

Introduction

- The Late Cretaceous volcanic and volcanoclastic rocks crop out along the Black Sea coastline in Turkey (Figure 1). They are part of a magmatic arc formed as a result of northward subduction of the Neo-Tethys ocean beneath the southern margin of Eurasia. Late Cretaceous volcanic and volcanoclastic rocks are well-exposed in the Kefken region, 100 km east of Istanbul (Figure 2). They are divided into lower and upper volcanic series based on their stratigraphic position. The lower volcanic series of Campanian age consists of agglomerate and tuff with minor amount of basaltic and andesitic lavas of Yemişliçay Formation, which is conformably overlain by Late Campanian-Early Eocene limestones and marls of Akveren Formation. The upper volcanic series of Maastrichtian age consists of trachyandesite, basalt, volcanic breccia, lapilli tuff and tuff. It forms a volcanic horizon within the limestones and marls (Akveren Formation) and is named as the Babaköy Member.
- The aim of the study is to understand the petrogenesis of Late Cretaceous magmatism and the evolution of magmatism over time in the Western Pontides by using geological mapping, U-Pb geochronology, geochemistry and biostratigraphy.

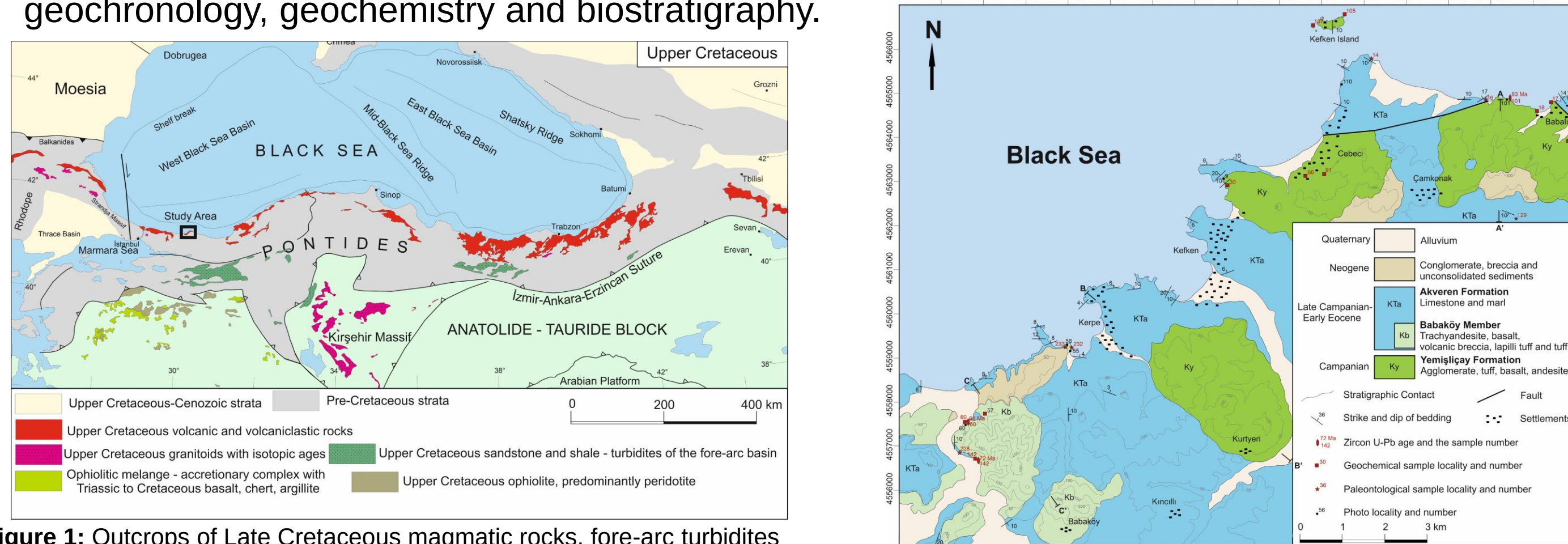


Figure 1: Outcrops of Late Cretaceous magmatic rocks, fore-arc turbidites and ophiolites in the Black Sea region (modified from Okay and Nikishin, 2015).

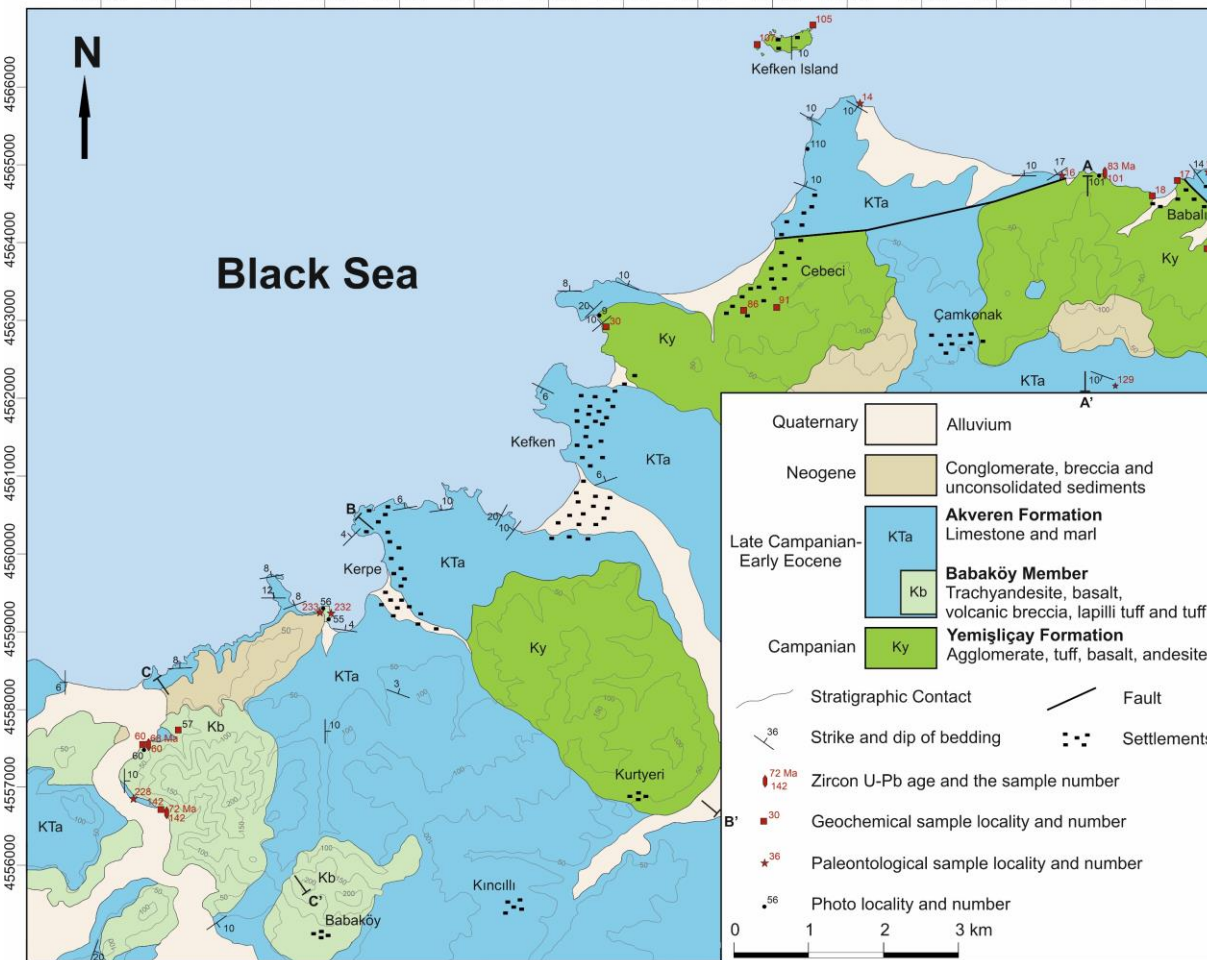


Figure 2: Geological map of the Kefken region.

Stratigraphy and Petrography

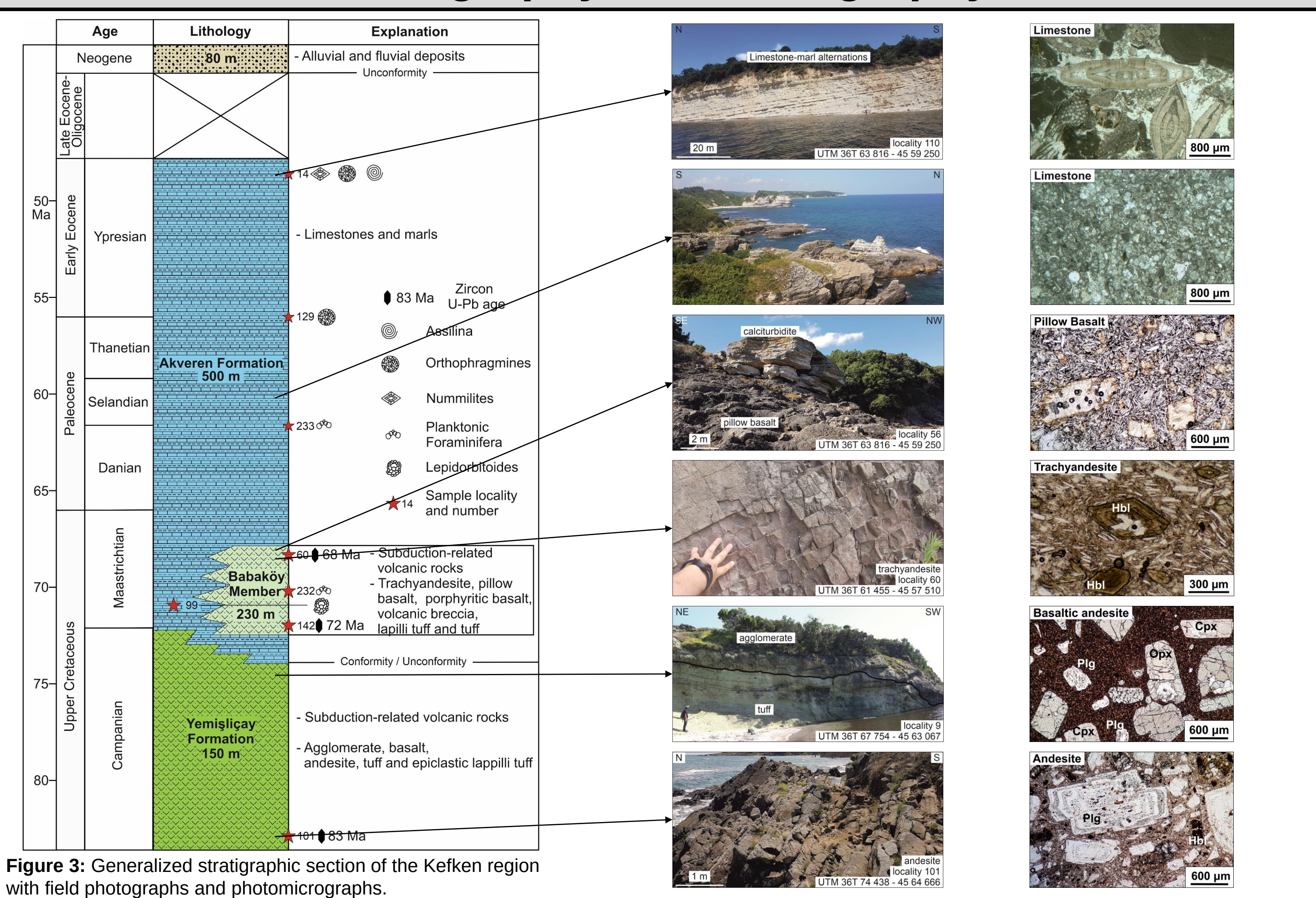


Figure 3: Generalized stratigraphic section of the Kefken region with field photographs and photomicrographs.

Geochronology

1-) U-Pb Zircon Ages

- U-Pb zircon dating was performed in three samples to constrain the magmatic crystallization ages of arc-related volcanic and volcanoclastic rocks in the Kefken region, Western Pontides.
- One andesite sample (101) from the lower volcanic series (Yemişliçay Formation) gave an U-Pb zircon age of 83.3 ± 1.8 Ma (Figure 4a). Two trachyandesite samples (60 and 142) from the upper volcanic series (Babaköy Member) gave U-Pb zircon ages of 68.3 ± 3.0 Ma and 71.5 ± 0.7 Ma, respectively (Figure 4b, c).
- Dated samples also contain inherited zircon grains with ages from Neoproterozoic (682 Ma) to Late Triassic (202 Ma).

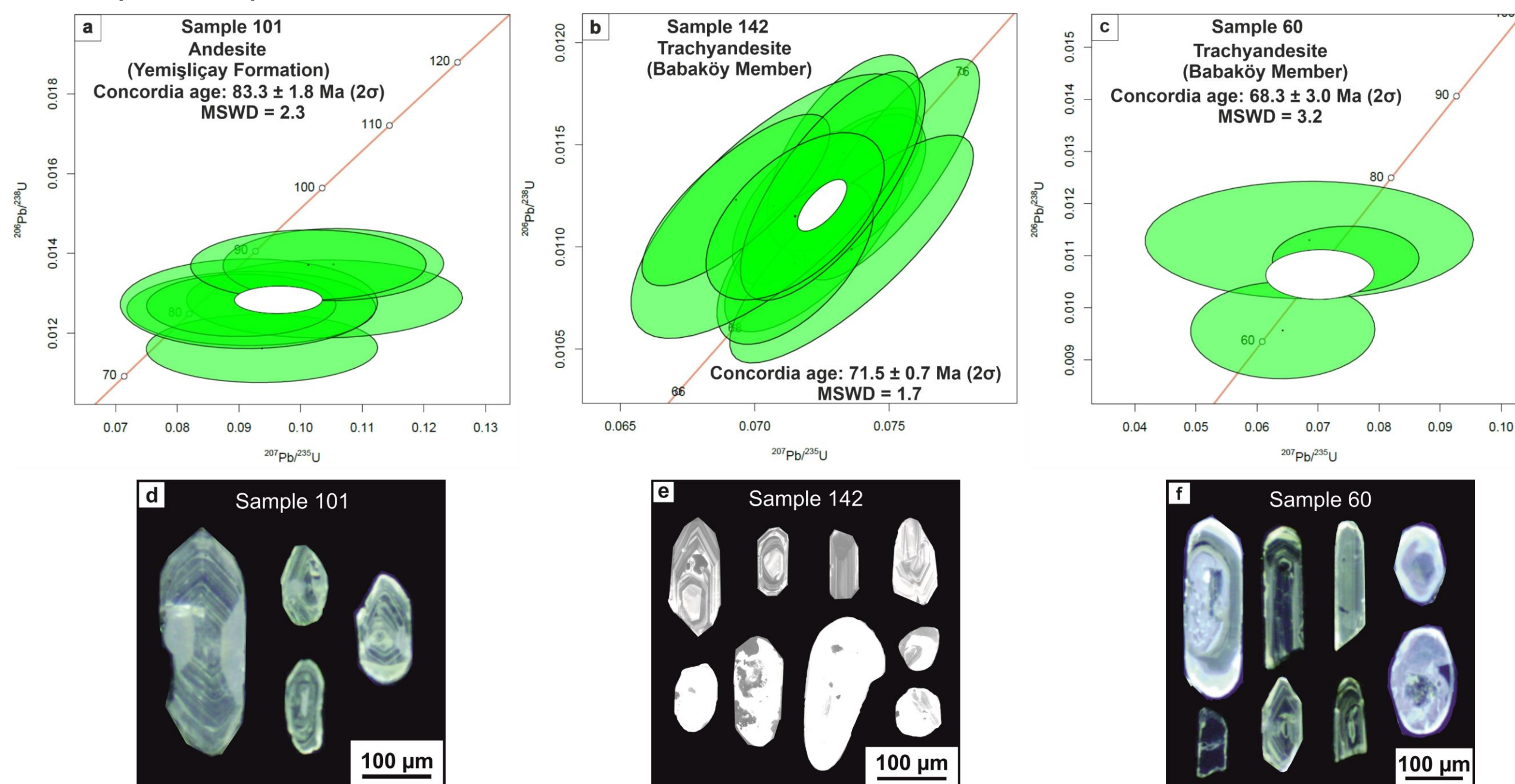


Figure 4: (a-c) Zircon U-Pb concordia diagrams from the Late Cretaceous volcanic rock samples in the Kefken region, Western Pontides. (d-f) Cathodoluminescence images of dated zircons from (d) andesite and (e, f) trachyandesite samples in the Kefken region. Ages were calculated by IsoplotR (Vermeesch, 2018).

2-) Paleontological Ages

- The fossils identified in the Kefken region provided important constraints for the age of the volcanic rocks in the light of the contact relations between the volcanic rocks and limestones.
- Intra-pillow biomicrites that contain the Maastrichtian planktonic foraminiferal assemblage (Figure 6a) show that the volcanism continuous in Maastrichtian. Danian-Selandian calciturbidite sequence contains planktonic foraminifera assemblages (Figure 6b) and lies directly over the Maastrichtian pillow basalts.
- Limestones and marls of the Akveren Formation deposited from Late Cretaceous to Early Eocene according to defined benthic and planktonic foraminiferal data in the Kefken Region (Figure 5, 6, 7).

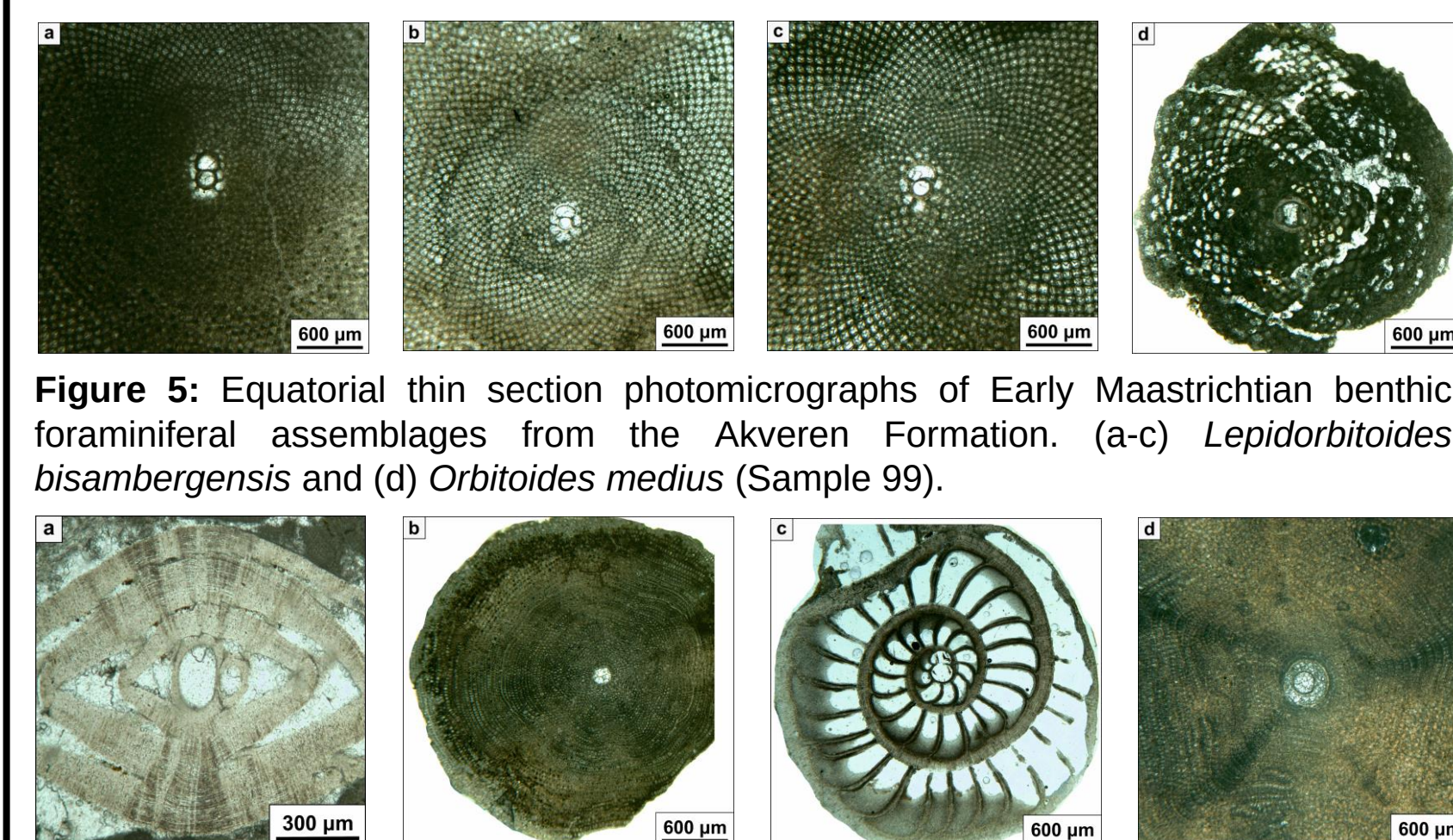


Figure 5: Equatorial thin section photomicrographs of Early Maastrichtian benthic foraminiferal assemblages from the Akveren Formation. (a-c) *Lepidorbitoides bisambergensis* and (d) *Orbitoides medius* (Sample 99).

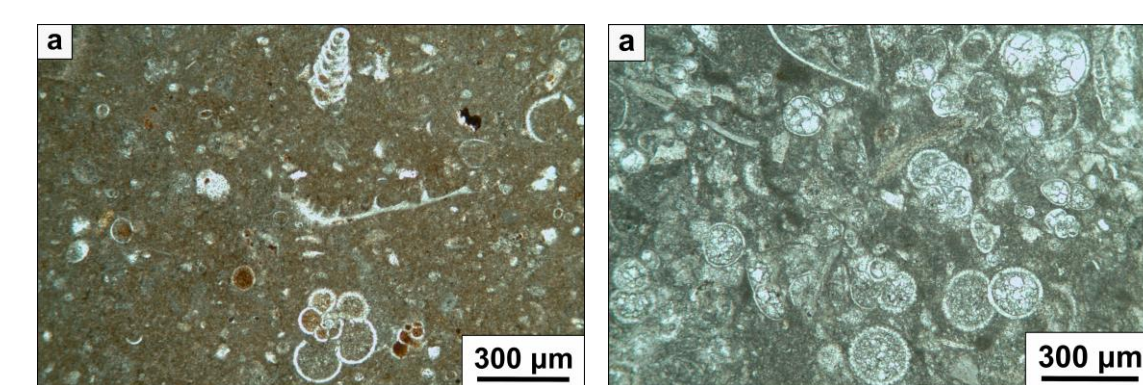


Figure 6: (a) Photomicrograph of the Maastrichtian intra-pillow biomicrite from the Babaköy Member contains planktonic foraminiferal assemblages *Heterohelix* sp., *Globotruncana* sp., *Globotruncanella havanensis*, *Globotruncanella petaloides*, *Pithonella ovalis*, *Globigerinelloides* sp., *Pseudotextularia* sp., *Macroglobigerinelloides* sp. and *Pseudotextularia elegans* (Sample 232). (b) Photomicrograph of the Danian-Selandian calciturbidite from the Akveren Formation contains planktonic foraminiferal assemblages *Parasubbotina pseudobulboides*, *Subbotina triloculinoidea*, *Globonomalina* sp., *Chiloguembelina* sp., *Praemurica* sp., *Subbotina* sp. and *Praemurica uncinata* (Sample 233).

Geochemistry

- Campanian **basaltic andesites – andesites (Yemişliçay Formation)** from the lower volcanic series are derived from the partial melting of the mantle wedge induced by hydrous fluids released via dehydration of the subducted oceanic slab with (Figure 8)
 - Marked negative anomalies in Nb and Ta and Ti.
 - Enrichment in large ion lithophile elements (LILE) (Cs, Rb, Ba, Th)
 - Slightly enrichment in light rare earth elements (LREE) relative to heavy rare earth elements (HREE)
- Maastrichtian **trachyandesites (Babaköy Member)** from the upper volcanic series are formed as a result of partial melting of the oceanic slab under garnet and amphibole stable conditions and show distinct adakitic geochemical signatures with (Figure 8, 9)
 - High ratios of Sr/Y (>85.5)
 - Low content of Y (7.4-8.6 ppm)
 - High content of plagioclase-compatible Sr, Ba
 - High ratios of La_{cn}/Yb_{cn}
 - Absence of Eu anomalies

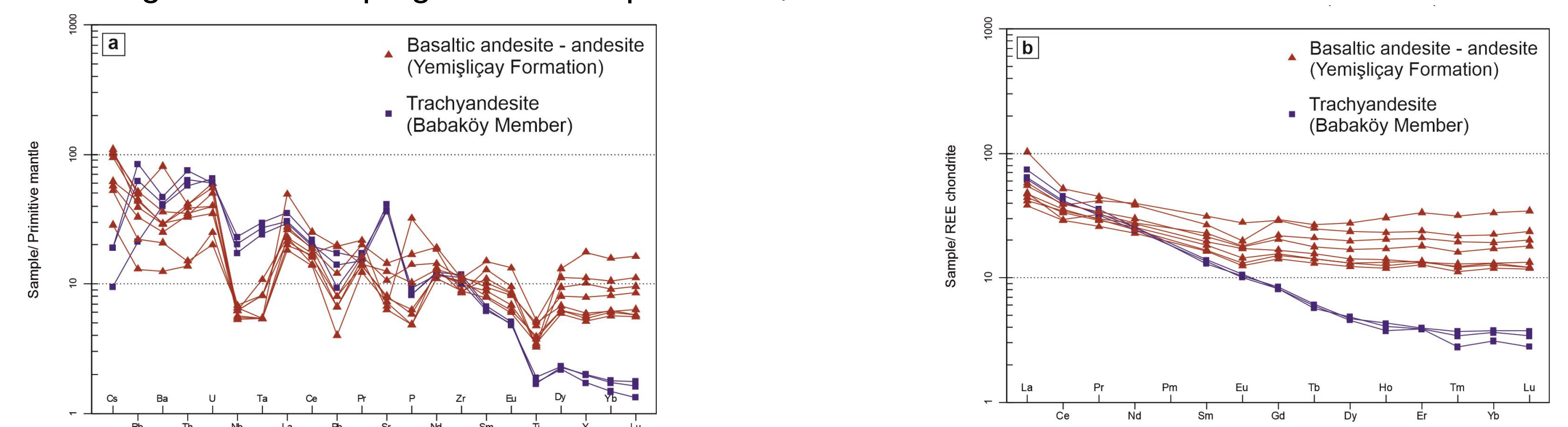


Figure 8: (a) Primitive mantle-normalized trace element abundance patterns (normalized to values given in McDonough and Sun, 1995) and (b) Chondrite-normalized REE patterns of two different volcanic series (normalized to values given in Boynton, 1984).

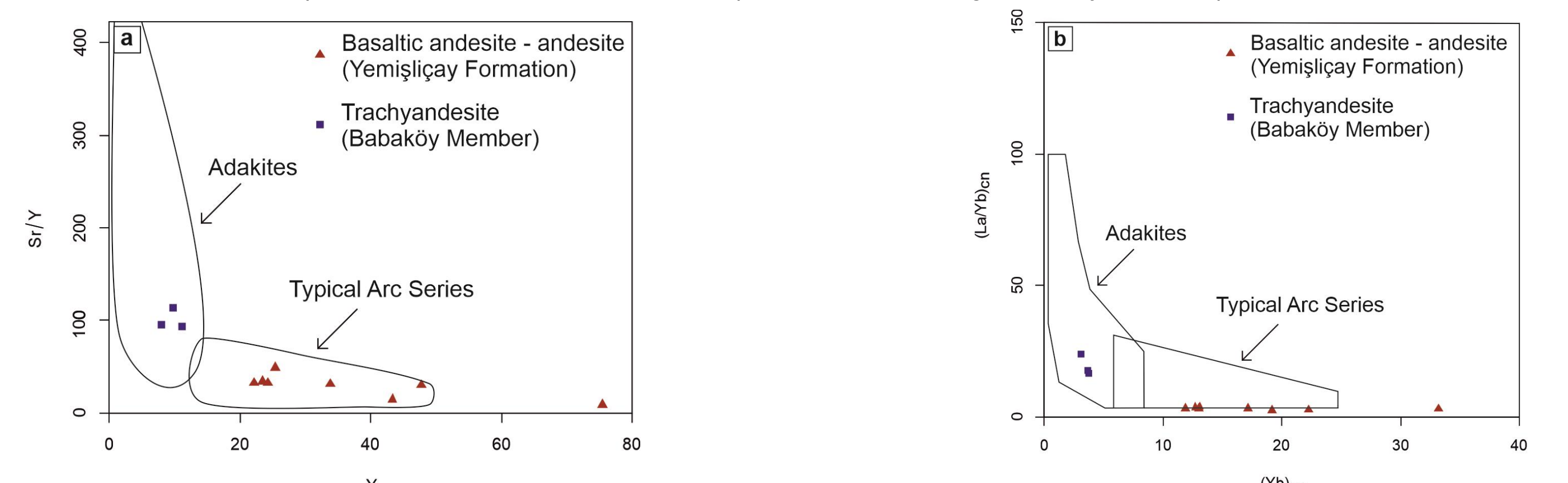


Figure 9: (a) Sr/Y vs Y and (b) $(La/Yb)_{cn}$ vs $(Yb)_{cn}$ adakite discrimination diagrams (Defant and Drummond, 1990) of two different volcanic series.

Conclusions

- The Late Cretaceous arc sequences in the Kefken region show a change from typical subduction-related magmas in Campanian (~83 Ma) to adakitic ones in Maastrichtian (72–68 Ma), accompanied by a decrease in the volcanism.
- U-Pb zircon ages from the volcanic rocks and foraminiferal data from the limestones provide that the volcanism in the region ceased towards the end of the Maastrichtian and the deposition was continued with the limestones and marls until the Middle Eocene.

References

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