73-35

Le Cheminant

GEOLOGICAL SURVEY OF CANADA · 1842 ·

GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

PAPER 73-35

USE OF A GEOLOGICAL FIELD DATA COLLECTING FORM ON OPERATION BYLOT, NORTH-CENTRAL BAFFIN ISLAND, 1968

E.W. Reinhardt and G.D. Jackson

Price, $2.00

1973

GEOLOGICAL SURVEY
OF CANADA

CANADA

PAPER 73-35

USE OF A GEOLOGICAL FIELD DATA COLLECTING FORM ON OPERATION BYLOT, NORTH-CENTRAL BAFFIN ISLAND, 1968

E. W. Reinhardt and G. D. Jackson

DEPARTMENT OF ENERGY, MINES AND RESOURCES

Available by mail from *Information Canada*, Ottawa

from the Geological Survey of Canada
601 Booth St., Ottawa

and

Information Canada bookshops in

HALIFAX - 1687 Barrington Street
MONTREAL - 640 St. Catherine Street W.
OTTAWA - 171 Slater Street
TORONTO - 221 Yonge Street
WINNIPEG - 393 Portage Avenue
VANCOUVER - 800 Granville Street

or through your bookseller

Price: $2.00 Catalogue No. M44-73-35

Price subject to change without notice

Information Canada
Ottawa
1973

FOREWORD

This report is a slightly revised version of a manuscript submitted in July, 1970, to the Canadian Centre for Geoscience Data as a contribution to a symposium volume that would comprise papers on the applications of computer-oriented field data files. Unfortunately, it appears unlikely that this volume will be prepared and it was decided to publish the following report as a Geological Survey paper.

E.W.R.

G.D.J.

CONTENTS

Illustrations

ABSTRACT

A computer-oriented data form was conceived, developed, and utilized on a helicopter-supported geological bedrock reconnaissance mapping project so as to assure consistency of note-taking among five participating geologists, to accumulate a greater volume of information from each data site, and to make a permanent data file available for machine processing. Other benefits include: more consistent and precise control in relating lithology to structure, ability to perform subsequent machine processing directly from the key-punched data file, easier search of the data forms than conventional notes for information, and a better pre-assessment of the proposed map-area.

Design considerations for a reconnaissance data-collecting format differ significantly from those for a detailed or topical investigation mainly because of: the large area to be examined - greater geological complexity; the fact that both related and unrelated types of data are collected at each outcrop; and the challenging logistics problems associated with helicopter reconnaissance mapping in remote Arctic regions with poor weather conditions. The data format had to be comprehensive enough to allow documentation of a large variety of lithologies, map-units, and structures; yet simple enough to be completed in a reasonable time period. Notable savings in time were realized through use of voice-tape records for initial recording of field observations.

Mechanical processing methods for reconnaissance manuscript map production are more limited than for detailed work or for topical studies because of extensive reliance on air photo interpretation, aeromagnetic maps, 'between-station' observations, the interpreter's experience, and on information gleaned from reports of early surveys and expeditions.

Mechanical processing will not likely be employed during preparation of preliminary publications but will undoubtedly be attempted in preparing final publications. Anticipated utilization will consist of sorting and compilation of lithological and mineralogical data to assist in refining definitions of rock-units, metamorphic grade, and structural domains.

RÉSUMÉ

L'auteur a conçu, mis au point et utilisé une formule de données automatisée lors d'un projet de cartographie géologique de reconnaissance de la roche en place à bord d'un hélicoptère afin d'assurer une uniformité des notes prises par cinq géologues qui participent au projet, d'accumuler une plus grande quantité de renseignements sur chacun des emplacements étudiés et de dresser un fichier de données permanent exploitable par machine. Il y a d'autres avantages: par exemple, un contrôle plus uniforme et plus précis concernant la relation entre la lithologie et la structure, la possibilité de faire du traitement subséquent par machine directement à partir du fichier de données perforées, une recherche des formules de données plus facile que dans le cas des notes de type classique pour trouver des renseignements, et enfin une meilleure évaluation préalable de la région proposée.

Les considérations relatives à la conception de l'organisation de la cueillette de données de reconnaissance diffèrent sensiblement de celles concernant une recherche détaillée ou locale surtout en raison de la dimension de la région à étudier (géologie plus complexe), du fait que des données ayant

rapport ou non entre elles sont recueillies à chaque affleurement, et enfin des problèmes impérieux d'organisation associés à la cartographie de reconnaissance en hélicoptère dans des régions éloignées de l'Arctique aux conditions atmosphériques défavorables. La formulation des données doit être suffisamment étendue pour permettre d'avoir des renseignements sur une grande variété de lithologies, d'unités stratigraphiques ou autres non-différenciées et de structures; elle doit enfin être suffisamment simple pour être remplie dans une période de temps raisonnable. On a sauvé un temps appréciable en utilisant des bandes enregistreuses pour l'enregistrement initial d'observations sur le terrain.

Les méthodes de traitement mécanographique pour la production de minutes de reconnaissance sont plus limitées que pour un travail détaillé ou des études locales en raison de la confiance répandue envers la photo-interprétation, les cartes aéromagnétiques, les observations entre stations, l'expérience de l'interprète et les renseignements tirés de rapports de levés et d'expéditions antérieurs.

On n'emploiera vraisemblablement pas le traitement mécanographique pendant la rédaction des publications préliminaires mais on essaiera sans doute de le faire lors de rédaction de publications finales. On anticipe une utilisation qui consisterait dans le choix et la compilation de données lithologiques et minéralogiques à l'appui du raffinement des déterminations d'unités rocheuses, du niveau du métamorphisme et domaines structuraux.

USE OF A GEOLOGICAL FIELD DATA COLLECTING FORM ON OPERATION BYLOT[1], NORTH-CENTRAL BAFFIN ISLAND, 1968

INTRODUCTION

History of Helicopter-supported Geological Reconnaissance

The development of helicopter-reconnaissance mapping by the Geological Survey of Canada began in 1952. Lord (1959) has summarized this development up to 1958 and more detailed accounts of specific operations in the Canadian Shield up to that time are given by Eade (1959) and Wright (1959). Several modifications in the overall approach subsequently added are mainly refinements in data collecting and greater use of photography. The chief initial advantages recognized from the early utilization of light helicopters for transporting geological observers are even more valid and consist of: greatly increased rate of mapping, improved consistency and uniformity of coverage, significant cost savings per square mile, and the ability to reach areas that were previously almost inaccessible.

Although an optimum level of operational efficiency was closely approached at the outset, each subsequent area required unique planning in order to allow for variations in terrain, weather, ecology, and geology. Factors related to speed, cost, and accessibility usually can be evaluated with reasonable confidence in advance, but the nature and complexity of the geology within a reconnaissance map-area are much more uncertain. Assuming efficiency in the logistics of such an operation, the quality of work becomes largely dependent on the training and experience of the participating geologists as well as the method of collecting and compiling data. Consequently, if qualified personnel are available, the only aspect left for significant improvement is the handling of data itself. This has become more demanding as major concepts of regional geology and evolution of the Earth's crust are revised and developed through advancing geological science. Furthermore, many relatively modern techniques can now be applied in conjunction with reconnaissance mapping, for example: radiometric dating, evaluation of metamorphic phase relations, and geochemical census. Each approach requires the collection of certain minimum fundamental information and specific sampling procedures. The availability of regional aeromagnetic maps demands that some attention be directed to providing some geological explanations for major anomalies while performing routine helicopter mapping. Technological advances in instrumentation have resulted in more compact equipment, for example, scintillometers that can be conveniently carried on geological traverses. Obviously, some realistic limit must be placed on the extent of these related endeavours, keeping in mind that the prime considerations in the initial survey must be to outline accurately the regional geology of a relatively large area in a relatively short time. The guiding

[1] One of the authors of this report, G.D. Jackson, was co-ordinator of Operation Bylot in 1968 and also of the next phase of the project, Operation Penny Highlands (1970).

(a) Photograph by S. L. Blusson

(b) Photograph by W. J. Crawford

principle in helicopter traversing therefore has been to refine remote visual identifications by frequent ground examinations at more or less regular intervals. This establishes more confident control along the traverse lines and permits more intelligent use of available photography and geophysics than could be realized from reliance on 'point ground observations' without intervening aerial observations.

Operation Bylot

Brief accounts of operational technique and geology are presented below to provide some appreciation of problems involved in applying a predetermined data format to reconnaissance in a region made up largely of Precambrian lithologies. The generalized geological map (Fig. 2) further emphasizes the diversity of geology encountered during the operation.

Operation Bylot was a helicopter-supported geological reconnaissance project that included Bylot Island and that part of Baffin Island north of 69°N latitude and east of 80°W longitude, an area of approximately 53,000 square miles. Like previous operations of similar nature undertaken by the Geological Survey of Canada the overall objective was to provide a broad regional framework which could serve as a guide for mineral explorations as well as establishing priorities relating to future, more detailed geological studies. The initial publication normally arising from such a project is a preliminary geological map on a scale of 1 inch to 8 miles, accompanied by concise descriptions of the geology and economic potential. The preliminary maps for Operation Bylot, however, are scheduled to be published on a scale of 1:250,000. The field approach to this operation did not differ substantially from that commonly used on similar reconnaissance elsewhere in the Canadian Shield with perhaps two exceptions. First of all, an extra geologist was available to carry out detailed work in critical areas while the reconnaissance mapping proceeded at the normal rate. The additional work included: measurement of stratigraphic sections, ground traversing, and the examination of gneiss-dome structures. This meant that at least some of the questions raised by reconnaissance examinations could be either answered or resolved without significant extra expense while support facilities were in the field area. Secondly, a standardized format for note-taking was applied. This was done in an attempt to systematize and avoid omissions in data collecting, thus improving consistency individually as well as collectively among the project geologists.

Figure 1. (opposite) GSC Photos 201923A and 201926A.

Typical rugged coastal terrain encountered on Operation Bylot.

(a) Exposures of granitoid gneisses as seen looking south along the west side of Sam Ford Fiord (70°35'N. latitude; 71°15'W. longitude). Highest elevation in background is about 4000 feet.

(b) Granitoid gneisses as seen looking to the west across Sam Ford Fiord (70°37'N. latitude; 70°40'W. longitude). Highest elevation in background is approximately 5500 feet and distance from helicopter to foot of glacier was 6 1/2 miles.

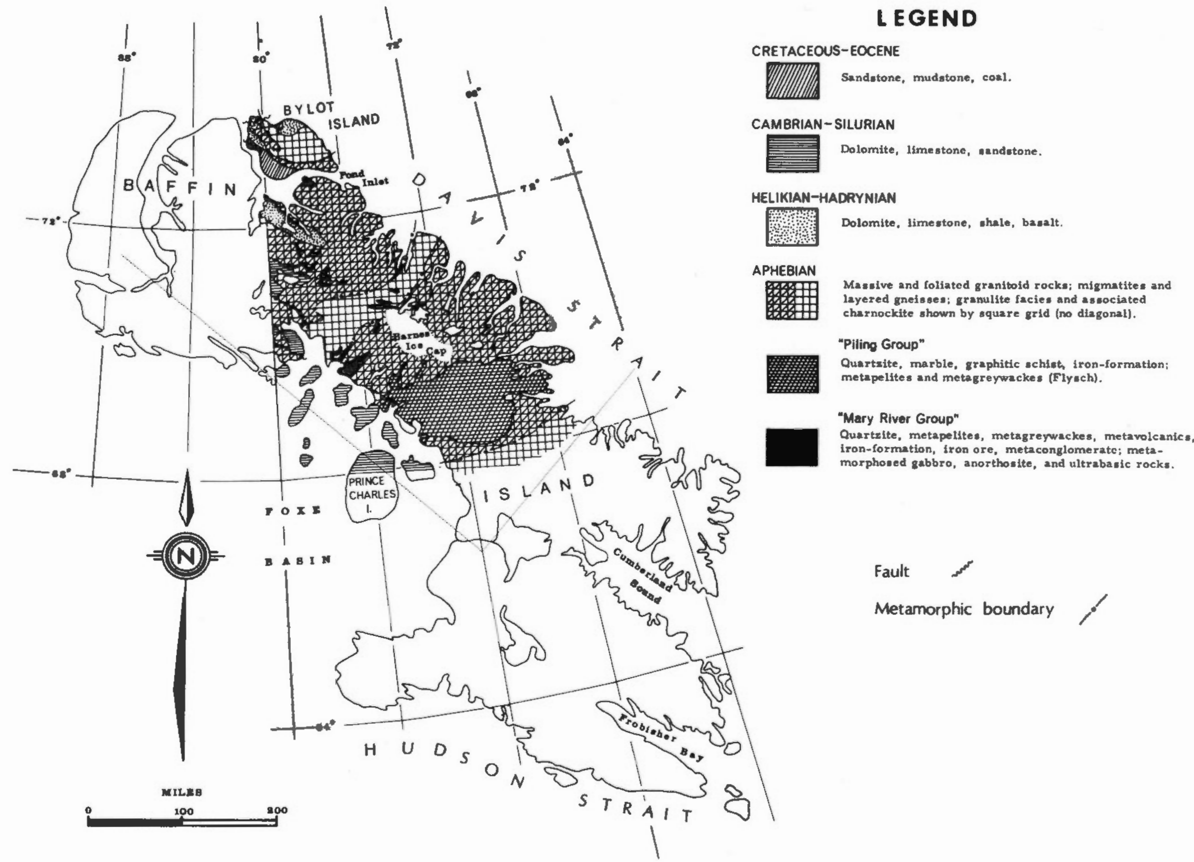

Figure 2. Generalized geological map of Operation Bylot area.

Planning for this operation began in 1967 and in August of that year Jackson made a preparatory visit (see Jackson, 1968) to gain first-hand information on the geology, terrain, weather, available facilities, and suitability of possible campsite locations. Travel in the area was by Cessna 180 equipped with oversized wheels in order to test the feasibility of using such fixed-wing support aircraft. Arrangements were also made for receival and storage of operational fuel shipments. The short time and large size of the proposed map-area allowed for little more than a cursory appraisal of the geological complexity but assisted in confirming the diversity of lithologies and ages of rocks that would be encountered. Special operational problems, apart from the normal adverse weather and short field season, were the high local relief (up to 6,000 feet), and lack of lakes suitable for use by a float-equipped aircraft. Some appreciation of the terrain and rock exposure can be gained from Figure 1.

Geological traversing was done with two helicopters (Bells, 47G4 and 47G4A); camp moves, supply flights and gasoline caching were accomplished with a single-engined DeHavilland Otter mounted with oversized wheels which permitted landings on rough, unprepared ground. The helicopter traverses varied in length from 120 to 350 miles, the pattern being a rectangular grid network with line spacings of about 6 miles except in fiord country where allowances for topography and shoreline configuration were necessary. Twenty to fifty landings were made per traverse and as many observations as possible were made in-flight between landings (referred to as 'stations'). Aerial photographs were employed for navigation, recording 'in-flight' observations, and locating stations in the field. The geological data were collected by the following geologists: S. Blusson, W.J. Crawford, A. Davidson, W.C. Morgan and G.D. Jackson (who also acted as co-ordinator). Traversing was done on alternate days so that a full day was reserved for consolidation, compilation, and assessment of data collected. Initial data records were in the form of voice-tape recordings and these were transcribed to the data forms. As mentioned previously, the extra geologist did detailed auxiliary work and used helicopter time only for transport to and from the work site.

Prior to the mounting of Operation Bylot, the geology of only a few scattered and small areas in north-central Baffin Island was known (Blackadar, 1958; Eade, 1953; Gross, 1966; Jackson, 1966; Kranck, 1955; Mathiassen, 1933, 1945; and Weeks, 1927). This previous work together with that done in adjacent areas (Blackadar, 1970; Trettin, 1969), and the preparatory reconnaissance in 1967 (Jackson, 1968) constituted the geological framework for the operation.

Figure 2, a much generalized geological map shows the major divisions recognized in the area examined in 1968. It is noteworthy that rocks from every geological era are represented. In addition, there exists a wide diversity of lithologies among sedimentary, volcanic, intrusive, and metamorphic rocks. Structures in the metamorphic terrain are particularly complex and include recumbent and refolded folds, thrust faults, nappe structures, gneiss domes, and structures associated with remobilization and partial melting of pre-existing rocks. Granitic rocks were emplaced during at least two plutonic events: one in the Archean and one, if not two, in the Aphebian. Similarly, there were at least two main periods of metamorphism: one Archean and another Aphebian.

Presently available information does not justify drawing consistent distinctions throughout the map-area between Archean and Aphebian gneisses and intrusive rocks. Nevertheless, the presence of both ages was deduced from a combination of detailed and reconnaissance mapping (Jackson, 1966, 1969) and is further substantiated by two Rb/Sr whole rock isochrons (see Jackson and Taylor, 1972, p. 1651). The values obtained are thought to reflect partial readjustment of the isotopic ratios in response to one or more Hudsonian and/or mid-Aphebian orogenic events. The Archean rocks form a complex consisting mainly of: both nebulitic and schlieren migmatites; granitic gneisses; and massive, lineated, and foliated granitic rocks of approximately granodioritic composition. Both the Mary River and Piling Groups are considered to be of Aphebian age. Certain observations suggest that the Mary River Group may be older whereas others suggest that the two groups may be correlative. Both groups have been involved in two major deformational events. They exhibit evidence of metamorphism, migmatization, and deformation during Aphebian time and available K/Ar ages for metamorphic rocks from the area, including the presumed Archean representatives, are near the time of Hudsonian Orogeny (Wanless et al., 1968; Jackson, unpubl. data).

Granulite facies metamorphism is developed in both Aphebian and Archean rocks in certain parts of the area (see Fig. 2). The approximate boundaries with amphibolite facies metamorphism transect the regional stratigraphic and structural trends at low to high angles suggesting different plutonic regimes for rocks that are, in fact, stratigraphically equivalent. About 80 per cent of the area can be summarily described as consisting of Archean and Aphebian migmatites, granitic gneisses, and granites or charnockites in the proportions 60:35:5, respectively.

All post-Aphebian rocks are unmetamorphosed and mainly preserved in northwestward-trending grabens. They include: Helikian-Hadrynian strata of the Eqalulik and Uluksan Groups; Hadrynian diabase dykes of the Franklin swarm; Cambro-Silurian strata; and Cretaceous and Eocene strata of the Eclipse Group. In general, the younger the strata, the less the deformation.

The results of the project, although as yet not fully published, have led to economic activity in the area. Subsequent exploration, claim staking, and acquisition of permit areas attest to the interest shown by mining and oil companies in the following possible resources and respective areas: iron ore - Eqe Bay, Grant-Suttie Bay, Rowley River, Mary River; sulphide mineralization - Tay Sound, Mary River; oil and gas - southwestern Bylot Island.

The format for the field data sheet was designed to record, by means of simple codes, observational data necessary for geological compilation in the form of an input document from which transcriptions to computer-punched cards could be made directly. The punched cards would in turn be used for input for machine sorting, retrieval, programmed processing, and file conversion. Initially the computer card file would constitute the reference data file for the project. In addition to improving observational consistency and providing a more concise and usable inventory for further work in the area, other advantages were anticipated and these are dealt with elsewhere in this paper. The writers have attempted to outline the development, application, merits, and shortcomings of the field data form designed for Operation Bylot.

ACKNOWLEDGMENT

The writers gratefully acknowledge the encouragement and constructive criticisms offered by T.M. Gordon, who critically read the manuscript.

THE FIELD DATA FORM

Planning and Development

In the early preparatory stages of Operation Bylot, Jackson and co-workers gave some consideration to devising a systematic method of note-taking mainly to avoid inconsistencies among participating geologists. It was agreed that some rigorous distinctions should be drawn between factual observations and interpretive or arbitrary decisions. The data form discussed in this paper was initially designed by Jackson with the assistance of Reinhardt and W.C. Morgan. Morgan in consultation with Jackson devised the initial list of codes and these in addition to certain parts of the initial data sheet were revised in the light of invaluable constructive criticism by co-workers, S.L. Blusson and A. Davidson.

Experience, mainly by others, and the geological complexity, strongly recommended that a 'manual' or 'key-sort' file would be far too limited to encompass the high diversity anticipated in describing the geology of the area. To embark on such a system would probably result in reversion to reading handwritten notes without performing extensive manual sorting. In our opinion, the main disadvantages and limitations of such a file are as follows:

1) lack of sufficient space to permit statement of degree, range or variability of properties, percentages, and measurements,
2) in striving for space conservation, the scope of data that could be sorted would have to be drastically reduced on strict priorities,
3) punching data from written, possibly randomly organized material on the face of the cards is both arduous and time-consuming,
4) revisions, integration of new data-types, file merging, and file reproduction would be virtually out of the question.

Some impetus for adopting a computer-based file system came partly through discussions with other users* and partly because of the obvious capability of such a system to accommodate highly variable properties and parameters, numerical data, and large numbers of entries from individual stations. Items such as geographical co-ordinates require excessive space on a 'key-sort' card but are easily accommodated on a computer-punched card. Each slot on a manual-sort card is capable of a yes or no type of distinction, whereas each punch location on a computer card can accept many degrees of distinction although in reality, the number is limited to what can be remembered or conveniently translated into code by the user. The computer card-file can also be revised in the light of new data, merged with laboratory data files, and processed mechanically. Furthermore, the data can be analyzed applying methods that are only feasible with a computer.

---

*Mainly members of the Subcommittee on Geological Field Data under the Ad Hoc Committee on Storage and Retrieval of Geological Data in Canada, National Advisory Committee on Research in the Geological Sciences.

Before adopting a predetermined systematic data-gathering procedure, certain specifications particular to this type of operation have to be satisfied. The more demanding of these considerations are listed below along with brief explanations:

1) Less information was known prior to the survey than is known prior to more detailed or specific investigations.

2) Unlike unidisciplinary studies where observations are mutually related through a common objective, reconnaissance observations must cover a broad scope and thus are often unrelated because several geological aspects are assessed at once. Any system devised must acknowledge this and at the same time cross-reference related data.

3) The extreme variations in rock-types and structures have to be described adequately enough to permit recognition and retrieval of distinctive units without ambiguity. This implies that over-simplified specifications might render the system useless for compilation. The proportion and variability of migmatites and granitic rocks over such a large area illustrates the extreme importance of comprehensive description.

4) Any predetermined system had to be 'elastic' enough to allow for the unexpected; if not, abandonment in favour of a more conventional method would be necessary and the whole experiment would have to be postponed until the next operational year.

5) Elaborate field-laboratory and field-office facilities were impractical in contrast to project-investigations in more accessible regions (with less rugged climate) so that all evaluations and identifications had, by necessity, to be kept simple.

6) Repeat or 'check' observations were normally not allowed.

7) Time allotted for recording data from each outcrop had to be kept to a minimum. Any significant increase in time used over conventional note-taking was prohibitive.

8) Logistics occupy a large proportion of the co-ordinator's attention, leaving less for close supervision of format-oriented data collecting. Once the system had been developed and agreed upon, it had to retain a strong element of standard meaning to users without precipitating serious controversy.

9) The data collecting program must not encumber or otherwise unduly impair the movement, observation sequence, or concentration of the observer; otherwise quality could be impaired.

At one stage, the discussion of desirable features that could be incorporated in a data form for reconnaissance mapping led to a critical review of our current practices. Re-examination was made from the viewpoint of density of coverage, number of rock specimens collected, type and usefulness of structural measurements, and the nature of 'follow-up' work intended. It was initially agreed that most structural measurements would be too widely separated to justify extensive machine compilation or processing. Also, a strong reliance would have to be placed on aerial photography and aeromagnetic maps (where available) in interpreting the regional structural pattern, and neither type of display is readily amenable to coding and machine manipulation. On the other hand, it was reasoned that better quality petrographic assessments could be made with computer-assisted compilation and thus a greater number of thin sections and a large number of stained rock-slabs were deemed worthwhile. These would amplify the field identifications with precise data pertaining to metamorphic associations, degree of deformation, and micrometric compositions, all of which would improve the classification and definition of map-units.

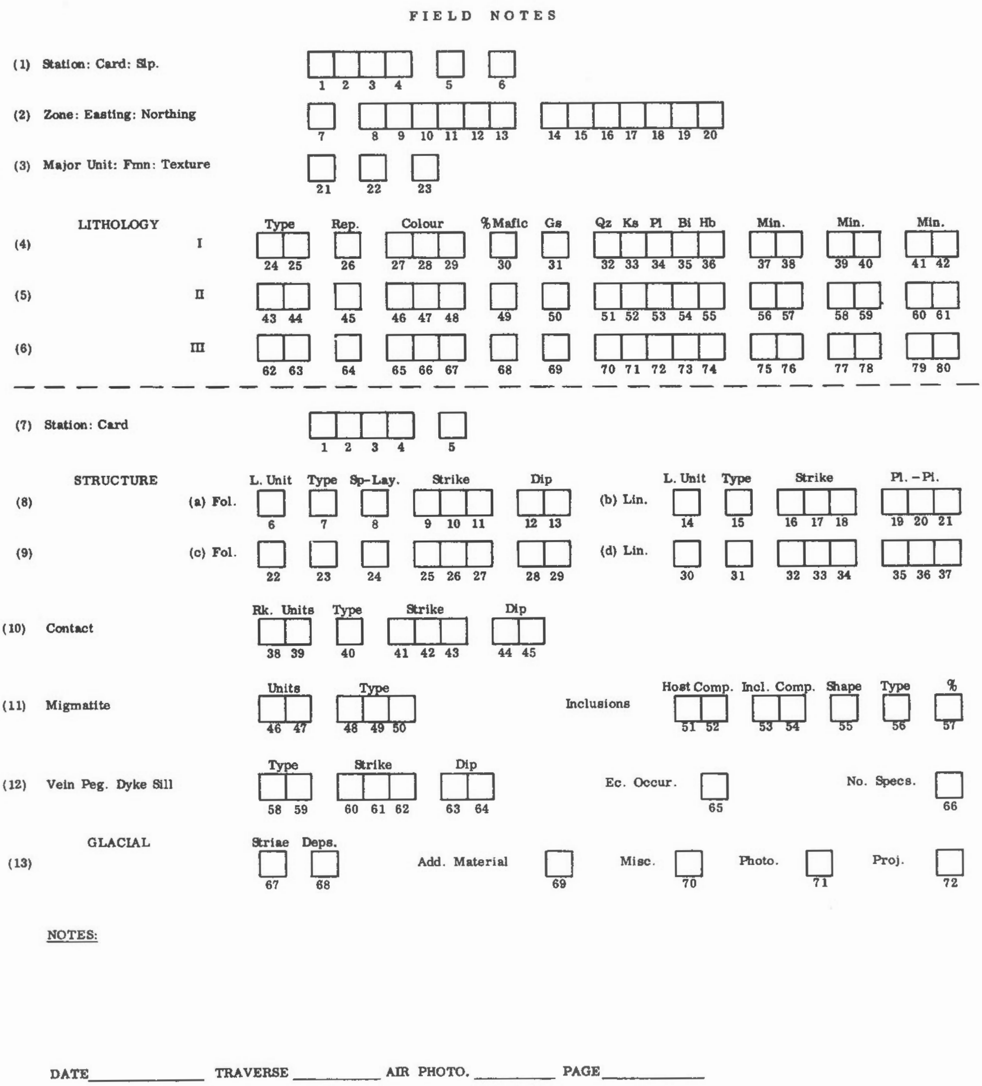

Figure 3. Field data collecting form, Operation Bylot.

In preparing a data form, some compromise between the convenience to the user and to the processor had to be made. Future storage and amplification of the file also had to be considered in designing the field format. The most difficult task, however, was in preparation of specifications for recording geological data and as a beginning, three main categories of data relating to location, lithology, and structure were proposed. Detailed specifications for descriptions within each general category are described in the following section.

Explanation

The sample form in Figure 3 shows that each station (outcrop) requires at least two cards to be key-punched from the coding blocks on the form. Coded data above the broken line on the form is to be entered on Card 1, and similarly that below is entered on Card 2. If subsequent cards are required because more than one sheet is needed at an outcrop, card numbers follow consecutively. In general, Card 1 is devoted to lithological data, whereas Card 2 contains relationships and structures. Space for handwritten notes and sketches was reserved near the bottom of the sheet and designated "notes". Code notation was both mnemonic and numeric and the former was devised wherever possible according to the "Franklin method" as recommended by the Ad Hoc Committee on Storage and Retrieval of Geological Data in Canada (report of, 1967, p. 45). One- or two-letter codes were adequate and conserved space, which was desirable in retaining a reasonable size and convenient groupings. Departures from the "Franklin method" were often necessary to avoid duplication. The codes used are compiled in the Appendices of this paper. As mineral and rock codes may be of more general application to other projects and because they are based on more widely understood terminology, they are catalogued separately in Appendix B and C, respectively. Appendix A contains the remaining codes which apply to terms or designations requiring further qualification or having specific meaning with respect to Operation Bylot. Explanation of coding blocks follows more or less the same sequence used in numbering the coding blocks on the data sheets, except of course, for mineral and rock codes.

The appendix alone, however, is not adequate to convey certain distinctions and qualifications inherent in the application of the data sheet so that a supplementary outline of sequential coding is presented below, beginning with Card 1:

Blocks 1-4 contain the station number of the recording geologist with his last name initial letter in block 1.

Block 5 contains the card number, thereby providing for more than one "lithology card" per station.

Block 6 indicates the presence (or absence) of observations in-flight from the previous stop.

Blocks 7-20 gives station location in UTM co-ordinates. Only the first or unit integer of the Zone number is used.

Block 21 was reserved for "major unit" which embodies in varying degrees, attributes of geological age, tectonic evolution, and distinctive lithology and petrology. Definitions to be employed require some regional appreciation of distribution and mode of occurrence before being adopted and in general can be expressed more confidently for the younger, less deformed rocks. The major-unit concept attempts to co-relate and combine history and lithology wherever possible so as to clarify the overall character of the area. As further work proceeds, definitions may require alteration and therefore are not yet 'statutory'. By introduction during mapping, the major units were subjected to early critical examination.

Block 22 contains "formations" or subdivisions of major units and as in the previous discussion, pre-definition was not always feasible except where prior information justified this (e.g., certain parts of the "Mary River Group" which were examined by Jackson (1966)) before the operation. In an area of this size and complexity, certain mappable units eventually will be designated by formalized formation names, whereas others will be more loosely referred to according to characteristic lithologies such as 'quartzite', 'iron-formation', etc.

Block 23 is reserved for dominant or characteristic textural or structural (not wholly "texture" in the narrow sense) features that might be useful in identifying, outlining, or correlating major mappable units, formations or structural domains. The rationale was that these features might serve as condensed definitions; they must therefore be strikingly obvious to the observer so that their distribution can be traced during the course of mapping.

Blocks 24-80 are for recording lithological and mineralogical characteristics of rock-types. The groupings I, II and III designate the three main lithologies that can be described on Card 1 (more can be added on Card 3). Using I as an example, blocks 24 and 25 show rock-type according to codes in Appendix C; the estimated proportion of the rock-type is given in block 26. Colour is inserted in blocks 27 to 29 with tone intensity or other modifier in 27. No refined comparison with standard colours was attempted in 28 and 29. Block 30 indicates estimated mafic content which in some rocks is a measure of colour index. Grain size appears in block 31 and blocks 32 to 36 are for indicating presence and rough percentages of common minerals. The remaining blocks (37-42) provide for less common minerals without estimates of their amounts, following the two-letter codes in Appendix B.

The first four blocks of Card 2 are identical to the first four blocks of Card 1. Block 5 contains the card number.

Blocks 6-37 relate to measured structures, and block groupings (a) and (c) are to deal with foliations, whereas (b) and (d) are to do with lineations. Considering first the entry of a foliation, block 6 provides a cross-reference between the foliation and the lithology in which it occurs. Block 7 gives the type of foliation, e.g. schistosity, cleavage, etc. and block 8 states average distance between planes or surfaces. Strike and dip measurements are recorded uniquely in blocks 9 to 11. Lineations are treated in an analogous manner except that in block 19 a distinction is made between 'pitch' and 'plunge' in defining the inclination of a linear feature. Provision is made to show lineations opposite or paired with appropriate foliations where both structures share a common plane and this is mandatory where pitch rather than plunge is recorded.

Blocks 38-45 contain data on contacts; blocks 38 and 39 indicate the appropriate lithologies (from Card 1) and were filled out only for small-scale contact features. Type of contact, e.g. fault, unconformity, is given in block 40 and the measured attitudes of planar contacts are recorded in blocks 41 to 45.

Additional data for migmatites are given in blocks 46 to 50 and the two major-component lithologies appear in blocks 46 and 47. The type of migmatite, using descriptive terminology, is given in 48. Either foliated or massive aspects of mafic and leucocratic components are shown in blocks 49 and 50 respectively.

Blocks 51-57 are for 'inclusions'; rock-types of host and inclusionary components, each in two-letter mnemonic rock-codes as in Appendix C, are stated in blocks 51 to 54. Shape description of inclusions (e.g. angular, equant, etc.) appears in block 55 and the dominant structural or textural aspect of the inclusionary component is given in block 56. Estimated amounts of inclusions relative to host rock appear in 57.

Blocks 58-64 concern veins, dykes, and sills, with rock-type (Appendix C) indicated in 58 and 59 and measured attitudes in blocks 60-64.

Block 65 provides for possible economic mineralization and a wide variation of occurrences could be accommodated by selecting codes rather than by reserving blocks.

The number of specimens collected at a given station appears in block 66 and this provided for 'cross-checking' to recognize irregularities caused by loss.

Blocks 67 and 68 were inserted to record presence of glacial striae and type of glacial deposits. Recorded measurements of glacial movement directions were uncoded.

Block 69 is for recording either need or presence of additional material. For instance, in the field this might suggest need for age date, thin section, etc. whereas in the office this could be updating of additional data provided by subsequent laboratory work.

Block 70 was left open for an extra data-type that had not been anticipated.

Block 71 is for indicating the type of photograph taken by the geologist.

Block 72 indicates the project year and could be used to rapidly separate one season's file from another if the same format was used in each case.

In addition to coding blocks and handwritten notes, provision was made at the bottom of the sheet to record the date and number of traverse, aerial photograph on which stations and air observations were marked, and the page number of the sheet.

Application

In practice, the field data form proved more useful than prior expectations suggested, in spite of the extensive number of codes needed to accommodate high variability of rock-types and structures. The main initial concern was that extra field time would be required in using the form compared to conventional methods. However, this potential drawback was largely eliminated by use of voice-tape recordings with the data format as a guide or checklist. In this way omissions were avoided and the observing geologist transcribed 'taped' data to the sheets thus gaining fluency with coding employed. We reckon that the time spent per outcrop would have been over three times as long if the data sheets had been filled out directly and the net result would have been less than one-third as much area covered. We further contend that a comprehensive data sheet would require more time to complete on an outcrop than would be spent in conventional note-taking, but submit that the former method supplies higher quality and a greater amount of data.

Some indirect definite benefits arise from the preparation of a rigid specificational code and a data format. First, one is obliged to organize all previous information in order to predict the relevant geological parameters that will be involved in the actual mapping program. In effect, this results in a critical preliminary analysis of the proposed area and suggests certain hypotheses that might be tested during the field examinations. Admittedly, this type of exercise could be implemented without application of coding and data sheets but the extreme necessity for rigidity is lacking and predictable complications are not usually anticipated in such detail. In brief, the data format not only serves to "spell out" one's mapping concepts and methods but also maintains a logical order in making decisions that combine to form regional interpretations.

Another desirable feature of the data form is the capability of cross-referencing structures to lithologies. In normal note-taking, this aspect can be inadvertently ignored unless certain relationships are specifically sought or recognized early in the field program. Information of this kind may be invaluable in tracing the imprints of deformational episodes. Frequency of occurrence of foliations and lineations in various rock-types may become an important element in the description of map-units. Origins of certain structural features may be more obvious if the character of the lithology containing them is accessible. Since most geological interpretations involve reorganizations within rock masses, whether it be mechanical or chemical, the ultimate assessment should be a reconciliation of structure and lithology, the data sheet being a means to this end.

Apart from the general comments presented above, there are more specific benefits and weaknesses that can best be discussed in the same sequence as followed in the format. Those portions of the data sheet (Fig. 3) that were obviously satisfactory will be excluded.

The UTM co-ordinate system was considered more advisable than designations by latitude and longitude because the 'Eastings' and 'Northings' could be measured with relative ease, directly from the topographic base-map with the aid of a transparent 'roamer'.

"Major units", "formations", and "textures" deserve passing comment. Blocks for the first two were commonly left blank in the field whereas the third was invariably completed and found to provide useful distinctions for correlating and/or separating map-units.

Migmatites are inherently difficult to handle on any mapping program and those on Baffin Island show extreme variations. Unlike the unmigmatized rocks in the area, migmatites could not feasibly be separated in the field according to age of formation, for example, Archean or Aphebian, because of the complexity of the geology and reconnaissance nature of the mapping. The "major-unit" designation was thus simply "migmatite" with further break-downs under "formation" (block 22, Card 1).

The distinction between migmatites with concordant leucocratic components and layered gneisses consisting of primary layers of highly variable composition is not always simple or even possible. The inference conveyed by 'migmatite' is that the rock contains some bands that were either magmatic injections or local anatectic derivatives. Where evidence of mobility, say in the form of local discordant relationships, exists, the initial distinction is clear. After establishing the presence of migmatite, it must be classified and described allowing for possible correlation of the metamorphic host component with unmigmatized equivalents (usually formations) occurring elsewhere in the area. The coding blocks reserved for migmatite on Card 2 were designed for this purpose. For example, the first unit (block 46) could be in formational code and the second (block 47) would specify the dominant granitic or mobile component corresponding to the lithological description on Card 1. An analogous procedure would be followed substituting "major-unit" code for "formation" code where the formation was not recognized. The above procedure proved to be reasonably sound, and precise descriptions of the leucocratic or granitic components were helpful in the event that the migmatite later proved to be a border phase of a homogeneous pluton. Another situation that did occasionally arise and that could be adequately handled by the migmatite blocks was the description of a "migmatized migmatite". In this circumstance one of the migmatite units would be either "migmatite" as a major unit or a migmatitic formation and the other would be the late granitic component again corresponding to a described lithology on Card 1. Where both migmatitic units are specified as previously described lithologies, however, blocks 46 and 47 (Card 2) become somewhat redundant because the major unit and/or formation given on Card 1 already indicates that described lithologies are combined as migmatite. One other minor difficulty that arose when more than three lithologies were employed to describe a migmatite (requiring a second "lithology card") was in maintaining the identity of all components as belonging to the migmatite.

The lithological part of the sheet has greatly facilitated the definition of metamorphic mineral assemblages by listing the mineral phases from each rock-type. Without this breakdown the mineral associations are often abbreviated to names such as sillimanite gneiss rather than quartz-feldspar-biotite-sillimanite gneiss.

Descriptions and attitudes of foliations and lineations could be adequately handled using the form. In reconnaissance mapping, more than two of each per outcrop are uncommon, taking into account that general attitudes representative of a whole outcrop are sought. Cross-referencing of lineations and foliations is also necessary, especially where "pitch" rather than "plunge" of the lineations are recorded. Apart from the option of machine processing, coding has no great advantage over shorthand symbols previously used by both writers in conventional note-taking.

The portion of the form devoted to contacts was seldom used and measured attitudes of contacts could be integrated with planar structures along with foliations possibly by the introduction of another group of coding blocks. This would both generalize and simplify the format, and as can be noted, the attitudes of veins, dykes, and sills have already been provided for. This complies with a general comment submitted by the users, namely: that coding priorities should be allocated only to data types that are likely to be encountered at virtually every outcrop examined. Unusual or infrequent observations should then be relegated to handwritten notes. If they happen to be critical relationships they will be absorbed in the running assessment and later may deserve separate mention in the geological report. They could also be coded as additional material indicating that written descriptions have been made.

The remaining items on the data sheet require no comment except that they are simple accounting aids which will undoubtedly facilitate compilation as well as constituting a complete permanent file. Blocks 73 to 80 of Card 2 should have been printed on the data sheets in the event that unanticipated data worthy of coding was found during the field work.

Our experience suggests that some attempt to show involved code meanings along with coding blocks on the face of the data sheet should be attempted. Admittedly space is limited in the present data sheet for listing rock and mineral codes but this endeavour should lead to time savings no matter what method of initial data collecting is used (e.g. tape recorders, direct insertion). Another useful addition would be to indicate that a representative specimen was collected of a given described lithology. This would simplify selection of material for further work, for example: thin sections, chemical analyses, etc.

In order to appreciate fully the function of the data sheet on Operation Bylot brief mention of other records and compilations is pertinent. First, an up-to-date field map showing briefly the geology at each station as well as air observations between was maintained. The specimen collection itself provides a reference suite of rocks for the whole area and field observations related to lithology and small-scale structures can be checked or revised if necessary from this collection. A greater emphasis was probably placed on specimen collecting than attempted in earlier reconnaissance work. Compilation maps of features observed on aerial photographs were also used in planning observation sites along traverse lines.

Compilation, Advantages, and Disadvantages

To date map compilation has proceeded without computer processing; largely because of the immediate need to provide some form of preliminary publication. A certain period of organization and development must precede machine processing of the actual data; neither time nor manpower were in plentiful enough supply to consider this method in preparing the preliminary report. However, some form of mechanical processing is envisioned for the preparation of final reports for both Operation Bylot and Operation Penny Highlands (1970 phase).

In comparison with similar-scale reconnaissance previously undertaken, the 'Bylot' format offered several advantages over conventional methods of note-taking and these have been apparent in compilation so far completed. Use of the data sheet led to more consistent records as well as providing a greater overall volume of information for each station. This is particularly true of data relating to lithologies, structure, and mineral associations. Part of the improved consistency can be attributed to the necessity of having mutual agreement among participants as to nomenclature and terminology prior to commencement of field work. This, plus the greater volume of information, lessens the uncertainties confronting the compiler and therefore should facilitate a more meaningful interpretation. In addition, searches for specific items can be accomplished more readily than with conventional notes because of the fixed location of each data-type on the form.

In contrast to the above advantages, the 'Bylot' format also showed certain disadvantages. None of the difficulties was particularly serious and the remedies, in general, are obvious once a problem is recognized. Revision of the 'Bylot' format for the next field phase of the project (Operation Penny Highlands) removed some of the inherent disadvantages discussed below.

The coding manual was separate from the data sheets and was too bulky and cumbersome for quick reference at the outcrop site; consequently, the data form was used as a checklist in conjunction with tape recorders. Transcribing taped records onto sheets using the manual slowed the field-office compilation. Code listings directly on the data sheets appears to be the best solution. As might be expected, certain codes had to be added during the field season to account for unforeseen items; some of these were not formalized with respect to the master listing by the originators resulting in loss of meaning or duplication.

Following the field season, it was discovered that data sheets for some stations had not been completed and others required extensive editing. Where geologists were uncertain about exact mineral identifications in the field, they were reluctant to insert the most likely choice. In short, the degree of certainty cannot be readily accounted for under a fixed format system of data recording and the same principle applies to some of the other items recorded.

In general, more thought might have been given to the arrangement of data items so as to allow for greater ease of programming for mechanical retrievals and comparisons. These objectives should, however, not significantly compromise the efficient application of the sheets in the field. The perennial problem of co-relating individual lithologies combined in migmatites is particularly frustrating.

The exercise of devising and applying a fixed format data sheet for reconnaissance mapping has outlined the extent to which it is practical to employ mechanical processing and compilation with respect to existing technology, schedules, and final product expected. Certain important realizations are discussed below. First of all, reconnaissance projects by definition must encompass large areas, such that fewer 'hard' points (stations) per unit area are obtained. 'In-flight' observations between consecutive stations provide data of a lesser degree of reliability and these are not conveniently coded, taking account of exact locations, on fixed format data sheets. In fact, 'in-flight' observations are best recorded directly on the aerial photos used for traverse lines and reasons for this will become apparent below. Secondly, the proper establishment of geological boundaries (contacts) and determinations of structures from reconnaissance data demands a high degree of sophisticated interpretation that to a large extent is dependent upon the interpreter's experience, and on the availability of additional information from many sources. This additional information, for many reasons not discussed here, either cannot be readily merged with the station data file, or should not be so merged. Such data includes: results of air photo interpretation; detailed and regional geophysical surveys, especially gravity, seismic and airborne magnetic surveys; and information in reports of early surveys and expeditions (e.g. Matthiassen, 1933, 1945). Thirdly, if a project is not extended beyond one field season, one should carefully weigh organizing and programming for mechanical retrievals against direct compilation from field notes, especially while the important features of the area are still fresh in the compiler's mind. Finally, the extra time spent in computerization of field data should not overlap with that budgeted for planning a new project such that the first project becomes a backlog of unpublished material while the second is also underway. The psychological aspects of such a backlog are anything but stimulating and we strongly advise a conventional approach, at the risk of appearing negative, under such circumstances.

As mentioned previously, mechanical processing is planned for final reports. Some of the main items that might be accommodated through retrievals are: cataloguing of metamorphic associations in order to establish metamorphic grades, assembling characteristic properties for description and definition of map-units, and, perhaps, a regional structural analysis for interpretation of major tectonic elements. Auxiliary files for office and laboratory data may also be set up.

GENERAL CONCLUSIONS

The application of a predetermined data collecting format to reconnaissance mapping has proven satisfactory for Operation Bylot and a revised format was employed in continuation of the project in 1970. The main objective of improving consistency was realized along with obtaining a greater volume of data. The pre-evaluation and assessment of the area was more thorough and systematic because of the development of the data form. Problems related to origin were confronted earlier in the field season than is probably normal. Earlier consideration of the data format would have been desirable and a better conception of alternative processing techniques through greater exposure of the developers to such techniques would also have been beneficial. Probably a complete schedule involving technical assistance throughout the processing period should be incorporated in the planning of such a program. Many of the difficulties that arise in actual processing are often not fully appreciated in advance. Another common fallacy is in assuming that the method will be faster right from the beginning. From our limited experience, we would disclaim this contention but at the same time emphasize the greater ultimate precision in compilation, the initiation of a permanent, accessible data file, and the ability to carry out evaluations that otherwise would not be feasible. Furthermore, once a system is thoroughly developed beyond the stage where processing methods are devised for all but special procedures, greater speed can be anticipated compared to conventional compilation.

In particular reference to 1:500,000 reconnaissance, the number of 'hard' data sites are fewer per unit area thus requiring heavier dependence on 'in-flight' observations and interpretations from aerial photos and aeromagnetic maps. The three latter ingredients are not readily amenable to mechanical processing in conjunction with the 'hard' data for purposes of producing a meaningful geological map.

Finally, we contend that direct use of data sheets in the field will not speed the recording of observations as opposed to conventional methods but quality will be improved. Conclusions stated here as well as those stated earlier apply specifically to procedures employed on Operation Bylot and prospective users of similar approaches under different circumstances should make individual judgments as to what factors influence the successful application of a field data form.

REFERENCES CITED

Ad Hoc Committee on Storage and Retrieval of Geological Data in Canada
1967: A national system for storage and retrieval of geological data in Canada; available through Geol. Surv. Can., Ottawa, 175 p.

Blackadar, R.G.
1958: Foxe Basin North, District of Franklin, Northwest Territories; Geol. Surv. Can., Map 4-1958.

1970: Precambrian geology northwestern Baffin Island, District of Franklin; Geol. Surv. Can., Bull. 191, 89 p.

Eade, K.E.
1953: Petrology of the gneisses of the Clyde area Baffin Island; unpubl. Ph.D. thesis, McGill Univ., Montreal, 175 p.

1959: Light helicopter reconnaissance in New Quebec; in Helicopter operations of the Geological Survey of Canada; Geol. Surv. Can., Bull. 54, p. 15-19.

Gross, G.A.
1966: The origin of high grade iron deposits on Baffin Island, N.W.T.; Can. Mining J., v. 87, no. 4, p. 111-114.

Jackson, G.D.
1966: Geology and mineral possibilities of the Mary River region, northern Baffin Island; Can. Mining J., v. 87, no. 6, p. 57-61.

1968: Operation Bylot, north-central Baffin Island; in Report of Activities, Part A: May to October, 1967; Geol. Surv. Can., Paper 68-1, Pt. A, p. 144-145.

1969: Reconnaissance of north-central Baffin Island; in Report of Activities, Part A: April to October, 1968; Geol. Surv. Can., Paper 69-1, Pt. A, p. 171-176.

Jackson, G.D., and Taylor, F.C.
1972: Correlation of major Aphebian rock units in the northeastern Canadian Shield; Can. J. Earth Sci., v. 9, p. 1650-1669.

Kranck, E.H.
1955: The bedrock geology of Clyde area in northeastern Baffin Island; Acta Geographica, v. 14, no. 14, p. 226-248.

Lord, C.S.
1959: Introduction; in Helicopter operations of the Geological Survey of Canada; Geol. Surv. Can., Bull. 54, p. 1-6.

Matthiassen, T.
1933: Contributions to the geography of Baffin Island and Melville Peninsula: Rept. of the Fifth Thule Expedition, 1921-24: v. 1, no. 3, 102 p.

1945: Report on the expedition: Rept. of the Fifth Thule Expedition, 1921-24, v. 1, no. 1, 135 p.

Trettin, H.P.
1969: Lower Palaeozoic sediments of northwestern Baffin Island, District of Franklin; Geol. Surv. Can., Bull. 157, 70 p.

Wanless, R.K., Stevens, R.D., Lachance, G.R., and Edmonds, C.M.
1968: Age determinations and geological studies; Geol. Surv. Can., Paper 67-2, Pt. A, K-Ar Isotopic Ages, Report 8, 141 p.

Weeks, L.J.
1927: The geology of parts of eastern arctic Canada; Geol. Surv. Can., Sum. Rept. for 1925, Pt. C, p. 136-141.

Wright, G.M.
1959: Light helicopter reconnaissance in the barren grounds, Northwest Territories; in Helicopter operations of the Geological Survey of Canada; Geol. Surv. Can., Bull. 54, p. 7-14.

OPERATION BYLOT, 1968

Appendices A, B and C

APPENDIX A

CARD 1

MAJOR UNIT, FORMATION, AND TEXTURE CODES (ROW (3))

Major Unit (block 21):

Q - Quaternary
M - Mesozoic-Tertiary
P - Paleozoic
H - Helikian-Hadrynian
B - "Piling Group" Type   Aphebian
C - "Mary River Group" Type
D - Post-Hudsonian basic intrusions
E - Pre- to Syn-Hudsonian basic intrusions
F - Post-Hudsonian acidic intrusions
G - Pre- to Syn-Hudsonian acidic intrusions
U - Ultrabasic rocks
A - Anorthosite
Ø - Orthogneiss
R - Paragneiss
N - Lineated to foliated granitic gneiss
L - Layered granitic gneiss
J - Gneiss undivided
K - Archean rocks
Ƶ - Migmatite, hybrid rocks

Formation (block 22):

One-letter alphabetic codes to be devised as formations recognized and named.

Texture (block 23):

M - massive
L - layered
F - foliated
S - sheared
C - cataclastic and protoclastic
E - equigranular
N - inequigranular
B - porphyritic (porphyroblastic)
K - poikilitic (poeciloblastic)
Ø - ophitic
P - pegmatitic
G - granophyric-graphic
R - rodded
X - xenolithic
A - augen
T - sedimentary
Ƶ - variable

LITHOLOGICAL DESCRIPTION CODES (ROWS (4), (5), (6))

Type (blocks 24, 25, 43, 44, 62, 63):

See Rock Codes - Appendix C.

Representation (blocks 26, 45, and 64):

The estimated percentage representation, coded as follows:

1% to 10% = 1
11% to 20% = 2
etc.
91% to 100% = X

Colour (blocks 27 to 29; 46 to 48; 65 to 67):

modifier: blocks 27, 46, 65	D - dark M - medium L - light P - pale T - mottled V - variegated G - greasy U - uniform	
colour: blocks 28, 29, 47, 48, 66, 67	BK - black BW - black-white BG - blue-green BR - brown BU - buff GN - green GY - grey GB - grey-blue GK - grey-black GG - grey-green ØL - olive	ØR - orange PK - pink PB - pink-black PU - purple RD - red RB - red-brown WH - white YE - yellow YB - yellow-brown YG - yellow-green YP - yellow-pink

Percentage Mafics and Mineral Percentages (blocks 30; 32 to 36; 49; 51 to 55; 68; 70 to 74):

Percentage estimates coded as follows:

Present (<1%) = P
1% to 10% = 1
11% to 20% = 2
etc.
91% to 100% = X
Variable = Z

Grain Size (blocks 31, 50, 69):

A - glassy, aphanitic
V - very fine grained .... <0.1
F - fine grained 0.1-1
M - medium grained 1-5
C - coarse grained 5-20
G - very coarse grained; pegmatitic .... >20
S - seriate
Z - variable

Sedimentary rocks (clastic and chemical; size in millimetres)

B - boulder .... >256
C - cobble 64-256
P - pebble 4-64
G - granule 2-4
L - coarse sand 1-2
M - medium sand 1/4-1
F - fine sand 1/16-1/4
S - silt 1/256-1/16
Ø - mud, clay .... <1/256
X - mixed, poorly sorted sandy rocks with appreciable silt/clay
Y - bimodal, conglomeratic with appreciable sand/silt

CARD 2

STRUCTURE CODES (ROWS (8) and (9))

Foliations (blocks 6 to 13; 22 to 29; groupings (a) and (c)):

Lithological unit (6, 22) coded from Card 1, groupings I, II, and III, as 1, 2, and 3 respectively.

Types of foliation (7, 23) code as:

M - massive
P - primary sedimentary layering
L - primary igneous layering
C - cleavage
A - axial plane cleavage
S - schistosity
F - foliation
G - gneissosity
J - jointing
H - shear zone, mylonite foliation
Z - variable

Average thickness of layers or average distance between planes; joints, cleavage, etc. ... (blocks 8, 24; measured in centimetres). Numeric code and equivalent distance interval as follows:

1.	<0.2 (cm)	5.	10-50 (cm)
2.	0.2-1	6.	50-100
3.	1-5	7.	>100
4.	5-10	8.	massive
		9.	variable

Strike and dip of planar structures in blocks 9 to 13 and 25 to 29. Azimuth measured in degrees, clockwise; dip always to the right (degrees).

Lineation (blocks 14 to 21; 30 to 37; groupings (b) and (d)):

Lithological units (14, 30), coded as for foliation.

Types (15, 31) code as follows:

F - microfold axis (microscopic to hand specimen size)
A - megascopic fold axis (hand specimen to outcrop size)
M - mineral
C - clast
W - mullion
R - rodding (aggregate)
B - s-plane intersection
S - slickenside

Lineation direction (16 to 18; 32 to 34) measured as azimuth clockwise in degrees; inclination as pitch or plunge indicated in blocks 19 and 35, if plunge code P, if pitch code T. Plunge preferable to pitch. Where lineations lie in plane of foliation, record data in block grouping (b) or (d) opposite appropriate foliation block grouping (a) or (c).

CONTACT CODE (ROW (10))

Rock-units (38, 39) separated by geological contact referenced to lithological groupings I, II, III of Card 1, coded respectively as 1, 2, 3 or coded as to appropriate major unit or formation using alphabetic code.

Type of contact (40), code as follows:

A - fault (movement undetermined)
B - fault (movement known or inferred)
C - intrusive contact
P - diapiric contact
D - disconformity
F - conformable
N - nonconformity
L - angular unconformity
G - gradational contact
T - tectonic contact
U - uncertain

MIGMATITE AND INCLUSION CODES (ROW (11))

Migmatite (blocks 47 to 50):

Units shown in blocks 46 and 47 may be referenced either to lithological groupings I, II, III of Card 1 (coded respectively as 1, 2, 3) or major unit or formation, alphabetic code where either major unit or formation is recognized.

Type of migmatite (48) and structure of mafic (49) and felsic (50) components respectively (in same order) code as follows:

(48) Type:

M - multicomponent migmatite
F - fluidal migmatitic gneiss
L - layered migmatitic gneiss (either regular or irregular layering)
V - veined migmatitic gneiss
N - nebulitic migmatitic gneiss
A - agmatite or stockwork migmatite
S - screen or schlieren migmatitic gneiss

(49, 50) Structure:

M - massive
F - foliated

Inclusions (blocks 51 to 57):

Host (51, 52) and inclusionary (53, 54) components given by rock-code designation (Appendix C).

(55) Shape: code as follows:

A - mainly angular
R - mainly rounded
approximately equidimensional

E - mainly angular
L - mainly rounded
elongate

Q - mainly equidimensional
G - mainly elongate or lenticular

(56) Type of inclusion, code as follows:

B - bedded	P - porphyritic (or porphyroblastic)
F - foliated	M - massive
N - nebulous	R - rodded

VEIN, PEGMATITE, DYKE, SILL (ROW (12))

Type (58, 59) given by rock-code designation.

(Appendix C)

Attitude (60 to 64) code same as for foliation.

ECONOMIC OCCURRENCE CODE (ROW (12))

Economic element, or grouping of elements, or mineralization; code as follows with additions as requirements arise:

F - iron	L - coal
M - molybdenum	Z - copper
P - copper-lead	S - sulphides
C - copper	

NUMBER OF SPECIMENS (ROW (12))

Insert (66) number of rock specimens collected; alphabetic code with equivalent digits as follows: A = 1, B = 2, C = 3, ... etc.

GLACIAL (ROW (13))

Insert Y if striae observed and measured (67); insert N if not observed.

Type of glacial deposit (68) code as follows:

Ø - outwash	F - fossils
E - esker	B - marine beach
G - ground moraine	L - lake beach
M - lateral, medial, or terminal moraine	T - terrace
D - interstadial	S - felsenmeer

ADDITIONAL MATERIAL (ROW (13))

Insert (69) appropriate alphabetic code, add as required:

T - thin section
R - radiometric date
C - chemical analysis
M - micrometric analysis
S - stained slab

PHOTOGRAPHY (ROW (13))

Insert (71) type of photography taken at outcrop; code as follows:

Y - more than one type
B - black and white
C - colour
P - polaroid

PROJECT (ROW (13))

For gang-punching of data file, identifying year or phase (e.g. 1, 2, 3, etc.) of project.

<u>APPENDIX B</u>

MINERAL CODES

(Card 1, blocks: 32 to 42; 51 to 61; 70 to 80)

AC - actinolite
AB - albite
AF - alkali feldspar
AM - amphibole
AD - andalusite
AN - anorthite
AL - anthophyllite
AP - apatite
AS - arsenopyrite
AZ - azurite

BR - barite
BL - beryl
BT - biotite
BØ - bornite
BZ - bronzite
BC - brucite

CC - calcite
CP - chalcopyrite
CB - carbonate
CS - cassiterite
CL - chlorite
CT - chloritoid
CN - cinnabar
CM - clay minerals
CO - cobaltite
CD - cordierite
CR - corundum
CG - cummingtonite

DP - diopside
DM - dolomite

EP - epidote
ES - enstatite
ER - erythrite

FA - fayalite
FP - feldspar
FL - fluorite
FR - forsterite

GL - galena
GT - garnet
GS - glass
GØ - goethite
GP - graphite
GR - grunerite
GY - gypsum

HM - hematite
HB - hornblende
HP - hypersthene

IL - ilmenite

KL - kaolinite
KY - kyanite

LM - limonite
LP - lepidolite

MG - magnesite
MT - magnetite
MA - malachite
MC - microcline
MZ - monzonite
MV - muscovite
MK - myrmekite

NE - nepheline

ØL - olivine
ØQ - opaque
ØR - orthoclase

PD - pentlandite
PE - perthite
PH - phlogopite
PG - plagioclase
PF - potash feldspar
PR - prehnite
PL - pumpellyite
PR - pyrite
PX - pyroxene
PØ - pyrrhotite

QZ - quartz

RL - rutile

SC - scapolite
SE - sericite
SR - serpentine
SD - siderite
SL - sillimanite
SP - sphalerite
SN - sphene
SD - spodumene
ST - staurolite
SM - stilpnomelane
SU - sulphide

TC - talc
TD - tetrahedrite
TM - tourmaline
TR - tremolite

VV - vesuvianite

WL - wollastonite

ZE - zeolite
ZR - zircon
ZØ - zoisite

APPENDIX C

ROCK CODES

AM - adamellite
AG - agglomerate
AB - amphibolite
AD - andesite
AR - anorthosite
AP - aplite
AL - argillite
AK - arkose

BL - basalt
BT - biotite
BS - biotite schist

CS - calcsilicate
CB - carbonatite
CK - charnockite
CH - chert
CR - chlorite schist
CL - clay
CØ - coal
CG - conglomerate (>2 mm)

DC - dacite
DB - diabase
DR - diorite
DM - dolomite
DS - dolomitic sandstone
DN - dunite

EC - eclogite
EV - evaporite

FG - feldspathic granulite
FL - felsite
FM - fluidal migmatite

GB - gabbro
GN - gneiss, granitic
GM - gneiss, mafic
GU - gneiss, undivided
GØ - gossan
GG - granite
GR - granitic rock, massive
GD - granodiorite
GP - granophyre
GL - granulite
GS - greenschist
GE - greenstone
GC - graphic schist
GK - greywacke

HG - hornblende gneiss
HB - hornblendite
HF - hornfels

IF - iron-formation

LP - lamprophyre
LT - latite
LM - layered migmatite
LS - limestone

MB - marble
MA - meta-arkose
MP - meta-pelite
MS - metasediment
MG - migmatite
MD - mudstone
MC - muscovite schist
ML - mylonite
MW - metagreywacke

NB - nebulite
NG - gneissic granite
NM - nebulitic migmatite
NR - norite

ØG - orthogneiss
ØQ - orthoquartzite

PG - paragneiss
PM - pegmatite
PE - pelite
PD - peridotite
PH - phonolite
PT - phyllite
PL - pillow lava
PP - porphyry
PN - pyroxene gneiss
PX - pyroxenite

QZ - quartzite
QD - quartz diorite
QL - quartz latite
QM - quartz monzonite
QF - quartzofeldspathic gneiss

RL - rhyolite

SS - sandstone
SD - sandy dolomite
SC - schist
SM - schlieren migmatite
SP - semi-pelite
SE - serpentinite
SH - shale
SN - siltstone
SK - skarn
SL - slate

ST - spilite
SW - stockwork migmatite
SY - syenite
SD - syenodiorite

TL - tonalite
TC - trachyte
TF - tuff

UB - ultrabasic

VM - veined migmatite
VB - volcanic breccia