apparent to the reader. It would have been a great help, if the descriptions accompanying such photographs had included labelled key sketches. The other criticism which needs to be made is more concerned with the FAMOUS project as a whole than this particular book. If this was truly an international enterprise, why must all the publications be so assiduously confined to either the French or the American sub-section of the area? The impact of this atlas would have been increased greatly, if it had been combined with its American counterpart into a single comprehensive volume. As it is, the potential buyer must decide whether to invest in the northern or southern part of FAMOUS. Only those with limitless budgets will afford both.

R. N. THOMPSON

Reeves (R. D.) and Brooks (R. R.). *Trace Element Analysis of Geological Materials.* New York (J. Wiley & Sons) 1979. x + 421 pp., 70 figs. Price £19·50.

Several books have appeared within the last decade in the field of analytical geochemistry, and this most recent addition must therefore compete with previous works. It does, however, specifically cover trace element analysis and it seeks to 'be of use not only to those with formal training in analytical chemistry and geochemistry, but also to those who are being drawn into this field from many other branches of science'.

After a short introductory chapter, a chapter is devoted to 'sampling and storage techniques'. This contains many platitudes including, for example, an exhortation to use plastic containers for the storage of solid samples 'because they are unbreakable and much less likely to contaminate the material'! The book continues in the same vein, with chapters on physical and chemical methods of sample pretreatment. Generalities abound, but specific information is lacking, although there are extensive collections of references.

The main part of the book is taken up with an account of various analytical methods, including those which are currently most widely used for trace element analysis. These chapters include some valuable accounts of the theoretical background to the analytical methods, which are most welcome. However, no attempt is made to provide detailed information on analytical methods. A reader seeking information on how to analyse a sample for a particular element would be little wiser from reading this book, nor would he receive advice on which method to use. There is also some lack of balance in the attention devoted to the different methods, molecular fluorimetry rates almost as much space as X-ray fluorescence, and the suggestion made that the *precision* achieved by X-ray fluorescence is only 5–10% leaves the impression that practising analysts have not been involved in the preparation of the text.

The book concludes with chapters on 'Uses of data on trace elements in geological materials' (which is of little geological value) and a chapter on 'statistical interpretation of geochemical data' which is of use.

Overall it is difficult to recommend this book, the lack of specific information on the analytical methods is a serious handicap, although the accounts of the theoretical background and the considerable collection of references may assist some readers.

J. N. WALSH

Pies (W.) and Weiss (A.). *Crystal Structure Data of Inorganic Compounds. Part c. Key Elements: N, P, As, Sb, Bi, C. Key Element N (Substance Numbers c1 . . . c1133).* (Landolt-Börnstein: Numerical Data and Functional Relationships in Science and Technology, New Series. Group III: Crystal and Solid State Physics. Vol. 7. Springer-Verlag. Berlin, Heidelberg, and New York, 1978. xxv + 260 pp., 35 figs. Price DM 290 ($145).

This is a further volume in the series of comprehensive crystal structure data compilations for inorganic compounds (*Mineral. Mag.* (1979), **43**, 187). The key element is nitrogen, thereby covering ammonia and its derivatives, azides, and oxy-compounds of nitrogen. Mineral species under these headings are few and far between but include osbornite, sinoite, kleinite, nitratine, nitre, nitrammite, nitrobarite, nitrocalcite, buttgenbachite, darapskite, and humberstonite. The data are clearly presented and, again, the series can be recommended to laboratories specializing in inorganic crystal-structure studies.

A. M. CLARK

Journel (A. G.) and Huijbregts (Ch. J.). *Mining Geostatistics.* London & New York (Academic Press), 1978. x + 600 pp., 267 figs. Price £32·00.

Geostatistics is a relatively young branch of statistical estimation theory pioneered by Professor G. Matheron, founder of the Centre de Géostatistique, Fontainebleau, in the mid 60s. Both the authors were members of his research group since its

foundation in 1968, and have themselves developed much of the theory. The primary literature in this field has hitherto mainly been in French, and only one English language text book ('Geostatistical Ore Reserve Estimation', by M. David, Elsevier, 1977) has so far appeared.

What is mining geostatistics? Traditional approaches to ore reserve estimation have been unable to fully take into account the statistical nature of the spatial variation of properties, such as ore grade, with which the geologist or mining engineer is concerned. Using the concept, pioneered by Matheron, of a 'regionalised variable', each analytical result for grade obtained by sampling of the deposit at a given point can be regarded as one particular realization of a random function which applies only at that point. The difference between the values obtained there, and at another sampling point some distance away will exhibit a degree of auto-correlation which will vary as a function of distance, and often direction as well, within the deposit. By making a study of this spatial behaviour, it is possible to not only make the best estimate of the probable grade of the block to be mined but, of equal importance, to assess the uncertainty of this estimate, something which cannot be achieved by any of the more traditional methods such as inverse distance weighting or the use of polygonal regions around each borehole. It is also shown that geostatistical methods can lead to the smallest estimation errors.

This review will no doubt be read by many geologists and geochemists who, while not concerned with ore reserves, are used to making extremely accurate analyses on a statistically small number of samples taken from outcrops in one, or perhaps two, dimensions. Only rarely are such studies accompanied by investigation of the natural sampling variability, which generally far exceeds analytical sources of error. This book could be read with benefit by most geologists concerned with such problems in order to bring home to them what spatial variability in rocks is all about, and the problems of estimating abundance in samples which may vary in size from drill cores to 8000 m^3 blocks.

The text follows an excellent plan, each chapter beginning with a summary of contents and, generally, proceeding through an in-depth study of theoretical considerations to real case histories. Thirty-six world-wide deposits are examined in detail, the majority of the results being post-1970, and the book is worthwhile for these alone.

The first chapter introduces the concepts of geostatistics, and how they are used in practice. Succeeding chapters outline the theory of regionalized variables; the nature of the semi-variogram, and its use as a practical tool to define the spatial variability of a deposit; the method of kriging, and its use in optimal prediction of total and recoverable reserves; techniques for digital simulation of a deposit in three-dimensions, as an aid to mine exploitation planning; and, lastly, new directions in geostatistical theory. The tone is authoritative throughout, and the theoretical background is extensively treated as well as more practical aspects. Production and illustrations are of high standard, and P. Dowd ably assisted the authors to reduce incidence of Franglais in the style.

Matheron states disarmingly in his introduction that the reader 'will come across nothing more than variances and covariances, vectors and matrices. After the preliminary effort of familiarizing themselves with the notations, they will note, possibly to their surprise, that they can follow all of the authors' steps without difficulty.' For many the mathematical formulation will prove daunting, although concepts are generally clearly explained, and a useful glossary of (most) notations used is provided. However, it is still possible to grasp the ideas involved, and their application, from the case histories on a first reading. Eleven Fortran computer subroutines are also included, and (taken in conjunction with the text) are reasonably well documented. Programme listings are produced with welcome clarity, and only minor changes would be required (mostly in input/output) to implement them on most computer systems.

Comparison with David's book is inevitable. This text covers the ground much more thoroughly, and includes new material, such as the computer program for the 'turning bands' method of deposit simulation. For the general geological student (particularly the less mathematically minded) David's book will be more approachable, but undoubtedly Journel and Huijbregts' book is destined to become the standard reference work on the subject, and will be indespensable for anyone seriously engaged in ore reserve estimation. It would certainly prove a useful addition to the library of anyone interested in spatial processes in the earth sciences.

R. J. HOWARTH