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Neogene exhumation of the Northern Carpathians revealed by low temperature thermochronology.

M. Śmigielski (1), F.M. Stuart (2), P. Krzywiec (3), C. Persano (4), H.D. Sinclair (5), K. Pisaniec (3), and K. Sobien (3)

(1) Institute of Geology, Faculty of Geology, University of Warsaw, Zwirki i Wigury 93, Warsaw (m.j.smigielski@gmail.com), (2) Scottish Universities Environmental Research Centre, Isotope Geosciences Unit, Rankine Avenue, East Kilbride G75 0QF, (3) Polish Geological Institute – National Research Institute, Rakowiecka 4, Warsaw, (4) University of Glasgow, School of Geographical and Earth Sciences, Gregory Building, Glasgow, G12 8QQ, (5) School of Geosciences, Drummond Street, Edinburgh, EH8 9XP

The deformation history of Northern Carpathians can be divided into a late Cretaceous 'Alpine' collision (Inner Carpathians) and a Neogene shortening related to the formation of the Outer Carphatians and Carpathian Foredeep. During Paleogene times, the Central Carpathian Basin (CCPB) developed on the northern edge of the Alcapa plate as a forearc basin. The topography of the Northern Carpathians records crustal thickening, followed by the subsequent erosion processes; however, the timing and amount of exhumation is poorly constrained. We have primarily used low temperature thermochronometry of surface samples and borehole material from the Carpathian Foredeep, Podhale syncline in the northern CCPB and High Tatras (Inner Carpathians) in order to improve constraints on their tectonic history. The project was supported by the EUROCORES programme TOPO-EUROPE of the European Science Foundation.

Apatite He ages from 14 samples from the Tatra Mountains are remarkably uniform, averaging at around 14.5±1.5 Ma. AFT ages range from 14±2 to 20±3 Ma and are characterized by unimodal track length distributions with mean track length of 13-14 microns. The combined AHe and AFT data indicate a pulse of rapid exhumation of at least 3 km between ∼18 and ∼14 Ma, with little exhumation in the last ∼10 Myr. Preliminary zircon He ages vary from 41±3 Ma in the north to 21±3 in the south. This difference might reflect northward tilting of the Tatra block prior to more uniform exhumation revealed by AFT and AHe ages.

Central fission track ages of detrital apatites from sediments in the BanskaIG-1 borehole in Podhale (CCPB) range from 21.4 ± 2.7 Ma at 750 m to zero at 4.6 km. Ages from the upper part of the borehole are only partially reset, indicating that the eroded overburden cannot exceed a crustal thickness corresponding to more than 50°C. ZHe ages from 4.6 km depth are 67±16 Ma and support the conclusions from the AFT detrital data. Preliminary AHe and AFT ages of 5 tuffs from the surface of the Podhale also suggest some partial resetting of the thermochronometric ages and indicate exhumation of 1 to 2.5 km across the syncline between 20 and 10 Ma.

Further to the north in the Carpathian foredeep surface and borehole sediments show a strong detrital age signal suggesting < 1 km of missing overburden and small exhumation in contrast to the Swiss Alps foredeep. AFT data from the Outer Carpathians obtained by parallel project reveal that the exhumation is partially coeval with thrusting at 27-10 Ma with period of tectonic extension and exhumation at 10-7 Ma (Zattin et al., 2011).

We conclude that the most significant episode of exhumation in the Northern Carpathians occurred between 21-14 Ma and is coeval with Miocene tectonic activity expressed in the folding of Podhale syncline, tilting the Tatra block and folding and thrusting the Outer Carpathians. After cessation of thrusting at the front of the orogen at ∼11-12 Ma only exhumation related to local tectonic activity was recorded with no significant inversion of the foredeep, nor exhumation of the Inner Carpathians.