Proposed Dorset and East Devon National Park

Evidence and Sources used to support the Proposal

Theme: The Geology of the Dorset and East Devon AONBs

Located on the south coast of England, the area comprises eight sections (the main geological exposures) along approximately 105 km of coast. The area has a combination of geological, palaeontological and geomorphological features. These include a variety of fossils, a beach renowned for its pebbles, and textbook examples of common coastal features such as sea stacks and sea caves.

The wide variety of geological components found in the area have given rise to the exploitation of a wide range of geological source materials, including limestone, oil deposits, high class ball clays, sand and gravel; these have been historically and continue to be used for petroleum products, china and other fine ceramics, brick making, and stone for high quality building purposes. Past quarrying in Dorset has contributed to the construction of another World Heritage site - the Tower of London.

The deposits of clay comprise the following: London, Kimmeridge, Oxford and plastic clay types.

Of the limestones, Portland, Purbeck, and Forest Marble are internationally known whilst the inferior oolite, fullers earth and greensands are also of geological significance. Coral rag is also present in the area. Corallian Limestone, a coralliferous sedimentary rock laid down in Jurassic times, is a hard variety of Coral Rag.

The coastal exposures along the Dorset and East Devon coast provide an almost continuous sequence of Triassic, Jurassic and Cretaceous rock formations spanning the Mesozoic Era (251-66 million years ago), and thus document approximately 185 million years of Earth's history.

The area contains a range of important Mesozoic fossil localities, which have produced well preserved and diverse evidence of life during Mesozoic times.

A large number of vertebrate, invertebrate and plant fossils have been discovered, amongst which are flying reptiles and marine reptiles, and well-preserved fossil dinosaur footprints. The area has yielded a rich source of ammonites, which have been used to zone the Jurassic period. Well-preserved remains of a late Jurassic fossil forest are exposed on the Isle of Portland and the Purbeck coast; many trees are preserved with their associated soils and pollen, the species of which, their age and locality have been determined by palaeo-ecologists.

The area also contains textbook exemplars of coastal geomorphologic features, landforms and processes.

Renowned for its contribution to Earth science investigations for over 300 years, the Dorset and East Devon coast has helped foster major contributions to many aspects of geology, palaeontology and geomorphology and has continuing significance as a high quality teaching, training and research resource for the Earth sciences.

Examples of geological exposures along the coast suggested for inclusion in a National Park

South Purbeck.

The Blue Lias is the unit most frequently discussed here.

The Fossil Forest, east of Lulworth Cove, Dorset, southern England, is a classic geological locality. It consists of a series of small embayments about half way up the cliff where a weak bed of evaporites or replaced evaporites crops out. The evaporitic beds and overlying tectonic-evaporite breccia, the Broken Beds, are eroded away on rare occasions by the action of great storms washing seawater up the cliff. The water returns to the sea with some debris through small run off channels, one of which is present in each small embayment.

The washing away of the evaporites and breccia reveals the remains of Late Jurassic trees and thrombolite mounds surrounding them. The trees are mainly of an ancient Cypress type (*Protocupressinoxylon*). They are rooted in a calcareous palaeosol (ancient soil), the Great Dirt Bed. Above the trees are microbial mounds of thrombolitic ("stromatolitic") limestone. Above this the unusual Broken Beds, a limestone breccia that was originally evaporitic (a cargneule). This is the thin margin of the Purbeck Anhydrite under much of southern and south-eastern England and well-known to the oil industry as a seismic reflector. These marginal facies of the Purbeck evaporites are well-seen at the Fossil Forest and the adjacent Potters Hole.

Axmouth – Lyme Regis Undercliffs.

The Blue Lias is the lowest unit discussed here. This consists of thin alternating shales, marls and argillaceous limestones at the bottom of this Jurassic succession. The Blue Lias is 32m thick, and includes all the Hettangian Stage - *Psiloceras planorbis, Alsatities liasicus, Schlotheimia angulata* plus the lower part of Sinemurian Stage - *Arietites bucklandi, Arnioceras semicostatum* . These limestones and shales overlie "Rhaetic " strata (Penarth Group) which is a lagoonal facies of Upper Triassic age (and in turn overlies Triassic red-bed, desert facies).

The Blue Lias represents the first normal marine sediments resulting from the transgression of the sea over the deserts and lagoons of parts of the great supercontinent Pangea. Evidence of the marine fauna increases upwards in abundance and diversity - as the sea opened and deepened and ammonites, ichthyosaurs and plesiosaurs lived in the fairly warm water of moderate depth above the muddy sea floor.

Marine mud facies of the Shales-with-Beef, an oil source-rock, and the Black Ven Marls follow. The Shales-with-Beef are 25m thick and belong to the zone of *Coenisites turneri.* These are important fossiliferus units. The Belemnite Marls lie above.

Kimmeridge

Bones of marine reptiles of dolphin-like appearance, the ichthyosaurs ("fish lizard"), occur in the marine clay formations of Dorset. These are particularly the Liassic clays, the Oxford Clay and the Kimmeridge Clay Formations. Dorset is historically important because the very first known ichthyosaur was found at Lyme Regis in the Lias by Mary Anning when she was only 12 years old.

J B Delair (1966) discussed the Dorset ichthyosaurs and provided a brief description of ichthyosaur characteristics. A simplified, modified version of this is given below.

Ichthyosaurs - Description: The Ichthyosaurs belong to the Order Ichthyopterygia, an Order of reptiles which returned to the sea and became highly adapted to this environment. They became aquatic during early Mesozoic times and ranged from the Triassic to the end of the Cretaceous Period.

Their ancestors are not known for certain but they seem to have descended from small Carboniferous reptiles which even at that time were undergoing anatomical changes necessary for an aquatic life. By the time of appearance of the first known genera it is clear that the ichthyosaurs had already had a long history. They were so adapted to the marine environment that they were unable to return to land to lay their eggs and, thus, brought forth their young alive. Fossil skeletons have shown the young ichthyosaurs emerging from the body of the mother.

The ichthyosaurs had a stream-lined, dolphin-like body without reptilian-type scales. They had four powerful paddle-shaped limbs. Below the strong limb bones of the humerus (upper arm) and femur (thigh bone) the paddle bones are not organised into the usual rows of finger or toe bones but arranged as a flat oar-blade. There are many small sub-circular or hexagonal bones, with probably not much movement between them. The skull was generally large and, unlike that of most reptiles, was joined to the trunk directly and without a neck (note that old reconstructions usually showed a neck but modern ones do not). There was a powerful usually elongated snout armed with numerous powerful teeth. In the skull the nasal openings for the nostrils were placed far back and not at the end of the snout. The round cavities in the skull for the eyes, the orbits, were very large. It is interesting that the eyes were protected by special circles of hardened (sclerotic) plates, presumably for use in deep diving. The ear-bone, the stapes, was unusually large, probably in connection with diving.

Sources include:

UNESCO/CLT/WHC
www. Southampton.ac.uk/~imw/
Geology of South Dorset and South East Devon, British Geological Survey [various authors] 2011
Geology of the Dorset Coast, J C W Cope, 2012
Collecting rocks and fossils, J B Delair, 1966

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