Exercise 3 Geological carbon sinks in the Cretaceous (Chapter 8 of *The Cretaceous World*)

You should allow about 1 hour to complete this Exercise. You will need a calculator, paper and pencil, and The Cretaceous World*.*

Chapter 8 of *The Cretaceous World* presented quantitative estimates of some of the major terrestrial and marine carbon sinks, so it is worth comparing these now in order to evaluate their relative importance.

> **Question 3.1** (a) From the estimate given in Section 8.1.2 of *The Cretaceous World* for Alaskan coals of predominantly Late Albian to Cenomanian age, calculate the average net rate of burial of carbon there in units of 10^{12} kg C per year. For ease of calculation, make the following (grossly) simplifying assumptions: that the coal is pure carbon; and that it was deposited over a time interval of 10 Ma. (b) Compare your answer with the estimate given in Section 8.2.1 of *The Cretaceous World* for the average rate of burial of carbonate carbon in the Tethyan carbonate platforms of the Late Cenomanian, by calculating the ratio between the two values. (c) The two estimates that you have just been comparing are based on geographically limited examples, but in each case the accompanying text mentions other deposits that would need to be considered in order to derive global estimates of terrestrial C_{org} and marine C_{carb} burial. Section 8.2.1 of *The Cretaceous World* also refers to estimated ratios of C_{carb} to C_{org} burial in marine environments during the Cretaceous. Making reasonable assumptions (i.e., 'guesstimates') about the relative sizes of the other deposits cited in the text, rank the three reservoirs – terrestrial C_{org}, marine C_{org} and marine C_{carb} in terms of their likely relative contributions as global sinks for carbon in mid-Cretaceous times.

You might care to think further about possible explanations for the answer to Question 2.8 in terms of the relative areas of the latitudinal zones concerned and the effects of eustatic changes of sea-level on their respective sedimentary deposits in the mid-Cretaceous. Crude though they are, such 'back-of-the-envelope' calculations help to explain why a sizeable proportion of the world's oil reserves are of Cretaceous origin (about 29% were derived from Aptian-Turonian source rocks), in contrast to coal, much of which is the legacy of Late Carboniferous to Early Permian times.

Section 8.2.1 of *The Cretaceous World* also touched on some of the feedbacks that may have controlled the behaviour of the Cretaceous global carbon cycle. To help you envisage the way that these might have interacted, try to think about them in terms of a cause and effect diagram, of the kind that was introduced in Chapter 6 of *The Cretaceous World* (Section 6.2.1), by answering the following question.

> **Question 3.2** Draw a cause and effect diagram linking the following components: atmospheric CO_2; climate (global mean temperature + precipitation); calcification on carbonate platforms; C_{carb} burial (long-term); polar forests; terrestrial C_{org} burial (long-term); and weathering of Ca-Mg silicates.

The list of components given in Question 3.2 is not comprehensive, of course, being intended merely to highlight the interactions of the processes particularly emphasized in Section 8.2.1 of *The Cretaceous World*. Think about other components that you might add to the diagram, in order to present a fuller picture of the controls on the Cretaceous global carbon cycle.