

BOOK REVIEWS

BOWEN, R., 1988. *Isotopes in the earth sciences*. Elsevier applied science publishers Ltd., Barking, Essex. 647 pages, 59 tables and 63 illustrations, £80.000 hardback. ISBN 1 85166 145 X.

This book is neither a text for the undergraduate nor a reference for the specialist. Rather it is an informed, personal overview and commentary on an ever expanding field of research with many and varied applications. As early as 1963 that doyen of isotope geologists Kalervo Rankama wrote, "that to keep abreast of the field as a whole is a Sisyphean task" and "future reviews of research [in isotope geology] will require the time and effort of more than one individual". Yet here, 25 years later, we have one person attempting once again this 'Sisyphean task'.

Robert Bowen is to be congratulated in producing an up-to-date book (albeit grossly overpriced) which in 647 tersely written, 110mm × 160mm pages of print, covers most of the subject factually, critically and sometimes discursively. Not everyone will agree with his selection or the emphasis he places on certain branches of the subject. For instance tritium dating has a chapter to itself whereas Sm-Nd dating is relegated to a rag-bag chapter entitled 'other dating methods': many geologists would rank Sm-Nd of comparable importance to the well established K-Ar and Rb-Sr methods.

Similarly, although radon health hazards are discussed in some detail its potential in geochemical prospecting is not. Indeed, in common with other isotope geology texts, the significance of the radionuclides in applied geophysics and geochemistry, for example in airborne reconnaissance mapping, borehole correlation and 'hot dry rock' geothermal energy, is largely ignored or only briefly mentioned. There are, however, other text books which deal with these subjects more adequately. The environmental aspects of isotope geology are, however, dealt with more fully than in most texts. In this connection his topical and pertinent comments on the Chernobyl disaster, the practical and political problems of disposing of radioactive waste and the safety of nuclear power will be read with great interest and respect even by those who do not share his view that, on balance, nuclear power is more environmentally friendly than other practical alternatives.

Following a short preface and table of contents there are three text figures, a Chronostratic (? Chronostratigraphic) Scale; the Periodic Table of Elements and a Chart of the Nuclides which are presumably intended for ready reference. Unfortunately although the chronostratigraphic scale is reasonably up-to-date, (c. 1982) the nuclide chart is not. The diligent reader will find that for U, Pb, Th, Rb, Sr and K more nuclides are cited in the text than are shown on the chart. Moreover the cosmogenic radionuclides ^{10}Be , ^{26}Al , ^{32}Si , ^{36}Cl , ^{53}Mn , ^{59}Ni , and ^{81}Kr which occur naturally, albeit due to extraterrestrial agencies, are shown on the chart as 'short lived unstable nuclides *not* occurring naturally'. The source of this chart is not acknowledged but it appears to be an over reduced copy of that published by GEC in 1972. It is a pity that the opportunity was not taken to bring this up-to-date or at least make it consistent with the author's text.

The author begins with the 'Big Bang', supernovae and the solar system. To begin at the beginning and go on at the end (nuclear power stations!) is certainly logical but it means that the general reader is faced with unfamiliar esoteric concepts from the outset for which the evidence is frequently tenuous. Moreover, the author either assumes that his readers have a working knowledge of the subject or refers them to later chapters for fuller explanations. Not until page 17 of this introduction is the term 'isotope' explained but thereafter follows about 50 pages usefully summarising the relevant features of isotope chemistry such as radioactivity, fractionation, decay mechanisms and decay series with brief reference to their significance to aspects of earth sciences. Equally good summaries are, however, readily available in much less expensive texts.

There follows a chapter on Mass Spectrometry based largely on instruments with which the author is familiar. The bulk of the book is, however, divided into two main sections namely 'Part II Dating methods', and 'Part III Environmental isotopes' but therein lies a difficulty. By no means all dating methods are confined to the 180 pages of part II. Thus under the umbrella of 'environmental isotopes' there are, albeit brief, discussions of the use of cosmogenic radio-nuclides for dating sediments, glacial ice, manganese nodules and exposures ages of rock and meteorites. Conversely within the 'dating methods' section there are discussions of the use of isotopes in determining the origin of granites, as clues to the composition of the earth's mantle and as indicators of deep

crustal and mantle processes. This valuable information and comment is not easy for the reader to extract, if using the book as a reference, since it is dispersed and referred to in chapters on dating methods such as Rb-Sr, Sm-Nd and Lu-Hf where the information obtained has also been applied to problems other than dating.

For the most part the chapters on dating methods are succinct and form a useful reference for readers wishing to inform themselves of both the principles of isotopic dating and recent developments. Occasionally the author includes data in the text which is of dubious relevance or would be better incorporated into tables or diagrams. For instance, although it is interesting to learn that thorium has 25 isotopes, is it really necessary to list them all (together with half lives and decay characteristics) when only one, ^{232}Th , is relevant to the earth sciences? Problems also arise for the reader who, like this reviewer, tries to read this book from cover to cover, in that as in the introductory chapters, complex concepts are often introduced before the less complex. This arises because the dating methods, together with their modern developments, are described in an historical sequence related to their first application. Thus, the many methods of uranium-thorium-lead dating are discussed before the simpler and arguably more easily comprehended Rb-Sr and K-Ar dating. Nevertheless as a comprehensive summary of both discredited and modern methods of dating this is useful, the problems and advantages of each technique being adequately discussed and often illustrated with well chosen examples. References at the end of each chapter give the reader both an historical perspective and an overview of recent (up to 1986) developments, there being almost 400 references to dating alone.

The final part of this book covers an immense range of topics, becomes progressively more discursive and arguably consequently more interesting to the general reader. Under the banner of 'environmental isotopes' both stable and radioactive nuclides, natural and artificial, in the atmosphere, hydrosphere, biosphere and lithosphere are described with comments on their significance in understanding the processes which may account for their abundance and distribution. Special chapters on palaeoclimatology and radioactive waste complete the book apart from a useful glossary and appendices, author and subject indices. Although the measurement of hydrogen, oxygen, sulphur and carbon stable isotopes is now routinely required for the study of sedimentary rocks and their groundwaters, interpretation of the data is still highly contentious and hopes that isotopes might unambiguously indicate the origin of most igneous and metamorphic rocks and mineral deposits have not been fulfilled. Much of what Robert Bowen discusses in these chapters is at the frontiers of science and he does well to distinguish between what is well established and what may be potentially useful to earth scientists in the future. In this latter connection his reference lists are particularly valuable with no less than 171 covering the atmosphere and hydrosphere, 26 on the biosphere and 63 on the lithosphere.

His final chapter on radioactive waste is out of kilter with the preceding chapters yet inasmuch as it is topical and of widespread concern to the general public it is a fitting way to complete the book. The chapter entitled 'Radioactive waste' is misleading since much more than the disposal of radioactive waste is discussed. Included are variations in natural radioactivity, health hazards from natural and artificial radioactivity, an account of nuclear accidents to date and an assessment of the probability of such accidents occurring in future. The politics of selecting waste disposal sites in the USA and the UK are discussed in some detail before concluding with his personal view of the balance between the advantages and disadvantages of the nuclear industry to the future of Mankind.

Given its encyclopaedic coverage and lack of enclopaedia format it is a 'dip-into' rather than a reference book. As such it may supplement and complement standard text-books but is unlikely to replace them. Undergraduates could use it as background reading together with other texts on the subject. The subject coverage is, however, so wide that only those students making a special study of isotopes in earth science will need to, or indeed bother to, read the whole book. Much the same is true of the specialist, for few if any, need to know more about the potential of isotopic data than that applicable to their particular researches. In short, therefore, it is desirable that all libraries serving Earth and other Science departments should stock it, but unlikely that it will have a wide appeal at its current price (£80) to individual earth scientists or interested laymen.

R.J. Firman

WHITTAKER, B.N. and REDDISH, D.J., 1989. *Subsidence. Occurrence, prediction and control.* Developments in Geotechnical Engineering. Elsevier Science Publishers, Amsterdam, the Netherlands and New York, USA, xii + 528 pages, hardback, US \$139.50/Dfl. 265.00. ISBN 0-444-87274-4.

The department of Mining Engineering at Nottingham University has long had an enviable reputation for the quality of its research, headed by the senior author B.N. Whittaker, into all aspects of mining subsidence. The publication of a balanced overview of the subject from such a source is, thus, most welcome. Not surprisingly the book is biased towards the effects of coal because, not only has this been the main thrust of the department's research but economic constraints world-wide have dictated that research be concentrated in this field. The

authors do, however, review the whole field of subsidence due to the extraction of raw materials insofar as published information is available. Natural subsidence and settlement are dealt with much more perfunctorily although the reader will find much perceptive, though brief, comment on natural phenomena.

Chapter 1 defines subsidence as a surface point sinking to a lower level. Whittaker and Reddish thus regard settlement as a form of subsidence. Having adroitly avoided sterile argument about what should be classified as settlement and what subsidence, and having included a summary of the principal features of soil compaction in Table 1, it is a pity that they did not also include in their text discussion of the spectacular effects in such 'sinking cities' as Bangkok and Mexico City. Similarly although their review of natural subsidence is meant to provide only a few examples, this reviewer regrets that important examples of natural subsidence, such as caldera collapses, are omitted. Collapse into voids in lavas is described but the geologically much more important phenomena of sinking into liquids (ie magmas) is not discussed at all. Criteria which would allow geologists to distinguish between natural small scale subsidence and that induced by mining would also have been welcome but perhaps there are no such criteria! In spite of its incompleteness Chapter 1 does illustrate the wide range of geological structures which have been ascribed to subsidence and to the need for geologists and subsidence engineers to cooperate in finding plausible mechanisms for the development of such features.

The engineer usually has the advantage of knowing in some detail what has been extracted and what support (if any) was in place before subsidence occurred. By correlating this information with the surface effects plausible models explaining the probable mechanism of subsidence can be devised. Chapter 2 is a fascinating historical account of the development of such models showing how, particularly in respect to longwall mining, the concepts became sufficiently precise to predict orthodox ground movements with remarkable accuracy. This theme is further developed in succeeding chapters which deal with ground movement observed underground (Chapter 3); methods of predicting mining subsidence and comparing these predictions with the observed results (Chapters 4 and 5 respectively); details of the application of empirical predictive models in the UK, (Chapter 6) and finally recent developments, mostly pioneered at Nottingham, of computer based predictions of mining subsidence (Chapter 7).

Most of this early part of the book (Chapters 2–7, pp. 15–152) is devoted to subsidence resulting from longwall mining although in Chapter 3 the effects of other types of mining, including solution, room and pillar, top slicing, sub-level caving and block caving, are reviewed succinctly in 6 pages. Most of the detailed case histories cited by Whittaker and Reddish are British but they do include (pp. 99–113) a valuable comparative review of mining subsidence reported from coalfields in France, South Africa, Japan, India, Australia, USA and Czechoslovakia as well as the thick lignite deposits of Yugoslavia. The authors conclude that although broadly similar to subsidence in the UK "dissimilar geological settings produced detailed differences in the magnitude of subsidence and extent of area of influence". This writer was struck by the apparent lack of detailed research into correlation between geology and subsidence in most coalfields and of the many coalfields of the world where, if Whittaker and Reddish's review is comprehensive, there is no published information at all. Worldwide comparative studies appear, therefore, to be a potentially fruitful field of research if the necessary data is obtainable.

Other aspects are dealt with in succeeding chapters. These include subsidence associated with near-surface tunnels (Chapter 8), with room and pillar mining (Chapter 9) with steeply inclined seams (Chapter 10) and with subsidence aspects of sloping ground surfaces (Chapter 11). Subsidence associated with rock-salt and potash mining is accorded a separate chapter (12). All these chapters (8–12 pp. 153–298) are, as is the whole book, illustrated with clear diagrams, a lucid text, reports of laboratory experiments and of case histories, many of which are drawn from the authors' own experience.

The same high standards are maintained in the following chapter in which the authors return to longwall mining subsidence to discuss the time factor. Regrettably errors and ambiguities have crept into Chapter 14, on the influence of geological factors. This contains diagrams which do not illustrate what the caption claims is illustrated. For instance Fig. 131d shows valley cambering not valley bulging and Fig. 187 is in fact a dip fault with a strike-slip movement and not as claimed a 'strike (wrench) fault', the authors having apparently confused (as do many students) the dip, strike, oblique classification based on orientation of faults in respect to the strata they transect with the dip-slip, strike-slip and oblique-slip classification of fault movement. There is clearly insufficient communication between geologists and mining engineers for which this writer is partly responsible. Whittaker and Reddish also continue to favour such outmoded concepts as lag faulting and seem from their text to be unaware of the prevalence and importance of growth faulting and reactivation. These are, however, minor blemishes in what for many geologists will be the most interesting section of this book. Most abnormal surface movements are due to geological factors and a more comprehensive understanding of the geological setting could lead to greater precision in predicting subsidence.

There follows an interesting chapter on the comparatively neglected field of subsidence resulting from withdrawal of fluids, (water, oil and gas) and of underground coal gasification, removal of rock salt by pumping brine having been discussed in an earlier chapter. From the well attested but relatively rare examples quoted, this reviewer suspects that subsidence associated with fluid extraction is much more common than previously envisaged but often has simply not been investigated. With more and more submarine oil fields the subject has become crucially important where drilling rigs rest on the sea bed.

To this reviewer the following chapter 16 is the most disappointing largely because Whittaker and Reddish appear to have grossly underestimated the scale of the subsidence aspects of abandoned mines. They draw attention to Littlejohn's 1979 estimate of 80,000 old shafts remaining in the UK but this estimate refers only to coal and should be compared with estimates of between 50,000–100,000 disused shafts in the Derbyshire orefield alone. Although they do mention iron ore working in Gloucestershire, chalk in Suffolk, Limestone in the West Midlands, veins in Cumbria (elsewhere in the book) and salt in Cheshire, this is but a small fraction of the raw materials which were formerly mined in the UK. These included sandstone, sand, sandstone flags, limestone 'slates', various limestone building stones and 'marbles', gypsum, anhydrite, ganister, seat earth, pottery and other ceramic clays, black band ironstone, hematite, oolitic iron ores, chert, flint, chalk in many other counties than Suffolk, slate, alum shales, jet, graphite, fluor spar and barytes replacements as well as a great variety of vein ores, of tin, tungsten, copper, antimony, gold, lead, zinc, etc., and gangue minerals such as calcite, barite and fluorite. Almost every county in the UK possesses abandoned mines which are usually still subject to unpredictable subsidence. Admittedly many are remote from centres of population but urban subsidence hazards other than those induced by coal mining are real as exemplified by the double decker bus which recently subsided into a chalk mine a few yards from Norwich Roman Catholic Cathedral. If one adds to this the deteriorating Victorian sewers and other man made underground structures such as the caves in Nottingham, unpredictable subsidence is a hazard over much larger areas of rural and urban Britain than seems to be indicated by Whittaker and Reddish. With this in mind it is salutary to read the case histories they do cite bearing in mind that subsidence is still occurring over mines and other underground excavations many of which are more than 100 years old (cf. 'The tale of two excursions' in this journal). There is, therefore, a clear need for local Planning Departments to be aware of, and take advantage of, all sources of information. Some of these sources are mentioned by Whittaker and Reddish, pre-eminent among them being British Coal and the Mines Record Office (which incidentally is at Bootle, Merseyside and not now in London). Geological Survey maps are mentioned but surprisingly not OS maps, the older editions of which show the location of many shafts now capped or filled and consequently not shown on more recent OS maps. Similarly the fact that BGS itself has an archive of old mine plans, as do some societies such as the Peak District Mines Historical Society, and some Records Offices (now Archive Offices) e.g. Camborne, is not reported.

Having on a number of occasions had cause to seek information on abandoned mines this reviewer has the greatest sympathy with Planning Authorities and developers who are unaware of potential hazards from specific underground excavations. This book highlights those hazards and it is high time that comprehensive guide to sources of information about the many disused mines, other than coal mines, was published.

In the penultimate chapter the authors return principally to longwall mining for coal in the UK by discussing its effects on the built environment and the way in which these may be minimised by good design and appropriate precautionary measures. The effect on road, railways, sewerage, water, gas and electricity supplies as well as buildings are considered and case histories illustrating good preventive practice are described. Effects on spoil heaps are also discussed as is the experience gained from working coal (but not tin) underseas around Britain. Interesting but brief mention is made of what the authors term 'pseudo mining damage' which includes damage such as that due to shrinking clay, sulphate attack on Portland cement, differential settlement, rust, thermal effects and roof spread which are not attributable to mining. The authors do not discuss how to apportion blame where the damage is partly due to genuine mining subsidence and partly due to other causes: a vital and vexed question in many compensation claims.

Finally the authors have chosen for their final chapter not so much a conclusion as illustrations of what has gone before. Oddly although empirical and computer modelling are discussed earlier in the book physical scale models are not and the authors take this opportunity not only to illustrate subsidence caused by longwall mining but to discuss the mathematical basis of such models. This final chapter thus introduces new concepts and contains much 'meat'. It is characteristic of the book as a whole in that, whilst there is much to interest the general reader and good illustrative diagrams and photos, there is much 'in depth detail' for the specialist. In short a useful complement to the Subsidence Engineers's Handbook giving a broad up-to-date authoritative overview of all aspects of subsidence. Essentially, it is likely to appeal most to mining engineers and to consultants whose work is concerned with construction in subsidence prone areas, but it is also a book which should be consulted by planners and architects and should be available to them through the appropriate libraries. Applied geologists working with or advising in mining areas will find this book particularly relevant but there is also much that should interest many geologists whether professional or amateur.

SIVETER, D.J., OWENS, R.M. and THOMAS, A.T., 1989. *Silurian field excursions: a geotraverse across Wales and the Welsh Borderland*. National Museum of Wales, Geological Series No. 10, Cardiff. 133 pages. £13.50, paperback. ISBN 0 7200 0329 6.

Roderick Impey Murchison's great work, *The Silurian System*, was published in the first few days of 1839. The volume was dedicated to Adam Sedgwick, Murchison's friend and Woodwardian Professor of Geology at Cambridge, and one of the first copies was sent to him at Norwich. Acknowledging the gift Sedgwick wrote: "Accept ... my best thanks, and warmest congratulations on the new birth, full-grown and strong, as it ought to be, after so long a period of gestation. And now I hope you are doing as well as can be expected!"

This year (1989), on the 150th anniversary, an international conference on the Silurian System, entitled "The Murchison Symposium" was held at the University of Keele. This guidebook was produced as a part of that event, and provided documentation for the post-symposium field trip to the classic areas of Silurian rocks across Wales and the Welsh Borderland. It is, though, much more than a mere conference excursion guide, being packed with detailed information on all aspects of Silurian geology. It is lavishly illustrated, with line drawings, charts, photographs of exposures, and plates of fossils. It was an ambitious undertaking and, unlike Murchison's original, was produced at breakneck speed. I was close enough to the authors to know that the final production involved frantic work into the early hours of several nights to meet the printer's deadlines. In the end, the copies of the guidebook were delivered to the symposium secretary at Keele just two days before the excursion was due to depart.

The book is designed as a traverse to give an appreciation of the variation in facies and fossils from the shallow shelf environments of the Midland Platform into the central and western Welsh trough. The first chapter is a well-written up-to-date account of tectonics and sedimentation in the area, providing a thorough background for the detailed documentation that follows. It could be read with profit by undergraduate students as an object lesson in the integration of geological information into an analysis of changing palaeogeography. Each succeeding chapter stands as an excursion in its own right, each selected to illustrate a particular depositional environment within the Welsh basin and its shelf seas. These are as follows:

Chapter 2: The northern Wenlock Edge area (shelf muds and carbonates on the Midland Platform).

Chapter 3: The Ludlow Anticline and contiguous areas (a shelf marine to non-marine transition).

Chapter 4: Shelf edge and slope sequences in south-central Wales.

Chapter 5: The Llandovery-Llandeilo area (shelf edge environments on the southern margin of the Welsh Basin).

Chapter 6: Nearshore clastic sediments, fluvial deposits and volcanic rocks in South Pembrokeshire.

Chapter 7: Basinal muds and turbidites in west-central Wales.

Each chapter begins with a brief geological introduction and a listing of relevant topographical and geological maps. Details of a series of localities are then presented, covering stratigraphy, lithology and fauna. Information on where to obtain permission, where to park, means of access etc. are included where appropriate. The book is a must for those leading or following excursions in the area, and will be invaluable as a holiday companion for those wishing to include a little geology on their vacation. The A4 format means that it will not fit snugly into any pocket, but will have to be carried in a rucksack, or read and left on the car seat. However, this is the price that has to be paid to allow the inclusion of so much information. The rapid production has inevitably led to the inclusion of some minor errors, but these are not sufficient to detract from the overall handsome presentation.

There is a bonus! Members of the East Midlands Geological Society may purchase a single copy of the book at the discount price of £10.00 (plus postage and packing; add £1 within Great Britain and Ireland, £1.50 abroad). Anyone ordering more than one copy should pay the full retail price of £13.50 for the additional copies, plus postage. All orders must be accompanied by payment in pounds sterling (cheques payable to "The Murchison Symposium") and should be sent to: Dr. M.G. Bassett, Department of Geology, National Museum of Wales, Cathays Park, Cardiff CF1 3NP.

Richard J. Aldridge

PARK, R.G., *Foundations of structural geology*. 1989. 2nd Ed. Blackie and Son Ltd., Glasgow and London, xii + 148pp., and 184 figs. £12.95 Paperback and £30 Hardback. ISBN 0 216 92491 X and IXBN 0 216 92492 8 Pbk.

Training in structural geology tends to be subdivided for logistical reasons into theory, practical, and field, sections with varying degrees of integration. My never achieved and ideal would be a several week course at a field centre where all three aspects would be interwoven. Graham Park's book provides very even coverage at the introductory level to the theory side. It is very much the beginners way into the topic which is how I have recommended it in the past. The caveat is that practical and field work aspects are virtually absent which will suit some needs and courses but not others.

Though the second edition is under review, comments will not be restricted just to the changes made. Basically the book is in three parts, two of which are a valuable separation of fact and inference. The bits and pieces of structural geology [folds, faults, cleavage, lineation, boudins, etc.] are dispassionately given the morphological treatment in 32 pages; mechanisms/processes are then dealt with in 72 pages. Such a clear separation is an object lesson for students which hopefully will be taken on board without the transgressions obscuring the principle. Part 3 deals with tectonics [Major earth structure, Plate tectonics, and Geological structure and plate tectonics].

Judging from reviews of the first edition it ranged from highly acclaimed to well received. It is interesting to see how authors respond to the flood of advice they get by way of reviews, correspondence, friends, colleagues, or being button-holed at conferences. The largest changes [5 pages on mainly stratigraphic matters labelled basic concepts, and a 2½ page appendix on stereographic projection] are the least satisfactory parts of the book. Both are so brief that a student would get little from them and several stratigraphic concepts are poorly defined presumably in an attempt to keep the section short. All first edition reviewers complimented the use of a second colour in the diagrams which is very effective. Unfortunately in my copy of the second edition, where diagrams had been changed or added, the second colour was not printed leaving glaring holes in the presentation.

Some reviewers of the first edition could see no point in part 3 and others thought it rewarding. You can't please all of the people all of the time! Putting structures into tectonic context is a worthwhile task but to devote two chapters to the basics of plate tectonics doesn't make sense when this is covered in so many other places. Throughout the book the battle for brevity whilst maintaining even coverage means that opportunities are lost. In many sub-sections I wondered if the reader had been given enough to grasp the essence of the topic. Because there is much excellent condensing in the book, a little bit more space would see a disproportionately greater gain. You may have already guessed my solution; cut out the plate tectonic fundamentals and the 'basic concepts' section, thus freeing space for expanding other topics.

Being required to read the entire book rams home a recurrent problem in structural geology. The subdiscipline is bedevilled by variable application of terminology and, adapting the observation about Anglo-American ties, we are often separated by a common set of terms. A multiplicity of terms for one feature also doesn't help. If outsiders had time to read several structural texts [thankfully they don't] they might rightly suggest we are in disarray. Communication of ideas begins with agreement on the meaning of terms. To take one example from the review text, in the section on fault morphology, the description of displacement is not distinguished from the effects of displacement. There is a very good terminology for this [slip and separation] but it has been ignored with clarity the loser.

Overall it is salutary to see what Graham Park has squeezed into a very small space and if I could convey this in a 20 lecture course I would be happy.

Clive Anthony Boulter