PGE 334 [Fall 2018] – Homework #1 **Instructor: DNE**

Reading assignment

Read Chapters 1 and 2 of the class notes: "Introduction to Energy Geomechanics" (bonus points if you find a typo or a grammar mistake).

Read Chapters 1 and 2 of the book: "Reservoir Geomechanics"

Problems

1) Compute the vertical stress gradient resulting from a carbonate rock made of 70% dolomite and 30% calcite, porosity 10% and filled with brine ~1,060 kg/m^3. Provide answer in psi/ft, MPa/km, and ppg.

2) Calculate (<u>without the help of a computer</u>) the total vertical stress in an off-shore location at 10,000 ft of total depth (from surface) for which: water depth is 1,000m, bulk mass density of rock at the seabed is 1,800 kg/m^3 increasing linearly until a depth of 500 m below sea-floor to 2,350 kg/m^3 and relatively constant after it. Why would rock bulk mass density increase with depth?

3) The following table contains the estimated bulk mass densities as a function of depth for an offshore location in Brazil. Water depth is 500m. Measurements indicate that porosity of shale layers estimated through resistivity measurements.
   a. Plot the profiles of S_v v.s. depth (MPa v.s. m and ft v.s psi)
   b. Plot the profile of hydrostatic water pressure. Assume the density of brine is1031 kg/m^3 in the rock pore space (MPa v.s. m and ft v.s. psi).
   c. Plot hypothetical vertical effective stress v.s. depth assuming hydrostatic pore pressure gradient (MPa v.s. m and ft v.s. psi).
   d. Additional compaction lab measurements on shale cores indicate a good fitting of the porosity-effective vertical stress relation through the equation $\phi = \phi_0 exp(-\beta \sigma_V)$, with parameters $\phi_0=0.38$ and $\beta = 3 \cdot 10^{-2} MPa^{-1}$. Estimate the actual pore pressure in the shale. Is there overpressure? At what depth does it start?
   e. Plot actual vertical effective stress v.s. depth (MPa v.s. m and ft v.s. psi).

Depth [m]	Bulk mass density [kg/m^3]	Shale porosity [-]
0	1025	
100	1026	
200	1026	
300	1030	
400	1030	
500	1031	
600	1900	
700	2190	
800	2200	
900	2230	
1000	2235	
1100	2240	
1200	2275	0.305
1300	2305	0.297
1400	2310	0.286
1500	2308	0.281
1600	2310	0.285
1700	2305	0.293
1800	2310	0.307
1900	2324	0.305
2000	2319	0.298

4. Go to https://github.com/dnicolasespinoza/GeomechanicsJupyter and download the files '1_14-1_Composite.las' and '1_14-1 deviation_mod.dev'. The first one is a well logging file (.LAS). You will find here measured depth (DEPTH - Track 1) and bulk mass density (RHOB - Track 8). Track 3 also shows bulk density correction (DRHO). Add RHOB to DRHO to obtain the corrected bulk mass density. The second file has the deviation survey of the well. Use this file to calculate true vertical depth subsea (TVDSS) as a function of measured depth (MD) in the well logging file. You may assume an average bulk mass density of 2 g/cc between the seafloor and the beginning of the density data. Summations with discrete data sets can be easily done through a 'for' loop or with a spreadsheet.