SUBDUCTION INITIATION CLOSE TO THE CONTINENTAL MARGIN?

Implications from U-Pb zircon geochronology of the Pınarbaşı metamorphic sole, central Turkey

Universiteit Utrecht

Kalijn Peters*, Douwe J.J. van Hinsbergen*, Fernando Corfu, Derya Gurer*, Fraukje M. Brouwer***, Herman L.M. van Roermund***

*Department of Earth sciences, Utrecht University, The Netherlands, e-mail: M.K.Peters@uu.nl, Department of Geosciences, University of Oslo, Norway, ***Department of Earth and Life sciences, VU University Amsterdam, The Netherlands

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PINARBAŞI METAMORPHIC SOLE

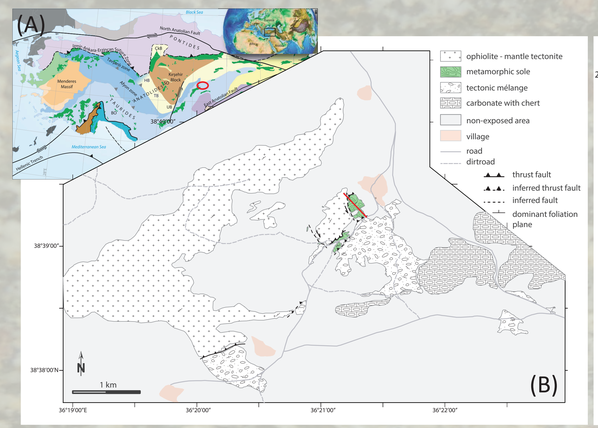

Figure 1. (A) Tectonic map of Turkey, van Hinsbergen et al. (2017). BO=Beyşehir Ophiolite; ÇkB=Çankırı Basin; HB=Haymana Basin, SO=Sarıkaraman ophiolite; TB=Tuzgölü Basin; and UB=Ulukışla Basin. (B) Geological map of the Pınarbaşı ophiolite. Metamorphic sole is indicated in green, with the profile for the tectonostraigraphic column in red.

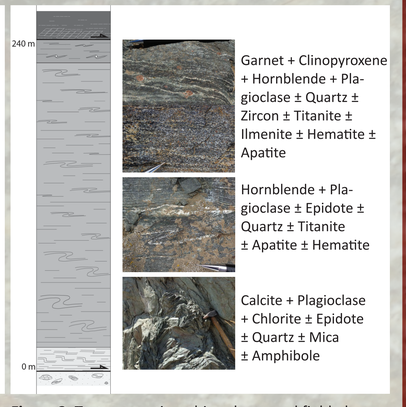

Figure 2. Tectonostratigraphic column and field photographs of the Pınarbaşı metamorphic sole, with the highest grade rocks at the structural top underneath the serpentinised peridotite and the lowest grade rocks at the bottom, overlying the tectonic mélange.

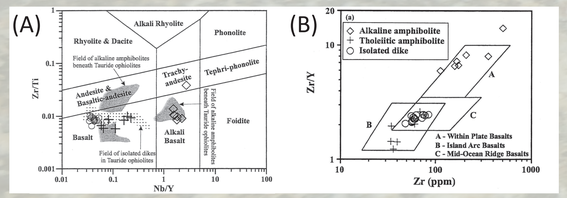

Figure 3. Rock classification diagram (A) and tectonomagmatic discrimination diagram, after Pearce (1979) (B) for the metamorphic sole rocks and isolated dikes of the Pınarbaşı ophiolite (Vergili and Parlak, 2005).
Field of metamorphic soles and mafic dikes from Tauride ophiolites are from Parlak et al. (1995), Lytwyn and Casey (1995), Dilek et al. (1999), Parlak (2000)and Çelik and Delaloye (2003).

Metamorphic soles below ophiolites record high (up to ~850°C) metamorphic temperatures at pressures up to 10-15 kbar, uncommon in normal subduction zones. They are therefore interpreted to form during intra-oceanic subduction initiation at locations within ocean basins where high temperatures exist at relatively shallow depths, i.e. in the vicinity of mid-ocean ridges.

The Pınarbaşı metamorphic sole in Turkey is a particularly well-preserved example and consists of a sequence of a few hundred meters thick strongly foliated metabasites and pelagic sediments. The Pınarbaşı sole thus fits well in the general tectonostratigraphy and metamorphic facies of soles worldwide, generally interpreted to represent the top of a nascent intra-oceanic subducting slab that accreted to the base of the hot overriding oceanic plate. This implies that the metamorphic sole could yield constraints on the initiation of subduction in an oceanic domain. One of the remaining questions is:

Did subduction start at, close to or further away from the mid oceanic ridge?

AGE DATING OF METAMORPHIC SOLE

Published 40Ar/39Ar chronology

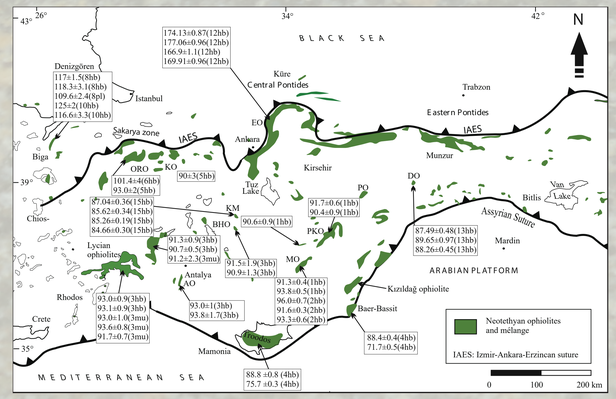

Figure 4. Distribution of ophiolites in Turkey and 40Ar/39Ar ages for the metamorphic soles, after Parlak (2016).

Data are from:
1. Dilek et al. (1999)
2. Parlak and Delaloye (1999)
3. Çelik et al. (2006)
4. Chan et al. (2007)
5. Önen (2003)
6.Harris et al. (1994)
8. Okay et al. (1996)
10. Beccaletto and Jenny (2004)
12. Çelik et al. (2011)
13. Parlak et al. (2013)
15. Daşçı et al. (2015)

Abbreviations:
AO - Antalya ophiolite
BHO - Beyşehir-Hoyran ophiolite
DO - Divriği ophiolite
EO - Eldivan ophiolite
KO - Kınık ophiolite
KM - Konya Melange
MO - Mersin ophiolite
ORO - Orhaneli ophiolite
PO - Pınarbaşı ophiolite
PKO - Pozantı-Karsantı ophiolite
hb - hornblende
mu - muscovite

The age of metamorphic soles has commonly been dated by 40Ar/39Ar chronology. Across Turkey, soles generally provide Ar-Ar ages of 94-90 Ma, interpreted as cooling of the soles during exhumation and subduction zone maturation.

New U/Pb zircon chronology

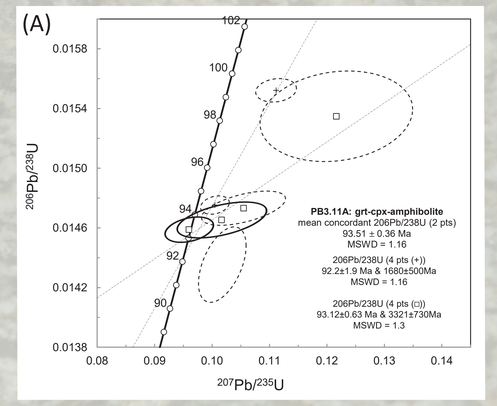

Figure 5. (A) Concordia diagram displaying U/Pb ages for zircon grains from the Pınarbaşı metamorphic sole. Ellipses indicate the 2σ uncertainty. MSWD + mean square of weighted deviates. (B) Photomicrographs of zircon grains used for dating; grainsize 90-120 µm.

The garnet-clinopyroxene amphibolite in the top of the metamorphic sole of the Pınarbaşı ophiolite contains zircon. U/Pb ID-TIMS zircon chronology gives a mean age of 93.51±0.36 Ma, which we interpreted as the age of peak metamorphism in the garnet-clinopyroxene amphibolites. Surprisingly, the zircon grains also include inherited cores pointing to a derivation from Precambrian crust. These zircon cores are likely a detrital component in the Pınarbaşı sole derived from the continental margin.

START OF SUBDUCTION CLOSE TO CONTINENTAL MARGINS LIKELY

From the inherited cores in the zircon grains we infer, that subduction initiation in Turkey occurred so close to the continental margin that clastic continent-derived sediments were incorporated in the sole upon subduction initiation. We therefore tentatively conclude that subduction initiation close to continental margins, within ancient oceanic crust seems to be possible.

Further research will be done to determine the origin of the inherited zircon cores.

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