



Post-Younger Dryas stabilization of rock glaciers in the High Tatra Mountains revealed by ^{10}Be cosmogenic nuclide dating

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Rock glaciers are valuable diagnostic landforms of both present and past permafrost evolution and high sensitive indicators of climate changes in the alpine environments. Although the rock glaciers are common features of the Tatra Mountains relief, contradictory opinion has been expressed regarding the age and the timing of their activity. In most of the previous studies they were classified as relict landforms of the Latest Pleistocene age, however, several authors state that some of the high located debris bodies may contain permafrost and were active during the Little Ice Age. In fact, a presence of ground ice inside rock glacier has not been confirmed directly but was assumed on the base of the geophysical studies. Here we present the first chronological evidence of rock glacier activity in the High Tatra Mountains based on ^{10}Be cosmogenic nuclide dating of boulders and glacial scoured bedrock in the Suchá važecká, Nefcerská, Mlynická and Mengusovská dolina valleys in the Kriváň massif (SW sector of High Tatra Mountains). Sampled rock glaciers belong to the youngest glacial landsystem in the High Tatra Mountains (Pusta II advance), which shows characteristics typical for marginal glaciation. It is developed as a nearly continuous, festoon-shaped pattern of moraines, debris-covered glaciers and rock glacier bodies found close to the cirque backwalls at an elevation range of 1980 to 2150 m asl. Dated rock glaciers are one of the highest located in the Tatra Mountains. They occur above the presumed lower limit of discontinuous permafrost (1930 m asl).

The mean exposure ages of four dated landforms indicate that the youngest moraines and rock glaciers in the Tatra Mountains were formed during the Younger Dryas, but the final rock glacier stabilization and permafrost melting out were delayed ca 1-1.5 ka after the end of Younger Dryas. These results bring into question the concepts of permafrost occurrence and rock glaciers mobility during the Holocene in the Tatra Mountains. Additionally, the moraines and glacially scoured bedrock located just outside the Pusta II landforms were dated to around 15-14 ka. It shows that high elevated glacial cirques in the High Tatra Mountains were deglaciated in the transition between the Oldest Dryas and Bølling-Allerød, thus long before the Younger Dryas. The Younger Dryas was the last period of widespread glacial/periglacial activity in this mountains. Our data suggest also that small glaciers and rock glaciers could expand again during this time after the ice-free Bølling-Allerød period.

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