# Castle Lime Works Quarry

[TL 228 026]

## Highlights

The preserved walls of this quarry provide the finest exposures in Britain through clay-filled pipes and fissures within the Chalk. The infills to these solution features are Tertiary sediments much older than the clay-with-flints commonly found on the Chalk outcrops.

## Introduction

The old chalk pit of the Castle Lime Works lies in the western slope of the Mimmshall Valley (Figure 7.1) and (Figure 7.11). It is partially backfilled, but a part of the final working faces has been retained to provide a clean section through the sediment cover and into the bedrock chalk. The rockhead is pitted with solution pipes and cavities, which are infilled with clays and sands of Tertiary age. These pipes are seen to penetrate several metres down into the chalk, and some continue beneath the floor of the exposed section; though they vary greatly in profile, they are collectively known as pipes. The Tertiary rocks crop out on higher ground immediately west of the quarry, and consist of thin Thanet Sands overlain by the sands and clays of the Palaeogene Reading Beds.

The geology and hydrogeology of the Mimms Valley was discussed by Wooldridge and Kirkaldy (1937), but a more thorough examination of the site was carried out by Kirkaldy (1950). The petrography and origin of the deposits infilling the pipes were studied and discussed by Thorez *et al.* (1971).

## Description

The solution pipes and cavities occur on the eastern face of the quarry, which stands nearly 5 m high and is a preserved, permanent exposure (Figure 7.12); other faces of the quarry have been backfilled or are still active. The poorly bedded, horizontal Upper Chalk is exposed; it is irregularly fractured and has ill-defined bands of nodular flint. It is overlain by less than a metre of Quaternary reddish clay containing flints, and this supports a thin layer of topsoil.

A complex rockhead relief and infilled solution features have long been recognized during the progressive advance of the quarry faces. Though many individual features have since been lost to the quarrying, three main types of filled pipes can be recognized, all lying beneath 1–2 m overburden of stony clay soil (Thorez *et al.,* 1971):

1. Shallow basins up to 3 m deep and 30 m wide. These contain disturbed units of the flint-rich glauconitic Bullhead Bed, the basal member of the Palaeogene deposits, overlain by grey and brown pebbly sands with clay partings.
2. Steeply inclined or vertical cylindrical pipes, between 0.5 and 5.0 m wide; many were seen extending to depths greater than 12 m in parts of the quarry now destroyed. They are mostly infilled with grey and brown pebbly sand and are lined with dark-brown clay.
3. Horizontal seams of dark-brown clay and sand, up to 0.5 m thick, veining the chalk and occurring to 20 m below ground level; these include the 'sheet-pipes' described by Kirkaldy (1950).

The chalk surface along the preserved face is pitted with a series of these filled cavities; they vary considerably in shape, from shallow, rounded depressions, to steep-sided pipes up to a metre deep, and all are infilled with flint-bearing clay soils. Three larger pipes up to 3 m deep and wide are largely infilled with varieties of brown clays, reddish clays and sandy deposits derived from the overlying Tertiary rocks. Many of the pipes are lined with a dark-brown, very porous clay. The mineralogy and microstructures of these sediments were documented in detail by Thorez *et al.* (1971).

## Interpretation

The pipes now exposed in the quarry formed as solutional voids or small caves in the chalk beneath the Tertiary cover rocks, causing the overlying sands and clays to slump into them. An early interpretation related the pipes to a group of fossil swallow holes, similar to the modern features at Water End (Kirkaldy, 1950). However, the quarry pipes are clearly subsurface solution features; structures within the Tertiary fills show that they have slumped and collapsed into them and were not the result of subaerial sedimentation in surface depressions.

The mineralogical composition of the infills supports this hypothesis, by showing that the pipe sediments are mainly a correct sequence of the Palaeogene cover rocks overlying the chalk (Thorez *et al.,* 1971); the clastic material does not have an inverted sequence which would evolve from erosion and redeposition. The lowest few metres of pebbly sand in the pipes relate to the Thanet Beds, which thin out beneath their cover 10 km south-east of the quarry. The higher sediments are typical of the Reading Beds which now outcrop on the hillside immediately west of the quarry. It appears that the chalk is initially dissolved beneath a cover of Thanet Sands and Reading Beds, which then slump into the underlying void. The relatively coherent Bullhead Bed at the base of the Palaeogene deposits was strong enough to support the upper sandier material until the cavities were enlarged sufficiently for collapse to occur. Disrupted Bullhead Bed material occurs up to 3 m below the original sub-Palaeogene surface.

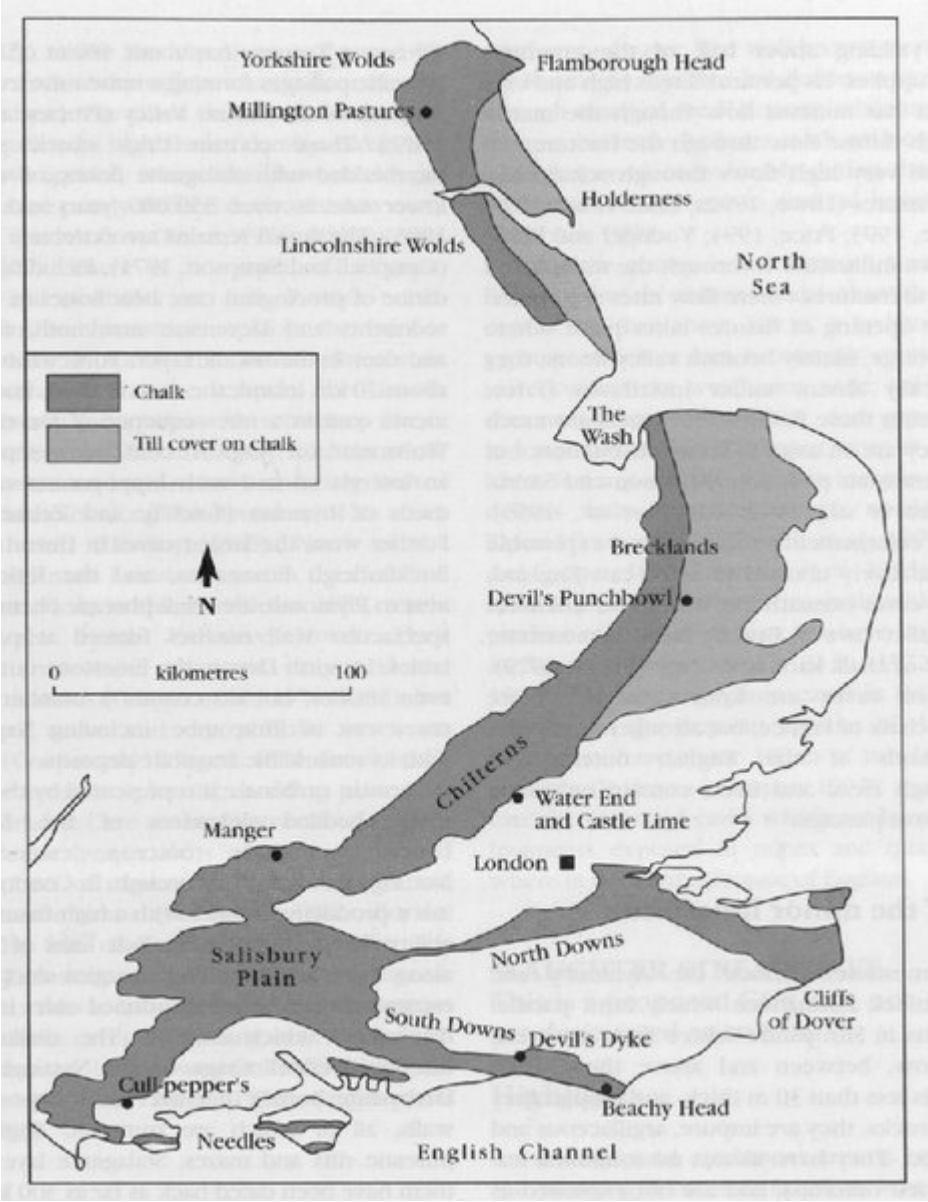
The dark clay lining many of the pipes was deposited from suspension in the percolating groundwater, into the voids created by solution of the chalk. The clay material was derived from the overlying Palaeogene sediments, with only a small component derived from the insoluble chalk residue (Thorez *et al.,* 1971). The clays infilling the sheet pipes appear to have a similar origin. If the solution of the chalk and redeposition of the clay was concentrated near the water table, the sheet pipes may represent palaeo-water tables. It appears that solution of the chalk has been enhanced along the feather edge of the Tertiary cover rocks (Edmonds, 1983), where concentrated allogenic recharge enabled greater solutional activity to create the multiplicity of pipes and solutional basins.

The age of the solutional features is open to some debate, and may cover a considerable range. It appears that the larger pipes are a feature of early solution, possibly during the late Tertiary, and are only preserved beneath the Tertiary cover. Thanet and Bullhead material has been preserved within the pipes while it is missing from nearby undisturbed stratigraphic sequences; this indicates solutional lowering before deposition of the Reading Beds. However, Reading material is also slumped into the pipes beneath undisturbed Quaternary soils, indicating renewed solution and subsidence in the later Tertiary. Estimation of solution rates in pipes elsewhere on the Chalk suggests that they form in 5–10 ka (de Bruijn, 1983), but this does not indicate the absolute age of fossil features. The more widespread smaller pits, infilled with clay-with-flints, are probably of Quaternary age. Some of the material mulling the upper parts of the larger pipes is heterogeneous, suggesting that it was reworked by solifluction, and infilled surface depressions that overlay any collapse feature (Thorez *et al.,* 1971). Chalk solution and sediment collapse associated with the pipes continues today, away from the quarry, at numerous sites where subsidence is observed.

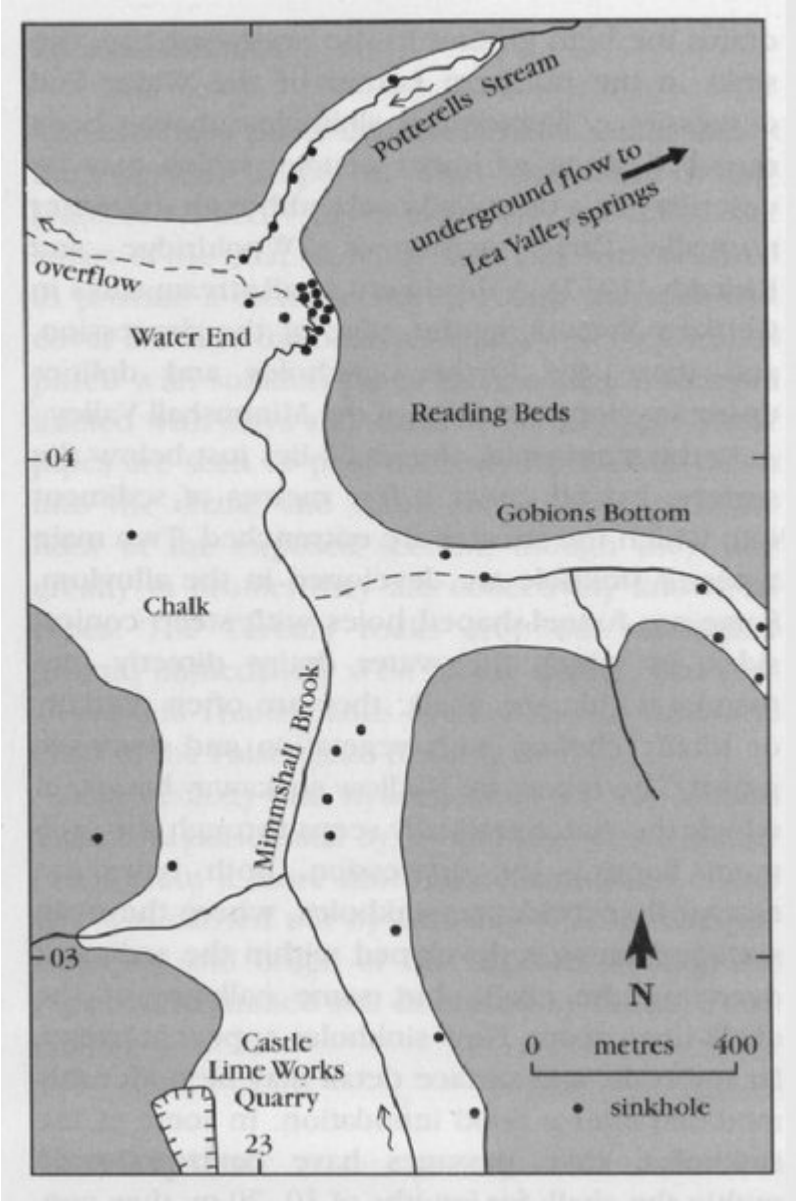
## Conclusions

The solutional features exposed along the eastern rockhead of the Castle Lime Works Quarry are some of the best preserved examples of clay-filled pipes in the chalk karst of Britain. They demonstrate a significant component of chalk karst morphology and provide evidence of the role of subsurface solution of the carbonate rock. The processes of chalk solution and subsequent subsidence of the cover rocks are analogous to those in the interstratal karst doline fields of South Wales (see Chapter 6), and also to those which preserved the Brassington Formation in the Peak District sinkholes (see Chapter 4).

**References**




*(Figure 7.1) Outline map of the chalk karst of England, with locations documented in the text. Superficial deposits occur on many parts of the Chalk outcrop; only the large areas of glacial till are distinguished on this map, as they mask most topographic expression of the karst.*




*(Figure 7.11) Geological map of the Mimmshall Valley with the Water End sinkholes and the Castle Lime Works Quarry.*

*(Figure 7.12) A section of the preserved face in the Castle Lime Works Quarry exposing the extremely irregular upper surface of the chalk, broken by clay-filled pipes and broader depressions. (Photo: A.C. Waltham.)*