

to igneous petrogenesis. This happens despite there being chapters on both topics – the integration of the modern techniques into the individual chapters is almost totally lacking. A reading of the 'Isotopic composition' chapter would leave a student with the totally incorrect concept that the main use of isotopes in igneous petrology is to yield the age of the rocks they are dealing with. The author largely avoids the concept of using isotopes as tracers to fingerprint petrogenetic processes and magma sources, and this is a serious flaw in the book.

The new edition had an opportunity to improve on this aspect, but in fact, only cosmetic changes have been made. A 'new' chapter on the 'Chemical composition of igneous rocks' turns out to be a re-write of the old chapter on trace elements, preceeded by 7 additional pages on major element composition and variation. Another 'new' chapter on 'Alkaline rocks' is likewise a concatenation of two old chapters, those on 'Trachytes and phonolites' and 'Nephelinites and carbonatites', but lacks a general introduction to the subject. Most of the major advances in isotope petrology, especially in the ^{10}Be , Lu–Hf and Re–Os systems, are ignored. Minor changes are evident elsewhere, for example in the chapter on 'Magmatic Differentiation' some diagrams have been replaced by more recent examples, and in the 'Granites' chapter isotherms have been added to the phase diagrams. Kimberlites finally receive an isotope diagram. The 'Peridotites' chapter has been improved but, as usual, has nothing on the isotope and trace element data which have become available for peridotite massifs since the first edition. Throughout the second edition, there is a minor upgrading of references, but few major changes.

In summary, if you already own the first edition, there is no compelling reason to rush out and buy the second. However, if you do not have a copy, the book is an important general textbook on the subject, and if you cannot distinguish Nb from Nd, it is definitely the igneous petrology textbook of choice.

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Schiffman, P. and Day, H.W., Eds. *Low-grade Metamorphism of Mafic Rocks*, Geological Society of America Special Paper 296, 1995. iv + 191 pp. Price US\$ 50.00 (post paid). ISBN 0-8137-22969

Physical conditions for sub-greenschist facies rocks range from ambient to temperatures of about 300°C and several kilobars pressure. They thus span a large proportion of the physical conditions to which rocks commonly exposed at the surface of the Earth have been submitted, including the field of diagenesis. Furthermore, a very large proportion of industrial

materials extracted from the Earth have been developed under these conditions. These are reasons enough for their intensive study by an expanding armoury of techniques. International Geological Correlation Program 294 was set up to advance the understanding of very low-grade metamorphism. An IGCP 294 meeting entitled 'The transition from basalt to meta-basalt: environments, processes and petrogenesis' was held at University of California, Davis, in September 1992, to discuss recent advances and to identify areas for further research in the study of low-grade metamorphism of mafic rocks, although many of the contributions considered other rock types including pelites and psammites. The present volume consists of papers based on presentations at that meeting. All workers in the field will need to consult it, and others will find it provides a useful sample of recent work on low-temperature alteration processes in rocks from a wide range of tectonic settings and employing a wide range of research techniques. A recurrent theme is the attempt to quantify pressure-temperature-compositional conditions in rocks in which a long-range approach to equilibrium is at best problematic.

First after the Introduction is a study of mineral parageneses involving pumpellyite and their graphical analysis. This is followed by three regional studies dealing respectively with the northern Sierra Nevada; a suite of mostly pumpellyite-actinolite facies rocks near Juneau, Alaska; and Early Proterozoic metabasalts near Flin Flon, Manitoba. A wealth of information on chemical mineralogy and, in one case, illite crystallinity is included. Fluid-rock interaction is a common theme in the next three papers, which are directed at a hydrothermal upflow zone in the Troodos Ophiolite, Cyprus; 'pumpellyosite' and 'prehnite' developed, like epidosite, by Ca metasomatism during upwelling of hydrothermal fluids attributed to a spreading axis in the case of the Josephine Ophiolite of northern California and southwest Oregon; and the inter-relationships of porosity, permeability, and contact metamorphism of basalt adjacent to the Skaergaard intrusion of east Greenland. These in turn are followed by a study of chloritic minerals from prehnite-pumpellyite facies rocks in Maine; mineral and isotope features associated with resetting of Rb-Sr isotope systems during low-grade metamorphism; and a detailed study of structurally homogeneous but chemically zoned pumpellyite from a metadolerite from the Archidona region, Subbetic Cordillera, Spain. Recent papers in the clay mineral literature demonstrate by use of transmission electron microscopy and selected area electron diffraction that low-temperature phyllosilicates are commonly mixed-layer intergrowths of two or more phases on a scale too small for resolution by the electron microprobe,

but that their compositions can be determined with surprising precision by analytical electron microscopy. Both TEM and AEM studies were employed for the pumpellyite paper referred to. The absence of a contribution on the application of these methods to phyllosilicates in low-grade metamorphic rocks highlights the need for more such studies.

I feel attention should be drawn to two slips of conceptual significance. A belief appears to have grown up that the zeolite and other very low-grade facies were originally defined largely for, or on the basis of, mafic rocks. This misconception is given some substance in the opening sentence of the introduction to the volume. In fact, while a mineral or metamorphic facies embraces rocks of *all* compositions, the facies concerned were defined on the basis of the co-existence of various *quartz-bearing* assemblages observed primarily in sandstones and tuffaceous rocks of *intermediate to siliceous composition*, and in the case of the prehnite-pumpellyite facies, in 'metagreywackes'. The second problem I refer to arises in a discussion of facies in the first paper following the introduction. Here it is stated that the founding definitions of the low-grade facies imply substantial overlap of P-T conditions, stating as an example that prehnite and pumpellyite commonly occur with zeolites 'in mafic bulk compositions'. The 'founding' definition of the prehnite-pumpellyite facies was, in fact, specifically worded to avoid this particular overlap by defining the facies "to include those assemblages produced under physical conditions in which the following are commonly formed: quartz-prehnite-chlorite or quartz-albite-pumpellyite-chlorite, *without zeolites.....*" (italics added by reviewer). Unfortunately, the second half of this sentence was overlooked in the paper referred to. The authors are correct, however, in pointing out difficulties that have arisen through attempts at defining facies too precisely. It is well to recall the definition of facies due to Eskola and F. J. Turner and others as associations of mineral assemblages that consistently recur together in the field. Boundaries will inevitably be fuzzy. Meanwhile attempts towards improved quantification of the many variables that have produced individual low-grade metamorphic rocks continue, as is evident from the present volume.

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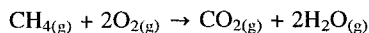
J.E. Andrews, P. Brimblecombe, T.D. Jickells and P.S. Liss. *An Introduction to Environmental Chemistry*. Oxford (Blackwell), 1996. xviii + 209 pp. £12.95 ISBN 0-632-03854-3.

The past ten years have seen the explosion of new BSc courses in environmental geology. Such degree programmes tend to appeal to students whose

background in the sciences is weaker than those entering mainstream geology courses. Anyone who accepts that some grasp of chemical principles forms a vital pre-requisite for a successful career in environmental geoscience is therefore bound to welcome the publication of an up-to-date text in environmental chemistry, if it caters for readers with little or no chemical background.

This book from the School of Environmental Sciences at UEA makes just such a claim, aiming 'to introduce some of the fundamental chemical principles which are used in studies of environmental chemistry and to illustrate how these apply in various cases, ranging from the global to the local scale'. The book is the successor to the established 1980 text by Raiswell and colleagues (*Environmental Chemistry: the Earth-air-water factory*), and follows a similar layout. The opening chapter deals briefly with the formation of the elements, the Earth, the hydrosphere and life. The three central chapters are devoted in turn to the physics and chemistry of the atmosphere, to the 'terrestrial environment' (including substantial sections on weathering, clays, and continental waters) and to the oceans. The concluding chapter examines various aspects of global change. The book is concise, well illustrated (except for Chapter 2) with high-quality diagrams, including three colour plates, and provides good value for money.

According to the introduction, the book caters for students with little or no previous chemistry background. Elementary chemical principles are introduced in text boxes which the chemically literate reader can bypass. This sensible arrangement is not always as successful as it might be, however; some of the explanations of basic chemistry are a little too compressed to enlighten, and will either mystify the reader or encourage a rote-learning strategy. Some of the notation used is also rather unsympathetic: for example on page 18, in relation to the reaction



we are confronted by the equation:

$$K = \frac{c\text{CO}_2 \cdot c\text{H}_2\text{O}^2}{c\text{CH}_4 \cdot c\text{O}_2^2}$$

in which the unsubscripted species labels and the ambiguously printed powers are certain to confuse some readers. Moreover, mystifying terms like 'hydrolysis', 'activity' and 'electrolyte' tend to creep into the discussion without sufficient definition: this could easily be overcome in a second edition by providing a simple glossary of terms. Whilst in carping mode, one might also question the occasional use of weight where mass is intended.

These reservations aside, however, the book is in nearly all environmental respects readable, well