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Comment on "Physical Constants of Alpine Rocks (Density, Porosity, Specific Heat, Thermal Diffusivity and Conductivity)" by H.-R. Wenk and E. Wenk

by *Richard C. Nolen-Hoeksema**

Abstract

In an article by H.-R. WENK and E. WENK (1969), thermal conductivity values for rocks from the Swiss Alps were incorrectly reported. The corrected thermal conductivity values are presented here.

H.-R. WENK and E. WENK (1969) published physical constants of Alpine rocks. Most of the samples were collected in the Lepontine area of the Swiss Alps. However, the published values of the thermal conductivity, K (Table II in WENK and WENK, 1969), are incorrect. Here, I present the corrected values (Table 1).

The thermal conductivity values in WENK and WENK (1969) were obtained indirectly. They are calculated from values of thermal diffusivity, α, density, ϱ and specific heat, c, using the formula

$$K = \alpha c \varrho$$

The values of α, ϱ and c were all obtained by direct measurement for each rock (WENK and WENK, 1969, p. 345–346).

H.-R. Wenk and E. Wenk published their calculated thermal conductivity values in the c.g.s. units of erg/ (cm sec °C). In calculating the thermal conductivity values, a conversion from calories to ergs was necessary. The conversion is (CLARK, 1966, p. 580)

$$1 \text{ calorie} = 4.1840 \cdot 10^7 \text{ ergs} = 4.1840 \text{ joules}$$

or

$$1 \text{ erg} = 0.23901 \cdot 10^{-7} \text{ calories}$$

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which was correctly stated in the text of WENK and WENK (1969, p. 345–346). During actual conversion of heat capacity from calories to ergs, however, WENK and WENK (1969) inadvertantly used the incorrect mantissa in the conversion factor and multiplied calories by $0.23901 \cdot 10^7$ erg/cal instead of by $4.1840 \cdot 10^7$ erg/cal; note, the exponent used was correct. Thus, in Table II of WENK and WENK (1969), columns 6 [Heat capacity in units of erg/(g °C)], and consequently, 10, 11, and 12 [Thermal conductivity in units of erg/(cm sec °C)] are all incorrect.

In Table 1, I present the corrected values. Unlike H.-R. WENK and E. WENK (1969), I have not converted calories to ergs, because the unit

$$\begin{aligned} 1\ \mathrm{TCU} &= 1 \cdot 10^{-3}\ \mathrm{cal/(cm\ sec\ {}^\circ C)} \\ &= 0.4184\ \mathrm{W/(m\ {}^\circ K)} \end{aligned}$$

is a standard unit used in geothermal investigations (1 TCU = 1 Thermal Conductivity Unit).

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Table 1 Corrected Thermal Conductivity Values for Alpine Rocks... Original Values From Table 2 in Wenk and Wenk (1969)...

Rock Type	Specimen No.	Area Code	K_a (T.C.U.)*	K_b (T.C.U.)*	K_c (T.C.U.)*
GRANITE	3	MALCANTONE	5.93	6.13	
	7	SCHWARZWALD	4.98	5.03	
	72	BERGELL	3.42	4.78	4.58
	73	NOVATE	4.83	4.98	5.13
	74	GRIMSEL	5.76	5.76	5.85
	104	BERNINA	4.61	4.61	5.37
	105	JULIER	5.69	5.59	5.35
	110	BALTSCHIEDERTAL	5.49	5.73	5.54
GNEISS	1	LEVENTINA	3.71	4.70	3.07
	8	MAGGIA	4.67	4.57	3.11
	9	LEVENTINA	4.66	4.87	3.16
	27	MATORELLO	5.46	5.04	4.42
	30	SAMBUCO	5.11	5.43	3.44
	32	SAMBUCO	4.80	5.71	4.09
	33	SAMBUCO	5.38	5.00	4.33
	34	SAMBUCO	4.28	4.84	3.51
	35	SAMBUCO	4.58	5.24	3.56
	36	SAMBUCO	4.12	4.94	4.07
	38	SAMBUCO	5.07	5.02	3.17
	39	MATORELLO	4.57	4.61	3.27
	40	CALANCA	5.52	5.82	4.21
	41	RIVIERA	4.43	4.69	4.48
	42	RIVIERA	3.85	4.10	3.27
	43	MAGGIA	4.67	5.94	4.16
	44	MTE. LEONE	3.71	3.90	3.52
	45	DOMODOSSOLA	3.10	4.29	3.58
	46	DOMODOSSOLA	5.25	6.20	3.92
	47	BEURA	4.22	5.25	3.59
	48	ANTIGORIO	4.85	5.21	3.01
	49	ANTIGORIO	4.30	5.55	3.55
	50	ANTIGORIO	3.80	4.90	3.59
	51	ANTIGORIO	4.77	4.82	4.46
	52	ANTIGORIO	4.60	4.75	3.83
	53	ANTIGORIO	4.56	4.46	3.91
	54	ANTIGORIO	4.90	4.66	4.33
	55	ANTIGORIO	4.50	4.97	3.93
	56	DEVERO	2.73	3.60	3.19
	57	VERZASCA	5.17	6.04	4.08
	58	VERZASCA	5.05	4.96	4.55
	59	VERZASCA	5.81	5.52	4.76
	60	SAMBUCO	5.04	5.04	4.77
	61	PECCIA	4.74	5.50	3.76
	62	PECCIA	5.21	5.31	5.36
	69	CALANCA	4.73	5.29	2.88
	75	GOTTHARD	5.76	5.36	5.61
	76	ADULA	6.07	5.77	3.09
	77	ROFLA	5.07	6.10	4.24
	78	ROFLA	4.47	5.99	4.47
	79	ROFLA	3.93	5.36	3.97
	80	SPLUEGEN	4.69	6.24	4.74
	81	ADULA	5.14	5.34	4.98
	82	BASODINO	4.24	5.19	4.62
	83	BASODINO	5.53	5.86	3.70
	84	BASODINO	6.25	7.68	6.15
	85	ROBIEI	5.72	6.96	5.34
	86	BASODINO	5.10	5.40	5.30

* a = measured parallel to a lineation; b = measured parallel to another lineation; and c = measured perpendicular to the foliation (Wenk and Wenk, 1969, p. 346).

Table 1 (Continued) Correctd Thermal Conductivity Values for Alpine Rocks

Rock Type	Specimen No.	Area Code	K_a (T.C.U.)*	K_b (T.C.U.)*	K_c (T.C.U.)*
GNEISS	93	CALANCA	5.53	5.33	4.36
	94	SAMBUCO	4.16	5.11	4.43
	95	WEISSMIES	5.97	7.26	4.77
	97	IVREA	7.42	7.32	6.42
	103	SPLUEGEN	4.61	4.61	3.73
	109	GOTTHARD	6.00	5.65	5.60
	111	CENTOVALLI	4.50	5.68	5.59
SCHIST	4	LEVENTINA	6.39	7.22	5.21
	16	BRIG	9.78	9.94	6.58
	19	VARZO	6.28	5.97	5.30
	26	BACENO	8.63	8.77	4.45
	28	SAMBUCO	5.83	7.37	3.98
	29	SAMBUCO	5.58	7.23	4.14
	31	SAMBUCO	4.26	5.73	3.55
	37	SAMBUCO	7.06	9.89	3.75
	68	BACENO	5.22	4.89	2.10
	87	ROBIEI	7.45	7.87	6.08
	88	CAVAGNOLI	4.85	6.46	4.31
	89	BAVONA	5.79	6.47	5.26
	90	CAVAGNOLI	6.85	8.30	6.64
	91	ROBIEI	6.30	7.67	3.86
	92	DERVIO	4.85	6.22	3.96
	96	CAVAGNOLI	7.57	8.52	6.75
	101	CAVAGNOLI	5.12	5.82	5.82
	108	SCHIN	5.57	6.15	3.87
QUARTZITE	100	WEISSMIES	8.39	7.90	8.35
	102	AVERS	11.15	11.91	12.08
PEGMATITE	63	MONTESCHENO	7.88	7.93	6.55
	64	DOMODOSSOLA	7.36	6.42	6.36
	65	CENTOVALLI	3.58	3.21	4.32
AMPHIBOLITE	20	RIVIERA	3.77	3.62	3.33
	21	CALANCA	3.98	3.87	3.10
	22	SAMBUCO	3.08	2.98	2.52
	23	ANZOLA	3.95	3.95	3.69
	66	CENTOVALLI	3.50	4.18	4.35
	67	SAMBUCO	3.04	3.62	2.22
	70	SISSONE	3.43	3.52	2.43
	71	SISSONE	3.46	3.37	2.32
ULTRABASIC	5	DISGRAZIA	6.00	6.00	4.11
	6	MALENCO	5.45	8.50	4.51
	24	RIVIERA	5.81	6.95	6.83
	25	MONTESCHENO	12.74	12.53	12.74
	106	POSCHIAVO	6.43	7.07	5.48
CARBONATE	2	JURA	4.87	4.92	
	10	PECCIA	4.95	4.00	4.22
	11	PECCIA	5.46	4.22	4.59
	12	CREVOLA			
	13	CREVOLA	6.94	7.62	6.50
	14	CANDOGLIA	5.75	5.47	5.64
	15	RIVIERA	5.35	4.75	5.69
	17	VALAIS	5.06	5.06	5.42
	18	SIMPLON	4.63	5.41	4.54
	98	CANDOGLIA	6.29	6.34	5.69
	99	ROBIEI	5.63	6.18	5.98
	107	POSCHIAVO	6.40	8.23	5.91

* a = measured parallel to a lineation; b = measured parallel to another lineation; and c = measured perpendicular to the foliation (wenk and Wenk, 1969, p. 346).