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Thermal histories of k-feldspar from granites located in the central and northern Menderes Massif, western Turkey: Implications for regional extension

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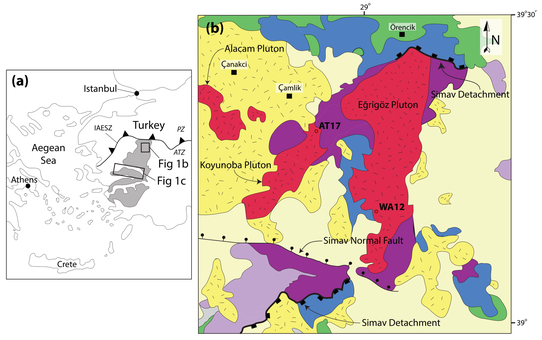
1. Summary

- The Menderes Massif (western Turkey) is a large metamorphic core complex.
  - o Divided into 3 submassifs (southern or Çine, central, northern)
  - o Consists of 4 nappes (Bayındır, Bozdağ, Çine, Selimiye)
- Metamorphic and igneous rocks formed from recurrent collisions between Gondwana related terranes and Laurasia
- Syntectonic magmatism associated with onset extension and unroofing
  - o CMM: Salihli and Turgutlu Plutons located along Alasehir detachment
  - o NMM: Koyunoba and Eğrigöz Plutons
- We report new k-feldspar $^{40}Ar/^{39}Ar$ ages for each above mentioned pluton to explore potential variability in cooling/exhumation histories
  - o Compared to known crystallization ages (zircon U-Pb; monazite Th-Pb)

2. Samples & methods



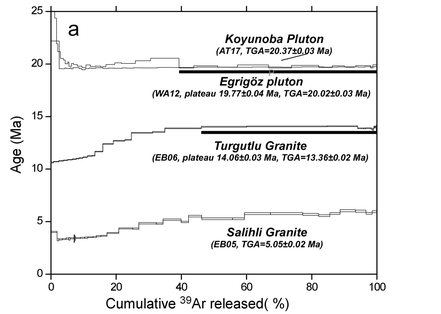
- Samples for k-feldspar $^{40}Ar/^{39}Ar$ geochronology from the NMM Koyunoba (AT17) and Eğrigöz (WA12) plutons, and the CMM Salihli (EB05) and Turgutlu (EB06) Plutons.
- K-feldspar seperates heated using a continuous 25 W CO_2 laser that incrementally increased in intensity from 0.2% to 13.0% total intensity over 31-36 steps.
- MM samples on CMM map relate to a broader study on reconstructing the Cenozoic thermo-tectonic history of the Menderes Massif - preliminary results presented here

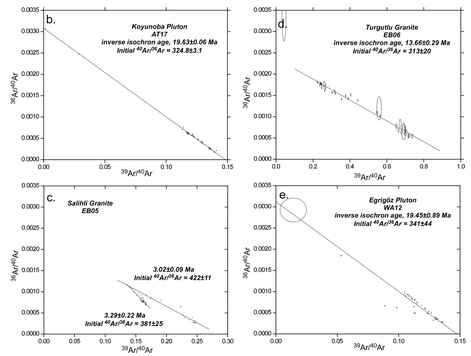
3. New k-feldspar $^{40}Ar/^{39}Ar$ ages

Results at a glance:

- Northern Menderes Massif
  - o Samples are peraluminous calc-alkaline granites to granodiorites
  - o Effectively flat age spectra for both samples
    - o Both early Miocene in age
    - o Rapidly cooled below Ar retention window (~250°C)
  - o Known crystallization ages:
    Eğrigöz pluton: 22.3±1.1-19.0±1.4 Ma (zircon U-Pb; Catlos et al., 2012)
    Koyunoba pluton: 30.0±3.9-14.7±2.6 Ma (zircon U-Pb; Catlos et al., 2012)

- Central Menderes Massif
  - o Samples are calcic to alkali-calcic granites
  - o Ar degassing patterns not flat (protracted cooling)
    - o Turgutlu ages: ranges from 10.62±0.02 Ma to plateau age of 14.06±0.03 Ma
      - o Inverse isochron age: 13.66±0.29 Ma
    - o Salihli ages: ranges from 3.27±0.10 Ma to a maximum age of 6.05±0.09 Ma
      - o Two inverse isochron ages:
        3.02±0.09 Ma (from intial to step 19)
        3.29±0.22 Ma (from step 20 to 31)
  - o Crystallization ages:
    Turgutlu granite: 15.0±1.7 Ma (monazite; Catlos et al., 2010)
    Salihli grante: 15.0±2.8 Ma (monazite; Catlos et al., 2010)





4. Cenozoic Metamorphism in the CMM: reconstructing pre-extensional tectonics

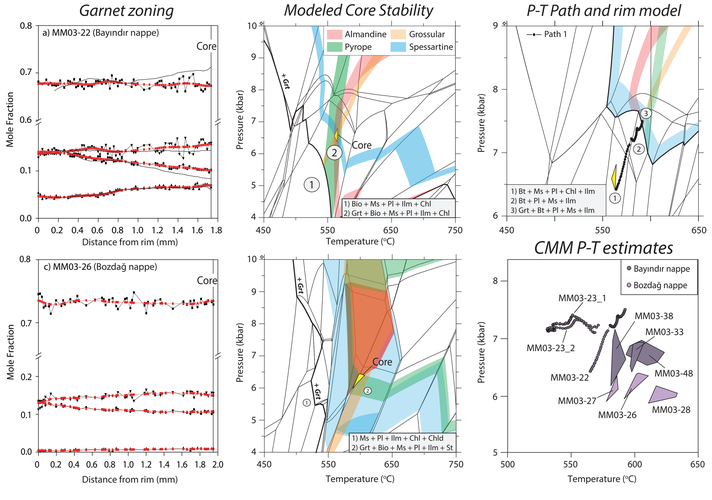
Approach:

- Metamorphic conditions were estimated for Bayındır and Bozdağ nappe garnet-schists using a new method recently applied elsewhere in the Menderes Massif (Etzel et al., 2019).

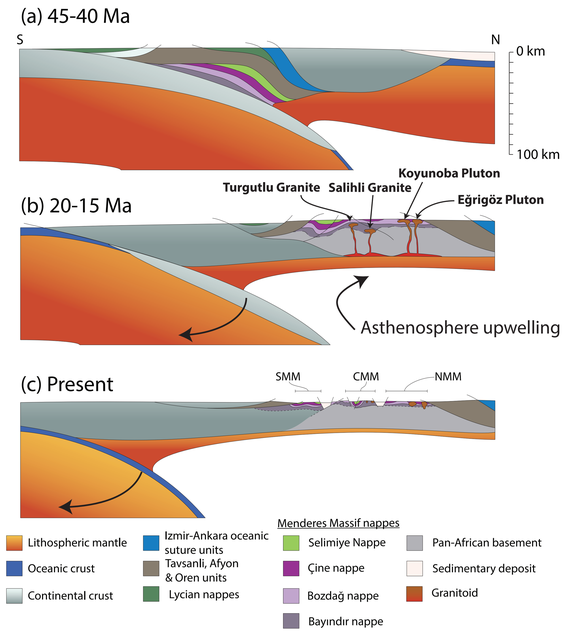
Results at a glance:

- Bayındır nappe (MM03-22, 23, 32, 33, 38, 48)
  - o Range of modeled core P-T conditions: 6.5-7 kbar and 540-600°C
  - o Two successful garnet P-T paths
    - o Isobaric with increasing T
    - o Increasing P with increasing T
  - o Monazite ages (Th-Pb): 20.6±3.3-31.5±2.7 Ma

- Bozdağ nappe (MM03-26, 27, 28)
  - o Range of modeled core P-T conditions: 6-6.3 kbar and 575-625°C
  - o Unable to model P-T path due to partial diffusion and resorption
  - o Monazite ages (Th-Pb): 28.0±2.5-35.8±3.0 Ma



5. Schematic evolution of the Menderes Massif



Based on results presented here, and in previous interpretations (e.g., Erkul and Erkul, 2012; Baran et al., 2017; Rossetti et al., 2017), we propose the following tectonic evolution model of the Menderes Massif from the Eocene to present:

a) Barrovian-style prograde metamorphism in the CMM reached peak conditions by late Eocene - Early Oligocene. This resulted from collision between Gondwana and Laurasia.

b) The region transitioned from shortening to extension by the mid-Oligocene. Extension was likely driven by rollback of the subducting oceanic lithosphere. Decoupling and rollback led to asthenosphere upwelling, which was responsible for melt generation and emplacement of the Oligo-Miocene granites exposed in the Central and Northern Menderes Massifs.

c) As extension continued, the Eğrigöz and Koyunoba Plutons exhumed and rapidly cooled below ~250°C by 20 Ma. In the CMM, the Turgutlu and Salihli Granites experienced a more prolonged cooling/exhumation history. Largely driven by tectonic extension, the Turgutlu granite cooled below 250°C over a 3 m.y. period between 13.5 Ma and 10.5 Ma. Undoubtedly the Salihli granite was also partially exhumed during this period, however, our $^{40}Ar/^{39}Ar$ data suggest it did not cool below 250°C until ~5 Ma, where a combination of tectonic forces and erosional denudation acted in concert to exhume this granitic body along the Alaşehir detachment. The results suggest the detachment did not have a homogeneous extensional history along strike.

Acknowledgements

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- *References can be provided upon request*