Homework Project No. 1

September 21, 2023
Due on October 5, 2023

PGE385K (Unique No. 20274)
Fall Semester 2023
Advanced Multi-Well Formation Evaluation

Instructor: Carlos T. Verdín, PhD, Professor

SHALY-SANDSTONE INTERPRETATION

DESCRIPTION:

This homework project is a hands-on exercise for the interpretation of well logs and core data acquired in a shale-sandstone laminated clastic sedimentary sequence. The objectives are (1) to identify and verify dominant lithology and dominant saturating fluids, and (2) to calculate hydrocarbon pore volume in shale-laminated sandstones.

GUIDELINES FOR THE PREPARATION OF HOMEWORK REPORTS:

(a) YOUR REPORT SHOULD BE CLEAN, NEAT, AND WELL ORGANIZED. DESCRIPTIONS SHOULD BE LEGIBLE AND READABLE.
(b) THE REPORT SHOULD INCLUDE CLEAR AND COMPLETE TECHNICAL DESCRIPTIONS WHEREVER NECESSARY.
(c) ALL FIGURES AND TABLES SHOULD BE LABELED AND PROPERLY ANNOTATED WITH A CAPTION. PLOTS SHOULD BE DISPLAYED WITH THEIR AXES, VARIABLES, AND MEASUREMENT UNITS.
(d) ALL RELEVANT RESULTS AND QUANTITIES SHOULD BE WRITTEN WITH THE CORRESPONDING MEASUREMENT UNITS.
(e) ATTENTION SHOULD BE PAID TO NUMBER OF SIGNIFICANT FIGURES USED TO DISPLAY RESULTS.
(f) SPREADSHEETS ARE NOT SELF-EXPLANATORY NOR ARE LOOSE FIGURES.

POINTS WILL BE DEDUCTED FROM HOMEWORK THAT DOES NOT ADHERE TO THE ABOVE PRESENTATION RULES.

TASKS:

1. Download the example LAS file and core data accompanying this homework project. Plot the core data together with the well logs and depth-shift them if necessary. Discard/flag measurements with dubious quality.

2. Consider the depth interval between 9,600 and 10,200 ft MD.

3. Identify lithology, water zones, and possible hydrocarbon zones. Make use of cross-plots to guide your analysis. What possible type of outcrop and sedimentary sequence do the well logs and core photographs indicate?

4. Verify that the gamma ray log truly responds to shale concentration. Estimate volumetric concentration of shale by two different methods. Diagnose whether shale distribution is laminar, dispersed (grain-coating clay), or structural. Identify "pure" shale segments in the well and verify that shale properties remain constant with depth within the sedimentary sequence. Identify formation tops for analysis/calculations if deemed necessary.

5. Calculate sandstone porosity and fluid density. Compare the calculated porosities to core data, pore pressure gradients, and sonic porosities. Note that this item is related to the items below.

6. Using the parallel- and perpendicular-to-bedding-plane resistivities, calculate hydrocarbon pore volume as a function of depth using the interpretation procedure intended for shale-laminated sandstone. Assume that a=1.0, m=2.1, and n=1.9 in sandstones. Calculate hydrocarbon density and compare your calculations to fluid density interpreted from pore-pressure gradients.

7. Calculate S_{xo}. Verify that your calculations of S_w and S_{xo} are consistent with your calculation of sandstone porosity.

8. Explore whether core permeability exhibits a clear correlation with your calculated sandstone porosities and irreducible water saturation.