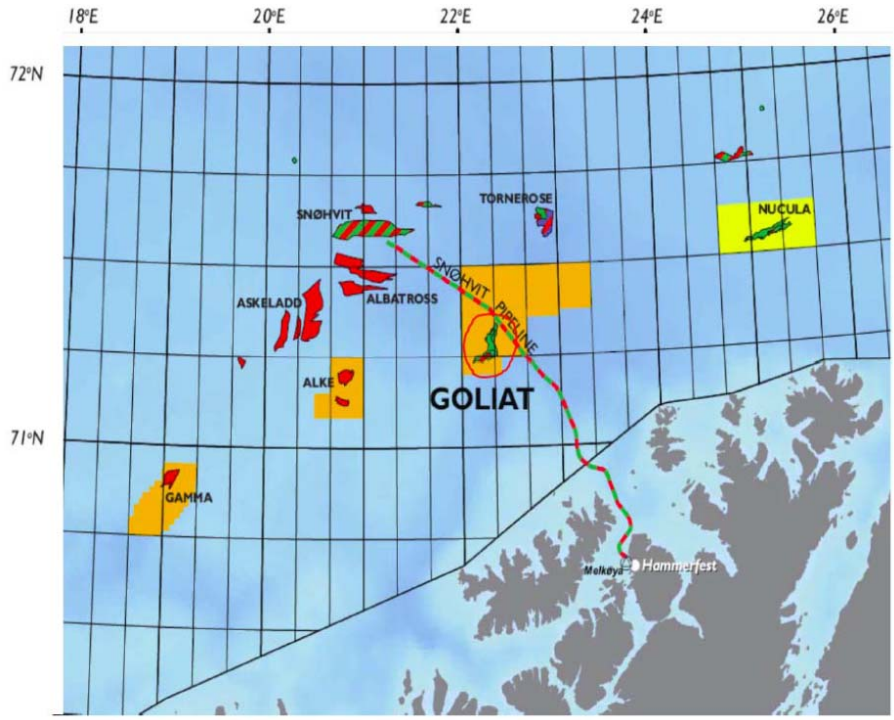
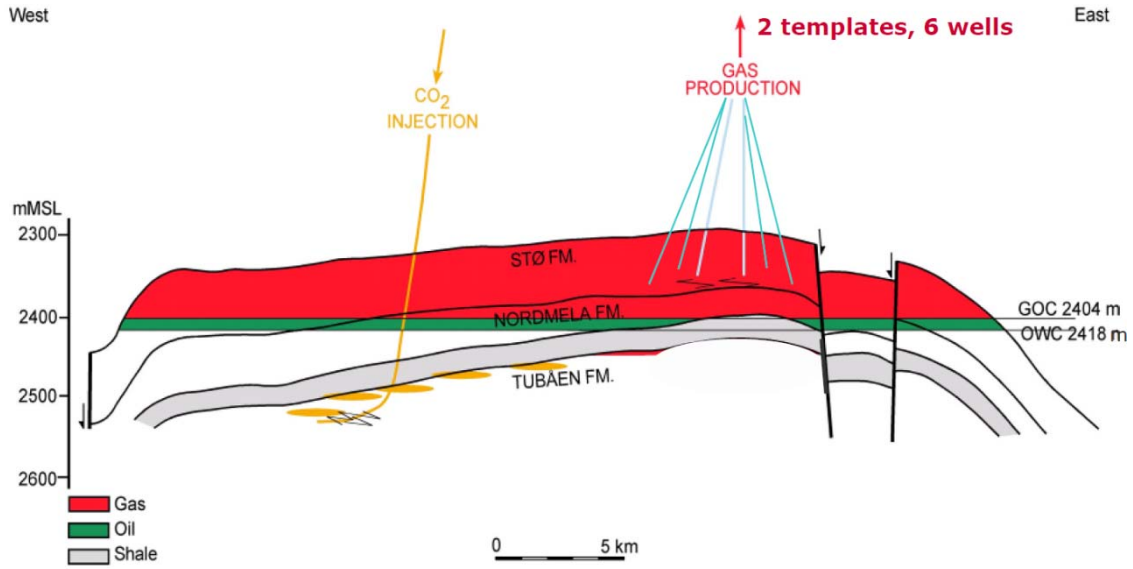
Exercise set 01 (Deadline: 27.01.2019)

Problem 1: Early production scheduling calculations for the Snowhite field.

Snohvit is an offshore gas field located 150 km from shore in the Northern part of Norway.



The field consists mainly of a single reservoir unit located in the Stø formation with a initial gas in place of 270 billion standard cubic meter, at an initial reservoir pressure of 276 bara and temperature of 92 ºC.



The development details are still very uncertain but the initial proposal is to develop the field using 6 subsea wells and a long pipeline to shore, to an LNG plant located on Melkøya. Due to the fact that it is a standalone development, and that the LNG plant is very costly, the

company has decided to produce the field in plateau mode and to establish long term gas delivery contracts with customers in Spain and Japan.
You are part of the team that is developing the field. You have been asked to generate production profiles using a simplified reservoir simulator.
Due to the fact that the reservoir is very homogeneous and has high permeability, a tank material balance is adequate to reproduce the decline of reservoir pressure with production and a IPR (inflow performance relationship) equation to estimate the productivity of a single well (from reservoir to bottom-hole). All wells can be assumed identical.
Because it is very early still, there are no details about the subsea system and the pipeline. A consultant from Schlumberger told you that the minimum pressure needed to be able to flow from the bottom of the well to shore should be around 120 bara.
The abandonment rate of the field is 5 E6 Sm^3/d (when operational expenditures are equal to the revenue).
Your tasks are as follow:

- Estimate the production profile until abandonment for the following plateau rates and the following number of wells:

$q_{\bar{g}\_field}$ [1E6 Sm^3/d]	N_{wells}
10	4
20	6
30	9
40	12

- For all cases, determine the plateau duration (exact value in fraction of a year), ultimate recovery factor, total producing time (exact value in fraction of a year), minimum well rate, net present value (considering revenue only).

Discuss the following questions:

- For a fixed number of wells, what is the relationship between plateau duration and plateau rate? (make a plot of plateau duration vs. plateau rate).
- For a fixed plateau rate, what is the relationship between plateau duration and number of wells? (make a plot).
- For a fixed number of wells, what is the relationship between plateau height and ultimate recovery factor?.
- For a fixed plateau height, what is the relationship between recovery factor and number of wells?
- For a fixed number of wells, what is the relationship between NPV and plateau height? (make a plot).
- For the post-plateau period, is it possible to represent the behavior with an exponential function? If yes, is the exponent different between all cases analyzed? What parameter affects it the most?
- Are the maximum well flow rates calculated realistic (feasible)? (when compared against typical production of subsea gas wells).
- Plot field potential versus cumulative production for all cases. Are there any differences?

- For a system of 6 wells, use the curve to estimate plateau duration when producing plateau rates of 10, 20, 30 and 40 Sm^3/d. How different are they from the value calculated using the reservoir simulator proxy?
- (**OPTIONAL**) Use the plot to estimate post plateau production when producing 20 E6 Sm^3/d and 4 wells. How different is the profile from the one calculated using the reservoir simulator proxy?
- (**OPTIONAL**) How different are your results if you use a more advanced integration method to estimate yearly gas production (e.g. the trapezoidal rule).

Based on the analysis performed above, what is the best number of wells and field plateau rate to produce the field?

Suggestions:
-The excel sheet provided has all information and equations needed.
-Perform your calculations in the excel sheet provided
-Perform your production scheduling calculations in a yearly or bi-yearly basis
-Estimate the yearly gas production using an explicit rectangular integration.
-Perform your NPV calculations using the discounted cash flow analysis on a yearly basis using the formula

$$DCF = \sum_{n=1}^{N} \frac{CF_n}{(1+i)^n}$$

Where:
-DCF is the discounted value of the revenue, in dollars of year "0"
-CF is the revenue in year "n", in USD.
-"i" is the discount rate, in fraction
-n is a year counter, measured from the start of the project.
-N is the total number of years.

Problem 2:

- Read (and understand) the power point presentation named "Field development process" available here . If one of the group members has a doubt about it, try to clarify it with your group mates or do a web search.
- Pick one of the other documents provided.
- Review the index, perform a quick scanning and skimming of the document (http://www.butte.edu/departments/cas/tipsheets/readingstrategies/skimming_scanning .ht ml) and pick a section, or a topic that you believe is relevant and interesting to learn more about. (It could be one over which you and your groupmates have some previous background on the matter). The topic should be related to some of the tasks that are typically performed in the life planning (and decommissioning) of an oil and gas field. It is possible to pick more than one topic (for example, if people in your team have different background)
- Read the section and prepare a power point presentation to present to your other classmates in class, take into account the following:
  - The presentation should last around 10 min.
  - One person or all in your team can contribute/present.

  - You are encouraged to find media, pictures, diagrams, example cases on the web to help you explain a topic. (remember to include the source on the slides)
  - If you explain a topic that requires very deep prior knowledge, it helps if you give a short introduction to the topic. Remember, quality is better than quantity!
  - Be prepared to answer questions from the audience about the topic you presented.

- Deliver your powerpoint presentation.
- You can deliver several powerpoint presentations if people performed this activity with other people outside the group (e.g. during the class session of 2019.01.18).