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IOSEA6

SCOPING REPORT - APPENDIX C

C.6 GEOLOGY, SUBSTRATES AND COASTAL SEDIMENTS

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C.6 GEOLOGY, SUBSTRATES AND COASTAL SEDIMENTS

This section describes the baseline, existing geology, substrates, and coastal Sediments in the IOSEA6 Study Area. The baseline draws on information from IOSEA4 and IOSEA5, providing updates where applicable.

C.6.1 Geology

The structural features of the north-west Atlantic Continental Margin are predominantly controlled by two distinctive, nearly perpendicular fault systems that have created a complex array of horsts and grabens/tilted-blocks within the continental crust, as well as a number of sedimentary basins (de Graciansky and Poag, 1984).

The morphology offshore of Ireland in the north-west Atlantic Ocean is a product of rifting, drifting and convergence between Europe, Iberia and North America which occurred during the Mesozoic Period. Successive tectonic episodes have created a series of highs (e.g. Porcupine, Hutton and Hatton Banks) and lows (the basins/troughs). During the Tertiary, extensive igneous episodes played an important role in the evolution of the region. The current topography of the area is the result of Mesozoic to Quaternary sediments forming a drape over underlying structures (Haas et al, 2002).

The geology of the southern and eastern Irish offshore area is dominated by six sedimentary basins: the Kish Bank Basin, the Central Irish Sea Basin, the Northern Celtic Sea Basin, the South Celtic Sea Basin, the Fastnet Basin and the Cockburn Basin. These basins are superimposed on a variably eroded Palaeozoic surface that contains potential hydrocarbon generating source rocks (Carboniferous). They generally have an elongate north-east – south-west morphology and are typically within 100 km of the shore. Exploratory drilling indicates that a wide range of reservoir and source-rock horizons (where hydrocarbons have been generated or are capable of being generated) are present in each of the basins.

The IOSEA6 Study Area predominantly lies within the Porcupine Basin, North Celtic Sea Basin and Slyne Basin. In 2021 the Department of the Environment, Climate and Communications published a new stratigraphic framework for the geology of offshore Ireland, which is an important and recent geological reference for the Irish offshore (Merlin Energy Consortium, 2020). The results of this study, together with an accompanying special publication on the stratigraphic nomenclature of the Irish offshore basins (Shannon, English, Hanrahan, 2021)

C.6.1.1 Porcupine Basin Area

The Porcupine Basin is located offshore of the south-west tip of Ireland. This basin is part of the continental rifting structure seen off the east coast of Ireland. It contains thick layers of Cretaceous - Tertiary rocks, and hydrocarbons have been discovered in reservoirs from the Triassic, Middle and Upper Jurassic, Lower Cretaceous, and Palaeocene periods (DCMNR/PAD, 2006).

C.6.1.2 Celtic Sea Basin Area

The North Celtic Sea basin is the largest of the basins off the south-eastern Irish coast. Three gas fields (Kinsale Head, Ballycotton & Seven Heads) were in production in the North Celtic Sea Basin until production ceased in May 2020, with gas being produced from reservoirs of Early Cretaceous age. Production facilities from these fields are currently being decommissioned. A number of undeveloped discoveries have also been made in the basin. The basin, like the South Celtic Sea basin, is defined by a 9km thick sequence of sediments accumulated during Mesozoic rifting and subsequent thermal subsidence. The Upper Cretaceous outcrops at seafloor in numerous locations are the result of

regional uplift during the Paleocene and basin inversion during the Middle Eocene to Miocene, which produced widespread erosion and basin inversion (King et al., 2016).

C.6.1.3 Slyne-Erris Basin Area

The Slyne and Erris Basins are on the eastern edge of the Rockall Basin, which formed as a result of rifting of the continental crust between the Irish mainland and the Rockall Bank (O'Reilly et al., 1996 The Corrib gas field, which is Ireland's only currently producing field is located in the Slyne Basin and the reservoir is Early Triassic in age. The geology has also been influenced by salt layers throughout the basins, which led to a series of salt-related structures such as salt pillows, salt rollers and a salt wall and contributes to the rift-basin development (O'Sullivan, 2021).

C.6.2 Bathymetry and Seabed Features

Ireland is surrounded by the Celtic and Irish Seas to the south and west, the continental shelf offshore of the west and south coasts and the deeper waters of the north-east Atlantic margin. Figure C-31 (Drawing Reference: P2510-BATH-001) presents an overview of the bathymetry.

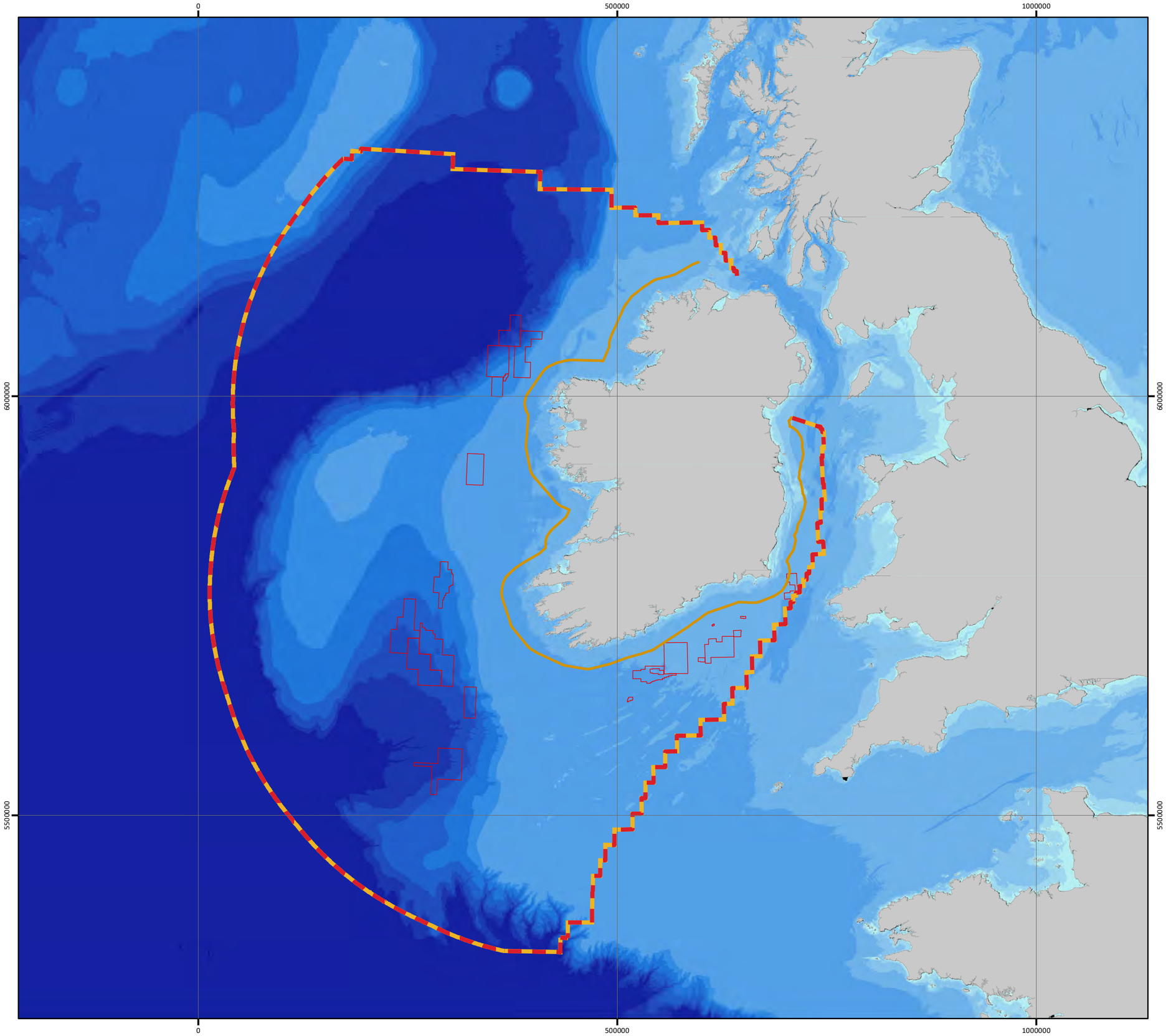
The Irish Sea separates Ireland's east coast from Great Britain and joins the Celtic Sea to the south-west via the St George's Channel. The Irish Sea is fairly shallow with depths ranging from 20 - 100 m over considerable areas, where depths increase gradually from the shoreline to 80 – 90 m in the deep central channel at the Irish national boundary (Croker et al., 2005). This deeper channel bisects the Irish Sea extending north-south and connecting with the Malin Shelf and Atlantic through the North Channel, and with the Celtic Sea via St George's Channel to the south. From Ireland's south-east coast, the Celtic Sea slopes quickly to depths of 90 – 100 m in the centre of St George's Channel. Seabed features within the Irish and Celtic Seas include a number of sandbanks and gas leak-related seabed structures such as pockmarks and mounds (Croker et al., 2005). The central and outer Celtic Sea continental shelf areas are characterised by an extensive field of south-west–north-west trending tidal sandbanks (Scourse et al., 2008) and basins.

The Irish continental shelf extends out to from the west to south-west coast of Ireland. Water depths range from approximately 50 m in the eastern part of the Donegal Basin to over 2,000 m in the area of the continental slope. The continental slope gradient is gentler in the north, without significant canyon or channel systems whilst further south the slope gradient is steeper with common slope failures and canyon complexes (Unnithan et al., 2000). Seabed features occurring within the continental shelf area include occasional sandbanks and two major seabed mound provinces: the Porcupine Bank Canyon Mounds on the western margin of Porcupine Ridge; and the Pelagia Mounds on the northern Porcupine Bank.

C.6.2.1 Deeper Atlantic Waters

The deeper north-eastern Atlantic waters include the Porcupine Seabight, the eastern margins of the Porcupine Abyssal Plain and the Rockall Trough and the eastern-most section of the Rockall Bank/Plateau. Water depths beyond the continental slope are often above 2,500 m, with water depths in the Porcupine Seabight ranging from 400 m in the north to 3,000 m in the south-west (Dorschel et al., 2010).

The Porcupine Seabight and the Rockall Trough are dominated by channels and canyons, the most notable of which is the Gollum Channel System, a 200 kilometre-long system of levees and flat-bottomed waterways (Unnithan et al., 2000). Canyons are common across the eastern boundary of the Rockall Trough but are absent from the western margins (Unnithan et al., 2000).



IOSEA6 - ENVIRONMENTAL REPORT

GEOLOGY AND SUBSTRATES
Bathymetry

Drawing No: P2510-BATH-001 | **B**

Legend

- IOSEA6 Area
- EEZ Boundary
- 12 NM Limit

EMODnet Bathymetry 2020

Depth - m (Below LAT)

- 0 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- 100 - 250
- 250 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500
- 2500 - 5000
- < 5000

NOTE: Not to be used for Navigation

Date	31 October 2022
Coordinate System	ED 1950 UTM Zone 29N
Projection	Transverse Mercator
Datum	European 1950
Data Source	EMODNET; DECC; GEBCO; ESRI
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Department of the Environment, Climate and Communications

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C.6.2.2 Porcupine Basin Area

The Porcupine Basin IOSEA6 Study Area extends across the eastern side of the Porcupine basin on the continental shelf. Within the IOSEA6 Study Area, the depth ranges from 430m at the northern most area, to 2350 m in the south. Three mound provinces are located within the Porcupine basin: the Megellan mound province and the Hovland mound province in the north, and the Belgica mound province on the eastern edge (Huvenne et al., 2007). These are carbonate mounds or cold-water coral banks, which are formed by hydrothermal hot springs, petroleum, sulphur and methane cold seeps on the seabed (Moore and Wade, 2013).

C.6.2.3 Slyne-Erris Basin Area

The Slyne-Erris Basin IOSEA6 Study Area is predominantly located on the north-west edge of Porcupine Bank, extending to 2665 m depth, with one area in the shallower southern extent of the Basin as shallow as 130 m depth.

C.6.2.4 Celtic Sea Basin Area

The Celtic Sea Basin IOSEA6 Study Area is mostly in the North Celtic Sea Basin, with one area to the east on the edge of the Central Irish Sea Basin. With depths ranging from 70 to 115 m, the Celtic Sea Basin IOSEA6 Study Area is the shallowest of the regions.

C.6.3 Substrates

C.6.3.1 Substrates, Sediment, Transport and Processes

Sediment distribution in the Irish and Celtic Seas is highly influenced by hydrodynamic conditions. To the north, where the tidal streams are weakest, the sediments are composed of muds or muddy sands, particularly in an area known as the western Irish Sea mudbelt (Jackson et al., 1995).

The Irish Sea, the strong tidal flows produce active sediment transport and erosion processes (Croker et al., 2005). In the northern Irish Sea, where currents are weakest, sediments are composed of muds or muddy sands, while sediments become sandier to the south with sandwaves present. In the southern Irish Sea and Celtic Sea, sediments are characterised by coarse deposits ranging from gravelly sands to cobble pavements. Areas of outcropping bedrock also occur in nearshore areas along the south coast (Croker et al., 2005). The seabed landscape in Irish Atlantic waters have been largely shaped by glacial periods, when large volumes of material were eroded from the land and shelf and deposited at the shelf edge and over the continental slope

The Celtic Sea was strongly influenced by Quaternary glaciation, and unconsolidated gravel lag deposits are widespread underlying Holocene sediments, with localised areas of iceberg dropstones and other glacial bedforms (Scourse et al. 1990; in Marathon 2000). Within the Celtic Sea, Holocene sediment fan deposits occur progressively from the St Georges Channel and Bristol Channels with zones of shelly gravel giving way to large zones of sandwaves up to 18 m high and to sheets of fine sand and mud in deeper areas (Irish Coast Pilot, 1997; McBreen et al., 2008). Areas of outcropping bedrock also occur in nearshore areas along the south coast, often in the vicinity of headlands where the seafloor is scoured by wind-driven wave and tidal action (e.g. Croker & Judge, 2009), and these are typically covered with a patchy and intermittent sediment cover (Tappin et al., 1994).

Continental shelf surface substrata are predominantly sandy, with patches of gravel and intermittent rock outcrops. Undulating silty clay has been described from the northern part of continental slope where the gradient is shallow. In the southern section the sediment is more mixed, with gravel and boulders exposed by erosion (IOSEA1). Figure C-32 (Drawing Reference: P2510-GEO-002) presents seabed substrates in the IOSEA6 Study Area.

C.6.3.2 Porcupine Basin Area

The Porcupine Seabight is generally composed of fine sediments and consists of clayey sands and overlaying silty clays. The Gollum Channel System acts as the main pathway for focused sediment transport out of this area (Dorschel et al., 2010).

According to the EMODnet Seabed Substrate data (EMODnet, 2021), the majority of the Porcupine Basin IOSEA6 Study Area is comprised of sand mud, apart from the eastern edge where there is insufficient data to determine the substrate type.

C.6.3.3 Slyne-Erris Basin Area

The seabed landscape in Irish Atlantic waters have been largely shaped by glacial periods, when large volumes of material were eroded from the land and shelf and deposited at the shelf edge and over the continental slope. Present day sediments in Irish Atlantic waters are subject to redistribution by nearbottom currents and gravity driven processes.

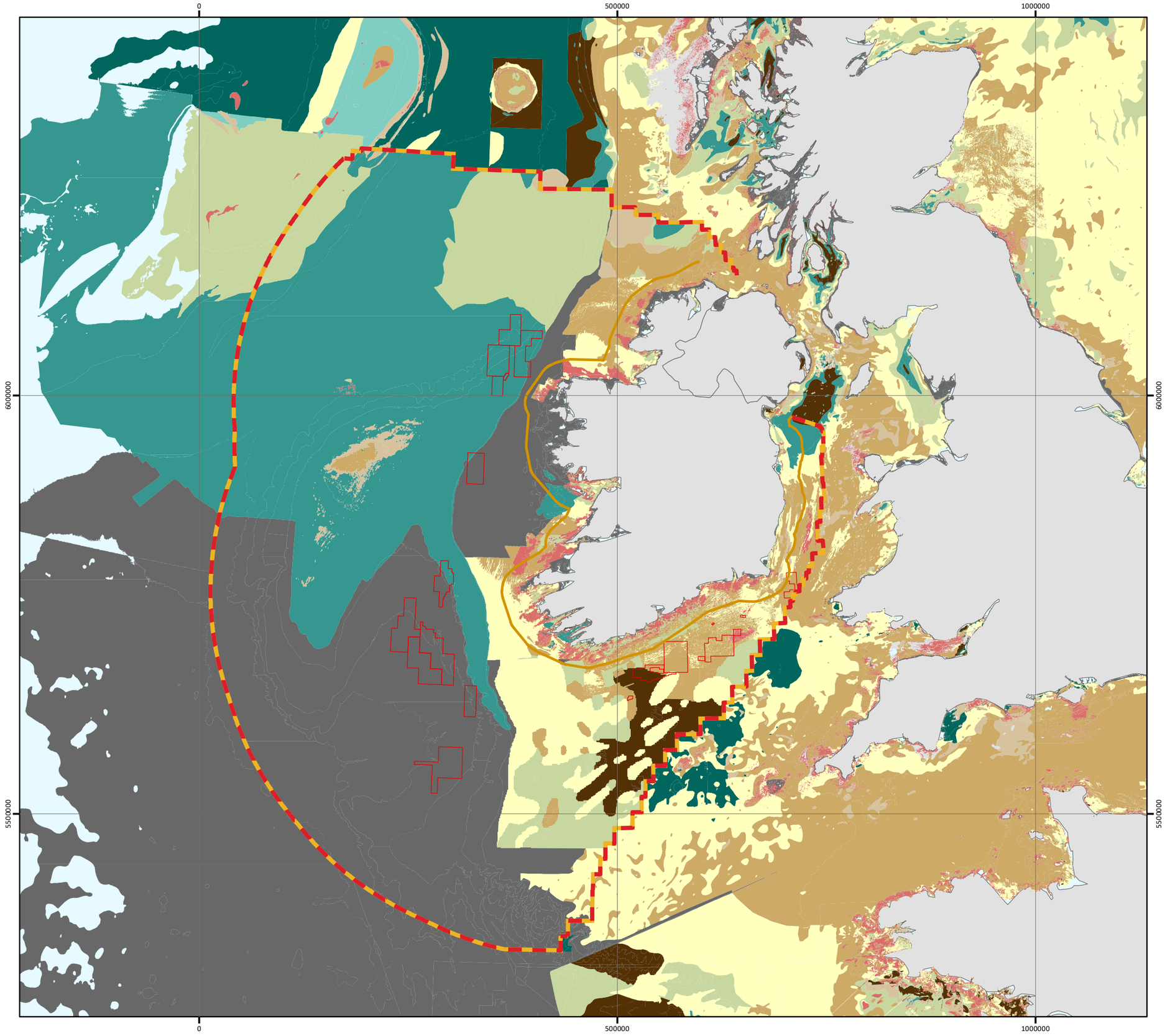
Continental shelf substrata are predominantly sandy, with patches of gravel and intermittent rock outcrops., with silty clay at the northern part of the continental slope where the gradient is shallow. In the southern section the sediment is more mixed, with gravel and boulders exposed by erosion. The deposits within the Rockall Trough and continental slope are predominantly composed of fine sediments (silts/clays) occurring in the deeper parts and more mixed substrata including sands and gravelly sands occur on the slopes.

The northern tip of the Slyne-Erris Basin IOSEA6 Study Area, according to the EMODnet Seabed Substrate data (EMODnet, 2021), is composed of deep sandy mud. The rest is defined as "seabed", where there is insufficient data to determine substrate structure.

C.6.3.4 Celtic Sea Basin Area

Coarse deposits ranging from gravelly sands to cobble pavements characterise sediments in the southern Irish Sea and Celtic Sea. Areas of outcropping bedrock also occur in nearshore areas along the south coast (Croker et al., 2005).

According to the EMODnet Seabed Substrate data (EMODnet, 2021), the substrates within the Celtic Sea Basin IOSEA6 Study Area is predominantly composed of a mosaic of sand and coarse substrate, with an area of fine mud at the western extent and a rocky outcrop in the centre.



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GEOLOGY AND SUBSTRATES
Seabed Substrates

Drawing No: P2510-GEO-002 | **B**

Legend

- IOSEA6 Area

Classified Seabed Substrate

- Coarse substrate
- Fine mud
- Fine mud or Sandy mud or Muddy sand
- Mixed sediment
- Muddy sand
- Rock or other hard substrata
- Sand
- Sandy mud
- Sandy mud or Muddy sand
- Seabed
- Sediment
- 12 NM Limit
- EEZ Boundary

N W E S

NOTE: Not to be used for Navigation

Date	15 November 2022
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Projection	Transverse Mercator
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Created By	Irinios Yiannoukos
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C.6.4 Existing Environmental Problems

C.6.4.1 Sediment Contamination

Sediment contamination is often associated with human activity (synthetic compounds) although naturally occurring geological and metallurgic complexes (naturally occurring compounds) can cause elevated levels of contaminants associated with sediments.

Due to its close association with human activity, most sediment monitoring is associated with near-shore monitoring stations. Poly Aromatic hydrocarbon (PAH) concentrations are variable in sediments in the Irish Sea/Dublin Bay with naphthalene, benz(a)anthracene and chrysene above threshold values. Increasing trends for PAHs have been detected in the Irish Sea station but not in Dublin Bay (DCLG, 2013).

In general, sediments in the Atlantic's offshore sections are less likely to be polluted by synthetic chemicals than those in the Irish Sea's nearshore parts. As a result of low levels of oil and gas exploratory activity in Irish offshore waters, it is anticipated that baseline concentrations of hydrocarbons, metals and persistent compounds in seabed sediments will be similar to background concentrations (OSPAR, 2005).

C.6.5 Potential Sensitivities to the Plan

A summary of the potential pressures and sensitive aspects of the topic are displayed in Table C-34.

Table C-34 Summary of potential pressures of the Plan on Geology, Substrates and Coastal Sediments

Plan activity	Aspect	Pressure	Sub-Topic	Key sensitivities
Drilling	Penetration of the seabed during drilling	Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion	Geology	Localised areas of the seabed will be disturbed by drilling. However, these will be at such a small scale compared with the scale of these receptors that there will be no significant impact to the local geology, bathymetry, seabed features or substrates.
			Bathymetry and seabed features	
			Substrates	
Seismic survey	Seabed disturbance from placement of equipment on seabed for seismic (e.g. sea nodes or sea bottom cable surveys)	Temporary habitat disturbance including penetration and abrasion	Geology	There is the potential for localised areas of seabed to be disturbed by the placement of survey equipment on the seabed. However, these will be at such a small scale compared with the scale of these receptors that there will be no significant impact to the local geology, bathymetry, seabed features or substrates.
			Bathymetry and seabed features	
			Substrates	
Drilling	Presence of subsea equipment (including wellhead, anchors and chains etc)	Temporary habitat disturbance including penetration and abrasion	Geology	There is the potential for localised areas of seabed to be disturbed by the placement of subsea infrastructure on the seabed. Exploratory drilling is unlikely to involve the deployment of significant amounts of seabed equipment, as the assessment only covers exploratory drilling and equipment placed is likely to be small scale there will be no significant impact to the local geology, bathymetry, seabed features or substrates.
			Bathymetry and seabed features	
			Substrates	
Seismic survey and drilling	Marine discharges (normal operations / drill rigs)	Sediment contamination	Substrates	Routine rig or vessel discharges will be controlled through compliance with various MARPOL requirements. Therefore impacts on seabed sediments and substrates is considered unlikely.
Drilling	Potential discharges from commissioning of drill rigs	Sediment contamination	Substrates	Potential for discharge of ballast water during commissioning of rigs. These are unlikely to impact seabed sediments and substrates and are controlled by the IMO BWM Convention.
Drilling	Mud, cement and cuttings release from tophole sections and WBM & WBM contaminated cuttings discharge from surface, including payzone cuttings	Sediment contamination	Substrates	The majority of chemicals used during offshore O&G operations are relatively benign, there is the potential for localised contamination of sediments through chemical discharges.

Plan activity	Aspect	Pressure	Sub-Topic	Key sensitivities
Seismic survey and drilling	Accidental events (e.g. loss of diesel, chemicals, base oil; worst case scenario - blowout)	Hydrocarbon & PAH contamination	Substrates	Oil may enter the marine environment during seismic and/or drilling operations as a result an accidental event. A well blowout would be the worst case scenario. Such an event would have the potential to contaminate the seabed or coastal sediment quality around the IOSEA6 Area.
Seismic survey and drilling	In-combination effect		Substrates	While the Planned activity has individual pressures which may or may not cause a significant effect, it is important to consider each pressure where a cumulative effect could occur in conjunction with another domestic or transboundary plan or project.

C.6.6 Data Gaps

Table C-35 Summary of data gaps on the topic geology, substrates and coastal sediments.

Section	IOSEA5 identified data gap	Update for IOSEA6	IOSEA6 Data Gap	Availability of other datasets
Geology	No data gaps were identified in IOSEA5.	IOSEA6 predominantly uses the same information that was available for IOSEA4 and IOSEA5. However, this is still deemed to be up to date as the geology will not have changed during this period.	No data gaps have been identified.	
Bathymetry and seabed features	No data gaps were identified in IOSEA5.	IOSEA6 predominantly uses the same information that was available for IOSEA4 and IOSEA5. However, this is still deemed to be up to date as the geology will not have changed during this period.	No data gaps have been identified.	
Substrates	IOSEA5 identified that there is a lack of data about sediment contamination, with only limited coastal areas been sampled through OSPAR. However, much of the area is likely to be uncontaminated so this did not preclude the assessment.	There is no more recent or comprehensive sediment contamination data available since IOSEA5. This continues to be a data gap.	Recent and comprehensive sediment contamination data.	
			A further data gap was that INFOMAR and EMODnet seabed substrates maps do not cover a wide area of the west coast of Ireland due to insufficient data. This overlaps the IOSEA6 Slyne-Erris Basin Area.	EMODnet seabed substrates map is updated every 2-3 years INFOMAR sediment classification map

C.6.7 Predicted future baseline for the topic

The bathymetry within the IOSEA6 Study Area is unlikely to change at all but the smallest scale, unless with human intervention such as dredging. Geological and seabed features are also unlikely to change within the IOSEA6 timeframe. Substrates are naturally mobile and may change slightly, however no significant trends are likely to occur within the IOSEA6 timeframe unless associated with human activity such as dredging.

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