

some event. To call such an age 'absolute' is a bit strong since it is always dependent on model assumptions, but I suppose that it is the way such ages are known by the intended readership. This readership could be large indeed because this book is certainly not just for the specialist but for all those who need a quick introduction in dating methods. The book covers some 80 different dating methods from the commonly used, such as Rb/Sr, Sm/Nd, K/Ar and ^{14}C , to the esoteric and the obsolete. The scope includes the traditional geological applications depending on half-lives from millions to billions of years and the archaeological and palaeoclimatological ones depending on half-lives of thousands of years. Environmental research employing the short half-lives of only tens of years of both cosmogenic and man-made nuclides are also covered. Various dating methods based on the effects of radiation such as fission track, thermoluminescence and electron spin resonances are also covered, as are chemical dating methods based on more or less constant reaction rates such as amino-acid racemisation and the highly fashionable DNA clocks based on nucleotide substitution in mitochondrial DNA. Least 'absolute' are the methods based on variations in $\delta^{18}\text{O}$ and $^{87}\text{Sr}/^{86}\text{Sr}$ with a few well-defined time markers. Arguably the 'most' absolute methods such as counting varves, tree-rings or growth-zones in corals or molluscs are only mentioned indirectly.

Treatment is highly structured in a more or less standard way which makes finding information fairly easy. Most topics include sections on age range and precision, the nature and required amount of sample and its pre-treatment, the basic concepts and the analytical techniques, scope and limitations and non-chronological applications. Clearly only limited detail can be given on each method but the basic coverage is sufficient to give non-specialists the background information that is usually left out of geochronological papers in geological journals.

There are over 50 pages with nearly 2000 references which always include the first proposal of a method and subsequent major advances; the latest references are up to 1989. A 22 page glossary and a comprehensive index further improve the accessibility for the non-specialist. The analytical section deals with standard mass-spectrometry and activity counting techniques and also laser resonance ionisation and accelerator mass spectrometry which are practised in only a handful of laboratories world-wide; there are also some useful hints on sample collection, packing and storing!

The book has some characteristics of a vade-

mecum although my soft-bound copy may not have the durability for such use. Typographically, the layout is clear, paragraph numbers and fonts make for easy searching and only in a few figures is the finest ornamentation a bit faded. The German origin of the book is evident from the names in some figures but the text translation is excellent with very few 'germanisms' or incorrect jargon. The same is not true for typo's which occur at a rate of one per page in some chapters.

This truly compendious book belongs on the shelves of every scientist who practises dating but is, like me, not *aux fait* with the whole scope of dating methods. It is certainly a good buy for libraries in earth and environmental sciences and archaeology departments.

P. VAN CALSTEREN

Harris, D. P. *Mineral Exploration Decisions: a Guide to Economic Analysis and Modeling*. Chichester and New York (John Wiley and Sons), 1990. xviii + 436 pp. Price £59.00.

Mineral exploration is a risk business and practitioners earn their daily bread by answering questions such as . . . Should we risk the cost of another drillhole? Where is it best located? Will the resulting new data contribute critically to a decision to stop or go? Or . . . What are my chances within budget of finding more deposits within this mineralised region or geological environment? Big or small? Potential profitable producers or technical successes only?

This 418 page text demonstrates how such management decisions can be enhanced by disciplined and professional use of economic analysis and modelling. It is for digestion by specialist mineral economists, who will find a text based on theory throughout, with liberal doses of mathematics. But it is also for tasting by those many practical but perhaps less numerate explorationists who seek in one handy volume an appreciation of the capabilities and limitations of the growing discipline of economic analysis and modelling.

Two introductory chapters and a final 5 page Summary chapter—that is the one to read first for the flavour—are linked through 12 chapters devoted to statistical methods. Best practice in geology and exploration technology is assumed, and the author deals with topics such as 'geoprobability models' and economic filters, methods of accounting for the risk of loss due to exploration failure, Monte Carlo computer simulations, fre-

quency distribution patterns and models, search theory, Bayesian statistical decision theory, with a brief excursion into geostatistical methods.

The author has backed up explanatory theory and comment with 19 illustrative case studies (some 60% of the text) taken from the literature and professional reports and studies between 1957 and 1988. These range from Allais' classical study (1957) of the economic feasibility of mineral exploration of the Sahara, through various oil plays and metallic mineral exploration cases, to a demonstration of the mathematical methodologies involved in a most detailed simulation (Harris and Ortiz-Vertiz, 1981) of roll-front sandstone uranium deposits, exploration procedures, and modelling of development and mining operations and costs, with consideration at all stages of economic factors and risks.

The contribution of economic analysis to the overall efficiency of the exploration process is optimised in situations where the objective of exploration is cost-effective extension of known mineralised environments, blessed by a rich data base. This point is demonstrated by nearly 75% of the case study material referring to oil, porphyry copper and sandstone uranium deposits. Enthusiasm for guidance by statistical analysis may, by contrast, be unwelcome in situations where greenfield discovery could be impeded by the cold touch of unimaginative statistics and economics. Some exploration managers guard against imposing on talented explorers those constraints that may stifle such qualities as flair, enthusiasm and geological inspiration that lead to discovery of the unexpected—cases where no model exists until the new find is made—for example Boddington and Olympic Dam. Like other exploration tools, economic analysis and modelling may be used or abused, and its proper application should be understood.

The book is well presented, with few typographic errors, clear diagrams (nearly all reproduced from earlier sources) and with ample help around the text from a 9 page index, many sub-titles in the text, a catalogue of Contents covering 7 pages, and a useful if not comprehensive 7 page reference list of the subject matter.

This volume will be very useful in libraries of specialist teaching and professional institutions and exploration companies, but not many individuals will wish to spend £59 for material that is, by and large, already available in the literature.

G. R. DAVIS

Dunham, K. C. *Geology of the Northern Pennine orefield—Volume 1. Tyne to Stainmore*, London (British Geological Survey), 1990. x + 300 pp., 10 plates, 46 figs. Price £32.00.

This volume describes the geology of the important carbonate-hosted lead/zinc deposits in the North Pennines district of Northern England. It is the second edition of the original 1948 publication and contains a large amount of additional information which has been derived during the last 40 years, much of it from the continued mining activity.

The first part of the text includes descriptions of the mining history, regional geology (of the granite, the host Carboniferous sediments, and the Whin Sill) and the regional structure. Then there follows a general description of the mineral deposits, including the primary and secondary mineralogy, paragenesis and zoning, wallrock alteration, age, and genesis. The second (and major) part is devoted to detailed descriptions of the individual deposits in the orefield, and includes numerous maps and sections.

The most valuable aspect of this publication is the presence of several diagrams showing the form of the ore 'shoots' and the structural and lithological controls to the mineralisation. Unfortunately, thoughtless binding means that some of the diagrams cannot be viewed fully, and this has marred their otherwise high quality and value.

The style of the text is rather ponderous and does not make for easy reading. In addition, some of the editing could have been better. A cursory glance through the reference list revealed several mistakes—including misspelling the names of BGS personnel! Most of the text is however informative, although the part which deals with the genesis of the deposits does appear rather dated. For instance the mineralisation is thought to be due to aqueous solutions as 'melts of the minerals could not exist within the introduced mineral suite'. Similarly, there is a discussion on whether saline brines necessarily point to a source from granites. Such discussions are unnecessary; it would have been much better to include some comparisons with similar deposits worldwide and make reference to recent conclusions concerning their genesis.

As a reference work for the location, form, geological setting and characteristics of these deposits, this is an excellent publication. Researchers involved in the North Pennines district or carbonate-hosted Pb-Zn-F-Ba deposits in general, will find it useful for this. However, it says little about their status as