thrown out by Skaptar Jökull would equal in quantity that which could be heaped up to a thickness of some seven or eight feet over almost the entire area which in California lies between the line of displacement in the recent earthquake and the Pacific Ocean; while the discharge from Temboro, if properly estimated, would have filled in a mile-wide canal to a depth of ten feet over a length of 15,000 miles. One may well stand appalled by these figures, but they have as yet produced little impression upon the geologist to whom the major lesson of vulcanology is taught by Vesuvius or Etna.

The general conclusions arrived at in this paper are:

1. A broad interrelationship exists between volcanic and seismic phenomena generally;

2. Interrelated manifestations of volcanic and seismic activity may extend over distances, as measured on the surface of the globe, of hundreds or even thousands of miles;

3. 'Tectonic' earthquakes, so-called, are only doubtfully to be distinguished from earthquakes of volcanic association, or those that have been brought about as the result of deep-seated strain;

4. The slipping, upheaval and torsion of terranes as accompaniments of earthquake action are the resultants of impacts or jars already delivered to the earth's crust, and are not the cause of such jars;

5. Earthquake and volcanic disturbances seem to be the expression of one common interior telluric strain or condition, and this condition may in some or many cases be clearly associated with a pronounced magnetic or electro-magnetic quality of the planet;

6. There would appear to be a marked synchronism or close following of major disturbances, whether volcanic or seismic, at distantly removed points of the earth's surface at certain periods.

ANGELO HEILPRIN.

SCIENTIFIC BOOKS.

The Adjustment of Observations by the Method of Least Squares with Applications to Geodetic Work. By THOMAS WALLACE WRIGHT, M.A., C.E., professor emeritus, Union College, formerly assistant engineer, Survey of the Northern and Northwestern Lakes. With the cooperation of JOHN FILLMORE HAYFORD, C.E., Chief of the Computing Division and Inspector of Geodetic Work, U. S. Coast and Geodetic Survey. Second edition. Pp. ix + 298. New York, D. Van Nostrand Company. 1906.

The average man of science generally exhibits a remarkable lack of ordinary common sense when dealing with the method of least squares and its conclusions. Inferences are drawn from a series of observations, and deductions made from the size of the probable error which at times seem so totally at variance with the truth that much fault has been found with the method. In theory, the probable error is based on the assumption that the errors are all accidental, that is, are just as likely to be positive as negative, and that there are a large number of observations, whereas in practise, the formula for finding the probable error is often applied to a very few observations not freed from their systematic or constant errors. A consequence of this is that a degree of precision is shown which is much greater than the observations themselves really warrant, and the probable error, therefore, does not seem an accurate measure of the error committed.

There are other scientists who believe that a least square reduction is a great correction of evils, and that by its means very satisfactory results may be derived from an indifferent set of observations. While poor observing will give nothing but poor conclusions, it seems to be quite a favorite trick of the computer, nevertheless, to introduce new unknowns into the observation equations with the hope of more correctly solving them. When

the sum of the squares of the residuals is diminished by this process, it is taken as a proof by the average computer that the introduction of the new unknown represents a closer approximation to the truth. As a matter of fact it is easily shown that the new unknown will *always* reduce the sum of the squares of the residuals, and consequently these diminished numbers are no proof of greater accuracy.

It is with the spirit of caution born of long practise that Wright and Hayford approach the subject. In the preface of the present volume, which is a second edition of Wright's 'Treatise on the Adjustment of Observations,' Mr. Wright tells us that so much of the new work is from Mr. Hayford's hands that it is no more than right that his name appear on the title page. The first edition is a very excellent book and has for years been recognized as the practical standard. The second edition is, if possible, better than the first, for it adds the great experience that Mr. Hayford has had in the work of the United States Coast and Geodetic Survey as chief of the Computing Division.

This experience is shown in chapter IX., wherein the principles of least squares are applied to a very important but little employed use, namely, that of the selection of methods of observations, for it may be possible for the observer either to increase the accuracy of his work by different instrumental methods or, on the other hand, to attain a given standard of excellency by a smaller amount of observing. The suggestions for applications to latitude and longitude determinations, the student of geodesy will find very helpful indeed.

The great advance in geodetic work during the past quarter of a century will be seen by referring to p. 349 of the first edition (published in 1884), wherein it says that,

> During the present century two forms of apparatus have been used in the measurement of primary bases, the compensation bars, and the metallic-thermometer apparatus. * * * Indications are not wanting that both forms will be supplanted before long by an apparatus consisting of simply a single metallic bar.

Since this was written the iced-bar and steel tape have made great changes in geodetic work.

The method of least squares which derived its birth from Legendre's attempt to find the figure of the earth thus receives a notable addition by its application to present geodetic problems.

S. A. Mitchell.

Technik des physikalischen Unterrichts. Von Freidrich C. G. Miller. Berlin, Otto Salle. 1906.

This volume of 364 pages is, as its title suggests, designed for the assistance of the instructor who must give a series of experimental demonstrations before a class beginning the study of physics. As is indicated by the preface, and also by the subject matter of the book, the class of students for whom the lectures have been especially designed would correspond in this country to college students in their first or second years.

The work is divided into thirteen parts: General Arrangements for Physical or Chemical Instruction, Measurements and Weighing, Statics, Dynamics, Statics and Dynamics of Liquids, Statics and Dynamics of Gases, Acoustics, Heat, Optics, Magnetism, Electrostatics, Electrodynamics, Introduction to Chemistry. Under each of these heads various important experiments are described in detail, and nothing could be clearer than the directions and suggestions. The author emphasizes at every point the necessity of the demonstrations being made in a quantitative manner, and he indicates the most suitable means by which measurements of all kinds can be made in such a manner as both to be accurate and to be visible to a comparatively large audience.

The book is by far the best of its kind that has come to the attention of the reviewer. It is not exhaustive, it is true, nor is it exhausting in its details. It should prove of value to every lecturer in physics and chemistry who has to deal with elementary classes.

J. S. Ames.