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Abstract

Five microfossil groups are herein described from the Upper Cretaceous Smoking Hills and Mason River formations in the Horton River area (Northwest Territories). Microfossil assemblages from the Smoking Hills Formation are dominated by radiolarians and foraminifera whereas the Mason River Formation mainly contains diatoms, silicoflagellates, and sponge spicules. These microfossil groups have been reported before in these units and age-equivalent strata from the Canadian Arctic except for radiolarians. The radiolarian assemblage described in this study represents one of the most diverse and abundant assemblages reported in Campanian-Maastrichtian rocks in North America and can be used to reconstruct the climatic, paleoceanographic, and paleobiogeographic conditions that took place at the end of the Cretaceous Period. This Open File documents the stratigraphic occurrence of the microfossil types.

Introduction

The Smoking Hills and Mason River formations represent the last stages of marine sedimentation during the Late Cretaceous in northern Canada. These mudstone-rich successions crop out along the lower Horton River in the Franklin Bay area of the Northwest Territories (Canada) and are ideally located to investigate the oceanographic connection between the Boreal and Western Interior seas at the end of the Cretaceous Period. This report integrates micropaleontological information on diatoms and silicoflagellates that have been previously published from the Horton River area (Tapia and Harwood, 2002; McCartney et al., 2010, 2011a) with new findings on two groups that had not been reported before, radiolarians and agglutinated foraminifera.

This project is being conducted under the TransGEM (Event Stratigraphy Activity) and GEM Western Arctic (Smoking Hills Activity) programs. The goal of the TransGEM Event Stratigraphy Activity led by Rob Fensome is to generate a Mesozoic-Cenozoic event-scheme for targeted Canadian frontier basins using biostratigraphy, lithostratigraphy, and geochronology. This work serves to support those objectives by correlating the micropaleontological data collected from the Horton River area with the stratigraphic information published in the last decades from the Sverdrup and Western Interior basins. This correlation is critical to reconstructing the paleoenvironmental conditions associated with the evolution of the Arctic Ocean and the paleobiogeographic distribution of marine species during the Late Cretaceous.

Samples for micropaleontological analyses were collected by JMG, MB, and SG during a Geological Survey of Canada field program led by Field Party Chief I. Rod Smith during summer 2018. During this program, lithostratigraphic sections of the Smoking Hills and Mason River formations were described, measured and sampled. The samples for this study were taken from the type sections of the Smoking Hills and Mason River formations described by Yorath et al. (1975) (Figure 1). The type section of the Smoking Hills Formation is located at 69°27′52″N, 126°58′13″W. During the visit to the section in 2018, the basal conglomerate that marks the base of the Smoking Hills Formation, as described by Yorath et al. (1975), was not observed in the type section or any other areas (Smith et al., 2018). The Mason River Formation outcrops located at approximately 69°28′46″N, 126°59′20″W form a composite section that comprises the lower and middle parts of the formation. The third section is located at 69°58′19″N, 127°07′15″W and covers the upper part of the Mason River Formation (Figure 1).

The Smoking Hills and Mason River formations have been dated as Early Campanian/Maastrichtian based on vertebrate fauna (Russell, 1967), palynomorphs (McIntyre, 1974), diatoms (Tapia and Harwood, 2002) and silicoflagellates (McCartney et al., 2011a) from the Horton River area. McNeil (1997) and Dixon and McNeil (2008) assigned an early Maastrichtian age to the Mason River Formation in the Beaufort-Mackenzie Basin based on the palynological interpretations of McIntyre (1974) and their analysis of benthic foraminifera. Unlike the works of Tapia and Harwood (2002) and McCartney et al. (2011a), no diatoms or silicoflagellates were recovered from the Smoking Hills Formation in this study. Assemblages from these two microfossil groups in the Mason River Formation, on the other hand, correlate well with the biozones proposed by the aforementioned authors. The agglutinated benthic foraminiferal fauna recovered from the Smoking Hills Formation is consistent with the fauna identified in the same unit (*Glaphyrammina spirocompressa* biozone) by McNeil (1997) and Dixon and McNeil (2008) in the Beaufort-Mackenzie Basin.

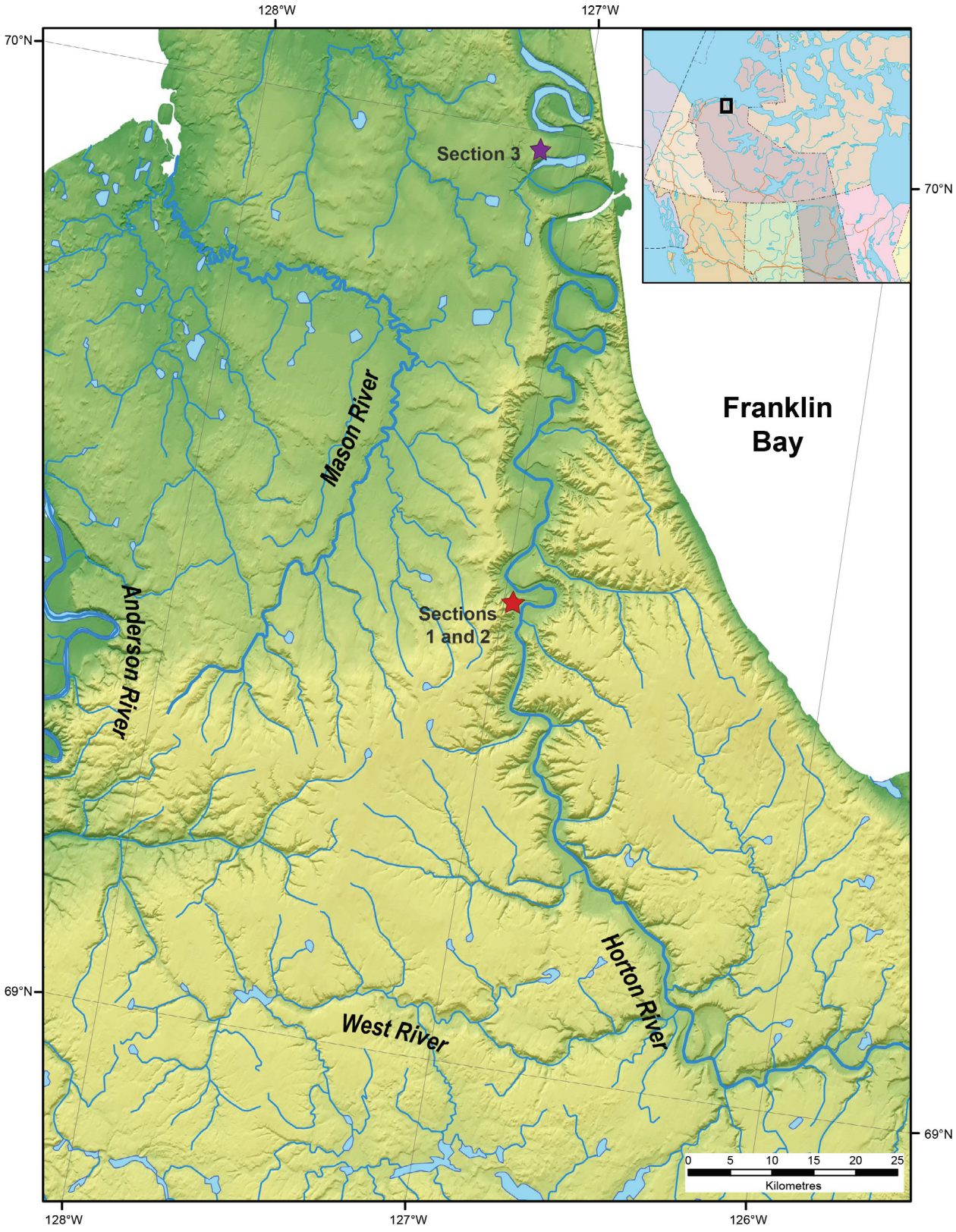

Figure 1. Location map of the three sections analyzed in this study. Sections 1 and 2 (red star) are located at 69°27'52"N, 126°58'13"W and 69°28'46"N, 126°59'20"W, respectively. Section three (purple star) is located at 69°58'19"N, 127°07'15"W. The black box in the insert indicates the Horton River area in the Horton-Anderson Plains. Modified from Smith et al. (2018).

Previous work

The stratigraphic framework used in this study is based on the investigations of Yorath et al. (1969), Yorath and Balkwill (1970), Balkwill and Yorath (1970) and Yorath et al. (1975) who surveyed the Horton River area in the late 1960s, and new observations made by the field team in 2018 (Smith et al., 2018). While several paleontological investigations of siliceous microfossils and agglutinated foraminifera in the Cretaceous System have been conducted in northern Canada, they have mainly focused on the Sverdrup Basin (e.g., Wall, 1983; Davies et al., 2018), the Eagle Plain region (e.g., Haggart et al., 2013), the Beaufort-Mackenzie Basin (e.g., Dixon and McNeil, 2008) and the Alpha Ridge in the Arctic Ocean (e.g. Jackson et al., 1985). The Horton River area, which lies near the triple-junction of the Sverdrup, Canadian Arctic Margin, and Western Canadian Interior basins, has received comparatively little attention. Biostratigraphic zonations in Upper Cretaceous strata from this area were proposed by Tapia and Harwood (2002) and McCartney et al. (2010, 2011a) based on diatoms and silicoflagellates, respectively. Fowler (1984) reported the occurrence of a low-diversity agglutinated foraminiferal assemblage from the Mason River Formation in the Horton River area, but the biostratigraphic correlation of this formation with other units was not further discussed. Other paleontological work on the Smoking Hills and Mason River formations includes McIntyre (1974, 1986), Plauchut and Jutard (1976), and Bujak et al. (1987) who presented palynological data from both units in the Anderson Plains.

Methodology

A total of 136 mudrock samples for micropaleontological analyses were collected from the reference sections shown in Figure 1 (Table 1). Samples were collected at regular increments of ~1.5 m vertical throughout both the Smoking Hills and Mason River formations. No macrofossils were observed. Thickness measurements and relevant observations (composition and sedimentary structures) are reported as well as the presence of jarosite beds.

Samples were prepared for micropaleontological analyses in the micropaleontology laboratory by JD at the University of Calgary using the methods of Kennedy and Coe (2014) and Diaz and Velez (2017, 2018). Briefly, aliquots of 100 g were crushed, immersed in distilled water for 24 hours and repeatedly frozen and thawed until nearly all the sample was disaggregated. The remaining sediment was washed with household bleach and heated on an oscillating hot plate for one hour and then filtered through a 63

μm brass sieve. The dried sediment was analyzed under a binocular microscope (WILD Heerbrugg) at 250X magnification. Radiolarian and foraminiferal tests were picked with a dissecting needle and placed in a cardboard case for subsequent classification. Diatom frustules and silicoflagellates were identified in smear slides using a transmitted light microscope (Zeiss Axio Imager 2) at 500X and 1000X magnifications. The list of radiolarian, foraminiferal, diatom, and silicoflagellate taxa shown in tables 2, 3, 4, and 5 includes the species name, the author of the specific name, and the year of publication.

Table 1. List of samples analyzed for micropaleontology from the Horton River area

Coordinates	Station	Collector ID GTA-	Meterage in section (m)	C-number	Unit
69°27'52"N-126°58'13"W	**18-GTA-YB-37**	135	3.0	C-628911	Smoking Hills Formation
		136	4.5	C-628912	Smoking Hills Fm.
		137	6.0	C-628913	Smoking Hills Fm.
		138	7.5	C-628914	Smoking Hills Fm.
		139	9.0	C-628915	Smoking Hills Fm.
		140	10.5	C-628916	Smoking Hills Fm.
		141	12.0	C-628917	Smoking Hills Fm.
		142	13.5	C-628918	Smoking Hills Fm.
		143	15.0	C-628919	Smoking Hills Fm.
		144	16.5	C-628920	Smoking Hills Fm.
		145	18.0	C-628921	Smoking Hills Fm.
		146	19.5	C-628922	Smoking Hills Fm.
		147	21.0	C-628923	Smoking Hills Fm.
		148	22.5	C-628924	Smoking Hills Fm.
		149	24.0	C-628925	Smoking Hills Fm.
		150	25.5	C-628926	Smoking Hills Fm.
		151	27.0	C-628927	Smoking Hills Fm.
		152	28.5	C-628928	Smoking Hills Fm.
		153	30.0	C-628929	Smoking Hills Fm.
		154	31.5	C-628930	Smoking Hills Fm.
		155	33.0	C-628931	Smoking Hills Fm.
		156	32.5	C-628932	Smoking Hills Fm.
		157	34.5	C-628933	Smoking Hills Fm.
		158	36.0	C-628934	Smoking Hills Fm.
		159	37.5	C-628935	Smoking Hills Fm.
		160	39.0	C-628936	Smoking Hills Fm.
		161	40.5	C-628937	Smoking Hills Fm.
		162	42.0	C-628938	Smoking Hills Fm.
		163	43.5	C-628939	Smoking Hills Fm.

		164	45.0	C-628940	Smoking Hills Fm.
		165	46.5	C-628941	Smoking Hills Fm.
		166	48.0	C-628942	Smoking Hills Fm.
		167	49.5	C-628943	Smoking Hills Fm.
		168	51.0	C-628944	Smoking Hills Fm.
		169	52.5	C-628945	Smoking Hills Fm.
		170	54.0	C-628946	Smoking Hills Fm.
		171	55.5	C-628947	Smoking Hills Fm.
		172	57.0	C-628948	Smoking Hills Fm.
		173	58.5	C-628949	Smoking Hills Fm.
		174	61.5	C-628950	Smoking Hills Fm.
		175	63.0	C-628951	Smoking Hills Fm.
		176	64.5	C-628952	Smoking Hills Fm.
		177	66.0	C-628953	Smoking Hills Fm.
		178	67.5	C-628954	Smoking Hills Fm.
		179	69.0	C-628955	Smoking Hills Fm.
		180	70.5	C-628956	Smoking Hills Fm.
		181	72.0	C-628957	Smoking Hills Fm.
		182	74.5	C-628958	Smoking Hills Fm.
		183	77.5	C-628959	Smoking Hills Fm.
69°28'46"N-126°59'20"W	**18-GTA-YB-38**	193	0.1	C-628969	Mason River Formation
		194	1.5	C-628970	Mason River Fm.
		195	3.0	C-628971	Mason River Fm.
		196	4.5	C-628972	Mason River Fm.
		197	6.0	C-628973	Mason River Fm.
		198	7.5	C-628974	Mason River Fm.
		199	9.0	C-628975	Mason River Fm.
		200	10.5	C-628976	Mason River Fm.
		201	12.0	C-628977	Mason River Fm.
		202	13.5	C-628978	Mason River Fm.
		203	15.0	C-628979	Mason River Fm.
		204	16.5	C-628980	Mason River Fm.
		205	18.0	C-628981	Mason River Fm.
		206	19.5	C-628982	Mason River Fm.
		207	21.0	C-628983	Mason River Fm.
		208	22.5	C-628984	Mason River Fm.
		209	24.0	C-628985	Mason River Fm.
		210	25.5	C-628986	Mason River Fm.
		211	27.0	C-628987	Mason River Fm.
		212	28.5	C-628988	Mason River Fm.
		213	30.0	C-628989	Mason River Fm.
		214	31.5	C-628990	Mason River Fm.
		215	33.0	C-628991	Mason River Fm.

		216	34.5	C-628992	Mason River Fm.
		217	36.0	C-628993	Mason River Fm.
		218	37.5	C-628994	Mason River Fm.
		219	39.0	C-628995	Mason River Fm.
		220	40.5	C-628996	Mason River Fm.
		221	42.0	C-628997	Mason River Fm.
		222	43.5	C-628998	Mason River Fm.
		223	45.0	C-628999	Mason River Fm.
		224	46.5	C-629000	Mason River Fm.
		225	48.0	C-629001	Mason River Fm.
		226	49.5	C-629002	Mason River Fm.
		227	51.0	C-629003	Mason River Fm.
		228	52.5	C-629004	Mason River Fm.
		229	54.0	C-629005	Mason River Fm.
		230	55.5	C-629006	Mason River Fm.
		231	57.0	C-629007	Mason River Fm.
		232	58.5	C-629008	Mason River Fm.
		233	60.0	C-629009	Mason River Fm.
		234	61.5	C-629010	Mason River Fm.
		235	63.0	C-629011	Mason River Fm.
		236	64.5	C-629012	Mason River Fm.
		237	66.0	C-629013	Mason River Fm.
		238	67.5	C-629014	Mason River Fm.
		239	69.0	C-629015	Mason River Fm.
		240	70.5	C-629016	Mason River Fm.
		241	72.0	C-629017	Mason River Fm.
		242	73.5	C-629018	Mason River Fm.
		243	75.0	C-629019	Mason River Fm.
		244	76.5	C-629020	Mason River Fm.
		245	78.0	C-629021	Mason River Fm.
		246	79.5	C-629022	Mason River Fm.
		247	81.0	C-629023	Mason River Fm.
		248	82.5	C-629024	Mason River Fm.
		249	84.0	C-629025	Mason River Fm.
		250	85.5	C-629026	Mason River Fm.
		251	87.0	C-629027	Mason River Fm.
		252	88.5	C-629028	Mason River Fm.
		253	90.0	C-629029	Mason River Fm.
		254	91.5	C-629030	Mason River Fm.
		255	93.0	C-629031	Mason River Fm.
		256	94.5	C-629032	Mason River Fm.
		257	96.0	C-629033	Mason River Fm.
		258	97.5	C-629034	Mason River Fm.
		259	99.0	C-629035	Mason River Fm.

		260	100.5	C-629036	Mason River Fm.
		261	102.0	C-629037	Mason River Fm.
		262	103.5	C-629038	Mason River Fm.
69°58'19"N-127°07'15"W	**18-GTA-YB-39**	263	3.0	C-629039	Mason River Formation
		264	4.5	C-629040	Mason River Fm.
		265	6.0	C-629041	Mason River Fm.
		266	7.5	C-629042	Mason River Fm.
		267	9.0	C-629043	Mason River Fm.
		268	10.5	C-629044	Mason River Fm.
		269	12.0	C-629045	Mason River Fm.
		270	13.5	C-629046	Mason River Fm.
		271	18.0	C-629047	Mason River Fm.
		272	25.0	C-629048	Mason River Fm.
		273	26.5	C-629049	Mason River Fm.
		274	31.0	C-629050	Mason River Fm.
		275	32.5	C-629051	Mason River Fm.
		276	35.5	C-629052	Mason River Fm.
		277	37.0	C-629053	Mason River Fm.
		278	38.5	C-629054	Mason River Fm.
		279	40.0	C-629055	Mason River Fm.

Radiolarians and foraminiferal tests were each counted to a maximum of 300 individuals to the lowest possible taxonomic rank. In radiolarian-rich samples, all the sediment was inspected, even after the 300 individuals were counted to look for any rare or biostratigraphically useful species. Abundance is considered low if not more than 50 radiolarians are found in one picking tray, moderate if the specimens counted vary between 50 and 200 per tray, and high if there are more than 200 individuals per tray. Diatoms, silicoflagellates, and sponge spicules were not counted in this study, so their abundance and diversity were estimated visually and compared to other microfossil groups. The classification of radiolarians and foraminifera was refined using a Quanta FEG 250 Scanning Electron Microscope (SEM) housed at the Department of Geoscience, University of Calgary.

Results

In the study area, the Smoking Hills Formation is 79.0 m thick and the Mason River Formation is 145.5 m thick (Figure 2). The Smoking Hills Formation is composed mainly of dark-grey to black, fissile, and bituminous mudstone with numerous jarosite bands (mainly in the lower part of the Formation) and sporadic bentonite (?) beds. Gypsum crystals are common on the outcrop surface. The Mason River Formation consists of pale to medium grey, blocky to fissile mudstones and very fine-grained sand layers

(Figure 2). The uppermost part of the unit is dominated by ferruginous lithic fragments. The contact between the Smoking Hills and Mason River formations was defined in the field by an abrupt color change (from black to pale grey).

Although the Smoking Hills and Mason River formations exhibit similar lithologies (same grain size, but differing color), their microfossil content is markedly different (Figure 2). The Smoking Hills Formation is dominated by radiolarians with rare agglutinated foraminifera. The Mason River Formation is barren of these two microfossil groups but contains a high abundance of diatoms, silicoflagellates, and sponge spicules except for the upper part of the unit, which is completely barren of siliceous microfossils and foraminifera.

Microfossil content of the Smoking Hills Formation

Radiolarian and foraminiferal taxa identified from the Smoking Hills Formation are listed in tables 2 and 3.

Forty-one radiolarian taxa were recovered from the Smoking Hills Formation (Table 2). The lower and upper parts of the unit are dominated by nassellarians (mainly *Diacanthocapsa* sp. aff. *D. cayeuxi*), whereas the middle part is dominated by spumellarians (mainly *Spongodiscus* sp. 1). Abundance, diversity, and quality of preservation of radiolaria increase upward in the section. Specimens in the lower and middle parts of the Smoking Hills Formation are highly corroded and recrystallized, hindering identification at the species, and sometimes generic level. The specimens from the uppermost part of the unit are exceptionally preserved and reveal internal and external morphological features.

Only ten taxa of agglutinated foraminifera were recovered from the Smoking Hills Formation (Table 3). The lower and middle parts of the unit are almost barren of foraminifera and only very poorly preserved specimens of *Saccammina* sp. and *Psammosphaera scruposa* were recovered. In the upper part, abundance is high, but diversity is relatively low and dominated by three species, *Haplophragmoides* sp., *Glaphyrammina spirocompressa,* and *Trochammina* cf. *T. rainwateri*. Preservation is moderate to low throughout the unit, but the foraminiferal tests are larger and more robust in the uppermost part.

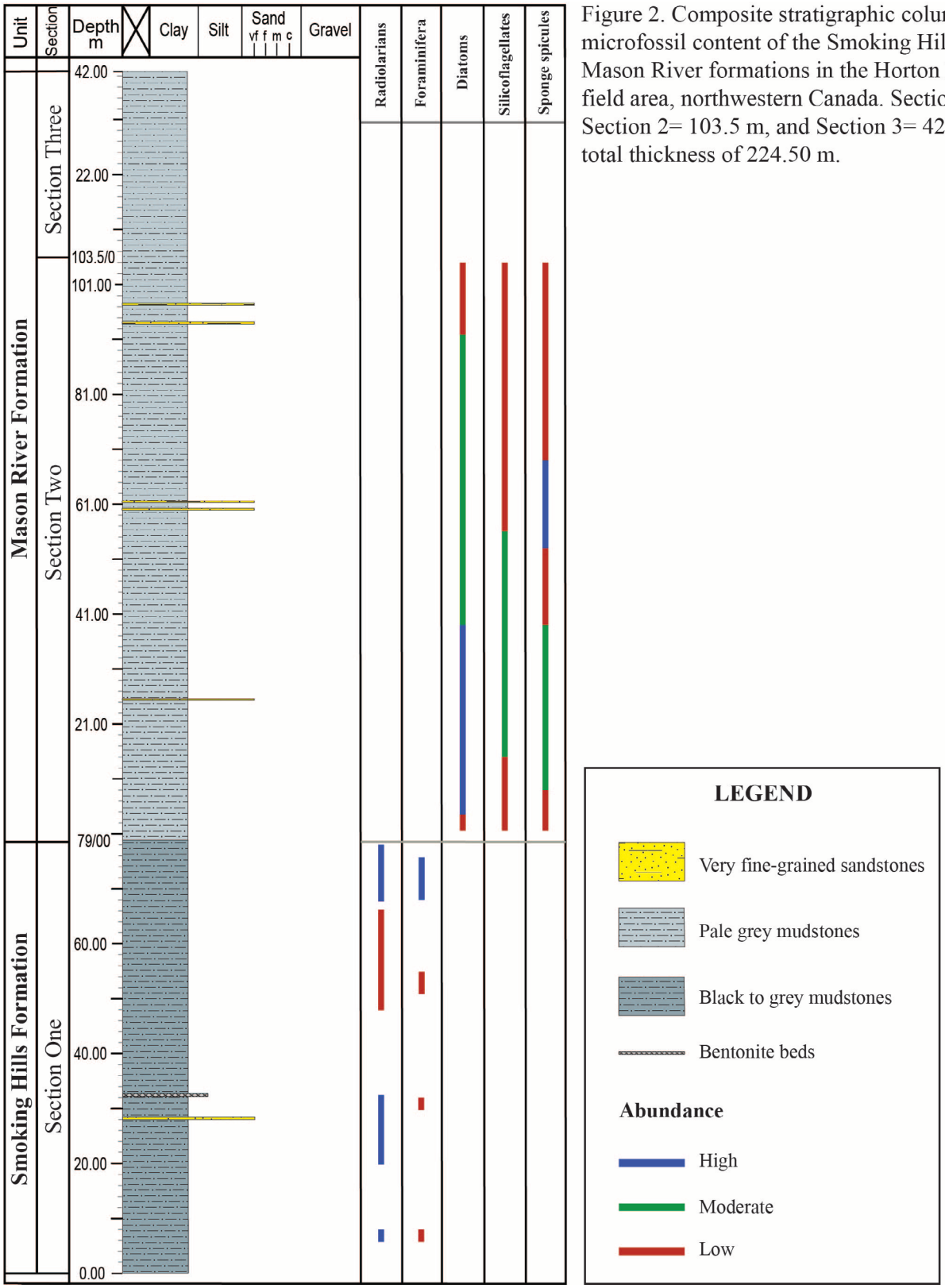

Figure 2. Composite stratigraphic column and microfossil content of the Smoking Hills and Mason River formations in the Horton River field area, northwestern Canada. Section 1= 79 m, Section 2= 103.5 m, and Section 3= 42 m for a total thickness of 224.50 m.

Table 2. List of radiolarian species recovered from the lower (L), middle (M), and upper (U) parts of the Smoking Hills Formation.

Radiolaria Species	L	M	U	Spumellaria	Nassellaria
Archaeocenosphaera (?) sp.	X	X	X	X	
Diacanthocapsa sp. 1	X		X		X
Dictyomitra multicostata Zittel 1876	X	X	X		X
Diacanthocapsa sp. 2	X		X		X
Diacanthocapsa sp. aff. *D. cayeuxi* Squinabol 1903	X		X		X
Dictyomitra (?) sp. 1	X				X
Orbiculiforma (?) sp.	X	X	X	X	
Eostichomitra (?) sp.	X		X		X
Diacanthocapsa cf. *D. fossilis* (Squinabol) 1904	X				X
Spongodiscus sp. 1	X	X	X	X	
Pessagnobrachia sp. aff. *P. fabianii* Squinabol 1914	X			X	
Phaseliforma cf. *P. laxa* Pessagno 1972		X	X	X	
Dactyliosphaera cf. *D. acutispina* Squinabol 1904		X		X	
Undetermined spumellarian 1		X	X	X	
Phaseliforma sp. 1		X		X	
Orbiculiforma monticelloensis Pessagno 1973		X	X	X	
Phaseliforma sp. 2		X	X	X	
Archaeospongoprunum bipartitum Pessagno 1973		X		X	
Orbiculiforma vacaensis Pessagno 1973		X		X	
Crucella (?) sp.		X		X	
Undetermined spumellarian 2		X		X	
Diacanthocapsa euganea Squinabol 1903			X		X
Dictyomitra (?) sp. 2			X		X
Orbiculiforma (?) *regis* Pessagno 1976			X	X	
Undetermined Orbiculiformidae			X	X	
Kreutzstella vierkantiga Empson-Morin 1981			X	X	
Diacanthocapsa sp. 3			X		X
Unidentified radiolarian 1			X	X	
Lithostrobus cf. *L. longus* Grigorieva 1975			X		X
Unidentified radiolarian 2			X	X	
Lithostrobus aff. *L. longus* Grigorieva 1975			X		X
Diacanthocapsa sp. 4			X		X
Undetermined Orbiculiformidae 2			X	X	
Dictyomitra (?) sp. 2			X		X
Orbiculiforma quadrata Pessagno 1973			X	X	
Archaeospongoprunum cf. *A. venadoensis* Pessagno 1973			X	X	
Diacanthocapsa sp. 5			X		X
Dactyliosphaera (?) sp. 1			X	X	
Undetermined spumellarian 3			X	X	
Lithostrobus borealis Kozlova and Vishnevskaya 2012			X		X

Table 3. List of agglutinated foraminiferal species recovered from the lower (L), middle (M), and upper (U) parts of the Smoking Hills Formation.

Foraminifera Species	L	M	U
Saccammina sp.	X		
Psammosphaera scruposa (Berthelin) 1880		X	
Reophax globosus Sliter 1968		X	
Bathysiphon vitta Nauss 1947		X	X
Glaphyrammina spirocompressa McNeil 1997		X	X
Balticammina? *neosuperstes* McNeil 1997		X	X
Uvigerinammina? sp. 1		X	
Haplophragmoides sp.			X
Trochammina cf. *T. rainwateri* Cushman and Applin 1946			X
Ammodiscus cretaceus Reuss 1845			X

Microfossil content of the Mason River Formation

The Mason River Formation samples are barren of radiolarians and foraminifera, but contain abundant diatom frustules, silicoflagellates and sponge spicules (Tables 4, 5, and 6).

Thirty-one diatom taxa were identified, mainly in the lower and middle part of the Mason River Formation (Table 4). Their diversity and abundance decrease upwards, and microfossils are absent in the upper part of the unit. Preservation is moderate throughout the unit, but most diatom frustules are fragmented and commonly obscured by organic matter. All species identified in this study were also reported by Tapia and Harwood (2002) in the Horton River area, Witkowski et al. (2011) in Devon Island, and Davies and Kemp (2016) in the Alpha Ridge, except for some unidentified resting spores. This assemblage is dominated by *Thalassiosiropsis wittiana, Cortinocornus rossicus, Stephanopyxis simonseni*, and *Basilicostephanus* sp. 1.

Table 4. List of diatom species recovered from the Mason River Formation.

Diatom Species
Costopyxis schulzii (Steinecke) Gleser 1984
Gladiopsis speciosus f. *poratus* Strelnikova (in Tapia and Harwood 2002)
Gladiopsis speciosa (Schulz) Gersonde and Harwood 1990
Unidentified resting spore 1
Costopyxix ornata (Schulz) Strelnikova 1974
Unknown diatom
Thalassiosiropsis wittiana (Pantocsek) Hasle 1985
Paralia crenulata (Grunow) Gleser 1992
Trinacria indefinita Jousé 1951

Stephanopyxis hannai Hajós 1975
Cortinocornus rossicus (Pantocsek) Gleser 1984
*Corinna s*p.1
Aulacodiscus septus Schmidt 1876
Trinacria acutangula (Strelnikova) Barron 1985
Sheshukovia sp. 1
Pterotheca aculeifera Grunow (in Van Heurck 1880-1885)
Odontotropis cristata (Grunow) Grunow 1884
Stephanopyxis turris (Greville) Ralfs, 1861
Hemiaulus (?) sp.
Pterotheca evermanni Hanna 1927
Hemiaulus speciosus Jousé 1951
Trinacria sp.
Basilicostephanus sp. 1
Unidentified resting spore 2
Pseudopyxilla dubia (Grunow in Van Heurck, 1883) Forti 1909
Stephanopyxis simonseni Hajós 1974
Actinoptychus tenuis Strelnikova 1974
Unidentified resting spore 3
Stephanopyxis sp.
Unidentified resting spore 4
Unidentified resting spore 5

Eleven species of silicoflagellates were identified throughout the Mason River Formation (Table 5). This assemblage is dominated by *Corbisema lateradiata* and species of the genus *Lyramula*. Specimens are very well preserved, but like diatoms, most of them are fragmented and obscured by amorphous organic matter. Diversity and abundance are low throughout the unit except for the upper part, which is barren of siliceous microfossils. All the species identified in this study had been reported before by McCartney et al. (2010, 2011a, 2011b) in the same area.

Table 5. List of silicoflagellates recovered from the Mason River Formation.

Silicoflagellate Species
Lyramula furcula Hanna 1928
Arctyocha mesocena McCartney Witkowski and Harwood 2011
Lyramula arctica Bukry 1985
Lyramula simplex var. *simplex* Hanna 1928
Corbisema parallela Hajós 1975
Cornua trifurcata Schulz 1928
Vallacerta hortonii Hanna 1928

Corbisema lateradiata (Schulz) Perch-Nielsen 1975
Arctyocha bukryi Desikachary and Prema 1996
Lyramula simplex var. inflata McCartney, Harwood and Witkowski 2011
Corbisema cf. C. geometrica Hanna 1928

Sponge spicules are abundant throughout the lower and middle parts of the Mason River Formation and absent in the upper part. Their size ranges between 63 µm and 500 µm, though some reach 1 mm size. Eight different types of megascleres and one microsclere were identified in this study (Table 6). Within the megascleres, monaxons dominate the assemblage followed by triaxons and tetraxons. Sponge spicules have received little attention in both biostratigraphic and paleoenvironmental analyses due to their long stratigraphic ranges and complex nature. However, their examination proves useful as they are the only benthic microfossils recovered from the Mason River Formation, which may be helpful to understand the biotic processes occurring at the sediment-water interface.

Table 6. List of sponge spicule morphotypes recovered from the Mason River Formation.

Sponge spicule morphotypes
Regular triactine
Spheraster
Spined triod
Sigma
Acanthoxea
Oxea
Strongyle
Stauractine
Triaene

Discussion

Radiolarian biozones have not been proposed for Campanian-Maastrichtian strata in North America, except for the ones proposed by Pessagno (1976) in the Great Valley sequence of California. A radiolarian zonation was recently proposed by Pugh et al. (2014), but in Cenomanian-Santonian rocks from the Sverdrup Basin on Ellef Ringnes Island, Nunavut, Canada. The few papers that have been published exclusively from the Pierre Shale Formation and equivalents in Canada and the United States only list a few species, but do not address their age or biostratigraphic correlation (e.g. Wall, 1975; Wall and Singh, 1975; Schultz et al., 1980; Bergstresser, 1983; Young and Moore, 1994; Muehlbauer et al., 2014). The radiolarian assemblage recovered from the Smoking Hills Formation in this study is therefore

key to create a new biozonation scheme that can be correlated with the scant information published from lower latitudes over the last decades. This radiolarian biozonation is underway and it is not further discussed in this report.

The use of radiolarians as paleobiogeographic proxies in the Canadian Arctic is challenging due to the paucity of micropaleontological information in North America. However, some preliminary conclusions can be drawn using the data collected thus far in this study. The exiguous radiolarians assemblages recovered from Campanian-Maastrichtian strata in the Western Interior Basin of North America correlate well with the assemblage from the Smoking Hills Formation, based on preliminary comparisons. Nevertheless, the absence of index species in the southern and central parts of North America inhibits a proper faunal correlation between the two regions. Most species recovered in this study have been reported from intermediate and low latitudes, although the conspicuous phaseliformids are more common in high latitudes (Empson and Morin, 1981; Bragin and Bragina, 2018). In general, the radiolarian assemblage from the Smoking Hills Formation shows a close affinity with the fauna identified from European and Tropical Pacific realms (e.g. Vishnevskaya and Kozlova, 2012; Pessagno 1972, 1973). Samples C-628955, C-628956, and C-628959 in the uppermost part of the Smoking Hills Formation (a few metres below the contact with the overlying Mason River Formation) contain an exceptionally preserved, diverse and abundant radiolarian fauna that may yield species endemic to the Canadian Arctic.

Conclusions

Forty-one species of radiolarians and ten species of agglutinated foraminifera have been recovered from the Smoking Hills Formation in the Horton River area, Northwest Territories. The radiolarians identified herein represent the first report of a Campanian-Maastrichtian assemblage in the Canadian Arctic and one of the few assemblages of this age in North America. The agglutinated foraminifera recovered correlate with the fauna identified in the Smoking Hills Formation (*Glaphyrammina spirocompressa* biozone) by McNeil (1997) and Dixon and McNeil (2008) in the Beaufort-Mackenzie Basin. The overlying Mason River Formation is barren of foraminifera and radiolarians but contains thirty-one species of diatoms, eleven silicoflagellates and nine sponge spicules morphotypes. Most species identified in the Mason River Formation have been reported before in the Canadian Arctic (including the Horton River area) except for a few unidentified resting spores. Correlation of the fauna recovered in this study with agglutinated foraminiferal (Dixon and McNeil, 2008), diatom (Tapia and Harwood,

2002), and silicoflagellate (McCartney, 2011a) zones indicates an early Campanian age for the Smoking Hills Formation and a middle Campanian-Maastrichtian (?) age for the Mason River Formation.

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