

The Exploration Play - What Do We Mean by It?*

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Abstract

Among the oil and gas exploration community the “play” has an almost mythical status - the successful play is the thing of which legends are made and “play-makers” are regarded as heroes of the industry. But what is the play exactly and why do we need it? Curiously, considering the long period it has been in daily use it has never really been unambiguously defined and, as a result, it can mean - within fairly broad limits - what people wish it to mean. Although the term is in common use therefore, in practice its imprecision often leads us to simply ignore its significance as a concept in our rush to concentrate on prospect definition. So the questions arise: Do we really need the play and can we gain by defining it more precisely? I strongly believe that the play concept is such a valuable one that it should be central to exploration decision making: Clustering petroleum accumulations into natural families helps us to manage the risks inherent in new and existing venture evaluation. However, I believe that plays can help us in this way best if they comprise meaningful, natural groups that we can use both for reliable analogue comparison and in meaningful statistical analysis. In this review I propose a three tier hierarchic framework for play definition based on (a) the petroleum charge system (b) the reservoir/seal formation pair or lithofacies and (c) the trap type. These tiers can be related to the geodynamic, sedimentary and tectonic events that drive stages in basin evolution, thus placing the concept directly in its geological context.

References

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Magoon, L.B., 1995, The play that complements the petroleum system; a new exploration equation: *Oil and Gas Journal*, v. 93/40, p. 85-87.

Magoon, L.B. and R.M.O. Sanchez, 1995, Beyond the petroleum system: *AAPG Bulletin*, v. 79/12, p. 1731-1736.

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Snedden, J.W., J.F. **Sarg**, and X. Ying, 2003, Exploration Play Analysis from a Sequence Stratigraphic Perspective: *AAPG Search and Discovery Article* 40079 (2003), Web accessed 9 November 2009
<http://www.searchanddiscovery.net/documents/snedden/index.htm?q=%2Btext%3Asnedden+text%3A2003+text%3A40079>

The background of the slide is a photograph of an oil pumpjack (jackal) in a desert landscape. The scene is captured during sunset or sunrise, with a warm, orange and yellow sky. The pumpjack is a large, dark silhouette against the bright sky. The overall tone is professional and related to the petroleum industry.

The Exploration Play, what do we mean by it?

Harry Doust

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*AAPG Conference, June 2009,
Denver, Colorado*

What is a petroleum play?

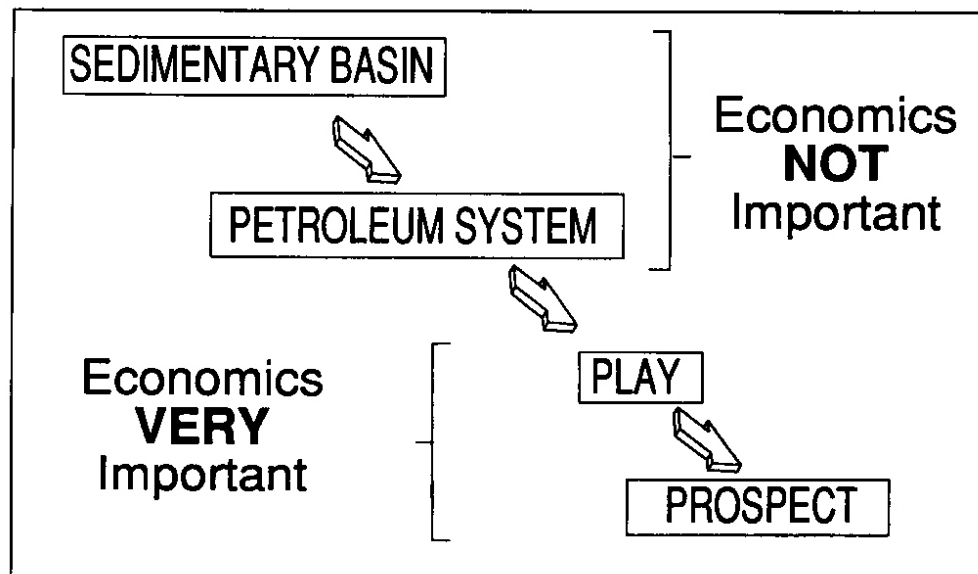
- A concept dear to the heart of all true-blood petroleum explorers in the industry – with lots of definitions!
- general agreement that the play describes **groups of accumulations and prospects that resemble each other closely geologically, sharing similar source, reservoir, seal and trap conditions**, but no clear agreement on a definition and an inherent lack of precision
- *Magoon (1995): "Depending on the objective of the explorationist, the play concept ... can have any degree of geologic similarity"*
- a very human concept, popular and useful just because it is not a precise, scientific concept, but...
- significant scope exists for limiting value through misunderstandings, but many good reasons to ensure the concept works well. The play is employed in day-to-day **risk management and planning activities** - for most explorers the most important decisions concern the areas and trends to investigate, rather than which individual prospects to drill

Why do we need the concept?

- To identify where and to what **objective future exploration activity** should be directed. i.e. which areas or trends are likely to become core future productive areas,
- **Management of the risks** associated with drilling mapped prospects by grouping them into families and comparing them with successful analogue fields,
- Prediction of **future possible volumes** using successful analogue fields or statistical techniques,
- Helping estimate the **potential value** of exploring in areas or for particular prospect types
- Identification of the **technologies needed** to explore for particular types of prospect as well as those needed to maximize the commerciality of discoveries through field development,
- Deciding when a type of prospect is no longer worth pursuing or when an exploration venture should be **terminated**.
- ...in short, plays rather than individual prospects **should form the basis of exploration strategy** definition

Magoon and Dow (1994) illustrate neatly that the play concept is a mixture of the commercial and the scientific by highlighting “four levels of petroleum investigation”, and contrasting the sedimentary basin and petroleum system levels, which are purely scientific concepts, with the play and prospect levels in which economics become very important.

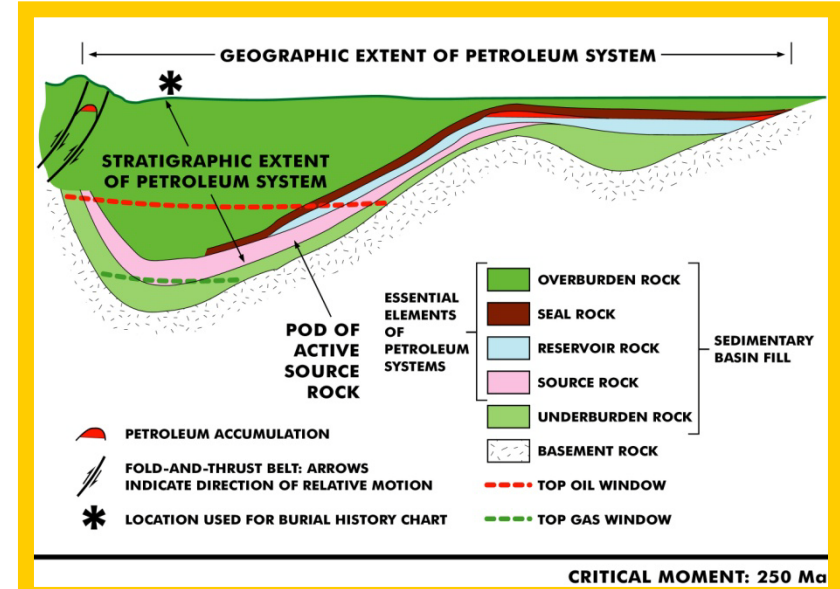
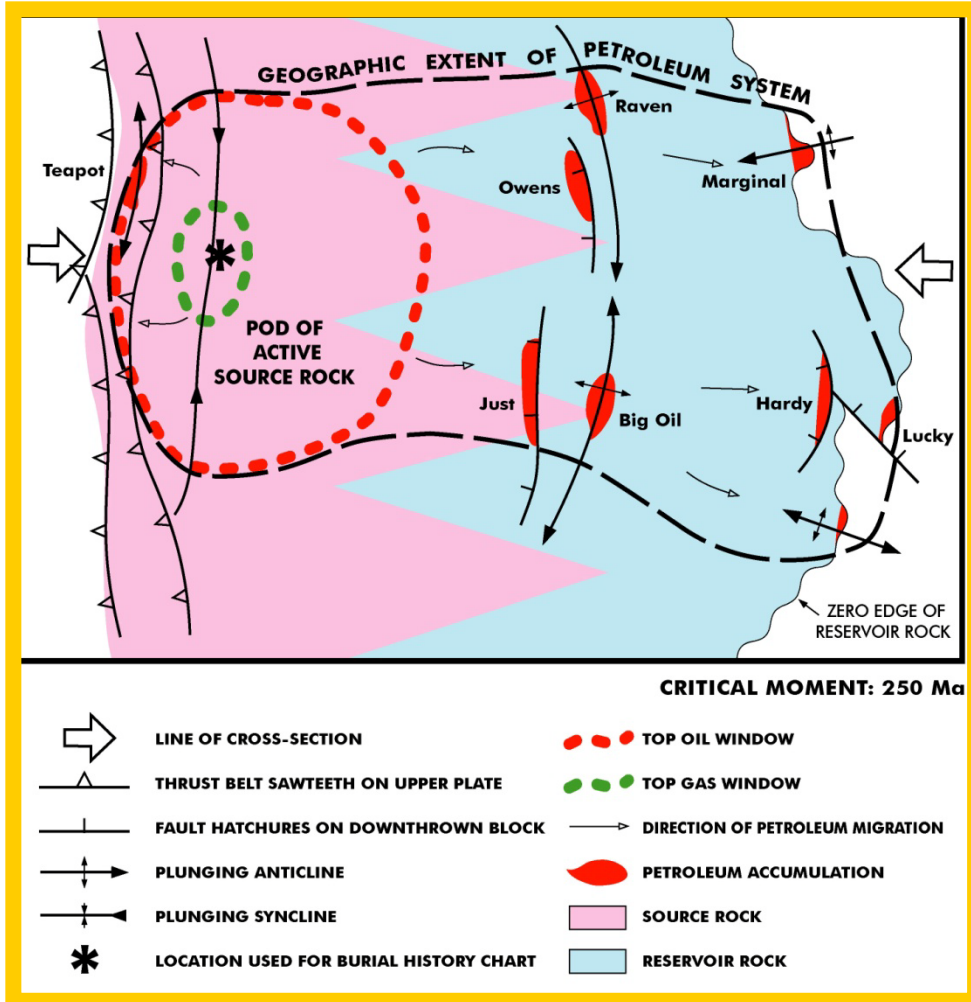
the underlying objective of play analysis *“is to find undiscovered petroleum accumulations at a profit”* (Magoon and Sanchez 1995)



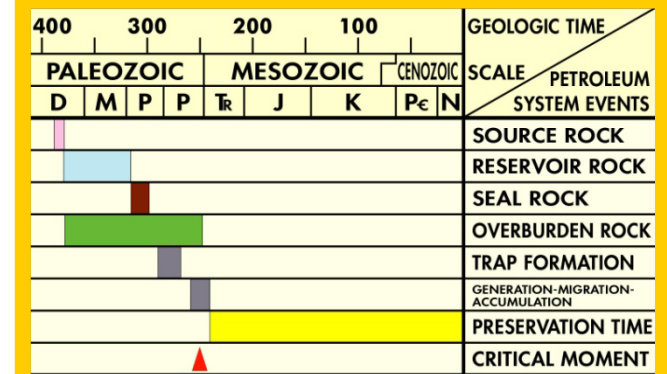
Magoon (1995) includes already discovered accumulations as part of the petroleum system, while undrilled prospects form “the complementary play”

Many other authors include both discovered accumulations and undrilled prospects in their definition of play

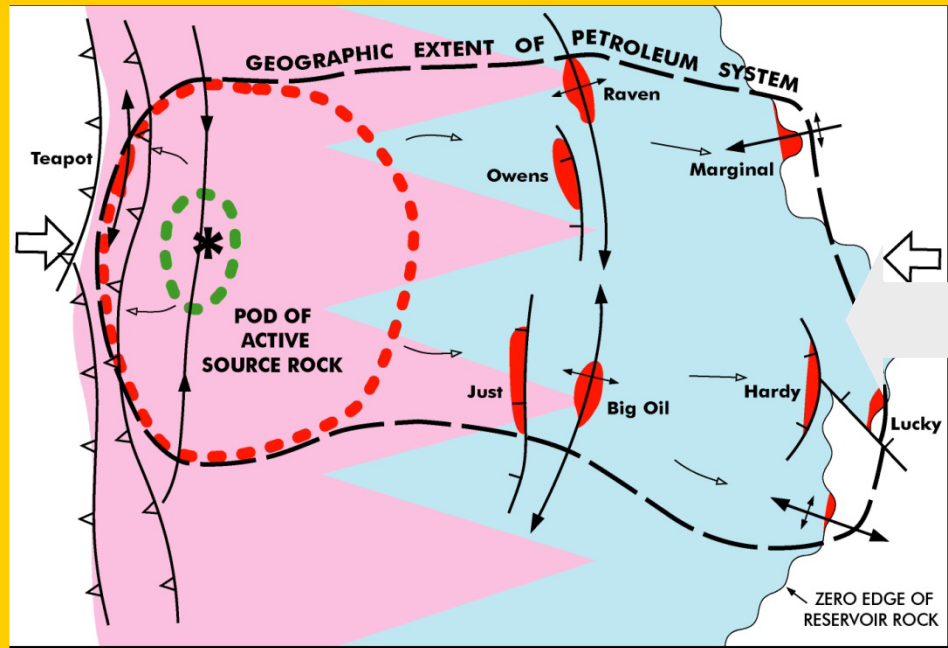
Relationship of the play to the Petroleum System concept



Critical Moment : 250 Ma



Relationship of the play to the Petroleum System concept



CRITICAL MOMENT: 250 Ma

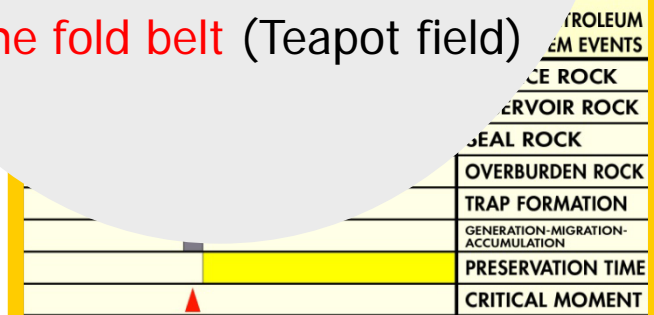
LINE OF CROSS-SECTION

Each of these represents a distinct "play", in which the source rock, reservoir/seal and trap type are shared. It must be assumed that each of these "plays" represents commercial or potentially commercial ventures.

Plays within this petroleum system:

- **Dip-closed anticlinal fields** (Raven and Big Oil fields)
- **Hanging-wall fault closure fields** (Just, Owens and Hardy fields)
- **Pinch-out fields at the zero edge of the reservoir** (Marginal and Lucky fields)
- **Thrust anticline fields in the fold belt** (Teapot field)

Critical Moment: 250 Ma



Proven and Exploration plays

The example makes use of existing fields, representing *Proven plays*: These are commercial accumulations that have been identified by drilling (e.g. oil or gas fields) which form part of the petroleum system. They are used in exploration as analogues for *Exploration plays*, for statistical purposes and in analysis of risk and uncertainty.

We can divide *Exploration plays*, the objectives for exploration, into:

- *Complementary plays* (sensu Magoon and Beaumont 1999), which comprise undrilled prospects within the boundaries of a petroleum system that are assumed to belong to the same (proven) play, and
- Groups of similar prospects belonging to as yet *Unproven* (*perhaps speculative*) *plays*. These will carry a *play risk*.

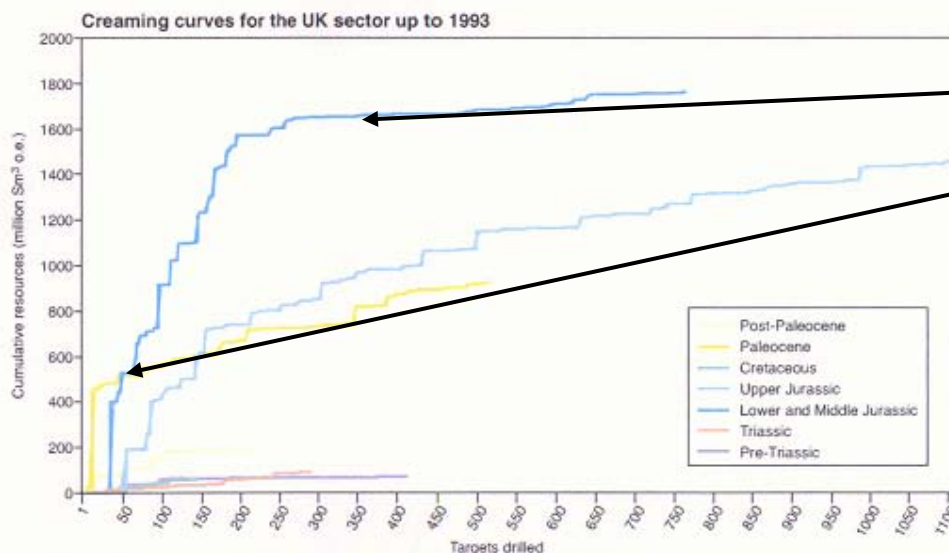
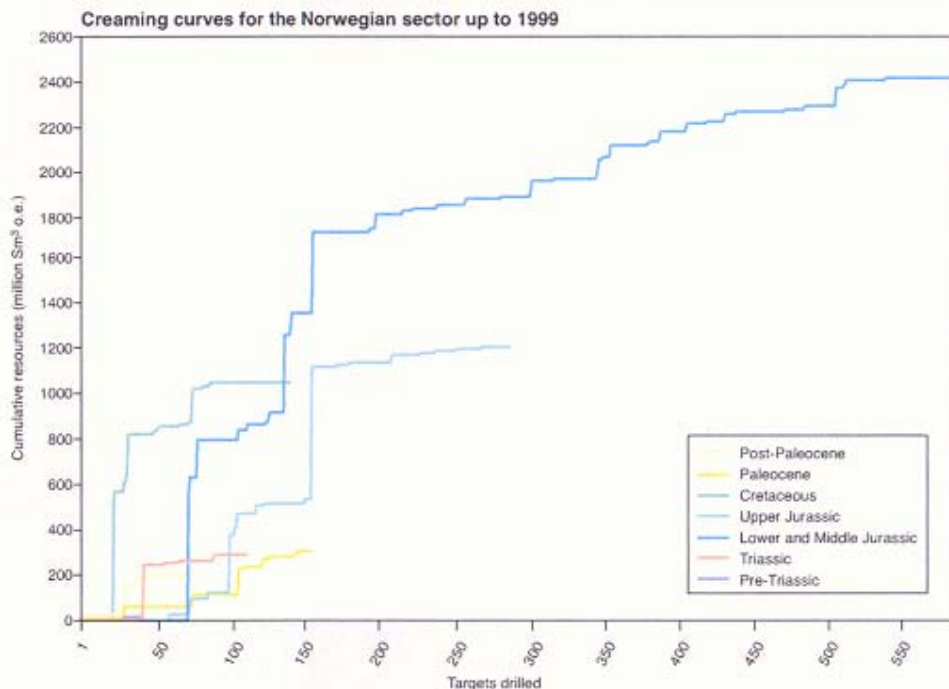
I believe that this approach clarifies much of the ambiguity around the definition of plays and I recommend its use.

Current uses of the play concept

- **Predicting the presence, distribution and likely performance of exploration opportunities**
 - Assessment of risks related to families of drilling opportunities according to the assumed presence and development of essential parameters as identified in a particular area or at a specific horizon
 - calibration against already tested analogues, or features belonging to the same “play” in or at the same area or level
- **Petroleum resource evaluations**
 - probabilistic prediction of long-term undiscovered resource volumes, such as carried out, for example, by the U.S. Geological Survey
 - predictions include the analysis of statistical techniques like creaming curves and field-size distribution charts
 - larger units than plays (as usually defined) are normally used: these **assessment units** can “include one or more plays” (USGS 2000).
- **Let’s look at some examples of statistics applied to plays**

Time / number of targets drilled

Cumulative discovered volumes



Stratigraphy	Hydrocarbon play
Post-Eocene	Post-Paleocene
Eocene	
Paleocene	Paleocene
Upper Cretaceous (including Danian)	Cretaceous (chalk)
Lower Cretaceous	Upper Jurassic
Upper Jurassic	
Lower – Middle Jurassic	Lower and Middle Jurassic
Triassic	Triassic
Permian, Carboniferous, Devonian, pre-Devonian	Pre-Triassic

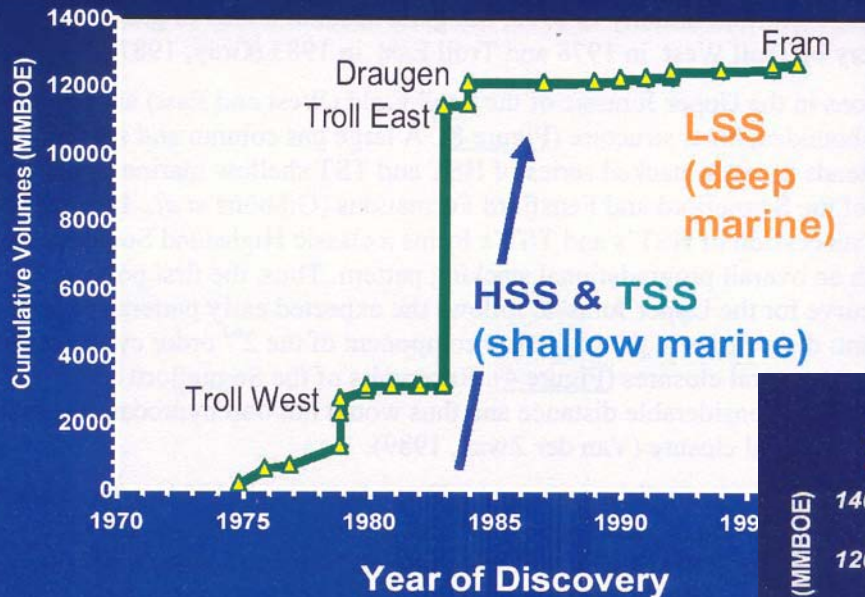
Creaming curves for play levels in the North Sea

Time to abandon play?

Early discoveries = the "cream"

Here the play comprises time units

Upper Jurassic Play, Norway (Viking Graben & Haltenbanken)



Here the play comprises time units analysed in a sequence stratigraphic context

HSS: Highstand Systems Tract

TSS: Transgressive Systems Tract

LSS: Lowstand Systems Tract

Snedden et al. (2003)

evaluated performance of plays defined as **stratigraphic intervals or trends**, as here

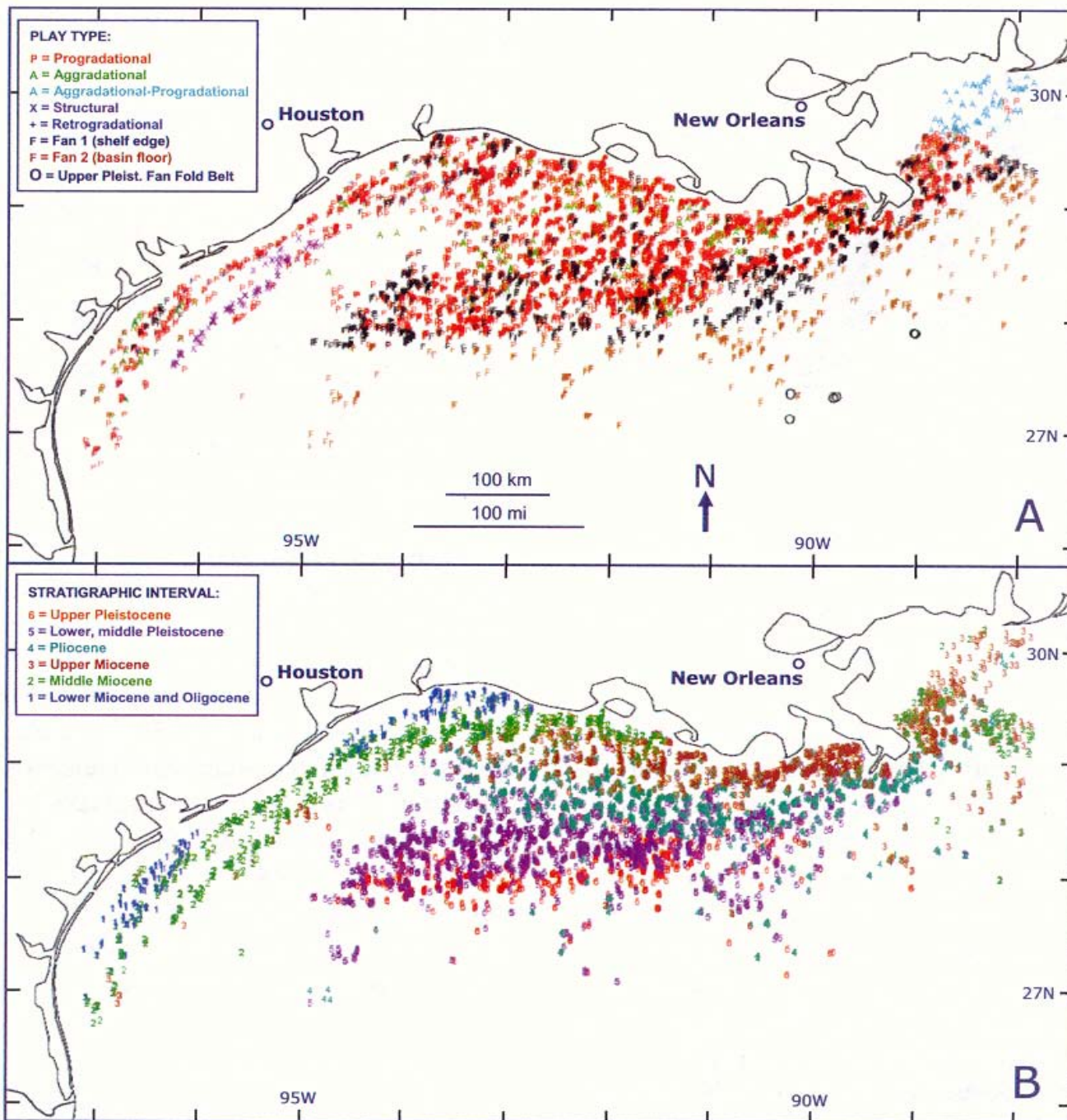
but they recognized that for their purposes the play represents "an assemblage of

several plays, each with its unique characteristics of reservoir, entrapment etc."

From: Snedden, Sarg & Ying 2003

Plio-Miocene Play, Kutei Basin, Indonesia





Example of the grouping of plays in the Gulf of Mexico into larger units or “play types” defined by reservoir stratigraphy

Minerals Management Service

from Ehrenberg et al. 2008.

Here a tailored mixture of play types is used, which makes it difficult to incorporate the analogue information elsewhere

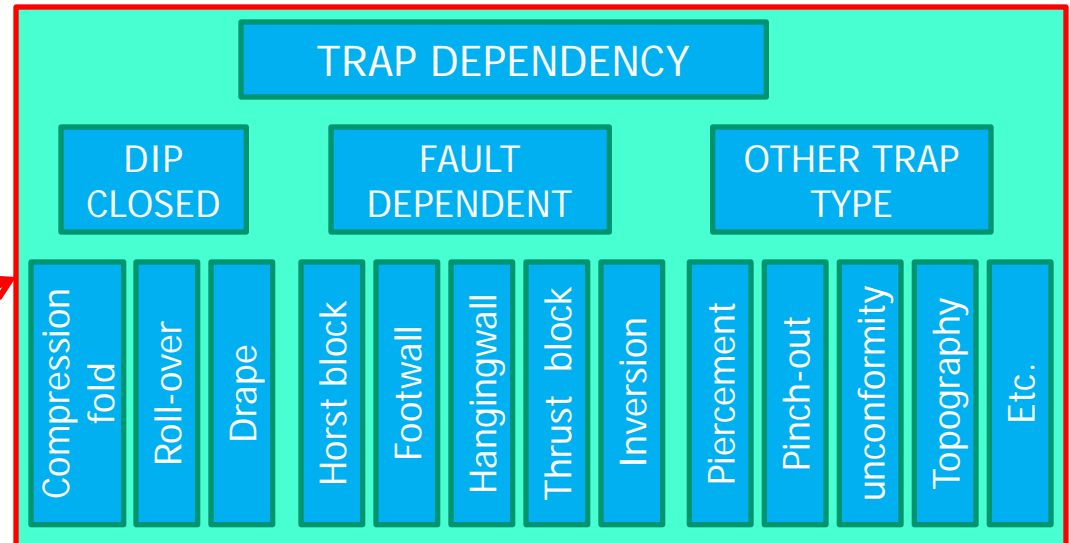
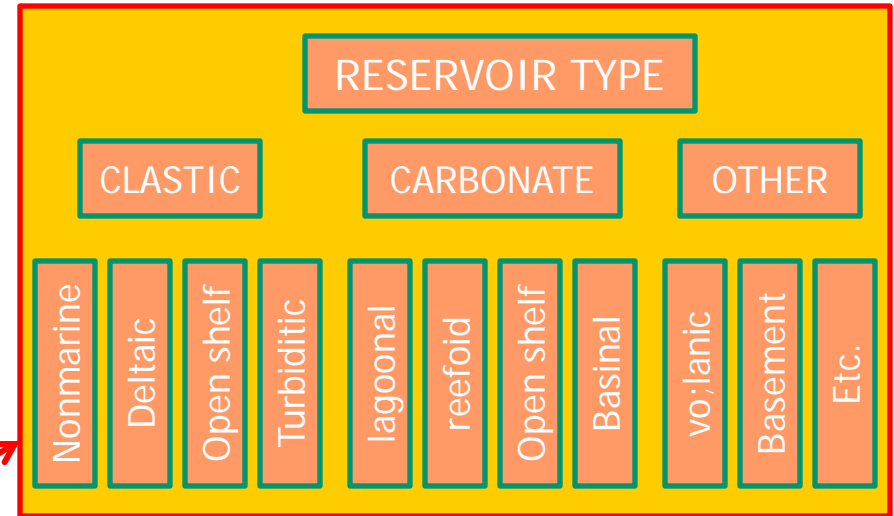
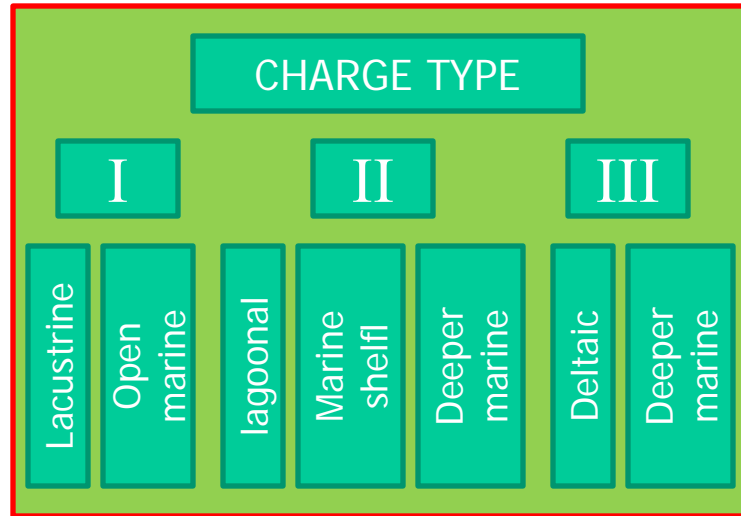
I believe that the variable use of the term “play”, evident in the few examples shown, complicates the identification and application of appropriate and useful analogues.

...so how can we classify proven plays so that they can be used in a more structured way to help evaluate exploration (unproven or complementary) plays, either to identify the most appropriate and useful analogues or for statistical purposes and to share play data?

A recommended approach

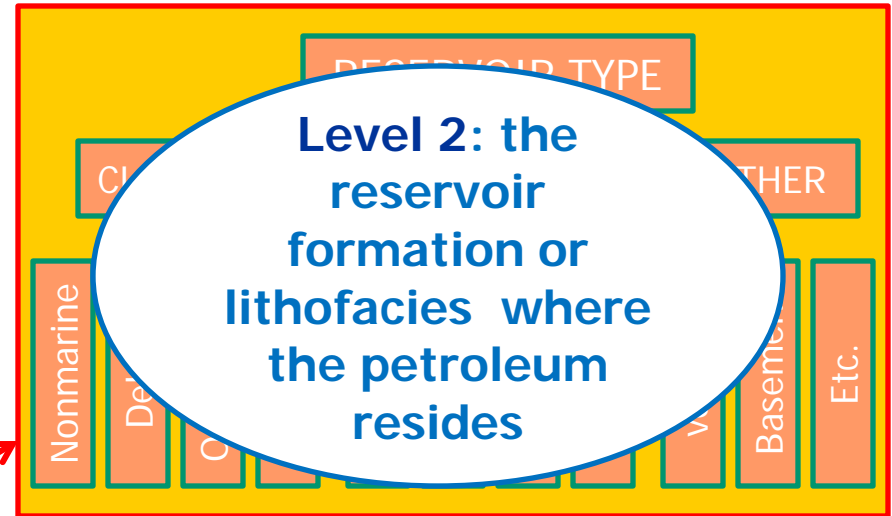
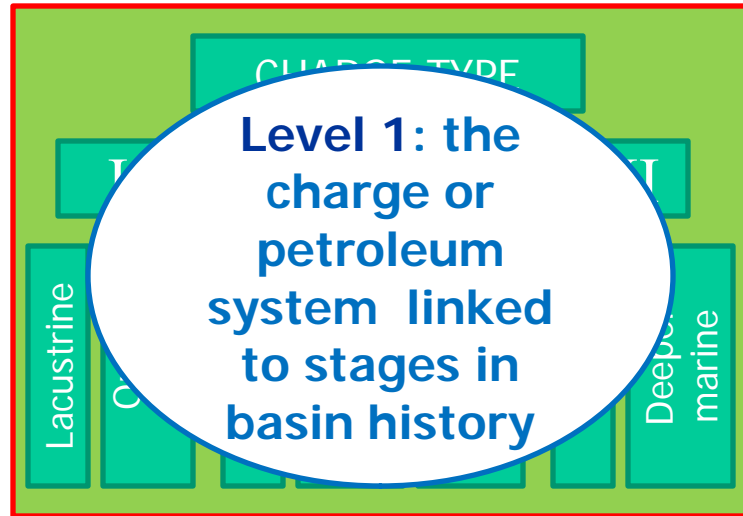
- a more **standardized hierarchic system** for play definition.
- At a high level, the presence and development of plays can most easily be compared and used for predictive purposes by identifying their place in basin history and/or their tectonostratigraphic context
- They can be defined further by three characteristics at three levels, corresponding to different parameters, spanning scales from more widespread to more local:
 - **Level 1:** the **petroleum charge system** which the play belongs to, usually the most widespread parameter, i.e. the source formation and migration process – this links directly to the petroleum system
 - **Level 2:** the **reservoir** in which the accumulation occurs, defined either by the formation name or where facies vary rapidly, by the reservoir lithofacies (and its overlying seal) – this also links directly to the petroleum system
 - **Level 3:** the **trap type**, usually the most restricted geographically & which usually comprises the most specific element of a play

Typical categories of essential elements used in play definition



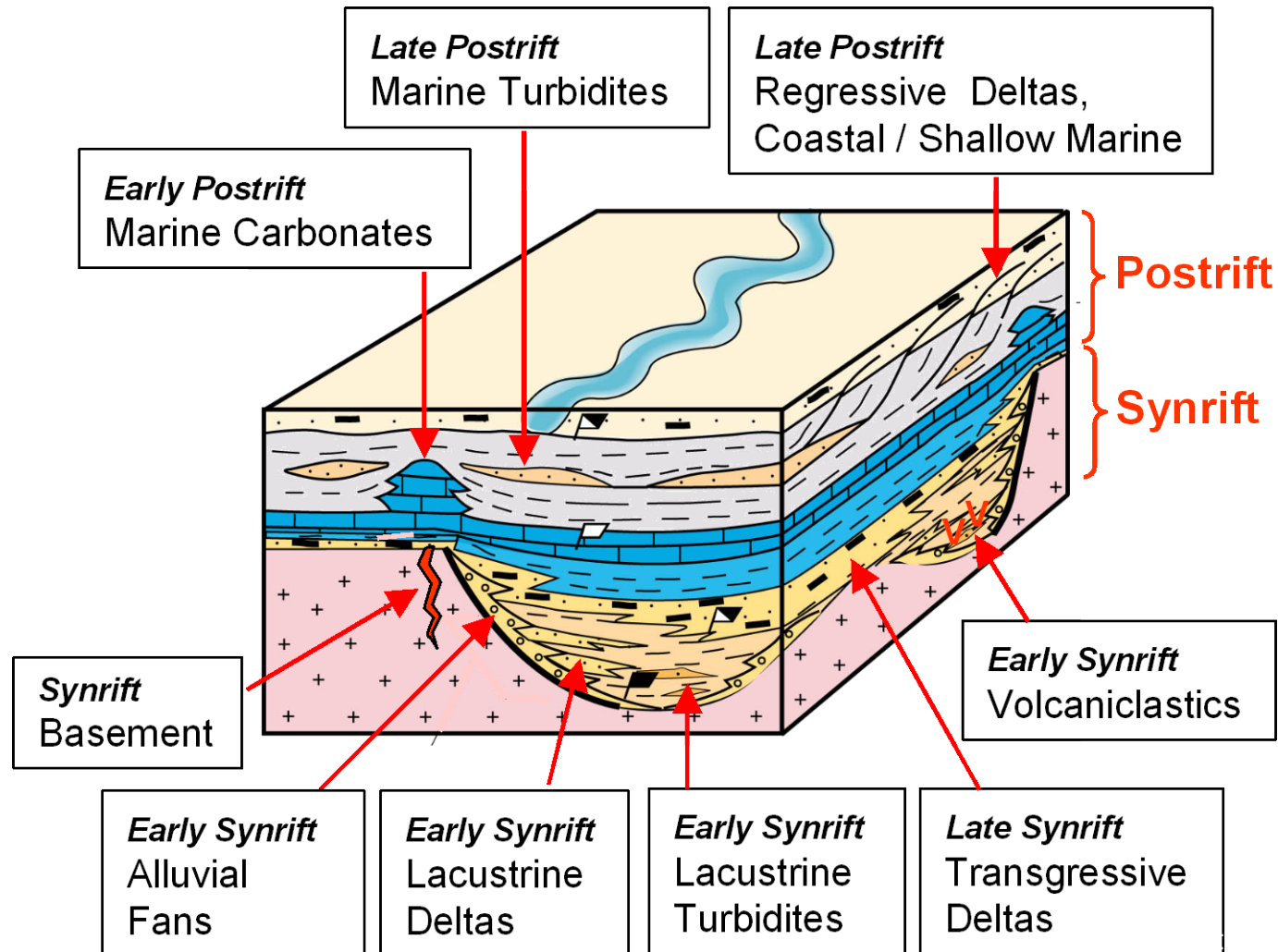
Combinations of some or all of these parameters can define more standard plays

3 hierarchic levels in play description

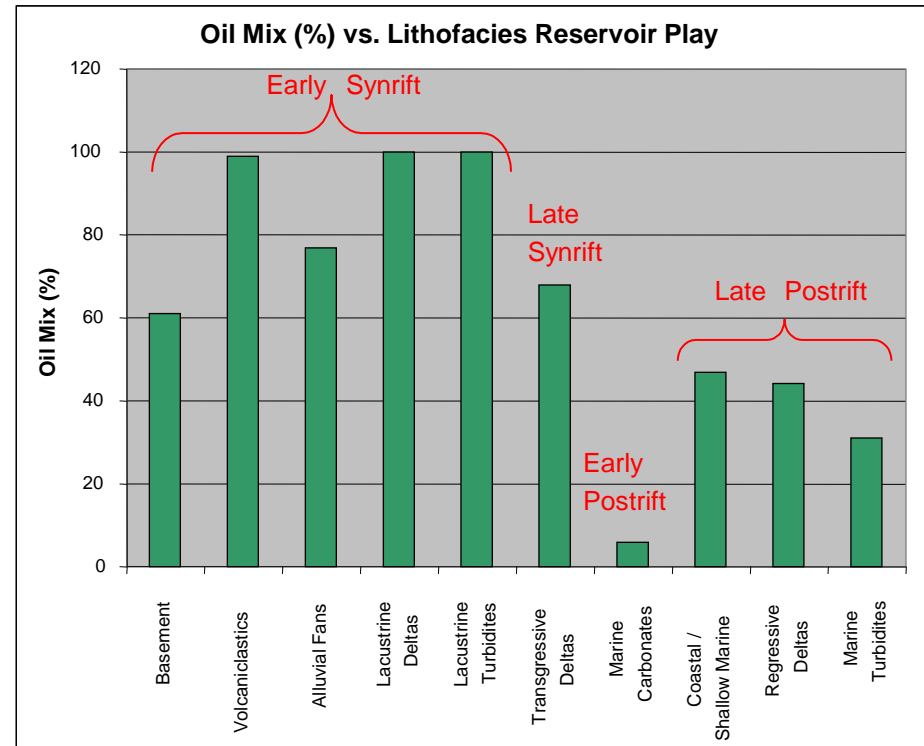
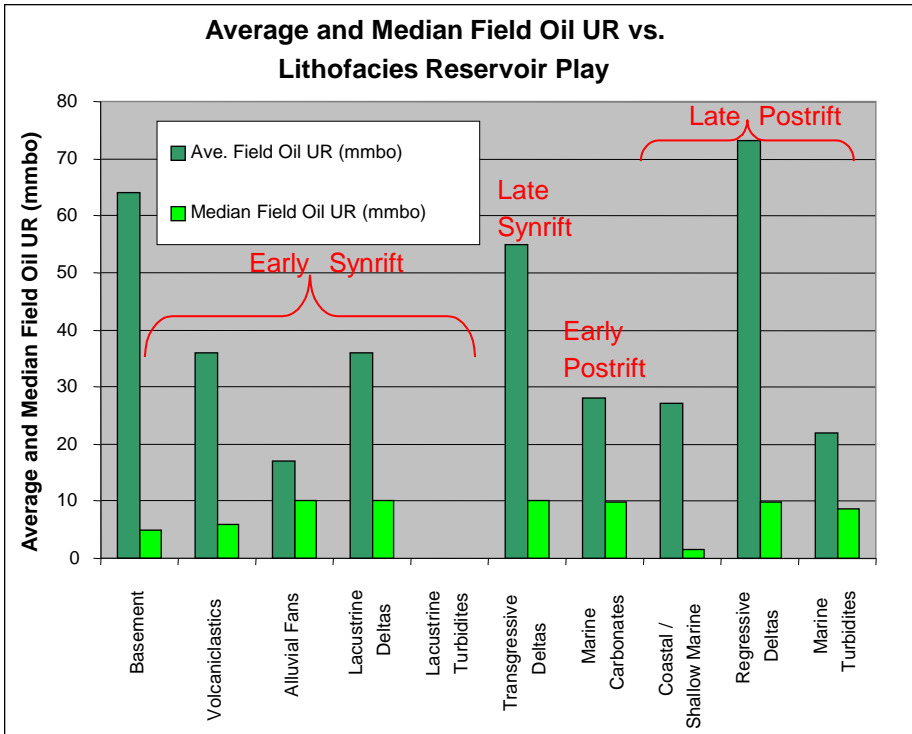


Combinations of some or all of these parameters can define more standard plays

For instance we can use basin cycle divisions (linked to separate charge systems) and reservoir facies to define “lithofacies” plays, as here in Southeast Asia Tertiary Rift Basins



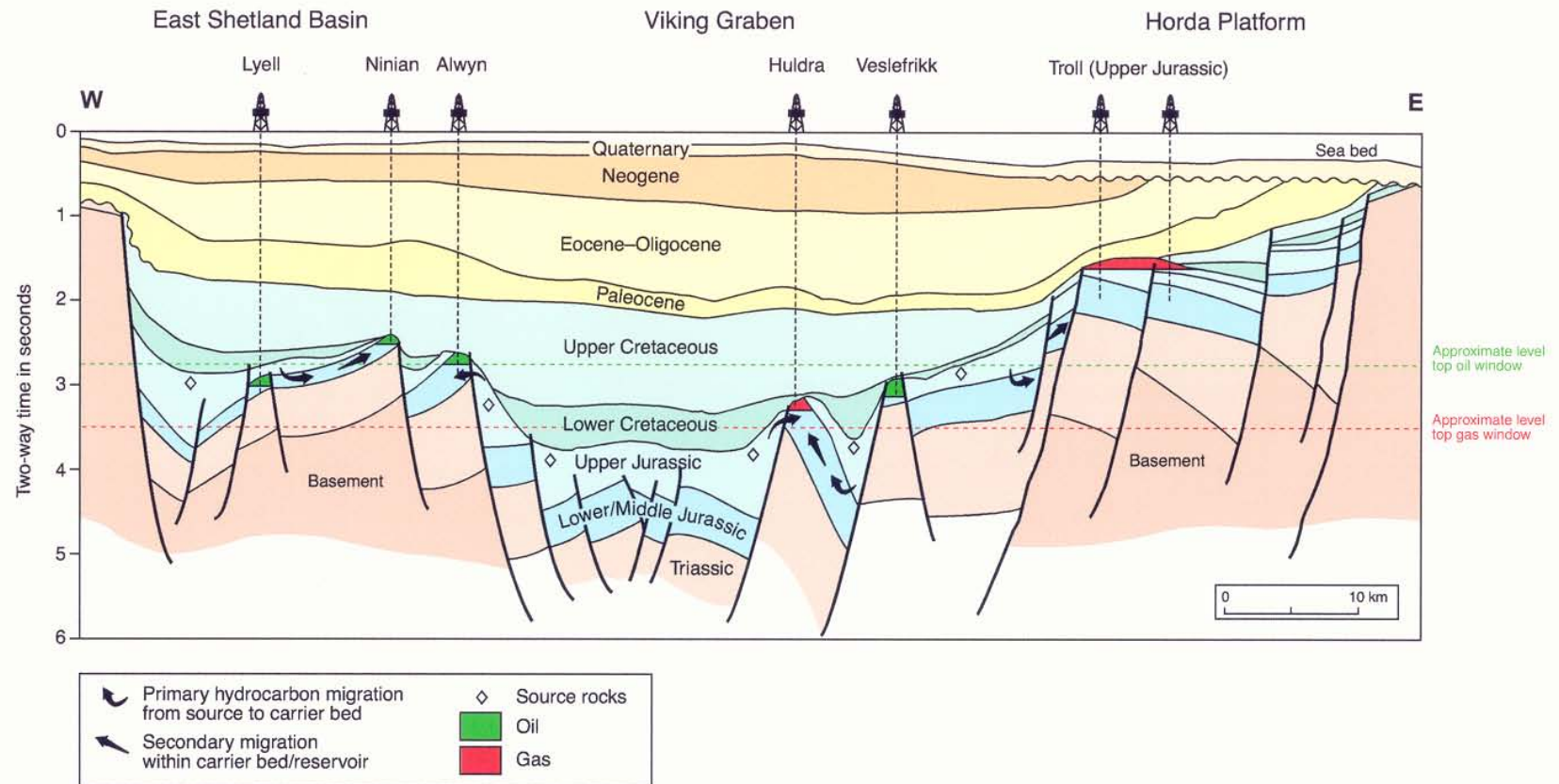
...and use such plays for statistical purposes: Hydrocarbon production summary for major lithofacies reservoir types in Southeast Asia Tertiary basins



OIL

OIL/GAS %

From Doust & Sumner 2007



The northern North Sea province:

Working of the petroleum system in the North Sea illustrating the hierarchic play definition recommended. Charge is from the synrift Upper Jurassic, the main reservoir/seal pair is the Middle Jurassic prerift Brent Formation, the traps are tilted footwall closures below the overlying postrift shale

Province: Northern North Sea

Basin cycle: Early synrift

PST: Synrift marine Type II

Active Source: Draupne Fm

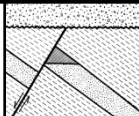
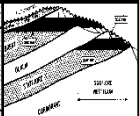
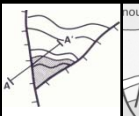
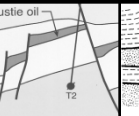

Petr.Syst: Draupne - Brent (!)

Prerift cycles

Synrift cycle

Postrift cycle

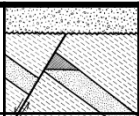
Trap types - plays

					
Brent (JM)	Beryl Tern Hudson	Brent Visund Ninian	Gullfaks 1		Sleipner
Dunlin (JL)			Gullfaks 2		
Statfjord (JL)	Beryl	Statfjord		Brage	

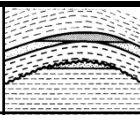
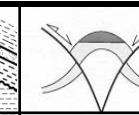
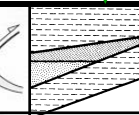
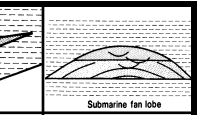
Late Prerift cycle

Early Prerift cycles

Play level (Formation / lithofacies)

	
Trias	Snorre
Dev	

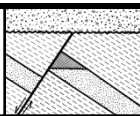
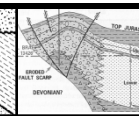
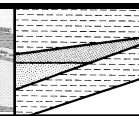
Trap types - plays

				
Palaeogene (Pc – Eo)	Frigg, Heimdal	Sleipner Oost	Balder	Gryphon, Forth

Early
Postrift
cycle

Early
Synrift
cycle

Play level (Formation / lithofacies)

			
Lower Cret.			Agat
JU/KL Volgian		Brae Miller Tiffany	
JU Kimm	Troll (sf) Magnus (turb)		

Province: Northern North Sea

Basin cycle: Early synrift

PST: Synrift marine Type II

Active Source: Draupne Fm

Petr.Syst: Draupne - Brent (!)

Prerift cycles

Synrift cycle

Postrift cycle

Trap types - plays

types - plays

Play name: **Brent**

Basin/area
Viking Graben

Petroleum system
Draupne – Brent (!)

Trap type
footwall fault-dip

Charge

synrift marine type II source, Late Jurassic (Kimmeridgian)

Reservoir level

deltaic channel and barrier sands, Middle Jurassic Brent group

Trap type

eroded and slumped tilted footwall fault-dip closure

Type & Other fields

Brent, Visund, Ninian etc

Play level (Formation / lithofacies)

Brent (JM)	Beryl Tern Hudson	Brent Visund Ninian	Gull- faks	
Dunlin (JL)			G f	
Stat- Fjord (JL)	Beryl	Stat- fjord		

Trias	Snorre
Dev	

Late Prerift cycle

Early Prerift cycle

Early
Synrift
cycle

Basin cycle

Early synrift

Late synrift

Early postrift

Late postrift

Source rock

Lacustrine shale

Deltaic coal / coaly shale

marine shale with terr. mat.

Deltaic coal / coaly shale

Reservoir levels

Basement quartzite

Lahat/Lemat alluvial facies

Talang Akar deltaics OIU-Mil

Talang Akar deltaics Mil

Batu Raja reefoid - platform Imsts

Telisa/Gumai basinal shales

L. Palembang - Air Benakat fluvio-deltaics

M. Palembang - Muara Enim fluvio-deltaics

Analysis of plays in the South Sumatra Basin, Indonesia

Data from: Oil & Gas field Atlas, Vol III, IPA (1990)

Mixed charge

Abab 1

Jene 6

Kruh 3

Jirak 9

Ibul 6

Raja 7

Rambu-Tan 3

Tanjong Lontai 1

Tj Laban 4

Tabuan 1

Ramba 2

Grissik 1

K.Minyak 5

Pangadang 1

Benakat 1

Talang Akar 18

Rimbabat 1

Bulu 3

Tempino Deep 1

Kenali Asam 11

Mangung Jaya 1

Limau TQ51 4

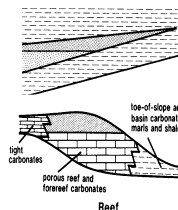
Langkap 1

Limau Timur 1

Arahan 4

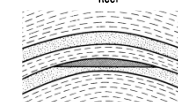
Senkuang 1

NE Teras 1



Stratigraphic sand pinch-out

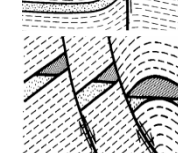
Reefoid relief



Simple anticline



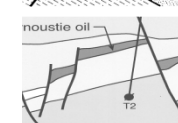
Inverted / thrust anticline



faulted anticline



Footwall / hangingwall closure



Tilted fault / horst block

Petroleum systems

Lahat-Lemat

Lahat/T.Akar- T.Akar

Talang Akar

Gumai

Palembang

Summary and conclusions

- It is recommended to keep the **proven play** distinct from the **exploration play** – the former provides analogues for the evaluation of the latter
- A structured hierarchic play definition would allow for identification of (i) more appropriate analogues (ii) more meaningful statistics based on more “normal populations” (iii) better sharing of play data
- Developing such a context for the classification of both proven and exploration plays allows for better comparison and prediction of play performance
- For most cases the **reservoir level (2)** represents the most suitable category for the study of plays, especially w.r.t. statistical methods, as there are commonly too few accumulations at the trap **level (3)**. However, this level is critical – there may be few examples, but it may provide the analogue for the subtle play that makes the difference!