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Mantle-Helium Distribution in Western Anatolia, Turkey: Relationship to Heat Distribution, Active Extension and Volcanism

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Western Anatolia comprises one of the world's best known extensional terrains and is characterized by the presence of several moderate- to high-enthalpy geothermal fields located along the boundary faults of the major grabens. Helium-isotope compositions of geothermal fluids reflect mixing between mantle ($^3He/^4He = 8R_A$ where R_A = air $^3He/^4He$; [1]) and crustal ($^3He/^4He < 0.1R_A$; [2]) components, the former ranging up to 45 % of the total helium in a given sample. There is a general positive correlation between the distribution of heat and helium in western Anatolia, suggesting similar mechanisms for their transfer to the surface. The fact that the mantle-He contribution in the vicinity of the Quaternary Kula volcanics is amongst the highest reported for western Anatolia ($2.8R_A$) further suggests that this transfer probably occurs in association with mantle melting accompanying current extension in the region. The spatial association of most of the high-entahlpy fields with the young alkaline volcanics (except in the Büyük Menderes Graben; BMG) is in support of this argument. On the other hand, the observations that i) there is a lack of volcanic exposures along the BMG (except at its western and southeastern terminations) where the highest values are recorded for both heat and helium, and ii) relatively high mantle-He contributions occur in areas of not only the young alkaline, but also the old calc-alkaline volcanics, imply that the transfer of heat and helium may also be accomplished via plutonic activity. In this respect, the large range observed in the helium-isotope compositions may be linked with differential (local) extension rates and associated melt generation in the respective areas. This suggestion can be substantiated with a better regional coverage of He-isotope data which, unlike heat flow data, are currently restricted to point localities. Nevertheless, the present study suggests that the eastern segment of the BMG is a target locality for further studies from various disciplines concerned with active tectonics.

References

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