The geology of East Cliff, Sidmouth, in the context of the Dorset and East Devon Coast World Heritage Site

Briefing note for the Sidmouth Beach Management Plan steering group, May 2017

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Eastward from the mouth of the river Sid the cliff exposes sandstone and mudstone layers that dip towards the east. These rocks represent a record of part of the Triassic Period and are around 242 million years old. The transition from sandstone to mudstone seen in these rocks shows a relatively rapid change in conditions in the geological past from a landscape dominated by seasonal rivers to a hot desert environment. The sandstones laid down in the rivers are relatively rich in fossils, including new species and specimens that have allowed the correlation of Devon's geology with other parts of the world. Similar fossils have been found in the same sandstone rocks to the west of Sidmouth, but Pennington point has proved to be the source of the most diverse fossil fauna. For these reasons Pennington Point and East Cliff at Sidmouth are a globally important scientific reference site helping us to understand causes and impacts of long-term climate change and patterns of evolution.

Key references: Geological Conservation Review volumes 10 and 24, and Gallois, R. W. 2004. *The type section of the junction of the Otter Sandstone Formation and the Mercia Mudstone Group (mid Triassic) at Pennington Point, Sidmouth*. Geoscience in south-west England, **11**, 51-58.)

The scientific value of the exposures at Pennington Point and East Cliff plays an important role in respect of the Dorset and East Devon Coast World Heritage Site (WHS). This is the highest possible global conservation designation and recognises sites of unique and exceptional heritage through the concept of Outstanding Universal Value (OUV). OUV itself is underpinned by three pillars – i) the site must meet one or more of the World Heritage **criteria**, ii) it must demonstrate **integrity** and iii) it must have **appropriate protection and management** in place. If any of these are compromised OUV, and therefore World Heritage Status, may be threatened.

The Dorset and East Devon Coast meets **criterion viii** due to the area's exceptional rocks, fossils and landforms. Full details at whc.unesco.org/en/list/1029

The concept of **integrity** is defined by UNESCO in the Operational Guidelines for the Implementation of the World Heritage Convention. Relevant statements and paragraph numbers are as follows:

> **87.** All properties nominated for inscription on the World Heritage List shall satisfy the conditions of integrity.
>
> **88.** Integrity is a measure of the **wholeness** and **intactness** of the natural and/or cultural heritage and **its attributes**. Examining the conditions of integrity, therefore requires assessing the extent to which the property:
>
> a) includes all elements necessary to express its Outstanding Universal Value;
>
> b) is of adequate size to ensure the complete representation of the features and processes which convey the property's significance;
>
> c) suffers from adverse effects of development and/or neglect.

This should be presented in a statement of integrity.

93. Properties proposed under criterion (viii) should contain all or most of the key interrelated and interdependent elements in their natural relationships. For example, an "ice age" area would meet the conditions of integrity if it includes the snow field, the glacier itself and samples of cutting patterns, deposition and colonization (e.g. striations, moraines, pioneer stages of plant succession, etc.); in the case of volcanoes, the magmatic series should be complete and all or most of the varieties of effusive rocks and types of eruptions be represented.

Attributes are aspects of a property which are associated with or express the Outstanding Universal Value and can be tangible or intangible. A full description of the Jurassic Coast's Attributes is appended to the end of this document. The statement for integrity for Dorset and East Devon Coast WHS includes the following statements:

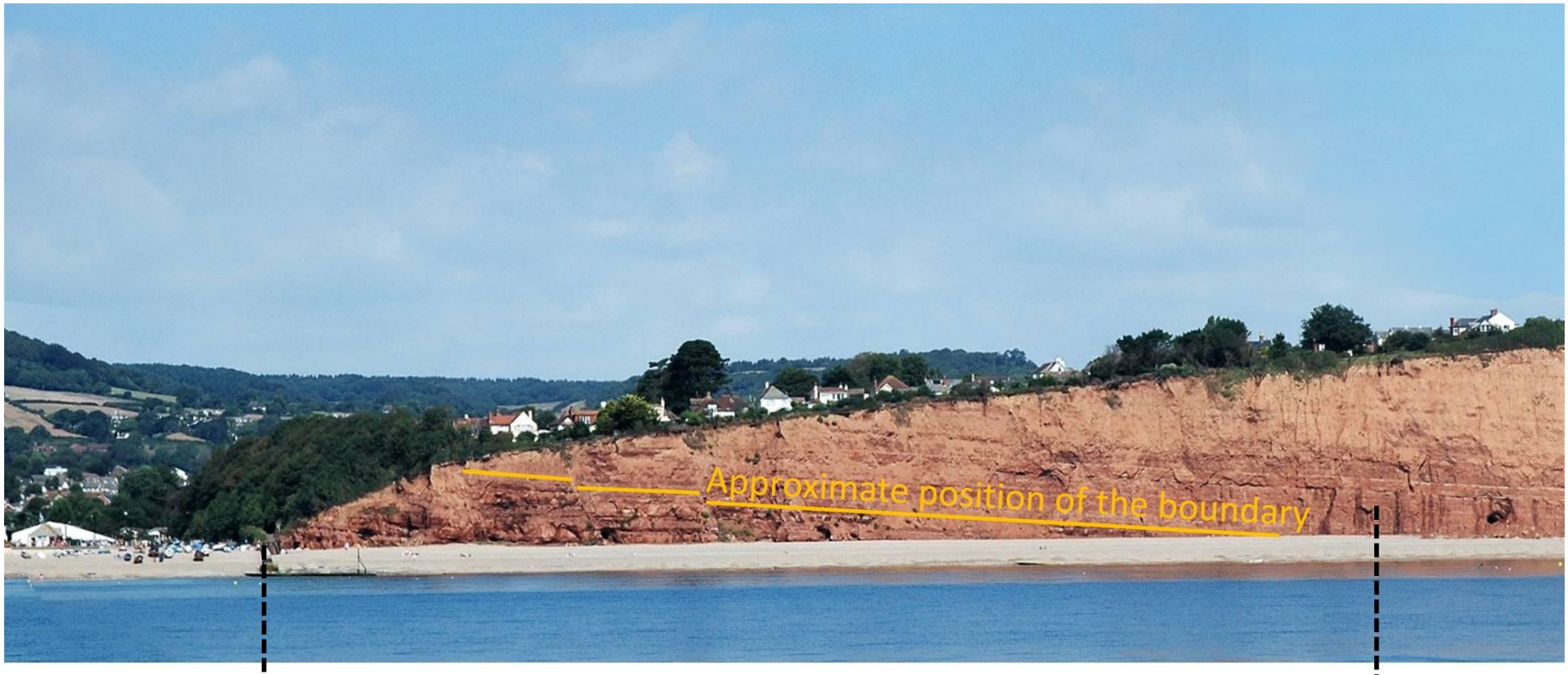
- The nominated Site contains all of the key interdependent elements of the geological succession exposed on the coastline. It is a near-complete and unique succession of Triassic, Jurassic and Cretaceous rocks.
- Its completeness in representing key features of the Mesozoic Era is clearly demonstrated by the remarkable range of localities selected through the Geological Conservation Review (GCR)
- The fossil faunas at the key localities are often very rich, and show key, interrelated elements of the record of life.

The transitional boundary between the Otter Sandstone Formation and the Mercia Mudstone Group (as seen at Pennington Point and East Cliff) is vital to establishing the near continuous record of the Triassic Period exposed on the East Devon Coast, and so plays an important role in the integrity of the WHS. Whilst this boundary is also visible under High Cliff in certain conditions, the exposure of it at Pennington Point and East Cliff has been shown to be the superior of the two from a scientific point of view. For more details please refer to Gallois, R. W. 2004. *The type section of the junction of the Otter Sandstone Formation and the Mercia Mudstone Group (mid Triassic) at Pennington Point, Sidmouth*. Geoscience in south-west England, **11**, 51-58.

Boundaries between geological units are crucial to understanding the large changes that take place over millions of years. In contrast to the separate rock units as a whole, which can be hundreds of meters thick, the boundaries between them are often very narrow and only visible and accessible in particular places. Pennington Point and East cliff is one such place and so is of great sensitivity relative to other locations along the WHS.

Together these characteristics account for two of the pillars of OUV – by helping to meet **criteria viii** and contributing to the **integrity** of the site. The third pillar – **appropriate protection and management** – comes through the inclusion of Pennington Point and East cliff in the Geological Conservation Review (GCR) and SSSI network. The baseline scientific value of the Otter Sandstone is described in the GCR volumes 10 and 24 and protected as part of the Sidmouth to Beer Coast SSSI. The GCR volumes are a baseline reference.

The image below shows the approximate position of the transitional boundary in the cliff and implications for coastal defence schemes.



Any hard coastal defences against the cliff or along the shoreline here would be a potentially significant threat to the integrity of the WHS

Attributes for the Dorset and East Devon Coast World Heritage Site

Agreed by Steering group meeting of 26/09/12

Introduction

The Earth science interests of the Dorset and East Devon Coast World Heritage Site are recognised within the Geological Conservation Review (GCR): a UK-wide audit of the best sites of their type in Great Britain. The GCR supports the Sites of Special Scientific Interest (SSSI) that provide the legal framework to protect the coast. The Site is currently monitored through the SSSI's but by looking at the GCR sites within them uses a set of **very detailed attributes** for the Site. Furthermore, the GCR sites on this coast lie within four categories; stratigraphy, palaeontology, geomorphology and structure, and are available on request.

Attributes

1) Stratigraphy (the rock record) and structure

The property includes a near-continuous sequence of Triassic, Jurassic and Cretaceous rock exposures, representing almost the entire Mesozoic Era (between 251 and 66 million years ago), or approximately 185 million years of Earth history. Because the overall tilt or 'dip' of the rocks is gently to the east, each section of coast contains its own unique part of the story that add up to the whole; a globally significant site.

2) Palaeontological record

The property contains a diverse range of internationally important Mesozoic fossil localities, including key areas for Triassic reptiles, and for Jurassic and Cretaceous mammals, reptiles, fish and insects. These chart virtually one third of the entire evolution of complex life forms. The ammonite zonation is also important as these animals changed rapidly through time and can therefore be used to date the relative ages of the rocks and place them in a time context with other sites.

3) Geomorphological features and processes

A wide range of significant geomorphological features and processes are also represented within the property. It is renowned for its demonstration of landsliding, and of beach formation and evolution in relation to changing sea level, including raised beaches and offshore peat deposits. The coast demonstrates spectacularly how geological structure controls the evolution of bays and headlands and how erosion on a discordant and concordant coastline creates these features. There are also superb examples of the formation of caves, arches and sea stacks.

4) Ongoing scientific investigation and educational use, and role in the history of science.

The coast played a key role in the development of the Earth sciences over the last two centuries and continues to provide an outdoor classroom for teaching, and an unparalleled resource for ongoing research. The continuous rock sequence contained in the naturally eroding cliffs allows scientists to test existing theories and generate new ones. Fossils new to science continue to be found through responsible collecting efforts, and thus contribute to maintaining the OUV of this Site. The ability to study erosional processes is also important, and is also now benefiting from the application of new monitoring techniques.

5) Underlying geomorphological processes in the setting of the Site

The reasons for the form, diversity and quality of the coastal landscape are found in the underlying geology and the geomorphological processes acting on it. Much of the landscape is dominated by relic features and dates back to a time of active processes under very different climatic conditions from today. The long-term preservation of the Site's OUV depends on the maintenance of dynamic natural processes in the setting, and the awareness that processes acting in the land or sea setting may impact on the Site itself.