

New oil and gas discoveries

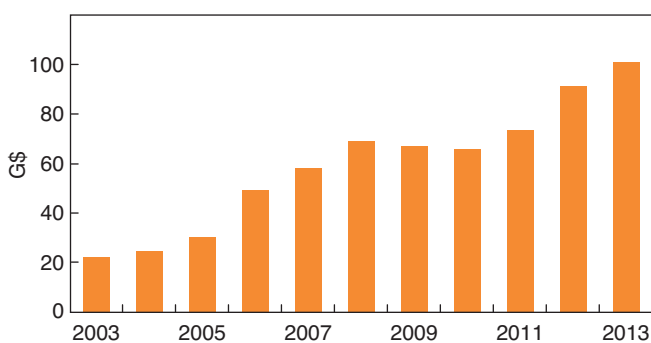
Spending on exploration increased significantly in 2012, and this growth should continue into 2013. Over a period of ten years, exploration budgets have increased five-fold, leading to major discoveries in regions as yet unexplored. In 2012, 25 billion barrels of oil equivalent (Gboe) were revealed. This is more than the average for the whole decade, but less than the amount for the previous year. Although knowledge of the volumes that have been discovered is still very fragmented, they should continue to fall into 2013. The main reason lies in the fact that spending on exploration is being shifted towards assessing discoveries made in previous years in the particularly prolific basins of Brazil and East Africa, while the exploration of border regions — such as the West African pre-salt formation — is still only in its early stages.

Acceleration in the increase in exploration spending in 2012

Spending on exploration increased by 25% in 2012, following the 11% increase in 2011. It should continue to grow into 2013, with total spending of close to \$100 billion (G\$) — a five-fold increase since 2003. It rose particularly sharply between 2004 and 2008, increasing by an annual average of nearly 30% over this period (Fig.1a).

This large-scale exploration has resulted in a number of major discoveries since 2006 (Fig.1b), some of which have led to new oil and gas provinces being opened.

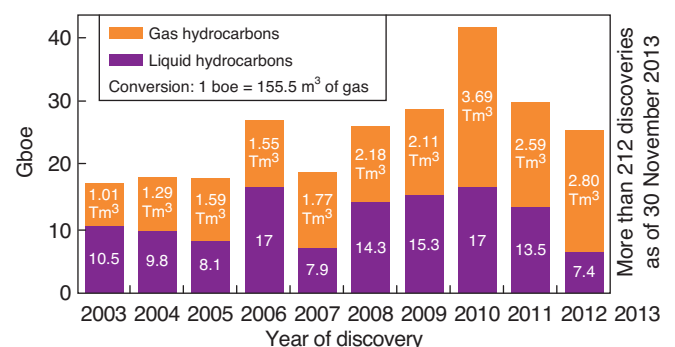
Fig. 1a – Increase/decrease in spending on exploration



Source: IFPEN

Among these are: the Brazilian pre-salt formation in the Santos and Campos basins (2006), the Levant Basin off the coast of Israel and Cyprus (2009) and the Rovuma Basin (2010) in Mozambique and Tanzania (Fig.2). More recently, the unearthing at the end of 2011 of oil from the Angolan pre-salt formation followed in 2013 by discoveries in the Gabon and Congo-Brazzaville pre-salt formation suggests a new high-potential oil province off the coast of West Africa. Other already-operational regions have continued to be a source of significant discoveries. This is particularly the case with the Zagros Basin in Iraq and Iran, the Caspian Sea region, the Gulf of Mexico, Australian offshore and the North Sea.

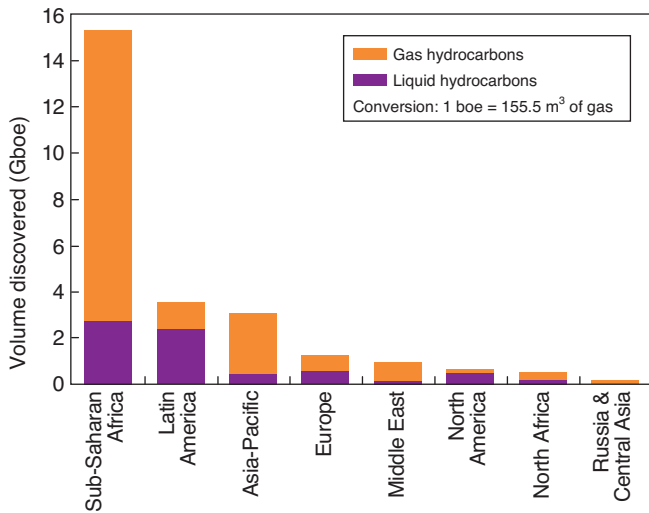
Fig. 1b – Estimated discoveries between 2003 and 2012



Source: Wood MacKenzie

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Fig. 2 – Volumes discovered by geographic region



Source: Wood MacKenzie

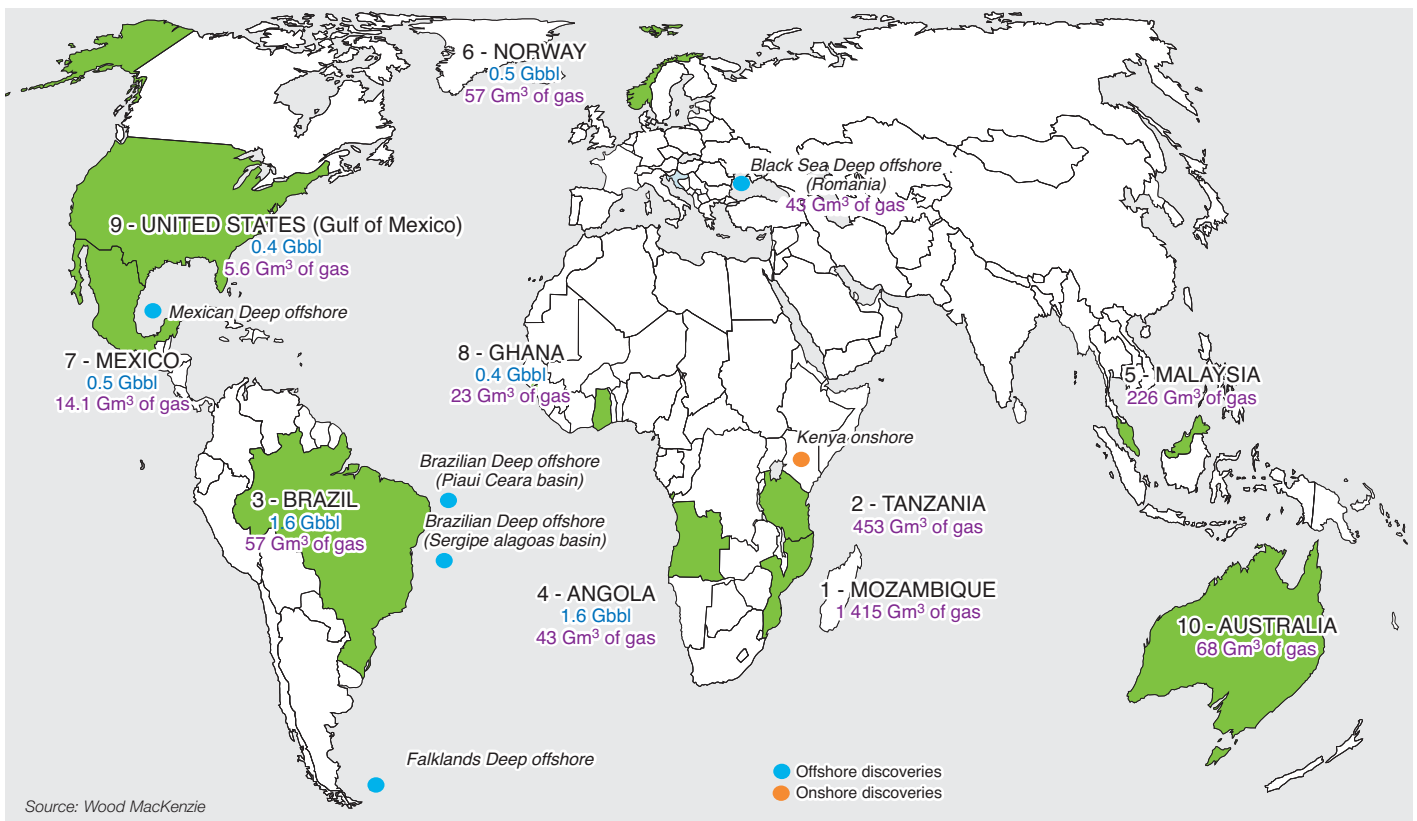
The main discoveries of 2012

Around 25 Gboe were discovered in 2012 — less than in the two previous years, but slightly above the average for the whole decade. Worth noting is the fact that

nearly 2/3 of the total volumes discovered were in sub-Saharan Africa, Ghana, Angola and — above all — Mozambique and Tanzania. In fact, these two countries account for nearly half of all reserves discovered. This is why the share of gas is particularly high in the discoveries made in 2012: it accounts for 70% of total oil equivalent, much more than in previous years.

Outside of sub-Saharan Africa, 2012 saw a slowdown in the number of discoveries being made in basins which had proved prolific in 2011. Brazilian offshore, for example, which had been the leading Basin in terms of volumes discovered in 2011, is behind Mozambique and Tanzania this year, despite being the source of two of the ten most significant discoveries of the year: Carcará in the Santos basin and Pão de Açúcar in the Campos basin. After a number of major discoveries in 2009 (Tamar), 2010 (Leviathan) and 2011 (Aphrodite), discoveries in the Levant Basin have levelled off, with only two modestly-sized ones: Shimson (65 Gm³) and Tanin (35 Gm³). The region remains classed as high-potential, though. Similarly, the volumes discovered in Kurdistan were lower than in previous years, despite a few major announcements (it should, however, be pointed out that the volumes discovered have not yet been properly established). This is also the case in Norway where the

Fig. 3 – Top 10 countries in terms of volumes discovered in 2012 and the new border basins



Source: Wood MacKenzie

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Table 1

The 11 most significant discoveries of 2012

Country	Basin	Field	Type	Oil (Gbbl)	Gas (Gm ³)	Total (Gboe)
Mozambique	Rovuma	Golfinho	Gas	0	525	3,255
Angola	Kwanza	Cameia	Oil	1,500	0	1,500
Mozambique	Rovuma	Coral	Gas	0	230	1,426
Mozambique	Rovuma	Mamba North East	Gas	0	185	1,147
Mozambique	Rovuma	Atum	Gas	0	185	1,147
Mozambique	Rovuma	Mamba North East	Gas	0	170	1,054
Mozambique	Rovuma	Mamba North East	Gas	0	140	868
Brazil	Santos	Carcarà	Oil	800	8	850
Brazil	Campos	Pão de Açúcar	Oil	490	42	750
Tanzania	Coastal basin	Zafarani	Gas	0	115	713
Tanzania	Rovuma	Mzia	Gas	0	115	713

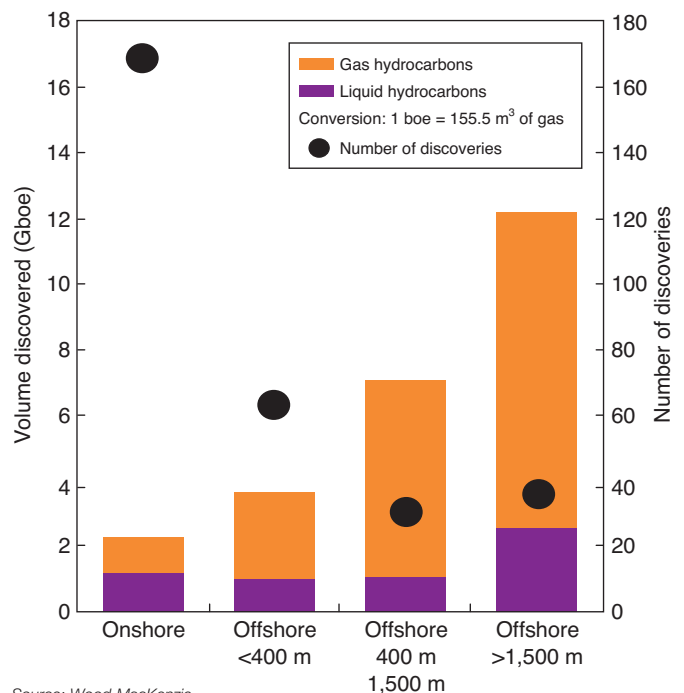
Source: Wood MacKenzie

Havis prospect in the Barents Sea proved to be the most significant of the year with 300 Mboe. Australia, the Gulf of Mexico and the Caspian Sea zone also all yielded less than in 2011. The Sarawak basin in Malaysia, on the other hand, produced a major gas discovery, Kasawari (85 Gm³), two significant discoveries, Kuang North (48 Gm³) and Tukau Timur Deep (45 Gm³) and several other smaller ones (Fig. 3 and Tab. 1).

2012 also saw the emergence of several new promising targets: the Angolan pre-salt layer yielded its first discoveries, as did the Black Sea (the Domino discovery); discoveries were made in the very deep offshore Sergipe and Piauí Ceara basins off the coast of Brazil; approximately 45 Gm³ of gas were discovered off the Falkland Islands; PEMEX made two oil discoveries in the ultra-deep waters off the coast of Mexico, and two onshore oil discoveries were made in Kenya.

The discoveries made in 2012 highlight the increasingly important role that offshore and very deep offshore in particular are playing (Fig. 4). Onshore discoveries accounted for less than 10% of the total in terms of oil equivalent. Very deep offshore, on the other hand (at depths of more than 1,500 m), accounted for nearly half the total of all volumes discovered. Of the 11 most significant discoveries of the year, 6 were in Mozambique, 2 in Tanzania, 1 in Angola and the remaining 2 in Brazil. All were at depths of more than 1,000 m, and only 2 of them were at depths of less than 1,600 m (Golfinho and Atum in Mozambique).

Fig. 4 – Discovery types



Source: Wood MacKenzie

Main trends for 2013

As of 29 November 2013, more than 200 discoveries have been announced in 47 countries. Although little is known about the exact volumes discovered, they will

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Table 2
Main announcements in 2013

Country	Basin	Field/Well	Onshore/Offshore	Volumes announced
Australia	Bonaparte	Evans Shoal	Offshore	230 Gm ³
Algeria	Amguid Messaoud		Onshore	1,300 Mbbl
Mozambique	Rovuma	Agulha	Offshore	140-200 Gm ³
Tanzania	Rovuma	Tangawizi	Offshore	100-170 Gm ³
Iraq			Onshore	1,000 Mbbl
Kazakhstan	Caspian Sea	Zhambil	Onshore	880 Mbbl
India	Krishna Godavari	3 discoveries	Offshore	700 Gm ³
Mozambique	Rovuma	Coral 3	Offshore	113 Gm ³
Congo-Brazzaville	Congo	Nene' Marine	Offshore	600 Mbbl
Canada	Flemish Pass	Bay du Nord	Offshore	400-800 Mbbl
Norway	Barents Sea	Whisting Central	Offshore	200-500 Mtoe

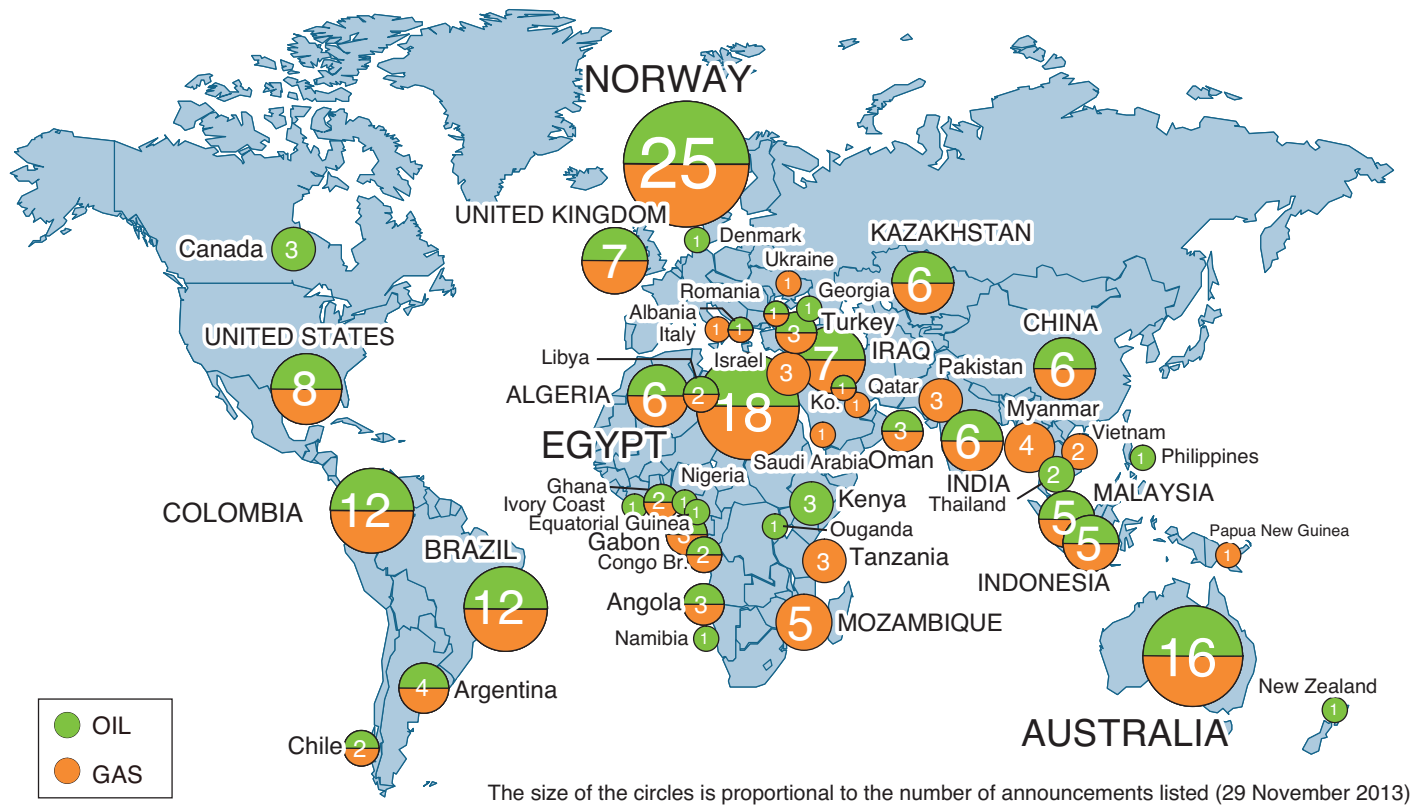
Source: IFPEN

most likely be lower than in previous years (Tab. 2). Indeed, the flagship basins of 2011 and 2012 (in terms of the volumes that had been discovered) — i.e., the Campos and Rovuma basins — seem to have been less prolific this year and fewer giant deposits have been discovered there. The main reason for this slight decline is most likely the fact that investments are being refocused on assessing the discoveries made in previous years. The West African pre-salt layer showed a number of very promising finds, but exploration in this zone is still only in its very early stages. A number of zones that are already well-established in terms of oil and gas exploration saw a number of success stories in 2013 — in Australia, Algeria, Kazakhstan and India in particular. Exploration off the coast of French Guiana, however, has not lived up to expectations, with 4 dry wells having been drilled since the start of Shell's campaign in 2012.

Main noteworthy facts (Fig. 5):

- in the Rovuma basin, the three discoveries that ENI made in Mozambique have increased estimates of the volumes contained in block 4 by approximately 300 Gm³, and a new deeper target has been identified. In Tanzania, the volumes in block 2 are now estimated at between 420 and 450 Gm³;

Fig. 5 – Discoveries announced in 2013 (as of 29 November)

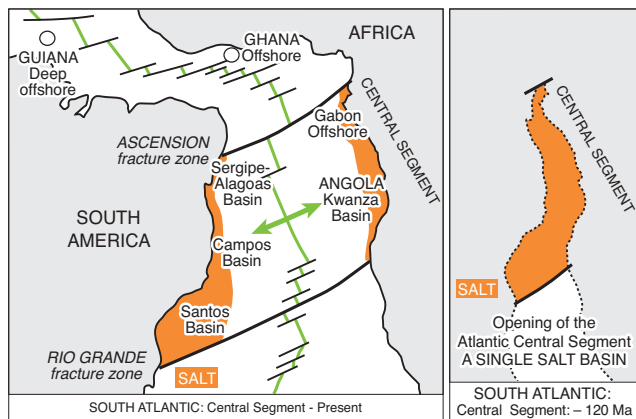


Source: IFPEN

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Learning from success

In October 2006, Petrobras drilled an appraisal well for what was to become the first deposit discovered beneath the salt. Brazil's national oil and gas company had just unearthed a new target for exploration. Numerous discoveries throughout the Santos and Campos basin demonstrated that this target extended across a significant section of Brazil's coast. In order to understand how these deposits were first created, we have to go back 120 million years to when the South Atlantic was first opened. During this period, the Atlantic was very narrow (100 km) and thick layers of salt were deposited along the coastlines of both South America and West Africa. So it was logical that explorers should attempt to replicate the successful discoveries that they made along the Brazilian coastline in the zones off the coast of West Africa extending from Gabon to Angola. The discoveries that have been made since the end of 2011 off the coast of Angola, Congo-Brazzaville and Gabon confirm that they were justified in doing so.

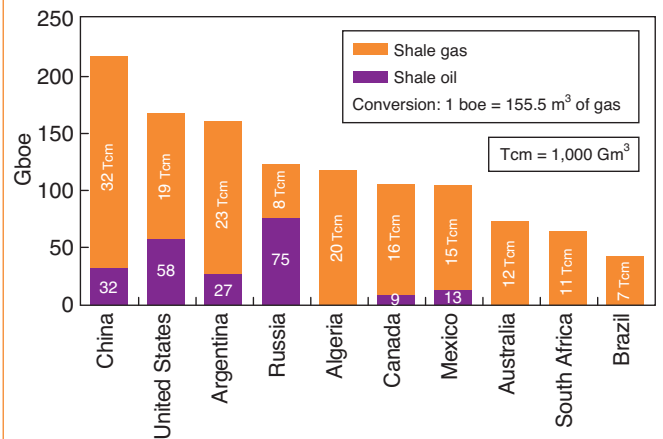


Source: IFPEN

Report on Source-Rock Hydrocarbons

Although source-rock hydrocarbon production has considerably increased over the last three years — now standing at more than 2 Mbb/d for shale oil and 272 Gm³/y for gas in the United States — assessments of the resources that are technically recoverable have scarcely begun in the rest of the world. In 2013, the US EIA (Energy Information Administration) put the volume of recoverable shale oil at 345 Gbbl, and the volume of recoverable shale gas at 204 Tm³. Countries such as China, Algeria and Argentina could become major gas players. As for shale oil, Russia has the most significant reserves, with most of them located in Western Siberia.

Recoverable resources of shale hydrocarbons:



Source: IFPEN

- in the Bonaparte Basin in Australia, the Evans Shoal North-1 appraisal well has put the estimated volume of gas contained in the Evans Shoal field at around 230 Gm³, according to ENI;
- in Algeria, 1,300 Mbbbl of oil have been discovered in the Amguid Messaoud basin;
- in Iraq, the government has announced that around 1 Gbbl of oil have been discovered;
- in Kazakhstan, 880 Mbbbl of the oil discovered in Zhambyl is technically recoverable;
- in India, three exploration wells have revealed some 700 Mbbbl of oil in the Krishna-Godavari basin, in a region that was until now reputed to contain gas only;
- in West Africa, several pre-salt discoveries have been made in Gabon and the Republic of Congo. According to ENI, it has discovered a block containing up to 600 Mbbbl in the Republic of Congo, with considerable additional potential;
- in the Barents Sea, OMV, Statoil and Tullow — which are all on the same exploration permit (PL537) — have announced the discovery of a new oil zone. Initial drilling in this region has revealed volumes of between 200 and 500 Mboe (mainly oil);
- in Canada, off the coasts of Newfoundland and Labrador, Statoil has carried out two drilling operations following an initial discovery in 2010, and in so doing has confirmed the existence of a new oil region. Between 400 and 800 Mbbbl of recoverable oil have so far been revealed following discoveries made in Mizzen (2010) and the Bay du Nord (2013). Discoveries in the Harpoon prospect (2013) are still under evaluation;

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- in Brazil, the Santos Basin is still yielding large volumes, with 12 new discoveries announced on 29 November, but the volumes revealed are not yet known. In September 2013, government sources in Brazil declared that discoveries made in the Sergipe Basin (16 wells between 2008 and 2012) had resulted in volumes of between 1 and 2 Gbbl of oil being discovered in the SEAL-11 block. If adjacent zones are taken into account, this figure could exceed 3 Gbbl — which would amount to around 1 Gbbl of recoverable oil. If these estimates prove correct, this discovery will be the biggest ever made in Brazil outside the pre-salt formations in the Santos and Campos basins;
- in the Levant basin, the Leviathan-4 appraisal well has been used to revise the field's perspective resources from 480 Gm³ up to 510 Gm³. Potential reserves in the Aphrodite field in Cyprus, on the other hand, have been revised downwards;
- in French Guiana, Shell announced in November that it had drilled a fourth dry well, but pointed out that the zone that had so far been explored only represented a small section of the area covered by the permit. All the data that has been collected will now have to be analysed before a decision is made as to whether or not drilling is continued.

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