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REPORT GD-3

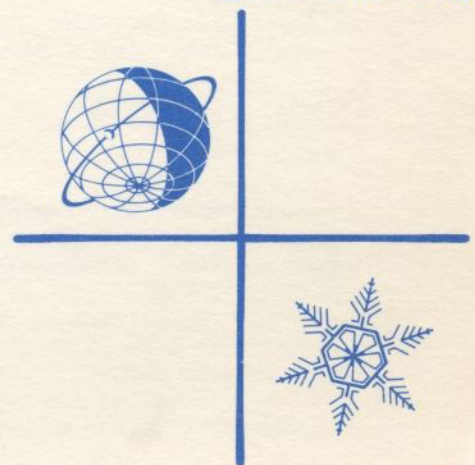
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GLACIOLOGICAL DATA

this issue:

WORLD DATA CENTER A ACTIVITIES

World Data Center A
for
Glaciology
[Snow and Ice]



DECEMBER 1978

Library
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WORLD DATA CENTER A
National Academy of Sciences
2101 Constitution Avenue, N.W.
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World Data Center A consists of the Coordination Office

and seven Subcenters:

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of the Earth
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Solar-Terrestrial Physics (Solar and
Interplanetary Phenomena, Ionospheric
Phenomena, Flare-Associated Events,
Geomagnetic Variations, Magnetospheric
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Aurora, Cosmic Rays, Airglow):

World Data Center A
for Solar-Terrestrial Physics
Environmental Data and Information
Service, NOAA
Boulder, Colorado, U.S.A. 80303
[Telephone: (303) 499-1000, Ext. 6467]

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Boulder, Colorado, U.S.A. 80303
[Telephone: (303) 499-1000, Ext. 6521]

NOTES:

1. World Data Centers conduct international exchange of geophysical observations in accordance with the principles set forth by the International Council of Scientific Unions. WDC-A is established in the United States under the auspices of the National Academy of Sciences.
2. Communications regarding data interchange matters in general and World Data Center A as a whole should be addressed to: World Data Center A, Coordination Office (see address above).
3. Inquiries and communications concerning data in specific disciplines should be addressed to the appropriate subcenter listed above.

GLACIOLOGICAL
DATA

REPORT GD-3

this issue:

**WORLD DATA CENTER A
ACTIVITIES**

DECEMBER 1978

Published by:
WORLD DATA CENTER A FOR GLACIOLOGY
[SNOW AND ICE]

Institute of Arctic and Alpine Research
University of Colorado
Boulder, Colorado 80309 U.S.A.

Operated for:
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Environmental Data and Information Service
Boulder, Colorado 80303 U.S.A.

DESCRIPTION OF DATA CENTERS

WDC-A, Glaciology is one of three international data centers serving the field of glaciology under the guidance of the International Council of Scientific Unions Panel on World Data Centres. It is part of the World Data Center System created by the scientific community in order to promote worldwide exchange and dissemination of geophysical information and data. WDC-A endeavors to be promptly responsive to inquiries of the scientific community and to provide data and bibliographic services in exchange for copies of publications or data by the participating scientists.

The addresses of the three WDCs for Glaciology and of a related Permanent Service are:

World Data Center A
INSTAAR
University of Colorado
Boulder, Colorado, U.S.A. 80309

World Data Center B
Molodezhnaya 3
Moscow 117 296, USSR

World Data Center C
Scott Polar Research Institute
Lensfield Road
Cambridge, CB2 1ER, England

Permanent Service on the Fluctuations of Glaciers
Section on Hydrology and Glaciology
Research Institute on Hydraulics and Soil Mechanics
Federal Institute of Technology
Voltastrasse 24
8044 Zürich, Switzerland

The World Data Centers follow the guidelines established by the International Council of Scientific Unions Third Consolidated Guide to International Data Exchange through the World Data Centres, 1973. The following description from the Guide details the form of the data accepted by the WDCs.

General. WDCs are prepared to accept raw, analyzed, or published data, including photographs. It is suggested that researchers submitting data to the WDCs do so in a form which will be intelligible to other users. Researchers should be aware that the WDCs are prepared to organize and store data which may be too detailed or bulky for inclusion in published works. It is understood that such data which are submitted to the WDCs will be made available according to guidelines set down by the ICSU Panel on WDCs in the Guide to International Data Exchange. Such material will be available to researchers as copies from the WDC at cost, or if it is not practical to copy the material, it can be consulted at the WDC. In all cases the person receiving the data will be expected to respect the usual rights, including acknowledgment, of the original investigator.

Fluctuations of Glaciers. The Permanent Service will be responsible for receiving data on the fluctuations of glaciers and will also receive such data as are generated by the International Hydrological Decade Project on Variations of Existing Glaciers. The types of data which should be sent to the Permanent Service are detailed in UNESCO/IASH (1969) Variations of Existing Glaciers: A Guide to International Practices for Their Measurement. These data should be sent through national correspondents in time to be included in the regular reports of the Permanent Service every 4 years (1964-68, 1968-72, etc.).

Projects of the International Hydrological Decade. In addition to the above, the International Hydrological Decade, 1965-74, sponsored an Inventory of Seasonal and Perennial Snow and Ice Masses, as well as a project on the Combined Heat, Ice and Water Balances at Selected Glacier Basins. A Temporary Technical Secretariat (UNESCO) for World Glacier Inventory is now operated by the Permanent Service on the Fluctuations of Glaciers.

In order that the WDCs may serve as information centers, researchers and institutions are requested:

To send WDCs reprints of all published papers and public reports which contain glaciological data or data analysis; one copy should be sent to each WDC or, alternatively, three copies to one WDC for distribution to the other WDCs.

To notify WDCs of changes in operations involving international glaciological projects, including termination of previously existing stations or major experiments, commencement of new experiments, and important changes in mode of operation.

FOREWORD

This issue departs from our general practice of providing a selected bibliography on some aspect of snow or ice, in order to give an overview of current activities at World Data Center A. The Center has now been located in Boulder for two years and we can begin to assess user opinions on some of our initiatives and attempt to respond to them. The results of the survey circulated in GD-1 are included here. This issue also includes a preliminary report on our ongoing inventory study of ice cores which is being undertaken for the National Oceanic and Atmospheric Administration, Environmental Data and Information Service (NOAA/EDIS). A future issue of GD will be devoted to the results of this inventory. This is the first issue which has been computer-produced using the National Geophysical and Solar-Terrestrial Data Center computer facilities. The Data Center terminal is also being heavily used to build the bibliographic data file.

The results of the survey of glaciological field stations conducted by R. Vivian and a bibliography with articles on snow cover will be published in GD-4 and GD-5, currently scheduled for January 1979 and March 1979.

In order to maintain a current mailing list, we would appreciate your completing and mailing to us the enclosed form if you wish to continue receiving Glaciological Data.

We thank all those who have sent publications/data to the Data Center in recent months.

Roger C. Barry
Director

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Overview of the Functions of WDC-A

Roger G. Barry

Introduction

Since October 1976, World Data Center (WDC)-A for Glaciology (Snow and Ice) has been operated by the Institute of Arctic and Alpine Research, University of Colorado, Boulder, in association with the Environmental Data and Information Service (EDIS), National Geophysical and Solar-Terrestrial Data Center (NGSDC) of the U.S. National Oceanic and Atmospheric Administration. NSGDC, which also operates World Data Centers A for Solid Earth Geophysics and for Solar-Terrestrial Physics, is located in Boulder, and is one of five major facilities of EDIS. The NSGDC operations are adjacent to the Institute of Arctic and Alpine Research, and many facilities and data management expertise are shared. WDC-A for Glaciology (Snow and Ice) is one of three international data centers serving the discipline; the others are WDC-B in Moscow, and WDC-C in Cambridge, England. In addition, there is a Permanent Service on the Fluctuations of Glaciers, and a UNESCO Temporary Technical Secretariat for the World Glacier Inventory, located in Zurich, Switzerland. The major purpose of these centers is to facilitate the international exchange of data on all forms of snow and ice. The materials relate to avalanches, freshwater ice, ground ice and permafrost data, glacier fluctuations and mass balance, polar ice sheets, sea ice, and seasonal snow cover. In the absence of a United States national center for snow and ice data, WDC-A also functions in this capacity, on request, for special data sets.

The World Data Centers operate in accordance with the basic principles laid down by the Comité Spécial pour L'Année Géophysique Internationale (CSAGI). These principles are stated in the Third Consolidated Guide to International Data Exchange through the World Data Centres, Washington, International Council of Scientific Unions Panel on World Data Centres, December, 1973. Particular stimulus in glaciological data exchange is given by the Committee on Glaciology of the Polar Research Board, U.S. National Academy of Sciences, and by the International Commission on Snow and Ice, although the materials are brought together through the cooperation of universities, government laboratories, and individuals involved in snow and ice research in the United States and abroad.

The activities of World Data Center A (seven discipline centers in the United States) are under the general guidance of a Coordination Office in the National Academy of Sciences, and of a committee of the Academy's Geophysics Research Board, as well as of the Panel on World Data Centers of the International Council of Scientific Unions.

Present Holdings

WDC-A maintains a representative collection of reprints, technical reports, monographs, and conference proceedings in the discipline, and subscribes to international scientific journals pertinent to snow and ice. The collection also includes data in written, tabular, and graphic form.

Historical material in the collection includes data important to the study of glacier variations and climatic changes. The material on glacier variations and

other subjects, collected by F. Matthes on behalf of the AGU Committee on Glaciers from 1931 to 1946, and other historical material, such as field records of H.F. Reid from Glacier Bay, Alaska, are preserved on 16-mm microfilm cartridges.

The photo collection consists of several thousand aerial and terrestrial photos and includes a historical collection which represents the work of many U.S. and foreign glaciologists since 1880. These photos constitute an original record of past glacier and snowline positions. High points are the photographs of Alaskan glaciers taken by J.F. Reid in the 1880's, by A. Curtis from the 1880's to the 1920's, and by W.O. Field from 1926 to 1976. Aerial photography taken by Austin Post for the U.S. Geological Survey and the University of Washington consists of glacier and snow-cover surveys in the western United States, Canada, and Alaska. This collection of approximately 80,000 frames is currently being indexed and microfilmed for archival in the Data Center.

The map collection contains maps of sea ice and snow-cover limits, as well as topographic maps showing glaciated areas and distribution of glaciers. Some are special large scale maps of individual ice bodies.

Activities

WDC-A serves as an archive for both published and unpublished data on snow and ice. It is developing automated systems for the storage and retrieval of bibliographic and quantitative data (see p. 23). The center can provide copies of research papers and data on request, either on an exchange basis or for the cost of reproduction. Computerized literature searches on any topic related to snow and ice are also available.

The Center publishes Glaciological Data several times a year. Most issues contain a specialized bibliography and related data information on a single theme. With the development of a computerized classification scheme for glaciological indexing, we expect to be able to provide computer-aided information retrieval of documents, photographs, and other material in the near future. Accessions lists will be prepared in this manner also.

A referral service on worldwide glaciological activities, such as glacier field stations, sites of avalanche and permafrost research, etc., is also being actively developed via questionnaires distributed to the international glaciological community.

The Data Center plans to take an active role in coordinating and carrying out a wide range of inventory studies, as well as development of data bases relating to snow and ice information. Specific inventories are being compiled for the National Oceanic and Atmospheric Administration, Environmental Data and Information Service, for snow and ice topics of major climatic and environmental significance. These include data on ice cores (see p. 5), and information on the mapping of seasonal snow cover and sea ice extent derived from satellite and ground observations. A workshop on this latter theme was held in Boulder on 2-3 November 1978; the results will be published in a future issue of Glaciological Data. Radioecho sounding records from the Greenland and Antarctic ice sheets have recently been archived in the Data Center.

Working visits to the Data Center to research the collection and make use of

the facilities are encouraged. Experience has shown such personal contacts to be a useful supplement to mail and telephone requests for data and information services. Recent visitors making extended stays have included Dr. R. Vivian (University of Grenoble), Dr. G.S. Boulton (University of East Anglia), Dr. W.S. Stringer (University of Alaska), and Austin Post (U.S.G.S. Project Office for Glaciology, Tacoma).

A list of the current permanent and project staff of the Data Center is appended. Primary responsibilities are identified so that telephone requests especially can be directed to the individual most likely to be able to provide assistance. It should be noted, however, that many of these positions are not full-time.

Personnel

Director: Roger G. Barry, B.A., M.Sc., Ph.D. (Professor of Geography)

Manager: Marilyn J. Shartran, B.A., M.A.

Staff:

Ann M. Brennan, A.B., M.A., M.A., Information Specialist
Priscilla A. Harvill, B.A., Library Assistant
Gloria J. Manzanares, Typist

Projects:

Claire S. Hoffman, B.A., M.L.S., Information Specialist
Ronald L. Weaver, B.S., M.S. (March-September 1978), Ice core inventory
Robert G. Crane, B.A., M.A., Snow cover/sea ice inventory
Charlene W. Locke, B.A., M.A., Glacier photo indexing
Betsy R. Armstrong, B.S., Glacier photo indexing
Gregory R. Scharfen, B.A., Snow cover inventory/DMSP imagery

The Development of an Inventory of Ice Core Data

R.L. Weaver

Introduction

In April 1978, WDC-A for Glaciology (Snow and Ice) began a survey and data inventory of ice core studies conducted by North American institutions. Ice core research is a major source of paleoclimatic information for long term studies of climatic change and trace chemical variations. This project is part of the United States effort to identify and consolidate "proxy" climate data. It assists worldwide efforts to improve man's understanding of past and present global climate. In total, over 20 km of ice have been drilled by international research teams; however, only a portion of these cores have been retrieved and analyzed and even less remains in storage. About 20 institutions worldwide are involved in these efforts. This inventory will document existing core storage locations, curator agencies, core samples available for analysis, and completed analyses, including microparticle, trace chemical, and oxygen isotope studies.

Following the present survey of North American based research on ice cores, the second stage of the project will endeavor to locate, collate, and index descriptive information about worldwide ice core research. We hope that the results will promote a wider knowledge of ice core derived data by offering an overview of current research locations, by centralizing access to publications, and by identifying active scientists. The analysis should be of special interest to those unfamiliar with ice core drilling programs and the types of glaciological data derived from them.

Methods

Three methods have been employed to collect the necessary data: 1) a written user survey (see appendix I); 2) searches of published literature; and 3) interviews with active scientists. Each is briefly described in the text which follows.

The user survey (appendix I) is designed to provide enough information about each core to characterize the types of studies completed, in progress, or possible; to provide the source for published information; and to provide a contact point for more data. In addition we will determine, where possible, the relative and absolute dating status for each and the availability of core material.

We are gathering references to published and in-house research reports which describe ice core collection, core analysis, or other ancillary studies. Our sources have included computerized bibliographic data bases, abstracting journals, and recommendations from individual scientists. These citations are scanned for data to complement the user survey, and pertinent information is added to the inventory. Copies of the less well known publications will be added to the WDC-A data collection, thereby permitting easier access by the scientific community.

Information Products

The initial results of the user survey will be tabulated, and a summary published in a future issue of Glaciological Data. In addition, the Environmental

Data Index (ENDEX) computer retrieval system of NOAA-EDIS will contain the survey results in the Environmental Data Base Directory (EDBD) file. Plans are underway to enter these data soon after the survey forms are returned from U.S. and Canadian scientists this fall. A brief outline of the type of information summaries WDC expects to produce may be found in figure 1.

In early 1979 a complete bibliography will be published in Glaciological Data. Updates will be published as they become available. The references will also be added to the computerized bibliographic catalog of WDC-A holdings. This system is designed to retrieve reference information about publications in the WDC collection. (See p. 23 of this issue.)

We have assembled a provisional list of all known core sites (appendix II) including year(s) collected, depths, information source type, and, where possible, the country and/or institution responsible for drilling and curation. In some cases, conflicting and unconfirmed data have been reported, especially from the internal report and verbal sources. We have made every effort to validate these data, but we feel it best to include all information so that scientists involved may provide us with any necessary corrections.

Future Plans

The survey form will be distributed worldwide in late 1978, after we receive responses from North American scientists and any necessary minor alterations are made to the survey form. The initial global inventory should be completed in 1979.

September 1978

References

Langway, Chester C.; Chiang, Erick (1977) Central ice core storage facility and information exchange. Antarctic Journal, v. 12(4), pp. 154-56.

Langway, Chester C.; Herron, Michael M. (1977) Polar ice core analysis. Antarctic Journal, v. 12(4), pp. 152-54.

Site Data

site name, collection date
site location (geographic description)
site coordinates
detailed site/core characteristics
ice mass description
types of drilling equipment
types of field measurements

Principal Investigator

other primary investigators

Collecting Agency

Types of Core Analysis Performed

references to published results, techniques
constituent studies linked to climate

Management

curating agency
amount of core material left
core availability to investigators
data availability

Publications

Figure 1. Outline of expected information summaries

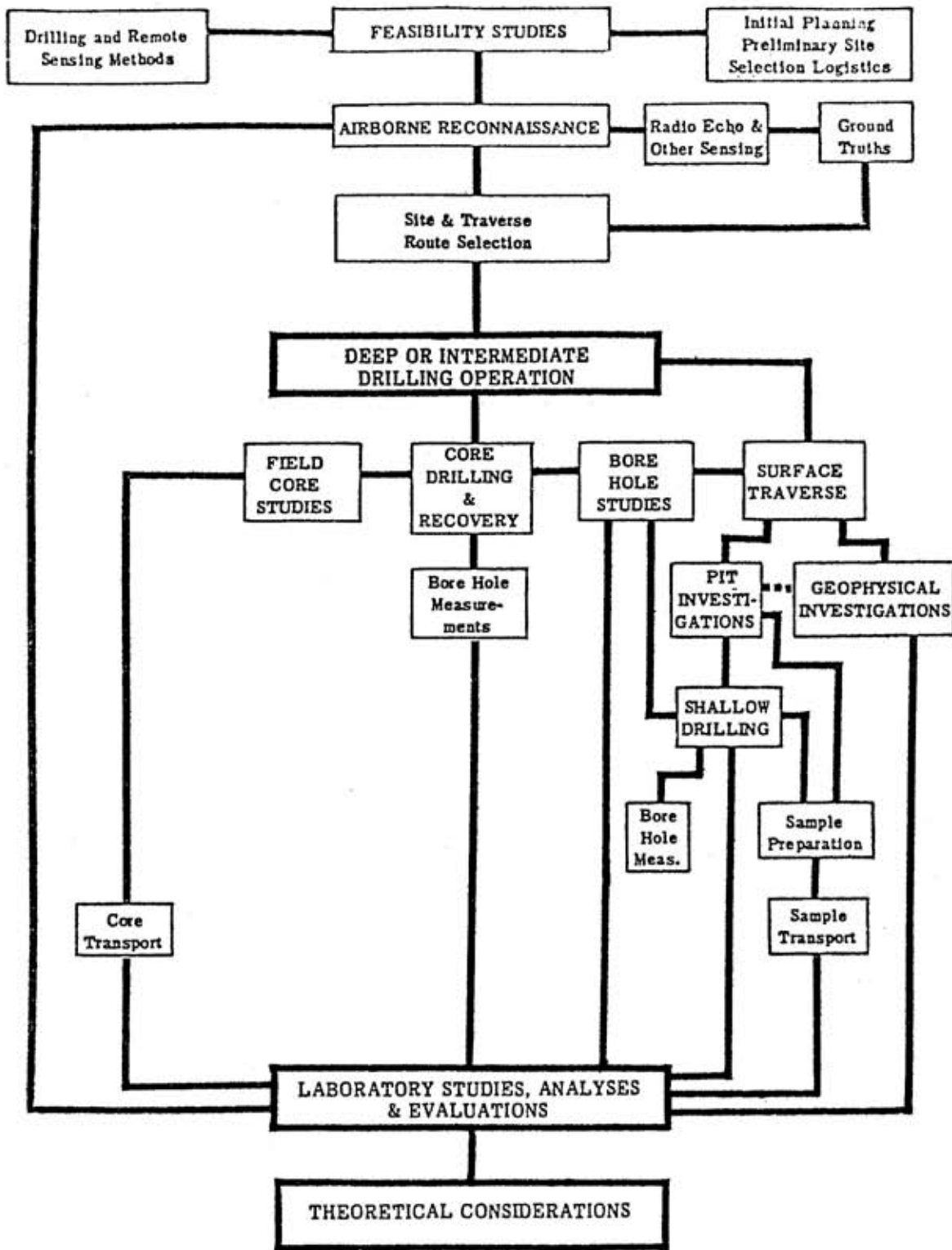


Figure 2. Flow diagram illustrating the steps taken to locate an appropriate core drilling site and various operations performed in association with the main base (Langway, personal communication).

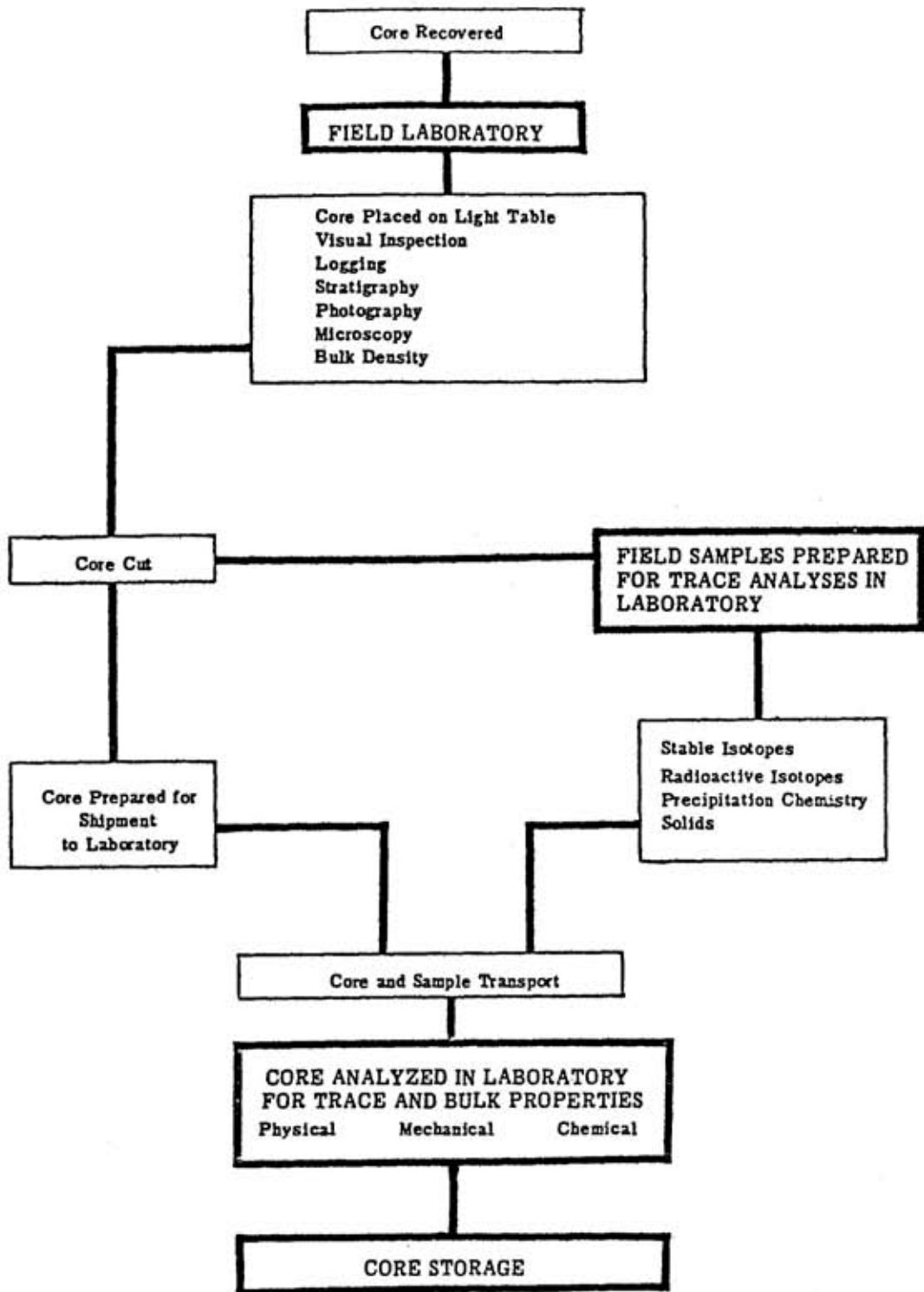


Figure 3. Flow diagram illustrating the standardized procedures followed in handling an ice core from the field to the core storage facility. (Langway, personal communication).



WORLD DATA CENTER A
for
GLACIOLOGY
[SNOW AND ICE]



SNOW COVER
GLACIER FLUCTUATIONS
AVALANCHES
POLAR ICE MASSES
SEA ICE
PERMAYFROST
PALEOGLACIOLOGY

OPERATED FOR ENVIRONMENTAL DATA SERVICE, NOAA, BY

Institute of Arctic and Alpine Research
University of Colorado
Boulder, Colorado, U.S.A.

IN REPLY ADDRESS:
WDC-A FOR GLACIOLOGY
INSTAAR, UNIVERSITY OF COLORADO
BOULDER, COLORADO 80309 U.S.A.
TELEPHONE: (303) 482-5171 FTS: 303-4311
TELEX: 45897 SOLTERWANN BDR
IN REPLY REFER TO:

July 14, 1978

ICE CORE SITE AND DATA AVAILABILITY INVENTORY

USER SURVEY

Please return completed forms by October 1, 1978 to:

Mr. Ronald Weaver
WDC-A: Glaciology (Snow and Ice)
INSTAAR, University of Colorado
Boulder, Colorado 80309

1.0 INTRODUCTION

1.1 Purpose

This user survey is the first step in a program to locate, collate, and index descriptive information about ice core research. The survey will promote a wider distribution of ice core derived data by offering centralized access to published results and by providing identification of active scientists in ice core research, especially for those unfamiliar with the field. This project is part of the United States effort to consolidate "proxy" climatic data and support worldwide efforts to improve man's understanding of past and present global climate. This survey is administered by WDC-A: Glaciology at the request of NOAA-EDS.

1.2 What Ice Cores Should Be Included?

Studies based on ice coring or on frozen or melted ice core material which fall into any of the general categories below should be referenced in this inventory. We include cores from polar (including ice shelves), temperate, and tropical ice masses. Please use your discretion when applying these criteria. If your data do not exactly fit these points yet you feel the information is unique or particularly valuable to ice core studies, please include it. Our categories are as follows:

- I. Any study with environmental, climatic, or paleo-climatic implications.
- II. Any study reporting specific ice core derived "proxy" climatic data sets, such as oxygen isotope, microparticle, or trace chemistry variations.
- III. Any program with ice cores or melted samples stored in accessible locations (with or without possible distribution of material to interested scientists).

Cores of any length may be included if they fit any of the above criteria. Snow, firn, and ice surface samples are of interest if they a) directly support ice core interpretation; or b) are from temperate or tropical ice masses, especially those which are seldom visited. We must exclude snow, firn and ice surface samples from polar regions (e.g. Antarctic traverse data) simply because we cannot process the voluminous quantities of known measurements.

1.3 Survey Organizational Structure

The survey document is divided into two sections:

1) institutional information, and 2) specific ice core information. The first part (form "A") requests details of the institutions actually responsible for ice core collection, storage, and analysis. The second part (form "B") asks for specific details about each core collected, including analysis either performed or in progress.

The survey is designed for rapid completion through use of either checkoff or short response blanks. Answers using abbreviations or references to the same information recorded elsewhere in the survey are welcome as long as they remain unambiguous. If for some reason you are unable to supply a response, please write in "data not available" or other appropriate remarks. In all cases, WE PREFER AN ABBREVIATED RESPONSE TO NONE AT ALL.

INSTITUTIONAL INFORMATION

2.0 NAME and ADDRESS of institution supplying information:

street _____
city _____ district(state) _____
country _____ postal code _____ telephone _____ - _____

2.1 NAME of RESPONDENT for this survey:

_____ title _____
Address same as 2.0? YES__NO__ If no, supply address.
institution _____
street _____
city _____ district(state) _____
country _____ postal code _____ telephone _____ - _____

2.2 PUBLICATIONS

Please attach a complete list of references to your ice core work. Include in-house, and in-press reports or student theses which you feel significantly contribute to a description of your work. Also list any data summaries if possible.

Number each citation so that you may identify which references pertain to individual studies described in Form "B" of this survey.

ICE CORE SITE AND GENERAL ANALYSIS SUMMARY

3.0 SITE NAME _____
BOREHOLE IDENTIFIER _____

3.1 GEOGRAPHIC INFORMATION

- .11 ice mass name _____ country _____
- .12 core site: latitude ____° ____' N S; longitude ____° ____' E W
How was location surveyed? (specify techniques) _____

- .13 year(s) core collected _____
- .14 site surface elevation _____ m a.s.l.
- .15 ice mass classification; (check where appropriate)
- | | |
|------------------------------|------------------|
| a) ___ ice cap | b) ___ ice shelf |
| c) ___ inland ice sheet | d) ___ ice rise |
| e) ___ ice dome | f) ___ glacier |
| g) ___ other (specify) _____ | |
- .16 air temperature (1.5-2 m)
- a) warmest month ____°C ____; b) mean annual ____°C
nearest weather station _____ (location)
- .17 Is the ice at the melting point:
- 1) ___ at the surface in summer?
 - 2) ___ for any englacial segments?
 - 3) ___ throughout its thickness?
 - 4) ___ at the base?

3.2 RESPONDENT

Same as in form "A"? YES ___ NO ___ If no, supply following:

name _____ title _____

institution _____

street _____

city _____ district (state) _____

country _____ postal code _____ telephone ____ - ____

Whom should we telephone for any additional information, if necessary? _____ telephone ____ - ____

3.3 PRINCIPAL INVESTIGATOR(S) Please list those individuals who specifically worked on this core. (If this information is already listed in form "A", section 2.4, check here ___; this part may then be omitted.)

name _____ title _____

institution _____

name _____ title _____

institution _____

name _____ title _____

institution _____

name _____ title _____

institution _____

(Use additional pages if necessary.)

5.3 CORE AVAILABILITY

.31 Is any of this core material available to qualified scientists outside your laboratory? YES__NO__ If yes, whom should they contact?

name_____title_____
institution_____

.32 What are the terms of use? (Reference published guidelines if you wish.)_____

6.0 FIELD COLLECTION METHODS

6.1 What type of DRILL was used?

- a)___thermal drill; model_____
b)___electromechanical drill; model_____
c)___rotary drill; model_____

6.2 Was MELTWATER collected? YES__NO__ If yes, was it used for analysis? YES__NO__ If yes, list references or describe use.

6.3 Was a DRILLING FLUID used? YES__NO__ If yes, specify fluid type(s).

Does this fluid limit types of core analysis? YES__NO__ If yes, specify_____

6.4 REFERENCES to drill design or use experiences_____

6.5 Were special PRECAUTIONS taken during drilling, core removal, and transportation which permit unique studies, such as highly precise trace chemistry? YES__NO__ If yes, please describe (or list references)._____

7.0 CORE DATING STUDIES

7.1 Which of the following GENERAL TIME PERIODS does this core span?

- a)___1800's to present
b)___last 1,000 years
c)___last 10,000 years
d)___last 30,000 years
e)___last 125,000 years
f)___other(specify)_____

What is the approximate time span covered by this core in calendar years?

from_____to_____ years AD__, BP__

7.8 Are any of the depth-time correlations in a computer compatible format? YES__NO__

If yes, are these data available to interested scientists?

YES__NO__

Would they be available to a WDC data file? YES__NO__ (This data base would be an archive of published primary and derived data.)

Are data available now? YES__NO__ If not now, when? _____ (date)

8.0 CORE ANALYSIS SUMMARY AND DATA AVAILABILITY

In the following table (form B-6) abbreviations are used for the major analysis studies generally associated with ice cores.

The key to these abbreviations follows:

primary studies (e.g. those directly using core material)

physical properties

CORELOGGING core logging; e.g. core orientation, inspection on a light table etc.

STRATIGRAPHY stratigraphy

FABRIC fabric analysis

DENSITY density

BUBBL CONTENT bubble content, pressure and/or composition

ELEC PROPERTIES electrical properties; e.g. conductivity, or dielectric constant

constituent studies

STAB ISOTOPES stable isotopes

RADIO ISOTOPES radioactive isotopes

TRACE CHEMISTRY trace chemistry (soluble)

PARTICULATES particulates (insoluble)

POLLEN pollen distribution

OTHER other studies

supportive studies (e.g. those relating to bore hole, site description, glaciology)

BOREHOLE MEAS bore hole measurements; e.g. inclination, temperature etc.

DEFORMATION ice deformation studies, strain nets

MASS BALANCE mass balance, accumulation studies

PITS pit studies to supplement core profile

AEROSOLS aerosols; e.g. surface sampling

METEOBSERVATIONS meteorological observations

SOUNDINGS echo sounding; e.g. radio, radar, acoustic, seismic, gravity

OTHER other studies

9.0 SUGGESTIONS

Please add any comments, criticisms, suggestions to this survey if you desire.

8.1 CORE ANALYSIS SUMMARY, DATA AVAILABILITY AND TYPES

Please check off or fill in the appropriate blanks for each study. List references where possible.

CORE ANALYSIS	ADDITIONAL WORK		DATA AVAILABILITY				DATA TYPES					
	ANALYSIS COMPLETED, PUBLISHED or IN PRESS (list reference number given in form A-1, 2.3)	IN PROGRESS	PROPOSED	PRINCIPAL INVESTIGATOR and INSTITUTION (reference names given in form A-2, 2.3 or form B-1, 3.2)	VIA PUBLICATION	UPON SPECIFIC REQUEST	NOT AVAILABLE	RAW (e.g. field or lab notes)	SUMMARIZED (basic organizations, reductions, associations)	COMPUTER COMPATIBLE	PUBLISHED	OTHER (specify)
Primary Studies												
CORELOGGING.....												
STRATIGRAPHY.....												
FABRIC.....												
DENSITY.....												
EBULL CONTENT.....												
ELEC PROPERTIES.....												
STAB ISOTOPES.....												
RADIO ISOTOPES.....												
TRACE CHEMISTRY.....												
PARTICULATES.....												
POLLEN.....												
OTHER (specify).....												
Support Studies												
BORHOLE MEAS.....												
DEFORMATION.....												
MASS BALANCE.....												
PITS.....												
AEROSOLS.....												
MET-OBSERVATIONS.....												
SOUNDINGS.....												
Other (specify).....												

Appendix II

A Preliminary List of Known Ice Core Sites

GEOGRAPHIC LOCATION Site Name	Date	Original Depth (meters)	Diameter	Drilling Agency	Curating Agency	Information Source
GREENLAND						
Station Centrale	1951	150	3.7 to 4.8 cm	5		B
Camp VI	1950	100 or 126	3.7 to 4.8 cm	5		B
Site 2	1956	305		21	3	A
Site 2	1957	411		21	3	A
Camp Century	1961	185	12.7 cm ?	1	3	A
Camp Century	1962	235			3	A
Camp Century	1963-66	1390	12 cm	1	3	A,B
Inge Lehman*	1966	55		6		B,C
DYE 3	1971	372		1	3	A,B,C
Milcent	1973	398	12.4 cm	1	3	A,B,C
Crête	1974	405	12.4 cm	1	3	A,C
DYE 2	1974	100	10.14 cm	1	3	A,C
Summit*	1974	31		4,7	4,7?	A,C
DYE 3	1975	95.2	7.6 cm	1	3	A,B,C
Hans Tavsens Ice Cap	1975	60	7.6 cm	2	4	B
South Dome*	1975	30	7.6 cm	2		A,C
South Dome	1975	79.58	7.6 cm	2	3	A,C
DYE 2	1975	20		2	3	A
DYE 2	1977	84	7.8 cm	2	3	A,C
Camp Century	1977	100	7.8 cm	2	3	A,C
Camp Century	1977	78	7.8 cm	2	3	A,C
Camp Century	1977	101	7.8 cm	2	4	A,C
Camp Century	1977	71	7.8 cm	2	4	A,C
North Central	1977	100	7.8 cm	2	3	A,C
North Central	1977	109	7.8 cm	2	3	A,C
North Central	1977	102	7.8 cm		4	A,C
ARCTIC CANADA						
Meighen Ice Cap	1965	121		8		A
Devon Ice Cap	1971	230		8		A
Devon Ice Cap	1972	299		8		A
Devon Ice Cap	1973	299		8		A
Mer de Glace Agassiz (Ellesmere Island)	1977	337		8		B
Barnes Ice Cap	?	?		8		C
ARCTIC OCEAN						
Ice Island T-3	1973	30	250 mm	11		A
Ice Island T-3	1973	31	132 mm	11		A
CONTINENTAL						
US - Blue Glacier	1971	90		18		A
Blue Glacier	1971	40		18		A
Iceland - Bardarbunga	1968	30		17		A
on Vatnajokull	1968	42		17		A
"	1969	108		17		A
"	1972	415		17		A
South America -						
Quelccaya	1976	15		16		B
"	1976	15		16		B
"	1976	16		16		B
Europe -						
St. Sorlin Glacier	1968	67		12		A
St. Sorlin Glacier	1969	72		12		A

* no core remains; consumed in its entirety during analysis

Appendix II (cont.)

GEOGRAPHIC LOCATION Site Name	Date	Original Depth (meters)	Diameter	Drilling Agency	Curating Agency	Information Source
Europe (cont.)						
Vallee Blanche, Mer de Glace	1971	187		12		A
New Guinea - Irian Jaya						
Meren Glacier	1971-73	10 (5 holes)		19		A
Carstensz Glacier	1971-73	4		19		A
ANTARCTICA						
(US)						
Byrd Station	1958	309	9.8 cm	21	3	A,C
Little America V	1958-59	258	9.8 cm	21	3	A,C
Byrd Station	1968	2164			3,1	A
Byrd Station	1971-72	366	12.7 cm	7	1,3	B,C
South Pole	1974	101	10 cm	23	3	A,C
J-9, RISP	1974	100	10 cm	23	3	A,C
J-9, RISP	1976	0 to 104	6 cm	23?	3	A,C
J-9, RISP	1976	150-156	12 cm (12.??)	3	3	A,C
Roosevelt Island	1976	51	7.6 cm	3	3,2	A
C-7-2, RISP	1976	20	7.6 cm	3	3	A,C
C-7-3, RISP	1976	50	7.6 cm	3	3	A,C
C-16, RISP	1977	100	10.16 cm	24	22,3	C
Q-13, RISP	1977	100	10.16 cm	24	22,3	C
J-9, RISP	1977	174	6 cm	24	22,3	C
South Pole	1977	111	10.16 cm	24	22,3	C
(AUSTRALIAN)						
Amery Ice Shelf Glac.	1968	310		10		A
Casey, Cape Folger	1969	324		10		A
Law Dome Summit	1969	385		10		A
Casey -						
Cape Poinsett, J	1972	112		10		A
Strain Grid B	1972	73		10		A
Strain Grid P	1972	113		10		A
Station S-1	1972	53		10		A
Cape Folger	1974	348		10		A
Law Dome	1977	430		10		A
(JAPANESE)						
Mizuho Camp	1971	39		11		A
Mizuho Camp	1971	71		11		A
Mizuho Camp	1972	147		11		A
Mizuho Camp	1975	145		11		A
(FRENCH)						
Terre Adelie	1972	44		12		A
Terre Adelie	1974	304		12		A
Dome C	1978	900		12		A
(RUSSIAN)						
Mirny Station	IGY?	370		15		B
50km inland from Mirny Station	1969	250		15		B
Vostok	1970-72	952		15		B
Vostok	1973	905		15		B
Lazarev Ice Shelf	1977?	357		15		B
Lazarev Ice Shelf	1977?	447		15		B
(BELGIAN)						
Base Roi Baudouin	1961	0 to 43.7 m	7.6 cm	13		B
Base Roi Baudouin	1961	43.7 to 115.7 m	4.8 cm	13		B

Appendix II (cont.)

GEOGRAPHIC LOCATION Site Name	Date	Original Depth (meters)	Diameter	Drilling Agency	Curating Agency	Information Source
ANTARCTICA						
(NORWEGIAN, BRITISH, SWEDISH) Maudheim	1949-52	100	8 cm	14		B
KENYA						
Lewis Glacier	1978	11.5		16		B
Lewis Glacier	1978	13.5		16		B
Lewis Glacier	1977?	8		20		A

Key to Table of Known Ice Core Sites

Drilling/Curating Agency

(The current institution with responsibility for the core is listed first, if two numbers are listed.)

1. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire (CRREL) (formerly SIPRE)
2. Greenland Ice Sheet Program (GISP)
3. State University of New York at Buffalo, Ice Core Facility (SUNY-Buffalo).
4. University of Copenhagen
5. French Greenland Expedition
6. United States Air Force
7. University of Bern
8. Polar Continental Shelf Project, Ottawa (PCSP)
9. University of Minnesota
10. Australian National Antarctic Research Expedition (ANARE)
11. Japanese Antarctic Research Expedition (JARE)
12. Laboratory of Glaciology, CNRS, Grenoble, France
13. Belgian Antarctic Expedition
14. Norwegian-British-Swedish Expedition
15. Russian Antarctic Expeditions
16. Institute of Polar Studies, Ohio State University
17. Icelandic Expeditions
18. University of Washington, Seattle
19. Australian Universities Expedition to New Guinea
20. University of East Anglia, Norwich, England
21. Snow, Ice and Permafrost Research Establishment (SIPRE) (currently CRREL)
22. Polar Ice Core Analysis Program, SUNY-Buffalo (PICAP)
23. Ross Ice Shelf Project, University of Nebraska (RISP)
24. Polar Ice Coring Office, University of Nebraska (PICO)

Information Sources

- A Published Accounts
 B Internal Reports, unverified
 C Verbal Communication

The Bibliographic Data File of WDC-A

Marilyn J. Shartran

Introduction

With the increase in the number of users of the data collection of WDC-A for Glaciology (Snow and Ice), it became apparent that the material could be more effectively utilized if it were fully cataloged and classified and the bibliographic information put into a computerized data file.

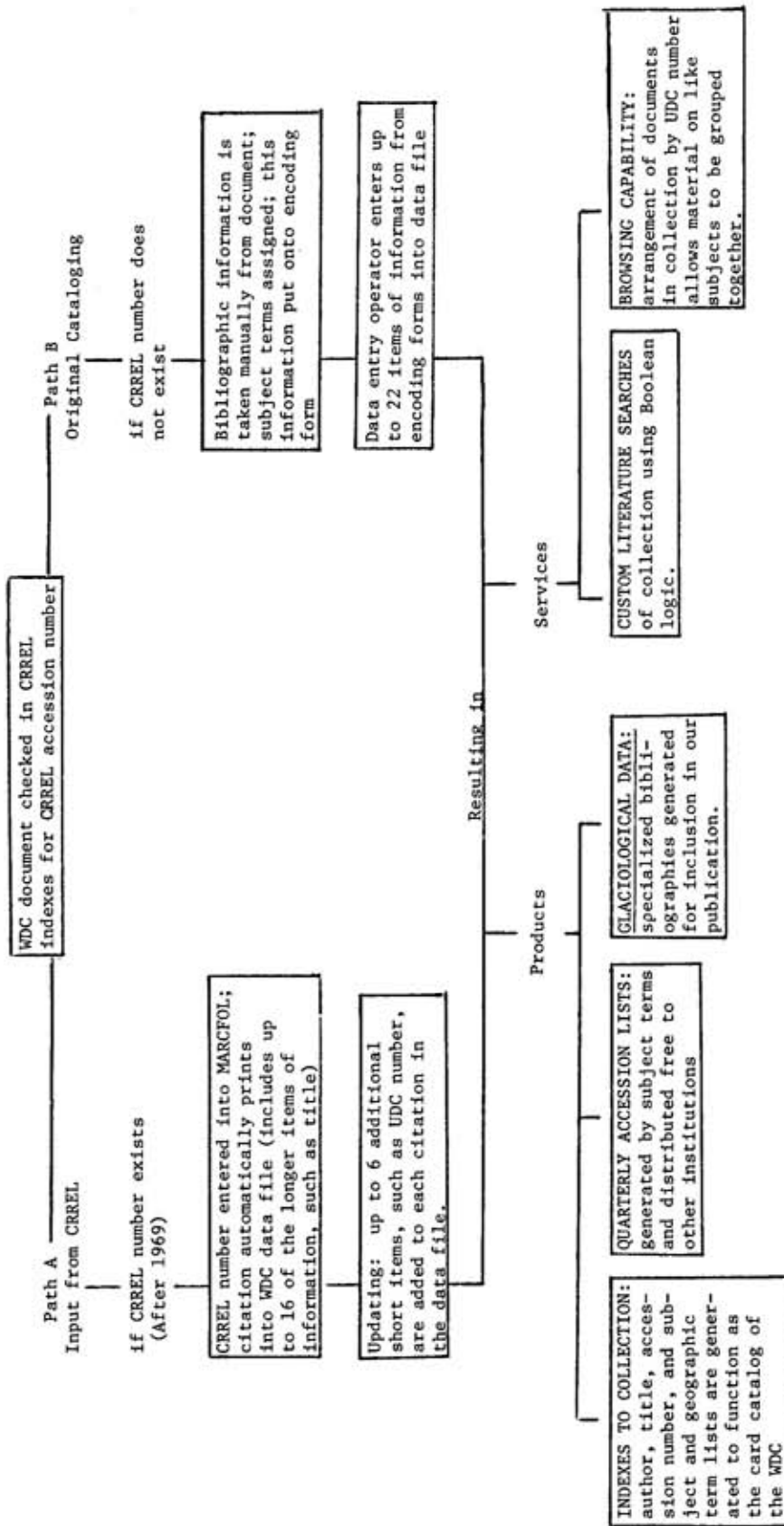
Since many of the titles in our collection are also owned by other institutions with glaciological interests, we investigated possible ways to avoid recataloging documents in our collection which have been cataloged by other institutions. We concluded that a cooperative arrangement between the WDC and the Cold Regions Bibliography Project could be mutually beneficial.

The Bibliography on Cold Regions Science and Technology is prepared by the Cold Regions Bibliography Project in the Science and Technology Division of the U.S. Library of Congress. It is sponsored by the Cold Regions Research and Engineering Laboratory (CRREL) of the U.S. Army Corps of Engineers. All bibliographic data for this bibliography and for the Antarctic Bibliography, which is sponsored by the National Science Foundation, are entered into a common computerized data base, thus eliminating duplication of effort between the bibliographies. The Antarctic Bibliography covers all disciplines relating to Antarctica, the Antarctic Ocean (south of 60° S), and subantarctic islands. The CRREL bibliography covers snow, ice, frozen ground, navigation in ice, civil engineering in cold regions, and the behavior and operation of materials and equipment at low temperatures. All citations from the section on snow and ice from the Antarctic Bibliography are coded so they will be automatically included in CRREL's bibliography. Citations in the system include data entered since 1962 for the Antarctic Bibliography, and since 1969 for CRREL's. The Project uses the MARC II format, which is used by the Library of Congress as well as some other institutions throughout the world.

Creation of the WDC file

At the onset of this bibliographic project in 1978, CRREL sent to us a magnetic tape in the MARC II format containing citations from the CRREL bibliography, 1969-77, and from the Antarctic Bibliography, 1962-77. Updated tapes are received at quarterly intervals. Our programmer created a program (MARCFOL) to interface between the MARC format and OUTFOL, the bibliographic program available to us through the U.S. National Oceanic and Atmospheric Administration. Because of the expense of maintaining the CRREL tapes online, thereby having them available for searching, we determined that the most effective method for searching the CRREL bibliography (to determine whether they had indexed documents in our collections), would be to search the manual CRREL indexes by author and title. Author-title-accession number printouts and 3x5 cards generated from CRREL's most recent input into their bibliographic system keep us abreast of their latest entries.

Figure 1 presents a simplified flow diagram of the steps followed when we



Note: Input by Path A is faster and more efficient than input by Path B.

Figure 1. WDC-A Bibliographic Data File

enter a citation into the data file. First, we search the CRREL author indexes to determine whether the document has been indexed by CRREL. If it has been indexed (figure 1, path A), the CRREL accession number is entered into the MARCFOL program, and the bibliographic data are automatically extracted from the MARC tape and put into the WDC OUTFOL file. After receiving a printout, we then add the items such as Universal Decimal Classification (UDC) number, document location, status, date entered into file, and country of publication, which are tailored to fit the needs of our own data file. We may also at this time add additional geographic or subject descriptors to supplement CRREL's indexing.

If no CRREL accession number is located for a document (figure 1, path B), then our cataloger must take the bibliographic information from the document itself, in addition to assigning subject and geographic descriptors. These data must then be manually typed into our data entry terminal. Statistics are not yet available for the amount of time this procedure takes compared with the automatic input from CRREL, but it is already apparent that the automatic input is more efficient.

Applications of the file

The data file is still in its initial trial phase, but four major applications are anticipated. Firstly, we intend to generate alphabetical printouts by author, title, accession number, and subject and geographic terms to serve as indexes to our collection. Tailored searches in batch mode can also be made with Boolean logic, in which a requester can specify certain parameters to be searched. (For example, we could retrieve all citations in the file published before 1965 on glaciers in Greenland.)

Secondly, the documents will be arranged in the WDC by a general Universal Decimal Classification number, allowing the users to browse by subject. Feedback from visitors has indicated this capability to be important.

Thirdly, we intend to generate quarterly lists of new accessions to the WDC. These will be available free of charge to interested individuals and institutions.

The last anticipated application of the computerized file is the creation of specialized bibliographies for publication in Glaciological Data. Even though we may not actually own all the documents cited in these bibliographies compiled by our staff, we will still enter them into the file so that we can manipulate the citations. The effort required to put them into the file is no more than is necessary for the typed bibliographies of the past, and we will have a much greater flexibility for formatting, making additions and corrections, etc.

Description of items in the file

Figure 2 gives two examples of citations, or records, from our file. Each item, or field of information, is reserved specifically for one category of data, such as author or title. This allows us to create alphabetical "sorts", or indexes. Those items with arrows to the left mark information which is not provided from the MARC tapes. Following is a brief description of each item.

NO: WDC accession number; assigned by the program in sequential order as the documents are entered into the file.

NO. 7800060
 → DATES 3 APR 1978 * 9 SEP 1974 * 14 JUL 1978
 TITLE ON THE SIGNIFICANCE OF POISSON'S RATIO FOR FLOATING SEA ICE
 AUTHOR HUTTER, K.
 AFFIL
 SOURCE
 SERIAL
 IN
 PUB
 PUB DATE MAY 1974
 PAG 78P.
 DOC TYPE TECHNICAL REPORT
 LANG ENG * GER,FRE
 SZ
 → COUNTRY
 → DOC LOC USGS-OFFICE * WDC-MONO
 → STATUS OLD, GD 2
 → UDC 551.326.7/HUT
 TECH RPT
 CRREL 29003244
 CONTRACT
 NOTES IN ENGLISH WITH GERMAN AND FRENCH SUMMARIES. 11 REFS.
 DESOR SUBJ BRINES * ANALYSIS (MATHEMATICS) * COMPUTER PROGRAMS * FLOATING ICE * SEA ICE * PLATES * ICE TEMPERATURE * ICE ELASTICITY
 DESCR GEOP

NO. 7800061
 → DATES 3 APR 1978 * 9999 * 14 JUL 1978
 TITLE SNOW CREEP! ITS ENGINEERING PROBLEMS AND SOME TECHNIQUES AND RESULTS OF ITS INVESTIGATION
 AUTHOR MATHEWS, M.H. * MACKAY, J.R.
 AFFIL
 SOURCE
 SERIAL
 IN CANADIAN GEOTECHNICAL JOURNAL, 12(2)
 PUB
 PUB DATE MAY 1975
 PAG P.187-198
 DOC TYPE JOURNAL ARTICLE
 LANG ENG * FRE
 → COUNTRY CN
 → DOC LOC USGS-OFFICE * WDC-VERT
 → STATUS OLD
 → UDC 551.576.46/HAT
 TECH RPT
 CRREL 30000132
 CONTRACT
 NOTES IN ENGLISH WITH FRENCH SUMMARY. 9 REFS.
 DESOR SUBJ PRESSURE * SNOW CREEP * BASAL SLIDING * SNOW LOADS
 DESCR GEOP CANADA * BRITISH COLUMBIA

2 ELEMENTS RETRIEVED AND 2 EXTRACTIONS PRINTED BY SET 4

Figure 2. Examples of records in data file.

DATES: Date of original input into the file from the MARC tape; date document was received by the WDC; date that the record was updated with the information not provided by CRREL. This item gives us the capability of generating statistics on turn-around time from the time a document is received, to the time its record is complete in our file.

TITLE: Original title; translated title; and English title, if first two are not English.

AUTHOR: Author of document, plus the author's role (editor, translator, compiler).

AFFIL: Author affiliation; no longer used because of the relatively large amount of time required to enter this information.

SOURCE: Corporate author; organization responsible for original document, as well as for translation, if applicable.

SERIAL: Journal or monographic series title, plus volume and issue number.

IN: Title and author of monograph if the document being indexed is an analytic, i.e., a chapter or paper from a monograph.

PUB: Name of publisher of original document and of translation, if applicable.

PUB DATE: Date of original publication; date of publication of translation.

PAG: Pagination.

DCC TYPE: Abstract, atlas, book review, conference paper or compendium article, conference proceedings, cross-reference, film strip, journal article, map, master's thesis, microform, monograph, patent, Ph.D. dissertation, photograph, recording, reprint, technical report, other. The categories in use by CRREL were adopted, and others were added to suit the needs of the WDC.

LANC: Language of document, plus language(s) of summary or abstract, if different.

COUNTRY: Country of original publication. This item was added in order to determine the number or identity of documents from a particular country. Foreign visitors are particularly interested in this question.

DCC LOC: Location of document (name of collection and location in collection). Documents belonging to our collection are tagged with WDC, plus the following notation for location within the Data Center:

PER-journals, monographic serials
MONO-main collection, monographs by UDC number
MICRO-microforms
VERT-vertical files (reprints); material arranged by UDC number

USGS documents are coded USGS-, (see below) followed by the name of the person's office in which the document is located.

STATUS: NEW - designates new material acquired by the WDC. This will enable us to generate quarterly accessions lists, as the material will be distinguished from that tagged OLD, which is material acquired by the WDC before the data file began. Documents marked ON ORDER have not yet been received, and documents tagged with GD(number) can be retrieved for a particular issue of Glaciological Data.

UDC: Universal Decimal Classification number, assigned from the Universal Decimal Classification for Use in Polar Libraries (Roberts, 1976), or taken from the Library Catalog of the Scott Polar Research Institute (1976). A "Cutter" designation of the first three letters of the author's surname, or in the case of corporate authors, the first three letters of an arbitrary keyword follows the UDC number. This designation enables the material to be shelved according to subject; the three letters assist in shelving within each UDC number.

TECH RPT: Technical report number, if applicable.

CRREL: CRREL accession number.

CONTRACT: For technical reports. Contract number and accompanying information, if applicable and readily available.

NOTES: Includes abstract or annotation, bibliographic notes (maps, number of references, tables, photos, figures, map scale, etc.), date of conference, etc. Abstracts are automatically provided by some records from the Antarctic Bibliography. If not provided, we do not add them.

DESCR SUBJ: Subject descriptors. Either provided automatically by CRREL, or assigned from their list adapted from the DOD Thesaurus of Engineering and Scientific Terms. New terms, tailored to the specific needs of glaciologists, will be created as the data file develops.

DESCR GEOG: Geographic descriptors. A hierarchy is used, in order to allow for retrieval at any level of specificity, i.e., glacier name, mountain range, (state), country. Columbia Lippincott Gazetteer is used as an authority.

Coordination with other institutions

By creating a bibliographic system whereby we can utilize CRREL cataloging for many of our documents, we are reducing duplication of indexing between at least one other institution and the WDC. The use of a MARC-compatible format, as well as the use of the same abbreviations and Cyrillic transliteration system, is a further attempt to create a basis for cooperation.

To further this philosophy of interagency cooperation, we are engaged in a trial arrangement with the U.S. Geological Survey (USGS) Project Office for Glaciology, Tacoma, Washington. We are experimenting with the input of citations from their glaciological documents into our data file, utilizing the same principles as above. If documents owned by USGS have already been indexed by WDC

or CRREL, the USGS need not duplicate these efforts by doing original cataloging. The staff in Tacoma has access to the citations in our data file through a remote terminal in the USGS office. In order to maintain standardization, all input is done by the WDC staff in Boulder. If the experiment is successful, a contract arrangement will be formalized.

A benefit which CRREL receives in exchange for providing the WDC with copies of their magnetic tapes is that they are alerted to documents we receive which are not in their holdings. CRREL then makes microfiche copies from our documents and enters them into their file. We, in turn, are able to peruse the USGS documents for possible acquisition into our own collection.

In addition to the benefits already being derived from these cooperative arrangements, we feel that the choice of a MARC-compatible format will allow for possible future collaboration with other institutions.

Conclusion

Any system has its problems to be solved, and we are still attempting to answer some questions in this initial phase of operation. For example, we have not yet decided how to deal with the inevitable delay involved from the time CRREL receives a document for indexing to the time we receive the citation on magnetic tape and can transfer it into our file.

In spite of the problems, however, and the large amount of time and effort expended to set up this cooperative arrangement, we feel that the long term mutual benefits make this a worthwhile endeavor.

For further details on the WDC data file, or for information regarding our accessions list or our publication, Glaciological Data, please contact a member of the Data Center staff.

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Results of a Survey on WDC-A Activities

Marilyn J. Shartran

The following tabulation summarizes the results of a user survey which was distributed with Glaciological Data number 1. The information has been very useful in assisting us not only in the planning of the content and format of Glaciological Data, but also in the planning of the overall direction of the activities of WDC-A. Some suggestions, such as the one of printing the bibliography in two columns, have already been incorporated in GD-2. Other comments, such as those regarding climatological data, have supported activities begun in the last year, such as the inventory of ice core data (see p. 5), and the inventory of snow cover and sea ice limits data.

We wish to thank all respondents for their efforts to complete and return the survey. Additional comments are always welcome.

Total no. questionnaires sent-----	540
Total no. questionnaires returned-----	238
Foreign-----	102
U.S.-----	116
Anonymous-----	20

I. USER PROFILE

1. Are you primarily affiliated with a:

College/University-----	120
Government agency-----	64
Research institution-----	56
Business-----	12

(Note: several respondents marked more than one category.)

2. Are you aware of the provisions of the International Council of Scientific Unions Guide to International Data Exchange?

No-----	118
Yes-----	68

II. FIELD OF INTEREST

<u>Primary</u>	<u>Secondary</u>	<u>Primary and Secondary Combined</u>
Mountain glaciers-----89	Climatology-----63	Climatology-----137
Climatology-----74	Remote sensing-----50	Mountain glaciers-----128
Ice sheets-----68	Glacial geomorphology--49	Glacial geomorphology-----108
Glacial geomorphology--59	Snow hydrology-----48	Ice sheets-----106
Snow/Ice physics-----45	Avalanches-----41	Snow hydrology-----88
Snow hydrology-----40	Snow/Ice physics-----41	Remote sensing-----87
Avalanches-----38	Mountain glaciers-----39	Snow/Ice physics-----86
Remote sensing-----37	Ice sheets-----38	Avalanches-----79
Sea ice-----36	Sea ice-----35	Sea ice-----71
Ground ice-----26	Ground ice-----35	Ground ice-----61
Freshwater ice-----21	Freshwater ice-----27	Freshwater ice-----48

III. CONTENTS AND FORMAT OF GLACIOLOGICAL DATA:

1. Are "thematic" issues (such as no. 1 on avalanches) useful to you?

Yes-----222

No-----11

2. If so, what topics would you like to see Glaciological Data cover?

Glaciers-----78

(including mass balance, surface features, glacial hydrology, world glacier inventory, glacier dynamics)

Climatology-----50

Snow hydrology-----42

(including seasonal snowpack, blowing snow, snow mechanics, snowpack energy balance, runoff models)

Sea ice-----36

Ice sheets-----36

(including ice cores, remote sensing, climatic change)

Snow/ice physics-----32

Glacial geomorphology-----31

Remote sensing-----30

Ground ice-----28

Avalanches-----24

Freshwater ice-----17

Geographic areas:

Antarctic-----8

Arctic-----7

Greenland-----2

Northern Hemisphere-----1

Canada-----1

Alaska-----1

Andes-----1

Other:

Dating methods for snow and ice----1

Long term snow and ice variations--1

Isotopes in glaciology-----1

Ice ages-----1

3. If the thematic issues are continued, which items would you like to see included in each issue?

Bibliography-----210

Reviews of new publications-----179

Contributions from researchers in the field--154
(especially in-depth state-of-the-art reviews)

New acquisitions to World Data Center-----126

Other comments:

-Research projects planned or in progress

-Announcements of conferences

-Access to Antarctica (scheduled NSF flights, etc.)

-List of institutions doing research in thematic area

-Articles on investigative procedures and techniques

IV. WORLD DATA CENTER SERVICES

1. Would you like to see the WDC develop the capability to provide tailored bibliographies upon request?

Yes-----166
No-----37

2. What bibliographic approaches do you find most useful?

Subject-----198
Region-----85
Author-----77
Keyword-----76

3. Are you currently able to acquire copies of the literature related to your field of interest?

Yes-----169
No-----20
Usually-----17
Sometimes-----10

4. What format of data is most useful to you?

Printed copy-----190
Photos-----79
Microforms-----38
Magnetic tapes-----35
Punched cards-----25

5. Do you see a need in your field for development of a standardized thesaurus?

Yes-----99
No-----75

6. What types of data sources related to your field would you like to see the WDC identify, collect, or store?

Unpublished data-----98

(the following specific comments were made):

- acquire data not available elsewhere
- conduct peer evaluation of all data to determine which should be archived in WDC
- non-U.S. data
- physical data collected from literature
- means and extremes of data
- field measurement data
- data summaries
- historical records from expeditions and military flights
- unpublished papers, field notes, manuscripts, etc.

-raw data on:	
mountain glaciers-----	26
climatology-----	17
snow hydrology-----	11
ice sheets-----	10
(including ice cores)	
sea ice-----	9
avalanches-----	5
snow/ice physics-----	3
ground ice-----	2
-raw data from:	
Antarctica-----	2
Canada-----	2
Alaska-----	2
N.W. Europe-----	1
U.S.-----	1
USSR-----	1
Scandinavia-----	1
Greenland-----	1
U.S. sources of Canadian data-----	1
Inventory-----	20
(individuals and institutions involved in glaciological research	
[including locations, research capability, data stored, document	
collections; government agencies and universities were mentioned	
specifically])	
Published data-----	33
(the following were specifically mentioned: maps, reprints,	
literature sources, translations, WDC acquisitions, reports of	
institutes and laboratories, theses, results of IHD/IHP Program,	
films)	
Imagery-----	31
(aircraft and terrestrial photography, and satellite imagery	
[including enhanced LANDSAT; satellite imagery cross-referenced	
with synoptic data])	

V. OTHER MISCELLANEOUS COMMENTS:

- several positive comments on new direction of WDC and Glaciological Data
- WDC should be involved in world glacier inventory
- do not need data from WDC
- WDC bibliographies should maintain close cooperation with CRREL's Cold Regions Bibliography and Journal of Glaciology's "Glaciological Literature"
- suggestion for format of Glaciological Data - print bibliography in two columns

An Outline of Glaciological Data Categories

Introduction

In 1970, a statement outlining glaciological material of interest to the World Data Centers was prepared by Professor R.P. Goldthwait, with the assistance of the (then) Glaciology Panel of the Committee on Polar Research, U.S. National Academy of Sciences. It was subsequently published in Ice (Goldthwait, 1970). In keeping with the current efforts of World Data Center-A for Glaciology (Snow and Ice) to widen the recognition by other environmental scientists of the actual scope of glaciology (Anonymous, 1961), we have attempted to revise and update the original checklist as a statement of data types that are suitable for submission and reporting to the World Data Centers for Glaciology. This list can serve as the skeleton for an eventual glaciological thesaurus and it may also provide the basis for developing criteria for recommended data sampling frequencies, resolution, precision, and accuracy in future information storage and retrieval systems and data banks.

The categories do not follow a strict morphologic or hierarchical classification. Research areas which WDC-A considers to be of current high priority with regard to numeric data are asterisked.

The present revision has been compiled by R.G. Barry and R.L. Weaver, with input from members of the Committee on Glaciology, Polar Research Board. We are grateful to Professor Goldthwait and to the International Glaciological Society for permission to publish a modified version of the original statement. We welcome any further suggestions for revision or additions.

Summary of Classification Scheme

SPATIAL AND TEMPORAL CHARACTERISTICS OF SNOW AND ICE TYPES

- I. Seasonal Snow Cover
- II. Variation of Snow and Ice Limits
- III. Snow and Ice Avalanches
- IV. Sea Ice
- V. Lake and River Ice
- VI. Ground Ice and Periglacial Phenomena

SNOW AND ICE PROCESSES

- VII. Glacier Mass Budgets
- VIII. Snow/Ice Hydrology
- IX. Snow/Ice-Environment Energy Exchanges (Glacial Meteorology)
- X. Physics and Chemistry of Snow and Ice
- XI. Ice Dynamics
- XII. Geophysical Surveys
- XIII. Ice Cores
- XIV. Cartographic and Geodetic Surveys
- XV. Isotopic Measurements

ORGANIZATIONS AND FACILITIES

SPATIAL AND TEMPORAL CHARACTERISTICS OF SNOW AND ICE TYPES

I. SEASONAL SNOW COVER

*A. Snowfall and snow cover dates

1. Snowfall
 - a. Type of solid precipitation and air temperature
 - b. First snowfall
 - c. Snowfall frequency, seasonal amount, water equivalent fraction of total precipitation
 - d. Snowstorm characteristics (duration, storm track, cloud seeding, etc.)
2. Snow cover (definition of % ground covered; type of observation)
 - a. First snowfall forming winter season cover
 - b. Duration of snow cover (according to depth ranges, if available)
 - c. Final disappearance
3. Location of "perennial" snow banks, patches

*B. Snow redistribution (see III for Avalanches)

1. Blowing/drifting snow (frequency, intensity, wind speed)
2. Measurement of snow transport
 - a. Gauges, traps
 - b. Optical or other meters

C. Depth of snow

1. 'Standard' or 'representative' site
2. Method
 - a. Snow stake
 - b. Snow board
 - c. Transect; number of samples
 - d. Aerial (markers, photography); resolution (spatial and vertical)
 - e. Remote sensing methods; resolution (spatial and vertical)
3. Depth averages for standard areas (sampling frequency)
4. Topographic variability

D. Water equivalent, or density

1. Method
 - a. Snow pressure pillow
 - b. Snow sampler (instrument type)
 - c. Storage precipitation gauge
 - d. Snow pit
 - e. Remote sensing methods (isotopic profiler, gamma radiation, microwave)

2. For standard areas
 3. Local baseline surveys of historical significance
- E. Surface features (local studies)
1. Drifts, cornices, barchans
 2. Sastrugi
 3. Melt crusts
 4. Melt channels
 5. Penitents
- F. Snowpack characteristics
1. Pit studies, time profiles of layers
 - a. Crystal morphology; types of metamorphism
 - b. Density profile
 - c. Ice lenses, glands, crusts
 - d. Temperature profile
 - e. Free water content
 - f. Impurities
 - g. Hardness profile (rain index)
 2. Probes
 - *3. Cores
- G. Soil beneath snow
1. Depth frozen (frost tube or other methods)
 2. Soil moisture conditions

II. VARIATION OF SNOW AND ICE LIMITS
 (see I for Seasonal Snow Cover; see IV for Sea Ice)

- *A. Snow line (date)
1. Slope, elevation, aspect (photograph, satellite image, map, survey)
 2. Transient snowline
 3. Maximum seasonal snow limit
 4. Dry snow line
 5. Climatic snow line (method of determination)
- B. Firn
1. Firn line

2. Equilibrium line (method of determination)
 3. Derived indices (see VII C)
 4. Glaciation level (limit)
- C. Glacier fluctuations (see Permanent Service on the Fluctuation of Glaciers, 1977)
1. Terminus position
 - a. Survey
 - b. Photographs, drawings, chronicles
 - c. Dated moraines
 2. Changes in area, thickness, profile, volume
 3. Surges (see XI D), past evidence
 4. Related climatic/hydrologic information
- D. Glacier/ice sheet reconstructions
1. Maps; isochrones of deglaciation
 2. Model simulations

III. SNOW AND ICE AVALANCHES

- A. Immediate phenomenon of avalanches
1. Descriptive (qualitative) characteristics
 - a. Date
 - b. Time
 - c. Location
 2. Morphological classification of avalanche path
 - a. Starting zone
 - (1) Manner of starting
 - (2) Position of sliding surface
 - (3) Liquid water in snow
 - b. Track
 - (1) Form of track
 - (2) Form of movement
 - c. Zone of deposition (runout zone)
 - (1) Surface roughness of deposit
 - (2) Liquid water in snow debris at time of deposition
 - (3) Contamination of deposit
 3. Measurable (quantitative) characteristics
 - a. Velocity
 - b. Impact

4. Avalanche effects
 - a. Number and names of people involved
 - (1) Victims
 - (2) Eyewitnesses
 - b. Structural damage
 - c. Interruption of traffic
 - d. Damage to forests, livestock losses
 - e. Rescue operations
 - f. Control measures

5. Genetic conditions of avalanche formation
 - a. Terrain conditions (fixed framework)
 - (1) Relative altitude
 - (2) Inclination, profile of path
 - (3) Orientation of slope
 - (4) Configuration of terrain
 - (5) Roughness
 - b. Genetic variables
 - (1) Preceding weather conditions (approximately 5 days back)
 - (2) Snowfall, snow crystal types
 - (3) Rain
 - (4) Wind
 - (5) Thermal conditions
 - (6) Old snow conditions
 - (7) Stratification
 - (8) Triggering conditions
 - (a) Natural release
 - (b) Human Release
 - c. Associated information and data - maps, photos, sketches

IV. SEA ICE

- *A. Areal extent, movements (for Ice Deformation, see XI C)
 1. Seasonal extent of pack ice, fast ice (location, date, method of observation)
 - a. Mean ice margin
 - b. Ice concentration by type (frazil, nilas, pancake, young, first year, multiyear, etc.)
 - c. Floe size
 - d. Surface features, (% puddling, ridging, hummocking)
 - e. Ridges, stamukhi, floebergs (location, dimensions, grounded or not)
 - f. Subsurface features, location, dimensions
 - g. Thickness
 - h. Icebergs
 - i. Ice islands

 2. Freeze-up dates
 - a. Location
 - b. Method (survey, aircraft, remote sensing data)

3. Break-up dates
 - a. Locations
 - b. Method (survey, aircraft, remote sensing data)
 4. Leads, polynyai
- B. Characteristics
1. Ice temperature, surface, and at stated depths
 2. Ablation, submelt, accretion rates
 3. Puddling, dates of onset and freeze-over
 4. Salinity of ice, natural and artificial desalination
 5. Water under ice: stated depth, temperature, current, salinity, supercooling
 6. Field observations on physical properties and composition
- C. Ice-atmosphere and ice-ocean interactions
1. Ice drift
 - a. Data buoys
 - b. Ice islands
 - c. Ocean current stresses
 - d. Net ice advection by unit area
 2. Meteorology (see X)
- D. Ice engineering problems
1. Forces on structures
 2. Forces on ships
 3. Artificial ice islands
 4. Seabed gouging
- E. Oil-ice interactions
- V. LAKE AND RIVER ICE
- A. Location
1. Latitude, longitude
 2. Name
 3. Surface area (m²)

4. Length, width
 5. Depth, average, maximum (m)
 6. Slope (m/m)
- *B. Seasonal variations
1. Freeze-up
 - a. Date first seasonal ice:
 - (1) Sheltered areas vs continuous cover
 - (2) Sheet ice (%)
 - (3) Consolidation of floes (%)
 - (4) Conglomerations of frazil (%)
 - (5) Anchor ice, supercooled water
 - b. Associated meteorological data
 2. Break-up
 - a. Date first active melt nearshore
 - b. Date central area free, how broken, wind or currents
 - c. Ice jams, dates, how formed, average thickness (m), changes in water level (m)
 - d. Associated meteorological data
 3. Characteristics of ice cover
 - a. Date, location of observations
 - b. Thickness (cm)
 - c. Ice type, e.g. clear, white, floe, frazil
 - d. Average snow depth on ice, % snow free

VI. GROUND ICE AND PERIGLACIAL PHENOMENA

A. Permafrost

1. Distribution, specific location
 - a. Area, maps, air photos, satellite imagery
 - b. Classification of permafrost [vein, wedge, tension-crack, closed-cavity, segregated ice, intrusive ice (pingo, sill), pore ice]
 - c. Depth, vertical distribution, where known
2. Properties, with specified depth
 - a. Surface characteristics
 - (1) Vegetation cover
 - (2) Snow cover
 - (3) Relief, drainage
 - (4) Seasonal active zone
 - b. Subsurface characteristics
 - (1) Composition, ice content
 - (2) Chemical content
 - (3) Temperature gradient, profile
 - (4) Seismic and electrical properties
3. Formation, with radiometric dating if possible
 - a. Climatic trends, records

- b. Vegetation influence, paleoecological evidence
 - c. Ground-ice morphology
- 4. Degradation - photographic, map, or descriptive records
 - a. Thaw lake: distribution, migration
 - b. Disturbance: man-made, river erosion, slope movement
- 5. Materials, soil
 - a. Sampling methods
 - b. Photogrammetry, ground patterns, temporal changes
- B. Periglacial phenomena
 - 1. Weathering information
 - a. Physical processes
 - b. Chemical processes
 - c. Climate-weathering associations
 - 2. Erosion
 - a. Rates: eolian, fluvial, mass-wasting
 - b. Morphology; forms
 - 3. Cryogenic processes (e.g., solifluction)
 - a. Rates of movement, with slope angle, vertical velocity profile
 - b. Conditions: thermal regime, material and grain size, moisture content
 - c. Special weather conditions associated with unusual rates
- C. Special forms
 - 1. Icings (naleds, aufeis); river, ground, spring icings
 - 2. Needle ice (pipkrake)
 - 3. Patterned ground - quantitative and three dimensional
 - a. Rates of growth, with thermal cycle, moisture content, energy studies
 - b. Mechanics of growth, with slope angle, material and grain size, moisture content and transfer

SNOW AND ICE PROCESSES

VII. GLACIER MASS BUDGETS (see Combined Heat, Ice...; Muller et al, 1977)

- *A. Identifying information (see also VIII A)
 - 1. Country or territory
 - 2. Glacier number (Permanent Service on the Fluctuation of Glaciers), or number already assigned from previous survey

3. Glacier name
 4. Geographical location, latitude, longitude (nearest minute)
 5. Orientation
 6. Highest elevation
 7. Mean elevation
 8. Lowest elevation
 9. Area
 10. Length
 11. Primary classification
 12. Investigators
 13. Sponsoring agency
- *B. Mass balance (glaciological method)
1. Time system: stratigraphic or fixed date
 2. Number of measurement points in accumulation and ablation basins
 3. Date, begin MB year
 4. Date, end winter season
 5. Winter balance (total, specific)
 6. Summer balance (total, specific)
 7. New accumulation (total, specific)
 8. Net ablation (total, specific)
 9. Net/annual balance (total, specific)
 10. Accumulation area
 11. Equilibrium line/annual equilibrium line
 12. Firn line, date of observation
- C. Derived indices
1. Accumulation area ratio
 2. Activity index, ablation gradient

3. Instability index

D. Mass balance (geodetic method)

E. Time variations (see II C)

VIII. SNOW/ICE HYDROLOGY

*A. Inventories of glaciers (see Muller, F. et al, 1977)

1. Location information

2. Area of permanent snow and/or ice

3. Depth, volume of permanent snow and/or ice

4. Hydrologic mass balance

B. Discharge measurements: water from glaciers or melting snow, indicating:

1. Instrumentation used

2. Daily discharge curves (graph) or table, with accuracy

3. Seasonal discharge curve, limits of error

4. Map of catchment area, or calculated area with topographic character

5. Rating curves

C. Energy budget and runoff: studies relating to meteorology (see IX) and to discharge

1. Correlations of discharge to climate - large scale, e.g. from satellites

2. Correlations of discharge to regional snow line trends

3. Estimation or forecast of yield, methods

D. Ablation process and meltwater routing

1. Maps and tracing of glacier water routes, supraglacial channels

2. Hydrostatic conditions, diagrams, time graphs for englacial waters

3. Snow and ice melt process studies

E. Proglacial lakes

F. Jokulhlaups

IX. SNOW/ICE-ENVIRONMENT ENERGY EXCHANGES AND FLUXES

A. Glacial meteorology (synoptic observations)

1. Air temperature
2. Wind velocity
3. Precipitation (amount, type)
4. Cloud (amount, opacity, type, height)
5. Particulates, e.g. dust, ice crystals, smog, fog droplets

B. Radiation fluxes: net, solar, albedo, infrared radiation (over snow/ice surface and adjacent ground)

1. Instrument type
2. Measurement height
3. Time, sampling frequency

C. Turbulent fluxes (or related parameters, wind, temperature, vapor pressure profiles)

D. Surface and englacial conditions

1. Diurnal, seasonal temperature curves
2. Energy distribution
3. Radiation penetration, light extinction

X. PHYSICS AND CHEMISTRY OF SNOW AND ICE

A. Structural properties

1. Pure ice
 - a. Water molecule
 - (1) Structure of isolated molecule
 - (2) Bonding of the water molecule
 - b. Structure of ice Ih
 - (1) Crystal structure of ice Ih
 - (2) Position of protons
 - c. Structure of other forms of ice
 - (1) Phase diagram
 - (2) High pressure phases and vitreous forms
 - (3) Structure of clathrate hydrates
2. Pure ice and impure ice mixtures
 - a. Freezing and crystal growth
 - (1) Structure of water with impurities
 - (2) Nucleation theory

- (3) Theory and practice of crystal growth
 - (4) Growth from the vapor phase
 - b. Grain boundaries
 - (1) Subgrains
 - (2) Voids
 - c. Defects
 - (1) Vacancies and interstitials
 - (2) Ionic and Bjerrum defects
 - (3) Dislocations
 - 3. Surface characteristics
 - a. Etching
 - b. Melt figures
 - c. Vapor figures
 - d. Regelation
 - e. Sintering and adhesion
 - 4. Petrography
 - a. Granularity
 - b. Texture
 - c. Fabric
 - 5. Macroscopic structure
 - a. Primary-secondary
 - b. Planar-linear
 - c. Saline related
- B. Energy properties
- 1. Thermal properties
 - a. PVT relationships
 - b. Conductivity
 - c. Thermal energy, latent heat, heat capacity
 - d. Thermal expansion
 - e. Lattice vibrations
 - f. Vapor pressures
 - g. Diffusion (self diffusion, diffusion of impurities)
 - 2. Electrical properties
 - a. Dielectric relaxation and conductivity
 - b. Effects of impurities, deformation, etc.
 - c. Dielectric constant
 - d. Thermoelectric effects
 - e. Properties related to active remote sensing systems (see also XII)
 - 3. Radiative and optical properties
 - a. Refraction
 - b. Absorption and reflection
 - c. Emissivity
 - d. Luminescence and thermoluminescence
 - e. IR and Raman spectra

- C. Mechanical properties: either laboratory or field tests
 - 1. Density: porosity, permeability, firn-ice transformation
 - 2. Strength: hardness, ram hardness, cleavage, fracture, flexure
 - 3. Elastic properties
 - 4. Anelastic properties, internal friction
 - 5. Plastic deformation, creep, kinetic friction
 - 6. Fracture
- D. Composition
 - 1. Isotopic composition
 - a. Stable isotopes, O^{18}/O^{16} , D/H
 - b. Radioactive isotopes
 - 2. Gas content: composition, distribution
 - 3. Salt content: composition, distribution
 - 4. Particulate matter
 - a. Organic
 - b. Microparticle
 - 5. Trace chemical content, heavy metals, etc.

XI. ICE DYNAMICS

- A. Ice flow, measurements, theory
 - 1. Velocity (horizontal, vertical)
 - 2. Strain rates
 - 3. Basal slip
 - 4. Water: interstitial, subglacial
 - 5. Erosional and depositional forms (glacial and fluvioglacial); till, moraines, drumlins, eskers
- B. Ice deformation-ice caps, ice sheets, ice shelves, glaciers
 - 1. Rheology
 - 2. Flow law theory
 - 3. Bore hole deformation

- C. Ice deformation-sea ice
 - 1. Ridge and hummock formation
 - 2. Keel formation
 - 3. Sea bed scouring
 - 4. Engineering problems related to offshore structure (see IV D)

- D. Surges
 - 1. Theory
 - *2. Observations

- E. Ice cap/sheet profile theory

XII. GEOPHYSICAL SURVEYS*

- A. Stations occupied, list
 - 1. Locations, map coordinates
 - 2. Precise surface elevation: method, types of corrections applied
 - 3. Specific geophysical instruments used (e.g., "LaCoste & Romberg #5", not "gravimeter")
 - 4. Geophysical anomaly maps
 - 5. Geodetic maps
- B. Gravity observations, table
 - 1. Observed values
 - 2. Computed free air anomalies
 - 3. Computed Bouguer anomalies with assumptions and densities used
- C. Seismic data, tabulated
 - 1. Vertical reflection times
 - 2. Reflection record reproduction, one per station
 - 3. Refraction velocity vs. distance and depth
 - 4. Wide angle reflection times and distances
- D. Electromagnetic surveying
 - 1. Active sensing systems (radio, RADAR echosounding)

- a. Profiles of vertical reflection
 - b. Tabulated echo times at seismic reflection stations
 - c. Wide angle reflection times and distances
 - d. Side Looking Airborne Radar (SLAR)
 - e. Synthetic Aperture Radar (SAR) (airborne, satellite)
- 2. Passive sensing systems (microwave)
 - a. Location of data points
 - b. Surface physical and electrical characteristics
- E. Magnetic observation - plotted profile of total or component magnetic field
- F. Electrical resistivity profiles
 - 1. Type of configuration
 - 2. Apparent resistivity curves
- G. Acoustical sounding (Sonar)
 - 1. Profiles
 - 2. Side looking Sonar
- H. Drill hole logging (see also section XIII)
 - 1. Identification of drill hole
 - 2. Type of measurement
 - 3. Tabulated parameter values vs. depth

XIII. ICE CORES*

- A. Location
 - 1. Country, region
 - 2. Latitude, longitude
 - 3. Year collected, dates
 - 4. Ice surface elevation
 - 5. Surface elevation datum year
- B. Core physical dimensions
 - 1. Diameter, length per section
 - 2. % recovery, significant gaps

- C. Collection methods
 - 1. Bore hole verticality
- D. Analysis
 - 1. Logging data vs. depth
 - a. Stratigraphy
 - b. Fabric
 - c. Density
 - d. Bubble content, pressure
 - e. Temperature
 - 2. Stable isotopes (see XV)
 - 3. Radioactive isotopes (see XV)
 - 4. Microparticle
 - 5. Trace chemicals

XIV. CARTOGRAPHIC AND GEODETIC SURVEYS

- A. Published and/or printed maps
 - 1. Distribution studies
 - 2. Surface, bottom contour maps: dates and survey techniques included
 - 3. Hydroglaciological studies
 - 4. Geophysical survey location maps (indexes)
 - 5. Mass budget studies
 - 6. Ice movement studies
- B. Unprinted, manuscript plots (Ozalid, Xerox, Thermofax, computer)
- C. Orthophoto maps

XV. ISOTOPIIC MEASUREMENTS

- A. Radiometric dating
 - 1. Location, latitude, longitude
 - 2. Depth, stratigraphic position
 - 3. Substance used for analysis
 - 4. Collector, where published (e.g. Radiocarbon)
 - 5. Dating laboratory

6. Date in radiometric, calendar years
 7. Standard error
 8. Standard half life used, corrections made
- B. Radioactive trace elements
1. Transuranics, Sr⁹⁰, Pu, Am, Ur
 2. Relative stratigraphic dates vs. concentrations
- C. Isotopic ratios (description as above)
1. ¹⁸⁰/₁₆₀ ratio used
 2. Chemical procedures
 3. Estimated error
- D. Amino acids

ORGANIZATIONS AND FACILITIES

- A. Universities
1. Departments, subject, chairman, address
 2. Institutes or centers, title, director, address
 3. Occasional workshops, seminars, courses, title, number, supervisor, address
 4. Data needed in each of the above
 - a. Number of researchers
 - b. Special fields of interest, publications, laboratory
 - c. Facilities available
- B. Non-university organizations and institutes (similar information to above)
- C. Field facilities
1. Geographical location
 - a. Country, locality, elevation
 - b. Name of director
 - c. Name of parent organization
 2. Description of station
 - a. Total floorspace, number of buildings
 - b. Special equipment, laboratories

3. Major research activities
4. Calendar timing of activities
5. Publications

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The World Atlas of Snow and Ice Resources Compiled in the Soviet Union

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The compilation of the World Atlas of Snow and Ice Resources was started in the USSR in 1975. The main purpose of the Atlas is the general estimation of ice resources, their regime and variability, and their potential use. This is a multidisciplinary glaciological atlas, presenting data on all kinds of natural ice.

The first proposal to prepare the Atlas was made by the Section of Glaciology of the Interdepartmental Geophysical Committee at the expanded meeting of its bureau on 25 October 1973. The idea of compiling this Atlas in the USSR was promoted by the International Commission on Snow and Ice of the International Union of Geodesy and Geophysics, which adopted a special recommendation at the meeting of its bureau on 29 March 1974, in Switzerland. In accordance with the decision of the Intergovernmental Union for the International Hydrological Programme, adopted in April 1975 in Paris, the compilation of the Atlas was introduced into this program on 2 October 1975. The Earth Sciences Section of the Presidium of the USSR Academy of Sciences decided to begin the compilation of the World Atlas of Snow and Ice Resources.

The aim of the Atlas is to systematize the storage and use of comprehensive glaciological data by specialists in related branches of science and industry. These data have been collected throughout the world during the last 20 years. The mapping of all glacial phenomena according to a common plan and specially developed methods will be accomplished in the course of compiling the Atlas.

The contents of maps and their regional series are designed to give a specialist every possibility to determine directly on a map the amounts and regime of the natural resources discussed (atmospheric precipitation; snow mantle; glaciers; augeis; ground, sea and river ice; climatic and hydrological phenomena). The maps will also provide the physical state, composition, time and spatial variability, and numerical data on snow and ice resources in any natural region of the world or any country. The data in the Atlas also can be used to calculate the prospects for efficient use of snow and ice resources in a national economy at the present and in the future.

The World Atlas of Snow and Ice Resources will contain about 300 pages with maps. It will consist of three main parts - the Introductory, Regional and Applied Parts. The Introductory Part will have small scale maps of the globe, showing the distribution of all types of natural ice over the earth. The Regional Part contains the principal information - from small scale maps of continents and natural areas, to the larger scale of the most typical and economically important glaciers. The Applied Part will show specific applications for the use of snow and ice as well as protection from them, and also will give useful information on some aspects of alpine recreation.

The most important Regional Part of the Atlas is based on the concept of

continents and their parts: West Europe, Asia, North America, the mountain areas of South America, and Antarctica. The Soviet Union is considered at the level of a continent. Areas with glacionival phenomena playing a significant role in their nature are shown in detail.

All the data of the Atlas are subdivided into 16 subject sections:

- Physical and general maps
- History of studies and present glaciological knowledge
- Atmospheric precipitation
- Winter climate
- Climate of the glacionival zone
- Snow cover
- Snow avalanches
- Glacial morphology
- Glacier regime
- Glacier variations
- Ice reserves
- Snowmelt and glacier runoff
- Subsurface ice and aufeis
- Sea, lake and river ice
- Former glaciers
- Applied studies of snow

For the above mentioned continents and natural regions (the Caucasus, Pamir-Alay, Tien-Shan, Alps, Alaska, etc.) a set of small scale maps has been compiled: a physical map, history of studies and present glaciological knowledge of the territory, climate of the winter period, solid precipitation, snow cover and avalanches, snowmelt runoff, and former glaciers. The set of maps for glacier areas is as follows: summer climate of the glacionival zone; morphology, morphometry and regime of glacier systems; glacier melt and runoff, and ice reserves. Depending on the scale of maps, they will either present direct glaciological indexes (e.g., zones of ice formation), or sets of such indexes (e.g., spectra of ice formation zones).

Some of the glacionival processes will be shown for the first time, while more traditional climatic and hydrological maps of the Atlas will differ from those compiled before. The main difference is that the maps are aimed at characterizing glacionival phenomena. On climatic maps of the winter period, the main attention is given to the duration of this period and its temperature characteristics, solid precipitation, and its transport by wind. On hydrological maps, special attention is paid to the relative proportion and absolute values of snowmelt and glacier runoff and their role in formation of water resources of adjacent areas.

For the compilation of maps of continents and natural regions, cadastre data (annuals, reference books, catalogs) and maps published earlier are used. In this case the mean long term and extreme indexes can be, as a rule, obtained by common methods. For mapping glacier areas proper, these data are mostly lacking, and to obtain the necessary parameters of the regimes of glaciers and glacier systems it is necessary to carry out indirect calculations with the help of special methods. These comprise calculations of snow and ice melting according to air temperatures, calculation of solid precipitation at the level of the accumulation line on glaciers, calculations of water-ice balance in glacier basins, etc.

For areas of insufficient glaciological knowledge, such as South America and Central Asia, and some territories of the Arctic and Siberia, satellite images are used. With the help of remote sensing, the missing data on the duration of snow cover, distribution and nature of sea ice, avalanche hazard of some territories, and glacier variations should be able to be obtained. It is planned to use the data from TV scanning and radiometric surveys from meteorological satellites, data from scanning and TV surveys of LANDSAT, and images taken on board manned spaceships, orbital stations, etc.

With the object of the maximum approach to simple multiplicity of scales and the use of the least number of different scales in the Atlas, the following scale series has been accepted: 1:25,000; 1:50,000; 1:100,000; 1:250,000; 1:600,000; 1:1,000,000; 1:1,500,000; 1:2,500,000; 1:3,000,000; 1:5,000,000; 1:7,500,000; 1:10,000,000; 1:20,000,000; 1:30,000,000; 1:40,000,000; 1:60,000,000; 1:90,000,000. The scales of 1:600,000; 1:1,500,000; 1:3,000,000; 1:7,500,000; 1:30,000,000; 1:60,000,000 and 1:90,000,000 are inserted into this series to fit the contents and size of the Atlas.

In general, 17 different scales are introduced covering all the mapped territories, which exceed 200 in the Atlas. Each territory is represented by a series of maps of the same scale, chosen in keeping with its position in the system of glaciological zonation, present knowledge, and scientific and practical significance. These series comprise 8-12 maps for the continents, 6-11 maps for natural regions and glacier areas, 2 maps for glacier localities, and 3-15 maps for large glacier complexes and separate glaciers.

The general correspondence between the regional structure and scale series of the Atlas is as follows:

Separate glaciers	
(glacier complexes)	- 1:25,000 - 1:250,000
Glacier localities	- 1:600,000 - 1:1,000,000
Glacier areas	- 1:1,500,000 - 1:5,000,000
Natural regions	- 1:3,000,000 - 1:20,000,000
Continents	- 1:40,000,000 - 1:60,000,000
The globe	- 1:60,000,000 - 1:90,000,000

The goal of the Introductory Part is to give general characteristics of the nature of global snow and ice. The maps of this part represent the distribution of snow cover and various kinds of ice all over the earth. All the maps are general and make up a series of glaciological maps of the world related to one another. The maps of the Western and Eastern Hemispheres in oblique azimuthal projection, including the polar areas, are used to show glaciological phenomena occurring over the earth: atmospheric precipitation and ice, glaciological zonation, and the general nature of glaciation and snow cover of our planet. The maps of the Northern and Southern Hemispheres in direct azimuthal equidistant Postel's projection, covering the territory from poles to tropics, are used to show glacial phenomena, occurring only in polar and midlatitude belts: snow cover, sea and river ice, potential ablation, former glaciers and glaciological knowledge of the earth. The scale of the main maps of the Introductory Part is 1:60,000,000 and that of the supplementary maps, 1:90,000,000.

The Introductory Part contains the glaciological zonation, singling out the

territories of natural units, within which all glacionival phenomena and all types of natural ice are considered as a whole, judged by their effect upon the environment, their interrelationships, and the influence of the environment upon the ice. A six-level pattern of zonation is proposed: belt-zone-province-area-locality-basin.

Four zones (moving south to north) are singled out in the Northern Hemisphere: 1) unstable snow cover; 2) stable snow cover; seasonal, sea, lake and river ice; 3) permafrost and mountain glaciers; and 4) pack ice and ice sheets. In the Southern Hemisphere, the four zones (moving north to south) occur respectively: 1) icebergs, 2) seasonal sea ice, 3) permanent sea ice, and 4) ice sheets. Each zone, defined by the zonal principle, is further subdivided into glaciological provinces and areas, according to the nature of atmospheric circulation and macrorelief of the surface. Thirty provinces and 51 areas have been singled out.

A river basin with more or less developed glacionival phenomena is considered as an elementary unit of glaciological zonation. A "glacier basin" should denote a basin, with glaciers and/or perennial snowfields present down to the outlet. It is expedient to draw the lower boundary of a glacier basin at the altitude of the snow field limits (orographic snow line), i.e., below the majority of seasonal and permanent snow drifts of the basin. A series of glacionival basins, which is geographically continuous and similar in mass balance, makes up a glaciological locality. A group of such localities is united into a glaciological area. Sometimes a subarea exists as an intermediate step.

The Regional Part of the Atlas is aimed at a multidisciplinary description of separate territories of our planet. Different scales are used, depending on the dimensions of the territory, knowledge of its glaciology, and its position in the system of glaciological zonation. As a rule, sets of maps of different subjects are given. In general, the Regional Part will contain about 750 different maps, and many schemes, diagrams and graphs. Specially prepared standard geographical bases are used for serial maps of the same scale.

About 20 institutions are participating in the compilation of the authors' original maps. The guidance of the compilation of the special maps is entrusted to the Soviet Section of Glaciology. Compilations are carried out under the direction of the Interdepartmental Geophysical Committee and the USSR Committee for the International Hydrological Programme. The mapping, editing, and publication of the Atlas will be undertaken by the Central Department of Geodesy and Cartography. The main task of compiling the authors' maps is expected to be completed by 1980. Publication will follow in ensuing years.

To guide the compilation of the Atlas, an editorial board of 40 persons, headed by the editor-in-chief, G.A. Avsyuk, and the editor of the Atlas, V.M. Kotlyakov, has been formed. Dr. N.N. Dreyer has been appointed as the scientific secretary of the Atlas.

By now the list of maps of the Atlas and its draft have been created. The Basic Premises (Statute) of the Atlas and the program and instructions for its compilation (Kotlyakov, 1977) have been worked out. At present, standard geographical bases for a number of maps of the Atlas of 1:1,500,000 to 1:7,500,000 scales are in the process of compilation. The basis for the 1:600,000 scale maps for some mountain glacier areas are made according to large scale data. Compilation of special maps of the Regional Part of the Atlas based on approved

instructions has been started. Proposals concerning the program and contents of the Applied Part of the Atlas are now being discussed.

The first attempts to compile special and general maps of the 1:600,000 scale show that very often we lack data on foreign territories. This is true of the data on the climate and hydrology of alpine areas, the morphology and regime of glaciers, snow cover, avalanches, etc. Large scale maps for some mountain glacier areas are also lacking. We propose to use satellite observations for the mapping of areas of scarce glaciological knowledge. We request all foreign glaciologists to help us with the missing information. All correspondence concerning compilation of maps and the use of data should be directed to the editor of the Atlas, Vice-President of the Snow and Ice Commission of the IUGG, V.M. Kotlyakov, at the following address:

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Reference

Kotlyakov, V.M. (1977) Programma i metodicheskie ykazaniia po sostavleniiu atlasa snezhno- ledovykh resursov mira. (Program and instructions on the compilation of the World Atlas of Snow and Ice Resources.) Materialy Gliatsiologicheskikh Issledovaniy. Khronika, Obsyzhdeniia, 29, pp. 53-188.

Satellite Image Atlas of Glaciers

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In June 1977, the Earth Resources Observation Systems (EROS) Program of the U.S. Geological Survey's (USGS) Land Information and Analysis Office (LIA) initiated a 3-year project to prepare a USGS Professional Paper, Satellite Image Atlas of Glaciers. The Glaciology Project Office (Tacoma, Washington) of the Water Resources Division (WRD) of the USGS, and the National Environmental Satellite Service (NESS) of the National Oceanic and Atmospheric Administration (NOAA) have been directly involved in the preparation of the atlas from the early stages. In addition, several other national and international organizations have agreed to participate and will be included in the authorship of the atlas.

LANDSAT imagery and other satellite imagery provide a wholly new source of data about the environment of our planet, particularly with respect to dynamic environmental phenomena. Sufficient LANDSAT, NOAA, and other satellite data now exist to compile a Satellite Image Atlas of Glaciers, and the preparation of such an atlas is considered a timely effort because of the wide variety of impending and ongoing national (U.S.) and international climatological studies. The primary objective of the Atlas is to provide a pictorial inventory, either in the form of a LANDSAT or other satellite image, or a tabular listing of the best available LANDSAT or other satellite images of extant glaciers. Such an atlas should provide a means of obtaining a better estimate of the total area of the planet covered by glaciers, and will also provide a "benchmark" for: 1) future and past studies of glaciers, and 2) global climatological studies. The Atlas should also be quite useful in providing a common data base (planimetric "map") for locating, describing, and measuring existing glaciers. By comparing images (with other images, aerial photographs and maps) over a period of time, it will be helpful for studying, describing, and measuring some of the parameters associated with the dynamics of glaciers.

The Atlas has been divided into two principal parts: Part I, "Geographic Distribution of Glaciers", and Part II, "Topics of Glaciology and Related Environmental Phenomena." The first part will include an introductory chapter on the classification and distribution of glaciers, and will be followed by approximately 11 geographic area chapters (Antarctica, Greenland, Iceland, and South America).

LANDSAT images of glaciers are archived by the United States, Canada, Italy, and Brazil. Excellent images of some areas and suitable images of many areas exist, but other areas have either inadequate coverage (too much cloud or snow cover) or none at all. As new receiving stations are placed in operation and as new spacecraft are developed, the coverage situation should steadily improve. LANDSAT imagery of the world is acquired in a logical and repetitive manner with each image having a unique path/row number pair which relates to a nominal scene center (for example, Vatnajokull area, Iceland; Path 235/Row 15; N6359 W01723). Computer search techniques are being used to identify the available images of each path/row number pair where glaciers are known or suspected. Once identified, the actual

LANDSAT images are evaluated on microfilm archives, and the best image available is ordered from the data archive as a 1:1,000,000 scale paper print. The 1:1,000,000 scale Operational Navigational Charts (ONC), published by the U.S. Defense Mapping Agency and distributed by NOAA, are being used as the primary global map base. Large-scale maps are also being used, where available. Where LANDSAT images do not provide adequate information, for example in Antarctica, then NOAA and other satellite images will be used.

Once the best images are acquired, they are evaluated and used in each geographic area chapter in the discussion of the occurrence and distribution of present day glaciers, the observation and mapping of glaciers in an area from both a historical (pre-aerial photographs) and a modern (aerial photogrammetry) viewpoint, and the types of observable glaciological phenomena in each geographic area (such as glacial surges, changes caused by jokulhlaups, glacial advance or recession, ablation phenomena, variation in existence or size of pro-glacial lakes, and the speed of glacier flow). Of course, an atlas of this size can only discuss the best examples of such phenomena in any given area. It is anticipated that a more careful and comprehensive analysis of existing satellite imagery, and continuing analysis of future satellite images by scientists from or working in each geographic area will contribute even more useful knowledge of global glaciological phenomena. All the geographic area chapters will be authored by scientists who have worked in and have extensively studied the areas imaged by LANDSAT, NOAA, and other satellites.

The second part of the Atlas contains a series of short topical papers on glaciers and related phenomena, each authored by a scientist who has studied the phenomena under discussion. Specific chapters include the following: glacier dynamics and glacier hazards, variation in extent of sea ice, variation in global snow cover, periglacial phenomena, climatic variation, present and future monitoring of changes of glaciers, and the use of LANDSAT imagery for the inventory of glaciers. Part II will be followed by an appendix containing specific information on the different types of imaging spacecraft and availability of imagery from each spacecraft.

Some results have already been derived from the preparation of the Atlas. We have compared the present day occurrence and distribution of many glaciers with the available literature and published maps on a global scale to determine both geographic location and an overall idea of advance or recession. Large discrepancies in mapped position or extent of icecaps or outlet glaciers in Greenland and Svalbard have been found, due either to incorrect mapping or to changes in the glaciers, or both. It is expected that minor or major discrepancies will be found in other areas as the project progresses. Although satellite image acquisition is not as frequent as desired for scientific research, there is a capability, if exercised, to image an area every 18 days with one spacecraft (or every 9 days with two spacecraft, etc.), and localities in the polar latitudes can be imaged 2 or even 3 days consecutively because of sidelap caused by converging orbits. With the resolution of LANDSAT images and a fixed reference point on the image, it is possible to obtain quantitative measurements of glacier movement or change as small as 0.1-0.2 km. It is concluded that publication of the Atlas will be of value to scientists studying the characteristics and dynamics of glaciers.

BOOK REVIEW

SCHNEE- UND GLETSCHERKUNDE by F. Wilhelm. (Lehrbuch der Allgemeinen Geographie III.3), Walter de Gruyter, Berlin/New York, 1975, vii, 434pp. 58 plates, 156 figures, 71 tables. 85DM.

This survey of snow and glacier studies is one of a series of geographic texts aimed at the university level. The book is divided into two major sections: snowcover (130 pages), and glaciers and icesheets (240 pages). These are followed by a 35-page bibliography grouped by subtopic. The references, mainly in German and English, cover essentially to 1970, with a few more recent ones.

The first section deals with solid precipitation, the accumulation and characteristics of a snow pack, snow measurements, surface forms, ablation, avalanches, snowline, the spatial characteristics of seasonal and permanent snowcover, and the influence of snow on the natural and cultural landscape. The second section treats the properties of glacier ice and its motion, the thermal characteristics of ice masses, mass balance, glacier fluctuations, ice ages, the classification of glaciers, their geographical distribution, and their influence on the landscape. While this structure seems rather awkward and nonsequential, the overall coverage is reasonably complete, and it is richly illustrated with numerous clear figures and photographs. A section on the Pleistocene and earlier ice ages already appears quite dated in its continental view of the glacial record.

The most serious weakness of the book would appear to be in its limited treatment of the physical basis of glaciological processes, although the author notes that Gletscherkunde represents only a part of the science of glaciology. While qualitative presentation of physical principles is important, and much use is made of graphical display, the reader would be assisted in following up topics such as glacier motion and avalanche mechanics in the modern literature if more mathematical formulation were introduced. In general, however, the book will serve as a useful introduction to the subject for the German reader. It should be available for reference in most university and special libraries interested in the earth sciences.

Roger G. Barry

GLACIOLOGICAL DATA SERIES

Glaciological Data, which supercedes Glaciological Notes, is published three to four times per year by World Data Center A for Glaciology [Snow and Ice]. It is distributed without charge to interested individuals and institutions. Listed below are the issues of Glaciological Data which have been published:

GD-1, *Avalanches*, 1977

GD-2, Parts I and II, *Arctic Sea Ice*, 1978

Additional information on this publication or on other services of World Data Center A for Glaciology [Snow and Ice] are available from the following address:

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