APPENDIX 6A

PALAEONTOLOGY REPORT

Paleontological report for the proposed Mary River Project, Baffin Island, Nunavut.

Prepared by
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Contents

1.0 Methodology

This report is the result of a desk study of paleontological resources in the Mary River Project area Relevant maps and publications were identified with the assistance of employees of the Geological Survey of Canada library (Booth Street, Ottawa). These sources were consulted (see section 7.0) with the aim of identifying paleontological resources that might be encountered within or adjacent to the Mary River project area. A literature search on the relevant fossiliferous rock units was conducted using Web of Science and GeoRef (online, through Carleton University library) to see if fossils have been or are currently under paleobiological investigation.

I also contacted David M. Rudkin, an invertebrate paleontologist at the Royal Ontario Museum, to determine whether there was existing expertise in Canada that might be able to assist, should Paleozoic macrofossils (see section 2.0) be encountered.

2.0 Bedrock geology background.

Most of the bedrock underlying the Mary River Project area is Paleozoic (carbonate and siliclastic) and Archean/Paleoproterozic (gneisses and plutonic) rocks. A third rock type occurs in small areas only, and comprises Archean volcanic rocks (Mary River and Prince Albert groups). Of these three bedrock types only Paleozoic rocks hold any possibility of containing fossils. The location of these Paleozoic rocks is shown in Figure 1. The Paleozoic rock units and associated fossils are described below, from oldest to youngest.

2.1 Gallery and Turner Cliffs Formations.— Cambrian to Ordovician in age, these formations together comprise up to 650m of carbonate and siliclastic rocks. The Gallery Formation is roughly 340m of quartzose sandstone with minor siltstone, conglomerate and shale, with rare breccia, dolomitic sandstone and dolostone. The Turner Cliffs Formation overlies the Gallery Formation and comprises about 310m of shaly to pure dolostone, interbedded with dolomitic conglomerates, dolomitic sandstone, minor dolomitic siltstone and shale.

"Body fossils" (e.g., shells) have not yet been reported but trace fossils (e.g., invertebrate burrows) have been described from both formations.

2.2 Ship Point Formation. — This Ordovician aged formation unconformably overlies the Turner Cliffs Formation and is represented on Northwestern Baffin Island by 50 to 275 m of cliff forming microcrystalline dolostone, interbedded with dolomitic sandstone and minor dolostone conglomerate (flat pebbles and cobbles) and dolostone chip breccia. Fossils collected from this formation include *Maclurites* sp. (see Fig. 2 in Appendix A), *Liospira* sp., *Lophospira* sp. and

Metaspiroceras sp. and are consistent with an early Middle Ordovician age (Lemon and Blackadar, 1963). On nearby Melville Peninsula, to the south, this unit has also yielded conodonts (Barnes, 1977).

2.3 Baillarge Formation**.** — The Baillarge Formation (410 m) is considered Ordovician to Silurian in age and is represented by fine grained, light bluish-grey limestone interbedded with minor dolostone, breccia, chip conglomerate, sandstone and cherty beds. Fossils suggest that the base of the formation is late Middle Ordovician Age, whereas the upper 150 m is Lower Silurian. Fossils commonly recovered include *Receptaculites* cf. *R. arcticus* Etheridge (see Fig. 3 in Appendix A), *Catenipora* cf. *C. rubra* Sinclair and Bolton, *Maclurites manitobensis* Whiteaves (see Fig. 2 in Appendix A), in addition to crinoids (stems) (Lemon and Blackadar, 1963; Trettin, 1969). This unit unconformably overlies the Ship Point formation.

3.0 Location of known fossil sites.

The above fossils are described from localities in the Admirality Inlet region, just west of the Mary River Project area (Lemon and Blackadar, 1963). There seems to be no known localities reported from the Mary River project area itself, however the creation of new exposures, resulting for example from road or railway construction, may reveal new fossil localities.

4.0 Significance of bedrock fossils

From my survey of the scientific literature (using Web of Science and GeoRef) it appears that the Northwestern Baffin Island fossils have not themselves been recently studied in a paleobiological context, although work has been done on the geology of the Ship Point and Baillarge Formations (see Appendix B).

Even so, the fossil record of Northwestern Baffin does document an important period in the history of reef ecosystems. During the Ordovician the arctic landmass was located near the equator and the Northwestern Baffin Island area was covered by shallow seas. Fossils from this time are of interest because they represent members of among the earliest reef-like ecosystems, and therefore provide an early analogue for modern reef ecosystems. Moreover, towards the end of the Ordovician the planet experienced significant cooling, culminating in glaciations, which led to the demise of these reefs. This dramatic period of earth history is captured in the Baffin Island fossil record. Thus the Baffin Island fossil record is significant in part because it may provide an opportunity to investigate the relationship between the evolution of reef ecosystems and climate.

5.0 Regulation overview.

Protection of the paleontology heritage of Nunavut is a joint responsibility of the Governments of Nunavut and of Canada. The federal government regulates the protection and care of paleontological resources, whereas the territorial government (Department of Culture, Language, Elders and Youth) administrates permitting for field and laboratory research. The Canadian Museum of Nature is the official repository of Nunavut fossils (collected since 2001), until such time as Nunavut has its own paleontological collections facility.

6.0 Results and additional considerations

6.1 Bedrock fossils**.** — The most important fossils that might be recovered from the bedrock of the Mary River project area are Ordovician and Silurian invertebrate fossils, such as shells and sponge-like animals. These will tend to be found in bluish grey limestone deposits.

6.2 Pliocene forest fossils**.** — An additional kind of fossil deposit that might exist in the project area is not identifiable from surficial or bedrock geology maps. These unconsolidated fossil deposits are mostly Pliocene in age (2-5 million years old), and are found overlying bedrock deposits (usually near hilltops). The deposits preserve ancient bogs and forests and can be identified from the appearance of unpetrified wood and/or peat (grey, dark brown or black). The best studied Pliocene forest/peat deposit site is the Beaver Pond site, on Ellesmere Island (Strathcona Fiord). The Beaver Pond site has yielded the remains of a diverse assemblage of organisms including mosses, water plants, mollusks and trees, along with numerous extinct mammals including a horse, deerlet and beaver (Tedford & Harington, 2003). Similar wood/peat deposits are known from Bylot Island as well (see Fig. 4). It is entirely possible that such deposits might occur on northwest Baffin Island.

Such deposits are important because they can be used to derive climate (temperature and humidity) and CO^2 data from before the onset of the last Ice Ages. Ultimately, such results will be useful for testing global climate models that are often used to predict future climate change in response to projected greenhouse gas emissions. If these climate models can accurately recreate past climates (especially arctic climates), then we will be more confident in our ability to predict future climate changes.

7.0 Recommendations

If any fossils are uncovered (e.g., Ordovician invertebrates or Pliocene wood- see Fig. 4) through the activities of the Mary River Project, work in the immediate area will cease and a paleontologist will be notified so that the significance of the find can be evaluated.

The Canadian Museum of Nature (CMN) will be contacted, and additional experts would be brought in if need be. Currently there are no researchers at the CMN that specialize in invertebrate paleontology, however I have made contact with David Rudkin at the Royal Ontario Museum who would be willing to assist should the need arise (See Appendix C for correspondence).

8.0 References consulted for this report

Barnes, C.R. 1977. Ordovician conodonts from the Ship Point and Bad Cache Rapids formations, Melville Peninsula, southeastern District of Franklin; in Geology of Ordovician rocks, Melville Peninsula and region, southeastern District of Franklin. Bolton, T.E. Sanford, B.V., Copeland, M.J., Barnes, C.R., and Rigby, J.K.; Geological Survey of Canada, Bulletin 269, p. 99-119.

Kemp, E.A de and D.J. Scott. 1998. Geoscience compilation of northern Baffin Island and northern Melville Peninsula, Northwest Territories. Geological Survey of Canada, Open source file D3636. 2 CD-ROMS, volumes 1 and 2.

Lemon, R.R.H., and Blackadar, R.G. 1963. Admiralty Inlet area, Baffin Island, District of Franklin; Geological Survey of Canada, Memoir 328, 84 p.

Trettin, H.P.1969. LowerPaleozoic sediments of northwestern Baffin Island, District of Franklin. Geological Survey of Canada, Bulletin 157, 70p.

Scott, D.J. 1998. Bedrock Geology Compilation Northern Bafffin Island and Northern Melville Peninsula, Northwest Territories geological compilation by D. J. Scott and E. A. de Kemp. Geological Survey of Canada, Open source file 3633. 2 maps : col. + legend (1 sh.).

Appendix A. Figures

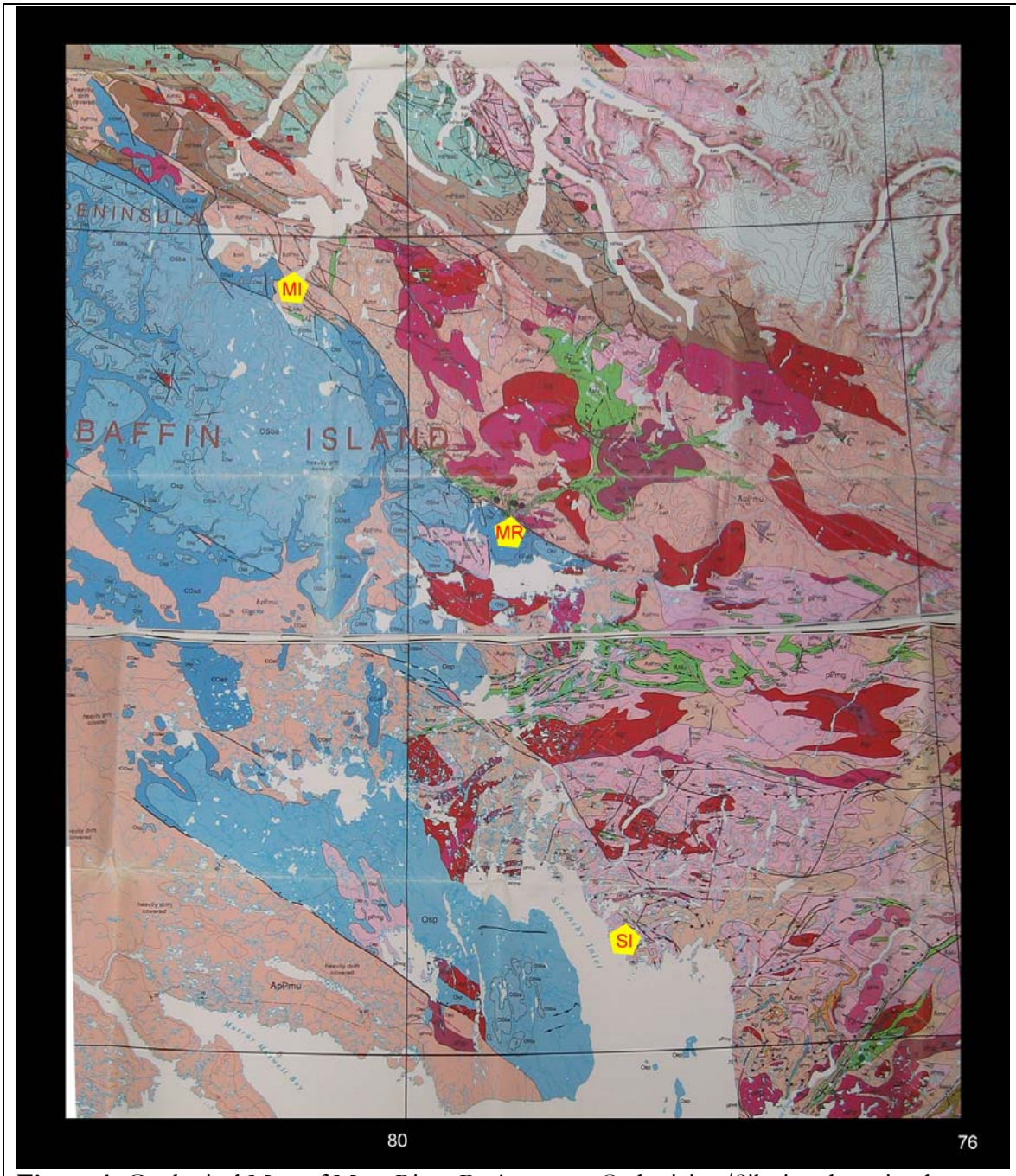

Figure 1. Geological Map of Mary River Project area. Ordovician/Silurian deposits that are fossiliferous are shown in blue. Most of these deposits are located in the area surrounding the Mary River site itself, and between the Mary Rive site and Milne Inlet. Abbreviations for lettering in yellow polygons: MI, Milne Inlet Camp and Port; MR, Mary River site; SI, Steensby Inlet. Map parts are from Scott, 1998: GSC, Open source file 3633.

Figure 2. *Maclurites* sp. fossil (snail). The shell is distinctive because one side is flat, and the other side (shown here) is strongly concave. Image South Dakota School of Mines and Technology - Museum of Geology. See http://www.palaeos.com/Invertebrates/Molluscs/Gastropoda/Eogastropoda/Macluritoidea.html

Figure 3. *Receptaculites* fossil. Specimen from Carleton College collection. This enigmatic organism appears superficially similar to corals or sponges, but may in fact be a calcareous green algae. Photo by Kelsey Dyck. see http://en.wikipedia.org/wiki/Receptaculites

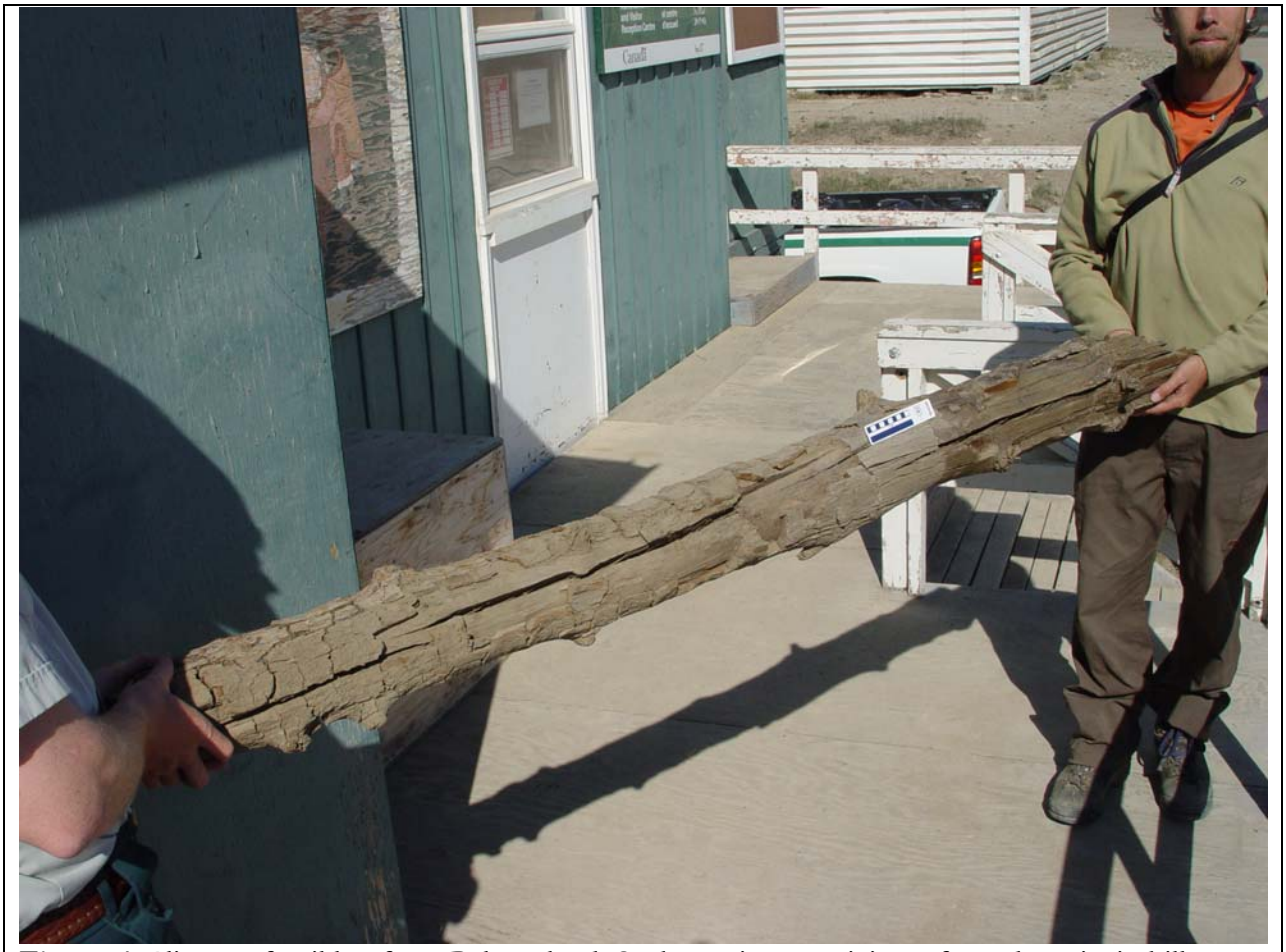

Figure 4. Pliocene fossil log from Bylot Island**.** Such specimens originate from deposits in hilltop areas. The wood is not petrified, but rather appears modern. This sample is currently housed at the Parks office in Pond Inlet, Baffin Island. Photograph by N. Rybczynski, July 2007.

Appendix B. Reference list from GeoRef search (Search on Baillarge and Ship Point Formation). If fossils are discovered in Paleozoic deposits of the Mary River Project area, research would involve consultation with these references.

Record 1 of 12

DN: Database Name
GeoRef
TI: Title
Lower Paleozoic geology, Foxe Basin, northeastern Melville Peninsula, and part of northern and central Baffin Island
AU: Author
Trettin, H P; Norford, B S; Barnes, C S; Boucot, A J; Copeland, M J
SO: Source
Open-File Report - Geological Survey of Canada, Report: 64, 151 pp., 1971

Record 2 of 12

DN: Database Name
GeoRef
TI: Title
Geology, Phillips Creek, District of Franklin
AU: Author
Blackadar, R G; Davison, W L; Trettin, H P
SO: Source
Geological Survey of Canada Map, 1968
AB: Abstract
Precambrian rocks in the Phillips Creek area are limited to gneissic rocks of Aphebian age and gabbro dikes of presumed Neohelikian age; lower Paleozoic strata rest with pronounced unconformity on the Aphebian rocks. Paleozoic rocks include the Cambrian Admiralty Group, Ordovician Ship Point Formation, and Ordovician and Silurian Baillarge Formation. Paleozoic strata are nearly horizontal, but locally are disturbed by several fault zones, the most important being a group of southeasterly striking normal faults that mark the northeastern boundary of the Paleozoic outcrop area. Drainage is partly rectilinear and is controlled, to some extent, by a complicated pattern of bedrock fractures that affect bedrock as old as Precambrian as well as unconsolidated Holocene sediments.

Record 3 of 12

DN: Database Name
GeoRef
TI: Title
Stratigraphic sections and reconnaissance studies of the geological structure in widely separated areas of Foxe Basin, Melville Peninsula and Baffin Island
AU: Author
Trettin, H P; Bolton, T E; Sanford, B V

SO: Source
Open-File Report - Geological Survey of Canada, Report: 236, 123 pp., 1974

Record 4 of 12

DN: Database Name
GeoRef
TI: Title
Investigations of lower Paleozoic geology, Foxe Basin, northeastern Melville Peninsula, and parts of northwestern and central Baffin Island
AU: Author
Trettin, H P
SO: Source
Bulletin - Geological Survey of Canada, no.251, 177 pp., 1975

Record 5 of 12

DN: Database Name
GeoRef
TI: Title
Stratigraphy and sedimentology of Ordovician and Silurian strata, northern Brodeur Peninsula, Baffin Island
AU: Author
Nentwich, Franz W; Jones, Brian
SO: Source
Bulletin of Canadian Petroleum Geology, vol.37, no.4, pp.428-442, Dec 1989

Record 6 of 12

DN: Database Name
GeoRef
TI: Title
Geological framework of the Ordovician system in the Southeast Arctic Platform, Nunavut
AU: Author
Sanford, B V; Grant, A C
MT: Monograph Title
Geology and paleontology of the Southeast Arctic Platform and southern Baffin Island, Nunavut
ED: Editor
McCracken, A D; Bolton, T E
SO: Source
Bulletin - Geological Survey of Canada, Report: 557, pp.13-38, 2000

Record 7 of 12

DN: Database Name
GeoRef In Process
TI: Title

Ordovician conodonts from Akpatok Island, Nunavut
AU: Author
McCracken, A D
MT: Monograph Title
Geological Association of Canada, Mineralogical Association of Canada; joint annual meeting abstracts--Association geologique du Canada, Association mineralogique du Canada; congres annuel conjointe recueil des resumes
AU: Author
Anonymous
SO: Source
Program with Abstracts - Geological Association of Canada; Mineralogical Association of Canada; Canadian Geophysical Union, Joint Annual Meeting, vol. 29, pp.80, 2004
PB: Publisher
Geological Association of Canada, Waterloo, ON, Canada (CAN)
PY: Publication Year
2004

Record 8 of 12

DN: Database Name
GeoRef
TI: Title
Geology, Nauja Bay, Baffin Island, Nunavut
AU: Author
St-Onge, M R (compiler); Scott, D J (compiler); Corrigan, D (compiler)
SO: Source
Open-File Report - Geological Survey of Canada, Report: 4482, 1 sheet, 1 disc, 2004

Record 9 of 12

DN: Database Name
GeoRef
TI: Title
Telychian (Lower Silurian) stromatoporoids from the Charlestown Inlier, Co. Mayo, Ireland
AU: Author
Nestor, Heldur
SO: Source
Irish Journal of Earth Sciences, vol. 17, pp.115-121, 1999
AB: Abstract
Four stromatoporoid species: Pachystylostroma sp., Petridiostroma cf. simplex (Nestor, 1966), Gerronostroma juveneforme sp. nov. and Eostromatopora ringerikensis (Mori, 1978), are described from the Uggool Limestone Member of the Cloonnamna Formation (upper Llandovery) in the Charlestown Inlier, Co. Mayo, Ireland. A new genus Eostromatopora is established with the type species Stromatopora impexa Nestor, 1966. The fauna described here is closely related to the Telychian stromatoporoid faunas from the Vik Formation of the Oslo

area and from the Baillarge Formation of north-western Baffin Island, Canada.

Record 10 of 12

DN: Database Name
GeoRef
TI: Title
Stratigraphy and sedimentology of the Ordovician and Silurian Brodeur Group, northern Brodeur Peninsula, Baffin Island
AU: Author
Nentwich, Franz Werner

Record 11 of 12

DN: Database Name
GeoRef
TI: Title
Paleokarst and origin of carbonate breccias of the Ordovician-Silurian Brodeur Group, northwestern Brodeur Peninsula, Baffin Island
AU: Author
Nentwich, Franz W; Jones, Brian
MT: Monograph Title
GAC, MAC, CGU 1986 joint annual meeting; program with abstracts
SO: Source
Program with Abstracts - Geological Association of Canada; Mineralogical Association of Canada; Canadian Geophysical Union, Joint Annual Meeting, vol.11, pp.107, Feb 1986

Record 12 of 12

DN: Database Name
GeoRef
TI: Title
Ordovician and Silurian depositional framework of Prince Regent Basin, Brodeur Peninsula to Somerset Island, N.W.T.
AU: Author
Nentwich, Franz W; Jones, Brian
MT: Monograph Title
GAC/MAC, joint annual meeting
AU: Author
Anonymous
SO: Source
Program with Abstracts - Geological Association of Canada; Mineralogical Association of Canada; Canadian Geophysical Union, Joint Annual Meeting, vol.10, pp.A43, 1985

Appendix C. Rudkin correspondence

-----Original Message-----
From: David Rudkin [mailto:davidru@rom.on.ca]
Sent: Thursday, June 26, 2008 8:31 AM
To: Natalia Rybczynski
Subject: Re: Ordovician Arctic fossils?

Hi Natalia,

If your Arctic Ordovician project involves macrofossils, I'd be happy to try and help you out myself ... microfossils are another story, but I can steer you towards some appropriate colleagues if that's the case. I'm reasonably familiar with most of the major groups of Ordovician shelly invertebrates (trilobites, nautiloid cephalopods, corals, etc.) from the southern Baffin Island Middle through Upper Ordovician sequences (the classic "Silliman's Fossil Mount" material) and have worked on similar stuff from mainland subarctic sections. There are several other references to the regional paleontology that would be worth consulting, but the most recent and comprehensive account is Geological Survey of Canada Bulletin 557 (2000), edited by McCracken and Bolton.

Please let me know how I can be of further assistance.

Best regards,

Dave

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http://www.rom.on.ca/collections/curators/rudkin.php
http://www.rom.on.ca/collections/research/drarthropoda.php
http://www.geology.utoronto.ca/facultyrudkin.htm

>>> "Natalia Rybczynski" <NRybczynski@mus-nature.ca> 6/25/2008 8:49 PM >>>
Dear David Rudkin,

I am a researcher in vertebrate paleontology, and I have fallen into a project that might down the road require collaboration with someone who has invertebrate expertise.

I am looking for someone in Canada who might have experience with Ordovician fossils from the Arctic (esp. Baffin Island).

Do you know of anyone who has done work in this area? Or who would be interested in work in this area?

The most recent papers in this area I have found so far are :
Lemon, R.R.H., and Blackadar, R.G. 1963. Admiralty Inlet area, Baffin Island, District of Franklin; Geological Survey of Canada, Memoir 328, 84 p.
Trettin, H.P.1969. LowerPaleozoic sediments of northwestern Baffin Island, District of Franklin. Geological Survey of Canada, Bulletin 157, 70p.

Thank you in advance for your time and consideration.

Regards,

Natalia

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