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Exhumation with a twist: restoration of the Menderes Metamorphic core complex since the late Oligocene

Douwe J. J. van Hinsbergen
University of Oslo, Physics of Geological Processes, University of Oslo, Norway (d.v.hinsbergen@fys.uio.no)

Here, I provide a restoration of the post-Oligocene unroofing history of the Menderes metamorphic massif of western Turkey. Exhumation of this massif – among the largest continental extensional provinces in the world – is generally considered to have occurred along extensional detachments with a NE-SW stretching direction. Restoration of the early Miocene history, however, shows that this simple history is impossible to reconstruct.

Restoration back to ∼15 Ma is relatively straightforward, and is mainly characterised by a previously reported ∼25° vertical axis rotation difference between the northern Menderes Massif, and the Southern Menderes Massif, Lycian Nappes and Bey Dağları about a pole close to Denizli. To the west of this pole, the rotation was accommodated by exhumation of the Central Menderes core complex since middle Miocene times, and to the east by compressional deformation of the Lycian Nappes. Evidence for the latter is not abundant, but a dextral transpressional system in the heart of the Isparta Angle, and post-Oligocene thrusting in the Denizli basin are in line with this suggestion.

At the end of the early Miocene, the Menderes Massif formed a rectangular, NE-SW trending tectonic window of ∼150x100 km. Fission track- and cooling ages suggest unroofing between ∼25 and 15 Ma. The northeastern Menderes Massif was exhumed along the early Miocene Simav detachment, over a distance of ∼50 km. The accommodation of the remainder of the exhumation is enigmatic, but was presumed to also result from NE-SW extension. This, however, requires a transform fault along the eastern margin of the Menderes massif with an offset of ∼150 km, cutting througth the Lycian Nappes, for which there is no evidence in the latter.

The Lycian Nappes have been previously shown to thrust to the SE between 23 and 15 Ma over at least 75 km. This is contemporaneously with, and orthogonally to stretching along the Simav detachment. It is argued that the amount of emplacement was twice the minimum amount of 75 km, which would restore the Lycian nappes back on top of most of the Menderes Massif, apart from the 50 km unroofed along the Simav detachment. A decollement was likely formed by the metamorphosed deeper structural levels of the Lycian nappes, in line with preserved E to SE-ward (corrected for rotation) kinematic indicators. Late Oligocene to earliest Miocene fission track ages of the Menderes Massif, as well as NE-SW trending grabens on the Massif support this hypothesis.

The main implications of this restoration are that 1) the eastern part of the Aegean back-arc accommodated only 50 km of NE-SW extension in the early Miocene, and 2) the bulk of exhumation of the Menderes massif occurred prior to Miocene extensional unroofing and can not be attributed to the known extensional detachments. The restoration in this paper suggests that most of the Menderes Massif already resided at upper crustal levels at the inception of extensional detachment faulting, a situation remiscent of the exhumation history of the island of Crete. A solution for this problem remains open for discussion.