REPORT

Unusual Newhaven Chalk Formation on the eastern Isle of Wight

The Isle of Wight is considered the 'Jewel in Britain's geological crown' (Hopson, 2011) due to its diverse suite of rocks from the Early Cretaceous to the Oligocene, encapsulating over 100 million years of geological history. Mesozoic deposition in the Isle of Wight occurred within the Wessex Basin, later transitioning into the Hampshire Basin.

Late Cretaceous chalk can be found at outcrop on the headlands in the east and west of the island. Chalk deposition occurred as a slow but extensive accumulation of calcium carbonate comprised of coccoliths, foraminifera and coprolite, as well as many whole and fragmentary echinoids, inoceramid bivalves and crinoids (Mortimore et al., 2001). Depositional blooms were followed by extensive lulls characterised by intense bioturbation and remineralisation (Mortimore et al., 2001). Reworking and remineralisation lead to the development of hardgrounds where the typically soft sediment hardens. The Newhaven Chalk Formation of the Santonian to early Campanian crops out on both sides of the Isle of Wight. This formation is characterised by soft, off-white, pelagic, micritic limestone. It usually contains abundant marl seams, detrital and volcanogenic in origin, with conspicuous flint bands that formed through siliceous precipitation in burrows.

Figure 1. *Flintless Belt at Culver Cliff.*

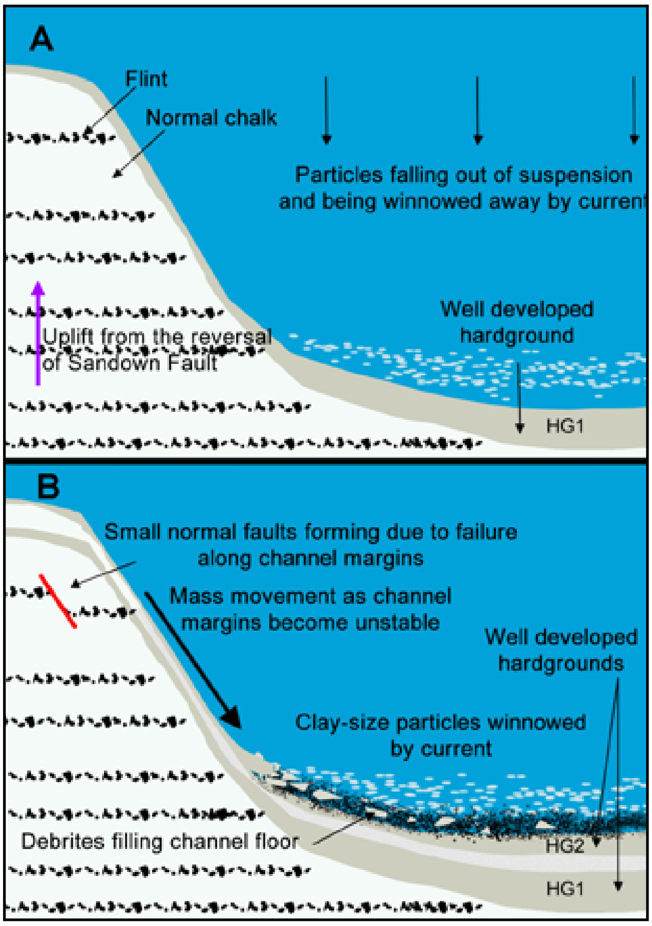
The Newhaven Chalk Formation at Culver Cliff, east of Sandown, includes a peculiar section distinguished by its lack of flint bands, the absence of some marl seams and the presence of nested hardgrounds. The distinct hardness of this chalk, and lack of flint nodules contrasts the soft, off-white holostratotype at Seaford, Sussex. The Flintless Belt of the Newhaven Chalk Formation contains several compositional changes as well as a considerable amount of truncation. In some horizons the usual clay-size chalk particles are exchanged for a gritty, silt-to-fine-sand-size sediment, which infills the burrows that are generally infilled by flint, as well as large clasts of reworked hardgrounds. This suite of hardgrounds also contains significant amounts of phosphate-coated grains, some of which may be micro-coprolites. Between some of the hardgrounds 'normal chalk' packages are observed. These contain marker marl seams but no flint bands. They are mostly topped by a strongly developed hardground. Following the Flintless Belt, ~17m of normal chalk completes the Newhaven Chalk Formation. In the uppermost Newhaven Chalk Formation and overlying lowermost Culver Chalk Formation small normal step faults are present. They were measured and corrected for Cenozoic deformation revealing a dominant orientation of NW-SE, dipping to the north.

The creation of the unusual Flintless Belt observed at Culver Cliff is an area of contention. Two main hypotheses have been proposed: (1) It is the product of tectonic inversion caused by Wernigerode tectonics and the early development of the Sandown pericline (Mortimore & Pomerol, 1997); (2) It represents a sea-floor channel formed through contour parallel bottom currents (Gale et al., 2013). Both arguments are supported by abundant evidence. However, the formation of this feature is unlikely to be solely sedimentary or structural.

A new hypothesis is proposed: the Flintless Belt at Culver Cliff is the product of tectonic inversion of the Sandown fault with concurrent sub-marine erosion caused by contour-parallel bottom currents marginal to a growing hanging-wall basin. Channelling and submarine erosive features are surprisingly common within Upper Cretaceous stratigraphy (Gale et al., 2015). They are observed at many localities, including Stonehenge, Normandy, Brie and the North Sea (Esmerode & Surlyk, 2009; Gale et al., 2013; Mortimore et al., 2017). Evidence from contemporaneous chalk channelling features in seismic profiles from Brie show steep walled channels with dolomitised bases (Esmerode & Surlyk, 2009). Steep-sided channels like this would be unstable and prone to both rotational and plane failure, causing the deposition of the debrites observed in the Flintless Belt. Slope failure during the proceeding fill of the channel lead to the slump beds and normal faulting observed above the Flintless Belt. Figure 3 shows the proposed mechanism for the formation of the nested hardgrounds observed in the initial phase of channelling. Channelling features are

Figure 2. Thallassinoides *burrows infilled with reworked chalk instead of flint, exposed on the base of a boulder; the pencil is 15 cm long.*

Figure 3. Early stages of channel formation at Culver Cliff. Vertical scale is exaggerated.
***A**: the initial phase of incision and truncation caused by current activity leading to a well-developed hardground; deposition continues on the flanks.*
***B**: current activity continues after a period of little to no current action leading to the deposition of normal chalk; increased slope angle leads to slope instability, faulting and deposition of debrites.*



usually confined by an existing structure, which may be constrained by topographical highs, possibly formed by fault inversion. The location of the Flintless Belt coincides with the Sandown fault, suggested to have begun inversion in the Late Cretaceous Wernigerode tectonic phase (Mortimore & Pomerol, 1997). The sedimentary implications of this feature are observed at outcrop. The overlying Culver Chalk Formation is significantly expanded due to increased space created by condensing of the Newhaven Chalk Formation. There is also an increased abundance of slump beds, offset flint bands and shattered flint nodules compared to other localities, caused by the increased slope angle during channel filling. It is clear that creation of the peculiar chalk outcrop at Culver Cliff was complex, and had long-lasting effects on the sedimentation in this part of the Wessex Basin.

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