



USGS WPA 2000 part 1 - A look at expected oil discoveries

Posted by [Rembrandt](#) on November 30, 2006 - 12:40pm in [The Oil Drum: Europe](#)

Topic: [Supply/Production](#)

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If you would read a random energy scenario study there is a very high chance that it is based on the United States Geological Survey's World Petroleum Estimate from the year 2000. This is because the estimate for the ultimate oil recovery of conventional oil + [Natural Gas Liquids \(NGL\)](#) of that study is being used as the basis for oil production projections in the:

[International Energy Agency - World Energy Outlook](#)

[Energy Information Administration - International Energy Outlook](#)

Since almost all energy policies in the world are based on scenario's from these two institutes, it is of the utmost importance that the USGS figure of 3345 billion barrels for ultimate recovery of conventional oil + NGL is correct. If not so, then the studies from the IEA and EIA give far too rosy projections on continuously rising oil production. Instead, the world will encounter a shortfall in the supply of oil far earlier than now anticipated. Besides the studies cited above the figures of the USGS are also used by oil companies such as [ExxonMobil](#) and even the [Saudi's](#) to give the impression that there is plenty of conventional oil remaining.

The USGS World Petroleum Assessment 2000 came up with two estimates. One for the potential of oil to be discovered between 1996 and 2030, the other for the amount of reserve growth between 1996 and 2030. [Reserve growth](#) is the increase in reserves over time due to past underestimates of oil reserves in oil fields and new technology that increases the recovery factor in a given field.

In this first part I will deal with the first branch of the report, expected discoveries between 1996 and 2030.

First a look at the study itself, in 2001, Jean Laherrerre, geophysicist of ASPO France already wrote some critical remarks about the USGS report:

This study [USGS world assessment 2000] was a good project to define all the petroleum Systems of the world with the help of the major oil companies and to draw good maps, but the results were poor because the oil companies did not participate in the assessment, preferring to keep their knowledge and ideas confidential since they were competing with each other for the prime areas. It was left to a single USGS geologist to assess each individual basin (in the past it was done with Delphi inquiries involving many geologists). It was done without the benefit of seismic coverage and well data. Most of the estimates were made by academic geologists with little oil exploration practice. The database for reserves by field from 1995 & 1996 was out of date for a 2000 assessment and it was also inconsistent, with Proved reserves being used for the US and Canada (P) and Proved & Probable reserves (2p) being used for the rest of the world."

Table AR-1. World level summary of petroleum estimates for undiscovered conventional petroleum and reserve growth for oil, gas, and natural gas liquids (NGL).

[BBOE, billions of barrels of oil equivalent. Six thousand cubic feet of gas equals one barrel of oil equivalent. F95 represents a 95 percent chance of at least the amount tabulated. Other fractiles are defined similarly. Production and reserves normalized to 1/1/96. Shading indicates not applicable]

	Oil				Gas				NGL				
	Billion Barrels				Trillion Cubic Feet				BBOE	Billion Barrels			
	F95	F50	F5	Mean	F95	F50	F5	Mean	Mean	F95	F50	F5	Mean
World (excluding United States)													
Undiscovered conventional	334	607	1,107	649	2,299	4,333	8,174	4,669	778	95	189	378	207
Reserve growth (conventional)	192	612	1,031	612	1,049	3,305	5,543	3,305	551	13	42	71	42
Remaining reserves*				859				4,621	770				68
Cumulative production*				539				898	150				7
Total				2,659				13,493	2,249				324
United States													
Undiscovered conventional**	86		104	83	393		698	527	88	Combined with oil			
Reserve growth (conventional)**				76				355	59	Combined with oil			
Remaining reserves				32				172	29	Combined with oil			
Cumulative production				171				854	142	Combined with oil			
Total				362				1,908	318				
World Total (including United States)				3,021				15,401	2,567				

*World reserve and cumulative production data reflect only those parts of the world actually assessed and are from Petroconsultants (1996) and NRG Associates (1995).

**U.S. data from Gautier and others (1996) and Minerals Management Service (1996).

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The table outlines three categories, Oil, Gas and Natural Gas Liquids (NGL). In this post I focus on the expectations for Oil + NGL only. These two liquid sources currently provide 98% of the world's liquids needed to fuel our cars, airplanes, plastics etc..

Below the categories are the probabilities of the expected recovery values, citing the figures for 95%, 50%, 5% and the mean value. The mean value is derived from taking the probabilities at 95%, 90%, 85%, 80% and so on until 10% and 5%, then dividing between the amount of probabilities taken (in total 20). The probabilities are derived from numerous statistical runs (monte carlo).

The categories cited are the undiscovered conventional (yet to be found) Reserve growth (expected increase of reserves due to new technology/insights), Remaining reserves and Cumulative production.

The ultimate recovery value for conventional oil + NGL is calculated by adding the 3021 billion barrel figure for oil + the 324 billion barrel figure for NGL. That adds up to 3345 billion barrels that will be recovered eventually according to the USGS. This 3345 billion barrel figure is the one that is being used by all the institutes such as the IEA for their scenario's.

It is very important to note that the figures start at 1 January 1996 as noted above the table! The end year of the estimate is 2030. As an example, the USGS expects the potential for discoveries between 1996 and 2030 to be 649 billion barrels for conventional oil (excluding the United States)

One may wonder why there has been no new assessment, since the study is already six years old. The authors in August of 2005 looked back at their study in a publication in AAPG bulletin ("An evaluation of the U.S. Geological Survey World Petroleum Assessment 2000", AAPG Bulletin, v. 89, no. 8 (August 2005), pp. 1033-1042). In this evaluation the authors (Albrandt et al.) claim

Discoveries in the past ten years

The USGS stated that between 1996 and 2030 a total of 939 billion barrels (649 + 207 + 83) could potentially be discovered. According to the ASPO International database and my own guesstimates between 1 January 1996 and 1 January 2006 around 110 billion barrels of oil were found. At the same time, 265 billion barrels of oil were produced. This is shown in the chart below.

Baseline Conventional + NGL (including deepsea + polar) (excludes oil sands, extra heavy oil, oil shale, CTL, GTL, BTL)			
Billion barrels	Cumulative Production	Annual Production	Amount discovered
1995	791	24.21	7
1996	816	24.75	11
1997	841	25.59	7
1998	867	25.98	10
1999	893	25.47	16
2000	919	26.41	19
2001	946	26.40	10
2002	972	26.01	11
2003	999	27.36	8
2004	1027	28.11	10
2005	1056	28.52	9
Total cumulative 1 Jan 1996 - 1 Jan 2006		265	110

Source: ASPO International database + estimates from ASPO Netherland for discoveries

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Of the USGS potential of 939 billion barrels, around 12%-13% has been realised so far, while already 30% of the time period (1996 - 2030) has passed. This is confirmed by figures from IHS Energy, as shown in the chart below.

Recent Discoveries and Yet-to-Find

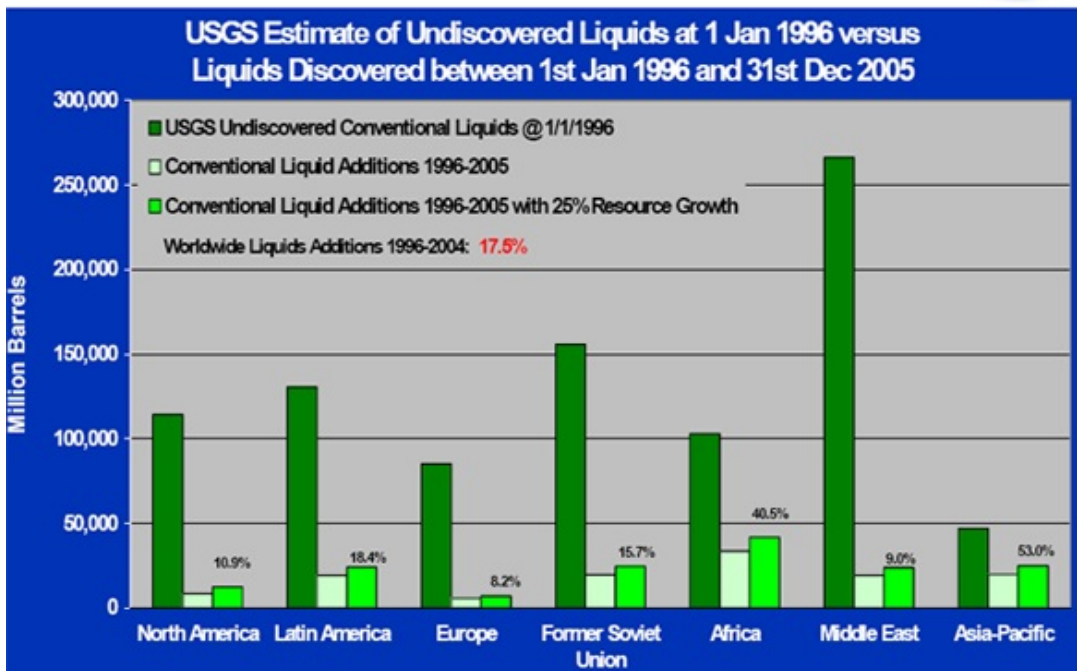


Chart from IHS Energy presentation by Ken Chew at the Energy Institute conference in London

IHS Energy states that 17.5% of the USGS potential for discovery has been realised by the beginning of 2006. In this figure they include a 25% increase in reserves from those discoveries (reserve growth). If we subtract the 25%, we get an amount of 14% that is realised from the USGS potential for discovery, or about 131 billion barrels.

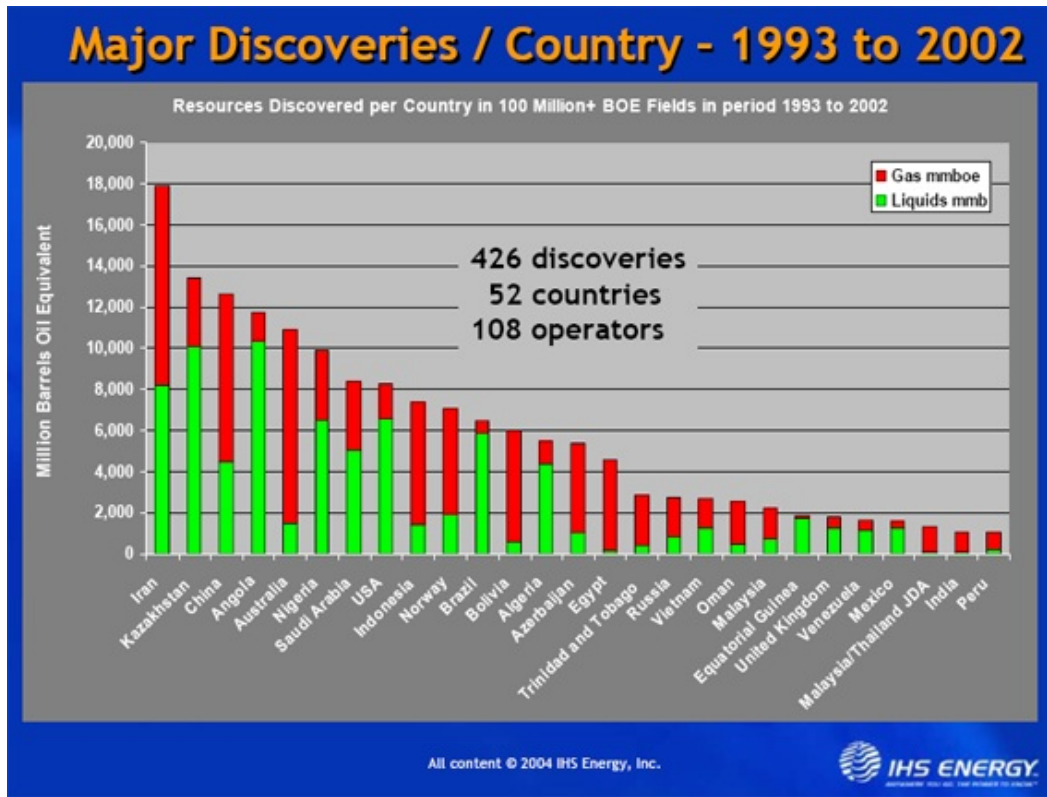
The USGS authors (Albrandt et al) in their August 2005 publication in the AAPG journal do acknowledge the low amount of discoveries in the past ten years. However, according to them this falls in line with what could have been expected:

"Most of the undiscovered resources reported in the U.S. Geological Survey World Energy study are in environmentally, economically, or politically difficult locations."

"Some of the oil resources estimated by the U.S. Geological Survey were expected to come from remote localities such as northeast Greenland, but the World Petroleum Assessment 2000 predicted that most of the undiscovered oil could be found in and around the existing major petroleum provinces of the Middle East, North Africa, and the countries of the former Soviet Union. Large parts of these important areas were not available to exploration during the first 8 yr of the forecast span. This is certainly the case in some of the countries of the Middle East and North Africa. Iraq, Iran, and Libya presented limited investment opportunities during the 8-yr period of this study, and investment in oil and gas exploration in Russia, Azerbaijan, and the central Asian republics has been limited also by various constraints on pipeline construction and perceived political and economic instability."

"In this context, it is surprising that as much as 11% [end 2003] of the estimated undiscovered oil resource was found"

While it is actually the case in some countries such as Iraq that very little exploration has taken place, for others this is simply not true. A significant amount of exploration is taking place in Iran, with good results. The country had the largest amount of large discoveries between 1993 and 2002 for oil and gas, as shown in the chart below from IHS Energy:

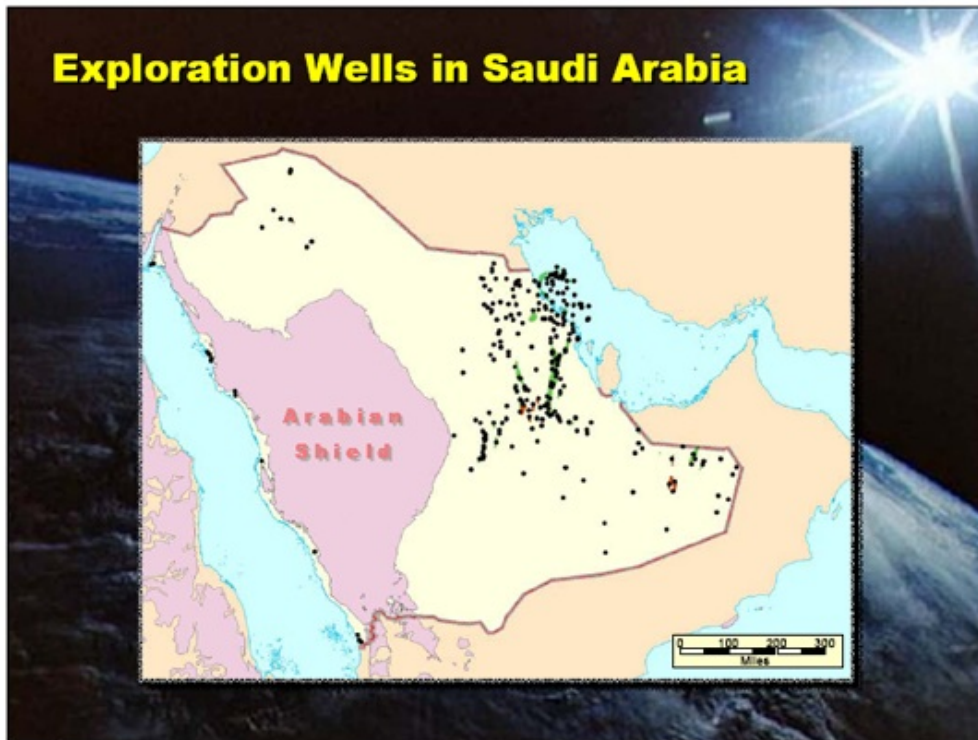


The authors also quote the lack of access due to environmental regions such as northeast Greenland, where no drilling has taken place so far. [Recently several oil companies have been given rights to start drilling in the remote region.](#) The USGS expects a potential of 51 billion barrels to be discovered in Greenland.

What do the two regions with the largest potential for oil discoveries tell us?

Saudi Arabia

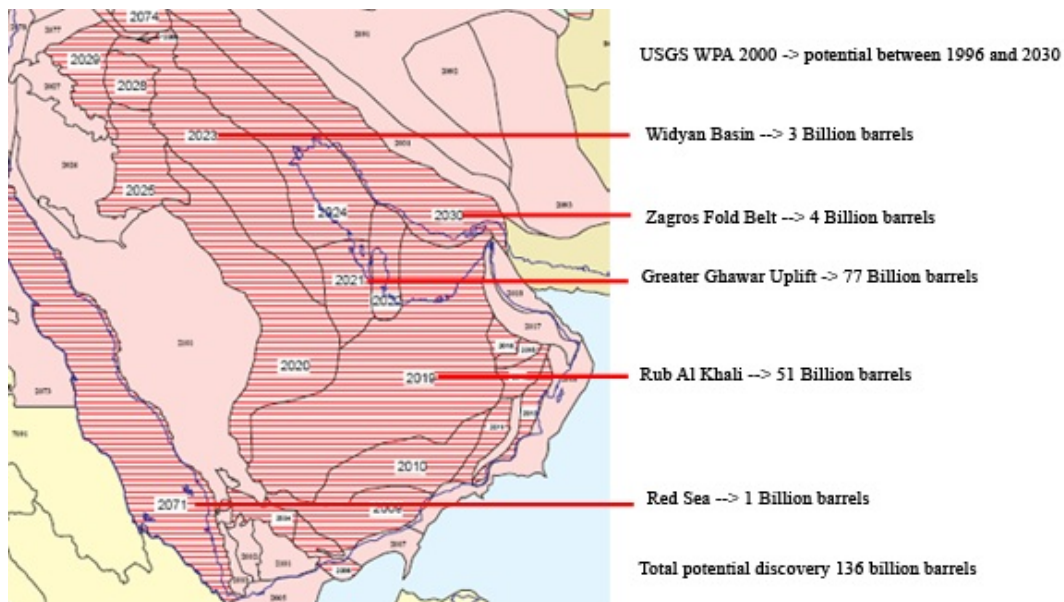
The USGS noted a potential of 136 billion barrels of conventional oil + NGL to be discovered between 1996 and 2030 in Saudi Arabia (9% of the total of 939 billion barrels). Between 1 January 1996 and 1 January 2006 approximately 5 billion barrels have been discovered in Saudi Arabia. Since the nationalisation in the '70s foreign companies could not drill in the country. Only since 2004 have several western oil companies have been allowed to drill for gas in the Rub Al Khali Region (empty quarter), which is positioned in the south and south/west. In the chart below we see that drilling so far has taken place mainly in the east:



The exploratory wells are clustered in and around discovered fields, with vast areas remaining relatively unexplored, including the Rub' al Khali (Empty Quarter) Desert, the northern basins along the borders with Iraq, and the offshore Red Sea Basin.

Chart from Saudi Aramaco presentation by Abdul Baqi and Saleri at a CSIS meeting in Washington in 2004.

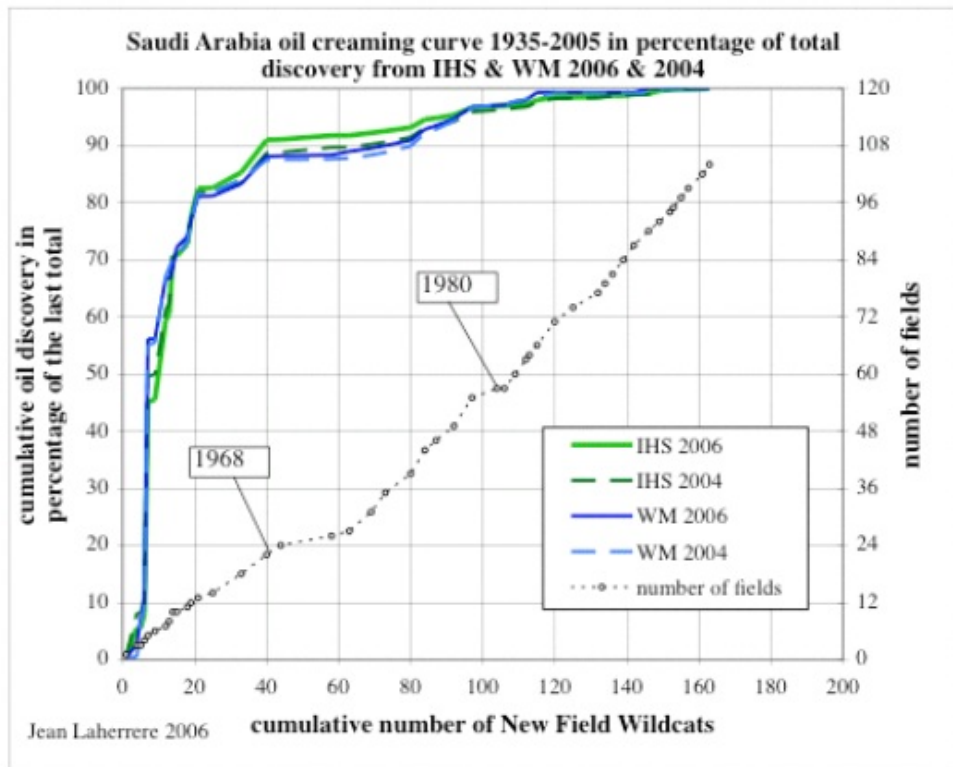
The Saudi's describe three regions as being relatively unexplored as shown above. the Rub Al Khali, the border with Iraq and the Red Sea. The USGS gives the following expectations for these regions in Saudi Arabia:



According to the USGS, there is very little potential in the Northern part and the Red Sea. Most of the potential lies in the already extensively explored region around Ghawar! The remainder is to be found in the Rub Al Khali.

Only 4% of the expected potential has been found so far in the first ten years of the period given by the USGS. Furthermore, the main potential for discoveries according to the USGS is in the already extensively explored part of the country. The authors of the study (albrandt et al) seem to contradict themselves in the case of Saudi Arabia, by stating that "Large parts of these important areas were not available to exploration during the first 8 yr of the forecast span". Those parts may not have been available, but that was not where the oil is expected to be.

In the chart below by geophysicist J. Laherrere drilling (new field wildcats) versus the amount of oil discovered is plotted. This clearly shows that new drilling does not deliver any giant discoveries in regions in Saudi Arabia where drilling has already taken place. No large field has been discovered since the end of the '70s in the country.



Russia

The USGS states a potential of 115 billion barrels for discovery in Russia between 1996 and 2030. The largest part, 75 billion barrels, is to be expected in the West Siberian Basin. This is the same Basin where the main stay of Russian production is currently coming from. However, the basin is very large. Most fields in the basin are concentrated in the centre.

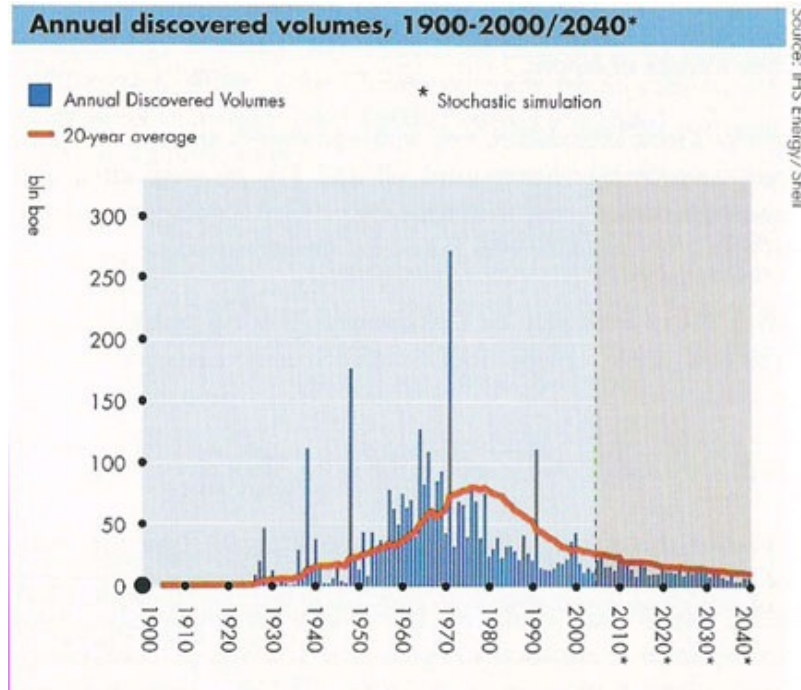
Very little fields have been discovered in the past ten years in Russia. Discovery in Russia peaked in the '60's, rose to a lower 2nd discovery peak at the end of the 70's. After that discoveries declined until after the fall of the Soviet Union. Around 1995 some discoveries started to pour in again, but no real big fields have been found. The largest discovery in [the past ten years has been found at the beginning of this year](#). The Vladimir Filanovsky discovery in the Russian part of the Caspian Sea containing 600 million barrels.

It is difficult to obtain reliable discovery for Russia. Discovery in the past ten years amounted to an approximate of 6 to 15 billion barrels, depending on the source.

Will discoveries lead to the 115 billion barrels eventually? Due to the lack of data on Russian exploration it is very hard to answer this question. However, the discoveries in the past ten years

What does shell think about future discoveries?

Oil majors almost never disclose any of their data or vision on future production potential. In the back of the latest Shell Global Scenarios to 2025, however, Shell printed a graph that showed future discovery expectations:



Under the graph Shell wrote:

"While major new finds cannot be ruled out, recent statistics do provide worrisome signals... Discoveries only replaced some 45% of production since 1999. In addition, the number of discoveries is increasing but discoveries are getting smaller in size. The 25 biggest fields hold some 33% of discovered reserves and the top 100 fields 53%; al but two of the giant fields were discovered before 1970."

"A simple extrapolation of the volumes discovered annually suggests that volumes to be found between now and 2050 could be as low as 500 billion barrels. However , this magnitude of undiscovered potential is considered conservative by some, who believe it is influenced too much by the declining exploration success of late and by cautious views about the commercial viability of future finds."

If we take the 500 billion barrels and subtract the period of 2030 to 2050 it gives an expected 350 billion barrels between 2005 and 2030. An amount that is far lower then the USGS expected figure of 939 billion barrels.

Concluding remarks

1) In the first ten years of the 34 year time period of the USGS WPA 2000 between 110 and 140 billion barrels have been discovered. An amount that is far lower then the expected 939 billion barrels between 1996 and 2030 from the USGS WPA 2000.

- 2) If the estimate from the USGS WPA 2000 is correct, approximately 800 billion barrels are awaiting discovery in the coming 25 years. Implying a tripling of current annual discovery for a period of 25 years.
- 3) There has been limited exploration access to several regions due to environmental, economical and political restrictions. However this does not necessarily imply that there is a large amount of oil in these regions.
- 4) Many of the environmental, economical and political restrictions have been lifted in the past few years. If the authors of the USGS study are correct (albrandt et al) this should result in a sharp increase in discoveries in the coming years.
- 5) The authors of the study (Albrandt et al) do appear to overestimate the discovery potential in Saudi Arabia.
- 6) It seems unwise to bet our future on a single study which has so far turned out to be too optimistic. Unfortunately, this is common practice throughout the world.



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