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Variable thermal histories along the northern Outer Carpathians: new thermochronological and thermal maturity data from Ukraine

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During last decades the Carpathian-Pannonian region has been object of a vivacious scientific debate, focusing on causes and dynamics of its evolution. Based on thermochronological and paleo temperature data, reconstruction of thermal history and of burial and exhumation paths represents a powerful tool to constrain the evolution of the chain.
Recently, a remarkable number of such studies focused on the Polish Outer Carpathians, allowing to well describe burial and exhumation history of that portion of the accretionary wedge. In particular Mazzoli et al. (2010) and Zattin et al. (2011) suggested that two different stages of exhumation occurred: an enhanced-by-thrusting erosional exhumation stage, and an extension related exhumation stage.
Topography and structural setting of the chain seem to support this hypothesis, appearing characterized respectively by alternation of heights and lows and by normal reactivation of reverse structures, particularly in the eastern Polish Carpathians, where extension-related ages occur.
As an integration to the thermal dataset of the Outer Polish Carpathians, new apatite fission track (AFT) and vitrinite reflectance samples, collected along three transects in the Ukrainian Outer Carpathians, were analyzed.
Coupled vitrinite reflectance and AFT annealing degree data highlight a trend of burial temperatures depending on structural position and increasing toward the inside of the chain, reaching temperatures higher than 120°C throughout the inner units, and being lower than 65°C only in the outermost unit (namely the Skole Unit). Considering a constant paleo-geothermal gradient of 35°C/Km, the estimated burial depth for the Skole unit is lower than 2 Km, whereas the innermost units were likely buried at depths higher than 3.5 Km; a contribution of tectonic load is required to reach these burial depths.
Ages of AFT totally annealed samples range between 8.4 and 11.6 Ma, indicating that the innermost portion of the wedge exhumed in the Tortonian, during or immediately after the final stages of thrusting. HeFTy backward models, based on AFT ages and length and vitrinite data, support this hypothesis.
Based on integration of structural and topographic features with thermochronological-paleothermal data, this study allowed the identification of well defined trends of cooling ages and burial temperatures throughout the Polish and Ukrainian Outer Carpathians. Burial temperatures gradually increase toward the inside of the chain, following the principal tectonic structures, and toward the East.
Ages of cooling reach their minimum in eastern Poland, where relief appears collapsed, and gradually increase toward the West and toward the East, along with increasing relief.
We suggest that exhumation driven by extension was active mainly in the eastern Polish sector. A partial collapse and related exhumation occurred in the western Poland, whereas in Ukraine mainly erosional exhumation of the accretionary wedge occurred and no extension related exhumation can be identified.

References

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