Ham Rong Dong & Ky Lan discoveries – a new significance and opening up vast opportunities in the Northern offshore Part of Song Hong basin

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Abstract

The exploration in the northern area of the Song Hong Basin, offshore Vietnam, was previously considered challenging. Most hydrocarbon discoveries had historically been made solely in Miocene inversion clastic and fractured/karstified carbonate basement and are marginal and sub-commercial discoveries.

Recently, further studies and extended exploration program have made two more important discoveries. The first one is the Ham Rong Dong gas and condensate discovery in Oligocene overlying the basement high in Block 106. This is the first significant hydrocarbon discovery of the Oligocene clastic reservoir in the northern offshore area of the Song Hong Basin. The reservoir is of good quality with net sand up to 60m and porosity from 13% to 16%. The second one is the Ky Lan gas discovery in four way-dip closure within a depocenter trough in Block 107. The reservoir quality is quite good with total net sands about 100m and porosity from 14% to 16%. In addition to these two significant discoveries, the recent E well on the V Island encountered ca. 500m of a massive Oligocene lacustrine “world class” claystone source rock with TOC up to 9% and containing mainly Type I and II kerogen. All of the above discoveries are very important and opening up vast exploration opportunities in the northern offshore part of the Song Hong Basin.

This talk will provide key information on the two new hydrocarbon discoveries, claystone source rock, and also the implication of these two new discoveries for further exploration.
Introduction

Song Hong Basin is characterized predominantly by northwest-southeast orientation, developing from the Hanoi Trough through the Gulf of Tonkin. The studied area is a part of the Song Hong Basin covering Blocks 101-100/04; 102/10-106/10; and 103-107 (Fig. 1).

![Figure 1: Location map of Song Hong Basin and the study area](image)

The hydrocarbon exploration activities in the basin started in the early 1960s and can be summarized as follows:

- 1960 - 1987: the activities first focused on the onshore part of Hanoi Trough which is a small part of the onshore Song Hong. The activities included magnetic and gravity surveys at regional scale. 2D seismic surveys were followed in the early 1970s. These surveys defined 11 areas with hydrocarbon potential, including some 4 way dip closure prospects.

  The drilling work started in 1975 and a total 42 exploration/appraisal/development wells were drilled from 1975-1985. The wells mainly targeted the Miocene inverted prospects with expected fractured carbonate basement at a depth range from 600 to 4,250m. Tien Hai gas field was discovered and brought on production during this period.

- 1988 – today: the exploration and development activities increased rapidly in the area by foreign companies under the PSC. More 2D infill and new 3D seismic surveys were conducted to better evaluate the hydrocarbon potential.

The exploration, appraisal, and development works up to date can divide the studied area (northern part of the Song Hong Basin) into five different regions as bellow (Fig. 2), in terms of the hydrocarbon potential:

- Pre-Tertiary basement highs
- Tertiary flanks around the basement highs
- Ky Lan Trough
- Miocene Inverted area
- Western Oligocene flank.
Until 2013, four oil discoveries in the carbonate basement and five gas discoveries in the Miocene Inverted region were made. The most important one during this period was Thai Binh gas discovery which was then brought on production in 2015.

Following the above successes, more exploration and appraisal works were carried out in the region. As a result, two more gas discoveries were made firstly in Oligocene of the Ham Rong Dong and secondly in the Miocene in the Ky Lan Trough. These are two new plays in the region that opened up a new concept and new plan for the further exploration in the region.

**Geological overview**
Tectonic and geological evolution of the region can be summarized as follows (Fig. 3):
- From Eocene to Oligocene: early rifting creating basement high and low.
- Late Oligocene: continued Bien Dong opening, resulted local inversion in Song Hong Basin.
- Middle Miocene: Red River Fault changed from left lateral movement to right lateral movement resulted strong inversion and erosion.
- Late Miocene: Red River Fault continued right lateral movement then followed by thermal subsidence.
Geological structure of the northern Song Hong Basin can be divided into two distinctive regions (Fig. 2):

- North West of Song Hong Basin:
  - Thanh Nghe Basement High
  - Miocene Inverted zone
  - Song Hong Central Trough
  - Dong Son Nose
  - Ky Lan Trough

- North East of Song Hong Basin:
  - Ha Long Shelf
  - PA Trough
  - Ham Rong Trough

Stratigraphy of the northern Song Hong Basin comprises of various Proterozoic schists and gneiss, Palaeozoic and Mesozoic clastics, carbonates and volcanic and clastic from Eocene - present day (Fig. 4).
Source rocks
The first one is oil prone – source rock in the North East Song Hong. In 2012, E well drilled in V Island encountered about 500m of massive claystone aged Oligocene. This claystone has a high TOC (from 1-7%); HI from 450-900 mg/gTOC; kerogen type 1-2 (Fig. 5).

Gas chromatography analysis results on fluid samples from DSTs of R-1X, R-2X, D-1X, N-1X and B-1X indicate that hydrocarbon from these wells are same type which were expelled from fresh water lacustrine source rock (Fig. 6).

Figure 4. Generalized Stratigraphy of Northern Song Hong Basin

Figure 5. Oil Prone Source Rocks – North East Song Hong (3D basin modelling in Blocks 103 and 107 of the northern Song Hong Basin, VPI)
Figure 6: Chromatography Analysis of Sterane m/z 217 (Geochemistry Report, VPI)

The second one is Upper Oligocene and Lower Miocene gas prone source rock in the central Song Hong Basin. This source rock has TOC normally less than 2%, HI less than 300 mg/g TOC, and kerogen mainly type III (Figure 7).
Figure 7. Gas prone source rock – Central Song Hong (3D basin modelling in Blocks 103 and 107 of northern Song Hong Basin, VPI)

Significant Ham Rong Dong and Ky Lan discoveries

**Ham Rong Dong Oligocene discovery**

Ham Rong Dong is located in southeast of Block 106/10 and a three way dip closure against faults (Fig. 8) defined by good 3D seismic data. The targets of this prospect for the D-1X were primarily Pre-Tertiary carbonate and secondary the Oligocene sands.

![Figure 8: Seismic line through D-1X](image)

The D-1X was drilled in 2014. Before reaching the primary targets of Pre-Tertiary carbonate, the well encountered a series of Oligocene sands, of which 4 sands (Sand 1, Sand 4, Sand 5, and Sand
6) contain significant hydrocarbon (Fig. 9).

The sand thickness varies from 7 to 40m with moderate porosity between 11%-16%. Total sand thickness encountered is around 100m, of which 46m is gas net pay (Table 1).

<table>
<thead>
<tr>
<th>Sand</th>
<th>Top(MD)</th>
<th>Bottom(MD)</th>
<th>Gross(TVDSS)</th>
<th>Net</th>
<th>N/G</th>
<th>SW</th>
<th>PHIE</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>3116</td>
<td>3127</td>
<td>11.2</td>
<td>9.7</td>
<td>0.86</td>
<td>0.46</td>
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<tr>
<td>4</td>
<td>3328</td>
<td>3336</td>
<td>8.4</td>
<td>5.1</td>
<td>0.6</td>
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<tr>
<td>5</td>
<td>3398</td>
<td>3424</td>
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<td>17.3</td>
<td>0.66</td>
<td>0.55</td>
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</tr>
<tr>
<td>6</td>
<td>3502</td>
<td>3543</td>
<td>41.1</td>
<td>13.5</td>
<td>0.33</td>
<td>0.29</td>
<td>0.11</td>
</tr>
<tr>
<td>1a</td>
<td>2749</td>
<td>2800</td>
<td>50.5</td>
<td>23.8</td>
<td>0.47</td>
<td>0.92</td>
<td>0.15</td>
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<tr>
<td>1b</td>
<td>2830</td>
<td>2882</td>
<td>52</td>
<td>30.6</td>
<td>0.59</td>
<td>0.95</td>
<td>0.14</td>
</tr>
<tr>
<td>1c</td>
<td>3090</td>
<td>3100</td>
<td>10.7</td>
<td>9.3</td>
<td>0.87</td>
<td>0.9</td>
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<td>3172</td>
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<tr>
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<tr>
<td>3</td>
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<td>0.57</td>
<td>0.87</td>
<td>0.12</td>
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</table>

Three DSTs were conducted. DST#1 was over the Pre-Tertiary carbonate interval; DST#2 was over Sand 6; and DST#3 was over Sand 5. Unfortunately, DST#3 failed due to the premature bullet firing. The result of the DST#2 is summarized in Table 2 below.
Table 2: Summary of D-1X DST#2 results

<table>
<thead>
<tr>
<th>Depth</th>
<th>Choke size</th>
<th>Q gas</th>
<th>Q cond</th>
<th>Q Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>mMD</td>
<td>inch</td>
<td>mmscfpd</td>
<td>bpd</td>
<td>bpd</td>
</tr>
<tr>
<td>3503.5 - 3520.5</td>
<td>56/64</td>
<td>30.5</td>
<td>2391</td>
<td>211</td>
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</table>

The discovery with commercial gas and condensate flows in Oligocene Ham Rong Dong has been significant for the further exploration and development in the northern Song Hong along with conventional Pre-Tertiary carbonate and Miocene sand in the Miocene Inverted region.

Ky Lan Miocene discovery

Ky Lan is located in the Ky Lan Trough in the eastern part of Block 107. It is a four way dip closure (Fig. 10) with the target from Lower to Middle Miocene sands.

Figure 10: Ky Lan structure maps and Seismic Attributes for Sand 1 and Sand 3

In 2015, L-1X was drilled with a planned TD of 4,200m TVDSS. At the depth of ~ 3,598m TVDSS around 6.5m of the top sand of the primary Middle Miocene target was penetrated, and the well encountered abnormal high pressure and stopped for safety reasons. Through the Middle Miocene section, the well encountered three gas bearing sands namely Sand 1, Sand 2 and Sand 3. These are interpreted to be associated with deltaic depositional environment.

- Sand 1 (3,439-3,476 mMD): Porosity is from 10-16%. Average water saturation is ca. 45%. This sand was tested with gas flow of around 8 mmscfpd (Fig. 11)
Figure 11: Well Log type of L-1X for Sand 1

- Sand 2: (3,485-3,496mMD): Porosity is from 9% to 15%; Water saturation is around 66.4%; net pay is 5m. This sand was not tested (Fig. 12).

Figure 12: Well Log Type L-1X Sand 2

- Sand 3: (3,585 to 3,591mMD): Porosity is 10-16%; average water saturation is ~51%. Net pay is around ~6m. The well was stopped at the sand pay, thus the net pay of the whole sand is expected to be significantly higher. The penetrated interval was tested with gas flow of ~6.5 mmscfd without water (Figure 13).
Summary

The Ham Rong Dong gas discovery is the first in the Oligocene sand with commercial gas and condensate flowing at rates in excess of 30 mmmscfpd gas and nearly 2,500 bpd of condensate. This is a significant achievement in hydrocarbon exploration in the region and confirms huge potential of the Oligocene sands for further exploration and then development.

The Ky Lan discovery again confirms significant potential of hydrocarbon in the Miocene sands in the east of Block 107. Before this discovery, the exploration for Miocene targets solely focused on the Miocene Inverted Region. The Ky Lan deeper target, which was not reached by L-1X, has considerable potential for new wells. The success of the Ky Lan gas discovery opens up great opportunities for further exploration and also confirms viable development.

A massive claystone with high TOC and kerogen Type I & II, oil prone source rock by the E well in the V Island is phenomenal important to help explorers with a new concept for upcoming exploration and then development. The new concept is to look for oil and condensate accumulations along with the previous “gas target” concept.
References