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PRESIDENCY UNIVERSITY BENGALURU

SCHOOL OF ENGINEERING

MAKE-UP EXAMINATION - JULY 2024

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| **Semester :** IV | **Date :** 11-July-2024 |
| **Course Code :** PET2002 | **Time :** 09:30 AM to 12:30 PM |
| **Course Name :** Fundamentals of Geophysical Logging Techniques | **Max Marks :** 100 |
| **Program:** B.Tech. (Petroleum Engineering) | **Weightage :** 50% |

**Instructions:**

1. *Read all questions carefully and answer accordingly.*
2. *Question paper consists of 3 parts.*
3. *Scientific and non-programmable calculator are permitted.*
4. *Do not write any information on the question paper other than Roll Number.*
5. ***Charts to be used for solving problems are printed herewith. Therefore, submit the Question Paper along with the Answer-script.***

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| **PART A** | | | |
| **ANSWER ANY 5 QUESTIONS 5Q X 2M=10M** | | | |
| 1 | Mention the objective of petrophysics. | (CO 1) | [Knowledge] |
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| 2 | List down the information gathered from petrophysical data. | (CO 1) | [Knowledge] |
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| 3 | Fill in the blanks: Archie’s equation express the relationship between \_\_\_\_\_ and \_\_\_\_\_. | (CO 2) | [Knowledge] |
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| 4 | Match the petrophysical data with their sources.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Petrophysical Data** | |  | **Sources** | | | 1 | Mud Log |  | A | Drill Core / Side-wall Core | | 2 | Cased Hole Log |  | B | Well Production Data | | 3 | Core |  | C | Log Data / Cuttings | | 4 | Open Hole Log |  | D | Wireline / While drilling | |  |  |  | E | Borehole Seismic | | (CO 2) | [Knowledge] |
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| 5 | Recall at least two uses of the sonic log. | (CO 3) | [Knowledge] |
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| 6 | List down the major applications of Cement Bond Logging (CBL) Tools. | (CO 4) | [Knowledge] |
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| 7 | Discuss the main objective of the Neutron-Density cross-plot. | (CO 5) | [Knowledge] |
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| **PART B** | | | |
| **ANSWER ANY 5 QUESTIONS 5Q X 10M=50M** | | | |
| 8 | Gamma Ray Log response is presented in the schematic diagram below. Classify the depositional environments based on the shape of log response.  C:\Users\Admin\OneDrive - presidencyuniversity.in\Desktop\GR Log Response - Serrated1.jpg | (CO 1) | [Comprehension] |
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| 9 | Geophysical log responses are plotted in Figure A. Interpret the log responses as an oil and gas professional. | (CO 2) | [Comprehension] |
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| 10 | 1. The drilling fluid, or mud, ranges in density between 9 and 16 lb/gal; weighting additives such as barite (BaSO4) or hematite are added to ensure that the hydrostatic pressure in the wellbore exceeds the fluid pressure in the formation pore space to prevent disasters such as blowouts. The salinity of the drilling mud ranges between 1,000 and 200,000 ppm of NaCl. The generally overpressured wellbore causes invasion of a porous and permeable formation by the drilling fluid. Figure 01 conveys the result of the invasion process. Explain Figure 01 concerning the degradations that took place during and after drilling.   C:\Users\Admin\OneDrive - presidencyuniversity.in\Desktop\Formation During and After Drilling.jpg   1. The borehole environment in which logging measurements are made, is of some interest from the standpoint of logging tool designs and the operating limitations placed upon them. Furthermore, it is important in terms of the disturbance it causes in the surrounding formation in which properties are being measured. A schematic model of the borehole and formation used to describe electric-logging measurements and corrections are presented in Figure 02 (Courtesy of Schlumberger). Interpret the Figure 02 to account for the distortion which frequently present with electrical measurements.   C:\Users\Admin\OneDrive - presidencyuniversity.in\Desktop\Borehole Environment.jpg | (CO 2) | [Comprehension] |
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| 11 | Porosity is the percentage of void space in a rock. It is defined as the ratio of the volume of the voids or pore space divided by the total volume. It is written as either a decimal fraction between 0 and 1 or as a percentage. For most rocks, porosity varies from less than 1% to 40%.  (a) Estimate porosity indirectly with the following available data:  ρb = 2.60 g/cc (Sandstone), ρma = 2.87 g/cc (Dolomite), and ρf = 1.1 g/cc (Salt Mud)  (b) Determine the porosity by plotting the above-mentioned data on Chart No. 3 shared below. | (CO 3) | [Comprehension] |
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| 12 | The Cement Bond Log (CBL) continuously measures the amplitude of sound pulses from a transmitter to a receiver. This amplitude (mV) is maximum in unsupported pipe and minimum in the well-cemented casing. This curve shows how much acoustic signal reaches a receiver and is an important indicator of cement bond. Record the amplitude on the 3-foot spaced receiver. The Travel Time (µs) curve shows the amount of time it takes an acoustic signal to travel between the source and a receiver. The travel time between points is very predictable for a free pipe of a given size and weight. Travel time is required as a quality control measurement. Record the travel time on the 3-foot spaced receiver. The wave train can be displayed as a Variable Density Log (VDL) where the positive and negative cycles of the wave train are shaded in black and white respectively. Pipe, formation, and fluid signals are usually easily recognizable on the VDL. If these signals can be identified, a practical determination of the presence or absence of cement can be made. VDL is logged on the 5-foot spaced receiver. The Casing Collar Locator (CCL) is used to correlate the bond log with cased hole logs and match casing collars with the collars that appear on the display's VDL portion. Figure 03 is displaying the parameters measured and presented on the Radial Bond Log (RBL). List any five of the parameters labelled 1 through 8 in Figure 03. | (CO 4) | [Comprehension] |
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| 13 | A cement bond log documents the evaluation of the integrity of cement work performed on an oil well. In the process of drilling and completing a well, cement is injected through the wellbore and rises up the annulus between the steel casing and the formation. Using cement between the steel well casings and the geologic formation is necessary to support the casing, prevent fluid from leaking to the surface, and provide isolation between water-bearing and producing zones. Cement bond log analysis is vital to ensure well integrity isn't compromised. Figure 04 displays the scenarios to remember while evaluating the cement bond log. Distinguish the scenarios labeled A through E in Figure 04. | (CO 4) | [Comprehension] |
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| 14 | A Pickett plot is a method used in petrophysical analysis to evaluate the formation characteristics of conventional, granular reservoirs. It was developed by Professor George Pickett. The method provides a graphical solution to Archie’s equation to determine the water saturation of a reservoir by plotting resistivity versus porosity on a log-log scale. The Pickett plot is based on a pattern recognition approach to solving Archie’s equation without the need for many of the constants that are often unknown. One benefit to this pattern recognition approach is that the water saturation can be derived without having any calibration data for the porosity measuring device, including grain density, etc. as well as not having to know the resistivity of the formation water. The important aspect of the pattern recognition approach is that there must be a statistically significant number of zones plotted in order to provide accurate calculations. Additionally, the unknown constants in Archie’s equations must be relatively constant for the reservoirs. Nevertheless, the Pickett plot has become a powerful tool to characterize reservoirs with a simple, quick plot. Summarize the purposes of Pickett Plot in petrophysics and reservoir characterization. | (CO 5) | [Comprehension] |
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| **PART C** | | | |
| **ANSWER ANY 2 QUESTIONS 2Q X 20M=40M** | | | |
| 14 | (a) In log interpretation, the bottomhole temperature (BHT) is taken as the maximum recorded temperature during a logging run or preferably the last of series of runs during the same operation. BHT is the temperature used for the interpretation of logs at total depth. The downhole temperature can be calculated by adding the surface temperature to the product of the depth and the geothermal gradient. Use the shared Schlumberger Chart and predict the depth (in ft) and BHT (in °F) at Point A, Point B and Point X.  C:\Users\Admin\OneDrive - presidencyuniversity.in\Desktop\Schlumberger Temp Grad Chart.jpg  (b) If the Resistivity of a water sample is 1.40 ohm-m at 25°C, then estimate NaCl concentration (in ppm) at 25°C and resistivity of the same NaCl concentration at 100°C with the help of a shared Chart No. 002 shared below. | (CO 2) | [Application] |
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| 15 | Direct measurements of filtrate and mud-cake samples are preferred. When the direct measurements of mud-filtrate resistivity (Rmf) and, mud-cake resistivity ((Rmc) is not possible, then the following methods can be used to estimate Rmf and Rmc.  Method 1: Lowe and Dunlap  Method 2: Overton and Lipson  Method 3: Statistical Approximation   1. Estimate Rmf and Rmc using all the methods when Rm = 3.5 ohm-m at 24°C and Mud Weight = 1920 kg/m3. 2. If any particular method is not applicable, then explain the reason. 3. If more than one method is applicable, then compare the results.   Required data form the following Table can be used for calculation,   |  |  |  | | --- | --- | --- | | **Mud Weight** | | **Km** | | **lbm/gal** | **Kg/m3** | | 10 | 1200 | 0.847 | | 11 | 1320 | 0.708 | | 12 | 1440 | 0.584 | | 13 | 1560 | 0.488 | | 14 | 1680 | 0.412 | | 16 | 1920 | 0.380 | | 18 | 2160 | 0.350 | | (CO 2) | [Application] |
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| 16 | Figure AB is displaying Caliper and Gamma Ray (GR) logs in Track 1, Sonic, Neutron, and Density logs in Track 2, and Deep Resistivity and Shallow Resistivity logs in Track 3 of PU Well 3. Table, PU Well 3 is displaying geophysical log data from selected depths.  (a) Pick GRsa and GRsh from the inspection of the logs,  (b) Calculate the Volume of Shale (Vsh) at 653.644 ft depth from GR Log,  (c) Pick the likely position of the reservoir zone,  (d) Pick the likely position of the OWC, and  (e) Assuming appropriate fluid densities for the oil and water legs (the well is drilled with fresh WBM) and a grain density of 2.660 g/cc, calculate the porosity at 653.644 ft depth. | (CO 3) | [Application] |
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