



## Ghawar reserves update and revisions (1)

Posted by [Euan Mearns](#) on May 2, 2007 - 11:13am in [The Oil Drum: Europe](#)

Topic: [Supply/Production](#)

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In this revisions post I want to update my views on Ghawar reserves incorporating 4 main changes:

1. A model base assumption error in the way initial reserves in Uthmaniyah were calculated is corrected.
2. The data vintage for the Linux oil saturation map has been revised to 2002 (from 2004).
3. 2002 based figures are re-based to 2006 by adjusting for 4 years production at 5 million barrels per day.
4. The production prognosis for Hawiyah has been revised down.

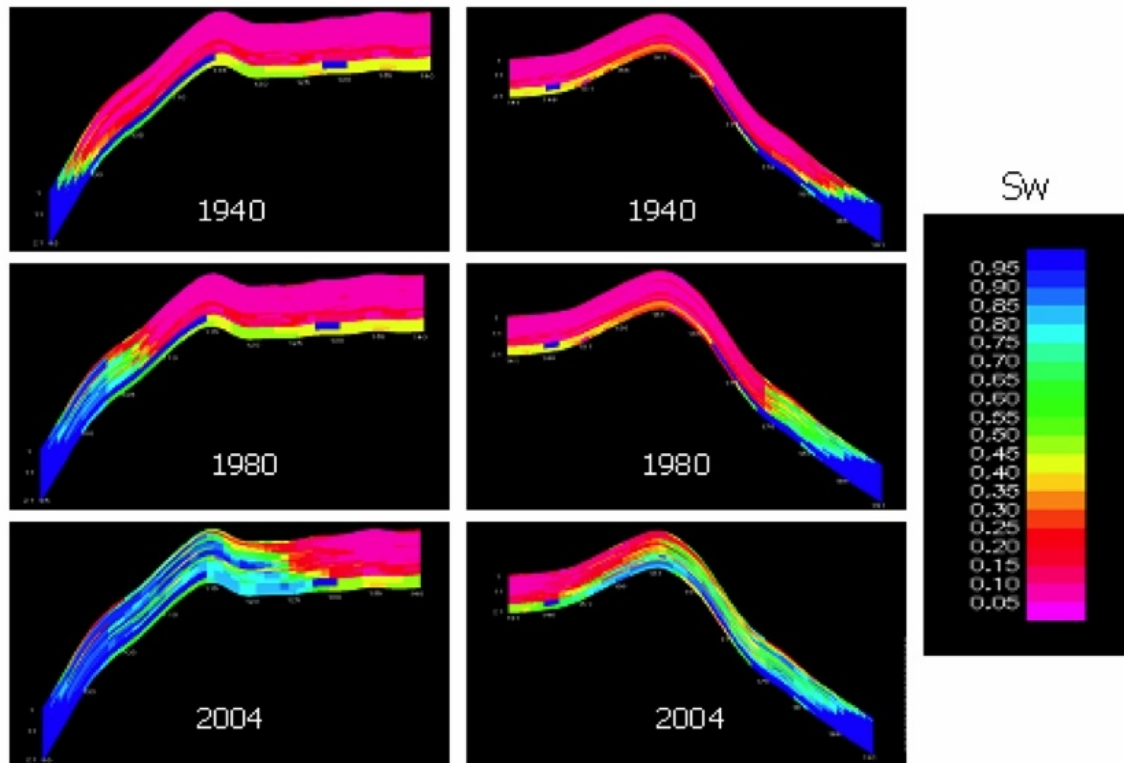
These adjustments result in the initial whole field reserves figure rising to 173 billion barrels and show the field in a more severely depleted state in 2006 than **previously shown**.

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## Uthmaniyah

In my **original post**, the oil column thickness in Uthmaniyah had been reduced from 180 to 144 ft in the initial STOIP calculation and from 180 to 120 ft in the 2004 reserves calculation. 180 ft is the net reservoir thickness reported by **Croft**.

The reason for this reduction was the observation of water at the base of the Uthmaniyah saturation profiles as shown below.



Oil saturation profiles in Uthmaniyah. Image source: [Water in the gas tank by SS](#), original source is: [Water Production Management Strategies in North Uthmaniyah Area, Saudi Arabia, SPE 98847, June 2006](#).

My interpretation of these profiles now is that they show a complete Arab D Zone 2 and Zone 3 section. The low oil saturation sections at the base of the Uthmaniyah profiles therefore are interpreted to be non-reservoir beds in Zone 3. In short the Uthmaniyah profile is believed to be about 250 ft thick, of which 180 feet is net reservoir, full of oil before production began.

The reduced oil thickness height of 120 ft in the 2004 (now 2002) calculation has not been changed, as this is an allowance for edge wedge effects and along strike variations in column thickness.

Using oil full 180 feet in Uthmaniyah has the effect of boosting my estimate of initial stock tank oil in place to 173 billion barrels from my initial estimate of 162 billion barrels.

This revision brings my initial STOIP value in line with the number reported by Simmons that was 170 billion barrels.

One consequence of boosting the initial STOIP in Uthmaniyah is that it also boosts the estimate of the amount of oil that has been produced but as the estimate of the amount of oil remaining is unchanged this increases the estimate of depletion in Uthmaniyah.

## Vintage of Linux oil saturation map

In my original estimates it was assumed that the Linux saturation map was showing the condition of the reservoir in 2004. One key piece of evidence that has shifted my view on this is the interpretation of the oil layer thickness map (Figure 11, IPTC 10295) that was presented by Stuart [here](#). This shows a significantly narrower oil ribbon in the crest of South Ain Dar than I have interpreted from the Linux saturation map. One explanation may simply be information transcription errors. Another explanation is that the data used to construct the Linux map pre-

Memmel pointed out [here](#) that they may have been testing the Linux super cluster technology doing simulation runs on various data vintages and combined these lines of argument point to the Linux map pre-dating 2004 and I have settled (for the time being) on 2002 as a more likely vintage for this information.

I disagree with the arguments that Linux may date from the 1990s. If this were the case then northern Ghawar would already be dead, in which case, how did the Saudis manage to produce at 10 million bpd in 2004 and 2005?

The Base Case and High Case reserves estimates shown in Tables 1 and 2 show updated estimates for Uthmaniyah and are now based on a 2002 assumption for the Linux map.

Base Case	Initial STOIP	Initial Reserves	2002 STOIP	2002 Reserves	% depleted	Produced
N Ain Dar	20.4	12.1	2.51	1.49	88	10.6
S Ain Dar	16.4	9.69	2.78	1.65	83	8.04
Shedgum	21.1	11.3	9.58	5.14	55	6.15
Uthmaniyah	54.4	36.6	9.67	6.50	82	30.1
Haradh	29.7	13.4	18.7	8.42	37	4.96
Hawiyah	30.6	13.8	24.7	11.1	19	2.62
<b>Totals</b>	<b>173</b>	<b>96.8</b>	<b>68.0</b>	<b>34.3</b>	<b>65</b>	<b>62.5</b>

**Table 1** Base Case reserves estimates for Ghawar oil field in 2002, Saudi Arabia. All figures in billions of barrels.

High Case	Initial STOIP	Initial Reserves	2002 STOIP	2002 Reserves	% depleted	Produced
N Ain Dar	20.4	14.3	3.14	2.21	85	12.1
S Ain Dar	16.4	11.5	3.48	2.45	79	9.06
Shedgum	21.1	13.4	12.0	7.62	43	5.78
Uthmaniyah	54.4	43.4	9.67	7.48	83	36.0
Haradh	29.7	15.8	18.7	9.90	37	5.86
Hawiyah	30.6	16.2	24.7	13.1	19	3.09
<b>Totals</b>	<b>173</b>	<b>115</b>	<b>71.7</b>	<b>42.8</b>	<b>63</b>	<b>71.9</b>

**Table 2** High Case reserves estimates for Ghawar oil field in 2002, Saudi Arabia. All figures in billions of barrels.

## Adjustments from 2002 to 2006

One flaw in my earlier post was that the reserves estimates were based on a 2004 assumption and I made no attempt to update these to 2006. The new 2002 based estimates have now been updated to 2006 by accounting for 4 years production at 5 million bpd as shown in Tables 3 and 4.

Base Case	Initial STOIP	Initial Reserves	2006 STOIP	2006 Reserves	% depleted	Produced
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N Ain Dar	20.4	12.1		0.76	94	11.3
S Ain Dar	16.4	9.69		0.92	91	8.8
Shedgum	21.1	11.3		3.7	67	7.6
Uthmaniyah	54.4	36.6		4.3	88	32.3
Haradh	29.7	13.4		7.1	47	6.3
Hawiyah	30.6	13.8		10.3	25	3.5
<b>Totals</b>	<b>173</b>	<b>96.8</b>		<b>27.0</b>	<b>72</b>	<b>69.8</b>

**Table 3** Base Case reserves estimates for Ghawar oil field in 2006, Saudi Arabia. These are the figures presented in Table 1 adjusted for 4 years production at 5 million barrels per day. All figures in billions of barrels.

High Case	Initial STOIP	Initial Reserves	2006 STOIP	2006 Reserves	% depleted	Produced
N Ain Dar	20.4	14.3		1.5	90	12.9
S Ain Dar	16.4	11.5		1.72	85	9.79
Shedgum	21.1	13.4		6.16	54	7.24
Uthmaniyah	54.4	43.4		5.29	88	38.2
Haradh	29.7	15.8		8.59	46	7.17
Hawiyah	30.6	16.2		12.2	25	3.96
<b>Totals</b>	<b>173</b>	<b>115</b>		<b>35.5</b>	<b>69</b>	<b>79.2</b>

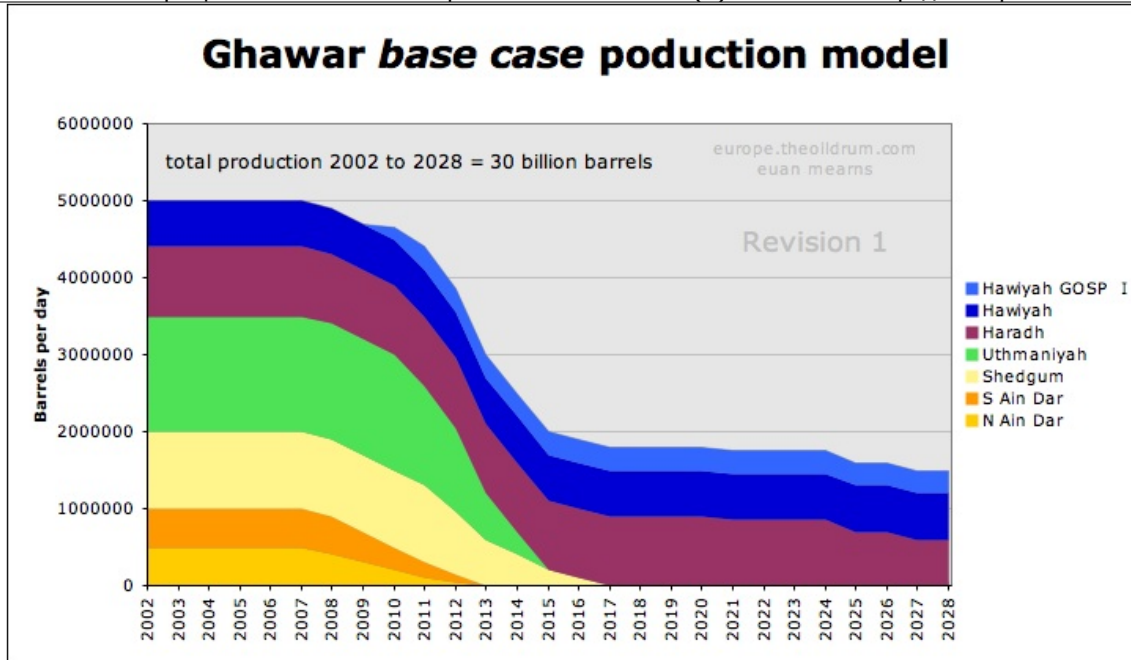
**Table 4** High Case reserves estimates for Ghawar oil field in 2006, Saudi Arabia. These are the figures presented in Table 2 adjusted for 4 years production at 5 million barrels per day. All figures in billions of barrels.

## Hawiyah

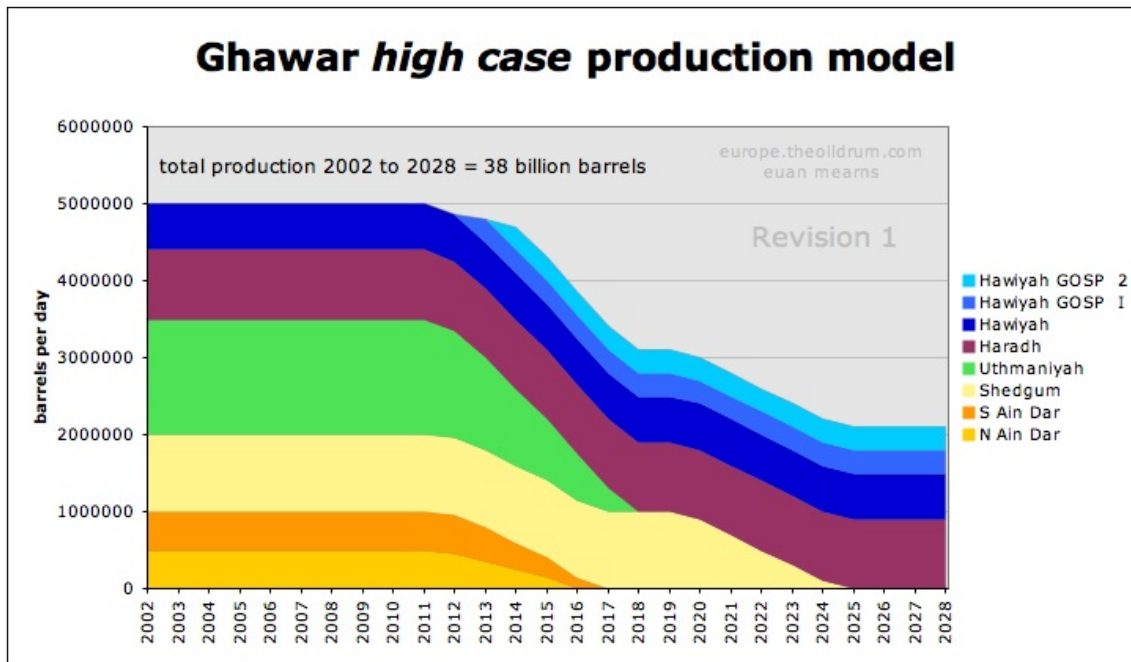
The discussion about high initial water saturations and SuperK problems in Hawiyah leaves me less certain about eventual recovery of oil from this region. In my revised production forecast (below) I have therefore reduced the anticipated expansion of this area by one GOSP (300,000 bpd) in the Base Case and High Case scenarios.

**Bunyonhead** also pointed to **natural gas liquids production from Hawiyah** that is most probably coming from the Permian Khuff formation. The report on this is a bit equivocal and it is not clear whether natural gas liquid (which is petroleum) or liquefied natural gas (LNG) is being produced. So I have left this Hawiyah “NGL” production off the forecast for the time being.

A revised spreadsheet (rev1) can be downloaded [here](#).



Base Case production scenario up-dated for revisions presented here. This places Ghawar on the cusp of production decline in 2007.



High Case production scenario up-dated for revisions presented here.

**In summary:**

Estimate of initial oil in place = 173 billion barrels (same for High and Base cases)

**High Case** Produced oil = 79 billion barrels  
 2006 reserves = 36 billion barrels 69% depleted

**Base Case** Produced oil = 70 billion barrels  
2006 reserves = 27 billion barrels 72% depleted

It needs to be noted that these relatively minor adjustments I have made here have a fairly dramatic effect on the reserves prognosis and state of depletion of Ghawar.

It needs also to be noted that I documented 4 areas of possible reserves underestimation in my original post and these still stand.



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