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Tectonic framework of hydrothermal and geothermal systems in the Menderes Massif, western Turkey

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The Menderes Massif in western Turkey lies at the eastern margin of the Hellenic subduction zone's continental backarc. Substantial hydrothermal alteration and geothermal activity have accompanied Miocene to recent extensional tectonics. Here we propose that the locations of Cenozoic magmatic, hydrothermal and geothermal activity are controlled by structures that formed to accommodate an overall E-W gradient in the magnitude of continental extension. We present data that demonstrate the close spatial relationship between Miocene transtensional deformation, magmatism, tectonic denudation, and the location of mineral deposits and geothermal fields.

The Menderes Massif is part of the Tauride block, a distinct lithospheric province within the Alpine orogenic belt in western Turkey. Alpine contraction occurred from Cretaceous to Palaeogene during N – S convergence, including subduction of the Vardar-Izmir and the Pindos oceans and the collision of adjacent continental fragments with the Tauride block. Pre-Alpine basement rocks are predominantly late Proterozoic to Cambrian ('Pan-African') in age, while basement rocks along strike in the Aegean Sea area are generally of Carboniferous age. While the nature of this boundary between the Pan-African and Carboniferous crustal domains is not clear, a significant difference exists in their geodynamic history. Whereas early in the Miocene the Hellenic subduction zone began to retreat in the Aegean Sea area, this apparently did not happen in western Turkey. Instead there is evidence for a tear in the slab that causes a thermal anomaly in the lithosphere.

Miocene to recent extension in the Menderes Massif has led to the formation of metamorphic core complexes, NE-striking basins and a series of large E-W trending graben. These structures accommodate the overall sinistral strike-slip deformation forced by the slab retreat in the Aegean Sea region. The Menderes Massif hosts a variety of hydrothermal mineral deposits, including gold, copper, antimony, uranium and mercury. While there is evidence for gold mineralisation during crustal shortening, most other deposit types including epithermal gold, detachment gold, mercury, and sandstone-hosted uranium formed during the Miocene to recent crustal extension.

Alteration of basement rocks and Cenozoic volcanic and sedimentary sequences is common in both fossil hydrothermal systems and geothermal fields. Hydrothermal activity is structurally controlled, and has predominantly occured along structures related to the formation of E-W graben. In addition to the involvement of meteoric fluids a mantle component has been shown.

The apparent continuity in tectonic boundary conditions in the Menderes Massif since the Miocene, and the ongoing hydrothermal activity provide important insights into the structural control on hydrothermal mineral systems within or near continental backarcs.