

Short Course on
Petroleum Reserve Estimation, Production,
and Production Sharing Contract (PSC)

PMRE, BUET,
29-30 April, 2008

Resource and Reserve Classification System
Resource Assessment

Prospect Evaluation

- A prospect is identified and mapped on the basis of geophysical and geological data. Lead is an indication of presence of play.
- Quantitative data for the prospect is derived from the most likely geological model and is given with a range of uncertainty.
- Risk is assigned to the probability of discovery of a minimum volume derived from volumetric estimate, and is evaluated with respect to the geological risk.
- Reliability of of the prospect definition will depend on the adequacy of the database and on the choice of reliable models for the relevant geological factors.
- Risk assessment is an analysis of the reliability of occurrence of the geological models relevant to the prospect under evaluation.
- For each prospect a value of probability of discovery is estimated

Prospect Evaluation

- For resource estimation in any basin, petroleum system, prospects and leads are identified on the basis of geophysical and geological data.
- Estimation of hydrocarbon resources in any basin/petroleum system is made following volumetric method and using risk factor.

Prospect Evaluation

- Hydrocarbon is distributed in the earth's crust.
- Hydrocarbon deposits are concentrated in relatively few basins.
- Exploration is not an equal chance game.

Prospect Evaluation

- Four different concepts of exploration
 - Basin framework
 - Petroleum System
 - Play
 - Prospect

Prospect Evaluation

- **Basin Framework**
- Sedimentary basin containing source rock, reservoir, trap and migration in proper timing
- **Petroleum System Framework**
- Defined as a volume of sedimentary rock containing hydrocarbon and charged by source rock. In a defined system there will be single source rock.

Prospect Evaluation

- Play
- Play is the elemental part of a petroleum system, and recognized as having one or more hydrocarbon accumulations identified by common geological character of reservoir, trap, and seal; timing and migration; preservation.

Prospect Evaluation

- Prospect Definition
- Geological Model and risk assessment
- Reservoir
- Presence of Reservoir facies
- Effective pore volume
- Trap Mechanism
- Presence of mapped structure
- Effective seal mechanism
- Petroleum charge
- Presence of mature source rock (sufficient)
- Effective migration
- Retention after accumulation

Prospect definition

		GEOLOGICAL FEATURES						
VOLUMETRIC ESTIMATION	Probability factors	Reservoir		trap		Charge		Retention
	Volumetric factors	Facies	Porosity	Mapping	Seal	Source	Migration	Retention
	Structural shape, Volume							
	Hydrocarbon Column							
	Reservoir Thickness							
	Porosity							
	Net/Gross ratio							
	Saturation							
	Proportion of oil & gas							
	Recovery factor							
	Formation Volume factor							
Relation between geological models and input parameters for volumetric estimation								
Source: CCOP Guidelines for risk assessment of petroleum prospects, 2000. www.ccop.or.th								

Prospect Evaluation

- Geological risk assessment requires evaluation of geological factors that are critical to the discovery of hydrocarbons in a mapped prospect.
- The probability of discovery is defined as the product of the following major probability factors, each of which must be evaluated with respect to presence and effectiveness.
- Reservoir, Trap, Charging, Retention and Accumulation

Presence of Reservoir Facies

Data Reliability		Direc data, Proximal deposit	Direc data, more distal deposit	Limited data, discontinous deposit	Indirect data, Seismic sequence analysis
■	Shallow marine	0.9 - 1.0	0.7 - 0.8	0.6 - 0.7	0.4 - 0.6
	Coastal, deltaic tidal	0.8 - 1.0	0.7 - 0.8	0.6 - 0.7	0.4 - 0.6
	Submarine fan	0.7 - 0.8	0.5 - 0.6	0.3 - 0.5	0.1 - 0.3
	Carbonates	0.8 - 1.0	0.6 - 0.8	0.5 - 0.7	0.3 - 0.5
■	Lacustrine deltaic	0.7 - 0.9	0.5 - 0.7	0.4 - 0.6	0.3 - 0.5
	Alluvial fan, Braided stream, Meandering channel	0.7 - 0.9	0.5 - 0.7	0.4 - 0.6	0.3 - 0.5
	Eolian	0.8 - 1.0	0.6 - 0.8	0.4 - 0.6	0.4 - 0.6
■	Fractures basement	0.4 - 0.6	0.3 - 0.5	0.2 - 0.4	0.1 - 0.3
	Fractured porous lava	0.4 - 0.6	0.3 - 0.5	0.2 - 0.4	0.1 - 0.3
Probability Scheme. Presence of effective reservoir					

Reservoir Depth Vs. Data

		Data Reliability	Direct data, Proximal deposit	Direct but less data, more distal deposit	Limited data, uncertain conditions	Indirect data
		Reservoir depth				
I	Homogeneous, clean reservoir		0.9-1.0	0.8 - 0.9	0.7 - 0.8	0.6 - 0.7
	Mixed unclean reservoir		0.8-1.0	0.7 - 0.8	0.6 - 0.7	0.4 - 0.6
II	Homogeneous, clean reservoir		0.8 - 0.9	0.7 - 0.8	0.5 - 0.7	0.4 - 0.5
	Mixed unclean reservoir		0.7 - 0.9	0.6 - 0.7	0.5 - 0.6	0.3 - 0.5
III	Homogeneous, clean reservoir		0.7 - 0.9	0.5 - 0.7	0.4 - 0.6	0.3 - 0.5
	Mixed unclean reservoir		0.6 - 0.9	0.3 - 0.5	0.2 - 0.4	0.1-0.3

Reservoir depth vs. data

Late uplift	Take maximum burial into consideration
Calcite cementation	Consider regional studies
Illitisation	Regional studies, clay content
Dolomitisation	Consider regional studies
Early migration	May preserve reservoir porosity
Secondary porosity	Pressure/solution studies etc.

Presence of effective structural closure

Data Reliability		3D seismic	2D seismic		
			Dense grid	Open grid	Very open grid
Good Corr. near by wells	Low structural complex	0.9 - 1.0	0.9 - 1.0	0.8 - 1.0	0.7 - 0.9
	High structural complex	0.7 - 1.0	0.6 - 0.9	0.5 - 0.8	0.4 - 0.7
	Low relief, uncertain depth conversion	0.6 - 0.9	0.5 - 0.8	0.4 - 0.7	0.3 - 0.6
Uncertain Correlation, distant wells	Low structural complex	0.9 - 1.0	0.8 - 1.0	0.7 - 0.9	0.5 - 0.8
	High structural complex	0.7 - 0.9	0.6 - 0.9	0.4 - 0.8	0.3 - 0.7
	Low relief, uncertain depth conversion	0.5 - 0.8	0.4 - 0.7	0.3 - 0.6	0.2 - 0.5
Unreliable Correlation, analogue model	Low structural complex	0.9 - 1.0	0.7 - 1.0	0.6 - 0.8	0.4 - 0.7
	High structural complex	0.4 - 0.7	0.3 - 0.6	0.2 - 0.5	0.1 - 0.4
	Low relief, uncertain depth conversion	0.3 - 0.7	0.2 - 0.6	0.1 - 0.5	0.1 - 0.4

Probability of an effective sealing mechanism

Seal Mechanism				Seal Quality			
				Very Good	Good	Acceptable	Poor
	Top Surface	Bottom Side	Structural Style				
■	Conform	N/A	Anticlines, Burried Highs, Build ups, Faulted Structures	0.9 -10	0.8 - 10	0.6 - 0.8	0.4 - 0.6
	Unconform	N/A	Faulted Structures	0.8 - 0.9	0.7 - 0.8	0.5 - 0.7	0.3 - 0.5
■	Conform	Unconformity	Onlap, Low stand wedge	0.5 - 0.7	0.4 - 0.5	0.3 - 0.4	0.1- 0.3
	Conform	Faults	Down faulted Structures	0.6 - 0.8	0.5 - .06	0.3 - 0.5	0.1- 0.3
	Conform	Facies Change	Shale out	0.6 - 0.8	0.5 - 0.7	0.4 - 0.6	0.1- 0.3
	Unconform	Conform	Subcrop Structures	0.4 - 0.5	0.3 - .07	0.2 - 0.4	0.1- 0.3

Probability of Effective Seal Mechanism

	Salt, Anhydrite, carbonates	Very good sealing properties
	Thick shales	Good sealing properties
	Thin Shales	Acceptable to good ealing P roperties
	Basalt	Acctable to good sealing properties
	Faults cutting top surface	Poor to acceptable sealing properties
	Faults Planes	Depend on sand/shale or shale /sand

Probability of effective source rock with respect to quantity and maturity

		Depositional Environment	Restricted marine or Lacustrine environment with concentrated sapropelic organic matter	Mixed marine or Lacustrine environment with dispersed sapropelic organic matter	Deltaic environment with mostly humic organic matter (terrestrial: mostly gas)
		Data Reliability			
Proven Source Rock	Sufficient Volume	0.9 - 1.0	0.8 - 1.0	0.8 - 1.0	
	Marginal Volume	0.5 - 0.8	0.4 - 0.7	0.4 - 0.7	
	Marginal Mature	0.3 - 0.6	0.2 - 0.5	0.2 - 0.5	
Quality Reduced Source Rock	Sufficient Volume	0.7 - 0.9	0.6 - 0.8	0.6 - 0.8	
	Marginal Volume	0.4 - 0.6	0.3 - 0.6	0.3 - 0.6	
	Marginal Mature	0.2 - 0.5	0.1 - 0.4	0.1 - 0.4	
Hypothetical Source Rock	Sufficient Volume	0.5 - 0.8	0.4 - 0.7	0.4 - 0.7	
	Marginal Volume	0.3 - 0.7	0.3 - 0.6	0.3 - 0.6	
	Marginal Mature	0.1 - 0.4	0.1 - 0.4	0.1 - 0.4	
Speculative Source Rock	Sufficient Volume	0.4 - 0.7	0.3 - 0.7	0.3 - 0.7	
	Marginal Volume	0.2 - 0.6	0.2 - 0.5	0.2 - 0.5	
	Marginal Mature	0.1 - 0.4	0.1 - 0.3	0.1 - 0.3	

Probability of effective migration and timing

Timing \ Migration	Trap formed before onset of migration	Trap formation and timing of migration overlapping	Trap formed when source rock overcooked
Local Migration	0.9 - 1.0	0.4 - 0.8	0.1 - 0.4
Lateral Migration without barriers	0.8 - 0.9	0.4 - 0.7	0.1 - 0.3
Lateral Migration with barriers	0.5 - 0.8	0.2 - 0.5	0.1 - 0.3
Vertical Migration without barriers	0.7 - 0.9	0.3 - 0.6	0.1 - 0.3
Vertical Migration with barriers	0.4 - 0.6	0.2 - 0.4	0.1 - 0.2
Long Distance "fill-spill"	0.4 - 0.6	0.2 - 0.4	0.1 - 0.2
Trap in the shadow of migration	0.2 - 0.4	0.1 - 0.3	0.1

Probability of Effective Migration and Timing