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Reconstruction of slushflow activity in the Khibiny Mountains based on investigations of associated landforms and deposits

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Slushflows represent a specific type of gravitational flow of water-saturated mixture of snow with relatively limited amount of clastic sediment (up to 10-15%). Different publications consider those as subtypes of wet snow avalanches, or debris flows, or independent phenomena between the latter two (Perov, 1996; Hestnes, 1998, Eckerstorfer and Christiansen, 2012). Slushflows are widespread in arctic and subarctic mountainous environments (Fleishman, 1978; Nyberg, 1989; André, 1995). Several recent large slushflow events, some with fatal consequences, reported for Scandinavia (Hestnes et al., 2012), have increased both the scientific community and public awareness and social demands for reliable risk assessment, prediction and sound protective measures. All these however are still limited by insufficient knowledge of spatial distribution, magnitude and frequency of such hazardous events. Here we report results of an attempt to reconstruct slushflow activity, evaluate its contribution into sediment budgets and impact on geomorphic structure and fluvial processes in several valleys of the Khibiny Mountains, Kola Peninsula, NW Russia by means of detailed description of associated landforms and correlated deposits analyses (including section descriptions, grain size, radionuclide fingerprinting and 14C dating).

Khibiny Mountains are unique by the fact that slushflows in the area were thoroughly investigated over the last 50 years (Bozhinsky et al., 2001). However those investigations were concentrated largely on monitoring the consequences of presently observed events and developing recommendations for protection of highly developed mining infrastructure. Hence we believe that our study can add some new perspective to that unique existing dataset. Available results for the five studied valleys suggest that slushflows and, possibly for some valleys, typical debris flows with lower frequency are a leading mechanism of downstream sediment delivery and valley floor topography formation. Recurrence interval of medium-magnitude slushflows in the studied valleys does not exceed 10-30 years, which is in agreement with the published monitoring data (Bozhinsky et al., 2001). Fluvial topography is extremely suppressed or nonexistent under such conditions, as stream channels are unable to rework slushflow deposits and are forced to passively adjust. Frequency of extreme events is however much lower. For example, large and still non-vegetated debris flow fan of the Alyavumjok valley is at least 80 years old. Interval between extreme events in the Mannepahkuaj valley causing debris fan formation in forested belt within the piedmont zone is about 500 years (according to 14C dating of humic layers separating different slushflow deposit bodies).

However, largest-scale bottom features and piedmont fans for the majority of small valleys of the Khibiny Mountains can most likely be related to much more intensive events associated with stages of deglaciation and, specifically, bursts of moraine-dammed lakes. Reliable chronology of those stages and events is yet to be obtained and represents the most challenging problem for future research in the area.

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