Reservoir Geomechanics

Homework No. 3 – Estimating Rock Strength from Geophysical Logs
Due 8:00 UTC March 9th, 2020
If you want to see the current time in UTC, please google: current time in UTC

In this homework assignment, you will be estimating the unconfined compressive strength (UCS) as a function of depth using the porosity calculated from the Barnett data assuming full saturation of 1.0 g/cm^3 water in pores and the density of a matrix of 2.7 g/cm^3 in the first homework assignment as well as a sonic log from the same well. The sonic log contains compressional and shear velocities expressed as travel times in a unit of μs/ft versus depth for a section of the Barnett Shale well.

Utilize a program such as Matlab, Excel, R, or Python to follow the steps below. A CSV file of the sonic log and an Excel file of information of the depth range of each formation can be downloaded by clicking the right tab on the top of this page.

Use the following units in your plot: 'ft' for depth, and 'psi' for unconfined compressive strength.

I. Estimate UCS for the given depths using known empirical relations

1. Use the empirical relationships given in Lecture 5, slides 33-36 to estimate UCS from the given sonic log and the Barnett density log in the first homework assignment. Equations to apply for each of the three lithological units are assumed in Barnett_assumed_formations_emperical_equations.xls. Calculate Young's modulus using the following equation (Zoback, 2007):

$$G = \frac{3KE}{9K - E}$$

   in which G is the shear modulus, K is the bulk modulus, and E is the Young's modulus. For each formation, you will use one method of estimating UCS from the sonic log and one method from the density log. Make sure to pay attention to the units for these calculations.

2. Plot UCS estimated from the sonic log versus depth and plot UCS estimated from the density log versus depth. It is conventional to put depth on an inverted y-axis (increasing depth downward) and UCS on the x-axis.

Zoback, M. (2007). Reservoir Geomechaincs. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511586477

II. Answer the questions on the page below

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