Hydrocarbon Exploration Challenges and Perspectives in Mexico*

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Abstract

In the late 1980's and 1990's, in a framework of large proven reserves and economic restrictions, petroleum exploration in Mexico had a very limited budget assignment (~500 million USD per year) and therefore booked reserves were low. During 2001-2006 exploration was reactivated, the budget increased to an annual average of 1.2 billion USD and booked 3P reserves raised to 4.6 billion barrels of oil equivalent (bboe). Based on the distribution of the 50 bboe of prospective resources in the Mexican petroleum provinces, a strategic plan was put in place in 2007 to improve exploration performance aiming at 100% 3P reserves restitution by 2012. Key elements of this strategy included focusing budget expenditures on the most prospective areas, ensuring a diversified portfolio, giving priority to oil-prone areas offshore and onshore southeastern Mexico, giving continuity to non-associated gas in Burgos and Veracruz, intensifying evaluation of the deepwater Gulf of Mexico (GoM), and, more recently, evaluating shale oil and gas resources.

Additional initiatives considered selective application of technology, development of personnel skills and increasing execution capacity, particularly in seismic acquisition and processing and deepwater drilling. Challenges included improving subsurface imaging in geologically complex areas, petroleum system modeling to predict hydrocarbon type as well as reservoir distribution and quality in the deepwater GoM.

In 2007-2012, Pemex Exploration and Production (PEP) gradually increased the budget for exploration to around 2.5 billion USD per year. This has allowed booking more than 9 bboe of 3P reserves, updating the prospective conventional resource estimation to 54.7 bboe, and having an initial estimation of shale oil and gas resources of 60 bboe. Discoveries include four giant fields in shallow waters offshore southeastern Mexico, significant discoveries onshore, a large gas province in the southern deepwater GoM and the first two light oil discoveries in the Perdido Fold Belt and Salina del Bravo provinces, close to the US border. Regarding shale oil and gas, the Cretaceous and Jurassic plays are showing encouraging results in northeastern Mexico.

Exploration activities carried out over the last years have confirmed a large conventional and unconventional potential in Mexico. Converting these resources into reserves requires technology application and continuing the increases in budget and execution capacity, including participation of third parties within Mexican regulation.

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Hydrocarbon Exploration Challenges and Perspectives in Mexico

J. Antonio Escalera Alcocer
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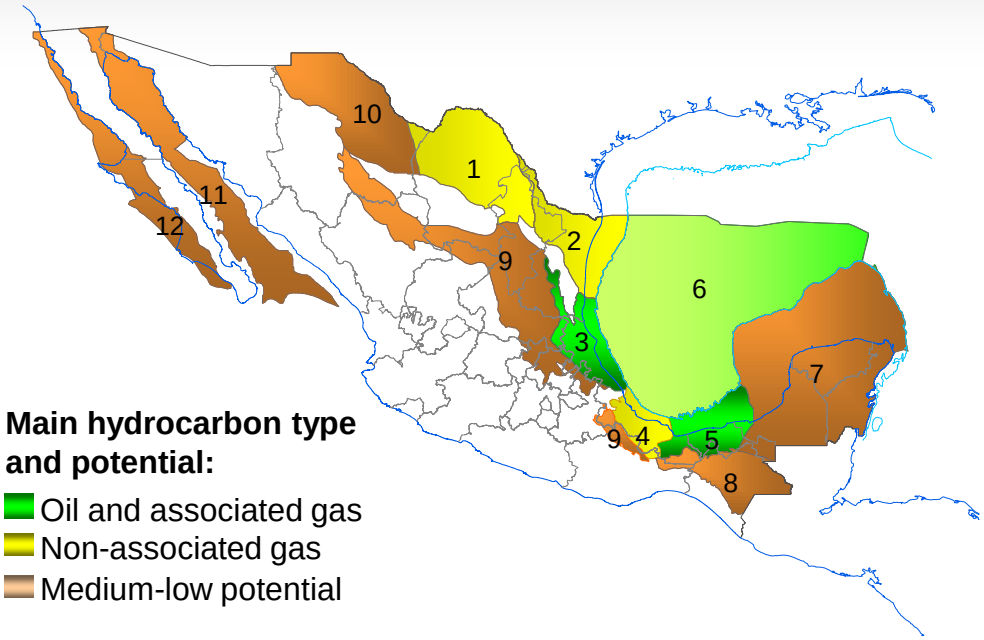
Cartagena, September 10th, 2013

Agenda

- Introduction
- Exploration strategy
- Results in 2007-2012
- Perspectives
- Concluding remarks

Introduction

PEMEX has explored in Mexico for 75 years and identified 12 prospective basins, half of which have established production



Main hydrocarbon type and potential:

- Oil and associated gas
- Non-associated gas
- Medium-low potential

Producing / With reserves

1. Sabinas
2. Burgos
3. Tampico-Misantla
4. Veracruz
5. South Eastern
6. Deepwater GoM

Medium / low potential

7. Yucatán Platform
8. Sierra de Chiapas
9. Sierra Madre Oriental
10. Chihuahua
11. Golfo de California
12. Vizcaíno-La Purísima

- Exploration in Mexico has evolved hand-in-hand with the development of methods and technologies, which has contributed to the discovery of important reserves and subsequent production

- Current geological knowledge has lead to quantify conventional and unconventional prospective resources that will allow Mexico to continue being one of the main producers of hydrocarbons in the world.

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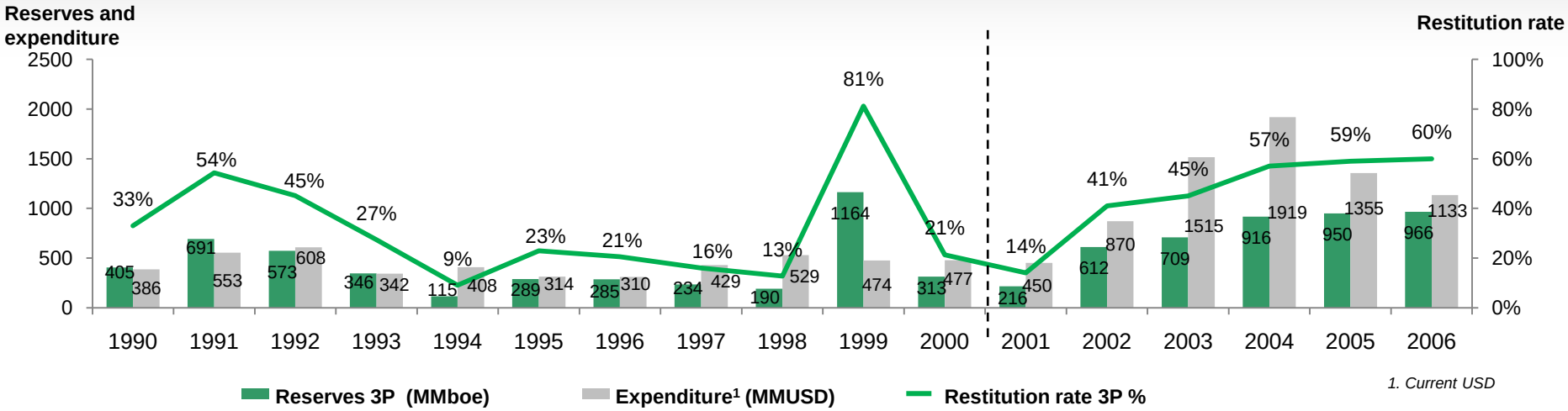
Recent history of exploratory activity



- During the nineties, reserves reached more than 60 Bboe, which, combined with the economic environment, derived in an annual average exploration budget lower than 500 MMUSD and total reserves restitution rate of about 30%
- In the late nineties, PEMEX adopted international rules and proven reserves were significantly reduced, triggering the reactivation of the investment in exploration
- In 2001-2006 booked 3P reserves were over 4.3 Bboe and exploration investment was equivalent to an annual average of 1.2 BnUSD, with a 60% total reserves restitution rate for the last year

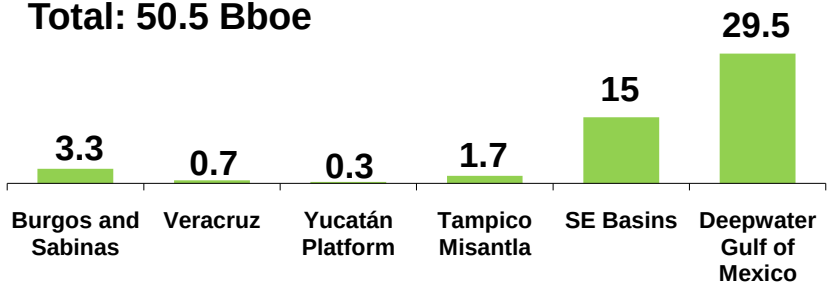
Exploration strategy

The PEP Strategic Program for 2007-2012 comprises five initiatives to foster exploration and a budget increase

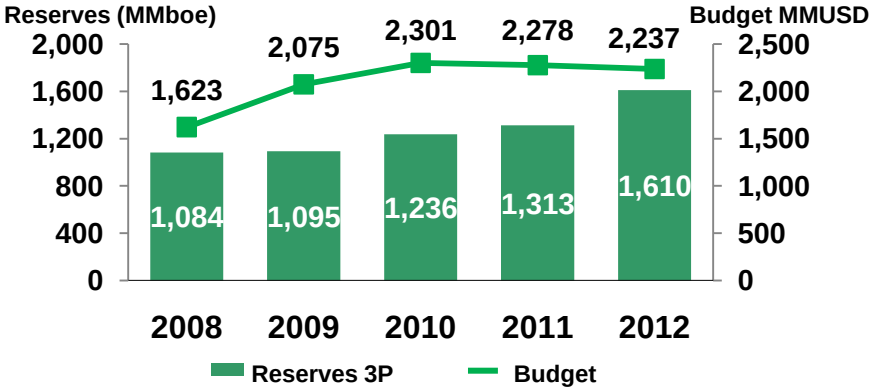
Strategic initiatives

1. Intensify exploration activity in deepwater Gulf of Mexico and maintain it in the remaining basins
2. Strengthen the exploration portfolio by increasing the number and average size of prospects
3. Improve performance of the main value levers of discovery cost
4. Define guidelines for the integration, execution and exit mechanisms of the exploration projects
5. Improve the results of the exploration orientated to reach total reserves restitution rates of 100% in 2012

Prospective resources
Total: 50.5 Bboe

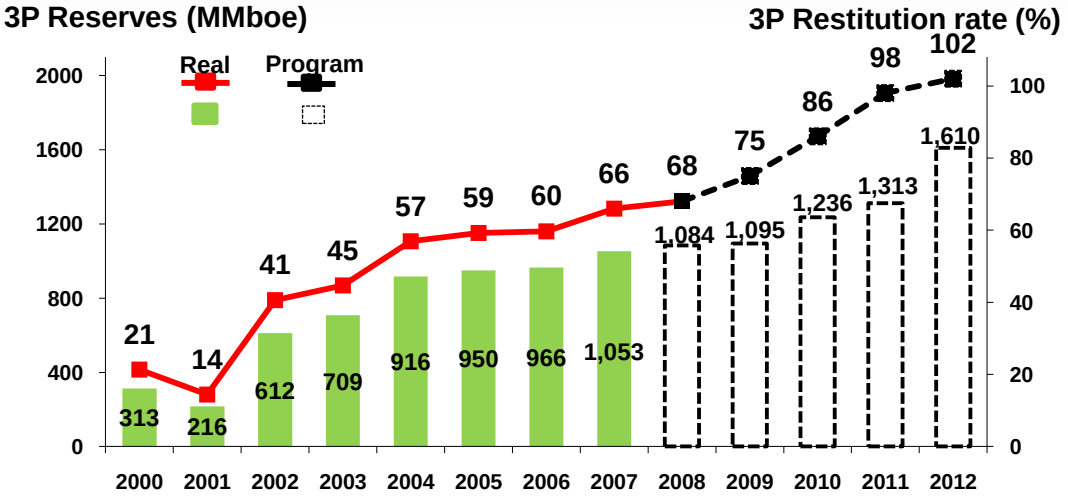


Budget[1]: 10.5 BnUSD
Total reserves to be booked: 6.3 Bboe



1. USD@2006

Based on these initiatives, an exploration strategy was defined for the 2008-2012 period



- Considering the distribution of prospective resources, exploration activity was focused on the search for oil in the Southeastern Basins and deepwater Gulf of Mexico as well as in the prospection of non-associated gas in the Burgos-Sabinas and Veracruz basins

- It is also planned to improve the exploration results orientated to reach a total reserves (3P) restitution rate of 100% in 2012 and therefore, gradually to recover a proven reserves/production rate for at least 10 years

- In order to reach the goals set in the exploration strategy, complementary supporting strategies were established such as human resource, service contracting as well as technology management to ensure assimilation and implementation

Results in 2007-2012

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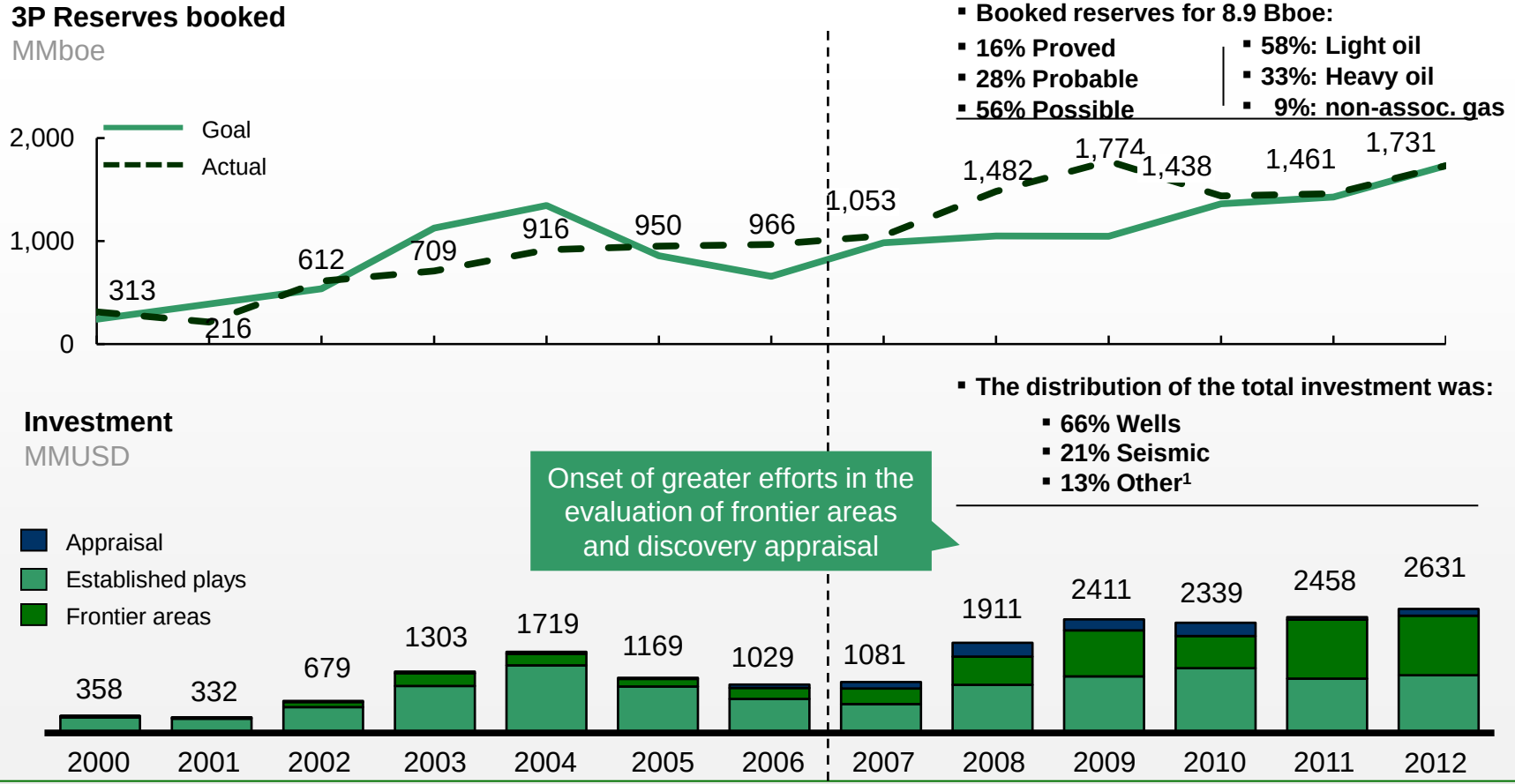
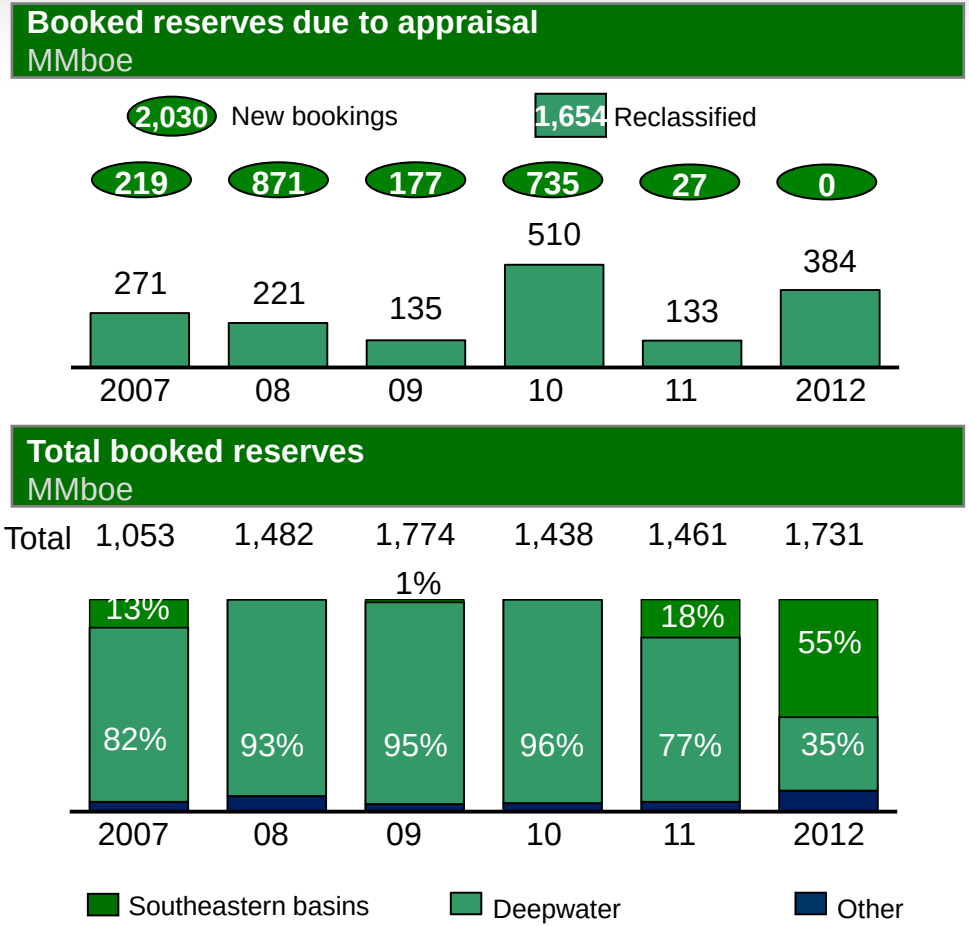
In the 2007-2012 period, a diversified strategy and investment greater than 12.8 BnUSD, allowed accomplishing the goals



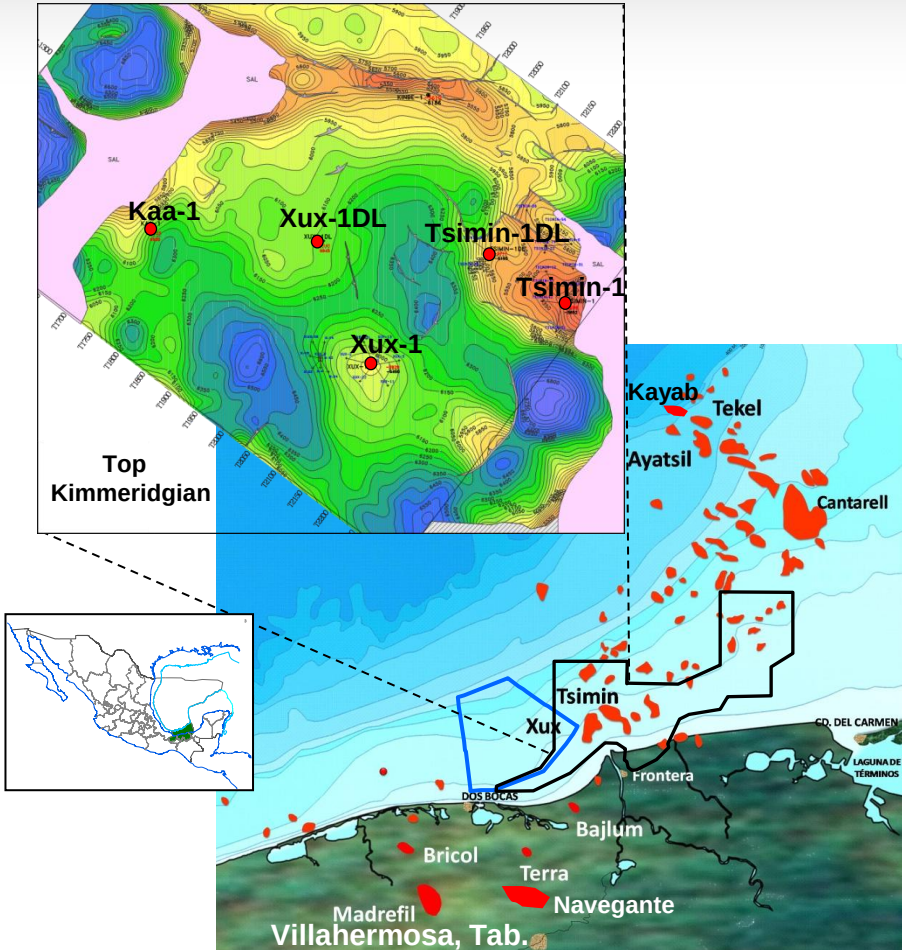
1 Includes OPEX
Paridad promedio12.6 pesos por dólar

Discoveries in the SE Basins and deepwater GoM as well as the appraisal activity played a key role in meeting the goals



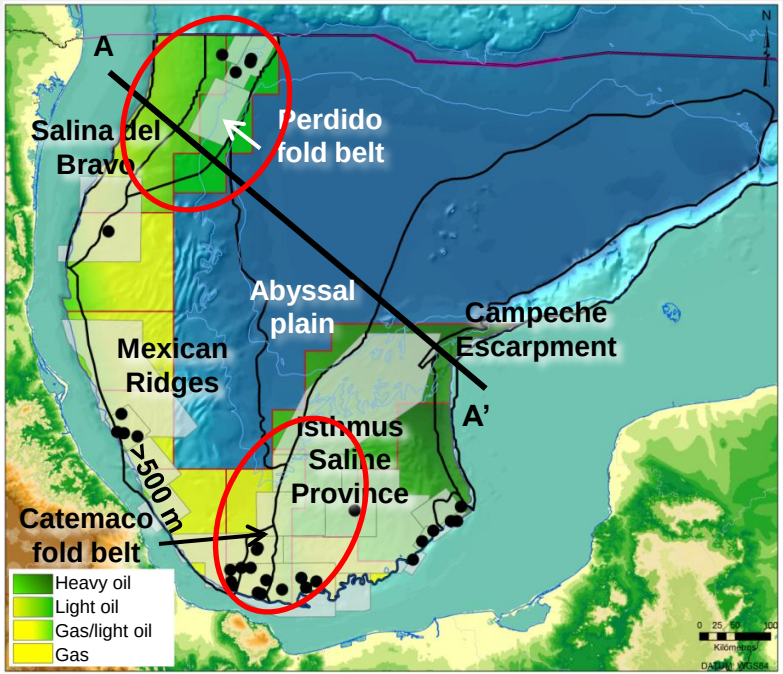
- 80% of the total booked reserves were from the Southeastern Basins, 15% from deepwater and 5% from Burgos and Veracruz basins
- 18 discoveries accumulated a reserve greater than 100 MMboe, standing out the giants Tsimin, Xux, Kayab and Ayatsil
- Appraisal activity reclassified reserves for 1.6 Bboe and booked additional reserves for 2.03 Bboe
- It is important to point out that in 2012 the contribution of the deepwater GoM was 55% of the total

Significant shallow water and onshore discoveries, Southeastern Basins

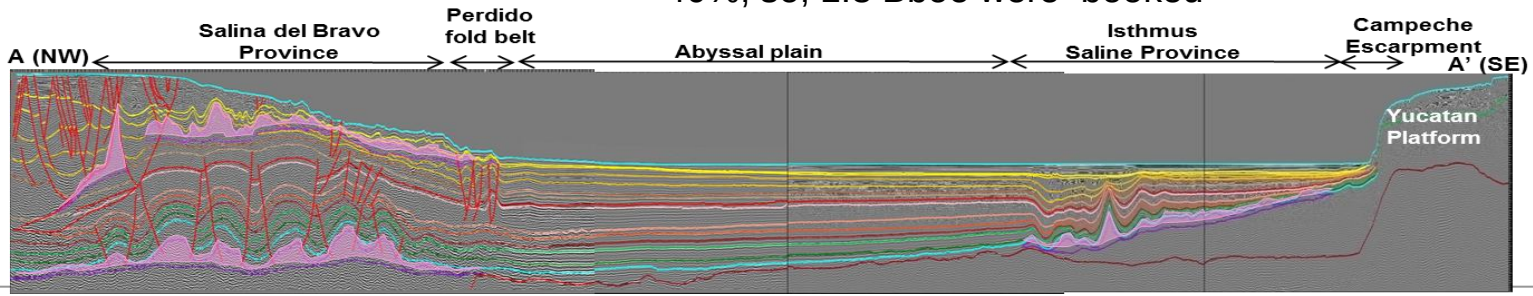


- The giant fields Ayatsil, Kayab, Xux and Tsimin stand out offshore, the first two contain heavy oil and the others gas and condensate
- Onshore, the main discoveries were Navegante, Bricol, Madrefil, Terra, Bajlum and Pareto, all with light oil
- Existing facilities onshore have allowed a quick incorporation of production from new discoveries, currently contributing with more than 130 Mbopd, which represents 28% of the onshore Southeastern Basins production
- Offshore, the development of the Tsimin field has been accelerated, reducing to less than 4 years the discovery-to-first-production time; the field currently produces 35 Mbopd and 160 MMcfpd

Exploration in the Mexican part of the deepwater Gulf of Mexico has focused on two areas



- In the southern Mexican Ridges, Catemaco Foldbelt and Salina del Istmo provinces searching for wet gas and light oil, and in the Perdido Foldbelt and Salina del Bravo provinces in the north exploring for light oil
- With an investment of more than 4.5 BnUSD, it was possible to have multi-year contracts for state-of-the-art seismic acquisition/processing services as well as for deepwater drilling rigs of sixth generation
- This allowed the visualization and evaluation of new prospects and reduced the uncertainty of the prospective resources as well as of the expected hydrocarbon types; 25 wells were drilled resulting in a commercial success rate of 40%; so, 1.8 Bboe were booked



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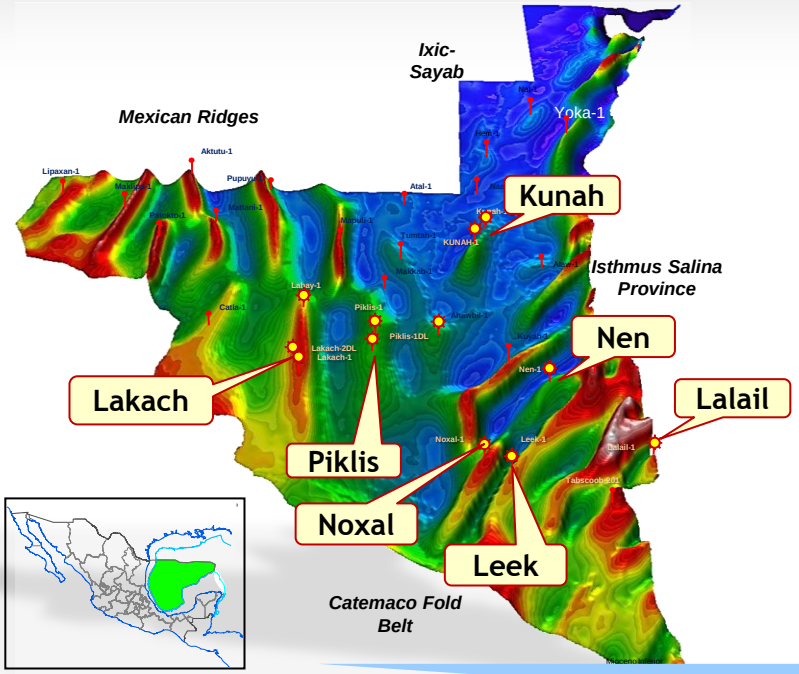
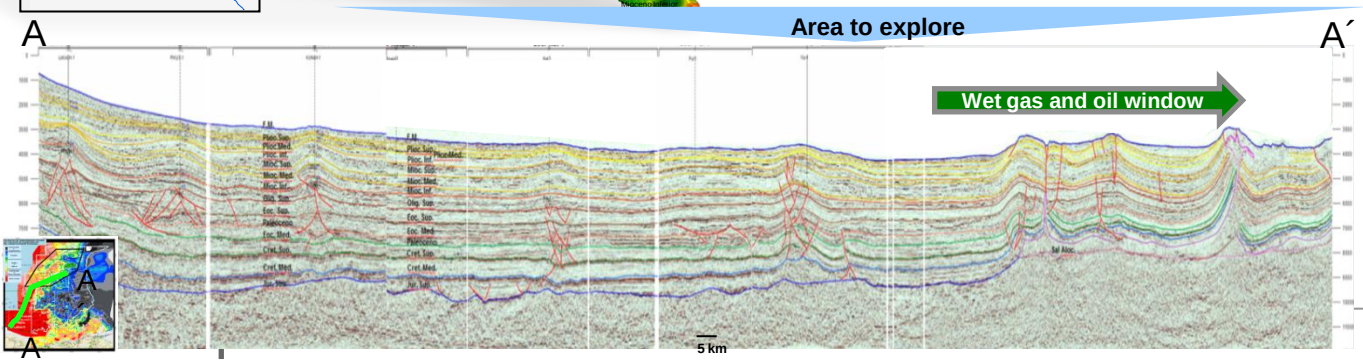
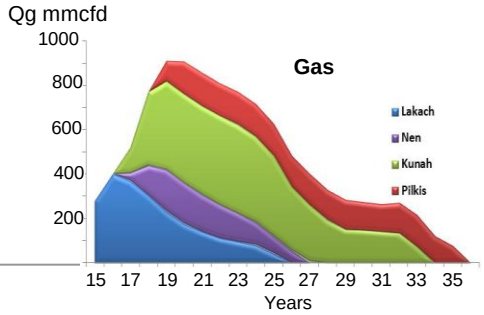
Exploration in the southern GoM has focused on evaluating the gas potential and defining oil-prone areas and prospects



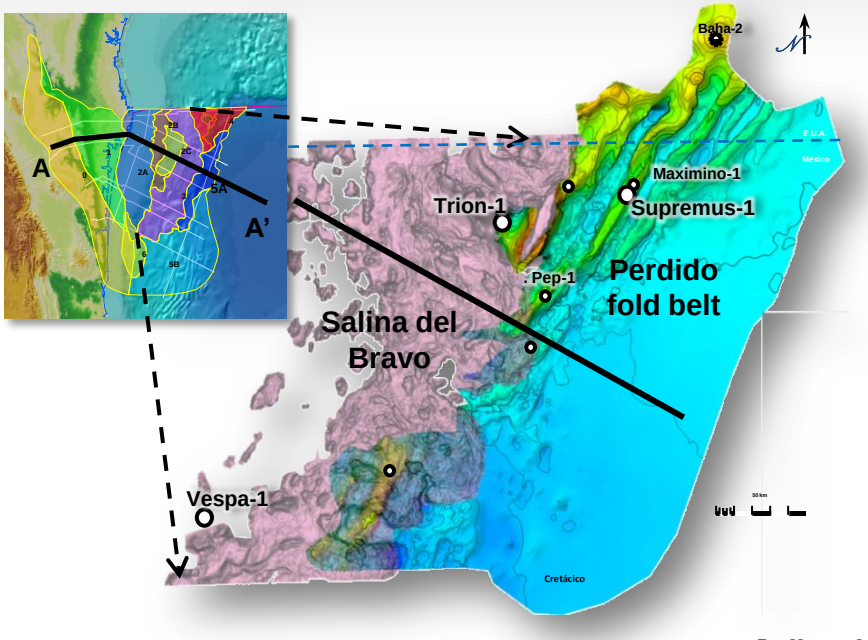
- In the southernmost portion of the Mexican Ridges and Catemaco Fold Belt about 5.0 Tcf of non-associated gas reserves (3P) have been discovered in Miocene rocks. Gas prospective resources range from 5.5 to 16.5 Tcf
- Discovered fields include Kunah, Piklis, Lakach, Lalail, Nen, Noxal and Leek. Kunah stands out with 1.8 Tcf of gas
- Currently the exploration is moving to the north east searching for wet gas and light oil
- The Lakach field is being developed, first production is expected for 2015



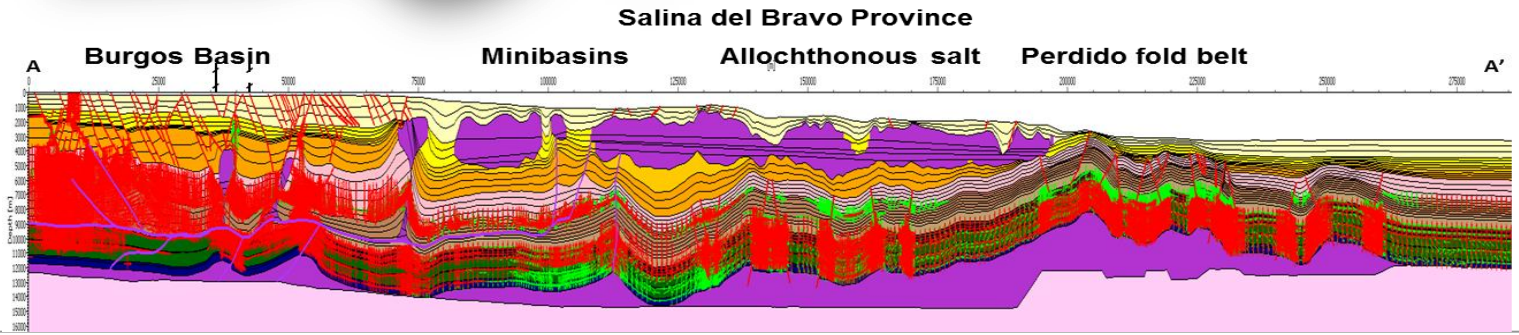
Preliminary production forecast



In the north, exploratory drilling in the Perdido Fold Belt and Salina del Bravo provinces started in 2012

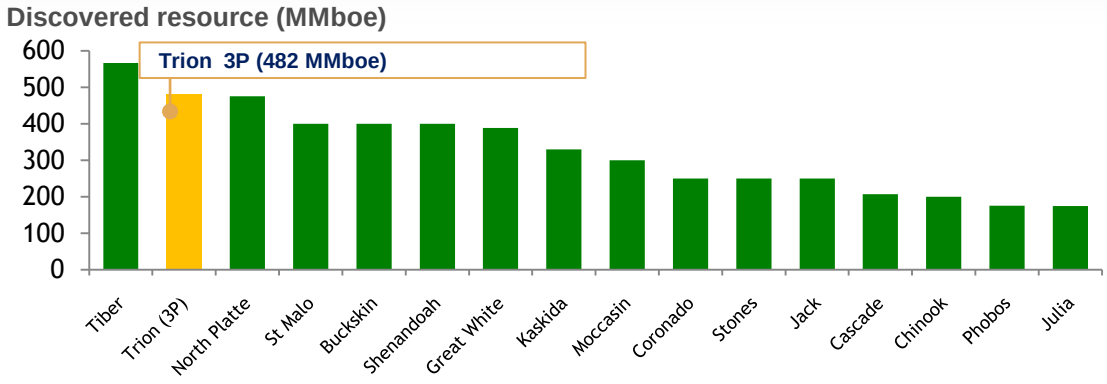


- Four wells have been completed so far: Trion-1 in the Salina del Bravo province and Supremus-1, Maximino-1 and PEP-1 in the Perdido Foldbelt
- Trion has been the main discovery with 482 MMboe, followed by Supremus with 98 MMboe; the Maximino discovery is being characterized
- Trion-1DL appraisal well has just been spudded and the minibasins subarea in the southwest of the Salina del Bravo province will be evaluated with the Vespa-1 well



The Trion discovery is amongst the largest in the deepwater Gulf of Mexico

Top 15 Paleogene discoveries in the US Deepwater GoM vs Trion



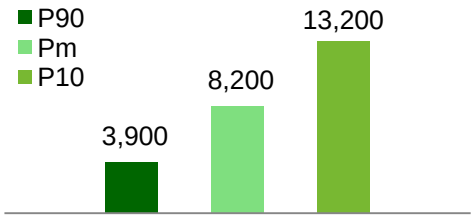
Source: Wood Mackenzie, Pemex for Trion

- Considering total (3P) reserves, Trion could be amongst the five largest discoveries in the Paleogene of the deepwater GoM if the appraisal well is successful

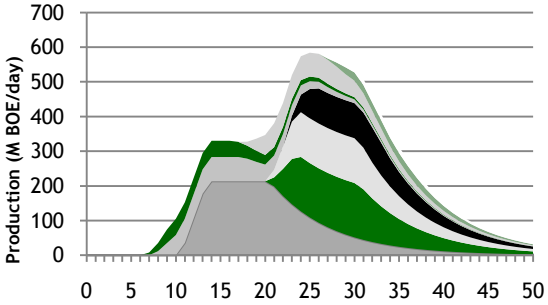
- Discoveries have reduced uncertatinty to the estimation of prospective resources in the Perdido Area, which ammount to a mean of 8.2 Bboe

- Probabilistic development scenarios, considering a recoverable volume of 4.6 Bboe and investment of about 40 BnUSD, indicate that a production plateau of about 550 Mbopd could be obtained by 2035

Prospective resource distribution in the Area Perdido Project MMboe

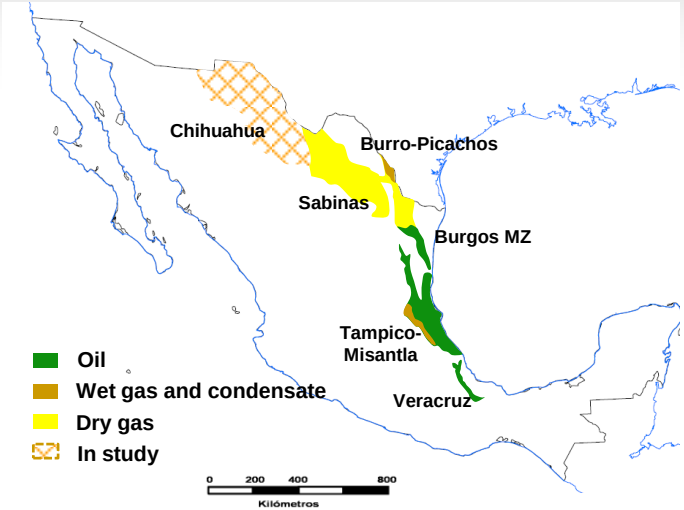


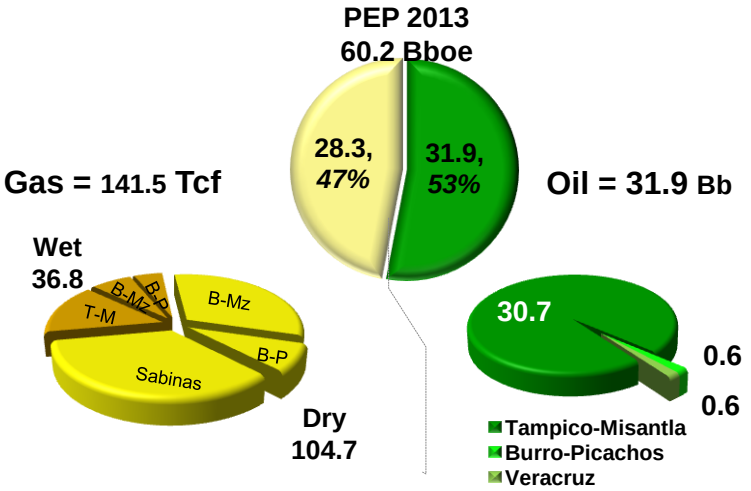
Development scenario Perdido Area



Source: Updated BDOE-II 2013

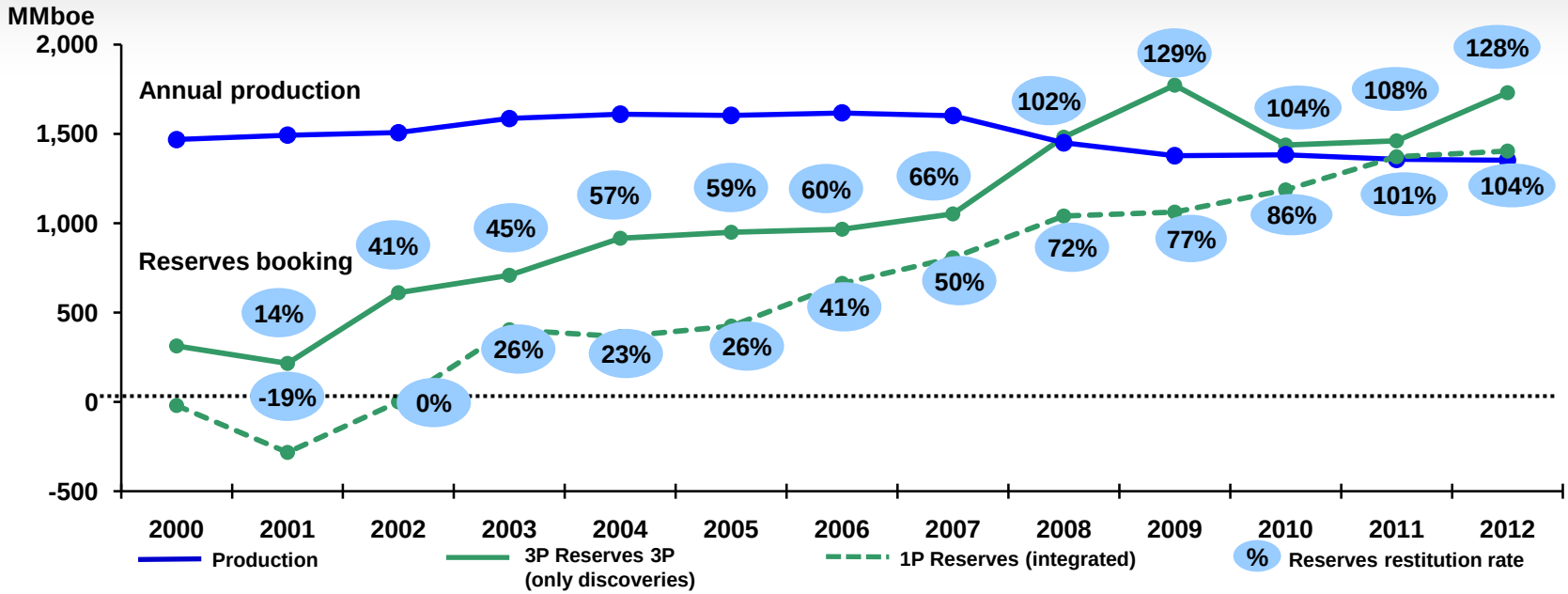
Unconventional resources have also been identified and are being evaluated





- Data integration and interpretation has allowed the estimation of technically recoverable mean resources of 60.2 Bboe and the differentiation of the expected hydrocarbon types
- In order to reduce uncertainty of these resources an exploration strategy has been designed that includes acquisition of ~10,000 km^2 of 3D seismic, drilling of ~175 wells and investment of ~3 BnUSD over the next 4 years
- To date, 9 wells have been completed for testing the Upper Cretaceous Eagle Ford-Agua Nueva and the Upper Jurassic La Casita-Pimienta formations
- This has allowed to start the delineation of oil, dry gas and wet gas areas; with a commercial success rate of 78%, booking 3P reserves for 112 MMboe

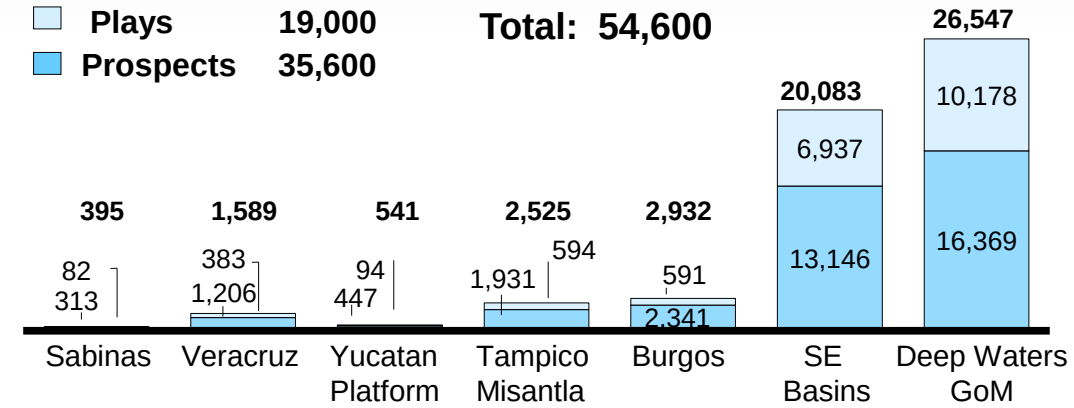
The exploration strategy combined with the budget increase allowed booking reserves at historic levels



- Investment in exploration of more than 12.8 BnUSD during the 2007-2012 period, derived in booked reserves for 8.9 Bboe, with an average discovery cost of 1.5 USD/Boe and a commercial success of 41%
- 3P reserves restitution rates greater than 100% have been reached since 2008 and maintained for five consecutive years
- Restitution rate of proven reserves has been increased since 2003, but it was until 2011 when it was greater than 100%

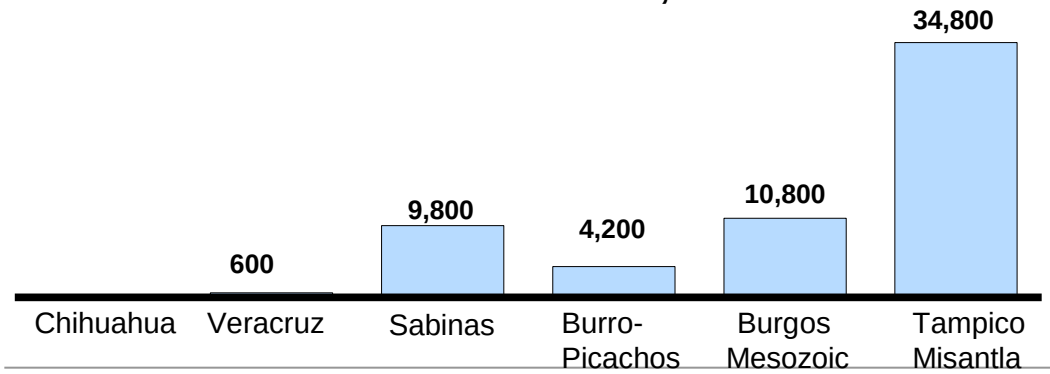
Moreover, the activities performed have increased the volume and reduced the uncertainty of the prospective resources

Conventional prospective resources (MMboe)



FUENTE: BDOE III-2011 y BDPlays

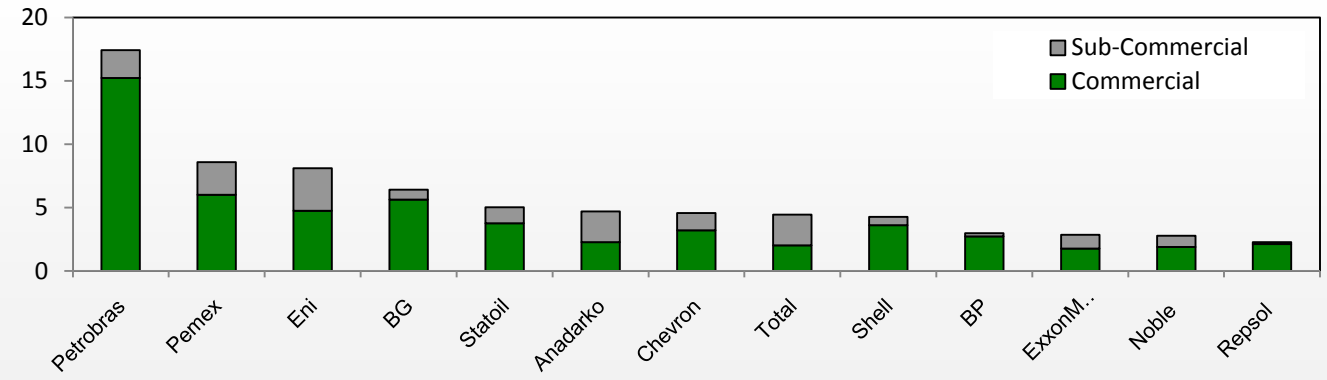
Unconventional prospective resources (MMboe)



- Conventional prospective resources increased to 54.6 Bboe, notwithstanding the booking of 3P reserves for about 8.9 Bboe
- Unconventional prospective resource (shale oil and shale gas) were quantified for the first time, amounting 60.2 Bboe

Performance in reserves booking in the period ranked PEMEX in a competitive place

Commercial and Technical Discoveries: 2003-2012
Bn boe



Source: Wood Mackenzie

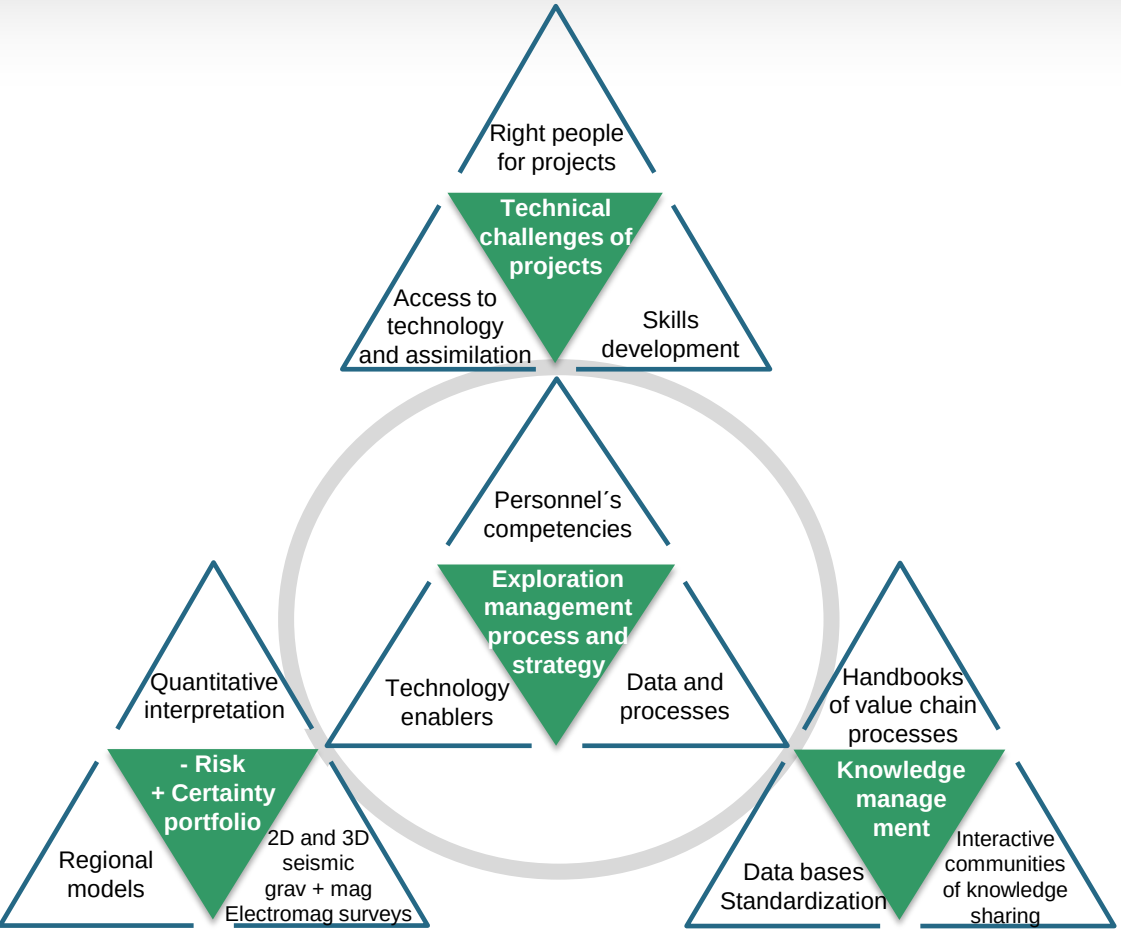
- Performance reached in reserves booking in the 2003-2012 positions PEMEX in second place worldwide
- In the case of deepwater, performance is competitive and in some cases, above average

Comparison of exploratory activity in the USA and Mexico deepwater GoM 2003-2012

	US Deepwater, West GC	US Deepwater, East GC	Mexico, Pemex
Exploration wells	197	236	25
Geologic success (%)[1]	29	36	60
Historic commercial success (%)[2]	23	27	48
Total reserves (MMboe)	6,214	3,248	1,782
Investment (MMUSD)[3]	15,332	16,954	4,695

[1]Overall success in US Deepwater GoM, Wood Mackenzie 2002-2013
[2]Commercial success rate in US Deepwater GoM, Wood Mackenzie 2002-2013
[3]Exploration Spend US Deepwater GoM Wood Mackenzie 2002-2011
Source: US Deepwater data: Wood Mackenzie 2003-2012, Pemex data: 2002-2012

A key element to reach the goals was the implementation of an integrated exploration management

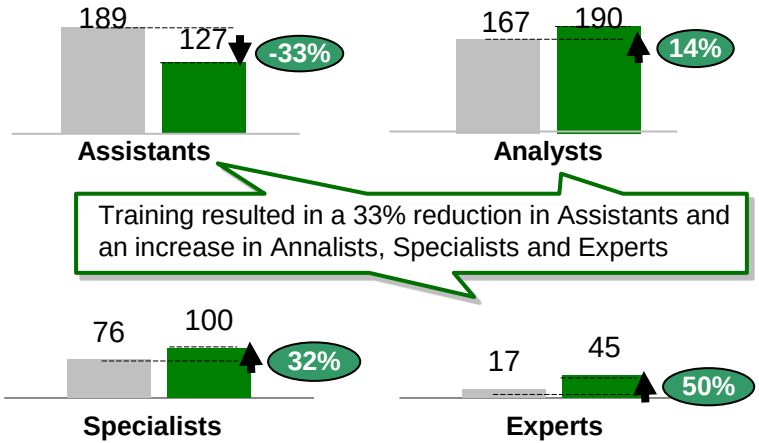


In order to improve exploration performance, a management model was designed in late 2008:

- Definition and implementation of exploration technologies based on the technical challenges of the priority projects
- Implementation of the sub-processes that favor the interrelationship between skills development and technology as well as knowledge management
- Technical skills development, career plan and geoscience personnel assignment to the exploration projects
- Collaboration with leading technology service companies through multi-year contracts

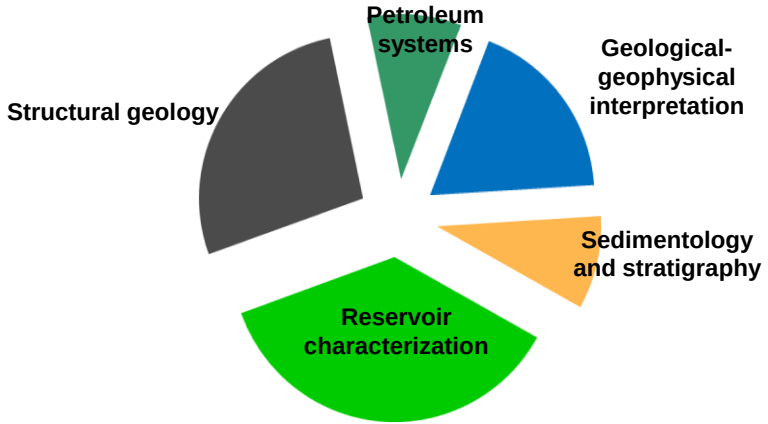
Skills development in critical disciplines and personnel specialization have been key initiatives of the strategy

Specialization for Geoscience and engineering personnel 2009 vs 2013



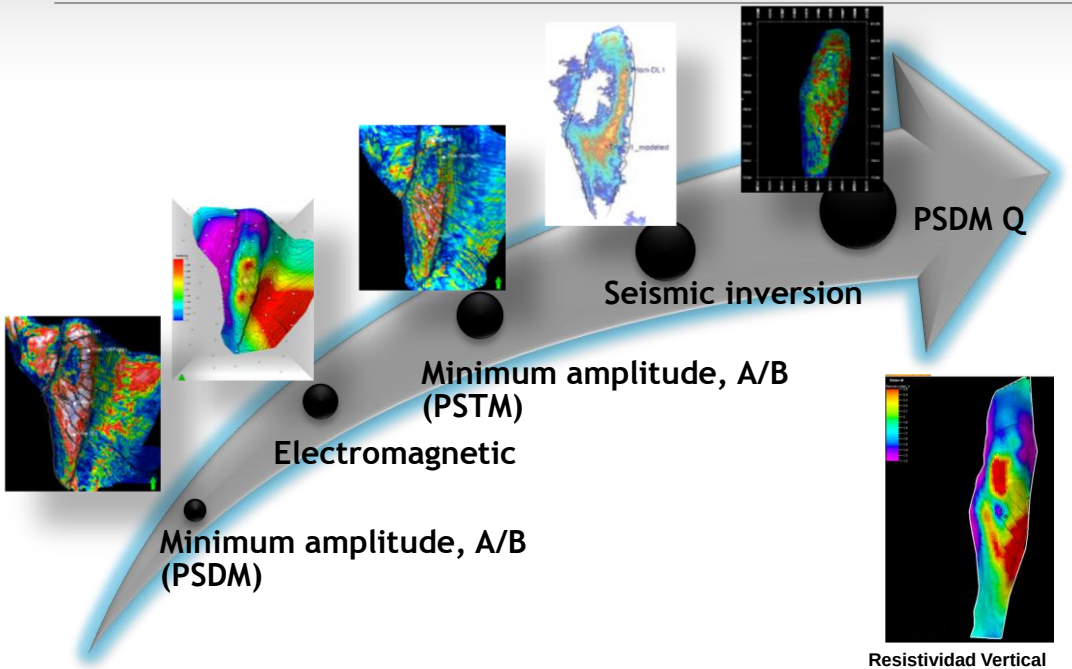
- Training for assistants and annalists include courses, diplomas and rotation in different exploration areas with mentors
- Specialists and experts are considered for stays and collaboration with leading operators and service companies as well as for master and PhD studies in world leading universities and institutions

Model of development for critical skills: Postgraduate studies

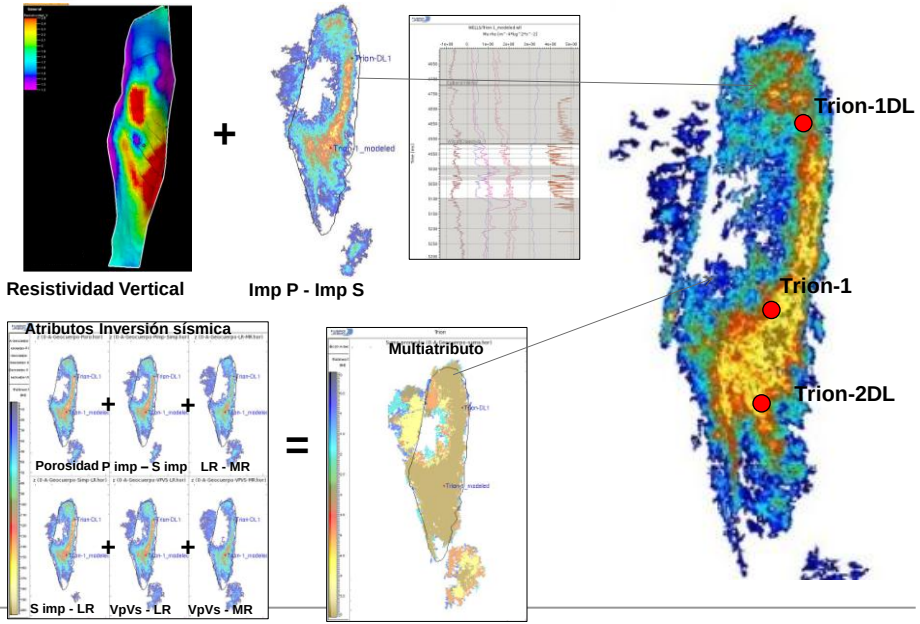


- A model was built to identify and develop critical skills as well as design individual learning maps, including training, rotation and postgraduate studies
- Skills have been monitored since 2006, with more than 460 surveyed professionals pear year
- There are currently 45 professionals in postgraduate programs.

Technology has been critical to reduce the cycle time from seismic acquisition to discovery: Trion case



- It took about two years from the first shot of the Centauro 3D Waz to the discovery
- It has also reduced uncertainty in reservoir characterization and in the definition of the delineation program

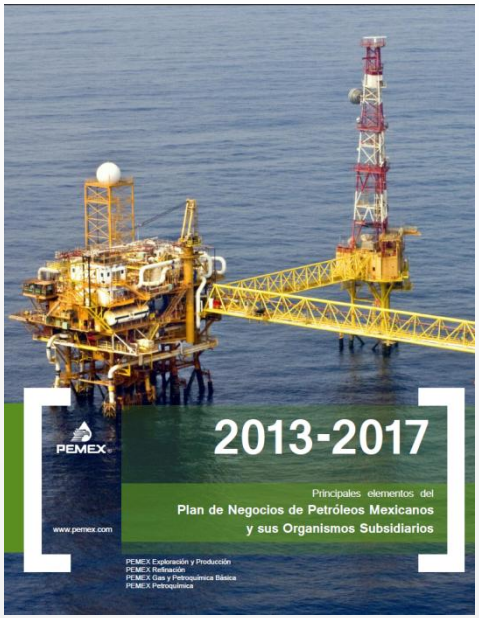


Perspectives

Exploration strategies were defined according to the PEMEX Business Plan

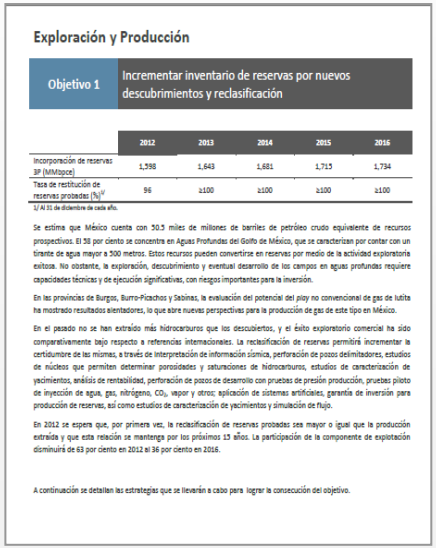
PEMEX Business Plan

The Plan consists of 15 strategic objectives and 49 strategies



Strategic Objectives of PEP

1. Increase the reserves inventory through new discoveries and reclassification
2. Increase hydrocarbon production



Exploración y Producción

Objetivo 1	Incrementar inventario de reservas por nuevos descubrimientos y reclasificación

	2012	2013	2014	2015	2016
Incorporación de reservas 3P [MMbpce]	1,598	1,643	1,681	1,715	1,734
Tasa de restitución de reservas probadas (%)[1/]	96	≥100	≥100	≥100	≥100

1/ Al 31 de diciembre de cada año.

Se estima que México cuenta con 50.5 miles de millones de barriles de petróleo crudo equivalente de recursos prospectivos. El 58 por ciento se concentra en Aguas Profundas del Golfo de México, que se caracterizan por contar con un tirante de agua mayor a 500 metros. Estos recursos pueden convertirse en reservas por medio de la actividad exploratoria exitosa. No obstante, la exploración, descubrimiento y eventual desarrollo de los campos en aguas profundas requiere capacidades técnicas y de ejecución significativas, con riesgos importantes para la inversión.

En las provincias de Burgos, Burro-Picachos y Sabinas, la evaluación del potencial del play no convencional de gas de lutita ha mostrado resultados alentadores, lo que abre nuevas perspectivas para la producción de gas de este tipo en México.

En el pasado no se han extraído más hidrocarburos que los descubiertos, y el éxito exploratorio comercial ha sido comparativamente bajo respecto a referencias internacionales. La reclasificación de reservas permitirá incrementar la certidumbre de las mismas, a través de interpretación de información sísmica, perforación de pozos delimitadores, estudios de núcleos que permiten determinar porosidades y saturaciones de hidrocarburos, estudios de caracterización de yacimientos, análisis de rentabilidad, perforación de pozos de desarrollo con pruebas de presión producción, pruebas piloto de inyección de agua, gas, nitrógeno, CO_2, vapor y otros; aplicación de sistemas artificiales, garantía de inversión para producción de reservas, así como estudios de caracterización de yacimientos y simulación de flujo.

En 2012 se espera que, por primera vez, la reclasificación de reservas probadas sea mayor o igual que la producción extraída y que esta relación se mantenga por los próximos 15 años. La participación de la componente de explotación disminuirá de 63 por ciento en 2012 al 36 por ciento en 2016.

A continuación se detallan las estrategias que se llevarán a cabo para lograr la consecución del objetivo.

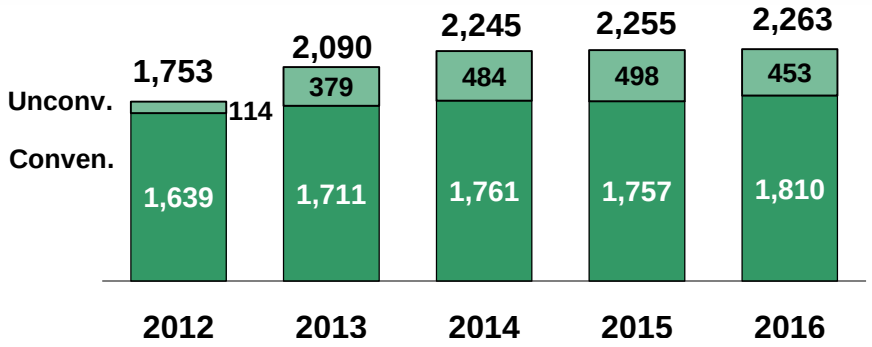
Exploration Strategies

1. Increase the level of booking oil reserves in shallow waters and onshore areas
2. Accelerate the evaluation of the deep-water Gulf of Mexico´s potential
3. Expand the portfolio of exploration opportunities in areas of non-associated wet gas
4. Strengthen the delineation drilling to accelerate the development of proven reserves
5. Intensify the evaluation of exploration potential of shale oil and shale gas

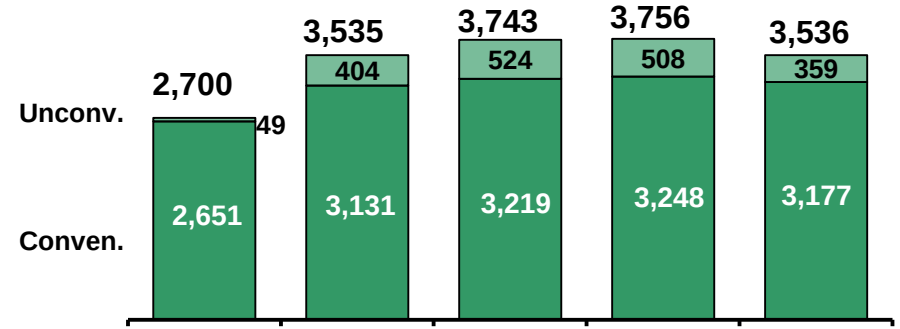
Source: Plan de Negocios de Petróleos Mexicanos y Organismos Subsidiarios 2013-2017

Execution of these strategies requires an investment close to 17.3 BnUSD

Reserves to be discovered: 10.6 Bboe

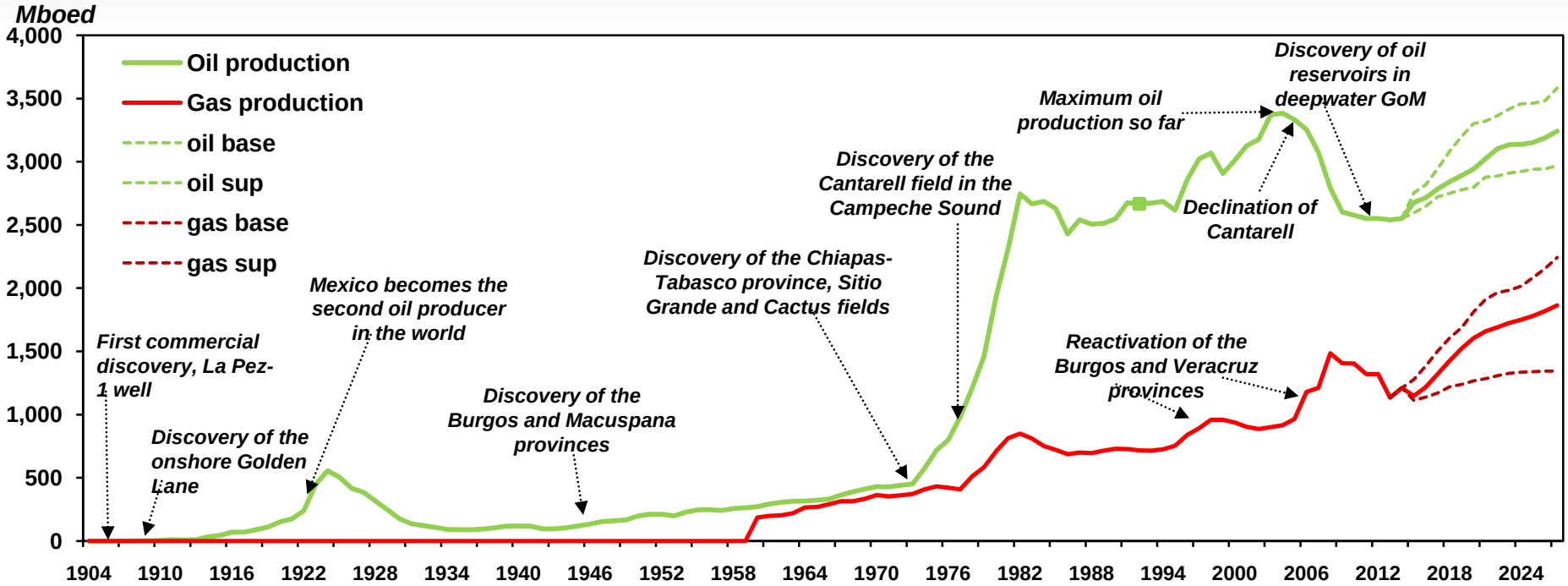


CAPEX: 17,270 MMUSD



- 72% of the total reserves to be booked are estimated to be light oil, 10% heavy oil and 18% non-associated gas
- The aim is to keep a discovery cost lower than 2 USD/Boe

Exploration will continue playing a key role in the growth of the national petroleum industry



- In 2012 Mexico ranked as the world´s tenth-largest oil producer, thirteenth in gas, and eighteenth in proven oil reserves
- Petroleos Mexicanos contributes with about 40% of the federal government income

Concluding remarks

- The investment in exploration as well as the implementation of new methodologies and technologies has allowed improving our knowledge of the Mexican petroleum basins, confirming that there is a great potential and large volumes of hydrocarbons to be discovered

- In order to confirm this potential, it is necessary to look for novel schemes that allow greater investment in exploration allowing private participation as well as access to services and technology to enable tackling the challenge of discovering hydrocarbons in geologically complex areas and extreme conditions

- We need to increase the collaboration between the petroleum industry and education institutions, research centers and other national industries to ensure sustainability in the country in the medium and long term

- Pemex Exploration & Production, aware of its role in the economic development of the country, embraces the challenge to continue discovering and producing hydrocarbons with safety as well as with social and environmental responsibility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