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Unconventional Reservoir Geomechanics
Spring 2019

Homework 1: State of Stress in Unconventional Reservoirs

Due April 15, 2019 at 08:00 UTC
Please direct any questions to the Piazza Discussion Forum on the course page

Background

This assignment focuses on determining the state of stress in the Barnett shale, TX using actual field and log data. The density log data can be downloaded by clicking the 'next' button on upper right hand corner of the page.

Utilize a scientific computing and/or plotting program such as MATLAB, Python or Excel to follow the steps below. Then, answer the questions on the page below.

Part 1: Compute the vertical stress and vertical stress gradient

a. *Plot density and function of depth*. Use a scientific computing or plotting program to plot density as function depth. It is conventional to put density on the x-axis and depth on an inverted y-axis.

b. *Divide the density profile into 5 blocks*. Designate 5 blocks representing sections of approximately constant density as a function of depth (*e.g.*, 0-500 ft, 500-1000 ft, 1000-3000 ft, 3000-5000 ft, 5000-7000 ft. Compute the average density in each block and plot blocked density vs. depth on the same plot as (a).

c. *Calculate the vertical stress*. Calculate and plot the vertical stress using both the continuous and blocked density profiles in units of psi. On the same plot, calculate and plot a hydrostatic pore pressure gradient. Use 1000 kg/m^3 for the density of water. Use 10.0 m/s^2 to approximate *g*, acceleration due to gravity.

d. *Calculate the vertical stress gradient*. Calculate and plot the vertical stress gradient using the blocked density profile by integrating the vertical stress as function of depth.

Part 2: Compute the stress polygon to constrain the stress state at 5500 ft depth

a. *Calculate the stress magnitude constraints for each type of faulting regime*. DFIT measurements indicate that the instantaneous shut-in pressure (ISIP) is 38 MPa at 5500 ft depth. Use frictional faulting theory (Unit 3) to calculate the stress magnitude constraints for each type of Andersonian faulting regime.

   Use the following values:

Depth = 5500 ft
Vertical stress, S_V = value obtained in Part 1c for blocked data
Coefficient of sliding friction, $\mu = 0.6$
Pore pressure gradient = 0.5 psi/ft

b. *Repeat (a) for an ISIP of 28 MPa*. If the Barnett shale is in a state of frictional equilibrium and there are both active normal and strike-slip faults in the area, determine the range of values of S_{Hmax} and S_{hmin}.

c. *Construct the stress polygon*. Plot your results from (a) on S_{Hmax} vs. S_{hmin} axes in units of MPa. Plot the value of S_V on the same axes and draw in the boundaries between the allowed stress magnitudes for each faulting regime as illustrated in Unit 3. Label each area correspondingly.

d. *Repeat (a) and (c) using a pore pressure gradient of 0.7 psi/ft*. Describe the impact of overpressure on the stress polygon and the range of allowable stress states.

Part 3: Answer the questions on the page below

Use the plots and calculations from Parts 1 and 2 to answer the questions on the page below. The answers and solutions will be posted after the due date. Numerical entry types responses have only a limited range of accepted values and are graded electronically, so follow the directions closely and adhere the to the given values of constants to prevent misgrading of your submissions.