[PS]Sub-Salt and Pre-Salt Plays – How Much Are Left To Be Discovered?*

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Abstract

The discovery of sub-salt and pre-salt fields has resulted in the addition of significant reserves in different parts of the globe. However, these may represent only a fraction of the play reserves. The question is how much are left? One way of evaluating the remaining reserves is to use geological models; another way is to use Field Size and Yet-To-Find (YTF) analyses. We focus here on the US Gulf of Mexico (GoM), offshore Brazil and offshore West Africa regions. We summarize the main hydrocarbon exploration events and give a description of the play characteristics. Creaming curves and field size graphs are presented and parabolic fractal distributions allow us to propose a low and a high estimate of the remaining recoverable reserves.

The US GoM has been extremely prospective with over 80 sub-salt/pre-salt discoveries. In the 1970s and 1980s, many wells were drilled into salt but the play exploration really took off during the 1990s. In 1995-1997, companies stepped up leasing into ultra-deep water; more recently, the deepest US wells have been drilled in shallow waters identifying a major new sub-salt trend. Over 1.5 Bboe are estimated for these plays only and our analysis indicates that several fields of 0.1 Bboe or more can still be discovered, with total recoverable reserves between two and nine Bboe.

First evidences of oil in pre-salt deposits of the Brazilian offshore were perceived on the shelf of the Campos Basin from Lagoa Feia carbonates (Badejo) in 1975, followed by about 10 discoveries in 1980s-1990s. In the mid-2000s, giant oil reserves were discovered in the Guaratiba pre-salt carbonates in the Santos Basin. The total recoverable reserves of the pre-salt accumulations exceed 50 Bboe. Our YTF analysis suggests that remaining recoverable reserves could be between 18 and 30 Bboe.

The first pre-salt discovery of offshore West Africa was made in 1966 in Angola. Since then, about 50 discoveries have been made with Malongo West being the largest. In late 2011, a large oil accumulation (Cameia 1) was found in the deep water Kwanza Basin. Approximately 3.1 Bboe have been discovered. The YTF method suggests that up to 1 Bboe are still to be found. However, if we consider the possibility to discover giant accumulations like offshore Brazil, this potential increases to 18 Bboe. Other salt basins around the world (E. Mediterranean

Sea, E. Canada, etc) are carefully revisited and sub-salt/pre-salt plays are now becoming part of many oil companies' portfolios.

Sub-salt and Pre-salt Plays
How Much is Left to Be Discovered?

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Introduction

The discovery and development of sub-salt and pre-salt fields in past decades have resulted in the addition of significant reserves and production in different parts of the globe. Most of the discoveries were made using less-advanced seismic-imaging technologies, and may therefore represent only a fraction of the potential that is likely to be discovered offshore, especially in deep and ultra deep waters. The question is: how much is there still to be discovered? One way of evaluating the remaining reserves is to use complex models including source rock richness and distribution, production index, and reservoir distribution. Another way is to apply the Field Size Distribution and Yet-To-Find methods to provide an estimate and distribution of remaining recoverable reserves.

In this study, we focus on the US Gulf of Mexico, offshore Brazil and offshore West Africa regions. We summarize the main events of the hydrocarbon exploration and give a brief description of the principal play characteristics for each region. Graphs such as creaming curves by time and field size distributions are presented, providing a better understanding of the exploration history of the regions. Finally, a low and high estimate of the remaining recoverable reserves are presented for each region, using different parabolic fractal distribution scenarios.

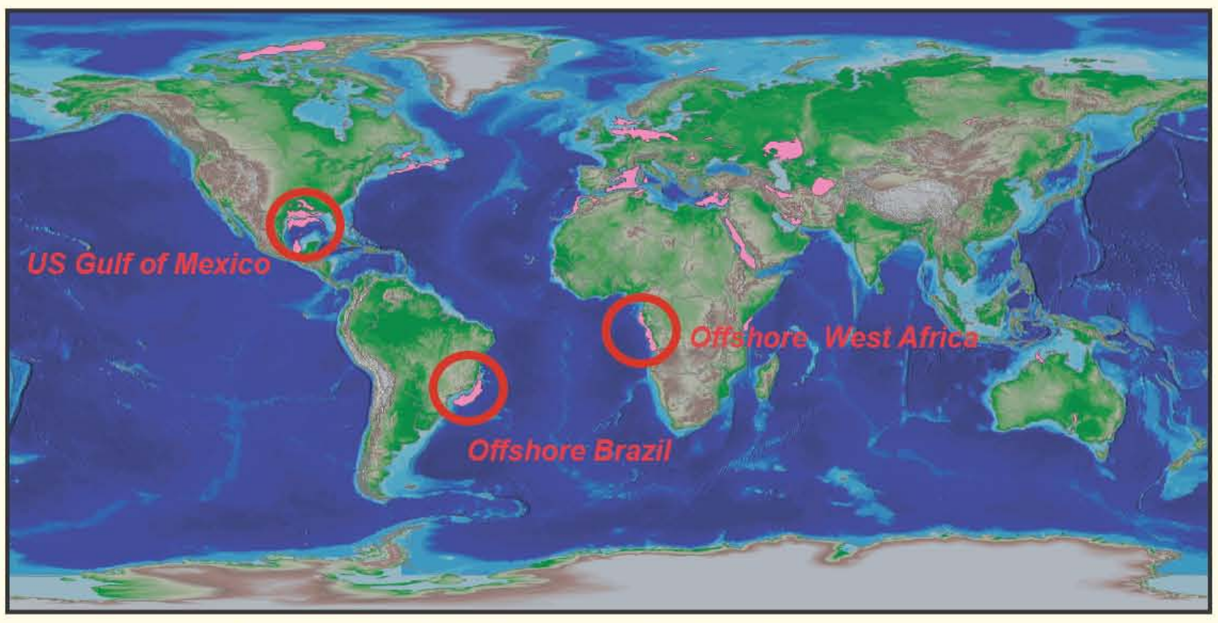


***Figure 1**. Main Salt Basins and Studied Areas.*

Methodology

The distribution of objects in the nature has been investigated over many years, and both linear and curved plots have been proposed to describe the relationship between size and rank. Two models, parabolic and lognormal distributions, are usually applied to estimate the Yet-To-Find (YTF) reserves of plays. The log-normal distribution is the distribution of a random variable whose logarithm is normally distributed, while for the parabolic fractal distribution, the logarithm of the rank is a quadratic polynomial of the logarithm of the rank. Laherrere (1996) has demonstrated that, when objects in a well-defined natural domain are listed in decreasing size and plotted on a log-log format with size against rank, the result is not a straight line as would be expected from usual models, but follows a parabolic distribution.
With the field size distribution and YTF methods we can attempt to provide an estimate and the distribution of the remaining recoverable hydrocarbon reserves. The main empirical feature of the hydrocarbon distribution applied here is that, in a given basin, there are usually a few large fields and a great number of small ones. The assumption is that the largest structures are drilled in the initial phase of exploration and, therefore, the biggest discoveries are made first, with the smaller fields being found during the later exploration phases.

A Parabolic model, known as Parabolic Fractal, demonstrates that a distribution of objects in a well-defined natural domain is parabolic when size is plotted against rank on a log-log format. A complete or near complete distribution of the larger fields, which in practice are usually readily identified and quantified, can be used to define the parabola following a rule of self-similarity, and hence describes the full distribution down to the smallest field (Laherrere, 1996).

In this graph, the black line projects the Existing Reserves (ER) and the red curve represents a synthetic distribution of the Estimated Total Reserves (ETR) - in mathematics, a quadratic function is a polynomial function of the form: $f(x) = ax^2 + bx + c$ - and displays the best fit through the measured values.

Based on the best fit, the YTF reserves are calculated by subtracting the ER from ETR.

By plotting known sizes versus the number of discoveries in a play, we obtain a field size distribution graph. Also based on the assumption that reserves are lognormally distributed in nature, a mature field size distribution would show a logarithmically increasing number of fields with decreasing reserves size.
In the initial phase of exploration, the largest structures are drilled and hence the biggest discoveries are made first. Subsequent discoveries will have smaller reserves.

The gaps between the actual number of fields and the mature field size distribution curve indicate the "missing fields".

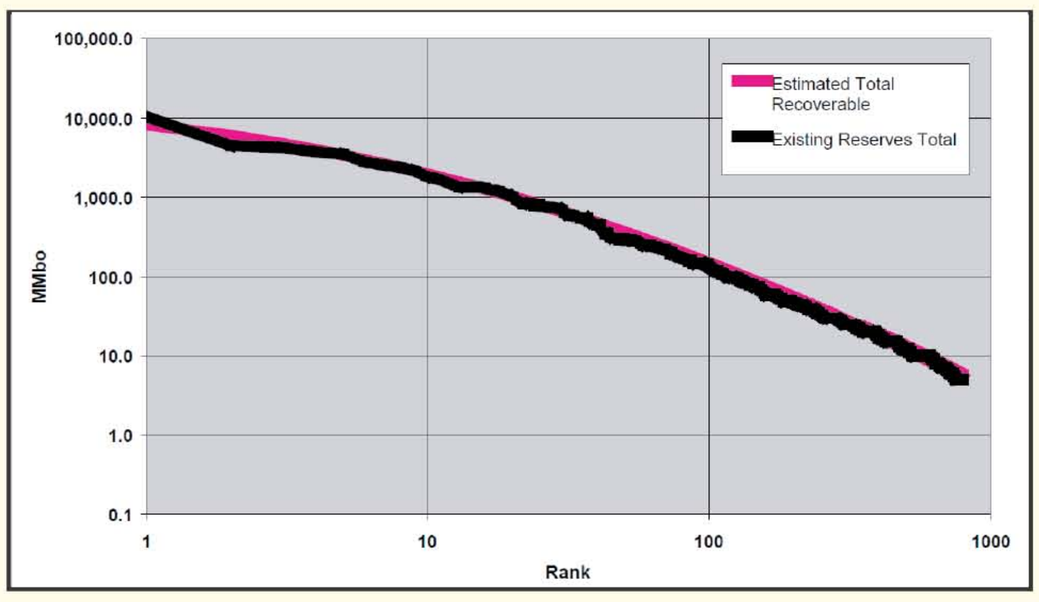


***Figure 2.** Example of Parabolic Fractal Distribution.*

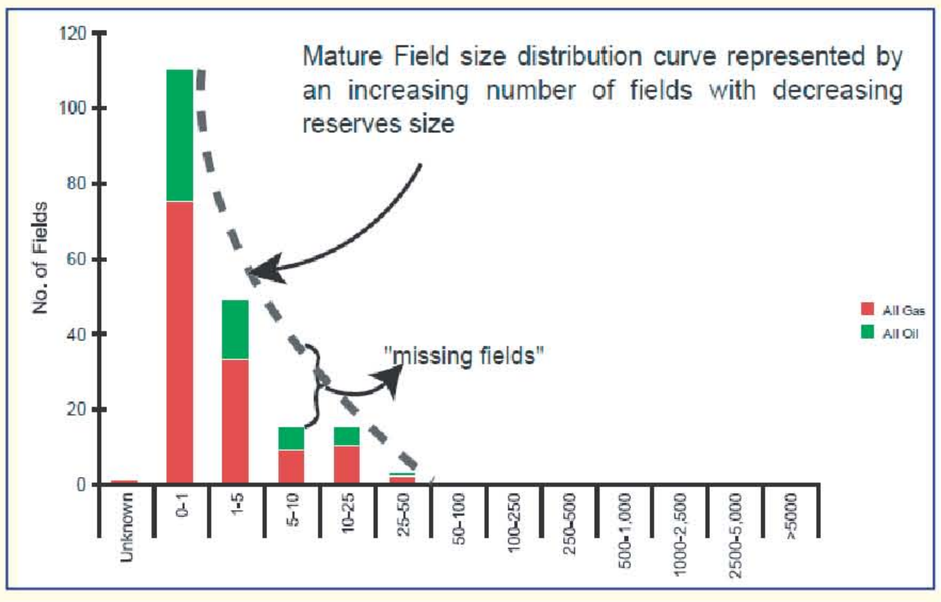


***Figure 3**. Example of Field Size Distribution.*

Exploration Trends

The Gulf of Mexico Basin has proven extremely prospective for oil and gas and about 80 sub-salt and pre-salt discoveries have been made to date. Throughout the 1970s and 1980s, hundreds of wells were drilled into salt on the outer shelf and slope of the northwestern Gulf of Mexico. These wells barely penetrated the whole salt features that are now known to be laterally emplaced horizontal salt sheets.

The exploration of the sub-salt play in the US Gulf of Mexico really took off during the 1990s. Several discoveries ranging from less than 100 million barrels of oil equivalent (MMboe) up to several hundred MMboe recoverable reserves have been made.

During the ultra-deep water lease sales in 1995-1997, companies stepped up leasing beyond the sub-salt play into ultra-deep water, encouraged by easier-to-image prospects near the edges of the salt structures. The deepest US oil and gas wells have been recently drilled in the shallow part of the Gulf of Mexico. Recent successes such as Davy Jones, Blackbeard East, Blackbeard West or Lafitte have identified a major new sub-salt trend (salt weld) on the shelf of the Gulf of Mexico and prospects on large structures with multi-Tcf of reserves potential.

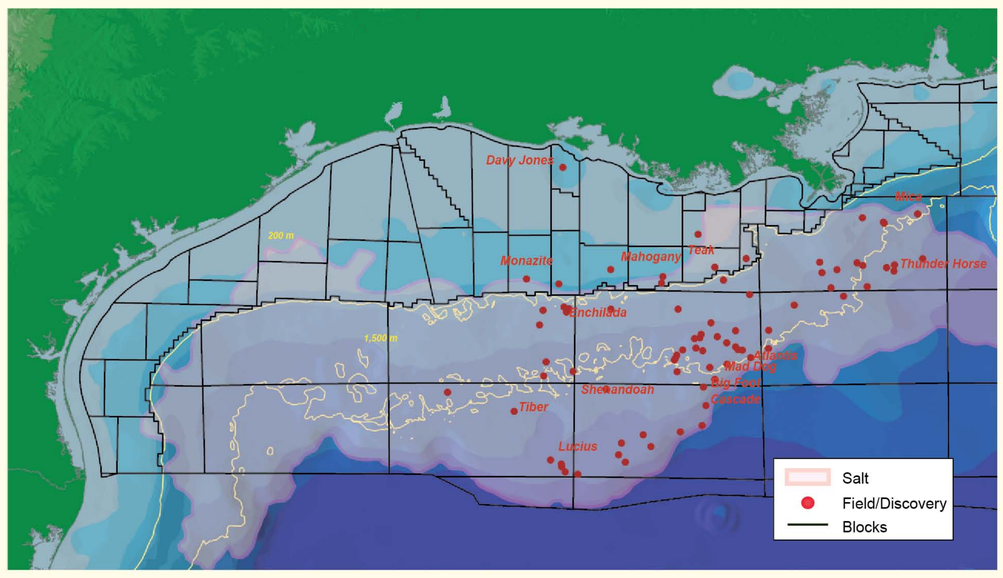


Figure 4. *Location of Sub-salt Fields and Discoveries, Offshore US Gulf of Mexico.*

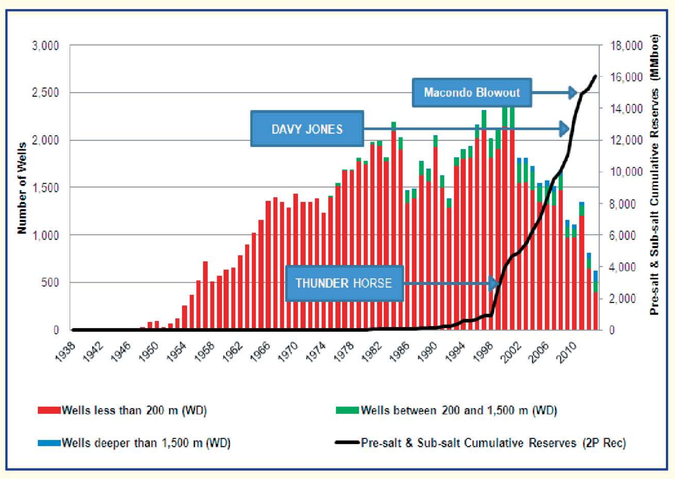
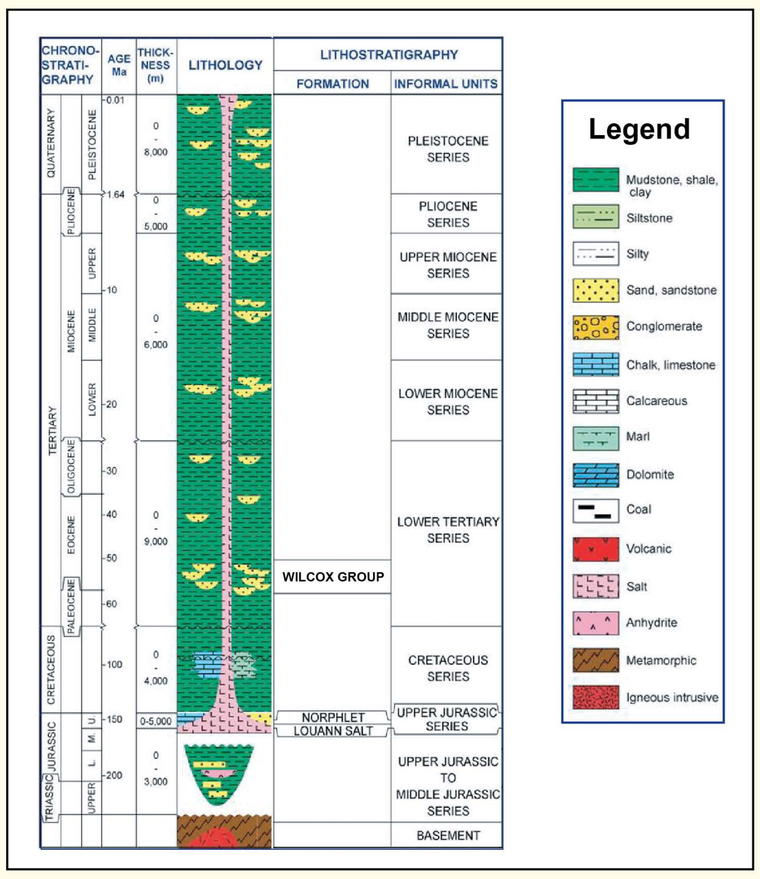


Figure 5. *Offshore Drilling History by Water Depth (WD) Range and Evolution of Sub-salt Cumulative Recoverable Reserves, Offshore US Gulf of Mexico.*

Play Characteristics



Reservoirs are in fine-grained turbiditic sands of Miocene, Oligocene, Eocene, Paleocene (Wilcox) and Cretaceous age that have been deposited in lower slope channels and ponded fans to regionally extensive basin floor fan systems.

The Callovian Louann Salt forms the most important up dip trap seal, but excellent seal rocks are intraformational shales and overlying laterally continuous shales of Miocene to Cretaceous age.

Primary trap styles are compressional Louann salt-cored symmetrical folds, symmetrical salt pillows and asymmetrical, salt cored, thrust anticlines.

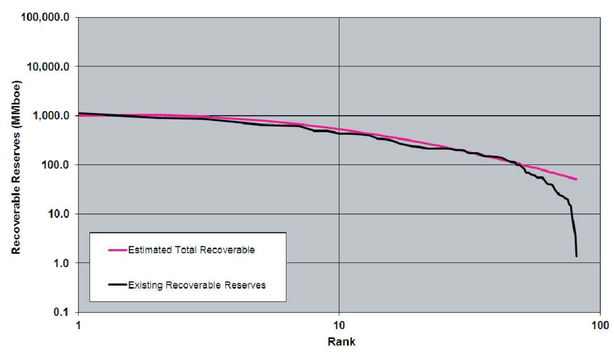
Figure 6. *Stratigraphic Chart of Offshore US Gulf of Mexico.*

YTF Study Results

Ultimate recoverable reserves are estimated at over 16,000 MMboe for the sub-salt and pre-salt plays of the US Gulf of Mexico only. The presented here YTF analysis indicates that estimated total recoverable reserves are between 4,000 MMboe (Low Case Scenario) and 12,000 MMboe (High Case Scenario).

Low Case Scenario

Gulf of Mexico Reserve Size Categories	Reserves to Date MMboe	Reserves to Date Number of	Estimated Total MMboe	Estimated Total Number of	Yet-to-Find MMboe	Yet-to-Find Number of Fields
<1.0	0	0	0	0	0	0
>=1 and <2.5	1	1	0	0	0	0
>=2.5 and <5	4	1	0	0	0	0
>=5 and <10	14	2	0	0	0	0
>=10 and <25	161	8	0	0	0	0
>=25 and <50	292	8	0	0	0	0
>=50 and <100	663	10	2,027	29	1,364	19
>=100 and <250	5,228	31	4,202	27	0	0
>=250 and <500	4,165	11	4,568	13	403	2
>=500 and <1000	4,421	6	5,684	8	1,262	2
>=1000 and <2500	1,117	1	2,019	2	902	1
>=2500 and <5000	0	0	0	0	0	0
>=5000	0	1	0	0	0	0
Total MMboe	**16,066**	**80**	**18,499**	**79**	**3,931**	**24**



High Case Scenario

Gulf of Mexico Reserve Size Categories	Reserves to Date MMboe	Reserves to Date Number of Fields	Estimated Total Recoverable MMboe	Estimated Total Recoverable Number of Fields	Yet-to-Find MMboe	Yet-to-Find Number of Fields
<1.0	0	0	0	0	0	0
>=1 and <2.5	1	1	0	0	0	0
>=2.5 and <5	4	1	0	0	0	0
>=5 and <10	14	2	0	0	0	0
>=10 and <25	163	8	0	0	0	0
>=25 and <50	292	8	0	0	0	0
>=50 and <100	663	10	977	11	314	1
>=100 and <250	5,228	31	5,236	33	8	2
>=250 and <500	4,165	11	5,916	17	1,751	6
>=500 and <1000	4,420	6	8,437	12	4,017	6
>=1000 and <2500	1,117	1	7,105	6	5,988	5
>=2500 and <5000	0	0	0	0	0	0
>=5000	0	0	0	0	0	0
Total MMboe	**16,067**	**79**	**27,670**	**79**	**12,077**	**20**

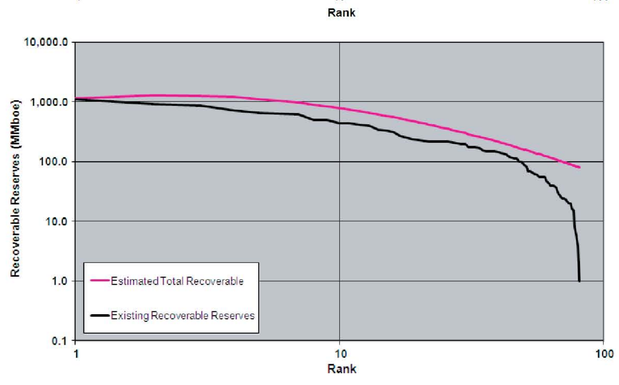


Figure 7. *Parabolic Fractal Distributions of Sub-salt Fields and Discoveries in Offshore US Gulf of Mexico.*

The field size distribution graph indicates that around 12,000 MMboe are still to be discovered, however most of the fields are in the 25-100 MMboe range.

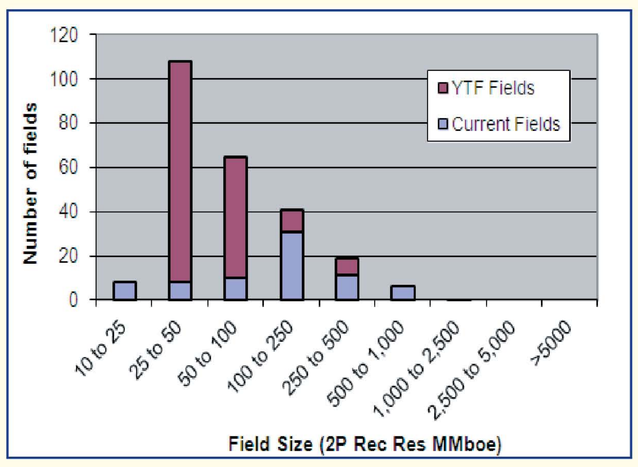


Figure 8. *Field Size Distribution of Sub-salt Fields and Discoveries in Offshore US Gulf of Mexico.*

Exploration Trends

Brazil's pre-salt trend differs significantly from the sub-salt trend found in the Gulf of Mexico. Brazilian pre-salt exploration and production activities are focused mainly in the Santos, Campos, and Espirito Santo basins. First evidence of oil in pre-salt deposits of the Brazilian offshore was perceived in the shelf of the Campos Basin from carbonate reservoirs of the Lagoa Feia Group in 1975 (Badejo field), followed by about ten other discoveries in the 1980s and 1990s. In the mid-2000s, giant oil reserves were discovered in the offshore pre-salt carbonate reservoirs of the Guaratiba Group in the Santos Basin. The Lula field found in 2006 is the largest pre-salt discovery to date on the Brazilian margin.

A total of 73 fields/discoveries have been made from 1975 to mid-2013. Three discoveries were made in pre-salt deposits in 2013. All three are in the Santos Basin: the 1-RJS-704-RJS (Florim), 1-RJS-711-RJS (Entorno de Iara prospect) and Sagitario oil fields. They are relatively small discoveries compared to Lula with recoverable reserves of 76, 97 and 92 MMboe, respectively (400, 600 and 450 MMb OIP 2P reserves).

Total Recoverable Reserves for the Offshore Brazil Pre-salt Plays are currently estimated at about 46 Bboe (2P).

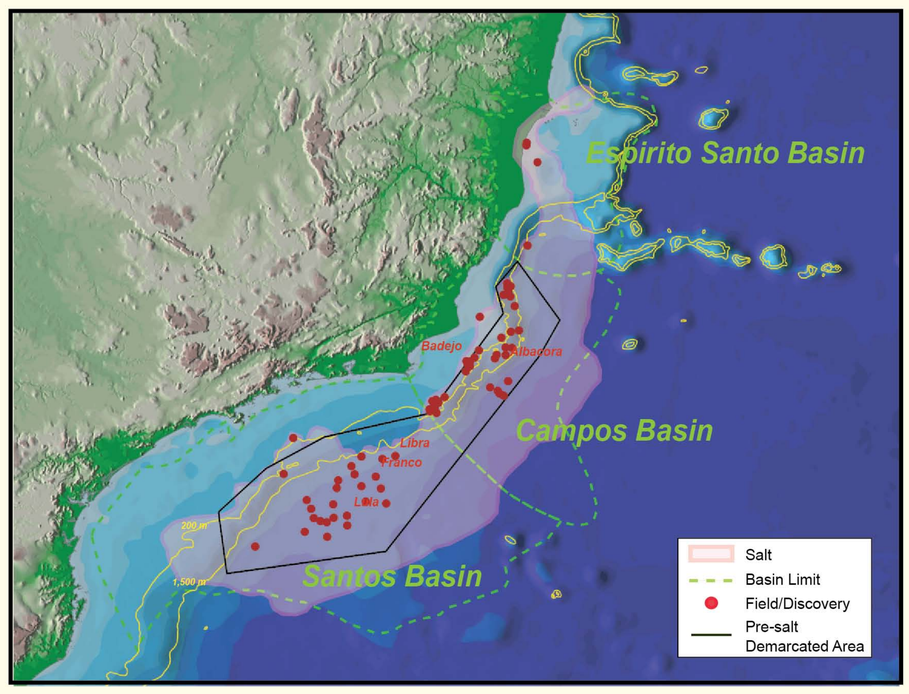


Figure 9. *Location of Pre-salt Fields and Discoveries, Offshore Brazil.*

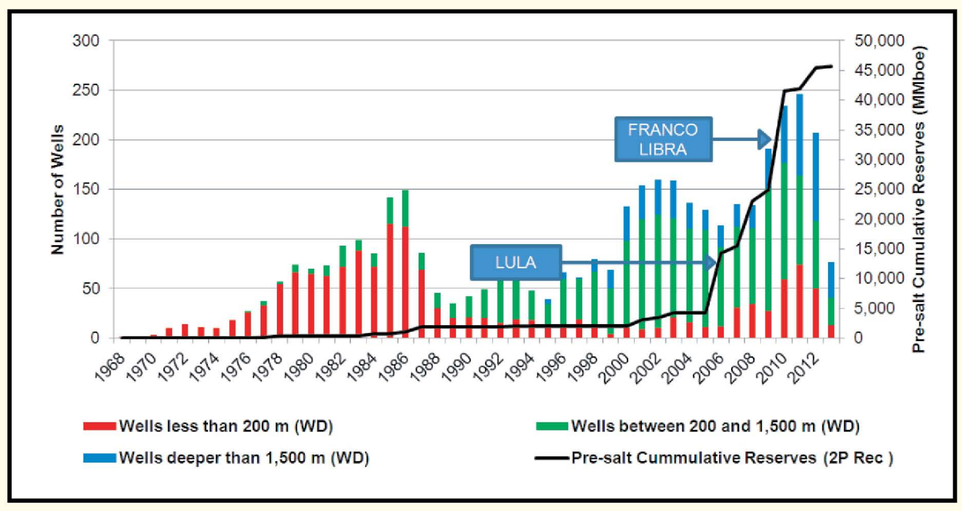
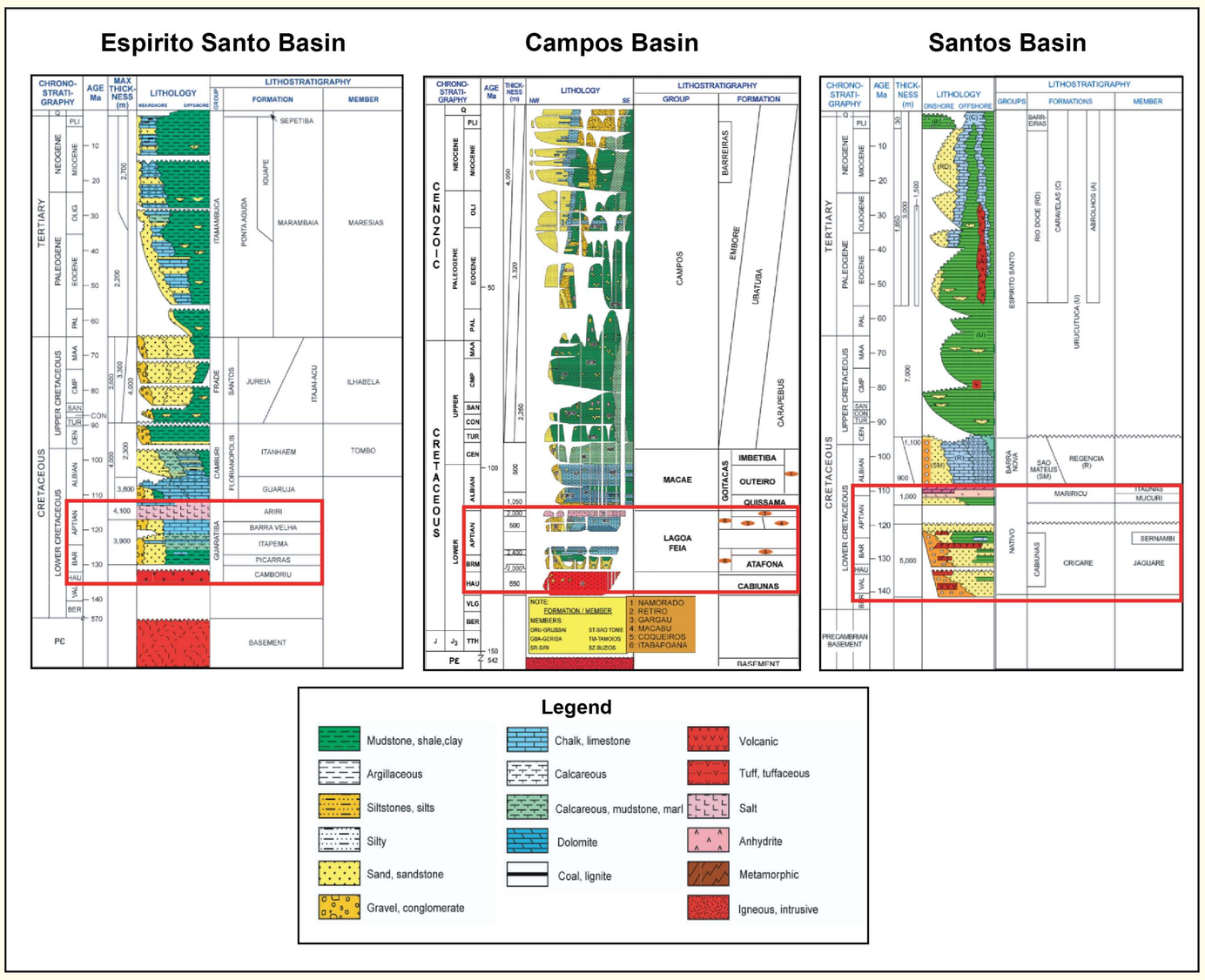


Figure 10. *Offshore Drilling History by Water Depth (WD) Range and Evolution of Pre-salt Cumulative Recoverable Reserves, Offshore Brazil.*

Play Characteristics



Pre-salt reservoirs in the offshore Brazil Plays include:
- Aptian limestones (microbialites or stromatolites), deposited under hypersaline, transitional marine conditions in the sag/transitional section (Barra Velha Fm);
- Barremian-Aptian limestones (coquinas or shell banks) deposited under lacustrine conditions at top of syn-rift section (Itapema & Coqueiros Fms);
- Hauterivian basalts (Cabiunas Fm);

The source rocks are organic-rich shales deposited in anoxic lakes of the middle syn-rift section (Picarras, Lagoa Feia & Cricare Fms) or Aptian-Albian lacustrine shales of the sag/transitional section (Mariricu Fm).

Seals are thick sections of Aptian salt (Ariri & Retiro Fms) or lacustrine shales (Lagoa Feia Gp).

Traps comprise drape features over basement high, four-way dip or dip/fault closed.

Figure 11. *Stratigraphic Charts of Brazillian Basins.*

YTF Study Results

Major pre-salt accumulations in the Santos, Campos and Espirito Santo basins hold recoverable reserves of about 46,000 MMboe. Our YTF analyses suggest that estimated total recoverable reserves could be between 18,000 (Low Case Scenario) and 32,000 MMboe (High Case Scenario) for this region.

Low Case Scenario

BRAZIL	Reserves to Date		Estimated Total		Yet-to-Find	
Reserve Size	MMboe	Number	MMboe	Number	MMboe	Number
<1.0	0	0	0	0	0	0
>=1 and <2.5	1	1	0	0	0	0
>=2.5 and <5	3	1	0	0	0	0
>=5 and <10	38	7	71	9	34	2
>=10 and <25	197	12	261	16	64	4
>=25 and <50	163	4	323	9	160	5
>=50 and <100	1,186	16	652	9	0	0
>=100 and <250	1,726	10	1,276	8	0	0
>=250 and <500	3,652	10	2,089	6	0	0
>=500 and <1000	1,443	2	3,718	5	2,276	3
>=1000 and <2500	11,305	7	6,389	4	0	0
>=2500 and <5000	0	0	9,964	3	9,964	3
>=5000	26,001	3	31,331	4	5,330	1
Total MMboe	**45,713**	**73**	**56,074**	**73**	**17,827**	**18**

High Case Scenario

BRAZIL	Reserves to Date		Estimated Total		Yet-to-Find	
Reserve Size	MMboe	Number	MMboe	Number	MMboe	Number
<1.0	0	0	0	0	0	0
>=1 and <2.5	1	1	0	0	0	0
>=2.5 and <5	3	1	0	0	0	0
>=5 and <10	38	7	0	0	0	0
>=10 and <25	197	12	213	11	0	0
>=25 and <50	163	4	425	12	262	8
>=50 and <100	1,186	16	781	11	0	0
>=100 and <250	1,726	10	1,746	11	20	1
>=250 and <500	3,652	10	2,411	7	0	0
>=500 and <1000	1,443	2	4,149	6	2,706	4
>=1000 and <2500	11,305	7	9,264	6	0	0
>=2500 and <5000	0	0	13,959	4	13,959	4
>=5000	26,001	3	41,277	5	15,276	2
Total MMboe	**45,713**	**73**	**74,225**	**73**	**32,224**	**19**

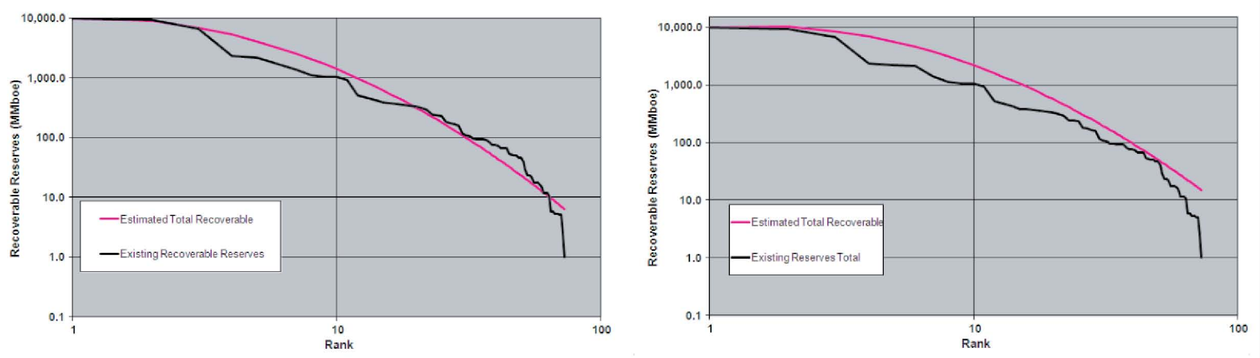


Figure 12. *Parabolic Fractal Distributions of Pre-salt Fields and Discoveries in Offshore Brazil.*

The field size distribution graph indicates that 32,000 MMboe are still to be discovered, with the main fields in the 500-1,000 MMboe range.

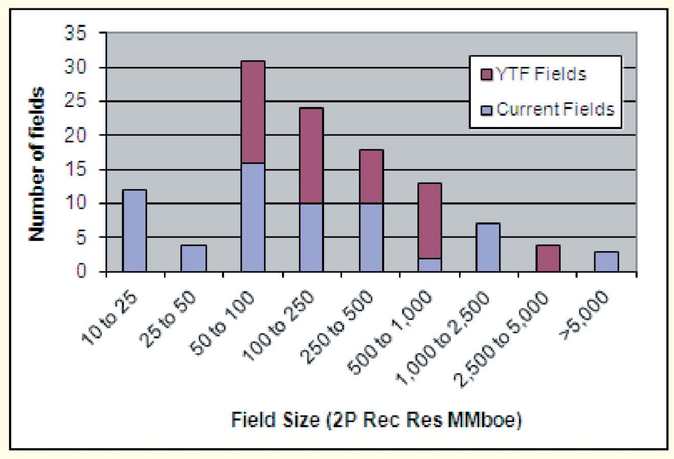


Figure 13. *Field Size Distribution of Pre-salt Fields and Discoveries in Offshore Brazil.*

Exploration Trends

The first offshore pre-salt discovery was found in 1966 in the Lower Congo Basin of Angola. Since then, some 49 discoveries have been made in shallow waters of the Gabon Coastal, Lower Congo and Kwanza basins. The Malongo West discovery in the Lower Congo Basin is the largest find with recoverable reserves estimated at 370 MMboe. The successful drilling campaigns in the pre-salt plays in deep water Brazil have encouraged companies to explore their counterparts in West Africa. In late 2011, Maersk Oil and Cobalt International found oil with the Azul 1 and Cameia 1 wells, respectively, in the deep water Kwanza Basin.

To date (August 2013), IHS estimates that approximately 2,460 MMboe recoverable reserves (2P) have already been discovered, of which about 2,025 MMboe in shallow waters.

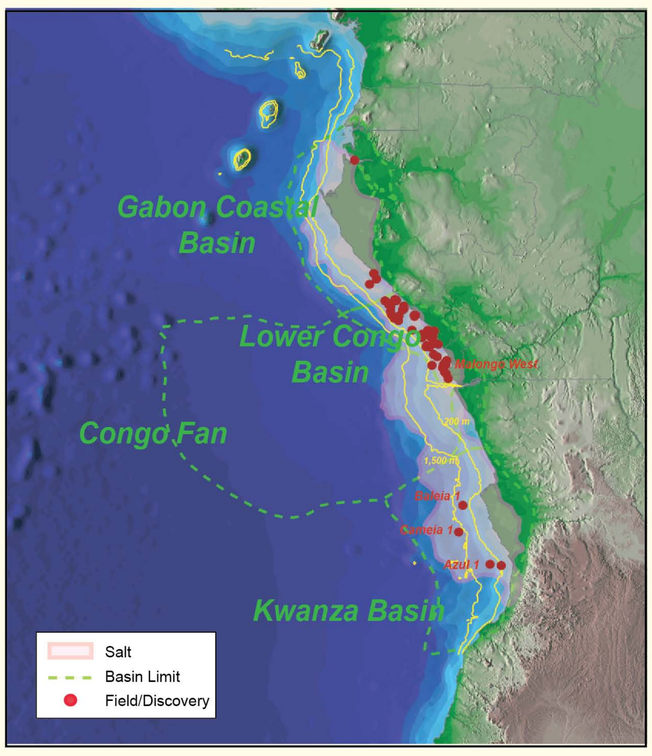


Figure 14. *Location of Pre-salt Discoveries, Offshore West Africa.*

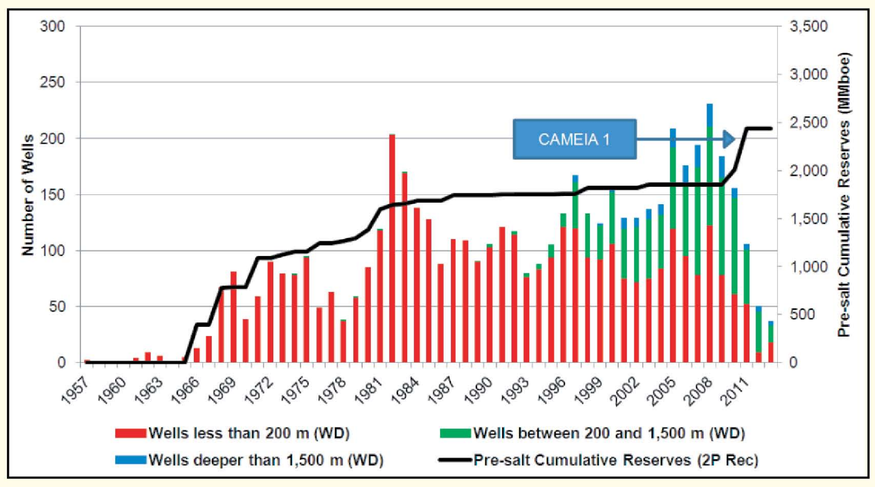


Figure 15. *Offshore Drilling History by Water Depth (WD) Range and Evolution of Pre-salt Cumulative Recoverable Reserves, Offshore West Africa.*

Play Characteristics

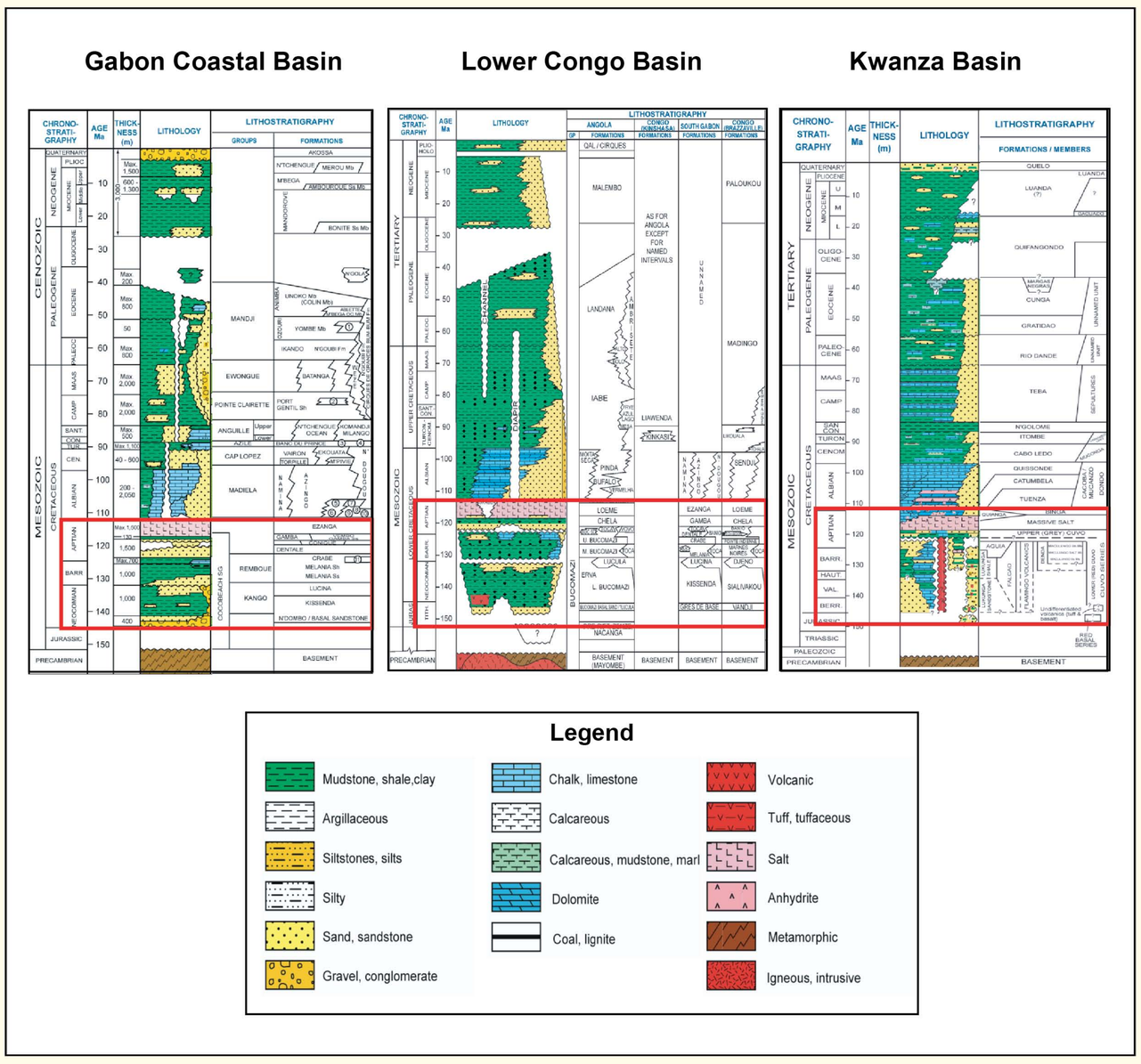


Figure 16. *Stratigraphic Charts of West Africa Basins.*

The pre-salt plays offshore West Africa include clastic and carbonate reservoirs within the Neocomian-Middle Aptian early-rift, middle-rift and late-rift sequences:
- Neocomian-Lower Aptian sandstone reservoirs deposited in fluvial-lacustrine environment (Lucula Fm) and Middle Aptian sandstone reservoirs deposited in transitional marine environment (Gamba Fm);
- Upper Barremian carbonate reservoirs formed as algal mounds or lake fringing build-ups (Toca/Banio Fms);
- Aptian carbonate reservoirs (recently discovered) which are equivalent to those in Brazil.

Source rocks comprise Barremian to Lower-Middle Aptian organic-rich shales deposited in anoxic lakes of the middle syn-rift and sag sections (Bucomazi, Kissenda, Sialivakou, Melania, Marnes Noires, Upper (Grey) Cuvo, Maculungo and Falcao Fms).

Seals are thick section of Aptian salt (Loeme, Ezanga & Massive Salt Fms) and intraformational shales.

Traps comprise drape features over basement highs, four-way dip or dip/fault closed, fault blocks and tilted fault blocks.

YTF Study Results

Due to the very early stage of exploration in the deep and ultra deep waters of the Offshore West Africa region, the parabolic YTF results are here very speculative. The method suggests that less than 1,000 MMboe are yet-to-be discovered (Low Case Scenario).
However, if we consider the possibility to discover giant accumulations such as Longhorn or Lontra, the latter being the largest four-way closure structure so far identified in the Kwanza Basin (>1,000 MMboe), the estimated YTF hydrocarbon reserves (High Case Scenario) increase to 3,500 MMboe.

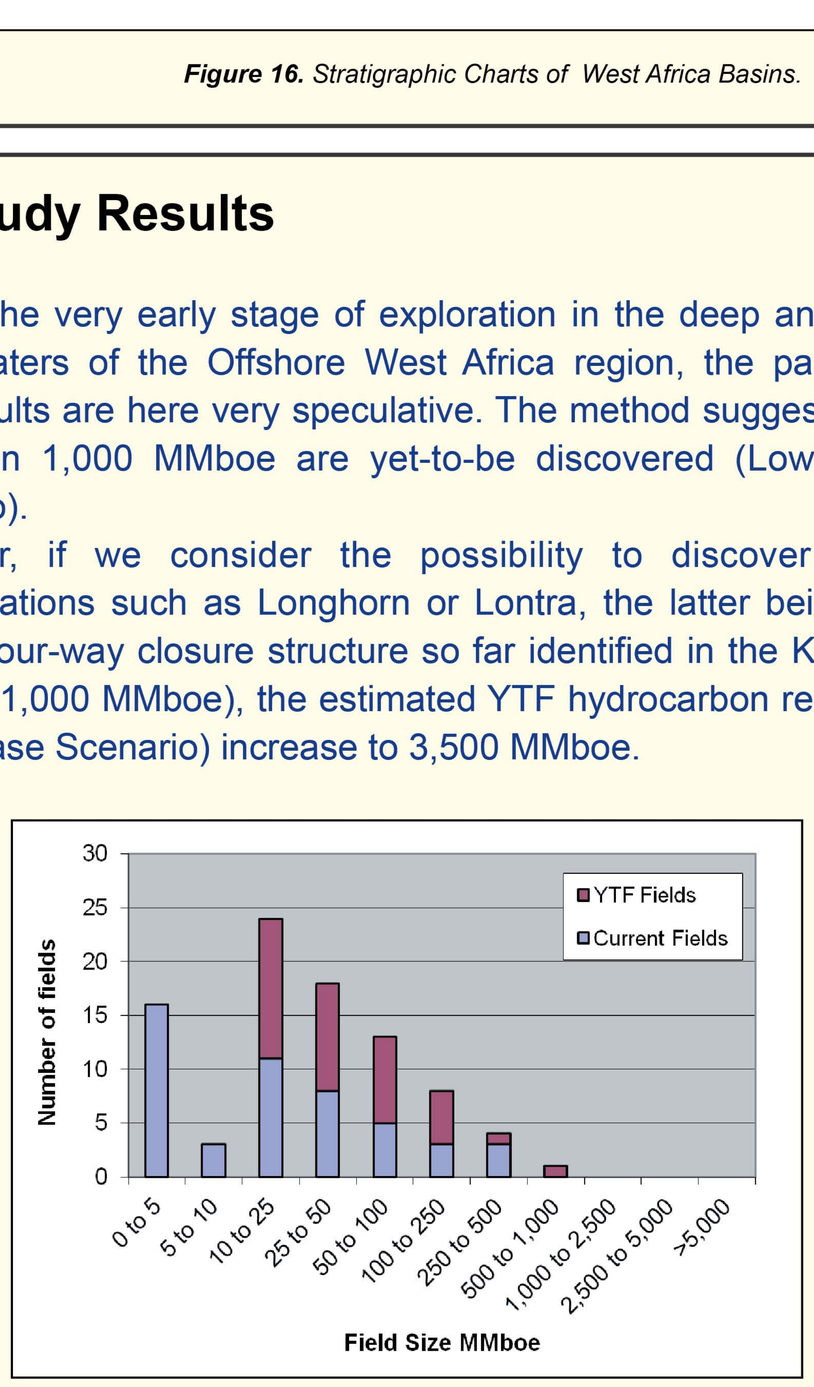


Figure 18. *Field Size Distribution of Pre-salt Fields and Discoveries in Offshore West Africa.*

Low Case Scenario

AFRICA	Reserves to Date		Estimated Total		Yet-to-Find	
Reserve Size Categories	MMboe	Number of Fields	MMboe	Number of Fields	MMboe	Number of Fields
<1.0	3	4	0	0	0	0
>=1 and <2.5	13	7	0	0	0	0
>=2.5 and <5	17	5	32	8	15	3
>=5 and <10	20	3	73	10	54	7
>=10 and <25	169	11	163	10	0	0
>=25 and <50	274	8	209	6	0	0
>=50 and <100	407	5	340	5	0	0
>=100 and <250	495	3	980	6	485	3
>=250 and <500	1,062	3	1,526	4	465	1
>=500 and <1000	0	0	0	0	0	0
>=1000 and <2500	0	0	0	0	0	0
>=2500 and <5000	0	0	0	0	0	0
>=5000	0	0	0	0	0	0
Total MMboe	**2,460**	**49**	**3,324**	**49**	**1,018**	**14**

High Case Scenario

AFRICA	Reserves to Date		Estimated Total		Yet-to-Find	
Reserve Size Categories	MMboe	Number of	MMboe	Number of	MMboe	Number of Fields
<1.0	3	4	0	0	0	0
>=1 and <2.5	13	7	5	2	0	0
>=2.5 and <5	17	5	36	10	19	5
>=5 and <10	20	3	60	8	40	5
>=10 and <25	169	11	129	8	0	0
>=25 and <50	274	8	216	6	0	0
>=50 and <100	407	5	286	4	0	0
>=100 and <250	495	3	780	5	285	2
>=250 and <500	1,062	3	1,047	3	0	0
>=500 and <1000	900	1	3,047	4	2,147	3
>=1000 and <2500	0	0	0	0	0	0
>=2500 and <5000	0	0	0	0	0	0
>=5000	0	0	0	0	0	0
Total MMboe	**3,360**	**50**	**5,606**	**50**	**2,491**	**15**

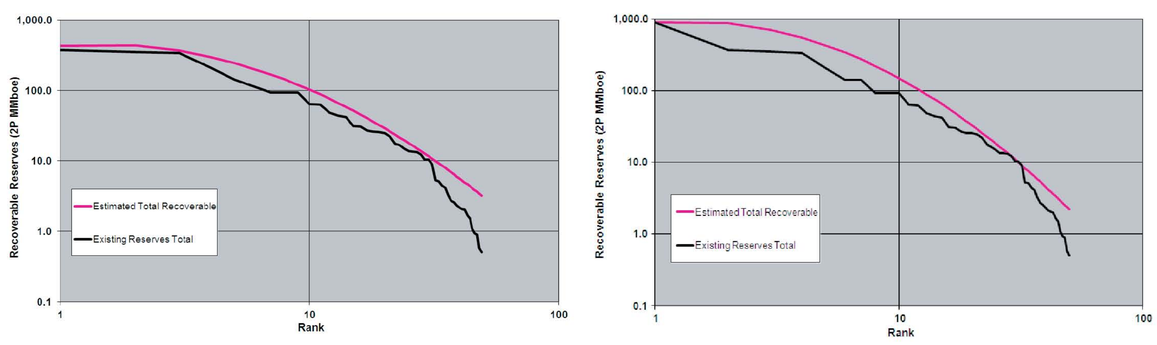


Figure 17. *Parabolic Fractal Distributions of Pre-salt Fields and Discoveries in Offshore West Africa.*

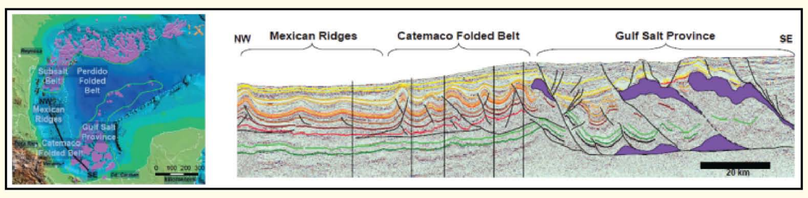
A large number of prospects has been identified offshore Gabon and Angola. However, the field size distribution suggests that the size of the future discoveries would be less that 500 MMboe and much smaller that their counterpart on the Brazilian Margin.

Offshore Sub-salt and Pre-salt Plays in the World

Sub-salt and pre-salt plays have been explored and developed for many decades but it is only since the 1990s that they evolved into global exploration targets of historic impact. We estimate that several tens of billions of oil equivalent are still to be discovered offshore Gulf of Mexico, Brazil and West Africa together. Sub-salt and pre-salt plays are now increasingly becoming part of many oil companies' portfolios. Other salt basins around the world are thus carefully revisited and analyzed and with the upcoming drilling programs, this reserves projection will move from forecast to reality.

Offshore Mexico

Sub-salt and salt-related plays do exist in the Campeche salt basin region. However, Mexico being currently closed to foreign investment, this inhibits the interchange of differing geotechnical ideas and denies Mexico sufficient risk capital to fully exploit these sub-salt plays.



NW-SE Seismic section in Campeche Basin (offshore Mexico) with potential sub-salt plays, from Morales Gil (2009)

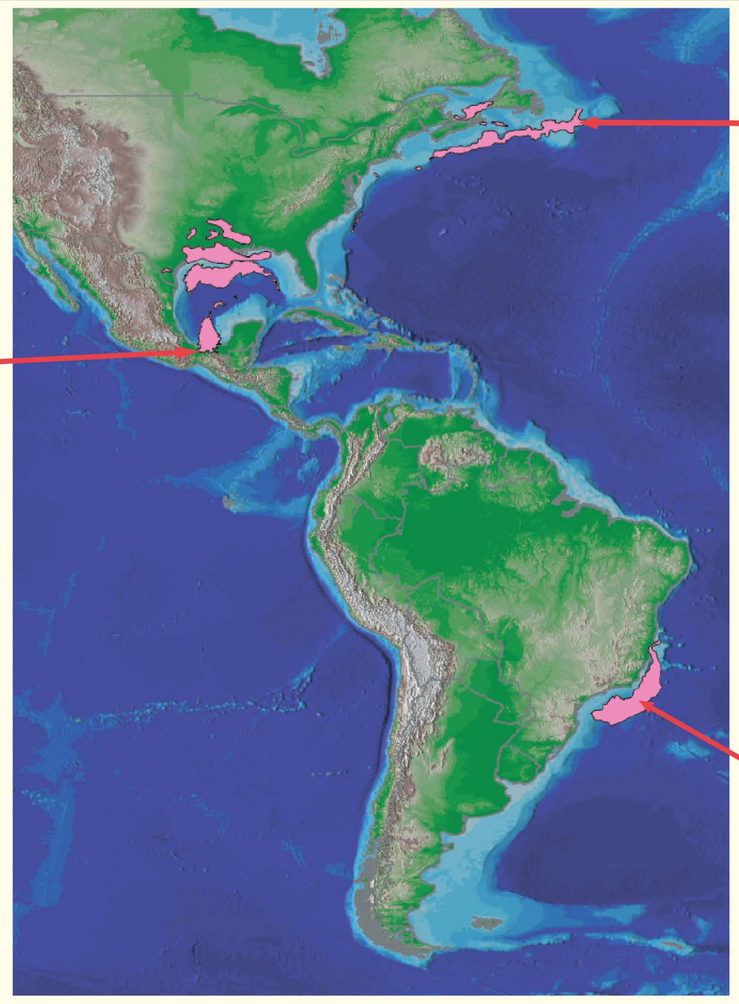
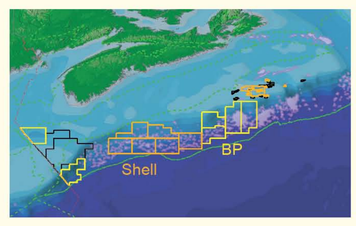


Figure 19. *Salt Basins in Americas.*

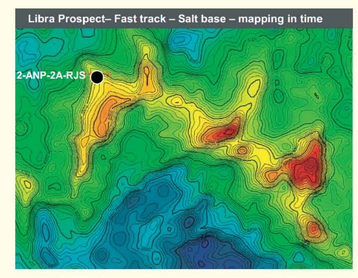
East Canada

In the Scotian Basin (offshore Nova Scotia), BP Exploration (Canada) has planned 14,000 sq km of 3D seismic over two seasons starting April 2014 in exploration licences EL 2431, EL 2432, EL 2433 and EL 2434. The licences were acquired by BP in 2012 and officially awarded in January 2013.



Offshore Brazil

The first Pre-salt Bid Round was launched on 9 July 2013 and includes the 1,547.76 sq km Libra block. Petrobras has at least 30% working interest and is the designated operator. The Libra block has potentially 6-8 Bboe recoverable reserves that still have to be confirmed with outpost wells.



Libra Prospect
Source: Chambriard (2013)

Queiroz Galvao will drill a pre-salt wildcat in the Atlanta Block in the Santos Basin next year.

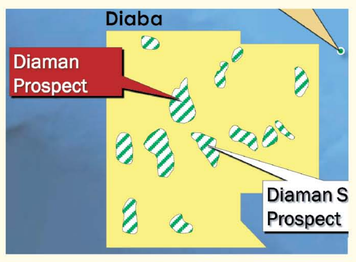
Offshore Morocco

Salt deposits in offshore Moroccan basins are of Triassic-Early Jurassic age and are interbedded with sandstones, shales and carbonates. Pre-salt plays are proven onshore in the Essaouira and Rharb-Prerif basins. Cairn Energy has plans to drill a wildcat in deep waters of the Foum Dra licence (Aaiun-Tarfaya Basin and Tafelney Plateau) in second half of 2013. The targeted prospect might contain gross mean prospective resources of 142 MMbl. Objectives are in the Triassic and younger sections.

Gabon

The Gabonese Government is to launch its long awaited bid round for the deep offshore exploration blocks in late 2013, once the new petroleum legislation is approved.

- In August 2013, Total/Marathon announced that the pre-salt Diaman-1B exploration well offshore Gabon had encountered 50-55 m of net pay (gas/condensate) in Diaba (G4-223) deep water block. Some 12 pre-salt prospects have been identified (Longhorn, Pioneer, Western, Alamo, Wendover, Mandalay, Boulder, Red Rock, Fiesta, Aztec and



Sub-salt prospects in Diaba Block (offshore Gabon)
Source: Cobalt (2013)

Sub-salt prospects in Mbeli and Ntsina Marin blocks (Offshore Gabon).
Source: Ophir (2013)

- Ophir has plans to drill the Padouk Deep structure (Ntsina Marin block, 575 MMboe net PP) during Q4 2013, and North Cluster prospect (443 MMboe net Pmean) in Q4 2013 - Q1 2014.

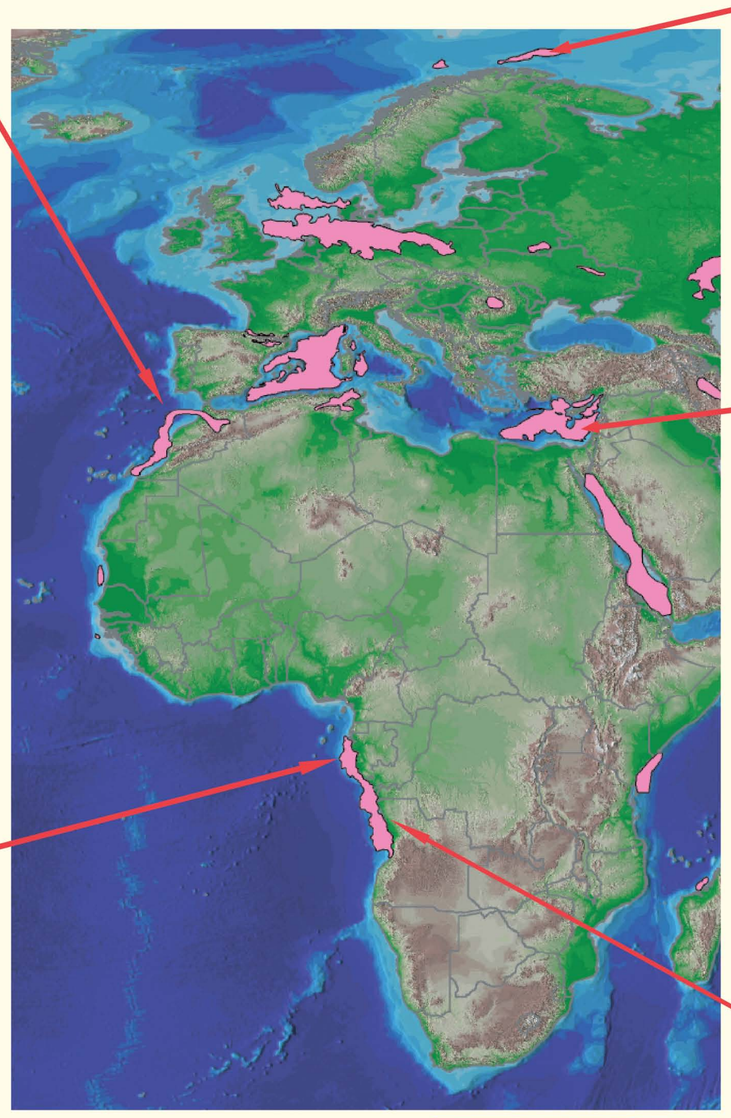


Figure 20. *Salt Basins in Europe and Africa.*

Offshore Norway

On the Barents Sea Platform, the salt section is of Late Carboniferous-Early Permian age. Very small amount of HC have been discovered to date. No pre-salt plays are known to be targeted in the near future.

Eastern Mediterranean Sea

The recent giant sub-salt gas discoveries (Tamar: 10 Tcf; Leviathan: 19 Tcf) made in the Levantine Basin, offshore Israel, are bringing the eastern Mediterranean Sea into the limelight. Many attractive sub-salt leads with associated direct hydrocarbon indicators have been identified on 2D and 3D seismic lines. Noble Energy made the Karish 1 gas discovery in May 2013 in Israel (1.3 Tcf unrisked contingent resources) and is to drill an appraisal well offshore Cyprus. The company is also looking at a deeper oil play which will be tested probably in late 2013 or early 2014.

In May 2013, the Lebanese Ministry of Energy & Water (MEW) officially opened Lebanon's First Offshore Licensing Round.

Seismic section in Levantine Basin with potential sub-salt plays, from Roberts & Peace (2007)

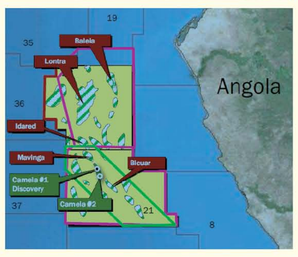
Angola

- Cobalt is preparing to test the Mavinga prospect (500 MMbo in place) in Block 21 (1,812 m water depth). The company is drilling Lontra 1 (> 1,000 MMbo in place) and is planning to drill Bicuar 1, probably by end-year 2013.

- Maersk has plans to drill the high impact Diamante prospect in offshore Block 8, Kwanza Basin, in 2013.

- ConocoPhillips plans four exploratory wells starting March 2014 in Blocks 36 and 37.

- BP (Blocks 19, 24), Repsol (Block 22), Total (Blocks 25, 40), ENI (Block 35) and Statoil (Block 39) are all expected to drill their first operated wells next year in the Kwanza Basin.



Prospects offshore Angola. Source: Cobalt (2013)

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