Geomorphology of the Continental Margin off the Dingle Peninsula, Ireland

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INFOMAR
Integrated Mapping for the Sustainable Development of Ireland's Marine Resource

BEAMS

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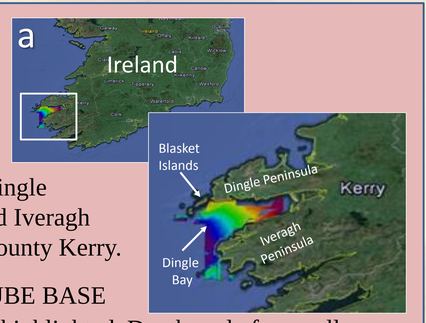
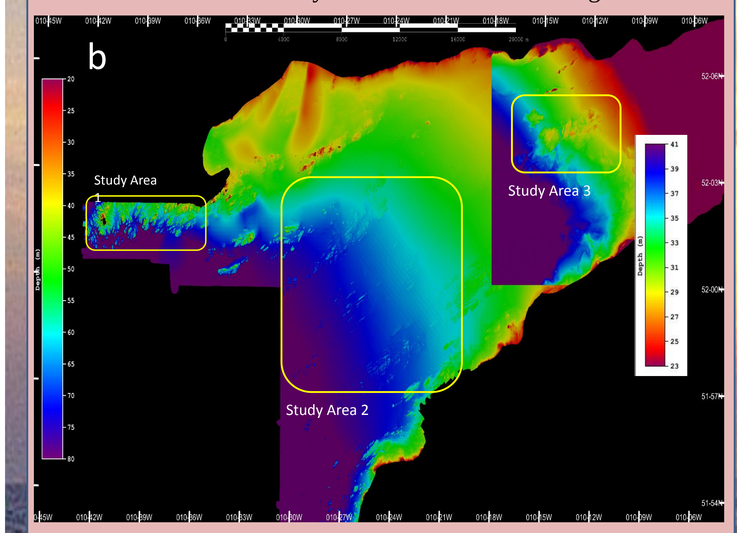
Figure 1:
a) Google Earth images showing location of study area off the SW coast of Ireland. Dingle Bay is bordered by the Dingle Peninsula to the north and Iveragh Peninsula to the south, County Kerry.



b) Two 5m resolution CUBE BASE surfaces with study areas highlighted. Depth scale for smaller surface that includes Study Area 3 is located on the right.



Abstract

From May to June 2009, the R/V *Celtic Voyager* collected multibeam bathymetric data off the southwest coast of County Kerry, Ireland for The Geological Survey of Ireland and Marine Institute. The system used for data collection was a Kongsberg EM3002 system. CARIS Hips and Sips 8.1 was used to post-process the data and create 2D and 3D bathymetric surfaces. The area of study is located within Dingle Bay and immediately south of the Blasket Islands where the seafloor ranges from a depth of 20 to 100 m. Rocky outcrops throughout the bay are oriented in a NE-SW direction indicative of compression forces acting NW-SE. The main deformational event that has shaped the geomorphology of Dingle Bay appears to be the Caledonian orogeny in the late Cambrian to mid-Devonian.

Background

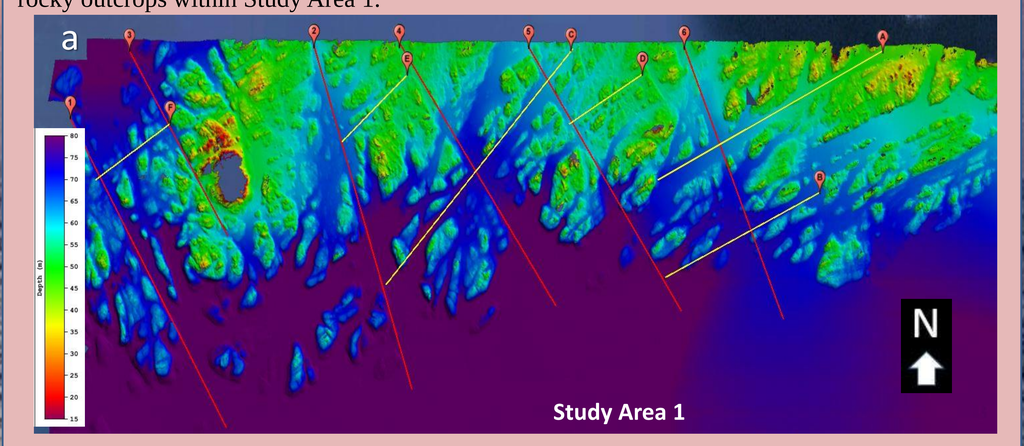
The southwestern coast of Ireland in County Kerry has undergone several deformational events dictating the overall structure of Dingle Peninsula, Dingle Bay, and Iveragh Peninsula (Fig. 1). The tectonic events known to have shaped the area are the Caledonian Orogeny from the late Cambrian to mid-Devonian and the Varsican Orogeny from the late Carboniferous to the early Permian (Bresser & Walter, 1999; Capewell, 1975; Holland, 1987; Meere, 1995). Holland (1987) claims that the Dingle Peninsula north of Dingle Bay displays structural features indicative of the NW-SE compression related to the Caledonian Orogeny. However, Capewell (1975), establishes the Variscan Orogeny as the major tectonic influence on Iveragh Peninsula south of Dingle Bay. The purpose of this study is to determine the tectonic origin of the structural features controlling the geomorphology of Dingle Bay.

The confines of the area studied for this project are within Dingle Bay and immediately south of the Blasket Islands (Fig. 1). Study Area 1 (Fig. 2) shows a series of joint networks superimposed on rocky outcrops immediately below the Blasket Islands. Study Area 2 (Fig. 3) includes a sequence of rocky outcrops in a uniform orientation with nearly equal distances between. Study Area 3 displays a section of polyphase fold structures within the shallower portion of of Dingle Bay (Fig. 4).

Methods

- In May-June of 2009, INFOMAR and The Geological Survey of Ireland collected multibeam sonar data using a Konsberg EM3002 system aboard the R/V *Celtic Voyager* within Dingle Bay, south of the Blasket Islands.
- Multibeam data were downloaded from the NOAA NGDC website and post-processed using CARIS Hips 8.1 to create CUBE BASE surface bathymetric images of 5 and 10 m resolution as well as profiles within the study areas.
- Rocky outcrops were analyzed for joint patterns, directional alignment, and spatial distribution to determine tectonic influences on the bathymetry.
- Google Earth was used to measure and compare tectonically-induced features on rocky outcrops as well as folding features observed in the study area.
- Stereonet was used to create rose diagrams of joint systems.

Figure 2: a) Measurement paths of joint headings superimposed on rocky outcrops within Study Area 1.



b) Rose diagram showing joint headings for Study Area 1. Red lines are NW-SE trending joints and yellow lines are NE-SW trending joints (Table 1).

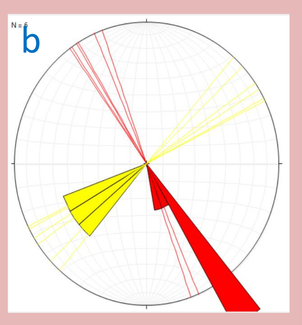


Table 1: Joint headings for both NW-SE and NE-SW trending joints

NW-SE trending joints	**1**	**2**	**3**	**4**	**5**	**6**
Headings (°)	148.1	160.4	148.9	144.5	145.6	156.8
NE-SW trending joints	A	B	C	D	E	F
Headings (°)	242.5	243.6	221.2	238.3	226.6	235.3

Figure 3:
a) Close up view of Study Area 2 showing location of profile A-A'.
b) Fold system within Study Area 2 is outlined by outcrop.
c) Profile A-A' shows spatial distributions of folds in Study Area 2.

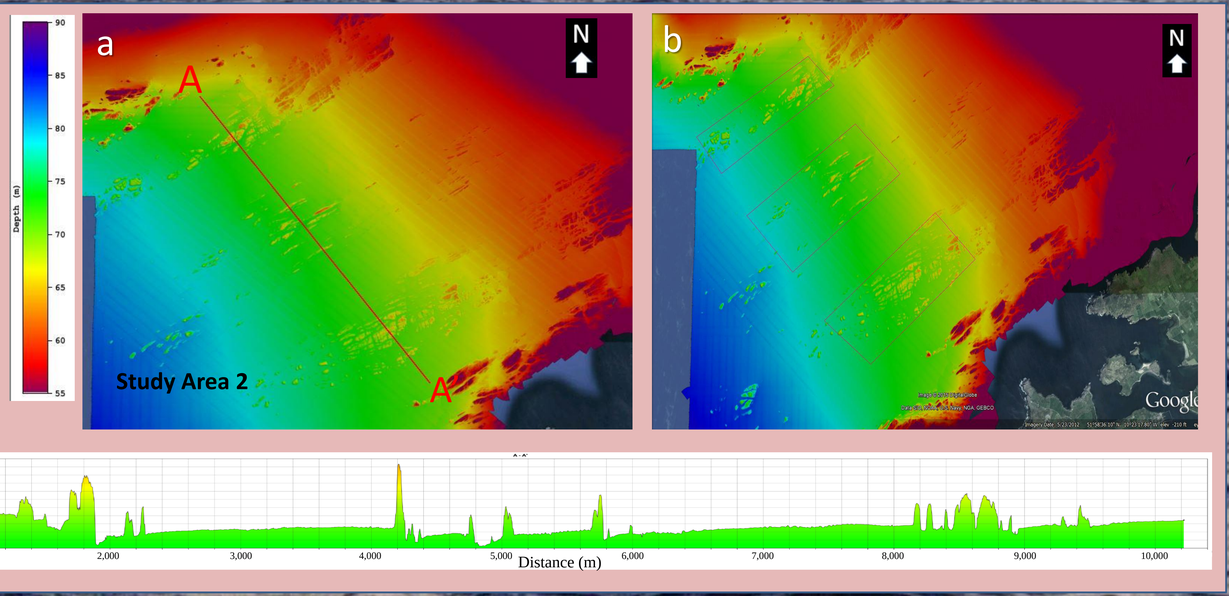
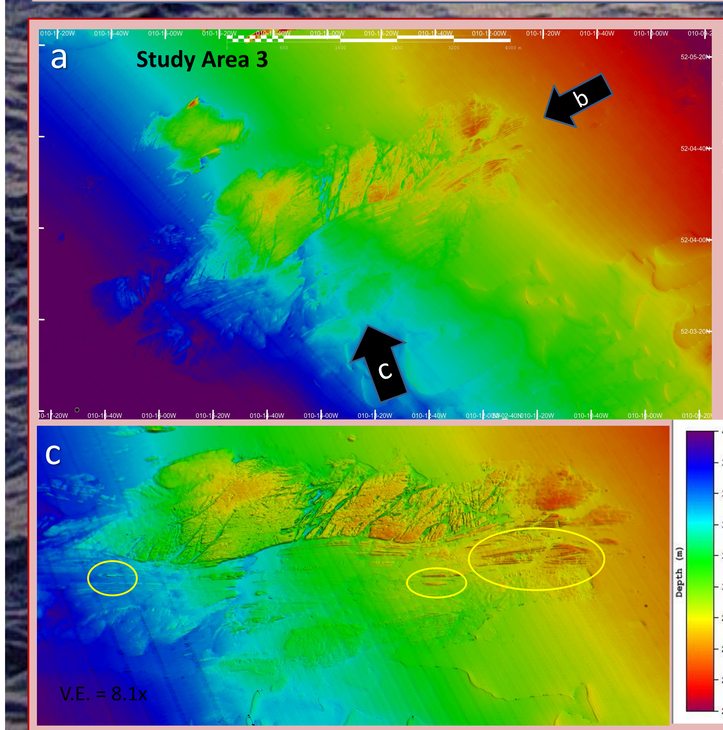
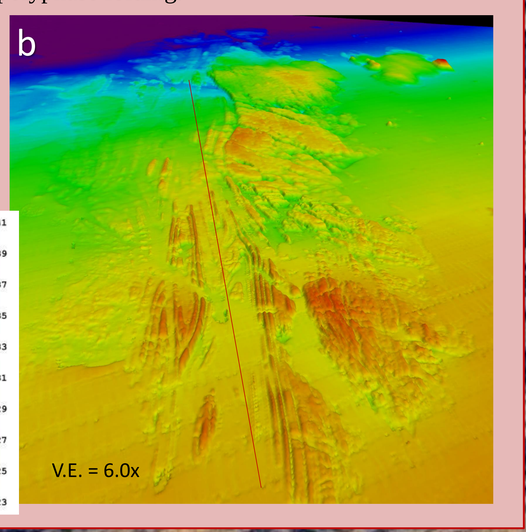


Figure 4: a) Close up of Study Area 3 with arrows showing the view directions for 3D images in 4b and 4c. Figure 4b shows the dominant orientation of the fold axis. Figure 4c outlines several sheath folds indicative of polyphase folding.



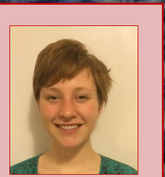


Results

- The NW-SE trending joints seen in Fig. 2a (red lines)extend through the NE-SW trending joints (yellow lines).
- NE-SW trending joints mostly extend across the intervals between NW-SE trending joints without cutting across them, making them cross joints.
- Joint sets found within Study Area 1 exhibit an average interlimb angle of ~60° as shown on the rose diagram (Fig. 2b).
- Three sections of rocky outcrops can be seen within Study Area 2 (Fig. 3a) and in the A-A' profile in Fig. 3b.
- The A-A' profile shows an average distance of 1,500 m between rocky outcrop features.
- Study Area 3 and 3D images (Figs. 4a,b,c) show the presence of various types of folds and a zone of vertical displacement of 3 m.
- Fold axes within Study Area 3 have mostly a NE-SW orientation. Evidence of polyphase folding is shown in Figure 4c.

Discussion

The overall orientation of Dingle Bay trending from NE-SW can be seen in Figure 1. This trending direction for the entire bay indicates that the major tectonic influence that created the structural constraints of the area is the Caledonian Orogeny. Joints typically form parallel to the maximum compressive stress and parallel to the least compressive stress (Burg, 2015). Joints within Study Area 1 show two different directions of maximum compressional stress indicating multiple phases of deformation. The presence of the NE-SW cross joints implies a regional principle stress rotation through 60° after the formation of the NW-SE joints and before the formation of the NE-SW joints (Bai et al., 2002). The bathymetric geomorphology of Study Area 1 was affected by NW-SE compression (yellow joints) and then NE-SW compression (red joints) during the Caledonian and Variscan Orogenies, respectively. An interlimb angle of 60° seen within the Rose Diagram (Fig. 2b) indicates that the types of folds associated with the formation of these joints are close chevron folds (Ramsay, 1974). The fold system located in Study Area 2 is highlighted by the presence of rocky outcrops in the bathymetry that are roughly equal in spatial distribution to the folds (anticlines and synclines) identified on Iveragh Peninsula by Capewell (1975). Although there has been a significant amount of erosion, the overall orientation and NE-SW trend of the folds is indicative of the Caledonian Orogeny and compression from the NW-SE (Capewell, 1975). The overall NE-SW orientation of fold axes within Study Area 3 also suggests that this part of Dingle Bay has been controlled by the Caledonian Orogeny. Although Study Area 3 also displays polyphase folding (sheath folds of Figure 4c) which indicates the presence of Variscan deformation events, the main folds are dominated by Caledonian forces. The apparent tectonic foundation that controls the geomorphology of Dingle Bay is the Caledonian Orogeny, which can be deduced by the mostly NE-SW trending structural remnants.



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Acknowledgements

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