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SEISMOLOGY FROM A MATHEMATICAL VIEW-POINT¹

By Professor W. D. CAIRNS

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THE high honor attaching to the office of vice-president of the American Association for the Advancement of Science demands a worthy effort on an occasion like the present. Very properly a general consideration of some field within the scope of mathematics may come under review, and all the more will this be appropriate for a section of the American Association if it links itself to some other department of science. I am therefore returning to an old-time love of mine and considering to-day the advance that has been made in seismology within, let us say, the last thirty years.

At first sight the phenomena to be studied seem hopelessly confused; the ground effects near the origin of

the earthquake show buffeting blows from all directions; earthquake records, even those of the same earthquake, often look widely different; and the layman wonders what can be made of these happenings as a science. It is, however, the glory of the human mind that it can select, classify, analyze, and can thus bring order out of chaos.

The universe is a system, a unit,
Only in the mind of man.

[The speaker described (1) the evident mechanism of earthquakes consisting of a gradually increasing strain and subsequent fracture of the rock structure; (2) the transmission of the shock, the longitudinal and transverse wave through the earth and a wave of greater amplitude over the surface; (3) various reflected and refracted waves; and (4) methods for obtaining information about velocities below the surface,

¹ Address of the retiring vice-president and chairman of the Section on Mathematics, American Association for the Advancement of Science, Richmond, December 28, 1938. The address was illustrated by a large number of slides.

tally, since the lamp glows each time an impulse is conducted, chatter of the key and other defects in the electrical system are easily detected. It may be, also, that making the electrical impulse "visible" will prove to have advantages for teaching purposes.

J. EARL THOMAS

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USE OF THE LUNDEGÅRDH SPECTRO-GRAPHIC METHOD

A SURVEY of the spectrographic methods used in this country for the quantitative determination of small quantities of mineral substances reveals the fact that the Lundegårdh¹ method is not employed here. In this method the emission spectrum is excited by means of the flame of a special air-acetylene burner, for which the acetylene and the air are supplied at constant pressure. The air is forced through a few milliliters of the solution of the substance under analysis, thus spraying the solution into the flame uniformly. In this way the spectra of 32 elements at different concentrations have been photographed and, from the intensity of a certain line in each, it has been found possible to make fairly rapid, quantitative determinations of great accuracy and dependability. This is especially true when the Lundegårdh system of constructing both a plate correction curve and a concentration curve for each plate is followed.

The problem of the determination of the mineral constituents of citrus fruits and of some vegetables has been in progress in this laboratory for some time. The material has been dried and ashed quantitatively and then the per cent. of calcium, copper, iron, magnesium, manganese and phosphate in the ash has been determined by micro-photometric or micro-volumetric methods. It has been necessary to use large quantities of the materials in order to obtain sufficient ash to carry through the above analyses. For instance, in the case of orange juice, a liter would be required. This process is long, subject to many sources of error, and dependent upon complicated technique, all of which are in great contrast to the Lundegårdh spectrographic method.

Professor Lundegårdh very kindly gave me the opportunity of working in his laboratory at the Agricultural College of Sweden this summer, and I was able to do some preliminary work on the determination of the mineral constituents of orange juice. By concentrating 100 ml of the juice nearly ten times and oxidizing the organic matter by one of several methods, for instance, by nitric acid and perhydrol, it was possible to obtain results for copper, iron and man-

ganese which were of the same order as our photometric methods. (See Table I.)

TABLE I
MILLEMOLES PER LITER JUICE

Oranges	Copper	Iron	Manganese	Method
Blue Goose	0.0061	0.042	0.0039	Lundegårdh
Sunkist	0.0072	0.030	0.0039	"
Valencia	0.0065	0.030	0.0043	"
South Africa	0.0068	0.043	0.0033	"
Average ² for California and Florida oranges	0.0069	0.025	0.0044	Micro-photometric

² Honors paper of Annette Florence, Wellesley College, 1936.

It was also possible to determine such metals as potassium and calcium which are present in much larger quantities without concentrating the juice, but by refluxing with hydrochloric acid, filtering out the solid material—really a form of wet ashing—and then spraying into the flame.

In this laboratory at the present time we are continuing the study of the various ways of preparing these solutions, as well as the spectrographic and photometric procedures. It is especially important to carry out careful blank determinations because of the possible contamination from chemicals and apparatus when such small quantities of some elements are to be determined. We also expect to use this method for the determination of mineral constituents in various biological materials, for which it is particularly well adapted.

MARY A. GRIGGS

WELLESLEY COLLEGE

BOOKS RECEIVED

- BABCOCK, E. B. and G. L. STEBBINS, JR. *The American Species of Crepis*. Pp. 108. 34 figures. Carnegie Institution of Washington.
- CRABTREE, J. I. and G. E. MATTHEWS. *Photographic Chemicals and Solutions*. Pp. 360. 95 figures. American Photographic Publishing Co. \$4.00.
- DARLING, F. FRASER. *Wild Country; Creatures of Mountain, Island, Sea and Moor*. Pp. vii + 104. Illustrated. Cambridge University Press, Macmillan. \$2.75.
- KING, JOHN W. *Give Your Hair a Chance*. Pp. 157. Illustrated. Bradner Publishing Co., Cambridge, Mass.
- MURRAY, HENRY A. *Explorations in Personality*. Pp. xiv + 761. Illustrated. Oxford University Press. \$8.50.
- RAWDON-SMITH, A. F. *Theories of Sensation*. Pp. xiii + 137. 18 figures. Cambridge University Press, Macmillan. \$2.75.
- ROOM, T. G. *The Geometry of Determinantal Loci*. Pp. xxviii + 483. Cambridge University Press, Macmillan. \$10.00.
- SHOENBERG, D. *Superconductivity*. Pp. ix + 112. 22 figures. Cambridge University Press, Macmillan. \$1.75.
- SMITH, ALEXANDER H. *Common Edible and Poisonous Mushrooms of Southeastern Michigan*. Pp. 71. 15 plates. Cranbrook Institute of Science. \$0.50.
- SOLLMANN, TORALD H. and PAUL J. HANZLIK. *Fundamentals of Experimental Pharmacology*. Pp. vi + 307. 37 figures. J. W. Stacey, San Francisco. \$4.25.
- STEFANSSON, VILHJALMUR. *Unsolved Mysteries in the Arctic*. Pp. xi + 381. Macmillan. \$3.50.

¹ H. Lundegårdh, "Die quantitative Spektralanalyse der Elemente II," Jena, 1934; *Lantbrukshögsk:s Annaler*, Vol. 3, s. 49.