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THE ICEFIELD RANGES RESEARCH PROJECT, 1963

The Icefield Ranges Research Project (IRRP), co-sponsored by the American Geographical Society and the Arctic Institute of North America, completed its third successful field season in early September 1963. The base camp at the south end of Kluane Lake, Yukon Territory, Canada was opened on June 4 and closed on August 27.

The field party consisted of Dr. W. A. Wood, as project leader and R. H. Ragle, who as field leader was assisted by four other staff members of the Institute. One of the objectives of the project is to provide graduate students working on a dissertation for a Master's or Ph.D. degree with opportunities for research and field work. Thus there were five candidates for graduate degrees among the ten scientists from various institutions and universities in the United States and Canada who carried out field work in glaciology, meteorology, climatology, geophysics, and glacial geology. One other graduate, who had received an M.S. on work in glaciology while with the IRRP in 1962, returned for further research in 1963. Support was provided by eight assistants, mostly students from U.S. and Canadian universities. The four camps that served as bases for operations were: (a) Base Camp at Kluane Lake, altitude 870 m.; (b) Kaskawulsh Camp at the glacier terminus, 920 m.; (c) Glacier Divide Camp, 2641 m.; (d) Glacier Camp, at the centre of the glacier, 2588 m. Despite the changeable weather experienced during the season the work that had been planned in the various disciplines was accomplished.

The following investigations were carried out in 1963.

Glacial geology

1. *Glacial geology of the northwest Shakwak Valley,* George Denton (Yale University). The field area is providing extensive information about the history of the large intermontane icefield located in the Icefield Ranges and also

about the small valley glaciers located in the Kluane Ranges. The results of the study will be a history of the Pleistocene of this area, based in part on radiocarbon dates. It will be used for comparison with the late-Pleistocene history of other areas in Alaska, Canada, and the western United States.

2. *Post-Pleistocene glacial history,* Dr. Harold W. Borns, Jr. (University of Maine). To investigate the post-Pleistocene glacial history of the area of the terminus of the Kaskawulsh Glacier and the Slims River valley.

3. *Processes in the ice at the present terminus of the Kaskawulsh Glacier,* Dr. Harold W. Borns, Jr. (University of Maine), Dr. Richard P. Goldthwait (Ohio State University).

Glacial Meteorology

Weather observations, James Havens (University of London); David E. Saarela (Massachusetts Institute of Technology).

1. Bi-hourly observations of temperature, wind speed and direction, air pressure, visibility, and cloud cover were made at the Glacier Divide Camp. At the main synoptic hours wet and dry bulb observations were made and snow surface conditions noted. In addition autographic records were obtained of the duration of bright sunlight and insolation.

2. Meteorological screens for synoptic observations were located at Base Camp, Glacier Camp, and Kaskawulsh Camp. Twice daily observations from the Glacier Divide Camp and Base Camp were coded and transmitted to the Meteorological Office in Whitehorse, Y.T., Canada.

Glaciology

1. *Diagenesis of the 1962-3 snow cover and the distribution of snow facies,* Philip Wagner (University of Michigan). Alteration of the snow-pack was followed daily by a pit study to measure temperatures, density, stratigraphy, and hardness. Particular attention was paid to the development of ice glands, lenses, and layers and to the surface expressions of subsurface irregularities. The study of facies encompassed the period of minimum stability. Thirty-four pits ranging in depth from 100 to 520 cm. were excavated.

A reconnaissance traverse was made from the firn line to the terminus of the Kaskawulsh Glacier. Notes on features observed included variations in ice surface topography, nature of numerous ice bands, bedrock, moraine lithologies, and geomorphic features on the valley walls.

2. *Flow on a snow divide and physical surface waves,* Richard H. Ragle (Arctic Institute of North America). A study of the velocity of flow on the glacier surface of a snow divide, of accumulation-ablation, bedrock topography, and surface velocity along a 25-km. line was started in 1961 and continued and expanded in 1962 and 1963. Over 100 metal poles have been placed in the snow along the flow line. In addition there are large and small diamonds at intervals and lines of poles across the flow line. The positions of all poles were fixed by triangulation each summer.

Measurements of velocities at depth by drilling and instrumenting the holes and more extensive mapping of bedrock, particularly in the proximity of the snow divide, by seismic and gravity instruments is planned. A reconnaissance altimetry study was initiated in 1963 in an attempt to follow the movement of physical surface perturbations that are detected on the highland glacier. Changes in the surface relief from one field season to the next are thought to occur. This led to the speculation that they may be manifestations of bed relief or be caused by drifting or other accumulation phenomena.

3. *Studies in the natural abundance of* $^{18}O/^{16}O$ *in glacier ice,* Donald Macpherson (University of Alberta). Over 50 snow and ice samples were collected for oxygen isotope studies. The analyses will be directed toward temperature investigations and correlation with meteorological data from nearby stations,

detection of a climatic divide between the marine and continental environments, consideration of melting action and subsequent homogenization by downward percolation of water, studies below the firn line using the values of $^{18}O/^{16}O$ as natural tracers of glacier flow, correlation of oxygen isotope variations with the glaciology and glacial geology of the area.

Geophysics

1. *Geophysical studies of the Kaskawulsh Glacier, 1963*, Garry Clarke (University of Toronto). In 1962 the seismic work under the leadership of Alex Becker (McGill University) was devoted mainly to reconnaissance and the development of techniques. In 1963 the party led by Garry Clarke endeavoured (a) to obtain a more complete picture of the bedrock profile; (b) to obtain cross profiles for estimation of the volume of flow; (c) to investigate the nature of a "rock divide" suggested by the reconnaissance in 1962; (d) to obtain a refraction profile on the Hubbard Glacier to compare the velocity distribution and firn thickness with that on the Kaskawulsh Glacier; (e) to initiate a study of the main tributaries of the highland glacier, and (f) to measure gravity at all reflection stations and at as many of the survey cairns as feasible. Over 100 seismic reflection stations were occupied. These included all except three of the flagged poles on the main 25-km. traverse as well as four cross profiles on two tributary glaciers. Gravity was measured at 110 localities.

Survey

1. *Measurement of movement and seismic poles,* Dan Sharni (Ohio State University). To determine the co-ordinates and altitudes of about 60 metal poles placed in 1962 for the purpose of measuring the flow rate of the glacier at various points and to measure 10 "diamonds" for strain rates. In addition temporary poles were fixed for seismic purposes. In all the position and altitudes of about 140 points were determined.

The rectangular co-ordinates of all poles were determined by standard methods. The results were very satisfactory, the horizontal accuracy being of the order of ± 30 cm. Preliminary results show movements at the east and west ends of the main line of poles to be about 143 and 115 m. for the last budget year.

Visitors to IRRP during the summer field season interested in the program and in specific objectives were, from Canada, G. R. Cameron, Commissioner of the Yukon Territory, Whitehorse; H. Wahl, Chief Forecaster, Whitehorse; Dr. R. Cook, McMaster University, M. E. Alford, Officer in Charge, Water Resources, Whitehorse; Dr L. Green and C. Godwin, Geological Survey of Canada, Whitehorse; from the United States, Prof. A. L. Washburn, Yale University; Prof. R. W. Decker, Dartmouth College; Prof. T. L. Péwé, University of Alaska; Dr. Carl S. Benson, University of Alaska.

RICHARD H. RAGLE

Meeting of icebreaker teams

The British Admiralty is considering the construction of an icebreaker to support British antarctic operations and has sent a group of construction and design experts to Canada and the United States for an exchange of ideas on this subject. Some of the earliest Russian icebreakers were built in Great Britain but the British have had no recent experience with this type of vessel. The group consists of Mr. T. R. Rumens, Constructor in charge of the design, Cdr. J. L. Breaks, Marine Engineer, Cdr. J. D. Winstanley, Representative of the Hydrographer, and Mr. G. Brombley, Electrical Engineer.

On November 4, 1963, accompanied by Capt. R. H. Graham, R.N. of the British Navy Staff, former Commanding Officer of H.M.S. *Protector,* the vessel that operates out of Port Stanley in support of the Falkland Island Dependencies