Chapter 2
Study Sites, Methods and Aim

Abstract Rocky shorelines within southeastern Galway Bay and on the Aran Islands exhibit stepped platforms as well as steep cliffs with heights up to more than 20 m. Here field research on recent boulder movement by six exceptional strong winter storms of the season 2013/14 has been made. Quantitative data on boulder location, size, distances moved horizontally and vertically, and source of the boulders have been collected, as well as observations and documentation on signatures of the transport process on the rock platforms and on boulders themselves. The results are compared with the size of existing (old) boulders and their potential transport data. During fieldwork special emphasis was given on the morphologic aspects of boulder deposits and their internal architecture, and to imply sites of different intensity of exposure and bathymetry. The investigations should contribute to the question of boulder ridge genesis, with an extended documentation from field impressions in figures and photos as a base for later conclusions.

Keywords Study sites · Impact marks · Quantitative boulder data · Bulk density · Coastal erosion · Morphologies of deposits

In this chapter, we concentrate on the boulder clusters and boulder ridges deposited at the coastlines of the three Aran Islands as well as at the south-eastern coast of Galway Bay (Figs. 2.1, 2.2, 2.3 and 2.4).

In 2006, 2007 and 2008, we inspected and documented all the coastlines of Inisheer, Inishmaan and Inishmore as well as the 20 km long coastal section between Black Head and Doolin at the mainland (see Scheffers et al. 2009, 2010a, b). In June, 2014, we visited the area again to document the consequences of six extreme winter storms of the season 2013/14. Beside measurements of boulder axes lengths, volume, density and mass, we collected data on (potential) horizontal and vertical transport distances (if source areas could be identified), and took samples for numerical dating from boring bivalves (*Hiatella arctica*) out of large dislocated boulders. We also observed other signatures of dislocation and relative age like lichen cover or biogenic hints like calcareous algae, *Patella* resting places, sea urchin resting places, and bioerosive rock pools, all from the supra-tidal to sub-tidal region, as well

W. Erdmann et al., *Origin and Formation of Coastal Boulder Deposits at Galway Bay and the Aran Islands, Western Ireland*,
SpringerBriefs in Geography, DOI 10.1007/978-3-319-16333-8_2

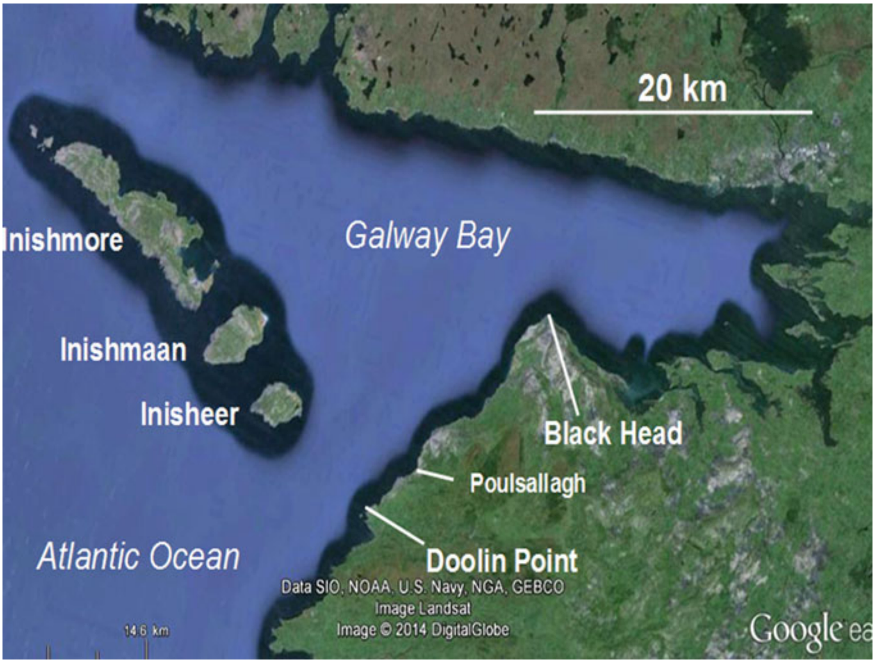

Fig. 2.1 Study area at the central west coast of Ireland: the three Aran Islands Inishmore, Inishmaan and Inisheer, and the SE coast of Galway Bay from Doolin to Black Head (*Image credit* © Google earth 2012, modified)

as the intensity (if given) of terrestrial limestone solution on rock and boulders. The setting of the boulders and the internal architecture of large deposits have been described, as well, either deriving from an original settling, or from later movements within boulder ridges.

One of our main objectives, however, was the reception of the total environmental parameters of these coarse coastal deposits in the Galway and Aran region, including

- degree of exposure;
- bathymetry (from Chart 3339, edition 2005, and new sounding of INFOMAR);
- potential sea level changes since the Recent Holocene;
- morphologies of the deposits like ridges, clusters, imbrication and imbrication trains, and parallel ridges, ripple-like ridges, or boulder piles;
- signatures of old and fresh impacts, such as striations or shatter marks;
- soil development and erosion of terrestrial deposits at or near the boulder deposits;
- the question of coastal erosion in exposed and sheltered as well as steep (vertical, overhanging) and stepped cliff profiles or rocky coastal slopes, and boulder and cobble beaches;
- the intensity of biogenous processes in the tidal realm forming, for example, rock pools or barnacle carpets.

Fig. 2.2 Typical aspect of the coastal landscape along the exposed coastlines of the Aran Islands (here: Inishmore): steep cliffs in slightly seaward dipping Carboniferous limestone along the main body of the islands, which are smoothed by ice age glaciers. Galway Bay in the background (*Image credit* Anja Scheffers)

Fig. 2.3 Quarrying of boulders along the well stratified limestone coast of eastern Galway Bay. The pattern of joints opened by terrestrial karstification can be seen inland among the drystone walls (*Image credit* Anja Scheffers)

Fig. 2.4 Extremely steep or even overhanging cliffs along the Aran Islands coastlines exposed to the open Atlantic Ocean (*Image credit* D. Kelletat)

Location was assigned from satellite images (by Google Earth Pro, covering at least the years 2000 to 2012) and our own oblique aerial photographs of 2007 as well as from the Helicopter flight documentation of the National Coastline Survey, Marine Institute, Dublin (Ireland 2000), also using DGPS and simple levelling where possible. The altitudes have been related to MHW, controlled by the upper barnacle and *Fucus vesiculosus* belt where possible. Bulk density of several limestone samples has been measured by the Archimedean principle to be from 2.543 g/cm^3 to 2.738 g/cm^3 with a mean of 2.64 g/cm^3. For simplification and to avoid over-scaling of the figures we calculated the volume (from multiplying the *mean* length of a-, b-, and c-axes of boulders) with 2.5 to get the mass of single fragments.

We also feel that it is important not only to concentrate on the very exposed cliff top deposits on the highest elevations with the largest boulders and most perfect ridges, but in particular to check the sheltered coastlines of the Aran Islands to their bay-ward sides, and along coastal sections within Galway Bay. These areas have not been inspected by other authors, but they may hold the key for improving our understanding on the energy and kind of coastal processes (storm waves or tsunamis), at least responsible for some of the movements and forms. The same is true regarding some forms combined with the main ridges like older ridges at their landward side (mentioned but not discussed in terms of their genesis by Williams and Hall (2004), or Zentner (2009)), piles of boulders, or ripple-like features within ridges. Our aim is to document the objective natural appearance as accurately as possible as a base for the interpretation of recent and old processes. This requires the collection of all geomorphologic arguments to establish the story of the Aran and Galway coastal boulder ridge genesis during the Recent Holocene, also to compare these features with similar ones around the World's coastlines.

References

National Coastline Survey (2000) Irish sea chart. Marine Institute, Dublin (Ireland)

Scheffers A, Scheffers S, Kelletat D, Browne T (2009) Wave-emplaced coarse debris and megaclasts in Ireland and Scotland: boulder transport in a high energy littoral environment. J Geol 117:553–573

Scheffers A, Kelletat D, Haslett SK, Scheffers S, Browne T (2010a) Coastal boulder deposits in Galway Bay and the Aran Islands, Western Ireland. Z Geomorph 54:247–279

Scheffers A, Kelletat D, Scheffers S (2010b) Wave emplaced coarse debris and megaclasts in Ireland and Scotland: boulder transport in a high-energy littoral environment: a reply. J Geol 118:705–709

Williams DM, Hall AM (2004) Cliff-top megaclast deposits of Ireland, a record of extreme waves in the North Atlantic—storms or tsunamis? Mar Geol 206:101–117

Zentner D (2009) Geospatial, hydrodynamic, and field evidence for the storm-wave emplacement of boulder ridges on the Aran Islands, Ireland. Williams College, Williamstown, MA

http://www.springer.com/978-3-319-16332-1

Origin and Formation of Coastal Boulder Deposits at
Galway Bay and the Aran Islands, Western Ireland
Erdmann, W.; Kelletat, D.; Scheffers, A.M.; Haslett, S.
2015, VIII, 125 p. 140 illus., 136 illus. in color., Softcover
ISBN: 978-3-319-16332-1