



The Geology of Ireland, 2nd ed., 2009, edited by Charles Hepworth Holland and Ian S. Sanders, published by Dunedin Academic Press Ltd., ISBN 13: 9781903765715, £130.00, hardcover, £90.00 paperback.

The island of Ireland has a tremendously varied and diverse geology, which is remarkable given its relatively small size (it is marginally smaller than the state of Indiana in the United States). Its rock heritage is the product of several significant past geological events, such as the destruction of the Iapetus Ocean during the Ordovician, the subsequent Caledonian Orogeny, which created a Himalayan-scale mountain range during the Silurian and early Devonian, and also the birth of the Atlantic Ocean during the Paleogene, to name but a few. Ireland may be currently positioned geographically on the periphery of the European mainland, but the geological history of this small island is intimately bound to the wider story of the evolution of the continent as a whole.

A full suite of rock types, with representatives from each of the major time periods from the Precambrian through to the Holocene is present in Ireland. Many of these are exposed in magnificent coastal outcrops, which are lashed by the powerful Atlantic Ocean along the western seaboard, and these have been regular haunts for field geologists for several centuries now. Such stratigraphic diversity attests to a dynamic and “action-packed” geological past. *The Geology of Ireland* (2nd Edition) attempts to tell this story and is, quite simply, the definitive and most authoritative account of the geological history of Ireland available today. Just as geology has no regard for political boundaries, this book treats the island of Ireland as a whole. This is actually a very necessary step, as there are very important parts of the story located on both sides of the present political divide. It is only when these are considered together that the complete picture of the geological evolution of the island as a whole can be fully and properly appreciated.

The concept of a volume devoted to providing a detailed and authoritative overview of Ireland's geology has been in existence since *A Geology of Ireland* (1981). In 2001, the subsequent follow-up was retitled *The Geology of Ireland*, to emphasize that it was intended as a more complete and definitive treatment of the subject. Both of these volumes were edited by Charles Hepworth Holland (Trinity College Dublin). The current version was published in 2009 and is larger, more comprehensive, and up to date. Ian Sanders (also TCD) joins Holland as coeditor.

The most significant development with the latest edition is, perhaps, the fact that it is now illustrated with color figures throughout. This has made an enormous difference to the aesthetic quality of the finished product and has vastly improved the illustrative power of the numerous figures. Field photographs are now vivid and very realistic. Maps and summary stratigraphic sections look vastly superior to versions that appeared in the earlier editions, which had to rely on greyscale or simple pattern fills to indicate separate lithological units. Color figure highlights in the second edition include a correlation of the Devonian Old Head Sandstone Formation (Fig. 9.34; based on the doctoral work of Jamie Quin) across southern Ireland, which illustrates and summarizes the dynamics of the sedimentary fill of the basin with great clarity. Another outstanding figure is a 3-dimensional model of the geological structure of southwestern Ireland (Fig. 12.6). This image shows the complexity of folding experienced by strata during the Late Paleozoic Variscan Orogeny. The image is stunning and could only have been generated in a color medium. I have no doubts that it will be reproduced in numerous undergraduate lectures dealing with the structural evolution of this part of southern Ireland.

Chapter 1 (written by the two editors) provides a short but useful introduction to both the geography and geology of the island of Ireland. It provides an overview to many of the key, significant geological events that have shaped Ireland (mentioned above) and relates them to the various chapters that follow, thus setting the scene, or agenda, for the entire book.

Chapter 2 (written by J.S. Daly, UCD) concerns the Precambrian and opens with mention of the oldest known rocks in Ireland: the  $1779 \pm 3$ Ma orthogneisses of the Rhinns Complex in Donegal. Precambrian rocks in Ireland have all been affected by metamorphism (to varying degrees) and they have survived through several orogenic events, commonly resulting in high levels of physical deformation. Given their age and metamorphic grade, fossils are (unsurprisingly) unknown from the Irish Proterozoic. A fair amount of Chapter 2 focuses on the use of isotopic dating, and several concordia and isochron plots are figured. A very useful and informative background review of all the various isotopic dating techniques utilized is included on

pages 10–18. This short section is really required reading for any undergraduate (or indeed postgraduate) studying isotope geochemistry and dating.

Subsequent chapters of the book covering the Phanerozoic are organized chronologically, as one would expect, with each covering the stratigraphy of a specific geological time period. There are also separate chapters documenting the Grampian, (Late) Caledonian, and Variscan Orogenies. The concept of arranging chapters in chronological sequence is pretty much the standard format for textbooks dealing with regional geology. However, *The Geology of Ireland* (2nd Edition), makes a minor departure from this tried and trusted formula in the opening few chapters. Chapters 3 and 4 deal with the Ordovician of the North and the Grampian Orogeny (respectively), while chapters 5 and 6 cover the Cambrian and Ordovician successions in the south and east of the island. When one initially picks up and browses through the book, this can seem a little confusing as the Cambrian is not slotted between the Precambrian and the first of the Ordovician sections. There is, however, a very logical explanation for this arrangement: this division of chapters is an attempt to mirror the physical division of Ireland during Cambrian and Ordovician by the Iapetus Ocean. Northwestern parts of Ireland were connected to Laurentia, while southeastern Ireland belonged to an entirely different continent, Avalonia. These two halves of the country essentially did not possess a fully integrated or shared history until they were connected later during the latter stages of the Caledonian Orogenic cycle.

The chronostratigraphic framework largely used by the book is that proposed by the ICS in the 2004 Time Scale, with updated information included for good measure. Adoption of this was entirely necessary, as, in the current global environment, it makes the book appeal to a much wider and more international audience. The only exception to this adoption of the 2004 Timescale is Chapter 14, entitled Tertiary Igneous Activity. Historical usage of the term Tertiary in the literature relating to magmatic activity in northeastern Ireland and northwestern Scotland during this time is cited as the main reason for retention of the term. This particular chapter includes information about the extensive Paleogene lava plateau, which is responsible for the spectacular Giants Causeway in County Antrim adorning the front cover of the book. This feature, created from thousands of interlocking columnar basalts, was designated a UNESCO World Heritage Site in 1986.

Elsewhere in the book, strict adherence to the latest time scale produces interesting chapter titles for the Carboniferous. This particular system is quite extensively developed across Ireland and divides (broadly) into a lower sequence of carbonate-dominated rocks and an upper siliciclastic-dominated unit, composed almost exclusively of terrigenous rocks. In the past, these two units were termed Dinantian and Silesian (respectively), and earlier versions of the book treated them in separate chapters. The two-part subdivision based on gross lithology is retained for convenience in the second edition; however, the chapters (10 and 11) are now titled Carboniferous: Mississippian (Tournaisian and Viséan) and Carboniferous: Mississippian (Serpukhovian) and Pennsylvanian.

The book closes with sections dealing with the geology of offshore Ireland, geophysics conducted in onshore areas, and the history of Irish geological research (Chapters 17–19 respectively). The latter chapter begins its story in 1770 and continues the narrative toward the present. It serves to illustrate just how important the rocks of Ireland were in the birth of geology as a science in the early 19th century. A good example was in the interpretation of basalt as either the product of precipitation from water (Neptunist theory) or as a product of cooling from a formerly molten state (Vulcanist theory). In the eyes of a modern geologist, this seems to be obvious, but in the very early days of geological investigation, this was an extremely important question to try to solve. The discovery in County Antrim (in the north of Ireland) of ammonite fossils apparently preserved in a dark, fine-grained igneous rock seemed to lend considerable weight to the Neptunist theory and, for a while, this tiny corner of Ireland rose to prominence as an extremely important site in European geology. Later reexamination of the site revealed the fossils to actually be preserved in a Jurassic dark shale, which had been baked due to proximity to a large igneous sill nearby. The Vulcanist interpretation was thus rerieved.

Perhaps the greatest strength of the book is the fact that each of the chapters is written by various individuals (or experts) who have a proven track record in publishing and research for that particular part of the stratigraphy. The information provided is thus very authoritative and is also up to date. The close connection the various chapter authors have with their particular subject areas is also indicated by the referencing of numerous PhD theses throughout the main text. Many of these were actually produced by the direct students of the authors concerned. Inclusion of information from doctoral theses is also very useful, as those that may remain unpublished are brought to the attention of the wider geological community.

Despite this being a multi-authored affair, it does not feel that way reading from chapter to chapter, which is very much to the credit of the editors. The only downside I can see for this particular book is the price. At present, the list price for the paperback is £90 (UK) and \$160 (US). This is likely to be out of the reach of most students, which is really most unfortunate given the wealth of information available inside. As the understanding of Irish geology is integral to a wider and fuller appreciation of the geology of both Britain and also the European Continent, this book should be an invaluable reference for anyone interested in (regional and local) stratigraphy. I imagine it could be a first port of call for anyone looking to begin to conduct research on Irish rocks. Given the very close physical connections between Ireland and North America in the (geological) past, I can see this book being of interest to researchers and students from that particular continent also.

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