The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Saudi Arabia's Crude Oil Reserves: Particulars or Propaganda?

Posted by ace on June 15, 2008 - 9:45am
Topic: Supply/Production
Tags: aramco, oil reserves, opec, original, peak oil, saudi arabia [list all tags]

This post originally ran 4 MAR 08, but it seems with the recent discussions about Saudi Arabia and OPEC (for example these pieces by Jad Mouawad and Fatih Birol) that the information in this post, in addition to the over 20 very important and related posts by TOD researchers linked at the bottom of this post in summary, is quite important to the recent discourse.

Furthermore, on 22 JUN 08, Saudi Arabia's Oil Minister Ali Al-Naimi will "convene a meeting of representatives of producer and consumer nations and firms operating in the production, export and trading of oil to discuss the jump in prices, its causes and how to deal with it objectively". Kuwaiti oil analyst Kamel Al-Harami added that this meeting "is an opportunity for a transparent and clear dialogue between producers and consumers to collectively explore solutions to the world's energy crisis, now and in the future". Perhaps there is a chance that Saudi Arabia and other OPEC members will offer some transparency about their oil reserves to the world at this important meeting in one week's time.

Executive Summary

1. Saudi Aramco has effectively used propaganda methods for at least the last fifteen years to convince many governments, corporations and individuals to believe their statements. However, Aramco's statement that it is the world's leading oil producer is now false as it now second after Russia since 2006. Nevertheless, Saudi Aramco's repeated statement about remaining recoverable oil reserves being 260 billion barrels (Gb) is still generally accepted.

2. In 2004, Saudi Aramco stated that its oil initially in place (OIIP) has been growing steadily since 1982. There is considerable doubt about the validity of this increase, given the lack of new oil discoveries and the unusual nature of its steady continuous increase. Aramco stated the OIIP was 700 Gb at year end 2003 while a more realistic estimate is 580 Gb.

3. Aramco may have some high recovery factor fields such as Abqaiq and Shaybah, but an average recovery factor range from 30-37% is assumed for the total OIIP in Saudi Arabia's fields. The trend of the recovery factor for Saudi Aramco indicates that there has been no effect on the recovery factor by recent technological advances in producing wells. **Saudi Aramco has kept remaining recoverable crude oil reserves constant simply by artificially increasing the OIIP each year since 1982, accompanied by an unrealistically high average recovery factor of 52% since 1988.**

4. **Saudi Aramco's propaganda campaign is failing.** Saudi Aramco is no longer the world's leading crude oil producer. Saudi Aramco's statement of 260 billion barrels of remaining recoverable reserves is almost certainly false. Instead, the remaining recoverable crude oil reserves are probably less than 100 Gb, instead of 260 Gb. **It is time to call on Saudi Aramco and the other OPEC members to tell the truth about their reserves.**

Definitions

OIIP – Oil Initially in Place
URR – Ultimate Recoverable Oil Reserves
RF – Recovery Factor (URR/OIIP)

1. Successful Propaganda

Almost all governments and large corporations use methods of propaganda to further their own interests. One of the masters of propaganda was Germany's Nazi Leader, Adolf Hitler, who said, in his book Mein Kampf: "But the most brilliant propagandist technique will yield no success unless one fundamental principle is borne in mind constantly and with unflagging attention. It must confine itself to a few points and repeat them over and over". Hitler's propaganda principles are described further below.

> It must repeat those points over and over again until the public believes it. The principles behind propaganda are the same principles of mind control, hypnotic suggestion, and mental programming: distraction and repetition. With propaganda, distraction draws attention away from information that is true and directs attention to information that is false. Repetition of the false information imbeds it in your subconscious mind so that your acceptance of its truth becomes a conditioned response. You accept this information as true without thinking whenever it is presented to you again.

The text in the figure below is from the event brochure of the 2008 Saudi Arabia International Oil & Gas Conference, hosted and supported by Saudi Aramco. Does the text below satisfy the first part of Hitler's quote and confine itself to a few points? Yes, the few points stated are that Saudi Arabia is the world's leading oil producer and exporter, is the main force for stability in the oil market, and has remaining recoverable reserves of 261.8 billion barrels.

SAUDI ARABIA: THE MARKET

Saudi Arabia is the world's leading oil producer and exporter. Oil accounts for more than 90 percent of the country's exports and nearly 75 percent of government revenues. Proven reserves are estimated to be 260 billion barrels (41 km³), about 25% of the world's proven petroleum reserves.

The Kingdom is the main force for stability in the oil market, always trying to balance the needs of the oil producers with the demands of the oil consumers

Oil Resources

According to the latest estimates, the Kingdom's recoverable reserves now stand at 261.8 billion barrels. This figure represents an increase of 1.8 billion barrels on the 1993 estimate of 260 billion barrels. (An increase in recoverable reserves, despite the daily extraction of millions of barrels of oil, is made possible by the discovery of new oil fields and improved technology in exploiting existing field.)

As techniques for extraction improve and new reserves are found, it is estimated that the oil reserves of the Kingdom of Saudi Arabia will last for some 90 years.

Fig 1 – Saudi Aramco Propaganda, 2008 *- click to enlarge*

Does Saudi Aramco's propaganda satisfy the second part of Hitler's quote and repeat these few points over and over again? Yes, Saudi Aramco has been repeating these few points for at least the last fifteen years. In the text in the figure above, there is a reference to a 1993 estimate of 260 billion barrels recoverable reserves. The text below is from the September 1993 issue of Saudi Aramco World:

> Saudi Arabia became the world's top oil-producing nation... and is also the world's number-one exporter of crude oil and natural gas liquids.
>
> At the end of 1992, recoverable crude oil reserves in the company's fields were 258.8 billion barrels. That quantity is not only about a quarter of the world's known total, it is also 6.4 billion barrels above the total in 1988, despite the production of some 10 billion barrels of crude in the intervening years -clearest proof of a successful exploration program.

Are the points stated by Saudi Aramco true? According to the EIA, Russia produced more oil than Saudi Arabia in 2006 (9.25 mbd vs 9.15 mbd), in 2007 (9.44 mbd vs 8.72 mbd), and in the first 3 months of 2008 (9.35 mbd vs 9.20 mbd). Thus, Aramco's 2008 statement (Fig 1) that it is the world's leading oil producer is now false.

Is the 2008 statement about remaining recoverable reserves of 261.8 billion barrels true? Saudi Aramco says that the increase in recoverable reserves, despite the daily extraction of millions of barrels, is made possible by the discovery of new oil fields and improved technology in exploiting existing fields (Fig 1). Unfortunately, there are no independently audited reserves data of Saudi Arabia but the discussion in the following sections indicates that Saudi Aramco's remaining recoverable reserves are far below 260 billion barrels.

Overall, Saudi Aramco's propaganda methods would satisfy Hitler's quote and have been successful. Many governments, corporations and individuals accept Aramco's statements and also

accept Aramco's repeated statement of 260 billion barrels remaining recoverable crude oil reserves.

2. Ever Increasing Oil Initially in Place

The statement in Fig 1 above by Aramco includes a reference to maintaining remaining recoverable reserves by discovery of new oil fields. If new fields are discovered then this can add additional reserves and will also increase the oil initially in place (OIIP). The figure below shows OIIP from 1982 to 2003 and is from Aramco's presentation, to the Center for Strategic & International Studies in Washington, DC, on February 24, 2004.

According to this summary of Saudi Arabia discoveries, only one significant discovery has been made since 1975, the Hawtah Trend, a collection of about six fields including Nuayyim, from 1989-91, with about 2 Gb reserves and 6 Gb OIIP. This discovery could partly explain the small step changes in OIIP in 1989 and 1991 in the figure below. However, from 1982 to 2004 there was a total change of 110 Gb OIIP which leaves a very large unaccounted 104 Gb. Page 28 of this 2005 ASPO presentation shows an increase in discovered reserves of about 5 Gb from 1982 to 2004, representing about 15 Gb OIIP which still leaves an unaccounted 95 Gb.

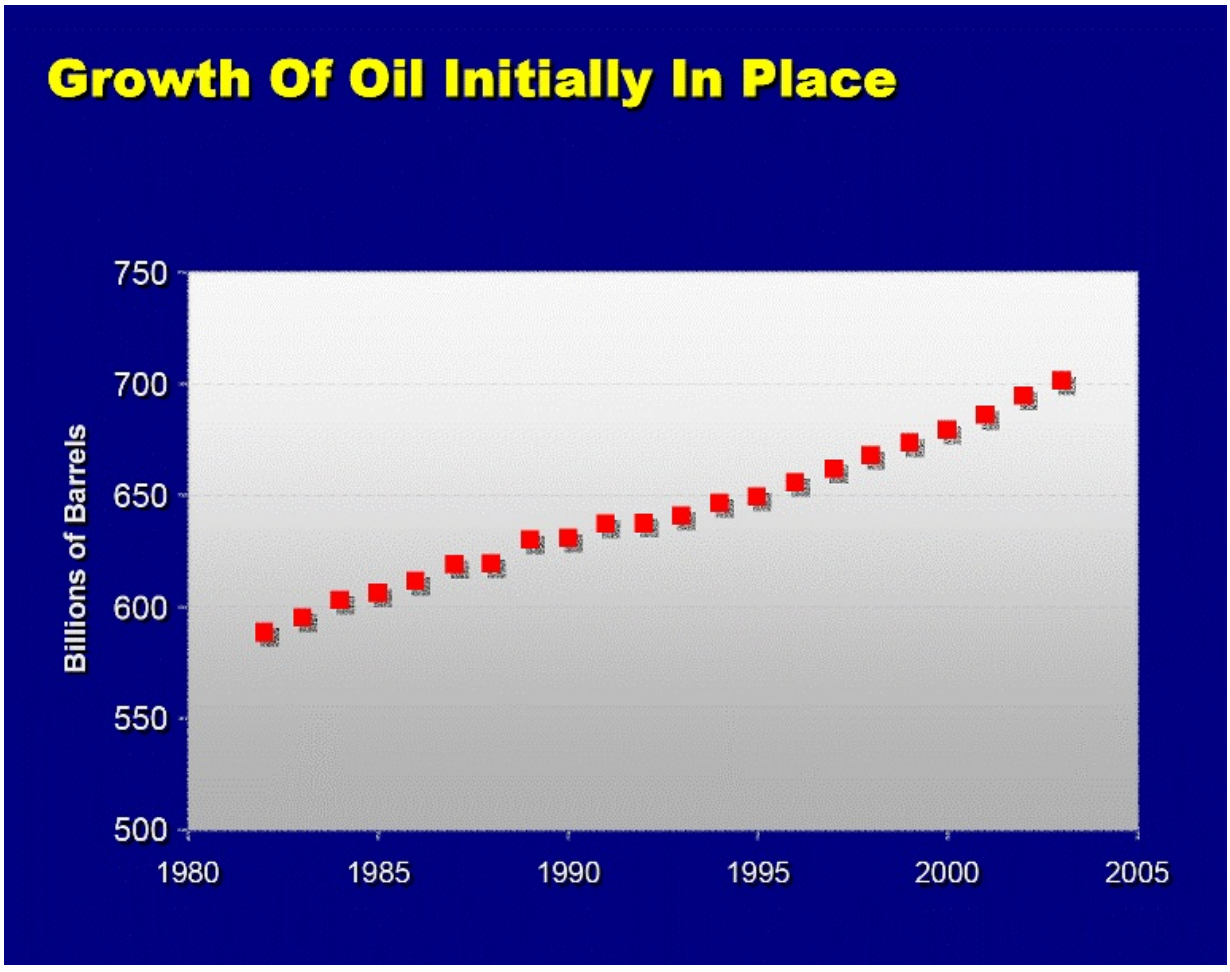

Fig 2 – Growth of Oil Initially In Place - *click to enlarge*

A common method to increase OIIP is to do further appraisal drilling to increase the reservoir volume, by infill and step-out wells. However, this appraisal drilling normally results in a

staggered, extremely gradual, OIIP growth over time rather than the smooth upwards trend shown above in Fig 2. Given the lack of significant new discoveries, this 2005 ASPO presentation estimates that in 2003 the OIIP was a more realistic 580 Gb as shown below in Fig 3, instead of Aramco's claimed 700 Gb.

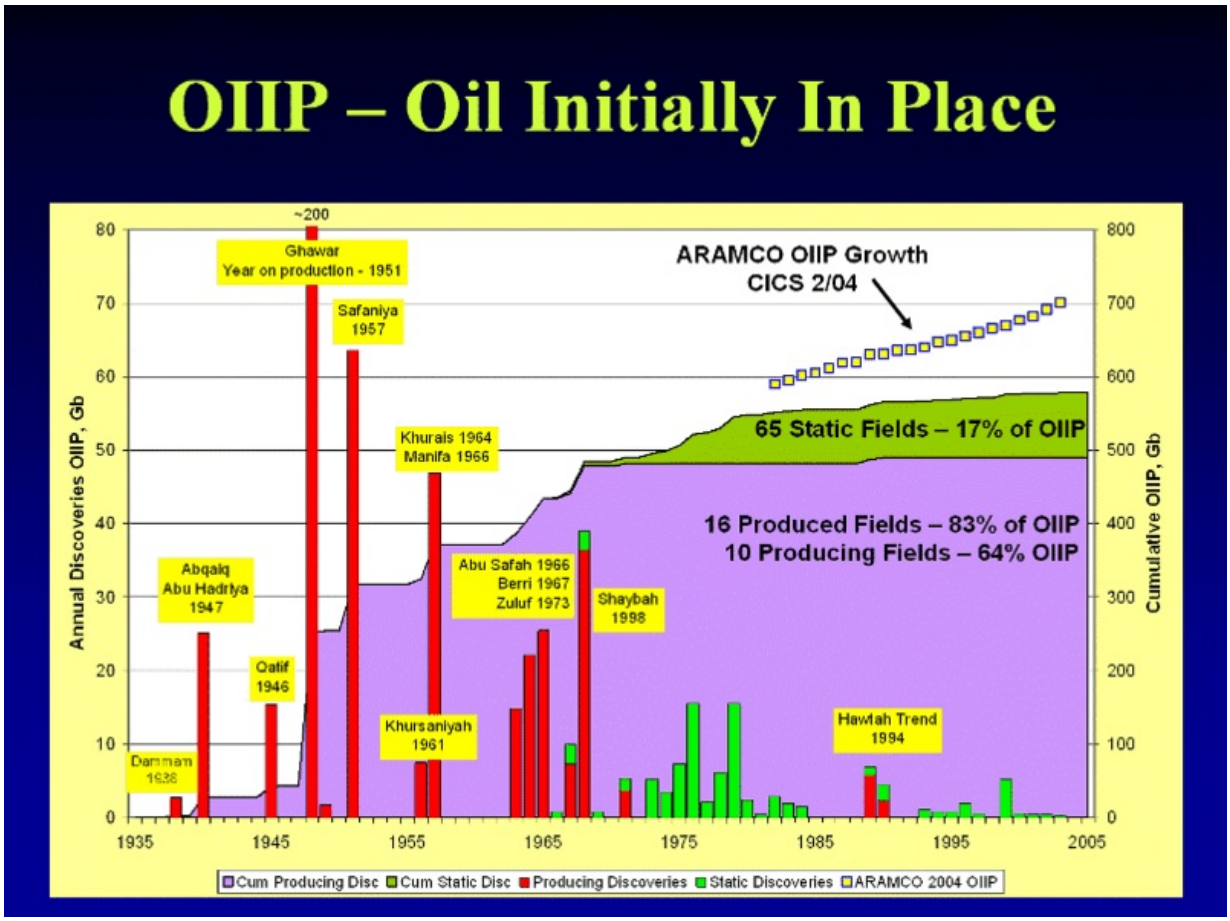

Fig 3 – ASPO 2005 Oil Initially In Place *- click to enlarge*

In Fig 4 below, also from Aramco's 2004 presentation, it is hard to believe that Aramco forecasts 200 gb new oil discoveries from 2004 to 2025, measured as OIIP. This is partly based upon their reliance of US Geological Survey World Petroleum Assessment 2000 in Aramco's presentation that states there is 87 Gb undiscovered recoverable oil in Saudi Arabia. The forecast 200 Gb yet to find OIIP based upon the USGS 2000 study could provide a weak basis to a continued increase in the OIIP. The future estimated OIIP increase of 200 Gb suggests an average discovery rate of about 10 Gb(OIIP)/year from 2004. It's now 2008 and there have been no discoveries announced which could comprise 10 Gb/year.

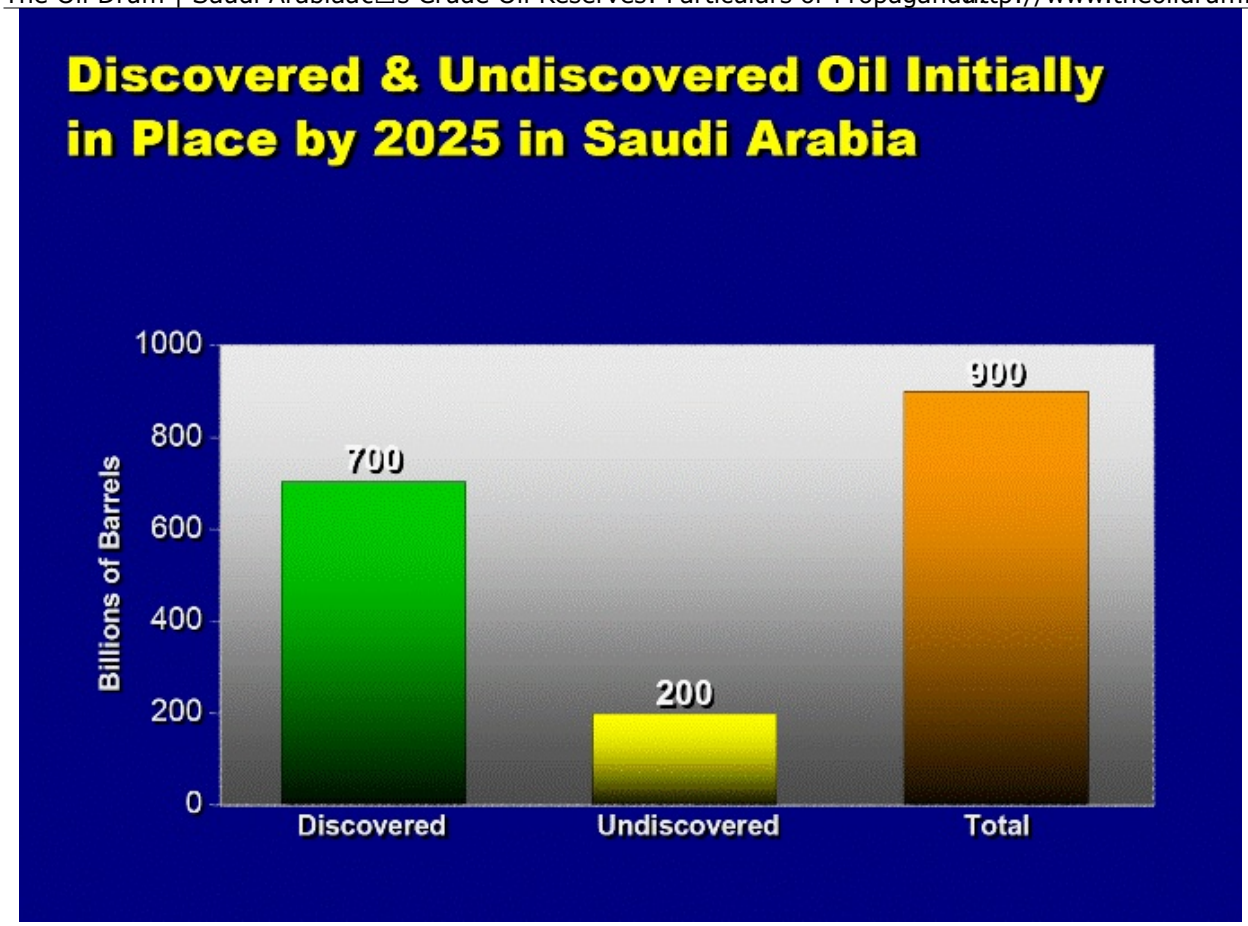

Fig 4 – Discovered & Undiscovered Oil Initially in Place by 2025 *- click to enlarge*

What is Aramco's purpose of showing a continuous and gradual increase in OIIP, without supporting evidence? An answer is proposed in the following section.

3. Recovery Factors and Remaining Recoverable Reserves

Recovery factors vary according to each field and each part of a field. The recovery factor is defined as the ultimate recoverable oil divided by the oil initially in place. This 2004 ASPO presentation stated that "the average global recovery factor is about 30-35%". This is based on data from the IHS Energy database on 9,000 fields worldwide containing 1,400 Gb reserves. The recovery factor bands are shown in the figure below.

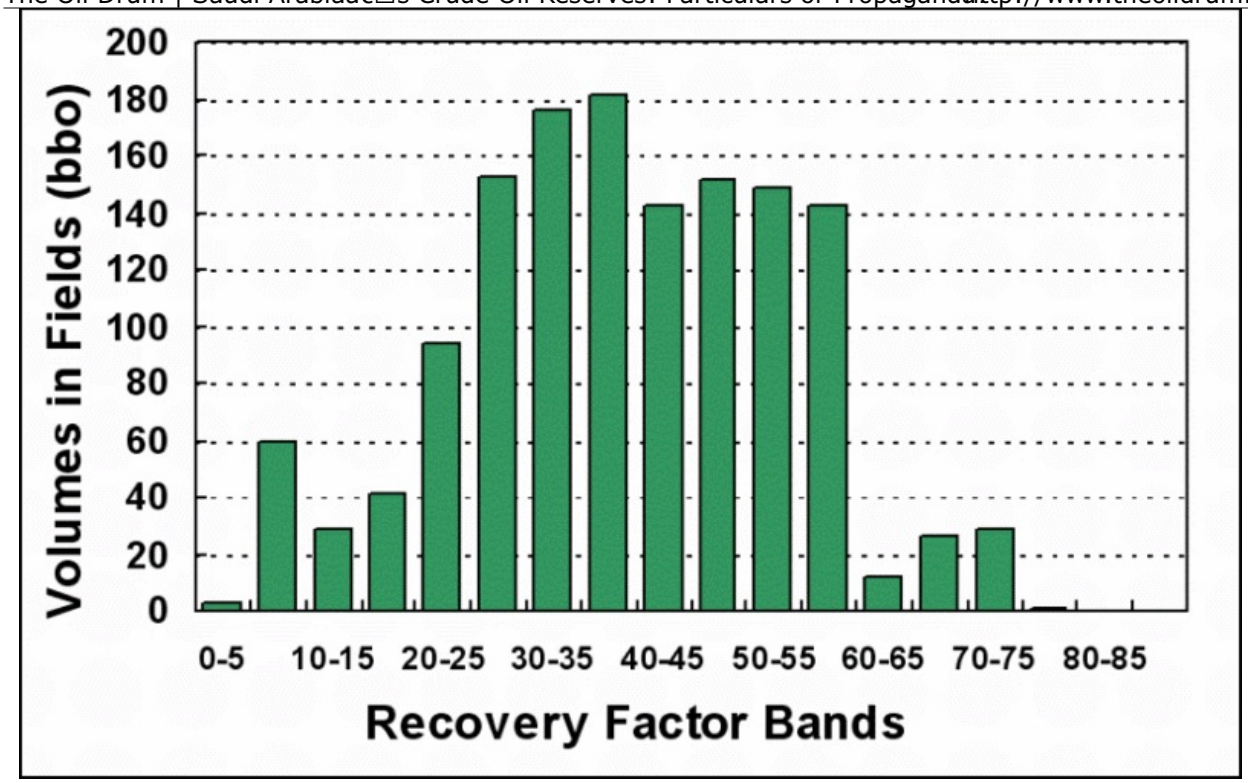

Fig 5 – Recovery Factor Bands, 9,000 Worldwide Fields with 1,400 Gb Reserves - *click to enlarge*

Schlumberger discusses recovery factors in their brochure called Carbonate Reservoirs – Meeting unique challenges to maximize recovery. This brochure states that "the average recovery factor – the ratio of recoverable oil to the volume of oil originally in place – is about 35%. However, it is recognized that recovery factors are higher for sandstone reservoirs that for carbonates". Given that the majority of Saudi Arabia's key reservoirs are carbonate, it would seem appropriate that 35% is assumed as a reasonable upper limit for the average recovery factor of all fields, based on Schlumberger's statements and on the 2004 ASPO presentation.

Part of Dr. Mamdouh Salameh's expert comment to the Oil Depletion and Analysis Centre (ODAC), made on May 7, 2007 discussed Saudi Arabia's recovery factors.

> And despite the great technological strides by the oil industry, the average global oil recovery rate has been stuck at 32% of the oil in place since the early 1990s. However, rates of 50% and even 55% have been achieved in the North Sea and also in the most recently-developed, state-of-the-art "Shaybah oilfield" in Saudi Arabia respectively. But I hasten to add that 90% of Saudi oil production comes from four giant oilfields (Ghawar, Safaniya, Hanifa and Khafji), all of which are more than 50 years oil and are being kept flowing by a huge injection of water. Oil recovery rate from these four oilfields ranges between 25% and 30%.

Based on Dr Salameh's statement, 30% is assumed as a reasonable lower limit for the average recovery factor of all Saudi Arabian fields.

The red line in the figure below is an estimate of the recovery factor from the end of 1976 to the

end of 2008. The scale for the recovery factor is on the right axis. The scale for the other four lines is on the left axis. The black line represents the OIIP. The OIIP data from 1982 to 2003 is from Fig 2. The OIIP data from 2004 to 2008 is a forecast assuming that recovery factor remains the same and that annual production is replaced 100% by new recoverable reserves. The OIIP data from 1976 to 1981 is based partly on Fig 3 and includes the year end 1978 data point of 530 Gb OIIP, sourced from the April 1979 Senate staff report titled "The Future of Saudi Arabian Oil Production" as referenced on page 378 of Twilight in the Desert.

The grey line represents remaining recoverable reserves sourced from BP annual statistics review for the years 1980 to 2006. It is assumed that remaining recoverable crude oil reserves in 2007 and 2008 will be equal to 2006. The remaining recoverable reserves from 1976 to 1979 are estimated using the data point of 110 Gb for year end 1978 as referenced also on page 378 of Twilight in the Desert. The data point for the year end 1979 is 160 Gb as referenced on page 73 of Twilight in the Desert coinciding with the Saudi government acquiring 100% of Aramco.

The pink line represents cumulative crude oil production and is sourced from OPEC's 2006 Annual Statistical Bulletin. The data point for 2007 is from the US EIA and the 2008 data point is from this recent world oil forecast. The green line is the ultimate recoverable crude oil reserves (URR) and is a sum of the remaining reserves (grey line) and the cumulative production (pink line).

The recovery factor (RF), shown by the red line, is the URR (green line) divided by the OIIP (black line). From 1976 to 1978, RF was about 27%. In 1979, upon full Saudi nationalization of Aramco, the RF increased to a 37% plateau until 1987. In 1988, the year that Aramco was renamed Saudi Aramco, RF increased by a huge step to a 52% plateau which extends to 2008.

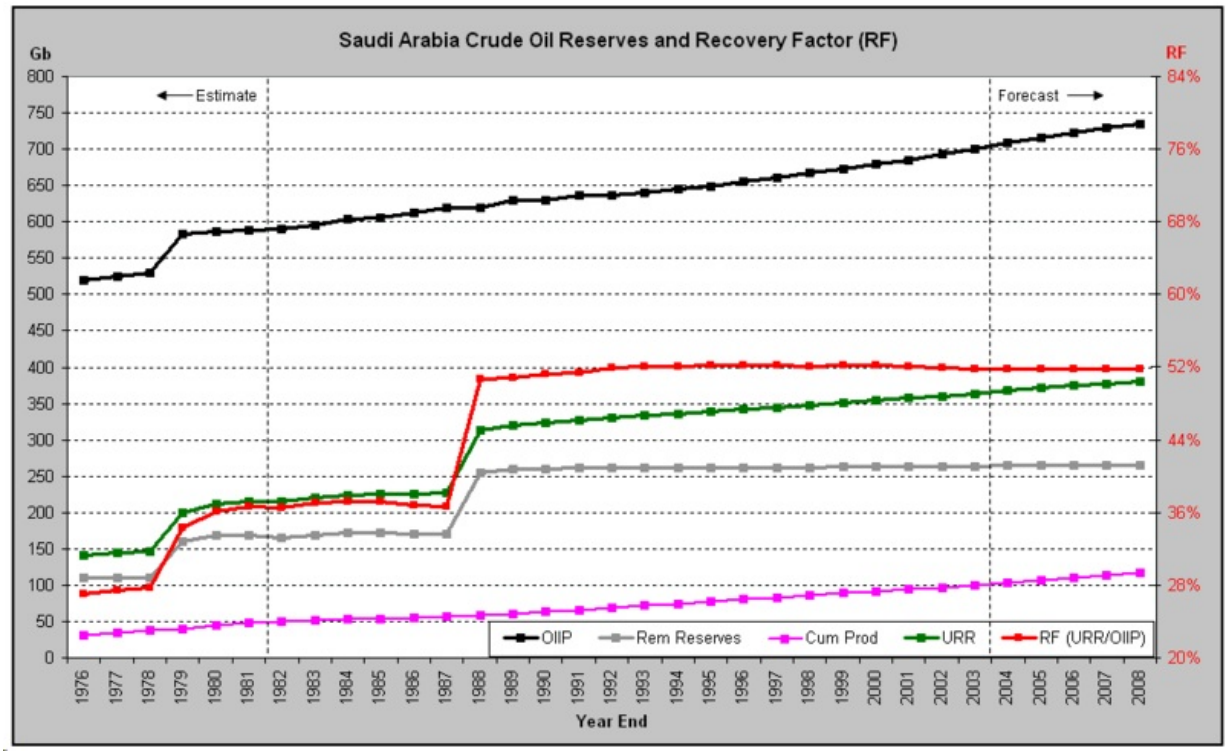

Fig 6 – Saudi Arabia Recoverable Oil Reserves and Recovery Factor *- click to enlarge*

Given that there is a 37% RF plateau which may have some credibility, should the upper RF limit of 35% be increased to 37%? Some assistance could be provided by the figure below from this

2003 Statoil presentation which discusses recovery factors and possible increases due to enhanced oil recovery (EOR) methods. The figure below shows how the recovery factor increases from 20%, for small fields, to over 30% for large fields (green line). Statoil calculated a higher improved oil recovery (IOR) factor by applying EOR methods. This red line shows an optimistic peak of about 44% for large fields. However, Statoil relies on IHS 2003 data which, in turn, relies on OPEC data. Since much of the increase in RF is due to the large fields within OPEC, discussed further in Statoil's 2003 presentation article, a strong upwards bias to the 44% RF is likely. Nevertheless, the increase of RF from 29% to 38% provides enough support to increase Saudi Arabia's RF upper limit of 35% to 37%.

This story from Saudi Aramco World from May/June 1984 edition was emailed to me on March 5. This is a quote from Sadad Al-Husseini, GM Petroleum Engineering at Aramco.

> People talk about oil running out in Saudi Arabia, but even if we do nothing else but enhance our average recovery factor by 10 percent, we would add 17 billion barrels to our reserves of 165 billion.

This quote indicates that Al-Husseini was disclosing total, not remaining, URR of 165 billion barrels (Gb) for 2003. Adding his 17 Gb gives a potential total URR of 182 Gb which represents a plausible average recovery factor of 33%, based on OIIP of 550 Gb. From Fig 2 above, Aramco's stated OIIP for 1983 was about 595 Gb; Fig 3 gives OIIP of about 550 Gb. 10 percent of 595 Gb is 59 Gb so this means that Husseini was not talking about an absolute increase in the recovery factor (RF) but rather a relative increase. Husseini's 17 Gb is 2.9% of the 595 Gb and 3.1% of the 550 Gb. If it is assumed that Husseini's RF increase is a relative 10%, this implies that the average RF for Saudi Arabia is between 29% and 31% for 1983. Applying the relative 10% increase of 17 Gb to give a total 182 Gb gives a possible average RF range of 31% to 33%, which is within the 30% to 37% previously assumed RF range. Thus, Husseini's reference to reserves of 165 Gb is most likely total URR. The reasoning is that Fig 6 above shows remaining reserves for 1983 of about 169 Gb but cumulative production of 51 Gb. The total URR is then 220 Gb. 220 Gb divided by 595 Gb gives a 37% RF. A relative 10% increase of 37% is 3.7% which is 22 Gb, well above Husseini's 17 Gb addition. However, the 169 Gb reserves divided by 595 Gb is 28%, coincidentally close to the 29% above.

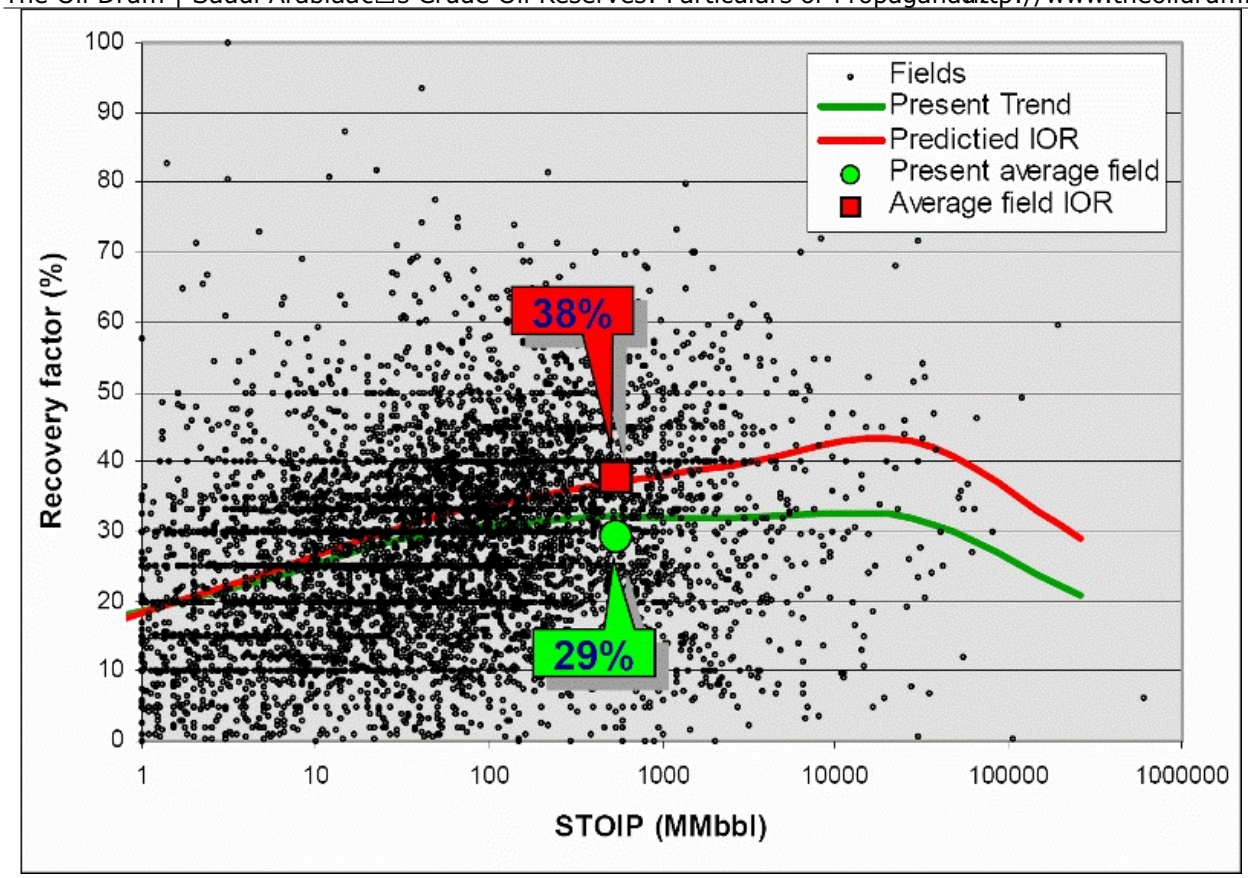

Fig 7 – Recovery Factor vs Field Size (OIIP), based on 8,600 Fields (IHS Data 2003) *- click to enlarge*

An answer can now be offered to the question from the end of section 2 above: What is Aramco's purpose of showing a continuous and gradual increase in OIIP, without supporting evidence? All oil companies, including state owned companies such as Saudi Aramco, are under great pressure by their owners to demonstrate replacement of reserves depleted by production. Aramco wanted to continue replacing annual production with new reserves, while assuming a constant RF. In the absence of sufficient real oil discoveries to increase OIIP enough to create new reserves, Aramco decided to artificially increase the OIIP each year to offset annual production losses. Aramco's behaviour is supported by an unusually high correlation coefficient, between cumulative production (pink line) and the OIIP (black line) from 1982 to 2003 (Fig 6), of 0.99.

The amount of the OIIP increase would be calculated after the end of every year, after total production was known. The total production would be divided by RF to calculate the increase in OIIP to keep remaining reserves constant. Normally, the reverse is performed. An oil company discovers more oil then subtracts produced oil for the year to derive a year end remaining reserves figure which would vary from year to year, unlike Aramco which targets a constant idealistic remaining reserves figure. From 1979 to 1987 the OIIP was increased at just the right amount each year to maintain remaining reserves at 160 Gb. From 1988 to 2003, Aramco also increased OIIP each year at just the right amount to keep remaining reserves constant at 260 Gb, but at an incredibly high RF of about 52%.

There is additional confirmation of this practice of increasing OIIP each year, to replace production with new reserves, by a small note from Aramco's February 2004 presentation: "(Note: the Company's Business Plan calls for a reserves replacement of 15 billion barrels during 2005-2009)". Aramco's crude oil production for the year ended 2003, two months to their

presentation, was 3 billion barrels. This note calling for reserves replacement of 15 billion barrels coincidentally represented exactly 5 years of 3 billion barrels/year production.

What about the effects of Aramco's improved technology in exploiting existing fields (Fig 1)? Aramco started using advanced horizontal wells about ten years ago for their Shaybah field and in other fields such as Ghawar. Surely multilateral horizontal wells and smart wells should increase RF even just by a couple of percent since 1998. However, Fig 6 shows a constant 52% RF starting in 1988. This is odd. Perhaps the real answer is that Aramco was unable to increase RF because 52% has been unrealistically high since 1988.

4. Failing Propaganda

Saudi Aramco's propaganda campaign is failing. Aramco says that they are the world's leading producer (Fig 1). As of 2006, Aramco is now second to Russia which produces more crude oil per day. Saudi Aramco says that they still have 260 Gb (billion barrels) remaining recoverable oil reserves. This is unbelievable and has probably been created by artificially increasing the OIIP every year by an amount to exactly offset production (Fig 6). Aramco says that the constant remaining recoverable reserves of 260 Gb since 1993 has been due to increased discoveries and improved technology. Oil discoveries since 1993 have been minimal, at most about 10 Gb OIIP which is insufficient. Improved technology is supposed to help increase the recovery factor but Aramco's recovery factor has been constant, at an unrealistically high 52%, since 1988 which indicates that the technology has had no effect on recoverable reserves. Instead Aramco just increases, artificially, the OIIP each year to maintain a constant remaining recoverable reserves.

Applying the previously assumed lower and upper RF limits of 30% to 37% to the estimate of 580 Gb OIIP from Fig 3 gives a URR range of 174 Gb to 215 Gb. Given that Aramco has cumulative production of 115 Gb to the end of June 2008, this gives a range of remaining recoverable crude oil reserves from 60 Gb to 100 Gb, not Aramco's propaganda statement of 260 Gb.

Ali Naimi, who joined Aramco in 1947 at age 11, prior to the kingdom's labor laws regulating hiring ages, is shown in the picture below. This year has been declared as Saudi Aramco's 75th anniversary which would be a symbolic year for Aramco to at least start telling part of the truth. A gradual elimination of Aramco's propaganda campaign would surely be preferable to a sudden elimination?

Unfortunately, on March 2 just before OPEC's March 5 meeting, Naimi was hiding the truth even more, by making further unsubstantiated and false statements raising Aramco's propaganda to a new peak. He said that Saudi Arabia planned to add another 200 Gb of oil to its proven reserves, which is equivalent to an absurd increase of over 75%, from 260 Gb to 460 Gb. No sources were given for this planned reserve increase of 200 Gb. Naimi said that the 200 Gb reserve increase was "to reassure the world that we are not going to run out of oil in the next five to ten years as peak oil theorists say." This statement is false. Peak oil theorists, such as one of Aramco's former executives, Sadad al-Husseini, do not believe that oil will run out but instead decline slowly. Just as Third Reich propaganda reached a peak in 1943 by this famous speech of Hitler's propaganda minister Joseph Goebbels, prior to the collapse of the Third Reich, it is likely that Aramco's propaganda has reached its peak prior to the collapse of its crude oil production, Naimi's long overdue resignation and release of the truth.

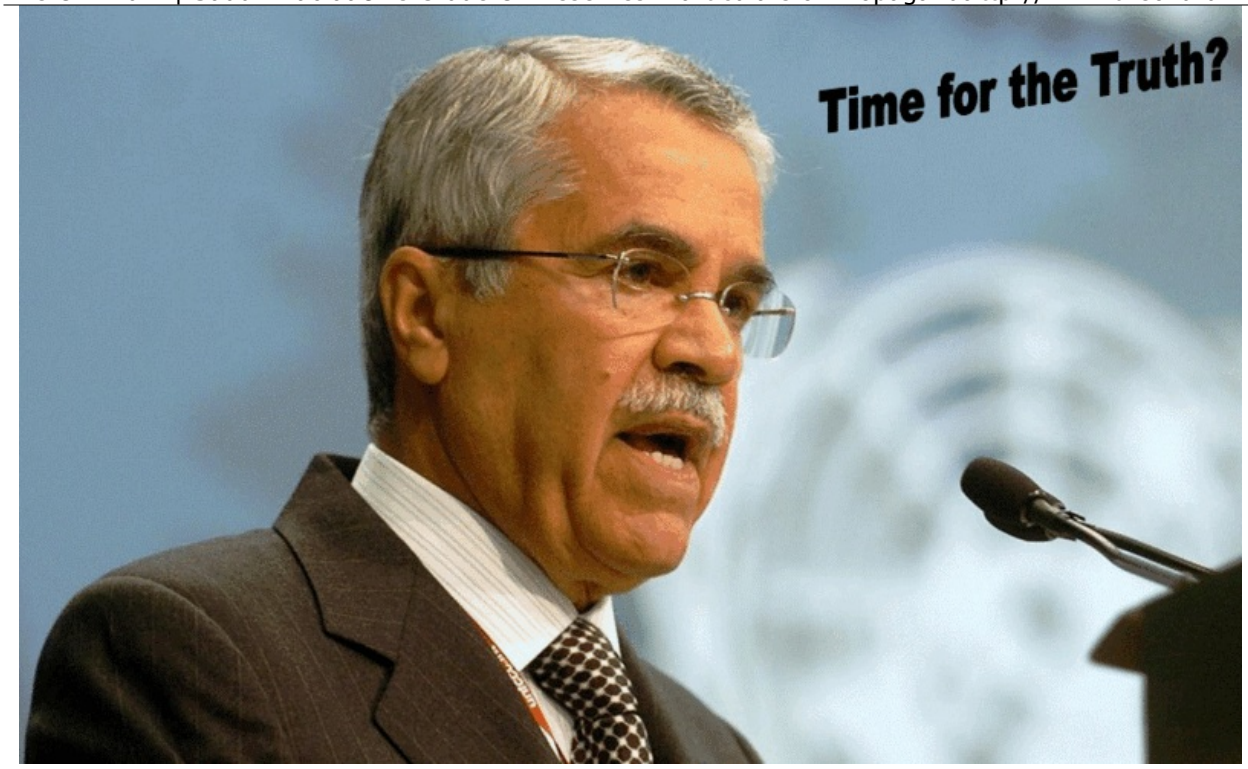

Fig 8 – H. E. Ali I. Naimi, Minister of Petroleum & Mineral Resources, The Kingdom of Saudi Arabia and Chairman of the Board of Directors, Saudi Aramco - *click to enlarge*

After Saudi Aramco tells the truth, the other OPEC members can do the same as it is highly likely that they have also artificially inflated their remaining recoverable crude oil reserves from 1980 to 1990 and continue to hold these reserves artificially high without making sufficient new discoveries. The two charts in the figure below show the years from 1980 to 1990 shaded in grey. The chart on the right shows that OPEC discovered most of its oil prior to 1980, as shown by the green area, and only about 20 to 30 Gb from 1980 to 1990. However, over the same decade, the chart on the left shows that OPEC reserves increased by over 300 Gb, which is greater than ten times these discoveries. These OPEC discoveries cannot possibly justify this huge increase in OPEC reserves between 1980 and 1990.

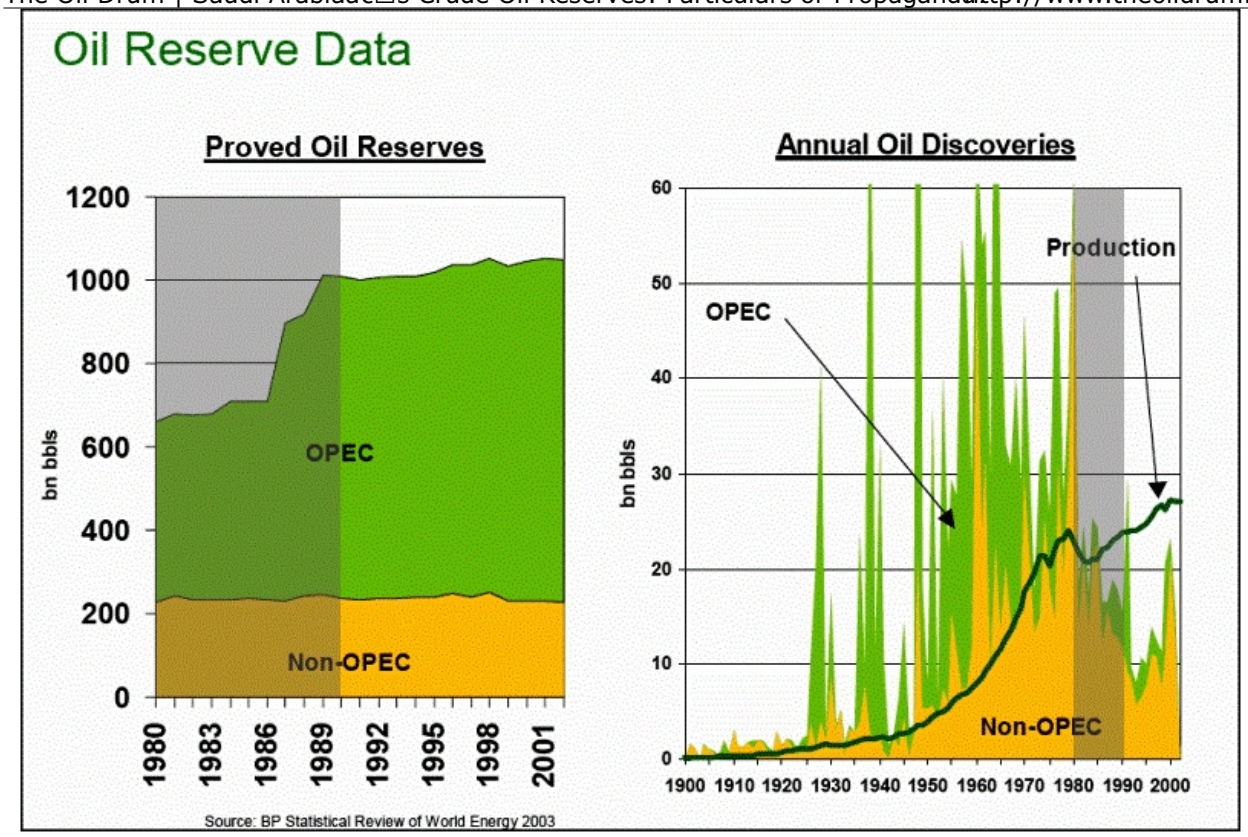

Fig 9 – OPEC 1980 to 1990 Reserves Increase not Justified by OPEC Discoveries (source of BP charts: Out of Gas, David Goodstein, Nov 30, 2006) *- click to enlarge*

By displaying the huge unqualified increase, of over 300 Gb, in OPEC reserves in the left chart of Fig 9, BP demonstrates that it accepts OPEC's propaganda. Do you?

5. Additional Information Sources

by Stuart Staniford

- **Satellite O'er the Desert**
- **Saudi Arabia and Gas Prices**
- **Depletion Levels in Ghawar**
- **The Status of North Ghawar**
- **Further Saudi Arabia Discussions**
- **Water in the Gas Tank**
- **A Nosedive Toward the Desert**
- **Saudi Arabian oil declines 8% in 2006**

by Euan Mearns

- Saudi Arabia - production forecasts and reserves estimates
- Ghawar reserves update and revisions (1)
- GHAWAR: an estimate of remaining oil reserves and production decline (Part 2 - results)
- GHAWAR: an estimate of remaining oil reserves and production decline (Part 1 - background and methodology)
- **Saudi production laid bare**

- **Saudi Arabia and that $1000 bet**

by Gail the Actuary

- **President Bush Questions Saudi Ability to Raise Oil Supply**

by Jerome a Paris

- **Saudis officially happy with $100 oil**

by JoulesBurn

- **Intro to Satellite Sleuthing 101: Finding Haradh III**

by Heading Out

- **Another look at the Kingdom of Saudi Arabia**
- **Simple mathematics - The Saudi reserves, GOSPs and water injection**
- **Of Oil Supply trains and a thought on Ain Dar**

by Khebab

- **Saudi Arabia: An Attempt to Link Oil Discoveries, Proven Reserves and Production Data**
- **The Hubbert Linearization Applied on Ghawar**
- **An Attempt to Apply The Parabolic Fractal Law to Saudi Arabia**

by Ace

- **World Oil Forecasts, including Saudi Arabia, Kuwait and the UAE – Update Feb 2008**
- **Saudi Arabia's Reserve "Depletion Rates" provide Strong Evidence to Support Total Reserves of 175 Gb with only 65 Gb Remaining**
- **Further Evidence of Saudi Arabia's Oil Production Decline**