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Density measurements of well samples from the Clear Lake–Geysers area, Lake and Sonoma Counties, California

by

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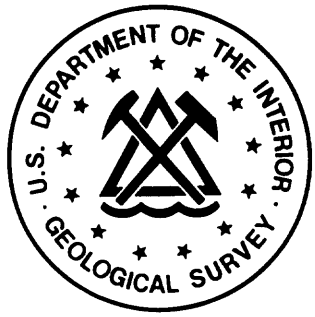

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INTRODUCTION AND PROCEDURES/METHODS

To aid with geophysical modeling and interpretation, density values were determined of cuttings and a few larger pieces from five wells in an area southwest of Clear Lake.

The Occidental Geothermal Neasham No. 1 well (Table 1) is located south of Mt Konocti in the SW 1/4 of the NW 1/4 of the SW 1/4 of Sec. 33, T13N, R8W.

The Magma Watson No. 1 well (Table 2) is located about 3 km southwest of Konocti Bay on the lower south slope of Mt Konocti in the SW 1/4 of the SE 1/4 of Sec. 20, T13N, R8W.

The Occidental Geothermal No. 68-21 well (Table 3) is located about 5 km east of The Geysers in Sec. 21, T11N, R8W.

The Boggs 77-1 well (Tables 4a and 4b) is located near Boggs Lake about midway between The Geysers and Clear Lake. Two samples of cuttings from it were measured and a few larger samples.

The Eureka-Magma-GRI-Getty Kettenhoffen No. 1 well (Table 5) is located about 2.5 km southwest of Konocti Bay, just southwest of the normally dry lake in Ely Flat and about 2400 feet north and 2250 feet west of the southeast corner of Sec. 28, T13N, R8W.

For all the wells, the identification on each sample bag was the depth range of the sample in feet. These identifications have been left in feet to avoid confusion. Since most sample bags contained very little material and it was desired that a portion of each sample be retained for future use, between two and five samples were combined to obtain enough material.

To measure the cuttings, small cylindrical containers with a volume of 8.725 cm^3 were weighed, then filled with well cuttings from a particular zone within a well and weighed again. The containers were then placed within a vacuum chamber and the air evacuated. Water was admitted to the chamber and the samples were left overnight before each container was removed from the water, surface water was removed and the now-saturated sample was reweighed. Only 16 samples per day could be measured with this procedure so samples were selected at fairly uniform intervals over the ranges for which samples were available.

For each sample, the following information was known:

Empty weight of container (we)
Volume of container 8.725 cm^3
Weight of container plus sample (dry) (wd)
Weight of container plus sample saturated with water (ww)

The density could then be calculated as follows:

Weight of sample = wd – we
Volume of sample = 8.725 – (ww – wd)

Therefore:
$$Density = \frac{wd - we}{8.725 + wd - ww}$$

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Lithology of the Occidental Geothermal Inc. well #68-21 is from the log by R.F. Smith Corp.

Lithology of the Neasham #1 well is by Robert J. McLaughlin, B. Carter Hearn, Jr., H.N. Ohlin, Cynde Sears, and Julie Donnelly-Nolan, USGS.

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Table 1. Density values for the Occidental Geothermal, Neasham # 1 well, located in Sec. 33 T13N, R8W, Lake County, CA

Sample Identification	Density g/cm^3	Lithologies
210-250	2.524	Rhyodacite of Sulphur Mound Mine, crystal rich, mostly light gray to dark gray, with intervals of reddish altered rhyodacite, in part altered.
400-450	2.450	
600-650	2.595	
1000-1050	2.530	Rhyodacite of Sulphur Mound Mine?, crystal rich, mostly light gray to dark gray, in part altered.
1200-1250	2.607	
1400-1450	2.602	
1600-1650	2.716	
1800-1850	2.650	
2000-2050	2.740	
2200-2250	2.554	Rhyodacite of Diener Drive, phenocryst-poor, contains tiny plagioclase laths, dark gray to black, in part glassy.
2730-2780	2.781	Silty argillite w/talc-serp, and db/gb pods
3000-3050	2.769	
3400-3450	2.779	
3800-3850	2.715	Clayey gouge
4200-4250	2.732	Silty argillite w/talc-serp
4400-4450	2.698	
5500-5550	2.784	Argillite and sandstone w/minor Sp/talc
5800-5850	2.824	
6500-6550	2.701	Argillite w/abundant Sp/talc lenses
6600-6650	2.842	
6900-6950	2.754	
8600-8650	2.928	Argillite; Gabbro, diabase, subequal mixture, with felsic intrusive rocks in upper part of interval
9000-9050	2.870	
9400-9450	3.170	Hornfelsic argillite; Gabbro, diabase
9750-9800	3.422	Hornfelsic argillite (tourmalinized)

Table 2. Eureka-Magma Inc., Watson #1 SW corner SE 1/4 SE 1/4 Sec 20 T13N-R8W

Sample Identification	Density g/cm^3	Lithologies
280-310	2.637	Dacite of Benson Ridge (biotite dacite)
360-390	2.521	Dacite of Bell Mine (phenocryst-poor dacite)
600-630	2.626	
820-850	2.656	
1060-1090	2.554	Basin deposits (fine-grained clay-rich to coarse sandstone and gravel, rich in dacite fragments)
1200-1230	2.596	
1370-1400	2.613	Dacite north of Ely Flat (biotite-hornblende dacite, prev. older dacite of Mt Konocti or dacite of Ely Ridge)
1580-1610	2.591	Rhyolite west of Sugarloaf (biotite rhyolite, crystal rich; prev. biotite ry. of Pink Hill, "Honeycutt" ry)
2000-2030	2.657	
2390-2420	2.613	
2780-2810	2.846	
3200-3230	2.661	
3590-3620	2.641	
3980-4010	2.799	
4190-4220	2.775	Argillite, dark gray, slaty, micaceous, + graywacke?
4250-4280	2.720	Serpentinite, green and brown, resinous, sheared, pyroxene gabbro, felsic-Qtzose-intrusive rocks
4370-4400	2.669	Chrysotile bearing serpentinite, porphyritic rhyolite, minor carbonate veins
4820-4850	2.604	Sheared serpentinite w/chrysotile, minor talc

Table 3. Occidental Geothermal, #68-21, Sec. 21, T11N, R8W, Lake County, CA, elevation 3809 feet, total depth 7344 feet.

Sample Identification	Density g/cm^3	Lithologies
100-150	2.769	Altered graywacke
400-450	2.632	Graywacke
800-850	2.766	Graywacke
1200-1250	2.704	Graywacke with increasing interbedded argillite to 45% of sample
1600-1650	2.812	Graywacke w/var amounts interbedded Argillite
1960-2010	2.973	Greenstone
2400-2450	2.920	Altered greenstone and graywacke
2800-2850	2.928	Greenstone w/5% each of graywacke, argillite, altered volcanic/greenstone
		No samples available for density measurements in this interval. Log shows mostly greenstone to 3570 feet, then serpentinite
4000-4050	2.826	Serpentinite
4400-4450	2.759	Serpentinite
5000-5050	3.006	Graywacke
5500-5550	3.013	Melange: 45% Grnstn, 35% Argil, 20% Grwke
5800-5850	2.813	Melange: Graywacke 40-70%, Arg 10-40%, Greenstone 10%, Serp 5%
6200-6250	2.828	Graywacke w/interbedded lenses of Argillite
6600-6650	2.891	Graywacke
7000-7050	2.814	Graywacke with 10-20% Argillite
7300-7340	2.878	Graywacke with 20-40% Argillite

Table 4a. Republic Boggs No. 77-1

Sample	Density	Lithologies
2003-2004	2.524	Serpentine rich mudstone/sheared
2234	2.642	

The samples in table 4b are from large >50g samples. Most were measured very quickly since they appeared ready to fall apart in water, thus the weight in water measurements include some air and the resulting densities should be considered as minimums.

Table 4b. Republic Boggs No. 77-1

Sample	Density	Lithologies and comments
1996	2.31	
2000	2.22	Mudstone (very fragile)
2029	2.31	Fine grain wacke sandstone
2039	2.24	Fine grain wacke sandstone (very fragile)
2070	2.42	Serp. pebble conglomerate, some clast, of vein quartz (very fragile)
2184	2.29	Sheared serpentinite
2309	2.65	Sheared graywacke
2325	2.55	
2339	2.59	Sandy argillite
2386	2.59	Black argillite
2427	2.57	Black argillite

Table 5. Eureka-Magma-GRI-Getty, Kettenhoffen No1

Location is 150 feet S and 125 ft E of the center of Section 28, T13N, R8W. Elevation 1836 feet.

Sample Identification	Density g/cm^3	Lithologies
200-220 & 240-260	2.528	Basin deposits, sand, clay, conglomerate rich in volcanic rock clasts (assorted volcanic rock fragments)
500-520 & 540-560	2.592	Clear Lake Volcanics (CLV); biotite-hornblende dacite
800-820 & 840-860	2.662	CLV (andesite)
1100-1120 & 1140-1160	2.578	CLV
1400-1420	2.593	
1700-1720 & 1740-1760	2.634	
2100-2120 & 2140-2160	2.578	
(2430)		Top of Great Valley
2440-2460	2.531	Great Valley (GV) sequence shale, siltstone: and serpentinite, in part sheared (medium dark gray shale interbedded with minor siltstone)
2600-2620	2.728	Fine grained micrograywacke intermixed with sheared black argillite - 60%, talcose sheared serpentinite - 30%, white resinous talc - 5%, Clear Lake Volcanics possibly 1-2%
2700-2720 & 2740-2760	2.693	Scaly, sheared black argillite, trace of green serpentinite, trace of Clear Lake Volcanics (down hole?)
3000-3020 & 3040-3060	2.743	GV (dark gray shale with minor interbedded siltstone)
3300-3320 & 3340-3360	2.757	GV (dark gray shale & siltstone interbedded serpentine cuttings 10%)
3600-3620	2.545	GV (serpentine, shale and siltstone)
3800-3820	2.587	GV (serpentine sheared)