUSK	SU	49	25.0	82	22.8	12	0.78	6.5	2.5	605	CJ 71	e
CN HEARST	SU	49	41.4	83	32.1	16	1.23	7.7	1.4	654	CJ 71	e
CN 66-1	SU	46	25.0	82	40.0	11	1.2	10.9	5.7	900	S+ 68	e
CN M-75	CL	42	6.0	83	1.0	18	1.2	6.7	6.9	945	JB 73	e
CN RUSSELL	SU	45	19.0	75	24.0	20	1.2	6.0	8.1	600	JB 73	e
CN BF-1	CL	43	27.0	80	7.0	14	0.9	6.4	10.7	1100	JB 73	e
CN MML-1	CL	43	40.0	79	52.0	16	1.1	6.9	11.7	710	JB 73	e
CN CG-648	CL	42	59.0	79	11.0	20	1.2	6.0	9.0	1000	JB 73	e
CN DW-7	CL	42	44.0	81	33.0	17	0.9	5.3	7.6	1000	JB 73	e

Table 2. Physiographic province codes used in Table 1 and Figure 1.

AC	Atlantic Coastal Plain	
AP	Appalachian Plateaus	(subprovince of Appalachian Highlands)
BL	Blue Ridge	(subprovince of Appalachian Highlands)
BR	Basin and Range	
CL	Central Lowland	
CA	Cascade Mountains	
CO	Colorado Plateaus	
CP	Colombia Plateaus	
GC	Gulf Coastal Plain	
GP	Great Plains	
IH	Interior Highlands	
MR	Middle Rocky Mountains	
NE	New England and Adirondack AD	(subprovinces of Appalachian Highlands)
NR	Northern Rocky Mountains	
PB	Pacific Border	
PD	Piedmont	(subprovince of Appalachian Highlands)
SN	Sierra Nevada	
SR	Southern Rocky Mountains	
SU	Superior Upland	
VR	Valley and Ridge	(subprovince of Appalachian Highlands)
WB	Wyoming Basin	

Table 3. Reference codes used in Table 1.

A+ 80	Arney and others, 1980
BC 82	Bodell, J. M., and Chapman, D. S., 1982
BE 47	Benfield, A. E., 1947; Spicer, H. C., 1964
BI 54	Birch, F., 1954; Spicer, H. C., 1964
BL 67	Blackwell, D. D., 1967; Blackwell, D. D., and Robertson, E. C., 1973
BL 80	Blackwell, D. D., 1980
BP 76	Brewster, D., and Pollack, H. N., 1976
BS 81	Blackwell, D. D., and Steele, J. L., 1981
BS 82	Blackwell, D. D., and Steele, J. L., 1982
B+ 78	Brott, C. A., and others, 1978
B+ 81	Brott, C. A., and others, 1981; Keys, W. S., and Eggers, D. E., 1980
B+82a	Blackwell, D. D., and others, 1982a; Steele, J. L., and Blackwell, D. D., 1982
B+82b	Blackwell, D. D., and others, 1982b
CA 30	Carlson, A. J., 1930; Spicer, H. C., 1964
CJ 71	Cermak, V., and Jessop, A. M., 1971
CS 73	Combs, J. B., and Simmons, G. 1973; Combs, J. B., 1970
CW 73	Costain, J. K., and Wright, P. M., 1973
C+ 77	Costain, J. K., and others, 1977
DA 78	Dashevsky, S. S., 1978
DB 74	Decker, E. R., and Birch, F., 1974
DB 79	Decker, E. R., and Bucher, G. J., 1979
DM80a	Dashevsky, S. S., and McClung, W. S., 1980a
DM80b	Dashevsky, S. S., and McClung, W. S., 1980b
DR 63	Diment, W. H., and Robertson, E. C., 1963; Urban, T. C., and others, 1974
DS 75	Decker, E. R., and Smithson, S. B., 1975; Decker, E. R., and Birch, F., 1974
DW 64	Diment, W. H., and Werre, R. W., 1964
D+ 65	Diment, W. H., and others, 1965; Urban, T. C., and others, 1974
D+ 72	Diment, W. H., and others, 1972; Urban, T. C., and others, 1974
D+ 80	Decker, E. R., and others, 1980
E+ 78	Edwards, C. L., and others, 1978
E+ 82	Eckstein, Y., and others, 1982
GA 81	Gardner, M. C., 1981
HA 30	Hawtof, E. M., 1930; Spicer, H. C., 1964
HO 80	Hodge, D. S., 1980
HW 71	Henyey, T. L., and Wasserburg, G. J., 1971
H+ 78	Hull, D. A., and others, 1978; Blackwell and others, 1982b
H+ 79	Hobba, W. A., and others, 1979
H+ 81	Hodge, D. S., and others, 1981
JB 73	Judge, A. S., and Beck, A. E., 1973
JJ 71	Jessop, A. M., and Judge, A. S., 1971
JO 60	Joyner, W. B., 1960; Spicer, H. C., 1964
KY 80	Keys, W. S., 1980
KS 72	King, W., and Simmons, G., 1972
LA 37	Lang. W. B., 1937; Spicer, H. C., 1964
LA 68	Lachenbruch, A. H., 1968
LG 80	Levitte, D., and Gambill, D. T., 1980
LS 80	Lachenbruch, A. H., and Sass, J. H., 1980
LW 80	Leonard, R. B., and Wood, W. A., 1980

MC 30	McCutchin, J. A., 1930; Spicer, H. C., 1964
MC 80	McClung, W. S., 1980
N+ 80	Nathenson, M. and others, 1980
P+ 80	Perry, L. D., and others, 1980
RC 73	Reiter, M. A., and Costain, J. K., 1973
RO 63	Roy, R. F., 1963
RS 79	Reiter, M., and Shearer, C., 1979
R+ 68	Roy, R. F., and others, 1968; Decker, E. R., and Roy, R. F., 1974
R+ 75	Reiter, M., and others, 1975
R+ 76	Reiter, M., and others, 1976
R+ 78	Reiter, M., and others, 1978
R+79a	Reiter, M., and others, 1979a
R+79b	Reiter, M., and others, 1979b
R+ 80	Roy, R. F., and others, 1980
SA 81	Sass, J. H., 1981
SB 82	Steele, J. L., and Blackwell, D. D., 1982.
SC 78	Scattolini, R., 1978
SD 80	Scott, J. H., and Daniels, J. J., 1980; Olhoeft, G.R., and others, 1981; Rahman, J. L., and Roy, R. F., 1981
SD 82	Smith, D. L., and Dees, W. T., 1982
SH 79	Shearer, C. R., 1979; Shearer, C., and Reiter, M., 1981
SM 81	Smith, R. N., 1981
SP 64	Spicer, H. C., 1964
SZ 77	Sass, J. H., and Ziagos, J. P., 1977
S+ 68	Sass, J, H, and others, 1968
S+ 71	Sass, J. H., and others, 1971; Munroe, R. J., and Sass, J. H., 1974
S+ 76	Sass, J. H., and others, 1976
S+ 81	Sass, J. H., and others, 1981
U+ 78	Urban, T. C., and others, 1978
VO 26	Van Orstrand, C. E., 1926; Spicer, H. C., 1964
VO 30	Van Orstrand, C. E., 1930; Spicer, H. C., 1964
VO 38	Van Orstrand, C. E., 1938; Spicer, H. C., 1964
VO 41	Van Orstrand, C. E., 1941; Spicer, H. C., 1964
VO 51	Van Orstrand, C. E., 1951; Spicer, H. C., 1964
WM 82	Wang, J., and Munroe, R. J., 1982

Table 4. Holes with two representative gradients. G_1 is near surface gradient to depth H_1, G_2 is assumed be the gradient to 2 km. Total depth TD is logged depth. When TD is less than H_1, deeper gradient is an estimate. G_{av} is the gradient that best represents temperature from a few hundred meters to 2 km. NY 13689 and 13675 have three gradients.

Name	G_1 °C/km	H_1 m	G_2 °C/km	TD m	G_{av} °C/km
AZ 42	50	460	33	610	33
CA USL 1-3	69	610	44	860	49
KS E-14	35	1160	21[a]	737	29
KS Smokyhill	32	1280	21[a]	1050	28
KS Butler	37	1160	21[a]	737	30
KS Rooks	26	1300	21[a]	1045	24
KS Gibsl	45	610	30	1455	33
KS Finegan	47	560	27	1410	30
KS Merz2	37	800	15	1010	24
MD DGT-1J	35	1362	16	980	31
NC Stumpy Pt	43	700	35	1350	35
NC C14A	31	460	19	545	22
NC C15	30	500	16	595	20
NM 3	13	1200	18	1829	16
NV UCE-18	37	1325	25	1642	34
NY 13689	25	320			
	38	560	17	725	20
NY 13675	26	290			
	39	550	18	695	21
NY 14310	28	880	16	1311	22
OR 11S/15E-22CD	47	630	31	820	38
OR OMF7A	67	960	57	1801	60
OR ORE-IDA	70	1200	43	3036	58
OR 11N/6W-3BD	72	400	59	611	59
PA 4	19	680	33	1676	30
PA 5	24	760	30	2134	29
PA 9	26	1100	31	2077	30
SC CHRLSTN	27	820	16	792	21
TX SHAFTER	25	500	17	880	19
VA C25A	32	560	23	612	26
WA R-4	37	460	27	701	27
WV 1	24	1500	36	2228	27
WV 3	24	1400	37	2286	28
WV 13	23	1300	32	2134	27
WV 15	22	950	29	1360	25
WY Quealy Dome	42	1050	29	1524	35
CN DW-7	9	500	26	1000	17

Note: [a] KS 21°C/km based on OK P-5.

Table 5. Statistics for heat-flow data from Lachenbruch and Sass (1977), subset used in this study, and geothermal gradient data.

		East				West			
		Mean	Standard Deviation	$\frac{\sigma}{m}$	Number	Mean	Standard Deviation	$\frac{\sigma}{m}$	Number
Heat flow (HFU)	All data (1977)	1.23	0.37	0.30	129	1.95	0.75	0.38	496
	This study	1.19	0.28	0.24	60	1.82	0.62	0.34	109
Gradients (°C/km)		25	10	0.41	137	34	11	0.31	147

Table 6. Characteristics of gradient data

Contour range, °C/km	Number of areas	Number of data	Number of outliers	Percent outliers
		East		
<15	2	7	0	0
15-24	2	73	12	16
25-34	3.5	30	2	7
35-44	4	27	6	22
Subtotal	11.5	137	20	15
		West		
<15	1	3	0	0
15-24	2	7	0	0
25-34	0.5	78	26	33
35-44	9	50	8	16
>45	2	9	1	11
Subtotal	14.5	147	35	24
Total	26	284	55	19

Table 7. Contour statistics for subset of heat-flow data obtained by measurements in deep wells.

Contour range, HFU	Number of areas	Number of data	Number of outliers	Percent outliers
		East		
<1.0	8	16	2	13
1.0-1.49	1	36	2	6
1.5-2.49	6.5	8	1	13
Subtotal	15.5	60	5	8
		West		
<0.75	1	2	0	0
.75-1.49	7	33	7	21
1.5-2.49	1.5	63	13	21
≥2.5	25	11	4	36
Subtotal	34.5	109	24	22
Total	50	169	29	17

Table 8. Statistics of derived thermal conductivities (mcal/cm sec°C) by physiographic province and east/west division.

Location	mean	Standard deviation	Number of data
Atlantic Coastal Plain	6.2	0.8	8
Appalachian Plateaus	4.6	0.5	11
Blue Ridge, Piedmont, New England and Adirondack, Valley and Ridge	7.1	2.1	12
without 12.0 in NY	6.7	1.5	11
Central Lowland and Interior Highlands	6.9	1.4	21
Great Plains	5.2	1.7	13
Superior Upland	6.7	1.8	9
without 10.9 value in Canada	6.2	1.0	8
Gulf Coastal Plain	5.4	0.7	4
Rocky Mountains and Wyoming Basin	7.3	1.4	15
Colorado Plateaus	5.6	1.7	19
Columbia Plateaus and Cascade Mountains	4.5	0.8	10
Southern Basin and Range	6.7	1.5	25
Arizona part of Southern Basin and Range	6.9	1.4	17
Great Basin	6.3	2.9	16
Sierra Nevada	6.9	0.7	4
Pacific Border (8 points in CA grouped as one point)	4.4	1.4	8
East	6.3	1.7	73
West	5.8	2.0	109
All	6.0	1.9	182

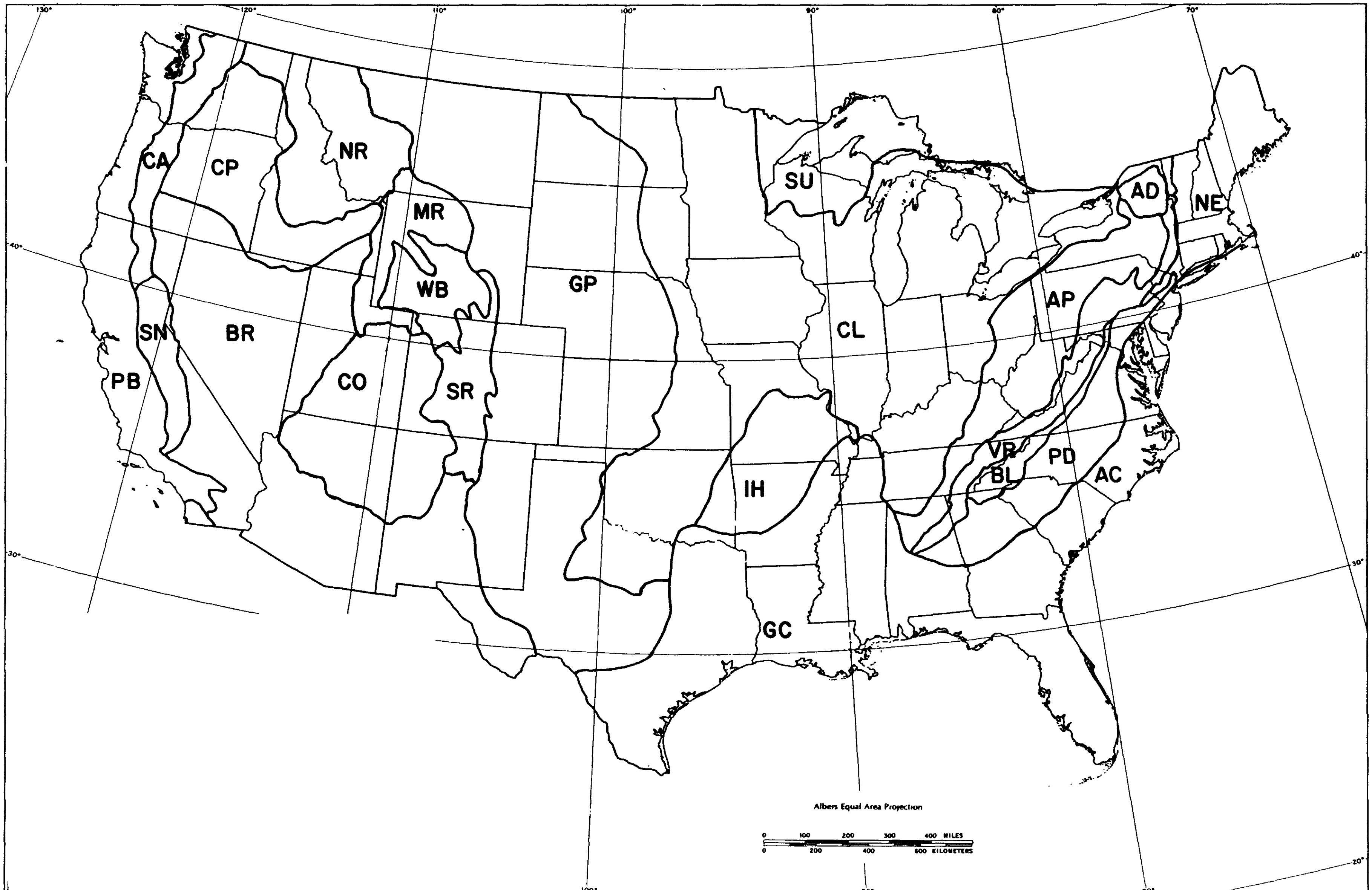

Figure 1. Physiographic provinces in the conterminous United States from Fenneman (1928). Abbreviations given in Table 2.

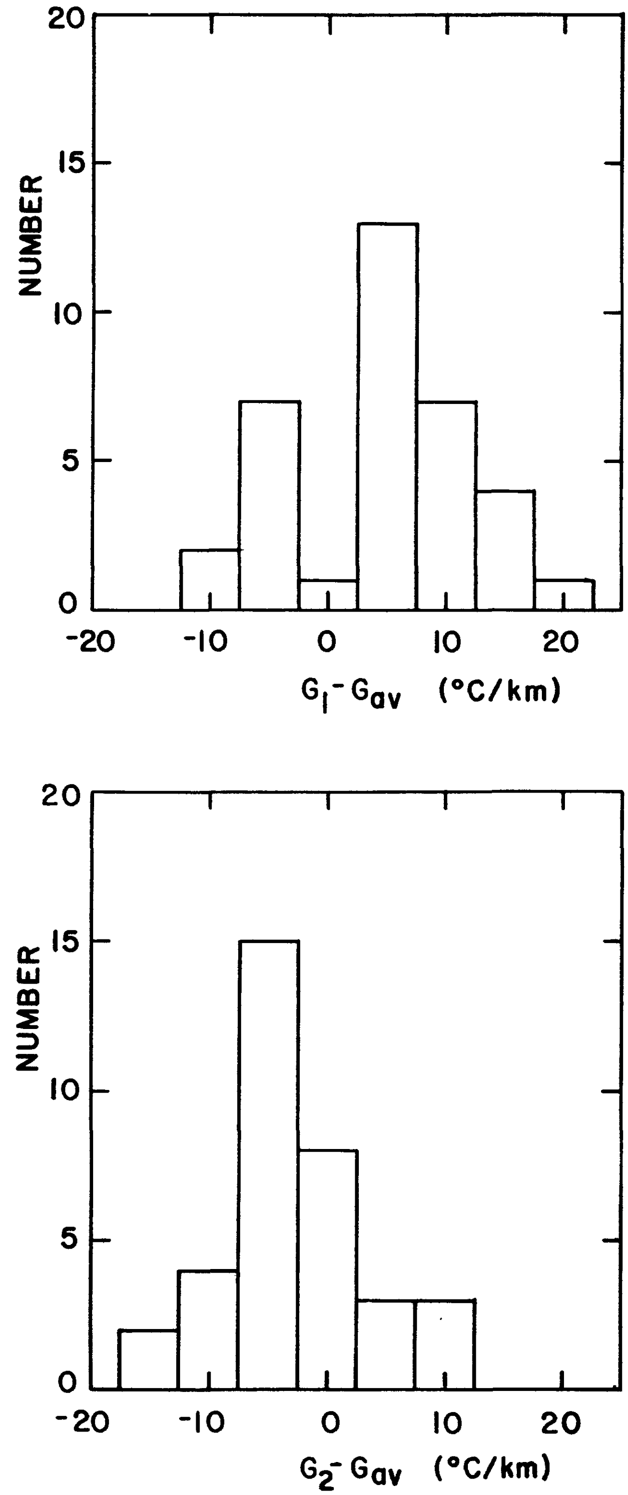

Figure 2. Histograms of upper gradient G_1 minus average gradient G_{av} and lower G_2 gradient minus average G_{av} gradient in holes where there are different gradients over substantial thicknesses in the depth range 0 to 2 km.

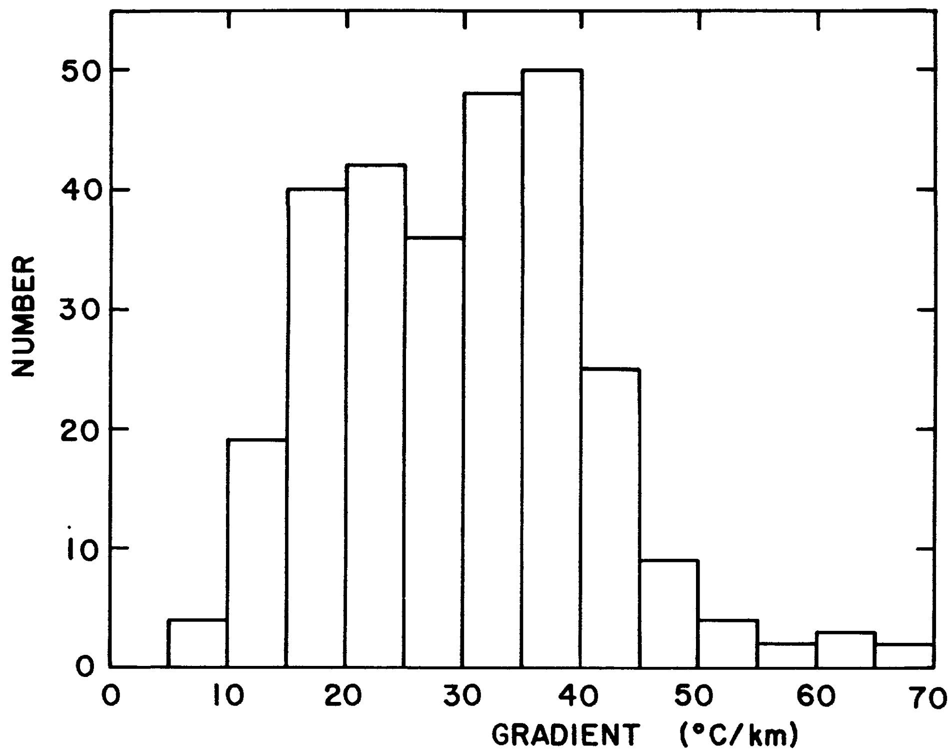

Figure 3. Histogram of gradients obtained from drill holes generally greater than 600 m deep in the conterminous United States.

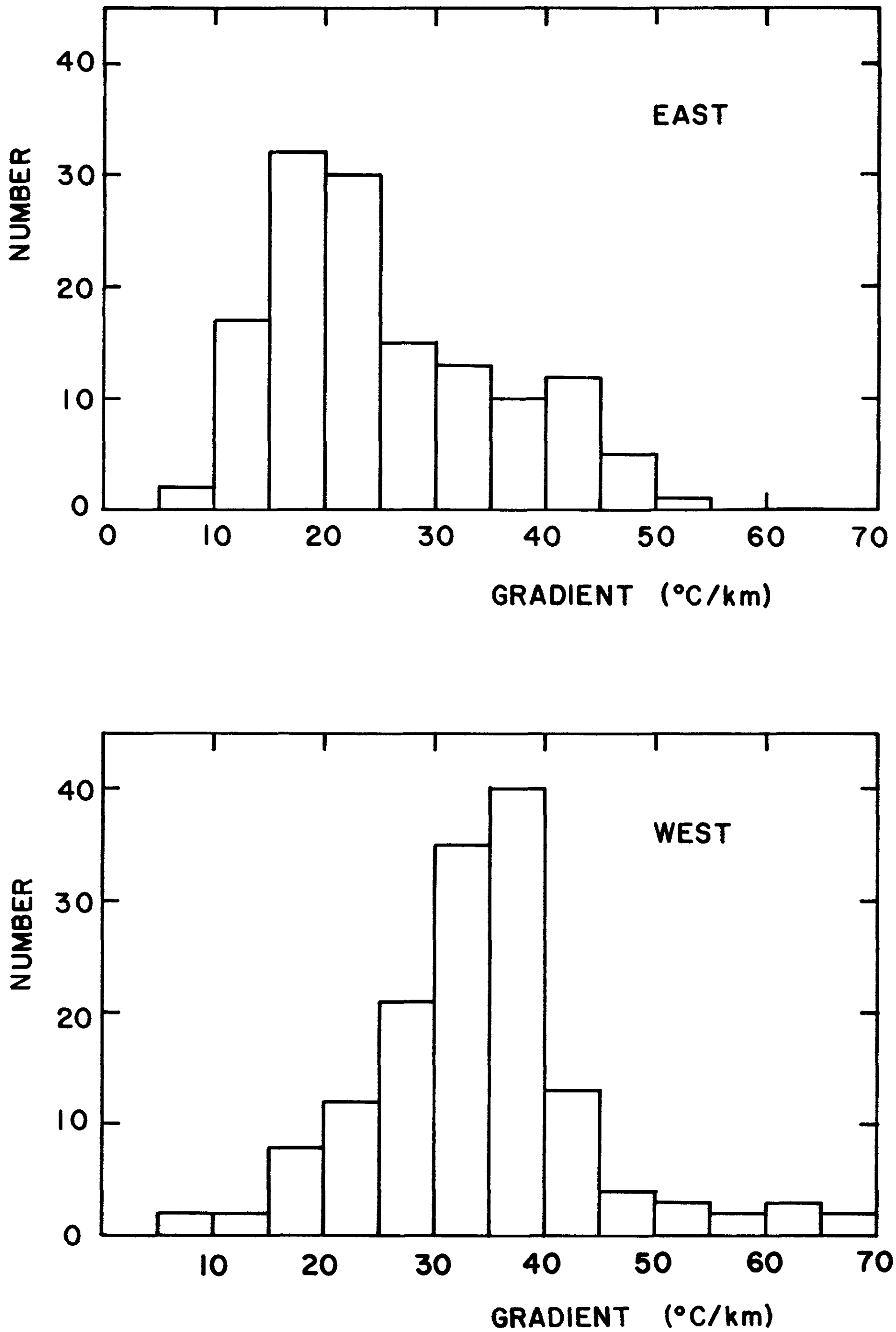

Figure 4. Histograms of gradients in the east and west obtained from drill holes generally greater than 600 m deep in the conterminous United States.

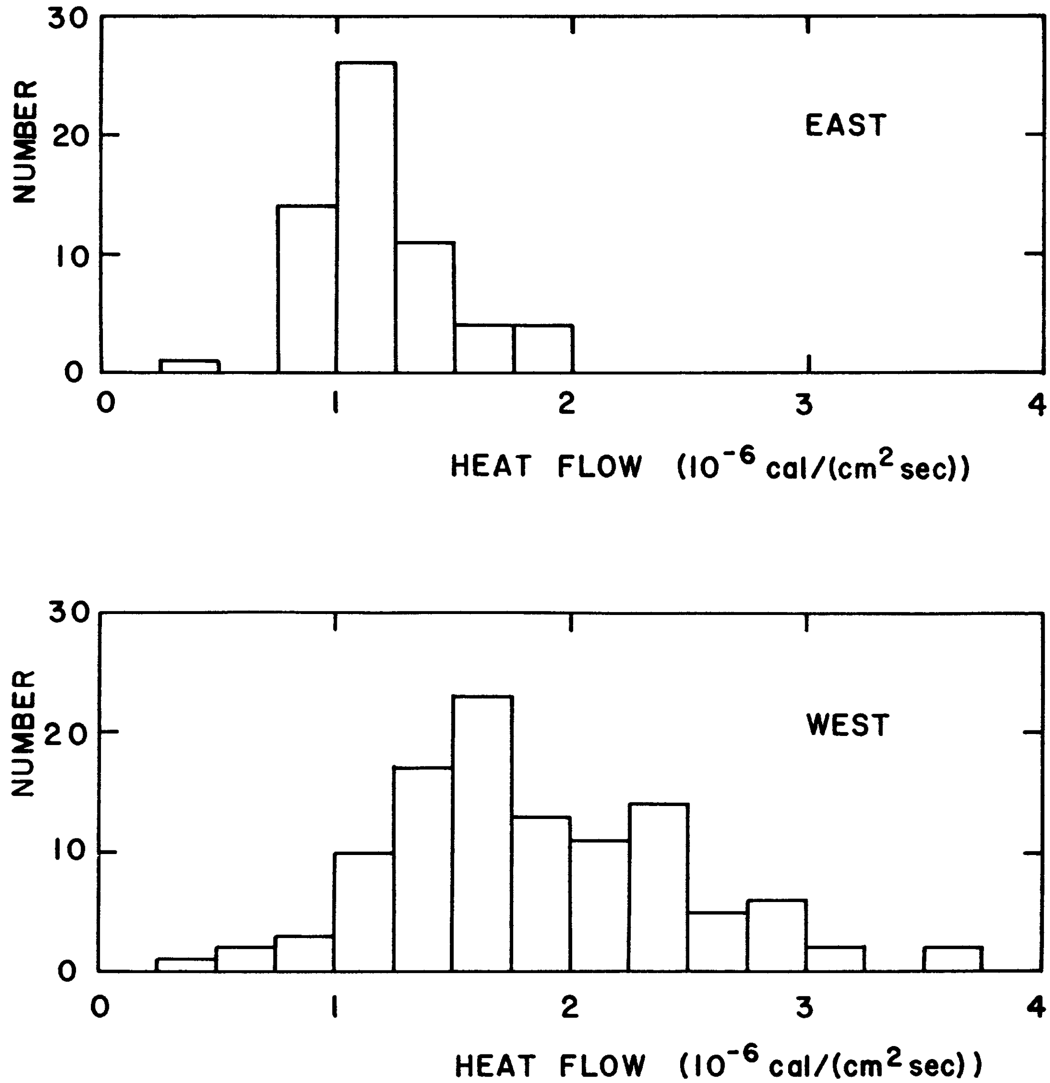

Figure 5. Histograms of heat flows in the east and west obtained from drill holes generally greater than 600 m deep in the conterminous United States.

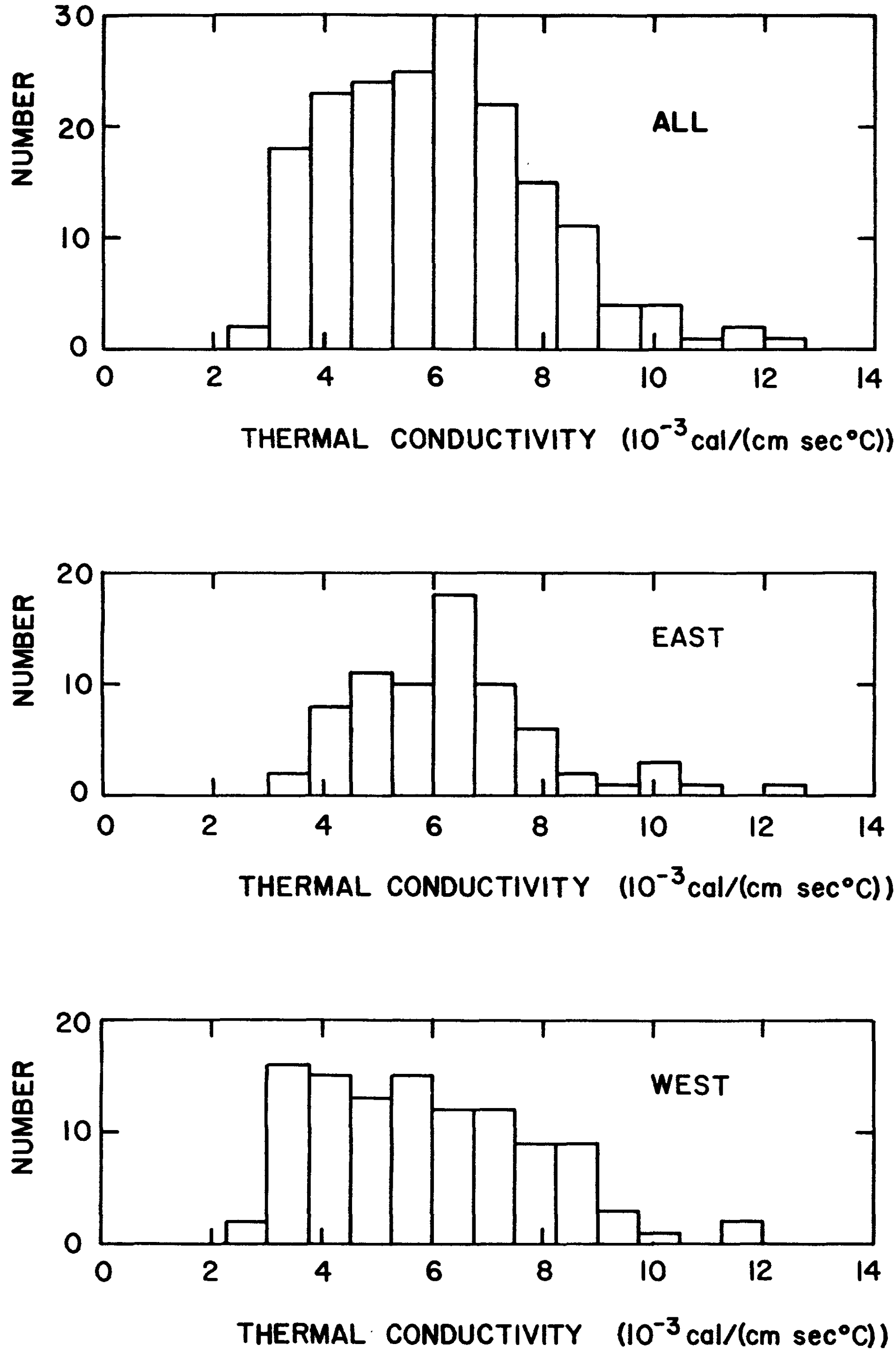

Figure 6. Histograms of derived thermal conductivity values for conterminous U.S., east, and west. See text for method of calculation.