

The Soil Frost Environment of Marion Island, Maritime Subantarctic**J.BOELHOUWERS¹ and S.HOLNESS²**¹Department of Earth Sciences, Uppsala University, Sweden²Department of Earth Sciences, University of the Western Cape, South Africa

Soil frost activity in an environment of low annual and diurnal temperature ranges was monitored for a period of three years on Marion Island. An altitudinal zonation of soil frost activity is presented, based on morphology of periglacial features, field observations on process, ground climate monitoring and sediment movement data. Four zones are described: needle-ice induced movement down to 10cm depth dominates coastal areas. Above 250m asl deeper soil frost is experienced with more frequent and intense frost cycles. Frost creep dominates with limited solifluction. Above 800m asl seasonal frost cycles are closely associated with snow. Solifluction plays a more important role, but frost creep still dominates. Finally, isolated pockets of permafrost exist in the summit areas at about 1200m asl.

Key words: periglacial, soil frost processes, maritime Subantarctic, Marion Island

A Genetic Model of Rock Glaciers in Mountain AreasF. DRAMIS^{1*} and M. GUGLIELMIN²¹ Department of Geological Sciences, "Roma Tre" University, Rome, Italy² ARPA Lombardia, Milano, Italy

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Rock glaciers are the best evidence of permafrost in mountain areas. A typical feature of rock glaciers is that of being made of two different layers: an upper layer, mostly consisting of open-work blocks, and a lower one, thicker and made of diamicton, with abundant fine material. Permanent ground ice is normally present in the lower layer, where climate is prone to permafrost aggradation or preservation. The occurrence of permafrost in the rock glacier may be strongly favoured by the thermal offset caused by the upper layer, where different processes may contribute to lower the mean annual surface temperature (chimney effect; balch effect, etc.). Moreover, the blocks overload may facilitate, or even trigger, permafrost creeping in the underlying ice-cemented debris. The origin of the blocky layer may be related to mass wasting from rocky slopes (rock falls and slides, debris flows), induced either by glacier retreat or permafrost degradation. The lower layer would be made of glacial drift or talus deposits. A favourable context for an immediate genesis of rock glaciers would be that of deglaciation (by reduced snowfall) in dry-cold climate; in other cases, permafrost aggradation and creeping would be produced later, in a subsequent dry-cold period.

Key words: rock glaciers, mountain permafrost, climatic change

**Absolute and Relative Age Dating of Rock-glacier Surfaces in
Alpine Permafrost: Possibilities and Limitations**

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Rock glaciers originate from the slow but long-term cumulative deformation of ice-rich, perennially frozen debris. Characteristic time scales involved are centuries to millennia. Surfaces of relict, inactive and active rock glaciers, therefore, reflect debris accumulations produced, deposited and deformed during late-glacial, holocene, historical and recent time periods. Dating of such surfaces can best be achieved by using a combination of absolute and relative age determination methods. Corresponding potentials of radiocarbon dating, optically stimulated luminescence, cosmogenic exposure dating, lichenometry, Schmidt-Hammer measurements, weathering-rind mapping and photogrammetric determinations of flow trajectories are presently explored. The principles of the applied methods are presented, their advantages and shortcomings discussed and first results presented.

Key words: rock-glacier, surface, age, dating

Forming Processes of Alpine Subnival Boulder Pavements

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Alpine subnival boulder pavement is one of debris(stone) pavements developed beneath a late-lying snow patch within alpine periglacial environments with paving processes of snow and ice. It is assumed that there are many processes for forming subnival stone pavements; weigh of snow, melting water to saturate fine materials beneath the pavement stones and to wash fines away from pavements. The surface topography and boulders on the pavements and their surrounding periglacial landforms were measured to examine the parts of forming processes of the pavements in the Colorado Front Range. The results from the measurements shows gradual transition from polygonal patterned ground to subnival boulder pavements in the glaciated valley floor. Furthermore, both boulder pavements and turf-banked terraces are developed very closely in the bottom of the glacier cirque. At the less snow parts in the cirque, the turf-banked terraces have been developed by an invasion of vegetation instead of pavementation because of little snow.

Key words: stone pavements, periglacial environment, late-lying snow patch, patterned ground, turf-banked terrace

Fossilization of rock glaciers in the Swiss Alps

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Morphology, structure and thermal condition were compared between active, inactive and fossil rock glaciers in order to evaluate rock glacier degradation due to permafrost melting. Bottom temperature of the winter snow cover (BTS) and seismic velocities indicate the presence of subsurface permafrost, separating fossil rock glaciers from the other two types. Moreover, the lack of vegetation on the frontal slope and negative mean annual surface temperatures (MAST) characterize active rock glaciers. Electrical resistivity of permafrost decreases with increasing MAST, which suggests partial melting of ice-rich permafrost and resulting inactivation of rock glaciers. Permafrost degradation results in a subsiding transverse profile and a reclining frontal slope, which are further promoted on fossil rock glaciers by the movement of surficial soil originating from long-term in-situ weathering of clasts.

Key words: rock glaciers, permafrost melting, ground temperature monitoring, geophysical soundings, Swiss Alps

Reconstruction of Three-dimensional Structure of Involution, Northeast Japan

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The involution in the middle Kitakami River basin in northeastern Japan consists of Murasakino Pumice layer (MP), which fell on the area about 60 ka B.P., and loamy volcanic ash with amplitude of ca. from 0.3 to 0.5 meter. The involution of the MP probably corresponds to festoon and/or injection type. The author attempted to reconstruct the three-dimensional structure of the involution by observing several plane and sectional forms at the lower, middle and upper part of the involution. In the horizontal section at the lower part of the involution, it was observed that there were many circular and elliptic forms with filled loamy volcanic ash with 1.5 meters in maximum diameter in the MP. On the other hand, the MP deposits in the form of circle or ellipse with from 1 to 3 meters in diameter and about 0.3 meter in maximum width at the top of the involution. In addition, it was observed that the width of the MP decreases upward in the cross section. These results lead to the conclusion that the MP shows the upturned structure which keeps the forms of circle or ellipse.

key words: involution, northeastern Japan, the Pleistocene, tephra, three dimensional structure

Quaternary Glaciation in the High Drakensberg and Lesotho Mountains,
Southern Africa: An Alternative Hypothesis.

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Evidence for Quaternary glaciation in the Drakensberg and Lesotho mountains of southern Africa is elusive and subject to considerable controversy. The existence of glaciers would require an environment that is more moist and cooler than present, which contradicts other palaeoenvironmental research. Field investigations indicate that the evidence for glacial features is limited to a few isolated locations and has been misinterpreted. Topographical and sedimentological analysis as well ice-mass balance studies indicate that glaciers could not have existed at the sites suggested in published literature. The existence of specific periglacial features in the landscape indicate a palaeoenvironment that is cooler and drier than present; a proposal that is supported by other proxy data. Further, it is suggested that many of the so-called landforms attributed to a glacial origin could equally have formed under relatively warm and moist environments subsequent to the last Glacial Maximum.

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Deglaciation in the Giant Mountains indicated by ^{10}Be Datings

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The ^{10}Be exposure age method was applied to 20 sediments, roches moutonnées, tors, and glacial cirques in the Bohemian Massif: the Obri dul and the Elbe dul valleys. Geomorphological evidence combined with ^{10}Be dating shows that deglaciation occurred between 23.0 ± 3.8 ^{10}Be ka and 11.0 ± 1.8 ^{10}Be ka on the high plateau (1200-1400 m). In the Elbe glacial valleys, the last terminal morainic ridge was dated at 11 ± 2.0 ka ^{10}Be (830 m). In the circular Obri dul cirque, the deglaciation began around 9.0 ± 1.8 ^{10}Be ka and was generalised in the main central cirque at 8.0 ± 1.5 ^{10}Be ka. The Elbe dul had a partly different course of deglaciation. It began at the end moraine and reached the facing slopes south at 12.0 ± 2.1 ka ^{10}Be , and east slopes at 9.0 ± 1.5 ^{10}Be ka, the valley bottom of 1000 m a.s.l. at 8.7 ± 1.5 ^{10}Be ka, and the upper end of the cirque at 8.5 ± 1.4 ^{10}Be ka. Some ice was still present in the upper Obri dul cirque after 7.3 ± 1.3 ^{10}Be ka, and at 6.0 ± 0.9 ^{10}Be ka on the upper Elbe plateau.
Key words : Deglaciation, Exposure age, ^{10}Be , Bohemian Massif, Holocene climate.

Comparative Study on the Periglacial Slow Mass-Movement in the Middle and High Latitude Regions

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The purpose of this study is to clarify the characteristics of slow mass-movement processes and their regional differences. The author bases on the data of the frost action and discusses the rates and processes of slow mass-movement in relation to the frost action and the composition of slope materials. The investigation sites included the Kitakami Mountains in Northeastern Japan and Spitsbergen Svalbard located on the western skirts of the Barents Sea. The Kitakami Mountains were chosen because they are located the mid-latitude seasonal frost zone. Spitsbergen was chosen because it belongs to a polar region with the continuous permafrost zone. Each site has a contrasting climatic condition.

Key words: slow mass-movement, processes frost action, slope materials, seasonal frost zone, continuous permafrost zone

Observations on the Geomorphological Dynamics of the ice-free areas of Hurd Peninsula, Livingston Island, Antarctic

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The Hurd Peninsula is located in the South coast of Livingston Island in the South Shetlands Archipelago (62°39'S 60°21'W). It is a high relief area *ci.* 8 km long and 4 km wide that reaches 392 m ASL at Binn Peak. About 70% of the peninsula is glacierized by Hurd Glacier (maximum altitude: 366m ASL). Coastal sectors (especially in the south and north) and nunataks are ice-free. The climate is cold oceanic with frequent summer rainfall and moderate annual thermal amplitude. During the field campaign of 1999-2000 a systematic geomorphological survey of the North of the Hurd Peninsula was conducted. The substratum is the Miers Bluff formation, a turbiditic sequence affected by low-grade metamorphism. A geomorphological map was made at the scale 1:5,000 and was digitised and integrated in a Geographical Information System. Detailed climatological data collected during several summer campaigns in the last 10 years and data from year-round ground and air temperatures are analysed. With the use of the GIS the geomorphological information is analysed and compared with models produced from the climate data (e.g. net-radiation).

Key words: periglacial, permafrost, solifluction, GIS, antarctic.

Study of Polygonal Fossil Periglacial Structures in Flanders (Belgium), Based on Aerial Photographs and Fieldwork

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In Flanders (Belgium) on various aerial photographs polygonal patterns are periodically visible upon the interfluvium between the Coastal Plain and the Lys-Valley. On the poster the origin and the age of these phenomena are discussed. The study is based on a comparative study of literature, aerial photographs and fieldwork. First of all, the spatial distribution and the spatial structure of the networks will be discussed. Different types of networks were recognised. Secondly, excavations along the polygonal sides reveal the occurrence of sandy involutions, showing sedimentary structures typical to composite – and ice-wedge pseudomorphs. The authors state that repetitive thermal contraction of frozen ground and the infilling with ice and/or ice-rich sediment under palaeo-periglacial conditions was the major cause in their development. They were formed during the Late-Pleistocene (Eltser-Weichsel).

Key words: aerial photographs, fossil periglacial environment, frost-fissure pseudomorph, ice-wedge pseudomorph, thermal contraction

**An Interdisciplinary Project for the Study of the Landscape Sensitivity
in Mediterranean Upland Environments**

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The objective of the ESTRELA project is to understand the landscape dynamics and evolution in a Mediterranean mountain environment considering geomorphological, climatological and vegetation changes at different spatial and time scales. Comparison of typology and spatial patterns of landscape units with the geomorphological dynamics, topo and microclimatology, vegetation ecology and phytosociology provide the assessment of the relationships between landscape structure and landscape dynamics. A significant issue is to use an integrated approach with emphasis on interdisciplinary research. The study area is located in the Natural Park of the Serra da Estrela, Portugal. Intense geomorphological dynamics in close relation to climate oscillations since the Last Glacial Maximum and the human influence known since 8.000 years ago strongly influenced landforms and vegetation, and today in close relation with altitude and aspect, the upper part of the Serra da Estrela shows a rich and diverse landscape. *Key words: Mediterranean environment, geomorphological dynamics, landscape sensitivity.*

**The Mechanism of Earth Hummocks Development in the Nemuro Peninsula,
Eastern Hokkaido**
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The mechanism of earth hummocks development was studied in the Nemuro peninsula, where belongs to seasonal frost zones. The rate of soil heaving was measured simultaneously at hummock and inter-hummocks. In the freezing period, the magnitude of heave was up to 18.5cm at top of hummock, while that was 16.8cm at inter-hummocks. Observations by excavation showed that ice lenses within the hummock were significantly thicker than those within the inter-hummocks. In the thawing period, thawing rate of the ice lenses within hummocks was slower than that of inter-hummocks. As all ice lenses have completely melted, the subsidence of inter-hummocks was complete, while that of the hummock not completed. The hummock had grown about 2cm/year in height. These results suggest that the hummock grow even in seasonal frost zone. In addition, the mechanism of hummocks development is due to annual accumulation of not only the difference of frost heave, but also uncompleted subsidence.

Key words: earth hummocks, seasonal frost zone, frost heave, ice lenses