The AAPG Century – Giant Fields through the Decades*

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Abstract

A giant oil field is generally estimated to contain in excess of 500 MMBOE estimated ultimate recovery. Since the late nineteenth century, at least four factors seem to control the frequency of discovery of giant oil and gas fields. These factors include concepts (e.g., geological models), technology, price, and access to drilling locations. The importance of understanding these factors drove creativity in the exploration process. In our efforts to understand common petroleum system parameters in these fields and, importantly, what is unusual about each field, leads to “Discovery Thinking” in our search for new oil and gas fields. In the mid- to late-nineteenth century the recognition of seeps focused exploration efforts. This was followed by recognizing the importance of anticlines. Petrophysical tools followed in the early 20th century as well as the application of seismic as an exploration tool. These tools continued to be developed and improved with time and processing advances in the 1970's significantly improved our ability to image the subsurface and characterize the reservoir. Advances in drilling technology have led us from the land to deep water. The integration of rock mechanics using geology, geophysics, and engineering in this decade led to new workflows for geologists, geophysicists, and engineers to complete wells in reservoirs previously considered too tight for economic production. This integration brought together intensive core analysis and new sample imaging techniques to characterize the pores in low-permeability rocks that we now recognize as basin-wide “unconventional” fields. Traditional roles in discovering giant fields over previous decades included the “rockers” (geologists well versed in reservoirs), the “trappers” (geophysicists mapping the geometry of accumulations), and the “sealers and the sourcers” (explorers following source rock and seals). More than ever, successful giant field discovery in the decade 2000 through 2010 was led by the “integrators.” If you know how to hammer, every problem is a nail. The enhancement of the tools including Basin analysis,
geochemistry, cutting-edge seismic imaging, and rock mechanics have become critical additions to the explorer's skill set. The ingenuity of combined disciplines continues to meet the demands of an energy hungry world. AAPG Memoir 113 documents the fifth decade of the Giant Fields series.

**Selected References**


**Website Cited**

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Why Study Giant Fields?

- Contribute prosperity and major wealth transfer for nations
- Provide significant infrastructure with economies of scale for smaller discovery developments
- Global supply tracks giant field output
- Giants keep getting bigger
- Provide insight into petroleum systems for exploration and development programs
Giant fields contribute 60% of Global Production since the 1960’s

**Figure 3.1** World daily oil production showing the contribution of giant fields (Kelley, et al, 2009, after Robelius, 2007, and Hook, et al, 2009).
Giants Keep Getting Bigger!

EXPLANATION
- Buena Vista (1909)
- Coalinga E Extension (1938)
- Coles Levee N (1938)
- Cymric (1909)
- Edison (1928)
- Elk Hills (1919)
- Fruitvale (1928)
- Greeley (1936)
- Kern Front (1912)
- Kern River (1899)
- Kettleman North Dome (1928)
- Lost Hills (1910)
- McKittrick (1896)
- Midway-Sunset (1890)
- Mount Poso (1926)
- North Belridge (1912)
- Rio Bravo (1937)
- Round Mountain (1927)
- South Belridge (1911)
- Yowlumne (1974)
- Coalinga (1887)

From: Tennyson, M.E., 2005, Growth history of oil reserves in major California oil fields during the twentieth century; U.S. Geol. Survey Bull. 2172-H, p.4

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What is a Giant Field?

- Oil: Estimated Ultimate Recovery (EUR) ≥ 500 MMBO
- Oil and Gas: EUR ≥ 500 MMBOE
  - Gas conversion = 6000 cu ft per barrel
- Gas Field ≥ 3 tcf gas
- Supergiant Fields ≥ 5 Billion BOE
- Megagiant Fields ≥ 10 Billion BOE
Future Giants Require

- Open access to exploration in remote and challenging areas
- Historical Explorers – “Rockers”, “Trappers” and “Sealers & Sourcers”
- Technological integration: The ingenuity of the combined disciplines
  - “Big Data” – Parallel processing & Neural networks
  - Understanding Reservoirs from the micro to macro scale
  - Mapping Traps and Migration paths
  - Geochemistry: Source Rock & HC Generation
  - Drilling and Completion practices
Source Material

- Database of 1,062 Giant Fields (Mike Horn)
- IHS Support
- AAPG Archives going back 100 years - Datapages
- AAPG Giant Field Memoirs like the upcoming release, Memoir 113
Where and When were they Found?
Giant Fields of the World by Decade

- Giant
- Super-giant
- Mega-giant
Giant Oil Fields Through the Decades

Giant Fields of the World
Decade 1911 - 1920
15 Fields

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Giant Fields of the World
Decade 1931 - 1940
48 Fields

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Giant Fields of the World
Decade 1971 - 1980
219 Fields

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Giant Oil Fields Through the Decades

Decade 1981 - 1990
94 Fields

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Giant Oil Fields Through the Decades

Giant Fields of the World
Decade 1991 - 2000
105 Fields

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Giant Oil Fields Through the Decades

Giant Fields of the World
Decade 2001 - 2010
128 Fields

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US Dominated Exploration 1856 – 1925
US Domained Exploration

- **Prior to 1900**
  - Emerging concept of where to drill – Seeps and Anticlines

- **1900 – 1925**
  - Surface mapping of Anticlines
  - 1914 First 1D seismic
  - 1921 Reflection seismograpy
  - First resistivity log
  - 1919 Cementing casing
  - Rotary Drilling

Courtesy Robbie Gries, 2016
Salt Creek, Field, Wyoming, USA

Adapted from: Stone, D.S., 2006
Global Expansion 1926 – 1945

Giant Fields of the World
Global Expansion
1926 - 1945
Global Expansion

- **1926 – 1935**
  - 1928 Reflection seismic
  - 1930 Stratigraphic traps

- **1935 – 1945**
  - 1938 First offshore drilling
  - Evolution of petrophysical logs
  - 1941 Archie’s laws
  - Three cone roller bit
  - 1941 Diamond bit
  - Multiple bullet-shot casing perforator
  - Texas RRC – Controlled & cooperative development

East Texas Field
Post WWII Growth 1946 - 1970

Giant Fields of the World
Post-WWII Growth
1946-1970
Post WWII Growth

1945 – 1960

- Petrophysical logs evolve
- 1947 – Kermac #16 drilled 10 miles offshore Louisiana
- 1949 – Hydraulic Fracturing license to Haliburton issued by Stanolind
- 1954 Jackup drilling

1961 – 1970

- Digital computers enable 2D seismic, log analysis, & data management
- 1965 “Bright Spots”
- Semisubmersible drilling rig
- Measurement while drilling

1970 – First Giant Fields Memoir 14
OPEC & Nationalization 1971 – 1987

Giant Fields of the World
OPEC - Nationalization
1971 - 1987

Emerging Countries
Globalization/Mergers
Post WW II Growth
Global Expansion
US Dominated Exploration
OPEC & Nationalization

Arab Oil Embargo

Seismic technology evolves
- Seismic data in color
- Seismic response & interval attributes
- Seismic stratigraphy
- 3D seismic emerges

Petrophysics
- 1977 first logging truck equipped with a computer
- 1978 Digital sonic tool (SDT)

Geochemistry

Directional Drilling

1980 - Giant Fields Memoir 30
Globalization & Mergers 1988 – 2005

Giant Fields of the World
Globalization - Mergers
1988 - 2005

Emerging Countries
Globalization/Mergers
OPEC/Nationalization
Post WW II Growth
Global Expansion
US Dominated Exploration
Globalization & Mergers

- Seismic attribute analysis matures
- Horizontal drilling & Staged hydraulic fracturing
- First subsalt discovery
- 1999 – First dual activity drill ship
- Deep water drilling matures
- Giant Fields Memoir 54 – 1992
- Giant Fields Memoir 78 – 2003
Emerging Countries 2006 – Present

Giant Fields of the World
Emerging Countries
2006 - Present
Emerging Countries

- Seismic technology
  - Processing algorithms evolve
  - Multi-attribute analysis matures
  - Spectral decomposition and elastic inversion
- Subsalt drilling becomes common
- New turbidite plays
- Source Rocks become reservoir targets
  - Horizontal drilling
  - Multi-stage fracs
  - Microseismic
- Giant Fields Memoir 113

From: Zagorski, in press

From: Ronnevik, in press

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The Usual, and the Unusual

“As we make it a point to learn how these giant fields formed, we should study the modes of occurrence of the accumulations, the types of trap, how each trap formed and how it was found, the age of the reservoir and the age, or ages, of the sediments in which the petroleum generated and from which it was expelled and migrated to the trap.

We should ask ourselves: first, what is usual about each of these accumulations? And second, what is unusual? Then we must concentrate on the unusual, for commonly it is that unusual aspect which is the key to accumulation.

Prejudiced ideas should be discarded, for it is these old, ingrained, hard-nosed prejudices which also stifle exploration; old prejudices must not be tolerated in our thinking of the future.” M.T. Halbouty (1970, Memoir 14)
Where We Have Been

Sediment Thickness in meters

https://www.ngdc.noaa.gov/mgg/sedthick/sedthick.html
Giant Oil Fields Through the Decades

The Journey Continues

Sediment Thickness in meters

https://www.ngdc.noaa.gov/mgg/sedthick/sedthick.html

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