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See Appendix 5 therein for updated results and interpretations.

PALYNOLOGICAL ANALYSIS OF SIX OILSANDS CORES

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CONTENTS

SECTION 1	INTRODUCTION	2
SECTION 2	RESULTS	3
	1AA/03-12-081-06W4	3
	1AA/05-17-083-06W4	6
	1AB/06-09-090-14W4	9
	100/05-17-092-17W4	12
	1AA/03-28-096-16W4	15
	1AA/16-17-101-13W4	18

As part of the study "Biostratigraphy and palynofacies of the Athabasca Oil Sands deposits" conducted with Dr. F. Hein, samples from a number of cores were taken. Of these, five had not been analyzed before and additional samples were analyzed from one well*. The wells in question are:

1AA/03-12-081-06W4
1AA/05-17-083-06W4
1AB/06-09-090-14W4
100/05-17-092-17W4
1AA/03-28-096-16W4
1AA/16-17-101-13W4*

The results are described in Section 3. A species occurrence chart follows each well description. The palynofacies symbol Hr* is used to denote probable freshwater dominated environments where there are no freshwater algae and there is no sign of any marine influence.

SECTION 2**RESULTS**

1AA/03-12-081-06W4

Twelve samples from a section that encompasses the Lower McMurray through to the basal Clearwater were analyzed.

Depth(m)	Formation/Member	Palynofacies
201.96	Clearwater (T21)	Cd
202.66	Wabiskaw A-B	Cd
204.48	Wabiskaw A-B	Cd
208.8	Wabiskaw A-B	Cd
210.47	Wabiskaw A-B	Cd
212.72	Wabiskaw C	COOP
215.55	Wabiskaw D	COOP + OS
217.53	Wabiskaw D	OS + TCT
222.06	Upper McMurray	OS
227.45	Upper McMurray	Hr
241.7	Middle McMurray	COOP into NyR/NyA
272.54	Lower McMurray	NyR

Depth: 272.54m

Palynofacies: NyR

Remarks

This sample from the Lower McMurray contained a rich spore-pollen assemblage with abundant marsh-derived species and an unusually large number of *Cerebropollenites mesozoicus*, a gymnosperm pollen grain.

There is one specimen of *Hurlandsia rugara* and 3 questionable freshwater dinocysts along with 6 *Nyktericysta* spp. The sample is assigned to NyR but the waters were essentially fresh.

Depth: 241.7m

Palynofacies: COOP flood into NyR/NyA

Remarks

There are 25 *Nyktericysta* specimens that indicate NyR/NyA palynofacies. However, there are also 11 COOP dinocysts and 4 OS species that suggest the mixing of brackish and sub-normal marine waters, possibly at the upper limit of marine influence in the estuary.

Depth: 227.45m

Palynofacies: Hr

Remarks

This is a rich spore-pollen assemblage in which marsh derived species are dominant. The rare dinocysts and other algae indicate an essentially freshwater environment for this sample for the lower part of the Upper McMurray.

Classopollis spp. and *Exesipollenites* spp. are abundant pointing to an arid climate.

Depths: 222.06m, 217.53m
Palynofacies: OS, OS + TCT

Remarks

The lower sample is from the Upper McMurray and the other from the base of the Wabiskaw D. Both contain OS assemblages with minor COOP components. The McMurray sample is particularly rich but the basal Wabiskaw assemblage is diluted by TCT pollen. The latter also contains moderately abundant *Classopollis* specimens suggesting an arid climate.

Depth: 215.55m
Palynofacies: COOP + OS

Remarks

This sample comes from the upper part of the Wabiskaw D. The assemblage is comprised of approximately equal numbers of COOP and OS dinocysts indicating a strong brackish influence.

Depth: 212.72m
Palynofacies: COOP

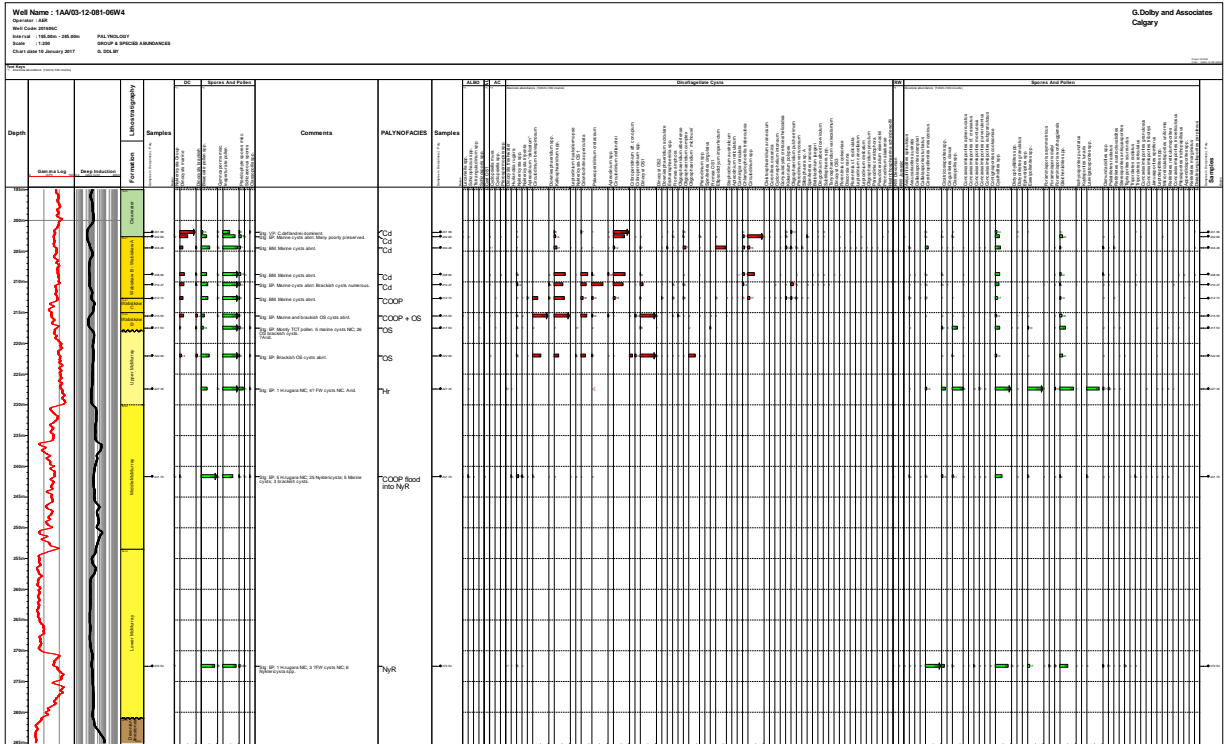
Remarks

This sample from the top of the Wabiskaw C yielded a rich and diverse assemblage of COOP dinocysts. A modest number of *Circulodinium deflandrei* suggests an increasingly marine environment and the bimodal kerogen sorting points to tidal influence.

Depths: 210.47m, 208.8m, 204.48m, 202.66m, 201.96m
Palynofacies: Cd

Remarks

Four samples come from the Wabiskaw A/B and the uppermost one from the basal Clearwater. All yielded specimens of *C. deflandrei* rather than *C. brevispinosum*, generally in large to very large numbers. The assemblages are much more diverse than those below indicating more open marine conditions.



1AA/05-17-083-06W4

Eleven samples from this core were processed:

Depth(m)	Formation/Member	Palynofacies
307.65	Wabiskaw A	Cd
308.4	Wabiskaw A	Cd
309.9	Wabiksaw B	COOP
311.4	Wabiskaw B	COOP
314.5	Wabiskaw D	COOP + OS
316.75	Middle McMurray	Hr
326.5	Middle McMurray	Hr
339.4	Middle McMurray	Hr*
345	Middle McMurray	Hr
346.45	Middle McMurray	Hr
346.9m	Marl	Karst deposit

Depth: 346.9m
Palynofacies: Karst deposit

Remarks

This assemblage is from a marl on top of the Devonian limestones and contains abundant Cretaceous spores and pollen and a few dinocysts. There are also some Devonian acritarchs and an abundance of what appears to be algal debris.

Depths: 346.45m, 339.4m, 326.5m, 316.75m
Palynofacies: Hr (Hr* at 339.4m).

Remarks

These samples from the Middle McMurray yielded rich spore/pollen assemblages but dinocysts are very rare. The dinocysts and other algae suggest a predominantly freshwater influence although a single brackish form was recorded at 326.5m.

Abundant *Classopollis* spp. and *Exesipollenites* spp. at 339.4m and 326.5m indicate an arid or semi-arid climate at those depths.

Depth: 314.5m
Palynofacies: COOP + OS

Remarks

This is a typical Wabiskaw D assemblage in which OS dinocysts are abundant. However, the more marine COOP component is dominant.

Depths: 311.4m, 309.9m
Palynofacies: COOP

Remarks

These assemblages from the Wabiskaw B are more diverse in composition than the 314.5m Wabiskaw D sample and also lack the brackish OS components.

Depths: 308.4m, 307.65m

Palynofacies: Cd

Remarks

Both assemblages from the Wabiskaw A are somewhat more diverse than those from the Wabiskaw B. In addition, one of the COOP indices, *Circulodinium brevispinosum*, is replaced by the Cd index, *C. deflandrei*.



1AB/06-09-090-14W4

Six samples from a section encompassing the McMurray through to the Wabiskaw C were analyzed.

Depth(m)	Formation/Member	Palynofacies
182.14	Wabiskaw C	COOP
185.25	Wabiskaw D	COOP
193.85	Wabiskaw D	COOP (restricted)
200.25	McMurray	?COOP
202.84	McMurray	Hr
207.7	McMurray	Hr

Depth: 207.7m
Palynofacies: Hr

Remarks

This is clearly a restricted, probably a marsh environment. *Hurlandsia rugara* is prominent, indicating fresh water, and *Gleicheniidites* spp. are also abundant. An unusual feature is the abundance of *Stereisporites antiquasporites*, a bryophyte spore.

Depth: 202.84m
Palynofacies: Hr

Remarks

H. rugara is also prominent here as are the marsh spores *Cyathidites* spp. and *Gleicheniidites* spp. There are also eight specimens of an unusual dinocyst that somewhat resembles *Nyktericysta* and four undoubted *Nyktericysta* spp.

Classopollis spp. are fairly abundant, pointing to a semi-arid climate for which there is often evidence in the uppermost McMurray.

Depth: 200.25m
Palynofacies: ?COOP

Remarks

There are very rare marine dinocysts in this sample that suggest COOP influence but the palynofacies are not well defined, due to the level of biodegradation. The abundance of *Classopollis* spp. is indicative of an arid climate.

Depth: 193.85m
Palynofacies: COOP (restricted)

Remarks

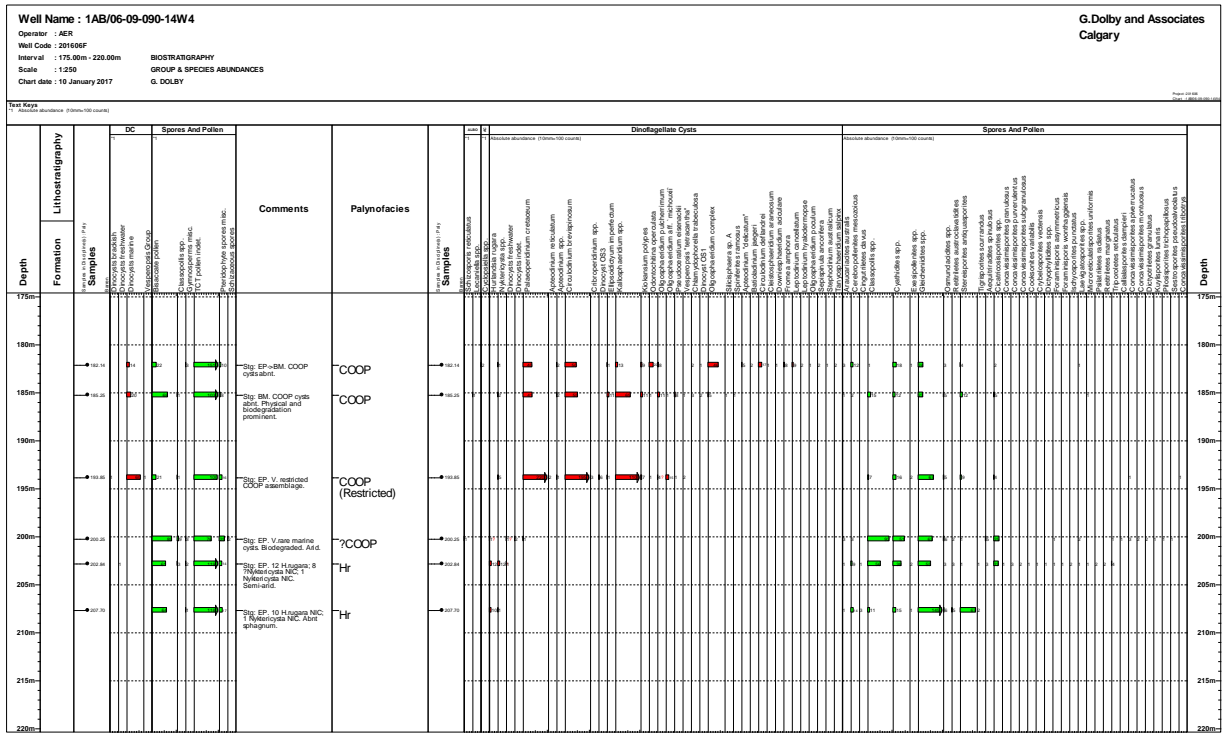
Two of the principal COOP markers, *Circulodinium brevispinosum* and *Palaeoperidinium cretaceum* are extremely abundant whereas the other two, *Odontochitina operculata* and *Oligosphaeridium* spp., are very rare. A very restricted marine environment is therefore indicated.

The OS components that are normally abundant in equivalent lower Wabiskaw D samples, are present but only in small numbers.

Depths: 185.25m, 182.14m
Palynofacies: COOP

Remarks

The lower sample is from near the top of the Wabiskaw D and the upper from near the base of the Wabiskaw C. Both are rich and diverse COOP assemblages. The lower sample shows evidence of the both biological and physical degradation. A modest number of *C. deflandrei* at 182.14m confirms a stronger marine influence.



100/05-17-092-17W4

Nine samples from this well were analyzed.

Depth(m)	Formation/Member	Palynofacies
199	Wabiskaw A	CD equivalent
224.38	Wabiskaw C	COOP
232.65	McMurray	OS
242.92	McMurray	OS
248.2	McMurray	Hr
254.45	McMurray	Hr
259.29	McMurray	Hr
260.45	Marl	Karst deposit
261.2	Marl	Karst deposit

Depths: 261.2m, 260.45m
Palynofacies: Karst deposit

Remarks

Both samples come from a marl on top of the Devonian and the organic yields were extremely low. Both assemblages contain Cretaceous spores and pollen but no Devonian palynomorphs.

Depths: 259.29m, 254.45m, 248.2m
Palynofacies: Hr

Remarks

These three samples from the McMurray contain essentially freshwater dinocyst assemblages characterized by numerous to abundant *Hurlandsia rugosa*. *Classopollis* spp. are also abundant at 259.29m and 248.2m pointing to an arid/semi-arid climate.

Depths: 242.92m, 232.65m
Palynofacies: OS

Remarks

The lower sample contains an OS assemblage with no COOP components, indicating a restricted, brackish setting. The 232.65m assemblage is richer in OS dinocysts and other algae but also contains a small number of COOP species.

Classopollis spp. are abundant and *Exesipollenites* spp. are numerous to abundant indicating an arid/semi-arid climate.

Depth: 224.38m
Palynofacies: COOP

Remarks

This is a typically diverse COOP assemblage of dinocysts with a very limited terrestrial component. The bimodal sorting and physical degradation of the palynomorphs indicates a shallow, tidally influenced environment.

Depth: 199m
Palynofacies: Cd equivalent

Remarks

This sample from a Wabiskaw A shale yielded a biodegraded and physically degraded assemblage. These factors coupled with a strong bimodal kerogen sorting indicate a shallow marine setting typical of tidal flats. *Canningia reticulata* is abundant equating the palynofacies with Cd.

1AA/03-28-096-16W4

Eight samples were processed from this well as follows:

Depth(m)	Formation/Member	Palynofacies
355.9	Clearwater	Cd equivalent
361.07	Wabiskaw A-C	Cd
363.75	Wabiskaw D	COOP
387.43	Wabiskaw D	OS
388.62	Wabiskaw D	OS
393.63	McMurray	NyR/NyA
398.25	McMurray	NyR
402.5	McMurray	Hr

Depth: 402.5m
Palynofacies: Hr

Remarks

Inertinite laths dominate the residue and dilute the assemblage. Three *H. rugara* and two hyaline dinocysts assign this sample to the Hr palynofacies. There is evidence of reworking of Devonian and probably Jurassic rocks.

Depths: 398.25m; 393.63m
Palynofacies: NyR; NyR/NyA

Remarks

The fair to good sorting in both samples indicates elevated energy levels and the degree of physical degradation is high. Twenty-one specimens of *Nyktericysta* spp. indicate NyR palynofacies at 398.25m and a slightly higher number of 393.63m suggests borderline NyR/NyA facies.

Cyathidites spp. and *Gleicheniidites* spp. are very abundant in both deriving from probable marsh environments.

Depths: 388.62; 387.43m
Palynofacies: OS

Remarks

Both samples from near the base of the Wabiskaw D yielded rich assemblages of OS dinocysts. *Fromea* OS1 dominates the lower sample and Dinocyst OS1 is dominant at 387.43m.

Depth: 363.75m
Palynofacies: COOP

Remarks

This is a rich, marine COOP assemblage. Bimodal sorting suggests tidal influence.

Depth: 361.07m
Palynofacies: Cd

Remarks

Circulodinium deflandrei dominates here and tidal influence is indicated by the bimodal kerogen sorting.

Depth: 3555.9m
Palynofacies: Cd equivalent

Remarks

Circulodinium brevispinosum is absent and *C. deflandrei* numbers are much reduced being replaced by abundant *Canningia reticulata*.



1AA/16-17-101-13W4

Four additional samples were taken from this core, which was originally analyzed in Report #2025. The entire section is described here.

Depth(feet)	Formation/Member	Palynofacies
1571.5	Upper McMurray	SF
1572.6	Upper McMurray	SF
1576.56	Upper McMurray	SF
1626.1	Upper McMurray	COOP
1642.83	Middle McMurray	V
1650.75	Middle McMurray	V?
1681	Middle McMurray	Uncertain
1737	Middle McMurray	Hr*/NyR
1741	Middle McMurray	NyR
1746	Lower McMurray	Hr*
1751	Lower McMurray	Hr*
1755.6	Lower McMurray	Hr*

Depths: 1755.6', 1751', 1737'

Palynofacies: Hr*

Remarks

These samples are from the Lower McMurray. No dinocysts or freshwater algae were recovered and they are assigned to Hr*.

The spore-pollen assemblages are similar to others from fluvial settings in this study and the proportions of schizaceous spores are above average suggesting an overbank setting. The kerogen is well sorted in 1755.6', fairly well sorted in 1751' and slightly winnowed in 1746' indicating varying levels of current activity. Laths of fusinite (bogen debris) derived from wild fires are prominent.

Depth: 1741', 1737'

Palynofacies: NyR, Hr*/NyR

Remarks

These samples from the base of the Middle McMurray are essentially fluvial samples, note the very high proportion of hinterland pollen. The small number of *Nyktericysta* spp. assigns the lower sample to NyR. The 1737' sample contains only one specimen of *Nyktericysta* sp. along with a hyaline cyst.

Depth: 1681'

Palynofacies: Uncertain

Remarks

The yield from this sample was low and the organic residue is dominated by bitumen and waxy residue. The spore/pollen assemblage is typical of an open, fluvial or estuarine environment. A single specimen of *Hurlandsia rugara* is more typical of fluvial to very high estuarine settings but a single specimen of *Circulodinium brevispinosum* suggests that there may be some COOP contribution. The yield is too small to be definitive.

Depth: 1650.75'
Palynofacies: ?V

Remarks

Dinocysts are in this sample from the upper part of the Middle McMurray and include 5 *Nyktericysta* spp., and very poorly preserved specimens of *Palaeoperidinium cretaceum* and *Vesperopsis* sp. *Classopollis* spp. and *Exesipollenites* spp. are moderately abundant pointing to a dry climate. The abundances of *Cyathidites* spp. and *Gleicheniidites* spp. suggest the proximity of marsh environments. The bimodal kerogen sorting is probably indicative of tidal influence.

Depth: 1642.83'
Palynofacies: V

Remarks

This assemblage closely resembles that from the underlying 1650.75' sample. Dinocysts are more numerous and there are two good specimens of *Vesperopsis* "*tetracantha*".

Depth: 1626.1'
Palynofacies: COOP

Remarks

COOP species are abundant, especially *C. brevispinosum* which comprises 29% of the assemblage. The sample is from the lower part of the Upper McMurray and confirms the stronger marine influence in this Member.

Depths: 1578.56', 1572.6', 1571.5'
Palynofacies: SF

Remarks

The SF marker *Kiokansium unituberculatum* (formerly *K. polypes*) is abundant and the dominant dinocyst in all three assemblages that also contain moderate numbers of COOP species. *Nyktericysta* spp. are common to abundant and there are also small numbers of OS palynofacies dinocysts indicating significant brackish influxes into this shallow marine setting.

Classopollis spp. are abundant at 1572.6' indicating an arid climate, a frequent feature of the uppermost Upper McMurray.

