In 1997, the ExxonMobil-operated Sakhalin I Consortium acquired a 3-D seismic survey over Chayvo Field, located off Sakhalin Island. Chayvo was previously thought to contain primarily gas given the results of 5 exploration wells. Interpretation of 3-D seismic revealed amplitude anomalies which conformed to structural spill downdip of gas accumulations seen in the crestal wells, indicating the potential for very large, previously unrecognized oil rims. An appraisal well was drilled in 2000 and penetrated several large oil legs postulated from the 3-D seismic. Associated sequence stratigraphic studies resulted in a significant oil project.

Development drilling at the field began in 2003, with the first phase comprising a series of extended reach wells drilled from an onshore location reaching offshore 9 to 11 kilometers to the western limb of the Chayvo anticline. These wells are technically complex and very expensive, but can be attractive considering offshore platform costs in a remote, environmentally sensitive location characterized by seismic activity and icebergs.

In 2002, a multi-disciplinary team was assembled to address these challenges. 3-D seismic visualization played a key role in planning the well paths. The primary geological concern was the accuracy with which the horizontal wellbores could be placed within the oil column as reservoir simulation indicated the need to be within 10 m of a specified vertical depth to optimize production performance. Ongoing ERD drilling has proven to be successful with actual reservoir depths coming within a few meters of prognosed depths at well reaches of 9-11 kilometers.
Chayvo Field, Sakhalin Island, Russia: Identification of a Significant Oil Leg from 3-D Seismic and Execution of a World Class Extended Reach Drilling Program

Ted Apotria, Randall S. Mathis*, Rick J. Powell, Bridget A. Venner

ExxonMobil Development Company

* Presenter

Portions of this paper were presented at the 2005 IPTC in Doha, Qatar.
Geological Setting
- Large anticlinal structure
- 10-30 m water depth
- Nutovo Formation (Miocene and Pliocene age)
- 14 hydrocarbon bearing zones
- Reservoir depths from 1,950 to 3,150 m subsea

Chayvo Exploration History
- 1971: structure identified from 2-D seismic data
- 1979: field discovery by SODECO and SMNG
- 1979 to 1981: 4 appraisal wells drilled
- 1982: Chayvo assessed as a gas resource and development deferred
- 1995: PSA awarded to Sakhalin I consortium
- 1997: ExxonMobil acquired 3-D seismic survey covering ~300 square kilometers
- 1998: 3-D seismic indicates potential oil rims
- 2000: Chayvo-6A drilled, confirmed significant oil leg identified from 3D seismic
- 2003: EMDC development drilling began
- 2005: First Oil production from Chayvo (October)
- 2006: Start-up of OPF (October)
- 2007: Achieved 250,000+ bbl/d (March)

Sakhalin-1 (3-fields) potential recov. resource:
- 2.3 BBLs, 17.1 TCF (Public Information)
**Exploration History**

- Thin oil rims in zones XVI and XVII
- Chayvo initially assessed as a gas resource
- Development was initially deferred

- **Pre-3-D Seismic**
  - XVI Depth Structure

- **Chayvo 3**
  - 900 m gross pay
  - Gas Cap
  - Oil Rim

- **Lower Nutov Reservoirs (Upper Miocene)**
  - XIV-U 40m
  - XVI-U 20m
  - XVII-U 35m
  - XX-U
  - XXII-U
• No down dip penetrations.
• Do deeper zones have potential?
• Water tests (Chayvo 3 & 5) indicated oil columns thin or absent
Chayvo 3D Survey
acquired in 1997

3-D Survey area

XVI Pre-3D structure

Gas Cap
Oil Rim

Gas Shadow/Chimney
Field pay

Amplitude terminations were well below known hydrocarbons seen in the wells

AAPG, Long Beach - Chayvo Field – Apotria, et. al.
02 April 2007
Amplitudes Enhanced With Visualization Tools

Numeric Summation/Amplitude Stacking

- Presence of multiple flat events in the same reservoir
- Suggested GOC and OWC full to structural spill
- Thicker oil zone not seen by pre-existing wells.

Dip anomaly expected from wavelet interference between the top reservoir and fluid contact

XVII – Time Structure Dip Map

AAPG, Long Beach - Chayvo Field – Apotria, et. al.
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Amplitudes Validated With Log and Test Data

Chayvo 3

- In Zone XVI, paired anomalies were consistent with known well tests indicating gas/oil/water, validating the seismic DHI
- Supported DHI interpretation in other reservoirs
Paired Anomalies Observed on 3-D Seismic

Significantly Thicker Oil Rim (~100m)

Previously Unidentified Oil Rim (~60m)
Oil Rims / Pre-drill Predictions Confirmed by the Chayvo 6 Well

CHAYVO FIELD CROSS SECTION

Chayvo 6 Chayvo 3 Chayvo 1 Chayvo 4 Chayvo 2 Chayvo 5

MDT pressure data indicated fluid contacts within 5 m of depths predicted from seismic.
Seismic Imaging of Depositional Facies

Chayvo 2

~ sand limit

Chronostratigraphy

Lithostratigraphy

XVII Amplitude

AAPG, Long Beach - Chayvo Field – Apotria, et. al.
02 April 2007
Targeting 9 - 11 km ERD Wells From Shore

Yastreb is one of the largest land drilling rigs in the world.
3D Survey Used to Target 9-11 km ERD Wells From Shore

Zone XVII Depth Map with Seismic Amplitude
Summary

- Large oil accumulation identified/tested twenty years after field discovery using integrated 3-D seismic interpretation and visualization tools.

- Initiated development drilling three years after discovery of the thicker oil columns.

- Targeting of 9 - 11 kilometer long ERD wells from onshore optimized the development plan.

- First oil achieved in October 2005 at 50,000 BOPD and currently producing 250,000+ BOPD (March 2007).

- Individual reservoir elements (deltaic clinoforms) are incorporated into geologic models/reservoir simulations.
Thank You
Acknowledgements

**ExxonMobil Colleagues:**
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**Sakhalin 1 Consortium Participants:**
*Exxon Neftegas Limited (Operator) – 30%*
*SODECO – 30%*
*ONGC-VIDESH – 20%*
*Rosneft-Astra – 8.5%*
*Sakhalinmorneftegaz (SMNG) – 11.5%*

*Portions of this paper were presented at the 2005 IPTC in Doha, Qatar.*
Geologic Setting

- Cenozoic back-arc rifting and extension
- Tertiary strike slip faulting on Sakhalin Island and transpression (inversion) offshore.
- Structurally controlled ramp undulations set up accommodation for deltaic clinoforms and local slope/fan deposits in <150m water depths.

From Worrall et al. 1996

AAPG, Long Beach - Chayvo Field – Apotria, et. al.
02 April 2007
### Regional Stratigraphy

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#### Exploration Wells and Nutov Formation
- **Nutov Fm.** comprises the productive section penetrated in Chayvo Exploration wells.
- Exploration wells penetrated ~3500m of Miocene-Pliocene deposits.
- **Nutov is subdivided into two groups:**
  - Upper Nutov
  - Lower Nutov (XI – XXII) – pays

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**AAPG, Long Beach - Chayvo Field – Apotria, et. al.**
**02 April 2007**
3-D Seismic Data Hypotheses

Stacked Amplitude
- Presence of multiple flat events in the same reservoir
- Suggested GOC and OWC full to structural spill
- Thicker oil zone not seen by pre-existing wells.

Optical Smash

AAPG, Long Beach - Chayvo Field – Apotria, et. al.
02 April 2007
Amplitudes Enhanced With Visualization Tools

XVII - Amplitude

- sand limit
- 6A
- 1
- 2
- 4
- 5

XVII – Time Structure Dip Map

- Chayvo 6a
- GOC
- OWC

Dip anomaly expected from wavelet interference between the top reservoir and fluid contact

Sun angle

~sand limit

 AAPG, Long Beach - Chayvo Field – Apotria, et. al.
02 April 2007
Seismically Identified Oil Rims Predicted

POST- 3D SEISMIC CHAYVO FIELD CROSS SECTION

Proposed Chayvo 6

Chayvo 3 Chayvo 2 Chayvo 5

Ch 1 Ch 4

Water tests in Chayvo 5 reflect complex clinoform stratigraphy and seal

Seismically identified/predicted oil rims

G - Gas test
O - Oil test
- Water test

2 km

ExxonMobil
Seismic Imaging of Depositional Facies

3-D seismic permitted the imaging of amplitude variation due to fluids and lithology.
Seismic Imaging of Depositional Facies

Chayvo 2

XVII

Clinoform Amplitude

Clinoform Hingeline Break

Channels

Chayvo 2

Chronostratigraphy

Lithostratigraphy

Insight into reservoir connectivity

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Shore-based Yastreb Drilling Rig

- Yastreb is one of the largest commercial drilling rigs in the world (70 m tall)
- Yastreb site contains the necessary equipment to drill and complete some of the longest ERD wells in the world
- Yastreb helps minimize environmental impact of drilling in this coastal area

Yastreb Rig Site, onshore Sakhalin Island

Offshore Field Locations Covered by Pack Ice in Winter

Testing Z-6, July 2004