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CURRENT FIELD MEASUREMENTS CONCERNING THE NATURE AND RATE OF PERIGLACIAL PROCESSES

Results of a survey sponsored by I.G.U. Co-Ordinating Committee for Periglacial Research

INTRODUCTION

In an attempt to obtain a better understanding of the present status of research involving the direct field measurement of periglacial processes, the Co-Ordinating Committee for Periglacial Research, in connection with the Commission on Present Day Processes (President: Dr. A. JAHN), circulated a questionnaire in March 1974. This short report summarises the results of that survey, and presents the data obtained in a form which may be of use to those interested in active periglacial processes. It must be emphasised that the survey is not comprehensive, since not all recipients of the questionnaire responded. Furthermore, although every effort was made to circulate the questionnaire as widely as possible, it is inevitable that there are individuals or groups working on active periglacial processes who were inadvertently excluded. However, to ensure that the information gathered does not become obsolete, early publication of the provisional results was thought necessary. We wish to continue the survey and invite additional information. Please write, following the format as set out in the Appendix (p. 87), to either the author or Dr. A. PISSART, President of the Co-Ordinating Committee for Periglacial Research.

THE SURVEY

Information was sought as to the process and/or phenomenon being investigated, the location and duration of the study, the methods utilised, and any publications arising from the research. Comments were also invited upon the adequacy

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Table I

Current field projects classified according to (a) the process or phenomenon studied and (b) the methods utilized

(Numbers in the Table refer to projects listed in table II)

Methods utilised / Process or phenomenon studied	Reconstruction	Painted objects	Deformation of layers	Levelling and direct measurement	Air photographs and pictures	Traps	Flexible tubing	T-bars	Test pillars	Hydrologic procedures	Taping	Strain gauges	Micro-climatic and soil measurements	Sediment fabric analysis	Frost heave recorders	Geo-chemical analysis and C_{14}
Needle ice				10.									26.	26.	26.	
Frost heave		36.8.		12.36.	12.				12.				14.36.	12.	6.12.14. 17.24.	
Creep		4.18.24. 32.33.36.		4.15. 33.36.	18.		4.	4.	4.			15.	4.36.			32.
Solifluction		9.24.31. 36.		14.36.	9.		14.31.					31.	36.			32.37.
Slumping		8.		8.	8.	16.								8.		
Slopewash and nivation				13.8.		4.10. 16.	13.		13.	11.			13.			13.
Fluvial processes										22.				22.		22.
Weathering and rockfalls		18.		18.	18.									18.		
Blockfields, rock glaciers and ploughing blocks				35.	5.21									5.21.		
Wind action														16.		
Patterned ground:																
(1) Micro-forms	27.	3.27.	27.	38.	38.					23.						
(2) Polygons and circles		3.28. 29.36.	29.	36.	3.28								12.34.	34.	6.	34.
(3) Stripes	27.	3.7.36.	27.	7.36.												
(4) Ice wedges											1.2. 19.					
Thermokarst				8.	8.	8.							8.	8.		
Pingos				20.	20.					25.						
Man-induced or biotic processes				8.	8.									30.		

of the methods used. Over 90 persons or institutions were contacted for the survey, and this yielded 38 field studies currently being undertaken or just recently completed.

The results of the survey are presented as follows; firstly, the various replies are classified in Table I according to both the processes and phenomenon involved and the methods utilised; second, Table II lists the replies alphabetically under the name of the principal investigator giving the nature of the study, its geographic location and reference to any publications; third, a bibliography has been compiled of all the material mentioned in the various replies. There is cross referencing from the bibliography to Table II, and from Table II to Table I.

DISCUSSION

The largest single concentration of field studies are being undertaken in the various middle latitude alpine or mountain regions of North America and Europe. Nearly 50 per cent of the replies indicate field sites in either the Rockies, the Alps, the Tatras, the Carpathians or the uplands of Scandinavia. The only other appreciable concentration of research activity is in the North American Arctic, especially the Canadian Arctic. The dominance of mid-latitude alpine studies contrasts with the relatively small global extent of alpine periglacial conditions. This probably reflects the relatively easy accessibility of such areas, an important factor in process studies which often demand repeated visits over a number of years. In the high latitude periglacial environments logistics are much more difficult and the opportunities for long term studies are more limited. Relatively few studies are being undertaken in Greenland, Spitsbergen or Antarctica. The recent growth of research activities in the Western North American Arctic has been stimulated by the search for oil and gas by private organisations and the desire to regulate such operations by governmental bodies. Information from the Soviet Union is not yet available, but almost certainly, a considerable amount of research activity is being undertaken in Siberia, where the Siberian Academy of Science maintains a large Permafrost Institute at Yakutsk.

The most frequently studied processes or phenomena appear to be those associated with either creep or solifluction, often in relation to small scale patterned ground phenomena (e.g. Price, 1973; Rampton, 1973; Shilts, 1973; French, 1974a; Worsley and Harris, 1974; Harris, 1973; Giles, 1972; Pissart, 1972). A variety of methods are being used (e.g. wooden dowels, T-bars, flexible tubes, Rudberg columns, tin foil strips, strain gauges). A recurrent comment upon all of these methods is the difficulty of establishing really permanent benchmarks and the need for measurement over 5—10 years.

Frost heave and related studies also appear to be reasonably well documented (e.g. Washburn, 1969; Fahey, 1973, 1974; Gerlach, 1972; Outcalt, 1970, 1971). It is now possible to obtain camparative data for a number of different climatic environments. The use of various types of 'bedstead frame' apparatus appears to be the best method for accurate long term heave studies (JAMES, 1971; GILES, 1972; FAHEY, 1973, 1974).

A number of studies concerned with ground ice and related phenomena are now underway, especially in the Western Arctic. The growth of ice wedges and the frequency and periodicity of frost fissure cracking has been monitored by taping or wiring across the cracks (BLACK, 1973; BLACK and MACKAY, 1973). Other techniques are being used experimentally in the Mackenzie Delta by MACKAY to measure the horizontal direction of the cracking, the time and depth of cracking, and the closure of cracks. The growth of pingos in the Mackenzie Delta has also been demonstrated by MACKAY (1973) to be capable of direct field measurement using accurate levelling techniques. Natural and man-induced thermokarst processes involving ground ice slumping and thermokarst subsidence have been described by FRENCH (1974b, 1974c) from Banks Island.

There appear to be several processes for which direct field observations are either lacking or few in number. For example, there is relatively little emphasis being given to general hydrological aspects of periglacial regions. Work by MCCANN and associates (1972, 1974) in the Canadian Arctic strongly suggests that fluvial processes, at all scales, are important in the High Arctic and in the overall development of the periglacial landscape. There is a lack of detailed quantitative studies on slopewash, snowmelt and nivation processes in high latitude environments, although studies are being undertaken in the mountain regions of Europe (e.g. JAHN, 1974; GIL and SŁUPIK, 1972; HALL, 1972). Another process which appears to be little studied apart from JAHN (1972) is the role of wind. This is rather surprising in view of the importance generally attached to this process in the interpretation of the Pleistocene periglacial environment. Finally, the effects of man as a geomorphic agent in either initiating or accellerating processes has not yet been fully considered. With the continued development of many periglacial regions, especially in the North American Arctic, this aspect of periglacial research will assume increasing importance.

CONCLUSIONS

The last 5—8 years have seen an increase in the number of studies concerned with the direct field observation and measurement of periglacial processes. Emphasis appears to have been upon creep and solifluction movement, frost heaving, pingo growth and ice wedge formation. More long term programs of observation and measurement are required of all processes, in conjunction with cold room and laboratory experiments. Thermokarst processes and all forms of fluvial activity require more information in view of their importance in many regions.

Table II

LIST OF INVESTIGATORS AND TOPICS

1. BLACK, R. F.: Department of Geology University of Connecticut, Storrs, Mass. 06268, U.S.A.
   Growth rate of patterned ground. Pt. Barrow, Alaska; Victoria Land, Antarctica.
   Bibliography: 1, 2, 3, 4, 6, 7, 8, 9, 59.

2. BLACK, R. F.: *Origin of ice wedges.* Pt. Barrow, Alaska.
   Bibliography: 5, 33.

3. CAILLEUX, A.: 9, avenue de la Trémouille 94100 Saint Maur, Val-de-Marne, France.
   Speed of movement of stones. Alpes de Haute-Provence (Basses Alpes); Bassin de l'Ubaye, France.
   Report deposited in 1948 and 1950 in Centre National de la Recherche Scientifique (C.N.R.S.), Paris.
   See also: 38, 43, 44.

4. DINGWALL, P. R.: Department of Geography, Queen's University, Kingston, Ontario, Canada.
   Rates of slope wash and soil creep on alpine debris slopes. Nigel Valley, Canadian Rocky Mountains (52°10'N; 117°05'W).
   Bibliography: 10.

5. DINGWALL, P. R.: *Rates and patterns of movement of rock glaciers.* Banff National Park, Canada.
   Bibliography: 11.

6. FAHEY, B. D.: Department of Geography, University of Guelph, Guelph, Ontario, N1G 2W1, Canada.
   Rates and magnitudes of seasonal and diurnal frost heaving. U.S.A. Front Range of the Colorado Rocky Mountains, Niwot Ridge, 3500 m a.s.l. (40°03'N; 105°35'W).
   Bibliography: 12, 13.

7. FRENCH, H. M.: Department of Geography, University of Ottawa, Ottawa, Ontario, K1N 6N5, Canada.
   Rates of movement of non-sorted stripes on low angled slopes, Sachs Harbour (72°59'N; 125°10'W) and other localities, Banks Island, N.W.T. Canada.
   Bibliography: 14.

8. FRENCH, H. M.: *Natural and man-induced thermokarst processes.* Banks Island, N.W.T. Canada (71—74°N; 116—125°W).
   Bibliography: 15, 16, 17.

9. GABERT, P.: Institut de Géographie, Faculté des Lettres, Aix-en--Provence, 13100, France.
Movement of blocks and stone streams in alpine tundra regions. Naute Ubaye, Massif du Chambeyron, Alpes du Sud Françaises.

10. GERLACH, T.: Institute of Geography, Polish Academy of Sciences, Department of Physical Geography, Kraków, ul. Grodzka 64, Poland.
Recent activity of needle ice and thurfurs. High Tatra Mts, Sucha Woda Valley, 1500–1800 m a.s.l. (49°N; 20°E).
Bibliography: 18.

11. GIL, E. and J. SŁUPIK: Institute of Geography, Polish Academy of Sciences, Department of Physical Geography, Kraków, ul. Grodzka 64, Poland.
Course and intensity of slope wash during snow melt periods. Flysch Carpathians, (Beskid Niski, Low Beskid, Roper Valley), 300 m a.s.l. (49°40′N; 21°10′E).
Bibliography: 19.

12. GILES, R. S.: Department of Geography, University of Reading, Reading, RG6 2AU, England.
The identification and monitoring of processes responsible for patterned ground formation. N. E. Okstindan Mountains (66°N; 14°E), Northern Norway, 590–1900 m a.s.l.
Bibliography: 20.

13. HALL, K. J.: Department of Geography, University of Reading, Reading, RG6 2AU, England.
The identification and monitoring of nivation processes, including mechanical and chemical weathering and mass movement. N. E. Okstindan Mountains, Northern Norway (66°N; 14°E), 800 m a.s.l.
Bibliography: 21.

14. HARRIS, C.: Geology Department, University College Cardiff, P.O. Box 78, Cardiff, CF1 1XL, South Wales, United Kingdom.
Rates and processes of solifluction and frost heave. Okstindan Mountains, Northern Norway (66°N; 14°E).
Bibliography: 22, 23, 24.

15. HUGHES, T.: Department of Geological Sciences, University of Maine, Orono, Maine, 04473, U.S.A.
Creep of permafrost underlain by glacial ice. Deception Island,

South Shetland Islands, Antarctica.
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16. JAHN, A.: Institute of Geography, University of Wrocław, Wrocław 9, Plac Uniwersytecki 1, Poland.
Niveo-eolian and slope wash processes. Sudetes Mountains, Southern Poland.
Bibliography: 26, 27.

17. JAMES, P. A.: Geography Department, University of Liverpool, P.O. Box 147, Liverpool, L37 7DF, United Kingdom.
Magnitude of soil frost heave. Nottingham, United Kingdom.
Bibliography: 28.

18. KOTARBA, A.: Institute of Geography, Polish Academy of Sciences, Department of Physical Geography, Kraków, ul. Grodzka 64, Poland.
Rockfall occurrence, displacement of ploughing blocks, talus creep, soil creep, development of nivation niches. Western Tatra Mts, Mała Łąka Valley, Miętusia Valley, 900—2100 m a.s.l. (49°N; 19°50′E).
Bibliography: 29, 30.

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Growth processes of ice wedges. Garry Island, N.W.T. Canada.
Bibliography: 32.

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Bibliography: 31, 33.

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Movements of stones and pebbles. Northwest Greenland, (Thule and Inglefield Land).

22. MCCANN, S. B. and J. G. Cogley: Department of Geography, McMaster University, Hamilton, Ontario, Canada.
Rate of operation of fluvial processes in High Arctic environments. Mecham River, Cornwallis Island, Vendom Fiord, Ellesmere Island.
Bibliography: 35, 36, 37.

23. MCCANN, S. B. and M. K. Woo: Department of Geography, McMaster University, Hamilton, Ontario, Canada.

Formation of earth hummocks; *drainage of the active layer*. Vendom Fiord, Ellesmere Island (78°03'N; 82°17'W).

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    Measurement of frost heave and creep/solifluction. Cairngorm Mountains, Scotland and Elephant Island, Antarctica.
    Bibliography: 38.

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    Bibliography: 39.

26. Outcalt, S.: Department of Geography, University of Michigan, Ann Arbor, 48104, U.S.A.
    The growth of needle ice. Vancouver, B.C., Canada, and Charlottesville, Virginia, U.S.A.
    Bibliography: 40, 41, 42.

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    Development of microscale sorted polygons and stripes. Chambeyron (Basses Alpes), France, 2700—3000 m a.s.l. (44°50'N; 6°50'E).
    Bibliography: 44, 45, 46.

28. Pissart, A.: *Speed of movement of stones and pebbles on different slopes*. Chambeyron (Basses Alpes), France, 2700—3000 m a.s.l.
    Bibliography: 43, 44.

29. Pissart, A.: *Development of sorted polygons*. Chambeyron (Basses Alpes), France, 2700—3000 m a.s.l.
    Bibliography: 43, 44, 45.

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    Effects of ground squirrels on geomorphology of solifluction slopes. Ruby Range, Yukon Territories, Canada (61°21'N; 138°13'W).
    Bibliography: 47.

31. Price, L. W.: *Rates of mass wasting under various local conditions*. Ruby Range, Yukon Territories, Canada (61°21'N; 138°13'W).
    Bibliography: 48.

32. Rampton, V. R.: Geological Survey of Canada (Terrain Sciences Division), 601 Booth Street, Ottawa, Canada.
    Soil creep and solifluction processes. Richardson and British

Mountains, Northern Yukon Territories, Canada.
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33. SELBY, M. J.: Department of Earth Sciences, University of Waikato, Hamilton, New Zealand.
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Nature of process and rates of movement involved in mud-boil (non sorted or sorted circle) formation. Chesterfield Inlet, N.W.T. Canada. Bibliography: 51, 52.

35. TUFNELL, L.: Department of Geography and Geology, The Polytechnic, Huddersfield, United Kingdom.
Ploughing block movement, 1965—75. Moor House National Nature Reserve, Northern Pennines (54°41′N; 2°27′W).
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Mass wasting processes. Mesters Vig, Northeast Greenland.
Bibliography: 54, 55, 56.

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The rate and timing of Holocene solifluction movement. Okstindan Mountains, Northern Norway (66°N; 14°E), 650—1000 m a.s.l.
Bibliography: 57.

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Rate of change of stone polygons and stripes. Welsh summit plateaus, Fed Grach, Carneddan (53°10′N; 3°57′W).
Bibliography: 58.

APPENDIX — EXAMPLE OF REPLY:

Aim of Study: Rate of re-development of soil stripes.

Location: France, Basses Alpes, Chambeyron Valley, 2,750 m. Lat. 44°50′; Long. 6°50′.

Methods Utilised: Soil stripes were destroyed and two years later were observed to be restored.

Comments on Method: Good. Even better if photographs were compared.

Research Completed: *Research in Progress*:

Publications: J. MICHAUD and A. CAILLEUX, 1950 — Vitesse des mouvements du sol au Chambeyron (Basses Alpes). *C. R. Acad. Sciences*. T. 230, pp. 314—315, Paris.

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