HW-4: SEDIMENTATION

In the Ursa Basin, the sedimentation rate over the last 50,000 yrs is 12mm/yr (0.012m/yr). The coefficient of consolidation (c_v) for mudstone is 2x10^{-8} m^2/s (0.63 m^2/yr). In contrast the coefficient of consolidation for siltstone is 2x10^{-7} m^2/s (6.3 m^2/yr).

The coefficient of consolidation is:

$$c_v = \frac{k}{\mu m_v}, \qquad \text{Eq. 1}$$

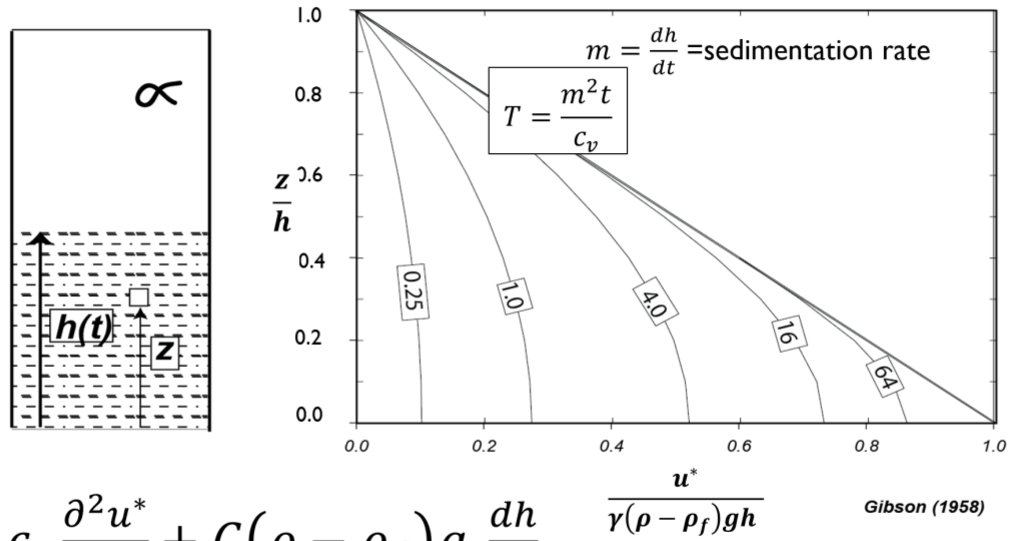
Where k is permeability, μ is viscosity, and m_v is compressibility.

The Time Factor, T is:

$$T = \frac{m^2 t}{c_v} \qquad \text{Eq. 2}$$

1. How severe is the overpressure for these two lithologies at a depth of 200 meters and 500 meters? Please plot predicted pressure on Figure 2. Please estimate the predicted pressure and λ^* value ($\lambda^* = \frac{u^*}{\sigma_v - u_h}$) at 200 and 500 meters after 50,000 years.

Gibson Sedimentation Model



$$\frac{\partial u^*}{\partial t} = c_v \frac{\partial^2 u^*}{\partial z^2} + C(\rho - \rho_f)g\,\frac{dh}{dt}$$

Change in Overpressure | flow | source

Figure 1: Right: A plot of Gibson's Time Factor (#s in boxes). Relative Pressure (hydrostatic to lithostatic) is on the horizontal axis. Relative depth is on the vertical axis.

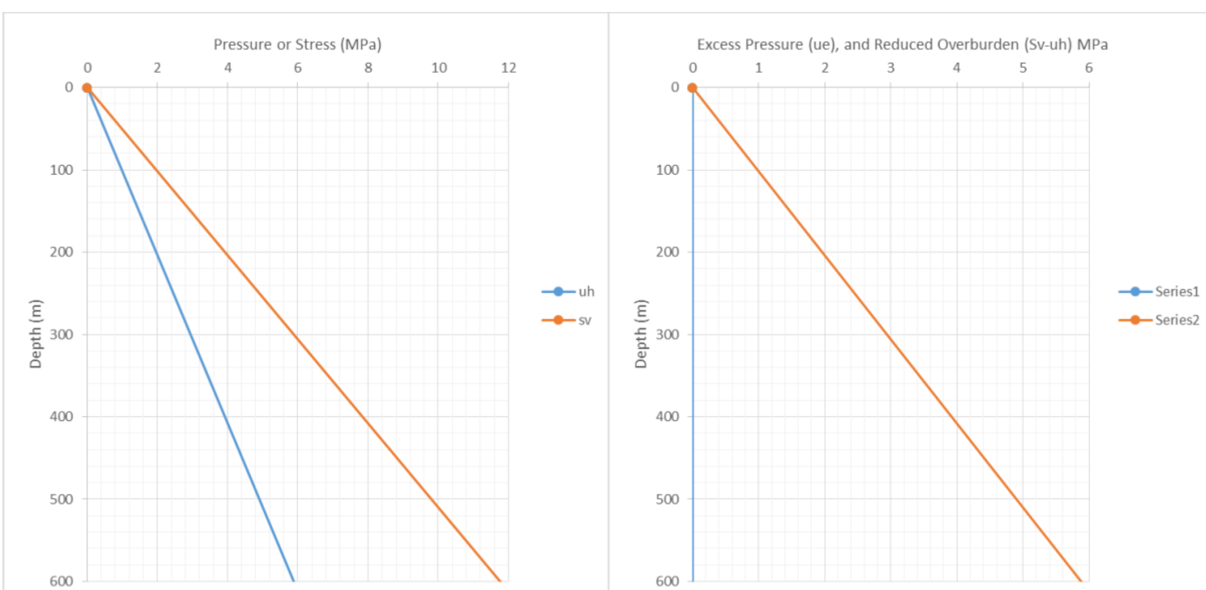


Figure 2: Pressure vs. depth (left) and Overpressure vs. Depth (right). Please plot pressure for both the mudstone and siltstone.

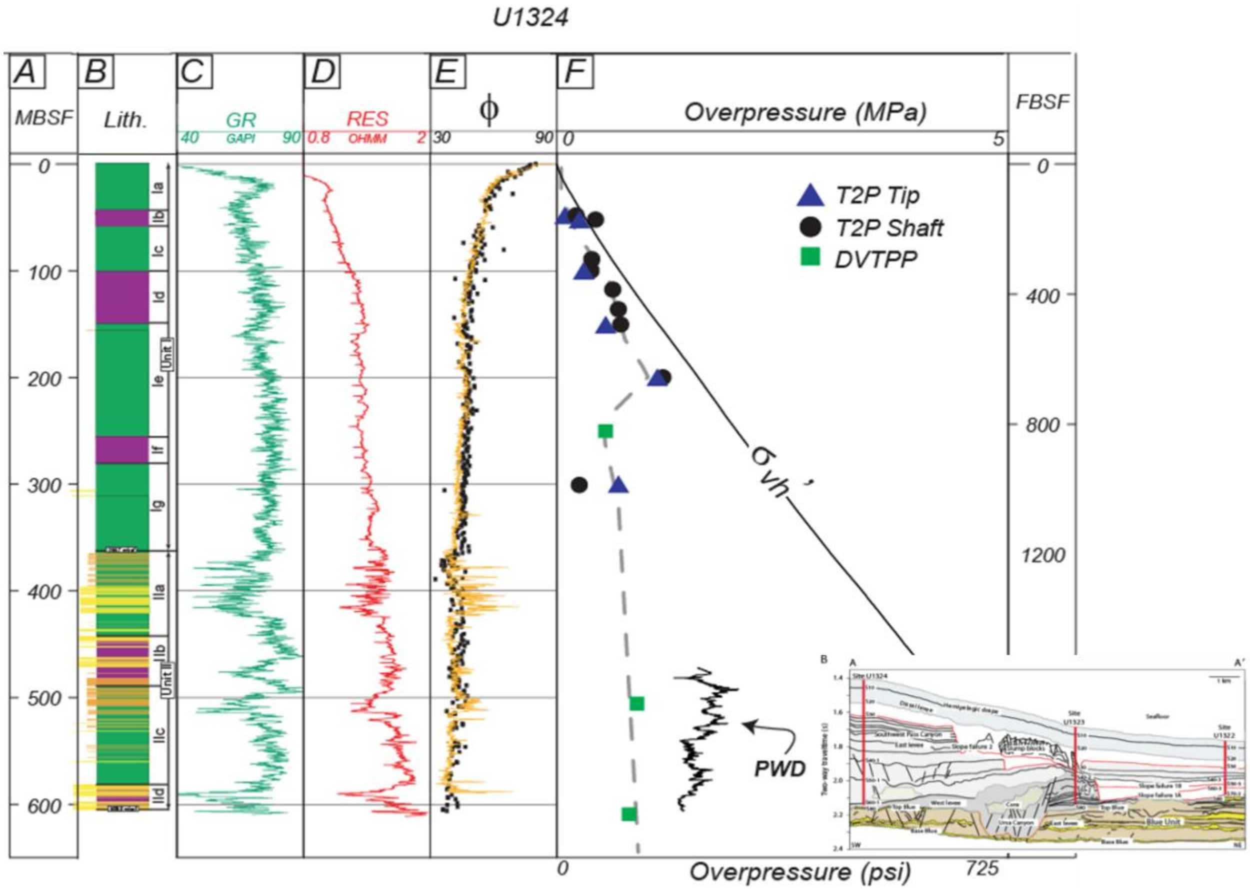
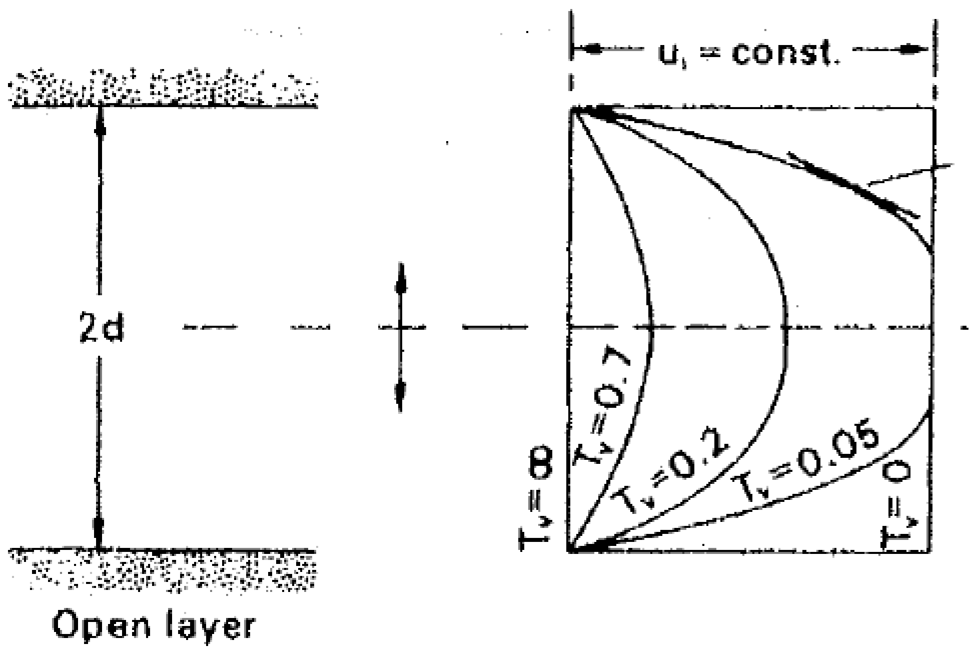


Figure 3: Observed pressures in the Ursa Basin.

2. c_v at Eugene Island at the depths you are looking at is very similar, but the permeability is much lower. Can you propose a reason why?

3. A way to estimate the time scale of pressure dissipation is to look at the scaling of the coefficient of consolidation.



(a)

$$C_v = \frac{k}{u\, m_v} \qquad \text{Eq. 3}$$

$$T_v = \frac{C_v t}{d^2} \qquad \text{Eq. 4}$$

Please rearrange Eq. 4 to solve for '*t*' given $T_v = 0.7$ to estimate the time it will take to dissipate the majority of the pressure at 0.01m, 100m, and 1000m thickness of Ursa mudstone.