Broken Hill district represented an inverted metallogenic sequence and that metamorphic mineral assemblages reflect original rock composition rather than a precise indication of *P–T* conditions.

Mt. Isa was not really considered to be a stratiform deposit until 1962, equivalent unmetamorphosed mineralization not being demonstrated until 1978 to 1983—that of McArthur River, described as having been deposited in a shallow lagoonal environment. The Cobar field is shown to be a camp where regional changes in Cu–Pb–Zn contents reflect a metallogenic sequence of original sedimentary origin, but present orebodies are mainly transgressive due to remobilization of the metals during metamorphism.

King draws comparisons of the Broken Hill district with widely separated regions of North America: Calumet, P.Q.; Balmat-Edwards, N.Y.; Franklin Furnace, N.J.; Sterling, N.J., and states that in order to dismiss a sedimentary origin for such deposits we must ignore much obvious data. Continuing the theme of a sedimentary or volcanogenic origin for many deposits he gives examples of Precambrian gold mineralization in Western Australia—many past and present producers are conformable lodes or stratiform reefs. Gold in the Kalgoorlie field has obviously been remobilized during shearing, but a preference for certain horizons still suggests that the metal may have had a local source.

Expanding the sedimentary theme, the author notes the presence of algal remains in many mineralized areas: the Belgian Congo; Bulman, McArthur River, Northern Territory; Weekaroo, South Australia; Rum Jungle and Mary Kathleen uranium; and the Pernatty Lagoon area of South Australia. He stresses the early experimental work of Baas Becking in demonstrating that organisms are capable of forming 'ore' minerals and emphasizes that it is necessary to consider the total environment in which mineralization may be found.

In considering mineralization throughout geological time he notes that concentrations of elements are typical of certain ages: Proterozoic—dolomite/BIF deposition; Palaeozoic—Pb/Zn/Cu/pyritic deposits, where pyrite:base metal is often 1000:1; Palaeozoic—phosphate, gold/quartz mineralization; Mesozoic—coal deposition. He compares the Palaeozoic bedded phosphate of Queensland with that of the U.S.A. and the uranium of the Northern Territory with Saskatchewan; the Bonaparte Gulf, Northern Territory with the Mississippi Valley; Hamersley iron with counterparts in South Africa and N. America and hints at a correlation of the central Australian ultrabasics with those of the Bushveld and Duluth.

The author emphasizes that we do not as yet understand the reason for such appearances of huge amounts of certain elements at discreet times, such as the Hamersley iron, magnesium in dolomite, and later in the Proterozoic: sulphur as at Mt. Isa and in the Palaeozoic deposits; phosphate; gold and the Malayan and Tasmanian tin provinces. In making large-scale correlation he notes the controversial work of Tim O'Driscoll in defining major lineaments which may be the result of long-lived deep crustal fracture patterns and which have major mineralized areas at their locus. He stresses the need that in order to understand it we must study mineralization from all scales and take 'a holistic view'. He observes: '... the trend today is heavily toward high-technology data. At the risk of appearing old-fashioned, this—as ore geology—is an unfortunate trend. The need is for understanding and through this, insight, not for pages and pages of instrumentally-acquired "data"', noting in the case of Broken Hill (p. 260) that: "Some geological concepts lack a sense of scale. Replacement processes, plausible on the scale of mineral boundaries as seen under a microscope, become absurd when extrapolated to field scale'. The central theme of the book is that there is *no substitute* for good field observation and mapping.

This book was of great interest to me, being one who had been engaged in mineral exploration in Australia during the 1960s, often working without any sound metallogenic model for mineralization. It is highly recommended to all exploration and mining geologists and will benefit students of ore geology and encourage them to think on *all* scales.

T. LIVERTON

Berkman, D. A. *Field Geologists' Manual*. Parkville, Victoria (Australasian Institute of Mining and Metallurgy: Monograph Series No. 9, Third Edition), 1989. 382 pp. Price $A 58.50.

This reference manual is written especially for the needs of geologists and geophysicists in Australia, New Zealand and New Guinea. It contains a wealth of basic reference data—the requirements for Australian Stock Exchange reports and the A.I.M.M.E. code of ethics; basic mineralogical and petrological tables plus criteria for environmental impact reports. Also included are compositional requirements for ore parcels; classification of Australian coals and a checklist

for small mine evaluation, including the reminder to check the location of lease pegs with respect to the orebody, a result of past sad experiences! Australian (B.M.R.) standard map symbols are reproduced plus basic geometrical formulae useful in surveying together with data for Engineering Geology; parameters for hydrogeology; geophysical quantities and some basic safety information. This is an essential book for Australasian geologists, but the amount of useful and sometimes hard-to-find data presented make it of interest to others.

T. LIVERTON

Boulter, C. A. *Four Dimensional Analysis of Geological Maps: Techniques of Interpretation.* Chichester and New York (John Wiley and Sons), 1989. xxiv + 296 pp. Price (paperback) £14.95.

This book introduces the science of interpretation of geological maps in terms of the three spatial dimensions plus time—the fourth dimension.

The book consists of twelve chapters, together with two appendices which deal with stereographic and related projections and with geological symbols. A comprehensive index is provided.

Chapter 1 outlines the philosophy behind the book in terms of presenting and understanding geological maps not only as depicting the spatial distribution of rock types on 2D maps but as also carrying fundamental information on the 3D geometry of an area as well as depicting time relationships—the fourth dimension. Chapter 2 introduces base maps used for geological mapping, the topographic map and discusses, albeit briefly, the problems of reliability of the geological information recorded on them, i.e. limitation of outcrop, limitations of scale, mapping style (reconnaissance or detail) and time spent mapping an area. Chapter 3 discusses two-dimensional presentation of 3D geology. Fundamental relationships of strike, dip, attitudes of lines, planes and apparent dips are presented. Chapter 4 deals with geology at the earth's surface and introduces outcrop and exposure, widths of outcrop, the effects of topography, the rule of V's, three-point problems and simple cross-section construction. The problems of structure contouring real data are discussed.

Chapter 5 on remote sensing adds an extremely useful and important dimension to the book by introducing the concepts of aerial photograph interpretation and the uses of other forms of remote sensing imagery (these too often are scantily dealt with in UK undergraduate courses, and students do not often use aerial photographs when mapping in the field in the UK). More examples of aerial photographs of deformed terrains and perhaps also examples of colour aerial photographs would strengthen this chapter. Chapter 6 introduces the fourth dimension into the analysis—chronology. Emphasis is placed upon stratigraphic concepts, stratigraphic principles, and upon stratigraphic information contained in maps. Only this chapter contains two references for further reading (except for chapter 12 where references for report writing styles are given). Chapter 7 briefly introduces the basics of geological deformation—displacement, rotation, strain and volume change, whereas Chapter 8 discusses the geometric features of continuous deformation—principally folding in more detail. Emphasis is placed not only on description of fold style but also upon thinking about folds in 3 dimensions; a three dimensional classification of folds is given. Minor structures and outcrop features are discussed as aids to interpreting geological structures and map patterns. Unfortunately in this chapter there is only a brief mention of the effects of topography on the outcrop patterns of folded strata, both single phase deformation and polyphase deformation. Many more examples here would be extremely useful for students working in polyphase terrains.

Perhaps the most useful chapter in this book is chapter 9, Discontinuous deformation—Faults. This introduces some of the more modern concepts of faulting and fault patterns, particularly emphasizing separation and displacement across fault surfaces. It is this chapter which could well do with a comprehensive reference list so that the reader could go beyond the basic features given in this book.

Chapter 10 discusses the forms and map expressions of igneous and metamorphic rocks. Fundamental features of these regions are somewhat briefly treated. More examples of real map patterns would be useful here. Chapter 11 presents the fundamentals of unconformity surfaces and stratigraphic nomenclature associated to them. Chapter 12 presents a synthesis of map interpretation and how to present the results of the analysis in a report (references to report writing are given at the end of the chapter).

The book, although well presented, does have shortcomings in that in the reviewer's opinion it never quite tackles the fourth dimension. The timing and sequencing of geological events is not sufficiently emphasized—for example in Chapter 12 the construction of synoptic progressive evolution diagrams for the development of the geological history of an area is not given emphasis. The book