Stratigraphic Architecture, Lithofacies, and Reservoir Quality: Tengiz and Korolev Fields, Caspian Basin, Kazakhstan

By
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Abstract

Tengiz and Korolev are isolated carbonate platform reservoirs separated by less than 15 kilometers in the southeastern portion of the PriCaspian basin. They have similar thickness and stratigraphic age range, but Tengiz is large (100 km^2) compared to Korolev (7 km^2).

Eight sequences are recognized within the Tengiz and Korolev platforms from seismic and well data: Devonian, Tournaisian, Visean D, Visean C, Visean B, Visean A, Serpukhovian, and Bashkirian. The Tournasian through Visean C sequences form the transgressive portion of a second-order supersequence that culminated in near-drowning of both platforms. The Visean B through Serpukhovian sequences comprise the regressive part of the supersequence. This regressive phase is characterized by up to 2 kilometers of basinward progradation during the Serpukhovian; the progradation is asymmetrical and irregular at both platforms.

Reservoirs in the Visean A through Bashkirian sequences are dominated by interparticle porosity and matrix microporosity in grain-rich facies over much of the Tengiz platform, whereas vugs and solution-enlarged fractures produce drilling circulation losses in microbial boundstone slope facies surrounding the platform. Lost circulation greatly enhances well productivity and reservoir connectivity in this facies even though it is commonly associated with scattered, relatively thin, high-permeability zones. At Korolev, secondary pore-types and lost-circulation zones (LCZs) are present in both the platform and slope facies in the same reservoir intervals, resulting in increased connectivity throughout the field.

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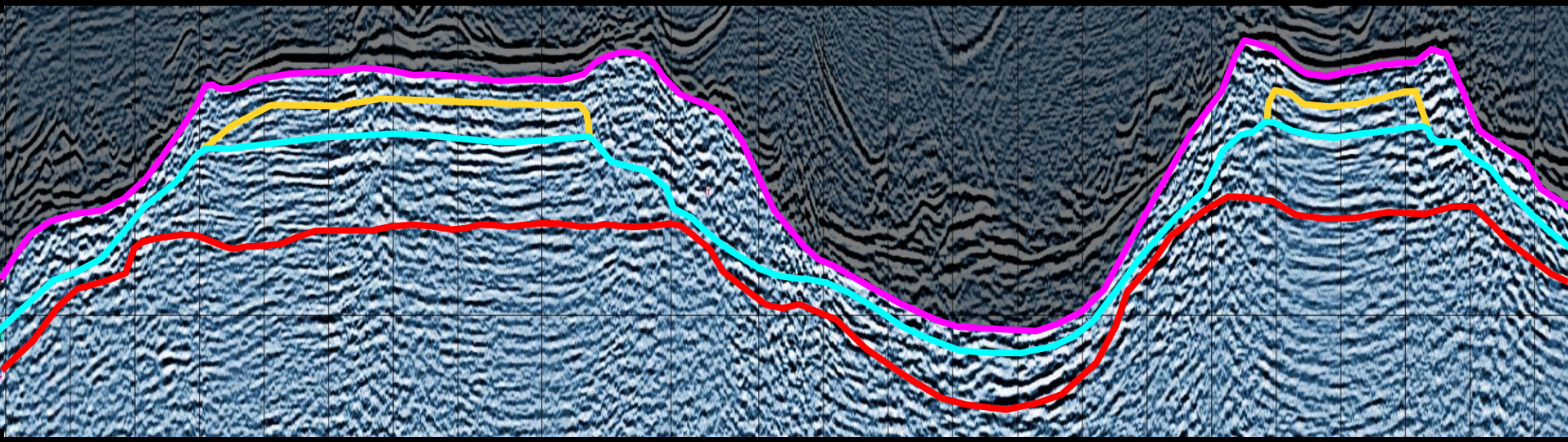


Paul M. (Mitch) Harris[1],
Joel F. Collins[2], Kevin L. Putney[2],
Akmaral Zhumagulova[3], Dennis J. Fischer[3]

1 Chevron

2 ExxonMobil Development

3 TCO ТЕНГИЗШЕВРОЙЛ

TALK OUTLINE

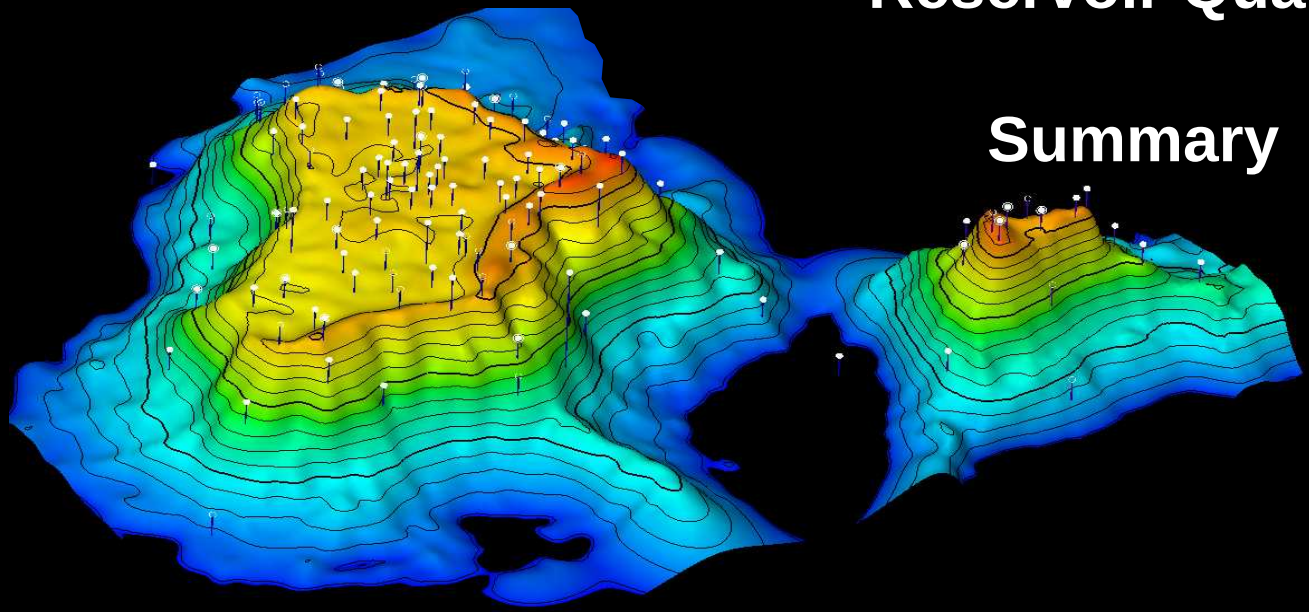
Introduction of Basin and Fields

Stratigraphic Architecture

Lithofacies

Reservoir Quality

Summary



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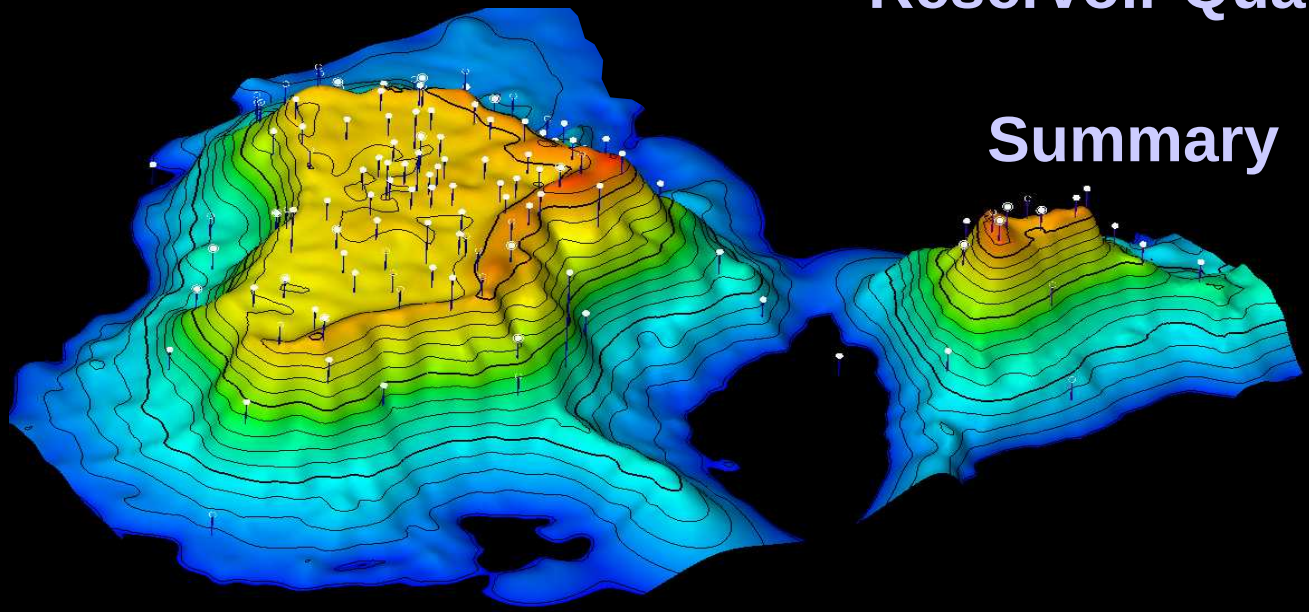
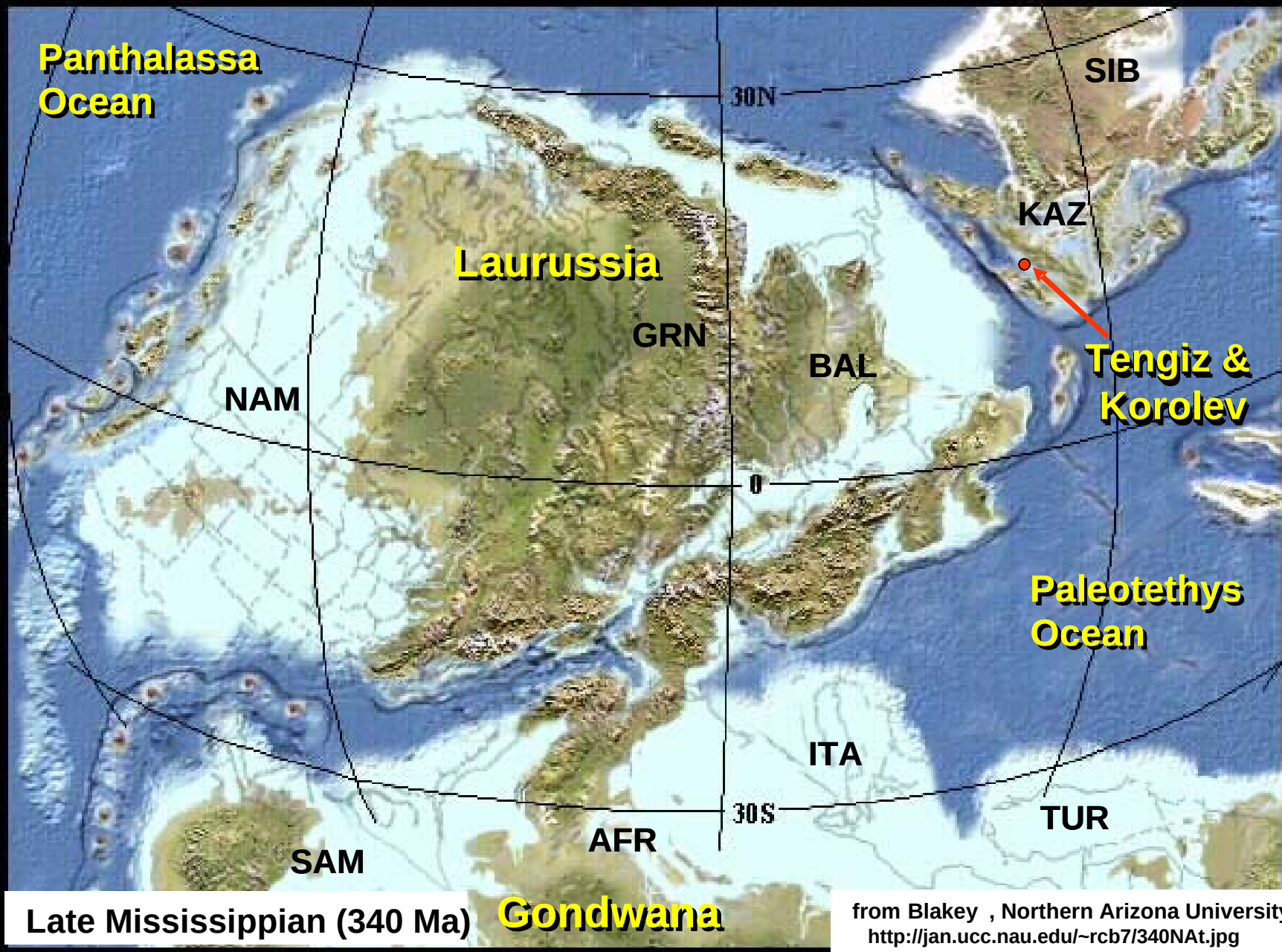


LOCATION OF CASPIAN BASIN AND MAJOR CARBONATE PLATFORMS

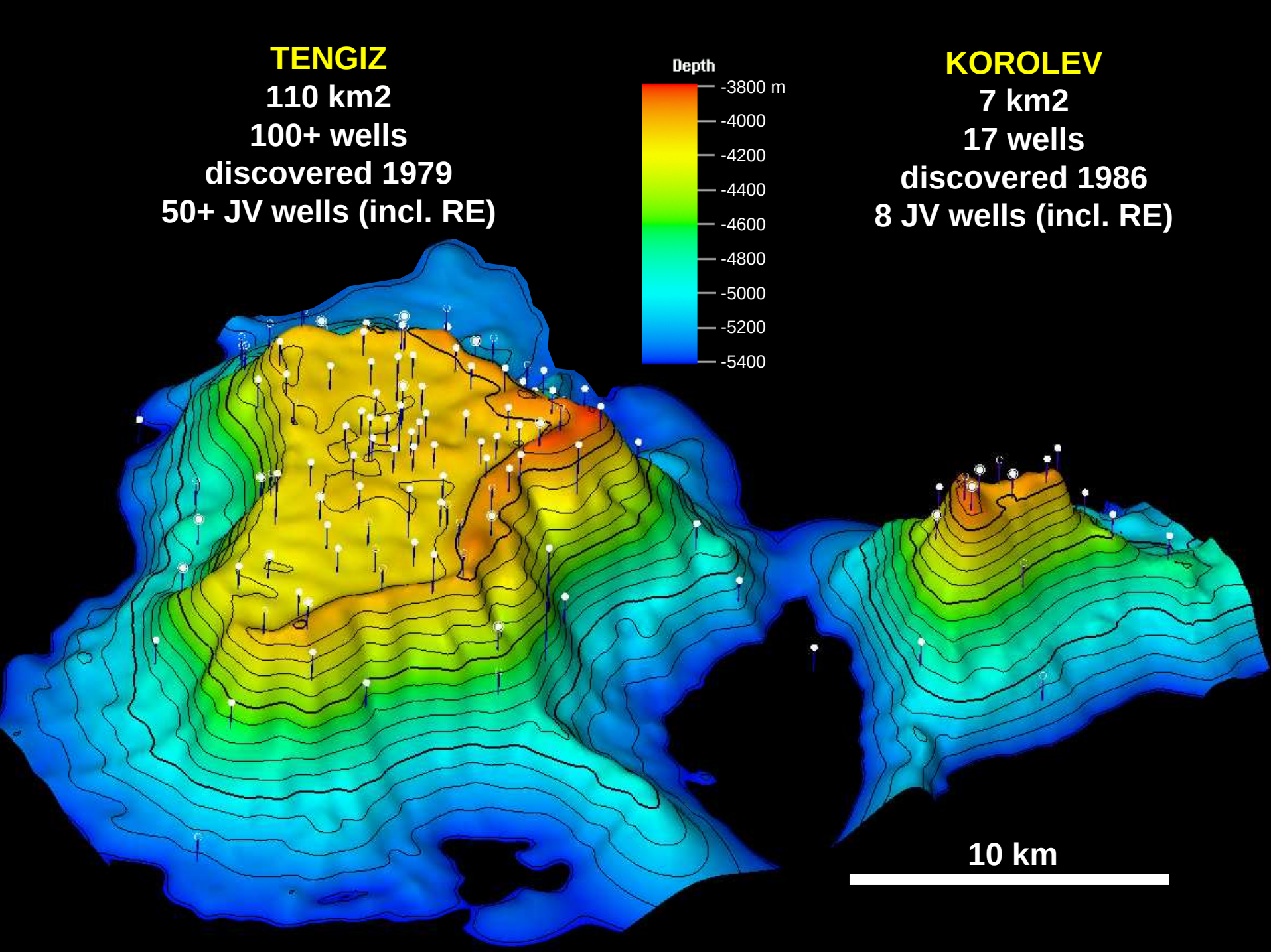
Map From Cook et al., 2000

PALEOLOCATION OF CASPIAN BASIN



Late Mississippian (340 Ma)

from Blakey , Northern Arizona University, http://jan.ucc.nau.edu/~rcb7/340NAt.jpg


TENGIZ
110 km2
100+ wells
discovered 1979
50+ JV wells (incl. RE)
Depth
-3800 m
-4000
-4200
-4400
-4600
-4800
-5000
-5200
-5400
KOROLEV
7 km2
17 wells
discovered 1986
8 JV wells (incl. RE)
10 km

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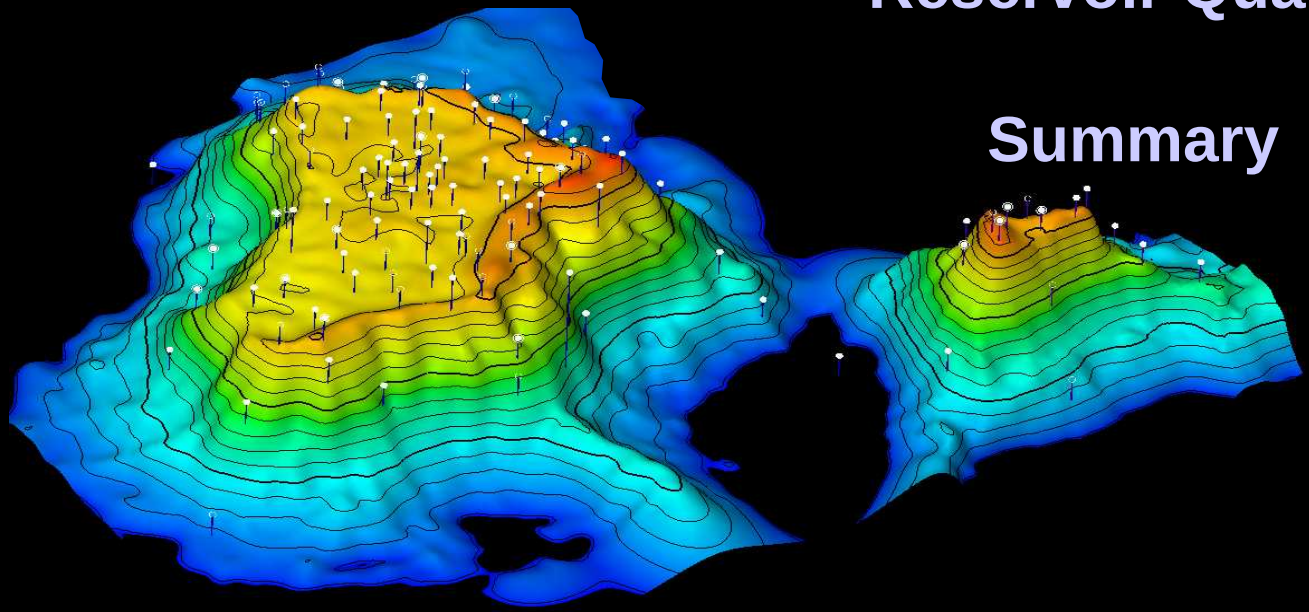
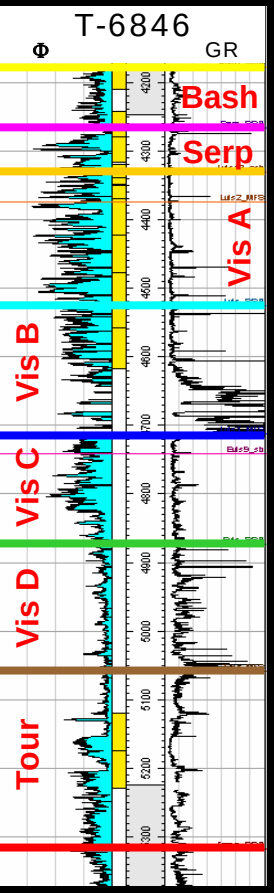
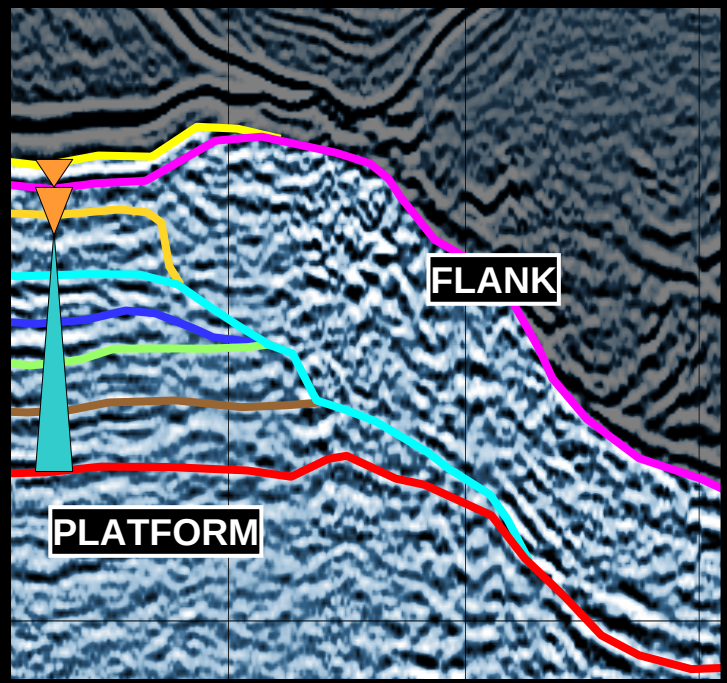


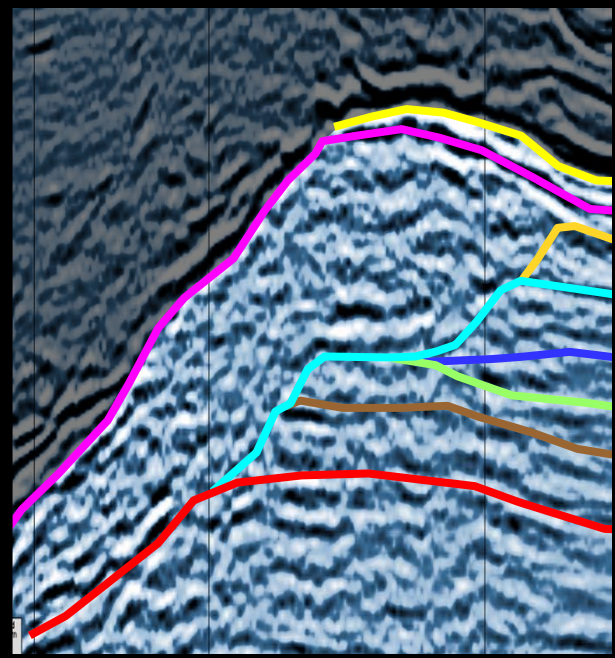
PLATFORM ARCHITECTURE

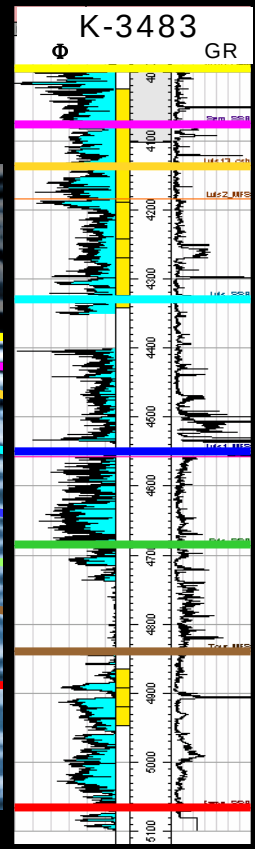


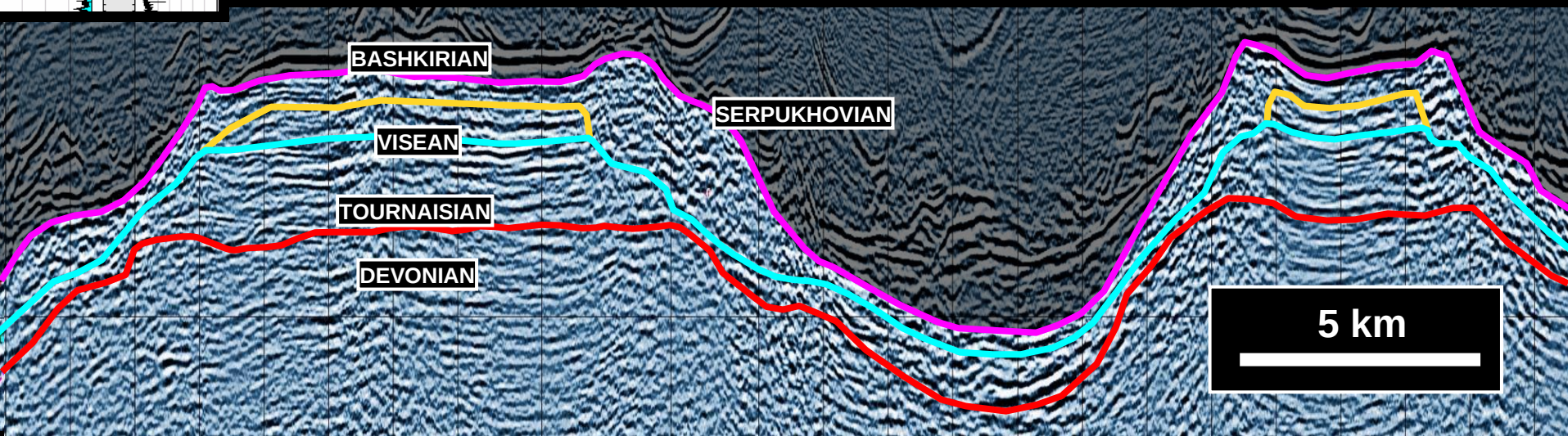
TENGIZ



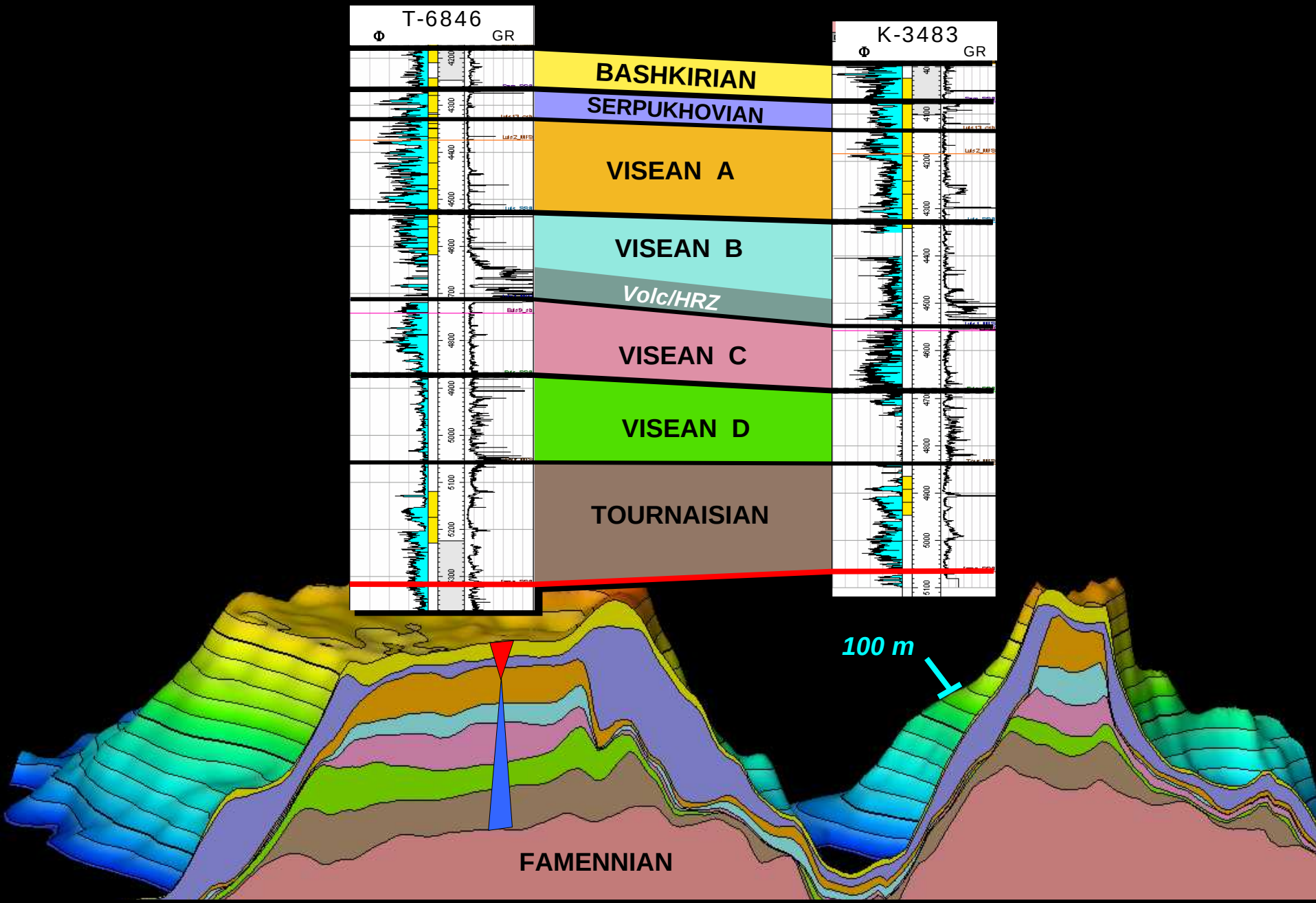
KOROLEV



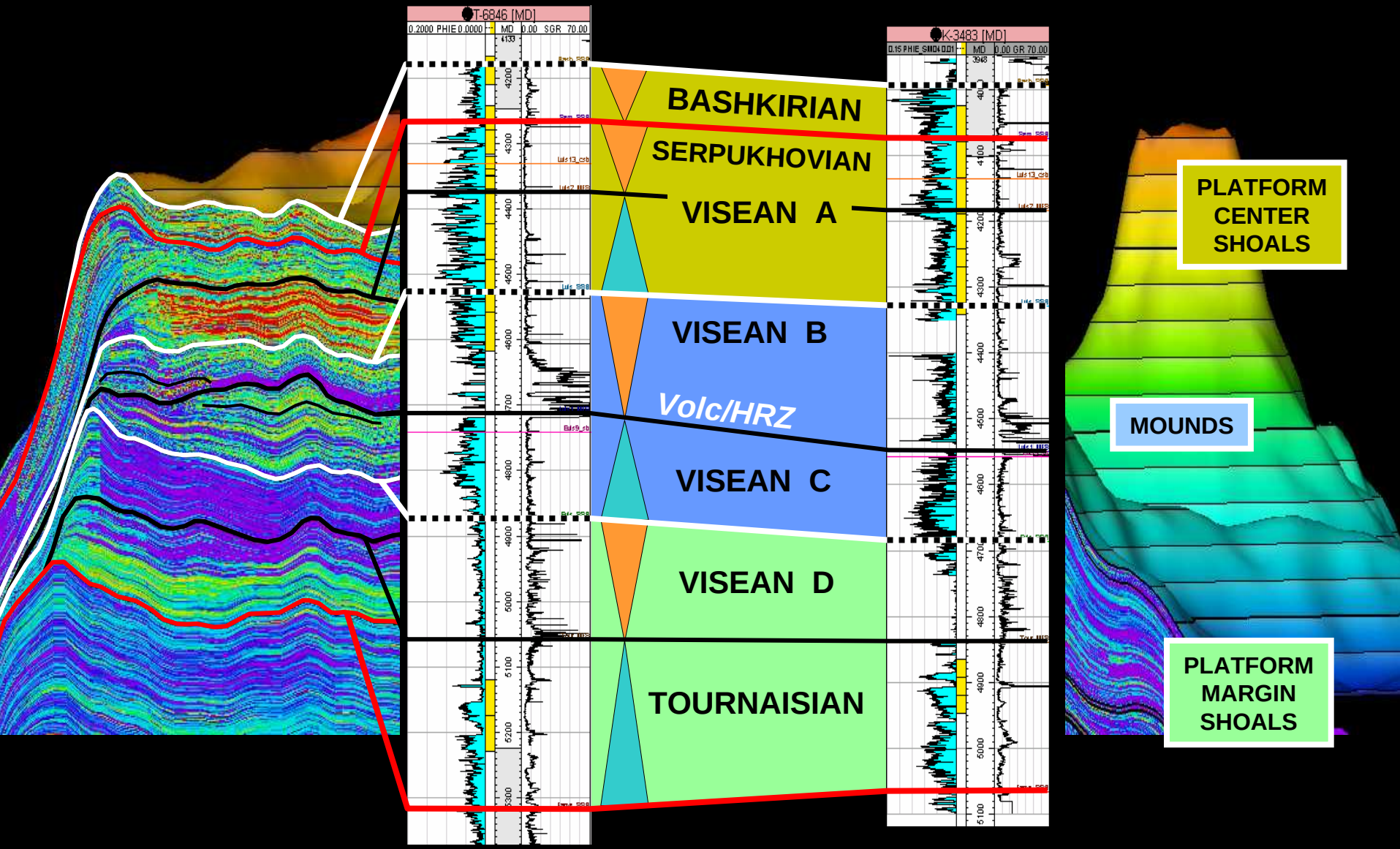




2nd-ORDER STRATIGRAPHIC ARCHITECTURE



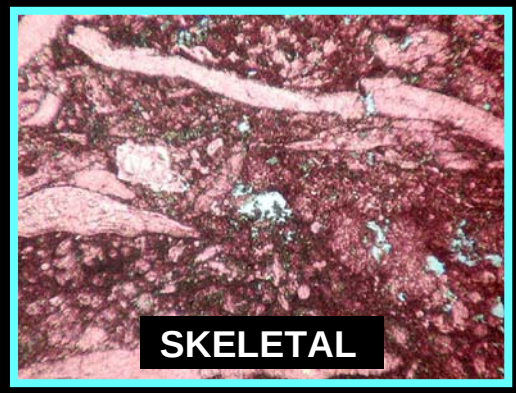
3rd-ORDER STRATIGRAPHIC ARCHITECTURE



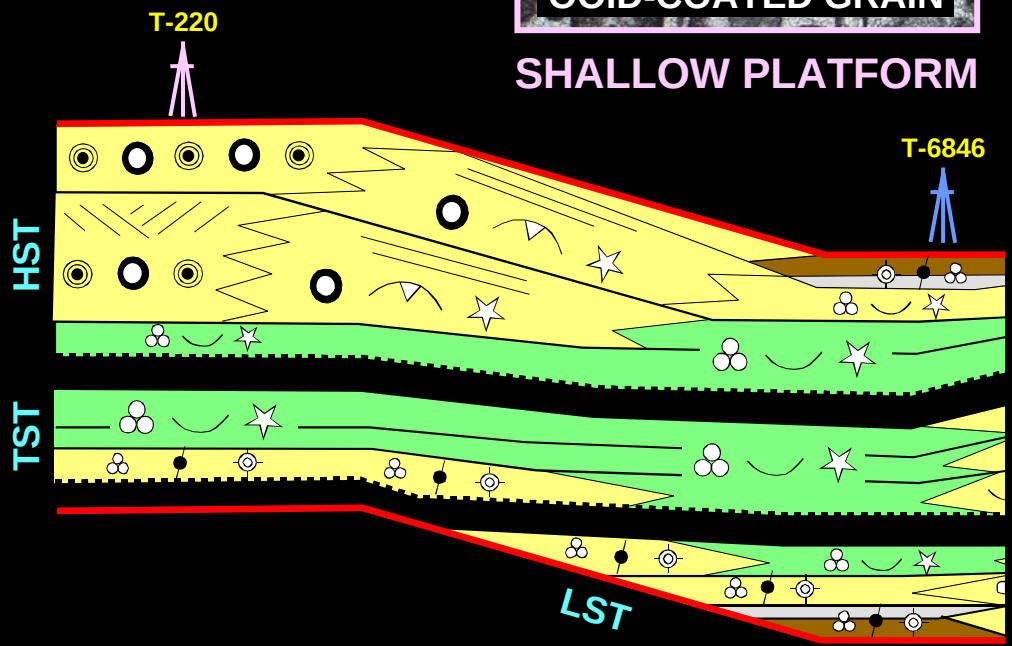
4th-ORDER PLATFORM SEQUENCES

BOUNDSTONE
GRAINSTONE
PACKSTONE to GRAINSTONE
PACKSTONE
WACKESTONE

SHALLOW PLATFORM



DEEPER PLATFORM



microbes
forams
crinoids
coated grns
ooids
peloids
calcispheres
skeletal undiff.
algae
brachs

Platform EOD's
Paleo-Relief Indicated by Grain-Type Assemblages and Textural Variation

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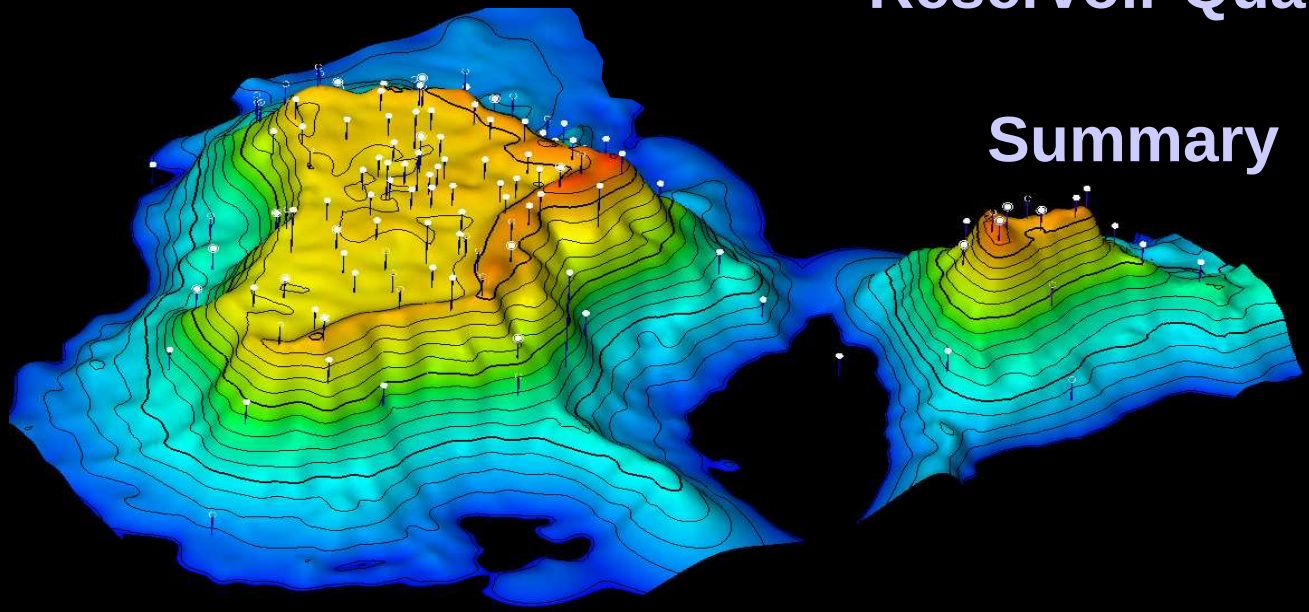
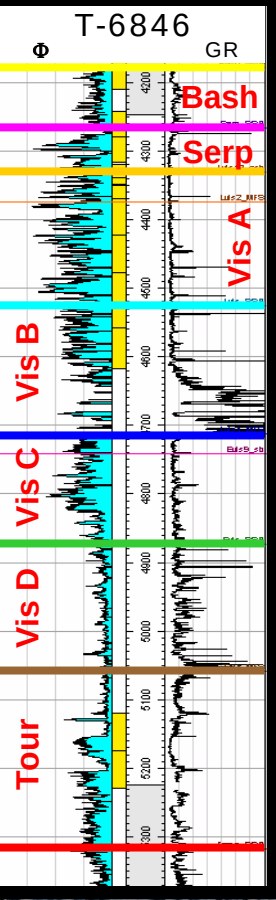
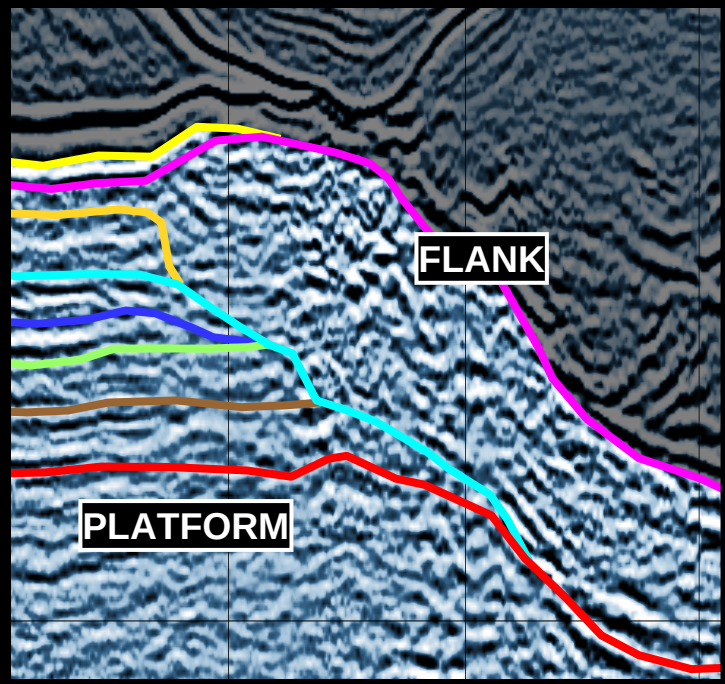


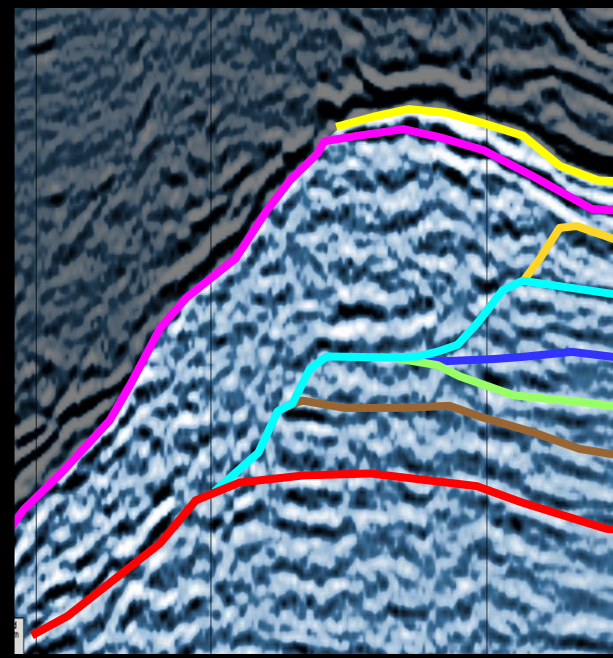
PLATFORM ARCHITECTURE

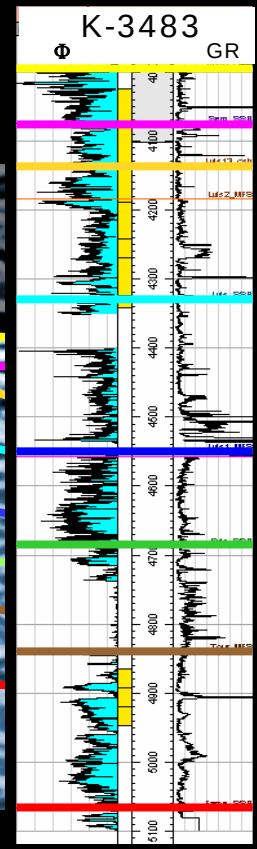


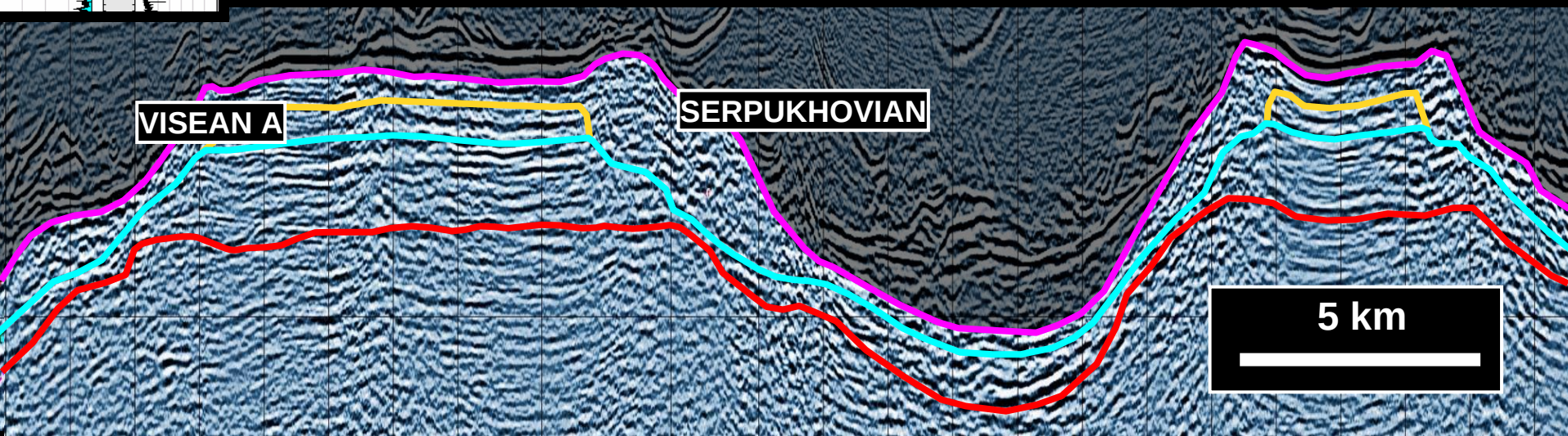
TENGIZ



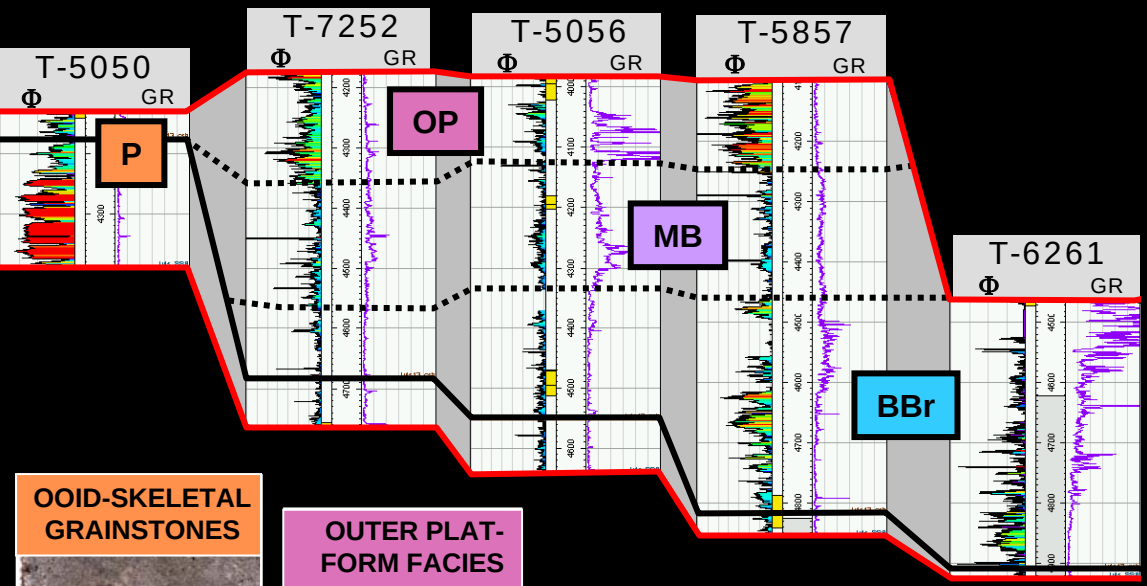
KOROLEV

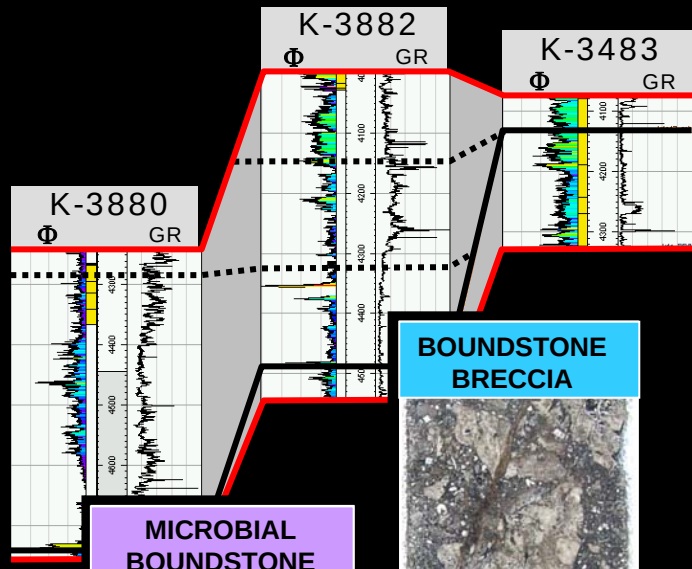






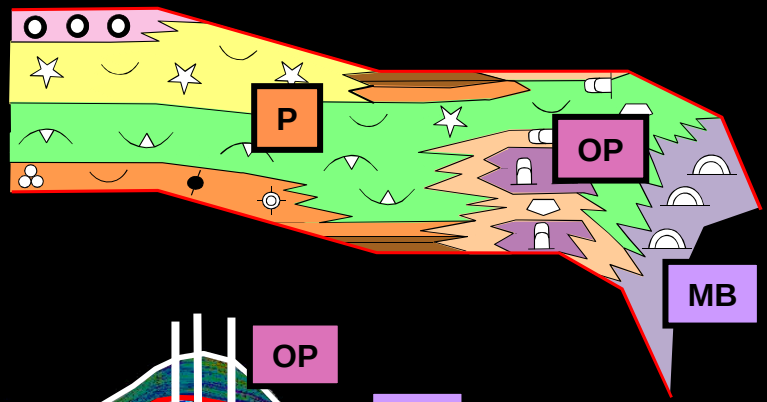
VISEAN A - SERPUKHOVIAN RESERVOIRS





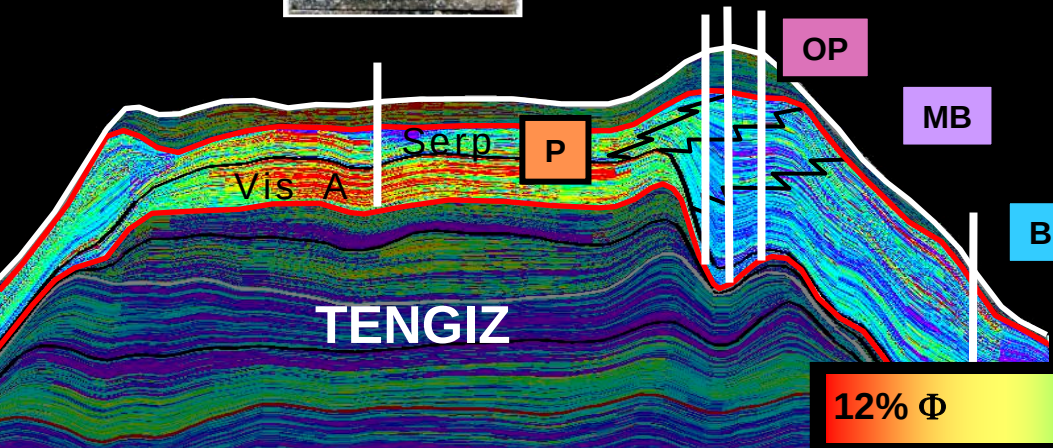
OOID-SKELETAL GRAINSTONES

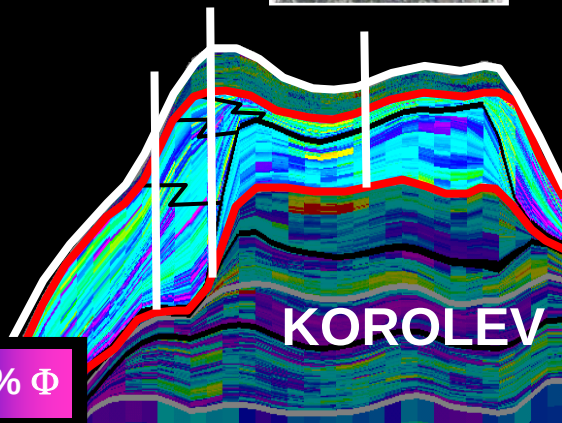
OUTER PLAT-FORM FACIES



MICROBIAL BOUNDSTONE

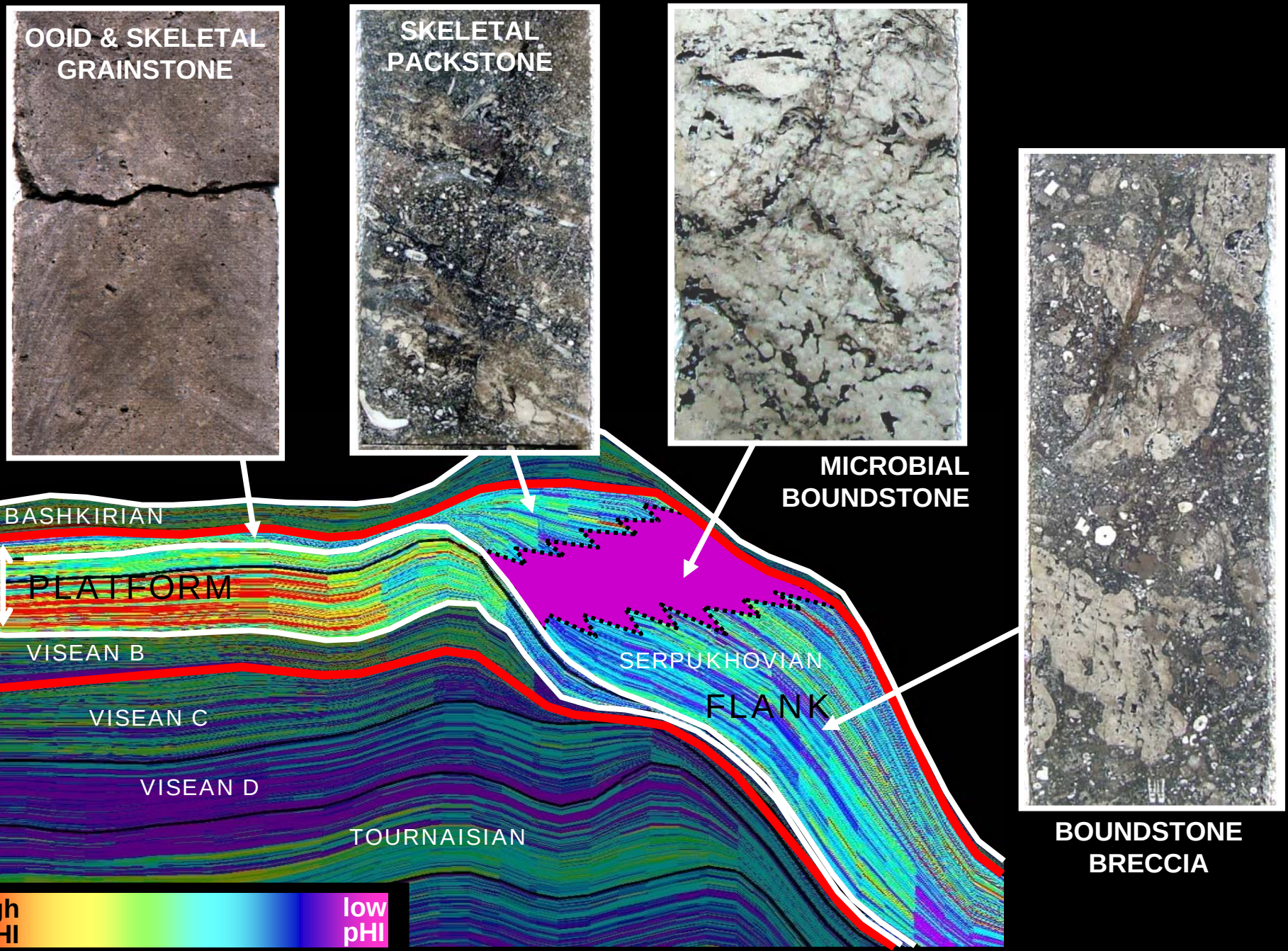
BOUNDSTONE BRECCIA





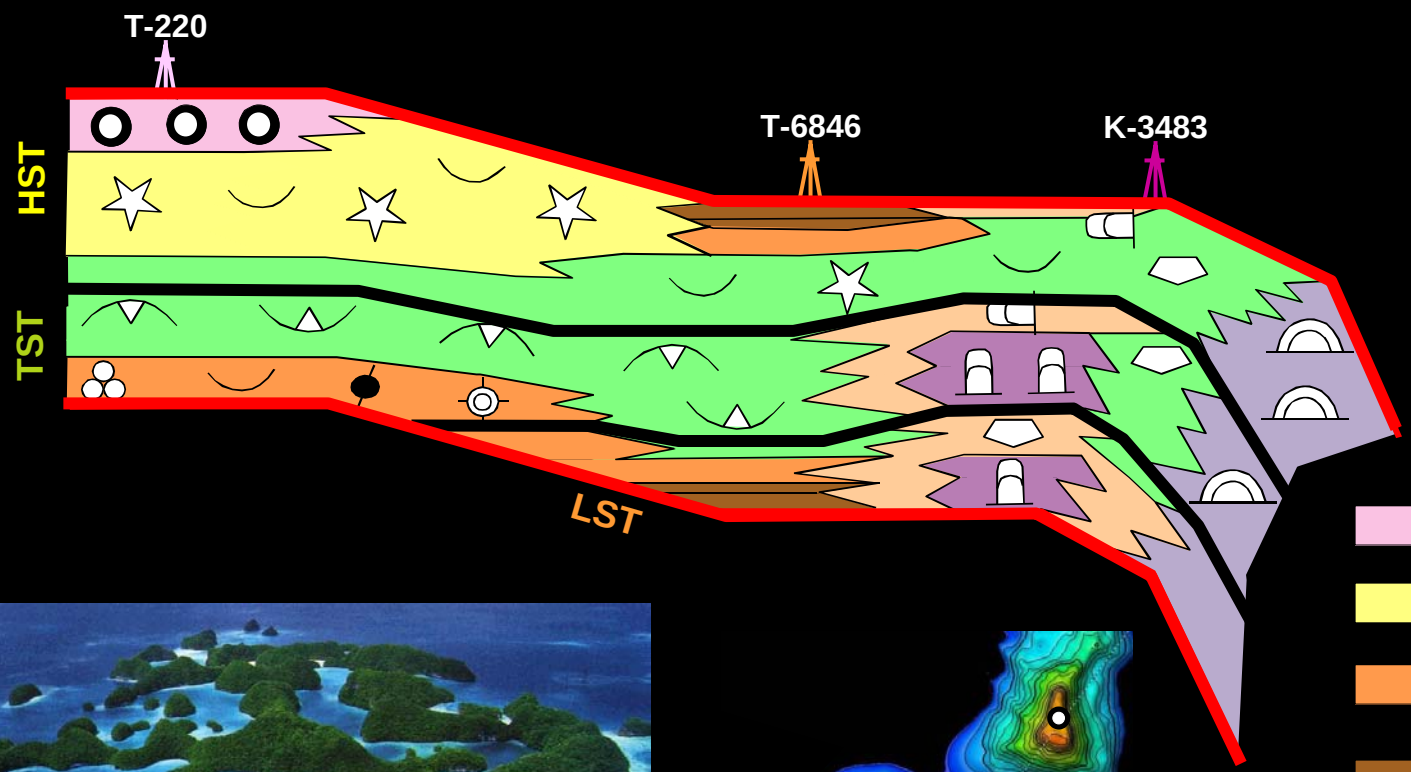
12% Φ — 1% Φ

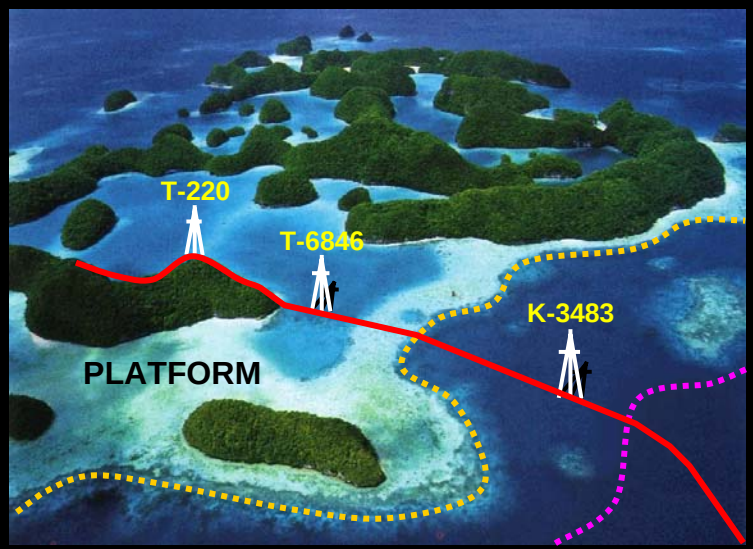
VISEAN A - SERPUKHOVIAN FACIES



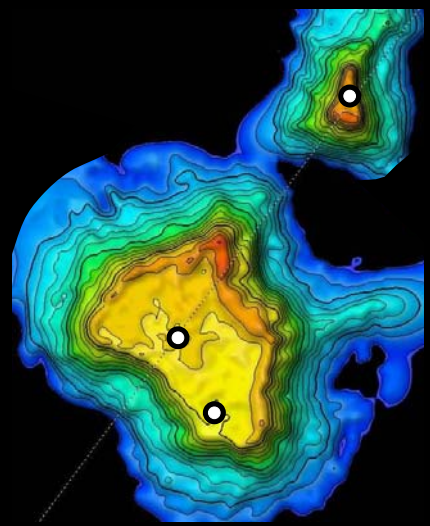
VISEAN A – SERP. PLATFORM ENVIRONMENTS

SHALLOW PLATFORM | DEEPER PLATFORM | OUTER PLATFORM





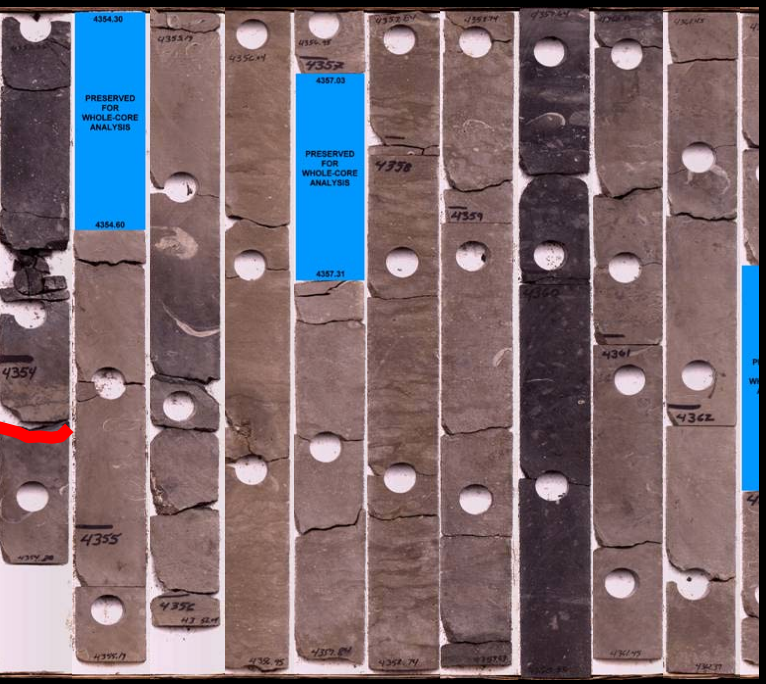
National Geographic photo by David Doubilet

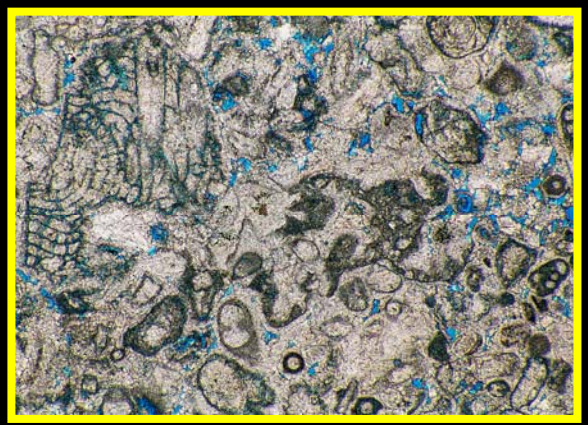


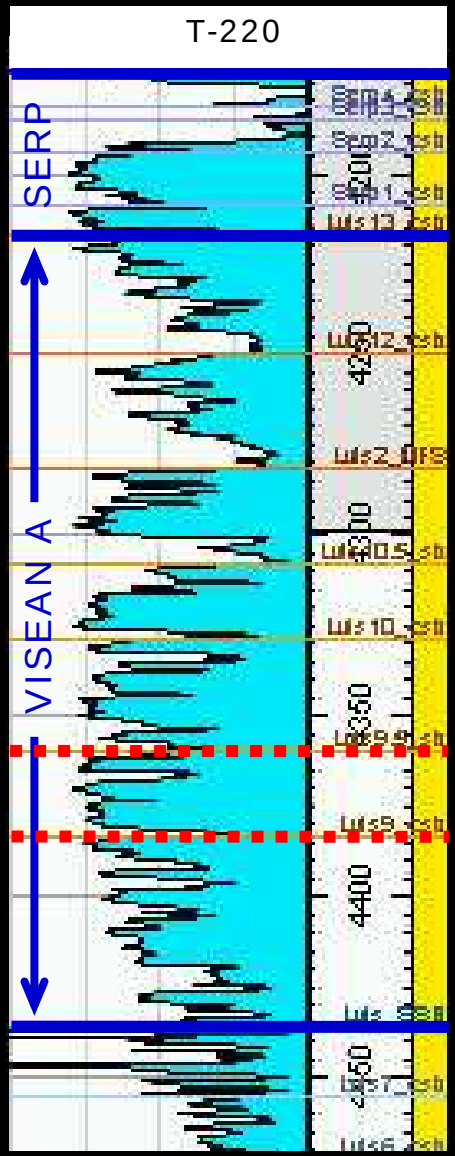
- CG-OOLITIC SANDS
- GRAINSTONE
- FINE GRAINSTONE
- MUDSTONE + ASH
- ALGAL SANDS
- PACKSTONE to GRAINSTONE
- ALGAL-SKEL. BOUNDSTONE
- MICROBIAL BOUNDSTONE

VISEAN A – SERP. PLATFORM RESERVOIR

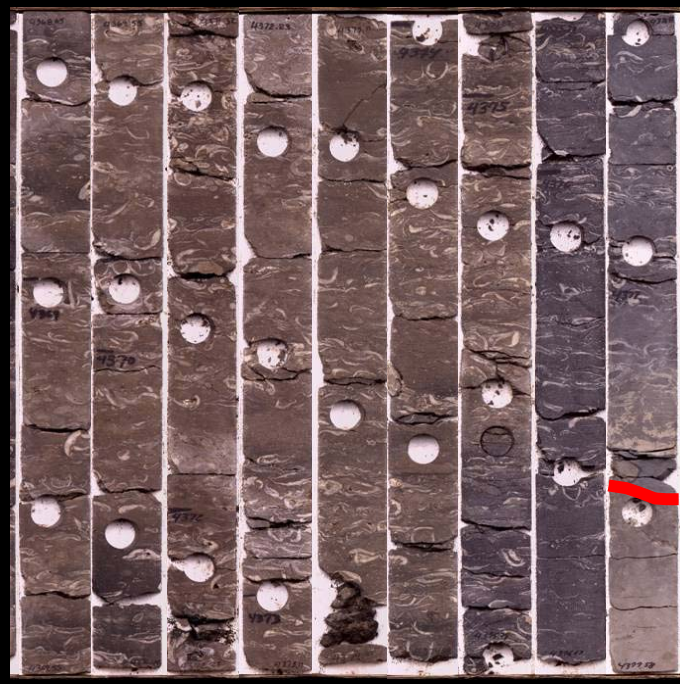
SKELETAL GRAINSTONE

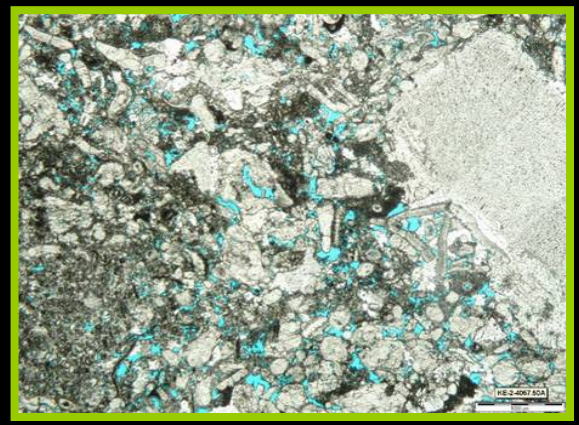






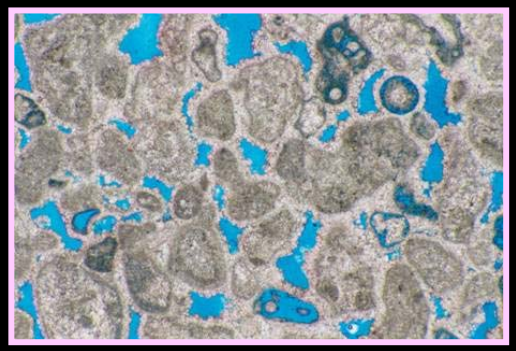
SKELETAL PACKSTONE-GRAINSTONE





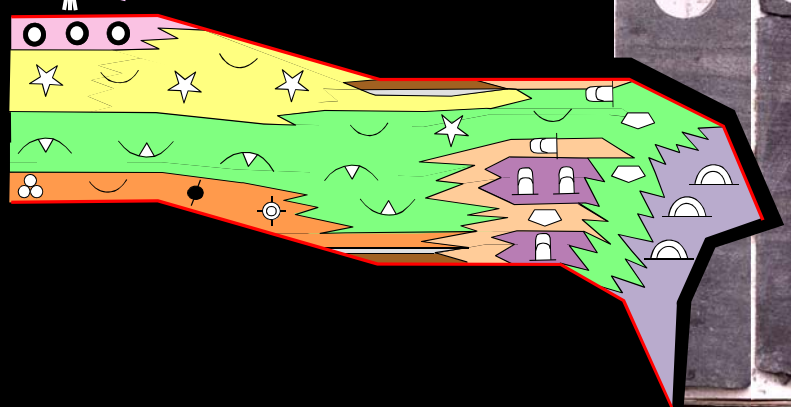
TENGIZ SHALLOW PLATFORM SEQUENCE BOUNDARY

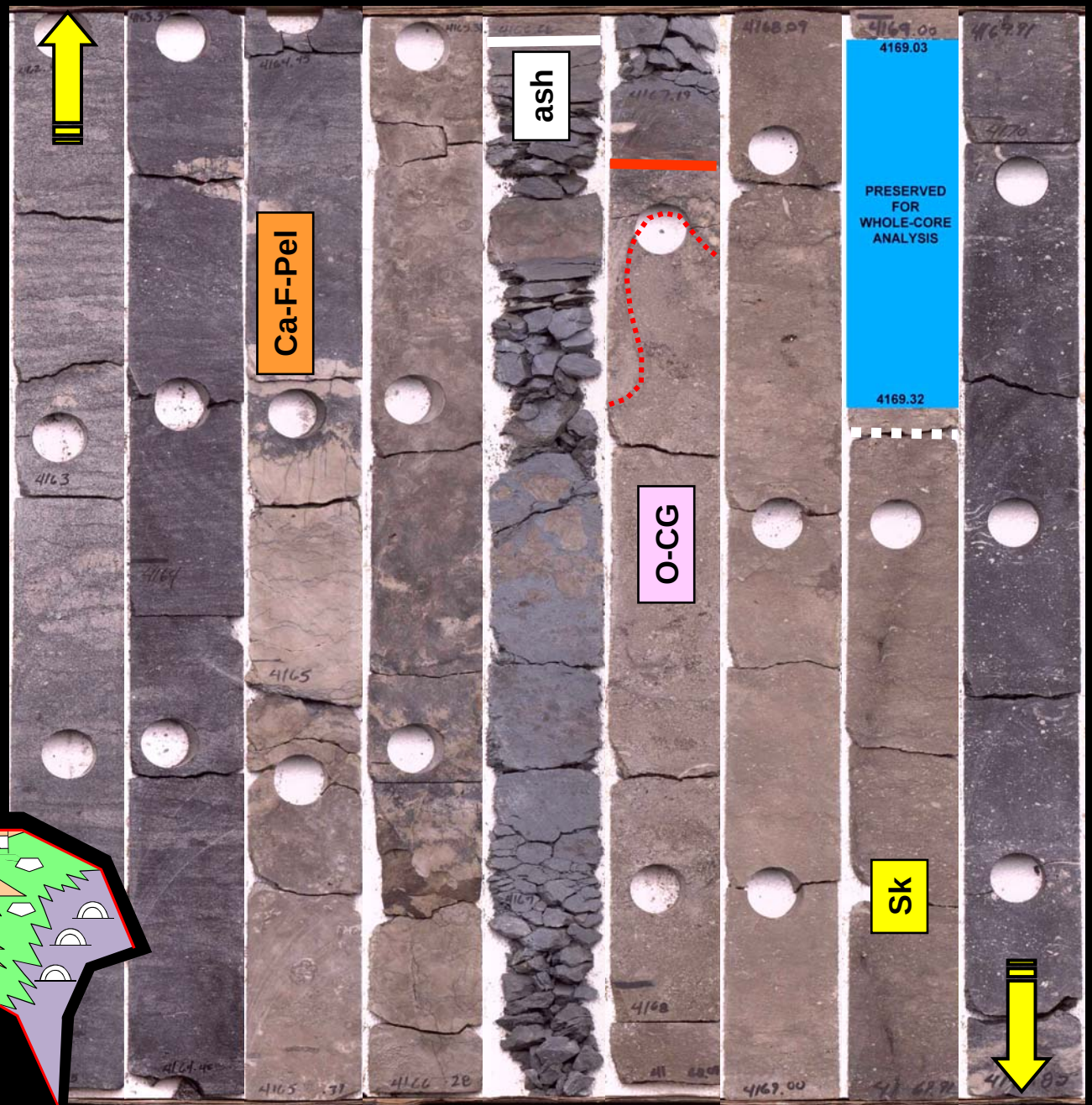
SHALLOW PLATFORM



OOID-COATED GRAIN

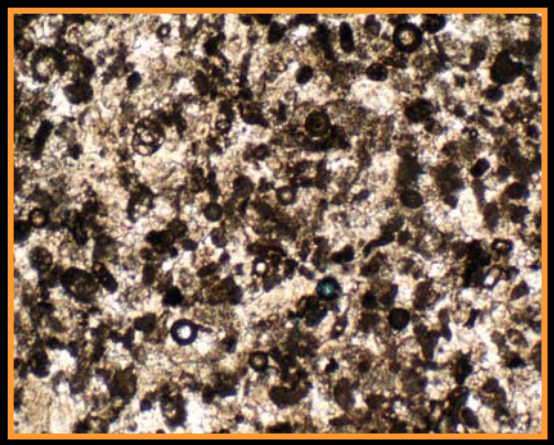
SHALLOW PLATFORM PALEO-RELIEF





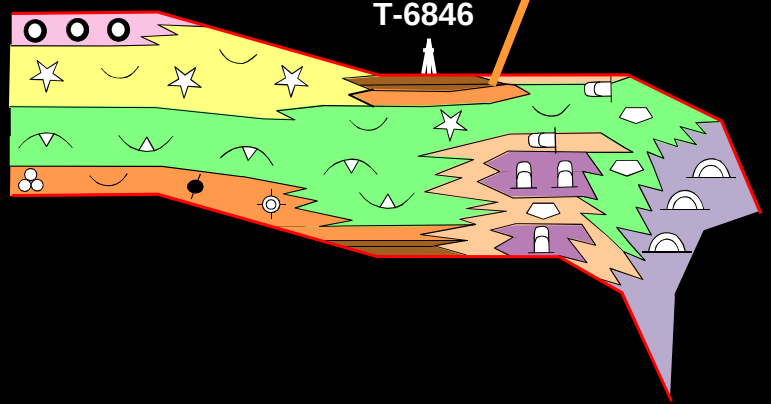
TENGIZ DEEPER PLATFORM SEQUENCE BOUNDARY

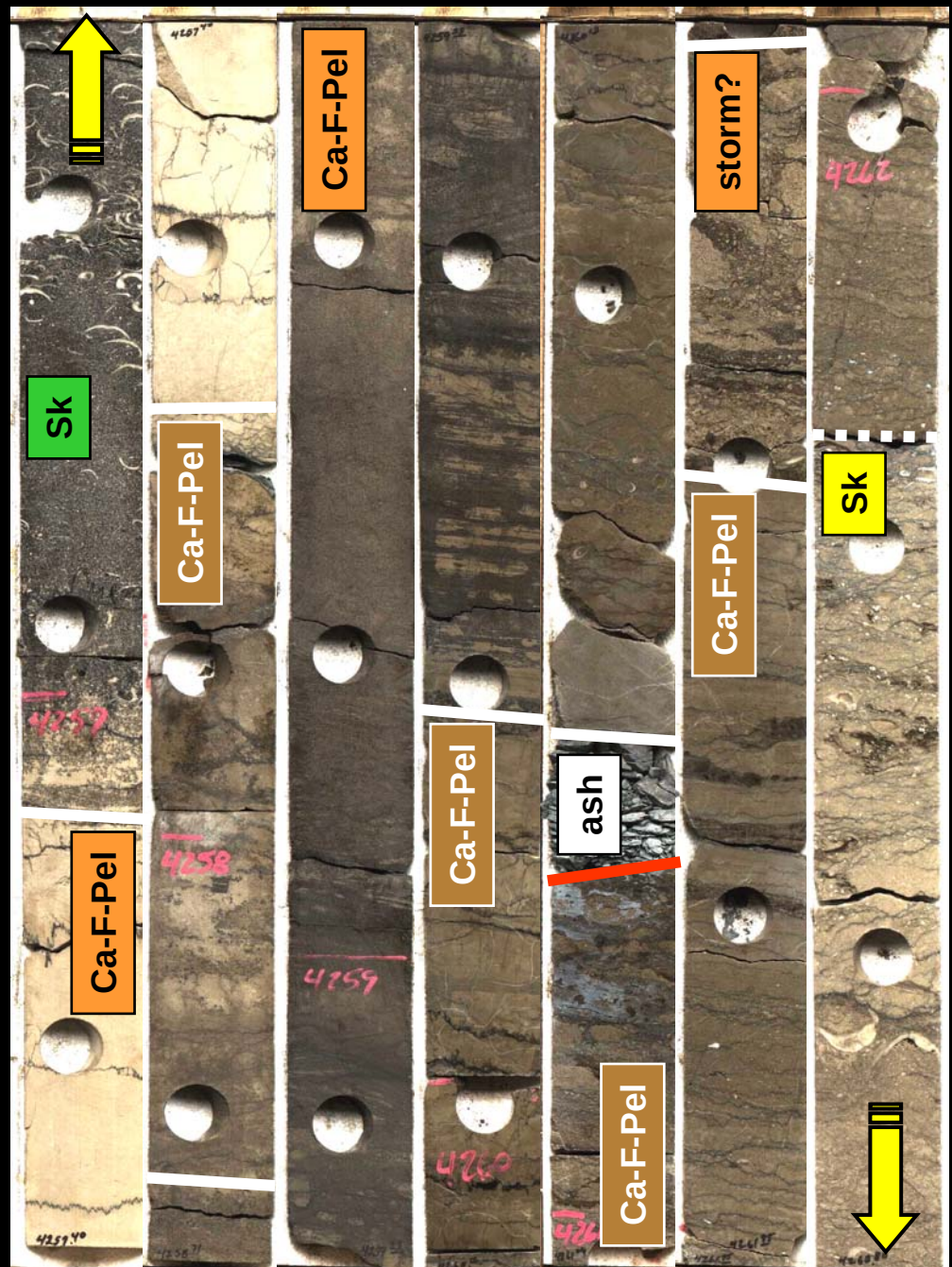
DEEPER PLATFORM



CALCISPHERE-FORAM-PELOID

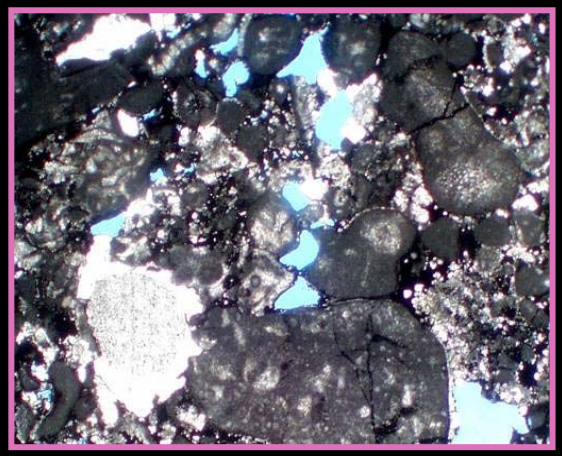
DEEPER PLATFORM PALEO-RELIEF



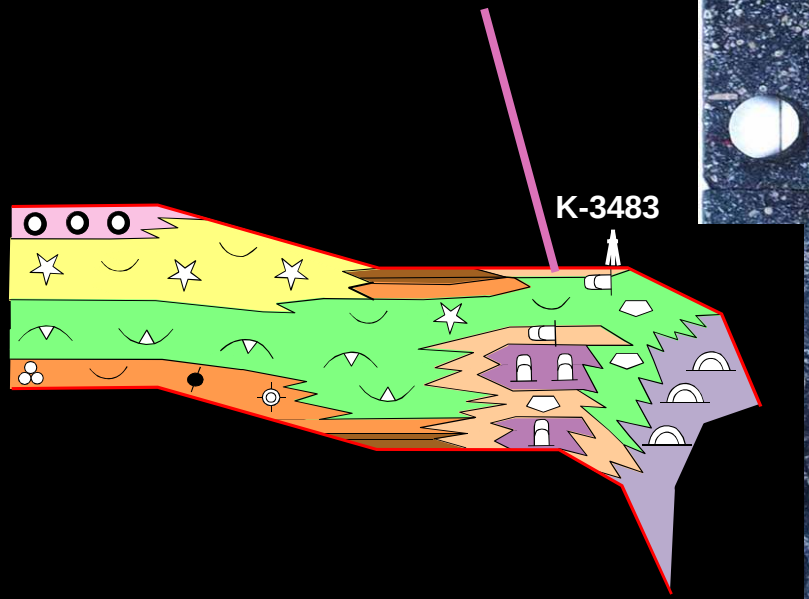


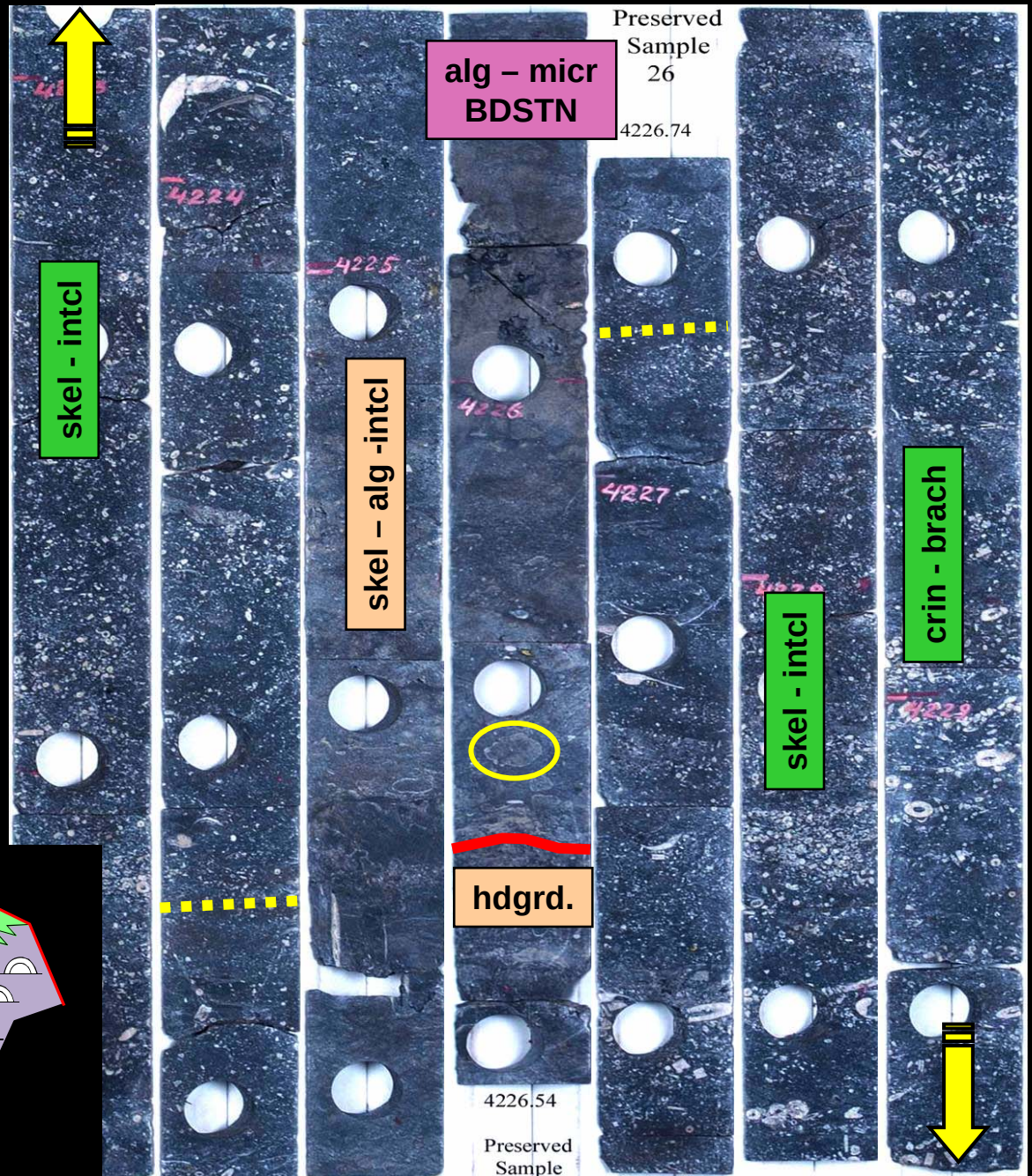
KOROLEV OUTER PLATFORM SEQUENCE BOUNDARY

OUTER PLATFORM



SKELETAL-ALGAL-INTRACLAST





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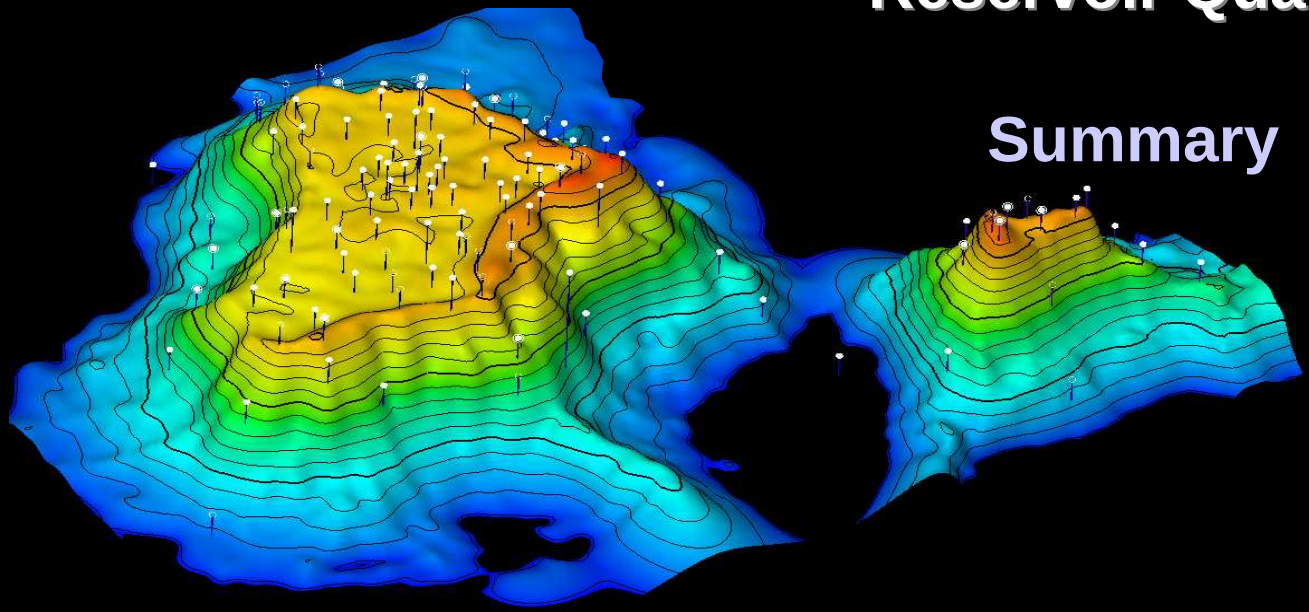
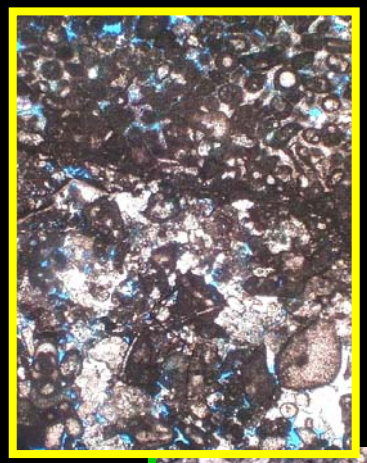
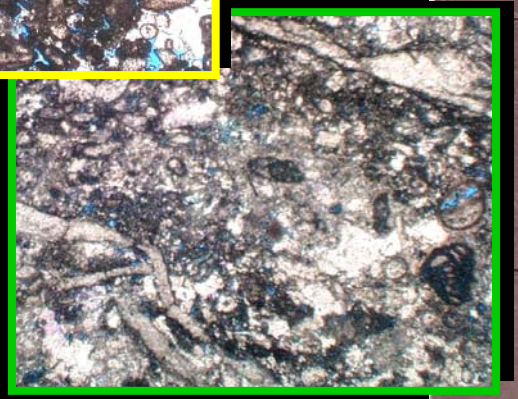
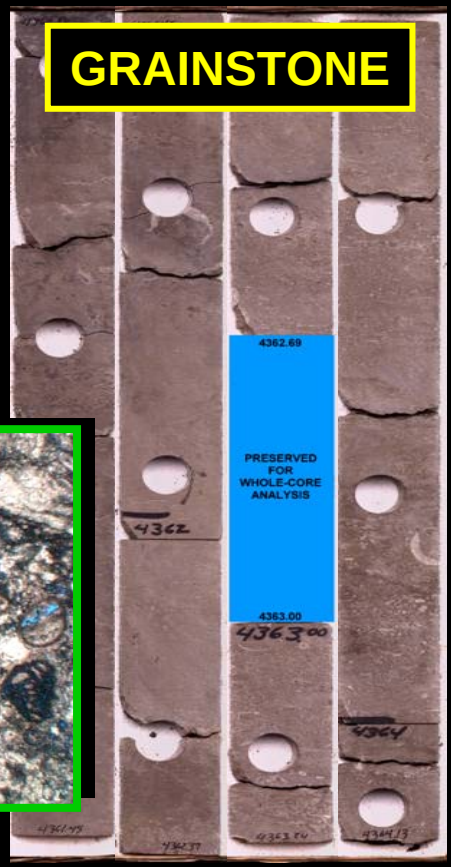


VISEAN A – SERP. PLATFORM RESERVOIR

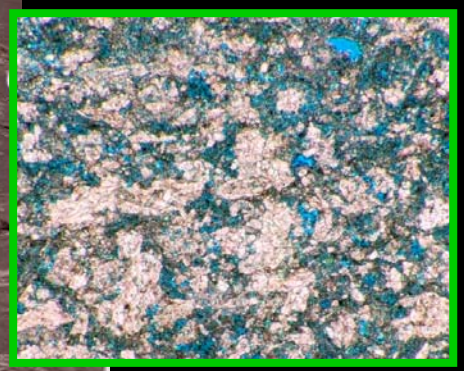


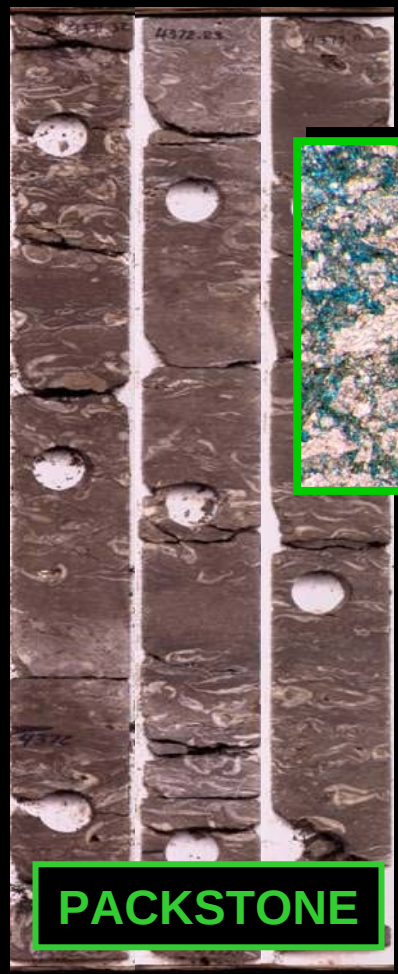


GRAINSTONE



POROSITY VARIATIONS ASSOCIATED WITH DISSOLUTION

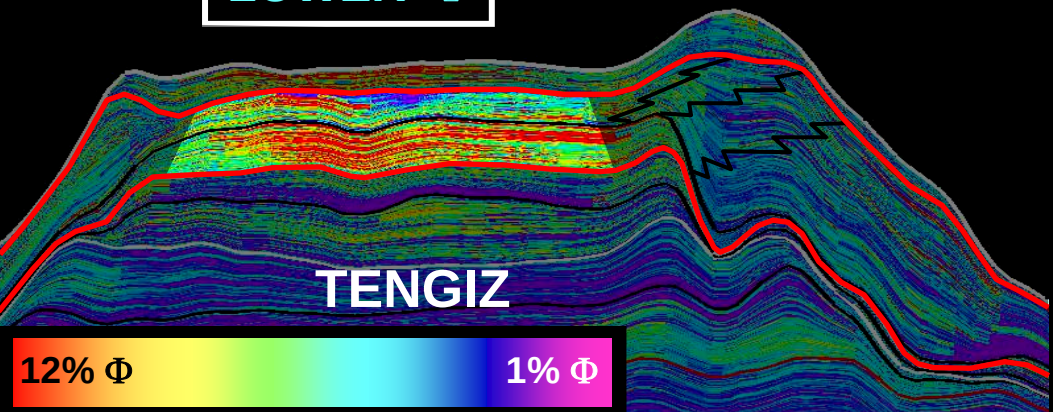




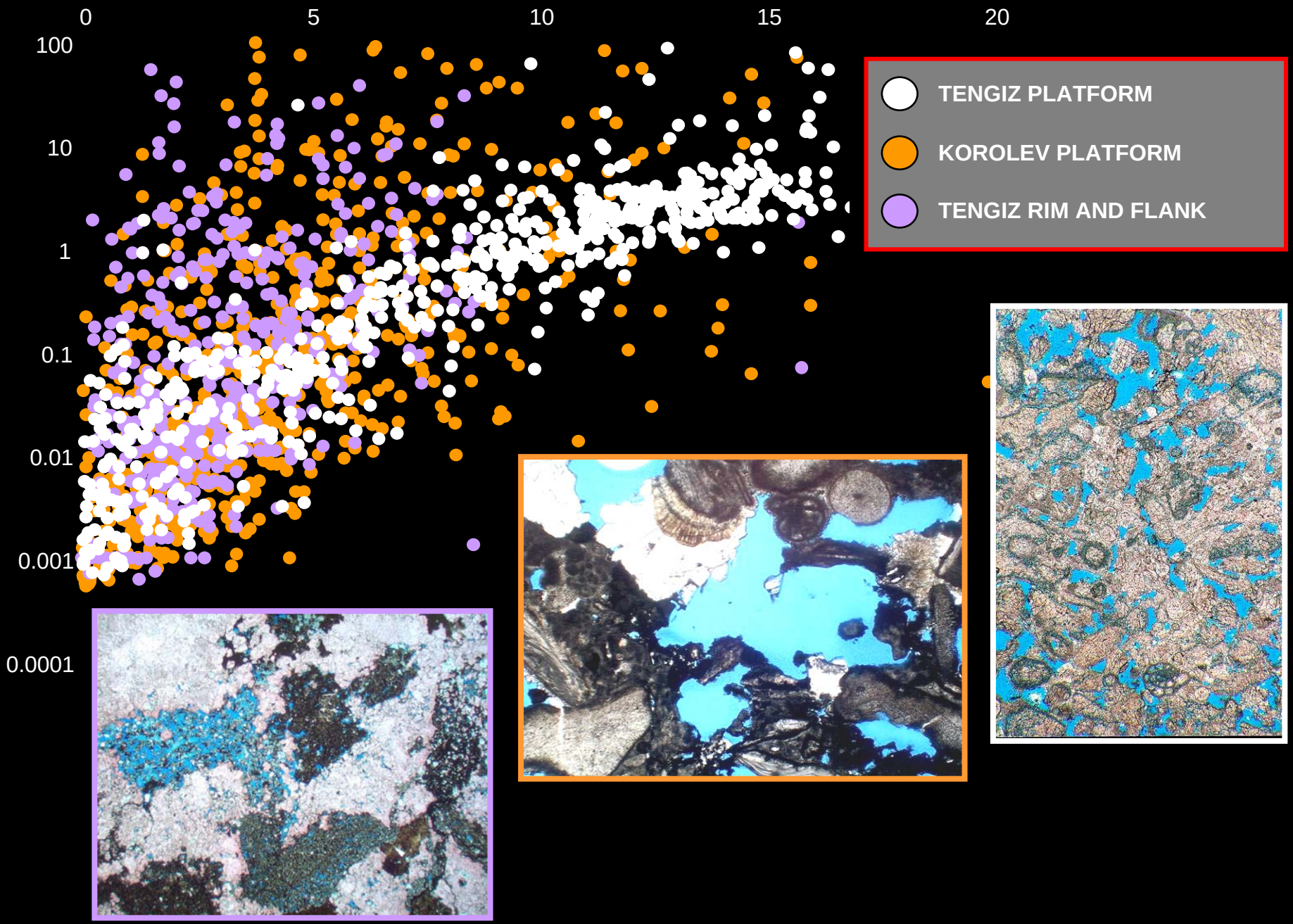
PACKSTONE

LOWER Φ

HIGHER Φ

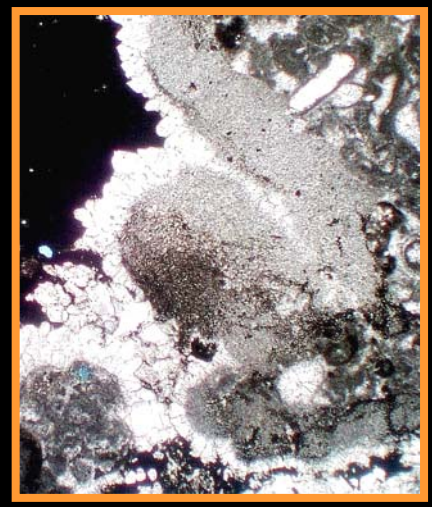


RESERVOIR QUALITY

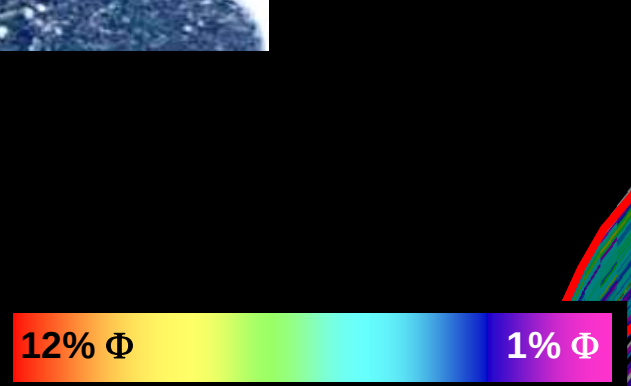


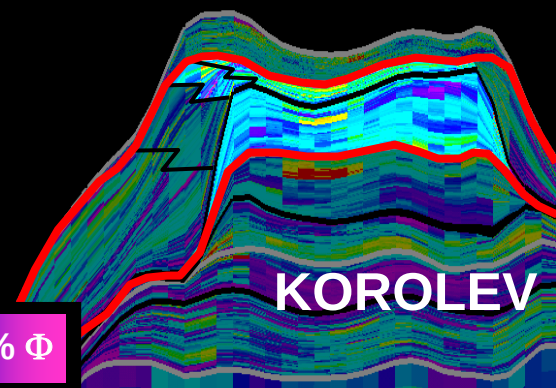
VISEAN A – SERP. PLATFORM RESERVOIR

Solution-Enlarged Fractures
Corrosion
LCZs

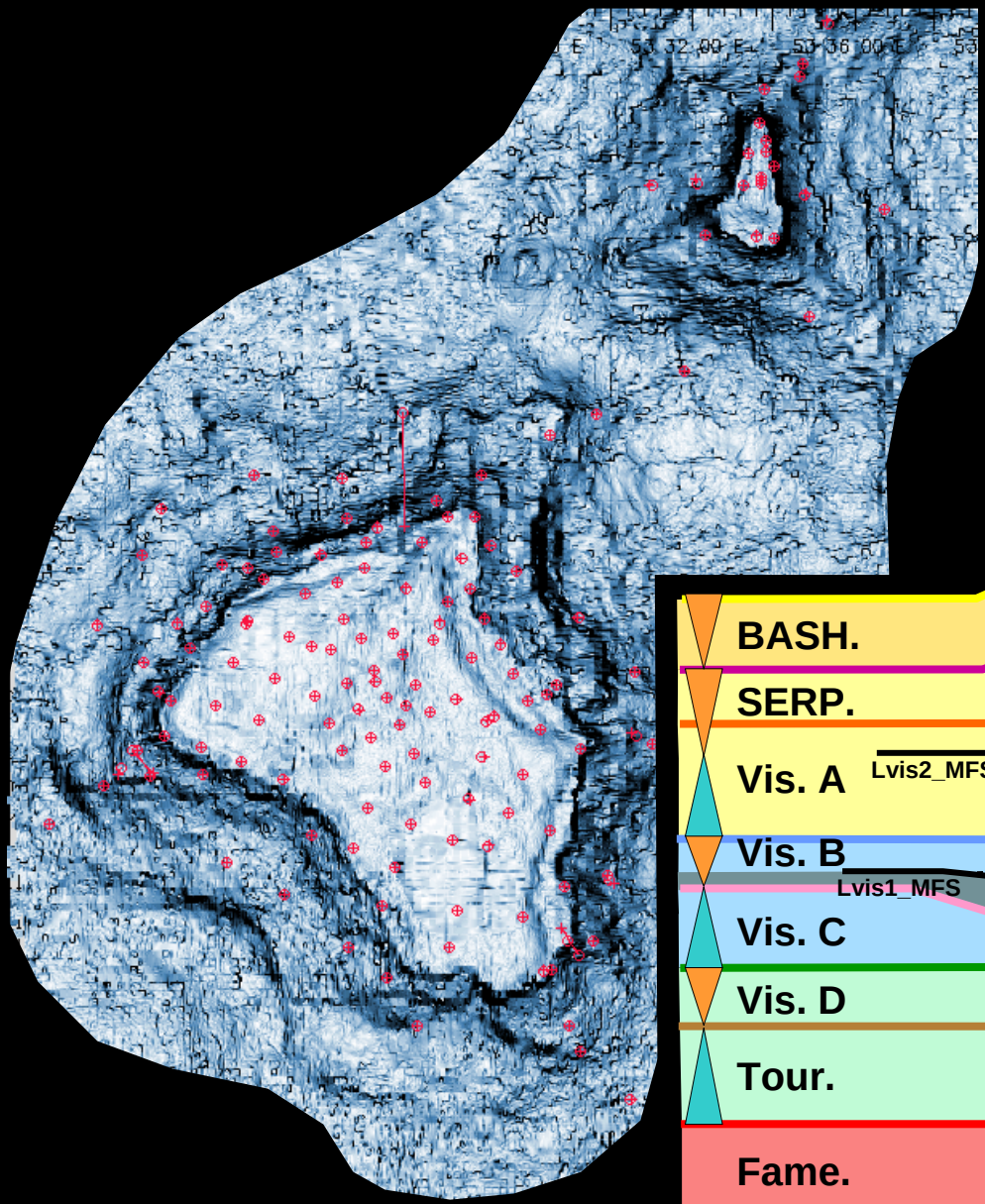


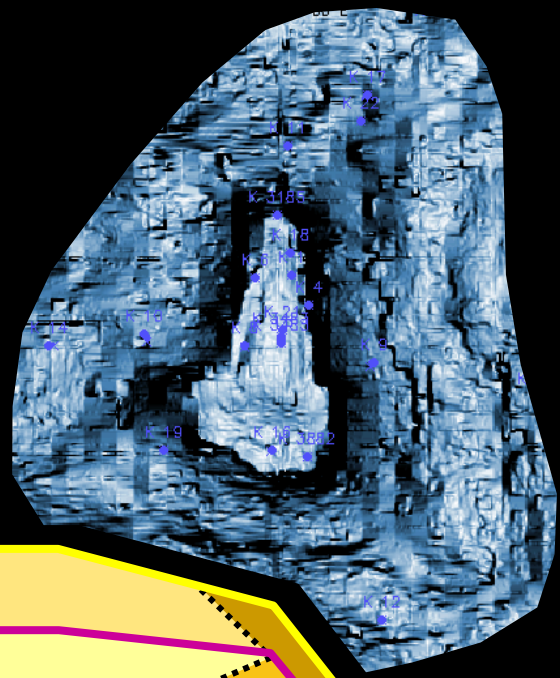
Pervasive Bitumen in Grainy Platform Facies

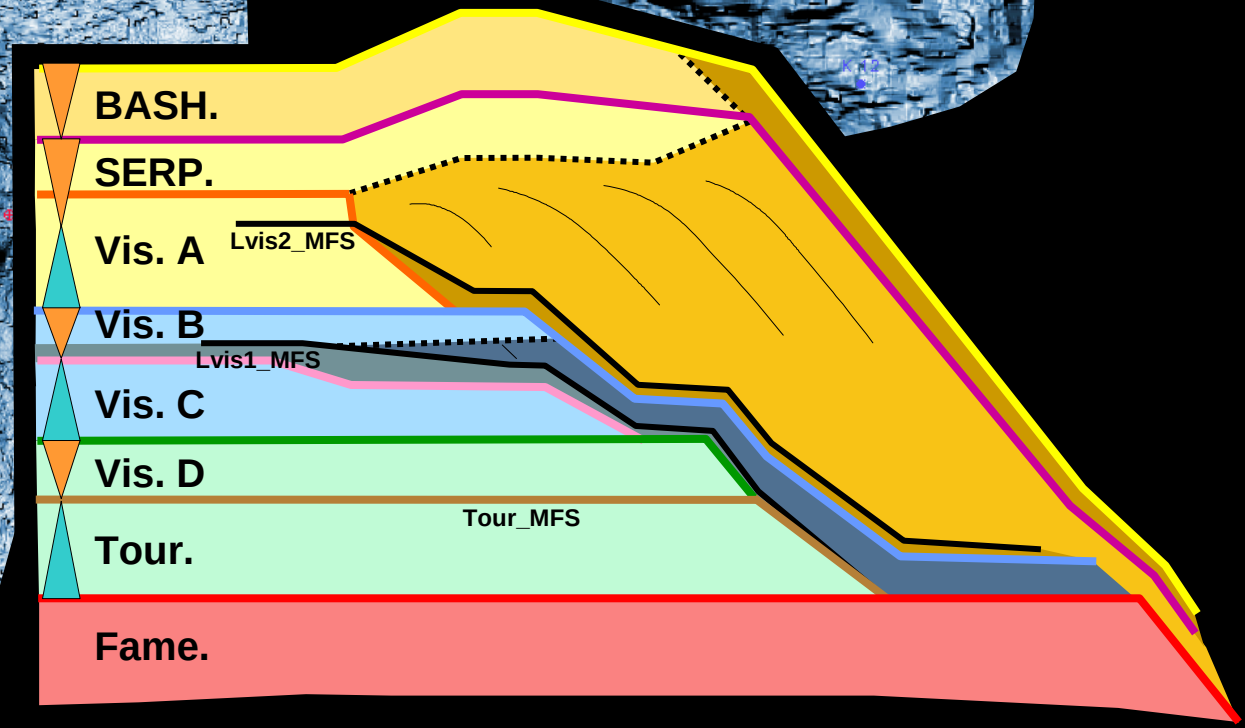




STRATIGRAPHIC COMPARISON: SERPUKHOVIAN FLANK







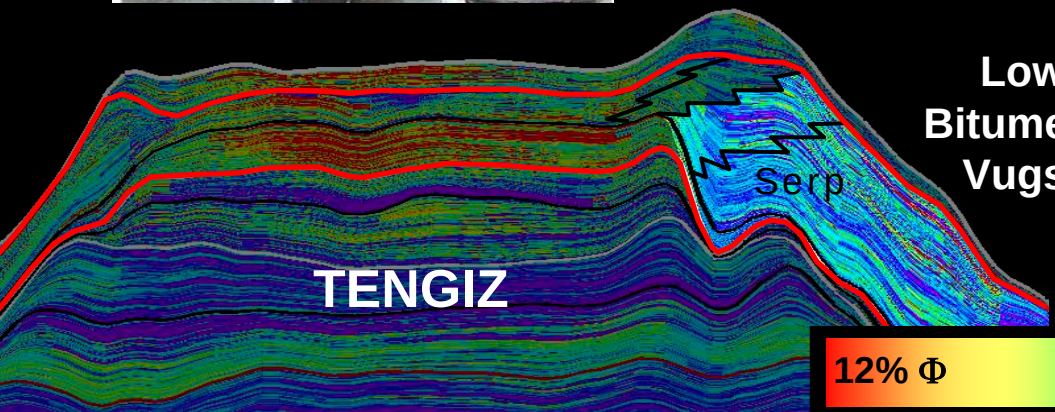
SERPUKHOVIAN FLANK RESERVOIR

TENGIZ BOUNDSTONE

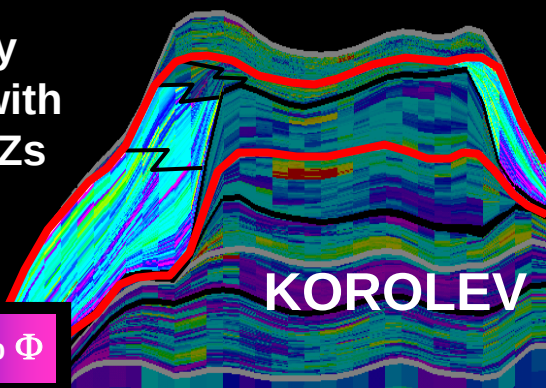
TENGIZ BRECCIA

TENGIZ BRECCIA

KOROLEV BOUNDSTONE



Low Matrix Porosity
Bitumen Associated with
Vugs, Fractures, LCZs

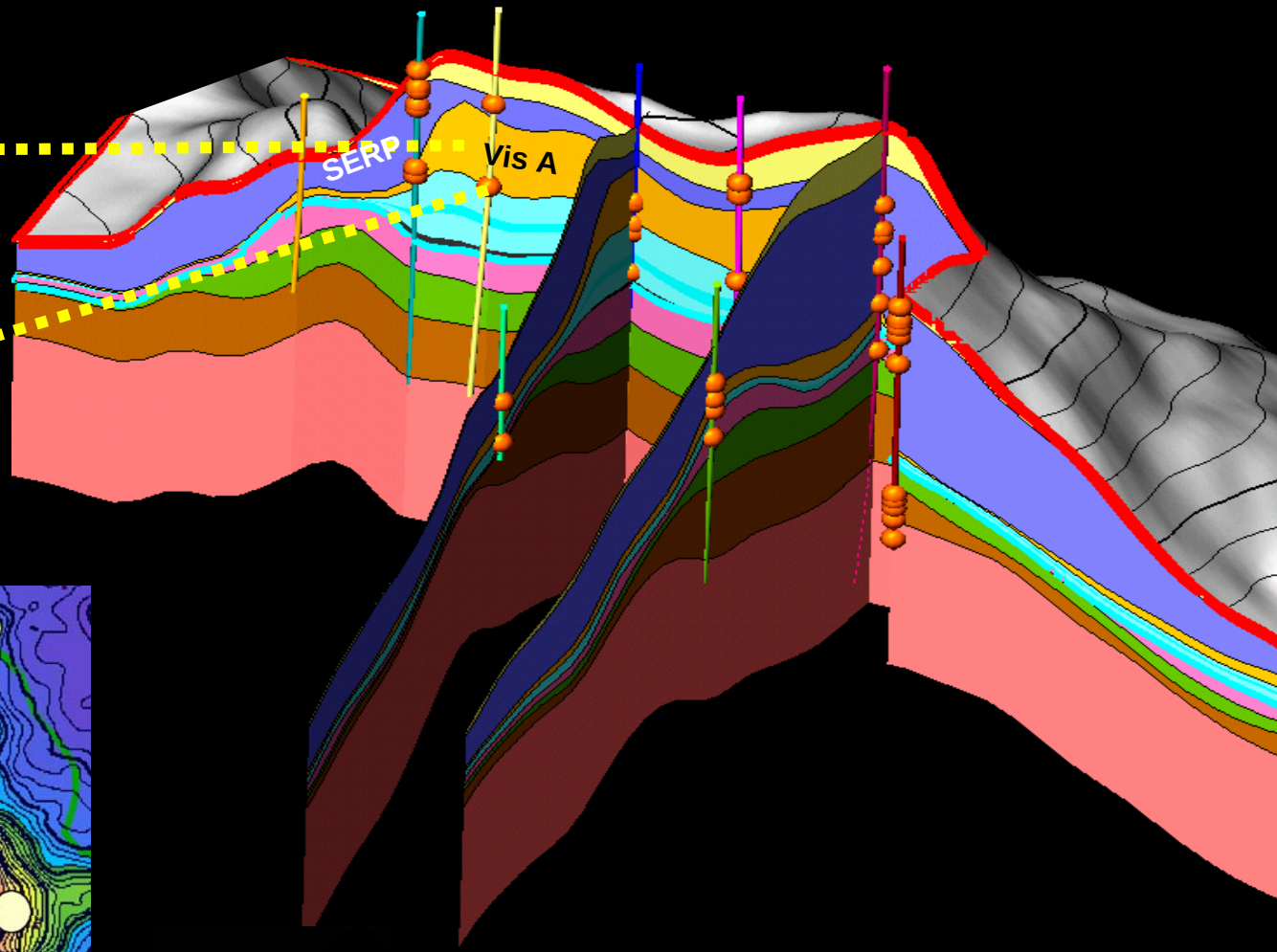


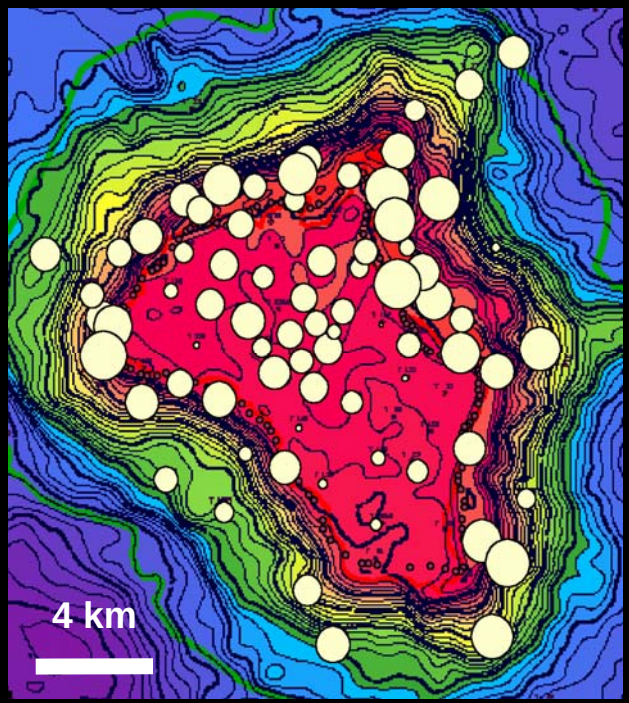
12% Φ 1% Φ

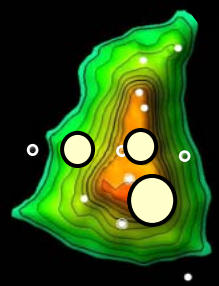
KOROLEV: IMPROVED RESERVOIR CONTINUITY

OUTER PLATFORM FACIES

PLATFORM LCZs







Higher Initial Rates
Greater Recovery Efficiency
Better Sweep Efficiency

TALK OUTLINE

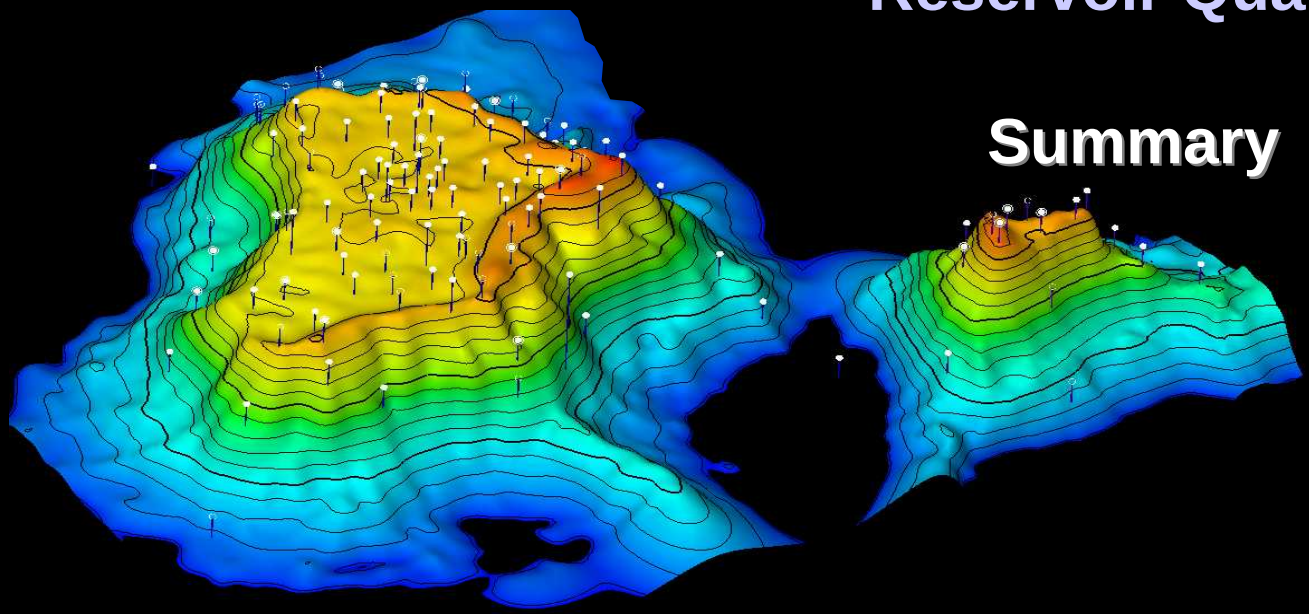
Introduction of Basin and Fields

Stratigraphic Architecture

Lithofacies

Reservoir Quality

Summary



CONCLUSIONS

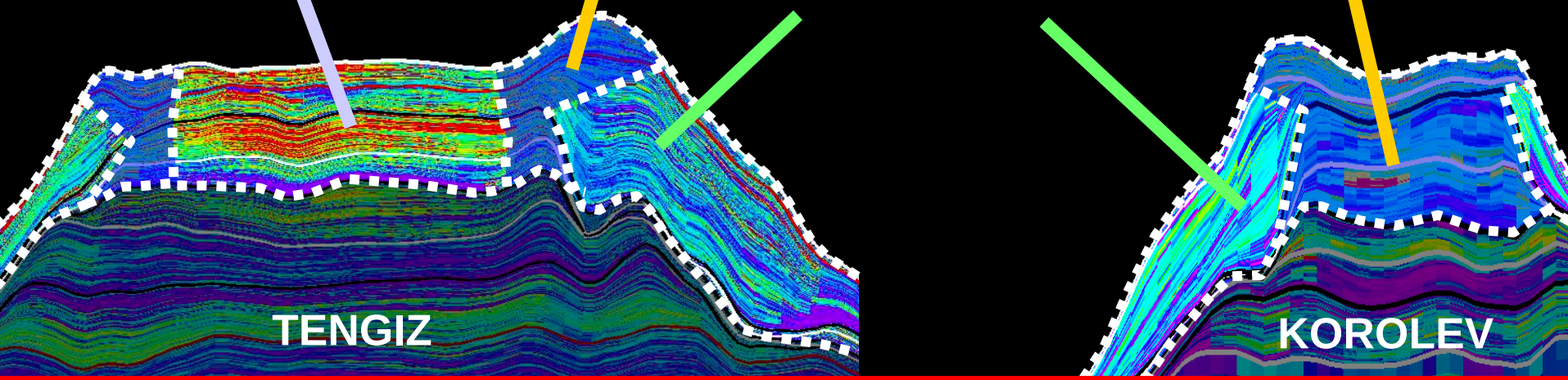
SIMILAR STRATIGRAPHIC ARCHITECTURE

COMPLEX PLATFORM FACIES:
- cyclic variations
- "matrix"- dominated
- high Kh component

TRANSITIONAL RESERVOIR AT PLATFORM MARGIN:
- reduced perm contrast
- LCZs

SIMILAR FLANK RESERVOIR
- low matrix Φ
- fractures and vugs (LCZs)
- high Kv component

PERVASIVE TRANSITIONAL RESERVOIR
- cyclic variations suppressed
- excess perm LCZs



Chevron

ExxonMobil Development

ТЕНГИЗШЕВРОЙЛ