

19. COCCOLITH AGE DETERMINATIONS LEG 3 DEEP SEA DRILLING PROJECT

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The data presented here represent age determinations made by means of calcareous nannofossils on sediment cores recovered in the Atlantic Ocean during Leg 3 of the Deep Sea Drilling Project. All of the determinations were made with a light microscope on smear slides prepared from unprocessed samples.

The accuracy of the age determination differs from one sample to the next, owing largely to the differences in assemblages. Assemblages containing age diagnostic species are readily assignable to a zone. Some samples, however, contain few or no age diagnostic species. In such cases relatively broader age assignments are made which are commonly equivalent to the interval represented by a stage. Stage terms are avoided here as it seems more reasonable to use such terms as upper Miocene or middle Eocene than to refer to one or another stage term used for the respective intervals.

In no case is an exhaustive species list given for a sample. For the most part only those species are recorded which actually aid in the age determination of a sample. It should be stressed that these results are preliminary, and, therefore, subject to minor revisions if more detailed studies are made.

Hole 13

Sample 3-13-1-1, 1 cm:

Discoaster pentaradiatus; Pseudoemiliania lacunosa; Discoaster brouweri; Cyclococcolithus leptoporus; Helicopontosphaera kamptneri.

Age: Late Pliocene.

Sample 3-13-1-2, 1 cm:

Pseudoemiliania lacunosa; Gephyrocapsa sp.; Discoaster pentaradiatus; Cyclococcolithus leptoporus; Helicopontosphaera kamptneri.

Age: Late Pliocene; probably contaminated.

Sample 3-13-1-3, 2 cm:

Pseudoemiliania lacunosa; Helicopontosphaera kamptneri; Discoaster pentaradiatus; Gephyrocapsa sp.; Cyclococcolithus leptoporus; Discoaster brouweri.

Age: Late Pliocene; probably contaminated.

Sample 3-13-1-4, 1 cm:

Discoaster pentaradiatus; Pseudoemiliania lacunosa; Cyclococcolithus leptoporus; Helicopontosphaera

kamptneri; Discoaster brouweri; Ceratolithus rugosus.

Age: Late Pliocene.

Sample 3-13-1-5, 2-3 cm:

Pseudoemiliania lacunosa; Discoaster pentaradiatus; Cyclococcolithus leptoporus; Helicopontosphaera kamptneri; Discoaster brouweri.

Age: Late Pliocene.

Sample 3-13-1-6, 3-4 cm:

Barren of calcareous nannofossils.

Sample 3-13-2-1, 30 cm:

Discoaster pentaradiatus; Discoaster brouweri; Ceratolithus cf. C. cristatus; Helicopontosphaera kamptneri; Pseudoemiliania lacunosa; Cyclococcolithus leptoporus.

Age: Late Pliocene.

Sample 3-13-2-2, 1-2 cm:

Discoaster pentaradiatus; Helicopontosphaera kamptneri; Cyclococcolithus leptoporus; Pseudoemiliania lacunosa.

Age: Late Pliocene.

Sample 3-13-2-3, 1-2 cm:

Cyclococcolithus leptoporus; Discoaster pentaradiatus; Discoaster challengerii; Ceratolithus cf. C. cristatus; Discoaster brouweri; Ceratolithus rugosus.

Age: Pliocene; probably middle.

Sample 3-13-2-4, 5-6 cm:

Barren of calcareous nannofossils.

Sample 3-13-2-5, 4-5 cm:

Barren of calcareous nannofossils.

Sample 3-13-2-6, 8-9 cm:

Barren of calcareous nannofossils.

Sample 3-13-3-1, 67-68 cm:

Barren of calcareous nannofossils.

Sample 3-13-3-2, 5-6 cm:

Barren of calcareous nannofossils.

Sample 3-13-3-3, 3-4 cm:

Barren of calcareous nannofossils.

Sample 3-13-3-4, 4-5 cm:

Barren of calcareous nannofossils.

Sample 3-13-3-5, 5-6 cm:
Barren of calcareous nannofossils.

Hole 13A

Sample 3-13A-1-1, 119-120 cm:
Discoaster barbadiensis; *Reticulofenestra umbilica*; aff.
Chiphragmalithus quadratus.
Age: Middle Eocene.

Sample 3-13A-2-1, 80-81 cm:
Cretarhabdus conicus; *Cribrosphaerella ehrenbergii*;
Microrhabdulus decoratus; *Arkhangelskiella cymbiformis*;
Maslovella barnesae; *Micula*; *Prediscosphaera cretacea*;
Zygodiscus elegans; *Lithraphidites carniolensis*;
Eiffellithus turriseiffeli.

Age: Upper Cretaceous, probably Campanian.

Sample 3-13A-3-1, 101-102 cm:
As above.

Sample 3-13A-3-2, 5-6 cm:
As above.

Sample 3-13A-3-3, 4-5 cm:
As above.

Sample 3-13A-3-4, 5-6 cm:
As above.

Sample 3-13A-4-1, 39-40 cm:
As above, but very poor assemblage.

Sample 3-13A-5-1, 33-34 cm:
As above.

Sample 3-13A-6-4, core catcher:
Barren of calcareous nannofossils.

Sample 3-13A-7-1, 89-90 cm:
Coccolithus sp.; unidentifiable placoliths, corroded.
Age: Indeterminable.

Hole 14

Sample 3-14-1A-1, 53-54 cm:
Sphenolithus belemnos; *Coccolithus neogammation*;
Discoaster deflandrei; cf. *Cyclococcolithus leptoporus*.
Age: Miocene; *Sphenolithus belemnos* Zone.

Sample 3-14-1A-2, 7-8 cm:
Coccolithus neogammation; *Sphenolithus belemnos*;
Cyclolithella rotunda.
Age: As above.

Sample 3-14-1A-3, 1-2 cm:
Coccolithus neogammation; *Discoaster obtusus*; *Cyclolithella rotunda*; cf. *Discoaster druggi*; *Sphenolithus*

moriformis; *Sphenolithus belemnos*.
Age: Early Miocene; probably pre-*Sphenolithus belemnos* Zone.

Sample 3-13-1A-4, 24-25 cm:
Coccolithus neogammation; *Discoaster druggi*; *Cyclolithella rotunda*; *Sphenolithus moriformis*; *Discoaster obtusus*.
Age: As above.

Sample 3-14-1A-5, 4-5 cm:
Coccolithus neogammation; *Sphenolithus moriformis*;
Discoaster druggi; aff. *Sphenolithus belemnos*; *Cyclolithella rotunda*; diagnostic fossils lacking.
Age: Late Oligocene to early Miocene.

Sample 3-14-1A-6:
Coccolithus neogammation; *Sphenolithus moriformis*;
Cyclolithella rotunda.
Age: As above.

Sample 3-14-2-1, 1-2 cm:
Coccolithus neogammation; *Sphenolithus moriformis*;
Cyclolithella rotunda; *Reticulofenestra* sp.
Age: Probably late Oligocene.

Sample 3-14-2-2, 1-2 cm:
As above.

Sample 3-14-2-3, 1-2 cm:
As above.

Sample 3-14-2-4, 2-3 cm:
As above.

Sample 3-14-2-5, 1-2 cm:
As above.

Sample 3-14-3-1, 5-6 cm:
Coccolithus neogammation; *Reticulofenestra scissura*;
Cyclolithella rotunda; *Sphenolithus moriformis*; *Sphenolithus ciperoensis*.
Age: Oligocene; *Sphenolithus ciperoensis* Zone.

Sample 3-14-3-2, 5-6 cm:
Sphenolithus ciperoensis; *Coccolithus neogammation*;
Reticulofenestra scissura.
Age: As above.

Sample 3-14-3-3, 6-7 cm:
As above.

Sample 3-14-3-4, 5-6 cm:
As above.

Sample 3-14-3-5, 5-6 cm:
As above.

Sample 3-14-3-6, 5-6 cm:
As above.

Sample 3-14-4-1, 10-11 cm:

Coccolithus neogammation; *Sphenolithus ciperoensis*; *Reticulofenestra scissura*; *Sphenolithus moriformis*; *Sphenolithus distentus*.

Age: Oligocene; probably *Sphenolithus ciperoensis* Zone.

Sample 3-14-4-2, 88-89 cm:

As above.

Sample 3-14-4-3, 10-11 cm:

Reticulofenestra scissura; *Coccolithus neogammation*; *Sphenolithus distentus*.

Age: Middle Oligocene; *Sphenolithus distentus* Zone.

Sample 3-14-5-1, 5-6 cm:

Coccolithus neogammation; *Sphenolithus distentus*; *Reticulofenestra scissura*.

Age: Oligocene; *Sphenolithus distentus* Zone.

Sample 3-14-5-2, 5-6 cm:

Coccolithus neogammation; *Reticulofenestra scissura*; *Sphenolithus moriformis*; *Sphenolithus distentus*.

Age: Oligocene; *Sphenolithus distentus* Zone.

Sample 3-14-5-3, 8-9 cm:

Reticulofenestra scissura; *Coccolithus neogammation*; cf. *Helicopontosphaera compacta*; *Sphenolithus distentus*; *Sphenolithus moriformis*; *Cyclolithella rotunda*.

Age: Oligocene; *Sphenolithus distentus* Zone.

Sample 3-14-5-4, 7-8 cm:

Reticulofenestra scissura; *Coccolithus neogammation*; *Sphenolithus moriformis*; *Sphenolithus distentus*; *Sphenolithus pseudoradians*; *Sphenolithus predistentus*.

Age: Oligocene; probably *Sphenolithus predistentus* Zone.

Sample 3-14-5-5, 5-6 cm:

Reticulofenestra scissura; *Coccolithus neogammation*; *Sphenolithus moriformis*; *Sphenolithus distentus*; *Sphenolithus pseudoradians*; *Cyclolithella rotunda*.

Age: As above.

Sample 3-14-5-6, 5-6 cm:

Sphenolithus predistentus; *Reticulofenestra scissura*; *Sphenolithus moriformis*; *Coccolithus neogammation*; *Sphenolithus distentus*.

Age: As above.

Sample 3-14-6-1, 20-21 cm:

Reticulofenestra scissura; *Coccolithus neogammation*; *Sphenolithus moriformis*; *Sphenolithus predistentus*; *Cyclolithella rotunda*; *Helicopontosphaera compacta*.

Age: As above.

Sample 3-14-6-2, 5-6 cm:

Reticulofenestra scissura; *Coccolithus neogammation*;

Sphenolithus moriformis; *Sphenolithus predistentus*; cf. *Sphenolithus distentus*.

Age: As above.

Sample 3-14-6-3, 5-6 cm:

Reticulofenestra scissura; *Coccolithus neogammation*; *Sphenolithus predistentus*; *Sphenolithus moriformis*; cf. *Discoaster tani*; *Helicopontosphaera compacta*.

Age: As above.

Sample 3-14-6-4, 4-5 cm:

Sphenolithus predistentus; *Coccolithus neogammation*; *Reticulofenestra scissura*; *Cyclolithella rotunda*.

Age: As above.

Sample 3-14-6-5, 4-5 cm:

Coccolithus neogammation; *Reticulofenestra scissura*; *Sphenolithus predistentus*.

Age: As above.

Sample 3-14-6-6, 5-6 cm:

Coccolithus neogammation; *Reticulofenestra scissura*; *Helicopontosphaera compacta*; *Sphenolithus predistentus*; cf. *Discoaster tani*.

Age: As above.

Sample 3-14-7-1, 5-6 cm:

Sphenolithus predistentus; *Coccolithus neogammation*; *Discoaster tani*; *Reticulofenestra scissura*.

Age: As above.

Sample 3-14-7-2, 4-5 cm:

Coccolithus neogammation; *Sphenolithus pseudoradians*; *Sphenolithus predistentus*; *Reticulofenestra scissura*; *Discoaster tani*; cf. *Sphenolithus distentus*.

Age: As above.

Sample 3-14-7-3, 5-6 cm:

Reticulofenestra scissura; *Coccolithus neogammation*; *Sphenolithus predistentus*; *Discoaster tani*; *Helicopontosphaera compacta*; cf. *Sphenolithus distentus*; *Sphenolithus pseudoradians*; aff. *Zygrhablithus bijugatus*.

Age: As above.

Sample 3-14-7-4, 5-6 cm:

Discoaster tani; *Reticulofenestra scissura*; *Coccolithus neogammation*; *Sphenolithus predistentus*; *Helicopontosphaera compacta*; aff. *Zygrhablithus bijugatus*.

Age: As above.

Sample 3-14-7-5, 5-6 cm:

Sphenolithus predistentus; *Coccolithus neogammation*; *Reticulofenestra scissura*; *Discoaster tani*; cf. *Zygrhablithus bijugatus*.

Age: As above.

Sample 3-14-7-6, 4-5 cm:

Reticulofenestra scissura; *Coccolithus neogammation*;

Reticulofenestra umbilica; cf. *Zygrhablithus bijugatus*; *Helicopontosphaera compacta*; *Discoaster tani*; *Sphenolithus predistentus*; *Sphenolithus pseudoradians*.

Age: As above.

Sample 3-14-8-1, 5-6 cm:

Sphenolithus distentus; *Coccolithus neogammation*; *Sphenolithus predistentus*; *Reticulofenestra scissura*; *Sphenolithus pseudoradians*; cf. *Zygrhablithus bijugatus*; *Bramletteius serraculoides*.

Age: As above.

Sample 3-14-8-2, 5-6 cm:

Reticulofenestra scissura; *Coccolithus neogammation*; *Sphenolithus predistentus*; *Bramletteius serraculoides*; cf. *Zygrhablithus bijugatus*; *Sphenolithus pseudoradians*; *Chiasmolithus oamaruensis*; *Discoaster tani*.

Age: Probably early Oligocene.

Sample 3-14-8-3, 8-9 cm:

Bramletteius serraculoides; *Reticulofenestra scissura*; *Coccolithus neogammation*; *Discoaster tani*; *Sphenolithus distentus*; cf. *Zygrhablithus bijugatus*; *Sphenolithus predistentus*; *Cyclococcolithus lusitanicus*; *Sphenolithus pseudoradians*.

Age: Early Oligocene; *Helicopontosphaera reticulata* Zone.

Sample 3-14-8-5, 5-6 cm:

Coccolithus neogammation; *Bramletteius serraculoides*; *Reticulofenestra scissura*; *Cyclococcolithus lusitanicus*; *Discoaster tani*; *Reticulofenestra umbilica*; *Helicopontosphaera reticulata*; *Sphenolithus predistentus*.

Age: Early Oligocene; *Helicopontosphaera reticulata* Zone.

Sample 3-14-8-6, 148-150 cm:

Reticulofenestra umbilica; *Reticulofenestra scissura*; *Bramletteius serraculoides*; *Coccolithus neogammation*; *Cyclococcolithus lusitanicus*; *Hayella situliformis*; *Discoaster tani*; *Sphenolithus pseudoradians*; cf. *Zygrhablithus bijugatus*.

Age: Early Oligocene or late Eocene.

Sample 3-14-9-2, 12-13 cm:

Reticulofenestra scissura; *Cyclococcolithus lusitanicus*; *Coccolithus neogammation*; *Bramletteius serraculoides*; cf. *Zygrhablithus bijugatus*; *Hayella situliformis*; *Reticulofenestra umbilica*; *Sphenolithus pseudoradians*.

Age: As above.

Sample 3-14-9-3, 148-150 cm:

Sphenolithus pseudoradians; *Reticulofenestra scissura*; *Cyclococcolithus lusitanicus*; *Bramletteius serraculoides*; *Reticulofenestra umbilica*; *Discoaster tani*; *Sphenolithus predistentus*; *Hayella situliformis*.

Age: As above.

Sample 3-14-9-4, 30-31 cm:

Zygrhablithus bijugatus; *Bramletteius serraculoides*; *Cyclococcolithus lusitanicus*; *Discoaster tani*; *Reticulofenestra scissura*; *Reticulofenestra umbilica*; *Coccolithus neogammation*; *Sphenolithus predistentus*; *Hayella situliformis*; *Helicopontosphaera compacta*.

Age: As above.

Sample 3-14-9-5, 16-17 cm:

Reticulofenestra scissura; *Coccolithus neogammation*; *Cyclococcolithus lusitanicus*; *Bramletteius serraculoides*; *Reticulofenestra umbilica*; *Helicopontosphaera reticulata*; *Hayella situliformis*; *Sphenolithus pseudoradians*; *Zygrhablithus bijugatus*; cf. *Isthmolithus recurvus*; *Discoaster tani*; *Sphenolithus predistentus*.

Age: As above.

Sample 3-14-9-6, 10-11 cm:

Reticulofenestra scissura; *Coccolithus neogammation*; *Reticulofenestra umbilica*; *Cyclococcolithus lusitanicus*; *Hayella situliformis*; *Zygrhablithus bijugatus*; *Bramletteius serraculoides*; *Discoaster tani*.

Age: As above.

Hole 15

Sample 3-15-1-1, 5-6 cm:

Gephyrocapsa sp.; *Helicopontosphaera kampfneri*; *Cyclococcolithus leptoporus*; *Reticulofenestra pseudoumbilica*; *Discoaster* sp.; *Pseudoemiliania lacunosa*; *Oolithotus antillarum*; *Sphenolithus abies*; *Reticulofenestra* cf. *R. scissura*.

Age: Sample badly mixed and includes Pleistocene, Neogene, and Tertiary elements.

Sample 3-15-1-2, 5-6 cm:

Helicopontosphaera kampfneri; *Gephyrocapsa* sp.; *Pseudoemiliania lacunosa*; *Cyclococcolithus leptoporus*.

Age: Quaternary, probably middle Pleistocene.

Sample 3-15-1-3, 8-9 cm:

Pseudoemiliania lacunosa; *Gephyrocapsa* sp.; *Oolithotus antillarum*; *Helicopontosphaera kampfneri*; *Umbilicosphaera mirabilis*; *Cyclococcolithus leptoporus*.

Age: Quaternary, probably early to middle Pleistocene.

Sample 3-15-1-4, 4-5 cm:

Pseudoemiliania lacunosa; *Cyclococcolithus leptoporus*; *Helicopontosphaera kampfneri*; *Umbilicosphaera mirabilis*; *Gephyrocapsa* sp.; *Oolithotus antillarum*.

Age: As above.

Sample 3-15-1-5, 5-6 cm:

Pseudoemiliania lacunosa; *Gephyrocapsa caribbeanica*; *Cyclococcolithus leptoporus*.

Age: As above.

Sample 3-15-1-6, 4-5 cm:

Pseudoemiliania lacunosa; *Gephyrocapsa caribbeanica*;

Helicopontosphaera kampfneri; *Cyclococcolithus leptoporus*.

Age: As above.

Sample 3-15-2-1, 5-6 cm:

Pseudoemiliania lacunosa; *Helicopontosphaera kampfneri*; *Cyclococcolithus leptoporus*.

Age: Quaternary; early Pleistocene.

Sample 3-15-2-7, 6-7 cm:

Pseudoemiliania lacunosa; *Discoaster* sp.; *Oolithotus antillarum*; *Discoaster brouweri rutellus*; *Discoaster brouweri*; *Umbilicosphaera mirabilis*.

Age: Late Pliocene.

Sample 3-15-2-3, 5-6 cm:

Pseudoemiliania lacunosa; *Cyclococcolithus leptoporus*; *Helicopontosphaera kampfneri*; *Discoaster brouweri*.

Age: As above.

Sample 3-15-2-4, 5-6 cm:

Pseudoemiliania lacunosa; *Cyclococcolithus leptoporus*; *Discoaster brouweri*; *Helicopontosphaera kampfneri*.

Age: As above.

Sample 3-15-2-5, 10-11 cm:

Pseudoemiliania lacunosa; *Cyclococcolithus leptoporus*; *Helicopontosphaera kampfneri*; *Discoaster brouweri*.

Age: As above.

Sample 3-15-2-6, 5-6 cm:

Pseudoemiliania lacunosa; *Cyclococcolithus leptoporus*; *Discoaster brouweri*.

Age: As above.

Sample 3-15-3-1, 5-6 cm:

Reticulofenestra pseudoumbilica; *Discoaster pentaradiatus*; *Cyclococcolithus leptoporus*; *Helicopontosphaera kampfneri*; *Ceratolithus* sp.

Age: Middle Pliocene.

Sample 3-15-3-2, 8-9 cm:

Reticulofenestra pseudoumbilica; *Discoaster brouweri*; *Cyclococcolithus leptoporus*; *Discoaster pentaradiatus*; *Helicopontosphaera kampfneri*.

Age: As above.

Sample 3-15-3-3, 5-6 cm:

Cyclococcolithus leptoporus; *Reticulofenestra pseudoumbilica*; *Discoaster brouweri*; *Discoaster pentaradiatus*; *Ceratolithus rugosus*; *Ceratolithus tricorniculatus*.

Age: Early to middle Pliocene.

Sample 3-15-3-4, 5-6 cm:

Reticulofenestra pseudoumbilica; *Discoaster brouweri*; *Discoaster pentaradiatus*; *Cyclococcolithus leptoporus*; *Sphenolithus abies*.

Age: Early Pliocene.

Sample 3-15-3-5, 6-7 cm:

Reticulofenestra pseudoumbilica; *Ceratolithus rugosus*; *Discoaster pentaradiatus*; *Discoaster brouweri*; *Cyclococcolithus leptoporus*; *Sphenolithus abies*.

Age: As above.

Sample 3-15-3-6, 4-5 cm:

Reticulofenestra pseudoumbilica; *Cyclococcolithus leptoporus*; *Discoaster pentaradiatus*; *Discoaster brouweri*; *Sphenolithus abies*.

Age: As above.

Sample 3-15-4-1, 6-7 cm:

Cyclococcolithus leptoporus; *Discoaster pentaradiatus*; *Discoaster brouweri*; *Sphenolithus abies*; *Reticulofenestra pseudoumbilica*; *Discoaster surculus*; *Ceratolithus tricorniculatus*.

Age: As above.

Sample 3-15-4-2, 10-11 cm:

Reticulofenestra pseudoumbilica; *Discoaster brouweri*; *Discoaster pentaradiatus*; cf. *Discoaster variabilis*; *Cyclococcolithus leptoporus*; *Ceratolithus tricorniculatus*; *Sphenolithus abies*.

Age: As above.

Sample 3-15-4-3, 5-6 cm:

Reticulofenestra pseudoumbilica; *Discoaster brouweri*; *Discoaster pentaradiatus*; *Cyclococcolithus leptoporus*; *Sphenolithus abies*; cf. *Discoaster variabilis*; *Ceratolithus rugosus*.

Age: As above.

Sample 3-15-4-4, 5-6 cm:

Discoaster pentaradiatus; *Reticulofenestra pseudoumbilica*; *Cyclococcolithus leptoporus*; *Discoaster brouweri*; *Sphenolithus abies*; *Ceratolithus rugosus*; *Discoaster extensus*.

Age: As above.

Sample 3-15-4-5, 5-6 cm:

Discoaster pentaradiatus; *Discoaster brouweri*; *Reticulofenestra pseudoumbilica*; *Cyclococcolithus leptoporus*; *Sphenolithus abies*; *Discoaster extensus*; *Ceratolithus rugosus*; *Ceratolithus tricorniculatus*.

Age: As above.

Sample 3-15-4-6, 4-5 cm:

Reticulofenestra pseudoumbilica; *Discoaster brouweri*; *Discoaster pentaradiatus*; *Discoaster variabilis*; *Cyclococcolithus leptoporus*; *Ceratolithus tricorniculatus*; *Sphenolithus abies*; *Discoaster extensus*.

Age: Early Pliocene or late Miocene (Messinian).

Sample 3-15-5-1, 5-6 cm:

Discoaster brouweri; *Discoaster variabilis*; *Cyclococcolithus leptoporus*; *Discoaster pentaradiatus*.

Age: As above.

- Sample 3-15-5-2, 4-5 cm:
Discoaster variabilis; *Discoaster brouweri*; *Cyclococcolithus leptoporus*; *Discoaster pentaradiatus*.
Age: Probably as above.
- Sample 3-15-5-3, 5-6 cm:
Cyclococcolithus leptoporus; *Discoaster brouweri*; *Discoaster variabilis*; *Discoaster extensus*; *Discoaster pentaradiatus*.
Age: Probably as above.
- Sample 3-15-5-4, 5-6 cm:
Discoaster brouweri; *Cyclococcolithus leptoporus*; *Discoaster extensus*; cf. *Reticulofenestra pseudoumbilica*.
Age: Probably as above.
- Sample 3-15-5-5, 5-6 cm:
Discoaster brouweri; *Discoaster variabilis*; *Cyclococcolithus leptoporus*; *Discoaster extensus*; *Discoaster pentaradiatus*.
Age: As above.
- Sample 3-15-5-6, 5-6 cm:
Discoaster brouweri; *Cyclococcolithus leptoporus*; *Discoaster pentaradiatus*; cf. *Discoaster variabilis*.
Age: As above.
- Sample 3-15-6-1, 9-10 cm:
Cyclococcolithus leptoporus; cf. *Reticulofenestra pseudoumbilica*; cf. *Discoaster variabilis*; cf. *Discoaster extensus*.
Age: Probably as above.
- Sample 3-15-6-2, 16-17 cm:
Cyclococcolithus leptoporus; cf. *Discoaster variabilis*; cf. *Discoaster brouweri*; *Reticulofenestra pseudoumbilica*; *Discoaster pentaradiatus*.
Age: Probably as above.
- Sample 3-15-6-3, 5-6 cm:
Reticulofenestra pseudoumbilica; *Cyclococcolithus leptoporus*; cf. *Discoaster variabilis*.
Age: Probably as above.
- Sample 3-15-6-4, 4-5 cm:
Cyclococcolithus leptoporus; cf. *Discoaster variabilis*; *Reticulofenestra pseudoumbilica*; cf. *Discoaster exilis*.
Age: Probably late-middle Miocene.
- Sample 3-15-6-5, 4-5 cm:
Coccolithus neogammation; *Cyclococcolithus leptoporus*; *Reticulofenestra pseudoumbilica*; *Discoaster* sp.
Age: Middle Miocene.
- Sample 3-15-6-6, 4-5 cm:
Coccolithus neogammation; *Reticulofenestrapseudoumbilica*; cf. *Discoaster exilis*; *Discoaster deflandrei*; cf. *Cyclococcolithus leptoporus*.
Age: As above.
- Sample 3-15-7-1, 4-5 cm:
Coccolithus neogammation; *Reticulofenestra pseudoumbilica*; cf. *Cyclococcolithus leptoporus*; *Sphenolithus moriformis*; *Sphenolithus heteromorphus*.
Age: Middle Miocene, *Sphenolithus heteromorphus* Zone.
- Sample 3-15-7-2, 6-7 cm:
Coccolithus neogammation; *Reticulofenestra pseudoumbilica*; *Discoaster aulakos*; *Sphenolithus heteromorphus*; cf. *Cyclococcolithus leptoporus*.
Age: As above.
- Sample 3-15-7-3, 5-6 cm:
Sphenolithus heteromorphus; *Coccolithus neogammation*; *Discoaster aulakos*; aff. *Cyclococcolithus leptoporus*.
Age: As above.
- Sample 3-15-7-4, 8-9 cm:
Coccolithus neogammation; aff. *Cyclococcolithus leptoporus*; *Discoaster aulakos*; *Sphenolithus heteromorphus*.
Age: As above.
- Sample 3-15-7-5, 4-5 cm:
Coccolithus neogammation; aff. *Cyclococcolithus leptoporus*; *Discoaster aulakos*; *Sphenolithus heteromorphus*.
Age: As above.
- Sample 3-15-7-6, 5-6 cm:
Coccolithus neogammation; *Sphenolithus heteromorphus*; aff. *Cyclococcolithus leptoporus*; *Cyclolithella rotunda*; *Discoaster aulakos*; cf. *Discoaster exilis*.
Age: As above.
- Sample 3-15-8-1, 148-150 cm:
Coccolithus neogammation; *Cyclolithella rotunda*.
Age: Probably as above.
- Sample 3-15-8-2, 5-6 cm:
Helicopontosphaera intermedia; *Coccolithus neogammation*; *Sphenolithus heteromorphus*; *Discoaster* sp.
Age: As above.
- Sample 3-15-8-3, 5-6 cm:
Coccolithus neogammation; *Sphenolithus moriformis*; *Cyclolithella rotunda*; aff. *Cyclococcolithus leptoporus*.
Age: Probably as above.
- Sample 3-15-8-4, 5-6 cm:
Coccolithus neogammation; *Sphenolithus moriformis*; *Cyclolithella rotunda*.
Age: Probably as above.
- Sample 3-15-8-5, 5-6 cm:
Coccolithus neogammation; *Sphenolithus moriformis*;

cf. *Sphenolithus heteromorphus*; *Cyclolithella rotunda*.
Age: As above.

Sample 3-15-8-6, 6-7 cm:
Coccolithus neogammation; *Sphenolithus moriformis*;
Cyclolithella rotunda; *Discoaster* sp.
Age: Probably as above.

Sample 3-15-9-1, 46-47 cm:
Coccolithus neogammation; *Sphenolithus heteromorphus*; cf. *Cyclococcolithus leptoporus*. (This sample appears to be younger than last sample above; probably from contamination due to caving.)
Age: Early middle Miocene, *Sphenolithus heteromorphus* Zone.

Sample 3-15-9-2, 9-10 cm:
Coccolithus neogammation; *Sphenolithus heteromorphus*; *Discoaster aulakos*; *Cyclolithella rotunda*; aff. *Cyclococcolithus leptoporus*.
Age: As above.

Sample 3-15-9-3, 4-5 cm:
Sphenolithus heteromorphus; *Coccolithus neogammation*; *Discoaster aulakos*; *Cyclolithella rotunda*; *Helicopontosphaera intermedia*; aff. *Cyclococcolithus leptoporus*.
Age: As above.

Sample 3-15-9-4, 4-5 cm:
Coccolithus neogammation; *Discoaster aulakos*; *Discoaster deflandrei*; *Sphenolithus heteromorphus*; aff. *Cyclococcolithus leptoporus*.
Age: As above.

Sample 3-15-9-5, 5-6 cm:
Coccolithus neogammation; *Sphenolithus moriformis*; *Cyclolithella rotunda*; cf. *Sphenolithus heteromorphus*.
Age: Probably as above.

Sample 3-15-9-6, 4-5 cm:
Coccolithus neogammation; *Sphenolithus moriformis*; *Discoaster obtusus*; cf. *Discoaster druggi*; *Cyclolithella rotunda*.
Age: Early Miocene.

Hole 16

Sample 3-16-1-1, 6-7 cm:
Gephyrocapsa oceanica; *Emiliania huxleyi*.
Age: Late Pleistocene.

Sample 3-16-1-2, 4-5 cm:
Gephyrocapsa oceanica; *Emiliania huxleyi*.
Age: As above.

Sample 3-16-1-4, 0-3 cm:
Gephyrocapsa oceanica; *Emiliania huxleyi*.
Age: As above.

Sample 3-16-2-1, 150 cm:
Pseudoemiliania lacunosa; no *Gephyrocapsa*; no *Discoaster*.
Age: Early Pleistocene.

Sample 3-16-2-2, 150 cm:
Pseudoemiliania lacunosa; no *Gephyrocapsa*; no *Discoaster*.
Age: As above.

Sample 3-16-2-3, 150 cm:
Pseudoemiliania lacunosa; *Gephyrocapsa oceanica*; *Gephyrocapsa aperta*.
Age: Middle Pleistocene.

Sample 3-16-2-4, 150 cm:
Pseudoemiliania lacunosa; *Discoaster brouweri*.
Age: Late Pliocene.

Sample 3-16-2-5, 150 cm:
Pseudoemiliania lacunosa; *Discoaster brouweri*.
Age: As above.

Sample 3-16-2-6, 5-6 cm:
Pseudoemiliania lacunosa; *Discoaster brouweri*.
Age: As above.

Sample 3-16-3-1, 150 cm:
Discoaster pentaradiatus; *Pseudoemiliania lacunosa*; *Discoaster brouweri*; *Discoaster surculus*.
Age: Late Pliocene.

Sample 3-16-3-2, 150 cm:
Discoaster pentaradiatus; *Pseudoemiliania lacunosa*.
Age: As above.

Sample 3-16-3-3, 150 cm:
Discoaster pentaradiatus; *Pseudoemiliania lacunosa*; *Discoaster surculus*; *Discoaster brouweri*.
Age: As above.

Sample 3-16-3-4, 150 cm:
Discoaster pentaradiatus; *Pseudoemiliania lacunosa*.
Age: As above.

Sample 3-16-3-5, 150 cm:
Discoaster pentaradiatus; *Pseudoemiliania lacunosa*; *Discoaster brouweri*.
Age: Late Pliocene.

Sample 3-16-3-6, 150 cm:
Pseudoemiliania lacunosa; *Discoaster pentaradiatus*; *Discoaster brouweri*.
Age: As above.

Sample 3-16-4-1, 5-6 cm:
Discoaster brouweri; *Reticulofenestra pseudoumbilica*; *Pseudoemiliania lacunosa*; *Discoaster pentaradiatus*.
Age: Middle Pliocene.

- Sample 3-16-4-2, 5-6 cm:
Discoaster pentaradiatus; Reticulofenestra pseudoumbilica; Discoaster brouweri.
 Age: Middle Pliocene.
- Sample 3-16-4-3, 4-5 cm:
Discoaster pentaradiatus; Reticulofenestra pseudoumbilica; Discoaster brouweri; Ceratolithus rugosus; Discoaster extensus.
 Age: Middle Pliocene.
- Sample 3-16-4-4, 4-5 cm:
Reticulofenestra pseudoumbilica; Discoaster brouweri; Discoaster pentaradiatus; Ceratolithus rugosus.
 Age: Middle Pliocene.
- Sample 3-16-4-5, 4-5 cm:
Reticulofenestra pseudoumbilica; Discoaster pentaradiatus; Discoaster extensus; Discoaster brouweri; Sphenolithus abies.
 Age: Early Pliocene.
- Sample 3-16-4-6, 150 cm:
Sphenolithus abies; Reticulofenestra pseudoumbilica; Ceratolithus tricorniculatus; Discoaster pentaradiatus; Discoaster brouweri; Discoaster extensus.
 Age: Early Pliocene.
- Sample 3-16-5-1, 150 cm:
Reticulofenestra pseudoumbilica; Discoaster variabilis; Discoaster pentaradiatus; Sphenolithus abies; Ceratolithus tricorniculatus.
 Age: Early Pliocene or late Miocene (Messinian).
- Sample 3-16-5-2, 150 cm:
Reticulofenestra pseudoumbilica; Discoaster pentaradiatus; Discoaster variabilis; Ceratolithus tricorniculatus; Discoaster brouweri.
 Age: As above.
- Sample 3-16-5-3, 150 cm:
Reticulofenestra pseudoumbilica; Discoaster brouweri; Discoaster pentaradiatus; Sphenolithus abies; Ceratolithus tricorniculatus.
 Age: As above.
- Sample 3-16-5-4, 150 cm:
Reticulofenestra pseudoumbilica; Sphenolithus abies; Discoaster pentaradiatus; Discoaster challengerii; Discoaster brouweri; Discoaster variabilis; Ceratolithus tricorniculatus.
 Age: As above.
- Sample 3-16-5-5, 150 cm:
Reticulofenestra pseudoumbilica; Discoaster brouweri; Discoaster pentaradiatus; Sphenolithus abies; Ceratolithus tricorniculatus.
 Age: As above.
- Sample 3-16-6-1, 150 cm:
Reticulofenestra pseudoumbilica; Discoaster pentaradiatus; Ceratolithus tricorniculatus; Discoaster brouweri.
 Age: As above.
- Sample 3-16-6-2, 150 cm:
Ceratolithus tricorniculatus; Reticulofenestra pseudoumbilica; Discoaster variabilis.
 Age: As above.
- Sample 3-16-6-3, 150 cm:
Reticulofenestra pseudoumbilica; Discoaster pentaradiatus; Discoaster brouweri; Ceratolithus tricorniculatus.
 Age: As above.
- Sample 3-16-6-4, 150 cm:
Reticulofenestra pseudoumbilica; Discoaster variabilis; Discoaster brouweri; Discoaster pentaradiatus.
 Age: As above.
- Sample 3-16-6-5, 150 cm:
Reticulofenestra pseudoumbilica; Discoaster variabilis; cf. Ceratolithus tricorniculatus.
 Age: Probably Messinian.
- Sample 3-16-6-6, 150 cm:
Sphenolithus abies; Discoaster pentaradiatus; Reticulofenestra pseudoumbilica; Ceratolithus tricorniculatus; Discoaster variabilis.
 Age: Probably Messinian.
- Sample 3-16-7-1, 150 cm:
Discoaster pentaradiatus; Reticulofenestra pseudoumbilica; Discoaster brouweri; Discoaster variabilis.
 Age: Late Miocene.
- Sample 3-16-7-2, 150 cm:
Reticulofenestra pseudoumbilica; Discoaster pentaradiatus; Discoaster variabilis.
 Age: As above.
- Sample 3-16-7-3, 150 cm:
Reticulofenestra pseudoumbilica; Discoaster variabilis; Discoaster brouweri.
 Age: As above.
- Sample 3-16-7-4, 150 cm:
Reticulofenestra pseudoumbilica; Discoaster variabilis.
 Age: As above.
- Sample 3-16-7-5, 150 cm:
Reticulofenestra pseudoumbilica; Discoaster brouweri; Discoaster variabilis; Discoaster pentaradiatus.
 Age: Late Miocene.
- Sample 3-16-7-6, 150 cm:
Reticulofenestra pseudoumbilica; Discoaster brouweri; Discoaster variabilis; Discoaster pentaradiatus.
 Age: As above.

Sample 3-16-8-1, 150 cm:

Reticulofenestra pseudoumbilica; Discoaster pentaradiatus; Discoaster variabilis; Sphenolithus abies.

Age: As above.

Sample 3-16-8-2, 150 cm:

Ceratolithus tricorniculatus; Discoaster variabilis; Reticulofenestra pseudoumbilica; Discoaster pentaradiatus.

Age: Late Miocene (Messinian).

Sample 3-16-8-3, 150 cm:

Reticulofenestra pseudoumbilica; Discoaster variabilis; Sphenolithus abies; Discoaster pentaradiatus; Discoaster brouweri.

Age: Late Miocene.

Sample 3-16-8-4, 150 cm:

Reticulofenestra pseudoumbilica; Discoaster variabilis; Discoaster pentaradiatus; Sphenolithus abies; Ceratolithus tricorniculatus; Discoaster challengerii.

Age: Late Miocene (Messinian).

Sample 3-16-8-5, 150 cm:

Reticulofenestra pseudoumbilica; Discoaster variabilis; Discoaster brouweri; Discoaster pentaradiatus; Ceratolithus tricorniculatus; Sphenolithus abies.

Age: Late Miocene (Messinian).

Sample 3-16-8-6, 150 cm:

Reticulofenestra pseudoumbilica; Sphenolithus abies; Discoaster variabilis; Discoaster pentaradiatus; Ceratolithus tricorniculatus.

Age: As above.

Sample 3-16-9-1, 150 cm:

Discoaster brouweri; Discoaster variabilis; Discoaster pentaradiatus; Reticulofenestra pseudoumbilica.

Age: Late Miocene.

Sample 3-16-9-2, 150 cm:

Discoaster variabilis; Discoaster brouweri.

Age: Late Miocene (Tortonian).

Sample 3-16-9-3, 150 cm:

Discoaster variabilis; Discoaster pentaradiatus; Discoaster brouweri; cf. Discoaster hamatus.

Age: As above.

Sample 3-16-9-4, 150 cm:

Discoaster variabilis; Discoaster brouweri; cf. Discoaster hamatus; Discoaster pentaradiatus.

Age: As above.

Sample 3-16-9-6, 150 cm:

Discoaster variabilis; Discoaster brouweri; Discoaster pentaradiatus; cf. Discoaster hamatus.

Age: As above.

Sample 3-16-10-1, 150 cm:

Reticulofenestra pseudoumbilica; Discoaster pentaradiatus; Discoaster brouweri; Discoaster variabilis; aff. Discoaster hamatus.

Age: As above.

Sample 3-16-10-2, 150 cm:

Discoaster brouweri; Discoaster aulakos; cf. Discoaster hamatus; Discoaster variabilis; Discoaster brouweri; Discoaster pentaradiatus.

Age: As above.

Sample 3-16-10-3, 150 cm:

Discoaster brouweri; Discoaster aulakos; Discoaster pentaradiatus; cf. Discoaster hamatus; Discoaster variabilis.

Age: As above.

Sample 3-16-10-4, 150 cm:

Discoaster brouweri; Discoaster variabilis; Discoaster pentaradiatus; cf. Discoaster hamatus.

Age: As above.

Sample 3-16-10-5, 150 cm:

Discoaster variabilis; Discoaster brouweri.

Age: As above.

Sample 3-16-10-6, 150 cm:

Discoaster brouweri; Discoaster pentaradiatus; Discoaster variabilis; cf. Discoaster hamatus.

Age: As above.

Sample 3-16-11-1, 150 cm:

Reticulofenestra pseudoumbilica; Discoaster variabilis; Discoaster pentaradiatus; Discoaster brouweri; cf. Discoaster hamatus.

Age: As above.

Sample 3-16-11-2, 150 cm:

Discoaster brouweri; Reticulofenestra pseudoumbilica; Discoaster pentaradiatus; Discoaster variabilis; aff. Discoaster hamatus.

Age: As above.

Sample 3-16-11-3, 150 cm:

Discoaster brouweri; Reticulofenestra pseudoumbilica; Discoaster variabilis; Discoaster pentaradiatus; aff. Discoaster hamatus.

Age: As above.

Sample 3-16-11-4, 150 cm:

Discoaster brouweri; Discoaster variabilis; aff. Discoaster hamatus; Discoaster pentaradiatus.

Age: As above.

Sample 3-16-11-5, 150 cm:

Reticulofenestra pseudoumbilica; Discoaster brouweri; Discoaster pentaradiatus.

Age: As above.

Sample 3-16-11-6, 150 cm:
Reticulofenestra pseudoumbilica; *Discoaster variabilis*;
Discoaster brouweri; *Discoaster aulakos*.
Age: Late Miocene.

Hole 17

Sample 3-17-1-1, 15-16 cm:
Pseudoemilia lacunosa; *Cyclococcolithus leptoporus*;
Discoaster sp.; *Gephyrocapsa caribbeanica*; cf. *Reticulofenestra pseudoumbilica*.
Age: Early Pleistocene-Pliocene.

Sample 3-17-1-2, 5-6 cm:
Pseudoemilia lacunosa; *Cyclococcolithus leptoporus*;
Gephyrocapsa oceanica; *Ceratolithus rugosus*.
Age: Probably Pleistocene; contaminated.

Sample 3-17-1-3, 5-6 cm:
As above.

Sample 3-17-1-4, 7-8 cm:
Discoaster pentaradiatus; *Discoaster brouweri*; *Pseudoemilia lacunosa*; *Gephyrocapsa oceanica*.
Age: Probably late Pliocene, contaminated with Pleistocene.

Sample 3-17-1-5, 3-4 cm:
As above.

Sample 3-17-2-6, 4-5 cm:
Reticulofenestra pseudoumbilica; *Discoaster pentaradiatus*; *Discoaster brouweri*; *Ceratolithus rugosus*.
Age: Middle Pliocene.

Hole 17A

Sample 3-17A-1-1, 5-6 cm:
Sphenolithus heteromorphus; *Coccolithus neogammation*; cf. *Discoaster pentaradiatus*.
Age: Middle Miocene, *Sphenolithus heteromorphus* Zone.

Sample 3-17A-1-6, 6-7 cm:
Coccolithus neogammation; *Cyclococcolithus leptoporus*; *Sphenolithus heteromorphus*.
Age: As above.

Sample 3-17A-2-1, 3-4 cm:
Coccolithus neogammation; *Sphenolithus moriformis*.
Assemblage not age diagnostic.

Sample 3-17A-2-6, 4-5 cm:
As above.

Sample 3-17A-3-1, 4-5 cm:
cf. *Sphenolithus ciperoensis*; *Coccolithus neogammation*; *Reticulofenestra scissura*.
Age: Oligocene, *Sphenolithus ciperoensis* Zone.

Sample 3-17A-3-6, 148-150 cm:
Chiasmolithus oamaruensis; *Reticulofenestra scissura*;
Coccolithus neogammation; cf. *Sphenolithus distentus*;
Discoaster tani.
Age: Middle Oligocene.

Sample 3-17A-4-2, 2-3 cm:
Reticulofenestra scissura; *Coccolithus neogammation*;
Helicopontosphaera compacta; *Sphenolithus distentus*.
Age: As above.

Sample 3-17A-4-5, 0-2 cm:
Discoaster tani; *Coccolithus neogammation*; *Sphenolithus predistentus*; *Reticulofenestra scissura*; *Sphenolithus distentus*; *Helicopontosphaera compacta*; *Chiasmolithus oamaruensis*.
Age: Middle Oligocene.

Sample 3-17A-4-6, 3-4 cm:
Reticulofenestra scissura; *Coccolithus neogammation*;
Sphenolithus predistentus; *Chiasmolithus oamaruensis*;
Helicopontosphaera compacta.
Age: Middle Oligocene.

Hole 17B

Sample 3-17B-1-1, 4-5 cm:
Reticulofenestra scissura; *Coccolithus neogammation*;
Sphenolithus ciperoensis
Age: Oligocene, probably *Sphenolithus ciperoensis* Zone.

Sample 3-17B-1-6, 42-43 cm:
Coccolithus neogammation; *Reticulofenestra scissura*;
cf. *Sphenolithus ciperoensis*.
Age: As above.

Sample 3-17B-2-1, 2-3 cm:
Chiasmolithus oamaruensis; *Coccolithus neogammation*;
Reticulofenestra scissura; *Discoaster tani*; *Sphenolithus ciperoensis*.
Age: Middle Oligocene.

Sample 3-17B-2-6, 3-4 cm:
Coccolithus neogammation; *Helicopontosphaera intermedia*; *Reticulofenestra scissura*; *Sphenolithus* cf. *ciperoensis*.
Age: As above.

Sample 3-17B-3-1, 3-4 cm:
Reticulofenestra scissura; *Coccolithus neogammation*;
Sphenolithus predistentus; *Sphenolithus distentus*.
Age: Middle Oligocene.

Sample 3-17B-3-6, 24-25 cm:
Reticulofenestra scissura; *Coccolithus neogammation*;
Sphenolithus distentus.
Age: Middle Oligocene.

Sample 3-17B-4-1, 25-26 cm:
Sphenolithus distentus; *Reticulofenestra scissura*; *Coccolithus neogammation*.
Age: As above.

Sample 3-17B-4-6, 2-3 cm:
Chiasmolithus oamaruensis; *Reticulofenestra scissura*; *Coccolithus neogammation*; *Sphenolithus predistentus*; *Discoaster tani*; *Helicopontosphaera compacta*; *Sphenolithus pseudoradians*.
Age: Oligocene, *Sphenolithus predistentus* Zone.

Hole 18

Sample 3-18-1-5, 9-10 cm:
Gephyrocapsa oceanica.
Age: Middle Pleistocene.

Sample 3-18-2-1, 0-2 cm:
Coccolithus neogammation; *Sphenolithus belemnos*; *Sphenolithus heteromorphus*; cf. *Cyclococcolithus leptoporus*.
Age: Early Miocene, *Helicopontosphaera ampliaperta* Zone.

Sample 3-18-2-6:
Coccolithus neogammation.
Assemblage not age diagnostic.

Sample 3-18-3-1, 150 cm:
Coccolithus neogammation.
Assemblage not age diagnostic.

Sample 3-18-3-6, 148-150 cm:
Coccolithus neogammation; aff. *Sphenolithus belemnos*.
Age: Probably early Miocene.

Sample 3-18-4-2, 0-2 cm:
As above.

Sample 3-18-4-5, 148-150 cm:
Coccolithus neogammation.
Assemblage not age diagnostic.

Sample 3-18-5-1, 148-150 cm:
Coccolithus neogammation; *Discoaster tani*.
Assemblage not age diagnostic.

Sample 3-18-5-6, 0-2 cm:
Coccolithus neogammation; *Helicopontosphaera intermedia*.
Assemblage not age diagnostic.

Sample 3-18-6-1, 2-3 cm:
Coccolithus neogammation; cf. *Sphenolithus belemnos*; *Helicopontosphaera parallela*.
Age: Early Miocene.

Sample 3-18-6-6, 2-3 cm:
Coccolithus neogammation.
Assemblage not age diagnostic.

Hole 19

Sample 3-19-1-1, 35-36 cm:
Discoaster brouweri; *Pseudoemilia lacunosa*.
Age: Late Pliocene.

Sample 3-19-3-1, 40-41 cm:
Reticulofenestra umbilica; *Reticulofenestra scissura*; *Coccolithus neogammation*.
Age: Probably middle Oligocene.

Sample 3-19-3-6, 4-5 cm:
Reticulofenestra scissura; *Coccolithus neogammation*; *Discoaster deflandrei*; *Bramletteius serraculoides*.
Age: Early Oligocene.

Sample 3-19-4-1, 148-150 cm:
Reticulofenestra scissura; *Coccolithus neogammation*; *Sphenolithus predistentus*; *Discoaster tani*; *Sphenolithus pseudoradians*.
Age: Oligocene, *Sphenolithus predistentus* Zone.

Sample 3-19-4-6, 148-150 cm:
Bramletteius serraculoides; *Reticulofenestra scissura*; *Coccolithus neogammation*; *Sphenolithus predistentus*; cf. *Reticulofenestra umbilica*; *Sphenolithus pseudoradians*; cf. *Cyclococcolithus lusitanicus*.
Age: Early Oligocene, probably *Helicopontosphaera reticulata* Zone.

Sample 3-19-5-1, 148-150 cm:
Reticulofenestra scissura; *Reticulofenestra umbilica*; *Cyclococcolithus lusitanicus*; *Coccolithus neogammation*; *Sphenolithus predistentus*; *Isthmolithus recurvus*; *Bramletteius serraculoides*.
Age: As above.

Sample 3-19-5-6, 2-3 cm:
Reticulofenestra scissura; *Discoaster saipanensis*; *Reticulofenestra umbilica*; *Discoaster barbadiensis*; *Cyclococcolithus lusitanicus*; *Bramletteius serraculoides*; *Isthmolithus recurvus*; *Discoaster tani*.
Age: Late Eocene, *Isthmolithus recurvus* Zone.

Sample 3-19-6-1, 148-150 cm:
Discoaster barbadiensis; *Reticulofenestra scissura*; *Cyclococcolithus lusitanicus*; *Reticulofenestra umbilica*; *Discoaster saipanensis*; *Bramletteius serraculoides*; *Discoaster tani*; *Isthmolithus recurvus*.
Age: As above.

Sample 3-19-6-6, 148-150 cm:
Reticulofenestra scissura; *Reticulofenestra umbilica*; *Cyclococcolithus lusitanicus*; *Discoaster tani*; *Discoaster saipanensis*; cf. *Sphenolithus radians*; *Bramletteius*

serraculoides; *Discoaster barbadiensis*; aff. *Chiasmolithus grandis*.

Age: Mixed middle/late Eocene.

Sample 3-19-7-1, 4-5 cm:

Reticulofenestra umbilica; *Cyclococcolithus lusitanicus*; *Discoaster saipanensis*; *Cyclococcolithus reticulatus*; cf. *Discoaster barbadiensis*; *Reticulofenestra scissura*; *Bramletteius serraculoides*; *Chiasmolithus grandis*.

Age: Late middle Eocene.

Sample 3-19-7-6, 2-3 cm:

Chiasmolithus grandis; *Reticulofenestra umbilica*; *Sphenolithus radians*; *Cyclococcolithus lusitanicus*; *Sphenolithus furcatolithoides*; *Bramletteius serraculoides*.

Age: Middle Eocene; probably mixed.

Sample 3-19-8-1, 148-150 cm:

Bramletteius serraculoides; *Reticulofenestra scissura*; cf. *Discoaster tani*; *Reticulofenestra umbilica*; *Cyclococcolithus lusitanicus*; *Sphenolithus radians*; *Discoaster barbadiensis*; *Chiasmolithus grandis*.

Age: Middle Eocene.

Sample 3-19-8-6, 148-150 cm:

Reticulofenestra umbilica; *Chiasmolithus grandis*; *Sphenolithus furcatolithoides*; *Sphenolithus radians*; *Bramletteius serraculoides*; cf. *Discoaster barbadiensis*.

Age: Middle Eocene.

Sample 3-19-9-1, 148-150 cm:

As above.

Sample 3-19-9-6, 2-3 cm:

Reticulofenestra umbilica; cf. *Sphenolithus radians*; *Discoaster tani*; *Discoaster barbadiensis*; *Chiasmolithus grandis*.

Age: Middle Eocene.

Sample 3-19-10-1, 148-150 cm:

Cyclococcolithus lusitanicus; *Discoaster barbadiensis*; cf. *Reticulofenestra umbilica*; *Chiasmolithus grandis*; *Sphenolithus radians*.

Age: As above.

Sample 3-19-10-6, 148-150 cm:

Chiasmolithus grandis; *Cyclococcolithus lusitanicus*; *Sphenolithus radians*; cf. *Reticulofenestra umbilica*; *Bramletteius serraculoides*.

Age: Middle Eocene.

Sample 3-19-11-4, 148-150 cm:

As above.

Hole 20A

Sample 3-20A-2-1, 49-50 cm:

Reticulofenestra scissura; *Coccolithus neogammation*; *Sphenolithus predistentus*.

Age: Middle Oligocene.

Sample 3-20A-2-6, 148-150 cm:

Reticulofenestra scissura; *Coccolithus neogammation*; *Reticulofenestra umbilica*; *Bramletteius serraculoides*; *Sphenolithus pseudoradians*.

Age: Early Oligocene.

Hole 20B

Sample 3-20B-1-1, 1-2 cm:

Coccolithus neogammation; *Reticulofenestra scissura*; *Sphenolithus distentus*.

Age: Middle Oligocene.

Sample 3-20B-1-6, 3-4 cm:

Reticulofenestra scissura; *Coccolithus neogammation*; *Sphenolithus distentus*.

Age: As above.

Hole 20C

Sample 3-20C-1-1, 47-48 cm:

Discoaster pentaradiatus; *Discoaster surculus*; *Discoaster brouweri*.

Age: Pliocene, probably middle Pliocene.

Sample 3-20C-1-2, 3-4 cm:

Barren of nannofossils.

Sample 3-20C-1-2, 79-80 cm:

Discoaster brouweri; *Discoaster pentaradiatus*.

Age: Probably Pliocene.

Sample 3-20C-1-3, 3-4 cm:

Coccolithus neogammation; cf. *Reticulofenestra scissura*.

Age: Probably Oligocene.

Sample 3-20C-1-6, 3-4 cm:

Reticulofenestra scissura; *Coccolithus neogammation*.

Age: As above.

Sample 3-20C-2-1, 148-150 cm:

Reticulofenestra umbilica; *Cyclococcolithus lusitanicus*; *Reticulofenestra scissura*; *Bramletteius serraculoides*; cf. *Helicopontosphaera compacta*; *Sphenolithus predistentus*; *Chiasmolithus oamaruensis*; *Discoaster tani*; *Sphenolithus pseudoradians*.

Age: Early Oligocene or late Eocene.

Sample 3-20C-2-5, 148-150 cm:

Reticulofenestra umbilica; *Reticulofenestra scissura*; *Hayella situliformis*; *Bramletteius serraculoides*; *Discoaster tani*; *Cyclococcolithus lusitanicus*; *Sphenolithus pseudoradians*; cf. *Helicopontosphaera compacta*.

Age: As above.

Sample 3-20C-2-6, 148-150 cm:

Reticulofenestra scissura; *Discoaster tani*; *Cyclococcolithus lusitanicus*; *Reticulofenestra umbilica*; *Bramletteius serraculoides*; *Helicopontosphaera compacta*; *Hayella situliformis*; *Sphenolithus predistentus*.

Age: As above.

Sample 3-20C-3-1, 3-4 cm:

Reticulofenestra umbilica; *Bramletteius serraculoides*; *Discoaster barbadiensis*; *Cyclococcolithus lusitanicus*; *Discoaster tani*; *Discoaster saipanensis*; *Reticulofenestra scissura*.

Age: Uppermost middle Eocene or late Eocene.

Sample 3-20C-2-6, 4-5 cm:

Discoaster barbadiensis; *Reticulofenestra umbilica*; *Reticulofenestra scissura*; *Discoaster saipanensis*; *Bramletteius serraculoides*.

Age: As above.

Sample 3-20C-4-1, 20-21 cm:

Reticulofenestra umbilica; *Discoaster barbadiensis*; *Reticulofenestra scissura*.

Age: Probably as above.

Sample 3-20C-4-4, 148-150 cm:

Discoaster barbadiensis; *Cyclococcolithus lusitanicus*; *Reticulofenestra cf. umbilica*; *Chiasmolithus grandis*.

Age: Middle Eocene.

Sample 3-20C-5-1, 148-150 cm:

Sphenolithus radians; *Discoaster barbadiensis*; *Sphenolithus cf. furcalithoides*; *Chiasmolithus gigas*; *Chiasmolithus grandis*; *Chiphragmalithus quadratus*; cf. *Chiasmolithus solitus*.

Age: Lowermost middle Eocene.

Sample 3-20C-5-6, 3-4 cm:

Chiasmolithus grandis; *Sphenolithus radians*; *Chiasmolithus cf. californicus*; *Marthasterites tribachiatus*.

Age: Early Eocene, probably *Marthasterites tribachiatus* Zone.

Sample 3-20C-6-1, 148-150 cm:

Chiasmolithus californicus; cf. *Discoaster multiradiatus*; cf. *Chiasmolithus bidens*; *Fasciculithus tympaniformis*; *Ellipsolithus distichus*; *Toweius craticulus*; *Toweius eminens*; aff. *Chiasmolithus grandis*.

Age: Early Eocene or late Paleocene.

Sample 3-20C-6-4, 1-2 cm:

Discoaster multiradiatus; *Ellipsolithus distichus*; *Toweius eminens*; *Fasciculithus tympaniformis*; *Toweius craticulus*; *Chiasmolithus bidens*; *Chiasmolithus californicus*.

Age: Late Paleocene, *Discoaster multiradiatus* Zone.

Sample 3-20C-6-5, 74-75 cm:

Micula; *Tetralithus murus*; *Lithraphidites quadratus*.

Age: Upper Cretaceous, Maestrichtian.

Hole 21

Sample 3-21-1-1, 148-150 cm:

Discoaster pentaradiatus; *Pseudoemiliania lacunosa*; *Discoaster brouweri*.

Age: Late Pliocene.

Sample 3-21-1-6, 148-150 cm:

Discoaster pentaradiatus; *Discoaster brouweri*; *Pseudoemiliania lacunosa*.

Age: As above.

Sample 3-21-2-1, 148-150 cm:

Toweius eminens; *Chiasmolithus consuetus*; *Toweius craticulus*; *Discoaster gemmeus*; *Discoaster multiradiatus*; *Ellipsolithus distichus*; *Chiasmolithus bidens*; *Fasciculithus tympaniformis*; *Zygrhablithus bijugatus*; aff. *Chiasmolithus grandis*; aff. *Marthasterites contortus*.

Age: Early Eocene, *Marthasterites contortus* Zone.

Sample 3-21-2-6, 4-5 cm:

Discoaster multiradiatus; *Toweius eminens*; *Ellipsolithus distichus*; *Toweius craticulus*; *Chiasmolithus consuetus*; *Fasciculithus tympaniformis*; *Chiasmolithus bidens*; *Chiasmolithus californicus*; *Cyclococcolithus robustus*; *Ellipsolithus macellus*.

Age: Late Paleocene, *Discoaster multiradiatus* Zone.

Sample 3-21-3-1, 148-150 cm:

Cylindralithus gallicus; *Micula*; *Tetralithus murus*; *Lithraphidites quadratus*.

Age: Upper Cretaceous, Maestrichtian.

Sample 3-21-3-6, 148-150 cm:

Micula; *Cylindralithus gallicus*; *Lithraphidites quadratus*.

Age: As above.

Sample 3-21-4-1, 148-150 cm:

Ellipsolithus distichus; *Chiasmolithus californicus*; *Eiffellithus turrisiffeli*; *Collvilia barnesae*; *Cretarhabdus*; *Arkhangelskiella parca*; *Tetralithus pyramidus*; *Micula*; *Cylindralithus serratus*; *Tetralithus aculeus*; *Rhabdolithina splendens*; *Rhabdolithina regularis*.

Age: Upper Cretaceous, probably Campanian.

Sample 3-21-4-6, 148-150 cm:

Prediscosphaera cretacea; *Micula*; *Tetralithus pyramidus*; *Cribrosphaerella ehrenbergii*; *Cylindralithus serratus*; *Rhabdolithina regularis*; *Arkhangelskiella parca*.

Age: As above.

Sample 3-21-5-1, 2-3 cm:

Arkhangelskiella parca; *Prediscosphaera cretacea*; *Collvilia barnesae*; *Micula*; *Cylindralithus serratus*; *Tetralithus pyramidus*; *Rhabdolithina regularis*.

Age: As above.

Sample 3-21-5-6, 148-150 cm:

Cylindralithus serratus; *Micula*; *Tetralithus pyramidus*; *Tetralithus aculeus*; *Rhabdolithina regularis*; *Arkhangelskiella parca*.

Age: As above.

Sample 3-21-6-3, 5-6 cm:

Arkhangelskiella parca; *Rhabdolithina regularis*; *Micula*;

Tetralithus aculeus; *Tetralithus pyramidus*.

Age: As above.

Sample 3-21-6-6, 2-3 cm:

Tetralithus pyramidus; *Micula*; *Prediscosphaera cretacea*; *Tetralithus aculeus*; *Rhabdolithina regularis*; *Arkhangelskiella parca*; *Chiasmolithus grandis* (contaminant); *Cylindralithus serratus*.

Age: As above.

Sample 3-21-7-1, 148-150 cm:

Tetralithus aculeus; *Micula*; *Rhabdolithina regularis*.

Age: As above.

Sample 3-21-7-6, 148-150 cm:

Arkhangelskiella parca; *Micula*; *Cylindralithus serratus*; *Rhabdolithina regularis*; *Tetralithus aculeus*.

Age: As above.

Sample 3-21-8-1, 0-2 cm:

Micula; *Prediscosphaera cretacea*; *Tetralithus pyramidus*; *Arkhangelskiella parca*; cf. *Kamptnerius magnificus*; *Cylindralithus serratus*; *Gartnerago* sp.

Age: Probably early Campanian.

Sample 3-21-8-6, 12-13 cm:

As above.

Hole 21A

Sample 3-21A-1-1, 148-150 cm:

Discoaster barbadiensis; *Sphenolithus radians*; *Cyclococcolithus lusitanicus*; *Chiasmolithus grandis*; *Chiasmolithus consuetus*.

Age: Probably early middle Eocene.

Sample 3-21A-1-6, 148-150 cm:

Chiasmolithus grandis; *Chiasmolithus gigas*; *Bramletteius serraculoides*; *Sphenolithus furcatolithoides*; *Discoaster perplexus*; *Sphenolithus radians*.

Age: As above.

Sample 3-21A-2-1, 148-150 cm:

Discoasteroides kupperi; *Chiasmolithus bidens*; *Sphenolithus radians*; *Cyclococcolithus gammation*; *Discoaster lodoensis*; *Coccolithus crassus* sst.

Age: Early Eocene, probably *Discoaster lodoensis* Zone.

Sample 3-21A-2-6, 148-150 cm:

Chiasmolithus bidens; *Cyclococcolithus lusitanicus*; *Discoaster lodoensis*; *Discoasteroides kupperi*; *Helicopontosphaera seminulum lophota*; *Chiasmolithus grandis*; *Cyclococcolithus gammation*; *Sphenolithus radians*; *Coccolithus crassus* sst.

Age: Early Eocene, probably *Discoaster lodoensis* Zone.

Sample 3-21A-3-1, 148-150 cm:

Chiasmolithus grandis; *Discoaster* cf. *barbadiensis*;

Chiasmolithus consuetus; *Chiasmolithus bidens*; *Cyclococcolithus gammation*; *Discoaster lodoensis*; *Discoaster multiradiatus*; *Sphenolithus radians*; *Ellipsolithus distichus*; *Coccolithus crassus*; *Toweius eminens*; *Toweius craticulus*; *Ellipsolithus macellus*; *Marthasterites tribachiatus*; *Fasciculithus tympaniformis*.

Age: Early Eocene, probably *Marthasterites tribachiatus* Zone, with some vertical mixing.

Sample 3-21A-3-6, 2-3 cm:

Chiasmolithus bidens; *Cyclococcolithus robustus*; *Fasciculithus tympaniformis*; *Toweius eminens*; *Chiasmolithus grandis*; *Discoaster lodoensis*; *Discoaster* cf. *gemmeus*; *Discoaster multiradiatus*; *Sphenolithus radians*; *Ellipsolithus distichus*; *Chiasmolithus californicus*.

Age: Probably as above.

Hole 22

Sample 3-22-1-1, 148-150 cm:

Pseudoemiliania lacunosa; *Cyclococcolithus leptoporus*.

Age: Early Pleistocene.

Sample 3-22-1-6, 23-24 cm:

Pseudoemiliania lacunosa; *Cyclococcolithus leptoporus*; *Discoaster brouweri*.

Age: Late Pliocene.

Sample 3-22-2-1, 2-3 cm:

Coccolithus neogammation; *Discoaster druggi*; cf. *Helicopontosphaera intermedia*; *Discoaster obtusus*; assemblage not diagnostic.

Age: Probably late Oligocene or early Miocene.

Sample 3-22-2-6, 2-3 cm:

As above.

Sample 3-22-3-1, 148-150 cm:

Coccolithus neogammation; aff. *Zygrhablithus bijugatus*; *Discoaster deflandrei*; *Coronocyclus serratus*.

Age: Probably Oligocene.

Sample 3-22-3-5, 148-150 cm:

Coccolithus neogammation; *Zygrhablithus bijugatus*; *Reticulofenestra scissura*; aff. *Reticulofenestra umbilica*.

Age: Early to middle Oligocene.

Sample 3-22-3-6, 2-3 cm:

As above.

Sample 3-22-4-1, 72-73 cm:

Coccolithus neogammation; *Reticulofenestra scissura*; mostly detrital carbonates.

Age: Probably Oligocene.

Sample 3-22-4-6, 7-8 cm:

As above.

Sample 3-22-5-1, 12-13 cm:
As above.

Reticulofenestra scissura; cf. *Discoaster saipanensis*;
Chiasmolithus oamaruensis; *Cyclococcolithus lusitanicus*.

Sample 3-22-5-2, 140-142 cm:
Reticulofenestra umbilica; *Discoaster barbadiensis*;

Age: Late Eocene.