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Geology, glacier changes, permafrost and related slope instabilities in a high-mountain rock face: Monte Rosa east face, Italian Alps

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The Monte Rosa east face, Italian Alps, is one of the highest flanks in the Alps (2200-4500m asl). Steep hanging glaciers and permafrost cover large parts of it. Since the end of the Little Ice Age (about 1850), the hanging glaciers and firn fields have retreated continuously. During the recent decades, the ice cover of the Monte Rosa east face experienced an accelerated and drastic loss in extent. Enhanced rock fall activity was observed. Some glaciers have totally disappeared leaving large parts of the underlying rock unprotected against mechanical and thermal erosion. Those changes in glacier extent, permafrost conditions, thermal and hydrological regimes, as related to present atmospheric warming, significantly affect the stability conditions of steep rock walls in high mountain areas.

The scope of this study is to analyze the linkage between the glacier shrinkage and permafrost degradation, on the one hand, and the observed increasing slope instabilities in the Monte Rosa east face, on the other hand. A number of amateur photos, air-photos and maps was compiled in order to reconstruct the development of the ice cover of the Monte Rosa east face. The geology of the Monte Rosa east face and the detailed extents of the hanging glaciers were mapped during fieldwork in summer 2003. The starting zones of rock fall, ice avalanches and debris flows were observed and localized as well. The permafrost distribution in the rock wall was computed with different models. Roughly one half to two thirds of the east face are estimated to be under permafrost conditions.

It turned out that:

- Most of the active starting zones are located in parts of the rock wall, where surface

ice disappeared recently.

- Most of the active starting zones are located in permafrost zones, mostly close to the estimated lower boundary of the permafrost occurrence.

- Many active starting zones are situated at the boundaries between two different lithologies.

In the view of ongoing or even enhanced atmospheric warming it is therefore very likely that the instabilities in the Monte Rosa east face will continue to represent a critical hazard source. Therefore some first-order modeling of rock fall events and ice avalanches has been conducted showing that particularly large events could endanger some parts of the upper part of the valle Anzasca, especially in the current situation of an elevated Ghiacciaio del Belvedere and an occasionally filled supraglacial lake on it.