The Cretaceous World - Figure captions

Selected original figures and photographs from this book. All these figures are
 The authors of the individual figures and photographs are given in italics at the end of each caption.

Cover Limestone that formed on a shallow marine platform in Early Albian times (c. 110 Ma ago), exposed in fields outside the town of Teloloapan, Guerrero State, SW Mexico, and showing classic karstic ('limestone pavement') weathering, yielding thin, well-drained soils. Such carbonate platform deposits were a common product of the climatically warm Cretaceous world, in low latitudes, giving rise today to characteristic landscapes from Mexico to the Far East. (*Peter Skelton, Open University*)

Figure 1.7 (a) Upright tree stump in Alaskan cliff face (Upper Cretaceous). *(Bob Spicer, Open University)*

Figure 1.9 Reconstruction of northern Alaskan forests of the Late Cretaceous. *(John Watson, Open University)*

Figure 1.11 Rudist limestones dating from the beginning of the Late Cretaceous (Cenomanian; see Section 1.3) in south-west Istria, Croatia (see Ti_ljar *et al*. 1998). (a) Close-up of a congregation of rudist bivalves preserved in life position on the platform top. Scale is 12 cm. (*Peter Skelton, Open University*)

Figure 1.12 Clinoforms (sloping down to the right) of redistributed bioclastic sediment, exposed along the coast of Fra_ker Island, south-west Istria, Croatia. (*Peter Skelton, Open University*)

Figure 1.13 Reconstruction of the carbonate platform illustrated in Figures 1.11 and 1.12. On the left, rudist 'meadows' are spread across the top of the platform, while slopes covered by their shelly debris run off to the right. (*John Watson, Open University*)

Figure 1.14 Shelf limestones deposited in the earlier part of the Late Cretaceous (across the Cenomanian/Turonian boundary; see Section 1.3) exposed on Jebel Bireno, Kasserine, Central Tunisia. Due to local tectonic folding, the beds are dipping steeply towards the right. Thick-bedded limestone (on the left) abruptly overlain by platy limestone (on the right). The geologist's right foot is on the boundary between the two facies. (*Peter Skelton, Open University*)

Figure 1.20 Photomicrographs (at the same scale) of foraminiferan microfossils: (a) immediately above; (b) immediately below the Cretaceous/Tertiary boundary at Gubbio in Italy. The small inset rectangle in the middle shows the clay layer between the two limestones, at natural size. (*Iain Gilmour, Open University, specimens courtesy of A. Montanari*)

Figure 1.28 Milankovich banding in the Grey Chalk at Arlesey Pit, Bedfordshire. (*Peter Skelton, Open University*)

Figure 2.3 The links between mountains and climate.

Figure 3.12 (a) A carbonate platform succession of Santonian age in the southern Central Pyrenees, showing the relatively low-amplitude minor sedimentary cyclicity typical of such Cretaceous successions. (*Peter Skelton, Open University*)

Figure 4.4 Aerial photograph of ribbon forests. Such forests form along the banks of streams and rivers where the upper surface of the permafrost is at its greatest depth below the land surface. (*Bob Spicer, Open University*)

Figure 4.18 A *Ginkgo* leaf from Nanushuk Formation sediments. (*Bob Spicer, Open University*)

Figure 4.31 A cross-section of a piece of angiosperm wood (oak) showing the large vessels. In this species, vessels produced in the spring, when the leaves are growing and demand for water is high, are large, whereas those produced in the autumn, when the leaves are beginning to die, are small. (*Bob Spicer, Open University*)

Figure 4.36 Diagrammatic reconstruction of a typical Cenomanian forest on the Arctic Slope of Alaska. (*Bob Spicer, Open University*)

Figure 4.42 Light micrograph of a transverse section of wood from a Nanushuk Formation tree. (*Bob Spicer, Open University*)

Figure 4.43 Light micrograph of a transverse section of part of a log from the Prince Creek Formation. Note the narrower rings and the development of false rings that indicate an interruption of growth rate during the growing season. (*Bob Spicer, Open University*)

Figure 5.1 Generalized history of carbonate platform development during the Cretaceous in the Tethyan/Atlantic oceanic realm, for (left) the New World (i.e. the Americas) and (right) the Old World (the other continental masses). Major crises in the growth of platforms are indicated by bold horizontal bars, and inferred oceanic anoxic events (OAEs) are shown on the right.

Figure 5.3 Rudist association in a bed of Lower Aptian limestone in SW Mexico (Huetamo area), viewed from above, showing transverse sections of small tubular elevators coming up from beneath, together with large shells of a recumbent form, again seen in section, at the top of the bed. (*Peter Skelton, Open University*)

Figure 5.4 Generalized model for the depositional structure of Cretaceous Tethyan carbonate platforms. Columns show minor depositional cycles (parasequences) in outer and inner platform settings, with rudist lithosomes in pale blue (one example in each column is extended laterally to show its cross-sectional form). Expanded logs show idealized cycles. Typical platform dimensions are shown below (note vertical exaggeration).

Figure 5.5 Example of a shallowing cycle (parasequence) from an outer platform-top sequence in the Santonian of the southern Central Pyrenees, Spain (another section of the cycle illustrated in Figure 3.12b; see Skelton *et al*. (1995)). (a) Section through the cycle showing a biostrome of platy to domal corals with scattered large elevator rudists in its lower part (1), followed by a biostrome of clustered elevator rudists in the middle part (2), and culminating with bioclastic beds in its upper part (3). (b) Detail of slender elevator rudists in unit 2, here largely toppled. (c) Photomicrograph of the fine matrix of unit 2, consisting largely of tiny chips of rudist shell produced by boring sponges. (d) Photomicrograph of the current-swept and coarser bioclastic sediment of unit 3. (*Peter Skelton, Open University*)

Figure 5.8 Outcrop of the Plenus Marls (indicated by the seated man) in a Chalk quarry in Buckinghamshire, England. (*Peter Skelton, Open University*)

Figure 7.3 Schematic diagram showing the overall radiation budget of the atmosphere, and the rough proportion of radiation absorbed at each level (figures are percentages). Values for outgoing radiation have been measured by satellite-borne radiometers; whereas the re-radiated radiation (back radiation) has a longer wavelength than the incoming radiation, radiation reflected by the Earth's surface, clouds or molecules in the atmosphere has the same wavelength after reflection as before. Other values are more difficult to measure precisely, and you may find slightly different values given elsewhere.

Figure 7.6 The interaction of a volcanic eruption with the atmosphere. The eruption releases sulfur dioxide (SO_2), which is eventually converted to sulfuric acid (through a reaction with atmospheric oxygen and water), producing a mist of droplets, or aerosol. This aerosol reflects the incoming solar radiation, so cooling the troposphere; it also absorbs some solar energy, warming the stratosphere. If the sulfuric acid aerosol is sufficiently large, it may absorb and re-irradiate thermal energy warming the lower atmosphere. The eruption also produces large amounts of CO_2, which mixes with atmospheric water to form a much weaker acid that falls locally as acid rain. Smaller amounts of hydrogen chloride are also released into the atmosphere, and mix with water to form hydrochloric acid and again form a component of acid rain.

Figure 7.9 A graph of the mass of aerosols injected into the stratosphere, plotted against the measured climate change for historic eruptions. The estimated effects in the cases of the prehistoric Toba eruption and the Roza flow of the Columbia River flood basalt are marked by larger symbols, indicating the uncertainty in global temperature change estimates. Explosive eruptions are marked as black or grey symbols. Many effusive eruptions are too small to have any global effects but the larger ones are marked by orange symbols. Note that the mass of aerosols is presented as a logarithmic scale.

Figure 8.7 (b) SEM photograph of *Classopollis* grains. Each grain is about 50 µm in diameter. (*Bob Spicer, Open University*)

Figure 8.10 The approximate relative proportions of the main chemical species of dissolved inorganic carbon vary with pH in natural waters. Average pH of open seawater today is about 7.7 (dashed vertical line), but may range between 7.2 and 8.2. Note that the positions of the curved lines also vary with temperature, salinity and pressure.

Figure 8.11 A model to explain the rapid growth of carbonate platforms despite high levels of CO_2 in the Cretaceous atmosphere, ultimately fuelled by increased volcanic emission (Section 7.2.6). CO_2 from calcification on the platform is pushed into the atmosphere because of the high temperature and salinity of the shallow water there (red), thereby both conserving the conditions favouring calcification and maintaining greenhouse warmth. Uptake of atmospheric CO_2 is essentially limited to cooler regions of the open oceans (blue), thereby lowering pH and raising the CCD.

Figure 11.4 The K/T boundary in the Bottaccione Gorge section near Gubbio, Italy. The pale pink rock below the K/T boundary is the Scaglia Rossa Formation which was deposited during the Maastrichtian. At this locality, the top of this limestone is white in colour, immediately below the K/T boundary. The boundary itself is marked by a thin clay layer some 1–2 cm thick. (*Iain Gilmour, Open University*)

Figure 11.6 The clay layer that marks the K/T boundary in most pelagic marine successions in the world. (a) The boundary claystone at Stevns Klint, Denmark. (b) The boundary claystone at Agost, S.E. Spain. (a, *Peter Skelton*; b, *Iain Gilmour, Open University*)

Figure 11.15 The K/T boundary claystone at the Clear Creek North K/T site in the Raton Pass, Colorado. At K/T sites in North America, the boundary clay consists of two layers. In this image the lower layer, some 2.5 cm thick, is the pale-coloured layer running through the middle of the photograph. This is overlain by a thinner darker-coloured layer about 5 mm thick which in turn is overlain by a thin coal around 3 cm thick. The rest of the exposure is composed of Late Cretaceous and Early Tertiary mudstones and shales. (*Iain Gilmour, Open University*)

Figure 13.3 Exposure of a K/T boundary sequence at Arroyo El Mimbral in north-eastern Mexico, marked by a coarse clastic sequence. (*Iain Gilmour, Open University*)