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Investigating Exhumation of the High Tatra Mountains: Implications for the Western Carpathians, Slovakia by Zircon and Apatite (U-Th)/He Thermochronometry

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The Carpathian Mountains form the large collisional orocline stretching from Vienna, Austria to Bucharest, Romania. The Western and Inner Carpathians include the High Tatra mountains, which exhibit the highest elevation peaks of the entire mountain belt. Here we studied the exhumation history of an area near Gerlachovský štít, the topographically highest point of the High Tatras. Granitoid samples from different elevations were collected and analyzed for apatite (U-Th)/He (n=12; 5-6 aliquots) and zircon (U-Th)/He ages (n=22; 2-4 aliquots). In addition, apatite U-Pb dating by LA-ICPMS was conducted to complement existing zircon U-Pb dates to track the evolution of the High Tatra Mountains from the onset of magmatism during the Variscan orogeny. The (U-Th)/He apatite ages show a general increase from 9.6 ± 0.6 Ma to 31.9 ± 2.0 Ma to from lower to higher elevations. The zircon (U-Th)/He ages are more scattered and range from 13.5 ± 1.1 Ma to 47.8 ± 3.9 Ma. These reported ages agree with published low-temperature thermochronometric results. However, the apparent average exhumation rates for zircon and apatite (U-Th)/He data derived from the age-to-elevation profile near Gerlachovský štít are inconsistent with a proposed rapid early Miocene exhumation pulse. Apatite U-Pb ages obtained in this study are between 337.61 ± 2.21 Ma and 372.74 ± 3.09 Ma. These ages agree with previously reported zircon dates from the same or nearby samples. This observation is indicative of rapid cooling of the granitoids following crystallization. However, the greatest variance in both data sets were observed from samples collected near the sub-Tatra fault and along the Ružbachy fault. This observation was used to confine regions about these major structures that have distinct exhumation records. The results of the (U-Th)/He ages captures both pre- and post-Miocene slow cooling interrupted by early Miocene tectonic unroofing. Overall, these results are used to outline the earliest tectonic history of the High Tatra Mountains until the onset of more recent exhumation and impacts our understanding of the origin and development of this section of the arcuate mountain belt.

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