MESOZOIC AND CENOZOIC SEQUENCE CHRONOSTRATIGRAPHIC CHART

Jan HARDENBOL, Jacques THIERRY, Martin B. FARLEY, Thierry JACQUIN, Pierre- Charles de GRACIANSKY, and Peter R. VAIL, 1998,
Mesozoic and Cenozoic Sequence Chronostratigraphic Framework of European Basins,
in, de Graciansky, P.-C., Hardenbol, J., Jacquin, T., and Vail, P. R., eds.,
Mesozoic and Cenozoic Sequence Stratigraphy of European Basins, SEPM Special Publication 60

Chart 1

Sequence Stratigraphy of European Basins Project
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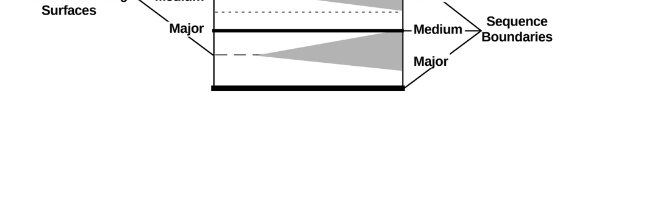
Total (France)



CENOZOIC SEQUENCE CHRONOSTRATIGRAPHY

JAN HARDENBOL, JACQUES THIERRY, MARTIN B. FARLEY, THIERRY JACQUIN, PIERRE-CHARLES DE GRACIANSKY, AND PETER R. VAIL

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Chart 2

TIME IN Ma

MAGNETO-CHRONO-STRATI-GRAPHY — Cande & Kent, 1992, 1995

POLARITY

POLARITY CHRONOZONES

STANDARD CHRONOSTRATIGRAPHY — BERGGREN et al., 1995

ERATHEM: CENOZOIC

SYSTEM: QUATERNARY; TERTIARY

SERIES: HOLOCENE; PLEISTOCENE; PLIOCENE (L, U); MIOCENE (UPPER, MIDDLE, LOWER); OLIGOCENE (UPPER, LOWER); EOCENE (UPPER, MIDDLE); PALEOCENE (UPPER, LOWER); NEOGENE; PALEOGENE

STAGES

0.95	IONIAN
1.77	CALABRIAN
2.60	GELASIAN
3.58	PIACENZIAN
5.32	ZANCLEAN
7.12	MESSINIAN
11.20	TORTONIAN
14.80	SERRAVALLIAN
16.40	LANGHIAN
20.52	BURDIGALIAN
23.8	AQUITANIAN
28.5	CHATTIAN
33.7	RUPELIAN
37.0	PRIABONIAN
41.3	BARTONIAN
49.0	LUTETIAN
54.8	YPRESIAN
57.9	THANETIAN
60.9	SELANDIAN
65.0	DANIAN

SEQUENCE CHRONOSTRATIGRAPHY / BIOCHRONOSTRATIGRAPHY

PLANKTONIC FORAMINIFERA — COORD. W. A. BERGGREN — BERGGREN et al., 1995

BLOW, 1979 / BERGGREN & MILLER, 1988

SUBTROPICAL

CALCAREOUS NANNOFOSSILS — COORD. M. P. AUBRY — BERGGREN et al., 1995

MARTINI, 1971

BUKRY, 1973, 1975

SEQUENCE CHRONOSTRATIGRAPHY — COORD. J. HARDENBOL, J. E. NEAL, N. VANDENBERGHE, G. A. VAKARCS, P. R. VAIL

SEQUENCES

T-R FACIES CYCLES

MAJOR T-R CYCLES

SEQUENCE BOUNDARIES — HAQ et al., 1987, 1988

ISOTOPE CHRONOSTRATIGRAPHY

OXYGEN ISOTOPES — COORD. V.S. ABREU

Composite smoothed oxygen isotope record based on DSDP/ODP sites.

$\delta^{18}O‰$

STRONTIUM ISOTOPES — COORD. M. B. FARLEY & K.E. MILLER

0.7074 0.7078 0.7082 0.7086 0.7090 0.7094

TIME IN Ma

NOTE:

Positive isotope events interpreted to be glacioeustatic falls are indicated by arrows and related to the chronostratigraphic record (ELi-1 = Eocene Lutetian isotope 1).

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Mobil North Sea (Norway)
Shell (UK & The Netherlands)
Saga Petroleum (Norway)
Total (France)

Schematic Condensed Section
Top Lowstand (where indicated)
Maximum Flooding Surfaces
Minor
Medium
Major
Sequence Boundaries

Sequence nomenclature

Sequence boundary nomenclature for the new sequences is based on the stage in which a sequence boundary occurs and its ordinal position counting up from the stage base. For example, the sequence boundaries in the Ypresian are Yp1 through Yp10 with Yp1 the oldest. Note that it is the position of the sequence boundary that determines the name, even if most of the sequence is in the next younger stage. In the new sequences lowstands are not distinguished. The systems tract boundary between lowstand and transgressive systems tracts is not of chronostratigraphic significance and thus is not shown on this chart.

CENOZOIC BIOCHRONOSTRATIGRAPHY

JAN HARDENBOL, JACQUES THIERRY, MARTIN B. FARLEY, THIERRY JACQUIN, PIERRE-CHARLES DE GRACIANSKY, AND PETER R. VAIL

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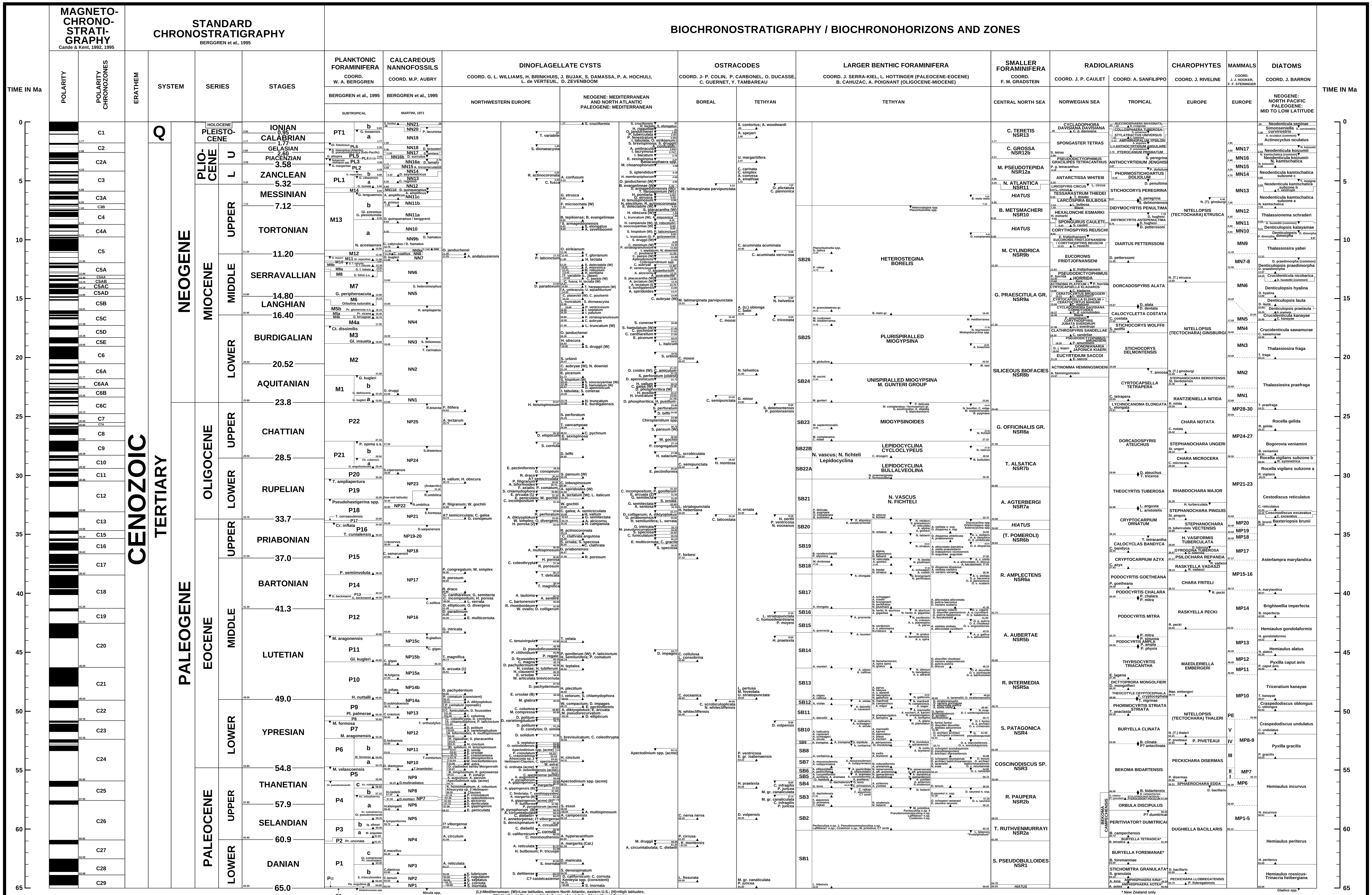
Chart 3



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Total (France)

1. Ages for the stage boundaries are directly inferred from radiometric data and are shown to the nearest 0.1 m.y. or 0.01 in the Neogene (Berggren, et al., 1995). All other ages shown to the nearest 0.01 m.y. are intended only as a place holder to help determine the relative position of events in different columns. Roundoff error in plotting required two decimal point precision for each entry to avoid apparent misalignments.

2. First Appearance Datums (FADs; originations; ▲) and Last Appearance Datums (LADs; extinctions; ▼) closely spaced in time may have bent flags. In this case, the time position of the event is the flag stem at the edge of the column.

3. The standard format for names other than ammonites is:
Zones--full generic and specific name
Appearance Datums--Abbreviated generic name and full specific name except for "sp(p)." for which full generic names are given.

4. Uncertain stratigraphic positions for zonal boundaries, FADs, and LADs are shown with dashed lines.

5. B. clinata / P? anteclinata — Evolutionary transition.

CRETACEOUS SEQUENCE CHRONOSTRATIGRAPHY

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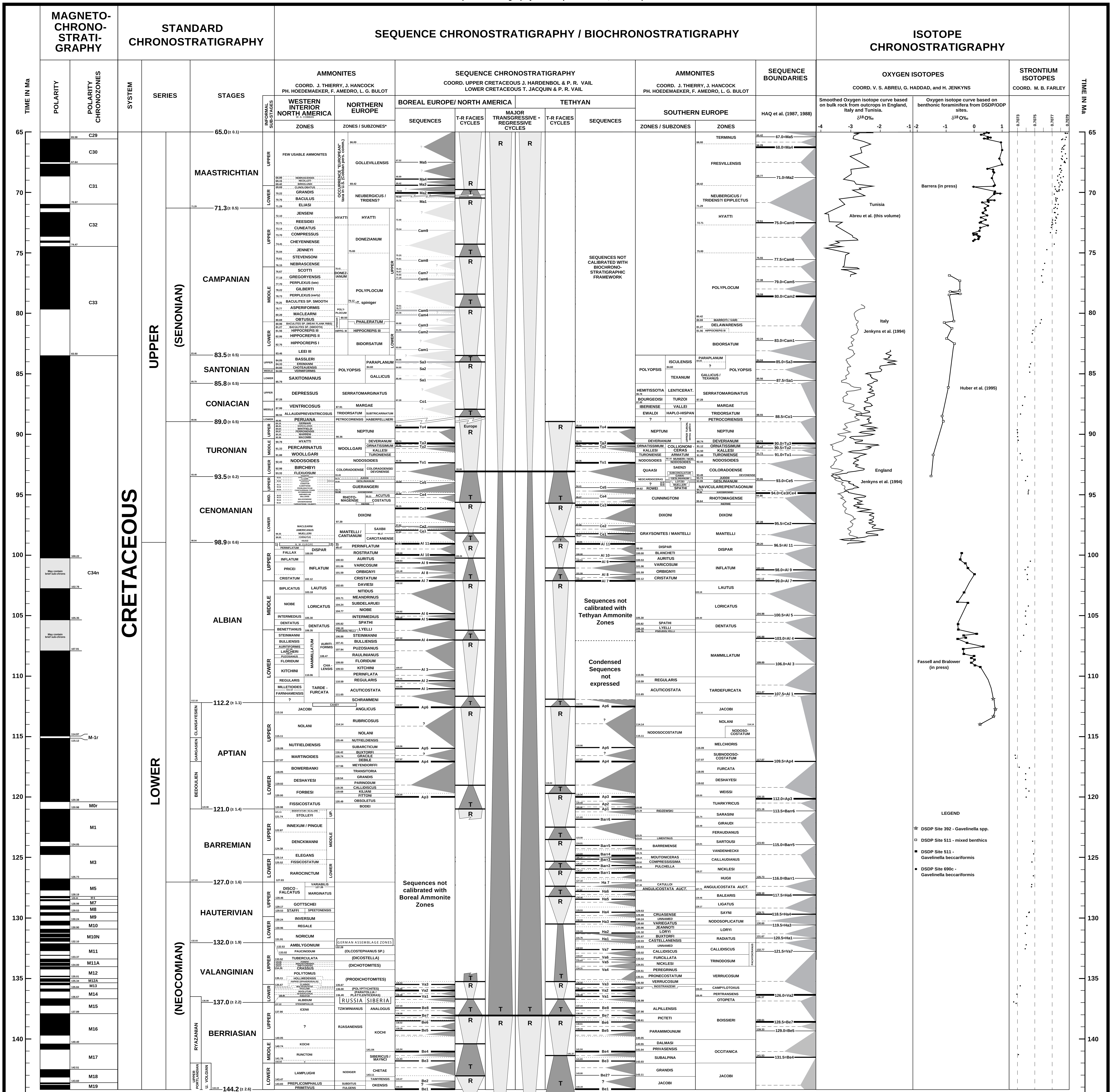
Chart 4



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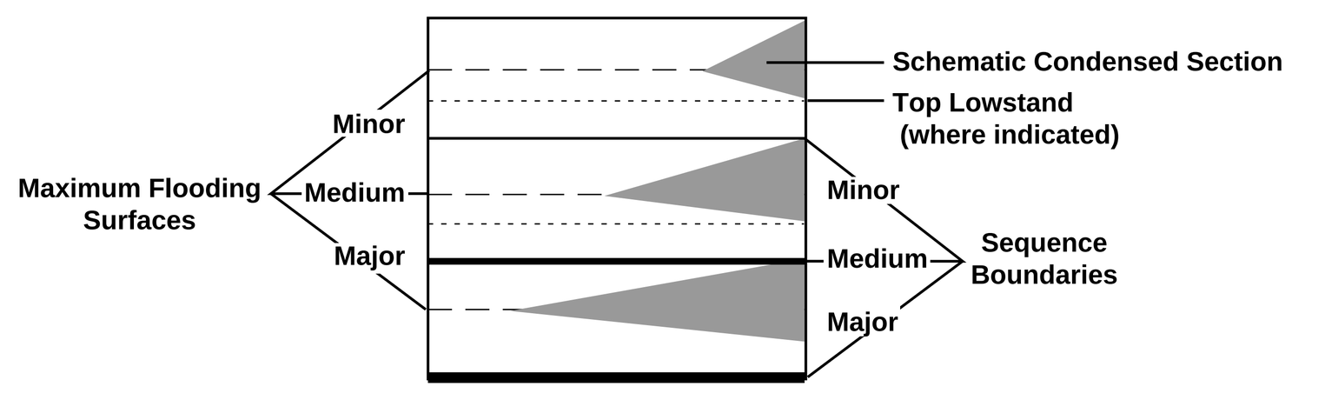
AMMONITE ZONATIONS:
....Albian - 1) Amedro Zones
2) Amedro / Owen Zones
3) Owen Subzones
....Aptian - Casey Zones / Subzones
....Barremian - Kemper/Koenen
....Hauterivian - Kemper
....Valanginian - Kemper
....U-M Berriasian - Casey/Bogoslovsky
....L Berriasian - Swinnerton
xxxxxxxxxxxxxxx DENOTES BOUNDARY DIFFERENT FROM STANDARD CHRONSTRATIGRAPHY

Sequence nomenclature

Sequence boundary nomenclature for the new sequences is based on the stage in which a sequence boundary occurs and its ordinal position counting up from the stage base. For example, the sequence boundaries in the Cenomanian are Ce 1 thru Ce 5 with Ce 1 the oldest. Note that it is the position of the sequence boundary that determines the name, even if most of the sequence is in the next younger stage. In the new sequences lowstands are not distinguished. The systems tract boundary between lowstand and transgressive systems tracts is not of chronostratigraphic significance and thus is not shown on this chart.



CRETACEOUS BIOCHRONOSTRATIGRAPHY

JAN HARDENBOL, JACQUES THIERRY, MARTIN B. FARLEY, THIERRY JACQUIN, PIERRE-CHARLES DE GRACIANSKY, AND PETER R. VAIL

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Chart 5

1. Ages for the stage boundaries are directly inferred from radiometric data and are shown to the nearest 0.1 m.y. with statistical uncertainty in parentheses (Gradstein, *et al*., 1995). All other ages shown to the nearest 0.01 m.y. are intended only as a place holder to help determine the relative position of events in different columns. Roundoff error in plotting required two decimal point precision for each entry to avoid apparent misalignments.

2. First Appearance Datums (FADs; originations; ——▲) and Last Appearance Datums (LADs; extinctions; ▼——) closely spaced in time may have bent flags. In this case, the time position of the event is the flag stem at the edge of the column.

3. The standard format for names other than ammonites is:
Zones--full generic and specific name
Appearance Datums--Abbreviated generic name and full specific name except for "sp(p)." for which full generic names are given.

4. Uncertain stratigraphic positions for zonal boundaries, FADs, and LADs are shown with dashed lines.

Sequence Stratigraphy of European Basins Project

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JURASSIC SEQUENCE CHRONOSTRATIGRAPHY

JAN HARDENBOL, JACQUES THIERRY, MARTIN B. FARLEY, THIERRY JACQUIN, PIERRE-CHARLES DE GRACIANSKY, AND PETER R. VAIL

1998

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Chart 6

MAGNETO-CHRONO-STRATI-GRAPHY

POLARITY

POLARITY CHRONOZONES

STANDARD CHRONOSTRATIGRAPHY

SYSTEM | SERIES | STAGES

SEQUENCE CHRONOSTRATIGRAPHY / BIOCHRONOSTRATIGRAPHY

AMMONITES

COORD. J. THIERRY

NORTHWESTERN EUROPE

BOREAL / SUBBOREAL

CONTINI, MOUTERDE, RIOULT, ELMI, MANGOLD, THIERRY, CARIOU, MARCHAND, ENAY

ZONES | SUBZONES

SEQUENCE CHRONOSTRATIGRAPHY

COORD. T. JACQUIN, P.- C. de GRACIANSKY, P. R. VAIL

BOREAL

SEQUENCES | T-R FACIES CYCLES

MAJOR TRANSGRESSIVE - REGRESSIVE CYCLES

TETHYAN

T-R FACIES CYCLES | SEQUENCES

AMMONITES

COORD. J. THIERRY

SOUTHWESTERN EUROPE

TETHYAN / SUBMEDITERRANEAN

ATROPS, HANTZPERGUE, GEYSSANT, CORNA, DOMMERGUES, MEISTER, RULLEAU

SUBZONES | ZONES

SEQUENCE BOUNDARIES

HAQ et al. (1987, 1988)

ISOTOPE CHRONO-STRAT.

STRONTIUM ISOTOPES

COORD. M. B. FARLEY

0.7068 | 0.7072 | 0.7076 | 0.7080

TIME IN Ma

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Saga Petroleum (Norway)
Total (France)

Minor
Medium
Major
Maximum Flooding Surfaces

Schematic Condensed Section
Top Lowstand (where indicated)
Minor
Medium
Major
Sequence Boundaries

*

190.13	SOLARE
190.26	LEVIDORSATUM
190.38	MENEGHINI
190.51	ACURATUM
190.63	BERTRANDI
190.76	RAGAZZONI

Sequence nomenclature

Sequence boundary nomenclature for the new sequences is based on the stage in which a sequence boundary occurs and its ordinal position counting up from the stage base. For example, the sequence boundaries in the Toarcian are Toa1 thru Toa7 with Toa1 the oldest. Note that it is the position of the sequence boundary that determines the name, even if most of the sequence is in the next younger stage. In the new sequences lowstands are not distinguished. The systems tract boundary between lowstand and transgressive systems tracts is not of chronostratigraphic significance and thus is not shown on this chart.

JURASSIC BIOCHRONOSTRATIGRAPHY

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Chart 7

Sequence Stratigraphy of European Basins Project

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Mobil North Sea (Norway)
Shell (UK & The Netherlands)
Saga Petroleum (Norway)
Total (France)

*

190.13	SOLARE
190.26	LEVIDORSATUM
190.38	MENEGHINI
190.51	ACURATUM
190.63	BERTRANDI
190.76	RAGAZZONI

1. Ages for the stage boundaries are directly inferred from radiometric data and are shown to the nearest 0.1 m.y. with statistical uncertainty in parentheses (Gradstein, et al., 1995). All other ages shown to the nearest 0.01 m.y. are intended only as a place holder to help determine the relative position of events in different columns. Roundoff error in plotting required two decimal point precision for each entry to avoid apparent misalignments.

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TRIASSIC SEQUENCE CHRONOSTRATIGRAPHY / BIOCHRONOSTRATIGRAPHY

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Chart 8

Sequence Stratigraphy of European Basins Project

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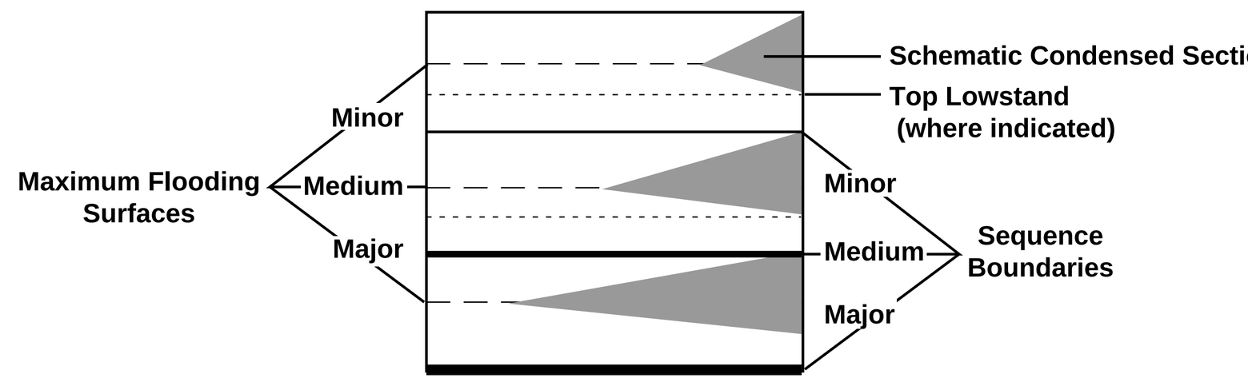

Sequence nomenclature

Sequence boundary nomenclature for the new sequences is based on the stage in which a sequence boundary occurs and its ordinal position counting up from the stage base. For example, the sequence boundaries in the Anisian are An1 thru An4 with An1 the oldest. Note that it is the position of the sequence boundary that determines the name, even if most of the sequence is in the next younger stage. In the new sequences lowstands are not distinguished. The systems tract boundary between lowstand and transgressive systems tracts is not of chronostratigraphic significance and thus is not shown on this chart.

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