Mechanisms of overpressure

Disequilibrium compaction

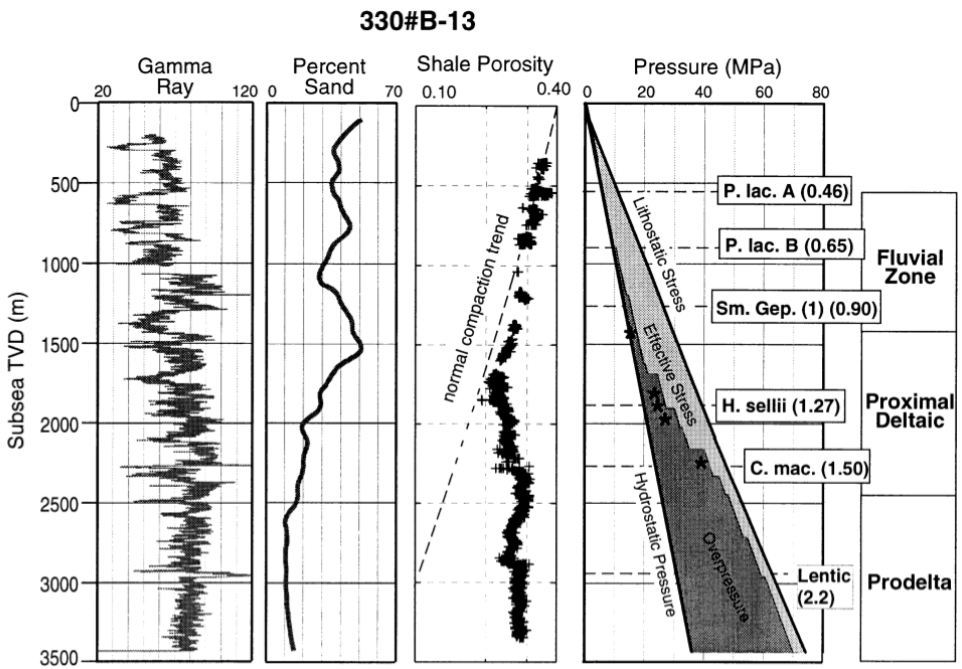
- Ongoing sedimentation increases overburden (vertical stress) faster than fluid diffuses out of zone

Characteristic time of diffusion in porous medium

$$\tau = \frac{(\phi\beta_f + \beta_r)\eta l^2}{k}$$

- low-permiability sand (~1 md)
  - τ on the order of years for $l = 0.1\text{km}$
- low-permiability shale (~10 nd)
  - τ on the order of 100,000 years for $l = 0.1\text{km}$

Common in Gulf of Mexico



 Gordon and Flemmings, 1998

Techtonic compaction

- Occurs in areas where large-scale tectonic stress changes occur over geolocgically short periods of time.

Hydrocarbon column heights

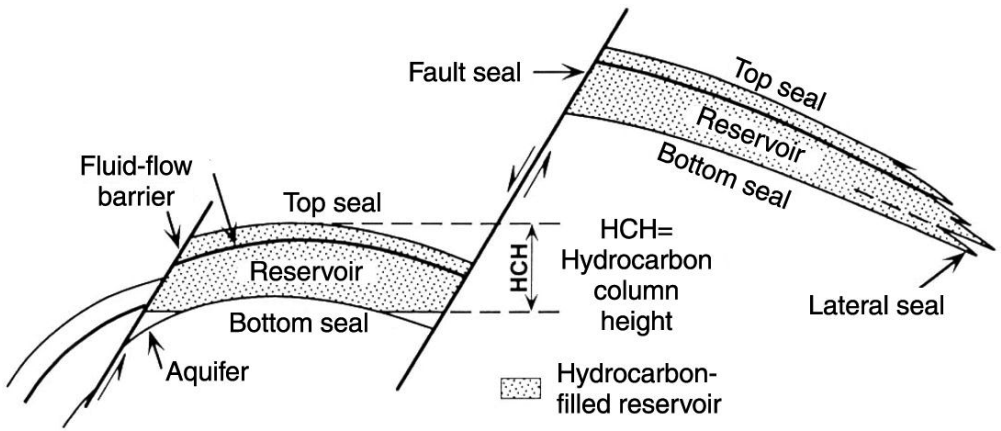
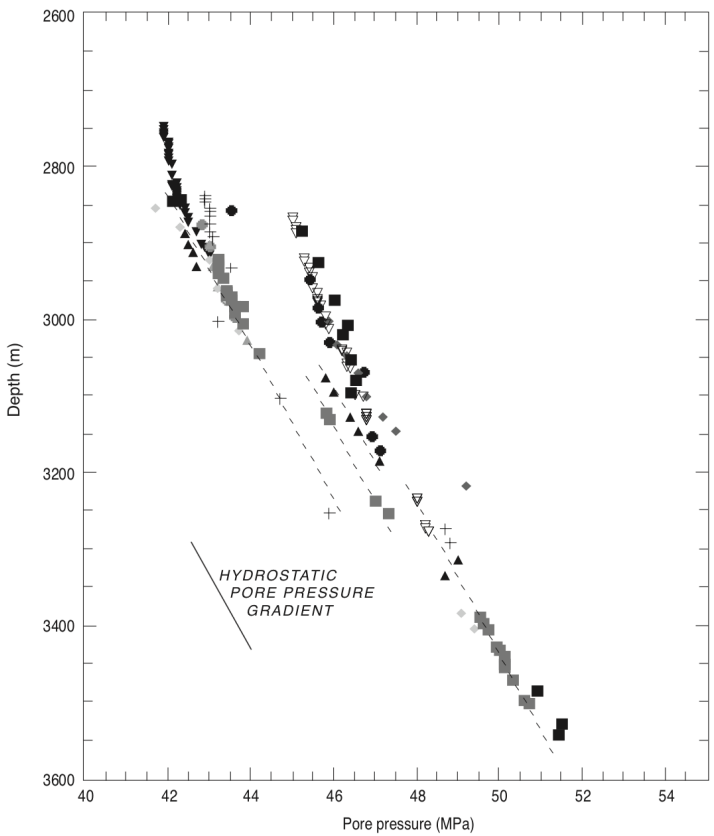


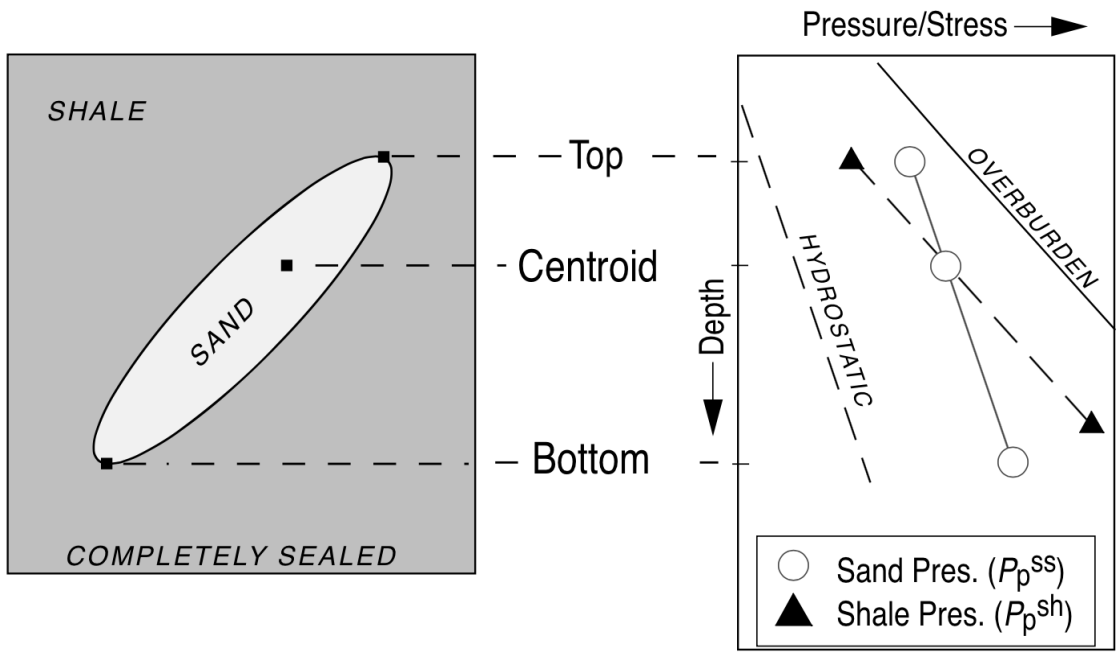
Image Source

Hydrocarbon column heights



 Zoback, *Reservoir Geomechanics* (Fig. 2.11, pp. 42)

Centroid effects



 Zoback, *Reservoir Geomechanics* (Fig. 2.12, pp. 43)

Other mechanisms

Aquathermal pressurization

- Temperature increases due to radioactive decay and upward heat flow from mantle

Hydrocarbon generation

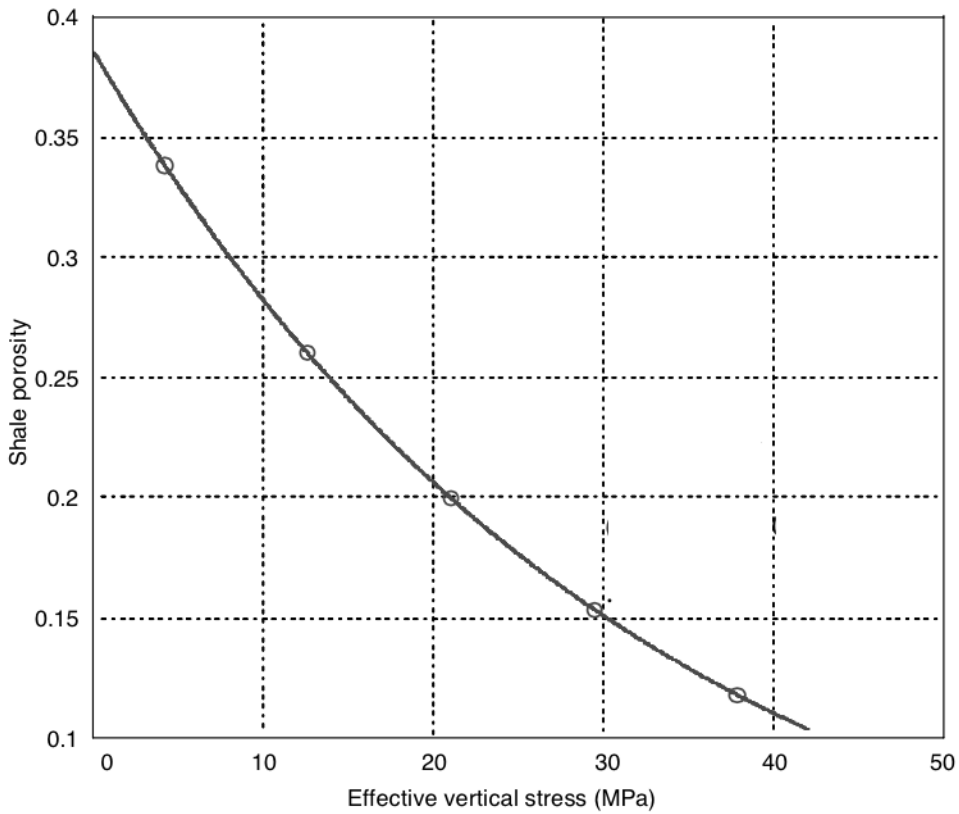
- From thermal maturation of kerogen

Direct measurement of pore pressure

- Via wireline samplers that isolate formation pressure from annular pressure in a small area at the wellbore wall.
- Mud weight

Estimation of pore pressure at depth

Confined compaction experiment

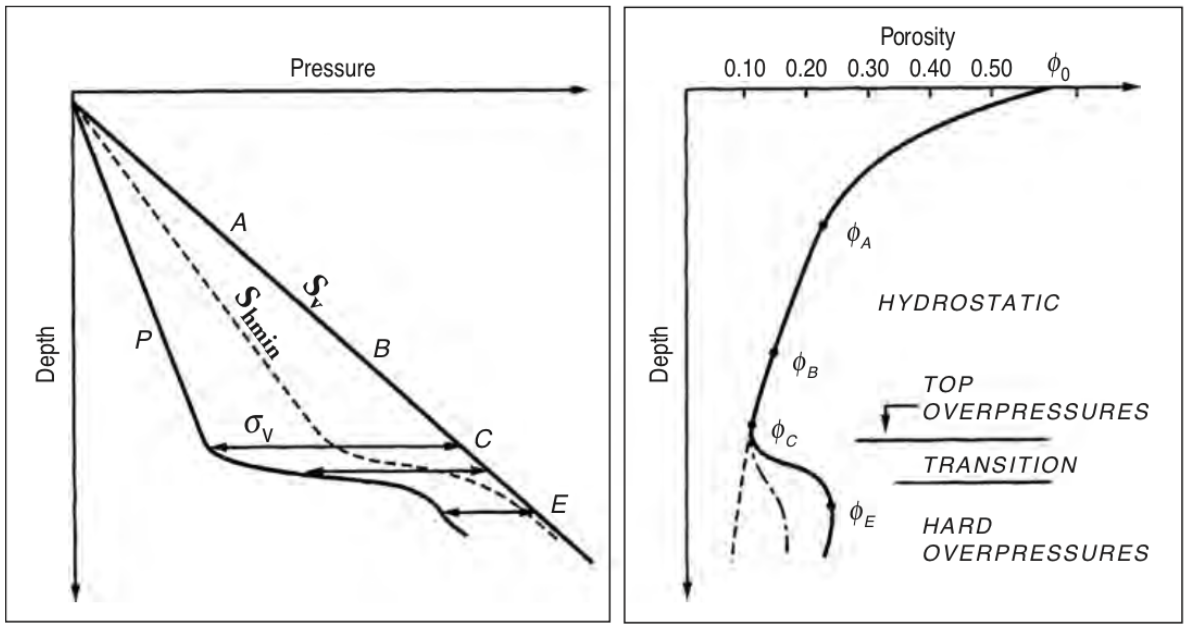


 Zoback, *Reservoir Geomechanics* (Fig. 2.13, pp. 46)

Shale compaction relation

$$\phi = \phi_0 e^{-\beta(S_v - P_p)}$$

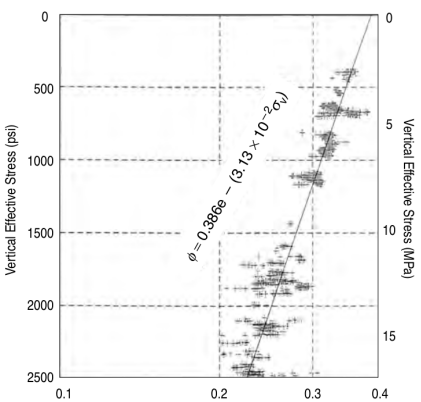
Use with caution!



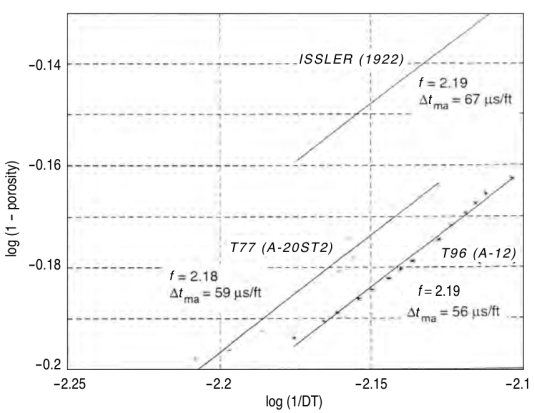
 Zoback, *Reservoir Geomechanics* (Fig. 2.14, pp. 48)

Porosity inference from P-waves

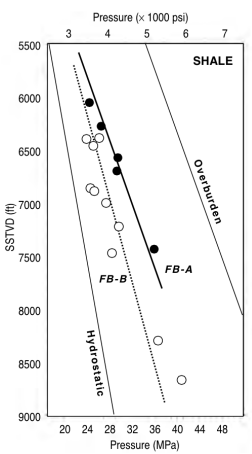
$$P_p = S_v + \left(\frac{1}{\beta}\ln\left(\frac{\phi}{\phi_0}\right)\right) \qquad \phi = 1 - \left(\frac{\Delta t_{ma}}{\Delta t}\right)^{\frac{1}{f}}$$



Compaction



P-wave



Pore pressures