STRATIGRAPHY, MORPHODYNAMICS, PALAEOENVIRONMENTS OF THE STEEP SEDIMENTARY TERRAINS OF THE ALPINE PERIGLACIAL DOMAIN

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In the context of a warmer climate, a « geosystemical » study of the permafrost distribution in a whole alpine periglacial hillslope, from the rockwall to the rockglacier, is of great importance. With respect to this problem, the general objective of this PhD thesis is the global study of talus slopes located within the alpine periglacial belt following two different research axes: the analysis of the internal structure and of the permafrost distribution of high altitude talus slopes and of the related processes; the reconstruction of the palaeoenvironmental history of the alpine periglacial belt during the Lateglacial and the Holocene.

The stratigraphy and the permafrost distribution were studied in five talus slopes of the Valais Alps (Switzerland) with the analysis of borehole data (on three of the five talus slopes) and other methods of permafrost prospecting: Electrical Resistivity Tomography (ERT), Refraction Seismic Tomography (RST) and nuclear well logging. The collected data shows that, in all of the studied talus slopes, permafrost distribution is discontinuous and that neither of the hillslopes is integrally characterised by permafrost. In particular, this data proves by direct investigations that, in talus slopes, permafrost is present in the lower parts of the hillslope, whereas it is absent in the upper parts. Permafrost distribution in alpine talus slopes is depending of the combination of almost three controlling factors, whose respective importance is variable: the chimney effect, the increase of grain size downslope and the redistribution of snow by avalanches. Depending on the size of the talus and on topographical and geomorphological heterogeneities, various cases are possible: one dominant controlling factor or the combination of various factors. Nevertheless, it would be an error to consider each controlling factor independently, without considering their relationships. Between these controlling factors, the relationship chimney effect/grain size seems to be the most important factor controlling the presence of permafrost in the lowest part of periglacial talus slopes, and its absence in the upper parts. Finally, the analysis of the talus structure shows that the permafrost stratigraphy may be an important element of interpretation of the palaeoclimatic significance of an alpine talus slope.

The second research axe focused on the establishment of a chronology of the Lateglacial glacier retreat and the dating of rockglaciers and talus slopes development in four studied regions of the Swiss Alps (Mont Gelé – Mont Fort, Fontanesses and Chamosentse regions, in the Valais Alps, and the Cima di Gana Bianca Massif, in the Ticino Alps). The compilation of the dates acquired through the combination of the palaeogeographical method and of the Schmidt hammer indicates that most of the investigated active rockglaciers started to evolve during the early phases of the Holocene or, at the latest, after the early-to-mid Holocene Climatic Optimum (ending around 6.3 ka cal BP). For the dated relict rockglaciers, most of them started to evolve in the second half of the Lateglacial, and probably became inactive at the beginning of the Holocene Climatic Optimum. For the investigated talus slopes, the relative dating carried out allowed to show that their surface date from the period included between the Boreal and the end of the Atlantic, pointing out that the rockwall retreat after the end of the Holocene Climatic Optimum was weak, and that the interval between maximal and minimal ages is in most cases relatively short (4–6 millennia). Therefore, the rockwall retreat during the development period of the talus slopes must has been considerable. Thanks to the calculation of rockwall erosion rates based on the volume of talus accumulations for four of the investigated hillslopes, it was possible to find evidences of the existence of "paraperiglacial rockfall phases" related to the permafrost degradation in rockwalls. These phases coincide with rapid climate warming periods, as at the beginning of the Bølling, during the Preboreal or, maybe, since 1980.