	Stratigraphic position	Section, Township, Range	Shown on measured section	Description	Pollen age	Suggested environment of deposition from palynomorphs	Suggested environment of deposition from field data	Suggested climate from pollen
76-10h	Green River Formation 131 m above base	7-7S-98W		Flaky clay shale	Early middle to early Eocene (lower part Dawson Formation)	N. D.	Open lacustrine	Subtropical
76-1i	Green River Formation 28 m above base	21-8S-98W	D	Flaky clay shale	N. D.	N. D.	Marginal lacustrine	N. D.
76-8f	Green River Formation 10 m above base	23-8S-100W	B	Flaky clay shale	Early middle to early Eocene (lower part Dawson Formation	N. D.	Marginal lacustrine	Subtropic
76-10a	Green River Formation 4 m above base	7-7S-98W		Flaky clay shale	N. D.	Freshwater lacustrine	Open lacustrine	N. D.
75-100b	Green River Formation just above base	26-6S-99W		Flaky clay shale	N. D.	Lacustrian	Open lacustrine	N. D.
H	Green River Formation just above base	10-8S-99W		Flaky clay shale	Early middle to early Eocene	N. D.	Open lacustrine	Subtropic
75-101a	Green River Formation just above base	26-6S-99W		Flaky clay shale	Early middle to early Eocene	Freshwater lacustrine	Open lacustrine	Subtropical
76-234e	Shire Member - 134 m above top of Molina Member	19-9S-96W	E	Carbonaceous shale	Early middle to late early Eocene	N. D.	Alluvial plain	Subtropical
76-1h	Middle part of Shire Member 7 m from top	28-8S-98W	D	Carbonaceous shale	N. D.	N. D.	Marginal lacustrine	N. D.
75-88	Middle part of Shire Member	26-6S-99W		Flaky, ostracodal clay shale	Early middle to early Eocene	Lacustrine	Marginal lacustrine	Subtropical
75-133	Middle part of Shire Member	15-7S-98W		Flaky clay shale	Early middle to early Eocene	Fresh water lacustrine	Marginal lacustrine	Subtropical
76-234c	Shire Member - 57 m above top of Molina Member of Wasatch Formation	19-9S-96W	E	Light gray claystone	N.D.	N. D.	Alluvial plain	Subtropical
77-16	Atwell Gulch Member of Wasatch Formation 0.3 m below Molina Member	23-9S-97W	E	Gray, silty claystone	Late Paleocene	N. D.	Paludal	Subtropical
76-1e	Atwell Gulch Member 30 m below Molina Member	27-8S-98W	D	Carbonaceous shale	Late Paleocene	N. D.	Paludal	N. D.
76-1d	Atwell Gulch Member 45 m below base of Molina Member	27-8S-98W	D	Carbonaceous shale	Middle Eocene to late Paleocene, probably late Paleocene	N. D.	Paludal	N. D.
76-2a	Atwell Gulch Member 12 m above Hunter Canyon Fm.	9-9S-98W		Carbonaceous shale	Late Paleocene	Lacustrine	Paludal	N. D.
76-4a	Atwell Gulch Member approx. 86 m above Hunter Canyon Fm.	5-9S-99W	C	Carbonaceous shale	Late Paleocene	N. D.	Paludal	Subtropical
76-3	Atwell Gulch Member 12 m above Hunter Canyon Fm.	9-9S-98W		Carbonaceous shale	Late Paleocene	Lacustrine	Paludal	N. D.
76-9b	Atwell Gulch Member 4 m above Hunter Canyon Fm.	12-8S-101W	A	Carbonaceous shale	Late Paleocene	Lacustrine	Paludal	Subtropical
75-73	Atwell Gulch Member 67 m below base Molina Member	35-8S-98W		Carbonaceous shale	Late Paleocene	N. D.	Paludal	Subtropical
77-4	Atwell Gulch Member 11 m above Hunter Canyon Fm.	22-9S-97W		Gray claystone	Early Eocene to late Paleocene, probably late Paleocene	N. D.	Alluval plain	N. D.
77-34b	Unnamed congl. unit of Hunter Canyon Fm. 37 m below top	6-10S-96W		Algal coal	N. D.	Marginal marine or lacustrine	Paludal	N. D.
77-34a	Unnamed congl unit of Hunter Canyon Fm. 37 m below top	6-10S-96W		Brown claystone	Early Maestrichtian to Campanian	N. D.	Paludal	N. D.
77-30	Unnamed congl unit of Hunter Canyon Fm. 62 m below top	18-10S-96W		Algal coal	N. D.	Marginal marine or lacustrine	Paludal	N. D.
76-8b	Hunter Canyon Formation 112 m below top	27-8S-100W	B	Carbonaceous shale	Campanian	N. D.	Paludal	N. D.
76-8a	Hunter Canyon Formation 118 m below top	27-8S-100W	B	Carbonaceous shale	Campanian	N. D.	Paludal	N. D.

	Carya	Platycarya	Syncolporites	Engelhardtia	Betulaepollenites	Alnipollenites non-specific	Ulmipollenites	Maceopolipollenites triorbicularis	Symplocospollenites	Fern spores	Taxodiaceaepollenites	Algal spores	Conifers (nondiagnostic)	Freshwater dinoflagellates	Angiosperms (nondiagnostic)	Tricolporates	Tricolpates	Botryococcus	Pediastrum	Symplocoipollenites	Maceopolipollenites non-specific	Fungal spores	Intratriporopollenites	Bombacaceae	Pistillipollenites	3-and 4-pored Alnipollenites	Quercus explimata	Pterocarya	Triumfetta	Steerculiaceae	Zilvisporis	Maceopolipollenites amplus	Tetraporina	Moraceae	3-6 pored Alnipollenites	Monolpites sanjuanensis	Tricolpites anguloluminosus	5-6 pored Alnipollenites	Onagraceae	Paraalnipollenites	Foraminisporis	Proteacidites	Loranthacites (C3rt48)	Liliacidites	Cranwellia	Balmeisporites	Seductisporis	Sphagnumsporites	Eucommiidites
76-10h	●	●	●	●	●	●	●	●	●																																									
76-1i											●																																							
76-8f			●	●		●	●					●	●	●																																				
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75-88		●	●															●			●																													
75-133		●	●		●					●	●		●	●							●							(?)																						
76-234c	●	●	●																					●					●	●													✳							
77-16	●						●																									●																			
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76-4a	●							●																	●							●	●	●																	
76-3						●	●																									●				●															
76-9b	●					●	●	●											●	●					●							●					●														
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76-8b																																									(?)	●				●	●	●	●	
76-8a																															●										●	●			●	●	●		

EXPLANATION

● Good identification

(?) Questionable identification

✳ Palynomorph is probably reworked

N.D. Not data

CHART SHOWING PALYNOMORPHS IDENTIFIED

SAMPLES ARE ARRANGED IN APPROXIMATE STRATIGRAPHIC SEQUENCE

ENVIRONMENTS OF DEPOSITION

Open Lacustrine — Laminated kerogen-rich mud-supported carbonates, with some massive brown weathering siltstone and numerous thin analcitized tuff beds. Laminae are commonly contorted or broken. Equivalent to the Parachute Creek Member of the Green River Formation

Marginal Lacustrine, Kerogen Bearing — Carbonate-rich rocks such as mud-supported carbonates, ostracodal, oolitic and algal limestone, interlayered with olive-green mudstone, medium- to dark-gray shale, siltstone, and fine-grained sandstone beds. Much of the shale and muddy carbonates contain minor amounts of kerogen with some thin beds averaging as much as 30 gallons of oil per ton (125 l/ton) with Fischer assay. Siltstone and sandstones are fairly persistent, well sorted, usually ripple bedded and generally a few meters or less thick. Locally, sandstones are nonpersistent, lens shaped in cross section and average about 10 m thick. Fish, gastropod, and pelecypod remains are rare. Found only in the Green River Formation

Marginal Lacustrine, Coaly — Carbonate-rich rocks such as muddy carbonates and ostracodal limestone, interlayered with medium- to dark-gray ostracodal shale, brown ostracodal and carbonaceous shale, coal, siltstone, and fine-grained sandstone beds. Siltstone and sandstone beds are fairly persistent, well sorted, usually rippled and are generally a few meters or less thick. Coal beds are usually less than 10 cm thick. Fish, gastropod, and pelecypod remains are common. Algal limestones are rare or absent. Found only in the Shire Member of the Wasatch Formation

Marginal Lacustrine, Deltaic — Fine- to medium-grained gray sandstone, gray siltstone, and gray and green mudstone with some carbonate-rich rocks such as muddy carbonates, ostracodal, oolitic, and algal limestones. Sandstone and siltstone units constitute about 50 to 80 percent of the facies, are fairly persistent, and have ripples and crossbeds as much as 1 m. Coarsening upward cycles can be identified in measured section E. This facies is found only in the lower part of the Green River Formation. It is best developed in the southeast part of the cross section and grades into kerogen-bearing marginal lacustrine facies in the northwest

Marginal Lacustrine, Algal — Algal stromatolite zones as much as 4 m thick interlayered with muddy carbonates, sandstone, and siltstone. Algal stromatolites constitute about 25 percent of the facies. Found only in section A. Grades laterally into marginal lacustrine kerogen-bearing facies

Alluvial Plain — Massive, gray, maroon, and purple banded claystone and mudstone with a few lenticular silty and clayey sandstone bodies as much as 10 m thick. Found in both the Atwell Gulch and Shire Members of the Wasatch Formation

Fluvial Sand — Light-gray to buff, fine to coarse conglomeratic sandstone interlayered with gray and maroon mudstone. Equivalent to the Molina Member of the Wasatch Formation. Sandstone units are from 2 to 15 m thick, fairly persistent but irregular in thickness. Bedding consists mainly of troughs as much as 3 m, even parallel laminae and climbing ripples. No large-scale lateral accretion was seen. The basal Molina sand is distinctly different, being very persistent with a relatively constant thickness and almost all even parallel laminae. Best developed in the southeast part of the cross section. Sandstone units become finer grained and less persistent to the northwest

Paludal — Dark-gray to black carbonaceous claystone and silty claystone with some coal beds as much as a few centimeters thick. Found only in the Atwell Gulch Member of the Wasatch Formation

INTRODUCTION

This is a preliminary report on stratigraphic investigations near DeBeque, in the southwestern Piceance Creek basin, Colorado. Five sections were measured of rocks of Late Cretaceous to middle Eocene age along a southeast-northwest line starting at Horsethief Mountain, 8 km southeast of DeBeque, and ending at the west end of Horse Mountain, about 35 km northwest of DeBeque. Samples were collected and examined for spore and pollen. Samples were collected from the measured sections and from other outcrops in the area.

The cross section is along the southwestern margin of Tertiary outcrops in the Piceance Creek basin. Structurally it lies in a northeast-plunging syncline between two ancient and present-day positive features, the Uncompahgre uplift and the Douglas Creek arch. Both probably existed in some form in Late Cretaceous and early Tertiary time when the rocks described in this report were being deposited.

Formal stratigraphic names for subdivisions of the Wasatch Formation of the study area are from Donnell (1969) and for the Green River Formation are modified from Johnson (1975, 1977). The facies interpretations are new in this report.

STRATIGRAPHY

Wasatch Formation

The Wasatch Formation underlies the Green River Formation and represents a period of dominantly fluvial deposition. The Wasatch Formation is divided in ascending order into the Atwell Gulch, Molina, and Shire Members.

The Atwell Gulch Member was divided into two facies, alluvial plain and paludal. The alluvial plain facies is composed almost entirely of variegated mudstones and claystones with a few small channel sandstones. The paludal facies, as much as 70 m thick, consists of carbonaceous claystones and thin coal beds, and represents an extensive long-lived swamp.

The Molina Member of the Wasatch Formation is interpreted as a fluvial sand facies. The sandstone units in this facies contain alternating zones of trough laminae, drift ripple laminae, and parallel laminae typical of most fluvial sandstones. The units contain conglomeratic lenses but lack large-scale lateral accretion beds suggesting that the stream system was dominantly braided. The contact with the underlying Atwell Gulch Member is sharp and marked by a very persistent basal sandstone. The basal sandstone, unlike other sandstones in the Molina Member, is composed almost entirely of even parallel beds. The significance of the unique basal sandstone is not yet known.

The Shire Member is divided into two facies, alluvial plain and coaly marginal lacustrine. The alluvial plain facies is similar to the same facies found in the Atwell Gulch Member. This facies, like its counterpart in the Atwell Gulch Member, contains very few channel sandstones. The coaly marginal lacustrine facies is found only in section D; however, it becomes thicker and better developed to the north along the Roan Creek drainage (Johnson, 1975, 1977). It is similar to the kerogen-rich marginal lacustrine facies found in the Green River Formation but contains less carbonate, and the dominant organic constituent appears to be woody material rather than kerogen.

Green River Formation

The Green River Formation is the youngest formation studied in this report and represents a period of widespread lacustrine deposition. The basal unit of the Green River Formation is a persistent, distinctive, gastropod-rich bed which is in sharp contact with underlying rocks and is informally known as the marker bed at Long Point. The contact marks an abrupt regional change from fluvial to marginal lacustrine deposition.

The formation is divided into three members (in descending order) the Parachute Creek, the Anvil Points, and the Douglas Creek Members. The members as used in this report correspond closely to our facies subdivisions. The Parachute Creek is the kerogen-rich open lacustrine facies; the Anvil Points Member is the very sandy marginal lacustrine or delta facies; the Douglas Creek Member consists of two marginal lacustrine facies, the kerogen-bearing marginal lacustrine and the algal marginal lacustrine facies. Both of these facies contain more carbonate and less sand than the delta facies, and were probably deposited in interdeltaic areas along the margin of the lake.

Problems with the Cretaceous-Tertiary boundary

The Cretaceous-Tertiary boundary is marked by a major regional disconformity. A highly weathered kaolinized zone as much as 120 m thick occurs just below the disconformity and is easily recognized throughout the area by its distinctive very light gray color. The weathering is thought to have taken place before the overlying Tertiary rocks were deposited.

Two conglomeratic units are associated with this disconformity, one above the disconformity and one below. The overlying unit is as much as 20 m thick and contains abundant rounded pebble to cobble size clasts. It is found in the vicinity of section E, but pinches out to the west. The lower unit is as much as 100 m thick and consists mostly of a sandstone with a few scattered lenses of conglomerate. This unit was measured and described at the locality of section B. Pebbles in the lower conglomerate are mostly dark colored chert and silicified limestone. The upper unit contains quartzite, red sandstone, as well as, dark chert and silicified limestone.

The name Ohio Creek Formation has been assigned to each of these units by previous workers. Gaskill (1963) called the lower unit Ohio Creek Formation and put the upper one into the Wasatch Formation. Donnell (1961) on the other hand called the upper unit Ohio Creek Formation and put the lower one in the Mesaverde Group. Both workers thought that the age of the Ohio Creek Formation was Paleocene, but had no paleontological evidence from the DeBeque area. This study has found Late Cretaceous pollen in the lower unit and late Paleocene pollen in the upper unit. The type locality of the Ohio Creek Formation is along Ohio Creek about 110 km southeast of DeBeque. Until the type can be reexamined to determine its relationship to the conglomerates in the DeBeque area, the upper unit will be considered an unnamed member of the overlying Wasatch Formation and the lower unit will be considered an unnamed member of the underlying Hunter Canyon Formation.

PALYNOLOGY

Hunter Canyon Formation (Mesaverde Group)

Two palyniferous samples were collected from the Hunter Canyon Formation below the Ohio Creek(?) interval (samples 76-8a and 76-8b). Three age diagnostic pollen were recovered from this interval:

Proteacidites	Turonian to Maestrichtian
Seductisporites	Late Campanian (Judith River Formation, Montana)
Cranwellia	Early-late Campanian to Maestrichtian

The range of *Proteacidites* is generally accepted to be Turonian to Maestrichtian. *Seductisporites* has been previously reported only from the Upper Campanian Judith River Formation of Montana (B. D. Tschudy, 1973), and the range of *Cranwellia* (lower-upper Campanian to Maestrichtian) has been determined by examination of reference collections in the Denver U.S. Geological Survey Palynology Laboratory. Based on this association, the age of the part of the Mesaverde Group sampled would be considered to be late Campanian; however, the overlying unnamed conglomeratic interval could be as young as early Campanian. It may be more reasonable to think of the overlying conglomeratic interval as being late Campanian to early Maestrichtian, and the underlying Mesaverde samples as still being late Campanian.

Unnamed conglomeratic unit of the Hunter Canyon Formation

Three palyniferous samples were collected from the unnamed conglomeratic unit of the Hunter Canyon Formation (samples 77-30, 77-34a, and 77-34b). Two age diagnostic pollen were recovered from this interval:

Loranthacites sp. (c3rt48 Denver Paly. Lab. Indent.)	Late Campanian to probably early Maestrichtian
Proteacidites	Turonian to Maestrichtian

Samples 77-30 and 77-34a are a carbonaceous shale and a 3 cm coal seam, respectively. Both samples yielded only abundant algal cells. Sample 77-34b, the underclay beneath the 3 cm coal seam, did yield a very sparse pollen assemblage, four species total, of which *Loranthacites* sp. (c3rt48) and *Proteacidites* suggest an age of early Campanian to possibly early Maestrichtian. The range of *Loranthacites* sp. (c3rt48) is not published, but has been determined through examination of reference collections in the Denver U.S.G.S. Palynology Laboratory. It is known to occur in the late Campanian Judith River Formation of Montana and in the late Campanian to possibly early Maestrichtian Vermejo Formation of the Raton Basin of southern Colorado and northern New Mexico. In the Hunter Canyon section which is not discussed in this paper, it occurs with *Kuylisporites scutatus* (Santonian to lower-upper Campanian), *Trudopollis* (Santonian to lower Campanian), *Plicapollis* (Santonian to Campanian), and *Pseudoplicapollis* (Santonian to lower Campanian). Therefore, based on its association with these other grains, the range of *Loranthacites* sp. (c3rt48) may extend into the lower Campanian. Its upper range into the Vermejo Formation suggests a youngest possible age of early Maestrichtian (R. H. Tschudy, 1973). Therefore, the age of the unnamed conglomeratic unit (Ohio Creek(?) Formation) is suggested to be early Campanian to early Maestrichtian.

Unnamed conglomeratic unit of the Wasatch Formation

One sample 77-4 was collected just south of DeBeque from the basal Tertiary conglomerate or the unnamed conglomeratic unit of the Wasatch Formation about 11 m above the disconformity. Only one species, *Symplocoipollenites* was recovered from this sample. The accepted range for this species is late Paleocene to middle Eocene, however, since late Paleocene pollen was collected stratigraphically above the sample, its age must also be late Paleocene.

Atwell Gulch Member of the Wasatch Formation

Nine palyniferous samples were collected from the Atwell Gulch Member of the Wasatch Formation (samples 76-2a, 76-3, 76-4a, 76-9b, 77-16, 76-1e, 76-1d, and 75-73). Eight age diagnostic pollen were recovered from this interval:

Maceopolipollenites amplus	Late Paleocene
Carya	Late Paleocene to Oligocene
Maceopolipollenites triorbicularis	Middle Paleocene to middle Eocene(?)
Pistillipollenites	Late Paleocene to middle Eocene
Symplocoipollenites	Late Paleocene to middle Eocene(?)
Tricolpites anguloluminosus	Paleocene
Symplocospollenites	Late Paleocene to middle Eocene
Paraalnipollenites	Maestrichtian to Paleocene

The ranges of *Symplocospollenites* and *Symplocoipollenites* have been determined through examination of reference collections of the Denver U.S.G.S. Palynology Laboratory (R. H. Tschudy, U.S. Geological Survey, oral commun., 1978). The ranges of *M. amplus*, *M. triorbicularis* (with the exception of its middle Eocene occurrence: see Green River discussion), and *T. anguloluminosus* are published in Leffingwell (1970). The ranges of *Carya* and *Pistillipollenites* are reported in Leopold and MacGinitie (1972), and the range of *Paraalnipollenites* is reported in Hills and Wallace (1969). Thus, the age of the Atwell Gulch Member of the Wasatch Formation is suggested to be late Paleocene.

Molina Member of the Wasatch Formation

About 20 samples of the Molina Member were collected and analyzed for pollen. All of the samples were barren, however, late Paleocene pollen was obtained from sample 77-16 which was collected 0.3 m below the base of the Molina. We are therefore tentatively suggesting that the age of the Molina Member is late Paleocene although the age on record is still considered to be Eocene.

Shire Member of Wasatch Formation

Five palyniferous samples were collected from the Shire Member of the Wasatch Formation (samples 76-234e, 76-234c, 76-1h, 75-88, and 75-133). Six age diagnostic pollen were recovered from within the Shire:

Platycarya	Early to early-middle Eocene
Carya	Late Paleocene to Oligocene
Intratriporopollenites	Earliest to mid-middle Eocene
Bombacaceae	Late early to early-middle Eocene
Pistillipollenites	Late Paleocene to early-middle Eocene
Triumfetta	Middle Eocene

The ranges of *Platycarya* and *Carya* are discussed below with the Green River assemblages. The ranges given above of *Intratriporopollenites* (Tilia), Bombacaceae, *Pistillipollenites*, and *Triumfetta* for the Rocky Mountain region are discussed in Leopold and MacGinitie (1972). Based on the assemblage listed above, the age of the Shire Member of the Wasatch Formation is considered to be middle Eocene.

Green River Formation

Seven palyniferous samples from the Green River Formation were collected from the base upward approximately 131 m into the formation (samples 75-101a, 75-100b, 76-10a, 76-10h, H, 76-1i, and 76-8f). Five age diagnostic pollen were recovered from this interval:

Platycarya	Early to late-middle Eocene
Carya	Late Paleocene to Oligocene
Symplocoipollenites	Late Paleocene - ?
Symplocospollenites	Late Paleocene to early Eocene
Maceopolipollenites triorbicularis	Middle Paleocene - ?

Platycarya and *Carya* are distinctive angiosperm pollen grains that occur in Tertiary floras of the Rocky Mountain region. According to Leopold and MacGinitie (1972), within this region *Platycarya* ranges from the lower to lower-middle Eocene, and *Carya* ranges from the lower Paleocene to Oligocene; the range of *Carya* in the Rocky Mountain region, as understood by Leffingwell (1970) and by R. H. Tschudy of the U.S. Geological Survey (oral commun., 1978) is late Paleocene to Oligocene. *Symplocoipollenites*, according to Tschudy, found through the late Paleocene, and *Symplocospollenites* ranges from the late Paleocene to early Eocene (R. H. Tschudy, oral commun., 1978), *Maceopolipollenites triorbicularis* is reported by Leffingwell (1970) to be found through the middle Paleocene. However, an association of *Platycarya*, *Carya*, and *Maceopolipollenites triorbicularis* occurs in the lower Eocene Dawson Formation of the Denver Basin (reference collection of U.S.G.S. Palynology Laboratory, Denver) suggesting the *M. triorbicularis* also found into the early Eocene. Although some of the assemblages reported in this paper (see DeBeque Range Chart, samples H and 76-8f) suggest an age of early to early-middle Eocene, the assemblages from samples 75-101a and 76-10h suggest an age of early Eocene for the part of Green River Formation examined. However, a more diagnostic assemblage in the underlying Shire Member of the Wasatch Formation suggests a middle Eocene age for that unit. Therefore, the part of the Green River reported on here is likely to be of middle Eocene age.

Environments of Deposition

In the Green River Formation, *Pediastrum*, and *Botryococcus*, colonial green algae, were recovered in sample 75-100b, suggesting a lacustrine environment of deposition. What appear to be fresh water dinoflagellates occur in samples 75-101a and 76-10a, also suggesting a lacustrine environment of deposition. The presence of *Platycarya* and *Carya* in some of the samples suggests a moist subtropical climate.

In the Shire Member of the Wasatch Formation, fresh water dinoflagellates occur in sample 75-133. Although *Pediastrum* was not recovered, *Botryococcus* was, suggesting a lacustrine environment of deposition. The presence of *Platycarya* and *Carya* in some of the samples suggests a moist subtropical climate.

In the Atwell Gulch Member of the Wasatch Formation, *Pediastrum* was recovered from samples 76-2a and 76-9b, suggesting a lacustrine environment of deposition. *Carya* was also recovered, suggesting a subtropical climate.

Little can be said of the paleoenvironments in the Mesaverde Group. Pollen assemblages that old (Late Cretaceous) are generally considered to be nondiagnostic in terms of environment. The 3 cm coal seam (sample 77-34a) and its overlying carbonaceous shale (sample 77-30) yielded algal spores only, indicating that the coal and other carbonaceous material was probably of algal origin.

REFERENCES

Donnell, J. R., 1961, Tertiary geology and oil-shale resources of the Piceance Creek basin between the Colorado and White Rivers, northwestern Colorado: U.S. Geological Survey Bulletin 1082-L, p. 835-891.

_____1969, Paleocene and lower Eocene units in the southern part of the Piceance Creek basin, Colorado: U.S. Geological Survey Bulletin 1274-M, p. M1-M18.

Gaskill, D. L., 1961, Age of the Ohio Creek Conglomerate, Gunnison County, Colorado, in Geological Survey Research 1961: U.S. Geological Survey Professional Paper 424-B, Article 96, p. B230-B231.

_____1963, Redefinition and correlation of the Ohio Creek Formation (Paleocene) in west-central Colorado, in Geological Survey Research 1963: U.S. Geological Survey Professional Paper 745-C, Article 69, p. C35-C38.

Hills, L. V., and Wallace, Sandra, 1969, *Paraalnipollenites*, a new form genus from uppermost Cretaceous and Paleocene rocks of Arctic Canada and Russia: Canada Geological Survey Bulletin 182, p. 139-145.

Johnson, R. C., 1975, Preliminary geologic map, oil-shale yield histograms and stratigraphic sections, Long Point Quadrangle, Garfield County, Colorado: U.S. Geological Survey Miscellaneous Field Studies Map MF-688.

_____1977, Preliminary geologic map and cross section of the Saddle Quadrangle, Garfield County, Colorado: U.S. Geological Survey Miscellaneous Field Studies Map MF-829 [1976].

Leffingwell, H. A., 1970, Palynology of the Lance (Late Cretaceous) and Fort Union (Paleocene) Formations of the type Lance area Wyoming, in Symposium on palynology of the Late Cretaceous and early Tertiary, San Francisco, Calif., 1966: Geological Society America Special Paper 127, p. 1-64, 10 plates.

Leopold, E. B., and MacGinitie, H. D., 1972, Development and Affinities of Tertiary Floras in the Rocky Mountains, in Graham, A., ed., Floristics and Paleofloristics of Asia and Eastern North America, Amsterdam, Elsevier Publisher, p. 147-189 [1973].

Tschudy, B. D., 1973, Palynology of the Upper Campanian (Cretaceous) Judith River Formation, North-Central Montana: U.S. Geological Survey Professional Paper 770, 42 p.,[1974].

Tschudy, R. H., 1973, The Gasbuggy Core--a palynological appraisal, in Fassett, James, ed., Cretaceous and Tertiary rocks of the southern Colorado Plateau: Four Corners Geological Society, Durango, Colorado, 1973. (Cretaceous-Tertiary Memoir) p. 131-143 [1974].

PRELIMINARY STRATIGRAPHIC STUDIES OF THE UPPER PART OF THE MESAVERDE GROUP, THE WASATCH FORMATION, AND THE LOWER PART OF THE GREEN RIVER FORMATION, DeBEQUE AREA, COLORADO, INCLUDING ENVIRONMENTS OF DEPOSITION AND INVESTIGATIONS OF PALYNOMORPH ASSEMBLAGES

By
Ronald C. Johnson and Fred May
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