Subsequent exhumation, burial and exhumation of the Tatra Mountains constrained by the low temperature thermochronology

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The Tatra Mountains form the highest peaks of the Carpathian mountain range in southern Poland and northern Slovakia. They are composed of a crystalline Variscan granite core and folded Mesozoic sedimentary cover, and are surrounded by slightly deformed sediments of the Central Carpathian Paleogene Basin (CCPB). In the north they are overlapped by transgressive Eocene conglomerates and carbonate deposits of the Podhale syncline – part of the CCPB. In the south they are separated from Eocene-Oligocene flysch strata of the Liptov Basin by the Sub-Tatra fault. The geometry and kinematics of the Sub-Tatra fault are still under debate. The deformation history of the Tatra block can be divided into the Late Cretaceous "Alpine" collision, a Paleogene burial under the CCPB forearc sediments and a Neogene exhumation and uplift. The amount of the pre-Eocene exhumation and timing of the Neogene emergence of the Tatra Mountains and its mechanisms are still poorly constrained.

Through the project IP7 of Thermo-Europe supported by the EUROCORES programme TOPO-EUROPE of the European Science Foundation we are performing the low temperature thermochronometry of apatite and zircon (AFT, AHe, ZHe) from the granite samples of the Tatra Mountains. We have sampled along sub-horizontal N–S profile through the High Tatras (including sub-vertical profile in the Czarny Staw area) as well as the E–W profile along the Sub-Tatra fault.

Apatite He ages from all samples (n = 14) are remarkably uniform with the average 14.5 ± 1.5 Ma. AFT ages range from 15 to 17 Ma in the north and 14 to 20 Ma in the south and along the Sub-Tatra fault. The AFT lengths are unimodal with a mean track length of 13–14 μm. The AHe and AFT data indicate a pulse of rapid, uniform exhumation of at least 3 km between ~18 and ~14 Ma, with exhumation of less than 2 km in the last ~10 Ma. Zircon He ages vary from 40 to 45 Ma in the north and core of the massif, to 21 ± 3 in the south close to the Sub-Tatra fault. This difference might reflect northward tilting or fault related folding of the High Tatras that caused exhumation of about 3 to 4 km along Sub-Tatra fault prior to more uniform exhumation revealed by AFT and AHe ages.

We conclude that the most significant episode of exhumation in the Tatra Mountains is non-rotational and is coeval with Miocene tectonic activity, expressed in folding and thrusting in the Outer Carpathians. After cessation of thrusting at the front of the orogen at ~11–12 Ma there has been no significant inversion of the Tatra Mountains. ZHe ages record post-Alpine exhumation prior to Eocene transgression of the CCPB on eroded and most probably strongly faulted Tatra block. The original thickness of Mesozoic nappes is estimated to be 5–7 km.