GLOBAL RESOURCE POTENTIAL OF GAS HYDRATE – A NEW CALCULATION

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ABSTRACT

A new evaluation of gas hydrate resource potential, utilizing a petroleum systems approach, has resulted in calculations that support the probability of a large volume of hydrate being present in sand reservoirs in polar and deepwater sediments. Previous global estimates published during the past 30 years have reported large volumes but have included the hydrate present in low concentration in shales that is not commercially viable. More recent estimates have utilized a petroleum systems approach but have only covered individual basins.

The new assessment includes every coastal margin on Earth along with Polar Regions. Of the total volume of hydrate in place, it is likely that only a relatively small percentage is technically recoverable, and an even smaller percentage will be commercially viable. Yet, even at the low end, the resource potential is significant.

Due to the lack of subsurface data for the hydrate stability zone in many parts of the world, the resulting range of values for the assessment extends over several orders of magnitude. With future drilling results and improved seismic evaluation techniques, the estimate of hydrate volume in place will be further revised.

This evaluation was conducted as part of the Global Energy Assessment (GEA), coordinated by the International Institute for Applied Systems Analysis.

Keywords: gas hydrate, resource assessment

INTRODUCTION

Estimates of global gas hydrate abundance that have been published during the past thirty years (Table 1) have pointed to a truly vast hydrate natural gas potential. While these estimates have been widely quoted, they include hydrate in low-grade (shale) deposits as well as in high-grade (sand) deposits, and are misleading as to actual economic potential. As noted in recent publications such as Max, et al [1] and Collett et al. [2], high-grade gas hydrate deposits are best viewed as an extension of the conventional petroleum system, and a petroleum systems approach is essential for a valid assessment of hydrate resource potential.

The combination of lithology and methane flux required for deposits of concentrated hydrate in producible reservoirs removes most of the world’s gas hydrate from consideration as an energy resource (Figure 1). However, the high concentrations of hydrate that may be present in...
Marine and Arctic sediments lead to the possibility of exceptionally large volumes of natural gas occurring in porous, permeable reservoirs.

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<thead>
<tr>
<th></th>
<th>Tcm</th>
<th>Tef</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trofimuk, [3]</td>
<td>5,000-25,000</td>
<td>176,574 - 882,868</td>
</tr>
<tr>
<td>Meyer [4]</td>
<td>3,100</td>
<td>109,475</td>
</tr>
<tr>
<td>Kvenvolden [5]</td>
<td>20,000</td>
<td>706,294</td>
</tr>
<tr>
<td>MacDonald, [6]</td>
<td>21,000</td>
<td>741,609</td>
</tr>
</tbody>
</table>

Table 1. Some Previous Estimates of Global Gas Hydrate Volumes

NEW GLOBAL GAS HYDRATE ASSESSMENT

HEI has undertaken a global assessment of gas hydrate potential as part of the Global Energy Assessment being conducted by the International Institute for Applied Systems Analysis (IIASA) with funding from the World Bank, United Nations Organizations, and national governments. In undertaking this study, HEI assessed data from every continental margin and utilized appropriate depositional models. Under the guidelines of the IIASA, the results are reported for the 18 Regions defined by the United Nations. In addition, separate resource assessments were conducted for the Arctic Ocean without regard for national boundaries, and for the Southern Ocean (from the coast of Antarctica north to 60 degrees south latitude).

METHODOLOGY

High-grade gas hydrate deposits are located where pressure-temperature conditions for hydrate formation occur with appropriate reservoir lithology and adequate gas input. Other than a few locations, such as those noted above, these parameters have not been adequately quantified at the shallow depths where gas hydrate may be present, even in areas with extensive conventional oil and gas drilling. Most of the marine gas hydrate systems that have been studied to date are fine-grained, with very poor reservoir potential. Since 2007, a general consensus has been growing for the need to adopt a petroleum systems approach that includes assessment of all of the parameters required for high-grade deposits.

For this study, three critical parameters were used: the thickness of the hydrate stability zone, probability of reservoir lithology within the hydrate stability zone, and probability of adequate gas charge.

The thickness of the gas hydrate stability zone was determined with the use of data and reports obtained from the U.S. Naval Research Laboratory [11], and the additional contribution of Warren Wood (NRL) in the success of the project is gratefully acknowledged. The NRL data was gridded by Wood and Jung at 2 minutes of latitude and 2 minutes of longitude to produce a global map. Figure 2 illustrates their results.
Figure 2. Thickness of the Gas Hydrate Stability Zone [11].

Calculation of the gas hydrate resource potential for each of the 18 regions was undertaken by first segregating each region into separate sub-regions based on the local depositional setting. For marine gas hydrate, a range of values for the volume of sediment within the gas hydrate stability zone (corrected for sulfate reduction of methane near the seafloor) was calculated using the model developed by Wood and Jung [11]. These volumes were multiplied by:

- a range of values of the percentage of sand within the hydrate stability zone,
- a range of values for the percentage of those sands that would be hydrate-bearing,
- a range of values for sandstone porosity,
- a range of values for hydrate saturation of the pore space

This calculation provides an estimate of the gas in place for the gas hydrate resource.

As each of these parameters is poorly constrained in most of the world’s depositional basins, the resulting resource estimates extend over several orders of magnitude. A narrower range of values will be obtainable in the future as additional data is collected. Where detailed analyses have been conducted by previous researchers, those results have been integrated into the new evaluation.

For Arctic sediments, the estimate was determined using the same petroleum systems approach or, where the parameters for a petroleum systems approach were not available, extrapolation of recent analyses such as Collett et al. [9].

Results and Summary

The results of this study are summarized in Table 2.

<table>
<thead>
<tr>
<th>REGION (United Nations Designation)</th>
<th>Gas in Place Range (TCF)</th>
<th>Gas in Place Median (TCF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>1,500 – 15,434</td>
<td>7,013</td>
</tr>
<tr>
<td>Canada</td>
<td>533 – 8,979</td>
<td>2,228</td>
</tr>
<tr>
<td>Western Europe</td>
<td>36 – 14,858</td>
<td>1,425</td>
</tr>
<tr>
<td>Central &amp; Eastern Europe</td>
<td>0 – 105</td>
<td>13</td>
</tr>
<tr>
<td>Former Soviet Union</td>
<td>1,524 – 10,235</td>
<td>3,829</td>
</tr>
<tr>
<td>North Africa</td>
<td>6 – 1,829</td>
<td>218</td>
</tr>
<tr>
<td>Eastern Africa</td>
<td>42 – 25,695</td>
<td>1,827</td>
</tr>
<tr>
<td>Western and Central Africa</td>
<td>79 – 26,672</td>
<td>3,181</td>
</tr>
<tr>
<td>Southern Africa</td>
<td>121 – 26,369</td>
<td>3,139</td>
</tr>
<tr>
<td>Middle East</td>
<td>31 – 3,848</td>
<td>573</td>
</tr>
<tr>
<td>China</td>
<td>10 – 1,788</td>
<td>177</td>
</tr>
<tr>
<td>Other East Asia</td>
<td>14 – 2,703</td>
<td>371</td>
</tr>
<tr>
<td>India</td>
<td>36 – 6,268</td>
<td>933</td>
</tr>
<tr>
<td>Other South Asia</td>
<td>20 – 3,497</td>
<td>557</td>
</tr>
<tr>
<td>Japan</td>
<td>71 – 471</td>
<td>212</td>
</tr>
<tr>
<td>Oceania</td>
<td>38 – 6,750</td>
<td>811</td>
</tr>
<tr>
<td>Other Pacific Asia</td>
<td>64 – 25,946</td>
<td>1,654</td>
</tr>
<tr>
<td>Latin America and the Caribbean</td>
<td>258 – 31,804</td>
<td>4,940</td>
</tr>
<tr>
<td>Southern Ocean</td>
<td>144 – 45,217</td>
<td>3,589</td>
</tr>
<tr>
<td>Arctic Ocean</td>
<td>178 – 55,524</td>
<td>6,621</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,705 – 313,992</strong></td>
<td><strong>43,311</strong></td>
</tr>
</tbody>
</table>

Table 2: Gas in Place in Hydrate-Bearing Sands

The global volume of gas hydrate is enormous, and a significant portion of the total volume occurs in reservoirs from which natural gas is technically recoverable. While the resulting resource estimates extend over several orders of magnitude, a narrower range of values will be obtainable in the future as additional data is collected.

This evaluation was conducted as part of the Global Energy Assessment (GEA), coordinated by
the International Institute for Applied Systems Analysis. The entire assessment will be published in summer, 2011 (IIASA 2011, in press).

REFERENCES