Miocene structural inversion of the Adjara-Trialeti back-arc basin as a far-field effect of the Arabia-Eurasia collision

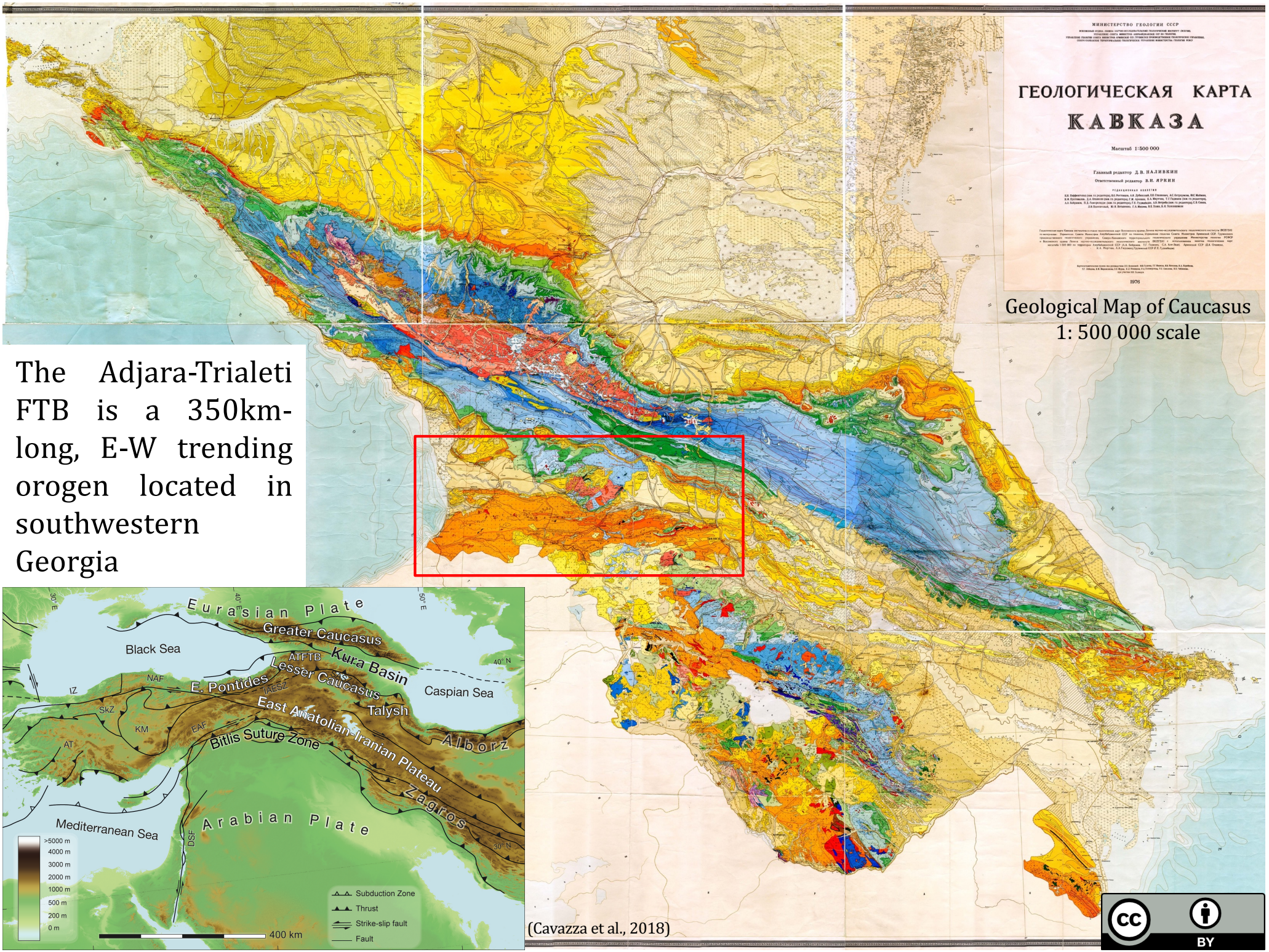


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[2]Institute of Geophysics, I. Javakhishvili State University, Tbilisi, Georgia
[3]Department of Geosciences, University of Padova, Italy
[4]Department of Sciences, University of Roma Tre, Italy
*thomas.gusmeo2@unibo.it

29th April 2021 EGU21-179 EGU General Assembly 2021

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Geological Map of Caucasus
1: 500 000 scale

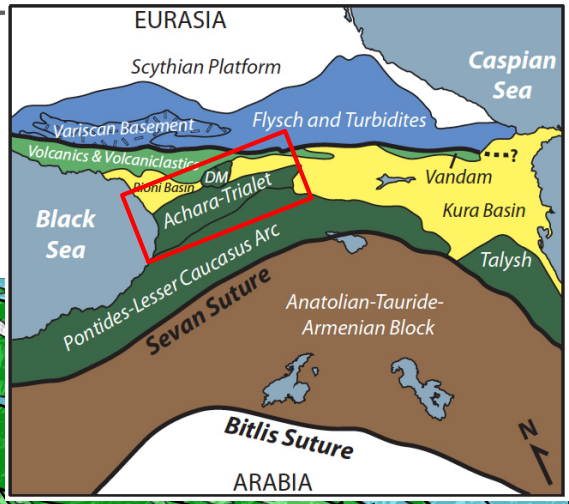
The Adjara-Trialeti FTB is a 350km-long, E-W trending orogen located in southwestern Georgia

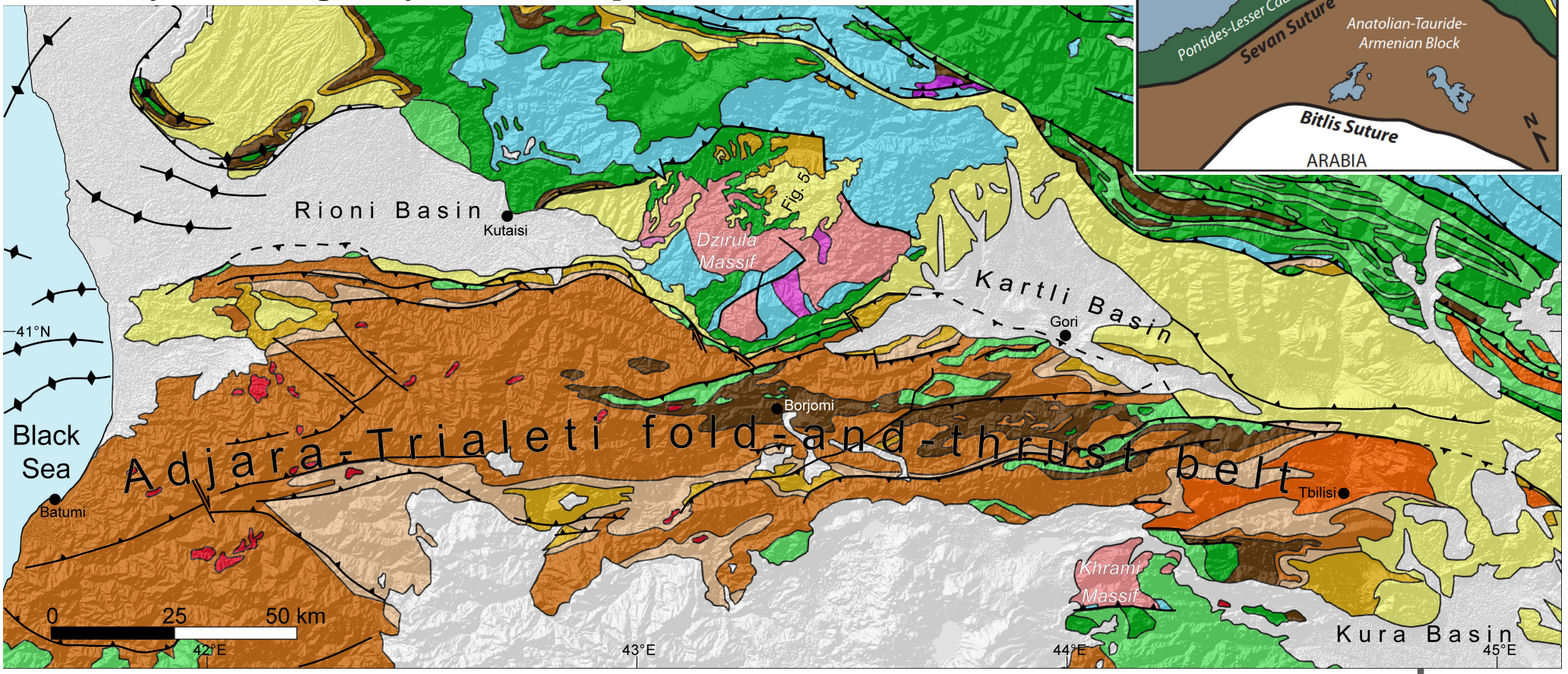
(Cavazza et al., 2018)

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An inverted back-arc basin

The Adjara-Trialeti fold-and-thrust belt results from the structural inversion of a Paleogene back-arc basin developed in the final stages of subduction of the upper (Eurasian) plate of the Northen Neotethys slab, arguably as a consequence of slab roll-back.

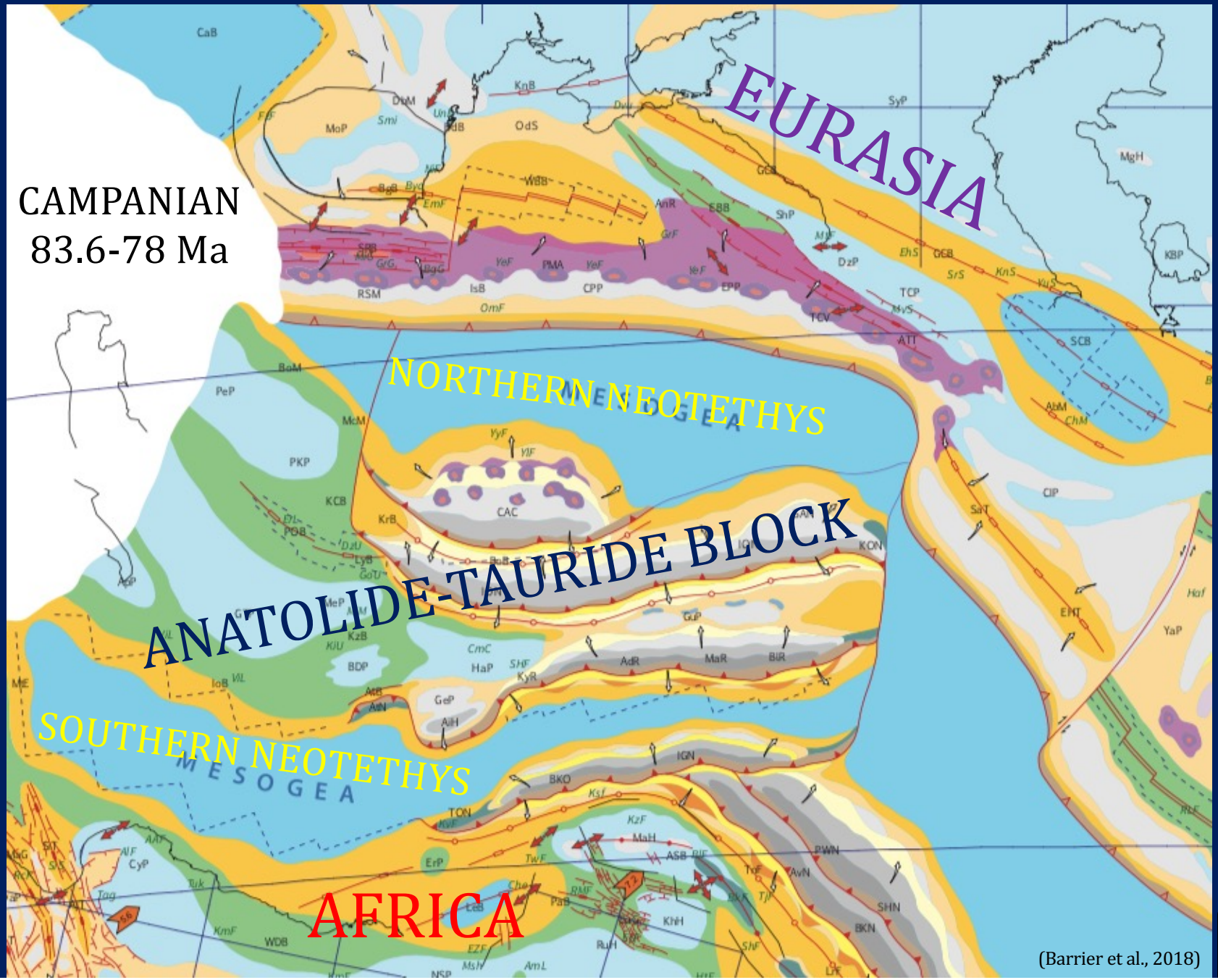




(Gusmeo et al., 2021 Tectonophysics 803)

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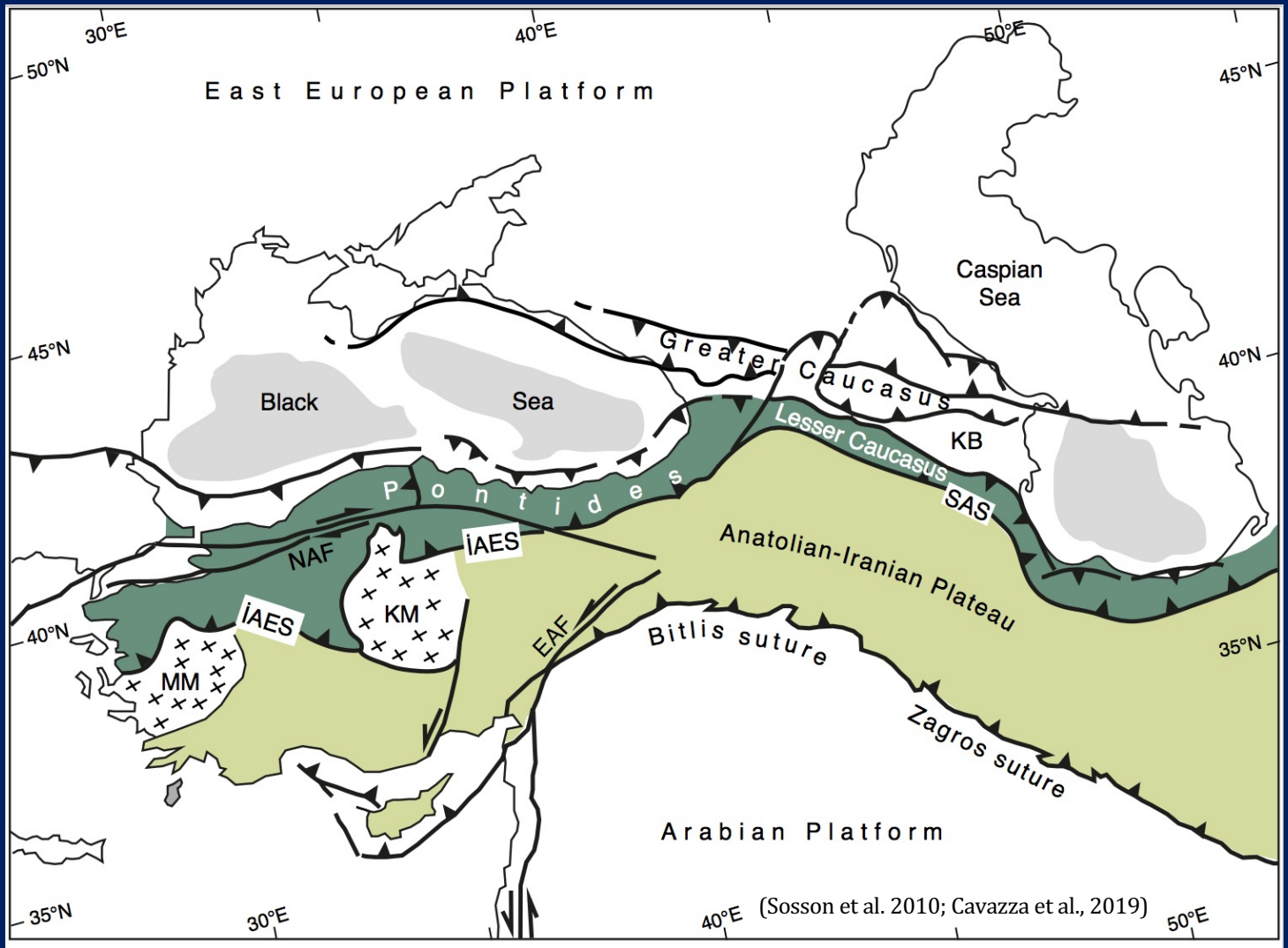
In Late Cretaceous times, two branches of the Neotethys separated Eurasia, the Anatolide-Tauride block and Africa. The Northern Neotethys slab was subducting below Eurasia



(Barrier et al., 2018)

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The northern branch of the Neotethys closed in Late Cretaceous-to-Paleocene times along the Izmir-Ankara-Erzincan suture zone, whereas final closure of the southern branch occurred in Middle Miocene times.

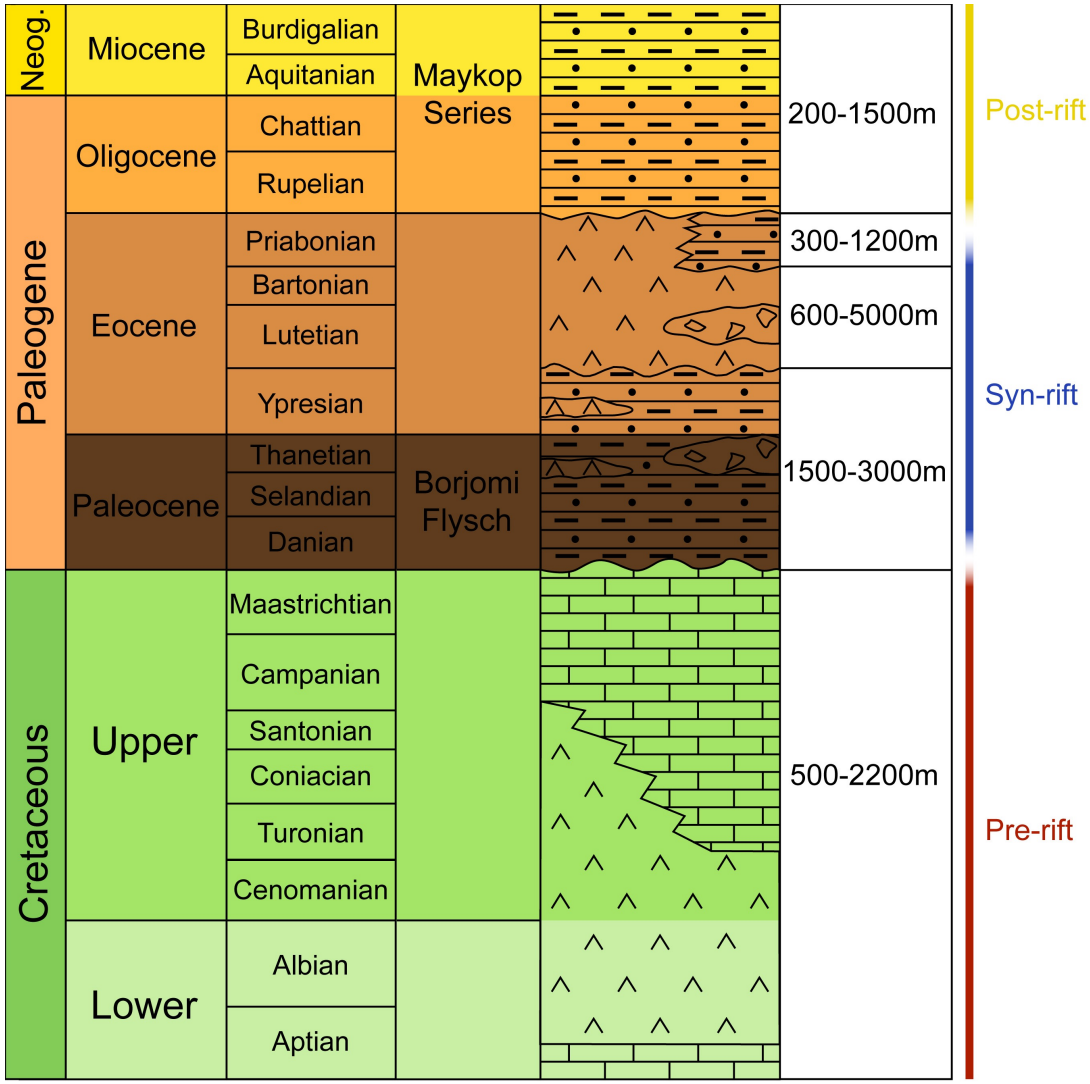


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Adjara-Trialeti back-arc basin stratigraphy

(after Adamia et al., 2011; Nemcok et al., 2013; Yilmaz et al., 2014; Gramkrelidze et al., 2018)

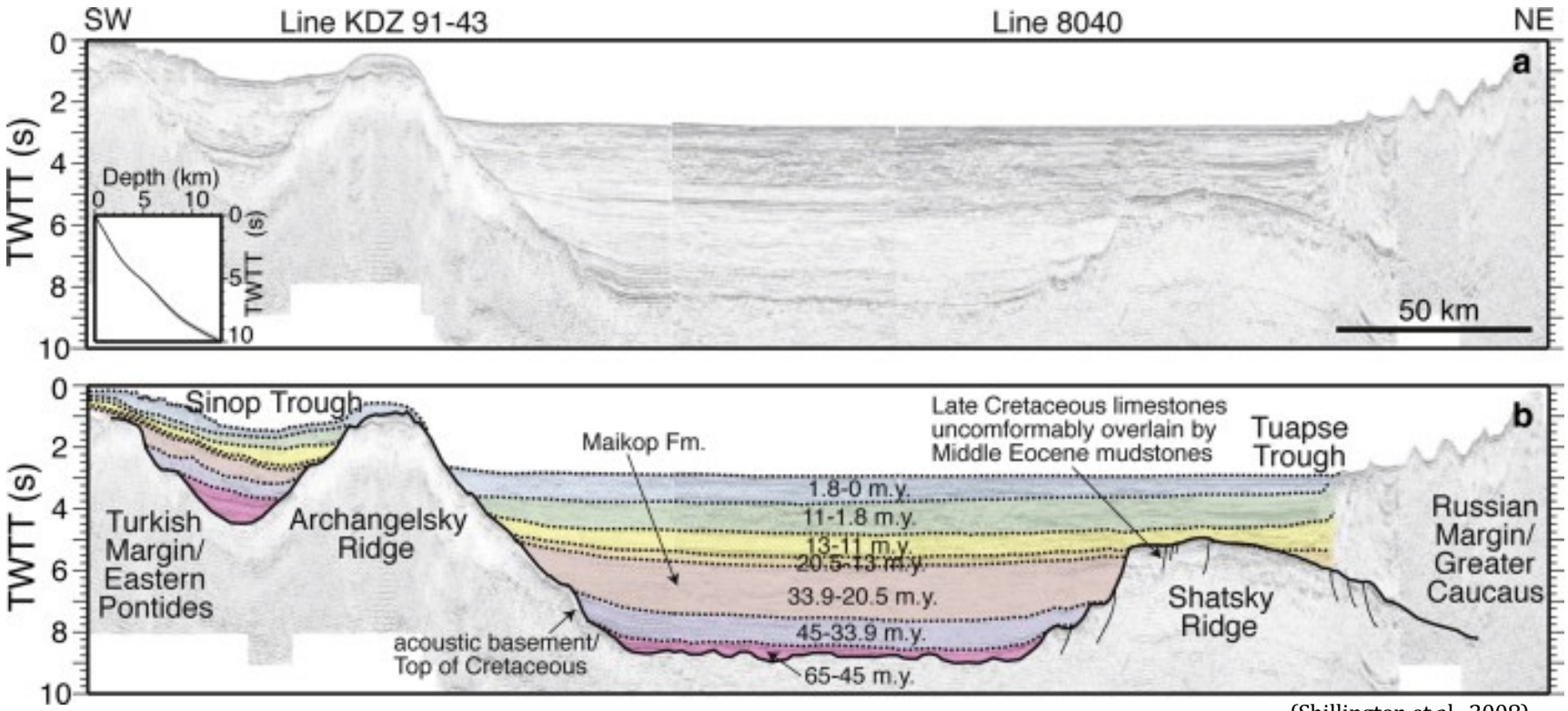
Back-arc extension began in the Paleocene. The main phase of rifting occurred in the Middle Eocene coeval with the deposition of extensive volcanic and volcaniclastic products and intrusion of shallow-depth mafic-intermediate plutons.



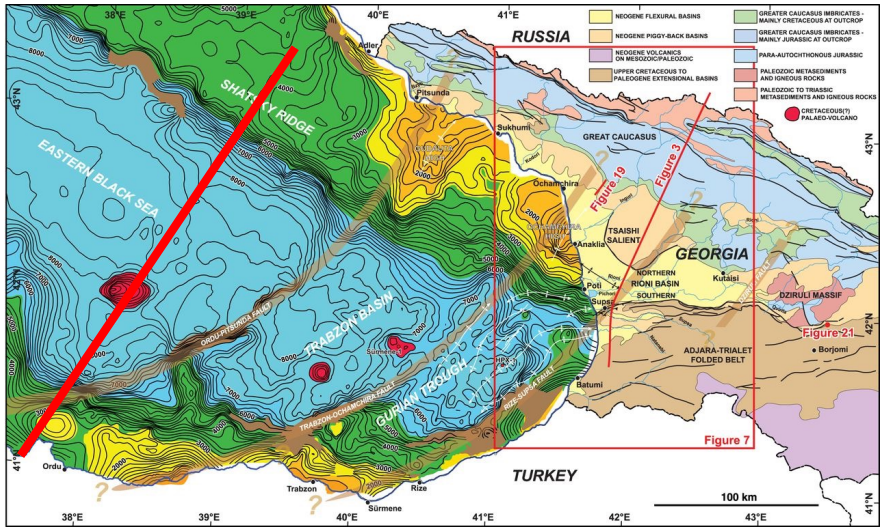
(Gusmeo et al., 2021)

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Eastern Black Sea: Paleocene-Eocene rifting?



(Shillington et al., 2008)

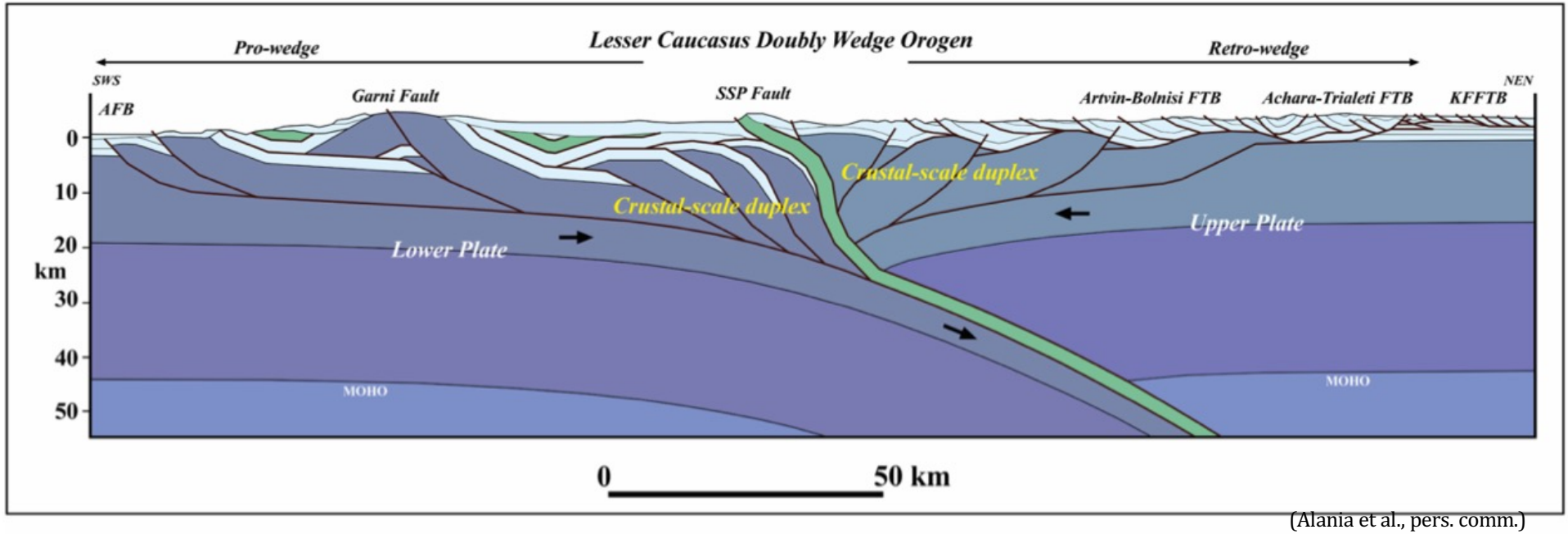


Timing of rifting in the Eastern Black Sea is debated, but may have occurred coevally with that in Adjara-Trialeti. Temporal and geometric relationships between the two basins could suggest a common genetic origin, although later they underwent different evolutions.

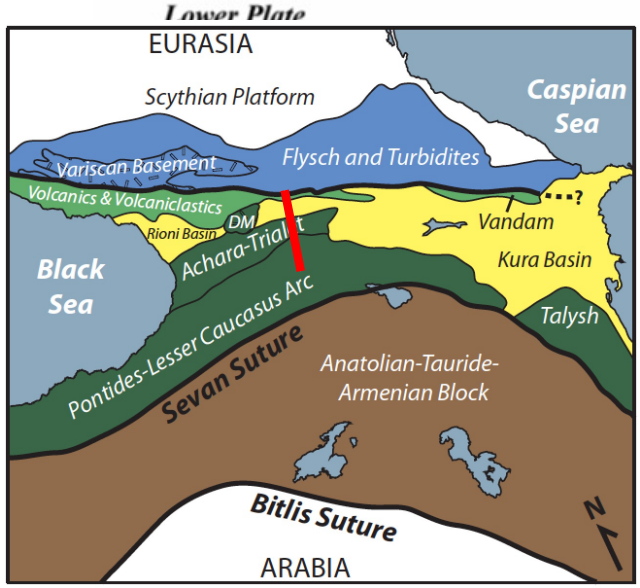
(Tari et al., 2018)

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The Adjara-Trialeti FTB is now incorporated in the retrowedge of the Lesser Caucasus



(Alania et al., pers. comm.)

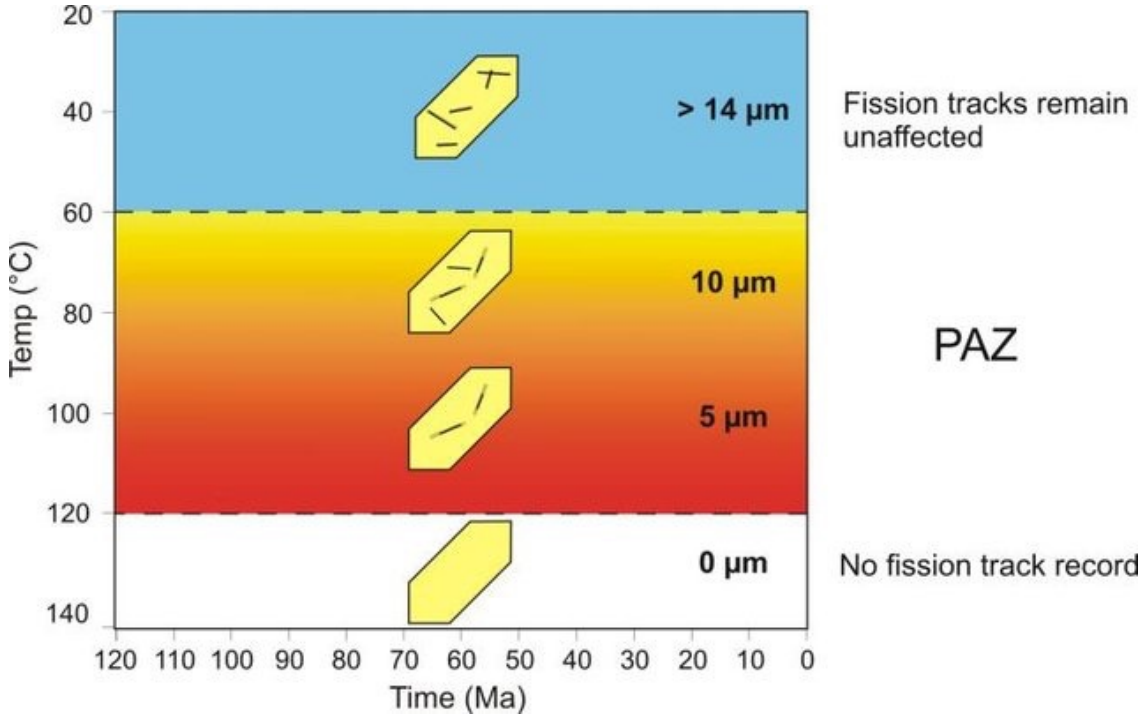




The Lesser Caucasus experienced incremental deformation: subduction, continental collision, reactivation of structures during far-field stress transmission and growth of the retro-wedge.

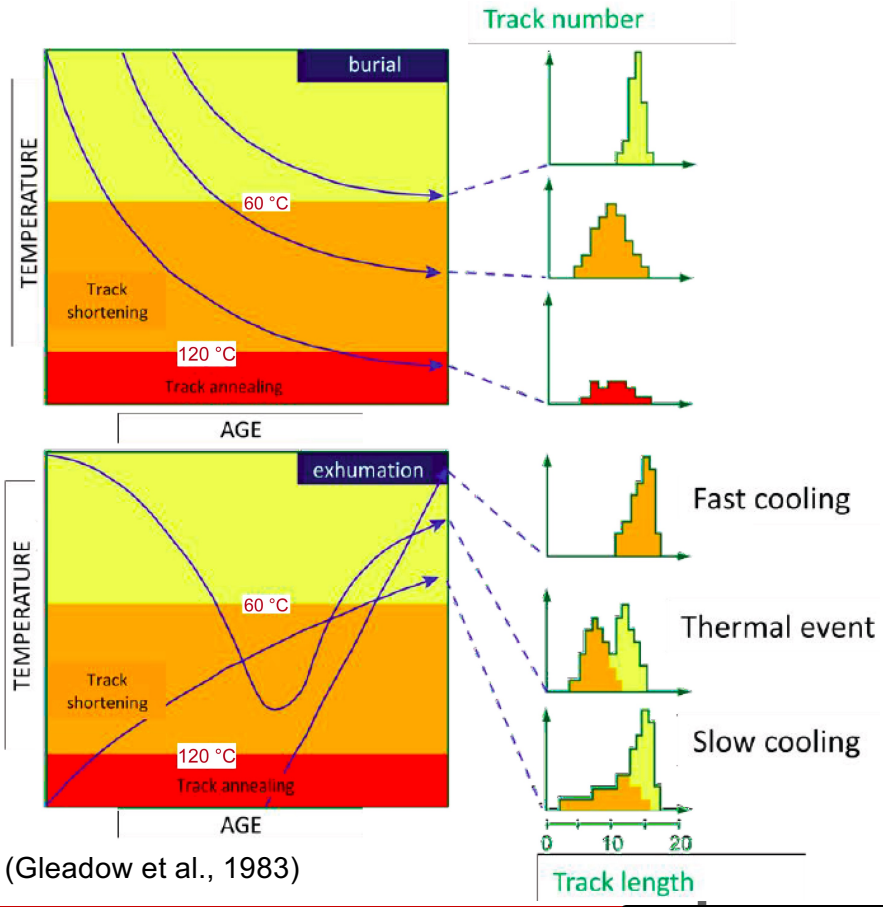
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Method 1:
Apatite fission-track thermochronology



(Doepke, 2017)

Closure temperature:
~ 100°C
PAZ: 60-120°C



(Gleadow et al., 1983)

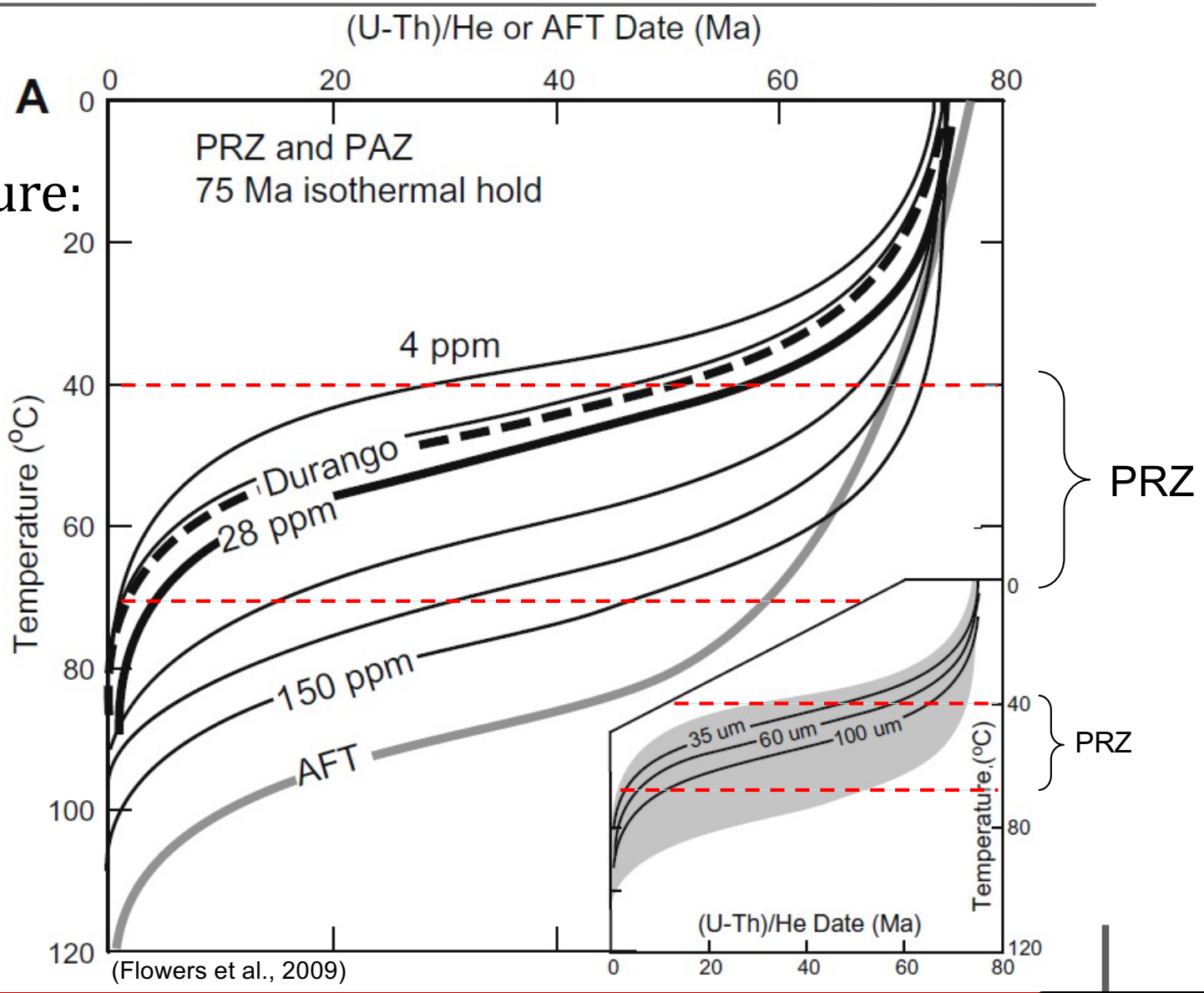
Rocks analysed:
Sandstones and intermediate intrusives

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Method 2:
Apatite (U-Th)/He thermochronology

Closure temperature:
~ 70°C
PRZ: 40-70°C

Rocks analysed:
Sandstones



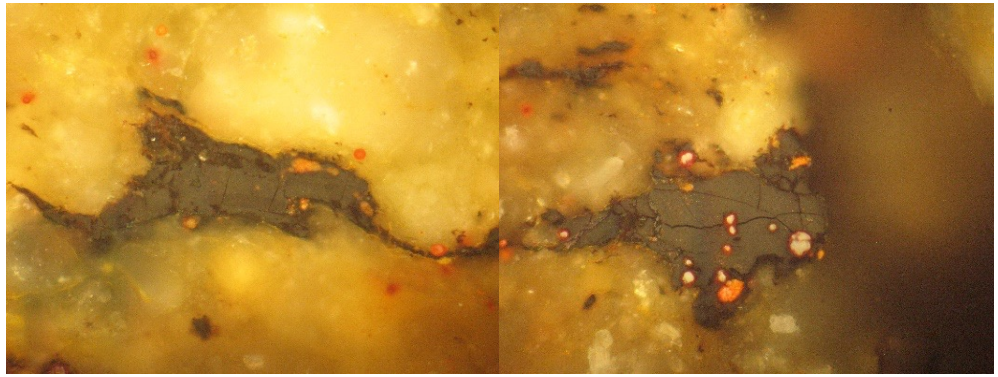
(Flowers et al., 2009)

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Method 3:
Thermal maturity analyses

Organic petrography:

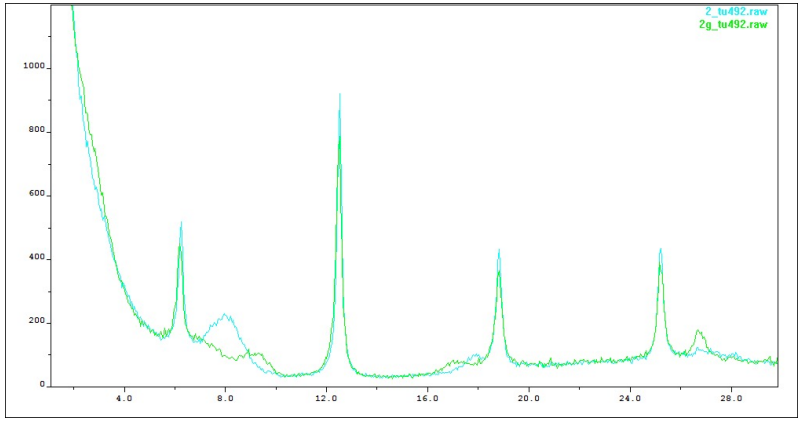
- Vitrinite reflectance (Ro%) analysis
- Pyrolisis



(Corrado et al., in review)

Inorganic petrography (clay minerals):

- X-ray fluorescence (XRF) to characterise composition
- X-ray diffraction (XRD) to quantify mineral abundance
- Illite percent in illite-smectite mixed layers (I% in I-S)

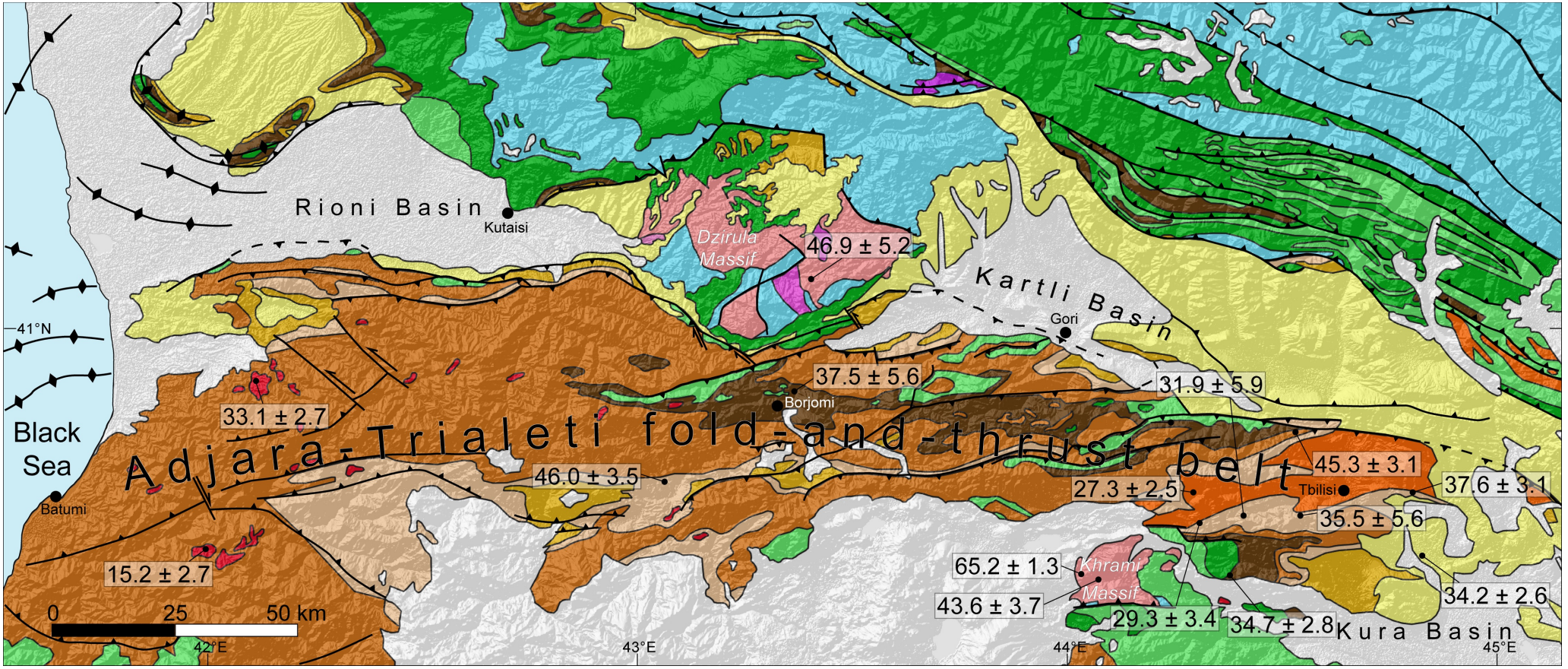


(Corrado et al., in review)

Rocks analysed:
Claystones and siltstones

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Result 1:
Apatite fission-track central ages

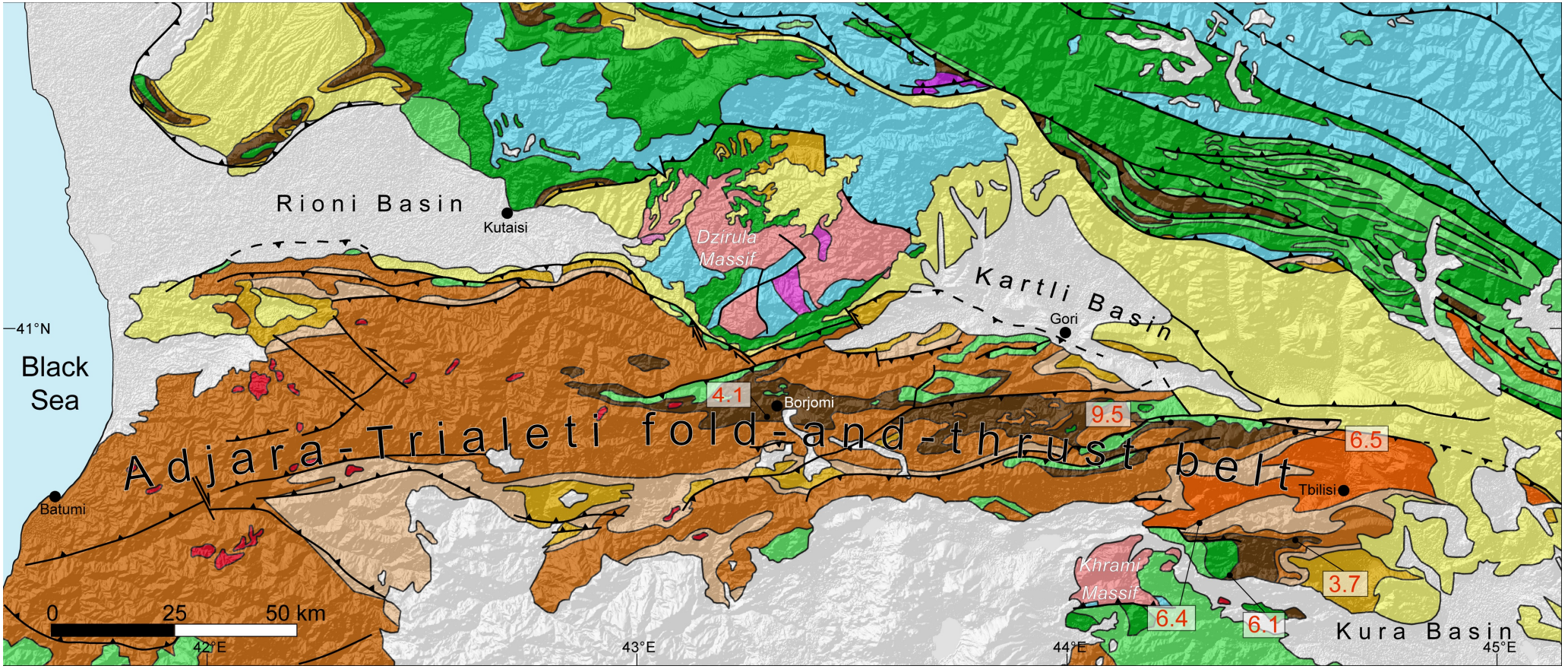


(Gusmeo et al., 2021)

AFT central ages range from about 46 to 15 Ma

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Result 2:
Apatite (U-Th)/He ages

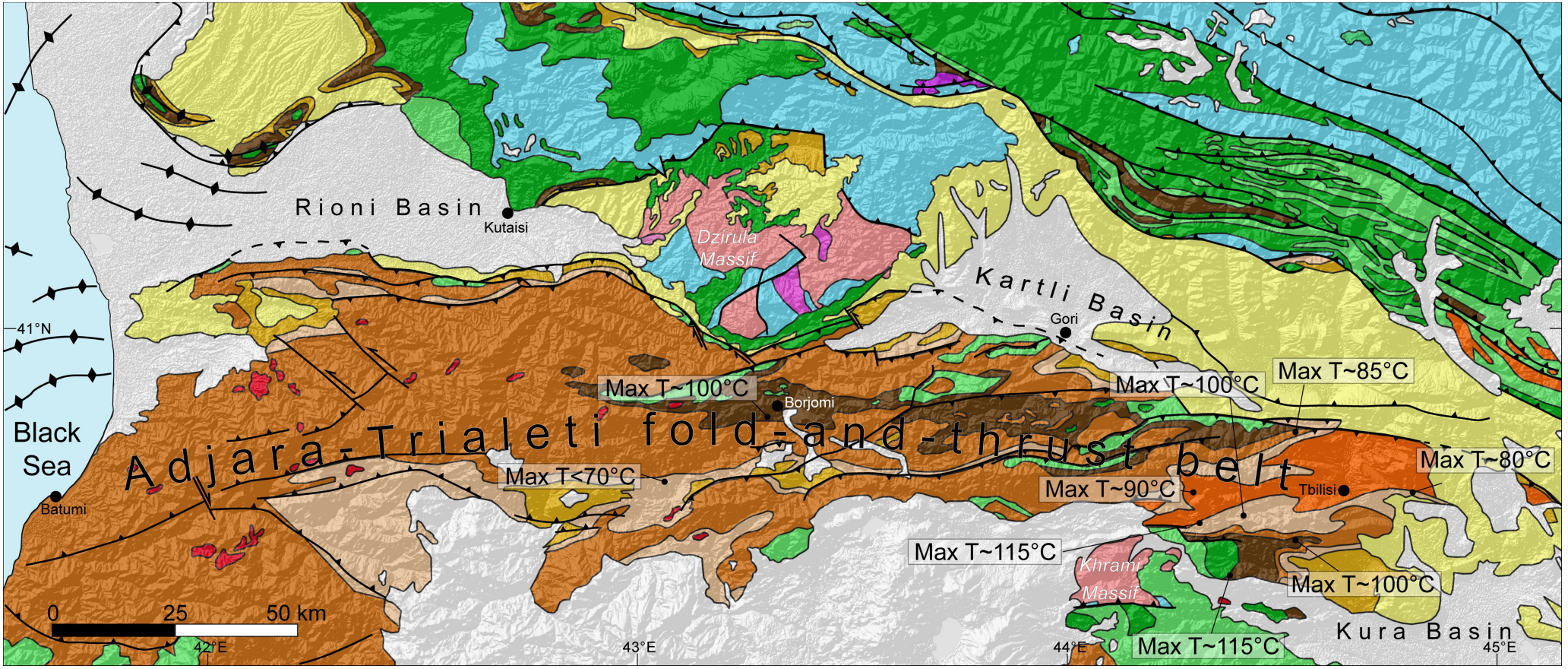


(Gusmeo et al., 2021)

Most AHe single-grain ages range between 10 and 3 Ma

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Result 3:
Maximum burial temperatures



(Corrado et al., in review)

Maximum paleotemperatures acquired during burial of the Adjara-Trialeti basin fill range from <70°C to about 115°C

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Since maximum paleotemperatures were not enough to completely reset the AFT system, inverse thermal modelling was performed integrating all available geological constraints

Apatite fission-track analysis

Apatite (U-Th)/He analysis

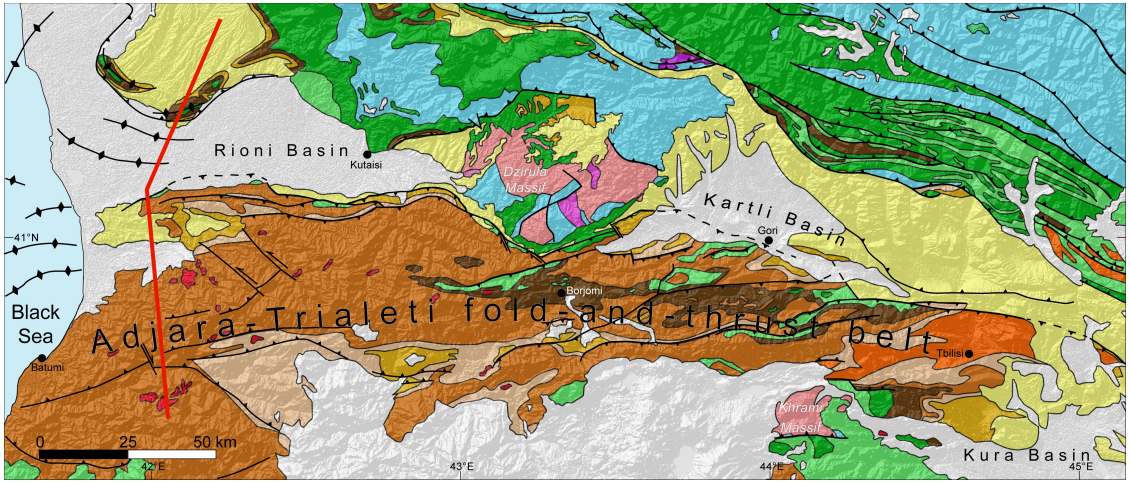
Thermal maturity indicators

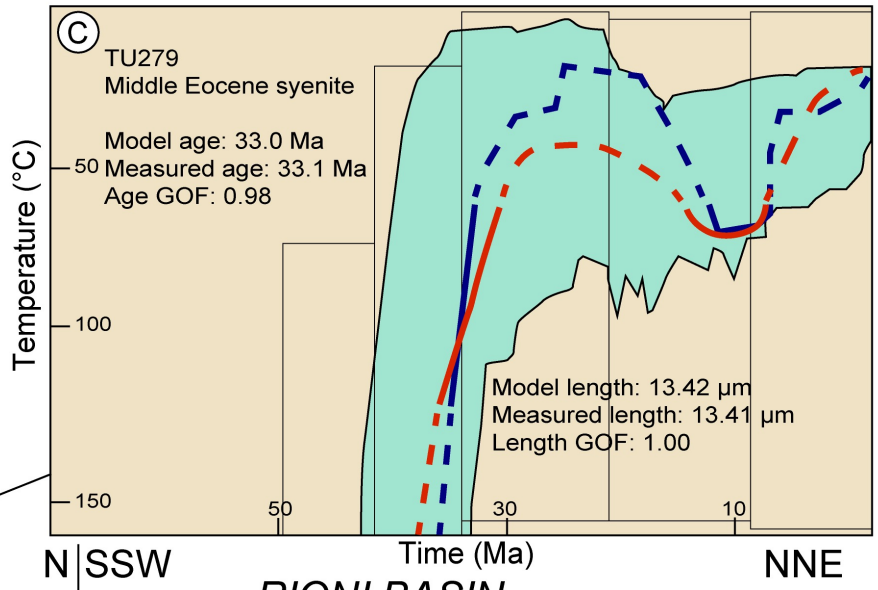
Stratigraphy

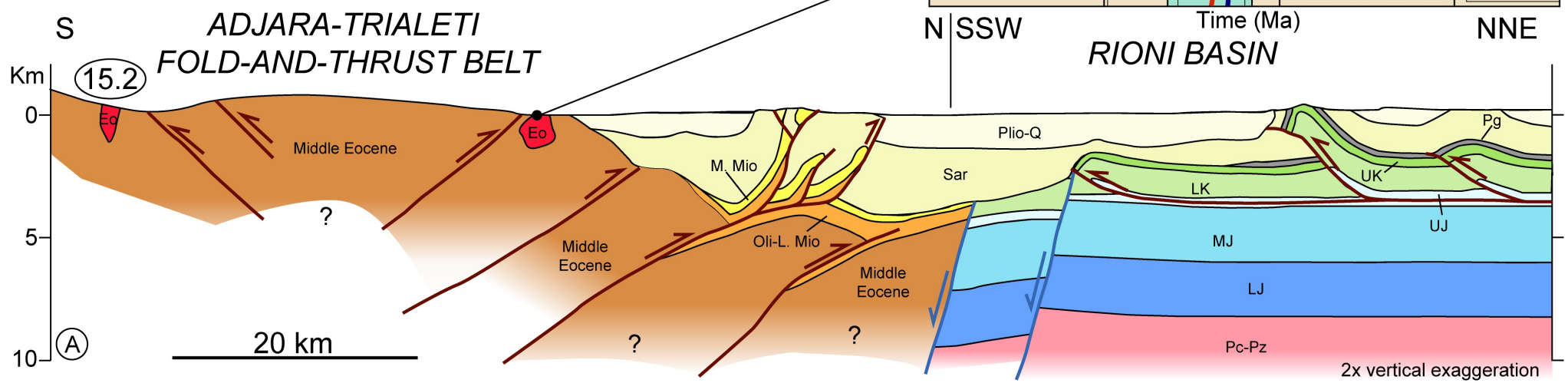
Geochronology

T-t modeling

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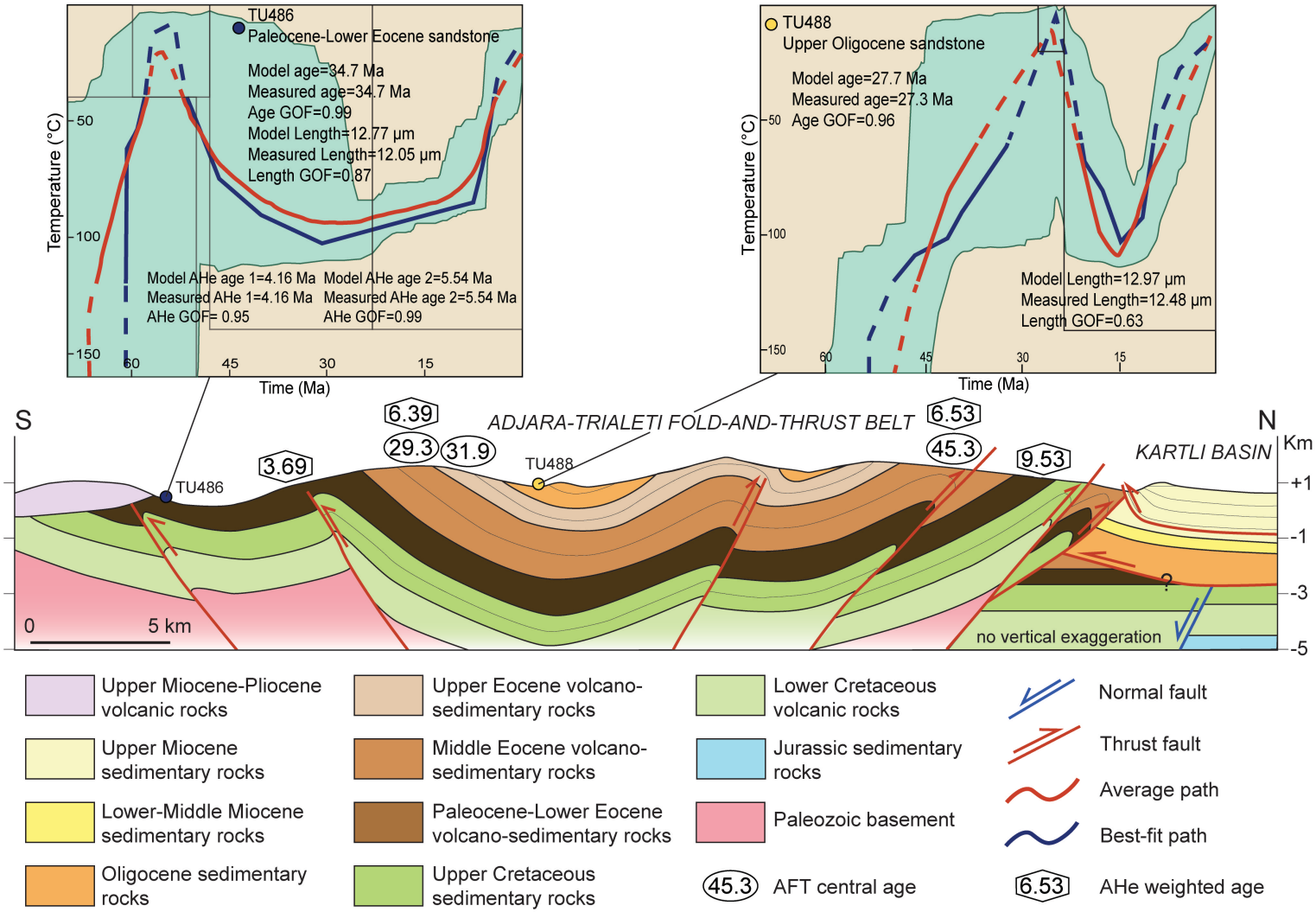


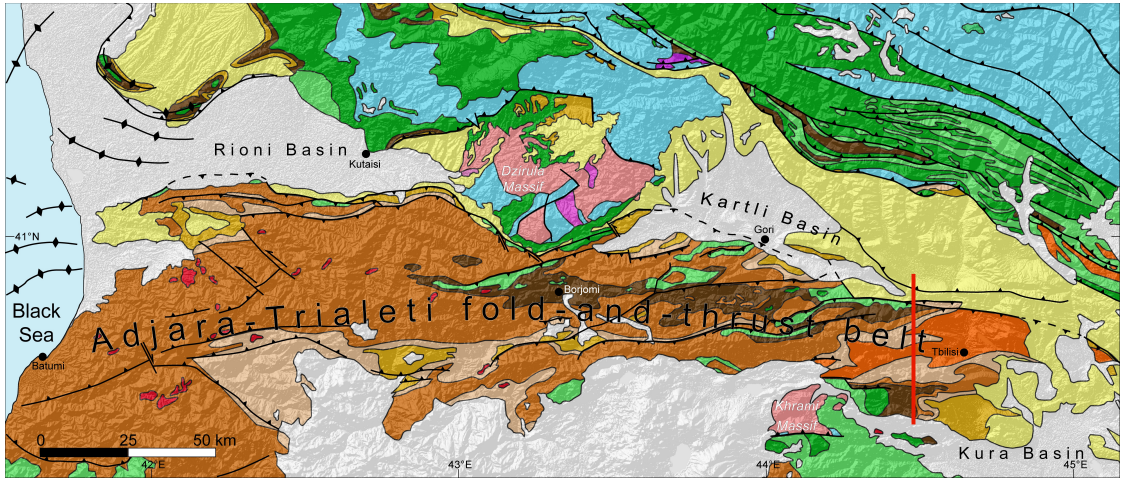


Quaternary-Pliocene
Sarmatian (Upper Miocene)
Middle Miocene
Paleogene (undivided)
Upper Cretaceous
Lower Cretaceous
Lower Miocene-Oligocene
Middle Eocene
Middle Eocene intrusives
Upper Jurassic
Middle Jurassic
Lower Jurassic
Precambrian-Paleozoic basement (undivided)
Thrust
Normal fault
15.2 AFT central age
Best-fit path
Average path
(Gusmeo et al., 2021)

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Inverse thermal modelling consistently idicates that, after Paleogene-early Neogene sedimentary burial, rocks of the Adjara-Trialeti back-arc basin were quickly exhumed starting at about 14-12 Ma. Hence, structural inversion of the basin began in the late Middle Miocene.

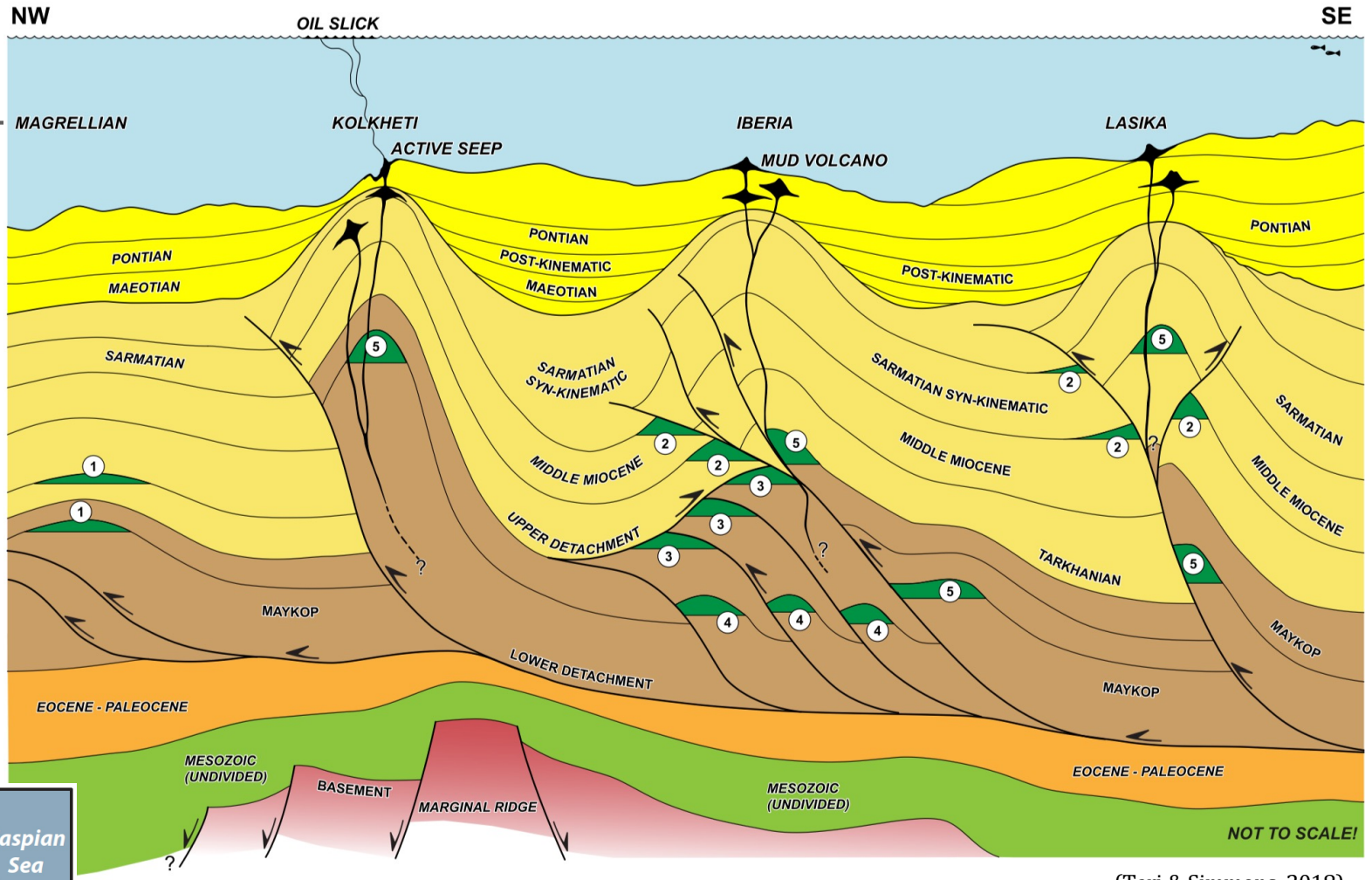




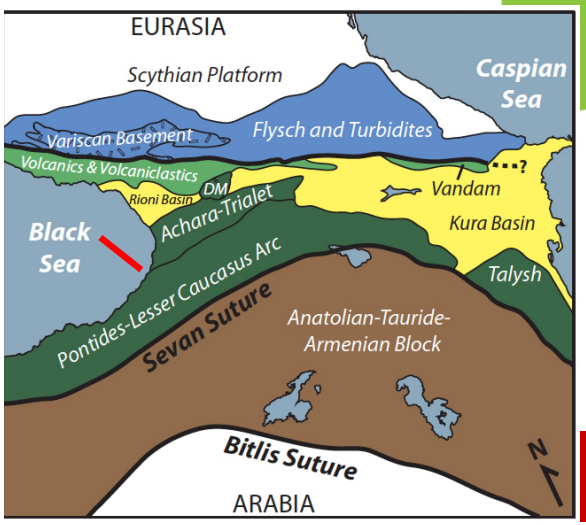
(Gusmeo et al., 2021)

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Gurian fold belt



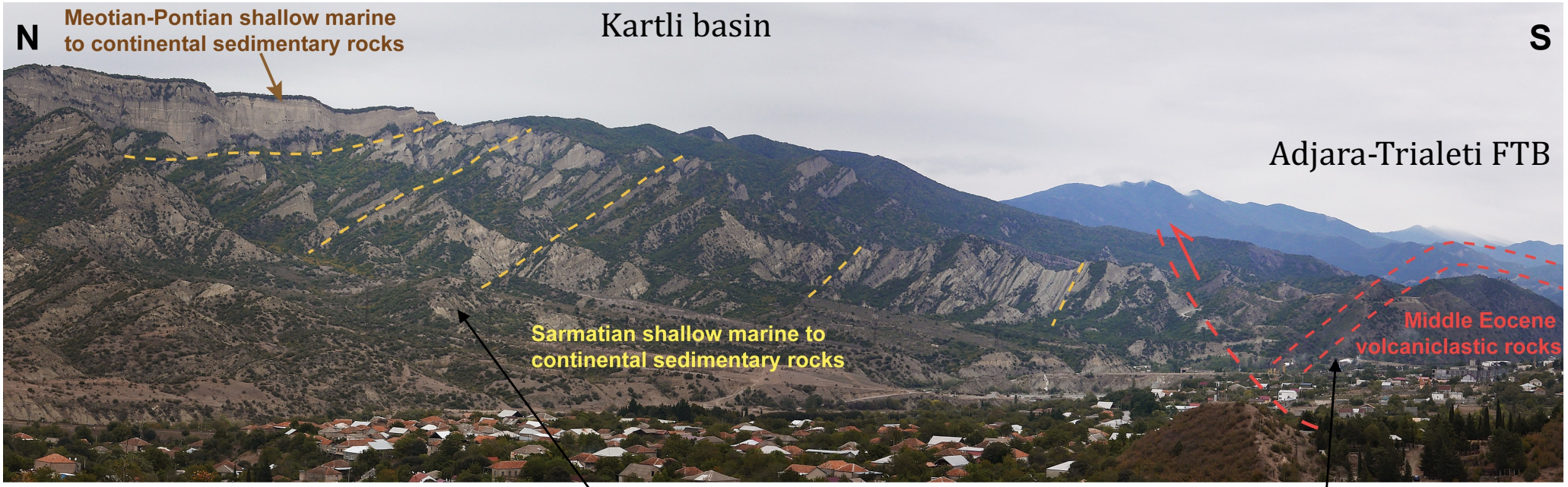
(Tari & Simmons, 2018)



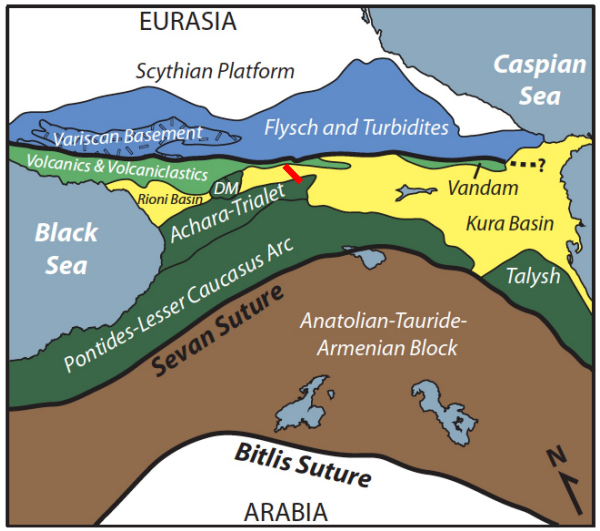
Modelling results are corroborated by widespread independent geological evidence, such as timing of deformation in the Gurian belt, the western continuation of Adjara-Trialeti in the eastern Black Sea, also occurring in the Middle-Late Miocene.

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Mtskheta progressive unconformity: syntectonic sedimentation in the Late Miocene



(Gusmeo et al., 2021)



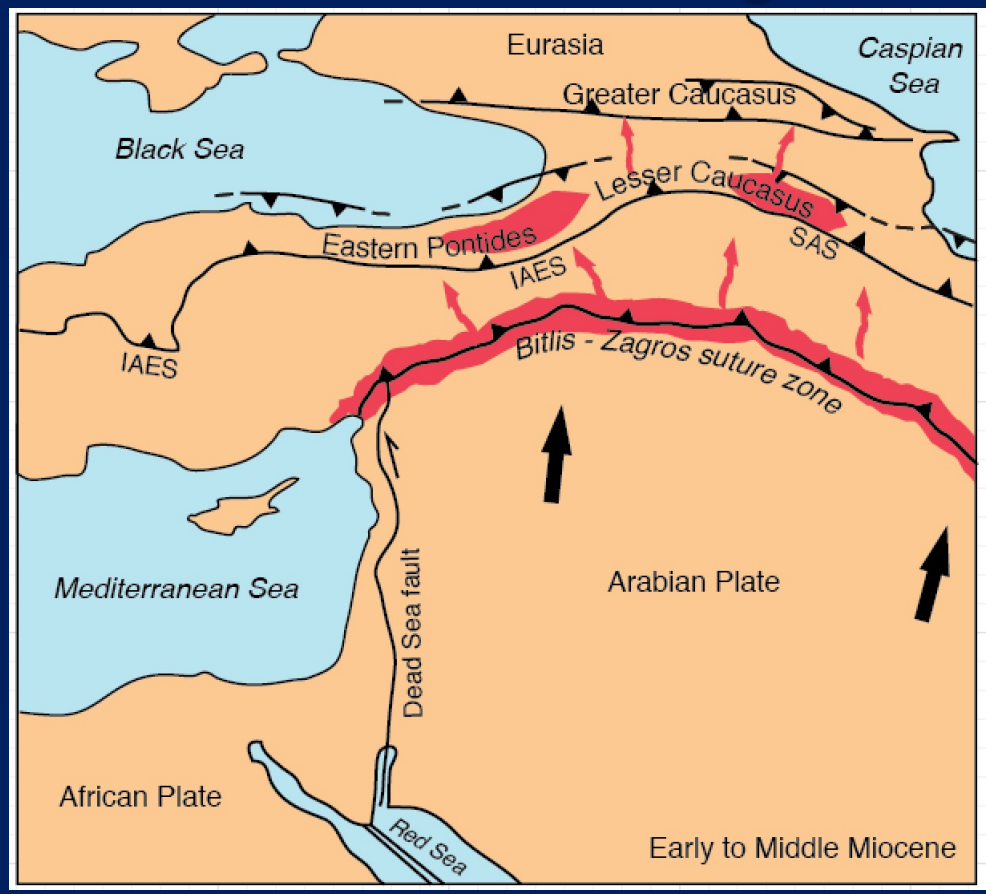
Upper Miocene syntectonic sediments with offlap geometry, onlap of latest Miocene sediments

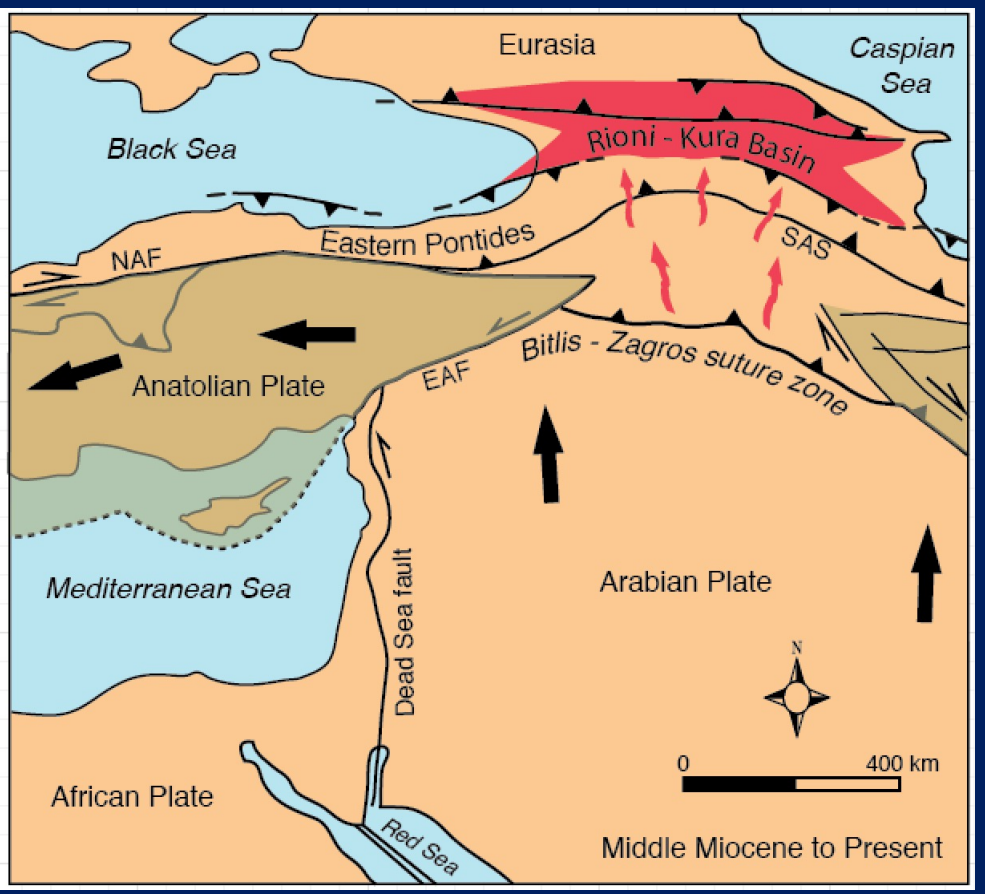
Middle Eocene volcaniclastic sandstones

Growth structures in the adjacent Rioni, Kura and Kartli sedimentary basins also witness the advancement of the Adjara-Trialeti orogen in Middle-Late Miocene times.

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Following Arabia-Eurasia hard collision along the Bitlis-Zagros suture, far-field compressional stresses were transmitted to the north inducing deformation in the hinterland





(Cavazza et al., 2019)

1. Early – Middle Miocene

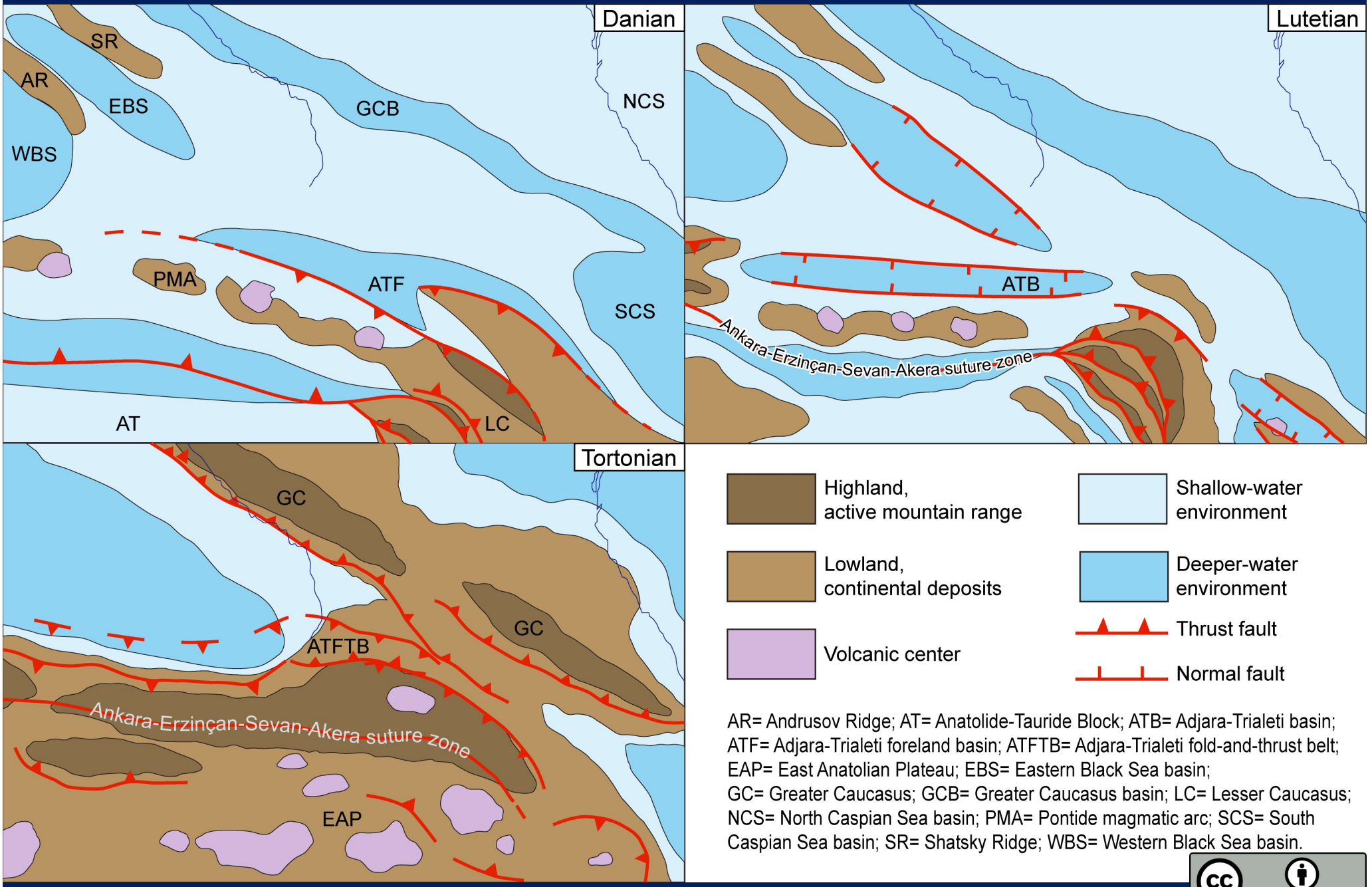
Arabia-Eurasia hard collision; wide area of diffuse deformation in the hinterland; focused deformation/exhumation along preexisting structural discontinuities

2. Middle Miocene – Present

tectonic "escape"; decoupling of portions of the foreland from the collision zone; wholesome uplift of Anatolian-Iranian Plateau; Kura-Rioni and Adjara-Trialeti basins inversion; Greater Caucasus uplift

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Paleogeographic reconstruction (Paleocene to Late Miocene)

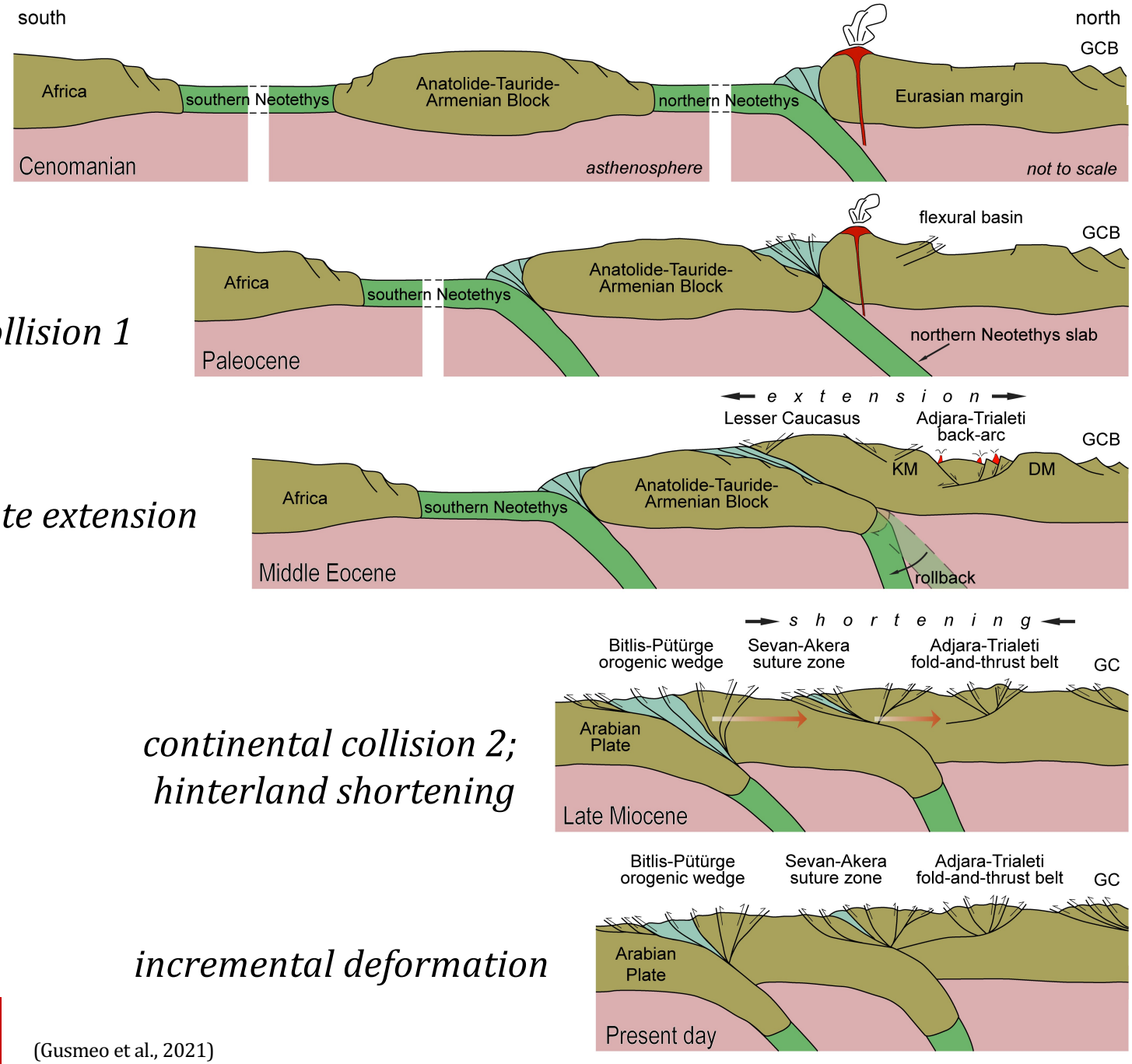


AR= Andrusov Ridge; AT= Anatolide-Tauride Block; ATB= Adjara-Trialeti basin; ATF= Adjara-Trialeti foreland basin; ATFTB= Adjara-Trialeti fold-and-thrust belt; EAP= East Anatolian Plateau; EBS= Eastern Black Sea basin; GC= Greater Caucasus; GCB= Greater Caucasus basin; LC= Lesser Caucasus; NCS= North Caspian Sea basin; PMA= Pontide magmatic arc; SCS= South Caspian Sea basin; SR= Shatsky Ridge; WBS= Western Black Sea basin.

(Gusmeo et al., 2021)

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N-S sketch sections showing the tectonic evolution of the Arabia-Eurasia collision zone



(Gusmeo et al., 2021)

CONCLUSIONS

- Adjara-Trialeti FTB: Miocene inversion of a Paleogene back-arc rift basin caused by far-field stress transmission from the Arabia-Eurasia collision zone

- Incremental deformation in the Lesser Caucasus during (1) subduction of the Northern Neotethys, (2) continental collision, (3) reactivation of structures following hard collision along Bitlis-Zagros suture

- Late stage incorporation of the Adjara-Trialeti FTB in the retrowedge of the Lesser Caucasus

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