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**Faculty of Science 2nd Semester 2016-2017**

**Dept. Of Geology Date: 06/06/2017**

**well logging (355G) for Third Level Students (Geophysics)**

**جامعة بنها – كلية العلوم – قسم الجيولوجيا**

**المستوى الثالث(جيوفيزياء)**

**يوم الامتحان: الثلاثاء**

**تاريخ الامتحان: 6 / 6 / 2017**

**الماده: سجلات الابار (355 ج)**

**الممتحن: د/ وفاء الشحات عفيفى الشحات**

**أستاذ مساعد بقسم الجيولوجيا بكلية العلوم**

**الاسئله ونموذج الاجابه**

**نصف ورقه امتحانيه**

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**Answer the following questions:**

**Question1. (16 Marks)**

**Write on four of the following:**

1. **Limitations of Core Measurements**
2. **Wellsite mud logging**
3. **Density and Neutron Tools**
4. **Uses of Resistivity logs**
5. **Pipe-Conveyed Logging**

**Question 2. (4Marks)**

**What is the evaluation sequence for a reservoir?**

**Question 3. (4Marks)**

**Write briefly about:**

1. **Conditions Allowing the Accumulation of Hydrocarbons in a Reservoir**
2. **Acoustic Log**

**BEST WISHES**

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**Answer of Question1. (8 Marks)**

**a)Limitations of Core Measurements**

The following may give reasons why the core data are not always correct:

• A core is a section of rock cut usually over only a subset of the reservoir in a particular part of a field. There is no *a priori* reason why it should be representative of the reservoir as a whole.

• The coring and recovery process subjects the rock to stress and temperature changes that may profoundly affect the rock structure.

• The plugging, cleaning, and drying process may completely change the wettability of the plugs, making them unrepresentative of down hole conditions.

• Resistivity measurements performed on plugs at ambient temperature, using air as the non-wetting fluid, may be wholly unrepresentative of reservoir conditions.

• When measurements are made on a selection of, say, 10 SCAL plugs, it will typically be found that the *m*, *n*, and *Pc* behavior of all 10 will be completely different. These are usually then averaged to obtain a representative behavior for the reservoir.

**b) Wellsite mud logging**

During the drilling of a well there will typically be a mud-logging unit on the rig. This unit has two main responsibilities:

1. To monitor the drilling of the parameters and gas/liquids/solids returns from the well to assist the drilling department in the safety and optimization of the drilling process

2. To provide information to the petroleum engineering department that can be used for evaluation purposes typically the mud-logging unit will produce a daily “mud log,” which

is transmitted to the oil company office on a daily basis. Items that will be included are:

• Gas readings as measured by a gas detector/chromatograph

• A check for absence of poisonous gases (H2S, SO2)

• A report of cuttings received over the shale shakers, with full lithological descriptions and relative percentages

• Rate Of Penetration

• Hydrocarbon indications in samples :the mud log may be of great use to the petrophysicist and geologist in operational decision making and evaluation. Areas in which the mud log may be particularly important include:

• Identification of the lithology and formation type being drilled

• Identification of porous/permeable zones

• Picking of coring, casing, or final drilling depths

• Confirmation of hydrocarbons being encountered and whether they are oil or gas

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1. **Density and Neutron Tools**

**Neutron Logging**

The Neutron Log is primarily used to evaluate formation porosity, but the fact that it is really just a hydrogen detector should always be kept in mind. It is used to detect gas in certain situations, exploiting the lower hydrogen density, or hydrogen index. The Neutron Log can be summarized as the continuous measurement of the induced radiation produced by the bombardment of that formation with a neutron source contained in the logging tool which sources emit fast neutrons that are eventually slowed by collisions with hydrogen atoms until they are captured. The capture results in the emission of a secondary gamma ray; some tools, especially older ones, detect the capture gamma ray (neutron-gamma log).

**The Density Log**

The formation density log is a porosity log that measures *electron density* of a formation. Dense formations absorb many gamma rays, while low-density formations absorb fewer. Thus, high-count rates at the detectors indicate low-density formations, whereas low count rates at the detectors indicate high-density formations. Therefore, scattered gamma rays reaching the detector are an indication of formation Density.

**d)Uses of Resistivity logs**

* Resistivity logs are electric logs which are used to:
* Determine Hydrocarbon versus Water-bearing zones,
* Indicate Permeable zones,
* Determine Resisitivity Porosity.
* **e)Pipe-Conveyed Logging**
* Where the borehole deviation or dogleg severity is such that it is not possible to run tools using conventional wireline techniques, tools are typically run on drill pipe. In essence, this is no different from conventional logging. However, there are a number of important considerations. Because of the need to provide electrical contact with the tool string, the normal procedure is to run the tool string in the hole to a certain depth before pumping down a special connector (called a wet-connect) to connect the cable to the tools. Then a side-entry sub (SES) is installed in the drill pipe, which allows the cable to pass from the inside of the pipe to the annulus. The tool string is then run in

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farther to the deepest logging point, and logging commences. The reason the SES is not installed when the tool string is at the surface is partly to save time while running in (and allowing rotation), and also to avoid the wireline extending beyond the last casing shoe in the annulus. If the open hole section is longer than the cased hole section, the logging will need to be performed in more than one stage, with the SES being retrieved and repositioned in the string. Pipe-conveyed logging is expensive in terms of rig time and is typically used nowadays only where it is not possible to acquire the data via LWD.

**Answer of Question 2. (8Marks)**

**a)The evaluation sequence for a straightforward reservoir will be as follows:**

For any given well interval:

* 1. Distinguish between reservoir and non-reservoir rock
* (Reservoir rock contains a reasonably high connected porosity.)
* 2. For the reservoir intervals only, distinguish between hydrocarbons and water filling the pores, hence calculate water saturation in reservoir rocks
* (Hydrocarbons are electrical insulators, while water conducts.)
* 3. For the hydrocarbon fraction, distinguish between oil and gas, hence calculate gas and oil saturations in reservoir rocks (Gas has a much lower density than oil.)

**Question 3. (8 Marks)**

**Write briefly about:**

**a)Conditions Allowing the Accumulation of Hydrocarbons in a Reservoir**

Oil and gas reservoirs have come into being over large periods of time as the result of geological processes. The gasses and oils have been formed from organic remains, have migrated into the reservoir rock, and then have been trapped there by overlying rock formations with very low permeability. Hence, for a hydrocarbon reservoir to exist we need the following to be available at the same location:

1. A *source rock* containing the original organic remains.

2. Pressure and temperature conditions suitable to convert the organic remains into oil and gas.

3. A *porous, permeable reservoir rock* where the hydrocarbon can accumulate.

4. A migration pathway from the source rock to the reservoir rock for the hydrocarbons.

5. A suitable *trap* to keep the hydrocarbons in the reservoir rock until we wish to exploit it.

**b)Acoustic Log**

Acoustic tools measure the speed of sound waves in subsurface formations. While the acoustic log can be used to determine porosity in consolidated formations, it is also

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* valuable in other applications, such as:
* Indicating lithology (using the ratio of compressional velocity over shear velocity),
* Determining integrated travel time (an important tool for seismic/wellbore correlation),
* Correlation with other wells
* Detecting fractures and evaluating secondary porosity,
* Evaluating cement bonds between casing, and formation,
* Detecting over-pressure,
* Determining mechanical properties (in combination with the density log), and
* Determining acoustic impedance (in combination with the density log).