Hastings, East Sussex

[TQ 831 095]–[TQ 853 105]

Highlights

The Early Cretaceous sandstones and shales that outcrop along the coast and foreshore east of Hastings have been famous for 150 years for specimens of dinosaurs, crocodilians, turtles, and footprints. More recent discoveries include rare mammal teeth, and other small bones, from the Cliff End Bone Bed.

Introduction

The Hastings Beds (Early Cretaceous: Berriaisian–Valanginian, (Figure 8.2)) of the cliff sections east of Hastings have been renowned for 150 years for finds of fossil reptile bones and footprints (Figure 8.4), and this century for microvertebrate remains in the Cliff End Bone Bed. Bones were first found at Hastings about 1830, and the brick pit and stone quarries around the town produced many specimens, but these quarries and pits are no longer accessible. The coast is subject to continuous erosion, and dinosaur footprints and a variety of reptile bones have been reported from the 1850s to the present day. Parts of the section are obscured by landslips, and there is limited access to the beach.

The stratigraphy of the Wealden of Hastings has been described by several authors (e.g. Beckles, 1856; Topley, 1875; White, 1928; Allen 1976; Lake and Shephard-Thorn, 1987). Accounts of reptiles and footprints have been given by Hulke (1885), Seeley (1887e), Lydekker (1892, 1893b), Ballerstedt (1914), Delair and Sarjeant (1985), Delair (1989) and Woodhams and Hines (1989), and the Cliff End Bone Bed has been described by Allen (1949) and Clemens and Lees (1971).

Description

The succession, in outline is (Lake and Shephard-Thorn, 1987):

	Thickness (m)
Hastings Beds	
Tunbridge Wells Sand	
Fine-grained, yellowish sandstones and silts with impersistent seams of mottled silty clay	up to 50
Wadhurst Clay	50–57
Grey mudstones interlaminated with thin siltstones. Also: calcareous sandstone beds (Tilgate stone), sandstone channel fills, soils and near the base:	
Cliff End Bone Bed	
Cliff End Sandstone	
Top Ashdown Pebble Bed	10
Ashdown Beds	180–200
The upper 30–50 m are chiefly sandstones, while the strata below are dominantly massive mottled spherosideritic clays with subordinate sandstone beds.	
Near the base: Lee Ness Sandstone	1–2

The geology of the Ecclesbourne–Fairlight section has been described by Allen (1962), Stewart (1981b) and Lake and Shephard-Thorn (1987). The sections immediately east of Hastings Old Town show the top Ashdown Beds and the cliff is topped by the Cliff End Sandstone, the lowest unit of the Wadhurst Clay. The lowest exposed unit, the Lee Ness Sandstone, is seen on the foreshore at low tide. These units appear throughout the section, repeated by faults and with

varying dips as a result of the WNW–ESE-trending Battle-Fairlight anticline. Individual horizons show lateral facies variation — the Cliff End Bone Bed does not occur throughout.

Most reptile remains do not have accurate local ity or horizon data. Bones and footprints seem to have been found at all levels in the section, and from several sites, which may be identified on the basis of the literature and museum labels.

1. Ecclesbourne Glen [TQ 837 099]. Tylor (1862) recorded fossil footprints 'upon detached blocks of sand-rock which had fallen in large masses from the upper part of the cliff a little west of Ecclesboume Glen'. Various crocodilian and dinosaur bones (e.g. BMNH R605–9, R1637) are labelled 'Ecclesbourne Glen'. Several specimens in Hastings Museum (GG94–101) are recorded from the Wadhurst Clay and Ashdown Beds of Ecclesbourne.

2. Lee Ness Ledge [TQ 867 108]. Beckles (1854, p. 457), Allen (1976, p. 393) and Lake and Shephard-Thom (1987) note 'casts of the footprints of *Iguanodon'* on the undersurface of blocks of the Lee Ness Sandstone. These may be the same specimens described *in situ* by Woodhams and Hines (1989), who report iguanodontid and theropod footprints at three levels 'near Lee Ness', two of these horizons being near the base of the Lee Ness Sandstone itself, and one 5–6 m lower.

3. Fairlight Cove–Cliff End [TQ 876 116]. White (1928, p. 30) noted 'a few footprints of *Iguanodon,* on a slab of light-grey sandstone… on the shore close to the base of the clif at Cliff End. Allen (1976, p. 393) notes large dinosaur footprints at the top of the Ashdown beds at Cliff End. Footprints have been seen along this section in fallen blocks (P. Allen, pers. comm. to M.J.B., 1982). Tylor (1862) also recorded footprints from the following sites: [TQ 835 097], [TQ 854 104], [TQ 860 107], and Lake and Shephard-Thorn (1987, p. 21) noted some at Goldbury Point [TQ 877 114]. Several turtles, crocodilians and dinosaurs are labelled 'Fairlight West' or 'Cliff End' (BMNH R1954, R4416, R4434, R4439, HASTM GG80–6, 88, 92, 105–7, 313). Source horizons are the 'Ashdown Sands' and the 'Fairlight Clays' (upper and lower portions of the Ashdown Beds respectively). In general, bones and footprints may be found anywhere along the section where there is fresh exposure.

Iguanodontid footprints figured by Ballerstedt (1914, figs 2, 4) 'aus dem Wealden von Hastings' may come from this area too: one of them is a photograph by C. Dawson, presumably the archaeologist associated with the Piltdown find, and with Tielhard de Chardin, who was involved with the first collections from the Cliff End Bone Bed.

Reptile remains are also known from the Cliff End Bone Bed (less than 5% of all bones: Patterson, 1966; two teeth, K.A. Kermack, pers. comm. 1982). The Cliff End Bone Bed fauna consists largely of sharks' teeth, and those of the actinopterygian fish *Lepidotes,* together with rare mammal teeth. The Bone Bed, exposed in the cliffs at [TQ 887 129] (Figure 8.4), 2.5 m above the Cliff End Sandstone (Lake and Shephard-Thorn, 1987, pp. 67–71), is a poorly sorted cross-bedded coarse sandstone or fine-grained conglomerate of quartz and chert pebbles and abraded fragments of sideritic mudstone, with abundant fragments of fishes and reptiles as well as mollusc debris.

Fauna

As already indicated, some specimens are labelled as coming from Ecclesboume, Fairlight or Cliff End. The majority, however, are labelled 'Hastings' and although many probably came from the cliffs east of the town, some must have been found in the old quarries and brickpits. In the following list, only those specimens definitely recorded from the cliffs are listed, and numbers of all 'Hastings' material are given.

	Numbers
Testudines: Cryptodira	
Tretosternon bakewelli (Mantell, 1827) HASTM GG92, 96	3
Plesiochelys brodiet Lydekker, 1889	3
Archosauria: Crocodylia: Neosuchia:	
Goniopholididae	
Goniopholis crassidens Owen, 1842 BMNH R605, R607	10

Goniopholis sp. BMNH R608; HASTM GG80–2, 84–6, 88, 105–7, 313	17
Archosauria: Crocodylia: Neosuchia: Pholidosauridae	
Suchosaurus sp. BMNH R4416, R4439	2
Archosauria: Crocodylia: Neosuchia: Bernissartlidae	
Bernissartia sp.	1
Archosauria: Crocodylia: Neosuchia: *inc. sed.*	
Heterosuchus valdensis Seeley, 1887 Type specimen: BMNH 36555	1
Archosauria: Pterosauria: Pterodactyloidea	
Ornithotheirus sp. HASTM GG100, 101	2
Archosauria: Dinosauria: Saurischia: Theropoda	
Megalosaurus dunkeri Dames, 1884 BMNH R1954	4
Megalosaurus sp. HASTM GG98	2
Archosauria: Saurischia: Sauropoda	
Cetiosaurus brevis Owen, 1842	4
Ornithopsis bulkei Seeley, 1870	5
Archosauria: Dinosauria: Ornithischia	
Iguanodon sp. BMNH R1637	20+
'?stegosaur' BMNH R4434	1
Polacanthus sp.	1
Sauropterygia: Plesiosauria	
Cimoliasaurus valdensis Lydekker, 1889 BMNH R609	3
'plesiosaur' HASTM GG94, 95	2

Interpretation

The Tunbridge Wells Sand has been interpreted as a fluvio-deltaic deposit, the Wadhurst Clay and Grinstead Clay as pro-deltaic or lagoonal in origin, and the Ashdown Beds as fluvial (Lake and Shephard-Thom, 1987). The environments of deposition in the Wealden of the Weald had formerly been interpreted as largely deltaic (e.g. Allen, 1959, 1962; Taylor, 1963), but Allen (1976, 1981) revised his former theory in favour of a model (Figure 8.8) in which the normal Wealden environment was a variable-salinity mudplain, periodically transformed into a sandy braidplain by powerful overloaded streams, the salinity changes being controlled by the rate of freshwater runoff. Allen (1981) argued that many of the rivers were braided in their proximal portions, whereas Stewart (1981a, 1981b, 1983) emphasized evidence for meandering streams. The climate was warm, with marked wet and dry seasons and 'herds of dinosaurs travelled freely across the basin and maintained themselves in it'.

The Cliff End Bone Bed was interpreted as a high-energy deposit by Allen (1949) and corre lated by him with the Telham Bone Bed, exposed near Battle, and with other occurrences of the Cliff End Bone Bed inland (Figure 8.3). Allen (1949) regarded this bone bed as a correlatable event horizon, restricted to the most eastern part of East Sussex, and neighbouring parts of Kent, and lying on top of the Tilgate Stone' horizon (Lake and Shephard-Thorn, 1987, p. 28).

The turtles *Tretosternon* and *Plesiochelys are* represented by fragmentary remains of the carapace, plastron and limbs. Such remains are relatively common in the Wealden of the Weald, but they are inadequate for a proper understanding of their anatomy and relationships.

The crocodilians are more abundant. *Goniopholis,* represented by numerous vertebrae, limb bones, teeth, jaws and scutes, was a moderate- to large-snouted aquatic crocodilian. The genus is known from the Late Jurassic and Early

Cretaceous of Europe and North America (Steel, 1973). *Suchosaurus,* an aquatic medium-sized pholidosaur, is represented by some teeth. *Bernissartia* (partial skeleton) was a small (1 m. long) animal with characteristic heterodont teeth, conical and pointed in the anterior part of the jaws, and rounded and blunt further back. The genus is known also from the Wealden of Bernissart, Belgium and the Isle of Wight and the Early Cretaceous of Galve, Spain (Buffetaut, 1975; Norell and Clark, 1990).

The type of the crocodilian *Heterosuchus valdensis* ((Figure 8.5)A probably came from the cliff section at Hastings. The specimen consists of a water-worn slab containing about 12 vertebrae of a small crocodilian (Seeley, 1887e). Further material from the Wealden of Sussex and the Isle of Wight was ascribed to this form by Lydekker (1888a), and Woodward and Sherborn (1890, p. 231) identified *as Heterosuchus* sp. specimens from the Isle of Wight and from the Middle Purbeck of Durlston Bay. The genus has been synonymized with *Hylaeochampsa* Owen, 1874, erected for Isle of Wight material (Steel, 1973, p. 53), but this cannot be demonstrated since the two taxa are based on non-overlapping material (Buffetaut, 1983; Clark and Norell, 1992). Indeed, Clark and Norell (1992) argue that the taxon is *a nomen dubium,* since it lacks diagnostic material. They regard it as a neosuchian, possibly a eusuchian, on the basis of its procoelous vertebrae and the well-developed condyles on the trunk vertebrae. If it is a eusuchian, as *Hylaeochampsa* is, then it is one of the oldest in the world.

A large carnivorous dinosaur, generally ascribed to *Megalosaurus* is represented by teeth and limb bones from Hastings. The generic assignment is unlikely, since *Megalosaurus* is typical of the Mid Jurassic. There is a problem over the definition of the two Wealden 'species', *M. dunkeri* and *M. oweni,* and Huene (1923) ascribed these to the new genus *Altispinax,* but the specimens are too incomplete for certain assignment. Molnar (1990) regards *M. dunkeri as* a 'problematic carnosaur' and *M. oweni* as a *nomen dubium.*

Some large bones, ribs and vertebrae from Hastings have been named *Cetiosaurus* and *Ornithopsis* (Lydekker, 1892, 1893b). While these assignments may or may not be correct, there seem to have been at least two large sauropods in the Wealden (Ostrom, 1970).

The commonest dinosaur remains from Hastings are teeth, jaws, vertebrae, ribs and limb bones of the large bipedal ornithopod *Iguanodon* (Hulke, 1885). The specific assignment is difficult and awaits revision (Norman, 1980, 1986). Several species of *Iguanodon* were named from the Hastings area, including *I. hollingtonensis* Lydekker (1889), based on a partial skeleton from Hollington Quarry, St Leonards, near Hastings [TQ 795 115], and *I. dawsoni* Lydekker (1888), both based on limb bones and vertebrae from Shornden Quarry, Hastings ([TQ 802 106], [TQ 803 104]) (Lydekker, 1888a, 1889e). The status of these taxa is currently unclear. Norman and Weishampel (1990, p. 530) synonymize *I. hollingtonensis* with *I. fittoni,* and accept *I. dawsoni* as valid, but do not elucidate the differences of these rather poorly known taxa from the typical *I. atherfieldensis* Hooley, 1924 and *I. bernissartensis* Boulenger, 1881, the sympatric small and large forms respectively found in most of the Wealden of Europe.

Armoured dinosaurs are represented by a '?stegosaur' tooth and a *?Polacanthus* spine. The English ankylosaurs *Hylaeosaurus* and *Polacanthus* are known from the Wealden of the Weald, the Isle of Wight, and the Upper Greensand of Charmouth, Dorset, but dermal elements such as the spine are hard to identify.

Pterosaurs are relatively uncommon, with only a few wing bones of '*Ornithocheirus'* known. Plesiosaurs, typically marine animals, are also uncommon; some vertebrae and limb bones of *Cimoliasaurus* suggest that they may have wandered into coastal fresh waters at times.

The iguanodontid and theropod footprints from Hastings (Tagart, 1846; Beckles, 1854; 1856; Tylor, 1862; White, 1928; Delair and Sarjeant, 1985; Lake and Shephard-Thorn, 1987, pp. 19–21; Woodhams and Hines, 1989) are large (0.3–0.6 m long), tridactyl (three-toed) imprints ((Figure 8.5)B,C. The 'toes' are broad, short and curved to a point and there is a broad heel impression. They are generally seen as casts on the underside of sandstone beds, or as wave-eroded hollows in silts on the present foreshore. Theropod prints have narrower toes than the iguanodontid prints, and they should have evidence of sharp claws if preservation is good enough. They are much rarer than the iguanodontid prints.

Comparison with other localities

In the Hastings area several quarries in the Wadhurst Clay and Ashdown beds have yielded similar fossil reptiles. These include St Leonards (0.02–0.1 m thick bed in Hall and Co.'s Quarry behind the church just off the West Marina; [TQ 797 088]; *Tretosternon, Goniopholis, Pleurocoelus, Iguanodon,* 'stegosaur', *Ornithocheirus, Cimoliasaurus,* Parish, 1833; Topley, 1875, p. 61; White, 1928, p. 47; Allen, 1949, p. 276); Hollington Quarry ('quarry at Rose Cottage', Topley, 1875, p. 61; [TQ 795 115]; *Tretosternon, Goniopholis, Megalosaurus, Iguanodon, Hylaeosaurus,* 'stegosaur', *Cimoliasaurus,* Lydekker, 1889f, p. 355; 1890b, pp. 40–3; White, 1928, pp. 66, 71); Little Ridge Farm Quarry ([TQ 809 127]; *Iguanodon*); Shornden Quarry ([TQ 802 106]; *Iguanodon*); Silver Hill/Tivoli Brickworks ([TQ 799 115]; *Iguanodon*); Bucks Hole Quarry ([TQ 806 110], [TQ 806 112]; *Iguanodon, Cimoliasaurus*); Ore (?[TQ 826 108]; *Goniopholis, Megalosaurus, Iguanodon, Cimoliasaurus*). Unfortunately, none of these sites is still extant.

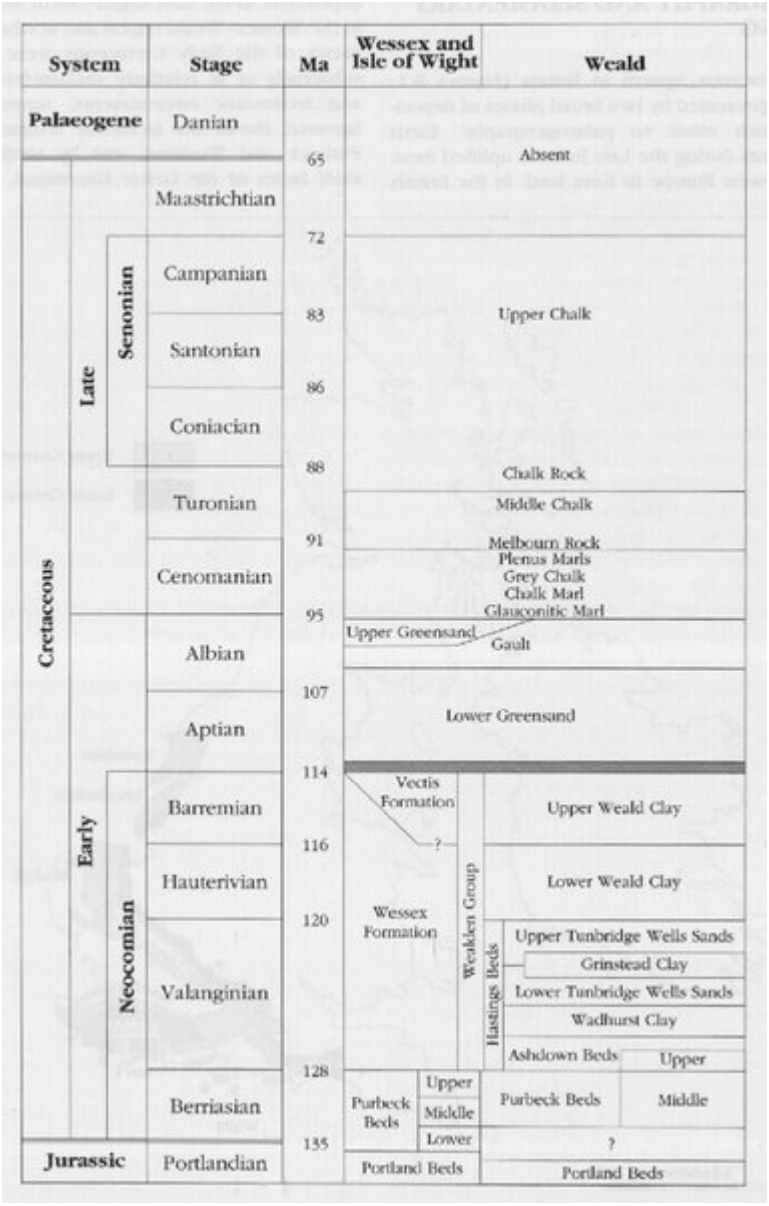
The Cliff End Bone Bed is currently exposed (Lake and Shephard-Thorn, 1987, pp. 37, 39) near the steps from the Undercliff to Watchbell Street, Rye ([TQ 9195 2018]), and formerly in a brickpit near Baldslow [TQ 810 133]. Bone beds which may be equivalent to the Cliff End Bone Bed are seen at Reyson's Farm, near Brede [TQ 832 192] and West Ascent, St Leonards [TQ 7982 0885].

Conclusions

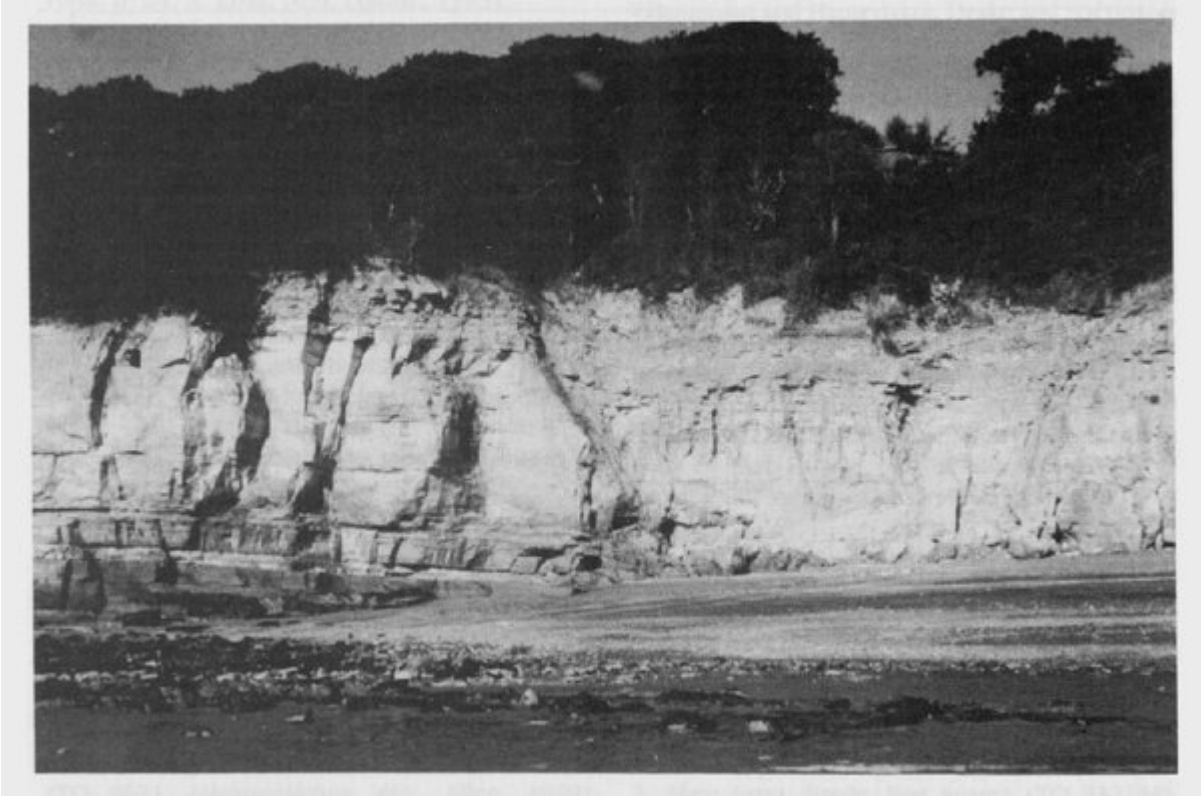
The most varied faunas of Early Cretaceous dinosaurs are known from the Wealden of Europe. One of the best of these faunas is that from the Hastings Beds in their type area, and the fossils include skeletons and footprints. Moreover, this is the only extensive, eroding coastal setting in these non-marine strata, which therefore has considerable potential for future finds. Previous finds include a selection of terrestrial and aquatic reptiles — two genera of turtles, four genera of crocodilians, one genus of theropod, two of sauropods, three of ornithischians, one genus of pterosaur and one plesiosaur. Also, further collecting from bone-rich horizons — such as the Cliff End Bone Bed — may yield new genera of smaller reptiles: lizards, snakes, turtles.

The conservation value lies in the combination of this potential for future discoveries and the importance of the fossil faunas recovered from the site over the past 150 years.

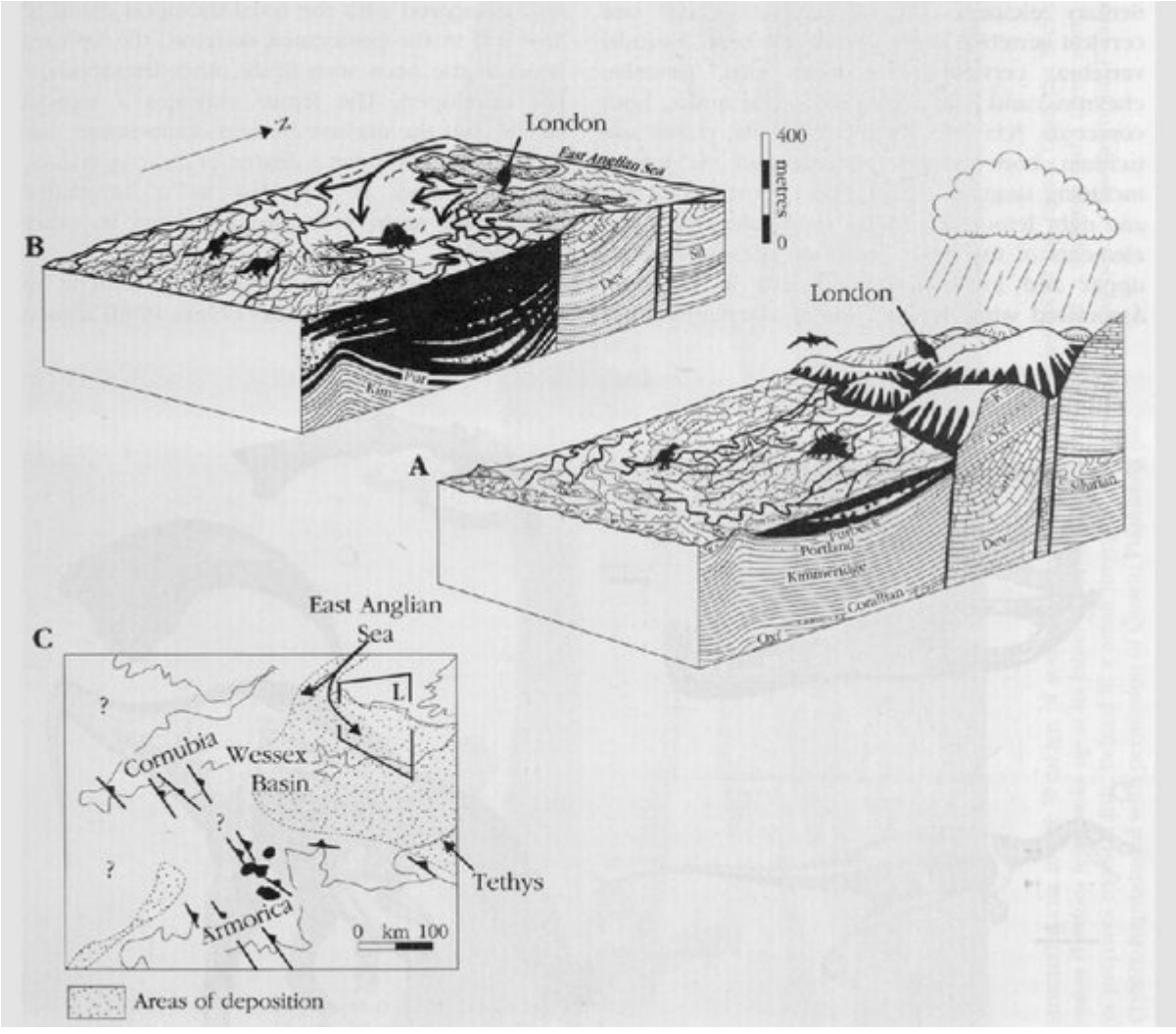
References



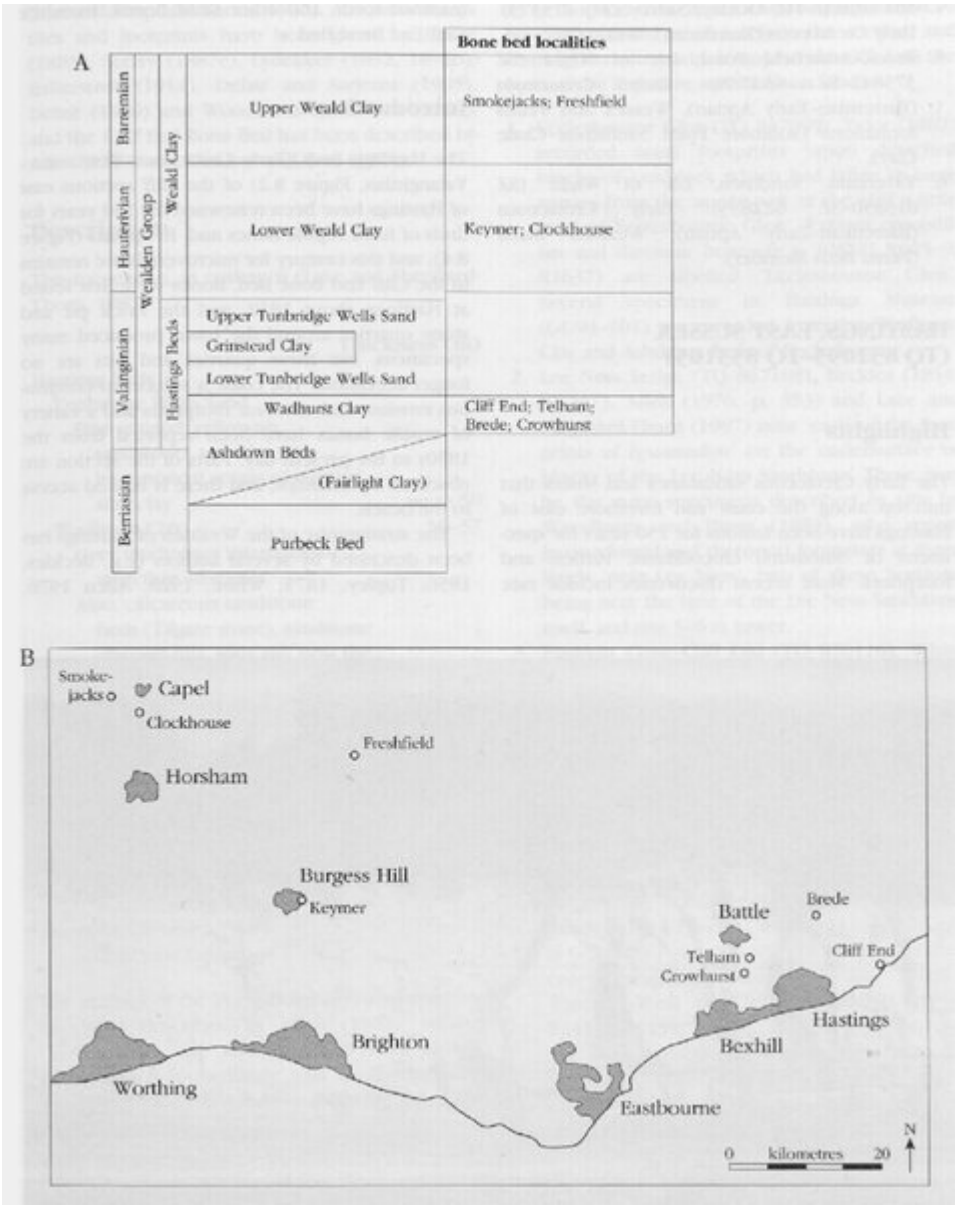
(Figure 8.2) Summary of Cretaceous stratigraphy, showing global stage nomenclature and some major southern British formations. Based on Harland et al. (1990).



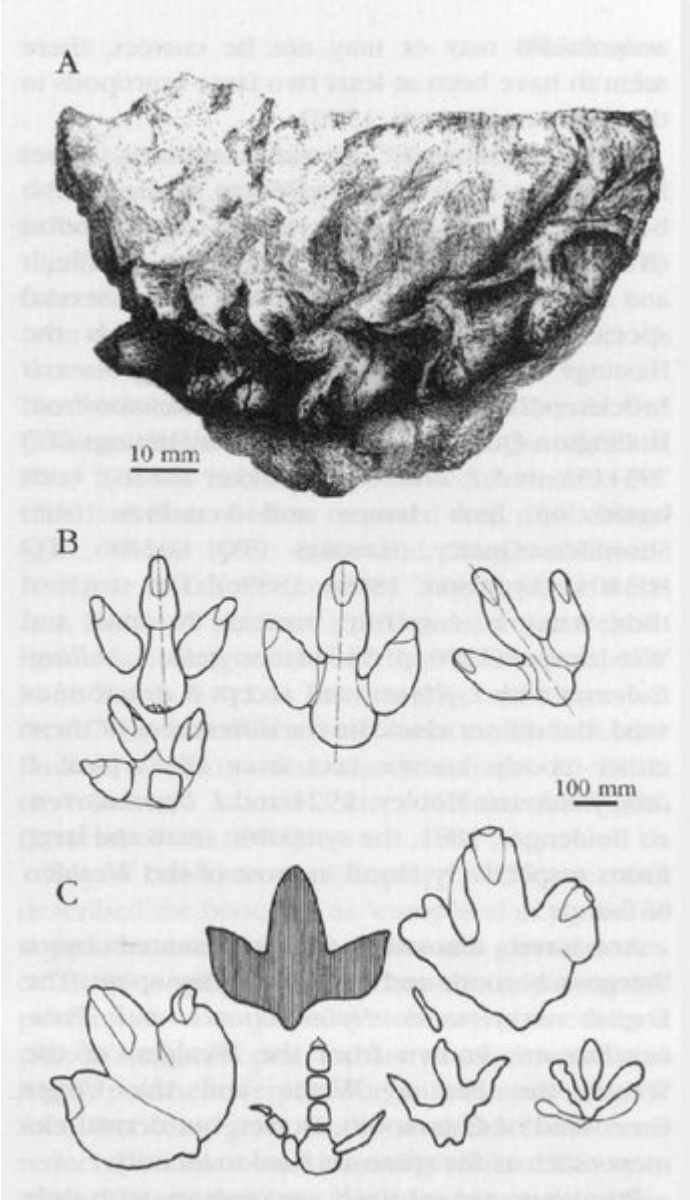
(Figure 8.4) The cliff at Cliff End, east of Hastings, with the Cliff End Bone Bed near the top of the section. Fossil footprints and reptile bones have been found at, and in the vicinity of this locality. (Photo: E. Cook.)



(Figure 8.8) Sedimentological process models for the formation of the Wealden of the Weald. (A) Arenaceous formations; (B) argillaceous formations; (C) regional setting. Uplift of the London horsts, to the north of the basin of deposition, produced an area of high relief and an extensive source of sediment (A). Braided alluvial sand plains expanded southwards from the uplands, and the lowlands supported diverse floras and faunas, including dinosaurs (A). Downfaulting and denudation of the London horsts reduced relief and the rate of sediment supply (B), and the Weald area became a brackish–freshwater lagoonal–alluvial mudplain. Again, abundant vegetation grew around the lakes, and a diverse fauna of fishes, insects and reptiles inhabited the area.



(Figure 8.3) The Wealden of the Weald. (A) Summary stratigraphic succession, showing the relative temporal position of the bone beds; (B) map of some key Wealden reptile sites. Courtesy of E. Cook.



(Figure 8.5) Fossil reptile remains from the Early Cretaceous Hastings Beds of Hastings. (A) Sequence of dorsal vertebrae of the crocodilian Heterosuchus valdensis Seeley, 1887; (B) iguanodontid footprints; (C) theropod footprints from the foreshore. (A) After Seeley (1887c); (B) and (C) after Woodhams and Hines (1989).