

Reservoir Geomechanics

Homework No. 2 – Estimating Pore Pressure

Due 8:00 am UTC March 2nd, 2020

Please direct any questions to the discussion forum. To see the current time in UTC, please google current time in UTC

In this homework assignment, you will be estimating the pore pressure from the porosity and the overburden stress calculated using the Gulf of Mexico (GOM) data from HW1.

Utilize a program such as Matlab, Excel, R, or Python for calculation and answer the questions below.

Use the following units in your plot: 'ft' for depth, 'psi' for pore pressure, and 'psi/ft' for pore pressure gradient.

I. Estimate the depths of Gulf of Mexico overpressure

1. Assume an exponential porosity reduction with the effective vertical stress given by the following empirical equation:

$$\phi = \phi_0 e^{-\beta \sigma_v}$$

$$\sigma_v = S_v - P_p$$

in which ϕ is the porosity, ϕ_0 is the initial porosity, β is the coefficient of compaction, S_v is the overburden stress, and P_p is the pore pressure. Assuming $\phi_0 = 0.4$ and $\beta = 0.0002 \text{ psi}^{-1}$ (Flemings et al., 2002), using the hydrostatic pore pressure 0.44 psi/ft, your calculation of the overburden stress from HW1, to predict porosity over the full depth range of the GOM data set. A porosity is calculated assuming full saturation of 1.0 g/cm³ water in the pores and a 2.7 g/cm³ density of matrix in HW1. Plot the predicted porosity versus depth and the calculated porosity versus depth obtained in HW1 on the same plot.

2. Assume that porosity increase with depth is due only to overpressure. By comparing your calculated porosity versus depth with your predicted porosity versus depth, estimate the depth at which the onset of overpressure first causes a deviation from a theoretical compaction trend.

II. Estimate the magnitude of Gulf of Mexico overpressure

1. Rearrange the equation in I to obtain an expression for pore pressure as a function of porosity. Calculate the pore pressure using the density porosity and the overburden stress

which are obtained in HW1. Plot this calculated pore pressure as well as the hydrostatic pore pressure and the overburden stress versus depth on the same plot.

2. By subtracting hydrostatic pore pressure from the calculated pore pressure using porosity data, estimate the magnitude of the overpressure in the GOM data set.

III. Answer the questions on the page below

Use the calculations from I and II to answer the questions on the page below. The answers will be posted a day after the homework assignment is due. Please adhere to the value of constants given here. Numerical entry type responses have a range of acceptable values and are graded electronically. Please do not write units in the answer, just write the number. We will specify the units that we want the answer in.

Flemings, P. B., Stump, B. B., et al. (2002). Flow focusing in overpressured sandstones: Theory, observations, and applications. *American Journal of Science*, Vol. 302, December, 2002, P. 827-855. doi: 10.2475/ajs.302.10.827