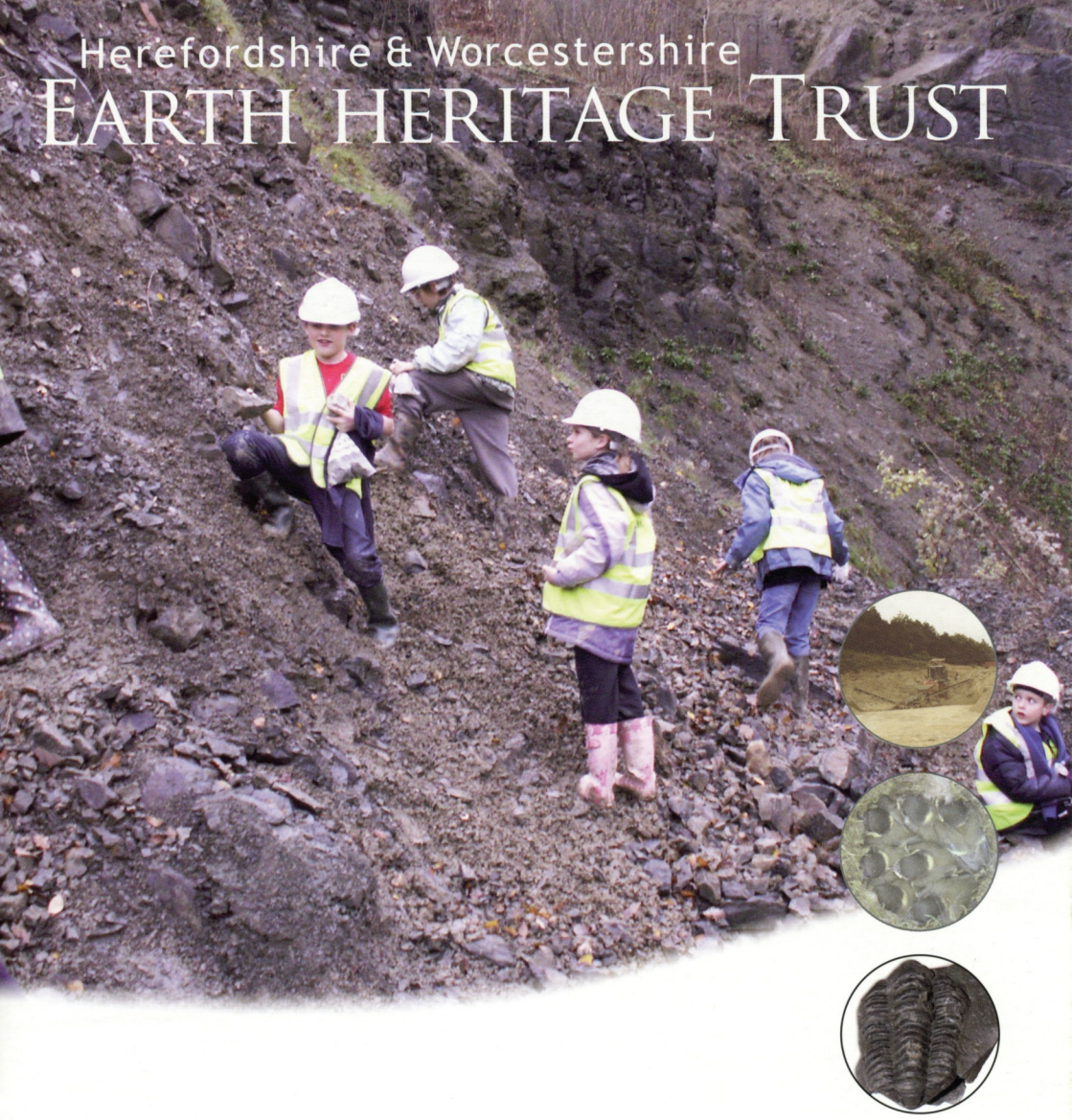
Herefordshire & Worcestershire

EARTH HERITAGE TRUST



The Geology of

Whitman's Hill Quarry

Whitman's Hill Geodiversity Discovery Venture

working to record & protect geology and landscape

www.EarthHeritageTrust.org

Geological Setting

On Whitman's Hill is a disused limestone quarry which allows us to see the excellent geological exposures of mudstones, limestones and thin volcanic ash bands of Silurian age (about 425 million years old - or 425 Ma). The mudstones and limestones are rich in the fossilised remains of Silurian sea creatures such as brachiopods, trilobites, corals, crinoids, bivalves and cephalopods.

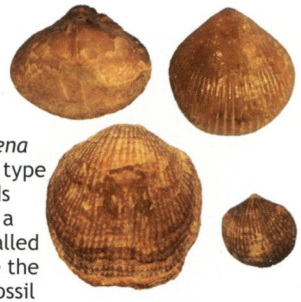
During the Silurian, the surface of the Earth looked very different - Britain as we know it today did not exist. An area of land that now makes up parts of Wales and England was located approximately 15° south of the equator. This land was covered in warm, shallow seas, in which all the creatures lived - it was quite like the Seychelles or the Bahamas.

Rivers flowing from distant land to the east carried mud and silt which built up in the sea, eventually forming the mudstones of the "Coalbrookdale Formation", the oldest rocks we see at Whitman's Hill. There was then a long period when mainly lime was deposited in the sea and small reefs, known as "**bioherms**", established themselves. These deposits formed the rocks of the "Much Wenlock Limestone Formation". Some of these limestones are full of lumpy nodules, earning them the local name of "Storridge Porridge". Both these mudstones and limestones are full of fossils.

At this time, volcanoes were also regularly erupting in the area. We know this because thin layers of volcanic ash (or "**bentonites**") are found between the rock layers at Whitman's Hill. These bentonites are discussed in more detail on page 7.

The Fossils of Whitman's Hill

Brachiopods



Brachiopods, such as *Atrypa, Gypidula, Sphaerirhynchia, Leptaena* and *Orbiculoidea,* are a type of shellfish. Brachiopods are filter feeders, using a special feeding organ called a lophophore. They are the most common type of fossil found in the rocks at Whitman's Hill, and still exist in seas today, but are much rarer than they were in the Silurian.

Calcareous algae

Calcareous algae deposit calcium carbonate (limestone) in their tissue, leaving a fossil "skeleton" behind when they die. Whilst these are not real skeletons, these deposits are important in binding reef deposits together. Examples of these, such as *Ischadites*, can be seen in the bioherm (see page 7) and surrounding rocks at Whitman's Hill.

Crinoids

Crinoids, which are more commonly known as "sea-lilies" or "feather-stars", are sea-dwelling animals which belong to the spiny-skinned group of animals known as echinoderms. Although they still exist today, they were much more abundant and diverse in the past. Complete crinoids are rare but the individual "polo mint" ossicles which made up the stalk are frequently found as fossils.

Bivalves

Bivalves are a group of molluscs which include oysters, mussels, scallops and clams. They form many different shapes and sizes, reflecting different lifestyles, such as burrowing, boring into rock or swimming. Most feed by using their gills to filter food from the water. Bivalves were much rarer in the Silurian than they are today; *Pteronitella* is one of the more commonly found bivalves at Whitman's Hill.

Orthocone Nautiloids

Nautiloids belong to a group of molluscs called cephalopods. They are related to ammonites, squids and octopuses. Orthocone Nautiloids, such as *Dawsonoceras*, were the top predators during the Silurian, feeding on smaller animals on and around the reef. They swam by water-jet propulsion and had shells with separate chambers (as you can see in the photo of the internal shell below, on the left) which were used for buoyancy control.

Gastropods

Gastropods, such as *Poleumita*, are a group of molluscs which includes snails and slugs. Whilst today they are found on land, in lakes and in rivers, as well as in the sea, during the Silurian all gastropods lived in the sea.

Trilobites

Trilobites are now extinct but were an extremely successful group of animals, existing for 300 million years. *Calymene*, the "Dudley Bug", is the most famous fossil that can be found at Whitman's Hill. Trilobites are related to crustaceans such as lobsters and crabs, having hard shells, segmented bodies and jointed legs. They were among the first creatures to develop complex eyes, with lenses made from crystals of calcite.

Corals

Corals are simple animals, closely related to sea anemones and jellyfish. Although solitary forms do exist, they often live in colonies of many genetically identical individuals ("polyps"), secreting a hard skeleton of calcium carbonate, which can sometimes form large reef structures. Whilst they are different to modern-day corals, Silurian solitary corals (as shown here) and colonial corals were important reef-builders, as can be seen by the corals making up the bioherm (see page 7) at Whitman's Hill.

Bryozoa

Bryozoa or "moss-animals" are colonial animals, commonly found today in shallow seawater but also in freshwater. Although they are not related to corals, they also build stony skeletons of calcium carbonate, which house tiny animals called "zooids". They are most easily spotted on the bioherm and encrusting other organisms at Whitman's Hill.

Identification guide for fossils commonly found at Whitman's Hill

Brachiopods

1. *Gypidula galeata* x1
2. *Sphaerirhynchia wilsoni* x1½
3. *Leptaena depressa* x1
4. *Amphistrophia funiculata* x2
5. *Eoplectodonta duvalii* x2
6. *Atrypa reticularis* x1
7. *Eospirifer radiatus* x1
8. *Howellella elegans* x2
9. *Meristina obtusa* x¾
10. *Orbiculoidea* sp. x2

Corals

11. *Favosites gothlandicus* x¾
12. *Halysites catenularius* x4
13. *Tryplasma loveni* x1
14. *Heliolites interstinctus* x6
15. *Syringopora bifurcata* x¾
16. *Kodonophyllum truncatum* x1

Trilobites

17. *Balizoma variolaris* x2
18. *Encrinurus punctatus* x1
19. *Calymene blumenbachii* x1
20. *Dalmanites myops* x1¼
21. *Cybantyx anaglyptos* x½

Bivalves

22. *Pteronitella retroflexa* x1

Gastropods

23. *Poleumita discors* x½

Orthocone Nautiloids

24. *Dawsonoceras annulatum* x½

Calcareous Algae

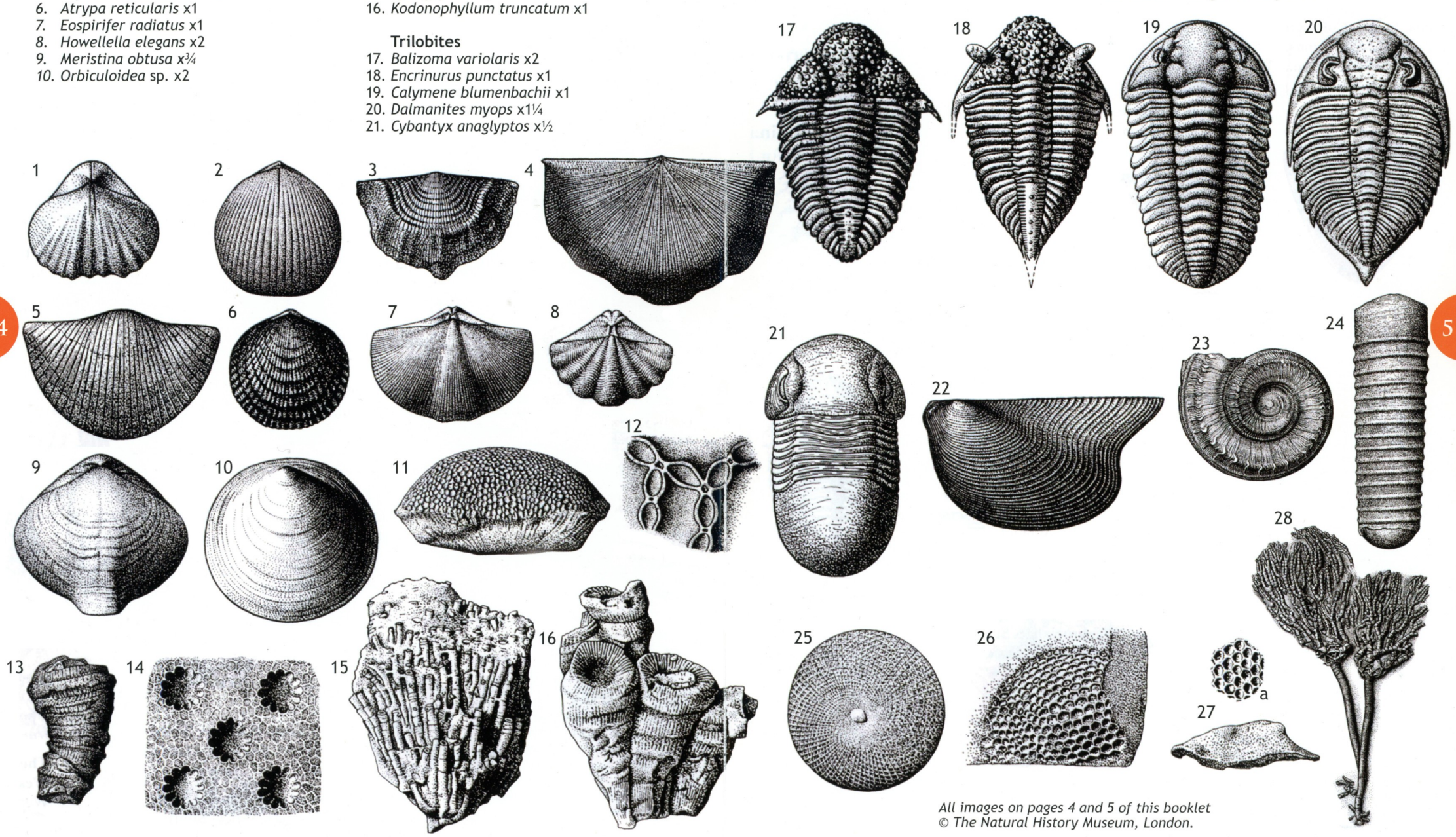
25. *Ischadites koenigi* x1½
26. *Mastopora fava* x1

Bryozoa

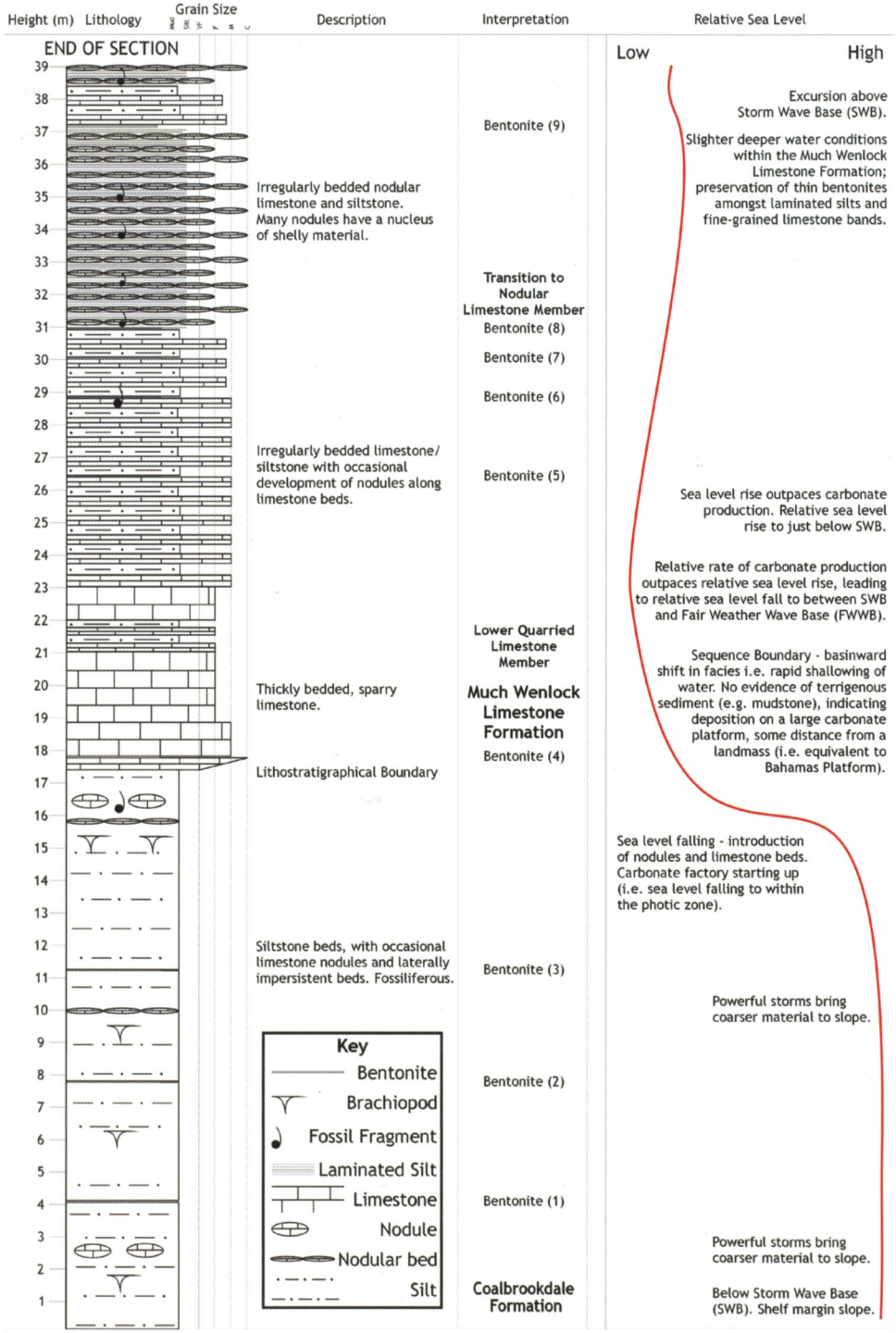
27. *Favositella interpuncta* x½, a x4

Crinoids

28. *Gissocrinus goniodactylus* x½



Graphic log of rocks at Whitman's Hill and relative sea level curve



Volcano!

Thin layers of volcanic ash, or bentonites, are found throughout the sequence of rocks at Whitman's Hill. Their positions in the rock section can be seen on the graphic log on the opposite page, and two of the more prominent bentonite layers are marked on the image on the left. We know from these bentonites that volcanic ash rained down on this tropical sea nine times, probably killing most of the sea creatures each time. We don't yet know the location of the volcano (or volcanoes) but we have used crystals of apatite (see crystal image below, which is greatly magnified, this crystal is actually about 0.25mm long) found in some of these bentonites to tell us more about the types of magma that came out of them. We now know that some of the older bentonites came from one type of magma (acid) whilst the youngest bentonite, at the very top of the exposure at Whitman's Hill, came from a less evolved magma (with a more mafic/intermediate composition). This suggests different volcanoes were responsible for the different ash layers.

We have also worked out how old the bentonites are, telling us the approximate age of the rocks at Whitman's Hill. Zircon crystals (see crystal image below, which is actually about 0.1mm long) in the bentonites at Whitman's Hill contain the radioactive element uranium, which decays at a known rate, eventually forming lead. By working out the ratio of uranium to radiogenic lead in the zircon crystals, we have been able to confirm the age of the rocks in this quarry as being around 425 million years old. Although the types of rocks and fossils found here give us a relative age (e.g. the Wenlock series, which is within the Silurian period), only the presence of these radioactive elements, such as uranium, which are not present in mudstones and limestones, can help us to work out the exact age of the rocks. The bentonites at Whitman's Hill are therefore very important.

Bioherm

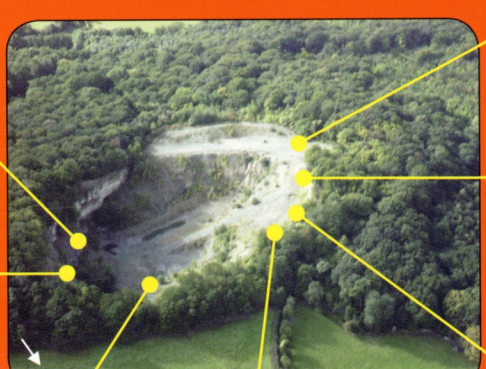
Whitman's Hill is an important locality because preserved here is a bioherm, a fossil reef. This small lens-shaped structure (diamond-shaped in the rock face) is similar to a modern-day patch reef, but is mainly made up of algae and stromatoporoids (types of sponges), as well as corals which primarily comprise patch reefs today. Brachiopods, bryozoa, corals and crinoid ossicles can be seen encrusting the bioherm.

Areas of interest around Whitman's Hill Quarry

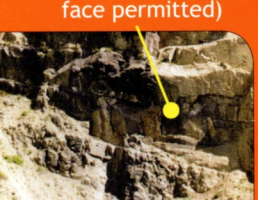
Boundary between Much Wenlock Limestone and Coalbrookdale Formations visible (no access to face permitted)

Entrance to quarry

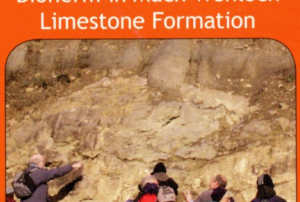
Children's fossil hunting rock piles



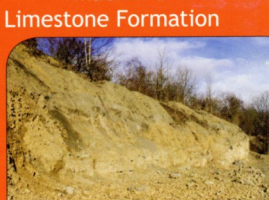
Bentonite layers visible in steep face (no access to face permitted)



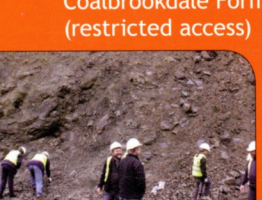
Bioherm in Much Wenlock Limestone Formation



Fossil hunting face - Much Wenlock Limestone Formation



Fossil hunting area and exposures of sphaeroidal weathering in Coalbrookdale Formation (restricted access)



Fossil Collecting Code

Fossil collecting is permitted, but please only collect a few representative samples. Please always store your fossils with this locality information: Whitman's Hill Quarry, Storridge, Herefordshire SO 748483. If you ever wish to get rid of these fossils **please do not throw them away** - please donate them to a local museum (with locality information) or contact the Herefordshire & Worcestershire Earth Heritage Trust, who will take them for others to enjoy.

Text and photos by H&WEHT, except aerial photo on back cover by D. Stamp, leftmost photo on p7/bottom right photo on back cover © Kay Ransom Photography and crystal images on p7 which were kindly taken by the British Geological Survey. All fossil line drawings (p4/5) © The Natural History Museum, London.

Herefordshire & Worcestershire EARTH HERITAGE TRUST

For more information on any aspect of the work of Herefordshire & Worcestershire Earth Heritage Trust contact us at:

Geological Records Centre, University of Worcester,
Henwick Grove, Worcester WR2 6AJ

Tel: 01905 855184 Fax: 01905 855132 Email: eht@worc.ac.uk

This publication has been funded by Natural England through Defra's Aggregates Levy Sustainability Fund.

Abberley and Malvern Hills Geopark

UNESCO GLOBAL GEOPARKS NETWORK

European Geoparks

www.EarthHeritageTrust.org

NATURAL ENGLAND

Supported through Defra's Aggregates Levy Sustainability Fund

The Geology Trusts

University of Worcester

Leaflet series Design/Art by: gary.davis@petrelporpoisedesign.co.uk