most idiosyncratic contribution in which an analogy is drawn between the development of individual oceanic island volcanoes, and the growth of oceanic plates. The same authors also speculate that some ophiolite complexes in Kamchatka represent abducted remnants of the Hawaiian–Emperor volcanic chain, where its northward extension appears to have been involved in subduction. (M.A. 93M/1073–1090)

Minor quibbles include the poor quality of the field photographs in an otherwise excellent account of the Josephine ophiolite; the lack of any diagrams in the valuable review article on the volcano-tectonic setting of oceanic lithosphere generation; and the frequent perpetuation of the unfortunate term 'sheeted dykes'—a tautology if ever there was one.

Overall, this compilation provides a stimulating basis for further research, and if it adds up to slightly less than the sum of its parts, this is surely a reflection of the current state of the ophiolite/oceanic crust debate, in which the detailed complications outweigh the overall simplicity of the concept.

W. J. WADSWORTH

Tossell, J. A. and Vaughan, D. J. *Theoretical Geochemistry: Applications of Quantum Mechanics in the Earth and Mineral Sciences.* Oxford (Oxford University Press), 1992. xiv + 514 pp. Price £60.00

This text by Tossell and Vaughan is outstanding and timely. At the beginning of this century, the applications of chemistry revolutionised the way in which we study the Earth and its constituent minerals. Today thanks to advances in supercomputing, we are in a position to apply more sophisticated aspects of chemistry to geology. This book provides the first major introduction and review of such advanced geochemical methods and shows how they can be applied to mineralogy.

After a brief introduction to the subject, the next eighty pages are dedicated to a discussion of the major advanced experimental methods which are used to measure the behaviour, properties and characteristics of solids. This includes a review of diffraction methods and of adsorption, vibration and nuclear spectroscopic techniques. There then follows a clearly and authoritatively written chapter on the basic theoretical methods used in quantum mechanics, including discussions of the Hartree-Fock method and density functional theory, which ends by bringing the reader to the forefront of research with a discussion of quantum molecular dynamics.

The three following chapters provide an outstanding review of the progress to date in the simulation and calculation of the properties of oxides, silicates and sulphides. The literature is well and fairly covered, and references to work done as recently as 1990 are included. Subsequently, progress on specific topics is reviewed, with fascinating discussions on, for example, the reinterpretation of Pauling's rules, the problems of studying the properties of the minerals of the Earth's deep interior, and of industrial minerals such as zeolites. A chapter on geochemical problems includes a discussion on the nature of melts and solutions, modelling of mineral surfaces, and the partitioning of elements.

For anybody interested in the way in which geochemistry will evolve in the 21st century, this book is essential reading. The authors are to be congratulated in producing a first-class contribution to literature.

R. J. PRICE

Butt, C. R. M. and Zeegers, H. (eds.). *Handbook of Exploration Geochemistry in Tropical and Subtropical Terrains.* Amsterdam (Elsevier Science Publishers), 1992. 630 pp. Price Dfl360.00 ($205.50).

Exploration geologists, to whom this Handbook is mainly directed, and who use geochemistry of surface and near-surface materials as one of their major ore-finding techniques will particularly welcome this large and comprehensive collection of data on the subject of the origin and interpretation of the regolith and its geochemistry in tropical and subtropical terrain. The regolith is incredibly complex and the interpretation of the results of mapping and geochemical surveys is often a frustrating experience. With climatic changes having superimposed different weathering products on older deposits the exercise in decoding the data is daunting. In addition it must also be remembered that the duricrust not only conceals ore bodies, but it also hosts them.

The message that this book delivers to all exploration geologists using geochemistry is quite clear. Prepare a regolith landform map and use it in the preparation of the sampling programme and in the interpretation of the results. If this is not done then the survey will be inadequate and most probably miss many of the important clues. If the authors' advice is followed then the chances of success will be greatly enhanced. How often do we hear of soil sample surveys being carried out with samples having been taken at a constant depth without any thought being given to the genetic significance that the samples have in the

overall regolith? This practical advice and numerous other simple but important statements are found throughout this volume.

The average exploration geologist urgently wants to find the next orebody as quickly and as efficiently as possible and, of course, ahead of the opposition. The geologist has to be sure that he has collected enough samples of the right kind as well as in the geologically meaningful sites. He also has to be familiar with the analytical methods available and be able to interpret even the most subtle geochemical results. This early phase of exploration is most critical as it is the guide for the expensive follow up drilling phase. Therefore the correct techniques have to be applied relevant to the expectations of the overall programme. Any help in establishing the correct procedure is most welcome.

The authors have produced a well integrated story and have addressed all these aspects adequately. They thoroughly discusss the overall duricrust in great detail and with abundant case histories of gold and base metals. They lay stress on the processes involved in the dispersion or concentration of metals in this environment. The interpretation of the geochemical data including a very adequate account relative to gossans is discussed in relation to the local weathering history. The graphs are generally clear and the abundant block diagrams I found particularly pleasing; they will be useful field guides, especially for the young geologists. A very substantial bibliography is included and the appendices will be frequently referred to.

Considerable emphasis has been placed on the practical aspect of exploration. This includes preparation of the exploration programme based on the logical considerations to be followed from a knowledge of the target area's weathering history and its present topography, to determination of sample locality and guidance in the selection of indicator elements and analytical methods suitable for the task involved. I thought that perhaps platinum considerations could have been given a section on its own rather than be distributed in several sections.

The chapter on diamond exploration and the accompanying summary was clear and concise and presented a simple to follow exploration guide, but I was surprised not to see any mention of the very rich Western Australian diamond mine at Argyle. My enquiries provided the answer that no geochemistry was undertaken as the exploration was based on heavy mineral sampling. I think that this is a major omission.

A few comments on the very large carbonatite at Mount Weld in Western Australia are relevant. Some of these comments are taken from a more recent reference (Duncan and Willett [M.A. 91M/4026]), than that used in the book. Mt Weld contains a particularly fine example of the development of a large *REE* orebody in the regolith and perhaps should have been given more stress. The concentrations of the two principal *REE* ore minerals, secondary monazite and churchite ($YPO_4 \cdot 2H_2O$), have reached very high amounts. The monazite in a number of one to two metre drill sections reaches over 40%, while the yttrium content of the main Y-rich zone is over 0.5% with very high *HREE*. Such concentrations of these minerals bear witness to the intensity of the chemical processes that can occur in the regolith. Regoliths or other carbonatites should be looked at carefully for churchite as it is a fibrous mineral and may be easily lost and go undetected in drilling fluid. The Table 111.3–4 has an error. The niobium reserve should read 273 Mt at 0.9% Nb_2O_5 at a cut off of 0.5%, while an additional reserve for the combined $LnO + Y_2O_3$ is 1.31 Mt at 23.6% grade using a cut off of 20.0%.

The chapter 'Summary and Procedural Recommendations' should be read first as it is a clear statement of the problem and how attempts to solve it may be understood, programmed, attacked and interpreted. For each of these sections the authors helpfully refer to the relevant detailed sections and stress the importance of understanding the development of the regolith if geochemical exploration is to have any chance of success.

This will be a useful reference work for many years as it fills a large gap in the literature. It will be not only of great use to geologists, but also to soil scientists, geomorphologists and environmental geochemists. While the price is not cheap there is plenty of value for money.

J. L. DANIELS

Ivanovich, M. and Harmon, R. S. (eds.). *Uranium-series Disequilibrium, 2nd edition.* Oxford (Clarendon Press) 1992. xxxiv + 910 pp. Price £110.00.

This timely second edition published ten years after the first is appropriately dedicated to John H. Rosholt—a pioneer in the field of uranium-series disequilibrium.

The field covered includes the physical, chemical and geological aspects of naturally occurring