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## Vertebrate-bearing fissure deposits of South-West England and South Wales

Cave and fissure systems developed in the Carboniferous Limestones of the Mendips and Glamorgan (Figure 4.22) during the Late Triassic and earliest Jurassic contain abundant reptilian and other vertebrate remains. The Mendips and parts of South Wales appear to have comprised an archipelago of low limestone islands, and the fissures developed in these limestones preserve a detailed record of the diverse and often insular herpetofaunas of the time (Robinson, 1957a; Tarlo, 1962; Halstead and Nicoll, 1971; Kermack *et al.*, 1973; Fraser, 1986, 1988b, 1994; Savage, 1993). The nature of the palaeokarst and the geology of the caves is reviewed by Simms (1990). The fossil bones, although isolated and disarticulated, are often well preserved and lend themselves to detailed anatomical studies involving a large number of individuals, for example Whiteside (1986) on *Diphydontosaurus avonis* and Fraser (1988c) on *Clevosaurus*. The main Late Triassic (1–8) and Early Jurassic (9–13) fissures of south-west England and Wales (Figure 4.22), and their reptile faunas see (Figure 4.24), are listed below:

1. Slickstones (Cromhall) Quarry, Avon [ST 704 916]. Seven species of sphenodontid, including the types of *Clevosaurus budsoni* Swinton, 1935, *C. minor* Fraser (1988c), *Planocephalosaurus robinsonae* Fraser (1982), *Sigmala sigmala* Fraser (1986) and *Pelecymala robustus* Fraser (1986), as well as two unnamed sphenodontids, a procolophonid, the gliding diapsid *Kuebneosaurus*, an ?aetosaur, a ?scleromochlid, a terrestrial crocodylomorph, a ?sphenosuchid, a rhamphorhynchoid pterosaur, the dinosaur *Thecodontosaurus*, the enigmatic diapsid/procolophonid *Variodens* and various unidentified diapsids.
2. Tytherington Quarry, Avon [ST 660 890]. Type of the sphenodontid *Diphydontosaurus avonis* Whiteside (1986), as well as the sphenodontids *Clevosaurus*, *Planocephalosaurus*, a crocodylomorph, the dinosaur *Thecodontosaurus*, a 'coelurosauae dinosaur, and unidentified sphenodontids and archosaurs.
3. Durdham Down, Avon [ST 572 747]. Types of the prosauropod dinosaur *Thecodontosaurus antiquus* Morris (1843) and the (?) phytosaur *Rileya platyodon* (Riley and Stutchbury, 1840). Also *Diphydontosaurus*.
4. Batscombe Quarry, Somerset [ST 460 550]. Type of the gliding diapsid *Kuebneosuchus* (?= *Kuebneosaurus*) *latissimus* (Robinson, 1962).
5. Emborough Quarry, Somerset [ST 623 505]. Types of the gliding diapsid *Kuebneosaurus latus* Robinson (1962) and the enigmatic diapsid *Variodens inopinatus* Robinson (1957b), as well as an archosaur, a sphenodontid and the mammal *Kuebneotherium* sp.
6. Highcroft Quarry, near Gurney Slade, Somerset [ST 623 499]. A reptile jaw (Robinson, 1957a), ?*Clevosaurus* (Fraser, 1994).
7. Pant-y-fynon Quarry, South Glamorgan [ST 047 741]. Type of the terrestrial crocodylomorph *Terrestrisuchus gracilis* Crush (1984), as well as the gliding diapsid *Kuebneosaurus*, the sphenodontid *Clevosaurus*, a scleromochlid, the dinosaurs *Thecodontosaurus* cf. *antiquus* (Kermack, 1984) and *Syntarsus*, and lepidosaurs.
8. Ruthin Quarry, South Glamorgan [SS 975 796]. Type of *Tricuspisaurus thomasi* Robinson (1957), as well as pleurodont reptiles, the sphenodontids *Clevosaurus* and *Planocephalosaurus* and archosaurs (Fraser, 1986, 1994).
9. Windsor Hill Quarry, near Shepton Mallet, Somerset [ST 615 452]. Types of the tritylodont mammal-like reptiles *Oligokyphus major* Kühne (1956) and *O. minor* Kühne (1956).
10. Holwell Southern Quarry, near Frome, Somerset [ST 727 452]. Types of the early mammals *Haramiya moorei* (Owen, 1871), *H. fissurae* (Simpson, 1928), *Thomasia anglica* Simpson (1928), *Eozostrodon parvus* Parrington (1941) and *E. problematicus* Parrington (1941), as well as teeth of crocodylians, and other reptiles (Robinson, 1957a), a tritylodont (Savage and Waldman, 1966) and *Clevosaurus* (Fraser, pers. comm., 1993).
11. Duchy Quarry, South Glamorgan [SS 906 757]. Type of *Morganucodon watsoni* Kühne (1949), as well as other triconodont teeth and a symmetrodont mammal.
12. Pont Alun Quarry, South Glamorgan [SS 899 765]. Types of the sphenodontian *Gephyrosaurus bridensis* (Evans, 1980, 1981) and *Kuebneosaurus praecursori* Kermack *et al.* (1968), as well as *Morganucodon/Eozostrodon*.
13. Pant Quarry, South Glamorgan [SS 896 760]. The sphenodontian *Gephyrosaurus*, three sphenodontids, one or more archosaurs, the tritylodont *Oligokyphus* and the mammals *Thomasia*, *Kuebneotherium* and *Morganucodon watsoni*.

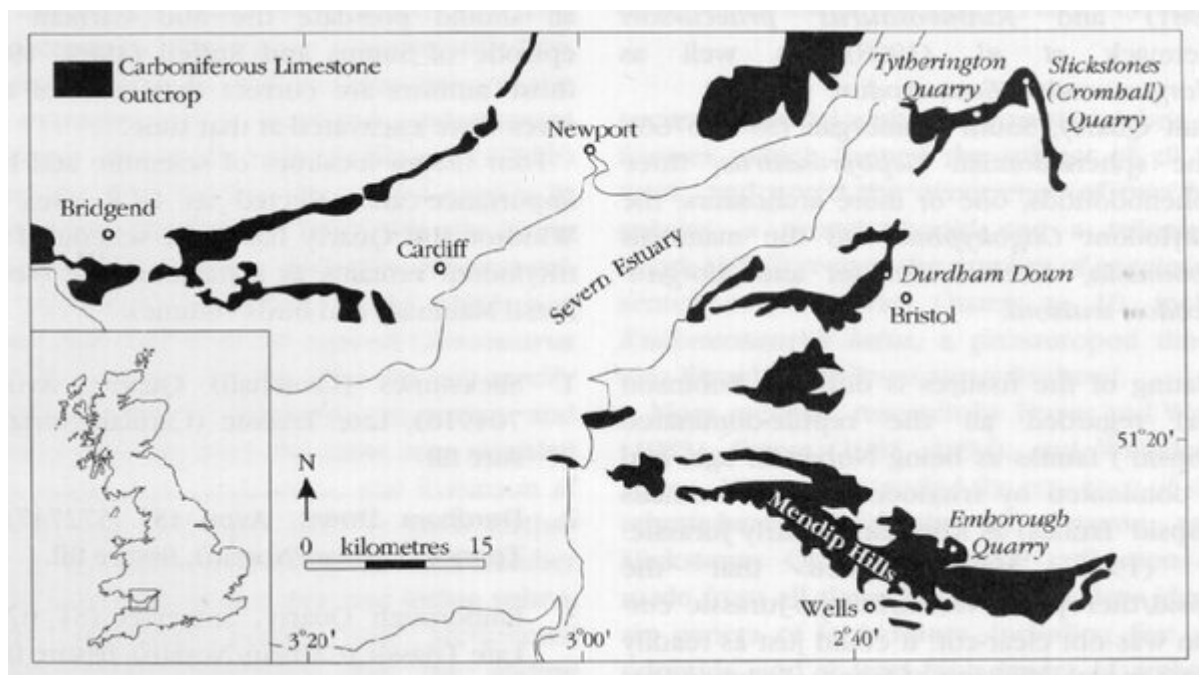
The dating of the fissures is difficult. Robinson (1957a) regarded all the reptile-dominated ('sauropsid') faunas as being Norian in age, and those dominated by tritylodonts and mammals ('therapsid' faunas) as Rhaetian or Early Jurassic. Fraser (1986, 1994) argued that the sauropsid/therapsid, Norian/Rhaeto-Jurassic correlation was not clear-cut: it could just as readily be a taphonomic division of faunas. Independent palynological evidence has established a Rhaetian age for some Tytherington fissures (Marshall and Whiteside, 1980) and a Hettangian–Sinemurian age for Duchy, Pant and Pont Alun Quarries, based on the occurrence of *Hirmerella* (*Cheirolepis*) spores in the last three sites. The division into sauropsid/therapsid assemblages was further challenged by the discovery of a mammal tooth, *Kuehneotherium* sp., at Emborough Quarry in a fissure otherwise clearly placed in the 'sauropsid' Triassic group (Fraser *et al.*, 1985).

In the absence of further palynological evidence, some indication of the ages of individual fissure faunas may be obtained by comparisons of reptiles and mammals with more securely dated localities elsewhere. For example, the crocodylomorph *Terrestriusuchus* is most like *Saltoposuchus* (and may be congeneric) from the middle Norian Mittlerer Stubensandstein of south-west Germany. *Thecodontosaurus* is a basal prosauropod, like forms of Late Carnian to Norian age in North America, central Europe and southern Africa. Procolophonids, aetosaurs and scleromochlids all died out before the end of the Triassic elsewhere, and aetosaurs are exclusively Late Carnian to Rhaetian in age. *Scleromochlus* is known otherwise only from the Late Carnian of Scotland. *Kuehneosaurus* is most like *Icarosaurus* from the Late Carnian of North America. All the evidence, therefore, confirms a Late Triassic age for the fissures nos. 1–8 in the above list, and probably a range of ages from Late Carnian to Rhaetian. There is no reason why all should be regarded as contemporaneous, but all should postdate the Mid Carnian pluvial episode of Simms and Ruffell (1989, 1990), if those authors are correct that most of the fissures were excavated at that time.

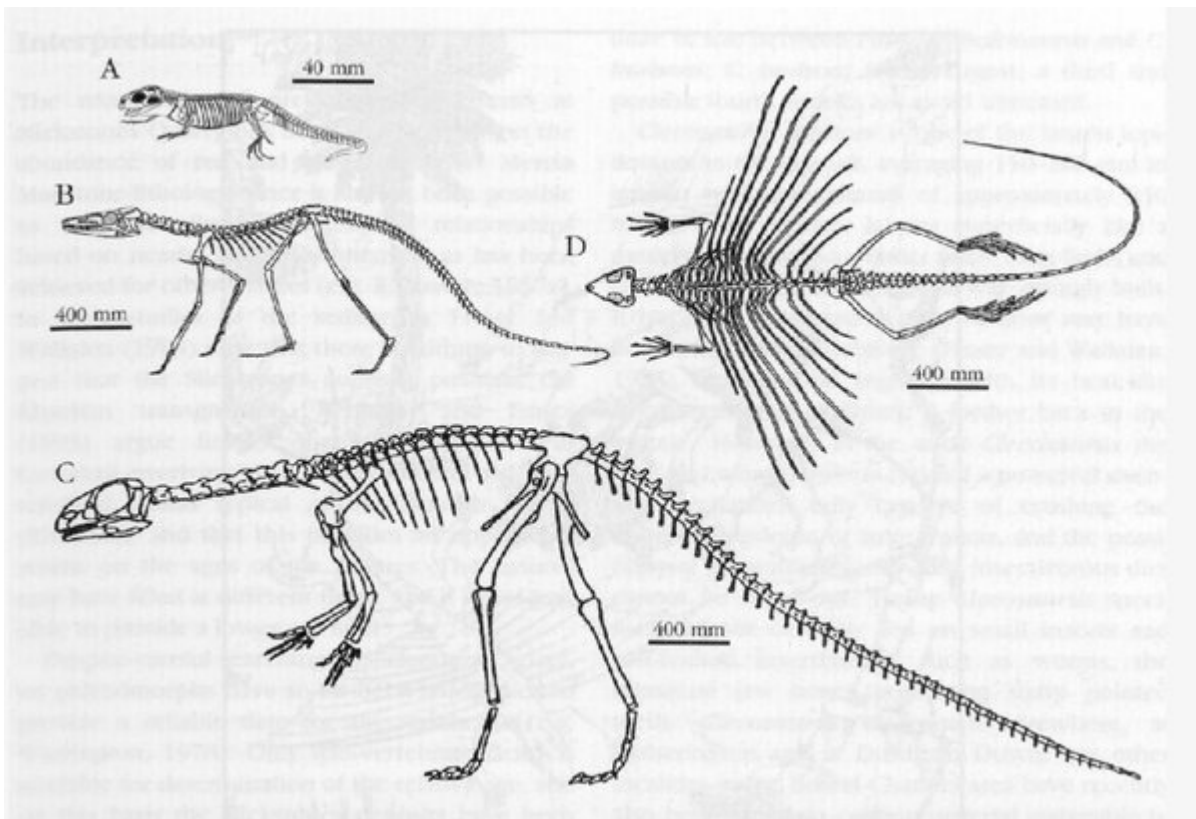
Four fissure localities of scientific and historic importance are selected as GCR sites, while Windsor Hill Quarry has been scheduled for its tritylodont remains as a mammal site (see GCR Fossil Mammals and Birds volume):

1. Slickstones (Cromhall) Quarry, Avon [ST 704 916]. Late Triassic (Carnian/Norian), fissure fill.
2. Durdham Down, Avon [ST 572 747]. Late Triassic (Carnian/Norian), fissure fill.
3. Emborough Quarry, Somerset [ST 623 505]. Late Triassic (Carnian/Norian), fissure fill.
4. Tytherington Quarry, Avon [ST 660 890]. Late Triassic (Carnian/Norian), fissure fill.

## References



(Figure 4.22) Map showing the distribution of Carboniferous Limestone and of tetrapod-bearing GCR fissure sites in south-west England. After Fraser (1985).



(Figure 4.24) Typical reptiles from the Late Triassic fissures in South Wales and around Bristol. Skeletal reconstructions of (A) the sphenodontid *Clevosaurus*; (B) the crocodylomorph *Saltoposuchus*; (C) the prosauropod dinosaur *Thecodontosaurus*; and, (D) the gliding diapsid *Kuehneosaurus*. After various sources; in Fraser (1994).