SHORE PLATFORMS

Niamh Cullen and Mary Bourke

Shore platforms are primary erosional geomorphological features associated with rocky coastlines. These landforms have many names, which are often based upon the inferred process involved in their formation. Examples include wave-cut platforms, abrasion platforms, intertidal platforms and wave benches. Many of these features are backed by cliffs, although they may also occur on low-lying rock shorelines or in association with beaches and sea walls. In some places, boulder banks and the accumulation of other sediments may obscure them from view, even at low tide. Globally, the percentage of coastlines fronted by shore platforms is unknown. In Ireland, however, mapping has revealed their widespread distribution along its rock-dominated coastlines.[8]

These platforms have been classified into three main types but this simple and widely used designation belies the diversity of platform morphologies that exist (Figure 10.12).[9] Shore platforms along the Irish coast occur in a variety of rock types, including limestone, sandstone, mudstone and hard igneous rocks. How and when these features formed is still under debate, but the huge variability in their morphology suggests that a combination of inheritance factors – such as rock type, geological, climatic and sea-level history – all play a significant role in their formation; they are not formed simply by contemporary processes (Figure 10.13a–e).

Present-day processes that influence the weathering and erosion of these extensive shoreline surfaces, however, include marine (for example, hydraulic action) and subaerial (for example, thermal expansion and contraction and salt weathering) processes. In addition to these, biological and chemical action also contribute to the rates and styles of rock breakdown. In Ireland, chemical weathering is most evident on the Carboniferous limestone shore platforms located along western coasts, as found in County Clare and County Sligo, and results in distinct morphologies. These platforms are controlled particularly by the angle of the rock bedding and thickness, with many distinctive rock benches exposed above the active shoreline platform. In contrast, bioerosion occurs more frequently in soft rock lithologies, such as siltstones and mudstones. These rock types are widespread in occurrence on Ireland's coasts, including in areas dominated by limestones, as in County Clare, or the sandstones of southern coasts (Figure 10.14a and b).

The rate of platform erosion along Ireland's coast is currently unknown. Globally, mean annual rates of vertical erosion (downwearing) on shore platforms, measured using a micro-erosion meter, are 0.397mm/yr, 1.282mm/yr and 0.625mm/yr for igneous, sedimentary and metamorphic rocks respectively. Although measurements of shore platform erosion have tended to focus on the micro-scale (mm/yr to cm/yr), geological controls, such as the spacing and orientation of joints and fractures, have been shown to strongly influence erosion of

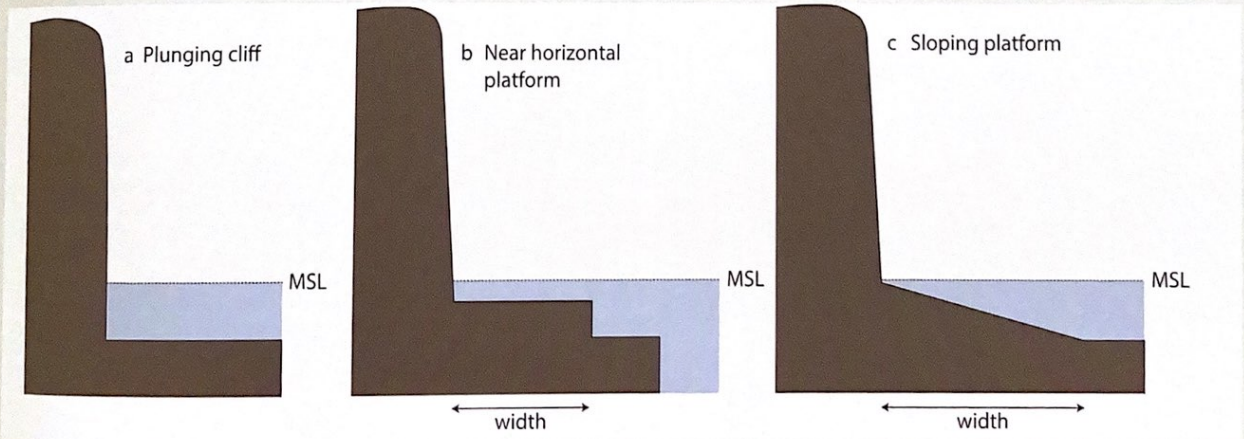

Fig. 10.12 COASTAL PLATFORM TYPES. Three main types of platform are recognised, based on their relationship to mean sea level and shape: a. plunging, b. horizontal, c. sloping. Shore rock platforms are generally exposed during some stage of a tidal cycle, but also exist completely submerged below water level at all times. If the shore platform is never exposed, even at low tide, and the adjacent cliff dives straight into deep water, it is termed 'plunging', as illustrated in a. Many examples of plunging cliffs and linked rock platforms occur along the west coast of Ireland. Most commonly this type of platform results from the dominant influence of the bedrock characteristics (that is, where the rock bedding is horizontal) and/or possibly from former sea-level changes. Shore platforms, also known as wave abrasion surfaces, develop usually at the toe of a cliff face, through wave erosion of the bedrock. They extend seaward from the cliff to the offshore limit of wave erosion, or to the seaward extent of the rock outcrop. In some places, the present-day shore platform is truncated offshore by another cliff, as shown in b, which may have been formed during an episode of lower sea levels. Platforms generally are either horizontal in shape (b), or sloping (c), at an angle of *c.*1–5 degrees in the seaward direction. This basic morphology is influenced strongly by the factors of bedrock geology and the tidal height range, over which the local spectrum wave action operates. The seaward dipping platforms are characteristic of wave-and-tide-dominated coasts. Comparatively flat platforms can occur in sedimentary rocks possessing horizontal bedding. Their shape and width, often forming as narrow platforms, can also be the result of the control of a microtidal range and/or exposure to processes of water freezing and are developed on ice dominated coasts, known as paraglacial. These are found today in high-latitude, Arctic-type regions, or in formerly glaciated environments, such as those of Ireland. [Source: adapted from Sunamura T., 1992. *Geomorphology of Rocky Coasts*. Chichester: John Wiley]

Fig. 10.13 (above) Shoreline Platforms in Ireland. a. Steeply dipping sandstone platform at Corraun, County Mayo [Source: Niamh Cullen]; b. washboard-type morphology in sandstone at Myrtleville, County Cork [Source: Niamh Cullen]; c. sub-horizontal limestone creating rock-benched cliffs and a lower shore platform, near the Bridges of Ross, County Clare [Source: David Hodgeson]; d. cliff overhangs and horizontal intertidal to subtidal platform (plunging type), developed in hard, interbedded sandstones and thin mudstones of Precambrian age at Muckross Head, County Donegal [Source: Liam Carr]; e. gently sloping platform backed by sea wall and unconsolidated Quaternary cliffs at Spanish Point, County Clare. [Source: Niamh Cullen]

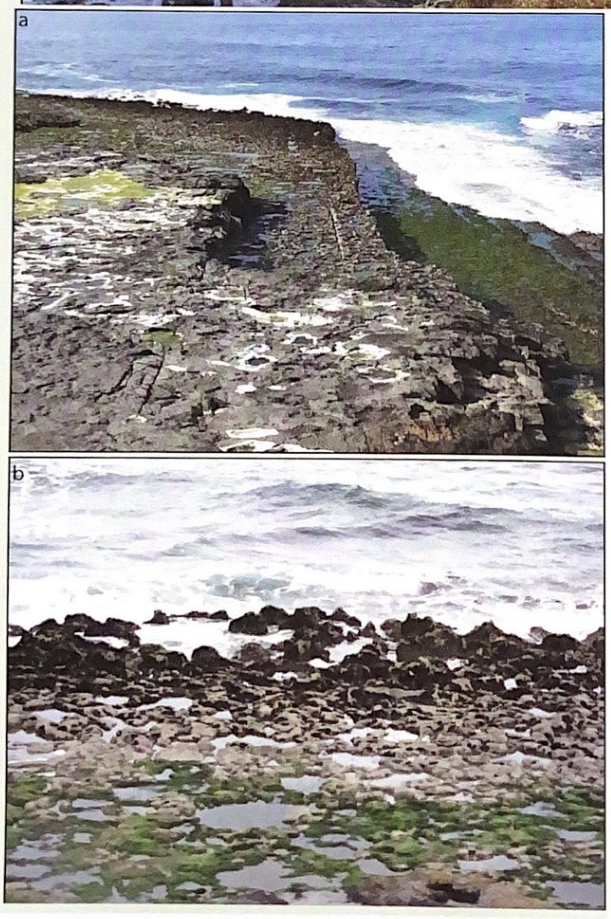

Fig. 10.14 (left) Shore platforms and rock benches on Inis Mór, the Aran Islands, showing the result of the chemical and bio-weathering of these surfaces. a. The bedrock-controlled rock benches exposed on the coast close to Dún Dúchathair (Black Fort), Killeany, Inis Mór. These benches occur within the present intertidal zone and have developed as the contemporary shore platform under wave and tide influences. Storms often bring the higher benches, seen at this site, under the effect of sea and salt spray. Consequently, these limestone surfaces, particularly those forming the active shore platform, are controlled by chemical weathering and, at times, the erosive action of waves and seawater. This creates surfaces showing extensive microscale rock pitting, with multiple larger shallow depressions. On the benches close to sea level, these develop as rock pools, with distinctive marine plant and faunal communities. Many features of normal karst weathering can occur on these surfaces. Sea lettuce (*Ulva*) and other green algae can be seen in the photograph, covering the lowest bench closest to the sea. Rock pools formed on higher benches are still within the intertidal zone and show white salt crusting around their edges as drying-out occurs between high tides. [Source: Robert Devoy]; b. Close-up photograph of the chemical and associated bio-weathering morphology in this limestone platform, showing the rock pools formed at the shoreline. The benthic flora and fauna colonising these shore platforms often provide a form of natural protection. The covering of biota helps to slow down the process of vertical wave erosion and, in a way, contributes towards overall coastal protection. A similar protecting role can be played by the wider supratidal ecology of these shores, as well as by any loose sediments covering the platform. In many places cliff erosion supplies boulder-size material, resulting in the formation of storm beaches with a steep/high gradient. These can also act as natural revetments, forming effectively a coastal protection measure. [Source: Niamh Cullen]

shore platforms at meso-scale (cm/yr to m/yr) by facilitating the removal of blocks via wave quarrying.[10]

Emerging evidence suggests that shore platforms may play an important role in protecting the coastline from erosion, by attenuating wave energy before it reaches the hinterland. Shore platforms also provide habitats for a range of intertidal organisms, such as limpets, mussels and micro- and macro-algae, which may be at risk from the effects of 'coastal squeeze', due to rising sea levels associated with climate change. Despite the intrinsic value of shore platforms and their geodiversity, until recent decades they have received relatively little attention as coastal environments, especially compared to the recognition given to the uses and value of soft sedimentary coasts with their beaches and dunes. In addition to ecosystem services provided by shore platforms, and of rocky coasts in general, the cultural value (for example, tourism and social amenity provision) of these coastal landforms warrants much greater attention (see Chapters 27: Tourism and Leisure and 33: Climate Change and Coastal Futures).[11]

Coastal Boulder Deposits on the Aran Islands

Ronadh Cox

Ireland's western coasts, imaged by the media most commonly as steep bedrock cliffs with open-ocean exposure, host some of the world's most spectacular coastal boulder deposits (CBD). These landforms easily rival in dimensions and scale those CBD found, for example, on the hurricane-driven coastal systems of Pacific ocean islands, including Hawaii and coasts of the Pacific shoreline rim, including those found in New Zealand, Chile or those of Atlantic Canada. CBD are generally perched above the highest high-tide levels and preserve a partial record of the history of these coasts' major storm events. Storms and waves are capable of transporting large rocks against gravity, depending on their shape characteristics, with flatter boulders able to be moved preferentially much further. As a result, very large boulder-sized blocks, and bigger, can be moved both upward and inland, to sit stranded for years or even centuries, as CDB, before the next big storm event, or even a tsunami (see Chapter 2: The Coastal Environment: Physical Systems, Processes and Patterns).

The highest deposits, situated *c.*45m above high water, are on Erris Head in County Mayo, and near Cathaoir Synge on the western coast of Inis Meáin. Boulders at those elevations are relatively small, mostly weighing less than 1 tonne, but have been moved and assembled in heaps at such sites by wave

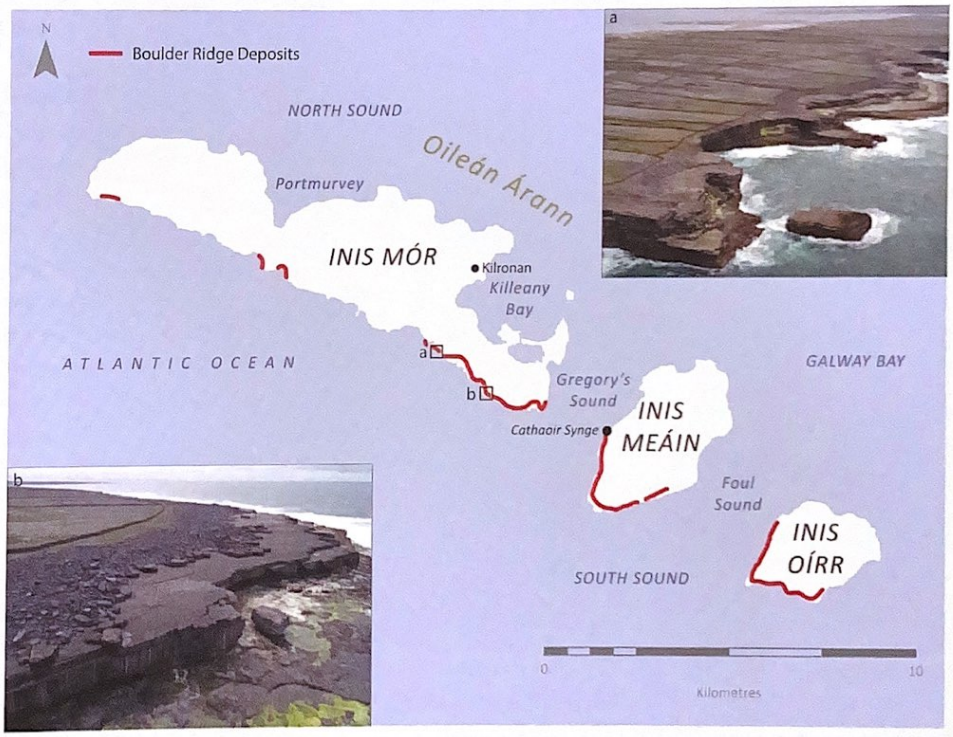

Fig. 10.15 Coastal boulder deposits (CBD) on the Atlantic-facing coasts of the Aran Islands (Oileán Árann), County Galway. a. View along the south-west coast of Inis Mór, east toward the Burren and the other Aran Islands, showing the extent and scale of these limestone-dominated coasts. The prominent cliff-edge rock benches, shore platforms and the linked CBD are visible. The heights and widths of the rock benches, particularly of the upper surfaces, are controlled by the bedrock geology. The effects of former Quaternary (or even earlier) sea-level changes on these geological features, and the subsequent development of shore platforms through the operation of coastal processes, impact only the rock benches closest to the sea. Extensive vegetation is largely absent from the cliff top, upper surface, on which the main spread of boulders and other loose rocks occurs. This surface has also been stripped of former soil cover, both by glaciations and, more recently, by the processes of erosion together with subaerial weathering and the impacts of people, from the time of the first Neolithic farmers onward (see Chapter 16: The Inhabitants of Ireland's Early Coastal Landscapes). The linear boulder spread over this surface (that is, the length and width of the main accumulation of boulders) is visible between the cliff edge and the field boundary wall. The boulders, once broken away from the eroding cliff edges, have been emplaced in their present positions by storm surge events. b. A closer view of the CBD on this coast, showing the range in size of the mega-clast boulders. A few of the limestone boulders can weigh >500 tonnes. Examples of some of these can be seen on both the upper and lower rock benches. Observation and monitoring show that the boulders are moving on the shore platform through contemporary wave and storm actions. [Photo source: Peter Cox; map data source: Cox, R., Zentner, D.B., Kirchner, B.J. and Cook, M.S., 2012. Boulder Ridges on the Aran Islands (Ireland): Recent movements caused by storm waves, not tsunamis. *The Journal of Geology*, 120(3), pp. 249–272]