

BOOK REVIEWS

BLÈS, J.L. and FEUGA, B., 1986. *The fracture of rocks*. North Oxford Academic Publishers Limited. Translated from French by J. Wanklyn. 131 pages of text and figures. £15.50 hardback. ISBN 0 946536 45 7.

There are many books dealing with rocks and their behaviour in engineering, but relatively few aimed at providing an in-depth understanding of fracture in rocks which embraces field observation and interpretation. This new book fills an important gap between theoretical rock mechanics and engineering geology, and will provide an important addition to texts dealing with rock mechanics.

Appreciation of the fracture of rocks requires an understanding of the parameters governing failure conditions, stress environment and mechanisms of failure. This is recognised by the authors who in the first section of the book provide the reader with a fairly concise treatment of rock mechanics concepts and thereby lays a solid foundation for the second part which is concerned with observation and interpretation of natural fractures.

There are nine chapters in the book, the first three dealing: review of solid mechanics; stress and behaviour; and rock failure. Chapters four, five and six cover: fracturing in geology; types of fractures; and interpretation of fracture mechanisms. The remaining three chapters are concerned with: fracture models; inter-relationship of fractures; and relationships between fractures and folds.

The first part of the book provides a useful insight into stress and strain concepts and the conditions governing fracture in rocks. There are several equations and diagrams supporting the text which allow rapid grasp of the fundamental principles.

The second part of the book discusses the various types of fracture observed in rock structures, and comments on the general conditions favouring their occurrence. The authors use ample illustrations to demonstrate the observed characteristics of rock fractures. Additionally the association of small fractures with major fracture development is clearly presented, as is the role of folding in inducing tension fractures and shearing between bedding planes.

This book provides a useful works of reference on the general character of fractures in rocks masses, and is recommended to geologists and engineers with interests in rock mechanics and engineering geology.

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GUILBERT, J.M. and PARK, C.F. Jr., 1986. *The geology of ore deposits*. W.H. Freeman and Company, New York, New York 10010. 985pp., 661 illustrations, £29.95 hardback. ISBN 0 7167 1456 6.

This new text book on ore deposit geology constitutes a major revision of the third edition of *Ore Deposits* by Park and MacDirimid. The book starts with eight chapters on principles which are only slightly changed from the last edition of *Ore Deposits*. These eight chapters, however, provide an adequate introduction to the principles behind the study of ore deposits although they are somewhat lacking in references to recent work. The authors assume that the reader has a good background in chemistry, physics and particularly in mineralogy. Without this several sections of the text will be virtually incomprehensible.

The main part of the text describes ore deposits, the basis of the subdivision of the major ore deposits in this text has changed from that in earlier editions of *Ore Deposits* from a 'Lingren-type' classification towards a "process-related, kindred group" type of classification. This has resulted in a much better classification than in its precursor texts but one which may cause confusion to the casual reader used to a more environmental classification system. This is particularly apparent with Banded Iron Formations which are classified as volcanic related in this text but sedimentary in many alternative texts. This main section of the book contains many examples, mainly from North America, and is therefore a very useful text, however, there is an almost total absence of information relating to the global distribution of the ore deposit types and also of theories related to the mechanism of formation of many of these deposits.

This text is more a compilation of 'case-studies' than an undergraduate text on ore deposits. To this end it is a worthwhile text but is, to the reviewer at least, spoiled by the lack of consideration of plate tectonic theory in relation to ore deposit genesis and also by the predominance of North American examples. Many of the diagrams and plates in the book are too detailed for the size of reproduction or of poor reproductive quality. There is also, in several places in the book, the annoying features that a diagram will appear before it is referred to in the text, in some cases by several pages. The general typographic quality of the text is good with very few errors.

In summary I feel that this book is a worthwhile addition to any library or individuals collection, its major 'selling point' being the wealth of information relating to specific deposits, but I have reservations as to its use as an undergraduate text outside North America.

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Proceedings 4th International Congress, International Association of Engineering Geology, New Delhi, 10–15 December 1982. A.A. Balkema, Rotterdam 1982. Volumes 1–9, £217.

This record of the 4th International Congress of the International Association of Engineering Geology constitutes a series of 9 volumes covering the presentations, panel reports and sessional reports of the six-day meeting. There is a total of pages in excess of 2800, covering every aspect of engineering geology, there being no single theme to the conference other than the subject of its parent association.

Volumes 1 to 8 include some 270 scientific and technical papers from 33 countries; about one third are representative of engineering geology activity in India. These papers are subdivided into 7 themes;

- I. Engineering geological studies for environmental evaluation and development (volumes 1, 2, & 3).
- II. Engineering geological problems of tunnelling and excavation of cavities (volumes 4 & 5).
- III. Soil and rock as construction material (volume 6).
- IV. Engineering geological problems of natural and man-made lakes (part volume 7).
- V. Engineering geological problems of sea-coast and shelf areas (part volume 7).
- VI. Seismic and seismo-tectonic investigations of engineering projects (part volume 8).
- VII. History and development of engineering geology (part volume 8).

Each major theme is subdivided so as to focus attention on specific problems or studies. This is both a help, and, at times, hindrance. There is no doubt that the total Congress Proceedings cover a vast wealth of topics pertinent to modern engineering geology. It is quite exhilarating to browse through the volumes in search of general topics of interest, for they occur in the most obvious of places, and also jump out from the most unexpected; it must have been a mammoth and most unenviable task to sort the papers into their respective groups, because given this amount of material there are, inevitably, substantial overlaps of subject, and consequently the pigeon-holing of material becomes most complicated and difficult. Having said that, the volumes are an excellent record of what appears to have been a most exciting and far-reaching meeting.

Volume 9 contains Panelists' and Sessional Reports summarising the main themes covered by the scientific and technical papers, together with written versions of the Special Lectures delivered during the Congress. Again the range of topics covered is enormous. Volume 10 is not included in this review, it was due for publication at a later date and has by now presumably been published. Its content should be a record of the Technical Sessions and the discussions that ensued. Consequently it is probably one of the most valuable of the series, since it is often only in the discussion sessions that the important issues surface and the more recent developments are aired.

At £217 the set of 9 volumes represents reasonable value for money at today's prices, always assuming the broad content is to your liking. Unfortunately this breadth combined with the large total cost is likely to place the Proceedings within the reach of only libraries and professionals, and, whilst, I was personally converted to them, I cannot recommend them otherwise.

Proceedings 5th International Congress, International Association of Engineering Geology, Buenos Aires, 20–25 October 1986. A.A. Balkema, Rotterdam, 1986. Volumes 1–3, £165.

The 5th International Congress of the International Association of Engineering Geology is recorded in a series of 3 volumes which contain some 263 scientific papers on a wide range of engineering geology topics. The scientific papers are divided into six themes:

Volume 1:

- I. Engineering geological investigations of rock masses for civil engineering projects and mining operations.
- II. Engineering geological problems related to foundations and excavations in weak rocks.

Volume 2:

- III. Engineering geological aspects of foundations in soils.
- IV. Engineering geological problems related to hydraulic and hydroelectric developments.

Volume 3:

- V. Engineering geology in the new development of road, railroad, coastal and offshore projects.
- VI. Engineering geological aspects in environmental planning and urban areas.

In addition, two colloquia were held and these have been published separately in Bulletin NO. 34 of the IAEG. The first was on engineering geology in geothermal energy projects, and the second on engineering geology related to nuclear waste disposal projects. A further volume (4) to the three reviewed here is due to be published at a later date. As with the 4th Congress described above it will contain a record of the discussions arising from the technical sessions, together with the inevitable late papers which missed the deadline (!) and special reports. The importance of the recorded discussion is highlighted in the review of the 4th Congress (above) and the same comments are equally applicable here.

The broad range of topics covered is again highly commendable; it really does make for avid browsing on a dark cold winter's night in front of the fire. Unfortunately it naturally restricts the number of people likely to consider giving it shelf room, for at the price it represents a substantial investment. It will no doubt feature highly on library and institutional lists; I recommend anyone with a passing interest to seek a copy out there.

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YOUNG, B. *Glossary of the minerals of the Lake District and adjoining areas*. 1987 Newcastle upon Tyne: British Geological Survey published HMSO, 104pp., £8.50, paperback. ISBN 0 85272 099 8.

Seventy five years ago Postlethwaite (1913) listed 108 minerals from the Lake District and adjoining areas. By 1940, due principally to petrographical and heavy mineral studies and indefatigable mineral collectors such as Sir John Russell, the total known minerals had increased to about 175 valid species. The post-war advent of X-ray powder photographs, reflected light microscopy and, more recently, X-ray diffraction spectrometry and microprobe techniques facilitated the identification of many more mineral phases so that this present glossary lists about 300 valid species. Identification of rare, often minute, minerals became easier than reporting their presence in the scientific literature! Not the least of the virtues of this glossary is that the author has, by working through collections in the British Museum (Natural History), the Geological Museum and the National Museum of Wales, brought to light several minerals either, hitherto unknown in the Lake District, or from new localities therein. In addition, he has collated published data from diverse sources and by well chosen quotations and personal commentary has compiled, not only a glossary, but descriptions of individual varieties, their geographical distribution and their geological settings.

Unlike other lists which were often restricted to well crystallised minerals (e.g. Davidson and Thomson, 1951) this glossary encompasses both vein and rock forming minerals irrespective of their crystallinity. Moreover, it is more useful to geologists and mineral collectors in that it is not confined, as many glossaries are, to a mere list of minerals with references to their first published occurrences. In fact one of my minor criticisms is that it is often impossible from this text to discover who first recorded a particular mineral. For instance the reader is referred to Firman 1978 for a reference to anorthite "in altered calcareous rocks in the granite aureole" [at Shap] whereas much more detailed and localised descriptions were published by Harker and Marr (1891 and 1893). These minor criticisms are, however, offset by the impressive comprehensiveness of both the list and the accounts of the geographical distribution of individual minerals. A summary in bold print is given when the occurrences are so numerous that they cannot all be quoted; nevertheless sufficient extracts from published papers (supplemented by the author's own comments) ensure that examples of most varieties and parageneses are adequately covered. For instance more than two A4 size pages each are devoted baryte, chalcopyrite, the chlorite group, galena, hematite (5.5pp) and quartz, and more than one page to arsenopyrite, calcite, cerussite, dolomite, epidote, fluorite, garnets, gypsum, malachite, muscovite, pyrite, pyromorphite, sphalerite and tourmaline. Thus in welcome contrast to many glossaries most space is devoted to the commoner or more widespread minerals the most notable exception being gold. The A4 equivalent page allocated to this very rare mineral is, however, fully justified since it has been reported, albeit in exceedingly small quantities, from no less than 25 localities. This glossary, therefore, is a most useful compendium, strongly recommended to both amateur and professional mineralogists.

Like most lists of minerals it must, however, be regarded as an interim rather than a definitive statement. Some of the older records, which have not been verified by subsequent research, such as kyanite from the Shap aureole, need to be reconsidered and if possible the original material re-examined. Also in spite of the considerable acceleration in discovery, identification and reporting (Fig 1) many minerals remain to be discovered. Indeed Brian Young and his co-workers (Young, Fortey and Nancarrow, 1986; Young, Firman and Starkey, 1988) have already added 5 more minerals since he compiled his glossary. The re-examination of collections such as the Harker collection at Cambridge may yield information which was unavailable to petrographers before the development of X-ray analysis and microprobe techniques. Moreover, although the latter technique has been applied to vein materials in the Lake District, it is only just beginning to be used for the systematic study of inclusions and the alteration products of rock forming minerals. Similarly X-ray diffraction studies of clay minerals in the many and varied sediments and comprehensive studies of such common, but neglected groups, as the chlorites are bound to yield new mineral species. Thus the next decade is likely to produce about 50 new minerals from the Lake District and adjoining areas if research continues at its present pace. Incomplete as it inevitably is, this publication contains abundant information which will form the basis for much subsequent fundamental research. For the first time we have a comprehensive description of both the nature and distribution of Lake District minerals which will allow such questions as why some areas have a wide variety of minerals and other areas a very restricted range to be addressed. The glossary is, therefore, not only intrinsically interesting but is a potentially valuable research data base.

As the author states in his introduction, "a detailed and accurate knowledge of which minerals occur in an area and where precisely they have been found is a pre-requisite for detailed studies on many aspects of the

geology, mineralogy and economic potential of that area". He contrasts the paucity of mineralogical information available to geologists with that on plants available to botanists through the excellent series of county floras. This glossary goes a long way to correct this information imbalance by giving the raw data from which something analogous to botanical distribution maps could be produced. Even without these maps some remarkable facts emerge from an analysis of the data. For example of the 300 or so valid mineral species listed almost two thirds occur within 6 kilometres of Grainsgill Mine and of these about 70 minerals are found nowhere else in the Lake District. The uniqueness of the Caldbeck Fells mineralogy has long been known but the full extent of its diversity is revealed only in this glossary. Were a map of mineral species per unit area to be constructed by any reckoning the Caldbeck Fells would have the greatest diversity of minerals in northern England, rivalling, if not exceeding, any other area of comparable size in Britain. What causes this astonishing diversity? Whilst it is true that the rock types range from ultrabasic to acid igneous rocks and include a variety of metamorphosed and unmetamorphosed sediments, comparable ranges of rock types occur elsewhere without such a unique range of minerals. In part the diversity can be explained by the fact that, in addition to a wide range of rock types the area has been subject to several periods of epigenetic mineralisation followed by deep weathering which oxidised many of the earlier epigenetic mineral deposits. But why should this sequence have occurred here and not elsewhere? Thus the fundamental causes of the Caldbeck Fells unique mineral assemblages still remain enigmatic.

Spectacular as the Caldbeck Fells 'mineral anomaly' is, this glossary also highlights that other areas, neglected until recently, also have unique, though less diverse, mineral assemblages notably in the Coniston and Causey Pike areas. Also more recent research (Young, Fortey and Nancarrow, 1986) has located another unique assemblage of minerals (including four minerals new to the Lake District) in the Eskdale Granodiorite. Each mineral assemblage is spatially associated with a specific part of the Lake District batholith and it is tempting to suggest, following Firman (1978 B), that each component part of the batholith (? separate pluton) has its own distinct associated epigenetic mineral assemblage. In addition the role of the country rocks in controlling epigenetic mineral assemblages needs to be evaluated. For example Redfern (1979) showed that in the Silurian meta-sediments south of the Shap Granite a mineral assemblage occurs which is similar to, but more impoverished in iron, than the metasomatised fissure veins in the meta-volcanics thus, clinozoisite instead of iron-rich epidote, grossularite instead of andradite and tremolite instead of actinolite occur in the meta-Silurian sediments and even

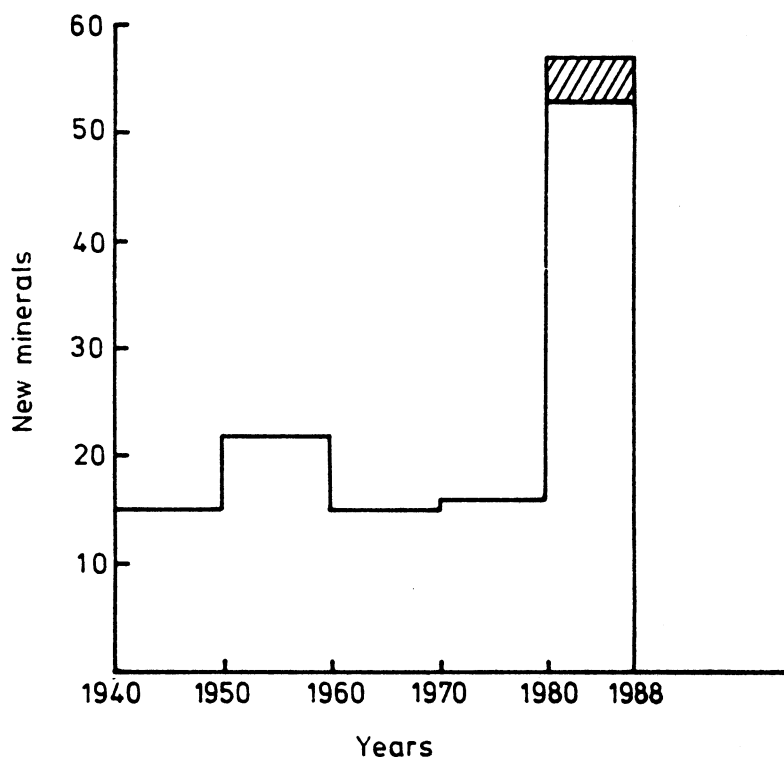


Fig. 1. Number of minerals new to the Lake district and adjoining as reported in the literature per decade since 1940. Data based on information in the glossary, the shaded area indicates new minerals reported since the glossary was published. Note that due to a time lag between discovery and publication the 'upsurge' in recent years is not wholly due to research since 1980.

baryte is white rather than pink as it is elsewhere in the Shap aureole. Similar effects of wall-rock mineralogy and geochemistry affecting the composition of minerals resulting from metasomatism are likely elsewhere. Similarly leaching of the country rocks by circulating brines, whether of juvenile, connate or meteoric origin, is likely to change the composition of the circulating fluids and hence the mineral phases which precipitate. The quantitative effects of such leaching have yet to be evaluated as have the contributions of juvenile and connate fluids.

If we are ever to produce a predictive model for mineralisation which can be used to forecast the likely location of the unexposed mineral deposits we have to thoroughly understand all aspects of the known geology and geochemistry of a given area. Not least is a detailed knowledge of what minerals are present and how they are distributed. Brian Young is to be congratulated for having done this so admirably for the Lake District and adjoining areas. Hopefully he will be able to publish supplements from time to time but in the meantime this glossary provides invaluable information to all interested in Lake District mineralogy and is strongly recommended as a reference for libraries, mineralogists and all interested in Lake District geology.

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