Assessing Previously Unassessed Petroleum Provinces Using the Variable Shape Distribution (VSD) Model*

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Abstract

Earlier size distribution models used to estimate undiscovered petroleum volumes relied mainly on the Lognormal and Pareto (i.e. Fractal) distributions. Historically, all the methods used have been based on an assumed form of the size distribution of nature’s endowment of petroleum volumes. Our new Variable Shape Distribution (VSD) model is different in that it allows the actual petroleum data, in this case the province volumes from the U.S. Geological Survey’s World Petroleum Assessment (2000), to determine the size distribution relationship of the petroleum volumes.

The USGS (2000) study presents volumes for 409 provinces worldwide. Since the world can be divided into 937 provinces, there are 528 provinces not represented in the study. After using non-linear regression to estimate the parameters of the VSD model that provide the best fit of the data from USGS (2000), the VSD is used to estimate reasonable volumes for all 937 provinces. The estimated volumes suggest that conventional petroleum is more abundant than commonly assumed, since there is a tendency to overlook previously unassessed provinces. The implication is that there is no danger of petroleum depletion over the next several decades.
Assessing Previously Unassessed Petroleum Provinces Using the Variable Shape Distribution (VSD) Model

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THE DEBATE

SOME EXPERTS PREDICT SCARCITY IN THE NEAR FUTURE

“the pessimists”

THE DEBATE

“the pessimists”
THE DEBATE

OTHER EXPERTS ARE NOT WORRIED “the optimists”
THE DEBATE

“middle of the road”

bp

HARD TRUTHS
Facing the Hard Truths about Energy

WORLD ENERGY COUNCIL
CONSEIL MONDIAL DE L'ENERGIE

NPC

USGS
science for a changing world
USGS World Petroleum Assessment 2000

- USGS (2000) provides estimates for 409 provinces
  - Known volumes, undiscovered volumes, reserve growth
- 937 petroleum provinces in the world
VSD (Variable Shape Distribution) Model

- New model (VSD) used to estimate volumes of conventional petroleum in all 937 provinces, including previously unassessed provinces

- Unlike other models, VSD is not based on an assumed distribution
Size Distribution Models

Source: adapted from Barton (1995)
Size Distribution Models

Source: adapted from Barton (1995)
Oil Endowment. USGS (2000) excludes provinces of USA.

VSD Model - Variable Shape Distribution

USGS (2000) data for 129 provinces = 2,047 BBOE
Oil Endowment. USGS (2000) excludes provinces of USA.

- USGS (2000) data for 129 provinces = 2,047 BBOE
- VSD for 129 provinces = 2,085 BBOE (R² = 0.99)
Oil Endowment. USGS (2000) excludes provinces of USA.
Global Cumulative Long Run Supply Curves for Conventional Oil and NGL

- Including Unassessed Provinces and Future Reserve Growth = 3561 BBOE
- Including Previously Unassessed Provinces = 2491 BBOE
- Total USGS (2000) Future Oil and NGL = 1898 BBOE

**Global Cumulative Long Run Supply Curves for Conventional Gas**

- Including Unassessed Provinces and Future Reserve Growth = 3375 BBOE
- Including Previously Unassessed Provinces = 2165 BBOE
- Total USGS (2000) Future Gas = 1685 BBOE

Global Cumulative Long Run Supply Curves for Conventional Petroleum

- Including Unassessed Provinces and Future Reserve Growth = 6936 BBOE
- Including Previously Unassessed Provinces = 4656 BBOE
- Total USGS (2000) Future Petroleum = 3563 BBOE

# LIFE EXPECTANCIES

<table>
<thead>
<tr>
<th>Product</th>
<th>Future Volume (boe)</th>
<th>Average Annual Production, 2004 – 2006 (boe)</th>
<th>Life in Yrs 0%</th>
<th>Life in Yrs 2%</th>
<th>Life in Yrs 5%</th>
<th>Average Annual Production Growth 1976 – 2006 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Oil and NGL</td>
<td>$3561 \times 10^9$</td>
<td>$2.96 \times 10^{10}$</td>
<td>120</td>
<td>61</td>
<td>39</td>
<td>1.04</td>
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<tr>
<td>Conventional Gas</td>
<td>$3375 \times 10^9$</td>
<td>$1.64 \times 10^{10}$</td>
<td>206</td>
<td>82</td>
<td>48</td>
<td>2.82</td>
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<tr>
<td>Heavy Oil</td>
<td>$4000 \times 10^9$</td>
<td>$4.59 \times 10^{10}$</td>
<td>87</td>
<td>50</td>
<td>34</td>
<td>-</td>
</tr>
<tr>
<td>Oil Sands</td>
<td>$5000 \times 10^9$</td>
<td>$4.59 \times 10^{10}$</td>
<td>109</td>
<td>58</td>
<td>37</td>
<td>-</td>
</tr>
<tr>
<td>Oil Shale</td>
<td>$14000 \times 10^9$</td>
<td>$4.59 \times 10^{10}$</td>
<td>305</td>
<td>98</td>
<td>56</td>
<td>-</td>
</tr>
</tbody>
</table>
IMPLICATIONS

- Conventional oil and gas more abundant than commonly assumed
- Tendency to overlook volumes from unassessed provinces and reserve growth
- Conventional oil and gas likely to last far longer than many now claim
- Production costs lower than current market prices
VSD Equations

\[ V_y = \frac{V_x \times \psi}{\psi + (1 - \psi) \cdot (1 - \exp(-V_t/V_s))^S} \]

where:

\[ V_t = \left[ \left( \frac{1}{N_t} - \left( \frac{V_m}{V_x} \right)^{\frac{\log N_x - \log N_m}{\log V_x - \log V_m}} \right)^{\frac{1}{a_0}} + \frac{V_m}{V_x} \right] \cdot V_x \]

Parameters:
- \( V_x \)
- \( a_p \)
- \( \psi \)
- \( V_s \)
- \( S \)
Log-log plots of cumulative number of pools, $N(V)$, versus pool size (MMBOE) for:

(a) Cardium Scour oil play of central Alberta, Canada, through 1982
(b) Frio Strand Plain oil and gas exploration play, onshore Texas, through 1985;
(c) oil fields in the conterminous 48 states through 1984;
(d) gas fields in the conterminous 48 states through 1984;
(e) giant oil and gas fields, worldwide, through 1980;
(f) oil and gas fields in the western Gulf of Mexico through 1976

Source: Barton and Scholz, 1995
Pareto (aka fractal) Distribution

Source: Barton, 1995
Distribution of Future Oil Volume

TOTAL: 3561 x 10⁹ BOE
Distribution of Future Natural Gas Volume

TOTAL: 3375 x 10⁹ BOE

- Former Soviet Union: 33%
- Middle East and North Africa: 32%
- North America: 10%
- South Asia: 2%
- Sub-Saharan Africa and Antarctica: 3%
- Asia Pacific: 7%
- Central and South America: 7%
- Europe: 6%
ASSESSING PREVIOUSLY UNASSESSED PETROLEUM PROVINCES USING THE VARIABLE SHAPE DISTRIBUTION (VSD) MODEL

THANK YOU

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References


