Origin and Expression of Pliocene Climate Cycles in the Caspian Basin*

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Abstract

Climate fluctuations did exert a dominant control on the style of sedimentation in the South Caspian Basin, through their direct impact both on lake levels and sediment supply. Spectral analyses of gamma logs reveal systematic patterns in sand/mud ratios. These patterns also reveal a set of nested cycles that correspond to the relative durations of Milankovitch precession cycles (~20 ky), short eccentricy cycles (~100 ky) and long eccentricity cycles (~400 ky). The Kirmaky Suite reveals a strong signal of sandstone-shale successions ranging in thickness between 12 and 22 meters, attributed to the ~20 ky precession cycles. Search for longer period cycles was limited to one subsurface gamma log of the Balakhany Suite. The associated spectrum revealed peaks in the 55 to 80 m range and 210 to 300 m range, attributed to short (~ 100 ky) and long (~ 400 ky) eccentricity cycles.

The observed sediments were deposited in fluvial, lake-margin playa, shoreline and open lake depositional systems. The sequence boundary is an exposure surface within mudstones. The palynology of mudstones documents an associated dry climate. Above the sequence boundary lays a forestepping succession of terminal splay sandstones and mudstones suggesting slowly rising lake level; the palynomorphs indicate corresponding increase in humidity. Above this there is a stack of braided stream deposits that generally represent the dominant sandstone interval of the entire sequence. This is interpreted as a lowstand systems tract, which is abruptly truncated by a lacustrine flooding surface, which in turn is capped by a backstepping succession of more terminal splay deposits. The palynomorphs indicate that the climate remained humid during deposition of this transgressive systems tract.

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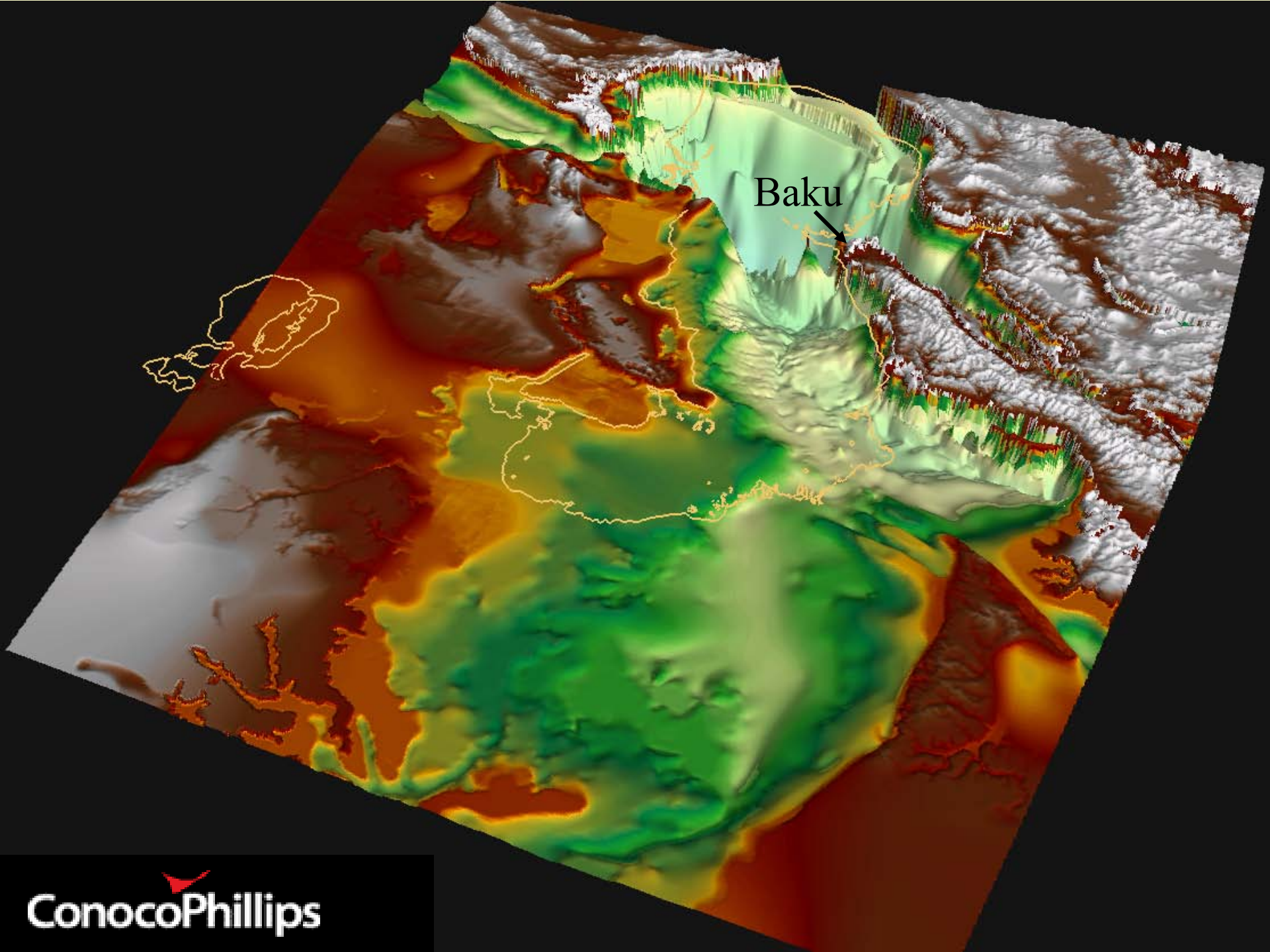
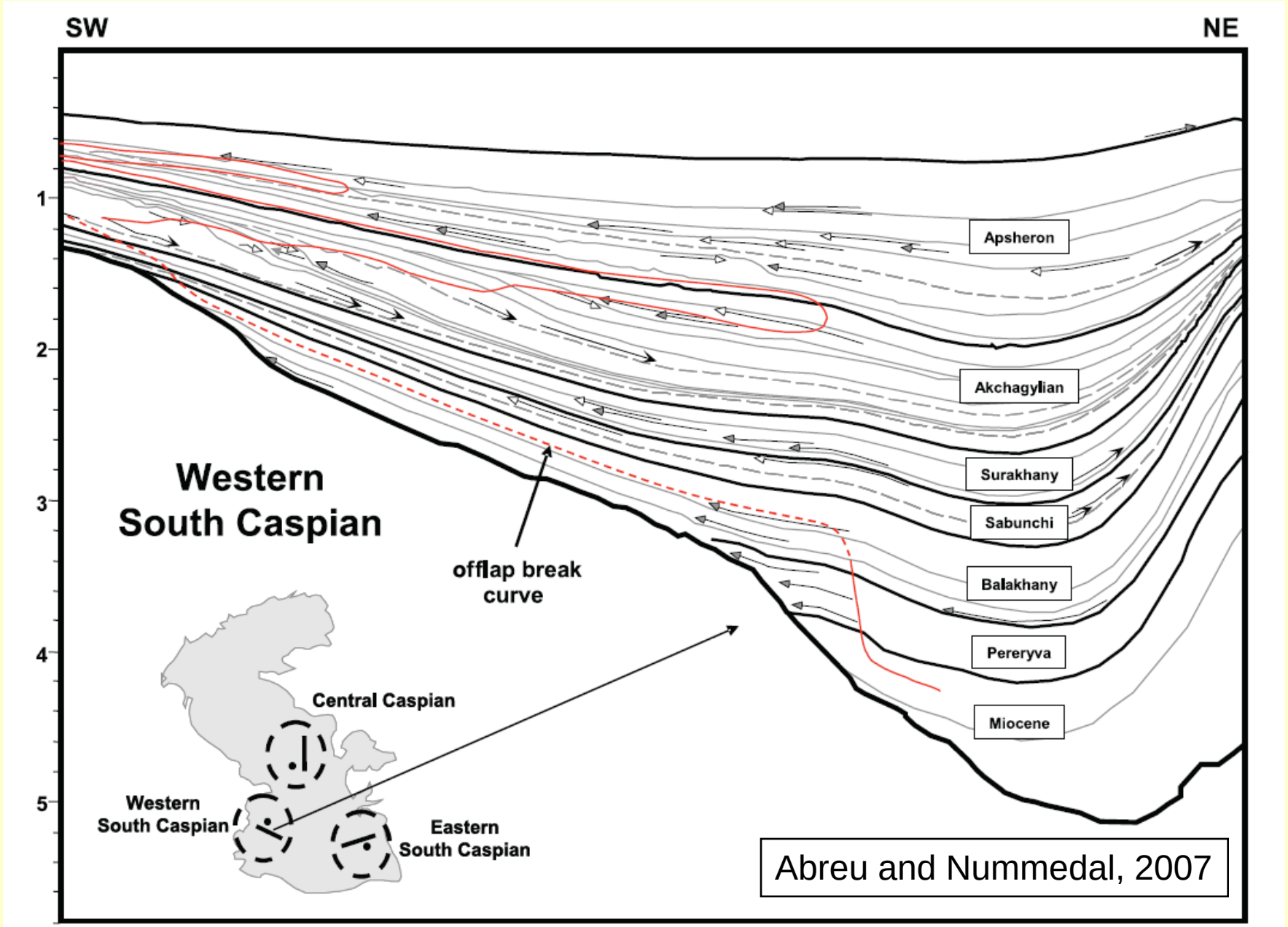
Caspian Sea



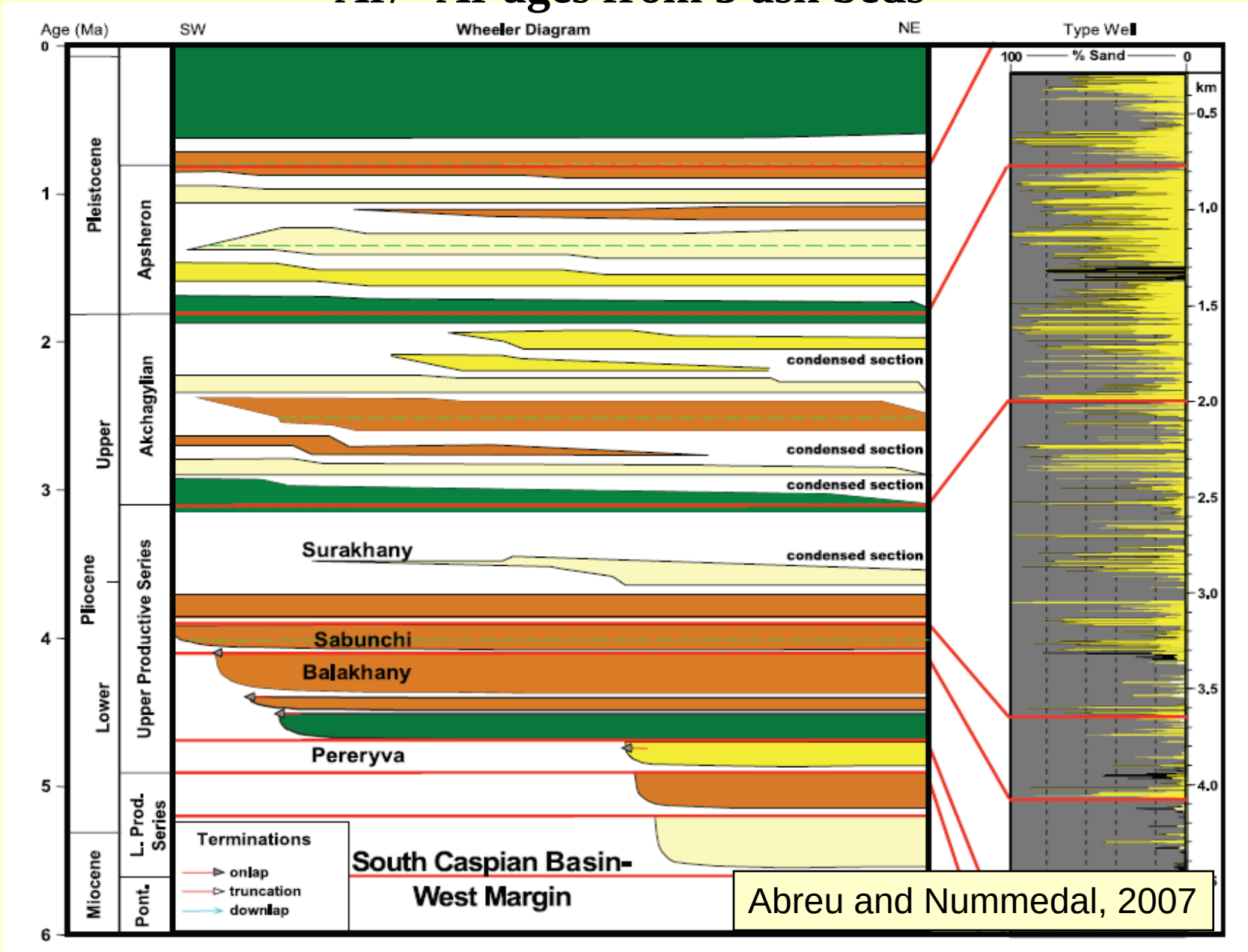
ConocoPhillips

Seismically Defined Sequences – in Depth



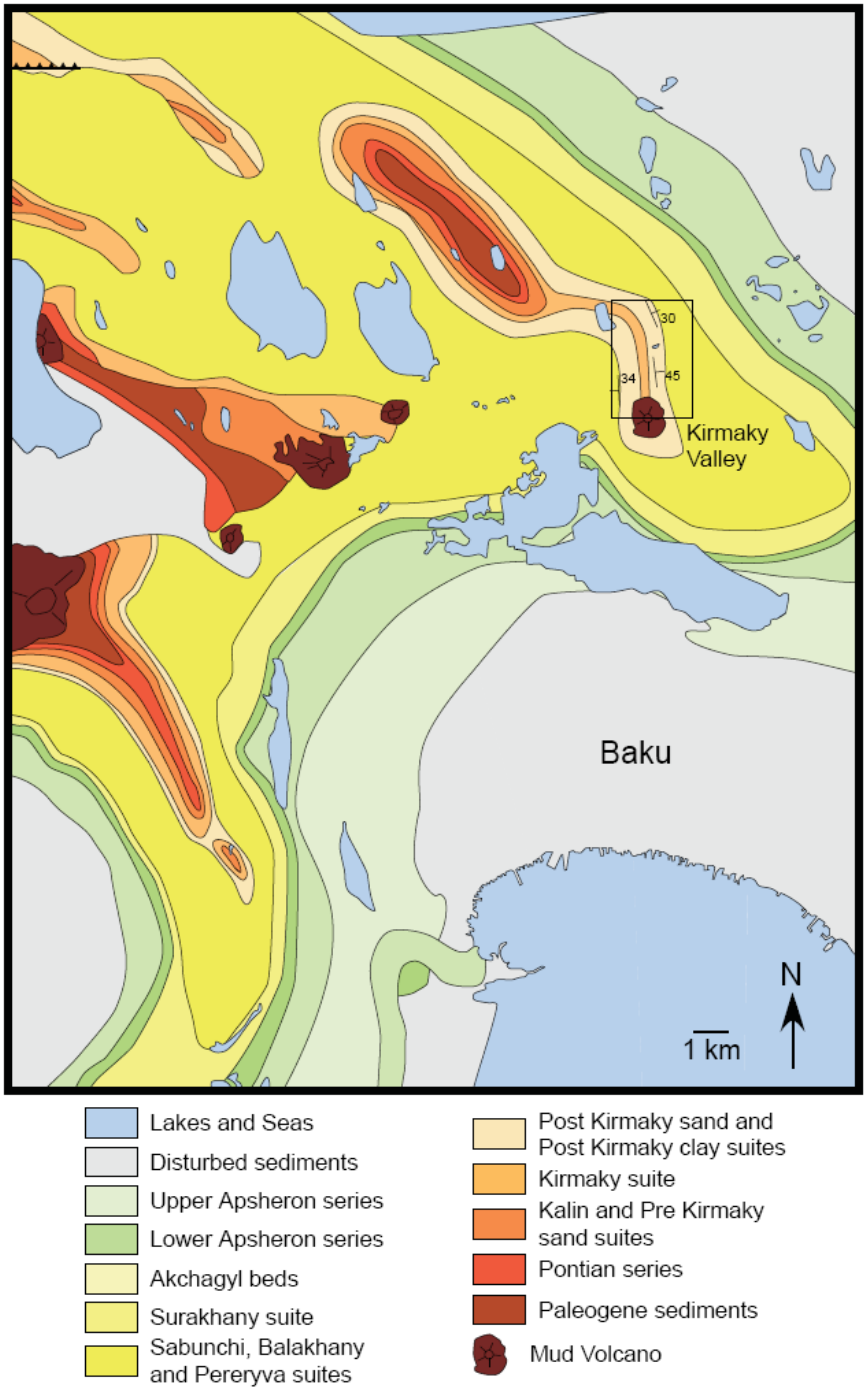
Seismically Defined Sequences – in Time

$^{40}Ar/^{39}Ar$ ages from 5 ash beds



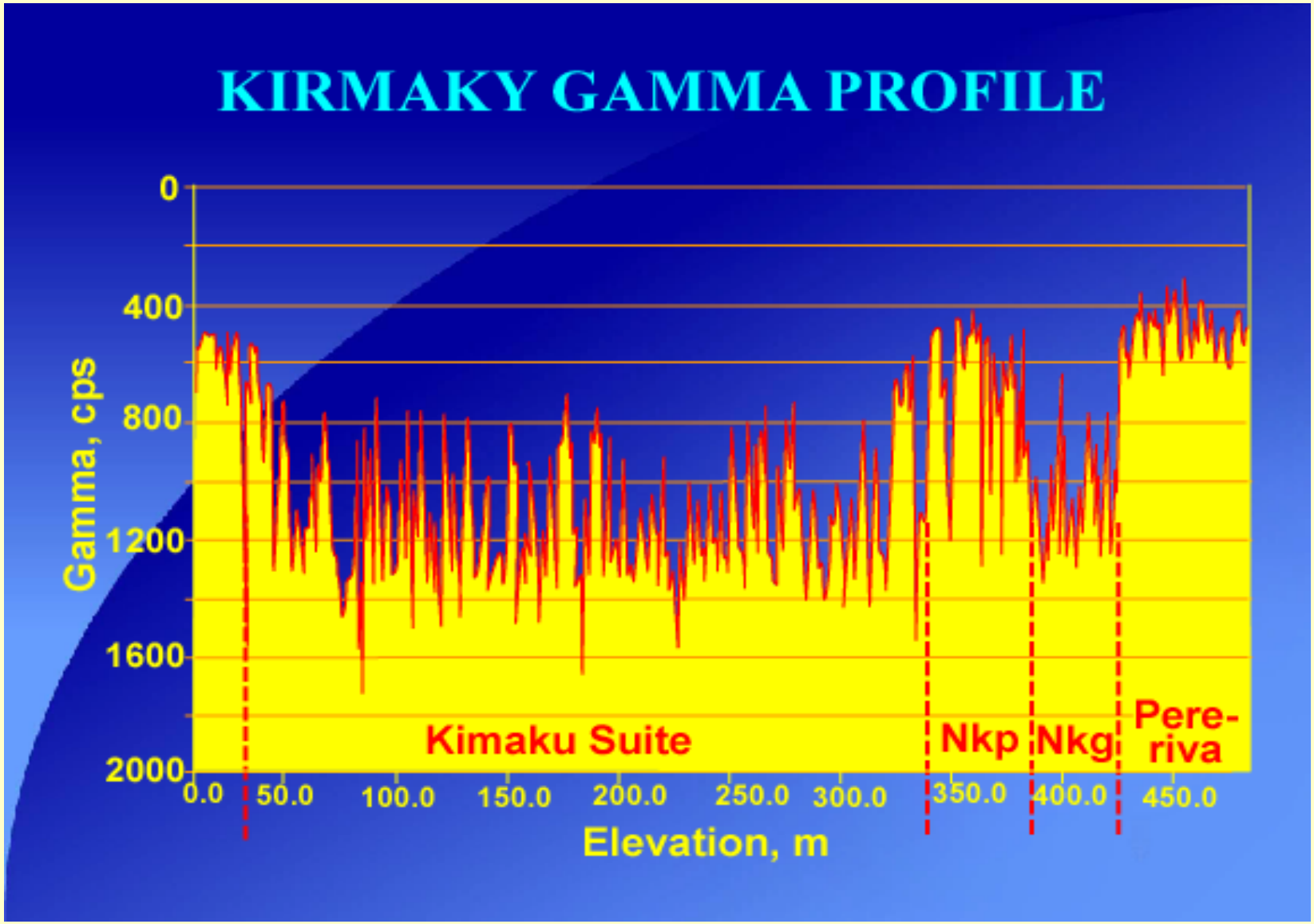
Geologic Map of the Surroundings of Baku

Note Kirmaky Valley

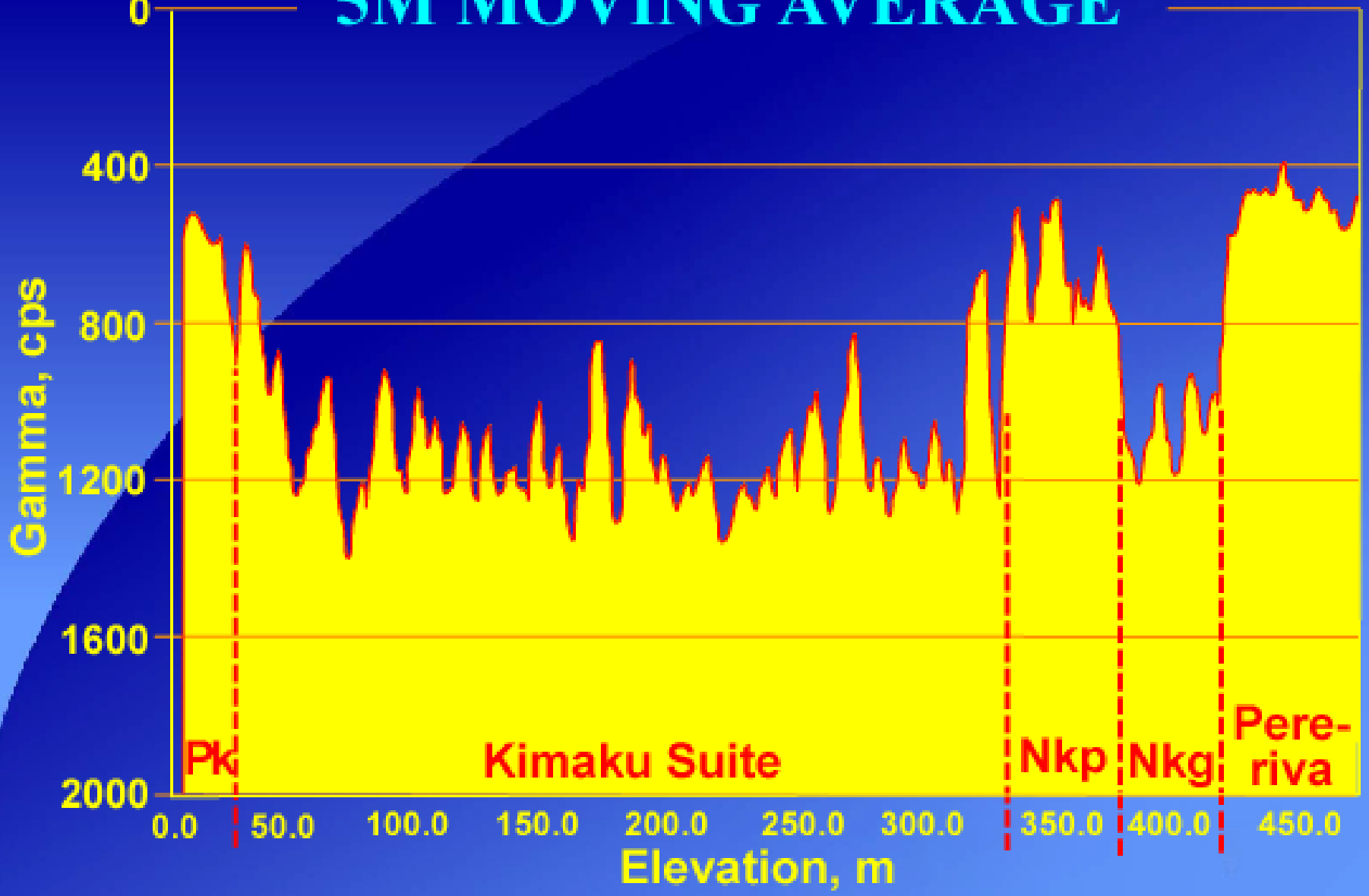


Kirmaky Valley

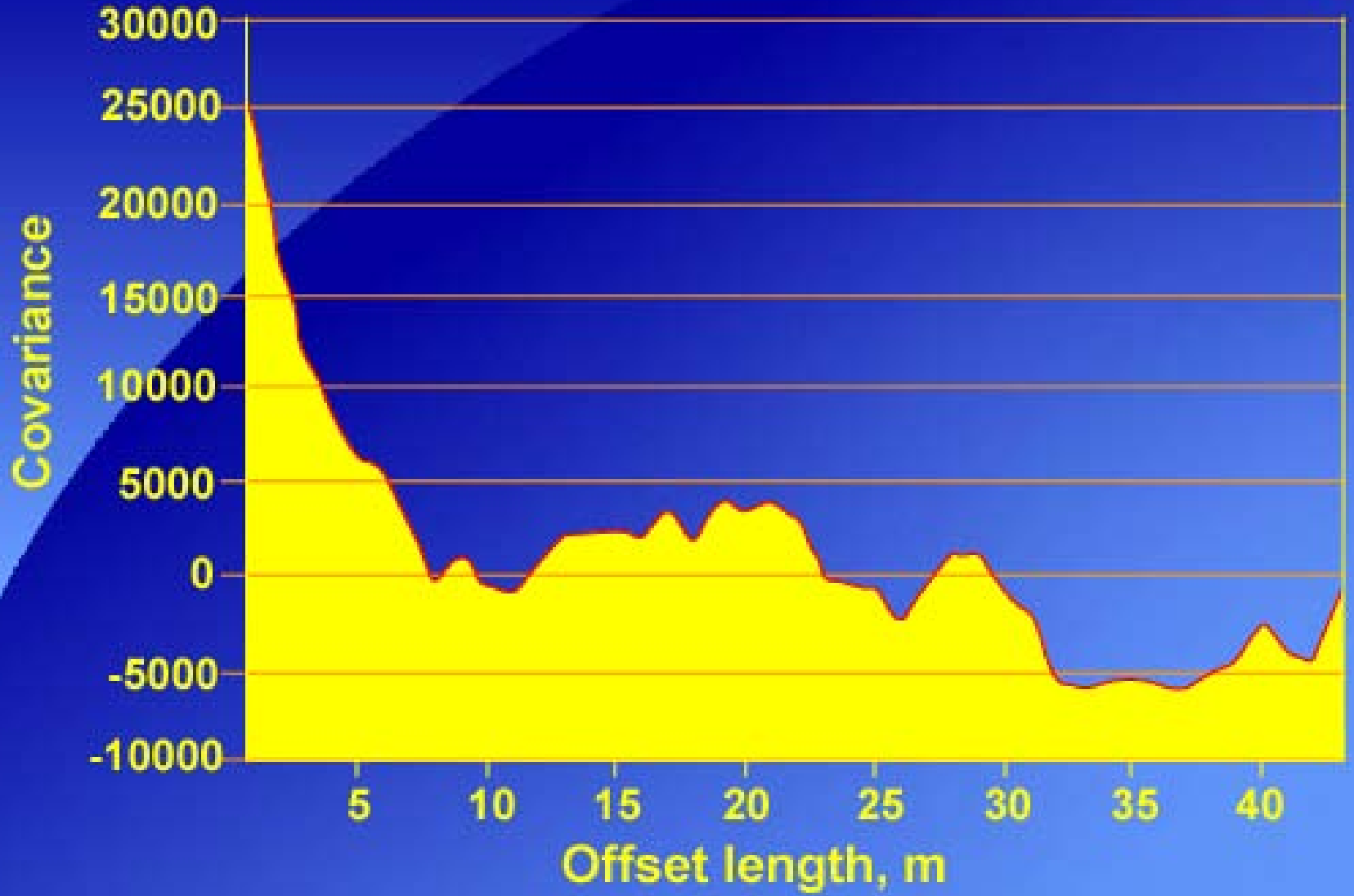
Outcrop Gamma Log at Kirmaky Valley



KIRMAKY VALLEY GAMMA LOG-5M MOVING AVERAGE



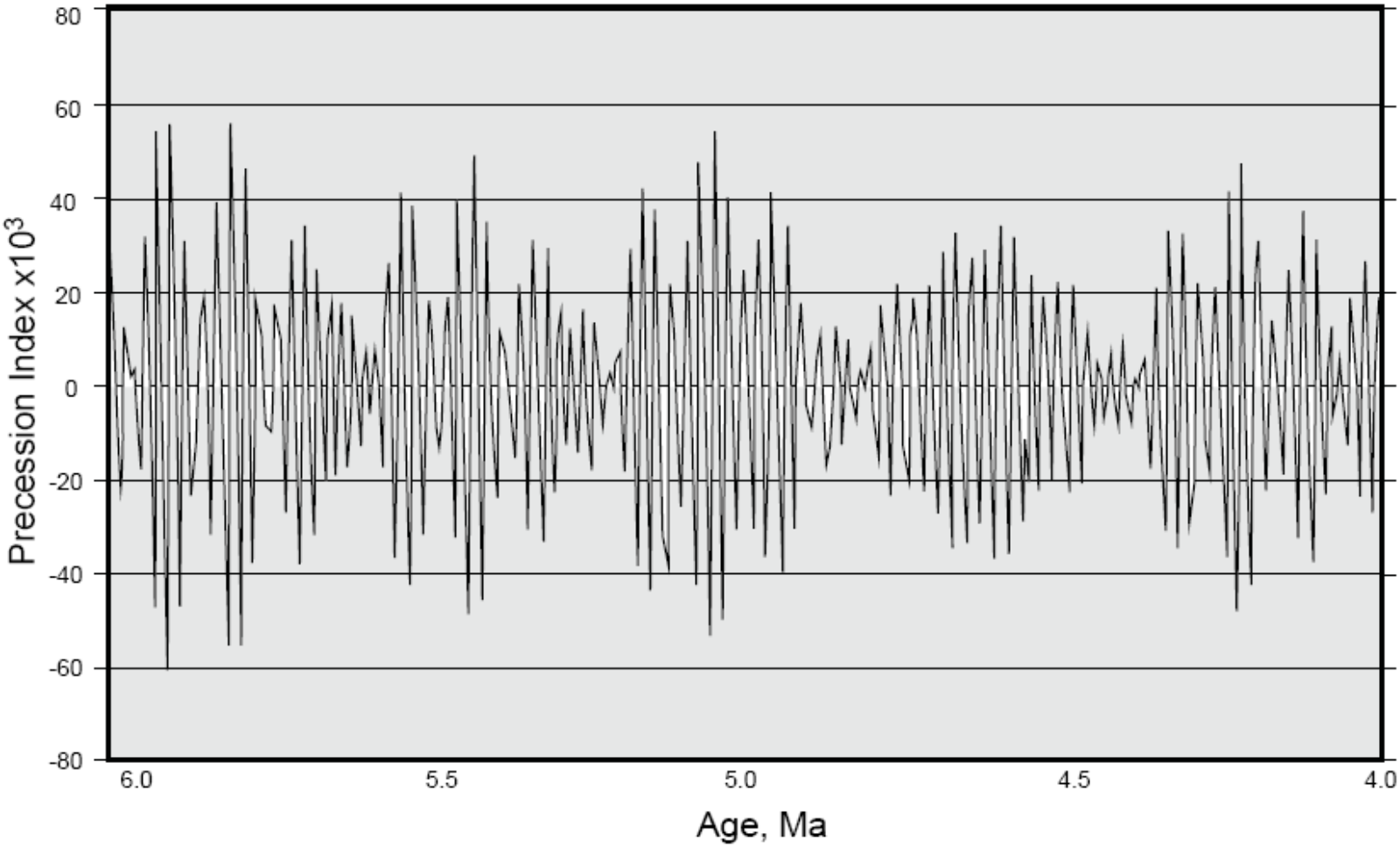
KIRMAKY VALLEY GAMMA LOG
KS COVARIANCE SPECTRUM



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			
MESSINIAN		Cardosphaeridium minimum Labyrinthodinium truncatum Systematophora placacantha	Kirmaku suite
	5.75-5.93 Ma 5.91 Ma 6.00 Ma 6.13 Ma 6.20 Ma		Pontian

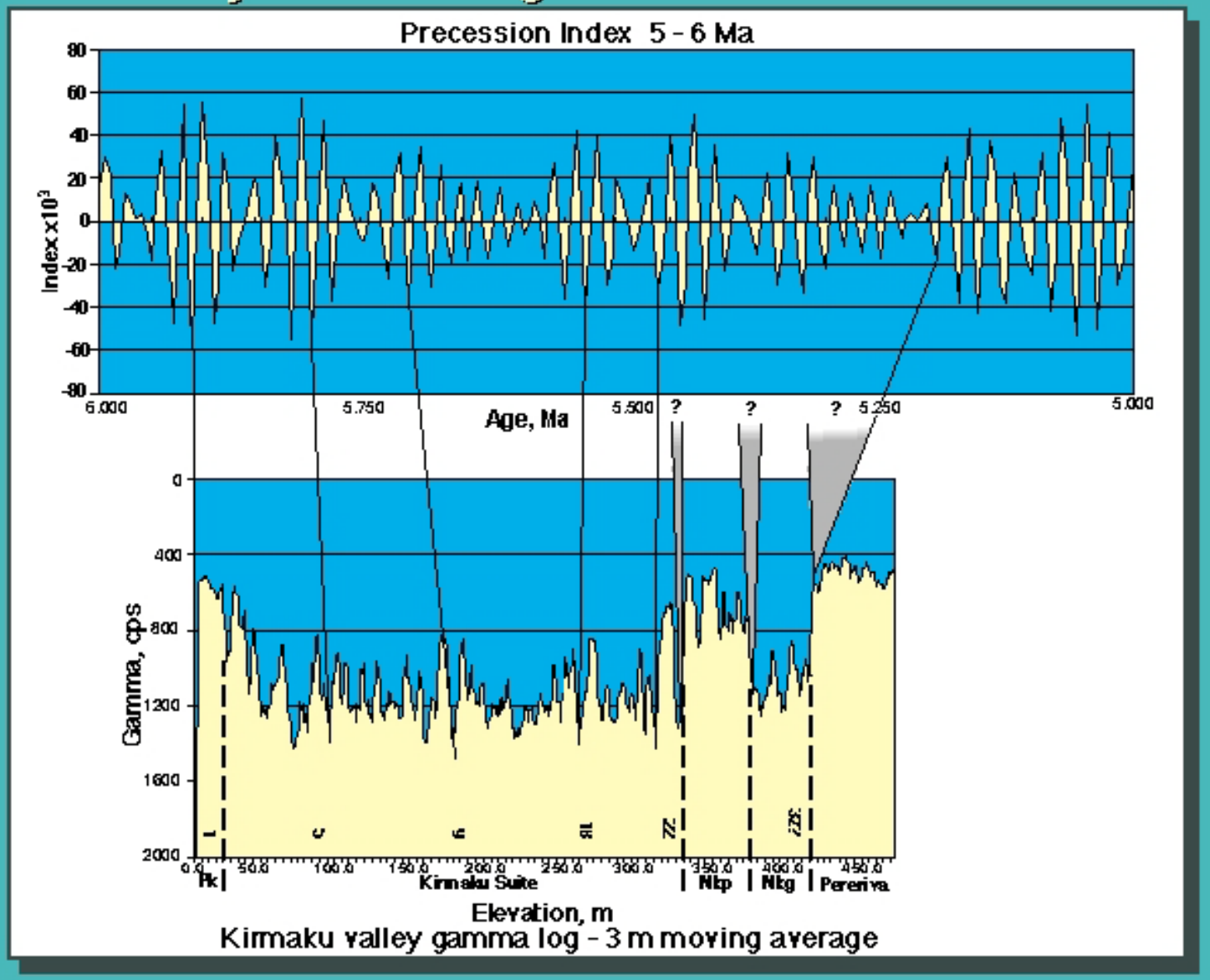
Insolation Index from 6 to 4 Ma



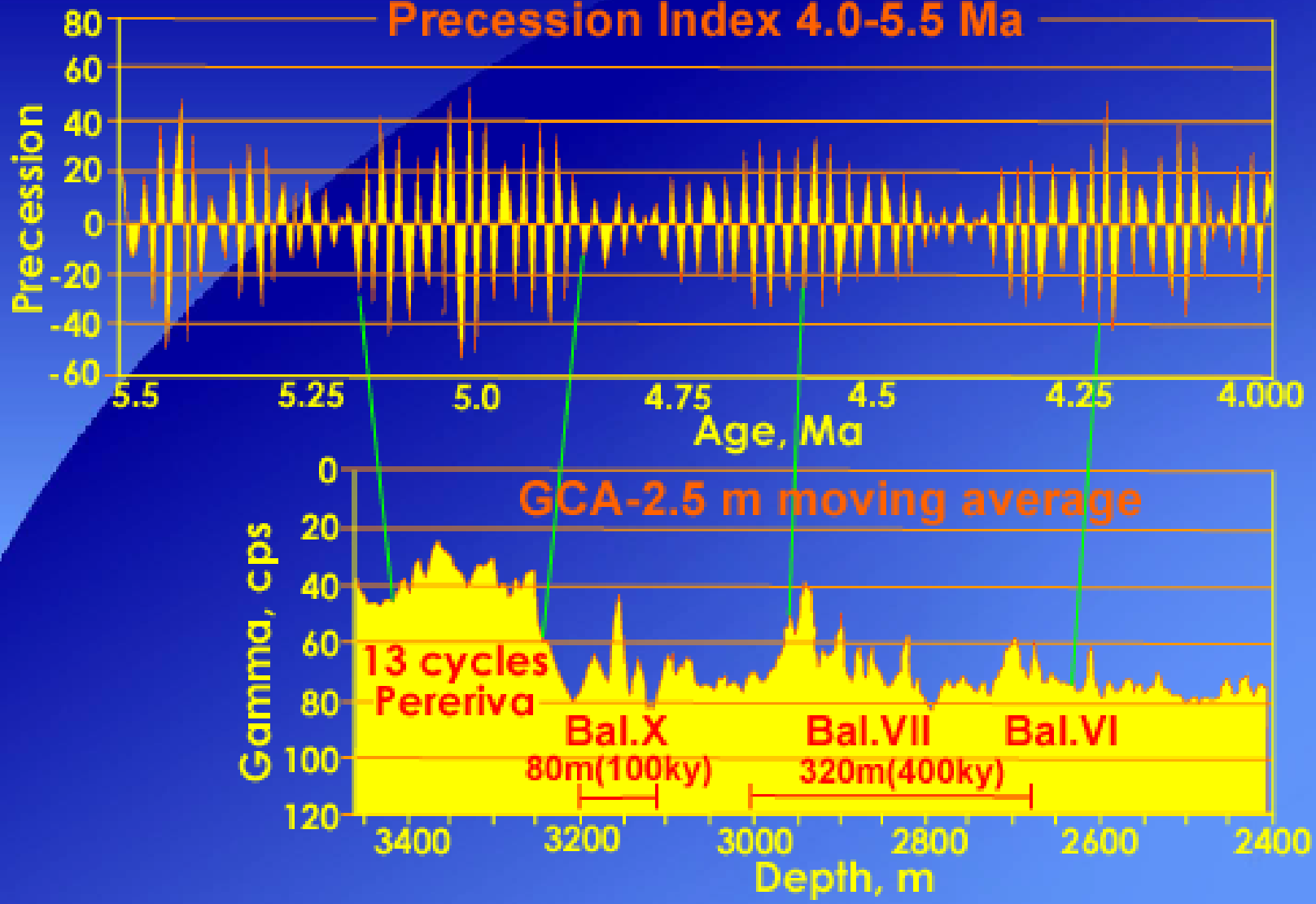
Berger and Loutre, 1992

Cycle Tuning, Kirmaky Suite

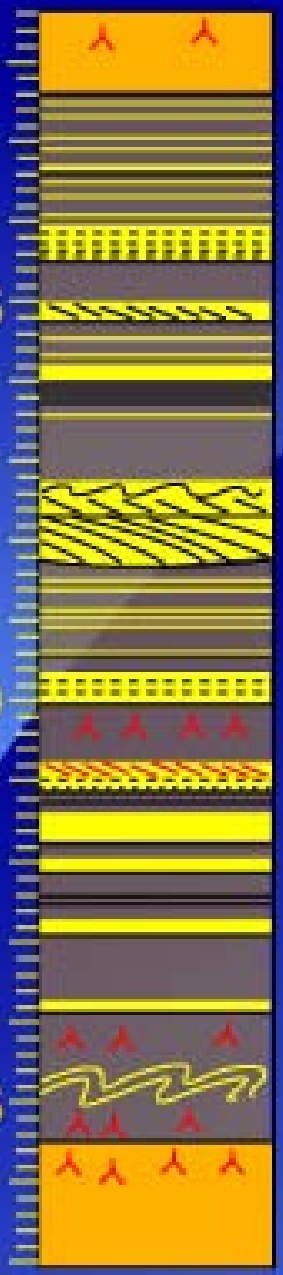
Kirmaku Valley Gamma Log correlated to Precession Index



BALAKHANY GAMMA LOG CORRELATED TO PRECESSION INDEX



Kirmaky Suite Outcrop



FINE-GRAINED INTERVAL KIRMAKY SUITE

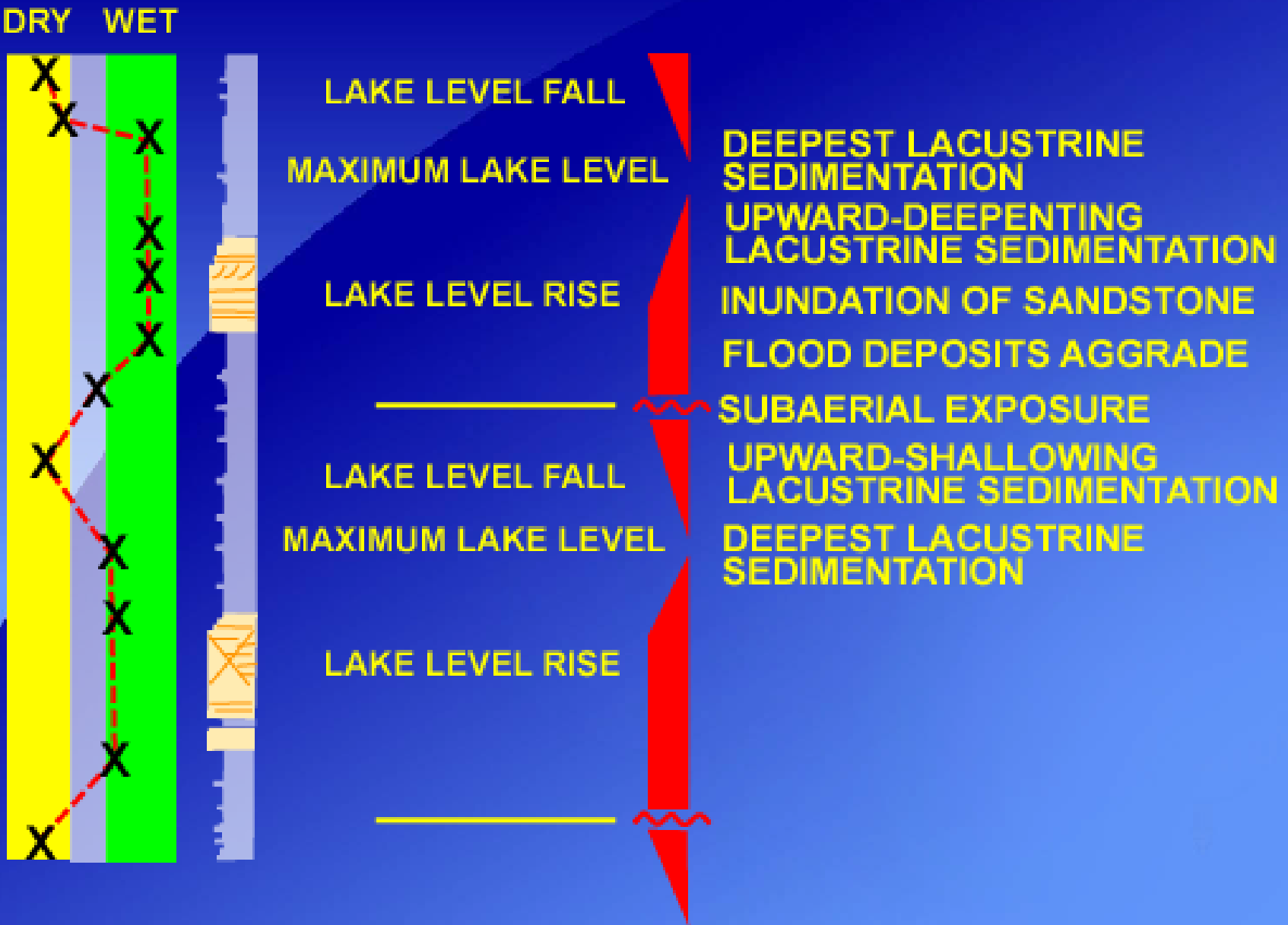
VERY FINE SAND

MUD

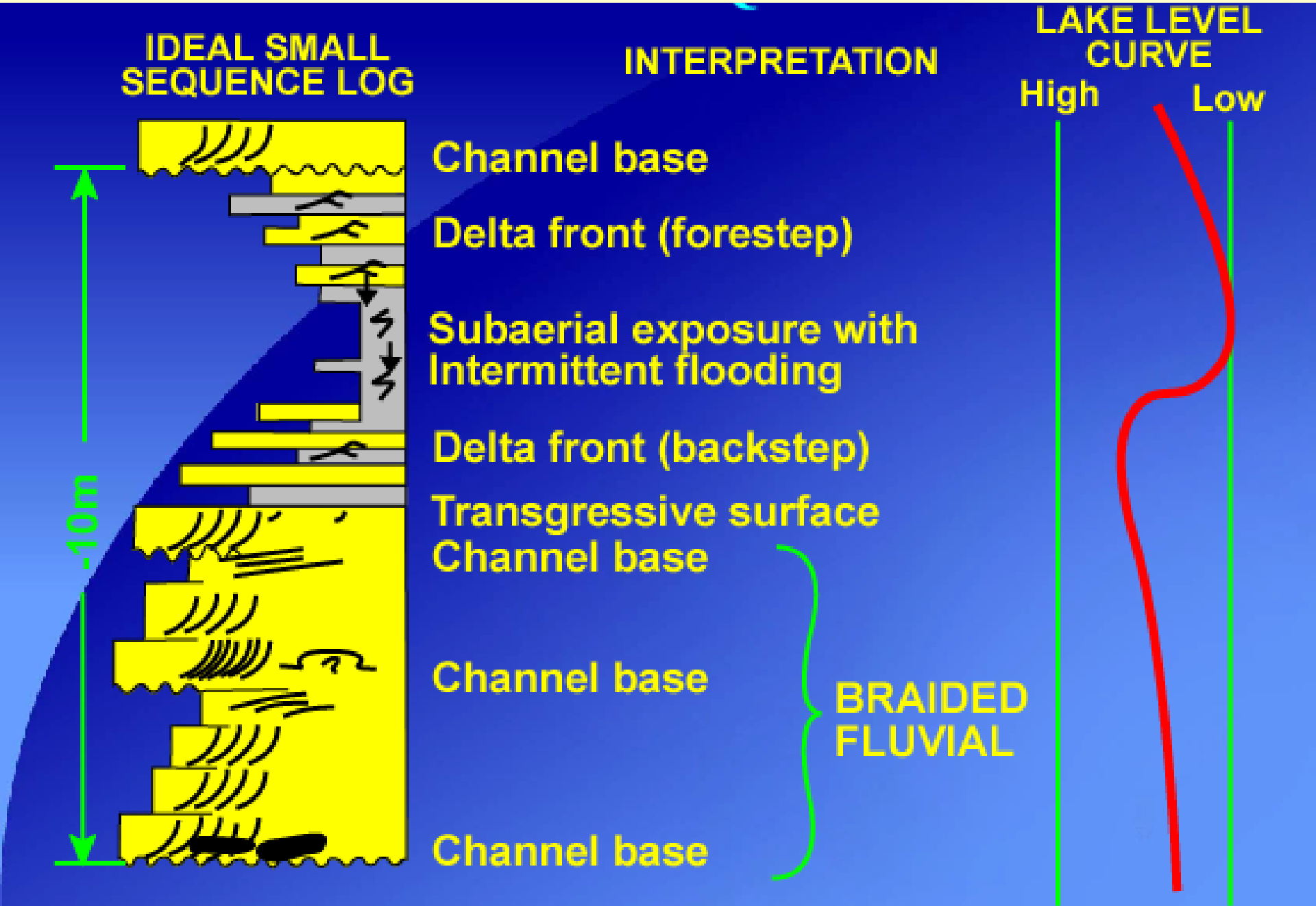
RIZOLITHS

Cemented Rhizomes in Kirmaky Suite

HIGH-FREQUENCY CLIMATIC/ SEDIMENTOLOGIC CYCLE, KIRMAKY SUITE

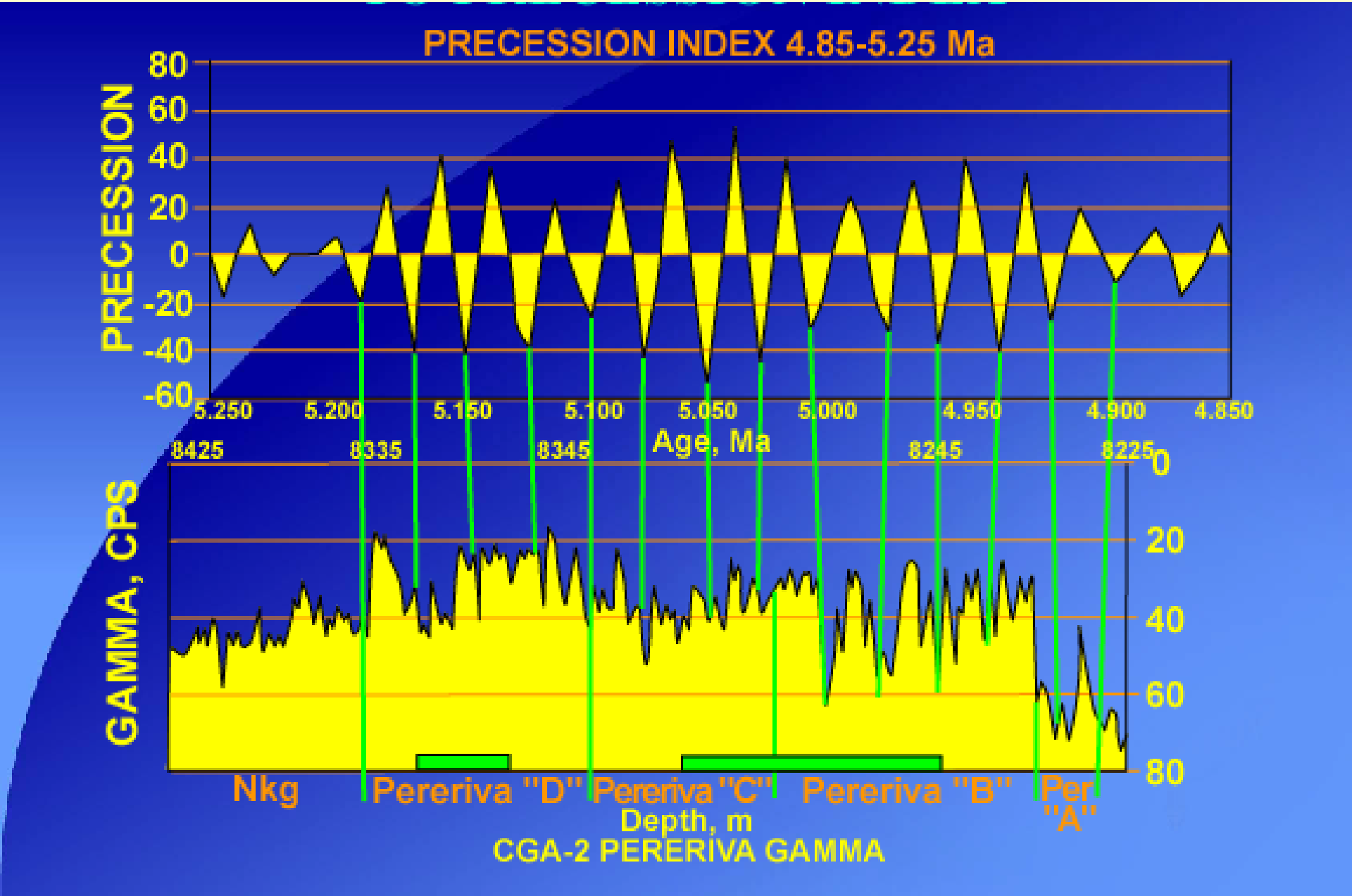


Lake Level Cycles – Pereriva Suite



Sequence Boundary in the Pereriva Suite

The Many Pereriva Sequences



Conclusions

The latest Miocene and Pliocene clastic succession in the SW Caspian Sea contains a nearly complete record of 20 ky to 400 ky Milankovitch climate cycles

Sediments, erosion surfaces, pollen, and ostracods all reflect these repeated cycles of climate and water depth

The 20 ky sequence boundaries are expressed as exposure surfaces in mudstones (Kirmaky Suite), and lags of lake-derived mudstone clasts with sandstones (Pereriva Suite)

The palynomorphs indicate that the climate was humid during deposition of the mostly sandy lowstand and transgressive systems tracts. HST and FSST are muddy, thin and formed during dry climate phases

Acknowledgments

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References

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