Giant Incised Valley Fill and Shoreface Ravinement Traps, Urna, Ust-Teguss and Tyamskaya Field Areas, Southern West Siberian Basin, Russia*

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Search and Discovery Article #10634 (2014)**
Posted August 29, 2014

*Adapted from oral presentation at AAPG Annual Convention and Exhibition, Houston, Texas, April 6-9, 2014

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Abstract

The West Siberian Basin, in addition to being a huge geographic province, has recoverable reserves in excess of 427 BBOE, most of which is within Upper Cretaceous strata, sourced primarily from the underlying Upper Jurassic Bazhenov Shale. However, at least 28 BBOE exists within stratigraphic and structural traps in Jurassic strata, sourced from both Bazhenov shales and numerous deeper Jurassic strata. Jurassic depositional systems are strongly controlled by a pronounced unconformity overlying Triassic and older strata which was heavily folded and faulted prior to, and during, burial of the Jurassic sediments. Paleo-topographic relief of over 1 KM occurs locally, much of the Jurassic onlapped around paleo-structural highs. The widespread occurrence of thin coals and carbonaceous shales interbedded with strata showing fining-upward log signatures has resulted in widespread classification of much of the Jurassic as ‘nonmarine’. This model has resulted in widely practiced lithostratigraphic correlations that show ‘layer cake’ correlations based on the vertical patterns of sands and coals. Detailed examination of cores, seismic and new log correlations in this study, however, show that pervasive estuarine sedimentation was common, confined in nested, incised valley-fill deposits. Towards the upper ‘J1’ intervals, strata become progressively more marine and shoreface ravinement traps are common. Layer cake correlations and assumptions about fluvial architecture from isopachs are grossly in error and do not explain high-resolution seismic facies maps or information from cores and log

correlations. The fields illustrated in this study are giant stratigraphic accumulations. More will be found with more careful integration of cores with 3D seismic.

References Cited

Igoshkin, V.J., J.C. Dolson, D. Sidorov, O. Bakuev, and R. Herbert, 2008, New interpretations of the evolution of the West Siberian Basin, Russia: Implications for exploration: Search and Discovery Article #10161 (2008) (http://www.searchanddiscovery.com/pdfz/documents/2008/08130dolson/ndx_dolson.pdf.html) (website accessed August 15, 2014).

Vavra, C.L., J.G. Kaldi, and R.M. Sneider, 1992, Geological applications of capillary pressure: A review: AAPG Bulletin, v. 76, p. 840-850.

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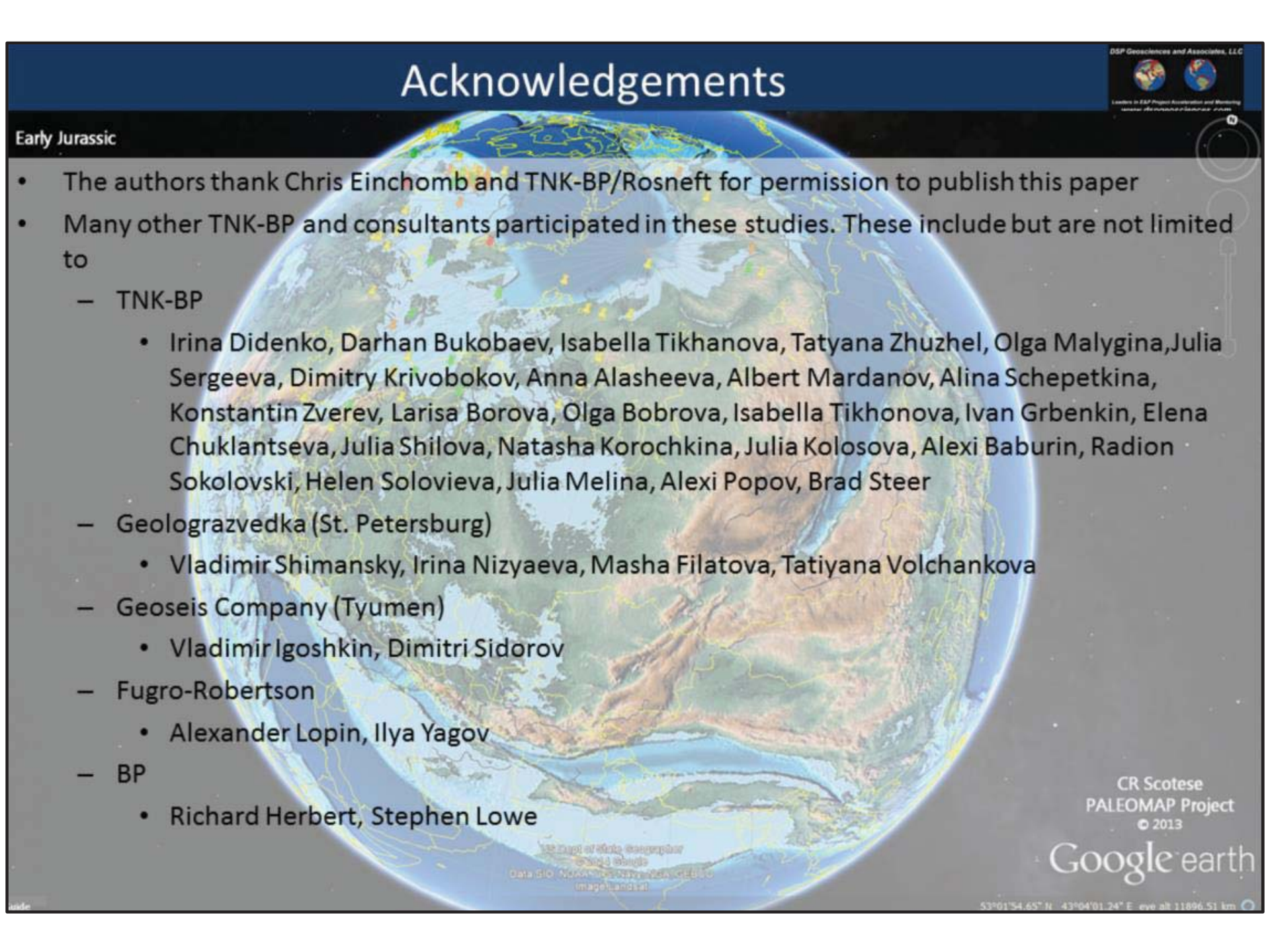
Acknowledgements

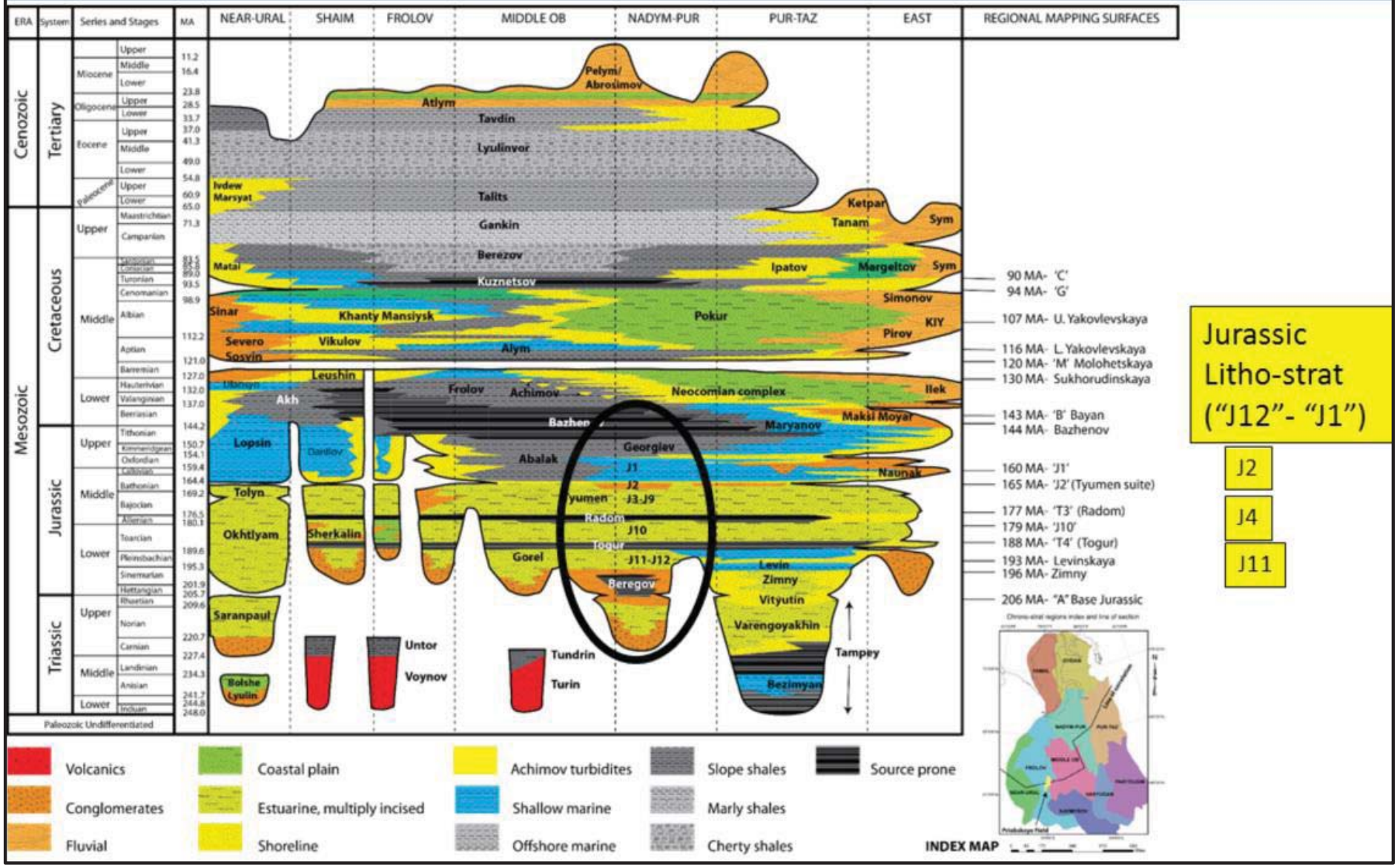


- The authors thank Chris Einchomb and TNK-BP/Rosneft for permission to publish this paper
- Many other TNK-BP and consultants participated in these studies. These include but are not limited to
  - TNK-BP
    - Irina Didenko, Darhan Bukobaev, Isabella Tikhanova, Tatyana Zhuzhel, Olga Malygina,Julia Sergeeva, Dimitry Krivobokov, Anna Alasheeva, Albert Mardanov, Alina Schepetkina, Konstantin Zverev, Larisa Borova, Olga Bobrova, Isabella Tikhonova, Ivan Grbenkin, Elena Chuklantseva, Julia Shilova, Natasha Korochkina, Julia Kolosova, Alexi Baburin, Radion Sokolovski, Helen Solovieva, Julia Melina, Alexi Popov, Brad Steer
  - Geolograzvedka (St. Petersburg)
    - Vladimir Shimansky, Irina Nizyaeva, Masha Filatova, Tatiyana Volchankova
  - Geoseis Company (Tyumen)
    - Vladimir Igoshkin, Dimitri Sidorov
  - Fugro-Robertson
    - Alexander Lopin, Ilya Yagov
  - BP
    - Richard Herbert, Stephen Lowe

Location

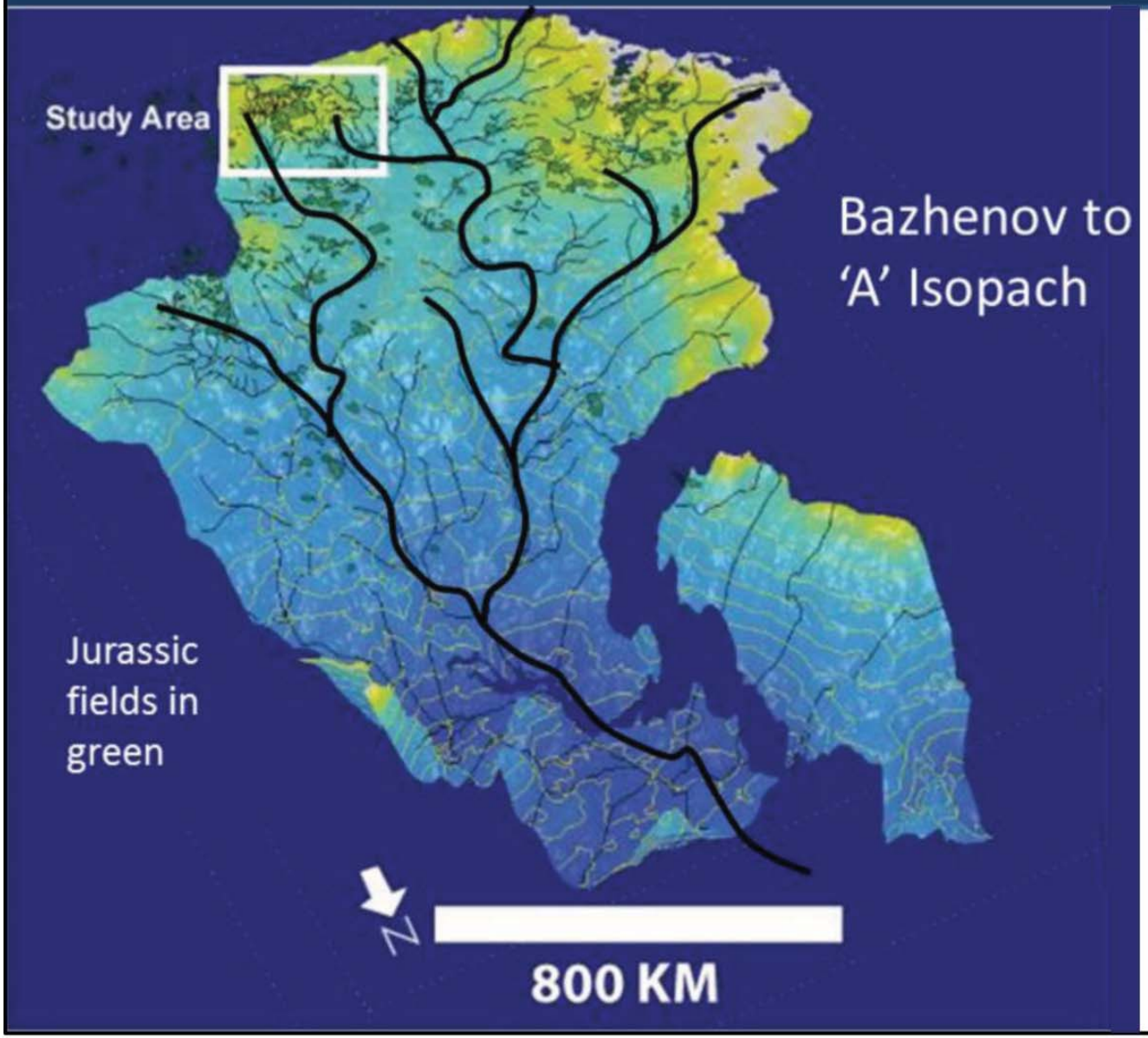
- Southern West Siberian Basin
- Largest Petroleum System in the World
- 450 + BBOE discovered
  - 28+ BBOE in Jurassic strata
- In excess of 2-3 BBOE reserves in this study area

Chronostratigraphy



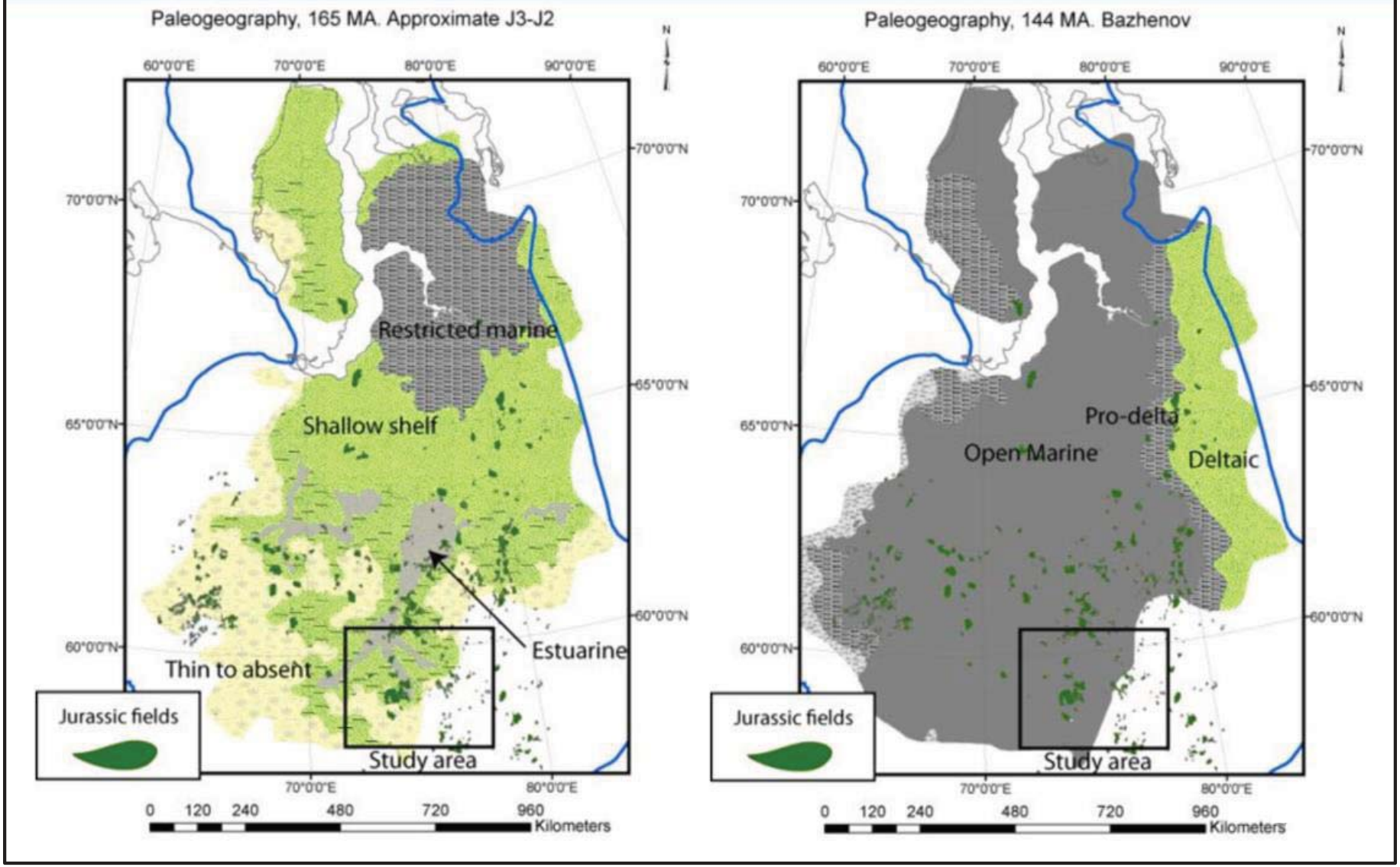
Slide modified from older work by Stephen Lowe, BP

Jurassic Paleo-topography



- 2000 + KM of erosional systems
- PZ and Triassic subcrop
- Multiple incisions and transgres-sions
- Interbedded source, seal and reservoir

Early Jurassic Paleogeography



Originally published in:
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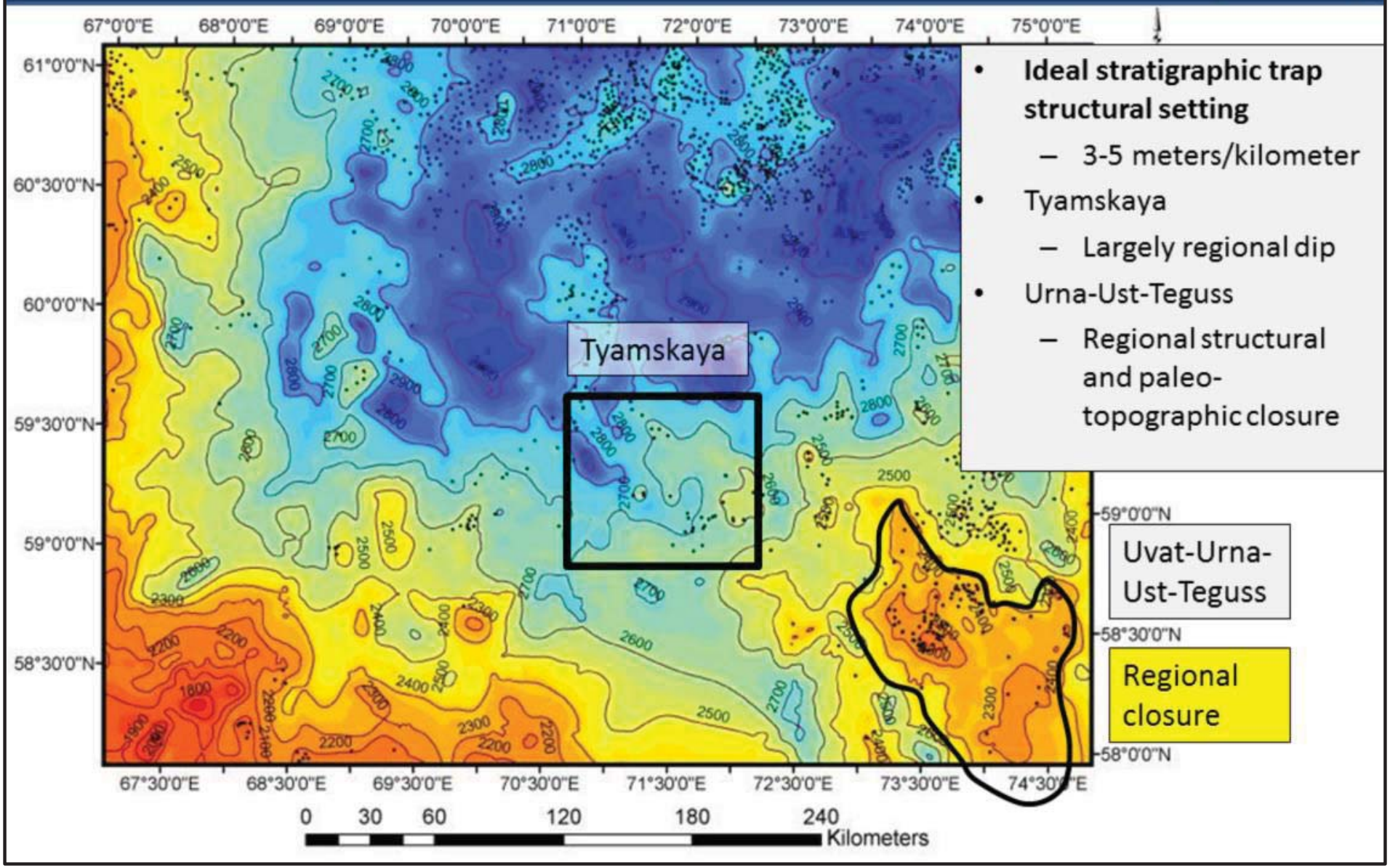
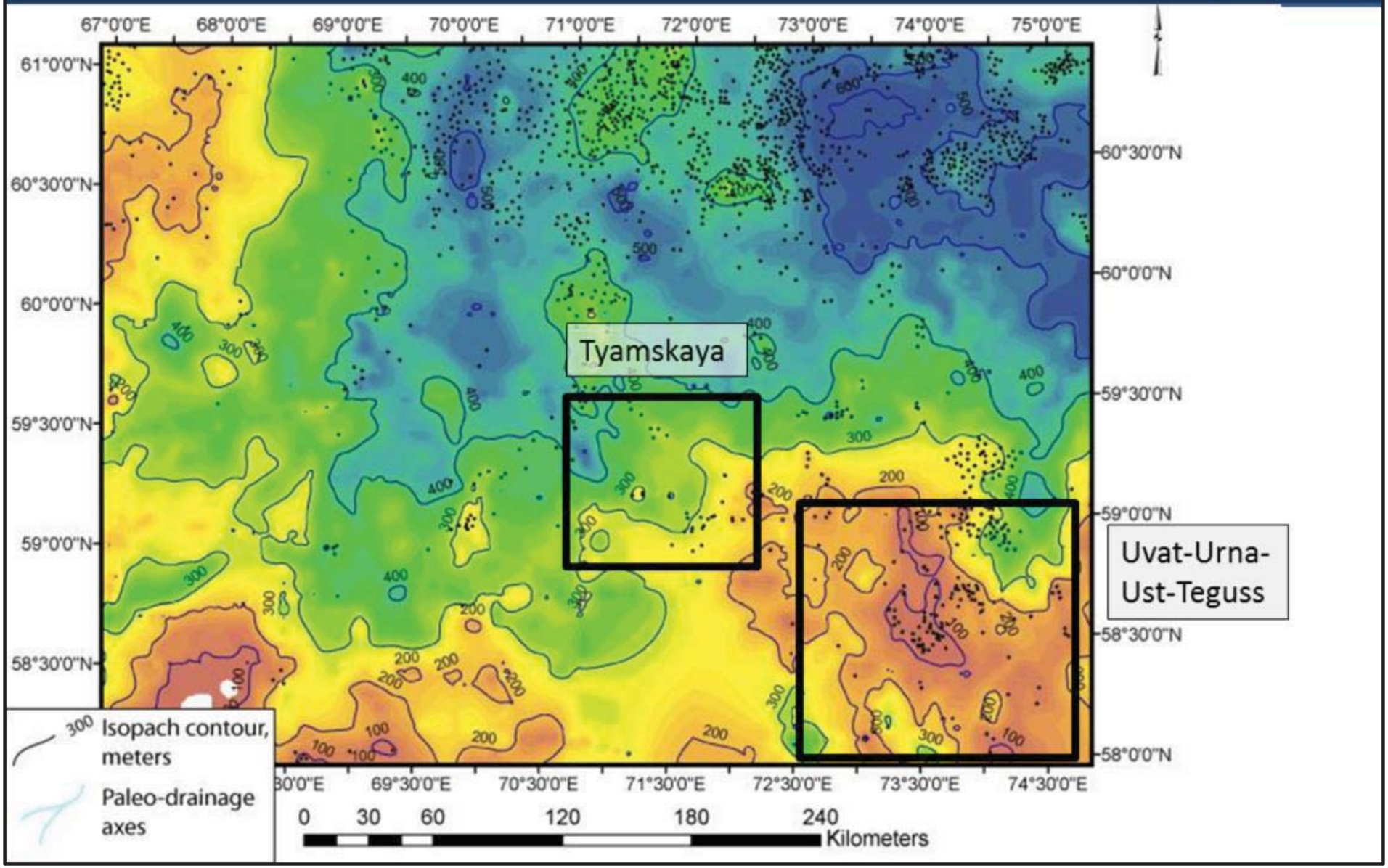
Structure, Top Bazhenov Shale

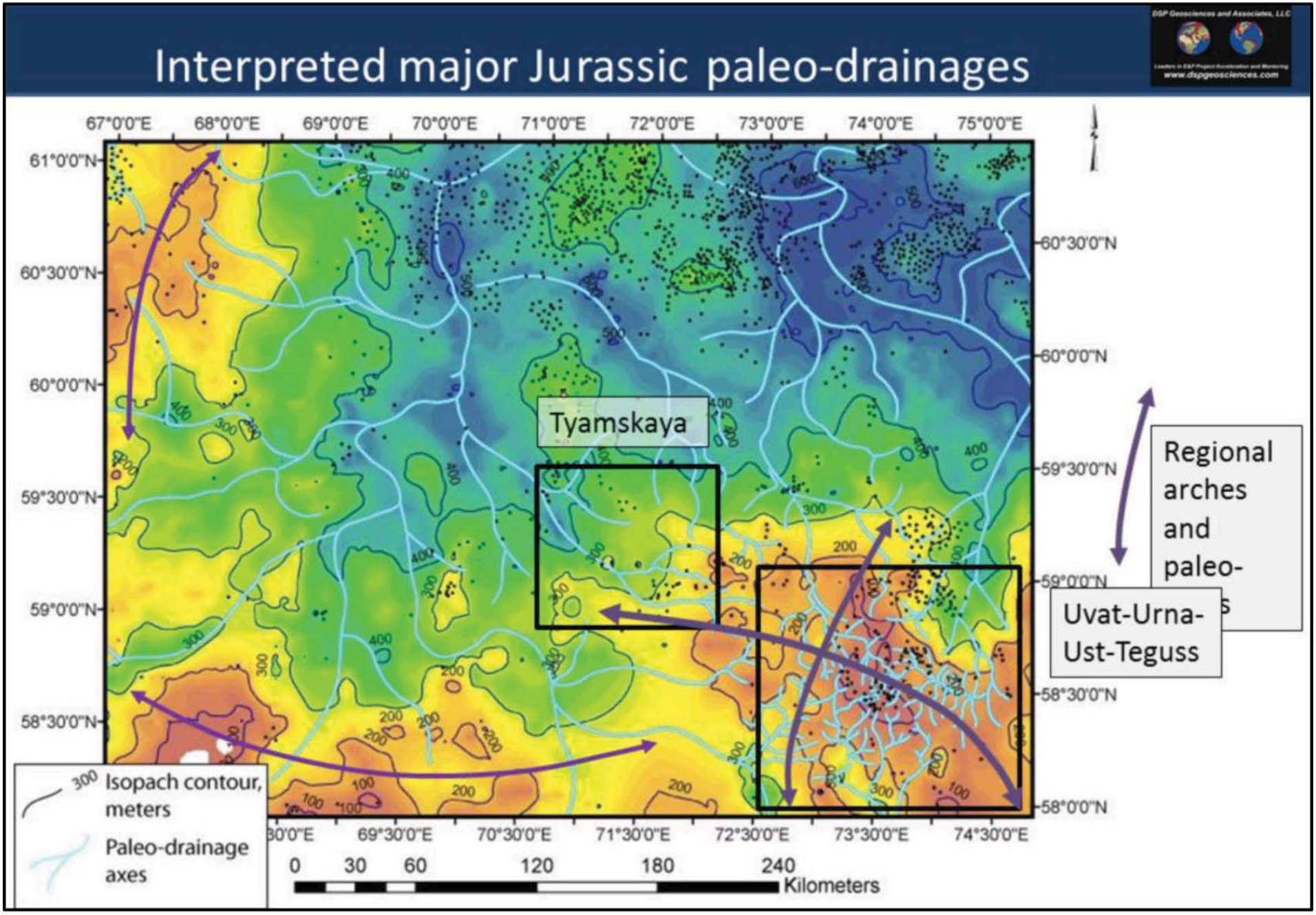


- **Ideal stratigraphic trap structural setting**
  - 3-5 meters/kilometer
- Tyamskaya
  - Largely regional dip
- Urna-Ust-Teguss
  - Regional structural and paleo-topographic closure

Isopach, Bazhenov to 'A' horizon with study areas



Interpreted major Jurassic paleo-drainages



Proportional slice-Bazhenov to A horizon with variation in seismic amplitude

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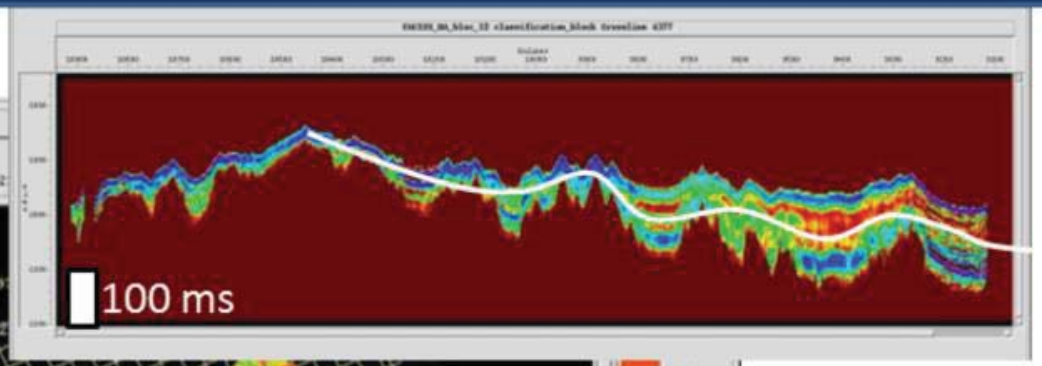
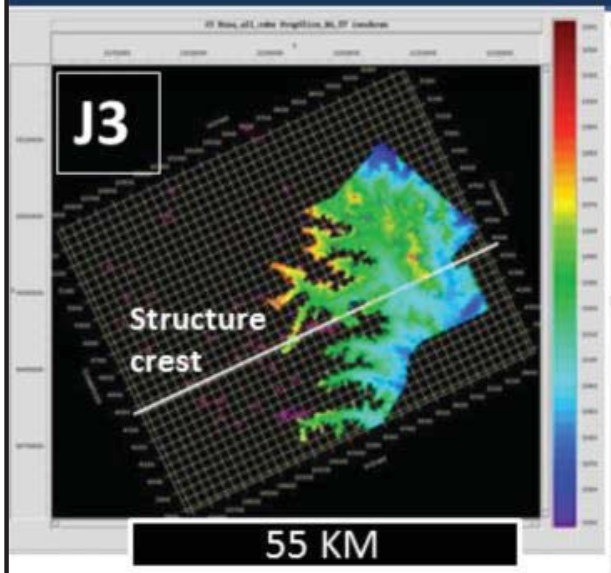
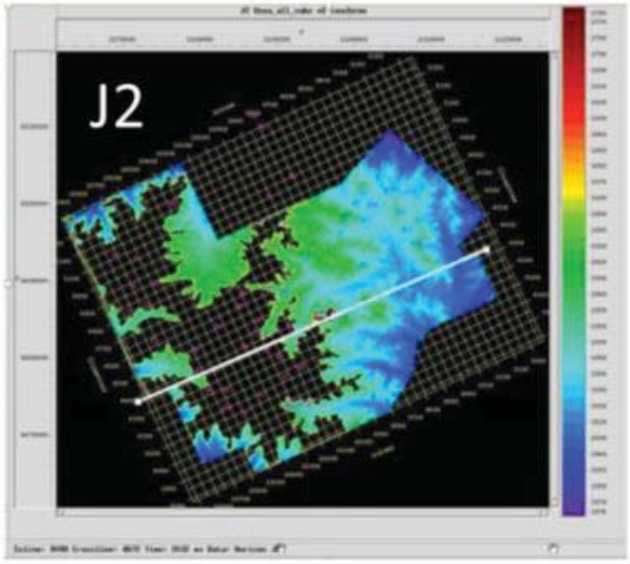
4377 Cross-Line

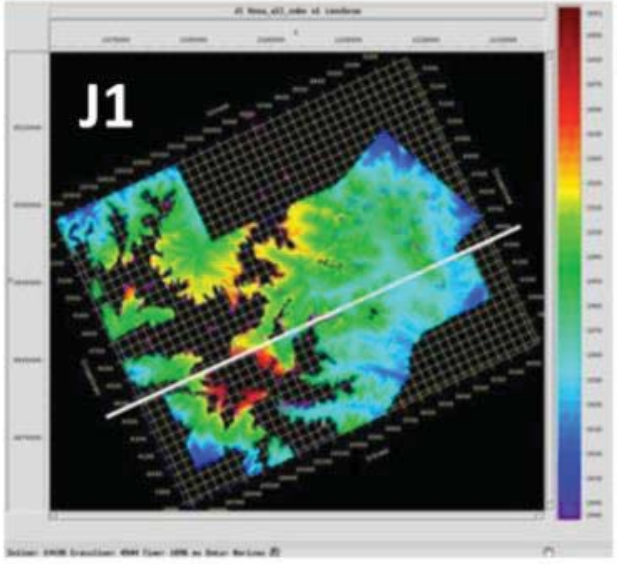


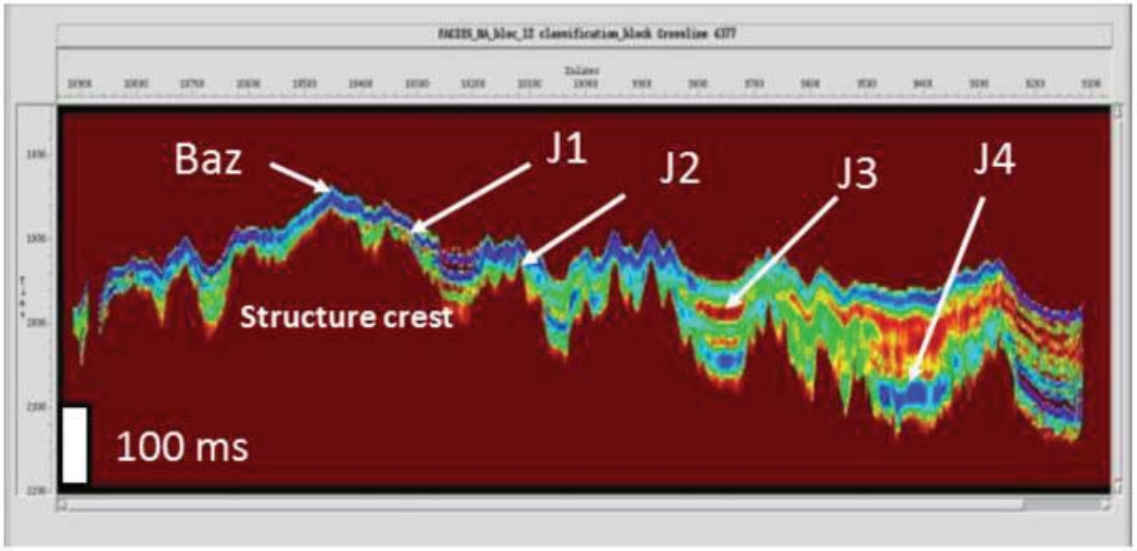
Seismic facies extraction from proportional slice (Stratimagic) across the regional closure

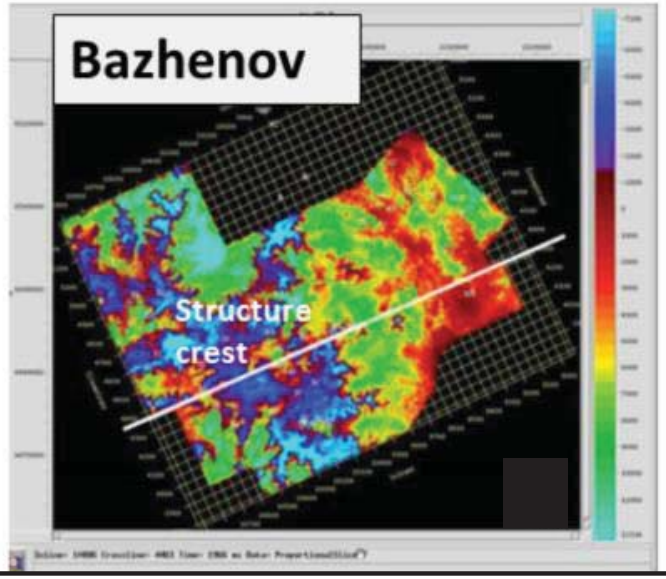
Images of progressive onlap across the paleo-high



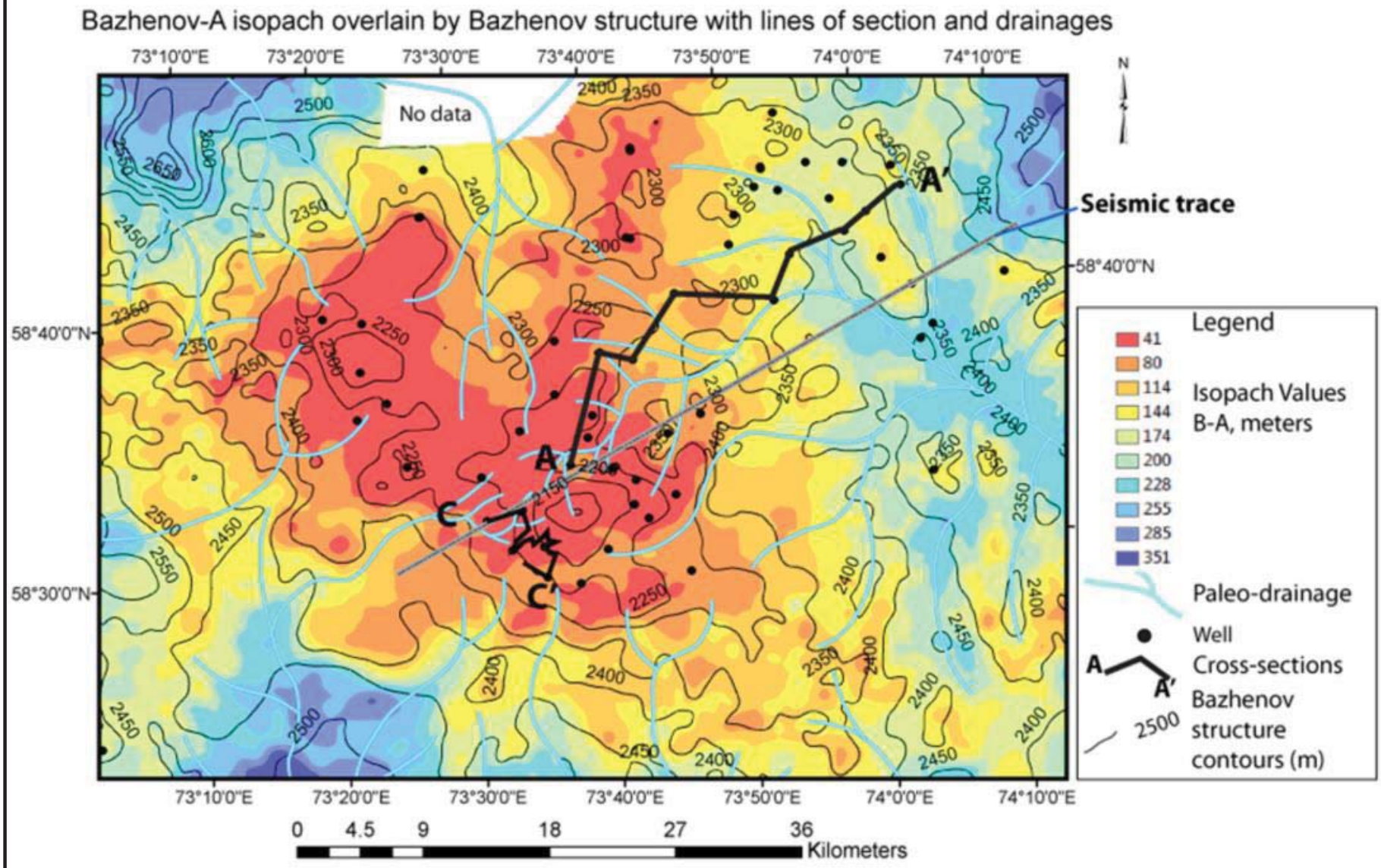








Bazhenov structural closure-Urna-Ust-Teguss area



Valley fill model and facies

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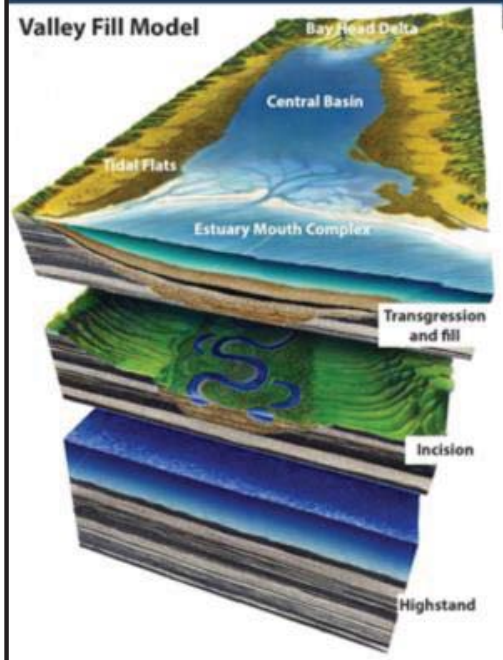
Valley Fill Model



Fine-grained Bayhead Deltas and Phytodetrital Deposits

Tidal Flats

Central Basin

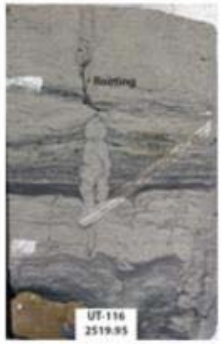
Channel Breccia

Hyperpychnite Muds J-1 Deltaic Deposits

Cryptic Channel

Rooting

Shoreface Sands



Distal Offshore

Glossifungites Ichnofacies

Glossifungites surface with Belemnites at contact between J-1 and J-2 Shales

Open marine shelf sediments in J1 and J2 strata

Offshore, marine assemblage consisting of *Scolicia*, *Phycosiphon*, *Thalassinoides*, *Chondrites*, and *Asterosoma*

Phycosiphon and *Chondrites* in marine offshore deposits

Phycosiphon and *Helminthopsis* in offshore marine deposits

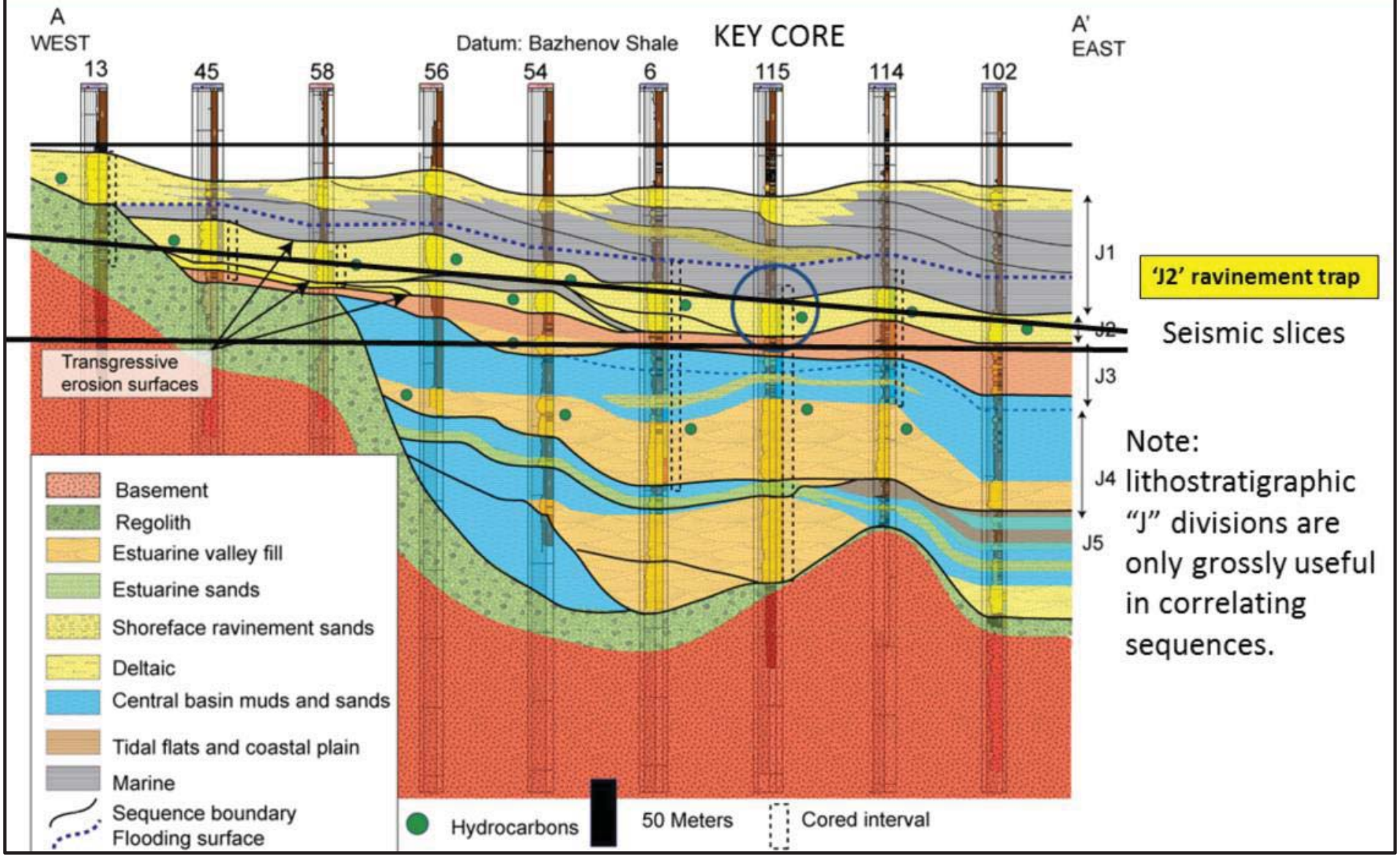
Phycosiphon illustrating the characteristic halo around the burrow

Phycosiphon and *Chondrites* in distal delta front deposits

Phycosiphon in delta fluid muds

- J2 interval previously considered fluvial to coastal transition
  - Correlations looked 'sheet like' but presumed complicated fluvial channels
- Cores reveal
  - *Glossifungites* surface underlying the J-2 throughout the eastern study area
  - Overlying strata are open marine shelf sediments (with *Phycosiphon, Helminthopsis, Chondrites, Scolicia* and *Asterosoma*)
- Correlations and seismic data confirm a shoreface ravinement model of deposition.

Stratigraphic section A-A' and horizon slices + key core



Evidence for shoreface ravinement

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115 Well

GR

Environment

Cored interval

2469
2472
2475
2478
2481
2484
2487
2490
2493
2497
2500
2525

M
SF
CP
CB

SB
"J2"
SB
"J3"
Rooted rubble zone with coals

Key surface about 2490

3m

"J2" Shoreface sands over "J3" Coastal Plain and Central Basin Muds

Glossi surfaces

SB

Erosional ravinement sequence boundaries

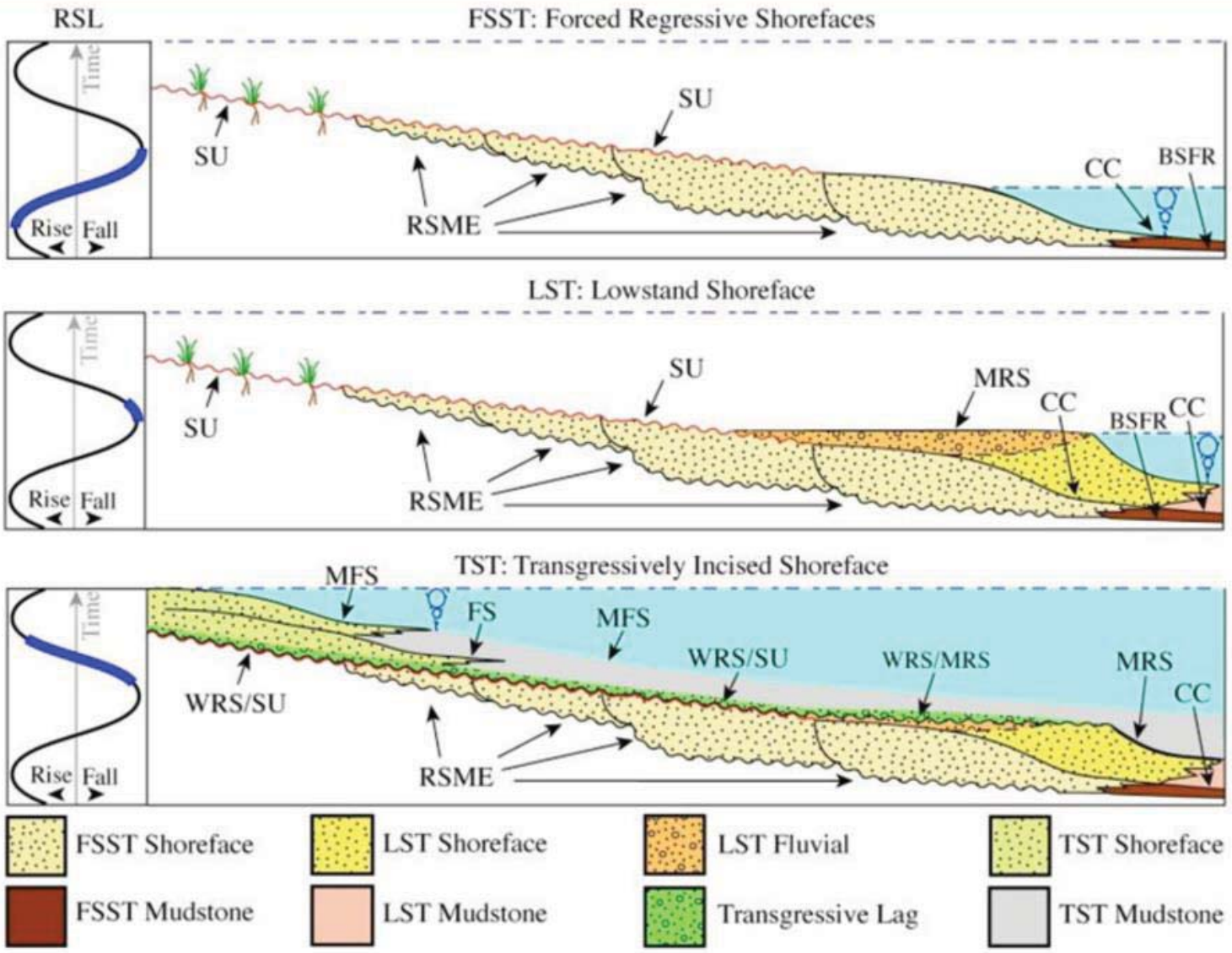
Environments

- M — Marine
- SF — Shoreface
- CP — Coastal Plain
- CB — Central Basin Mud and tidal flats

Lithology GR shade

- Shale
- Siltstone
- Carbonaceous/coaly Shale
- Fine sandstone

J2- Ravinement shoreface model

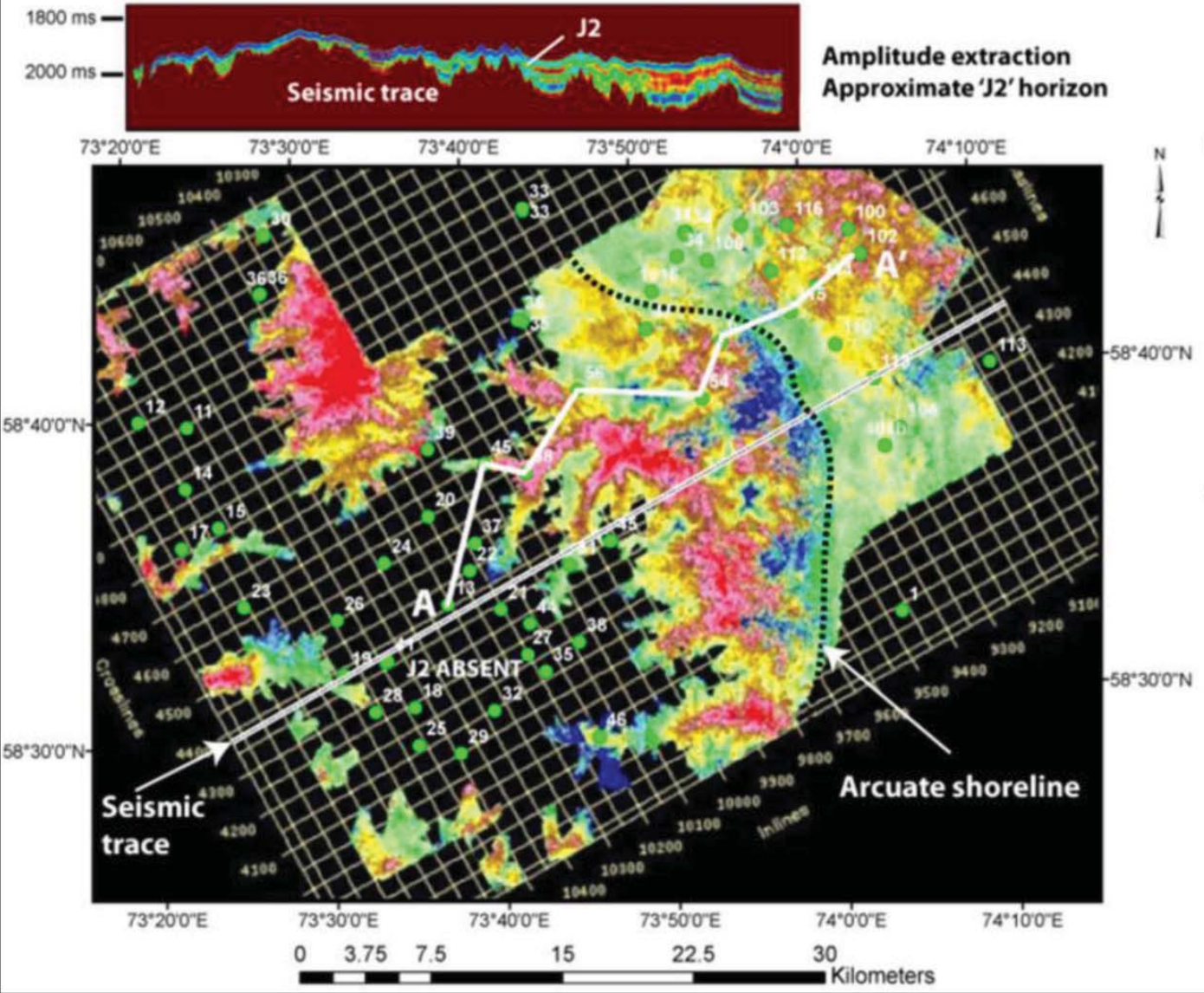


Incised shorefaces form in response to allogenically induced relative sea level changes.

Changes in relative sea level shifts the position of fair-weather wave base and storm wave base, allowing waves to cut the erosional discontinuities.

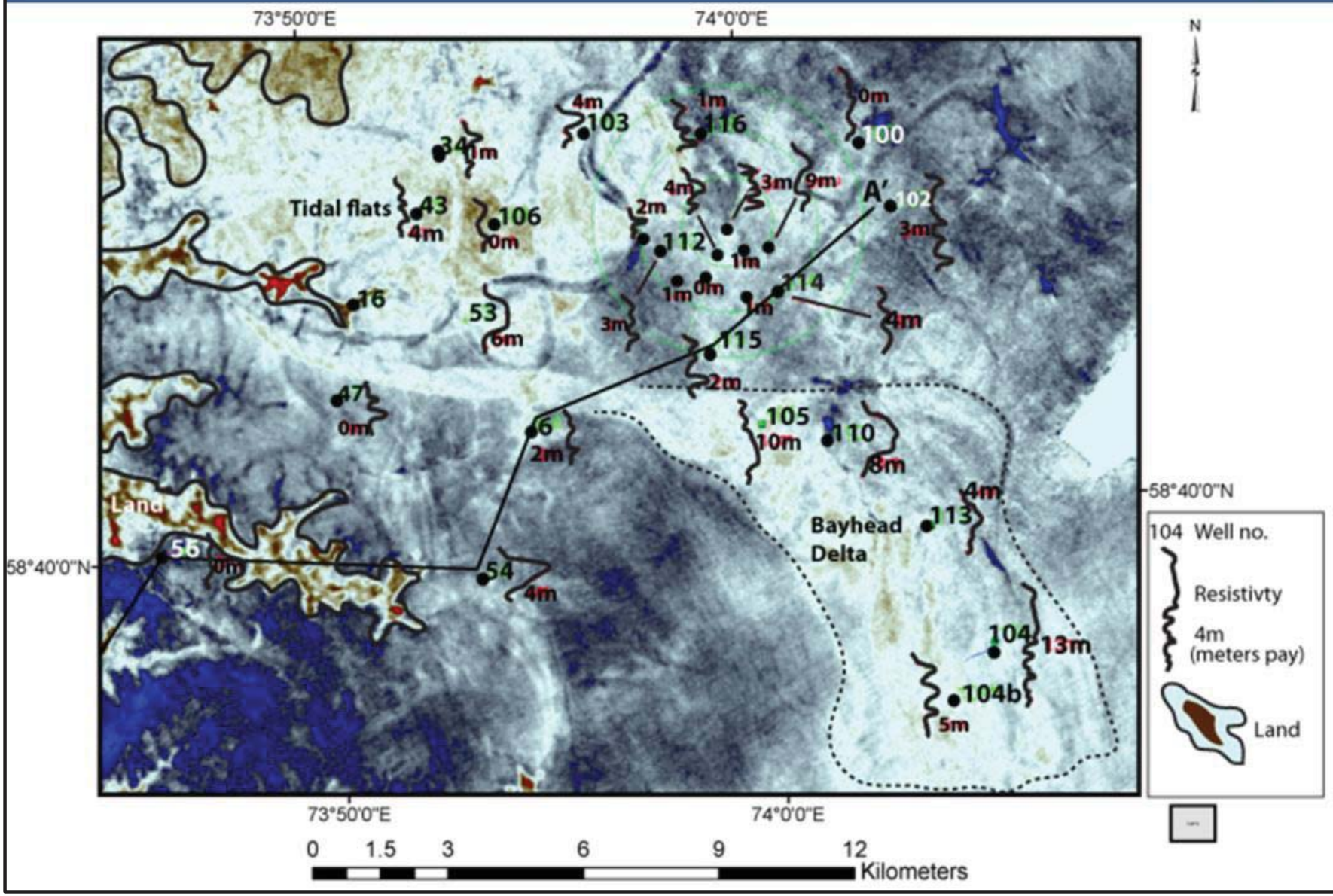
Slide courtesy of George Pemberton.

Section A-A' location and J2 Amplitude extraction

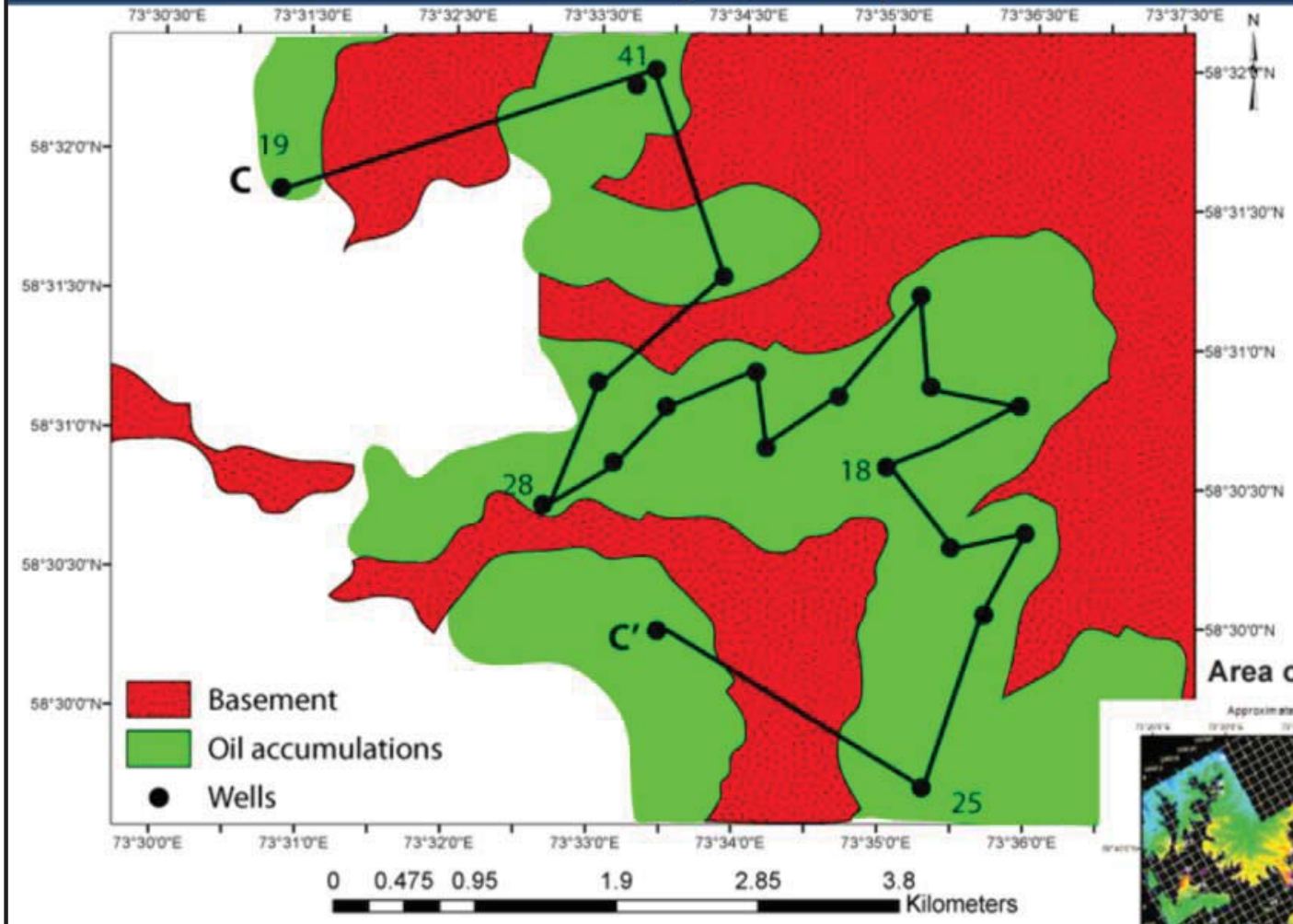


- Arcuate shoreline in front of narrow incised valleys
- Original interpretation was fluvial pre core and 3D seismic

Stratal slice—approximate 'J3' and 'J4' level and section A-A' location

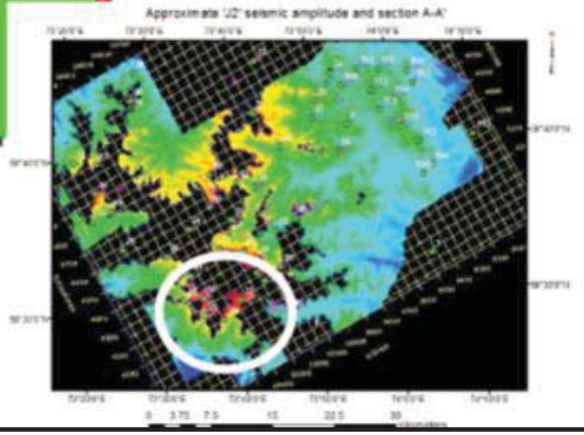


J1 shoreface traps, SW part of Urna Field

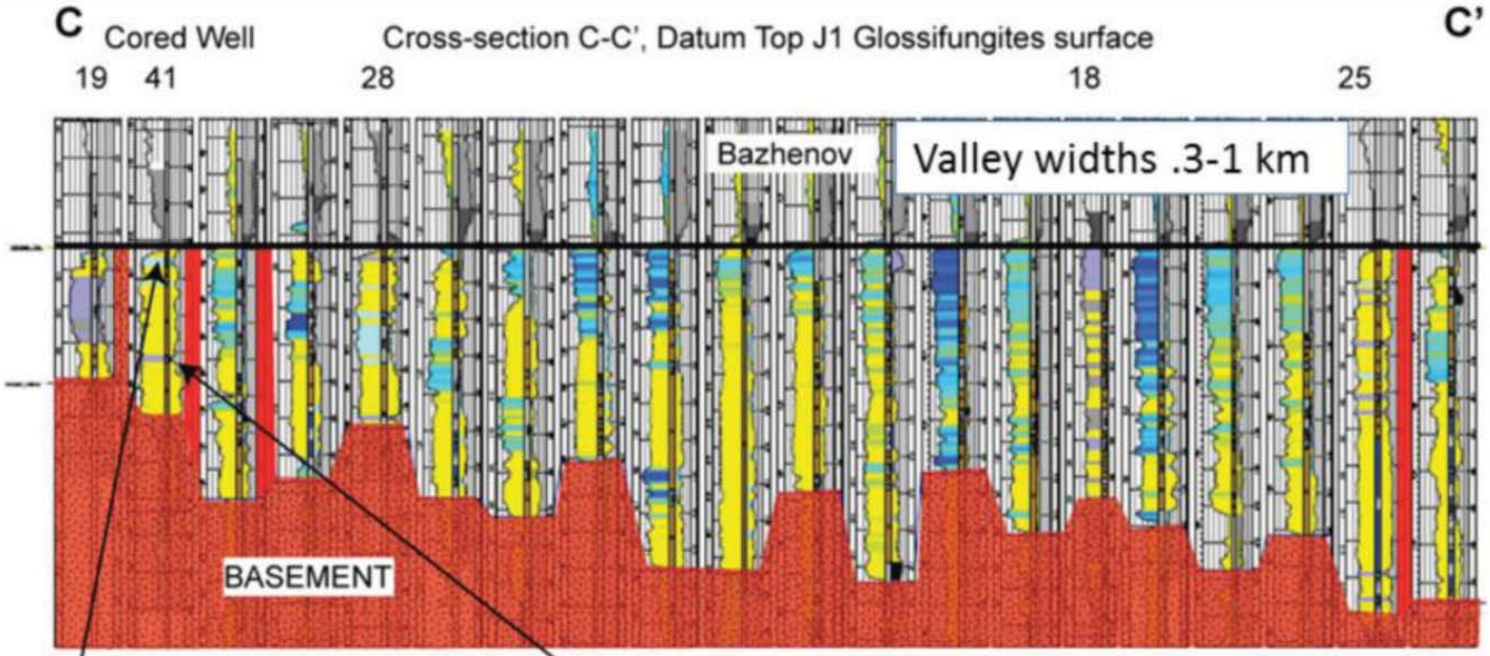


- Terminal valley networks
- Bioclastic conglomerates Belemnites and marine trace fossils
- Shoreface ravinement deposits
- Oil controlled by valley geometry
- Reservoirs have significant calcite cement degrading quality

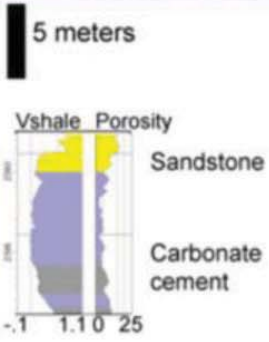
Area of map and J1 slice

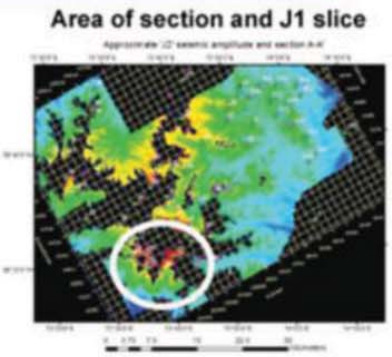


Urna field area (southwest side of closure)



Calcite-cemented, shell-bearing conglomeratic rubble



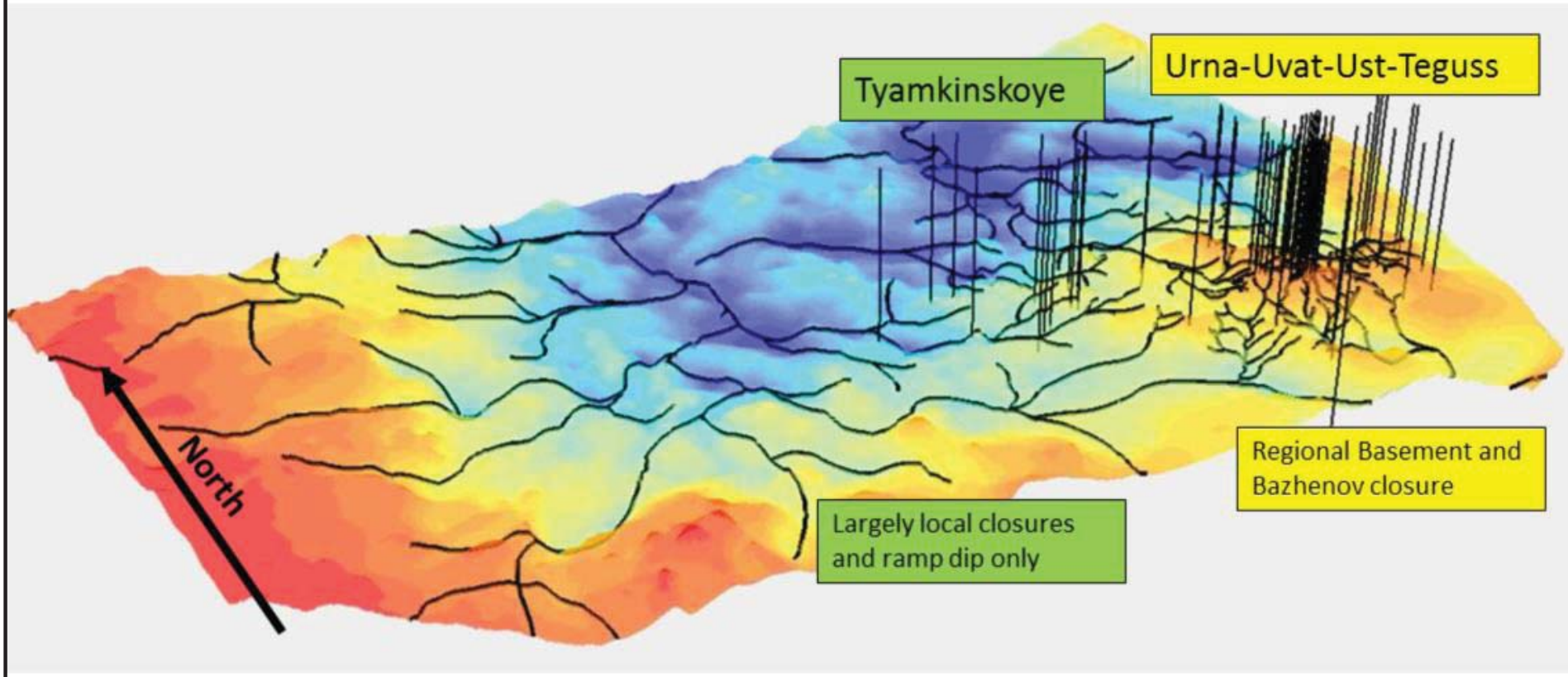


- Terminal valley networks
- Bioclastic conglomerates Belemnites and marine trace fossils
- Shoreface ravinement deposits
- Oil controlled by valley geometry
- Reservoirs have significant calcite cement degrading quality

Tyamkinskoye Field Area

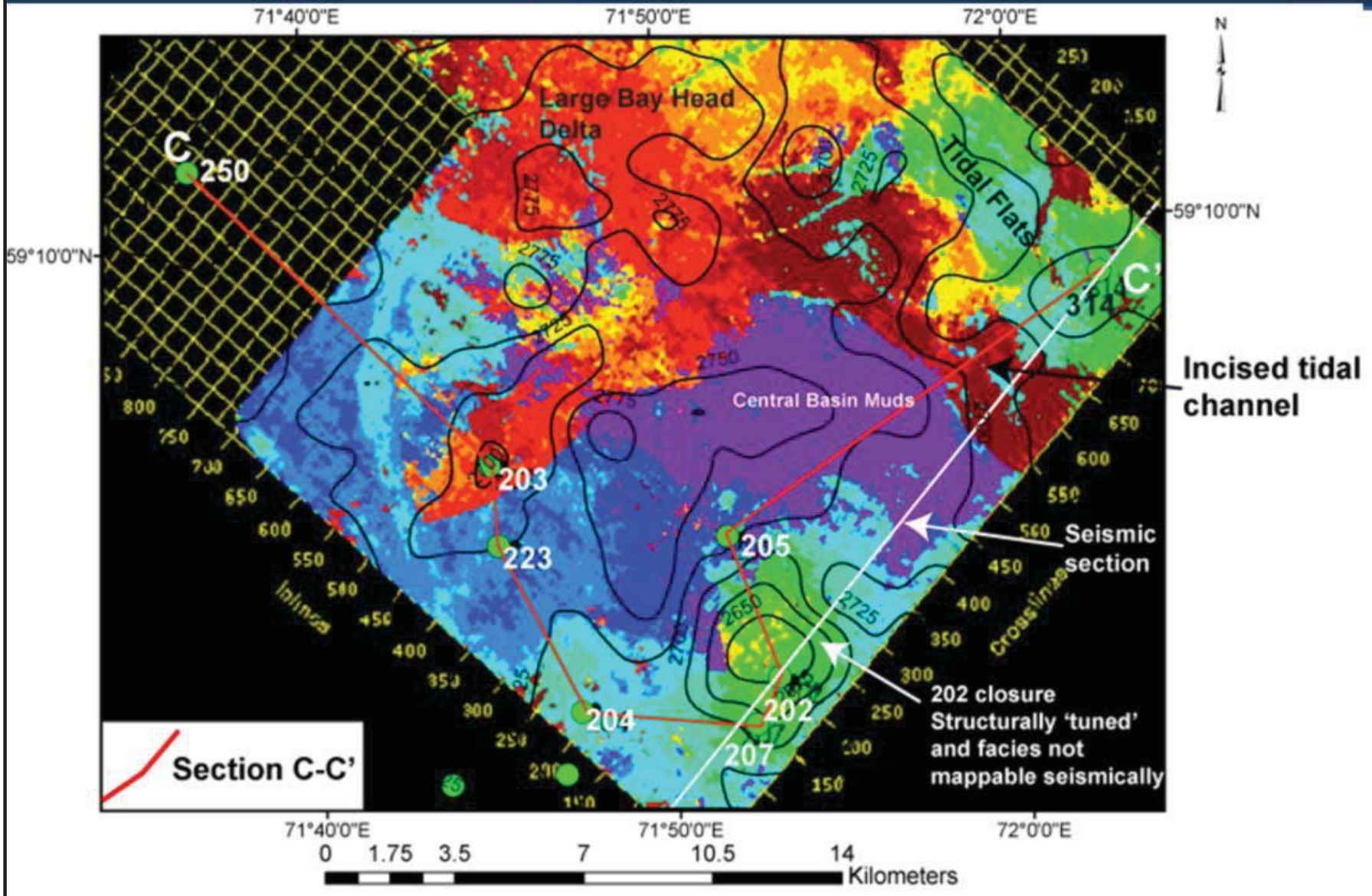
A probable giant but complex stratigraphic trap

Regional setting-Tyamkinskoye

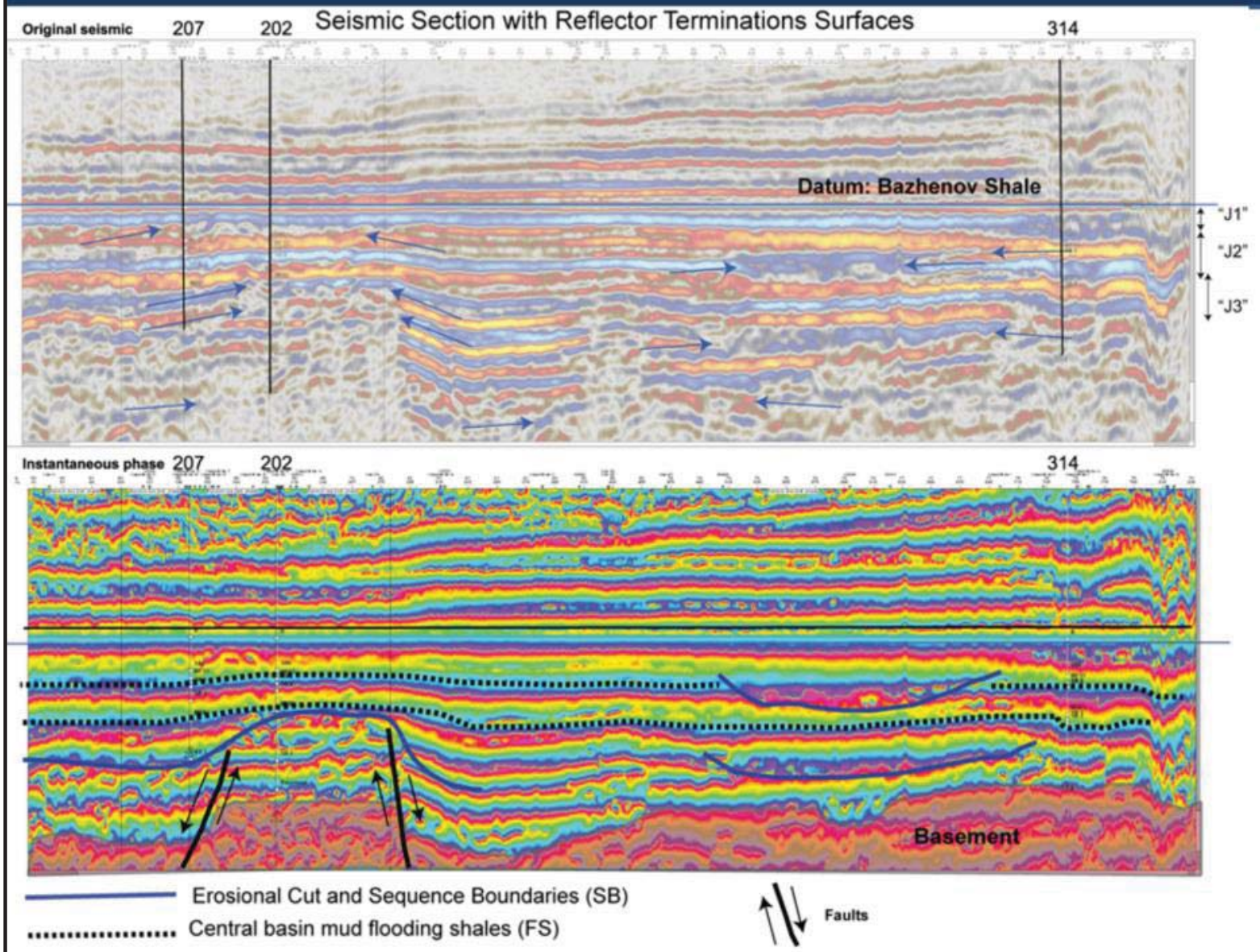


3D structural shape, top of 'A' (Basement) horizon, with regional Jurassic paleo-drainage networks superimposed. Tyamskaya is downdip both structurally and stratigraphically, with little to no closure on drilled productive wells.

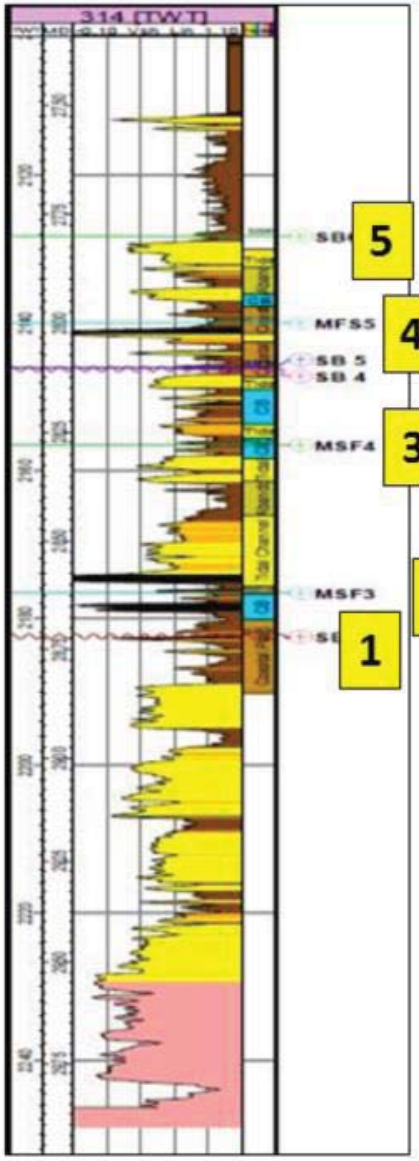
Stratimagic seismic facies, approximate 'J2' with Bazhenov structure



Seismic reveals multiple sequences and erosion surfaces



Valley edge well: 314– all microporous waste zone



Channel breccia

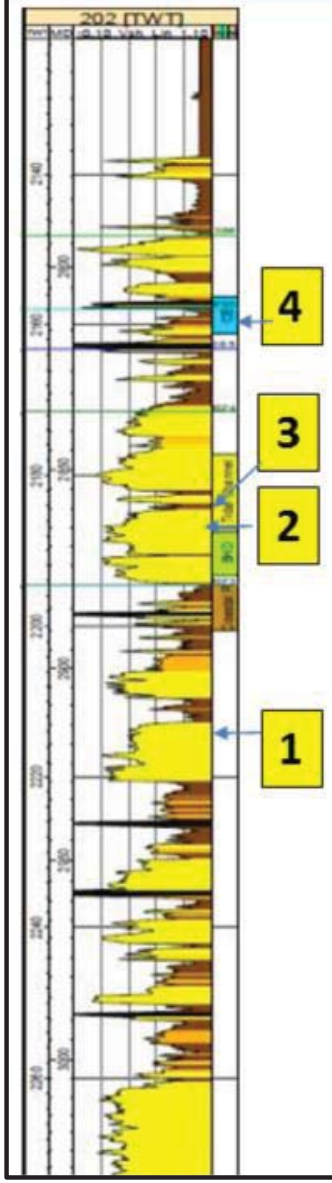
Tidal Flat

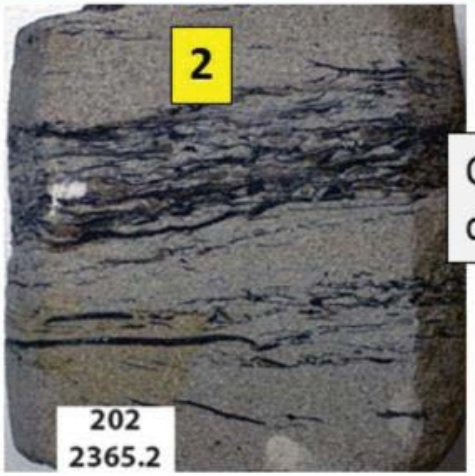
Central Basin muds

Glossifungites surface

Cryptically bioturbated channel

Productive Macro-porous bayhead deltas

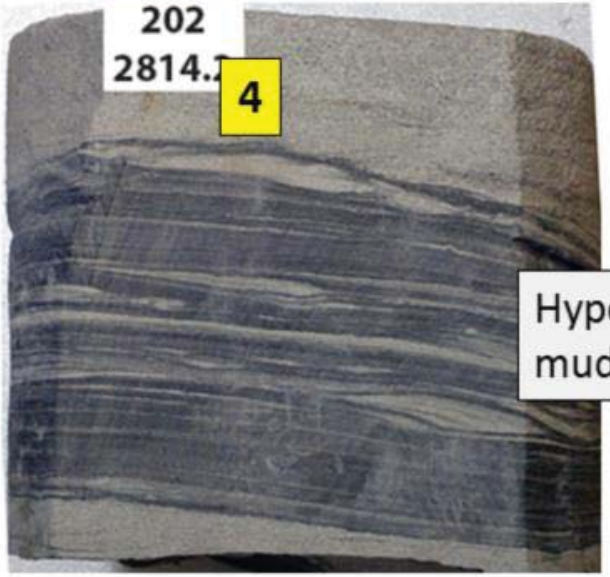




Organic debris

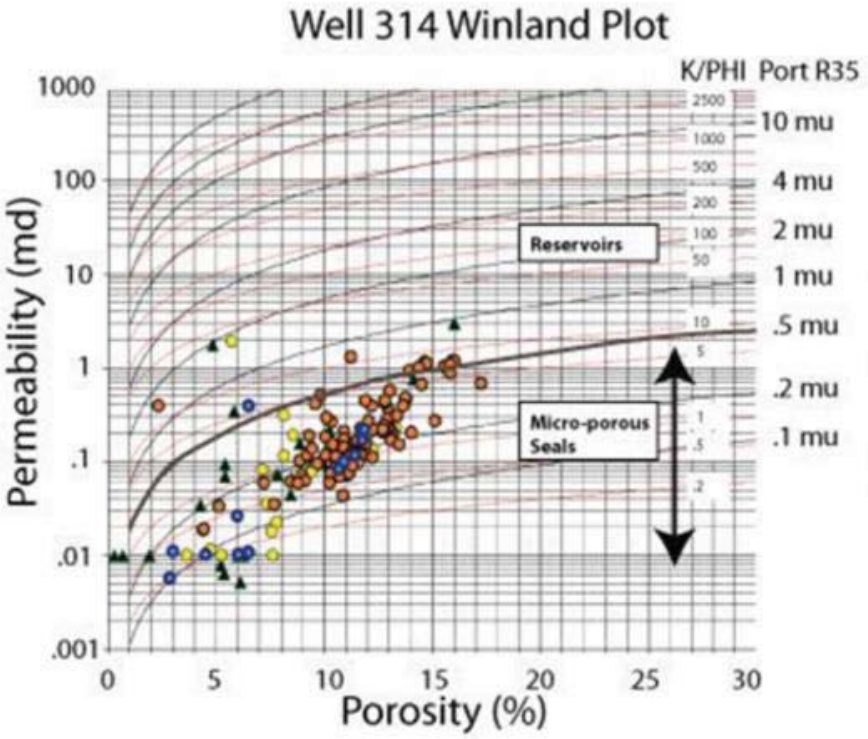
Tidal bundles at top of channel

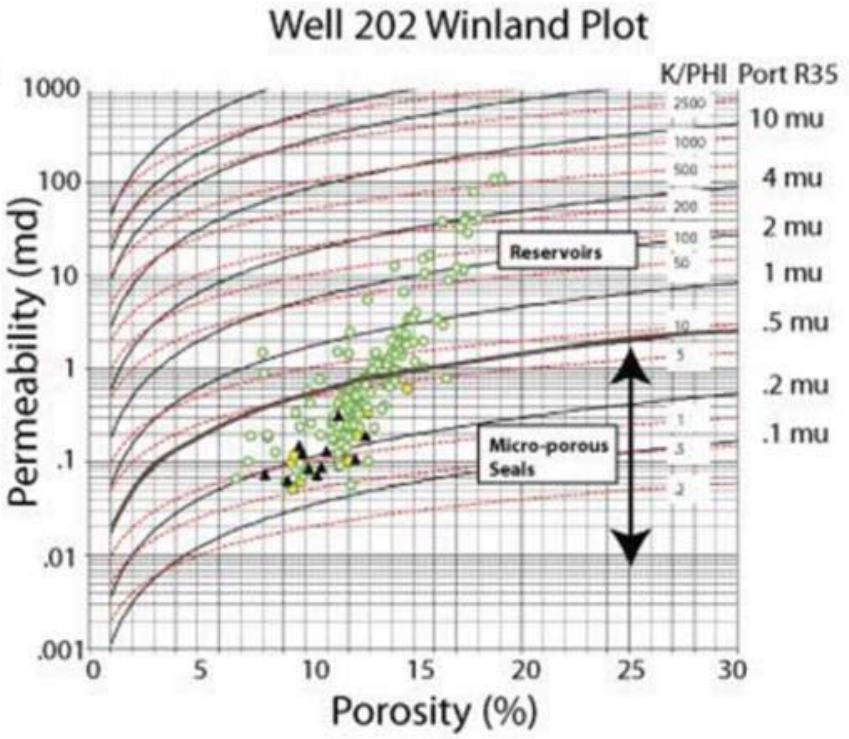
Bayhead delta



Hyperpychnal muds

Tidal flat seals, tidal channel and bayhead delta reservoirs





- Coastal plain
- Central basin
- Tidal flats
- Abandoned channel
- Tidal channels and bayhead deltas

K/PHI ratio

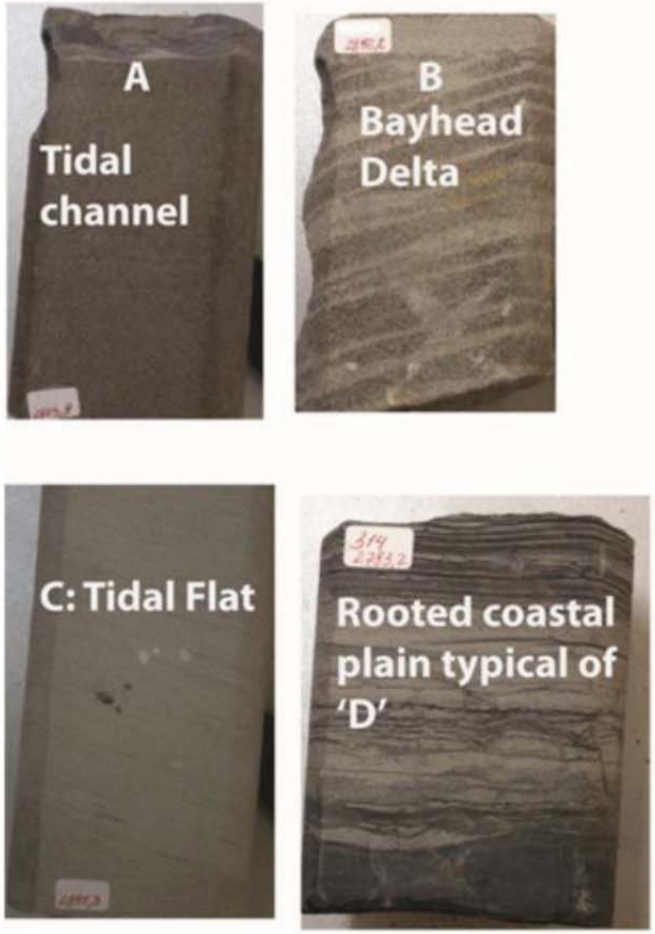
R35 pore throat

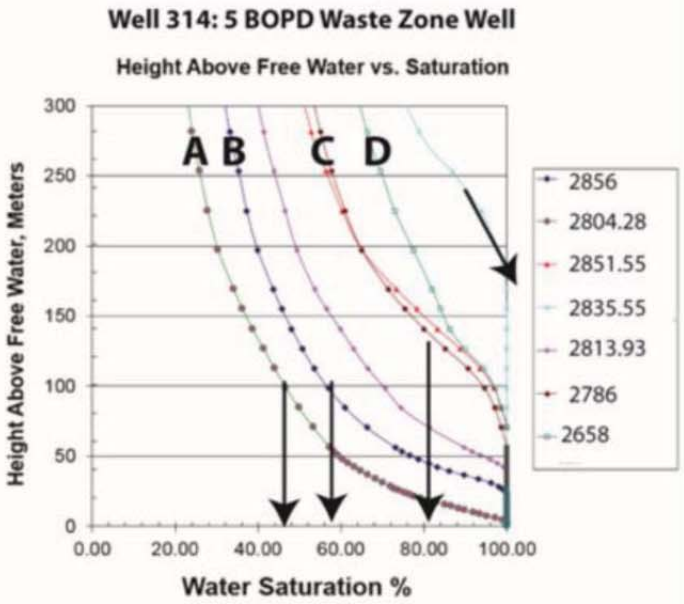
HIGHER ENERGY FACIES ARE RESERVOIRS

LOWER ENERGY-VALLEY EDGE AND CENTRAL BASIN MUDS ARE SEALS

Capillary pressure and height above free water—314 waste zone well

Reservoir facies used for height above free water estimate





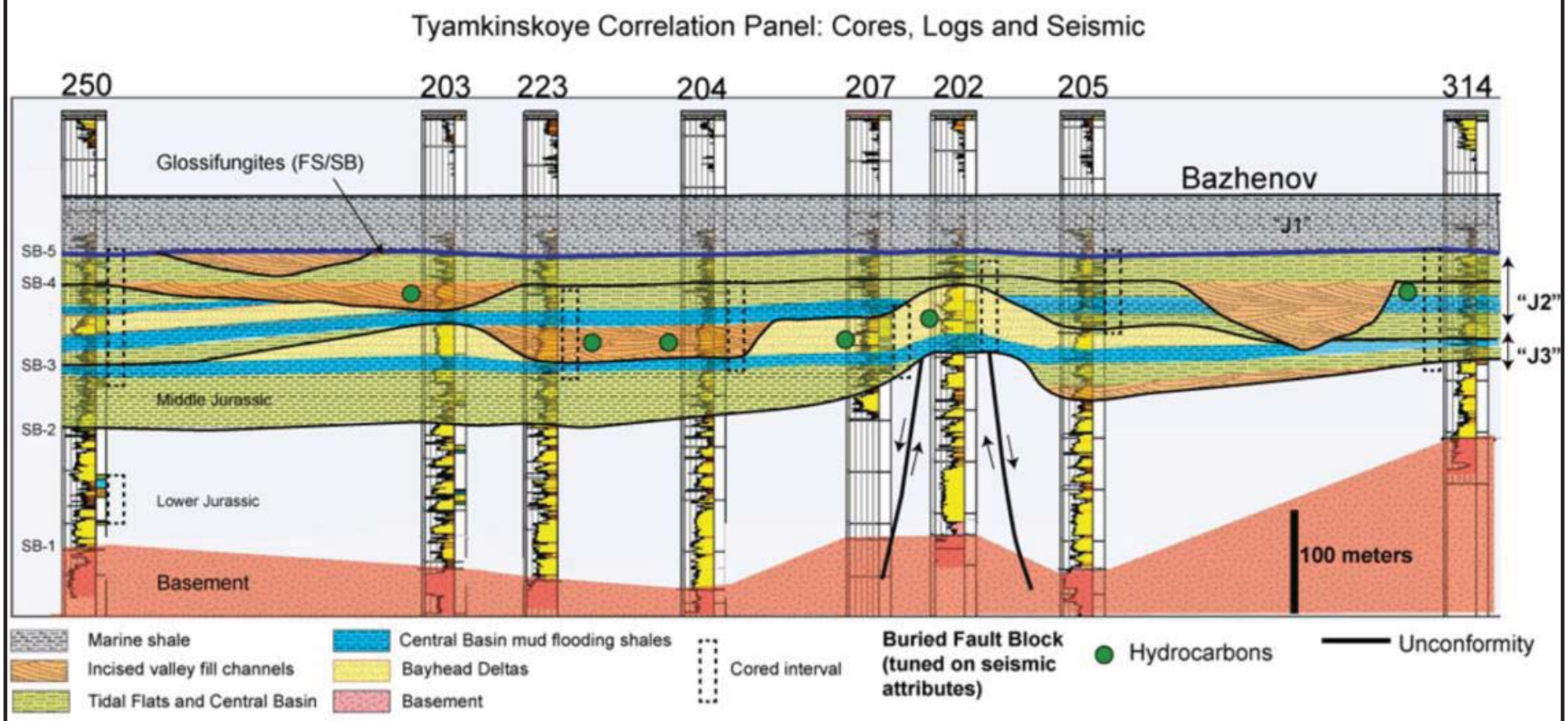
Estimated height above free water 80-120 meters

Coastal plain facies can seal 100-150 meters 35 API oil

- Saturation and shows from core:
  - ***Well is 80-120 meters above free water***
  - No structural closing contour at this level
  - Coastal plain can seal!
  - Stratigraphic closure into valley wall pinch-out or coastal plain defines the possible trap

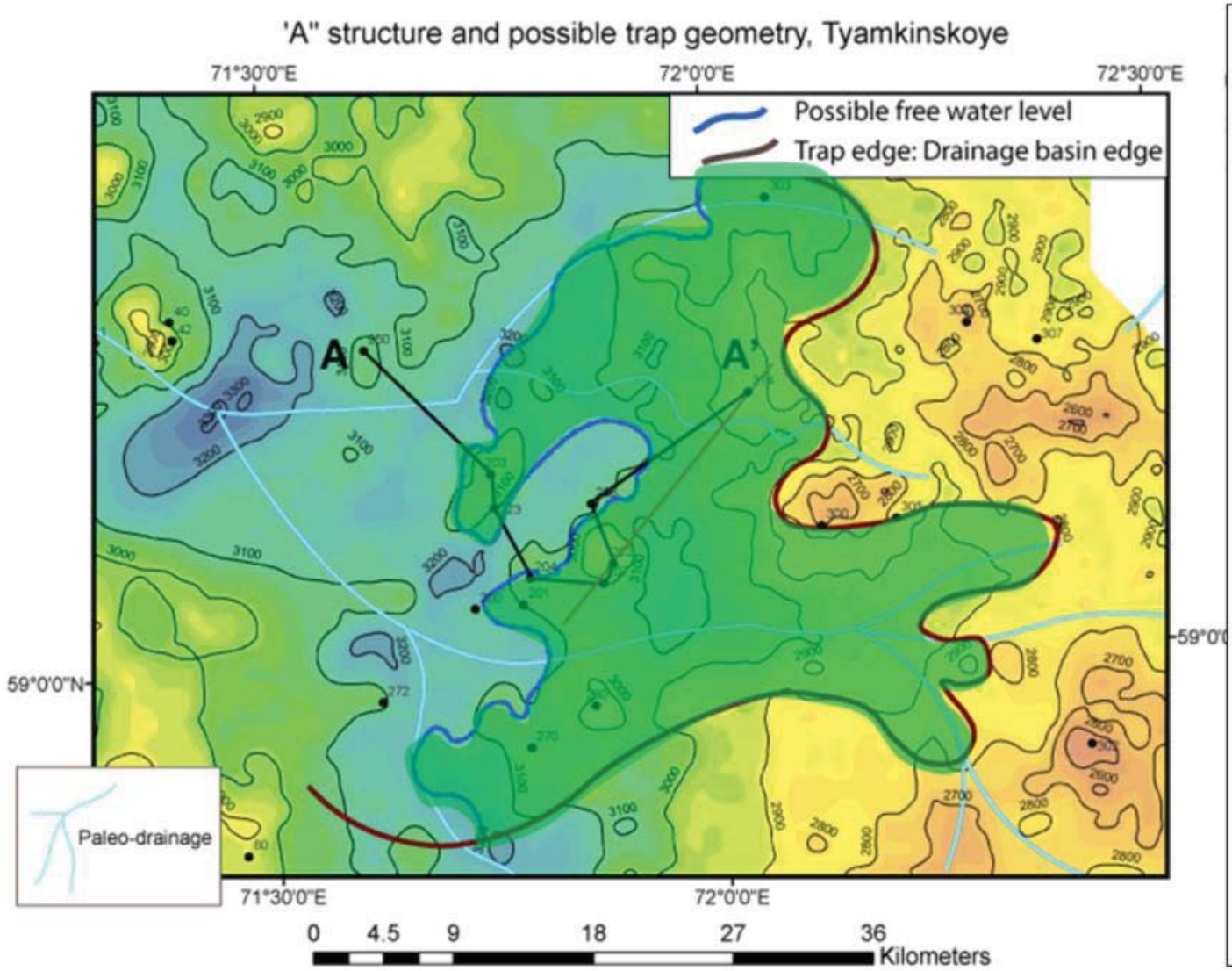
This technique is covered well in Vavra, C. L., J. G. Kaldi, and R. M. Sneider, 1992, Geological applications of capillary pressure: a review: American Association of Petroleum Geologists Bulletin, v. 76, p. 840-850.

Final log correlation reveals complexity not addressed by lithostratigraphy



Horizon slices down from the Bazhenov will cross multiple facies with multiple ages.

Potential large trap size > 800 Km^2



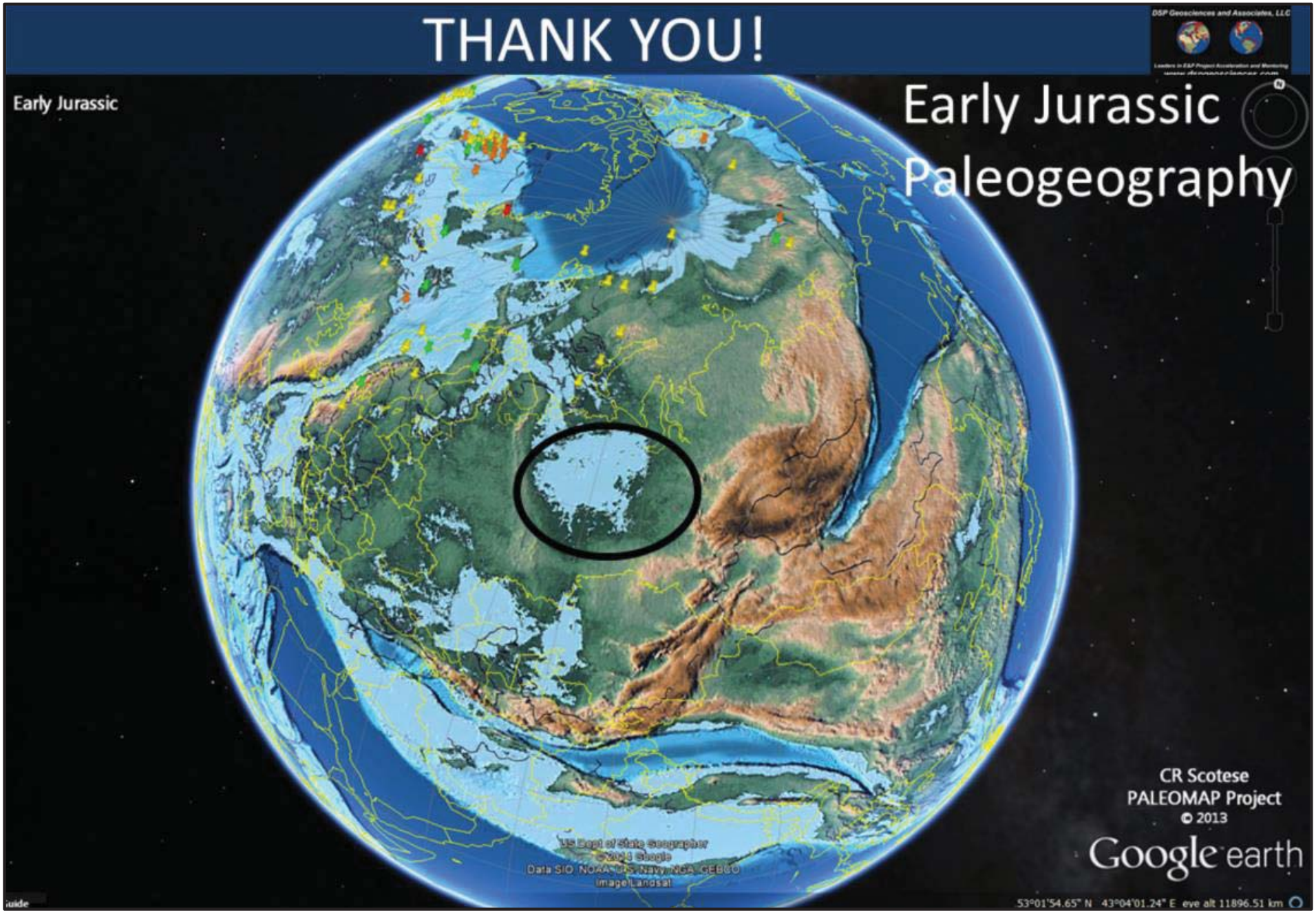
- Wells inside green area
  - Tested oil from Jurassic
  - Cap pressure, shows support trap
  - Several oil wells on ramp dip
  - Column height shown would be about 100-150 meters at Bazhenov level
  - Seals set up by edge of broad drainage basin possibly by coastal plain shales

The seal edge shown explains the oil shows in downdip wells and fits with earlier established locations of major drainage basin networks.

Conclusions

- **Lithostratigraphy nomenclature is useful only at a broad scale**
  - Many higher resolution sequences exist and subtle facies changes and pinch-outs control traps.
- **Ideal stratigraphic trapping geometries**
  - Multiple unconformities and facies changes
  - Low structural dip
  - Pervasive source rocks interbedded with reservoirs and seals
- **Overall control on trapping are paleo-drainage basin pinch-outs with interfluves as seals**
  - Secondary trapping by micro-porous flanking coastal-plain and tidal-flat deposits,
    - Can seal > 100 m of oil column
  - Likely multiple free water levels, but regional traps are probably the norm, not the exception.
  - Reservoirs are key: higher energy tidal channels and bayhead deltas
- **2-3 BBOE of reserves, perhaps larger**
  - **Urna-Ust-Teguss Bazhenov closure > 3,000 Km²**
  - **Tyamkinskoye trap may exceed 800 Km² in closure**
    - **Much more drilling is needed to confirm**
    - **Seals within valleys may be as important as facies pinchouts**

THANK YOU!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