INFOMAR Integrated Mapping for the Sustainable Development of Ireland's Marine Resource
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Marine Institute Foras na Mara



Marine Geoscience Report 014

Pockmarks in Dunmanus Bay

Overview

Dunmanus Bay is a narrow inlet on the south-west coast of Ireland, situated between Bantry Bay and Roaringwater Bay in West Cork. The bay is part of the South Munster Basin, with a geological history spanning the Devonian (419 – 359 Ma) and Carboniferous (359 – 299 Ma) periods. During the Quaternary Period, beginning 2.58 Ma, glacial and glaciofluvial sediments were deposited across the region, leaving the muddy sands that now dominate much of the bay floor.

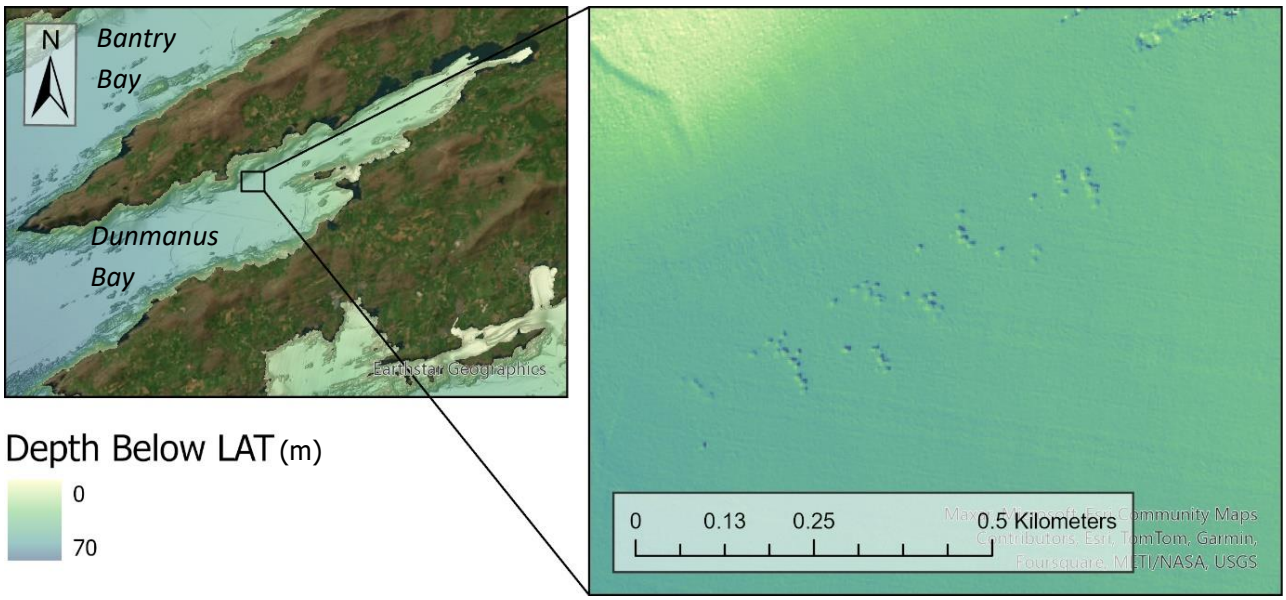


Figure 1: Bathymetry of pockmarks, with overview location of Dunmanus Bay to the left. Depths are referenced to Lowest Astronomical Tide (LAT).

Within these fine-grained seabed sediments lies a field of pockmarks – small, circular depressions formed by the escape of gas or fluids. The presence of such features in Dunmanus Bay is of particular interest due to their implications for fluid migration, seabed stability, and global carbon cycling. Similar pockmarks have been documented elsewhere along the Irish margin, including the north-west Irish Sea, the Malin Shelf and nearby Bantry Bay, showing that these features form part of a wider pattern around the Irish shelf.

Regional Geology

Dunmanus Bay is underlain by a conformable stratigraphic sequence extending from the Upper Devonian (380 Ma) through the Devonian-Carboniferous transition into the Early Carboniferous, from 359 Ma (Hennessy, et al., 2023). The Late Devonian rocks form part of the Old Red Sandstone (ORS) Group and were deposited under semi-arid terrestrial conditions. They include red sandstones, siltstones and mudstones derived from mountainous areas to the north and deposited within the Munster Basin (Pracht & Sleeman, 2002).

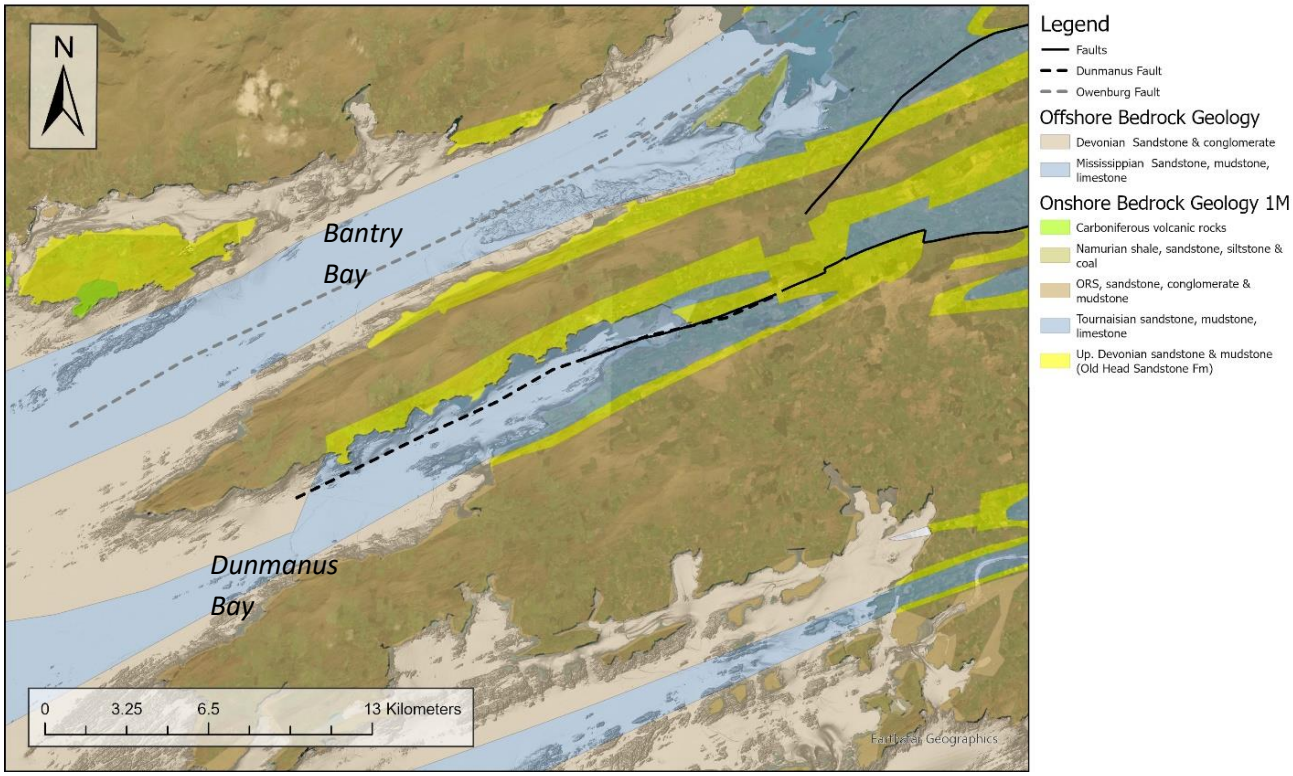


Figure 2: Geology of Dunmanus Bay and Bantry Bay, after (MacCarthy, 2007), highlighting major faults.

A marine transgression during the Late Devonian inundated the margins of the ORS continent with shallow tropical seas, leading to the deposition of marine sands and muds as the South Munster Basin continued to deepen. Marine deposition continued into the Early Carboniferous, from about 359 Ma onwards, accompanied locally by volcanic intrusions and ash deposition (Pracht & Sleeman, 2002). In places, these Early Carboniferous formations contain organic-rich shales that may have contributed to later gas generation (O'Reilly, et al., 2012)

By the Late Carboniferous, around 300 Ma, the Variscan Orogeny, a continental collision and mountain-building event, caused intense tectonic compression from the south. This deformation folded and faulted the Devonian and Carboniferous strata into broad E – W structures. As a result, Carboniferous rocks underlie many of the low-lying areas, including the bay itself, while the surrounding peninsulas and ridges are formed mainly of older, harder Devonian rocks. A prominent structure is the Dunmanus Fault, which crosses the bay parallel to the coastline. Faults of this kind can provide pathways for fluids and gases to migrate upwards through the crust (O'Reilly, et al., 2012).

Following the Variscan Orogeny, there is a significant gap in the geological record from the end of the Carboniferous Period until the Quaternary, beginning around 2.58 Ma. This gap largely reflects prolonged uplift and erosion, which removed much of the sediment that may have accumulated during this interval.

During the Quaternary, the area was glaciated, and much of the bedrock was covered by glacial and glaciofluvial sediment, especially in valleys and lowlands. These sediments were deposited directly by ice or by meltwater from retreating glaciers (Pracht & Sleeman, 2002). Today, the seabed of Dunmanus Bay consists mostly of muddy sand, with some sandy patches and occasional exposed bedrock, reflecting this glacial inheritance.

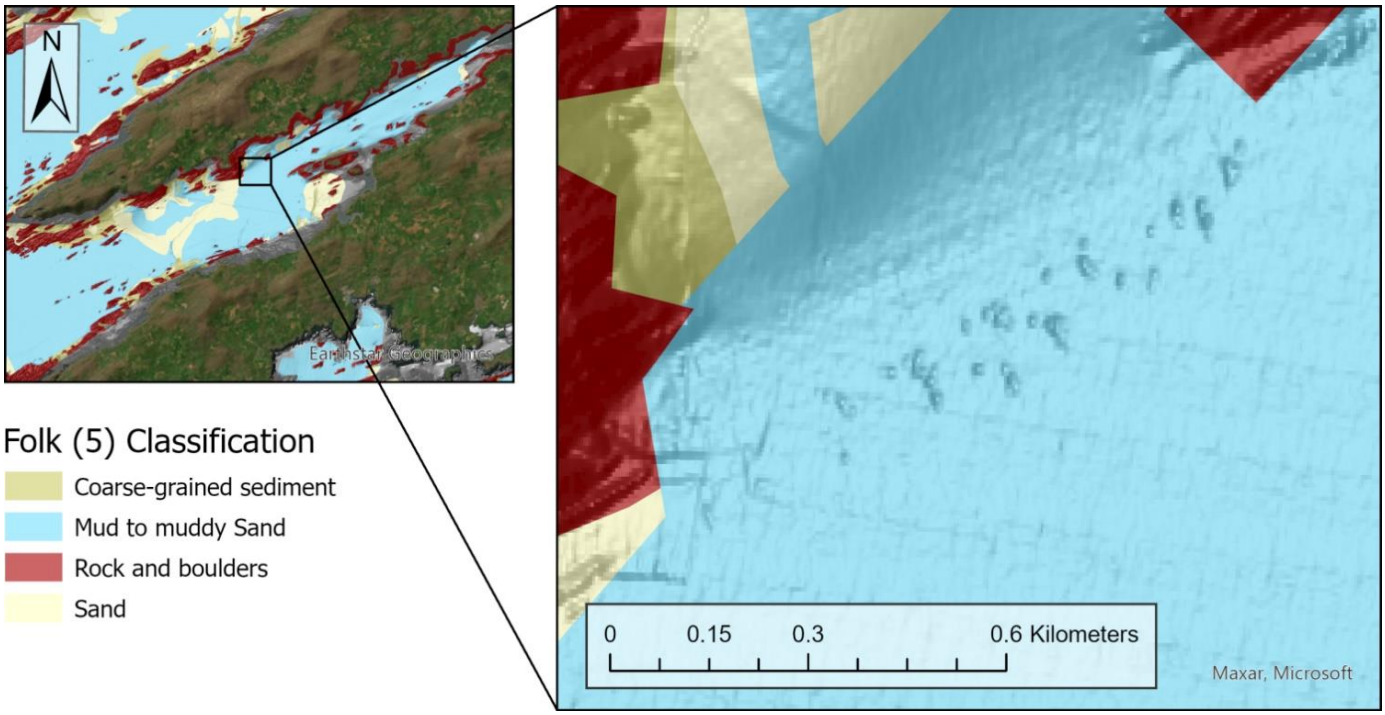


Figure 3: Sediment classification of the pockmark field.

Formation of Gas Pockmarks

Pockmarks are shallow, sub-circular depressions formed by the escape of gas or fluids through soft seabed sediments. As gases such as methane, or fluids, migrate upwards and seep out, they displace sediment and create crater-like features. Pockmarks can occur as isolated features, in linear chains, or clustered in fields, depending on the underlying fluid pathways and sediment conditions (O'Reilly, et al., 2012).

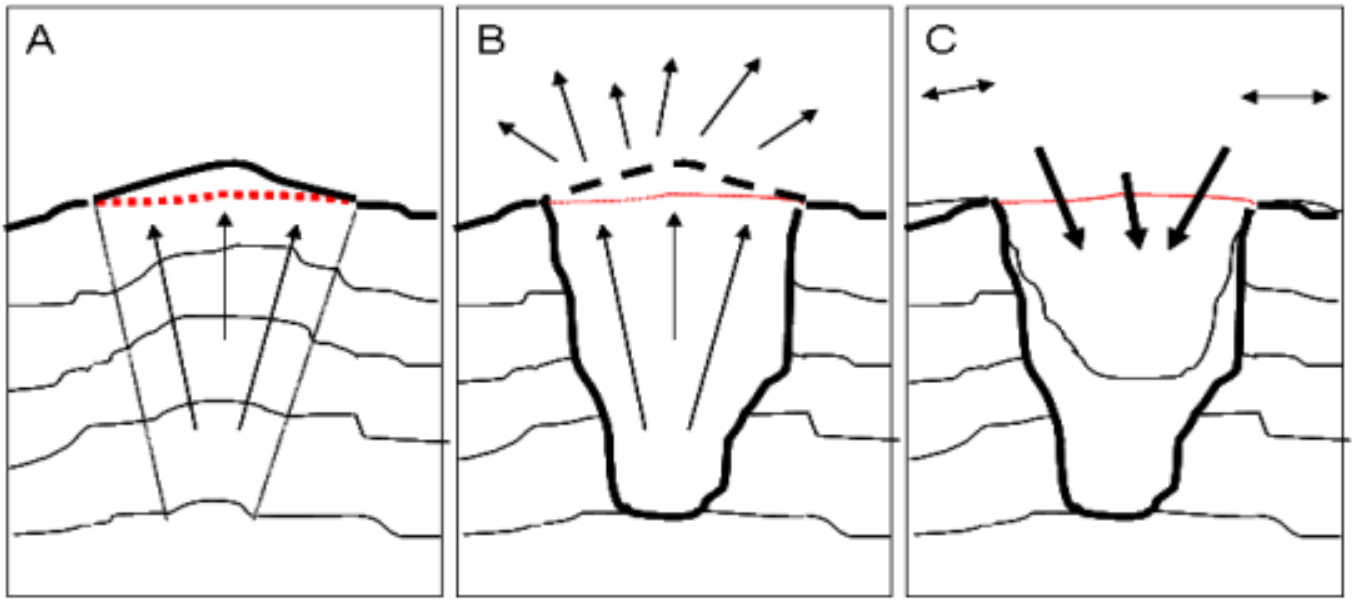


Figure 4: Suspected pockmark formation mechanism. (A) Seabed doming caused by increasing fluid pressure; (B) Blow-out of gas charged sediment; (C) Sedimentation infill and side-wall slumping. Red dotted curve depicts initial seabed profile. Image from (O'Reilly, et al., 2012).

Pockmarks are increasingly recognised as geochemically and ecologically important seabed features. Methane, a potent greenhouse gas, may be transferred from the seabed to the ocean and, in some cases, towards the atmosphere. Microbial oxidation and sediment filtering can intercept some methane, but shallow coastal settings such as Dunmanus Bay may be more susceptible to atmospheric release (O'Reilly, et al., 2021). These emissions can contribute to local and potentially regional carbon budgets. The extent of methane release from the Dunmanus Bay pockmark field remains uncertain (O'Reilly, et al., 2021).

Seepage environments can support distinctive biological communities, including microorganisms associated with methane cycling (Judd & Hovland, 1992). In Dunmanus Bay, the pockmarks mainly support typical benthic communities, with little evidence of specialised methane-dependent fauna (Szpak, et al., 2015). However, subsequent research identified microorganisms involved in methane production and consumption within the sediments (O'Reilly, et al., 2021).

Dunmanus Bay Pockmarks

Dunmanus Bay is approximately 25 km long and over 6 km wide at its mouth, with depths reaching up to 60 m. The mapped pockmark field lies near the northern shore of the bay and comprises approximately 121 depressions, ranging from 5 – 17 m in diameter and up to 1 m deep (Szpak, et al., 2015). The pockmarks are arranged in a linear WSW – ENE orientation, paralleling the bay axis and likely reflecting underlying structural controls. Muddy substrates provide the conditions for gas to accumulate, over-pressurise, and eventually vent. Gas seepage may occur more widely in the bay, but pockmarks are most readily formed and preserved in muddy substrates.

The modest size and shallow depth of the Dunmanus pockmarks, together with low methane concentrations recorded in the water column above them, suggest periodic, low-level gas release rather than continuous vigorous venting. The field appears to experience intermittent venting episodes that are sufficient to form pockmarks, but not large or sustained enough to produce strong methane anomalies in the bay waters (Szpak et al., 2015).

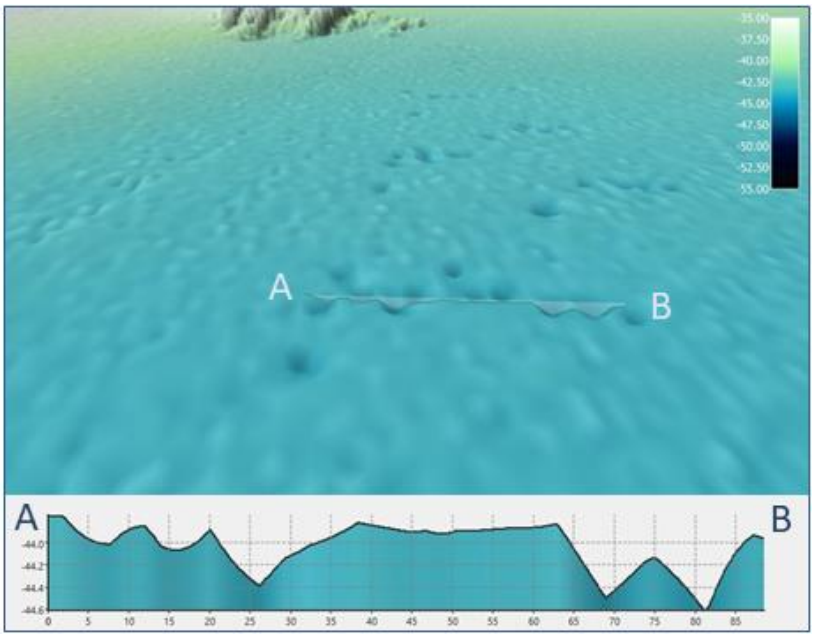


Figure 5: Elevation profile of pockmarks.

Sub-bottom seismic profiles confirm the presence of shallow gas in the area. Acoustic blanking, chimney-like structures and zones of disrupted weak reflections (acoustic turbidity) within the unconsolidated Quaternary sediments indicate vertical gas migration towards the seabed. These chimney features are interpreted as focused pathways for rising gas bubbles and fluids. The gas appears laterally extensive, trapped beneath glacial sediments, and concentrated below the main pockmark clusters (O'Reilly, et al., 2021). Water-column acoustic data have also recorded streams of gas bubbles rising from some pockmarks, confirming active seepage into the bay (O'Reilly, et al., 2012).

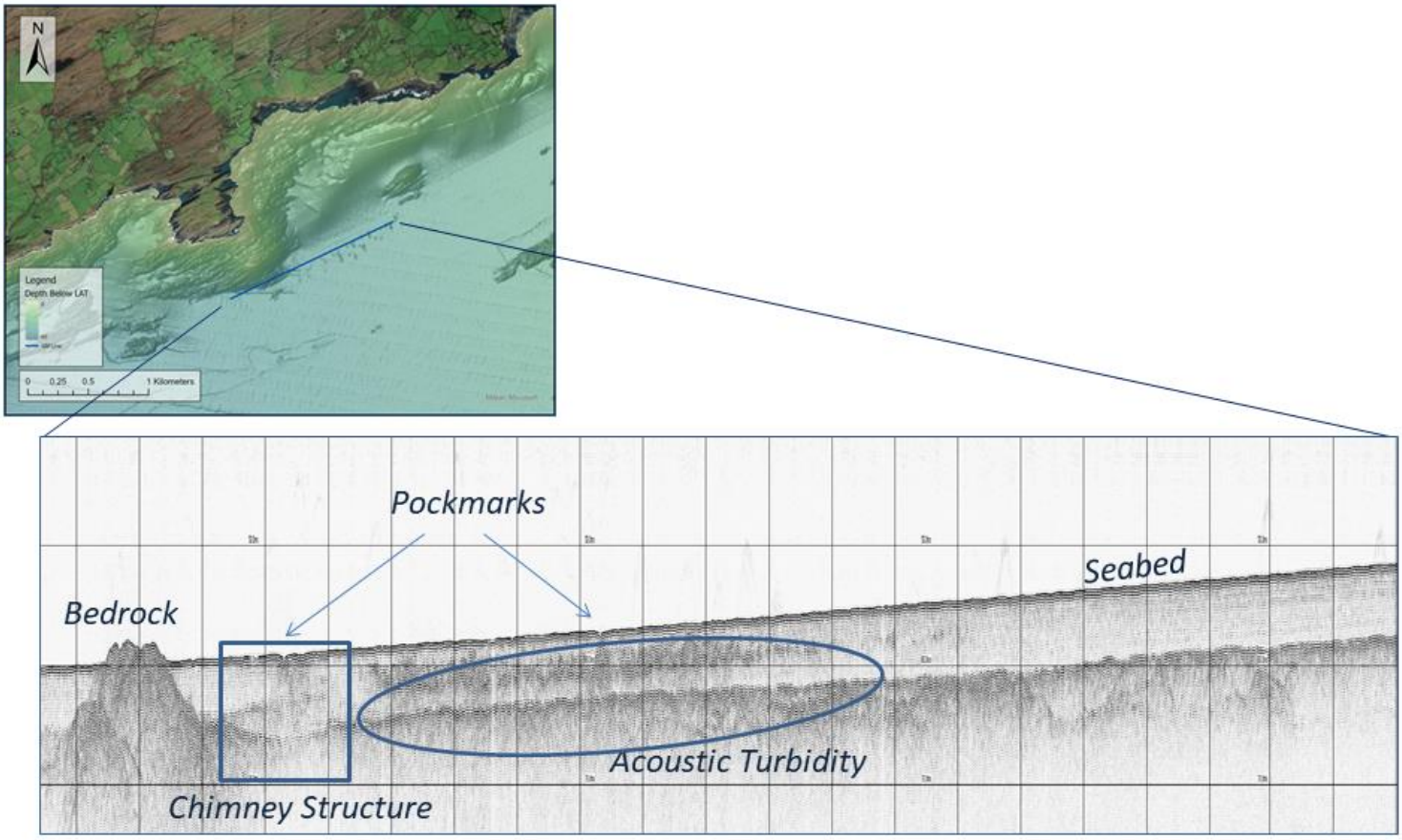


Figure 6: Sub-bottom profile from the pockmark field, with acoustic turbidity and chimney-like structures indicated.

The origin of the gas remains unresolved. Both biogenic sources, involving microbial degradation of organic-rich sediments, and thermogenic contributions, produced by the thermal breakdown of organic matter at greater depths, are plausible (O'Reilly, et al., 2021). The alignment of the pockmarks with the Dunmanus Fault suggests that deeper structural controls may influence gas migration and venting, although definitive links have not yet been established. Further geochemical analysis would help clarify gas provenance and the relative roles of shallow microbial and deeper thermogenic sources.

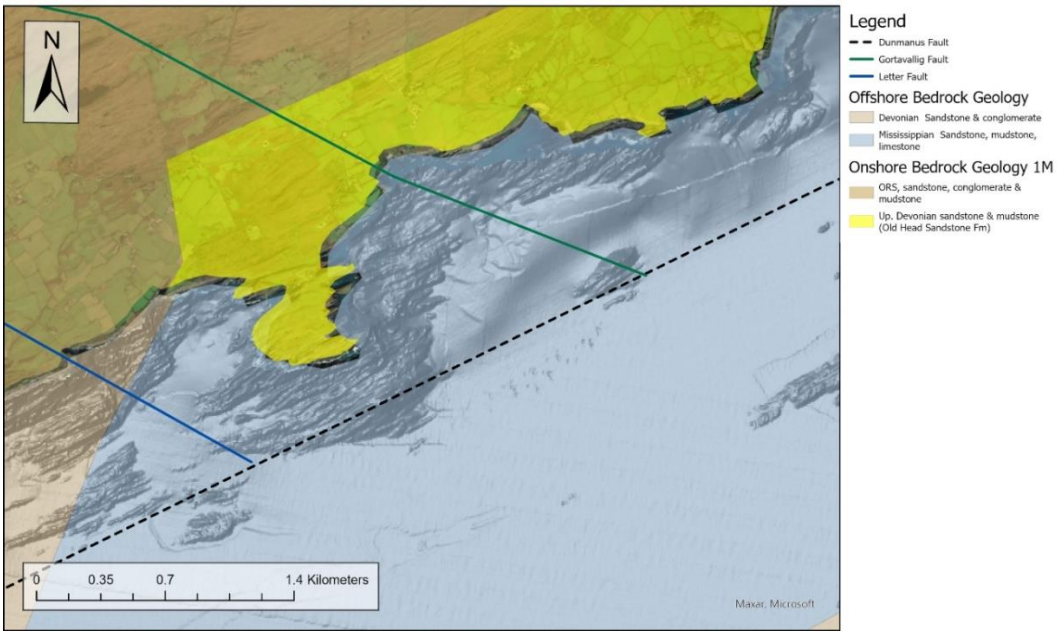


Figure 7: Possible structural controls on the Dunmanus Bay pockmark field, after (MacCarthy, 2007), illustrating how the Dunmanus Fault aligns with the pockmark field.

Comparison with Bantry Bay Pockmark Field

A similar pockmark field has been documented in Bantry Bay, just north of Whiddy Island. Like Dunmanus Bay, it comprises small pockmarks, typically less than 1 m deep and several metres across, arranged in clusters (Jordan, et al., 2019). Both bays are shallow marine basins underlain by structurally influenced Devonian and Carboniferous rocks. The Bantry Bay features also align with faults, including the Owenberg River Fault, supporting the interpretation that tectonic structures help guide fluid migration.

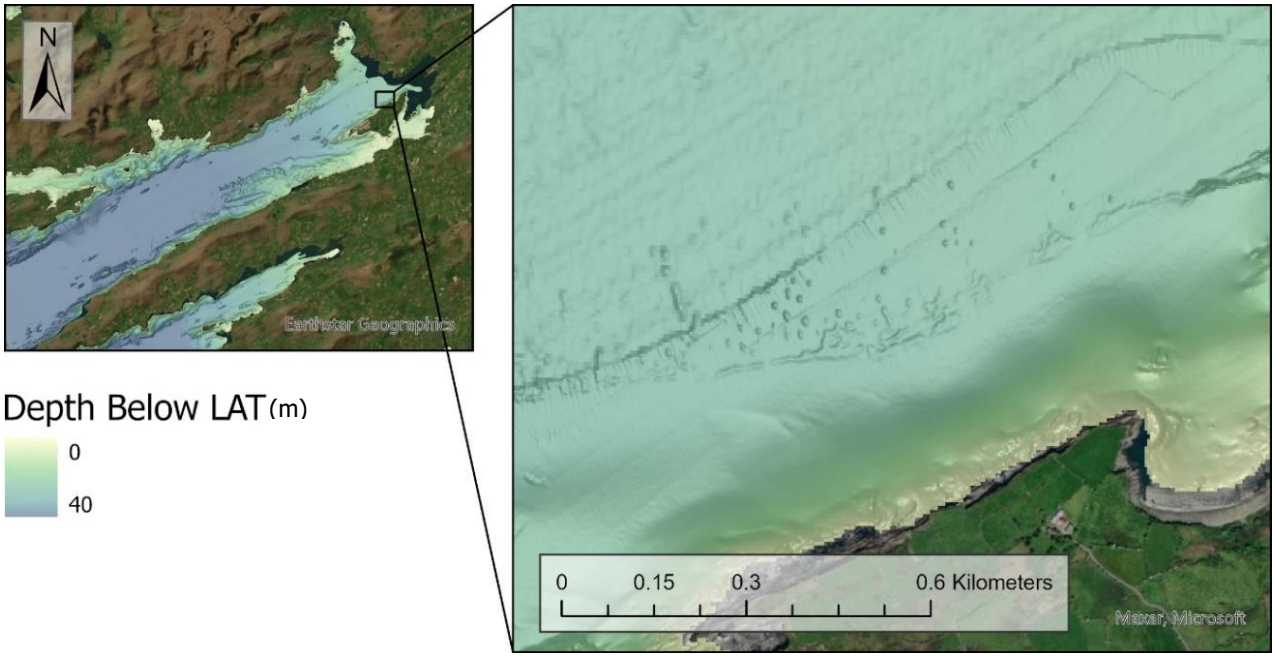


Figure 8: Bathymetric map of pockmarks in Bantry Bay, showing pockmark distribution north of Whiddy Island.

Sediment patterns in Bantry Bay, with fine muds in the inner bay transitioning to coarser sands towards the mouth, are similar to those in Dunmanus Bay. Subsurface indicators such as acoustic blanking and chimney anomalies support the interpretation of active seepage (Jordan, et al., 2019). As in Dunmanus Bay, the exact gas source is uncertain. Organic-rich muds make biogenic production plausible, but contributions from deeper thermogenic sources cannot be excluded. In both bays, faults intersect gas-prone sediments and appear to influence the development and localisation of pockmarks.

Conclusion

The Dunmanus Bay pockmarks reflect episodic gas and fluid escape through fine-grained seabed sediments, with structural features such as the Dunmanus Fault likely focusing fluid migration. Venting appears intermittent and generally low-level. Although methane has been detected, its precise origin remains unresolved, and a contribution from deeper processes cannot be ruled out.

Comparison with Bantry Bay supports a regional pattern of fault-influenced pockmarks across south-west Ireland. These seabed features indicate subsurface fluid movement and may also influence sediment stability and local carbon cycling. In some cases, they can provide habitats for specialised microbial and benthic communities linked to methane and sulphide cycling.

Dunmanus Bay provides a clear example of how shallow gas, muddy seabed sediment and bedrock structure can interact to form pockmark fields. Further research is needed to constrain the origin, frequency and environmental effects of gas venting, and to clarify how geological structures and sedimentary processes combine to produce these features.

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