Geophysical Research Abstracts
Vol. 20, EGU2018-345, 2018
EGU General Assembly 2018

Glacier expansions in southwestern Macedonia (FYROM): implications for paleoclimatic and environmental reconstructions

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The Former Yugoslavian Republic of Macedonia (FYROM, Macedonia) provides numerous remnants of glacial advances, particularly in its western part. Geomorphologic analyses of glacial valleys in southwestern Macedonia reveal several cirques, terminal moraines, and some lateral moraines. After detailed geomorphic mapping, the best-preserved terminal moraines were dated using samples from stable boulders at the moraine crests. At Mt Pelister an average 10Be age of 15.24 $\pm$ 0.85 kyr (2215 m a.s.l, Oldest Dryas) is retrieved from three quartz-rich schists covering/ranging between 14.8 and 15.3 ($\pm$0.8) kyr, and in the Galicica mountains an average 36Cl age of 11.97 $\pm$ 0.57 kyr results from five limestone boulders yielding between 11.3 and 12.8 ($\pm$1.2) kyr (2050 m, Younger Dryas) (Ribolini et al., 2017; Gromig et al., 2017).
The Oldest Dryas moraine at Mount Pelister marks the youngest glacial feature in this area, suggesting that the wide cirque was not or not significantly re-glaciated during the Younger Dryas and Little Ice Age (ruling out significant topoclimation snow accumulation). The temporal relationship between Older Dryas glacier advances in the Balkan region and recorded changes in the Atlantic thermohaline circulation during the Laurentide Ice Sheet massive ice discharge (H1 event), confirms the strong climatic link between the Mediterranean regions and the North Atlantic Ocean. The reconstructed equilibrium line altitude (ELA, 2250 m) at Mt Pelister is in good agreement with the height of the ELAs of Oldest Dryas glaciers in the Mediterranean mountains, demonstrating a comparable response to this cold event.
In contrast, the ELA during the Younger Dryas in the Galicica mountains (2130 m) is most likely not suitable for regional climate reconstructions due to topoclimatic driven snow input in the small enclosed cirque. Such additional windblown snow accumulation has been observed at other small cirques (Hughes, 2009; Kozamernik et al., 2017). The analyses of nearby lake sediments indicate that cold conditions promoted the formation of Oldest and Younger Dryas local cirque glaciers. However, studies of sediment records of the adjacent lakes Ohrid (Republic of Albania/FYROM) and Prespa do not indicate the presence of a proximal glaciation. An explanation might be a combination of (i) the small size of the cirque glacier, generating only small amounts of debris or meltwater, and (ii) the karstic bedrock, which hampers fluvial transport and traps sediment in its aquifer system.

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