TEXAS A&M UNIVERSITY

spe

PROBLEM # 1

Three core samples were evaluated to obtain drainage capillary pressure data. Because mercury injection was used to determine capillary pressure, the samples could not be used to determine relative permeability functions. Determine the two phase, drainage relative permeability functions using the process described by Standing.

- Use the S_w^* model to determine an average λ. Assume S_{wi}=0.10. See attached graph of p_c vs S_w^*. Assume the line accurately averages the data.
- Estimate endpoint relative permeability of the non-wetting phase using Standing's Eq. 9 (see Fig. 9, page 12). This endpoint relative permeability is used to rescale the normalized nonwetting phase relative permeability function from the previous step.
- Assume S_m = 0.98

THEORY

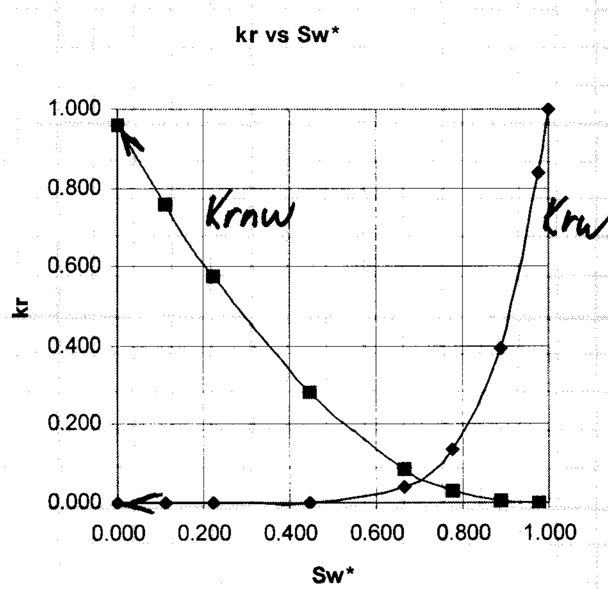
$$\lambda = -\left[\frac{\log(p_{c2}/p_{c1})}{\log(S_{w2}^*/S_{w1}^*)}\right];\quad S_w^* = \frac{S_w - S_{iw}}{1 - S_{iw}};\quad k_{rw]dr} = (S_w^*)^{3+2/\lambda};\quad k_{rnw]dr} = k_r^o\left(\frac{S_m - S_w}{S_m - S_{iw}}\right)^2\left[1 - (S_w^*)^{1+2/\lambda}\right]$$

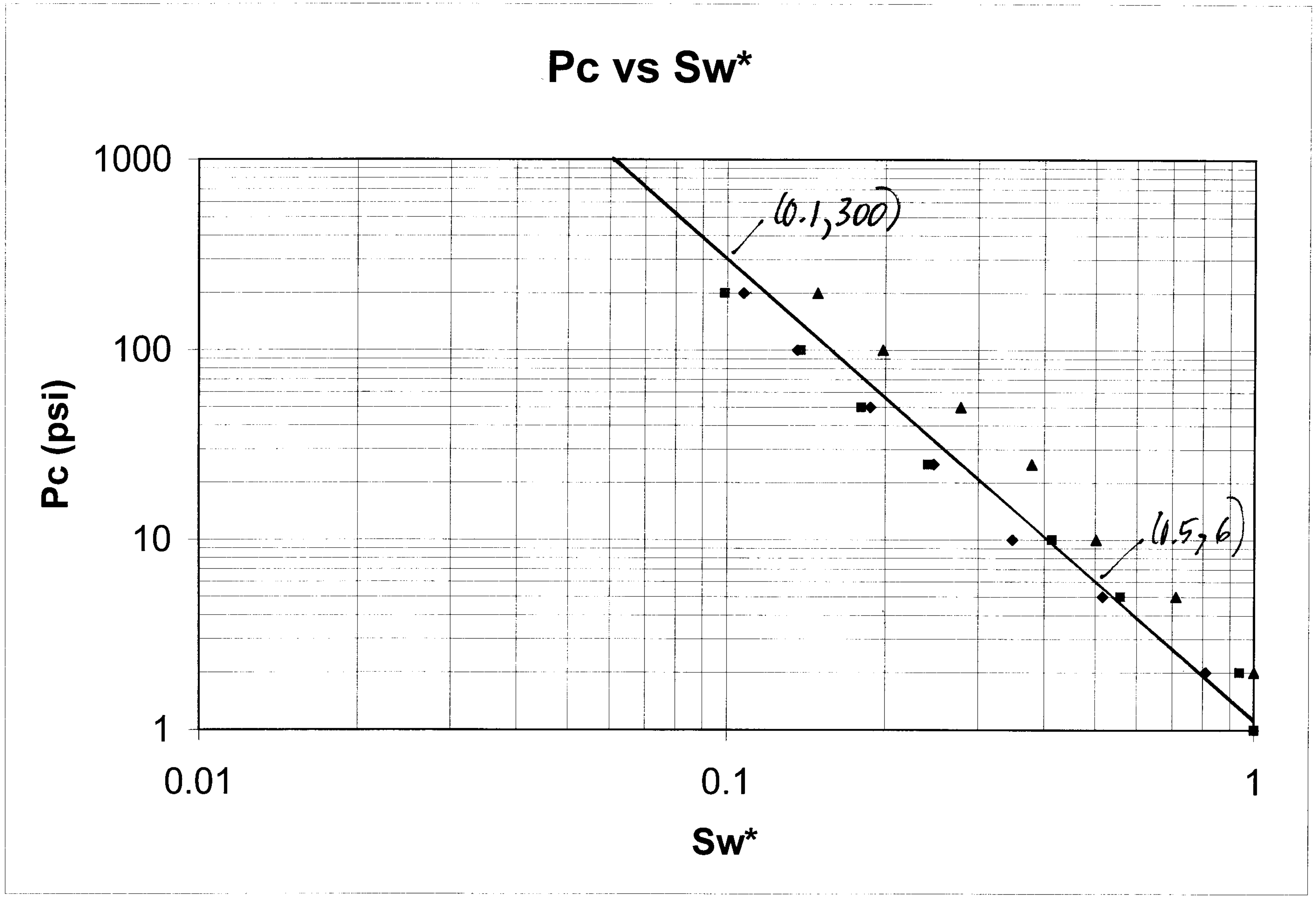
SOLUTION

λ = 0.411 (see attached)

Sw, fraction	Sw*, fraction	$k_{rw}]_{dr}$	$k_{rnw}]_{dr}$	$k_{rnw}]_{dr}$
1.00	1.000	1.000	0.000	0.000
0.98	0.978	0.838	0.000	0.000
0.90	0.889	0.396	0.004	0.004
0.80	0.778	0.139	0.032	0.031
0.70	0.667	0.041	0.092	0.088
0.50	0.444	0.002	0.295	0.284
0.30	0.222	0.000	0.597	0.574
0.20	0.111	0.000	0.786	0.756
0.10	0.000	0.000	1.000	0.962

k_r^0 = 0.962




Pc vs Sw*
1000
100
10
1
Pc (psi)
0.01
0.1
1
Sw*
(0.1,300)
(0.5,6)

PROBLEM # 2

Calculate the value of the trapping constant, C, using Standing's Eq. 25 (see pages 33-35) and the attached experimental data showing the effect of saturation history on oil-flow behavior. Assume S_{wi} = 0.2.

THEORY

$$S_{or}^{*} = \frac{S_{or}}{1 - S_{iw}}; \quad C = \frac{1}{\left(S_{or}^{*}\right)_{max}} - 1$$

SOLUTION

From data (Fig 11, Geffen, et al), $(S_{or})_{max} = 0.43$

$$(S_{or}^{*})_{max} = \frac{0.43}{0.8} = 0.54$$

$$C = \frac{1}{0.54} - 1 = \underline{\underline{0.86}}$$

NOTE: Remember that C and the initial non-wetting phase saturation determine the value of the residual non-wetting phase saturation.

<u>Example</u>: see Fig 11

when $S_{oi} = 0.31$, $S_{oi}^{*} = \frac{0.31}{0.8} = 0.39$

$$S_{or}^{*} = \frac{S_{oi}^{*}}{C\,S_{oi}^{*} + 1} = 0.291 \Rightarrow S_{or} = 0.23$$

This is close to the experimentally determined value of $S_{or} = 0.24$

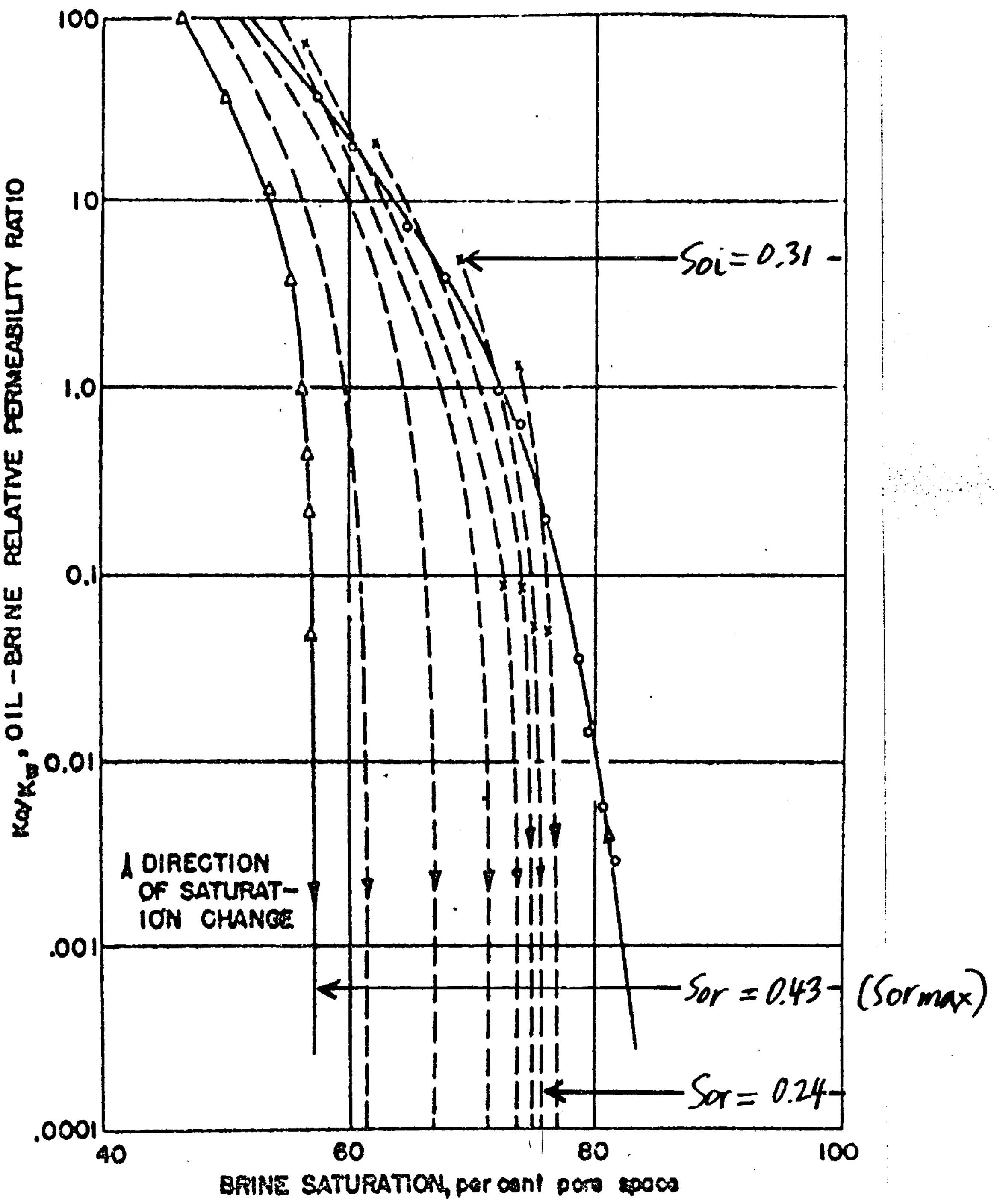


FIG. 11 — EFFECT OF SATURATION HISTORY ON OIL-FLOW BEHAVIOR, NELLIE BLY SANDSTONE.