

The background of the slide is a composite image. The upper portion shows an oil field with several derrick structures silhouetted against a vibrant sunset sky of orange, red, and purple. The lower portion shows the silhouettes of a camel caravan with riders and a person leading a camel, set against a bright sun on the horizon.

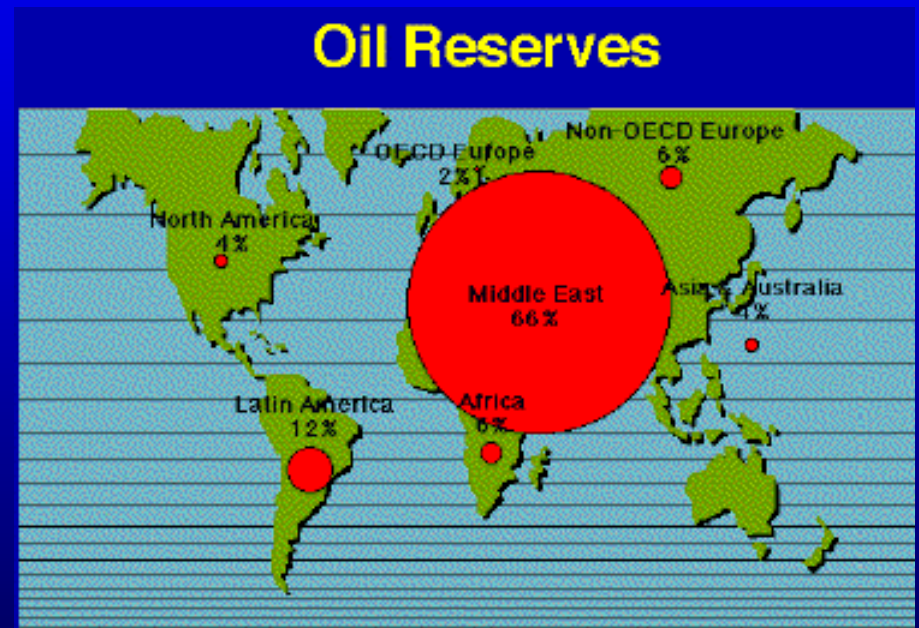
*Twilight In The Desert:
The Fading Of
Saudi Arabia's Oil*

Hudson Institute
September 9, 2004
Washington, DC

Presented By:
Matthew R. Simmons

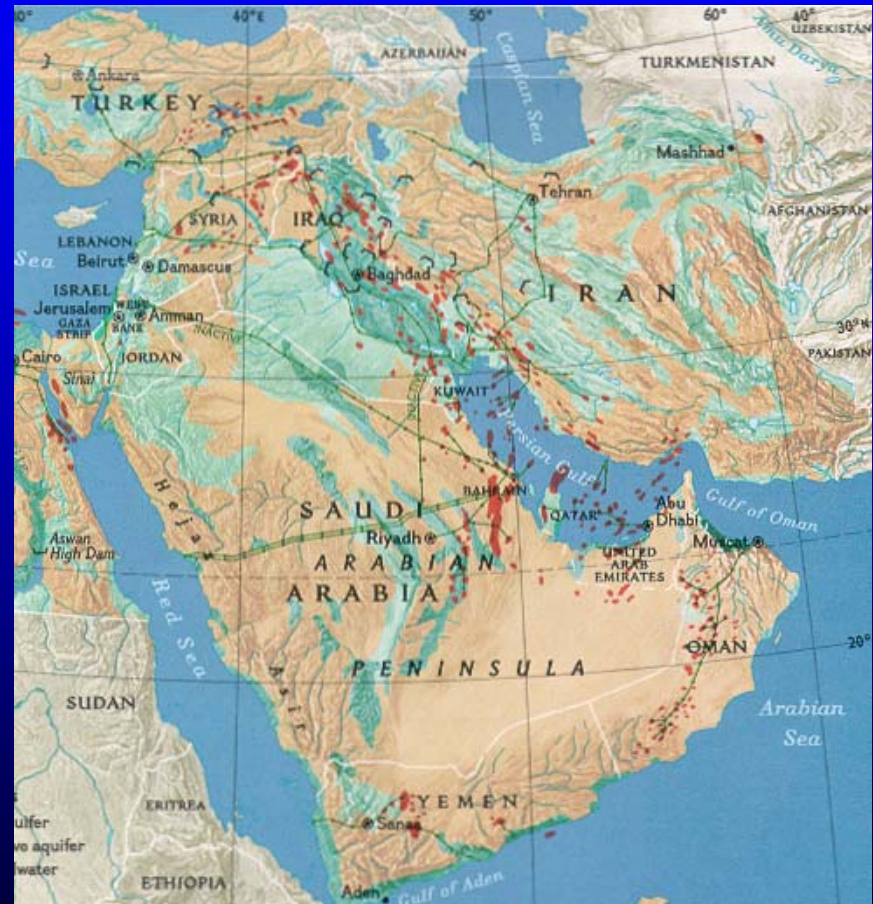
Conventional Energy Wisdom: Middle East Oil Is Limitless

- All long-term oil supply/demand models assume Middle East oil can grow as fast as oil demand rises.
- Middle East oil will also be “cheap”.
- If more is needed, drill anywhere.



Saudi Arabia Is The Middle East's Oil King

- Energy planners' assumption:
 - Saudi Arabia can produce 10, 15, 20 or even 25 million barrels per day.
- Common belief:
 - More oil can easily be found;
 - Many discovered but yet to be produced fields are waiting in the wings.



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Saudi Arabia Is World's "Oil Cornerstone"

- World's top oil exporter.
- 25% of world's reported proved reserves.
- Lowest cost oil producer.
- Only significant provider of spare daily capacity.
- No other oil producer could begin to replace a Saudi Arabian oil shortfall.



This Middle East Energy Belief Is An Illusion

- Middle East oil is NOT “everywhere”.
- Few giant oilfields were found after mid-1960s.
- Many giant producers are nearly depleted.



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Even Saudi Arabia's Great Oil Resources Are Scarce

- Seven key fields produce 90%+ of Saudi Arabia's oil.
- Average "life" of this produced oil is 45 to 50 years.
- The sweet spots of these fields are almost depleted.

<u>Field</u>	<u>1994 Production (B/D)</u>
Ghawar	5,000,000
Safaniya	960,000
Abqaiq	650,000
Berri	400,000
Zuluf	500,000
Marjan	400,000
Abu Sa'fah	<u>150,000*</u>
Total	<u>8,060,000</u>

*Approximate

Saudi Arabia's Oil Endowment Was Tightly Bunched

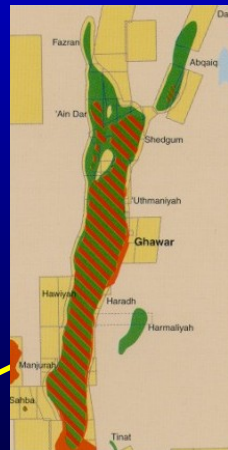
■ The northern sandstone complex:

- Safinaya
- Zuluf
- Marjan



■ The three great carbonate fields:

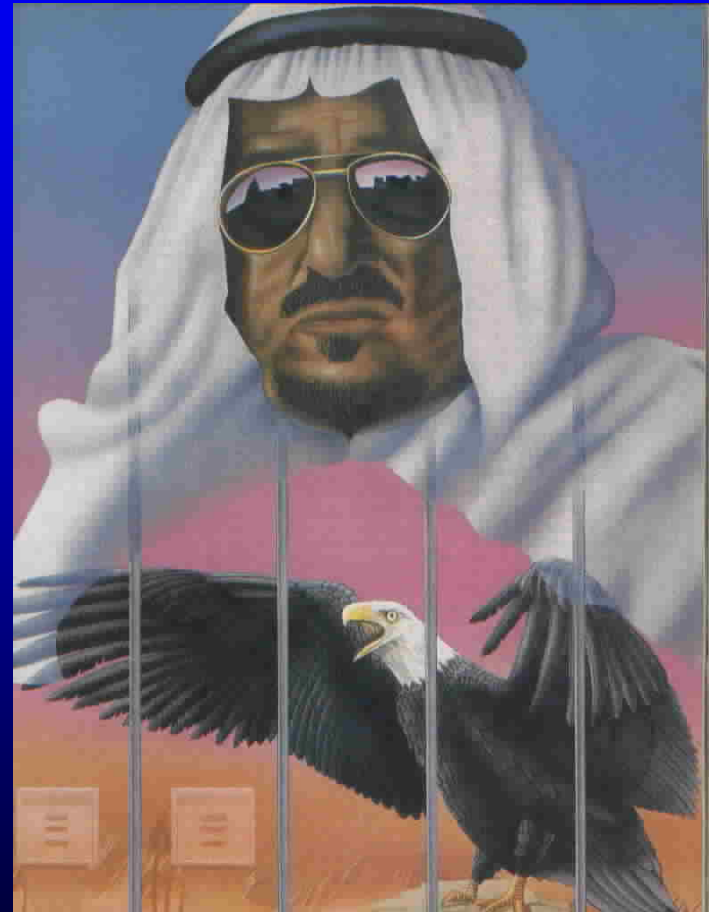
- Ghawar's 'Ain Dar, Shedgum and North Uthmaniyah
- Abqaiq
- Berri



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Saudi Arabia's Real Oil Story Is Shrouded In Secrecy

- The key secrets:
 - How much oil is produced?
 - How much spare capacity really exists?
 - How many proven reserves are really proven?
 - What are the production volumes of each field?
 - What is the average well productivity?
 - What will the decline by field be?



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Experts Cannot Even Agree On Historical Production

(Thousands of barrels per day)

	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>	<u>2003</u>
<u>Various Reports</u>					
Saudi Aramco ¹	7,274	7,779	7,571	6,792	8,103
OPEC	7,565	8,095	7,819	7,093	8,410
IEA	7,780	8,280	7,985	7,650	8,785
BP	8,694	9,297	8,992	8,664	9,817
EIA/DOE	7,833	8,404	8,031	7,634	8,848
Variance ¹	1,129	1,202	1,173	1,571	1,407

¹ Excludes 50% of empty quarter (rest included).

How Real Are Saudi Arabia's Proven Reserves?

Reported Numbers (Billions of barrels)

<u>Year</u>	
1978	108
1983	169
1984	172
1985	172
1986	170
1987	170
1988	255
1989	260
1990	260
1995	261
2000	263
2003	263

- “We used technology to better understand how conservative our estimates had been.”
- “Our 260 billion reported reserves understate the true number.”

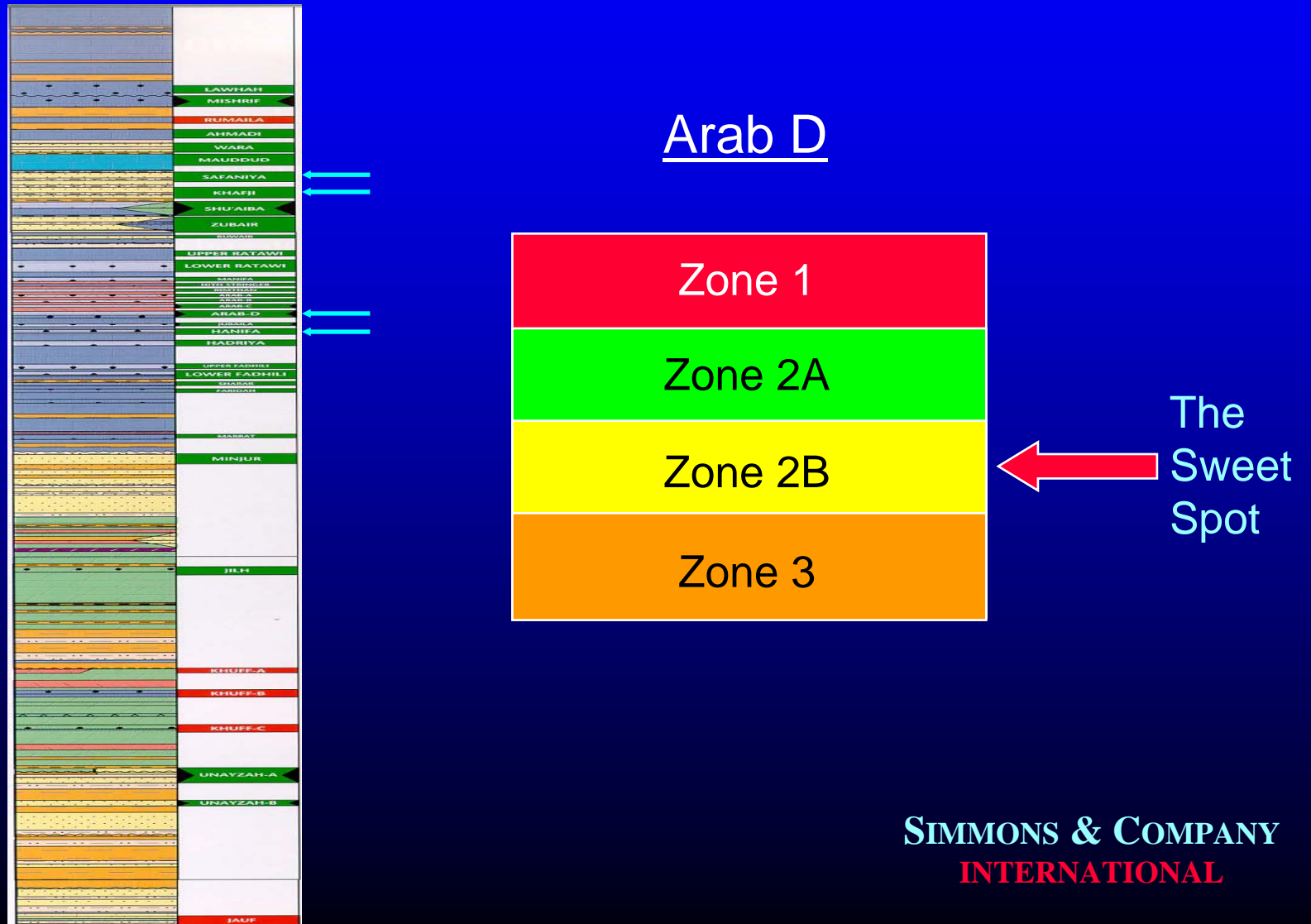
The reported reserve jump from 108 billion to 169 billion came in 1979. The increase to 255 billion came in 1988.

Why I Worry About Saudi Arabia's Oil



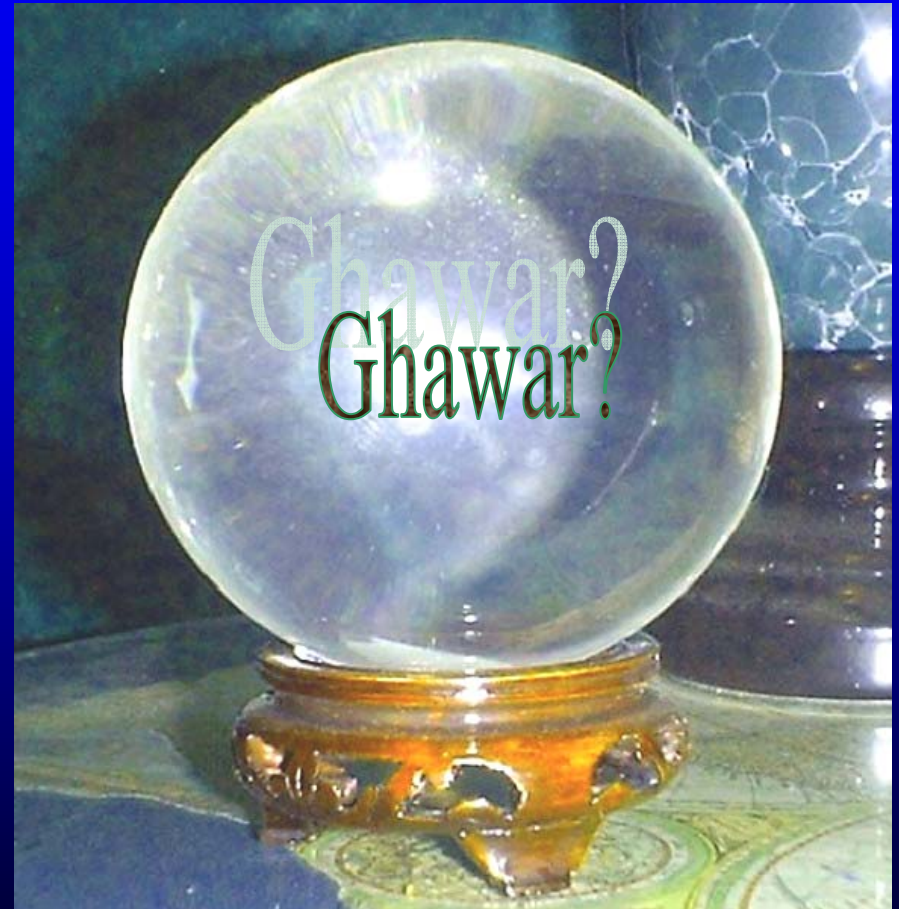
- Lack of “good” OPEC data for all producers is alarming.
- No solid data on any aspect of Saudi Arabia’s oil.
- “Trust me” is Saudi Arabia’s only “proof”.
- Analysis of over 200 SPE papers on Saudi Arabian oil is troubling.

Saudi Arabia's Great Reservoirs Are Sparse



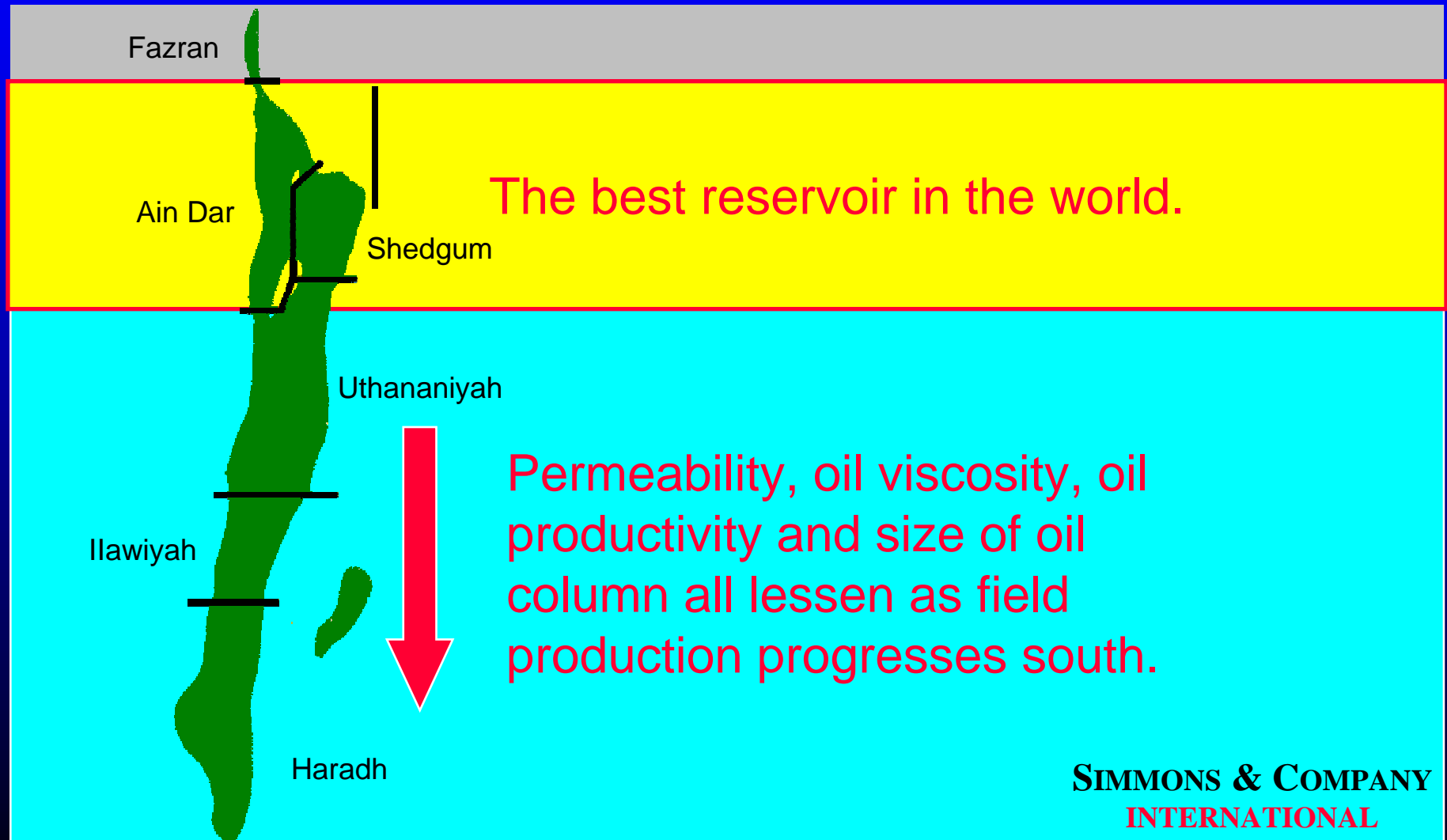
Ghawar's Fate Underpins The World's Future Oil Supply

- Ghawar has provided 55% to 65% of all Saudi Arabian oil from 1951 through 2004.
- When Ghawar's oil output declines, Saudi Arabia's output will have peaked.
- The world's oil output will have likely peaked, too.
- Could peaking be "near at hand"?



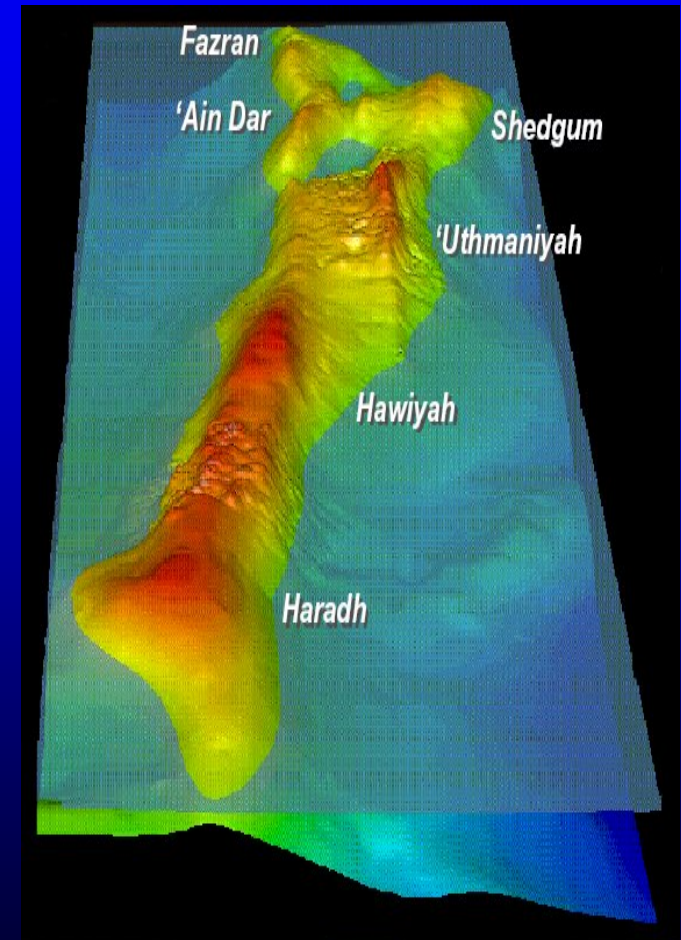
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Ghawar: An Enormous Structure Of Varied Quality



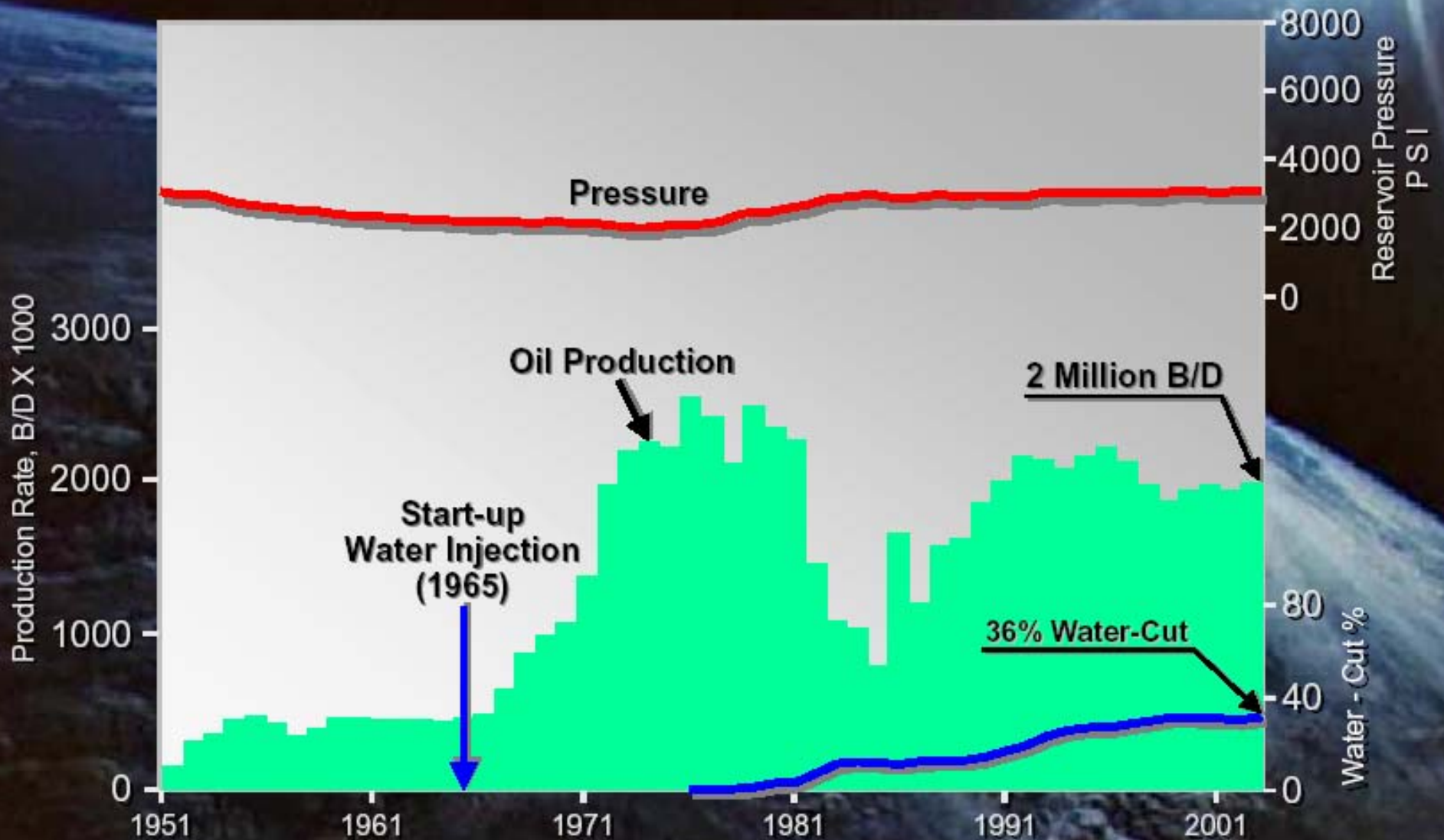
Ghawar Will Eventually Lose Its Reservoir Pressure

- When Ghawar's reservoir pressure drops:
 - Water problems accelerate.
 - High productivity well output ends.
 - There will be massive amounts of “oil left behind”.
- The “Ghawar Facts” highlight this vulnerability.
- If Ghawar experiences significant production declines, Saudi Arabia's oil output will have peaked.



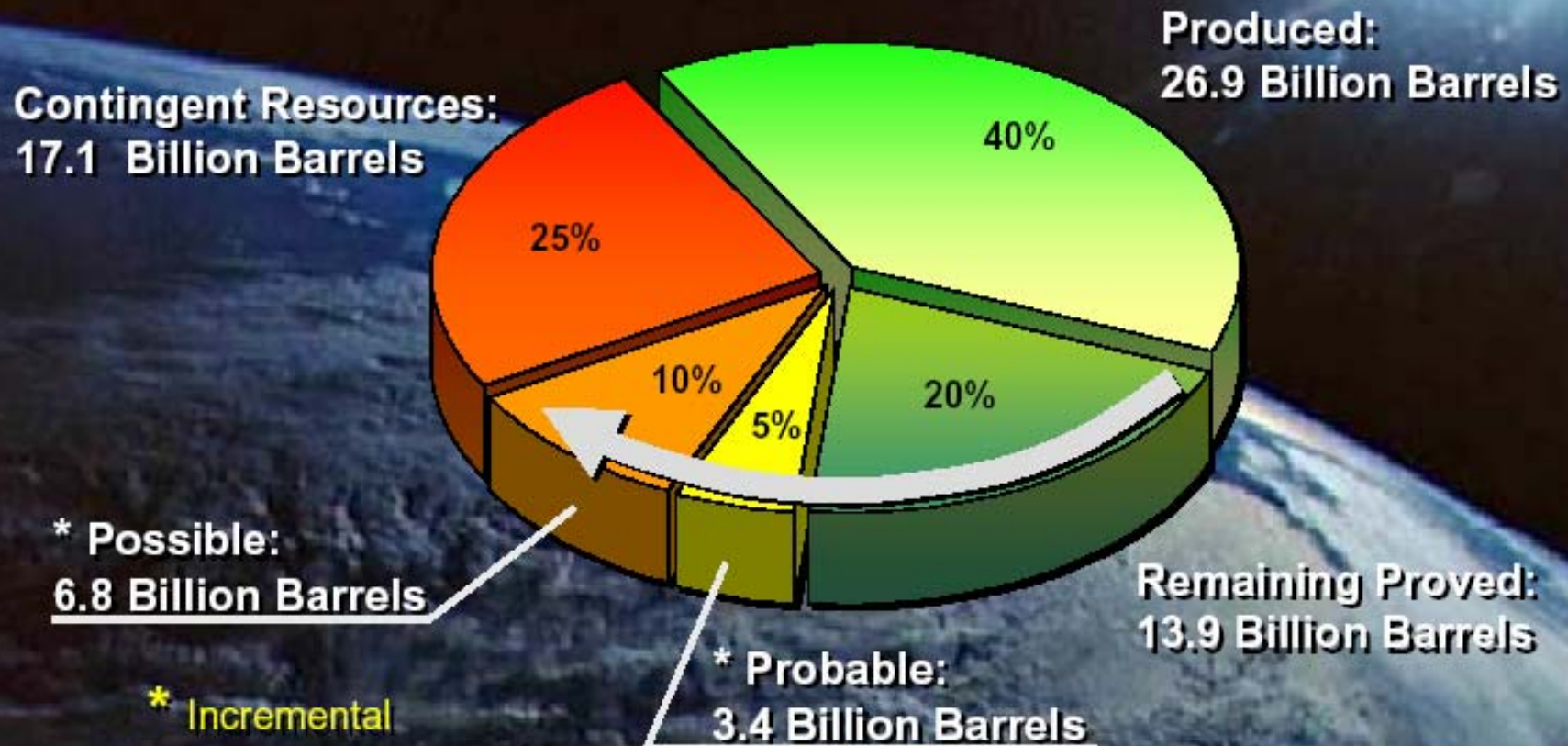
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'Ain Dar/Shedgum Area Arab D Production History



Source: "Fifty Year Crude Oil Supply Scenarios: Saudi Arabia's Perspective", Saudi Aramco, February 2004.

'Ain Dar/Shedgum Area / Arab D Resources Depletion State (1/1/2004)



OIP: 68.1 Billion Barrels

Proved Reserves: 40.8 Billion Barrels (60% of OIP)

Estimated Ultimate Recovery: 51 Billion Barrels (75% of OIP)

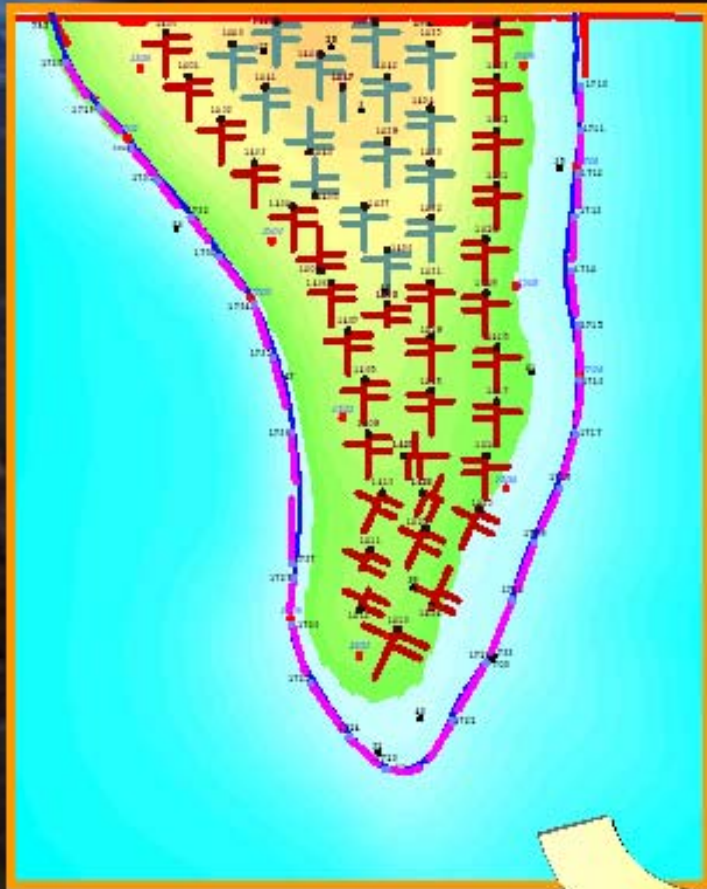
Ghawar Field

Water Management

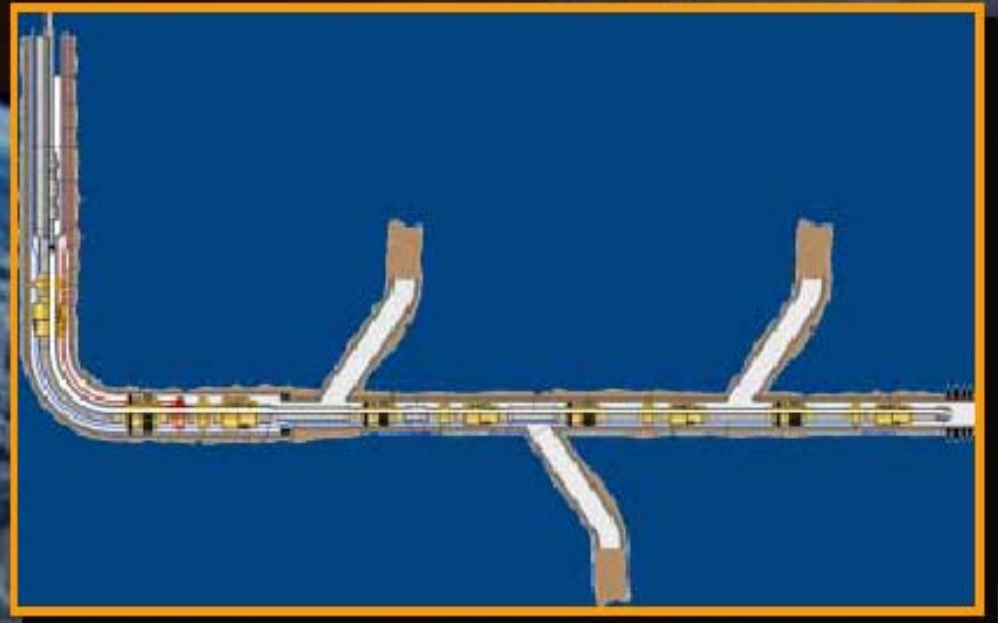


Source: "Fifty Year Crude Oil Supply Scenarios: Saudi Arabia's Perspective", Saudi Aramco, February 2004.

e-Field/Smart Wells Haradh Increment III

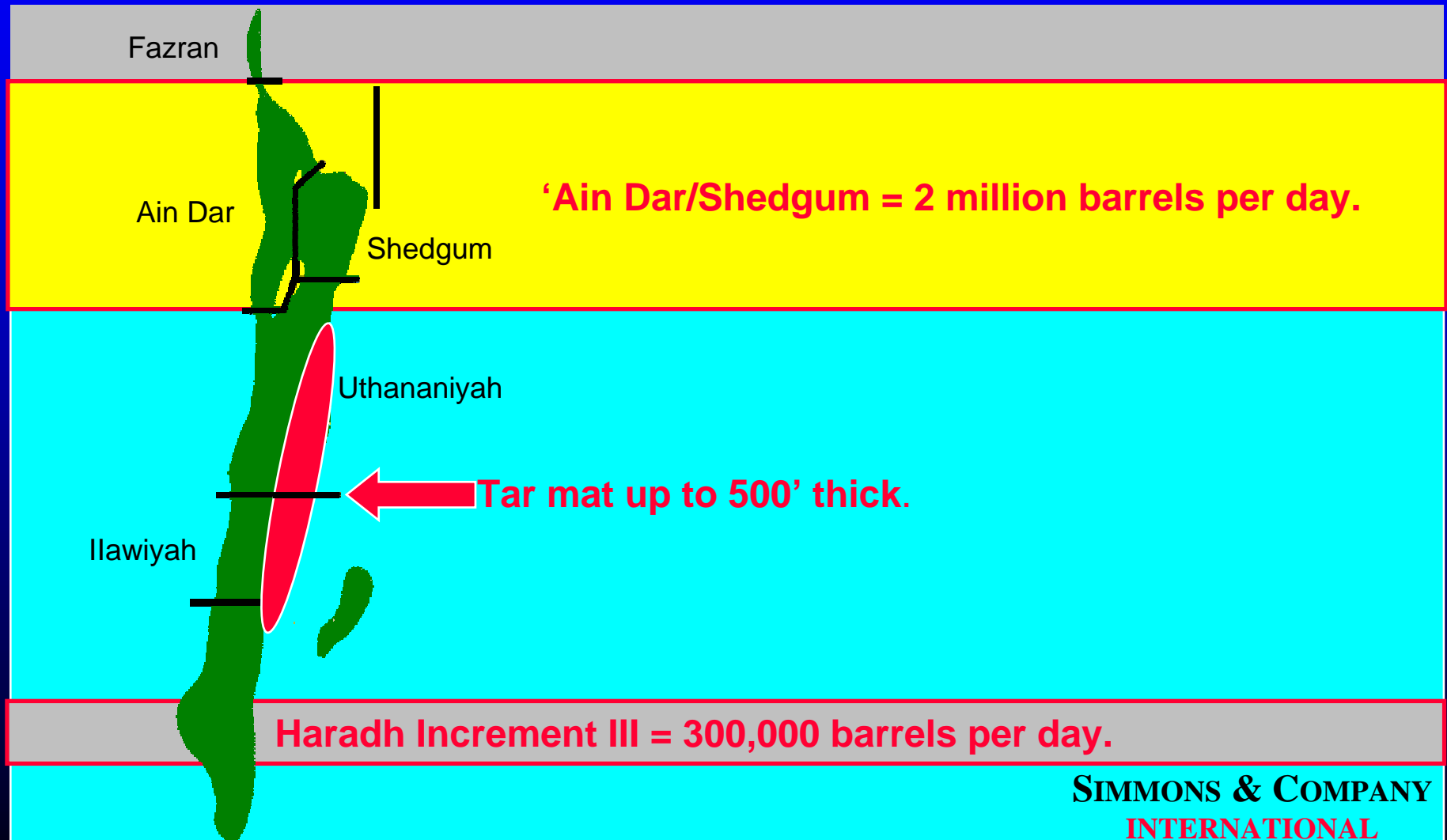


Quad-Lateral Smart Completion



Onstream: July 2006
Rate: 300,000 B/D
Plateau: 30 Years
Depletion: 1.7% per Year

Nobody Saves The Best For Last



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The Other Key Fields Are All “Mature”

- Abqaiq’s key producing areas are now “pockets” of by-passed oil.
- Berri appears headed for a “gas blow down”.
- Safaniya/Zuluf/Marjan are losing their great water aquifer and are all old, too.
- Shaybah is a very complex to produce reservoir.
- Hawtah Trend was contaminated by injected water.

Rewards And Risks Of Water Injection During Primary Depletion

- Saudi Arabia's aggressive use of water management has kept its prime reservoir pressures high.
- This led to extremely high flow rates.
- Well productivity has been steadily declining.
- Extended reach, multilateral wells/intelligent wells are finishing the primary/secondary sweep.
- Once it is over, tertiary recovery is "the next step".

Tertiary Recovery Can Still Recover Oil

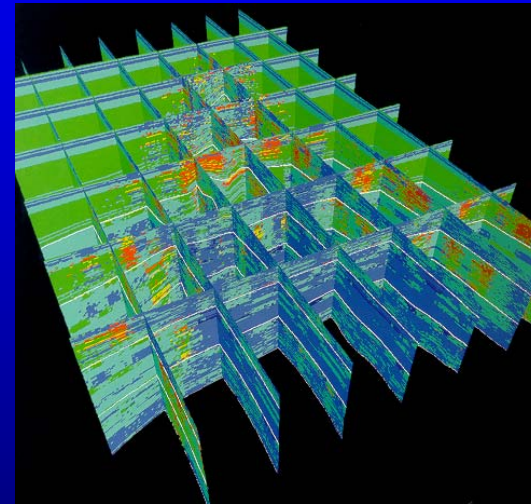
- When water injection/water drive ends, there will still be billions of barrels of oil left behind.
- Artificial lift/tertiary recovery can extract billions of barrels of oil, BUT.....
 - Development wells need to grow exponentially.
 - Most fluid produced will be water, not oil.
 - Costs to extract become very high.



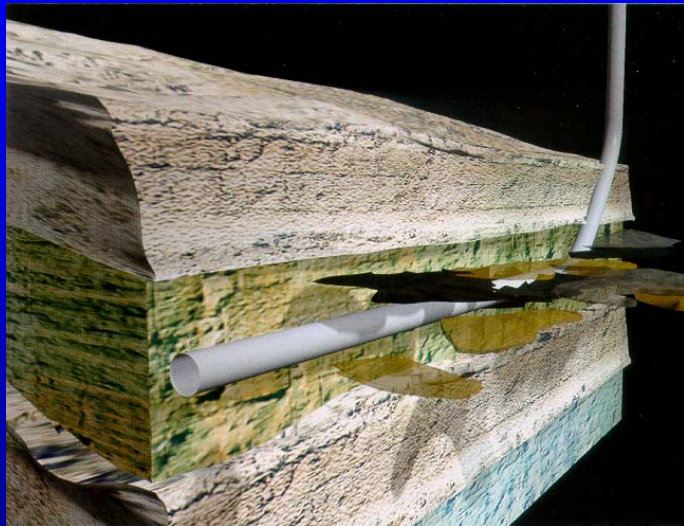
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Is Technology The Solution Or The Problem?

- Advanced oilfield technology is keeping well productivity high.
- Is this sustainable?
- Will far more oil in place be recovered?
- Or is this technology accelerating the last easily produced oil?
- This is the core issue.



Vertical Wells In Saudi Arabia Are Now Obsolete



- By late 1990s, vertical production wells watered up too fast.
- 2nd generation wells: Extended reach horizontal wells.
- 3rd generation wells: Maximum reservoir contact (“MRC”) wells.
- 4th generation wells: Intelligent well completions (automatic water shutoff valves).
- This is how rising water cut was “solved”.

Saudi Aramco's "New Projects" Are Extremely Complex

- Qatif will be a key test: Can it produce 500,000 barrels per day for any time (let alone 30 years)?
 - Discovered in 1945.
 - Field was converted into naphtha storage cavern in 1977.
 - High percent of H₂S.
- Abu Sa'fah will use massive numbers of ESP.

These New Projects Are Designed To Offset Depletion

- Qatif and Abu Sa'fah's anticipated 800,000 barrels per day were announced as merely offsetting normal production declines in certain mature oilfields. (December 2003)
- If true, this makes real decline problems far greater than 2004 claims have been.

Future Field Development Becomes More Challenging

- Khurais has been a problem field for 40 years.
- Over 90 wells had tried to get oil to flow properly.
- Perhaps advanced technology will finally solve this riddle.
- Between Khurais and Manifa lie 41 billion barrels of Saudi Arabia's proved reserves.

Are There Vast Areas Yet To Be Explored?

- Saudi Aramco has employed state-of-the-art geophysical tools to find new oil sources.
- So far, the only commercial success was in Hawtah Trend (200,000 barrels per day of extra light oil).
- The remaining unexplored areas:
 - Iraq's southern border.
 - Deepwater Red Sea.
 - Bottom end of Empty Quarter.



How Real Are My Worries?

- 200+ technical papers do not exaggerate.
- Paper trail of challenges/problems has exponentially grown.
- Most alarming technical papers were presented in last 12 months.
- Not one single paper condemns the Kingdom's resources.
- Viewed as a whole, the papers create a forensic pathology of Saudi Arabia's oil system.

Saudi Aramco's Response To My Concerns

- Current oil output can reach 10.5 million barrels per day.
- “Original oil in place” has grown by 20% in 20 years.
- Proven oil reserves are a conservative 260 billion barrels.
- There are still 200 billion barrels of undiscovered oil.
- Finding and development costs are “incidental” (\$0.50 per barrel).
- Saudi Aramco's use of new oilfield technologies is exemplary.
- The Kingdom can safely produce 10 to 15 million barrels per day for the next 50 years.

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Could Aramco's Claims Be True?



- “We sent our best experts and they proved we have no problems.” (Oil Minister Naimi, Washington, D.C., April 2004)
- “SPE papers only deal with problems, not all the good news.” (Dr. Nansen Saleri, Washington, D.C., February 2004)
- Saudi Aramco and Saudi Petroleum Ministry have released vast amounts of “new data”.
 - To some, it proves “no problems”.
 - To others, it reinforces my concerns.

What Aramco's Top Experts Really Said

- If all the new information revealed is studied, problems are real.
- Their “50-year belief” is simply more “Trust us. We delivered for 70 years and can do it again.”
- Trust me, the world's most important energy supply is insufficient for comfort.
- TRUST but VERIFY is the only solution.

It Is Time For Genuine New Era Of Real Transparency

- If Saudi Arabia's oil miracle begins to fade, world has no "Plan B" prepared.
- Any key supplier needs to insure its customers both reliability and durability.
- The solution: Timely field-by-field verified data.
 - Historical production.
 - Average wellbores.
 - Three reserve data points (latest estimates).
 - Original oil in place.
 - Ultimate recoverable reserves.
 - Cumulative production.



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Can Reform Happen? Is It Too Late?

- Secrecy has been an OPEC mantra for two decades.
- All stakeholders need to insist on changing this culture.
- Saudi Arabia has advocated better energy transparency.
- This is their time to lead!
- If data confirms supply worries, did reform come too late?
- “Plan B” will take time.



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