and volcanic associations there may be a third, the diatremic association, consisting of kimberlites and lamprophyres found in dykes and diatremes. An evolutionary sequence outlining the method of generation and ascent of granitic magma to form a batholith is given by W. S. Fyfe. He considers that such granitic liquids, which are often deficient in water, are produced by partial fusion of dry, high-grade metamorphic rocks; the liquid collecting together to form drops (3–7 km radii), which move upwards due to buoyancy. A chapter, which the reviewer considers to be out of place in this volume, by J. M. Ade-Hall and E. A. Lawley describes and discusses the differences in opaque mineralogy between Tertiary Icelandic basalt lavas and dykes from Mull.

It is a pity that S. A. F. Murrell did not devote the whole of his contribution to rock mechanics, rather than embark on an elementary account of global tectonics. An article by J. W. Elder is mainly concerned with quantitative studies of dynamical models, in particular penetrative convection as it might occur in the mantle, to account for the origin or sources of some of the processes that ultimately lead to intrusion. One of the most stimulating chapters, and undoubtedly the redeeming feature of Part 5, is by H. Ramberg who describes the results of centrifuged model experiments that were constructed to simulate the intrusion of plutonic bodies. To illustrate some of the results there are 14 excellent plates, comprising 40 photographs. Those who have mapped in detail igneous complexes and the adjacent country rocks will closely study these photographs to ascertain the extent to which the models imitate known geological structures. J. L. Roberts considers from a theoretical aspect the mechanics of the intrusion of magma into brittle country rocks. Doubt is cast on the value of this chapter in that the interpretation given to the complexes quoted by the author, to substantiate his theoretical models, may not always be the correct ones. Also, some of his conclusions, in particular about dyke swarms, are not endorsed by field observations.

The final part of the book consists of a discussion chapter by N. Rast. In it he not only summarizes, under the headings of initiation, ascent, and emplacement of magmas, the papers and any pertinent points made in discussion by various people at the Symposium, but adds some of his own views.

The standard of production and printing of this book is good, there being very few typographical errors. Also, the diagrams and the photographs that form the plates are of high quality. Unfortunately, the price is high, which puts it out of the range of the average undergraduate, who would benefit by reading it.

The reviewer enjoyed reading this book and thoroughly recommends it to others, for, by and large, the theme as stated by the editors has been adhered to. However, the point that blatantly emerges is the lack of numerous, quantitative studies on the form and structure of igneous complexes and their country rocks. R. R. SKELHORN

KLEBER (W.) *An Introduction to Crystallography*. Berlin (VEB Verlag Technik), 1970. 366 pp., 361 figs., Price £3·80.

This is a well-established textbook that has gone through 10 German editions in 15 years and is now published for the first time in English. It is written mainly for

the use of undergraduate students of mineralogy and other subjects in which crystallography plays a part.

Unlike most other crystallography textbooks, this volume covers all aspects of crystallography in one volume, including morphology (50 pp.), growth (40 pp.), crystal chemistry and types of structure (80 pp.), physical properties (75 pp.), and X-ray methods (40 pp.). The author has made a determined and conscientious attempt to make the book as comprehensive as possible, and has clearly put a lot of work into it. The book is profusely illustrated, with no less than 361 diagrams, 49 tables, an interference colour chart, and a periodic table in the back cover. There are very few aspects of crystallography that are not mentioned, and the book is sufficiently up to date to mention resonance spectroscopic methods.

Such an effort on the part of the author deserves success, but the reviewer views the final product with considerable reservations. The content is certainly sound, and the author mentions every subject the student ought to know about, but the balance and the exposition are not right. Major topics receive the same coverage as sidelines, as though the author had started by making a list of points to be covered and then writing a fixed number of paragraphs on each, without regard to their relative importance. No special effort is made to elaborate on those points that it is most important for the student to understand fully. The author is at pains to ensure that the student is presented with every fact, but does not follow this up by making sure that he understands it or knows how to use it. For example, the reciprocal lattice is described, but it is not at all clear how it is used in interpreting X-ray patterns. The relations between cell dimensions and interplanar spacings are mentioned, but there is no real explanation of how one actually goes about measuring cell dimensions. The section on crystal optics makes few references to actual minerals; chrysoberyl is quoted as an example of anomalous interference colours, rather than chlorite, which the student is much more likely to see. The unsatisfactory early definition of crystals as *homogeneous anisotropic bodies* (p. 20) can only confuse the student who later discovers that crystals may be optically isotropic or anisotropic. In the author's defence it must be said that he does not consider this as a book to be used on its own. It is intended to accompany a course of lectures and practicals, and the numerous illustrations and tables certainly make this an excellent book for reference.

The author has not been well served by either the translator or publishers. The translation is clumsy and too often literal rather than idiomatic; a sentence from p. 24 will give an idea of the standard: 'Such a proceeding is not the most useful way to proceed however'. The combination of poor exposition and poor translation make this a difficult book to read. Sentences and even whole paragraphs are almost incomprehensible, and the text has to be ploughed through rather than read. The lengthy bibliography at the end of the book is heavily weighted towards German references, and the substitution of more appropriate references in English would have been worthwhile for a textbook of this kind. It would also be less confusing to the English language student if the term 'Loschmidt number' were replaced by the more familiar 'Avogadro's number'. Less serious, but more conspicuous, is the practice of using capital initial letters for minerals named after people or places. This rule

has been applied with ridiculous inconsistency, and while coesite, ilmenite, and sillimanite have been demoted to lower-case status, batisite and occasionally sanidine receive a capital letter. Several mineral names are among the many spelling mistakes in the book.

This is the most comprehensive textbook on crystallography that has been published at this level, and has no serious rival in content. The price is reasonable, considering that the book covers ground that is usually split up between smaller textbooks of more limited scope. A beginning student will find this a difficult book to follow, but the more advanced student will find it an excellent book to which to refer.

A. HALL

ERNST (W.). *Geochemical Facies Analysis*. Amsterdam, London, and New York (Elsevier), 1970. vi+152 pp., 34 figs. Price £3·58.

This short book, eleventh in the series *Methods in Geochemistry and Geophysics*, is intended to demonstrate to what extent sedimentary facies can be interpreted by geochemical criteria. The physicochemical criteria considered to affect the sediments deposited are salinity, temperature, and redox potential, which form subsidiary units of the 'hydrofacies', the special facies term coined for geochemical purposes.

Interpretation of the environment of deposition from the geochemistry of the rock is complicated by theoretical and practical factors. The chemistry of the sediment supplied to a basin is governed by the extent of weathering (a factor of climate and topography in the source area) and provenance. The grain-size distribution and rate of sedimentation determine whether the sediment equilibrates with the depositional environment, and the addition of plant or animal material may affect the sediment. Though the chemistry of the oceans has varied with their evolution it has remained almost constant since the Cambrian. Diagenesis alters the composition of the sediment by the expulsion of pore-water removing soluble material and by the fixing of some elements in authigenic minerals, which may develop under conditions different from the depositional environment. Medium to high grade metamorphism precludes geochemical interpretation of sedimentary environment.

On the practical side interpretation can only be based on a statistically significant number of samples that have been routinely collected, prepared, and analysed. Any conclusions reached require standardization against lithological and biological facies indicators.

Half the book comprises brief but critical reviews of element or isotope variations in sedimentary rocks that have been purported to correlate with variations in the depositional environment. The environmental variables can be defined with varying degrees of certainty: salinity from boron and, perhaps, chlorine in clays and bromine in evaporites, temperature by using oxygen isotopes in unrecrystallized organically precipitated calcite, and neutral to negative redox potentials from vanadium/chromium, ferrous/ferric iron, and iron/manganese ratios and the sulphur content.

Chemical variations with palaeogeography suggest a change from non-marine