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GINGIN No. 1

Mercury Injection Capillary

Pressure and

Wettability Tests

by

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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

PETROLEUM TECHNOLOGY SECTION

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CAPILLARY PRESSURE AND WETTABILITY TESTS ON EIGHT CORE SAMPLES FROM THE WELL

by

B.A. McKAY

GINGIN NO. 1

MERCURY INJECTION CAPILLARY PRESSURE

AND WETTABILITY TESTS

INTRODUCTION

This report presents the results of a mercury injection capillary pressure study on eight core samples taken in proximity to gas and condensate producing zones of the Gingin No. 1 well in the Perth Basin, Western Australia. Pore size distribution data, calculated from the capillary pressure information are also presented in the report.

PROCEDURE AND APPARATUS

Eight $\frac{3}{4}$-inch diameter plugs were drilled out parallel to bedding from samples of $3\frac{1}{2}$-inch cores which were available for the tests. Each plug was trimmed to approximately $1\frac{1}{4}$ inches in length, extracted with toluene and then oven-dried for 24 hours. Absolute nitrogen permeability and effective porosity were determined on the plugs upon cooling.

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, A.I.M.E., 1949. Upon extensive evacuation, each of the samples was subjected to increasing mercury pressure and the volume of mercury injected at each pressure "step" was measured. The ultimate pressure used in each sample was 1,500 PSIA.

The pressure/volume data obtained from tests on these eight samples were subsequently used for the compilation of mercury capillary pressure curves, after corrections for mercury surface conformance and pump expansion had been made.

Pore size distribution data were then calculated from these curves utilizing the formula $r = \frac{2\gamma \cos \theta}{\Delta P}$, ΔP being the arithmetical average pressure over the respective saturation intervals; the other two parameters, γ and θ, respectively the mercury surface tension and contact angle with the solid, were taken from Purcell's paper referred to previously in this report.

DISCUSSION

The results of the mercury injection capillary pressure tests are presented in figures 1 to 8 attached to this report. Pore size distribution and absolute permeability and porosity data are listed in tables I and II respectively, while the electrical log together with the sample depths is shown in Figure 9.

The capillary pressure curves for these samples are characterized by the relatively high initial displacement pressures and generally moderate to high indicated water saturation at ultimate test pressure. Since measured absolute permeability values (to nitrogen) were very low, the threshold pressures and equivalent water saturations obtained seemed compatible with the measured flow capacity in the samples.

In order to investigate the capillary effects a little further, imbibition tests were conducted in some of the core material. Samples, pressure-saturated with water, were immersed in oil (kerosene) and adjacent oil-saturated samples were immersed in water and left in this state, undistrubed for a period of $2\frac{1}{2}$ weeks. It was found, after this time, that only the oil-saturated samples immersed in water had been affected, and relatively small amounts of the saturating oil (kerosene) were displaced by the water.

However, the nature of these imbibition forces was so weak, it is not expected to play a dominant role in the fluid saturation distribution of this type of core material at stabilized reservoir conditions.

CONCLUSIONS

Because of the scarcity of core material from the producing sections of this well, the number of samples analysed was limited. However, tests on the few samples available in proximity to the producing zones give the following results:

1. The sample material tested was generally "tight", with low porosity and permeability values.

2. The threshold pressure of all samples analysed was generally high.

3. Imbibition tests performed on the samples have shown them to be slightly water-wet.

4. The calculated maximum average pore size of the samples was 1.6 microns.

(B. A. McKAY)

TABLE 1

AVERAGE PORE ENTRY RADIUS (MICRONS)	SATURATION (% PORE VOLUME)							SAMPLE DEPTH (FEET)
	0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60	60 - 70	
	0.711	0.603	0.476	0.321	0.164	0.089	--	12,470
	1.645	1.368	1.090	0.867	0.593	0.356	0.172	12,515
	1.619	1.215	0.960	0.647	0.440	0.232	0.101	12,527
		0.468	0.381	0.257	0.119	--	--	14,570
	0.990	0.820	0.647	0.478	0.301	0.148	--	14,576
	0.721	0.650	0.555	0.441	0.276	0.125	--	14,584
	0.712	0.556	0.411	0.254	0.129	--	--	14,587

TABLE 2

SAMPLE DEPTH (FEET)	EFFECTIVE POROSITY (% BULK VOLUME)	(DRY NITROGEN) ABSOLUTE PERMEABILITY (MILLIDARCY).
12,470	8.4	Less than 0.5
12,515	12.0	4.6
12,527	13.5	4.5
13,046	7.0	Less than 0.5
14,570	6.6	" " 0.5
14,576	5.7	" " 0.5
14,584	7.2	" " 0.5
14,587	7.8	" " 0.5

FIGURE 1

MERCURY CAPILLARY PRESSURE

WELL NAME– GINGIN No 1 SAMPLE DEPTH–12470

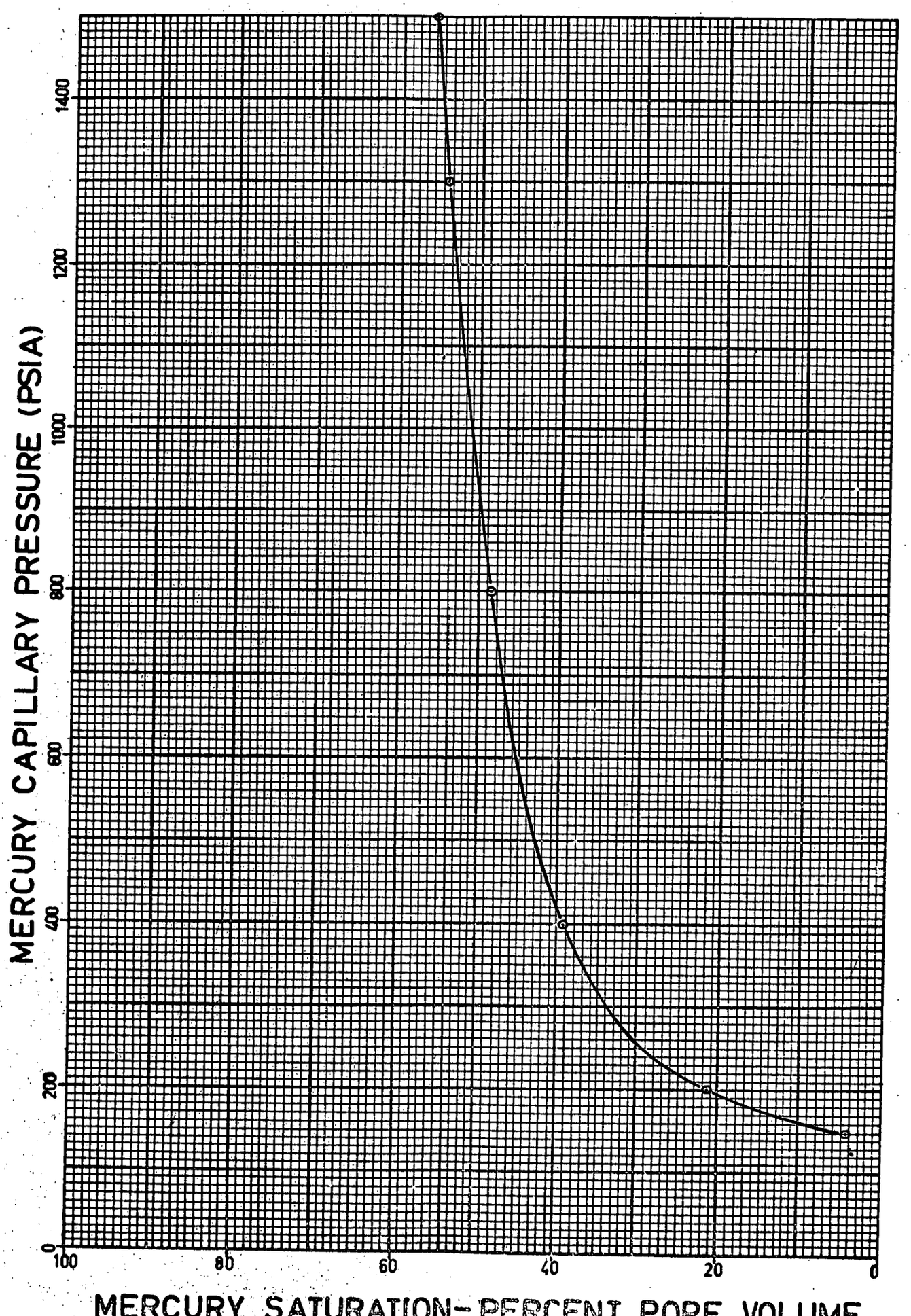

FIGURE 2

MERCURY CAPILLARY PRESSURE

WELL NAME-GINGIN No 1 SAMPLE DEPTH-12515

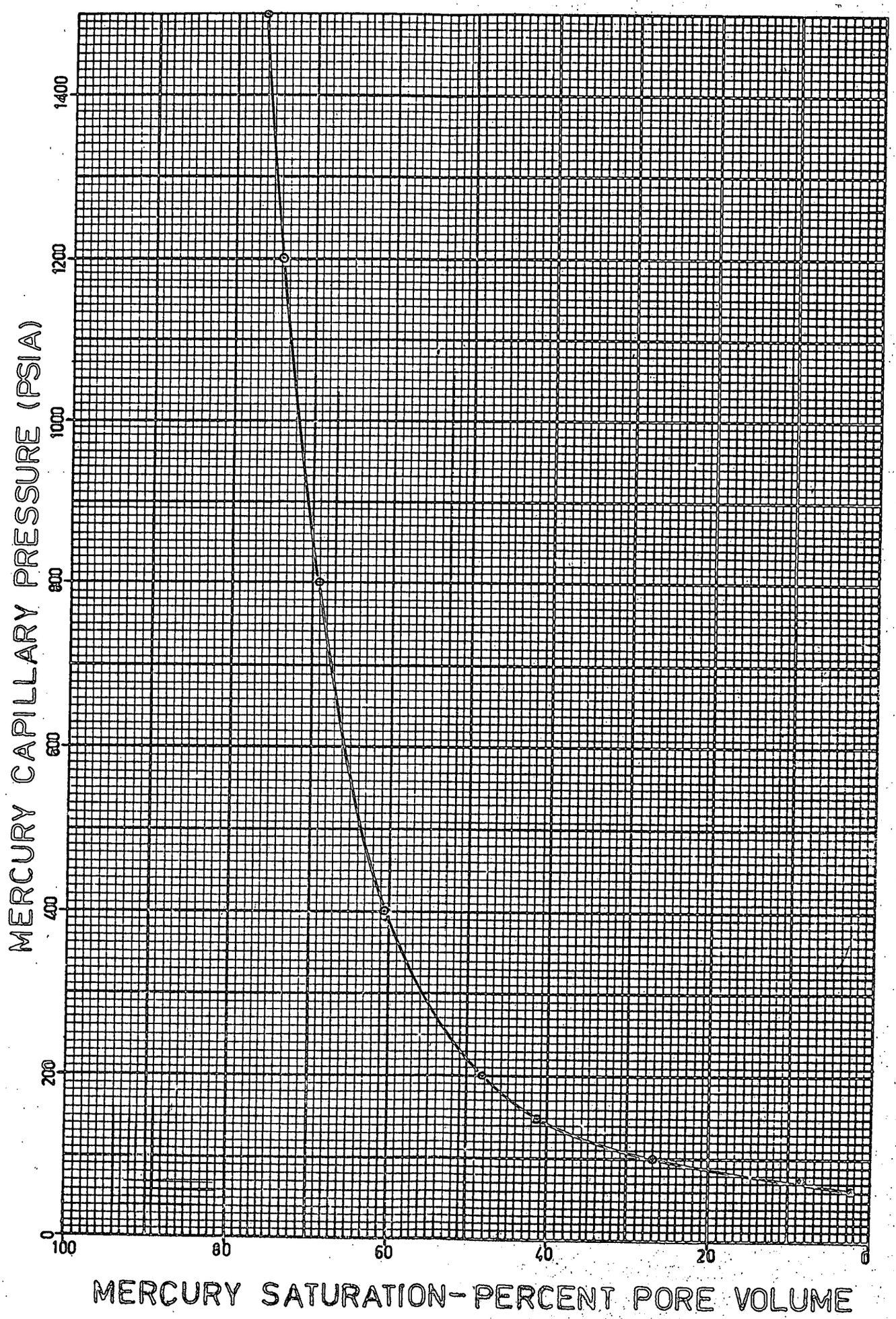

FIGURE 3

MERCURY CAPILLARY PRESSURE

WELL NAME–GINGIN No 1 SAMPLE DEPTH–12527

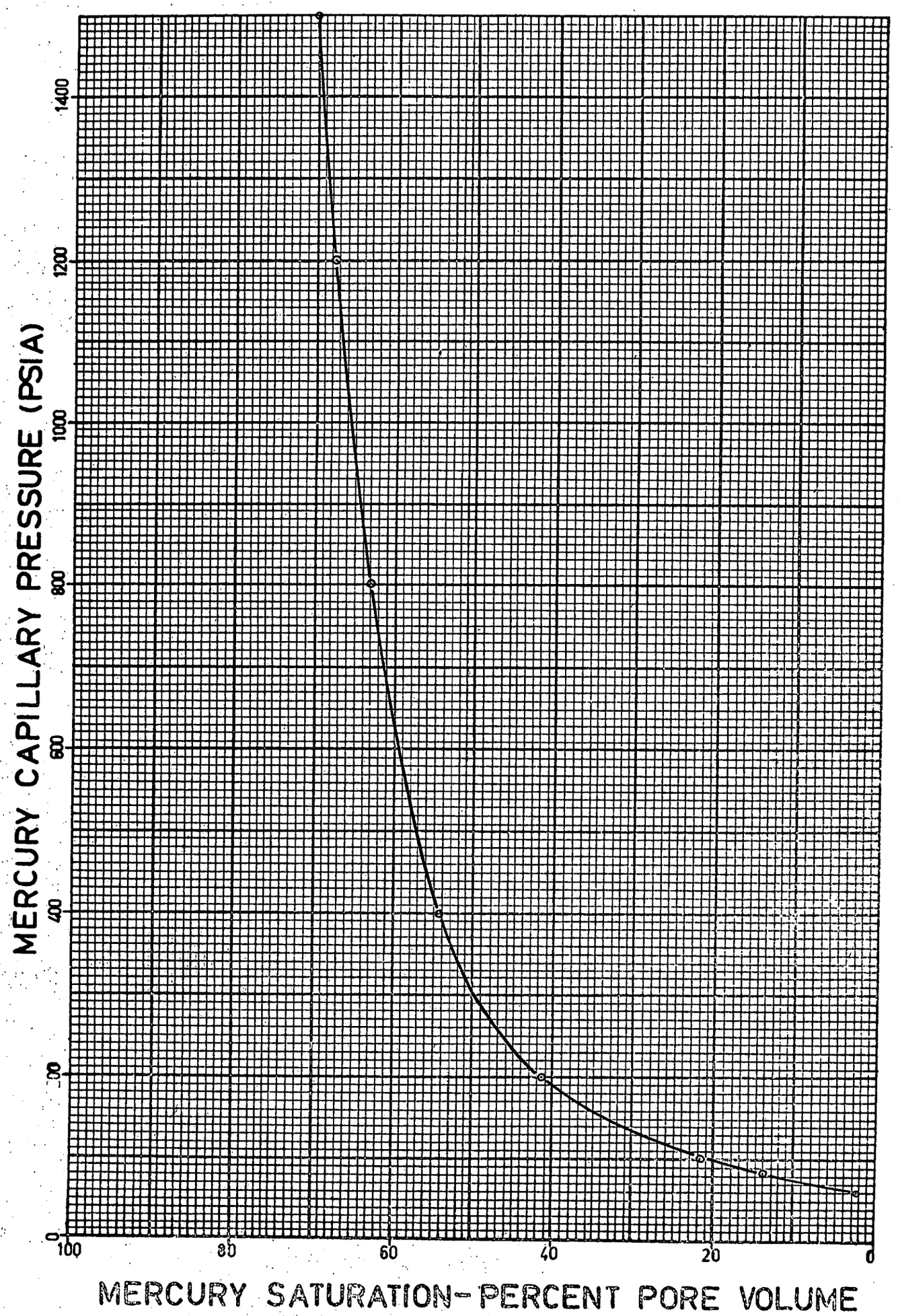

FIGURE 4

MERCURY CAPILLARY PRESSURE

WELL NAME - GINGIN No 1 SAMPLE DEPTH - 13046

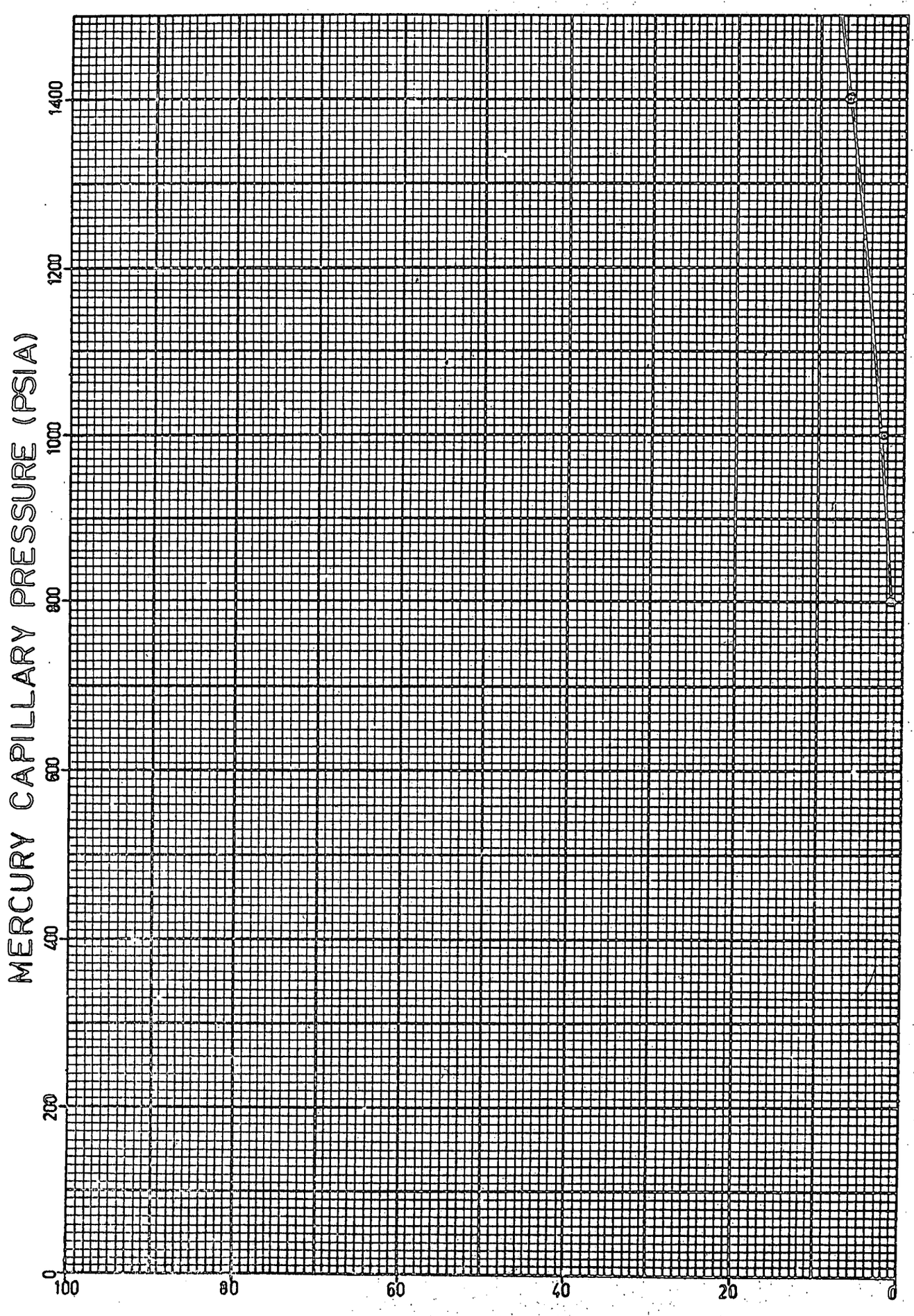

FIGURE 5

MERCURY CAPILLARY PRESSURE

WELL NAME–GINGIN No 1 SAMPLE DEPTH–14570

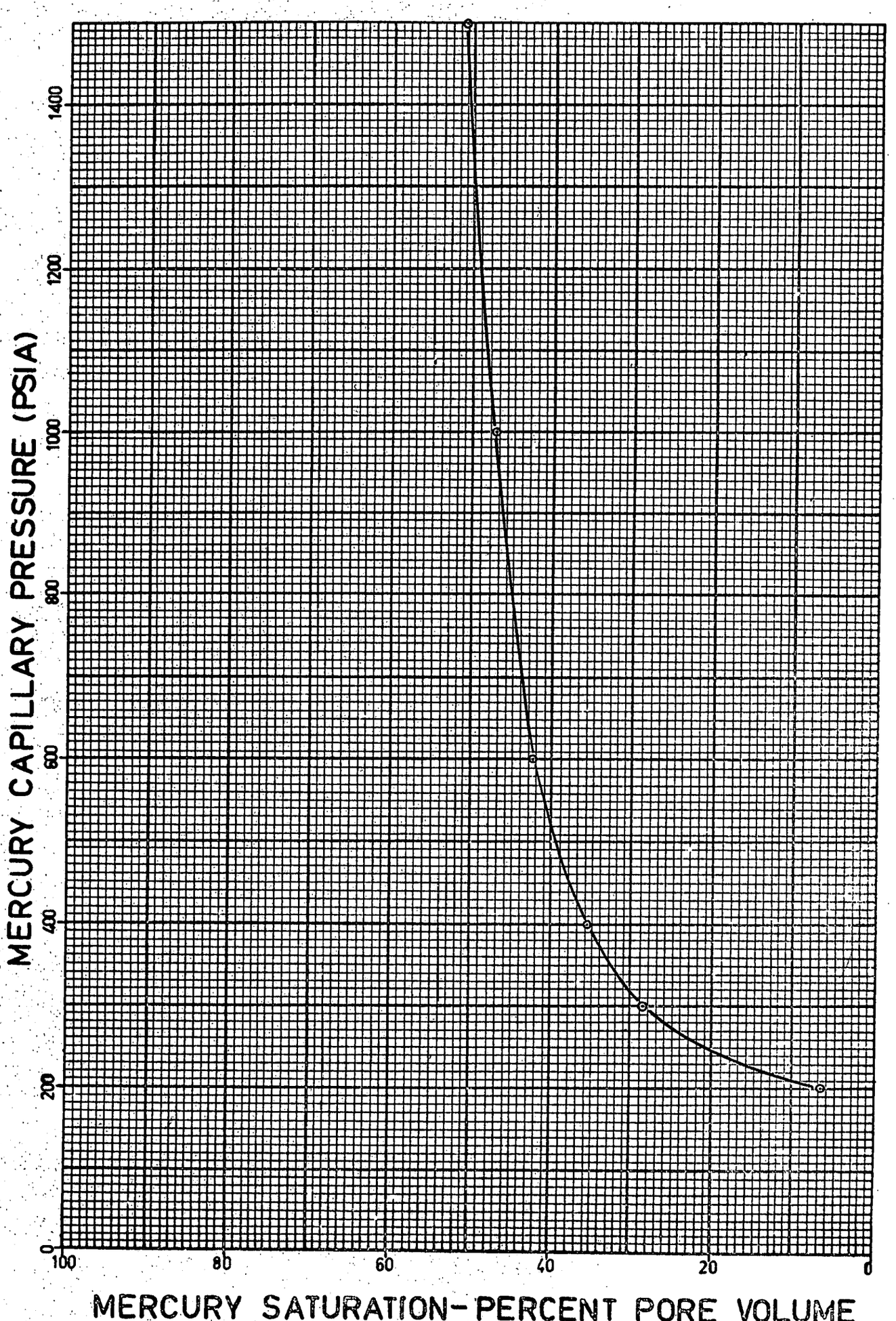

FIGURE 6

MERCURY CAPILLARY PRESSURE

WELL NAME-GINGIN No 1 SAMPLE DEPTH-14576

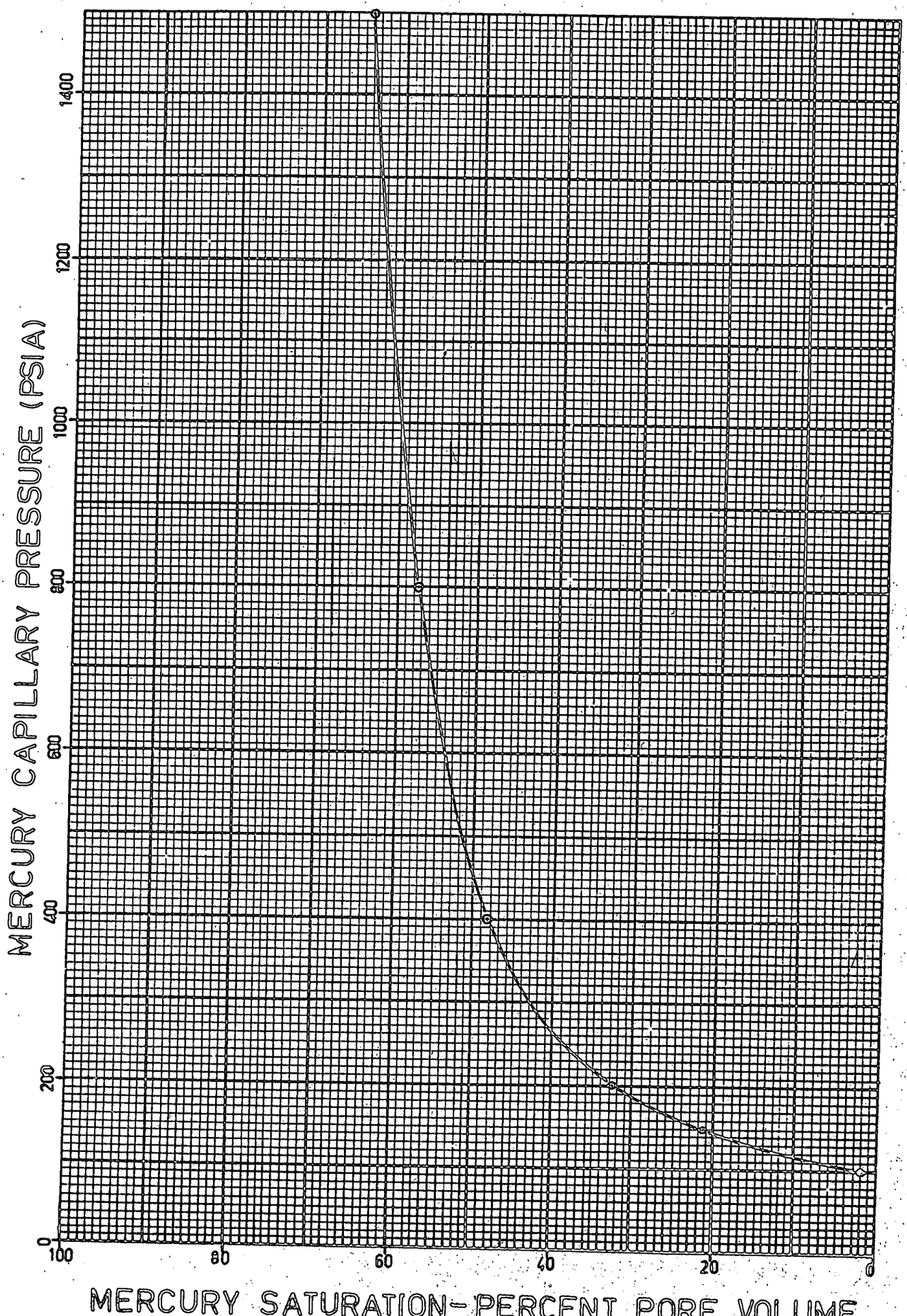

FIGURE 7

MERCURY CAPILLARY PRESSURE

WELL NAME—GINGIN No 1 SAMPLE DEPTH—14584

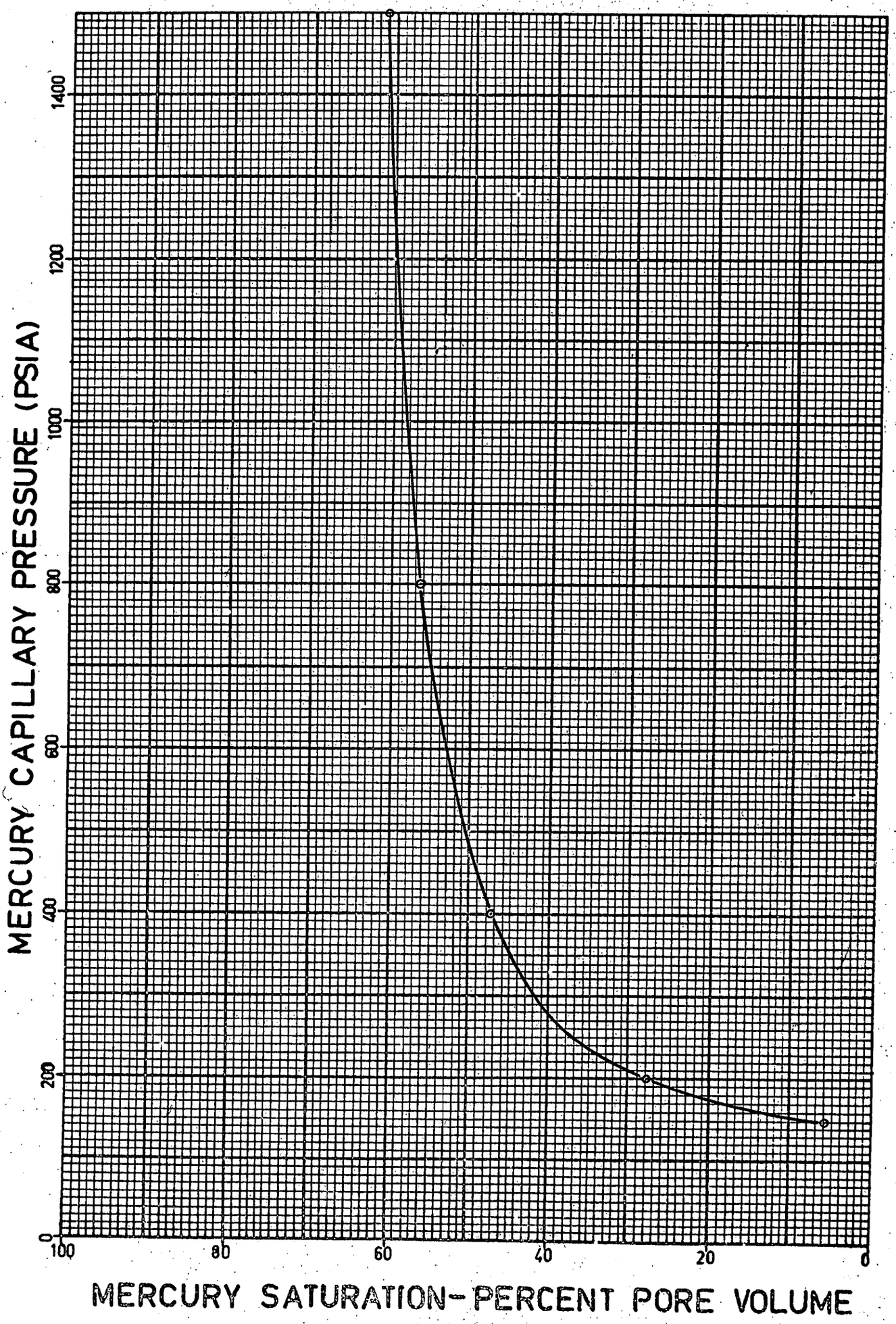

FIGURE 8

MERCURY CAPILLARY PRESSURE

WELL NAME-GINGIN No 1 SAMPLE DEPTH-14587

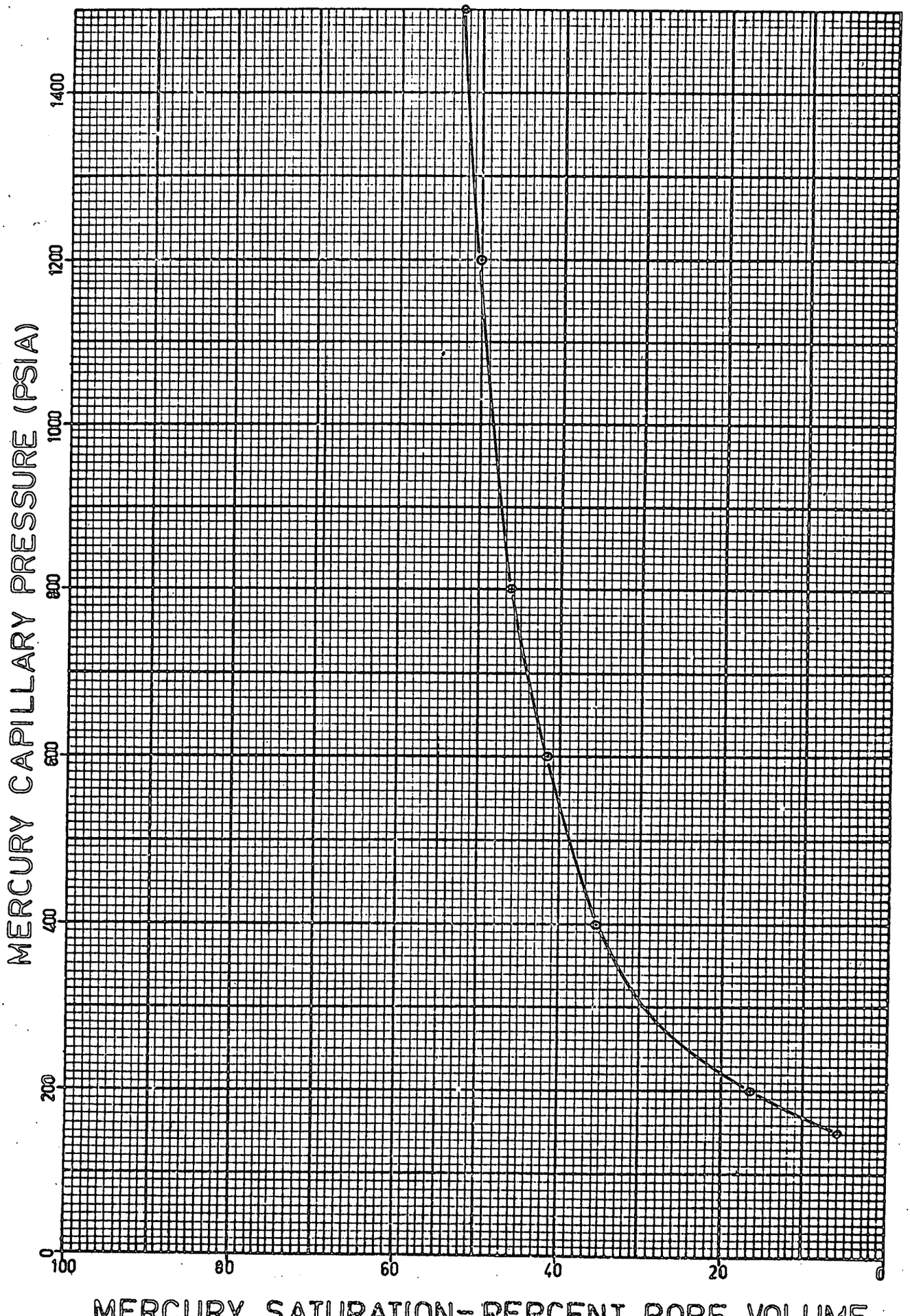

FIGURE 9

GINGIN No 1 ELECTRICAL LOG