flux, basal sliding, melting, and velocity; glacier seismicity; and water movement at the base of ice sheets.

Session H was concerned with conditions at the base of Pleistocene Ice Sheets. S. R. Moran, L. Clayton, M. M. Fenton, L. D. Andriashek and R. Le B. Hooke's paper dealt with large-scale landforms on the continental glacier bed, including both descriptions and modes of origin. Once again, only the abstract was available for publication. B. E. Broster, A. Dreimanis and J. C. White commented upon the importance of bedrock wedging as a process in glacial erosion. It was suggested that detrital material can be forced down into pre-existing cracks, aiding joint development and eventually causing the entire bedrock block to be wedged out of position and transported. I. M. Whillans's presentation attributed the erosion of grooves on Kelley's Island, Lake Erie, to subglacial meltwater channels. R. P. Goldthwait discussed the same grooves, but argued for their creation by fast moving ice under compressive flow. The last paper was by T. J. Hughes, who discussed the CLIMAP project and his interpretation of the nature of Pleistocene ice-sheets.

Session I, Subglacial Hydrology, was the last session consisting of formally presented papers. S. M. Hodge reported on progress and problems of direct measurement of basal water pressure on South Cascade Glacier, Washington. He concluded that 90% of the bed is hydraulically inactive and that only a few active subglacial conduits were present. The sealed-off areas were thought to control large-scale changes in glacier sliding, and water pressures in active areas are 50-75% of ice overburden pressure. Therefore, sliding is controlled largely by the basal water pressure. The abstracts of the next two papers are published. These are by A. Iken, A. Flotron, W. Haeberli and H. Roethlisberger, on the uplift of the Unteraargletscher at the beginning of the melt season, and by W. St. Lawrence and A. Qamar, who discussed transient water flow in subglacial channels. B. Hallet presented a paper concerning subglacial regelation water film that outlined the evidence for precipitated carbonate deposits, associated solutional furrows, and chemical exchange at the glacier bed. Channelized water is chemically distinct from film water, as is proglacial stream water. One implication is that a temperate cirque glacier is separated from its bed by a thin water film. J. Walder and B. Hallet described the geometry of surficial features on recently deglaciated limestone bedrock, and used these to recognise formerly active processes. They concluded that a nearly continuous, non-arborescent network of cavities and incised channels existed as primary drainage for meltwater, 20% of the glacier sole was separated from the bed by water-filled cavities, and abrasion was locally intensified relative to chemical alteration in 5-10 m wide zones paralleling the ice flow direction. D. N. Collins dealt with the subglacial hydrology of two alpine glaciers. He found two internal hydrological systems which could be separated on chemical grounds. Increased ionic concentrations were noted in film waters relative to the values for conduit waters. B. Wold and G. Østrem presented results on investigations made during construction of a hydroelectric power station in Norway. They observed that most meltwater discharge from the Bondhusbreen Glacier flowed in a single main subglacial channel. The last paper presented in this session, by W. H. Theakstone and N. T. Knudsen, concerns the englacial and subglacial hydrology of Austre Okstendbreen, Okstindan, Norway.

Session J was a general discussion of the entire symposium. Discussion covered many of the points brought out during the formal sessions but centered around such items as the need for coordination and cooperation between glacial geologists and glaciologists, and areas where more work is required. For example, we need to know more about the method of incorporation of debris into ice and its influence on the physical properties and rates of abrasion of glaciers, the relative importance of plucking versus abrasion, the importance of subglacial streams in abrasion processes and modification of till, and the provenance of till. Some participants mentioned problems in flow law modelling, especially in regard to the assessment of creep rates. It was also thought by some that remote sensing methods may be valuable in solving some of problems discussed during the meeting.

All in all, the reviewers were impressed by the variety and scope of research that has taken place in the past few years in order to resolve various problems connected with glacier beds. Impressive also was the Organizing Committee's success in bringing together many of the key workers, both in glacial geology and glaciology, from around the world. Our main criticism is that not all eligible papers were published in this volume. The reviewers realize, of course, that if the volume is to be timely editors cannot wait forever for late contributions. We believe, however, that this volume will be a valuable reference for some time to come to those interested or actively engaged in glacial research.

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GEOBOTANICAL ATLAS OF THE PRUDHOE BAY REGION, ALASKA. By D. A. Walker, K. R. Everett, P. J. Webber and J. Brown. United States Army Corps of Engineers, Cold Regions Research and Engineering Laboratory. Hanover, New Hampshire, U.S.A. CRREL Rept. 80-14. 69 p. $25.00 U.S.

The publication of this atlas represents the culmination of a long-term study begun in 1971, conducted jointly by the U.S. Tundra Biome portion of the International Biological Programme and the U.S. Cold Regions Research and Engineering Laboratory. The study objectives were to: 1) document the history of industrial and scientific development in and adjacent to the region; 2) describe the environment in terms of climate, geology, soils and vegetation; and 3) describe mapping techniques and show how the methods are suited to the derivation of special purpose maps for land use consideration. A fourth objective, that of providing baseline data for monitoring future site changes, could easily have been added as the atlas provides this information very adequately. This latter objective would have been particularly appropriate as one of the aims of the International Biological Programme was to provide environmental monitoring sites.

The atlas is profusely illustrated in both colour and black and white and the text is clearly and concisely written. It measures 44.4 x 39.3 cm with map foldouts up to 1.2 m, and consists of seven summary papers and two appendices. The content of each of the papers is as follows:

Paper 1, by J. Brown, is an overview that outlines the objectives of the study and, through sequential chronological maps and aerial photographs at various scales, reconstructs the sequence of road and installation developments within the area from 1970 to 1977.

Paper 2, by K. R. Everett, outlines the geology and permafrost features and conditions within the area. It shows diagramatically the development of ice wedges and provides a cross-section indicating the relationship of various surficial deposits.

Paper 3, by D. A. Walker, summarizes climatic conditions providing basic information on temperature, precipitation, and wind velocity, frequency and direction (annually).

Paper 4, by K. R. Everett, focuses on landforms such as thermokarst lakes, polygonal ground, sand dunes, hummocky ground and pingos. Polygonal ground is subdivided into five landform units based on whether the polygons are high- or low-centered and on their location in the topography. Two black and white photgraphs, one aerial and one surface, illustrate each of the landforms described.

Paper 5, by K. R. Everett, describes the U.S. soil classification as it pertains to the area and gives brief description of Entisols, Inceptisols, Mollisols and Histisols. Colour photographs with descriptions of typical soils are presented.

Paper 6, by D. A. Walker and P. J. Webber, examines the vegetation in terms of soil moisture, temperature gradient from coast to inland, and soil pH. Four broad vegetation categories, based on aerial photographs, include: 1) vegetation growing on dry, barren or exposed sites (map code B); 2) vegetation growing on moist, well-drained upland sites or well-drained microsites (map code U); 3) vegetation growing on wet or lowland sites (map code M); and 4) vegetation growing on sites where water is present during the entire growing season (map code E). Each of these categories is further subdivided on the basis of associated plant species, i.e. B1 is a dry, alkaline tundra characterized by *Dryas integrifolia, Oxytropis nigrescens* and *Lecanora epibryon*, whereas in B2 *Saxifraga oppositifolia* replaces *Carex nigrescens*. Each in turn is related to the landform and soil type. Colour photographs of each of the vegetation categories are given. Disturbed sites are identified, classified and characterized in terms of types of disturbance and their effect on vegetation.

The final chapter presents a numerically-coded master map which outlines the distribution of dominant vegetation, soil type, landform and slope class. This is followed by specialized derivative maps, in colour,

outlining landform unit, soils and vegetation, and special-purpose maps (i.e. active layer thickness, plant growth form, etc.).

The final section includes the References and two Appendices. Appendix A consists of four master maps, coded numerically and by colour, outlining landforms, soils, vegetation, etc. Appendix B presents profiles of the major soils in the area.

The atlas, though an interesting document, would be much more useful if the authors had provided at least one bar scale and north arrow per page of maps. The authors create some confusion about the size of the area they are mapping. Their detailed colour maps for area three are not 3.6 km², but rather 3.6 km square.

Should the atlas be revised and a new edition be brought forth, we feel that the special-purpose maps would merit considerable elaboration so as to demonstrate the great potential of the data in assisting in the orderly industrial development of the region. For example, in developing the oil spill sensitivity map the authors use essentially a single factor, vegetation recoverability potential, to delineate their units. They note that willow and sedge species are quite resilient to moderate spills and that these species are associated with wet areas. On the other hand, *Dryas integrifolia*, which is found on the dry tundra, is a species very sensitive to oil. Thus their sensitivity map delineates the dry tundra with *Dryas* as the most sensitive area and the wet tundra as having a good recovery potential. They fail to consider that in the event of an oil spill the oil, if above its pour point, would migrate to the wet tundra and terrain depressions thus complicating the development of sensitivity maps. This confusion could be eliminated if the authors had labeled their map "vegetation recovery potential under oil spills of moderate intensity".

For anyone interested in undertaking similar geobotanical studies, the atlas provides a format and a methodology that can be adopted or modified to fit special circumstances. For those interested in the environment of the North Slope or in teaching about it, it provides an easily comprehended style and many interesting observations. The extensive references provide access to additional data.

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AN ARCTIC ECOSYSTEM: The Coastal Tundra At Barrow, Alaska. Edited by JERRY BROWN, PHILIP C. MILLER, LARRY L. TIESZEN, and FRED L. BUNNELL. US/IBP Synthesis Series No. 12. Stroudsburg, PA: Dowden, Hutchinson and Ross, 1981. i-xxv + 571 p. $29.50 U.S. (Distributed by Academic Press, Inc., 111 Fifth Avenue, New York, NY 10003.)

Establishing during the last war, the Naval Arctic Research Laboratory at Barrow, Alaska, has been the base for many fundamental arctic studies. It is regrettable that lack of funding has recently resulted in the closing of its doors to the support of scientific research.

The present book synthesises much of the extensive U.S. IBP tundra biome research that was carried out at the lab from 1970-1974. Thirty-two authors and 24 contributors are listed and many others assisted in various ways. The broad objectives of this research were to: determine how the coastal tundra operates; obtain data to compare this with cold-dominated ecosystems elsewhere; and gather information on degradation, maintenance, and restoration of temperature-sensitive and cold-dominated tundra and taiga ecosystems. Companion volumes have appeared elsewhere on the limnology of tundra ponds by John Hobbie, and the vegetation and production ecology of tundra by Larry Tieszen. Actually, the title of the present book is misleading as it encompasses the content of all three volumes.

There are 12 chapters: the coastal tundra at Barrow; climate, snow cover, microclimate and hydrology; biophysical processes and primary production; photosynthesis; control of tundra plant allocation patterns and growth; pattern and succession in the vegetation; the soils and their nutrients; composition, biomass and ecology of the microflora; microfloral activities and decomposition; the herbivore-based trophic system; the detritus-based trophic system; and carbon and nutrient budgets. The editors point out that "within each of these subdivisions, the reader will find the common theme of the limitation of rates of biological processes by low temperature and related conditions of short growing season and the presence of permafrost". The book ends with a list of references cited; appendices listing the IBP tundra biome projects, personnel, site locations, and location of the major biome plots; and a subject index.

The extensive use of ecological models has aided understanding by allowing ecosystem simulations; however, oversimplification has at times led to an inadequate coverage of the individual species that occur in the area. Lichens, bryophytes, insects and spiders, all of which are abundant and important in the area, have, with few exceptions, received very scant treatment. It would have helped if there had at least been an Appendix in which all life forms known from the area were listed. It is a sad documentary that recent arctic ecological work has often been carried out by individuals who knew, and gathered data on, only the larger and more striking species, and that funding for major research programs did not allow the hiring of scientists with better taxonomic knowledge.

An impressive amount of information has been discovered about the coastal tundra at Barrow, and it is generally well presented, but one should not get the impression that the job has been thoroughly done; much work remains. Little attempt has been made to show how typical or atypical the tundra on the Barrow area is to that found elsewhere. While many general principles hold true throughout the arctic, the tundra is far more variable than most people realize.

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EFFECTS OF FIRE IN ALASKA AND ADJACENT CANADA — A LITERATURE REVIEW. By LESLIE A. VIERECK and LINDA A. SCHANDELMEIER. Anchorage, Alaska: U.S. Department of the Interior, Bureau of Land Management. Alaska Technical Report 6. 1980. 124 p. Soft cover. Gratis.

This comprehensive, highly readable and useful review brings together more than 300 papers on the ecological effects of fire in taiga and tundra ecosystems of Alaska and adjacent Canada. Based on a computerized and abstracted bibiliography containing about 750 references, the review discusses the most recent and important of these. Since some of this literature is contained in unpublished reports, the review provides access to otherwise unavailable information. The authors interpret and derive conclusions from these diverse studies to describe the available information and unanswered questions about fire effects in Alaska resulting in a reference, state-of-the-art handbook. This review is one of a series of recent high-quality technical reports produced by the Bureau of Land Management in Alaska.

The review is organized into six sections. Literature references for each of the topics covered are listed at the end of each section as well as all together at the end of the report. An introductory section summarizes the information sources including a list of several symposia and workshops which have been held to discuss and review fire effects in the North. Viereck and Schandelmeier's review clearly fills a need not addressed by these symposia proceedings, which tend to lack continuity owing to the diversity of authors and geographic areas covered.

The second section on fire regimes and fire history is particularly useful in that it brings together a number of reports on fire frequencies in different parts of Alaska and Canada. Exceptional fire years appear to be characteristic of the Alaskan taiga and tundra with 1940, 1957 and 1969 outstanding in the taiga and 1977 a year of widespread tundra fires in northwestern Alaska. The authors point out that better fire records and more accurate mapping of fire boundaries are needed, particularly for tundra regions. This second section of the review also clarifies a number of important but confusing terms in the literature such as fire severity and fire intensity. In the following section on the effects of fire on soils and watersheds, fire severity is discussed in relation to the amount of organic material removed from the soil surface — a key effect which subsequently controls permafrost changes and post-fire revegetation.