

Tale of three rivers – How Large Parts of Northern Eurasia Ended Up in the Caspian and what does it mean for climate

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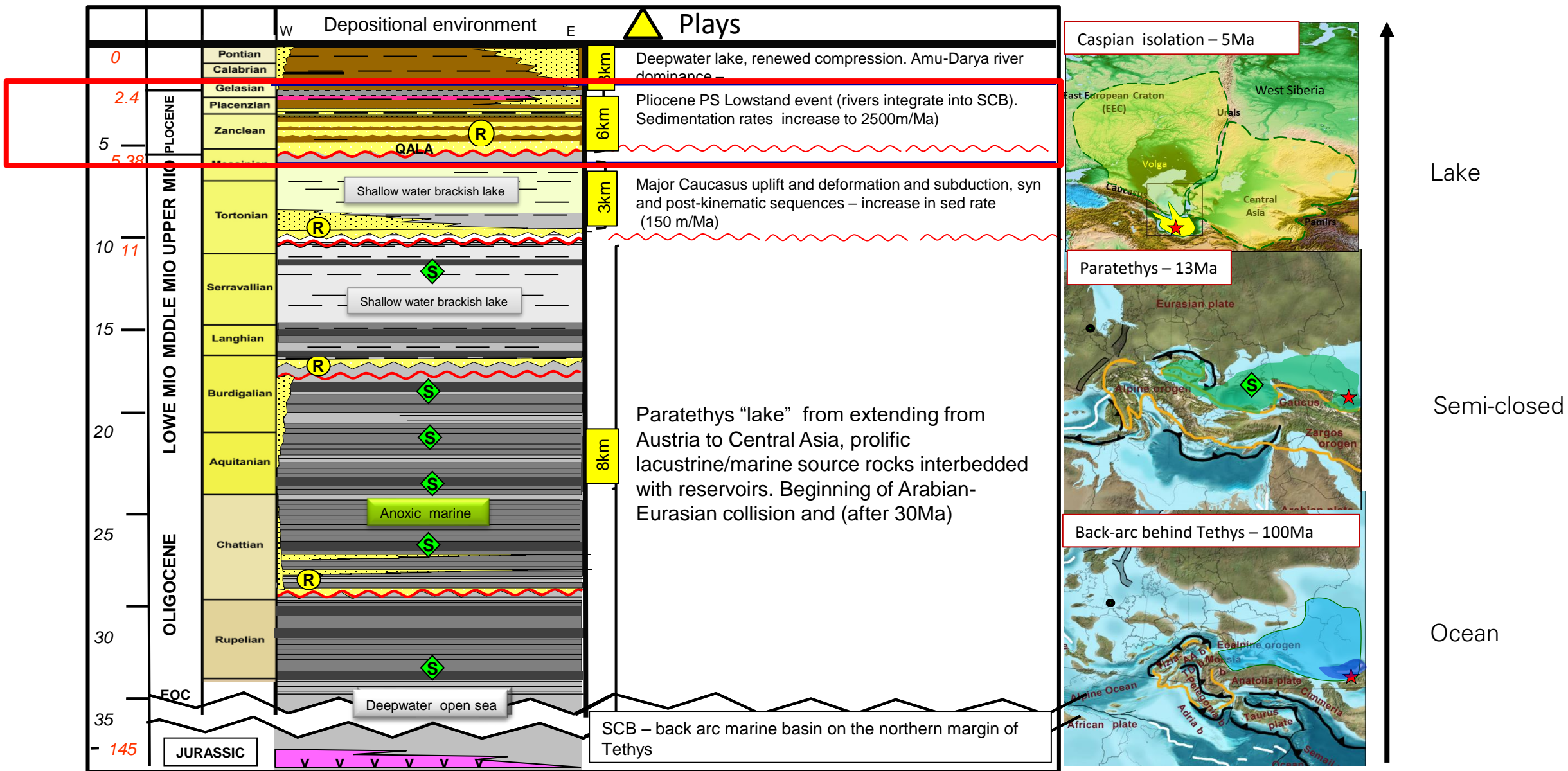
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Summary

- South Caspian Basin (SCB) is a unique and dynamic petroleum system compared to other basins largely because of depositional history and Incredibly high rates. South Caspian is a “super-basin” – and superbasins clastics reservoirs always need “**big**” rivers
- A number of river systems delivered sediments into the South Caspian Basin during Pliocene. Three comparable river systems delivered sediments into the South Caspian Basin during Pliocene – for simplicity called Paleo-Volga, Paleo-Amu-Darya and Paleo-Kura.
 - Paleo-Volga or Northern system integrated drainage from Russian Platform, Urals and Greater Caucasus
 - Paleo-Amudarya or Eastern System – integrates drainage from Central Asia, Pamirs and possibly Western Siberia
 - Paleo-Kura or Western System – integrates drainage from Lesser Caucasus, Greater Caucasus and Talysh. Elborz system is “subset” of that
- Paleo-Amudarya dominates sediment input into the South Caspian Basin with over half of total volume. Seismic evidence for this comes from integrating seismic mapping with new well findings.
- The Pliocene age Productive Series, represents significant increase in sedimentary volume after a base level fall in Early Pliocene. This increase occurred during a relatively short period of time between 3.6 Myr and 2.71 Myr, especially increasing in Upper Productive Series where the sedimentation rates reached 9km/yr in some periods

Caspian Tectonostratigraphy – Long History of Basin Isolation

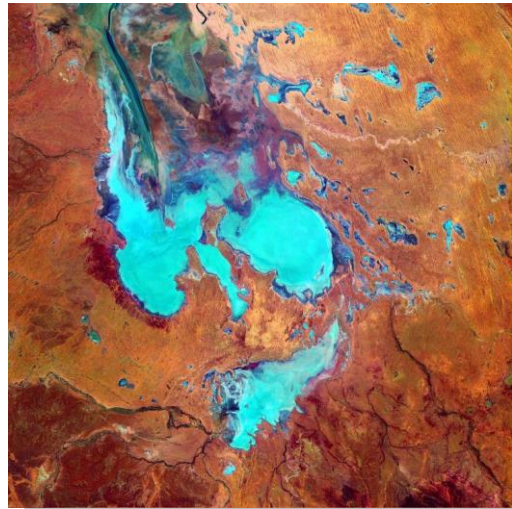
"I was once an ocean – I became a lake"



What are sediments of Pliocene Productive Series?

"Lakes are not small oceans"

Lake Eyre analogue



- Climate change is key

Implications

- Climate driven sedimentary cycles mostly not related to global sea level.
- Climate changes rapidly
- Endemic fauna or none at all.
- Stacked and regionally continuous fluviodeltaic reservoirs and lacustrine mudstones
- Dramatic fluctuations in base level.
- Shallow water — laterally extensive facies belts

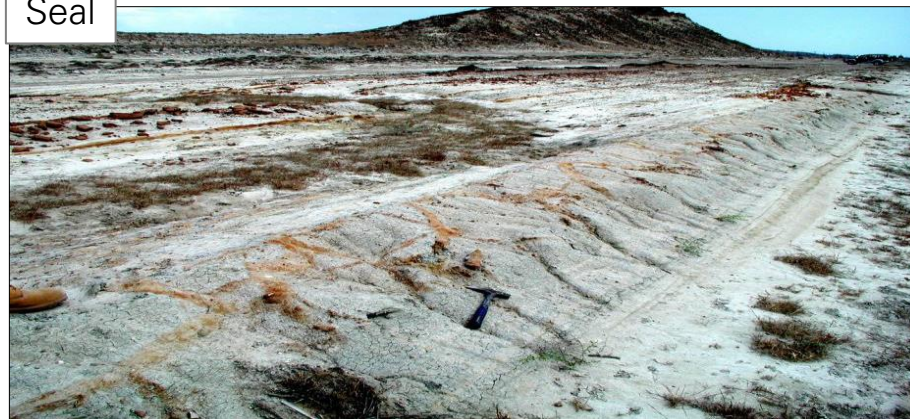
Source Upper Maykop



Reservoir



Seal



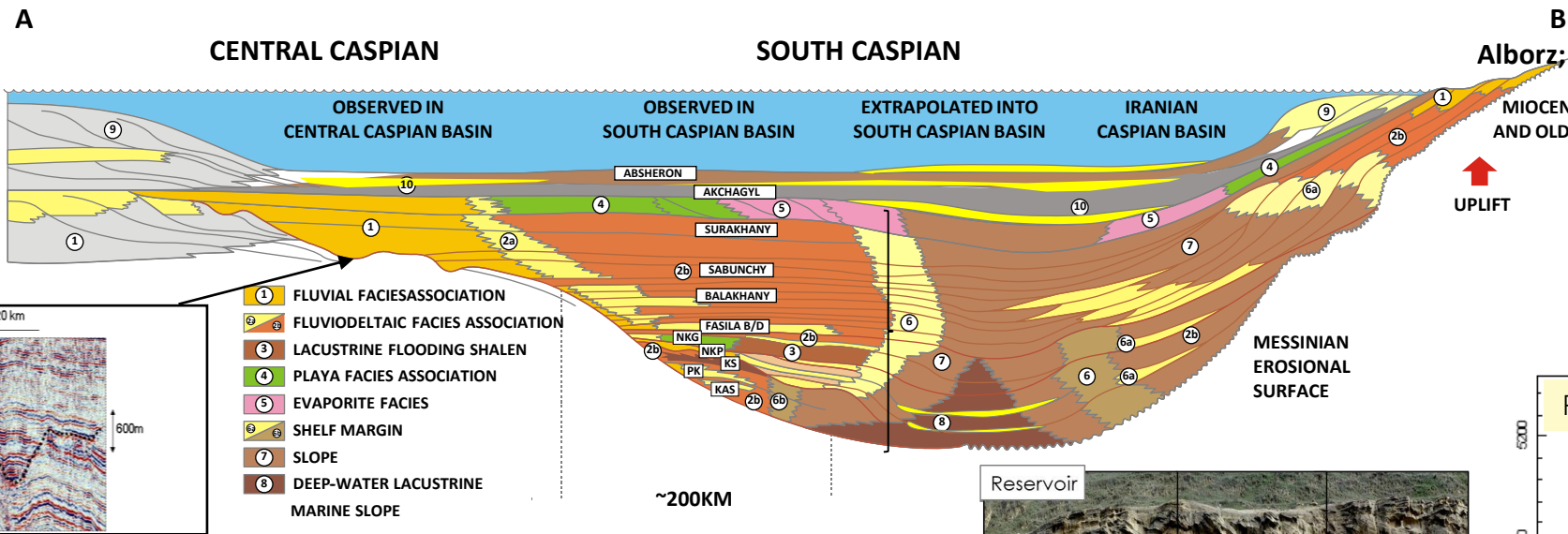
7000 km coastline
386,400 km² Area
Volga drainage basin
1,400,000 km²
78700 km³ Water Volume



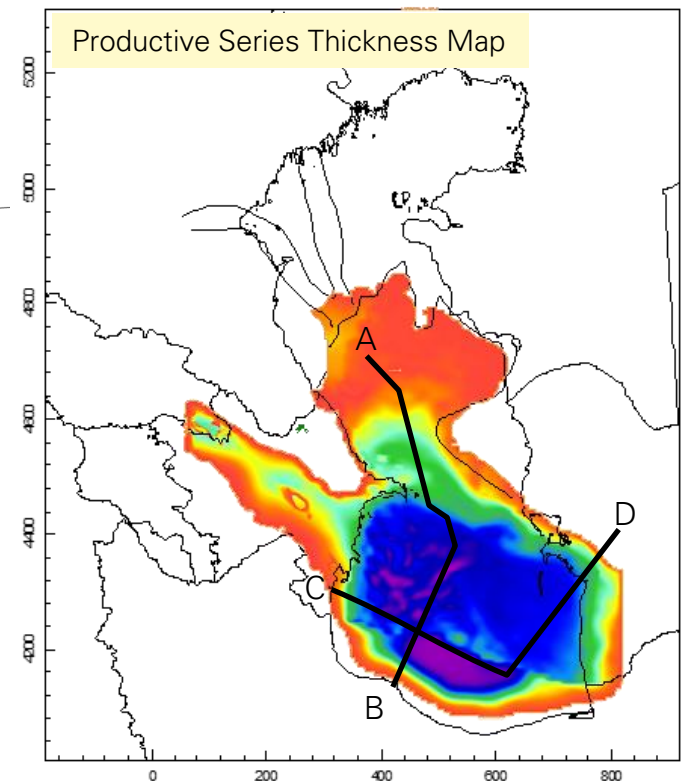
Unusual reservoir system of the South Caspian Basin

"Tale of three rivers" – Pliocene Productive Series, and Red Series and Kura

Modified from Abdullayev et al, 2012 by Tari G and Fallah M



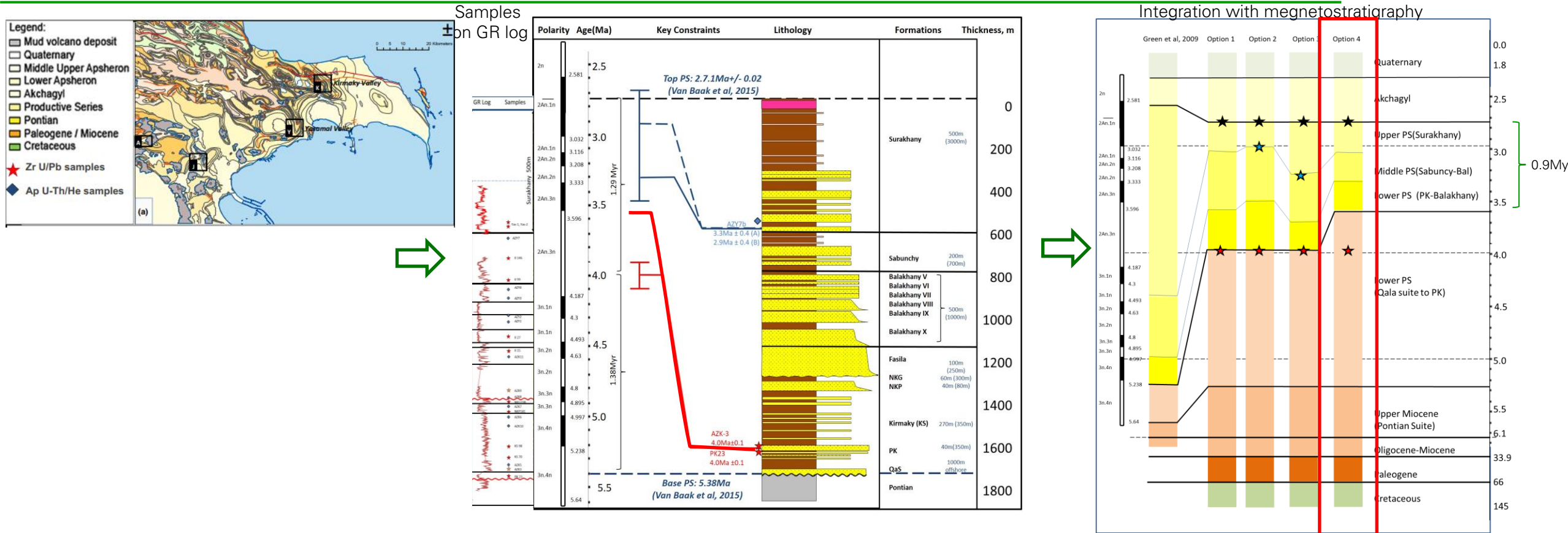
- Productive Series is interpreted as a lacustrine lowstand systems tract, deposited after the base-level fall at Pliocene/Miocene boundary
- Regionally extensive reservoirs and lacustrine shales in the Middle/Lower Productive Series
- Deposition of mostly lacustrine shales in the Upper Productive Series by Paleo-Volga and progradation of Paleo-Amudarya
- Amu-Darya **regresses** while Volga transgresses



Modified from Abdullayev et al, 2018

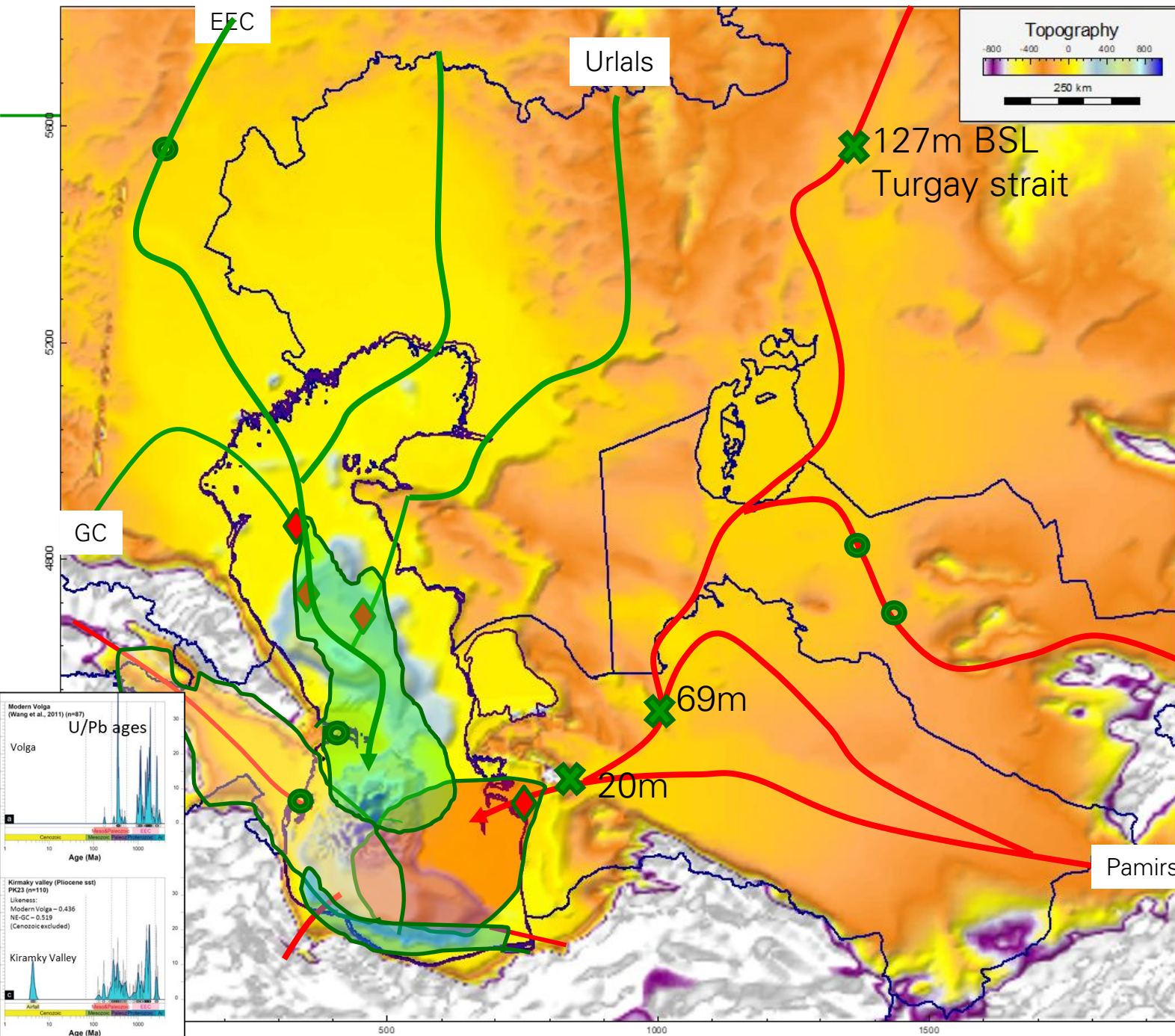
Constraining the ages and sedimentation rates for Productive Series

It was much faster than I realized at the time



- Age constraints from U/Pb and apatite (U-Th-Sm)/He for the Lower Productive Series gave much faster sedimentation rates than previously estimated – 4.0Mya for base of PK.
- **1.3 km/Myr** in the South Caspian Basin margin outcrops and up to **3.9 km/Myr** in the basin center. Integrating magnetostratigraphic timescale from Hligen et al, (2012) with thermochronology may assume that PK is younger than age of 4.0Ma and would start at 3.6km Myr!! This will make its sedimentation rates to be faster. Maybe even up to 5km /mln years
- The sedimentation rates are one of the highest in comparison to other sedimentary basins and coeval to global increase in sedimentation rates 2–4 Myr (Molnar, 2004)

Regional drainage patterns into Caspian

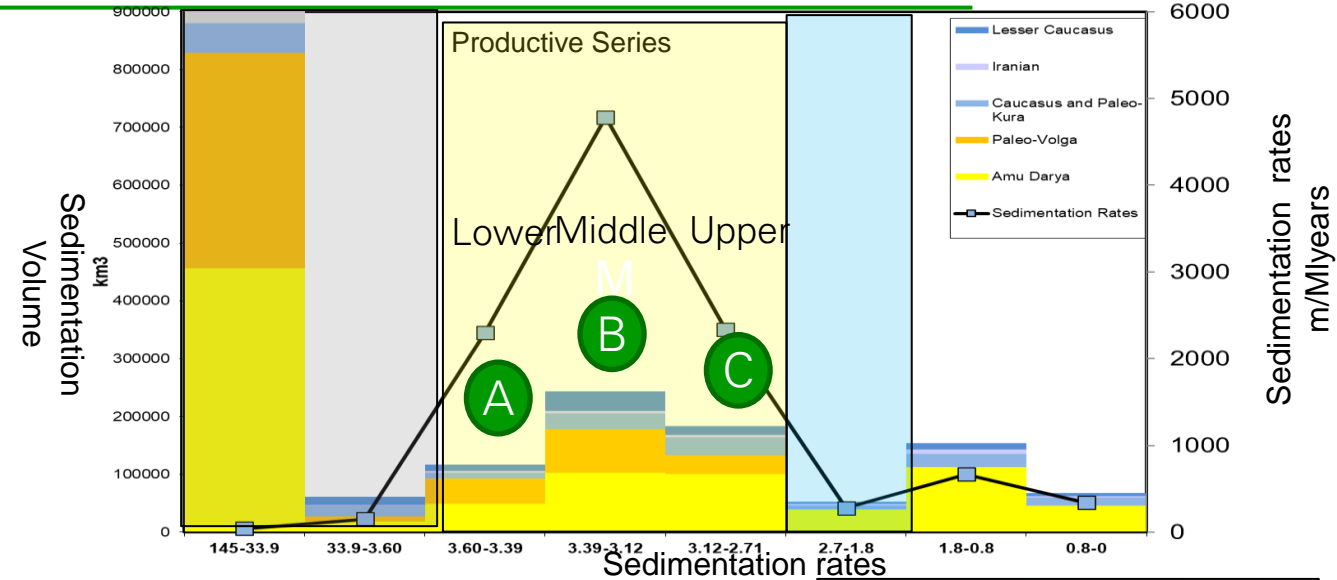
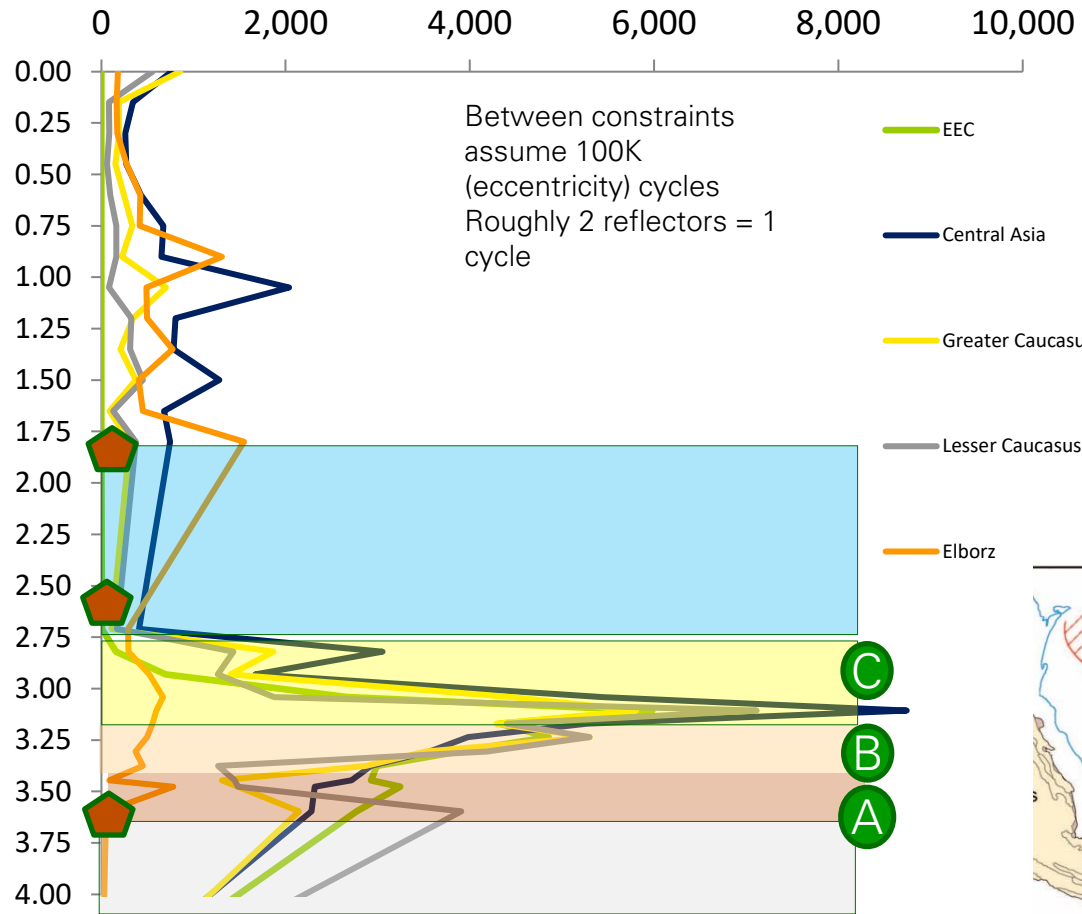


- Large Runoffs
- Large Hinterland coverage
- Large sediment volume
- **Three River Systems**
 - Paleo-Volga (Northern)
 - East European Platform
 - Urals
 - Mangyshlak
 - Greater Caucasus (N.Flank)
 - Paleo-Amudarya (Eastern)
 - Pamirs
 - Central Asia/Aral
 - West Siberia
 - Paleo-Kura (Western)
 - Lesser Caucasus
 - Greater Caucasus
 - Elborz (South)

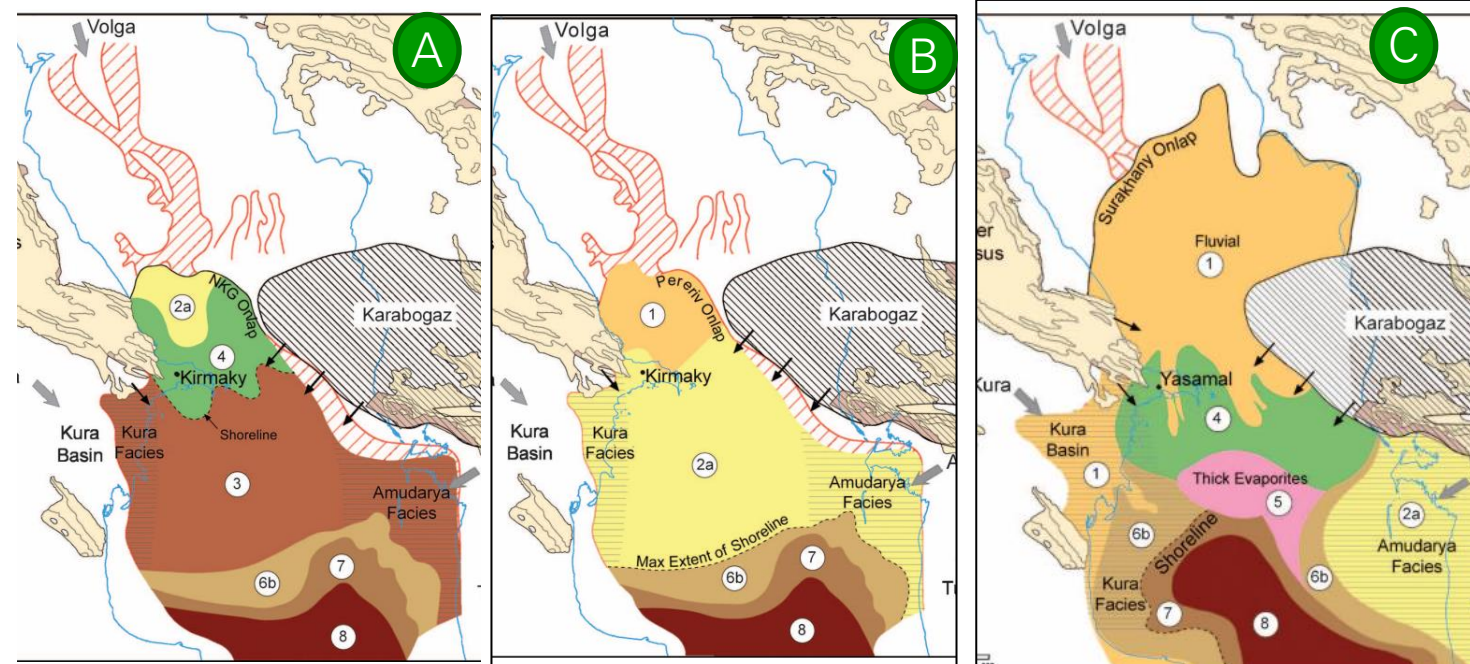
- ◆ Incisions served on seismic
- ✕ Key sediment entry points
- analyses

Sediment volumes and sedimentation rates in Lower, Middle and Upper Productive (Red) Series - much variation (probably climatically driven)

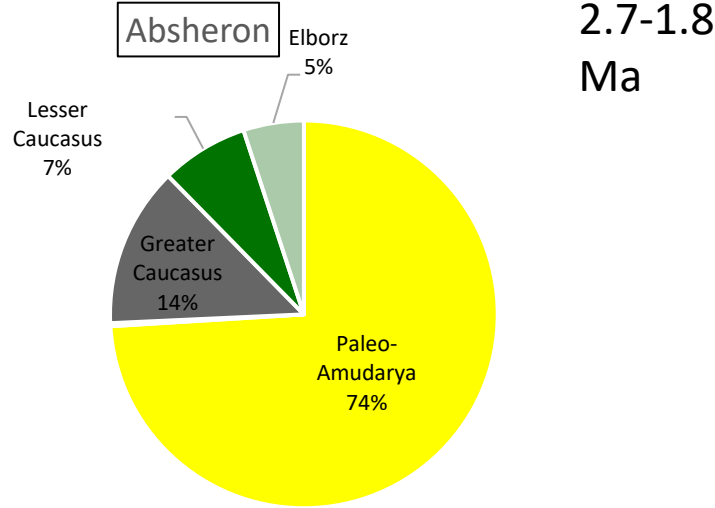
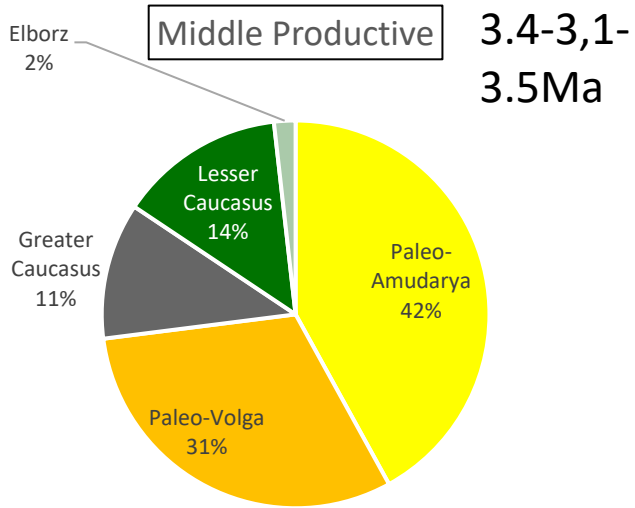
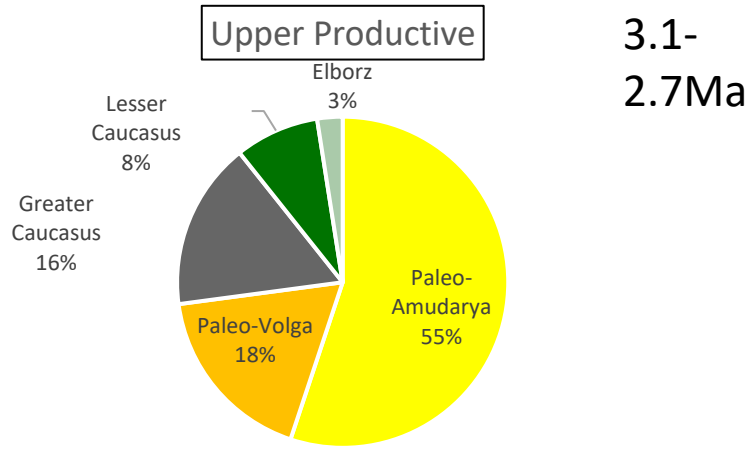
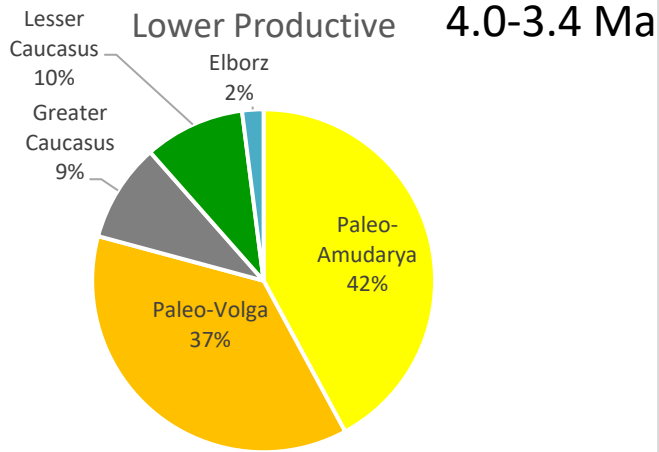
Averaged Accumulation rates and Net Rock Volumes for SCB(km³) Modified from Abdullayev et al, 2012, 2018



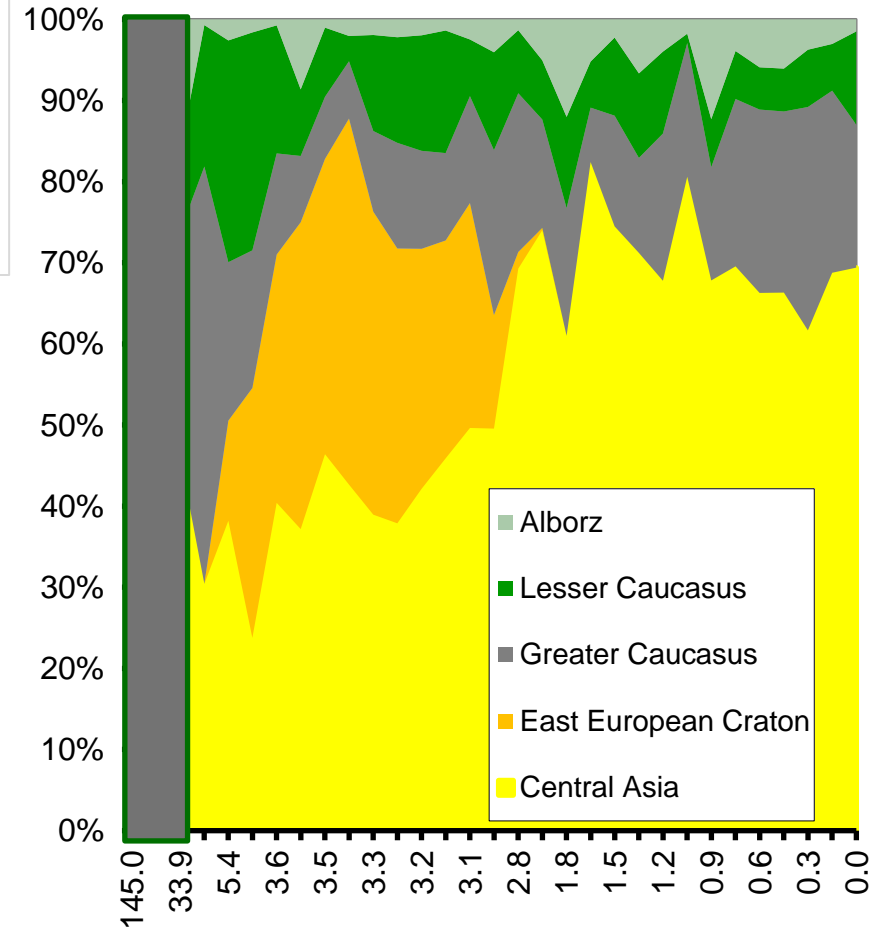
- More than 1.6 million cubic meters of net rock volume (mass) of which 492 thousand km³ was in Pliocene and 282 thousand km³ in Quaternary.
- Sedimentation rates reach 500M/Ma or for some intervals in Upper PS (Surakhany) from Paleo-Amudarya >9000m/Ma- similar to Bengal Fan and Amazon fan



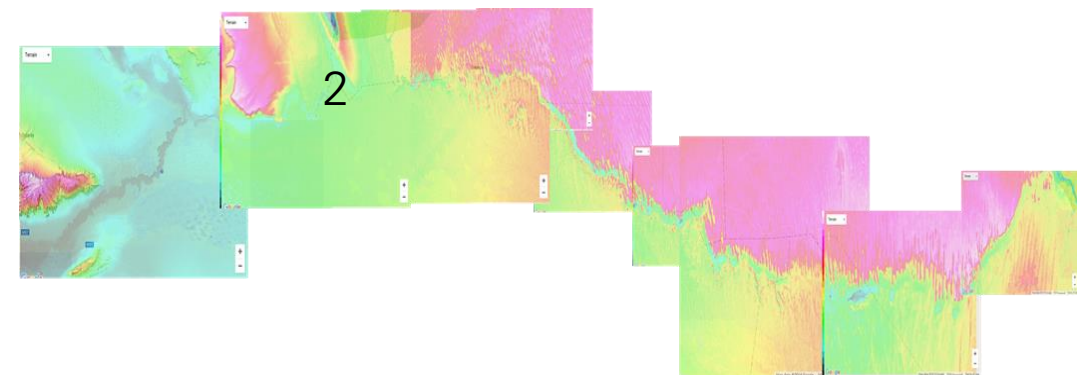
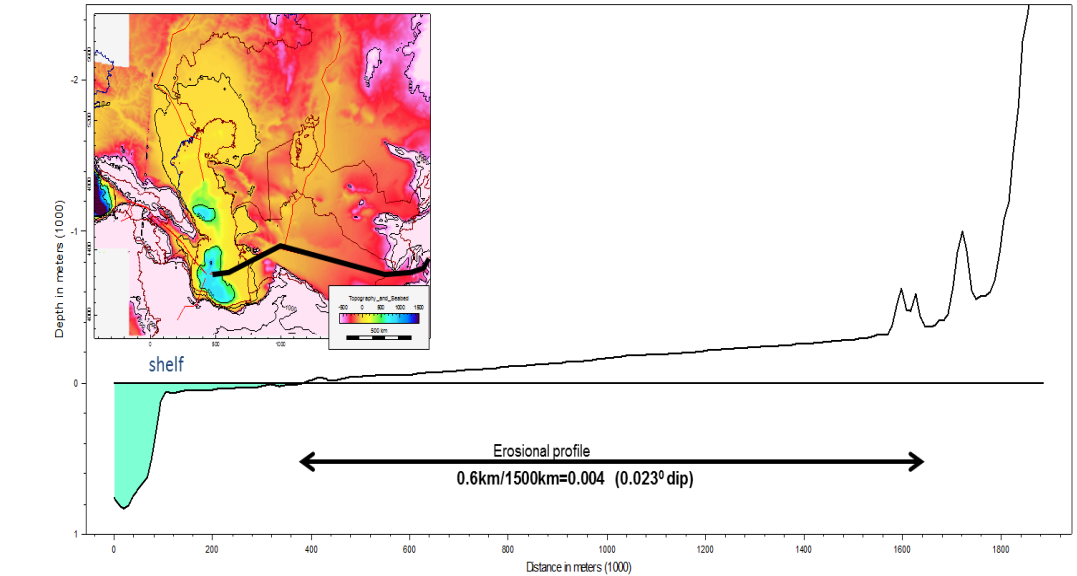
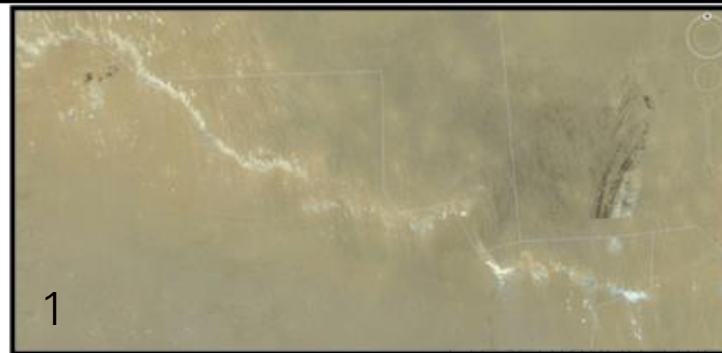
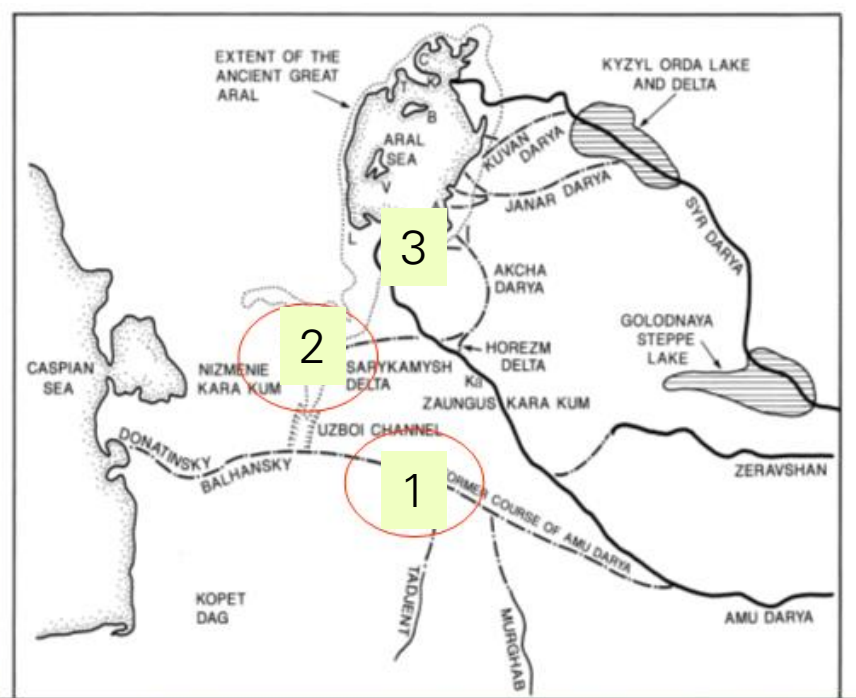
Evolution of sediment input systems in the Caspian Sea



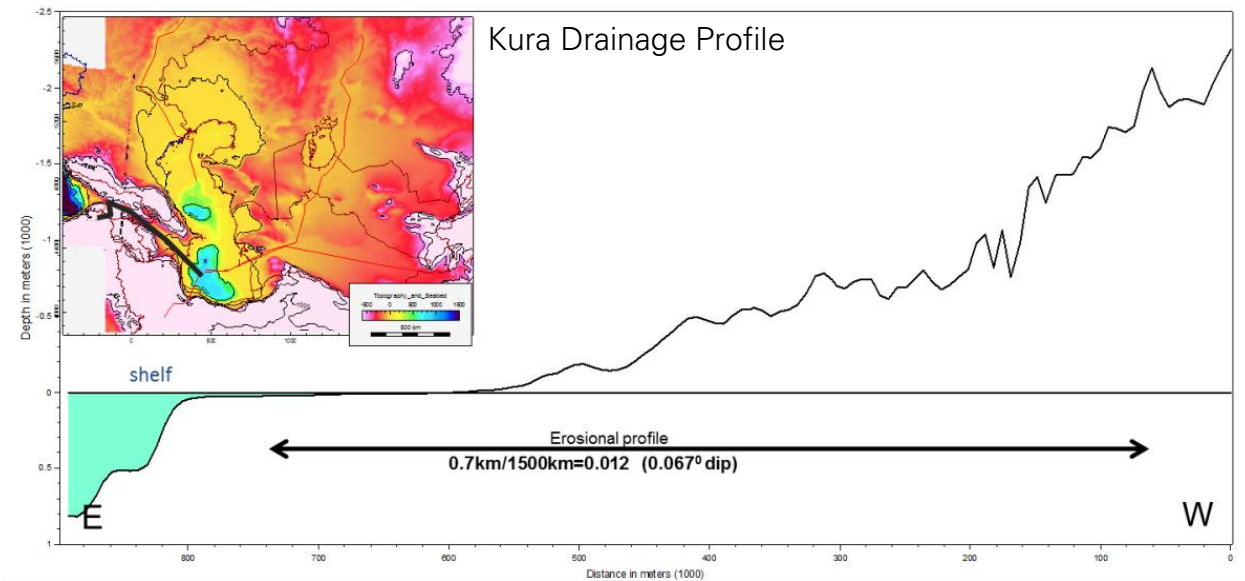
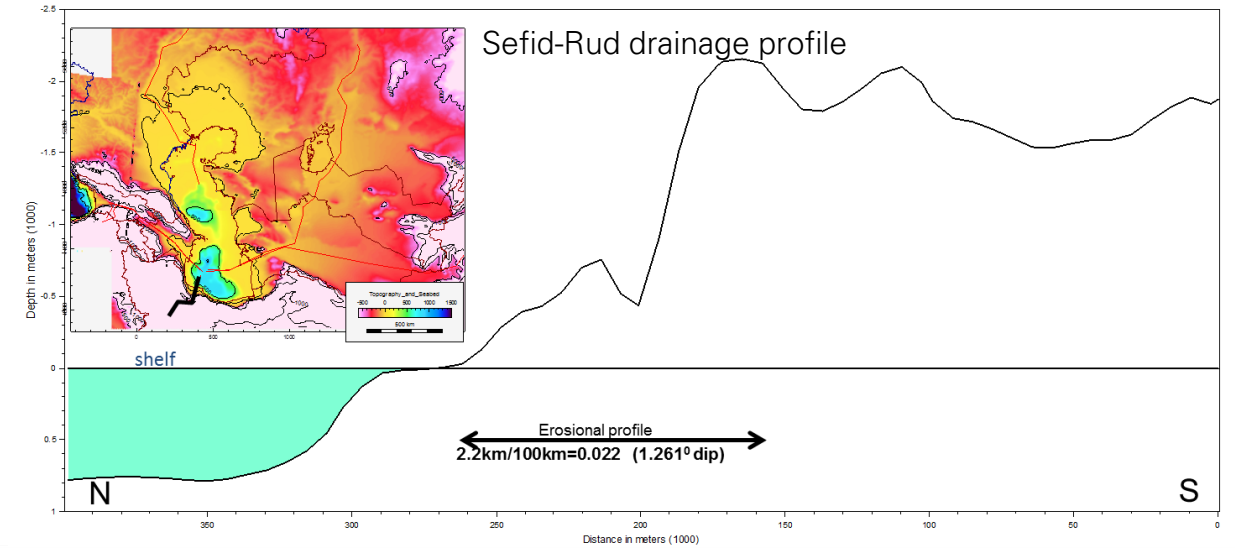
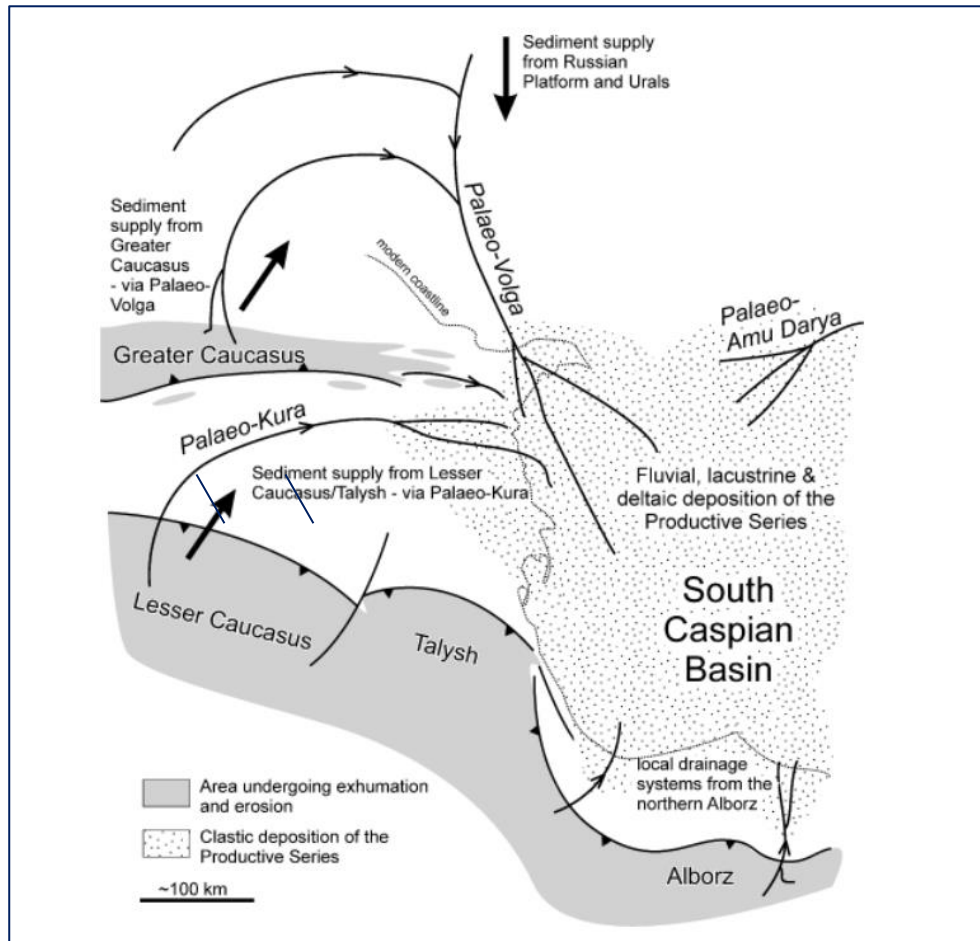
- Paleo-Amudarya dominates throughout Pliocene
- Very Dominant in Pleistocene till modern times



Turkmen delta – examples of other incisions



“Third river” -Kura River “plus” Iranian drainage



Modified from Allen et al, 2003

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