perimental Relativity is a printed version of the author's lectures at the 1963 Les Houches summer school, supplemented by reprints of a dozen articles by the author and his collaborators. Several ideas link the notes and appendices, and reveal the extent of the author's preoccupation with gravitation during the past several years. He (i) follows Mach and postulates gravitational fields accounting for inertial forces in a less passive way than does general relativity; (ii) investigates other covariant theories satisfying (i); (iii) advocates accurate null experiments to reject some of the many candidates admitted by (ii); (iv) believes that among cosmic "experiments" being performed, astronomers may see some which he would like to be attempting in his own laboratory; (v) stresses the importance of additional clues that are lying about the Earth and solar system; (vi) criticizes the three tests of general relativity. Red-shift experiments do not test Einstein's field equations. Many distrust the measurements of light deflection by the Sun. Now the author makes the alarming suggestion that we cannot exclude effects like solar oblateness on Mercury's perihelion motion. He has impressive experiments in train to test some of his suggestions, most notably a refined Eötvös experiment.

The very form of this group of writings precludes much organization. Neither is the layout very clear nor the typography free from error. Nevertheless, this is a most welcome provisional collection of provocative ideas.

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Geological Society of America Charts

Physiographic Diagram of the Indian Ocean: The Red Sea, the South China Sea, the Sulu Sea, and the Celebes Sea. Bruce C. Heezen and Marie Tharp. Geological Society of America, New York, 1964. $2.

This large (4 by 5 feet) and excellent physiographic diagram of the entire Indian Ocean is the third in a series of charts prepared by Heezen and Tharp. (The two previously published diagrams deal with the North Atlantic and South Atlantic areas.) The diagram is accompanied by a brief descriptive text and figures that show (i) sounding lines of bathymetric data used in compilation of physiography; (ii) physiographic provinces, including continental margins, ocean-basin floors, plateaus and aseismic ridges, midoceanic ridges, and fracture zones; and (iii) a generalized bathymetric sketch based on 500 meter isobaths.

Of necessity considerable subjective interpretation is incorporated in such a hachured diagram, compared to a contoured bathymetric chart, but happily this is the work of professional marine geologists. Most of the sounding data were collected in connection with the International Indian Ocean Expedition, so the chart has been made possible by broad international cooperation, including the soundings of the U.S.S.R.'s ships *Vitiaz* and *Ob.* Agencies from participating countries have been given due credit for contributed sounding data. The authors promise the eventual preparation of a full scientific text in the form of a monograph to accompany the physiographic diagram.

The diagram opens to view, for the first time, the general geomorphology of a region almost as extensive as the combined area of the North and South Atlantic Oceans. The midocean ridge, so prominent in the Atlantic Ocean, continues through the Indian Ocean where it takes the form of an inverted Y, but it is no longer a geometrically median ridge. Numerous fracture zones are delineated, often generating transcurrent offsets of the topography.

Large, isolated blocks of presumed sialic rock are delineated and have been termed "microcontinents" by Heezen and Tharp. Remarkably straight north-south lineaments are perhaps the most striking feature of the diagram and should precipitate great speculation or, hopefully, working hypotheses for the interpretation of the geologic history of this little-known area. Advocates of continental drift will find comfort in the strong geomorphic suggestion that the Indian subcontinent moved northward as much as 50 degrees, as had been suggested previously by paleomagnetic data.

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The Tropical Atmosphere

Cloud Structure and Distributions over the Tropical Pacific Ocean. Joanne S. Malkus and Herbert Riehl. University of California Press, Berkeley, 1964. x + 229 pp. Illus. $7.50.

The tropical atmosphere is a region of great importance to the understanding of our weather. Half the atmosphere is situated between 30°N and 30°S latitude, and within this region large transformations of energy (for example, absorption of radiation, evaporation, and vertical convection) occur which are certain to influence the large-scale behavior of the whole atmosphere in important ways. The tropical atmosphere also exhibits fascinating and unique phenomena of more specific scientific interest—the hurricane, the equatorial convergence zone, and the 26-month cycle of equatorial stratospheric winds. Yet the tropical atmosphere remains a *terra incognita* from which travelers return with tales that are fragmentary and sometimes conflicting.

We owe our limited knowledge of the tropical atmosphere, to a considerable degree, to the analyses and interpretations of tropical observations which Joanne S. Malkus (Simpson) and Herbert Riehl have made during the past two decades. Malkus has specialized in tropical cloud phenomena of mesoscale (~ 10 km) while Riehl has specialized in synoptic-scale (~ 1000 km) phenomena; they are therefore uniquely equipped by experience and interest to collaborate in a descriptive investigation of the relations between meso- and synoptic-scale phenomena. *Cloud Structure and Distributions over the Tropical Pacific Ocean* describes the results of three aircraft flights over the tropical Pacific, made in July and August 1957, on which cloud photographs were taken at 1-second intervals at heights of 7000 to 9000 feet. The flights covered a total period of about 80 hours. These data are supplemented by surface observations from ships and meteorological stations and by a very few upper-air observations. The bulk of the book is devoted to a systematic analysis of each flight: included are synoptic charts of streamlines, wind shear, pressure, and precipitable moisture, soundings of temperature and wind velocity in the upper air, a few pictures, and flight cross sections showing prevailing cloud distributions.

The data reveal distinct organizational patterns of cumulus clouds: in one pattern rows of cumuli are aligned parallel to the low-level wind direction; in the other, the rows are aligned at a considerable angle to the low-level wind. The distributions of these organizational patterns are shown on descriptive charts. A "Whole Sky Code" consisting of 27 categories is proposed by the authors for use in subsequent analysis of tropical cloud data.

The chief deductive results of the study are the conclusions that (i) cloud distribution and structure appear to be controlled by the large-scale planetary flow and (ii) abrupt transitions between organizational patterns of clouds are observed which are evidently related in a sensitive way to the velocity, temperature, and moisture fields. Both of these are consistent with other inferences concerning the tropical atmosphere, and the first confirms the concept underlying the global observation program now being studied by national and international scientific groups.

With great effort and ingenuity Malkus and Riehl have lifted a corner of the veil that obscures the tropical atmosphere, affording a very brief and severely limited glimpse. In almost all respects (except heights of cloud tops and bases) the TIROS satellites now provide much better data in numbers that begin to match the demands of the problem. So I am left with the impression that I have been reading the daily journal written by an early explorer of the unknown new world, full of detail about the geography encountered but in sum providing far less reliable information than one needs to know and far less than is provided on a single page of a modern atlas.

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Textbook on Dynamics: Engineering Aspects

Principles of Dynamics. Donald T. Greenwood. Prentice-Hall, Englewood Cliffs, N.J., 1965. x + 518 pp. Illus. $14.

The author has written an admirable intermediate level textbook on dynamics. Although emphasis is placed on engineering aspects, the book could be used in a physics sequence. The topics covered include dynamics and kinematics of a particle and of a system of particles, orbital motion, Lagrange's equations, rigid body kinematics and dynamics, and linear vibration theory. In the lucid exposition Greenwood maintains a good balance between too little explanation and overmotivation to the point of obscurity. Vector and matrix methods are used throughout, in line with a long overdue innovation in American textbooks on engineering mechanics. Artificial satellites and space exploration have given classical dynamics a rich harvest of new and interesting problems. Not surprisingly, the author has used many of these as illustrative examples and as exercises. We find mention of such things as the "yo-yo" despin mechanism (fortunately without the nickname) and gravity-gradient torque (which provides a natural example of the difference between center of mass and center of gravity).

I found the fundamental chapter on dynamics of a system of particles especially noteworthy. For once the reader is warned that $F = \mathrm{d}(mv)/\mathrm{d}t$ is generally incorrect when m varies! Equations of motion are derived and used for an arbitrary, moving reference point, as well as for the usual fixed or center-of-mass reference point.

Of course, I also found some things not to my taste. The term *tensor* is used superficially and without proper definition; it could have been omitted altogether. The angular velocity of a rigid body is introduced as an almost intuitively obvious concept on page 32 and used freely; on page 330 it is defined. A discussion of Euler or Cayley-Klein parameters would have been welcome because of their newly found importance in computer solutions of rigid body problems.

Finally, the following errata were noted: Problem 5-9 has only the trivial answer $I = 0$, not the answer given in the text. The first of equations (8-308) is incorrect. On page 452 nonnegativeness of the *successive* principal minors (9-33), does not guarantee that V is positive semidefinite; *all* principal minors must be nonnegative.

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Geologic Self-Analysis

The Fabric of Geology. Claude C. Albritton, Jr., Ed. Freeman, Cooper, Stanford, Calif., 1964. x + 374 pp. Illus. $8.

On the first page of the preface we are told that "the very lack of any modern book on the philosophy of geology is justification enough for this work," a statement that not only gives us the principal subject but implies that the philosophy of geology is a neglected branch of the science.

Really, *The Fabric of Geology* is not philosophy as many of us understand that term. Seventeen well-known authors examine questions like these: Can geology be called a science in its own right, or is it only bits and pieces of other sciences, applied to the earth? Does it have "laws and theories of its own"? Is it, uniquely, a historical science? A few of the 17 chapters discuss these matters in considerable detail. Other chapters are peripheral to the central theme; still others confine themselves pretty much to geologic methods, with only tangential reference to philosophic principles.

Paradoxically, the book is wide-ranging and at the same time limited in scope. It is wide-ranging because, in searching for fundamental principles, such diverse fields as paleontology, mineral deposits, geomorphology, and the "historiography" of historical geology are explored. It is rather severely limited by its unremitting search for general geologic laws and theories, which appear to be difficult to find or to formulate.

Who will be interested in geology treated in such limited fashion? Historians and philosophers of science may be expected to take note of a new self-examination in geology, and will look eagerly for general principles and laws by which the science operates. A certain, perhaps small, number of geologists will regard the book as a milestone in geologic thought. The majority will probably put it on the shelf and forget it, or will take it in small doses, at the geologic bedside. A few chapters should make excellent reading for seniors or graduate students; I particularly recommend two chapters—"Rational and empirical methods of investigation in geology" and "Historical science."

Prospective readers should look through the volume, especially at the