General Information

Area : 181 035 sq.km
Prov. : 24
Capi. : PP
Popu. : app. 13 mm.
Rel. : Buddhism
Seas. : dry&rainy
Clim. : tropical.
Av.T : 27
Lang. : Khmer
Prim. : Hun Sen
Curr. : Riel
Exch. : 3930R/dol.
GDP : 271
Section 1 : Objective, reasons and ideas of the case study.

Section 2 : Exploration History

Section 3 : Fiscal Regime

Section 4 : CNPA Organization and players
Section 1: Objective, reasons and ideas of the case study.

Section 2: Exploration History

Section 3: Fiscal Regime

Section 4: CNPA Organization and players
Objective of the case study

To assist the Exploration and Production Division of the Cambodian National Petroleum Authority and the other participating nations in developing a resource overview of the resources in this semi-mature offshore basin and identifying the critical elements of a gas field development. The objective is further to consider appropriate petroleum policies for an optimal exploitation of the resources and value creation for the society of this, and other similar semi-mature areas.
The study area is the Khmer Basin Offshore Cambodia, proposed by the Cambodian National Petroleum Authority (CNPA). The area has been explored for 30 years. So far 12 exploration wells have been drilled and four oil and gas discoveries have been made.

The Khmer Basin is relatively small, situated adjacent to the petroliferous Pattani and Malay Basins.
Well Location Map

Koah Tang-1
H-1
Poulo Wai-1
Angkea Sil
Bayon-1
Da-1
L-1
Devada B-1
Apsara
Angko
Preah Khan-1
Khmer, Pattani and Malay basins in Gulf of Thailand
Geological Background

Khmer Basin was tectonically formed by the result of extrusion in Indochina that was caused by a collision of Indian Plate into Eurasian Plate.

Coupling with Indian-Australian Plate movement and Philippines Plate, it formed main petroleum basins in Southeast Asia, especially in the Gulf of Thailand. The basement of the Khmer Basin consists of mainly the pre-Tertiary age.
STRUCTURE ELEMENTS MAP
Even though some previous studies indicated that Khmer Basin may consists of several types of play, four types have been identified to be more likely prospective. Those types are synthetic, antithetic, inner terrace and horse. Of them synthetic of Angkor Prospect is the most viable for gas and condensate development.
## Sequence of Khmer basin

<table>
<thead>
<tr>
<th>Seq.</th>
<th>Age Description</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seq. X</td>
<td>E. Pliocene-? Pleistocene</td>
<td>Interb.sts.cls.&amp; minor coals</td>
</tr>
<tr>
<td>Seq. IX</td>
<td>L. Miocene-E. Pliocene</td>
<td>Interb.sts.cls.&amp; minor coals</td>
</tr>
<tr>
<td>Seq. VIII</td>
<td>M. Miocene-L. Miocene</td>
<td>Minor sts. Interb. With slt. Coal &amp; lignite</td>
</tr>
<tr>
<td>Seq. VII</td>
<td>Middle Miocene</td>
<td>Interb. Sts. Cls. &amp; slt. with minor coal</td>
</tr>
<tr>
<td>Seq. VI</td>
<td>Middle Miocene</td>
<td>Minor sts. Interb.with shl. &amp; coal</td>
</tr>
<tr>
<td>Seq. V</td>
<td>E. Miocene-M. Miocene</td>
<td>Minor sts. Interb.with shl. &amp; coal</td>
</tr>
<tr>
<td>Seq. I</td>
<td>Late Eocene</td>
<td>Local conglomerates</td>
</tr>
<tr>
<td><strong>Basement</strong></td>
<td></td>
<td><strong>Largely metam. Sedt&amp; volc. igno. rock</strong></td>
</tr>
</tbody>
</table>
Well Logs

Calliper (Cali)
Spectroscopy Gamma Ray (SGR)
Neutron Porosity (NPHI)
Bulk Density (RHOB)
Bulk Density Correction (DRHO)

etc.
Reservoir characters are expected as thick distribution channels and stacked channel sandstones in the Miocene and Oligocene sequences.

From the porosity trends studied as expected porosity decreases as depth increases because of compaction. It goes from 30% to 10% at the reservoir zones.

It considers economically 15% of porosity as lower limit for a reservoir of oil and there is a reservoir of gas even below 3000m.
3D VIEW OF SHALLOW SEISMIC, SHOWING CHANNEL RELATED ANOMALIES AND A CHANNEL BODY
By the 1998 Core-lab study of the Khmer Basin concluded that many source rocks (shale, mud-stone, coal) exist at several stratigraphic levels.

But sequence III (Late Oligocene-Earliest Miocene) contains the best source rock in the basin. This consists organically rich, lacustrine mud-stones, with up to 11% TOC and HI of up to 700.
Formation pressure of exploration wells in the Khmer Trough indicated an abnormal high pressure below 2300m. The previous exploration wells showed that the formation pressure can be up to 7000 psi.

Temperature gradient is about 5.14 degree centigrade per 100m. The highest temperature is up to 200 degree centigrade. This could be necessary to use oil based mud for drilling the wells.
KHMER TROUGH REGIONAL SEISMIC CROSS-SECTION
Referring to the formation study (medium porosity and permeability), high faulted zones, stacked reservoirs etc., many wells is going to be drilled in the offshore Cambodia.

Wells should be drilled along the faults (down) and as closer as possible to the faults with the distance from well to well around 100m.

But this is not telling that we could not find another possibility to reduce the numbers of wells according to modern drilling technology and the future technology.
Gas Consumption

By an official evaluation the gas is imported into Cambodia approximately 22,000 tons per year. Most of the gas imported products are used for cooking.

For the future the Government of Cambodia has a plan to build two 90 MW combined circle power plants in Sihanouk Ville. As well as, the Government has a plan to organize the Industrial Zones near Sihanouk Ville for the future development of Cambodia.

This plan was study by Chinese Experts in cooperation with the Ministry of Industry, Mines and Energy.
Gas Distribution

International Sale
To Thailand

Domestic Sale
Power Plant
Factory and House Supply
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Exploration History

- 1950 geological surveys by a team of Chinese geologists
- 1960 geol.&struct. mapping by Polish geologists.
- 1972-74 drilled 3 wells by Elf and Esso.
- 1998 5000 sq.km in blocks 5&6 by Woodside.
- 1999 study agreement between CNPA&Woodside.
SCHHEMATIC CROSS SECTION THROUGH WELL L-1
BASED ON LINE 92-540

TD : 1705 mss @Lower Miocene
Untested closure remains in synrift and earliest post-rift sections.

RESERVOIRS ✓
NO SOURCE ROCKS
NO SHOWS
VALID TRAP

SOURCE ROCKS
POTENTIALLY DEVELOPED
IN THE SYNrift
NO BANDED REFLECTORS

EASTERN BASIN
EASTERN PLATFORM
CENTRAL SAG

Late Miocene
Early Miocene
Middle Miocene
Early Miocene/Late Oligocene

Reservoir Rocks
Thin Rich Lacustrine Source Rock
Lean and Dispersed Mixed Lacustrine
Terrestrial Source Rocks
Pre-Tertiary
Synrift
Schematic Cross Section through Well H-1 Based on Line 92-561

Late Miocene
Lean and Dispersed Mixed Lacustrine
Thick Rich Lacustrine Source Rock
Reservoir Rocks
Pre-Tertiary
Early Mocene
Early Mocene/Late Oligocene
Thin Middelian Source Rock
Source Rocks Potentially Developed in the Basin Centre

Prospects

Khmer Basins
Khmer Ridge

Reservoirs
No Source Rocks
No Shows
Valid Trap
Lateral Migration
Not Effective

BlocK 1 & 2 Enterprise
Well_H1_cross.cd
SCHEMATIC CROSS SECTION THROUGH WELL B1-1
BASED ON LINE 92-501

KHMER BASIN
EASTERN PLATFORM

CAMBODIA BLOCK I & II

NE

Late Miocene to Early Miocene Synrift Reservoir Rocks
Lean and Dispersed Mixed Lacustrine Source Rocks
Thick Rich Lacustrine Source Rock
Lean and Dippered Mixed Lacustrine Turbidite Source Rocks
Pre-Tertiary

Lateral Migration Not Effective

Reservoirs
No Source Rocks
No Shows
Valid Trap

Source Rocks Potentially Developed in the Basin Centre

Prospect

48 km

1 2 3 4 5

TWT in Seconds
Preah Khan -1  >800m from fault
ENT92-077 Mig -Filtered

PREAH KHAN-1 WELL PATH
Da - 1 > 300m from fault
Crossline Migration 2129

DA-1 WELL PATH
POULO WAI-1 WELL PATH
SUMMARY OF BASINAL WELLS

- Deviated Wells
  Bayon, Da, Preah Khan
  All >200m downdip of fault no pay

- Wells Should Be:
  Deviated <200m from fault
  Or Vertical on closure in graben centre

- Vertical Wells
  Angkor, Poulo Wai, Apsara
  Limited scope for pay

PROVEN PLAY
Oil and Gas in SEQ3
Kaoh Tang-1

PROVEN PLAY
Oil and Gas in SEQ3
Aspara-1 Angkor-1
Poulo Wai-1

PROVEN PLAY
Angkor-1 DST#4
4.7mmscf/d 180bopd
MAIN HYDROCARBON TESTS

**Oil**
- 1100 scf/bbl GOR;
- 42° API;
- DST-3 1180 stb/d (early depletion);
- (3 mbbls STOIL); Sequence III;
- (also minor gas on RFT in Sequence IV)

**Oil**
- 300 scf/bbl GOR;
- 33.5° API;
- DST-3 250 stb/d (early depletion);
- (0.7 mbbls STOIL); Sequence III;
- (also minor gas on RFT in Sequences V, VI)

**Condensate**
- 38 bbls/mmscf CGR;
- 60° API;
- DST-4 4.7 mscf/d;
- (100 bcf GIIP); Sequence IV;
- (also oil, gas and light oil in Sequences III, IV)
In 1999, Woodside entered into the Study Agreement with CNPA covering blocks I-IV and VII with the purpose to determine the prospectivity of those blocks and feasibility of developing the discovered reserves.

The result of the Study has shown that there is some potential for gas to be present in the area and model has been developed to assess the reserve potential of the area based on analogue from elsewhere in the Gulf of Thailand.
Recently, on 15th August 2002 the Government of Cambodia represented by the Cambodian National Petroleum Authority has signed the Production Sharing Contract with Chevron Texaco and Moeco to explore the Area “A” offshore Cambodia.

Area A is the parts of Blocks I, II, III and IV
During 1990-1997 about 13,675 km of 2D seismic lines and 1,050 sq.km of 3D seismic surveys were acquired and processed in these offshore blocks by Enterprise Oil, Premiere Oil, Campex, Idemitsu and Woodside.
STUDY AREA
H-1, B-1, L-1 wells were drilled by Elf-Esso from 1972 to 1974. The wells were drilled outside the Khmer Basin with total depth around 2000m.

There is no oil and gas show in these wells and almost no data to study.
Apsara-1 well

Operator : Campex
Rig Name : Ocean Clipper
Spudded Date : 01/12/93
P&A Date : 03/02/94
Total Depth : 3308m
Well Status : oil and gas discovery
Devada–1 well

Operator : Campex
Rig Name : Ocean Clipper
Spudded Date : 05/02/94
P&A Date : 16/03/94
Total Depth : 3207 m.
Well Status : Dry
Angkor-1 well

Operator: Enterprise Oil
Rig Name: Canmar Explorer III
Spudded Date: 17/01/94
P&A Date: 16/04/94
Total Depth: 3933m (3951m. Of MD)
Well Status: oil, gas and condensate discov.
Koah Tang–1 well

Operator : Premier
Rig Name : Neddril I
Spudded Date : 19/05/94
P&A Date : 26/09/94
Total Depth : 3500m (3867m of MD)
Well Status : oil and gas show discovery
Da-1 well

Operator: Enterprise Oil

Rig Name: Canmar Explorer III

Spudded Date: 23/03/96

P&A Date: 22/05/96

Total Depth: 3437m (3923m of MD)

Well Status: oil show
Preah Khan-1 well

Operator: Enterprise Oil
Rig Name: Canmar Explorer III
Spudding Date: 23/05/96
P&A Date: 22/06/96
Total Depth: 2519m (3045m of MD)
Well Status: Dry
Poulo Wai-1 well

Operator : Campex
Rig Name : Ocean Clipper
Spudded Date : 28/08/96
P&A Date : 02/11/96
Total Depth : 3460 m.
Well Status : Oil Show
Bayon-1 well

Operator: Enterprise Oil

Rig Name: Canmar Explorer III

Spudded Date: 03/11/96

P&A Date: 21/12/96

Total Depth: 3039m (3744m of MD)

Well Status: Gas Show
Koah Pring-1 well

**Operator:** Idemitsu  
**Rig Name:** Energy Searcher  
**Spudded Date:** 10/04/98  
**P&A Date:** 14/05/98  
**Total Depth:** 3018m  
**Well Status:** Dry
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The Government of Cambodia will assist Contractor and its Subcontractors in obtaining all government permissions, registration, licenses, visas and other approvals and right which are necessary to carry out Petroleum Operations under the Petroleum Agreement.
Fiscal Regime

**Area** : No bidder shall be granted more than two exploration blocks for Petroleum Operations, with total acreage of not exceeding 15 000sq.km., but in case for the study of comprehensive reviews and appraisal of the data, which may be considered as non commercial activities, the bidder may be granted several petroleum exploration blocks as mutually agreed.

**Duration** :

- Exploration 4y + 2+2-year extensions
- Development 3 or 4 ( oil or gas )
- Production up to 30 years + 5-year extensions
**Fiscal Regime**

**Relinquishment:**
- 30% initial exploration period
- 25% extension of exploration period

**Exploration Obligation:**
- conduct 2-D seismic *(specified in the Petroleum Agreement)*
- conduct 3-D seismic *(specified in the Petroleum Agreement)*
- drilling 1-2 wells
Fiscal Regime

Royalty: 12.5%
Signature Bonus: Negotiable
Production Bonus: Negotiable
Depreciation: Negotiable
Cost Recovery:
- 70-80% for oil based on negotiation
- 80-100% for gas based on negotiation
## Fiscal Regime

### Profit Oil Split

<table>
<thead>
<tr>
<th>Production (bopd)</th>
<th>Government (%)</th>
<th>Contractor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 10,000</td>
<td>42</td>
<td>58</td>
</tr>
<tr>
<td>10,001-25,000</td>
<td>47</td>
<td>53</td>
</tr>
<tr>
<td>25,001-50,000</td>
<td>52</td>
<td>48</td>
</tr>
<tr>
<td>50,001-75,000</td>
<td>57</td>
<td>43</td>
</tr>
<tr>
<td>75,001-100,000</td>
<td>62</td>
<td>38</td>
</tr>
<tr>
<td>over 100,000</td>
<td>67</td>
<td>33</td>
</tr>
</tbody>
</table>
## Fiscal Regime

### Profit Gas Split

<table>
<thead>
<tr>
<th>Production (MMm³/d)</th>
<th>Government (%)</th>
<th>Contractor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 5</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>5.1 - 10</td>
<td>45</td>
<td>55</td>
</tr>
<tr>
<td>10.1 - 15</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>over 15</td>
<td>60</td>
<td>40</td>
</tr>
</tbody>
</table>
Fiscal Regime

**Taxation**: Income tax 25 to 50%

**Ringfencing**: Each license ringfencing

**Domestic Market Obligation**: required to meet the internal demand of Cambodia

**State Participant**: The Cambodian Government shall have the right to participate in petroleum operation under Petroleum Agreement.
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Before CNPA set-up

The organization set-up for petroleum management in Cambodia was placed within various ministries. The management of petroleum resources (exploration and production) was entrusted by the Ministry of Industry, Mines and Energy while petroleum import-export was jointly controlled by the Ministry of Commerce and the Ministry of Economy and finance.
To manage and develop effectively the petroleum in the country, a separate national institution, Cambodian National Petroleum Authority “CNPA“ was established in accordance with Royal Decree dated on 22 January 1998, with the important role and responsibility to manage and develop both upstream activities within the petroleum sector.
CNPA Structure

Chairman

Vice-Chairmen

Director General

Upstream Division

Downst. Division

Legal&Negt Division

Administ. Division
Cambodian National Petroleum Authority is under the direct supervision of the Prime Minister and headed by a Chairman, H.E Sok An, is currently senior minister in charge of the Council of Ministers. The Chairman has the full authority necessary to oversee the CNPA’s work performance and responsibility for facilitating petroleum operations, both upstream and downstream, policy-making, planing and drafting legislation in relation to petroleum management and development.
The case study team will consist of professional staff from the Exploration and Production Division of CNPA and individuals appointed from the authorities of the other CCOP Member countries that take part in the case study.

Technical personnel from the member Countries will be given the opportunity to participate in the case study, both to gain experience and to contribute their expertise to the project.
The Cambodian National Petroleum Authority will provide in-kind contribution to the project, such as technical staff and secretariat services, office facilities and data.
The case study on Natural Gas Development in Kusrovie field offshore Cambodia is very important in our petroleum Exploration, Development and Production.

The Petroleum Exploration and Production Division of the Cambodian National Petroleum Authority needs more experience in the petroleum Policy and Management, and especially this case study project with strengthening, upgrading the development of Natural Gas in offshore Cambodia.