DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Palynologic data from Cretaceous and early Tertiary rocks in the Salt Lake 30' x 60' quadrangle

by

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U.S. Geological Survey

Open-File Report 86-116

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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CONTENTS

INTRODUCTION

This report presents occurrence data on palynomorphs (spores, pollen, and dinocysts) recovered from samples collected from outcrop within the Salt Lake 30' x 60' quadrangle. Collections were made during field work for geologic mapping of the quadrangle (Bryant, in preparation). The objectives of the palynologic study were: (1) to obtain biostratigraphic (palynostratigraphic) evidence on the age of units within the map area and (2) to identify different but lithologically similar stratigraphic units exposed in isolated outcrops by their palynologic content.

Palynomorph occurrence data, plotted in presence/absence format, are shown in Figure 1. Detailed explanations of the data summarized in Figure 1 follow in five appendixes. Numbers at the top of the figure designate the palynomorph taxa recorded, and the large dots indicate their presence at each sample locality. Appendixes 1 and 2 are lists of the palynomorph taxa; both lists are keyed to Figure 1. Appendix 1 is numerical, by index number in the figure, and Appendix 2 is alphabetical, by palynomorph name. Appendix 3 shows the palynostratigraphic zone represented at each locality. The zones named were described by Nichols and others (1982) for the Cretaceous and by Nichols and Ott (1978) for the Tertiary. Equivalent European stage names and absolute-ages for the Cretaceous zones are indicated in Nichols and others (1982, pl. 1). Appendix 4 is a summary of the formation or interval sampled at each locality. Localities are U.S. Geological Survey paleobotany localities and are identified by numbers with the prefix "D" in Figure 1 and all appendixes. Descriptions of the sample localities are given in Appendix 5. Microscope slides used in the analyses summarized here, labeled with the appropriate locality numbers, are on file at the U.S. Geological Survey's Denver laboratory.

Occurrence data and palynostratigraphic interpretations presented in this report are based on scattered and isolated sample localities. In Figure 1, localities may be shown only in approximate stratigraphic order within each formation. Although the formations are shown in correct stratigraphic order (youngest at top of figure), the samples do not represent a continuous stratigraphic sequence, and a reference section is not represented.

Recovery of palynomorphs from some samples was poor, and some samples lack forms useful for age determination. Therefore, assignment of some localities to a palynostratigraphic zone was based in part on the stratigraphic position of the sample and (or) the general similarity of contained assemblages of palynomorphs; the zone was not actually identified on the basis of characteristic fossils. Not all palynostratigraphic zones known regionally are represented in this data set.

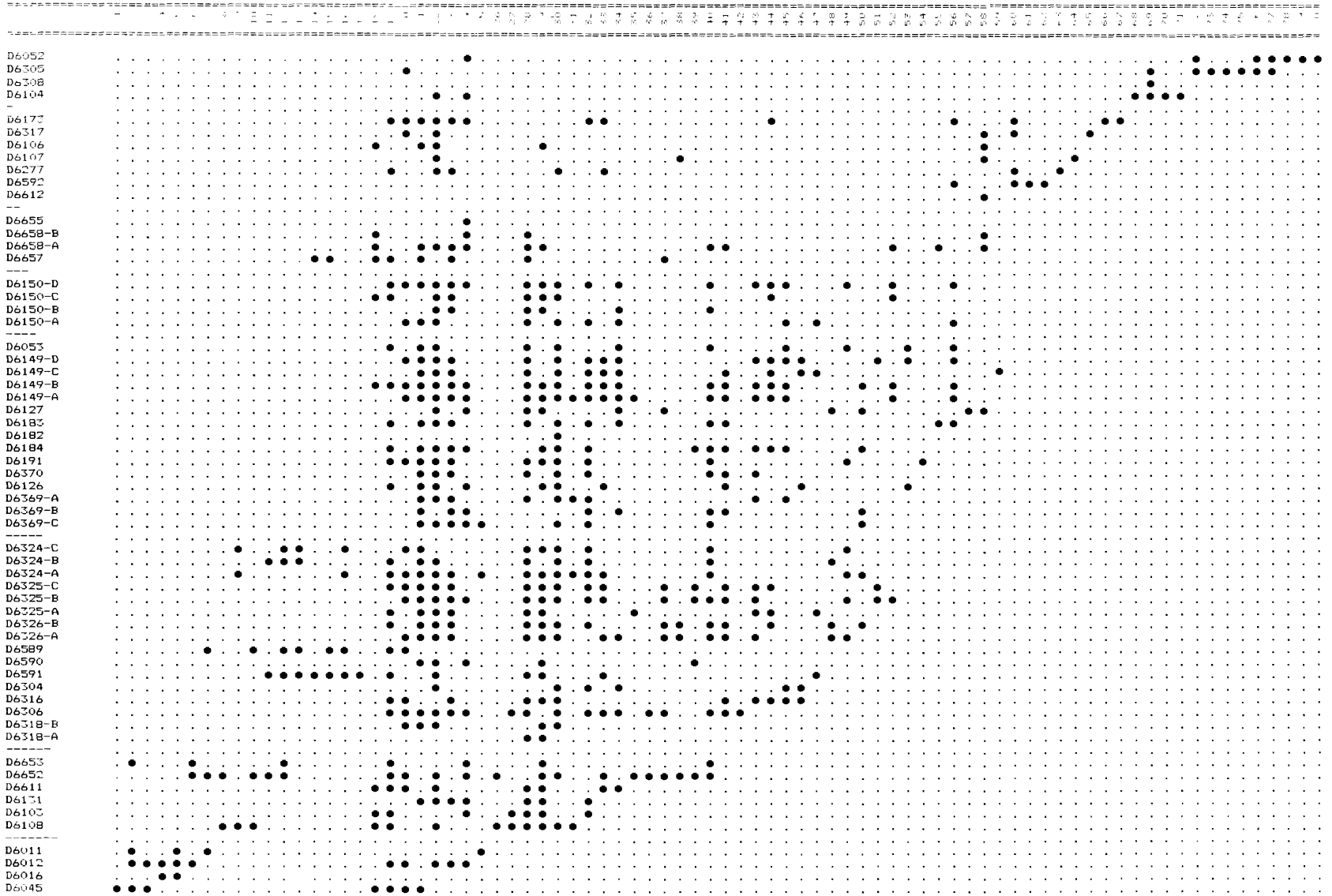
In Appendixes 1 and 2, the palynomorph taxa listed are both individual species and genera including one or more species. As is conventional, the epithet "sp." indicates an identification only to the genus level. The epithet "spp." indicates that more than one species of the genus was identified but all are grouped as a single taxon. Where named species of a genus are also listed, "sp." or "spp." refers to other, unnamed species.

References Cited

Nichols, D. J., Jacobson, S. R., and Tschudy, R. H., 1982, Cretaceous palynomorph zones for the central and northern Rocky Mountain region of the United States, in Powers, R. B., ed., Geologic Studies of the Cordilleran Thrust Belt: Denver, Colorado, Rocky Mountain Association of Geologists, vol. 2, p. 721-733.

Nichols, D. J., and Ott, H. L., 1978, Biostratigraphy and evolution of the Momipites-Carypollenites lineage in the early Tertiary of the Wind River Basin, Wyoming: Palynology, vol. 2, p. 94-112.

Figure 1. Occurrences of palynomorphs at localities sampled



APPENDIX 1

NUMERICAL LIST OF PALYNOMORH TAXA KEYED TO FIGURE 1

1 Aptea polymorpha Eisenack

2 Chichaouadinium vestitum (Brideaux) Bujak & Davies

3 Cribroperidinium edwardsii (Cookson & Eisenack) Davey

4 Cymatiosphaera sp.

5 Pterospermella sp.

6 Baltisphaeridium multispinosum Singh

7 Deflandrea spp.

8 Chlamydophorella sp.

9 Cyclonephelium sp.

10 Tanyosphaeridium sp.

11 Odontochitina operculata (Wetzel) Deflandre

12 Palaeohystrichophora infusorioides Deflandre

13 Chatangiella cf. C. victoriensis (Cookson & Manum) Lentin & Williams

14 Dinogymnium sp.

15 Oligosphaeridium pulcherriumum (Deflandre & Cookson) Davey & Williams

16 Spiniferites spp.

17 Surculosphaeridium cf. S. longifurcatum (Firtion) Davey et al.

18 Appendicisporites spp.

19 Gleicheniidites senonicus Ross

20 Pityosporites spp.

21 Taxodiaceaepollenites hiatus (Potonié) Kremp

22 Cyathidites minor Couper

23 Laevigatosporites haardtii (Potonié & Venitz) Thomson & Pflug

24 Tricolpites spp.

25 Liliacidites peroreticulatus (Brenner) Singh

26 Appendicisporites auritus Agasie

27 Cicatricosisporites hallei Delcourt & Sprumont

28 Cicatricosisporites spp.

29 Corollina sp.

30 Cupuliferoidaepollenites minutus (Brenner) Singh

31 Liliacidites spp.

32 Echinatisporis varispinosus (Pocock) Srivastava

33 Foraminisporis wonthaggiensis (Cookson & Dettmann) Dettmann

34 Foveosporites sp.

35 Camarozonosporites insignis Norris

36 Cicatricosisporites australiensis (Cookson) Potonié

37 Cingutriletes cf. C. clavus (Balme) Dettmann

38 Ephedra spp.

39 Rouseisporites reticulatus Pocock

40 Vitreisporites pallidus (Reissinger) Nilsson

41 Araucariacites sp.

42 Costatoperforosporites foveolatus Deak

43 Eucommiidites minor Groot & Penny

44 Pseudoschizaea sp.

45 Quadripollis krempii Drugg

46 Tsugaepollenites sp.

47 Stereisporites antiquasporites (Wilson & Webster) Dettmann

48 Osmundacidites wellmanii Dettmann

49 Rugubivesiculites sp.

50 Nyssapollenites spp.

51 Aequitriradites spinulosus (Cookson & Dettmann) Cookson & Dettmann

52 Microreticulatisporites spp.

53 Hazaria cf. H. canadiana Srivastava

54 Cycadopites sp.

55 Lycopodiumsporites sp.

56 Proteacidites retusus Anderson

57 Dicotetradites sp.

58 Proteacidites spp.

59 Pristinuspollenites sp.

60 Aquilapollenites quadrilobus Rouse

61 Cranwellia rumseyensis Srivastava

62 Erdtmanipollis pachysandroides Krutzsch

63 Aquilapollenites turbidus Tschudy & Leopold

64 Balmeisporites kondinskayae Srivastava & Binda

65 Aquilapollenites spp.

66 Densoisporites sp.

67 Leptolepidites sp.

68 Caryapollenites inelegans Nichols & Ott

69 Caryapollenites veripites Nichols & Ott

70 Momipites ventifluminis Nichols & Ott

71 Momipites wyomingensis Nichols & Ott

72 Alnus speciipites Wodehouse

73 Arecipites tenuiexinous Leffingwell

74 Momipites coryloides Wodehouse

75 Tilia tetraforaminipites Wodehouse

76 Tilia vescipites Wodehouse

77 Ulmipollenites spp.

78 Momipites spp.

79 Platycarya platycaryoides (Roche) Frederiksen & Christopher

80 Triporopollenites sp.

APPENDIX 2

ALPHABETICAL LIST OF PALYNOMORPH TAXA KEYED TO FIGURE 1

Aequitriradites spinulosus (Cookson & Dettmann) Cookson & Dettmann	51
Alnus speciipites Wodehouse	72
Appendicisporites auritus Agasie	26
Appendicisporites spp.	18
Aptea polymorpha Eisenack	1
Aquilapollenites quadrilobus Rouse	60
Aquilapollenites turbidus Tschudy & Leopold	63
Aquilapollenites spp.	65
Araucariacites sp.	41
Arecipites tenuiexinous Leffingwell	73
Balmeisporites kondinskayae Srivastava & Binda	64
Baltisphaeridium multispinosum Singh	6
Camarozonosporites insignis Norris	35
Caryapollenites inelegans Nichols & Ott	68
Caryapollenites veripites Nichols & Ott	69
Chatangiella cf. C. victoriensis (Cookson & Manum) Lentin & Williams	13
Chichaouadinium vestitum (Brideaux) Bujak & Davies	2
Chlamydophorella sp.	8
Cicatricosisporites australiensis (Cookson) Potonié	36
Cicatricosisporites hallei Delcourt & Sprumont	27
Cicatricosisporites spp.	28
Cingutriletes cf. C. clavus (Balme) Dettmann	37
Corollina sp.	29
Costatoperforosporites foveolatus Deak	42
Cranwellia rumseyensis Srivastava	61
Cribroperidinium edwardsii (Cookson & Eisenack) Davey	3
Cupuliferoidaepollenites minutus (Brenner) Singh	30
Cyathidites minor Couper	22
Cycadopites sp.	54
Cyclonephelium sp.	9
Cymatiosphaera sp.	4
Deflandrea spp.	7

Appendix 3. Palynostratigraphic zone at each locality

D6052	E (Eocene)
D6305	P5 - P6 (upper Paleocene)
D6308	..... do. .....
D6104	..... do. .....
-	
D6173	Aquilapollenites quadrilobus
D6317	..... do. .....
D6106	..... do. .....
D6107	..... do. .....
D6277	..... do. .....
D6592	..... do. .....
D6612	..... do. .....
--	
D6655	Proteacidites retusus
D6658-B	..... do. .....
D6658-A	..... do. .....
D6657	Chatangiella

D6150-D	Proteacidites retusus
D6150-C	..... do. .....
D6150-B	..... do. .....
D6150-A	..... do. .....

D6053	Proteacidites retusus
D6149-D	..... do. .....
D6149-C	..... do. .....
D6149-B	..... do. .....
D6149-A	..... do. .....
D6127	..... do. .....
D6183	..... do. .....
D6182	..... do. .....
D6184	..... do. .....
D6191	..... do. .....
D6370	..... do. .....
D6126	..... do. .....
D6369-A	..... do. .....
D6369-B	..... do. .....
D6369-C	..... do. .....

D6324-C	Chatangiella
D6324-B	.... do. ...
D6324-A	.... do. ...
D6325-C	Nyssapollenites
D6325-B	..... do. .....
D6325-A	..... do. .....
D6326-B	..... do. .....
D6326-A	..... do. .....
D6589	Chatangiella
D6590	Nyssapollenites
D6591	Chatangiella
D6304	Nyssapollenites
D6316	..... do. .....
D6306	..... do. .....
D6318-B	..... do. .....
D6318-A	..... do. .....

D6653	Alterbia
D6652	.. do. .
D6611	Nyssapollenites
D6131	..... do. .....
D6103	..... do. .....
D6108	Alterbia

D6011	Chichaouadinium (= "Spinidinium") vestitum
D6012	..... do. .....
D6016	..... do. .....
D6045	..... do. .....

Appendix 4. Summary list of formations or intervals by locality

D6052	Wasatch Fm.
D6305	... do. ...
D6308	... do. ...
D6104	... do. ...
D6173	Hams Fork Mbr.
D6317	..... do. ....
D6106	..... do. ....
D6107	..... do. ....
D6277	..... do. ....
D6592	..... do. ....
D6612	..... do. ....
D6655	Adaville and Hilliard fms. undivided
D6658-B	..... do. .....
D6658-A	..... do. .....
D6657	..... do. .....
D6150-D	Echo Canyon Conglomerate
D6150-C	..... do. .....
D6150-B	..... do. .....
D6150-A	..... do. .....
D6053	Henefer Fm.
D6149-D	... do. ...
D6149-C	... do. ...
D6149-B	... do. ...
D6149-A	... do. ...
D6127	... do. ...
D6183	... do. ...
D6182	... do. ...
D6184	... do. ...
D6191	... do. ...
D6370	... do. ...
D6126	... do. ...
D6369-A	... do. ...
D6369-B	... do. ...
D6369-C	... do. ...
D6324-C	Frontier Fm. above Oyster Ridge Sandstone Mbr.
D6324-B	.... do. ... . do. .....
D6324-A	.... do. ... . do. .....
D6325-C	.... do. ... . do. .....
D6325-B	.... do. ... . do. .....
D6325-A	.... do. ... . do. .....
D6326-B	.... do. ... . do. .....
D6326-A	.... do. ... . do. .....
D6589	.... do. ... . do. .....
D6590	.... do. ... . do. .....
D6591	.... do. ... . do. .....
D6304	.... do. ... . do. .....
D6316	.... do. ... . do. .....
D6306	.... do. ... . do. .....
D6318-B	.... do. ... . do. .....
D6318-A	.... do. ... . do. .....
D6653	Frontier Fm. below Oyster Ridge Sandstone Mbr.
D6652	.... do. ... . do. .....
D6611	.... do. ... . do. .....
D6131	.... do. ... . do. .....
D6103	.... do. ... . do. .....
D6108	.... do. ... . do. .....
D6011	Cokeville Fm.
D6012	.... do. ....
D6016	.... do. ....
D6045	.... do. ....

APPENDIX 5

DESCRIPTION OF PALYNOMORPH LOCALITIES

WASATCH FORMATION

D6052 Black clay below upper conglomerate bed. Collected by J. H. Dover and Bruce Bryant, Red Hole quadrangle. Cutbank in unnamed south tributary to Chalk Creek 80 m from junction with Chalk Creek at west edge of Sec. 30, T. 3 N., R. 7 E., 111° 05' 36", 40° 58' 11". Summit County.

D6305 Gray silty clay about 200 m above base of formation. Collected by D. J. Nichols and Bruce Bryant, Crandall Canyon quadrangle. At 6640' altitude, east side of gully north of north branch of Pecks Canyon. Sec. 2, T. 1 N., R. 5 E., 40° 50' 31", 111° 20' 48". Summit County.

D6308 Light-gray to gray silty clay from within 200 m of base of formation. Collected by D. J. Nichols and Bruce Bryant. Crandall Canyon quadrangle. At 6640' altitude on ridge between two branches of Pecks Canyon. Sec. 11, T. 1 N., R. 5 E., 40° 50' 25", 111° 20' 41". Summit County.

D6104 Gray, silty sand and sandy silt; a few leaf impressions present in finer grained beds. Base of variegated unit above tan conglomerate. Collected by Bruce Bryant. Upton quadrangle. Roadcut on South Fork Chalk Creek, 420 m north of south border of quadrangle. Sec. 25, T. 2 N., R. 6 E., 40° 52' 44", 111° 12' 55". Summit County.

HAMS FORK MEMBER OF THE EVANSTON FORMATION

D6173 Dark-gray silty clay about 30 m below unconformably overlying tan conglomerate. Collected by D. J. Nichols, Bruce Bryant, J. H. Dover, and T. D. Fouch. Upton quadrangle. Streamcut on southwest side of valley of South Fork of Chalk Creek, 1360 m northwest of mouth of Fish Creek. Center NW 1/4 Sec. 14, T. 2 N., R. 6 E., 111° 15' 33", 40° 54' 42". Summit County.

D6317 Gray clay from beneath light yellowish gray medium-grained sandstone bed. Collected by D. J. Nichols and Bruce Bryant. East Canyon Reservoir quadrangle. Roadcut on East Canyon Creek, 660 m due east of west boundary of quadrangle. Sec. 4, T. 2 N., R. 3 E., 40° 55' 42", 111° 37' 02". Morgan County.

D6106 Dark-gray carbonaceous silty shale. Collected by Bruce Bryant. Upton quadrangle. Roadcut on Chalk Creek road immediately northwest of Morby Creek. Sec. 31, T. 3 N., R. 7 E., 40° 57' 09", 111° 12' 04". Summit County.

D6107 Gray silty clay. Collected by Bruce Bryant. Turner Hollow quadrangle. West side of Elkhorn Canyon, 2470 m airline from South Fork Chalk Creek and at 6320' altitude. Sec. 17, T. 2 N., R. 6 E., 40° 54' 18", 110° 17' 04". Summit County.

D6277 Gray clay. Collected by D. J. Nichols and Bruce Bryant. Red Hole quadrangle. 360 m N. 25° E. of BM 6706. Sec. 26, T. 3 N., R. 7 E., 40° 57' 43", 111° 06' 57". Summit County.

D6592 Carbonaceous clay about 5 m thick in light-gray siltstone and clayey siltstone about 100 m below conglomerate. Collected by Bruce Bryant. Crandall Canyon quadrangle. At 7400' altitude on west side of north tributary to Crandall Canyon. NE 1/4 NW 1/4 Sec. 29, T. 1 N., R. 6 E., 40° 47' 51", 111° 17' 47". Summit County.

D6612 Gray silty clay about 5 m from base of sequence unconformably overlying Kelvin Formation. Collected by Bruce Bryant. Red hole quadrangle. Roadcut at 7570' altitude 400 m S. 15° E. from spot elevation 7688. NW 1/4 SE 1/4 NW 1/4 Sec. 1, T. 2 N., R. 7 E. 40° 56' 21", 111° 06' 27". Summit County.

HILLIARD AND ADAVILLE FORMATIONS UNDIFFERENTIATED

D6655 Gray clay 0.4 m thick between yellowish-gray sandstone and light-gray siltstone. Collected by Bruce Bryant. Hidden Lake quadrangle. Gulley about 1 m deep on east side of west fork of Neil Creek about 15 m above valley bottom, 960 m N. 38° E. from spot elevation 8085. NW 1/4 NE 1/4 NE 1/4 Sec. 25, T. 1 N., R. 6 E. 40° 47' 45", 111° 12' 31". Summit County.

D6658-A Gray clay with carbonized wood fragments and invertebrate fossils. Collected by Bruce Bryant. Hidden Lake quadrangle. Cut bank on south side of Perdue Creek valley 100 m S. 65° E. from center of Sec. 26, T. 1 N., R. 6 E. 40° 47' 27", 111° 15' 03". Summit County.

D6658-B Gray silty clay lens 5 cm thick in medium-grained sandstone. Contains carbonaceous fragments. Same locality as above.

D6657 Gray clay. Collected by Bruce Bryant. Hidden Lake quadrangle. Cut bank on south side of Perdue Creek 1230 m S. 87° W. from spot elevation 8085' SE 1/4 NE 1/4 SE 1/4 Sec. 26, T. 1 N., R. 6 E. 40° 47' 18", 111° 13' 50". Summit County.

ECHO CANYON CONGLOMERATE

D6150-A Gray silty carbonaceous clay from a 20 m thick section of gray sandstone, siltstone, and clay about 250 m above base of Echo Canyon Formation. Collected by D. J. Nichols, Bruce Bryant, J. H. Dover, and T. D. Fouch. Coalville quadrangle. Cut along Union Pacific Railroad at northeast end of Echo Reservoir dam. SE 1/4 NW 1/4 Sec. 30, T. 3 N., R. 5 E., 40° 58' 04", 111° 25' 40". Summit County.

D6150-B Gray silty clay. Same locality as above.

D6150-C Gray clayey siltstone. Same locality as above.

D6150-D Gray calcareous clay. Same locality as above.

HENEFER FORMATION

D6053 Dark-gray clay about 1.5 m below Echo Canyon conglomerate. Collected by Bruce Bryant. Coalville quadrangle. Roadcut along Highway I-80, 400' south of north edge of Sec. 31, T. 3 N., R. 5 E., 40° 57' 25", 111° 25' 24". Summit County.

D6149-A Gray calcareous silty clay about 12 m below base of Echo Canyon Conglomerate. Collected by D. J. Nichols, Bruce Bryant, T. D. Fouch, and J. H. Dover. Same locality as D6053.

D6149-B Gray calcareous silty clay about 19 m below base of Echo Canyon Conglomerate. Same locality as D6053.

D6149-C Gray siltstone with plant fragments. About 25 m below base of Echo Canyon Conglomerate. Same locality as D6053.

D6149-D Dark-gray carbonaceous sandy siltstone about 33 m below base of Echo Canyon Conglomerate. Same locality as D6053.

D6127 Gray clay with some plant fragments. About 610 m above base of formation. Collected by Bruce Bryant. Turner Hollow quadrangle. Roadcut on South Fork Chalk Creek, 1065 m airline from junction with main Chalk Creek road. Sec. 9, T. 2 N., R. 6 E., 40° 55' 44", 111° 16' 55". Summit County.

D6183 Gray silty clay from about 350 m above base of Henefer Formation. Collected by Bruce Bryant. Coalville quadrangle. West shore of Echo Canyon Reservoir, 950 m S. 49° E. of S. end of spillway. North edge Sec. 31, T. 3 N., R. 5 E., 40° 57' 29", 111° 25' 24". Summit County.

D6182 Carbonaceous siltstone about 240 m above base of formation. Collected by Bruce Bryant. Coalville quadrangle. West shore of Echo Canyon Reservoir, 1.56 km S. 37.5° E. of south end of spillway. SE 1/4 NE 1/4 Sec. 31, T. 3 N., R. 5 E., 40° 57' 09", 111° 25' 14". Summit County.

D6184 Carbonaceous siltstone from about 20 m above base of formation. Collected by Bruce Bryant. Coalville quadrangle. Roadcut in northbound lane of Highway I-80, SW 1/4 SW 1/4 Sec. 32, T. 3 N., R. 5 E., 40° 56' 46", 111° 24' 52". Summit County.

D6191 Same bed as D6184 but 30 m along strike.

D6370 Dark gray silty clay containing mollusk fragment. Same locality as D6184 and D6191.

D6126 Dark-gray silty, carbonaceous clay. Collected by Bruce Bryant. Upton quadrangle. 6675' altitude on slope north side of Chalk Creek valley, 620 m N. 71° W. of BM 6182 at Upton, west-central Sec. 26, T. 3 N., R. 6 E., 40° 57' 56", 111° 14' 35". Summit County.

D6369-A Gray silty clay from beneath 1-2 m thick coal bed. Contains pelecypods. About 10 m above base of formation. Collected by D. J. Nichols and Bruce Bryant. Same location as D6126.

D6369-B Mottled-gray, light-gray and brownish-gray clay. About same stratigraphic horizon as D6369A.

D6369-C Dark-gray clay 1.5 m above base of formation. 640 m N. 76° W. from BM-6182 and at 6600' altitude. 150 m SW of D6369A and B and D6126, 40° 57' 54", 111° 14' 37". Summit County.

FRONTIER FORMATION

D6324-A Dark-gray clay, Upton Sandstone Member below resistant yellowish-weathering sandstone and above less-resistant gray-weathering sandstone and silty sandstone. Roadcut on Highway I-80, 380 m southeast of stream in Carruth Canyon. Collected by D. J. Nichols and Bruce Bryant. Coalville quadrangle. Sec. 5, T 2 N., R. 5 E., 40° 56' 27", 111° 24' 42". Summit County.

D6324-B Gray clayey siltstone 6 m below sandstone that is light gray to north and yellowish gray to south. Same locality as above.

D6324-C Gray silty clay 20 m below more resistant sandstone section but still in dominantly sandstone section. Same locality as above.

D6325-A Gray clay beneath crossbedded medium grained sandstone 0.5 to 0.8 m thick in north end of cut. Grass Creek Member. Collected by D. J. Nichols and Bruce Bryant. Coalville quadrangle. Roadcut on Highway I-80, 780 m southeast of creek in Carruth Canyon. Sec. 5, T. 2 N., R. 5 E., 40° 56' 14", 111° 24' 35". Summit County.

D6325-B Gray clay from lens with 1 m and thinner lens of coal at base. About 6 m below D6325A at same locality.

D6325-C Gray clay 10 m below sandstone bed underlain by 1 m thick coal. 10 m below D6325B.

D6326-A Clayey coal from section with numerous coaly beds and one bed rich in marine fossils. Grass Creek Member. Collected by D. J. Nichols and Bruce Bryant. Coalville quadrangle. Roadcut on Highway I-80, 1070 m N. of creek in Lewis Canyon. Sec. 5, T. 2 N., R. 5 E., 40° 55' 48", 111° 24' 39". Summit County.

D6326-B Gray clay from just above coal and shaley coal 5-10 m thick and below 15 m thick sandstone. From near bottom of Grass Creek member. Collected by D. J. Nichols and Bruce Bryant. Coalville quadrangle. Roadcut on Highway I-80, 530 m north of creek in Lewis Canyon. Sec. 8, T. 2 N., R. 5 E., 40° 55' 38", 111° 24' 40". Summit County.

D6589 Gray clayey siltstone containing some fragments of megafossils. Collected by Bruce Bryant. Crandall Canyon quadrangle. On east side of bottom of slide scar north of Crandall Canyon at 7860' altitude. NW corner Sec. 28, T. 1 N., R. 6 E., 40° 47' 53", 111° 16' 55". Summit County.

D6590 Carbonaceous clay 2-4 m thick below sandstone. Collected by Bruce Bryant. Crandall Canyon quadrangle. On west side of bottom of slide scar north of Crandall Canyon at 7940' altitude. SW corner Sec. 21, T. 1 N., R. 6 E., 40° 47' 56", 111° 16' 56". Summit County.

D6591 Gray silty clay about 5 m below top of shale interval. Collected by Bruce Bryant. Crandall Canyon quadrangle. On north side of tributary gulley west of mudflow north of Crandall Canyon at 7920' altitude. SW corner, Sec. 21, T. 1 N., R. 6 E., 40° 47' 53", 111° 16' 55". Summit County.

D6304 Gray to light-gray silty clay containing tiny fragments of plant material. About 1300 m above Oyster Ridge Sandstone Member and 300 m below unconformity at top. Collected by Bruce Bryant. Big Dutch Hollow quadrangle. At 7080' altitude in gulley in north central part of Sec. 19, T. 1 N., R. 4 E., 40° 48' 39", 111° 32' 25". Morgan County.

D6316 Light-gray to gray clay about 40 m stratigraphically lower than D6304. Collected by Bruce Bryant. Big Dutch Hollow quadrangle. At 7100' altitude in gulley north of north branch of West Schuster Creek. Northeast corner of Sec. 19, T. 1 N., R. 4 E., 40° 48' 36", 111° 31' 56". Morgan County.

D6306 Gray to light-gray silty clay about 700 m below unconformity at top of formation. Collected by Bruce Bryant. Big Dutch Hollow quadrangle. At 7020' altitude in gulley north of north branch of west fork of Schuster Creek in northwest corner of Sec. 19, T. 1 N., R. 4 E., 40° 46' 33", 111° 31' 56". Morgan County.

D6318-A Gray silty clay in clayey siltstone about 280 m above sandstone correlated with the Oyster Ridge. Collected by D. J. Nichols and Bruce Bryant. Big Dutch Hollow quadrangle. Roadcut on East Canyon

Creek road 220 m north of Big Bear Hollow stream. Sec. 27, T. 1 N., R. 3 E., 40° 47' 32", 111° 35' 52". Summit County.

D6318-B Gray silty clay parting 0.5 m thick in siltstone 15 m above D6318-A at same locality.

D6653 Dark-gray clay. Collected by Bruce Bryant. Hidden Lake quadrangle. Cut for domestic water supply line on east side Neil Creek 860 m airline from its mouth. SE 1/4 NE 1/4 NW 1/4 Sec. 31, T. 1 N., R. 7 E. 40° 46' 55", 111° 11' 54". Summit County.

D6652 Gray to yellowish-gray clay. Collected by Bruce Bryant. Hidden Lake quadrangle. Cut for domestic water line on east side of Neil Creek 700 m airline from its mouth. Close to center N 1/2 Sec. 31, T. 1 N., R. 7 E. 40° 46' 59", 111° 11' 49". Summit County.

D6611 Gray clay bed 1-4 cm thick in siltstone. Collected by Bruce Bryant. Hidden Lake quadrangle. Cut bank on west side of Neil Creek 500 m airline from its mouth. SW 1/4 SW 1/4 NE 1/4 Sec. 31, T. 1 N., R. 7 E. 40° 46' 44", 111° 11' 43". Summit County.

D6131 Gray clayey siltstone containing wood fragments and shells about 2000 m above base of formation. Collected by D. J. Nichols, Bruce Bryant, J. H. Dover, and T. D. Fouch. Big Dutch Hollow quadrangle. Roadcut on east side of East Canyon Creek opposite Big Bear Hollow. East central part of Sec. 27, T. 1 N., R. 3 E., 40° 47' 24", 111° 35' 53". Summit County.

D6103 Gray clay. In Chalk Creek Member about 185 m below Wasatch coal bed. Collected by Bruce Bryant. Turner Hollow quadrangle. Roadcut on Chalk Creek road 122 m due E. of W. boundary of quadrangle. Sec. 10, T. 2 N., R. 5 E., 40° 55' 29", 111° 22' 25". Summit County.

D6108 Brownish-gray siltstone from just below coal bed above Longwell Sandstone Member. Collected by Bruce Bryant. Turner Hollow quadrangle. At 6800' altitude on west side of Turner Hollow about 40' above gulch bottom. Sec. 6, T. 2 N., R. 6 E., 40° 56' 25", 111° 19' 12". Summit County.

COKEVILLE FORMATION

D6011 Black shale with beds of yellowish-brown sandstone. Collected by J. H. Dover. Red Hole quadrangle. At 7080' altitude on east side of ridge 560 m N. 14° E. from BM 6706 on Chalk Creek road SE 1/4 Sec. 26, T 3 N., R. 7 E., 111° 06' 59", 40° 57' 51". Summit County.

D6012 Black shale with beds of yellowish-brown sandstone. Collected by J. H. Dover. Red Hole quadrangle at 6885' altitude 360 m N. 15° E. from BM 6706 on Chalk Creek road, SE 1/4 Sec. 26, T. 3 N., R. 7 E., 111° 07' 01", 40° 57' 44". Summit County.

D6016 Black shale with beds of yellowish-brown sandstone. Collected by J. H. Dover. Red Hole quadrangle. At 7440' altitude 50 m N. 65° W. of spot elevation 7604', SW 1/4 SW 1/4 Sec. 36, T. 3 N., R. 7 E., 111° 06' 44", 40° 56' 51". Summit County.

D6045 Black shale with beds of yellowish-brown sandstone. Collected by J. H. Dover. Red Hole quadrangle. At 7960' altitude on ridge in NW corner Sec. 23, T. 3 N., R. 7 E., 111° 06' 44", 40° 59' 15". Summit County.