EDISON

Exploration watch

Offshore Mexico

Mexico's offshore acreage is vastly underexplored compared to the US Gulf of Mexico, but now the region is being opened up to international investment as the country implements its 2013 energy reform. Three offshore rounds have been held since 2015, attracting a range of companies including majors ExxonMobil, Total, Chevron, Statoil and BP, and two further rounds are expected in 2017. International companies have drilled a number of successful appraisal wells in shallow waters here over the last nine months, while the first non-Pemex exploration well in over 80 years, Zama-1, was spudded in May 2017. However, the deepwater round generated most interest and activity here is expected to commence from late 2018.

Shallow water exploration and appraisal ongoing

International companies have been active in the shallow waters of the Sureste Basin since October 2016. Appraisal wells at existing Pemex discoveries for Eni at Amoca and Pan American in Hokchi have reported better than expected results, and Fieldwood Energy is currently drilling its first well at Ichalkil. Meanwhile, results from the Talos Energy-operated Zama-1 exploration well are expected in July. The well is targeting light oil in the Lower Pliocene and Miocene and has a 52% geological chance of success. Partner Premier Oil estimates that Zama holds 100-500mmbbls.

Deepwater to build on US Gulf of Mexico experience

The first and only deepwater round to date, Round 1.4, was the most hotly anticipated and the most successful, with eight out of 10 blocks on offer awarded. The acreage is split between the Perdido fold belt, where Pemex has made a number of key discoveries, and the Salina del Istmo, which is a frontier basin. The geology across both regions is expected to be similar to that seen in the US Gulf of Mexico. The successful candidates, including ExxonMobil, Chevron, BP and Statoil, will be looking to bring their US experience to acreage that offers plenty of running room. Similarly, BHP Billiton sees synergies between its US operations and the appraisal and development of Trion, after it was awarded 60% and operatorship of the field in Pemex's first ever farm-out deal. Activity in this region could begin by late 2018, when BHP is planning an appraisal well in Trion. An exploration well is also being scheduled in the Salina del Istmo from late 2018 by a consortium led by Murphy Oil (and including UK independent Ophir Energy).

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COMPANIES IN THIS REPORT

BHP Billiton
BP
Cairn Energy
Chevron
CNOOC
Eni
ExxonMobil
Fieldwood Energy
Murphy Oil
Pan American Energy
Pemex
Petronas
Premier Oil
Ophir Energy
Sierra Oil & Gas
Statoil
Talos Energy
Total

EXPLORATION WATCH

A periodic look ahead from our in-house petroleum engineer, Elaine Reynolds, focusing on interesting exploration activities with significant potential impact on E&P equities.

Offshore Mexico opens up to international investment

Mexico's oil and gas sector is undergoing a profound shift as the government enacts its 2013 energy reform. The country is looking to bring in new investment and technology from international players to reverse the decline in production it has seen over the last decade and to open up more technically challenging areas. As part of this drive, Mexico has held three offshore licensing rounds since 2015, attracting major international companies such as ExxonMobil, Total, Chevron, Statoil and BP. In addition, it farmed out its giant deepwater oil discovery, Trion, to BHP Billiton. As a result, 2017 has seen the first non-Pemex wells being drilled offshore Mexico in over 80 years. The first of these have been appraisal wells on existing Pemex discoveries and have been drilled by operators ENI, Pan American and Fieldwood Energy. Meanwhile, Talos Energy, partnered by Premier Oil and Sierra Oil & Gas, spudded an exploration well, Zama-1, in May 2017. For the moment, this drilling activity is concentrated in shallow waters. Activity has yet to commence in deepwater, which includes acreage in the Perdido fold belt where Pemex has made a cluster of discoveries since 2012 not far from the US Gulf of Mexico and Shell's Perdido development. The licence rounds are opening up a prolific hydrocarbon basin where the salt flank and subsalt plays found in US waters are underexplored.

Production decline provides impetus for change

Mexico nationalised its oil sector in 1938, when Pemex was created as the sole oil operator. The company concentrated its offshore exploration and development in the shallow waters in the south-eastern basins of the Gulf of Mexico, where the giant Cantarell field is located.

Exhibit 1: Mexico oil and gas fields

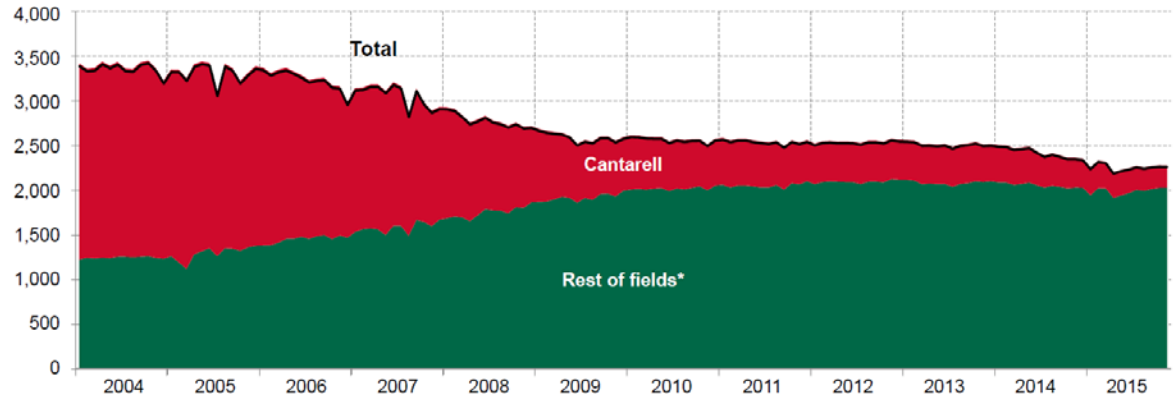
Source: EIA

Exhibit 2: Exploration opportunities

Source: Oil & Gas Journal

In 2004, Cantarell was producing over 2.1mmbopd and accounted for almost two-thirds of total production in Mexico, but this has since declined to less than 280,000bopd in 2015. Pemex has been unable to make the investment necessary to arrest the decline at Cantarell and other fields and this has been instrumental in Mexico opening up its energy sector to increase competitiveness and investment in the sector.

Exhibit 3: Mexico crude oil production (mb/d)



Source: Pemex

The energy reform process was initiated in 2013 and the first licence rounds commenced in 2015. To date there have been three offshore licensing rounds, with the offers for further rounds due in June and December 2017.

- **Round 1.1** results were announced in July 2015 and focused on exploration licences in shallow waters.
- **Round 1.2** dealt with existing shallow water discoveries, and these were awarded in September 2015.
- **Round 1.4** was the most eagerly anticipated as it covered deepwater exploration and included acreage in the Perdido fold belt close to the US Gulf of Mexico. These licences were awarded in December 2016.
- **Round 2.1** will focus on exploration and production licences in shallow waters and will open for offers on 19 June 2017.
- **Round 2.4** bids will open in December 2017 for deepwater and the first offering of onshore unconventionals. Details of the blocks on offer are expected to be released in July 2017.

Rounds 2.2 and 2.3, covering onshore acreage, will also open for bids on 15 July 2017. In the future, Mexico's energy ministry plans to hold two bidding rounds per year, with Round 3.1 for shallow water and onshore conventionals expected in February 2018 and Round 3.2 for deepwater and onshore unconventionals in October 2018. The ministry has decided to standardise the block sizes on offer in these future rounds at 1000km^2 for deepwater blocks and 400km^2 for shallow water.

Shallow water: Exploration and appraisal underway

The Sureste Basin has been by far the most prolific hydrocarbon basin in Mexico. It contains the offshore fields of the shallow water Bay of Campeche, including the giant Cantarell and the Ku-Maloob-Zaap field, which overtook Cantarell as the largest producing field in Mexico in 2009 when it produced over 800,000bopd.

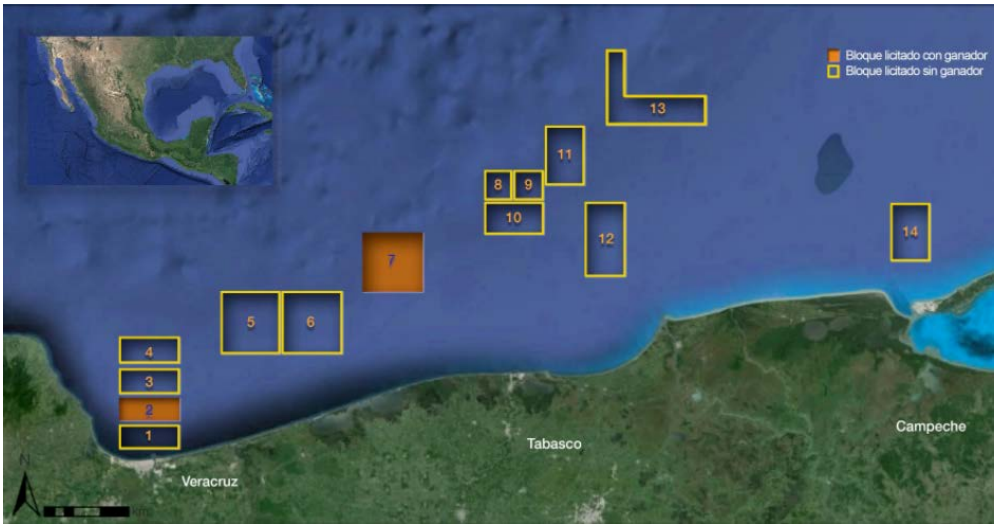
Cantarell produces from Late Cretaceous carbonate breccias believed to have been formed when the Chicxulub asteroid impacted the Yucatan peninsula and caused the carbonate platform to collapse. The Cantarell field is estimated to produce 60% to 70% of its oil from the Chicxulub impactites, with the remaining production coming from the Kimmeridgian and Eocene. While carbonate reservoirs are common in the eastern portion of the basin, the main plays in the western region are clastic. The shallower sandstone Miocene is believed to have a high prospective potential, while further west gas is found in the Pliocene in the Catemaco fold belt. The source rock

across the basin is the Tithonian, the same source found in the US Gulf of Mexico. In the east of the basin, the Tithonian is early mature resulting in heavy oil (eg the Maloob and Zaap fields in Ku-Maloob-Zaap produce 12° API oil), while in the west the Tithonian is more mature and produces lighter oils. During the early opening of the Gulf of Mexico, salt was deposited in the basin and salt tectonics in the area have resulted in the formation of structural and stratigraphic traps in the basin.

Round 1.1: Only two blocks awarded but Zama-1 now drilling

The inaugural oil and gas auction for shallow water concessions was considered a disappointment when the results were announced in July 2015. Only two of the 14 blocks on offer were secured, with offers on four further blocks rejected and the remaining blocks receiving no bids.

Exhibit 4: Round 1.1 licences



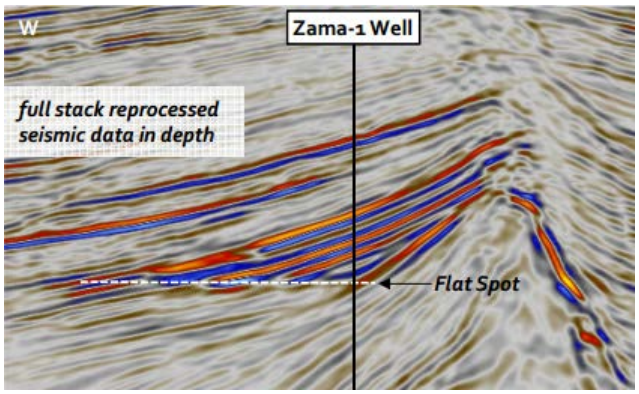
Source: CNH

Blocks 2 and 7 were picked up by Talos Energy in partnership with Sierra Oil & Gas and Premier Oil. The consortium won Block 2, which was also contested by Hunt Oil, by offering the state an operating profit margin of 55.99% and a 10% increase in work programme. The group also offered a state profit margin of 69% on Block 7, which was the most contested block with offers from four other groups that included Statoil and Eni. Murphy Oil's and Petronas's offer for Blocks 3 and 4 and India's ONGC bid for Blocks 6 and 12 were all rejected as the required minimum profit share was not met.

Zama-1 exploration well

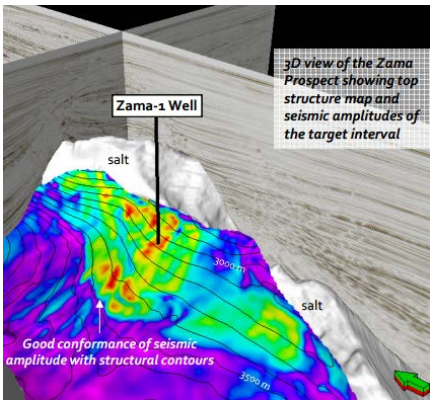
In May 2017, the Zama-1 exploration well was spudded in Block 7. The prospect sits in 165m water and Premier estimates that it contains 100-500mmbbls. The well is targeting tertiary targets in the Lower Pliocene and Miocene, with light oil in the mid-20s API range expected and as seen in the Cinco Presidentes fields onshore. Premier originally held 10% WI in Block 7, but increased its interest to 25% in December 2016 (Talos 35%, Sierra 40%).

Exhibit 5: Zama seismic



Source: Premier Oil

Exhibit 6: 3D view of Zama prospect



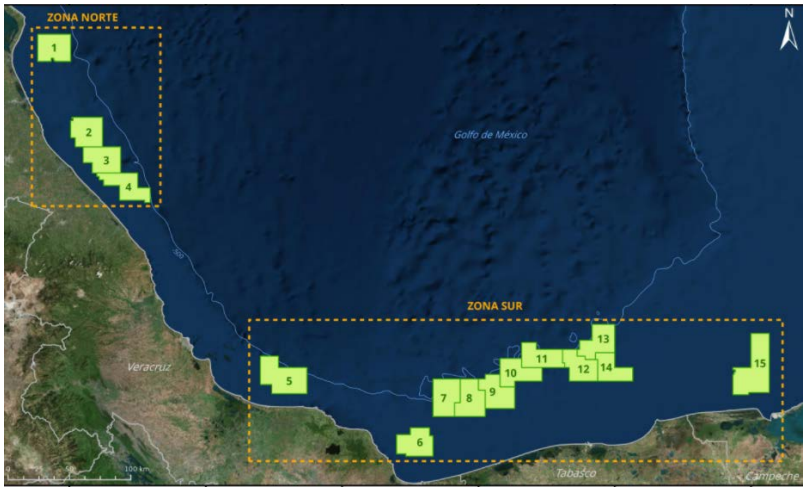
Source: Premier Oil

Premier assigns a geological CoS to Zama-1 of 52%, which is low risk for an exploration well. This is due to the fact that the prospect sits in a known petroleum system with source, charge and reservoir all proven. The prospect is a three-way dip closure sealed against a salt feature, so there is a risk in the trapping mechanism. However, the company believes that this is mitigated by the presence of bright amplitudes on the crest of the structure on 3D seismic that dim below what Premier believes is the oil water contact based on a well-developed flat spot. The company sees both shallower amplitude supported prospects and subsalt prospects elsewhere in the block.

Round 2.1: Generating major interest

Round 2.1 is offering 15 blocks and offers are due on 19 June. Blocks 1-4 are located to the north-west of the previous shallow water offshore rounds and are offshore Tampico-Misantla, an established onshore basin that has produced 7.4bnboe and extends into the Gulf. Block 5 is offshore Veracruz and is a gas-prone area and the remainder, Blocks 6-15 are in the Sureste Basin. 20 companies have pre-qualified as individual bidders for the round, including majors Shell, BP, Statoil, Chevron, CNOOC and ConocoPhillips. US independents Noble Energy, Murphy Oil and Hunt Oil have also qualified, as has UK independent Ophir Energy. Ten companies have pre-qualified as part of five consortia, including existing players in the area, Premier/Sierra and Murphy/Talos, together with new entrants Dea Deutsche/Diavaz and Cairn Energy (as Capricorn) in two separate consortia, Capricorn/Citla and Capricorn/Citla/Eni.

Exhibit 7: Licences on offer in Round 2.1



Source: CNH

Round 1.2: Successful appraisal in all three blocks awarded

The second phase of Mexico's lease sale offered five development blocks with proven reserves in shallow water. The results were announced in September 2015, with three blocks awarded and two blocks, 3 and 5, receiving no bids. Block 3 contains heavy oil reserves, while Block 5 is condensate rich.

Exhibit 8: Round 1.2 blocks

Source: CNH

Block 1: Amoca

Eni was awarded the most competitive licence, Block 1, which attracted nine bidders. The block contains three discoveries, Amoca, Mizton and Teocalli, which altogether contain 2P reserves of 107mmbbl of light oil and 69bcf of natural gas found in Pliocene sands in 33m of water. Eni committed to a $245m delineation programme and offered a state profit margin of 83% and a 33% increase in investment. As part of this programme, the company began a four-well appraisal campaign in January 2017, when it spudded the Amoca-2 appraisal well. Amoca-2 was drilled to 3,500m and encountered 110m of net oil play across the Pliocene and the deeper Miocene, of which 65m was in the previously untested Miocene. The shallower target contained 18^{o} API oil, but the oil in the Miocene was lighter and described as high-quality light oil. Eni said the results "indicated a meaningful upside to the original estimates". The company is currently drilling the Amoca-3 well in an unexplored area of the field and is looking at the possibility of implementing an early production phase.

Block 2: Hokchi

Block 2 was awarded to a consortium led by Pan American Energy, Argentina's largest private oil and gas operator and 60% owned by BP. The remaining 40% is held by Argentinian company Bridas (which is 50% owned by CNOOC), together with E&P Hidrocarburos y Servicios. The consortium beat four other bids by offering a state profit share of 70% and a 100% increase in investment.

Pan American spudded Hokchi-2 in October 2016, making it the first non-Pemex offshore well to be drilled in over 80 years and the first in a planned four-well campaign. The well targeted light oil in the Middle Miocene and was drilled 2.5km from the discovery well to determine the lateral extent and variation in Hokchi. Hokchi-3 was spudded in February 2017 and was looking for the oil-water contact on the western extent of the discovery. Hokchi-4 was tested in April 2017 and produced

4,201bbls of 29.4° API oil. The company has not given further details of its progress other than to say that the results have been better than expected. Mexico's National Hydrocarbons Commission (CNH) estimated prior to the drilling campaign that Hokchi contains 2P resources of 61mmboe and 20bcf.

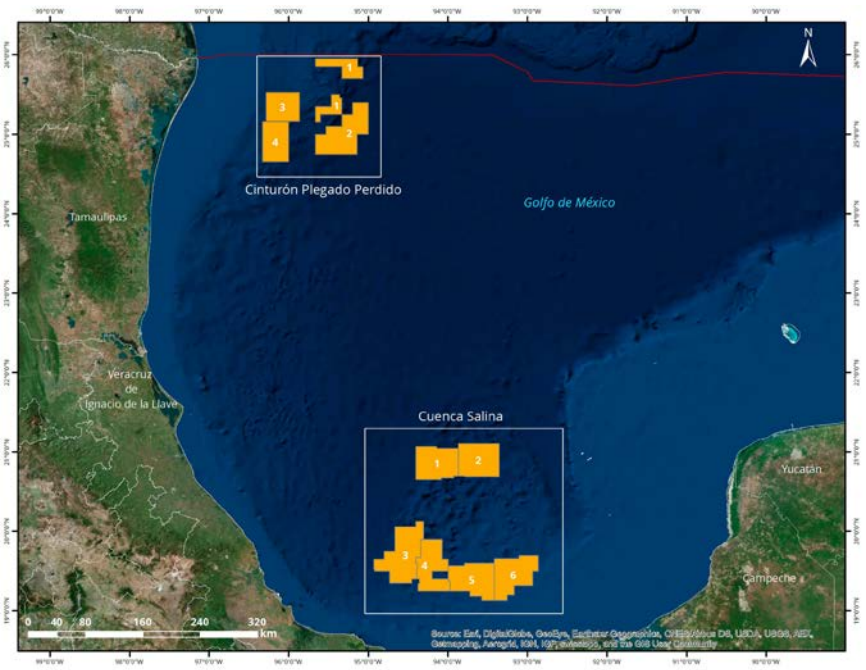
Block 4: Ichalkil

Block 4 went to the consortium of US company Fieldwood Energy and Petrobal, a Mexican company led by former Pemex E&P director Carlos Morales Gil. The block was uncontested and the consortium offered a state profit share of 74%. The block contains the Ichalkil and Pokoch fields which, prior to the round, were estimated to hold 2P reserves of 68mmbbl of light oil and 92bcf of gas found in Cretaceous and Jurassic limestone in 45m of water. The discovery well encountered 33° API light oil in the Lower and Middle Cretaceous and Pemex estimated that it contained 2P reserves of 25.5mmbbls and 15.9bcf. The Ichalkil-2 well commenced drilling in March 2017 and is ongoing, targeting 120mmboe in Cretaceous and Jurassic objectives. Fieldwood is planning to drill its first well in Pokoch after it completes operations on Ichalkil-2.

Deepwater: Read-across from US Gulf of Mexico

Fewer than 45 deepwater exploration wells have been drilled in Mexican waters compared to over 1,200 such wells in the US Gulf of Mexico. International companies are keen to explore here and this was reflected in the most anticipated round to date, and the first deepwater round, Round 1.4, with eight out of 10 blocks on offer awarded. The round covered two separate deepwater areas, Perdido and Salina del Istmo. The Perdido fold belt is a shared structural trend that straddles the US/Mexico border. The Perdido has seen a number of commercial discoveries drilled by Pemex in Mexican waters since 2012, including Trion, Exploratus, Maximino and Supremus, while Shell's Perdido development is around 50 miles to the north in US waters. In contrast, Salina del Istmo is a frontier basin located to the north of the shallow Sureste Basin. Discoveries here to date have been Miocene in age and wet gas.

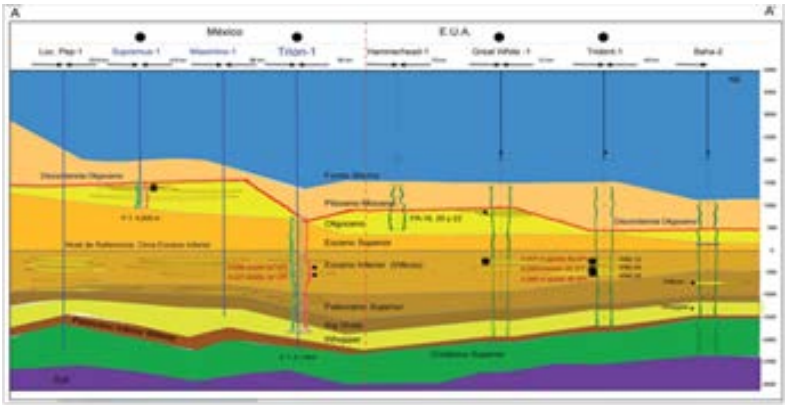
Exhibit 9: Round 1.4 deepwater licences



Source: CNH

Development in the deepwater US Gulf of Mexico is dominated by two key geological trends: the Miocene and the Lower Tertiary, or Paleogene. Production was originally centred on Miocene turbidite sands and this remains the most important producing zone in the region. The Paleogene play sits to the south of the Miocene and is at an earlier stage of development. The play was initiated by the discovery of reservoir quality sands in the Baha-2 well drilled in Alaminos Canyon in 2001. This well was targeting Mesozoic fractured carbonates, but established good-quality sands in a turbidite section of the Wilcox Formation. The Paleogene has been the focus of recent deepwater Gulf of Mexico investment and home to some of the largest discoveries. However, to date only four developments are producing from the Paleogene. Shell's Perdido development, covering Great White, Silvertip and Tobago in Alaminos Canyon, was the first commercial Paleogene development and came onstream in 2010. This was followed by Petrobras's Cascade/Chinook in 2012, Chevron's Jack/St Malo in December 2014 and Shell's 250mmboe Stones project in 2016.

Exhibit 10: Perdido stratigraphic correlation



Source: CNH

The industry anticipates any developments in deepwater Mexico to be across these same trends, which will bring a number of technical challenges. Both the Miocene and Paleogene are masked by subsurface salt, so that state-of-the-art 3D seismic acquisition, processing and interpretation is required to accurately image prospects. The Paleogene is characterised by older sediments with low permeabilities, lateral heterogeneity and dead oil, which all contribute to low recovery factors in the order of 10%. In addition to the complex reservoirs, the prospects have high bottom hole pressures and ultra-deepwater depths, making the wells technically challenging (ultra-deepwater is defined as greater than 1,500m). In addition, there is no infrastructure in the deepwater region. It is possible that commercial discoveries in the Perdido area could be tied back to US infrastructure, while developments in Salina del Istmo will most likely be via FPSO.

Exhibit 11: Round 1.4 deepwater blocks

Region	Block	Operator	Partners	Additional royalty (%)	Prospective resources (mmboe)	Area (km^2)	Water depth (m)
Perdido	1	CNOOC		17.01	625.8	1,678	2,515
	2	Total	ExxonMobil	5	1,439	2,977	3,237
	3	Chevron	Pemex, Impex	7.44	1,304	1,687	1,005
	4	CNOOC		15.01	540.5	1,877	1,264
Salina	1	Statoil	BP, Total	10	1,852	2,381	2,437
	2	No bids				2,411	2,205
	3	Statoil	BP, Total	10	1669	3,287	1,763
	4	Petronas	Sierra Coronado	22.99	392	2,359	1,196
	5	Murphy Oil	Ophir, Petronas, Sierra Offshore Exploration	26.91	621	2,573	848
	6	No bids				2,606	604

Source: Edison Investment research, CNH

Perdido awards

Four blocks were offered in the Perdido and all received bids. Blocks 1 and 4 were awarded to CNOOC on a sole basis, with Block 2 awarded to Chevron/ExxonMobil and Block 3 awarded to Chevron/Pemex/Impex.

CNOOC has committed to drill two wells and a minimum work programme of $129.4m in Block 1, and one well and a $33.6m minimum spend in Block 4. Total/ExxonMobil have committed to two wells in Block 2 and will spend a minimum of $129m. In Block 3, Chevron/Pemex/Imex have no well commitment and will have the lowest spend for the Perdido of $3.4m, which will cover studies particularly focused on seismic processing and interpretation.

Salina del Istmo basin: Drilling from 2018

The Salina del Istmo basin is a sub basin of the Sureste Basin. The deepwater region of the basin is unexplored. However, there is evidence supporting the presence of oil that is being squeezed up to the seafloor through faults, which leads to the expectation of mostly light oil hydrocarbons in the sector, although there is also the potential in some areas for heavy oil and wet gas.

The most contested area was Block 5, which received offers from four bidders. A consortium led by Murphy Oil (30% WI) won the block over offers from Shell, Statoil and Eni/Lukoil with a bid of a 26.91% additional royalty. The JV, including UK independent Ophir Energy (23.33% WI) alongside PC Carigali (23.34% WI) and Sierra (23.33% WI), has purchased new seismic and Murphy has stated that the block has a number of different plays that are seen in the US Gulf of Mexico, including subsalt. The block is believed to have attracted the most interest on the basis of the potential in fractured carbonates. An exploration well is being planned for late 2018.

Block 4 was contested by two bids and was awarded to a consortium of Petronas (as operator) and Sierra, which beat Statoil/BP/Total into second place with an additional royalty offer of 22.99%. Sierra sees similarities in the deepwater features here to those it has found in the shallow Block 7 containing Zama, although the largest structure in the block is a carbonate prospect. More study and analysis is required to improve imaging of the structures seen on the block.

Blocks 1 and 3 will operated by Statoil, partnered by Total and BP. These blocks cover the largest area and have the highest mean prospective resources at 1,852mmboe and 1,669mmboe offered in the basin. Statoil has committed to drill one well in each block, and has said it does not expect this to occur until at least 2019.

The remaining blocks, 2 and 6, were the most eastern blocks on offer and received no bids.

Trion farmed out to BHP

In December 2016, Pemex awarded its first ever farm out deal. BHP Billiton acquired a 60% WI and become operator of the deepwater Trion field in the Perdido fold belt by bidding a cash contribution of $624m and an additional royalty of 4%. BP was the only other bidder for Trion, but lost out with a lower cash contribution of $606m.

BHP holds a significant position in the western US Gulf of Mexico in the Alaminos Canyon area. Its experience here points to improved deliverability from the Paleogene in these western areas and the company plans to bring this expertise to the development of Trion. The field sits 179km offshore Mexico and 40km to the south of the Mexico/US maritime border in water depths of over 2,500m. Pemex had planned to develop Trion via an FPSO, although BHP is also considering the option to export production either via existing US infrastructure or through a Mexican pipeline.

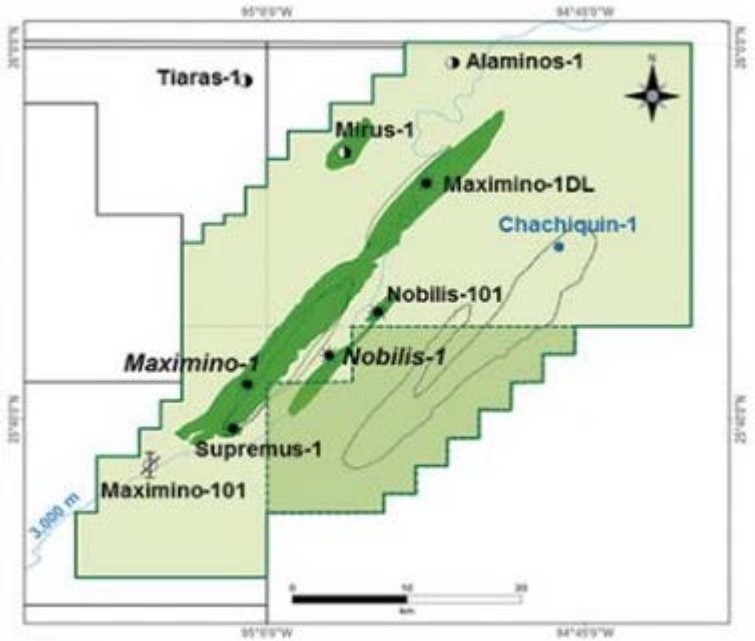
Trion was discovered in 2012 and is estimated to hold 3P reserves of 485mmboe. Prior to the farm-out, Pemex indicated that it expected production of 120,000bopd by 2025, at a development cost of

$11bn. An appraisal well is being targeted for 2018, with a further well planned over the next 24 months.

Maximino and Nobilis farm-out planned for end 2017

Pemex is planning to farm out further Perdido discoveries, Maximino and Nobilis, potentially by the end of 2017.

Exhibit 12: Maximino and Nobilis map



Source: Pemex

Mexico's CNH is currently considering increasing the area under offer as part of this farm-out to encourage development clusters in the area. It recently approved the inclusion of the Chachiquin prospective area to the Maximino-Nobilis farm-out, although it may also include the Exploratus and Supremas finds, together with the non-commercial Tiaras and Alaminos wells. The block would hold reserves of 346mmboe from Maximino and Nobilis and 171mmboe contingent resources from Supremus and Mirus.

In addition to the Maximino-Nobilis farm-out, CNH plans to hold a bid event in October 2017 for the shallow water Ayin-Batsil field.

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