

## 15. COCCOLITH AGE DETERMINATIONS, LEG 9 DEEP SEA DRILLING PROJECT

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The following are age determinations made by means of calcareous nannofossils on selected samples from cores recovered during Leg 9 of the Deep Sea Drilling Project. All determinations were made with a light microscope on smear slides prepared from unprocessed samples.

With few exceptions all of the samples listed contain rich nannofossil assemblages—coccoliths, discoasters and associated forms. In no case is an exhaustive assemblage list given, and in many instances some of the most abundant but long ranging species are not listed; only those determinations which actually aid in dating a particular sample are given. Since routine dating of a sample commonly involves restricting the age range of a sample with successive species determinations, the first species identified generally has a relatively long range and each species identified subsequently serves to restrict the age of a sample to a shorter time interval.

Because entire assemblages are seldom determined for routine dating, assemblage zones are used very little. Total range zones are useful, especially when the species characterizing the zone is a common constituent of the assemblage and is easily identified. Most frequently used, however, are the zones based on concurrent ranges of two species, that is, the co-occurrence of two species, or the partial range of a species. The last is based on the absence of one species and the presence of another, and the partial range zone is, therefore, the least reliable. But in many cases the least age determination that can be made is to a partial range zone.

In the following section several of the samples on which age determinations were made are obviously contaminated, and these samples are labeled as contaminated or as containing mixed assemblages. Other age determinations seem inconsistent with the position of the sample in the core, for example, a particular sample is younger than the samples which presumably came from above it (Samples 9-77B-15-4, 86-87 cm and 9-83A-2-4, 2-3 cm) or a sample is older than samples from below it (Sample 9-83A-12-4, 12-13 cm). The determinations on these samples have been double checked, and I am satisfied that the ages assigned to them are correct. These anomalous samples may be

significant, if they are correctly labeled, in that they would then record a disturbance in the section. Alternatively, they may represent nothing more than mislabeled samples or contamination introduced during or after coring.

9-70-0-6, 14-15 cm:

*Coccolithus pelagicus*, *Sphenolithus abies*, *Discoaster druggii*, cf. *Discoaster aulakos*, *Coccolithus floridanus*, *Coronocyclus nitescens*, *Orthorhabdus serratus*.

Age: Basal Miocene.

9-76-1-2, 2-3 cm:

Barren of calcareous nannofossils.

9-76-1-3, 8-9 cm:

Barren of calcareous nannofossils.

9-76-1-5, 5-6 cm:

*Chiasmolithus consuetus*, delicate 6-rayed Neogene asterolith, cf. *Discoaster barbadiensis*, *Helicoponto-sphaera* sp. Nannofossils rare—probably mostly contaminants

Age: Probably early Tertiary.

9-76-1-6, 4-5 cm:

*Sphenolithus abies*, *Coccolithus pelagicus*, *Discoaster hamatus*, *Reticulofenestra pseudoumbilica*.

Age: Probably late Miocene.

9-76A-1-1, 7-8 cm:

*Coccolithus floridanus*, *Sphenolithus abies*, *Sphenolithus distentus*, *Coronocyclus nitescens*, *Sphenolithus ciperoensis*, *Bramletteius serraculoides*, *Discoaster tani*, cf. *Zygrhablithus bijugatus*, *Reticulofenestra scissura*, *Reticulofenestra umbilica*.

Age: Assemblage mixed early and middle Oligocene.

9-76A-1-6, 6-7 cm:

*Coccolithus floridanus*, *Sphenolithus moriformis*, *Sphenolithus distentus*, *Coronocyclus nitescens*, *Zygrhablithus bijugatus*, *Reticulofenestra scissura*, *Chiasmolithus oamaruensis*, *Discoaster tani*, *Bramletteius serraculoides*.

Age: Middle Oligocene.

9-76A-2-1, 116-117 cm:

*Coccolithus floridanus*, *Sphenolithus distentus*, *Bramletteius serraculoides*, *Discoaster barbadiensis*, *Reticulofenestra scissura*, *Sphenolithus radians*, cf. *Discoaster lodoensis*, *Cyclococcolithina formosa*, *Zygrablithus bijugatus*, cf. *Chiasmolithus titus*, *Helicopontosphaera wilcoxonii*, *Campylosphaera dela*, *Helicopontosphaera seminulum lophota*.

Age: Probably early to middle Oligocene. The sample is badly contaminated with early Miocene forms.

9-76A-6-3, 3-4 cm:

*Coccolithus floridanus*, *Sphenolithus moriformis*, *Coronocyclus nitescens*, *Discoaster woodringi*, *Bramletteius serraculoides*, cf. *Sphenolithus ciperoensis*, *Discoaster tani*.

Age: Probably middle Oligocene.

9-77A-1-4, 10-11 cm:

*Cyclococcolithina leptopora*, *Gephyrocapsa oceanica*, *Rhabdosphaera clavigera*, *Umbilicosphaera mirabilis*.

Age: Pleistocene; *Gephyrocapsa* Zone.

9-77B-1-4, 13-14 cm:

*Cyclococcolithina leptopora*, *Umbilicosphaera mirabilis*, *Pseudoemiliania lacunosa*, *Helicopontosphaera kampfneri*, *Gephyrocapsa* sp.

Age: Pleistocene; *Pseudoemiliania lacunosa* Zone.

9-77B-2-4, 2-3 cm:

*Pseudoemiliania lacunosa*, *Cyclococcolithina leptopora*, *Gephyrocapsa* sp., *Ceratolithus cristatus*.

Age: Pleistocene; *Pseudoemiliania lacunosa* Zone.

9-77B-3-3, 5-6 cm:

*Discoaster brouweri*, *Coccolithus pelagicus*, *Cyclococcolithina leptopora*, *Discoaster asymmetricus*, *Pseudoemiliania lacunosa*.

Age: Pliocene; *Discoaster surculus* Zone.

9-77B-4-4, 6-7 cm:

*Cyclococcolithina leptopora*, *Pseudoemiliania lacunosa*, *Discoaster brouweri*, *Coccolithus pelagicus*, *Discoaster asymmetricus*, *Discoaster surculus*.

Age: Pliocene; *Discoaster surculus* Zone.

9-77B-5-4, 9-10 cm:

*Sphenolithus abies*, *Discoaster variabilis*, cf. *Ceratolithus rugosus*, *Reticulofenestra pseudoumbilica*, *Discoaster brouweri*, *Discoaster asymmetricus*, *Discoaster pentaradiatus*.

Age: Middle Pliocene; *Reticulofenestra pseudoumbilica* Zone.

9-77B-6-4, 3-4 cm:

*Discoaster brouweri*, *Reticulofenestra pseudoumbilica*, *Cyclococcolithina leptopora*, *Discoaster variabilis*, *Sphenolithus abies*, *Ceratolithus rugosus*.

Age: Early to middle Pliocene.

9-77B-7-4, 8-9 cm:

*Reticulofenestra pseudoumbilica*, *Cyclococcolithina leptopora*, *Discoaster pentaradiatus*, *Discoaster brouweri*, *Discoaster variabilis*, *Ceratolithus rugosus*, *Helicopontosphaera sellii*, *Ceratolithus tricorniculatus*.

Age: Early Pliocene; *Ceratolithus rugosus* Zone.

9-77B-9-4, 7-8 cm:

*Reticulofenestra pseudoumbilica*, *Cyclococcolithina leptopora*, *Discoaster brouweri*, *Discoaster variabilis*, *Discoaster surculus*, *Cyclococcolithina leptopora*, *Sphenolithus abies*, *Ceratolithus tricorniculatus*.

Age: Latest Miocene or earliest Pliocene; *Ceratolithus tricorniculatus* Zone.

9-77B-10-4, 8-9 cm:

*Reticulofenestra pseudoumbilica*, *Coccolithus pelagicus*, *Cyclococcolithina leptopora*, *Discoaster brouweri*, *Sphenolithus abies*, *Ceratolithus tricorniculatus*.

Age: As above.

9-77B-13-4, 86-87 cm:

*Coccolithus pelagicus*, *Cyclococcolithina leptopora*, *Reticulofenestra pseudoumbilica*, *Discoaster challengerii*, *Discoaster variabilis*, *Discoaster surculus*, *Sphenolithus abies*, *Discoaster brouweri*, cf. *Ceratolithus tricorniculatus*.

Age: As above.

9-77B-15-4, 11-12 cm:

*Discoaster brouweri*, *Discoaster surculus*, *Discoaster asymmetricus*, *Discoaster variabilis*, *Cyclococcolithina leptopora*, *Coccolithus pelagicus*, *Reticulofenestra pseudoumbilica*, *Sphenolithus abies*.

Age: Middle Pliocene. This sample is younger than the one above. It is either mislabeled or contaminated.

9-77B-16-4, 2-3 cm:

*Discoaster variabilis*, *Coccolithus pelagicus*, *Cyclococcolithina leptopora*, *Discoaster brouweri*, *Sphenolithus abies*, *Reticulofenestra pseudoumbilica*.

Age: Late Pliocene.

9-77B-17-4, 6-7 cm:

*Coccolithus pelagicus*, *Cyclococcolithina leptopora*, *Discoaster brouweri*, *Reticulofenestra pseudoumbilica*, *Discoaster aulakos*, *Discoaster variabilis*.

Age: Probably late middle Miocene.

9-77B-19-4, 2-3 cm:

*Cyclococcolithina leptopora*, *Coccolithus pelagicus*, *Reticulofenestra pseudoumbilica*, *Sphenolithus abies*, *Discoaster aulakos*.

Age: Probably late middle Miocene.

9-77B-20-4, 1-2 cm:

*Coccolithus pelagicus*, *Reticulofenestra pseudoumbilica*, *Cyclococcolithina leptopora*, cf. *Discoaster*

*druggii*, *Discoaster aulakos*, *Discoaster obtusus*, *Sphenolithus abies*.  
Age: Middle Miocene.

9.77B-23-4, 6-7 cm:  
*Coccolithus pelagicus*, *Coccolithus floridanus*, *Sphenolithus abies*, cf. *Cyclococcolithina leptopora*, *Discoaster aulakos*.  
Age: Middle Miocene.

9.77B-24-4, 18-19 cm:  
*Helicopontosphaera intermedia*, *Sphenolithus heteromorphus*, cf. *Cyclococcolithina leptopora*, *Coccolithus floridanus*.  
Age: Middle Miocene; *Sphenolithus heteromorphus* Zone.

9.77B-25-4, 3-4 cm:  
*Sphenolithus heteromorphus*, *Coronocyclus nitescens*, *Helicopontosphaera intermedia*, *Coccolithus pelagicus*, *Coccolithus floridanus*.  
Age: Middle Miocene; probably *Sphenolithus heteromorphus* Zone.

9.77B-26-4, 2-3 cm:  
*Sphenolithus heteromorphus*, *Coccolithus pelagicus*, *Coccolithus floridanus*.  
Age: As above.

9.77B-27-4, 2-3 cm:  
*Sphenolithus heteromorphus*, *Coccolithus floridanus*, *Coccolithus pelagicus*.  
Age: As above.

9.77B-28-4, 10-11 cm:  
*Coccolithus floridanus*, *Coccolithus pelagicus*, *Coronocyclus nitescens*, cf. *Sphenolithus heteromorphus*.  
Age: Probably as above.

9.77B-29-4, 4-5 cm:  
*Coccolithus floridanus*, *Coccolithus pelagicus*, *Discoaster druggii*, *Sphenolithus belemnos*.  
Age: Early Miocene; *Sphenolithus belemnos* Zone.

9.77B-30-4, 3-4 cm:  
*Coccolithus floridanus*, *Discoaster druggii*, *Coccolithus pelagicus*, *Orthorhabdus serratus*.  
Age: Early Miocene.

9.77B-32-4, 2-3 cm:  
*Sphenolithus belemnos*, *Discoaster druggii*, *Coccolithus pelagicus*, *Coccolithus floridanus*, *Coronocyclus nitescens*, *Triquetrorhabdulus carinatus*.  
Age: Late Oligocene.

9.77B-33-4, 2-3 cm:  
*Coccolithus floridanus*, *Coccolithus pelagicus*, *Triquetrorhabdulus carinatus*.  
Age: Late Oligocene.

9.77B-34-4, 5-6 cm:  
*Coccolithus floridanus*, *Triquetrorhabdulus carinatus*.  
Age: As above.

9.77B-36-2, 16-17 cm:  
*Triquetrorhabdulus carinatus*, *Discoaster druggii*, *Coccolithus floridanus*.  
Age: As above.

9.77B-37-4, 1-2 cm:  
*Coccolithus floridanus*, *Triquetrorhabdulus carinatus*, *Sphenolithus moriformis*.  
Age: Late Oligocene.

9.77B-39-4, 6-7 cm:  
*Coccolithus floridanus*, *Sphenolithus moriformis*, *Coccolithus pelagicus*.  
Age: Probably late Oligocene.

9.77B-40-4, 1-2 cm:  
*Coccolithus floridanus*, *Sphenolithus ciperoensis*, *Sphenolithus distentus* (no *Reticulofenestra scissura*).  
Age: Oligocene; probably *Sphenolithus ciperoensis* Zone.

9.77B-41-2, 1-2 cm:  
*Sphenolithus ciperoensis*, *Coccolithus floridanus*, *Coccolithus eopalagius*, *Sphenolithus moriformis* (no *Reticulofenestra scissura*).  
Age: Probably as above.

9.77B-42-2, 6-7 cm:  
*Sphenolithus ciperoensis*, *Sphenolithus moriformis*, *Coccolithus pelagicus*, *Coccolithus floridanus*, *Coronocyclus nitescens*.  
Age: As above.

9.77B-43-5, 2-3 cm:  
*Coccolithus floridanus*, *Coccolithus pelagicus*, *Sphenolithus moriformis*, *Sphenolithus ciperoensis*, cf. *Reticulofenestra scissura*.  
Age: Probably as above.

9.77B-44-5, 2-3 cm:  
*Coccolithus floridanus*, *Sphenolithus moriformis*, *Sphenolithus ciperoensis*.  
Age: As above.

9.77B-46-5, 6-7 cm:  
*Sphenolithus moriformis*, *Coccolithus floridanus*, *Reticulofenestra scissura*, *Discoaster tani*, *Sphenolithus distentus*, cf. *Helicopontosphaera compacta*.  
Age: Middle Oligocene; probably *Sphenolithus distentus* Zone.

9.77B-48-5, 3-4 cm:  
*Sphenolithus distentus*, *Coccolithus floridanus*, *Sphenolithus moriformis*, *Reticulofenestra scissura*, *Chiasmolithus oamaruensis*.

- Age: Middle Oligocene; probably *Sphenolithus distentus* Zone.
- 9-77B-50-2, 13-14 cm:  
*Sphenolithus moriformis*, *Coccolithus floridanus*, *Sphenolithus distentus*.  
Age: As above.
- 9-77B-51-5, 3-4 cm:  
*Reticulofenestra scissura*, *Sphenolithus moriformis*, *Cyclococcolithina formosa*, *Bramletteius serraculoides*.  
Age: Early Oligocene; *Helicopontosphaera reticulata* Zone.
- 9-77B-52-2, 3-4 cm:  
Barren of calcareous nannofossils.
- 9-77B-53-1, 6-7 cm:  
*Reticulofenestra umbilica*, *Discoaster saipanensis*.  
*Reticulofenestra scissura*, *Discoaster barbadiensis*, *Cyclococcolithina formosa*, *Discoaster tani*, *Sphenolithus moriformis*.  
Age: Probably late middle Eocene.
- 9-78-1-4, 2-3 cm:  
*Reticulofenestra pseudoumbilica*, *Cyclococcolithina leptopora*, *Coccolithus pelagicus*, *Discoaster aulakos*, cf. *Discoaster exilis*.  
Age: Middle Miocene.
- 9-78-3-4, 2-3 cm:  
*Coccolithus floridanus*, *Coccolithus pelagicus*, *Sphenolithus heteromorphus*, *Coronocyclus nitescens*, *Helicopontosphaera intermedia*.  
Age: Early middle Miocene, *Helicopontosphaera amplioperta* or *Sphenolithus heteromorphus* Zone.
- 9-78-5-4, 5-6 cm:  
*Coronocyclus nitescens*, *Coccolithus floridanus*, *Sphenolithus moriformis*, *Coccolithus pelagicus*, *Sphenolithus belemnos*.  
Age: Early Miocene; probably *Sphenolithus belemnos* Zone.
- 9-78-7-4, 1-2 cm:  
*Sphenolithus moriformis*, *Coccolithus floridanus*, *Coccolithus pelagicus*, *Helicopontosphaera intermedia*, *Triquetrorhabdulus carinatus*.  
Age: Early Miocene.
- 9-78-10-4, 3-4 cm:  
*Coccolithus floridanus*, *Sphenolithus moriformis*, *Coccolithus pelagicus*, *Coronocyclus nitescens*.  
Age: Early Miocene.
- 9-78-12-4, 1-2 cm:  
*Coronocyclus nitescens*, *Coccolithus floridanus*, *Helicopontosphaera intermedia*, *Coccolithus pelagicus*, *Sphenolithus moriformis*, *Triquetrorhabdulus carinatus*, *Discoaster druggii*.  
Age: Probably earliest Miocene.
- 9-78-14-4, 7-8 cm:  
*Triquetrorhabdulus carinatus*, *Orthorhabdus serratus*, *Discoaster druggii*, *Coccolithus floridanus*, *Coccolithus pelagicus*, *Sphenolithus moriformis*.  
Age: Earliest Miocene.
- 9-78-16-4, 2-3 cm:  
*Coccolithus floridanus*, *Sphenolithus moriformis*, *Coccolithus pelagicus*, *Triquetrorhabdulus carinatus*, *Discoaster druggii*, *Discoaster deflandrei*.  
Age: Early Miocene.
- 9-78-18-6, 9-10 cm:  
*Coccolithus floridanus*, *Discoaster druggii*, *Sphenolithus moriformis*, *Discoaster deflandrei*, *Coccolithus pelagicus*, *Helicopontosphaera truncata*.  
Age: Oligocene, probably *Sphenolithus ciperoensis* Zone.
- 9-78-20-4, 2-3 cm:  
*Coccolithus floridanus*, *Coccolithus pelagicus*, *Discoaster druggii*, *Sphenolithus moriformis*, *Sphenolithus ciperoensis*.  
Age: Oligocene; *Sphenolithus ciperoensis* Zone.
- 9-78-22-6, 2-3 cm:  
*Coccolithus pelagicus*, *Coccolithus floridanus*, *Sphenolithus moriformis*, *Sphenolithus ciperoensis*, *Coronocyclus nitescens*.  
Age: Oligocene; *Sphenolithus ciperoensis* Zone.
- 9-78-25-4, 1-2 cm:  
*Coccolithus floridanus*, *Coccolithus pelagicus*, *Sphenolithus distentus*, *Pedinocyclus larvalis*.  
Age: Oligocene; *Sphenolithus distentus* Zone.
- 9-78-28-4, 2-3 cm:  
*Coccolithus floridanus*, *Coccolithus pelagicus*, *Sphenolithus distentus*, *Reticulofenestra scissura*.  
Age: As above.
- 9-78-32-6, 0-2 cm:  
*Coccolithus pelagicus*, *Coccolithus floridanus*, *Sphenolithus distentus*, *Reticulofenestra scissura*, *Helicopontosphaera compacta*.  
Age: Oligocene; *Sphenolithus distentus* Zone.
- 9-79-1-4, 22-23 cm:  
*Gephyrocapsa oceanica*, *Pseudoemiliania lacunosa*, *Cyclococcolithina leptopora*, *Umbilicosphaera mirabilis*, *Helicopontosphaera sellii*.  
Age: Middle Pleistocene.

9-79-2-4, 14-15 cm:

*Reticulofenestra pseudoumbilica*, *Discoaster brouweri*, *Cyclococcolithina leptopora*, *Sphenolithus abies*, *Discoaster surculus*, *Ceratolithus tricorniculatus*, *Discoaster pentaradiatus*, *Discoaster variabilis*.

Age: Late Miocene or early Pliocene.

9-79-3-4, 32-33 cm:

*Coccolithus pelagicus*, *Discoaster variabilis*, *Sphenolithus abies*, *Cyclococcolithina leptopora*, *Discoaster brouweri*, cf. *Discoaster quinqueramus*.

Age: Late Miocene.

9-79-4-4, 18-19 cm:

*Reticulofenestra pseudoumbilica*, *Cyclococcolithina leptopora*, *Coccolithus pelagicus*, *Sphenolithus abies*, *Discoaster exilis*, cf. *Discoaster variabilis*.

Age: Probably late middle Miocene.

9-79-5-4, 14-15 cm:

*Sphenolithus heteromorphus*, *Coccolithus pelagicus*, *Coccolithus floridanus*, *Cyclococcolithina leptopora*.

Age: Middle Miocene; *Sphenolithus heteromorphus* Zone.

9-79-6-4, 33-34 cm:

*Coronocyclus nitescens*, *Coccolithus floridanus*, *Coccolithus pelagicus*, *Sphenolithus heteromorphus*.

Age: As above.

9-79-7-4, 40-41 cm:

*Sphenolithus belemnos*, *Coccolithus floridanus*, *Coccolithus pelagicus*, *Coronocyclus nitescens*.

Age: Early Miocene; *Sphenolithus belemnos* Zone.

9-79A-1-4, 12-13 cm:

*Cyclococcolithina leptopora*, *Helicopontosphaera kampfneri*, *Discoaster* sp., *Pseudoemiliania lacunosa*.

Age: Probably late Pliocene.

9-79A-3-4, 31-33 cm:

*Discoaster variabilis*, *Reticulofenestra pseudoumbilica*, *Discoaster brouweri*.

Age: Late Miocene to early Pliocene.

9-77B-31-4, 10-11 cm:

*Coccolithus floridanus*, *Sphenolithus moriformis*, *Coccolithus pelagicus*.

Age: Probably late Oligocene.

9-80-1-4, 1-2 cm:

*Cyclococcolithina leptopora*, *Gephyrocapsa oceanica*, *Gephyrocapsa aperta*.

Age: Late Pleistocene.

9-80-2-4, 1-2 cm:

*Cyclococcolithina leptopora*, *Sphenolithus abies*, *Reticulofenestra pseudoumbilica*, *Discoaster surculus*, *Discoaster variabilis*, *Ceratolithus tricorniculatus*.

Age: Probably latest Miocene.

9-80-3-4, 1-2 cm:

*Coccolithus floridanus*, *Sphenolithus heteromorphus*, *Coronocyclus nites*??

Age: Middle Miocene; *Sphenolithus heteromorphus* Zone.

9-80-4-4, 1-2 cm:

*Coccolithus pelagicus*, *Coccolithus floridanus*.

Age: Late Oligocene to early Miocene, probably late Oligocene.

9-80-5-2, 2-3 cm:

*Coccolithus floridanus*, *Coccolithus pelagicus*, *Sphenolithus moriformis*, cf. *Triquetrorhabdulus carinatus*.

Age: As above.

9-80A-3-4, 20-21 cm:

*Cyclococcolithina leptopora*, *Reticulofenestra pseudoumbilica*, *Discoaster variabilis*, *Discoaster aulakos*.

Age: Middle Miocene.

9-80A-4-4, 1-2 cm:

*Sphenolithus heteromorphus*, *Coccolithus pelagicus*, *Coccolithus floridanus*.

Age: Early middle Miocene; *Sphenolithus heteromorphus* Zone.

9-80A-4-4, 64-65 cm:

*Discoaster exilis*, *Coccolithus pelagicus*, *Coccolithus floridanus*, *Sphenolithus moriformis*, *Sphenolithus heteromorphus*, *Coronocyclus nitescens*.

Age: Early middle Miocene; *Sphenolithus heteromorphus* Zone.

9-80A-5-4, 29-30 cm:

*Coronocyclus nitescens*, *Coccolithus pelagicus*, *Coccolithus floridanus*, *Discoaster deflandrei*, *Sphenolithus moriformis*, *Sphenolithus belemnos*.

Age: Early Miocene; *Sphenolithus belemnos* Zone.

9-81-1-4, 16-17 cm:

*Pseudoemiliania lacunosa*, *Gephyrocapsa oceanica*.

Age: Middle Pleistocene.

9-81-3-4, 1-2 cm:

*Coccolithus pelagicus*, *Sphenolithus heteromorphus*, *Coccolithus floridanus*.

Age: Early middle Miocene; *Sphenolithus heteromorphus* Zone.

9-82-1-4, 1-2 cm:

*Gephyrocapsa oceanica*, *Cyclococcolithina leptopora*, *Umbilicosphaera mirabilis*.

Age: Late Pleistocene.

9-82-2-4, 1-2 cm:

*Reticulofenestra pseudoumbilica*, *Cyclococcolithina*

*leptopora*, *Discoaster brouweri*, *Discoaster variabilis*, *Discoaster surculus*, *Ceratolithus rugosus*, *Sphenolithus abies*, *Discoaster pentaradiatus*.

Age: Early Pliocene.

9-82-3-4, 2-3 cm:

*Cyclococcolithina leptopora*, *Reticulofenestra pseudoumbilica*, *Sphenolithus abies*, *Discoaster surculus*, *Discoaster brouweri*, *Coccolithus pelagicus*, *Discoaster pentaradiatus*.

Age: Late Miocene.

9-82-4-4, 1-2 cm:

*Coccolithus pelagicus*, *Discoaster brouweri*, *Cyclococcolithina leptopora*, *Sphenolithus abies*, *Ceratolithus tricorniculatus*.

Age: Late Miocene.

9-82-6-4, 1-2 cm:

*Sphenolithus abies*, *Coccolithus pelagicus*, *Reticulofenestra pseudoumbilica*, *Cyclococcolithina leptopora*, cf. *Discoaster surculus*, *Discoaster aulakos*, *Discoaster brouweri*.

Age: Probably late Miocene.

9-82A-1-4, 1-2 cm:

*Pseudoemiliania lacunosa*, *Cyclococcolithina leptopora*, *Umbilicosphaera mirabilis*, cf. *Ceratolithus rugosus*.

Age: Uppermost Pliocene.

9-82A-2-4, 1-2 cm:

*Pseudoemiliania lacunosa*, *Cyclococcolithina leptopora*, *Helicopontosphaera sellii*, *Discoaster brouweri*, *Coccolithus pelagicus*.

Age: Late Pliocene.

9-82A-3-4, 1-2 cm:

*Reticulofenestra pseudoumbilica*, *Discoaster brouweri*, *Discoaster variabilis*, *Discoaster surculus*, *Sphenolithus abies*, *Discoaster pentaradiatus*, *Ceratolithus tricorniculatus*, *Ceratolithus rugosus*, *Discoaster asymmetricus*.  
Age: Early Pliocene; *Discoaster asymmetricus* Zone.

9-83-2-4, 1-2 cm:

*Gephyrocapsa oceanica*, *Cyclococcolithina leptopora*, *Pseudoemiliania lacunosa*.

Age: Middle Pleistocene.

9-83-5-4, 8-9 cm:

*Discoaster brouweri*, *Sphenolithus abies*, *Reticulofenestra pseudoumbilica*, *Discoaster variabilis*, *Discoaster surculus*, *Discoaster quinqueramus*.

Age: Late Miocene.

9-83-6-4, 12-13 cm:

*Sphenolithus abies*, *Reticulofenestra pseudoumbilica*, *Coccolithus pelagicus*, *Cyclococcolithina leptopora*, *Discoaster variabilis*, *Discoaster brouweri*.

Age: Late Miocene.

9-83-7-4, 8-9 cm:

*Discoaster quinqueramus*, *Discoaster variabilis*, *Coccolithus pelagicus*, *Reticulofenestra pseudoumbilica*, *Sphenolithus abies*.

Age: Late Miocene.

9-83A-1-4, 2-3 cm:

*Cyclococcolithina leptopora*, *Pseudoemiliania lacunosa*, *Helicopontosphaera kamptneri*, no *Gephyrocapsa*, no *Discoasters*.

Age: Looks to be right about the Pliocene-Pleistocene boundary.

9-83A-2-4, 2-3 cm:

*Pseudoemiliania lacunosa*, *Cyclococcolithina leptopora*, *Helicopontosphaera sellii*, *Helicopontosphaera kamptneri*, *Gephyrocapsa caribbeana*, *Gephyrocapsa oceanica*.

Age: Middle Pleistocene (contaminated with *Discoaster brouweri*).

9-83A-3-4, 1-2 cm:

*Cyclococcolithina leptopora*, *Pseudoemiliania lacunosa*, *Coccolithus pelagicus*, *Ceratolithus cristatus*, *Discoaster sp.*

Age: Late Pliocene.

9-83A-4-4, 2-3 cm:

*Discoaster brouweri*, *Coccolithus pelagicus*, *Ceratolithus rugosus*, *Pseudoemiliania lacunosa*.

Age: Latest Pliocene.

9-83A-5-4, 3-4 cm:

*Discoaster brouweri*, *Ceratolithus rugosus*, *Pseudoemiliania lacunosa*, *Coccolithus pelagicus*, *Cyclococcolithina leptopora*, *Discoaster surculus*.

Age: Late Pliocene; *Discoaster surculus* Zone.

9-83A-6-4, 13-14 cm:

*Discoaster brouweri*, *Discoaster variabilis*, *Cyclococcolithina leptopora*, *Pseudoemiliania lacunosa*.

Age: Late Pliocene; *Discoaster surculus* Zone.

9-83A-7-4, 3-4 cm:

*Discoaster brouweri*, *Reticulofenestra pseudoumbilica*, *Sphenolithus abies*, *Cyclococcolithina leptopora*, *Discoaster variabilis*, *Discoaster asymmetricus*, *Ceratolithus rugosus*.

Age: Middle Pliocene; *Reticulofenestra pseudoumbilica* Zone.

9-83A-8-4, 2-3 cm:

*Sphenolithus abies*, *Discoaster pentaradiatus*, *Reticulofenestra pseudoumbilica*, *Discoaster brouweri*, *Cyclococcolithina leptopora*, *Discoaster surculus*.

Age: Early to middle Pliocene.

9-83A-9-4, 2-3 cm:

*Reticulofenestra pseudoumbilica*, *Sphenolithus abies*,

*Cyclococcolithina leptopora*, *Discoaster pentaradiatus*,  
*Discoaster variabilis*, *Discoaster brouweri*, *Discoaster surculus*, cf. *Ceratolithus rugosus*.

Age: Early Pliocene; probably *Ceratolithus rugosus* Zone.

9-83A-10-2, 9-10 cm:

*Reticulofenestra pseudoumbilica*, *Sphenolithus abies*,  
*Cyclococcolithina leptopora*, *Discoaster pentaradiatus*,  
*Discoaster brouweri*, *Discoaster surculus*, *Ceratolithus tricorniculatus*.

Age: Latest Miocene; *Ceratolithus tricorniculatus* Zone.

9-83A-11-4, 2-3 cm:

*Discoaster pentaradiatus*, *Discoaster brouweri*, *Cocco lithus pelagicus*, *Reticulofenestra pseudoumbilica*,  
*Sphenolithus abies*, *Discoaster surculus*, *Cyclococcolithina leptopora*, *Ceratolithus tricorniculatus*.

Age: As above.

9-83A-12-4, 12-13 cm:

*Reticulofenestra pseudoumbilica*, *Sphenolithus abies*,  
*Discoaster variabilis*, *Discoaster quinqueramus*, *Discoaster brouweri*.

Age: Late Miocene; *Discoaster quinqueramus* Zone or older.

9-83A-13-4, 4-5 cm:

*Reticulofenestra pseudoumbilica*, *Cyclococcolithina leptopora*, *Discoaster variabilis*, *Sphenolithus abies*,  
*Discoaster brouweri*, *Discoaster quinqueramus*.

Age: Late Miocene.

9-83A-14-4, 2-3 cm:

*Discoaster surculus*, *Cocco lithus pelagicus*, *Discoaster variabilis*, *Reticulofenestra pseudoumbilica*, cf. *Discoaster quinqueramus*, *Discoaster brouweri*, *Ceratolithus tricorniculatus*, *Sphenolithus abies*, *Discoaster pentaradiatus*.

Age: Late Miocene; *Ceratolithus tricorniculatus* Zone.

9-83A-15-4, 2-3 cm:

*Cocco lithus pelagicus*, *Reticulofenestra pseudoumbilica*, *Sphenolithus abies*, *Discoaster variabilis*, cf. *Discoaster brouweri*, *Triquetrorhabdulus rugosus*.

Age: Probably late middle Miocene.

9-83A-16-4, 2-3 cm:

*Cocco lithus pelagicus*, *Discoaster variabilis*, *Sphenolithus abies*, *Discoaster brouweri*, *Reticulofenestra pseudoumbilica*, *Discoaster surculus*, *Triquetrorhabdulus rugosus*, cf. *Discoaster bollii*.

Age: As above.