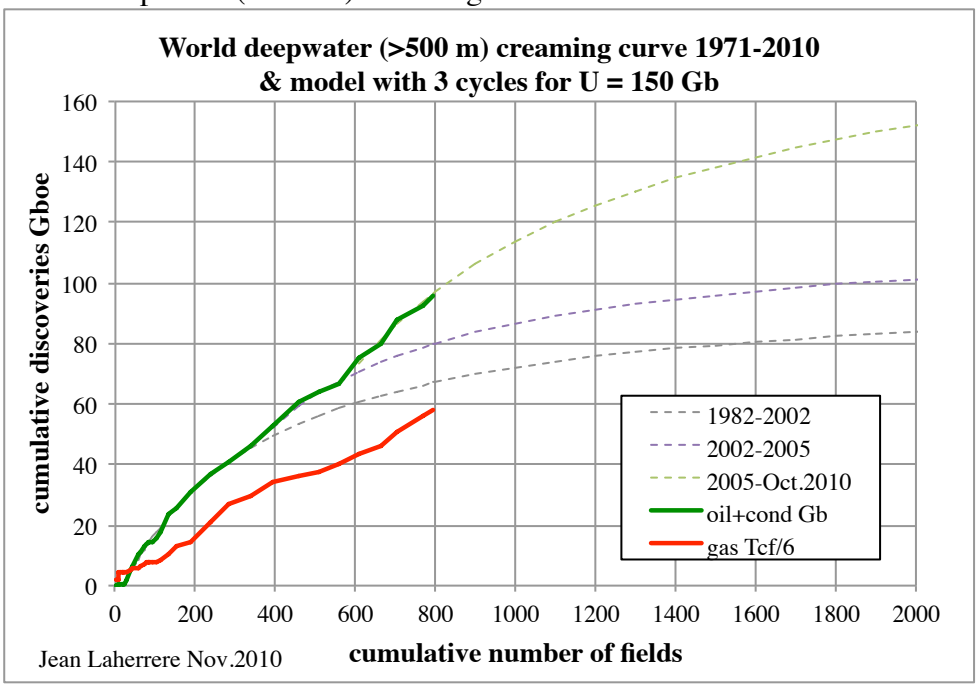
Jean Laherrere 9 April 2012

Updating world deepwater oil & gas discovery

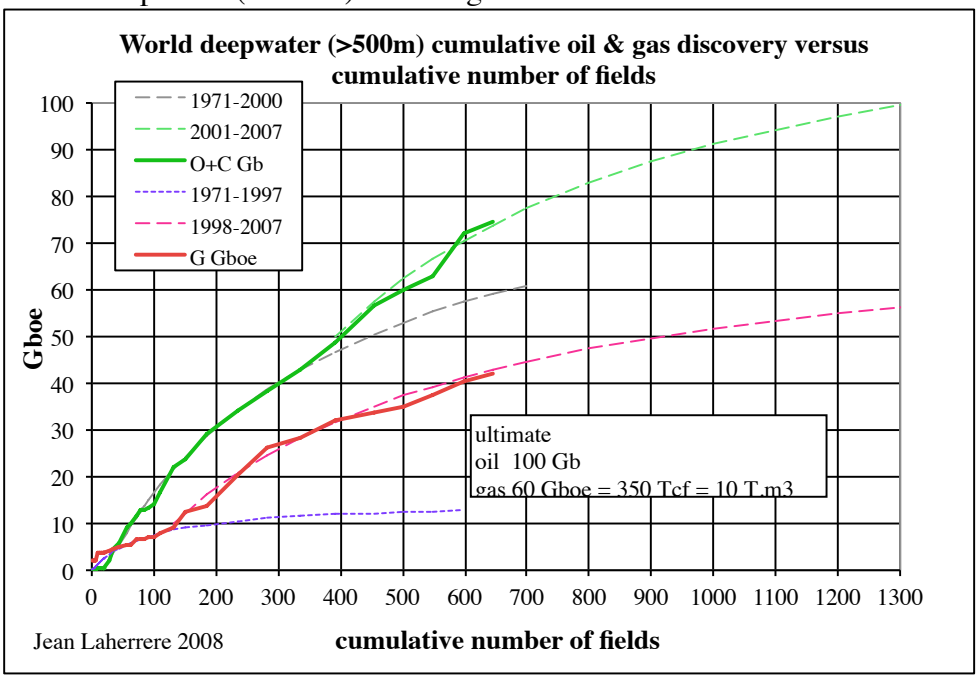
Last year the deepwater creaming curve for a definition of >500 m from data at October 2010 was extrapolated for an oil ultimate of 150 Gb.

Figure 1: world deepwater (>500 m) creaming curve 1971-Oct 2010



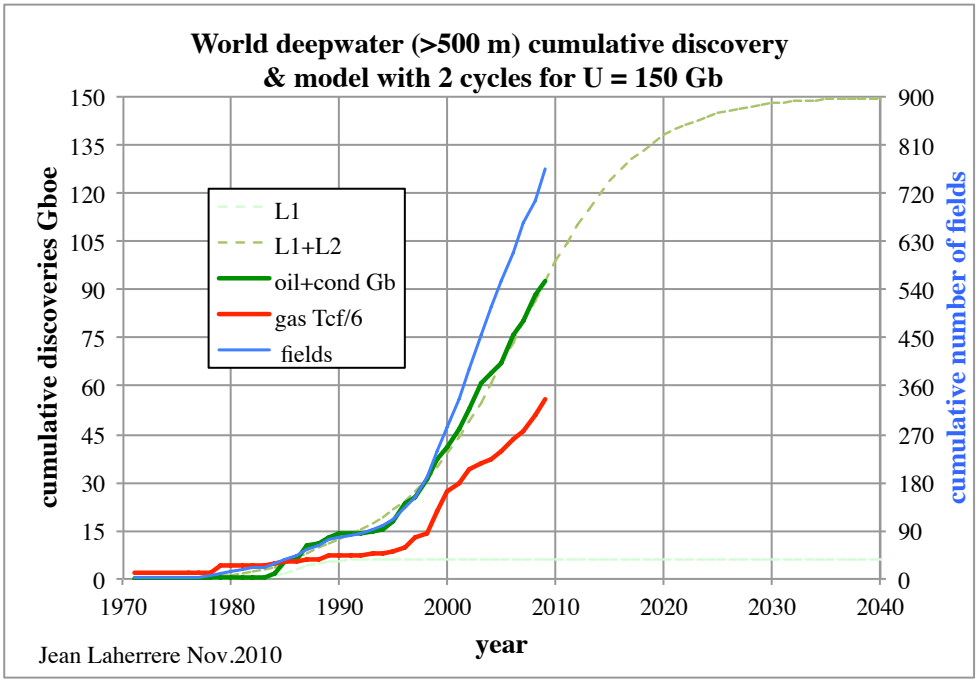
The previous ultimate estimate in 2008 was 100 Gb, missing the third cycle (subsalt)

Figure 2: world deepwater (>500 m) creaming curve 1971-2007

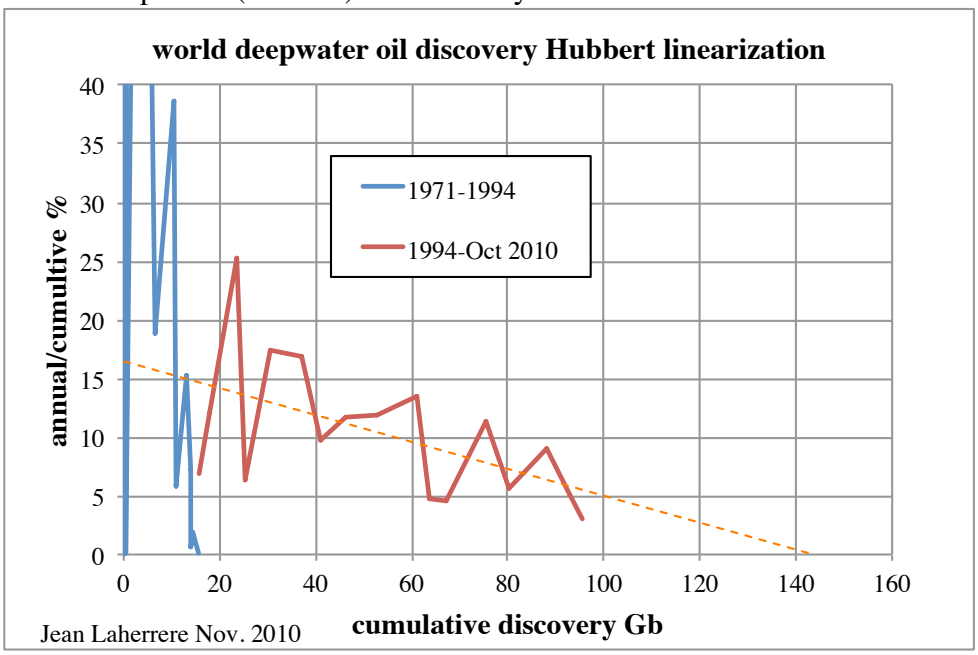


The cumulative discovery versus time (Oct 2010) forecasted that most discoveries be found before 2025.

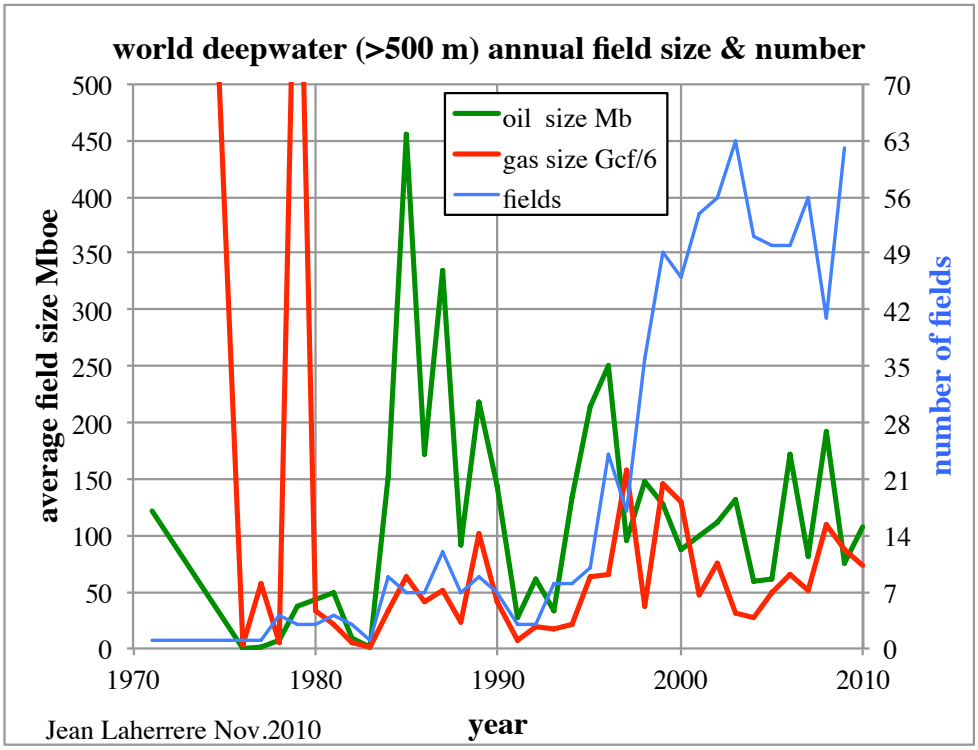
Figure 3: world deepwater (>500 m) cumulative discovery versus time 1971-2009



The Hubbert linearization of the oil discovery confirmed an ulitmate of about 150 Gb
Figure 4: world deepwater (>500 m) oil discovery Hubbert linearization

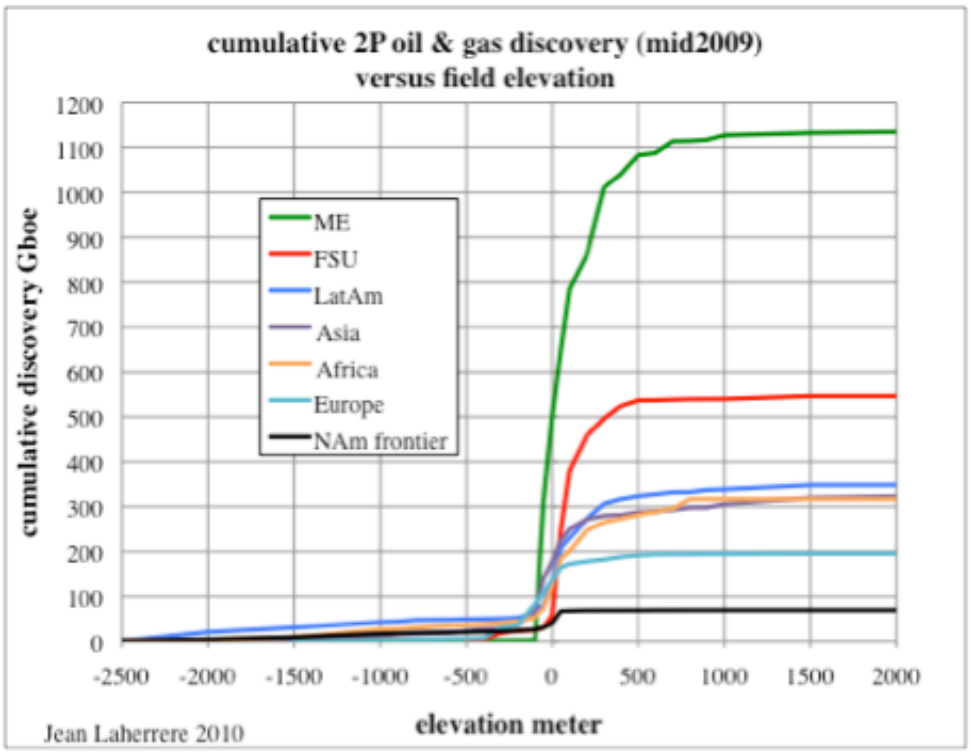


The average field size for oil was around 100 Mb since the last 20 years and a little less for gas in Mboe. There is a sharp change in number since 1995 : less than 10 before and over 50 beyond !
Figure 5: world deepwater (>500 m) annual oil & gas size



The plot of cumulative discovery versus field elevation shows that the break for water depth is more about 200 m than 500 m

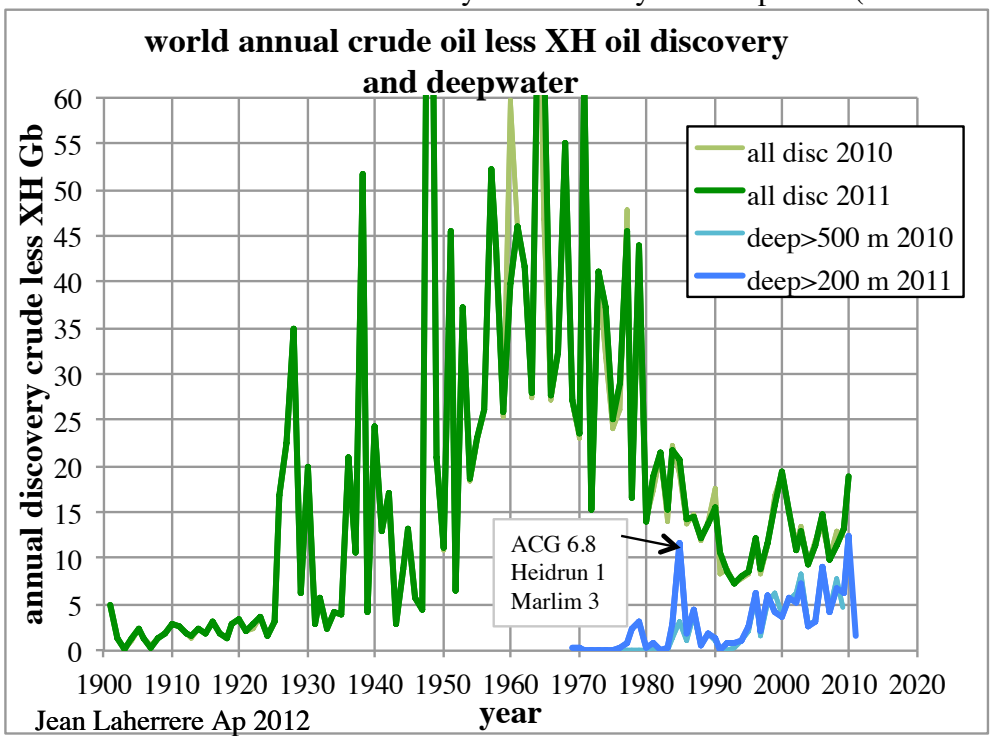
Figure 6: cumulative 2P discovery versus field elevation per continent (mid 2009)



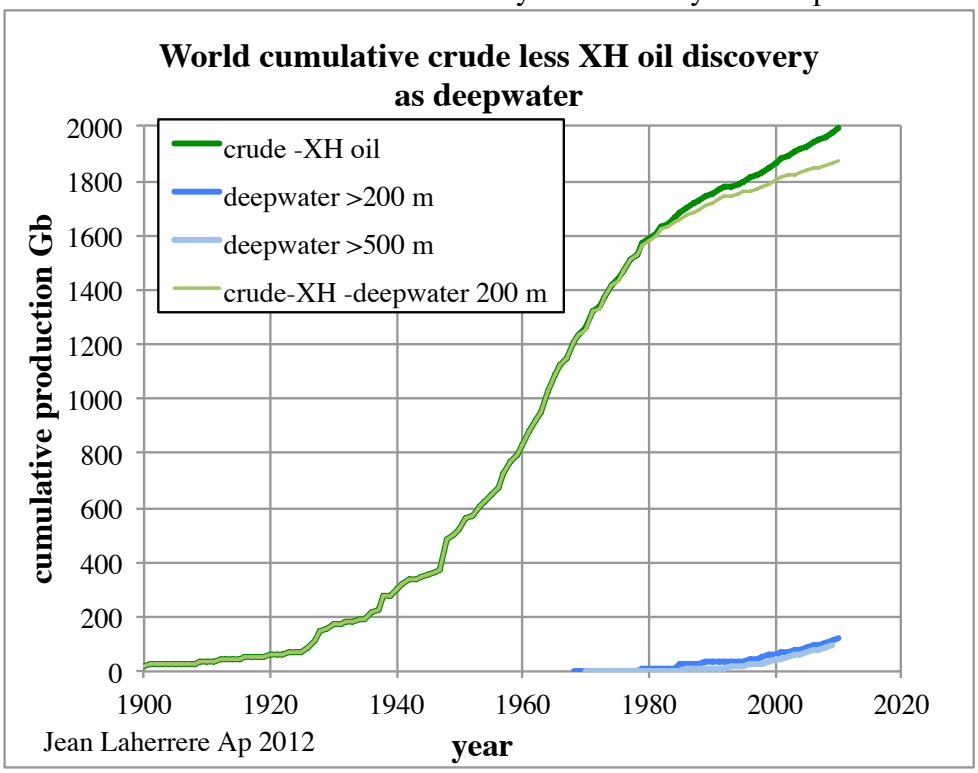
Update from data at Oct. 2011 was done this time with the definition for deepwater >200 m. IHS claims that deepwater is for > 400 m but the database indicates in Terrain that deepwater is only for > 200 m

In the GOM US deep water royalty relief act of 1995 is for a depth over 200 m (656 ft), but MMS (now BOEMRE) reports deep from 1000 ft.
There is little consensus on deepwater definition, same for ultra deep.

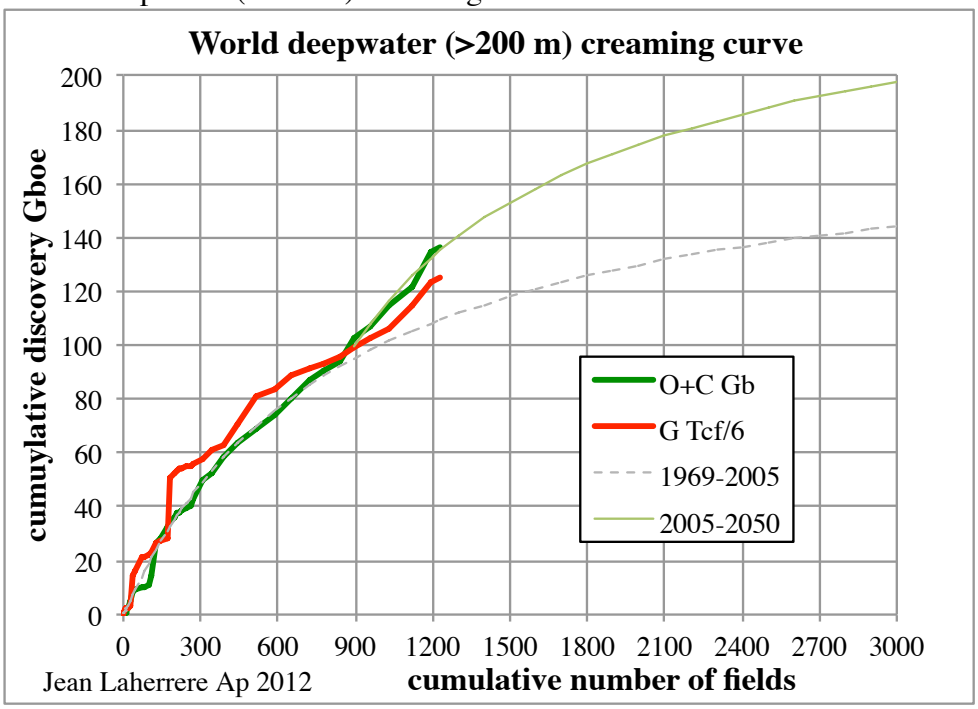
The annual crude less extra heavy oil discovery is shown since 1900 as the deepwater discovery (>200 m and >500 m)
Figure 7: world annual crude less extra-heavy oil discovery and deepwater (>200 & 500 m)



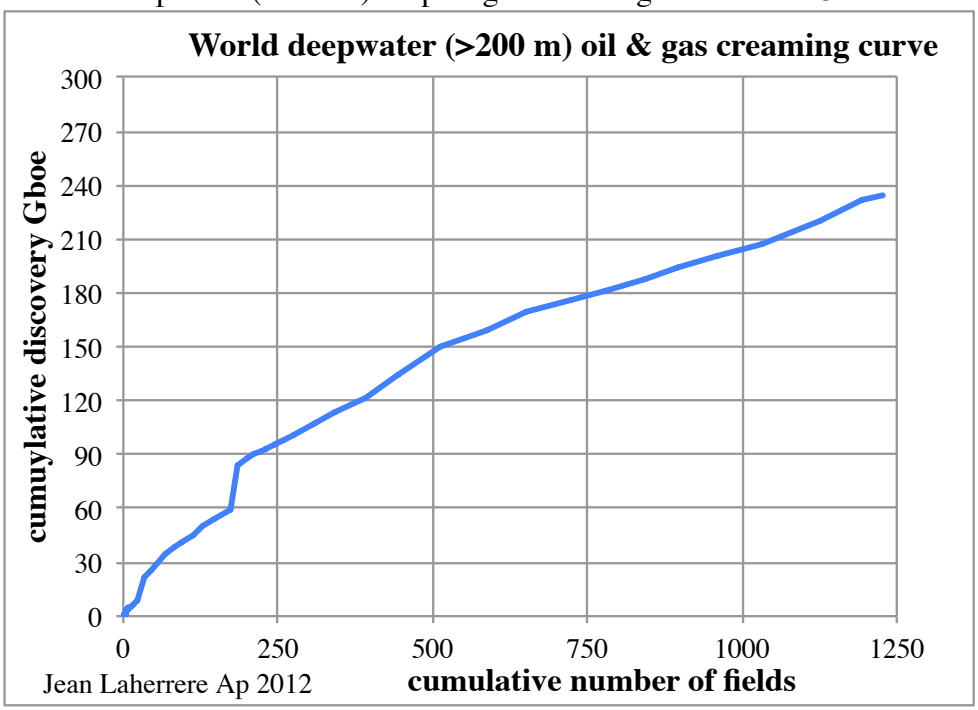
Same data plotted as cumulative discovery.
Figure 8: world cumulative crude less extra-heavy oil discovery and deepwater



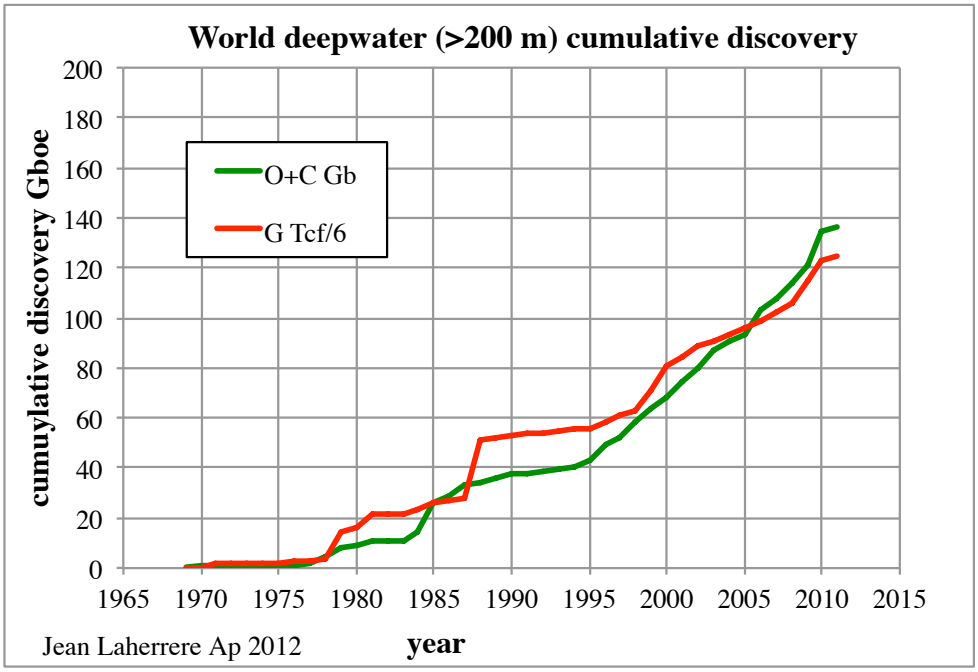
The world deepwater >200 m creaming curve is extrapolated with two cycles towards 200 Gb, meaning about 50 Gb for the water interval 200-500 m.
There is enough uncertainty to allow a third cycle, with a possible increase in a ultimate, but another new subsalt is needed!
Figure 9: world deepwater (>200 m) creaming curve 1969-Oct 2011



The combined oil and gas displays a simpler creaming curve, except for the last 200 fields.
Figure 10: world deepwater (>200 m) oil plus gas creaming curve 1969-Oct 2011

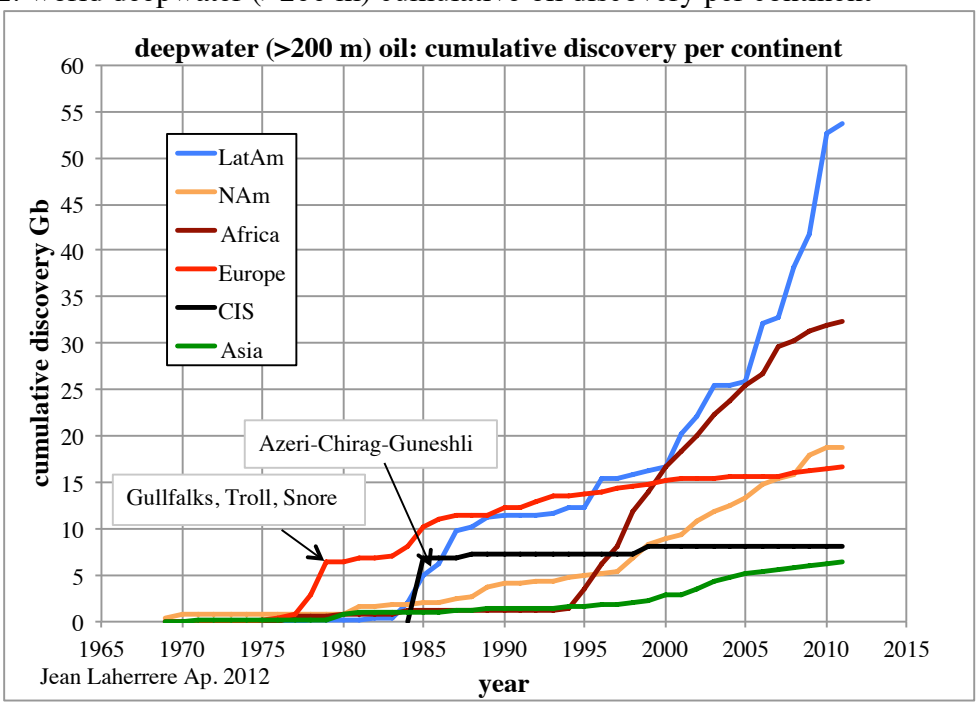


The cumulative discovery versus time displays a sharp increase in the last 15 years with the subsalt.
Figure 11: world deepwater (>200 m) cumulative discovery



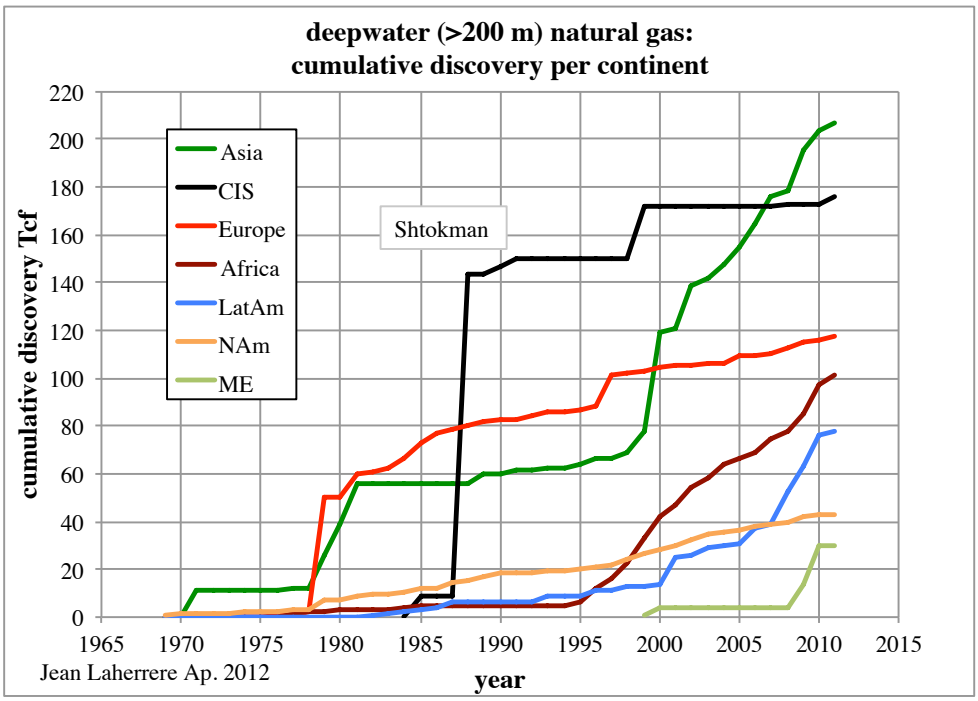
The plot for oil discovery per continent shows that Latin America with Brazil has the sharpest increase. In the past is was a jump in North Sea with Gullfalks, Troll and Snore in 1978 and in Caspian with Azeri-Chirag-Guneshli in 1985

Figure 12: world deepwater (>200 m) cumulative oil discovery per continent



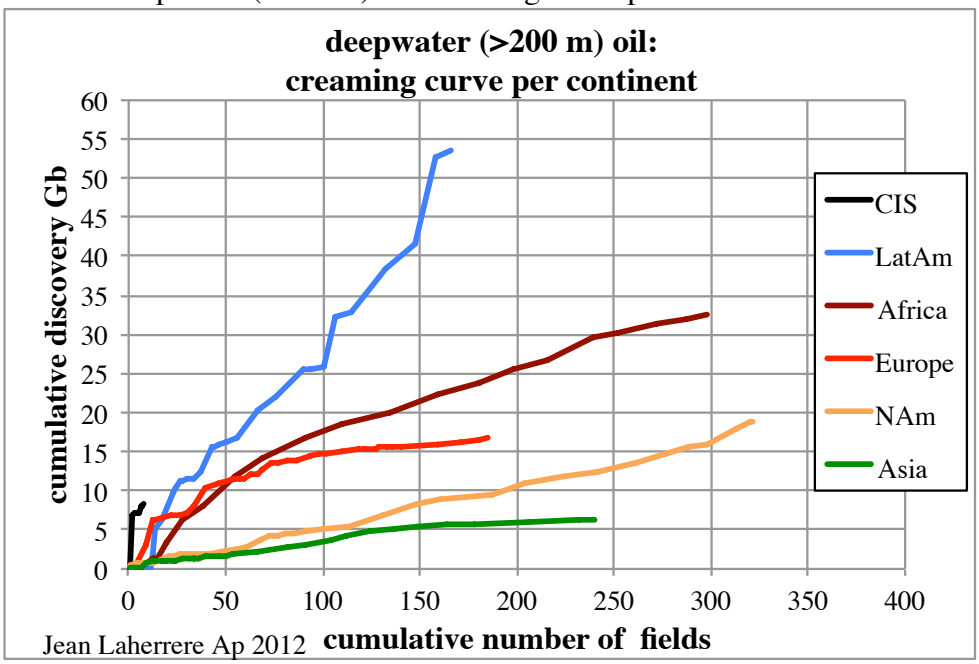
The plot for gas discovery per continent shows the large jump in 1988 with Shtokman and the recent increase in Asia since 2000.

Figure 13: world deepwater (>200 m) cumulative natural gas discovery per continent



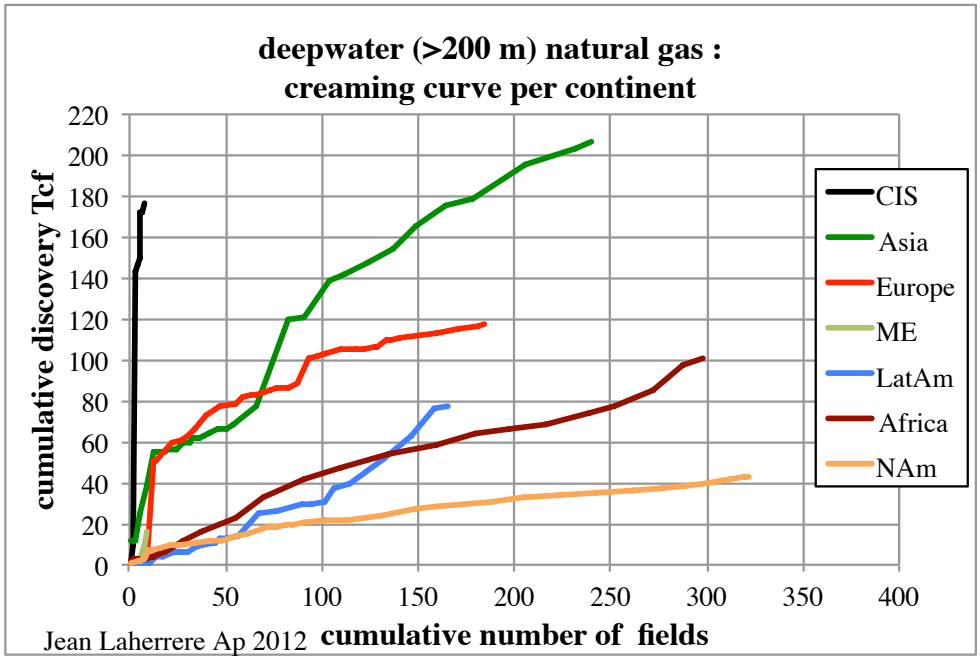
The creaming curve for oil per continent shows that Brazil with the subsalt has the largest increase and that North America has still a potential, but the average size is quite less than in Brazil.

Figure 14: world deepwater (>200 m) oil creaming curve per continent 1969-Oct 2011

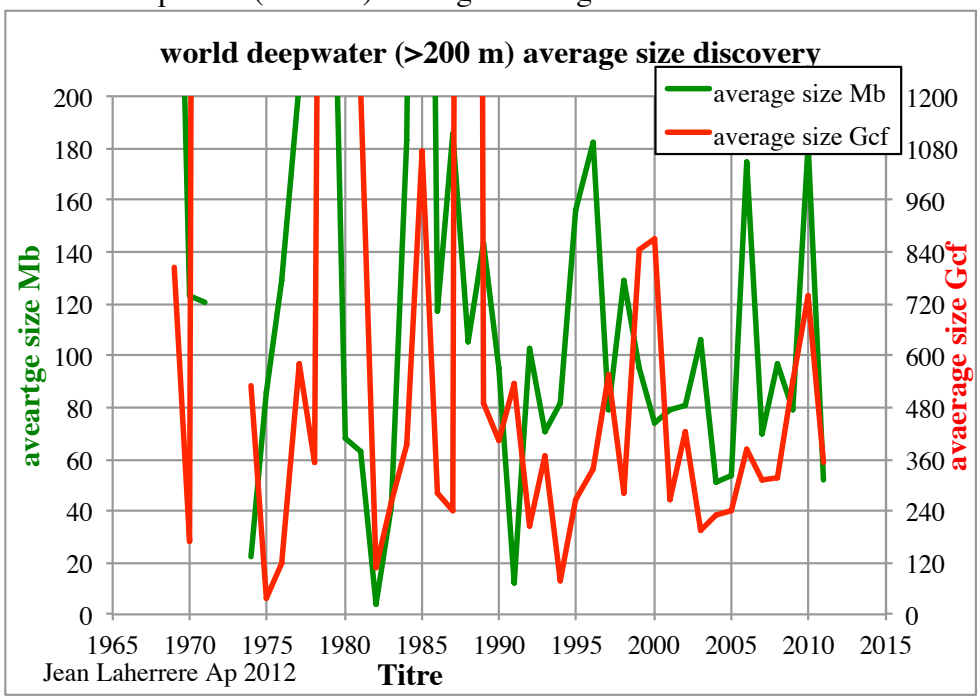


The creaming curve for gas shows that the best result is for CIS (Former Soviet Union) with Barentz and Caspian 9 discoveries. Second is Asia and the least efficient is North America. Middle East with 20 Tcf (Israel) is a good start.

Figure 15: world deepwater (>200 m) gas creaming curve per continent 1969-Oct 2011

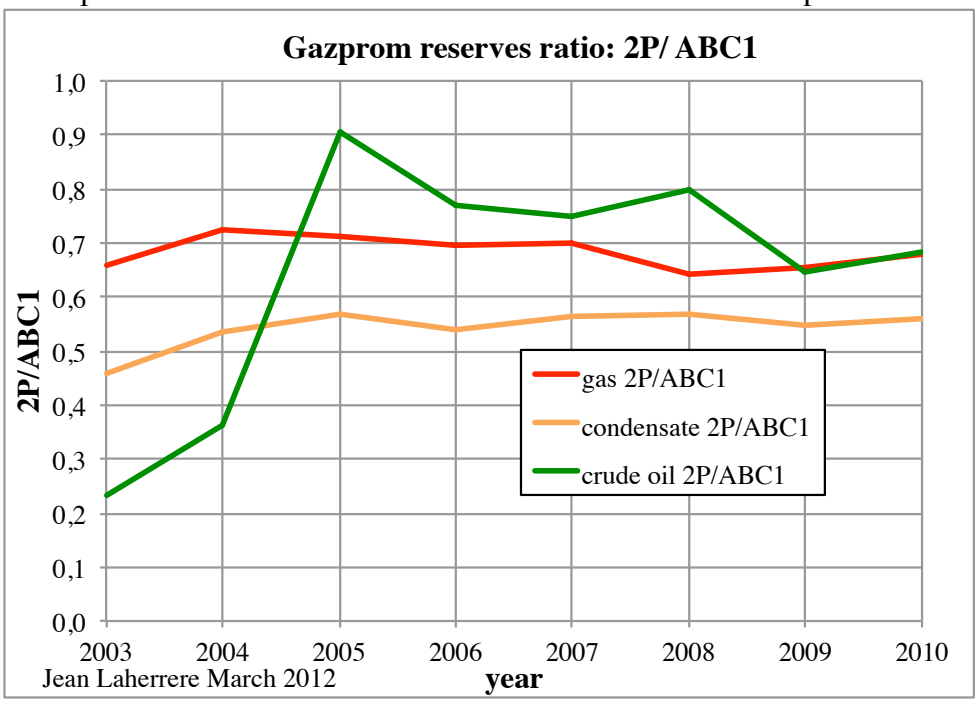


The average size is about 100 Mb for oil and 400 Gcf for gas.
Figure 16: world deepwater (>200 m) oil & gas average field size



Conclusion
The subsalt discoveries are now well taken into account in the deepwater oil ultimate and have increased it by around 50 Gb since 2008. It is a significant increase, but very small compared to the uncertainty of the past world oil discovery with the 300 Gb of speculative resources (Sadad Al-Huseini) in OPEC reserves and with the 150 Gb correction from ABC1 reserves (used in scout databases) to 2P reserves. For more than 10 years I corrected FSU ABC1 reserves data by 30 % to reduce them to 2P, based on the comparison of ABC1 field data and ultimates from oil decline of some Russian fields. Now Gazprom in their annual reports publishes the ABC1 reserves and 2P reserves from audit and this correction of 30% seems correct for oil and gas (ratio 2P/ABC1 = 70 %), but it seems more for condensate.

Figure 17: Gazprom reserves ratio 2P/ABC1 2003-2010 from annual reports



Furthermore I have some doubt on the reliability of the deepwater oil reserves. My paper on "deepwater GOM reserves versus production" (TOD 8366, 8557 & 8604) shows that the oil estimate of deepwater fields reserves seem optimistic for the Gulf of Mexico in particular Thunder Horse.

The Brazilian subsalt reservoirs are complex and there is little historical production, with only a pilot since Oct 2010 for Tupi, now called Lula (already 14 wells drilled) with 6 Gb of 2P reserves.

BG group partner in Lula (25 %) reports the first production test with a FPSO (three producing wells and one gas injector) which reached 70 000 b/d (100 000 b/d expected) since Dec 2011 with a decline of 5000 b/d in two months.

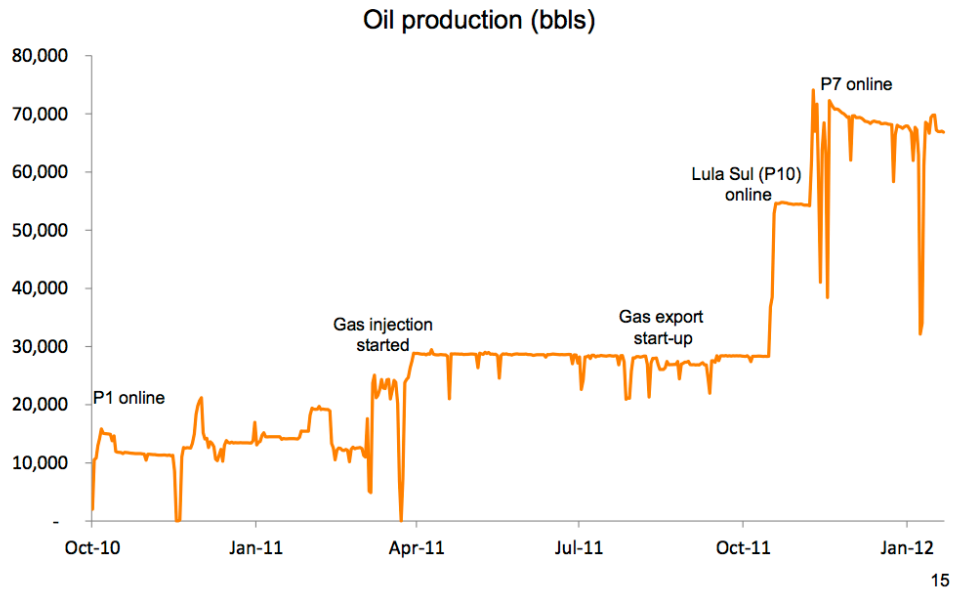
http://www.bg-group.com/InvestorRelations/Presentations/Documents/BG-Brazil2012-Field-development.pdf

Figure 18: Lula first production: Oct 2010-Jan 2012 from BP Group

Field development

Lula – first production

BG GROUP



BG Group 2010 annual forecasts a gross production capacity of 2.3 Mboe/d in 2017 with 13 FPSOs from Lula, Cernambi (formerly Iracema) and Guara fields.

Deepwater oil production will help reduce the decline of present production.
IEA claims that four Saudi Arabia need to be discovered to replace the present decline (about 5 %/a) of present production.
Deepwater ultimate is likely to represent less than half Saudi Arabia's oil ultimate.
It is not enough!