Future trends in oil and gas exploration

Mike Daly
Executive Vice President, Exploration
BP plc

Oil Technology Centenary 2013
Imperial College London
Disclaimer

“This document is made available for information only and on the following conditions. The BP Group, along with its officers, directors and employees makes no representations or warranties, express or implied, as to the quality, accuracy and/or completeness of the information, views or opinions expressed in this document. Nothing in the document constitutes technical, commercial, legal or any other advice.

The information contained herein does not purport to be all-inclusive or necessarily contain all the information available on or material to a particular subject matter addressed in the document. The information, views and opinions contained in this document have not been independently verified by BP or any of its advisers and should not form the basis of any investment decision by a prospective purchaser or current holder of an interest in securities of the BP Group.

The information provided herein may contain certain forecasts, projections and forward-looking statements - that is, statements related to future, not past events - with respect to the financial conditions, results of operations and businesses of the BP Group and certain of the plans and objectives of BP with respect to these items. By their nature, forward-looking statements involve risk and uncertainty because they relate to events and depend on circumstances that will or may occur in the future. Actual results may differ from those expressed in such statements, depending on a variety of factors. The BP Group assumes no obligations to update the forward-looking statements contained herein to reflect actual results, changes in assumptions or changes in factors affecting these statements.

The BP Group, along with its officers, directors and employees, shall have no liability whatsoever regarding the use of or reliance upon the information, views or opinions expressed in this document to any recipient of this presentation, along with its affiliated companies and/or beneficial owners.”
Global trends influencing exploration

Future resource trends

• Deepwater: the drill out of passive margins and deltas
• Arctic: ice-bound offshore
• Re-exploration of onshore basins and shallow waters
  ➢ Unexplored Rock Volume
  ➢ Tight oil giants, Shale plays & EOR

Future technology trends

• Striving for the perfect seismic image
• Ice management, arctic spill response and reduction of environmental impact
• Transformation of $K_h$ and $\mu$ & characterisation of unconventional pay
• Digitisation of everything

Future geopolitical trends

• Mexico, Venezuela, Iran, KSA…
Global discovered resource and yet-to-find

**Conventional Discovered:** 4.5 tnboe

- **1948:** Ghawar 176 bnboe
- **1971:** North Field 193 bnboe
- **2004:** Yoloten 67 bnboe
- **1979:** Troll 10 bnboe
- **1992:** Qatar Arch 103 bnboe
- **1927:** Kirkuk 26 bnboe
- **1936-40:** Supergiants in Venezuela, Iran, Kuwait

**Conventional YTF:** ~ 1 tnboe

Source: IHS, EIA and CAPP (Canadian Association of Petroleum Producers) for onshore North America data
Exploration delivery – past and future

- The growth and decline of deepwater
- The emergence of the sub-ice arctic
- Sustained delivery from onshore & shelf

Deepwater - cumulative discovered resource

Yet-to-find resources

Source: BP Yet-To-Find data
Material new plays of the past decade – all deepwater

- Deeper stratigraphy in existing provinces
- Delta’s medial and distal fans

Source: IHS EDIN/BP
Arctic yet-to-find

Alaska: Beaufort
N Slope
Chukchi

C Beaufort

Arctic Islands

NE Greenland

E Siberia

Laptev

N Kara

R Chukchi

Baffin

YTF volume (bnboe)

Source: USGS 2008
Arctic frontiers: untested basins with great DHI’s
Ice management key issue

Lomonosov Ridge, 2004: seabed coring, drifting pack ice
And society’s opinion?
Onshore frontier basins

Strongly asymmetric resource distribution - North and South

80bnboe

Saharan Africa | Sub-Saharan Africa
---|---
Remaining | Produced

Source: Basin Resources (IHS, 2013); Depth to basement (E.D. Purdy – Exploration Fabric of Africa)
The Congo: 1.2m km² of unexplored basin

H6  Base Jurassic Unconformity
H5  Hercynian Unconformity (Late Paleozoic)
H4  Pan-African Unconformity (Early-Mid Paleozoic)
H3  Early Pan-African Unconformity (Late Precambrian-Early Cambrian)
Congo and Oman Infra-Cambrian seaways

Oman time equivalent
Ara Gp. petroleum system

‘U’ shale and Athel silicilyte source rocks have delivered ~20bnboe

540Ma Reconstruction
Unexplored rock volume in mature basins

East Texas: >100,000 wells total

East Texas: wells below 14,000’

Industry 3D seismic data
The Bakken: dramatic reserves growth

**Prior to Lower TF:**
577 BBo in place (2010)
- 20 BBo recoverable @ 3.5%**
- 320-acre spacing per zone

**Now: Estimate +57%**
903 BBo in place (2012)
- 32 BBo recoverable @ 3.5%
- 36 BBo @ 4%
- 45 BBo @ 5%

*The Bakken Petroleum System ranges in thickness from 250 feet to 400 feet
**24 BBoe = 20 BBo (3.5%) + 4 BBoe natural gas at 320-acre spacing per zone, (Oct. 2010), not including any reserves from the lower TF benches.*
Exploring for ‘reserves growth’…

Source: Penn Virginia
By exploiting missed pay – a lot of it!

IHS well completion zones in red
Source rock (shale) plays

The distribution of shale is known... understanding quality is key. Instead, success will be predicated upon:

- best shale (e.g. Eagleford)
- cheapest operating model
- scientific understanding / technology
- deploying the above internationally

Source: Reuters

Eagleford: drilling, logging and evaluating the type outcrop

Source: Reuters
**Exploration convergence with EOR**

- 1200 bnboe remaining HCIP in Middle East carbonates
- 300 bnboe HCIP in rest of world carbonates
- Each 1% EOR increase = 15 bnboe
- Sweet spot identification key criteria
- 1380 bnboe HCIP globally in clastics/shales
Future trends in oil & gas exploration

Resource trends

- **Deepwater**: T and K deltas; plays explored up from the source rock
- **Arctic**: ice-bound offshore, Russia is leading
- **Re-exploration of the onshore** (and shallow water) basins
  - Needs a new image, or a new idea, or new technology
    - Onshore frontier basins
    - Unexplored Rock Volume in established basins
    - Tight oil in old giants
    - Shale sweet spots
    - Convergence with EOR