



ESTIMATION OF RESORUCES/RESERVES

MFFAT720014

Petroleum Geoengineering MSc,
2020/21 I. félév

COURSE COMMUNICATION FOLDER

University of Miskolc
Faculty of Earth Science and Engineering
Institute of Mineralogy and Geology

Course datasheet

Course Title: Estimation of resources/reserves	Credits: 2
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: lec. 1, sem. 1	
Neptun code: MFFAT720014	
Type of Assessment (exam. / pr. mark. / other): pr. mark	
Grading limits: >80%: excellent, 70-80%: good, 60-70%: medium, 50-60%: satisfactory, <50%: unsatisfactory	
Position in Curriculum (which semester): third	
Pre-requisites (<i>if any</i>):	
Course Description:	
Acquired store of learning: <u>Study goals:</u> The aim of the course is to provide comprehensive knowledge of resource and reserve estimation and categorization. <u>Course content:</u> Maturation classes of petroleum resources: prognostic, prospective, discovered (contingent), undeveloped and developed. The nature of uncertainties in resource estimations and the understanding of the associated geological risks. Parameters of volumetric calculations. The In-Place and the Recoverable (Technical) Resource volume categories. Summary of the probability theory: characteristics of probability variables, discrete and continuous variables, probability density and cumulative probability functions. Review of statistical methodologies: data categorizations, histograms, indices of averages and fluctuations. Introduction to the uncertainty-based pre- and post-discovery categorization of petroleum resources: probabilistic and deterministic approaches. Geostatistics based uncertainty evaluation of the volumetric calculation parameters (rock volumes, porosity, saturation, formation volume factors, recovery factor). The log-normal distribution of petroleum resources: characteristic values and the range of the uncertainty. Reserve estimations: definition of commerciality. Economic thresholds, marketability and legal criteria. Separation of reserves and contingent resources. Reserve reporting guidelines and reserve audits. <u>Education method:</u> Competencies to evolve: T1, T2, T7, T8, T10, T11, T12, K1, K3, K5, K6, K7, K8, K10, F5	
The 3-5 most important compulsory, or recommended literature (textbook, book) resources:	
<ul style="list-style-type: none">• Miller, B.M., 1986: Resource Appraisal Methods: Choice and Outcome. In Rice ed.: Oil and Gas Assessment – Method and Applications. In AAPG Studies in Geology, No. 21.• Quirk, D. G. Ruthrauff, R. G., 2008: Toward consistency in petroleum exploration: A systematic way of constraining uncertainty in prospect volumetric. AAPG Bulletin, V. 92, No. 10.• Rose, P.R., 2001: Risk Analyses and Management of Petroleum Exploration Ventures. In AAPG Methods in Exploration Series No. 12.• SPE/AAPG/WPC/SPEE, 2007: Petroleum Resources Management System.• Steiner, F., 1990: A geostatisztika alapjai. Tankönyvkiadó, Budapest.	
Responsible Instructor (<i>name, position, scientific degree</i>): Károly Kiss, lecturer, Msc. Geology, (Research fellow, Research Institute of Applied Earth Sciences)	

Other Faculty Member(s) Involved in Teaching, if any (name, position, scientific degree):

Syllabus of the semester

Monday, 13:00 – 15:00

2020.09.07.	Maturation classes of petroleum resources: prognostic, prospective, discovered (contingent), undeveloped and developed.
2020.09.14.	The nature of uncertainties in resource estimations and the understanding of the associated geological risks.
2020.09.21.	Parameters of volumetric calculations.
2020.09.28.	The In-Place and the Recoverable (Technical) Resource volume categories.
2020.10.05.	Summary of the probability theory: characteristics of probability variables, discrete and continuous variables, probability density and cumulative probability functions.
2020.10.12.	Review of statistical methodologies: data categorizations, histograms, indices of averages and fluctuations.
2020.10.19.	Introduction to the uncertainty-based pre- and post-discovery categorization of petroleum resources: probabilistic and deterministic approaches.
2020.10.26.	Geostatistics based uncertainty evaluation of the volumetric calculation parameters (rock volumes, porosity, saturation, formation volume factors, recovery factor).
2020.11.02.	The log-normal distribution of petroleum resources: characteristic values and the range of the uncertainty.
2020.11.09.	Reserve estimations: definition of commerciality.
2020.11.16.	Economic thresholds, marketability and legal criteria.
2020.11.23.	Separation of reserves and contingent resources.
2020.11.30.	Reserve reporting guidelines and reserve audits.
2020.12.07.	Final test

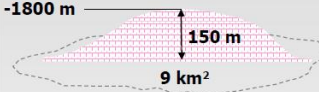
Practice work:

During the semester there are practice exercises

One in the meantime of the semester:

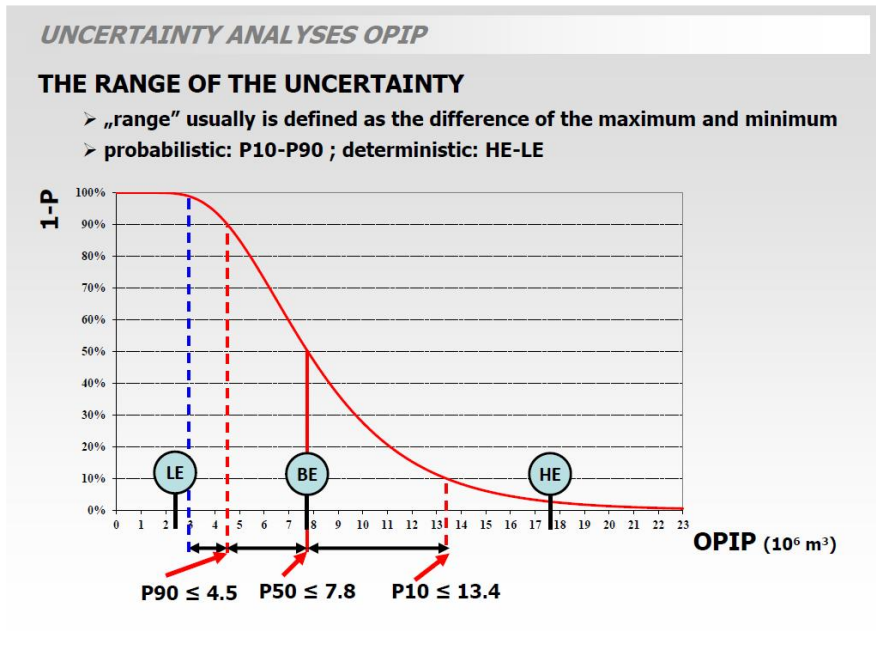
UNCERTAINTY ANALYSES OPIP

RESOURCE ASSESSMENT EXERCISE



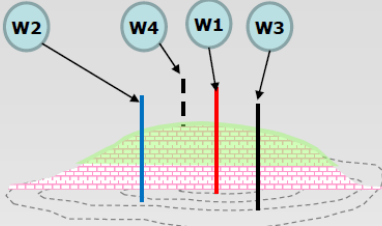
Prospect:

- Reservoir: shelf carbonate with fractured porosity
- Depth to top: - 1800 m a.s.l.
- Max. Closure: 150 m
- Geometry factor: 0.33
- Area (at spill-points): $9 \text{ km}^2 = 9 \times 10^6 \text{ m}^2$
- Minimum charge to recoverability: 10%
- Uncertainty of V_{trap} is ignored
- Only $BE=1.1$ for Bo (FVF)



The second exercise will be close to the end of the course:

RESERVES EVALUATION EXERCISE



Status at Year „0“:

- W1: Producing (for 1 years) Discovery Well
- W2: Completed non-producing Appraisal Well
- W3: Approved Development Well
- W4: Conceptual Development Well

Production Pasts & Forecasts (mmboe):

Wells	Years:	-1	0	1	2	3	4	5	6	7	8	9	10
W1	LE	0.2	0.2	0.2	0.2	0.2	0.2	0.1					
	BE	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1				
	HE	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1			
W2	LE			0.1	0.1	0.1	0.1	0.1					
	BE			0.2	0.2	0.2	0.2	0.2	0.1				
	HE			0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.1		
W3	LE			0.2	0.2	0.2	0.2	0.2	0.1				
	BE			0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.1		
	HE			0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.2	0.1	
W4	LE			0.1	0.1	0.1	0.1						
	BE			0.2	0.2	0.2	0.2	0.2	0.1				
	HE			0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.2	0.1

RESERVES EVALUATION EXERCISE

Task 3: Categorize Reserves (Developed 1P, 2P, 3P and Undeveloped 1P, 2P, 3P)

Developed Reserves

	PV (mn\$)	Production Forecast (mmboe) & Cash-Flow (mn\$)												
		Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7					
LE	35.9	0.2	0.2	0.2	0.2	0.2	0.1						1P	?
		8	8	8	8	8	2						1C	?
BE	40.6	0.2	0.2	0.2	0.2	0.2	0.2	0.1					2P	?
		8	8	8	8	8	8	1					2C	?
HE	44.9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1				3P	?
		8	8	8	8	8	8	7	1				3C	?

Undeveloped Reserves

	NPV (mn\$)	Production forecast (mmboe) & Cash-flow (mn\$)													
		Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9				
LE	20.0	0	0.3	0.3	0.3	0.3	0.3	0.1						1P	?
		-22	11	11	11	11	10	-2						1C	?
BE	80.5	0	0.5	0.5	0.5	0.5	0.5	0.4	0.2	0.1				2P	?
		-22	23	23	23	23	22	16	4	-2				2C	?
HE	155.7	0	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.3	0.1			3P	?
		-22.0	32.4	30.0	27.8	25.7	23.1	21.4	12.8	5.4	-1.0			3C	?

Assessment

There is assessment at the end of the course in written form. The test consists of two parts, definitions and essay questions.

Definition samples:

(Five shall be asked in the Test. One or two sentence short answer is expected for each.)

1. Original Petroleum In-Place (OPIP)
 2. Estimated Ultimate Recovery (EUR)
 3. Technically Recoverable Volume (TRV)
 4. P90 Estimate for OPIP
 5. P50 Estimate for OPIP
 6. P10 Estimate for OPIP
 7. Low Estimate for OPIP
 8. Best Estimate for OPIP
 9. High Estimate for OPIP
 10. Recovery Factor
- etc.

Essay samples:

(One shall be asked in the Test. As an answer one-page long discussion of the topic is expected)

1. Describe the volumetric calculation methodology of the Original Petroleum In-Place resources of hydrocarbon accumulations!
 2. Discuss the methodology of probabilistic estimation for the Original Petroleum In-Place volumes! Which are the probabilistic categories of the OPIP?
 3. Discuss the methodology of deterministic estimation for the Original Petroleum In-Place volumes! Which are the deterministic categories of the OPIP?
 4. Discuss the methodology for Recoverable Resource Classification at the different maturity statuses (Prospective, Discovered, Undeveloped, Developed) of the Original Petroleum In-Place Volumes!
 5. Describe the Uncertainty Analyses methodologies for the Prospective and the Contingent Recoverable Resources! Elaborate on the P90-P50-P10 and the Low-Best-High Estimate probability-based categories!
- etc.