Stratigraphy and Palynomorph Biostratigraphy of the Lower Mannville Group, Western Saskatchewan and Eastern Alberta – Preliminary Report

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1. Introduction

Oil and gas discoveries in widely spaced localities throughout Alberta and Saskatchewan have led to the use of a plethora of names for subsurface Lower Cretaceous strata (Figure 1). Where these strata are essentially flat lying and laterally continuous, correlations are straightforward. They are, however, difficult where multiple incisions have occurred, where paleotopographic highs are covered by thin deposits, and where deposits have different sediment provenances or represent different depositional environments within adjacent "valleys".

In the absence of substantive macrofossil evidence, palynomorph biostratigraphy offers significant opportunity to subdivide strata, to establish age relationships, and to test correlations in Lower Cretaceous strata of eastern Alberta and western Saskatchewan.

Previous palynology studies have identified abundant and diverse assemblages of terrestrial and marine palynomorphs in the Lower Cretaceous Mannville Group (Pocock, 1962; Singh, 1964; Norris, 1967; Vagvolgyi and Hills, 1969; Playford, 1971; Burden, 1984; Banerjee and Davies, 1988; and Burden and Hills, 1989). Dinoflagellates track a long and punctuated history of Early Cretaceous marine transgression in the Western Canada Basin. Spores and pollen, and in particular pollen from flowering plants, track major evolutionary events in earth history as coastal environments were periodically drowned. The reports by Burden (1984) and Banerjee and Davies (1988) independently offer evidence suggesting the Ostracode Zone is diachronous as is, by implication, the lower-upper Mannville contact. Furthermore, their reports indicate that the Ostracode Zone may be Barremian in age in southern Alberta and Montana. If true, testing these concepts with a biostratigraphic transect from southern Alberta to the heavy oil belt of Saskatchewan may lead to significant revision of current stratigraphic models and depositional histories. This transect will generate significant new information on the regional distribution of lower Mannville palynomorph species in western Canada.

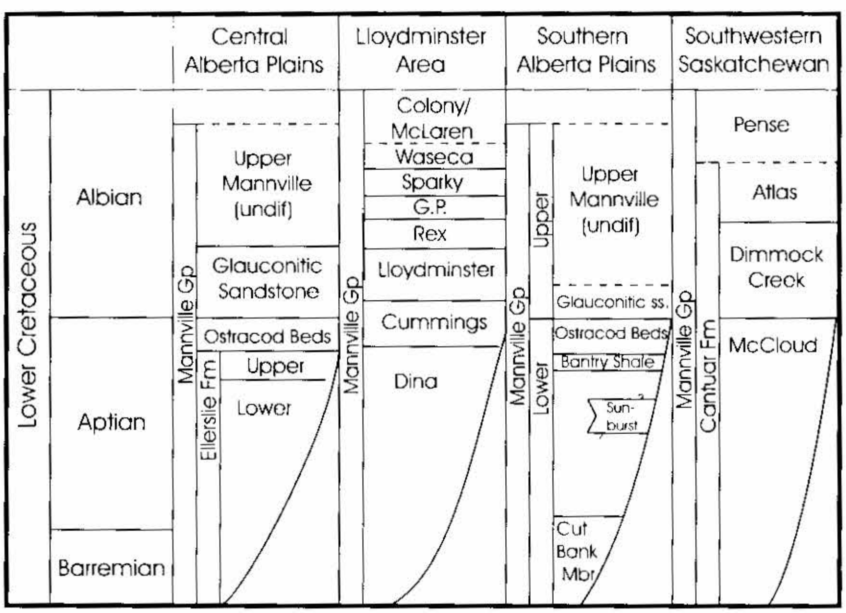

Figure 1 - Stratigraphic nomenclature of the Mannville Group in the study area (after Hayes et al., 1994).

2. Stratigraphic Framework

Glaister (1959) examined lithology of outcrop and core from southern Alberta and Montana and subdivided the Blairmore (Mannville) into Lower and Upper formations. The division between quartzose sandstones and cherty and glauconitic litharenitic sandstones was placed at the top of the Calcareous Member or Ostracode Zone as defined by Loranger (1951). Subsequent studies by Williams (1963) and Mellon

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(1967) confirmed details of this tripartite lithology in Alberta, identifying a complex channeled and unconformity-bounded stratigraphy which formed part of what we now recognize as an emerging foreland basin. Farther east in Saskatchewan, quartzose strata derived from the Canadian Shield form a significant fraction of the rocks of the Lower Cretaceous. Here, Vigrass (1977) employed an informal breakdown of the Mannville Group into lower, middle, and upper subgroups for the Lloydminster area. In this classification, the lower Mannville comprises the Dina and Cummings members; the middle Mannville, the Lloydminster, Rex, General Petroleums, and Sparky members; and the upper Mannville (well above the strata examined in this present study), the coal and cherty litharenite of the Waseca, McLaren, and Colony members. Christopher (1980, 1997) examined the Mannville stratigraphy in Saskatchewan and identified the Cantuar and Pense formations. He proposed that the Cantuar incorporate the Dina, Cummings, Lloydminster, Rex, General Petroleums, Sparky, and Waseca members, and that the Pense include the McLaren and Colony members.

Lithologically, the Mannville Group consists generally of interbedded shale and sandstone with minor coal. Mannville sediments were deposited in marine, estuarine, and fluviatile environments, in settings controlled by paleotopographic relief and changes in relative sea levels. Sediments were derived from local Paleozoic and Lower Mesozoic landforms, the Precambrian Shield, and rising volcanic uplands of the emerging Cordilleran orogen. In outcrop and core, Mannville Group strata show great lateral variation that developed as sea levels fluctuated through the Early Cretaceous. Internal architecture shows fluvial and tidal channels cutting into essentially flat surfaces. Evidently, little accommodation space was available. In absence of distinctive marker beds, detailed stratigraphic correlation of lower Mannville strata is difficult without closely spaced core control.

3. Preliminary Results

Field work on this project included a detailed examination of 57 cores along a transect from southeast Alberta to west-central Saskatchewan (Figure 2). Table 1 outlines details for each core examined for this study, including the interval logged as well as the number of samples taken for palynological investigation. Samples were selected to provide coverage of each lower Mannville member and to capture changes between important lithologic units. Strata selected for collection were determined from geophysical log correlations and from lithological comparisons between cores. In Alberta, samples chosen for palynological processing were from cores of undifferentiated lower Mannville strata and the Glauconite sandstone. In Saskatchewan, the samples were constrained to those cores comprising Lloydminster, Cummings, and Dina members.

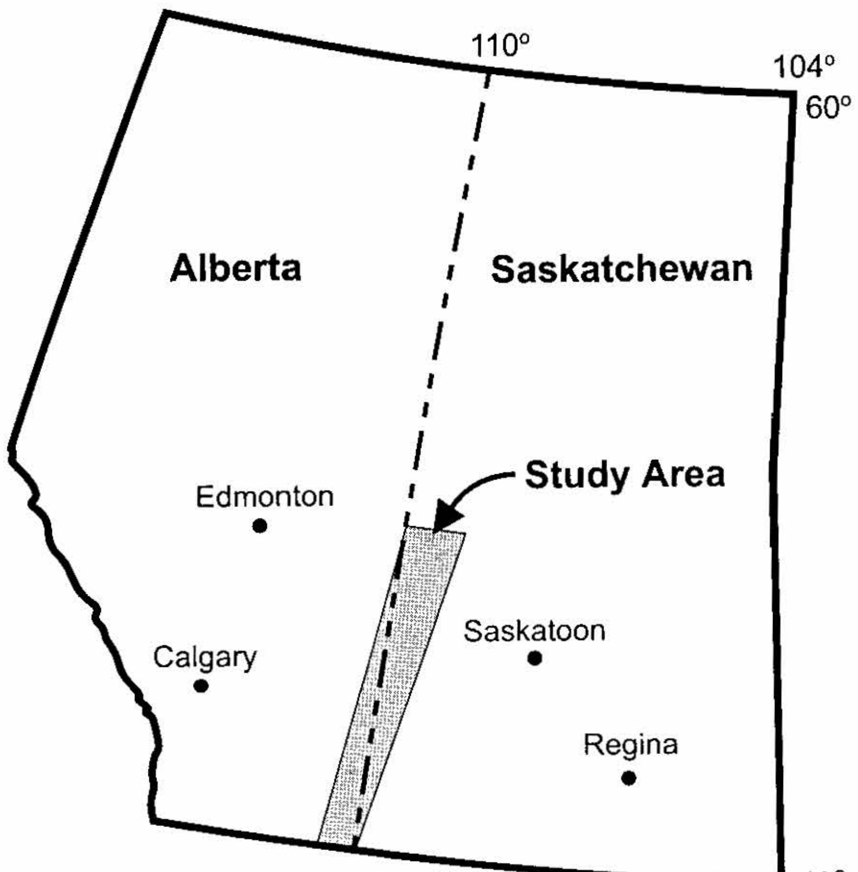

Figure 2 - Location of study area along the Saskatchewan/Alberta border.

Samples were processed using standard palynological processing techniques. Samples were crushed to pea-sized fragments, of which 5 to 10 g were weighed into labelled beakers. To determine fossil concentration, *Lycopodium* spore tablets having concentrations of 12 542 ±375 were added to each sample. A 10% hydrochloric acid solution was added to each sample to remove carbonates. After approximately 24 hours, samples were washed with distilled water and then mixed with hydrofluoric acid to dissolve silicates. After another 24 hours, samples were washed again, following which an unsieved slide was prepared. Residues were then sieved with a 10 μm screen to remove fine organic fragments and clay. Following sieving, two additional slides were prepared for each sample; these provide information on organic maturation. Samples were then stained with Safranin O solution to enhance morphologic features of the specimens, after which another two slides were prepared. Highly organic samples, such as coals, were further oxidized with Schultze solution to remove humic matter and to lighten the material for easier microscopic observations.

Table 1 - List of cores logged and sampled.

Well Name	Well Location	Interval logged (m)	No. of samples taken
Shell Meaota	C13-17-46-17W3	498.0-584.0	10
Shell Dee Valley	11-18-48-21W3	479.0-588.5	28
Shell Husky Paradise Hill	A13-19-52-23W3	516.0-657.25	26
G&W Jordan Dankin	4-32-26-24W3	885.0-901.0	3
Shell Manitou	6-7-43-24W3	672.0-741.5	12
Saskoil Winter	10-28-42-25W3	645.0-675.0	6
H.J. McLaren #1	4-6-50-25W3	527.3-579.1	0
Husky McLaren #8	12-6-50-25W3	605.3-607.8	0
Mobil Tangleflags	A10-34-50-25W3	539.0-548.0	3
Mobil Tangleflags	6-36-50-25W3	524.9-569.7	4
Husky Tangleflags	A7-01-51-25W3	506.3-511.1	0
Husky Hillmond	111/5-7-51-25W3	532.0-547.0	5
Saskoil Gulf Senlac	1-6-39-26W3	783.2-800.6	6
Gulf Saskoil Senlac	B3-7-39-26W3	787.0-784.0	5
Shell Senlac	2-21-40-26W3	740.0-794.0	11
Saskoil PCI Marsden	A10-16-44-26W3	627.0-636.0	1
Wascana Marsden	A12-19-44-26W3	626.0-634.0	1
Saskoil PCI Marsden	A15-19-44-26W3	693.5-710.5	4
Conoco Neilberg	A3-11-46-26W3	596.0-612.0	5
G&W et al. Mantario N	A5-25-27-27W3	850.5-871.0	2
G&W Wascana	A13-32-27-27W3	897.0-915.0	4
Mantario N	A1-6-28-27W3	915.0-921.0	2
Saskoil Gulf Senlac	2-1-39-27W3	785.0-803.0	4
Gulf Saskoil Senlac	A4-1-39-27W3	786.5-804.5	5
Morgan Evesham	13-25-39-27W3	775.0-793.0	0
Calex et al. Court	A7-26-33-28W3	856.0-872.0	0
Texaco Court North	B6-6-34-28W3	872.0-891.95	3
Pex et al. Cactus LK	5-36-35-28W3	825.0-849.5	4
Pex et al. Cactus LK	5-1-36-28W3	806.0-815.0	3
Wascana Cuthbert	A2-2-27-29W3	933.5-948.5	3
Delhi Ba Antelope Hills #1	11-7-21-1W4	858.0-922.3	8
DS&W et al. Graindale	11-6-25-1W4	922.6-935.4	5
Wascana Alsask	5-13-27-1W4	891.0-906.0	7
Wascana Alsask	9-13-27-1W4	890.0-904.0	6
BP Sibbald	100/5-30-27-1W4	878.0-884.9	4
Compadre Sibbald	6-30-27-1W4	874.8-890.9	4
BP Sibbald D-32	10-32-27-1W4	842.0-851.0	3
Cass Alsask	14-02-28-1W4	816.5-852.5	6
BA et al. Antelope	10-12-30-1W4	766.6-774.2	2
Gardiner Compeer	10-24-33-1W4	843.0-851.5	6
Centennial Compeer	1-30-33-1W4	852.8-858.4	3
Anglo Royalite Kroy Acadia	7-25-23-2W4	881.5-890.6	0
D.S. Wetah Grandalee	10-13-25-2W4	915.9-932.1	6
Crestar Med. Hat	13-25-18-3W4	893.0-911.0	7
Crestar 102 Med. Hat	02/10-35-18-3W4	917.0-934.8	4
Ridgeway Wagner Cavendish	7-17-21-3W4	868.7-897.6	2
CMG Cyprus	6-1-8-4W4	1235.0-1250.0	4
Britalta DR Many Isl. #7	10-11-13-4W4	821.4-927.2	2
Gascan Med. Hat	14-9-14-4W4	878.0-895.0	5
Altex et al. Sapphire	16-5-2-5W4	1012.0-1021.0	2
TNR Omega Comrey	10-27-2-5W4	956.2-972.9	5
Shell et al. Sapphire	16-35-2-5W4	993.0-1002.0	0
Shell Bain	12-14-3-5W4	1034.0-1041.8	3
Triumph Manyberries	14-11-4-5W4	1048.0-1066.0	3
Anderson et al. Manyberries	4-35-4-5W4	1058.0-1076.0	0
Huber et al. Manyberries	6-3-5-5W4	1029.0-1045.0	3
Shell Manyberries	14-5-6-5W4	1055.0-1073.0	3

Preliminary examination of slides for species indicate the presence of the following taxa: *Baculatisporites, Cicatricosisporites, Cyathidites, Gleichiniidites, Impardecispora, Inaperturopollenites, Januasporites, Lycopodiacidites, Osmundacidites, Stereisporities*, and Taxodiaceae, as well as a number of bisaccates. These represent commonly reported Cretaceous plant fossils occurring in terrestrial settings.

Preliminary analysis of one distinctive coal horizon confirms that it can be correlated throughout the area. However, palynological assemblages suggest different coal-forming environments existed for the same coal. This implies facies variations and possible diachronism in the deposition of coaly sediments.

4. Further Work

Additional research will endeavor to clarify some of the complexities of correlating lower Mannville sediments using biostratigraphic controls. A comparative analysis of biostratigraphy and lithostratigraphy will attempt to determine whether strata and unconformities are easily identified with palynomorph biostratigraphy.

5. Acknowledgments

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