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Book Review

LES VERSANTS DU SPITZBERG. APPROCHE GÉOGRAPHIQUE DES PAYSAGES POLAIRES. Marie-Françoise André. Presses Universitaires de Nancy, 25 rue Louis Baron, 54000 Nancy, 1993. 361 pp. 87 figures et 65 photos.

'The Arctic: a stable environment or one of rapid evolution?' It was to answer this question that M. F. André spent five summers, from 1982 to 1986, on expeditions to Spitsbergen. There, she examined active geomorphological processes and did her best to determine their rates. It was a study based on detailed field observations. This work was presented as a doctoral thesis at Université Paris I (Panthéon, Sorbonne) on 8 November 1991.

The first part of the book (106 pp.) describes the environmental conditions associated with slopes on Spitsbergen. Dr André begins first with a general summary of the geological history of Spitsbergen as a means of explaining large-scale morphostructure. Then she outlines the current bioclimatic environment. Although the air temperature regime appears well known, the nature of precipitation, and especially the occurrence of exceptionally intense summer rains, is poorly understood. The vegetation cover is then described from a morphodynamic perspective, that is to say the author explains what is relevant to an understanding of slope evolution. Finally, she outlines the palaeoclimatic and Quaternary fluctuations which have affected Spitsbergen. She emphasizes the climatic fluctuations and glacial advances of the Holocene. At the end, she outlines the characteristics of the present regime.

The second part (134 pp.) of the volume is devoted to her study of slope evolution on Spitsbergen. One approach used was to analyse the quantity of slope debris and fragments weathered during the Holocene. A scale of rock gelifraction is the result. This was then compared with that of Labrador, where the author has also worked for a long period. Large fissures on nunataks are interpreted as dilation cracks on the basis of their location behind overhanging rock walls. These fissures are as much as 1.2 m wide at the surface and between 0.6 and 3.0 m in depth. In order to better understand the frost shattering process a summary is made of over 10 years of frost action experiments made upon rocks from Spitsbergen and Labrador. Unfortunately, these laboratory experiments are undertaken at a scale which is not the same as that in the field, and the problems associated with these types of experiments are clearly presented. It is necessary to submit several hundreds of samples to frost weathering in order to obtain significant results since the results are very variable. For certain rocks the size limit above which fragmentation ceases is too large and cannot be studied in the laboratory, but only in the field on the rock walls. The resulting numbers give only the potential for slope evolution and the author passes over the results of these experiments.

A morphodynamic classification of slopes according to aspect is used as a second method to study Holocene dynamics. The following are recognized: chutes and debris flow fans, scree slopes and rock glaciers, and supraglacial slopes. Fans and debris flows are present in all lithologies. The author explains that debris flows were first attributed to snowfall and later to intense rain in summers. Rock glaciers relate to thrust faults and are located where bedrock has been weakened by tectonic action.

The problem of rock glaciers is first and foremost that of the interpretation of the ramparts/ridges which mark their surface. Are they simply due to rotational movements or are they thermokarst forms? Among the supraglacial slopes, the author identifies rocky slopes with slow evolution, slopes with sliding rock (following observations of debris layers slipping on the permafrost), and bare overhanging slopes with chaotic rock accumulations due to relaxation. The bare slopes which are present on Spitsbergen are preglacial since present-day processes destroy them. The range of periglacial slope forms is well illustrated by this description of slopes on Spitsbergen.

The author uses various dating methods to estimate the speed of slope processes. Carbon 14 dates from marine terraces give little usable data. By contrast, measuring the size of lichens which grow on acidic rocks is extremely interesting. This approach suggests that rock glaciers began to develop about 3000 BP at the beginning of the neoglacial period which followed the Atlantic optimum. Their advance has continued with a

mean speed of between 1 and 5 cm/y. As far as *éboulis* (scree) are concerned, nothing is clear; it is possible that maximum activity took place during the Little Ice Age.

The third part of the volume (78 pp.) is the most interesting. The author attempts, by all possible methods, to understand the speed of different processes. However, the period of study (1982–88) was short and did not witness any exceptional events. Lichenometric analysis supplied the most useful data. The absence of lichens on certain quartzite rock walls led the author to promote the hypothesis of stress relaxation to explain the fissures which were mentioned earlier. Mean rates of rock wall retreat are proposed for different rock types: for example, retreat of 2 mm per 1000 years is typical for rock walls in amphibolites because they promote slow biological flaking. Other rates of retreat are 3.0 mm per 1000 years for dissolution of carbonate rocks, 150 mm per 1000 years for gelifraction on jointed quartzites, 70 mm per 1000 years in amphibolite bands, and 700 mm per 1000 years on average for retreat associated with stress relaxation.

Study of the accumulation of debris trapped by the snow cover shows limited aeolian transport and instead the large variations in supply of debris by spring avalanches, giving mean values of 0.04 to 8 mm/y depending on site. The higher values include episodic events such as debris flows and slush avalanches. Lichenometry permits understanding of the accumulations associated with these surfaces and enables one to estimate the return period for rainy episodes to be 80–500 years for debris flows and probably only 50 years for slush avalanches. The significance of these values is carefully evaluated in the text. The influence of structure and especially of faults is clearly evident. Relaxation is locally dominant while other factors such as exposure and microclimate are secondary. The author does not try to resolve everything; she balances the results. The data obtained are extremely valuable for we lack comparable data. The study also support the important role of lichenometry in the study of slope processes in cold regions.

The volume is well illustrated and easy to understand. We believe it is a study which cannot be ignored by researchers studying the dynamics of periglacial slopes and investigating the speed of cold-climate processes.

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