writes on the classification of land forms in Tibesti, based on geological and climatic controls, and in another paper describes the Tibesti people, whom he considers of Nilotic origin.

Two final papers report on palaeolithic industries and prehistoric sites, and the volume ends with a road log of the excursions. The work is well supplied with maps, correlation tables, sections, photographs and bibliography, and will serve as a valuable reference work to an interesting and until recently almost unknown area.

R. J. G. SAVAGE

STATISTICAL DESCRIPTION OF GEOLOGICAL PHENOMENA

An Introduction to Statistical Models in Geology

By W. C. Krumbein and Franklin A. Graybill. (International Series in the Earth Sciences.) Pp. xi+475. (New York: McGraw-Hill Book Company, Inc.; Maidenhead: McGraw-Hill Publishing Company, Ltd., 1965.) $13; 104*s*.

THIS book is a welcome addition to that small but growing number of texts concerned to show how the use of numerical methods can yield a better understanding of geological phenomena. Therein lies its main attraction and its present weaknesses. The volume is directed to the attention of geologists with minimal mathematical training: would-be readers are recommended to familiarize themselves with elementary calculus and elementary statistical methods before reading it.

In the first four chapters the authors show on a simple level why they believe statistical models—rather than what they call the "deterministic" models of the physical sciences where relations are expressed by equations—are necessary in geological studies, and how these models and their properties apply to geological situations.

The four chapters that follow present the properties of the standard population distributions and give examples of their geological application (normal, lognormal, gamma, circular normal, binomial and Poisson). The use of chi-square, Student's t and Snedecor's F distribution in testing statistical hypotheses is also discussed.

I found much of these eight chapters rather dull reading. They illustrate the mathematical technique well enough, but the examples given do not greatly clarify or advance one's understanding of the geological phenomena under discussion. Moreover, one of the examples used throughout the book—a selected set of drainage basins—seems the antithesis of the kind of problem best suited to illustrate statistical methods. In the first place, to make it amenable to these methods, the geological setting has had to be oversimplified; and second, even with these necessary simplifications (or perhaps because of them), no clear idea of the factors controlling the properties of this drainage network emerges at the end of the calculations. A situation such as this does not inspire the reader with confidence, for he may perhaps assume that he has misunderstood the mathematics; or worse, he may conclude the statistical methods have little bearing on geomorphological problems. In an introductory book, it is surely of the greatest importance to show not only the underlying mathematical structure of the statistical model (which the book does well), but also to relate the components of this model to its geological properties. If these properties are too numerous, or difficult to quantify, little is gained by applying statistical analysis—particularly when, as seems the case with the drainage network problem used here, the conclusions are those a geologist might draw from a casual glance at the data, or simply from his experience in the field.

The second half of the book deals with topics such as the analysis of variance, the simply and general linear model (with a brief account of vector and matrix algebra), map analysis, advanced models, evaluation of data and empirical models. Every chapter except the introductory one provides a long list of references, furnishing an invaluable bibliography covering the field up to 1964.

The chapters on the general linear model and map analysis are among the most interesting parts of the book. The treatment is clear and from the beginning it is geared to eventual computer use. Moreover, the possible range of applications is considerable, and the methods will almost certainly assume an important role in many fields in the near future. The advanced models discussed include factor analysis and discriminant functions, and one feels that if this all too brief account had been expanded into two or more chapters—with a corresponding condensation of some of the earlier material—this would have added to the interest of the volume. Although "advanced" in character, the models are only slightly more complex than the general linear model; and, like it, they will also come to occupy a position of increasing importance in the range of statistical techniques available to the geologist.

Yet even these last sections left me unconvinced that statistical analysis had yielded significant results unobtainable by conventional "subjective" methods. For example, although the mathematical significance of the "trends" extracted from a map pattern and the "factors" composing a pattern of sedimentation is made quite clear, it is not always certain what their geological significance might be. The root of this problem may lie in an attempt to analyse too complex a phenomenon, or possibly in the use of inadequate data. It may be that other fields of geology, such as palaeontology or petrology, could provide more suitable illustrative material.

Some of the shortcomings may also spring from the novelty of the subject, for in many respects the book is the first in its field. The book cannot be ignored by those geologists interested in using statistical methods to gain a better understanding of geological phenomena and the problems associated with them; but the methods themselves cannot provide short cuts to their solution, nor can they act as substitutes for the time-consuming process of accumulating the necessary data.

A. GILBERT SMITH

ORGANIC OXIDATIONS

Oxidation in Organic Chemistry

Edited by Kenneth B. Wiberg. Part A. (Organic Chemistry: a Series of Monographs, Vol. 5.) Pp. xii+443. (New York: Academic Press, Inc.; London: Academic Press, Inc. (London), Ltd., 1965.) 112*s*.

THIS book, the first of two parts, considers in turn each of certain inorganic oxidants and its oxidation of organic compounds. The final chapter, however, deals with glycol fission by several reagents.

Only since 1943 have these reactions been studied using the full range of physical methods. Fortunately, several of those most closely concerned with this development have contributed. The editor deals with Cr(VI), Ross Stewart with Mn(VII), Waters and Littler with V(V), Co(III) and Mn(III), Richardson with Ce(IV) and Criegee with Pb(IV). Bunton covers glycol fission. Cu(II), $Fe(CN)_6^{3-}$ and others are reserved for the forthcoming companion volume.

Each author presents concisely the inorganic chemistry of his chosen oxidant. Most kinetics for the oxidation of organic molecules refer to aqueous solution, and consequently mechanisms relate to simple (water-soluble) organic species which are, nevertheless, representative of the behaviour of larger molecules. Emphasis is placed on kinetics in the chapters on V(V), Co(III), Mn(III) and Ce(IV), for these reagents have been used very largely in aqueous solution, while, conversely, there is a dearth of