

the future!

"Pine Point is assured of a place in the history of northern development but the future will probably bring much bigger developments in other parts of the North . . .

"We at Northern Affairs have been in a position to become very familiar with the tremendous effort, ingenuity and application of skill that private industry is putting behind its many exploratory ventures . . .

"The success of new projects and the continuing success of existing ones will, to a large extent, depend on whether or not there is an open road to the markets of the world...

"It will be to everyone's benefit if we continue searching for more open roads thereby securing markets for our products now and in the future."

Devon Island Programs, 1966

INTRODUCTION

Five field parties availed themselves of the facilities at the Arctic Institute's Base Camp on Devon Island during the 1966 field season (see Fig. 1). Each party consisted of two men (or in the case of the glaciology party, one man and one woman). The general areas of study were glaciology, botany, ornithology, periglacial geomorphology, and glacio-isostatic geomorphology. A base-camp staff of three, including two Boy Scouts, provided a valuable service in maintaining the Base Camp, and in assisting the various field parties as required.

The first party flew to Devon Island from Resolute Bay on 11 June, and the remainder followed on 16 and 29 June. Some of the party left Devon Island by air on 13 August, while the remainder were evacuated by the icebreaker *John A. Macdonald* on 29 August.

Transport to and from Devon Island was greatly simplified through the kind assistance of Dr. F. Roots of the Polar Continental Shelf Project; whenever weather and the needs of his own project permitted, he made every effort to assist in the movement of equipment and personnel to and from Devon Island. The loan of a 'Polaris' motor-toboggan was also a very valuable contribution, particularly appreciated by the glaciology party.

GLACIOLOGY

Glaciological work in the summer of 1966 was carried out by R. M. and A. E. Koerner who were flown to Devon Island by Polar Continental Shelf Otter on 29 June. Mass balance measurements were made in early July and mid-August on the northwest side of the ice cap.

The melt season proved to be late compared to the previous 5 years and melting continued over the entire ice cap until 16 August. Whereas in 1963, 1964, and 1965 only the valley glaciers lay below the equilibrium line, in 1966 the equilibrium line was at an elevation of 1,250 m. above sea-level. This elevation is 300 m. higher than the edge of the ice cap and the upper reaches of the valley glaciers. On the northwest side of the ice cap the firn edge lay below the equilibrium line in 1966 owing to considerable runoff from more than a metre of firn which had accumulated in 1964, 1965, and 1966 below the normal elevation of firn formation.

Dye and percolation trays were used to measure accumulation above the firn line. Without the use of these devices mass change measurements would have been grossly inaccurate due to percolation deep into the previous years' accumulation. Growth of superimposed ice, determined by measuring the thickness of ice coloured by dye, reached a thickness of 40 cm. Dye was nowhere exposed at the surface so did not itself affect the melting process. Summer accumulation, much of it in the form of rain, formed c. 50 per cent of the budget year accumulation above the firn edge (c. 20 cm. water equivalent). Below the firn edge this rain promoted ablation by saturating the firn/snow mass and promoting runoff and slush movement. During late July and the first half of August there was a marked contrast in weather conditions above and below 1,000 m. above sea-level on the northwest side of the ice cap. Between sea level and 1,000 m. above sea-level overcast conditions and rainfall were common whereas above 1,000 m., i.e. on the ice cap, the sky was usually cloudless.

The final gross and net mass change/altitude relationships were similar to those which obtained in 1961 although the melt season sequence in each year was quite dissimilar.

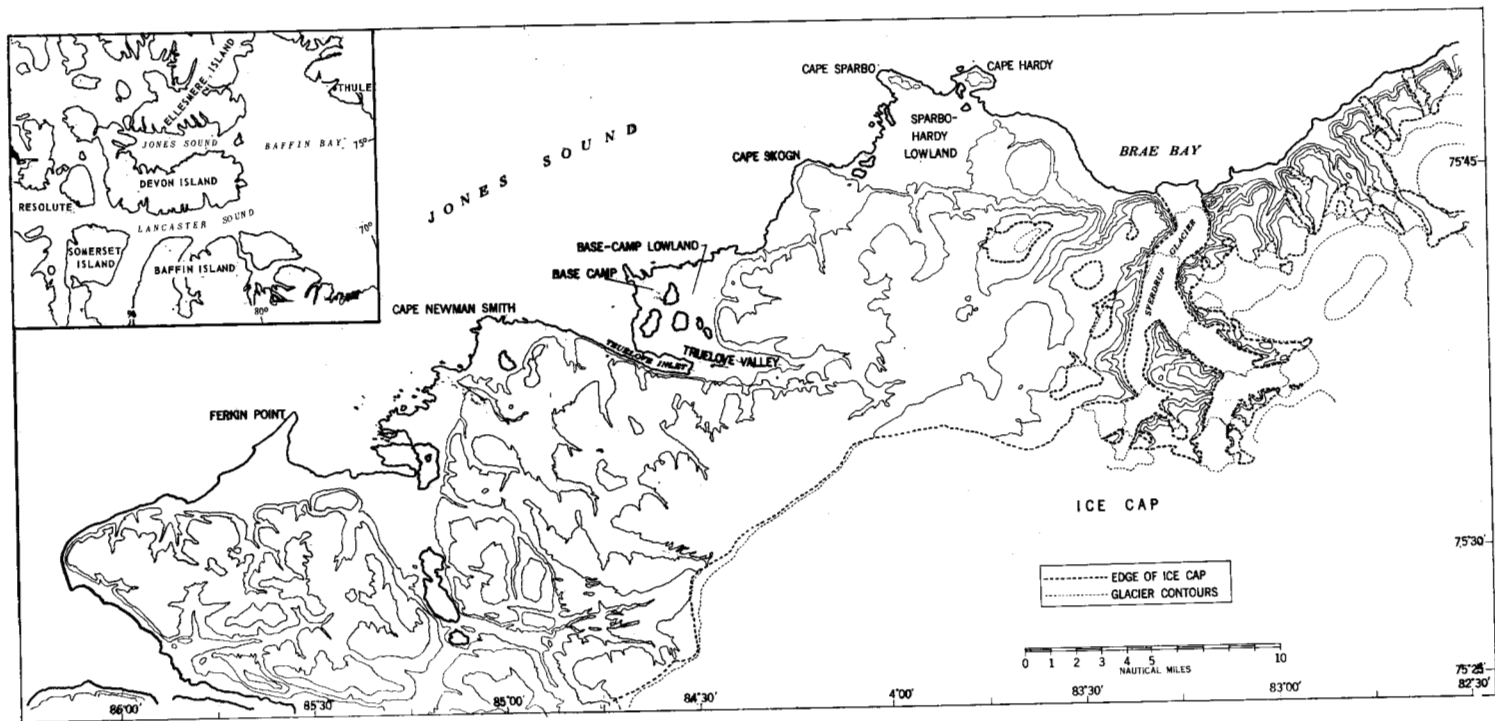


FIG. 1. Location of field studies, Devon Island 1966 (Contour interval 500 feet)

The 1966 melt season was late (maximum ablation mid-August) whereas in 1961 it was early (maximum ablation mid-July). Further measurements are necessary to determine more closely the climate/mass balance relationship. Meteorological observations have been recorded during each summer since 1961 with the exception of 1964. As it appears likely that in the future, mass balance of the ice cap may be measured only on short expeditions each spring, it will be necessary to provide instrumentation capable of recording temperature, wind, and sunshine duration in June, July, and August.

During July daily measurements of ablation (at an ablatometer), runoff (depths of 3 melt streams on the glacier), and glacier movement (resections at one point) were made at 300 m. above sea level on Sverdrup Glacier. These measurements supplement those taken by P. Cress in 1963 which indicated irregular movement of this cold glacier (Cress, personal communication). Stake positions at 300 m. above sea level were resected, and the glacier levelled back to the original (1961) stake positions. These measurements will indicate any change in elevation of the glacier surface.

GLACIO-ISOSTATIC GEOMORPHOLOGY

In continuation of the program of the 1965 field season, William Barr and Hugh G. Lloyd again concerned themselves with the postglacial raised marine features of the coastal lowlands. Field work was extended some 25 miles to the west of the area previously examined around Base Camp, and areas already studied, for example Truelove Valley and the Sparbo-Hardy Lowland, were scrutinized more closely.

Field work began on 27 June, by which time snow-melt was sufficiently advanced in the coastal lowlands to permit useful field work. Transport to outlying parts such as Ferkin Point was by *Beaver*, and after break-up, which occurred at the end of July, by canoe. On one trip to Cape Sparbo, transport was by boat through the courtesy of Corporal L.B. Schollar of the R.C.M.P. detachment at Grise Fiord who visited the Base Camp in mid-August. On several occasions during the field season, rivers draining the ice cap and swollen by snow-melt on the plateau and on the ice cap presented serious

barriers to movement on foot in the coastal lowlands, and resulted in numerous delays, detours, and minor crises.

As in the previous season, extensive leveling traverses were carried out. The reference datum employed was mean sea level. On the basis of several measurements made after break-up, mean tidal range was established at 2.1 m.

The height of the upper marine limit, as indicated by the lowest level of undisturbed ground moraine, or the lowest level of perched blocks, was established at eight different localities; it was found to vary between 69.4 and 71.3 m. in the Ferkin Point area, and to lie at 64.7 m. at the mouth of the Gill River, at 73.5 m. in the Base-Camp Lowland, and at 73.0 m. in the Sparbo-Hardy Lowland. These figures compare favourably with those obtained from completely independent traverses made during the previous field season: 65.9 m. in the Base-Camp Lowland, and 74.1 m. in the Sparbo-Hardy Lowland.

Samples of marine shells were collected from heights ranging from sea level to 56.5 m. The commonest species, as in the previous season, were *Mya truncata* (Linne), *Hiatella arctica* (Linne) and *Astarte borealis* (Schumacher). By radiocarbon dating of these shells it is hoped to be able to amplify, corroborate, or modify our present knowledge of the history of glacio-isostatic uplift in this area.

At a river mouth some 4 miles south of Cape Newman Smith, one natural exposure of considerable interest was discovered. Here the river had cut through unconsolidated till and raised-beach material to produce steep bluffs, some 12 m. high. In the upper part of the exposure, embedded in fine sand and silt were innumerable marine shells. In many cases, both valves were still intact, and often still united, and in some examples the periostracum was still evident. All this evidence would indicate that these shells were still *in situ*, at the precise spot where they had lived and died. Although there is no way of relating these shells to any specific sea-level elevation, this exposure is significant in that it is the first occasion in which the shells collected have been quite indisputably *in situ*.

Samples of whalebone and driftwood were also collected from various elevations to be used to cross-check the radiocarbon dates obtained from the shells. The whalebone con-

sists usually of the skulls, vertebrae and ribs, presumably of the Greenland or right whale (*Balaena mysticetus* L.).

One of the principal objects of the visit to Cape Sparbo was to locate and examine the site where Frederick Cook spent the winter of 1909-10, on the return journey from his Polar attempt. A chance remark of Cook's, about the partial submergence of ancient Eskimo dwellings being indicative of recent subsidence of the land in this area, has given rise to considerable speculation on this subject in literature. The site in question lies at the extreme eastern tip of Cape Hardy, and not on Cape Sparbo as described by Cook. The structures concerned lie above the present high-water mark, and are well vegetated, indicating that they are never washed by the sea, even at high spring tides. The writer can only refute, and is unable to explain, the remarks made by Cook on this subject. However, the relatively small elevations of these structures above high-water mark (less than 1 m.) indicates that isostatic uplift has now almost ceased, and that equilibrium between uplift and eustatic sea-level rise may have been reached.

PERIGLACIAL GEOMORPHOLOGY

During the summer of 1966 a field research program was initiated by R. H. King assisted by H. Costello to study the geomorphological processes and resultant landscape features to be found in an active periglacial environment such as that of Devon Island.

The research program concentrated on three main aspects: the nature and relative significance of the geomorphological processes at present active within the area; the nature and distribution of such periglacial phenomena as were observed; pedogenesis and the resultant soils.

The field work was largely undertaken within the coastal lowlands adjacent to the Institute's Base Camp but further studies were made of Truelove Valley and the surface of the interior plateau, whilst a detailed study was made of the surfaces of the escarpments separating the coastal lowlands from the interior plateau.

An initial reconnaissance survey of the area began on 20 June, and this was followed by more detailed studies of weathering pro-

cesses, the movement of rock waste, the nature and distribution of patterned ground, slope morphology and development, and soil formation. The reconnaissance survey revealed a distinct dichotomy in terms of process and periglacial phenomena between the coastal lowlands and the surface of the interior plateau. The coastal lowlands are dominated by the presence of active ice-wedge polygons and nonsorted circles, nets and stripes whilst the almost complete lack of vegetation on the interior plateau has resulted in the dominance of frost sorting and solifluction together with the occurrence of sorted circles, nets, polygons and stripes.

The widespread and relatively thick mantle of frost-shattered debris within the study area clearly indicates the effectiveness of frost-shattering as a geomorphological process, although it is considerably less so than in the past. Frost-shattering appears to be aided by the presence of a continuous permafrost table at depth, which maintains the surface of the ground in a semi-saturated state, and thus provides abundant moisture for the development of ice structures. However, although greatly subdued by the low ground and air temperatures, chemical solution of the calcareous rocks is widespread. Numerous examples of deeply pitted limestone fragments occur on the surfaces of the raised beaches and on the interior plateau. Carbonate solution and subsequent precipitation is also revealed by the presence of a crust — often several millimetres thick — on the undersides of surface stones.

Frost-heaving is general within the area and is obviously aided by the silt-sized material in the surface deposits — a product of mechanical weathering, aeolian deposition, or perhaps a combination of both. Clay-sized material, on the other hand, is extremely rare indicating the relative insignificance of chemical weathering as a process apart from carbonate solution.

Mass movement appears to be widespread on the interior plateau but the presence of a general vegetative cover tends to reduce its effectiveness in the coastal lowland zone. Here solifluction is infrequent but results in well-developed solifluction lobes in contrast to the plateau surface where terrace forms are more dominant. Often the development of such terraces has the effect of converting the generally convex slopes into stepped but

overall rectilinear slopes.

The detailed surveys that followed the initial reconnaissance were aimed at determining the exact nature and mode of occurrence of patterned ground together with the nature and rate of development of the soils. A series of profile measurements were made of the succession of talus cones and talus slopes both on the sedimentary and on the crystalline rock escarpments. Fabric analyses of the slope detritus revealed the overall instability of the slopes. Recordings were also made of the size, angularity, and lithology of the slope detritus. The angle of repose of the material on the linear portions of the slopes were found to vary according to rock lithology and slope aspect, being 25° for the west-facing slopes of the sedimentary rock escarpment and 35° for the north-facing slopes of the crystalline rock escarpment.

In an attempt to determine the rate of slope development within the study area lines of stakes of differing lengths were inserted in solifluction lobes and lines of painted stones were placed on the talus slopes and talus cones. In all cases the positions of the lines were accurately fixed in relation to a rock outcrop. Measurements made in the future should provide an accurate measure of the rates of both solifluction and unsaturated creep.

The pedological studies consisted of a general reconnaissance soil survey to identify and map the distributions of the major soil types within the area and this was, in turn, followed by a detailed soil study of arctic brown soil profiles along a sequence of raised beaches extending from the most recent beach to the postglacial marine limit. This was to assess the rate of soil evolution since the onset of isostatic recovery subsequent to the deglaciation of the area. Soil samples were obtained from all the major inspection pits and reserved for the laboratory analyses which are at present under way.

BOTANY

Field work was carried out from 30 June to 14 August inclusive using the Devon Island Research Station southwest of Cape Sparbo as the field base camp. During that time field activities were confined largely to the lowland area lying between Truelove

Inlet and the western edge of Brae Bay east of Cape Hardy (a lowland area 35 miles long).

Major emphasis in the 1966 program was on the collection of botanical specimens including vascular plants, bryophytes and lichens, an evaluation of the diversity of communities and their possible environmental relationships, and an evaluation of the Devon Island Research Station facilities for further detailed plant ecological studies.

A collection of approximately 1,500 numbers was made in the localized area described above. Identification of the material has been initiated and experts on difficult groups such as the *Salix*, *Carex*, *Cruciferae*, bryophytes and lichens will be consulted. In addition, some material was collected at the request of cytotoxic specialists. Specimens will be forwarded to the National Museum herbarium in Ottawa and the University of British Columbia herbarium for deposit.

ORNITHOLOGY

The work was carried out by D. J. T. Hussell from 11 June to 14 August, assisted by R. W. Stamp from 29 June to 13 August.

The primary object of the work was to investigate the breeding of the Lapland Longspur (*Calcarius lapponicus*) at a locality near the northern limit of its range, for comparison with previous work at lower latitudes. Twenty-three longspur nests were found and routine observations were made on all nests to determine laying and hatching dates, incubation periods, clutch size, hatching and fledging success. Automatic incubation recorders were used in six nests, primarily to investigate the timing of the start of incubation. Growth rates of young were measured in six nests, but, as a result of the high rate of predation (see below), information from only three of these nests was reasonably complete. However, by trapping young after they left the nest it was possible to follow the development of some of them to ages of up to 36 days. Activity of adults feeding nestlings was recorded automatically at five nests for varying periods of time. Fifteen samples of food, which had been fed to nestlings at four nests, were collected.

Predation was extremely heavy: only three of the twenty-three nesting pairs of longspurs succeeded in rearing young to the

flying stage. Predation was also heavy on other nesting birds, particularly Snow Buntings (*Plectrophenax nivalis*), Oldsquaws (*Clangula hyemalis*), and Eiders (*Somateria* spp.). There was evidence that Long-tailed and Parasitic Jaegers (*Stercorarius longicaudus* and *S. parasiticus*), and Arctic Foxes (*Alopex lagopus*) were the principal predators. Long-tailed Jaegers were very abundant (groups of 20-30 were seen frequently) but were not breeding, possibly because of the scarcity of lemmings (*Dicrostonyx torquatus*). No lemmings were seen in 1966, but the abundance of burrows, nests, and droppings indicated that there had been a high population, perhaps as recently as 1965.

In addition to the detailed work on Lapland Longspurs, similar information was obtained on some aspects of the breeding of Snow Buntings. Also, a general survey of the birds of the Base Camp Lowland was made; the Cape Sparbo region and the area between Truelove Valley and the icecap were briefly investigated in early August. Twenty-three species of birds were recorded, of which thirteen were proved to be breeding. Nineteen specimens of twelve species of birds were collected for the Museum of Zoology, University of Michigan.

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Icefield Ranges Research Project, St. Elias Mountains, Yukon, 1966.

INTRODUCTION

The Icefield Ranges Research Project (IRRP) continued in 1966 to expand its areas of research (see Fig. 1). Though work began 1 June and continued until the first week in September, the major portion of the summer investigations was carried out between 20 June and 20 August.

Interdisciplinary by nature IRRP is a combination of investigations in many research fields. In the broad categories of

geography, geology, and biology, there were in 1966 twenty studies conducted by more than forty persons, including support personnel. Twelve graduate and two undergraduate college students represented eight colleges and universities in Canada and the United States. Three Canadian scouts, with a number of young students and technical personnel, also assisted in various programs.

The Arctic Institute was again awarded by the National Science Foundation a Research Participation for College Teachers (RPCT) grant to allow six teachers to take part in the IRRP research program. Three teachers who were awarded 1965-66 Academic Year Extension grants by the Division of Undergraduate Education in Science of the National Science Foundation returned as participants in the 1966 RPCT program. Participants were equally divided between the earth and biological sciences. IRRP also gave support in part to four independent short-term studies in geology and biology, as well as to a special reconnaissance of mountaineering objectives for the Yukon Territory's Canadian Centennial project in 1967.

A STUDY OF THE KASKAWULSH GLACIER MEDIAL MORaine

A reconnaissance study of the medial moraine formed at the confluence of the north and middle arms of the Kaskawulsh Glacier was started for the purpose of collecting data for both a qualitative and quantitative investigation in an attempt to explain the distinctive morphology. Several profiles were run, one down the moraine from the base of the nunatak to a point 1,700 metres distant, and seven cross-profiles. Four triangulation stations provided control. Vertical aerial photographs were taken for mapping purposes. Thirty-one ablation stakes were set at 15-metre intervals across the moraine, and local change in moraine morphology was noted. Rock samples were collected at each stake site for later analysis. Transverse crevasses across the moraine, longitudinal lineation of different rock types, and longitudinal shear zones in the moraine were noted and vegetation samples were collected for identification and analysis.