HW-5.3: Pore Pressure Prediction — Pathfinder

(accounting for illite-smectite transition)

We will use the approach of Lahaan (2002). This approach assumes that the compression behavior of an illitic mixture is different from that of a smectitic mixture:

$\sigma_v' = \sigma_v - u$ Eq. 1

$u = \sigma_v - \sigma_v{}'$ Eq. 2

$n = n_m + n_o e^{-\beta \sigma_v'}$ Eq. 3

$u = \sigma_v - \frac{1}{\beta} \ln\left(\frac{n_o}{n - n_m}\right)$ Eq. 4

Lahann (2002) suggests that the Pathfinder well (EI-330) has undergone a transformation from smectite-rich to illite-rich sediments with depth due to diagenesis (Fig. 1).

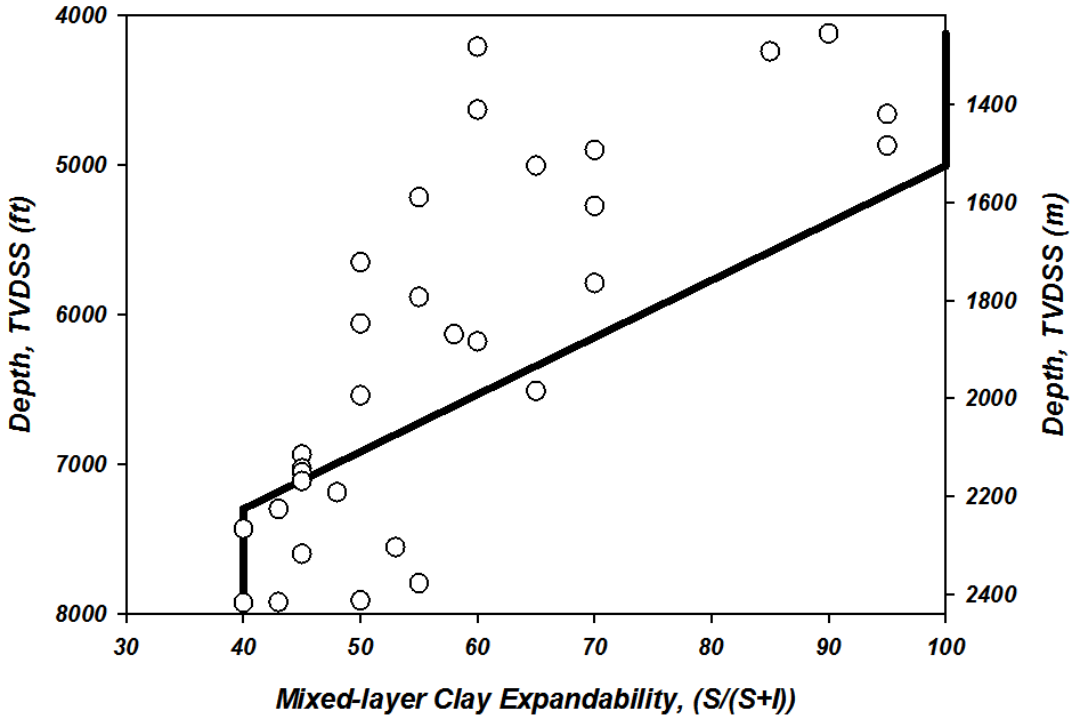

Figure 1: Depth variation of mixed-layer clay expandability, smectite/(smectite + illite) (S/(S+I)) for the Pathfinder well. Data from Table 1 of Losh et al. (1999). Note that below 1500 m, the maximum smectite fraction is 0.7, substantially less than the maximum value above 1500 m. A top of the clay transition of 1500m is interpreted for this well (from Lahann 2002).

Lahaan (2002) suggests this transition can be accounted for with Eq. 3 describing the compression behavior: n_m=0.12 for smectitic material and n_m= 0.03 for illitic material. A regression of Eq. 3 assuming the material is smectitic (n_m=0.12) is shown in Fig. 1 (solid line). The illite compression curve (n_m=0.03) is shown below this (dotted line).

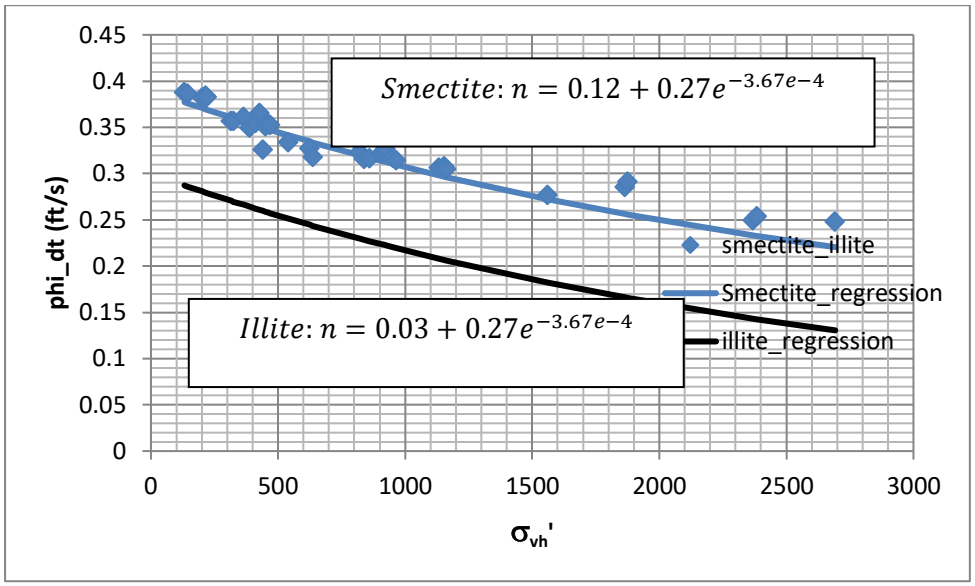

Figure 2: Illustration of how to perform regression to solve for n_0 and β. Note that these are not the same parameters as derived in the Hubbert regression.

1. Calculate the value of the pore pressure (Eq. 4) and fill in the table below and then plot these values in Figure 3.

label	Depth (ft)	***n***	u_h (psi)	σv (psi)	*u* smectite	*u* illite	*u* mid
a	4717	0.243	2189	4239			
b	5258	0.235	2440	4754			
c	5945	0.229	2757	5423			
d	7210	0.307	3345	6638			
e	7854	0.302	3644	7273			

References:

Lahann, Richard, 2002, Impact of Smectite Diagenesis on Compaction Modeling and Compaction Equilibrium, in: A.R. Huffman and G.L. Bowers, eds., Pressure Regimes in Sedimentary Basins and Their Prediction: AAPG Memoir 76, p. 61-72.

Gutierrez, Mario A., Braunsdorf, Neil R., Couzens, Brent, A., 2006, Calibration and ranking of pore-pressure prediction models, The Leading Edge, v.23, p. 52-59

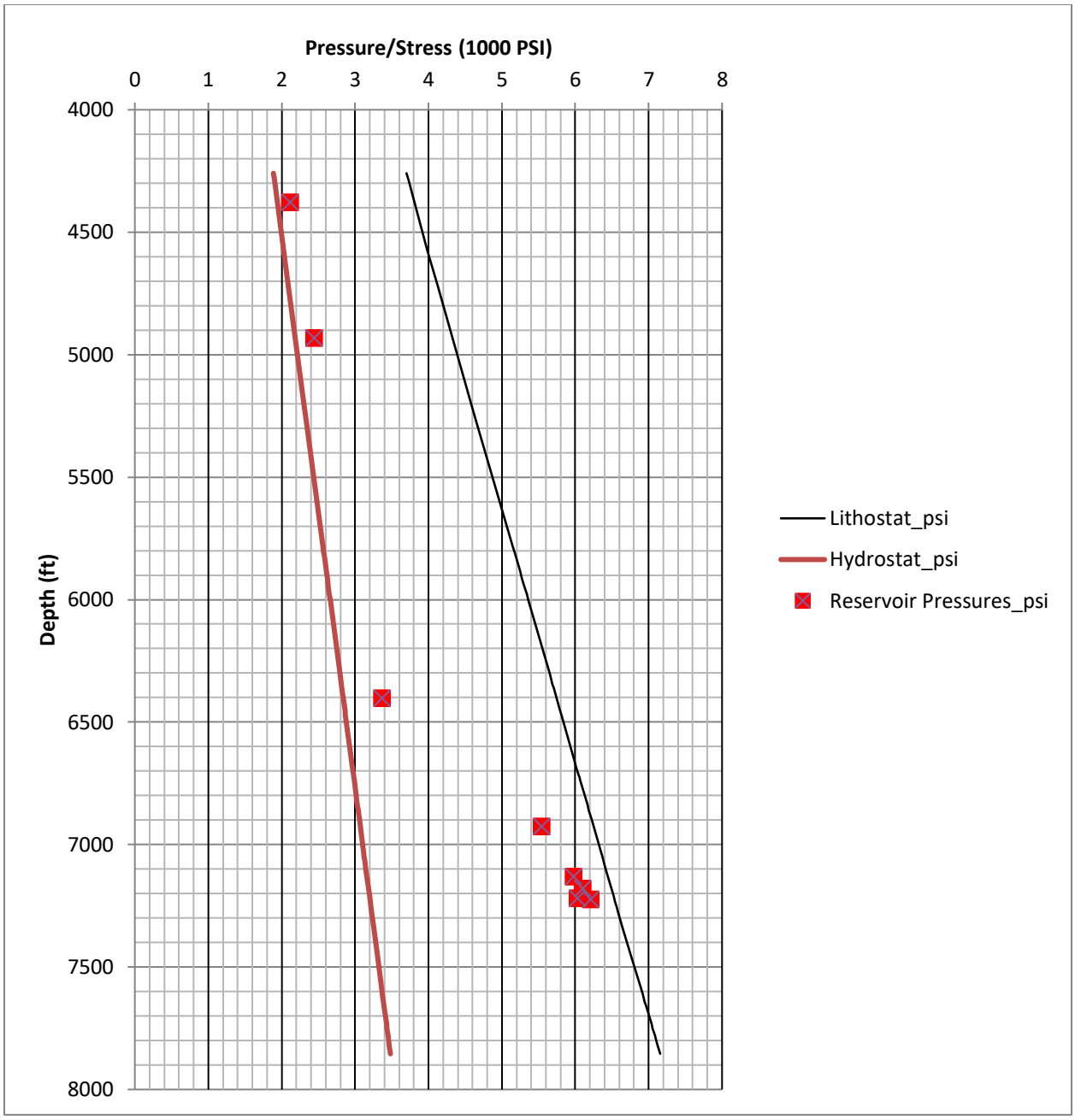

Figure 3: