constant orientation of the internal S_i of some garnets across tens of cm even with a completely re-made S_e. This is a good teaching book, greatly improved by revision, and strongly recommended.

B. E. LEAKE

Parnell, J. (Ed.). *Dating and Duration of Fluid Flow and Fluid-Rock Interaction*. London (Geological Society Special Publication 144). 1998. vi+284 pp. Price £69.00. ISBN 1-86239-019-3.

In 1997, the Geofluids conference in Belfast included an international seminar entitled 'Dating of Fluid Flow'. This volume contains 18 papers from that seminar, and an overview by the editor. There are five sections: (1) Specific techniques for dating of fluids and fluid flow (five papers); (2) Isotope techniques for dating of fluid flow (four papers); (3) Case studies assessing timing of fluid flow events (four papers); (4) Timing, duration and speed of oil migration (three papers); (5) Dating of Quaternary fluid flow events (two papers).

Within this overall structure, there is a limited number of review papers; most contributors appear to have used the seminar as an opportunity to update presentations of their research. Consequently there are substantial summaries of data, often tabulated and so suitable for creative use by the reader.

Specific techniques addressed by the first five papers include palaeomagnetism, apatite fission track dating, helium isotopes and fluid inclusions. Elmore *et al.* and Symons *et al.*, respectively present detailed palaeomagnetic data for hydothermally altered rocks from the Arbuckle Mountains, S. Oklahoma, and for MVT deposits, Viburnum Trend, SE Missouri, supported by substantial bibliographies. Similarly, indirect evidence for timing of fluid–rock interaction is considered for apatite fission track dating coupled with vitrinite reflectance data and thermal histories in general terms and for three case studies: west of Shetland, an unspecified well somewhere in Asia and for NW Australia (Duddy *et al.*). This papers focuses on the identification of anomalies attributable to the influx of fluids hotter than the geotherm. Pinti and Marty give a detailed review of the use of helium and noble gas isotopes in dating very old groundwaters (104–107 years), giving copious data for the Paris Basin. Finally, Wilkinson *et al.* present fluid inclusion data for Brent Group reservoir sandstones from the Columba Terrace, northern North Sea, constraining the timing of quartz overgrowths by reference to regional burial histories.

Isotopic methods of dating are addressed specifically by Zwingmann *et al.*, who use K-Ar dating of 'hydrothermal' illite to determine the timing of fluid flow in Rotliegend reservoir sandstones. Abundant data are provided, and relationships between K-Ar results and illite morphology are discussed. Spötl *et al.* use ^{40}Ar-^{39}Ar techiques to date authigenic K-feldspars from veins in Permian carbonates from the Austrian Alps. Data for $\delta^{18}O$ and Rb/Sr isotope ratios are also given, together with feldspar compositions (microprobe), which are critically interpreted to identify some of the limitations of the use of feldspars as well as their evident potential. In a very brief paper, Wayne and McCaig use Rb-Sr and U-Pb data for separated minerals to date shear zones in the Néouvielle Massif, central Pyrenees. Importantly, the lack of isotopic equilibrium for both systems is described. Moving back to MVT ore deposits, Walshaw and Menuge review the use of Rb-Sr techniques to date sphalerite, providing data for deposits from the Mississippi Valley, Pine Point, Polaris and the Lennard Shelf. Again, the limitations of the technique are addressed, and summary data from other sources are presented.

There are four case studies. Pagel *et al.* describe the results of a multidisciplinary study of the Ardèche passive margin (SE Massif Central). Summary data are presented for fluid inclusions, apatite fission track analysis, vitrinite reflectance, Rock-Eval pyrolysis and stable and radiogenic isotope studies, together with a thermal history. Hollis addresses the timing of fluid expulsion and migration associated with the formation of the South Pennine Orefield, using fluid inclusion data, mineral parageneses and burial histories. Morris and Nesbitt provide substantial geological information concerning fluid-rock interaction in the MacKenzie Mountains, Northwest Territories, with stable isotope data for C, O and H presented in summary form. Qing then provides a focused study of the Presqu'ile reef (Pine Point), with stable isotope data of O and C, some $^{87}Sr/^{86}Sr$ data and some summary fluid inclusion data (T_h), acknowledging the difficulties involved in estimating an age for the Pine Point mineral deposits.

The problem of timing petroleum migration is addressed by Lisk *et al.*, who describe fluid inclusion work on the Australian NW Shelf,

specifically considering the importance of quartz and feldspar grains containing oil inclusions. Abundant fluid inclusion data are presented in summary form, together with the geological information necessary for their interpretation. Carruthers and Ringrose present a model for the flow of oil in porous media in the context of secondary migration, modelling trajectories and the consequent proportion of oil-rock contact, on a centimetre scale. Secondary migration on a basinal scale is modelled in the next paper, by Sylta *et al.* Attractive colour prints from the model are given but one has to read the fine print of the text to realise that these describe areas of 10s of km^2.

Quaternary dating problems are addressed in two papers. Metcalfe *et al.* give a review of the methods used to date groundwater flow events, drawing on their experience with characterisation of Quaternary deposits in the context of radioactive waste management. This substantial critical review emphasises the importance of mineralogical observations such as the characteristic morphology of calcite cements. Finally, Fukuchi and Imai use ESR isochron dating to identify the first movement of the Nojima Fault, last active in 1995. ICP-MS data are given for clays from fault gouge, but do not really contribute to the task in hand, and the authors interestingly allude to formation of clays deep in the Earth's crust as a phenomenon associated with earthquake activity.

As with all symposia volumes, this book contains some gems and other papers which are less appealing, and identification of these will vary from reader to reader. It is quite clear that the bulk of dating methods are indirect, and depend very much on geological as well as geochemical or mineralogical information. This book is useful for those working on the problem of "when did it happen?", as a summary of the available approaches and by providing examples of how data from many sources can be integrated. Appealing mainly to postgraduates and professional researchers, this is a book for the library, and perhaps for the personal bookshelves of the specialist.

D. A. C. MANNING

Holtstam, D. and Langhof, J., (Eds). *Långban: the Mines, their Minerals, Geology and Explorers.* Raster Förlag, Swedish Museum of Natural History, Stockholm, 1999. 215 pp Skr 450 (400 for direct purchase), approx. £34. ISBN 91-87214-881.

The Fe-Mn deposit of Långban, in Värmland, Sweden, is one of the half-dozen most productive mineral localities in the world. About 270 mineral species have been described from Långban; it is the type locality for 67 of these and 23 occur nowhere else. The dust jacket of this book features a beautiful hexagonal prism of the eponymous mineral långbanite, a member of a distinctive chemical class of Långban minerals, the Mn-Sb oxide silicates. A monograph on this complex locality has been long awaited, and the authors, editors, and publishers of this book are commended on addressing this need with such style. The book is robustly bound, printed on stout high-grade paper, and lavishly illustrated with beautiful diagrams and photographs. The quality of the mineral micrographs, in particular, is superb. The text is lively and reasonably up-to-date, with only a few trivial typographic errors. Above all, the price is extremely reasonable for a book of this quality.

Långban is organized into a foreword, introduction by the editors, seven main chapters, bibliography and appendices. In the inspiring foreword, Paul Moore compares Långban with other localities such as Franklin and Tsumeb, muses on the relationship between crystal chemistry and paragenetic conditions, and spotlights areas for future research. The editors' short introduction then explains the context in which the book was planned and written.

Ingmar Lundström's chapter on 'Geology of the Bergslagen ore region' provides an invaluable account of the regional stratigraphy and tectonic and intrusive history. 'Geology of the Långban deposit' (Frej Sandström and Dan Holtstam) focuses on the immediate setting of the mines and the paragenetic sequence in the skarns. This chapter is followed by Bengt Bollmark's 'Some aspects of the origin of the deposit', a complementary account with a more geochemical bias. This chapter presents interesting major and minor element analyses for nine bulk rock types, which are, alas, the only analyses in the book. Attention then shifts from the Proterozoic to the Quaternary with 'Långban's mining history' (Jörgen Langhof and Thomas Österberg) and 'Mineralogists and collectors' (Langhof). The individual case histories are fascinating, especially that of the remarkable Gustaf Flink (1849–1932), whose collection of 'unknowns' is still providing species new to science.

The stage thus set, the main act follows: the 95 pages of 'The Långban minerals' by Per Nysten,