

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

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Tectonic compaction

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

Hydrocarbon column heights

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<img src = "images/HCH.png" width = 500 >
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Image Source

Hydrocarbon column heights

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Centroid effects

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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

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Shale compaction relation

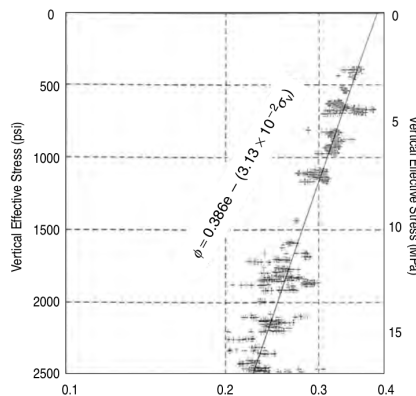
$$\phi = \phi_0 e^{-\beta(S_v - P_p)}$$

Use with caution!

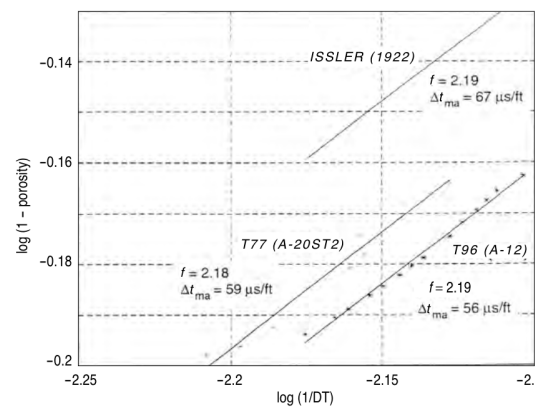
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Porosity inference from P-waves

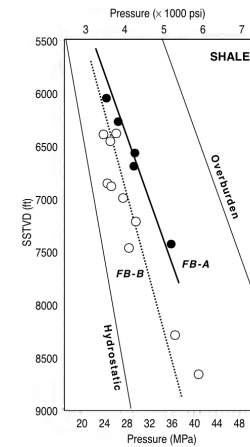
$$P_p = S_v + \left(\frac{1}{\beta} \ln \left(\frac{\phi}{\phi_0} \right) \right) \quad \phi = 1 - \left(\frac{\Delta t_{ma}}{\Delta t} \right)^{\frac{1}{f}}$$



Compaction



P-wave



Pore pressures

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