Renner in Chapter 3. They describe evidence indicating that UHP rocks appear to have undergone little deformation requiring a high degree of strain partitioning. However, shear zones have not yet been identified in these rocks. The suggested low strength of UHP rocks is interpreted to be due to the presence of fluid released by metamorphic reactions or by small amounts of melt which wets grain boundaries.

In Chapter 4 Davies and von Blackenburg discuss the theory of thermal controls on slab breakoff and make comparisons between modern and Archaean environments. The differences between old, cold, thick slab and thinner, hotter, younger crust subduction are examined. This theme is followed by Grasemann *et al.* who discuss the exhumation of UHP rocks in Chapter 5. The different shapes of *P-T-t* paths are explained by using an exhumation rate of ~5 mm/yr and argue that the two-stage cooling proposed for some occurrences could be the result of a constant rate of exhumation. Chapter 6 by Blythe presents a comparison of the uplift and exhumation rates observed in active orogenic zones with the theoretical rates required for the preservation of UHP assemblages. It is found that few modern environments produce the >10 mm/yr rate theoretically required for preservation. The conclusions are that exhumation of these rocks might be possible at rates <10 mm/yr and researchers are urged to find alternative explanations.

The $^{40}Ar/^{39}Ar$ geochronology of UHP assemblages, which so far has proven rather difficult, is examined in Chapter 7 by Scaillet. Using the western Alps it is shown that by careful choice of samples and the path by which peak conditions were obtained, the excess Ar problem can be overcome and a sensible interpretation reached. Other geochemical and isotopic characteristics of the Dabie Shan UHP and associated ultramafic rocks are presented by Jahn in Chapter 8. The results show that the types I and II eclogites are of basaltic chemistry with a Precambrian signature. The case is presented that the rocks were not Thethyan oceanic crust. Type III eclogites are related to the ultramafic rocks which were mantle-derived.

In Chapter 9, which could easily have been the first in the book, Rumble asks the fundamental question "were the protoliths of UHP rocks ever at the surface?". He shows conclusively that the answer is "yes", and that the rocks have participated in near-surface processes. Using the Chinese rocks at Dabie Shan he describes some of the very low $\delta^{18}O$ values as "shocking" and sets about investigating the nature of this negative signature. Chapter 10 by Tabata *et al.* also describes aspects of the Dabie Shan rocks. Zircons can provide resistant time capsules regarding inclusions and they may preserve UHP minerals. This concept is tested here and it is found that in totally retrogressed areas, UHP inclusions are still present in some of the zircons. The original extent of the UHP rock was clearly much greater. From this work the size of the crustal slab that was subject to UHP conditions is shown to be much larger than previously thought. This obviously has consequences for modelling.

Fluids during metamorphism are obviously important in controlling the results and the final two chapters address this aspect. In Chapter 11 Ernst *et al.* look at the theory of water recycling during collision and discuss consequences for phase-equilibrium and kinetics. Austrheim describes convincing field evidence for the importance of fluid ingress and the controls on development of eclogitic and UHP assemblages in Chapter 12. Examples from several of the main occurrences are discussed using several different starting protoliths. The implications are explored regarding crustal thickening, the timing of fluid influx and the possible source of the fluid, as well as both prograde and retrograde effects.

Even accepting that UHP rocks are a specialist subject, the volume is not cheap and there are a couple of points that are disappointing. First, reproduction of many of the figures is poor which, given modern computer techniques, is surprising. Second, there is a loose erratum sheet, which only applies to one chapter and does not cover the typographical errors in others. Given the rate at which discoveries are being made and the subject is advancing, with all the implications for the validity of the models proposed, some may query if it represents good value. However, as a summary of our present knowledge of these incredible rocks the book currently stands alone and should be in the library available to researchers.

C. R. L. FRIEND

Papike, J.J. (Ed.) *Planetary Materials*. Washington (Mineralogical Society of America, Reviews in Mineralogy, Vol. **36**), xvi + 1059 pp. US $40. ISBN 0-93950-46-4

I am not quite sure where to begin in reviewing this book, just as I was not quite sure where to

begin reading it and so ended up simply dipping in to it. The publication is one of the most comprehensive tomes on planetary materials that has been published, certainly in recent years, possibly ever. It consists of chapters on each of the main types of planetary material available for study: interplanetary dust particles, chondritic meteorites, non-chondritic meteorites and lunar materials, plus a shorter chapter devoted to Martian meteorites. Each chapter has been written by a different set of authors, is individually paginated and concludes with its own set of references, the whole being brought together in a splendid set of indexes.

The short introductory chapter (28 pages) by C.K. Shearer *et al.* takes an overview of planetary samples, with broad descriptions of the different sample suites from the Moon, Mars, the asteroid belt and interplanetary space. The relative abundance of material from the parent object(s) of each sample type is given, along with a condensed review of the physical, chemical and isotopic properties of the parent bodies, thus allowing definition of the reservoirs from which the planetary materials have been derived.

Chapter 2 (95 pages) by Frans Rietmeijer covers interplanetary dust particles, and starts with a review of the origins and formation of stratospheric dust, and a summary of the work carried out on IDPs prior to 1982, when the NASA Cosmic Dust Program started its regular series of stratospheric collection trips. The main body of the chapter is a thorough discussion of the chemistry and mineralogy and petrology of stratospheric dust particles, with important sections on classification, modification during space exposure and atmospheric entry, and physical properties. However, even though the chapter is entitled 'Interplanetary Dust Particles', it covers only one set of particles, those collected in the stratosphere, and completely omits mention of deep sea cosmic spherules and Antarctic micrometeorites. This is a serious omission in an otherwise excellent compilation.

Chapter 3, on chondritic meteorites, by Adrian Brearley and Rhian Jones, is a blockbuster effort at synthesizing everything we know about chondrites into a manageable length. At 398 pages long, the chapter is a book in itself. It starts with a brief overview of chondrite formation and classification, ages and compositions, before continuing with in-depth sections on the different components that make up chondrites: chondrules, CAIs, matrix, opaque minerals and interstellar grains. The importance of distinguishing between primary, secondary and tertiary effects is emphasised with a final section on shock metamorphism. The chapter is comprehensive as far as the mineralogy and petrology of chondritic meteorites is concerned, but its treatment of chondritic components as individual components, rather than parts of a whole, might have benefited from a final section relating the different components to each other in terms of the timescale of chondritic formation, and subsequent processing experienced by the meteorites. Very little discussion of oxygen isotopic composition is included, which is surprising given its importance both for chondritic classification and in the comprehension of primary and secondary effects in meteorites.

Chapter 4, on non-chondritic meteorites from asteroidal bodies, by David Mittlefehldt and colleagues, covers a huge amount of ground in its 195 pages. Each section of the chapter covers a specific parent object, or group of objects, and follows a similar structure, discussing the chemistry, mineralogy and petrology of the relevant meteorites. One strength of the chapter is the links that are made between the groups when discussing petrogenetic assemblages and the genesis of the meteorites.

Chapter 5 comes closest to home, with a review of lunar samples by James Papike *et al.* (234 pp.). After an introduction covering lunar sampling sites, the chapter continues with descriptions of the regolith, and the petrology of lunar soils and agglutinates. This section is followed by one on lunar minerals, then continues with the mare basalts and highland rocks. Not surprisingly, discussions of minor and trace element data form a large part of the chapter.

The penultimate chapter, by Harry McSween and Allan Treiman, covers martian meteorites (53 pp.). In addition to descriptions of the mineralogy and petrology of the martian meteorites, the chapter includes valuable sections on the petrogenesis of the rocks, their inter-relationships and relationship to the martian surface. There is a section answering the question that is always asked whenever martian meteorites are discussed – "How do you know they are from Mars?", and a whole segment on ALH 84001 that manages not to mention microfossils.

A final short (11 pp.) chapter by James Papike on the chemistry of olivine, pyroxene and feldspar draws the volume to a close, the purpose of the chapter being an intercomparison between the

chemistry of melts from different planetary environments. The main conclusion of this chapter, that silicate minerals are recorders of the geochemical and petrological processes on their parent bodies, will come as little surprise to geochemists and petrologists. The summary highlights the regular fractionation trends between the Earth, Moon, Mars and asteroid 4 Vesta that reflect nebular accretion location and variable core formation.

Overall, this is an excellent book that is going to be a valuable resource for meteoriticists and planetary scientists for at least the next decade. It provides a wealth of information and data; the appendices to each chapter containing representative analyses of specific planetary materials will be particularly useful. The layout, content, diagrams, references and indexes are first-rate. I have two complaints, one which is technical, the other scientific. First, reproduction of SEM and thin section images is poor, presumably a reflection of the production mechanism rather than the authors. But the authors must take responsibility for my second complaint: even though (as stated in the introduction) the text aims primarily at "a comprehensive coverage of the mineralogy and petrology of planetary materials", too little space was dedicated to discussion of the wider issues concerning planetary materials. I am thinking specifically of more process-oriented discussion, focusing on formation histories, chronology and alteration. Isotope chemistry, particularly noble gas geochemistry was sadly underrated.

Having said this, as soon as I received the book to review, I ordered a further two copies, one for home and one for my office, so that I will always have the volume to hand! I recommend this text to meteoriticists and planetary scientists, and congratulate the authors and the editor on their efforts in producing the book. M. M. GRADY

Aleksandrov, S.M. *Geochemistry of Skarn and Ore Formation in Dolomites.* Utrecht (VSP) 1998, x + 300 pp. Price DM 248 / US $148 / Sterling £98. ISBN 90-6764-281-9

This book provides a summary of the author's research into metasomatism and ore formation in magnesian skarns carried out over the last 30 years. The book is divided into several sections. The first two chapters deal with the formation of zoned skarns at the magmatic stage, reviewing primary skarn formation and the contact metamorphism of marbles, the influence of intrusion composition on skarn composition, and the influence of the primary skarn composition and zonation on later stages of alteration and mineralization. The second section (Chapters 3, 4 and 5) reviews the effects of post-magmatic metasomatism and ore formation in skarns. The chapters dealing with ore formation review both oxide and sulphide deposits, and focuses particularly on mineralogical aspects of skarn-related tin and boron deposits. Part three deals with the hypergene modification of skarn deposits, whilst part four reviews stable isotope and experimental studies of skarn mineralization. The final section addresses the application of mineralogical and geochemical data in prospecting for, and appraising, magnesian skarn related ore deposits.

The book contains many descriptions of Russian skarn related deposits that may be new to the western reader, and provides reviews of many details of the mineralogy of boron, tin and other elements in skarn environments which may not be available elsewhere. It also covers the basic description, classification, formation and modification of zoned skarns at the magmatic and post-magmatic stages. This work is extended to examine hypergene alteration. Coupled with details of experimental studies into the formation and stability of Sn and B minerals, and detailed discussions of their mineralogy, this means that the book may be of interest to many other researchers working in this field and have some value as a reference text.

However, both the preface and the publisher's sales publicity describe the book as a fundamental investigation into skarn and ore formation. As such one would expect it to include, under the above headings, reviews of many aspects of skarn formation including fluid chemistry, thermodynamics, fluid flow, and flow and reaction modelling, isotope geochemistry, mineralogy and ore formation. On many of these counts the book is disappointing, being largely descriptive in nature. Equally it is difficult to extract information from some sections due to the dense and convoluted grammatical style.

Many areas are inadequately referenced, either omitting mention of other work, or concentrating only on a specific subset of the Russian literature. One notable example is the brief section on boron isotopes, which makes no reference to the work of any other author. Other areas are almost reverential in their reference to the work of