Glacio-Karst Limestone and Jointing of Inishmore, Ireland

RJ Kozich and Dr. Leslie Sautter
Dept. of Geology and Environmental Geosciences, College of Charleston

ABSTRACT

Bathymetric data were collected from May to August 2014 in the northwest channel of Inishmore Island, Ireland by the Marine Institute and Geological Survey of Ireland as part of the INFOMAR Project. The vessel used to collect this data was the R/V *Celtic Voyager*, with a Kongsberg EM2040, and 2D and 3D bathymetric and backscatter surfaces were created using CARIS HIPS and SIPS 9.1. During the Carboniferous Period (359-299 Ma) a shallow sea formed causing the formation of the Aran Islands and nearby Burren. The shallow, warm tropical seas allowed for the deposition of biogenic carbonate sediments which would eventually form limestone. This study site has since been greatly affected by tectonic uplift, sea level rise and fall and glacial action. The submarine glacio-karst features were examined to help understand the relationship of the study site to the adjacent terrestrial areas.

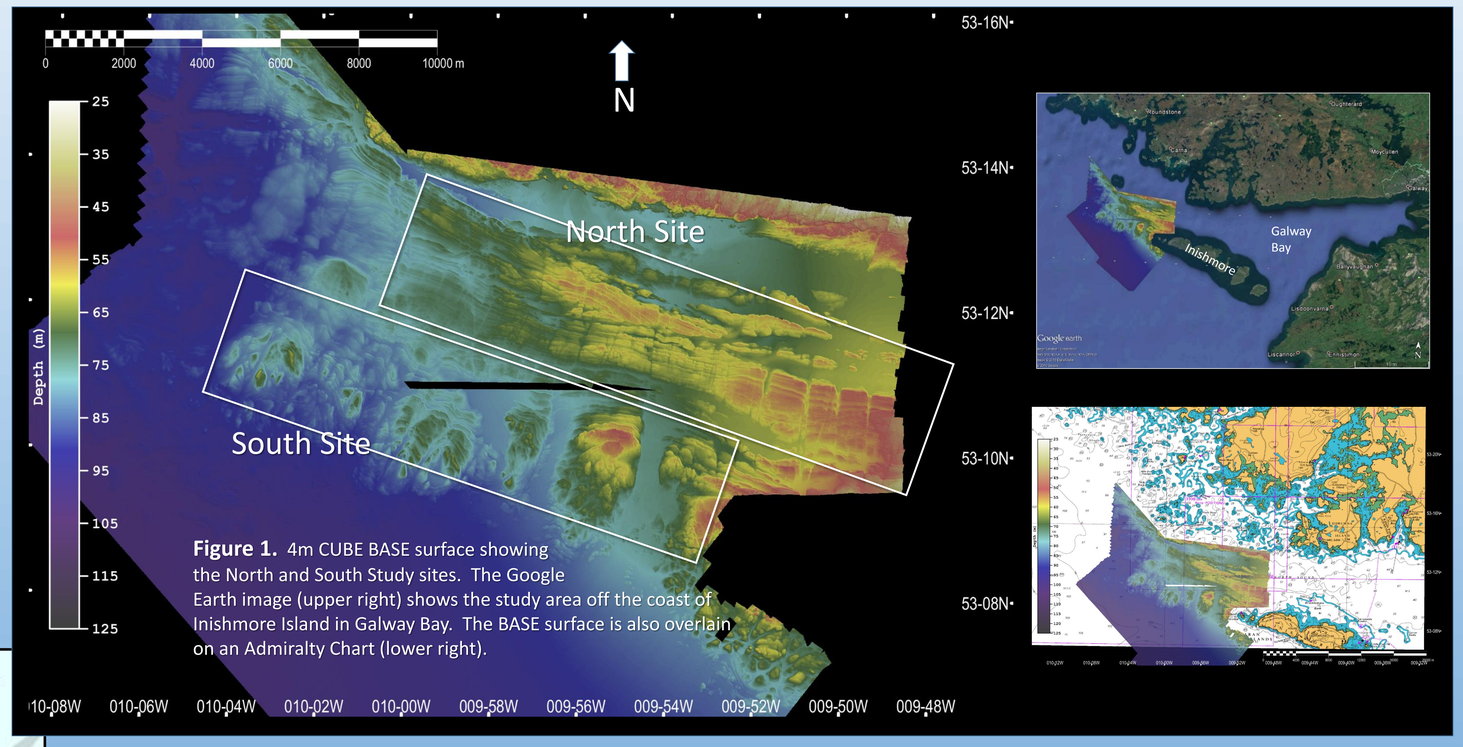

Figure 1. 4m CUBE BASE surface showing the North and South Study sites. The Google Earth image (upper right) shows the study area off the coast of Inishmore Island in Galway Bay. The BASE surface is also overlain on an Admiralty Chart (lower right).

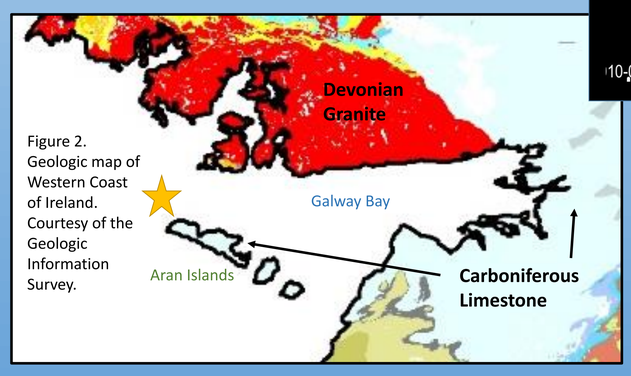

Figure 2. Geologic map of Western Coast of Ireland. Courtesy of the Geologic Information Survey.

METHODS

- Bathymetric data were collected by the Marine Institute and Geological Survey of Ireland as part of the INFOMAR Project on the R/V *Celtic Voyager* from May to August 2014.
- Bathymetric data were collected using a Kongsberg EM2040.
- The raw sonar data was processed using CARIS HIPS and SIPS 9.1 to create 2D and 3D CUBE 4m surfaces.
- Profiles were measured using digitalize profiling in CARIS HIPS and SIPS 9.1.
- Joint orientation (heading) and lengths were measured using Google Earth Pro.

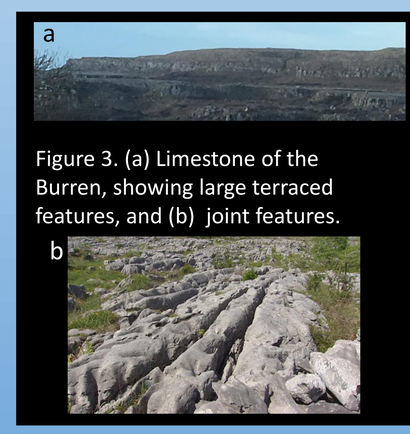

Figure 3. (a) Limestone of the Burren, showing large terraced features, and (b) joint features.

BACKGROUND

Inishmore is an island located off the western coast of Ireland in the Galway Bay (Figure 1). The seafloor around Inishmore includes a variety of geological structures such as karst-limestone, faults, and joints that are in the limestones formed during the Carboniferous Period, 359 and 299 Ma. At that time Galway Bay had a tropical environment with shallow warm tropical seas which allowed for the wide spread deposition of calcareous biogenic muds that lithified to limestone. The entire study site was later subaerially exposed (likely due to tectonic uplift) and was chemically eroded by rainfall, creating karst features (Figure 3b). Approximately 18,000 years ago, during the Pleistocene, sea level was 125 m below present level (USGS, 2012), and glaciers smoothed the landscape's exposed limestone that makes up the Burren (Figures 2 and 3a) (McNarmara 2009). Glaciers may have also plucked edges of the tilted limestone beds to make terraced features (Figure 3a). The purpose of this study is to explore and compare the geomorphology of the terraced, karst, and joint features present in the limestone seabed of Galway Bay to its terrestrial counterpart in the Burren.

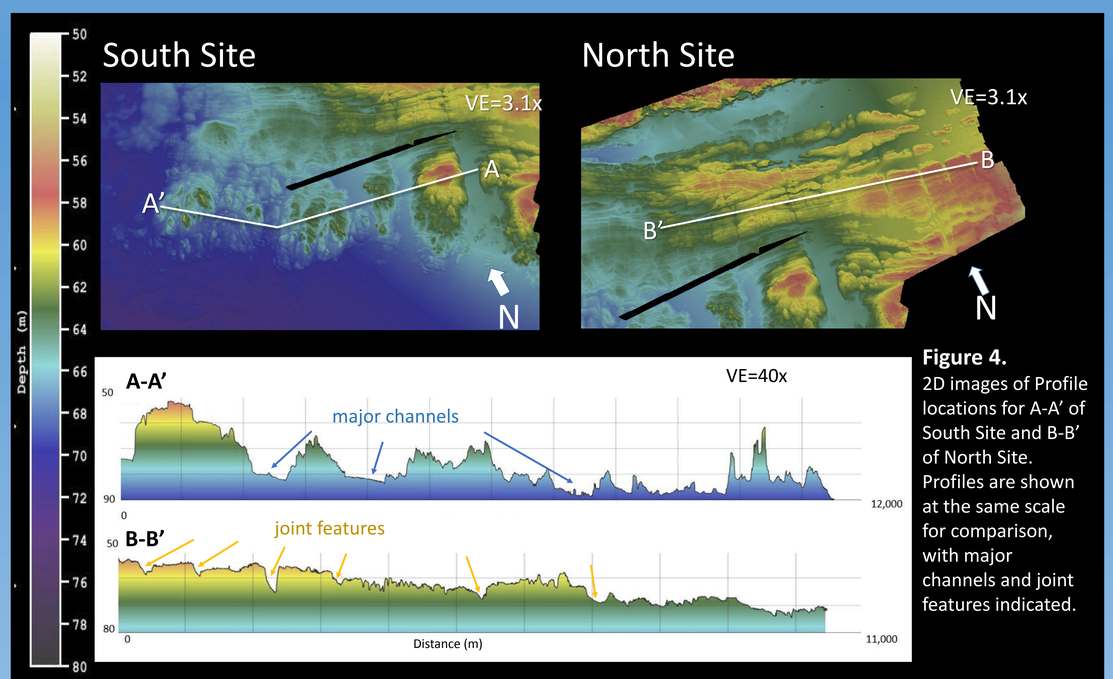

Figure 4. 2D images of Profile locations for A-A' of South Site and B-B' of North Site. Profiles are shown at the same scale for comparison, with major channels and joint features indicated.

RESULTS

- South Site has Profile D-D' showing terraced features from tilted limestone beds (Figure 5, bottom) which are similar to the terraced features of the Burren (Figure 3a).
- North Site, Profile C-C' (Figure 5, top) shows a jagged horizontal profile which may show the exposed edges of limestone beds tilting at a higher angle than those at South Site. A fault was also observed. 3D images of Profile C-C' show the fault – the contact between the different tilted beds.
- At both North and South Sites lateral east-west profiles (Figure 4) depict the limestone outcrops and their joints.
- Channels between outcrops are relatively flat from sediment deposits.
- Joint lengths varied from 744 to 4,753 m. Nine out of the ten joints had north to south headings ranging from 174 to 201° (Figure 7, Table 1).

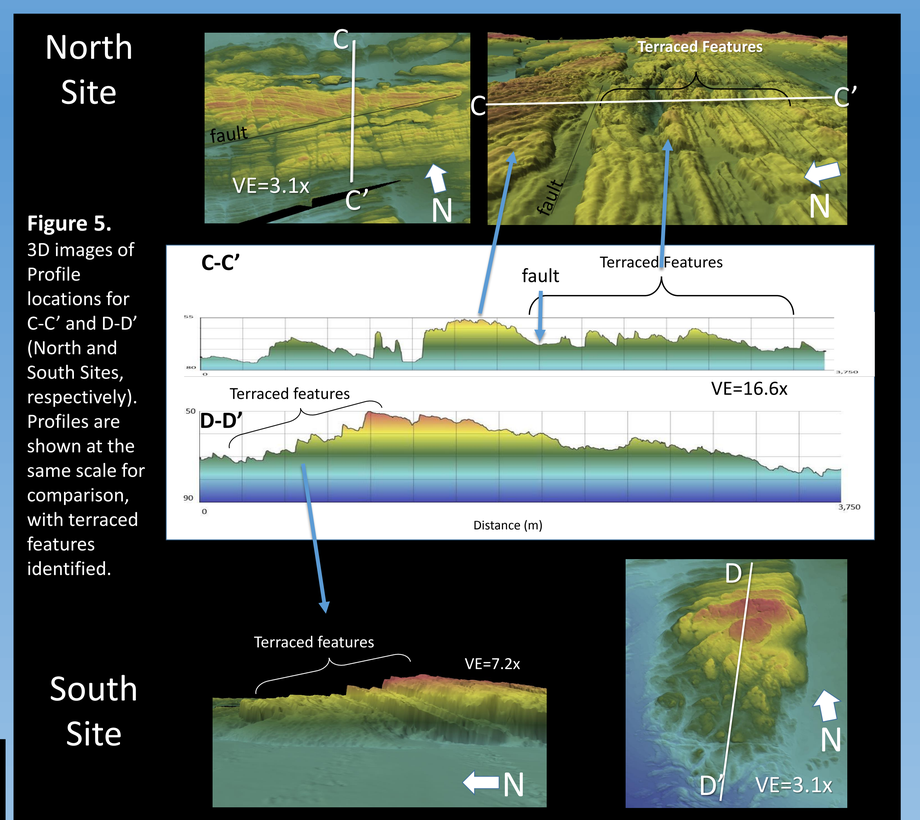

Figure 5. 3D images of Profile locations for C-C' and D-D' (North and South Sites, respectively). Profiles are shown at the same scale for comparison, with terraced features identified.

Figure 6. The slope surface shows the steep (>20o) slope of the terrace cliffs. Terracing is likely the result of tilted limestone beds that have been plucked by glaciers to generate scarps.

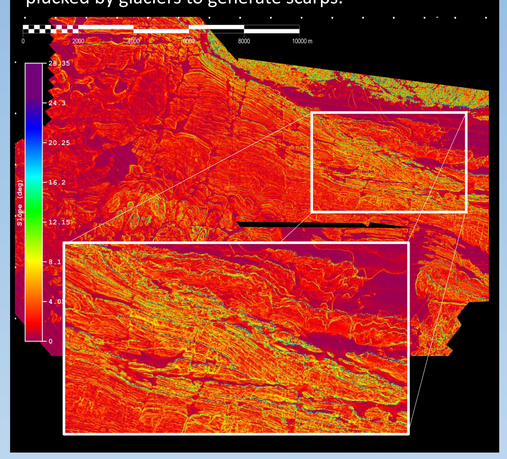

Figure 7. Headings for Joints 1-10 were measured in Google Earth (Table 1). Joint headings are similar, though lengths vary greatly throughout the study area.

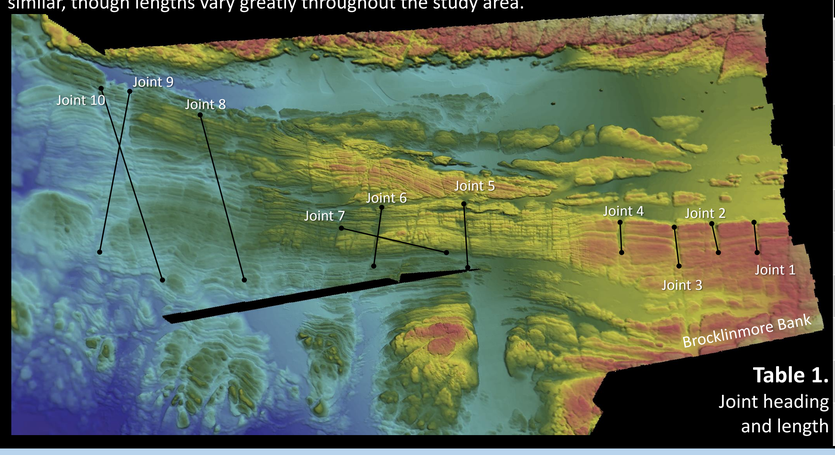

Table 1. Joint heading and length

Site	Heading (degrees)	Length (m)
Joint 1	183.59	744
Joint 2	184.96	771
Joint 3	183.83	826
Joint 4	192.97	655
Joint 5	191.09	962
Joint 6	197.79	1,555
Joint 7	115.21	2,046
Joint 8	174.64	4,123
Joint 9	201.86	4,007
Joint 10	174.78	4,753

DISCUSSION

The geology around Inishmore can be compared to that of Ireland's famous Burren. In the Galway Bay study site west of Inishmore, terracing of tilted limestone beds is a great example of possible plucking by glaciers, resulting in a stair-step profile (Figures 3a and 5). Joints present on the seafloor are nearly parallel to one another (Figure 7), and may be karst features from rainwater and dissolution of fractures during subaerial exposure throughout its long geologic history. These joints can be compared to the joints that are commonly present in the Burren, but are much larger (Figures 3b and 7).

This study site exemplifies many of the same geological features that are present in the Burren and on Inishmore. Further study of this and nearby sites will help to gain a greater understanding of the submerged geology of the Burren landscape.

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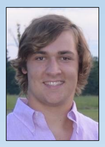

Robert J. Kozich
kozichrj@g.cofc.edu

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