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Palm Valley No.1

Mercury Injection Capillary Pressure Tests

by

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BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PETROLEUM TECHNOLOGY SECTION

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INTRODUCTION.

This report presents results of a mercury injection capillary pressure study on core samples selected from the gas producing horizons of the Horn Valley, Stairway, and Pacoota Formations in the Palm Valley No. 1 well, Northern Territory.

PROCEDURE & APPARATUS.

Fourteen $\frac{3}{4}$-inch diameter plugs were drilled-out parallel to bedding from cores taken in the gas producing intervals of the above well. The plugs were trimmed with a diamond saw to an approximate length of $1\frac{1}{4}$ inches, then extracted with toluene and oven - dried at 110°C for 24 hours. Porosity and absolute permeability to nitrogen were determined after the plugs had cooled to room temperature.

Mercury Injection capillary pressure tests were then carried out in a Ruska-type mercury injection apparatus, according to a method described by Purcell in Petroleum Transactions, AIME, 1949. Upon extensive evacuation, each of the samples was subjected stepwise to increasing mercury pressure, and the volume of mercury injected at each step was measured when stalilization had been achieved. The ultimate pressure used on each sample was 1500 psia.

The pressure-volume data obtained from tests on the samples were then used in compiling mercury capillary pressure curves, after application of measured corrections for mercury surface conformance and pump expansion had been made.

Finally, pore size distribution of the samples was determined; using the capillary pressure function $r = \frac{2\,\gamma \cos\theta}{\Delta P}$, a value for the average pore entry radius was calcualted over a particular saturation interval. The values γ and θ, respectively representing the surface tension of mercury (480 dynes/cm) and the mercury-rock contact angle were obtained from Purcells paper referred to above.

DISCUSSION.

Test results, comprising capillary pressure curves for seven of the fourteen samples tested are presented in Figures 1 to 7. Pore size distribution

values calculated from the capillary test results of these same seven samples are listed in Table 1. Porosity and permeability values of all the samples are listed in Table II, while the electrical log together with the relevant sample depths are shown in Figure 8.

Capillary pressure curves could not be determined for half of the fourteen samples used in these tests; no penetration of mercury into their rock matrix was noticed over the whole test pressure range. Capillary pressure results for the remainder of samples tested were characterized by high threshold pressures, and very high indicated water saturations at ultimate test pressure. These results could be considered mormal for this type of material, since measured porosity and permeability values of all the samples tested were very low to nil.

The porosity, permeability and capillary pressure characteristics of this reservoir suggest that the major portion of the production may be occurring along fracture systems, and other planes of weakness in the formation. Such is also indicated by the core descriptions taken throughout the productive intervals.

CONCLUSIONS.

Capillary pressure characteristics were obtained from only seven of the fourteen samples utilized in the tests from the gas producing zones. Capillary pressure tests on the other seven samples were negative bedause of their extremely impermeable nature.

Those samples for which test results were obtained showed that:

(1) Threshold pressures and water saturations were very high.

(2) Porosity and permeability values were of a very low order.

(3) Production is probably occurring from fractures and other planes of weakness in the formation.

TABLE I

AVERAGE PORE ENTRY RADIUS (MICRONS)

SATURATION (% PORE VOLUME)														SAMPLE DEPTH (FEET)
0-4	4-8	8-12	12-16	16-20	20-24	24-28	28-32	32-35	36-40	40-44	44-48	48-52	52-56	
	0.248	0.222	0.196	0.146	0.091									5199
	0.178	0.114												5625
0.254	0.228	0.201	0.178	0.153	0.130	0.110	0.093	0.081						5742
0.099	0.078													5904
0.520	0.504	0.468	0.442	0.396	0.358	0.312	0.268	0.235	0.198	0.160	0.129	0.100	0.081	5922

TABLE I (CONT'D)

AVERAGE PORE ENTRY RADIUS (MICRONS)	SATURATION (% PORE VOLUME)			SAMPLE DEPTH (FEET)
	1-2	2-3		
	0.112			5742
	0.114	0.083		5898

TABLE II

POROSITY & PERMEABILITY PALM VALLEY NO. 1.

CORE NUMBER	SAMPLE DEPTH	POROSITY % BULK VOLUME	PERMEABILITY TO DRY NITROGEN (MILLIDARCYS)
13	5199'	6.7	less than 0.5
14	5570	1.0	" " "
15	5625	2.0	" " "
15	5628	5.6	" " "
15	5637	1.0	" " "
16	5639	5.7	" " "
16	5742	6.1	" " "
16	5751	6.3	" " "
16	5754	6.3	" " "
16	5771	2.5	" " "
16	5779	3.6	" " "
17	5898	6.9	" " "
17	5904	5.1	" " "
17	5922	6.2	" " "

FIGURE 1

MERCURY CAPILLARY PRESSURE

WELL NAME-P.VALLEY No 1 SAMPLE DEPTH-5199

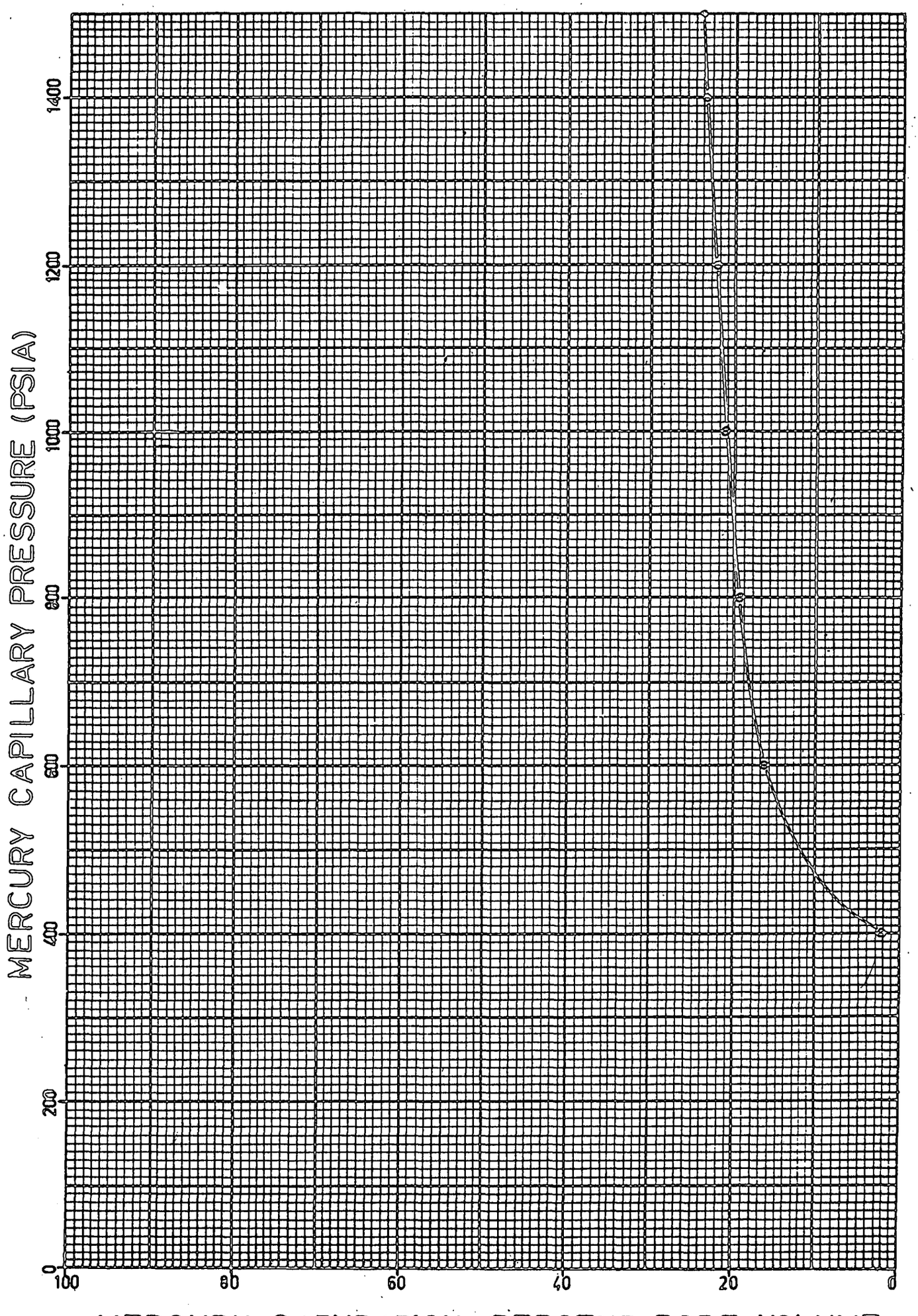

FIGURE 2

MERCURY CAPILLARY PRESSURE

WELL NAME PVALLEY No 1 SAMPLE DEPTH 5625

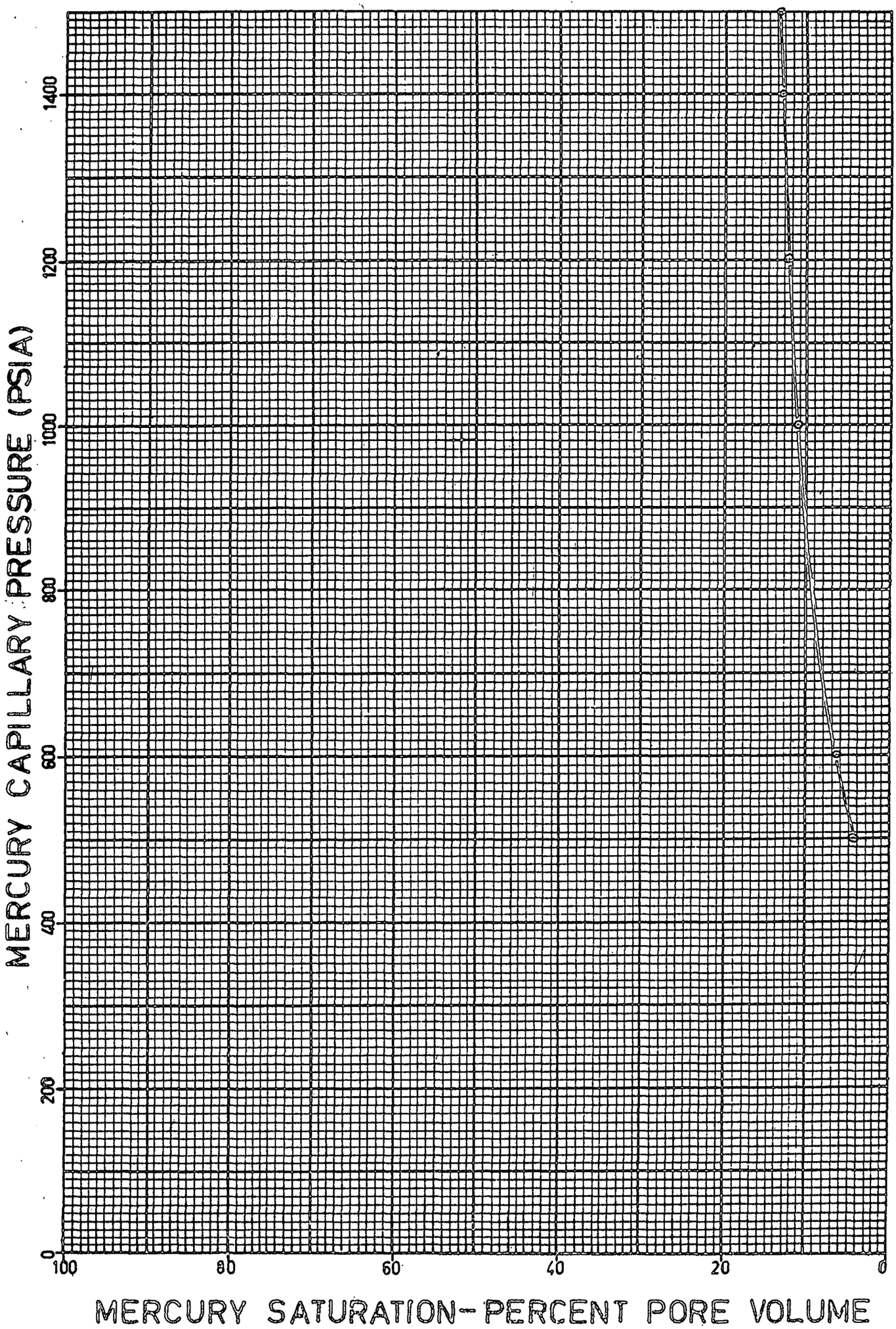

FIGURE 3

MERCURY CAPILLARY PRESSURE

WELL NAME-PVALLEY No 1 SAMPLE DEPTH-5742

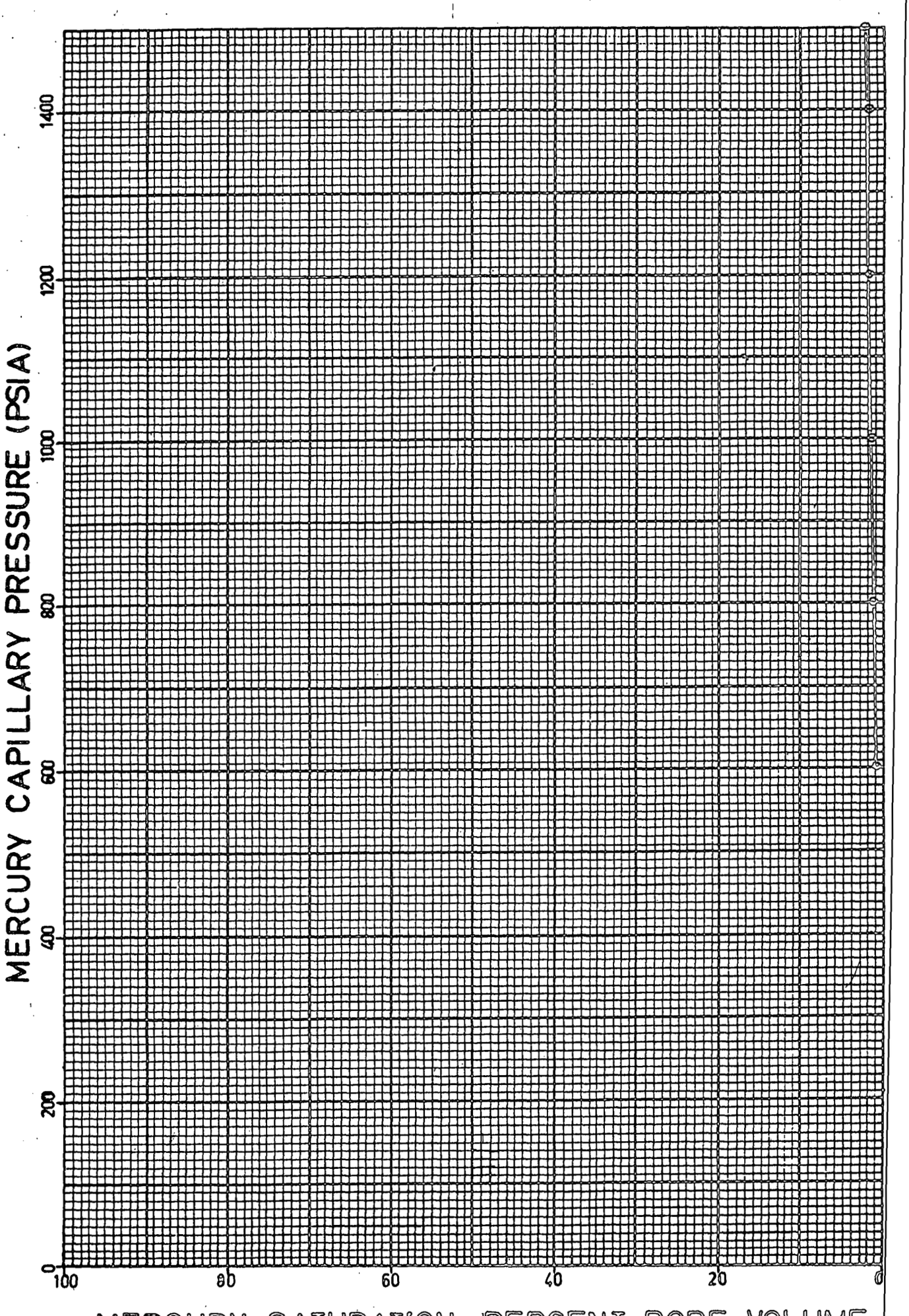

FIGURE 4

MERCURY CAPILLARY PRESSURE

WELL NAME-P.VALLEY No 1 SAMPLE DEPTH-5778

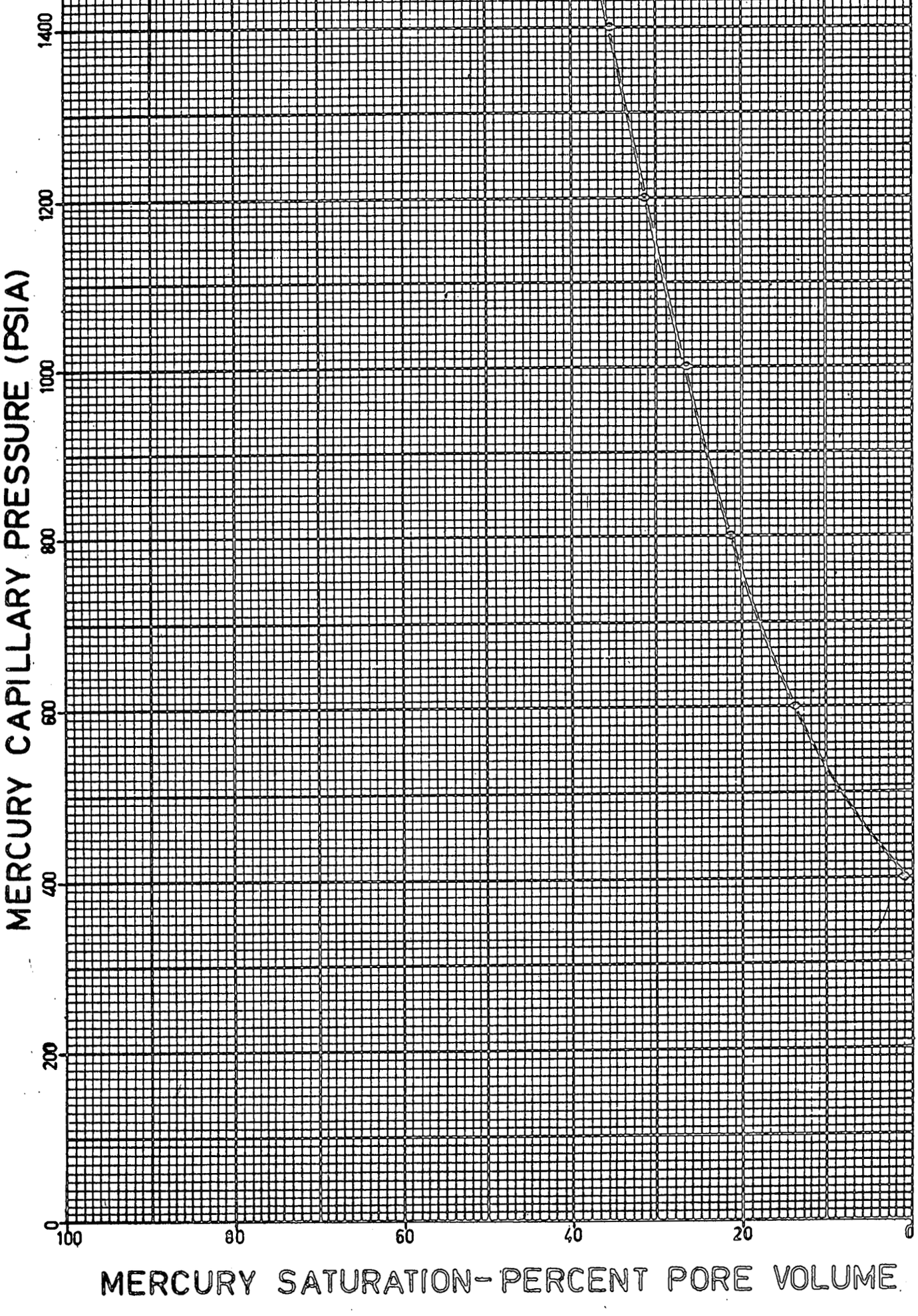

FIGURE 5

MERCURY CAPILLARY PRESSURE

WELL NAME-P.VALLEY No 1 SAMPLE DEPTH-5898

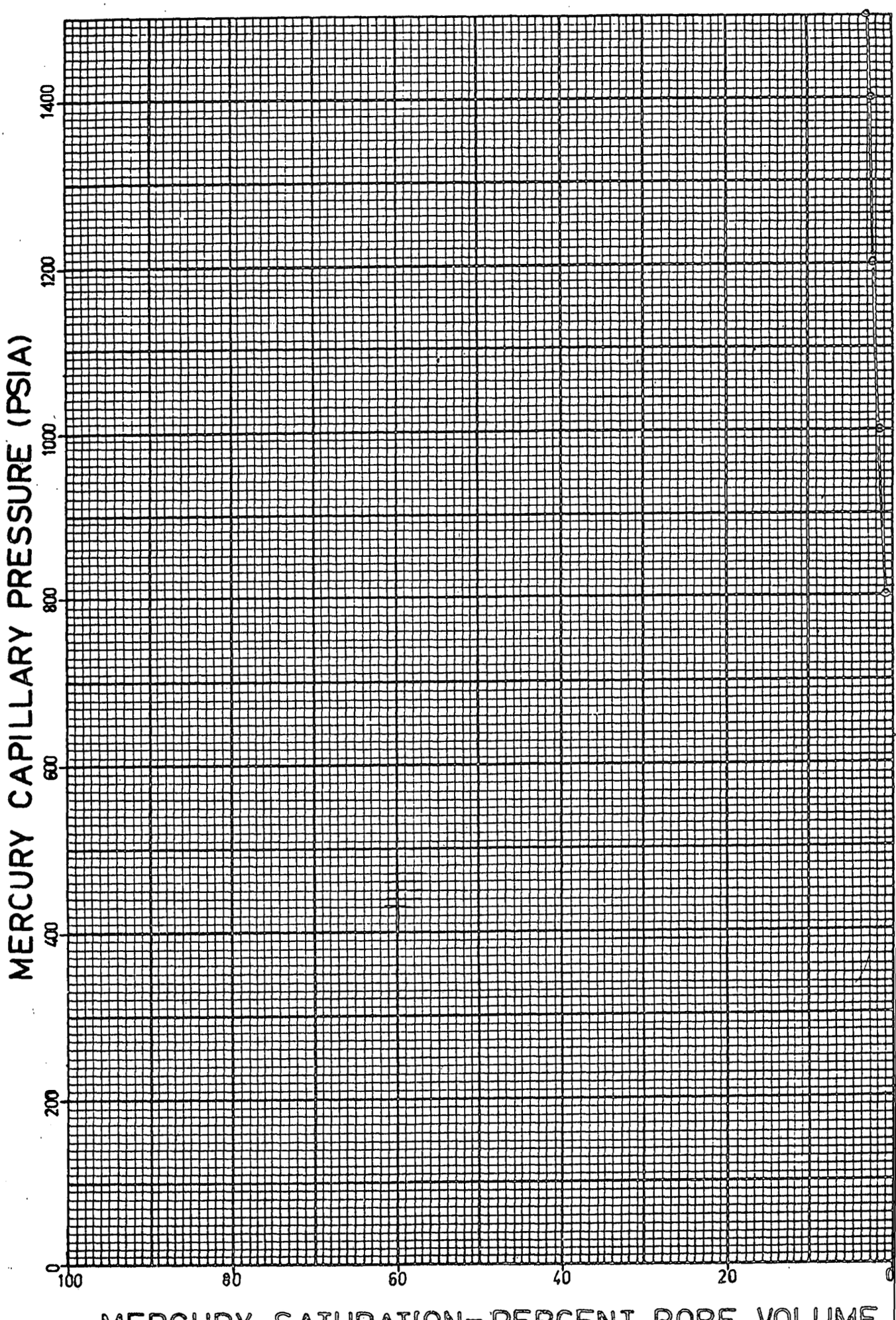

FIGURE 6

MERCURY CAPILLARY PRESSURE

WELL NAME-PVALLEY No 1 SAMPLE DEPTH-5904

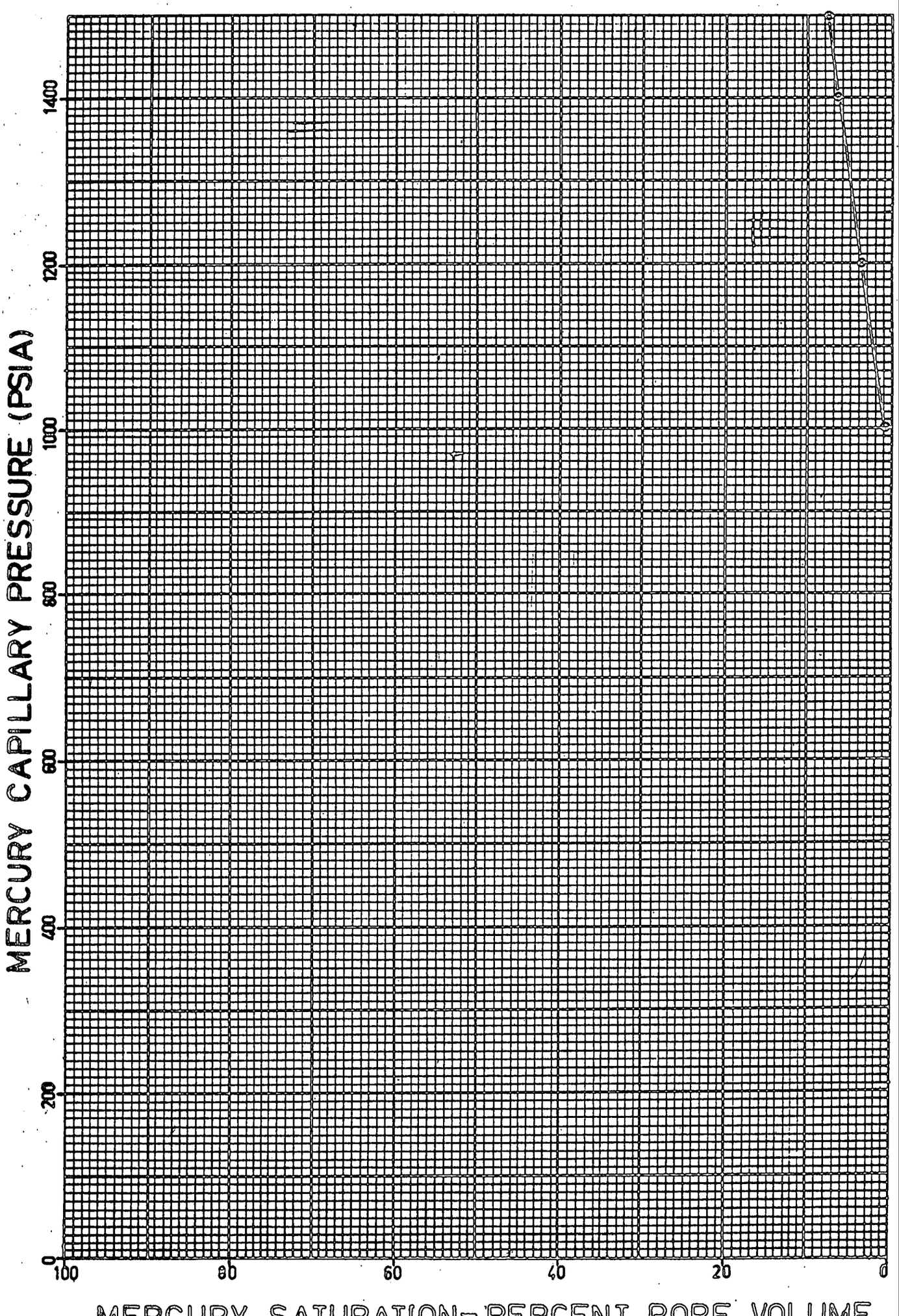

FIGURE 7

MERCURY CAPILLARY PRESSURE

WELL NAME-P.VALLEY No 1 SAMPLE DEPTH-5922

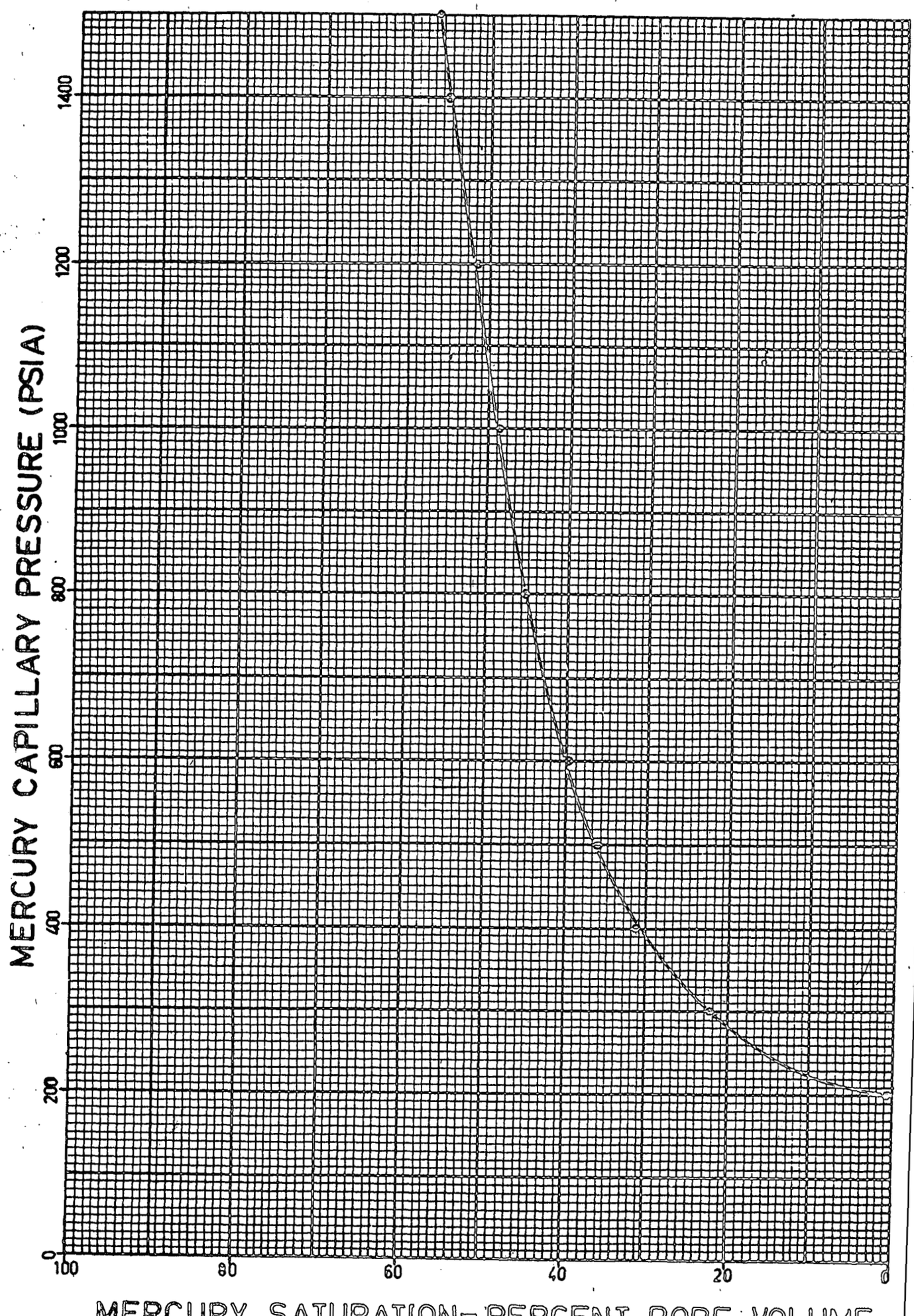

FIGURE 8

PALM VALLEY No 1 – ELECTRICAL LOG