INFOMAR Integrated Mapping for the Sustainable Development of Ireland's Marine Resource
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Department of Climate, Energy and the Environment
Geological Survey Suirbhéireacht Gheolaíochta Ireland | Éireann
Marine Institute Foras na Mara

Marine Geology Report 030

Inisbofin & Inishark

Overview

The islands of Inishbofin (*Inis Bó Finne*: “Island of the White Cow”) and Inishark (*Inis Airc*) lie off the west coast of Connemara, County Galway. The meaning of Inis Airc is less certain, and has been variously interpreted as “island of hardship” (from Old Irish *airc*), as a personal name (e.g., Erc) and other derivations (Flanagan & Flanagan, 2002); (Irish Islands Heritage, n.d.); (Walsh, 2014); (Hogan & Gibbons, 1991). Though only a few kilometres in extent, these islands preserve some of the most complex and ancient geology in Ireland, stretching back over half a billion years. Their rocky shorelines are carved into cliffs, sea caves, arches, and blowholes, while offshore, INFOMAR bathymetry data has revealed reefs, fault scarps, and glacial sediments.

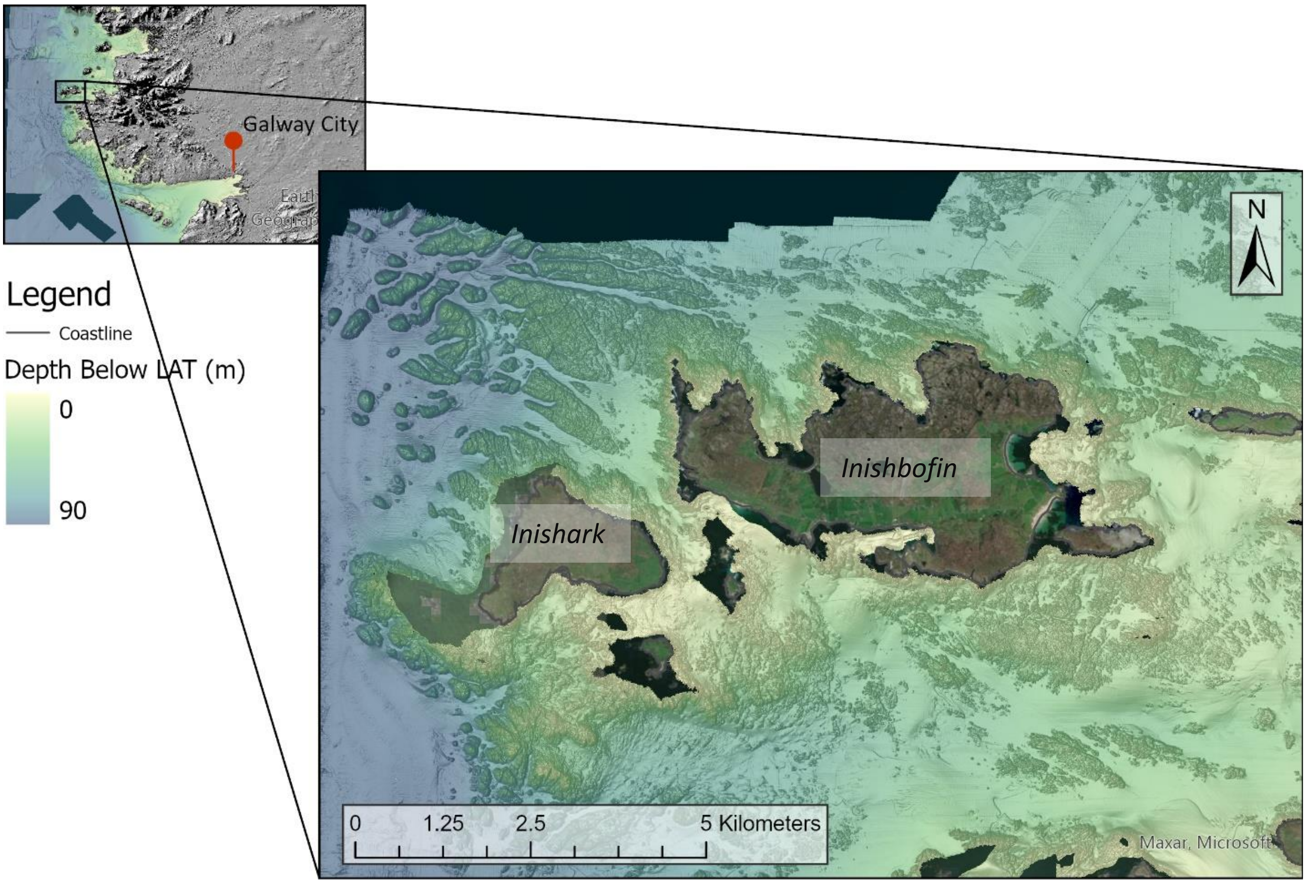

Figure 1: Bathymetry of the seabed around Inishbofin and Inishark. Depths are given referenced to Lowest Astronomical Tide (LAT)

Both islands and their surrounding waters form part of the Inishbofin and Inishark Special Area of Conservation (SAC) (National Parks & Wildlife Services, 2013), while Inishark is additionally designated as part of the High Island, Inishark and Davillaun Special Protection Area (SPA) (National Parks & Wildlife Services, 2010).

Geological History

The bedrock of Inishbofin and Inishark belongs to the Dalradian Supergroup (>540 Ma), a sequence of late Precambrian to early Cambrian-age sediments that were originally deposited at the edge of the Iapetus Ocean. During the Ordovician Period (475-460 Ma), these sediments were buried and intensely metamorphosed in the Grampian Orogeny, a mountain-building event (Morris, et al., 1995). The Grampian orogeny, which can also be described as the Grampian phase of the wider Caledonian orogeny, occurred when the margin of the ancient continent Laurentia collided with a volcanic island arc in the Iapetus Ocean, causing intense folding, faulting, and metamorphism (Badley, et al., 2024).

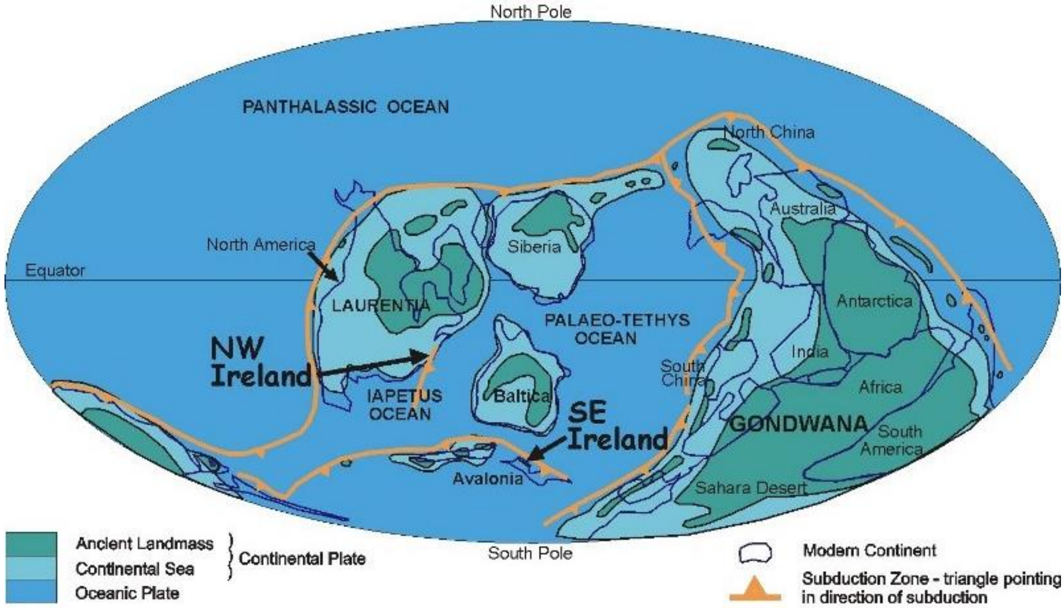

Figure 2: Paleogeography of Ireland at the beginning of the Ordovician period. Image from (Geological Survey Ireland, n.d.).

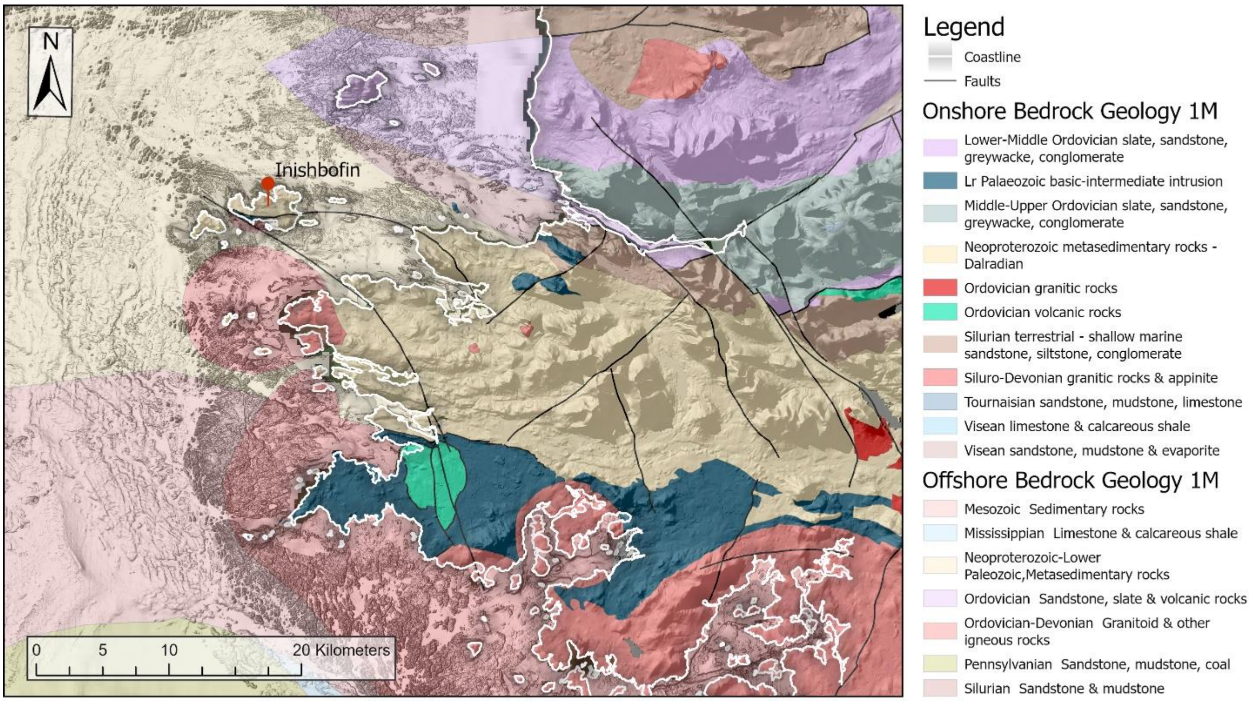

Figure 3: Geology of Connemara.

The Grampian phase gave Connemara (western Galway) its schists, gneisses, and quartzites, and emplaced ultramafic bodies (igneous rocks rich in magnesium and iron, originally from the mantle), later altered to talc. Later phases of the Caledonian Orogeny (425-400 Ma) brought further deformation and the intrusion of large granite bodies, including as the Galway Batholith, which imparted a strong thermal imprint, adding to the island's complexity (Feely, 2025).

A major structural feature is the Renvyle-Bofin slide, an E-W trending ductile shear zone that cuts across Inishbofin and extends onto the Connemara mainland. A shear zone is a long, narrow zone in the crust where rocks have been intensely deformed by shearing (a sideways grinding motion). In the ductile regime, deep in the crust under high heat and pressure, rocks deform plastically, bending and stretching rather than fracturing, resulting in streaky, layered textures called mylonite (Mukherjee, 2015). These zones often act as terrane boundaries, juxtaposing contrasting rock packages. The Renvyle-Bofin Slide is a prime example: to the north, Dalradian quartzites and schists dominate, cut by prominent dolerite dykes of Caledonian age, while to the south fragments of ultramafic rock, interpreted as fragments of ancient oceanic mantle, were caught up and deformed within the shear zone (Ryan, 2022) 452- 457 Ma (Badley, et al., 2024).

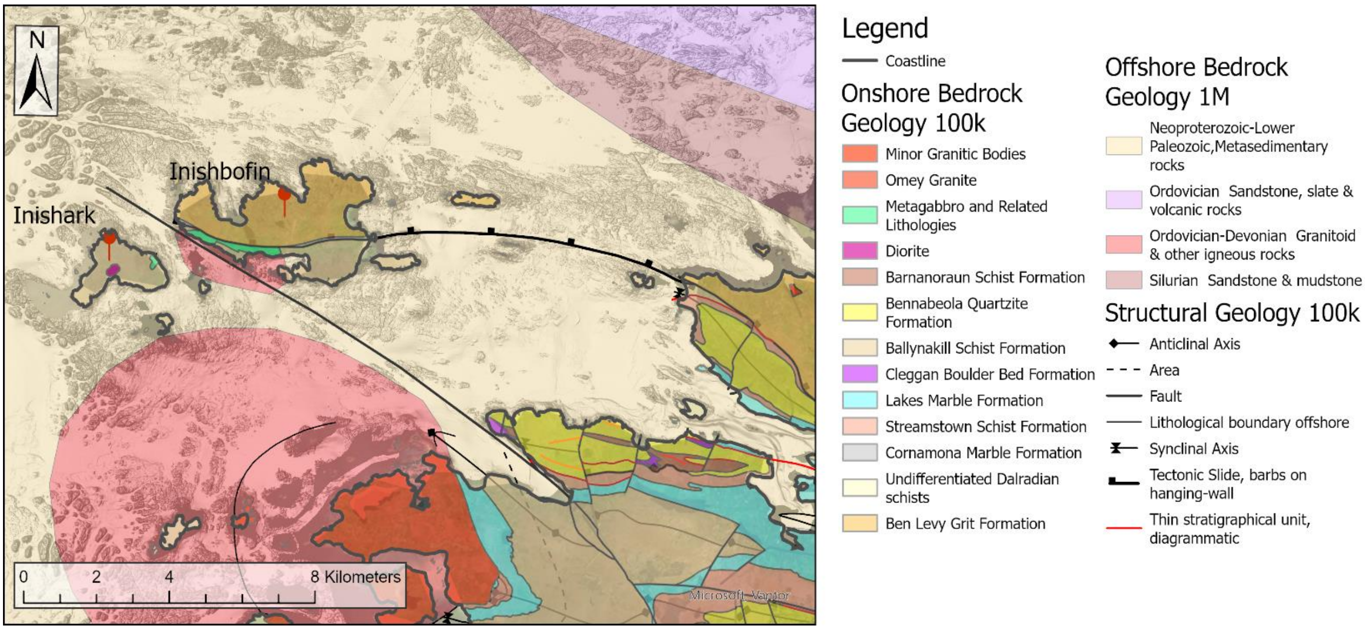

Figure 4: Detailed geology map showing the Renvyle-Bofin tectonic slide, indicated by the black line with barbs on the hanging wall (the upper block).

These ultramafic rocks were later altered by hydrothermal fluids, producing talc and associated minerals (Costanzo & Feely, 2019). On Inishbofin, talc was quarried during the 19th century for use in wool processing, and later exploration suggested significant talc–magnesite ore resources (Meehan, et al., 2019). Similar talc-bearing ultramafic rocks crop out in the northeast of Inishark, showing that this process was regionally extensive.

Both islands were also intruded by dolerite dykes (vertical or near-vertical sheets of igneous rock) during the Caledonian cycle. On Inishbofin, prominent N-S and E-W trending dykes cut the Dalradian rocks north of the Slide, while Inishark is cut by numerous E-W trending dolerite dykes representing multiple pulses of igneous activity (Cruse & Leake, 1969).

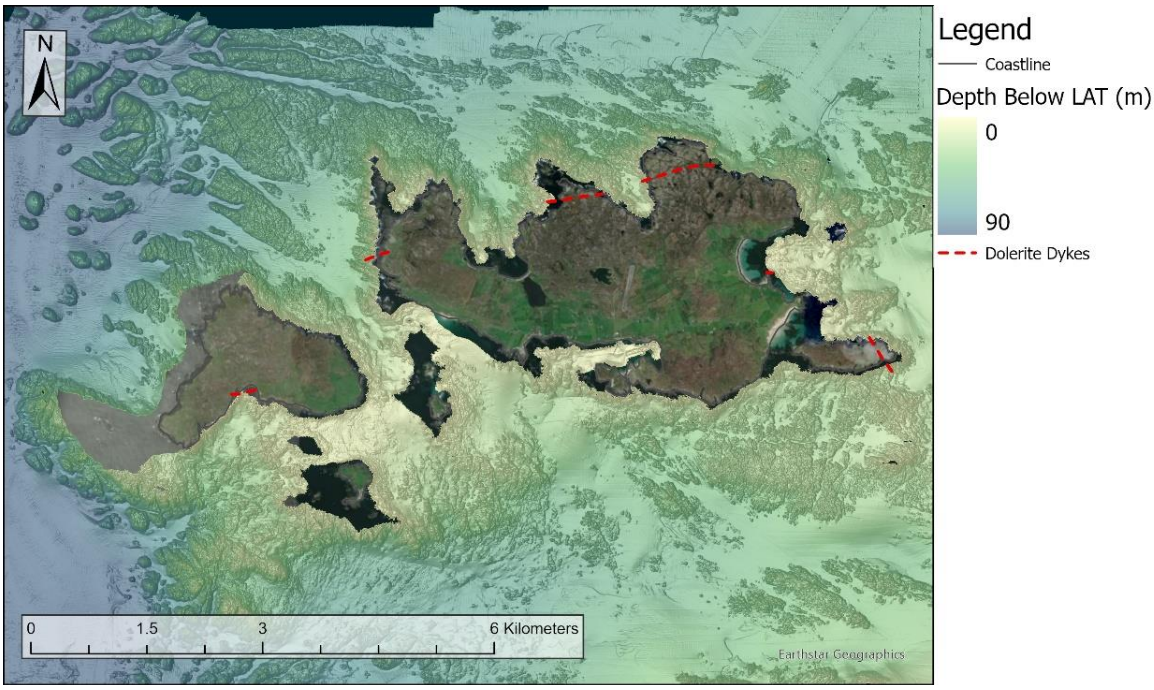

Figure 5: Bathymetry of Inishbofin and Inishark, with dolerite dykes traced after (Cruse & Leake, 1969).

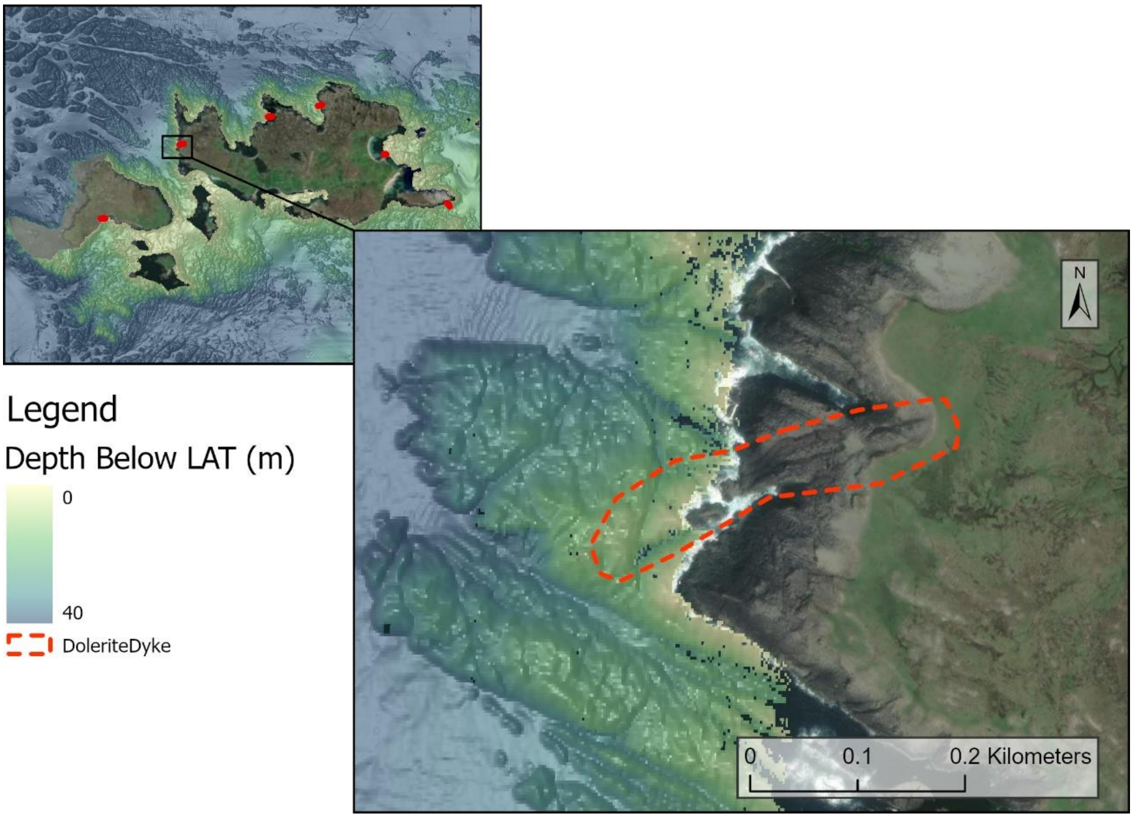

Figure 6: Offshore continuation of dolerite dyke on Inishbofin. Dyke location from (Cruse & Leake, 1969).

Following the closure of the Iapetus Ocean, the region entered a prolonged period of erosion. Although Devonian and Carboniferous (419–299 Ma) sedimentary basins developed elsewhere in Ireland, south Connemara preserves little record from this time (Meehan, et al., 2019). Prolonged uplift and erosion removed any sedimentary cover, resulting in a major gap in the geological record until the onset of the Quaternary (2.58 Ma).

During Quaternary glaciations, ice sheets smoothed and scoured the bedrock and deposited glacial till, particularly along southern shores. Rising sea levels following deglaciation left the islands as rocky remnants surrounded by Atlantic waters.

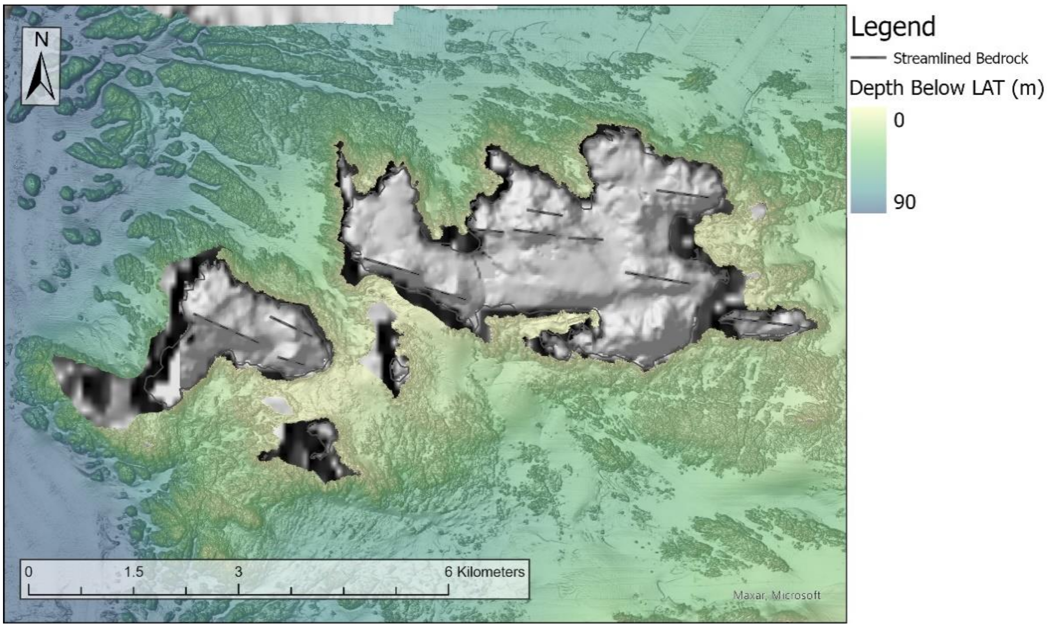

Figure 7: Terrestrial Quaternary geomorphological features of Inishbofin and Inishark.

Inishbofin

Inishbofin's coastline is rugged yet relatively low in profile, with cliffs generally between 10 and 30 m high. These cliffs are interrupted by sheltered coves, some containing sandy beaches of shell and quartz sand (Meehan, et al., 2019). The island's interior is relatively low-lying, rising to about 89 m above sea level, with gentle hills underlain by quartzite and schist.

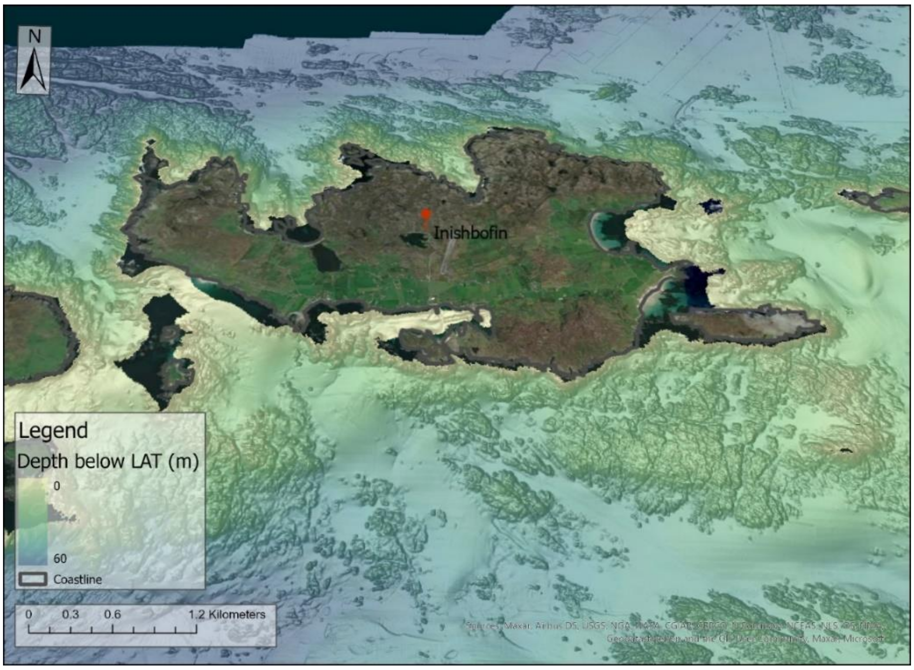

Figure 8: Bathymetry of Inishbofin.

Wave action has exploited weaknesses in the bedrock, forming sea caves and, in places, natural arches. Two active blowholes occur on the northern coast, where Atlantic waves can force water and spray up through vertical shaft.

Figure 9: 3D imagery of NW Inishbofin showing the location of blowholes (left); Image looking north of the larger blowhole from (Connemara Wild Escapes, 2019).

The location and orientation of the blowholes align with a distinct SSW–NNE trending seabed lineation visible in the bathymetry data, interpreted as a possible fault or zone of structural weakness, as illustrated by the dashed orange line in the figure below.

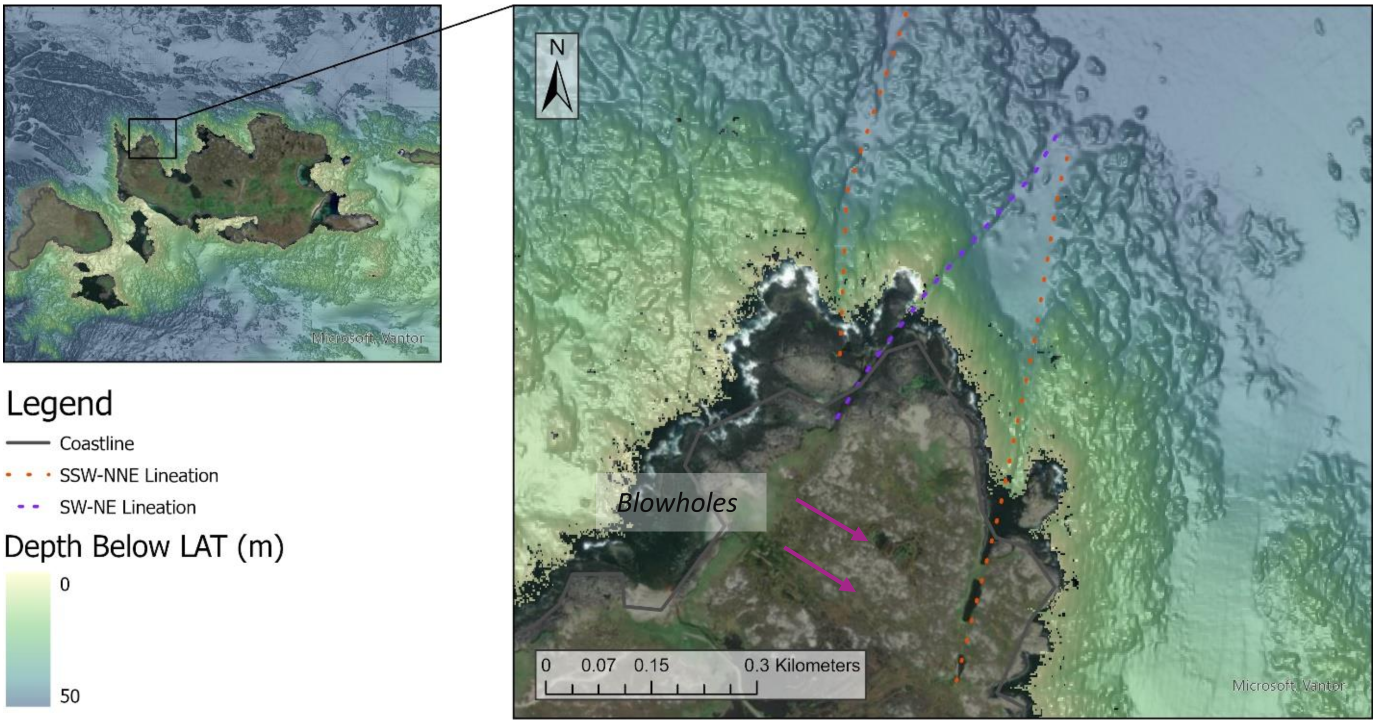

Figure 10: Bathymetry around the blowholes showing a SSW–NNE oriented seabed lineation aligned with their orientation.

Bathymetry north of Inishbofin also shows a prominent WNW to ESE trending seabed lineament that extends for at least 10 km and is interpreted as a possible fault or bedrock fracture zone. The lineament appears to be locally displaced by shorter NNW to SSE trending lineaments, suggesting later cross-faulting has offset the main structure in places.

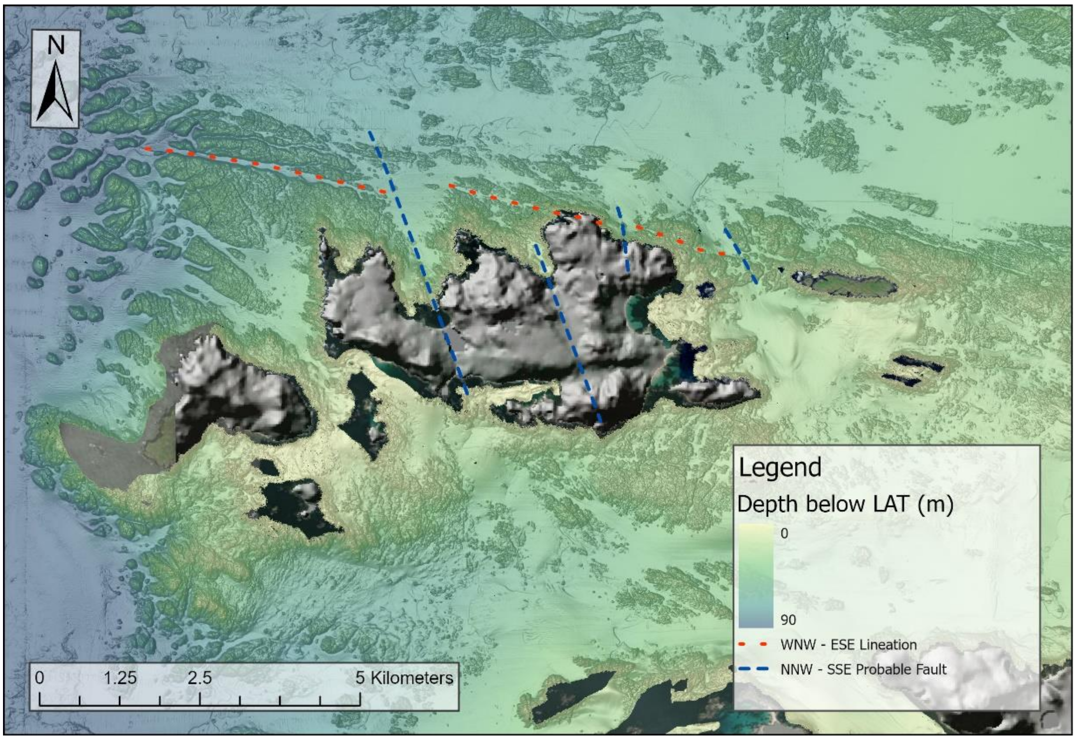

Figure 11: Bathymetry around the blowholes showing a large WNW-ESE lineation, pos

Offshore, the Stags of Bofin form a cluster of jagged sea stacks composed of resistant bedrock left standing after surrounding headlands were eroded. Atlantic wave action exploits joints and other zones of weakness to cut sea caves into the cliff line. With continued undercutting, caves can enlarge and link through narrow rock spurs to form sea arches, and when an arch roof collapses it leaves an isolated stack separated from the mainland. Ongoing wave attack then lowers stacks into smaller stumps and skerries. The Stags provide a clear example of this cave–arch–stack sequence, showing how bedrock structure and high-energy wave processes combine to drive coastal retreat.

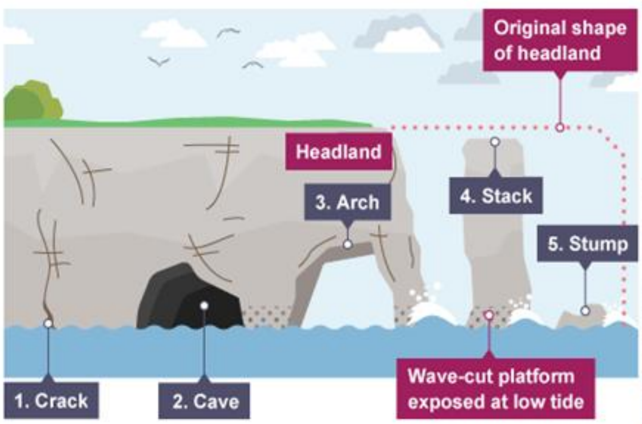

Figure 12: (Left) Diagram showing the formation of caves, sea stacks and sea stumps from (BBC, n.d.); (Right) The Stags of Bofin from (Geological Survey Ireland, n.d.)

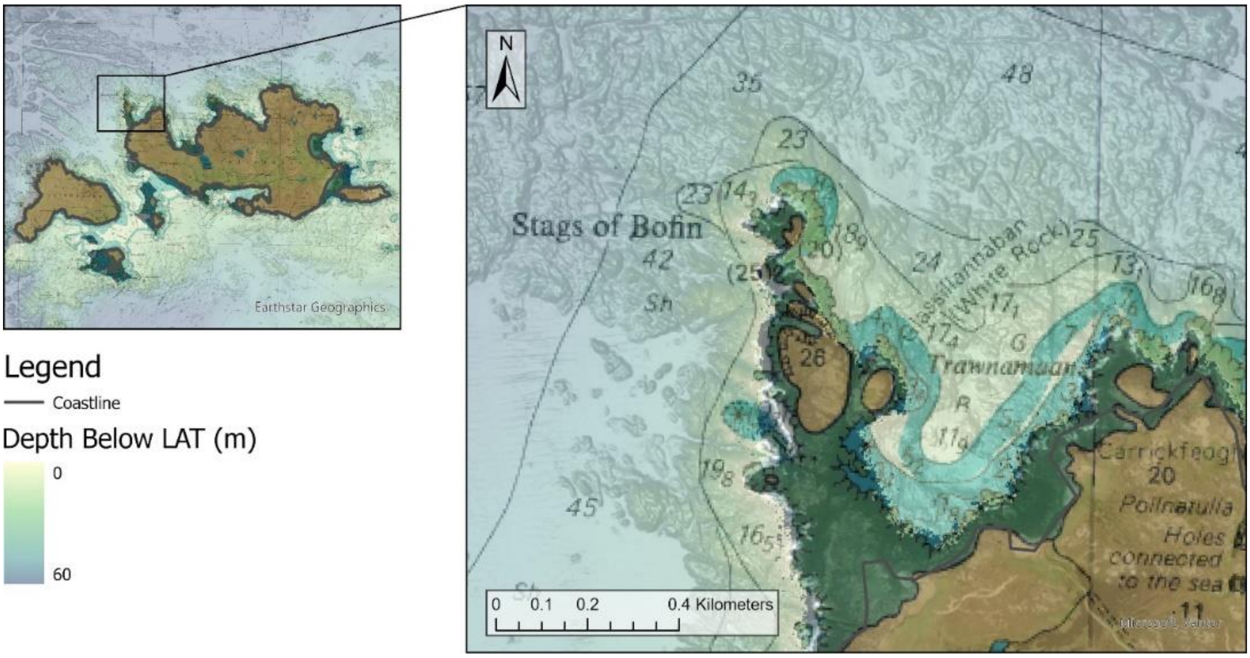

Figure 13: Bathymetry around the Stags, underlain by Admiralty Chart 2707.

On the southern side of the island, Inishbofin possesses one of the best natural harbours on the west coast of Ireland. The harbour is protected from Atlantic swell by surrounding headlands, forming an outer anchorage and an inner harbour. The inner basin is separated by a shallow bar, but a dredged channel now allows vessels to pass safely (eOceanic, n.d.). This safe anchorage has been critical for centuries of settlement, fishing, and, more recently, tourism – contrasting starkly with Inishark's lack of a suitable harbour.

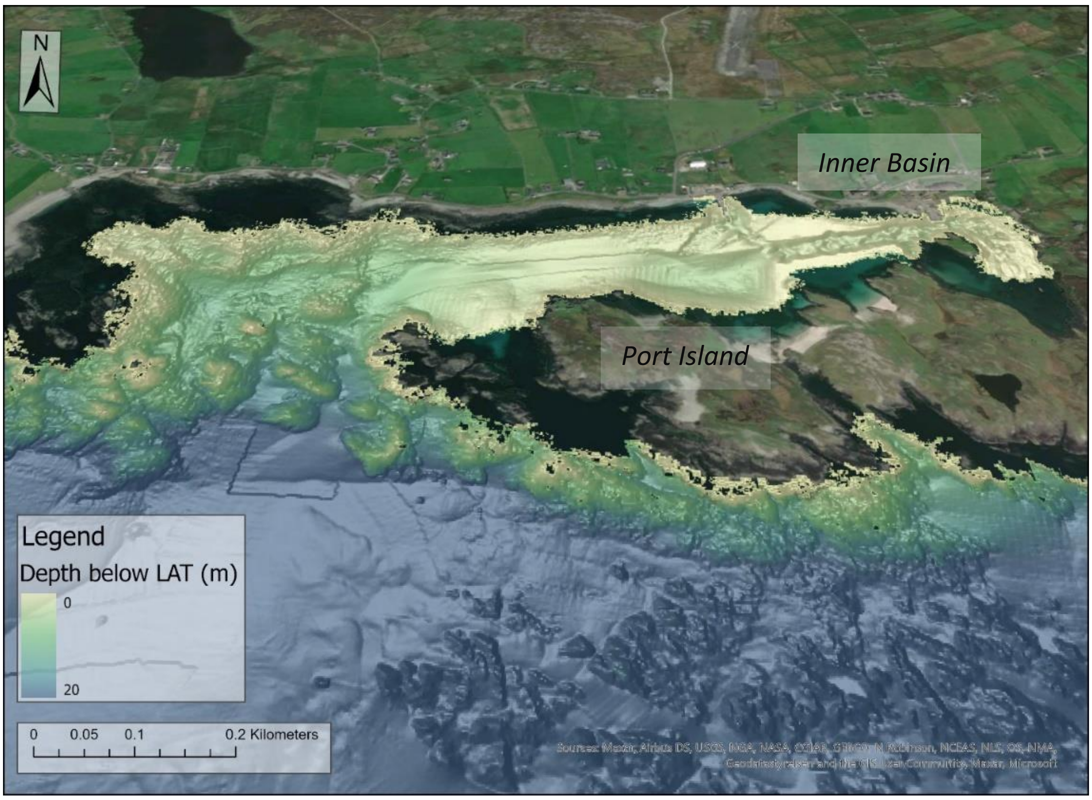

Figure 14: 3D Bathymetry of Inishbofin Harbour.

The harbour's shelter also helps explain why Inishbofin is unusually rich in coastal built heritage for an Atlantic island. The island is closely associated with Gráinne Ní Máille (Grace O'Malley), sometimes styled the "Pirate Queen", and with the Ó Máille (O'Malley) lordship, one of the most powerful seafaring dynasties on Ireland's west coast in the sixteenth century (Feeney, 2020). There are references to at least one, and possibly two, Ó Máille castles on Inishbofin. Dún Gráinne refers to fortified ground at the inner harbour opposite Port Island, and the placename is significant because *dún* is the Irish word for a fort. Tradition also holds that Grace O'Malley and an ally known locally as Don Bosco, who is said to have had a stronghold on Port Island before the later fort was built, stretched a chain boom across the harbour entrance to control access and potentially trap vessels within the anchorage (Siggins, 2016).

Figure 15 : Cromwell's Barrack on Port Island, Inishbofin, looking NE, from (Tuatha, 2022)

Inishbofin's best-known fortification is the ruin on Port Island at the harbour mouth, commonly called Cromwell's Barracks. This star-shaped bastioned fort was built in the mid seventeenth century, and it is associated with Cromwellian (Commonwealth) forces who sought to secure strategic Atlantic anchorages; it was later used as a place of detention for priests and other prisoners during that period (Feeney, 2020).

Between areas of exposed bedrock, reworked glacial sediments occur on the seabed, deposited originally as till and later redistributed by waves and currents, creating sand waves and scour features.

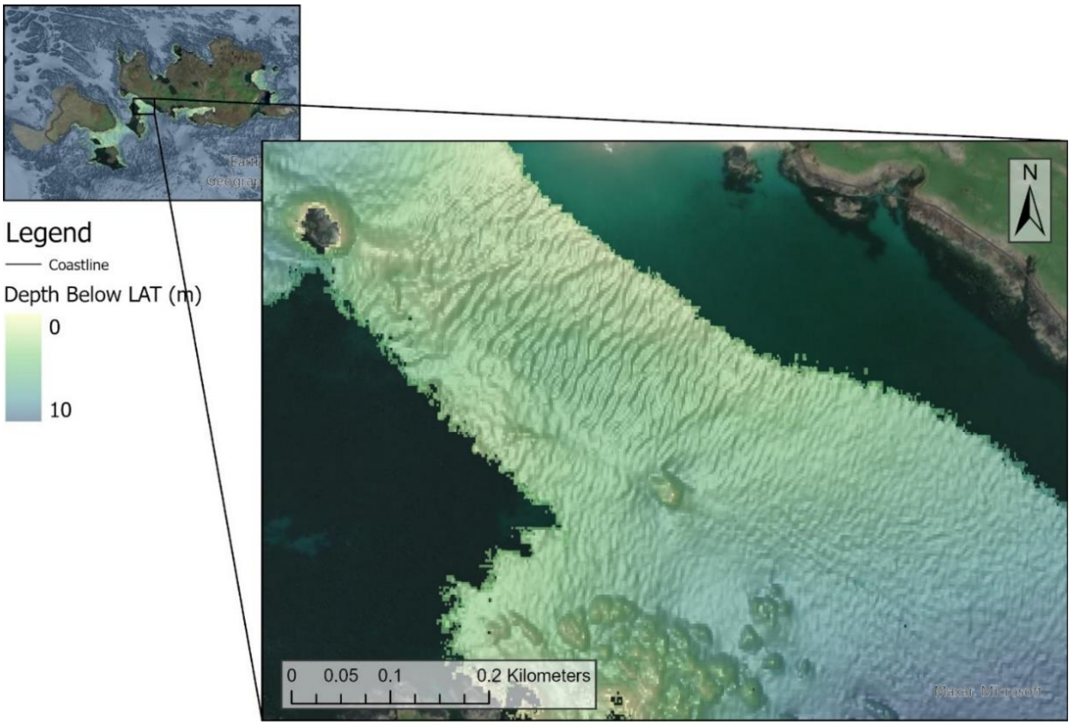

Figure 16: Sandwave field to the SW of Inishbofin.

Lough Bofin

Lough Bofin is located on the NW shore of Inishbofin and is classified as a natural sedimentary coastal lagoon separated from the Atlantic by a cobble barrier. Lough Bofin forms part of the Inishbofin and Inishark SAC, designated under the EU Habitats Directive, including for the priority habitat Coastal Lagoons (National Parks & Wildlife Services, 2013).

Seawater enters by percolation through the cobble barrier and by overtopping during storm events, while freshwater inflows increase substantially during periods of heavy rainfall. This produces marked variability in salinity through time (National Parks & Wildlife Services, 2013).

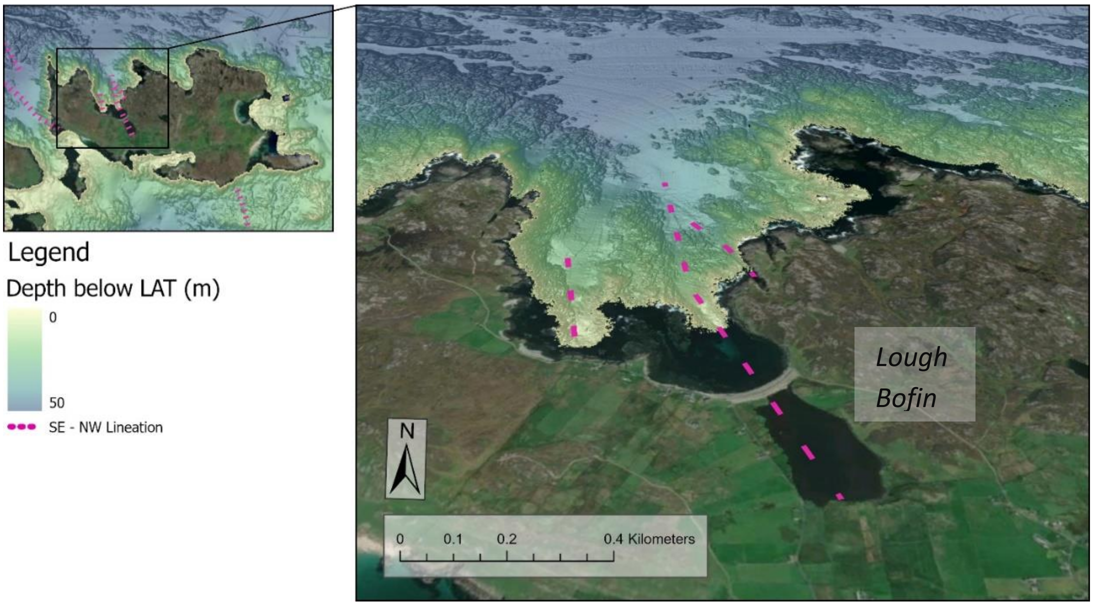

Figure 17: 3D imagery of Lough Bofin and surrounding nearshore seabed.

Although INFOMAR bathymetry does not extend into the lagoon, adjacent nearshore seabed data show a sheltered cove with a gently sloping seafloor aligned with the lagoon. The lagoon basin is elongated in a NW–SE direction, and this orientation is consistent with the trend of the nearby coastal embayment. The lagoon's position and elongate form may reflect geological control. The NW–SE alignment suggests development along a pre-existing lineament or zone of weakness within the local Dalradian bedrock, potentially guiding both coastal erosion and the preservation of the lagoonal depression.

Inishark

Inishark's coastline is slightly lower in profile than Inishbofin's but similarly rugged, with cliffs typically 10 – 20 m high. Sea caves and occasional natural arches are present, and small rocky islets fringe parts of the coastline where resistant rock has been isolated by erosion (Meehan, et al., 2019).

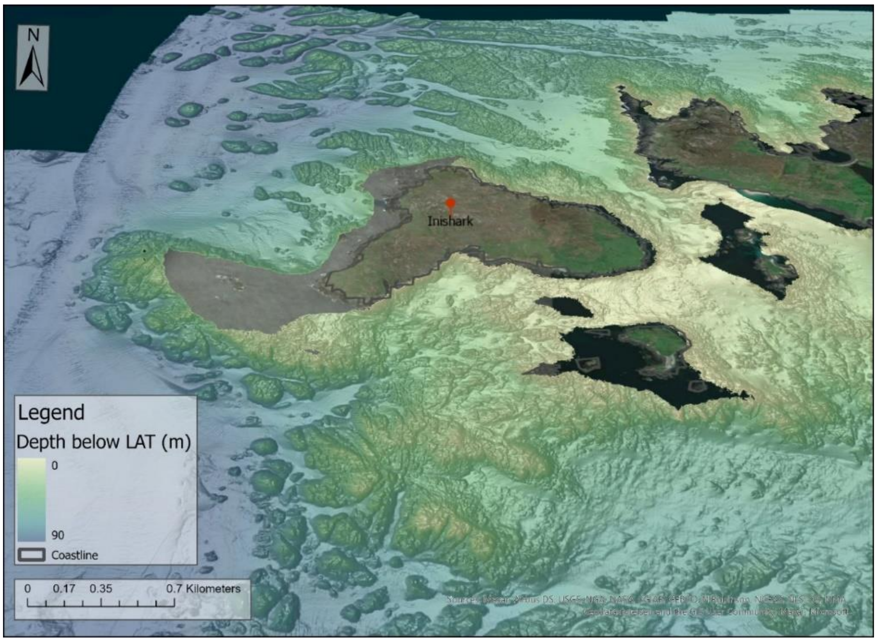

Figure 18: Bathymetry of Inishark.

Along the southern shore, several metres of glacial till remain preserved. At the boundary between till and bedrock, glaciotectonite structures indicate deformation caused by ice movement, making Inishark an important site for Quaternary research (Meehan, et al., 2019).

Figure 19: Till over glaciotectonite on Inishbofin. Image from (Meehan, et al., 2019).

The island's interior consists of low hills of quartzite and schist, with outcrops of dark dolerite dykes and patches of green talc schist (altered ultramafics). The green talc schist marks places where very magnesium-rich rocks were altered by hot fluids moving through fractures and shear zones, progressively replacing the original minerals with serpentine and then talc-rich assemblages. On Inishark, this change can be followed in the field from less-altered country rock into serpentine-bearing rocks and ultimately into talc-carbonate rich material, producing the distinctive green, soft, "soapy" outcrops noted on the NE coast (Cruse & Leake, 1969). This alteration took place during the Grampian phase of the Caledonian orogeny (Morris, et al., 1995).

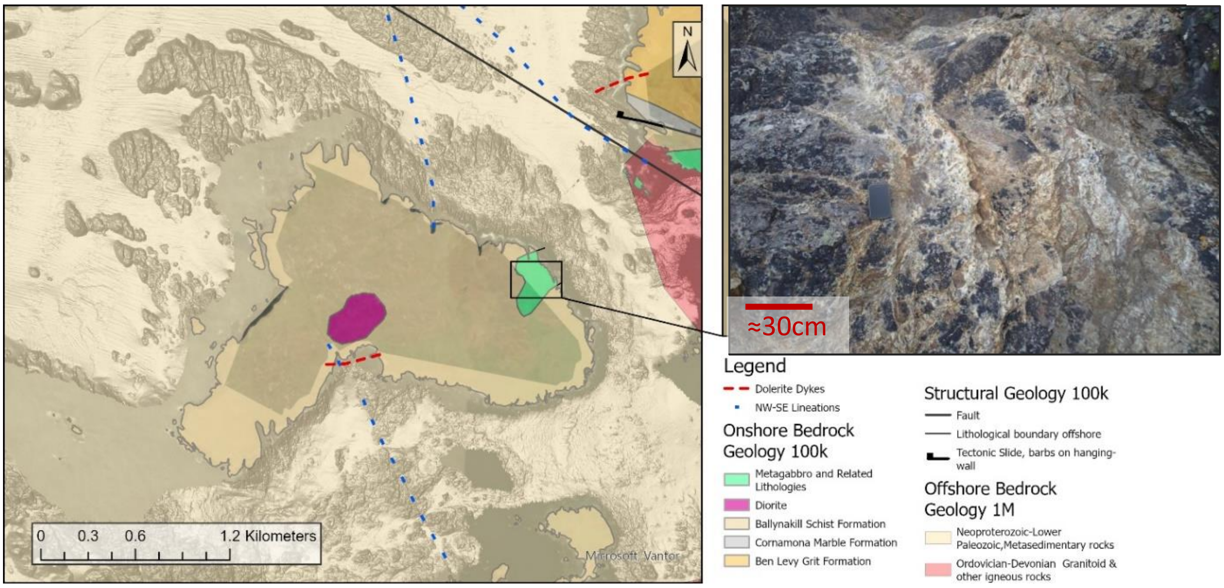

Figure 20: Geology of Inishark, with image of exposed talc on the NE shore from (Meehan, et al., 2019).

Offshore, the seabed around Inishark is dominated by bare rocky outcrops with little sediment cover, reflecting the strong Atlantic wave and tidal energy that constantly reworks the area. Structural lineaments corresponding to faults and dykes onshore can also be traced offshore in satellite and sonar imagery.

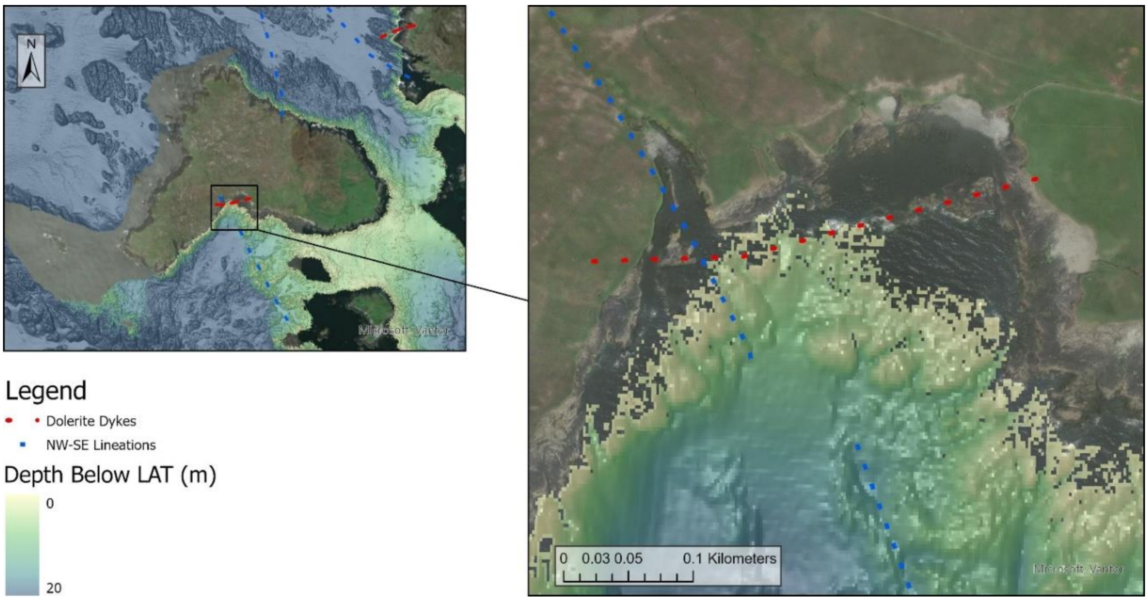

Figure 21: Offshore expression of a dolerite dyke near Inishark after Cruse & Leake (1969).

Compared with Inishbofin, Inishark exhibits fewer sandy deposits and lacks sheltered sedimentary basins, reflecting its greater exposure to Atlantic wave and tidal energy. The submarine landscape closely mirrors the onshore geology, with extensive bedrock outcrop and minimal sediment accumulation, emphasising the island's character as a small, highly exposed remnant of metamorphic basement.

Geology has also strongly influenced human history on Inishark, because the island lacks a sheltered deep-water harbour and landings depended on small boats and favourable sea conditions, leaving the community frequently isolated during bad weather, with limited communications and limited on-island medical support. Long-term depopulation began in the mid-nineteenth century through emigration and gradual decline, and by the mid-twentieth century only a small population remained. A widely recorded tragedy occurred on Easter Sunday 1949, when three young men drowned returning by currach from Inishbofin after travelling over for Easter Sunday Mass, which dealt a major blow to the island community (Feeney, 2020). In 1959 the death of a young man from appendicitis, when storm conditions prevented timely medical assistance, became a key catalyst alongside continuing depopulation and hardship. On 20 October 1960 the remaining 24 inhabitants left Inishark and were resettled on the Connemara mainland (MacCarthy, 2018).

Conclusion

Inishbofin and Inishark record a geological history spanning more than half a billion years, from Dalradian sedimentation on the margin of the Iapetus Ocean, through Ordovician Grampian metamorphism and later Caledonian deformation and intrusion, to Quaternary glaciation and the modern Atlantic coast. The Renvyle–Bofin Slide and the dyke swarms demonstrate how deep crustal structures partitioned the bedrock into contrasting rock packages, and INFOMAR bathymetry shows that the same structural grain continues offshore as reefs, scarps and lineaments that influence seabed morphology and sediment pathways.

Today, the dominant agents of change are wave attack, storm-driven water levels and ongoing sediment reworking, which continue to drive the cave–arch–stack sequence seen at the Stags of Bofin and to maintain the strong contrast between bedrock-dominated seabed and small pockets of mobile sediment. These processes are likely to intensify as sea level rises and coastal flooding risk increases around Irish coasts, increasing the potential for cliff-foot undercutting, barrier overtopping and erosion of low-lying sedimentary features.

Climate change adds an additional pressure on these island systems, because rising sea levels and more energetic storm impacts can increase the frequency of damaging surge and wave events, as well as compound flooding during high tides and heavy rainfall. Continued mapping and repeat surveying offshore and along the shorelines will therefore be important, both for understanding geological evolution and for anticipating future coastal change affecting habitats, infrastructure and cultural heritage.

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