Bursting and heaving ledges on Monmouth Beach, Lyme Regis

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Since 2004 the loss, or rather the erosional changes, in the middle foreshore ledges of Monmouth Beach, west of Lyme Regis, have been monitored using a variety of photographic techniques. The ledges appear most susceptible to change in the late summer and early autumn and while some changes can be attributed to what might be expected in such a wave dominated environment, others are not. In the summer of 2011 one ledge burst open with very obvious evidence of compression. Following that observation, a number of other compressional and extensional features have been identified, some clearly dating back many years, yet still propagating westwards. These almost certainly play a significant role in the distribution of the ledges as we see them today but the forces at work are unknown and only suggestions for their operation are described. The changes are either happening very slowly, or periodically, in response to specific conditions and monitoring is on-going in an effort to learn more.

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Introduction

The cliffs and foreshore of Monmouth Beach, west of Lyme Regis, display a world-famous succession through the Blue Lias Formation of the Lower Jurassic (House, 1993; Cope, 2015). It is a very well-visited locality for field work, geo-tourism and fossil collecting. This coastal section is a Geological Conservation Review site for Lower Jurassic stratigraphy (Simms *et al.*, 2004), fossil fishes (Dineley and Metcalf, 1999), fossil reptiles (Benton and Spencer, 1995), mass movements (Cooper, 2007) and coastal geomorphology (May and Hansom, 2003) and it is one of the highlights of the Dorset and East Devon ('Jurassic Coast') World Heritage Site.

The cliffs and foreshore ledges are subject to the forces of erosion through both the direct action of the sea and landslides. Around 2004, the seemingly stable and iconic 'Ammonite pavement' or 'Top Tape', (Bed 29 of Lang, 1924) started to break up along its eastern edge, with holes appearing within the pavement itself. Photographic monitoring between 2004 and 2011 recorded the changes and the 'loss' of parts of the ammonite pavement. This recording, coupled with the observations of others (e.g., M. B. Hart, *pers. com.*, 2014), has suggested that the greatest change appears to take place in the early autumn: the main break-up events were recorded in October 2006, October 2008 and October 2009.

Catastrophic changes

Sometime between the 19th and the 28th July 2011 an area in the middle of the most easterly of the extensive middle shore wave cut platforms (Grid Reference: SY33021 91243), the Specketty (Bed 19 of Lang, 1924), burst open over an 8 m by 3 m area. The jointed edges showed compression, with uplifted blocks and spalling or flaking along the surfaces adjacent to the jointing which extended into the unbroken areas of the pavement (Figure 1). The failure was progressive, continuing until the 11th August. An earlier but smaller event was observed in August 2010 and previous photographic monitoring showed that another had occurred sometime before the summer of 2008.

As the monitoring increased in response to these observations, another event was captured in October 2011. This broke off 2 m by 4 m sections of ledges in the Gumption (Bed 32, Lang, 1924), the Third Quick, (Bed 31), the Top Copper (Bed 25) and the Second Mongrel (Bed 21). Anecdotal evidence from surfers identified a wave event on the 29th September as the likely cause and the West Bay wave rider buoy, provided by the Strategic Monitoring Programme through the Plymouth Coastal Observatory (www.chanelcoast.org), recorded a 2 m swell with a 15–16 second period on a 4.6 m tide. This was an event that could typically go unnoticed. Furthermore, larger and more frequent storm and swell wave events take place in the winter and seemingly produce far less 'damage' to the ledges.

In August 2011 the failure in the Specketty (Bed 19) was captured by shooting a photographic mosaic of images and stitching them together to create a very high resolution record of the feature before it was modified by the sea. The bed had thinned very considerably in places, due to attrition of the surface and the failure appeared to be controlled by a bioturbated parting within the limestone. The Specketty is characterised by this bioturbated level, but here the limestone, which is up to 40 cm thick, was split and this level took the form of a clay parting. In places where the failure occurred, the top surface was between about 12 cm and just 3 cm thick. A simple model is proposed for the failure: attrition thins the upper limestone layer, the jointing opens up and then it fails. The cause is more problematic and will be discussed later. This event happened during a very hot spell of weather, as recorded at Bridport (www.bridportweather.co.uk/weather/index.htm), during neap tides and calm seas as recorded by the West Bay wave rider buoy.

A separate, compressional, failure feature was also observed in August 2011 in the Third Quick (Bed 31) towards Seven Rock Point (SY32889 91107). Here the limestone appeared to have sheared through the middle of the bed, and large flat flakes had, or were in the process of spalling off. It took place at the end of a sinuous joint feature extending eastwards towards the edge of the limestone ledge and appeared to be a westerly