# Source to Sink in the Easternmost Mediterranean: Insights from the Provenance of Oligo-Miocene Turbidites in the South Turkish Basins

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## Abstract

South Turkish Neogene basins record post-collisional exhumation/erosion of Neotethyan basins. Facies and paleocurrent data indicate general northerly derivation of siliciclastic sediments. Provenance is further indicated by integrated detrital zircon U-Pb geochronology (29 samples; 2748 grains) of 7 mapped late Oligocene-Miocene basins (from E-W): 1. Hatay, 2. K.Maraş, 3. Adana, 4. Misis, 5. Mut, 6. Manavgat and 7. Köprü. 1-4 and 6-7 represent two separate tectonically active depocenters, whereas 5 was a relatively stable platform. The early-mid Miocene of Hatay Basin contains sparse zircons with Precambrian (570-900 Ma) and Cretaceous (73-99 Ma) populations that become prominent in the mid-late Miocene. The early Miocene of K.Maraş Basin has abundant Pan-African, Grenvillian and Eocene zircons; mid-Miocene exhibits scarce Neoproterozoic-Mesoproterozoic but abundant Cretaceous-Neogene zircons. The late Oligocene-early Miocene of Adana Basin has minor Cretaceous-Neogene zircons, becoming more abundant in the early Miocene. The Miocene of Misis Basin has abundant Precambrian grains, mainly restricted to the NE. The Miocene of Mut Basin has major zircon populations of 544-710 Ma, 730-990 Ma, and two subordinate 1700-2000 Ma and 2400-2700 Ma clusters. Early Miocene (17-19 Ma) zircons occur in some samples. The Manavgat Basin samples are similar to the Mut Basin ones but with more evidence of mid-late Miocene (8-14 Ma) zircons. Lastly, the Köprü Basin (E Isparta Angle) has Pan-African (540-640 Ma) and Grenvillian (810-1000 Ma) populations, and small Paleozoic clusters. The Pan-African and Grenvillian-aged material was probably supplied directly and/or recycled from rifted Gondwanan Cadomian 'basement' and its Paleozoic passive margin cover, as partly exposed in south/central Anatolia. Sparse Permian-Triassic zircons relate to Neotethyan rifting. Late Cretaceous-early Cenozoic grains were derived from adjacent Late Cretaceous ophiolitic, magmatic arc and related metamorphic units. Early Miocene zircons relate to local basaltic volcanism. The variable zircon abundances hint at differential exhumation/erosion. Two regional drainage system dominated, one through the K.Maraş basin system (E) and the other through the Isparta Angle basin system (W).

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## Introduction

- Neogene basins mainly record **collision-related exhumation/erosion** of Neotethyan crustal units in S Turkey.
- Existing facies and paleocurrent evidence indicate mainly **southward sediment transport** from a collisional setting within Anatolia towards the E Mediterranean deep-water basin to the S.
- **Detrital zircon U-Pb geochronology** allow the existing basin models to be tested and developed, and indicate how supply from different aged units varied in space and time.
- The new zircon age data also shed light on **depositional pathways** of regional to local scale.

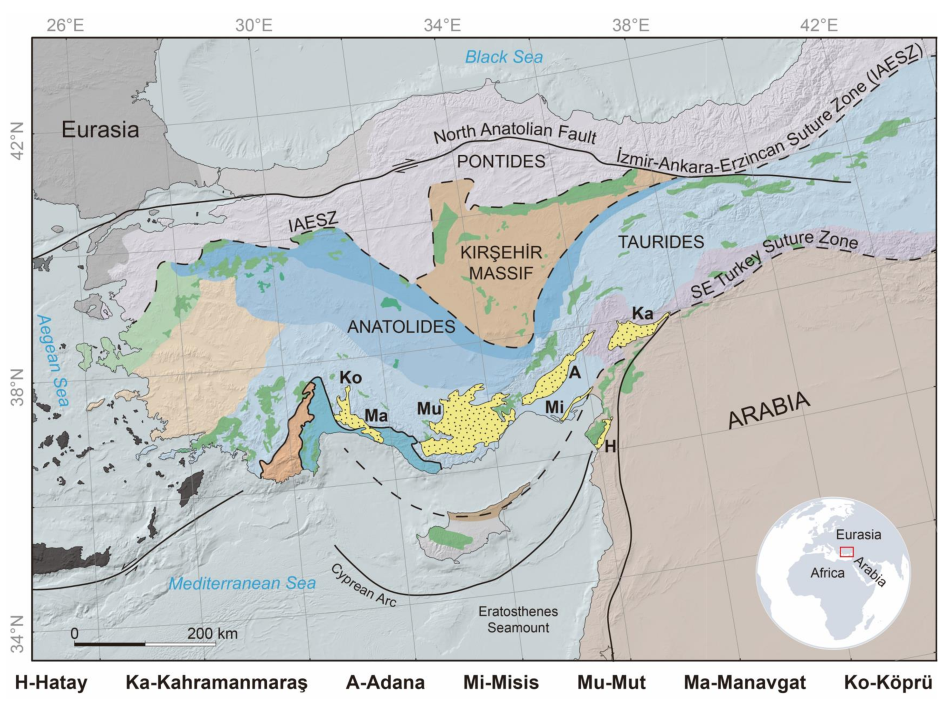



Fig. 1 Outline tectonic map showing the Eastern Mediterranean region with its major tectonic zones, including the basins studied (highlighted in bright yellow).

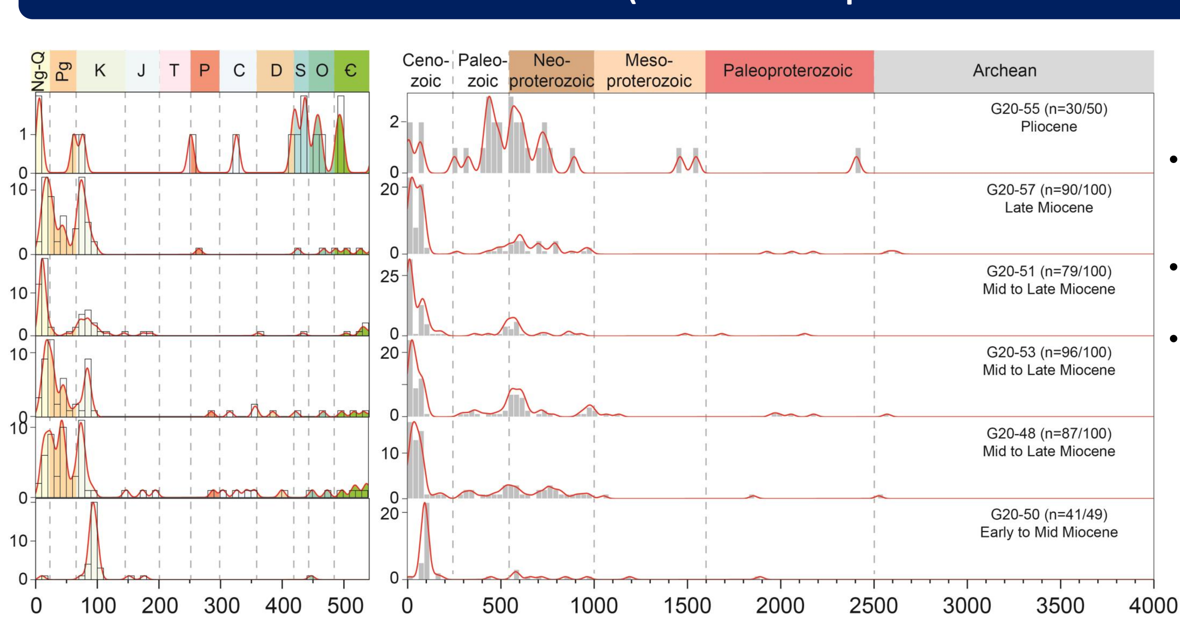
## Specific objectives

- To determine the **detrital provenance** of seven related Oligocene-Miocene marine basins in S Turkey;
- To determine the **exhumation/erosional history** of key regional magmatic and/or metamorphic units;
- To test the existing paleontologically **assigned ages of depositional formations**;
- To improve understanding of the **closure history of Tethyan ocean basin** in the E Mediterranean region.

## Methods

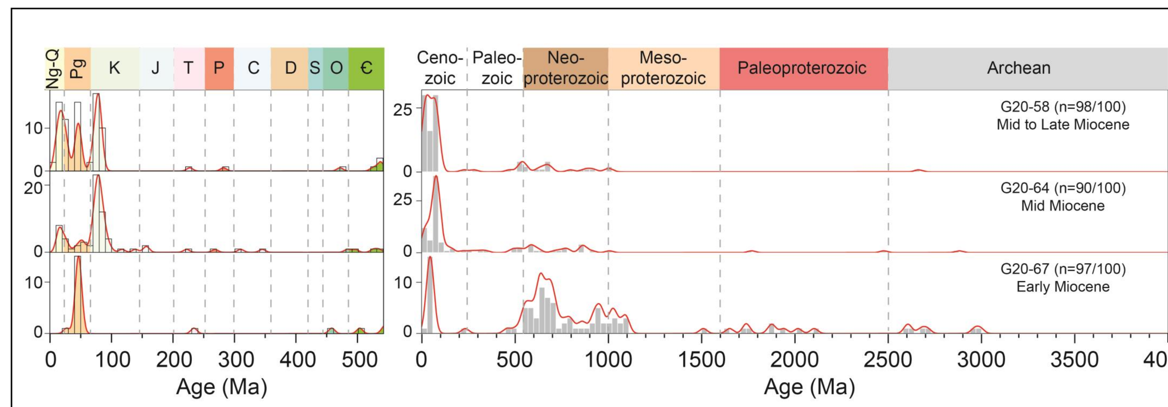
- Cathodoluminescence (CL) imaging: zircon morphology and internal microtexture
- U-Pb dating: Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS)
- Data reduction: GLITTER 4.0 (Griffin et al., 2008) and Iolite software package (Wu et al., 2018)
- Zircon age interpretation: for zircon <1000 Ma, $^{206}Pb/^{238}U$ ages preferred; for zircon >1000 Ma, $^{207}Pb/^{206}Pb$ ages preferred
- Data filtering: for zircon <200 Ma, discordance <20%; for zircon >200 Ma, discordance <10%

## Main results (zircons inputs to each basin)



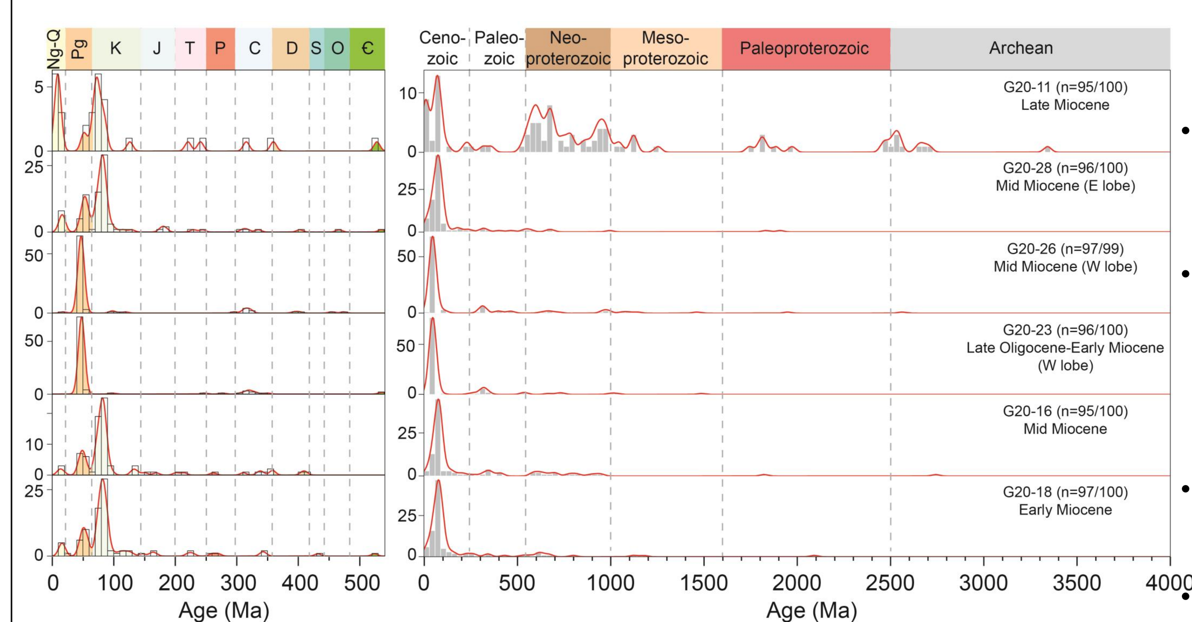
### Hatay basin

- **L. Miocene**: mainly high-level crustal input (little Precambrian 'basement');
- **M. Miocene**: zircons become younger up-sequence;
- **Pliocene**: increased 'basement' input (probably from Arabia).



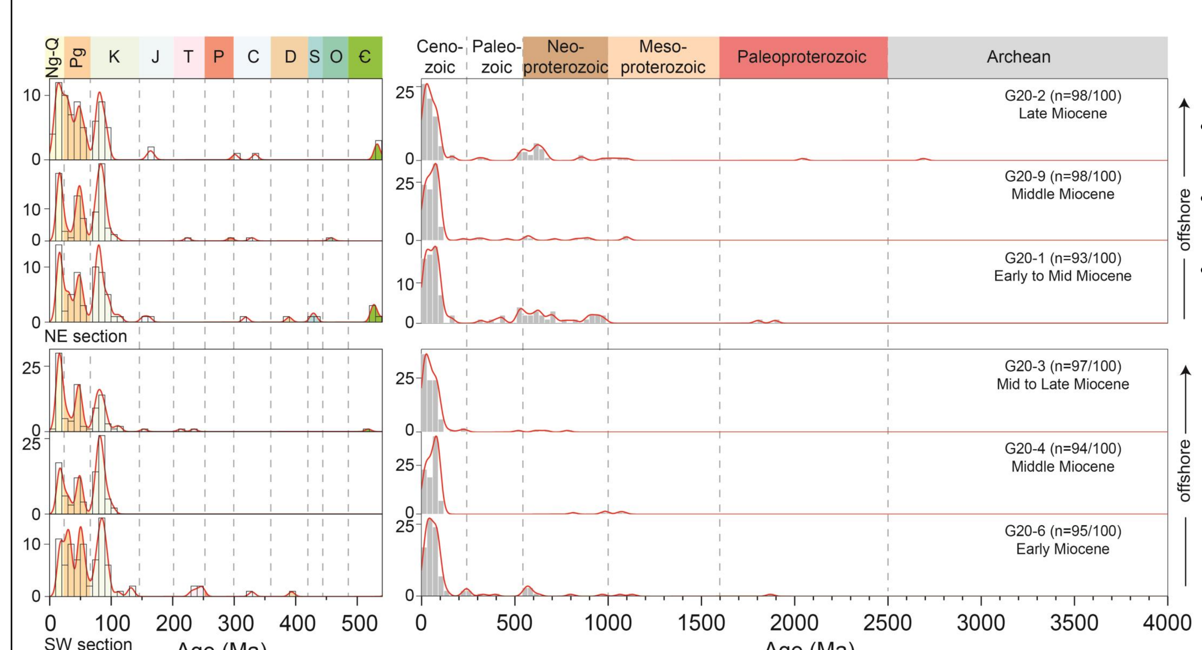
### Kahramanmaraş basin

- **L. Miocene**: major Precambrian 'basement' input;
- **M. Miocene**: major Late Cretaceous input



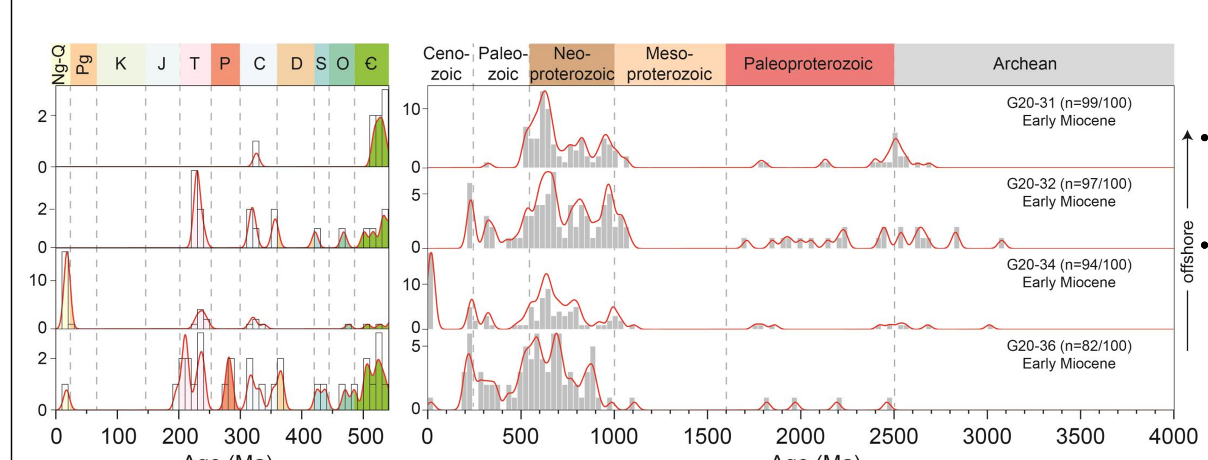
### Adana basin

- Two (known) **sedimentary lobes** (turbidites) have contrasting **Late Cretaceous** vs. **Eocene** input;
- **U. Oligocene-L. Miocene**: Late Cretaceous input to the SW/W of the W lobe (from possible topographic highs); also dominant Eocene input near the W lobe;
- **M. Miocene**: consistent provenance as Late Oligocene-Early Miocene;
- **U. Miocene**: Precambrian 'basement' supply (probably from the Taurides)



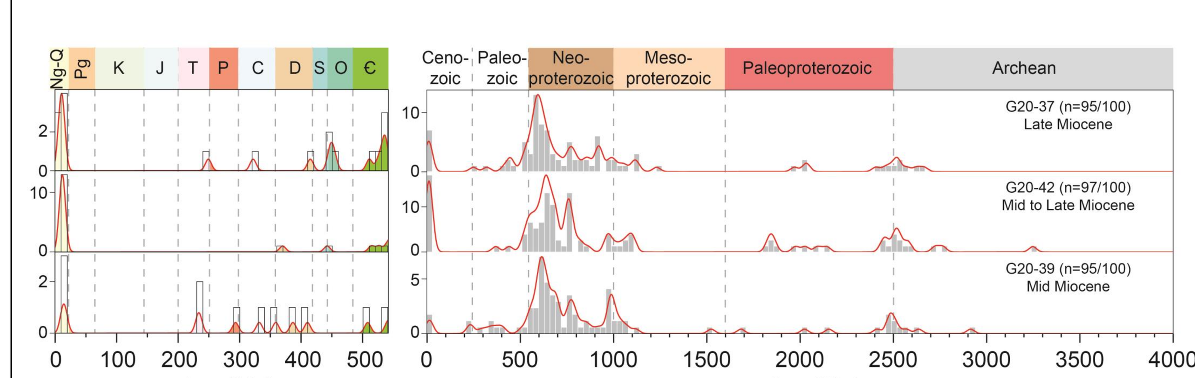
### Misis basin

- **Continuous input** from Late Cretaceous-Miocene units;
- Evidence of **Oligocene-Miocene volcanism**;
- Abundant **input** from **'basement'** only in NE.



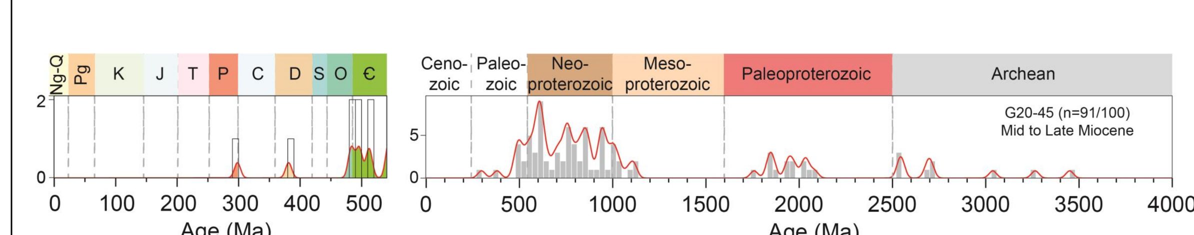
### Mut basin

- **Background input** from Precambrian 'basement' **(ultimately from Gondwana)**;
- **Miocene zircons** from coeval volcanism (to the north).



### Manavgat basin

- **Late Cretaceous input** is relatively **minor**;
- **M. Miocene**: 'basement' grains increase (probably from the Taurides);
- **U. Miocene**: renewed 'basement' input.



### Köprü basin

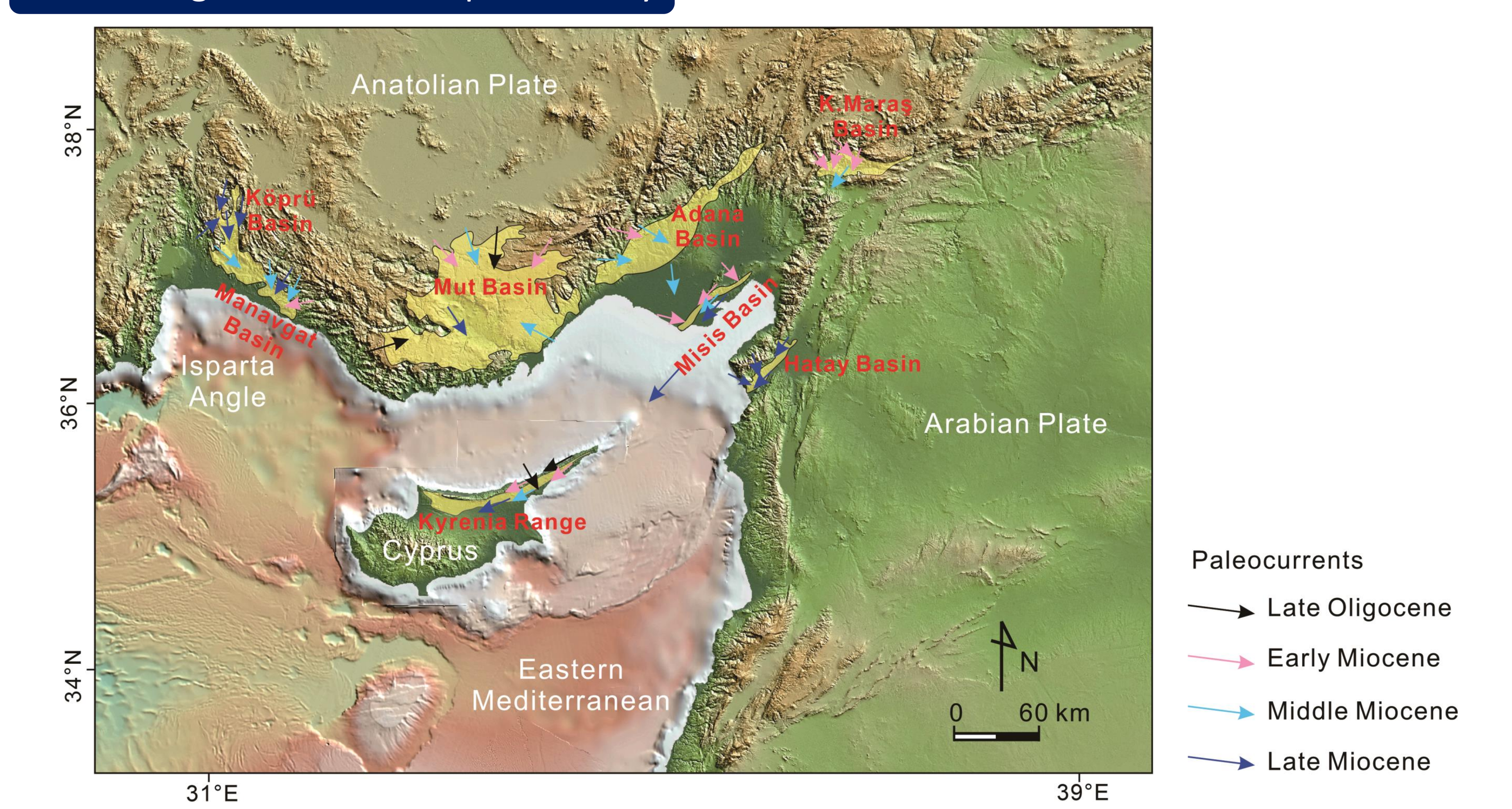
- Precambrian 'basement' grains dominate;
- **Rift-related** zircon distribution;
- Miocene zircons are relatively rare.

## Discussion

### Provenance implications

- Precambrian-Cambrian (1.1-0.9 Ga, 750-500 Ma): NE Africa/Arabian-Nubian Shield origin
- late Ediacaran-early Cambrian (570-520 Ma): Andean-type, Cadomian magmatism
- Ordovician-Devonian (480-360 Ma): extensional pulses in N Gondwana margin (to N)
- Carboniferous (350-310 Ma): recycled from Paleotethys (to N)
- Permian (290-280 Ma): early stage rifting of Neotethys
- Triassic (240-210 Ma): major rifting to open Neotethyan oceans
- Jurassic (170-150 Ma): magmatism within Inner Tauride and/or N Neotethyan oceans
- Cretaceous (97-70 Ma): supra-subduction zone ophiolite and/or magmatic arc
- Paleogene: Eocene (arc magmatism); Oligocene (uncertain, little crustal record)
- Neogene: post-collisional magmatism

### Unravelling sediment transport history




- Each basin has its own sediment transport pathways from its erosional hinterland;
- Late Oligocene: S Turkish basins are mainly non-marine in contrast to deep Mediterranean basin to S (e.g., Kyrenia Range, N Cyprus);
- Early Miocene: multiple feeder channels (e.g., Adana basin); drainage connection of Kahramanmaraş and Misis basins; southeastward transport of detritus in Adana and Mut basins;
- Middle Miocene: regional subsidence created deep-marine depocenters that sloped southwards into the E Mediterranean basin; increased 'basement' input in places (e.g., Hatay and Adana basins);
- Late Miocene: increased basement input related to uplift/exhumation of the Taurides.

## Preliminary conclusions and further research

- Variable zircon populations in the individual Neogene basins point to differing exhumation/erosion histories (related to closure of Neotethyan basins).
- Two main regional drainage system dominated, one through the Kahramanmaraş basin system (E) and the other through the Isparta Angle basin system (W).
- Basement topography/characteristics influenced the basin development/provenance, e.g., the formation of two sedimentary lobes in the Adana basin.
- Erosion/exhumation history relates to an interplay between collisional processes to the N (Inner Tauride and N Neotethyan suture zones) and 'back-arc' extensional processes to the S (subduction of S Neotethys).
- To further determine the provenance affinities, zircon Lu-Hf isotopes will be analyzed using the LA-MC (multi-collector)-ICP-MS.

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