

the book. The geological map (Fig. 8) has areas of missing ornament; Figure 9 appears to have an error (the early fault followed by dyke) in coal outcrop pattern; the coal seams of Ceres White Den (Fig. 10) seems to show opencast mining in the Lower Five Foot Coal correctly but the same ornament appears in the Lower Four Foot Coal underground for example. I assume this figure attempts to show unrecorded workings underground.

Although this book is not about social history, I think readers will feel some social empathy with the miners and their wives and children who all worked arduously in the collieries in their particular roles. It is fascinating to think how their progress in working the coal underground was probably advertised in the landscape by the redeployment of the wooden pithead winding frames from one site to another over a time span of months rather than years.

This book will be of interest to Fifers generally (and East Fifers in particular), people like me who just love all things Fife, those with an interest in mining and its history and some just interested in the geology and looking for a brief readable account. This book encourages readers to get outdoors to see some of the mining features (I must go to the Drumcarrow area) but is not a field guide. It is not for cavers as it carefully avoids the pitfalls of suggesting where access to old adits hint at exploration in the galleries of old coal, ironstone and limestone mines. I look forward to further books on this particular topic. Go out and buy a copy before the limited print run sells out.

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**Regional Geophysics of Northern Scotland.** K.E. Rollin 2009. *Regional Geophysics of Northern Scotland*. Version 1.0 on CD-ROM. Keyworth, Nottingham: British Geological Survey, £25.

Just over 30 years ago, the Finnish Geological Survey undertook a very high resolution air-borne magnetic survey of the whole of Finland and revealed, in unexpected detail, a coherent image related to hitherto unknown tectonic processes in the Baltic Shield. Although the UK aeromagnetic coverage began earlier, it has evolved more gradually, and in a piecemeal fashion, with more widely spaced flight lines; consequently, it does not have the same coherence or resolution. This CD '*Regional Geophysics of Northern Scotland*' shows that the painstaking task of putting it all together has been effective in now giving us a nationwide image of the magnetic signatures of basement and igneous structures.

In contrast to magnetics, the UK has one of the most impressively complete and uniform coverages of gravity data. In 1982, the Institute of Geological Sciences (IGS), a new assemblage including the Geological Survey, published gravity maps with various levels of processing

and a report entitled '*British Regional Gravity: 1 Northern Britain*'. This CD shows just how much progress has been made in the last quarter of a century.

The principal value of this guide is as a reference work, bringing to light what potential field data exist and what patterns are revealed when they are processed with modern graphical enhancement techniques. The images, their analysis and the models created to help interpret them, are combined with a review of the tectonic and geological setting of the area, and a brief review of relevant deep seismic profiles. So, although the publication intends to be primarily about potential field data, it does serve, just about adequately, as a more comprehensive tool for introducing a classical geologist to what we know about the whole upper crust of Northern Britain.

I think that it is helpful to look upon the CD as a tourist guide rather than an encyclopaedia. It is able to draw the users' attention to a comprehensive coverage of detailed images and illustrates and explains what types of conclusion may be drawn from them. This ability partly reflects the medium of publication; the CD allows the user to see a sometimes bewildering array of differently enhanced images that could never be economically viable in a printed publication. I particularly liked the 'rotating Sun' display in which a movie displays the gravity or magnetic field in shaded relief with the direction of illumination moving round the whole perimeter. To see lineations suddenly become prominent, for some optimal solar direction, only to disappear into obscurity as the Sun moves on was an inspiration. Hence the CD does exploit the medium successfully.

It is not an encyclopaedia in the sense that it is not the place to go deeply into a problem and find a definitive answer. The sections on quantitative modelling are good as they consider alternatives and give a proper sense of being provisional. An earlier reviewer of the CDs covering two other areas of Great Britain saw them as a good exemplar for students, being taken from the data and their distribution, through maps and sections to the simplifying geophysical models of structures that fit them, is a necessary part of an educational process.

The ability to copy and print the maps and images is an important step towards the user being able to complete the process by finding firmer conclusions based on more extensive and focused work. For those of us who prefer to study a larger version of the data in the smaller region of interest, the CD offers the route of printing a paper copy. Nevertheless the inability to enlarge the images on screen is a small but unnecessary niggle. A zoom option is sometimes available but then only with one level of magnification. Many online digital document displays, such as the National Library of Scotland's digital map site, allow a continuous range of magnification and to choose where the magnified window on the image is centred. This would have made the CD better suited to the needs of specialists.

On a more technical side I found the section on lineaments off-putting. The root of the word implies an elongated feature so drawing lots of short criss-crossing

lines on a pattern without clear linear features may not be a very useful form of artistry. To convince me that this form of interpretation was real would have needed the much higher resolution data of the kind collected in Finland. This may be a case of not seeing the wood for the trees because one of the more significant features of the gravity field in northern Britain, and a 'lineament' not suspected until highlighted by the 1982 IGS Report, does not appear on the maps of gravity lineations at all. What was later called the Cruachan line, and found to correlate with a clear boundary in geochemical anomalies, is the NW-trending truncation of the Grampian Highlands. In fairness, the text refers to this at some point in the later discussion as possibly being a significant change in deep crustal properties.

These quibbles should not distract from the fact that the CD does what its sets out to do. It 'provides a review of the subsurface geological structure of northern Scotland, based primarily on interpretation of the results of potential field (gravity and magnetic) surveys.' It brings this wealth of information to the user in an easily accessible form; indexing and navigation is simple and effective; for those wanting to follow up with their own investigations, the maps can be printed for closer study and a catalogue of measurements of the physical properties of rocks comes as a bonus. The CD is a valuable tool for the Scottish geologist.

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**Plates vs. Plumes: A Geological Controversy** Gillian R. Foulger. Wiley-Blackwell, Chichester, 2010. 328 pp. ISBN 978-1-4051-6148-0, £37.50, paperback.

The advent of plate tectonics in the 1960s provided a theoretical framework that unified the Earth sciences and made sense of phenomena that had previously defied rational explanation. At a stroke it explained over 90% of volcanism on Earth as being the product of the creation (at mid-ocean ridges) or destruction (at subduction zones) of tectonic plates. But there remained a significant number of volcanic areas, notably Hawaii, that didn't fit into the basic plate tectonic framework. In 1971, W.J. Morgan proposed that J. Tuzo Wilson's relatively fixed mantle hotspots were manifestations of 'convection plumes' rising from the deep mantle, and the mantle plume concept was born. Since then mantle plumes have grown in popularity to the extent that, by the late 1990s, they had become the explanation of choice for any mantle melting anomaly not readily explained by plate tectonics, and even for compositionally anomalous segments of oceanic spreading centres. This is clearly lazy and unscientific, and the very existence of mantle plumes has, over the past decade and a half, been questioned. Lately, the debate has been led by Professor Gillian Foulger, Professor of Geophysics at Durham University, and the purpose of her book is to

challenge the assumption that mantle melting anomalies must be caused by mantle plumes.

The title of this book might lead one to expect a balanced review of the current mantle plume controversy, but it isn't and it doesn't claim to be one. Instead it is an eloquent polemic against the plume hypothesis written by someone who genuinely can see no merit in it and is passionate in her opposition to it. The reader should bear this in mind. Professor Foulger starts from the position that the plume concept has been so stretched to accommodate all mantle melting anomalies that it is by now untestable and therefore unfalsifiable, and that the term plume is 'so often used for convenience that the difference between a label and an explanation has become lost'. In this she is undoubtedly correct. Her thesis is that all melting anomalies, intraplate (e.g. Hawaii) or on spreading centres (e.g. Iceland), can be explained by shallow plate tectonic processes without recourse to hot, buoyant plumes rising from the deep mantle. In this she is, in my view, almost certainly wrong. A hypothesis is not invalid simply because it has been misused by some of its supporters.

The book starts with a review of the origins of the mantle plume hypothesis and of the predictions that follow from it. Plumes that have been proposed by several authorities in the field are tabulated and their attributes compared to those expected. The next five chapters concern each of the five main predictions of the plume hypothesis: uplift during the initiation phase, excess volcanism, time-progressive trails of volcanoes leading away from fixed hotspots, seismological observations of mantle plumes, and measurement of mantle temperatures. A seventh chapter then reviews the petrological and geochemical observations that have been used to characterize mantle plumes. In every case the conclusion is the same; the observations don't fit the hypothesis very well. The book ends with a synthesis chapter in which all the various strands are drawn together to conclude, unsurprisingly, that plumes are not needed to explain mantle melting anomalies and that plate tectonic processes can do the job equally well if not better. The book is very well illustrated with both monochrome diagrams and a central section of colour illustrations, and has an impressive 30-page list of references. Most pages have one or more footnotes directing the reader to items in [mantleplumes.org](http://mantleplumes.org), the web site that Professor Foulger manages. This is an easy way to find background information, but the reader should be aware that much of the material on the web site has not been peer reviewed.

One cannot help being impressed by the breadth of material presented in this book. Experts in each of the various disciplines covered will no doubt find things to quibble with or even find things that are simply wrong. But, taken as a whole, Professor Foulger does a skillful job of attacking the plume hypothesis. This isn't to say that she's right, of course. The book is rather like a very clever case presented by a talented counsel for the prosecution in a criminal trial. The jury would almost certainly convict were it not for the equally clever