GEOLOGICAL INVESTIGATIONS FOR COASTAL PROTECTION AND LANDSLIDE REMEDIAL WORKS AT LYME REGIS, DORSET, UK

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The south coast resort of Lyme Regis has for many years been threatened by a combination of marine erosion and active landslides. Multidisciplinary studies instituted by West Dorset District Council (WDDC) as part of a succession of environmental improvement plans included geological surveys and an extensive drilling programme. The most recent works, Phase IV, included the stabilisation of landslides abutting the eastern side of the town and the construction of a new sea wall. Part of the Phase IV area, Church Cliffs and East Cliff and the adjacent intertidal area fall within the Dorset and East Devon Coast World Heritage Site (the 'Jurassic Coast' WHS). The geological importance of the exposures is also reflected in their designations as Geological Conservation Review sites (GCRs) for Lower Jurassic stratigraphy, fossil fishes and fossil reptiles. In addition to the geological data gathered in advance of the design of the engineering works, the drainage and wall-foundation excavations were geologically monitored. Concerns expressed at the design stage that the works might destroy or make inaccessible some unique part of the stratigraphical succession proved unfounded. Since the completion of the new sea wall, the intertidal area fronting the wall has been almost entirely sediment free with the result that the geology is currently better exposed than at any previous time on record.

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INTRODUCTION

Lyme Regis can trace its origin back for over 1000 years to a fishing settlement sited on the left bank of the River Lim adjacent to its outfall (Figure 1). There has been a church at this locality since 1145 or earlier (Roberts, 1834; Fowles, 1991), constructed on a small, flat-topped promontory that was largely protected from the effects of marine erosion by a cliff of Jurassic Blue Lias Formation and Blue Lias limestone ledges (Figure 2). The town has a history of building protective sea walls and groynes that dates back to medieval times. On the west side of the town, the 13th century Cobb wall protecting the harbour is thought to be the oldest working breakwater of its type in the country. On the east side, the construction of the Eastern Jetty (1662 or earlier; Bull, 2015) led to enhanced erosion at the junction with Church Cliffs in the area adjacent to St Michael's Church. Roberts (1834) reported that 90 ft (*c.* 27 m) of Church Cliffs had been lost between 1803 and 1833 due to a combination of marine erosion and the removal of limestone from the cliffs and intertidal outcrops for cement manufacture and building stone. Erosion of the cemetery and the presence of graveyard bones on the beach (Fowles, 1990) led to a ban on stone working along that part of the cliff with the result that by the late nineteenth century it was again partially protected from marine erosion by a natural apron of fallen limestone blocks derived from the Blue Lias. These mostly came from the thicker beds exposed in the cliff and probably also from the intertidal ledges during storms.

A short length of sea wall and three groynes to protect the church were completed in 1910. This stabilised the bottom part of the cliff adjacent to the church, but the processes of weathering and shallow-seated landslide formation continued in the overlying Charmouth Mudstone Formation. A new sea wall designed to protect the full length of Church Cliffs was completed in 1957. Much of this was founded directly on Blue Lias limestones and mudstones with the result that the more vulnerable parts, those founded on more fractured rocks, were undermined from to time during storms. Remedial works included the construction of 14 groynes and concrete aprons in 1969 and the infilling of fracture zones with concrete and/or bituminously cemented beach cobbles. None of these was lastingly successful with the result that by the late 1990s some of the wall was in poor condition and parts were again undermined during storms. On the east side of the town and eastwards from there, failure surfaces in the Jurassic and Cretaceous rocks have given rise to the Black Ven-Spittles landslide complex (Figure 1, 2), the western part of which has been especially active during the past 100 years. This reactivated older failure surfaces that caused the complex to migrate westwards to the point where it posed a threat to the urban area and the Lyme Regis to Charmouth road.

The geology beneath much of Lyme Regis and the adjacent area consists of Blue Lias and Charmouth Mudstone formations (Lias Group) unconformably overlain by the Cretaceous Gault and Upper Greensand formations (Figure 3) which give rise to a variable thickness of Head Deposits on the lower slopes. The Jurassic and Cretaceous successions are well documented. Early descriptions of the Jurassic rocks of the area include those of Maton (1797), De Luc (1805), Townsend (1813) and De la Beche (1822, 1826) who provided the first complete descriptions of the lithological and palaeontological successions. Later descriptions of the stratigraphy that contain