Miocene astrochronology exercise

This hypothetical Miocene exercise is designed to bring together knowledge of maine sedimentology, magnetostratigraphy, cyclostratigraphy, and biostratigraphy to illustrate how climate changes related to Milankovitch orbital forcing can be used to refine the time scale, determine the timing of events, and estimate rates ("astrochronology").

Background

The column to the left is the hypothetical global geomagnetic polary time scale for the Miocene. Stratigraphic columns 1 and 2 come from two different drill core and outcrop localities. There is one dated ash bed near the top of column 1. The basic cyclostratigraphic motif is light gray bioturbated limestones (containing planktic forams and coccoliths) rhythmically interbedded with dark, laminated calcareous shales (sparse fossils) (photo provided). Magnetostratigraphic data for the bottom half of section 2 is not available. The biostratigraphic range of index fossils A through E in column 2 are shown to the right; index fossils A, B, C, and D went extinct at the same time. Note that the index fossil (*) indicates a very earliest Middle Miocene age.

Questions

1) Estimate the average duration of the limestone-shale cycles. Explain how you arrived at your answer.

2) 3) Using the concepts of astronchronology discussed in lecture, estimate the numeric age of the extinction event involving A, B, C, & D. Explain how you arrived at your answer.

3) How much time elapsed before the new index fossis E & F evolved after the extinction?

4) With lines, indicate where columns 1 and 2 overlap in time.

5) Approximate the location of the Early-Middle Miocene boundary and show this with a colored line. Explain how you arrived at your answer.

6) Calculate the sedimentation rates for column 1.

7) Using the sedimentologic data, photos, cycle duration, and discussions in lecture, suggest what paleoceanographic and paleoclimatic conditions might explain why bioturbated limestones are interbedded with laminated dark calcareous shales.