A firm grasp of classical analysis is necessary but hardly sufficient equipment, for the subject demands a remarkable delicacy of touch; for instance, the reduction of an upper bound for a certain exponent from $27/82$ to $15/46$ was a noteworthy performance.

The first chapter deals with Selberg's formula, from which a proof, elementary in the technical sense, of the prime number theorem can be deduced. The next three chapters are concerned with the Riemann ζ function; Weyl's method for estimating trigonometric sums yields a proof of Littlewood's theorem on the distribution of the zeroes of $\zeta(s)$, and Vinogradov's powerful refinement on Weyl's method enables Littlewood's result to be improved. Another aspect of the distribution of the primes is discussed by the theorems of Hoheisel and Ingham on the order of magnitude of the difference between two consecutive primes. Dirichlet's theorem on the infinity of primes in an arithmetic progression is essentially connected with the L functions, which generalize the ζ function; chapter VI studies those properties of the L functions which are analogous to but rather deeper than those of the ζ function.

The partitions of an integer are its representations as a sum of integers. For the number $p(n)$ of possible partitions of n , Hardy and Ramanujan gave a remarkable asymptotic formula, which in turn led Rademacher to a convergent series for $p(n)$. Ramanujan's work here was probably the finest of his short career and the account of the way in which he and Hardy collaborated on this topic is fascinatingly described in Littlewood's review of Ramanujan's *Collected Papers*, in *Math. Gazette*, XIV (1929). Finally, another problem, simple enough in statement, asks for information about the number $d(n)$ of divisors of a positive integer n . For $D(x)$, the sum of $d(n)$ from $n=1$ to $n=x$, Dirichlet gave the dominant terms with an error term of the order of $x^{1/2}$. It is now known that the index is not less than $\frac{1}{4}$ and not greater than $\frac{1}{2}$; but while the upper bound has been reduced, the conjecture that the correct value is $\frac{1}{4}$ remains an open question.

Chandrasekharan has incorporated much of his own research work in order to present complicated and delicate analysis with clarity and precision; and even without the acknowledgment in the preface, the strong influence of Siegel may be detected. Instead of the fashionable pedantry of an immense but unannotated bibliography, the author has added critical notes to each chapter, giving comments and references which will help the reader to pursue his study of a topic which, in one form or another, has fascinated mathematicians for 2,000 years.

T. A. A. BROADBENT

Geology Quantified

Physical Processes in Geology: a Method for Interpretation of Natural Phenomena — Intrusions in Igneous Rocks, Fractures and Folds, Flow of Debris and Ice. By Arvid M. Johnson. Pp. xiii+577. (Freeman, Cooper: San Francisco, 1970.) \$14.75.

ANYONE who is misled into thinking that this book is concerned with geomorphology is in for rather a shock! The "physical" here is physics. The book is concerned solely with introducing a numerate approach to geological processes, continuing the current trend in the literature.

As mathematics does not, as a rule, endear itself to geologists, it should be stressed that the physics and mathematics involved are nowhere beyond first year level, and, in any event, each step is thoroughly explained. The discourse is confined to mechanics and the types of problems which may be solved by mechanical applications. The first chapter explains the elementary principles of stress and strain, force and fluid dynamics, and much of what follows illustrates very clearly structural situations in which these principles can be gainfully applied. Three types of situation are recognized—flexures, linear structures, and flow structures—and throughout these sections of the book "structural interludes" are inserted. These "interludes" (essentially extensions to the theoretical principles already educed in the first chapter), when taken together, provide a very full account of physical principles as they may be applied to rocks. This method of presentation has the obvious advantage of giving the reader merely sufficient of possibly unfamiliar mathematics and physics to make the relevant points. It also makes the progression of ideas easier to follow.

In the first section of the book, dealing with flexuring, the emplacement of the Henry Mountains laccoliths is investigated, together with three different styles of fold structure—ptygmatic type, multi-layer deformation and "concentric" angular folding. Comparison between the theoretical models of these flexures and the actual forms is often significant in deducing the actual mode of formation. As far as linear features are concerned, faults, igneous sheets and dyke patterns are examined. The fundamental idea is the relation of linear features to the physical properties of the rocks into which they are imprinted, and understanding of them depends very much on the "Stress/Strain" and "Elasticity" sections in the earlier part of the book. The final section on flow structures deals with the properties of moving ice, lava and talus material—for example, moving ice is related to the form of U shaped valleys

and to the way in which they develop.

It must now be abundantly clear to most geologists that it is no longer sufficient to describe and discuss geological phenomena in qualitative terms, without at least alluding to the processes by which they were produced. Quantification in geology is fast becoming accepted, and those who do not master the numeracy of their subject may find that their branch of specialization has overtaken them. Bearing this in mind, it is difficult to see how this book can be overlooked.

J. R. V. BROOKS

Conceptual Physics

Properties of Matter. By B. H. Flowers and E. Mendoza. (The Manchester Physics Series.) Pp. xiii+318. (Wiley: London and New York, October 1970.) 110s boards; 55s paper.

If this book could have been printed on the backs of envelopes it would have completed the style of presentation. The underlying idea is to discuss the properties of matter from a microscopic point of view emphasizing the conceptual physics. To this end the analyses have been kept short and simple with just the essentials retained so that the first year undergraduate student does not lose sight of the objective and the essentials are not lost in a morass of detail. The analytic answers that are derived have the correct form but the numerical coefficients are often not quite right. The correct coefficients are then quoted. In this way, for example, the Gruneisen relation can be found in a very clear way. The numerical orders of magnitude of quantities are prominently discussed.

The starting points of nearly all the discussions of solids, liquids and gases are the interatomic potential and the Boltzman distribution. Energy arguments are then used to derive a variety of macroscopic properties. To simplify, a conceptual approximation is consistently made to neglect entropy and use internal energy instead of free energy. I am not convinced that this is a good idea. The treatment of metals has a hollow ring because no quantum mechanics is used. This approach, however, successfully unifies the properties of matter.

The authors are clearly against SI units for which there will be, no doubt, some sympathy but to use c/s instead of Hz and °K instead of K is of no help, and to use the centigrade scale, even sparsely, denies the physics which is otherwise so well stressed. Students should gain a lot from this unique presentation and they will be able to judge their misunderstanding from the questions and answers included.

A. F. G. WYATT