The Hydrocarbon Potential of Block SS-11, Offshore Bengal Basin – An Insight from 3D Seismic Data

April 2019
Introduction

Block SS-11:
Bangladesh, Offshore Bengal Basin
Proven underexplored play
Early stage of exploration
50% relinquishment after the end of the Initial Exploration Period (March 2021).

Partners:
- Ophir 45%
- KrisEnergy 45%
- BAPEX 10% carried interest

PSC signed 12 March 2014

Work Commitments:
- 1 well in shallow water (TD ≥ 3300m TVDSS, below mudline)
- 300km² 3D survey (completed 2018)
Block SS-11

- Offshore Bengal Basin
- Bengal Shelf
- Water depths: 10 – 700m, with the majority of the block lying in water depths less than 200m
- Area: 4,475km²
Tectonics – Dominated by India-Asia Collision and Subduction

Key Tectonic Events:

Late Jurassic–Early Cretaceous magmatic arc and metamorphism associated with India-Asia collision and eastwards subduction.

Mid-Eocene–Oligocene post collision crustal thickening, metamorphism and S-type leucogranite magmatism along the Burma Mogok metamorphic belt.
Tectonics – Resultant Domains
“Passive Margin” vs. “Intraplate Deformation” "Gentle Folds" vs. "Tight Folds":

This deformation is most intense in the east, resulting in tight faulted and very elongated anticlines exposed in the onshore Chittagong Fold Belt.

Towards the west, deformation is progressively younger, and characterized by gentler less elongated anticlinal structures that are less affected by faulting, as seen in the SS-11 and Shwe areas.

Structure – Dominated by NNW-SSE Folds
Megasequence 1 (MS1)
- Laterally continuous events, high amplitude reflectors and minor channel incision
- The southernmost extent is marked by the shelf-edge and well-developed clinoforms

Megasequence 2 (MS2)
- Abundant large-scale erosive canyons, resulting limited lateral continuity.
- The canyons are filled with seismically different reflectors

Megasequence 3 (MS3)
- Laterally continuous seismic reflectors with many small-scale, estuarine erosive events
Bengal Fan Depositional Model
Block SS-11 – Petroleum Systems Summary

Source rocks and Charge
- Mio-Pliocene gas prone shales providing both biogenic and thermogenic gas charge

Reservoirs
- Mio-Pleistocene sands of the Bengal Fan
- Southerly prograding and aggrading delta system sourced from the Ganges-Brahmaputra drainage system.
- Various depositional environments identified, ranging from deepwater basin floor fans and slope fans to shallow marine delta tops and channel sands

Traps
- Anticlines forming part of the Magnama-Shwe anticlinal trend have been recognised and mapped in the eastern part of Block SS-11.
- Stratigraphic traps, largely associated with shale-filled channel or canyons which cut into stacked, reservoir quality sands and interbedded shales.
- SS-11 is characterised by various play types from broad and tight anticlines, through to stratigraphic/structural and fault dependent closures.

Seals
- Top seals are largely Plio-Pleistocene regional shales, with intraformational and shale filled channel cuts forming additional lateral and/or additional top-seals.
Miocene and Pliocene gas prone shales provide both biogenic and thermogenic gas charge.

The average TOC content of Mio-Pliocene Surma Group is 0.2 - 0.78%.

Late Miocene/Early-Late Pliocene biogenic origin confirmed for the adjacent Thalin and Shwe gas Field.

Organic rich Oligocene-aged shales another potential source.
Block SS-11 – Reservoirs

Legend

- Leveed Channel/Shelfal Sand
- Channel Fill Sand
- Complex Channel Fill
- Mass Transport Deposit
- Prograding Wedge/Slope fans
- Basin Floor Fan
- Proven Reservoir
- Unproven Reservoir

Mass Transport Deposit

R

Basin Floor Fan

R

Prograding Wedge/Slope fans

Complex Channel Fill

R

Mass Transport Deposit

R

Proven Reservoir

Unproven Reservoir
Block SS-11 – Traps and Seals

1. Anticlines forming part of the Magnama-Shwe anticlinal trend have been recognised and mapped in the eastern part of Block SS-11.

2. Stratigraphic traps, associated with mud-filled channel or canyons that cut into stacked, reservoir quality sands.


Top seals are largely Plio-Pleistocene regional shales.

Lateral sealing provided by mud filled channels.
Exploration Targets – “Tight Fold” Examples

Kailashtilla Field

Bibiyana Field

Rashidpur Field
Regional Example – Offshore Hatia Trough

Sangu Field, Hatia Trough, Bengal Basin, offshore Bangladesh

Seismic section from the Sangu to Jaldi structures - Jaldi lies within the coastal Chittagong Foldbelt whereas Sangu is located within the Hatia Trough - both structures though are a result of late stage, westward fold and fault propagation. (modified from Najman et al., 2011).
Exploration Targets – “Gentle Fold” Examples (SS-11)

(modified from McKenna, 2006)
SS-11 – Multiple Play Types

1. By-pass Channel
   - Proven: Stratigraphic

2. Shelfal and channel levee sands
   - Proven: Stratigraphic

3. Weakly confined channel complex
   - Proven: Stratigraphic

4. Slope fans and channels
   - Proven: Stratigraphic

5. Low Relief Anticline
   - Proven: Combined Anticlinal

6. Mass Transport Deposits
   - Proven: Stratigraphic

Block SS-11

- Megasequence 1
  - Slope to Basin Floor Facies

- Megasequence 2
  - Incised Canyon Fills
  - Shelf Breaks

- Megasequence 3
  - Shelf Breaks

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Shwe Discovery – Original Target - Shwe Anticline

Main reservoir Anticline at surface

Outboard anticline trend

Shwe anticline trend

(from Santos, 2013)
Comprises of three (3) back-stepping distributary channel/fan **complexes** (Shwe, Shwe Phyu and Mya), aligned from N-S along west flank of the Shwe Anticline.
Block SS-11 – Prospects and Leads Summary

- Prospective areas have been mapped with more than 7 tcf of associated recoverable reserves
- Multiple play types identified on the Block
- Potential to test multiple targets from a single drill location.
- Multiple gas chimneys throughout the Block indicate an active petroleum system
- The majority of the identified prospects are in shallow water (less than 100m) with reservoir intervals depths of 2,600 – 3,200m
Block SS-11 – 3D Paleoscan Image (Colour Blended)

- **Megasequence 2**
- **Megasequence 3**
- **Shelfal Sands (laterally sealed)**
- **Incised Canyon Fills (sand)**
- **Basin Floor Fans**

5Km
Block SS-11 – RMS Amplitude Map - Major Canyon-fill

2018 3D seismic

Major Canyon

5Km 5Km
Block SS-11 – RMS Amplitude Map - Basin Floor Fans

[Diagram showing RMS Amplitude Map with numbered areas and labels]

- Feeder channel
- SS-11 Block Boundary
- 5Km scale
Genetic-link – Block SS-11 and the Multi-TCF Shwe Discovery

RMS Amplitude map at various t=2.6s – Basin floor fans
Block SS-11 – Sheemanto Prospect

- High potential, untested in Bangladesh but similar to successful Myanmar plays
- Multiple plays tested from one surface location
  - Shelfal facies sealed by shale filled channels (2,500m)
  - Sand filled channel (3,300m)
  - Basin floor fans (4,100m)

- Sheemanto focus of 3D seismic acquisition. 308km² acquisition completed May 2018
- Drilling 2021/2022
- Water depth circa 90m

Arbitrary NS 3D seismic dip line showing the multiple targets of Sheemanto

VRMS Map of 430 Basin Floor Fan 1

Sheemanto basin floor fan (~37 km north of the Thalin gas field)

Sheemanto shelfal sands cut by shale filled channels

Sheemanto channel lead