Wave Energy Test Site
Galway Bay

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1.1 Background

IMAR Survey Ltd carried out a geophysical and hydrographic survey of north eastern Galway Bay in October and November 2007 on behalf of the Marine Institute. The purpose of the work was to provide hydrographic and geophysical data for the National Marine Mapping Programme over areas not covered by earlier surveys. Previous surveys were carried out by the R.V. Celtic Voyager and a Tenix LADS. The IMAR survey area (figure 1) covers the extent of the Wave Energy test site in the Spiddal area.

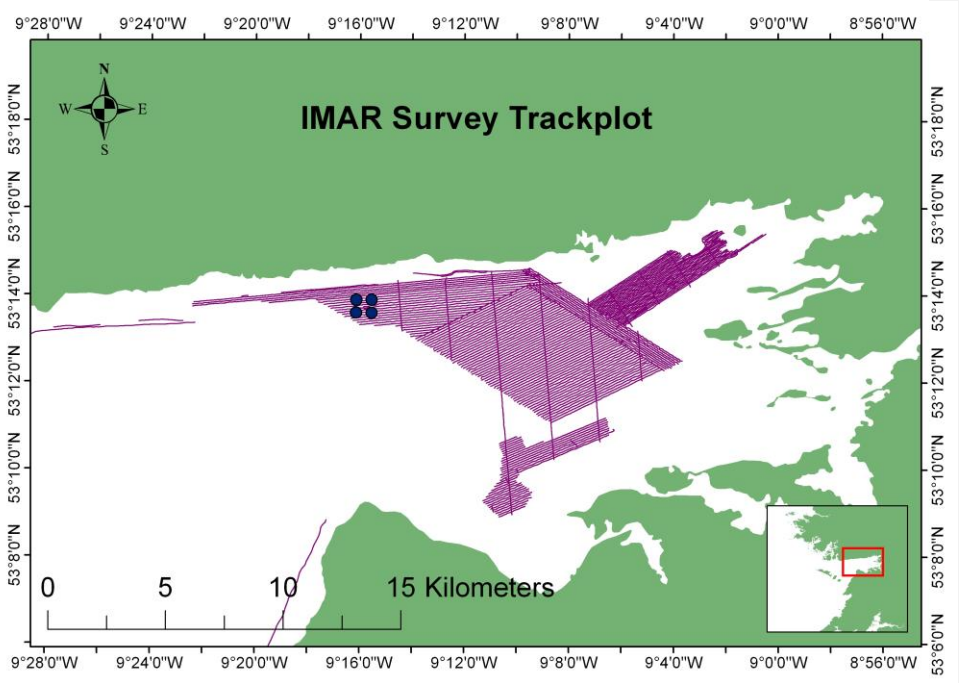

Figure 1 Survey Line Trackplot showing extent of IMAR survey and the Wave Energy test site.

1.2 Wave Energy Test Site Area

The site lies approximately 1.3 km south of the north shore of Galway Bay. Its east west extent is approximately 670 m and its north south extent approximately 560 m. The test site with boundary coordinates is presented in figure 2.

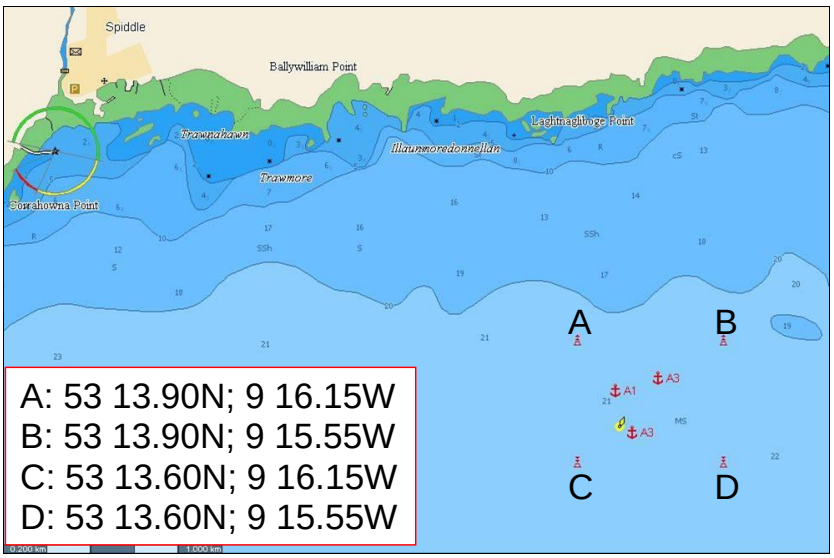

Figure 2 Wave Energy test site with boundary coordinates.

1.3 Objectives

This report was commissioned by the Ocean Energy team at the Marine Institute and presents a review of the Wave Energy test site in Spiddal from data acquired from the IMAR 2007 survey and R.V Geo 2008 groundtruthing survey.

Three principal objectives of the report were determined:

- Describe the sea floor and sub seabed conditions utilising the available datasets
- Produce GIS images showing the interpretation.
- Data sets to analyse: multibeam bathymetry and pinger.

1.4 Equipment

Sub-bottom Profiler
A four element, side mounted SES Probe 5000 pinger system was utilised. The pinger achieved good penetration in this area. Horizons were tagged in CODA and exported to XYZ files.

Sub-bottom profiler data was recorded using a CODA Octopus DA200 recording system, 120ms were recorded as a minimum and a sweep of 70ms. A swell filter rate of 22 was selected in CODA before horizons were picked.

Multibeam
The primary system for gathering the bathymetric data was the Kongsberg Simrad EM3002D multibeam echosounder, mounted on the bow underwater plate and operating at a frequency of 297 khz (Sonar Head1) and 303 kHz (Sonar Head2). Vessel heading and attitude is input to the EM3002D from the IXSea-3000 SubSea to correct bathymetric data in real time.

RESULTS SUMMARY

1.5 Bathymetry

Water depths in the Wave Energy test site (figure 3) are approximately 21 m with little variation over the entire site. Water depths of approximately 5 m are found due north of the test site. The seabed slope in the site area is very gentle with a gradual deepening from north to south.

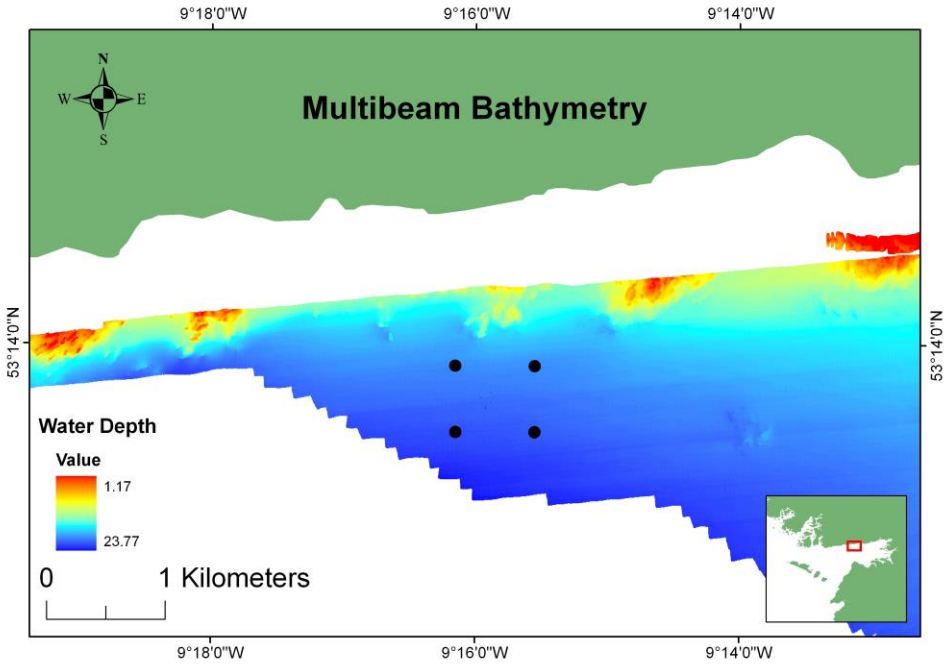

Figure 3 EM3002 multibeam bathymetry image produced in Caris processing software.

1.6 Seabed Topography

Multibeam shaded relief imagery (figure 4) is used to assess seafloor topography and seabed expression. The seafloor topography in the test site can be broadly designated as having very low relief with a very gentle slope.

Figure 4 shows bedrock outcrop located north of the test site. The ripple-like features on the shaded relief image are artefacts caused by poor motion reference corrections on the survey vessel.

Within the test site four objects (figure 4) are visible on the seabed. The objects vary in size from 20 to 30 m approximately. Table 1 shows the position and length of each object.

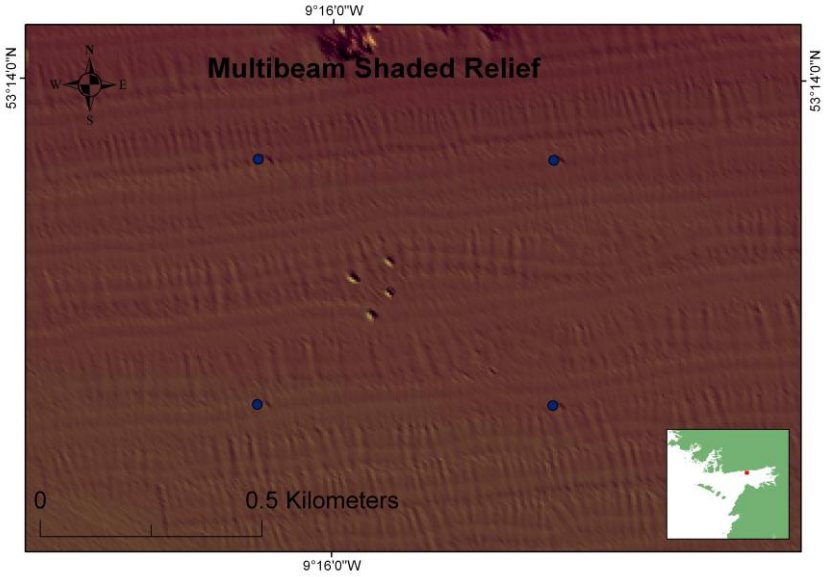

Figure 4 EM3002 multibeam shaded relief image produced in Caris processing software.

Latitude	Longitude	Object Length
53 13.758	009 15.956	30 m
53 13.777	009 15.884	20 m
53 13.713	009 15.921	25 m
53 13.739	009 15.885	22 m

Table 1 Position and size of seabed objects.

1.7 Seabed Texture

Multibeam backscatter data (figure 5) is used to indicate the relative hardness of the seafloor; the harder the substrate the more energy there is reflected from it and returned to the onboard sensors. The convention used in figure 5 is that dark areas are relatively harder and light areas relatively softer. Data from two different survey vessels is merged together in the image and this coupled with two different line headings produces the contrast between data in the southwest and the remainder. This contrast is an artefact and is not indicative of a change in seafloor conditions.

Two acoustic facies can be identified from the backscatter image and these are areas of:

1. Uniform low reflectivity
2. High reflectivity

Uniform low reflectivity facies is present in the test site area and is interpreted to be mud and fine sand (see section 2.5). The dark areas within the bounds of the test site are data artefacts caused by the vessel making sharp turns while acquiring infill data between the major survey lines. It appears that the objects seen on the shaded relief data are also present on the backscatter data and they have a high backscatter return. At least two of these objects are masked by the artefact in the data and are not visible.

High reflectivity backscatter facies is located in the north of the area and indicates bedrock outcrop. This facies is not found within the test site boundary.

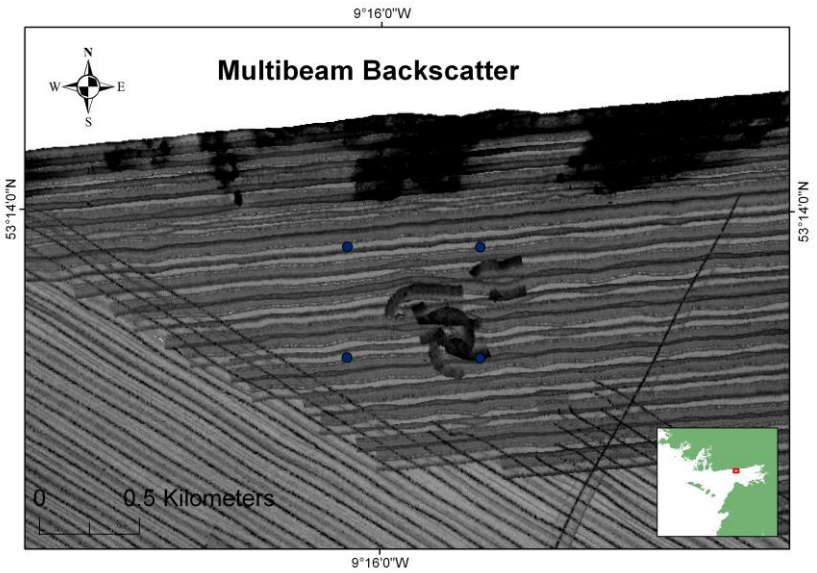

Figure 5 EM3002 multibeam backscatter image produced in Caris software.

1.8 Shallow Geology

The shallow geology in the test site is interpreted from the sub-bottom profiler data. Data quality is good but poor heave compensation from the vessels Motion Reference Unit (MRU) results in artefacts in the data. As no groundtruthing of sub-bottom profiler data was undertaken, unit compositions are on a tentative basis only.

Sub-bottom profiler was only acquired on two survey lines (figure 6) in the vicinity of the test site as prevailing poor weather conditions allowed for multibeam acquisition only. Sub-bottom profiler acquisition is more sensitive to the weather and sea state than multibeam. Data interpretation is based on the two lines acquired and interpretation spans the east-west width of the test site only.

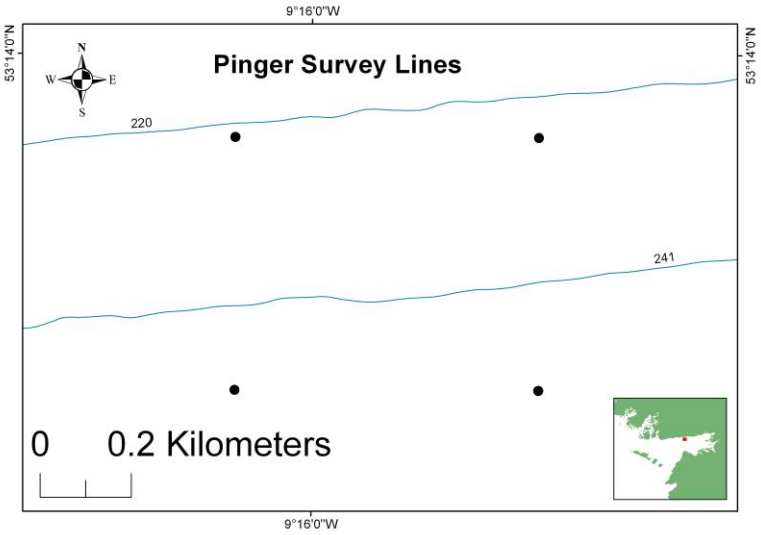

Figure 6 Sub-bottom profiler lines plotted with the test site boundary locations.

Survey line 241 was acquired on a heading of 264º and runs through the centre of the test site. The interpretation for line 241 shows a sub-horizontal reflector (figure 7) at a depth of between 2.3 and 3.3 m beneath seabed (table 2). The unit above this horizon comprises soft sediment, interpreted to be mud and fine sand. Beneath horizon 1 is a unit characterised by broken reflectors and it is interpreted to be glacial till or gravel.

Survey line 220 (figure 6) was shot on a heading of 084º and is located close to the northern boundary of the test site. Data quality for line 220 is superior to that of line 241 as it was shot in the direction of the swell. The interpretation for line 220 shows a sub-horizontal reflector (figure 8) at a depth of between 2.4 and 3.3 m beneath seabed (table 3). A second undulating horizon marking an unconformity surface is found between 5.0 and 9.5 m (table 2) beneath seabed. The unit above horizon 1 is acoustically featureless and is interpreted to be mud and fine sand. The unit below horizon 1 is characterised by having broken reflectors and is interpreted to be glacial till.

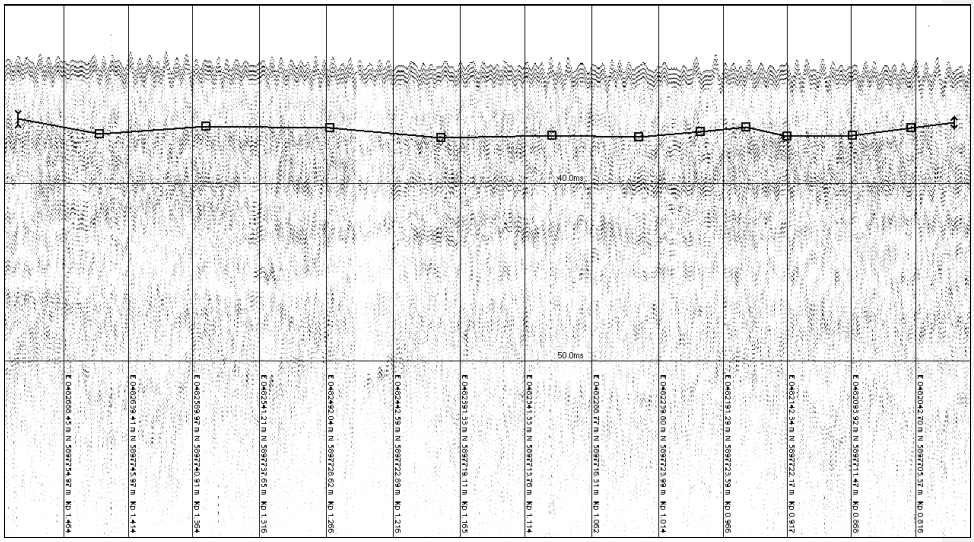

Figure 7 Sub-bottom profiler line 241with interpreted horizon.

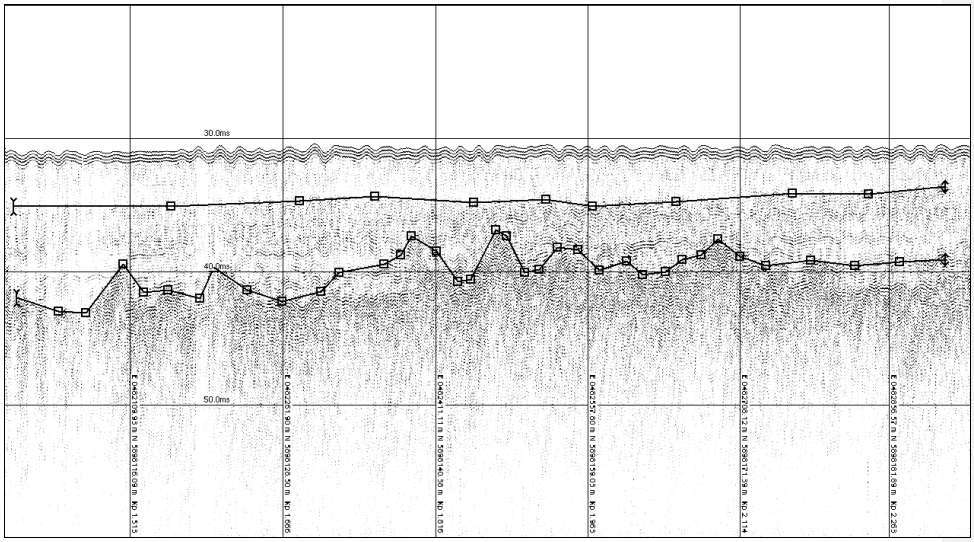

Figure 8 Sub-bottom profiler line 220 with interpreted horizons.

Tag-Name	Depth from Seabed	Depth from Surface	Easting	Northing
Horizon 1	2.82	27.62	482723.3	5897759
Horizon 1	2.86	27.66	482662.6	5897750
Horizon 1	2.94	27.84	482581	5897741
Horizon 1	2.82	27.82	482489.7	5897728
Horizon 1	3.19	28.19	482407.6	5897721
Horizon 1	3.35	28.35	482317.6	5897713
Horizon 1	3.19	28.19	482255.4	5897721
Horizon 1	2.62	27.62	482209.7	5897725
Horizon 1	2.66	27.76	482174.9	5897723
Horizon 1	3.23	28.23	482142.3	5897722
Horizon 1	3.06	28.16	482093.9	5897711
Horizon 1	2.58	27.68	482045	5897706
Horizon 1	2.3	27.5	482011.2	5897705

Table 2 Interpretation for sub-bottom profiler line 241.

Tag-Name	Depth from Seabed	Depth from Surface	Easting	Northing
Horizon 1	3.31	26.71	481994	5898109
Horizon 1	3.31	26.51	482149.5	5898121
Horizon 1	2.98	26.08	482275.7	5898132
Horizon 1	2.78	25.78	482350.8	5898143
Horizon 1	3.15	26.15	482446.5	5898143
Horizon 1	3.31	26.31	482515.8	5898160
Horizon 1	3.47	26.47	482560.7	5898159
Horizon 1	3.19	26.19	482644.7	5898168
Horizon 1	2.62	25.62	482759.5	5898177
Horizon 1	2.86	25.86	482835.5	5898180
Horizon 1	2.42	25.42	482910.1	5898190
Horizon 2	8.67	32.07	481997.1	5898110
Horizon 2	9.35	32.55	482036.9	5898113
Horizon 2	9.48	32.78	482064.5	5898114
Horizon 2	6.69	29.89	482104	5898116
Horizon 2	8.43	31.63	482122.3	5898117
Horizon 2	8.35	31.55	482146.6	5898120
Horizon 2	9.07	32.17	482179.1	5898126
Horizon 2	6.94	30.14	482191.5	5898127
Horizon 2	8.35	31.45	482224.1	5898125
Horizon 2	9.07	32.17	482261.9	5898129
Horizon 2	8.51	31.51	482295.8	5898138
Horizon 2	7.58	30.58	482314.5	5898142
Horizon 2	7.06	30.06	482360	5898142
Horizon 2	6.41	29.41	482374.8	5898141
Horizon 2	5.2	28.4	482387.2	5898141
Horizon 2	6.13	29.13	482411.1	5898140
Horizon 2	8.02	31.02	482431.9	5898141
Horizon 2	7.7	30.7	482446.5	5898143
Horizon 2	5.04	28.04	482468.8	5898150
Horizon 2	5.32	28.32	482477	5898153
Horizon 2	7.46	30.46	482494.7	5898158
Horizon 2	7.38	30.38	482510	5898160
Horizon 2	5.77	28.77	482527.9	5898160
Horizon 2	6.05	29.05	482548.8	5898160
Horizon 2	7.26	30.26	482569.5	5898159
Horizon 2	6.81	29.81	482596.6	5898161
Horizon 2	7.62	30.62	482611.1	5898163
Horizon 2	7.54	30.54	482632.1	5898167
Horizon 2	6.77	29.77	482650.7	5898168
Horizon 2	6.57	29.57	482669.1	5898169
Horizon 2	5.4	28.4	482687	5898170
Horizon 2	6.57	29.57	482708.1	5898171
Horizon 2	6.81	29.81	482732.2	5898175
Horizon 2	6.85	29.85	482777.7	5898178
Horizon 2	6.89	29.89	482823.5	5898179
Horizon 2	6.98	29.98	482865.1	5898183
Horizon 2	6.77	29.77	482910.1	5898190

Table 3 Interpretation for sub-bottom profiler line 220.

1.9 Groundtruthing

The Geological Survey of Ireland vessel, the R.V. Geo carried out groundtruthing (figure 9) of the multibeam data in 2008 as part of the INFOMAR project. Two of these stations are in close proximity to the test site and the results are presented in table 4. A small Van Veen grab sampler was used for the groundtruthing so results are only indicative of the surface sediment and should not be interpreted as a groundtruthing of the sub-bottom profiler data.

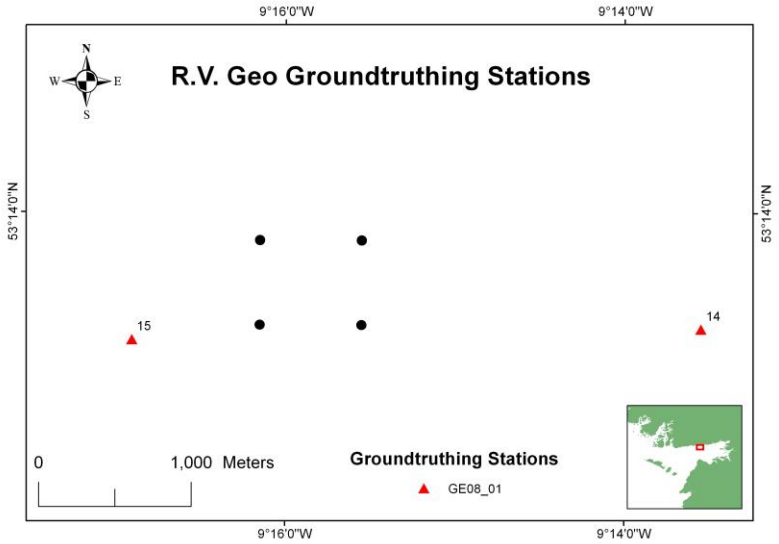

Figure 9 R.V. Geo Groundtruthing stations.

Station	Latitude	Longitude	Description
15	53 13.55	009 16.907	Silty Sand
16	53 13.67	009 19.269	Mud and Silt with shell fragments

Table 4 Groundtruthing Information.

CONCLUSIONS

1.10 Conclusions

- Four objects were located on the seabed at the time of acquisition in November 2007.
- No bedrock outcrop exists within the test site.
- The seabed is homogenous and composed of soft sediment.
- Interpretation of sub-bottom profiler data indicates soft sediment within the top 2.3 m of the seabed.
- A reflector at between 2.3 and 3.5 m depth marks the transition from the soft sediment into a more compact inhomogeneous and coarser sediment type.