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Paramount et al Cameron M-73

AGAT Laboratories
Core Services Division

RESERVOIR ELECTRICAL FORMATION RESISTIVITY STUDY

June 1991

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EXECUTIVE SUMMARY

This report contains the results of a formation resistivity factor study on 6 samples drilled from core cut in the Cameron Hills area.

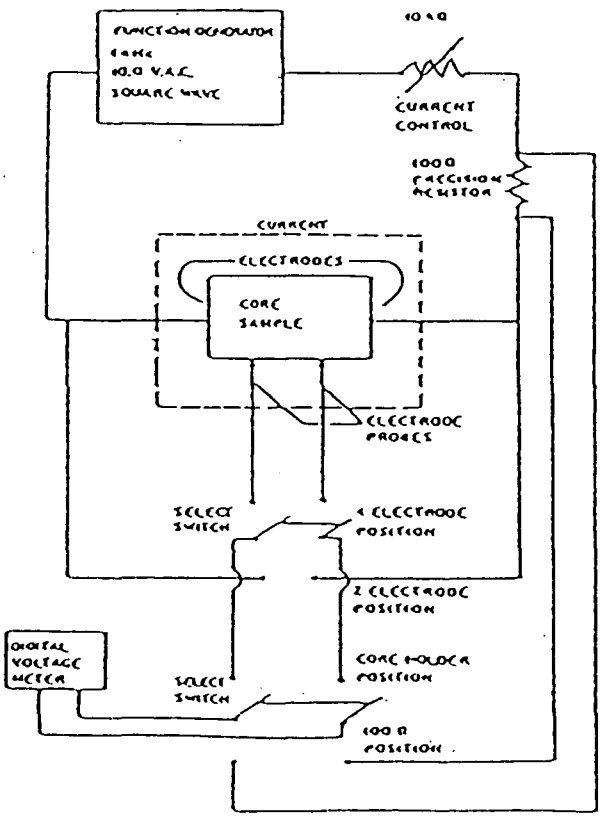
Formation resistivity factors were measured at net overburden pressure of 15900 kPa, and reservoir temperature of 50°C. The Archie's relationship yielded on ***m*** *(cementation exponent) of 2.19 an* ***a*** *(porosity constant) of 1.00 with a correlation coefficient of 0.4670.*

EXPERIMENTAL PROCEDURE

The following is a discussion of the details of the experimental procedure used. For the current study, six plug samples were tested for their formation resistivity factors.

The formation resistivity factor measurements were performed using the two electrode method, at the following conditions:

Net Overburden Pressure:	*15900 kPa*
Temperature:	*50°C*
Brine Used:	*Sample supplied;* R_w *= 0.186 @ 50°C.*



The six clean samples were saturated to 100% of their pore volumes with filtered (0.45 micron) and deaerated brine. The samples were individually sleeved with heat shrink teflon tubing and mounted in a core holder. The resistivity was measured by closing the 2 electrode circuit (see Resistivity Apparatus diagram) at ambient pressure. Net overburden pressure was applied and the sample was heated to reservoir temperature, and the resistivity was measured. Finally, the overburden pressure was released and resistivity was measured at ambient pressure again. The formation resistivity factor (F) of the sample was calculated using the following equation:

$$F = R_o/R_w$$

where

F = formation resistivity factor
Ro = resistivity of the 100% saturated sample
R_w *= resistivity of the saturating brine*

Archie related the formation resistivity factor (F) to the porosity (phi) by the following equation:

$$F = a/phi^m$$

where
a = porosity constant
m = cementation exponent

The formation resistivity factors were plotted versus the sample porosities on a log-log graph. The slope of the least squares fit line, force fitted through a unit a (i.e. phi = 1 and F = 1), is m.

DISCUSSION OF RESULTS

The experimental results are presented in a series of tables and figures at the back of this report. These results consists of the following:

1. *Detailed geological descriptions of each sample tested (Table 1).*
2. *Sample summary (Table 2). This summary contains the following information for all samples: depth, gas permeability, porosity, grain density and dimensions. Values for gas permeability and porosity were measured at AGAT.*
3. *A gas permeability vs. porosity crossplot (Figure 1).*
4. *Tabular and graphical presentation of formation resistivity factor (Table 3, Figure 2).*

The six samples tested by this study range in porosity and permeability from 5.2% to 16.5% and from 0.06 md to 16 md respectively.

*The six samples yielded an **m** (cementation exponent) of 2.19 an **a** (porosity constant) of 1.00 and a correlation coefficient of 0.4670 at reservoir conditions.*

Depending upon the salinity of the formation brine, the presence of conductive clays in samples may adversely affect the resistivity measurements and corrections for the cation exchange capacity of the samples would be required.

GEOLOGICAL DESCRIPTIONS

AGAT LABORATORIES

SAMPLE #	LITHOLOGY	DESCRIPTION
7P	Dolostone	- mottled cream beige and medium grey-brown - moderately hard - micro to very fine crystalline, locally microsucrosic - cream coloured fossiliferous breccia consisting of stromatoporoid fragments in a dark, shaly, carbonaceous, dolomitic matrix - individual fossil fragments are occasionally draped by shale laminae - fair to good visible intercrystalline porosity
10	Dolostone	- beige-brown - moderately hard - fine crystalline to microcrystalline - sucrosic texture - highly recrystallized, no primary structures observed - occasional microcrystalline bands and patches (possible tabular stromatoporoids) - abundant pinpoint vugs (dissolution) - occasional patches anhydrite - numerous scattered calcite crystals - good visible intercrystalline porosity
18P	Dolostone	- grey-beige - moderately hard - fine crystalline, microsucrosic - highly recrystallized, massive - rare dare, argillaceous, shaly patch - scattered pinpoint vugs - rare argillaceous shaly microlaminae - fair to good visible intercrystalline porosity
27P	Dolostone	- medium to light grey brown - moderately hard - sucrosic texture - numerous pinpoint vugs (dissolution) - highly recrystallized,masking primary structures - weakly calcareous - weakly argillaceous locally, rare shaly microlaminae - fair to good visible intercrystalline porosity

GEOLOGICAL DESCRIPTIONS

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SAMPLE #	LITHOLOGY	DESCRIPTION
84	Dolostone	- mottled cream-beige and grey - moderately hard - micro to fine crystalline - abundant bulbous stromatoporoid fragments in a shaly, crinoidal, pyritic matrix - fossils are weakly calcareous - scattered pinpoint vugs - fair visible intercrystalline porosity
99	Dolostone	- medium brown with cream coloration - moderately hard - fine crystalline - fossiliferous floatstone of branching stromatoporoid fragments in a sucrosic dolomite matrix - fossils are moderately leached, producing patches of fenestral and pinpoint vugs - occasional small moldic vugs - good visible intercrystalline and pinpoint porosity

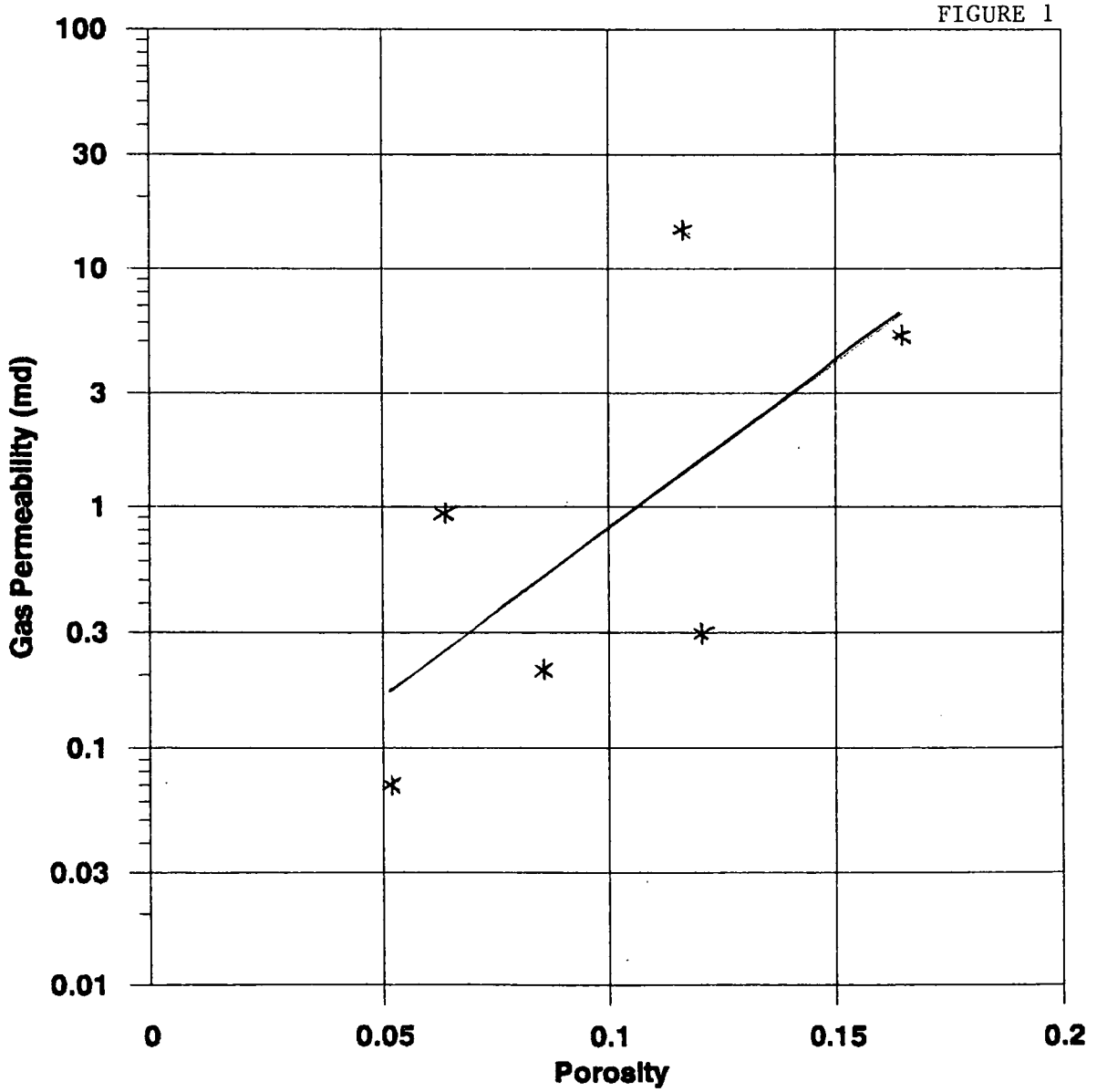
TABLE 1 (CON'T)

CORRELATION COEFFICIENT = 0.4349

EQUATION: LOG (Kg) = -1.4835 + 13.944 phi

GAS PERMEABILITY (Kg) vs POROSITY (phi)

FIGURE 1



AGAT LABORATORIES

$F = 1.00/phi^{2.19}$

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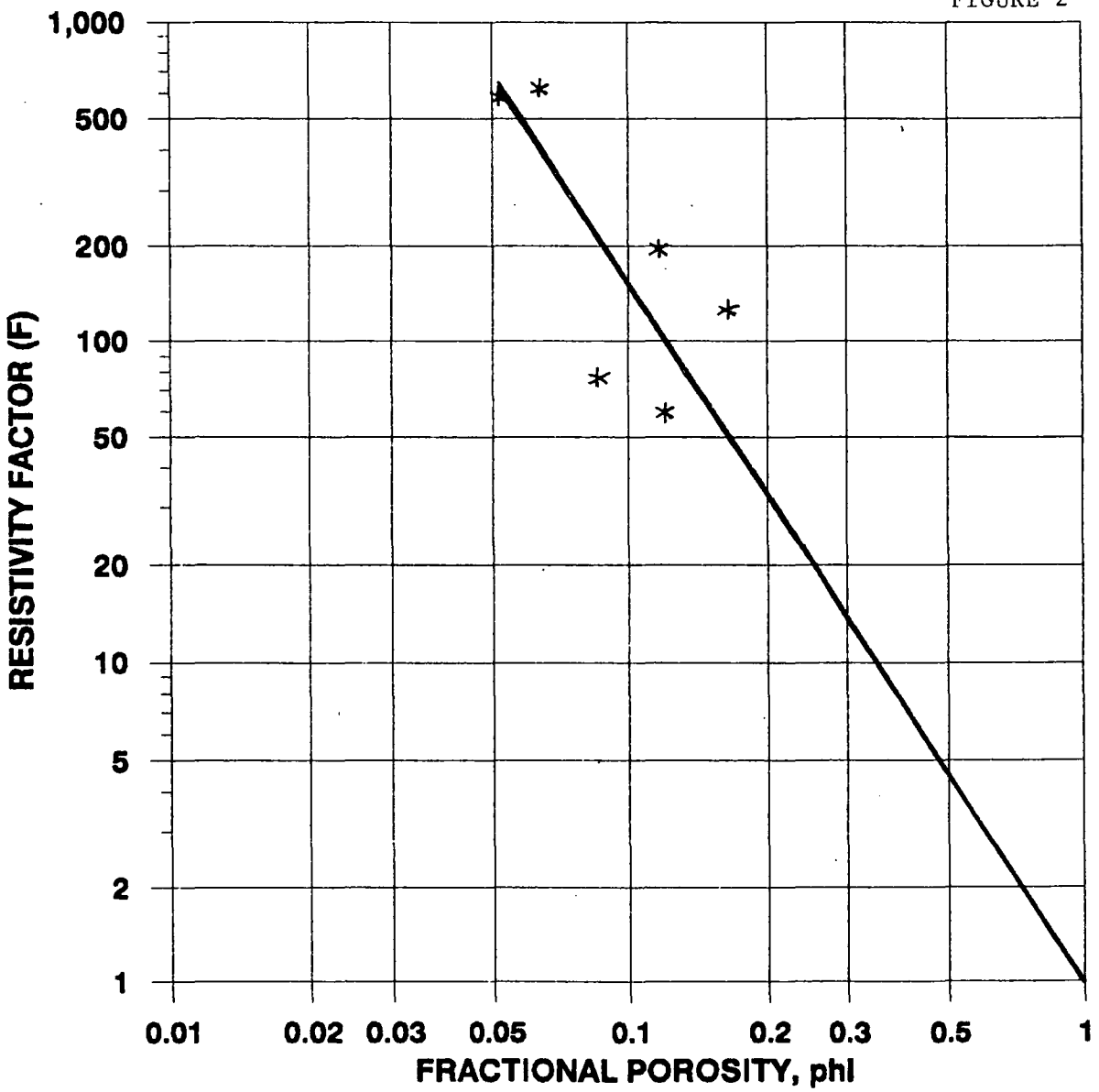
CEMENTATION EXPONENT (m): 2.19
CORRELATION COEFFICIENT: 0.4670

TEST TEMP. : 50.0 °C
NET OVERBURDEN: 15.9 MPa

FORMATION RESISTIVITY FACTOR

ARCHIE'S RELATIONSHIP

FIGURE 2



SAMPLE SUMMARY

SAMPLE NUMBER	DEPTH (m)	GAS PERMEABILITY (md)	POROSITY* (%)	POROSITY (%)	GRAIN DENSITY (kg/m3)	LENGTH (cm)	DIA. (cm)
			WELL: G-21				
7P	1422.5	0.21	8.6	8.9	2828	6.14	2.52
10	1423.9	5.23	16.5	17.6	2817	6.78	2.51
18P	1427.5	0.07	5.2	5.8	2830	4.31	2.53
27P	1431.6	0.94	6.4	6.6	2843	6.11	2.52
			WELL: M-73				
84	1411.2	0.30	12.0	11.3	2840	6.42	2.51
99	1417.1	14.50	11.6	10.3	2840	5.72	2.51

* The porosities are based on Archemede's bulk volume measurements.

TABLE 2

Porosity Cons. (a) : 1.00
Cem. Exponent (m) : 2.19
Correlation Coef. : 0.4670

FORMATION RESISTIVITY FACTOR DATA USING ARCHIE'S RELATIONSHIP

Sample Number	Fractional Porosity	Gas Perm. (md)	Grain Density (kg/m3)	Formation Resistivity Factor, F
7P	0.086	0.21	2828	76.48
10	0.165	5.23	2817	126.30
18P	0.052	0.07	2830	587.83
27P	0.064	0.94	2843	624.79
84	0.120	0.30	2840	59.65
99	0.116	14.50	2840	195.34

$$F = \frac{1.00}{phi^{2.19}}$$

TABLE 3

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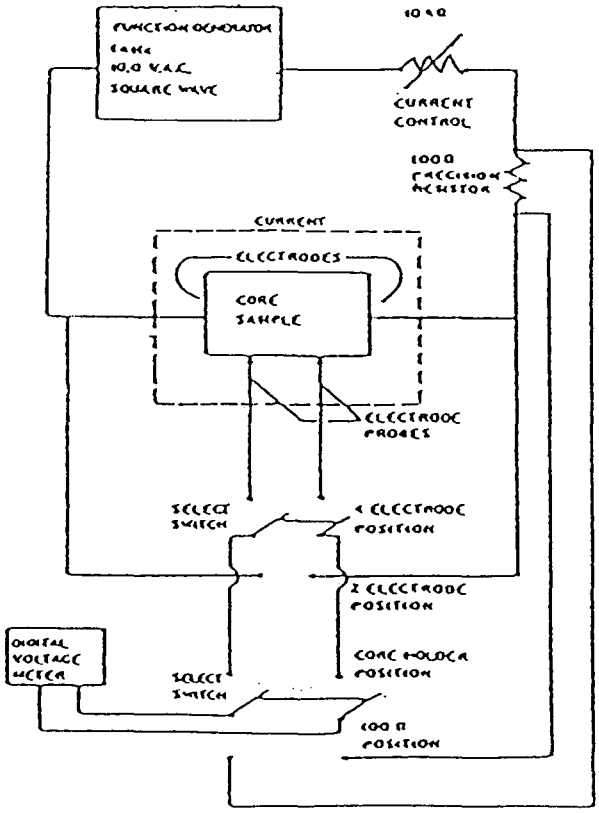

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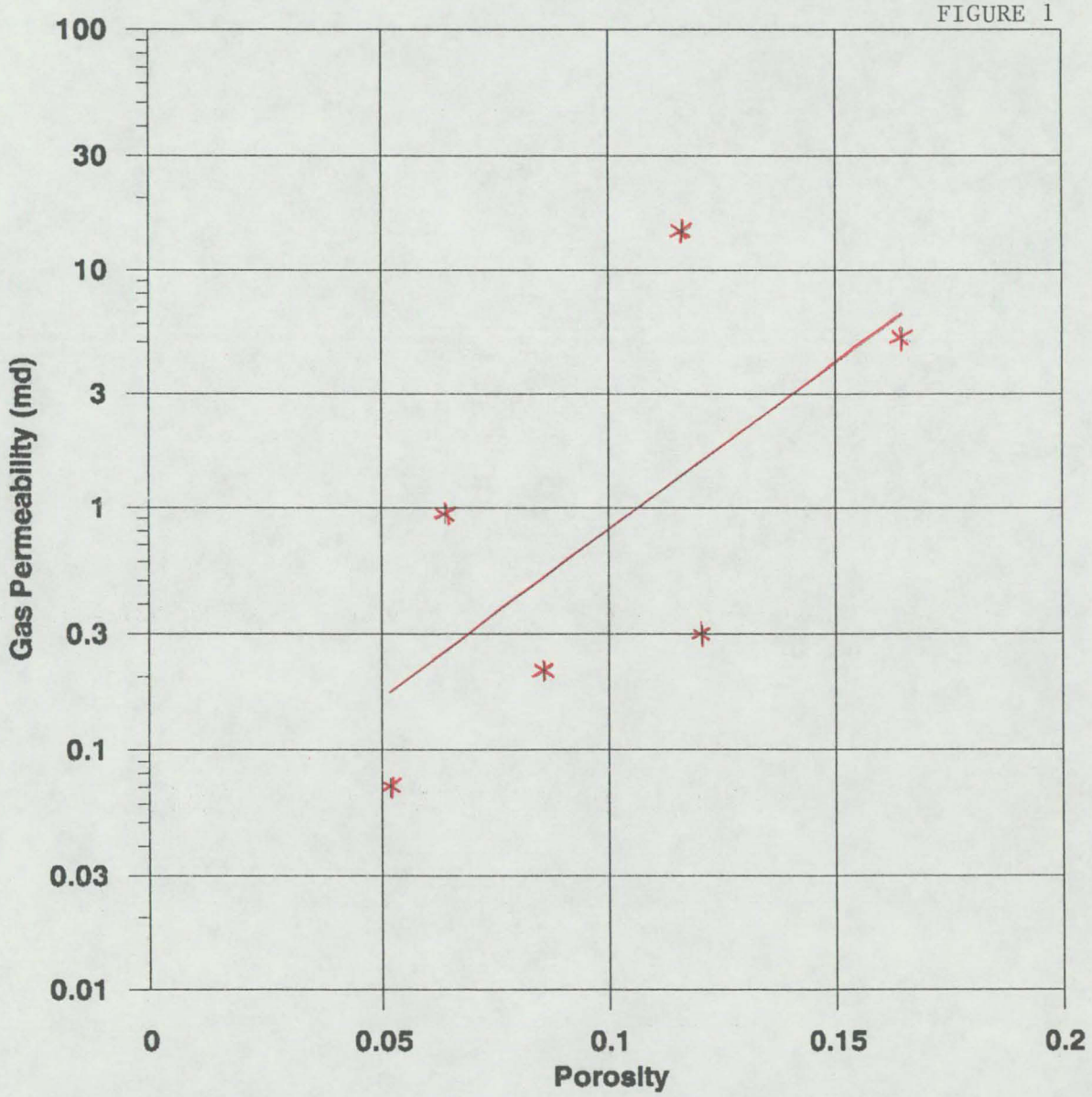

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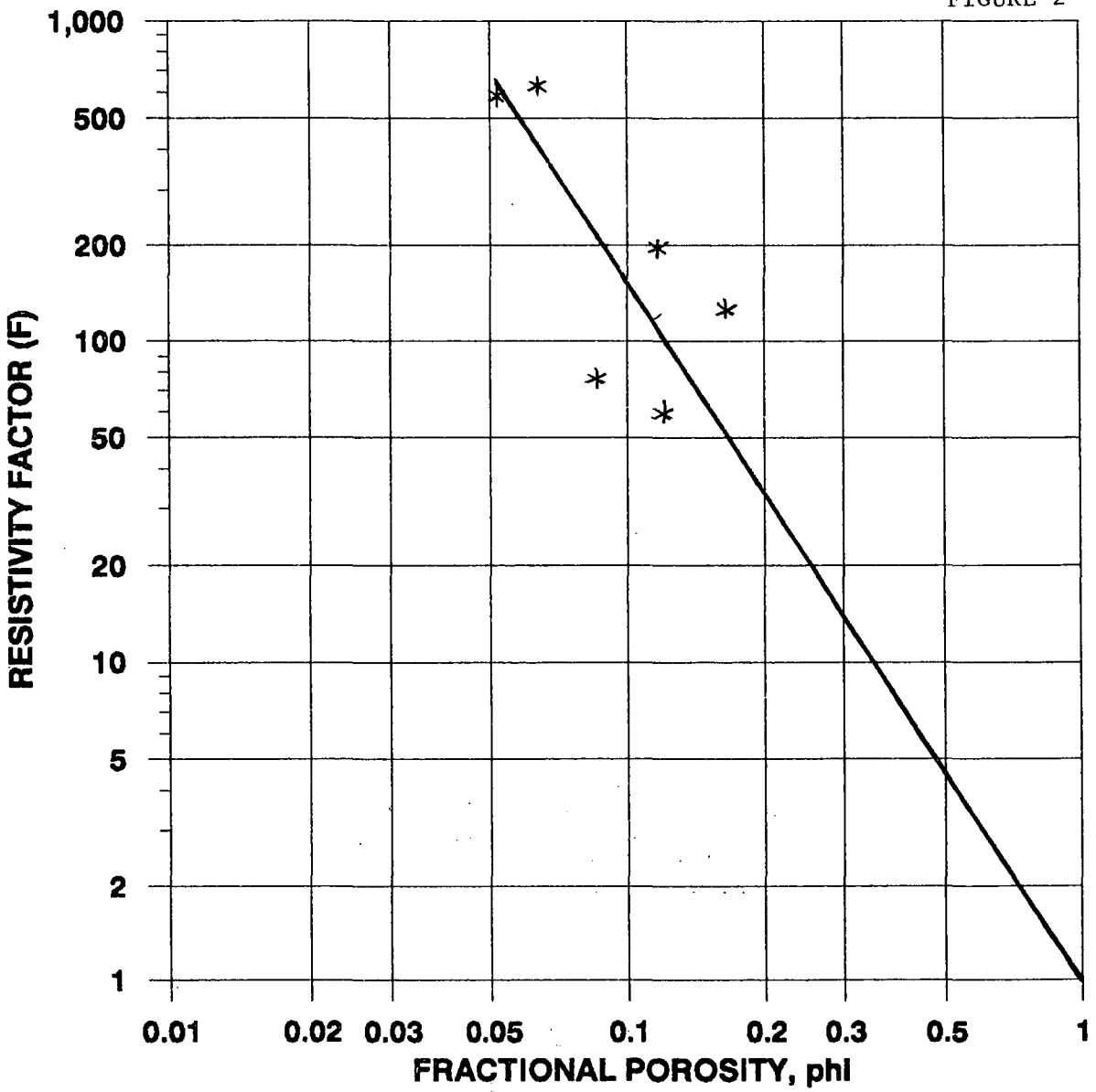

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