**Faculty of Science and Technology**
**Institute of Petroleum Technology**

University of Stavanger

**EXAMINATION:** PET110 Well logging part **DATE:** 15.05.14

**TIME OF EXAMINATION:** 3 hours

**EXAMINATION IN ENGLISH AND ALL ANSWERS MUST BE IN ENGLISH**

**AUTHORIZED HELP**:

- Simple calculator (Casio FX-82, TI-30 or HP30S)
- Language dictionary between your mother tongue and English

**The exam consists of total of 7 pages: 3 pages consisting of 3 exercises plus 4 pages of 3 enclosures. The enclosures must be handed in with the answers.**

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**Exercise 1 – Gamma ray and spectral gamma ray logs**

Use short answers and sketches.

1. Explain the principle of a Gamma Ray log and spectral Gamma Ray log measurements in 3 steps. Use sketches.

2. Explain why both of these logs are passive logs using sketches.

3. What are the advantages of the spectral gamma ray log according to the simple gamma ray log?

4. What are the differences between a wireline tool and logging while drilling tool? Use sketches.

5. What is a shale indicator? Explain.

6.
    a. What can be the impact of the mud on the gamma ray log?
    b. What is the impact of a washout on the gamma ray log?

7.
    a. How do we calculate the volume of shale using the gamma ray log? Illustrate with sketches.
    b. Is it better to use the spectral gamma ray log? Explain.

8. Use sketches to illustrate.
    a. What is the effect of sandstone with micas minerals in it on the gamma ray log?
    b. Show why the spectral gamma ray log can solve this problem.

9.
    a. What is a source rock?
    b. Which is the best tool to use between the gamma ray and the spectral ray log to determine a source rock? Illustrate with sketches.

**Exercise 2**

1. The following 5 logs are given from a well from the Haltenbanken area (Fig. 2.1):
    - Gamma log
    - Density log
    - Neutron log
    - Sonic log
    - Induction log (RILD)

    a. Mark the lithology in the depth track for the log interval.
    b. For the high resistivity zones there are 2 solutions. Mark both solutions on the log. What is the most likely solution? Explain why.

2. Figure 2.2 presents a lithology section. Draw directly in Figure 2.2 the log responses to this column for:
    a. Density log
    b. Neutron log
    c. Resistivity log

**Exercise 3 – Well evaluation**

From a well from the Oseberg field the following wireline logs are given (Figure 3):

- Gamma log
- Density log (FDC)
- Neutron logs (CNL)
- Sonic log (BHC)
- Dual induction log

The following values are given:

Density oil filtrate (Oil mud) = 0.75 g/cm$^3$

Density formation water = 1.03 g/cm$^3$

Oil density = 0.67 g/cm$^3$

a = 1, m = 1.85, n = 2

$\rho_{ma}$ = 2.82 g/cm$^3$ (mica), $\rho_{ma}$ = 2.41 g/cm$^3$ kaolinite

1. This well was drilled through an oil zone.
    a. Is there oil for all sands? Mark on the log.
    b. What about the vertical communication through the log interval?
    c. Mark the lithology in the depth track for the log interval.

2. This well has been drilled with oil based mud.
    a. Make a sketch of the saturation profile (oil or/and water in the pores) for the invaded/flushed zone around a well both for the oil zone and the water zone.
    b. Which saturation values are normal for oil filtrate in oil and water zone? Use these values for later evaluation.

3. The logs show 2 different sedimentological depositional environments.
    a. Mark those on the logs.
    b. Make a drawing of these 2 types.

4.
    a. Dual Laterolog has not been run in this well. Explain why.
    b. Why has the SP log not been run?
    c. The logs are based on 2 runs: Run 1 – GR_FDC_CNL and Run 2 – GR_IL_BHC. Why do we run GR for both runs?
    d. $\Delta\rho$ log is missing log interval. What is $\Delta\rho$?

5.
    a. Estimate the porosity only based on the density log for the zone A. Zone A consists of quartz (60%), mica (30%) and kaolinite (10%). What is the porosity for zone A corrected for the mineralogy effect?
    b. Estimate the water saturation for the zone A.

# 3 ENCLOSURES

## The 3 enclosures must be handed in with the answers

**ENCLOSURE 1**

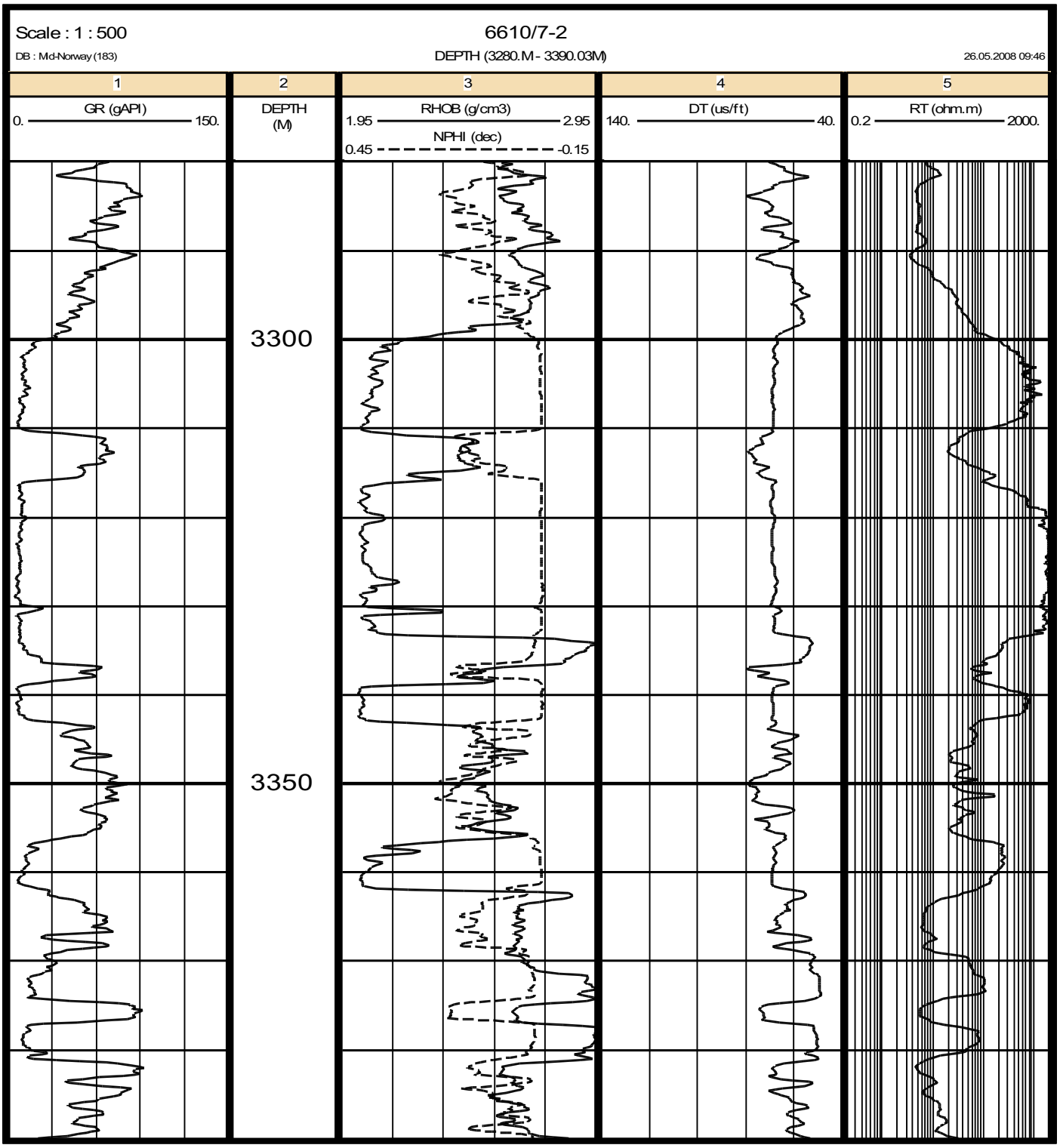


**FIGURE 2.1**

**ENCLOSURE 2**

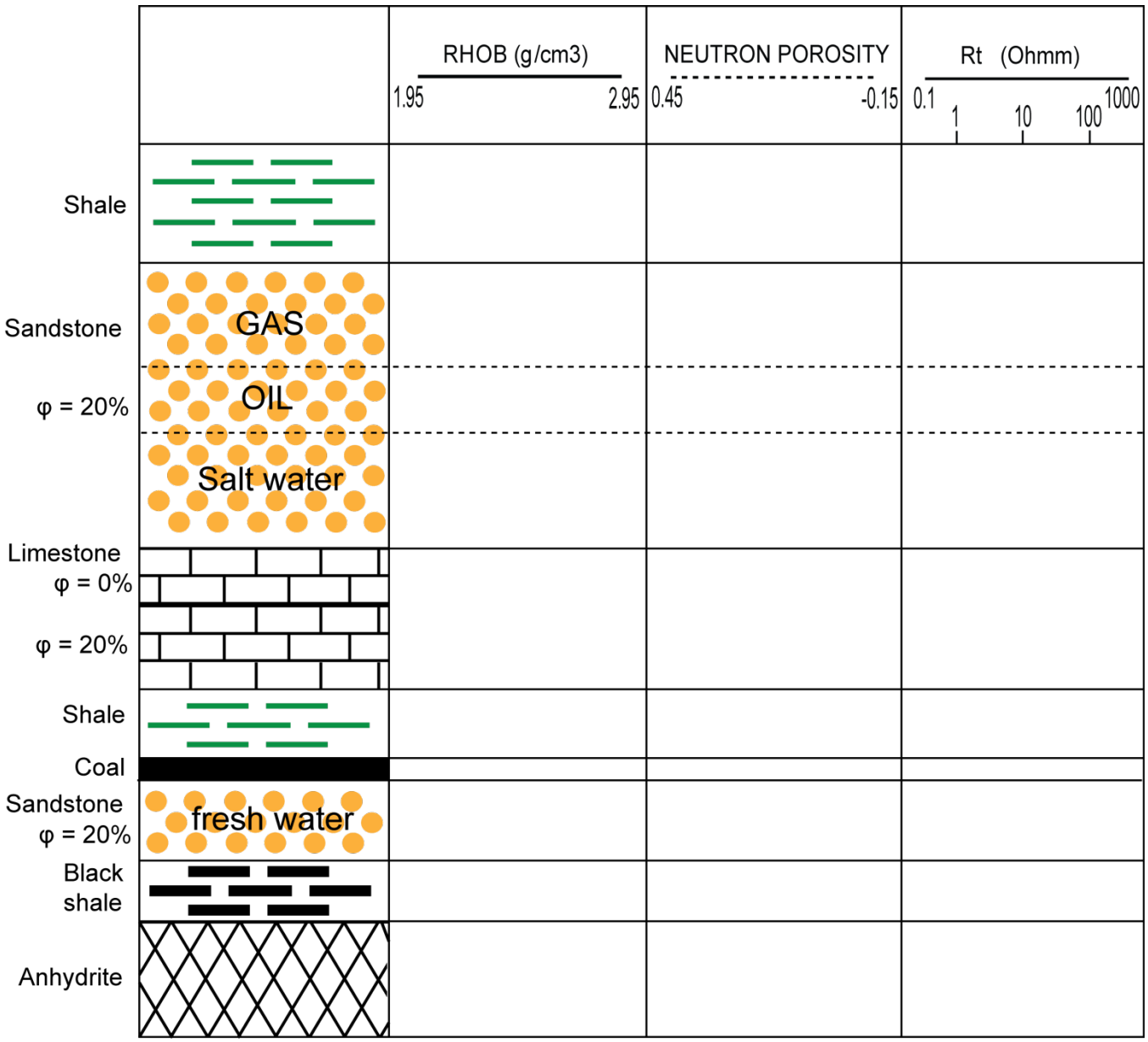


**FIGURE 2.2**

**ENCLOSURE 3**

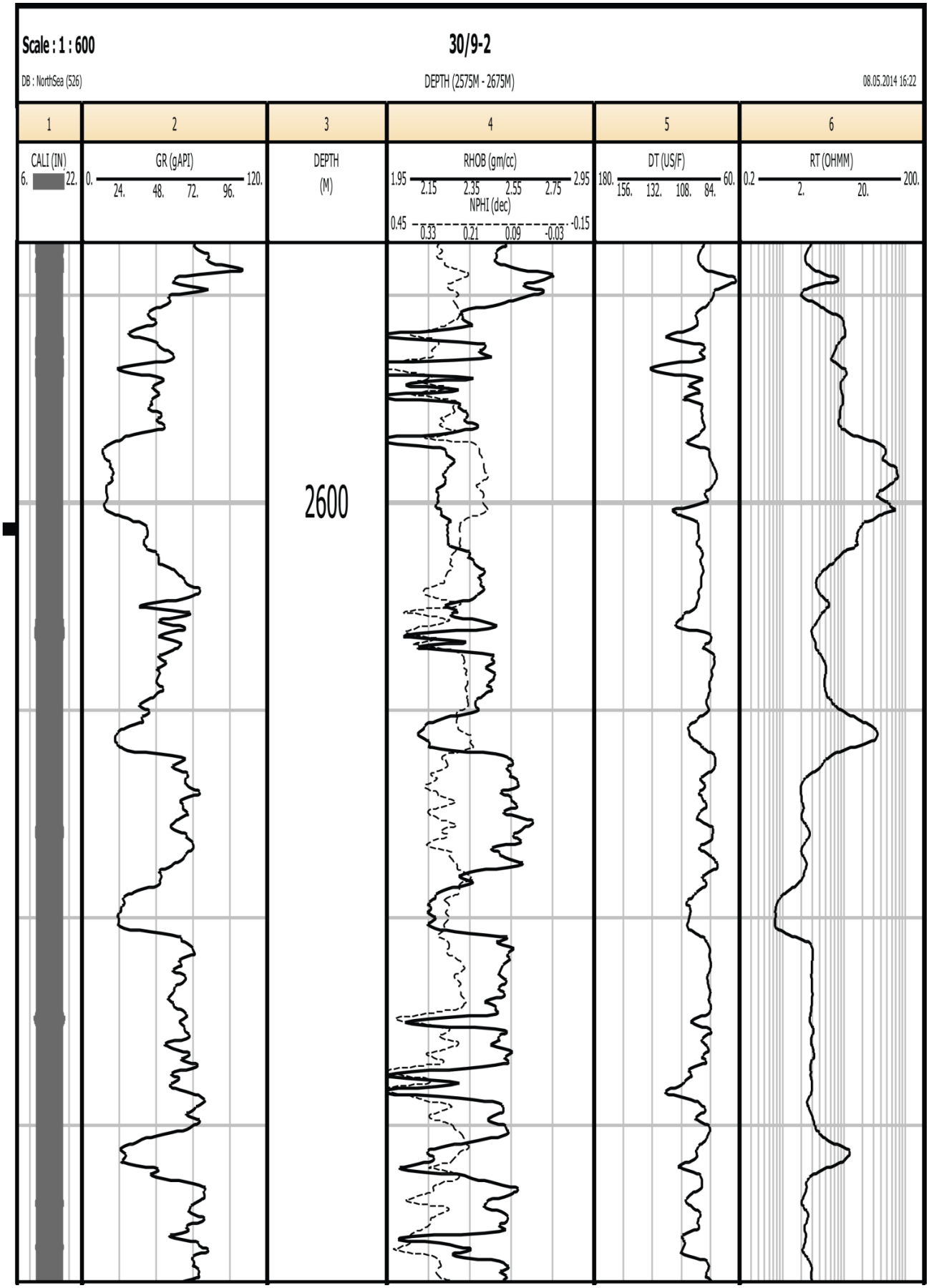


**FIGURE 3**