[AV]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*

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Abstract

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.

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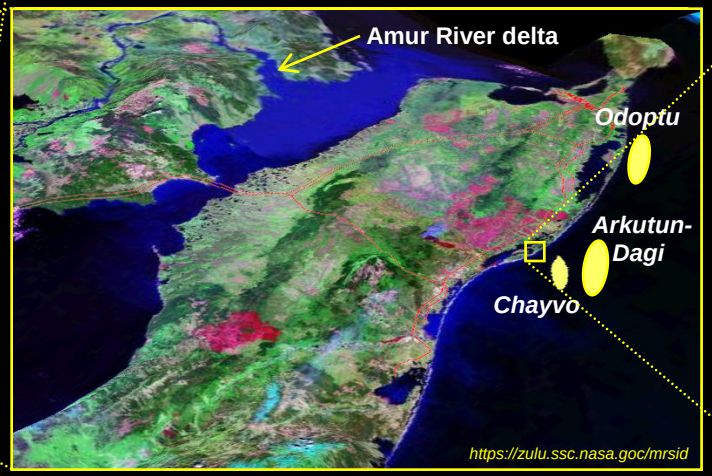
** Presenter*

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

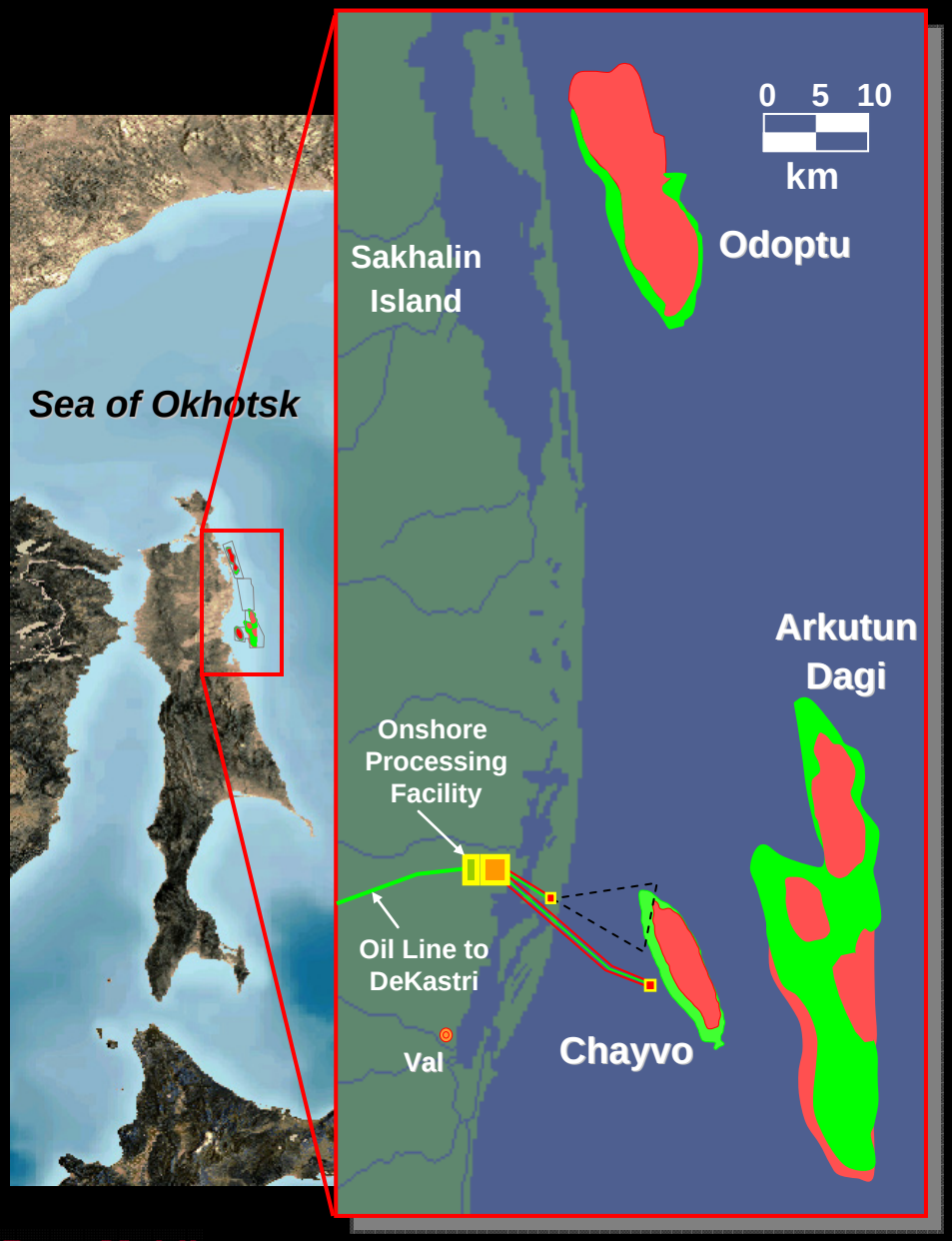

Sakhalin
~9,500 km
Long Beach
http://www.fourmilab/to/earthview


Sea of Okhotsk
Kamchatka Peninsula
Sakhalin Island
Russian Far East
Kuril Trench
Hokkaido, Japan
Google Maps


Amur River delta
Odoptu
Arkutun-Dagi
Chayvo
https://zulu.ssc.nasa.goc/mrsid


Yastreb Rig Site
Chayvo ERD
Google Maps

Chayvo Field Overview



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

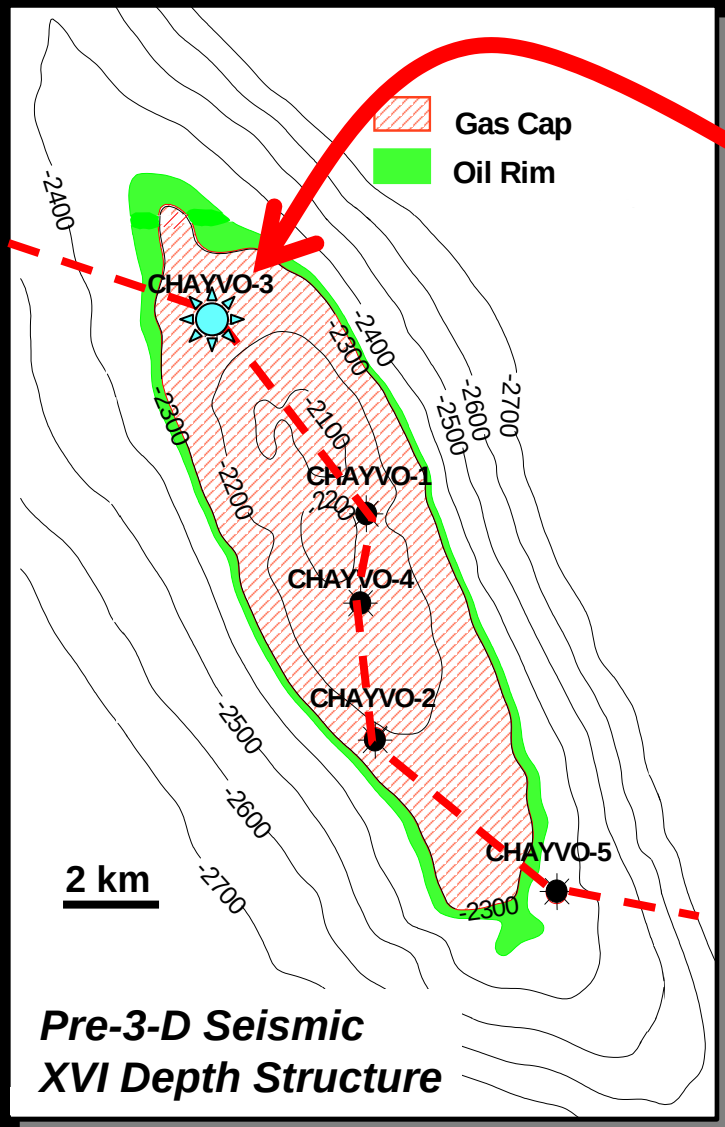
Chayvo Exploration History

- 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:

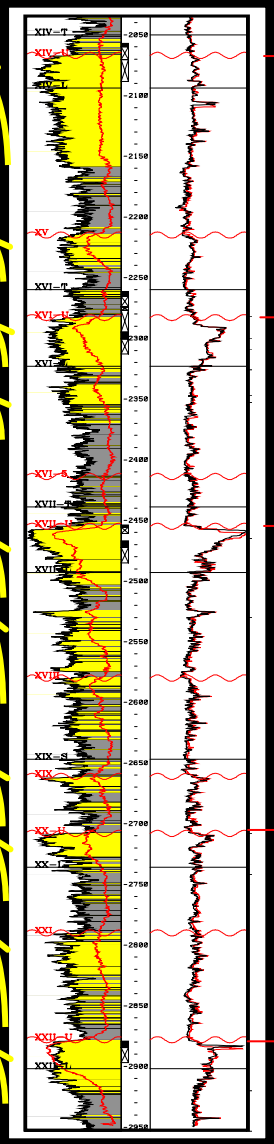
- 2.3 BBLS, 17.1 TCF (*Public Information*)

Exploration History



Lower Nutov Reservoirs
(Upper Miocene)

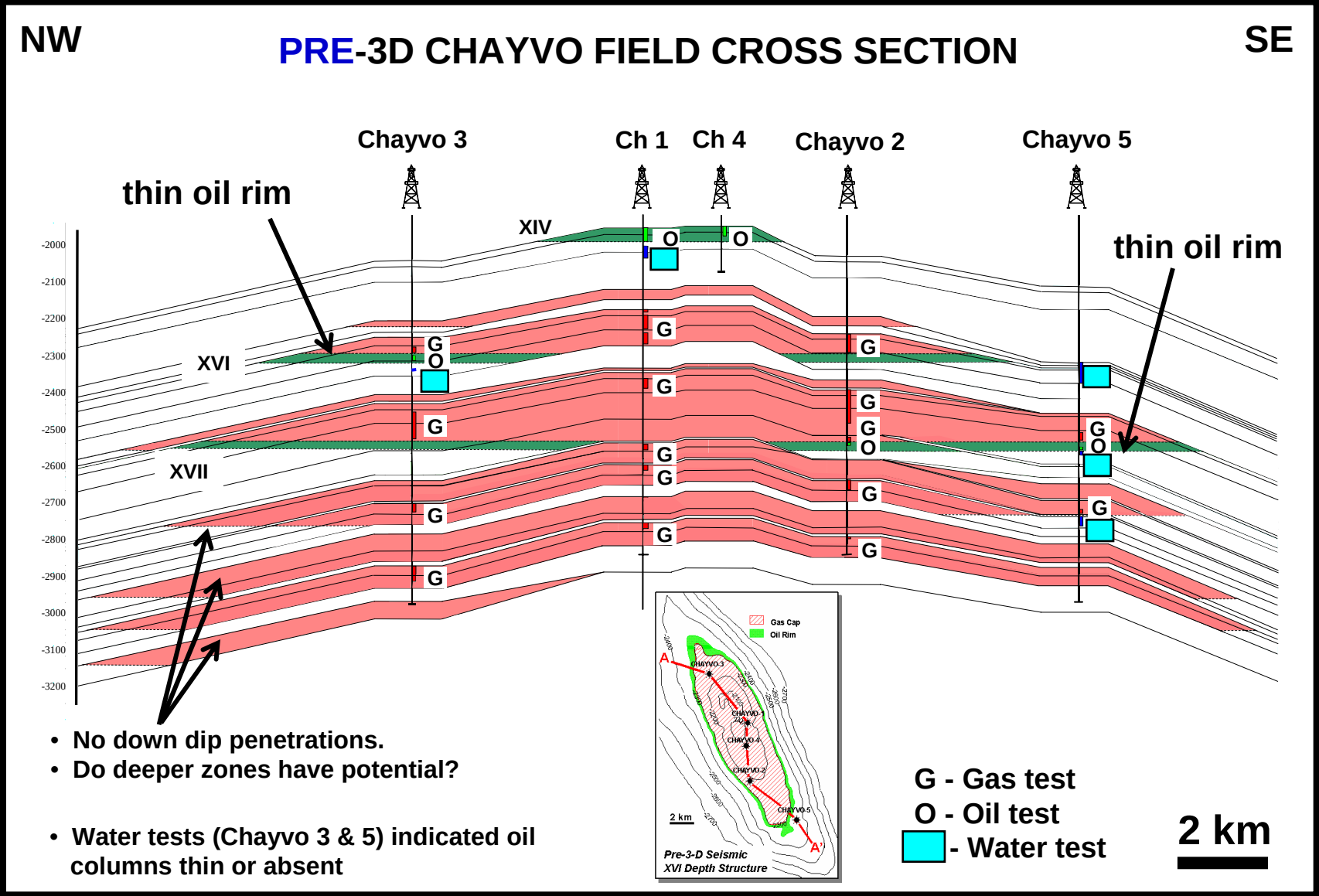
Chayvo 3



900 m gross pay

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

Exploration Well Test Summary

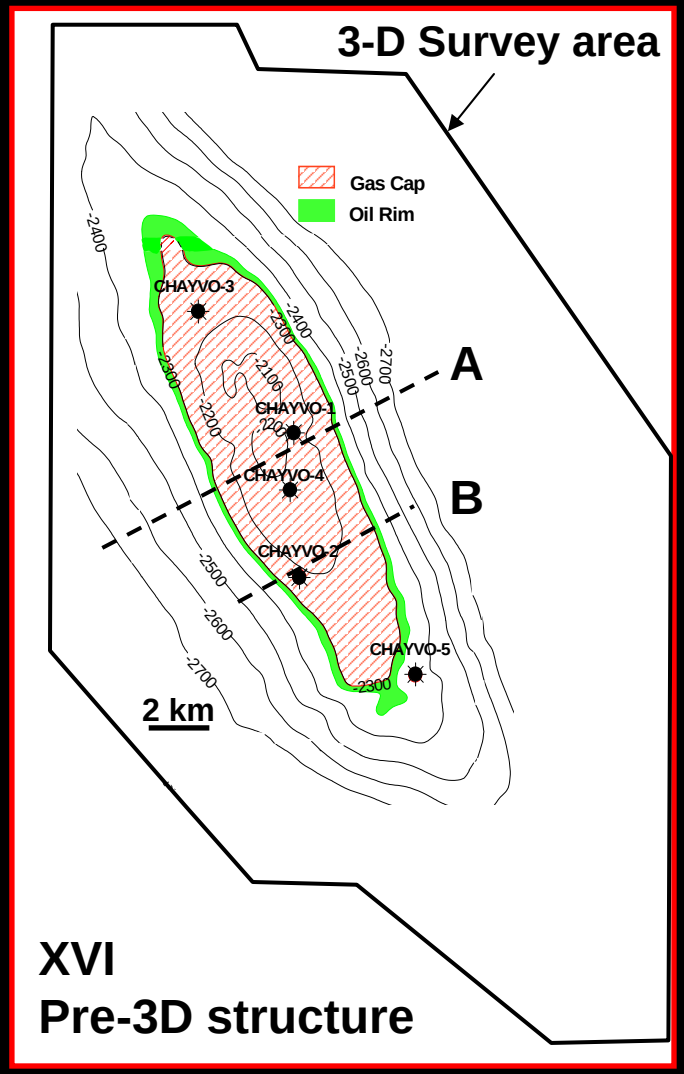


- No down dip penetrations.
- Do deeper zones have potential?

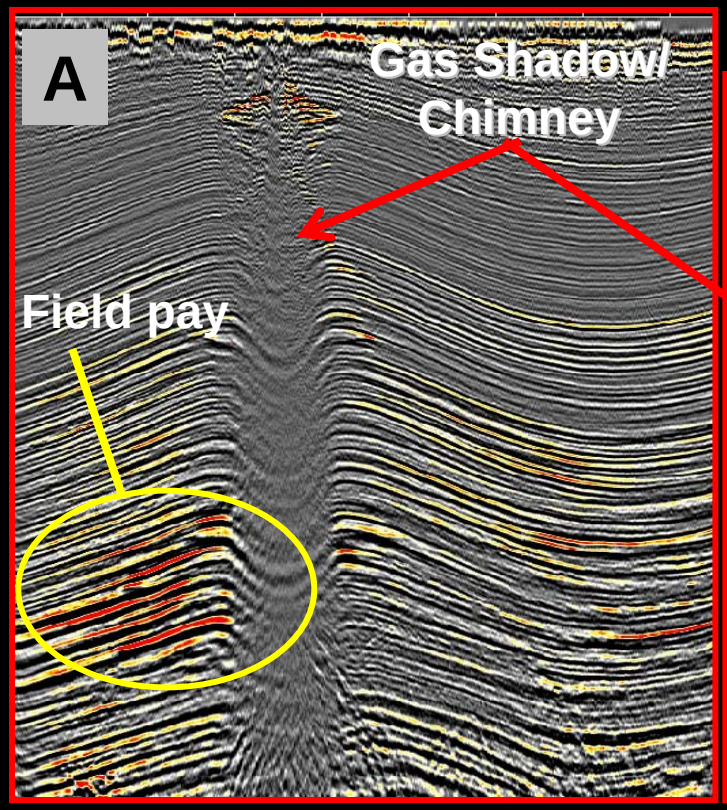
- Water tests (Chayvo 3 & 5) indicated oil columns thin or absent

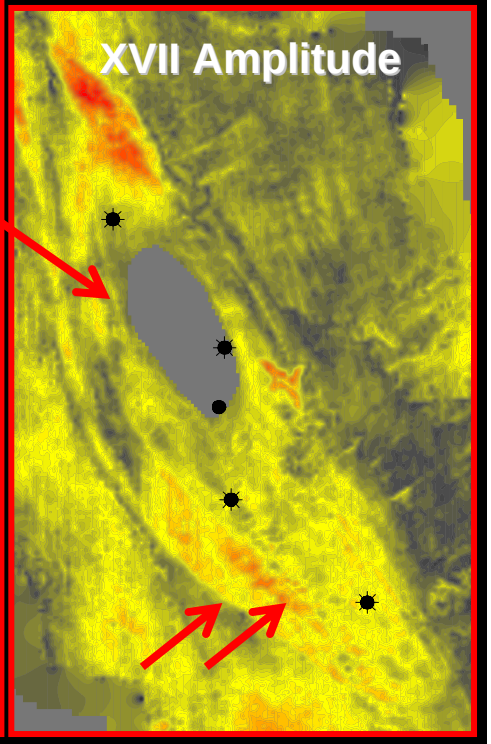
Chayvo 3D Survey

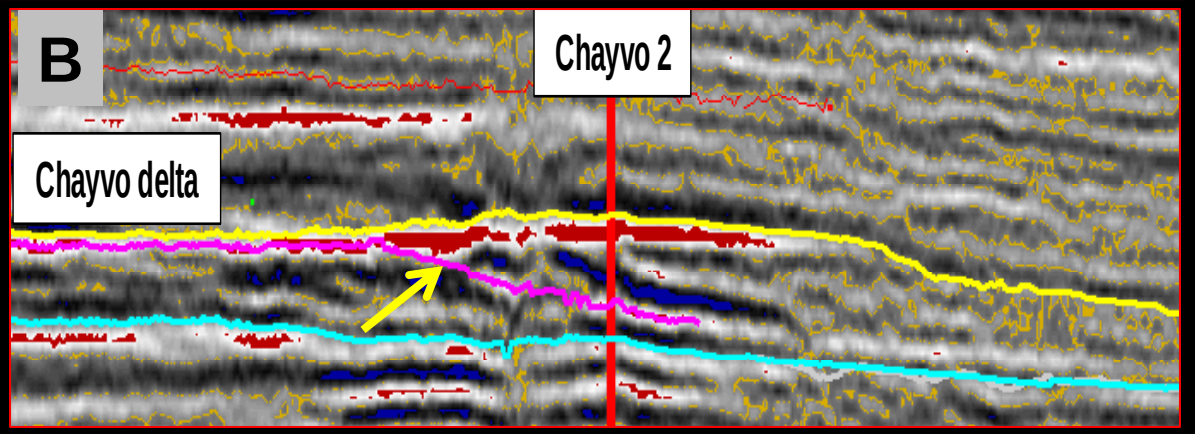
acquired in 1997



XVI
Pre-3D structure

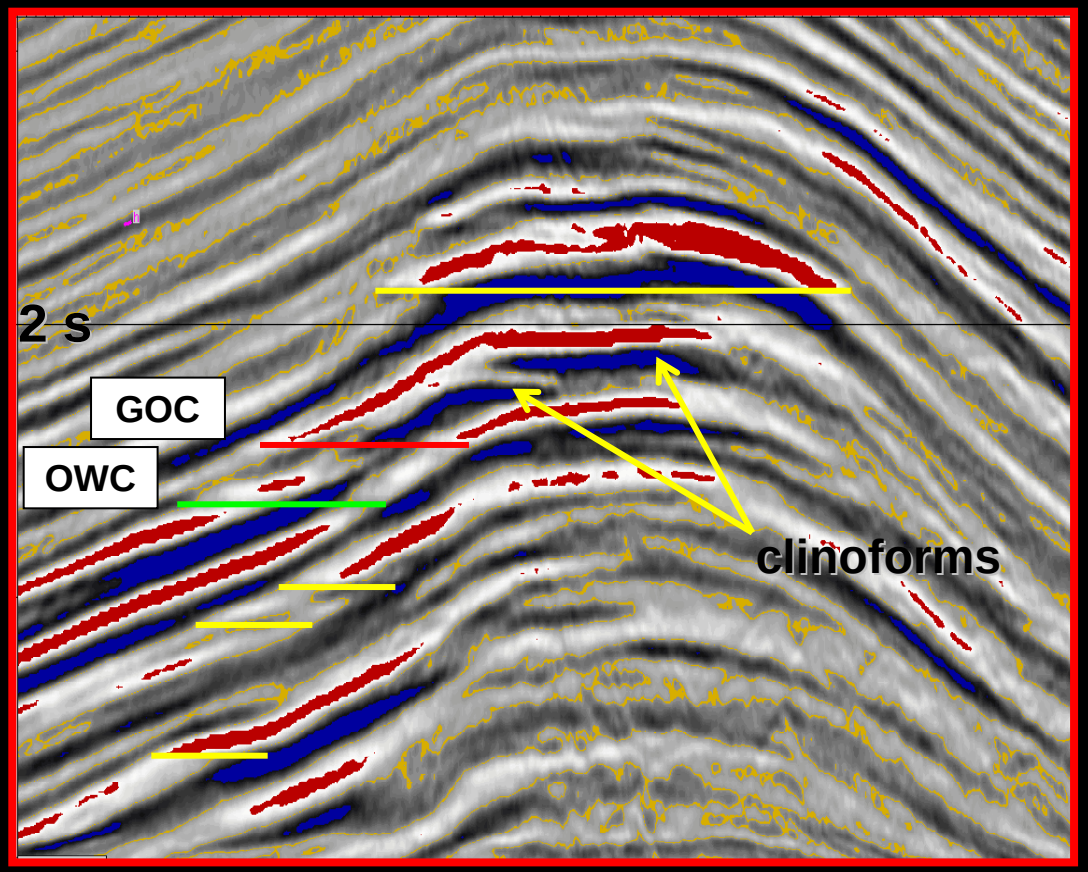






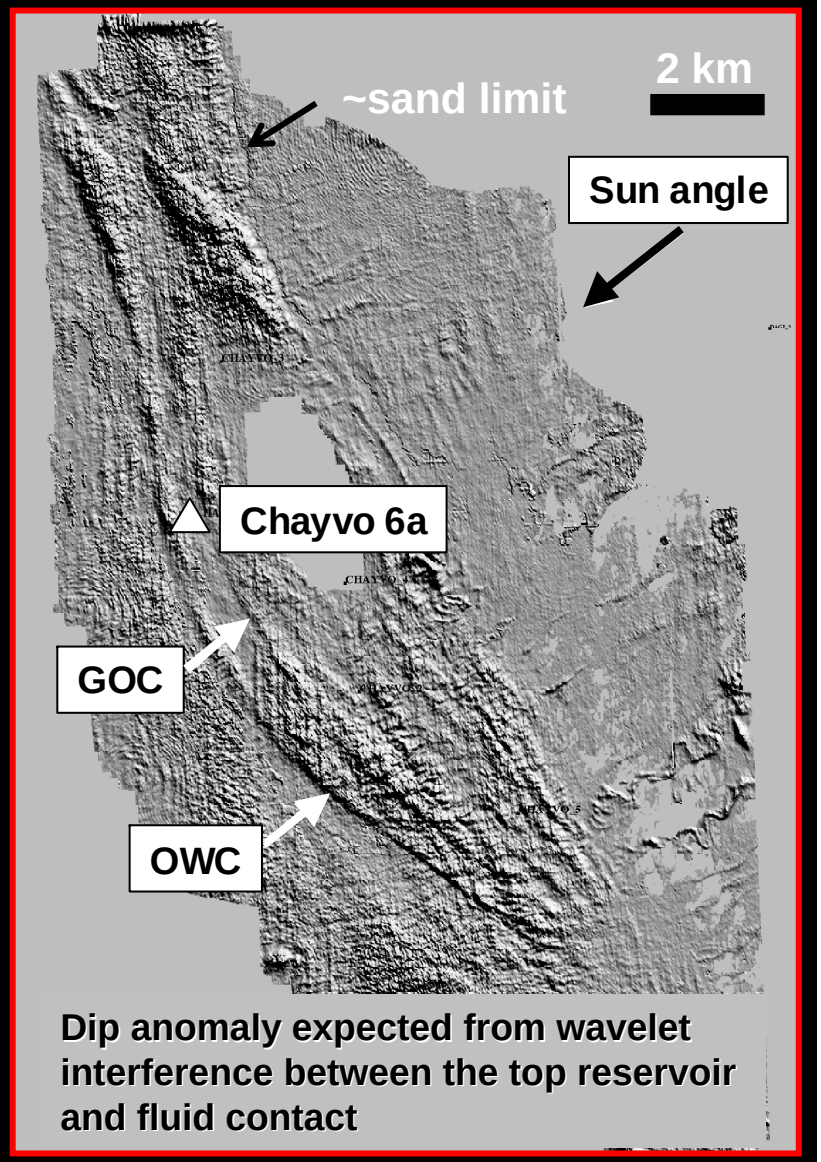
Amplitude terminations were well below known hydrocarbons seen in the wells

Amplitudes Enhanced With Visualization Tools



Numeric Summation/Amplitude Stacking

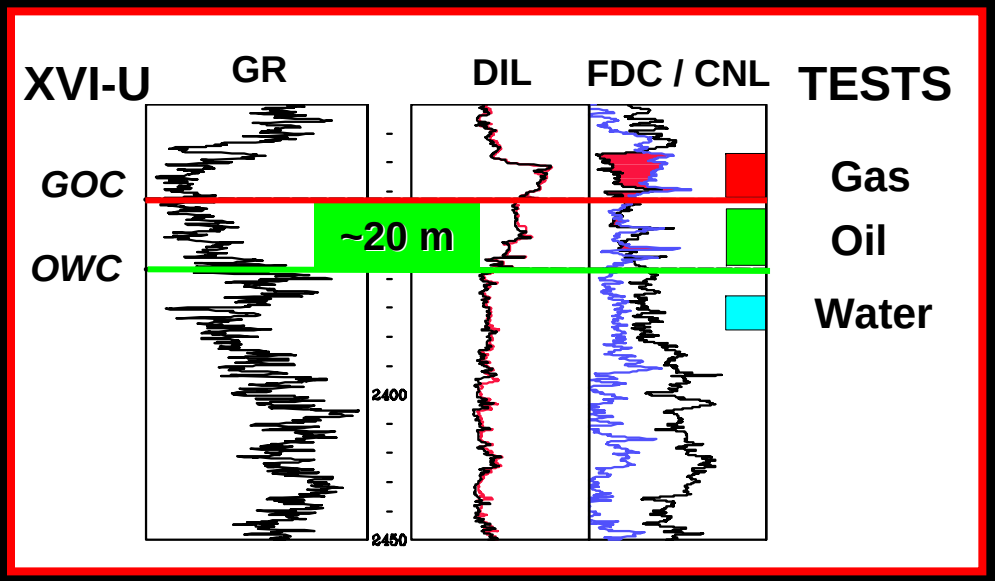
- Presence of multiple flat events in the same reservoir
- Suggested GOC and OWC full to structural spill
- Thicker oil zone not seen by pre-existing wells.

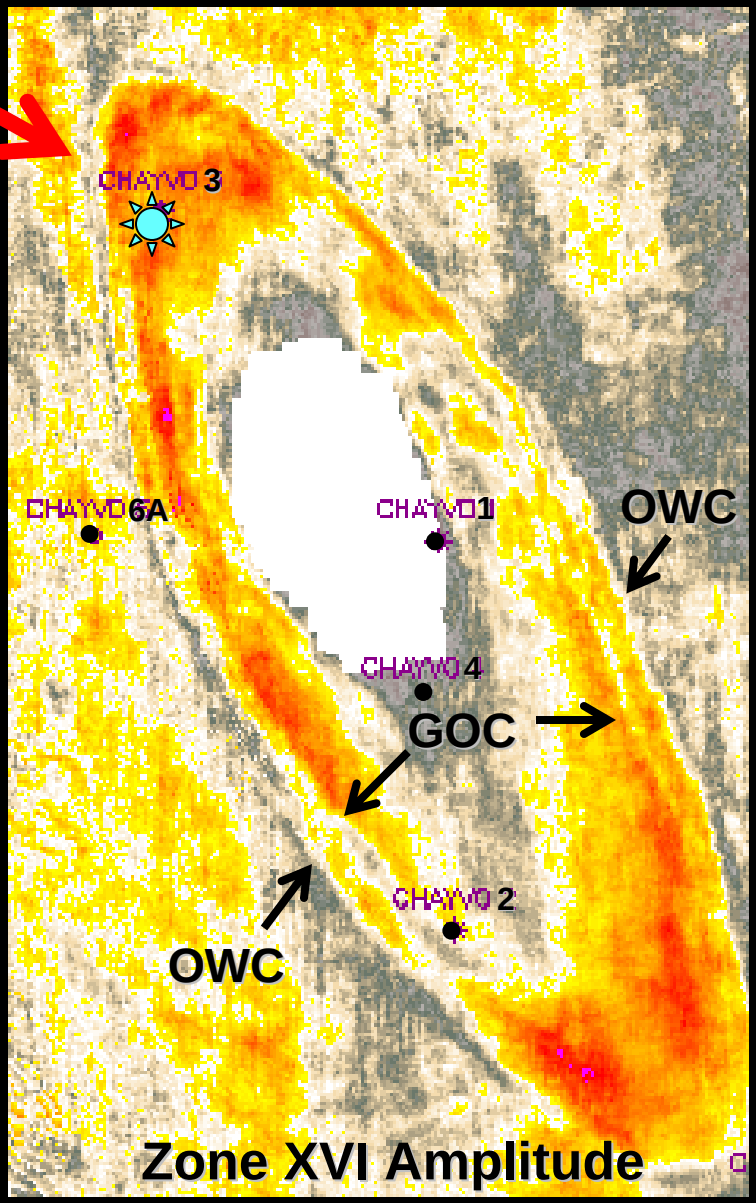


XVII – Time Structure Dip Map

Amplitudes Validated With Log and Test Data

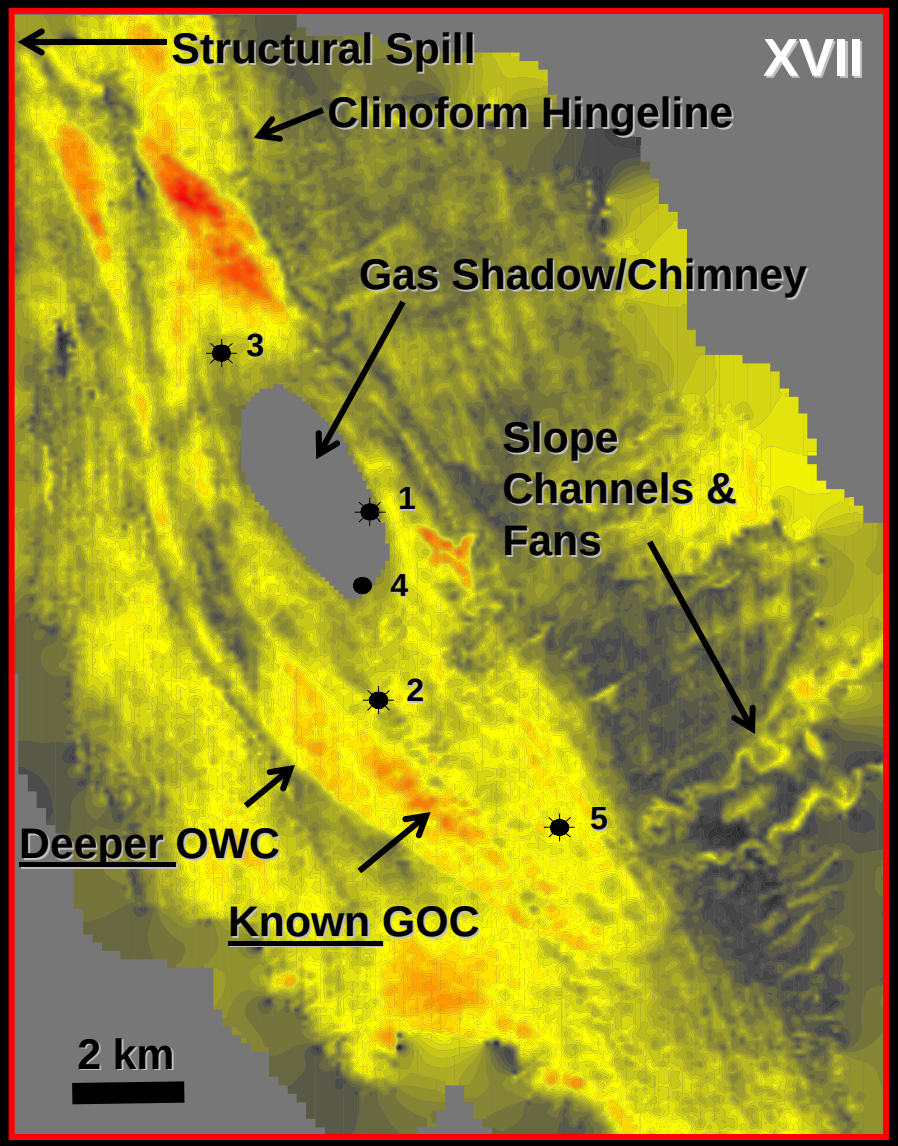
Chayvo 3



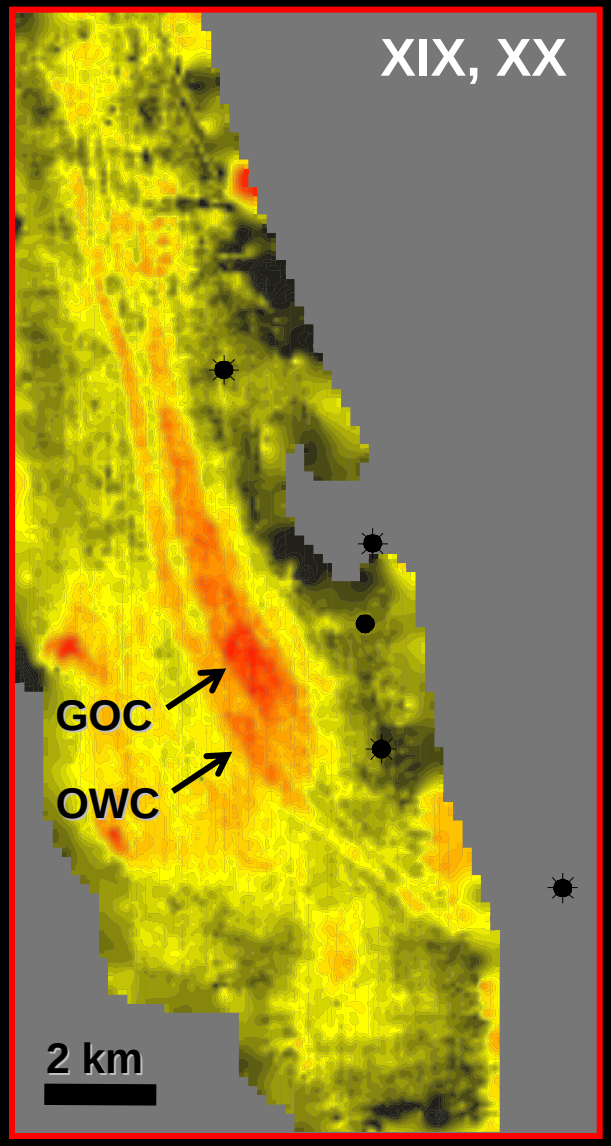


- In Zone XVI, paired anomalies were consistent with known well tests indicating gas/oil/water, validating the seismic DHI
- Supported DHI interpretation in other reservoirs

Paired Anomalies Observed on 3-D Seismic



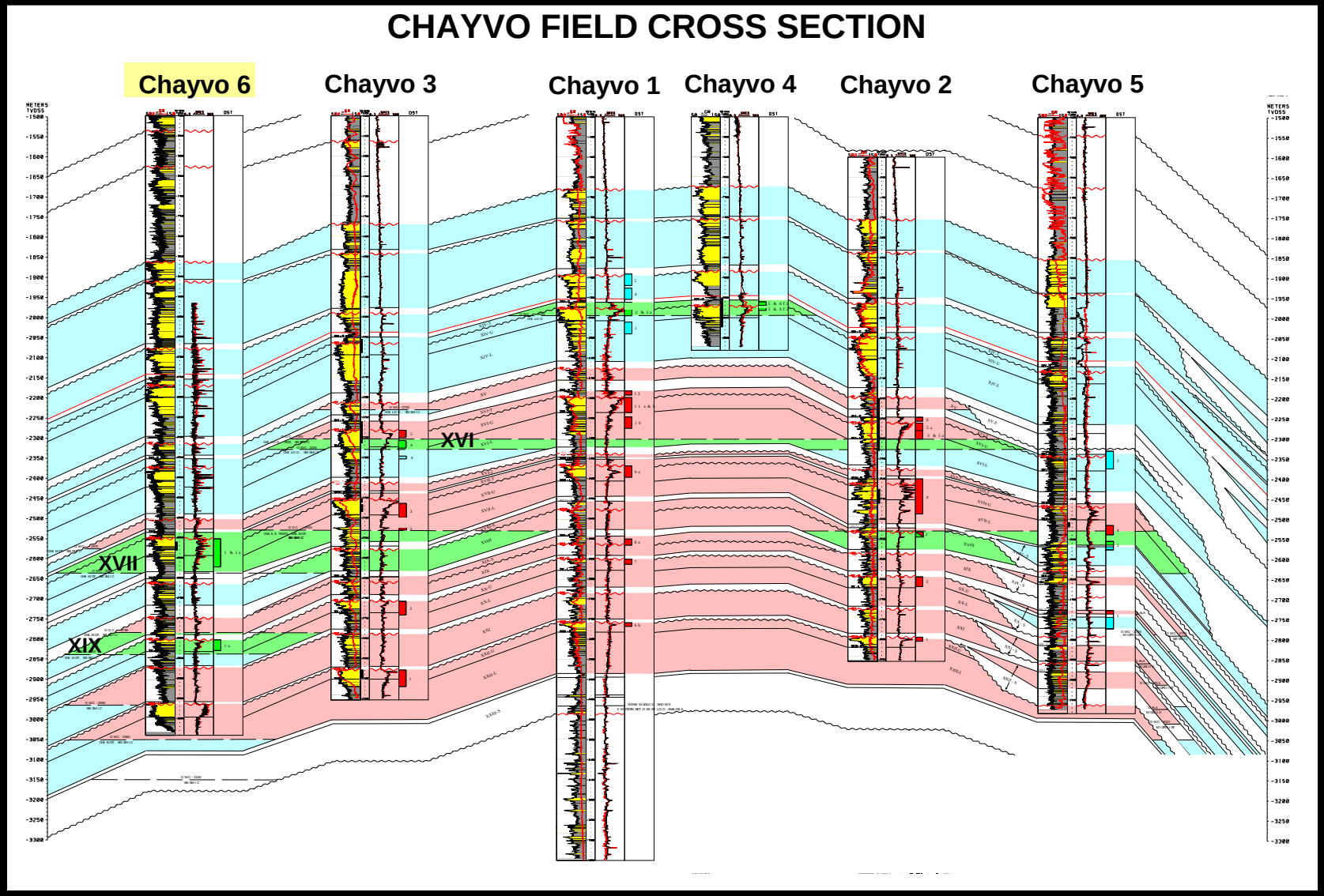
Significantly Thicker Oil Rim
(~100m)



Previously Unidentified Oil Rim
(~60m)

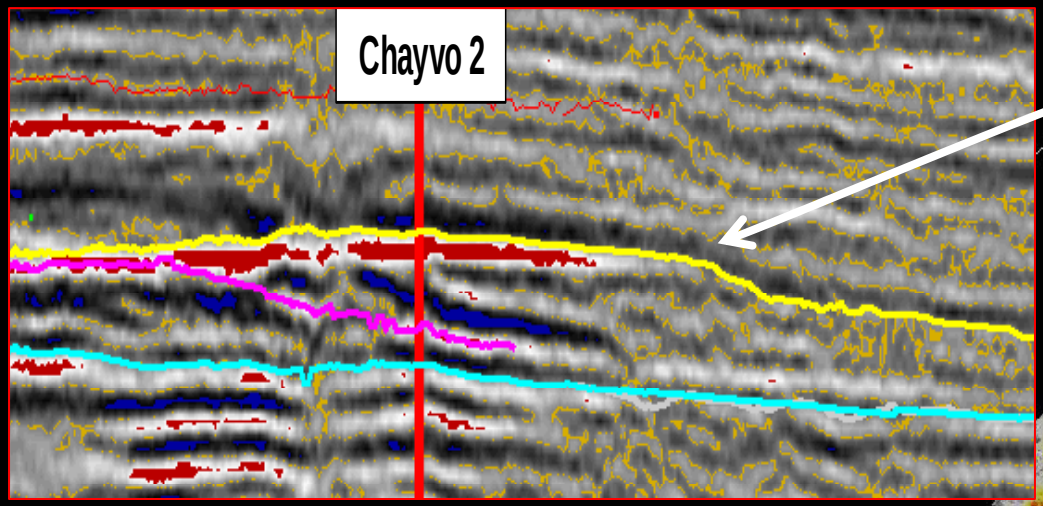
Oil Rims / Pre-drill Predictions Confirmed

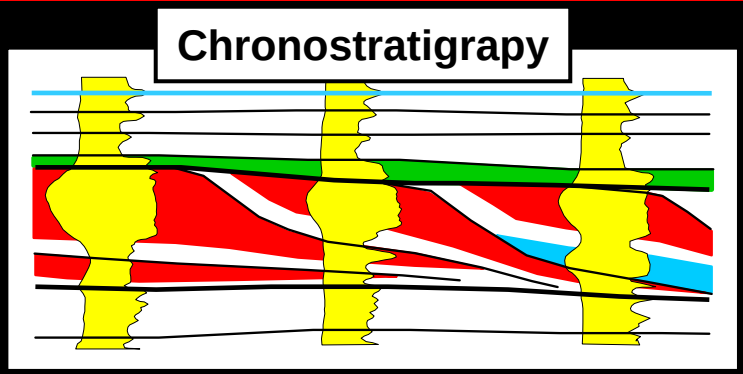
by the Chayvo 6 Well

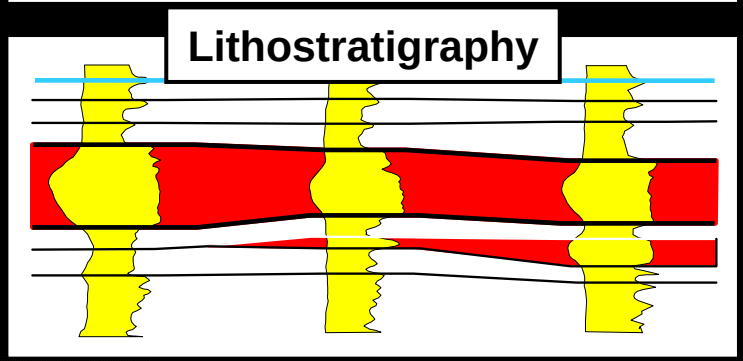


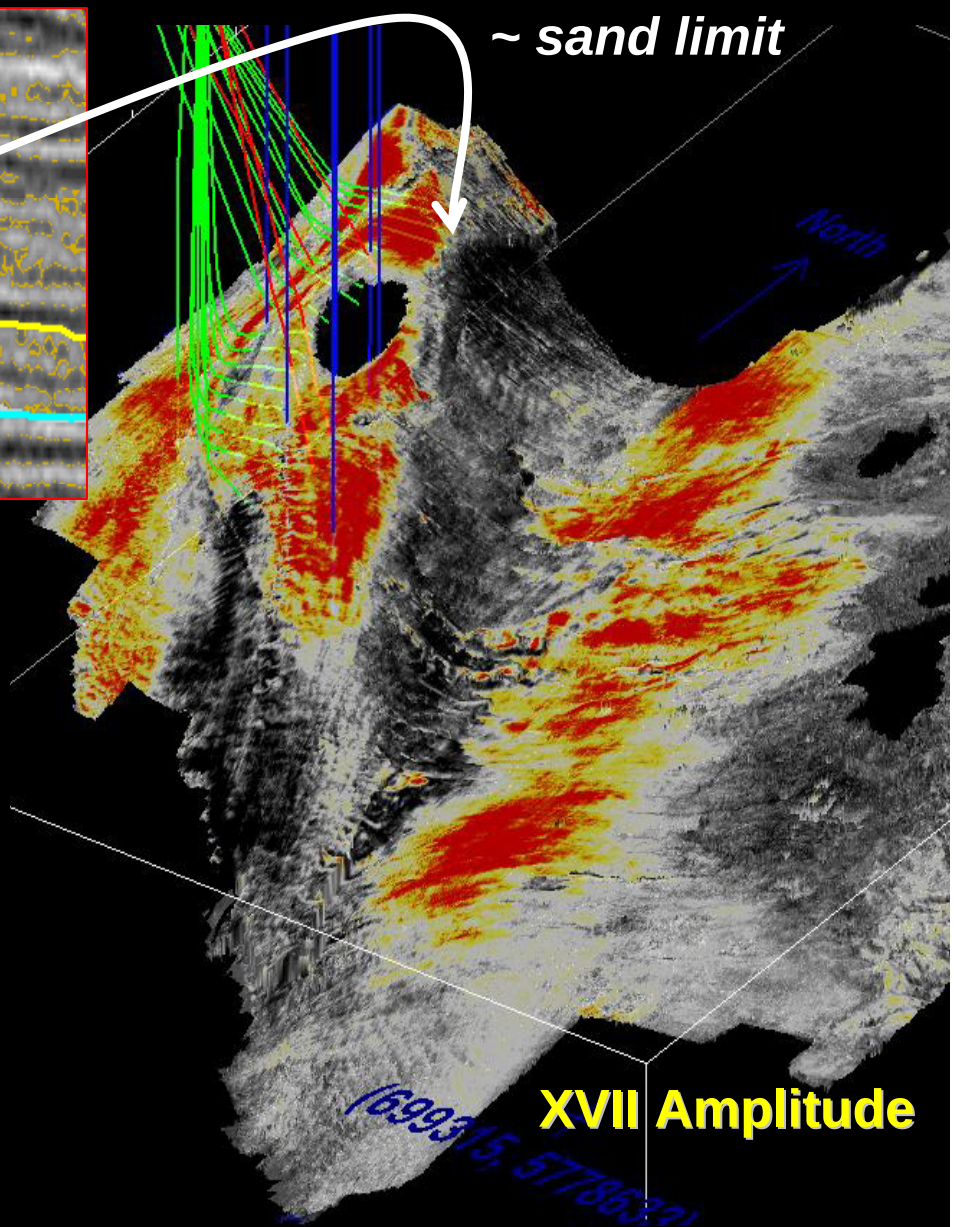
MDT pressure data indicated fluid contacts within 5 m of depths predicted from seismic.

Seismic Imaging of Depositional Facies

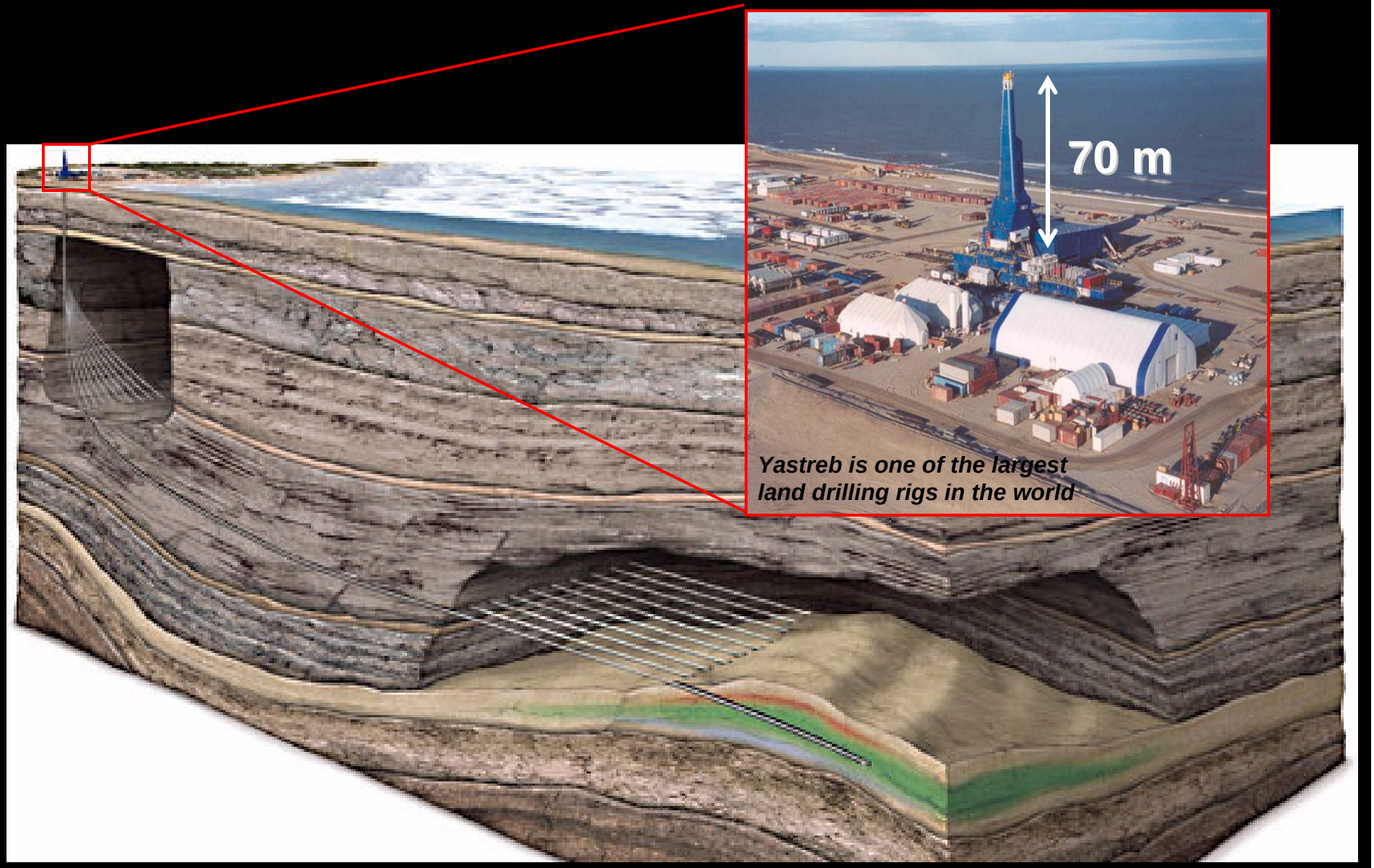




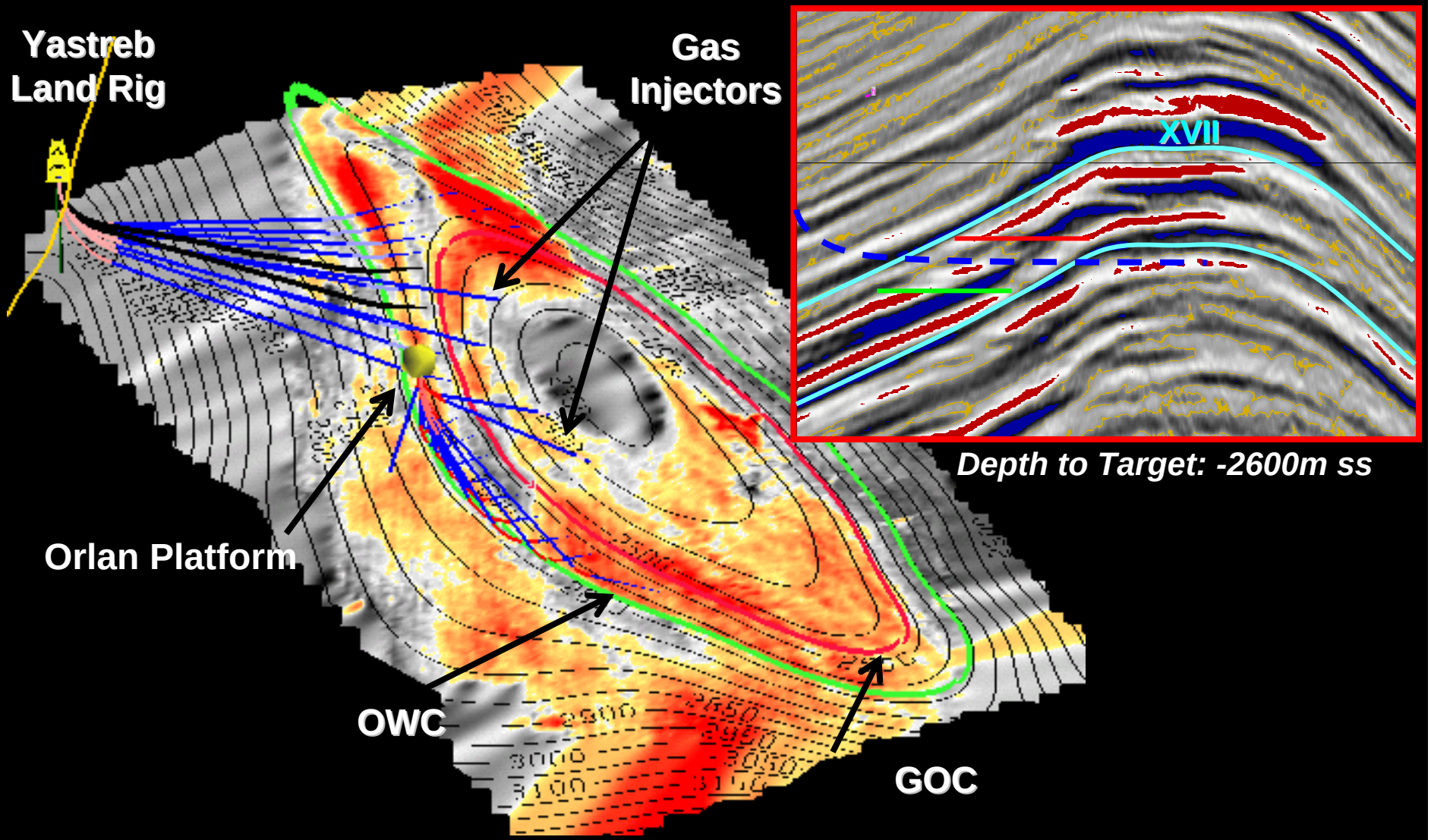




Targeting 9 - 11 km ERD Wells From Shore



3D Survey Used to Target 9-11 km ERD Wells From Shore



Zone XVII Depth Map with Seismic Amplitude

Summary

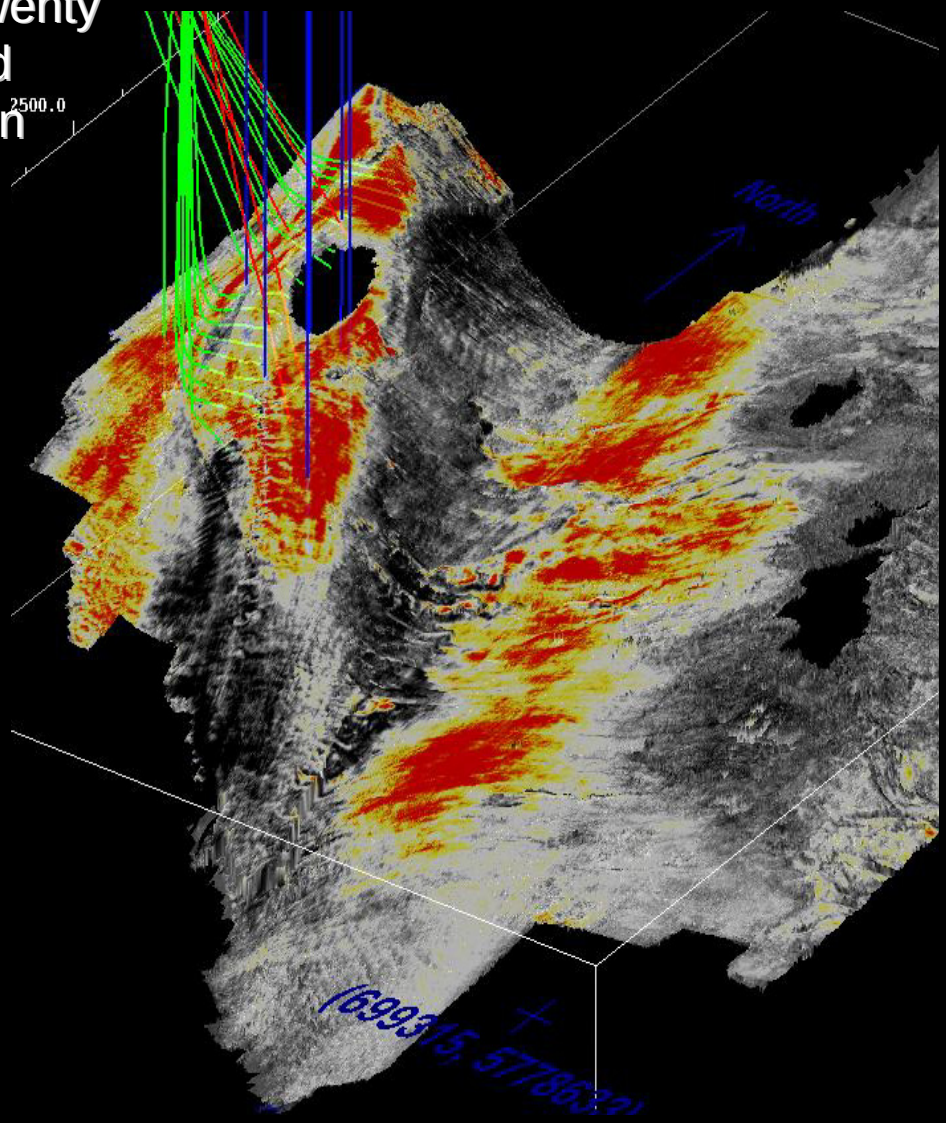
- Large oil accumulation identified/tested twenty years after field discovery using integrated 3-D seismic interpretation and visualization tools

- 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 reservoirs elements (deltaic clinoforms) are incorporated into geologic models/reservoir simulations



Thank You

Acknowledgements

ExxonMobil Colleagues:

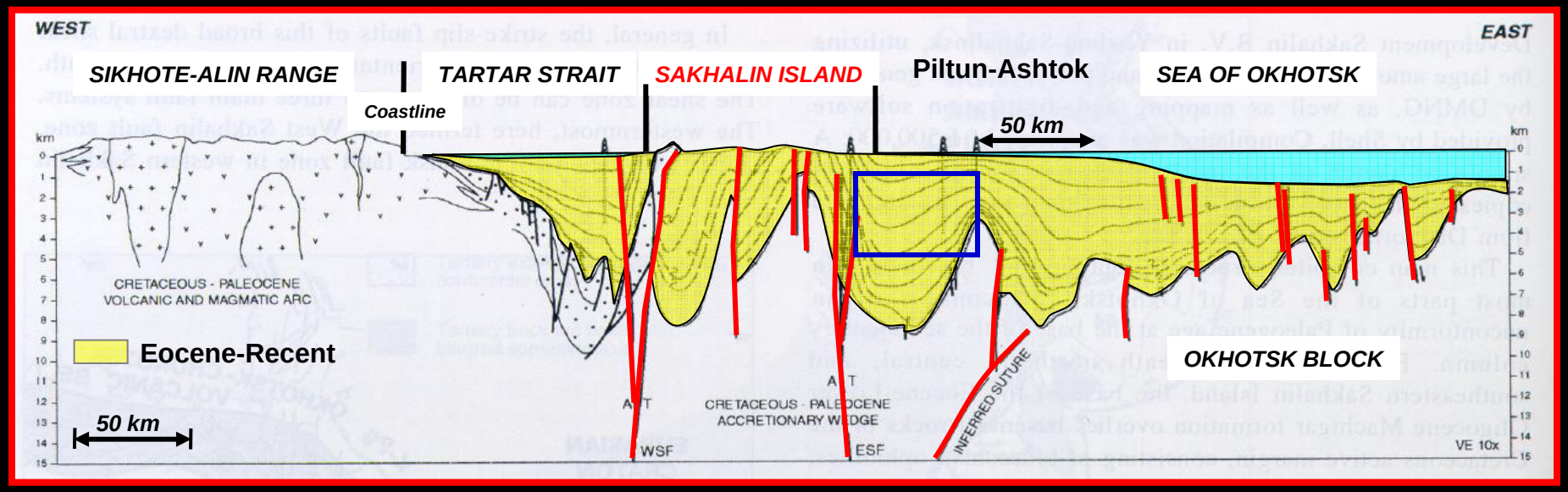
John Lohmar, Doug Freeman, Errol Johnstone, Dave Kasper, Art Donavan, Bill Tate, Chris Johnson, James Dulaney, Tim Streltsov, Mike Poffenberger, Rong Li, Jeff Davis, John Snedden, Jeff Rogers, Roger Bloch, Steve Young, Heidi Hoffower, Conrad Allen, Sarah Pietraszek-Mattner, Bruce Kofron, Amy Ruf

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.

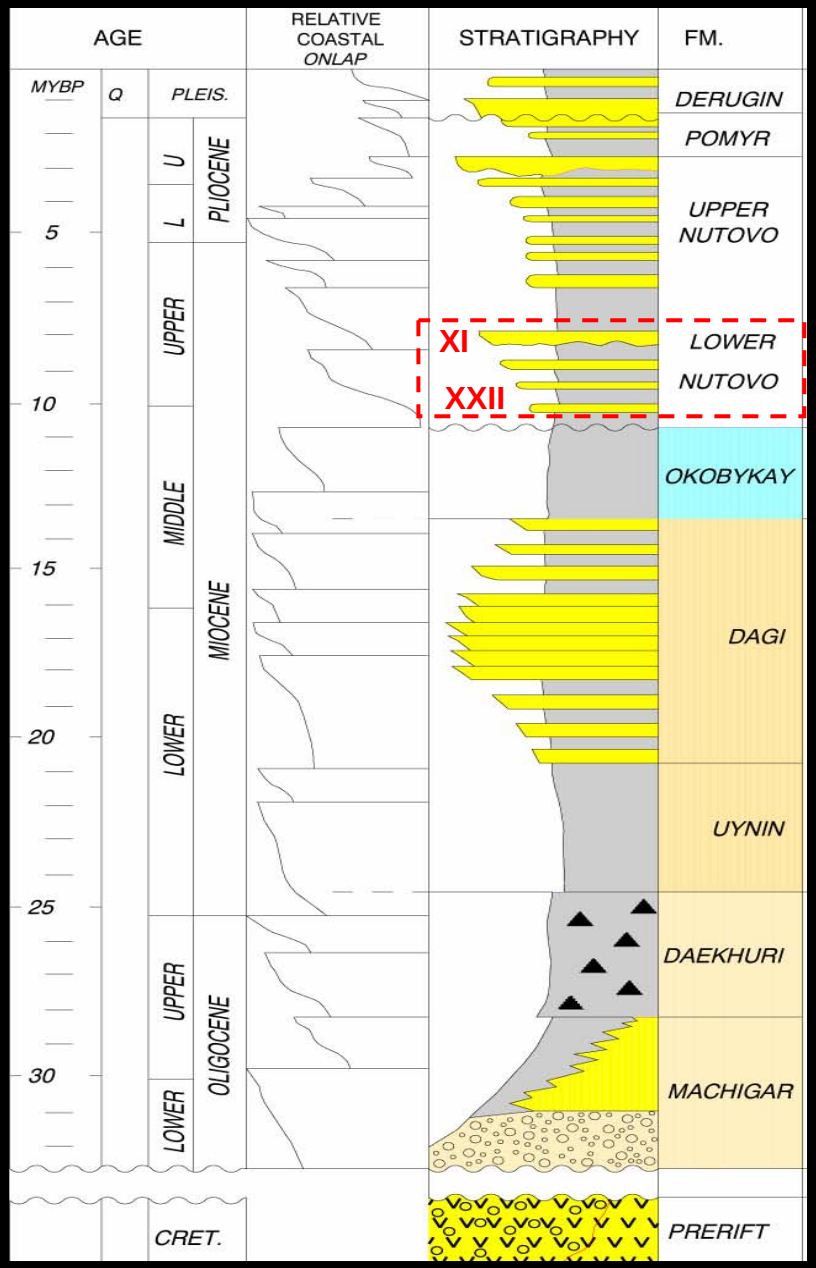
Geologic Setting



From Worrall et al. 1996

- 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.

Regional Stratigraphy



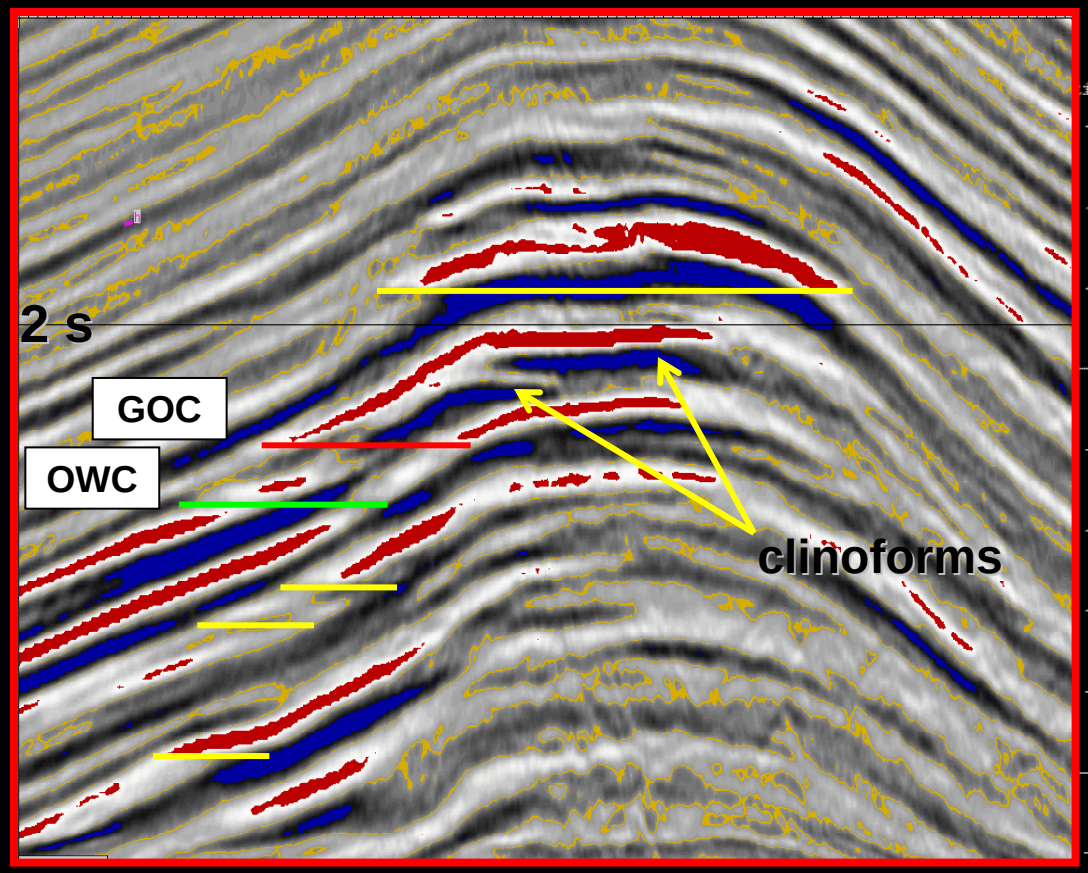
Pomyrskaya

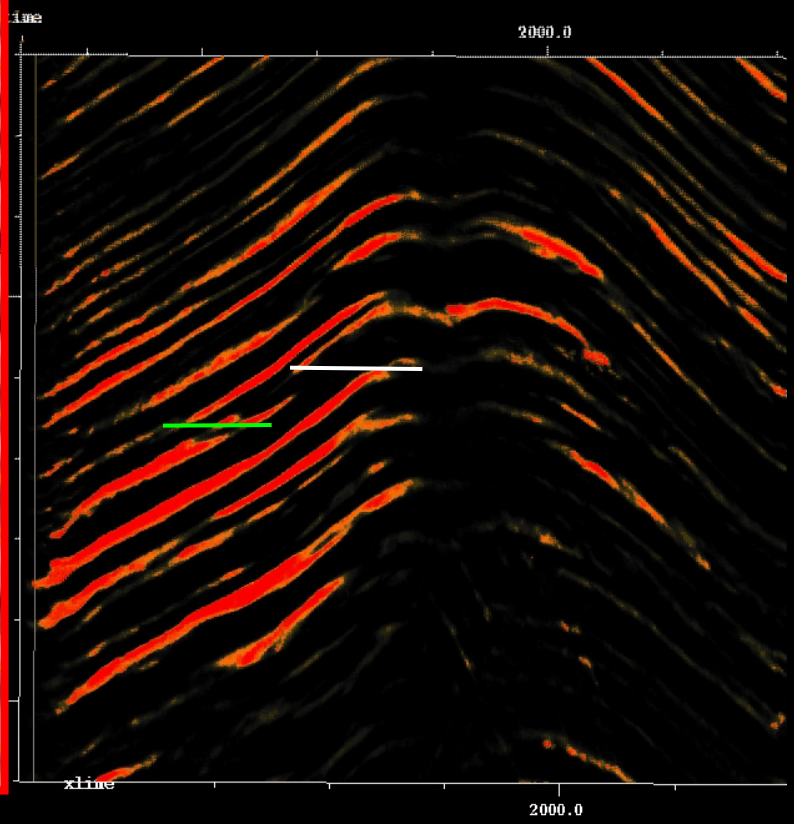
Nutov

Okobykai

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

3-D Seismic Data Hypotheses



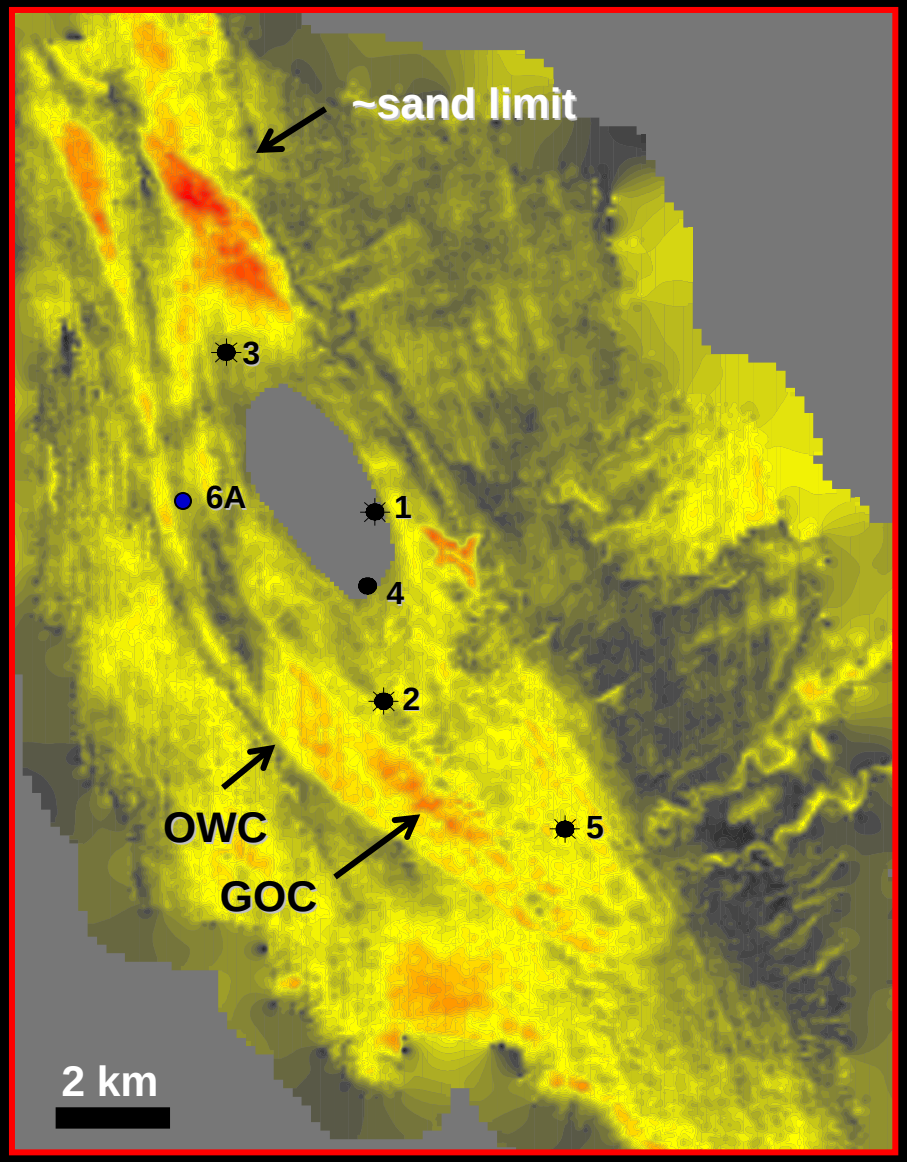


Stacked Amplitude

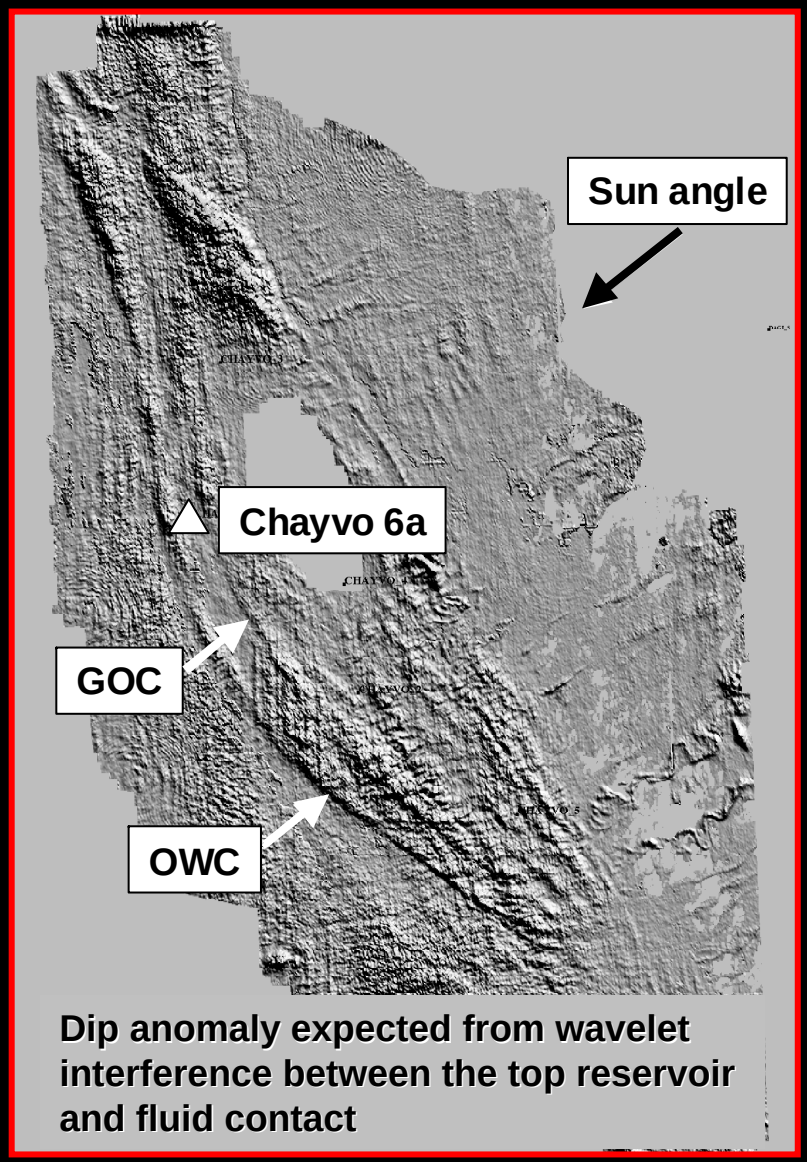
Optical Smash

- 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.

Amplitudes Enhanced With Visualization Tools

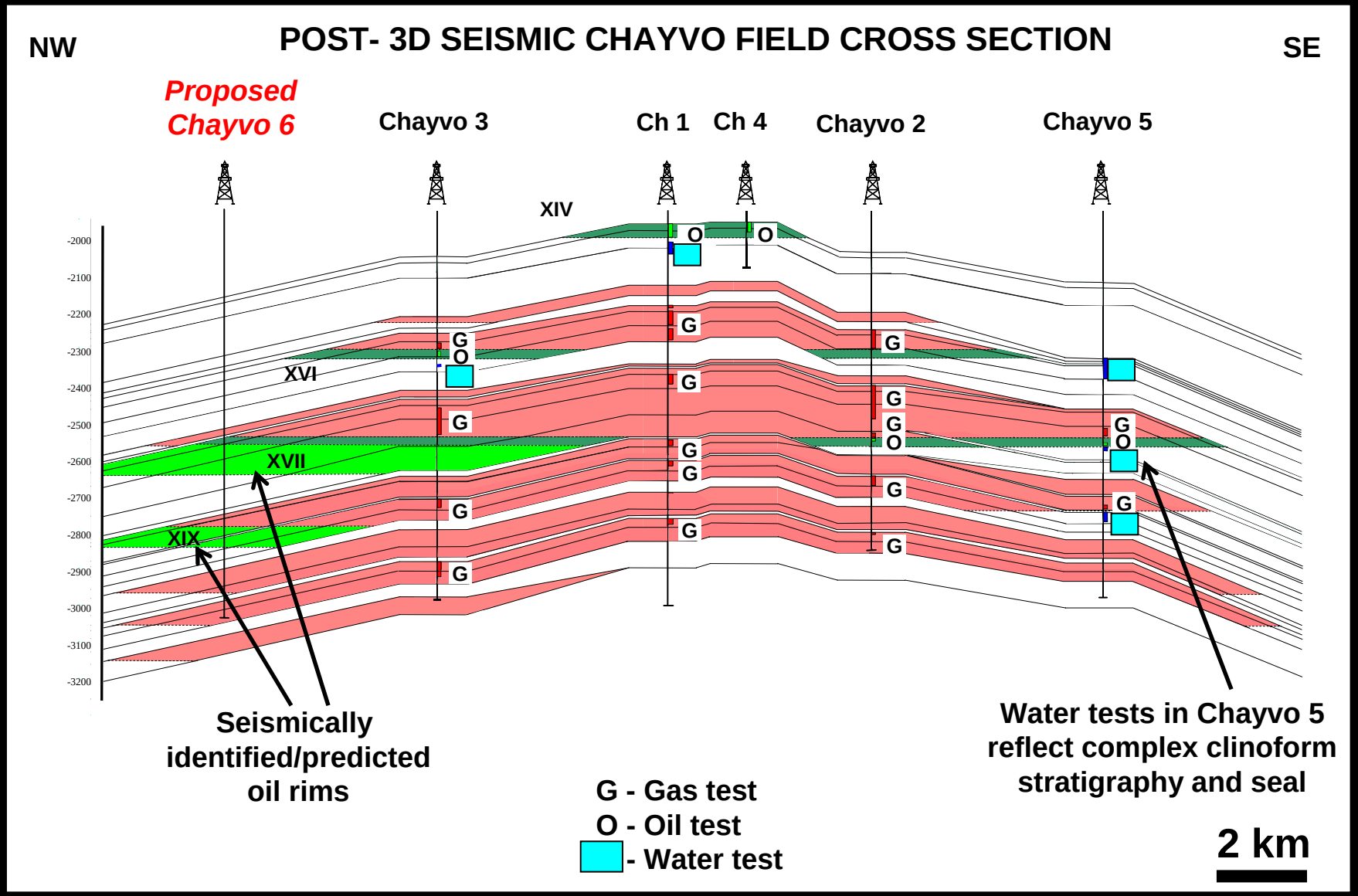


XVII - Amplitude

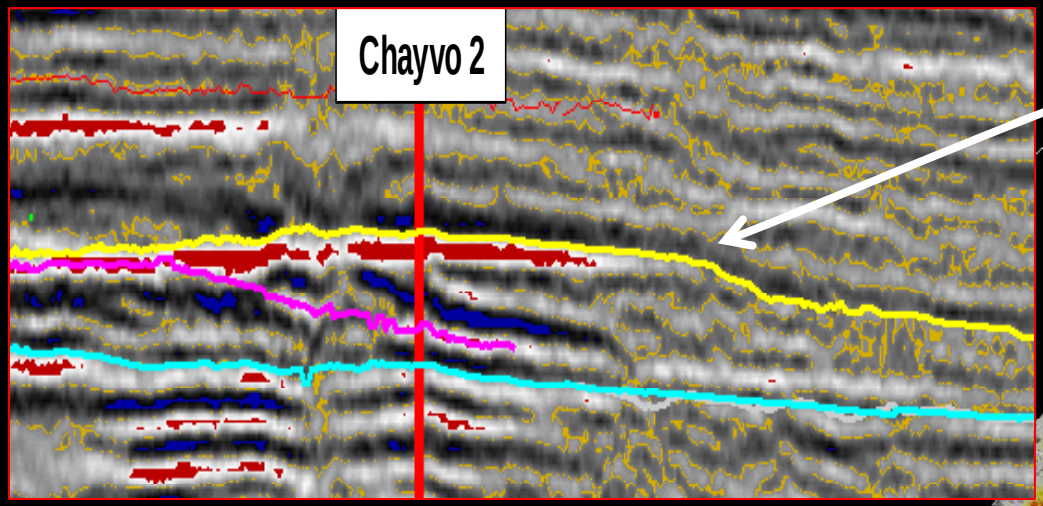


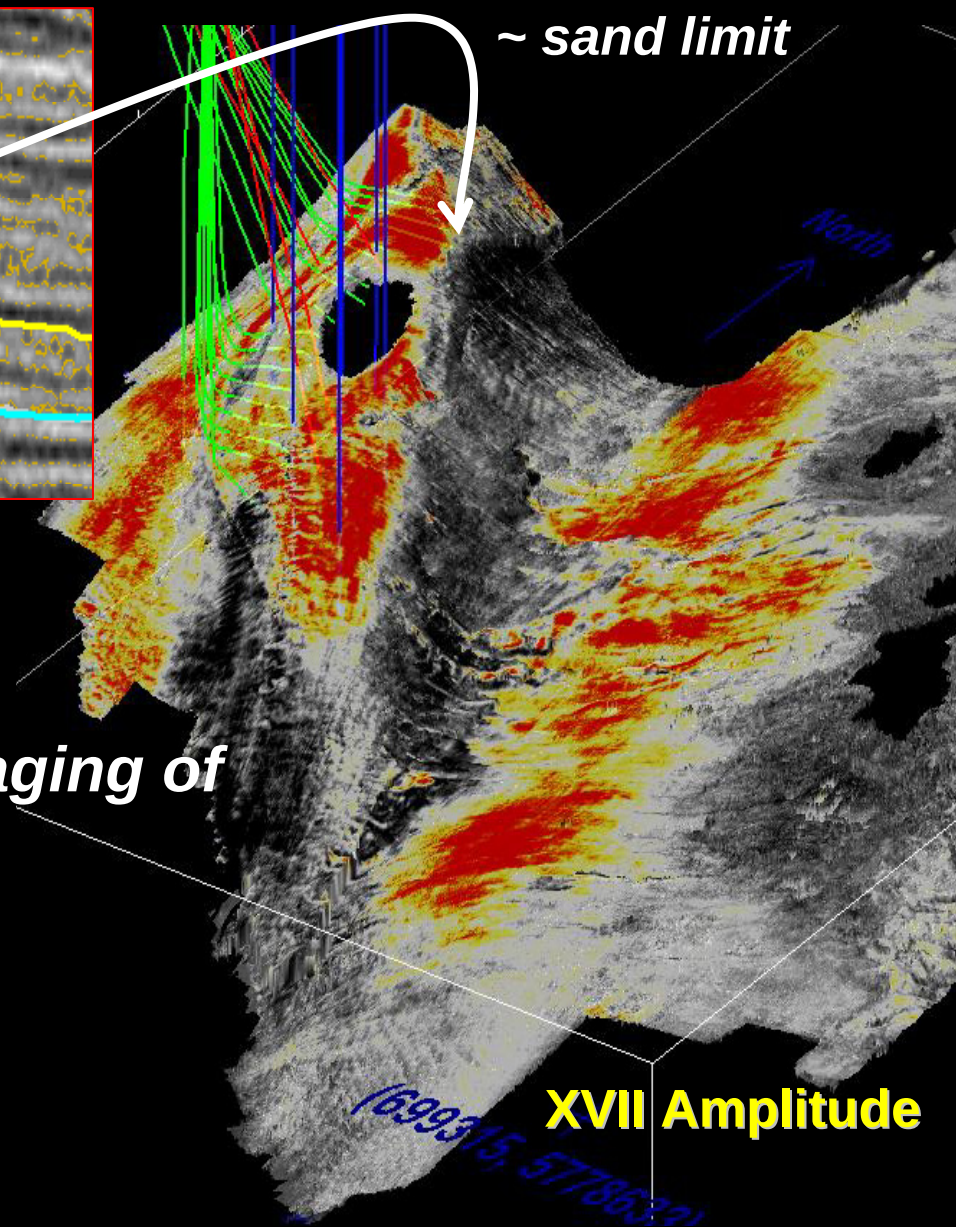
XVII – Time Structure Dip Map

Seismically Identified Oil Rims Predicted



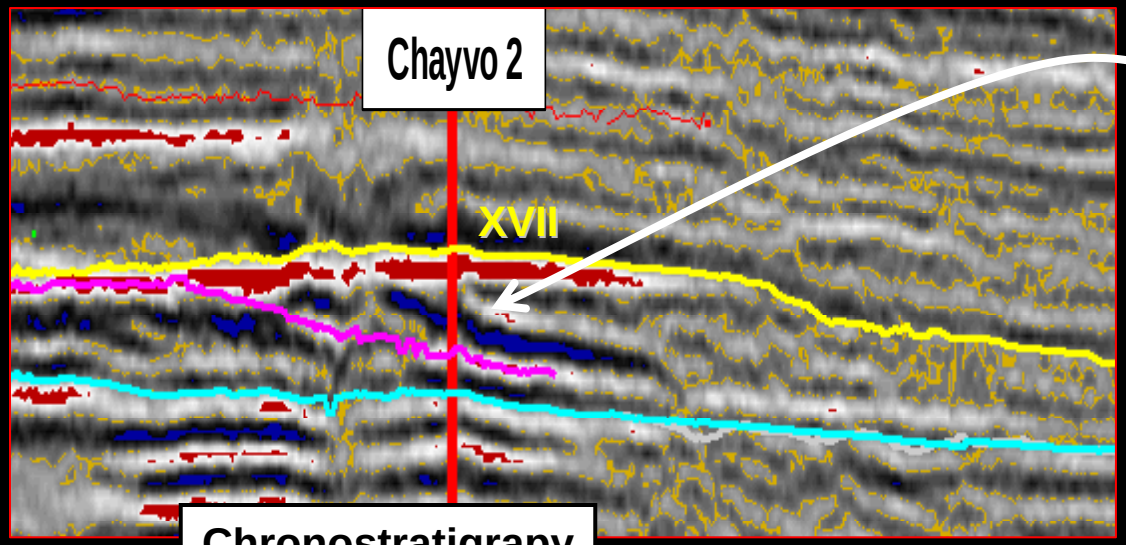
Seismic Imaging of Depositional Facies

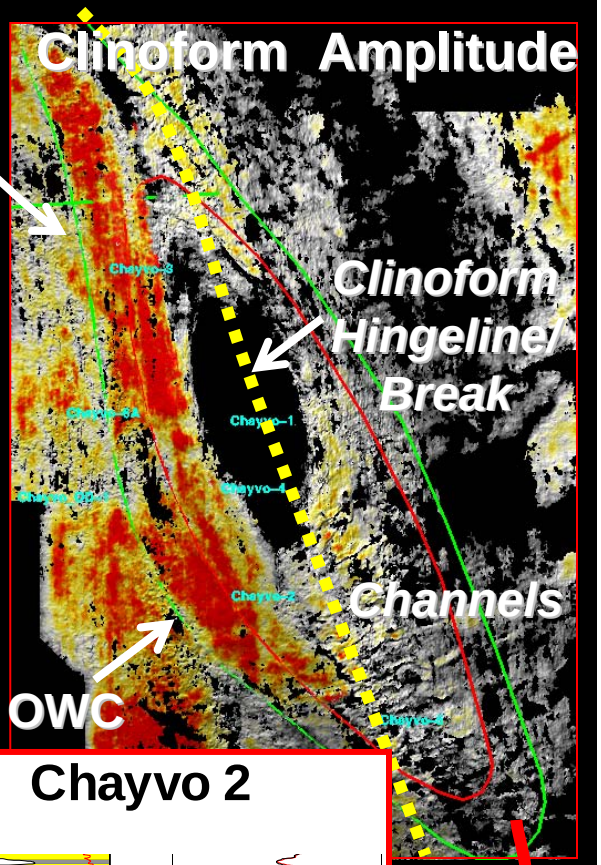


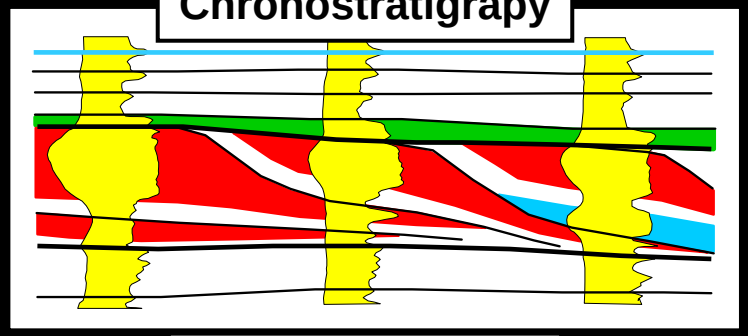


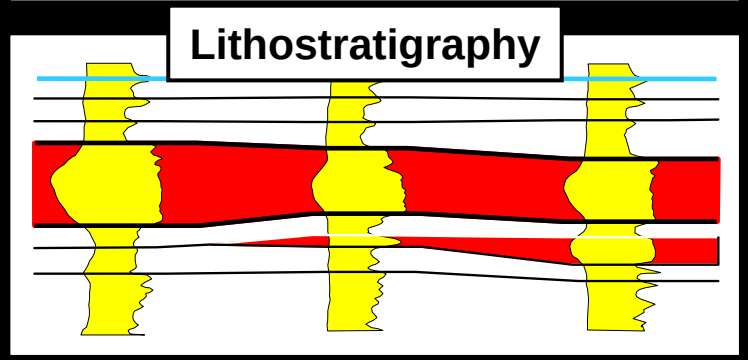
3-D seismic permitted the imaging of amplitude variation due to fluids and lithology.

Seismic Imaging of Depositional Facies

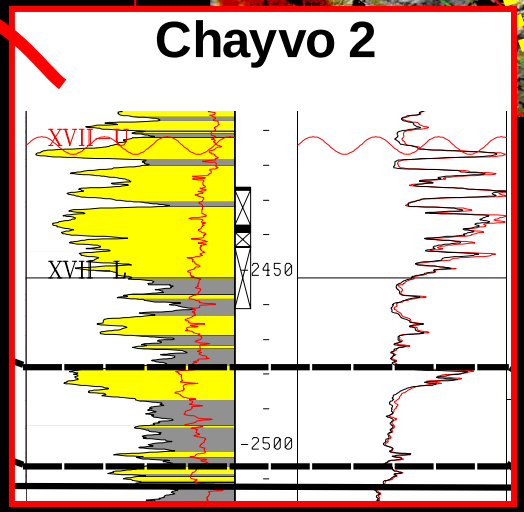








Insight into reservoir connectivity



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