Table 17.--Chemical compositions (in percent) and physical and hydrologic properties of principal rock types

	Sandstone 1/	Shale 2/	Limestone 3/	Dolomite 4/	Granite 5/	Granodiorite 6/	Diorite 7/	Gabbro 8/	Rhyolite 9/	Quartz latite 10/	Dacite 11/	Andesite 12/	Basalt 13/	Quartzite 14/	Amphibolite 15/	Gneiss 16/	Schist 17/	Phyllite 18/	Slate 19/
SiO_2	78.66	58.10	5.19	4.08	70.18	65.01	56.77	48.24	72.80	62.43	65.68	59.59	49.06	83.30	50.39	64.17	65.74	61.78	61.90
TiO_2	.25	.65	.06	---	.39	.57	.84	.97	.33	.85	.57	.77	1.36	.49	1.88	1.03	.55	.73	.82
Al_2O_3	4.78	15.40	.81	.83	14.47	15.94	16.67	17.88	13.49	16.15	16.25	17.31	15.70	7.44	14.67	15.90	17.35	16.54	16.54
Fe_2O_3	1.08	4.02	.54	.13	1.57	1.74	3.16	3.16	1.45	4.04	2.38	3.33	5.38	3.69	4.02	2.31	1.90	2.43	2.73
FeO	.30	2.45	---	.95	1.78	2.65	4.40	5.95	.88	1.20	1.90	3.13	6.37	.62	8.34	4.56	3.35	5.45	3.63
MnO	Trace	Trace	.05	.14	.12	.07	.13	.13	.08	.09	.06	.18	.31	<Trace	<.28	<.15	.03	.07	Trace
MgO	1.17	2.44	7.90	19.28	.88	1.91	4.17	7.51	.38	1.74	1.41	2.75	6.17	.92	5.85	2.63	1.90	2.35	2.99
CaO	5.52	3.11	42.61	29.48	1.99	4.42	6.74	10.99	1.20	4.24	3.46	5.80	8.95	.33	9.12	3.40	1.25	1.94	1.07
Na_2O	.45	1.30	.05	---	3.48	3.70	3.39	2.55	3.38	3.34	3.97	3.58	3.11	1.56	2.84	2.62	1.78	1.89	2.57
K_2O	1.32	3.24	.33	---	4.11	2.75	2.12	.89	4.46	3.75	2.67	2.04	1.52	1.62	.96	1.87	3.28	4.14	3.15
P_2O_5	.08	.17	.04	---	.19	.20	.25	.28	.08	.27	.15	.26	.45	.21	.24	.15	.12	.27	.04
H_2O	1.64	5.00	.77	.41	.84	1.04	1.36	1.43	1.47	1.90	1.50	1.26	1.62	1.16	1.54	1.15	2.01	2.32	3.84
CO_2	5.04	2.63	41.58	44.42	---	---	---	---	---	---	---	---	---	---	Trace	<.03	None	---	.59
Grain size (mm) 20/	0.05-0.8	<0.01	0.001-0.85	3.5-4.0	0.1-12.0	---	0.2-10.0	<1.0-3.0	---	---	---	0.3-1.6	0.01-20.0	<0.3	0.1-2.0	0.1-18.0	0.04->6.0	0.01-3.0	>0.03-0.2
Mohs' hardness 20/	2.42-6.13	3.16-5.68	2.79-4.84	5.26	5.83-6.5	---	4.68-6.37	5.68-6.14	---	---	---	6.17-6.25	3.95-6.21	5.75	4.74-6.37	5.26-6.58	5.2-5.68	3.47-5.11	3.79-4.32
Specific gravity (avg) 20/	2.06-3.26	2.4-2.92	2.44-2.83	2.72-2.84	2.61-2.65	21/ 2.68-2.98	1.0-3.03	2.81-2.93	21/ 2.26-2.50	---	---	2.57	2.04-3.01	2.75	3.01-3.12	2.65-3.36	2.68-2.75	2.18-3.24	2.74-2.83
Compressive strength (psi) 20/	2,270-34,100	4,970-34,800	9,700-29,500	46,700	8,250-35,400	---	9,310-48,300	18,300-40,200	21/ 17,200-42,000	---	---	18,710-19,150	2,470-52,000	91,200	30,400-74,900	22,200-36,400	1,160-23,500	970-11,300	22,500-30,400
Modulus of elasticity (10^6 psi) 20/	0.87-7.02	6.73-9.87	4.1-10.73	12.3	3.85-6.41	---	4.4-12.2	12.3	---	---	---	---	0.91-13.9	12.3	6.74-15.1	3.48-15.0	2.6-8.7	2.7-11.1	11.8-13.66
Interstitial porosity (percent)	22/ 0-51	23/ 22/ 0.7-45	22/ 0-32		Granitic and other plutonic rocks: 24/ 25/ 0.05-3.0				Volcanic rocks excluding basalt: 26/ <1 23/ 48				27/ 0.9 28/ 37	Metamorphic rocks: 24/ 27/ 0.02-2.4					26/ <1
Interstitial permeability (gpd/sq ft)	29/ 30/ 2X10^{-3}-220	23/ 7X10^{-7}-4	23/ 2X10^{-5}-26/ 6		Granitic and other plutonic rocks: 31/ 9X10^{-7}-5X10^{-6}				Volcanic rocks excluding basalt: 23/ 2X10^{-6}-18				30/ 4X10^{-5}-0.9	Metamorphic rocks: 31/ 1X10^{-6}-0.05					26/ 1.3X10^{-4}-0.07
Production rates from wells (gpm)	32/ 26/ <0.1-870	29/ 33/ <0.1-64	32/ <0.1-33/ 2,950		Granitic and other plutonic rocks: 26/ 0-63				Volcanic rocks excluding basalt: 23/ <1-700				27/ 10-5,300	Metamorphic rocks: 34/ <1 26/ 56					---
Types of principal permeability 23/26/27/	Interstitial, fracture	Fracture	Interstitial, fracture, solution		Granitic and other plutonic rocks: fractures				Volcanic rocks excluding basalt: fractures, interstitial				fractures, interstitial	Metamorphic rocks: Fractures					---
Solubility 27/	Low	Low	Moderate		Granitic and other plutonic rocks: low				Volcanic rocks excluding basalt: low				low	Metamorphic rocks: Low					High
Cation-exchange capacity 35/ (milliequivalents/100 g)	---	10.0-41.0	---	---	---	---	---	---	---	---	---	---	0.5-2.8	0.6-5.3	---	---	---	---	---
Thermal conductivity 36/ (10^{-3} cal/cm sec °C)	3.5-10.2	2.8-6.9	4.7-8.0	9.6-12	6.2-9.0	6.2-8.3	22/ 5.53	27/ 4.16	7.4-8.8	---	---	37/ 3.06	37/ 3.45-4.09	8.7-19.2	6.1-9.1	4.6-11.4	4.1-8.9	6.5-14.0	---
Thermal expansion, 20°-100°C 38/ (avg linear expansion coefficient ΔL/LΔT)	10±2X10^{-6}	---	8±4X10^{-6}	---	8±3X10^{-6}	---	7±2X10^{-6}	5.4±1X10^{-6}	8±3X10^{-6}	---	---	7±2X10^{-6}	5.4±1X10^{-6}	11X10^{-6}	---	---	---	---	9±1X10^{-6}
Incipient melting (°C) 39/	---	---	---	---	Below 700	---	---	---	---	---	---	1095-1098	1040-1072	---	---	---	---	---	---

	Salt	Marble	Tuff
Grain size (mm) 20/	10-40	<1-8.5	0.12-0.25
Mohs' hardness 20/	---	3.7-4.32	---
Specific gravity (avg) 20/	2.5	2.72-3.2	21/ 2.42-2.55
Compressive strength (psi) 20/	1,080-5,000	18,400-33,000	21/ 40,000
Modulus of elasticity (10^6 psi) 20/	---	7.15-11.9	---
Interstitial porosity (percent)	26/ <1	21/ 0.9-2.3	21/ 29.1-42.5
Interstitial permeability (gpd/sq ft)	26/ 1.3X10^{-4}-0.07	---	---
Production rates from wells (gpm)	---	---	---
Types of principal permeability 23/26/27/	---	---	---
Solubility 27/	High	---	---
Cation-exchange capacity 35/ (milliequivalents/100 g)	---	---	32-49
Thermal conductivity 36/ (10^{-3} cal/cm sec °C)	36/ 12.75-17.2	37/ 5.2-7.14	---
Thermal expansion, 20°-100°C 38/ (avg linear expansion coefficient ΔL/LΔT)	---	7±2X10^{-6}	---
Incipient melting (°C) 39/	---	---	---

1/ Composite analysis of 253 samples (Clarke, 1924, p. 547) (includes 0.07 percent SO_3, trace Cl).
2/ Average of 78 analyses (Pettijohn, 1957, p. 344) (includes 0.64 percent SO_3).
3/ Composite analysis of 345 samples (Clarke, 1924, p. 564) (includes 0.05 percent SO_3, 0.02 percent Cl).
4/ Average of 5 analyses (Clarke, 1924, p. 579).
5/ Average of 546 analyses (Daly, 1933, p. 9).
6/ Average of 40 analyses (Daly, 1933, p. 15).
7/ Average of 70 analyses (Daly, 1933, p. 16).
8/ Average of 41 analyses (Daly, 1933, p. 17).
9/ Average of 126 analyses (Daly, 1933, p. 9).
10/ Average of 12 analyses (Daly, 1933, p. 13).
11/ Average of 90 analyses (Daly, 1933, p. 15).
12/ Average of 87 analyses (Daly, 1933, p. 16).
13/ Average of 198 analyses (Daly, 1933, p. 17).
14/ Average of 3 analyses (Clarke, 1924, p. 619).
15/ Average of 3 analyses (Clarke, 1924, p. 603).
16/ Average of 7 analyses (Clarke, 1924, p. 630) (includes 0.03 percent S).
17/ Average of 5 analyses (Clarke, 1924, p. 631) (includes 0.03 percent SO_3, 0.58 percent C).
18/ Average of 4 analyses (Mehnert, 1969, p. 278) (includes 0.01 percent S).
19/ Average of 22 analyses (Clarke, 1924, p. 631) (includes 0.11 percent FeS_2)
20/ Wuerker (1969, tables 1-5).
21/ Judd (1969, Appendix I).
22/ Manger (1963).
23/ Winograd and others (1971).
24/ Talobre (1957).
25/ Izett (1960).
26/ Davis and DeWiest (1966).
27/ Meinzer (1923).
28/ Mundorff and others (1964).
29/ Levorsen (1954).
30/ Morris and Johnson (1967).
31/ Johnson (1963).
32/ O'Connor (1971).
33/ Cederstrom (1972).
34/ McConaghy and others (1964).
35/ Carroll (1959, table 3).
36/ Clark (1966, tables 21-1 and 21-2).
37/ Daly (1933, table 12).
38/ Clark (1966, table 6-10).
39/ Daly (1933, table 16a).