Geophysical Research Abstracts,
Vol. 11, EGU2009-9043, 2009
EGU General Assembly 2009

Holocene collapse of a mountain summit in the Belledonne massif (France): evidence from geomorphological mapping

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Rock avalanching is a high magnitude / low frequency process in mountain environment. It is an extremely rapid flow of fragmenting rock particles, with a volume > 1 M m3, involving a large amount of energy and travelling farther than expected with a normal sliding friction law. Rock avalanches are not uncommon in the Alps, in particular because of debuttressing of rock slopes due to glacier retreat and downwasting since the last Glacial maximum.
The upper Vorz catchment basin is one of the few still glaciarized basins in the Belledonne massif (French external crystalline massif, peaking at 2977 m a.s.l.). A deposit related to a rock avalanche lies at the Habert du Mousset (1680 m a.s.l.), covering an area of 95 000 m2, tens of meters-thick and with a volume exceeding 1 M of m3.
A geomorphological study suggests that the deposit should result from the collapse of the palaeo-summit of Roche Rousse (2753 m a.s.l. at present). The main part of the collapsed volume fell on the east side of the mountain ridge, but a smaller part probably travelled along the west side to form the deposit of the Habert du Mousset. Vertical and horizontal travel distances would have been 1100 m and 2750 m, respectively. The apparent coefficient of friction (height-over-length H/L ratio) is 0.4, indicating a highly mobile rock avalanche (H/L ratio is 0.62 with a 'normal' coefficient of friction).
Two elements support the hypothesis of a Holocene collapse: (i) glacial striations, rat tails, chattermarks and grooves are present on roches moutonnées up to 20 m to the crest. Those inherited glacial forms required a glacier thick enough to erode the bedrock. Because the surface of the Last Glacial Maximum glacier was standing well below this site (> 1000 m), only a local glacier could have form, which would have been impossible with the present topography. Thus, the palaeo-summit of Roche Rousse collapsed not before the Lateglacial. As suggested by (ii) the very steep, sometimes overhanging rock wall which forms the present east side of Roche Rousse, not glacially eroded, the collapse could have occurred after the Lateglacial.