TWILIGHT IN THE DESERT

THE COMING SAUDI OIL SHOCK AND THE WORLD ECONOMY

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Boston Committee on Foreign Relations
Boston, MA
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Presented by:
Matthew R. Simmons

Genesis Of The Book

- I studied energy for 34 years.
- And spent decades analyzing energy problems:
  - 1973 Oil Shock
  - 1979 Oil Shock
  - 1982 – 1992 Oil Depression
  - Misunderstanding the post-depression era (1993-2003)
  - Depletion studies (1995+)
  - China's insatiable energy needs (1999)
  - The World's Giant Oilfields (2001)
  - Middle East oil: A mystery; no worthwhile data
  - My visit to Saudi Arabia began to resolve the mystery

For Decades Erroneous Conventional Wisdom Dominated Oil Companies' Behavior

- Early 1970s: No growth in oil demand
- Post 1973: Spiking oil prices
- Post 1979: Oil prices heading toward $100
- Post 1982: "Stay alive 'til 85"
- Post 1986: Oil prices will stay low forever
- We created a 20 – 25 million barrel glut

WRONG!

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Past Decade's Energy Mistakes Grew Even Worse

Conventional Wisdom Mantras: 1990-2000

- Oil demand growth is slowing down.
- New technology is reducing costs and adding far greater supply:

Disruptive Technology

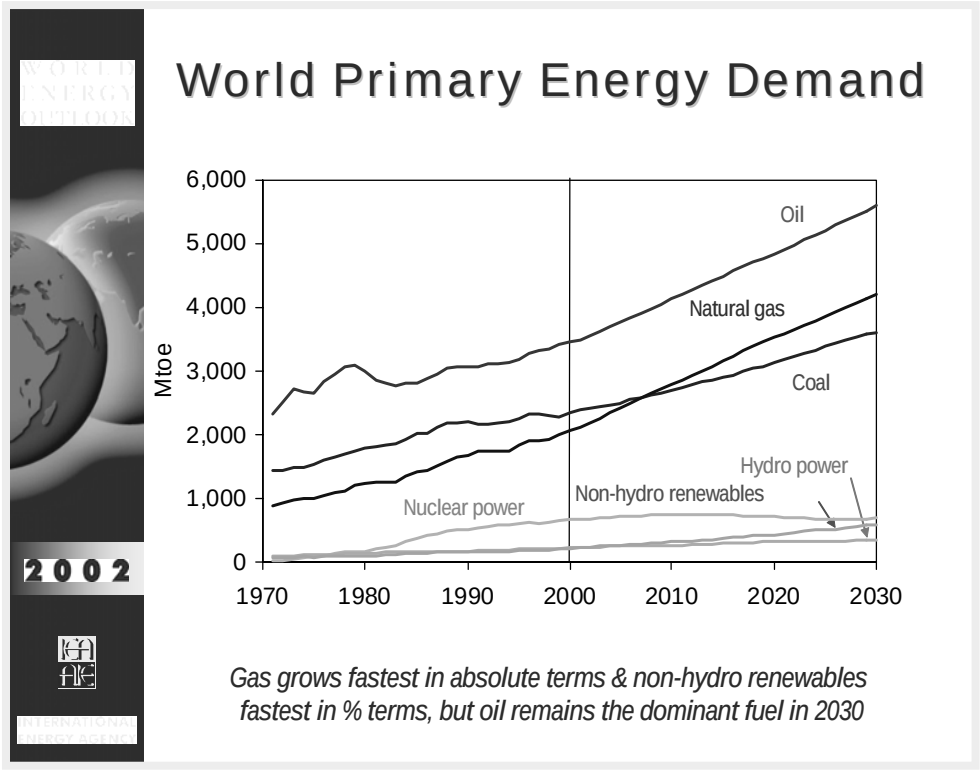
- 3-D seismic
- Extended reach multilateral horizontal wells.

- Supply glut is just ahead.
- "Moore's Law" of natural resources always reduces costs.

Conventional Energy Wisdom Was Wrong (Once Again)

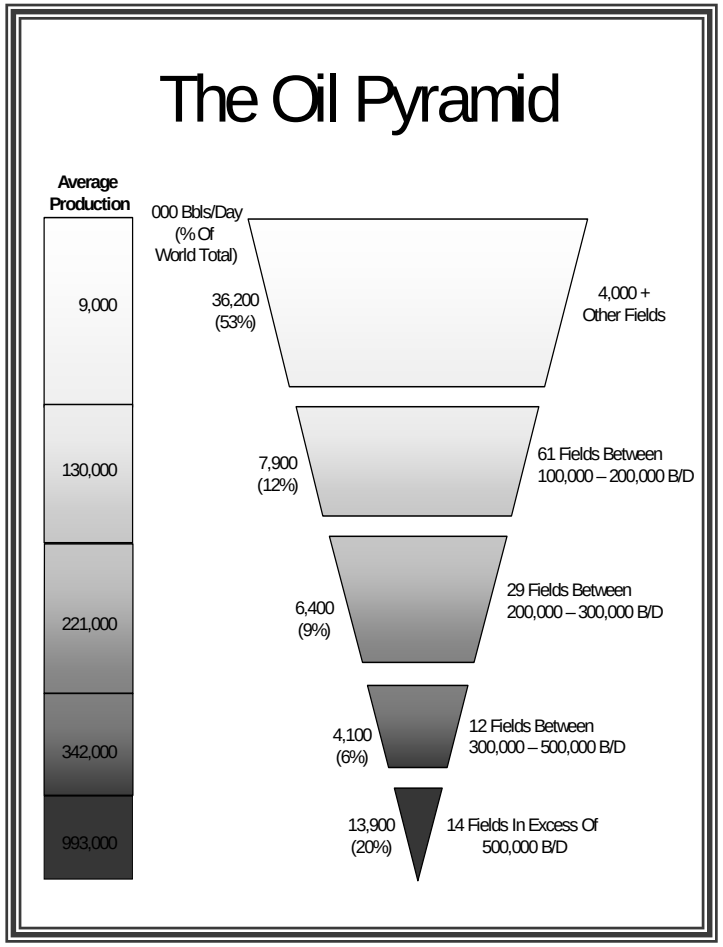
THE REALITY

- Demand grew (1995 – 2004: 12.5 million barrels a day).
- Finding and development costs incurred soared.
- New oil finds dwindled in size, quantity and quality.
- New technology inventions did not “find oil”, but instead accelerated decline curves.
- Non-OPEC supply growth was tiny.
- OPEC regained its driver’s seat.



Giant Oil Field Study Was "Eye-Opener"

- Fall of 2001: What are the world's largest oilfields?
- Answer: The world has only a limited number of giant oilfields:
  - 14 old largest fields make up 20% of total global supply.
  - Giant fields got increasingly smaller with each passing decade.
  - Every Middle East country has only a handful of giant fields that provide virtually all supply.
- Key field-by-field production data "disappeared" in 1982.
- No data exists on reliable field-by-field declines.
- Proven reserves were "worthless data" (and not field specific).

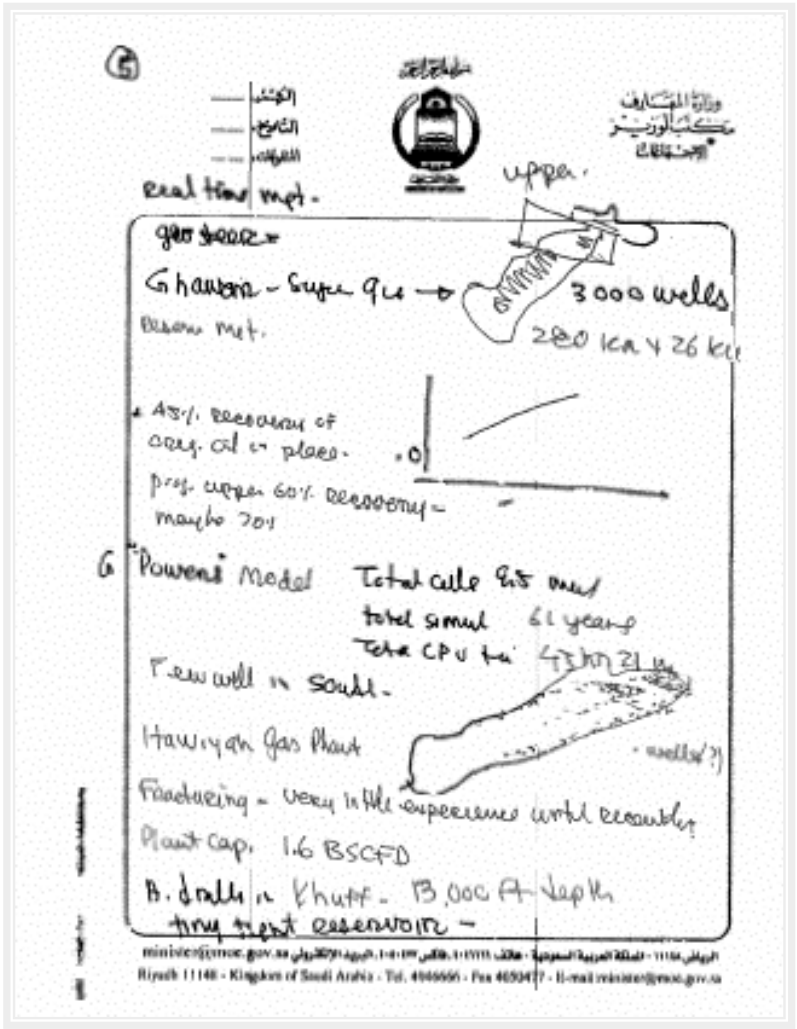


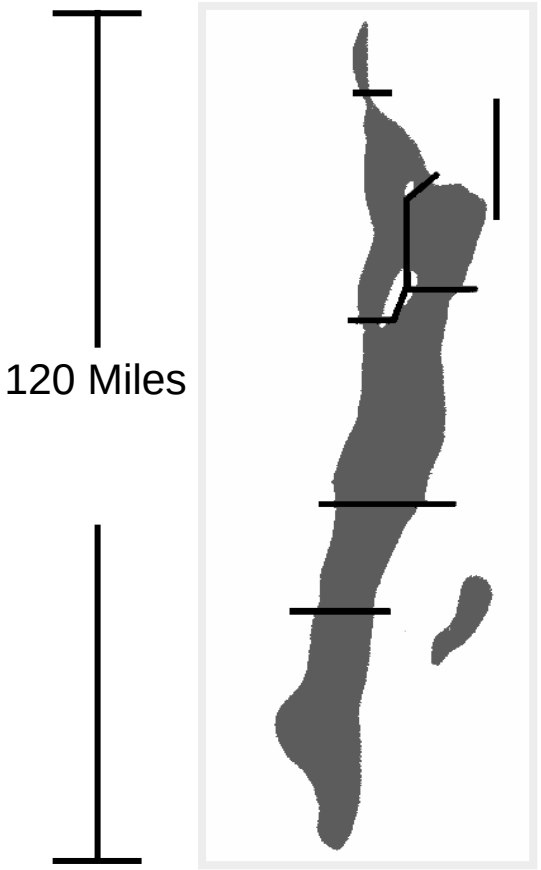
The Saudi Arabian Trip I Almost Did Not Take

- January 31, 2003: Our 9-man delegation arrived in Riyadh.
- Met with key Ministers and scores of business executives.
- Toured Aramco's head-quarters and key Saudi Aramco oil facilities.

- February 6, 2003: I left Saudi Arabia with serious concerns that everything I had been told about Middle East oil might be wrong.

The Key Smoking Gun





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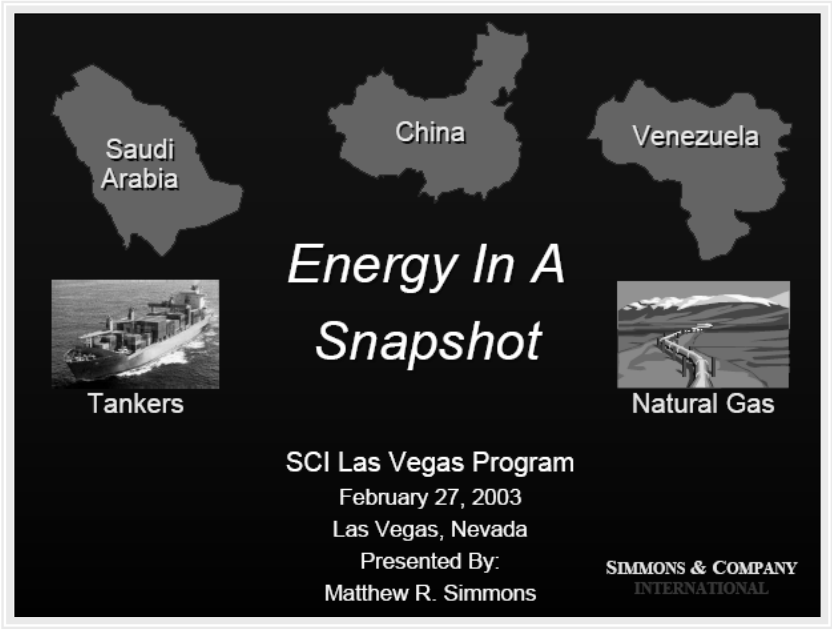
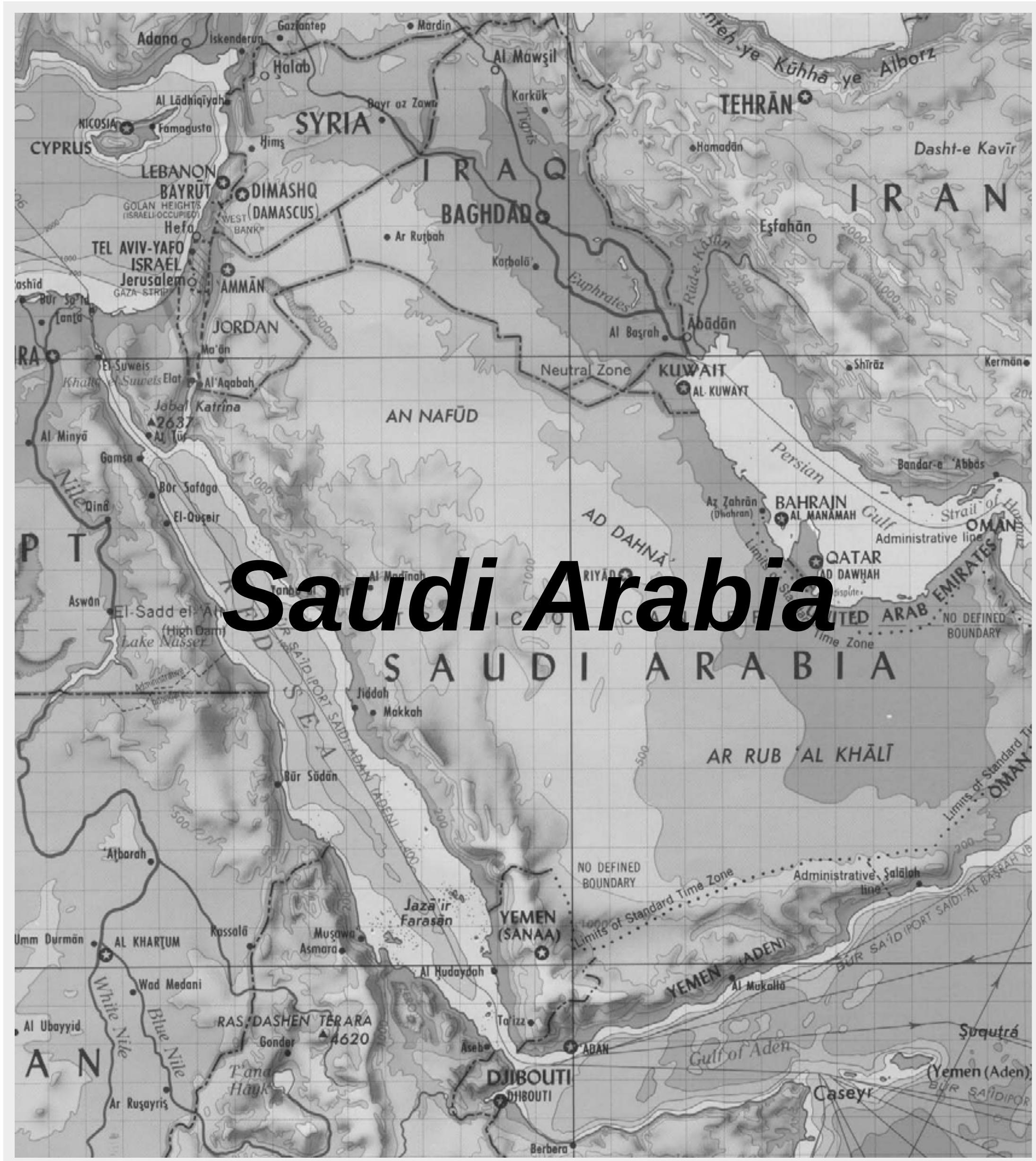
When I Returned, I Delivered An "Energy Snapshot"

- Overview on Saudi Arabia (three weeks after visit).
- Overview on tankers, Venezuela and natural gas (two weeks after testifying at a Senate Energy Hearing).
- Overview on China (one week after Saudi visit).



Saudi Arabia



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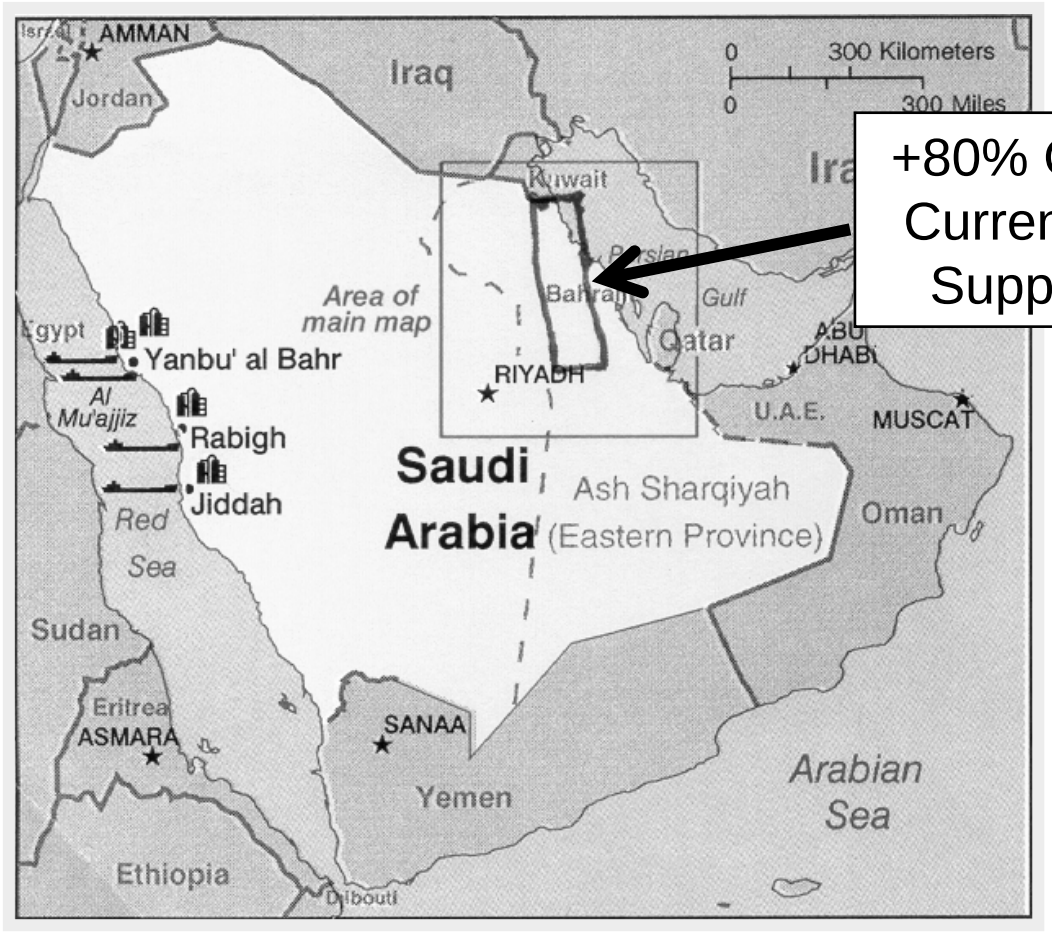
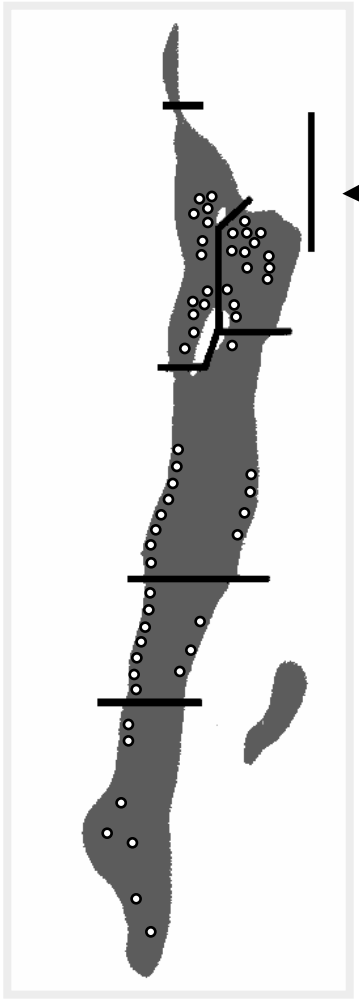
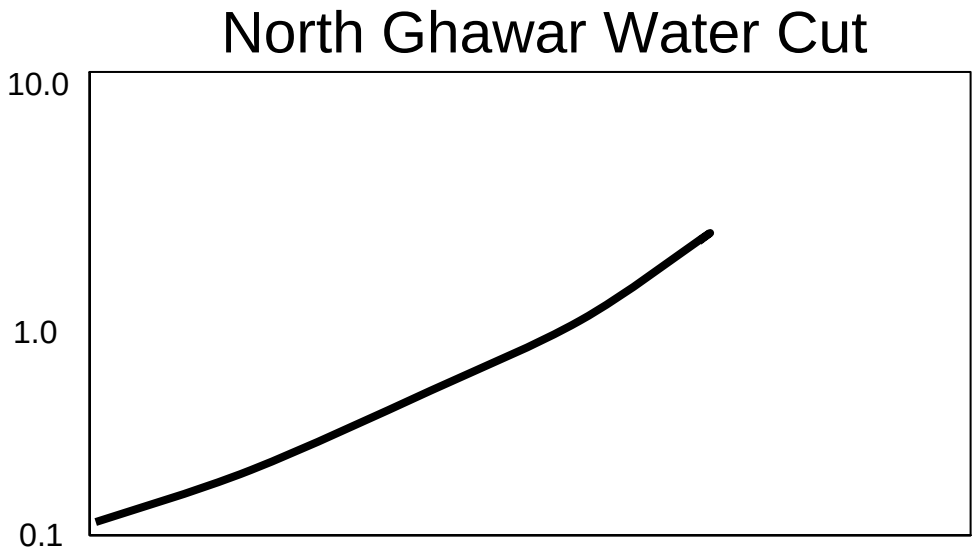
Saudi's Oil Comes From Small Area



Key Slides About Saudi's Oil



High Concentration Of All Ghawar's Oil Wells



Saudi's Oil Challenges

- Age Of Fields
- Rising Water Cuts
- Tight & Complex Formations

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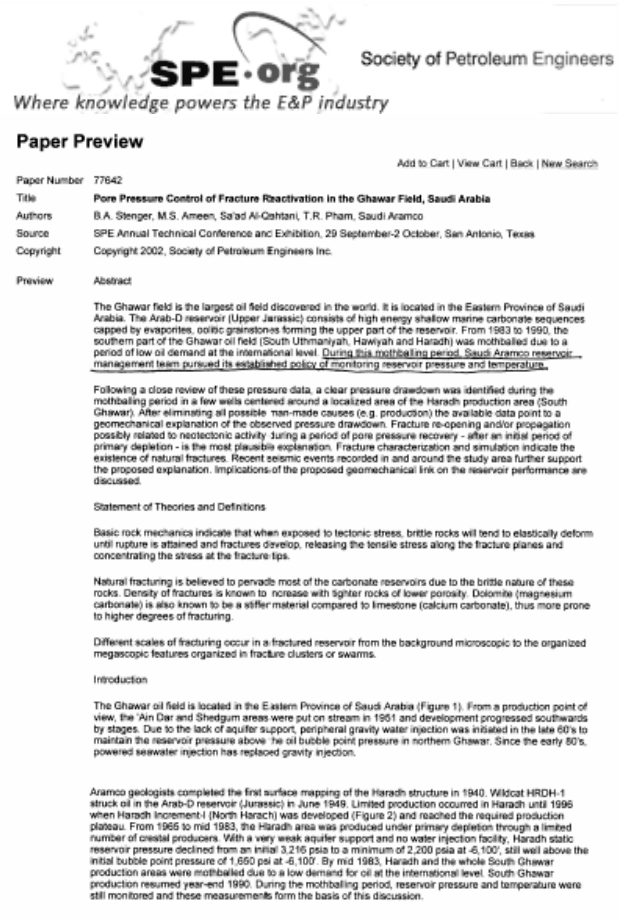
Saudi Arabia's Excess Capacity Could Be Small

- Saudi Arabia's current production is as high as any time since 1980.
- Surge exports probably come partially from tank farms.
- "To maintain 10.5 million barrels per day, we need to drill more wells."
- Are there any new giant Saudi Arabian oilfields?

“Don’t Read Too Much” Into My First SPE Papers



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Paper Preview

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Paper Number	77642
Title	**Pore Pressure Control of Fracture Reactivation in the Ghawar Field, Saudi Arabia**
Authors	B.A. Stenger, M.S. Ameen, Sa'ad Al-Qahtani, T.R. Pham, Saudi Aramco
Source	SPE Annual Technical Conference and Exhibition, 29 September-2 October, San Antonio, Texas
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Preview

Abstract

The Ghawar field is the largest oil field discovered in the world. It is located in the Eastern Province of Saudi Arabia. The Arab-D reservoir (Upper Jurassic) consists of high energy shallow marine carbonate sequences capped by evaporites, oolitic grainstones forming the upper part of the reservoir. From 1983 to 1990, the southern part of the Ghawar oil field (South Uthmaniyah, Hawiyah and Haradh) was mothballed due to a period of low oil demand at the international level. During this mothballing period, Saudi Aramco reservoir management team pursued its established policy of monitoring reservoir pressure and temperature.

Following a close review of these pressure data, a clear pressure drawdown was identified during the mothballing period in a few wells centered around a localized area of the Haradh production area (South Ghawar). After eliminating all possible man-made causes (e.g. production) the available data point to a geomechanical explanation of the observed pressure drawdown. Fracture re-opening and/or propagation possibly related to neotectonic activity during a period of pore pressure recovery - after an initial period of primary depletion - is the most plausible explanation. Fracture characterization and simulation indicate the existence of natural fractures. Recent seismic events recorded in and around the study area further support the proposed explanation. Implications of the proposed geomechanical link on the reservoir performance are discussed.

Statement of Theories and Definitions

Basic rock mechanics indicate that when exposed to tectonic stress, brittle rocks will tend to elastically deform until rupture is attained and fractures develop, releasing the tensile stress along the fracture planes and concentrating the stress at the fracture tips.

Natural fracturing is believed to pervade most of the carbonate reservoirs due to the brittle nature of these rocks. Density of fractures is known to increase with tighter rocks of lower porosity. Dolomite (magnesium carbonate) is also known to be a stiffer material compared to limestone (calcium carbonate), thus more prone to higher degrees of fracturing.

Different scales of fracturing occur in a fractured reservoir from the background microscopic to the organized megascopic features organized in fracture clusters or swarms.

Introduction

The Ghawar oil field is located in the Eastern Province of Saudi Arabia (Figure 1). From a production point of view, the 'Ain Dar and Shedgum areas were put on stream in 1951 and development progressed southwards by stages. Due to the lack of aquifer support, peripheral gravity water injection was initiated in the late 60's to maintain the reservoir pressure above the oil bubble point pressure in northern Ghawar. Since the early 80's, powered seawater injection has replaced gravity injection.

Aramco geologists completed the first surface mapping of the Haradh structure in 1940. Wildcat HRDH-1 struck oil in the Arab-D reservoir (Jurassic) in June 1949. Limited production occurred in Haradh until 1996 when Haradh Increment-I (North Haradh) was developed (Figure 2) and reached the required production plateau. From 1965 to mid 1983, the Haradh area was produced under primary depletion through a limited number of crestal producers. With a very weak aquifer support and no water injection facility, Haradh static reservoir pressure declined from an initial 3,216 psia to a minimum of 2,200 psia at -6,100', still well above the initial bubble point pressure of 1,650 psi at -6,100'. By mid 1983, Haradh and the whole South Ghawar production areas were mothballed due to a low demand for oil at the international level. South Ghawar production resumed year-end 1990. During the mothballing period, reservoir pressure and temperature were still monitored and these measurements form the basis of this discussion.

I Discover “The Vault” of Saudi Arabia’s Oil Secrets

- I seek more papers from SPE library and discover their electronic library.
- By mid-April 2002, I download 39 different technical reports.
- In summer 2002, I order another 105 SPE papers on Saudi Arabia’s oilfields.
- End of August 2002, I decide to write a book.

Time Line Of The Book

- Summer 2003: Read, re-read and digest all SPE papers
- Fall 2003: Reorder papers by field, by age and reassess
- Late Fall 2003: Begin writing first rough draft
- December 2003: Rough draft goes to “review board”:
  - Ten top experts I identify.
  - One given to a Saudi Aramco board member.

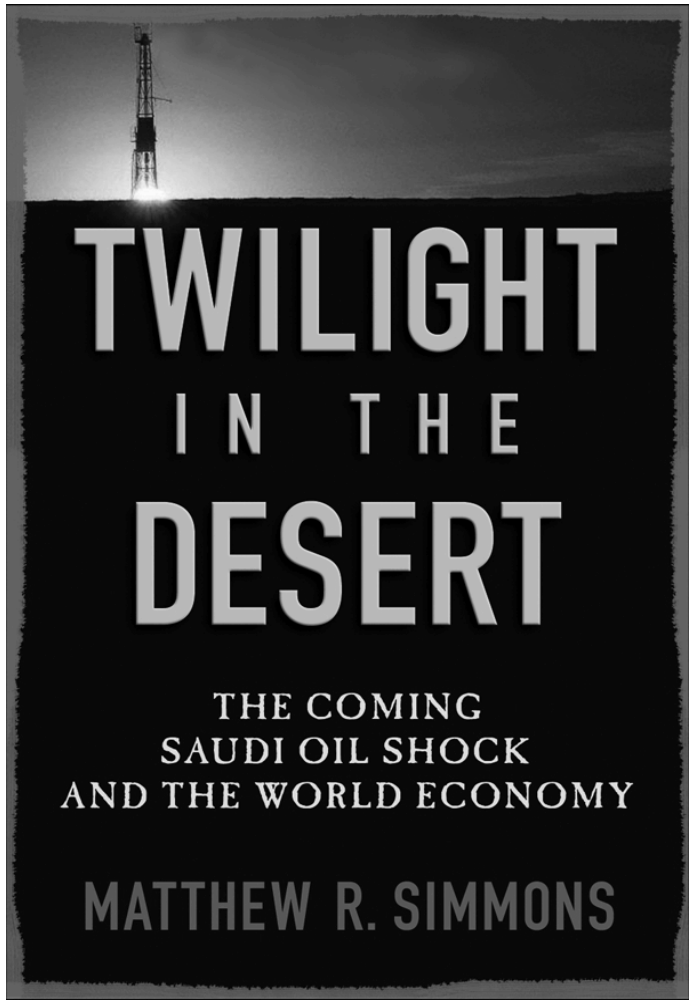
The CSIS Energy Debate (February 2004)

Matthew R. Simmons

- My pending book created “a stir” within Aramco and the Saudi Petroleum Oil Ministry.
- CSIS scheduled debate between and Aramco’s “A Team” and me.
- I previewed my findings in Kuwait and Qatar.
- At CSIS debate, Aramco experts “proved” they had no problems.
- Some data they release argues otherwise.

Nansen Saleri

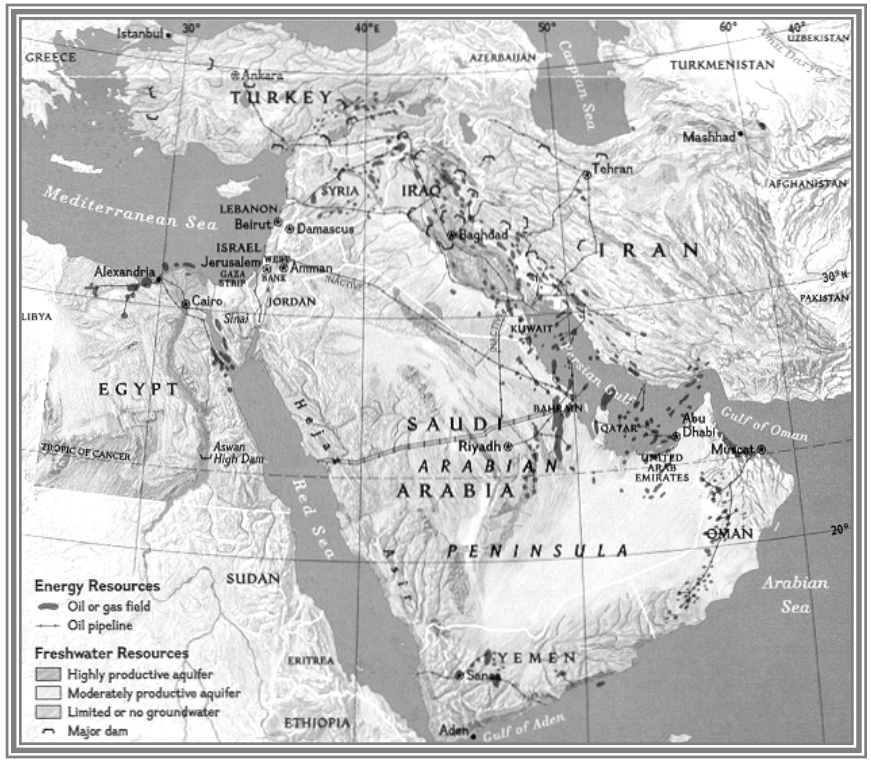
Creating A Finished Book Takes Time



- Upon conclusion of my research, I had digested 235 individual SPE reports (all listed in the book's bibliography).
- My editor and I reworked every chapter over the course of the last 9 months.
- My two goals:
  - Keep it technically correct; and
  - Make it readable for my wife and daughters.

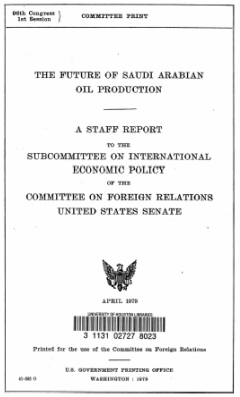
Key Issues Which “Twilight” Spells Out

- Saudi Arabia does not have an inexhaustible oil supply.
- Four to five key fields provided 90+ % of its oil output for past 40 years.
- Three lesser fields made up almost everything else.
- Real proven reserves were 110 billion barrels in 1979 (and 77 billion probable reserves).
- Since then, oil produced totaled 63 billion barrels.
- Traditionally, once 50% of recoverable reserves are used, production begins to decline.



Oil: The 1970's Cover-Up

- One interesting aspect of my research was the 1974/1979 "Energy cover-up."
  - *1974 Subcommittee on Multi-National Corporations of the Committee of Foreign Relations Hearings, United States Senate.* (1,390 pages of hearings plus subpoena documents.)
  - *1979 Staff Report to the Subcommittee on International Economic Policy of the Committee on Foreign Relations, United States Senate.* (33 pages of garbled text concealing "the smoking gun".)



96th Congress 1st Session } COMMITTEE PRINT

THE FUTURE OF SAUDI ARABIAN OIL PRODUCTION

A STAFF REPORT
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APRIL 1979

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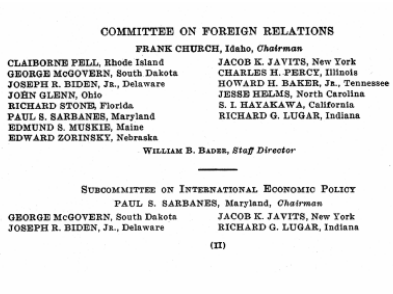

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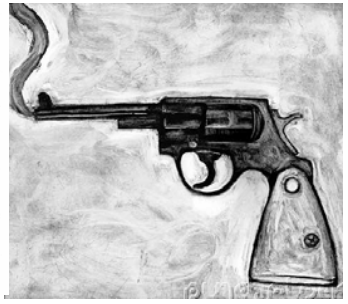

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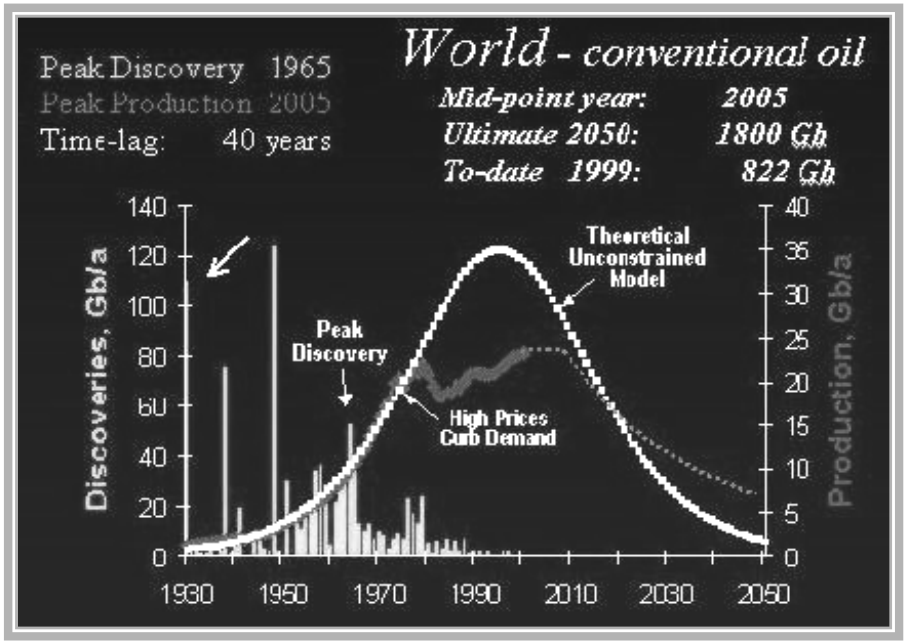
What Twilight In The Desert Means

- Pressurized oil fields all have “rate sensitivity” to how they are drained.
- The higher the production, the faster high reservoir pressures end.
- Once pressure falls to “bubble point”, gas bubbles to top of the field and pressure falls faster.
- Once dew point is reached, remainder of oil is “inert” or “left behind.”

Saudi Arabia is over producing its key fields.

Once Saudi Arabia Reaches Peak Oil, So Will The World

- On a sustainable basis, Saudi Arabia could have already passed peak output.
- If so, the world's oil supply (on sustained basis) has peaked.
- Peak oil is a world class event.
- It is a crisis few understand.



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Aftermath: How The World Copes With Post-Peak Oil? (Chapter 17)

- Coping with post-Peak Oil can be a manageable event.
- If not understood, it can also be a “global tipping point.”
- Coping requires series of fast changes.

The Key Issues

- Understanding the true value of scarce oil.
- Understanding how to manage high oil revenues.
- Understanding how to allocate too much demand/too little supply.

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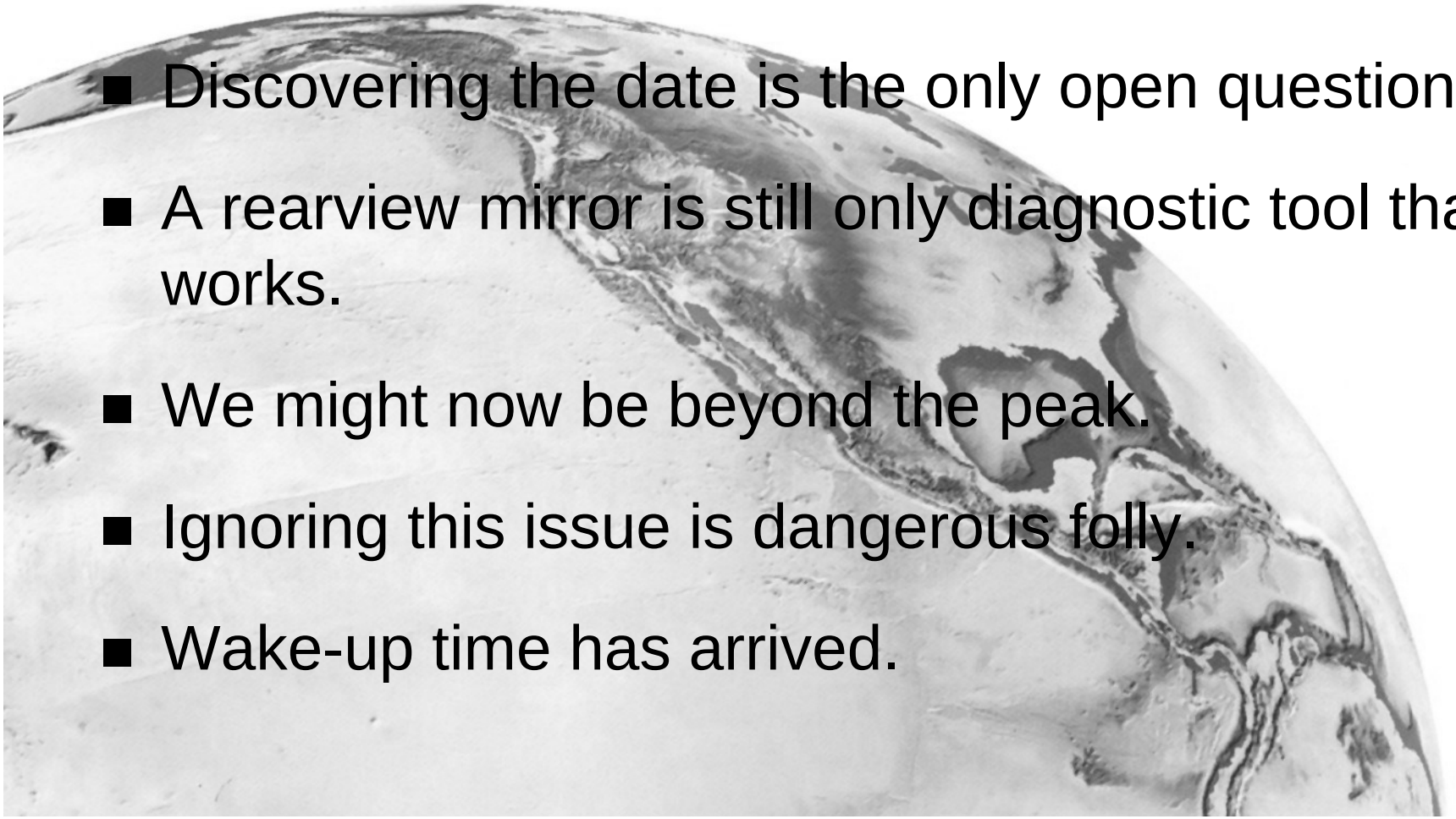
The Key Changes Peak Oil Introduces

- Oil prices need to soar (not spike).
  - Recycling petrodollars will work.
  - Excess profits can fund creating new energy.
- Oil use needs to become highly efficient.
  - Transportation by rail is far more energy efficient than vehicles or boats.
  - Feedstock for petrochemicals is far higher added value than transportation.
- Globalization model based on cheap energy was flawed.
- Global energy cooperation is vital.

Peak Oil Is A Global Event

- Oil is not renewable and will peak.
- Discovering the date is the only open question.
- A rearview mirror is still only diagnostic tool that works.
- We might now be beyond the peak.
- Ignoring this issue is dangerous folly.
- Wake-up time has arrived.



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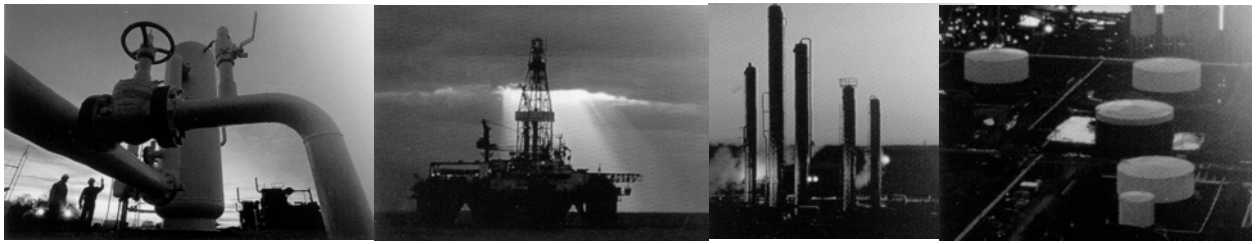

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