Detrital rutile U-Pb geochronology of the Alpine convergence in the External Western Carpathians

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The Carpathian Flysch Belt represents a Paleogene accretionary wedge (External Western Carpathians – EWC) located in front of the narrow Pieniny Klippen Belt zone and the Cretaceous Central Western Carpathian nappe stack. The Flysch Belt is formed of several nappes thrust over the slope of the European Platform in the Miocene. This study is focused on the uppermost Magura Nappe, which consists of the Rača, Bystrica and Krynica subunits. As there are no relics of pre-Miocene oceanic crust in the EWC, the sedimentary rocks of the Flysch Belt are the only source of information available about the Alpine collisional events. U-Pb geochronology was applied to detrital rutile from sandstones of the Magura Nappe in order to better understand the closure of the Alpine Tethys in the Western Carpathians. Ten medium-sized sandstone samples were collected across the Bystrica and Krynica subunits in the Nowy Targ region in southern Poland. The samples represent synorogenic clastic sediments with inferred deposition ages between the Late Cretaceous and Oligocene. Approximately 200 rutile grains were separated from each sandstone sample and around half of them were selected for further analyses. The age and appearance (shape, inclusions, zoning etc.) of the dated rutile show significant variations, suggesting derivation from various sources. The most prominent age peaks represent the Variscan (c. 400–280 Ma) and Alpine (c. 160–90 Ma) tectonic events which are well-pronounced in all but the oldest dated sample. It is also noteworthy that four distinct Alpine signals were detected in our rutile data set. The two most prominent peaks with ages of 137–126 Ma and 115–105 Ma are found in majority of the samples. In two sandstone samples, deposited between the Eocene–Oligocene and the Late Cretaceous–Paleocene, the youngest peak of 94–90 Ma appears. Another peak of 193–184 Ma is also present in these two samples, as well as in another sandstone deposited between the Paleocene and the Eocene. In addition, most samples show few Proterozoic ages (approx. 1770 Ma, 1200 Ma, 680 Ma and 600 Ma). Since metamorphic rutile requires relatively high pressure to crystallize, its formation in the course of an orogeny is possible in a subduction setting. Hence, our new age data may reflect tectonic events related to subduction of oceanic crust and overlying sediments. Tentatively, we propose that recognizable events include the Jurassic subduction of the Meliata Ocean (~180–155 Ma), the Early Cretaceous thrust stacking of the Veporic and Gemeric domains (140–105 Ma) and possibly the Late Cretaceous subduction of the Váh Ocean (c. 90 Ma). In addition to dating, the Zr content of the rutile formed during the Alpine orogeny was measured by electron microprobe at the AGH University in Krakow. The amount of Zr varies between 37–420 ppm in almost all grains, with the exception of 4 rutile grains where ~1100 ppm was reached. The Zr in rutile thermometer, based on the approach of Kohn (2020) was used to calculate the possible metamorphic conditions at 450–650°C and >7.5 kbar. This data set corroborates formation of the Alpine rutile under relatively high pressure and rather low to moderate pressure/temperature gradient, i.e. typical of subduction-related tectonic environments.

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References

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