Global Overview of Recent Exploration Investment in Deepwater - New Discoveries, Plays and Exploration Potential*

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Abstract

Strong global demand for liquid hydrocarbons and restricted access to new opportunities continues to push the oil and gas industry to explore frontier deep- and ultradeepwater basins. IHS data indicates that in the last 10 years, more than half of new global oil and gas reserves were discovered offshore. Remarkably, deep and ultra deepwater discoveries are becoming the dominant source of new reserve additions accounting for 41 percent of total new reserves based on a statistical evaluation of discoveries between 2005 and 2009. Despite all challenges such as the global economic downturn, fluctuation of oil prices and rising capital costs, this trend will continue into the future, making deepwater a key contributor to a new reserve and supply growth. Looking at the last five years: Giant and significant deepwater discoveries of oil and gas (41 BBOE, 2P) were made in Brazil, United States, Angola, Australia, India, Nigeria, Ghana and Malaysia. A number of countries recently joined the "Deepwater Club" including Ghana, China, Russia, Mexico, Trinidad & Tobago, Mozambique, Cameroon, Libya.

This study is aimed at identifying new plays in deepwater settings worldwide. These new plays were not known either on- or offshore prior to 2005, and represent new concepts of hydrocarbon accumulation in deepwater. In Brazil, almost 20 BBOE was reported discovered in sub-salt Cretaceous deposits. These finds inspired global interest in basins with evaporite deposits, especially those with pre-salt oil and gas accumulations. Although the Brazilian discoveries represent a new play type (Guaratiba Stratigraphic-Structural) in the Santos Basin, this geologic setting not is not unique. Globally about 30 BBOE were discovered in sub-salt Cretaceous reservoirs. Another significant oil discovery (3 BBOE, 2P) was made in Santonian turbidite sands of the Cote d'Ivoire Basin in Ghana. This discovery opens two new play fairways in the basin - a Turonian turbidite play and Campanian stratigraphic play. A significant

natural gas discovery of 6.3 Tcf (2P) was made in a Lower Miocene structure in the Levantine Basin, Israel. A new play in Israel - Miocene Clastics Stratigraphic shows a high potential for gas reserve additions in Miocene channel-fills and deepwater fans. Other new deepwater plays were established in the in North Luconia Province (Malaysia), South Makassar Basin (Indonesia), Faridpur Trough (India), More Basin (Norway) and Campeche Deep Sea Basin (Mexico).

Selected Reference

Gardosh, M.A. and Y. Druckman, 2006, Seismic stratigraphy, structure and tectonic evolution of the Levatine Basin, offshore Israel: Geological Society Special Publications, v. 260, p. 201-227.

Global Overview of Recent Exploration Investment in Deepwater

- Focused on global Deepwater hydrocarbon reserves additions and exploration drilling results
- 5 year interval is looked at
- Based on IHS International data covering global conventional oil and gas excluding North American onshore
- Our Definitions:

  Shallow water (SW) <400m

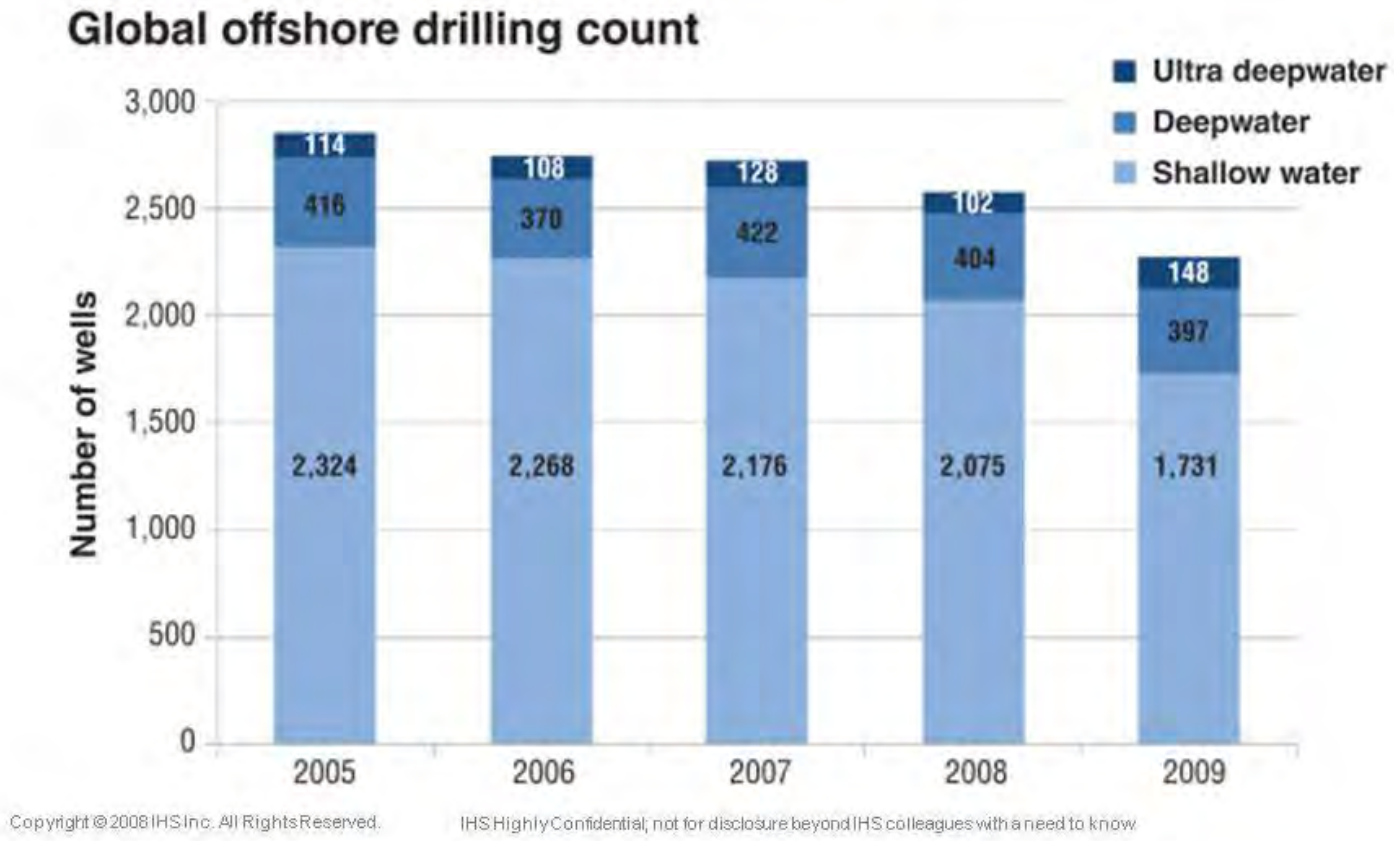
  400 <Deep water (DW) <1,500 m

  Ultra Deep water (UDW)>1,500 m

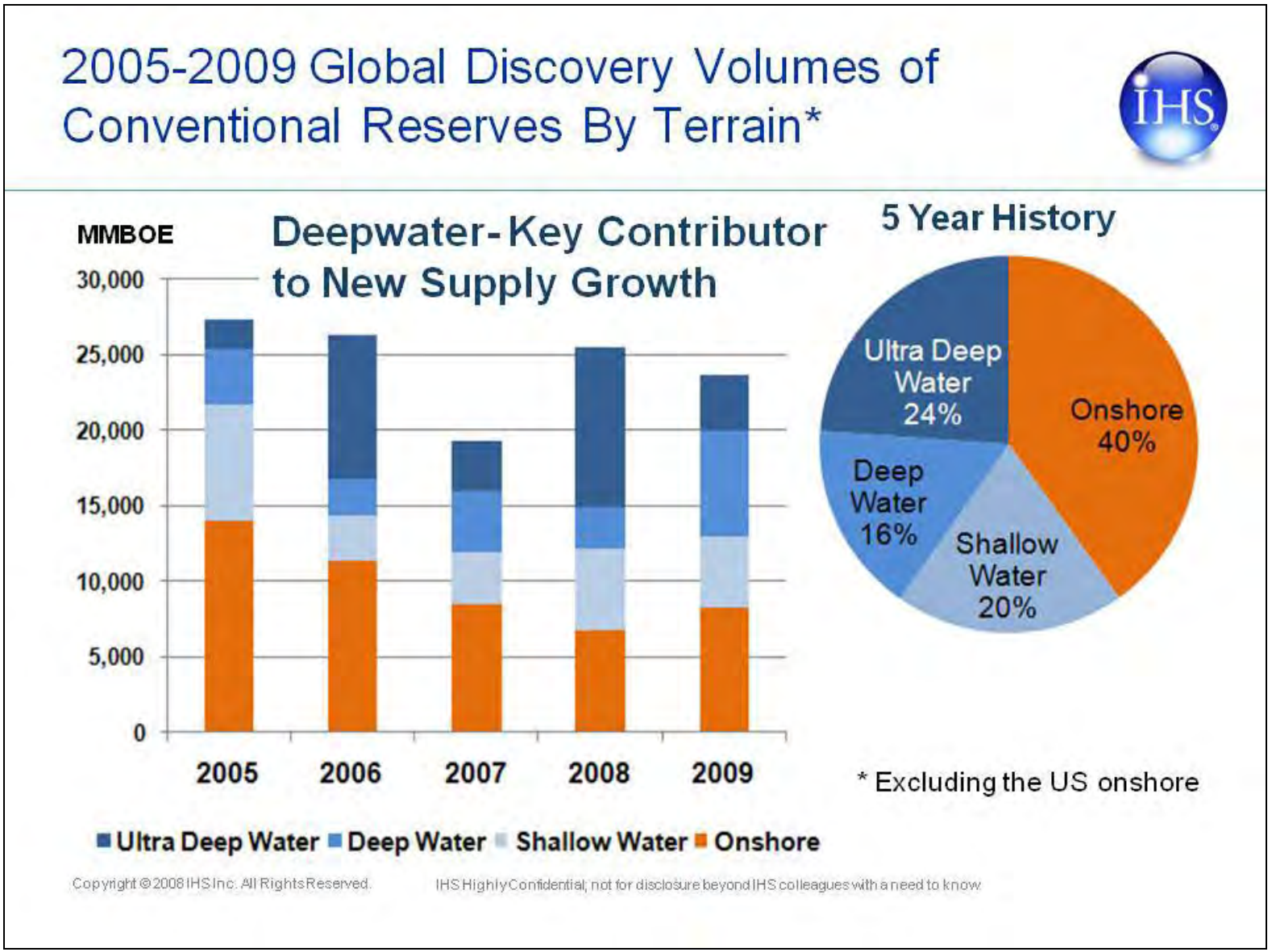
  2P or P+P reserves = Proven plus Probable

Notes by Presenter: The analysis presented in this paper is based on the IHS international E&P databases and the IHS Global E&P Reporting Service covering global conventional oil and gas excluding North American onshore. In this study, we used the following definitions: shallow water (SW) <= 400 m (1,312 ft), 400 m < deepwater (DW) <= 1,500 m (4,921 ft), and ultra deepwater (UDW) > 1,500 m; all related to bathymetric depth. In our reserve discussion we are using 2P reserves or P+P reserves=Proven plus Probable

2005-2009 Global Offshore Drilling Trend

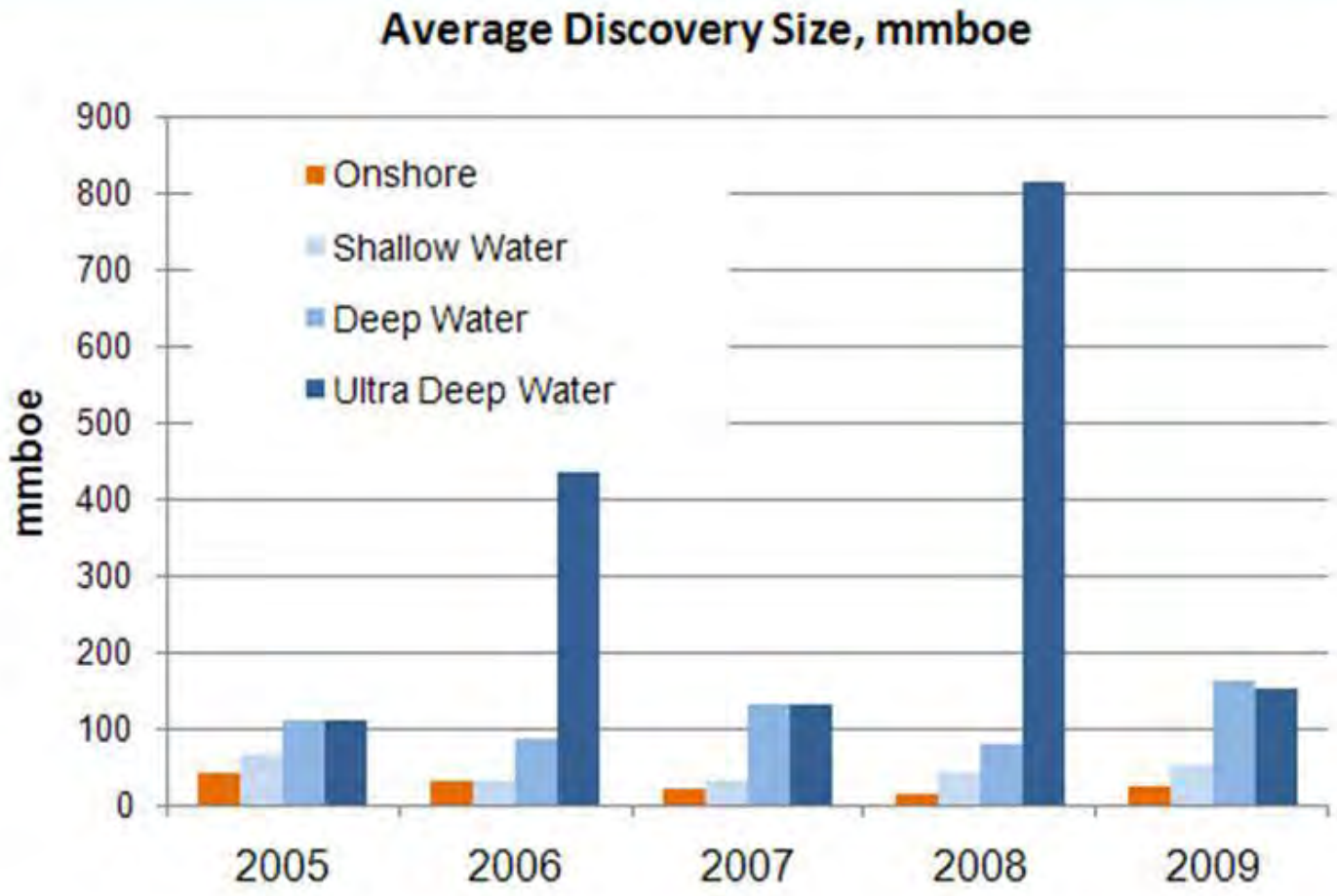


Notes by Presenter: **Looking at historical offshore drilling trend:** The 2008 global recession has had a strong impact on offshore drilling activity, including a slowing of the drilling rate in shallow water and shelf drilling. However, this decline trend in SW started earlier and was caused by various factors including the utilization of new technology, higher drilling success rates, and higher flow rates in deviated wells. Also, shallow water/shelf production in some countries approached an advanced stage of development and does not require extensive drilling programs. DW and UDW diverge considerably: exploration and development drilling trends do not show any indication of a reduction. In fact, 2009 became a record year for UDW drilling, totaling 150 wells. A preliminary well count also suggests strong DW and UDW drilling rates in 2010. On average, through 2005 and 2009, the drilled depth offshore increased from 3,100 m to 3,600 m (10,171 ft to 11,811 ft) and the average water depth from 450 m to 600 m (1,476 ft to 1,969 ft).

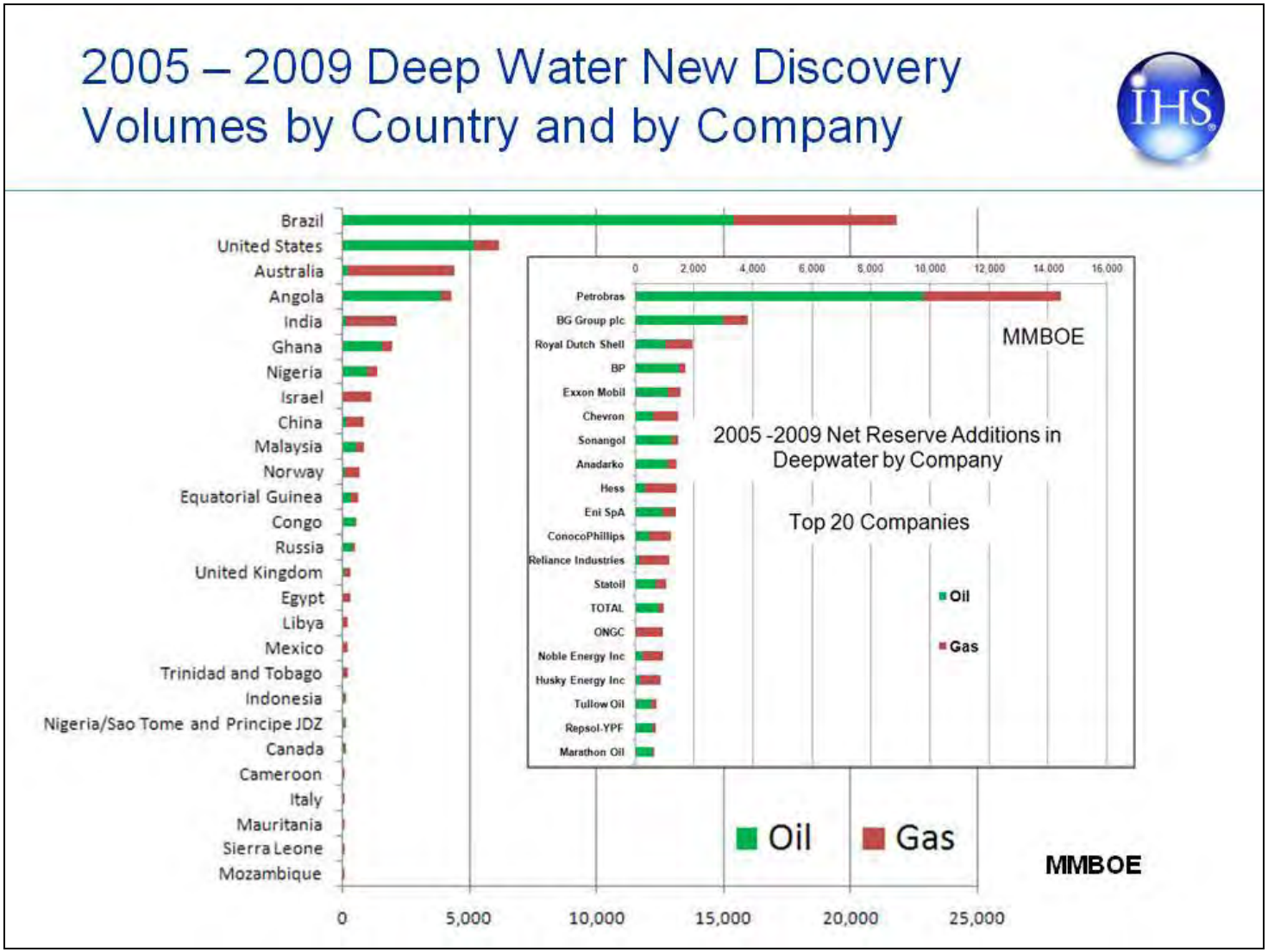


Notes by Presenter: A paucity of new giant discoveries in mature onshore petroleum provinces and restricted access to new business opportunities in major oil and gas producing countries are pushing the industry to explore offshore locations and especially frontier deepwater and ultra deepwater basins. IHS data indicates that, in the last 10 years, more than half of new global oil and gas reserves were discovered offshore. Deepwater and ultra deepwater discoveries are becoming the dominant source of new reserve additions, accounting for 41% of total new reserves based on a statistical evaluation of discoveries between 2005 and 2009. Despite all recent challenges such as the global economic downturn, credit crises, fluctuation of oil prices, and increased capital costs; this trend will likely continue, making offshore and particularly deepwater, key contributors to new supply growth.

Size of Opportunity – Global Overview by Terrain



Notes by Presenter: Five-year trend shows that average hydrocarbon discovery size is considerably larger offshore and especially in DW and UDW. In 2009, the average new discovery size in DW and UDW was about 150 MMboe (Millions of barrels of oil equivalent) that is considerably higher than that onshore (about 25 MMboe, 2P reserves). The economic threshold is forcing DW and UDW operators to focus their efforts on relatively large prospects and, fortunately, they were able to find these big scale opportunities.



Notes by Presenter: Twenty seven countries made oil and gas discoveries in DW and UDW. Brazilian DW discovery volume is off chart. Other countries made significant additions including the US, Australia, Angola, India, Ghana, Nigeria, Israel. In some of these countries, deepwater discoveries were made in known before plays (US, Australia, Angola, Nigeria, and China). In nine countries, new deep-water plays were established. Also, there is third category of countries which joined Deepwater Club, another words, Deepwater discoveries were made in these countries for the first time.

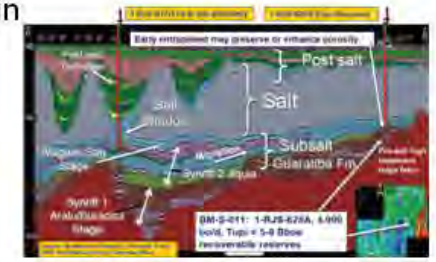
Talking about the companies who made these successful exploration efforts:

In top 20 list we see absolute leader Petrobras and his lucky partner in Brazil BG…..Not a big surprise to see super majors Shell, BP, Exxon Mobil, Chevron and big independents Anadarko, Hess, ConocoPhillips, National Oil Companies Sonangol, ONGC, Satoil, European Eni, Total..

2005-2009 New Deepwater Plays

These new plays were not known either on- or offshore prior to 2005, and represent new concepts of hydrocarbon accumulation in deepwater.

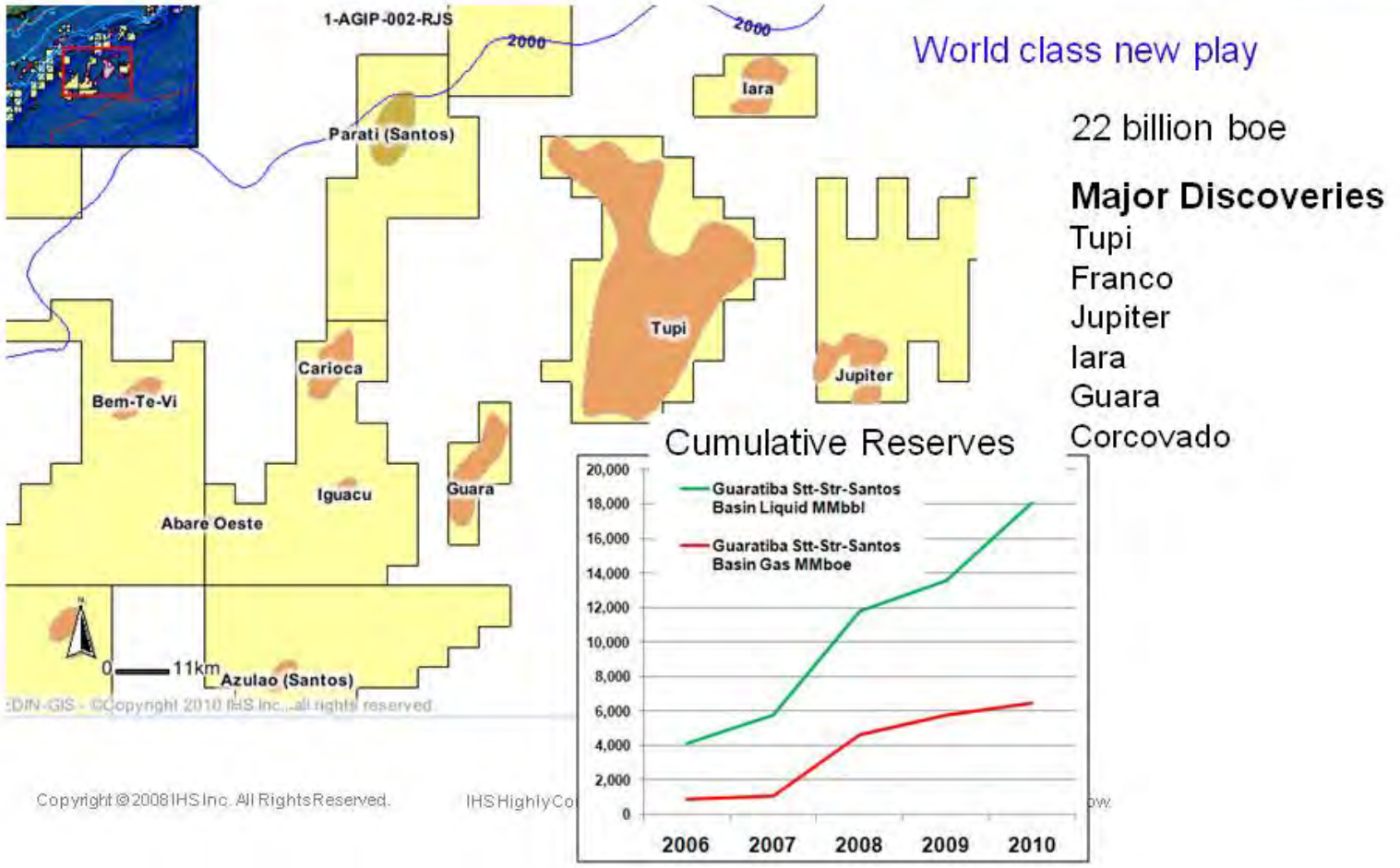
- Guaratiba Stratigraphic-Structural - Santos Basin
- Oligocene-Early Miocene Clastic Structural - North Luconia Province
- Turonian (turbidite) Stratigraphic - Cote d'Ivoire Basin
- Campanian Stratigraphic - Cote d'Ivoire Basin
- Oligocene-Pliocene Sandstone Structural - Campeche Deep Sea Basin
- Santul Clastic Stratigraphic-Structural-Unconformity - Greater Tarakan Basin
- Matla/Surma Stratigraphic - Bengal Basin)
- Paleocene Stratigraphic - More Basin
- Miocene Clastics Stratigraphic - Levantine Deep Marine Basin
- Tonasa Equivalent Stratigraphic - South Makassar Basin



Notes by Presenter: These new plays were not known either on- or offshore prior to 2005, and represent new concepts of hydrocarbon accumulation in deepwater.

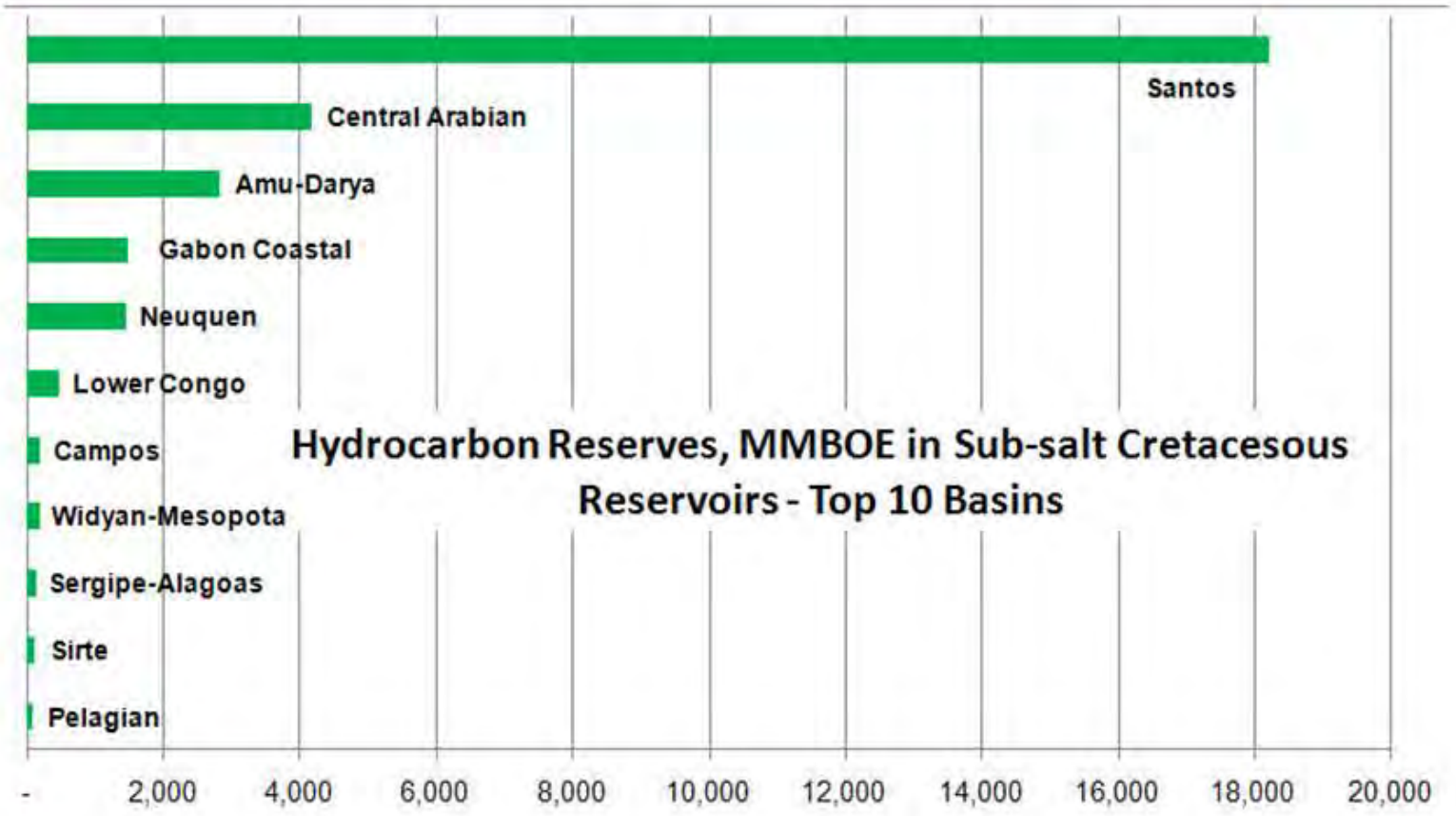
From 2005 to 2009 a number new plays were discovered in DW settings worldwide. These new plays were not known either on- or offshore prior to 2005, and represent new concepts of hydrocarbon accumulation in Deepwater. In Brazil, almost 20 Bboe, (Billions of barrels of oil equivalent), 2P reserves were reported discovered in sub-salt Cretaceous deposits of Santos Basin. Another significant oil discovery (3 Bboe, 2P) was made in Santonian turbidite sands of the Cote d'Ivoire Basin in Ghana. A significant natural gas discovery of 7 Tcf, (trillions of cubic feet), 2P was made in a Lower Miocene structure in the Levantine Basin, Israel. Other new deepwater plays were established in the North Luconia Province (Malaysia), South Makassar Basin (Indonesia), Faridpur Trough (India), More Basin (Norway) and Campeche Deep Sea Basin (Mexico).

Brazil – Guaratiba Stratigraphic-Structural Play



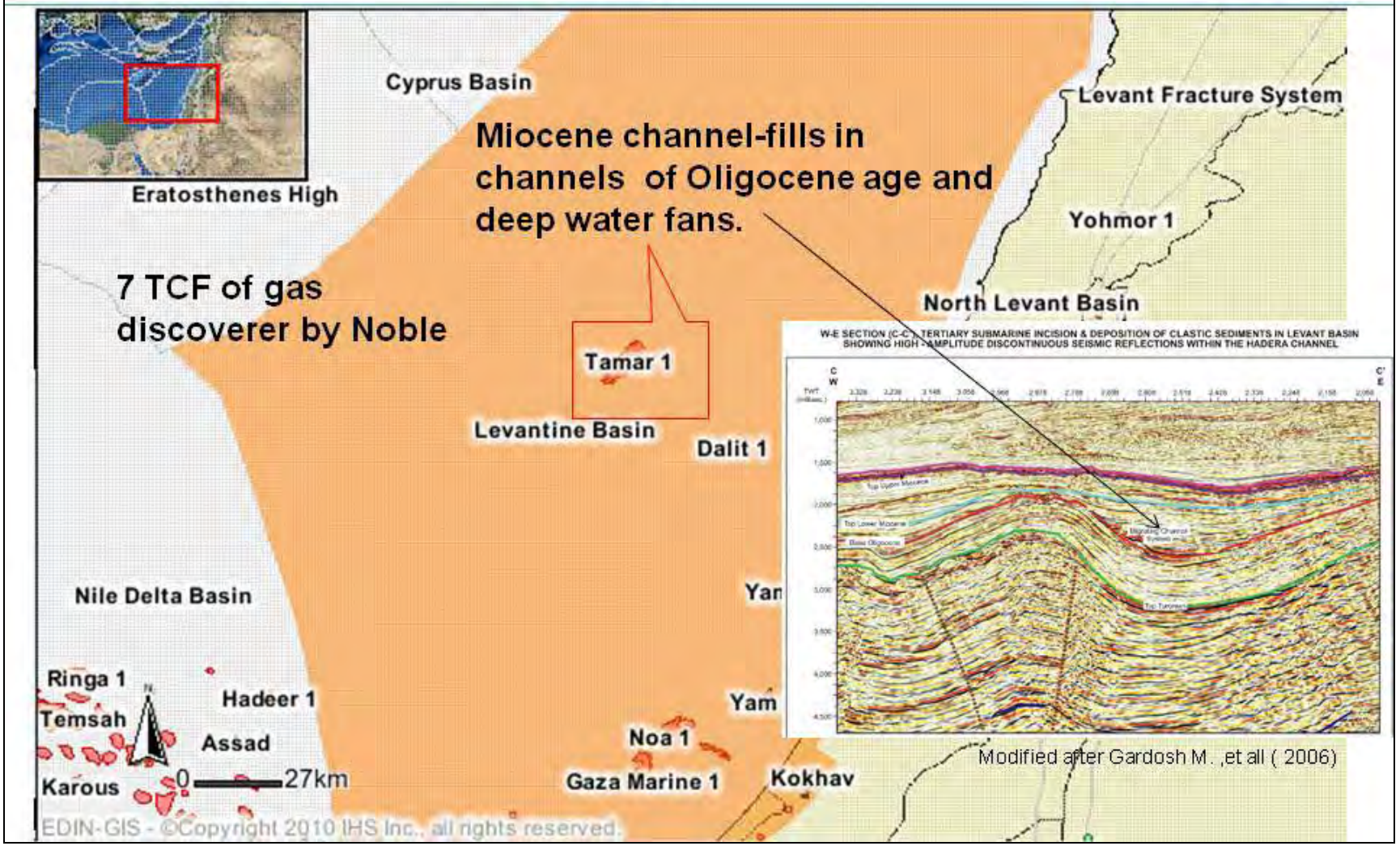
Notes by Presenter: Deepwater Brazil continues to surprise the world by adding reserves in sub-salt Cretaceous deposits (Lower Aptian-Barremian Lacustrine). These finds inspired global interest in basins with evaporite deposits, especially those with pre-salt oil and gas accumulations. The Brazilian pre-salt extends some 800 km from Espirito Santo state to Santa Catarina and is about 200 km wide. More than 20 billion beo were found in Guaratiba Formation heterogeneous layered carbonate - microbiolates with variable reservoir quality lies below salt layers of up to 2,000m. The trap type is structural, stratigraphic including pinch-outs, and faulting. As a result of further exploration efforts total reserve volume in sub-salt may double in Santos basin…Unofficial and highly speculative reserve estimates range wildly between 50 billion and 80 billion barrels.

Sub-Salt Reservoirs of Cretaceous Age

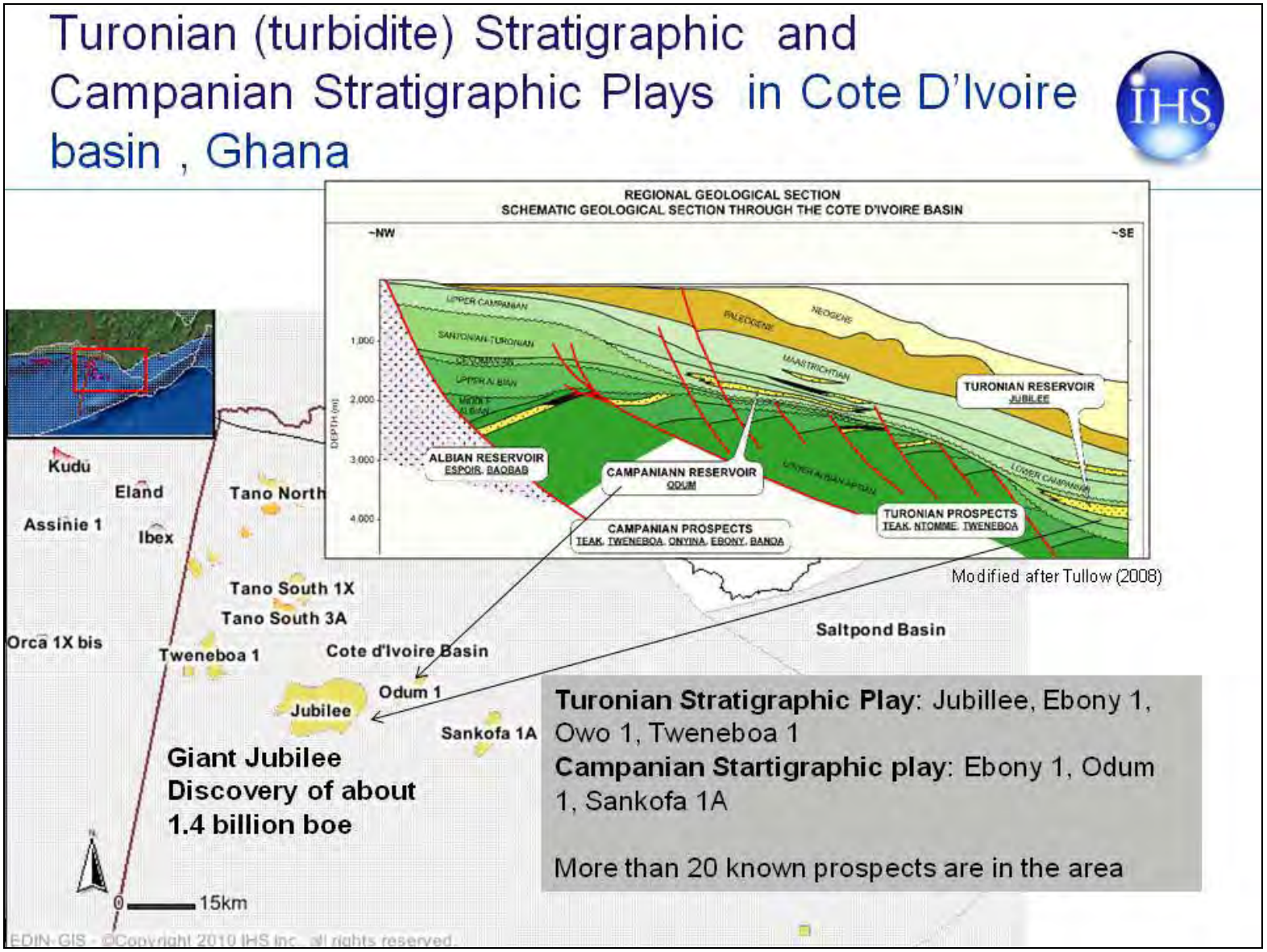


Notes by Presenter: Although the Brazilian discoveries represent a new play type in the Santos basin, this geologic setting is not unique. Globally, about 30 Bboe were discovered in sub-salt Cretaceous reservoirs, including Central Arabian, Amu-Darya, Gabon Coastal, Neuquénand , Lower Congo…and other basins

Miocene Clastics Stratigraphic in Levantine Deep Marine Basin, Israel



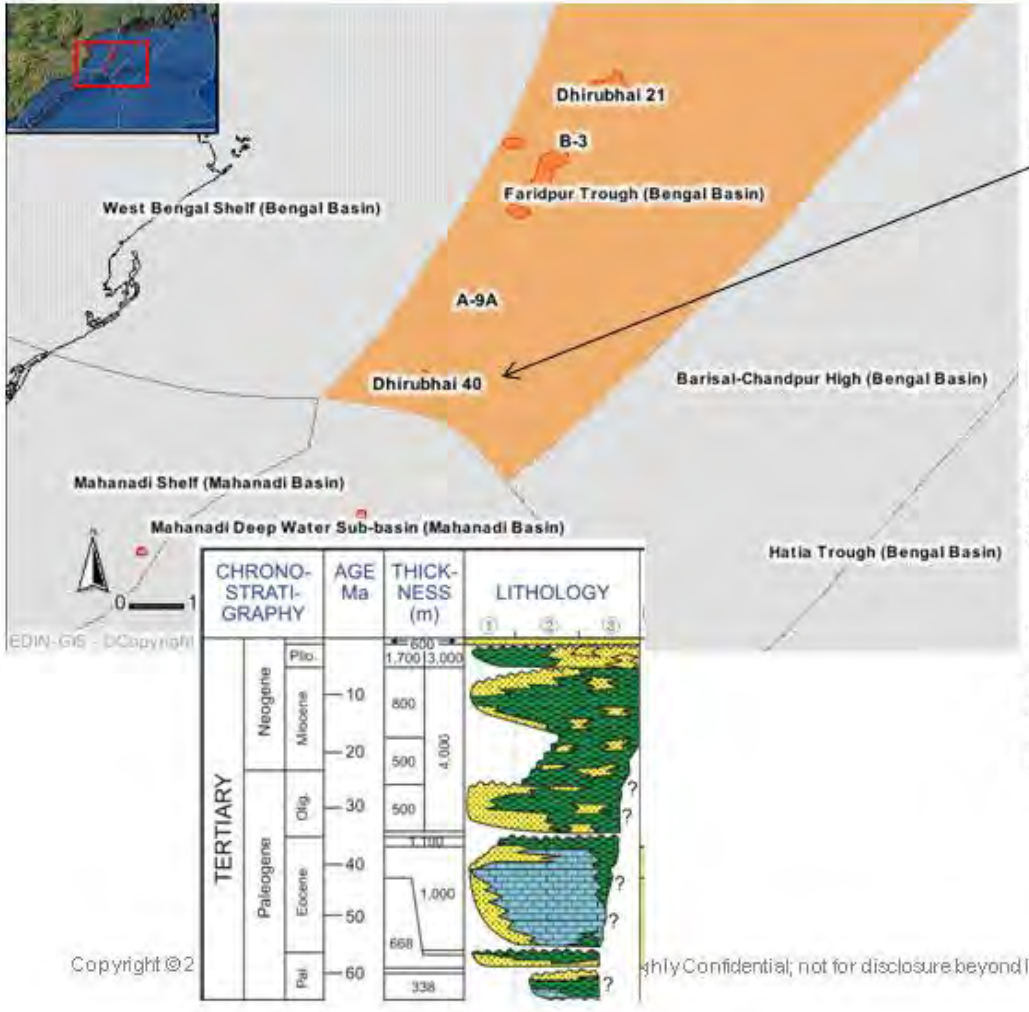
Notes by Presenter: **Levantine Basin is Passive margin overlying rift based on Bally Snelson:** In beginning of 2009, Noble announced that it had made a significant natural gas discovery at the **Tamar 1** wildcat. The well, which was drilled to test a subsalt, Lower Miocene structure in the Levantine Basin, reached a TD of 4,900m (16,076 ft). More than 140m (460 ft) of net pay in three high-quality Tertiary reservoirs has been identified on formation logs. The play has a potential for more significant discoveries within the basin….multi TCF amplitude. There is additional exploration potential in Albian turbidite sand unit. However, Cretaceous horizons were not penetrated during the initial exploration.



Notes by Presenter: **Turonian (turbidite) Stratigraphic:** Within the West Africa's transform margin, the exploration concept of Kosmos Energy has been innovative. The company has been looking for stratigraphic traps in reservoirs of Upper Cretaceous age while most of the already discovered hydrocarbon in the area has been drilled based on structural traps in rather formations of Lower Cretaceous age. Therefore with the Mahogany find (renamed Jubilee in 2008) Kosmos Energy has opened up a new petroleum play within the West Africa's transform margin. The Turonian (turbidite) Stratigraphic Play is present in the Jubilee field (or previously known as Mahogany and Hyedua discoveries) (March 2008).

The Campanian Stratigraphic is a new play discovered recently at Odum 1 in deep water in Ghana. The well encountered a gross oil column of 60 m, and 22 m of net pay samples recovered from the reservoir indicate the presence of 29 deg. API oil.

Matla/Surma Stratigraphic Play in Faridpur Trough, Bengal Basin, India



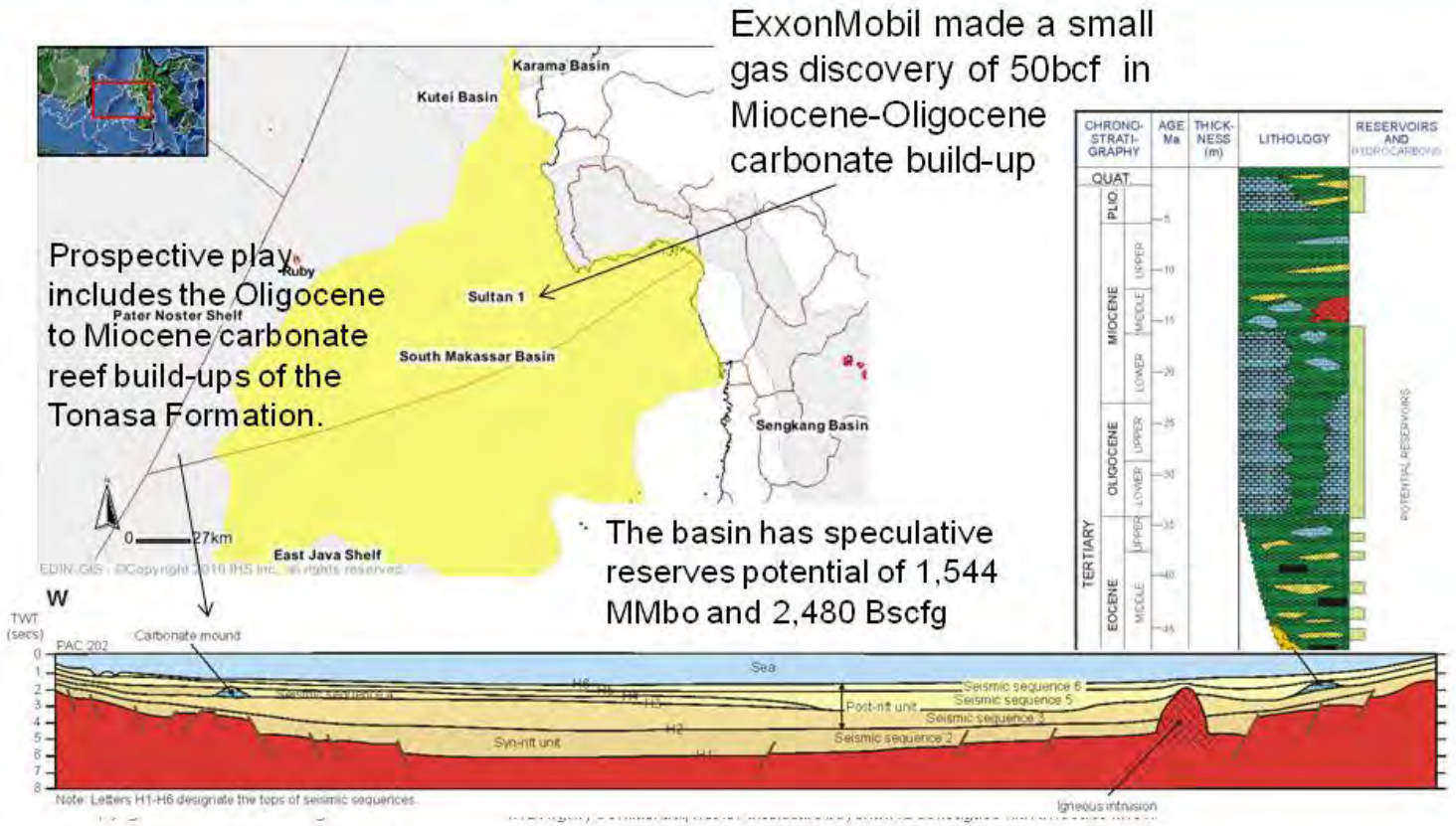
Dhirubhai 40 gas discovery made by Reliance
150 bcf of gas

Matla/Surma Stratigraphic Play – Neogene sandstone reservoirs within this play were deposited by turbidites in deep water submarine fan systems .

Potentially is widespread in Bengal basin, contains significant gas reserves 2-3 TCF.

Notes by Presenter: **Moving to Asia: Bengal Basin – India:** Dhirubhai 40 Discovery (150 bcf of gas) made by Reliance. Sandstone reservoirs within this Matla/Surma Stratigraphic play were deposited in by turbidites in deep water submarine fan systems that developed in this area during the Neogene. The Matla/Surma Stratigraphic Play is expected to be widespread in the basinal area of the Bengal Basin (Faridpur and Hatia troughs). This play potentially contains significant gas reserves of 2-3 TCF.

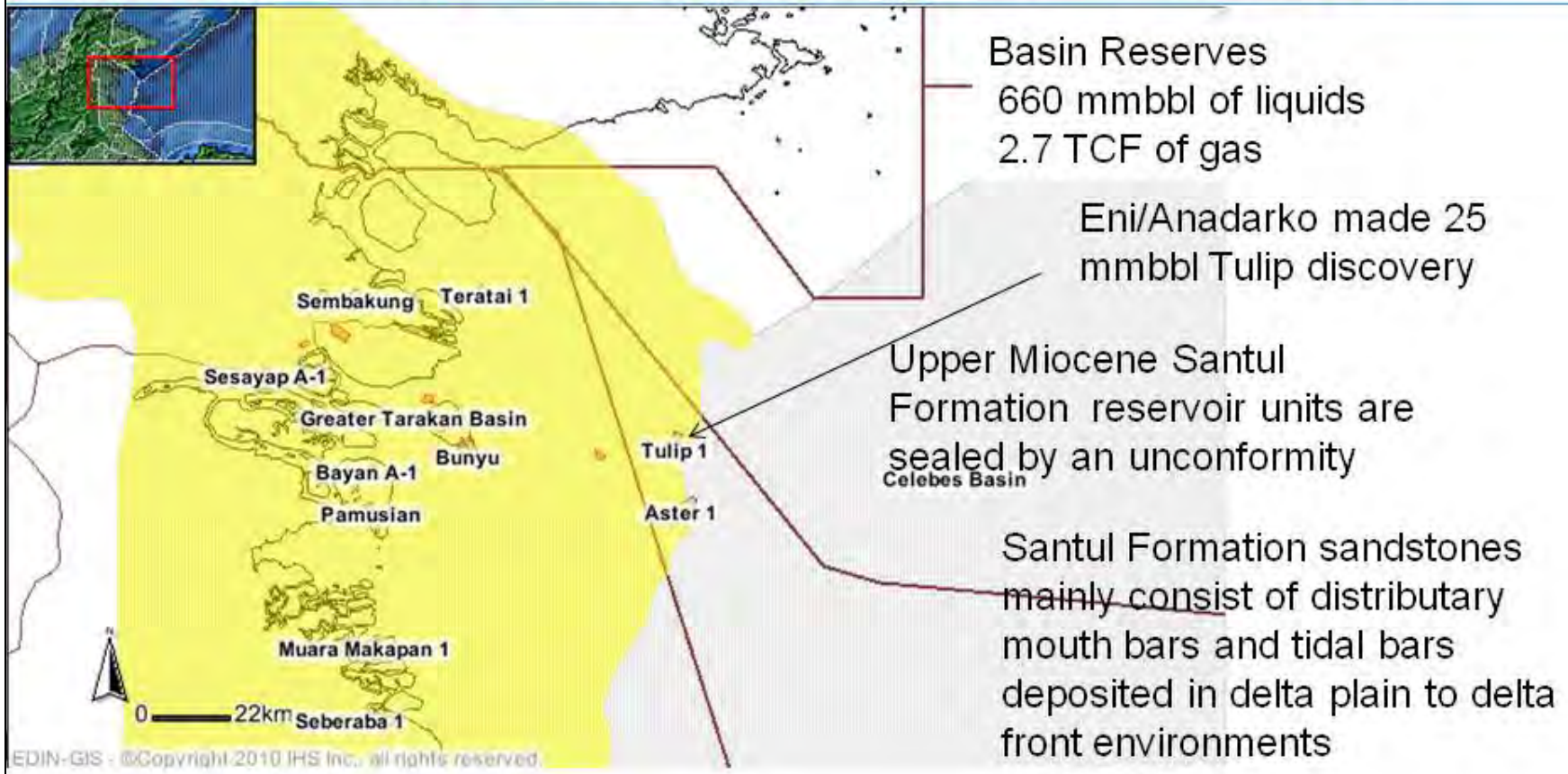
Tonasa Equivalent Stratigraphic, South Makassar Basin, Indonesia



Notes by Presenter: **Makassar Basin, Indonesia:** ExxonMobil made a small gas discovery of 50bcf in Miocene-Oligocene carbonate build-up in South Makassar Basin. The South Makassar Basin (Rift type) is located between the islands of Borneo and Sulawesi in Indonesia. The basin has speculative reserves potential of 1,544 MMbo and 2,480 Bscfg. Primary hydrocarbon targets for the basin are fluvio-deltaic to marine sandstone reservoirs of the Eocene age. A new prospective play includes the Oligocene to Miocene carbonate reef build-ups of the Tonasa Formation.

High-risk elements in this potential play include the following:
- Presence of a source rock is not proven;
- Inversion during the Middle to Late Miocene, aside from forming large trap structures, might have ruptured top and lateral seals by initiation or reactivation of faults.

Santul Clastic Stratigraphic-Structural-Unconformity Greater Tarakan Basin, Indonesia



Basin Reserves
660 mmbbl of liquids
2.7 TCF of gas

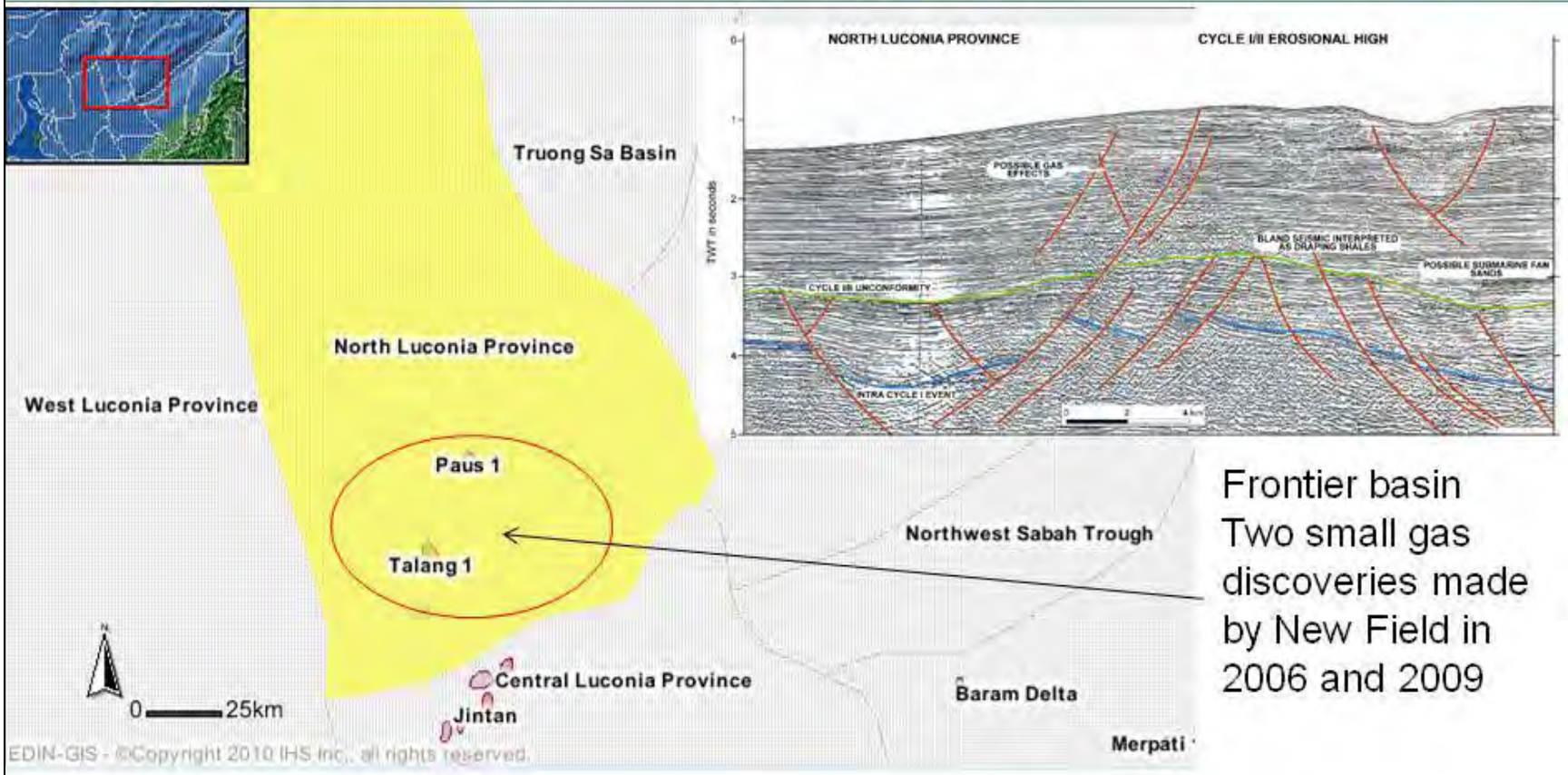
Eni/Anadarko made 25 mmbbl Tulip discovery

Upper Miocene Santul Formation reservoir units are sealed by an unconformity

Santul Formation sandstones mainly consist of distributary mouth bars and tidal bars deposited in delta plain to delta front environments

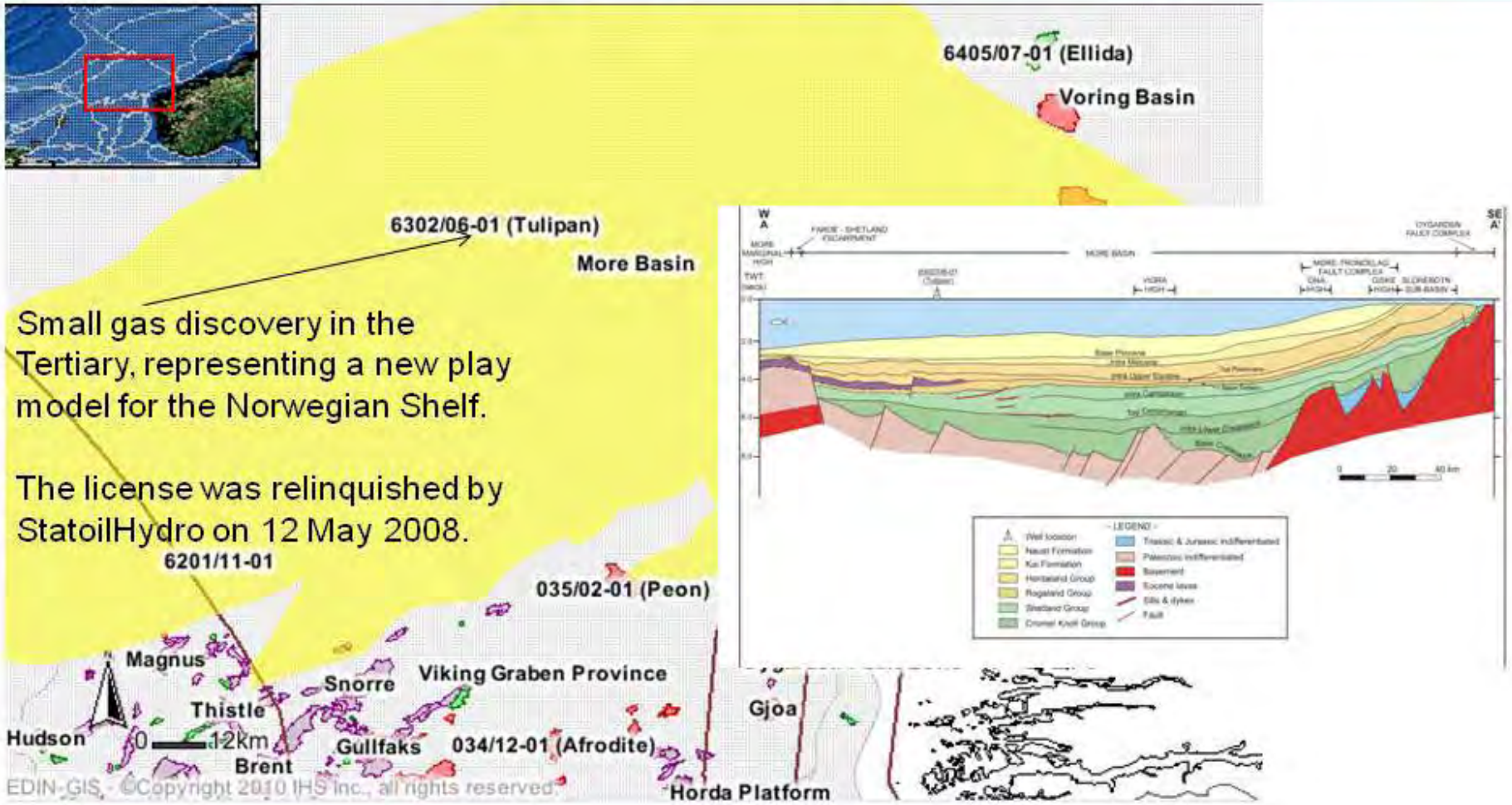
Notes by Presenter: Eni/Anadarko made 25 mmbbl Tulip discovery in Upper Miocene Santul formation.
The reservoirs are sealed by unconformity. Santul Formation sandstones mainly consist of distributary mouth bars and tidal bars deposited in delta plain to delta front environments

Oligocene-Early Miocene Clastic Structural in North Luconia Province, Malaysia



Notes by Presenter: The North Luconia Province is a frontier province located in northernmost Sarawak, Malasia. The province lies entirely within the southwestern South China Sea in water depths of between 200-2,000 m. Two small gas discoveries made by New Field in 2006 and 2009. Oligocene-Early Miocene Clastic Structural play is speculated to be the predominant play in the province. These sandstones were deposited in lower coastal plain to shallow marine environments.

Paleocene Stratigraphic in More Basin, Norway

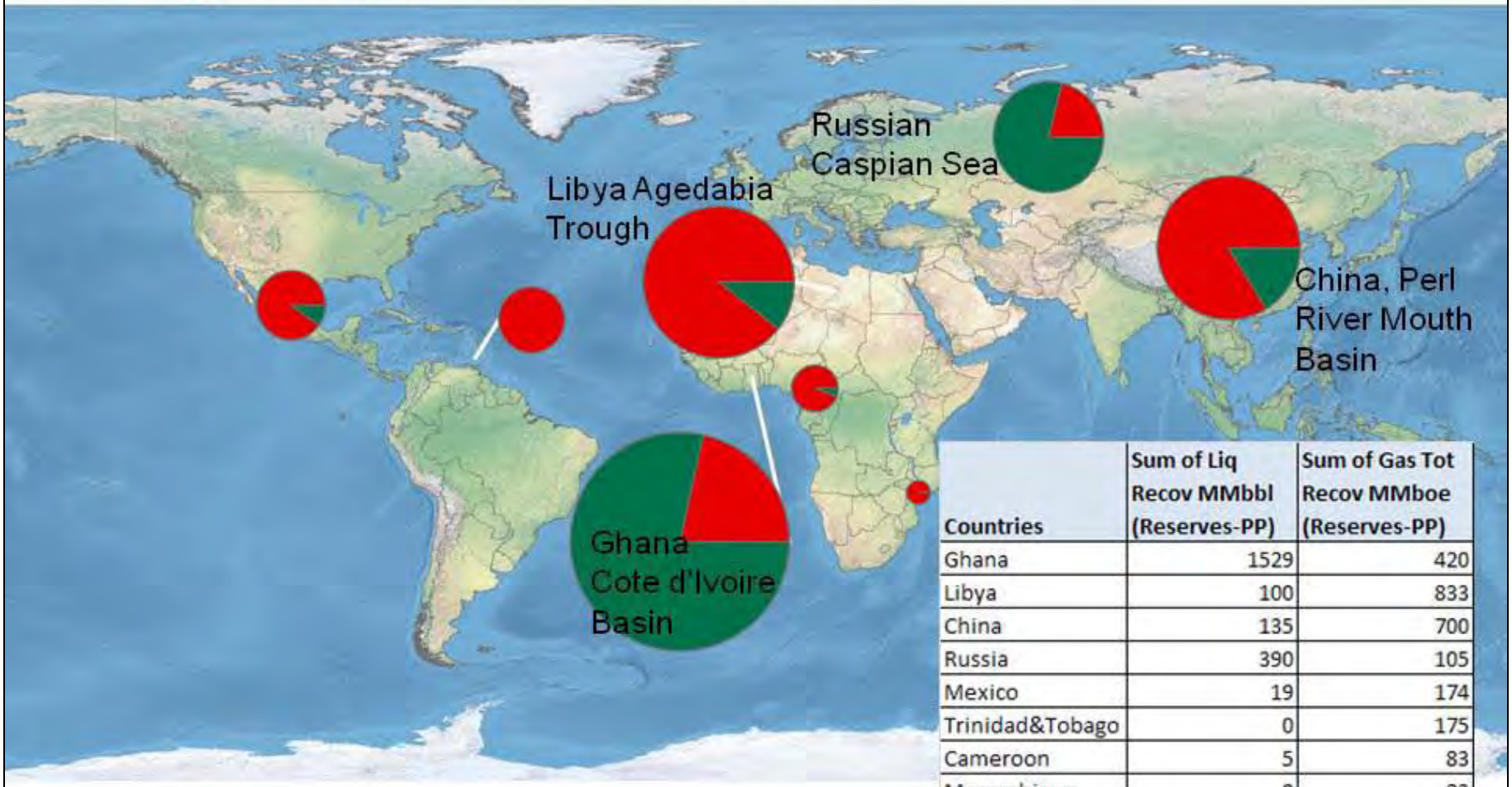


Notes by Presenter: The recent 6302/6-1 (Tulipan) discovery in the deepwater western part of the More Basin is a small gas discovery in Early Tertiary sandstone and a new play model on the Norwegian Continental Shelf.

Oligocene-Pliocene Sandstone Structural Campeche Deep Sea Basin, Mexico

Notes by Presenter: The last new play in our list is Oligocene-Pliocene Sandstone Structural in Campeche Deep Sea Basin, Mexico, an anticlinal structure, similar to Lakach field. The reserve size is 240 bcf.

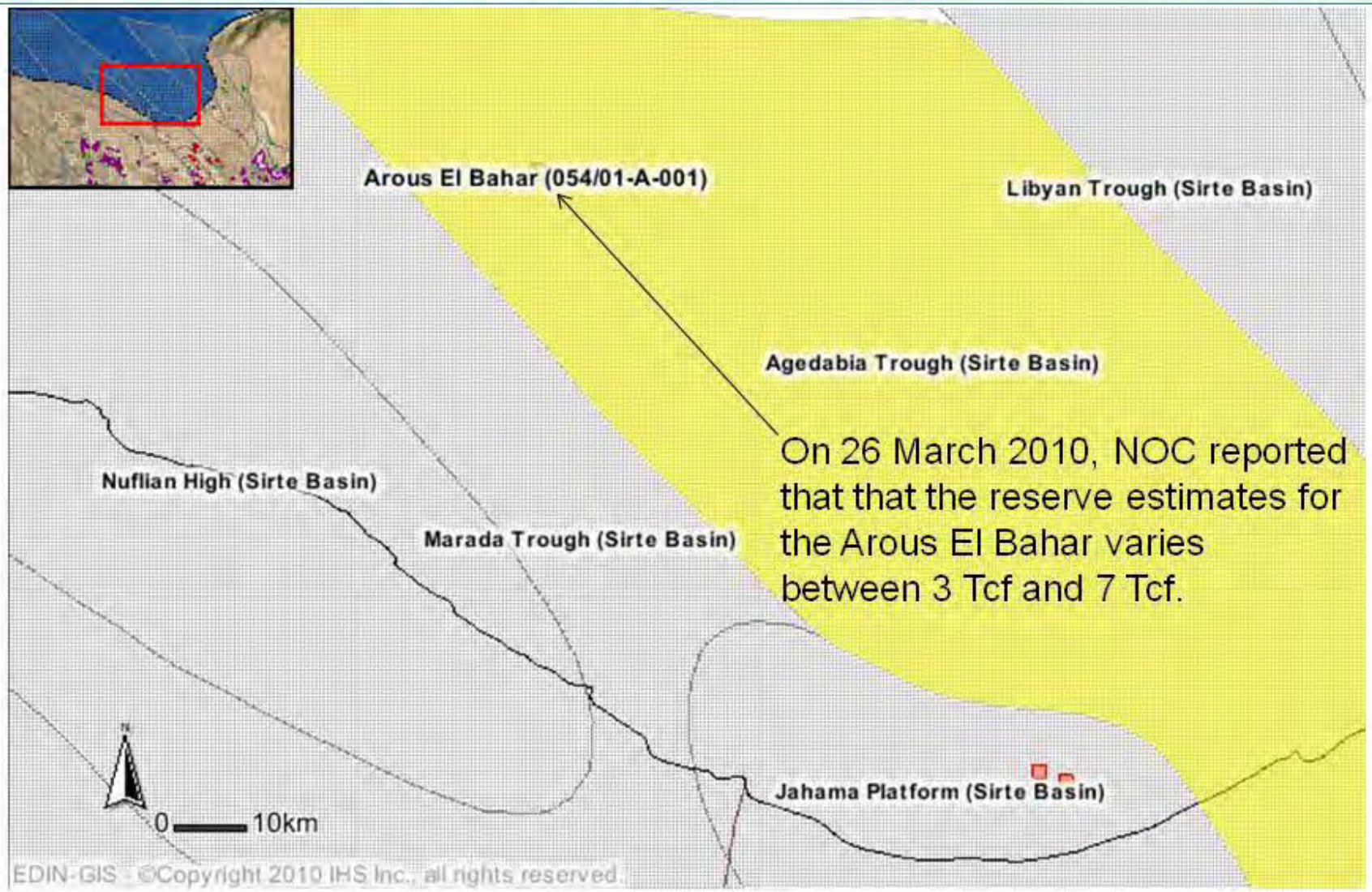
A number of countries recently joined the "Deepwater Club" - 2005-2009



Countries	Sum of Liq Recov MMbbl (Reserves-PP)	Sum of Gas Tot Recov MMboe (Reserves-PP)
Ghana	1529	420
Libya	100	833
China	135	700
Russia	390	105
Mexico	19	174
Trinidad&Tobago	0	175
Cameroon	5	83
Mozambique	0	23

Notes by Presenter: Recently eight countries joined Deepwater Club, in other words, deepwater discoveries were made in these countries for the first time. Four of them Ghana, Libya, China and Russia made significant discoveries. We talked about Ghana earlier. In our next few Notes by Presenter: s, we will review these discoveries starting from Libya.

First Deep Water Discovery in Libya

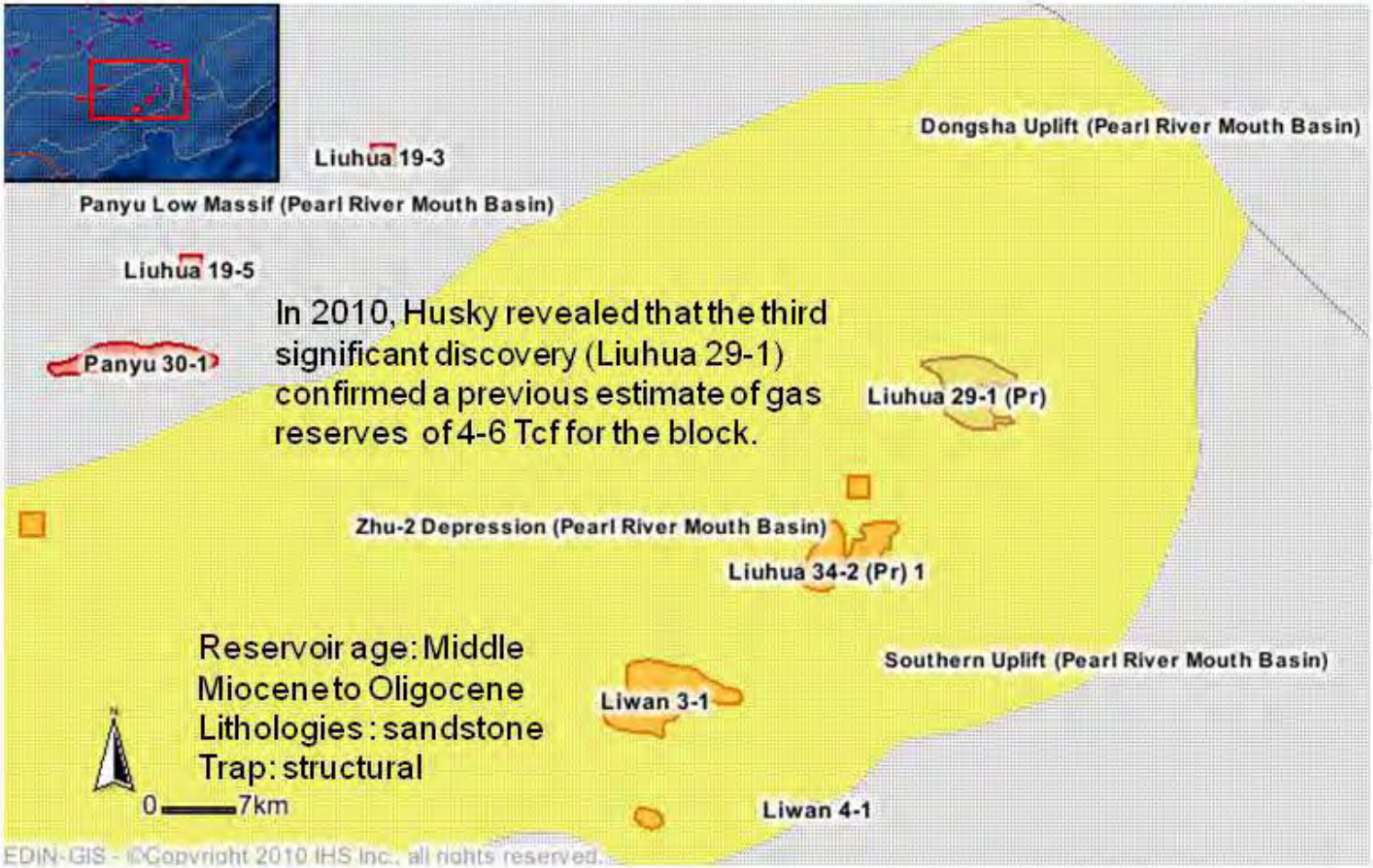


Notes by Presenter: This is the very first discovery in deepwater in Libya. Hess reported that the discovery well encountered a gross HC section of about 150 m at various intervals in the well. The operator logged also 6 m gas pay in Eocene carbonates and 9 m oil section in Bahi Fm.

First Deep Water Discovery in Russian Caspian

Notes by Presenter: **Central Caspian Basin:** This large structure is located on the border of the Kazakhstan and the Russian republic of Dagestan (at about 150 km of the Russian coast). The structure was identified by 2D seismic in 1997 and delineated for exploratory drilling in 2005. 390 mmbbl of oil and 100 mmboe of gas were discovered in Lower Cretaceous reservoirs.

First Deep Water Discovery in China



Notes by Presenter: Husky made three significant discoveries in Zhu-2 depression, Pearl River Mouth Basin. Three gas fields in Block 29/26: Liwan 3-1, Liuhua 34-2, and Liuhua 29-1 have initially in place of 4-6 Tcf for the Block.

Notes by Presenter:

- The 2008 global recession has had a strong impact on offshore drilling activity, including a slowing of the drilling rate in SW. DW and UDW diverge considerably: exploration and development drilling trends do not show any indication of a reduction. In fact, 2009 became a record year for UDW drilling, totaling 150 wells.
- Deepwater and Ultra Deepwater discoveries will become more important in maintenance of production levels in the face of increasing global demand, especially for liquids.
- In 2009 the average new discovery size in DW and UDW was about 150 MMboe that is considerably higher than that onshore (about 25 MMboe, 2P reserves).