Integrated Chronostratigraphy of Cretaceous and Paleogene Sequences: Evidence of Global Events?

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A key issue in sequence stratigraphy is how to determine the age of a depositional sequence accurately and precisely. Many depositional cycles are shorter than the ranges of associated fossils, resulting in the uncertainty of where in fossil zone is the cycle. Because sequence stratigraphic methodology is predicated upon global sea-level events, the accurate testing of synchroneity of sequences within a basin and between basins is essential.

Graphic correlation is a simple and rapid methodology for the objective and testable correlation of sequences and their bounding hiatuses. It is a quantitative, non-statistical technique that tests the coeval relationships between sections by comparing the first and last records of shared events in X/Y plots. To apply this technique a data base of chronostratigraphic events in globally distributed sections is essential. In addition the sequences must record chronostratigraphic events such as fossil tops and bases or magnetochrons. The strata above and below bounding surfaces of depositional sequences can be dated by graphic correlation based on the associated biota. The sequences can then be defined in the composite standard and the sequences in these reference sections can be projected into other fossiliferous sections by graphic correlation. In this way the hypothesis of synchroneity of the sequences can be tested.

The Paleogene composite standard data was compiled from thirty-one DSDP-ODP cores and key outcrops. The ranges of over 1200 planktic and benthic foraminifers, nannofossils, dinoflagellates, magnetochrons, geochemical events, marker beds, and sequence boundaries were integrated by graphic correlation in a mega-annum scale. The Alabama Paleogene section defines eighteen traceable sequence boundaries (SB) calibrated by foraminifers and nannofossils and defined by abrupt lithological changes and facies shifts (Mancini and Tew, 1991, 1995). The sixteen Paleogene sequences range in duration from 0.14-4.30 m.y. and the mean is 1.51 m.y. (Fig. 1).

In southern England five sequence boundaries (SB) divide the Eocene Bracklesham Formation (Fig. 2). The hiatus at sequence boundary T1 spans from 51.50-51.30 Ma, which in Alabama correlates within the age span of SB TE2.1 between the Hatchetigbee and Tallahatta Formations. Hiatuses at SB T2 and T3 in the Bracklesham span 50.83-49.80 Ma and 48.26-48.58 Ma respectively and correlate within the conformable Tallahatta. The hiatus of SB T4 spans 47.00- 45.90 Ma and is within the duration of SB TE2.2 at 45.95-45.29 Ma between the Tallahatta and the Lisbon Formation in the Gulf Coast. The hiatus of SB T5 spans 43.15-42.98 Ma and is slightly older than SB TE2.4 at the base of the upper Lisbon at 42.75 Ma. Twenty-one unconformities within the Paleogene sections correlate globally confirming that they record global changes in sea level or oceanic water mass conditions.

Modern definitions of stage boundaries require not only detailed biostratigraphic and lithologic data but also precise correlation of the data into other sections. The Mid-Cretaceous composite data base of more than 1200 fossil ranges, geochemical, and lithological markers was compiled from fifty-three cores and outcrops and calibrated to the Harland time scale. In the composite data set the base of the Aptian is defined in the Gorgo a Cerbara, Italy section, the bases of the Albian and Cenomanian in the Vocontian Basin, France, and the base of the Turonian in Colorado. Cenomanian and Turonian depositional sequences are defined in the Tunisian reference section and integrated with ammonite zones (Robaszynski and others, 1990, 1993) (Fig. 3). These sequences can be correlated with sequences in any other section to test their timing. In the Omani sections of the Nahr Umr and Natih Formations eight composite submarine hardgrounds are about the same age as Tunisian sequence boundaries or downlap contacts (Scott and others, 2000).

Graphic correlation is a technique that has the precision and accuracy required for the consistent and objective identification and correlation of sequences to test their synchroneity and potential record of eustatic events. Twenty-one Paleogene sequences correlate globally confirming that they record global changes. The onset of Antarctic glaciation spanned a period of 1.5 m.y. beginning about 33.73-33.68 Ma and continuing to about 32.26-32.22 Ma. Two of several Late Eocene iridium anomalies are dated at 35.81 ma and 35.67 Ma, and an associated tektite layer is 35.70 Ma.

Graphic correlation also enables the precise testing of the position in any fossiliferous section of stage boundaries defined in standard reference sections. Depositional sequences in The U.S. Gulf of Mexico can be correlated accurately with sequences defined by composite hardgrounds in Oman, supporting the interpretation of global sea–level events.

References

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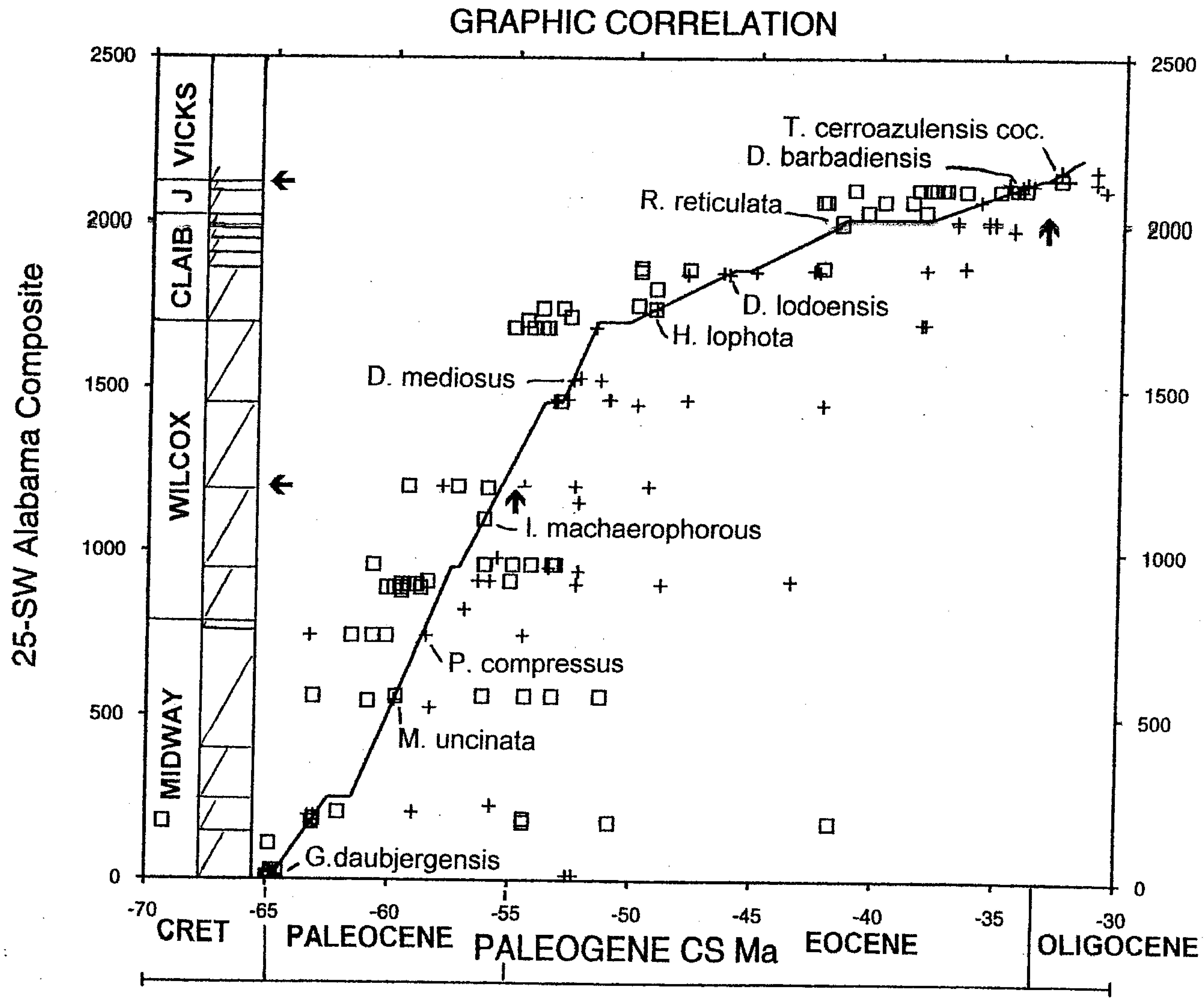

Figure 1. Graphic correlation plot of biostratigraphic data of the Alabama composited section (Mancini, E.A., and Tew, B.H., 1991). The sixteen sequences are plotted in the column next to the lithostratigraphic group divisions. Large arrows show the stratal positions of projecting the base of Eocene and base of Oligocene into the Alabama section.

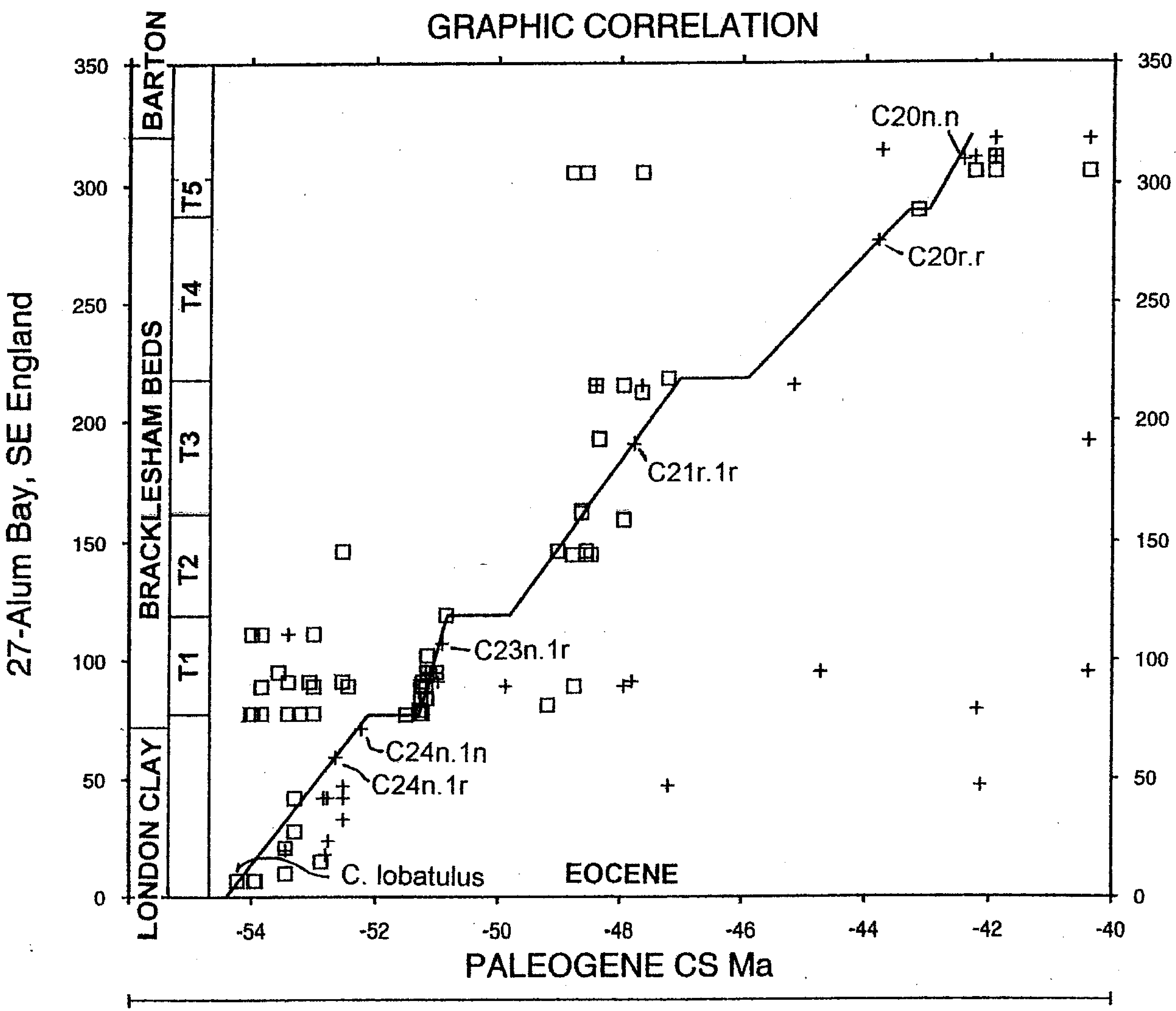

Figure 2. Graphic correlation plot of biostratigraphic data of the Alum Bay, southeastern England section (Plint, 1983). Intervals T1-T5 are depositional sequences. Note that four of five sequence boundaries match horizontal terraces in the graph which represent the duration of the hiatus at each unconformity.

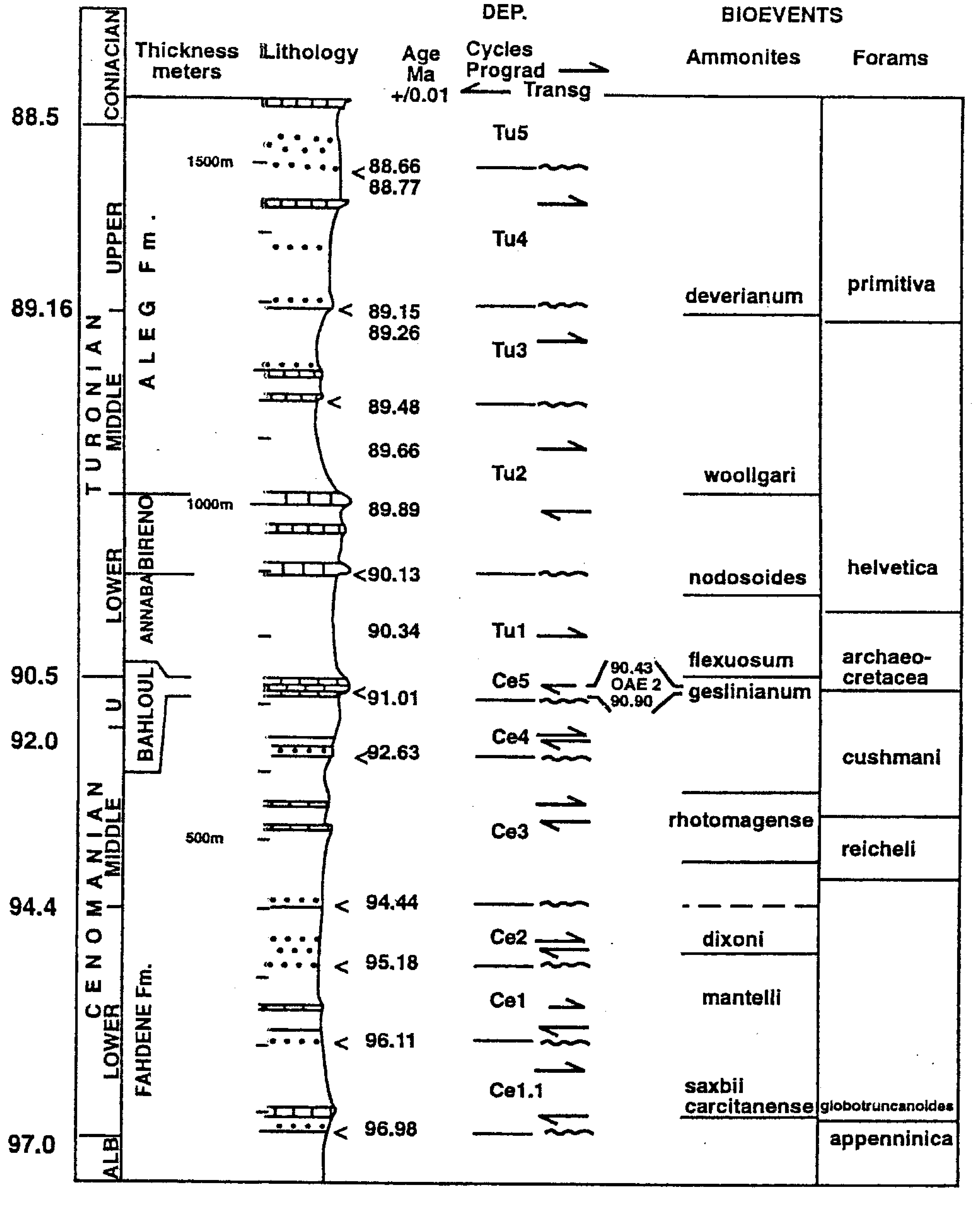

Figure 3. Cenomanian-Turonian sequence stratigraphy of northern Tunisia reference sections based on data and analyses by Robaszynski and others (1990, 1993). The horizontal arrows indicate transgressive and downlap contacts. Oceanic anoxic event 2 is defined by the change in the carbon isotope ratio.(From Scott and others, 2000, published with permission from SEPM.).