

19. COCCOLITH AGE DETERMINATIONS LEG 5, DEEP SEA DRILLING PROJECT

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By utilizing calcareous nannofossils, the data presented here represent age determinations of sediment cores recovered in the Pacific Ocean during Leg 5 of the Deep Sea Drilling Project. All 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 may be assigned to a zone. However, some samples contain few or no age diagnostic species, in which case relatively broader age assignments are made, commonly equivalent to the interval represented by a stage. Stage terms are avoided (except in the late Miocene), however, and it seems more reasonable to use such terms as early Miocene or middle Eocene, than it is 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 32

Sample 5-32-3-1, 6-7 cm:
Discoaster surculus, *Discoaster brouweri*, *Cyclococcolithus leptoporus*, *Coccolithus pelagicus*, cf. *Reticulofenestra pseudoumbilica*, *Coccolithus pelagicus*, *Discoaster pentaradiatus*, *Discoaster asymmetricus*.
Age: Middle Pliocene.

Sample 5-32-3-2, 4-5 cm:
Discoaster brouweri, cf. *Discoaster pentaradiatus*, *Discoaster surculus*, cf. *Reticulofenestra pseudoumbilica*.
Age: Probably as above.

Sample 5-32-3-4, 7 cm:
Coccolithus pelagicus, *Cyclococcolithus leptoporus*, *Pseudoemiliania lacunosa*, cf. *Discoaster brouweri*, *Discoaster surculus*, sample probably mixed middle Pliocene and early Pleistocene.
Age: Middle Pliocene to early Pleistocene.

Sample 5-32-3-5, 5-6 cm:
Cyclococcolithus leptoporus, *Coccolithus pelagicus*, *Discoaster* sp., *Helicopontosphaera kampfneri*, *Pseudoemiliania lacunosa*, cf. *Discoaster brouweri*, *Discoaster surculus*.

Age: Late Pliocene.

Sample 5-32-4-1, 19-20 cm:
Barren of calcareous nannofossils.

Sample 5-32-4-2, 2-3 cm:
Coccolithus sp., *Cyclococcolithus leptoporus*, *Coccolithus pelagicus*, *Reticulofenestra pseudoumbilica*.
Age: Probably early Pliocene.

Sample 5-32-4-3, 2-3 cm:
Reticulofenestra pseudoumbilica, *Cyclococcolithus leptoporus*, *Coccolithus pelagicus*, *Discoaster brouweri*, *Sphenolithus abies*.
Age: Probably early Pliocene.

Sample 5-32-4-4, 3-4 cm:
Barren of calcareous nannofossils.

Sample 5-32-4-5, 10-12 cm:
Barren of calcareous nannofossils.

Sample 5-32-5-6, 9-10 cm:
Barren of calcareous nannofossils.

Sample 5-32-6-6, 2-3 cm:
aff. *Discoaster surculus*, *Reticulofenestra pseudoumbilica*, *Discoaster variabilis*, *Coccolithus pelagicus*, cf. *Cyclococcolithus leptoporus*.
Age: Late Miocene to early Pliocene, probably early Pliocene.

Sample 5-32-7-1, 5-6 cm:
Reticulofenestra pseudoumbilica, *Cyclococcolithus leptoporus*.
Age: As above.

Sample 5-32-8-1, 5-6 cm:
Barren of calcareous nannofossils.

Sample 5-32-8-3, 5-6 cm:
Barren of calcareous nannofossils.

Sample 5-32-8-6, 4-5 cm:
Barren of calcareous nannofossils.

Sample 5-32-9-3, 6-7 cm:
Barren of calcareous nannofossils.

Hole 33

Sample 5-33-1-1, 11-12 cm:
Barren of calcareous nannofossils.

Sample 5-33-1-2, 8-9 cm:
Coccolithus pelagicus, *Gephyrocapsa aperta*.
Age: About middle Pleistocene.

Sample 5-33-1-3, 12-13 cm:
Coccolithus pelagicus, *Gephyrocapsa aperta*.
Age: Probably middle Pleistocene.

Sample 5-33-1-4, 10-11 cm:
Coccolithus pelagicus, *Gephyrocapsa* sp.
Age: Probably middle Pleistocene.

Sample 5-33-1-6, 12-13 cm:
Barren of calcareous nannofossils.

Sample 5-33-2-1, 12-13 cm:
Cyclococcolithus leptoporus, *Helicopontosphaera kampfneri*, *Coccolithus pelagicus*.
Age: Probably Pleistocene.

Sample 5-33-2-3, 15-16 cm:
Coccolithus pelagicus, *Pseudoemiliania lacunosa*, *Gephyrocapsa* sp., *Cyclococcolithus leptoporus*.
Age: Middle Pleistocene.

Sample 5-33-2-4, 4-5 cm:
Barren of calcareous nannofossils.

Sample 5-33-2-5, 4-5 cm:
Cyclococcolithus leptoporus, *Coccolithus pelagicus*,
Gephyrocapsa sp.
Age: Middle Pleistocene, if indigenous.

Sample 5-33-2-6, 5-6 cm:
Barren of calcareous nannofossils.

Sample 5-33-3-1, 6-8 cm:
Coccolithus pelagicus, *Cyclococcolithus leptoporus*,
Pseudoemiliania lacunosa, "Discolithus" phaseolus.
Age: Early Pleistocene.

Sample 5-33-3-2, 4-5 cm:
Coccolithus pelagicus, *Cyclococcolithus leptoporus*,
Pseudoemiliania lacunosa.
Age: Probably early Pleistocene.

Sample 5-33-3-3, 3-4 cm:
Barren of calcareous nannofossils.

Sample 5-33-3-4, 3-4 cm:
Pseudoemiliania lacunosa, *Coccolithus pelagicus*, cf.
Cyclococcolithus leptoporus.

Age: Probably early Pleistocene.

Sample 5-33-3-5, 4-5 cm:
Discoaster sp., cf. *Coccolithus pelagicus*, *Cyclococcolithus leptoporus*.
Age: Neogene.

Sample 5-33-3-6, 10-11 cm:
Coccolithus pelagicus, *Cyclococcolithus leptoporus*,
Pseudoemiliania lacunosa.
Age: Probably early Pleistocene.

Sample 5-33-4-1, 13-14 cm:
Barren of calcareous nannofossils.

Sample 5-33-4-3, 3-4 cm:
Cyclococcolithus leptoporus, cf. *Pseudoemiliania lacunosa*, cf. *Discoaster brouweri*.
Age: Probably late Pliocene.

Sample 5-33-4-5, 3-4 cm:
Ceratolithus rugosus, *Coccolithus pelagicus*, *Cyclococcolithus leptoporus*, *Pseudoemiliania lacunosa*, *Discoaster surculus*.
Age: Early late Pliocene, *Discoaster surculus* Zone.

Sample 5-33-5-3, 10-11 cm:
Cyclococcolithus leptoporus, *Discoaster variabilis*, *Coccolithus pelagicus*, *Discoaster surculus*, *Discoaster brouweri*, *Ceratolithus tricorniculatus*, *Reticulofenestra pseudoumbilica*.
Age: Probably early Pliocene.

Sample 5-33-5-6, 3-4 cm:
Coccolithus pelagicus, *Reticulofenestra pseudoumbilica*,
Discoaster variabilis, *Discoaster stellulus*, *Discoaster surculus*, *Ceratolithus tricorniculatus*.
Age: Late Miocene (Messinian) to early Pliocene.

Sample 5-33-6-6, 15-16 cm:
Reticulofenestra pseudoumbilica, *Discoaster variabilis*,
Discoaster stellulus, *Discoaster surculus*.
Age: Probably late Miocene.

Sample 5-33-8-1, 9-10 cm:
Discoaster variabilis, *Sphenolithus abies*, *Reticulofenestra pseudoumbilica*, aff. *Discoaster bollii*.
Age: Late Miocene, probably Tortonian.

Sample 5-33-8-2, 10-11 cm:
Reticulofenestra pseudoumbilica, *Discoaster variabilis*,
Sphenolithus abies, *Discoaster brouweri*, *Cyclococcolithus leptoporus*.
Age: Probably as above.

Sample 5-33-8-3, 2-3 cm:

Discoaster variabilis, *Reticulofenestra pseudoumbilica*,
aff. *Triquetrorhabdulus rugosus*.

Age: Late Miocene.

Sample 5-33-8-4, 5-6 cm:

Reticulofenestra pseudoumbilica, *Discoaster variabilis*,
Discoaster aff. *D. variabilis*, *Cyclococcolithus leptoporus*.

Age: Probably middle Miocene.

Sample 5-33-8-5, 5-6 cm:

Reticulofenestra pseudoumbilica, cf. *Discoaster bollii*,
cf. *Discoaster variabilis*, *Discoaster variabilis*.

Age: Late Miocene, probably Tortonian.

Sample 5-33-8-6, 4-5 cm:

Discoaster variabilis, *Reticulofenestra pseudoumbilica*,
cf. *Discoaster exilis*.

Age: Probably as above.

Sample 5-33-9-3, 4-5 cm:

Barren of calcareous nannofossils.

Sample 5-33-9-6, 4-5 cm:

Barren of calcareous nannofossils.

Sample 5-33-10-2, 2-3 cm:

Reticulofenestra pseudoumbilica, cf. *Discoaster exilis*,
cf. *Discoaster variabilis*, *Catinaster caliculus*.

Age: Late Miocene, Tortonian.

Sample 5-33-10-5, 22-23 cm:

Discoaster exilis, *Reticulofenestra pseudoumbilica*.

Age: Probably as above.

Sample 5-33-11-2, 5-6 cm:

Sphenolithus abies.

Age: Insufficient nannofossils for age determination.

Sample 5-33-11-3, 12-13 cm:

Barren of calcareous nannofossils.

Sample 5-33-12-3, 11-12 cm:

Reticulofenestra pseudoumbilica, cf. *Discoaster exilis*.

Age: Probably late middle Miocene to early late
Miocene.

Sample 5-33-12-6, 4-5 cm:

Barren of calcareous nannofossils.

Sample 5-33-15-1, 37-38 cm:

Reticulofenestra pseudoumbilica, *Coccolithus pelagicus*,
aff. *Coccolithus neogammation*, *Discoaster exilis*.

Age: Middle Miocene.

Hole 34

Sample 5-34-1-1, 4-5 cm:

Barren of calcareous nannofossils.

Sample 5-34-1-2, 10-11 cm:

Barren of calcareous nannofossils.

Sample 5-34-1-3, 4-5 cm:

Cyclococcolithus leptoporus, *Coccolithus pelagicus*, cf.
Pseudoemiliania lacunosa, no *Discoasters*, no *Gephyrocapsa*.

Age: Probably early to middle Pleistocene.

Sample 5-34-1-4, 15-16 cm:

Barren of calcareous nannofossils.

Sample 5-34-1-5, 15-16 cm:

Barren of calcareous nannofossils.

Sample 5-34-1-6, 9-10 cm:

Coccolithus sp., *Cyclococcolithus leptoporus*, *Pseudoemiliania lacunosa*.

Age: Probably early Pleistocene.

Sample 5-34-2-1, 12-13 cm:

Cyclococcolithus leptoporus.

Age: Not determinable.

Sample 5-34-2-2, 9-10 cm:

Barren of calcareous nannofossils.

Sample 5-34-2-3, 4-5 cm:

Barren of calcareous nannofossils.

Sample 5-34-2-4, 8-9 cm:

Barren of calcareous nannofossils.

Sample 5-34-2-5, 11-12 cm:

Cyclococcolithus leptoporus, aff. *Pseudoemiliania lacunosa*.

Age: Probably early Pleistocene.

Sample 5-34-2-6, 11-12 cm:

Coccolithus pelagicus, *Pseudoemiliania lacunosa*, *Helicopontosphaera kampfneri*, *Cyclococcolithus leptopus*.

Age: Probably early Pleistocene.

Sample 5-34-3-1, 7-8 cm:

Cyclococcolithus leptoporus, cf. *Discoaster brouweri*,
Discoaster surculus, *Coccolithus pelagicus*, *Discoaster asymmetricus*.

Age: Middle to late Pliocene.

Sample 5-34-3-2, 10-11 cm:

Coccolithus pelagicus, *Cyclococcolithus leptoporus*,
Discoaster asymmetricus.

Age: Probably as above.

Sample 5-34-3-3, 7-8 cm:

Cyclococcolithus leptoporus, *Coccolithus pelagicus*, *Discoaster surculus*, *Discoaster pentaradiatus*, *Pseudoemiliania lacunosa*.

Age: Middle to late Pliocene.

Sample 5-34-3-4, 8-9 cm:

Cyclococcolithus leptoporus, *Coccolithus pelagicus*, aff. *Reticulofenestra pseudoumbilica*, *Discoaster brouweri*, cf. *Discoaster surculus*.

Age: Middle Pliocene.

Sample 5-34-3-5, 9-10 cm:

Cyclococcolithus leptoporus, *Coccolithus pelagicus*, *Discoaster surculus*, *Discoaster brouweri*, *Reticulofenestra pseudoumbilica*.

Age: Early to middle Pliocene.

Sample 5-34-3-6, 78 cm:

Discoaster pentaradiatus, *Cyclococcolithus leptoporus*, *Coccolithus pelagicus*, *Discoaster brouweri*, *Discoaster surculus*, aff. *Reticulofenestra pseudoumbilica*.

Age: Probably middle Pliocene.

Sample 5-34-4-1, 13-14 cm:

Reticulofenestra pseudoumbilica, *Cyclococcolithus leptoporus*.

Age: Insufficient nannofossils for age determination; Neogene.

Sample 5-34-4-2, 11-12 cm:

Reticulofenestra pseudoumbilica, *Coccolithus pelagicus*, *Cyclococcolithus leptoporus*, cf. *Discoaster brouweri*.

Age: Probably early Pliocene.

Sample 5-34-4-3, 24-25 cm:

Reticulofenestra pseudoumbilica, *Cyclococcolithus leptoporus*.

Age: Probably as above.

Sample 5-34-4-4, 8-9 cm:

Cyclococcolithus leptoporus, *Coccolithus pelagicus*, *Reticulofenestra pseudoumbilica*.

Age: Probably as above.

Sample 5-34-4-5, 10-11 cm:

Coccolithus pelagicus, *Reticulofenestra pseudoumbilica*, *Cyclococcolithus leptoporus*.

Age: Probably as above.

Sample 5-34-4-6, 14-15 cm:

Reticulofenestra pseudoumbilica.

Age: Insufficient nannofossils for age determination.

Sample 5-34-5-1, 5-6 cm:

Barren of calcareous nannofossils.

Sample 5-34-5-2, 19-20 cm:

Reticulofenestra pseudoumbilica, *Discoaster* sp.

Age: Nannofossils insufficient for age determination.

Sample 5-34-5-3, 46-47 cm:

Reticulofenestra pseudoumbilica, *Cyclococcolithus leptoporus*, *Coccolithus pelagicus*, *Discoaster surculus*.

Age: Probably early Pliocene.

Sample 5-34-5-4, 62-63 cm:

Cyclococcolithus leptoporus, *Reticulofenestra pseudoumbilica*, *Coccolithus pelagicus*.

Age: Probably as above.

Sample 5-34-5-5, 72-73 cm:

Barren of calcareous nannofossils.

Sample 5-34-5-6, 11-12 cm:

Reticulofenestra pseudoumbilica, *Cyclococcolithus leptoporus*.

Age: Insufficient nannofossils for age determination.

Sample 5-34-6-1, 30-31 cm:

Reticulofenestra pseudoumbilica.

Age: Insufficient nannofossils for age determination.

Sample 5-34-6-2, 70-71 cm:

Reticulofenestra pseudoumbilica, *Discoaster* sp.

Age: Insufficient nannofossils for age determination.

Sample 5-34-6-3, 89-90 cm:

Barren of calcareous nannofossils.

Sample 5-34-6-4, 13-14 cm:

Reticulofenestra pseudoumbilica.

Age: Insufficient nannofossils for age determination.

Sample 5-34-6-5, 90-91 cm:

Barren of calcareous nannofossils.

Sample 5-34-6-6, 10-11 cm:

Barren of calcareous nannofossils.

Sample 5-34-7-3, 58-59 cm:

Reticulofenestra pseudoumbilica, *Cyclococcolithus leptoporus*, *Discoaster* sp.

Age: Insufficient nannofossils for age determination.

Sample 5-34-7-4, 20-21 cm:

Reticulofenestra pseudoumbilica, *Cyclococcolithus leptoporus*, *Discoaster* sp.

Age: Probably late Miocene to early Pliocene.

Sample 5-34-7-6, 15-16 cm:

Barren of calcareous nannofossils.

Sample 5-34-8-1, 35-36 cm:

Reticulofenestra pseudoumbilica, cf. *Discoaster bollii*,
Coccolithus pelagicus, cf. *Discoaster variabilis*, *Cyclococcolithus leptoporus*.

Age: Late Miocene.

Sample 5-34-8-2, 21-22 cm:

Cyclococcolithus leptoporus, *Coccolithus pelagicus*,
Reticulofenestra pseudoumbilica, *Discoaster variabilis*,
cf. *Discoaster exilis*, *Discoaster brouweri*, cf. *Discoaster quinqueramus*.

Age: Late Miocene (probably Messinian).

Sample 5-34-8-4, 27-28 cm:

Reticulofenestra pseudoumbilica, *Discoaster exilis*, *Ceratolithus tricorniculatus*, cf. *Discoaster bollii*, *Helicopontosphaera* sp., cf. *Discoaster variabilis*.

Age: Late Miocene (Messinian).

Sample 5-34-8-5, 30-31 cm:

Reticulofenestra pseudoumbilica, *Cyclococcolithus leptoporus*, *Discoaster variabilis*, *Ceratolithus tricorniculatus*.

Age: As above.

Sample 5-34-8-6, 21-22 cm:

Reticulofenestra pseudoumbilica, cf. *Discoaster variabilis*, *Coccolithus pelagicus*.

Age: Probably as above.

Sample 5-34-9-1, 48-49 cm:

Barren of calcareous nannofossils.

Sample 5-34-9-2, 134-135 cm:

Reticulofenestra pseudoumbilica, *Discoaster variabilis*,
cf. *D. bollii*.

Age: Late Miocene.

Sample 5-34-9-3, 61-62 cm:

Discoaster variabilis, *Reticulofenestra pseudoumbilica*.

Age: Probably as above.

Sample 5-34-9-4, 2-3 cm:

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

Age: Probably as above.

Sample 5-34-9-5, 5-6 cm:

Reticulofenestra variabilis, cf. *Discoaster bollii*, *Discoaster variabilis*, cf. *Cyclococcolithus leptoporus*.

Age: Probably as above.

Sample 5-34-9-6, 7-8 cm:

Discoaster variabilis, *Reticulofenestra pseudoumbilica*,
Cyclococcolithus leptoporus.

Age: Probably as above.

Sample 5-34-10-1, 50-51 cm:

Discoaster variabilis, *Reticulofenestra pseudoumbilica*.

Age: Probably as above.

Sample 5-34-10-2, 15-16 cm:

Reticulofenestra pseudoumbilica, *Discoaster variabilis*,
Sphenolithus abies.

Age: Probably as above.

Sample 5-34-10-3, 13-14 cm:

Discoaster variabilis, *Reticulofenestra pseudoumbilica*.

Age: Probably as above.

Sample 5-34-14-4, 3-4 cm:

Discoaster exilis, *Reticulofenestra pseudoumbilica*.

Age: Late middle to late Miocene.

Sample 5-34-10-5, 4-5 cm:

cf. *Discoaster exilis*, *Sphenolithus abies*, *Reticulofenestra pseudoumbilica*, cf. *Discoaster variabilis*.

Age: As above.

Sample 5-34-10-6, 10-11 cm:

Discoaster exilis, *Reticulofenestra pseudoumbilica*.

Age: Probably as above.

Sample 5-34-11-2, 20-21 cm:

Discoaster exilis, *Reticulofenestra pseudoumbilica*.

Age: Probably as above.

Sample 5-34-11-3, 4-5 cm:

Discoaster variabilis, *Discoaster exilis*, *Cyclococcolithus leptoporus*, *Reticulofenestra pseudoumbilica*, cf. *Ceratolithus tricorniculatus*.

Age: Late Miocene (possibly younger than above).

Sample 5-34-12-1, 85-86 cm:

Barren of calcareous nannofossils.

Sample 5-34-12-2, 18-19 cm:

Barren of calcareous nanonfossils.

Sample 5-34-14-2, 33-34 cm:

Barren of calcareous nannofossils.

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Sample 5-35-1-1, 30-31 cm:

Barren of calcareous nannofossils.

Sample 5-35-1-2, 40-41 cm:

Gephyrocapsa oceanica, cf. *Emiliania huxleyi* (turbidite).

Age: Pleistocene (probably *Emiliania huxleyi* Zone).

Sample 5-35-1-3, 21-22 cm:

As above.

Sample 5-35-1-5, 14-15 cm:

Gephyrocapsa sp., aff. *Emiliania huxleyi*.

Age: Pleistocene.

Sample 5-35-2-1, 41-42 cm:
Gephyrocapsa oceanica, *Coccolithus pelagicus*.
Age: Pleistocene.

Sample 5-35-2-2, 18-19 cm:
Coccolithus pelagicus, *Gephyrocapsa oceanica*.
Age: Pleistocene.

Sample 5-35-2-3, 18-19 cm:
Gephyrocapsa oceanica, *Coccolithus pelagicus*, *Braarudosphaera bigelowi*.
Age: As above.

Sample 5-35-2-4, 17-18 cm:
Gephyrocapsa oceanica, *Coccolithus pelagicus*.
Age: As above.

Sample 5-35-2-5, 8-9 cm:
Gephyrocapsa oceanica.
Age: Pleistocene.

Sample 5-35-2-6, 15-16 cm:
Gephyrocapsa oceanica, *Coccolithus pelagicus*.
Age: As above.

Sample 5-35-6-2, 54-55 cm:
Gephyrocapsa oceanica, *Coccolithus pelagicus*.
Age: Pleistocene (?turbidite).

Sample 5-35-6-4, 13-14 cm:
Gephyrocapsa oceanica.
Age: As above.

Sample 5-35-6-5, 13-14 cm:
Gephyrocapsa oceanica, *Coccolithus pelagicus*.
Age: As above.

Sample 5-35-6-6, 14-15 cm:
Gephyrocapsa oceanica, *Braarudosphaera bigelowi*.
Age: As above.

Sample 5-35-7-3, 15-16 cm:
Barren of calcareous nannofossils.

Sample 5-35-7-4, 16-17 cm:
Coccolithus sp.
Age: Not age diagnostic.

Sample 5-35-8-1, 102-103 cm:
Gephyrocapsa oceanica.
Age: Pleistocene.

Sample 5-35-9-1, 94-95 cm:
Gephyrocapsa oceanica.
Age: As above.

Sample 5-35-9-2, 13-14 cm:
Gephyrocapsa oceanica.
Age: As above.

Sample 5-35-9-3, 13-14 cm:
Coccolithus pelagicus, *Gephyrocapsa oceanica*.
Age: As above.

Sample 5-35-11-6, 23-24 cm:
Gephyrocapsa oceanica.
Age: Pleistocene (turbidite).

Sample 5-35-12-6, 50-51 cm:
Gephyrocapsa oceanica.
Age: As above.

Sample 5-35-13-4, 60-61 cm:
Barren of calcareous nannofossils.

Sample 5-35-14-4, 16-17 cm:
As above.

Sample 5-35-15-4, 31-32 cm:
As above.

Sample 5-35-16-2, 30-31 cm:
As above.

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Sample 5-36-1-1, 5-6 cm:
Coccolithus pelagicus, *Cyclococcolithus leptoporus*.
Age: Probably Pleistocene.