No. _____

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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
TOPICAL REPORT NO. 47

POLAR CONTINENTAL SHELF PROJECT, WESTERN QUEEN ELIZABETH ISLANDS, DISTRICT OF FRANKLIN, 1961

PROGRESS REPORT OF THE SUBMARINE GEOLOGY UNIT

BY

B. R. PELLETIER

OTTAWA
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Contents

Illustrations

Map of Arctic Islands. Traverses of 1960–61 shown in solid lines; traverses of 1962 shown in dashed lines. Shaded areas indicate inshore traverses

Progress Report of the Submarine Geology Unit, Polar Continental Shelf Project, District of Franklin.

Introduction

The purpose of this report is to summarize the activities of that part of the submarine geology unit of the Geological Survey of Canada which is participating in the Polar Continental Shelf Project (Frontispiece). Programs and results of the past two field seasons are reviewed and references are made to earlier reports and to projected publications of the near future. Future programs for field work and laboratory studies are presented with conclusions regarding these researches and the applications attempted.

The Geological Survey is responsible for geological phases of the Polar Continental Shelf program. These investigations are planned in consultation with the co-ordinator of the PCSP, given logistic support in the field by the PCSP, and carried out, supervised, and prepared for publication by officers of the Geological Survey. Survey officers have assumed the following responsibilities: offshore sampling and laboratory scheduling - B.R. Pelletier; inshore and inter-island sampling - D.R. Horn; faunal description - F.J.E. Wagner; chemical analysis - E.M. Cameron (spectrochemical laboratory); mechanical analysis of sediments - E.F. Field and R.G. Kelly (sedimentology laboratory); X-ray analysis for clay minerals A.P. Sabina and R.J. Traill (X-ray diffraction laboratory); acidity and oxidation determinations - G. Bender and J.A. Maxwell (wet chemical laboratory); analysis of common metallic elements - W.H. Champ and W.F. White (spectrographic laboratory).

Previous and Current Field Programs

During the winter of 1960-61 samples obtained the previous year from the floor of the Arctic Ocean and adjacent channels were analyzed in the laboratories of the Geological Survey. Laboratory schedules were organized in order to maintain a continuous flow of samples so that data could be interpreted without long delay (Flow sheet). At the same time, plans were made for another field season to commence in March, 1961, and extend to the following August. These and earlier projects are summarized as follows:

1. Arctic Ocean study undertaken in April and May. This project is a continuation of the offshore sampling program, over the western Arctic Ocean and adjacent channels, which began in April, 1960. In 1961 the area of study extended across the continental shelf northwest of Meighen Island. A study of bottom topography, sediments and fauna were the chief interests of the project with a view to interpreting the physiographic history of the Arctic Islands, channels and shelf, as well as establishing conditions for sedimentation and bathymetry. From a limited sampling and sounding program carried out by B.R. Pelletier in 1961 over the offshore area, and a somewhat larger one carried out at the same time by A.E. Collin over M'Clure Strait and Eureka Sound it appears that glaciation of the interisland areas took place when the land was at a higher elevation relative to sea level, and that this event was followed by submergence. This is consistent with the results of the field work of 1960.

2. Perry Channel study which took place from March to August 1961. This project consisted of a study of sediments and bottom topography in inshore and channel waters adjacent to eastern Ellef Ringnes Island, northern Amund Ringnes Island, south-western Axel Heiberg Island, and the southern parts of Meighen Island. Geological formations underlying the main drainage areas, as well as the drainage areas themselves, were sampled in order to study source material and its alteration during sedimentary transport. Sediments and conditions at the site of deposition were investigated for the purpose of making environmental studies. Soundings were taken to establish further the topography, and the physiographic history of Arctic islands and channels. This project was carried out by D.R. Horn who is currently preparing a preliminary report on his results which will be completed early in 1962.

3. Foxe Basin, Foxe Channel, and Hudson Strait. This was an oceanographic program carried out in 1959 by A.E. Collin of the Atlantic Oceanographic Group of Fisheries Research Board. It was undertaken for the Polar Continental Shelf Project and was supported by the Atlantic Oceanographic Group and the Ontario Department of Lands and Forests. At present the bottom samples are being prepared for faunal and sedimentary analyses which will be undertaken jointly by F.J.E. Wagner and B.R. Pelletier. This project should be completed in mid-1962.

Future Field Programs

Field programs for 1962 will include a continuation of work done in previous years, but the surveys will move to the south. The inshore and channel program under D.R. Horn will operate from Isachsen with the main activity concentrated over the eastern part of the Prince Gustaf Adolf Sea. The remaining part of this channel will be investigated in the latter part of the season, or the following year. As in previous years attempts will be made to recover both bottom sediments and short cores. The samples will be sent to the Geological Survey, Ottawa, for analytical work.

The offshore program will be undertaken by B.R. Pelletier and will take place over the continental shelf of the western Arctic Ocean northwest of Ellef Ringnes and Borden Islands. It will be reconnaissance in scope and will consist of a sampling program based on a 10- to 15-mile grid extending perpendicular to the general northeasterly trending coast of the Arctic Ocean. Earlier investigations have shown that uniform conditions of sedimentation and biologic activity prevail over broad areas so that, with the exceptions of local areas of restricted circulation and narrow areas of inshore waters, there is little need for a greater density of sampling stations. Both short cores and bottom grabs will be attempted in order to initiate a broad mapping and stratigraphic program.

Continuing Laboratory Studies and Results

Faunal studies undertaken by F.J.E. Wagner will continue on sediments obtained from wide regions of the Arctic Ocean, island channels

and various near-shore waters. The collections are representative of all depths at 10- to 50- metre intervals down to 1,300 metres. It is significant that a bathymetric change can be indicated by the fauna providing the change is of the order of several hundred metres. At present the relationship of distance from shore and change of faunal content is not significant, nor is the change of water depth of 300 metres or so. However these results are based solely on a reconnaissance sampling program and possibly more detailed collecting would change the overall view. An intensive study of forms occurring on the modern sedimentary surface will be used to establish a framework of biostratigraphy in the Arctic environment involving the examination of the cores from different areas of the Arctic.

Deltaic samples from an inshore region described as a protected bay, in the vicinity of Isachsen, have been submitted for complete chemical analyses. Preliminary results from the emission spectrograph indicate very little chemical activity in the Arctic sediments, but only a semi-quantitative statement could be prepared because of the range of the instrument. At present new spectrochemical apparatus is being installed in the Geological Survey which will process up to 50 samples a day when working under a regular schedule. This work will be supervised by E.M. Cameron, and the data will assist in determining the role of chemical weathering and diagenesis in an Arctic environment. This study may also lead into considerations of past climatic regimes of ocean and land as certain minerals such as the deposition of $CaCO_3$ are related to temperature belts.

Many samples were submitted for X-ray analysis to establish the groups or families of clay minerals occurring in the Arctic environment. The results of these analyses indicated that clay minerals occurred in groups which were related to the geological formation in the immediate vicinity of the drainage basin. This led to the conclusion that clay minerals, in the Arctic environment at least, are detrital in nature and hence can be used as tracers in order to establish routes of sedimentary transport and, eventually, the source area contributing the sediments.

Mechanical analyses were carried out on sediments from many environments. These included the following: lake, river, delta, protected bay, channel, and open ocean. The results have been elaborated in earlier reports and can be summarized here: 1) in fluvial and inshore deposits there is a direct relationship of decrease in size of detritus with distance of sedimentary transport, and this is concomitant with a reduction in the number of heavy mineral species, a decrease in the percentage frequency of heavy minerals in the sample, as well as a decrease in the mean size of the heavy minerals. This means that under certain restrictions limited to traverses across the strike of a sedimentary deposit heavy minerals can be used in attempts at correlation, and can be used as sedimentary tracers as outlined above for clay minerals. 2) Offshore in areas of drifting ice, which probably contributes sediments to the sea floor, no progressive variation in texture from station to station occurs. However where currents are known to exist the sediment is sorted to a better degree than in areas where currents are extremely slow or absent altogether. This was corroborated

by a plot of the sediments over the sampling area. Greyish brown, fresh-smelling mud with a high sand content occurred in areas of moderate circulation of water whereas black and green, sour-smelling mud with low sand content occurred in areas over which circulation from ocean to island channels was not suspected. 3) Certain characteristic distortions of the isopleths in an areal pattern of a sand-mud lithofacies map indicate that such methods of analyzing data may be useful to demonstrate the existence of longshore currents around the vicinity of deltas and protected bays.

Samples were collected for the purpose of determining the presence of bacteria in anaerobic environments and, in particular, the sulphate reducers. Recent work has demonstrated the relationship of bacteria and the precipitation of certain heavy metallic elements in the form of sulphides. This aspect of sedimentation will be expanded on the Polar Shelf program, and will cover contrasting environments with respect to acidity, oxidation-reduction, depth, temperature, physiography and geography.

Publications and Reports

Two papers covering similar aspects of the above work but in more detail are now in press.

1) Pelletier, B.R. (1961), Submarine Geology Program, Polar Continental Shelf Project, Isachsen, District of Franklin, Geo. Surv. of Canada, Paper 61-21.

2) Wagner, F.J.E. (1961), Faunal Report - Submarine Geology Program, Polar Continental Shelf Project, Isachsen, District

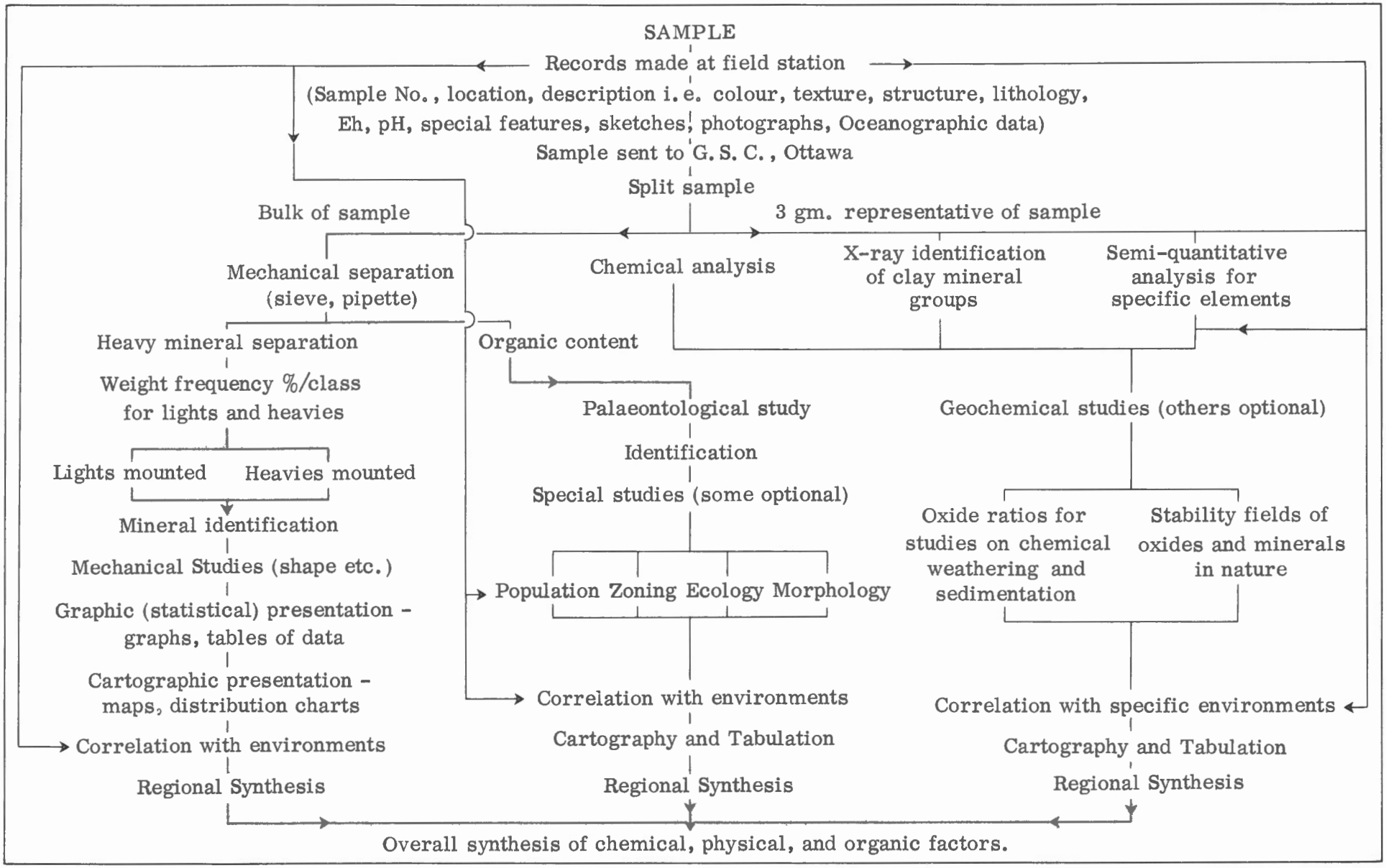
of Franklin, Geol. Surv. of Canada, Paper 61-27.

Two unpublished reports under similar titles have been submitted earlier to the office of the Polar Continental Shelf Project. A separate report has been submitted to the Division of Oceanographic Research on submarine geology programs undertaken by the Geological Survey.

1) P.C.S.P. Paper #35 (1960) by B.R. Pelletier

2) P.C.S.P. Paper #36 (1960) by F.J.E. Wagner

3) Summary Report of Submarine Geology Programs of the Geological Survey, submitted to the Director of Oceanographic Research, October 26, 1961.



Flow sheet for processing data and samples.