2001-02 AAPG Distinguished Lecture

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Hydrocarbons of the South Caspian Basin: How Exploitation Depends on the Understanding of the Neogene Paleoclimate

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Volga
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GEORGIA
Kura
Apsheron Peninsula
TURKMENISTAN
ARMENIA
AZERBAIJAN
Turkmenbashi
Baku
TURKEY
AZ.
IRAN
IRAQ

EARLY MILESTONES IN AZEBAIJAN'S HYDROCARBON HISTORY

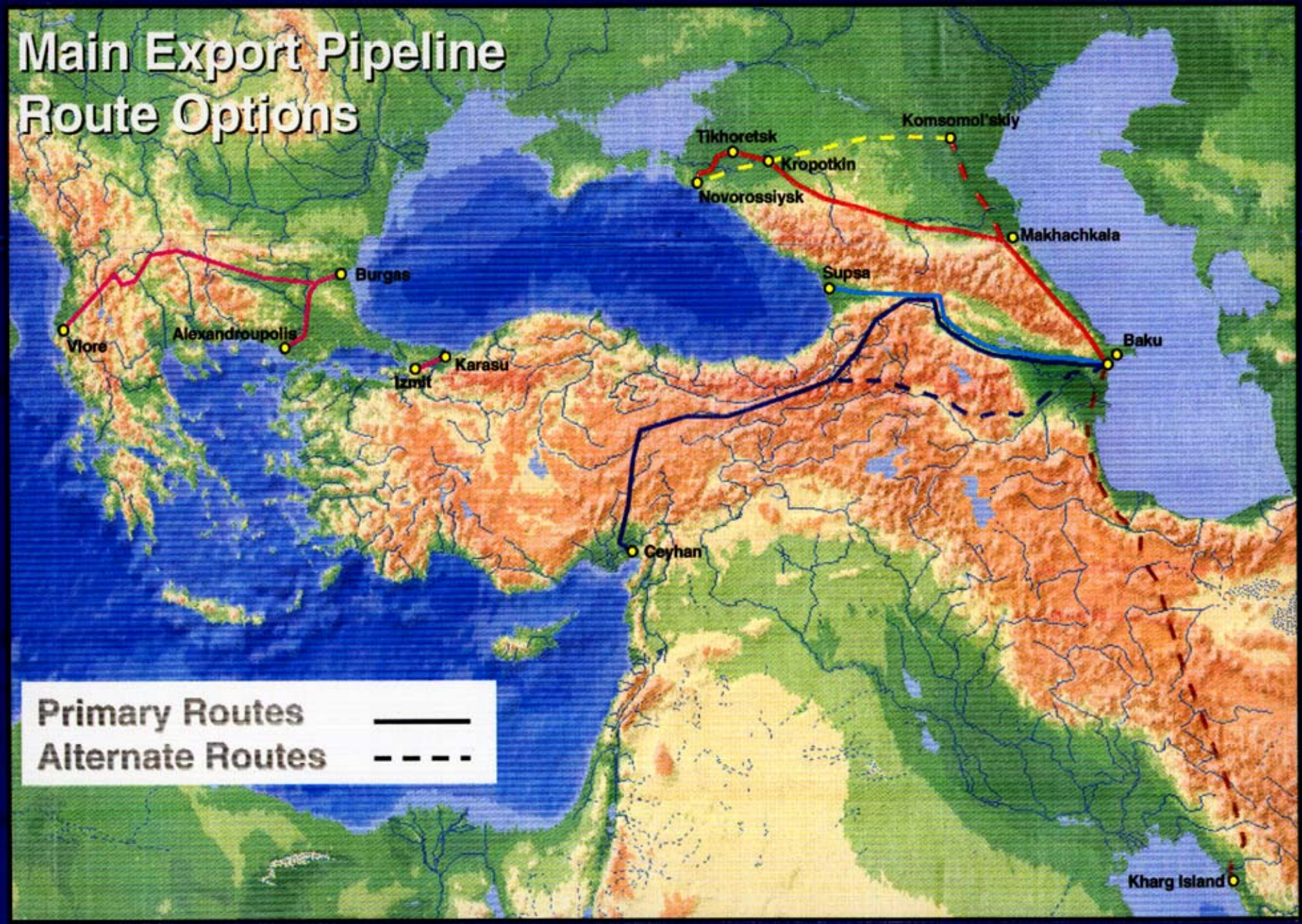
- 6th century-Baku home to the Zoroastrians, worshippers on "eternal pillars of fire"
- 13th century-Marco Polo reported oil springs
- 1829-Hand-dug wells producing hydrocarbons near Baku
- 1848-First derrick in the world installed near Baku
- 1871-First oil will dug near Baku using "modern" technology: the steam engine
- 1873-Nobel family's involvement in Baku began
- 1883-Rotschilds sponsored first railroad to Baku for oil shipments
- 1901-Baku produces half of the world's oil (60 million barrels per year)
- 1903-Oil workers began series of strikes in Baku, Joe Stalin prominent labor leader

From: UNOCAL

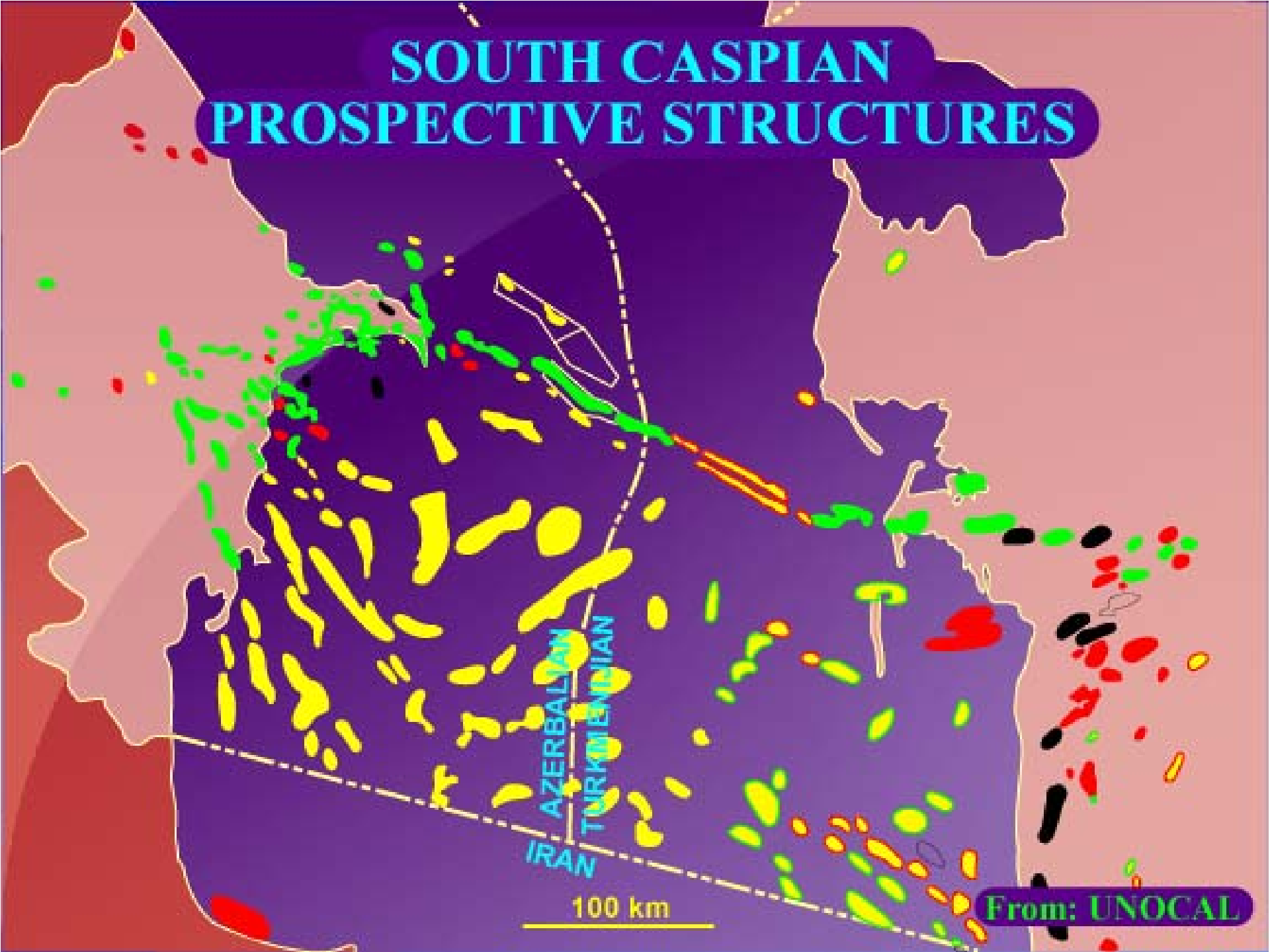
CURRENT OFFSHORE ACTIVITY - AIOC

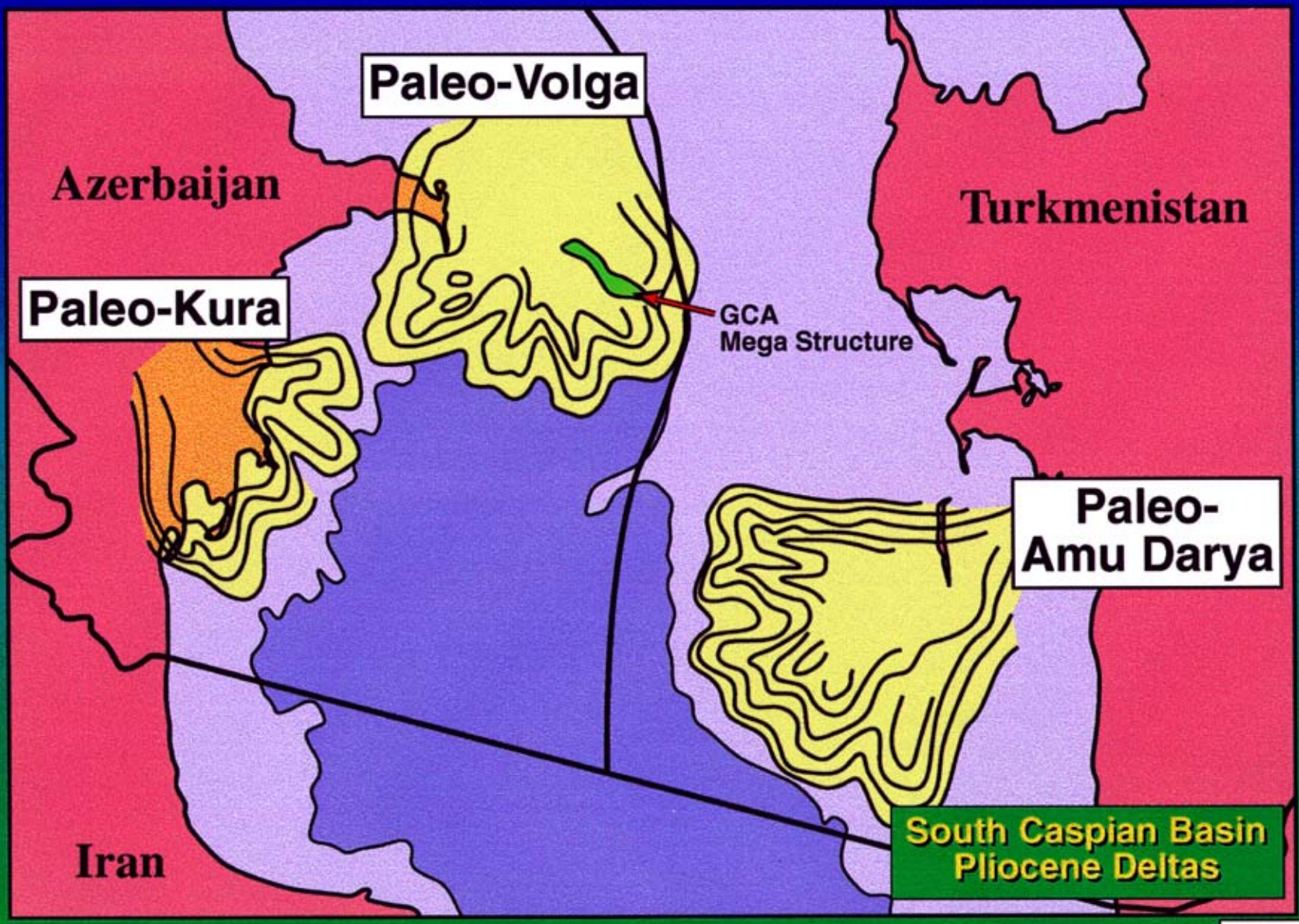
- 1949-Azerbaijan began offshore oil production
- 1991-Azerbaijan becomes independent. War with Armenia follows.
- 1994-Contract to form the Azerbaijan international oil company was signed between 11 companies from 7 countries, including SOCAR. Concession was the "GCA megastructure" consisting of deepwater Gunashli, Chirag and Azeri structures on the Apsheron Sill.
- 1997-August-First producing well spudded from refurbished Chirag-1 platform. Chirag-1 has 24 well slots. Current production is 100,000 BOPD, with a maximum attainable of 130,000 BOPD.
- 1997-November-First oil began flowing in the northern export pipeline, through Russia.
- 1999-March-Oil began flowing in the western export pipeline.
- 1999-April-main export pipeline remains undetermined.

From: UNOCAL

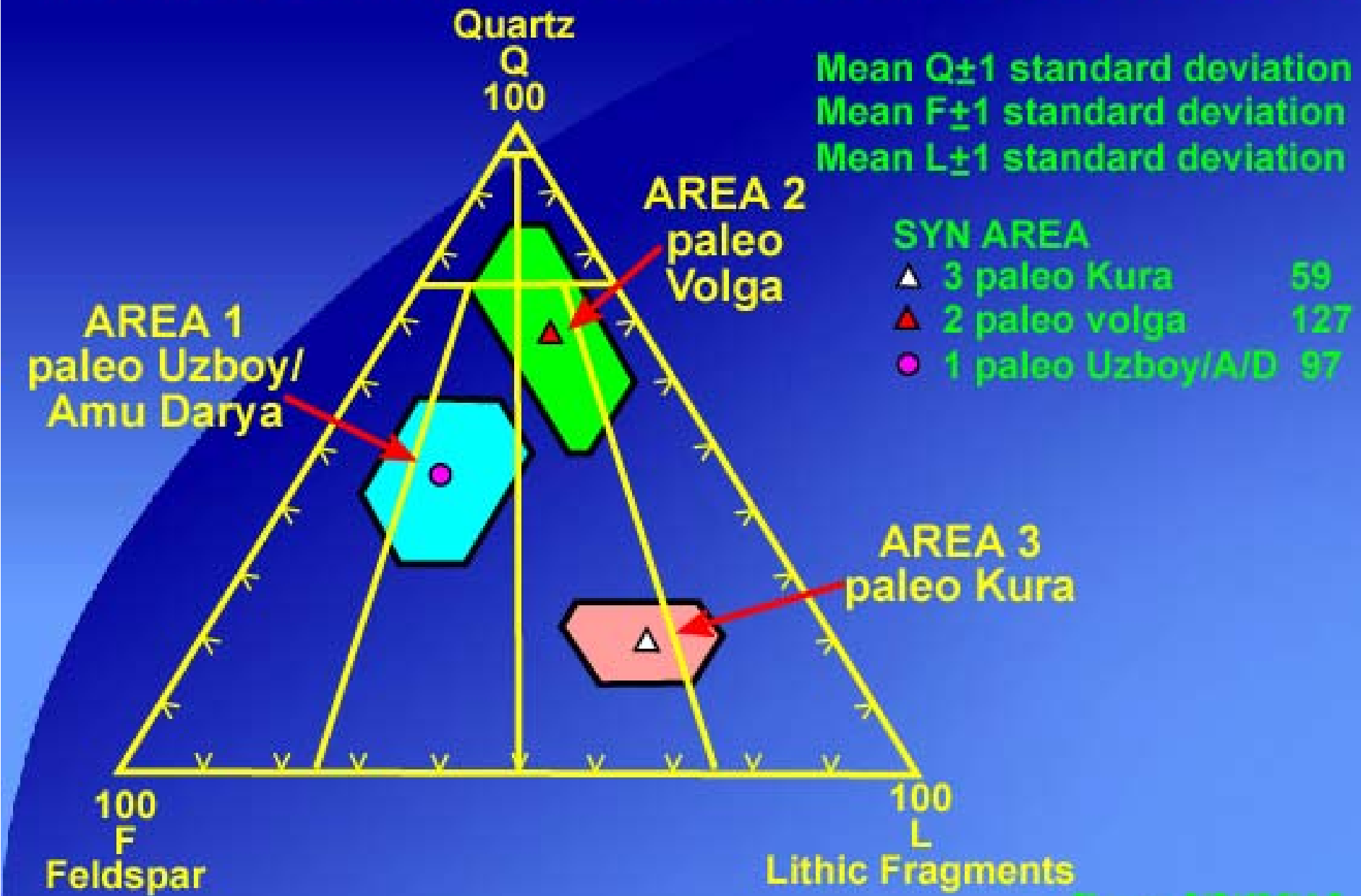

Main Export Pipeline
Route Options
Komsomol'skiy
Tikhoretsk
Kropotkin
Novorossiysk
Makhachkala
Supsa
Burgas
Alexandroupolis
Vlore
Izmit
Karasu
Baku
Ceyhan
Kharg Island
Primary Routes
Alternate Routes

SOUTH CASPIAN
PROSPECTIVE STRUCTURES




Paleo-Volga
Azerbaijan
Turkmenistan
Paleo-Kura
GCA
Mega Structure
Paleo-
Amu Darya
South Caspian Basin
Pliocene Deltas
Iran

AVERAGE SANDSTONE COMPOSITION

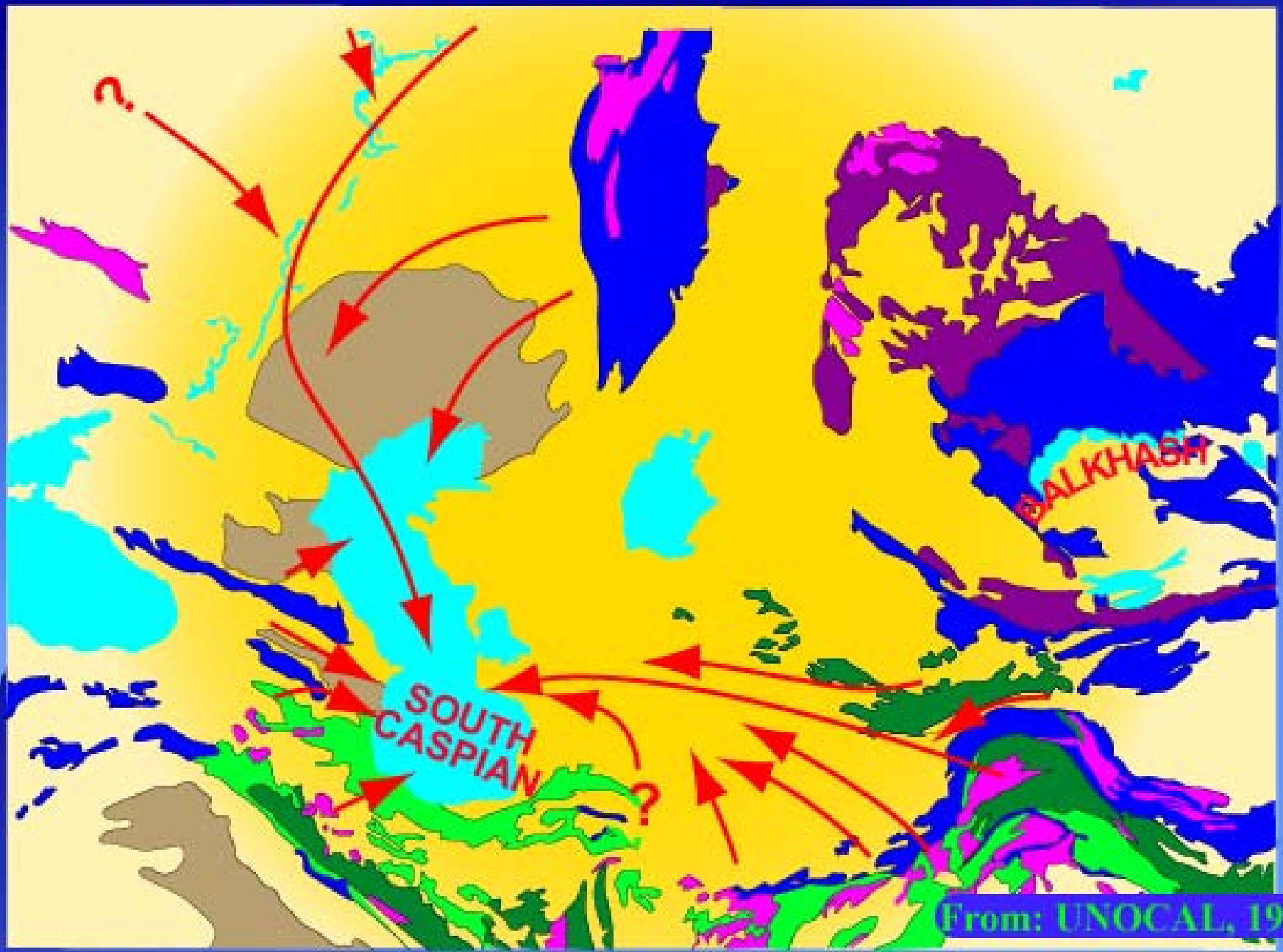


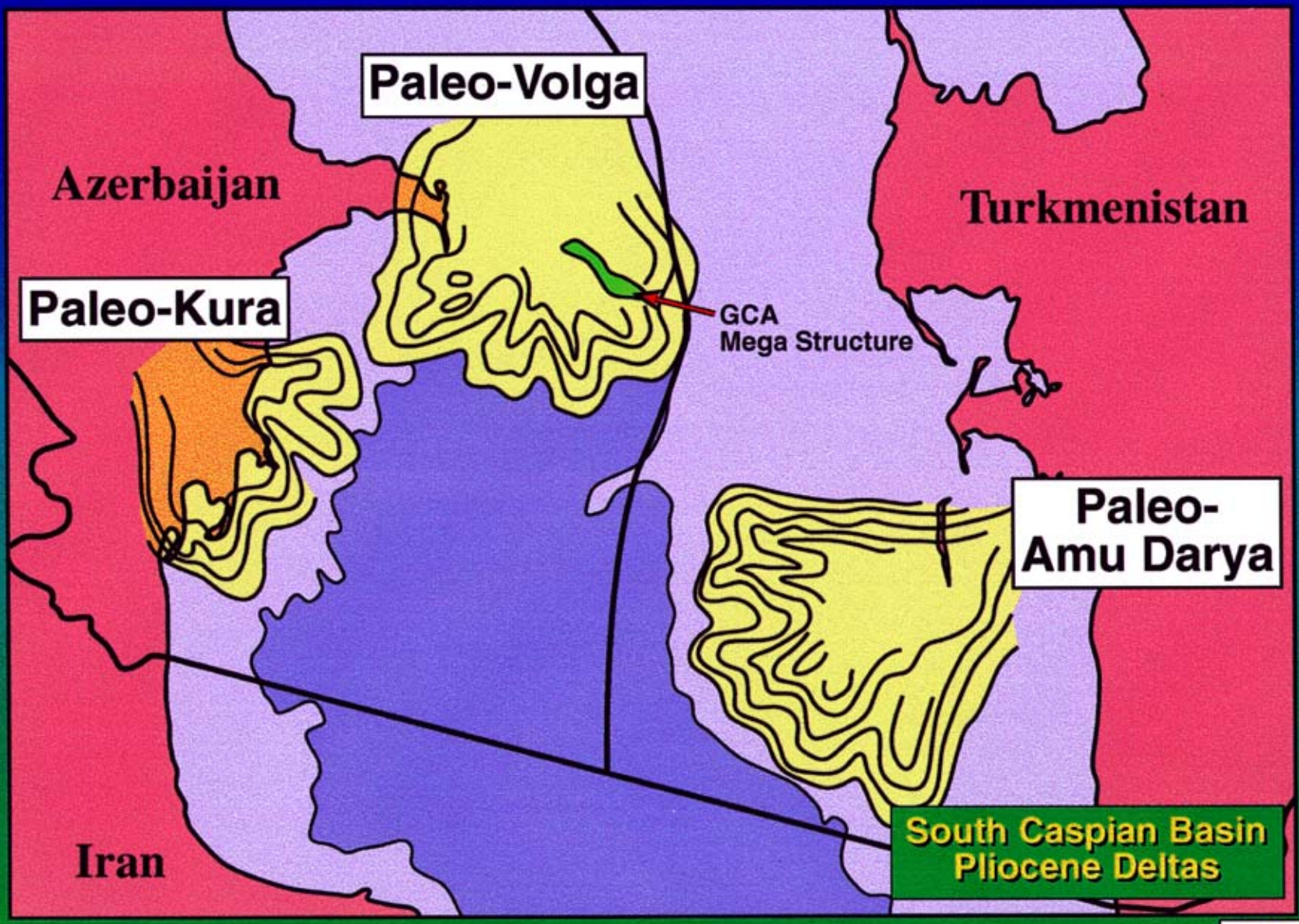
Mean Q±1 standard deviation
Mean F±1 standard deviation
Mean L±1 standard deviation

SYN AREA		
▲	3 paleo Kura	59
▲	2 paleo volga	127
●	1 paleo Uzboy/A/D	97

From: UNOCAL

CASPIAN SEDIMENT SOURCES




Paleo-Volga
Azerbaijan
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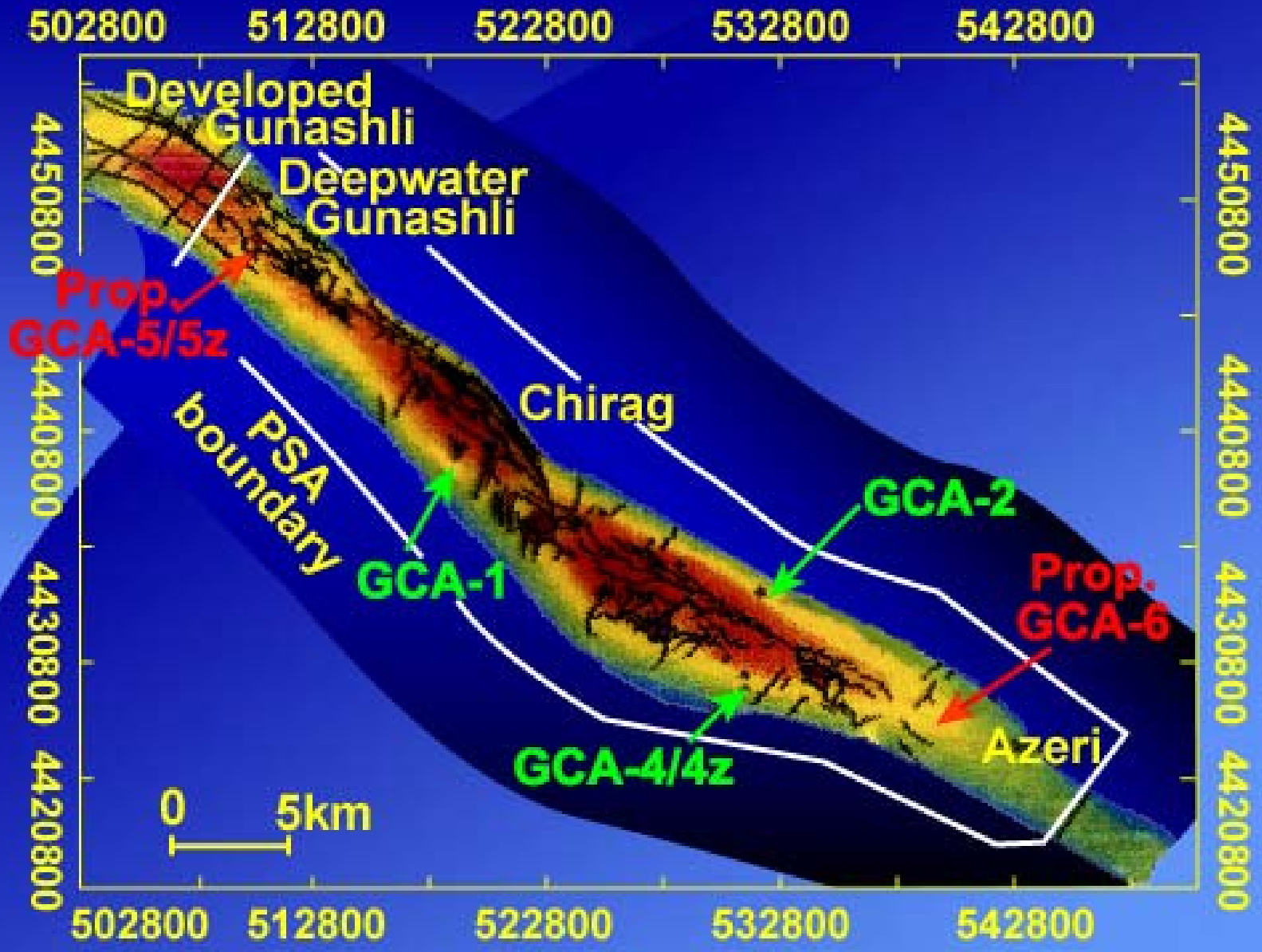
Paleo-Kura
GCA
Mega Structure
Paleo-
Amu Darya
South Caspian Basin
Pliocene Deltas
Iran

DEVELOPMENT OF GUNASHLI, CHIRAG, AZERI MEGA-STRUCTURE

APPRAISAL WELL LOCATION MAP



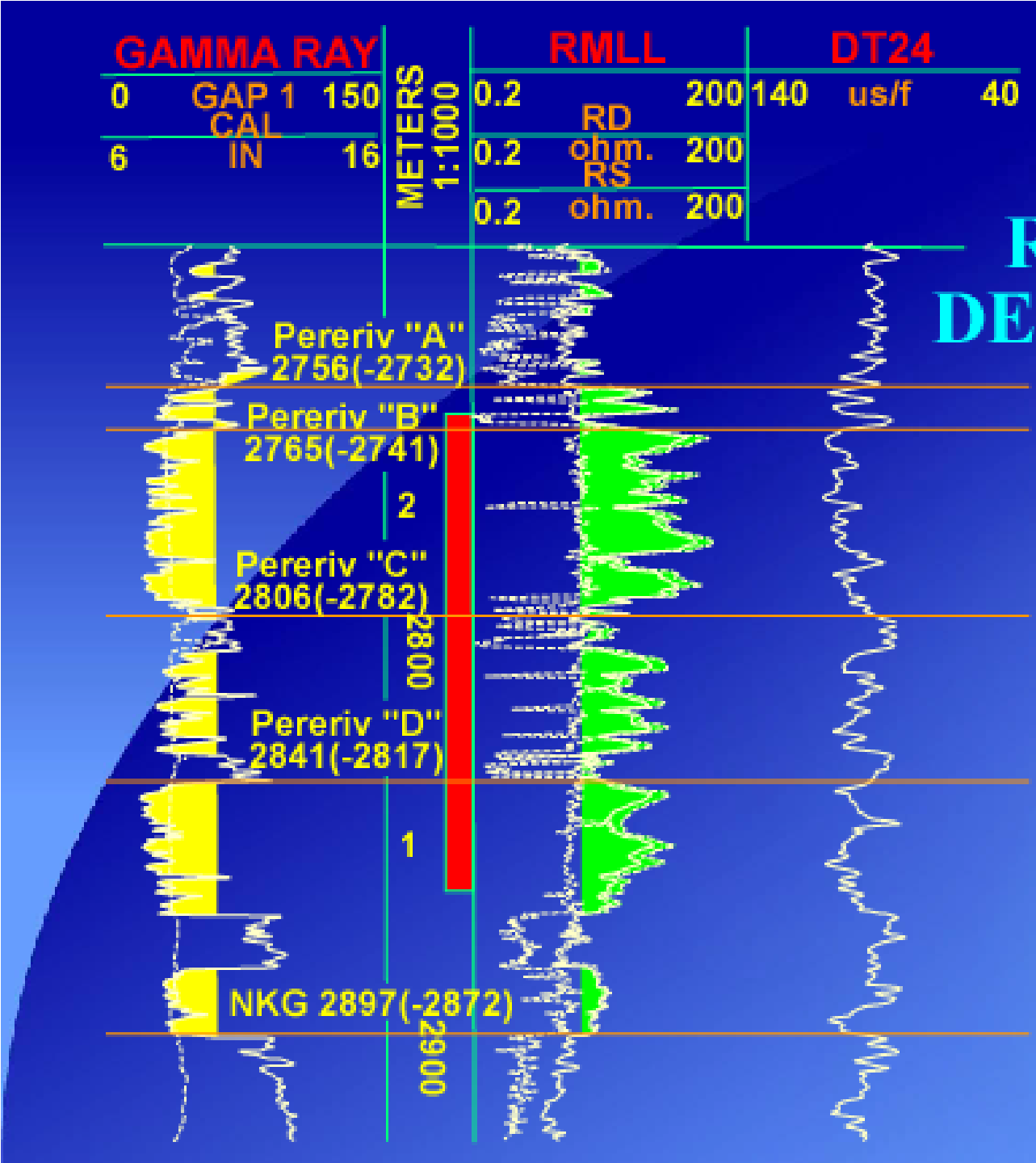
The Caspian – is a lake just a small ocean?

- Lakes are not just ‘small oceans’ (Bohacs, 1999)

- Lakes are much more sensitive to changes in climate and accommodation than oceans are

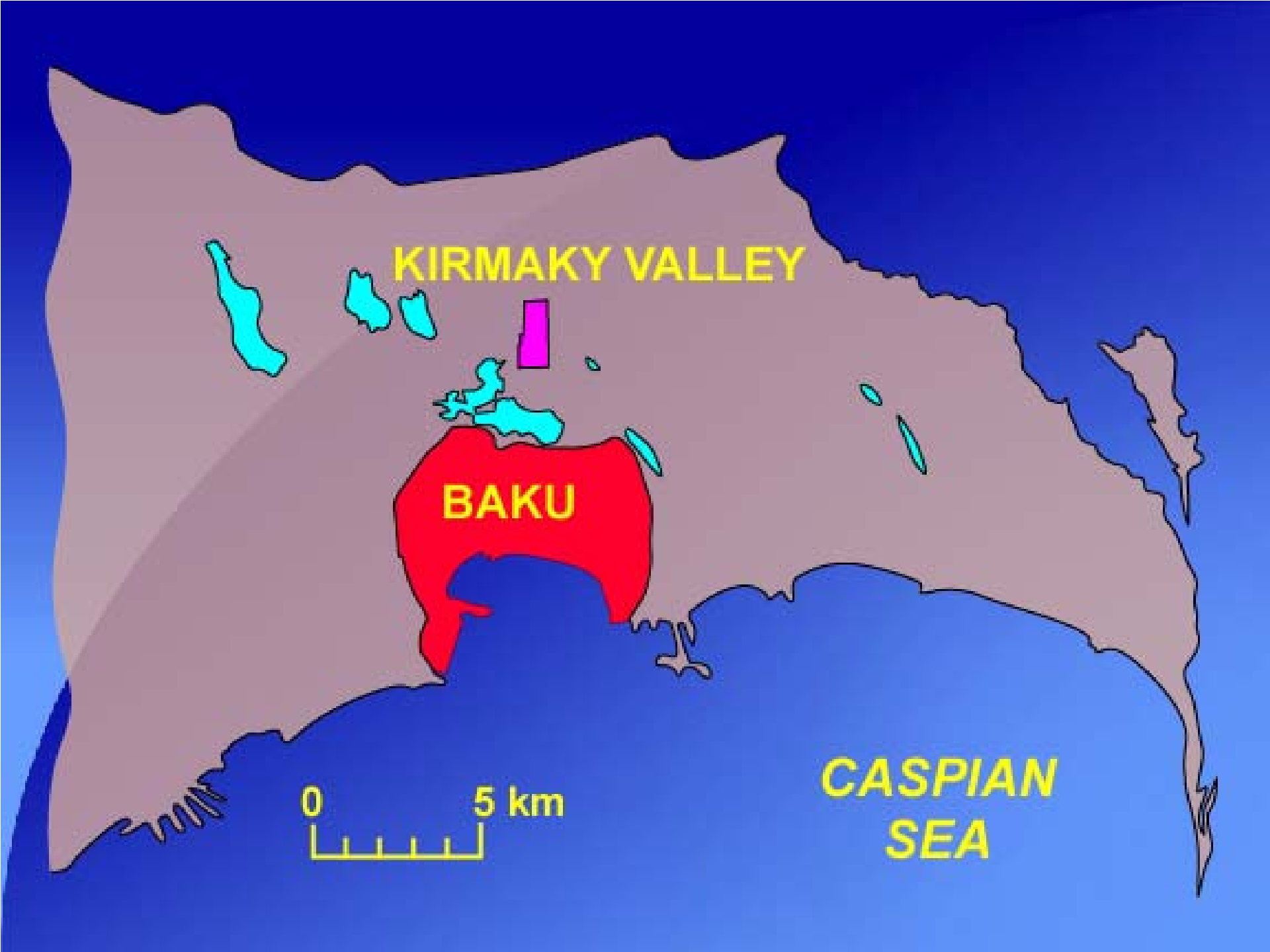
- Lake levels and sediment supply are directly linked (Schumm, 1977; Perlmutter and Matthews, 1990)

- Shorelines move extensively and rapidly, due to water withdrawal and backfill

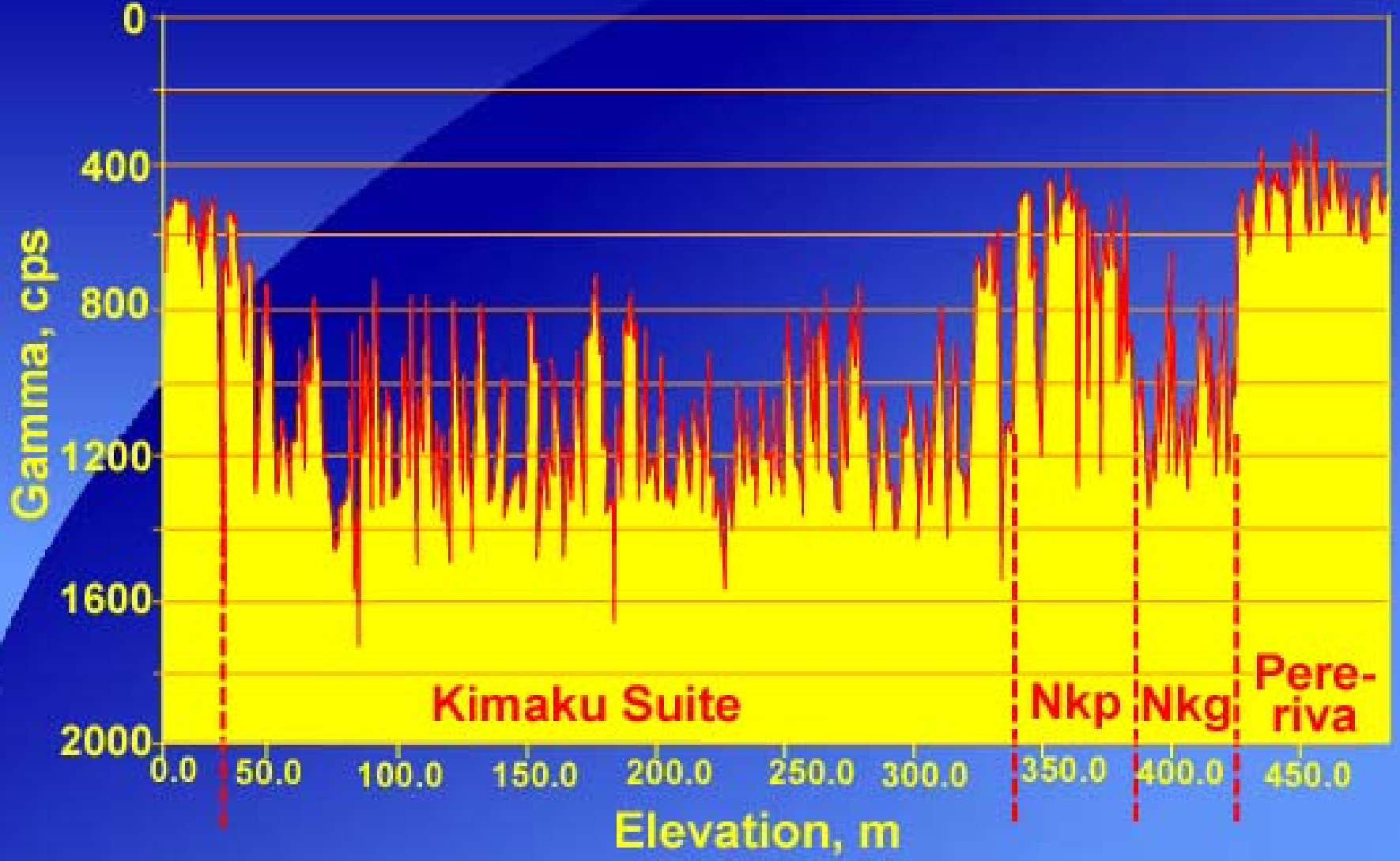


RESERVOIR DEVELOPMENT GCA NO. 1

From: AIOC

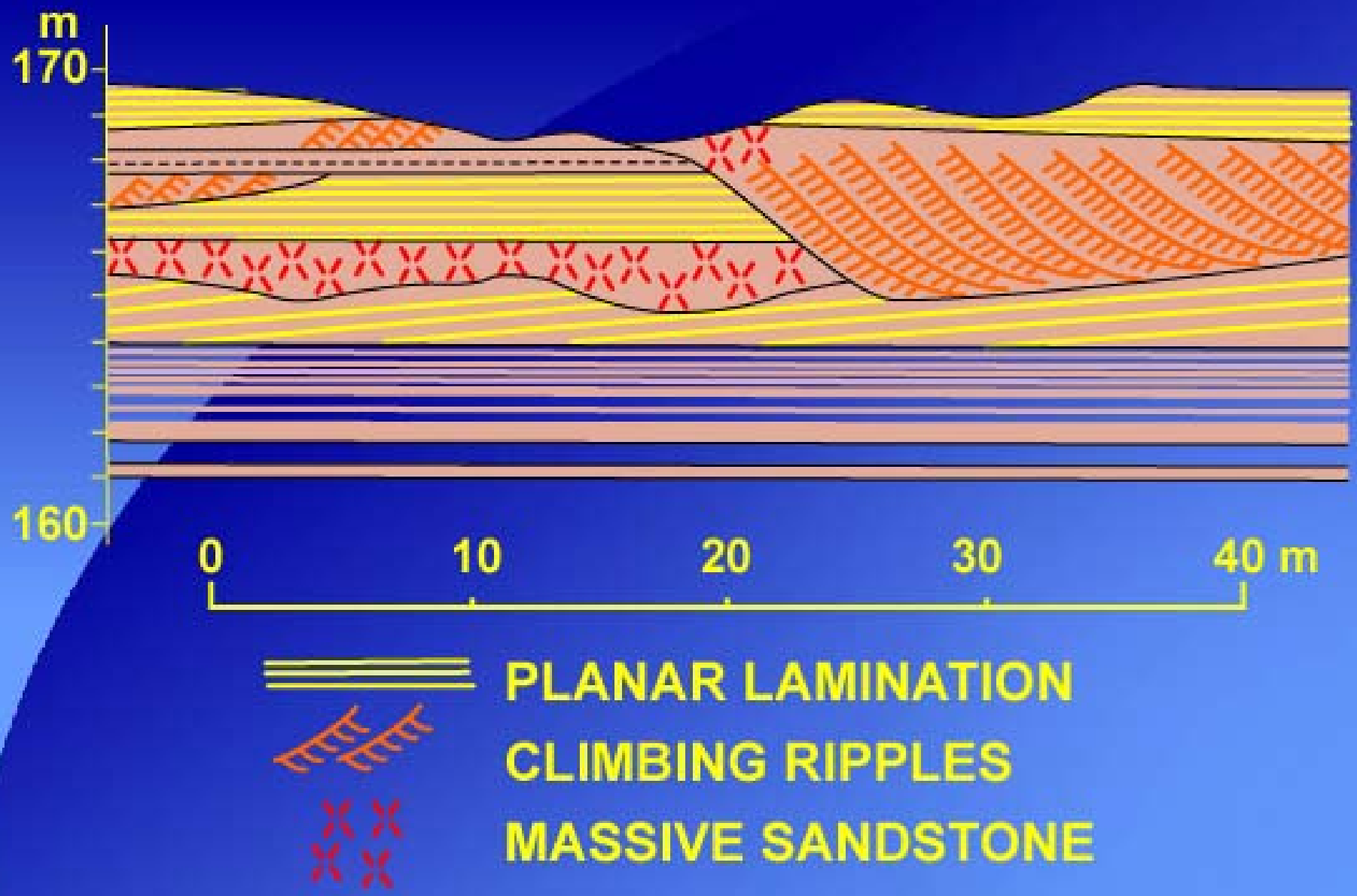

KIRMAKY VALLEY
BAKU
0
5 km
CASPIAN
SEA

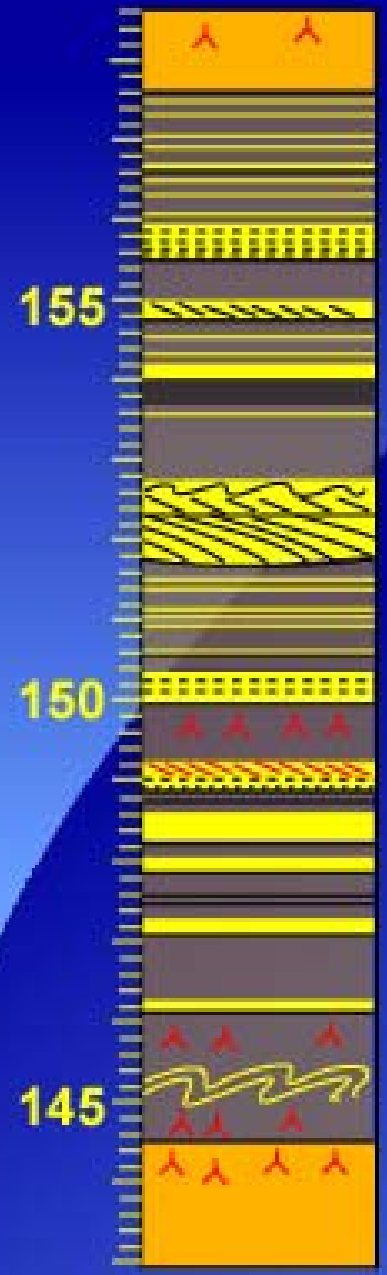
KIRMAKY GAMMA PROFILE




'96 8 25

TYPICAL FLUVIAL SANDSTONE BED





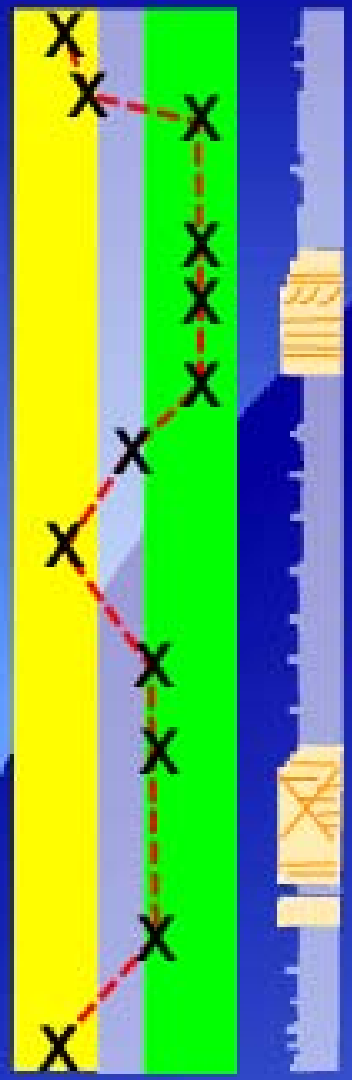
FINE-GRAINED INTERVAL KIRMAKY SUITE

VERY FINE SAND

MUD

RIZOLITHS

HIGH-FREQUENCY CLIMATIC/ SEDIMENTOLOGIC CYCLE, KIRMAKY SUITE



LAKE LEVEL FALL

MAXIMUM LAKE LEVEL

DEEPEST LACUSTRINE SEDIMENTATION

UPWARD-DEEPENTING LACUSTRINE SEDIMENTATION

LAKE LEVEL RISE

INUNDATION OF SANDSTONE

FLOOD DEPOSITS AGGRADE

SUBAERIAL EXPOSURE

LAKE LEVEL FALL

UPWARD-SHALLOWING LACUSTRINE SEDIMENTATION

MAXIMUM LAKE LEVEL

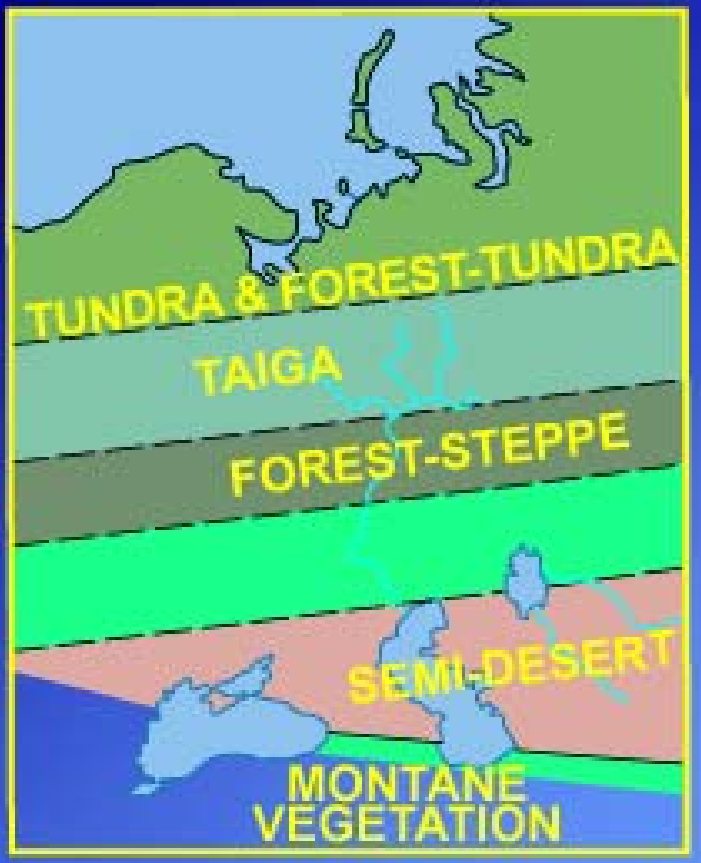
DEEPEST LACUSTRINE SEDIMENTATION

LAKE LEVEL RISE

VEGETATION ZONES IN RUSSIA AND CENTRAL ASIA

GLACIAL - REGRESSION

- Water locked up in Ice Sheet.
- Pollen Spectra of Arid Aspect.
- Contraction of Forest Zone

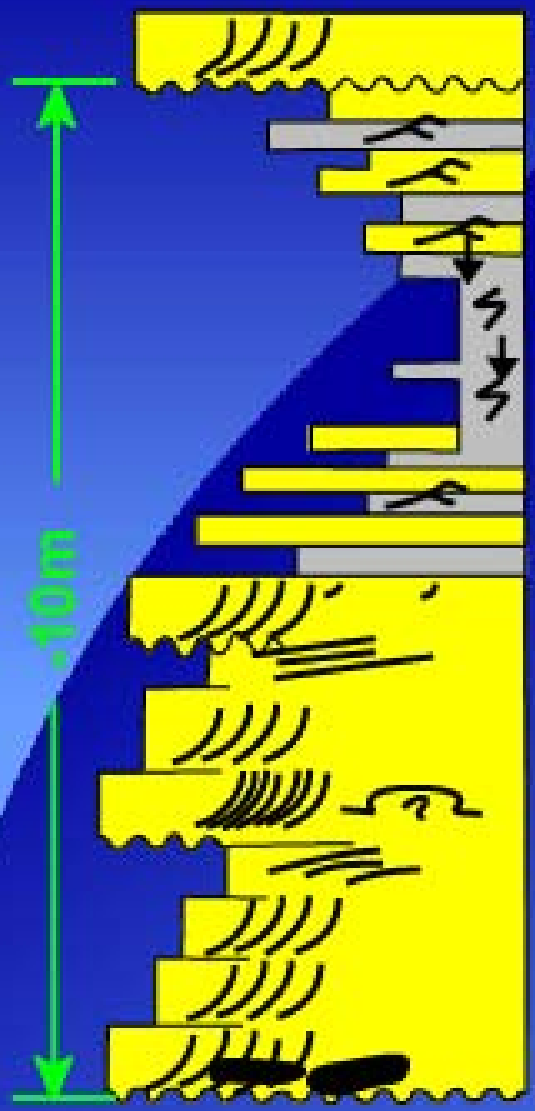


INTERGLACIAL - TRANSGRESSION

- Water released from melting Ice Sheet
- Expansion of forest zone

From: Jones and Simmons (1996) based on data in Grichuk (1984)

PERERIV SEQUENCE



INTERPRETATION

Channel base

Delta front (forestep)

Subaerial exposure with Intermittent flooding

Delta front (backstep)

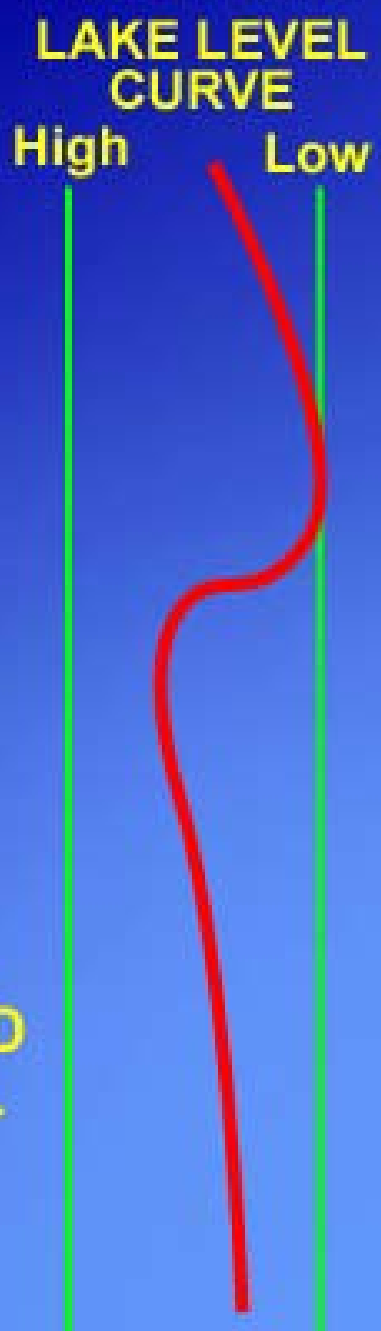
Transgressive surface

Channel base

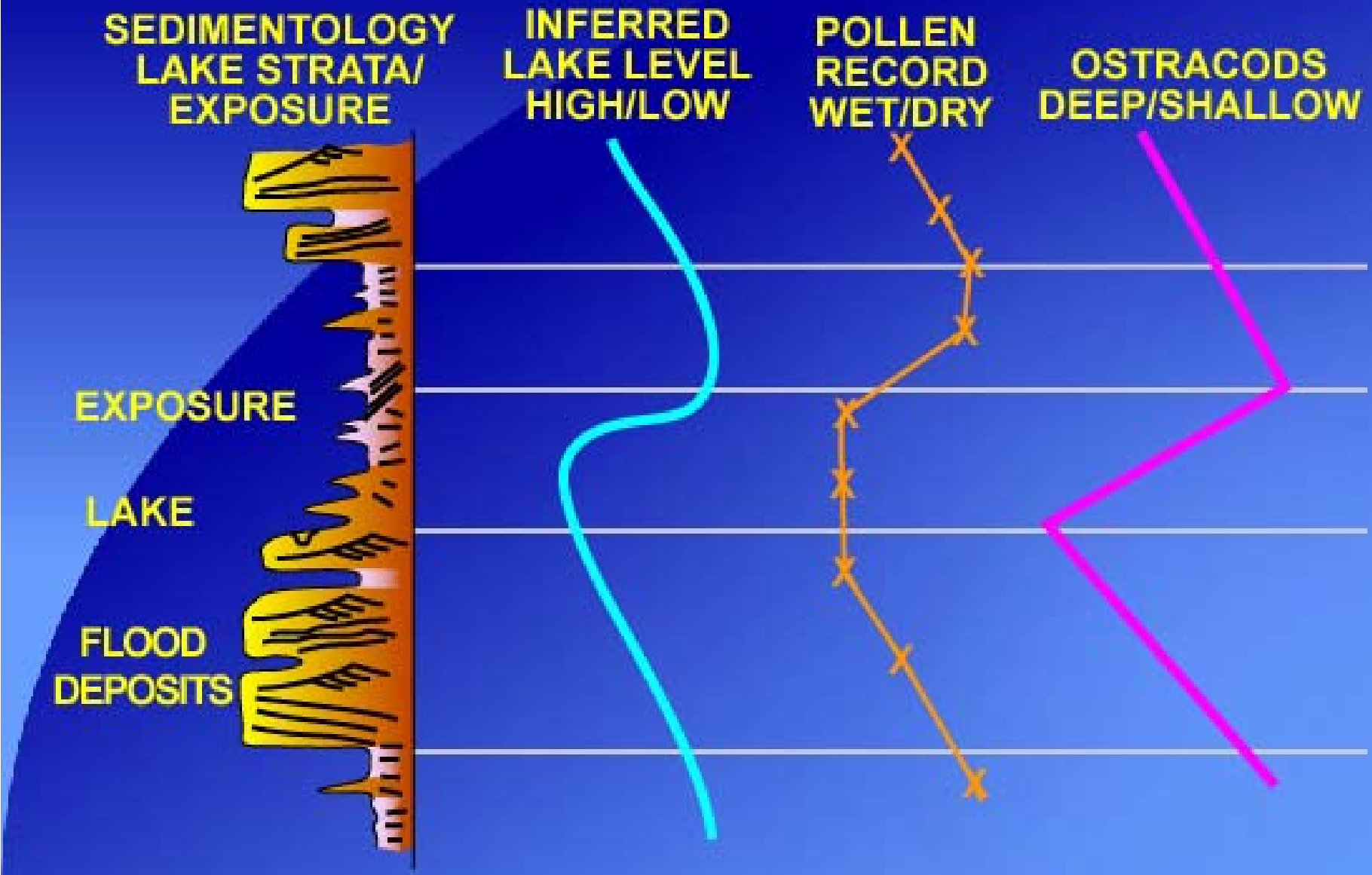
Channel base

Channel base

BRAIDED FLUVIAL



EXPRESSIONS OF PRECESSIONAL CYCLES IN SEDIMENTS OF THE SOUTH CASPIAN BASIN

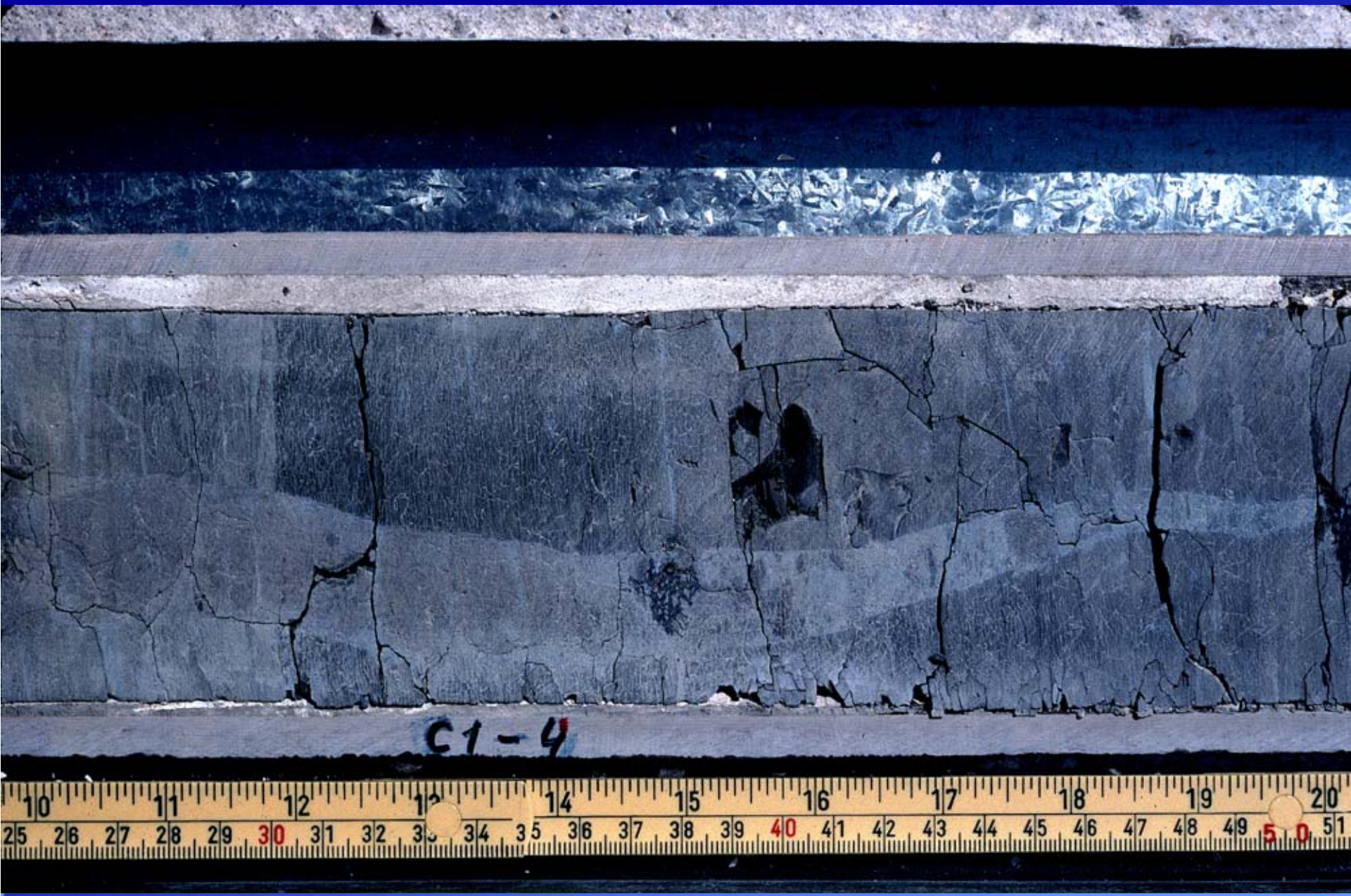


So, what did we observe?

- Sandstones mostly deposited by flash floods
- Multiple surfaces of exposure (root, soils)
- Exposure surfaces (SBs) in middle of lacustrine (ostracods) mudstone intervals
- Arboreal/herbaceous pollen ratios indicate that climate cycles generated sequences, 10 to 20 m thick
- There is a large number of these sequences


'96 8 28


mm
2805.30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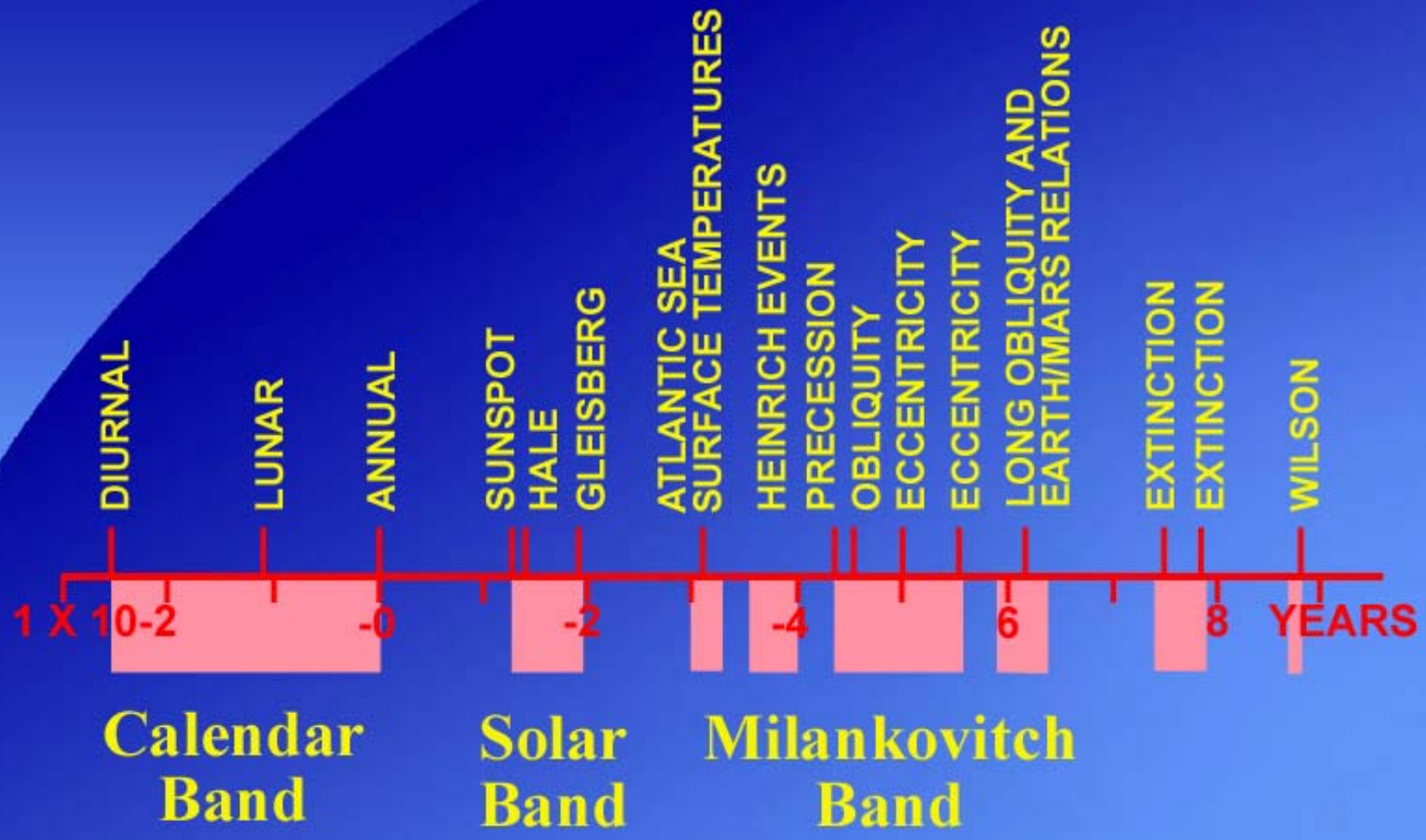
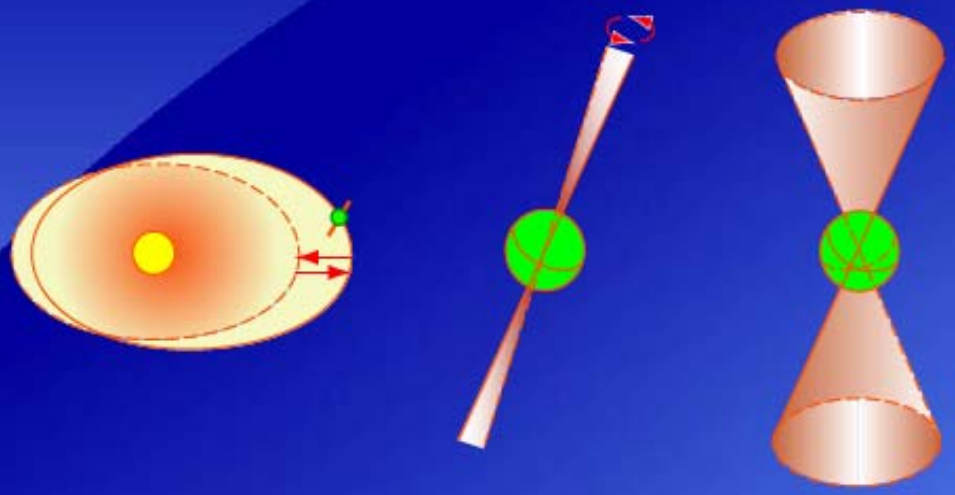
THE EVOLVING UNDERSTANDING OF CLIMATE CYCLES



MILANKOVITCH CYCLICITY-PRINCIPLES
ORBITAL VARIATIONS



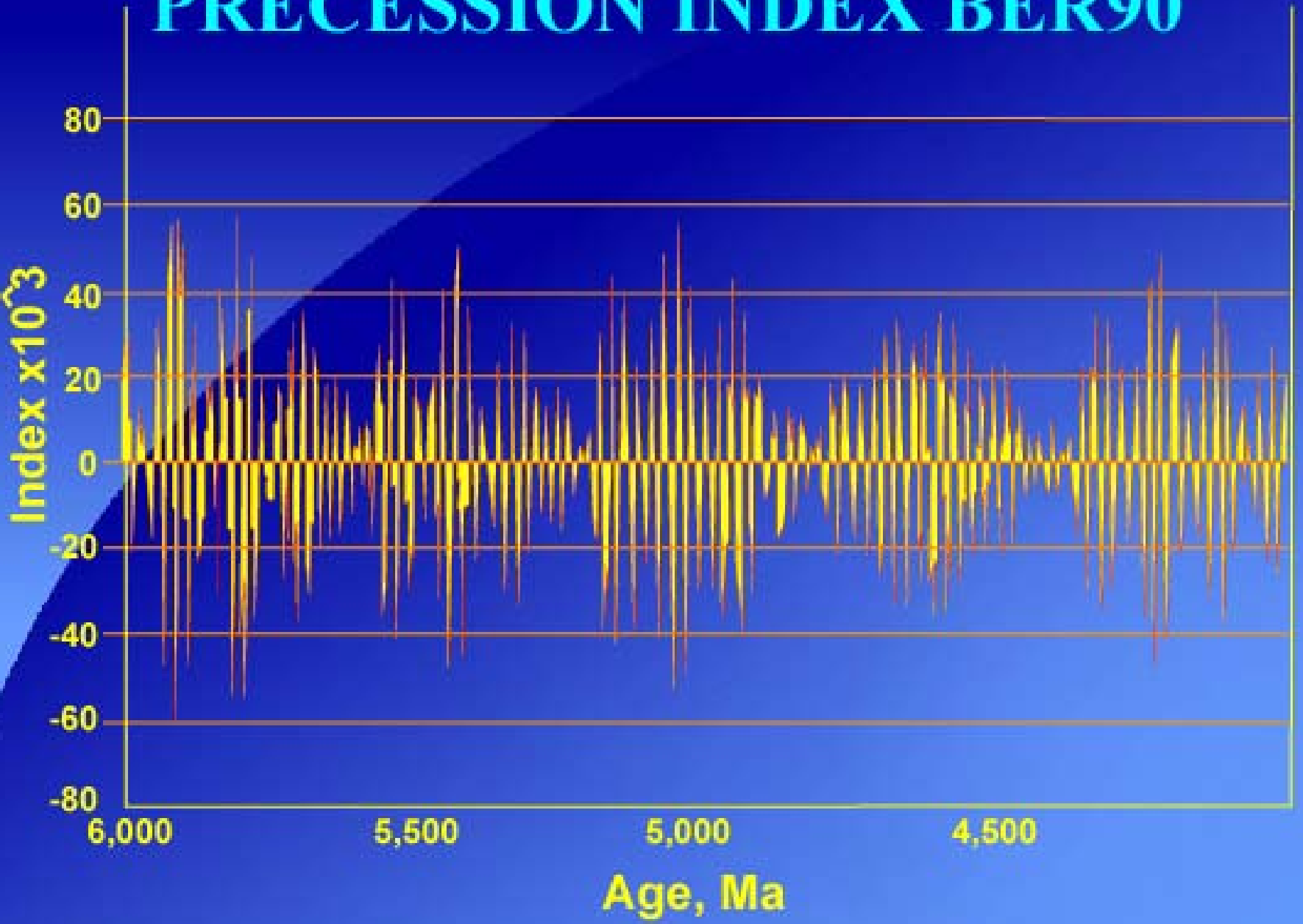
eccentricity obliquity precession

Precessional signal strongest at 35° latitude
Obliquity signal strongest at 70° latitude

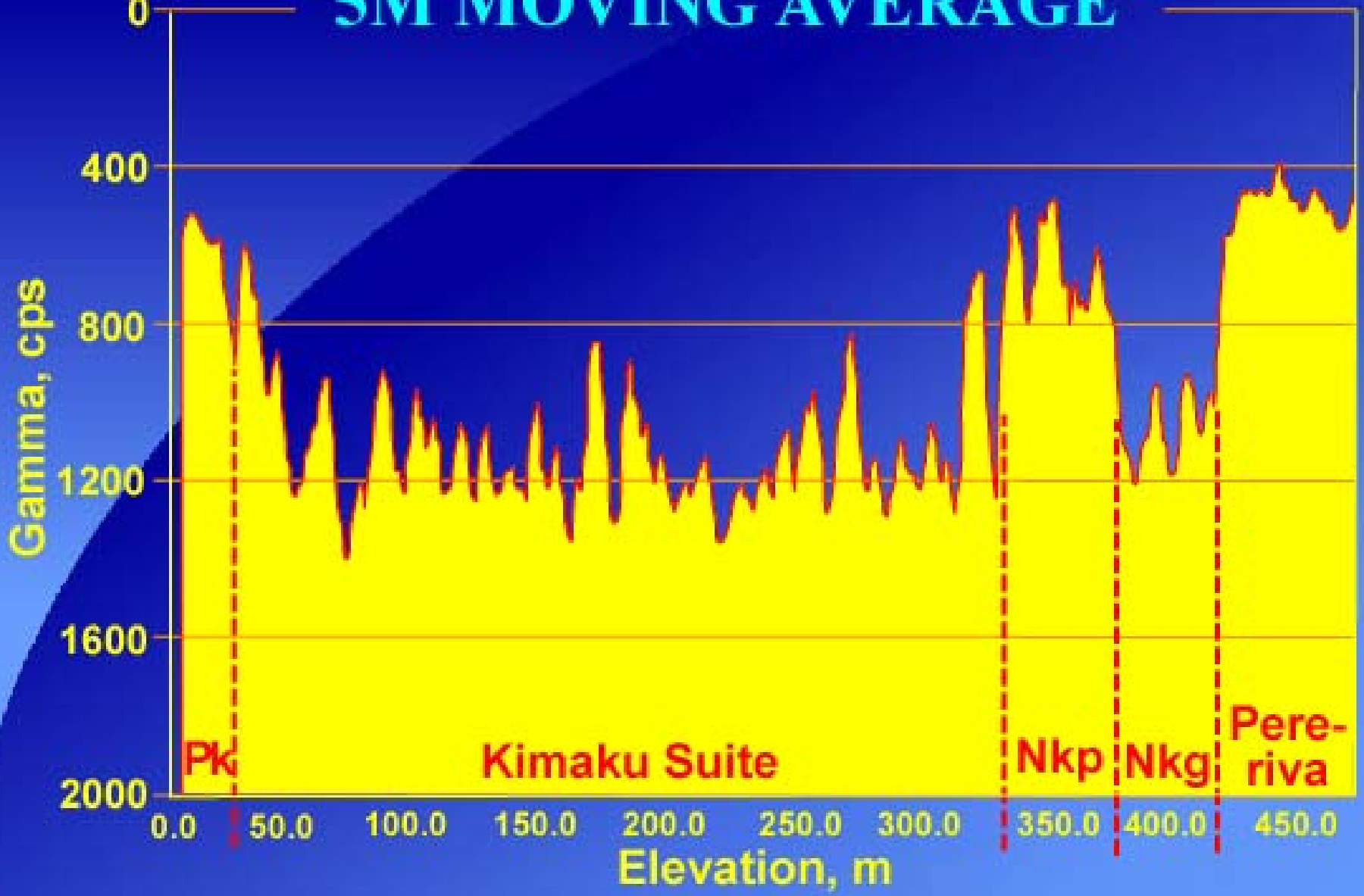
ISOTOPE AND BIOSTRAT CALIBRATION

	Ar^{39}/Ar^{40}	COSMOPOLITAN DINOFLAGGELATES	SUITES
PLIOCENE	2.6 Ma	Batiacasphera sphaerica Lejeunecysta globosa Selenopemphix brevispinosa	Akchagylian
	3.34 Ma		Surakhany Sabunchi Balakhany Pereriva
5.32 Ma		Cardosphaeridium minimum Labyrinthodinium truncatum Systematophora placacantha	Kirmaku suite
MESSINIAN	5.75-5.93 Ma 5.91 Ma 6.00 Ma 6.13 Ma 6.20 Ma		Pontian

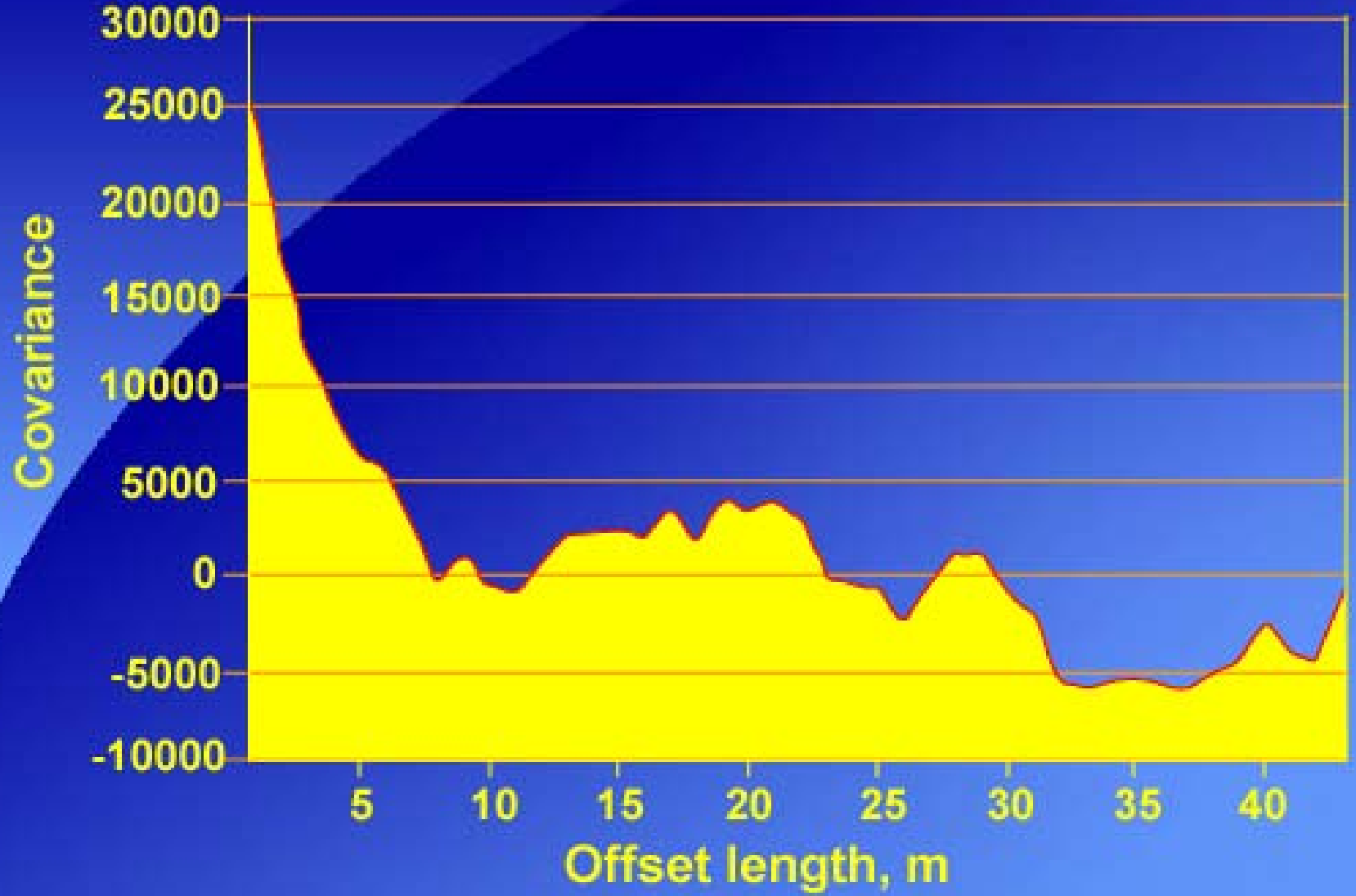
PRECESSION INDEX BER90



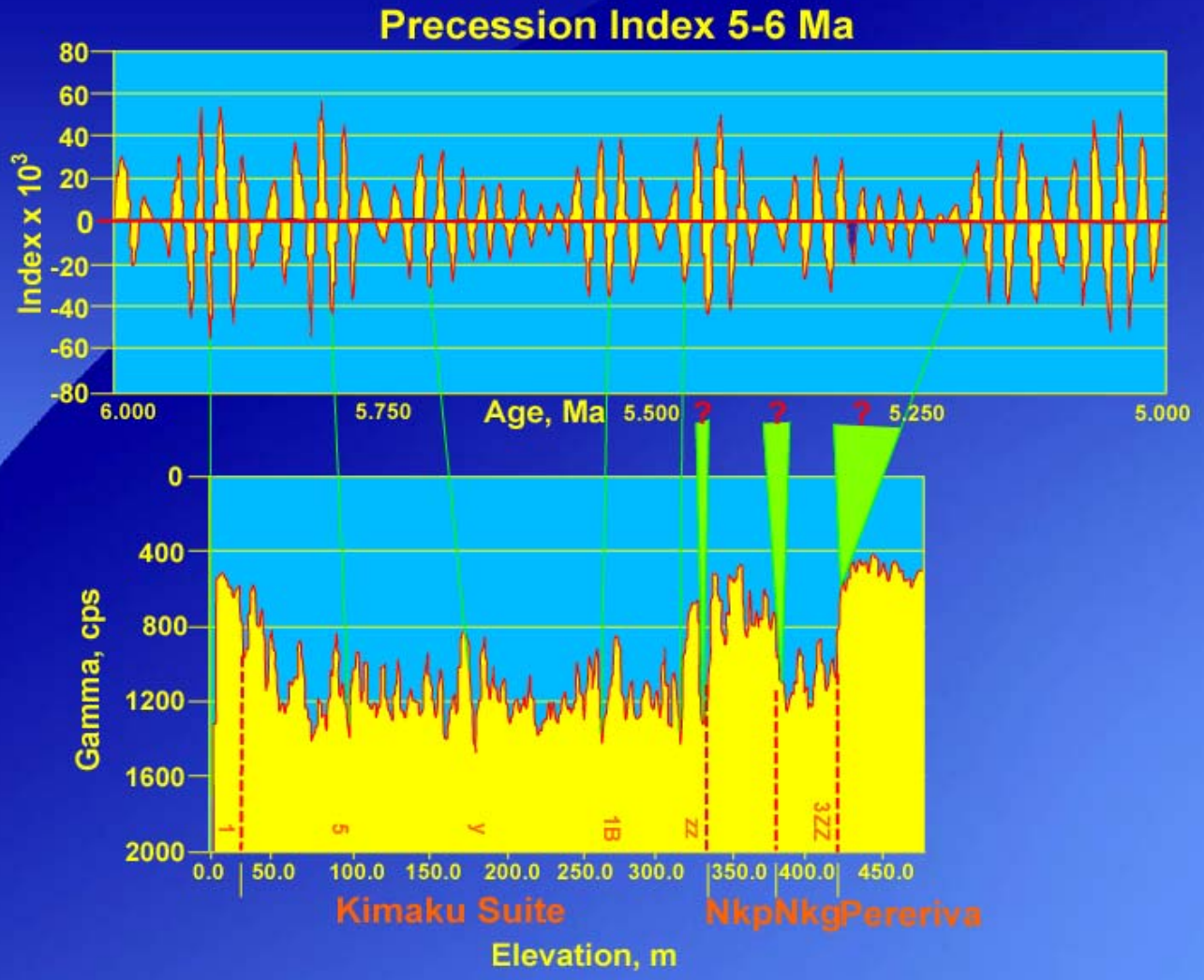
KIRMAKY VALLEY GAMMA LOG-5M MOVING AVERAGE



KIRMAKY VALLEY GAMMA LOG KS COVARIANCE SPECTRUM



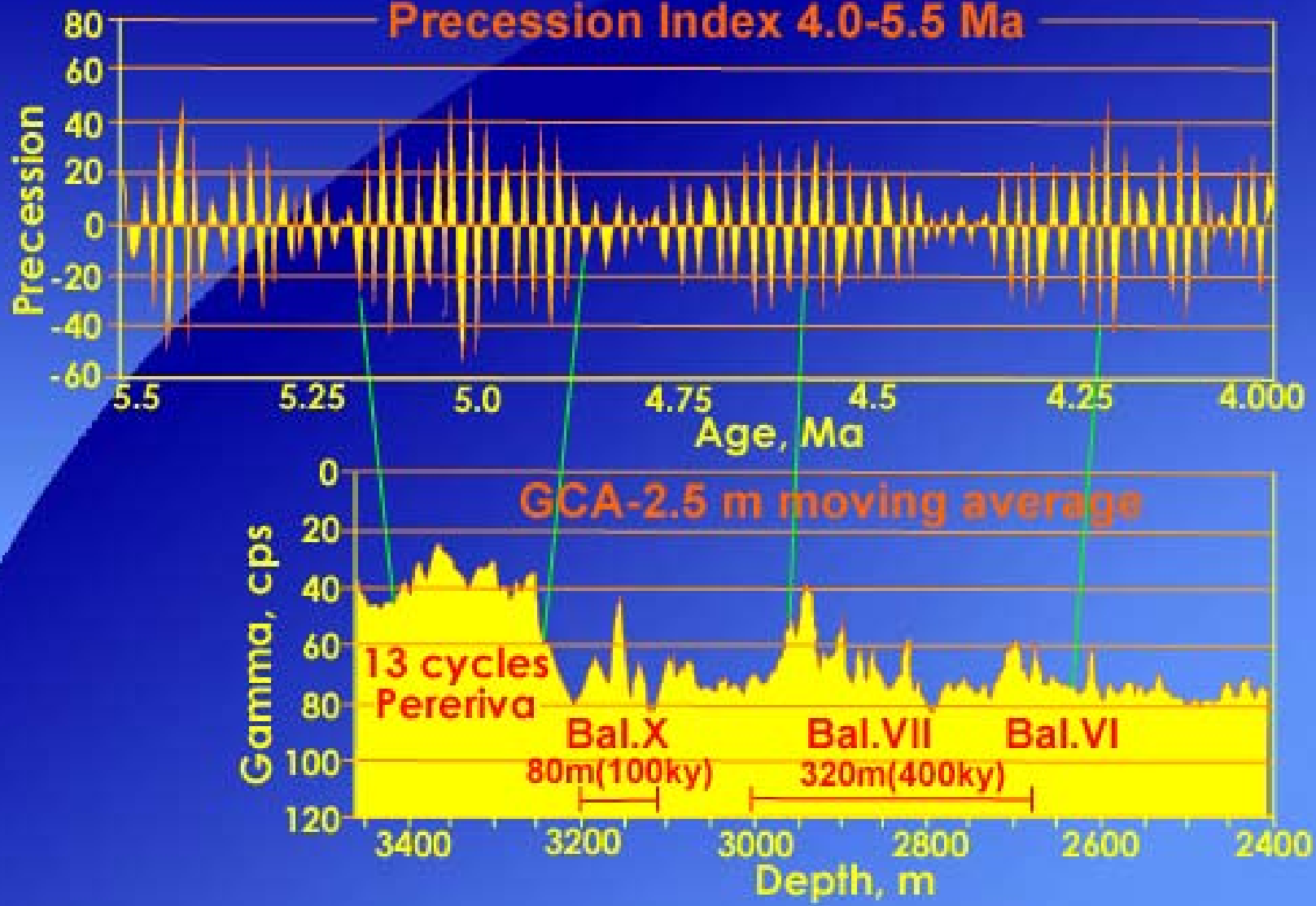
KIRMAKU VALLEY GAMMA LOG CORRELATED TO PRECESSION INDEX



From Nummedal and Clifton, 2000


97 4 26

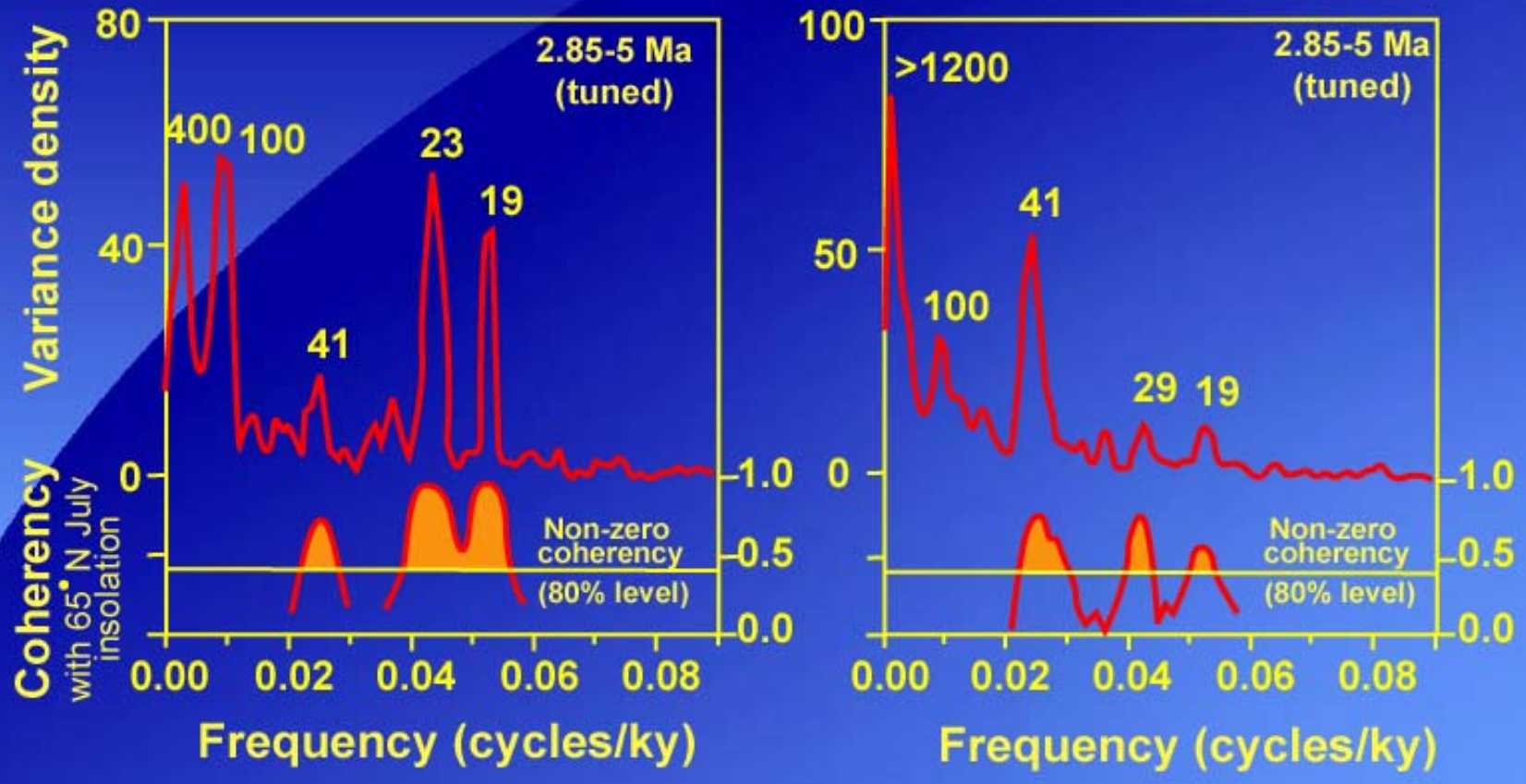
BALAKHANY GAMMA LOG CORRELATED TO PRECESSION INDEX



- **Is the Caspian unique in this astronomical forcing?**

- **Is there evidence for precessional and eccentricity controls on sedimentation at adjacent lower mid-latitude regions?**

DUST FLUX FROM THE SAHARA DESERT



From Tiedemann et al., 1994

Conclusions - 1

- L.Mio-Pliocene sequences in South Caspian Basin are fluvial/lacustrine, ~ 10-20 m thick

- Sedimentation is dominated by fluvial flash- flood deposition

- The Caspian sedimentary cycles are very pronounced, because local sea (lake) level and sediment supply vary at the same frequencies (20 ky, 100 ky) and in phase

Conclusions – 2

- Remarkably continuous record, due to sediment accumulation rate of 1 km/my
- Caspian sequences differ from shallow marine in a fundamental way: there appears to be hardly any deposition associated with lake level fall
- Exposure surfaces (SBs) in middle of lacustrine (ostracods) mudstone intervals

STATE OIL COMPANY OF AZERBAIJAN REPUBLIC: CURRENT DEVELOPMENTS

Thank You!