GEOLOGICAL SURVEY OF CANADA

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PRELIMINARY GEOLOGICAL MAP AND NOTES, PARTS OF OTTO FIORD AND CAPE STALLWORTHY AREAS, DISTRICT OF FRANKLIN

(NTS 340 C, 560 D)

by

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April, 1981

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INTRODUCTION

Geological maps of the Otto Fiord and Cape Stallworthy areas, based on field work by Thorsteinsson, Tozer and Trettin between 1956 and 1966 were published in 1972 (Thorsteinsson and Trettin, 1972a, b; Trettin, 1972b). Because of insufficient helicopter support during these earlier years, ground control was poor in the northeasternmost part of the Cape Stallworthy map-area and in the northern and eastern parts of the Otto Fiord map-area. The geology of these areas therefore was inferred largely from airphotographs and the northeasternmost part of the Otto Fiord area remained unmapped.

A program to complete the reconnaissance of nine map-areas in northern Ellesmere Island was begun by the Geological Survey in 1975 and will continue probably until 1982. In the course of this program major parts of the Otto Fiord area and an adjacent small part of the Cape Stallworthy area were remapped or newly mapped and the preliminary results are presented here. Additional work is required in the area north of Hare Fiord, especially at the western end of the outcrop belt of the Grant Land Formation.

In 1975 a base camp was occupied on the delta southwest of the head of Kulutingwak Fiord just north of the northeastern part of the present area. Trettin spent about one week, D.C. Wilson a day, and U. Mayr part of a day in the northern half of the Otto Fiord map-area. The work consisted mainly of foot traverses with a few helicopter traverses, using a Bell G 4A machine. In addition Trettin did some stratigraphic and structural work in the area north of Hare Fiord out of a base camp at Tanquary Fiord. He continued the reconnaissance mapping during a total of about three days in 1977, 1979 and 1980, using Bell 206B machines out of a base camp at Tanquary Fiord.

The compilation of the geology of the early Paleozoic and older rocks is by Trettin and that of the upper Paleozoic and Triassic formations in the northeastern part of the Otto Fiord map-area by U. Mayr. Some information on this area was obtained by him in 1970, during field work for J.C. Sproule and Associates Ltd. (1971). The undifferentiated upper Paleozoic map-unit CPnl in the remaining parts has been copied from Thorsteinsson's original compilation (Thorsteinsson and Trettin, 1972a) without change.

To date, age determinations, petrographic and chemical analyses and interpretations of the depositional and structural history are in various stages of progress; they will be published at a later time. The following notes are mainly intended to explain stratigraphic nomenclature and age assignments of the present map legend.

The last section of this brief report summarizes new information bearing on the age of some unfossiliferous units in the Cape Stallworthy map-area and the adjacent Bukken Fiord map-area.

REMARKS ON AGE ASSIGNMENTS AND STRATIGRAPHIC NOMENCLATURE

Proterozoic

Two outcrops areas of gneissic rocks, one in the northwestern part of the Otto Fiord map-area, and the other in the northeastern part of the Cape Stallworthy map-area, are regarded as outliers of a gneissic belt that extends continuously from Phillips Inlet to the mouth of Ayles Fiord (Yelverton Inlet map-area). Samples from the area between the mouth of Yelverton Inlet and Ayles Fiord gave a whole-rock Rb/Sr isochron age of 742 ± 12 Ma, interpreted as a minimum age (Sinha and Frisch, 1975). A lithologically similar gneiss belt at Cape Columbia (Clements Markham Inlet map-area) gave a Rb/Sr isochron age of

1083 ± 18 Ma and discordant zircon ages of 926 and 980 Ma (Sinha and Frisch, 1976). Additional zircon determinations from the present gneiss belt are in progress.

Proterozoic and/or lower Paleozoic

The units in this category constitute a seemingly thick and varied assemblage of predominantly metasedimentary rocks. Most are metamorphosed in the lower greenschist facies, but some are metamorphosed in the upper greenschist to amphibolite facies (e.g. map-unit s). The rocks are different from all known units of early Paleozoic age. Stratigraphic and structural relationships in the Yelverton Inlet and M'Clintock Inlet map-areas indicate that they either are Proterozoic in age and indigenous or that they represent an exotic succession of early Paleozoic and older age that collided with the Franklinian succession of northern Ellesmere Island in mid-Ordovician (or earlier) time.

Grant Land Formation

The Grant Land Formation (Trettin, 1972a) is a more than 1.5 km thick succession of variably feldspathic quartzite and purple, green, and grey slate and phyllite with minor amounts of granule and pebble conglomerate in the lower part. Both average and maximum grain size decrease stratigraphically upwards so that the uppermost part consists mainly of slate or phyllite. The formation has neither yielded fossils nor diagnostic trace fossils. Stratigraphic relationships with the overlying Hazen Formation suggest that it is mainly Cambrian in age although it may extend into the Early Ordovician.

Hazen Formation

Fossil collections indicate that in the northern part of the Hazen Plateau region the Hazen Formation ranges in age from Early Ordovician to Early Silurian

(Trettin et al., 1979). There it is divisible into: a lower carbonate member composed mainly of resedimented carbonate sediments (calcilutite, calcarenite, pebble and granule conglomerate) and mudrock with lesser amounts of chert and calcareous sandstone; and an upper chert member, composed mainly of radiolarian chert with interlaminated mudrock. The boundary between the two members is markedly diachronous. A unit of calcilutite and mudrock, overlying the Grant Land Formation in the northeastern parts of the Otto Fiord map-area, is interpreted as a northwestern tongue and facies of the carbonate member (map-unit Oh1). The entire Hazen Formation, together with some multicoloured mudrocks of the uppermost Grant Land Formation, appears to be present in an outcrop belt farther to the southeast but is here almost entirely replaced by chert (map-unit OSht). This chertified belt appears to be bounded on the northwest by a major fault, concealed by a glacier, that has been projected into the present area from the adjacent Tanquary Fiord map-area.

Map-unit Sc

Air photo interpretation suggests that a very small area on the southeastern margin of the present area is underlain by a unit of carbonate rocks and/or replacement chert that has been investigated on the ground in the northwestern part of the adjacent Tanquary Fiord map-area. There it overlies the Hazen Formation (map-unit OSht) and is locally unconformably overlain by the Borup Fiord Formation. Corals and conodonts from that area are middle to late Llandoverian in age (Barnes and Pedder in Trettin et al., 1979).

Map units OSv, OSc

These two map-units together represent a thick succession of predominantly basaltic and andesitic volcanic rocks, locally metamorphosed in the greenschist facies, with associated minor units of carbonate and mudrocks. In some areas the

volcanics lie on the carbonate member of the Hazen Formation (map-unit Oh1) and in others directly on the Grant Land Formation. This relationship suggests a disconformity at the base of the volcanic succession. The northernmost outcrop belt of map-unit OSv in the present area continues into the Yelverton Inlet map-area. There, limestone associated with it contained conodonts of early to middle Llandoverian age (Barnes in Trettin et al., 1979). The unit probably is not restricted to the early Llandoverian but extends into the Ordovician because it seems to be very thick. Its top is not exposed.

Imina and Lands Lokk Formations

The Imina Formation is a thick succession of compositionally immature sandstone and interstratified mudrock showing flysch-like primary structures. The sandstones of the Imina Formation are distinguished from those of the Lands Lokk by a generally much higher content of detrital calcite and dolomite, but in some areas the carbonate content is too variable for this distinction (undifferentiated map-unit Si, l). In these areas either rocks of transitional composition are present or strata of the Lands Lokk and Imina formations are closely associated owing to folding or faulting. The Imina Formation has yielded graptolites of late Llandoverian age east of Emma Fiord (Trettin, 1969a) and of unspecified late Llandoverian or Wenlockian age at M'Clintock Inlet (Trettin, 1969b).

In the type area east of Emma Fiord, the Lands Lokk Formation is divisible into three members (Trettin, 1969a). Member A consists mainly of mudrock with minor amounts of tuff and tuffaceous sediments; member B of mudrock, tuff, volcanic flows and lenses of limestone; and member C of mudrock and sandstone with lesser amounts of granule and pebble conglomerate. It has flysch-like primary structures. Member A contains graptolites of unspecified late Llandoverian to Wenlockian and of early Ludlovian age, and member C graptolites of early

Ludlovian age. Member B is restricted to the vicinity of Emma Fiord so that in the northeastern parts of the present area member C directly overlies member A.

Granitic intrusions

The three small plutons of quartz diorite and related rocks in the Otto Fiord map-area have not yet been dated although a sample from the northwesternmost pluton has been submitted for age determination (zircon analysis if feasible). Their age assignment is tentative and based on the K/Ar (biotite) age of 360 ± 25 Ma of a comparable small pluton on northern Axel Heiberg Island (Trettin, 1969a). However, a larger pluton at the entrance of Phillips Inlet has a K/Ar (biotite) age of 345 ± 15 Ma The small, elongate pluton in the northeastern part of the Otto Fiord map-area is petrographically comparable to a quartz diorite body in the M'Clintock Inlet area that recently has given Late Cretaceous K/Ar (hornblende) ages of 92 and 94 Ma; their significance is not clear.

Upper Paleozoic

Nomenclature and age of the upper Paleozoic formations are based on Thorsteinsson, 1974 (see also Nassichuk and Davis, 1980) and need not be discussed here. It should be mentioned, however, that two small areas in the northwestern part of the Otto Fiord map-area, previously mapped (on the basis of airphoto interpretation) as underlain by the Lands Lokk Formation now are known to be underlain by volcanic rocks. Two specimens from locality 77T334D are classified as "alkali basalt, potassic series" and "tholeiitic basalt, potassic series" respectively on the basis of chemical analyses (classification of Irvine and Baragar, 1972). The volcanics, which are in fault contact with Imina, Lands Lokk and Nansen formations, are tentatively assigned to the Lower Permian Esayoo Formation.

Mesozoic

The Mesozoic stratigraphy of the Otto Fiord area has been described by Tozer (1963) and Moore (1981). Dark grey mudrocks, overlying Upper Permian strata in the eastern part of the present area are interpreted as Triassic on the basis of their stratigraphic position. They have been seen from the air only and have to be sampled for microfossils before they can be assigned to stratigraphic units.

A newly discovered outcrop area of Deer Bay and Isachsen formations at 82°30'W, 81°42'N is significant in that it constitutes the northernmost occurrence of these units. The Deer Bay Formation consists of 160 m + (base not exposed) of mudrock with minor amounts of sandstone and contains fossils, including Buchia. The Isachsen Formation, 60 m + thick (top eroded) is composed of sandstone, in part pebbly, with some mudrock and coal seams (D.G. Wilson, unpublished field notes, 1975).

REVISIONS IN AGE ASSIGNMENTS AND NOMENCLATURE, CAPE STALLWORTHY AND BUKKEN FIORD MAP-AREAS (PARTS THAT HAVE NOT BEEN REMAPPED)

Rens Fiord Complex, northern Axel Heiberg Island

The original sandstone unit of the Rens Fiord Complex is identical with the Grant Land Formation, presumably of Cambrian age. The "pelitic and cherty unit" (map-unit Orp) is correlative mainly with the Hazen Formation but also includes phyllites and slates of the uppermost Grant Land Formation. An essentially flat-lying sheet of dolostone in the Bukken Fiord map-area assigned to the carbonate unit of the Rens Fiord Complex (map-unit Orc) overlies tightly folded strata of the Grant Land Formation with an angular discordance up to 90°. In the original report (Trettin, 1969a) it was left open whether the concealed contact represents an angular unconformity or a low-angle thrust fault, but the first alternative can now be ruled out. Map-unit Orc of the Bukken Fiord area therefore probably is Proterozoic in age and the same may apply to map-unit Orc of the Cape Stallworthy map-area and the associated volcanic and carbonate rocks of map-unit Orv.

Map-unit lPhl, kleybolte Peninsula, northwestern Ellesmere Island

Map-unit lPhl consists of thermally metamorphosed quartzite, carbonate rocks and mudrocks with small intrusions of diorite and related rocks. The metasediments of this unit have no counterpart in the known early Paleozoic succession of Ellesmere Island but are comparable to successions that must be Proterozoic if indigenous but could be early Paleozoic or Proterozoic if exotic.

Bourne Complex, Kleybolte Peninsula

Five whole-rock K/Ar analyses, four from the same diabase dyke or sill and the fifth from an adjacent gabbro, gave highly discrepant apparent ages ranging from 98 ± 4.5 Ma to 230 ± 22 Ma (Wanless et al., 1978). These results demonstrate primarily that the whole-rock K/Ar method is unsuited for this complex. They may also indicate that the complex is late Paleozoic or Mesozoic rather than early Paleozoic in age, but this is not certain.

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Acknowledgments. We are indebted to the Director and officers of the Polar Continental Shelf Project for fixed-wing aircraft support, management of the helicopter and numerous courtesies. Thanks also are due to pilots E. Lozo (deceased), A. Benson, F. Eilertsen and B. Russel and to assistant J. Calvert. The chemical analyses were made in the laboratories of the Geological Survey of Canada, Ottawa under the supervision of P.G. Bélanger, G.P. Bender, J.L. Bouvier and R.M. Rousseau; the computer analysis was carried out by J.H. Maley.

PRELIMINARY GEOLOGICAL MAP, PARTS OF OTTO FIORD AND CAPE STALLWORTHY AREAS, DISTRICT OF FRANKLIN (NTS 340C, 560 D)

LEGEND

QUATERNARY

Q — unconsolidated sediments obscuring bedrock geology

CRETACEOUS

Lower Cretaceous

Isachsen Formation

Ki — sandstone; minor pebbly sandstone, mudrock; a little coal

JURASSIC AND CRETACEOUS

Upper Jurassic and Lower Cretaceous

Deer Bay Formation

JKd — mudrock; minor sandstone

TRIASSIC

Lower to Upper Triassic

Undivided Blind Fiord and Blaa Mountain Formations

R — mudrock, in part calcareous; minor sandstone

PERMIAN

Upper Permian

Undivided van Hauen and Degerbøls formations

Pv,d — limestone, chert, mudrock

van Hauen Formation

Pv — mudrock, chert

PERMIAN (?)

Lower Permian (?)

Esayoo Formation (?)

Pe ? — basalt flows and (?) pyroclastic rocks

ORDOVICIAN AND SILURIAN

Ordovician and Lower Silurian

Hazen Formation

OShţ — replacement chert (locally includes strata of uppermost Grant Land Formation)

Oh1: tongue of carbonate member --calcilutite, mudrock (underlies map-unit OSv and is restricted to the Ordovician)

OSv — pyroclastic and volcanic flow rocks, mainly andesitic and basaltic, locally metamorphosed in greenschist facies; minor carbonate rocks, mudrock

OSc — carbonate rocks and minor mudrocks associated with volcanics

CAMBRIAN (?) AND ORDOVICIAN

O — mainly map-units OSv , OSc and Oh1; minor €g

CAMBRIAN AND/OR ORDOVICIAN

Cambrian and/or Lower Ordovician

Grant Land Formation

€g — quartzite, variably feldspathic; mudrock, slaty to phyllitic; minor granule and pebble conglomerate (?)

€g*: includes Oh1, OSv

PROTEROZOIC AND/OR LOWER PALEOZOIC

stratigraphic order uncertain

P — phyllite, slate, variably calcareous

C — original limestone, dolomitic limestone and dolostone, variably recrystallized to marble

CqPS — recrystallized carbonate rocks, quartzite, phyllite, schist

S — schist

PROTEROZOIC

Hadrynian and/or Neohelikian

Pngm — metamorphosed quartz monzonite

P_{scn} schist, marble, gneiss (including augen gneiss)

P_n gneiss (including augen gneiss)

geological boundary (defined, approximate, assumed or projected through ice or overburden)

fault (defined, approximate, assumed or projected through ice or overburden; solid circle indicates downthrow side)

thrust fault (defined, approximate, assumed or projected through ice or overburden; teeth on hanging wall)

lineament (from air photographs)

anticline (arrow indicates plunge)

syncline

20 strike and dip of bedding, tops known (inclined, overturned)

strike and dip of bedding, tops unknown;
dip estimate from air photographs:

- g: gentle (3^o- 10^o)
- m: medium (10^o-25^o)
- s: steep (25^o-45^o)
- vs: very steep (45^o-89^o)

vertical, dip unknown

mafic dykes and sills of different ages (from air photographs)

× helicopter landing, outcrop observation during foot traverse, or sample locality

× Ⓕ fossil locality

Geology by U.Mayr 1975 , H.P.Trettin 1975, 1977, 1980, and D.G.Wilson, 1975

Compiled by H.P.Trettin and U. Mayr, April, 1981

(partly based on Thorsteinsson and Trettin, 1972a)