INFOMAR Integrated Mapping for the Sustainable Development of Ireland's Marine Resource
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Geological Survey Suirbhéireacht Gheolaíochta Ireland | Éireann
Marine Institute Foras na Mara

Marine Geoscience Report 026

The Burren

Overview

The Burren forms the rocky southern margin of Galway Bay on Ireland's west coast, stretching from Black Head eastwards towards Ballyvaughan and southwards towards the Cliffs of Moher. It is internationally recognised for its extensive limestone pavements, unusual flora and rich archaeological heritage, and is a core part of the Burren and Cliffs of Moher UNESCO Global Geopark (Doyle, 2022). The name "Burren" derives from the Irish *Boireann*, meaning "rocky place", a direct reference to the area's widespread bare limestone (National Parks, 2025).

Offshore, the same Carboniferous limestone plateau continues beneath the sea as a broad, gently sloping bedrock platform. INFOMAR bathymetry data reveals a terraced seafloor with shallow benches, joint-controlled pavements and short submerged cliffs that closely mirror the stepped hillsides, terraces and pavements on land.

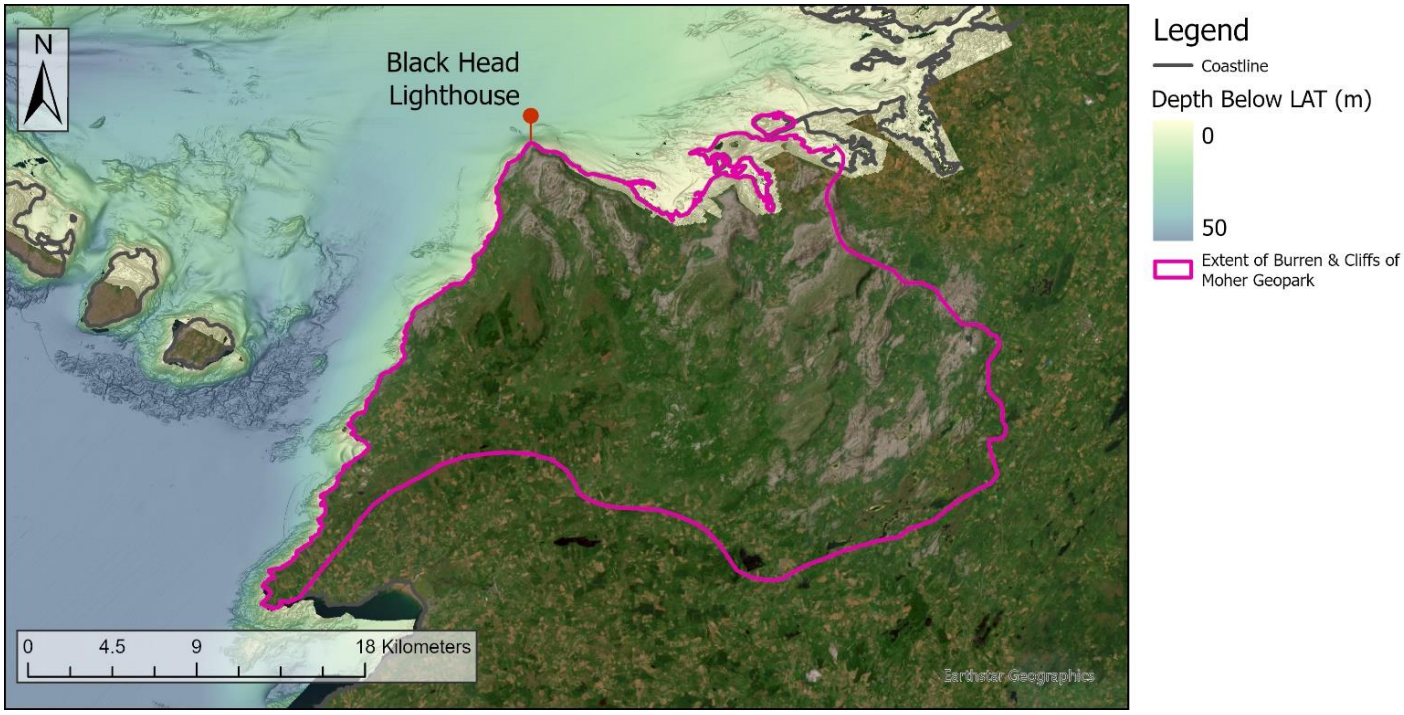

Figure 1: Bathymetry around the Burren, with the extent of the Burren and Cliffs of Moher UNESCO Global Geopark indicated. Depths are referenced to Lowest Astronomical Tide (LAT).

The Burren coast fronts the more exposed outer part of Galway Bay and the South Sound between the Aran Islands and the Clare coast. Residual circulation in the bay is broadly anti-clockwise, with Atlantic water entering mainly through the South Sound and leaving predominantly via the North Sound off Connemara (Wheeler, et al., 2023). Strong tidal currents accelerate around Black Head and other headlands, sculpting dune fields, scour hollows and sediment corridors that stand out clearly in the bathymetry and highlight the interaction between bedrock, glacial legacy and modern processes.

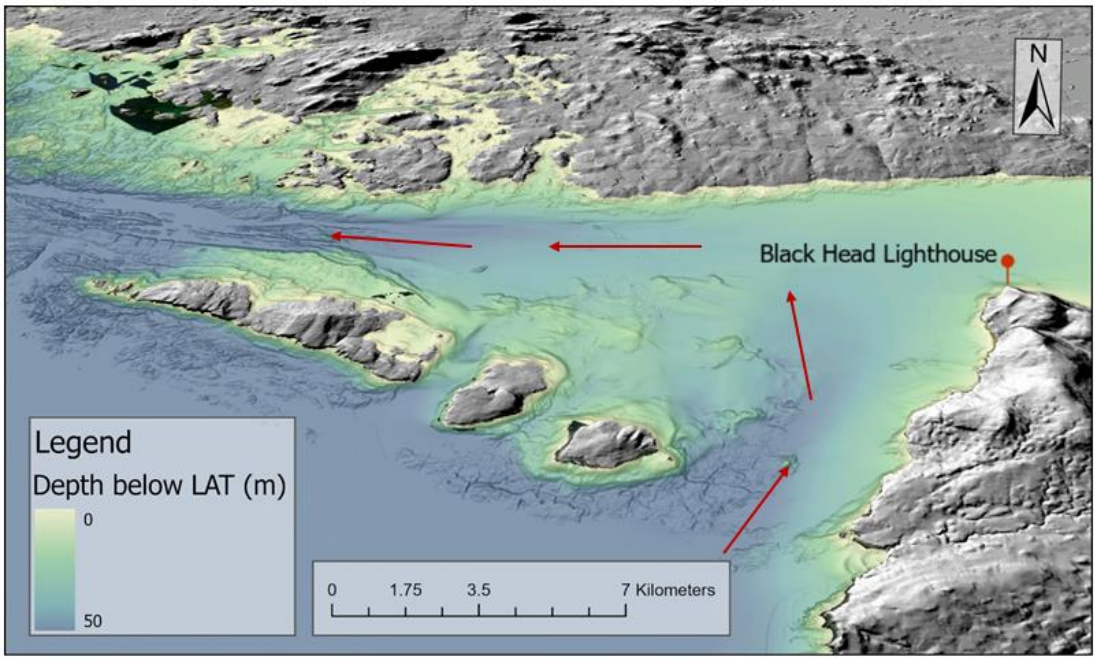

Figure 2: 3D bathymetry of the South Sound, between Inisheer and the mainland, with residual currents indicated by red arrows.

Regional Geology

The Burren is underlain by a thick succession of Carboniferous sedimentary rocks, dominated by limestones deposited around 330-325 Ma in warm, shallow tropical seas south of the equator. These limestones are typically medium- to thick-bedded, grey and fossil-rich, containing corals, crinoids and brachiopods that indicate deposition on a shallow marine shelf. The limestone pile in the region is up to several hundred metres thick and rests on older Devonian rocks that do not crop out at the surface (McNamara & Hennessy, 2010).

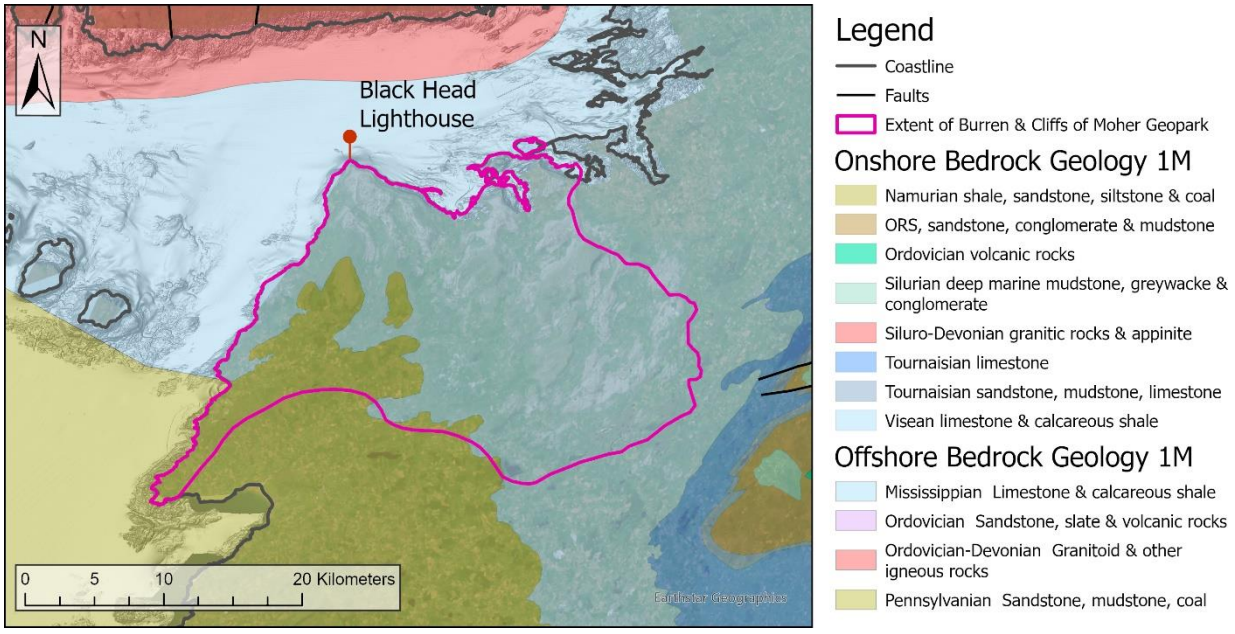

Figure 3: Geology of the Burren.

During the Late Carboniferous, compressional forces associated with the Variscan Orogeny, a significant continental collision and mountain building event, gently folded the limestone succession and generated sets of faults and joints (Pracht & Freely, 2004). The limestones in the Burren now dip only a few degrees, but the combination of slight tilting, bedding and jointing has produced a staircase of structural benches and scarps expressed both onshore and offshore. Following the Variscan Orogeny, there is a significant gap in the geological record in the region from the end of the Carboniferous until the Quaternary, around 2.58 Ma. This gap is largely due to prolonged uplift and erosion, which removed much of the material deposited during this interval (Pracht & Freely, 2004).

In the Quaternary, the region was repeatedly glaciated. During the last glaciation, the British-Irish Ice Sheet extended across Galway Bay, with ice flowing mainly towards the west and south-west from domes in Galway (McCullagh, et al., 2020). On land, the ice scoured and streamlined the limestone surface, creating drumlins, overdeepened valleys and smoothed pavements, and stripping soil and weathered rock from much of the plateau. This sharpening of pre-existing dissolution features contributed to the Burren's classic glaciokarst character, where glacially smoothed pavements have been further modified by solution (McNamara & Hennessy, 2010).

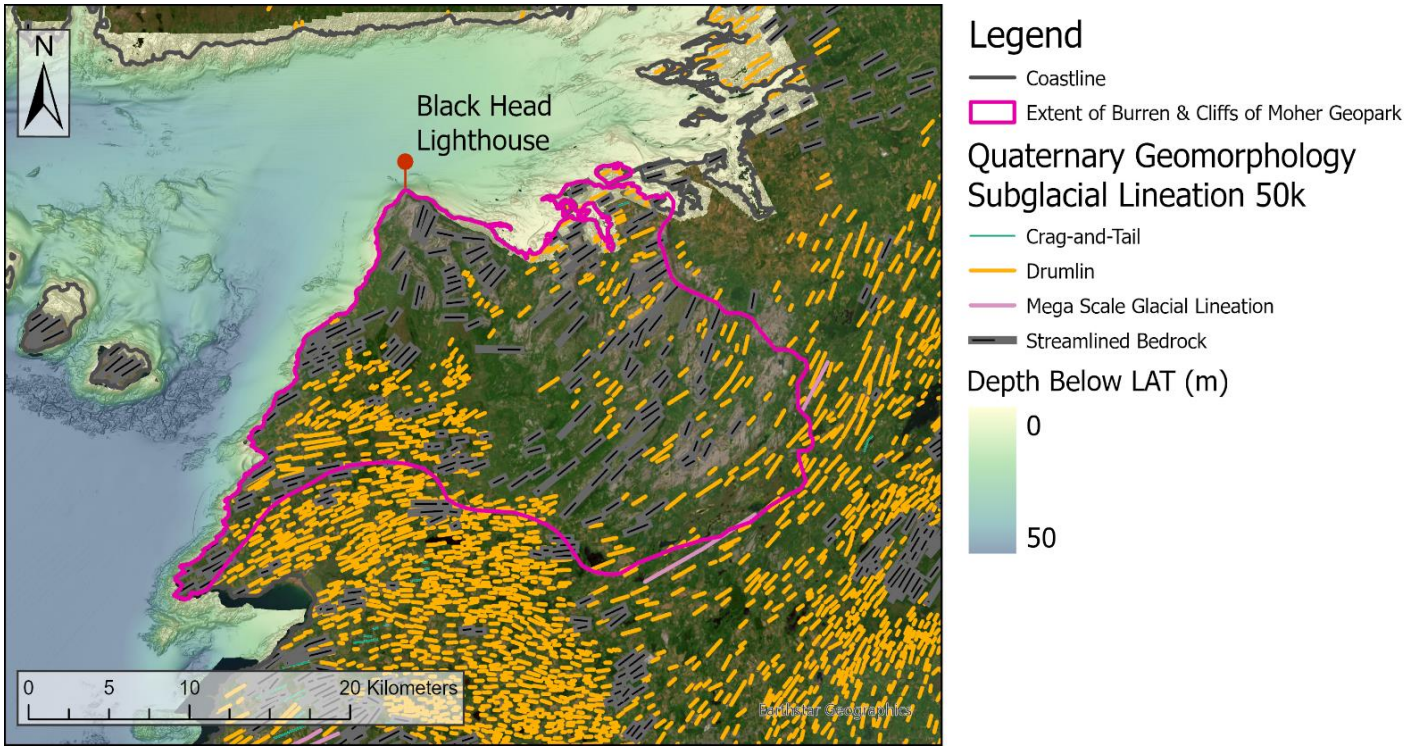

Figure 4: Quaternary geomorphology of the Burren.

As the ice sheet retreated after the Last Glacial Maximum 24,000 years ago and sea level rose, former river valleys and low-lying coastal plains were drowned, forming Galway Bay and submerging the outer parts of the Burren platform (Ó Cofaigh, et al., 2012).

The Burren

The distinctive Burren landscape of County Clare continues beneath the bay's southern margin as a terraced limestone platform shaped by glacial and karstic processes. INFOMAR bathymetry data shows the bedrock stepping down from the coast into the bay in a series of ledges and scarps controlled by bedding and jointing. Off Black Head and along the Burren shoreline, these joint-controlled breaks form submerged extensions of onshore pavements, locally capped or partly masked by a thin sediment cover.

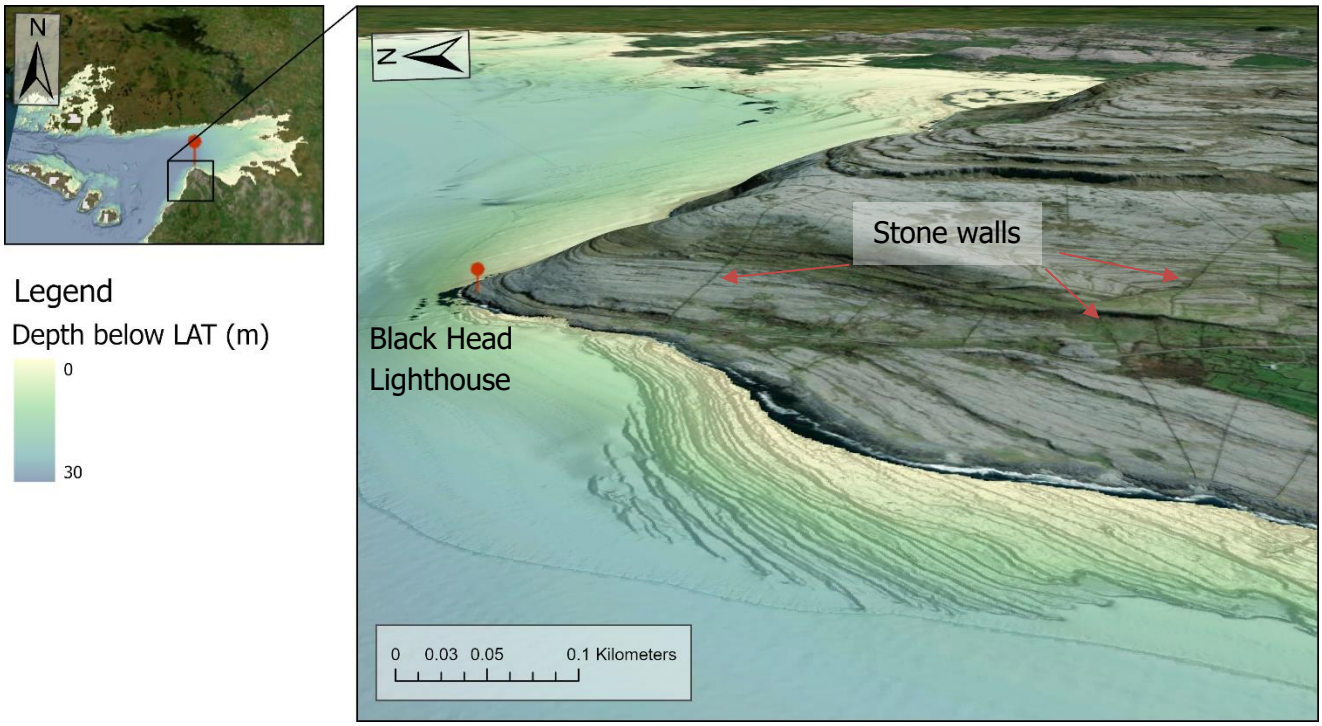

Figure 5: 3D imagery displaying terraced bedding onshore and offshore the Burren, with stone walls indicated.

Karst describes terrain developed on soluble rocks, where subaerial dissolution, when the limestone was exposed to air, by slightly acidic rainwater and soil water along fractures and bedding planes creates a characteristic suite of landforms – pavements, fissures, dolines and caves – and where much of the drainage is underground. Palaeokarst (or fossil karst) refers to ancient karst systems that have lost their active drainage function, for example where old solution surfaces and cavities created during earlier periods of subaerial exposure have since been buried by younger sediments (Drew, 2018).

In the Burren succession, the top of the Burren Formation is marked by an irregular palaeokarst surface overlain by a distinctive fossil-rich limestone horizon, indicating that during the Carboniferous, parts of the limestone pile were periodically uplifted and exposed subaerially, allowing weathering and dissolution before later marine inundation and renewed carbonate deposition buried the surface beneath younger limestones (McNamara & Hennessy, 2010).

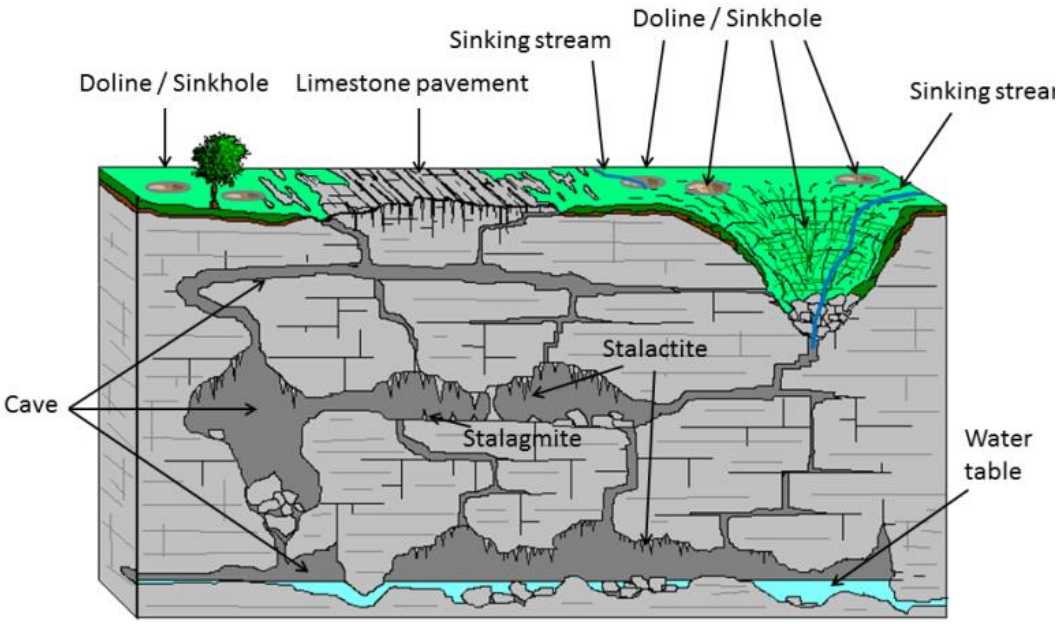

Figure 6: Diagram of karst landforms from (Geological Survey Ireland, n.d.).

Underwater, karst expression differs from the sharp, open grikes seen on land. On the submerged terraces, bathymetry reveals irregular pitting, shallow depressions and possible sinkhole-like features where dissolution has exploited joints and fractures beneath a thinning sediment veneer (McNamara & Hennessy, 2010). Many of these hollows are partly infilled by marine sediment and bioclastic debris, indicating that palaeokarst cavities and solutional lows now act as traps for younger material.

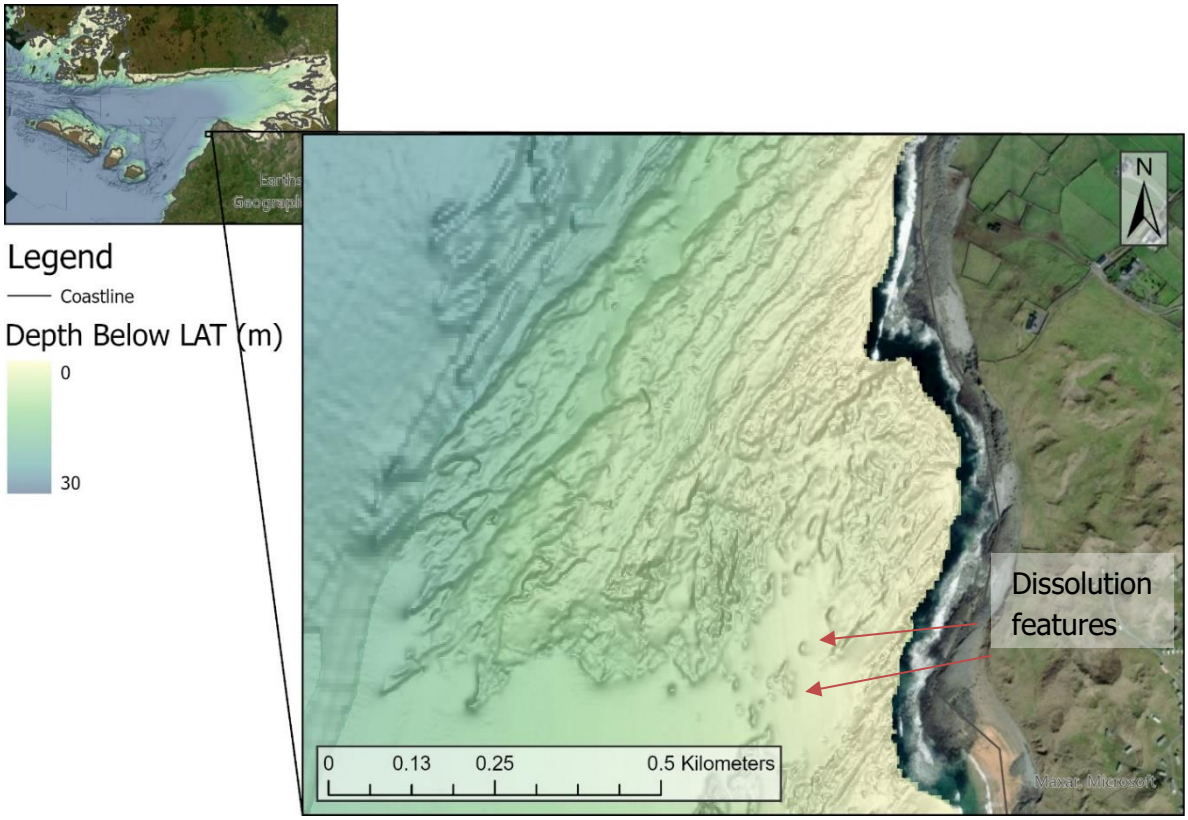

Figure 7: Karst dissolution features.

Submerged terraces at around 20 to 30 m depth off the Burren coast are interpreted as post-glacial rock platforms and palaeoshorelines that are now colonised by marine biota (McCullagh, et al., 2020). Regional palaeogeographic reconstructions show that, as the last ice sheets retreated and relative sea level rose, coastlines around north-west Europe migrated substantially, with large areas of continental shelf transitioning from dry land to seabed (Brooks, et al., 2011). Against this wider pattern of changing palaeocoastlines, the Burren terraces mark a geological and ecological continuum between land and sea: the same limestone architecture that supports grasslands, pavements and turloughs onshore underlies kelp-covered ledges, faunal-encrusted cliffs and sediment-filled hollows offshore.

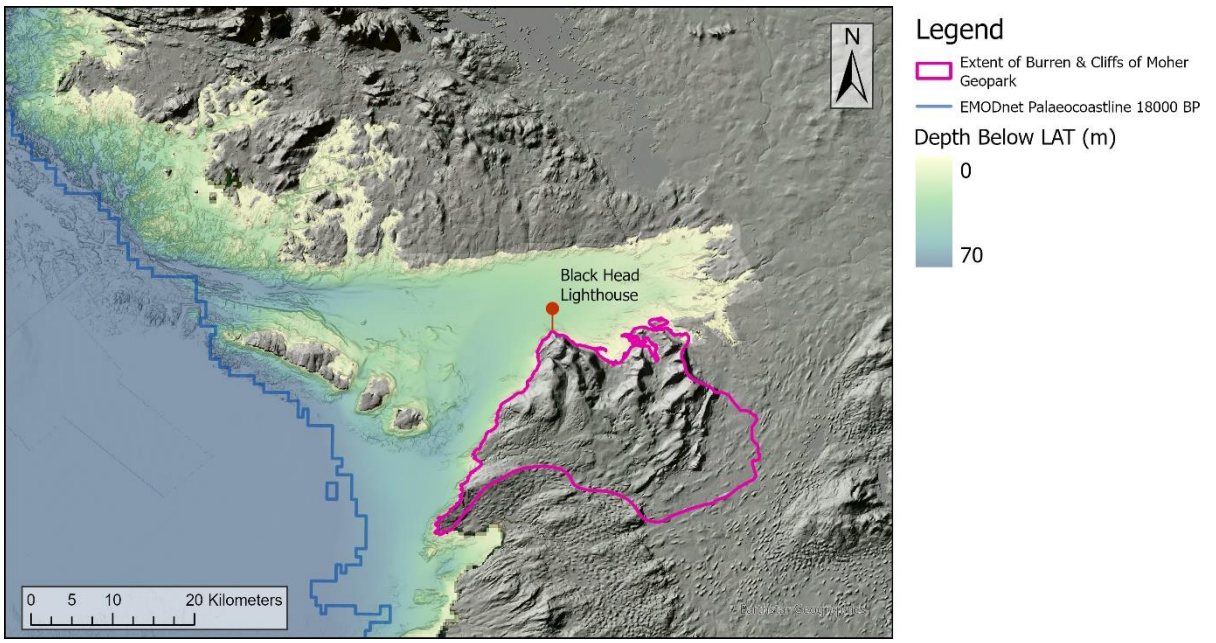

Figure 8: Modelled palaeocoastline of Ireland approximately 18 ka. Palaeocoastline data from (Brooks, et al., 2011).

Scour off Black Head

Where seabed currents encounter resistant obstacles such as outcropping bedrock, flow accelerates and becomes locally turbulent, winnowing finer sediment and excavating scour depressions in the downstream, or lee, area. This process is well expressed west of Black Head, where isolated limestone highs disrupt residual and tidal currents and generate clusters of scour hollows (McCullagh, et al., 2020).

The mapped scour layer shown in Figure 9, with polygons delineating scour features, is derived from the integrated geomorphology and substrate mapping of Galway Bay by McCullagh et al. (2020) and highlights how scour is concentrated around bedrock highs and other zones of enhanced near-bed flow. These hollows are typically a few tens of centimetres to several metres deep, with steep sides and floors commonly lined by coarse gravel and lag deposits that record the removal of finer material under strong currents. Multibeam imagery shows the seabed west of Black Head marked by depressions with coarse rims, which are typical of current-driven scouring around rock obstacles (McCullagh, et al., 2020). Scouring increases seabed complexity by exposing hard substrate, creating flow-sheltered pockets and maintaining localised high-energy seabed. From a practical perspective, these natural scour features provide useful analogues for how currents might affect human-made structures such as piers, cables or moorings in comparable settings.

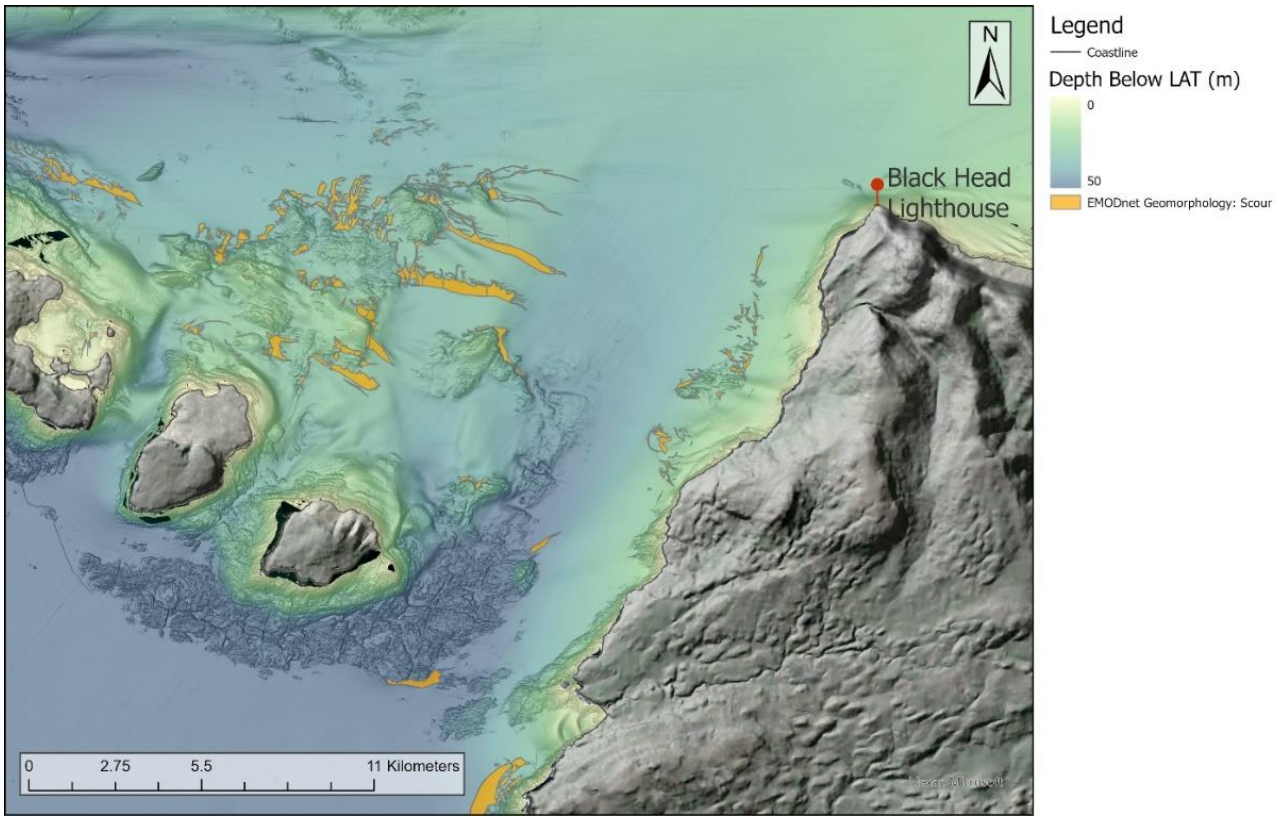

Figure 9: Bathymetry west of Black Head with mapped scour polygons overlain. Scour data from (McCullagh, et al., 2020).

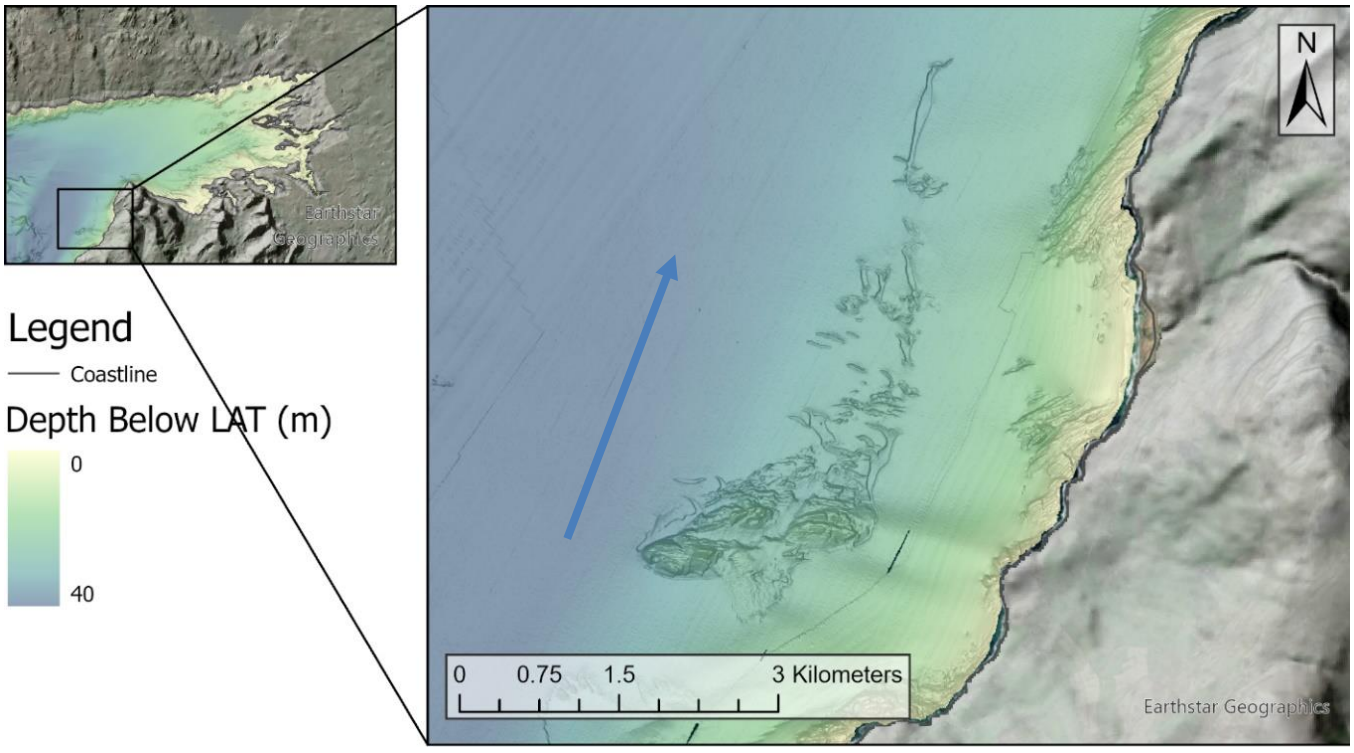

Figure 10: 3D bathymetry west of Black Head showing scour depressions formed by current interaction with outcropping bedrock. The arrow indicates residual current direction, with flow from the south, and scour developed predominantly to the north (downstream/lee side) of the bedrock outcrop.

Sand Dunes

Where sufficient mobile sediment is available, tidal currents sculpt the seabed into subaqueous dunes. These sand dunes, comparable to desert dunes, are built by strong flows that mobilise sand and pile it into ridges; their shape and orientation provide a clear record of present-day sediment transport pathways. East of Black Head, several notable dunes lie close to the coast (McCullagh, et al., 2020).

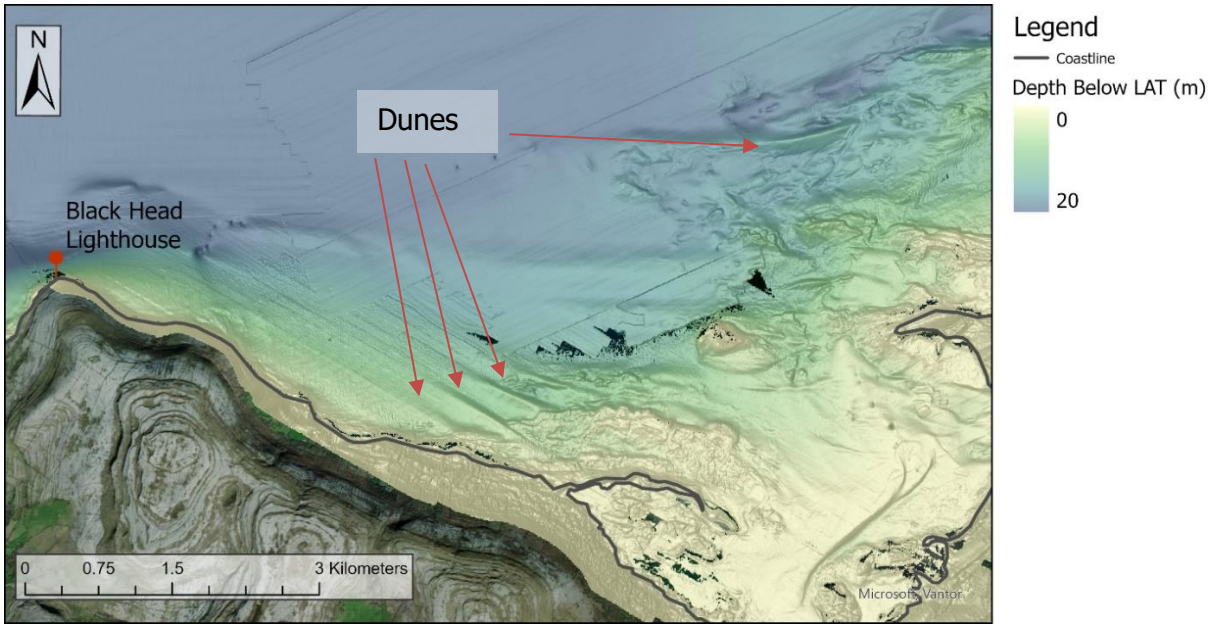

Figure 11: Sand dunes east of Black Head.

The dunes closest to Black Head are elongated and slightly asymmetrical with rounded crests and are composed chiefly of sand reworked by tidal currents. Further east, two more isolated dunes have been mapped: one is larger and crescent-shaped, built from sand with patches of coarser sediment, while the other is narrower and sinuous, formed almost entirely of sand (McCullagh, et al., 2020).

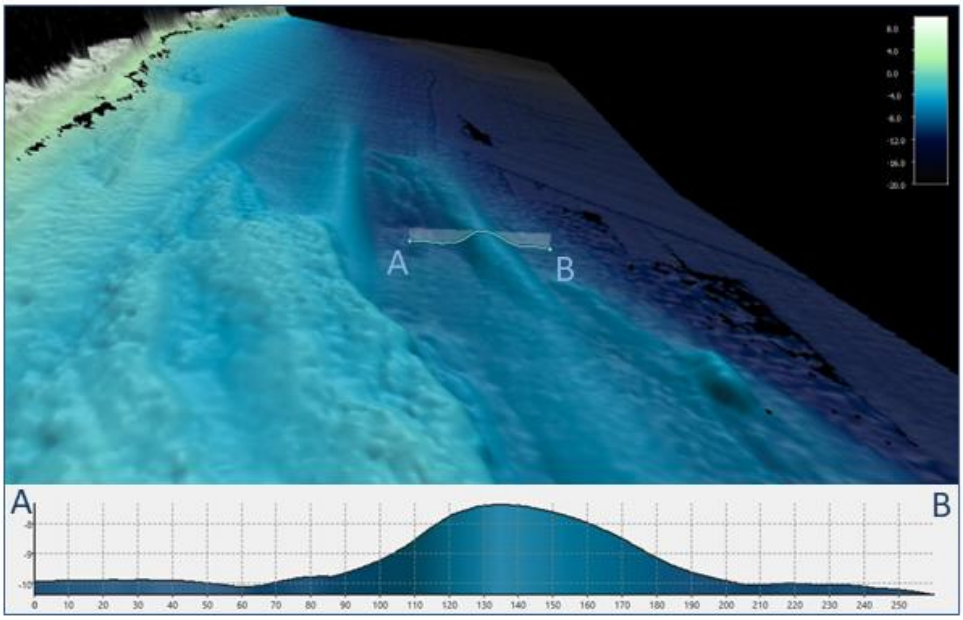

Figure 12: Bathymetric profile across a sand dune east of Black Head, illustrating dune relief and slight asymmetry.

Geoparks and Geoheritage

The Burren and Cliffs of Moher form part of the Burren and Cliffs of Moher UNESCO Global Geopark, an internationally recognised "living landscape" where geological heritage is managed alongside education, community benefit and sustainable tourism (Geological Survey Ireland, n.d.). UNESCO Global Geoparks are single, unified geographical areas that contain sites and landscapes of international geological significance, managed through a holistic approach that links protection, education and sustainable development. As of September 2025, there are 229 UNESCO Global Geoparks in 50 countries worldwide (UNESCO, 2025). The Burren and Cliffs of Moher Geopark covers over 500 km² of County Clare, spanning the Burren limestone plateau and the Atlantic coast. UNESCO Global Geopark status is not permanent: each geopark undergoes a formal revalidation every four years to assess ongoing quality, governance, interpretation and delivery (UNESCO, 2025).

Within this global network, Ireland's geoparks form a small but important set of place-based geoscience areas. Across the island of Ireland, four areas currently hold UNESCO Global Geopark status: Burren & Cliffs of Moher (Clare), Copper Coast (Waterford), Cuilcagh Lakelands (Cavan/Fermanagh), and Mourne Gullion Strangford (Down/Armagh) (Geological Survey Ireland, n.d.). In addition, Joyce Country and Western Lakes (Galway/Mayo) was granted UNESCO Global Geopark status by the UNESCO Geoparks Council in September 2025, with formal ratification expected at a UNESCO Executive Board meeting in 2026 (Department of Climate, Energy and the Environment, 2025).

Biodiversity

The East Burren Complex SAC encompasses upland limestone pavement, characterised by clints, flat limestone blocks, separated by grikes, open solution-widened fissures, as well as orchid-rich calcareous grasslands, turloughs, hard-water lakes and caves. These habitats support a rich flora and fauna, including species such as otter and lesser horseshoe bat (National Parks & Wildlife Service, 2016).

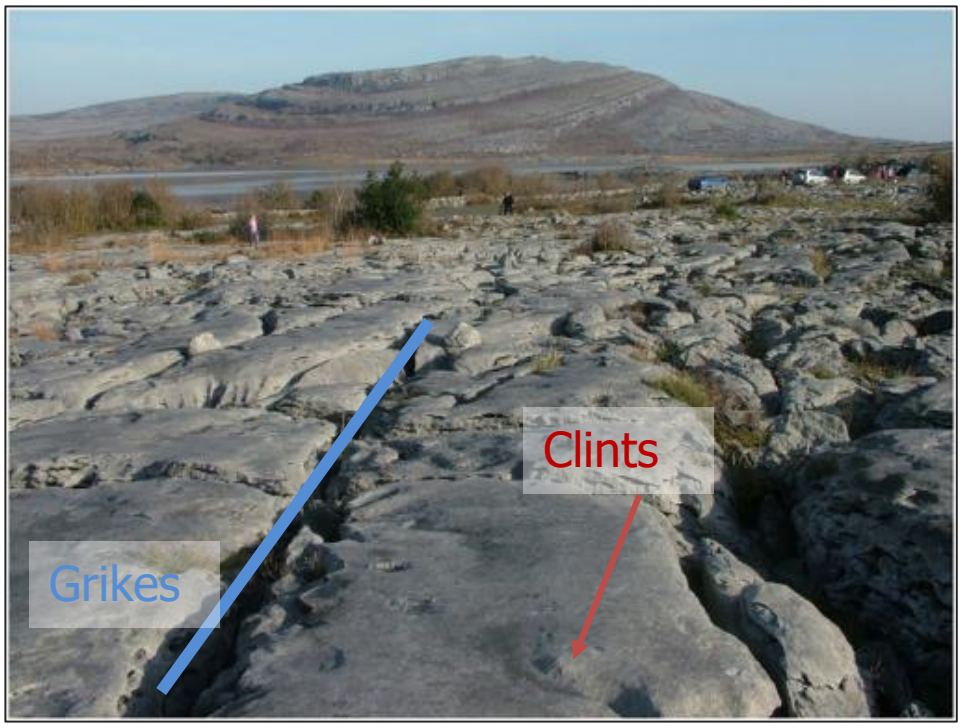

Figure 13: Image of limestone pavement in the Burren, from (Doyle, 2022).

Along the shore, the Black Head-Poulsallagh Complex SAC includes a full range of rocky Burren habitats from coastal limestone pavements to high heaths, as well as dune systems at Fanore, extensive vegetated shingle and an extensive network of sea caves. Its intertidal reefs are notable open-coast shores in Britain and Ireland, with gently stepped limestone platforms, shallow rockpools and a distinctive biota including purple sea urchins, coralline algae and a range of red and brown seaweeds close to their northern distribution limits (National Parks & Wildlife Service, 2015).

These coastal communities continue into the shallow subtidal zone, where submerged limestone ledges and blocks provide firm substrate for kelp, sponges, bryozoans and other encrusting organisms, while pockets of sand and gravel between reefs host infaunal burrowers and mobile fauna (National Parks & Wildlife Service, 2015). The presence of maërl and seagrass beds in parts of the inner bay, including near some of the dunes, creates structurally complex habitats that enhance biodiversity and are important for conservation under the Habitats Directive (McCullagh, et al., 2020).

Conclusion

The Burren sector of Galway Bay shows how a single geological framework can be expressed across land and sea. Carboniferous limestones, locally capped by a palaeokarstic surface and younger sediments, form a gently tilted platform that has been repeatedly modified by uplift, karstification, glaciation and post-glacial marine processes.

Onshore, this history is recorded in the famous karst landscapes of pavements, grikes and clints, while offshore, bathymetry data reveal the continuation of that story in submerged limestone terraces. Against this structural and karstic template, glacial till, modern muds and sands, sand dunes and scour hollows document changing ice, sea-level and tidal regimes from the last glaciation to the present.

The result is a coastal and submarine landscape shaped by linked geological controls: bedrock type and structure set the broad morphology; karst and palaeokarst add subtle relief and groundwater pathways; glaciation sculpts and strips; and modern hydrodynamics continue to reshape the sediment veneer. Recognising these links between the Burren uplands and the adjacent seabed improves understanding of the landscape and provides useful context for habitat management and future activity along this karstic Atlantic margin.

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