Book Reviews

Geology of the Glen Shee District, A. Crane, S. Goodman, M. Krabbendam, A. G. Leslie, I. B. Patterson, S. Robertson & K. Rollin. 2002. Memoir for 1: 50 000 Geological Sheet 56W together with adjacent parts of Sheets 55E, 65W and 64E (Scotland). British Geological Survey, Edinburgh. 131 pp (soft back). ISBN 0-11-884546-2. £35.

At the outset, I should declare an interest in this work. In 1993, I teamed up with Graham Leslie to study the Ben Vuirich Granite after we had met at a Tectonic Studies Group meeting and found that we were working on the same ground. Graham had come striding up from Glen Shee to examine Ben Vuirich, which is outwith Sheet 56W but so crucial to understanding the timing of events in the Dalradian that he could not resist mapping a part of it. I was an intruder, outside my usual territory, but also looking to establish a sound structural framework for the U-Pb (zircon) age on the granite of bedrock geology, but the applied and geophysical accident in 2000.

This Memoir is an excellent example of what can be achieved through whole-hearted collaboration between BGS and an experienced team of university staff, funded by an NERC academic mapping contract. The result is a comprehensive analysis of the geology of a structurally complex area of Dalradian and other rocks, for which there is no previously published account. The volume is dedicated to the memory of Steve Robertson, a BGS member of the team, who was tragically killed in a road accident in 2000.

This work is primarily concerned with the stratigraphy, structure, and metamorphism of the Dalradian rocks in an area that straddles the boundary between the Highlands and the Lowlands. The emphasis is on bedrock geology, but the applied and geophysical aspects are given due prominence. Presentation of the results is enhanced by in-text maps, cross-sections and diagrams, in which a single colour is used very effectively. Even the limitations imposed by the map format have been overcome by providing thematic maps that have been extended in the NW corner to capture part of the Ben Vuirich pluton.

The Dalradian rocks generally dip to the north and are inverted on the lower limb of the ‘Tay Nappe’. They range in age from the Ballachulish Subgroup (Appin Group) in the north, to the upper part of the Southern Highland Group at the Highland Boundary Fault Zone, in the south. Rocks of Silurian to Lower Devonian age are found SE of the fault zone. The structural setting is typical of the Highland Border: four phases of ductile deformation are recognized (D1–D4), with structural complexity increasing from south to north. D1 is dominant in a narrow zone adjacent to the Highland Boundary Fault, but is progressively overprinted by D2 and D3 northwards. A point to note is that the interpretation of some S1/S2 interference patterns as C–S fabrics (p. 56) is incorrect: to be classified thus, the S and C elements had to have formed simultaneously.

The prograde regional metamorphism is interpreted as a single, progressive event that peaked in pre- to syn-D2 times: it increased in grade northwards from the chlorite zone adjacent to the Highland Boundary Fault, to the kyanite zone (with two episodes of migmatization) in the area east of Ben Vuirich. Previous work indicating that there was an early low-P event in the Tummel Steep Belt (i.e. Dempster & Harte 1986) is not referenced, although it is implicitly rejected. Two generations of sill-like metamafic bodies, emplaced pre-D2 and post-D2 respectively, are particularly common in the upper part of the Argyll Group and the lower part of the Southern Highland Group. There are two kilometre-scale, post-orogenic, undated intrusions of granodiorite, and a variety of dykes and minor intrusions ranging in composition from aplite to lamprophyre. The landscape was sculpted into its present form during the late Devensian glaciation.

In addition to producing a fine map and 117 pages of carefully documented observations, what else of importance has been achieved? I select the following:

(1) The lithostratigraphy of the area has been revised and rocks previously considered to belong to the Killiecrankie Schist Formation (Argyll Group) are now correlated with the Blair Atholl Subgroup (Appin Group).

(2) Pronounced lateral facies changes are a feature of the revised stratigraphical interpretation. A newly defined unit, the Tulaichean Schist Formation, is interpreted as a local facies-bound unit within the Blair Atholl Subgroup. There is also a considerable east–west facies change in the Southern Highland Group across Strathardle, marked on the 1:50 000 map by an unnecessarily prominent break in colour.

(3) The main benefit of mapping large continuous tracts of ground is that, where rock exposure allows, one can ‘walk out’ structural and stratigraphical correlations. In this case it is adequate to demonstrate the continuity of deformation phases D1–D4 from the Southern Highland Group at the Highland Border, across the Tayvallich Lavas, and down into the upper part of the Appin Group. There is neither evidence for a break in this continuum, nor the sudden appearance northwards of an ‘additional’ deformation phase, that could signal the
presence of the much sought after orogenic break in the Dalradian edifice. This finding reinforces similar correlations made in adjacent areas (i.e., Schiehallion, Sheet 55W); enables earlier, incorrect correlations (Bradbury et al. 1976) to be discarded; and provides a structural age (D2) for the foliation imprinted on the Ben Vuirich pluton.

(4) The present work demonstrates that the ‘Tay Nappe’ (here consisting of a number of separate, major folds) was originally an upright structure that was made recumbent, and transported to the SE by top-to-SE shear on the lower limb of the structure during D2. This process was accompanied by the development of major D2 tectonic slides.

(5) There is a large, NE–SW-trending, aeromagnetic and gravity anomaly just north of the Highland Boundary Fault that is interpreted as being due to a large body of basic and ultrabasic rocks (Highland Border ophiolite) lying partly beneath the leading edge of the Dalradian block.

There are few typographical or spelling errors in the Memoir but Table 1, printed on the back of the front cover and showing the geological sequence in the area, is a disaster. The Highland Border Complex is incorrectly shown as Cambrian whereas in Chapter 8 (p. 93, and on the 1:50 000 map) it is listed as Ordovician. Likewise, the Strathmore Group, which belongs to the Lower Devonian (Chapter 10), is placed in the ‘Carboniferous’ pigeonhole in Table 1. To help the reader, the ‘Silurian’ and ‘Devonian’ labels should read Upper Silurian and Lower Devonian, but what will he/she make of ‘? intrusion of amphibolites’ in the events column?

And now to the rock names. I find that the terminology adopted by the BGS for naming metamorphic rocks is, in some cases, both unnecessary and cumbersome. This system was introduced to facilitate data storage and retrieval, but is it really necessary to replace slate, a word whose meaning every geologist understands and that is enshrined in the geological literature, by slaty pelite? Likewise, phyllite becomes phyllitic pelite. If metacarbonate, why not metaquartzite? It was therefore a relief to find on p. 34 some ordinary green slates and black slates that had passed through the net. Also a phyllitic slate, which should have been a phyllitic slaty pelite, when perhaps phyllite would have served the purpose just as well.

Crane and co-authors present a shining example of the scientific value of a BGS Memoir. One could quibble about the limited amount of space devoted to discussion of the results in a wider context, but this is not what the Memoir is principally for. It is a source of primary data that will still be of value long after some of the current models and hypotheses have been discarded. The Glen Shee map and its accompanying memoir are an invaluable source of data to accompany the map sheet. The memoir is designed to stand the test of time and so is a disaster. The Highland Border Complex is incorrectly shown as Cambrian whereas in Chapter 8 (p. 93, and on the 1:50 000 map) it is listed as Ordovician. Likewise, the Strathmore Group, which belongs to the Lower Devonian (Chapter 10), is placed in the ‘Carboniferous’ pigeonhole in Table 1. To help the reader, the ‘Silurian’ and ‘Devonian’ labels should read Upper Silurian and Lower Devonian, but what will he/she make of ‘? intrusion of amphibolites’ in the events column?

And now to the rock names. I find that the terminology adopted by the BGS for naming metamorphic rocks is, in some cases, both unnecessary and cumbersome. This system was introduced to facilitate data storage and retrieval, but is it really necessary to replace slate, a word whose meaning every geologist understands and that is enshrined in the geological literature, by slaty pelite? Likewise, phyllite becomes phyllitic pelite. If metacarbonate, why not metaquartzite? It was therefore a relief to find on p. 34 some ordinary green slates and black slates that had passed through the net. Also a phyllitic slate, which should have been a phyllitic slaty pelite, when perhaps phyllite would have served the purpose just as well.

Crane and co-authors present a shining example of the scientific value of a BGS Memoir. One could quibble about the limited amount of space devoted to discussion of the results in a wider context, but this is not what the Memoir is principally for. It is a source of primary data that will still be of value long after some of the current models and hypotheses have been discarded. The Glen Shee map and its accompanying memoir are an invaluable contribution to Highland geology, and it is to be deeply regretted that future maps will not be accompanied by an explanatory text of this depth and quality.

I was given a copy of the Memoir to review but as stated on page one ‘This memoir is designed to be read in conjunction with the … map’. So I recommend that, like me, you buy the map, which is a bargain at £11, but also try to ensure that your library purchases a copy of the Memoir so that it is there for all to consult when needed. At £35 it is not a casual purchase, and not vital unless you are particularly interested in, or researching, some aspect of the geology of this beautiful and remote area.

References

BRADBURY, H.J., SMITH, R.A. & HARRIS, A.L. 1976. ‘Older’ granites as time-markers in Dalradian evolution. Journal of the Geological Society London, 132, 677–684.

DEMPSTER, T.J. & HARTE, B. 1986. Polymetamorphism in the Dalradian of the central Scottish Highlands. Geological Magazine, 123, 95–104.

Geoff Tanner
Division of Earth Sciences
University of Glasgow

Geology of the Ballater District by C. G. Smith, S. Goodman and S. Robertson. British Geological Survey Memoir for 1:50 000 Geological Sheet 65E. 2002. The Stationery Office. 131 pp. ISBN-0-11-884563-2. £35.

Very much in the traditional memoir style, the Geology of the Ballater District contains loads of essential information in an accessible format and is an invaluable source of data to accompany the map sheet. The memoir is designed to stand the test of time and so generally contains little new insight and interpretation but is consequently not the most riveting of books to read. As it is not being marketed as a cure for insomnia the memoir is never likely to attract a mass readership by enthusing the casual reader.

The Ballater district is not only an area of outstanding natural beauty but like so many areas in Scotland is also an area of outstanding geology. Given the former it seems somewhat odd that such a weird image was chosen for the front cover: according to the caption, the view is supposed to be of Lochnagar; however one must presume that there is a less well-known Lochnagar on the planet Zog!

The memoir is organized in conventional style with separate chapters covering most aspects, with some topics allocated more than one chapter. Thus, somewhat confusingly the igneous suite seems to have been split to a greater degree than other topics. Rather bizarrely for a descriptive account of an area containing a wealth of different regional metamorphic lithologies, the regional metamorphic chapter in the memoir concentrates exclusively on pelitic lithologies. Consequently the work as a whole has a rather bitty feel to it, accentuated by the rather variable treatment given to different topics and contrasting levels of synthesis and speculation in the different chapters. Because the memoir is not sold with the accompanying map sheet it is difficult to assess in isolation. That map and memoir are divorced in this...
fashion leaves one wishing for a more comprehensive account of the geology of the area. Given the recent trend in Earth sciences towards near-surface processes it is a little disappointing and perhaps a missed opportunity, that the geomorphology of the area is not covered in BGS memoirs. There seems to be no obvious vehicle in which such information can currently be presented if memoirs are restricted to the frequently concealed 'solid geology'.

The memoir will probably only be read through in full by those few asked to review the text and hence perhaps the patchwork nature of the coverage is less significant and only a minor irritation. Almost exclusively it will be used as a source of highly focused, selected information. In this regard the quality of descriptions and images, the index, structure of the memoir and reference list are probably the most important features and should be the focus of any review. Thus one can best put the memoir through its paces by dipping into the detailed rock descriptions to assess whether there are gaps in the information likely to be required. In most of these key areas the memoir scores well. First impressions are a little disappointing, principally because of the quality of the photographs which are commonly out of focus and lacking contrast and in some instances, such as Plate 14, plainly wrong. However, delving more deeply into the text, one cannot fail to be impressed by the wealth of readily accessible detail. The memoir will without doubt serve its major users well as a text providing an outstanding level of background information and will continue to be used as a basis on which to build other aspects of Earth science research.

That this memoir is one of the last of a dying breed is undoubtedly a cause for great concern amongst geologists who have come to rely on these texts as a primary source. However one must question whether such memoirs remain the most appropriate format for this level of geological information. I would hope that reviews such as this are not obituaries for the content of the BGS memoir but might act as a spur to find a more appropriate format in which the immensely useful information they contain can be accessed. Although it seems that shorter, rather less comprehensive sheet explanations are to replace the full memoirs, if the level of available information currently provided in memoirs is downgraded or produced in even less readily accessible format, then this does not represent an improvement. At a cost of £35 it is apparent that here lies the cause of the memoir demise. It is too expensive to be widely purchased, and presumably too expensive to produce. Whilst I would urge all libraries to maintain up-to-date versions of the survey memoirs, I doubt whether enough will, and certainly the memoirs seem unlikely to be as widely available as the quality of information they contain should dictate. It seems unlikely that any other paper-based equivalent could provide a sufficiently economic basis for providing continued access to the BGS data. I would hope that the BGS could replace the memoirs with a national geological data-base available on the internet with rock descriptions, geophysical and geochemical information linked to BGS maps and images. This should provide data in a highly focused and perhaps more easily accessible form than the current format. Such a scheme could be readily expanded to include images of thin sections within the BGS collections, and would not be constrained by the artificial boundaries of the map sheets.

Tim Dempster
Division of Earth Sciences
University of Glasgow

The Later Proterozoic Torridonian Rocks of Scotland: Their Sedimentology, Geochemistry and Origin by A. D. Stewart. 2002. Geological Society of London Memoir No. 24. 130 pp. ISBN 1-86239-103-3. £70.00 (£35.00 to members of the Geological Society).

The Proterozoic Torridonian continental sediments form the craggy mountains and wild precipitous cliffs of NW Scotland, and constitute one of the principal elements of British stratigraphy. In this Geological Society Memoir, Dr A. D. (Sandy) Stewart aims to provide a comprehensive field description of the Torridonian, replacing that given in the Geological Survey's NW Highlands Memoir of 1907.

The Torridonian is exposed over a north–south distance of at least 200 km between Cape Wrath in the far north and Rum, overlying the Lewisian complex with profound unconformity. The 1.15 Ga Stoer Group comprises 2000 m of fluvial red sandstones and lacustrine sediments forming limited exposures between Loch Maree and Stoer. The Stoer Group was tilted and partly removed by erosion prior to deposition of the c. 990 Ma Torridon Group, which consists of 7000 m of mainly fluvial red sandstones and subordinate lacustrine or shallow-marine shales. The Torridon Group is divided into the Diabaig, Applecross, Aultbea and Cailleach Head formations and is by far the most extensive part of the Torridonian. The Sleat Group comprises 3500 m of fluvial grey sandstones that conformably underlie the Torridon Group in the Kishorne Nappe in the south.

Stewart's memoir has six chapters containing 115 figures, followed by a comprehensive list of over 400 references and a four-page index. Two regional sketch maps are attached inside the back cover, and several supplementary geological maps have been deposited with the Geological Survey in Edinburgh. The introductory Chapter 1 summarizes Torridonian stratigraphy and research from 1811 to 1969. Chapters 2, 3 and 4 on the Stoer, Sleat and Torridon groups, respectively, discuss their stratigraphy, facies, depositional environments, geochemistry, palaeomagnetism, age and correlation. The lengthy discussion of the Stoer Group, volumetrically the smallest of the three groups, reflects Stewart's particular research interests. Chapter 5 provides a brief overview of Torridonian deposition, burial history and palaeogeography. Chapter 6 is the Directory of field descriptions, commencing at Cape Wrath...
and progressing to Rum and possible Torridonian correlatives on Iona and the Isle of Islay in the far south.

In the Directory, ground that was covered in earlier chapters is revisited and the Stoer Group again receives special attention, with all but one of the 12 photographs showing Stoer Group rocks or their unconformable contact with the Torridon Group. National grid co-ordinates are given for many localities and locality maps are provided for some areas. Material is drawn from five PhD theses at the University of Reading, the products of a Torridonian research programme initiated in the early 1960s by Professor Perce Allen. PhD theses at the universities of London, Glasgow, St Andrews and Birmingham also are consulted. The approach is lithostratigraphic, illustrated by 32 graphic logs, and sequence-stratigraphic concepts are not used to help subdivide the thick, fluvioglacial successions. Sedimentary architecture and regional facies relationships receive little attention.

Stewart’s memoir adds weight to the long-favoured view that the Torridonian accumulated in a rift setting, with the Stoer and Torridon groups having formed in separate rift basins near the eastern margin of Laurentia. Stewart concludes that the Stoer Group had a local Lewisian source, and he tentatively suggests that the basin boundaries coincide with the positions of the Caledonian Moine Thrust in the east and the Minch Fault in the west. The line of the Minch Fault also may mark the western limit of the sedimentary basin during Torridon Group deposition, but the western source area of the Applecross and Aultbea formations was more extensive. Stewart notes that the Torridonian is nearly contemporaneous with the Keweenawan (1.1 Ga) volcanic and sedimentary rocks of the Mid-continent Rift System in North America, but he believes that any proposals to link the Torridonian with the Moine and Dalradian supergroups should be viewed with reserve.

Several aspects of the Torridonian are of special interest. In 1952 Ted Irving at Cambridge University started the earliest palaeomagnetic work on the Precambrian of Britain in the Loch Torridon area. Subsequent palaeomagnetic studies have shown that Torridonian poles are close to contemporaneous poles for Laurentia, demonstrating that NW Scotland was an integral part of that shield during Torridonian times. The Stac Fada Member of the Stoer Group provides evidence of coeval volcanism, with the presence of accretionary lapilli suggesting a type of volcanic mudflow. Most notably, the Torridonian buries a Lewisian landscape that typically is unweathered and irregular to mountainous with relief as great as 600 m, which Stewart rightly describes (p. 30) as ‘probably the most dramatic Precambrian landscape in Europe’. Near Cape Wrath, by contrast, a weathered surface of low relief is developed on the Lewisian. Geological, geochemical and palaeomagnetic data indicate that the c. 3 m thick weathering profiles are palaeosols that formed close to the time of Applecross deposition in moderate palaeolatitudes. The palaeosols are well exposed in coastal cliffs 15 km south of Cape Wrath, and particpants in NW Highlands field trips will be pleased to know that, contrary to Stewart’s claim, the palaeosols at Sheigra are not covered by a rock fall.

Some of Stewart’s views on the Torridon Group are contentious. Southward thickening of the Diabaig Formation is ascribed to southward tilting, and the flat, weathered surface in the Cape Wrath area to a change in climate causing unrealistically high rates of erosion. Such suggestions are ad hoc, and southward tilting seems incompatible with the eastward palaeocurrent flow directions for the Torridon Group. Stewart’s hypothesis that Applecross deposition was controlled by a basin-margin fault along the line of the Minch Fault also appears an oversimplification. The Applecross Formation consists mainly of distal braidedplain deposits, whereas the Cape Wrath Member in the north includes a conglomeratic alluvial fan succession. Stewart believes that the Cape Wrath Member is coarser because it is nearer the source, but his figure 1 shows that the Cape Wrath area is about the same distance from the Minch Fault as are the areas of distal Applecross sediments in the south. It could be argued that deposition of the Cape Wrath Member was controlled by a fault to the east of the Minch Fault, with subsequent faulting along the line of the Minch Fault controlling later Applecross deposition. Stewart seems to concede this by stating (p. 33) that ‘The existence of recognizable fans in the mainland Applecross Formation might be because they are close to their source, perhaps a fault scarp’. Such cutting back of faults towards the undeformed footwall agrees with the sequence of listric faulting at extensional basin margins.

The limitations of a strictly lithostratigraphic approach are exemplified by Stewart’s subdivision of the Applecross Formation at Quinag. Palaeocurrent flow directions show that the lowermost Applecross strata at Quinag are genetically related to the alluvial fan deposits of the Cape Wrath Member, but Stewart excludes them from that member. Vertical changes in grain size and some trace element values, upon which Stewart bases his subdivision, are explicable by change in the extent and depth of erosion in the developing drainage basin of the alluvial fan. The application of sequence-stratigraphic concepts would relate all of the Applecross sediments from Cape Wrath to Quinag as the ‘Cape Wrath Sequence’.

Twice Stewart states (pp. 34, 47) that the frequency of soft-sediment deformation structures (‘contorted beds’) in Applecross arenites and their prevalence at higher stratigraphic levels remain ‘a mystery’. As he notes, soft-sediment deformation structures are abundant in the arenaceous, topmost facies of the Cape Wrath Member, yet they are virtually absent in the immediately underlying facies that is of similar grain size. Stewart does not consider regional facies relationships, which indicate that the structures mark a distal bajada setting where a high water-table would likely occur. A palaeo-geographic picture that should be considered shows an outwash apron of gravelly, well-drained alluvial fans passing distally into a sandy, waterlogged braidedplain
with unstable quicksands subject to disturbance through stream turbulence, upwelling ground-water, and seismicity.

A substantial part of the memoir is given to geochemistry and its implications for the provenance and diagenetic history of the Torridonian. According to Stewart, trace-element geochemistry shows that the Torridon Group was derived from recycled sedimentary and supracrustal rocks rather than from a crystalline terrain. While it has long been known that the Applecross pebble suite shows that sedimentary, metasedimentary and volcanic rocks were part of the source, Stewart places undue weight on the presence of red sandstone pebbles: published counts of more than 5000 pebbles have yielded only 12 of sandstone. Indeed, the immature, largely first-cycle arkoses and feldspathic sandstones forming much of the Applecross Formation indicate that crystalline rocks were a significant source. Much sedimentological and petrographic evidence implies a more varied Applecross source than that claimed by Stewart, comprising moderately weathered, felsic crystalline and supracrustal sedimentary, volcanic and low-grade metamorphic rocks that reached westward onto what are now the continental margins of the North Atlantic. Stewart shows that much of the Torridonian has undergone sodium metasomatism through albitionization of detrital plagioclase. Potassium metasomatism also has affected the Torridon Group mostly through illitization of clay minerals. From the diagenetic mineralogy Stewart presents a thermal history of the Torridonian and infers burial depths of several kilometres and burial temperatures of \( \leq 300^\circ\text{C} \).

Overall, notwithstanding the questionable balance and some errors and doubtful interpretations, Stewart’s memoir forms a useful field guide to a region of magnificent geology and unsurpassed grandeur. A more comprehensive study of the Torridonian is now required that aims to relate the nature of the ancient Lewisian landscape and overlying sediments through the concepts of basin development. Sequence-stratigraphic concepts would have a place, and geochronological studies should include the search for possible basin brittle deformation coeval with Torridonian deposition. Additionally, Torridonian terminology needs some revision. There is no all-embracing lithostratigraphic name, and Stewart believes that the time gap between the Stoer and Torridon groups is too large to permit any such name. But various stratigraphic codes do not include any geochronological constraint in the definition of supergroup, and the name ‘Torridonian Supergroup’ seems appropriate. Furthermore, the name ‘Torridon Group’ may confuse because that group is only part of the Torridonian: better perhaps would be ‘Slioch Group’ after the peak rising above Loch Maree where a mountainous Lewisian landscape is seen buried by Diabaig and Applecross sediments.

George Williams

School of Earth and Environmental Sciences
University of Adelaide, South Australia

Cainozoic geology and landscape evolution of north-east Scotland by J. W. Merritt, C. A. Auton, E. R. Connell, A. M. Hall, & J. D. Peacock. 2003. Memoir of the British Geological Survey, Sheets 66E, 67, 76E, 77, 86E, 87W, 87E, 95, 96W, 96E & 97 (Scotland). British Geological Survey, Edinburgh. 178 pp + CD-ROM. ISBN 0-85-272463-2. £40 (paperback).

This Memoir presents a synthesis of the nature, origin and distribution of the Palaeogene, Neogene and Quaternary drift deposits both on land and offshore in a belt extending from Elgin in the north to Inverbervie in the south. It uses information derived from survey and academic sources, in addition to pipeline and foundation exploration data.

The Cainozoic history of the area is summarized in the opening chapter, before the mineral resources, mainly sands and gravels, are explored and information on foundation conditions is outlined. The history of landscape evolution from the Lower Devonian onwards, and the unusually well-preserved features of Palaeogene and Neogene weathering and deposition are examined in Chapters 3 and 4. Reviews of the records of past climate changes, models of glaciation and the interpretations of earlier research are given in Chapter 5. The Quaternary deposits are presented, and the geomorphological features summarized in Chapter 7. The final chapter examines the Quaternary lithostratigraphy and correlations.

The gross relief features are said to have taken on their general distribution and form by the end of the Mesozoic. Ancient, sometimes deeply chemically weathered peneplanation surfaces pre-dated and survived the rather limited erosion of the Quaternary glaciation. Sluggish, cold-based ice streams advanced into the area during at least three major glacial periods, and there are substantial deposits from the intervening ice-free periods.

No less than five distinct ice masses coexisted during the Late Devensian glaciation. The Eastern Grampian Drift Group is mainly of thin sandy diamictons from the sluggish flows from the Cairngorms. In the NW the Central Grampian Drift Group, which originated in the Monadhliath Mountains and the Spey valley, is recognized. The Banffshire Coastal Drift Group, derived from a northern flow, carried onto the northern coastlands dark blue-grey diamictons, with rafts of Mesozoic rocks dredged from the bed of the Moray Firth. In the east an ice stream derived from Strathmore (The Mearns Drift Group) was deflected onshore. It carried red tills originating from the Old Red Sandstones. The Buchan Gravels are overlain by dark grey tills from offshore (The Logie-Buchan Drift Group). As the East Grampian ice sheets retreated, ice from the more active Moray Firth and Strathmore flows is believed to have encroached onshore, damming meltwaters to produce glacio-lacustrine deposits, which interdigitate with the late tills. The entire area is thought to have become ice-free by 13,000 years BP, and no evidence of Loch
Lomond Stadial (11,000–10,000 years BP) glaciers has been recorded from the area.

The global climatic changes during the Quaternary are outlined in Chapter 5, and interpreted in relation to the deposits both onshore and offshore, and these are then discussed in relation to a range of models previously suggested for glaciation in the area. A new model is presented which incorporates multistage elements for the Main Late Devensian glaciation.

The characteristics of the deposits, the tills, hummocky glacial, glaciofluvial and glaciolacustrine deposits are examined in Chapter 6, before the periglacial, organic, past and present marine materials are discussed. In Chapter 7 the geomorphological features, from glacial and glaciofluvial erosion and deposition through periglacial phenomena to marine erosion and raised beaches, are examined and a curve derived showing local sea-level changes over the past 15,000 years.

The volume is very well illustrated, with colour photographs of many sites and clear summary maps of distributions of features, from suggested Palaeogene drainage patterns to paths of ice movement, and the distributions of the different drifts and their relative positions where superposition occurs. Included in the Memoir is a CD-ROM containing the full text, diagrams and references quoted in the work, and three Appendices. The first contains maps, and detailed and very informative descriptions of 26 areas of prime interest. The second appendix gives a historical account of assessment of resources in the area, their potential for dry or wet workings and end-use projections. Appendix 3 provides an assortment of geophysical data derived from conductivity, resistivity and ground-penetrating radar surveys carried out at scattered localities. All three appendices are illustrated with clear site diagrams and cross-sections.

The well-focused and very informative Memoir will be an invaluable reference volume for those involved with the Quaternary deposits of Scotland. It incorporates a wealth of information on an unusually interesting area and confirms the expertise in the superficial deposits which is known to reside in the British Geological Survey, but rarely has the opportunity to express itself. This authoritative, well argued and admirably illustrated text is definitely not one to miss.

John McManus
University of St Andrews

The purpose of the book and its intended audience seem slightly unclear. The title and format imply that it is to be a brief introduction to the geology of the area, perhaps suitable for non-specialists. However, I think it will disappoint many such readers. The book is also rather expensive. In the BGS shop, it is priced at £9 – fairly steep for a slim 30-page paperback, especially when £20 will buy you the complete sheet description.

Part One is an introduction featuring a succinct, if rather dry summary of geology, plus a couple of rather formidable-looking tables summarizing stratigraphy. These actually contain a lot of useful information, although parts of this are repeated in tables within Part Two: this duplication is a bit odd in a summary explanation.

Part Two, the meat of the book, consists of summary geological descriptions of the various units. It includes a simplified geological map, a strange photograph (of which more later) and further stratigraphic tables, which duplicate much of the information in Part 1, although they very usefully include key localities for each unit with six- or eight-figure grid references.

I enjoyed Plate 1, although perhaps for the wrong reasons. As well as showing a rather fuzzy photograph of one of the less spectacular lithological boundaries in the UK, it includes an odd aside about the stick featured for scale. No particular reason is given why this might have a significance worth illustrating: the stated lithostratigraphic stratotype status hardly seems to merit a colour plate. On page 13 we are told that the Spango granodiorite is composed of hornblende–biotite–granodiorite and hornblende-bearing biotite–granodiorite. This seems an unduly repetitious and pointless summary of a pluton which surely must have other features of interest. On pages 14–15 there is a good, although quite technical discussion of structure and metamorphism, which would have been helped by a simplified cross-section or other diagrams. The mica crystallinity map and discussion is again fascinating, but the arcane terminology associated with this might have benefited from a little explanation. The reference given in the text (Merriman & Roberts 2001) is not given in the reference list.

The Moniave Shear Zone features prominently on the summary geological map, and is fleetingly mentioned under Regional Metamorphism, but is nowhere adequately described, explained or interpreted. The discussion of magnetic and gravity maps are similarly vague; for example, "The gravity gradient on the south side of the high is probably due to concealed structures" – statements like this give geophysics a bad name!

The summary description of the Quaternary geology is one of the best bits of the book. It seems stylistically distinct, and clearly written for a less-specialist audience. I found this clearly written, informative and interesting.

Part Three deals with applied geology. To most of the general public, or even geologists, the Leadhills area is perhaps best known for its deposits of gold, lead and...
zinc. Indeed, interest in these deposits is likely to be the main reason for public interest in this book – geotourism is mentioned as a significant economic activity on page 24. The treatment of these deposits is disappointing, despite a nice map. There is little description, and no discussion of the genesis of the deposits, although admittedly there is a shortage of modern work. The number of mineral species recorded from the orefield is given as 57 – a badly out of date figure. The current total is probably nearer 90, of which four are completely new mineral species (scotlandite, macphersonite, chenite and mattheddleite) described in the past 20 years. The text implies that the only new minerals from the area were those described by Beudant in 1824! There is no discussion of the geological significance of these extraordinary oxidized lead mineral assemblages. The weathering of these deposits since they formed 250 million years ago is unusual on a global scale, and must contain the story of a very exotic interaction with water and air.

The book closes with lists of information sources and references. The list of BGS information sources and collections is useful, but would have been improved by including a list of geological SSSIs rather than simply referring the reader to SNH. These are an important factor for many interested in industrial, agricultural, recreational and scientific land use – books like this could be a useful starting position for information which may otherwise be hard to find.

Overall, the book raises expectations of a more generally accessible approach than it delivers. The text is neither successfully explanatory nor comprehensive. Although the diagrams look good at first sight, many are explained inadequately. Finally, the book is overpriced – for specialist users the sheet description looks much better value. Having said this, the book has some good features. I liked the size and external appearance. It has some useful maps. The stratigraphic tables, despite a bit of repetition, do provide an excellent summary of up-to-date unit names, together with thicknesses and grid references of good exposures.

I feel that this series would be better aimed at a general audience. There is definitely a market for a clear, non-specialist summary of new BGS maps for use by the public, as well as policy-makers. It’s a pity this book doesn’t seem to quite meet this, or any other, need especially well.

John Faithfull
Hunterian Museum University of Glasgow

Exploring the Landscape of Assynt: A walkers’ guide and map showing the rocks and landscape of Assynt and Inverpolly by Kathryn Goodenough, Elizabeth Pickett, Maarten Krabbendam and Tom Bradwell. 2004. British Geological Survey (with financial support from BP). 55 pp. ISBN 085272471-3, £12.

The subtitle of this publication provides a clear indication of its intended target audience: the hill walker. However, Exploring the Landscape of Assynt will also undoubtedly appeal to any visitor to this part of NW Scotland. The package, which comprises a geological map and booklet, will work well as an ‘on the hoof’ field guide, but also provides background information which can be read quickly prior to visiting the area. It will also be a major asset for educators at upper secondary or undergraduate level preparing geological field trips to this classic area of Scottish geology.

The guide starts by introducing the concept of plate tectonics and the formation of rocks. The text is perfectly pitched for the non-specialist, but a lack of diagrams to enhance the formation of igneous and metamorphic rocks may reduce the learning experience for some readers. The next two pages give a clear summary of the main rock types to be found in the area. It provides a simple but well informed explanation of their age and mode of formation. Page 8 includes a brief description of the impact of ice on the landscape of Assynt and page 9 is a summary of the geological history of the area. Although brief, both pages are perfectly pitched for the non-specialist providing just enough information to help the uninitiated to see the overall picture by avoiding a level of detail which would cloud their understanding. These introductory pages are thoughtfully put together and should get many non-specialists ‘hooked’.

The main part of the guide is dedicated to ten geological excursions. A geological map at 1:50 000 scale has been included to enhance the whole experience, but more of this later. The first excursion covered is the recently completed interpretation centre and associated walk at Knockan Crag. This is without question the obvious starting point for anyone interested in learning about the landscape development of Assynt. For readers who have worked through pages 1 to 9, this site would certainly enhance their learning and leave many thirsting for more knowledge. More ‘geological strolls’ follow Knockan Crag. The Traligill Caves and Bone Caves near Inchnadamph introduce the walker to some rare, (for Scotland) karst scenery. Achmelvich provides good exposures of Lewisian Gneiss and a chance to view a Scourie Dyke. The excursion to Clachtoll describes the excellent exposures of Torridonian Sandstone (including well preserved ripple marks and a volcanic mudflow) as well as a visit to the very recent (geologically speaking) Iron Age broch.

After this, the routes get tougher, and next on the list is Stac Pollaidh. This is a personal favourite from my undergraduate days and I was not disappointed by the coverage it was given by the guide. Geomorphological features and processes were heavily featured and as is the case throughout the guide, explanations are brief and highly informative. The next three walks are for the serious adventurer: Suilven, Quinag, Conival and Ben More Assynt. Key geological structures and geomorphological features are covered in these longer excursions, such as thrusts, unconformable relationships and glacial striations. The final route in the guide is unlike all the others as it involves a boat trip up Loch Glencoul. The geology could prove to be quite complex for the
non-geologist but a useful cross-section has been included at the top of page 49, which should be of great assistance to the non-specialist reader. The remainder of the guide includes glossaries of geological terms and Gaelic words. Both are essential to allow a fully developed understanding of the area. Page 53 is dedicated to more in-depth literature which this package may inspire the non-geologist to read.

The map which accompanies the guide is a magnificent piece of cartography. It is eye-catching and attractive to look at. More importantly, it shows solid geology and accurate topographic information at 20-metre contour intervals. Shading has been utilized to produce an illusionary three-dimensional effect. The inclusion of 1:250 000 scale maps of ice cover and 1:25 000 scale maps of some of the excursions, plus cross-sections and dramatic photographs, results in a product which is stunning. The map is not to be used for navigation, but the 1:50 000 scale was a sensible choice, as this is the most commonly used map scale by hill walkers. The geological information provided by the map is, like the guide, pitched at the correct level for the non-specialist. The balance between informing but not over-informing has obviously been given careful consideration.

The only potential flaw is that major landforms mentioned in the guide are not always easy to locate on the map, as they are not reproduced in a bold typeface. This was brought home to me as I read about the boat excursion to Loch Glencoul. Not being familiar with this particular area of Assynt, I was viewing it as a newcomer, and it took me longer than I would have expected to locate the Stack of Glencoul and Beinn Aird da Loch. For a while, this geographer was disorientated. What an admission! The back cover of the map also provides a map showing access routes to all the excursions. This is an important inclusion as it will help to encourage people to visit the area.

Overall, one is left with the impression that much thought, time and effort has been put into the presentation of this package. More and more geological information has been provided for visitors throughout Scotland in recent years. The growth of ‘geotourism’ is to be commended, but it is often at a fairly shallow level. The strength of this package is that it provides the non-specialist with a reasonable level of detail but avoids getting too bogged down in it. This allows the reader a chance to grasp the big picture. The superb illustrations and map work complement the well written text. This is a new venture for the British Geological Survey and I am very impressed by the educational potential of this package. This type of product supports the hard work of a small but enthusiastic group of teachers that have tried to promote the geology of this area for many years. This is an outstanding teaching tool for the individual who wants to enhance their understanding of the physical environment. As a support for professionals attempting to enhance the learning of Earth science students through fieldwork, this package is a must.

As a guide to the discerning walker or tourist I am certain that it will work well and may encourage many to return to this area. Such is the strength of the package, I would venture to suggest that it might be a good starting point for a specialist not familiar with the area. To an educator such as me it is a major asset. I hope that this is the start of a more widespread coverage. Many other parts of Scotland could do with this treatment.

Paul Ewing
Arbroath High School