



Saudi Arabian Oil: *A Glass Half Full Or Half Empty?*

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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.



Saudi Arabia Has Been A Gold Standard Oil Steward

- Once U.S.'s oil output peaked, Saudi Arabia inherited mantle as world's oil steward.
- Saudi Arabia's track record has been exceptional.
 - 70 years of outstanding performance.
 - Long-term advocate for “fair pricing” between consumers and producers.
 - Passionate belief in need for “spare capacity cushion”.



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Why I Worry About Saudi Arabia's Oil



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

The Specifics Underpinning My Worries

- 5 to 7 oilfields produce 90% to 95% of Saudi oil output.
- “King of Kings: Ghawar” accounts for 60% of output.
- All but two key fields are extremely old.
- Intense water drive/water injection masks normal depletion.
- Unannounced, high reservoir pressures will end.
- Intense exploration failed to find much added oil.
- Lack of verified data leaves the world in the dark.

Saudi Aramco's Response To My Concerns

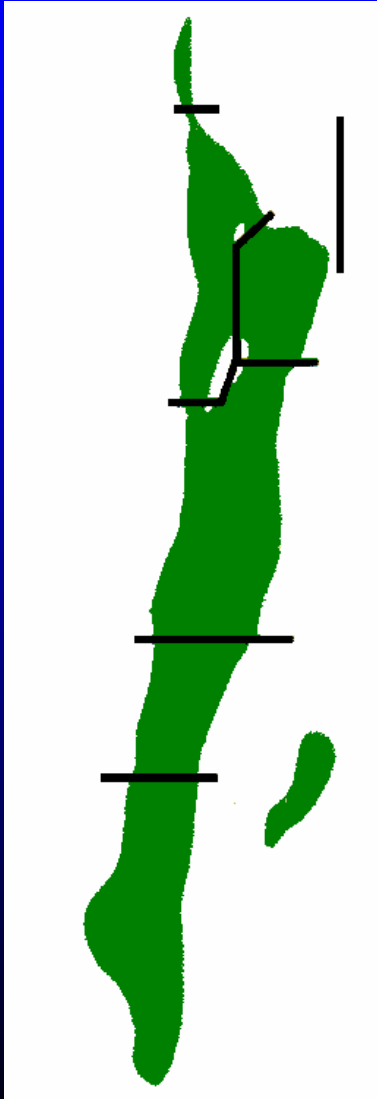
- Current oil output can reach 10.5 million barrels per day.
- “Original oil in place” has grown by 20% in 20 years.
- Proven oil reserves are a conservative 260 billion barrels.
- There is still 200 billion of undiscovered oil.
- Finding and development costs are “incidental” (\$0.50 per barrel).
- 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 These 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 If Ghawar Finally Loses Reservoir Pressure?



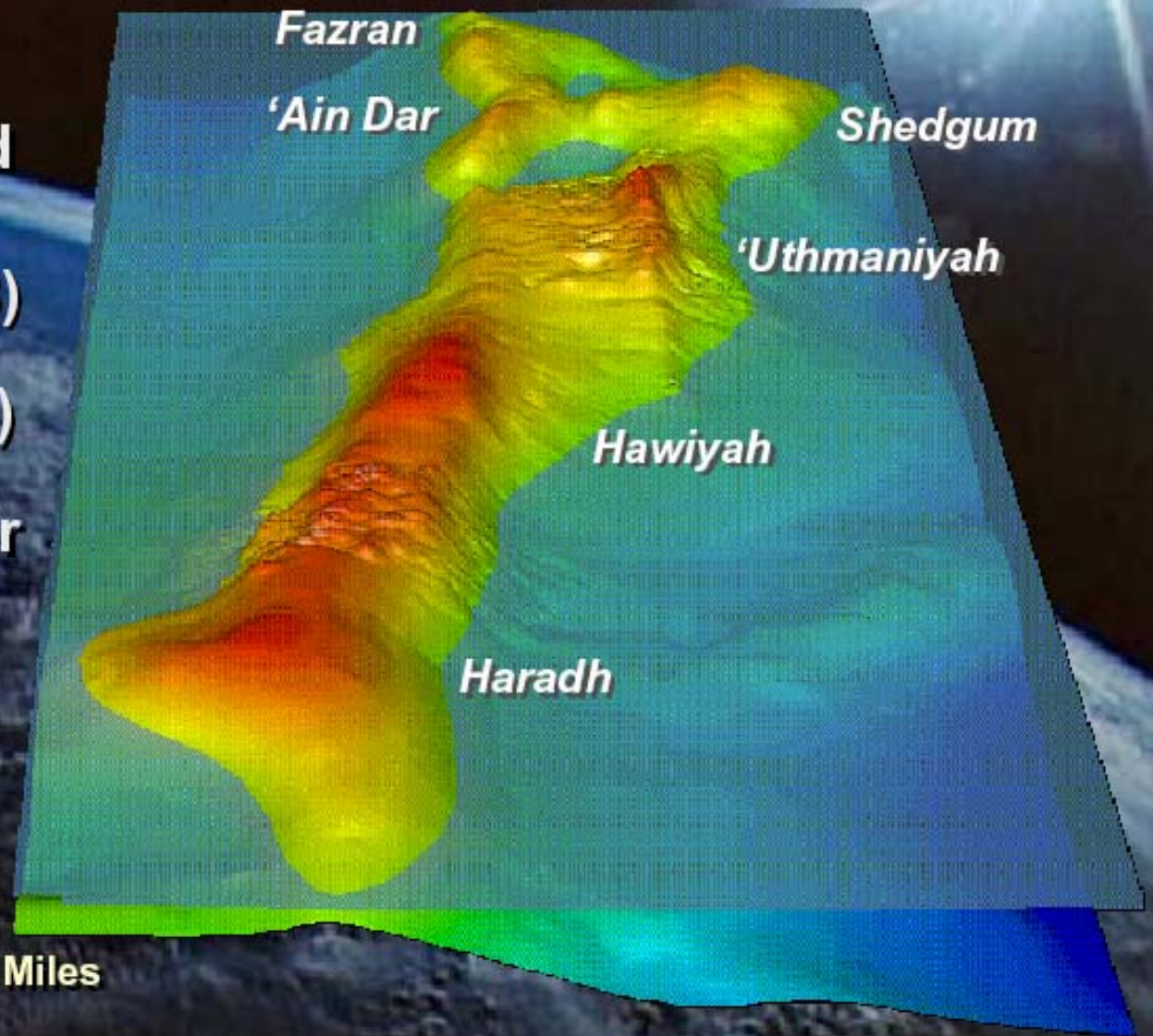
- If Ghawar finally sees its reservoir pressure drop:
 - Water problems accelerate.
 - High productivity well output ends.
 - There will be massive amounts of “oil left behind”.
- The “Ghawar Facts” highlight this vulnerability.
- If Ghawar experiences significant production declines, Saudi Arabia’s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

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Ghawar Field

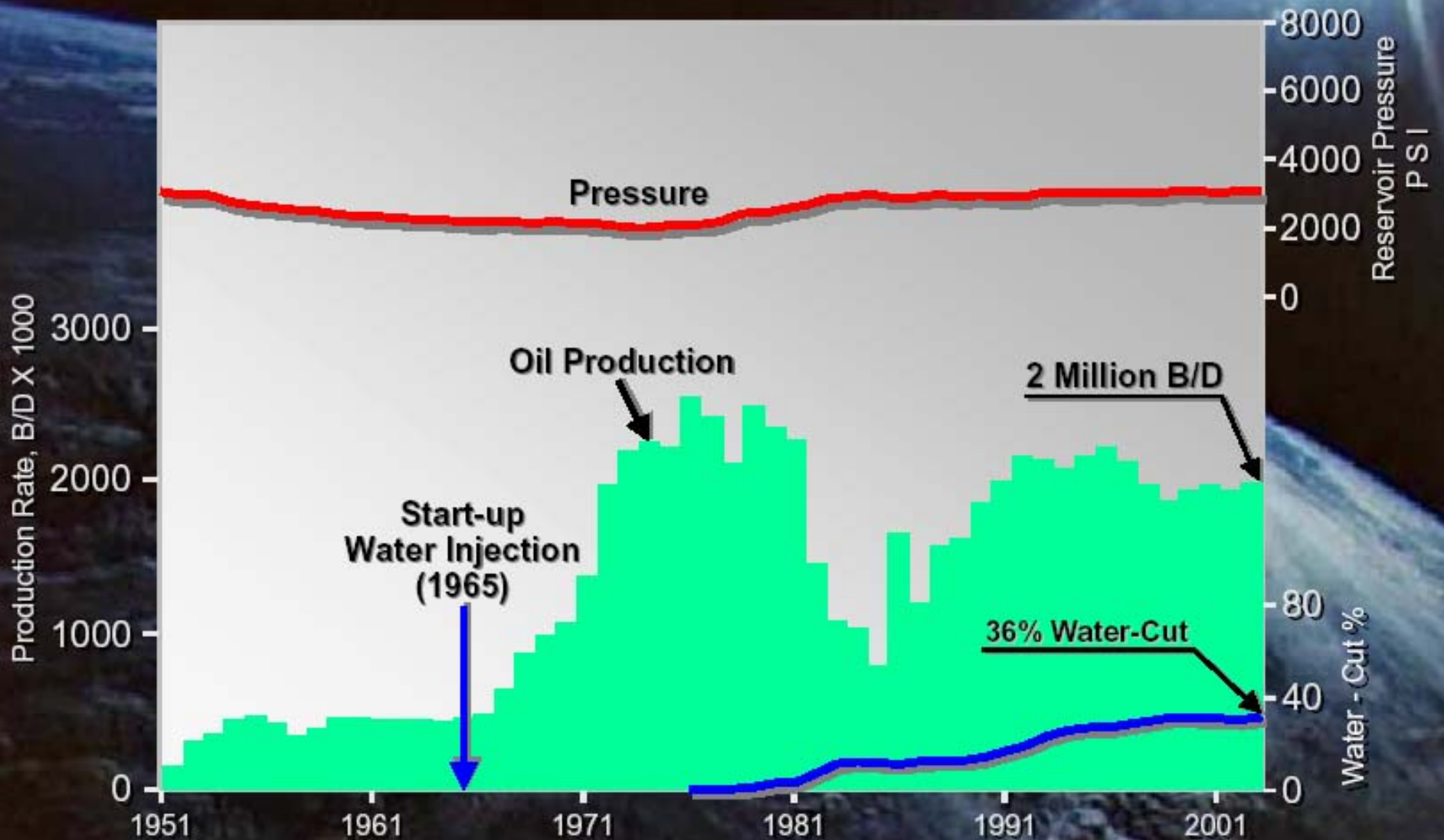
The Super Giant

- Largest Oil Field in the World
- Discovery (1948)
- Onstream (1951)
- Peripheral Water Injection (1965)



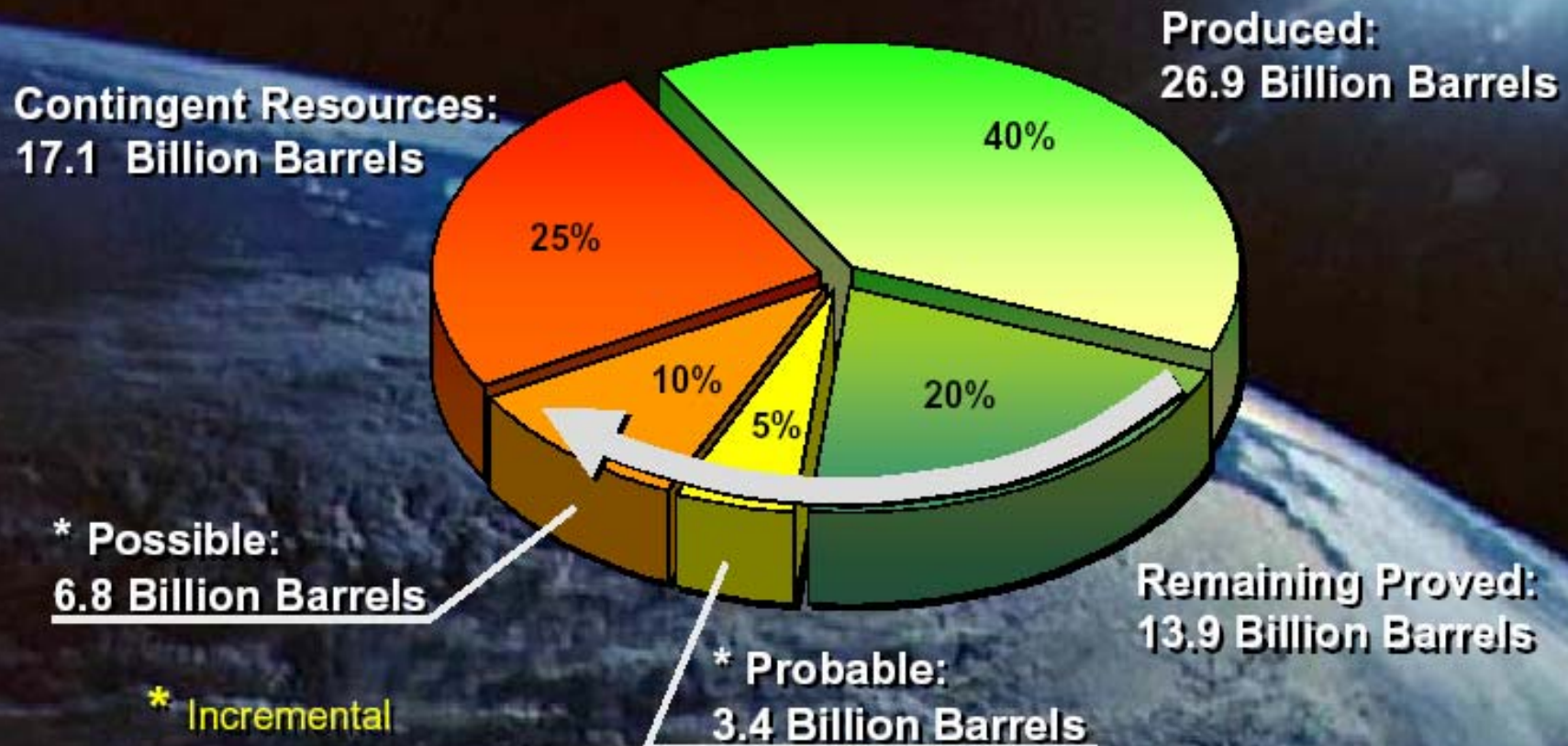
Area Size: 174 Miles x 16 Miles

'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)

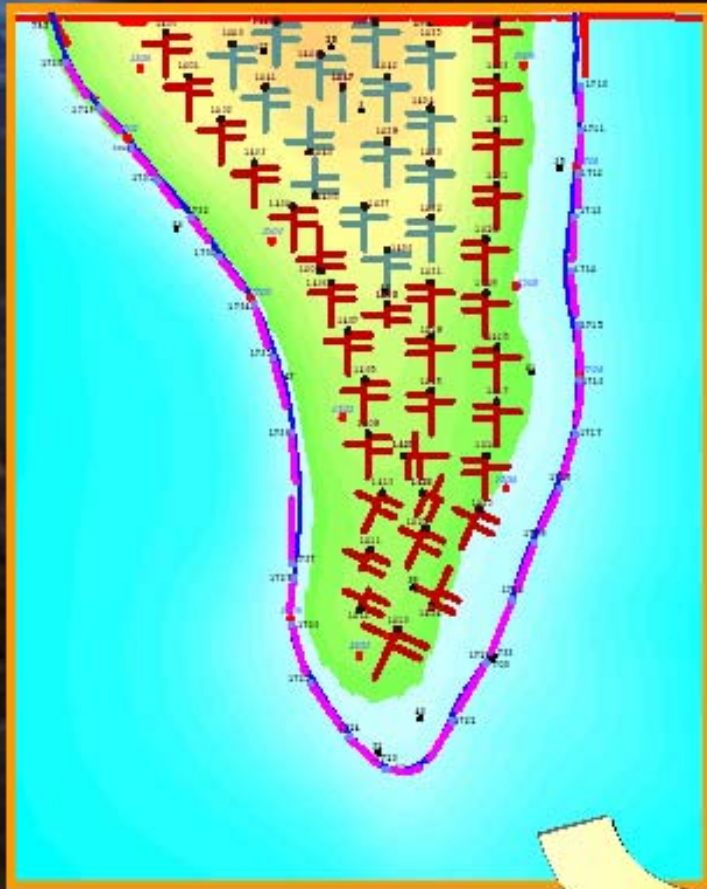
Ghawar Field

Water Management

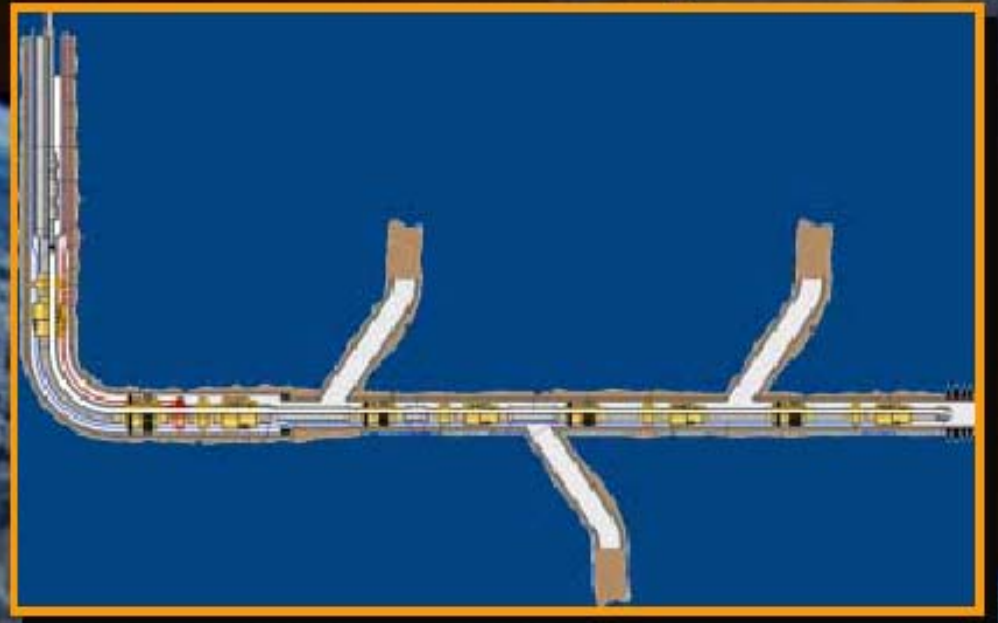


Source: "Fifty Year Crude Oil Supply Scenarios: Saudi Arabia's Perspective", Saudi Aramco, February 2004.

e-Field/Smart Wells Haradh Increment III



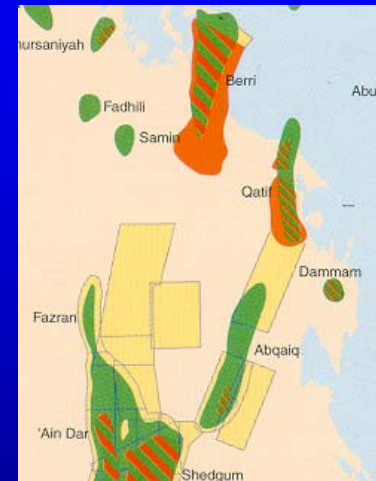
Quad-Lateral Smart Completion



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

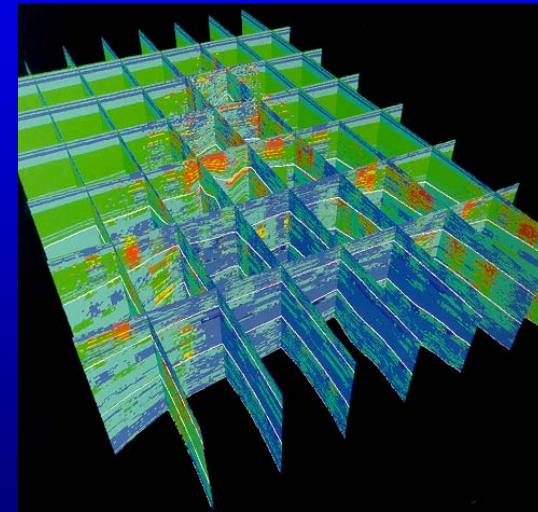
Aging Issues Are Worse At Other Key Fields

- Abqaiq had recovered 73% of its total oil in place at December 2003.
- Berri is about to become a gas field (though it only recovered 28% of its oil in place).
- Safaniya/Zuluf/Marjan face water aquifer depletion risk and major sand problems.
- Corrosion is key issue at all key fields.

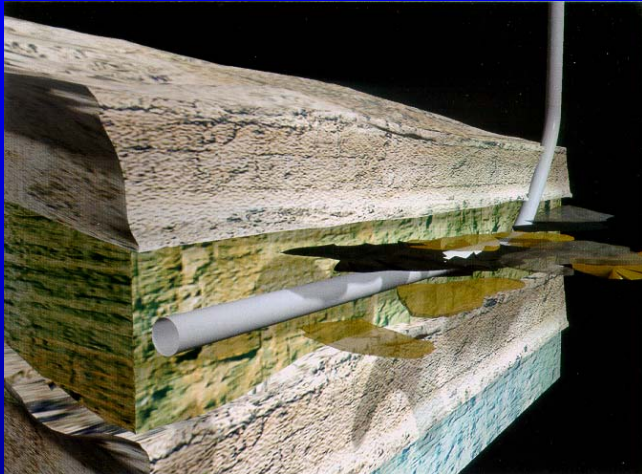


Is Technology The Solution Or The Problem?

- 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 shut off 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)?
 - Discovery was 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 puts real decline problems far higher than 2004 claims have been.

Future Field Development Gets 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 are 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.



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Is The IFP's "Royal Family Of Hydrocarbon" Theory Correct?

- Thesis: In first decade you find the "Queen" and "King" in all great hydrocarbon basins. In the next decade, you find the 6 to 10 "Lords".

- Saudi Arabia's experience:

| | | |
|-------------|------|---------|
| – Abqaiq: | 1940 | Queen |
| – Ghawar: | 1948 | King |
| – Safaniya: | 1951 | Queen |
| – Berri: | 1965 | } Lords |
| – Zuluf: | 1964 | |
| – Marjan: | 1967 | |
| – Shaybah: | 1968 | |

What If Aramco's 1975 Reserve Estimates Were Correct?



- At end of 1975, Aramco was managed by Exxon, Mobil, Chevron and Texaco.
- The world's best reservoir experts modeled Aramco's key fields.
- Ghawar's estimated recoverable reserves were 61 billion barrels.
- All fields had 108 billion barrels of oil.
- If these estimates were "correct", the end is in sight.

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 of 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.



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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