COMPTES RENDUS BIBLIOGRAPHIQUES

L. E. Hamelin et F. A. Cook — Le périglaciaire par l'image — Illustrated glossary of periglacial phenomena. Travaux et documents du Centre d'études nordiques: 4; Les Presses de l'Université Laval, Québec, 1967. 237 p., 117 photos, 13 drawings, selected bibliography (395 items), index of periglacial phenomena (263 items).

The authors have undertaken to present an "inventary" of periglacial facts and phenomena in the form of an illustrated glossary whose entries are both described in the text and shown in photographs and drawings. Both Hamelin and Cook declare that "the present glossary does not attempt to be exhaustive and it is more factual than theoretical" (p. 8, 13). Their main object was to provide a dictionary of present-day phenomena and forms as well as of the evidence recorded by sedimentary ones.

The composition of the Glossary is founded on a genetic basis. Nine groups have been distinguished and treated in nine chapters, falling into three parts which indicate the major categories of division. Presentation in the text is two-grade: each chapter begins with an introduction including a general explanation of the whole group of facts comprised in that section. Further direct explanations refer to each separate entry and illustration, photograph and diagram.

The book is bilingual. The texts — in English and French — are parallel (and corresponding) though not identical. Although the general idea of the Glossary, its division into parts and sections and the selection of illustrations have been agreed upon by both the authors, their discussion and commentaries are sometimes widely divergent. Even the titles of the parts and chapters are not always identical. In that respect the book has an unprecedented character. For, far from being a simple presentation of the same text in two different languages it is the work of two authors who have left themselves a broad margin for the expression of their personal opinion.

The Glossary opens with an introduction containing a discussion of the current terminology, definitions and classification based — as already mentioned — on genetic grounds. Both authors unanimously state that the terminology of the subject is imprecise and confusing. Although both accept the term *periglacial,* Cook stresses the fact that in English it can be used only adjectively, in just the same way as it is used in Polish, Russian, German, etc. Hamelin however uses the term *périglaciaire* as a noun, introducing besides some new descriptive terms, even such neologisms as *périglacialiste, périglaciologie*. These neologisms strike the reviewer as being rather strange; but as the question falls beyond his competence he hopes that better judges of the French language will settle that question.

Cook's definition of periglacial geomorphology is certainly too broad, as this branch of study does by no means include all the processes and phenomena found in cold regions.

The first part of the Glossary (pp. 15-105) is devoted — according to the tenor of the French title — to categories determined by dominant periglacial factors. In the title of the English text, the processes and their effects are enumerated successively in keeping with the titles of the single chapters of that part.

First chapter: ground ice — or gélisolation in the French text (pp. 16-51). The introduction includes a classification of ground ice with reference to the conditions of freezing and the mode of occurrence. It fails, however, to discuss the climatic conditions of ground-ice formation, of such climatically widely different types in particular as are segregation ice and injection ice. In contrast with the well-distinguished varieties of segregation ice no mention is made of the genetically proper kind of fissure ice instead of which the term *wedge* is used descriptively. In the English text there are misconceptions concerning permafrost. Permafrost is here said to be the most common form of ground ice and at the same time to be one which does not always contain ice. It is well known that: 1° the exclusively thermal criterion with regard to permafrost has been discarded long ago, ° permafrost, though containing various types of ground ice does not by itself represent any of those types.

Apart from ground-ice types as needle ice, small ice-lenses, ice masses (segregation ice) and fissure ice (ice wedges) — frozen ground both permanent and seasonal is presented together with the forms resulting from the development of ground ice such as pingos and palsas, thermokarst and the effects of its action. Pingos and palsas are treated almost synonimously, without any reference to the quality of segregation ice in palsas and injection ice in pingos. Hydrolaccoliths however are presented as micro-pingo forms. Hamelin believes that palsas are invariably built of organic material, while Cook mentions mineral material as well. None of the authors, however, underlines the fact that the major difference between a pingo and a palsa results from that of the corresponding ground-ice type. In disaccord with its title the chapter includes apart from ice wedges and veins — instead of fissure ice — also open fissures and those with mineral filling. Hamelin introduces a new term *fissure gélivale* as a substitute for *fissure de gel.*

Chapter II (pp. 52-65) deals with frost-weathering and its products: Gélivation — gélifraction — météorisation, Frost-shattering (congelifraction). It includes a presentation of such products of weathering as: Gélifracts — Frost-shattered blocks, Eboulis (de gravité) — Talus (slopes and cones), Champs de blocs — felsenmeere (block fields), and the residual forms left after the removal of debris e.g. craggy outcrops of the tor type (surface résiduelle — surface remnants). Thus, the scope of the facts and phenomena presented is broader than that announced in the title. It includes in addition to forms of weathering also transportation of the waste as well as the resulting land-forms and deposits.

Chapter III (pp. 66-89) is devoted to nivation. Hamelin proposes the term *nivalisation* with a narrower connotation, for not every snow action is a periglacial phenomenon. He recognizes the importance of peripheral destruction by snow banks and the release of water beneath them, the contribution of snow to the formation of grèzes litées and accumulational glacis as well as to the development of asymmetrical valleys. Cook points out that the concentration of carbon dioxide in snow banks being sometimes twenty times greater than in rain water, it induces increased chemical weathering especially in limestone areas. The chief items of that chapter are: avalanches, nivo-karst, nivation hollows, debris at the foot of snowbanks (bourrelets de congère, protalus), rock glaciers, and cryoconite.

It may seem somewhat questionable whether rock glaciers do actually fall into the group of phenomena produced by nivation. Rock glaciers do not always border on glaciers. Their movement is in fact controlled by ice which may however be ground- instead of firn ice derived from snow.

Part first is closed by chapter IV (pp. 90-105) on the phenomena of floating ice forms: river, lake and especially sea floes including icebergs (glace flottante, floating ice) and their results, sedimental ones in particular. Those are referred to by Hamelin as *glaciellisation*, a term hitherto unknown. Among these phenomena are presented: blocks, stones and debris transported by floating ice which on melting of the ice form ridges (levées nivo-glacielles) along river terraces or shores; fields of blocks in glacial areas (champs de blocs, ice-rafted blocks); ramparts or irregular hillocks (chaos et bourrelets, floating ice ridges) composed of loose material driven onto the shores by floes, either fluvial or marine, moved by waves or by the wind; similar forms on lake shores (bourrelets lacustres, lake ramparts); ice-foot niches (pied de glace); glacier-like striation (rayures, floating ice striations).

Entitled in the French text "Catégories définies par le milieu froid" the second part of the book (pp. 107-138) deals in fact, as announced by its English title to running water and wind action in a periglacial enviroment. Chapter V (pp. 108-127) is devoted to fluvial run-off and to the resulting land-forms. The Introduction emphasizes the — usually underestimated though prime — importance of runoff in a periglacial environment and enumerates its major characteristics which are: short duration, youthful and poorly organized drainage system, disturbance of the classical cycle (precipitation, infiltration, runoff) owing to the presence of permafrost, the melting of snow, the high rate of permanent flow resulting from the intensity of slope processes. The chapter includes: asymmetrical periglacial valleys, denudation vales (vallon en berceau, periglacial vale), flat-bottomed valleys, rill- and sheet-wash (ruissellement en filets et en lame, rill network on snowbanks), rhythmically bedded deposits (dépôts à litage périodique — grèzes, stratified slope deposits), thermal erosion, modelling of slopes due to the combined action of runoff, floes, and snow (processus fluvio-nivo--glaciel, fluvial, snow and floating ice features).

Wind action is discussed in Chapter VI (pp. 128-138) in so far, of course as concerns its conditions and effects in a periglacial environment, where the efficacy of eolian processes is increased by an arid climate, insufficient vegetation cover and frequent lack of snow. On account of the fact that aggregates of snow crystals tend to harden with decreasing temperature, reaching a hardness of approximately 6 at —45°C, non-mineral particles alone are the instrument of erosion by wind. The most common effects of that erosion are amorphous ones on the bedrock, tafoni and glyptoliths (why not eologlyptoliths?). The chapter includes the following topics: eolian erosion, loess, niveo-eolian deposits (which Hamelin proposes to call nivéolienne and Cook niv-eolian instead of nivéo-éolienne and niveo-eolian), oriented lakes.

Part three (pp. 139-205) comprises according to Hamelin's formula a "family" of polygenetic phenomena (Famille de phénomènes polygénétiques) or in other words what Cook calls patterned ground, solifluxion and cryoturbation.

Hamelin holds that, unlike the phenomena presented in the first six chapters, which were each an effect of some dominant factor — those which are dealt with in the IIIrd part of the Glossary have a complex genesis; their classification must therefore be based on various criteria. Despite that genesis — complicated, varying and still imperfectly known — these facts exhibit some striking features, which are both characteristic and — to a certain degree — common to the whole group. Such may be for instance a network pattern (réticulation végétale) or disturbances (turbation) manifested by configuration (figuration) and gelifluction. Chapters 7, 8 and 9 are therefore closely linked with the contents of the preceding one which they supplement (p. 140).

In chapter VII (pp. 140-177) devoted to patterned ground Hamelin introduces the neologism *figuration* as a substitute for *polygonation*. In Cook's text the title of that chapter mentions patterned ground (p. 140-141). Changes in volume due to freeze-and-thaw, sorting (triage) and cracking are the major processes contributing to the formation of patterned ground.

The chief entries of that part of the Glossary designate either forms or processes; here — like in all the other chapters — the French text differs from the English one: macropolygonation and tundra polygons, mésofiguration circulaire and sorted circles, micropolygonation and desiccation polygons, gradins — small and medium polygenetic flattenings and micro et mésoreplat polygénétiques, macroreplat de géliplanation or goletz- and altiplanation terraces, replat d'étalement or large solifluxion forms and lobate soils (steps), traînées minérales et végétales and stripes, figuration végétale fermée (with vegetation in the center or at the borders) and vegetation polygons, tourbières réticulées and string bogs, thufurs and earth hummocks, dallage de pierres and — though the connotation of the term does not seem to be identical — boulder pavement.

The authors have undertaken the ambitious task of classifying patterned grounds on a genetic basis. Its realization however is not free from sometimes even serious shortcomings. In a whole number of cases, each of the authors obviously means something else in his discussion of the same "types". Hamelin includes into his "mésofiguration circulaire" stone circles and tundra spots (ostioles) which besides differ widely from each other in their genesis. Cook regards as belonging to the type which he calls „sorted circles" also such stone rings and polygons, which again differ in their mode of formation. The same refers as well to the already mentioned dallage de pierres and boulder pavement. Moreover, such elements of the slope as denudation or congelifluxion lobes, referred to in the Glossary as replat d'étalement and lobate soils (steps) are not usually regarded as patterned ground.

Congelifluxion (gélifluxion périglaciaire, solifluxion) forms the subject--matter of Chapter VIII (pp. 178-189). Following B a u l i g, H a m e l i n uses the term *gélifluxion* without any critical estimation of the present reviewer's *congelifluxion* (D y l i k, 1951) besides erroneously attributing the introduction of that term to B r y a n (1946). C o o k retains the term *solifluction.* The processes enumarated in that chapter are: gelifluction assisted by down-wash (gélifluxion et fluviation, solifluction flow), sheets and streams (nappes et coulées, solifluction slopes), heads called in the French text "profils de dépôts soliflués", glacio-solifluction.

All the periglacial disturbances, other than those previously ennumerated (turbation périglaciaire — autre que celle mentionnée précédemment, congeliturbation — frost churning) are discussed in the Glossary's IXth and last chapter (pp. 190-205). H a m e l i n uses *géliturbation* and *cryoturbation* in the strictest sense of these terms, in other words, to designate disturbances of the former rock structure. These differ in appearance and belong to various genetic types. Most of them are due to the presence of ground ice. Some result from upfreezing (englacement) owing to the action of ice wedges, ice masses (champs) and injection ice. The melting of ice (déglacement) induces likewise many characteristic disturbances, which are apparent only in exposures. Not all structural deformations however arose in a periglacial environment. Some are due to the uprooting of trees, to solifluxion and subaqueous processes. Most extensive and best developed are those produced in permafrost areas (pp. 190-193).

Phenomena and effects of deformation are illustrated by a number of types such as: upward movements (mouvements vers le haut, frost-heaved congelifracts), downward movements, designated in the English text as involutions, movements in various directions (mouvements multidirectionnels, congeliturbation or frost churning), glacial tectonics (glacio-turbation, deranged stratigraphy).

Structures, especially periglacial ones, not forms or phenomena but their fragments shown in a vertical cut, are the main topic of that chapter. It therefore includes cross-sections of structures produced by ice or mineral injected masses, by lobate congelifluxion as well as profiles of glacio--tectonic structures.

Special consideration is due to the composition of the book. It was certainly no easy task and therefore could not possibly be wholly faultless. Rather puzzling is the difference between the French titles of the two first parts of the Glossary. Despite the fact that according to their respective titles the first part is said to be devoted to phenomena and facts occurring under periglacial conditions, and the second — to those found in cold regions, both of them are in fact dealing with periglacial phenomena. The fact that the second part is concerned with running water and wind action which are azonal processes, might be taken as a reason of that division into two parts, if 1° the authors had not failed to mention that reason, 2° the action of running water and wind discussed in chapters 5 and 6 of the second part were not exclusively those belonging to that particular variety which is actually zonal and typically periglacial. In addition, some of the land-forms presented there, such as denudational vales and asymmetrical valleys are not produced by running water alone but by other factors as well e. g. by congelifluxion which is not mentioned in this part.

The problem of complex genesis is associated with the third part of the Glossary dealing with polygenesis. Chapter VIII is devoted to congelifluxion. One may wonder whether it is correct and justified to place this process which is so typically periglacial in the part dedicated to polygenetic phenomena. It is true that there may exist various, perhaps still imperfectly known forms of congelifluxion or gelifluxion; all these forms however have one general dynamical feature in common due to the presence of a frozen ground.

As concerns the periglacial structures included in that part, Chapter IV, they are — as already mentioned above — shown in two dimensions, in vertical cuts through disturbances of various types whose full appearance is actually three-dimensional. Should not the illustrations of these structures be shown rather in their direct connection and association with the phenomena discussed above as it has been done with the structure of the head type?

Finally, the contents of Chapter VII is neither uniform nor consistent in its arrangement. Gradins and steps of all kinds do not belong to the category of patterned ground. A whole number of patterned ground types are grouped on the basis of a relationship between their descriptive features, despite the adopted principle of a genetic division. It is true, that the still imperfect knowledge of certain forms does not yet permit to ascribe them safely to one or another category. Nonetheless, the chapter contains some glaring errors. As a result of a classification suggested by certain descriptive features, macropolygonation for instance, has been inserted in that section. As a matter of fact, tundra polygons, or rather frost-fissure polygons are genetically uniform. Their formation is controlled by thermal contraction. If there exist any open fissures either containing ice or primary mineral filling, they may at best provide a possibility for subdivisions but cannot affect the genetic uniformity of the frost-fissure system themselves. A classification in which frost-fissure polygons rank together with ring-mezofiguration which includes various forms of clearly different origin like stone circles and ostioles, cannot possibly be called correct.

The authors have, however, all the credit of having dedicated much attention — more than has anyone before — to nival phenomena and still more to floating ice. A number of effects due to these processes are presented and a number of new terms proposed. Nonetheless, one may and perhaps ought to ask the question whether all these facts fall within the scope of periglacial geomorphology. One must confess however that at the present moment any conclusive reply to that question would be premature.

There can be no doubts concerning the floating ice of rivers and lakes. They certainly contribute to the modelling of periglacial surface features and do belong into areas controlled by a periglacial environment. Far more complicated is the case of sea floes. Anyway, icebergs detached from glaciers do not certainly belong to the category of periglacial events. Both their existence and their activity have their source in glaciers and all the processes induced by them. are presumably controlled by glaciers. Detached from glaciers and frequently far-transported, they moreover are no glacial but extra-glacial phenomena.

An important part of the book is given to illustrations whose total number amounts to 117 photos and 13 diagrams. An unusually careful selection and splendid photographs form the backbone of the Glossary. They actually constitute its objective contents by providing a possibility of immediate confrontation of theortical concepts with plain facts. For that reason undoubtedly do the authors themselves declare in their introductory preface that the presentation will be factual rather than theoretical. Their success in achieving that purpose constitutes the unsurpassed value of the book. Nearly 1/3 of the photographs, taken by the authors themselves, especially by Hamelin in England, Austria, France, Canada, Poland, Hungary and Spitsbergen testify to their wide direct experience, evidence of which is found likewise in the impressive number of their works on periglacial problems listed in the bibliography.

As the book is a glossary, the authors were necessarily compelled to put the discussion of the single entries as it were, "in a nut shell", to condense their great knowledge based both on their personal experience and on that of the authors of 395 bibliographic items. As a result, their definitions are brief and substantial and the reader may easily find the most important and well-selected information.

Further recognition is due to the authors for their ambitious attempt to create a classification of their own, based on genetic foundations. The greatest success in that respect seems to have been achieved in the chapters on nivation, floating ice and wind action. Objective difficulties, resulting from the hitherto imperfect knowledge of a whole range of periglacial phenomena and of their effects, are responsible for certain, hardly avoidable failures and shortcomings in the realization of their plan. The treatment of present-day or recent phenomena on equal terms with their conjectural Pleistocene antecedents creates additional complications which render a uniform classification hardly possible. The reader will have easily notice that the reviewer himself had to consider those objective difficulties while formulating his criticisms.

The Glossary of Hamelin and Cook is a most valuable compendium of many processes, especially of their effects whose Index comprises 263 items. In addition to the advantage of providing condensed and easily understandable definitions it will no doubt stimulate further studies and debates on the still open question of an adequate classification of periglacial processes and their results both fossil and those still in progress.

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Jean Tricart — Le modelé des régions périglaciaires. II[nd] tom of »Traité de géomorphologie« by J. Tricart et A. Cailleux. Soc. d'Edition d'Enseignement Supérieur, Paris, 1967. 512 p., 127 figs., alphabetic and authors' indexes.

Tricart is one of the most distinguished among those modern scientists who have largely contributed to the advancement of our knowledge of the Quaternary, especially of its characteristic morphogenetic processes and land-forms. His book requires therefore the most careful attention chiefly because it represents the fullest and most up-to-date synthesis of the author's vast experience accumulated during a period of 20 years. This synthesis was preceded by "Le modelé périglaciaire" that appeared in 1950 and its second edition. Likewise worth recalling is Tricart's pamphlet "La partie orientale du Bassin de Paris", étude morphologique, vol. II, Paris 1952. Field studies and a perfect acquaintance with a voluminous, multilingual literature constitute the main support of the first edition of "Le modelé des régions périglaciaires". Tricart's rapidly advancing studies impelled him to elaborate a second and finally a third edition of the work. That third edition differs from the former not only by its title but by its far more mature, profound and largely modified contents and its rich up--to-date selection of drawings and photographs. Moreover, unlike the former editions which were mimeographed, this one has appeared in print.

Tricart's treatise is composed of two introductory discussions: The geomorphology of cold regions (pp. 5-14), The concept of "périglaciaire" (pp. 15-18) and of five chapters: I. The periglacial zone (pp. 19-99), II. Soils and microforms — cryopedology (119-263), III. Periglacial modelling and its development (285-408), IV. Distribution of land-forms and types (423-459), V. Principles of applied periglacial geomorphology (467-478). These chapters are followed by an annex on: Rapid methods of estimating the susceptibility of rocks to frost-heaving (pp. 479-480), General conclusions (483-488), a List of illustrations (489-493), An alphabetic index (495-497) and an index of authors (499-508). The introduction and each of the chapters as well as the annex are provided with bibliographic indications, classified into separate sections amounting jointly to 65 pages.

The introduction into the geomorphology of cold regions includes such landscapes as those of: continental and mountain glaciers, moraines, patterned grounds and the peculiar land-forms produced by solifluxion, accumulation of blocks, stone streams, rock glaciers, altiplanation (goletz) terraces, etc. One may wonder whether a distinction between two landscape types would not be more appropriate for a separate treatment of glaciers and moraines as well as of patterned grounds etc. and the peculiar periglacial land-forms is often practically impossible and therefore rather theoretical.

Worthy of note is the author's opinion concerning the defficiency of both the astronomical and the climatic definitions of cold regions on account of which his own definition of cold regions is based on their morphodynamical properties. The most basic one of those properties is water action controlled by its occurrence in a solid condition, either permanent of periodical (p. 9). In connection with his division of cold regions into afacial and periglacial, the writer expresses certain views which are not quite in concordance with those held by the majority of experts on periglacial problems, those scholars in particular who debated these questions during the sessions of the Commission on Periglacial Geomorphology devoted to the conception of *periglacial*, chiefly in Paris (1962) as well as in Vienna and London in 1964. Moreover, those views of Tricart are not in keeping with his own views formulated in his numerous works on periglacial problems. The author says for instance that: "Ces régions (périglaciaires) forment autour de lui (domaine glaciaire) une sorte de ceinture"... (p. 10) [these (periglacial) regions form a kind of belt around it (glacial region)], a statement which suggests that the term *periglacial* ought to be understood in conformity with its etymology, although neither Tricart himself nor the majority of other scientists do agree with the idea. A similar instance is that of the author's enunciation concerning the relations between glacial and periglacial dynamics. Such relations do actually exist, but not in every sense. Glacial and periglacial events may be synchronous, but throughout rather longthy time units: in periods including less than centuries they are not sufficiently clear and well-defined. First of all, a spatial relationship between both these categories — though it often actually exists and is in many cases morphogenetically important — is neither general nor absolutely necessary; such periglacial phenomena as, for example, frost weathering or frozen ground either permanent or seasonal, are in principle independant of glaciers, being like the glaciers themselves a direct result of cold climate. These statements of Tricart may be suspected of being symptoms of a "glacial complex" if Tricart were not one of the first who got rid of that complex and emphatically declared it in a whole number of his valuable works including also the one in question which contains (p. 15) the following sentence: "Elle (l'étude des phénomènes périglaciaires) a longtemps été éclipsée par la notion de "glaciaire" [It (the study of periglacial phenomena) has long been overshadowed by the notion of "glacial"].

The introduction, La notion de "périglaciaire" deals with the origin and the meaning of the term, giving a sketch of the history of periglacial research work and of its present stage. The concept itself of periglacial — with reference to areas and phenomena — is discussed in the above mentioned general introduction and in the following chapters, especially in chapter I.

Entitled "Le domaine périglaciaire" (The periglacial zone) this chapter includes: I. A definition of periglacial areas, both recent and Quaternary and their delimitations, II. A characteristic of the periglacial environment divided into: A. dry, with severe winters, B. humid with well-defined (marquants) winters, and C. cold climates with reduced annual amplitudes; III. The mechanism of upfreezing in which are succesively considered: A. thermal properties of rocks, B. amplitudes, C. the penetration of low temperatures into the ground, D. various forms of ground freeze. Section D. is devoted to (1) structures (and types) of ground-ice, (2) the conditions of formation of ground-ice types, and (3) the distribution of ground-ice in rocks (... du gel dans les sols).

Tricart rightly observes that many difficulties arise from the simultaneous presence or the close neighbourhood of the results of Pleistocene and present-day phenomena as it is, for instance, the case with rubble fields.

Not for the first time does the author criticize the methods commonly used in marking the boundaries of periglacial areas. He declares that mean annual air temperatures provide no sufficient evidence and data concerning ground temperatures are lacking. He holds that a determination of the limits of periglacial areas in the direction of the Equator based usually on the course of the July isotherm and that of the wood-line is inadequate and in disaccord with the facts observed in nature. From this statement the author derives the conclusion of the prime importance of contemporary periglacial phenomena or of their records, either recent or Pleistocene. Already expressed in the general introduction (p. 9) this belief, which is in fact the only one that may be called justified at the present stage of knowledge is consistently applied in the following chapters.

One must likewise agree with the author when, in his discussion of periglacial area he demonstrates the necessity of a reduced application of Lyell's uniformitarianism. One may only add the remark that the morphogenetic differences between the present-day Arctic or sub-Arctic regions and those of West-Europe do not result merely from a different angle of solar radiation. Among other circumstances the huge volume of waste, consisting moreover of fine and finest-grained material, accumulated during the Tertiary and the interglacials, should be also taken into consideration; the tremendous significance of such material for the trend of congelifluxion and many other periglacial processes is well-known (pp. 39-40). To be sure, Tricart emphasizes the importance of Tertiary weathering but does it much later (p. 124) and in a different context.

In the same chapter, the author points out a fact of great importance in Pleistocene paleogeography and one that is still insufficiently popularized, namely that periglacial phenomena — unlike glacial ones — develop without any noticeable delay almost instantaneously under the influence of climatic fluctuations. Some doubts are aroused by the author's subsequent opinion which is that a sudden warming up causes the glaciers to retreat at a more rapid rate than does a relatively slow extinction of periglacial phenomena (p. 40). The statement can be objected to, for two reasons: (1) no sudden retreat of the glaciers was possible if deglaciation were not frontal, but areal; (2) warming up of the climate must have induced a rapid development of a deep active zone, which of course was bound to call forth lively and vigorous along-slope movements of the water-saturated masses. In p. 41 Tricart returns to the already mentioned and basically correct principle of the coincidence of glacial "ages" by saying that "young Salpausälka advance may be correlated with a recurrence of frost during the Younger Dryas which was short but intensive". The statement seems somewhat puzzling for, as well known, the advance of the ice-sheet results from increased snow-fall rather than from a sudden cooling of the temperature.

A periglacial climatic environment is primarily characterized by the significance of frost-action together with the rhythm and intensity of temperature and precipitation, chiefly on account of the importance of a snow-cover in the process of low temperatures pervading the depth of the ground. The author pertinently emphasizes the importance of the freeze--and-thaw cycles; unfortunately however he failed to or rather did but casually underline the basic significance of very law temperatures in thermal contraction. Rainfall and its influence on the course of downwash and wind--action, a very potent factor in periglacial morphogeny are, however, taken into consideration.

From his analysis of its major meteorologic elements Tricart deduces a division of the periglacial zone into the aforesaid main climatic provinces. The nothern part of Central Siberia, the north Canadian Archipelago and the northern confines of the North-American Continent as well as the inland of Alaska and the Yukon Plateau are arid climate areas with severe winters. Low temperatures prevail here during the major part of the year, precipitation is scanty, < 200 mm, owing to which wind-action is vigorous and permafrost active and aggrading. Humid climates with well-defined winters are characterized by lesser annual amplitudes and a higher degree of humidity. In the Arctic it represents the humid variety of the type described above. In both the Arctic and the mountain variety of that climate, gelivation cycles occur during the whole year, wind-action is inhibited by the presence of a snow-cover, the melting of snow in summer promotes solifluxion; in the Arctic variety, downwash over the permafrost surface is very intensive in summer. In the mountain variety, fluvial cutting prevails while periglacial activity is mainly reduced to ablation and the modelling of slopes.

Cold climate of reduced annual amplitudes is typical of the islands: Yan Mayen, St. Paul, Kerguelen, Bouvet, of a part of the Kuril Islands, a part of the Sakhalin coast and the mountainous areas of Far-Ör and Great Britain. In those regions with their absence of permafrost, the frequent gelivation cycles are confined to the sub-surface material. Gelivation itself is increased by frequent rainfall. The mountain variety of that type shows similar morphogenetic features.

Most interesting in the section dealing with the mechanism of upfreezing, are the considerations concerning the thermal amplitudes of rocks which do, as a rule, differ from the atmospheric ones. Hence, the capital importance in periglacial morphogeny of the fact that the larger number of gelivation cycles occur on the surface of rocks.

Ground ice is divided into three main groups: dispersed ice; surface ice — glazing ice (verglas) and needle ice; inner accumulation of ice in the form of lenses or wedges. Ice — apart from surface ice — is usually divided into three major types which are: segregation ice that may occur either in a dispersed form produced by upfreezing of water films and small quantities of unbonded water in pores or in that of larger accumulations having the shape of horizontal lenses or vertical schlieren; the last type is that of fissure- and injection ice. Those are the genetic types distinguished by Shumski (1955); the French translation (Tricart) fails to mention injection ice and refers to fissure ice by the rather unlucky term of *ice wedges*. Without a distinction of injection ice, the whole sentence concerning the large contribution of permafrost to the formations of injections (p. 96) sounds rather enigmatic.

Chapter II — the longest (pp. 119-263) concerns patterned grounds and micrforms or otherwise cryopedology (sols et microformes: cryopédologie). It consists of a brief introduction and four major sections which are subdivided into a number of paragraphs: I. Freeze and thaw, A. consequences of the cyclic change in the volume of rocks under the influence of upfreezing, B. effects of varying consistence; II. Biogeographic environments, A. conditions and varieties of periglacial biochemical processes; III. Classification of periglacial structures (Classification des formations superficielles périglaciaires), A. microforms with geometrical patterns, B. amorphous upheaving (soulèvements), C. slope formations; IV. Conditions determining the distribution of structure types (... des types de sols).

Tricart rightly claims that — since freeze-and-thaw is the chief cause of the phenomena modyfying the structure and texture of rocks — the terms *nival* and *subnival* applied to their effects are incorrect. There are various conditions under which gelivation may occur, depending on both supply and content of water, thermal conditions and lithology (p. 128). The geomorphic role of frost weathering or else gelifraction is so preponderant because of the varying resistance of rocks to that type of weathering (p. 132). Of decisive importance as concerns both the course and the effects of gelifraction is the number of gelivation cycles and the magnitude of thermal amplitudes as well as the character of the rock that determine the basic forms of frost-weathering — macro- and microgelivation.

The effects of changes in the consistence of rocks manifest themselves in the first place by periglacial solifluxion which Tricart, following Baulig, calls *gelifluxion,* without discussing the term *congelifluxion* proposed by the present reviewer as far back as 1951, 5 years before Baulig's term was introduced.

The synonymous treatement of nonsorted- and tundra polygons (p. 173) appears rather unconvincing for desiccation polygons are likewise nonsorted. *Frost-fissure polygons,* being an unambiguous and genetic term seems to be more appropriate than the descriptive and already rather historical term *tundra polygons.* It must be further remarked that palsen (correctly: palsa) „Aufeiskegeln" and ground ice mounds (p. 221) are by no means analogous forms in either appearance or origin. On the contrary, hydrolaccoliths are commonly used as a synonymous term. Hydrolaccoliths cannot therefore be defined as basically seasonal forms (p. 221). In accord with the results of study is the statement that palsa are built up of, or rather owe their origin to segregation ice, but an extension of that statement to forms referred to by the Eskimo term of *pingo* or the Yakutian one of *bulguniak* is inaccurate. There is no general agreement as to the fact that palsa are formed exclusively in peat. Their character is determined by the development of lenses of segregation ice, while the material may be not only organic but mineral as well, though usually fine and very fine. String bogs (tourbières cordées) are proper to Boreal rather than to sub-Arctic regions. The fact is known from Troll's description (1944) just as well as from the distribution of these forms in Swedish Lapland and Finland.

The chapter (II) discussed above is certainly too extensive. This is, no doubt due to the author's desire to make the best of his vast knowledge by giving a most precise and extensive account of all the facts. The undertaking has been crowned with success. Less successful is the attempt to develop a new system of classification. This attempt was of course bound to be partly a failure because of the present state of research which is still far from a coherent and uniform system; for such a system can be based on genetic grounds alone, not on a pretendedly easy application of descriptive criteria. That partial failure is plainly due to objective causes. In addition to the misconceptions mentioned above one may cite another example, that of the stone rings placed in a different category than the "soulèvement". As suggested by the results of recent investigations, heaving induced by accumulation (development) of segregation-ice lenses much like in the case of forms of the palsa type has largey contributed to the production of those forms. "Soulèvements amorphes" does not accord with the well defined shape of the forms listed in that category such as palsa, pingos or string bogs. One of the main causes of the failure of create a genetic system of periglacial forms and structures results from the underestimation of the role of various ground-ice types which play a preponderant part in the genesis of the majority of periglacial forms and structures.

One of the most interesting and certainly the most important one from the geomorphologic point of view is chapter III on periglacial modelling (Le modelé périglaciaire et son évolution, pp. 285-422). It discusses the following topics: slope modelling which Tricart regards — on the background of his so numerous and so valuable studies — as the most conspicuous, both with reference to interfluve relief as to the role of slope development in the shaping of river valleys; the river drainage and the modelling of river-valleys and of accumulation plains; the morphogenetic significance of poli- and azonal processes (p. 285).

Slope modelling is discussed in two main sections. The first deals with the system of ablation (pp. 285-300) and presents successively: A. comminution of rocks *in situ* and B. ablation of particles on slopes. Disintegration of rocks is chiefly the work of gelifraction, whose course depends on the rock type, the climate and the topographic situation, the importance of which manifests itself by moisture and lingering snow patches. Special stress is laid on lithology, for the structure and texture of rocks has a decisive influence on the course and the results of gelifraction. Macrogelifraction predominates in vigorously and deeply shattered rocks which facilitate penetration of varying atmospheric temperatures. In the reverse case of shallow penetration — microgelifraction prevails. Instances are cited of gelifraction operating in various rock types: crystalline, shales and schists, basalts, sandstones and conglomerates, crystalline limestones, dolomites, and sedimentary rocks. These are no theoretical examples but such as are based on experimental and field studies as well as on the results of a confrontation of both; the value of these examples is thus enhanced and testifies to eminently up-to-date quantitative research methods.

Ablation of particles on slopes depends on: geliturbation — disturbances of all kind affecting the surface and structure of deposits created in a periglacial environment — which requires moisture and promotes transportation of the slope material; downwash, favored by a frozen substratum and poor vegetation; eolian ablation (pp. 296-300).

Slope types and their development (pp. 300-361) form the second section, of the chapter on slope modelling. The first type comprises the slopes modelled by gelifluxion (... à gélifluction inégale) — landslide lobes, reduced mud-flow (... à coulées boueuses localisées), cryoturbation covers (? ... à lames de cryoturbation), slopes with protruding rocks (... à pointements rocheux), sheet solifluxion. The division appears somewhat questionable. Mud streams of the mudflow type are a result of over-saturation of mineral masses with water, not merely of their saturation, as it is the case with congelifluxion or — according to Tricart's nomenclature — gelifluxion. Besides, such mudflows are also common in non-periglacial morphogenetic environments just like — as pointed out by Tricart (pp. 304-306) — landslide lobes. Hence, mudflows should have been treated as poli- or azonal phenomena, rather than placed within the group of slopes modelled by gelifluxion alone. As to lobes which are very characteristic of periglacial morphogeny, they rather ought to be defined as congelifluxion or gelifluxion lobes.

Most interesting is the following scheme of the development of the slope types in question: at the initial stage, gelifluxion flows concentrate within depressions, chiefly in smaller valleys and on the rocks that are most liable to gelivation; at a more advanced stage, begins the development of landslide (congolifluxion) lobes, the breaks of the long-profile diminish, finally sheet congelifluxion intervenes and increases; at the terminal stage the irregularities are smoothed out, the profile becomes rectlinear or uniformly concave-convex. Tricart, standing firmly on the ground of modern geomorphology, declares that cyclic development must not be understood in the broad sense, advocated by Peltier (p. 322). He is fully aware of the fact that a full reconstruction of the development of periglacial slopes is something of an "utopia" ("Etablir une évolution idéale des versants périglaciaires est donc utopique", p. 321). The reviewer believes that the major difficulty in that respect is not in the question of the initial slope form — one that may be overcome with the aid of detailed studies of exposures — but, at least in Pleistocene areas, a determination of the boundaries between correlate periglacial and Holocene sediments. It seems furthermore likely that downwash, rather than congelifluxion is the dominant factor contributing to the formation of slopes with smooth, rectlinear profiles.

The discussion relating to the final stage of slope evolution includes also the parallel retreat of slopes and equiplanation. The question arises whether the problem of slope formation ought not to be separated from that of goletz planations (... à replats goletz) which represent a case — though a peculiar one — of parallel backwearing of slopes.

Slopes modelled by azonal denudation processes (p. 330-345) are considered as the second type group known from periglacial regions. Such are the processes of gravity screes, either typical or complex, which result in rhythmically bedded slope deposits in the form commonly referred to as éboulis ordonnés, or grèzes litées — and in downwash. Downwash forms are by far less common than gravity screes. Their development is widely diversified, depending on rock type, climate and even exposure; development of that process is the most conspicuous in fine grained material. Often however, downwash is of lesser importance, being rather sporadic and ephemeral, for its deposits and forms are almost immediately removed by more efficient processes, like solifluxion (pp. 339-340). The problem of periglacial downwash is still imperfectly known and its activity depends largely on rock material and land-forms. In mountainous areas, vigorous snow melting promotes the activity of downwash which builds up large piedmont glacis. Under certain conditions sheetwash may develop in a periglacial environment, resulting likewise in the production of glacis.

The excellent and exhaustive presentation of debris slopes and such as are formed by downwash does not suggest many criticisms. For the sake of clarity, however, typical gravity screes should have been treated apart from the processes producing grèzes litées which ought to be rather referred to by the overall term of rhythmically bedded slope deposits. For, the deposits themselves as well as their genesis — in particular — are very complex and depart widely from the simply gravitational fall of detached stones. It is well-known that the rhythmically bedded deposits occurring especially in lowland areas, but likewise in Lorraine, have a dip of barely a few degrees. This cannot be satisfactorily accounted for by a progressive weathering of the scree. One must admit the assistance of congelifluxion and — in a still larger measure — of downwash. At least in lowland areas, the exclusive activity of congelifluxion whose deposits occur commonly close by those of downwash is hardly admissible. Detailed investigations in the Łódź region (Józefów, Góra Św. Małgorzaty, Walewice) have revealed the frequent variability of subsynchronous congelifluxion and downwash. The fact confirms the opinion that both the process of downwash and its role in a periglacial environment are still imperfectly known and rather underestimated.

In the next — and last — paragraph on slope problems the author discusses the conditions of selective denudation. These are: (1) the lithologic conditions which, in a number of rock types with varying resistance to periglacial processes result in a diversified slope profile; (2) climatic conditions due to exposure, accumulation and persistent lingering of snow, as well as those determined by the prevailing wind directions controlling the accumulation of snow and loess. These conditions tend to diversify the periglacial processes which are already by themselves largely controlling the phenomenon of a asymmetry, that of asymmetrical valleys in particular.

The section dealing with the drainage and the cutting of valleys, though rather substantial and exhaustive (pp. 361-394) is much shorter than that on slope problems. This testifies to a right sense of proportion corresponding to the nature of periglacial modelling. The main topic is here that of the special drainage conditions, first of all its periodicity due to winter or diurnal upfreezing as well as flow — liquid and constant, assisted by a large inflow of lateral material, especially in small rivers where the removal of the abundant waste supplied by vigorous slope processes is largely inhibited. The essential difference between mountain rivers alimented by snow and glaciers and lowland rivers as well as the important difference between local and allochtonous rivers, is duly emphasized.

On the background of the major properties of runoff in a periglacial environment, T r i c a r t presents the main types of dissection and the corresponding types of the resulting valleys. Most characteristic are the small valleys produced by gelifraction whose formation is the work of frost weathering and downwash which constantly removes the comminuted finest rock particles. Dry valleys in Pleistocene periglacial areas are genetically, either wholly or partially connected with the former presence of permafrost. The fact is indicated by the equally dense system of these valleys in clayey, sandy, limestone or slate terrains. Beside forms produced by predominant downwash there are other ones that are exclusively the result of gelifraction and geliturbation ("Une partie de ceux-ci est façonnée uniquement par la gélifraction et la géliturbation", pp. 368-369). The validity of this opinion appears doubtful for gelifraction is a factor of comminution of rocks *in situ* but not one of transportation; as concerns the term *geliturbation* it is imprecise for it seems rather difficult to find any element suggestive of transportation in a term relating to the deformation of the previous pattern of rock structure. Smaller denudational valley forms are treated separately as Delle, dels and vallées en berceau. A pertinent remark is that the valley sides of those forms pass imperceptibly into the valley floor. The fact is indicative of a regular transportation of the material, similar to that which takes place in the downward concavities of slopes modelled by colluvial processes. Flat-floored valleys are rather a result of fairly vigorous runoff, sometimes *en nappe* over a frozen surface. Under such conditions, lateral erosion predominates, accompanied by the characteristic phenomenon of undercutting of river banks.

Forms produced by fluvial accumulation and extensive accumulational plains are dealt with in a separate paragraph. Local accumulation, overstrewing of river floors as well as the formation of fans and piedmont glacis are the results of intensive periglacial weathering and, in consequence, of the immense amount of solid flow (débit solide) as well as of the prevalence of downslope transportation over organized runoff of water.

Periglacial accumulational plains exhibit a number of peculiar features depending on the hydrologic and geomorphic properties of Arctic rivers. Those features are most conspicuous in large rivers but are likewise discernible in smaller sea-shore ones (? les fleuves côtiers). They are due to rapid meltwater flow (? débâcle) and to the abundance of mud created by gelifraction and conveyed by downwash during seasons of thawing. Fluvial accumulation may therefore take place over vast areas within the reach of flood waters, the more so as any possible obstacles or limitations are practically next to none on account of the lack or scarcity of vegetal cover. Further phenomena are accompanied by other both phenomena and properties of large accumulational plains. Such are the operations and effects of floating ice, with the ensuing diversifications and irregularities. Plains are dotted with mounds (bosses), lakes or swampy depressions and braided river channels. Lateral erosion becomes therefore unusually active and effective. This excellent characteristic might be usefully completed by a word on thermal erosion which the author has left undiscussed.

The relief of widespread alluvial plains is clearly diversified owing to the development of mounds of the pingo type and to their degradation as well as to other thermokarst phenomena whose evolution and the preservation of valleys and other similar depressions provide evidence of a slack activity of running waters. Among those depressions special attention is given to lake basins with a constant orientation of their longer axes (lacs orientés) whose formation is partly the work of the prevailing winds.

The last section of the chapter in question concerns the periglacial varietes of azonal processes (pp. 394-408). After a description of the conditions favouring wind-action in a periglacial environment there follows a characteristic of the eolian processes and of their particular effects, such as: erosion by hard (owing to low temperatures) snow grains; sliding of coarser mineral particles over glazing ice (verglas); the formation of sand covers and niveo-eolian deposits; accumulation of loess. Specific is further the development of periglacial sea-shores, as revealed by the shapes of cliffs and beaches. The last paragraph of that section deals with the peculiarities of karst development — chiefly based on the results of Corbel's studies. The discussion of the peculiar features of azonal processes operating under periglacial conditions emphasizes the basic belief concerning the specific character of the periglacial morphogenetic zone in which, apart from particular morphogenetic processes, unknown from other zones, also various poli- and azonal processes contribute to a distinct style of land-relief pattern.

Geographic distribution of land-forms and types constitutes the subject matter of chapter IV (pp. 423-465). The author luckily reduced the discussion to the factors modelling the land types and forms instead of trying to present their distribution. An expression of the difficulty to present a clear picture in that field of knowledge is the paradoxical though perfectly true statement that despite a steadily growing number of data collected in present-day periglacial areas, still more information is derived from detailed studies of Pleistocene forms and sediments (p. 423).

The chapter's first section contains several examples of present-day periglacial provinces: (1) Antarctica, (2) the N-Canadian and N-Siberian Archipelagos, (3) Spitsbergen and Iceland. The problem of periglacial climatic phenomena — treated in the next section — is initiated by that of the climatic importance of microforms and structures. Their significance is not always clear and well-defined. Indicative of the presence of permafrost are such facts as: frost-fissure polygons, structures due to congelistatic pressure, diapir injections and ostioles, structures due to stiff glacial tectonics and thermokarst phenomena. Simple "involutions" however have no such significance and provide no evidence of permafrost. In that connection it seems appropriate to underline the absence of any adequate explanation of the term *involution*, which seems already rather vague. Without a genetic connotation, the term fails to convey any climatic indications, for *involutions* have a purely descriptive meaning and in consequence, the corresponding notion comprises a variety of sedimentary structures. The book contains no reference to these structures.

In consequence of the statements concerning the basic importance of morphogenetic processes and of their fossil traces (p. 436), the problem of periglacial morphogenetic provinces is presented after the discussion of microforms and structures and as a sequel to the review of the major examples of present-day periglacial provinces.

The author holds that the days have already gone when the idea of "periglacial regions" conveyed a well-defined homogeneous meaning. A division of periglacial areas must, first of all, be based on thermal, pluviometric regimes and on the intensity of wind action.

The following types have been distinguished: the hyperperiglacial or Arctic one including the varieties of McMurdo and Bunger; the mesoperiglacial one corresponding to rubble-deserts with the varieties of Victoria, Disko, Torrel; the tundra one including the varieties of Alaska and Kerguelen: the steppe one with the Icelandic and Albertian varieties; the taiga one.

The last section of the chapter deals with the types of periglacial modelling in the Quaternary. It describes and characterizes the following types: (1) Atlantic Europe; (2) those defined by continental tendencies including Poland, Hungary and Roumania; (3) the Mediterranian where glacis, characteristic of that type pass into the semi-arid areas of North Africa. Examples known from Europe — where abundant factual data concerning the manifestations of a periglacial environment elicited by means of detailed studies of the sediments and structures, have contributed to a considerable advancement in the knowledge of the correlate processes — afford a sound basis for a reconstruction of the various types of periglacial morphogeny in the Quaternary (p. 459). It may be remarked that Roumania, quoted by the author has until lately been so poorly investigated that, in fact not much can be said as yet about the course of Pleistocene periglacial events in this country. The results obtained so far seem to indicate that Roumania differs widely from its neighbour — Hungary, where very conspicuous structures provide evidence of a continental sequence of periglacial events in the Pleistocene.

The fifth and last chapter on the principles of applied periglacial geomorphology is short (pp. 467-478) and not overburdened with geomorphologic substance. Rather serious problems are set by such phenomena as soil erosion and instability of slopes, chiefly in areas of permafrost, gelivation and frost-heaving. The chapter has a rather introductory character because — the author declares — geomorphologists usually fail to pay due attention to the problem; this interesting and important branch of study remains so far the exclusive province of engineering enterprises (p. 467).

Tricart's book is provided with an impressive bibliography including some 2000 titles. Apart from doing the greatest credit to the author's eminent scholarship, that voluminous literature of the subject systematized into separate grounds of problems forms an integral part of the book and may serve as a guide to bibliography. The work is outstanding among many others of that type for, far being confined to the literature of the subject in its own language it is based on those of a vast number of foreign countries, and cites the works of authors representing practically all the world's nationalities (approximate percentage of the bibliographic items from various countries: Germany — 21%, France — 19%, U.S.A. — 11%, the Soviet Union — 10%, Poland — 4%, Sweden — 3%, Belgium — 2%, Czechoslovakia — 2%, varia — 12%).

Likewise, a large number of drawings and photographs from various lands will undoubtedly contribute to broaden the field of the reader's knowledge. The only point that may be called inconvenient is the absence of a consistent system of references to the illustrations in the text.

Apart from Tricart's great experience derived from his own studies and from profound knowledge of those of so great a number of other workers one cannot but admire his great skill in handling the subject especially from the geographical view-point. The author himself has perfectly formulated the necessity of that view-point and one must admit that he never departs from it. His sentence on that point reads as follows: "L'interprétation des phénomenès périglaciaires quaternaires doit donc être faite avec tact. Elle repose nécessairement sur une comparaison avec les phénomènes actuels. Mais elle doit tenir compte des conditions spéciales introduites par le milieu géographique propre de chaque région, par sa position par son orographie, par ses roches. Elle exige un sens aigü de géographie, conseient de l'unité profonde du milieu physique tout entier." (p. 38-39).

Tricart's book is a masterly and certainly the most exhaustive presentation of periglacial geomorphology. The reviewer's criticisms were largely inspired by its riches, for, a few corrections only, making allowance for the modified interpretations of the workers cited by the author, would bring his book to the point of perfection. One can hardly imagine a student involved either in the investigation of a particular problem or trying to develop a new interpretation of that branch of geomorphology who could dispense himself from consulting this outstanding work. Let us hope that the author will not refuse to take the reviewer's remarks into consideration before the publication of the next edition of his valuable book and that it will stimulate the readers interest in periglacial problems to further speculations and studies.

Translation by T. Dmochowska

Jan Dylik (Łódź)

Robert F. Black — Ice-wedge casts of Wisconsin. *Wisconsin Academy of Sciences, Arts and Letters*, vol. 54, 1965; pp. 178-222, 11 drawings, 6 photographs, 2 tables.

The paper deals with the origin, age and paleoclimatic significance of ice-wedge casts in Wisconsin. The problems discussed are beyond the regional scope, especially as concerns the origin of ice-wedge casts. The author performed the long and detailed investigations of the present-day development of ice-wedge casts in the polar areas.

R. F. Black examined 20 localities in which over 200 ice-wedge casts were found, 45 of them in one locality. The ice-wedge casts described from 2 other localities are most probably of different origin, especially those occurring in the dolomites. In Poland the analogous structures in carbonate rocks are usually karstic forms.

The author thoroughly investigated ice-wedge casts, especially the shape and deformations of layers in the adjacent material. On the basis of measurements of the distances between the casts and their strikes the diameters of polygons were determined. Special attention was paid to the analyses of wedge infillings, their grain size and roundness, mineralogical composition and structure of infilling material.

The data obtained permitted to state that in Wisconsin the ice-wedge casts form a system of polygons 5-20 m in diameter, whose network size corresponds to the primary polygons in the regions of present-day development of ice-wedges. The secondary polygons, 2-5 m in diameter, were also found but rather rarely.

The convergency of fossil frost-fissure polygons with the active frost--fissures induces to recognize their genetic similarity. The further step of importance in defining the origin of fossil frost-fissure polygons is to state whether the mineral material infilled the fissures simultaneously with their growth or was deposited after the melting of wedge ice.

Black holds that the resolution of this problem demands first of all a very thorough analysis of the wedge fillings. In general, this material is composed of medium-sized sand with an admixture of fine- and coarse sand, well-rounded and well-sorted. It bears a strong resemblance to the eolian material and its origin is most likely eolian, hence, the forms in question seem to be sand-wedges. However, the more detailed analysis revealed that in the wedge filling there were large inclusions and slumps of the material from the fissure walls and from the covering material such as clay. These facts suggest that the voids were filled up after melting of ice. Thus, the forms examined appear to be the ice-wedge casts. There are also few structures in which the lowermost tips filled with sand indicate that initially they were sand wedges, but the inclusions deriving from the material surrounding the wedges and found in the upper parts of these structures support the conclusion that they must have been at least partly the ice-wedges.

The method applied by the author to determine the origin of frost-fissure polygons is very helpful and merits special attention. It seems, however, that in places more care should be taken at interpreting some structures as ice-wedge casts.

While defining the time of formation of the ice-wedge casts in Wisconsin and of filling the voids by sand, the author had to overcome great difficulties but he menaged to obtain fairly precise dating.

Black distinguishes two main periods of the formation of ice-wedge casts. The first one comes back as far as 20,000 years ago, the second — 10,000 years ago. There should be stressed a remarkable coincidence of the former with the main phase of the formation of ice-wedge casts during the last glaciation in the Netherlands and Poland. The second period also has some approximative counterpart in Europe, the most of wedges from the Older Dryas being found in the Scandinavian countries.

The ice-wedge casts present the paleoclimatic evidence of great value. It is certain that at the time of their formation there was continuous permafrost in Wisconsin. The author holds that the ice-wedges could have come into being only when the mean annual temperature was not higher than —5°C. Other scientists mention almost the same temperature. However, Black does not give enough reason why —5°C should be regarded as limit value.

The most essential problems for investigations of the fossil ice-wedge casts discussed here as well as the originality of conclusions well supported by documentary evidence make this paper a very valuable position in the recent periglacial literature.

Translation by Z. Apanańska

Jan S. Goździk (Łódź)

Arnt Bronger — Lösse, ihre Verbraunungszonen und fossile Böden. Ein Beitrag zur Stratigraphie des oberen Pleistozäns in Südbaden. *Schriften des Geographischen Instituts der Universität Kiel*, Bd. 24, H. 2, Kiel 1966, 113 p., 6 tables, 16 photographs, 3 figures.

A. Bronger discusses the structure, origin and stratigraphy of loess in Baden. The loess section in the brick-field at Heitersheim is presented as leading profile. There are four loess horizons interbedded by three fossil soils of the "Parabraunerde" type. In the youngest loess there are two poorly developed horizons of brown soil (the lower one being better developed). As denudational and erosional processes are slightly perceptible in the whole profile, it is of an essential significance for the study of the origin and stratigraphy of loess and therefore of the whole Quaternary of the southern part of Baden.

Because of the method applied by the author to the research work, his paper has a much wider meaning than the regional one. From the whole excavation face (28 m) he prepared a "firm profile" (*Lackfilm*) to examine micromorphology according to the method described by E. W. Guenther (1953, 1961). The laboratory work comprised: the micromorphological analysis of films both of fossil soils and loess, determination of $CaCO_3$ content in samples taken at 10 cm intervals, detailed characteristic of the evolutional forms of carbonates, evaluation of humus content, of grain-size distribution, of the mineral composition of clay fraction and of the quantity of feldspars and quartz. The mammals remains and molluscs are also described.

Micromorphological analysis of films of fossil soils is of special value due to which the author could make a typological classification of soils according to W. L. Kubiena (1953, 1956). The identification of the soil type led to a thorough characteristic of the climatic conditions and their changes during the formation of individual horizons. Three fossil soils of the "Parabraunerde" type are characterized by a leached zone as deep as 2.5 m, by decreasing quantity of feldspars and by an increased content — in relation to the loess — of the clay minerals of the illite and montmorillonite group. These soils are genetically similar, their properties testify to interglacial conditions under which they were formed, though warmer and more humid than the Holocene.

Two brown soil horizons within the youngest loess are partially leached and contain a greater amount of humus particles and — in relation to the loess — a little higher content of clay particles. The molluscs fauna indicates a slight increase of temperature during these two interstadials. There in no evidence of forest vegetation of that time.

In the final part of his paper, Bronger presents an attempt at dating of the profile at Heitersheim and of some smaller ones in neighbouring area as well as correlation of the leading horizons in this profile with the stratigraphy of loesses in Middle Europe. Three soils of the "Parabraunerde" type correspond to the Interglacials: R/W (Eem), RI/RII (Integracial Treene) and M/R (Holstein). Two brown soil horizons in the Würmian loess are correlated by Bronger with two interstadials of the Würm glaciation, the younger horizon with the Intestadial Arcy (Paudorf), while the older one with the interstadial to which correspond: the chernozems in the complex of Stillfried A in Austria and the horizon PKII in Czechoslovakia. At Heitersheim, the typical calcareous loess, 2 m. in thickness, overlying the Eemian soil is immediately mantled by the older brown soil horizon. The fact is significant because in the more arid areas of Middle Europe — which are favourable for the loess sedimentation — the thickness of such beds does not exceed several dcm.

Bronger's paper offers a new study of the leading profile in the area in which only few loess profiles of a stratigraphical significance so far were known (i.e. et Riegel, Achenheim). The profile at Heitersheim was examined in all its aspects by means of the methods, the part of which has never or very seldom been applied. The results obtained as concerns the stratigraphy and chronology give the opportunity to further discussion on the conception of Fink, Ložek, Lieberoth and others about the stratigraphical division of the last glaciation on the basis of profiles of loess, which is one of the most interesting periglacial deposits.

Translated by Z. Apanańska

Józef E. Mojski (Warsaw)

A. Cailleux et L.-E. Hamelin — Périglaciaire actuel sur le littoral du Bic (Bas-Saint-Laurent). *Cahiers de Géographie de Québec,* no. 23, 1967; pp. 361—378, 14 photos.

Le stage de recherches organisé en septembre 1965 par l'Institut de Géographie de l'Université Laval a été l'occasion d'observation de certains aspects et effets périglaciaires développés en milieu littoral. Plusieurs de ces traits n'ont pas été décrits auparavant. La région étudiée a été celle du Bic, dans le Bas-Estuaire du Saint-Laurent.

La ligne de rivage coupe ici en biais les plissements appalachiens, constitués par des schistes, grès et conglomérats ordoviciens. C'est pourquoi la côte comprend une série de noyaux rocheux séparés par des baies en voie de colmatage. Le découpage de la côte est très prononcé surtout entre le Bic et Saint Fabien, soit sur une distance d'environ 13 km.

Les conditions climatiques de la région sont sévères. En année 1964-1965 par exemple aucun mois n'avait une température moyenne dépassant 18°C, trois mois en avaient une de +18° à +14°C, deux de +14° à +6°C, deux autres mois de +6° à 0°C et cinq mois de 0° à —18°C. La température moyenne annuelle est de +2,7°C. En 1964 tout près de la moitié des jours de l'année, soit 179, ont enregistré une température minimum inférieure à 0°C. Dans ces conditions, malgré la salinité des eaux, une glace locale se forme sur les rivages et s'ajoute à la glace allogène. En décembre, janvier et février, au coeur de l'hiver, il pleut parfois, donc la température monte au-dessus de 0°C. Dans ces conditions les cycles gélivaux de l'air et surtout ceux de l'épiderme du sol sont nombreux, les premiers sont de quelques dizaines. Climat est froid mais contrasté aussi autour de températures relativement molles.

Pendant que les noyaux rocheux sont recouverts d'une forêt mixte, les hauts estrans en pente notable (5 à 8°) sont sablo-graveleux et nus. Les estrans en pente faible, au niveau des basses mers, sont nus ou portent des *Fucus*. Plus haut, ils sont couverts d'un gazon de graminées et autres plantes à racines. Dans des anses abritées on obtient ainsi un marais littoral. Ce sont ces lieux qui ont fait l'objet de l'intérêt particulier de deux auteurs.

Les auteurs posent les questions suivantes: Comment les glaces flottantes, la gélifraction et la neige agissent-elles dans ce milieu dépourvu du pergélisol? Est-ce un modelé littoral pur? Comment le tapis végétal réagit-il à l'action de tous ces processus?

En discutant l'action de la gélifraction les auteurs soulignent le rôle de la coopération étroite des actions du gel et de la mer sur ces rivages de climat froid et en présentent des exemples concrets.

Sur l'estran ils ont observé des blocs échoués, apportés par des radeaux de glace flottante. Ils ont couramment de 0,5 à 2 m mais peuvent dépasser 5 m. Certains portent des stries, marques de choc et marques de frottement, ces dernières acquises par combat mutuel et balancement de la glace de mer sous l'effet des marées. Pour la plupart des cas ces blocs sont situés sur le bas de la plage, en pente faible. Les auteurs les appellent *blocs glaciels.*

Dans la région du Bic on a observé un bel exemple de dallage de pierres. Il est situé dans le bas de plage, légèrement incliné vers la mer et périodiquement envahi par la marée. Les gros cailloux qui le composent ne sont pas des gélifracts, car la plupart sont émoussés. La nature pétrographique est très variée (roches cristallines et métamorphiques, quartzites, grès et conglomérats) ce qui semble indiquer qu'ils sont venus d'un complexe glaciaire. Granulométriquement, nombreux sont les blocs de l'ordre de 30 cm; entre ces blocs se trouvent des cailloux, des granules et des sables grossiers. Plus on descend vers le niveau de la basse mer, plus ces dernières fractions sont abondantes. Du fait de l'enfoncement différentiel des blocs la surface supérieure du dallage est remarquablement plate. Seuls quelques gros blocs récents dominent la platitude. Il y a de diverses hypothèses sur l'origine de tels dallages. Les auteurs les expliquent par l'action des glaces flottantes et des marées. Ils remarquent aussi qu'on n'en a pas signalé sur les littoraux tempérés et chauds. Au contraire, on les a signalés dans l'Arctique et dans la zone subarctique, au Labrador.

D'autres formes intéressantes ont aussi attiré l'attention des auteurs. Il y en a sur le bas de plage en pente très faible. Ce sont des *flaques d'eau de bas de plage*, petites (0,6 à 2 m en diamètre), peu profondes, circulaires ou presque. Leur origine est également liée à l'action des glaces flottantes et des marées. Leurs formes et dimensions correspondent aux blocs glaciels. L'explication pourrait être la suivante: Un bloc apporté par les glaces flottantes s'est échoué en bas de plage. Par son poids il a fait fléchir le sable vaseux, et du sable nouveau a pu se déposer autour, accentuant ainsi la dénivellation relative du creux central. Plus tard, une autre année probablement, un autre radeau de glace, enchâssant le bloc de roche l'a transporté ailleurs. Le fait qu'on n'a pas décrit de semblables phénomènes sur le bas de plage sablo-vaseux de pays tempérés ou chauds indiquerait, que, dans leur genèse, le froid, le gel ou les glaces littorales ont eu au moins une part.

Sur l'estran on a observé également des plaques de gazon, isolées. Leur forme est en général circulaire ou ovale, leur diamètre le plus fréquent d'environ 80 cm. On a constaté qu'elles sont couvertes de *Spartina alterniflora*. Le milieu normal pour ces spartines est le marais littoral. Les plaques isolées, observées loin de leur lieu d'origine ont dû être donc déplacées. Les auteurs supposent qu'une zone continue de gazon a pu être déchirée par le gel probablement. Peut être les vagues y ont-elles coopéré, et la poussée des radeaux de glace aussi. Ensuite, les glaces flottantes ont transporté certaines plaques de gazon plus loin. D'où le nom *plaques de gazon glacielles*.

Les marais littoraux, appelés *marais troués* ont constitué aussi l'objet d'étude. La végétation y est composée avant tout par *Spartina* et *Salicorna*. Le tapis végétal plat et en pente très faible (de l'ordre de 3 à 6 millièmes), est creusé de cuvettes à fond plat, profondes seulement de 10 à 20 cm. En plan, la dimension des dépressions varie considérablement, de 1 à 30 ou 40 m et plus; le maximum de fréquence se fixe à 6 m environ. La forme est extrêmement variable: cercle, ovale, quadrilatère, triangle, polygone, parfois demi-lune. Les grandes cuvettes ont toujours des formes irrégulières. Leur bord est vertical, taillé comme à l'emporte-pièce et extrêmement frais. Sous le gazon, se voit un limon ou sable vaseux. La tranche vive du bord indiquerait qu'elle soit rafraîchie périodiquement. C'est pourquoi les auteurs les considèrent comme des formes d'érosion. Les marais troués voisinent avec les champs d'atterrissement de blocs glaciels, d'où la conclusion que leur origine est liée à la coopération du gel avec l'action des marées et des glaces flottantes.

Les auteurs précisent que leur étude ne constitue pas un inventaire complet de tous les phénomènes périglaciaires de la région du Bic. Ils remarquent que la région est témoin de l'action de plusieurs processus „froids" et terminent ayant rappelé qu'il n'apparaît plus déplacé maintenant, après ces nouvelles études, d'avoir, il y a plusieurs années, parlé „d'un faciès périglaciaire laurentien".

Traduction de T. Kubiak

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