NORWEGIAN PETROLEUM DIRECTORATE

Petroleum Resource Assessment and Risking

Knut Henrik Jakobsson

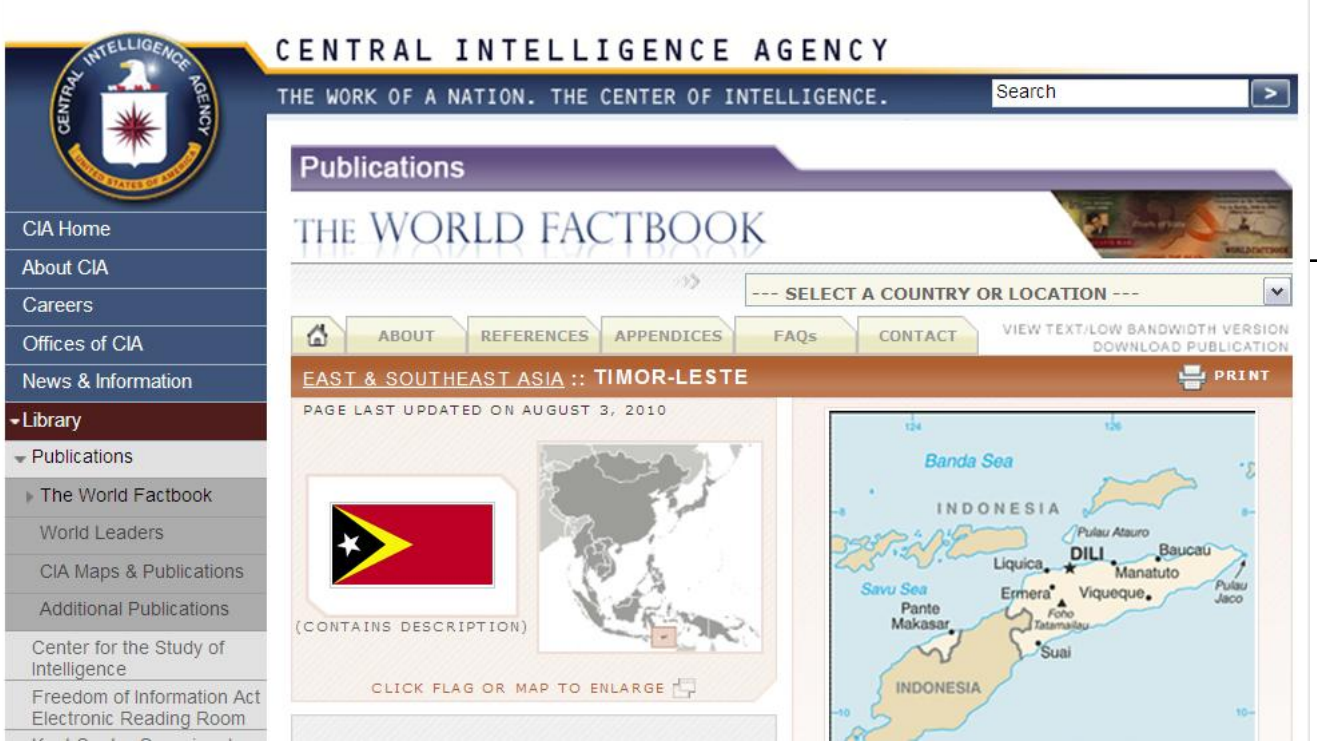
CCOP Chiang Mai February 2011

Gunnar V. Søiland

Norwegian Petroleum Directorate

Key questions:

- How much oil and gas ?
- Where are the resources ?
- When will they be found ?
- When can they be produced?



Oil - proved reserves:

553.8 million bbl (1 January 2008)

Oil - proved reserves This entry is the stock of proved reserves of crude oil in barrels (bbl). Proved reserves are those quantities of petroleum which, by analysis of geological and engineering data, can be estimated with a high degree of confidence to be commercially recoverable from a given date forward, from known reservoirs and under current economic conditions.

Offshore oil and gas fields closer to Timor-Leste than to any other country

Name of field Operator[+]	Location	%TL under treaties	Status	Total oil reserve million barrels	Total gas reserve trillion cubic feet	Oil already produced million barrels	Gas already produced trillion cubic feet	Total carbon in reserve[12] million metric tons C	Carbon already released million metric tons C
Greater Sunrise **Woodside**	20% in JPDA[13], rest claimed by both countries.	50%[14]	On hold until boundary or other agreement is finalized.	290	7.7	0	0	233	0
Bayu-Undan **Conoco-Phillips**	JPDA	90%	Began production in 2004; TL's principal income.	400	3.4	20	0	135	2
Buffalo **Nexen (was BHP)**	JPDA	90%*	In production 1999-2004, now being decommissioned.	31	0	31	0	4	4
Elang-Kakatua **Conoco-Phillips**	JPDA	90%*	Began production in 1998; nearly exhausted.	56	0	50	0	7	6
Laminaria-Corallina **Woodside**	Just outside JPDA; claimed by TL & Australia. Occupied by Australia	0%	Began production in 1999; mostly depleted. Australia has taken $1.2 billion in revenues.	210	0	167	0	25	20
TOTAL		**61%**		**987**	**11.1**	**268**	**0**	**403**	**31**

+ In addition to companies which operate projects, joint venture partners in these fields include Royal Dutch Shell, Santos, Inpex, Osaka Gas, Tokyo Electric, Paladin and Agip.
* These fields started production under the illegal Timor Gap Treaty. The revenue split and ownership has changed twice since 1999.

NPD

OILWATCH

Oil in Timor-Leste

By Guteriano Nicolau and Charles Scheiner, La'o Hamutuk

September, 2005

TL reserves:

(987-268)*61%=

438 mmbbl (??)

Timor-Leste (East Timor) Energy Profile

Select a Country Go

Last Update: June 30, 2010 (All Fuels) | July 14, 2010 (Petroleum)
Next Update: August 1, 2010 (All Fuels)
For the most recent data, please visit **International Energy Statistics**

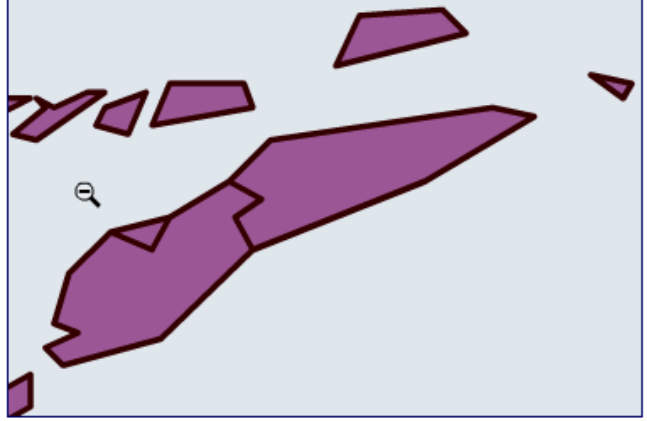
Print this page

Data

	30 Year History	2008 Timor-Leste (East Timor)	2008 Asia & Oceania	2008 World	2008 Rank	2009 Timor-Leste (East Timor)
Petroleum (Thousand Barrels per Day)						
Total Oil Production		100.01	8,554	85,454	51	96.27
Crude Oil Production		100.01	7,499	73,652	44	96.27
Consumption		2.30	25,198	85,758	168	2.50
Net Export/Imports(-)		97.71	-16,644	--	169	93.77
Total Oil Exports to U.S.		NA	203	12,915	NA	NA
Refinery Capacity		0	22,214	85,460	111	0
Proved Reserves (Billion Barrels)		0.00	34	1,332	84	0.00

	29 Year History	2008 Timor-Leste (East Timor)	2008 Asia & Oceania	2008 World	2008 Rank	2009 Timor-Leste (East Timor)

Map of Timor-Leste (East Timor)



Country Analysis Brief

No report available at this time.

View list of countries with a Country Analysis Brief >>

LAFAEK

http://www.anp-tl.org/webs/anptlweb.nsf/pgMaps

- Bayu Undan 4Tcf – 550 MMbbls
- Chuditch 0.7 TCF
- Elang Kakatua-Kakatua North 33 MMbbls
- Greater Sunrise 7.7 Tcf – 300 MMbbls
- Jahal gas
- Kelp Deep 8.4 – 13.6 Tcf
- Kitan 40 MMbbls
- Kuda Tasi 20 MMbbls
- Troubadour gas

TOTAL: 23.4 Tcf 943 MMbbls

National resource management - includes many aspects, but:

- For the macro economic planning governments need to know
  - Future production, investments and costs
  - The full resource base – discovered and undiscovered resources
  - Environmental aspects of the petroleum activity
- Companies report data to NPD annually as part of the National Budget process
- Classification of the petroleum quantities is vital for the reporting process and for the subsequent analysis of the data

Petroleum resource classification; a tool to serve -

- Needs in International Energy Studies – *international policy formulation*
- Needs in Resource management at National level – *optimizing values*
- Needs in Business Process Management – *exploration and production*
- Needs in Financial Reporting – *capital cost*

- Many different classification systems
- No single global system - yet

NPD's petroleum resource classification

- NPD has used **project based** classification since 1992
- Only **recoverable** quantities are classified
- Basis on **Maturity of projects** to produce petroleum

  prospect → discovery → field → produced volumes

- One field can have several production projects of different maturity, i.e. petroleum quantities relating to the different projects will be classified in different categories.

NPD's classification

	Class	Project category	
Discovered	Historic prod.	0	Sold and delivered
	Reserves	1 2 F/A 3 F/A	In production Approved PDO Decided for development
	Contingent resources	4 F/A 5 F/A 6 7 F/A	In the planning phase Recovery likely, but undecided Recovery not very likely Not evaluated
Un-discovered	Undiscovered resources	8 9	Prospects Plays

F = First, A = Additional

NPD, SPE PRMS and UNFC

SPE PRMS 2007	
Production	**Project Maturity sub-classes**
RESERVES	**On Production**
	Approved for Development
	Justified for Development
CONTINGENT RESOURCES	**Development Pending**
	Development unclarified or on Hold
	Development not Viable
Unrecoverable	
PROSPECTIVE RESOURCES	**Prospect**
	Lead
	Play

NPD 2001	
Project status category	
S	Sold and delivered
1	**In production**
2 F/A	**Approved PDO**
3 F/A	**Licencees have decided to recover**
4 F/A	**In the planning phase**
5 F/A	**Recovery likely but undecided**
7 F/A	**Not yet evaluated**
6	**Recovery not very likely**
8	**Prospect**
9	**Lead and Play**

Reserves are like fish *(H.E. Te Duong Tara, Cambodia)*

- Developed
  - The fish is in your boat.
  - You have weighed it, you can smell it and you will eat it.

- Discovered – but not yet developed
  - The fish is on your hook in the water by your boat and you are ready to net it.
  - You can tell how big it looks (they always look bigger in the water).

Reserves are like fish

Prospective

- There are fish in the lake and you may have caught some yesterday.
- You may even be able to see them, but you have not caught any today (yet).

Speculative

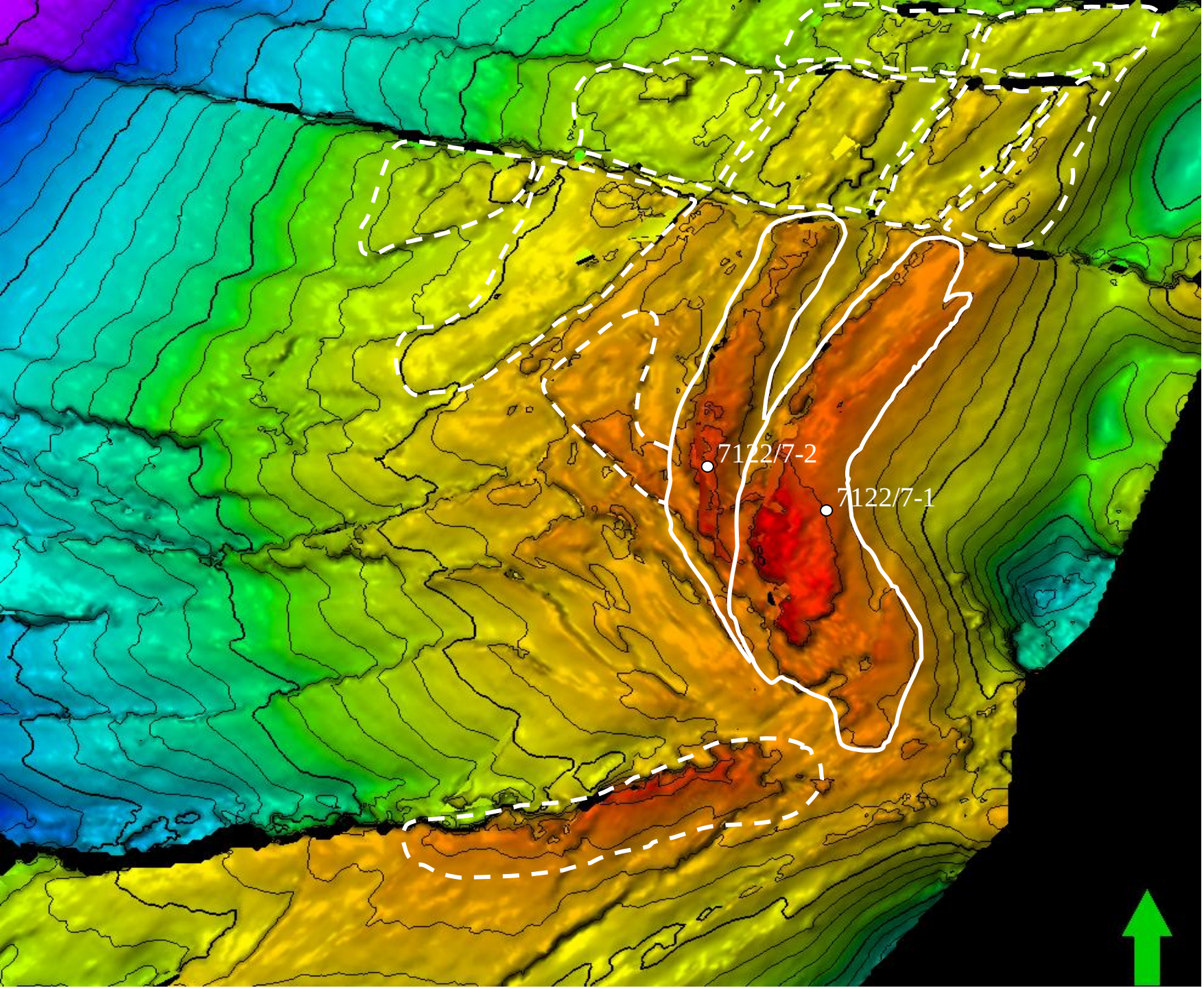
- There is water in the lake and someone may have told you that there are fish in the lake.
- You have your boat on the trailer but you may go golfing instead.

Contingent resources are also like fish

Has all the same physical certainty categories, but you can't catch, sell, or eat the fish because:

- Market/ Infrastructure
  - The whole country is totally vegetarian.
  - There are no refrigerated trucks to get the fish to market.

- Political
  - You don't have a fishing license.


7122/7-2
7122/7-1

Reliably assessing the resource base must be the basis for:

- National financial strategies and budgeting
- Legislation and tax regulations
- Promotion, licensing and contracts
- Investment strategies

Resource Management in Norway

Resource management of petroleum resources shall be carried out in a long-term perspective **for the benefit of the Norwegian society as a whole**.

In this regard the resource management shall **provide revenues to the country and shall contribute to ensuring welfare, employment**

……

(The Petroleum Act - Section 1-2)

Timor Leste LAW No. 13 /2005 ON PETROLEUM ACTIVITIES

Article 6

Exercise by the Ministry of its competencies and functions

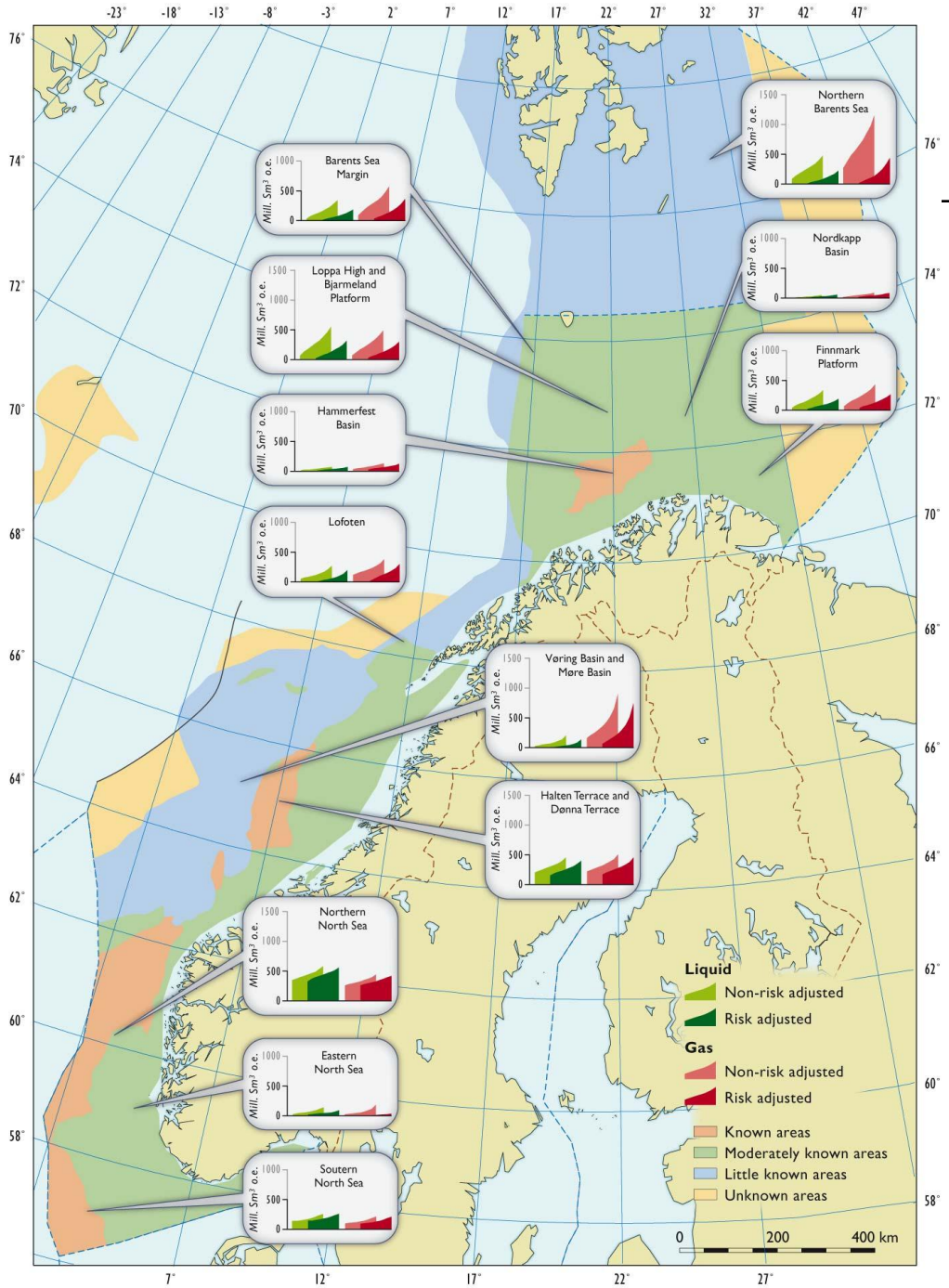
1. The Ministry shall exercise its competencies and functions under the present Law, including under Authorisations granted hereunder, in such a manner as:

(a) to ensure a balanced and **sound resource management**;

(b) to ensure that Petroleum is exploited and developed in a way that minimises damage to the environment, is **economically sustainable, promote further investment and contributes to the long-term development of Timor-Leste**;

Industry and Society – Different objectives!

Industry focus		*Society - focus*
Short-term profits	⟷	Long-term resource management
Business Unit / company / licence Internal effects	⟷	Focus across licences External effects
High NPV-requirements (materiality / limited capacity)	⟷	Positive NPV / marginal projects
Private information	⟷	Sharing information
Post-tax	⟷	Pre-tax



NPD

Resource account for Norwegian shelf

Systematic analysis based on all data acquired

Published on paper and internet

Resource overview as of 31 December 2009

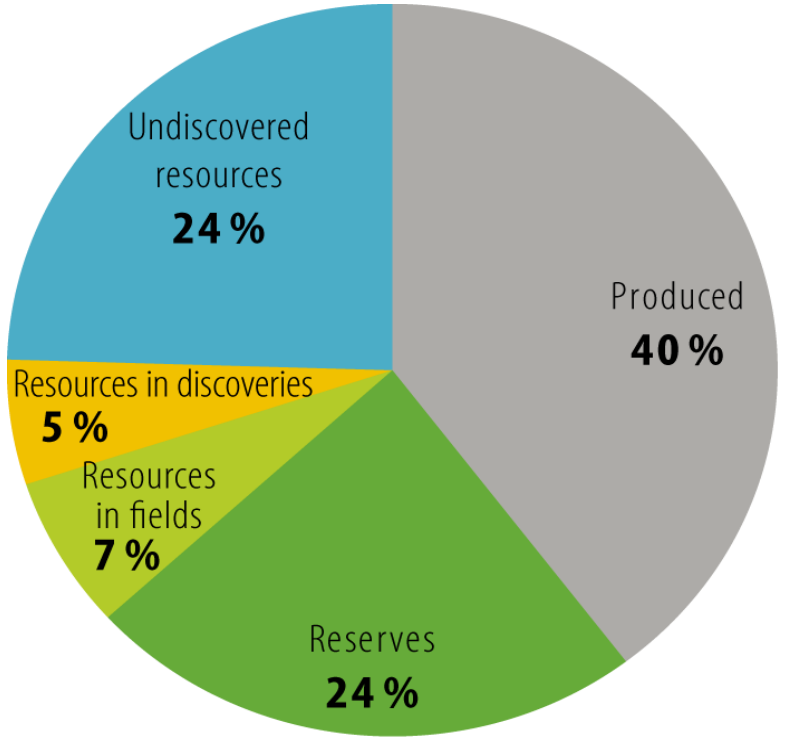
Expected recoverable

- Produced: 5.3 bill Sm^3 o.e
- Remaining proven: 4,8 bill Sm^3 o.e.
- Undiscovered: 3.3 bill Sm^3 o.e.

  (1.6 - 5.8 bill Sm^3 o.e)

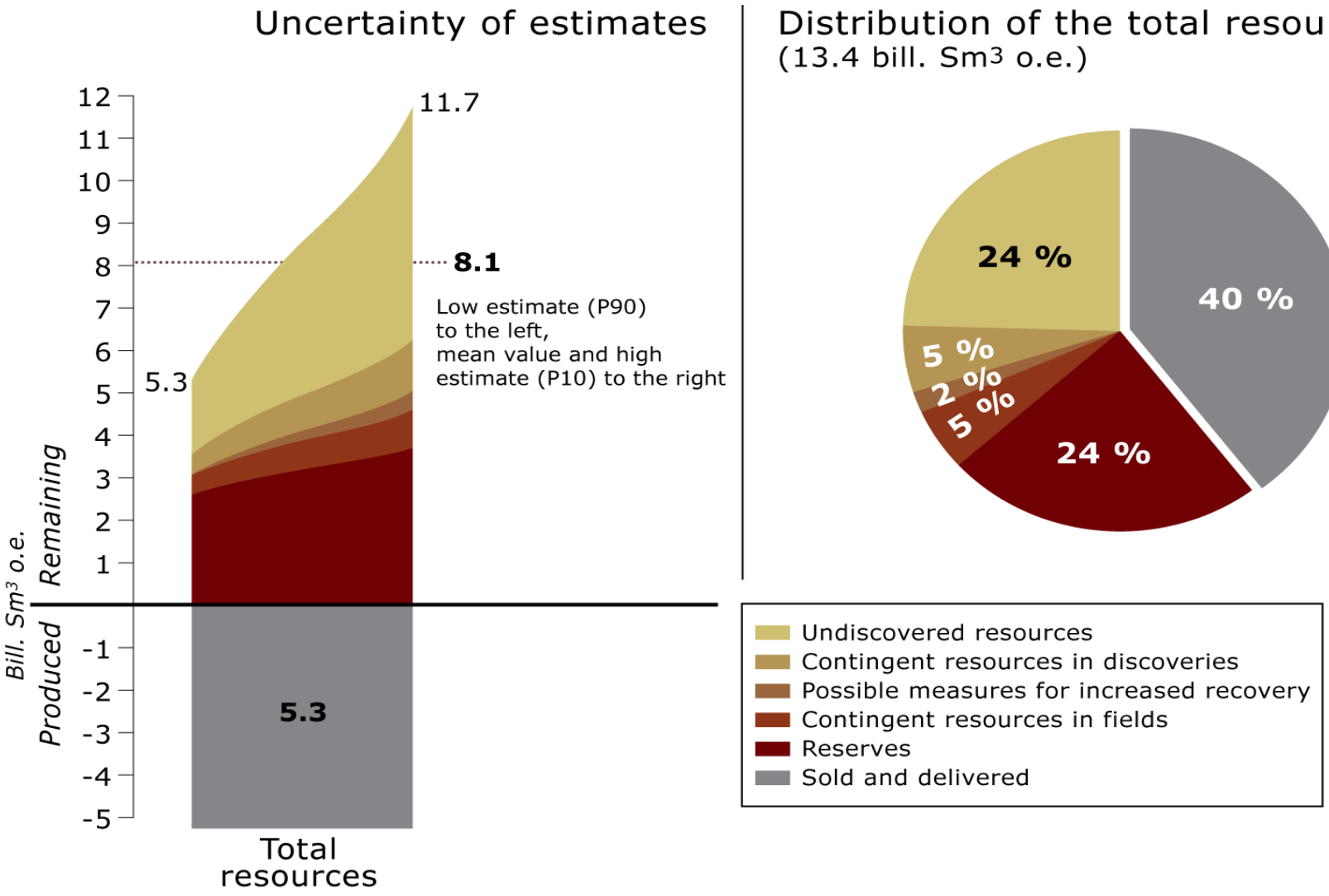
- 65 fields in production
- 8 fields being developed
- 82 discoveries under evaluation
- ~ 290 projects for improved recovery in existing fields

Expected recoverable = ~13 bill Sm^3 o.e.



Uncertainty range: 10-16 bill Sm^3 o.e.

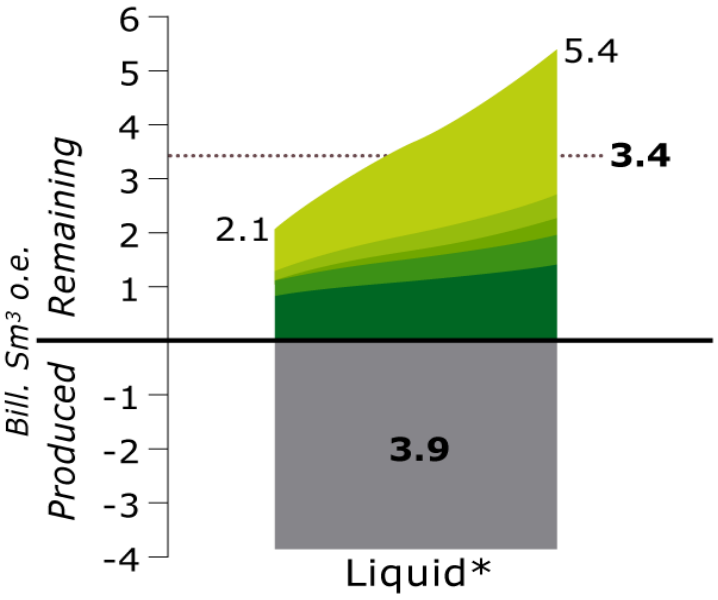
Recoverable petroleum resources – RNB2010



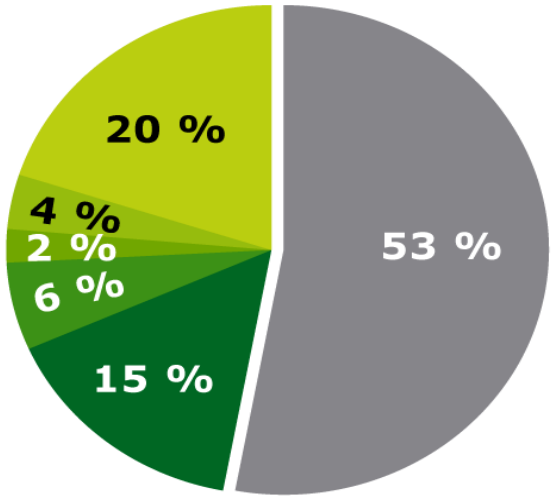
Recoverable liquid resources – RNB 2010

Uncertainty of estimates

Low estimate (P90) to the left, mean value and high estimate (P10) to the right



Distribution of liquid resources*
(7.3 bill. Sm³ o.e.)

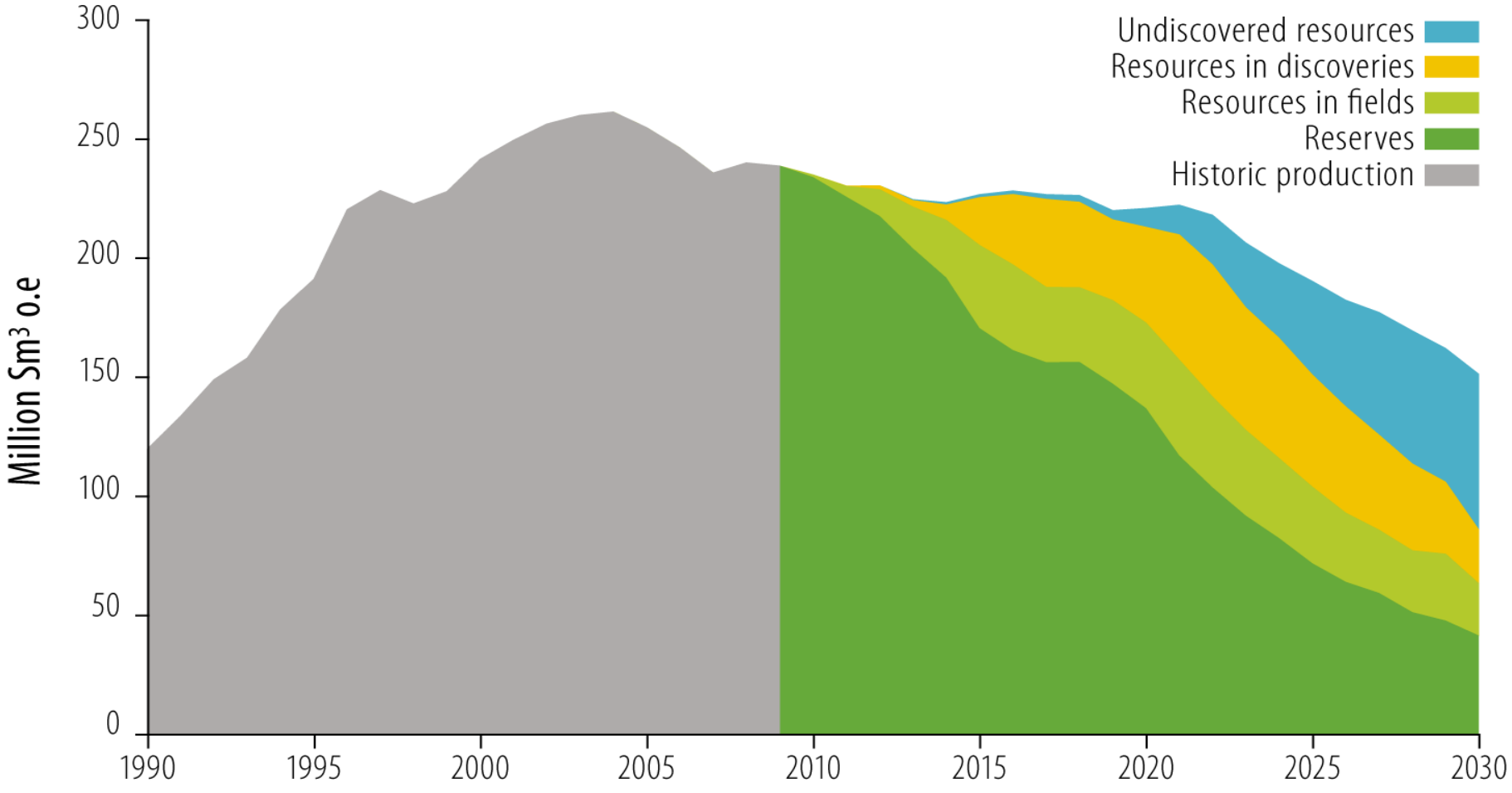


- Undiscovered resources
- Contingent resources in discoveries
- Possible measures for increased recovery
- Contingent resources in fields
- Reserves
- Sold and delivered

* Liquid includes oil, NGL and condensate

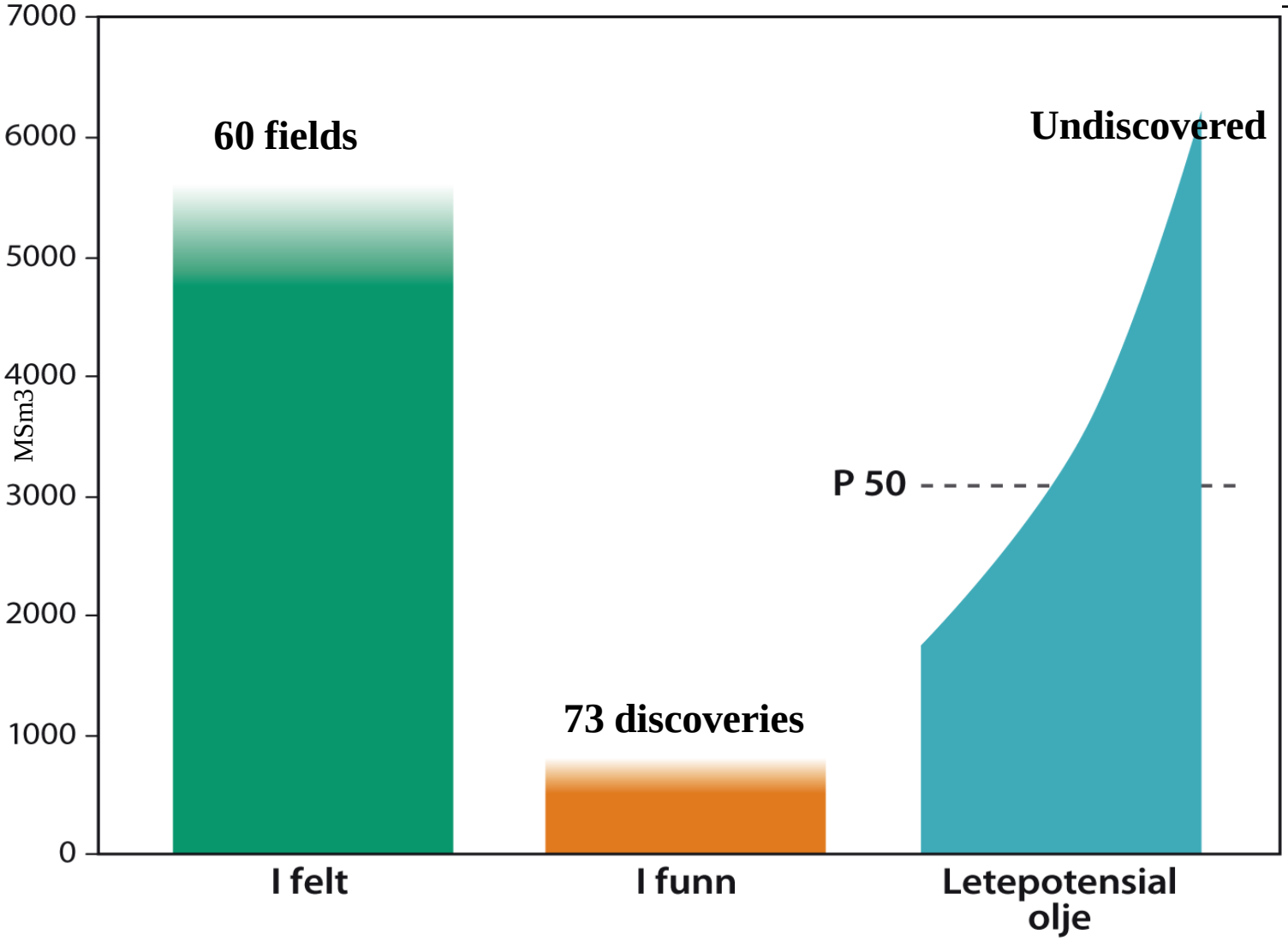
OD 1002014

Production Historic and Prognosis to 2030



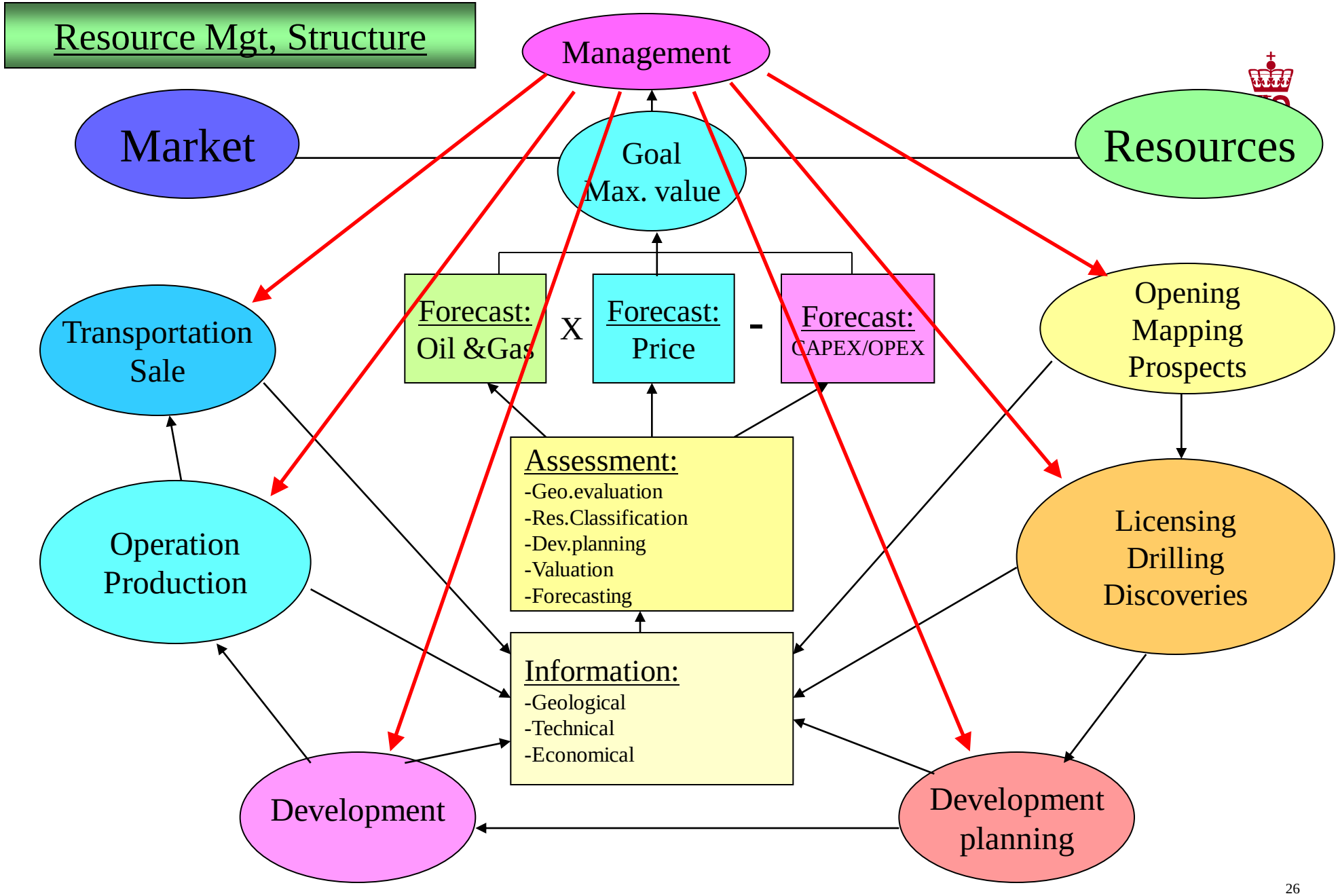
OD 1001034

Remaining oil in place

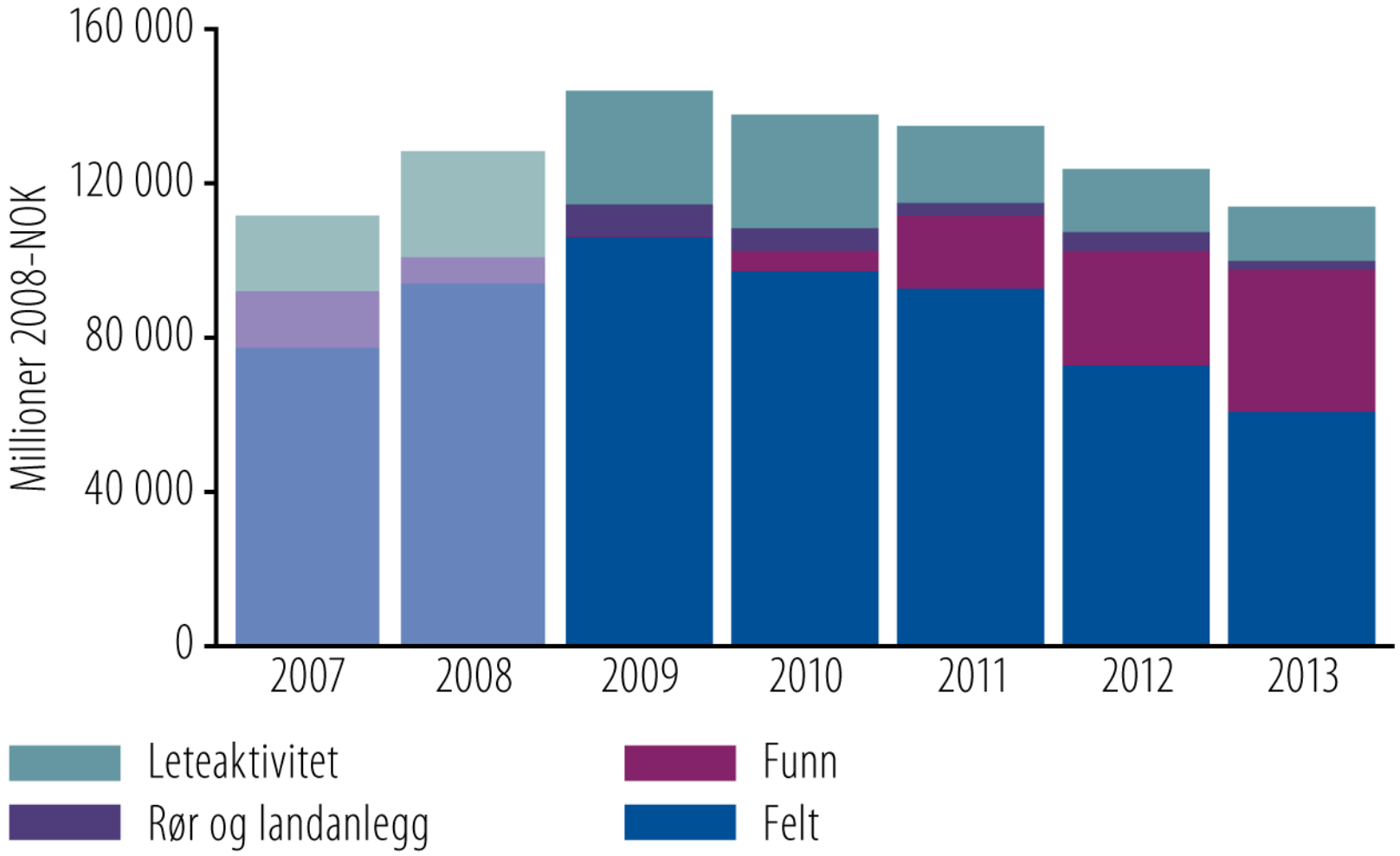


OD 0811004

Resource Mgt, Structure



Investments in the Petroleum sector historic and forecast



Promotion

OLJEDIREKTORATET
NORWEGIAN PETROLEUM DIRECTORATE

Rules and regulation

Topical | Subjects | Products and services | About the NPD

WHY NORWAY?

Oil & Gas in Norway

CONTENTS

Offshore Norway; an area with large remaining petroleum resources

Norway ranks as the world's third largest exporter of oil and gas. Oil production (including NGL and condensate) stands at about 2,8 million barrels per day and net gas production exceeds 3 tcf a year. The first exploration well was drilled in 1966 and since then 1100 exploration wells have been drilled, proving 60 billion barrels o.e. of recoverable resources. The average technical discovery rate is about 40 %. The mean estimate for the undiscovered resources is 21 billion barrels o.e. of recoverable resources, equivalent to the quantity that has been produced to date.

The Norwegian exploration policy has favoured a sequential opening of exploration areas through licensing rounds. As a result, the Norwegian continental shelf can offer opportunities for different categories of companies, and companies may establish a balanced portfolio of acreage in mature areas, frontier areas and virgin areas. The last two categories still have potential for making huge discoveries.

The Norwegian continental shelf may be divided into three main petroleum provinces; the North Sea, the Norwegian Sea and the Barents Sea. These areas differ in geology and exploration maturity. The North Sea is the most mature, having a well-developed infrastructure for production and transportation. The eastern part of the Norwegian Sea is relatively well known as several fields are in production, whereas the deep-water areas are less explored, thus representing frontier exploration areas. The Barents Sea has been successfully explored in the south, but there are vast virgin areas in the eastern and northern parts, where geological data indicate large structures with petroleum potential.

A difficult task…

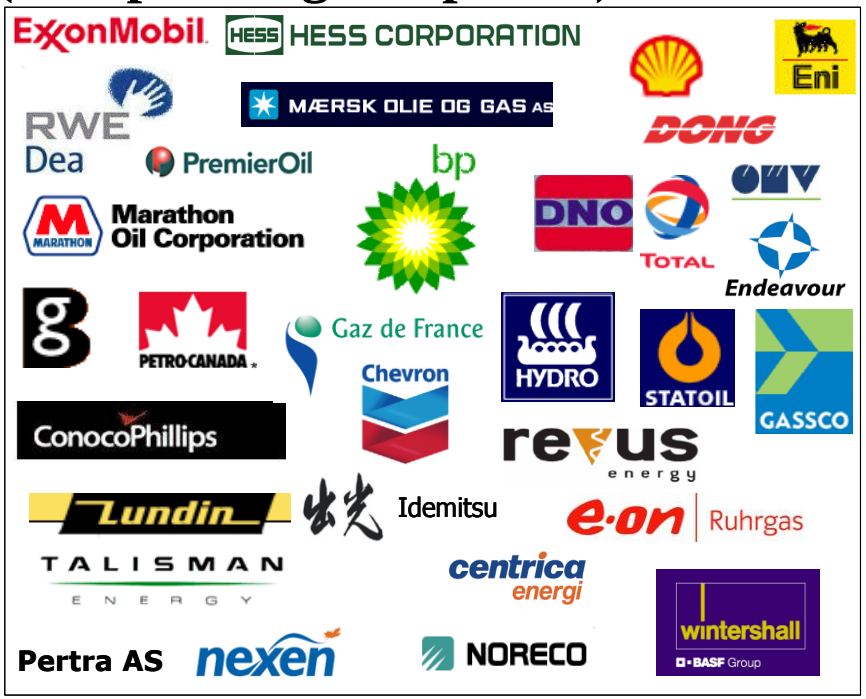
Assessment of undiscovered oil and gas resources is a difficult task.

Satisfactory results can only be obtained on the basis of all our knowledge and by using all data and suitable statistical methods.

Reporting of data in Norway

NORWEGIAN PETROLEUM DIRECTORATE

(31 Operating companies)

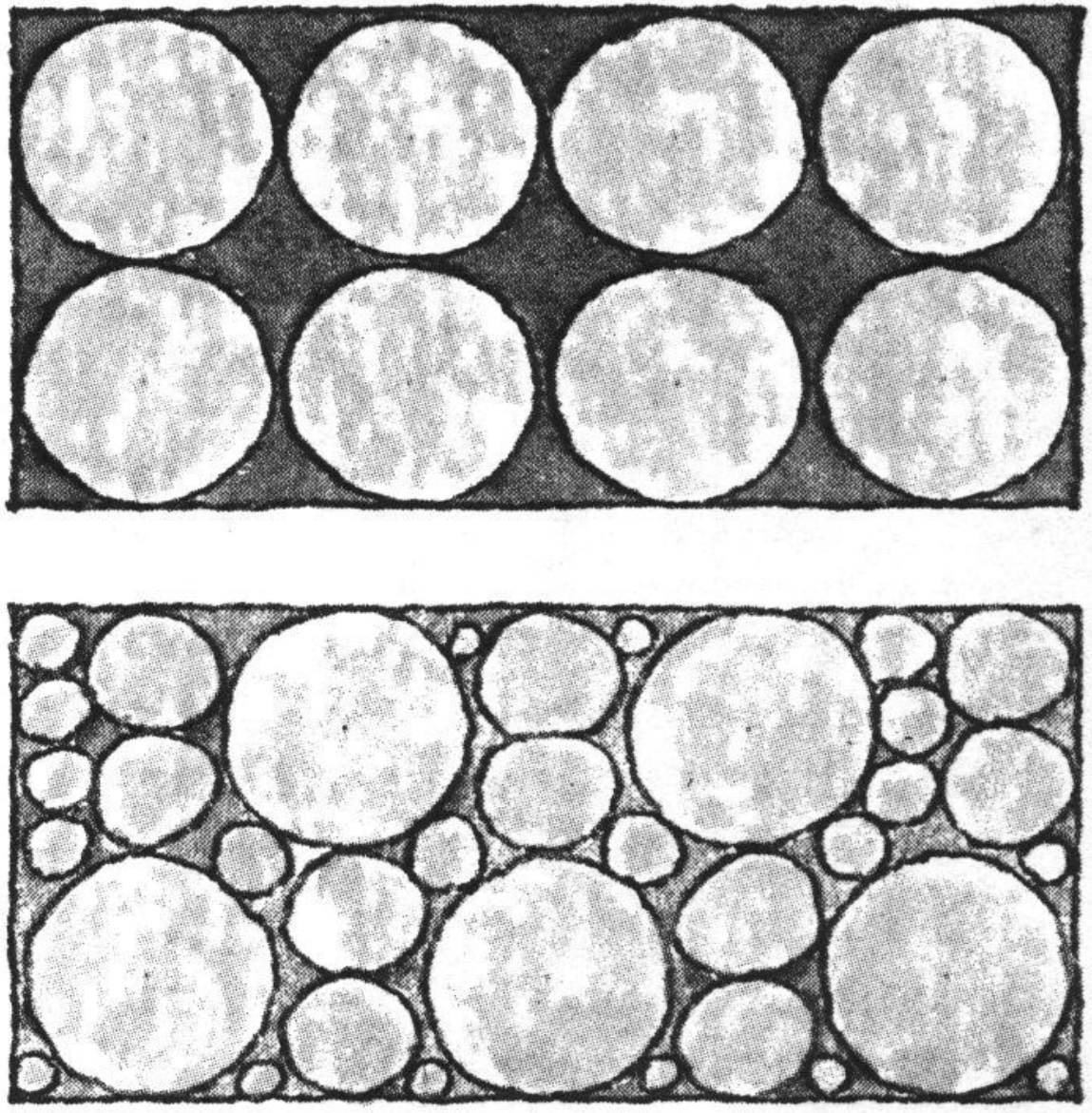


Operating companies report annually to NPD data and forecasts on:

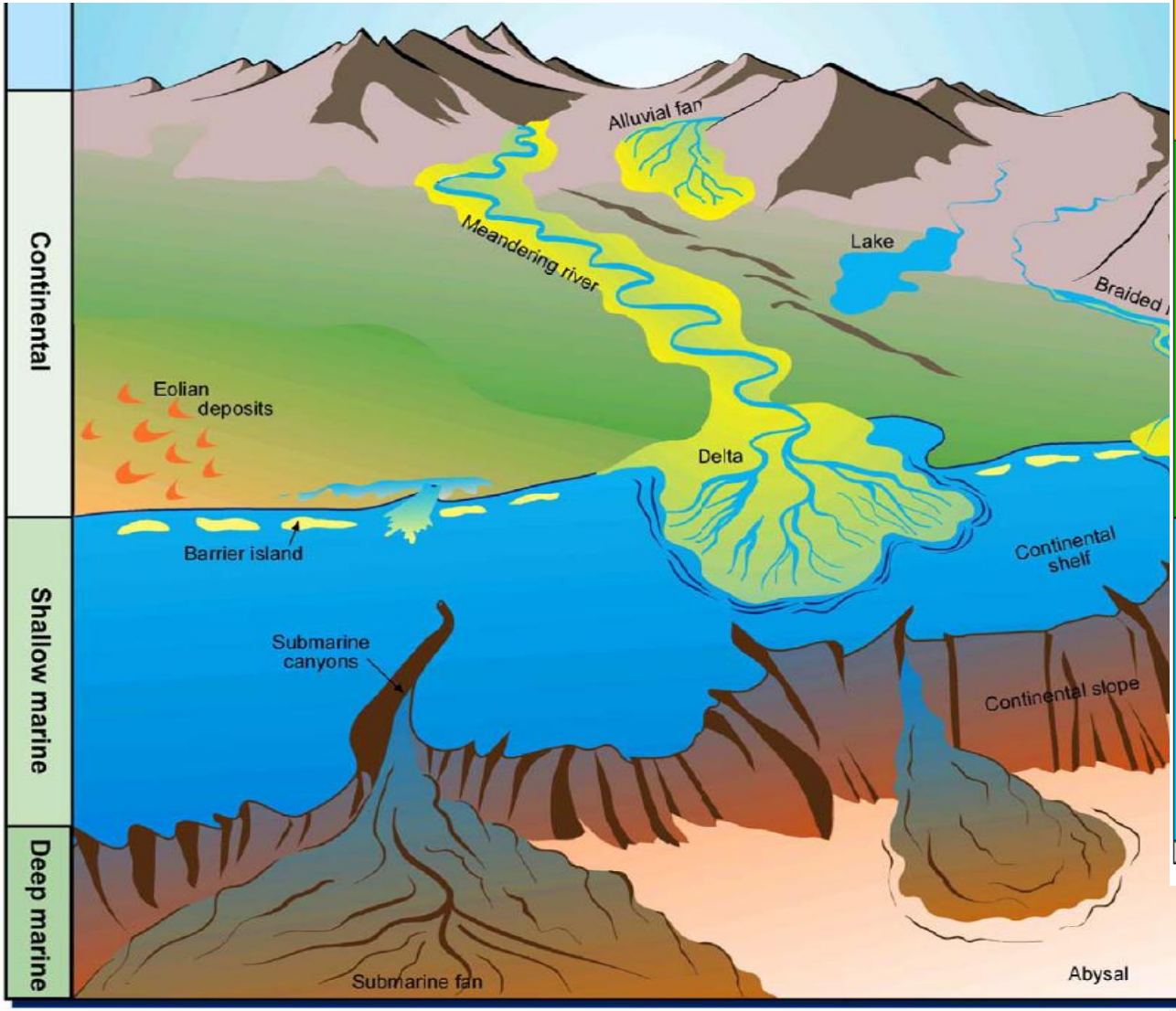
- Resources
- Production
- Investments
- Emission

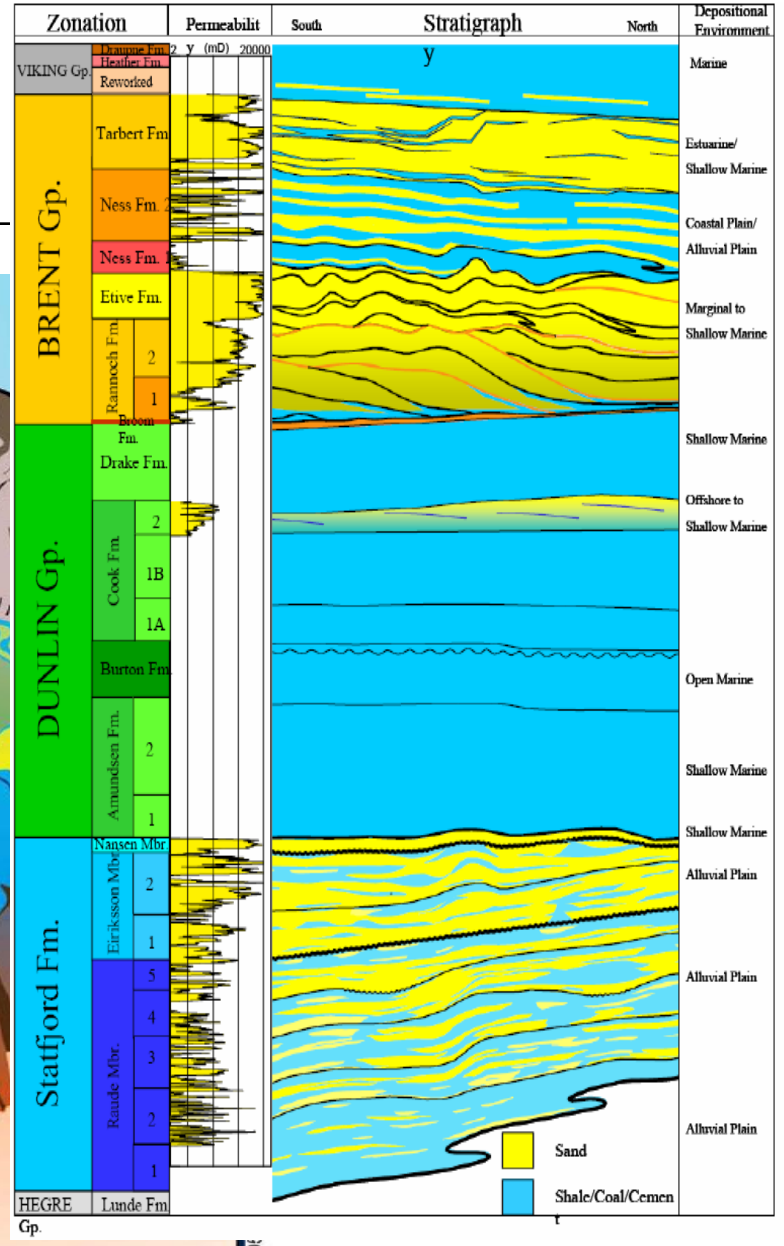
Geologic knowledge

Reservoir knowledge

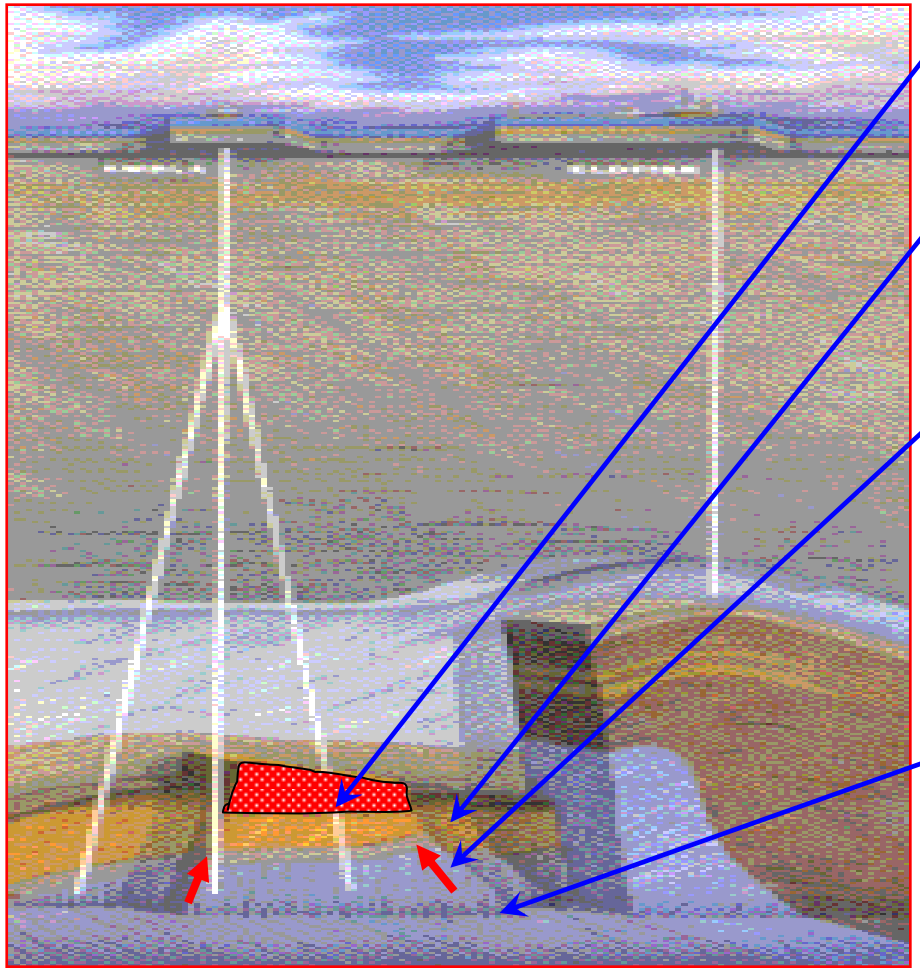


Knowledge on sedimentary deposits



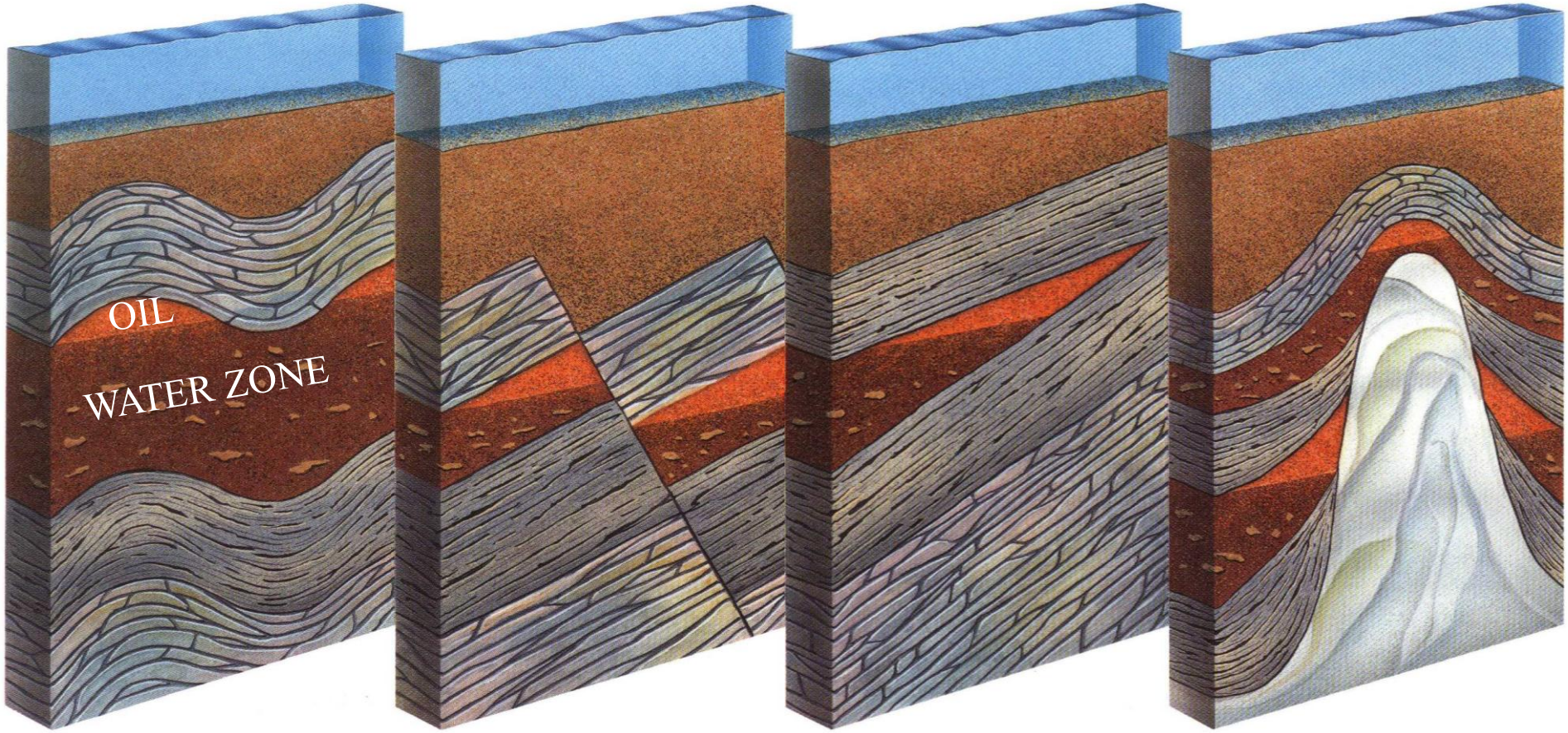


GEOLOGICAL FACTORS NECESSARY FOR THE PRESENCE OF OIL AND GAS



- **TRAP**
  - *sealed geometric form*
- **RESERVOIR ROCK**
  - *sandstone and limestone*
- **MIGRATION PATHS**
  - *hydrocarbon migration into the trap from mature [i.e. hydrocarbon generating] source rock (kitchen)*
- **SOURCE ROCK**
  - *claystone rich on organic material*
- Correct **timing** of these factors

DIFFERENT TYPES OF TRAPS FOR OIL



The Volumetric Function

Producable oil volume =

Gross Rock volume x

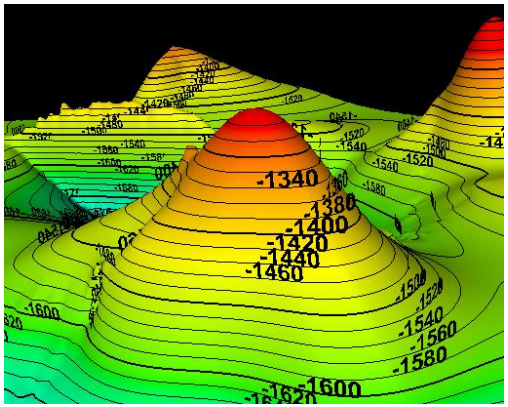
N/G ratio x

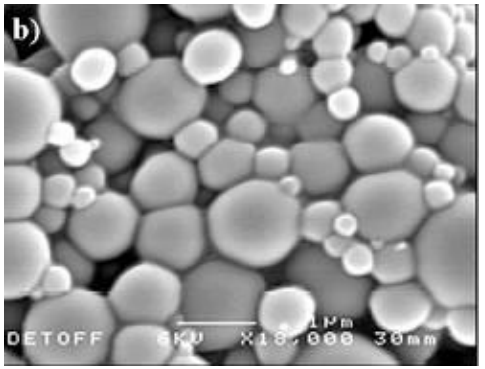
porosity x

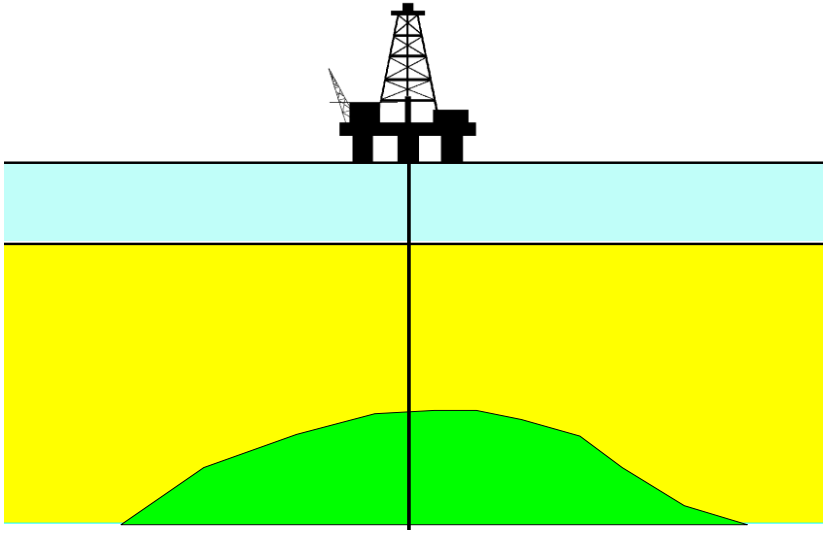
Hydrocarbon saturation x

Formation volume factor x

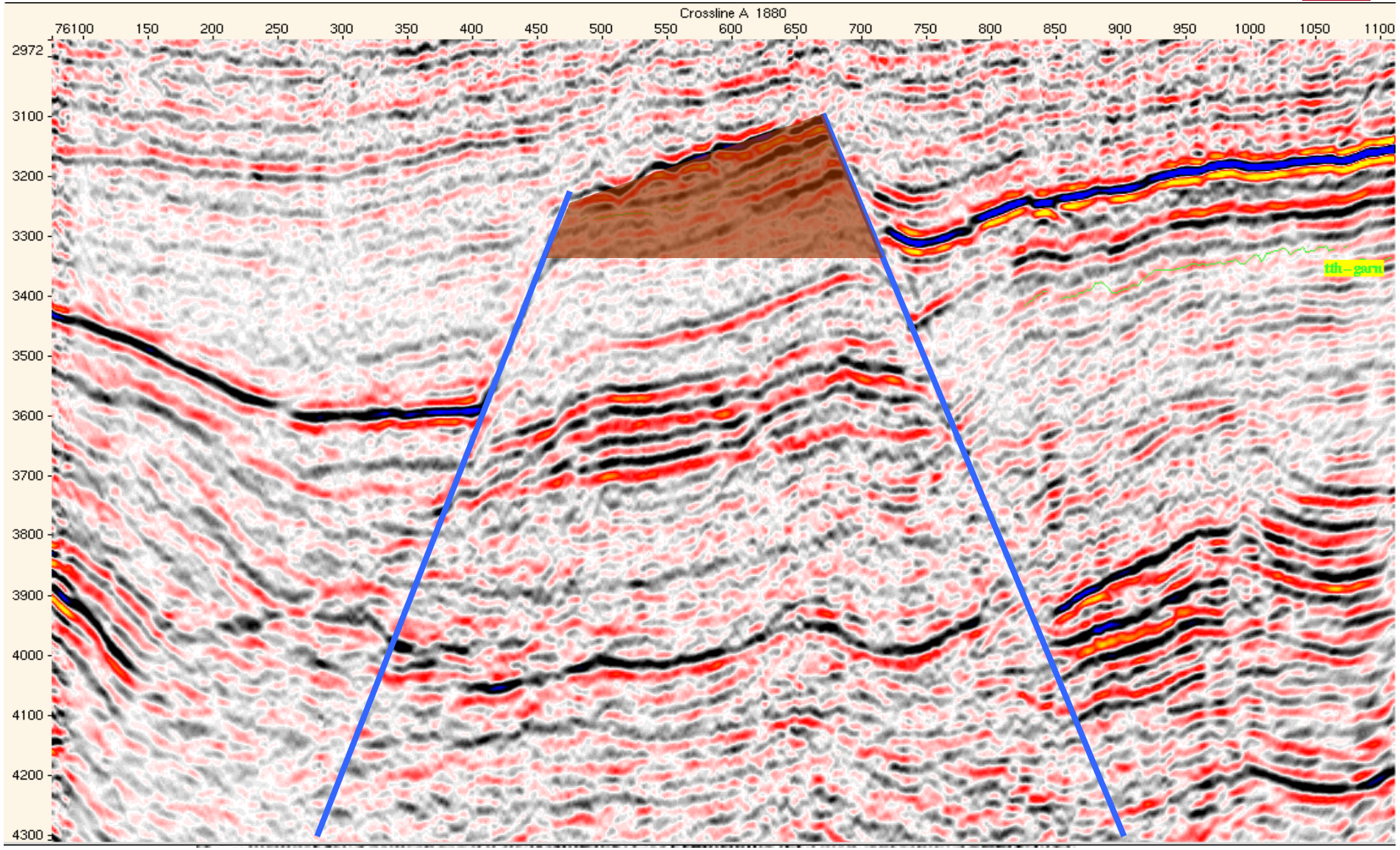
Recovery factor





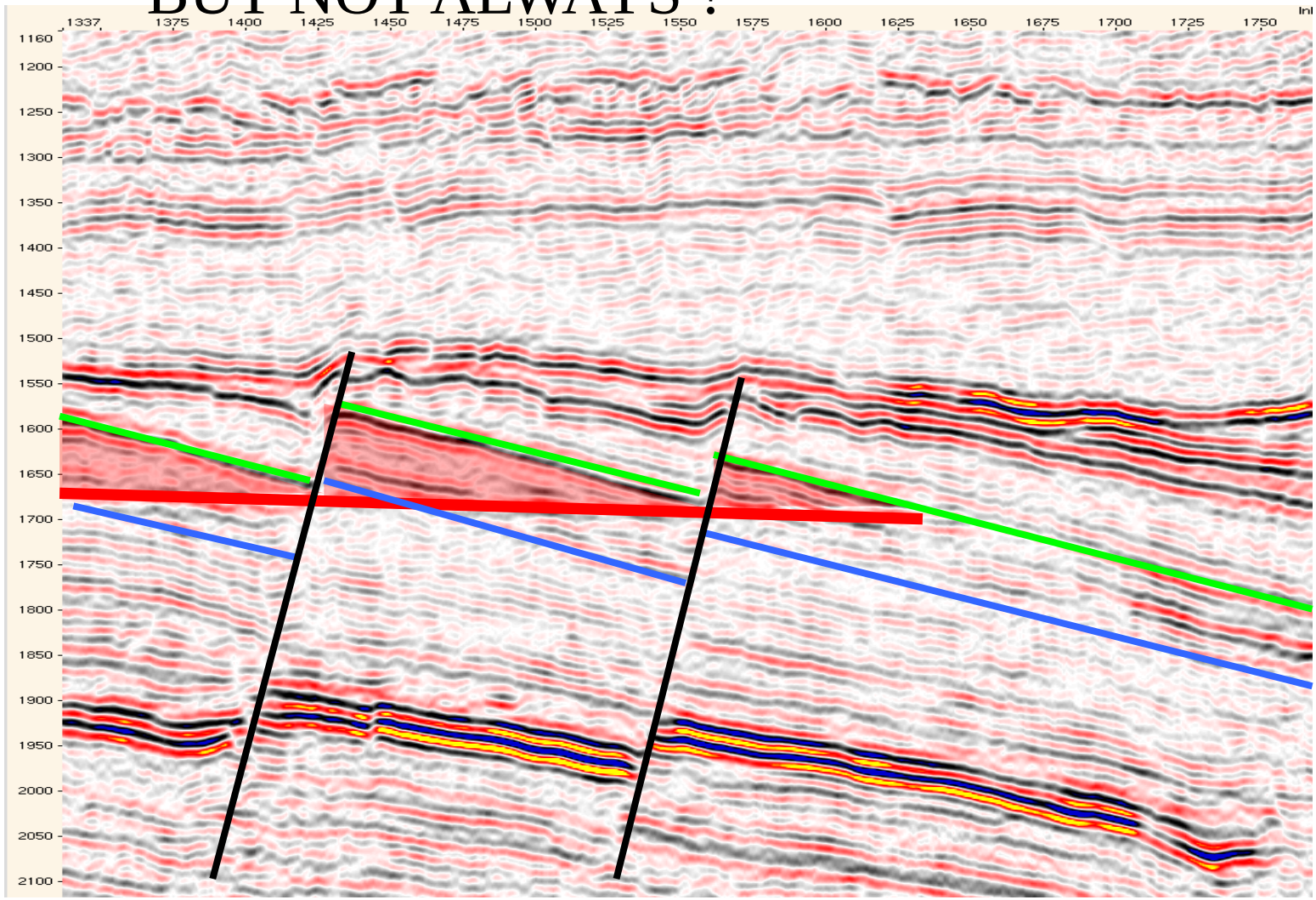


2D Seismic

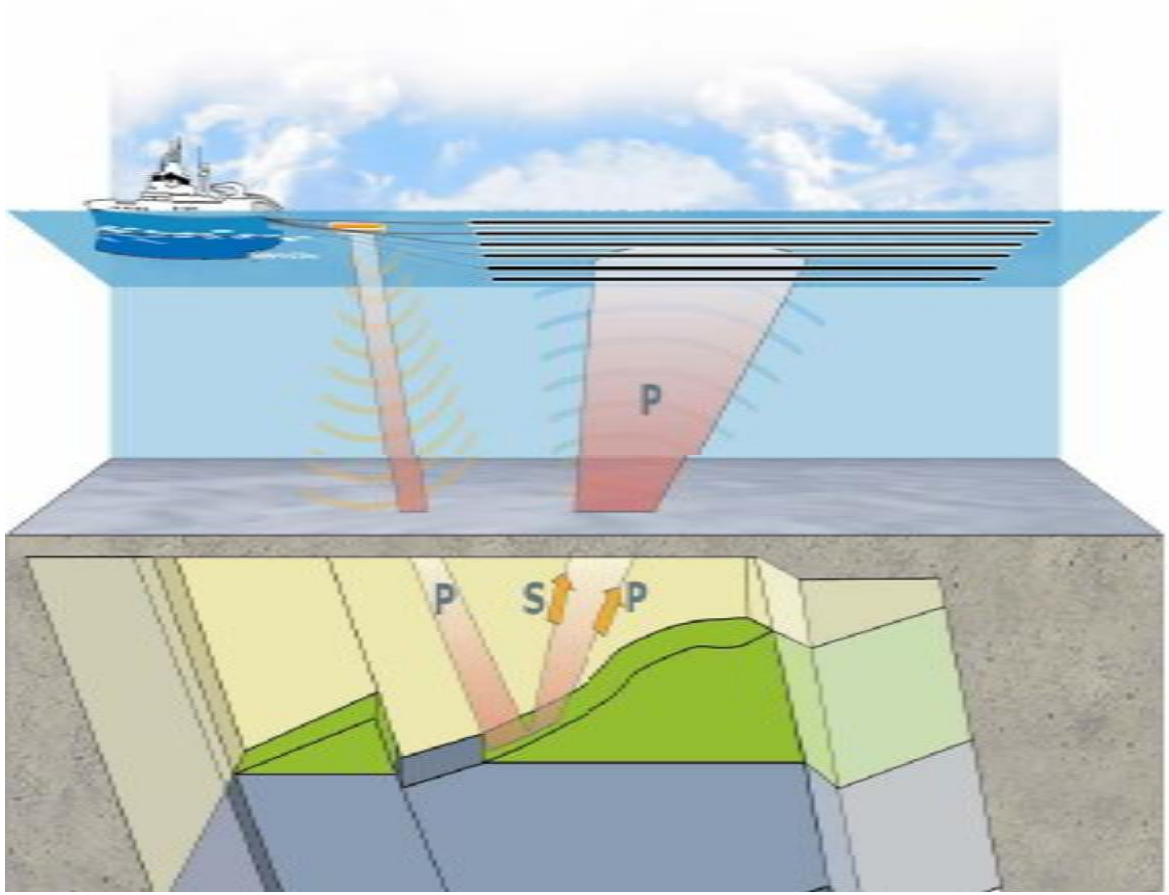

Crossline A 1880
76100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
1100
2972
3100
3200
3300
3400
3500
3600
3700
3800
3900
4000
4100
4200
4300
tth – garn

SOMETIMES IS IT POSSIBLE TO SEE HYDROCARBONS WITH SEISMIC

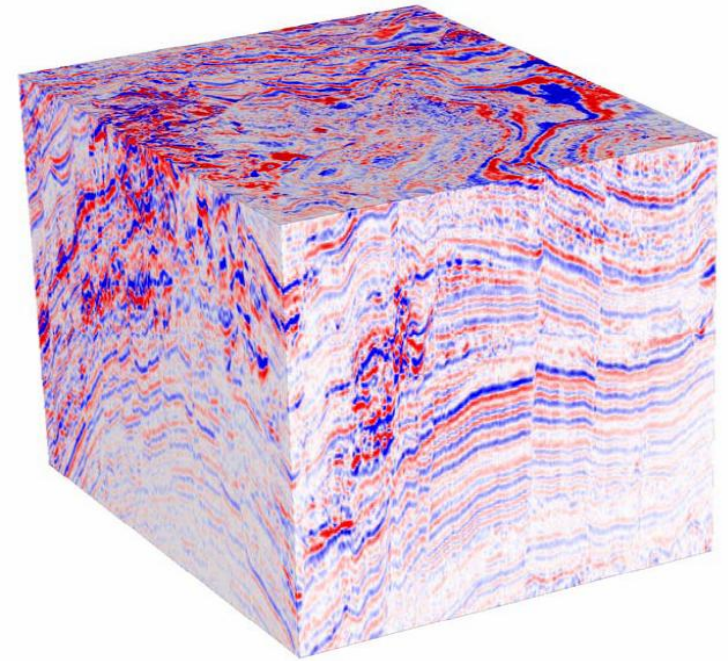
– BUT NOT ALWAYS !



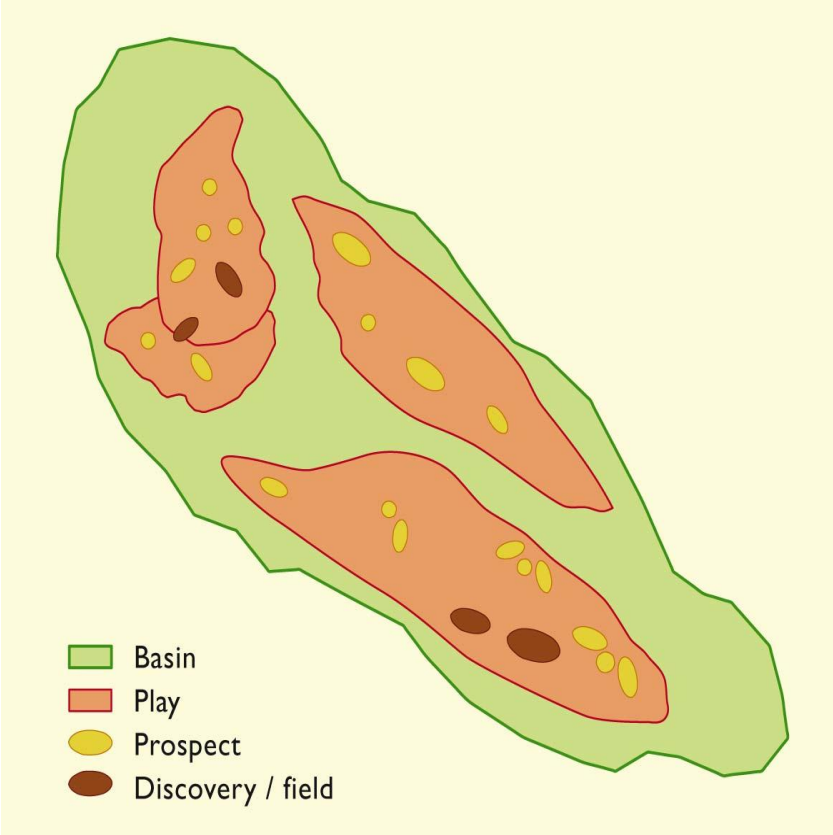
Seismic data acquisition



3D seismic cube



Estimating undiscovered resource volumes by statistical methods – play modelling

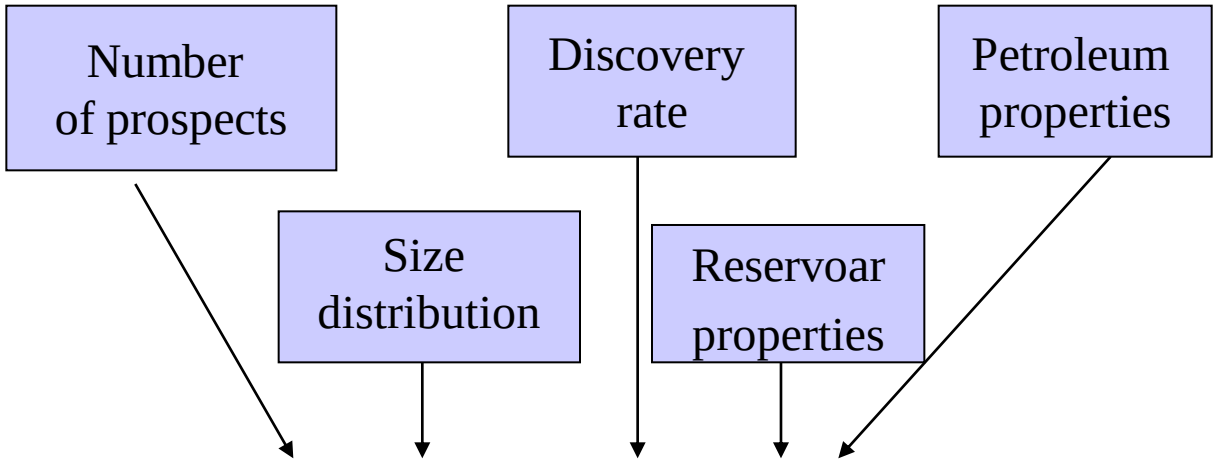


A Petroleum play is:

- Geographically and stratigraphically delimeted area.
- Spesific set of geological factors; reservoir, trap, source.
- Confirmed play: discovery.
- Unconfirmed play: no discovery. The play is risked.

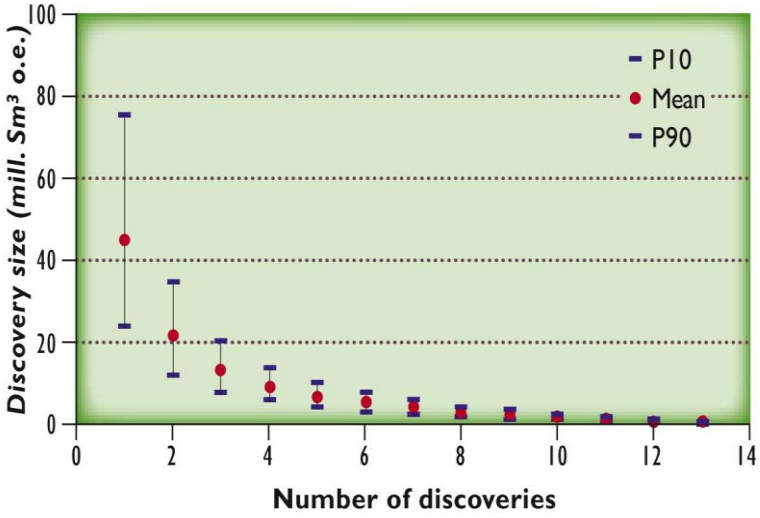
Statistical modeling

Input data:



Assessment software:

Results: Number and size distribution of future discoveries, volume of oil, gas and condensate.



Reliably assessing the resource base takes:

1. **Hard work**
2. **Skilled civil servants**
3. **Functional government institutions**

- **May require assistance from cooperating countries**
- **May require use of independent consultants**

Without knowing the resource base I may face:

1. Poor national policy and strategy
2. Inefficient legislation and tax regulations
3. Poor promotion and bad contracts
4. Poor investment strategies
5. Developments and production rates that are not optimal for the country
6. Lost revenue.

NORWEGIAN PETROLEUM
DIRECTORATE

Thank you for your attention!

www.npd.no