Cloford Quarry, Somerset

[ST 718 444]

Introduction

Cloford Quarry, a large disused aggregate quarry, is a nationally important site exposing the finest assemblage of Mesozoic fissure-fills seen anywhere in Britain, ranging from Triassic to early Jurassic in age. These are overlain by Middle Jurassic limestones that cap the unconformity on the Carboniferous Limestone. Some of the fissures here have been crucial to understanding the mechanism of fissure development and in reconstructing the history of this area in early Jurassic times. The fissure fills have been the subject of several research projects notably by Charles Copp and subsequently by Gavin Wall, but little has been published. Copp (in Duff *et al.,* 1985) tabulated the main facies and ammonite zones present at Cloford Quarry and other Mendip fissure sites, but otherwise the only publications that specifically referred to this site were by Copestake (1982) who described the significance of foraminifera and ostracods from one of the fissures, by Fraser (1994) who noted some of the vertebrate material, and by Simms (1997, fig. 7) who figured the clearest example of a pull-apart fissure from here.

Description

Cloford Quarry is excavated into Lower Carboniferous limestones of the Vallis Limestone Formation, part of the Clifton Down Group, on the south-east flank of Beacon Hill, about 1 km west of the village of Holwell (Figure 3.20). Bedding is on a metre-scale and dips at about 18° to the south-west, broken only by slight flexuring in the north-west corner. The Carboniferous limestones are truncated by a planar unconformity, above which lies a thin, near-horizontal, development of bioclastic limestones of the (Upper Bajocian) Upper Inferior Oolite Group (Copestake, 1982). The Carboniferous Limestone is cut by numerous sub-vertical, sediment-filled fissures (Figure 3.21), which are truncated at the unconformity surface. Copp (unpublished) identified 21 fissures at Cloford Quarry, numbered CI to CXXI, but recognized that some probably linked up across the quarry. On a visit to the site in May 2000 at least 26 'fissures' of various types were noted (Figure 3.22), although several clearly represented different parts of the same fissure. At least some of these can be matched with those identified by Copp.

Most of the fissures have an ENE–WSW orientation, roughly parallel to the axis of the Beacon Hill pericline, although a few have discordant trends. By far the largest is Fissure 1, and its continuation farther west as Fissure 25 (= CI and CXXI of Copp, unpublished), which has been left as an unquarried ridge of Carboniferous Limestone and fissure-fill sediments extending across the quarry floor. This fissure is up to 6 m wide and 15 m high, though extending to an unknown depth below the quarry floor, and can be traced along-strike for several hundred metres. Copp (unpublished) recorded a complex assemblage of distinctive facies occurring in a definite sequence, from the margins towards the centre, within this fissure and also within Fissure 5 (= CIV of Copp, unpublished). Against the walls of the fissure is commonly found a red, haematite-stained limestone and limestone breccia. Observations of Fissure 5, made in May 2000, revealed that here at least this marginal layer is a thin flowstone, analogous to re-deposited calcite flowstones found in many limestone caves and fissures. This is succeeded by three distinct units; a 'Complex Breccia', a clastic limestone, and a pink crinoidal limestone. The fissure fill is commonly divided medially by a vuggy calcite vein, with this same facies sequence mirrored on the opposite side. The 'Complex Breccia' comprises an assemblage of intermixed breccias, conglomerates and marine limestones. The marine limestones include pale-yellow calcilutite, pale-grey calcarenite and pink biosparite, while the breccias and conglomerates contain lasts of Carboniferous Limestone, chert and weathered andesites and tuffs. One conglomerate type has rounded lasts of calcilutite in a clastic limestone matrix and this, and the other rudaceous facies, are sometimes rich in late Triassic (Rhaetian or Penarth Group) fish teeth. Laminations are predominantly sub-parallel to the fissure walls but some blocks are horizontally bedded and may show soft-sediment deformation.

Succeeding the 'Complex Breccia', towards the centre of the fissure, are pale bioclastic limestones and pink crinoidal biosparites. The pale limestone is often richly fossiliferous, particularly with bivalves, mostly infaunal taxa, and brachiopods but also yielding belemnites, gastropods and solitary corals. The base (outer edge) of this limestone grades down into calcarenite locally rich in hybodont shark teeth. The pink crinoidal biosparite is coarse grained and contains occasional angular clasts of Carboniferous Limestone and chert. It contains a fossil fauna similar to, though better-preserved than, that of the pale limestone beneath including the brachiopods *Cirpa fronto, Zeilleria subdigona, Z. sarthacensis* and *Tetrarhynchia subconcinna,* the bivalves *Chlamys, Oxytoma, Placunopsis* and *Gryphaea,* and rare ?echioceratid ammonite fragments.

Although these two limestone types occur towards the centre of the largest fissures, they may also comprise the main infill of some of the smaller fissures. Additional facies associated with these two limestone facies are a blue-grey argillaceous limestone, with belemnites and brachiopods, and a brown siltstone in the centre of Copp's Fissure CIXTV (Fissure ?22). The latter facies yielded a rich microfauna dominated by the foraminifera *Planularla protracta* and representatives of the *Lingulina tenera* group, along with several other species and some indeterminate cytheacean ostracods (Copestake, 1982). Pale cream-coloured, ironshot limestone in Copp's Fissure CXX yielded well-preserved Toarcian ammonites, including *Hildoceras, Hildaites, Nodicoeloceras* and *Lytoceras* (Figure 3.23).

Of the remaining fissures it is Fissure 24 (figured by Copestake, 1982, fig. 3; Simms, 1997, *fig.* 7) that is perhaps of greatest interest. Copestake (1982) noted that this had sub-parallel sides and a flat base coincident with a bedding plane in the Carboniferous Limestone, but observations in 1991 showed that this apparent base represented a plane of offset, of about 0.5 m to the south, with the fissure continuing down below the quarry floor. Furthermore, the main fissure-fill is cut by a second parallel fissure, filled with slightly darker and coarser sediment, which passes across the bedding plane without any offset (Figure 3.21).

In general the narrower fissures have fissure-parallel sediments, such as in fissures 6, 12 and 13 but the larger ones often have slumped, sub-horizontal sediments, such as in fissures 5 and 23. Although the fissure walls tend to be sub-parallel, they often converge upwards or downwards; for instance Fissure 11 narrows upwards, the adjacent Fissure 12 narrows downwards, while Fissure 4 pinches out altogether about halfway up the quarry face and Fissure 19 bifurcates and then rejoins in the upper part of the quarry face.

Copp (unpublished) recorded the presence of at least one fissure (his Fissure CIX), since destroyed, that appeared to have uneven, 'water eroded' walls but no similar examples were visible in May 2000 or on an earlier visit in 1991.

Interpretation

The history of the fissures at Cloford Quarry is complex and enigmatic, although observations made here have proven crucial to understanding their origin. The straight and often sub-parallel sides of many of the fissures has established that most of the fissures at this site, and indeed throughout the Mendip region, are 'pull-apart' structures resulting from extensional tectonic activity. Their orientation sub-parallel to the major Leighton Fault suggests that their development was associated with antra Jurassic movement on this structure, as was proposed for similar fault-parallel fissures at the Leighton Road Cutting GCR site Oenkyns and Senior, 1991). Fissure 24 is particularly illuminating in this respect since the offset of the earlier fissure-fill but not the later one (Figure 3.21) indicates at least two extensional events, with the later one initially being accommodated by bedding-plane sliding prior to further widening of the original fissure.

The presence of red flowstone against the walls of Fissure 4 demonstrates that its initial phase of development must have occurred in a subaerial environment, probably in late Triassic times (Simms, 1990b), but the major early Jurassic transgression clearly led to the relatively rapid submergence of the area, with the result that all subsequent sediments are demonstrably marine in origin. Copp (in Duff *et al.,* 1985) proposed a model whereby much of the Jurassic sediment was sucked into the fissures as they opened abruptly beneath a cover of sediment on the sea floor. He termed these 'injection fissures' and cited various lines of evidence to support this interpretation, among them the lack of solutional modification of the fissure walls, the common occurrence of fissure-parallel laminations, and the frequent reworking of older sediments. However, all can be accounted for by more conventional processes. The lack of solutional modification may reflect limited hydrological input during the subaerial phase and exclusion of light, upon which marine bio-erosion is dependent, following submergence (direct dissolution of limestone by seawater does not occur; see Simms, 1990c). The accretion of sediment parallel to the walls is a well-documented phenomenon in caves and fissures (Bull, 1981), while collapse and reworking of earlier sediments might be expected if the fissure experiences more than one episode of extension. It is clear that the largest fissures experienced several successive episodes of widening, now represented by the distinct 'zones' of fissure-parallel sediments and an often central calcite vein. It is unlikely that many of these fissures were open on the sea floor during the early Jurassic Period for more than very short periods of time. Certainly, upward-narrowing fissures, such as Fissure 4, cannot have done so while even those that extended to the sea floor may well have had the actual opening blocked by collapse debris and accumulated sediment, such that sediments and fossils worked their way only slowly down into the lower parts of the fissures (Simms, 1997). The presence of angular blocks of Carboniferous Limestone within the finer Jurassic sediments is clear evidence of instability and collapse of the fissure walls, while the presence of large rounded clasts and larger fossils, indistinguishable from those in normal bedded sequences such as those of the Radstock Shelf indicates periods when the fissures were more open to the sea floor. It is unlikely that most of the fossils were actually living in the fissures, while the rounded calcilutite clasts, of presumed reworked Jurassic sediment, cannot have reached this state within the confines of the fissure and indicate erosion on the sea floor before being incorporated into the fissure. The presence of 'fissure facies' limestones in a 'normal' bedded sequence at the Leighton Road Cutting GCR site is particularly significant in this respect, but the lithology of other clasts in the conglomerates indicate that the Mendip Massif was already deeply eroded, with the presence of andesitic clasts indicating that even the Silurian volcanic rocks were unroofed by earliest Jurassic times.

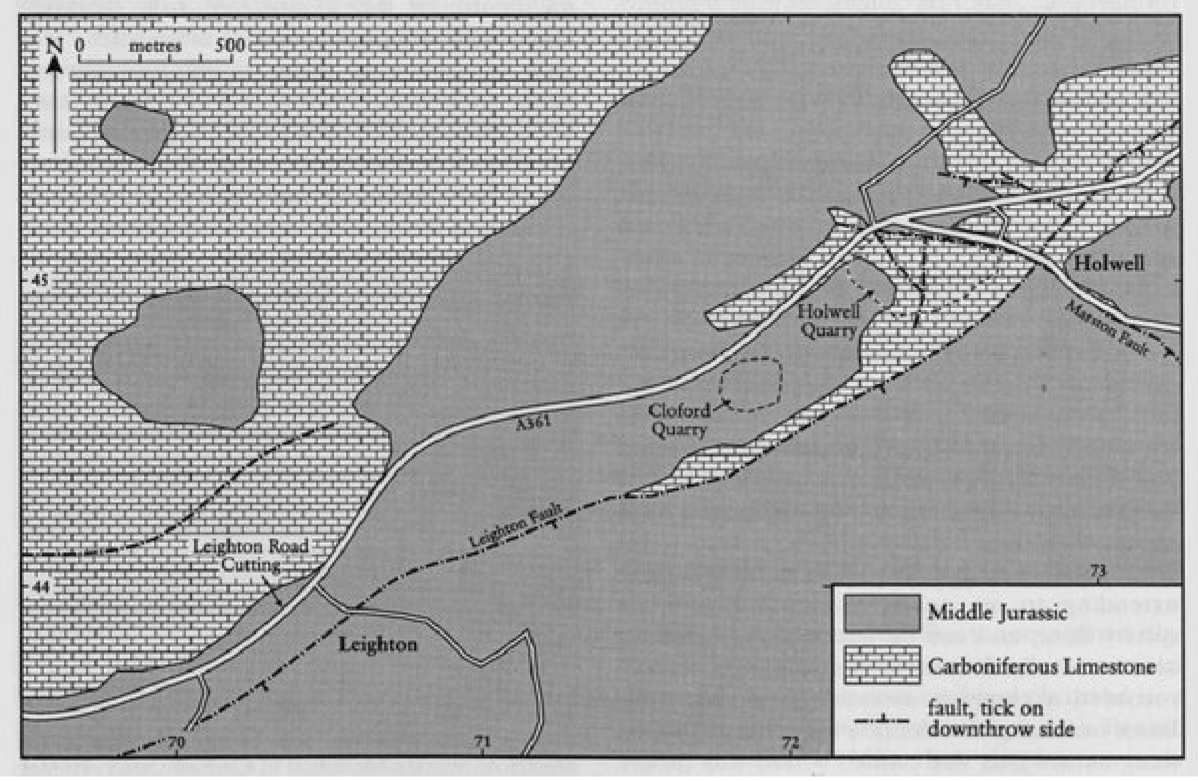
The inferred age range of the various facies represented in the Cloford Quarry fissures is considerable and their relationship to each other apparently complex. The results were summarized in a table by Copp (in Duff *et al.,* 1985). Conventionally the reddened sediments close to the fissure walls have been interpreted as Triassic in age although there is no conclusive proof of this. Copp (in Duff *et al.,* 1985) considered much of the 'Complex Breccia' to be latest Triassic (Penarth Group) or earliest Hettangian in age. The pale bioclastic limestones and calcilutitic conglomerates were assigned a Raricostatum Zone age and the succeeding pink crinoidal limestones were considered to be of Jameson Zone age, although at least one of the brachiopods, *Tetrarhynchia subconcinna,* is known only from the Spinatum Zone (Ager, 1956–1967). Copp (in Duff *et al.,* 1985) also noted the presence at Cloford Quarry of sediments of the (Upper Pliensbachian) ?Margaritatus Zone, the (Toarcian) Serpentinum and Bifrons zones and the (Upper Bajocian) Garantiana Zone.

Only the microfossil work by Copestake (1982) has been published in any detail. He noted that most of the foraminifera recovered from the brown siltstone in Fissure CXIV were of long-ranging taxa known to extend from at least the Rhaetian or Hettangian strata to high in the Lower Jurassic succession. However, most of these taxa are characteristic of the Lower Sinemurian Substage and, by comparison with other well-documented sites such as Hock Cliff, he suggested that the fauna indicated a Bucklandi Zone or Semicostatum Zone age.

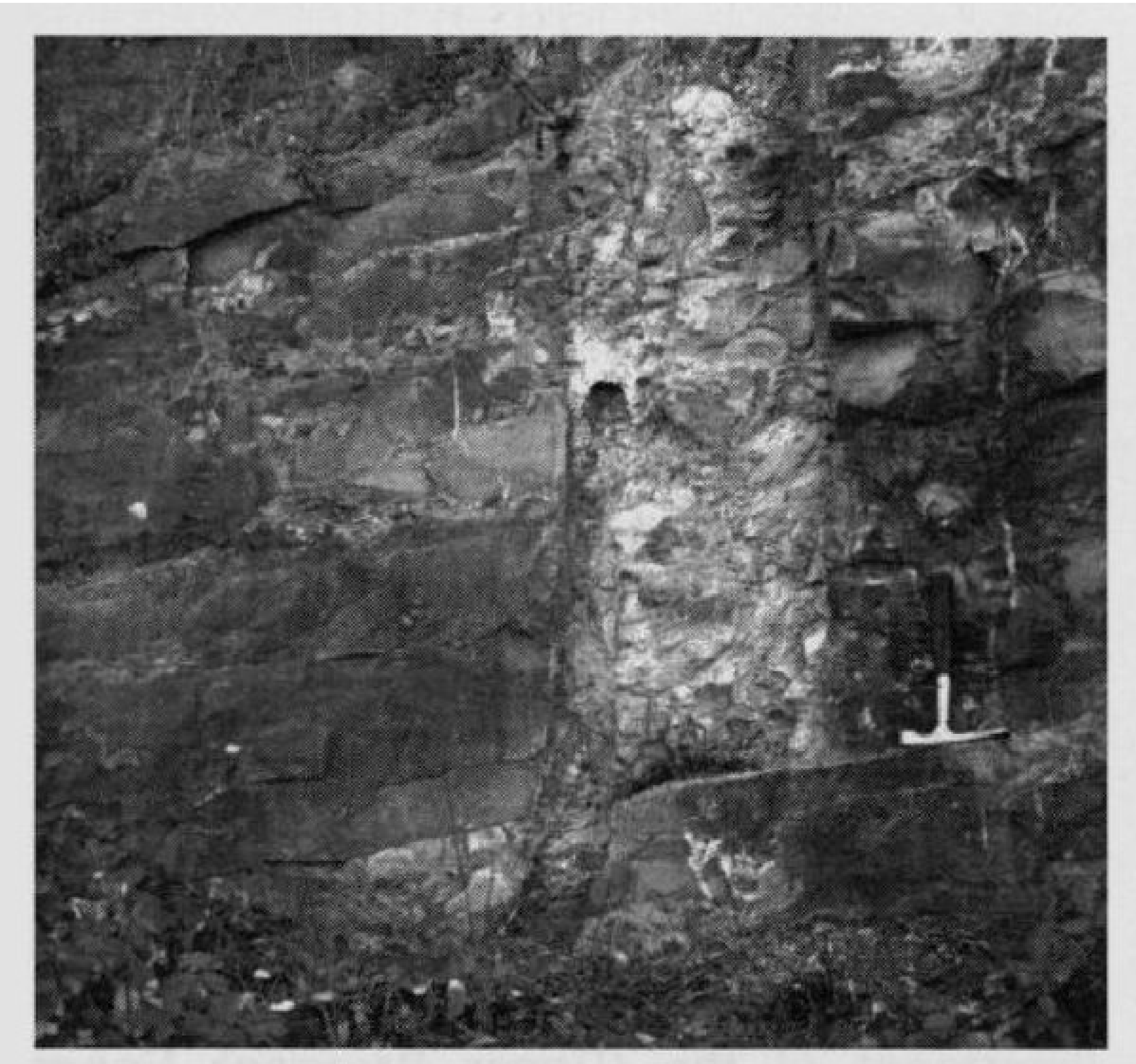
Conclusions

The Carboniferous Limestone at Cloford Quarry is cut by an unusually clear and diverse assemblage of the sediment-filled, tectonic pull-apart fissures which are such a long-noted feature of the Mesozoic succession in the Mendip Hills. Certain of the fissures here provide important evidence for the mechanism by which these fissures form, whereas others record a clear sequence of distinctive facies demonstrating a long and complex history of extension in this region. The earliest phase of fissure opening appears to have been in a subaerial (?Triassic) environment although subsequently this was inundated by the early Jurassic transgression and all subsequent sediments are exclusively marine. The presence in the fissure fills of locally derived Silurian, Devonian and Carboniferous clasts testifies to the extent of erosion of the Mendip Massif already by Early Jurassic times.

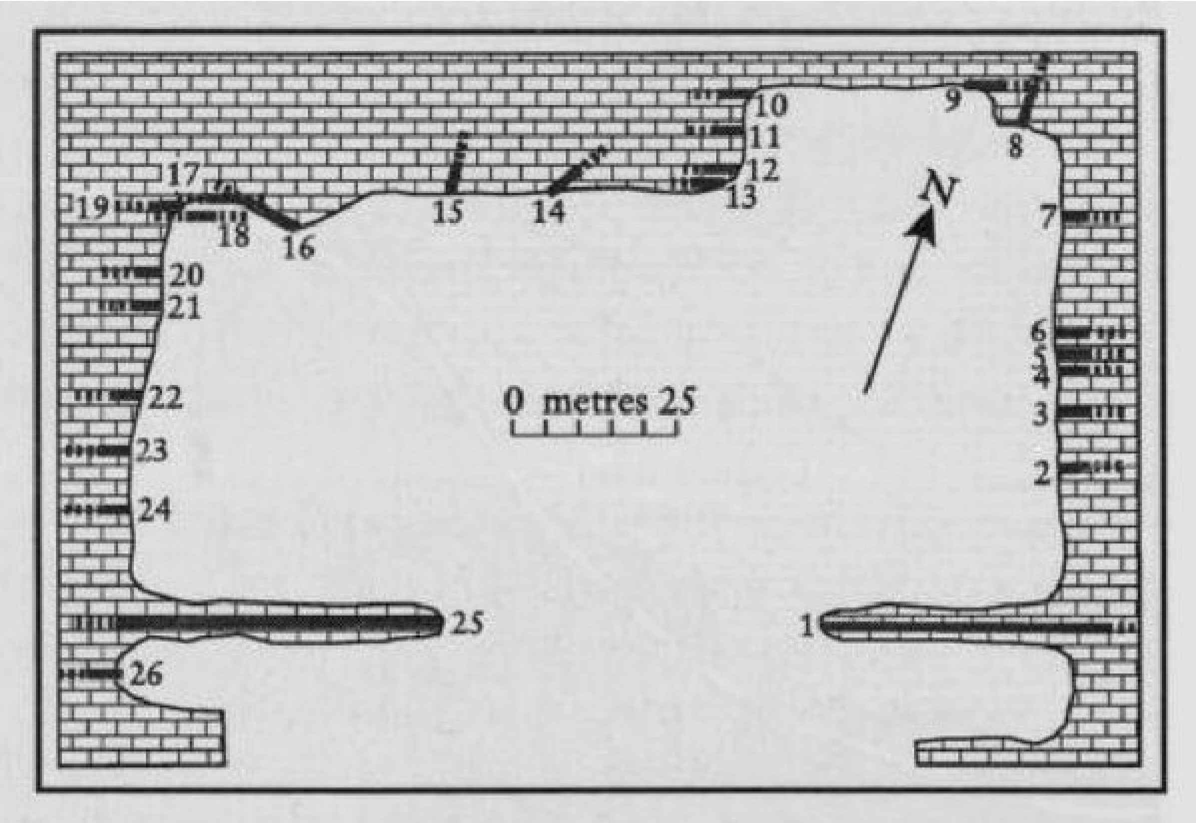
References



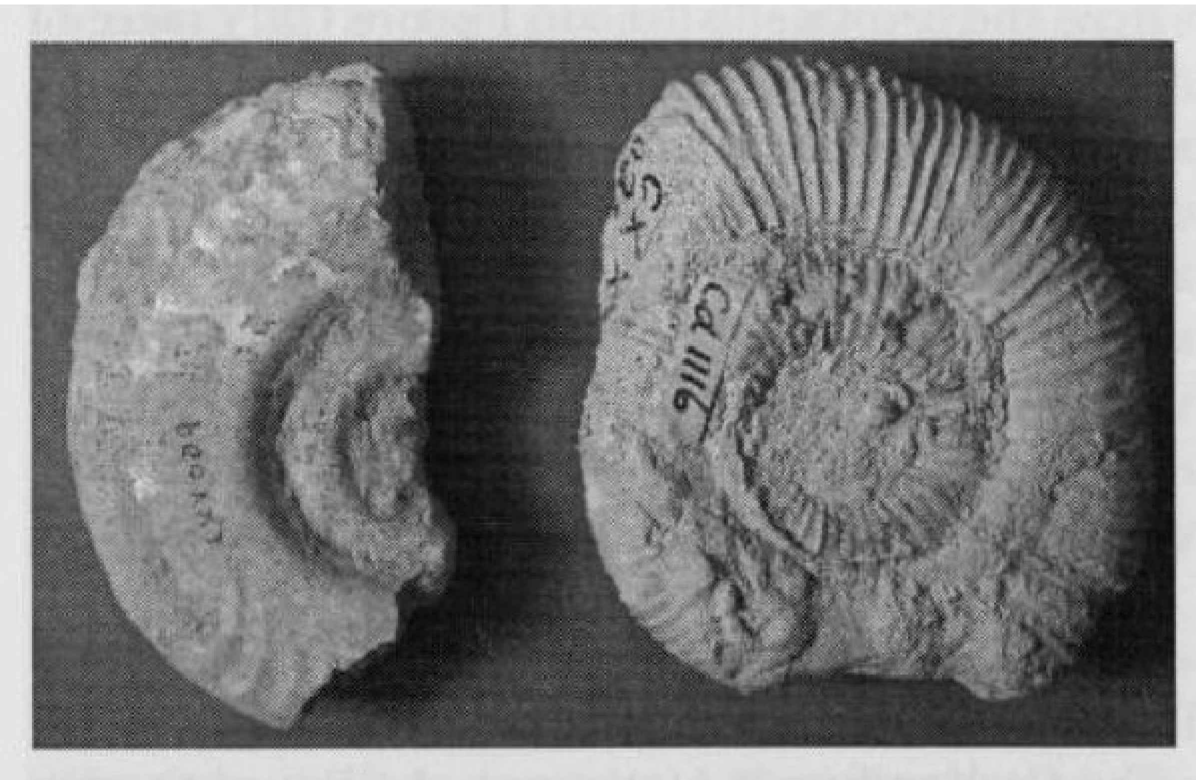
(Figure 3.20) Sketch map of the geology in the Cloford and Holwell area of the eastern Mendip Hills.



(Figure 3.21) Pull-apart, sediment-filled fissure (Fissure 24 of (Figure 3.22)) at Cloford Quarry. At least three distinct events are discernable in this example; (1) extension to form a 0.5 m-wide joint-guided pull-apart fissure subsequently filled with pale fine-grained sediment; (2) lateral offset of parts of this fissure by movement on a bedding plane (on which the hammer rests); (3) further extension to form a 0.1 m-wide fissure whose sediment fill (slightly darker and coarser than the earlier fill) is continuous across the bedding plane on which the earlier offset occurred. The bedding plane offset and opening of the second fissure probably represent different phases of the same extensional event. (Photo: M.J. Simms.)



(Figure 3.22) Sketch map of the distribution of Mesozoic fissures identified in Cloford Quarry in May 2000 (widths of fissures not to scale).



(Figure 3.23) Hildoceras (left) and Nodicoeloceras (right) from Fissure CXX at Cloford Quarry, indicating a Lower Toarcian Bifrons Zone age for the infill. Specimens from the Charles Copp Collection at Bristol City Museum. Nodicoeloceras is 50 mm across. (Photo: M.J. Simms.)