Later Codere concludes, "The record shows Boas to have made twelve field trips to the Northwest Coast. During five of these trips, he was exclusively preoccupied with the Kwakiutl; and he worked in part with them on three further trips, bringing the Kwakiutl total to eight." As I have already mentioned, Boas made 13 trips to the coast. During only three of these trips, at most, can he be considered to have been (almost) "exclusively preoccupied with the Kwakiutl"; he worked in part with them on five other trips.

I comment on these inaccuracies not to disparage Codere's unquestionably valuable work but to correct the published record; until recently (*9*) almost nothing has been known about Boas's actual field work—how often he went to the field, what he did when he was there, how he felt about field work, the way in which he financed his field trips, and so forth.

Despite Codere's patient efforts, however, to develop an integrated, comprehensive ethnography from Boas's incomplete manuscript, anthropology is ultimately left with only a partial and inadequate insight into the rich cultural system of the traditional Kwakiutl. This must be the final verdict, even though the ethnography contains some valuable new information as well as amplifications on previously described issues. Disappointing though this is, scholars who are familiar with the general nature of Boas's Northwest Coast ethnographic output cannot be surprised.

RONALD P. ROHNER
Department of Sociology and Anthropology, University of Connecticut, Storrs

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Chemistry to About 1700

The Origins of Chemistry. ROBERT P. MULTHAUF. Oldbourne, London, 1966, 70s; Watts, New York, 1967, $7.95. 412 pp., illus.

The writing of one-volume histories of chemistry remains a steady industry, but this latest product has more to commend it than most. Taking his title seriously, Multhauf devotes roughly equal portions of the book to the workers of antiquity, the medieval alchemists, and the new developments of the 16th and 17th centuries. He is content to end his tale "about 1700," when "within four generations . . . the basis of the science as we know it" would be constructed.

As an example of *haute vulgarisation* this book is outstandingly successful. Making few concessions to the general reader for whom he is avowedly writing, the author yet succeeds in providing a text which is lucid as well as detailed and scholarly. His writing is careful and his interpretations closely argued. With disarming ease he conjures up a wealth of names and dates to support his argument whenever he feels it necessary. The result is a work that is always readable and never dull. It will make an excellent replacement for J. M. Stillman's still-in-print but aging *Story of Early Chemistry*, to which it bears similarities that Multhauf himself notes.

Indeed one's major feeling of unease is that perhaps these two books are *too* similar. Surely we have obtained new historiographic insights into the periods in question, as well as new facts about them, since 1924. Multhauf is content to say that "perhaps I differ most with Stillman and other earlier historians in the attention here given to the history of medicine." His stress on the relation of medical and chemical thought is wholly admirable. But it is a pity that he does not draw on other recent scholarly developments, as seen in the writings of Pagel, Yates, Debus, and Rattansi. Then we would have had a high-level general work that truly reflected the findings of present-day scholarship.

Even so this is an impressive piece of work. Clear printing and adequate name and subject indices enhance its usefulness. If the argument is at times compressed almost to the point of meaninglessness (as in much of the discussion of the Pre-Socratics), this may be a penalty willingly paid by a writer determined to cram in so much. Indeed, at moments one is uncertain whether the author is informing the intelligent layman or lecturing his wayward colleagues. The wealth of footnotes and references adds to this uncertainty. Nonetheless this book can be confidently recommended to any intelligent chemist with a lively curiosity about how it all began. And no doubt many of the author's colleagues will purchase a copy, not least for its excellent 35-page bibliography.

ARNOLD THACKRAY
Department of the History of Science, Harvard University, Cambridge, Massachusetts

Archeological Report

Early Cultures and Human Ecology in South Coastal Guatemala. MICHAEL D. COE and KENT V. FLANNERY. Smithsonian Press, Washington, D.C., 1967. 179 pp., illus., plates. Available from the Government Printing Office, $3.50. Smithsonian Contributions to Anthropology, vol. 3.

Most archeological site reports are dreary affairs, rarely read except by a few specialists and rarely a pleasant experience even for them. Coe and Flannery have broken many of the rules. In fact the present synthesis of early material in the Ocos area of Guatemala is like a breath of fresh air in dusty library stacks.

The report succinctly presents the results of brief but effective test-pitting at Salinas la Blanca on the far northern Pacific coast of Guatemala (the title is geographically somewhat misleading). The artifacts discovered are clearly described and illustrated and are then related to Coe's previously published material from nearby La Victoria. This is followed by a detailed alignment of the local sequences with those of neighboring regions. Probably wisely, the question of very early maritime contacts with the north coast of South America, which Coe suggested in earlier publications, is not introduced.

Ecology is a term frequently used in titles these days, but a subject rarely set forth in any detail in the text. It is doubly important in early cultures, such as these (dated by radiocarbon about 1000 B.C.), when man's control of his surroundings was merely be-

ginning and his dependence much greater. Coe and Flannery begin with a careful description of the physical environment and a detailed delineation of the several ecological zones comprised therein. Attention is given to both faunal and floral species which might have influenced human habitation. After description and analysis of the artifacts, the authors return to a study of the subsistence of these Formative groups and how they succeeded in making use of what the environment offered. The results are mixed and interesting. The basis of subsistence was sedentary maize agriculture in the rich local soil, which permitted up to three crops a year without land rotation. Vegetables were not found, but probably some had been planted in the cornfields. Several species of fruit were eaten, perhaps cultivated. Meat requirements seem to have been filled largely from the sea: 11 species of fish, 5 of crabs (which were extensively collected), and 24 of molluscs. As at Dzibilchaltun, in Yucatán, species of Mollusca chosen for use varied so sharply from period to period that they could almost replace pottery in the dating of deposits. But, as was not the case at contemporary Dzibilchaltun, the avifauna, both resident and migratory, and the numerous mammals were rarely hunted. This might reflect, as the authors suggest, that subsistence was at such a comfortable level at Ocos that ventures to any considerable distance from home were simply not considered worthwhile. In Yucatán, on the other hand, where slash-and-burn agriculture demanded daily trips to often distant milpas, hunting was probably as much the order of the day as it is now.

Archeology has for two generations been reluctant to allow for the steadily increasing costs of publication. Funds for clearly contributive field studies are not hard to come by in these years, and foundations and often the universities are not loath to pay salaries later for principal officers to complete studies of artifacts and prepare reports of their work. But when it comes to the relatively minor expense of publication, the purse strings tighten. Reports on highly successful and expensive projects are often never published; many linger for years until their usefulness is largely lost; others are condemned to the microfilm or mimeograph. Among those actually printed, many are characterized by poor typography and almost illegible illustrations, often so reduced in size that a lens is needed to use them. The Smithsonian has been most wise in this new series to sacrifice nothing to clear presentation. The print is large and legible, the illustrations excellent, and the format relaxing to the reader. The palatability of this volume is further enhanced by the concise but most readable style of the authors and the excellent organization of material.

E. WYLLYS ANDREWS IV
Middle American Research Institute,
Tulane University,
New Orleans, Louisiana

Assessing Accuracy

Interval Analysis. RAMON E. MOORE. Prentice-Hall, Englewood Cliffs, N.J., 1966. 159 pp., illus. $9.

A central problem in numerical mathematics is the calculation of estimates or bounds on the approximate answers obtained. The answers are approximate because an infinite process has been replaced by a finite one or because infinite precision arithmetic (the arithmetic of mathematics) has been replaced by finite arithmetic (the arithmetic of calculation). Often both effects are present. In addition, the answers are approximate because the data are approximate. Causes for this may be uncertainty in physical measurement or truncation of input data (perhaps known to infinite precision) to finite length. An example of the latter occurs when 1/3 has to be stored in a computer.

The approximations mentioned above are sometimes viewed as being due to errors in an exact quantity. The traditional method of error analysis is a *forward* analysis. The object of this analysis is to estimate by how much the computed answer differs from the "exact" answer. Such an analysis is usually very difficult to carry out for error due to the use of finite-length arithmetic. A recent approach has been *backward* error analysis, in which one investigates to which problem the computed answer is the exact solution. This approach has been exploited with great success by J. H. Wilkinson. Theoretical error analysis, either forward or backward, has a number of drawbacks. The analysis is often difficult to carry through. Furthermore, such a theoretical analysis is of necessity an a priori analysis of a certain method for a class of problems (for example, Gaussian elimination for a system of linear algebraic equations). Thus the results do not depend on the particular problem at hand and are therefore not "sharp."

There has been considerable interest in methods by which the computer automatically bounds the error in the answer at the same time that it calculates the answer. A promising approach is through the use of *interval analysis.* In interval analysis, numbers are replaced by interval numbers, that is, by pairs of numbers which denote the upper and lower ends of an interval. The interval numbers are combined according to the rules of *interval arithmetic.* (On a computer, interval arithmetic is performed by software rather than hardware.) The data are interval numbers which are operated on in interval arithmetic, and the answer is given in terms of interval numbers. Giving the data as interval numbers is certainly reasonable since the data are, after all, generally not exact. Thus the chemist's measurement of a quantity as $.152 \pm .0005$ may be thought of as specifying the interval number [.1515, .1525].

The author of this book is an authority on his subject. Much of the material presented results from his own research. After introducing interval numbers, he discusses interval arithmetic and a metric topology for interval numbers. He then applies interval analysis to a variety of problems including function evaluation, root-finding, and the solution of integral and differential equations.

Interval analysis does not provide a panacea. To get the benefits of interval analysis, one cannot simply write an algorithm in a procedure-oriented language such as FORTRAN and specify that the arithmetic to be used is to be interval arithmetic. Constructing an appropriate algorithm so as to be able to reap the benefits of interval analysis is a matter for an expert. It is clear that a great deal of research remains to be done in the area of automatic error analysis. Interval analysis is an important tool, and Moore gives an authoritative account of it.

J. F. TRAUB
Computing Science Research Center,
Bell Telephone Laboratories,
Murray Hill, New Jersey