36. GEOLOGICAL AND PALYNOLOGICAL INTERPRETATION OF EUREKA SOUND FORMATION ON SABINE PENINSULA, NORTHERN MELVILLE ISLAND, DISTRICT OF FRANKLIN

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Introduction

A 33 m composite section of the Eureka Sound Formation, exposed on the northern tip of Sabine Peninsula, Melville Island (Fig. 36.1), is described. The significance of this section lies in the fact that this is one of the few locations where the Eureka Sound Formation is exposed in the western half of Sverdrup Basin (Tozer and Thorsteinsson, 1964). Therefore, age determination and structural and stratigraphic relationships of these rocks with the underlying formations are critical for the elucidation of Late Cretaceous-early Tertiary geological history of the western part of Sverdrup Basin and its relationships with the geological events of the same time span of the eastern part of Sverdrup Basin.

Preliminary studies of the structural and stratigraphic relationships of Mesozoic and Tertiary rocks in the eastern Sverdrup Basin (Balkwill, 1974; Balkwill and Bustin, 1975; Balkwill et al., 1975; Balkwill and Hopkins, 1976) resulted in recognition of three phases of the Eurekan Orogeny: (1) a phase of uplift (Maastrichtian/late Paleocene) exemplified by such features as the Princess Margaret Arch on Axel Heiberg Island and the Cornwall Arch of Amund Ringnes Island; (2) a phase of regional compression [(?)Middle Eocene/Oligocene] which produced large folds and faults in Eocene and older rocks in eastern Axel Heiberg and western Ellesmere Islands; and (3) a renewed phase of uplift with local normal faulting (Miocene/Pliocene) as exemplified along the eastern flank of Princess Margaret Arch in eastern Axel Heiberg Island, accompanied by the syntectonic deposition of the coarse clastic sediments which characterize the Beaufort Formation.

Description

About 33 m of moderately well exposed Eureka Sound Formation were measured in two closely spaced sections directly west of Colquhoun piercement dome on the northern tip of Sabine Peninsula (Fig. 36.1). Section 1 (Fig. 36.2) is 16 m thick and contains the gradational Kanguk-Eureka Sound contact near the base; the beds dip about 12 degrees westward away from the piercement dome. Section 2 (Fig. 36.2) is 23 m thick, composed entirely of Eureka Sound beds. It overlaps with and is better exposed than Section 1. The Eureka Sound beds of Section 2 are nearly horizontal and the top of the section is the present erosional surface. Stratigraphic evidence suggests that these two sections are separated by a reverse fault, probably as a result of the evaporite intrusion nearby. The base of the Eureka Sound Formation in this location was placed at the first appearance of light grey sand beds above the dark brown silty and argillaceous rock types of the underlying Kanguk Formation. The Kanguk-Eureka Sound contact is gradational and conformable, as indicated by lithological and paleontological

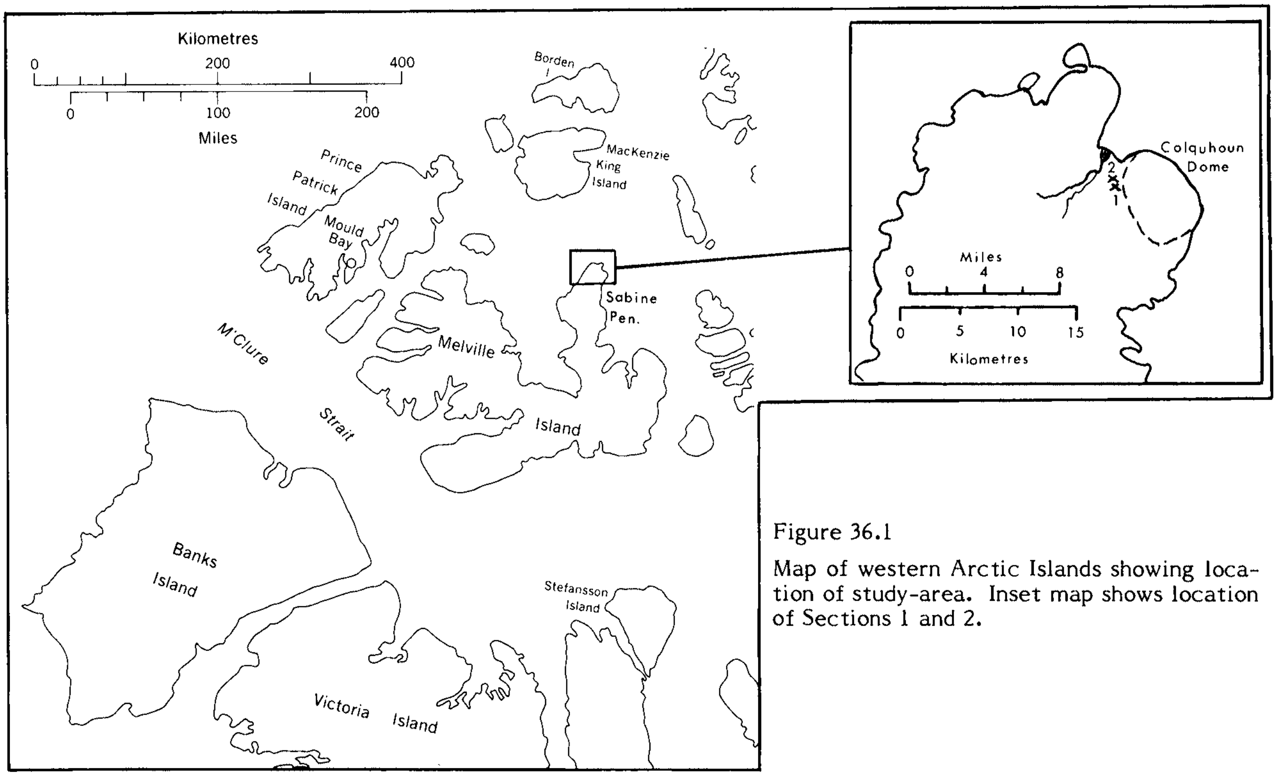

Figure 36.1

Map of western Arctic Islands showing location of study-area. Inset map shows location of Sections 1 and 2.

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evidence discussed below. For reasons of time shortage in the field, Section 1 only was sampled and detailed lithological notes were not taken (Fig. 36.2).

This exposure of Eureka Sound Formation generally represents a coarsening-upward sequence of sand, silt, and mud. The rocks of the upper part of the Kanguk Formation are generally argillaceous and of shallow-marine nature based on micropaleontological interpretations by J.H. Wall. Lithological and palynological data suggest that this sequence becomes progressively nonmarine upward. In Section 2, the Eureka Sound Formation is composed mainly of very fine to medium grained sand, except for the uppermost 3.5 m which are shale.

Friability of the silt and sand beds tends to obscure the sedimentary structures. However, the volumetrically dominant sedimentary structure observed is large-scale cross-stratification which comprises the entire thickness of two thick (6 m each) sand beds in the middle part of Section 2 (Fig. 36.2). The lower of these two beds contains ripple laminations in the top 1 m, and both beds are fining upward. The foresets of the cross-stratified beds dip southeasterly (120°). These cross-stratified beds extend the entire width of the outcrop, a distance of about 200 to 250 m. Lack of time prevented tracing the extent of the sedimentary structures along the third dimension. The remaining beds, in the lower part of Section 2, are laminated only vaguely. A carbonaceous shale-filled channel, oriented approximately NE-SW (30°), occurs near the 4 m level above the base of Section 2. This channel, scoured into the underlying very fine grained sand, contains incompletely carbonized wood and logs. Other sedimentary structures observed are organic burrows in two beds near the base of Section 2 and plant root remnants (Fig. 36.2, Sec. 2).

Sieve grain size data are shown in Figure 36.3 plotted on probability paper using quarter phi intervals. Three of the seven sand samples shown have bimodal size distribution. The sands of the Eureka Sound Formation are moderately well to moderately sorted [using Folk's (1966) terminology] and are generally angular to very angular (Power's scale) in the modal and fine grades, but generally show better rounding in the coarser grades. In some of the samples, however, it was observed that the finer sand grade, which is usually angular, also commonly contains rounded grains. Quartz makes up 90 per cent or more of the sand, whereas feldspar, dark rock fragments, accessory minerals, and muscovite constitute the remaining fraction. Carbonaceous debris is present throughout, either disseminated or concentrated in discrete laminae.

Palynology

Eleven samples were collected for palynological analysis from these two sections (see Fig. 36.2). Ten of the eleven were productive in both microspores and megaspores. The stratigraphic position and GSC locality numbers are indicated on the accompanying range chart (Fig. 36.4). Samples C-60024 and C-60030 are isolated samples taken from what was considered in the field to be the oldest exposed strata of the Eureka Sound Formation, a conclusion borne out by palynological analysis. Section 1 is represented by samples C-60020 (20) to C-60023 (23) and Section 2 by samples C-60025 (25) to C-60029 (29), inclusive.

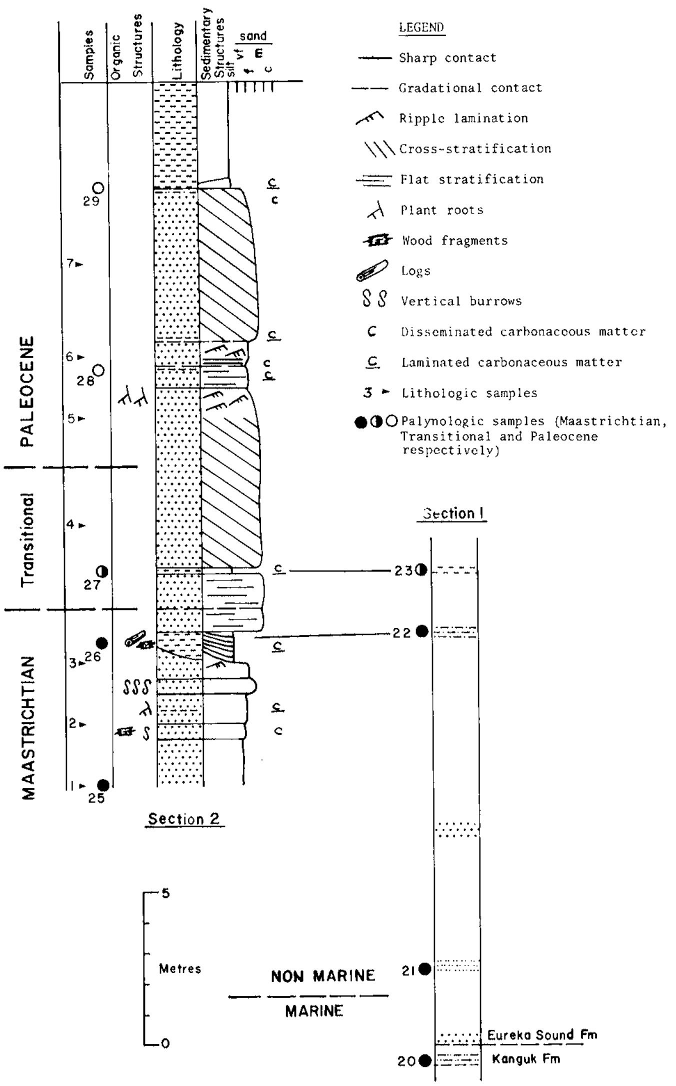

Figure 36.2. Sections 1 and 2 of the Eureka Sound Formation on Sabine Peninsula. See Figure 36.4 for GSC locality numbers of palynologic samples.

The total microflora is itemized on the microfloral list (Table 36.1), and age-significant palynomorphs are indicated on the accompanying range chart (Fig. 36.4). Two comparatively distinct groups of key palynomorphs are present, indicating a transition from Maastrichtian to Paleocene. Pollen characteristic of, and almost completely restricted to, the Maastrichtian include **Aquilapollenites, Fibulapollis mirificus, Orbiculapollis globosus, Expressipollis barbatus, E. accuratus, Azonia, Clanculatus, Wodehouseia spinata,** and **Integricorpus.** The Maastrichtian microflora appears to be common to the entire circumpolar area (see for example, Felix and Burbridge, 1973; Brattseva, 1965; Chlonova, 1961; Hopkins, unpubl. data). The second assemblage is marked by more typical Tertiary forms, especially **Alnus,** which becomes abundant near the top of Section 2. Although **Alnus** (alder) may occur sporadically in upper Maastrichtian rocks, it does not become abundant until the Paleocene. Early forms of **Pterocarya, Carya** and

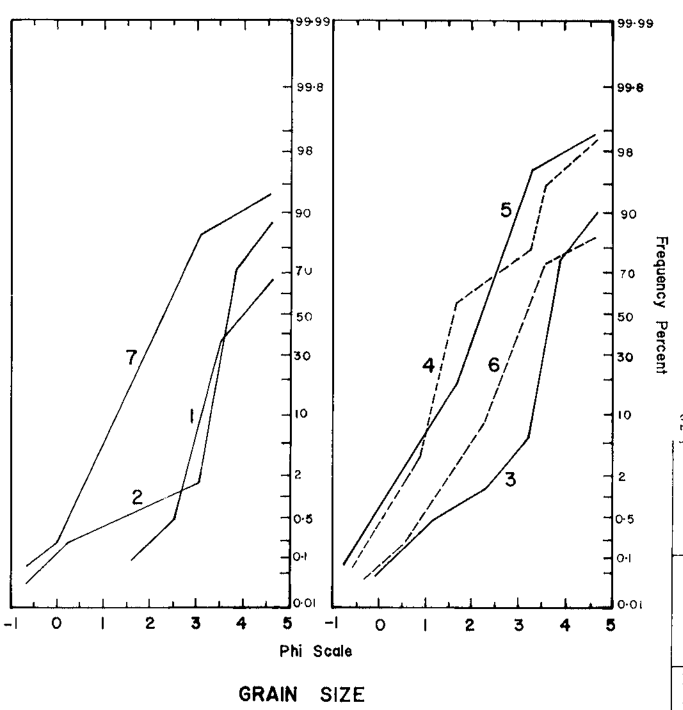

Figure 36.3. Grain-size probability plots of Eureka Sound sands of Section 2. See Figure 36.2 for stratigraphic positions of samples numbered 1 to 7.

Carpinus are present and appear to be Paleocene forms. Sample C-60023 (23) is somewhat ambiguous in that it contains some Tertiary palynomorphs and the Late Cretaceous **Orbiculapollis**. This appears to be a transition sample, occurring at the boundary between the Cretaceous and Tertiary strata. Although it is not discussed in this report, the megaspore data basically support the interpretations derived from microspore analysis (A.R. Sweet, pers. comm.).

Consequently, we can conclude only that this is a transition unit, essentially representing deposition during the latest Cretaceous and early Tertiary. The top two samples of Section 2, on the basis of both micro- and megaspores, clearly are Paleocene. Therefore, sample C-60023 (23) at the top of Section 1 would seem to be equivalent essentially to C-60027 (27).

The indicated environment of deposition is deltaic with a lowland of lakes, swamp and meandering streams. The abundance of **Sphagnum** spores, plus the excellent preservation of all pollen and spores indicates, at least locally, the presence of **Sphagnum** bogs. **Lycopodium** and **Selaginella** are both moderately common which suggest moist conditions; some of the **Lycopodium** may have been epiphytic. Representatives of the ferns such as **Osmunda** and **Laevigatosporites** occur in some places and rare spores of **Gleichenia** and **Cicatricosisporites** are present. All of these suggest a warm, damp climate.

With the exception of the Taxodiaceae, the gymnosperms are not common. **Taxodium** and/or **Glyptostrobus** are common palynomorphs, again suggesting damp and warm conditions. However, the microflora of all samples is dominated by the angiosperms. Unfortunately, more than one half of these cannot be related to modern forms and, although some are age diagnostic, they are not particularly useful environmentally.

To summarize the microspore data, the rocks from this locality are uppermost Cretaceous to lowermost Tertiary, and exemplify a rare exposure of the Cretaceous-Tertiary transition in the Sverdrup Basin. This transition, based on both lithologic and palynologic evidence, lies about 15 m above the Kanguk-Eureka Sound boundary. The depositional environment appears to be deltaic in a warm temperate to even subtropical climate. The overall climatic and environmental conditions probably were not dissimilar to those now prevailing in the Mississippi delta area.

30	24	25	26	27	28	29	20	21	22	23	
X	X	X	X	X	X	X	X	X	X	X	Inaperturopollenites sp.
							X				Cycadopites follicularis
X	X	X	X	X	X	X	X			X	Extratriporopollenites sp.
X	X	X	X			X	X	X	X	X	Osmunda sp.
X	X	X					X				Aquilapollenites spp.
X	X	X	X	X	X	X	X	X	X	X	Sphagnum spp.
X	X	X	X	X	X	X	X	X	X	X	Glyptostrobus-Taxodium
X	X	X	X	X	X	X	X	X	X	X	Lycopodium sp.
X		X	X		X		X	X			Gleicheniidites sp.
X	X	X	X		X	X	X	X		X	Lycopodiacidites sp.
							N				Fibulapollis mirificus
N	N	N	N					N	N	N	Orbiculapollis globosus
X	X	X	X		X			X	X	X	Sequoiapollenites sp.
								N			Expressipollis barbatus
N	N		N					N	N		E. accuratus
X	X	X	X		X	X		X	X	X	cf. Betula sp.
								N			Azonia sp.
								N			Clanculatus sp.
		X						X			cf. Ulmus sp.
								N	N		Aquilapollenites cf. A. attenuatus
X	X	X	X		X	X		X	X	X	Engelhardtia (= Momipites sp.)
X	X	X	X		X	X			X		Podocarpus sp.
	N	N							N		Wodehouseia spinata
			N								W. fimbriata
		N							N		Integricorpus sp.
		O			O	O				O	Pterocarya sp.
					O	O				O	Alnus sp.
		X				X				X	Cicatricosisporites sp.
					O					O	Carya cf. C. paleocenica
					O	O				O	Carpinus cf. C. subtriangula
										X	Selaginella sp.
					X	X				X	Ericaceae
										X	Corylus sp.
										X	Typha sp.
				X	X	X				X	Paraalnipollenites sp.
	X	X	X		X	X					Schizosporis cf. S. scabratus
			X								Castanea-type
					X	X					Tsuga sp.

X Palynomorph present

N Characteristic Maastrichtian palynomorph

O Characteristic Paleocene palynomorph

Geological Survey Locality Numbers

20 = C-60020
21 = C-60021
22 = C-60022
23 = C-60023
24 = C-60024
25 = C-60025
26 = C-60026
27 = C-60027
28 = C-60028
29 = C-60029
30 = C-60030

Figure 36.4. Stratigraphic distribution of selected palynomorphs.

Table 36.1

Microflora of Eureka Sound Formation, northern Sabine Peninsula

Bryophyta	Sphagnaceae	**Sphagnum** spp.
Lycopodophyta	Lycopodiaceae	**Lycopodium** sp. **Lycopodiacidites** sp.
	Selaginellaceae	**Selaginella** sp.
Pterophyta	Osmundaceae	**Osmunda** sp.
	Schizaeaceae	**Cicatricosisporites** sp.
	Gleicheniaceae	**Gleicheniidites** sp.
	Polypodiaceae-Dennstaedtiaceae	**Laevigatosporites** sp. **Deltoidospora** sp. verrucate monolete spores
	Incertae sedis	**Undulatisporites** sp.
Cycadophyta	Cycadaceae	**Cycadopites follicularis** Wilson and Webster
Coniferophyta	Pinaceae	**Pinus** sp. **Tsuga** sp.
	Taxodiaceae	**Inaperturopollenites** sp. **Glyptostrobus** sp. **Taxodium** sp. **Sequoia pollenites** cf. **paleocenicus** Stanley
	Podocarpaceae	**Podocarpus** sp.
Anthophyta	Cyperaceae	Cyperaceae
	Liliaceae	**Liliacidites** sp.
	Typhaceae	**Typha** sp.
	Betulaceae	**Alnus** sp. **Paraalnipollenites** sp. cf. **Betula** sp. **Carpinus** cf. **C. triangula** Stanley cf. **Corylus** sp.
	Fagaceae	**Castanea** sp.
Anthophyta	Juglandaceae	**Carya** cf. **C. paleocenica** Stanley **Engelhardtia (Momipites**-type) sp. **Pterocarya** sp.
	Ulmaceae	?**Ulmus** sp.
	Ericaceae	Ericaceae
	Dicotyledonae — **Incertae sedis**	**Extratriporopollenites** sp. **Aquilapollenites** cf. **A. attenuatus** Funkhouser **Aquilapollenites** spp. **Fibulapollis mirificus** (Chlonova) Chlonova **Expressipollis accuratus** Chlonova **E. barbatus** Chlonova **Orbiculapollis globosus** Chlonova **Azonia** sp. **Clanculatus** sp. **Wodehouseia spinata** Stanley **Integricorpus** sp. (McIntyre, 1974, Pl. 21, figs. 1-3) **Schizosporis** cf. **S. scabratus** Stanley **Tricolpites** sp. **Triporopollenites** spp. **Tricolporopollenites** spp.

Interpretation

The overall coarsening upward and the disappearance upward of marine influence (the latter assumption based on paleontological evidence) suggest that the sedimentary regime of the Eureka Sound Formation in this locality was that of prograding, shallowing-upward environments.

Comparison of the grain size probability curves (Fig. 36.3) with those published by Visher (1969) and Glaister and Nelson (1974) suggests that the thick, cross-stratified sand beds of the present study-area were formed in deltaic distributary channel environments, probably as laterally migrating sand waves.

The above lithological and paleontological evidence suggests that these sediments were deposited as a fluvial-dominated delta (see deltaic classification of Galloway, 1975) prograding, probably in a northeasterly direction, into a marine basin where waves and tidal current influence were too weak to keep up with the rapid rate of fluvial sediment influx and to sort and round the sand grains. Diagnosis of the specific deltaic subenvironments of the study sequence is difficult due to lack of more detailed field observations. Texture (bimodal grain size and shape) of the sand suggests a multi-source rock provenance.

Palynological evidence suggests that deposition of rocks of the Eureka Sound Formation, especially the upper part, took place largely in lowlands of lakes, swamps and streams in warm, humid temperate to subtropical climate.

Conclusions

The Cretaceous-Tertiary transition in northern Sabine Peninsula is gradational within the detrital, arenaceous sequence of the Eureka Sound Formation, about 15 m above its base. Deposition was rapid and continuous as a fluvially dominated deltaic sequence prograding into a marine basin of low wave and tidal current energy under humid and warm temperate to subtropical climate. The gradual change of sedimentary regime from marine Kanguk to the nonmarine Eureka Sound marks a period of gradual uplift of the source area. This period of uplift (Maastrichtian in age) may be synchronous with the late Maastrichtian/late Paleocene "phase of local uplift" (Balkwill et al., 1975) in the eastern part of the Sverdrup Basin.

References

Balkwill, H.R.
1974: Structure and tectonics of Cornwall Arch, Amund Ringnes and Cornwall Islands, Arctic Archipelago; in Canadian Arctic Geology, J.D. Aitken and D.J. Glass, eds., Proceedings Volume, 1973 Symposium of the Geol. Assoc. Can./Can. Soc. Petrol. Geologists, p. 39-62.

Balkwill, H.R. and Bustin, R.M.
1975: Stratigraphic and structural studies, central Ellesmere Island and eastern Axel Heiberg Island, District of Franklin; in Report of Activities, Part A, Geol. Surv. Can., Paper 75-1A, p. 513-517.

Balkwill, H.R., Bustin, R.M., and Hopkins, W.S., Jr.
1975: Eureka Sound Formation at Flat Sound, Axel Heiberg Island, and chronology of the Eurekan Orogeny; in Report of Activities, Part B, Geol. Surv. Can., Paper 75-1B, p. 205-207.

Balkwill, H.R. and Hopkins, W.S., Jr.
1976: Cretaceous stratigraphy, Hoodoo Dome, Ellef Ringnes Island, District of Franklin; in Report of Activities, Part B, Geol. Surv. Can., Paper 76-1B, p. 329-334.

Brattseva, G.M.
1965: Pollen and spores of the Maastrichtian deposits of the Far East; Akad. Nauk SSSR, Geol. Inst., Tr., no. 129.

Chlonova, A.F.
1961: Spores and pollen of the upper half of the Upper Cretaceous in the eastern part of the western Siberian Lowland; Akad. Nauk SSSR, Geol. Geofiz. Inst. Sib. Otd., Tr., v. 7.

Felix, C.J. and Burbridge, P.P.
1973: A Maastrichtian age microflora from Arctic Canada; Geoscience and Man., v. 7, p. 1-29.

Folk, R.L.
1966: A review of grain-size parameters; Sedimentology, v. 6, p. 73-93.

Galloway, W.E.
1975: Process framework for describing the morphological and stratigraphic evolution of deltaic depositional systems; in Deltas, Models for Exploration, 2nd ed., M.L. Broussard, ed.; Houston Geol. Soc., p. 87-98.

Glaister, R.P. and Nelson, H.W.
1974: Grain-size distributions, an aid in facies identification; Bull. Can. Petrol. Geol., v. 22, p. 203-240.

Leffingwell, H.A.
1970: Palynology of the Lance (Late Cretaceous) and Fort Union (Paleocene) Formations of the type Lance area, Wyoming; Geol. Soc. Am., Spec. Paper 127, p. 1-64.

Stanley, E.A.
1965: Upper Cretaceous and Paleocene plant microfossils and Paleocene dinoflagellates and hystrichosphaerids from northwestern South Dakota; Bull. Am. Paleont., v. 49, p. 179-384.

Tozer, E.T. and Thorsteinsson, R.
1964: Western Queen Elizabeth Islands, Arctic Archipelago; Geol. Surv. Can., Mem. 332.

Visher, G.S.
1969: Grain size distributions and depositional processes; J. Sediment. Petrol., v. 39, p. 1074-1106.