but not KI and NaCl. In Table 2 a few carbonates and about 35 silicates are included among the oxides. Several formulas and names are listed without data. No explanation is offered for this seemingly capricious coverage.

This compilation may prove useful to those who work within the undefined limits of its particular range and do not require such comprehensive and authoritative treatment as that given by the new edition of *Crystal Data*, recently reviewed in *Science* [**140**, 1230 (1963)].

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Mathematics

Mathematical Discourses. The heart of mathematical science. Carroll V. Newsom. Prentice-Hall, Englewood Cliffs, N.J., 1964. x + 125 pp. Illus. $5.

Topics in Modern Mathematics. Ralph G. Stanton and Kenneth D. Fryer, Eds. Prentice-Hall, Englewood Cliffs, N.J., 1964. xii + 187 pp. Illus. $5.95.

Although a few of the same topics are discussed in both of these books, the books were written with very different purposes in mind. Carroll Newsom's *Mathematical Discourses* is an attempt to explain to the layman what a deductive, or axiomatic, system is. (Why the author prefers the name "mathematical discourse" is not clear.) *Topics in Modern Mathematics*, edited by Ralph Stanton and Kenneth D. Fryer, is intended chiefly for high school teachers.

In the first three chapters of *Mathematical Discourses*, Newsom discusses the historical development of the concept, in the fourth he gives several examples, listing the axioms and proving a few theorems, and in the fifth he discusses the use of axiomatic systems in dealing with practical and scientific problems.

I do not think the book successfully achieves its aim. The historical parts are superficial, with far too many names and dates, some of them unimportant. The style is heavy—for example, "utilize" is preferred over "use," and there is the strange expression (page 93) "by actually indulging in the process of division," which is apparently not intended to be humorous.

What is more serious is that there are a good many mathematical statements which will confuse or be meaningless to the average reader. One example is on page 93: "Interestingly enough, one may write, 1 = 0.99999 . . . and 23 = 22.99999. . . ." There is no explanation. In the discussion of the postulates for a complete ordered field (pp. 96–102), it is not pointed out that the subset P is the set of positive real numbers. Finally, some of the proofs are probably too difficult for the readers for whom the book was intended.

Topics in Modern Mathematics contains ten independent chapters with the following titles: "Groups and fields," "Set theory," "Boolean algebra," "Logic and computing," "Vector spaces and matrices," "Numerical analysis," "Functions of a single variable," "Fundamental concepts of calculus," "Probability theory and statistics," and "Some types of geometry." There is an epilogue, in which the editors express their misgivings about many aspects of the current curriculum reform in American high schools.

Most high school teachers could profit from reading this book. Many topics are discussed which they will soon be teaching, if they are not already doing so. However, there is, unfortunately, not a single chapter about which I do not have serious reservations. The treatment simply does not have the accuracy and clarity required in a book of this sort. It is impossible, in a brief review, to argue the point in detail, but perhaps the following examples will show what I mean.

The discussion of the null set (p. 20) does not make it clear that what is involved is merely a convention. The proof that 3 has no rational square root is not complete. In a discussion of the vector space of ordered pairs of real numbers (p. 68), it is stated that addition and scalar multiplication will be defined and then a zero vector will be selected; we have no choice, of course. The relation between 2 × 2 real matrices and the transformations of a plane into itself is discussed (pp. 72–75), but the fact that the transformations are linear is not mentioned. In a discussion of scalar multiplication (p. 78), it is claimed that (a, b) and $\lambda\ (a, b)$ have the same direction; on the next page there is a simple error in algebra, which is the result of the same disregard of signs. We are told (p. 78) that in a later section it will be proved that 0/0 can have no meaning, but that at the moment it is enough to notice that it certainly differs from the quantity 14/9. The list of Hilbert's undefined relations for geometry (p. 167) includes three that do not belong there.

My list of examples is far from exhaustive, but perhaps it is enough to show why I do not think the book should be used in training high school teachers.

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Satellite Geodesy

The Use of Artificial Satellites for Geodesy. A symposium held at Washington, D.C., in April 1962. G. Veis, Ed. North-Holland, Amsterdam; Interscience (Wiley), New York, 1963. xii + 424 pp. Illus. $14.

This collection of papers that were presented at the first international symposium on the use of artificial satellites for geodesy gives evidence of the wide range of talents that are necessary to exploit the new area of satellite geodesy. The invited papers were augmented by a considerable number of contributed papers, in order to provide more complete coverage of the subject matter. George Veis, the editor, has succeeded in arranging the material with as much continuity as can be expected in a collection of individual papers, written by more than 50 of the most knowledgeable but, nevertheless, highly specialized authors.

The well-rounded coverage is a reflection of the excellent planning of the symposium; W. M. Kaula, as chairman of the program committee, saw to it that the necessary geographical and technical diversity was reflected in the presentations on the new approaches to the classic problem of geodesy—the determination of the size and shape of the earth. In addition to geodesists and photogrammetrists, the list of authors contains the names of specialists in the fields of mathematics, astronomy, physics, geophysics, electronic engineering, and other fields, thus providing evidence of the numer-

ous disciplines involved in the exploitation of such new tools as artificial satellites for geodesy.

The book is not a textbook, with respect to either the theoretical or the engineering aspects of satellite tracking. However, the articles will serve as an excellent status report for knowledgeable readers in the various fields. Those who can follow both the highly theoretical contributions that cover gravitational mechanics and the articles on complex measuring and data evaluation systems will be rewarded with a knowledge of a factual cross section of the status of satellite geodesy at the time of the symposium.

Part 1 deals with the dynamics of satellite motion, and it concentrates on unusual cases, such as resonance, giving evidence that the basic problems associated with the mechanics of gravitational motion are largely solved.

Part 2 deals with satellite tracking and is concerned almost exclusively with the photogrammetric techniques of interpolating satellite imagery into the star background. The described techniques either result from astronomical observational methods or are applications of measuring techniques developed for the precision tracking of missiles and rockets.

Among the several aspects of the data evaluation problem discussed in part 3 are the basic problems of terrestrial and celestial reference frames, the accuracy of star catalogs, and the precise measurement of time. It is evident from the contents that, in the general area of error propagation, there remain quite a few problems which must be solved before valid geodetic information can be obtained.

The contents of part 4, on geometric methods, anticipate the interest in a geometric solution to the problem of a geodetic world-wide reference system, which, in the meantime, has attracted much attention. Part 5 is devoted to numerical results. Parts 6 and 7 deal with some tangential topics and comparisons between satellite geodesy and other (classical) methods. Geophysical implications are mentioned. Part 8 is a summary and a review of the main papers and topics of discussion.

That the financial assistance of UNESCO made the publication of this timely and interesting symposium possible should not go unmentioned.

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Geological Sciences Today

The Earth Sciences: Problems and Progress in Current Research. Thomas W. Donnelly, Ed. Published for William Marsh Rice University by University of Chicago Press, Chicago, Ill., 1963. viii + 195 pp. Illus. $6.

This handsome, well-printed book consists of six papers, first presented (in November 1962) at a symposium entitled "Frontiers of Geology" as part of the semicentennial celebrations of Rice University. It follows a pattern now common in offering essays on a wide variety of topics, and one wonders what the hard-pressed geologist who even rips his journals apart to eliminate unwanted material will do with the current spate of heterogeneous books. No doubt some of this material will also appear in journals, but the problem of keeping up with work first published in books of this character is becoming acute. Diversity is, of course, a striking feature of the present state of the geological sciences, and the difficulty of fitting together the six papers in this book merely exemplifies the obstacles in the way of a future synthesis. To comment intelligently and critically on each of the papers would require a most unusual breadth of competence, to which I lay no claim.

The first paper (38 pages), "Variation of density in the Earth and the melting curve in the mantle," is by Sydney P. Clark, Jr. This chapter summarizes the older work on density distributions and adds some new computations intended to establish limits of variation consistent with present knowledge. The new data obtainable from satellite orbits, high-pressure mineralogy, shock-wave equations of state, velocity measurements, and other sources are discussed and used to establish the broad chemical outlines of the constitution of the earth. Melting curves are of importance as setting upper limits for the temperatures of the mantle, and lower limits for the temperature of the liquid core. The uncertainties of these estimates are brought out, and the chapter concludes with a list of important unanswered questions. Like the other papers in this volume, the chapter includes a valuable bibliography of recent work.

The paper (18 pages) by John A. O'Keefe, "Two avenues from astronomy to geology," discusses the recent advances in knowledge of the earth's external gravitational field obtained from the perturbations of orbits of artificial satellites and the problem of the origin of tektites. Harmonics of the external potential up to the ninth degree have been evaluated, and although the uncertainties of some of these are still relatively large, it is now clear that the earth's figure departs from one of fluid equilibrium; even the second degree harmonic, usually described in terms of the "flattening," is appreciably different from the value that it would have for a fluid Earth of the same mass, moment of inertia, and angular velocity. O'Keefe discusses the bearing of these results on the theory of mantle convection. On his other theme, O'Keefe traces tektites to the moon, and then, because "Every attempt to find a decisive chemical or nuclear difference between tektites and terrestrial rocks has failed," suggests a return with variations to the Darwinian hypothesis of the separation of the moon from a primitive Earth-Moon system.

W. S. Fyfe contributes a chapter (24 pages) entitled "Experiment and the crust of the Earth: Problems and approaches." Fyfe points out the slowness with which classical thermodynamics and electrochemistry have made their way into the geological sciences; even today, much that is "new" in petrology and geochemistry had its origins nearly a century ago. Some of the newer geochemical fields are reviewed—the use of the electron microprobe, the study of phase transitions, solid and aqueous solutions, and reaction rates. A more profound study of physics and chemistry by the future students of geology is recommended.

The next paper (22 pages) is "Fundamental problems in dynamic structural geology" by Fred A. Donath. Much of this is devoted to experimental work on rock deformation, especially to the factors of anisotropy and ductility and to methods of judging the local deformations in the field from distorted pebbles or fossils. The difficulties and ambiguities of model studies are emphasized.

S. S. Wilks contributes a 32-page paper, "Statistical inference in geology." For a statistician "who knows virtually no geology," Wilks has nevertheless acquainted himself with much of the recent statistical work of a geological flavor. Statistical procedures have long flourished in many branches of geophysics, Jeffreys in particular having made judicious use of, and many original