recent work on the Lu–Hf, La–Ce, La–Ba and K–Ca systems is covered in Chapter 9 (20 pp). The next chapter (32 pp) covers K–Ar and Ar–Ar dating and includes the recent applications of laser ablation microprobe studies to the ^{40}Ar–^{39}Ar method. Chapter 10 (28 pp) follows on by covering the application of the inert gases (He, Ar, Xe and Ne) as isotopic tracers, in particular to studies involving the degassing of the Earth.

The next two chapters show how secular disequilibrium between the short-lived isotopes of the uranium decay series can be applied to dating young sediments (25 pp) and to the elucidation of the timescales of mantle melting and magma chamber evolution (29 pp). In Chapter 14 (36 pp), work on the cosmogenic nuclides ^{14}C, ^{10}Be, ^{36}Cl, ^{129}Xe and ^{26}Al is reviewed with wide-ranging examples including environmental geoscience appplications. Extinct radionuclides (^{129}I, ^{244}Pu, ^{26}Al, ^{107}Pd, ^{53}Mn, ^{60}Fe, ^{247}Cm, ^{41}Ca) are briefly dealt with in Chapter 15 in the context of the primaeval nature and early development of the solar system. The final chapter (23 pp) covers the experimental techniques of fission-track dating with applications chosen from tectonic uplift and subsidence rate studies.

Overall, the book is clearly written and contains abundant information with numerous clear figures. The treatment of analytical strategies gives a useful insight for the non-specialist, while the approach of providing wide-ranging case histories gives a clear picture of the importance of isotope geochemistry in Earth Sciences research areas varying from processes of Earth formation to mantle–crust–hydrosphere–atmosphere evolution and, more recently, to topics of environmental interest. Researchers and advanced undergraduate students alike will find it a useful compendium of information which, together with texts such as Faure's *Principles of Isotope Geology*, provide a comprehensive coverage of the systematics and applications of isotope geochemistry in geosciences research. C.M.B. HENDERSON

Coleman, R. G. and Wang, X. (eds) *Ultrahigh Pressure Metamorphism.* Cambridge Topics in Petrology, CUP, 1995, ISBN 0 521 43214 6, x + 528 pp. Price £55.00, US$79.95.

The expression UHPM (Ultrahigh Pressure Metamorphism) was born about 10 years ago and is now widely used, though not always in precisely the same sense. The editors of this book use UHPM to mean "a metamorphic process that occurs at pressure greater than ~28 kbar (the minimum pressure required for the formation of coesite at ~700°C)". This is essentially equivalent to the 'coesite-eclogite (sub)facies' defined as those parageneses corresponding to the P–T stability field of coesite, in contrast to the 'quartz-eclogite (sub)facies' applicable at lower pressure, as introduced by the present author in 1985.

Stable coesite is obviously a diagnostic mineral for UHPM in rocks containing free SiO_2, but above some 300°C stable diamond is also a diagnostic mineral in rocks containing free C, but here graphite can also be stable with coesite in the lower pressure part of the UHPM P–T field. Of course several other single minerals can be stable only under UHPM conditions, as is the case of innumerable specific combinations of minerals such that one can justifiably contemplate UHPM conditions without any trace of coesite or diamond. Nevertheless these two minerals carry a certain aureole of glamour which incites petrologists to eagerly hunt for them. Since their grain sizes are normally microscopic — indeed one often writes about microcoesite or microdiamond — they fortunately present no interest to the gemmological trade or to amateurs so that there is little risk of important scientific occurrences being destroyed for commercial reasons except when they occur in particularly beautiful eclogites.

The editors, who include a highly-respected forefather of 'modern' research into eclogites in the early 1960s and a representative of the new school of better-equipped younger researchers, created this high-standard multi-author book in order to provide in one volume an overview of recent knowledge about UHPM. In effect this topic has become a new discipline in the Earth Sciences since such high pressures in previous crustal rocks were not conceived in the 'classic' 1960s vintage texts on metamorphism, for example those of Barth, Miyashiro, Turner, Winkler, and Pitcher and Flinn. The authors chose, for detailed description in one chapter each, the four areas for which most data are available and which correspond historically to the first-known definite UHPM areas: W. Italy (Chap. 7 by R. Compagnoni, T. Hirajima and C. Chopin), S.W. Norway (Chap. 9 by D.C. Smith), E. China (Chap. 10 by X. Wang, R. Zhang and J.G. Liou) and N. Kazakhstan (Chap. 12 by V.S. Shatsky, N.V. Sobolev and M.A. Vavilov). Subsequently-reported localities of definite or deduced UHPM such as Kirghizstan, Poland, Togo and the German/Czech border receive only scant attention, which is regrettable. Even if there is insufficient data available here to produce one review chapter per locality, it would have been useful if someone had been invited to present a combined review of these 'other' localities.

Garnet can occur stably in peridotites at pressures several kilobars lower than those necessary for stable coesite. However, in many world-wide occurrences of peridotite massifs enclosed within crustal rocks,

variably called 'Alpine-type peridotites', 'orogenic peridotites', 'diamondiferous ophiolites', etc. UHPM conditions have been deduced with P as high as 40, 50 or even 60 kbar. In this book, unfortunately, only Morocco and Spain (Chap. 13 by D.G. Pearson, G.R. Davies and P.H. Nixon) and Norway (Chap. 8 by E.J. Krogh and D.A. Carswell) receive detailed treatment. The latter chapter is, however, predominated by a review of non-UHPM eclogites in the Scandinavian Caledonides; although undoubtedly an interesting half-chapter, one can honestly ask why it figures in this book.

The above-mentioned chapters, principally devoted to specific regions, are accompanied by some useful thematic chapters dealing with subjects of general interest. Thus, in addition to an overview (Chap. 1 by R.G. Coleman and X. Wang), experimental/thermodynamical/paragenetical aspects are dealt with by H.-J. Massonne (Chap. 2). C. Chopin and N.V. Sobolev (Chap. 3) summarize a series of mineralogical indicators of UHPM. A. Michard, C. Henry and C. Chopin (Chap. 4) review structures in UHPM rocks.

Of course the logical objective of any petrographical/petrogenetical study is to try to fit the origin of the rocks concerned into an appropriate geodynamical context. Not surprisingly, the Plate Tectonic Theory was seized by most eclogitologists as an ideal way for creating first eclogite and then UHPM parageneses by subduction to ever-increasing depths of crustal material from one plate under another plate, in particular by continental collision. However, the subsequent exhumation and preservation of thoroughly metastable relict UHPM mineral assemblages creates problems which are difficult, if not impossible, to solve in the context of presently-accepted geodynamical models. Three chapters discuss these aspects: B.R. Hacker and S.M. Peacock in general (Chap. 5); M.C. Blake, D.E. Moore and A.S. Sayko with special reference to the Western Alps (Chap. 6) and E.A. Eide with special emphasis on Eastern China (Chap. 11).

One of the greatest challenges to today's scientific research in the Earth Sciences as a whole, and not just concerning metamorphic rocks, is to satisfactorily solve the overall geodynamical problem of the creation, exhumation and preservation of UHPM terranes; the solution will undoubtedly have significant repercussions for the geodynamics of igneous and sedimentary rocks. It is often stated, including in this book, that no single model can be applied to all UHPM terranes. This is certainly the case, but the present writer has often declared his opinion (1985, 1993) that no single model yet applies satisfactorily to any terrane and that the solution to this intriguing problem may not come from adjusting existing inadequate models but from a future revolutionary approach which, by definition, is quite unknown and unpredictable, and hence towards which future research cannot be aimed. It is thus important that researchers learn to think in other directions, in particular sideways into other disciplines where new clues might be found, whilst maintaining a forward effort in the ever-deepening description and analysis of old and new localities of UHPM, especially of their micro-minerals and micro- to mega-structures.

This book provides a solid base for anyone pursuing these courses, in particular new students and young researchers; established UHPM researchers will no doubt have already acquired this well-written book which will, no doubt, soon become a standard text. As for libraries, this is the third book devoted to eclogites (following *Eclogites and Eclogite-Facies Rocks* [ed. D.C. Smith, Elsevier, 1988], and *Eclogite Facies Rocks* [ed. D.A. Carswell, Blackie, 1990] and it should rapidly join its two elder brothers on the bookshelves. D.C. SMITH

Bender, F. K. and Raza, H. A., eds. *Geology of Pakistan*. Stuttgart (E. Schweizerbart'sche Verlagsbuchhandlung: Nagele u. Obermiller), 1995. x + 414 pp, 3 coloured maps (1:500 000). Price DM 248.00 (US$ 178.00). ISBN 3 443 11025 8.

The *Geology of Pakistan* is a monograph covering the overall geology (chapters on sedimentary sequences, igneous and metamorphic rocks, tectonics and structure, palaeogeographic and dynamic evolution) and energy resources and raw materials of the country. The latter section includes chapters on hydrocarbons, coal, nuclear fuels and geothermal energy, metallic and non-metallic raw materials, water and soils. The approach is a basic descriptive one, with little discussion of geological processes, kinematics or dynamics. Pakistan contains some of the most spectacular geology in the world with the unique and beautiful mountains of the Karakoram and Hindu Kush. It contains probably the world's best exposed section through a deeply eroded arc complex (Kohistan), the world's fastest and youngest exhuming partially melted crust (Nanga Parbat), and the deep erosion and high uplift of the Karakoram range has unlocked many of the secrets of processes of crustal thickening, melting and exhumation. However, none of these processes are discussed and the text often reads like a bland shopping list. Although it is undoubtedly a source of much information on Pakistan, there is none of the excitement of new tectonics, dynamics and kinematics of the Himalaya–Karakoram mountain ranges. References seem to be largely pre-1990, which is a pity because so much excellent new work has come