UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Estimating Heat Capacity and Heat Content of Rocks[1]

by

E. C. Robertson[2] and B. S. Hemingway[3]

Open-file Report 95-622

---

[1] This report is preliminary and has not been edited or reviewed for conformity with Geological Survey editorial standards.

[2] Scientist Emeritus, U. S. Geological Survey, Reston, VA 22092

[3] U. S. Geological Survey, Reston, VA 22092

Abstract

New heat-capacity measurements are reported for four rock types; Westerly granite from Bradford, RI, andesite from Lake County, OR, peridotite from Sonoma County, CA, and basalt from the Columbia River Group. Measurements were made on powders of the rocks in the temperature range of 340 to about 1000 K.

Our measured heat-capacity values for rocks and other measurements of heat capacity or heat content of rocks found in the literature have been compared with estimated rock heat capacities calculated from the summation of heat capacities of both minerals and oxide components. The validity of calculating the heat content or heat capacity of rocks to better than about ± 3% from its mineral or chemical composition is well demonstrated by the data presented here.

Introduction

Knowledge of the heat content ($J \cdot mol^{-1}$) and/or heat capacity ($J \cdot mol^{-1} \cdot K^{-1}$, or specific heat, $J \cdot g^{-1} \cdot K^{-1}$) of rocks and minerals is necessary for modelling, controlling, redesigning and refining, and developing industrial processes and in modelling and interpreting geologic processes. Such processes range from extraction of elements such as aluminum and vanadium from rock; to modelling the evolution of subducting plates and generation of magma; to containment of radioactive and hazardous waste. Examples drawn from recent literature include Somerton (1992) who describes the use of heat capacity data as applied to the recovery of petroleum from old or low yield reservoirs and Jacobs et al. (1992) who describe "In Situ Vitrification" as a method of containing radioactive and hazardous waste.

The heat content is the quantity of most general use in the types of calculations cited above. Although commercial instrumentation for the direct measurement of heat capacities at super ambient temperatures has been available for about 20 years, most of the super ambient data for minerals and rocks have been developed using drop calorimeters that measure the heat content. The heat capacity is the first derivative of the heat content. Good heat capacity measurements can easily be integrated to give better detail in the heat content than can be obtained from direct heat-content measurements, and this may be critical for some processes. Measured heat-content values are commonly known to ±0.5%, but the first derivative has a larger uncertainty and the derived values can vary with the form of the fitting equation. Where heat-capacity values are critical to a process, derivation of the heat capacity must be done carefully.

Few measurements of the heat capacity or heat content of rocks are available. Measurement of one of these properties for all the compositions of rocks for which model calculations may be necessary is a much more time consuming and expensive task than calculation of the quantity to the accuracy necessary from data that already exist. This report provides a method for estimating the heat capacity of rocks to better than ± 5%.

Measured rock heat capacity or heat content

Previous measurements of the heat capacity or heat content of rocks are essentially limited to the following studies. Lindroth and Krawza (1971) published heat-content values for six rock types at temperatures between 25° and 1000°C (St. Cloud gray granodiorite, Holston limestone, Sioux quartzite, Rockville quartz monzonite, Salem limestone, and Dresser basalt). Somerton (1958) graphically presented heat-capacity values at temperatures between 77° and 1000°F for six rock types that were calculated from heat-content measurements (sandstone, two silty sands, two siltstones, and shale). Somerton (1992) presented the experimental values from Somerton (1958) in tabular form. Robie et al. (1970), Robie and Hemingway (1971), and Hemingway et al. (1973) published heat-capacity values for lunar basalts and soils for temperatures between 90 and 350 K. Goranson (1942) lists heat capacity values for rocks derived from pre-1925 literature and some estimates. The data are for the temperature range of 0° to 1200° C, but chemical or mineralogical characterization of the samples is poor.

Estimating the heat capacity and heat content of rocks

Modifications of the Neumann-Kopp rule (Swalin, 1962) to estimate heat capacities have been cited in several studies (Somerton, 1958 and 1992; Wechsler and Glaser, 1964; and Lindroth and Krawza, 1971). The rule states that the heat capacity of a solid can be calculated from the weighted sum of the heat capacities of the elements forming the solid. Wechsler and Glaser (1964) claim that specific heats for nearly all rock systems may be calculated to ±10% using this rule. However, for the refinement of industrial processes and for other studies ±10% is not adequate. Somerton (1958, 1992) modified the rule and used the heat capacities of oxides to calculate specific heats for the sedimentary rock types listed above. Somerton found agreement to ±2% between measured and calculated specific heats. He calculated fictive values for oxide components such as H_2O and CO_2 that have standard states (liquid and gas) that differ from the state of those components in the rock by taking the difference in the heat capacities between an hydroxide or carbonate phase and the corresponding oxide phase, that is $Mg(OH)_2 - MgO$ or $CaCO_3 - CaO$. Finally, Lindroth and Krawza (1971) argued that heat capacities or heat contents must be measured to be accurate, citing variations in rock structure and composition that can effect the representative chemical and mineralogical analyses as critical factors.

This study corroborates the use of the modified Neumann-Kopp rule for estimating heat contents, heat capacities or specific heats for rocks from their chemical analyses. We have measured the specific heats of four U.S. Geological Survey standard rock samples (Chayes, 1951; Schlecht and Stevens, 1951; and Flanagan, 1967) and have compared the calculated values with those measured values. Similar comparisons were made between the measured values obtained from the literature on other rock samples and the values calculated from standard equations for minerals and oxides. Good agreement is found for all rock systems examined.

The specific heat of the four USGS silicate rock standards (in the form of fine powders) have been measured using a differential scanning calorimeter; the procedures are described by Hemingway et al. (1984). The results are listed in Table 1. Smoothed values of the specific heat (in J/g) for these rock standards may be calculated from the equations given in Table 2. The samples and the chemical compositions are described by Flanagan (1967). Sample G-2 is Westerly granite from Bradford, RI, AGV-1 is andesite from Lake County, OR, PCC-1 is peridotite from Sonoma County, CA, and BCR-1 is basalt from the Columbia River Group, WA and OR. Small amounts of H_2O (presumably adsorbed on the powder) were lost from each sample during the measurements. At temperatures above about 650 K, sample PCC-1 lost significant H_2O, presumably the result of the breakdown of a hydrous mineral (lizardite, Flanagan, 1967). Specific-heat measurements for PCC-1 were terminated at that temperature and the measured values were extrapolated to 750 K. Measurements of the remaining three samples were extended to about 1000 K. The chemical analyses for these rocks and for other samples for which comparison calculations are made are listed in Table 3.

A comparison of the measured specific heats and specific heats estimated from the modified Neumann-Kopp rule are presented in Table 4 for the four USGS rocks measured in this study. Comparisons were made using both minerals and oxides for separate estimations of specific heats. Representative values for the heat capacity and molar mass are given in Table 5 (mineral and oxide data from Robie and Hemingway, 1995) and Table 6 (values for fictive phases like crystalline H_2O and CO_2). For Table 4, the mineral compositions of the rocks were taken from petrographic studies of the rocks given in Flanagan (1967) and Chayes (1951) and from the X-ray diffraction tests by our Survey colleague, Howard T. Evans, Jr., (written communication, 1993). The estimate based on the oxides was calculated directly from the chemical analysis. Values are given in the measurement column (Obs) for 300 K. These values are based on unconstrained extrapolations that may have significant error. At temperatures near 1000 K, the heat-capacity equations are constrained by only a few data points and thus have a larger uncertainty than the ±1% that is the norm for differential scanning calorimetric measurements. Heat-capacity values were calculated from the heat-capacity equations given in Robie et al. (1979), with the exception of H_2O, CO_2, F_2, and silica glass (which is discussed below). Equations for the heat capacity of H_2O, CO_2 and F_2 in the crystalline phases (Table 6) in the rocks were calculated as the difference between the equations for two appropriate phases (e.g., $CaCO_3$ - CaO, as discussed above). Quartz was used in calculations based on mineral compositions where quartz was or was expected to be present, but silica glass was used in the calculations based on the oxides. This is because quartz has an α-β phase change and an associated heat-capacity anomaly near 844 K. A recent analysis (Richet, et al., 1982) suggests that the heat capacity for silica glass at 298.15 K that was used by Robie et al. (1979) is significantly low (about 14%). At higher temperatures the equations of the two groups are in good agreement. The results calculated in this study support the analysis of Richet et al. (1982), because the values based on the oxides and calculated from the equations of Robie et al. (1979) are anomalous at 300 K and the magnitude of the anomaly varies directly with the silica glass content.

Bearing in mind these comments, the specific heat, and thus the heat content, of these rocks can be estimated to better than ± 5% using either minerals or oxides as the basis for the estimate. A review of the results presented in Table 4 shows that the calculations based on the summation of the specific heats of minerals are somewhat better than those based on the oxide heat capacities. Either method is most likely adequate for modelling calculations.

Heat-capacity (or specific-heat) measurements generally provide a better definition of the enthalpic anomalies associated with phase changes than do heat-content measurements. However, equations that faithfully reproduce the heat-capacity (or specific heat) anomalies are generally complex and difficult to work with, and often provide more information than is necessary for analysis of a problem. The general practice in fitting experimental heat-capacity data in the region of a heat-capacity anomaly has been to use fairly simple equations for the measurements above and below the transition. An enthalpy of transition that accounts for the difference between the observed heat capacities and the fitted equations is then reported. Even simple equations can reproduce some of the pre-transition increase in heat capacity, and this practice provides a good description of the heat capacity except within about ±10 K of the transition. Thus the calculated values (from the minerals) for sample AGV-1 (Table 4) show an anomalous increase near 850 K that reflects the contribution of the heat-capacity anomaly in magnetite. The observed data set for sample AGV-1 was sparse in this region and was fit to one equation which would obscure contributions from a heat capacity anomaly from a minor mineral. In this example, the calculated values are probably better than the measured values. But the example is cited to illustrate the caveat that care must be exercised in selecting the representative mineral phases for such calculations.

The results of Lindroth and Krawza (1971) were refit and equations for the specific heats of the six rocks (Table 3, analyses 5 - 10) are given in Table 2. Lindroth and Krawza (1971) fit the heat content data for the Dresser basalt, Rockville granite, St. Cloud granite, and Sioux quartzite with two equations, breaking the data sets at the temperature of the quartz phase change. This treatment is not appropriate for rocks that contain only small (or no) quantities of the mineral quartz. The Rockville granite contains about 30% quartz by volume. A two equation fit to this data set was better below the quartz transition temperature, but the values at 744° C appear to be significantly in error and cause the fit for temperatures above the quartz transition to be anomalous. Therefore, the equation fit to temperatures below the quartz transition was selected for the Rockville granite. For temperatures above the quartz transition, the measured values for the Rockville granite were equivalent to those reported for the St. Cloud granite so the equation derived for the latter rock was used. The St. Cloud granite is actually a granodiorite having only about 17% (by volume) quartz. The Dresser basalt has no quartz. However, the fit to the Dresser basalt heat-content data yields a maximum in the derived heat capacity in the 750 to 800 K temperature interval. This is likely caused by the dehydration of a hydrous mineral. Even in samples that appear fresh, the Dresser basalt is an altered rock that contains hydrous minerals.

The results of Lindroth and Krawza (1971) as derived from the equations given in Table 2 are compared to estimated values calculated from equations for the oxides in Table 7. The deviations are comparable to those found in Table 4. As noted above, a hydrous mineral likely dehydrated during the measurements of the Dresser basalt. That is probably the explanation for the large deviation of the observed and calculated results at 1000 K. Clinochlore is a likely candidate mineral that occurs in weathered basalt and that dehydrates in the temperature interval (Chernosky et al., 1988) where the heat capacity appears anomalously high. This effect can be illustrated by the difference in the heat capacity of $Mg(OH)_2$ and the sum of the heat capacities of MgO and steam, all at 900 K, which is about 20% (112.59 vs 90.56 J, respectively).

The results of Somerton (1958, 1992) are compared with values calculated from oxide summations in Table 8. Again, good agreement is achieved, but some differences lie outside the ±2%

found by Somerton.

Conclusions

The validity of obtaining the heat content of a rock from its mineral or chemical composition has been well demonstrated by the data assembled here. The importance of this result lies in the very great difficulty of measuring the heat content of any rock at even one temperature, much less an extended temperature range. Corrections for real rocks may be needed to account for porosity with air, water, or other fluids in the pores.

Comparisons of measured specific heats with calculated values for four rocks, reported in this paper, indicate a precision of the values calculated from the mineral compositions of about ± 1%, and of the values calculated from the chemical compositions is about ± 3%.

Both natural and man-made processes in the earth almost inevitably require heat exchange. Geothermal power and secondary oil recovery require fluid flow, but the rocks are the ultimate reservoir for heat exchange. Applications can be made to magma generation and movement, as well as to static problems such as storage of nuclear waste and radiative heating by sun.

References

Chayes, Felix, 1951, Part 5. Modal analyses of the granite and diabase test rocks: in A cooperative investigation of precision and accuracy in chemical, spectrochemical and modal analysis of silicate rocks, U. S. Geological Survey Bulletin 980, 59-68.

Chernosky, J. V., Jr., Berman, R. G., and Bryndzia, L. T., 1988, Stability, phase relations, and thermodynamic properties of chlorite and serpentine group minerals, in Hydrous Phyllosilicates (exclusive of micas), ed., Bailey, S. W., Mineralogical Society of America, Reviews of Mineralogy, v. 19, Chapter 9, 295-346.

Flanagan, F. J., 1967, U. S. Geological Survey silicate rock standards: Geochimica et Cosmochimica Acta, v. 31, 289-308.

Goranson, R. W., 1942, Heat capacity; heat of fusion, in Handbook of Physical Constants, ed., Birch, F., Geological Society of America, Special Paper 36, Section 16, 223-242.

Hemingway, B. S.,Robie, R.A., Kittrick, J. A., Grew, E. S., Nelen, J. A., and London, D., 1984, The thermodynamic properties of two natural chlorites to 500 K, the heat capacities of osumilite from 298.15 to 1000 K, and the thermodynamic properties of petalite to 1800 K: American Mineralogist, v. 69, 1205-1215.

Hemingway, B. S., Robie, R. A., and Wilson, W. H., 1973, Specific heats of lunar soils, basalts, and breccias from the Apollo 14, 15, and 16 landing sites, between 90 and 350°K: Geochimica et Cosmochimica Acta, Supplement 4, Pergamon Press, New York, 2481-2487.

Jacobs, G. K., Dunbar, N. W., Naney, M. T., and Williams, R. T., 1992, Petrologic and geophysical studies of an artificial magma: EOS, 73, 401.

Lindroth, D. P. and Krawza, W. G., 1971, Heat content and specific heat of six rock types at temperatures to 1,000° C: U. S. Bureau of Mines Report of Investigations 7503, 24p.

Richet, P., Bottinga, Y., Denielou, L., Petitet, J. P., and Tequi, C., 1982, Thermodynamic properties of quartz, cristobalite and amorphous SiO_2: drop calorimetry measurements between 1000 and 1800 K and a review from 0 to 2000 K: Geochimica et Cosmochimica Acta, 46, 2639-2658.

Robie, R. A. and Hemingway, B. S., 1971, Specific heats of the lunar breccia (10021) and olivine dolerite (12018) between

90° and 350°Kelvin: Proceedings of the Second Lunar Science Conference, The M.I.T. Press, Cambridge, MA, v. 3, 2361-2365.

Robie, R. A. and Hemingway, B. S., 1995, Thermodynamic properties of minerals and related substances at 298.15 K and 1 bar (10^5 Pascals) pressure and at higher temperatures: U. S. Geological Survey Bulletin 2131, 461 p.

Robie, R. A., Hemingway, B. S., and Fisher, J. R., 1979, Thermodynamic properties of minerals and related substances at 298.15 K and 1 bar (10^5 Pascals) pressure and at higher temperatures: U. S. Geological Survey Bulletin 1452, 456 p.

Robie, R. A., Hemingway, B. S., and Wilson, W. H., 1970, Specific heats of lunar surface materials from 90 to 350 degrees Kelvin: Science, v. 167, 749-750.

Schlecht, W. G. and Stevens, R. E., 1951, Part 2. Results of chemical analysis of samples of granite and diabase: in A cooperative investigation of precision and accuracy in chemical, spectrochemical and modal analysis of silicate rocks, U. S. Geological Survey Bulletin 980, 7-11.

Somerton, W. H., 1958, Some thermal characteristics of porous rocks: Journal of Petroleum Technology, v. 10, No. 5, 61-64.

Somerton, W. H., 1992, Thermal properties and temperature-related behavior of rock/fluid systems, Developments in Petroleum Science 37, Elsevier, New York, Chapter 2, 8-21.

Swalin, R. A., 1962, Thermodynamics of solids: John Wiley & Sons, Inc., New York, pp. 60-61.

Wechsler, A. E. and Glaser, P. E., 1964, Research directed toward the study of heat transfer in complex rock systems: Prepared for Air Force Cambridge Research Laboratories by Arthur D. Little, Inc., AFCRL-64-738, September 1964, pp. 20-21.

Table 1. Specific heats for several rock types at selected temperatures. Temperature in K, heat-capacity values in $J \bullet g^{-1} \bullet K^{-1}$.

Temperature	G-2	AGV-1	PCC-1	BCR-1
338.7	0.8118	0.8015	0.9101	0.7973
348.8	0.8227	0.8138	0.9222	0.8083
358.8	0.8334	0.8260	0.9349	0.8240
368.9	0.8452	0.8371	0.9469	0.8390
379.0	0.8557	0.8493	0.9584	0.8553
389.0	0.8681	0.8594	0.9703	0.8701
399.1	0.8786	0.8714	0.9810	0.8833
409.1	0.8871	0.8810	0.9902	0.8896
419.2	0.8957	0.8933	1.002	0.8998
429.3	0.9051	0.9054	1.011	0.9033
439.3	0.9111	0.9153	1.021	0.9102
449.4	0.9198	0.9277	1.032	0.9185
459.4	0.9277	0.9378	1.043	0.9247
469.5	0.9384	0.9478	1.055	0.9341
479.6	0.9437	0.9538	1.063	0.9393
489.6	0.9550	0.9635	1.075	0.9449
499.7	0.9627	0.9701	1.085	0.9524
509.7	0.9748	0.9724	1.094	0.9585
519.8	0.9814	0.9742	1.101	0.9639
529.9	0.9945	0.9819	1.110	0.9732
539.9	1.006	0.9885	1.119	0.9773
549.0		0.9967	1.128	0.9846
539.9	1.005	0.9833	1.122	0.9808
550.0	1.011	0.9891	1.126	0.9871
560.0	1.009	0.9906	1.125	0.9892
570.0	1.017	1.000	1.136	0.9993
580.2	1.019	1.002	1.137	0.9952
590.2	1.019	1.008	1.138	1.000
600.3	1.026	1.011	1.144	1.002
610.3	1.031	1.017	1.151	1.006
620.4	1.043	1.020	1.154	1.015
630.5	1.050	1.026	1.161	1.016
640.5	1.061	1.032	1.168	1.021
649.6	1.067	1.034	1.181	1.030
640.5	1.057	1.032		1.024
650.6	1.064	1.037		1.018
660.7	1.069	1.042		1.028
670.7	1.072	1.048		1.036
680.8	1.075	1.052		1.038
690.8	1.076	1.053		1.044
700.9		1.060		1.050
711.0	1.089	1.060		1.047
721.0	1.090	1.066		1.049
731.1		1.068		1.055
741.1	1.106	1.070		1.048
750.2	1.123			1.059
761.3	1.116	1.081		1.067

Table 1. Continued.

Temperature	G-2	AGV-1	PCC-1	BCR-1
771.3	1.119	1.080		1.066
781.4	1.131	1.085		1.071
791.4	1.134	1.090		1.075
800.5		1.101		1.086
771.3				1.051
781.4				1.056
791.4				1.057
801.5				1.065
811.6				1.068
820.6				1.066
821.6		1.090		
831.7		1.088		
841.7		1.093		
851.8		1.096		
860.9		1.109		1.079
929.9	1.164			
948.5		1.135		1.097

Table 2. Equations[1] for the specific heat of several rock types.

Sample	a_1	a_2	a_3	a_4	Valid range
G-2	2.29354	-1.9986	2.0526	-29.3049	298 - 1000K
AGV-1	1.61648	-0.47131	-0.68382	-13.5460	298 - 1000K
PCC-1	3.99066	-9.9989	4.54157	-57.6564	298 - 650K
BCR-1	1.65291	-0.9541	-0.89296	-13.5666	298 - 1000K
DB[2]	1.95807	-4.4	-4.81952	-10.9362	298 - 1273K
RG[2]	2.43251	-4.286	-0.22667	-26.7659	298 - 844K
GG[2]	0.67797	1.594	-7.38482	12.647	298 - 1273K
SQ[2]	-5.20995	31.06	-19.00936	121.7236	298 - 844K
SQ[2]	1.12843	0.506			844 - 1273K
BL[2]	-2.78857	17.08	-15.36498	81.0669	298 - 1140K

[1] Specific heat equation: $C_P = a_1 + a_2 \bullet 10^{-4} T + a_3 \bullet 10^{4} T^{-2} + a_4 T^{-0.5}$, values in $J \bullet g^{-1} \bullet K^{-1}$.

[2] DB - Dresser basalt; RG - Rockville granite; GG - St. Cloud gray granite; SQ - Sioux quartzite; BL - Salem limestone, commercial name is Bedford limestone. These equations were developed from the data of Lindroth and Krawza (1971) using a commercial spreadsheet.

Table 3. Chemical analyses of selected rocks.

	1	2	3	4	5	6	7	8
SiO_2	69.20	59.00	41.92	54.10	63.48	66.26	48.42	97.84
Al_2O_3	15.42	17.10	0.77	13.70	15.62	15.62	15.23	0.87
Fe_2O_3	1.01	4.35	2.72	3.24	1.85	1.04	6.60	0.27
FeO	1.49	2.07	4.93	9.07	2.70	2.58	6.70	0.25
MgO	0.76	1.50	43.35	3.47	2.23	0.70	6.14	0.05
CaO	1.98	4.89	0.40	6.91	4.15	2.65	8.35	0.81
Na_2O	4.05	4.23	0.00	3.26	3.59	3.51	2.30	0.02
K_2O	4.46	2.87	0.01	1.69	3.58	4.85	0.58	0.03
H_2O^+	0.47	0.69	4.54	0.50	0.59	0.47	2.26	0.32
H_2O^-	0.18	1.46	0.67	1.24	0.11	0.10	0.14	0.08
TiO_2	0.47	1.05	0.01	2.25	0.56	0.46	1.90	0.02
P_2O_5	0.28	0.49	0.00	0.35	0.21	0.13	0.17	0.009
MnO	0.04	0.10	0.12	0.19	0.05	0.06	0.18	<0.05
CO_2	0.08	0.01	0.18	0.02	---	---	---	---
Cl	0.01	0.02	0.01	0.01	---	---	---	---
F	0.13	0.04	0.00	0.05	---	---	---	---
S	0.01	0.00	0.00	0.04	0.071	0.016	0.033	0.011
Cr_2O_3	---	---	0.42	---	---	---	---	---
NiO	---	---	0.30	---	---	---	---	---
BaO	0.22	0.13	0.01	0.06	---	---	---	---
Totals	100.11	100.00	100.36	100.15	98.68	98.35	98.86	100.55

Table 3. Continued.

	9	10	11	12	13	14	15	16
SiO_2	0.34	0.06	67.67	66.02	67.50	66.04	66.42	66.98
Al_2O_3	<0.06	<0.06	17.29	17.66	17.66	18.10	17.01	15.42
Fe_2O_3	0.11	0.11	3.78	4.01	3.24	4.39	4.13	6.15
FeO	0.03	0.03	---	---	---	---	---	---
MgO	0.56	0.28	1.55	1.44	1.70	1.39	1.66	1.96
CaO	55.02	55.86	1.96	2.49	2.08	1.38	3.02	2.22
Na_2O	0.03	0.02	1.84	1.85	1.84	1.86	1.88	0.97
K_2O	0.02	0.01	1.02	1.03	1.02	1.03	0.54	---
H_2O^+	---	---	2.84	3.45	2.91	3.74	3.28	2.78
H_2O^-	0.01	0.04	---	---	---	---	---	---
TiO_2	0.01	0.01	---	---	---	---	0.17	---
P_2O_5	0.004	0.057	---	---	---	---	---	---
MnO	<0.05	<0.05	---	---	---	---	---	---
CO_2	42.75	43.48	2.05	2.05	2.05	2.07	1.89	3.52
Cl	---	---	---	---	---	---	---	---
F	---	---	---	---	---	---	---	---
S	0.062	0.016	---	---	---	---	---	---
Cr_2O_3	---	---	---	---	---	---	---	---
NiO	---	---	---	---	---	---	---	---
BaO	---	---	---	---	---	---	---	---
Totals	99.83	100.37	100.00	100.00	100.00	100.00	100.00	100.00

1. G-2, Westerly granite; 2. AGV-1, andesite; 3. PCC-1, peridotite; 4. BCR-1, basalt; 5. gray granite; 6. Rockville granite; 7. Dresser basalt; 8. quartzite; 9. Bedford limestone; 10. Tennessee marble; 11. (2) sandstone; 12. (3) silty sand; 13. (4) silty sand; 14. (5) siltstone; 15. (6) siltstone; 16. (7) shale. Analyses 1 - 4 from Flanagan (1958), 5 - 10 from Lindroth and Krawza (1971), and 11 - 16 from Somerton (1958).

Table 4. Comparison of measured (Obs) and calculated specific-heat values for U.S. Geological Survey standard rock samples.

		Minerals		Oxides	
Temp. K	Obs $J \bullet g^{-1} \bullet K^{-1}$	Calc $J \bullet g^{-1} \bullet K^{-1}$	Diff %	Calc $J \bullet g^{-1} \bullet K^{-1}$	Diff %
		G-2			
300	0.7697	0.7621	-1.0	0.7746	0.6
350	0.8247	0.8336	1.1	0.8502	3.1
400	0.8766	0.8920	1.8	0.9109	3.9
450	0.9235	0.9406	1.8	0.9613	4.1
500	0.9652	0.9818	1.7	1.0044	4.1
550	1.002	1.0174	1.5	1.0421	4.0
600	1.034	1.0488	1.4	1.0756	4.0
650	1.063	1.0772	1.3	1.1059	4.0
700	1.088	1.1031	1.4	1.1335	4.2
750	1.110	1.1275	1.6	1.1591	4.4
800	1.130	1.1506	1.8	1.1830	4.7
850	1.147	1.1778	2.7	1.1604	1.2
900	1.162	1.1463	-1.4	1.1710	0.8
950	1.176	1.1578	-1.5	1.1811	0.4
1000	1.188	1.1697	-1.5	1.1948	0.6
		AGV-1			
300	0.7556	0.7663	1.4	0.7724	2.2
350	0.8326	0.8366	0.5	0.8466	1.7
400	0.8910	0.8929	0.2	0.9053	1.6
450	0.9370	0.9385	0.2	0.9529	1.7
500	0.9744	0.9762	0.2	0.9925	1.9
550	1.005	1.0078	0.3	1.0260	2.0
600	1.032	1.0349	0.3	1.0547	2.2
650	1.054	1.0586	0.4	1.0797	2.5
700	1.074	1.0798	0.5	1.1017	2.6
750	1.090	1.0991	0.8	1.1214	2.8
800	1.106	1.1170	1.0	1.1392	3.0
850	1.119	1.1461	2.4	1.1555	3.3
900	1.131	1.1361	0.5	1.1705	3.5
950	1.142	1.1466	0.4	1.1845	3.7
1000	1.151	1.1569	0.5	1.2151	5.5
		PCC-1			
300	0.8665	0.8679	0.2	0.8836	2.0
350	0.9296	0.9470	1.9	0.9644	3.7
400	0.9917	1.0094	1.8	1.0256	3.4
450	1.047	1.0596	1.2	1.0739	2.6
500	1.094	1.1010	0.6	1.1132	1.8
550	1.132	1.1358	0.3	1.1454	1.2
600	1.163	1.1656	0.2	1.1727	0.8
650	1.187	1.1917	0.4	1.1963	0.8
700	1.204	1.2150	0.9	1.2169	1.1
750	1.216	1.2362	1.7	1.2351	1.6

Table 4. Continued.

Temp. K	Obs $J \bullet g^{-1} \bullet K^{-1}$	Minerals Calc $J \bullet g^{-1} \bullet K^{-1}$	Minerals Diff %	Oxides Calc $J \bullet g^{-1} \bullet K^{-1}$	Oxides Diff %
		BCR-1			
300	0.7418	0.7342	-1.0	0.7658	3.2
350	0.8215	0.8185	-0.4	0.8343	1.6
400	0.8806	0.8801	-0.1	0.8886	0.9
450	0.9263	0.9270	0.1	0.9328	0.7
500	0.9628	0.9641	0.1	0.9695	0.7
550	0.9924	0.9945	0.2	1.0006	0.8
600	1.017	1.0203	0.3	1.0272	1.0
650	1.038	1.0427	0.5	1.0504	1.2
700	1.055	1.0628	0.7	1.0709	1.5
750	1.070	1.0813	1.1	1.0891	1.8
800	1.083	1.0989	1.5	1.1055	2.1
850	1.094	1.1309	3.4	1.1204	2.4
900	1.104	1.1142	0.9	1.1341	2.7
950	1.112	1.1236	1.0	1.1468	3.1
1000	1.120	1.1329	1.2	1.1714	4.6

Note: SiO_2 was taken as the mineral quartz for values calculated from the minerals, and as silica glass for the oxide calculations, except for G-2 where half the SiO_2 contribution was calculated as quartz under the assumption that the other half was in other silicate phases.

Table 5. Heat-capacity equations for oxides and other minerals taken from Robie and Hemingway (1995), except for silica glass which is from Richet et al. (1982).

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR SULFIDE AND SULFOSALT MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 $(T^{-0.5})$	A_5 (T^2)	T range
COVELLITE CuS	95.612	4.305E+01	2.025E-02	-1.38072E+05			298 800
CHALCOPYRITE $CuFeS_2$	183.525	-5.8753E+02	3.7073E-01	-1.4721E+07	1.275E+04		298 830
CHALCOPYRITE $CuFeS_2$	183.525	-1.01845E+03	1.358E+00				830 930
PYRITE FeS_2	119.979	-2.032E+01	5.030E-02	-3.200E+06	1.787E+03		298 1000
ALABANDITE MnS	87.004	1.353E+02	-5.775E-02	1.169E+06	-1.435E+03	2.087E-05	298 1800
MOLYBDENITE MoS_2	160.072	1.045E+02	-4.812E-03	-6.291E+03	-6.817E+02		298 1200
HEAZLEWOODITE Ni_3S_2	240.202	1.057E+03	-8.988E-01	8.139E+06	-1.388E+04	4.660E-04	298 840
GALENA PbS	239.266	4.460E+01	1.640E-02				298 900
STIBNITE Sb_2S_3	339.698	1.705E+02	-4.860E-03	7.539E+05	-9.978E+02		298 900
HERZENBERGITE SnS	150.776	2.672E+01	3.035E-02				875 1153
TUNGSTENITE WS_2	247.982	7.633E+01	5.561E-04	-1.137E+06		1.408E-06	298 1500
SPHALERITE ZnS	97.456	6.151E+01	7.631E-04	-7.963E+04	-2.604E+02		298 1300
BERTHIERITE $FeSb_2S_4$	427.611	1.000E+01	7.930E-02	-6.416E+06	3.691E+03		298 900
CHALCOSTIBITE $CuSbS_2$	249.428	8.810E+01	4.040E-02				298 900

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR OXIDE AND HYDROXIDE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 ($T^{-0.5}$)	A_5 (T^2)	T range
CORUNDUM Al_2O_3	101.961	1.612E+02	-1.353E-03	-1.815E+06	-1.059E+03	5.381E-07	298 2250
BOEHMITE AlO(OH)	59.988	2.057E+02	-3.492E-02	1.027E+06	-2.635E+03		298 600
DIBORON TRIOXIDE B_2O_3	69.620	1.847E+02	7.108E-03	6.441E+05	-2.270E+03		298 723
DIBORON TRIOXIDE B_2O_3 (Liquid)	69.620	1.297E+02					723 2200
BARIUM MONOXIDE BaO	153.326	5.722E+01	5.370E-03	-1.669E+05	-1.668E+02		298 1800
BROMELLITE BeO	25.012	8.274E+01	-7.301E-03	-4.158E+05	-8.718E+02	1.845E-06	298 2000
BISMITE Bi_2O_3	465.959	1.036E+02	3.336E-02				298 800
LIME CaO	56.077	5.185E+01	2.444E-03	-9.340E+05			298 2500
PORTLANDITE $Ca(OH)_2$	74.093	1.867E+02	-2.191E-02		-1.600E+03		298 700
CERIANITE CeO_2	172.114	8.029E+01	5.699E-03	-7.294E+05	-2.099E+02		298 1800
COBALT MONOXIDE CoO	74.933	-3.047E+01	2.946E-02	-4.166E+06	1.932E+03		298 1800
TRICOBALT TETROXIDE Co_3O_4	240.797	1.316E+02	6.602E-02	-2.480E+06			298 1000
ESKOLAITE Cr_2O_3	151.990	1.190E+02	9.496E-03	-1.442E+06	-3.405E+00		298 1800
TENORITE CuO	79.545	3.097E+01	1.374E-02	-1.258E+06	3.693E+02		298 1400
CUPRITE Cu_2O	143.091	4.260E+02	-2.508E-01	4.898E+06	-6.078E+03	9.244E-05	298 1500
WUSTITE $Fe_{.947}O$	68.887	-1.930E+01	3.017E-02	-2.533E+06	1.501E+03		298 1652

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR OXIDE AND HYDROXIDE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 ($T^{-0.5}$)	A_5 (T^2)	T range
FERROUS OXIDE FeO (fictive)	71.846	3.908E+01	8.574E-03	-7.325E+05	2.466E+02		298 1800
HEMATITE Fe_2O_3	159.692	8.378E+02	-6.656E-01	4.989E+06	-1.075E+04	3.487E-04	298 950
HEMATITE Fe_2O_3	159.692	-1.096E+03	2.727E-01	-1.024E+08	3.396E+04		950 1800
MAGNETITE Fe_3O_4	231.539	2.659E+03	-2.522E+00	2.073E+07	-3.646E+04	1.368E-03	298 800
DIPOTASSIUM MONOXIDE K_2O	94.196	7.450E+01	3.965E-02	-2.346E+05			298 2000
DILITHIUM MONOXIDE Li_2O	29.881	6.133E+01	3.568E-02	-1.168E+06	-7.050E+01	-7.318E-06	298 2000
PERICLASE MgO	40.304	6.653E+01	-6.143E-03	-6.093E+05	-3.592E+02	2.451E-06	298 2500
BRUCITE $Mg(OH)_2$	58.320	1.022E+02	1.511E-02	-2.617E+06			298 900
MANGANOSITE MnO	70.937	6.028E+01	3.510E-03		-2.975E+02		298 2000
PYROLUSITE MnO_2	86.937	2.904E+02	-1.442E-01	2.012E+06	-3.787E+03	4.541E-05	298 850
BIXBYITE Mn_2O_3	157.874	1.624E+02	1.211E-02	1.046E+06	-1.317E+03	3.462E-06	325 1400
HAUSMANNITE Mn_3O_4	228.812	-7.432E+00	9.487E-02	-6.712E+06	3.396E+03		298 1400
BRAUNITE Mn_7SiO_{12}	604.645	4.301E+02	1.110E-01	-7.325E+06			298 1500
MOLYBDITE MoO_3	148.938	6.433E+00	6.278E-02	-2.460E+06	1.337E+03		298 1074
DISODIUM MONOXIDE Na_2O	61.979	1.140E+02	7.486E-03		-8.134E+02		298 1000
BUNSENITE NiO	74.689	4.111E+03	-5.302E+00	2.431E+07	-5.304E+04	3.521E-03	298 519

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR OXIDE AND HYDROXIDE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 $(T^{-0.5})$	A_5 (T^2)	T range
BUNSENITE NiO	74.689	-8.776E+00	4.223E-02	3.607E+06	7.873E+02	-7.526E-06	519 1800
LITHARGE PbO	223.199	5.102E+01	1.027E-02	-7.387E+05			298 1000
PLATTNERITE PbO_2	239.199	7.312E+01	7.484E-03	-1.261E+06			298 1200
MINIUM Pb_3O_4	685.598	1.779E+02	3.326E-02	-2.926E+06			298 1800
SILICON MONOXIDE SiO (IDEAL GAS)	44.085	5.686E+01	-5.616E-03	4.922E+05	-5.335E+02	8.594E-07	298 2500
QUARTZ SiO_2	60.084	8.145E+01	1.828E-03	-1.810E+05	-6.985E+02	5.406E-06	298 844
QUARTZ SiO_2	60.084	5.796E+01	9.330E-03	1.835E+06			844 1700
CRISTOBALITE SiO_2	60.084	-4.160E+03	2.548E+00	-6.286E+07	7.168E+04		298 523
CRISTOBALITE SiO_2	60.084	7.275E+01	1.300E-03	-4.132E+06			523 1800
COESITE SiO_2	60.084	2.331E+02	-7.777E-02	2.604E+06	-3.375E+03	1.924E-05	298 1800
STISHOVITE SiO_2	60.084	1.470E+02	-4.027E-02	-2.834E+05	-1.559E+03	1.203E-05	298 1800
SILICA GLASS SiO_2	60.084	1.27200E+02	-1.0777E-02	4.3127E+05	-1.4638E+03		298 1620
CASSITERITE SnO_2	150.709	7.604E+01	7.364E-03	-2.224E+06			298 1800
STRONTIUM MONOXIDE SrO	103.619	5.365E+01	5.982E-03	-3.666E+05	-1.019E+02		298 2500
THORIANITE ThO_2	264.037	7.138E+01	7.556E-03	-1.053E+06			298 1200
RUTILE TiO_2	79.879	8.462E+01	5.990E-04	-1.101E+06	-2.957E+02		298 2100

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR OXIDE AND HYDROXIDE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 $(T^{-0.5})$	A_5 (T^2)	T range
ANATASE	79.879	4.396E+01	1.374E-02	-2.595E+06	6.294E+02		298
TiO_2							1300
URANINITE	270.028	5.845E+01	1.606E-02	-1.867E+06	3.689E+02		298
UO_2							1800
KARELIANITE	149.881	5.799E+01	4.120E-02	-3.872E+06	1.351E+03		298
V_2O_3							1800
TUNGSTEN DIOXIDE	215.849	6.638E+01	1.326E-02	-1.294E+06			298
WO_2							2500
ZINCITE	81.389	4.350E+01	7.658E-03	-7.573E+05	5.456E+01		298
ZnO							1800
BADDELEYITE	123.223	1.073E+02	-5.011E-03	-2.203E+05	-8.141E+02		298
ZrO_2							1478

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR MULTIPLE OXIDE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 ($T^{-0.5}$)	A_5 (T^2)	T range
TIALITE Al_2TiO_5	181.840	2.111E+02	1.461E-02	-3.625E+06	-6.610E+02		298 1800
CHRYSOBERYL $BeAl_2O_4$	126.973	3.627E+02	-8.353E-02	-6.798E+04	-4.034E+03	2.248E-05	298 1800
CALCIUM FERRITE $CaFe_2O_4$	215.770	9.588E+01	4.666E-02	-3.360E+06	1.410E+03		298 1510
DICALCIUM FERRITE $Ca_2Fe_2O_5$	271.847	2.223E+02	9.728E-03	-5.661E+06	5.420E+02		298 1750
PEROVSKITE $CaTiO_3$	135.956	1.250E+01	4.516E-02	-6.302E+06	2.462E+03		298 1530
HERCYNITE $FeAl_2O_4$	173.808	2.247E+02	4.480E-03	-1.581E+06	-1.370E+03		298 1200
CHROMITE $FeCr_2O_4$	223.837	3.018E+02	-4.157E-02	4.877E+05	-2.803E+03	1.147E-05	298 1800
ILMENITE $FeTiO_3$	151.725	2.627E+02	-7.999E-02	3.827E+05	-2.538E+03	3.388E-05	298 1000
ULVOSPINEL Fe_2TiO_4	223.592	-1.026E+02	1.425E-01	-9.145E+06	5.271E+03		298 1800
PSEUDOBROOKITE $Fe2TiO_5$	239.571	2.136E+02	1.625E-02	-2.345E+06	-4.795E+02		298 1800
SPINEL $MgAl_2O_4$	142.266	2.229E+02	6.127E-03	-1.686E+06	-1.551E+03		298 1800
MAGNESIOCHROMITE $MgCr_2O_4$	192.295	1.961E+02	5.398E-03	-3.126E+06	-6.169E+02		298 1800
GEIKIELITE $MgTiO_3$	120.183	2.225E+02	-5.274E-02	-6.092E+05	-1.875E+03	1.878E-05	298 1800
PYROPHANITE $MnTiO_3$	150.816	2.611E+02	-7.950E-02	3.804E+05	-2.522E+03	3.367E-05	298 1000

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR MULTIPLE OXIDE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 ($T^{-0.5}$)	A_5 (T^2)	T range
TREVORITE $NiFe_2O_4$	234.382	9.559E+01	1.705E-01	3.993E+04			298 1000
FRANKLINITE $ZnFe_2O_4$	241.082	1.995E+02	3.045E-02	-1.352E+06			298 600
ZINC TITANIUM SPINEL Zn_2TiO_4	242.658	2.613E+02	-5.138E-03	-4.317E+05	-2.09E+03		298 1800

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR HALIDE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 ($T^{-0.5}$)	A_5 (T^2)	T range
BROMARGYRITE AgBr	187.772	3.317E+01	6.443E-02				298 703
POTASSIUM BROMIDE KBr	119.002	-4.392E+01	5.855E-02	-1.839E+06	1.717E+03		298 1000
CHLORARGYRITE AgCl	143.321	5.996E+01	7.620E-03	-1.017E+06			298 728
HYDROPHILITE $CaCl_2$	110.983	-4.725E+00	4.504E-02	-2.037E+06	1.503E+03		298 1045
LAWRENCITE $FeCl_2$	126.752	-1.123E+02	8.951E-02	-5.115E+06	3.790E+03		298 950
MOLYSITE $FeCl_3$	162.205	1.237E+02		-2.556E+02			298 577
SYLVITE KCl	74.551	-2.452E+01	4.852E-02	-1.605E+06	1.371E+03		298 1043
CHLOROMAGNESITE $MgCl_2$	95.210	7.690E+01	8.496E-03	-7.463E+05			298 987
SCACCHITE $MnCl_2$	125.844	7.626E+01	1.191E-02	-6.048E+05			298 923
HALITE NaCl	58.442	4.515E+01	1.797E-02				298 1074
NICKELOUS CHLORIDE $NiCl_2$	129.595	-5.078E+01	5.748E-02	-4.064E+06	2.608E+03		298 1303
COTUNNITE $PbCl_2$	278.105	1.229E+02		-8.585E+02			298 768
FLUORITE CaF_2	78.075	2.033E+03	-1.436E+00	2.988E+07	-3.312E+04	5.040E-04	298 1400
SELLAITE MgF_2	62.302	9.474E+01	1.595E-04	-7.328E+05	-4.322E+02		298 1600
VILLIAUMITE NaF	41.988	-2.612E+00	3.347E-02	-1.402E+06	9.542E+02		298 1269

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR HALIDE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 ($T^{-0.5}$)	A_5 (T^2)	T range
CRYOLITE Na_3AlF_6	209.941	4.024E+03	-3.858E+00	3.407E+07	-5.588E+04	2.004E-03	298 836
CRYOLITE Na_3AlF_6	209.941	2.367E+02	4.799E-02				836 1000
CHIOLITE $Na_5Al_3F_{14}$	461.871	5.099E+02	8.768E-02	-7.301E+06			298 1010
IODARGYRITE AgI	264.773	2.435E+01	1.008E-02				298 423
MARSHITE CuI	190.450	-3.328E+01	1.723E-01	9.198E+06	9.956E+04		298 643

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR CARBONATE AND NITRATE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 $(T^{-0.5})$	A_5 (T^2)	T range
WITHERITE $BaCO_3$	197.336	-9.936E+01	1.258E-01	-6.274E+06	3.760E+03		298 1079
ARAGONITE $CaCO_3$	100.087	8.153E+01	4.567E-02	-1.141E+06			298 1000
CALCITE $CaCO_3$	100.087	9.972E+01	2.692E-02	-2.158E+06			298 1200
DOLOMITE $CaMg(CO_3)_2$	184.401	5.479E+02	-1.676E-01	2.840E+06	-6.548E+03	7.708E-05	298 700
SIDERITE $FeCO_3$	115.856	2.574E+02	-4.620E-02	1.523E+06	-3.082E+03		298 600
MAGNESITE $MgCO_3$	84.314	8.112E+01	5.225E-02	-1.832E+06			298 1000
RHODOCHROSITE $MnCO_3$	114.947	1.497E+02	1.876E-02	1.417E+05	-1.314E+03		298 600
THERMONATRITE $Na_2CO_3 \cdot H_2O$	124.004	7.240E+01	2.607E-01	-1.258E+05			298 380
DAWSONITE $NaAlCO_3(OH)_2$	143.995	3.441E+01	3.347E-04	7.464E+02			298 500
STRONTIANITE $SrCO_3$	147.629	-1.618E+02	1.280E-01	-9.018E+06	5.294E+03		298 1197
SMITHSONITE $ZnCO_3$	125.399	1.4838E+02	2.835E-02	4.796E+05	-1.419E+03		298 1200
NITROBARITE $Ba(NO_3)_2$	261.337	1.255E+02	1.497E-01	-1.670E+06			298 800

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR SULFATE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 ($T^{-0.5}$)	A_5 (T^2)	T range
ALUMINUM SULFATE $Al_2(SO_4)_3$	342.154	7.877E+02	-9.899E-02		-8.615E+03		298 1100
BARITE $BaSO_4$	233.391	1.412E+02			-3.507E+06		298 1300
ANHYDRITE $CaSO_4$	136.142	3.728E+02	-1.574E-01	1.695E+06	-4.331E+03	7.993E-05	298 1000
CHALCOCYANITE $CuSO_4$	159.610	1.615E+02	4.796E-02	-3.192E+06			298 1200
FERRIC SULFATE $Fe_2(SO_4)_3$	399.885	2.553E+02	2.269E-01	-4.260E+06			298 800
ARCANITE α-K_2SO_4	174.260	1.204E+02	9.958E-02	-1.782E+02			298 856
ARCANITE β-K_2SO_4	174.260	-8.445E+02	6.845E-01	3.499E+08			856 1342
K-Al SULFATE $KAl(SO_4)_2$	258.207	2.370E+02	7.828E-02	-5.988E+06			298 1000
ALUNITE $K_2Al_6(OH)_{12}(SO_4)_4$	828.428	1.029E+03	2.275E-01	-3.127E+07			298 700
LANGBEINITE $K_2Mg_2(SO_4)_3$	414.997	5.359E+02	1.101E-01	-1.020E+06	-4.040E+03	-4.909E-05	298 1000
MAGNESIUM SULFATE $MgSO_4$	120.369	1.056E+02	4.717E-02	-2.129E+06			298 1400
MANGANOUS SULFATE $MnSO_4$	151.002	1.203E+02	3.999E-02	-2.818E+06			298 1000
MASCAGNITE $(NH_4)_2SO_4$	132.141	1.0436E+02	2.788E-01				298 600
NICKELOUS SULFATE $NiSO_4$	154.754	1.240E+02	3.062E-02	-3.150E+06			298 1200
ANGLESITE $PbSO_4$	303.264	4.683E+01	1.278E-01	1.724E+06			298 1100
ZINKOSITE $ZnSO_4$	161.454	4.019E+01	1.243E-01	2.389E+06			298 1100

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR PHOSPHATE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 $(T^{-0.5})$	A_5 (T^2)	T range
BERLINITE $AlPO_4$	121.953	1.203E+03	-9.564E-01	1.078E+07	-1.706E+04	4.691E-04	298 830
WHITLOCKITE $Ca_3(PO_4)_2$	310.177	1.929E+02	1.742E-01	-1.174E+06			298 1373
FLUORAPATITE $Ca_5(PO_4)_3(F)$	504.302	7.543E+02	-3.026E-02	-9.084E+05	-6.201E+03		298 1600
HYDROXY-APATITE $Ca_5(PO_4)_3(OH)$	502.311	3.878E+02	1.186E-01	-1.270E+07	1.811E+03		298 1500

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR ORTHO AND RING STRUCTURE SILICATE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 ($T^{-0.5}$)	A_5 (T^2)	T range
TOPAZ $Al_2SiO_4F_2$	184.043	4.714E+02	-8.165E-02	1.270E+06	-5.486E+03		298 1000
KYANITE Al_2SiO_5	162.046	2.794E+02	-7.124E-03	-2.056E+06	-2.289E+03		298 2000
ANDALUSITE Al_2SiO_5	162.046	2.77306E+02	-6.588E-03	-1.9141E+06	-2.2656E+03		298 2000
SILLIMANITE Al_2SiO_5	162.046	2.8019E+02	-6.900E-03	-1.376E+06	-2.399E+03		298 2000
MULLITE $Al_6Si_2O_{13}$	426.052	7.546E+02	-2.943E-02	-3.454E+06	-6.576E+03		298 1800
DUMORTIERITE $Al_{6.75}\square_{.25}Si_3BO_{17.25}(OH)_{.75}$	565.938	1.439E+03	-2.427E-01	3.860E+06	-1.682E+04	4.884E-05	298 1800
PHENAKITE Be_2SiO_4	110.107	4.2849E+02	-9.958E-02	2.083E+06	-5.6705E+03	1.989E-05	298 1800
BERYL $Be_3Al_2(Si_6O_{18})$	537.502	1.625E+03	-4.252E-01	6.825E+06	-2.018E+04	1.203E-04	298 1800
BERTRANDITE $Be_4Si_2O_7(OH)_2$	238.230	8.253E+02	-9.965E-02	3.662E+06	-1.057E+04		298 1400
EUCLASE $BeAlSiO_4(OH)$	145.084	5.329E+02	-1.507E-01	2.198E+06	-6.726E+03	4.122E-05	298 1800
LARNITE α-Ca_2SiO_4	172.239	2.487E+02	-8.315E-04	-9.077E+04	-2.052E+03		298 970
BREDIGITE α'-Ca_2SiO_4	172.239	1.346E+02	4.611E-02				970 1710
CALCIO-OLIVINE γ-Ca_2SiO_4	172.239	1.327E+02	5.251E-02	-1.905E+06			298 1200
HATURITE (ALITE) Ca_3SiO_5	228.317	3.339E+02	-4.651E-03	-6.526E+04	-2.766E+03		298 1800
RANKINITE $Ca_3Si_2O_7$	288.401	4.732E+02	-4.207E-02	3.397E+05	-4.319E+03		298 1400
ROSENHAHNITE $Ca_3Si_3O_8(OH)_2$	366.500	3.650E+02	5.419E-02	-8.161E+06			298 1800

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR ORTHO AND RING STRUCTURE SILICATE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 $(T^{-0.5})$	A_5 (T^2)	T range
SPURRITE $Ca_5(SiO_4)_2CO_3$	444.565	6.141E+02	-3.508E-03	-2.493E+06	-4.168E+03		298 1300
TILLEYITE $Ca_5Si_2O_7(CO_3)_2$	488.575	7.417E+02	-5.345E-03	-1.435E+06	-5.879E+03		298 1200
GEHLENITE $Ca_2Al_2SiO_7$	274.200	4.057E+02	-7.099E-03	-1.188E+06	-3.174E+03		298 1800
GROSSULAR $Ca_3Al_2Si_3O_{12}$	450.446	1.5293E+03	-6.990E-01	7.443E+06	-1.894E+04	2.530E-04	298 1200
ZOISITE $Ca_2Al_3Si_3O_{12}(OH)$	454.357	1.134E+03	-4.523E-01		-1.157E+04	2.391E-04	298 750
LAWSONITE $CaAl_2Si_2O_7(OH)_2H_2O$	314.238	2.7732E+02	2.341E-01	-6.389E+06			298 600
DATOLITE $CaB(SiO_4)(OH)$	159.979	1.448E+02	6.895E-02	-3.142E+06			298 1000
ANDRADITE $Ca_3Fe_2Si_3O_{12}$	508.177	8.092E+02	-7.025E-02	-6.789E+05	-7.403E+03		298 1000
MONTICELLITE $CaMgSiO_4$	156.466	2.314E+02	-8.531E-04	-1.247E+06	-1.623E+03	-1.333E-06	298 1000
AKERMANITE $Ca_2MgSi_2O_7$	272.628	7.813E+01	1.6573E-01	-6.7914E+06	2.865E+03	-3.344E-05	298 1700
MERWINITE $Ca_3Mg(SiO_4)_2$	328.705	6.508E+02	-1.816E-01		-6.053E+03	7.036E-05	298 1600
TITANITE (Sphene) $CaTiSiO_5$	196.041	1.767E+02	2.385E-02	-3.991E+06			298 1670
COBALT-OLIVINE Co_2SiO_4	209.950	3.0583E+02	-3.195E-02	2.693E+05	-2.865E+03		298 1100
FAYALITE Fe_2SiO_4	203.777	1.7602E+02	-8.808E-03	-3.889E+06		2.471E-05	298 1490
ALMANDINE $Fe_3Al_2Si_3O_{12}$	497.753	8.629E+02	-8.288E-02	1.697E+06	-8.875E+03		298 1000
STAUROLITE $Fe_4Al_{18}Si_8O_{46}(OH)_2$	1703.727	2.798E+03	7.921E-02	-9.952E+06	-2.474E+04		298 1000

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR ORTHO AND RING STRUCTURE SILICATE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 $(T^{-0.5})$	A_5 (T^2)	T range
OSUMILITE $KMg_2Al_3[Si_{10}Al_2O_{30}]\cdot H_2O$	1001.468	5.842E+02	1.276E+00	-3.967E+06	-1.556E+03	-6.497E-04	298 1000
CORDIERITE $Mg_2Al_3(AlSi_5O_{18})$	584.953	8.123E+02	4.334E-02	-8.211E+06	-5.000E+03		298 1700
FORSTERITE Mg_2SiO_4	140.693	8.736E+01	8.717E-02	-3.699E+06	8.436E+02	-2.237E-05	298 1800
PYROPE $Mg_3Al_2Si_3O_{12}$	403.127	8.730E+02	-1.374E-01	4.500E+03	-8.794E+03	3.341E-05	298 1570
GLASS $Mg_3Al_2Si_3O_{12}$	403.127	5.138E+02	7.119E-02	-5.857E+05	-2.439E+03		298 1020
TEPHROITE Mn_2SiO_4	201.959	2.613E+02	-1.378E-02		-2.218E+03		298 1600
LIEBENBERGITE Ni_2SiO_4	209.463	2.897E+02	-2.402E-02	1.310E+05	-2.779E+03		298 1300
ZIRCON $ZrSiO_4$	183.307	2.370E+02	-1.788E-02	-1.496E+05	-2.268E+03		298 1600

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR CHAIN STRUCTURE SILICATE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 $(T^{-0.5})$	A_5 (T^2)	T range
WOLLASTONITE $CaSiO_3$	116.162	2.0078E+02	-2.589E-02	-1.579E+05	-1.826E+03	7.434E-06	298 1400
PSEUDOWOLLASTONITE $CaSiO_3$	116.162	1.578E+02	-1.045E-03	-6.396E+05	-1.077E+03		298 1821
Ca-Al PYROXENE $CaAl_2SiO_6$	218.123	4.652E+02	-7.838E-02	6.729E+05	-4.941E+03	1.934E-05	298 1000
FERROBUSTAMITE $CaFeSi_2O_6$	248.092	4.038E+02	-4.444E-02		-3.757E+03	1.597E-05	298 1600
HEDENBERGITE $CaFeSi_2O_6$	248.092	3.1046E+02	1.257E-02	-1.846E+06	-2.040E+03		298 1600
DIOPSIDE $CaMgSi_2O_6$	216.550	4.7025E+02	-9.864E-02	2.454E+05	-4.823E+03	2.813E-05	298 1700
GLASS $CaMgSi_2O_6$	216.550	1.041E+03	-6.358E-01	6.677E+06	-1.351E+04	2.724E-04	298 1400
FERROSILITE $FeSiO_3$	131.931	1.243E+02	1.454E-02	-3.378E+06			298 700
α-SPODUMENE $LiAlSi_2O_6$	186.090	4.212E+02	-2.401E-02	1.910E+06	-4.776E+03		298 1200
β-SPODUMENE $LiAlSi_2O_6$	186.090	3.628E+02	-3.684E-03		-3.435E+03		298 1700
ENSTATITE $MgSiO_3$	100.389	3.507E+02	-1.472E-01	1.769E+06	-4.296E+03	5.826E-05	298 1000
CLINOENSTATITE $MgSiO_3$	100.389	2.056E+02	-1.280E-02	1.193E+06	-2.298E+03		298 1600
$MgSiO_3$-ILMENITE $MgSiO_3$	100.389	6.912E+01	7.330E-02	1.037E+06			298 700
HYPERSTHENE $(Mg_{.85}Fe_{.15})SiO_3$	105.120	2.079E+02	-1.489E-02	1.921E+05	-2.135E+03		298 1000
RHODONITE $MnSiO_3$	131.022	9.904E+01	1.915E-02	-3.041E+06	2.745E+02		298 1500
JADEITE $NaAlSi_2O_6$	202.139	3.011E+02	1.014E-02	-2.239E+06	-2.055E+03		298 1300

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR CHAIN STRUCTURE SILICATE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 ($T^{-0.5}$)	A_5 (T^2)	T range
ACMITE $NaFeSi_2O_6$	231.004	1.994E+02	6.197E-02	-4.267E+06			298 1300
TREMOLITE $Ca_2Mg_5Si_8O_{22}(OH)_2$	812.366	6.131E+03	-4.189E+00	5.139E+07	-8.566E+04	1.757E-03	298 1100
GRUNERITE $Fe_7Si_8O_{22}(OH)_2$	1000.614	7.555E+02	3.620E-01	-1.621E+07			298 900
ANTHOPHILLITE $Mg_7Si_8O_{22}(OH)_2$	780.820	1.260E+03	1.888E-02	-1.164E+07	-8.127E+03		298 1200
RIEBECKITE $Na_2Fe_3Fe_2Si_8O_{22}(OH)_2$	935.900	7.721E+02	2.827E-01	-1.598E+07			298 1000
GLAUCOPHANE $Na_2Mg_3Al_2Si_8O_{22}(OH)_2$	783.543	1.718E+03	-1.211E-01	7.075E+06	-1.927E+04		298 1200

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR FRAMEWORK STRUCTURE SILICATE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 ($T^{-0.5}$)	A_5 (T^2)	T range
ANORTHITE $CaAl_2Si_2O_8$	278.207	5.168E+02	-9.249E-02	-1.408E+06	-4.589E+03	4.188E-05	298 1800
$CaAl_2Si_2O_8$-glass $CaAl_2Si_2O_8$	278.207	3.752E+02	3.197E-02	-2.815E+06	-2.459E+03		298 1500
BICCHULITE $Ca_2Al_2SiO_6(OH)_2$	292.216	2.803E+02	8.204E-02	-5.679E+06			298 1800
MEIONITE (ordered) $Ca_4Al_6Si_6O_{24}CO_3$	934.709	9.103E+02	1.9435E-01	-2.300E+07			298 1000
DANBURITE $CaB_2Si_2O_8$	245.866	1.488E+02	2.173E-01	-3.280E+06			298 1000
POLLUCITE $(Cs_{.65}Na_{.19}Rb_{.03})Al_2Si_4O_{12}\cdot H_2O$	245.488	1.128E+02	1.876E-01	4.556E+05			298 700
MICROCLINE $KAlSi_3O_8$	278.332	7.595E+02	-2.171E-01	4.746E+06	-9.527E+03	6.433E-05	298 1400
HIGH SANIDINE $KAlSi_3O_8$	278.332	6.934E+02	-1.717E-01	3.462E+06	-8.305E+03	4.919E-05	298 1400
GLASS $KAlSi_3O_8$	278.332	6.295E+02	-1.084E-01	2.496E+06	-7.210E+03	-1.928E-05	298 1300
KALIOPHILLITE $KAlSiO_4$	158.163	1.889E+02	5.519E-02		-1.479E+03		298 810
LEUCITE $KAlSi_2O_6$	218.247	1.4842E+02	1.343E-01	-2.165E+06			298 955
EUCRYPTITE $LiAlSiO_4$	126.006	2.470E+02		-1.290E+06	-2.058E+03		298 1300
PETALITE $LiAlSi_4O_{10}$	306.259	8.763E+02	-2.079E-01	4.033E+06	-1.069E+04	5.301E-05	298 1300
LOW ALBITE $NaAlSi_3O_8$	262.223	5.839E+02	-9.285E-02	1.678E+06	-6.424E+03	2.272E-05	298 1800
ANALBITE $NaAlSi_3O_8$	262.223	6.714E+02	-1.467E-01	3.174E+06	-7.974E+03	3.659E-05	298 1400
GLASS $NaAlSi_3O_8$	262.223	9.180E+02	-3.824E-01	5.280E+06	-1.151E+04	1.474E-04	298 1200

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR FRAMEWORK STRUCTURE SILICATE MINERALS

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 ($T^{-0.5}$)	A_5 (T^2)	T range
NEPHELINE $NaAlSiO_4$	142.054	2.774E+01	2.954E-01				298 457
CARNEGIEITE $NaAlSiO_4$	142.054	1.161E+02	8.595E-02	2.000E+06			273 966
CARNEGIEITE $NaAlSiO_4$	142.054	1.5232E+02	2.883E-02				966 1700
GLASS $NaAlSiO_4$	142.054	3.171E+02	-4.320E-02	4.163E+05	-3.244E+03		272 1033
NEPHELINE $(Na_{.78}K_{.22})AlSiO_4$	145.277	1.121E+02	6.711E-02				467 1180
ANALCIME $NaAlSi_2O_6 \cdot H_2O$	220.154	1.3438E+02	2.5415E-01	1.845E+05			298 700
DEHYDRATED ANALCIME $NaAlSi_2O_6$	202.139	1.921E+02	8.074E-02	-4.723E+06			298 1000

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR SHEET STRUCTURE SILICATES

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 ($T^{-0.5}$)	A_5 (T^2)	T range
DICKITE $Al_2Si_2O_5(OH)_4$	258.160	9.084E+02	-2.113E-01	3.804E+06	-1.120E+04		298 1000
KAOLINITE $Al_2Si_2O_5(OH)_4$	258.160	1.4303E+03	-7.885E-01	8.334E+06	-1.852E+04	3.034E-04	298 800
HALLOYSITE $Al_2Si_2O_5(OH)_4$	258.160	2.463E+02					298
PYROPHYLLITE $Al_2Si_4O_{10}(OH)_2$	360.314	7.468E+02	-5.345E-02		-7.578E+03	1.986E-05	298 800
ILLITE $K_3(Al_7Mg)(Al_2Si_{14})O_{40}(OH)_8$	1553.665	1.291E+03					298
MARGARITE $CaAl_2[Al_2Si2O_{10}](OH)_2$	398.184	4.163E+02	1.090E-01	1.124E+07			298 1000
PREHNITE $Ca_2Al[AlSi_3O_{10}](OH)_2$	412.384	7.491E+02	4.844E-02		-7.365E+03	-6.668E-05	298 800
MUSCOVITE (disordered) $KAl_2[AlSi_3O_{10}](OH)_2$	398.308	9.177E+02	-8.111E-02	2.834E+06	-1.035E+04		298 1000
MUSCOVITE (ordered) $KAl_2[AlSi_3O_{10}](OH)_2$	398.308	9.177E+02	-8.111E-02	2.834E+06	-1.035E+04		298 1000
ANNITE $KFe_3[AlSi_3O_{10}](OH)_2$	511.886	6.366E+02	8.208E-02	-4.860E+06	-3.731E+03		298 1000
PHLOGOPITE (disordered) $KMg_3[AlSi_3O_{10}](OH)_2$	417.260	8.721E+02	-7.725E-02	3.575E+05	-8.601E+03		298 1200
PHLOGOPITE (ordered) $KMg_3[AlSi_3O_{10}](OH)_2$	417.260	8.721E+02	-7.725E-02	3.575E+06	-8.601E+03		298 1000
FLUORPHLOGOPITE (disorder) $KMg_3[AlSi_3O_{10}]F_2$	421.242	4.9288E+02	4.910E-02	-6.599E+06	-1.569E+03		298 1670
FLUORPHLOGOPITE (ordered) $KMg_3[AlSi_3O_{10}]F_2$	421.242	4.9288E+02	4.910E-02	-6.599E+06	-1.569E+03		298 1670
TALC $Mg_3Si_4O_{10}(OH)_2$	379.266	5.654E+03	-5.272E+00	4.021E+07	-7.693E+04	2.729E-03	298 800
CHRYSOTILE $Mg_3Si_2O_5(OH)_4$	277.112	8.996E+02	-1.448E-01	4.500E+06	-1.093E+04		298 900

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR SHEET STRUCTURE SILICATES

NAME AND FORMULA	Molar Mass g	A_1	A_2 (T)	A_3 (T^{-2})	A_4 ($T^{-0.5}$)	A_5 (T^2)	T range
PARAGONITE (disordered) $NaAl_2[AlSi_3O_{10}](OH)_2$	382.200	6.6844E+02	3.627E-02	-1.860E+06	-5.816E+03		298 800
PARAGONITE (ordered) $NaAl_2[AlSi_3O_{10}](OH)_2$	382.200	6.6844E+02	3.627E-02	-1.860E+06	-5.816E+03		298 800

Table 6. Heat-capacity equations for fictive crystalline components that have a standard state as a liquid or a gas. Equations valid from 298.15 K (25°C) to stated temperature limit.

Phase	mass g	a_1*	a_2	a_3	a_4	a_5	Temperature limit
H_2O	18.015	85.285	-0.00155	-537000	-620.9	-1.226E-06	1500
OH	17.007	78.85	-0.02513	-464050	-664.3	5.88E-06	1000
S	32.066	25.258	0.002585	-367450	-34.2	-2.36E-07	1500
NO_2	46.006	355.068	-0.06716	5861168	-5863.5	2.443E-06	1200
Br	79.904	21.91	0.05274	212400	-225.3	.	1500
Cl	35.453	38.45	-0.01642	-237100	-156.6	6.873E-06	1500
F	18.988	49.37	-0.02059	-230300	-372.7	6.873E-06	1500
CO_2	44.010	5.677	0.044	-1997570	730.6	.	1500
SO_3	80.064	47.07	0.05331	-1520000	359.2	-2.451E-06	1500
P_2O_5	141.945	41.05	0.1669	1628000		.	1000
O	15.999	-31.5	0.04249	-1591000	936.4	-1.42E-05	1500

* $C_p = a_1 + a_2T + a_3T^{-2} + a_4T^{-0.5} + a_5T^2$

Table 7. Comparison of observed and calculated specific-heat values for rocks measured by Lindroth and Krawza (1971).

Temp. K	Obs $J \bullet g^{-1} \bullet K^{-1}$	Calc $J \bullet g^{-1} \bullet K^{-1}$	Diff %	Obs $J \bullet g^{-1} \bullet K^{-1}$	Calc $J \bullet g^{-1} \bullet K^{-1}$	Diff %
	Dresser basalt			Rockville granite		
350	0.8261	0.8650	4.7	0.8333	0.8480	1.8
400	0.9340	0.9224	-1.2	0.9086	0.9077	-0.1
450	1.0065	0.9684	-3.8	0.9667	0.9571	-1.0
500	1.0562	1.0061	-4.7	1.0121	0.9990	-1.3
550	1.0904	1.0378	-4.8	1.0479	1.0354	-1.2
600	1.1137	1.0649	-4.4	1.0763	1.0675	-0.8
650	1.1290	1.0884	-3.6	1.0987	1.0963	-0.2
700	1.1384	1.1093	-2.6	1.1162	1.1223	0.5
750	1.1431	1.1280	-1.3	1.1296	1.1462	1.5
800	1.1441	1.1451	0.1	1.1397	1.1683	2.5
850	1.1423	1.1610	1.6	1.1450	1.1552	0.8
900	1.1380	1.1759	3.3	1.1518	1.1666	1.3
950	1.1319	1.1902	5.2	1.1579	1.1773	1.6
1000	1.1240	1.2302	9.4	1.1635	1.1915	2.4
	St. Cloud granite			Sioux quartzite		
350	0.8069	0.8476	5.0	0.8318	0.8274	-0.5
400	0.9125	0.9063	-0.7	0.9305	0.8918	-4.2
450	0.9812	0.9541	-2.8	0.9871	0.9478	-4.0
500	1.0279	0.9938	-3.3	1.0263	0.9979	-2.8
550	1.0608	1.0275	-3.1	1.0437	1.0402	-1.6
600	1.0848	1.0563	-2.6	1.0863	1.0827	-0.8
650	1.1028	1.0812	-2.0	1.1334	1.1265	-0.6
700	1.1169	1.1031	-1.2	1.1770	1.1648	-1.0
750	1.1280	1.1225	-0.5	1.2263	1.2018	-2.0
800	1.1372	1.1397	0.2	1.2814	1.2376	-3.4
850	1.1450	1.1552	0.9	1.1714	1.1437	-2.4
900	1.1518	1.1693	1.5	1.1740	1.1472	-2.3
950	1.1579	1.1821	2.1	1.1765	1.1515	-2.1
1000	1.1635	1.2012	3.2	1.1790	1.1574	-1.8
	Bedford limestone			Tennessee marble		
350	0.8881	0.9136	2.9	0.8772	0.9142	4.2
400	0.9876	0.9681	-2.0	0.9800	0.9688	-1.1
450	1.0428	1.0097	-3.2	1.0396	1.0105	-2.8
500	1.0762	1.0433	-3.1	1.0778	1.0441	-3.1
550	1.0996	1.0716	-2.5	1.1057	1.0725	-3.0
600	1.1189	1.0964	-2.0	1.1290	1.0973	-2.8
650	1.1376	1.1186	-1.7	1.1512	1.1196	-2.7
700	1.1575	1.1389	-1.6	1.1739	1.1400	-2.9
750	1.1794	1.1580	-1.8	1.1982	1.1591	-3.3
800	1.2039	1.1760	-2.3	1.2245	1.1772	-3.9
850	1.2311	1.1931	-3.1	1.2531	1.1945	-4.7
900	1.2611	1.2097	-4.1	1.2840	1.2111	-5.7
950	1.2939	1.2258	-5.3	1.3173	1.2273	-6.8

Table 8. Comparison of observed and calculated specific-heat values for rocks measured by Somerton (1958).

Temp. K	Obs $J\bullet g^{-1}\bullet K^{-1}$	Calc $J\bullet g^{-1}\bullet K^{-1}$	Diff %	Obs $J\bullet g^{-1}\bullet K^{-1}$	Calc $J\bullet g^{-1}\bullet K^{-1}$	Diff %
	Sandstone 1			Sandstone 2		
400	0.8828	0.9035	2.3	0.9498	0.9486	-0.1
500	1.0083	0.9994	-0.9	1.0627	1.0446	-1.7
600	1.0669	1.0680	0.1	1.1046	1.1121	0.7
700	1.1046	1.1188	1.3	1.1464	1.1627	1.4
800	1.1380	1.1576	1.7	1.1799	1.2025	1.9
	Silty sand 3			Silty sand 4		
400	0.9540	0.9597	0.6	0.9372	0.9510	1.5
500	1.0627	1.0563	-0.6	1.0293	1.0472	1.7
600	1.1632	1.1241	-3.4	1.1255	1.1148	-1.0
700	1.2134	1.1748	-3.2	1.1799	1.1653	-1.2
800	1.2552	1.2148	-3.2	1.2050	1.2049	-0.0
	Siltstone 5			Siltstone 6		
400	0.9540	0.9654	1.2	0.9540	0.9551	0.1
500	1.0418	1.0630	2.0	1.0502	1.0512	0.1
600	1.1213	1.1314	0.9	1.1129	1.1187	0.5
700	1.2050	1.1826	-1.9	1.1548	1.1691	1.2
800	1.2803	1.2231	-4.5	1.2089	1.1799	2.5
	Shale 7			Limestone 8		
400	0.9121	0.9440	3.5	0.9540	0.9733	2.0
500	1.0209	1.0400	1.9	1.0334	1.0494	1.5
600	1.1004	1.1076	0.7	1.0753	1.1030	2.6
700	1.1548	1.1584	0.3	1.1339	1.1460	1.1
800	1.1757	1.1990	2.0	1.1715	1.1833	1.0