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Principal facts for borehole gravity stations in wells
DC-3, DC-5, DC-7 at the Hanford Site, Washington, and in
well RSH #1 on Rattlesnake Hills, Washington

by

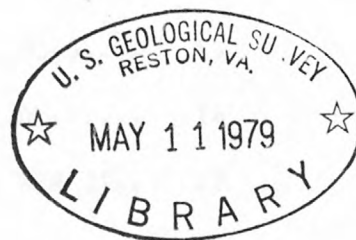
S. L. Robbins, R. J. Martinez, and D. L. Smith

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Table of Contents

Introduction.....	1
Borehole Data.....	3
BHGM Interpretations Summary.....	4
References.....	26

Tables of Principal Facts

Table 1. Well DC-3.....	6
2. Well DC-5.....	8
3. Well DC-7.....	9
4. Well RSH #1.....	11

Illustrations

Figure 1. Map showing location of wells logged.....	5
2. Drift correction curve for BHGM in well Dc-3....	12
3. Drift correction curve for BHGM in well DC-5....	13
4. Drift correction curve for BHGM in well DC-7....	14
5. Drift correction curve for BHGM in well RSH #1..	15
6. Gamma-ray and CCL log from well DC-3.....	16
7. Gamma-ray and CCL log from well DC-5.....	18
8. Gamma-ray and CCL log from well DC-7.....	20
9. Gamma-ray and CCL log from well RSH #1.....	23
10. Recording of BHGM data during Iran Earthquake on September 16, 1978.....	25

Principal facts for borehole gravity stations in wells
DC-3, DC-5, and DC-7 at the Hanford Site, Washington, and in
well RSH #1 on Rattlesnake Hills, Washington

by

S. L. Robbins, R. J. Martinez, and D. L. Smith

Introduction

Borehole gravity surveys were carried out in four wells in the State of Washington by the U.S. Geological Survey (U.S.G.S.) in September and October of 1978 using the U.S.G.S. - LaCoste and Romberg^{1/} borehole gravity meter G-95 (BHGM) (McCulloh and others, 1967a; McCulloh and others, 1967b). The primary objective of this study was to obtain data for the determination of accurate in-situ formation densities in the Umtanum Flow and other flows that might be considered for storage of radioactive wastes (Atlantic Richfield Hanford Co., 1976). Another objective was to obtain accurate densities of the sediments above the basalts and of the basalt interbeds for use in making more accurate interpretations of surface gravity studies throughout the Columbia Plateau.

^{1/} Use of brand names in this report is for descriptive purposes only and does not necessarily constitute endorsement by the U.S. Geological Survey.

The BHGM is primarily a density logging tool having a very large radius of investigation compared to conventional logging tools. Also, measurements are not significantly influenced by casing, borehole rugosity, or formation damage caused by drilling. Therefore, a borehole gravity survey provides a unique and independent measurement of in-situ bulk density which when integrated with data from conventional logs and (or) cores can provide a better understanding of the subsurface rock properties.

This report contains the principal facts obtained during the surveys of wells DC-3, DC-5, DC-7, and RSH #1 (fig. 1) located near Richland, Washington. Also included are reduced sections of the gamma-ray logs with the BHGM station locations indicated. An informal report by Ledgerwood and others (1978) summarizes the stratigraphic section that these wells penetrate.

This study was carried out in cooperation with Rockwell International at Richland, Washington, and their assistance is acknowledged. This is the second BHGM study that has been made in a radioactive waste storage study area. The first was in salt deposits near Carlsbad, New Mexico which was run in March, 1978 (Kososki and others, 1978), in cooperation with Sandia Laboratories.

Borehole Data

Tables 1, 2, 3, and 4 present the principal facts for the gravity stations occupied during the BHGM surveys. Accuracies of the data are assumed to be between ± 10 and ± 14 μ gals (Schmoker, 1978). The column headings for these tables are explained in the following list:

Reading #:	The order in which the borehole gravity stations were read.
Depth:	Depth of stations in feet and (meters). Datum is the ground level at the well.
Time:	Coordinated Universal Time (CUT) of the mean of each set of gravity slope readings (beam velocities).
Uncorr. gravity:	Observed gravity in milligals, referenced to an arbitrary base, uncorrected for tide, terrain, and drift effects.
Tide corr.:	Theoretical correction for earth tides in milligals (Darroll Wood, 1968, written commun.).
Terr. corr.:	Terrain correction in milligals, calculated for a density of 1.9 g/cm^3 for all compartments with a elevation below 900 feet (275 meters) and a density of 2.7 g/cm^3 for all compartments above 900 feet (275 meters), out to a distance of 71,996 feet (21,944 meters), corresponding to zone M of Hammer's terrain correction chart (Hammer, 1939; Beyer and Corbato, 1972).
Drift corr.:	Correction for instrument drift in milligals derived from station reoccupations. Figures 2, 3, 4, and 5 show the curves used.
Corr. gravity:	Observed gravity in milligals, referenced to an arbitrary base, corrected for tide, terrain and drift effects.

Prior to conducting the BHGM surveys, a gamma-ray log was run in each well for stratigraphic correlation and wireline depth correlation. Reduced sections of this logs are shown in figures 6, 7, 8, and 9.

During the logging of well DC-7 on September 16, 1978, the gravity survey was interrupted for about two hours due to excessive ground motion. Figure 10 shows our recording of that motion which was caused by an earthquake in Iran.

BHGM Interpretations Summary

Fundamentals of borehole gravity logging, data interpretation, and relationships between subsurface gravity measurements and mass distributions in the earth are given by McCulloh (1967) and Beyer (1971). In the absence of complicating factors (that is, assuming near horizontal beds), the in-situ bulk density, in g/cm^3 , between two points in a borehole is given by:

$$\rho_B = \frac{(F - \frac{\Delta G}{\Delta Z})}{0.02552}$$

where F is the free-air gradient of gravity in milligals/feet, and $\frac{\Delta G}{\Delta Z}$ is the measured gradient of gravity between the two points in the borehole in mgal/ft.

The assumed "normal" value for F is 0.09406 mgal/ft but can vary from area to area. Therefore, caution should be exercised in the use of the densities that are computed when using this value until its accuracy is verified. Although, an error in F will bias the computed densities causing a DC shift, it will not effect density differences between intervals.

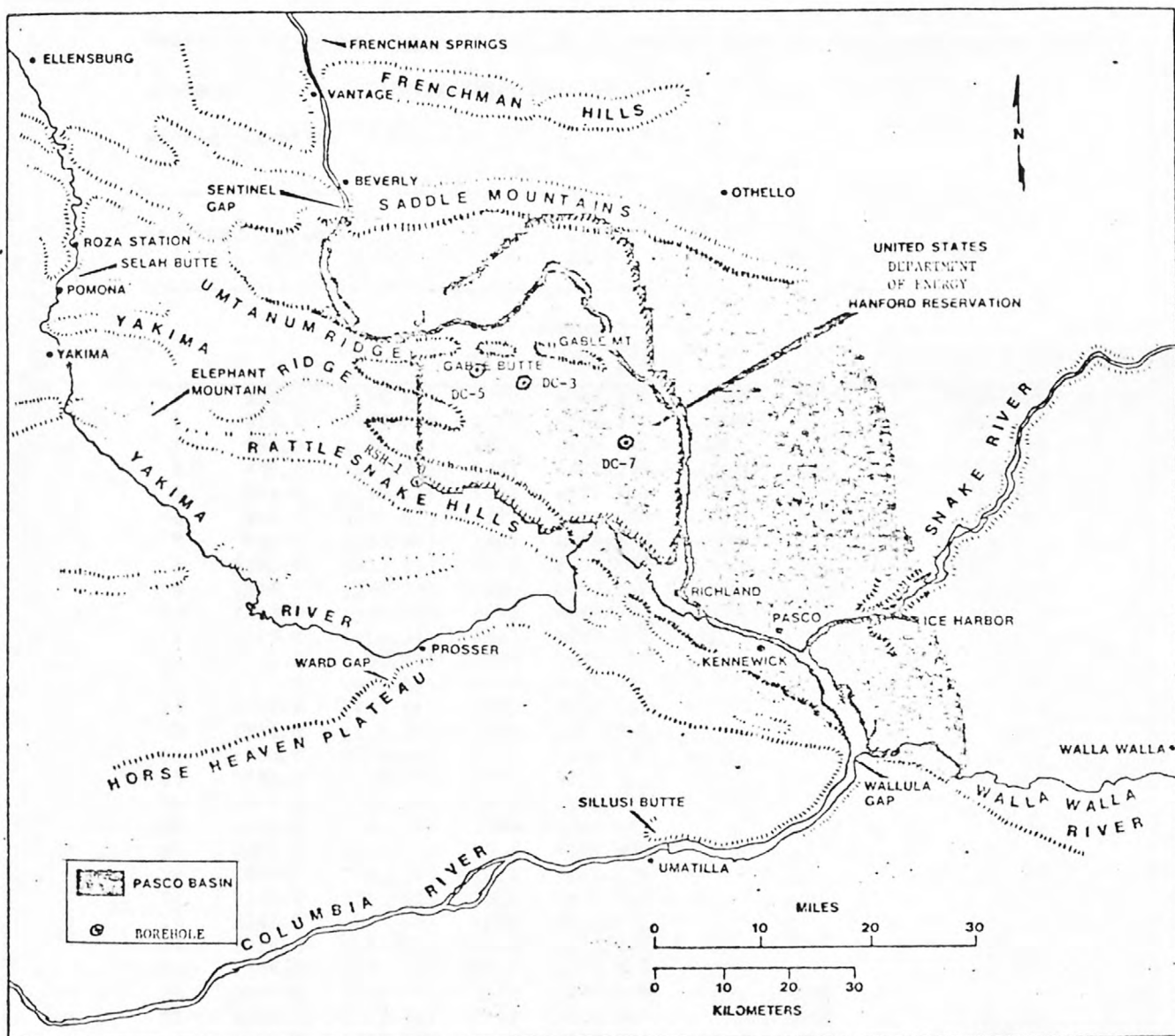


Figure 1. Map showing location of wells logged with the BHGM northwest of the Tri-Cities in the State of Washington.

Table 1.--Principal Facts of Well DC-3, Hanford Site, Benton County, Washington

[Located in sec.6,T12N.,R.26E.; Lat, 46°33'34"N., Long, 119°36'20"W.;

ground elevation, 734 ft (223.7 m)]

Reading #	Depth		Time CUT	Uncorr.	Tidal	Terr.	Drift	Corr.
	ft	(m)		gravity mgal	corr. mgal	corr. mgal	corr. mgal	gravity mgal
Logged 9-9-78								
1	519.0	(158.19)	1700	4066.570	.007	.249	0	4066.826
2	610.0	(185.93)	1712	4068.530	.002	.250	-.003	4068.779
3	638.0	(194.46)	1722	4069.791	-.001	.251	-.006	4070.035
4	693.0	(211.23)	1732	4072.239	-.005	.252	-.009	4072.477
5	837.0	(255.12)	1743	4075.308	-.008	.256	-.012	4075.544
6	910.0	(277.37)	1753	4078.024	-.012	.258	-.016	4078.254
7	990.3	(301.84)	1805	4079.779	-.015	.261	-.019	4080.006
8	1093.0	(333.15)	1814	4083.897	-.019	.266	-.015	4084.129
9	1236.0	(376.73)	1829	4087.449	-.024	.275	-.009	4087.691
10	1278.0	(389.53)	1838	4088.920	-.026	.278	-.005	4089.167
11	1360.0	(414.53)	1847	4092.357	-.029	.283	-.001	4092.610
12	1452.0	(442.57)	1857	4095.257	-.032	.291	.003	4095.519
13	1612.0	(491.34)	1908	4098.933	-.035	.305	.006	4099.209
14	1627.0	(495.91)	1915	4099.341	-.037	.307	.008	4099.619
15	1738.0	(529.74)	1927	4101.803	-.039	.318	.012	4102.094
16	1760.0	(536.45)	1934	4102.228	-.041	.320	.014	4102.521
17	1794.0	(546.81)	1945	4102.915	-.044	.324	.017	4103.212
18	1848.0	(563.27)	1953	4104.500	-.045	.330	.018	4104.803
19	1973.0	(601.37)	2004	4107.107	-.047	.345	.018	4107.423
20	2001.0	(609.90)	2012	4107.900	-.049	.348	.019	4108.218
21	2057.0	(626.97)	2022	4109.178	-.051	.355	.019	4109.501
22	2149.0	(655.02)	2033	4111.899	-.052	.368	.020	4112.235
23	2185.0	(665.99)	2041	4112.671	-.053	.373	.020	4113.011
24	2212.0	(674.22)	2048	4113.485	-.054	.376	.020	4113.827
25	2236.0	(681.53)	2055	4113.949	-.055	.380	.019	4114.293
26	2307.0	(703.17)	2105	4115.906	-.056	.390	.018	4116.258
27	2339.0	(712.93)	2112	4116.562	-.057	.395	.018	4116.918
28	2364.0	(720.55)	2120	4117.425	-.057	.398	.017	4117.783
29	2470.0	(752.86)	2131	4119.654	-.058	.414	.016	4120.026
30	2488.0	(758.34)	2137	4120.296	-.058	.417	.016	4120.671
31	2512.0	(765.66)	2145	4120.874	-.059	.421	.015	4121.251
32	2532.0	(771.75)	2152	4121.503	-.059	.424	.015	4121.883
33	2568.0	(782.73)	2200	4122.646	-.059	.430	.014	4123.031
34	2672.0	(814.43)	2211	4125.248	-.060	.447	.013	4125.648
35	2695.0	(821.44)	2220	4126.052	-.060	.451	.010	4126.453
36	2814.0	(857.71)	2230	4128.899	-.060	.471	.008	4129.318
37	2876.0	(876.60)	2240	4130.645	-.060	.482	.006	4131.073
38	2934.0	(894.28)	2250	4131.844	-.060	.493	.003	4132.280
39	3024.0	(921.72)	2259	4133.953	-.060	.509	.001	4134.403
40	3078.0	(938.17)	2310	4135.099	-.060	.519	-.002	4135.556
41	3114.0	(949.15)	2319	4135.868	-.060	.526	-.005	4136.329
42	3133.0	(954.94)	2328	4136.535	-.060	.529	-.007	4136.997
43	3197.4	(974.57)	2338	4138.199	-.060	.541	-.010	4138.670
44	3214.0	(979.63)	2346	4138.541	-.060	.545	-.012	4139.014
45	3254.0	(991.82)	2356	4139.373	-.060	.552	-.014	4139.851
46	3281.1	(1000.08)	2404	4140.115	-.060	.558	-.016	4140.597
47	3299.7	(1005.75)	2416	4140.646	-.060	.561	-.019	4141.128

Table 1.--Principal Facts of Well DC-3, Hanford Site, Benton County, Washington--Continued

Reading #	Depth		Time CUT	Uncorr.	Tidal	Terr.	Drift	Corr.
	ft	(m)		gravity mgal	corr. mgal	corr. mgal	corr. mgal	gravity mgal
Logged 9-10-78								
48	3299.7	(1005.75)	1558	4140.597	.060	.561	-.090	4141.128
49	3318.0	(1011.33)	1609	4140.974	.058	.565	-.090	4141.507
50	3341.0	(1018.34)	1616	4141.623	.056	.569	-.090	4142.158
51	3365.0	(1025.65)	1624	4142.180	.054	.574	-.091	4142.717
52	3390.0	(1033.27)	1632	4143.008	.051	.579	-.091	4143.547
53	3468.0	(1057.05)	1642	4144.789	.048	.595	-.091	4145.341
54	3480.0	(1060.70)	1649	4145.154	.046	.597	-.095	4145.702
55	3500.0	(1066.80)	1701	4145.860	.043	.601	-.101	4146.403
56	3574.0	(1089.36)	1710	4147.934	.039	.616	-.106	4148.483
57	3627.6	(1105.69)	1721	4149.154	.035	.627	-.113	4149.703
58	3627.6	(1105.69)	1728	4149.160	.032	.627	-.116	4149.703
59	3468.0	(1057.05)	1742	4144.843	.027	.595	-.124	4145.341
60	3299.7	(1005.75)	1756	4140.672	.020	.561	-.125	4141.128
61	3114.0	(949.15)	1808	4135.922	.016	.526	-.135	4136.329
62	2672.0	(814.43)	1824	4125.337	.009	.447	-.145	4125.648
63	2185.0	(665.99)	1841	4112.781	.001	.373	-.144	4113.011
64	1794.0	(546.81)	1855	4103.028	-.005	.324	-.135	4103.212
65	1452.0	(442.57)	1909	4095.355	-.011	.291	-.116	4095.519
66	990.3	(301.84)	1924	4079.849	-.017	.261	-.087	4080.006
67	519.0	(158.19)	1944	4066.698	-.025	.249	-.096	4066.826
68	494.8	(150.82)	1953	4065.962	-.029	.249	-.091	4066.091

Logged 9-11-78

69	519.0	(158.19)	1624	4063.693	.078	.249	2.806	4066.826
70	494.8	(150.82)	1634	4062.968	.077	.249	2.797	4066.091
71	450.8	(137.40)	1648	4061.637	.075	.248	2.797	4064.757
72	411.7	(125.49)	1706	4060.342	.071	.248	2.797	4063.458
73	282.8	(86.20)	1727	4055.786	.065	.246	2.797	4058.894
74	181.5	(55.32)	1740	4052.301	.061	.242	2.797	4055.401
75	103.7	(31.61)	1753	4048.246	.056	.237	2.797	4051.336
76	81.7	(24.90)	1804	4047.139	.051	.234	2.797	4050.221
77	1.2	(0.37)	1819	4043.457	.045	.259	2.797	4046.558
78	519.0	(158.19)	1840	4063.744	.036	.249	2.797	4066.826

Table 2.--Principal Facts of Well DC-5, Hanford Site, Benton County, Washington

[Located in sec.34,T.13N.,R.25E.; Lat, 46°34'36"N., Long, 119°39'55"W.;

ground elevation, 748 ft (228 m)]

Reading #	Depth		Time CUT	Uncorr. gravity mgal	Tidal corr. mgal	Terr. corr. mgal	Drift corr. mgal	Corr. gravity mgal
	ft	(m)						
<u>Logged 9-13-78</u>								
1	618.9	(188.64)	1543	4065.822	.055	.515	0	4066.392
2	637.1	(194.19)	1553	4066.294	.060	.517	0	4066.871
3	677.2	(206.41)	1602	4067.153	.064	.522	0	4067.739
4	797.0	(242.93)	1615	4071.619	.070	.536	0	4072.225
5	924.0	(281.64)	1625	4074.607	.074	.552	0	4075.233
6	1002.0	(305.41)	1636	4077.932	.078	.563	0	4078.573
7	1097.0	(334.37)	1652	4080.114	.083	.576	-.007	4080.766
8	1173.0	(357.53)	1702	4083.007	.085	.588	-.012	4083.668
9	1393.0	(424.59)	1711	4088.401	.087	.623	-.016	4089.095
10	1477.0	(450.19)	1721	4092.022	.089	.638	-.021	4092.724
11	1506.0	(459.03)	1731	4093.405	.090	.643	-.026	4094.112
12	1905.1	(580.67)	1746	4102.326	.091	.721	-.033	4103.105
13	2000.1	(609.63)	1754	4104.789	.091	.742	-.037	4105.585
14	2134.1	(650.47)	1802	4107.769	.090	.772	-.041	4108.590
15	2241.1	(683.09)	1813	4110.238	.089	.796	-.040	4111.083
16	2589.1	(789.16)	1828	4118.742	.087	.882	-.038	4119.673
17	2607.1	(794.64)	1835	4119.217	.085	.887	-.038	4120.151
18	2660.1	(810.80)	1842	4120.442	.084	.900	-.037	4121.389
19	2674.1	(815.07)	1850	4120.988	.081	.904	-.050	4121.923
20	2724.1	(830.31)	1901	4122.479	.078	.917	-.063	4123.411
21	2842.0	(866.24)	1911	4125.755	.074	.949	-.079	4126.699
22	2966.0	(904.04)	1921	4128.644	.070	.983	-.093	4129.624
23	3126.1	(952.84)	1933	4132.403	.064	1.028	-.100	4133.395
24	3230.1	(984.53)	1950	4134.573	.055	1.058	-.111	4135.575
25	3370.1	(1027.21)	2001	4138.285	.049	1.100	-.117	4139.317
26	3449.2	(1051.32)	2011	4140.312	.043	1.123	-.123	4141.355
27	3564.2	(1086.37)	2024	4143.100	.034	1.159	-.131	4144.162
28	3592.2	(1094.90)	2033	4143.723	.028	1.167	-.140	4144.778
29	3689.2	(1124.47)	2043	4146.510	.022	1.197	-.150	4147.579
30	3713.2	(1131.78)	2052	4147.020	.015	1.205	-.159	4148.081
31	3949.3	(1203.75)	2110	4152.920	.003	1.280	-.176	4154.027
32	3949.3	(1203.75)	2115	4152.926	0	1.280	-.179	4154.027
33	3881.1	(1182.96)	2125	4150.936	-.007	1.258	-.189	4151.998
34	3564.2	(1086.37)	2140	4143.224	-.018	1.159	-.203	4144.162
35	2966.0	(904.04)	2202	4128.886	-.033	.983	-.212	4129.624
36	2660.1	(810.80)	2214	4120.773	-.041	.900	-.243	4121.389
37	2134.1	(650.47)	2231	4108.109	-.052	.772	-.239	4108.590
38	1506.0	(459.03)	2250	4093.778	-.063	.643	-.246	4094.112
39	1002.0	(305.41)	2306	4078.329	-.072	.563	-.247	4078.573
40	618.9	(188.64)	2321	4066.192	-.079	.515	-.236	4066.392
41	591.1	(180.17)	2329	4065.206	-.082	.512	-.231	4065.405
42	481.1	(146.64)	2338	4061.133	-.086	.500	-.224	4061.323
43	339.1	(103.36)	2351	4056.587	-.091	.482	-.215	4056.763
44	251.9	(76.78)	2405	4053.849	-.095	.468	-.205	4054.017
45	214.0	(65.23)	2420	4052.536	-.098	.461	-.194	4052.705
46	138.0	(42.06)	2431	4048.628	-.100	.440	-.186	4048.782
47	69.1	(21.06)	2443	4045.401	-.101	.412	-.177	4045.535
48	2.3	(0.70)	2456	4042.370	-.102	.380	-.167	4042.481
49	618.9	(188.64)	2518	4066.131	-.102	.515	-.152	4066.392

Table 3.--Principal Facts of Well DC-7, Hanford Site, Benton County, Washington

[Located in sec.35,T.12N.,R.27E.; Lat, 46°28'45"N., Long, 119°23'15"W.;

ground elevation, 546 ft (166.4 m)]

Reading #	Depth		Time CUT	Uncorr gravity mgal	Tidal corr. mgal	Terr. corr. mgal	Drift corr. mgal	Corr. gravity mgal
	ft	(m)						
Logged 9-15-78								
1	725.2	(221.04)	1540	4074.050	-.026	0.101	0	4074.125
2	770.2	(234.76)	1552	4075.377	-.018	0.103	0	4075.462
3	826.2	(251.83)	1600	4076.523	-.012	0.106	0	4076.617
4	919.2	(280.17)	1609	4080.431	-.006	0.113	0	4080.538
5	1085.2	(330.77)	1619	4084.088	.001	0.128	0	4084.217
6	1115.2	(339.91)	1626	4085.262	.005	0.132	0	4085.399
7	1207.2	(367.95)	1636	4087.357	.012	0.142	-.004	4087.507
8	1298.2	(395.69)	1643	4090.500	.017	0.153	-.006	4090.664
9	1505.2	(458.78)	1653	4095.227	.024	0.182	-.010	4095.423
10	1605.2	(489.26)	1702	4099.198	.029	0.197	-.014	4099.410
11	1666.2	(507.86)	1711	4100.406	.035	0.207	-.016	4100.632
12	1696.2	(517.00)	1718	4100.971	.039	0.212	-.018	4101.204
13	1825.2	(556.32)	1728	4104.746	.044	0.234	-.021	4105.003
14	2002.2	(610.27)	1738	4108.435	.049	0.266	-.023	4108.727
15	2125.3	(647.79)	1750	4112.072	.055	0.289	-.027	4112.389
16	2221.3	(677.05)	1800	4114.035	.059	0.308	-.030	4114.372
17	2423.2	(738.59)	1812	4119.554	.063	0.350	-.033	4119.934
18	2605.2	(794.06)	1823	4123.783	.067	0.389	-.036	4124.203
19	2718.2	(828.51)	1832	4126.722	.069	0.414	-.038	4127.167
20	2731.2	(832.47)	1840	4127.139	.071	0.417	-.040	4127.587
21	2811.2	(856.85)	1848	4129.147	.072	0.435	-.048	4129.606
22	2967.2	(904.40)	1858	4132.983	.073	0.472	-.055	4133.473
23	3075.2	(937.32)	1910	4136.002	.074	0.497	-.064	4136.509
24	3228.2	(983.96)	1921	4139.339	.074	0.534	-.074	4139.873
25	3263.2	(994.62)	1929	4140.313	.074	0.543	-.079	4140.851
26	3294.2	(1004.07)	1937	4140.994	.073	0.551	-.085	4141.533
27	3335.2	(1016.57)	1945	4142.031	.072	0.561	-.091	4142.573
28	3375.2	(1028.76)	1957	4143.357	.069	0.571	-.099	4143.898
29	3426.3	(1044.34)	2006	4144.537	.067	0.583	-.105	4145.082
30	3471.2	(1058.02)	2014	4145.871	.064	0.595	-.110	4146.420
31	3491.2	(1064.12)	2025	4146.350	.060	0.600	-.118	4146.892
32	3510.3	(1069.94)	2032	4146.771	.057	0.605	-.123	4147.310
33	3554.2	(1083.32)	2040	4147.673	.054	0.616	-.128	4148.215
34	3591.2	(1094.60)	2048	4148.816	.050	0.625	-.131	4149.360
35	3625.2	(1104.96)	2057	4149.907	.045	0.634	-.135	4150.451
36	3669.3	(1118.40)	2104	4151.170	.042	0.645	-.138	4151.719
37	3690.2	(1124.77)	2110	4151.594	.039	0.650	-.140	4152.143
38	3719.2	(1133.61)	2116	4152.221	.035	0.658	-.143	4152.771
39	3749.2	(1142.76)	2124	4152.881	.030	0.666	-.146	4153.431
40	3786.2	(1154.03)	2131	4153.696	.026	0.675	-.149	4154.248
41	3814.2	(1162.57)	2138	4154.396	.021	0.683	-.152	4154.948
42	3843.2	(1171.41)	2145	4155.169	.017	0.690	-.158	4155.718
43	3869.2	(1179.33)	2152	4155.786	.012	0.697	-.163	4156.332
44	3906.2	(1190.61)	2159	4156.603	.007	0.707	-.169	4157.148
45	3965.2	(1208.59)	2212	4158.095	-.002	0.722	-.179	4158.636
46	4039.2	(1231.15)	2222	4160.011	-.009	0.742	-.187	4160.557
47	4051.2	(1234.81)	2230	4160.277	-.015	0.745	-.194	4160.813
48	4051.2	(1234.81)	2239	4160.279	-.021	0.745	-.190	4160.813
49	3814.2	(1162.57)	2252	4154.501	-.031	0.683	-.205	4154.948
50	3554.2	(1083.32)	2304	4147.843	-.039	0.616	-.205	4148.215
51	3228.2	(983.96)	2319	4139.607	-.049	0.534	-.220	4139.873
52	2731.2	(832.47)	2337	4127.469	-.060	0.417	-.239	4127.587
53	2125.3	(647.79)	2356	4112.406	-.072	0.289	-.234	4112.389
54	1605.2	(489.26)	2412	4099.525	-.081	0.197	-.231	4099.410
55	1115.2	(339.91)	2429	4085.591	-.088	0.132	-.236	4085.399
56	725.2	(221.04)	2447	4074.346	-.095	0.101	-.227	4074.125

Table 3.--Principal Facts of Well DC-7, Hanford Site, Benton County, Washington--Continued

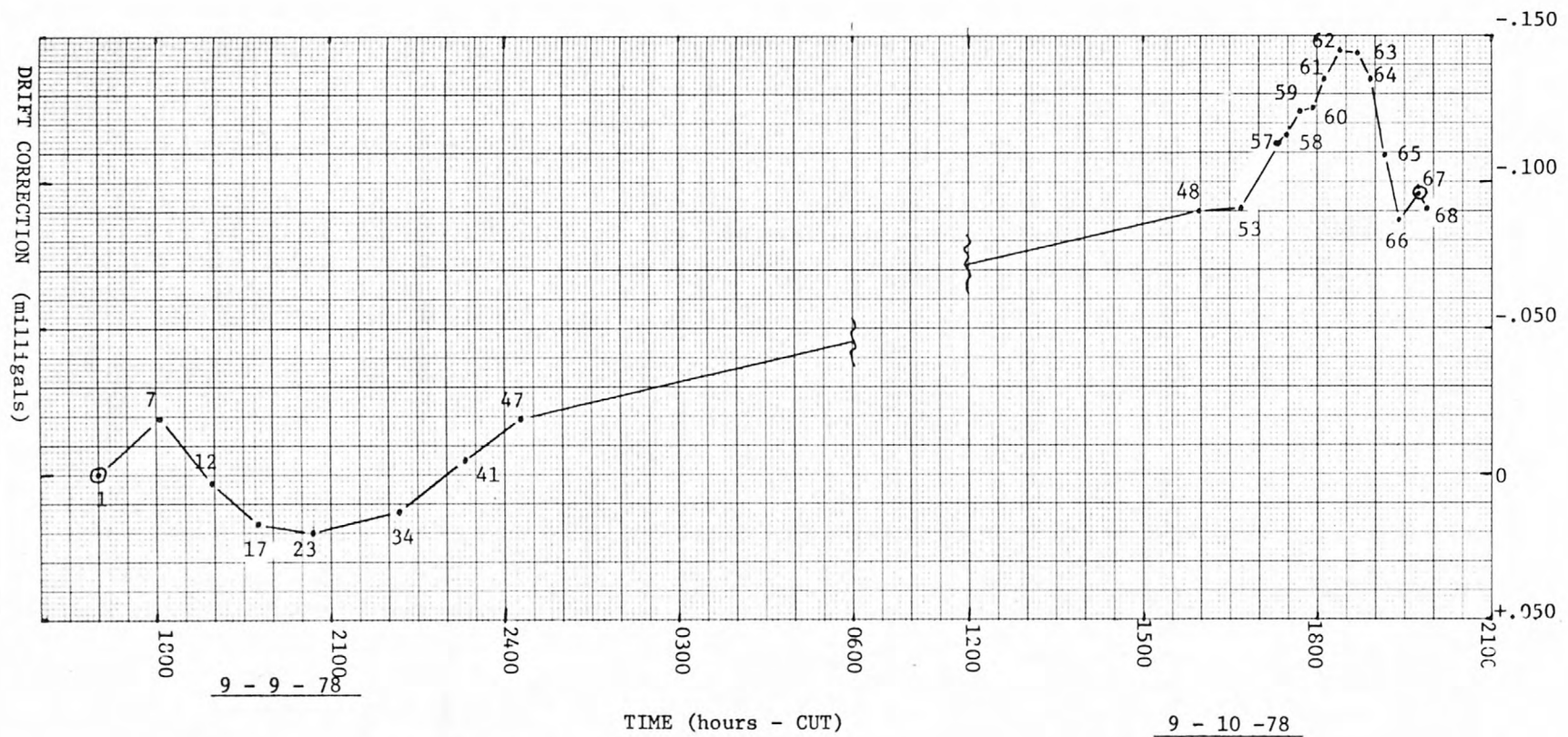
Reading #	Depth		Time CUT	Uncorr.	Tidal	Terr.	Drift	Corr.
	ft	(m)		gravity mgal	corr. mgal	corr. mgal	corr. mgal	gravity mgal
Logged 9-16-78								
57	725.2	(221.04)	1519	4074.176	-.075	0.101	-.077	4074.125
58	639.6	(194.95)	1532	4071.715	-.067	0.097	-.077	4071.668
59	539.5	(164.44)	1544	4067.039	-.060	0.095	-.077	4066.997
60	488.5	(148.89)	1605	4065.348	-.047	0.095	?	-----
61	354.5	(108.05)		Iran	earthquake			-----
62	725.2	(221.04)	1811	4074.070	.031	0.101	-.077	4074.125
63	488.5	(148.89)	1828	4065.215	.038	0.095	-.079	4065.269
64	354.5	(108.05)	1843	4059.808	.044	0.096	-.081	4059.867
65	264.4	(80.59)	1856	4056.873	.048	0.099	-.082	4056.938
66	218.4	(66.57)	1909	4054.907	.052	0.101	-.084	4054.976
67	142.4	(43.40)	1923	4052.413	.055	0.103	-.086	4052.485
68	2.4	(0.73)	1934	4045.077	.056	0.128	-.087	4045.174
69	725.2	(221.04)	1957	4074.057	.057	0.101	-.090	4074.125

Table 4.--Principal Facts of Well RSH #1, Rattlesnake Hills Ridge, Benton, Co., Washington

[Located in sec.15,T.11N.,R.24E.; Lat, 46°26'00"N, Long, 119°47'13"W.;

ground elevation, 2880 ft (878 m)]

Reading #	Depth		Time CUT	Uncorr gravity mgal	Tidal corr. mgal	Terr. corr. mgal	Drift corr. mgal	Corr. gravity mgal
	ft	(m)						
Logged 10-11-78								
1	449.5	(137.01)	1706	3919.921	.055	0.489	0	3920.465
2	393.5	(119.94)	1730	3916.991	.051	0.697	.029	3917.768
3	179.5	(54.71)	1748	3910.917	.046	1.512	.051	3912.526
4	48.5	(14.78)	1805	3907.193	.041	2.040	.071	3909.345
5	2.4	(0.73)	1819	3905.505	.035	2.232	.087	3907.859
6	449.5	(137.01)	1846	3919.876	.024	0.489	.076	3920.465
7	593.5	(180.90)	1907	3924.542	.014	- 0.039	.107	3924.624
8	652.5	(198.88)	1922	3925.985	.006	- 0.253	.129	3925.867
9	702.5	(214.12)	1934	3927.440	-.001	- 0.434	.147	3927.152
10	726.4	(221.41)	1947	3928.251	-.008	- 0.520	.166	3927.889
11	857.4	(261.34)	2001	3931.581	-.016	- 0.991	.187	3930.761
12	897.4	(273.53)	2015	3933.211	-.024	- 1.134	.208	3932.261
13	929.4	(283.28)	2029	3934.034	-.032	- 1.248	.209	3932.963
14	955.4	(291.21)	2040	3934.722	-.038	- 1.341	.210	3933.553
15	1009.4	(307.67)	2053	3936.161	-.045	- 1.533	.211	3934.794
16	1076.4	(328.09)	2105	3938.084	-.051	- 1.771	.212	3936.474
17	1430.5	(436.02)	2119	3949.046	-.059	- 3.014	.212	3946.185
18	1577.5	(480.82)	2130	3952.773	-.064	- 3.521	.213	3949.401
19	1662.5	(506.73)	2142	3955.218	-.069	- 3.811	.214	3951.552
20	1673.5	(510.08)	2149	3955.734	-.072	- 3.848	.212	3952.026
21	1751.5	(533.86)	2159	3958.359	-.076	- 4.112	.211	3954.382
22	1793.5	(546.66)	2206	3959.550	-.079	- 4.254	.210	3955.427
23	1863.6	(568.03)	2215	3961.786	-.082	- 4.488	.208	3957.424
24	1959.6	(597.29)	2225	3964.313	-.085	- 4.807	.207	3959.628
25	1979.6	(603.38)	2233	3965.146	-.088	- 4.873	.205	3960.390
26	2099.6	(639.96)	2243	3968.381	-.090	- 5.265	.203	3963.229
27	2151.6	(655.81)	2252	3969.662	-.092	- 5.434	.201	3964.337
28	2179.6	(664.34)	2300	3970.338	-.094	- 5.524	.200	3964.920
29	2195.6	(669.22)	2308	3970.942	-.095	- 5.576	.198	3965.469
30	2267.6	(691.16)	2318	3973.087	-.096	- 5.806	.193	3967.378
31	2297.7	(700.34)	2326	3974.143	-.097	- 5.902	.189	3968.333
32	2392.6	(729.26)	2335	3976.573	-.097	- 6.201	.185	3970.460
33	2411.7	(735.09)	2343	3977.320	-.097	- 6.261	.181	3971.143
34	2534.7	(772.58)	2352	3981.058	-.097	- 6.643	.176	3974.494
35	2612.7	(796.35)	2403	3983.224	-.097	- 6.882	.171	3976.416
36	2659.7	(810.68)	2412	3984.993	-.096	- 7.025	.171	3978.043
37	2829.7	(862.49)	2422	3989.472	-.095	- 7.535	.170	3982.012
38	2928.7	(892.67)	2430	3992.342	-.093	- 7.826	.170	3984.593
39	2991.7	(911.87)	2439	3994.303	-.091	- 8.010	.170	3986.372
40	3016.7	(919.49)	2452	3995.035	-.089	- 8.082	.170	3987.034
41	3059.7	(932.60)	2507	3996.179	-.085	- 8.206	.169	3988.057
42	3059.7	(932.60)	2519	3996.185	-.081	- 8.206	.159	3988.057
43	2612.7	(796.35)	2536(9)	3983.215(25)	-.075(4)	- 6.882	.158;147	3976.416
44	2195.6	(669.22)	2557	3970.982	-.067	- 5.576	.130	3965.469
45	1959.6	(597.29)	2612	3964.366	-.062	- 4.807	.131	3959.628
46	1662.5	(506.73)	2625	3955.287	-.057	- 3.811	.133	3951.552
47	897.4	(273.53)	2651	3933.303	-.046	- 1.134	.138	3932.261
48	449.5	(137.01)	2712	3919.866	-.038	+ 0.489	.148	3920.465
49	1662.5	(506.73)	2744	3955.229	-.027	- 3.811	.161	3951.552
50	449.5	(137.01)	2818	3919.847	-.017	+ 0.489	.146	3920.465
51	2.4	(0.73)	2834	3905.496	-.013	+ 2.232	.138	3907.859



• Drift correction used at particular reading when more than one reading was made at that depth.

○ Base Station at 519.0 feet (158.19 m).

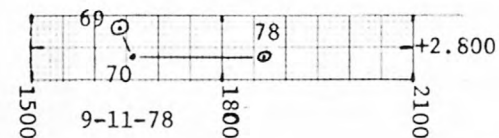


Figure 2.--Drift correction curve for BHGM in well DC-3, sec.6,T.12N.,R.26E., Benton County, Washington.

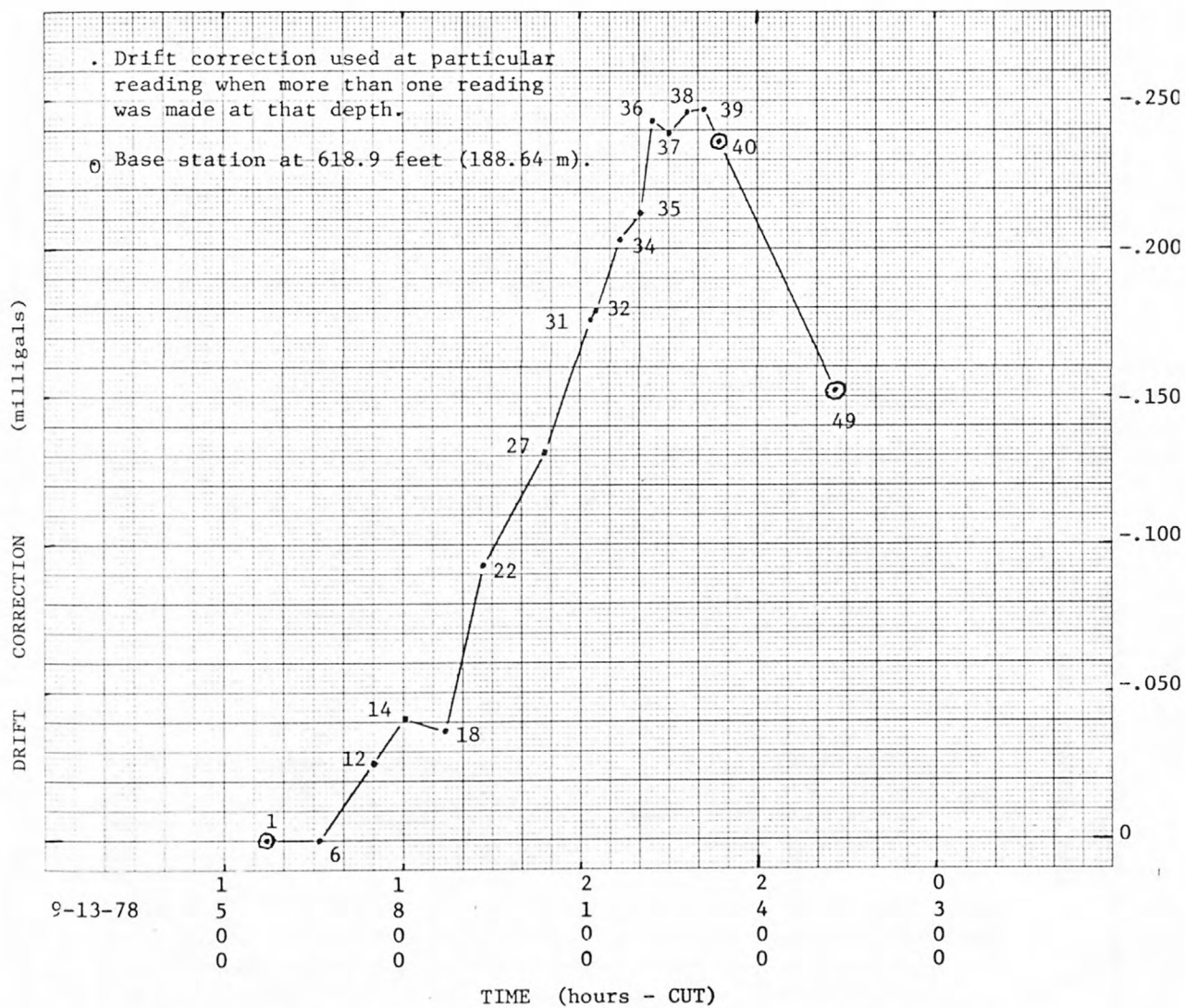


Figure 3.--Drift correction curve for BHGM in well DC-5, sec.34,T.13N.,R.25E., Benton County, Washington.

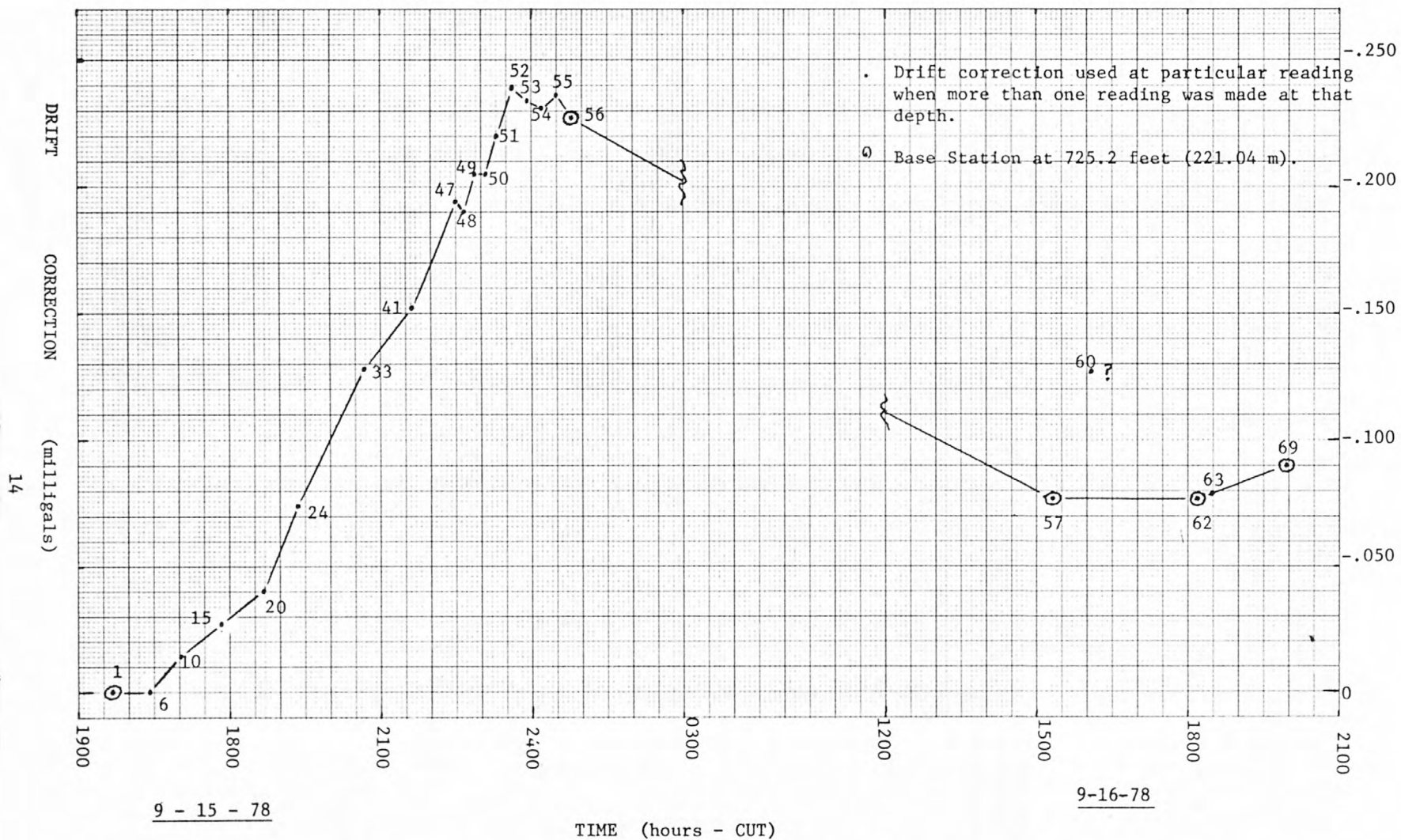


Figure 4.--Drift correction curve for BHGM in well DC-7, sec.35,T.12N.,R.27E., Benton County, Washington.

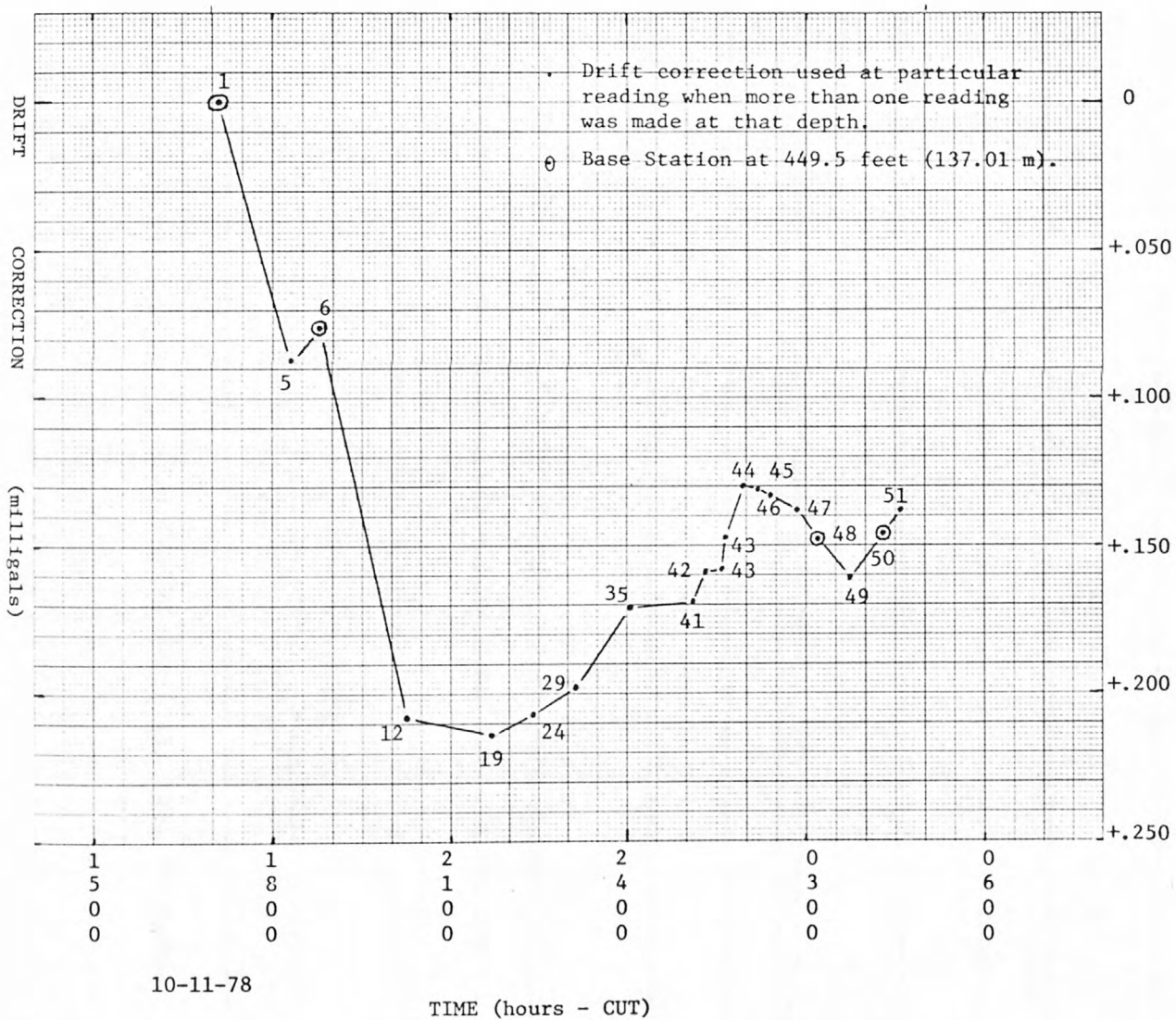


Figure 5.--Drift correction curve for BHGM in well RSH #1, sec.15,T.11N.,R.24E., Benton County, Washington.

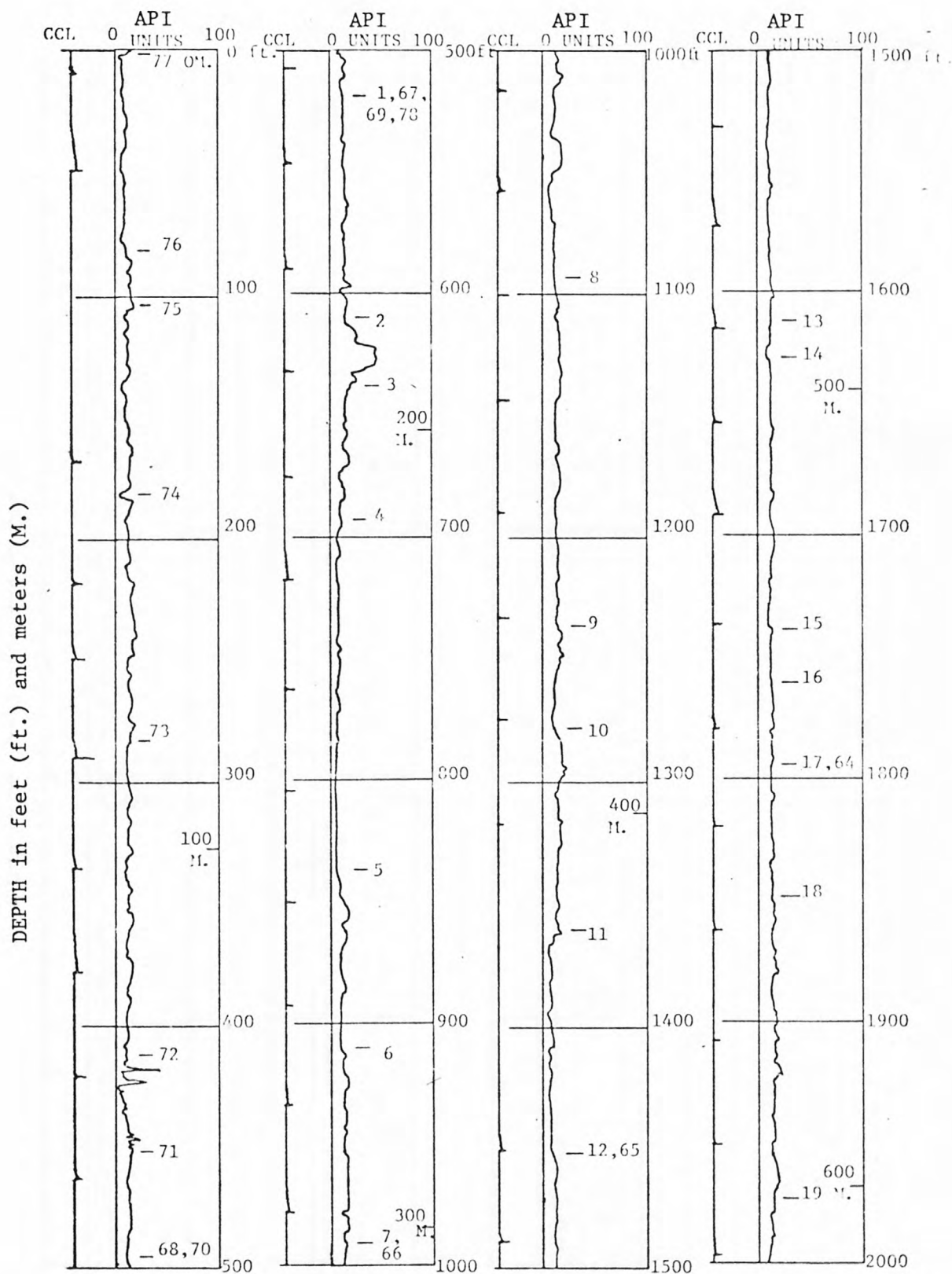


Figure 6. Gamma-ray intensity, in API units, and casing collar locator (CCL) logs from well DC-3, sec. 6, T. 12N., R. 26E., Benton County, Washington. Numbers 1 through 78 refer to gravity readings. Depth datum is ground level.

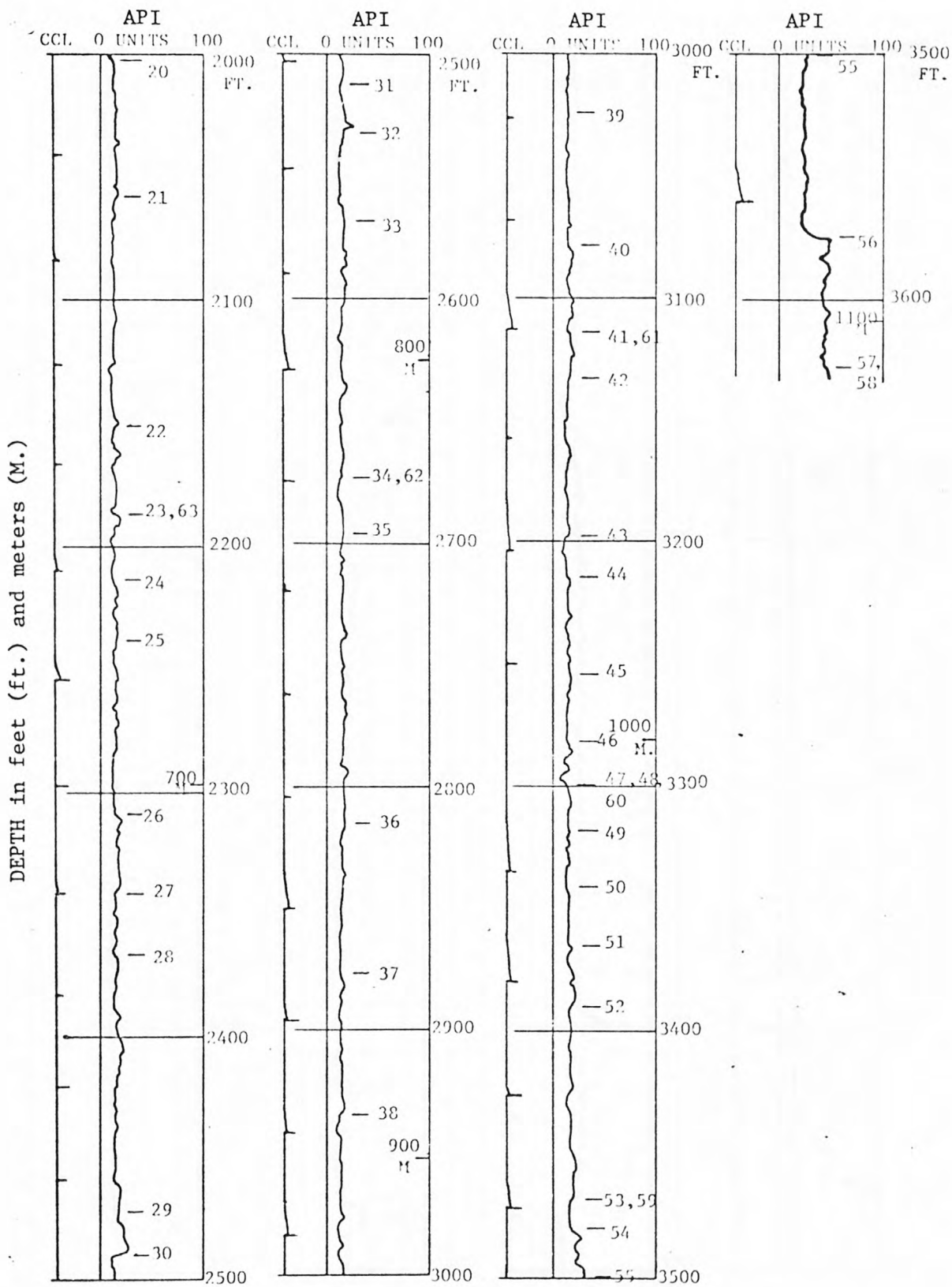


Figure 6.--Continued from pg 16

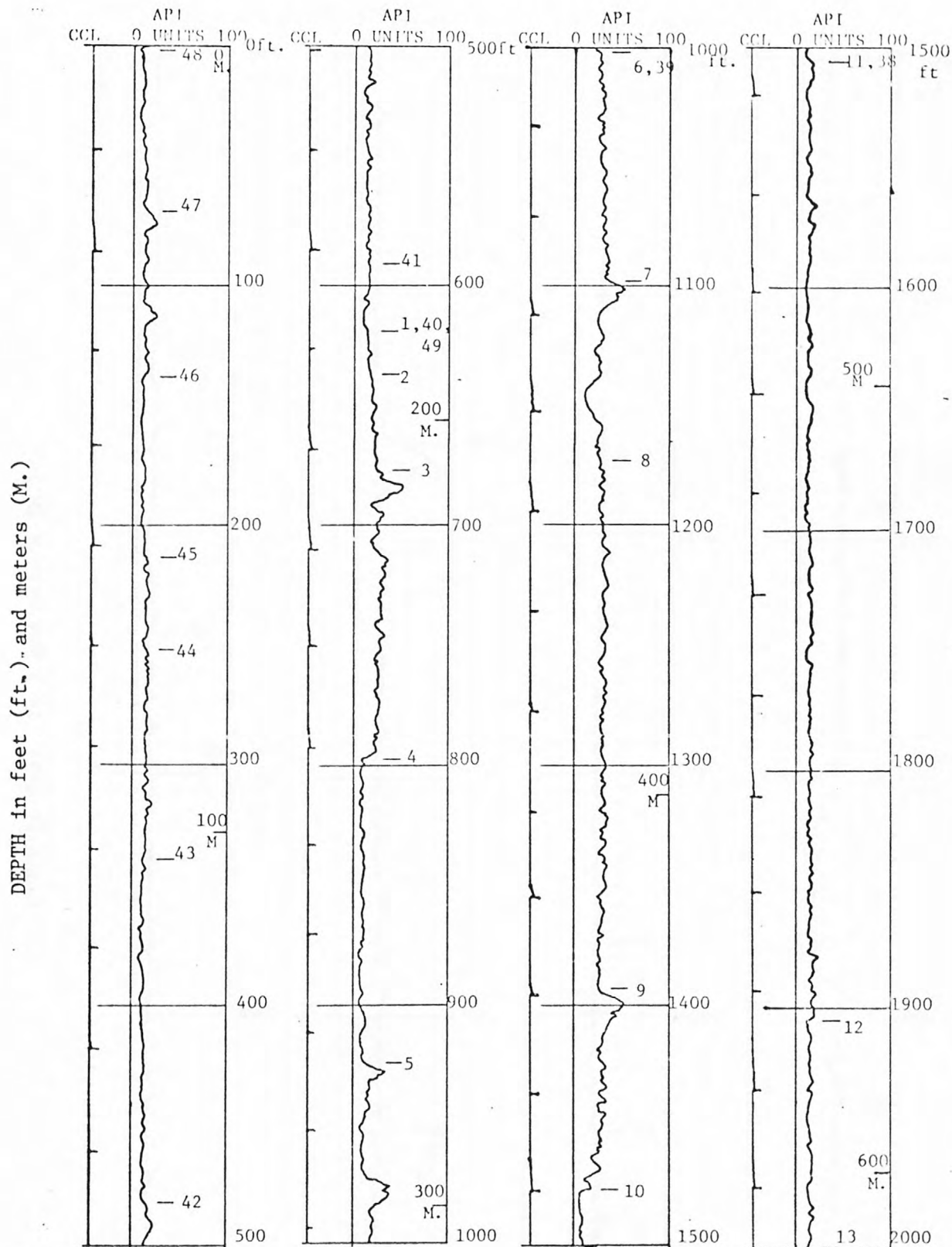


Figure 7. Gamma-ray intensity, in API units, and casing collar locator (CCL) logs from well DC-5, sec. 34, T.13N., R.25E., Benton County, Washington. Numbers 1 through 49 refer to gravity readings. Depth datum is ground level.

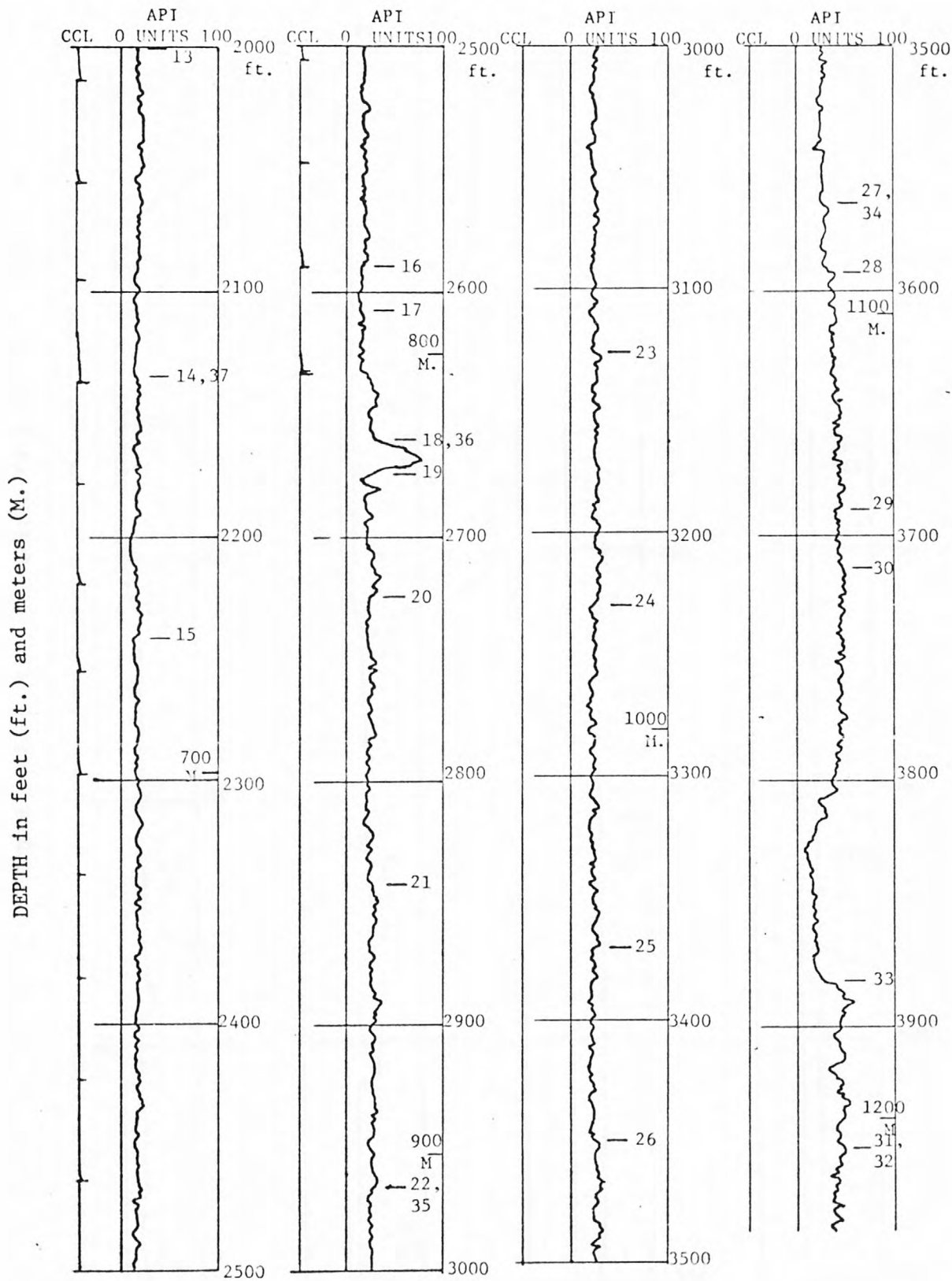


Figure 7. --Continued from pg 18

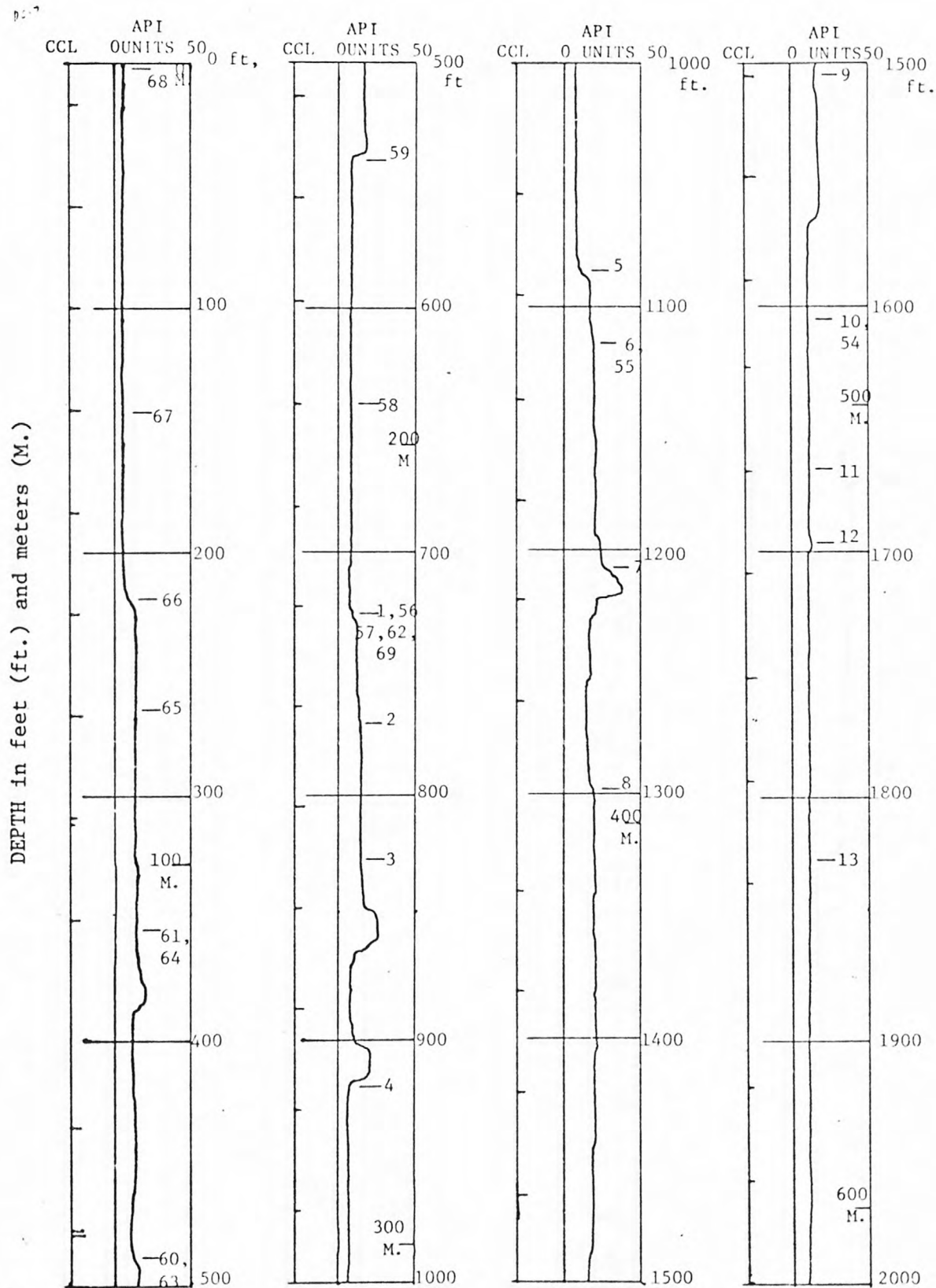
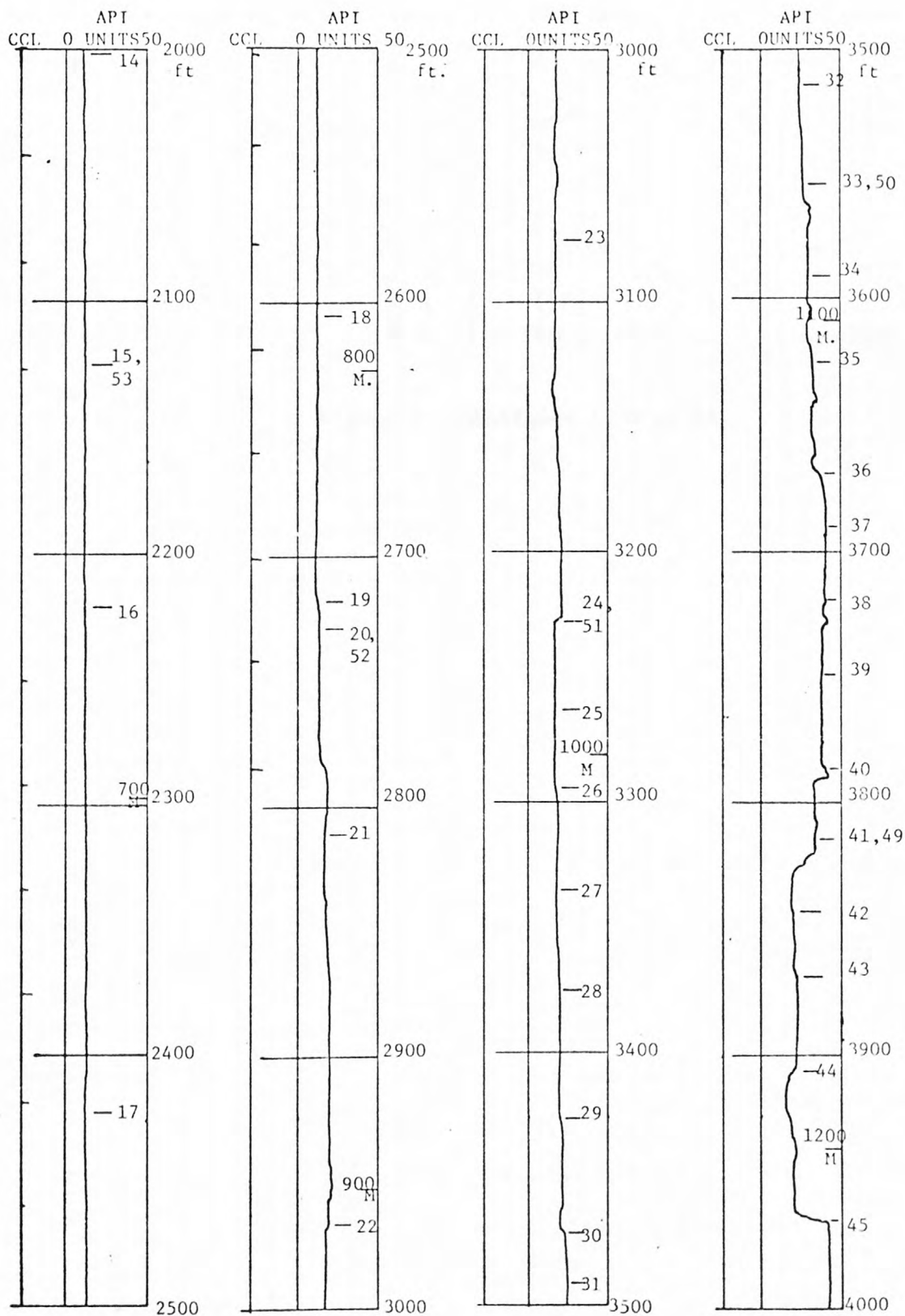


Figure 8. Gamma-ray intensity, in API units, and casing collar locator (CCL) logs from well DC-7, sec. 35, T. 12N., R. 27E., Benton County, Washington. Numbers 1 through 69 refer to gravity readings. Depth datum is ground level.

DEPTH in feet (ft.) and meters (M.)



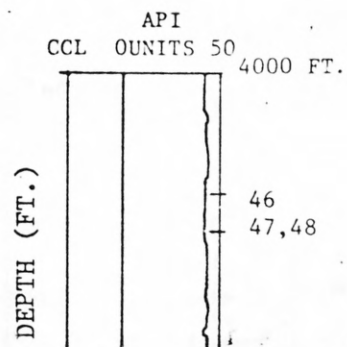


Figure 8.--Continued from pg 21

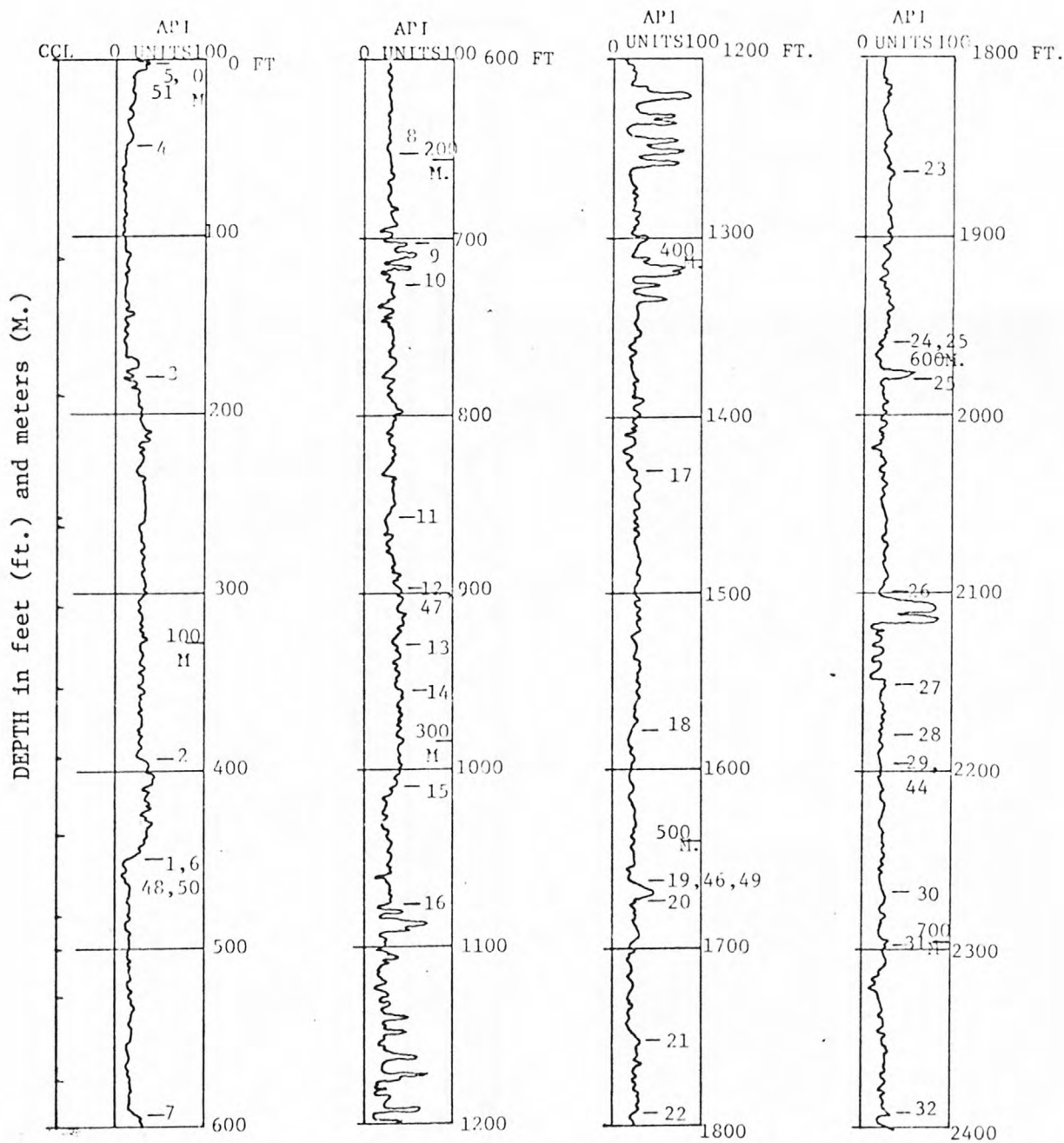


Figure 9. Gamma-ray intensity, in API units, and casing collar locator (CCL) logs from well RSH #1, **sec.15,T.11N.,R.24E.**, Benton County, Washington. Numbers 1 through 51 refers to gravity readings. Depth datum is ground level.

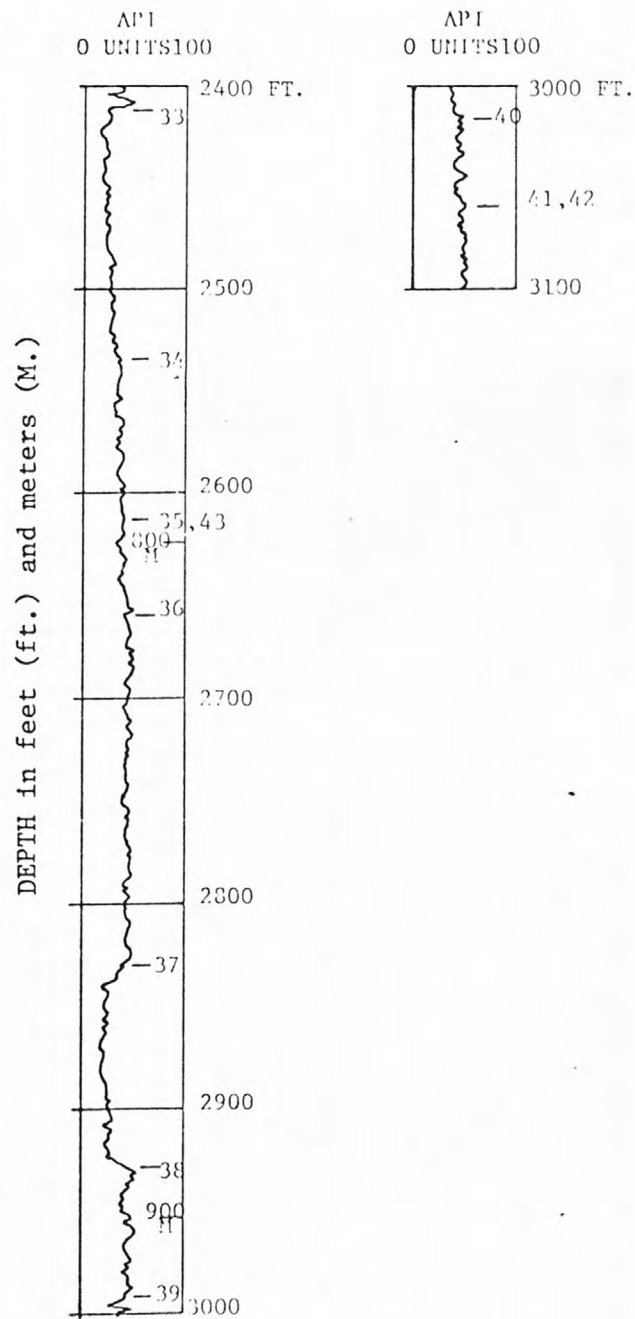


Figure 9. --Continued from pg 23

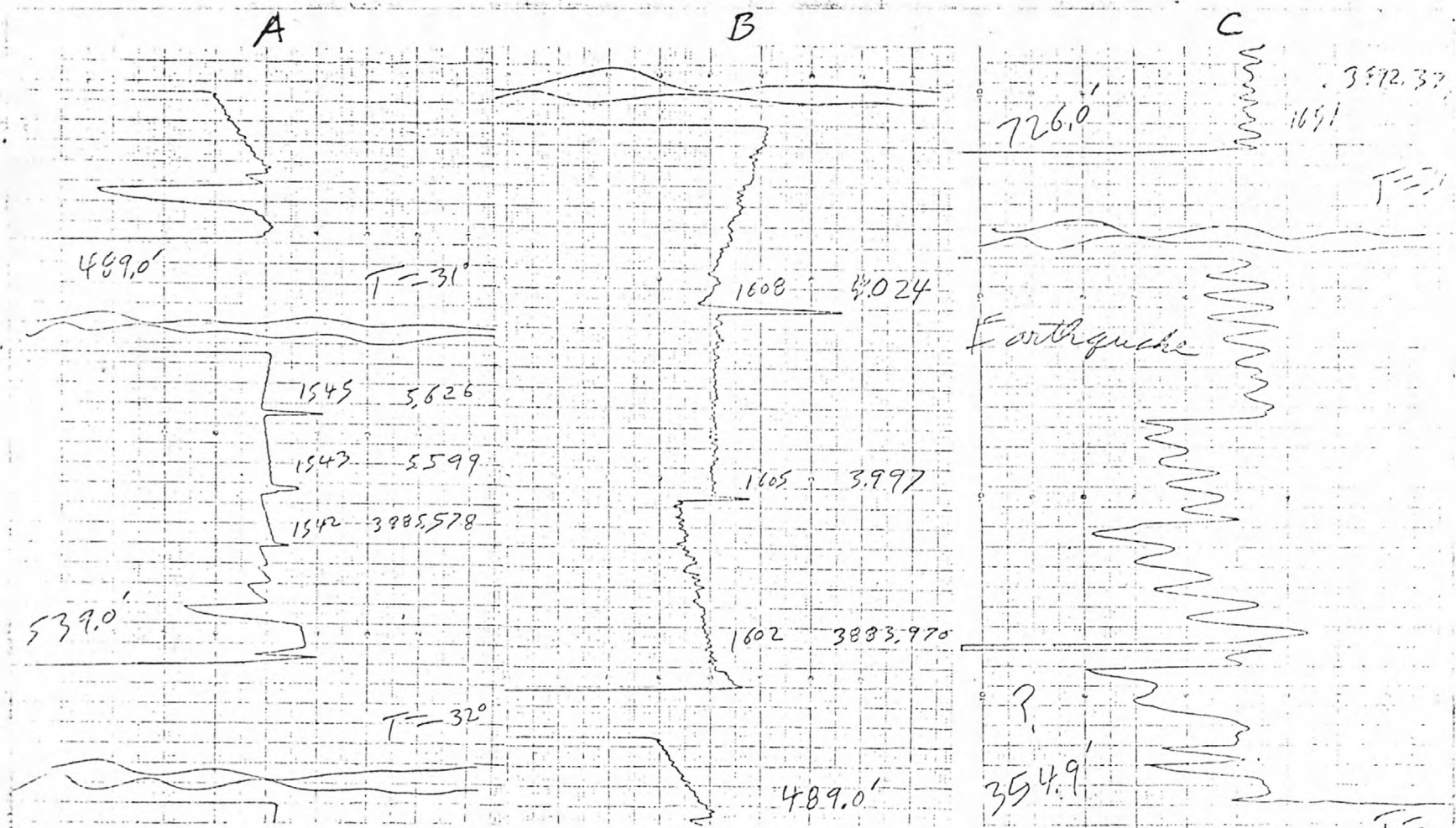


Figure 10. Reduction of the actual BHGM data in well DC-7 on September 16, 1978 before and during the Iran earthquake. These are recordings, in terms of slopes, of the beam velocities which are created by having a dampening mechanism on the beam. A) Recording at depth 539 ft between 1542 and 1546 CUT. The ground is very quiet. B) Recording at depth 489 ft between 1602 and 1610 CUT. Some ground motion is evident, possibly due to P-waves. C) Recording at depth 355 ft at about 1625 CUT. Earthquake motion is shown. At top of recording, back at depth 726 ft at 1651 CUT, earthquake motion is still evident, but amplitude is less.

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