

# VRIJE UNIVERSITEIT, AMSTERDAM / UNIVERSITEIT UTRECHT

## MSc Tentamen (examination) 2010

### Petroleum Systems and Regional Geology (VU 450179)

October 29th 2010, 09.00 - 12.00hrs, room .....

Time allocation: 3 hours

---

**Answer 5 questions. You must answer questions 1 and 2.**

- Answers may be in English or Dutch
  - Credit will be given for indications of understanding the basic principles and for your reasoning
  - Make as much use as you can of diagrams and illustrated examples
  - You will **not** earn more marks by answering more than 5 questions
  - When you have finished please hand in all the material, including support for your interpretations
- 

#### **Question 1** (35% of the marks, obligatory)

Use figures 1 - 4, which summarize the geology and petroleum prospects of the Gilbertland offshore area.

Fig 1: Gilbertland area, structure and prospect map.

Fig 2: Gilbertland area, geological column and stratigraphy.

Fig.3: Gilbertland area: Distribution, depth and maturity of early to middle Jurassic source rock

Fig.4: Gilbertland area: Distribution, depth and maturity of late Jurassic source rock

No wells have yet been drilled in this area, but 19 numbered structural prospects have been identified. I would like you to group the prospects into families or "exploration plays" with similar characteristics. For this you should carry out the following tasks:

1. In the empty column in fig 2 provide an interpretation of the main cycles and stages that the basin passes through.
2. Tabulate the 19 prospects and indicate for each your interpretation of (a) the basin cycle/stage in which they are most likely to occur (alternatives or multiple levels may be possible) (b) the age and likely depositional environment of the reservoir (c) using figures 3 and 4, suggest from which source rock horizon(s) they are likely to be charged (assume that migration is vertical - only on the

Beagle Ridge can some horizontal migration take place along the basement surface), and (d) whether they will contain oil, gas or water.

3. On the basis of your tabulation, group the prospects into exploration "plays", and give these a name. Which do you think are the best? Lastly, indicate how many Petroleum Systems there are in the area.

**Question 2.** (20% of the marks, obligatory)

Complete the events chart Fig 6, for the Laojunmaio and Yaerxia fields, Fig 5a. Remember, the actual ages are not as important as the relative ages of the various rocks and structural events. (Advice: Do the geology before you start to analyse the origin of the petroleum accumulations).

Number the oil-bearing accumulations (T1-Tn) and faults (F1-Fn) and then:

1. Specify the nature of the various traps
2. Indicate how each was charged with oil and whether the trap is or is not filled
3. Indicate which faults act as migration paths and which are sealing (these can vary along the fault and through time!)

**Question 3.** (15% of the marks). Describe a known petroleum system of your choice, noting the area where it developed, the type of basin/cycle it occurs in and the main characteristics of the petroleum parameters. Indicate some of the traps and plays associated with it.

**Question 4.** (15% of the marks). Fig 7 A and B are summary sections of two sedimentary basins. Divide each up into basin cycles and stages (as appropriate) and number these from the bottom upwards (oldest 1, etc). Make a table and for each cycle or stage indicate (i) the age (ii) the lithology and formation names (if present) (iii) the structural features present. Suggest which depositional environments may characterize each cycle/stage.

**Question 5.** (15% of the marks). Provide a short resume of the main elements of the Northwest Europe Carboniferous/Permian petroleum system and its sedimentary basin area and contrast them with the main elements of the Jurassic North Sea petroleum system.

**Question 6.** (15% of the marks). Look at the geological cross-section, Fig 8. Do the following:

- (i) Construct a stratigraphic column for the area, dividing it into basin cycles and showing the tectonic events and when they occurred.
- (ii) How many petroleum systems are there? Number them and note the source rock on your stratigraphic column. Use arrows to show the direction of migration.
- (iii) On the cross-section note the location of three potential "plays". List them, indicating the petroleum system they belong to, the reservoir lithology and the type of structure

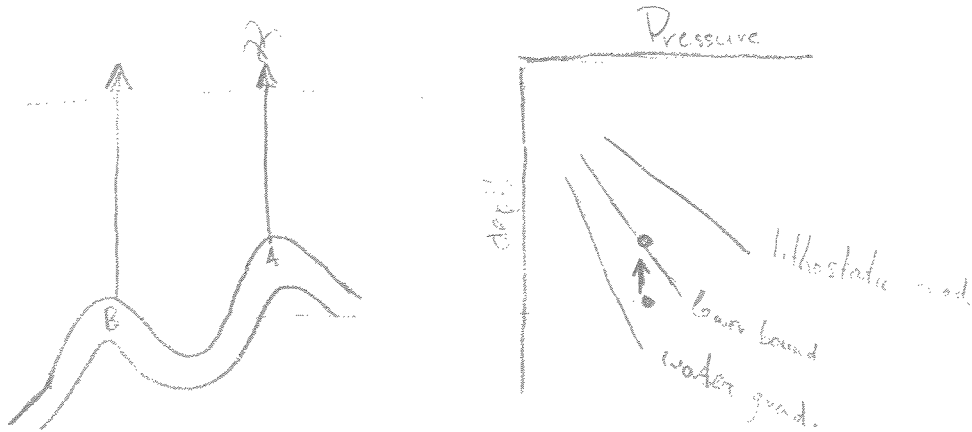
**Question 7.** (15% of the marks). Describe the main differences between conventional and unconventional gas accumulations. Name the three main types of unconventional gas accumulations and describe their characteristics.

- tight gas (shale gas)
- coal bed gas
- ??

**Question 8.** (15% of the marks). You have Gamma Ray, resistivity and FDC/CNL logs of wells A, B and C across a growth fault (fig 9). Number the horizontal lines in well B and correlate them with wells A and C. Draw in the growth fault and for each interval calculate the "growth index" (difference in thickness between foot and hanging walls). Mark this in the hanging wall section.

**Question 9.** (15% of the marks). A well has been drilled in the shallowest prospect in a pressure cell (A), see figure 10. The well found the reservoir overpressured and water-bearing, but with good oil shows. We strongly suspect that the seal was breached because of seal failure due to the overpressure.

- What can we say about the level of overpressures in the pressure cell (draw the overpressured water gradient on the pressure depth plot)?
- What can we say about the chances of finding oil in prospect B?
- Is there a risk that structure B is underfilled because of the overpressures? explain why or why not?



- Same hydrostatic pressure at varying depth.
- over pressure at A causing seal to break; seal at B remains intact due to higher surrounding P.