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Principal facts for borehole gravity stations in Stratigraphic Test Well ERDA No. 9, Eddy County, New Mexico

by

Bruce A. Kososki, Stephen L. Robbins, and James W. Schmoker

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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards and nomenclature.

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INTRODUCTION

Since 1972 the U.S. Geological Survey has been conducting a series of field evaluation studies in southeastern New Mexico for the Waste Management Division of the Department of Energy (formerly U.S. Energy Research and Development Administration). On the basis of these studies, a tentative site for a nuclear waste repository/disposal facility has been selected near the center of the Los Medaños area in Eddy and Lea Counties, New Mexico (Fig. 1). The proposed host rock for the emplacement of nuclear waste at the potential repository site consists of the bedded evaporite deposits of the Salado Formation. Numerous test holes have been drilled in the Los Medaños area to determine geologic conditions and to obtain geophysical data and rock samples for additional site-evaluation studies. This report tabulates borehole gravity data acquired in one of these test holes, ERDA No. 9, and summarizes the geology of the consolidated rock formations in which gravity observations were made.

LOCATION AND GEOGRAPHICAL SETTING

Stratigraphic Test Well ERDA No. 9 is located in sec. 20, T. 22 S, R. 31 E. in Eddy County, New Mexico, approximately 27 miles (43 km) east of Carlsbad. The well site lies on the broad sand-covered plain that extends from the Pecos River drainage to the western edge of the Llano Estacado (fig. 1).

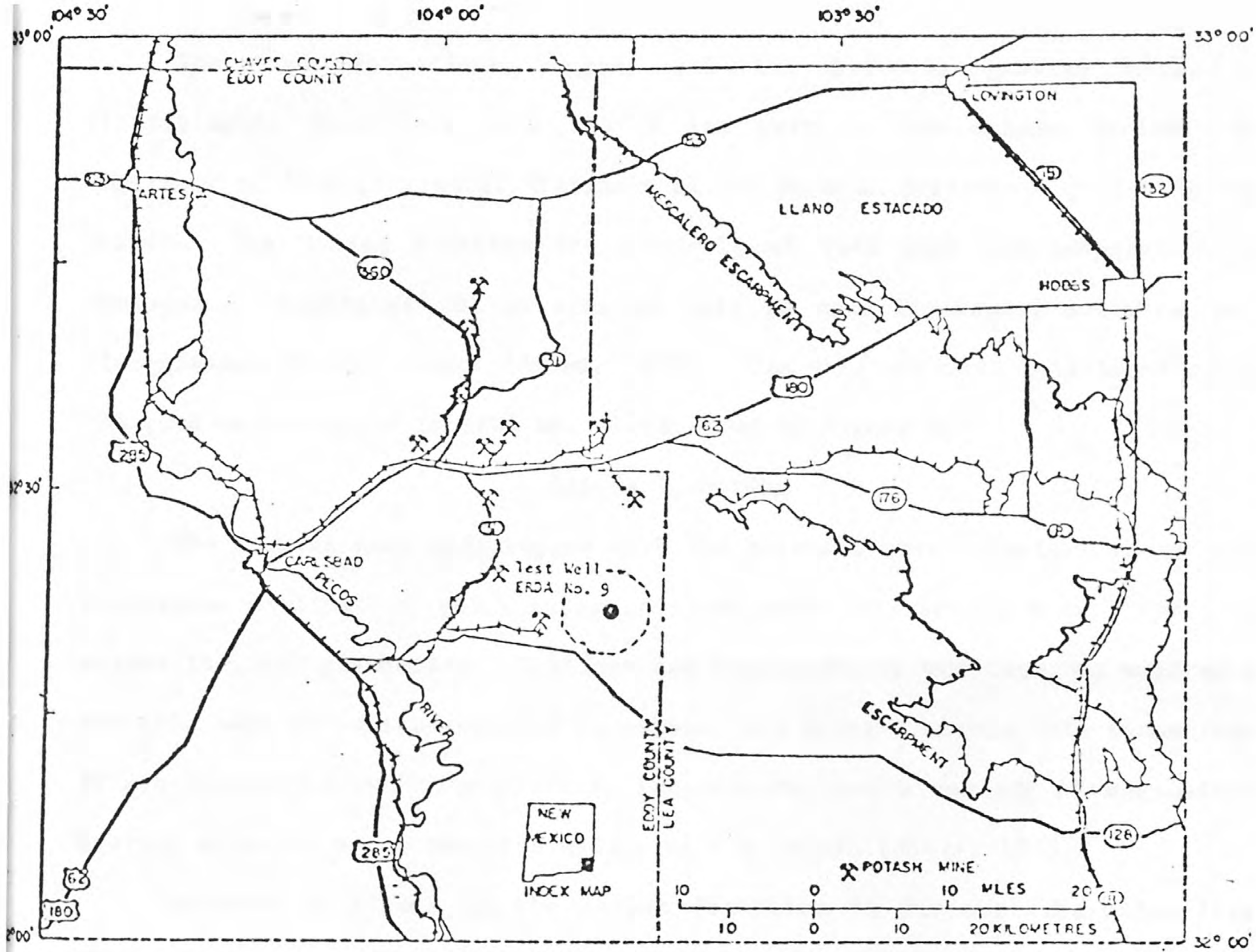


Figure 1. Map of southeastern New Mexico showing the location of the potential repository site in Los Medaños and Stratigraphic Test Well ERDA No. 9. (Modified from Jones, 1975.)

STRATIGRAPHIC RELATIONSHIPS

The rock formations logged with the borehole gravity meter in Stratigraphic Test Well ERDA No. 9 are part of the Ochoan Series, the uppermost of four provincial divisions of the Permian System recognized in New Mexico. The Ochoan consists predominantly of rock salt and anhydrite, but includes a variety of potash ores as well as some limestone, dolomite, and fine-grained clastic rocks (Jones, 1975). The stratigraphic relationships of the rock units logged in ERDA No. 9 are shown in figure 2.

Salado Formation

The deepest rock unit logged with the borehole gravity meter, the Salado Formation, consists of thick layers of rock salt interbedded with anhydrite, polyhalite, and glauberite. Partings and thin seams of mudstone, as well as a few thin beds of halite-cemented sandstone, are present within this formation. Potash deposits containing sylvite, langbeinite, and a variety of magnesium-bearing minerals occur near the middle of the Salado (Jones, 1975).

As seen on figure 2, the Salado Formation is further subdivided into three members: a lower member, the McNutt potash zone, and an upper member. For the purposes of gravity observations, however, little if any distinction can be made between these three units since they are quite similar in lithology.

The upper boundary of the Salado Formation is characterized by a sharp but conformable contact between rock salt and sandstone.

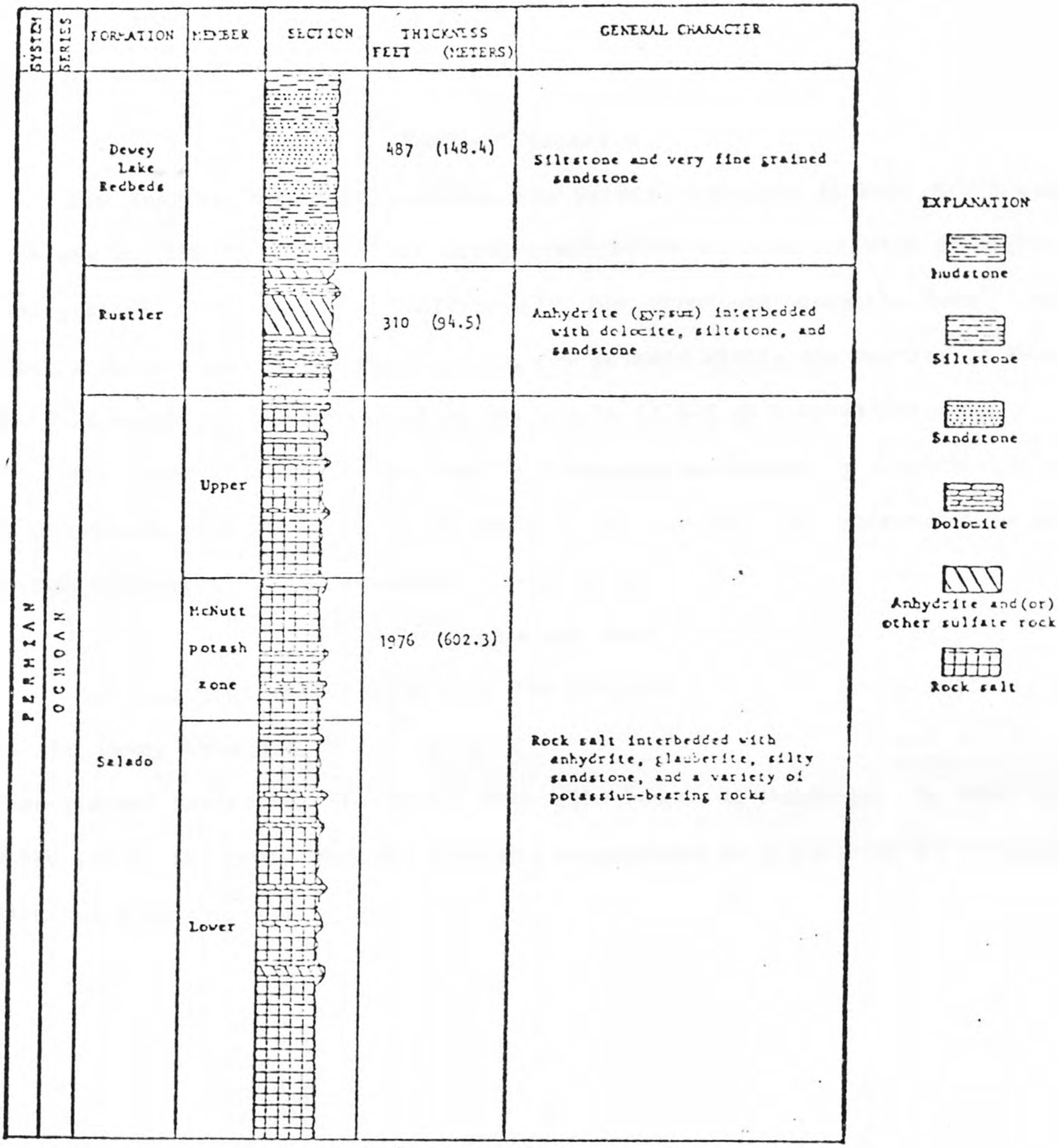


Figure 2. Stratigraphic column of consolidated rocks logged with the borehole gravity meter in Test Well ERDA No. 9. (Modified from Jones, 1975.)

Rustler Formation

The Rustler Formation overlies the Salado Formation in ERDA No. 9 and consists of 310 ft (94.5 m) of massive anhydrite interbedded with dolomite, fine-grained sandstone, and siltstone. Two prominent dolomite beds, the Magenta Member and the Culebra Member, are present within the Rustler in ERDA No. 9 at depths of 608 ft (185.3 m) and 716 ft (218.2 m) respectively.

The upper contact of the Rustler Formation is marked by a sharp change in lithology from anhydrite to mudstone. This contact is interpreted as an unconformity of slight discordance (Jones, 1975).

Dewey Lake Red Beds

The uppermost unit logged with the borehole gravity meter in ERDA No. 9 is the Dewey Lake Red Beds. This formation consists of siltstone and very fine-grained sandstone interbedded with thin layers of mudstone. In ERDA No. 9 the top of the Dewey Lake Red Beds was encountered at a depth of 63 ft (19.2 m) below ground level.

BOREHOLE GRAVITY DATA

Stratigraphic Test Well ERDA No. 9 was logged on 8-9 March 1978 with the U.S. Geological Survey - LaCoste and Romberg[1/] borehole gravity meter (McCulloh, and others, 1967a; McCulloh and others, 1967b). Including station reoccupations for drift control, 44 subsurface gravity observations were made in this well. The data associated with each subsurface gravity station are recorded in table 1. The column headings of this table are explained in the following list:

Station number:	A numbering of borehole gravity stations in the order recorded.
Depth:	Depth of stations in feet and meters. Datum is the wellhead elevation.
Time:	Greenwich mean time of each gravity reading.
Uncorrected gravity:	Observed gravity in milligals, referenced to an arbitrary base, uncorrected for tide, terrain, and drift effects.
Tide correction:	Theoretical correction for earth tides in milligals.
Terrain correction:	Terrain correction in milligals calculated for a density of 2.67 g/cm^3 out to a distance of 71,996 ft (21,944 m), corresponding to zone M of Hammer's terrain correction chart (Hammer, 1939).
Drift correction:	A correction for linear instrument drift derived from station reoccupations.
Corrected gravity	Observed gravity in milligals, referenced to an arbitrary base, corrected for tide, terrain, and drift effects.

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

Table 1

Stratigraphic Test Well ERDA No. 9, Eddy County, New Mexico. Well location 280 ft (85.3 m) from south line and 184 ft (56.1 m) from east line of sec. 20 T. 22 S., R. 31 E. Wellhead elevation 3409.99 ft (1039.36 m).

Station number	Depth ft	Depth m	Time	Uncorrected gravity	Tide correction	Terrain correction	Drift correction	Corrected gravity
1	196.6	59.98	2011	3.659	.075	.042	.168	3.944
2	339.7	103.54	2043	7.944	.054	.048	.150	8.196
3	439.8	134.05	2054	11.024	.046	.054	.144	11.268
4	567.8	173.07	2122	14.701	.024	.062	.129	14.916
5	626.8	191.05	2131	16.481	.016	.067	.124	16.688
6	679.8	207.20	2138	17.511	.010	.071	.120	17.712
7	784.8	239.21	2150	20.745	.000	.079	.114	20.938
8	848.8	258.71	2159	22.790	- .008	.083	.109	22.974
9	970.8	295.90	2210	27.382	- .018	.092	.103	27.559
10	1089.8	332.17	2221	31.597	- .027	.100	.097	31.767
11	1174.8	358.08	2231	34.572	- .036	.106	.091	34.733
12	1269.9	387.07	2239	38.235	- .042	.111	.087	38.391
13	1352.8	412.33	2248	41.285	- .049	.116	.082	41.434
14	1442.8	439.77	2257	44.706	- .056	.121	.077	44.848
15	1539.8	469.33	2308	48.196	- .064	.125	.071	48.328
16	1618.8	493.41	2318	51.131	- .071	.129	.066	51.255
17	1727.8	526.63	2326	55.058	- .076	.133	.061	55.176
18	1849.8	563.82	2335	59.651	- .081	.138	.057	59.765
19	1919.8	585.16	2344	62.287	- .086	.140	.052	62.393
20	2047.9	624.20	2355	66.714	- .091	.143	.046	66.812
21	2163.8	659.53	0007	71.114	- .095	.146	.039	71.204
22	2232.8	680.56	0018	73.630	- .099	.147	.033	73.711
23	2312.8	704.94	0028	76.540	- .101	.148	.028	76.615
24	2424.8	739.08	0037	80.468	- .102	.150	.023	80.539
25	2526.8	770.17	0045	84.025	- .103	.151	.019	84.092
26	2549.8	777.18	0053	84.512	- .103	.151	.014	84.574
27	2609.9	795.50	0102	86.709	- .102	.152	.009	86.768
28	2717.8	828.39	0109	90.784	- .102	.152	.005	90.839
29	2779.8	847.28	0119	92.838	- .100	.152	.000	92.890
30	2779.8	847.28	0127	92.839	- .098	.152	- .004	92.889
31	2609.9	795.44	0139	86.725	- .094	.152	- .011	86.772
32	2549.8	777.15	0146	84.532	- .091	.151	- .015	84.577
33	2526.8	770.11	0159	84.045	- .085	.151	- .022	84.089
34	2312.8	704.85	0211	76.563	- .079	.148	- .028	76.604
35	2232.8	680.44	0221	73.679	- .072	.147	- .034	73.720
36	2047.9	624.02	0233	66.744	- .064	.143	- .040	66.783
37	1919.8	584.97	0246	62.354	- .054	.140	- .047	62.393
38	1618.8	493.20	0259	51.249	- .044	.129	- .054	51.280
39	1352.8	412.06	0312	41.431	- .033	.116	- .060	41.454
40	848.8	258.35	0328	23.015	- .018	.083	- .070	23.010
41	626.8	190.65	0339	16.740	- .008	.067	- .076	16.723
42	567.8	172.67	0347	14.918	.000	.062	- .081	14.899
43	538.4	164.10	0358	14.326	.010	.060	- .087	14.309
44	339.7	103.05	0411	8.211	.023	.048	- .094	8.188

A detailed discussion of the relationship between subsurface gravity measurements and mass distributions within the earth is given by McCulloh (1966). Other literature on borehole-gravity-logging fundamentals and data interpretation include Smith (1950), Goodell and Fay (1964); Howell, Heintz, and Barry (1966); Beyer (1971); and Brown and others (1975).

In the absence of complicating factors, the in situ density in grams per cubic centimeter between two observation points in a borehole is given by the equation:

$$\rho = \frac{1}{4\pi K} (F - \Delta g/\Delta z), \qquad (1)$$

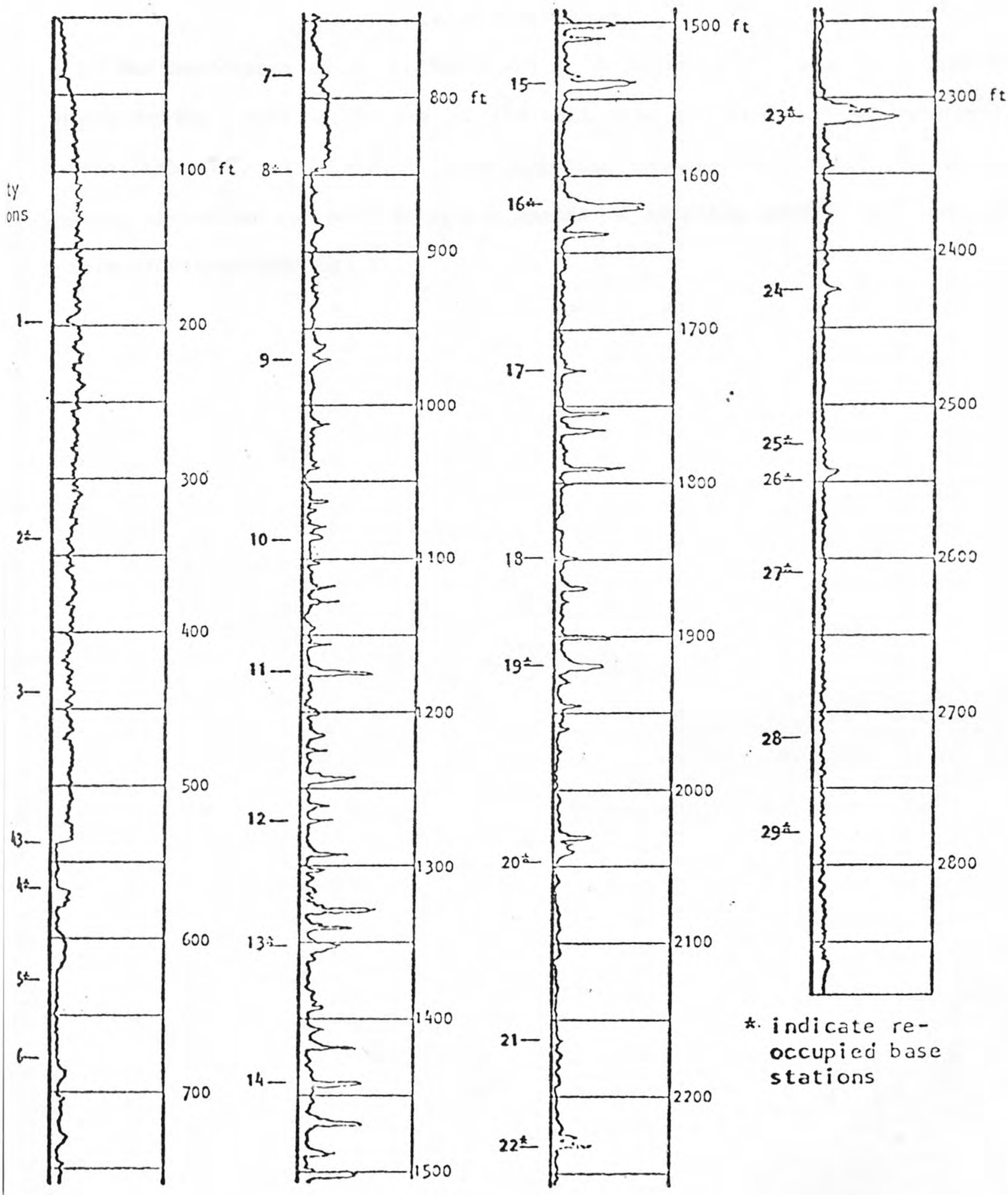
where K is the gravitational constant; F, the free-air vertical gradient of gravity; and $\Delta g/\Delta z$, the vertical gradient of gravity between discrete pairs of gravity measurements in the well. Assuming a "normal" free-air gravity gradient of 0.09406 mgal/ft, equation (1) becomes:

$$\rho = 3.686 - 39.185\ (\Delta g/\Delta z) \qquad (2)$$

GAMMA-RAY LOG

Prior to conducting the borehole gravity survey in Stratigraphic Test Well ERDA No. 9 a gamma-ray log was run for stratigraphic correlation. A reduced section of this log is shown in figure 3. Most of the gravity stations were located where either the gamma-ray log or driller's log indicated variations in formation properties.

Figure 3. Gamma-ray log, Stratigraphic Test Well ERDA No. 9



*- indicate re-occupied base stations

ACKNOWLEDGMENTS

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